Unusual warmth in the Central Sierra Nevada during the last 5 years

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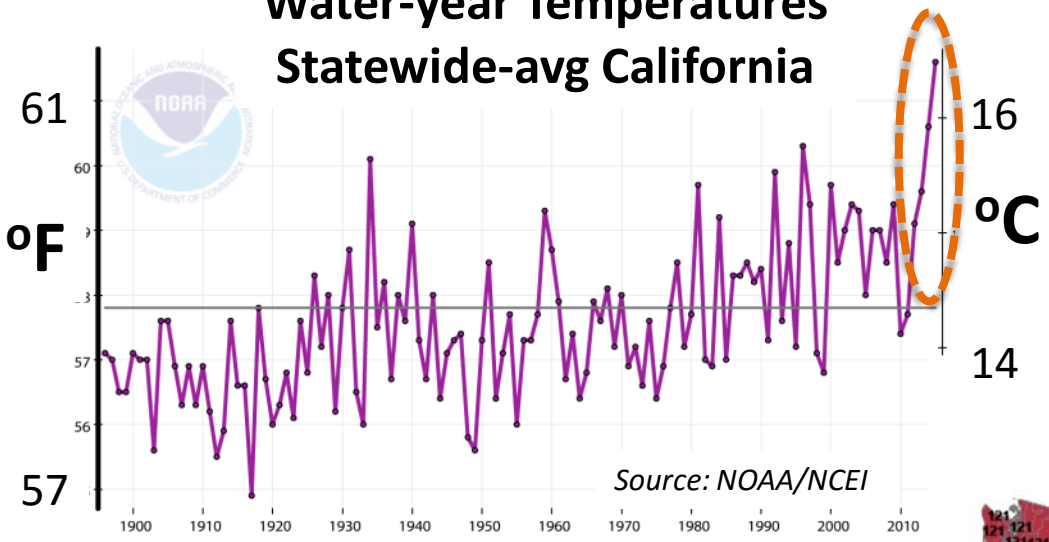
USGS
science for a changing world

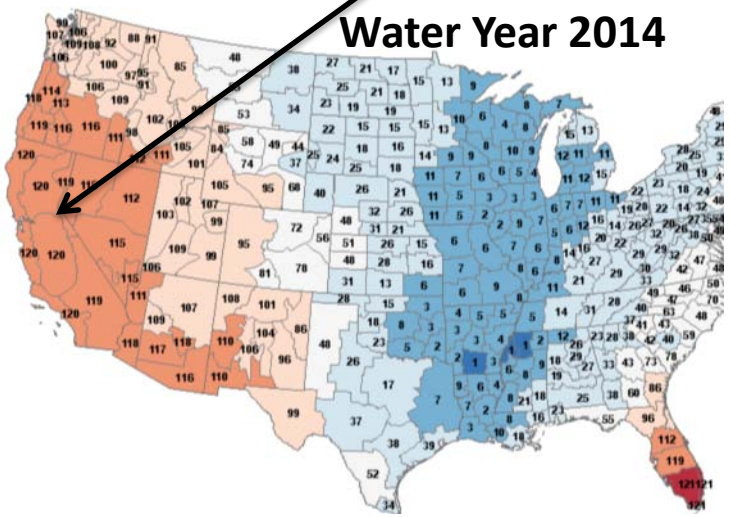
Water-year Temperatures
Statewide-avg California



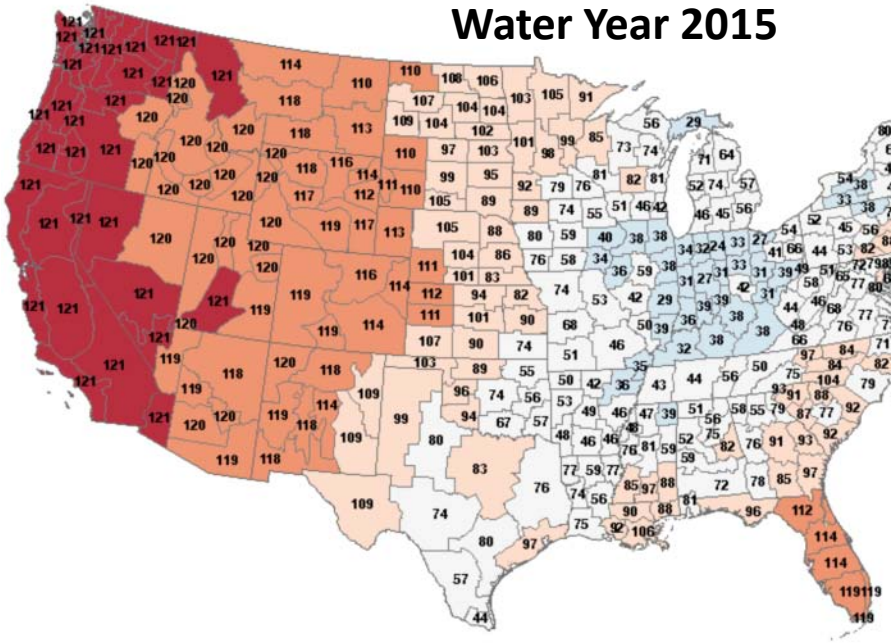
Divisional Average Temperature Rank
October 2014 - September 2015

Record breaking warmth

Water Year 2014



Water Year 2015

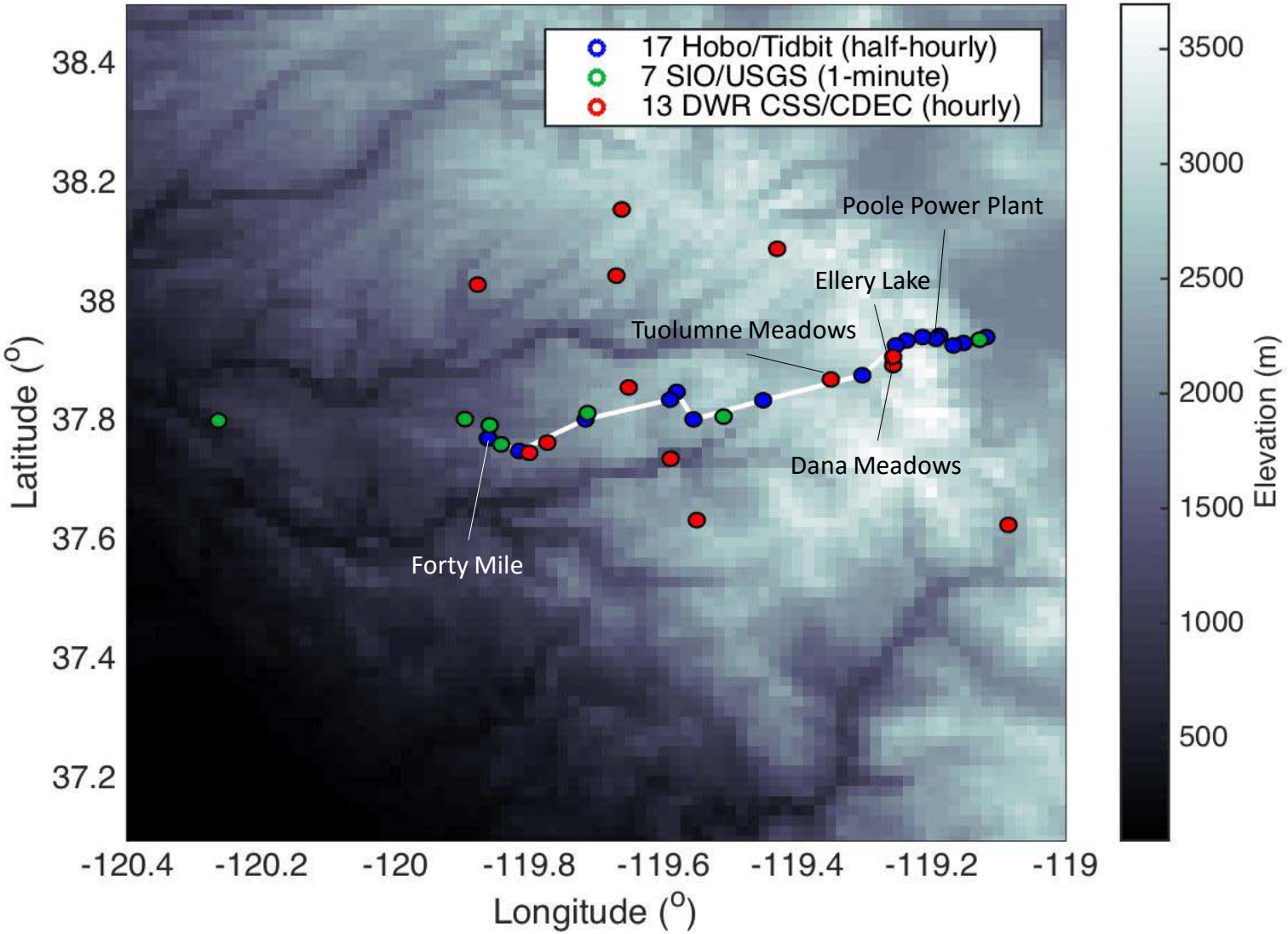


Probing the Unusual Warmth During 2014-2015

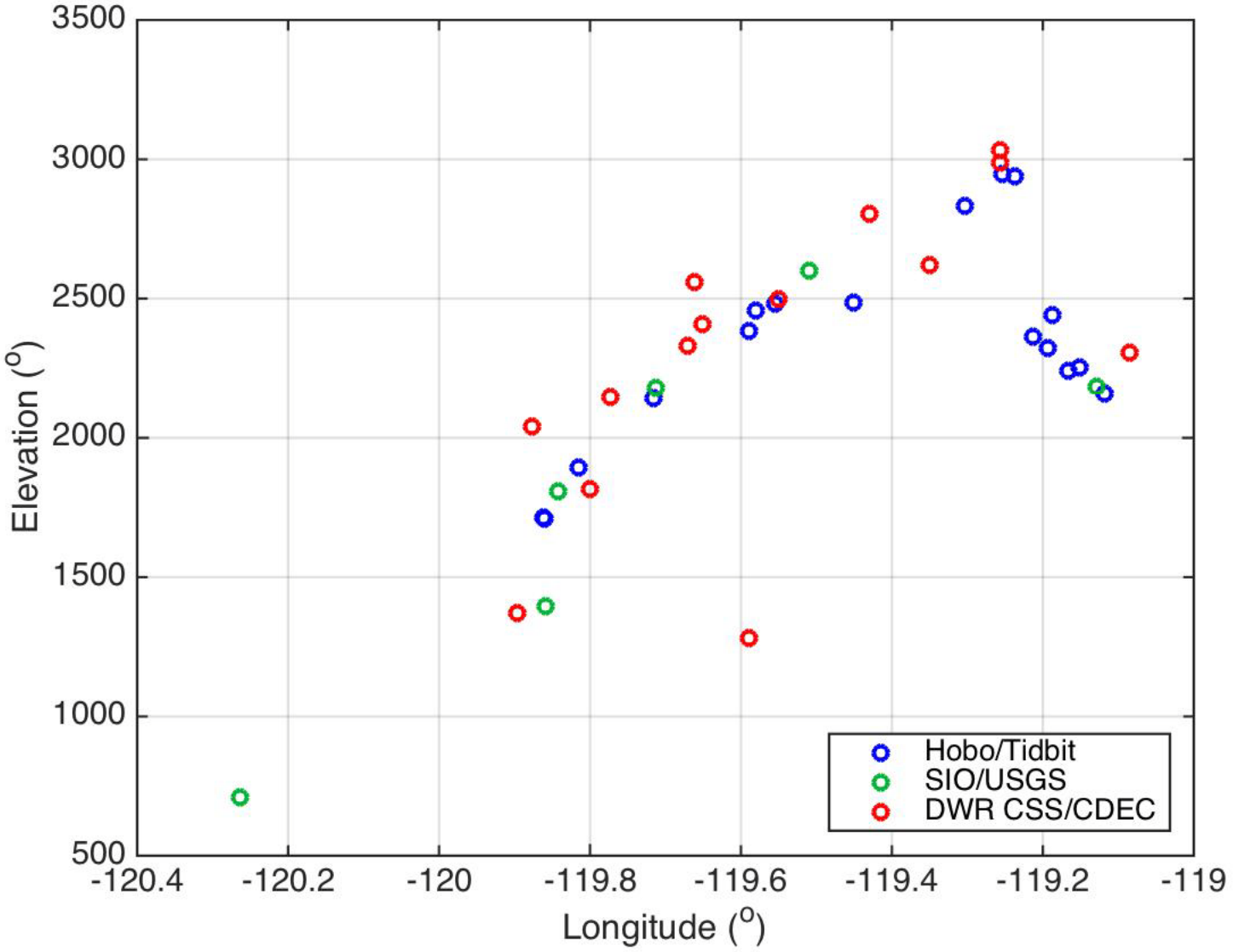
Was the overall warmth in these recent years attributed to:

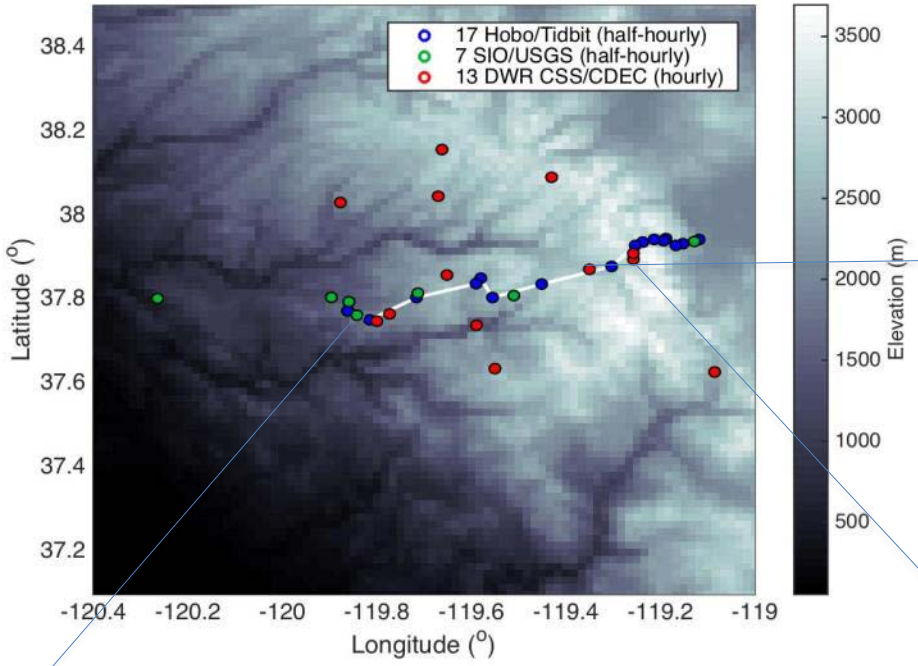
- warmer days or warmer nights?
- general increase in positive anomalies (across small- to large-anomaly magnitudes)?
- increased occurrence of high positive anomalies?
- lack of negative anomalies and particularly lack of strong cold outbreaks?

Highway 120 Temperature Network



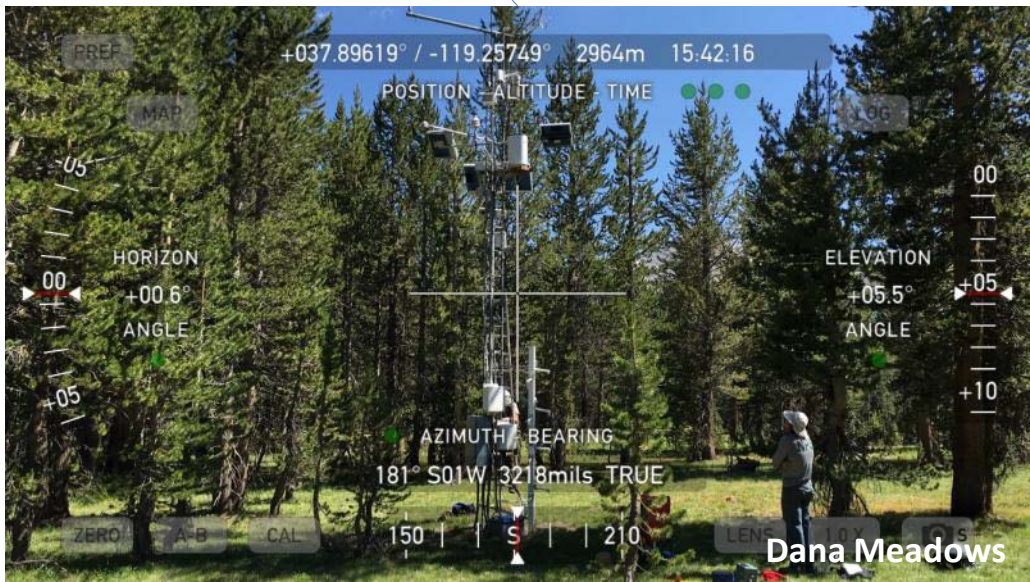
Highway 120 Temperature Network




17 Hobo/Tidbit (half-hourly)
7 SIO/USGS (half-hourly)
13 DWR CSS/CDEC (hourly)
38.4
38.2
38
37.8
37.6
37.4
37.2
Latitude (°)
-120.4
-120.2
-120
-119.8
-119.6
-119.4
-119.2
-119
Longitude (°)
3500
3000
2500
2000
1500
1000
500
Elevation (m)

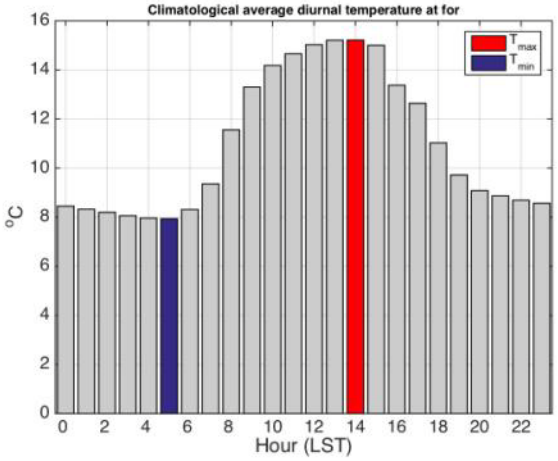

Tuolumne Meadows

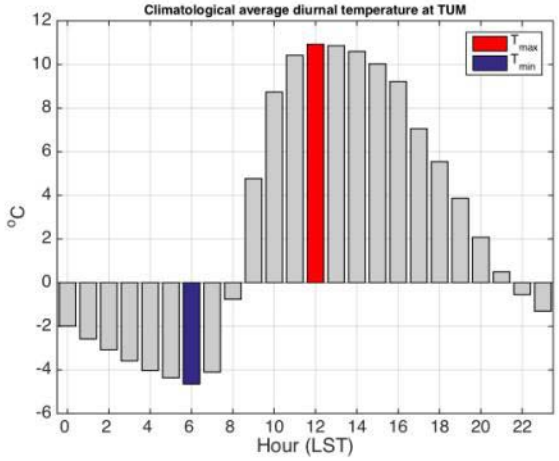

Forty Mile

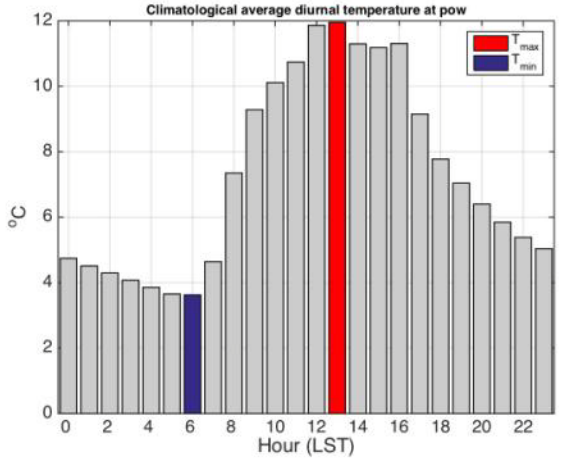

PREP
+037.89619° / -119.25749° 2964m 15:42:16
POSITION ALTITUDE TIME
MAP
LOG
HORIZON
+00.6°
ANGLE
ELEVATION
+05.5°
ANGLE
AZIMUTH / BEARING
181° S01W 3218mils TRUE
ZERO
A-B
CAL
150
S
210
Dana Meadows

Diurnal Cycle and Daily Maximum and Minimum Temperature

- The diurnal cycle is an interesting property of mountain climate
- Daily temperature minima (T_{min}) and maxima (T_{max}) vary across this network and with season, but in this study we approximate the time of minima as 6 LST and maxima as 13 LST.







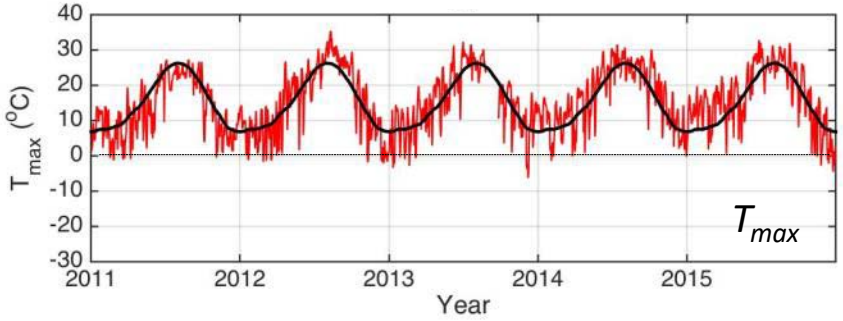
Daily T_{max} and T_{min}

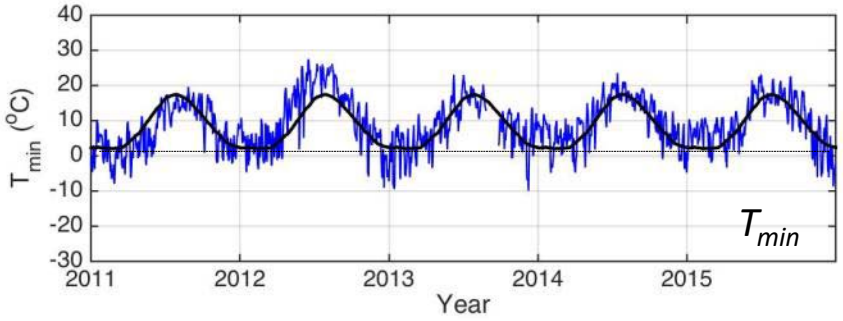
Western Sierra

Eastern Sierra

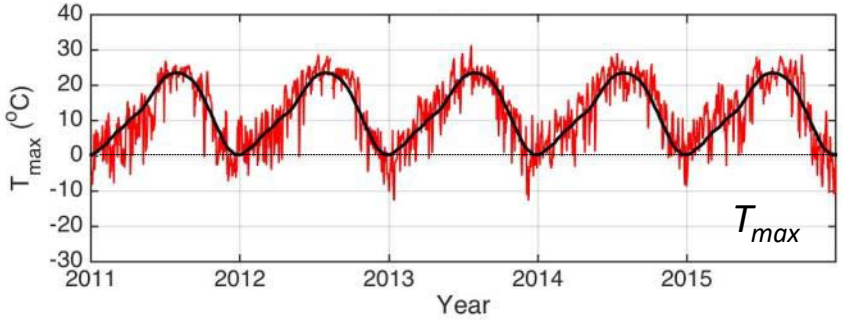
Lower elevation

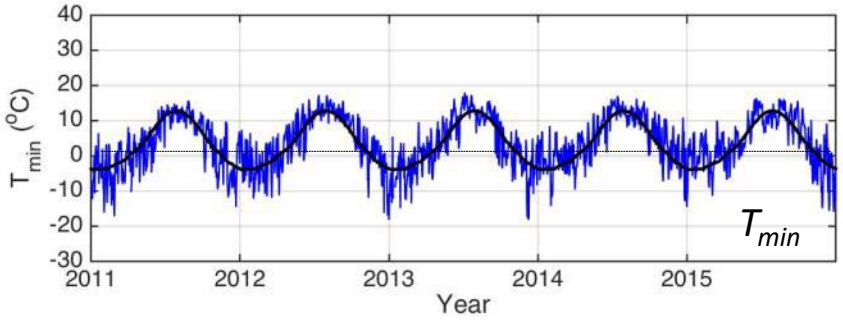
Forty Mile





Poole Power Plant





Note: The black curves are 2006-2015 climatological averages

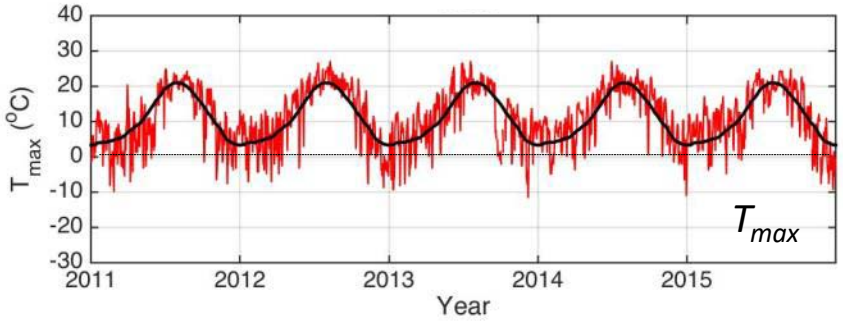
Daily T_{max} and T_{min}

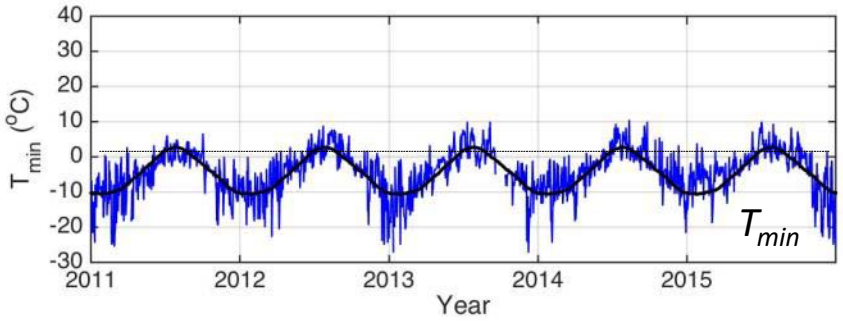
Western Sierra

Eastern Sierra

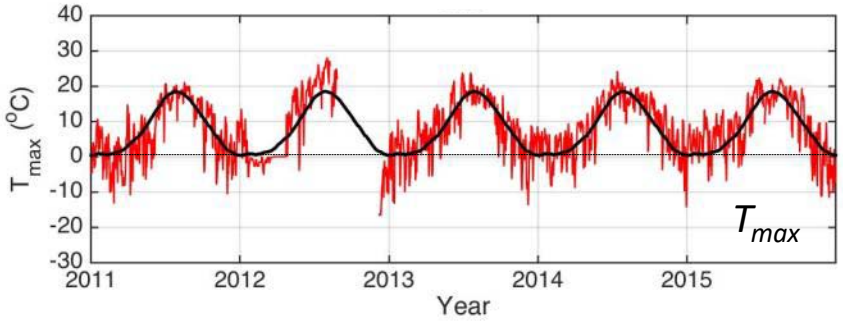
Higher elevation

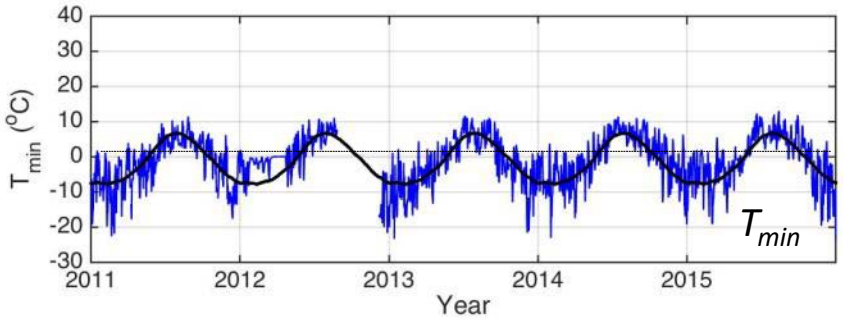
Tuolumne Meadows





Ellery Lake





Note: The black curves are 2006-2015 climatological averages

Daily T_{max} and T_{min} Anomalies

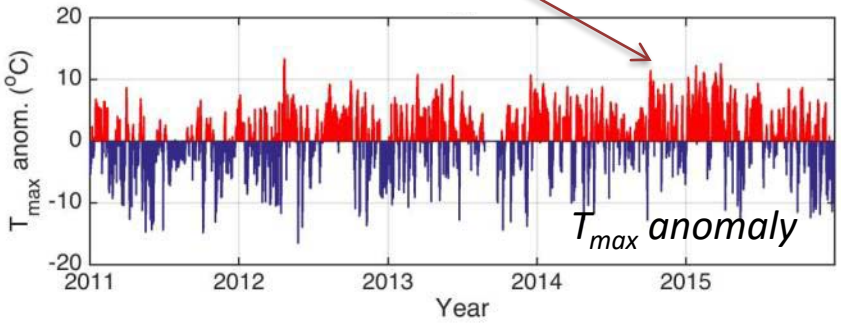
Western Sierra

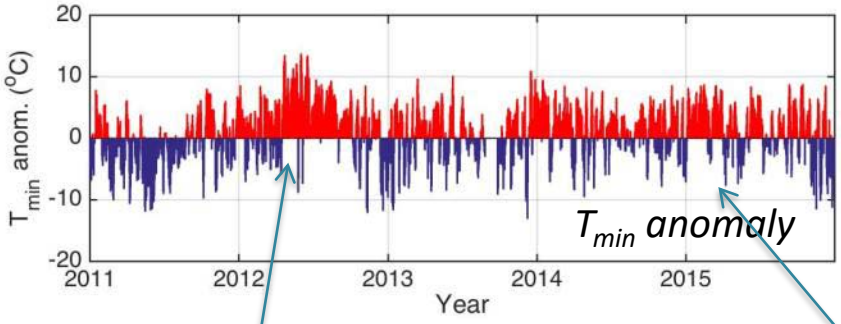
Eastern Sierra

More positive T_{max} anomalies

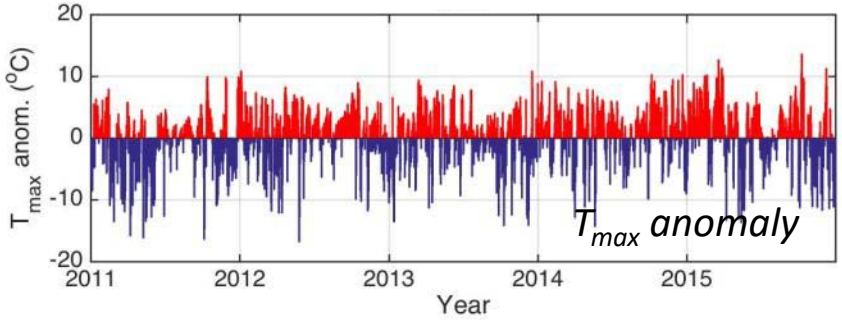
Lower elevation

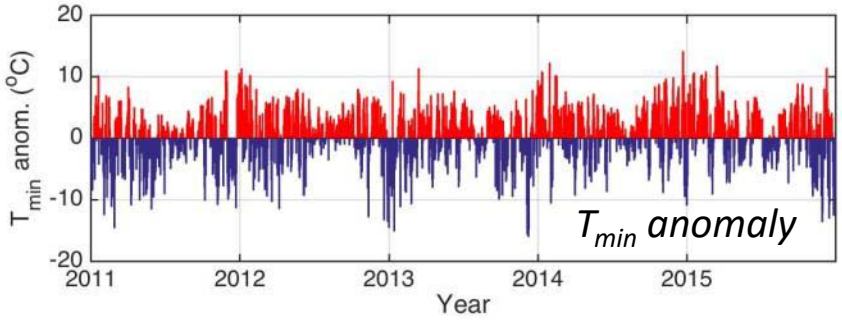
Forty Mile





Poole Power Plant





Highly positive T_{min} anomalies

Lack of negative T_{min} anomalies

Note: The anomalies are based on 2006-2015 climatological averages

Daily T_{max} and T_{min} Anomalies

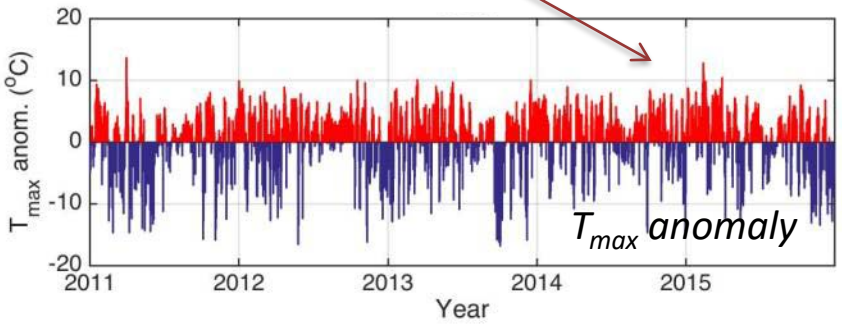
Western Sierra

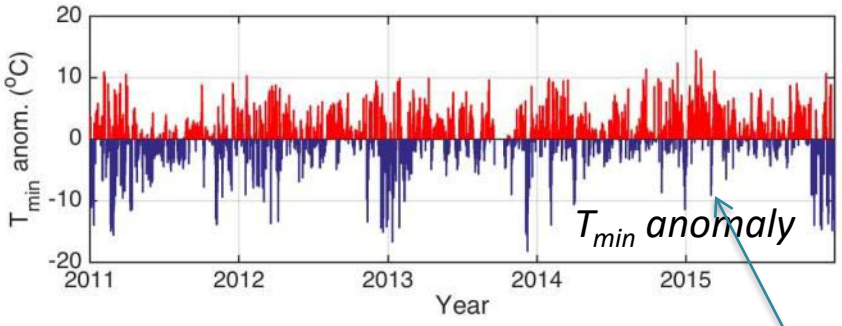
Eastern Sierra

More positive T_{max} anomalies

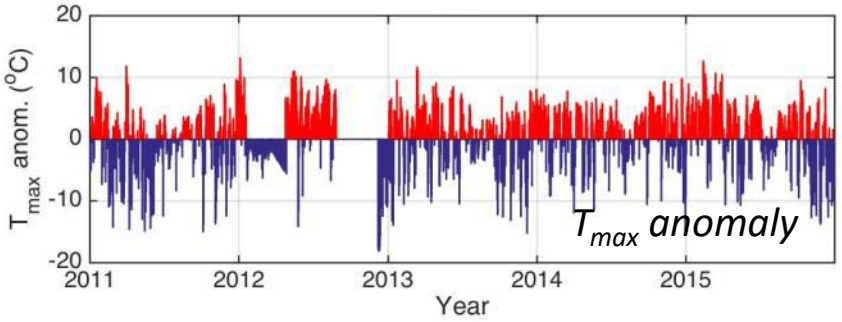
Higher elevation

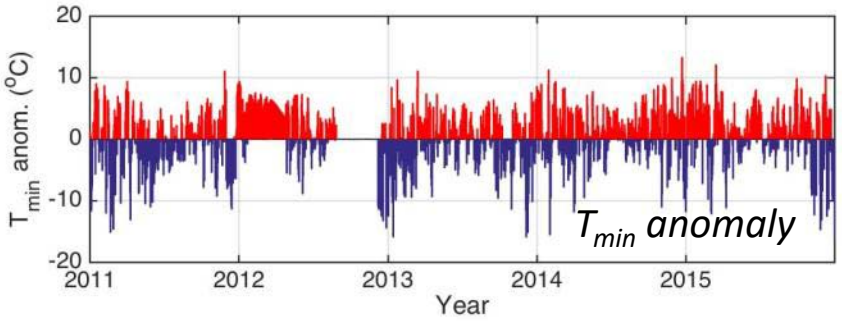
Tuolumne Meadows





Ellery Lake



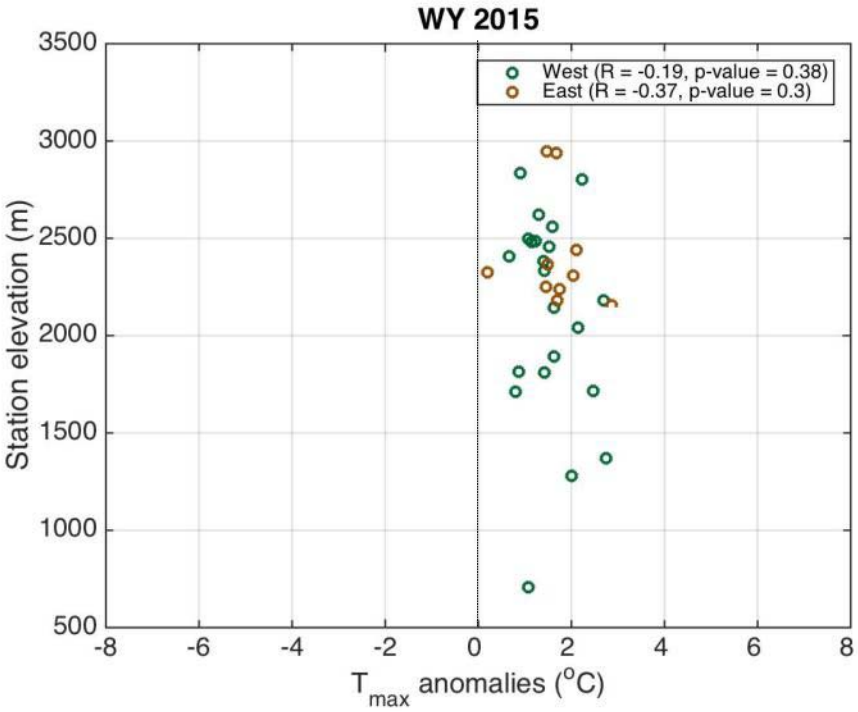


Lack of negative T_{min} anomalies

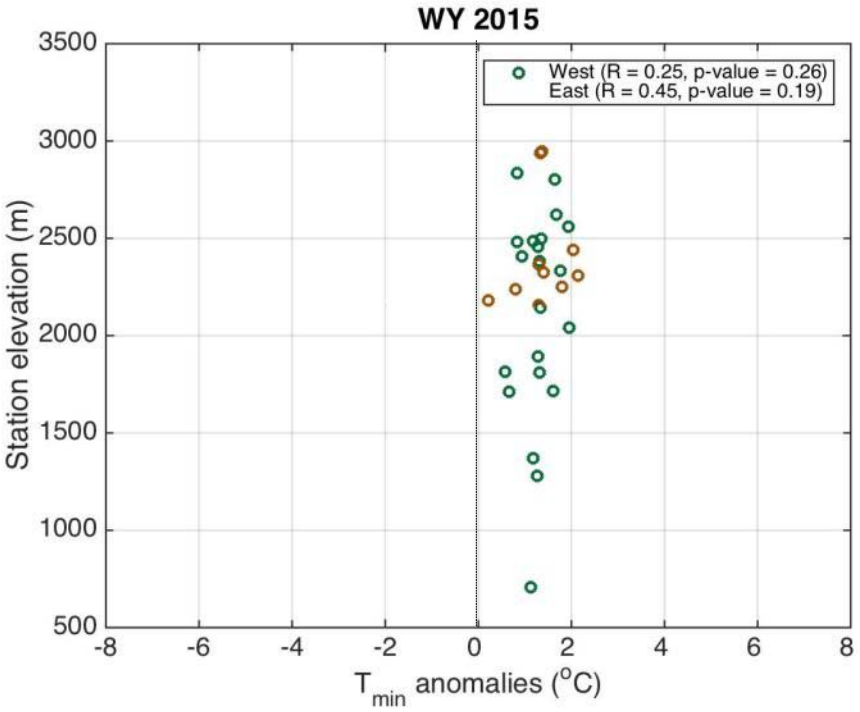
Note: The anomalies are based on 2006-2015 climatological averages

T_{max} and T_{min} Anomalies vs. Elevation (All Seasons)

T_{max}



T_{min}

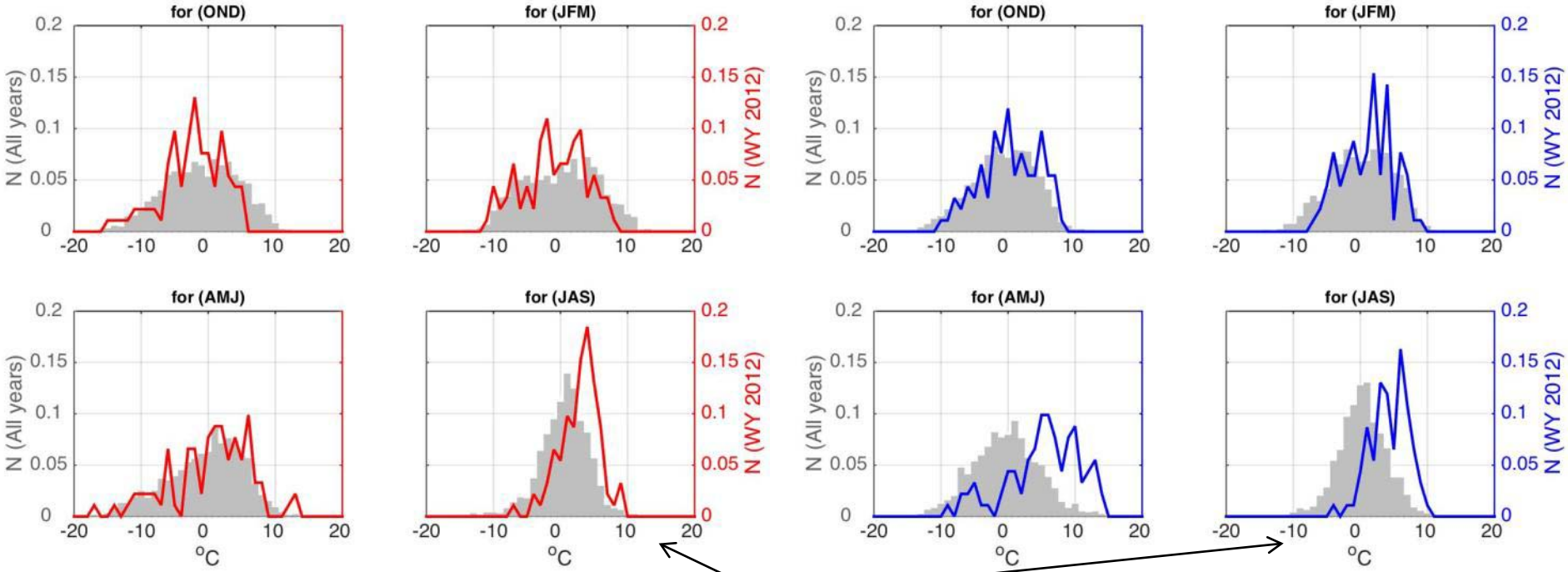


No obvious T_{max}/T_{min} anomalies relationship with elevation

T_{max} and T_{min} Anomaly Distributions at Forty Mile

T_{max} T_{min}

WY 2012 (compared to all year results)

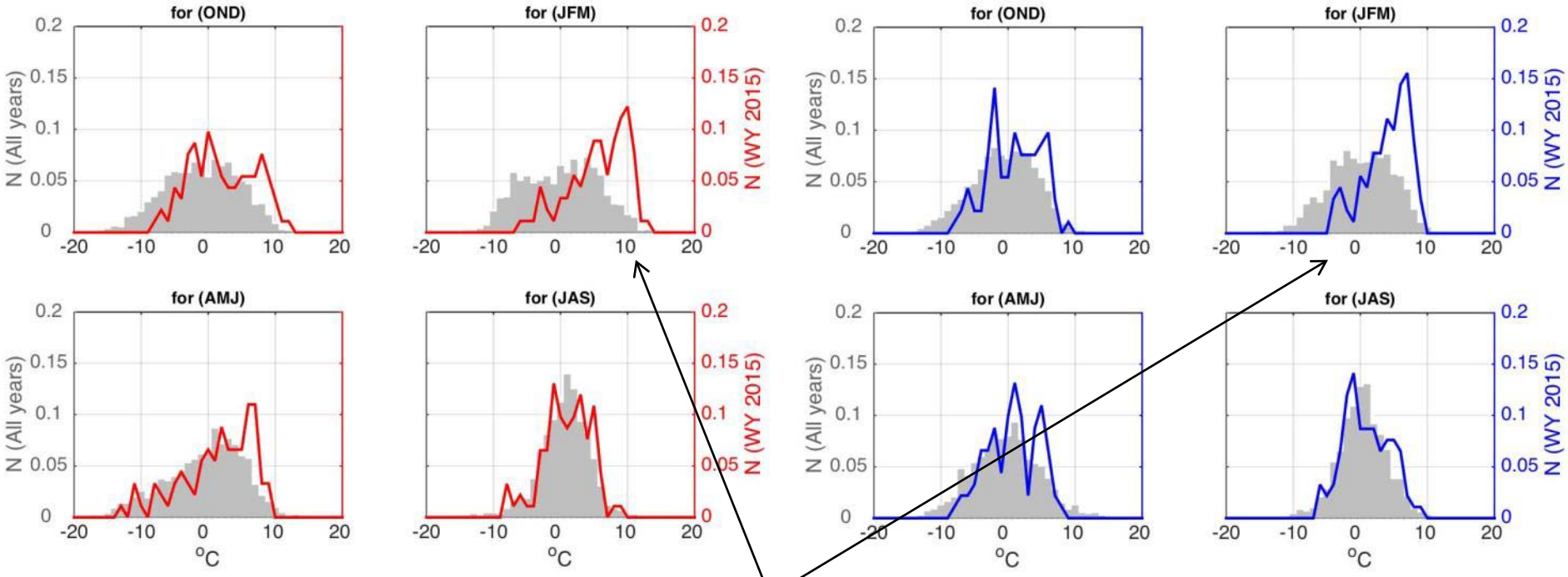


Note: N = Total number of occurrences, normalized by the sample size, for = Forty Mile
OND = Oct-Dec, JFM = Jan-Mar, AMJ = Apr-Jun, JAS = Jun-Sep

T_{max} and T_{min} Anomaly Distributions at Forty Mile

T_{max} T_{min}

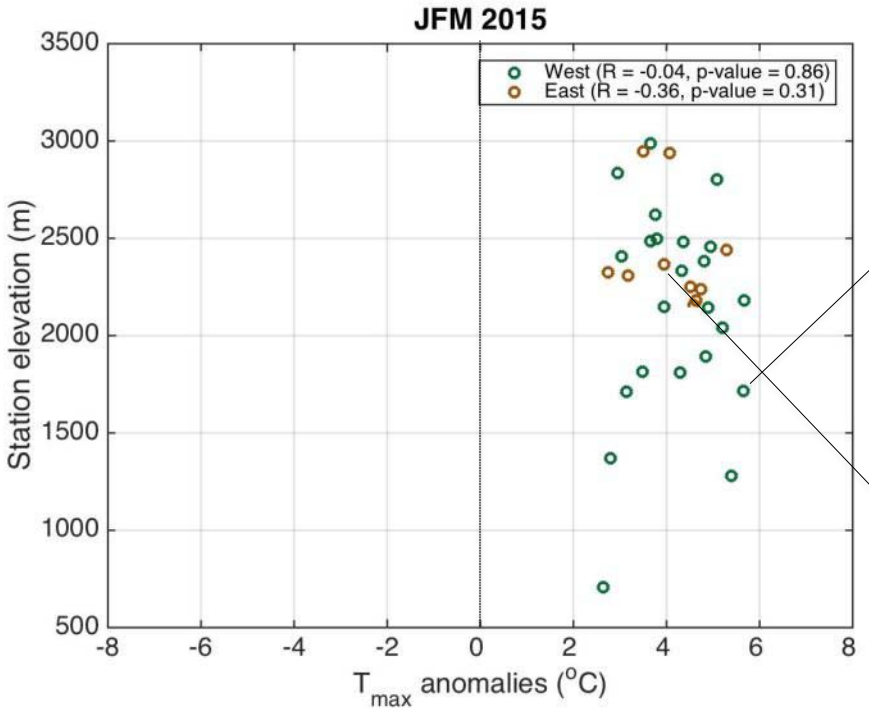
WY 2015 (compared to all year results)

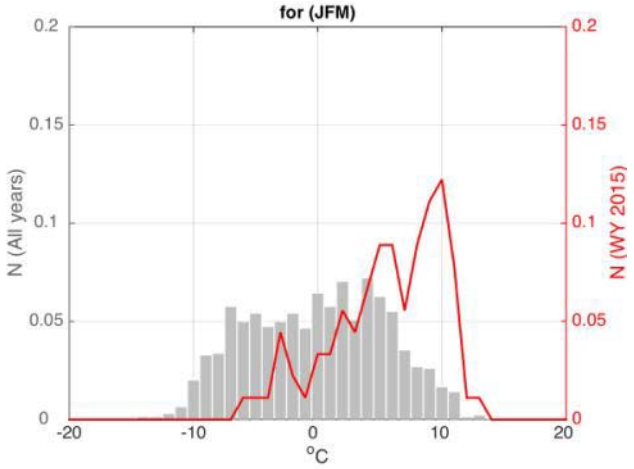


Note: N = Total number of occurrences, normalized by the sample size, for = Forty Mile
OND = Oct-Dec, JFM = Jan-Mar, AMJ = Apr-Jun, JAS = Jun-Sep

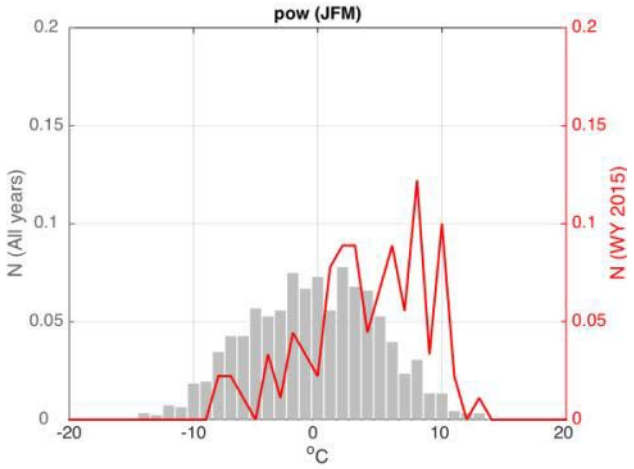
T_{max} Anomalies vs. Elevation (Jan-Mar)

Lower elevation





Western Sierra

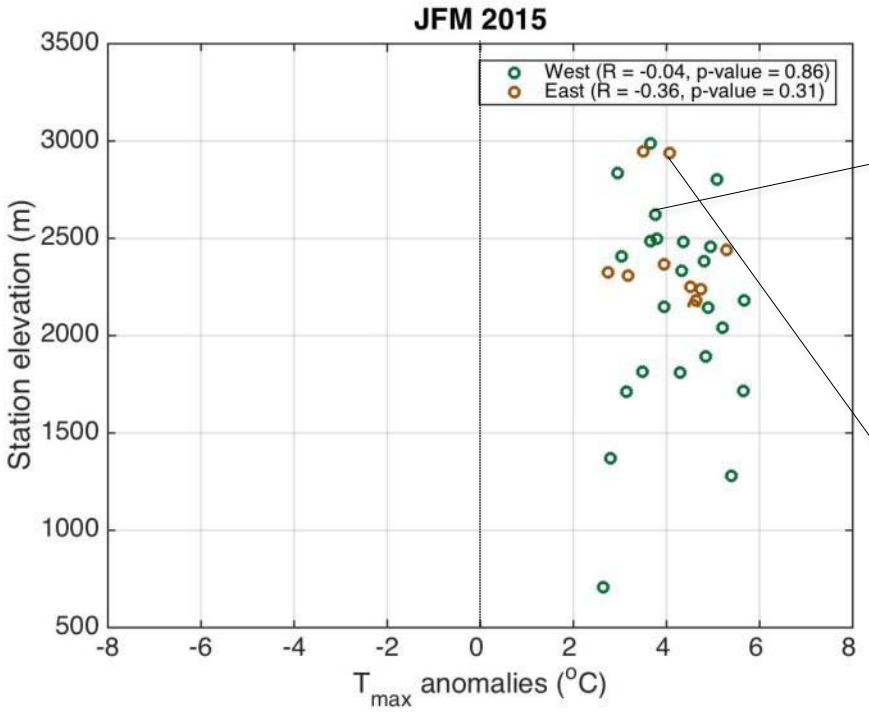


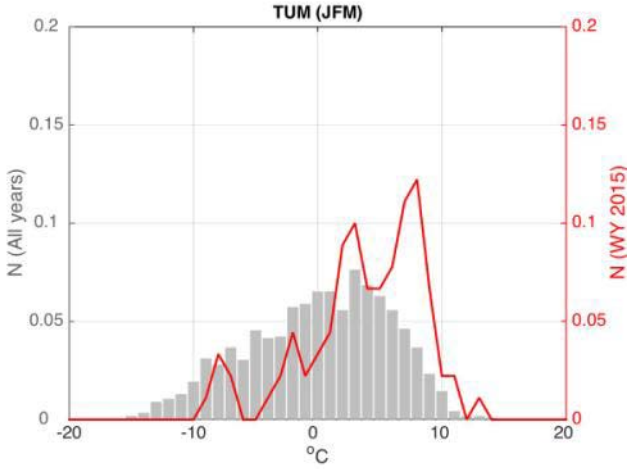
Eastern Sierra

Note: N = Total number of occurrences, normalized by the sample size
for = Forty Mile, pow = Poole Power Plant

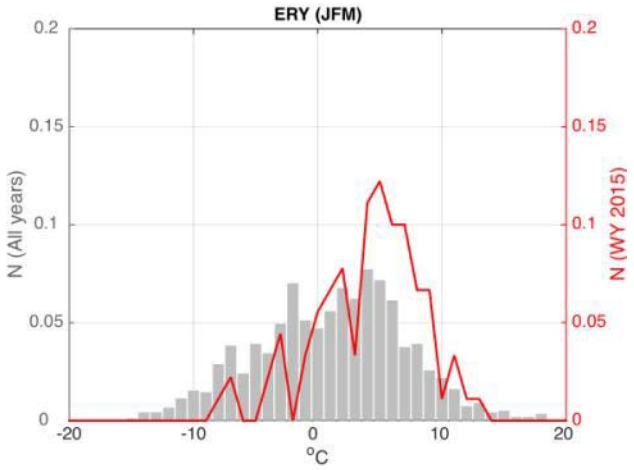
T_{max} Anomalies vs. Elevation (Jan-Mar)

Higher elevation





Western Sierra

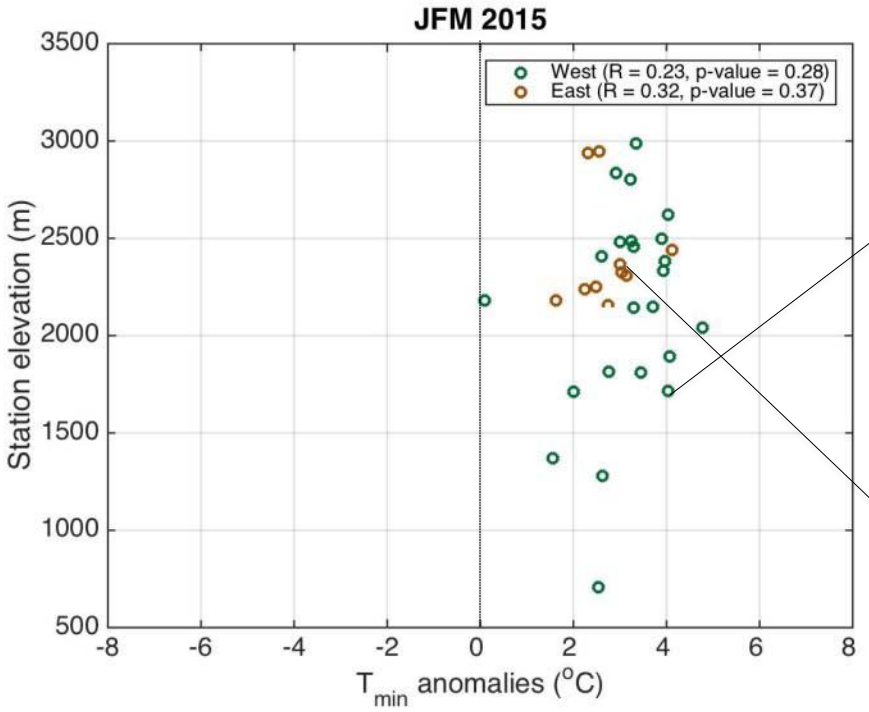


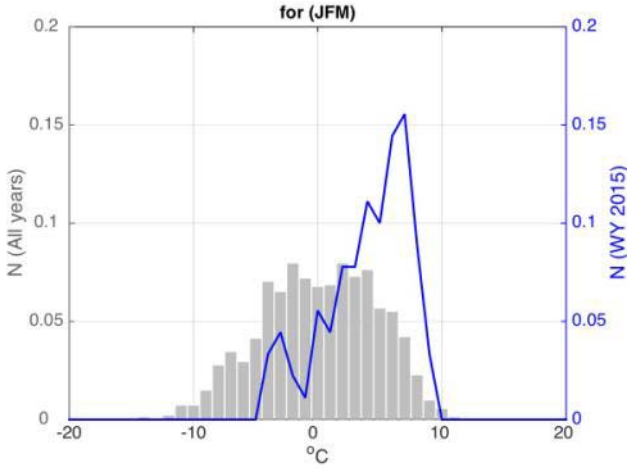
Eastern Sierra

Note: N = Total number of occurrences, normalized by the sample size
TUM = Tuolumne Meadows, ERY = Ellery Lake

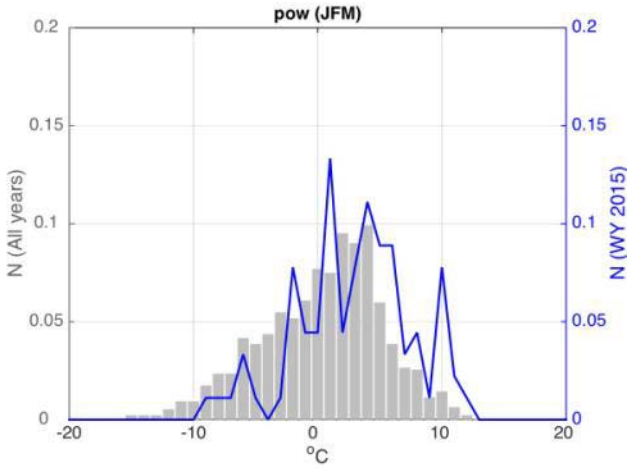
T_{min} Anomalies vs. Elevation (Jan-Mar)

Lower elevation





Western Sierra

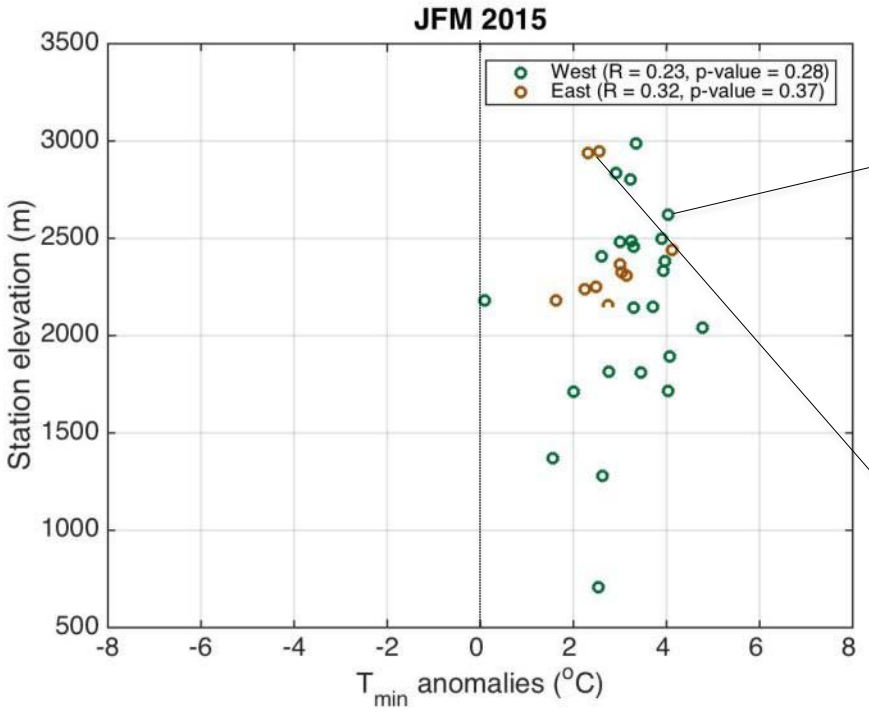


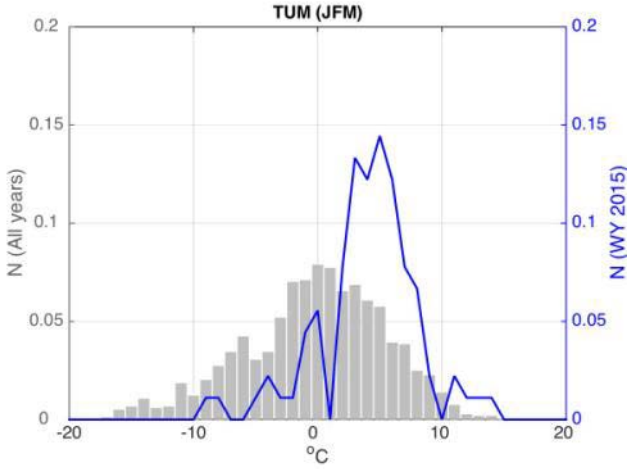
Eastern Sierra

Note: N = Total number of occurrences, normalized by the sample size
for = Forty Mile, pow = Poole Power Plant

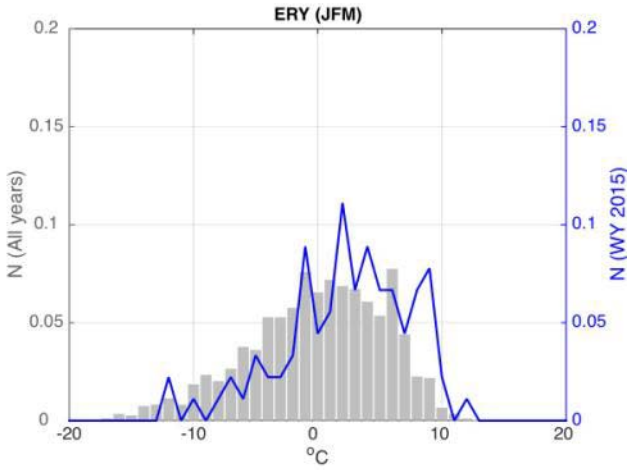
T_{min} Anomalies vs. Elevation (Jan-Mar)

Higher elevation





Western Sierra

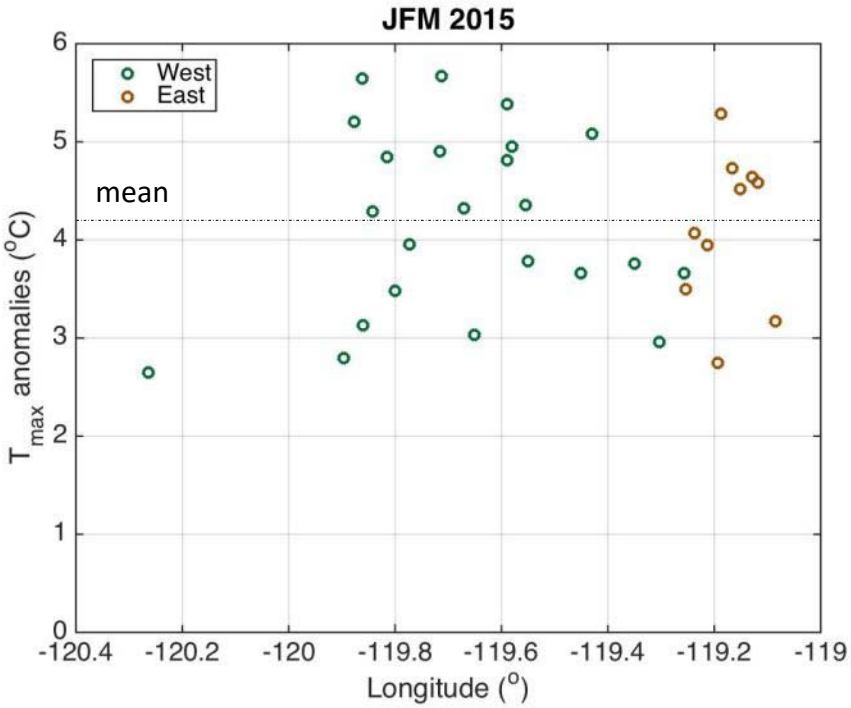


Eastern Sierra

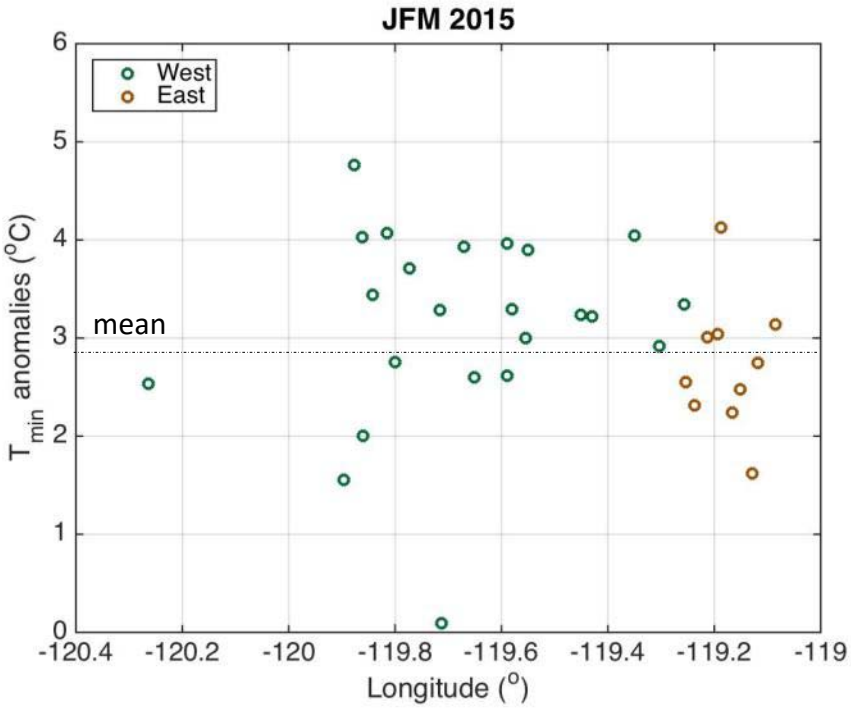
Note: N = Total number of occurrences, normalized by the sample size
TUM = Tuolumne Meadows, ERY = Ellery Lake

T_{max} and T_{min} Anomalies vs. Longitude (Jan-Mar)

T_{max}



T_{min}



No obvious T_{max}/T_{min} anomalies relationship with longitude

Seasonal T_{max} and T_{min} anomaly averages during 2015

Season	T_{max} anomaly (°C)	T_{min} anomaly (°C)
OND	1.24	0.84
JFM	4.15	2.93
AMJ	0.30	0.48
JAS	0.73	0.68

Conclusions

- Both days and nights were warm during the last 5 years, but the days were particularly warm, most notably in JFM (winter) of 2015.
- Increasing occurrences of positive T_{max} and T_{min} anomalies
- Provisionally, based on limited number of stations, warm anomalies during 2015 were greater in the western than in the eastern Sierra.
- Low elevation temperatures exhibited more frequent strong positive anomalies than high elevation anomalies

Work in progress to more fully study the space/time temperature variations and the recent warm spells