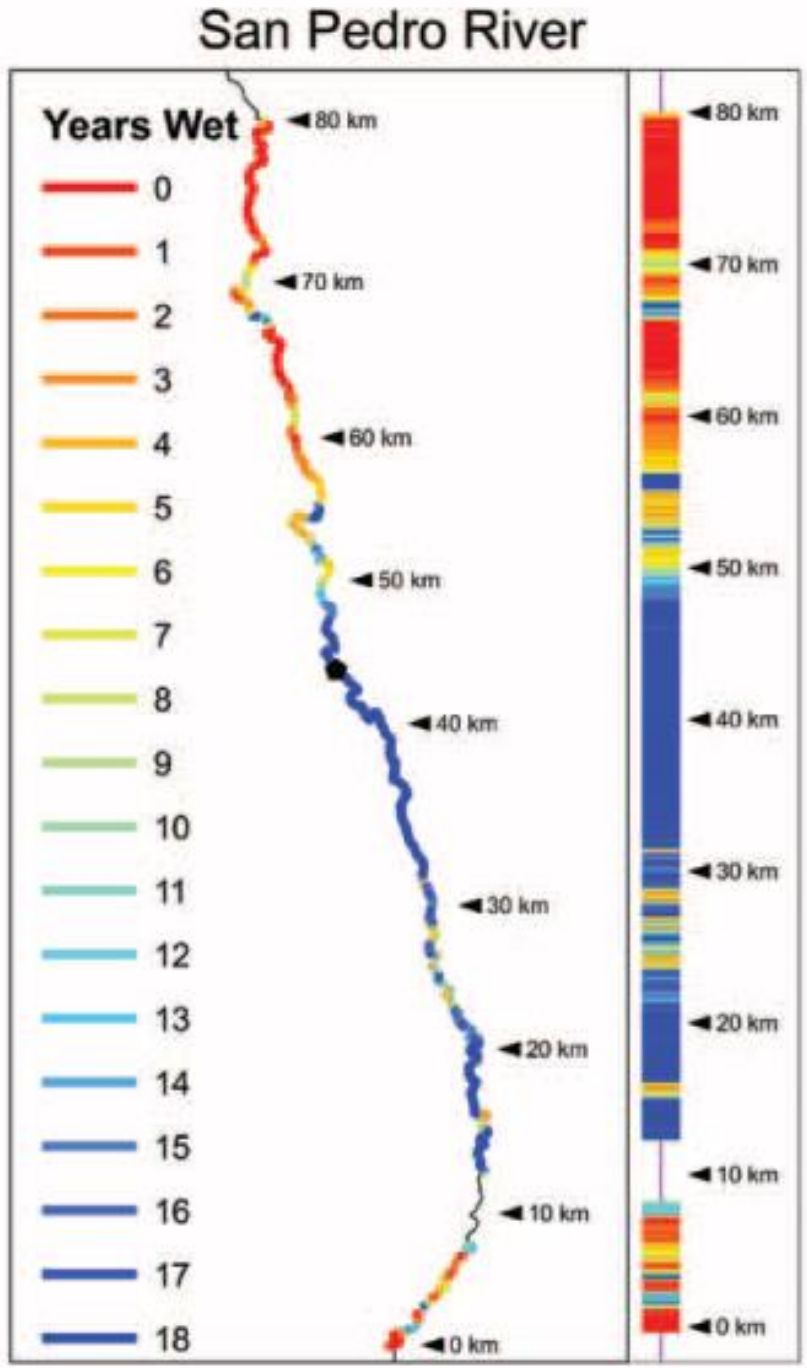
Wet/Dry large-scale climate exploratory analysis and opportunities

Jessie Pearl

4.21.22



Adapted from Allen *et al* 2019 (Freshwater Science)

From our website…

APPLICATIONS OF WET/DRY MAPPING

Wet/dry mapping has been used to:

- quantify long-term trends in surface water patterns
- better understand groundwater/surface water interactions
- identify near-steam properties for conservation projects, such as easements and recharge
- identify study reaches to design and implement ecological research and monitoring
- manage fish and wildlife populations and riparian habitat

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What I hope to get out of today…

Discuss key questions we can answer with these data

Insight into geographic delineations (ecologic, geologic, climatic, topographic) for next analysis

Suggestions of additional datasets to incorporate (ground water etc.)

Prior work

Numerical models suggest Elevation, Bedrock Depth, Streamflow, and Channel Geomorphology (and not climate) can predict streamflow persistence in the San Pedro River, however insufficient data leads to sub-optimal model skill (Soto-López et al. 2012)

Simple linear regressions (with multiple predictors) show significant linkages between precipitation and the total wet length, mediated through effects on low streamflow and drought severity (Allen et al 2019)

The wet length of the San Pedro has relatively low variability for AZ rivers (Allen et al. 2019) , however at finer spatial scales certain reaches are very dynamic, with very high year-to-year wet/dry (Turner and Richter 2011, Lacher et al. 2014)

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Can we parse out climate vs geologic influence and human influence by looking at tributaries?

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What are the spatial patterns of this relationship?

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How can we use this data/knowledge to isolate conservation actions & impacts of gw pumping at a local scale?

Allen et al. (2019) showed negative effects of precipitation from the previous monsoon season coupled with a positive effect of precipitation from the previous 12 mo.

I found this result as well – these opposing effects could indicate that magnitude of recent precipitation is a more important determinant to base flow

Limitations and Considerations

23 data points (even fewer when overlapping climate data)

larger scale vs regional scale climate

Spring (MAM), Summer(JJA), Winter (D*JF)

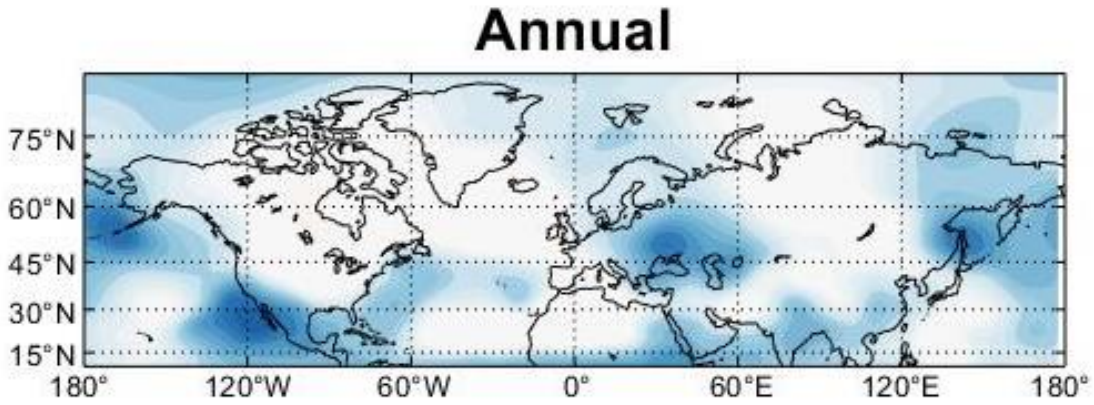
Field correlation

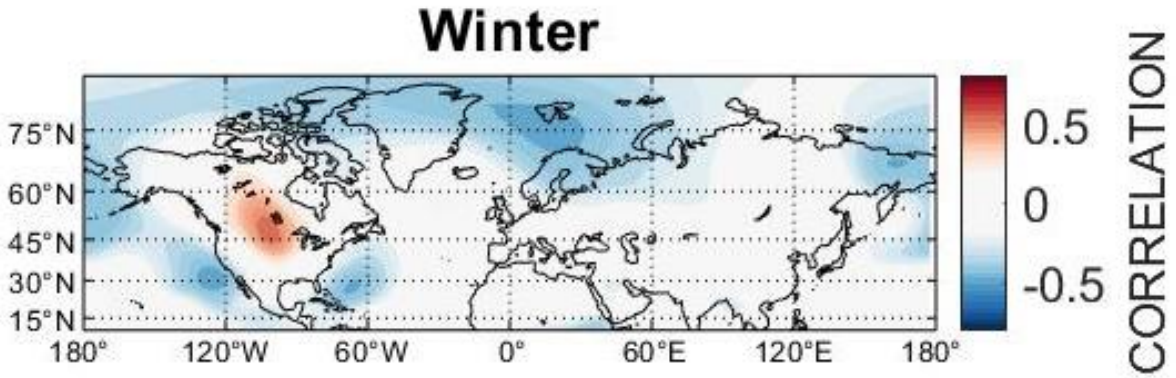
- more likely to have spurious correlations and spatially autocorrelated fields
- used ERA5 (ECMWF reanalysis for the past 4 to 7 decades)
- Pearson's "R" correlations

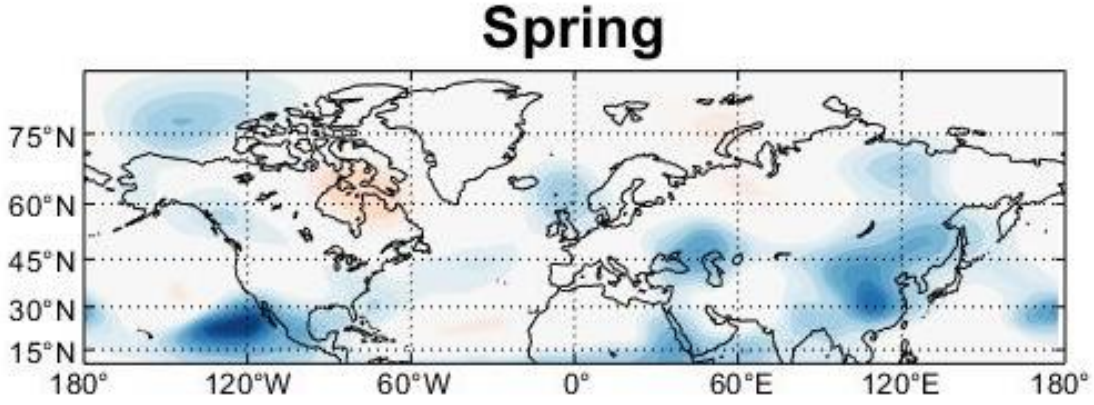
Composite Reanalysis/Satellite Data

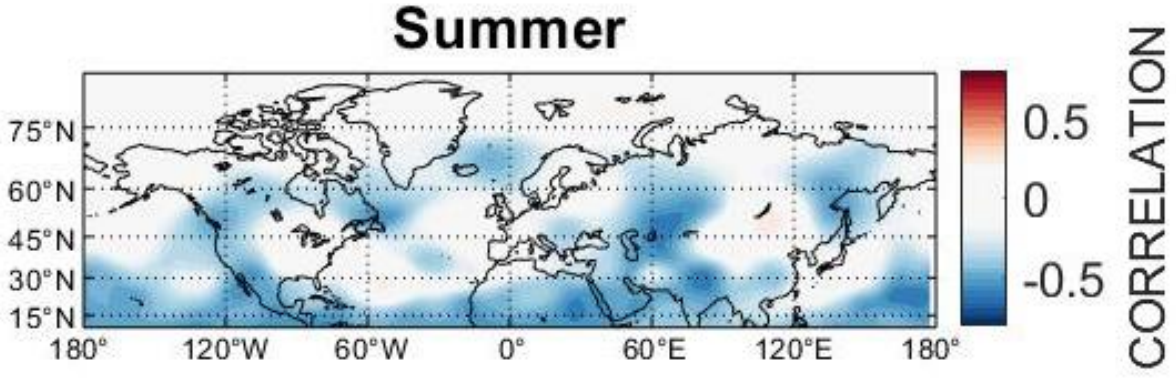
- low n makes can make for messy composites
- allows us to see how much influence the recent trends (the past 20 years is very trendy) has on field correlations

500mb Geopotential Height Correlation

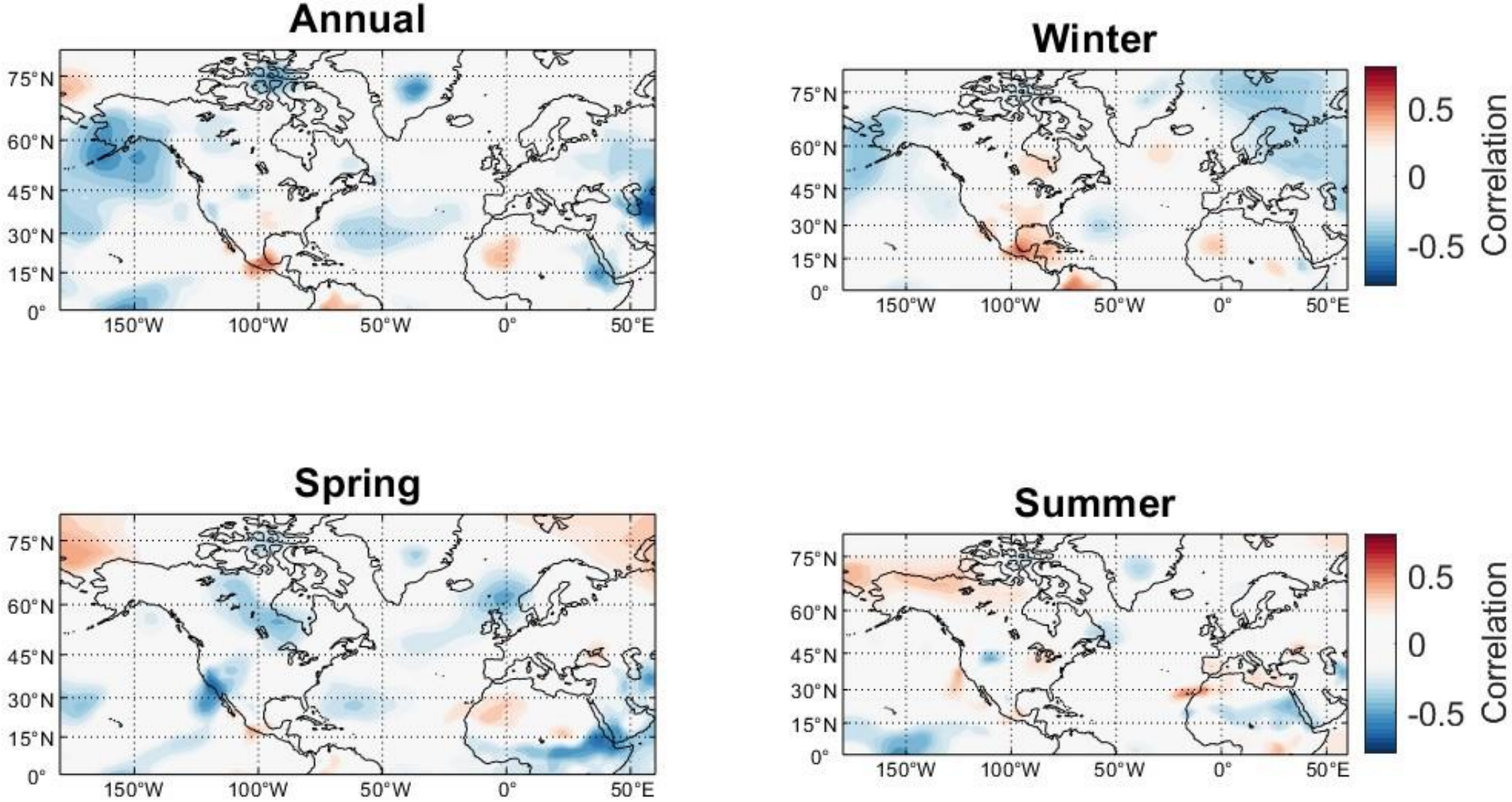




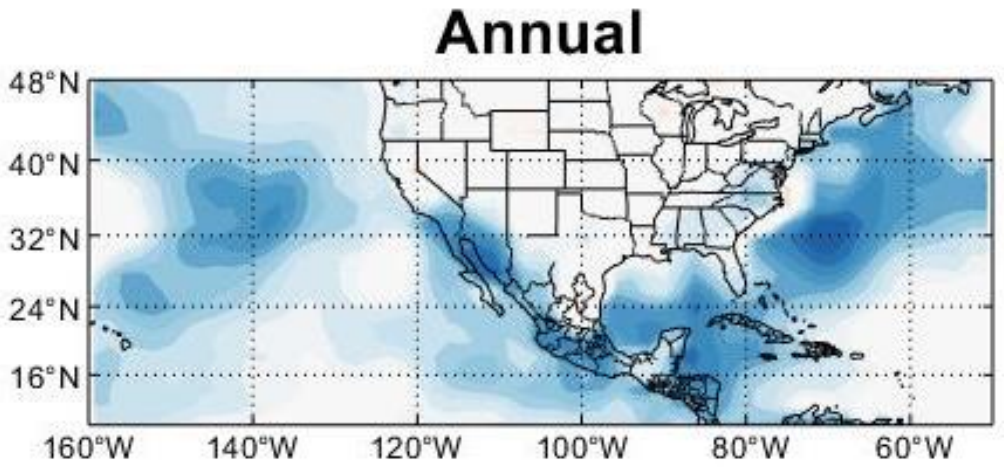


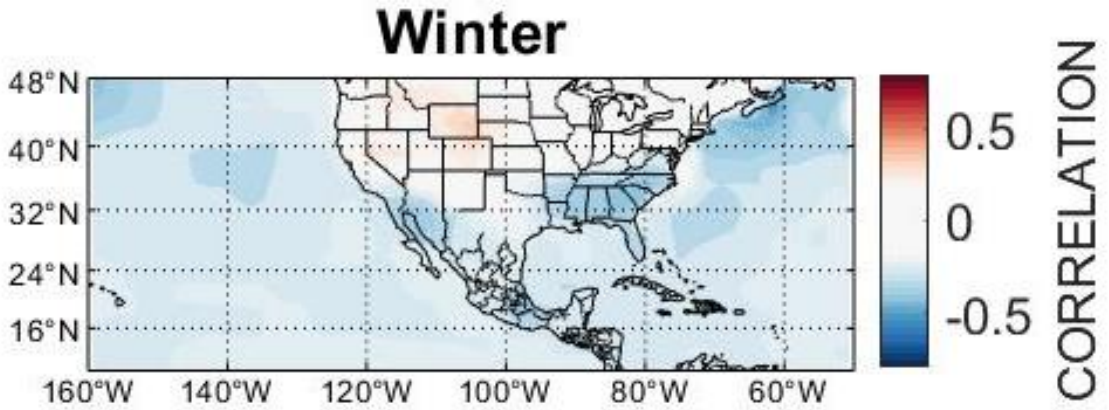


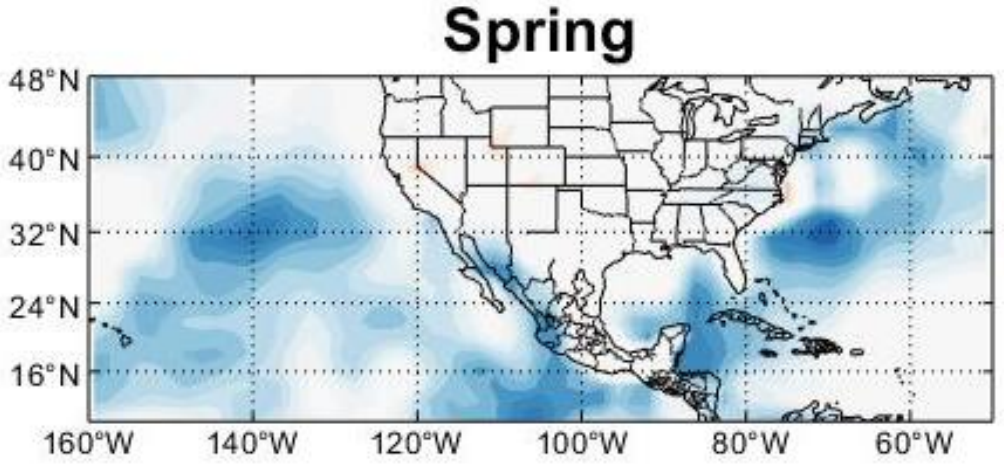
Mean Sea Level Pressure Correlation

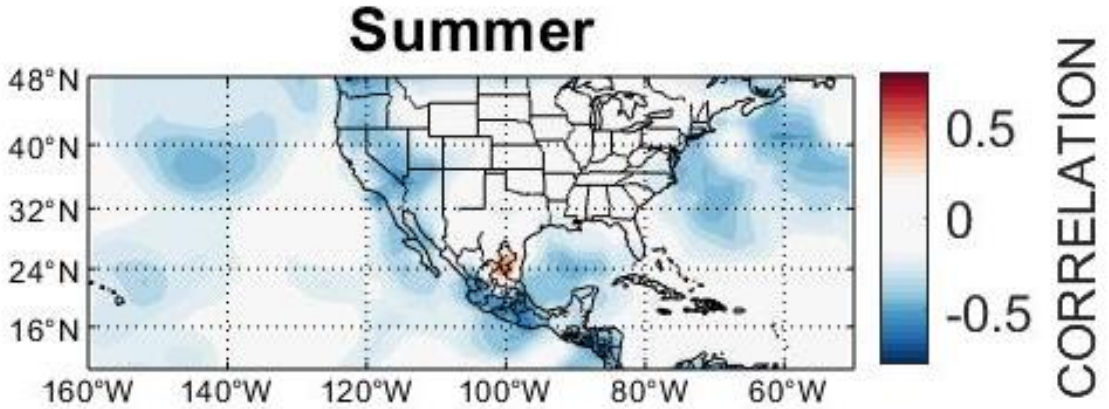


Temperature Correlation

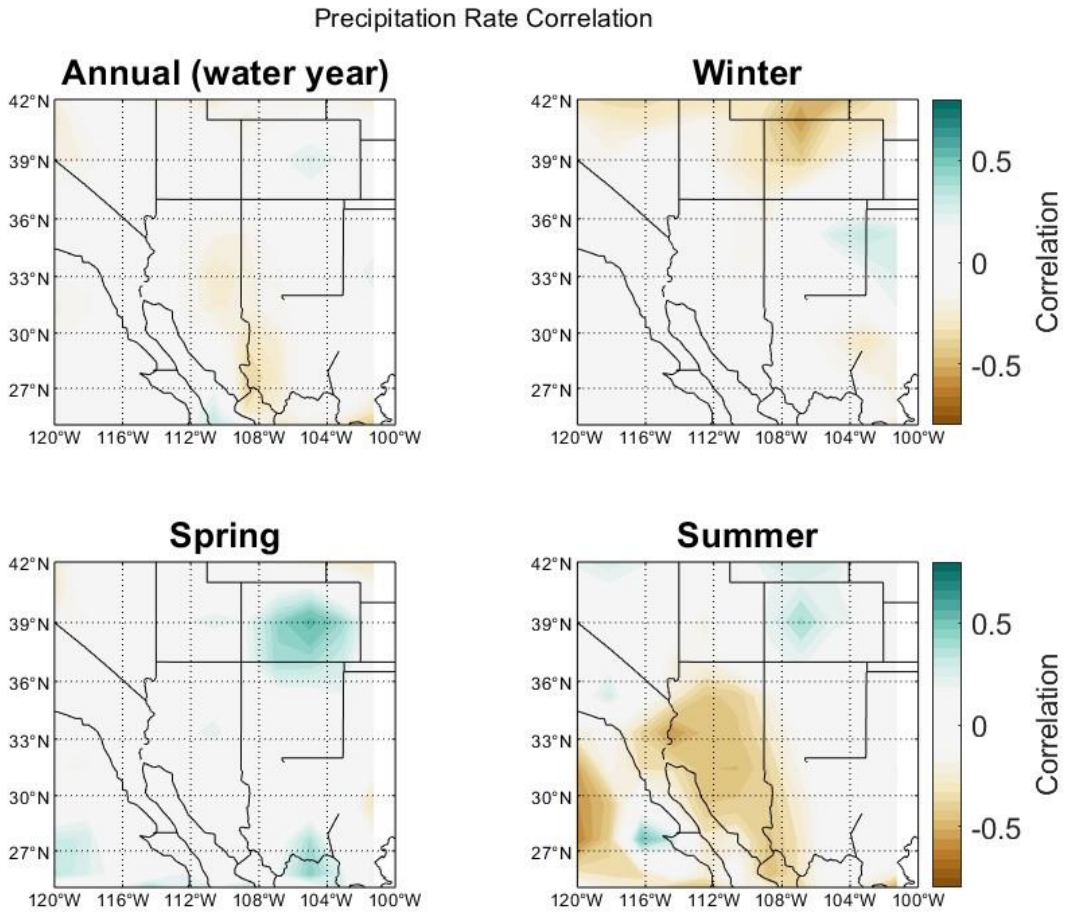


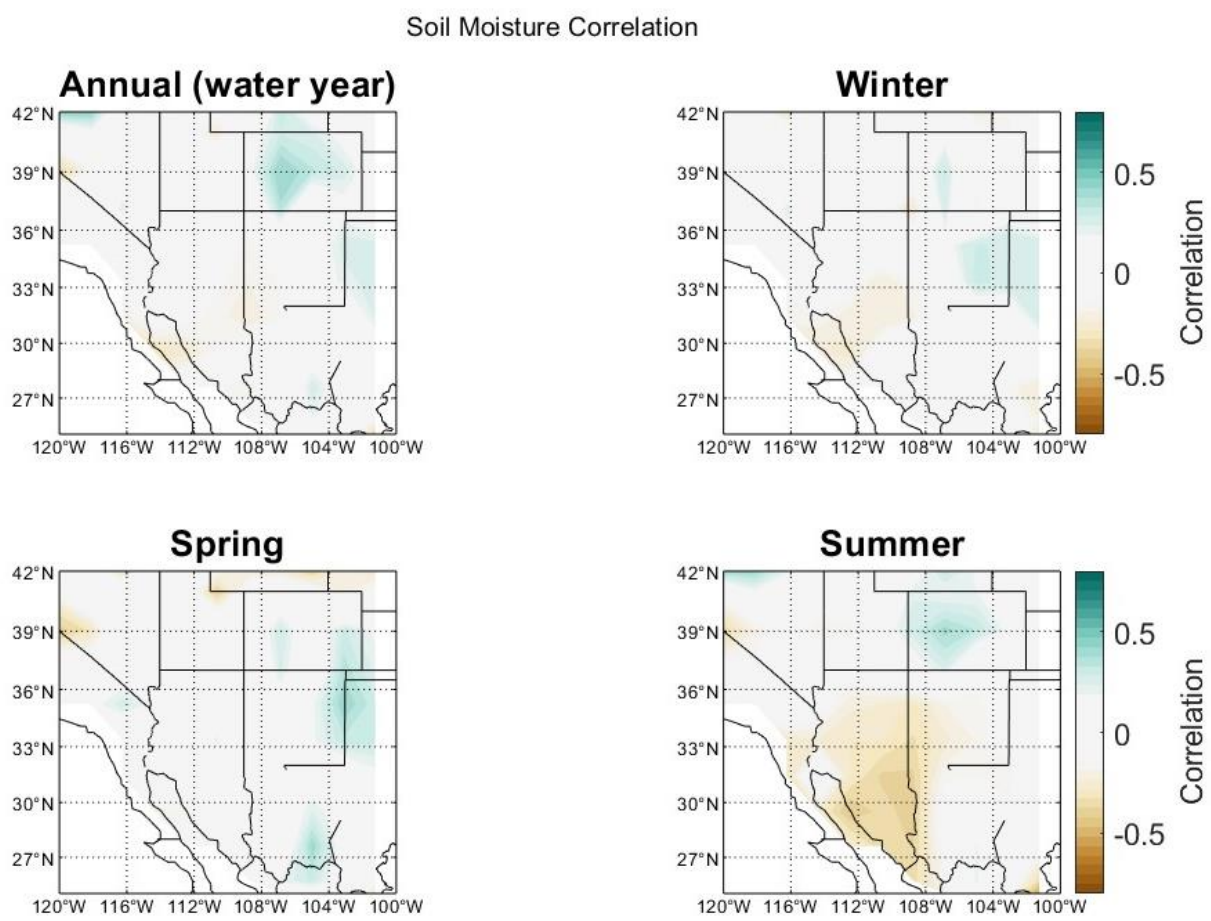






Precipitation and Soil Moisture Correlation





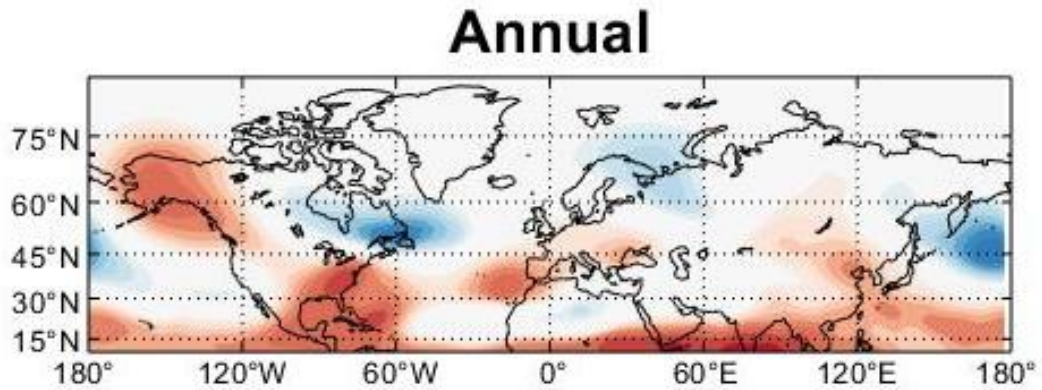
San Pedro Tributaries

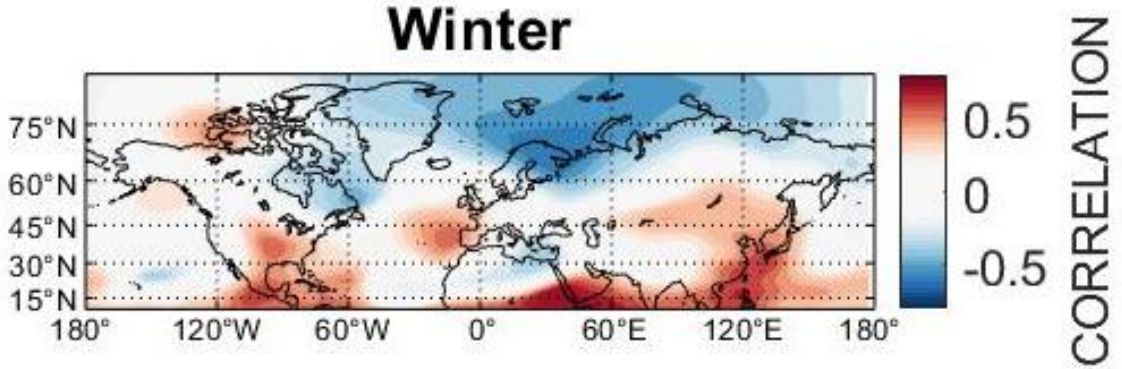
Less impacts from pumping and certain conservation actions

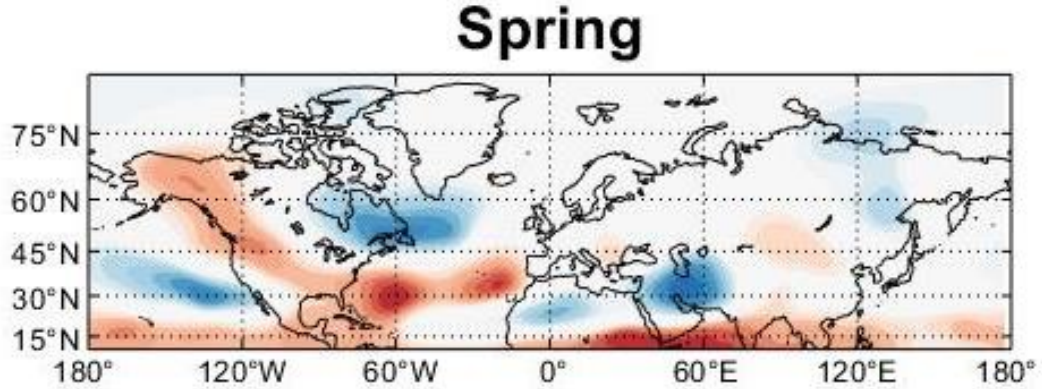
Potential to pull out which tributaries are highly sensitive to climate, and those less reliant on year of, or prior year precipitation

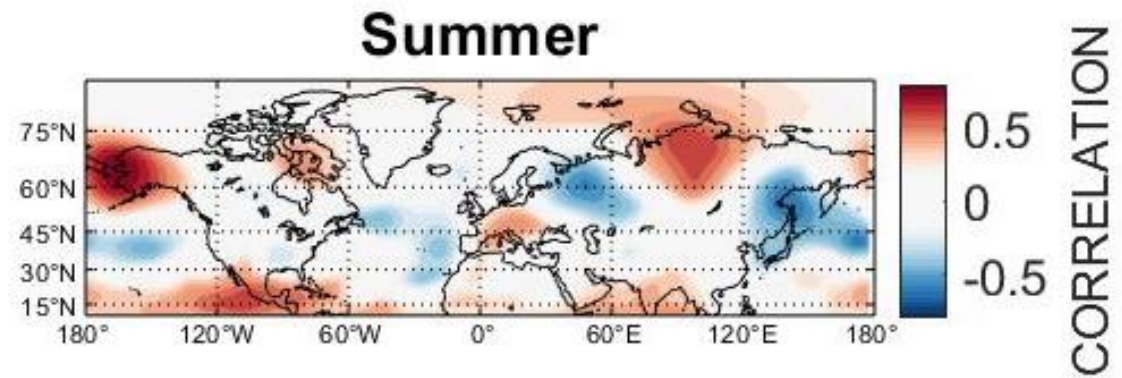
Likely the best locations for smaller case studies, further data explorations (e.g. Aravaipa)

500mb geopotential height Correlation









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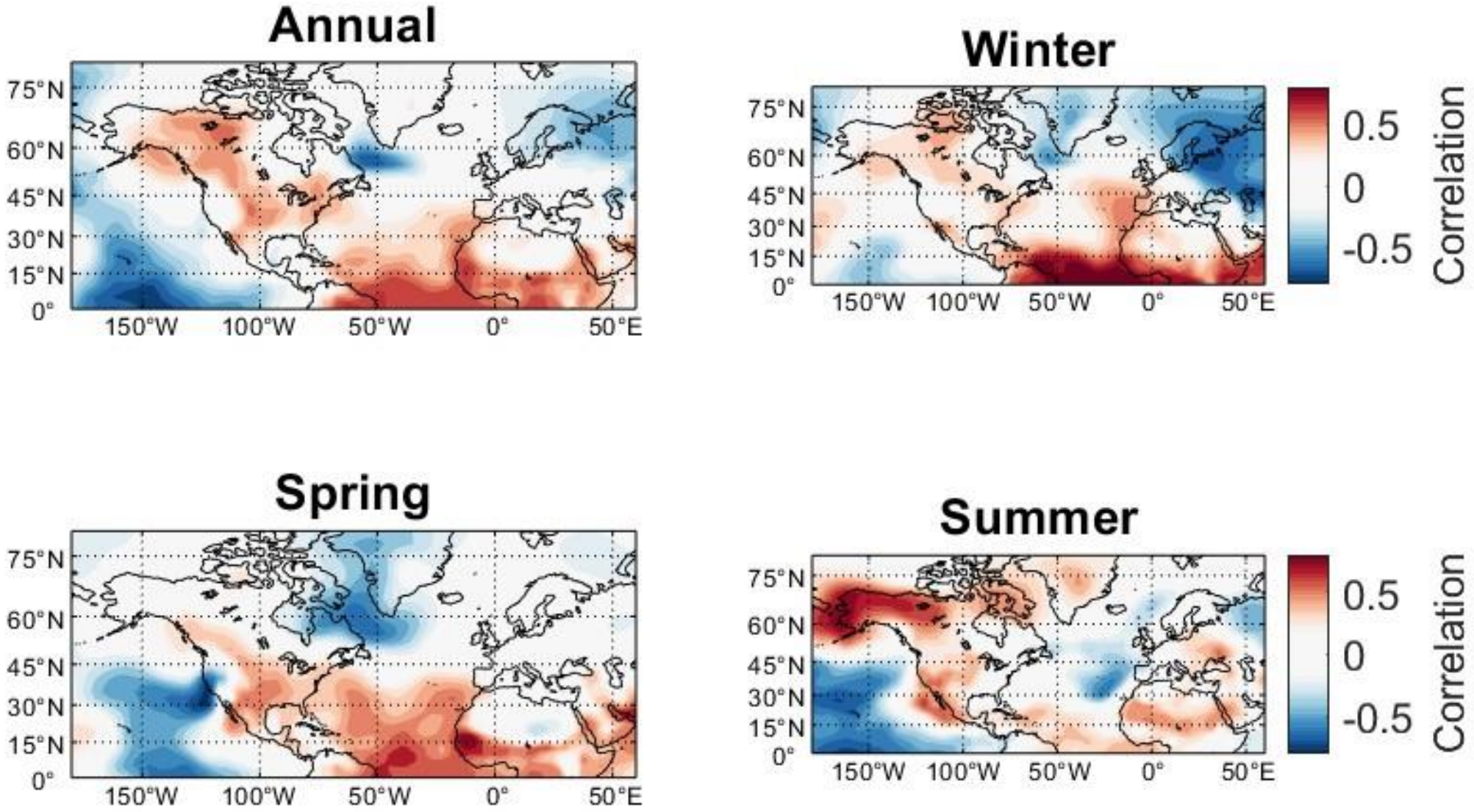
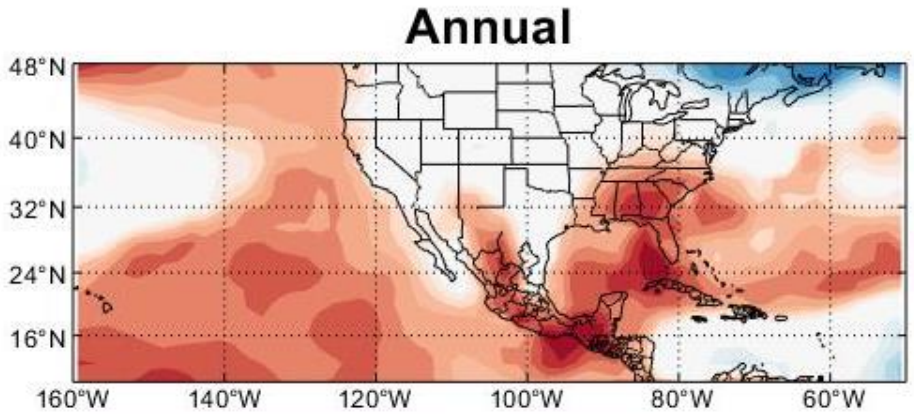
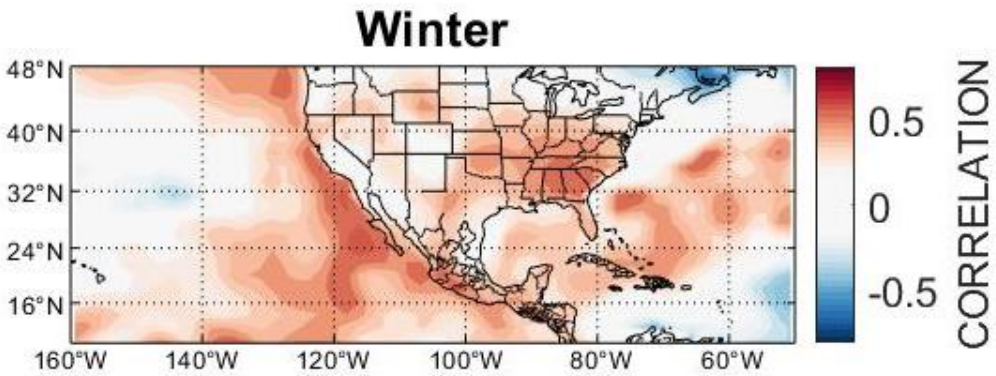
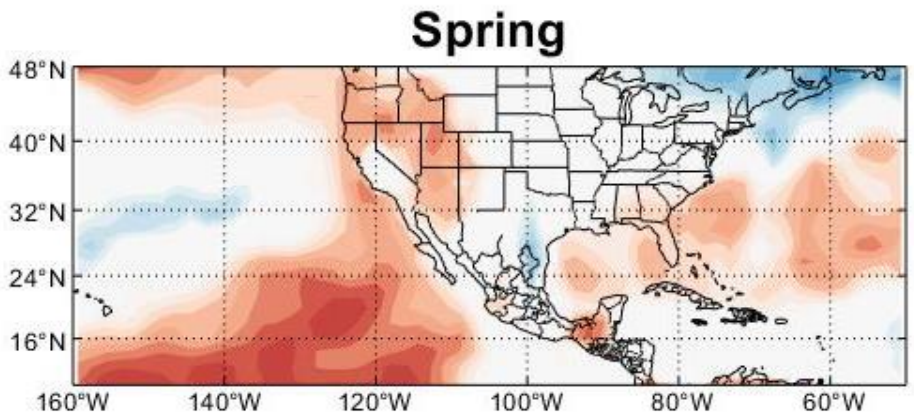
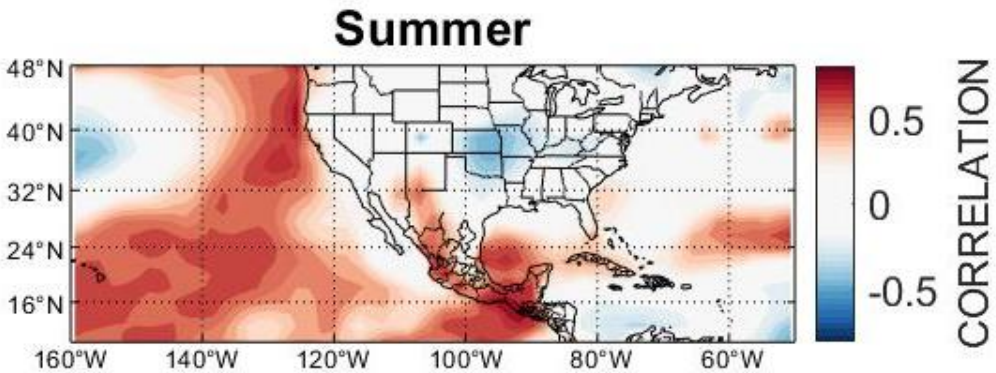


Temperature Correlation

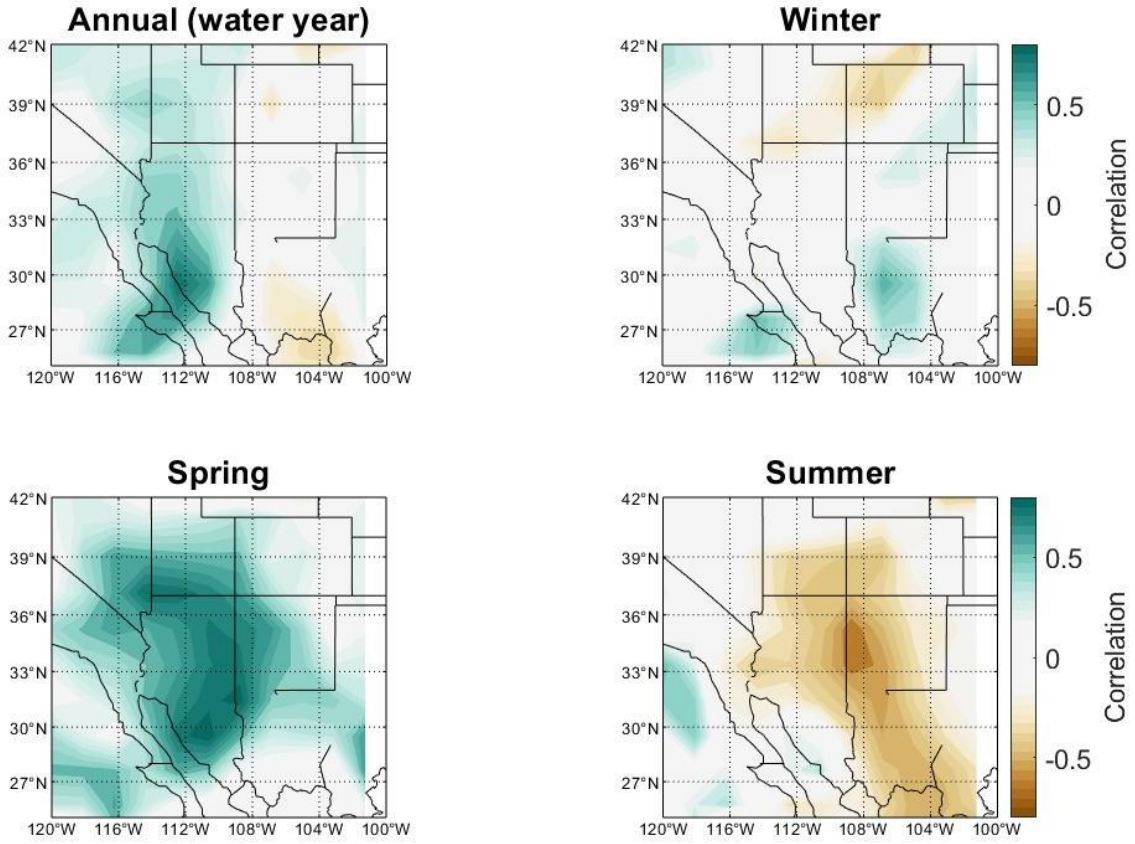




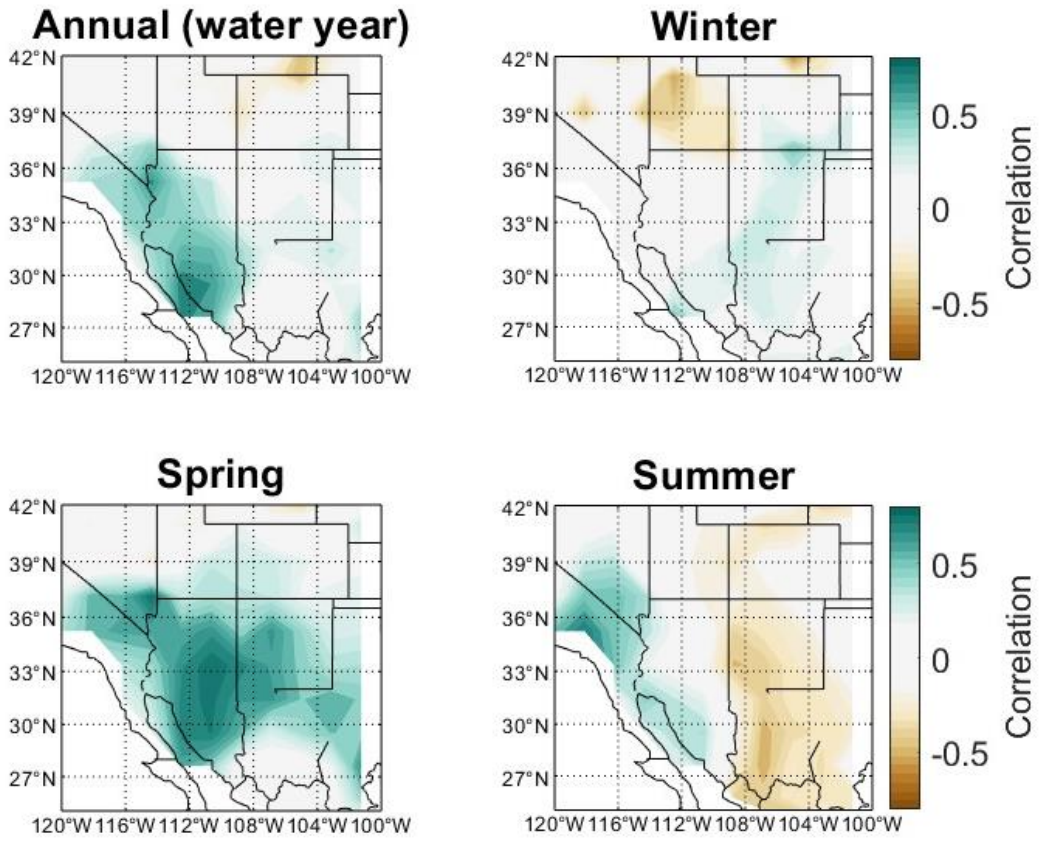




Precip. Rate Correlation



Soil Moisture Correlation

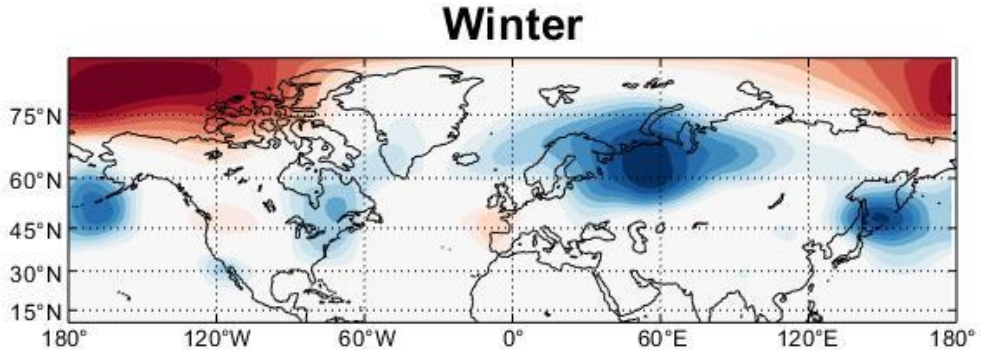


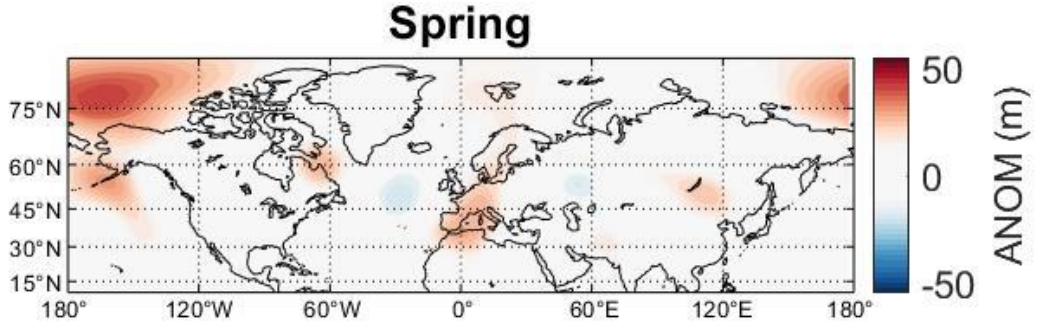
75^{th} and 25^{th} percentile
(total wetted length)

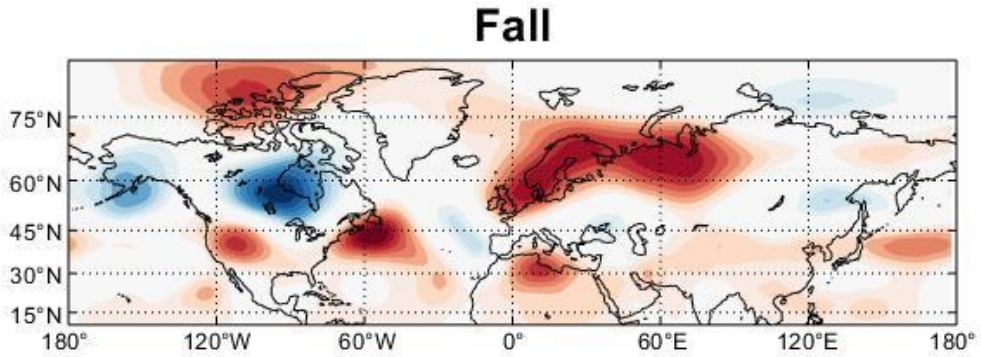
1. 2001 (wettest)
2. 2002
3. 1999
4. 2005
5. 2003

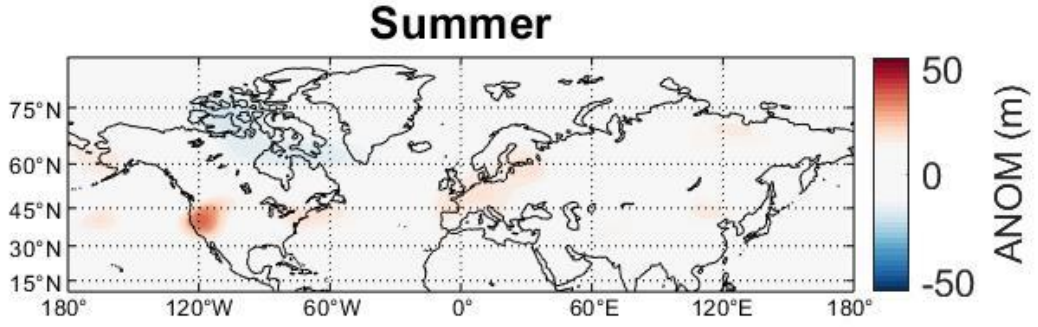
1. 2021 (driest)
2. 2018
3. 2014
4. 2017
5. 2012

500mb Geopotential Height Anomalies – Wet Years



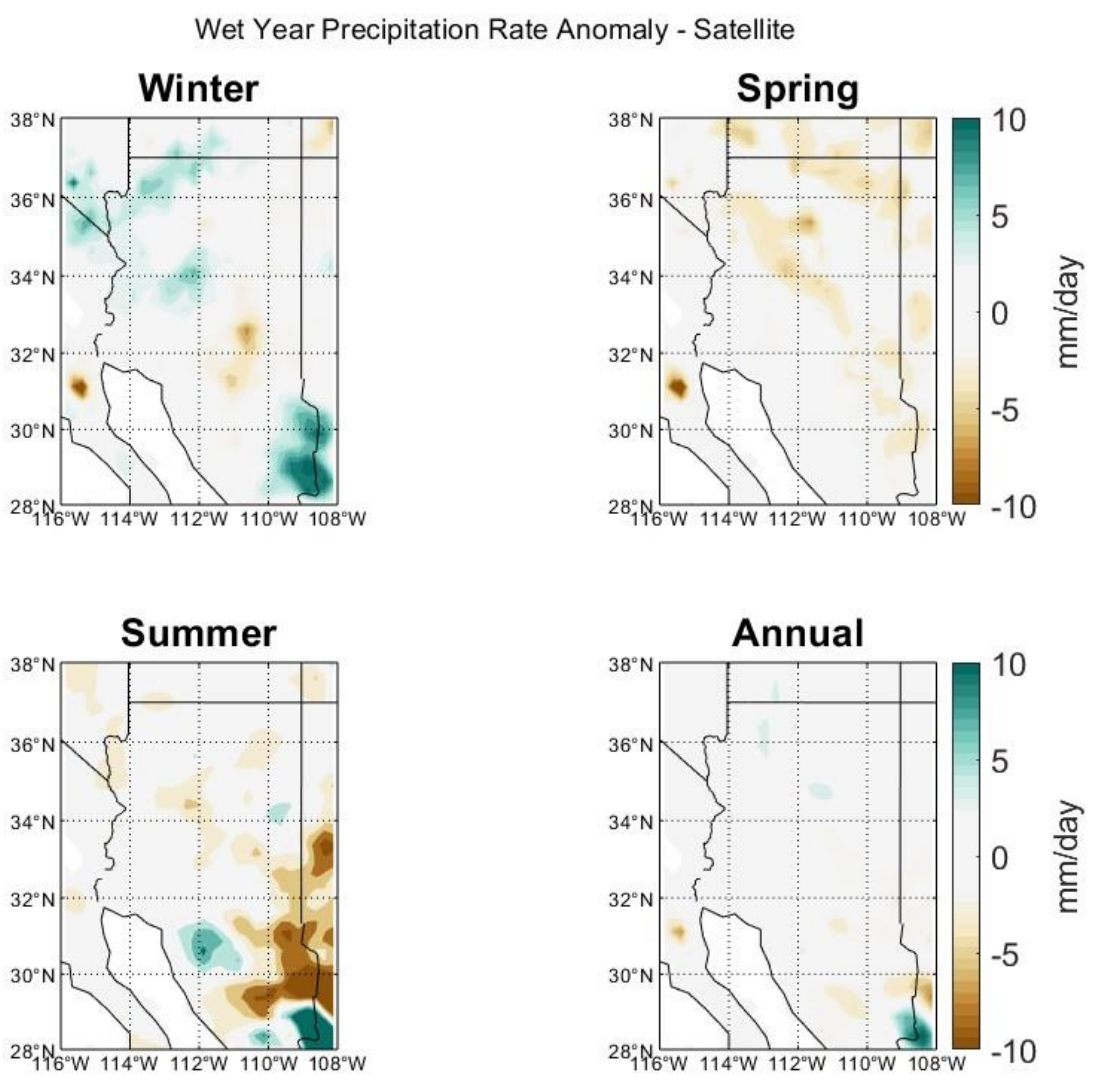


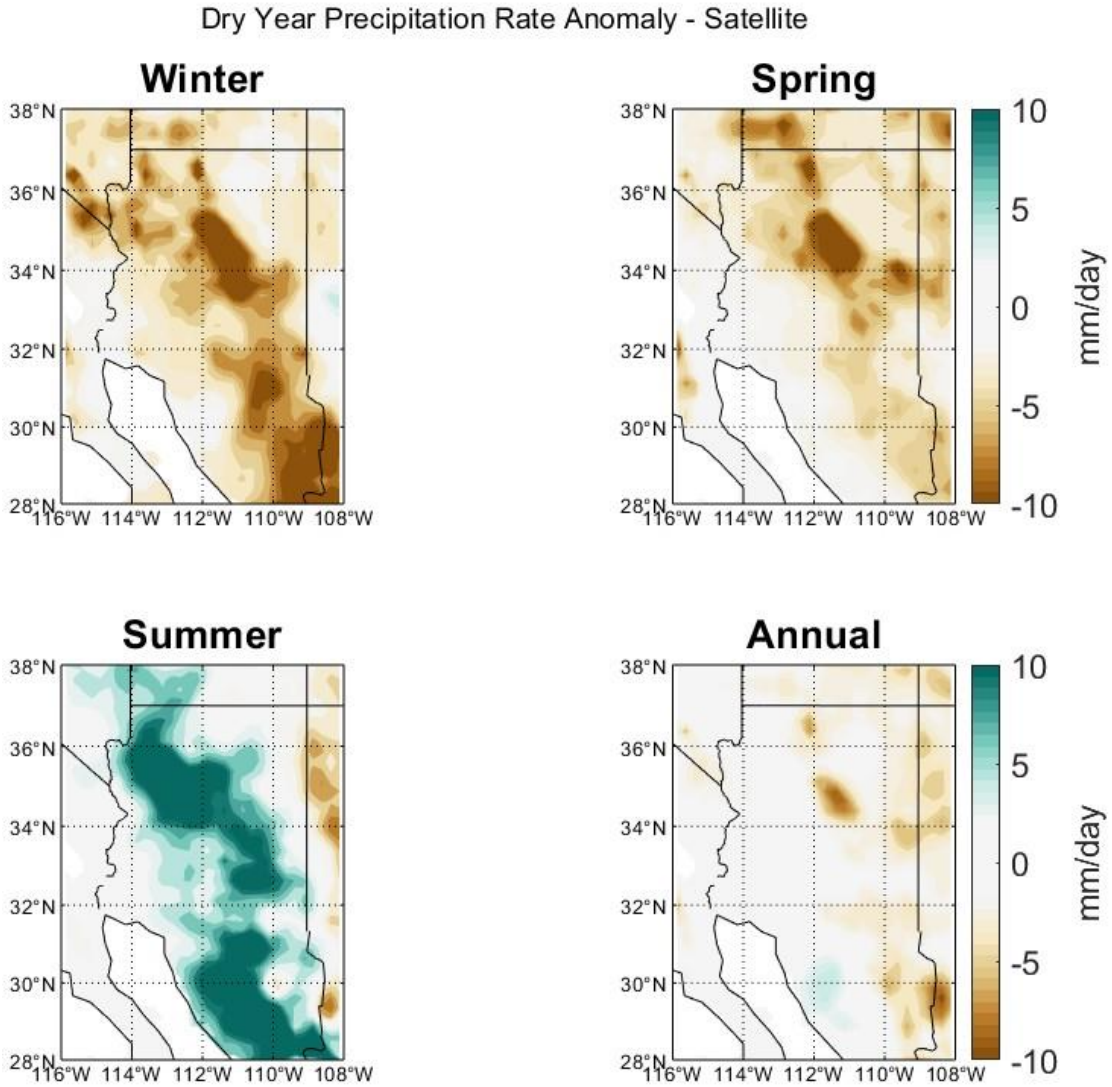




20th century reanalysis product: Compo et al., *Quarterly Journal of the Royal Meteorological Society* (2011)

CHIRPS Precipitation Rate Anomalies



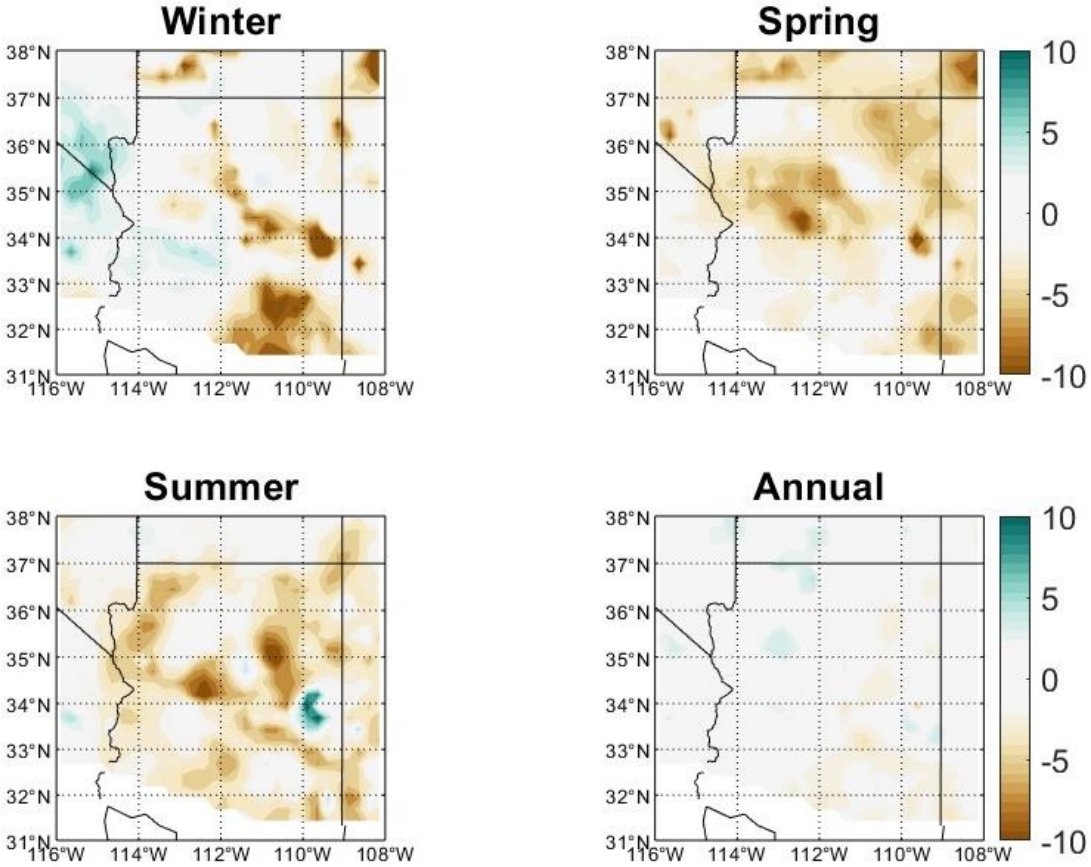


Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)

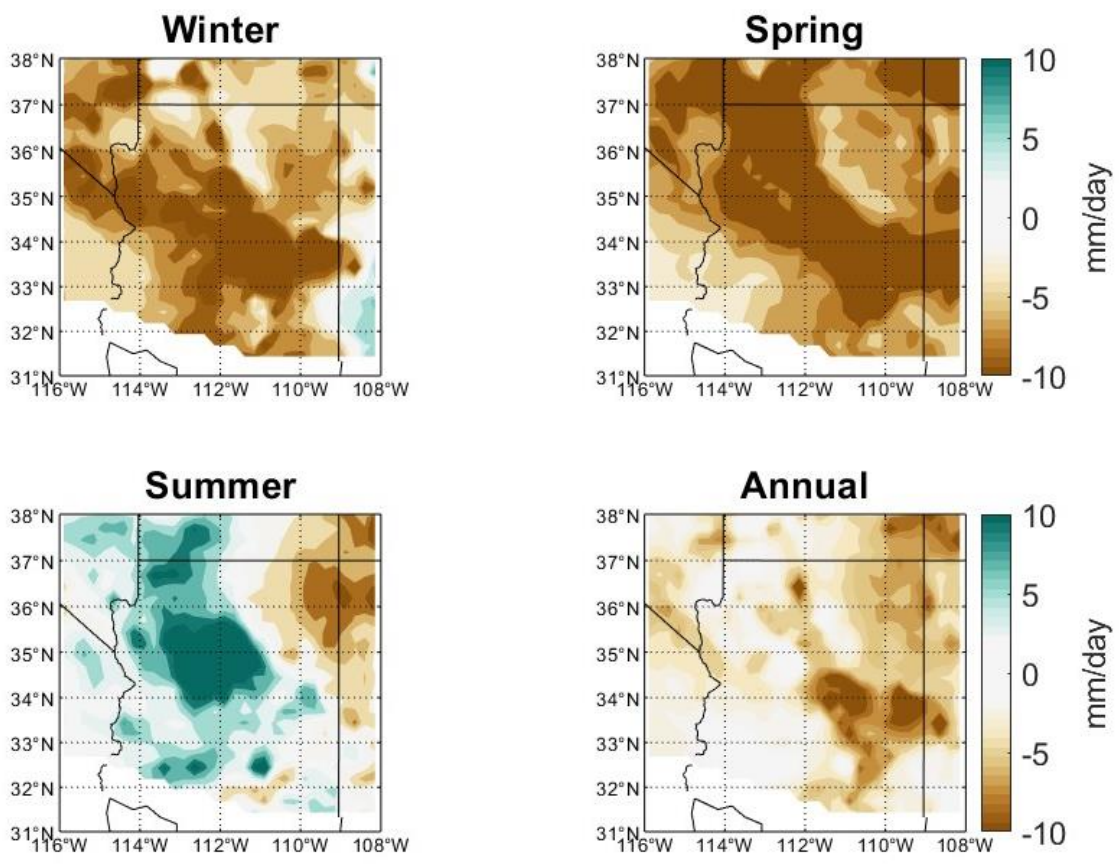
Funk *et al*, Sci Data (2015)

PRISM Precipitation Rate Anomalies

Wet Year Precipitation Rate Anomaly - PRISM

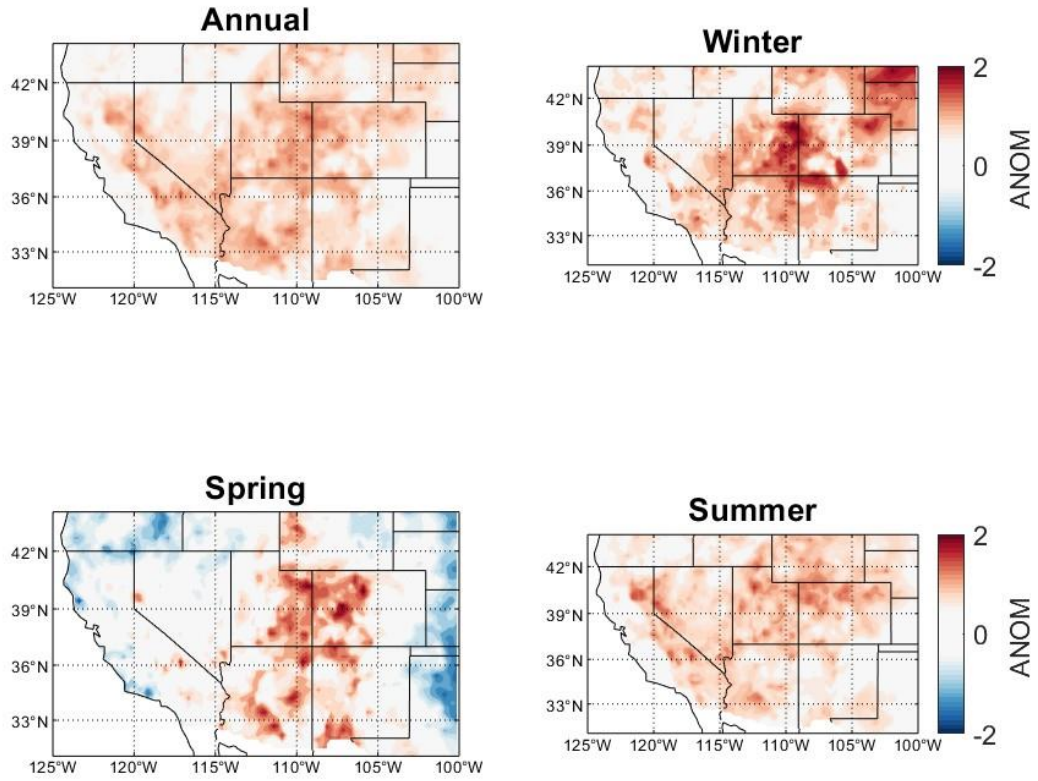


Dry Year Precipitation Rate Anomaly - PRISM

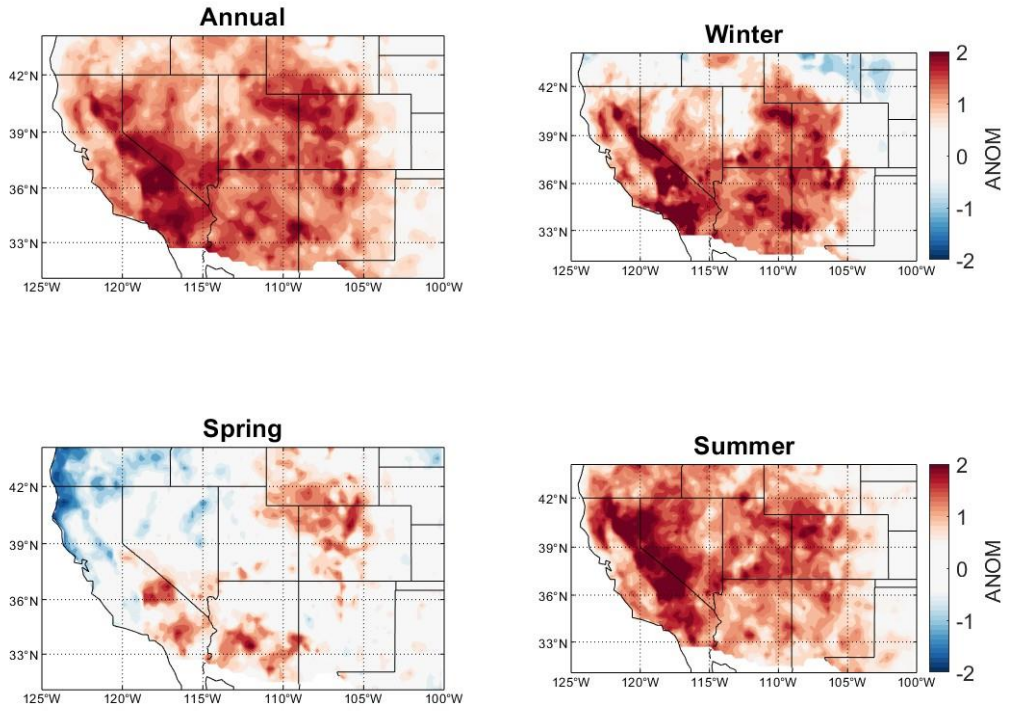


PRISM Temperature Anomalies

PRISM Wet Years Temp Anomaly

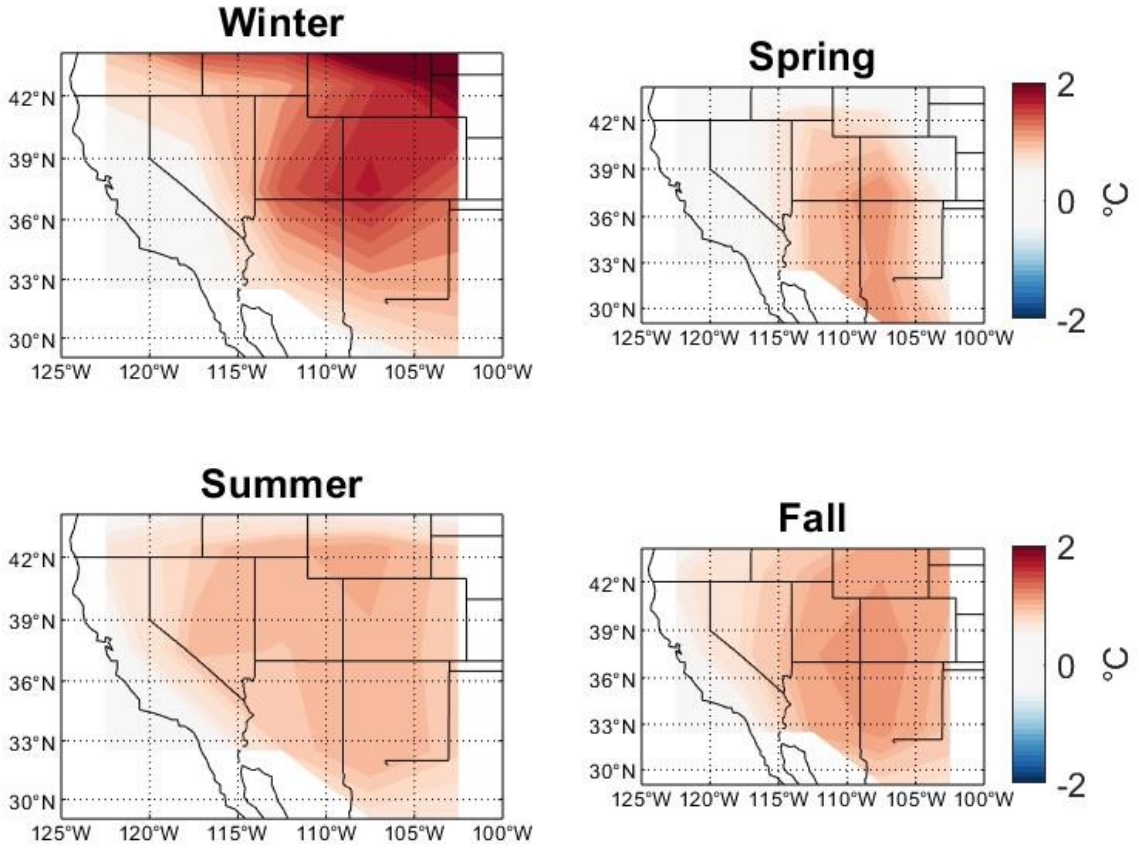


PRISM Dry Years Temp Anomaly

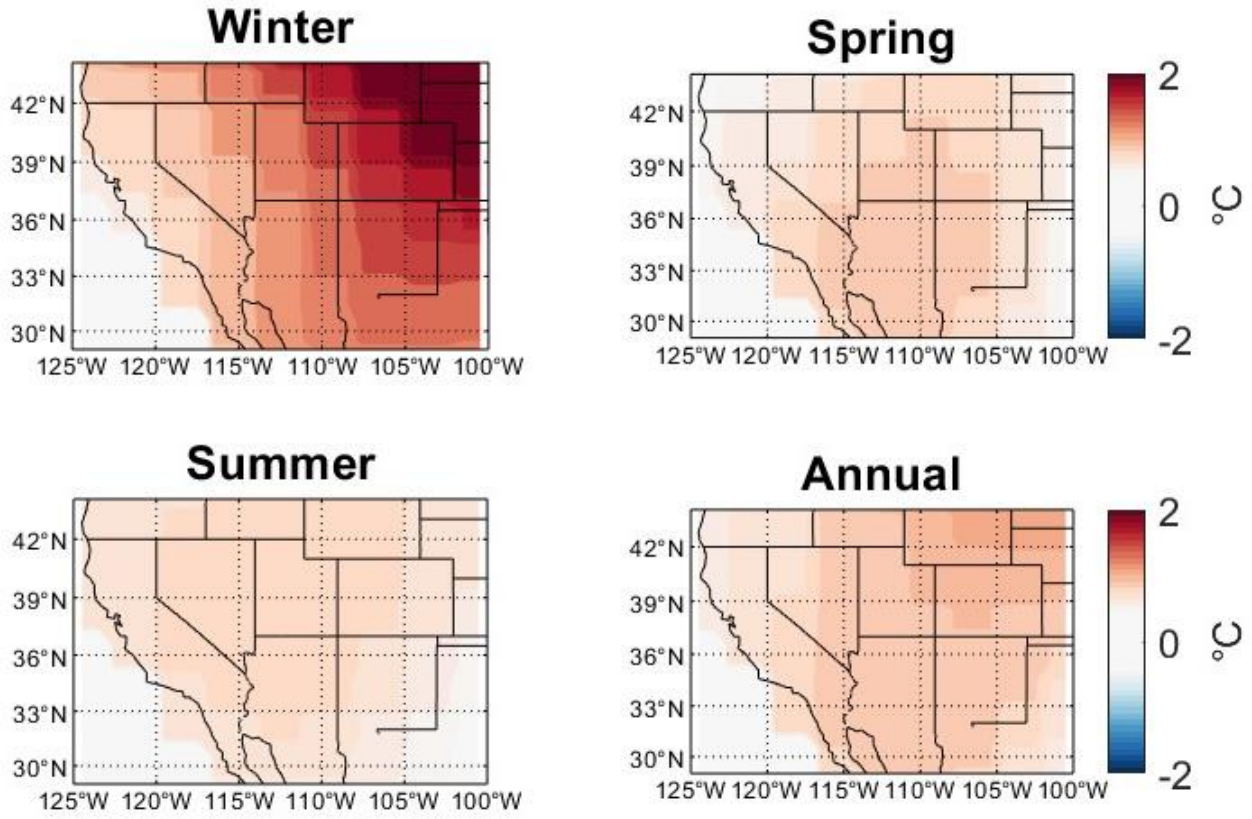


Different Temperature Products Anomalies

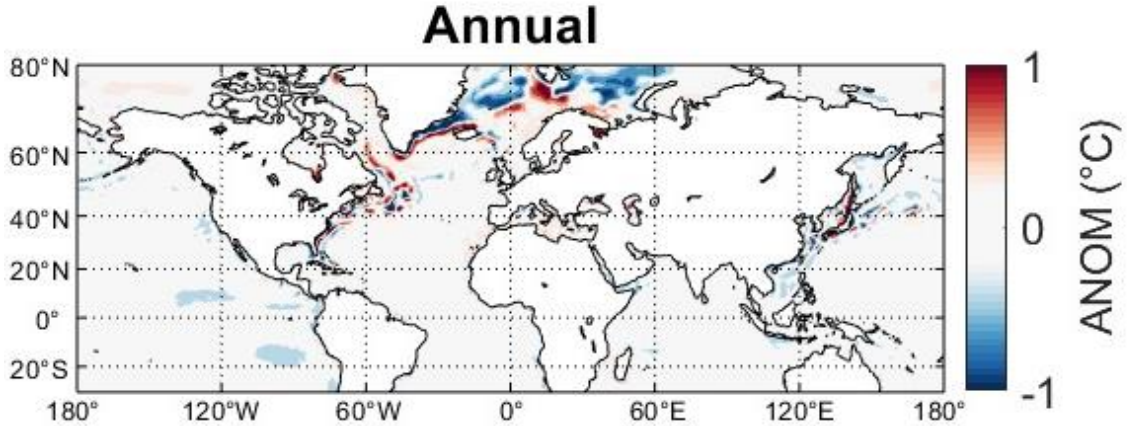
Wettest Years Temperature (CRU) Anomaly

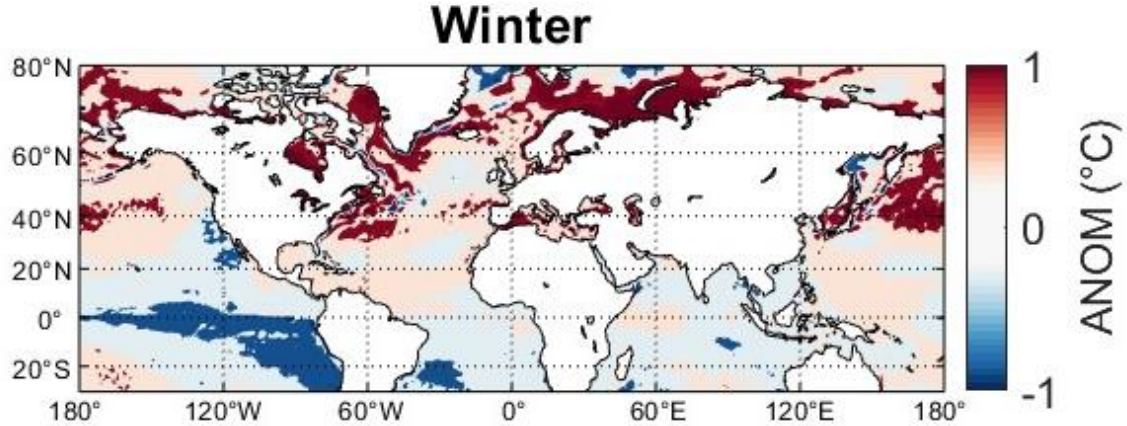


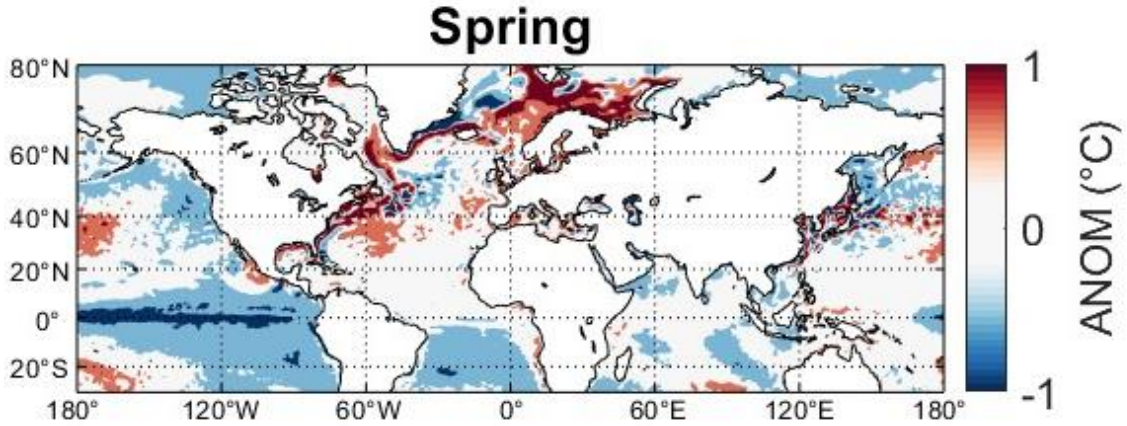
Wet Years Temperature Anomaly -GISTEMP

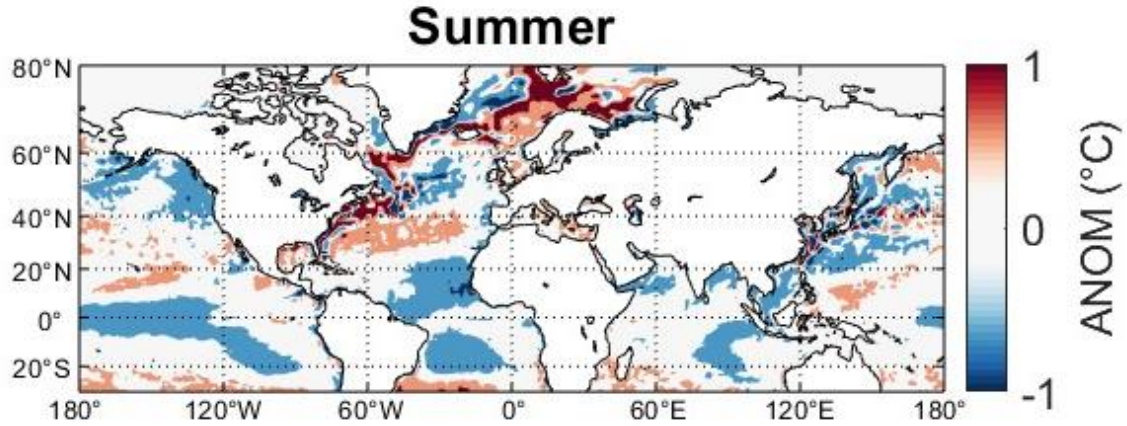


SST Dry Years Anomalies

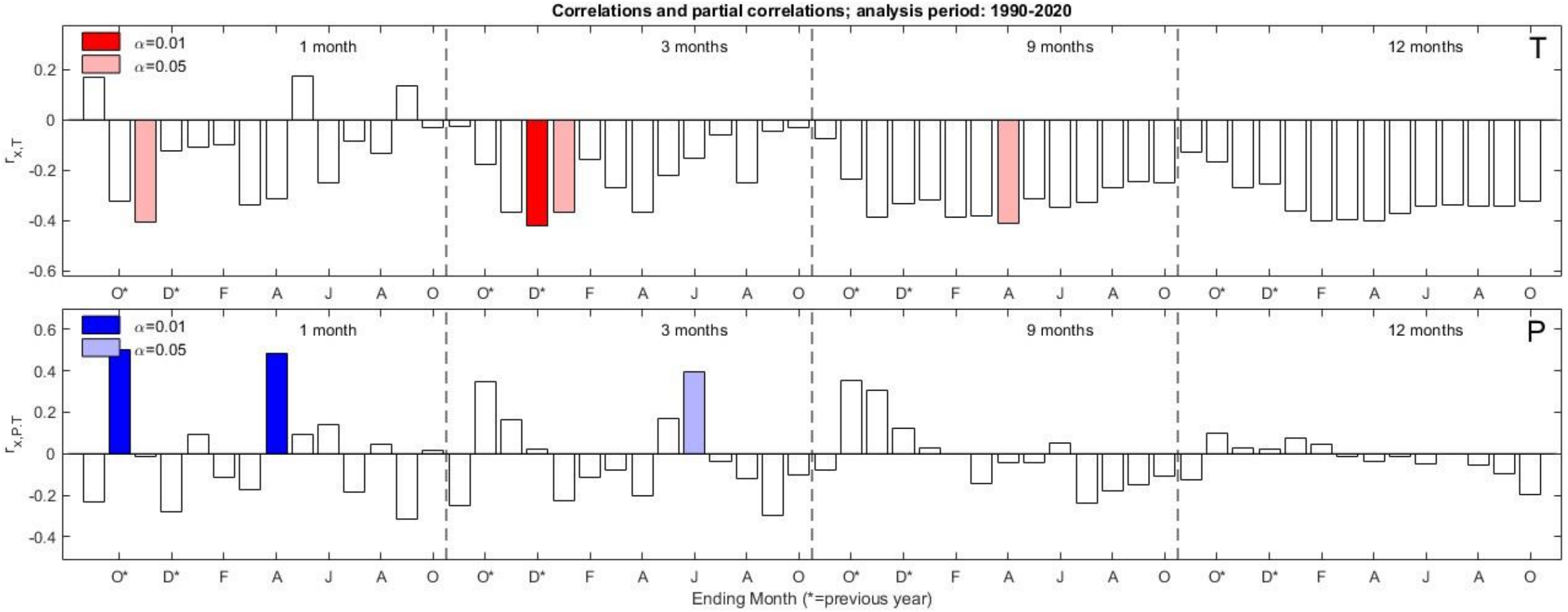








Seasonal Correlation of Temperature and Precipitation of Wet/Dry Data



Summary

Geopotential height show winter/spring AR likely play a significant role in moisture delivery

Temperature has a bigger influence on full wetted length % than precipitation (data flawed)

Soil moisture sees the positive impact of spring and prior winter precipitation

Negative correlations with prior winter and fall temperatures

El Niño influence seen for tributaries - SSTs off CA coast can be related $r>0.5$

Tributaries (less influence from pumping/local geology?) have a clearer climate signal

Future Directions?

Groundwater influence on surface flow *(Turner and Gungle)*

in valleys the surface water is essentially top of aquifer, can we combine wet/dry with well data to determine surface water persistence or quantify conservation actions?

SST anomaly Wet years