

Reconstructing Sierra Nevada Snowpack Using Conifer Tree Rings

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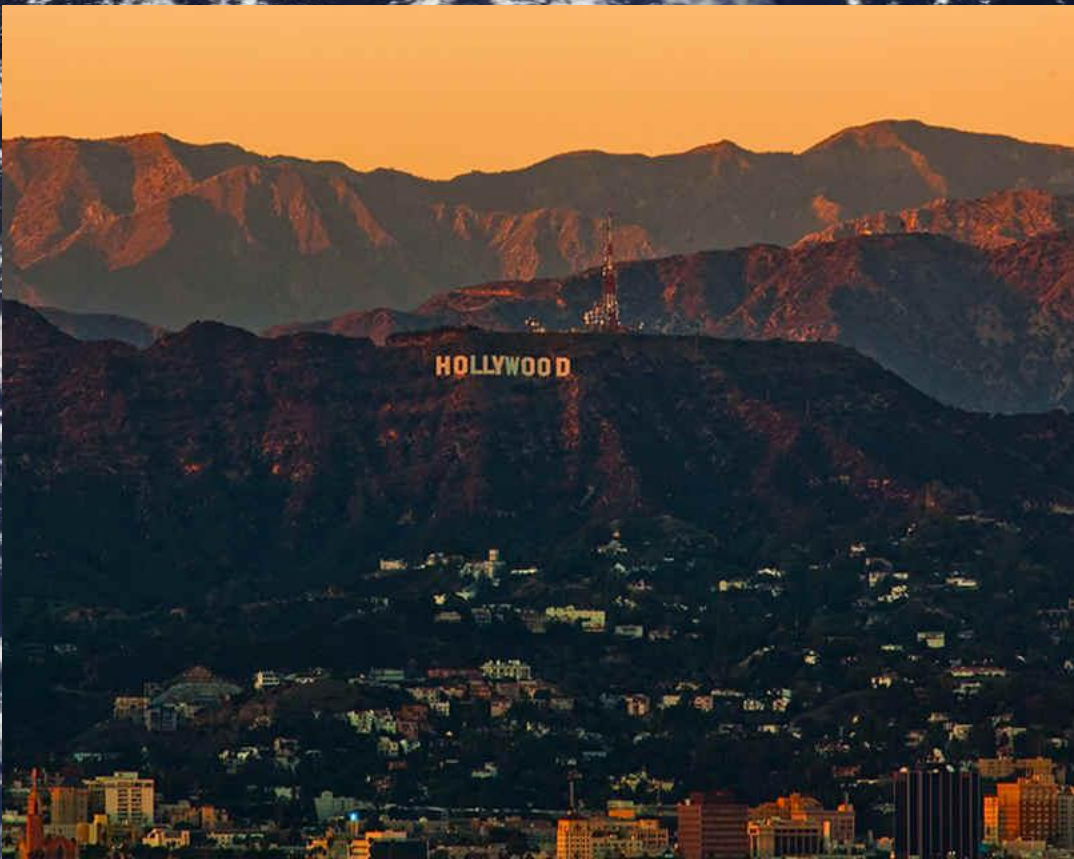


Overview

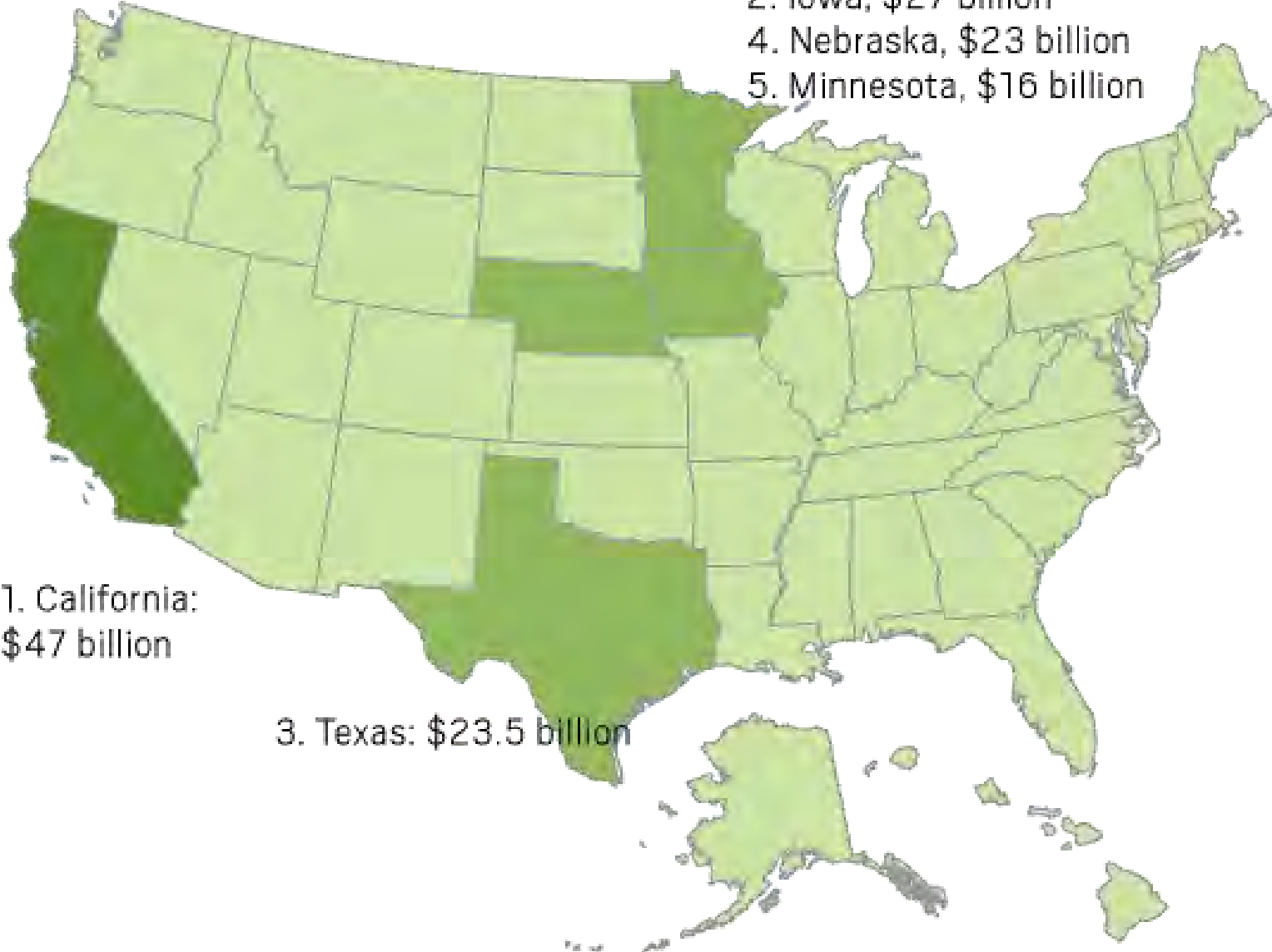
1. Introduction
 1. California Water
 2. Recent Drought
 3. Sierra Nevada Paleosnow
2. Snow-Water Reconstruction
 1. Study Region
 2. Climate Signal
 3. Reconstruction
 4. Regional Paleoclimate
3. Conclusions
4. Discussion



California



California Agriculture



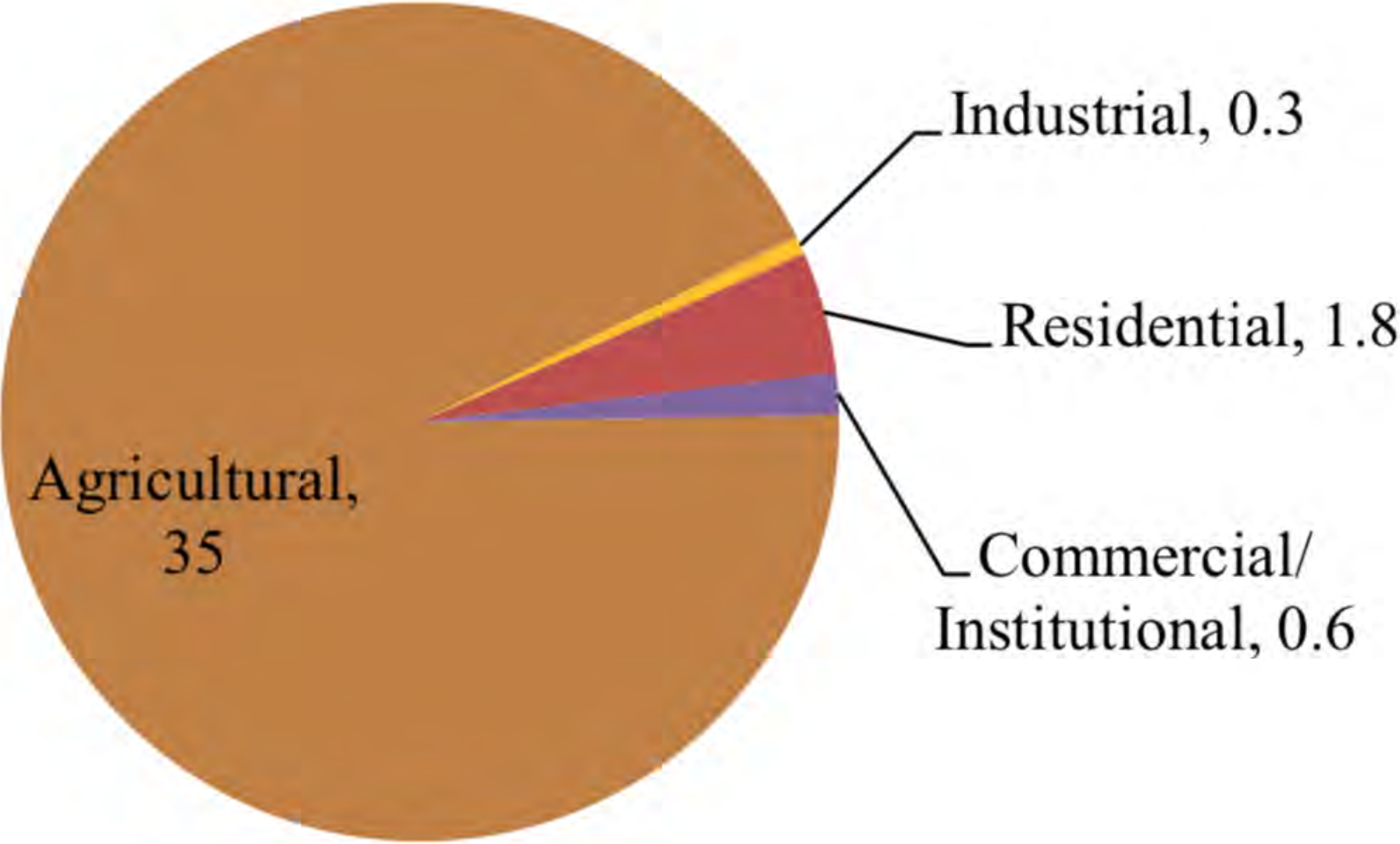
1. California:
\$47 billion

3. Texas: \$23.5 billion

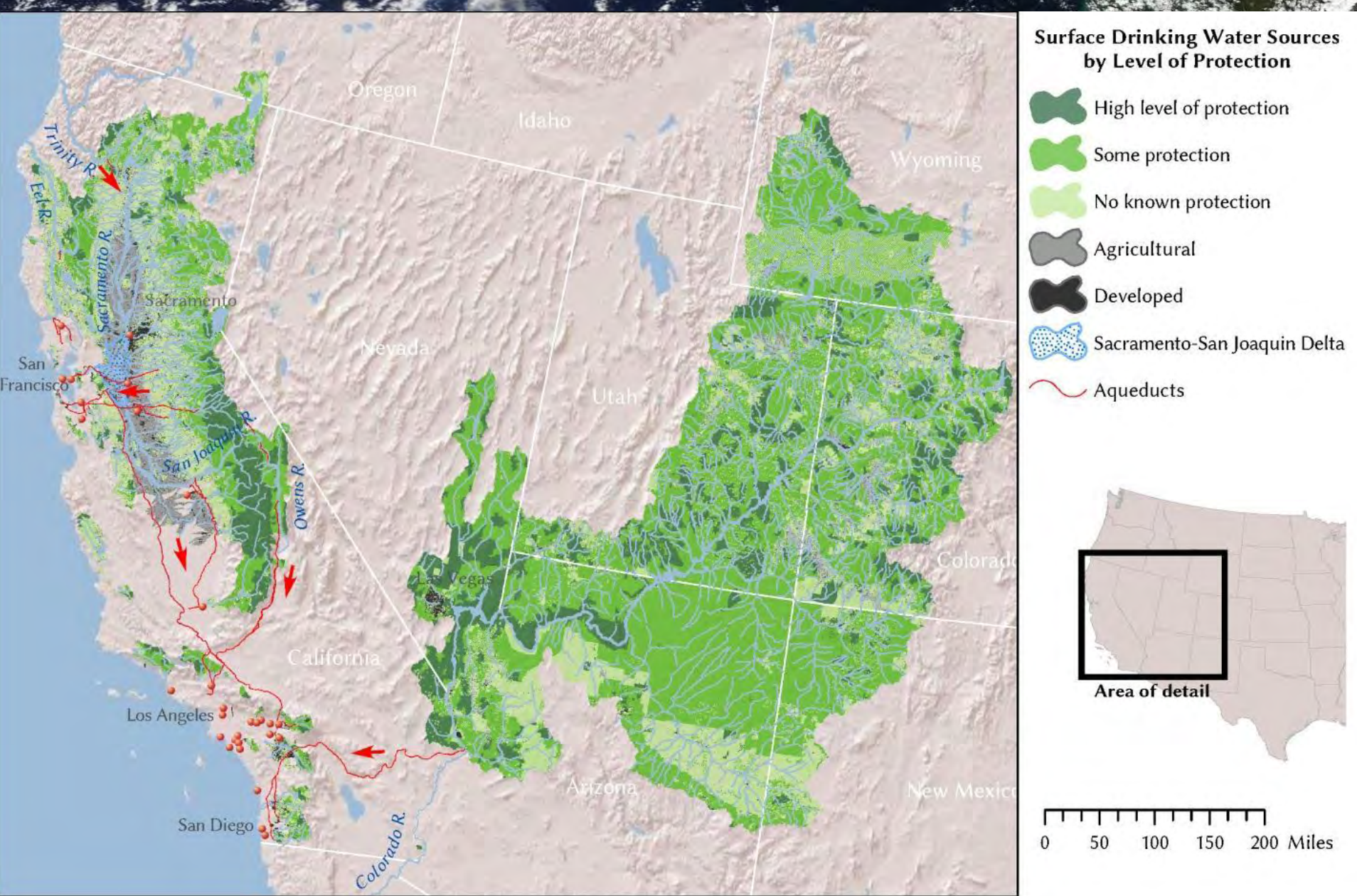
2. Iowa, \$27 billion
4. Nebraska, \$23 billion
5. Minnesota, \$16 billion



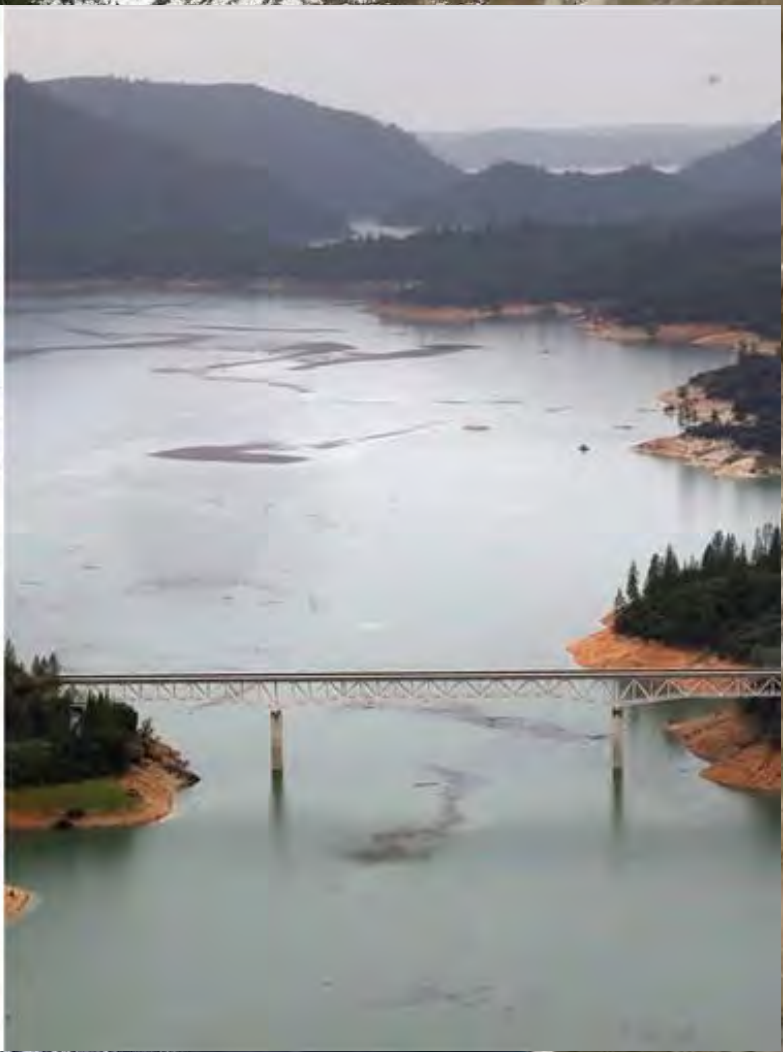
California Water Use



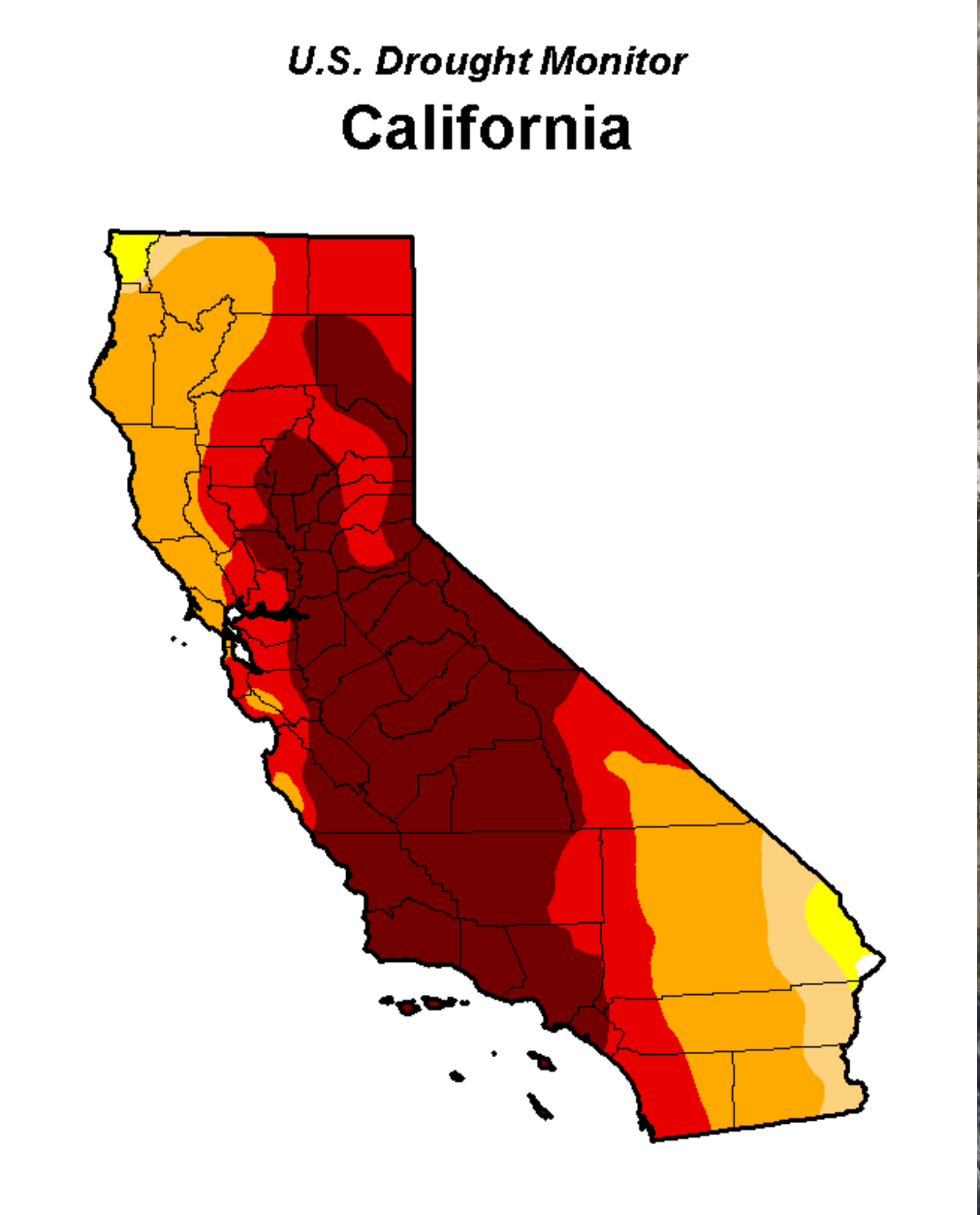
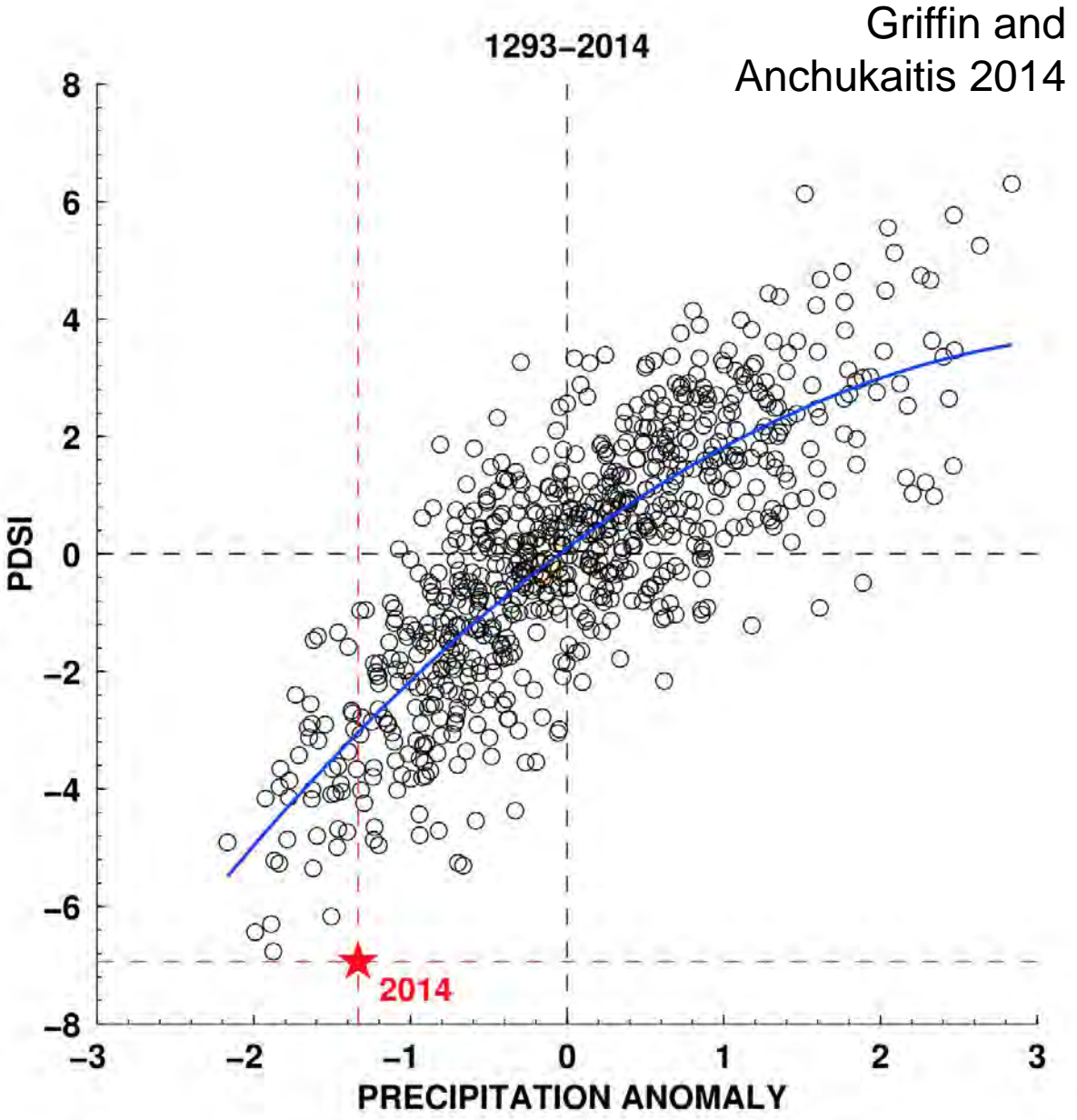
California Water Sources



California Drought

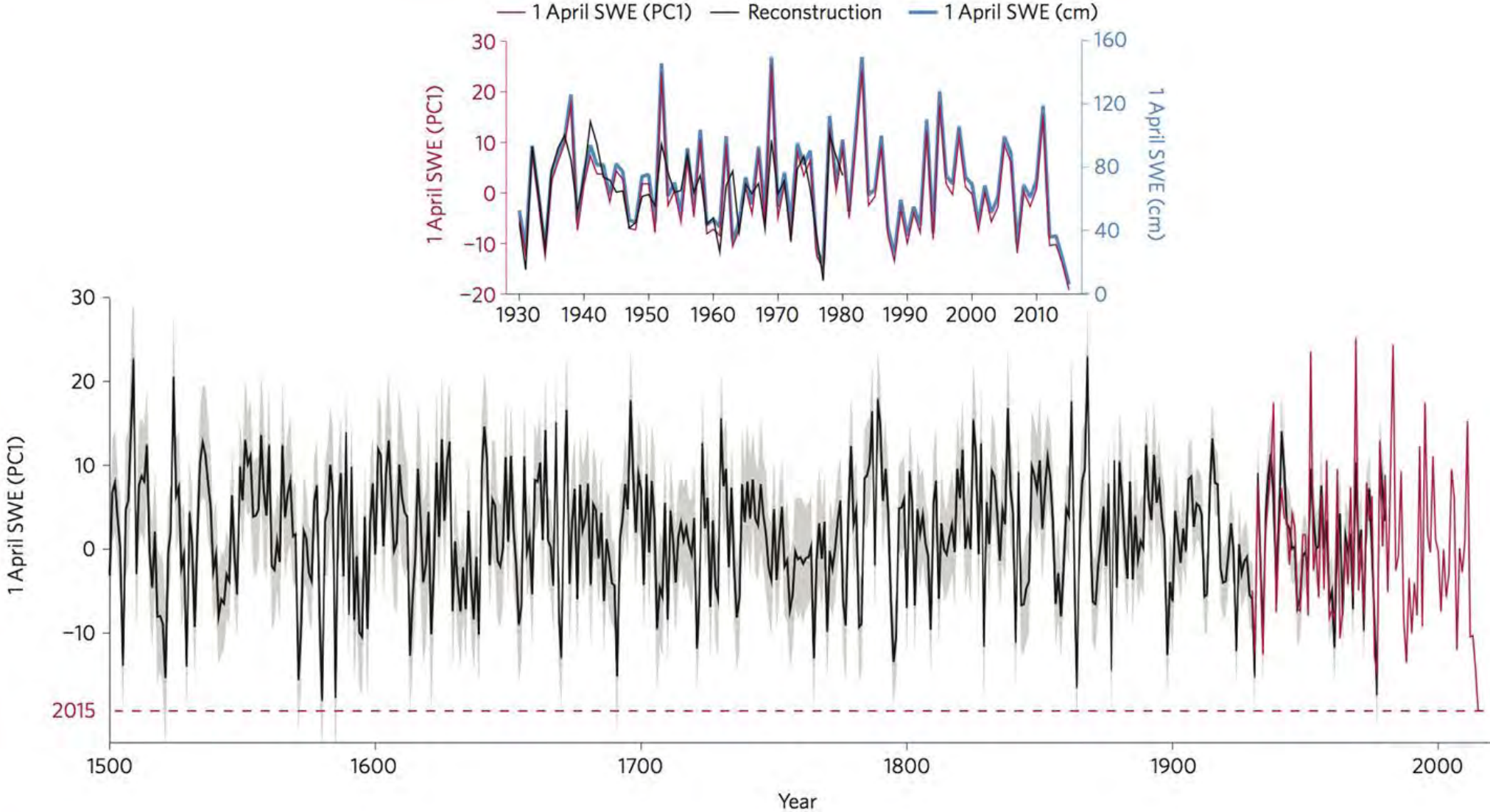


California Drought



California Drought

Belmecheri *et al.* 2016

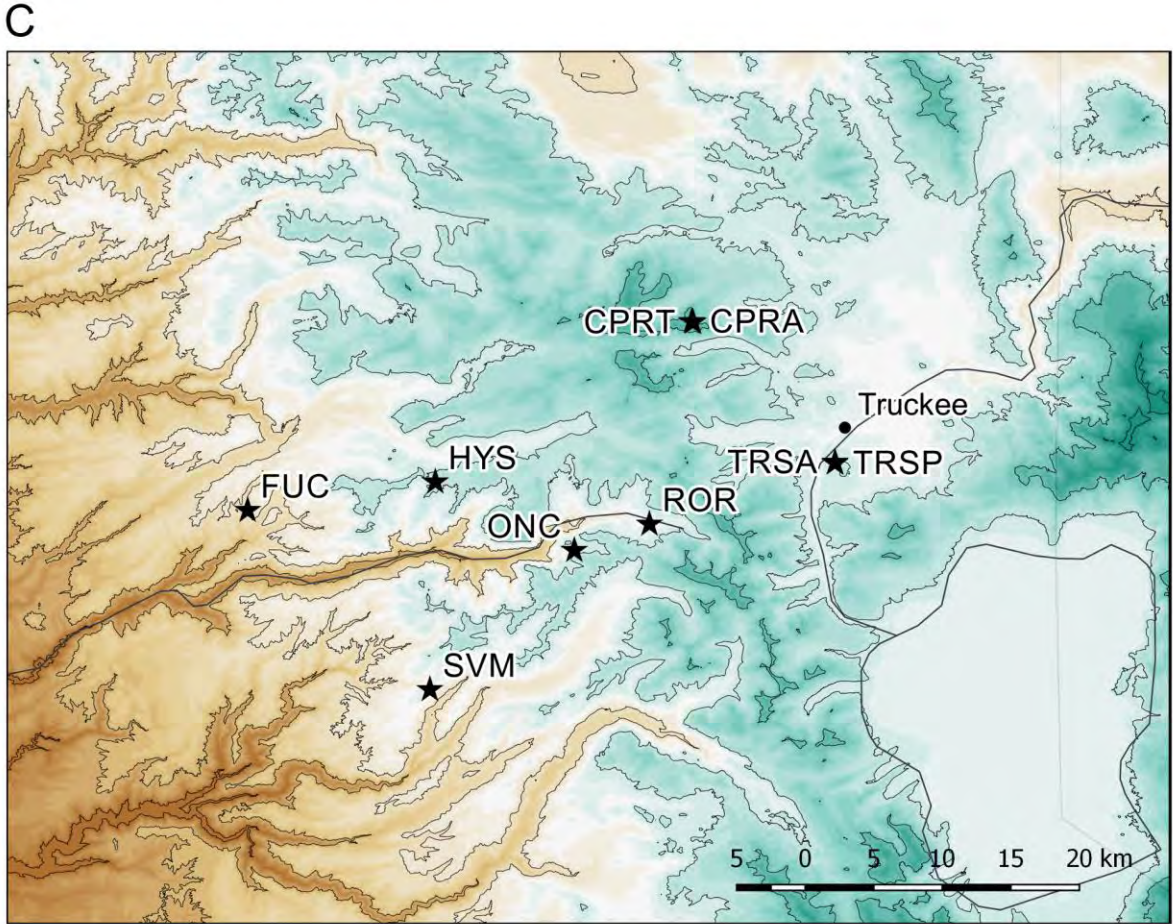


Objectives

1. **Sample diverse group of conifer species along 1000 m elevational gradient in northern Sierra Nevada**
2. **Create high-quality tree-ring chronologies for each species at each site**
3. **Identify seasonal climate drivers of tree-ring growth at these sites**
4. **Develop robust snow-water equivalent (SWE) reconstruction for North Fork American River basin**
5. **Place SWE reconstruction in context of regional paleoclimate**

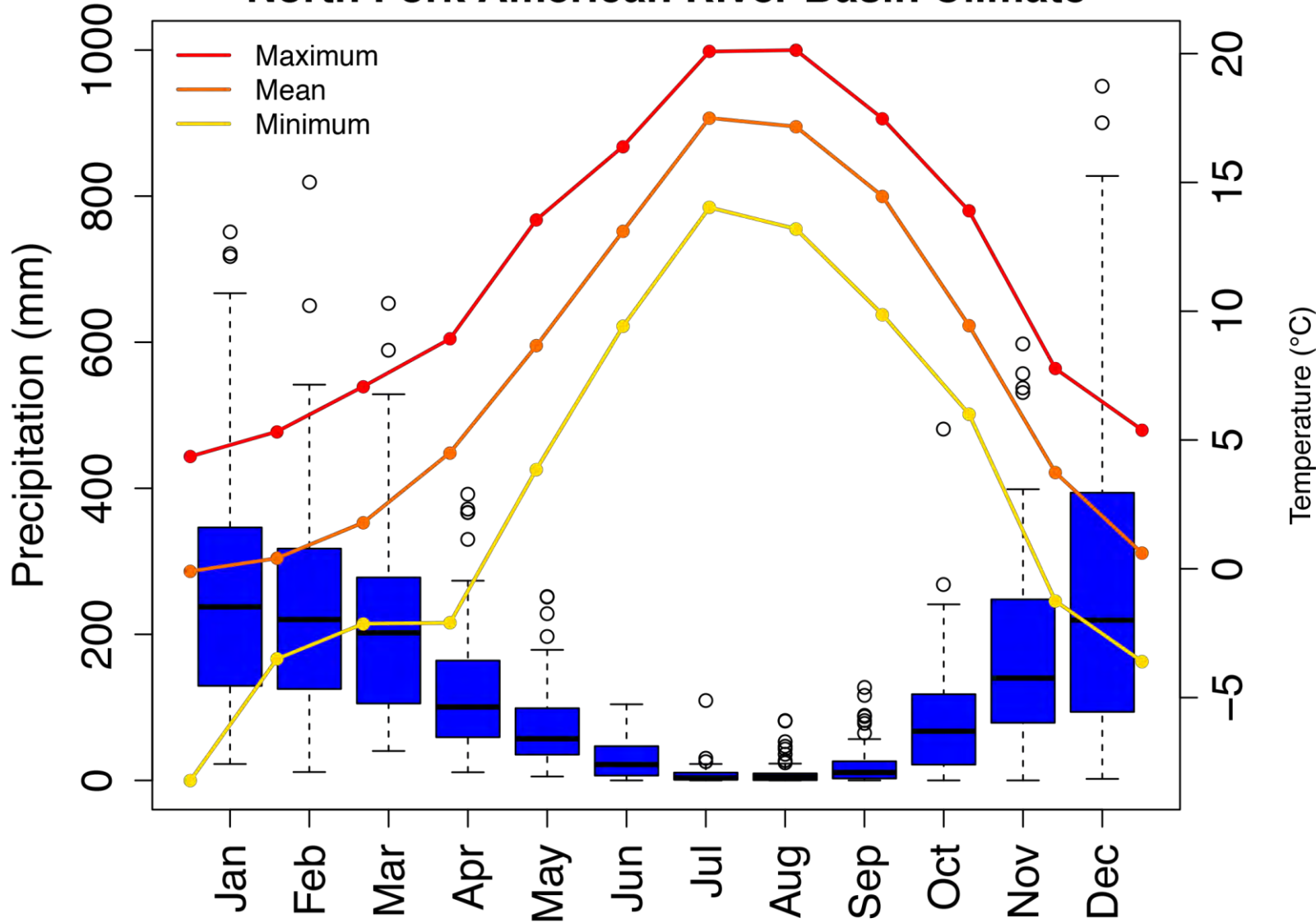


Study Region



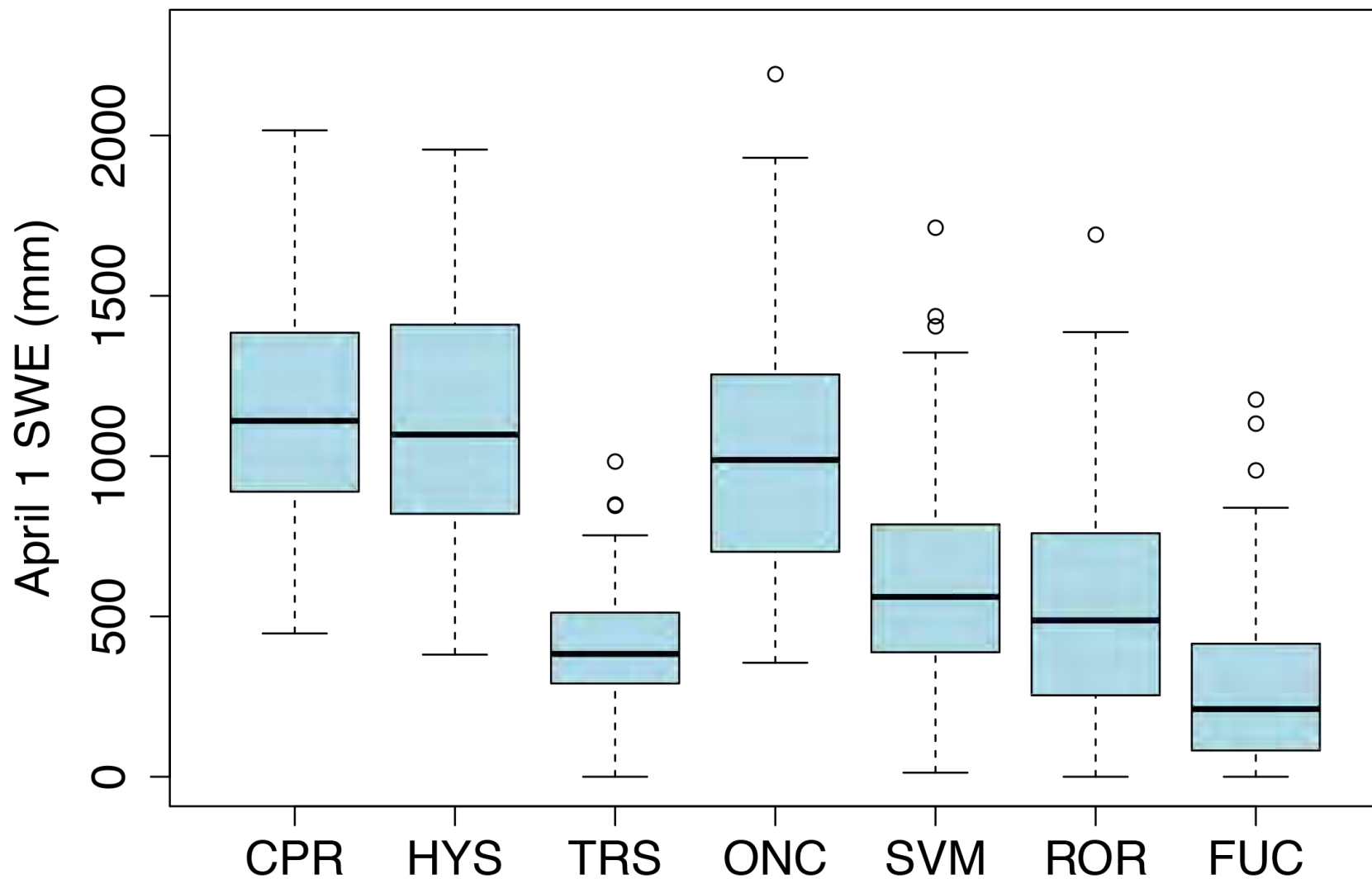
Regional Climate

North Fork American River Basin Climate



Regional Climate

Snow–Water Equivalent at Tree–Ring Sites



Conifer Species

Abies concolor



Abies magnifica



Calocedrus decurrens



Juniperus occidentalis



Pinus ponderosa

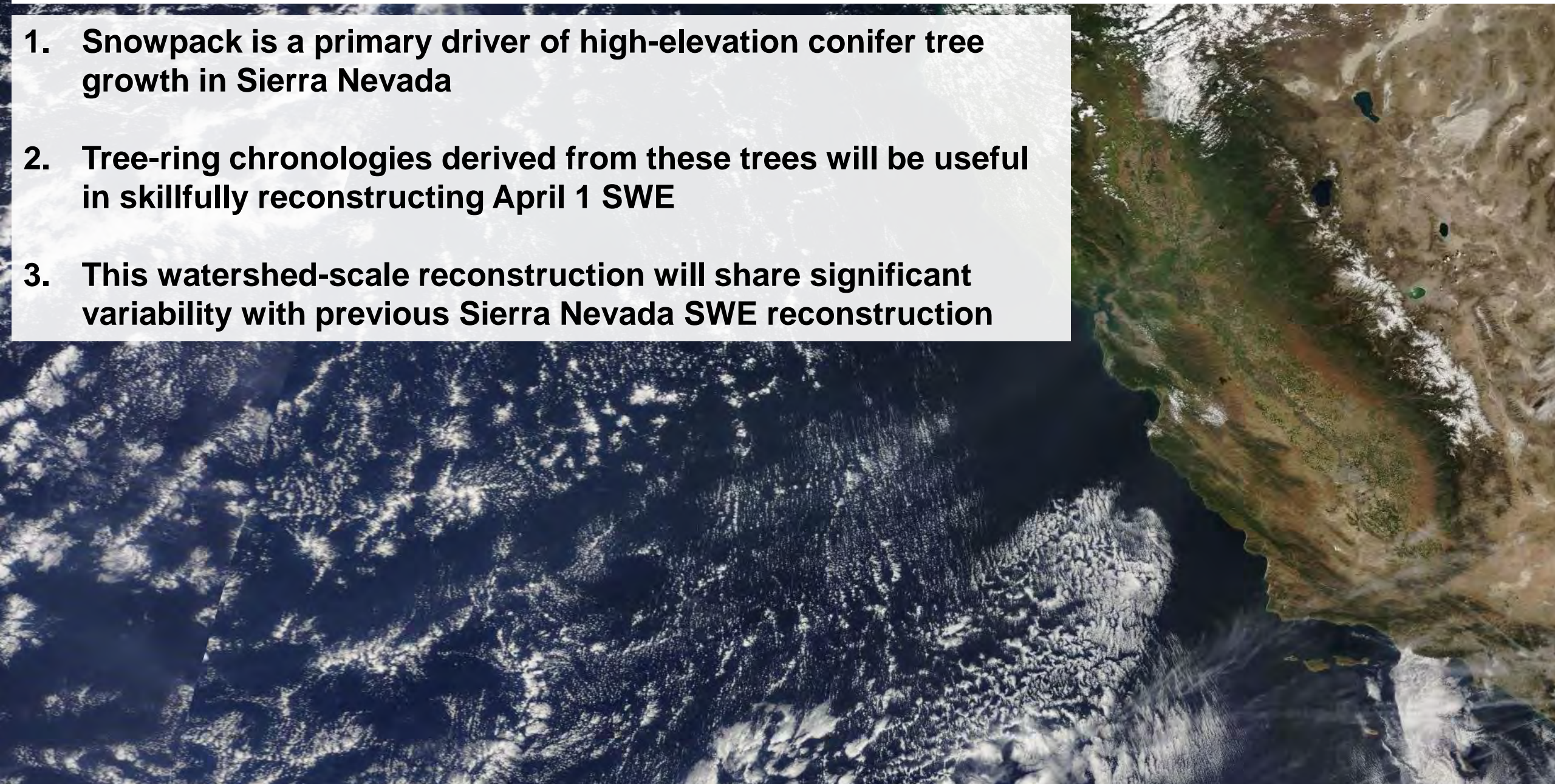


Tsuga mertensiana



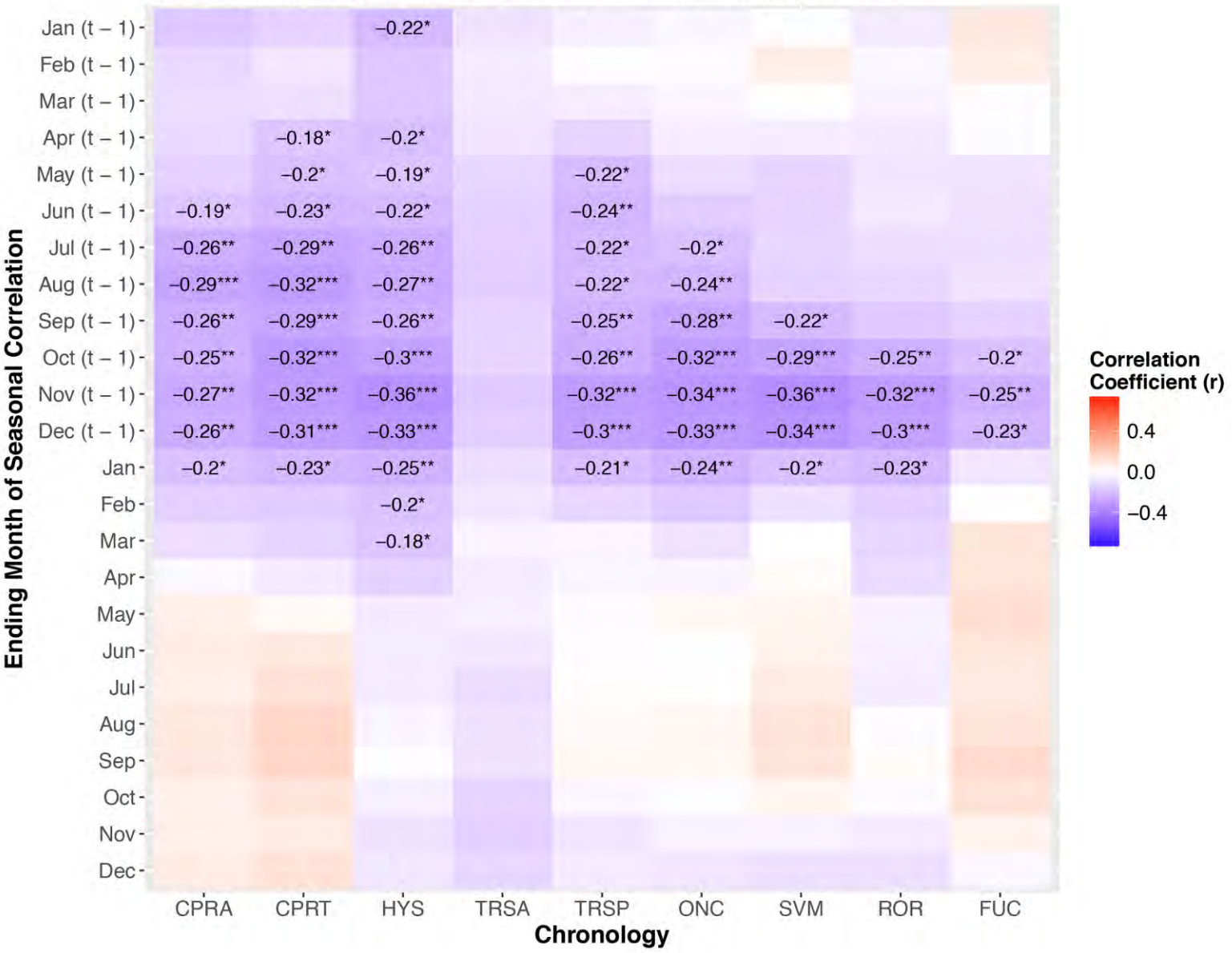
Hypotheses

1. **Snowpack is a primary driver of high-elevation conifer tree growth in Sierra Nevada**
2. **Tree-ring chronologies derived from these trees will be useful in skillfully reconstructing April 1 SWE**
3. **This watershed-scale reconstruction will share significant variability with previous Sierra Nevada SWE reconstruction**



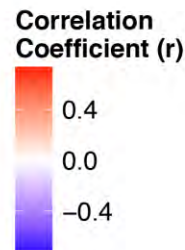
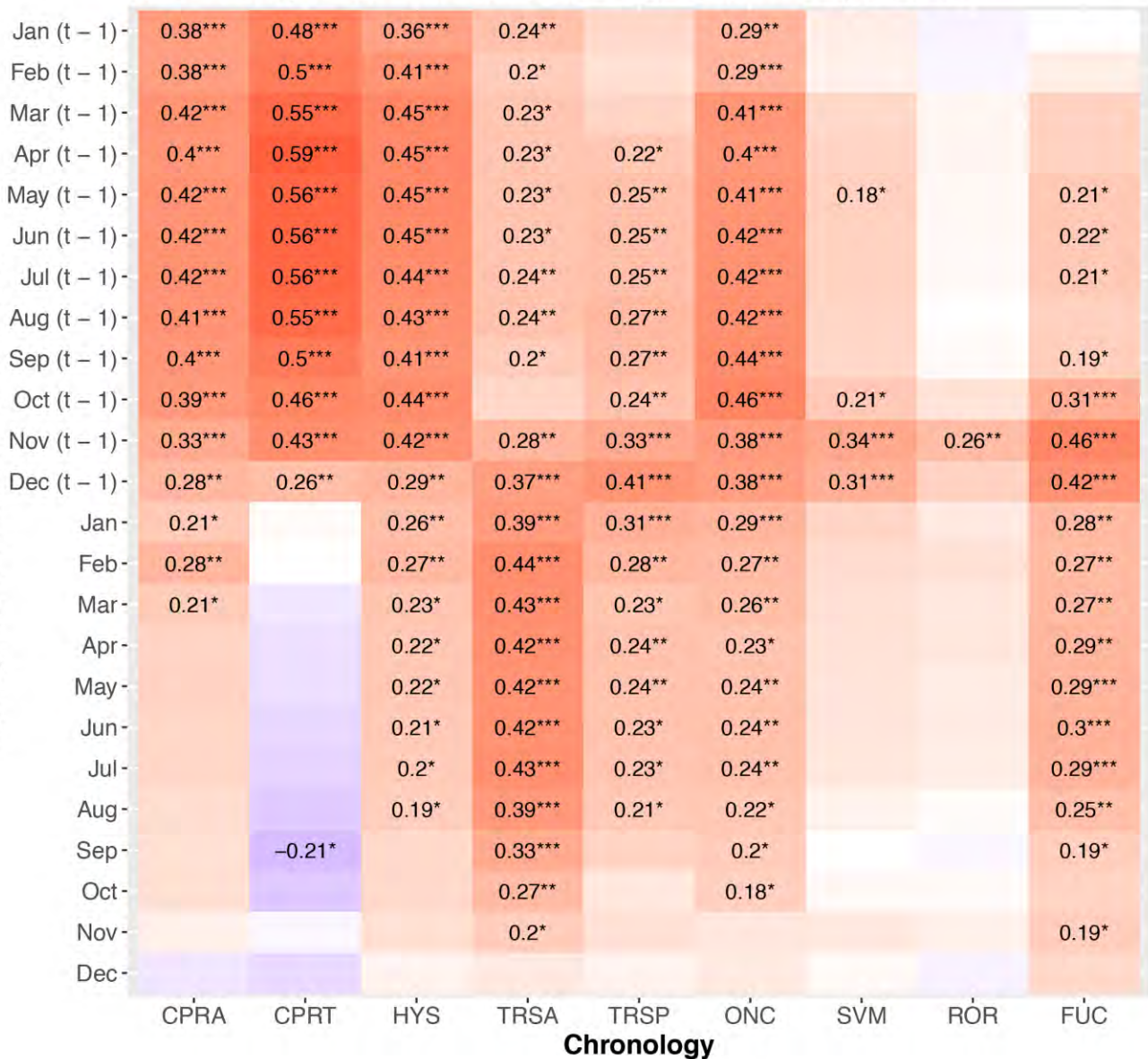
Temperature Signal

Tree-Ring Correlations with 9-Month Temperature



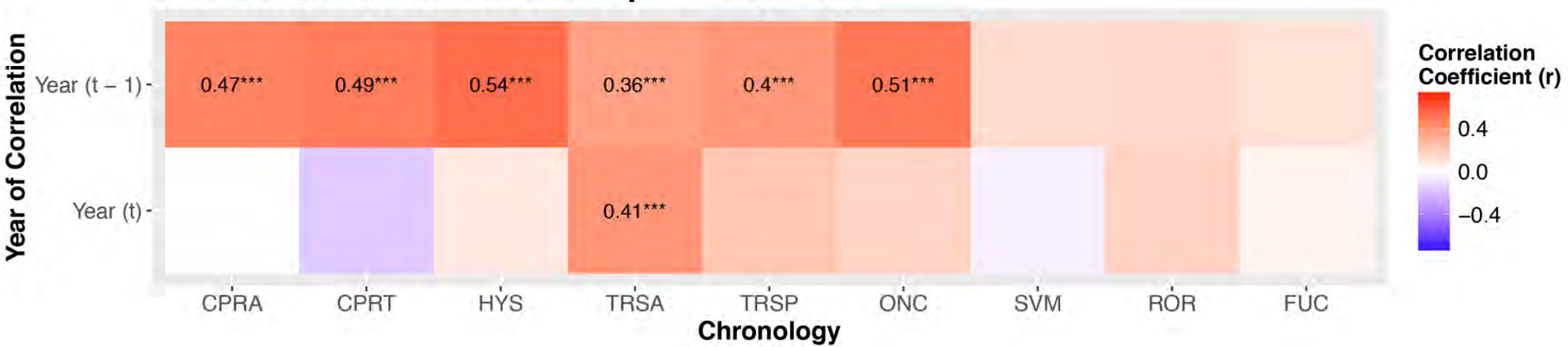
Precipitation Signal

Tree-Ring Correlations with 9-Month Precipitation



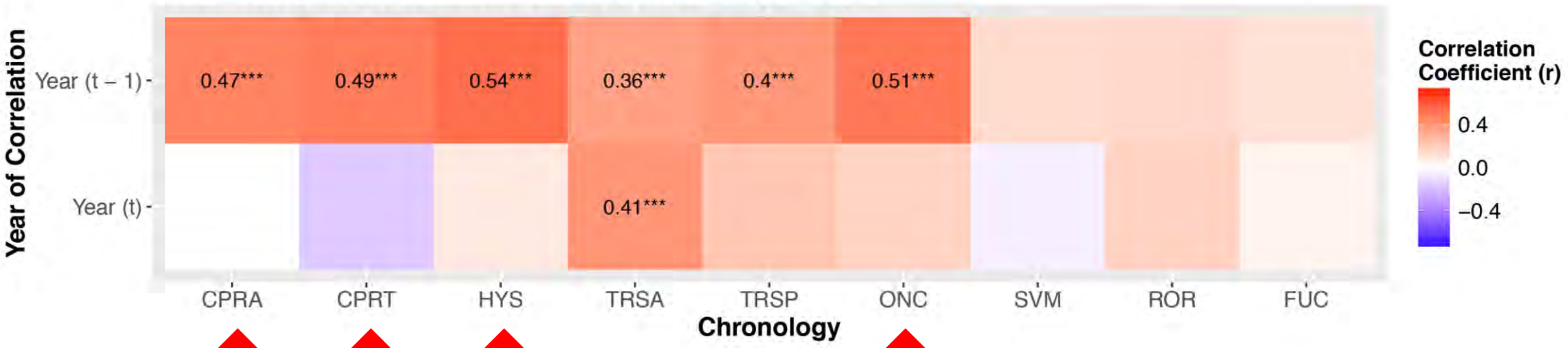
Snowpack Signal

Tree-Ring Correlations with April 1 ONC SWE



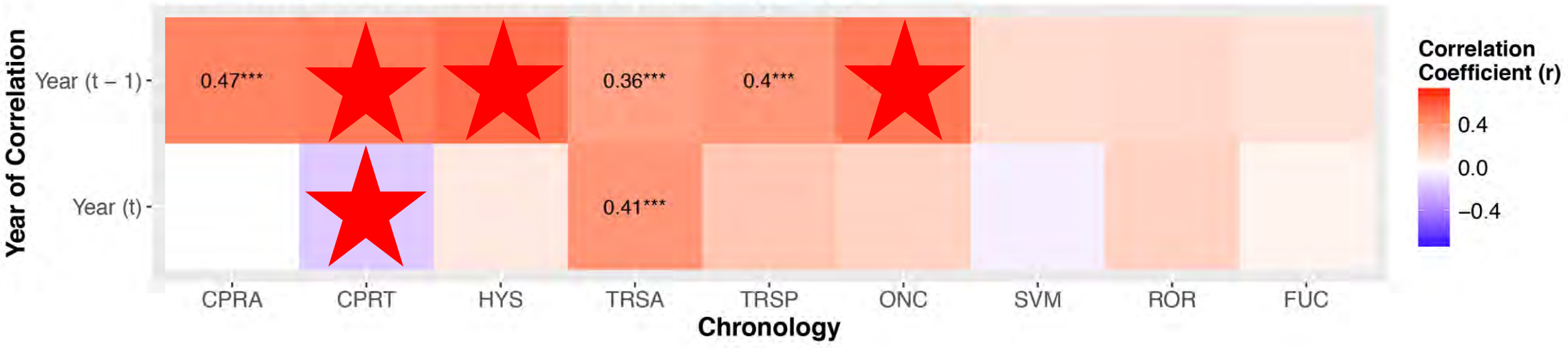
Predictor Pool

Tree-Ring Correlations with April 1 ONC SWE



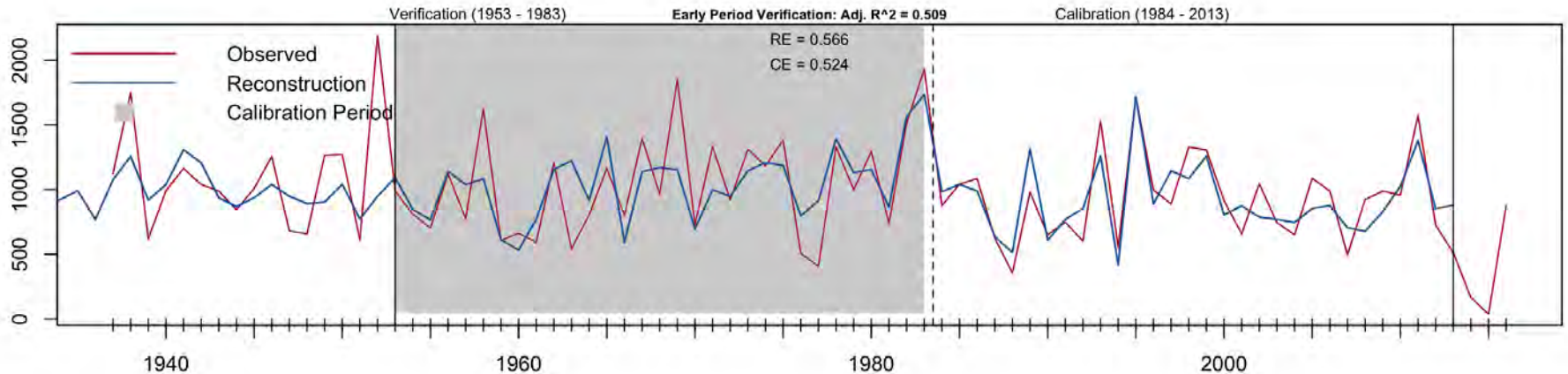
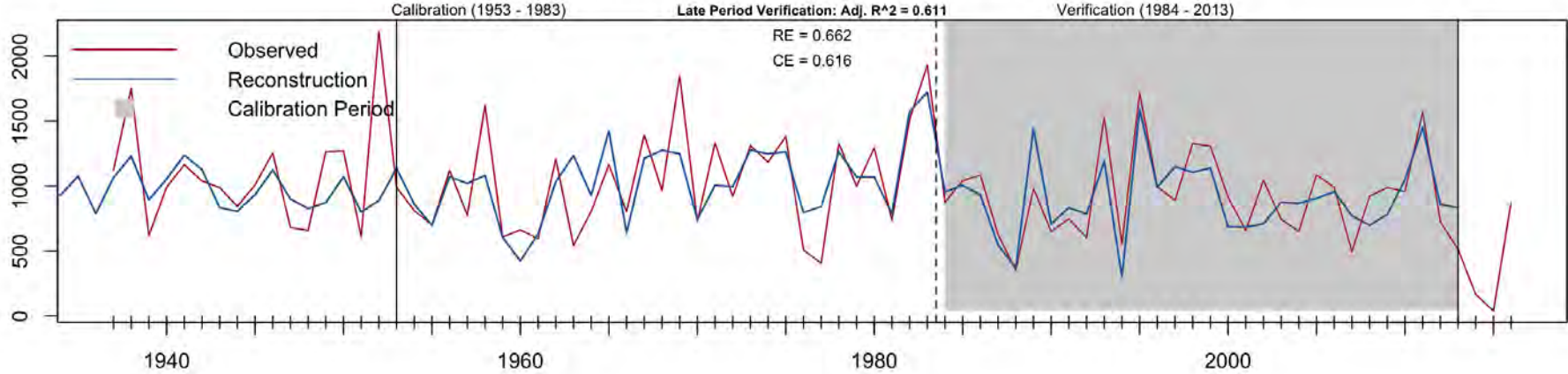
Predictors

Tree-Ring Correlations with April 1 ONC SWE

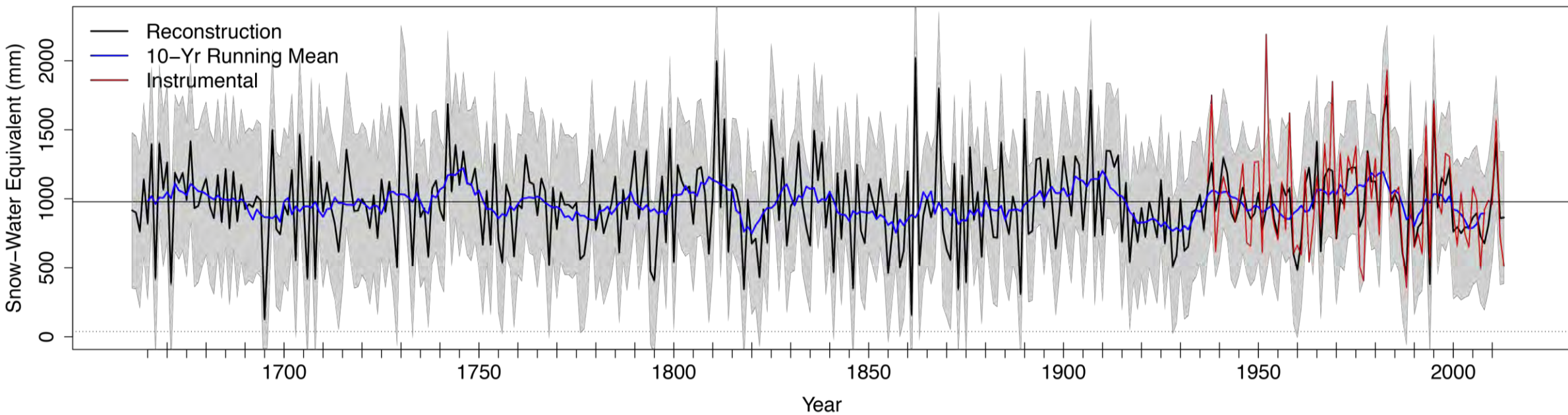
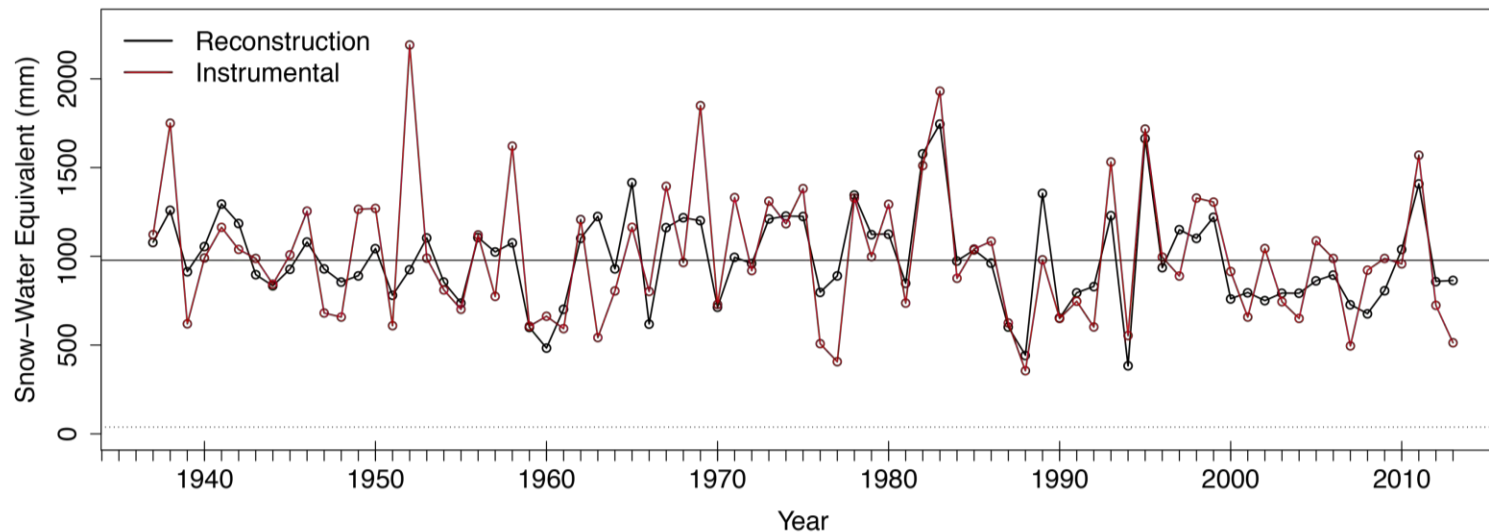


Calibration - Verification

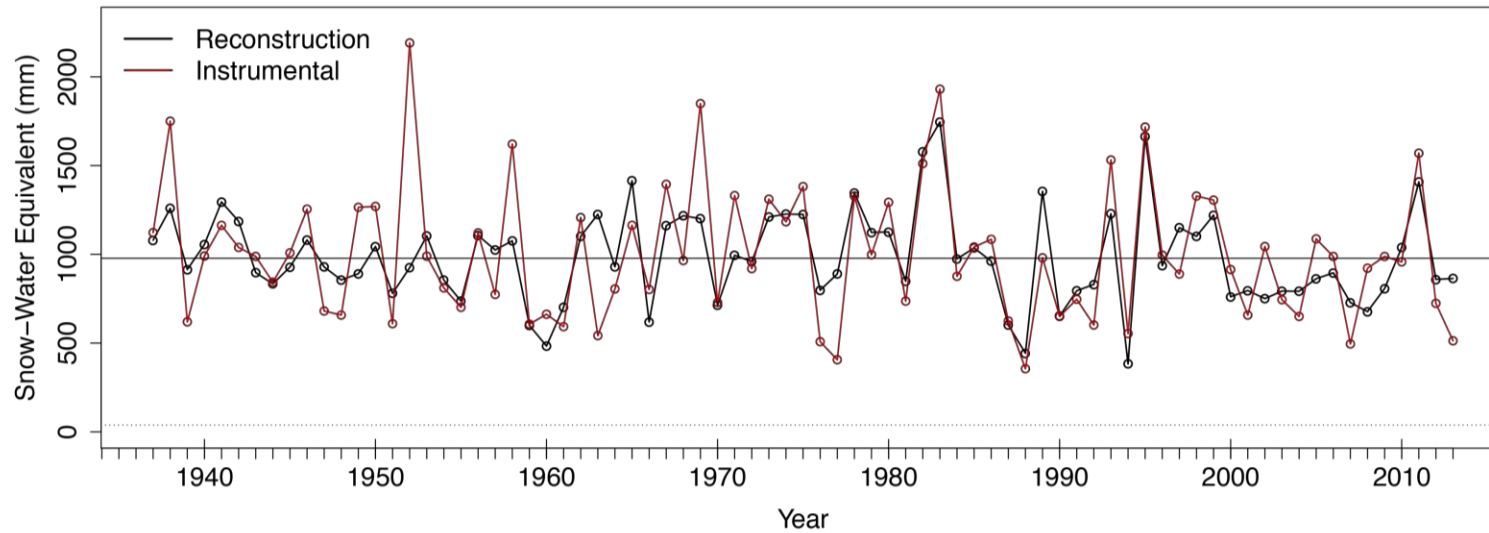
Split-Period Calibration Verification



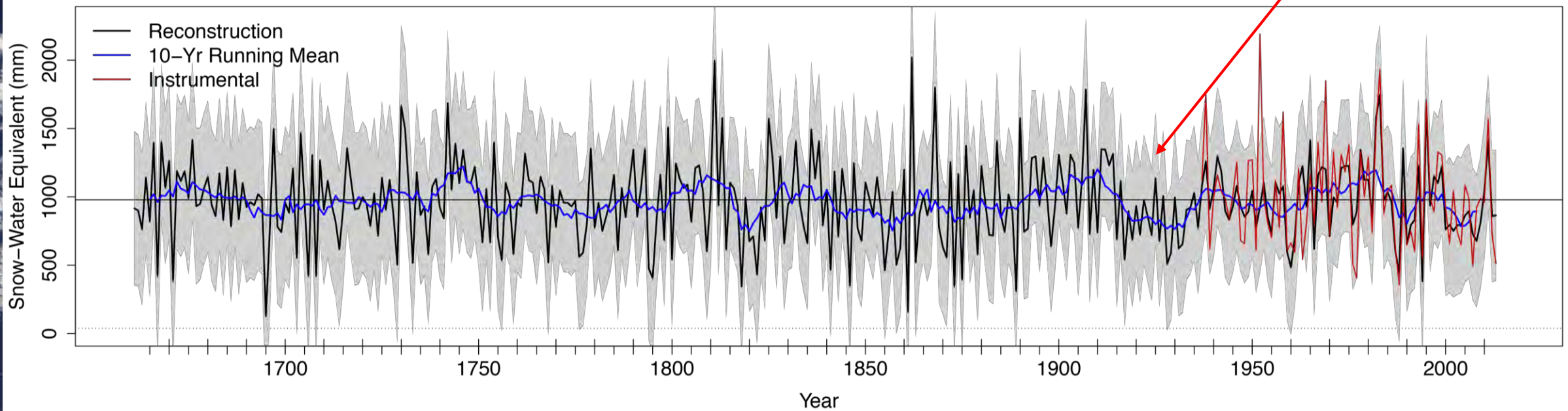
North Fork American River Reconstruction



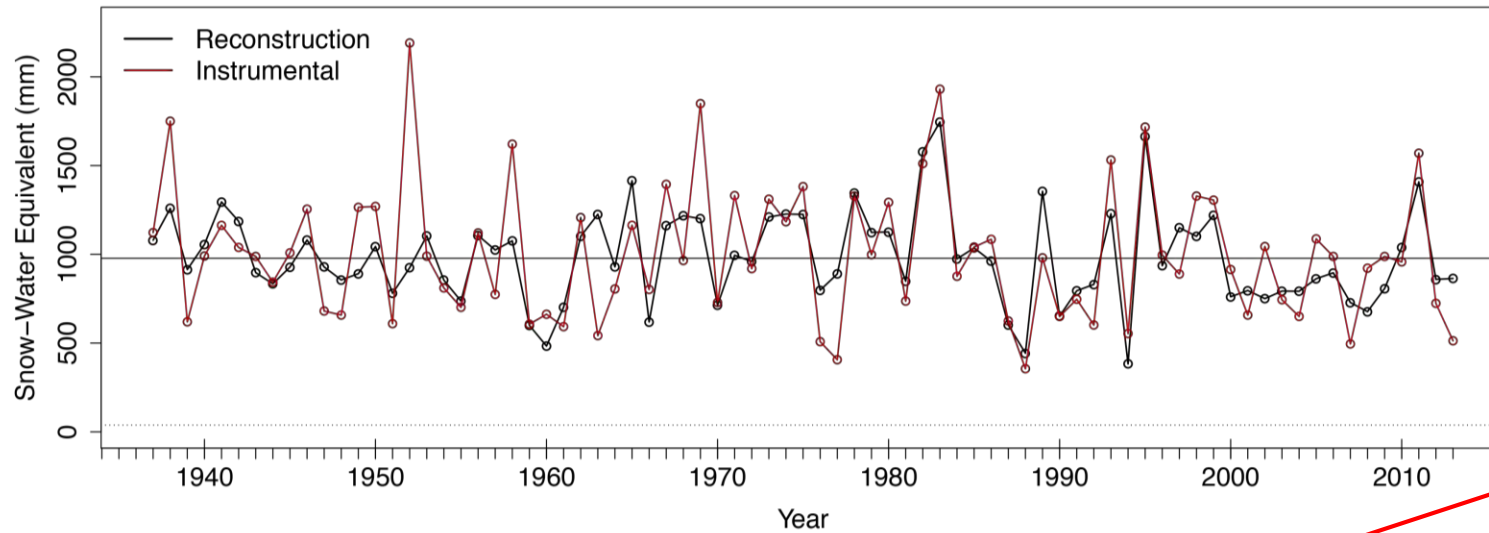
North Fork American River Reconstruction



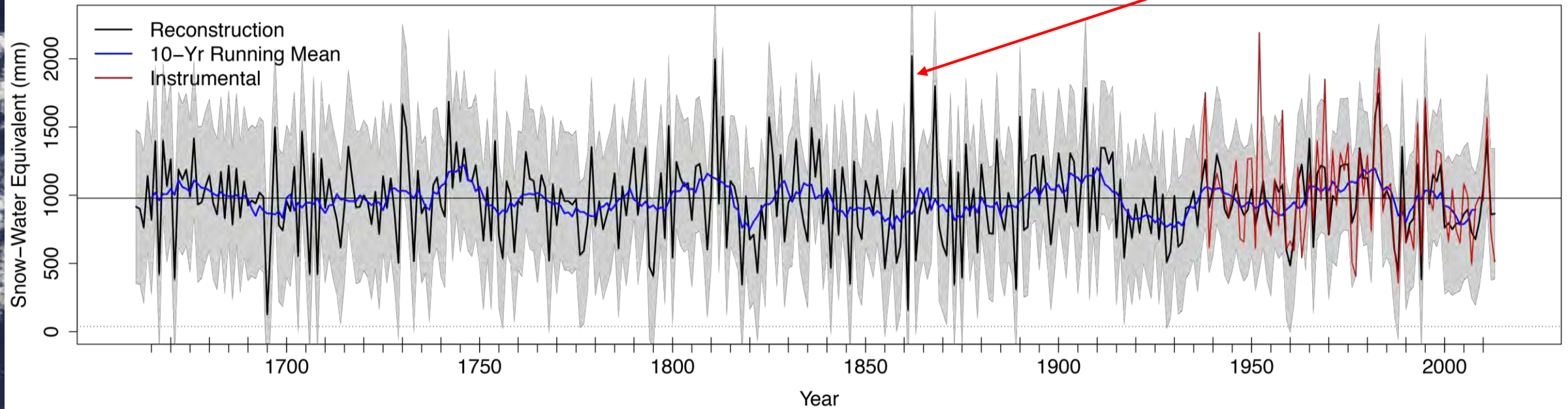
**Droughts of
1917 - 1937**



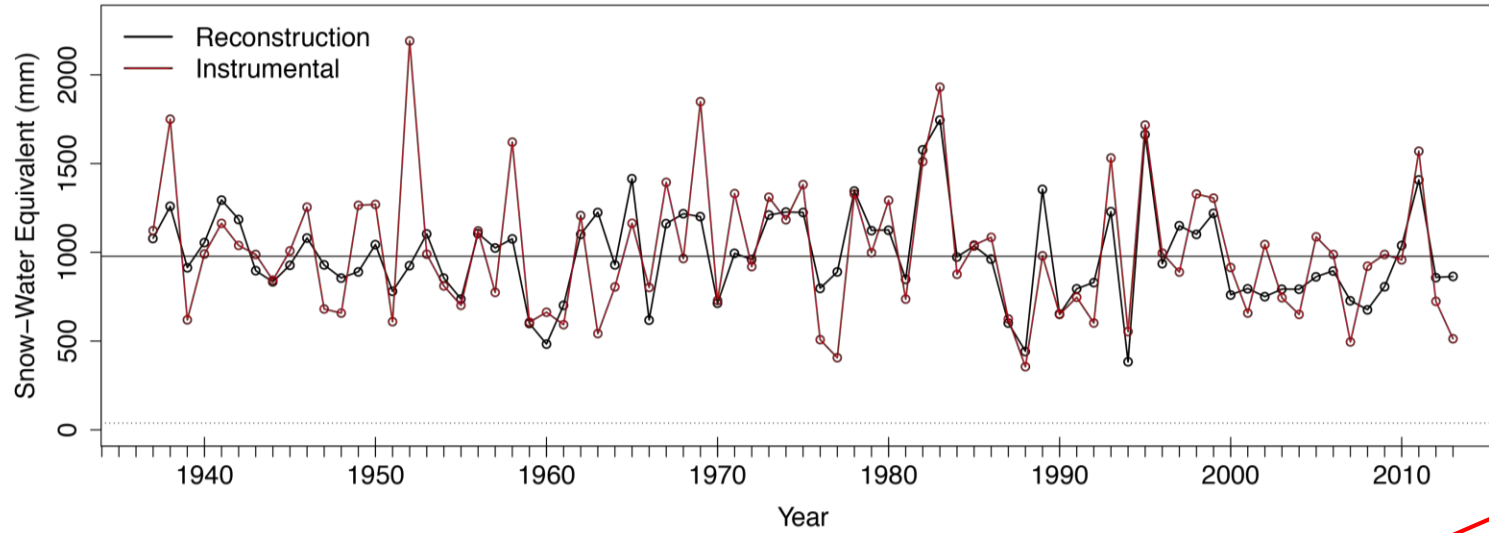
North Fork American River Reconstruction



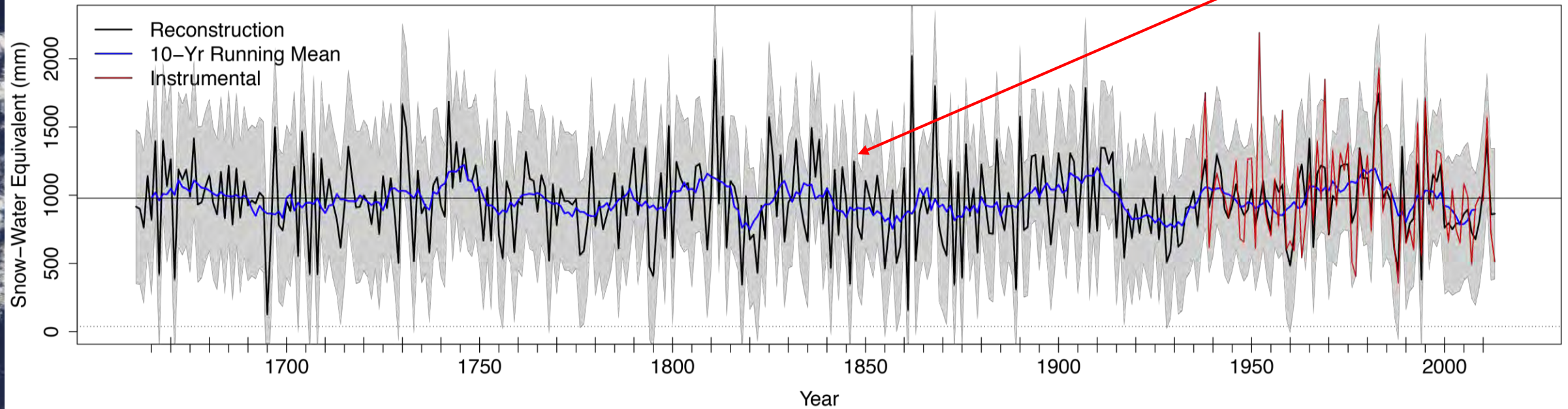
**Great flood of
1861/1862**



North Fork American River Reconstruction

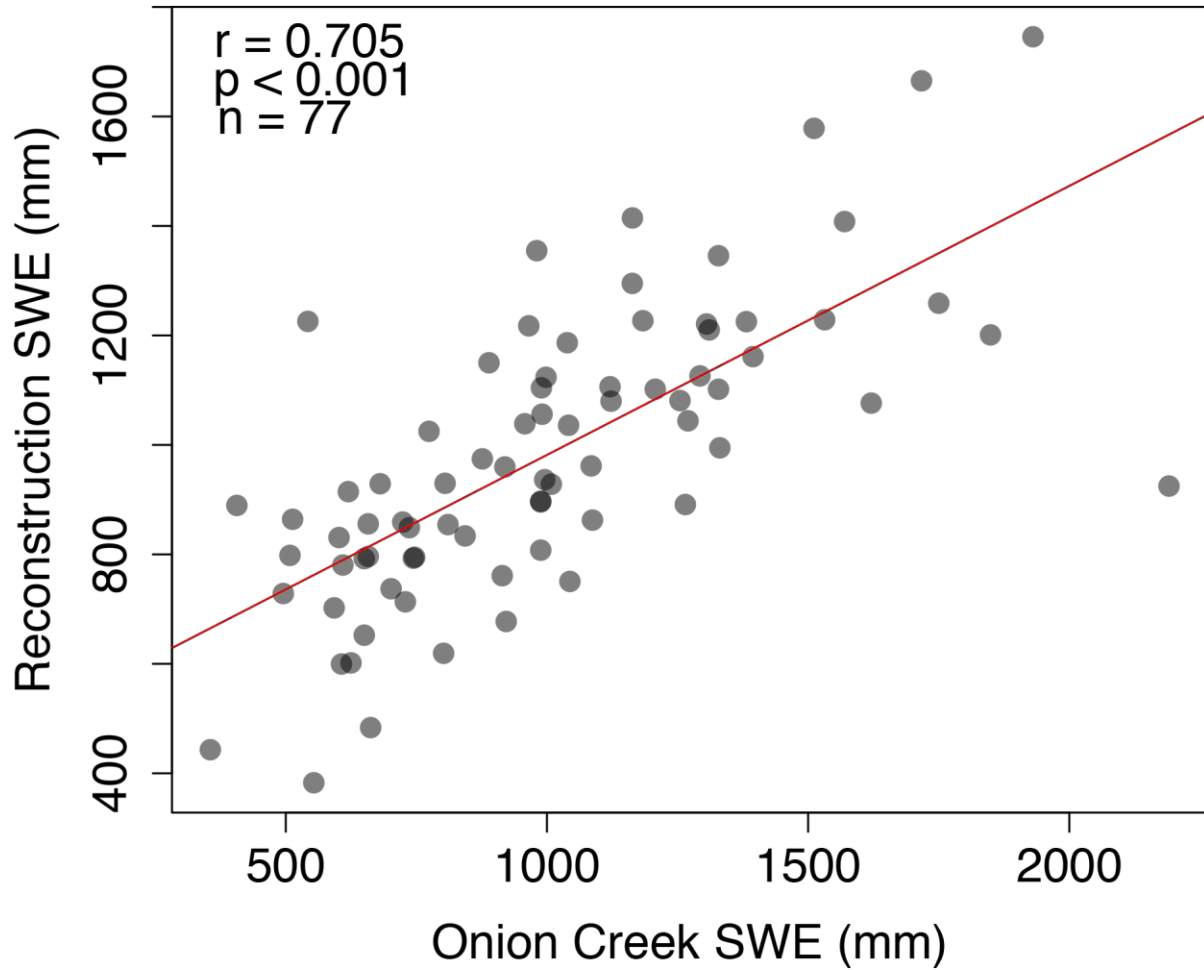


**Donner Party
winter
1846/1847**



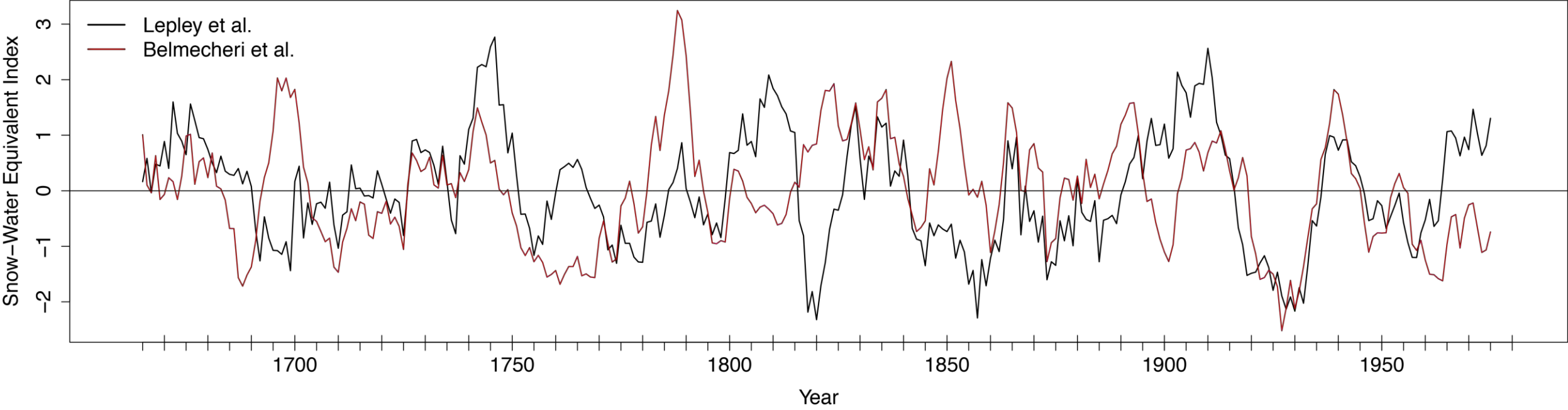
North Fork American River Reconstruction

Common Period Correlation



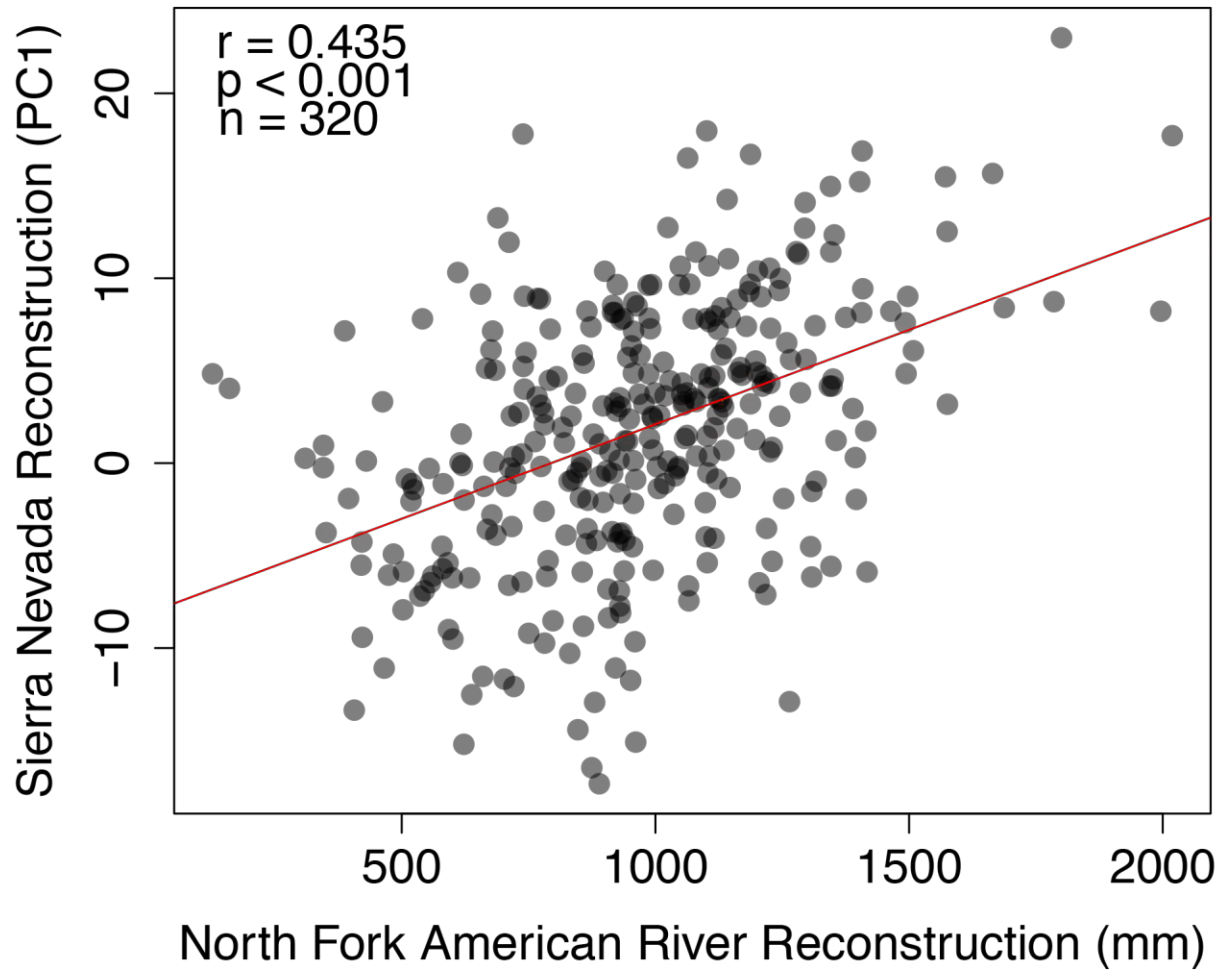
Sierra Nevada Reconstruction

Sierra Nevada and North Fork American River Snowpack Reconstructions

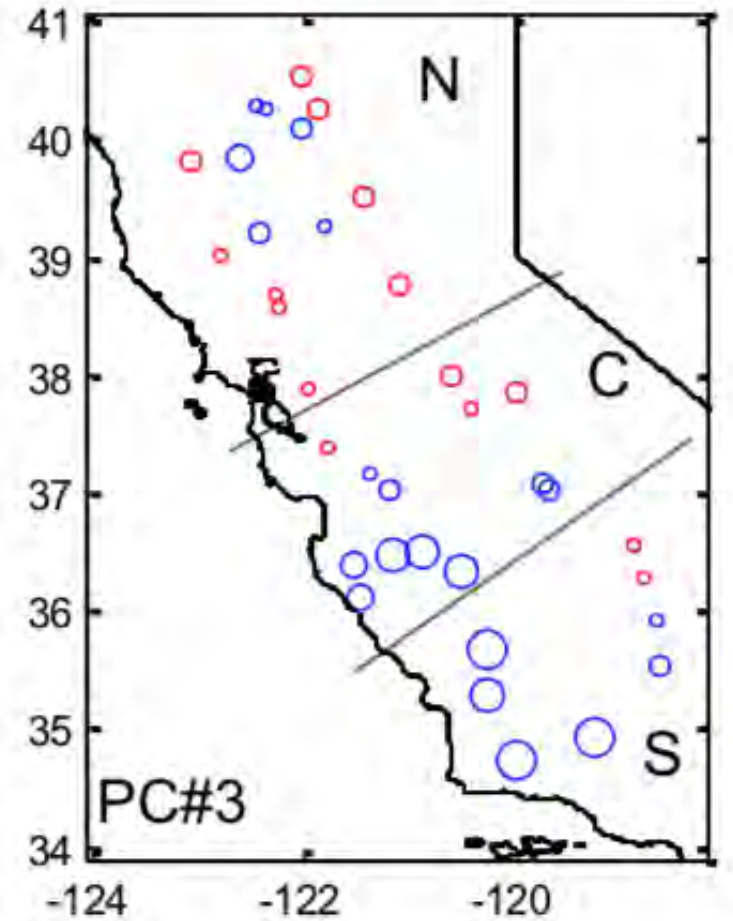
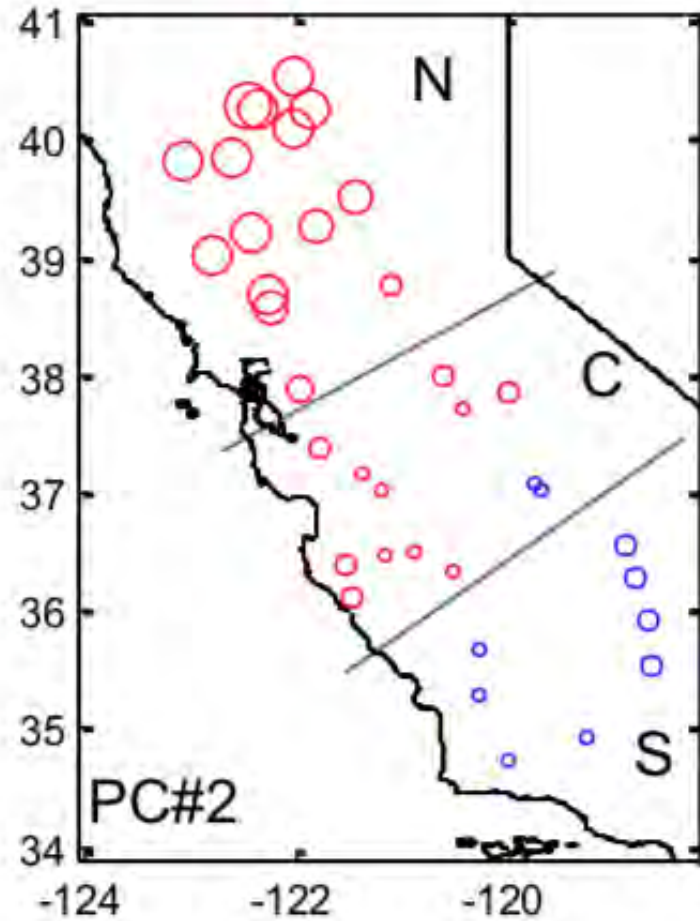
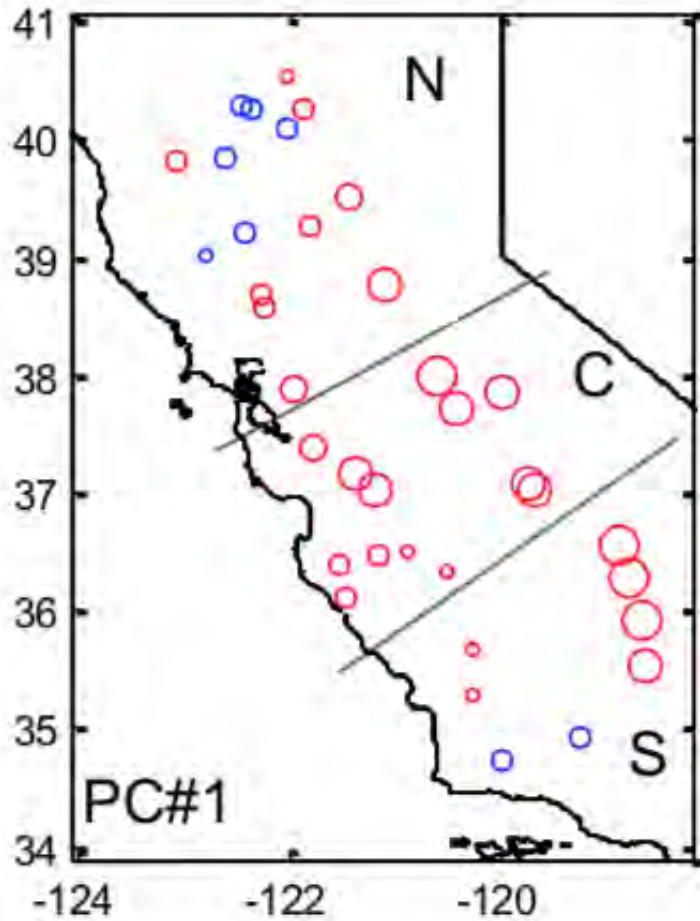


Sierra Nevada Reconstruction

Correlation of Reconstructions



Spatial Precipitation Variability



Conclusions

1. *Abies magnifica*, *Abies concolor*, *Calocedrus decurrens*, *Pinus ponderosa*, and *Tsuga mertensiana* tree rings reflected SWE variation
2. Tree-ring growth correlated with April 1 SWE of year prior
3. Chronologies developed from these tree rings were useful in skillfully reconstructing April 1 SWE
4. Record-low 2015 snowpack exceeds estimates of SWE in the pre-instrumental period
5. The watershed-scale reconstruction was significantly correlated with the broad-scale reconstruction by Belmecheri *et al.* (2016) despite numerous differences



Discussion

1. **April 1 SWE reconstruction captures significant 20th century variability and historically validated climate events lending support for methodology**
2. **Significant correlation with regional Sierra Nevada SWE reconstruction; additional support for severity of 2015 snowpack; various causes for differences**
3. **Ecophysiological mechanisms of lagged tree-growth response to climate in this region requires further investigation; potentially non-structural carbohydrates or bedrock moisture**



Thank you!

