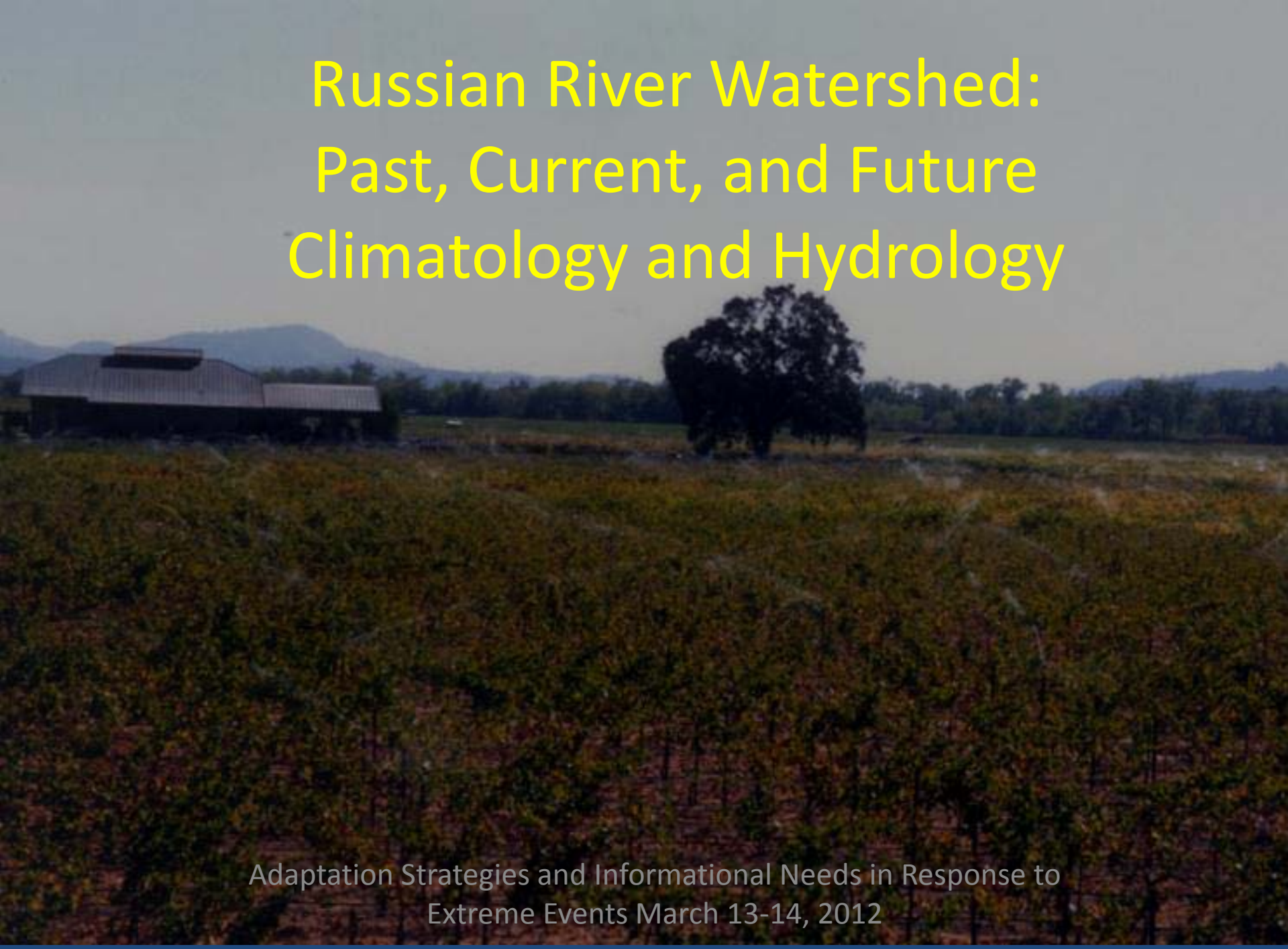
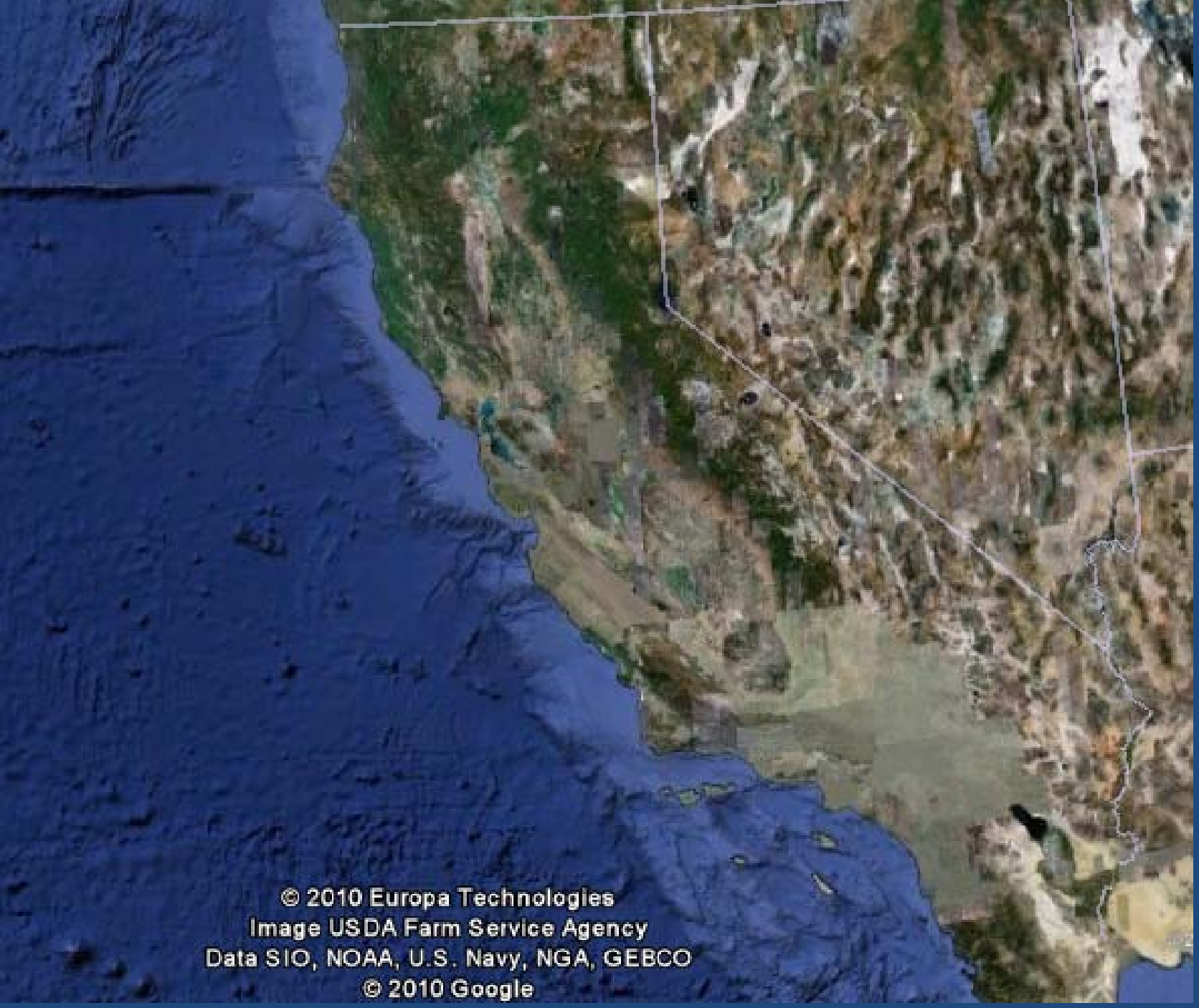
Russian River Watershed: Past, Current, and Future Climatology and Hydrology



Adaptation Strategies and Informational Needs in Response to Extreme Events March 13-14, 2012

Talk Overview

- Geography
- Temperature and Precipitation
- Flow
- Extremes
- Projected Change


© 2010 Europa Technologies
Image USDA Farm Service Agency
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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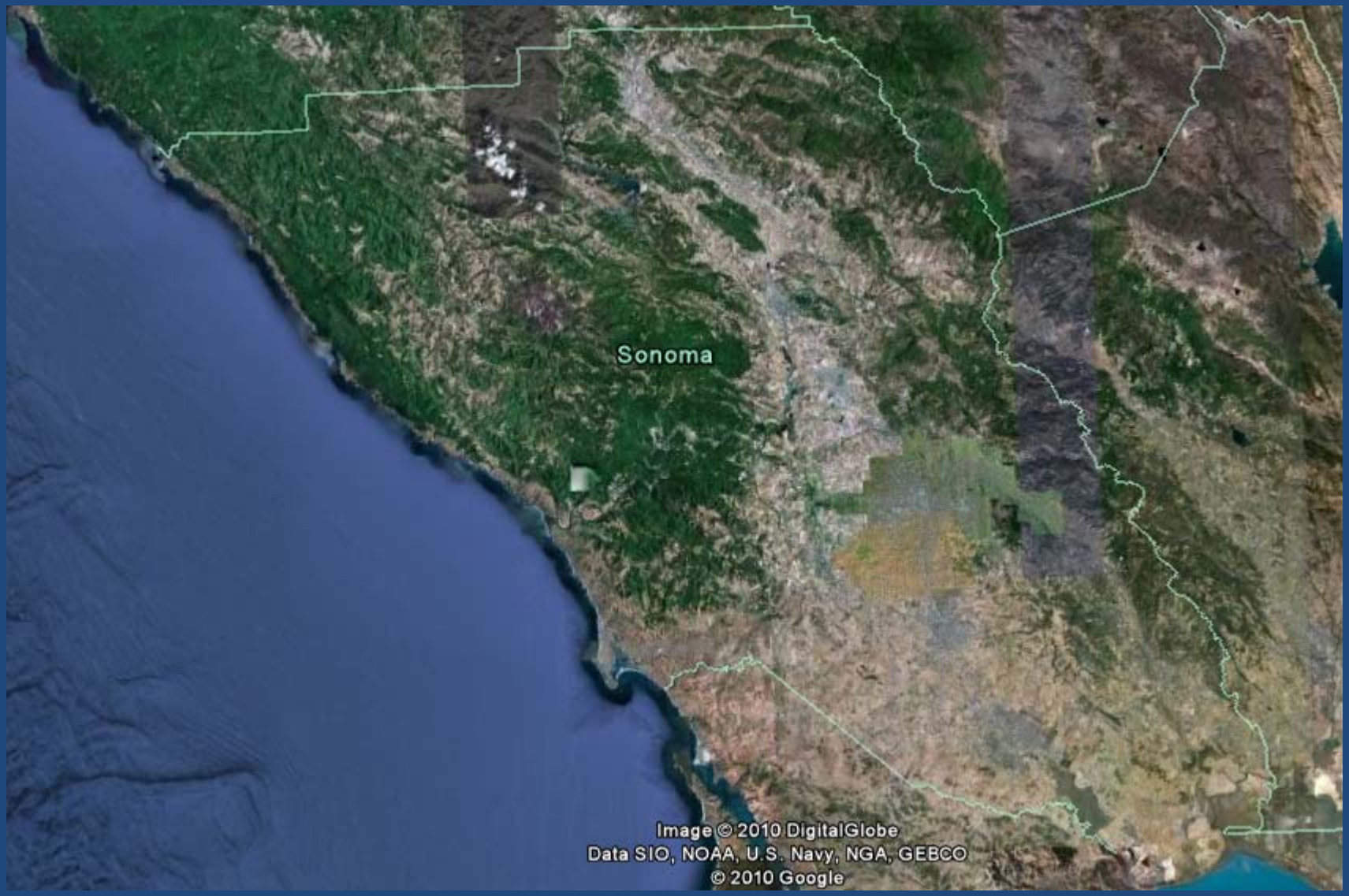
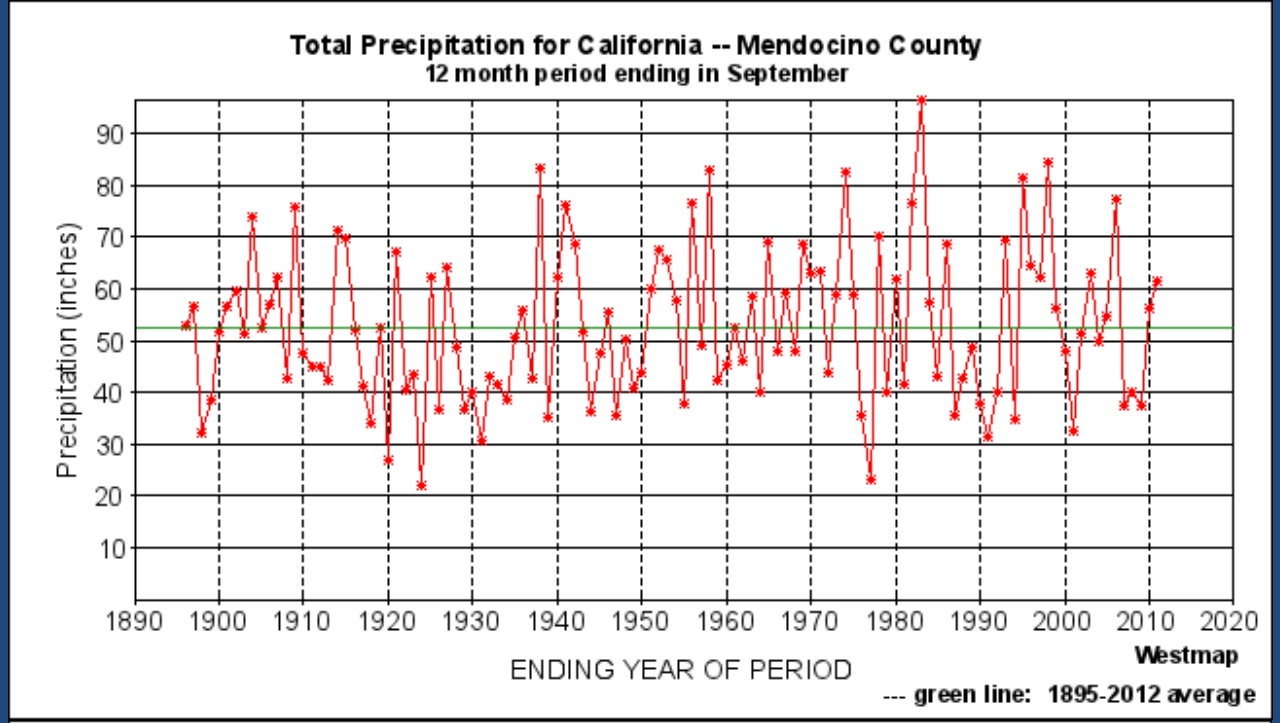

Sonoma
Image © 2010 DigitalGlobe
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2010 Google

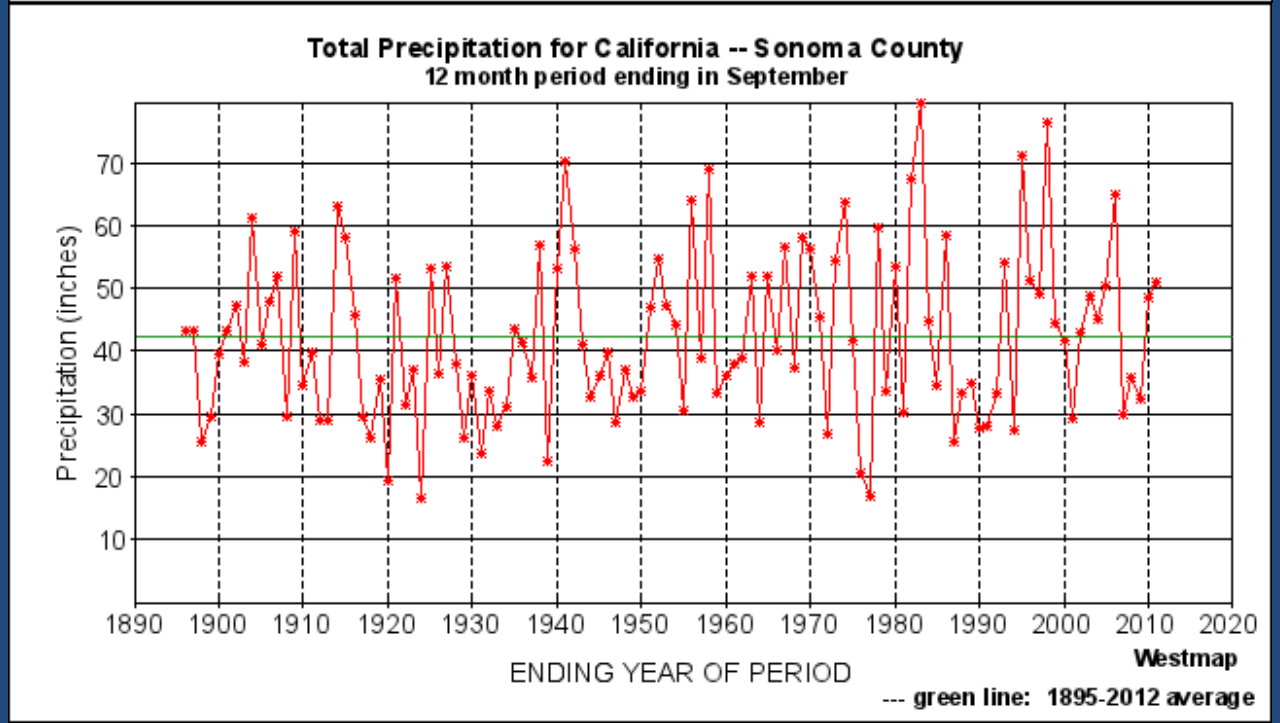
Data CSUMB SFML, CA OPC
Image © 2010 DigitalGlobe
©2009

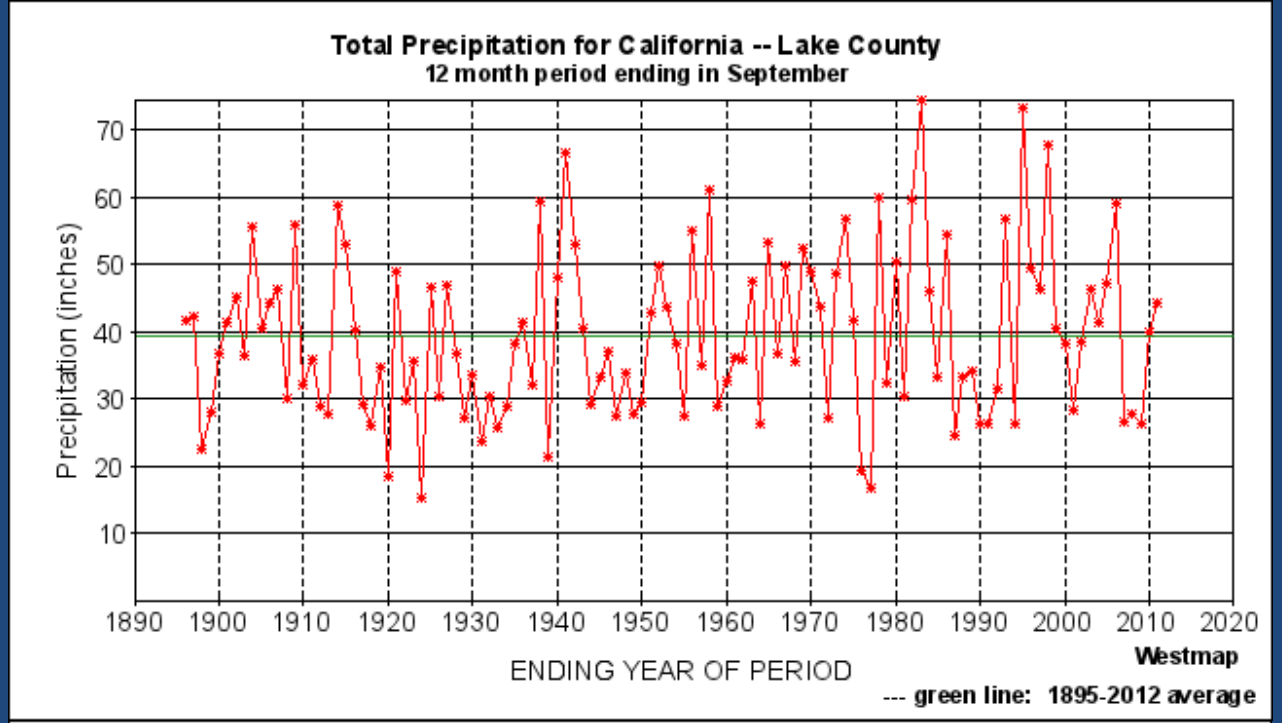
Russian River Geography

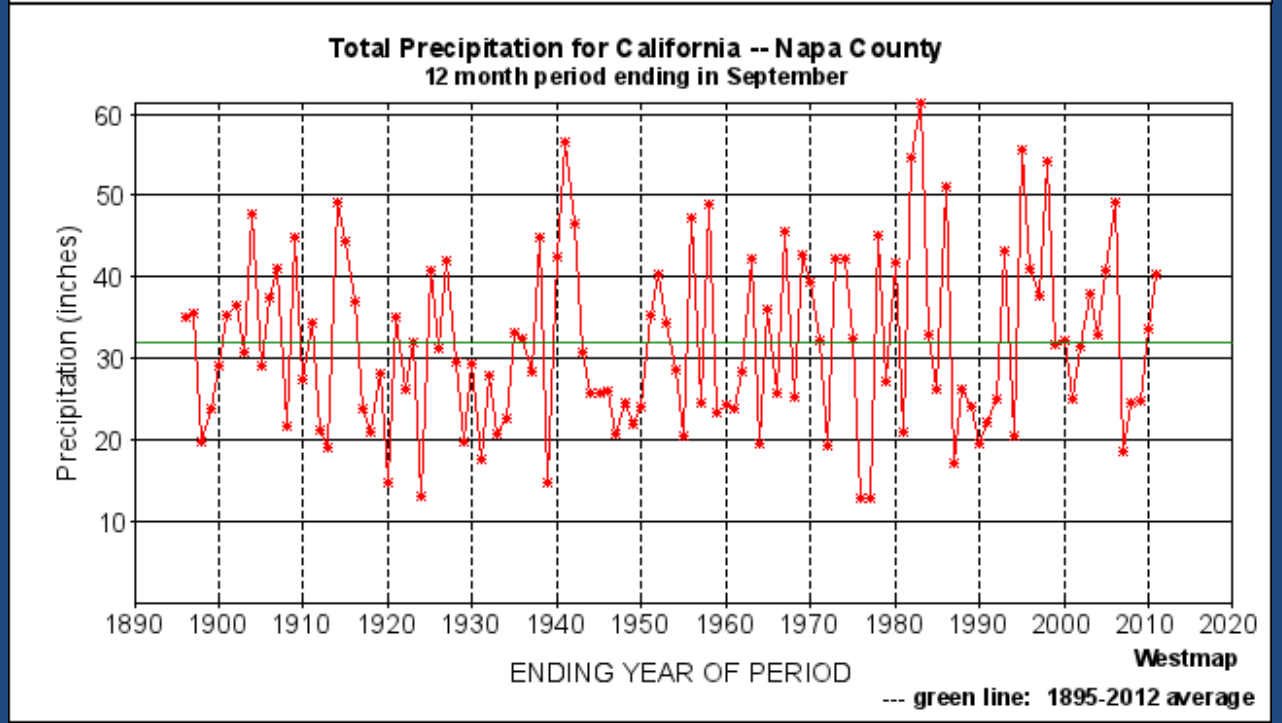
Map from Wikkepedia

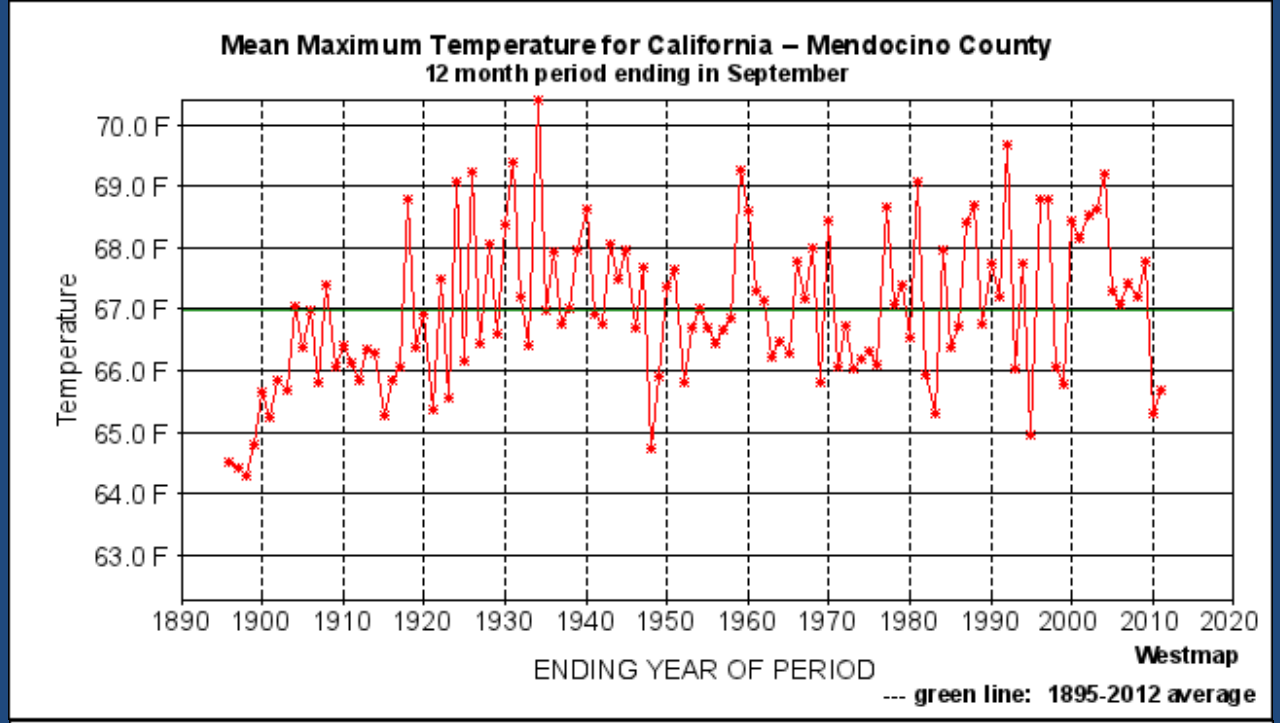
- 1485 square miles
- 110 miles long
- Elevation Range ~2000 ft.
- Located in Coastal Range
- Flow volume avg 1.6 MAF (0.17-4.9MAF)

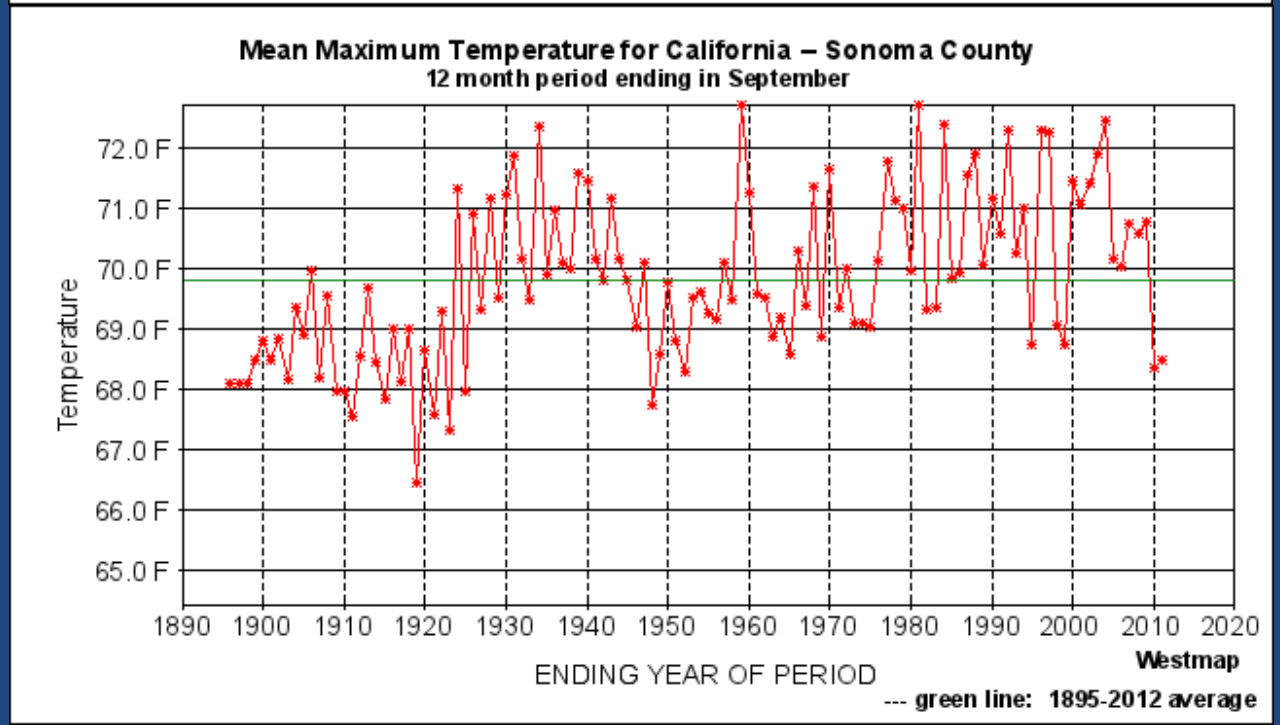

Total Precipitation for California -- Mendocino County
12 month period ending in September
Precipitation (inches)
90
80
70
60
50
40
30
20
10
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

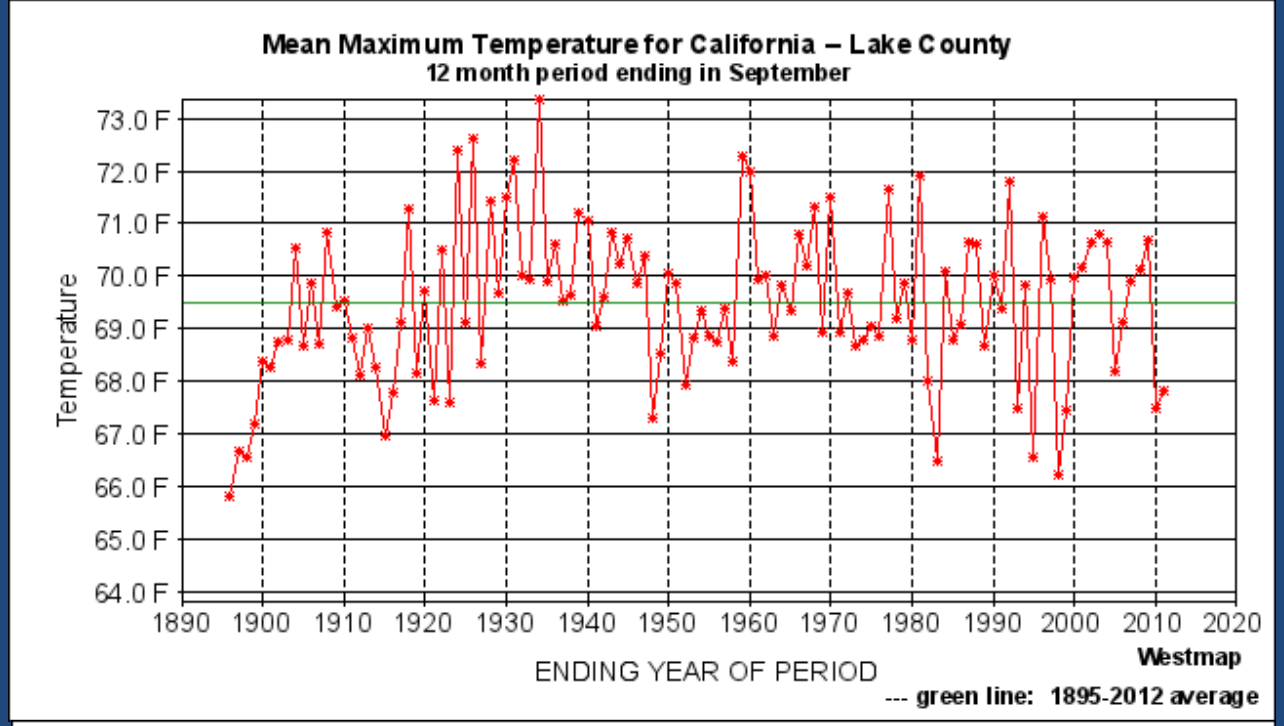

Total Precipitation for California -- Sonoma County
12 month period ending in September
Precipitation (inches)
70
60
50
40
30
20
10
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

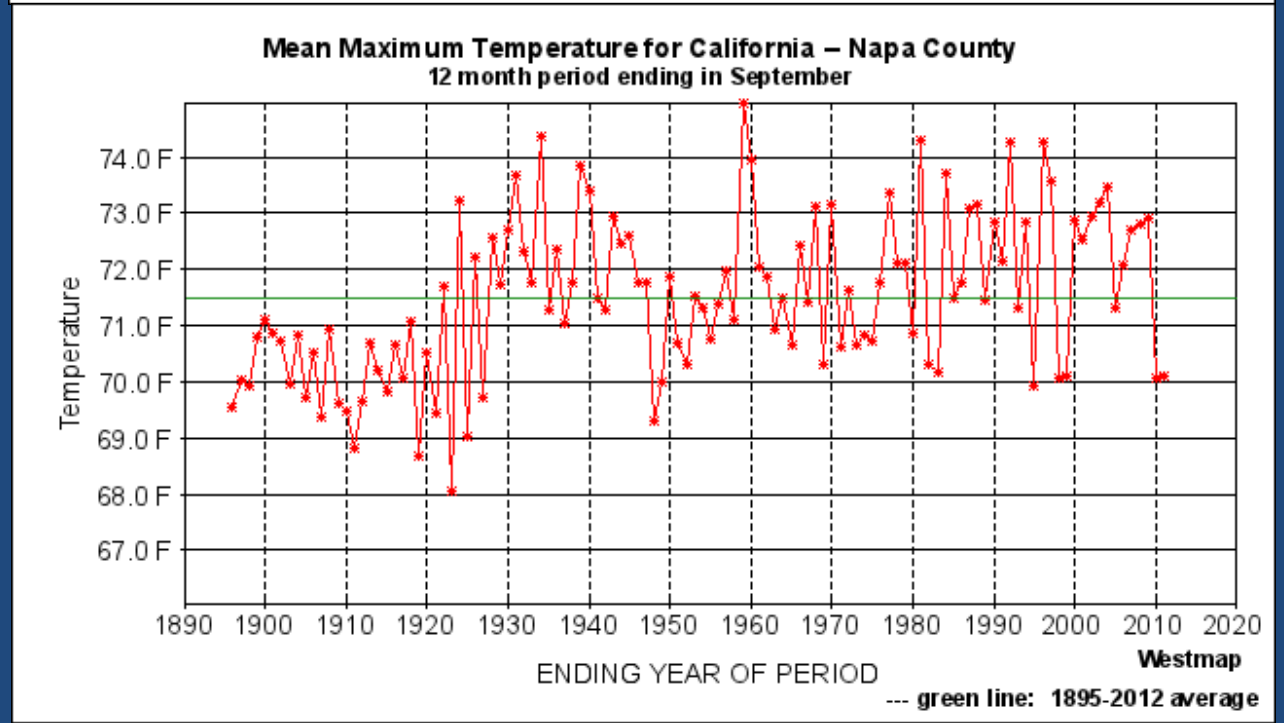

Total Precipitation for California -- Lake County
12 month period ending in September
Precipitation (inches)
70
60
50
40
30
20
10
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

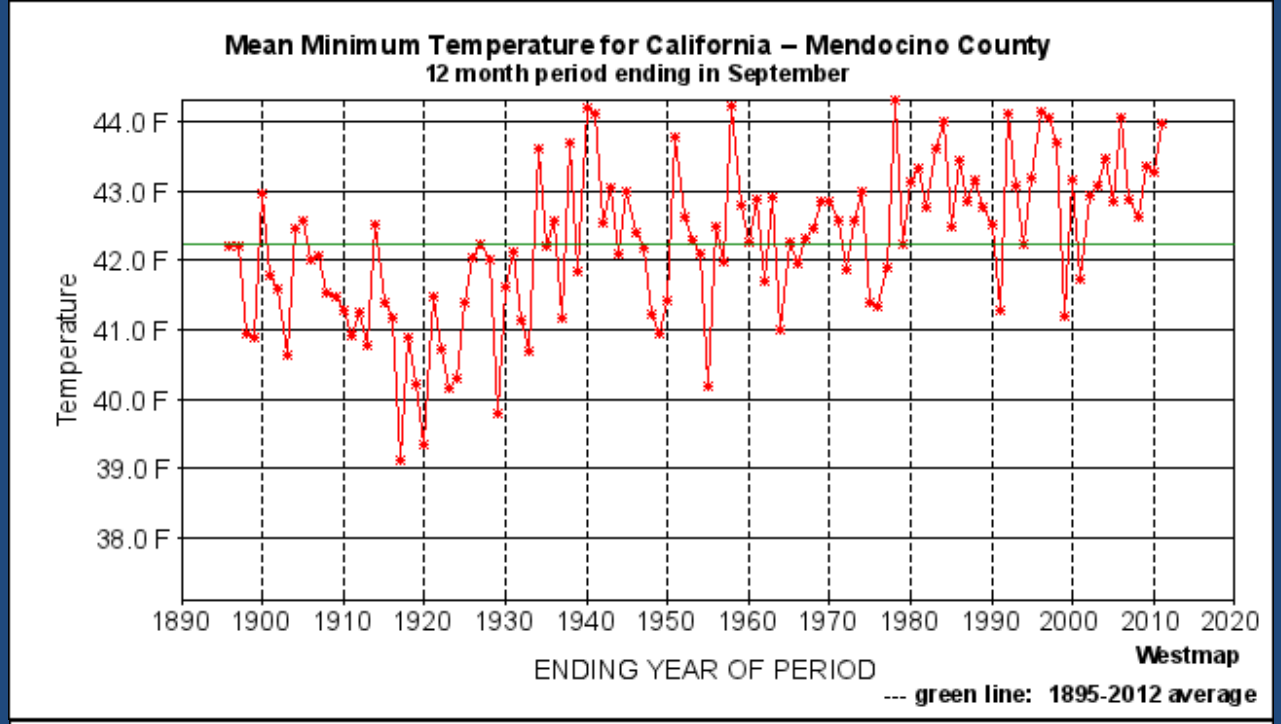

Total Precipitation for California -- Napa County
12 month period ending in September
Precipitation (inches)
60
50
40
30
20
10
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

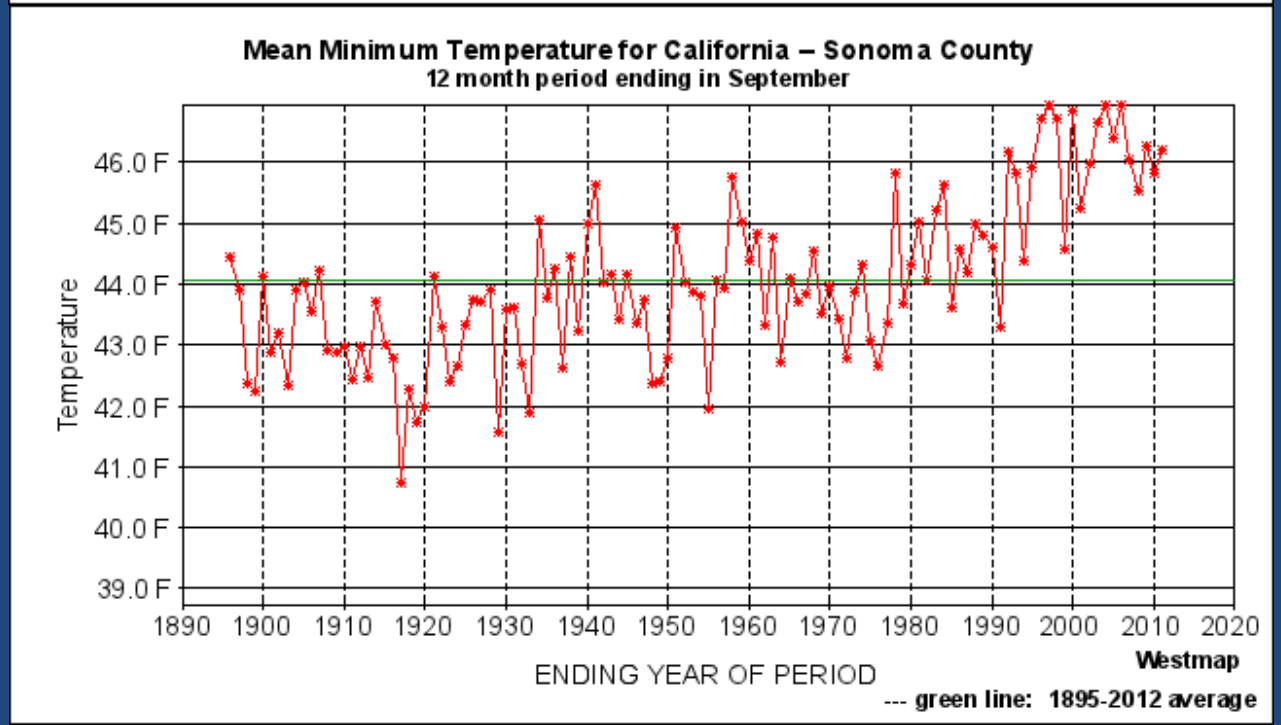

Mean Maximum Temperature for California – Mendocino County
12 month period ending in September
Temperature
70.0 F
69.0 F
68.0 F
67.0 F
66.0 F
65.0 F
64.0 F
63.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

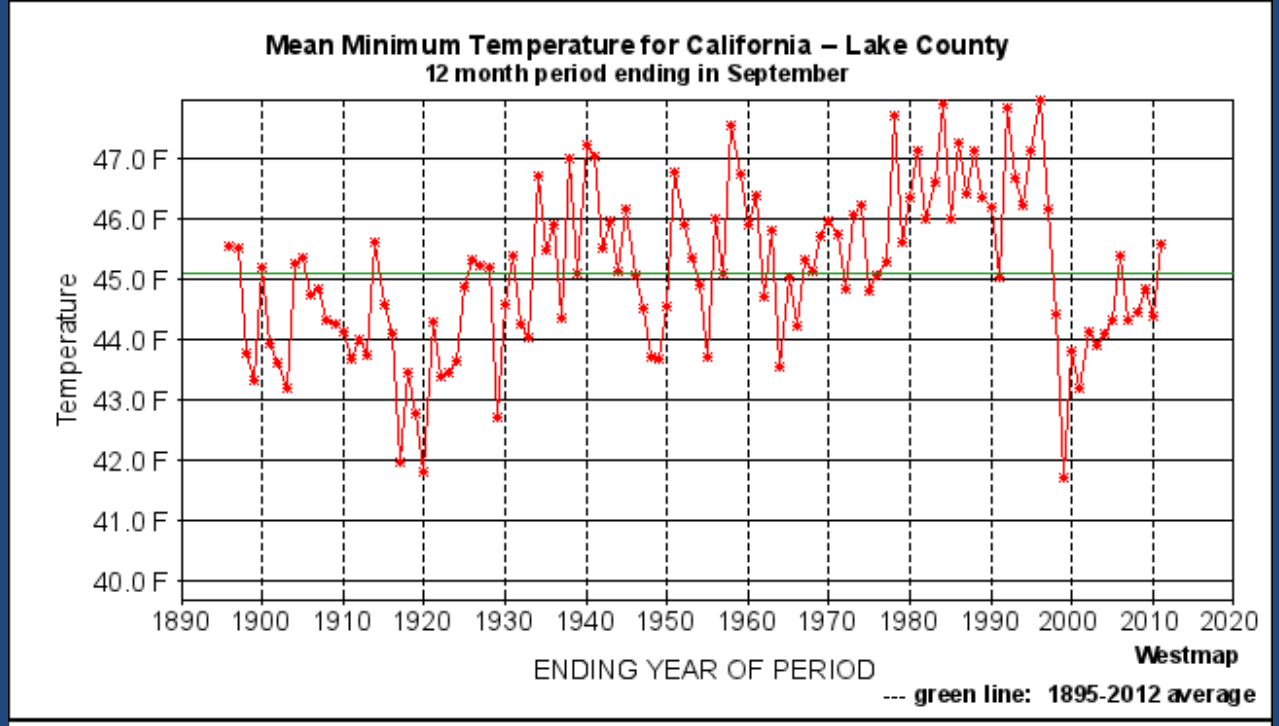

Mean Maximum Temperature for California – Sonoma County
12 month period ending in September
Temperature
72.0 F
71.0 F
70.0 F
69.0 F
68.0 F
67.0 F
66.0 F
65.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

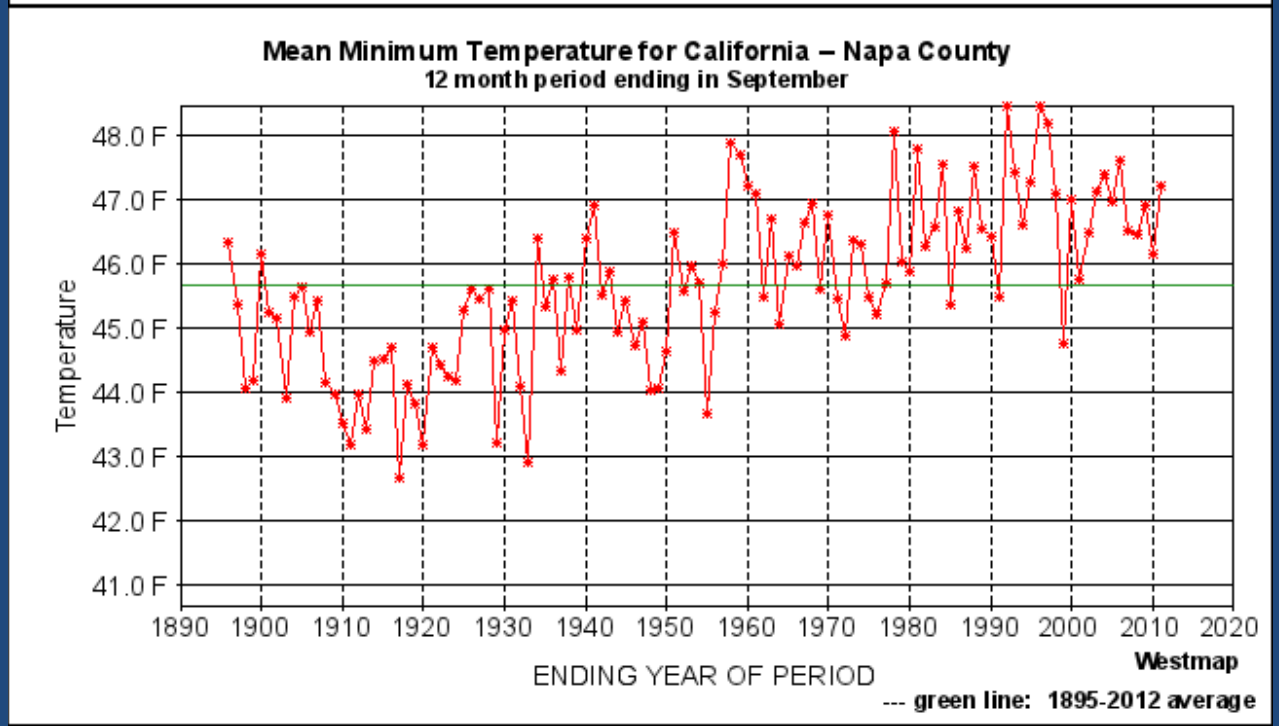

Mean Maximum Temperature for California -- Lake County
12 month period ending in September
Temperature
73.0 F
72.0 F
71.0 F
70.0 F
69.0 F
68.0 F
67.0 F
66.0 F
65.0 F
64.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average


Mean Maximum Temperature for California -- Napa County
12 month period ending in September
Temperature
74.0 F
73.0 F
72.0 F
71.0 F
70.0 F
69.0 F
68.0 F
67.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

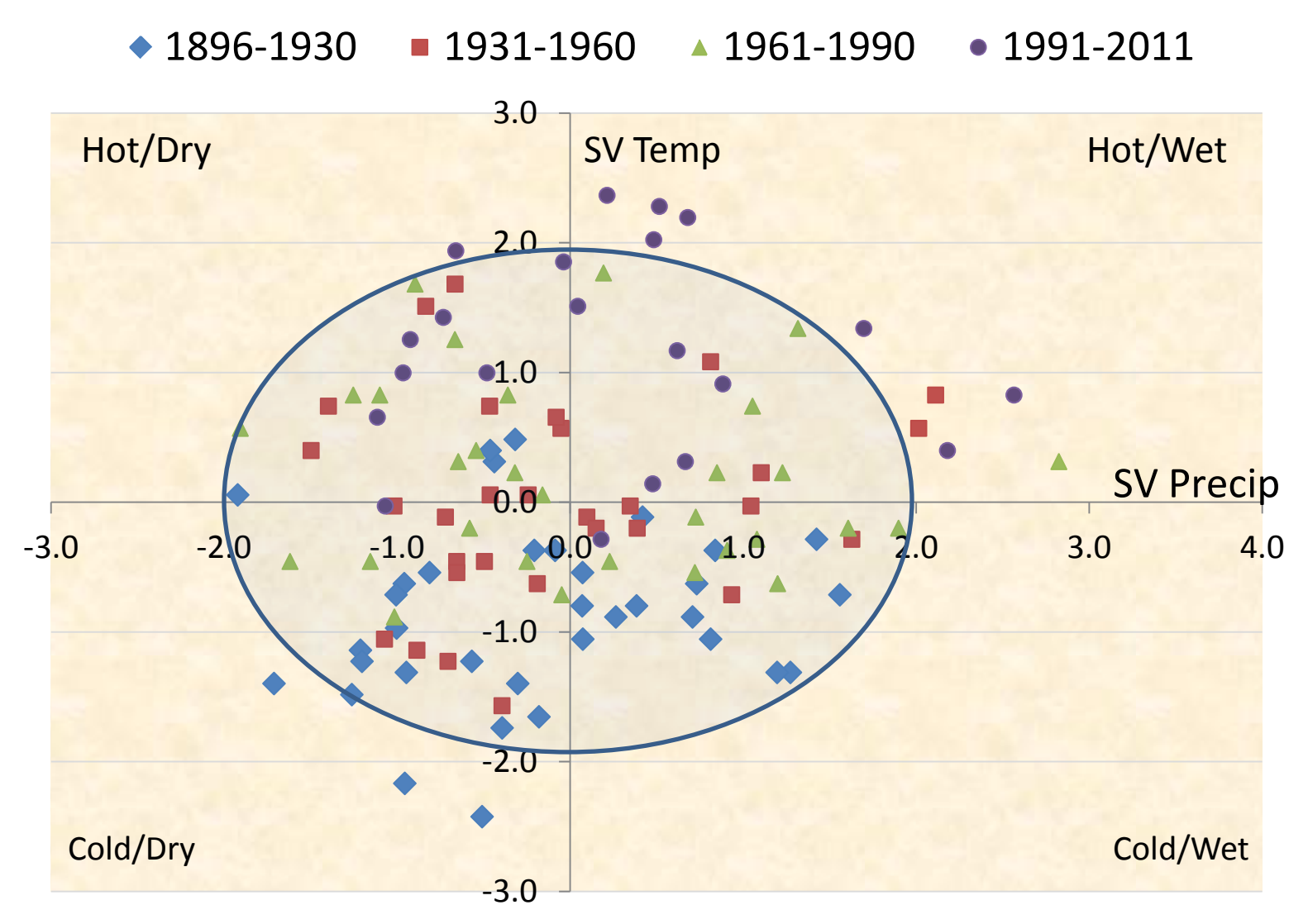

Mean Minimum Temperature for California – Mendocino County
12 month period ending in September
Temperature
44.0 F
43.0 F
42.0 F
41.0 F
40.0 F
39.0 F
38.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average


Mean Minimum Temperature for California – Sonoma County
12 month period ending in September
Temperature
46.0 F
45.0 F
44.0 F
43.0 F
42.0 F
41.0 F
40.0 F
39.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

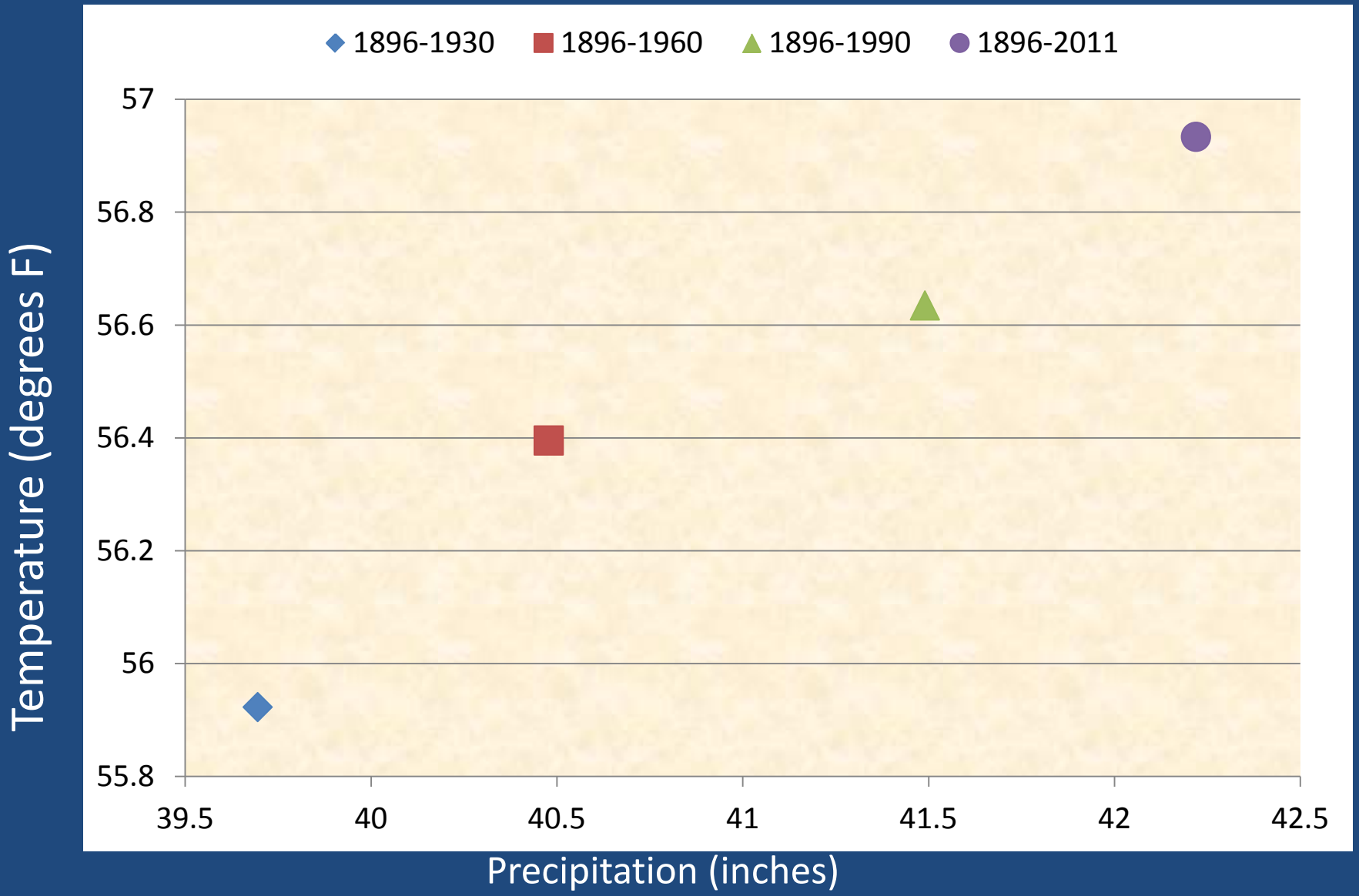

Mean Minimum Temperature for California – Lake County
12 month period ending in September
Temperature
47.0 F
46.0 F
45.0 F
44.0 F
43.0 F
42.0 F
41.0 F
40.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average


Mean Minimum Temperature for California – Napa County
12 month period ending in September
Temperature
48.0 F
47.0 F
46.0 F
45.0 F
44.0 F
43.0 F
42.0 F
41.0 F
1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020
ENDING YEAR OF PERIOD
Westmap
--- green line: 1895-2012 average

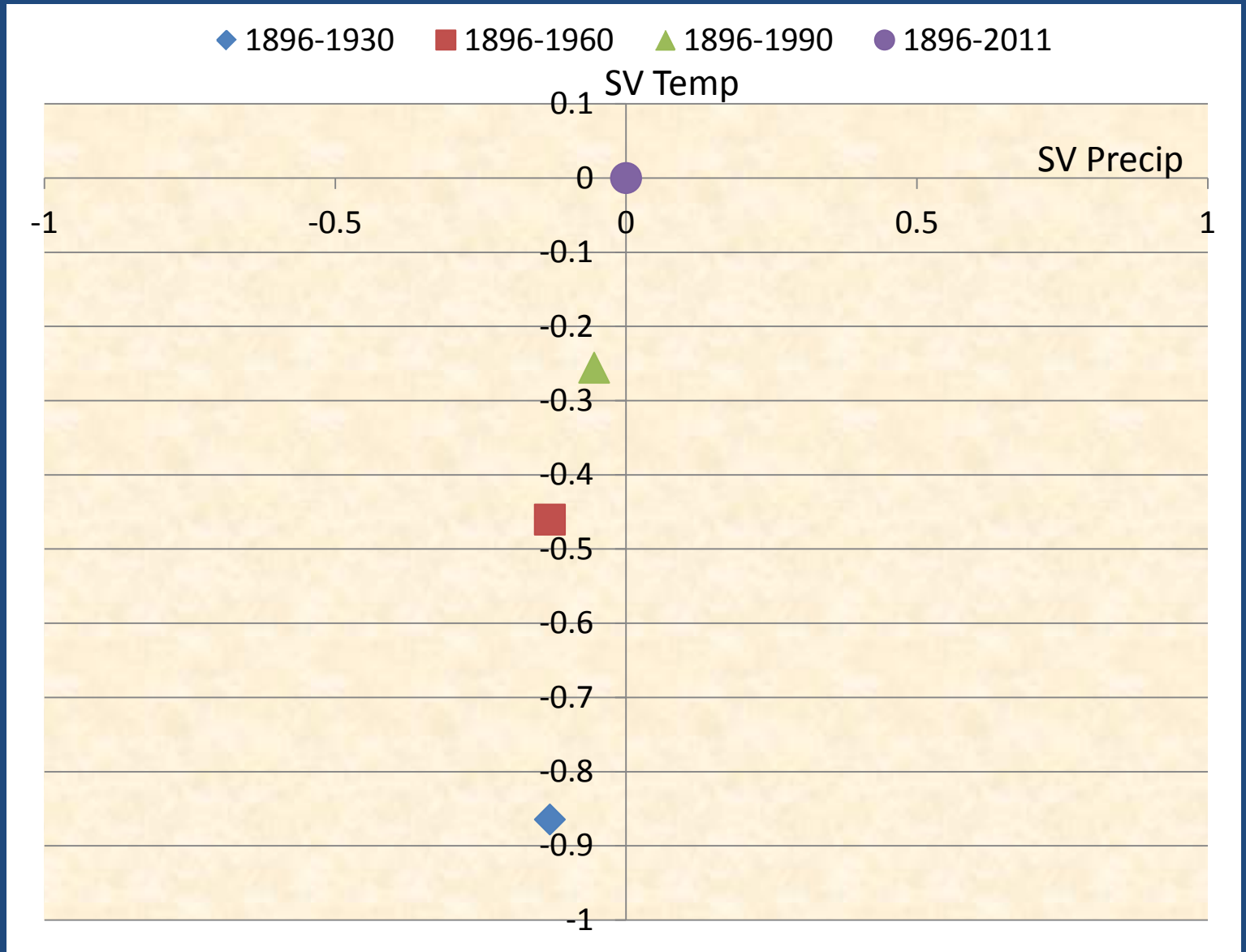
Precipitation/Temperature Distribution Sonoma County



Evolution of the Mean – Sonoma County

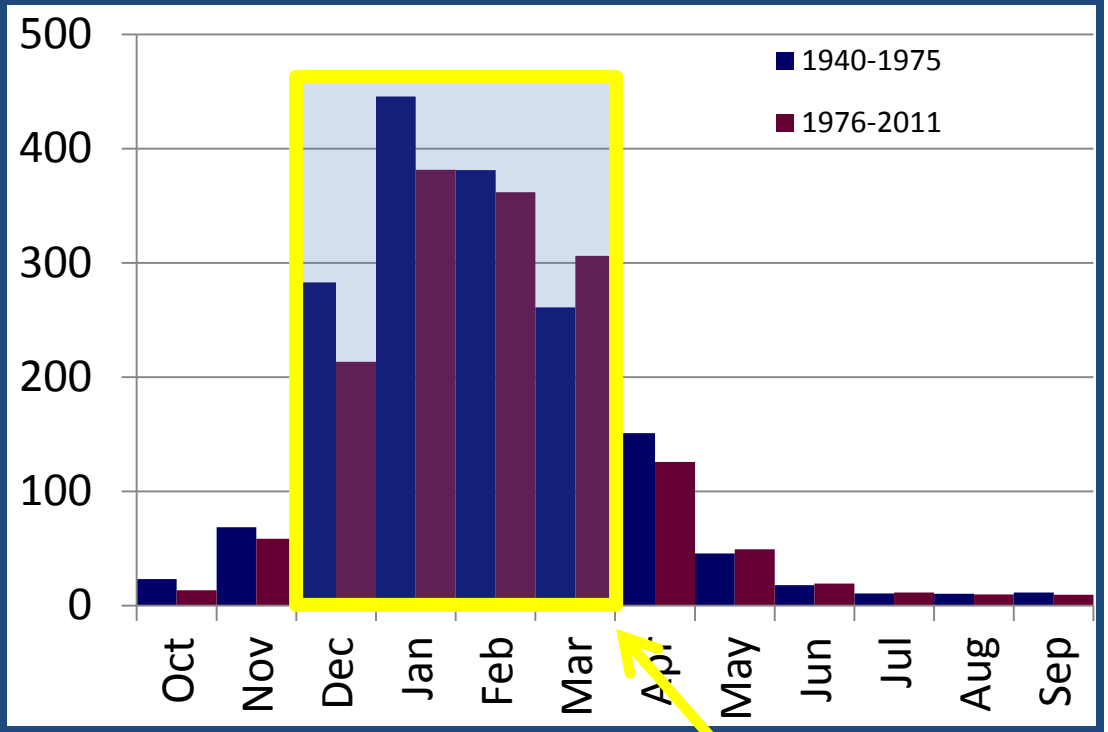


Evolution of the Mean – Sonoma County



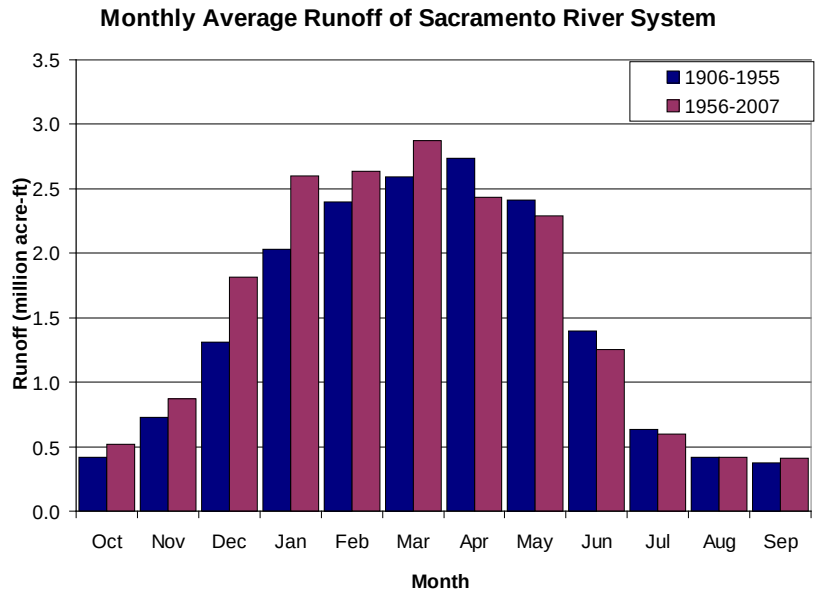
Comparing Runoff Patterns

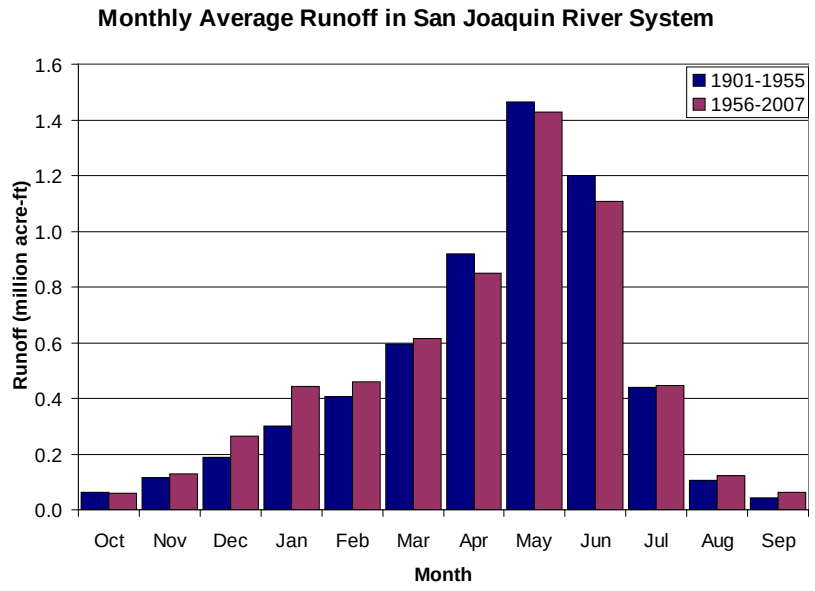
Average Runoff in taf for
Russian River at Guerneville



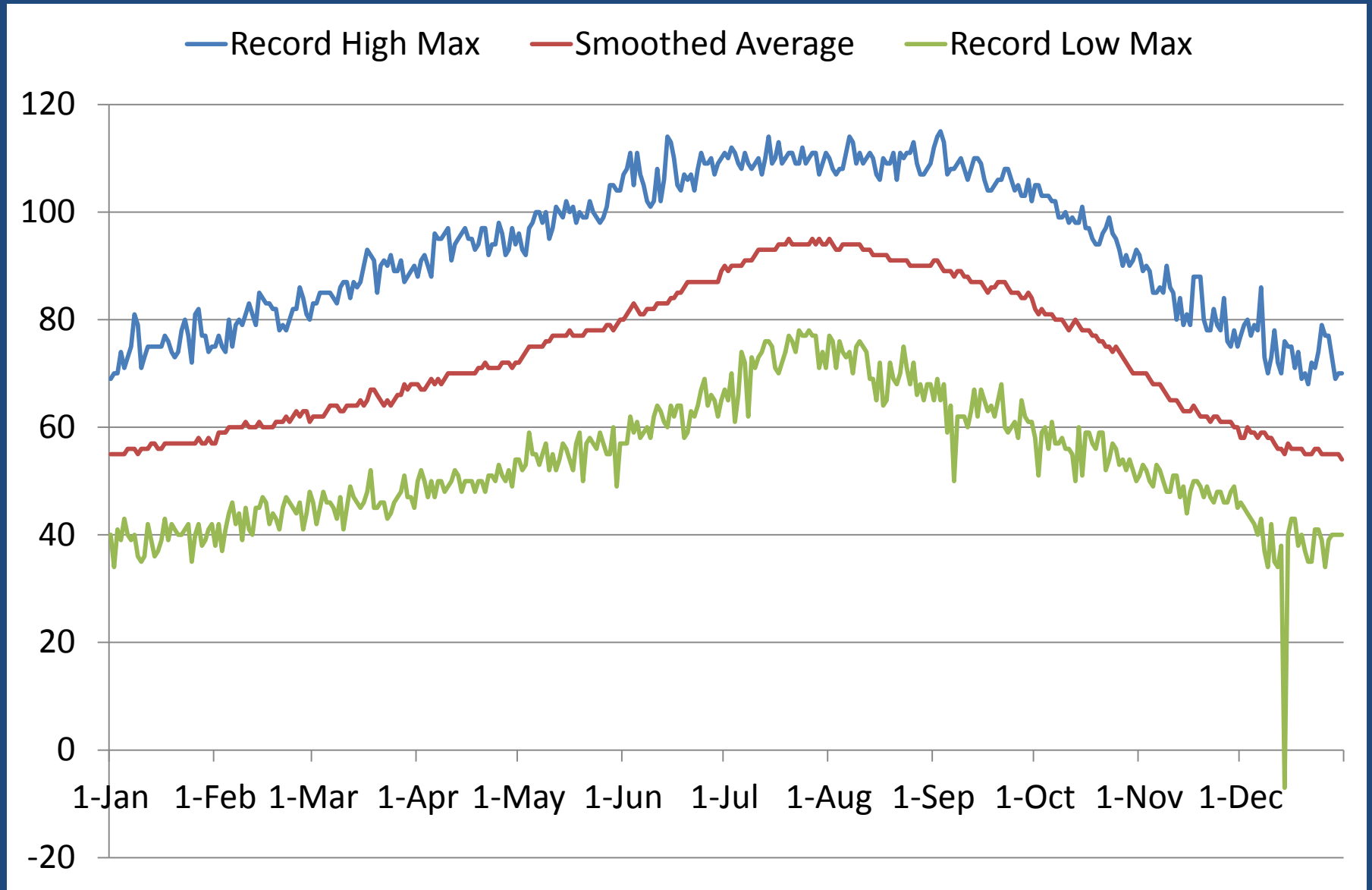
1940-1975 1.71 MAF
1976-2011 1.59 MAF

80% Dec-Mar

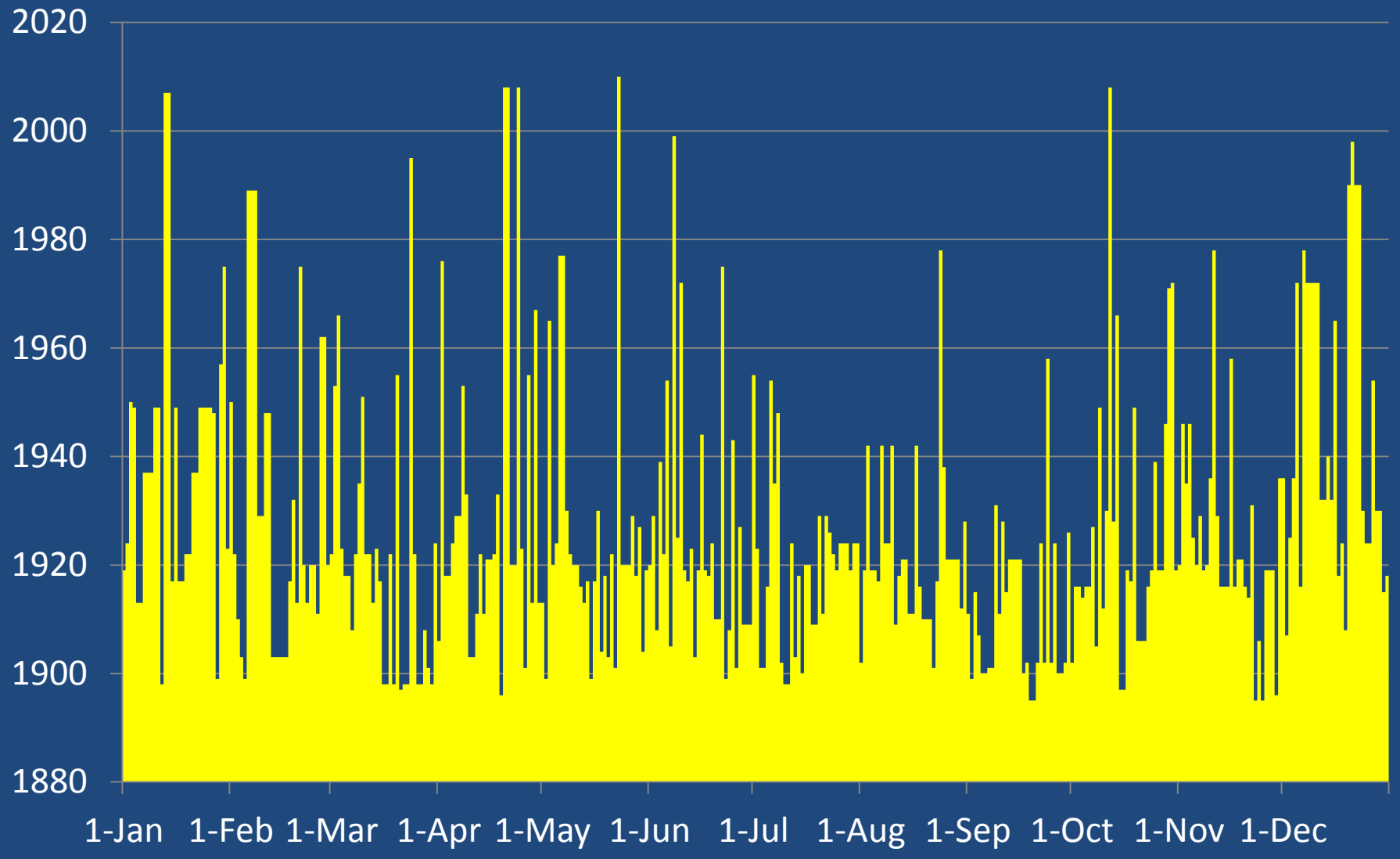




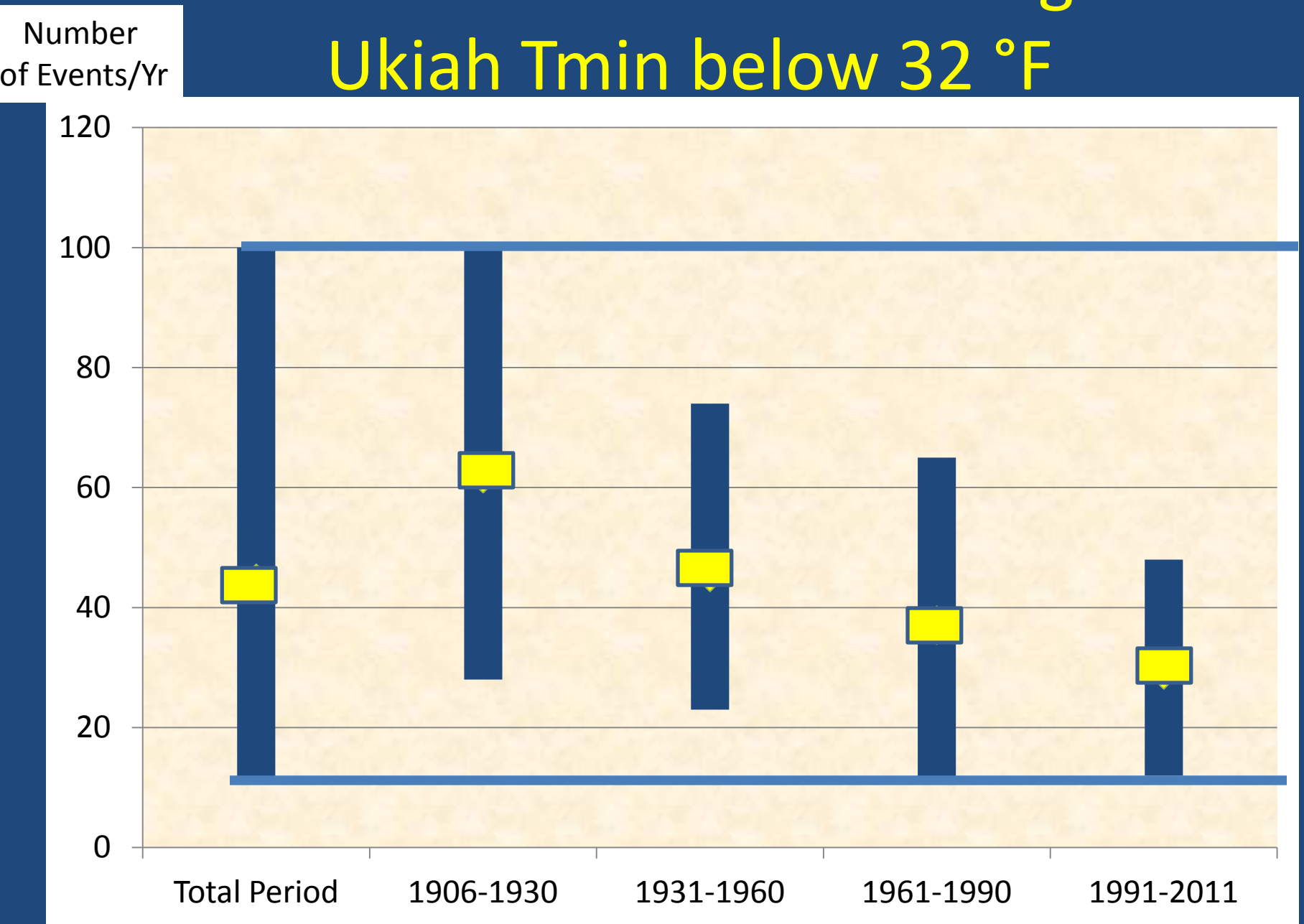
Current Daily Extremes – Tmax Ukiah



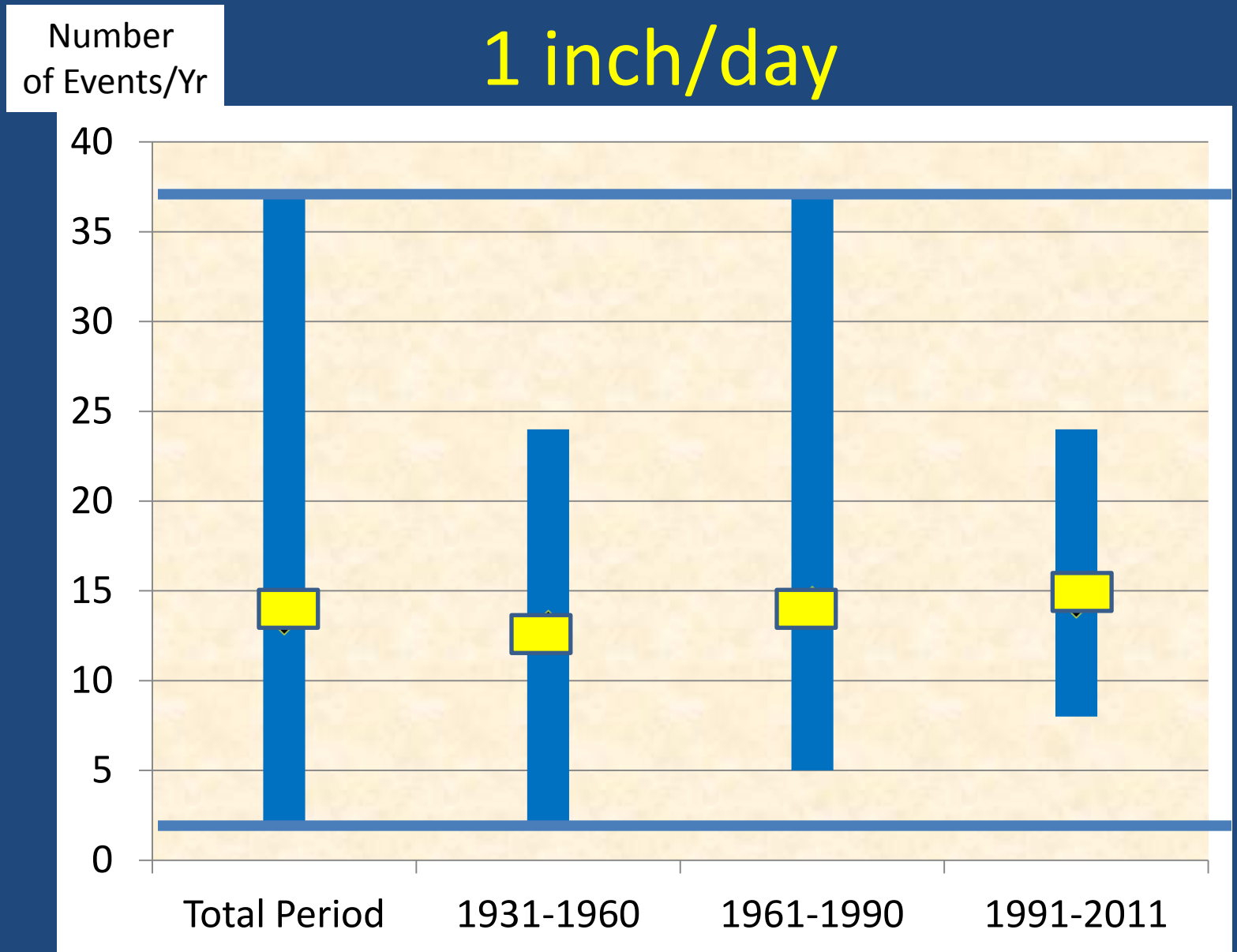
Year of Record Low Tmin Ukiah



Event Threshold Tracking
Ukiah Tmin below 32 °F



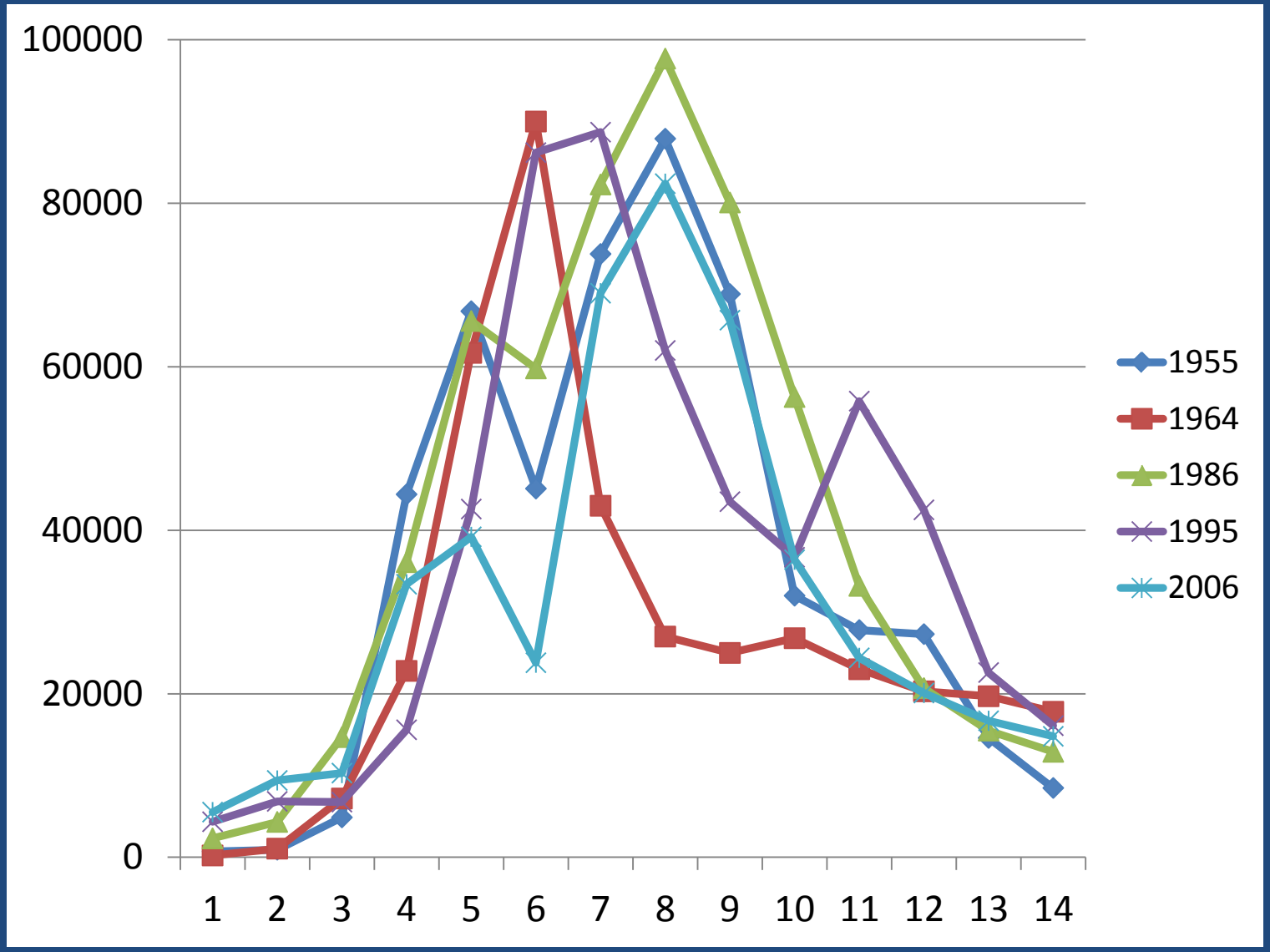
Event Threshold Tracking Healdsburg Precipitation Above 1 inch/day



Top 5 Flood Peaks

Hopland		Healdsburg		Guerneville	
Year	Flow	Year	Flow	Year	Flow
1955	33,800	1995	69,300	1986	97,700
1964	33,700	1964	62,700	1964	90,000
1986	28,500	1940	62,200	1995	88,700
2005	27,400	1986	59,700	1955	87,900
1940	25,500	1997	59,400	2006	82,400

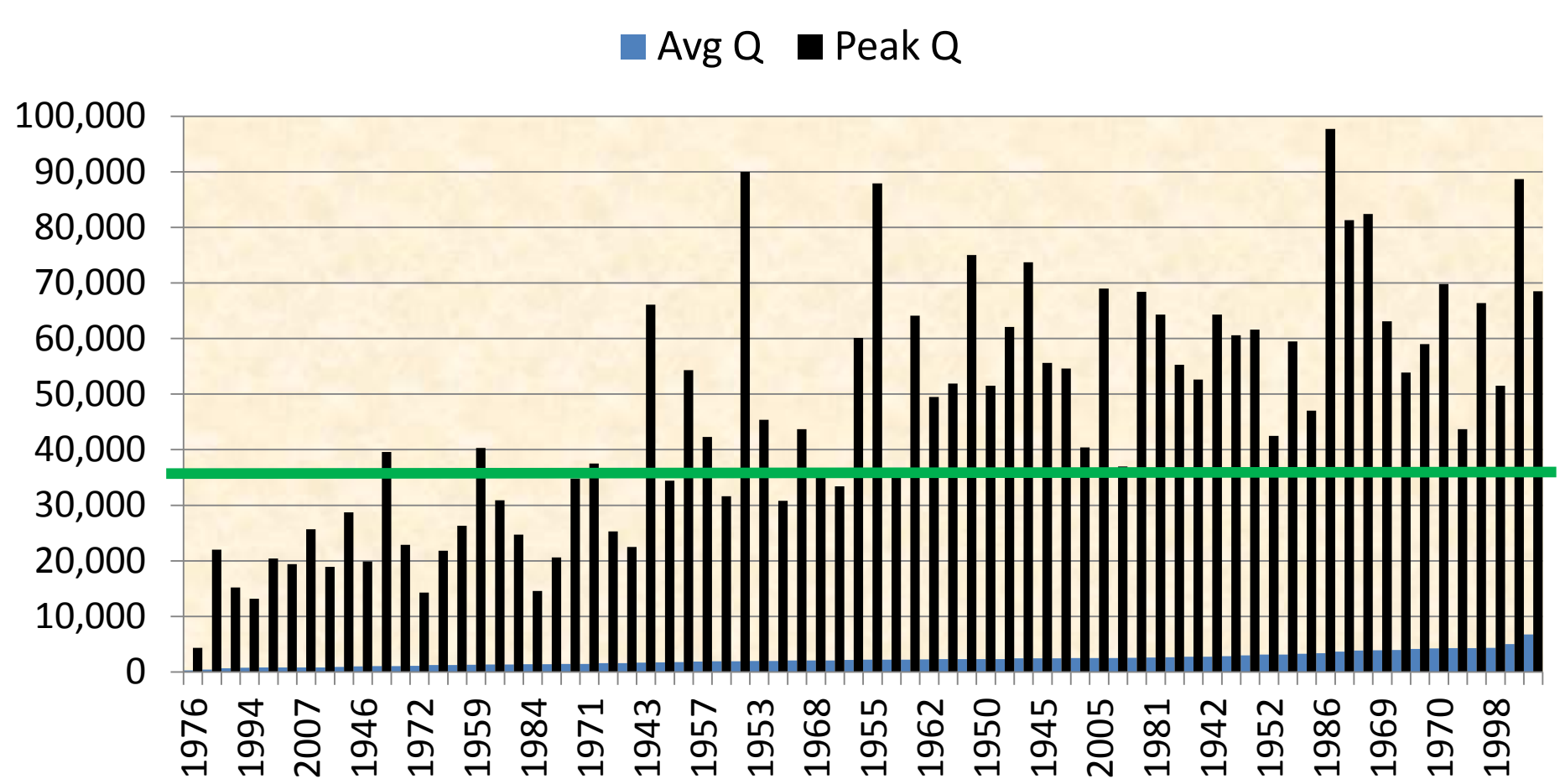
Top 5 Floods Guerneville



5 Lowest Annual Volumes (taf)

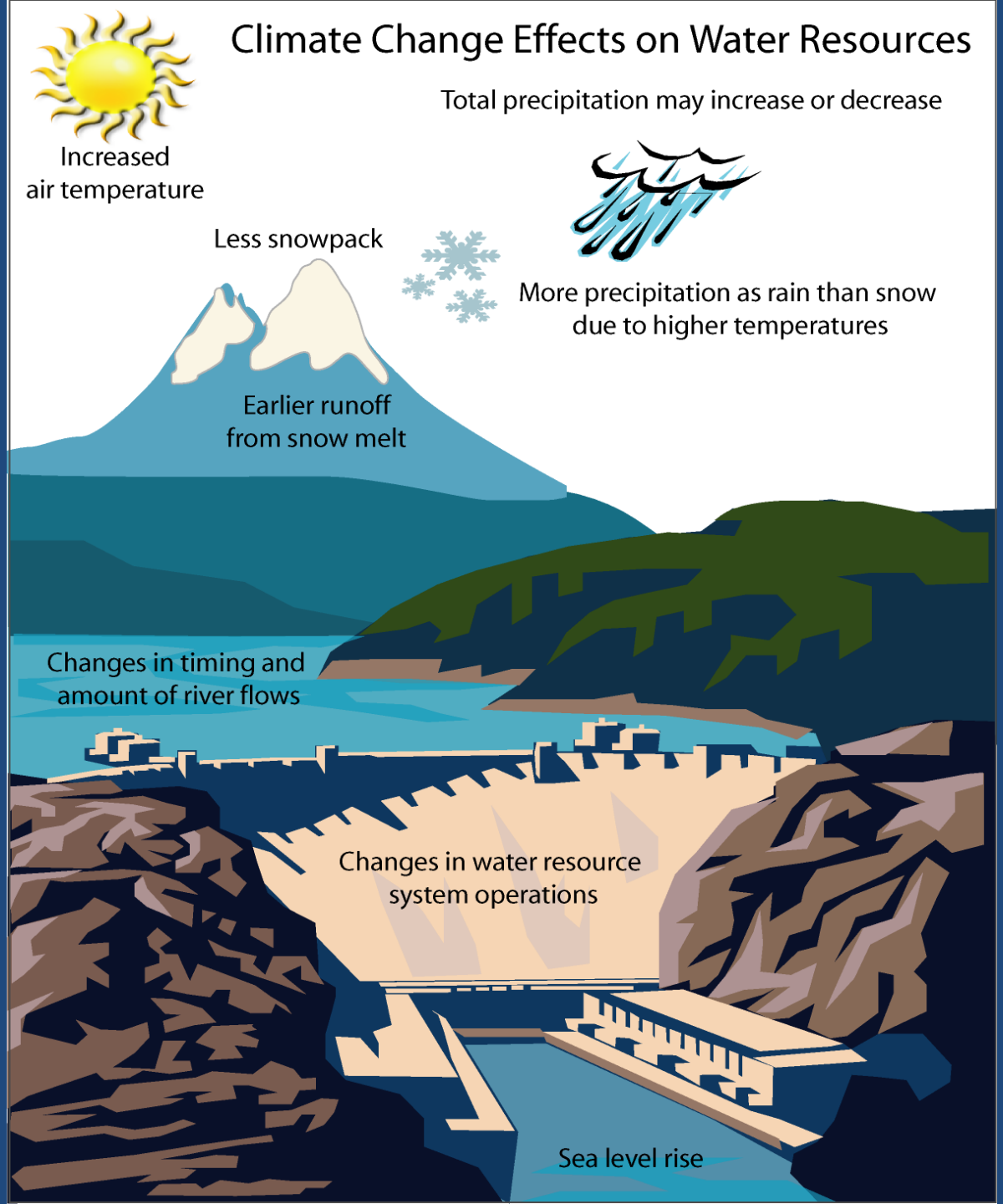
Hopland		Healdsburg		Guerneville	
Year	Volume	Year	Volume	Year	Volume
1977	105	1977	205	1976	221
2009	163	1976	207	1977	322
1976	170	1990	352	1990	477
1994	196	1994	372	1994	544
1991	201	2009	392	2009	582

Floods and Droughts



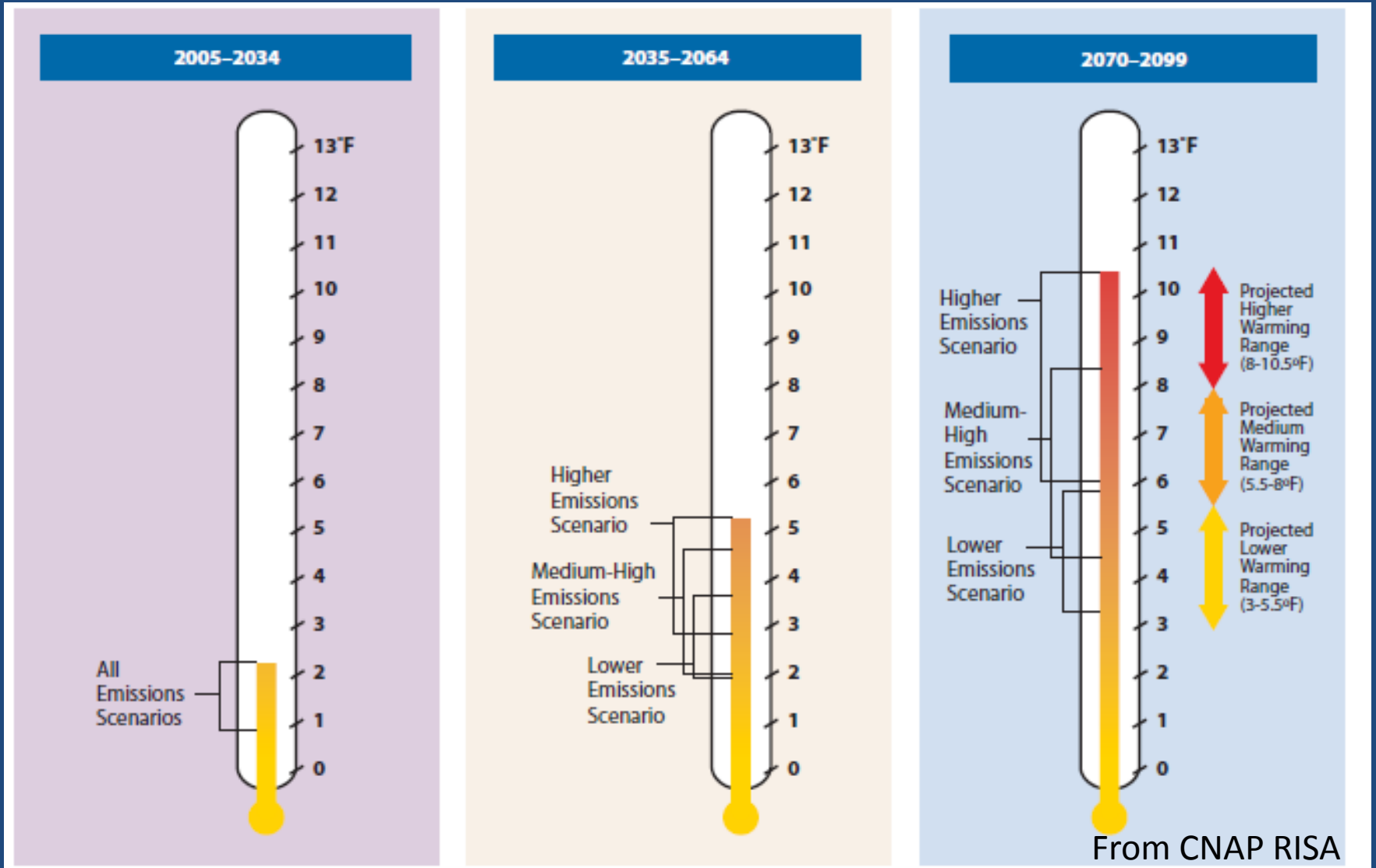
1964 Peak Flow 90,000 cfs Annual Volume 1.4 million acre-ft

2010 Peak Flow 37,000 cfs Annual Volume 1.8 million acre-ft



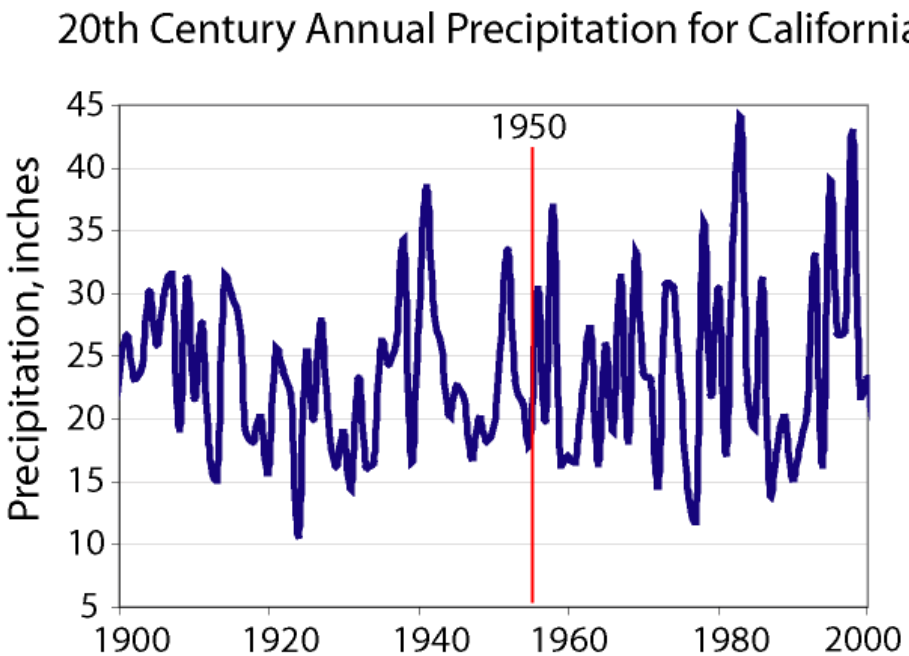
Slide from
Jamie Anderson
DWR- Bay Delta

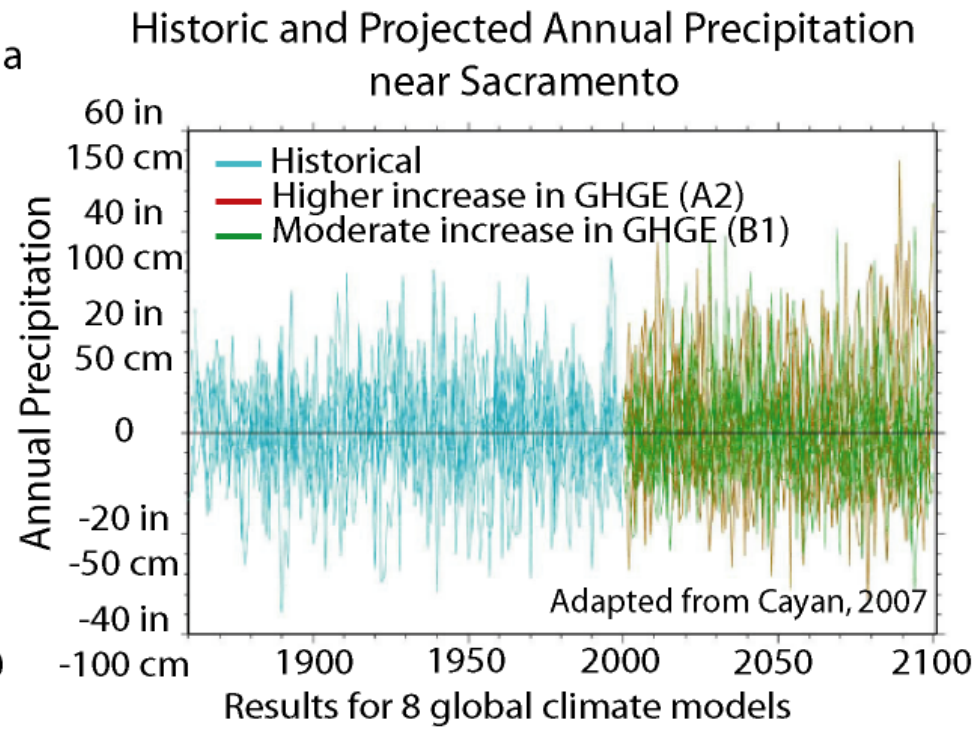
Future Temperature Projections



From CNAP RISA

Precipitation

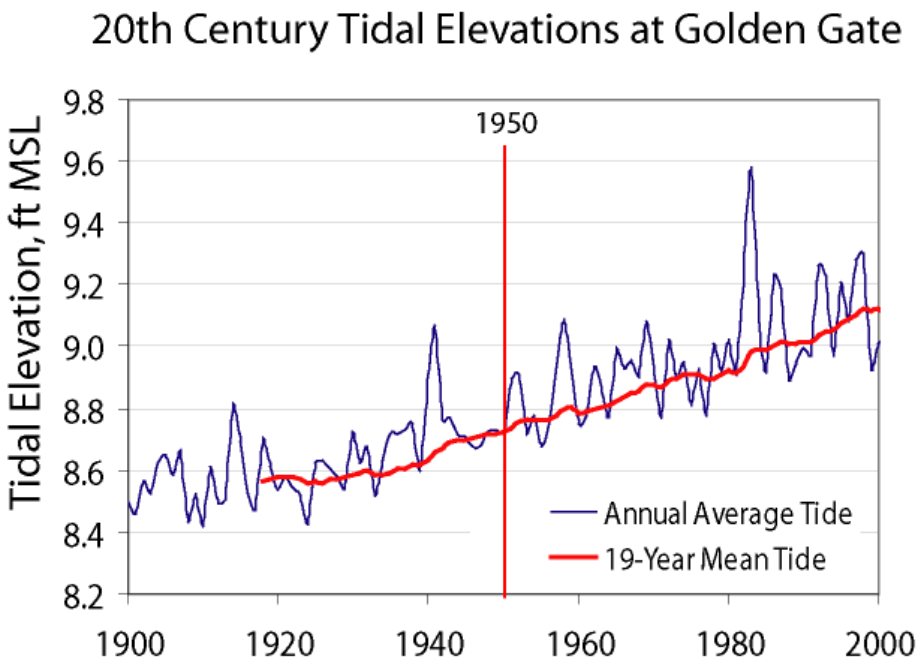


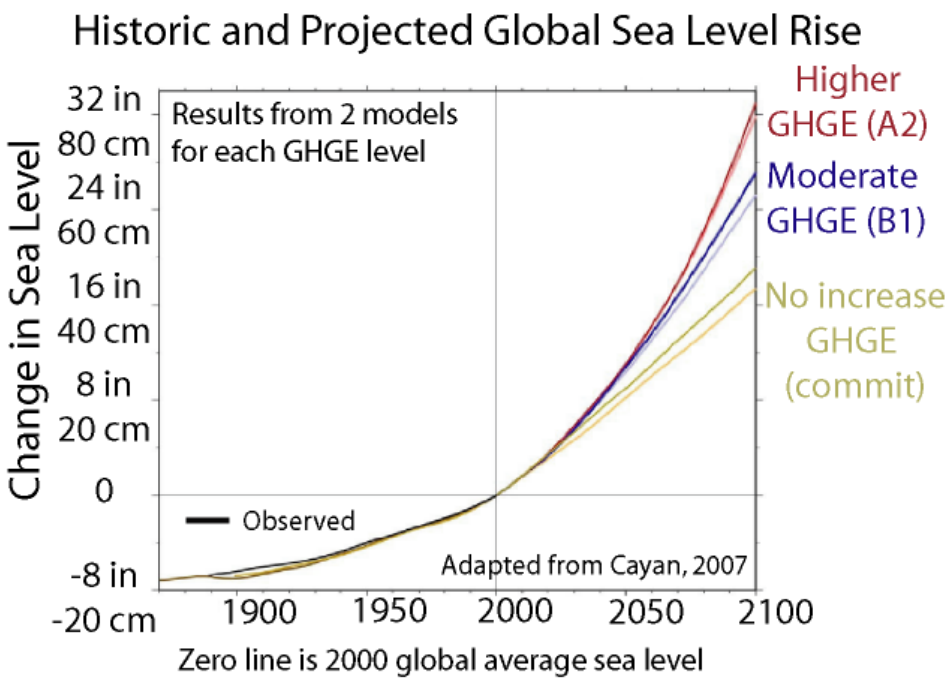


Annual Precipitation, in	Max	Average	Min
Pre-1950	38.5	23.1	10.7
Post-1950	43.8	24.4	12.1

Abbreviations:
GHGE=Green House Gas Emissions

Sea Level Rise





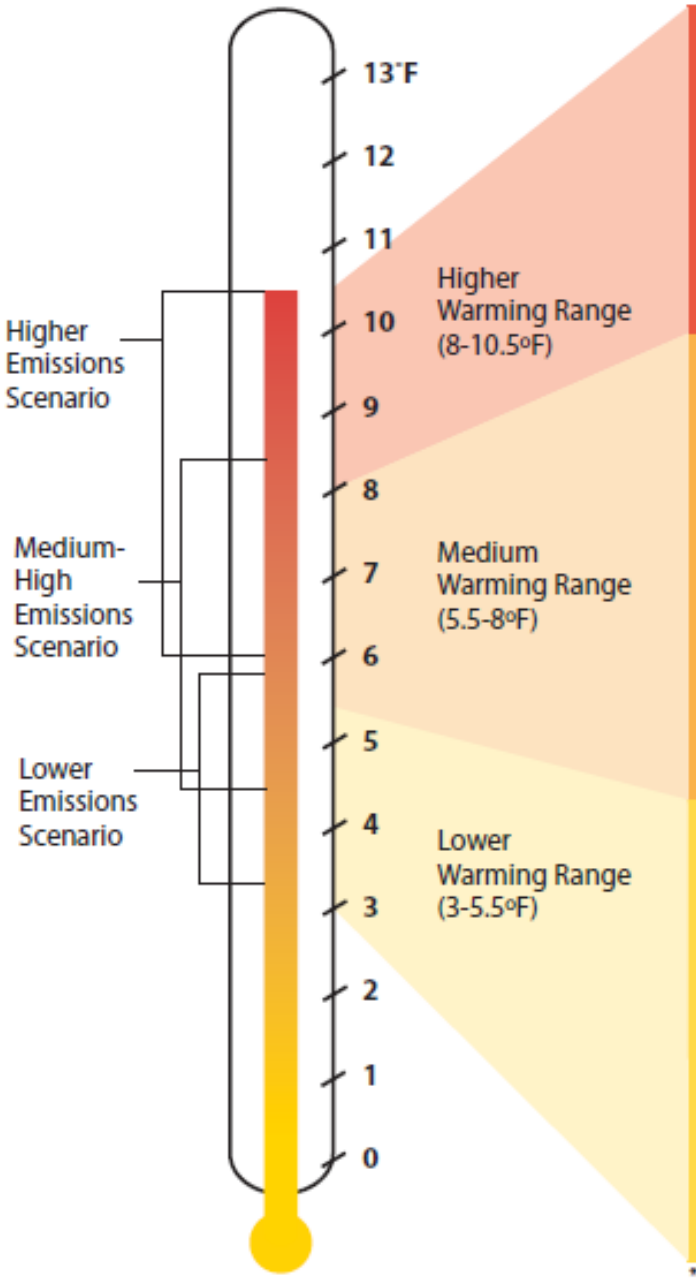
Changes in 19-yr Trend

	Total Rise	Rate of Rise
Pre-1950	1.9 in	0.060 in/yr
Post-1950	4.6 in	0.095 in/yr

Abbreviations:
GHGE=Green House Gas Emissions
MSL=Mean Sea Level

Jamie Anderson
DWR- Bay Delta

Summary of Projected Global Warming Impact, 2070–2099
(as compared with 1961–1990)



Higher Warming Range (8-10.5°F)

- 90% loss in Sierra snowpack
- 22–30 inches of sea level rise
- 3–4 times as many heat wave days in major urban centers
- 4–6 times as many heat-related deaths in major urban centers
- 2.5 times more critically dry years
- 20% increase in energy demand

Medium Warming Range (5.5-8°F)

- 70–80% loss in Sierra snowpack
- 14–22 inches of sea level rise
- 2.5–4 times as many heat wave days in major urban centers
- 2–6 times as many heat-related deaths in major urban centers
- 75–85% increase in days conducive to ozone formation*
- 2–2.5 times more critically dry years
- 10% increase in electricity demand
- 30% decrease in forest yields (pine)
- 55% increase in the expected risk of large wildfires

Lower Warming Range (3-5.5°F)

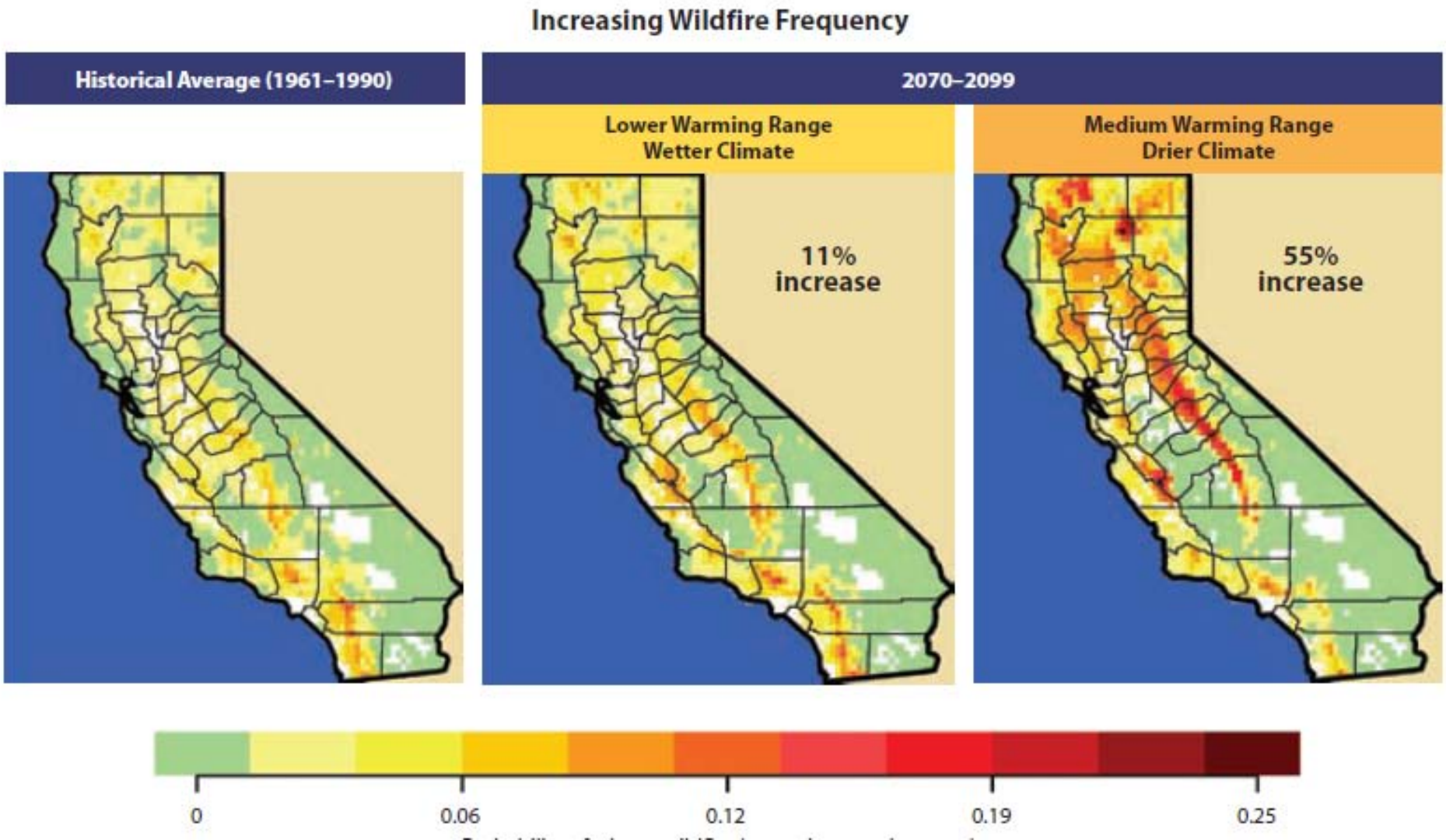
- 30–60% loss in Sierra snowpack
- 6–14 inches of sea level rise
- 2–2.5 times as many heat wave days in major urban centers
- 2–3 times as many heat-related deaths in major urban centers
- 25–35% increase in days conducive to ozone formation*
- Up to 1.5 times more critically dry years
- 3–6 % increase in electricity demand
- 7–14% decrease in forest yields (pine)
- 10–35% increase in the risk of large wildfires

* For high ozone locations in Los Angeles (Riverside) and the San Joaquin Valley (Visalia)

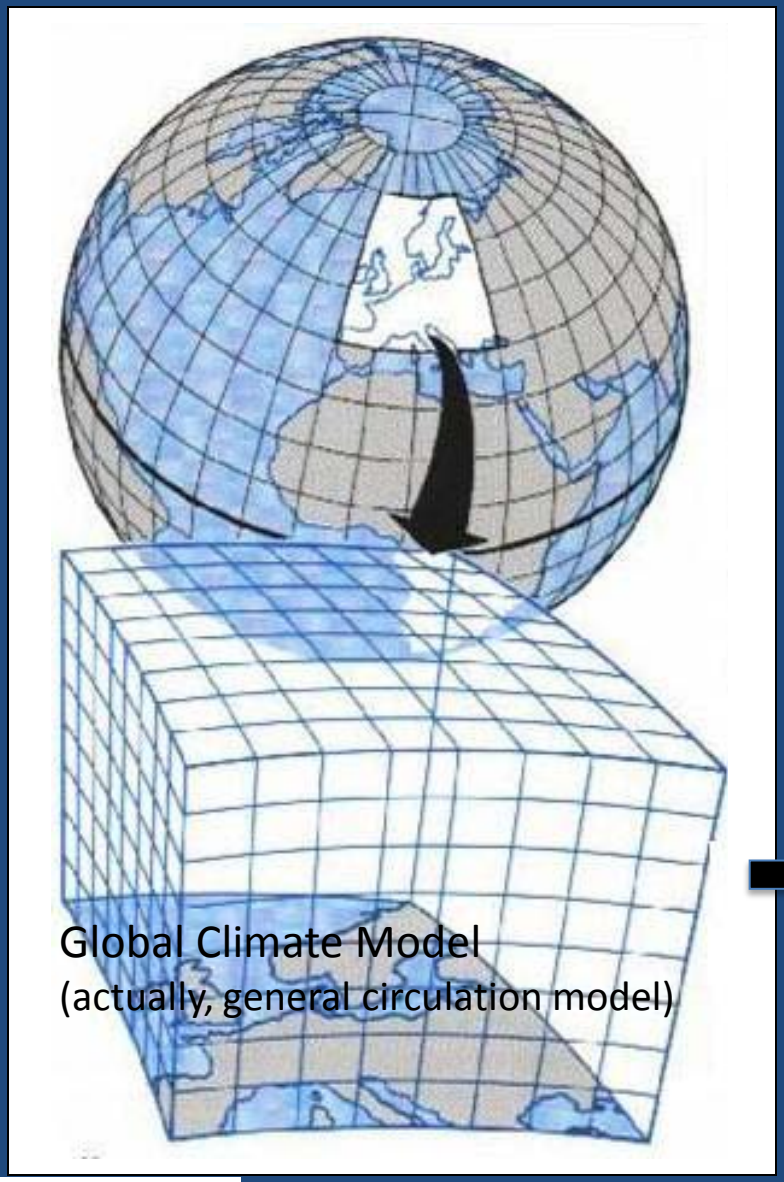
From CNAP RISA

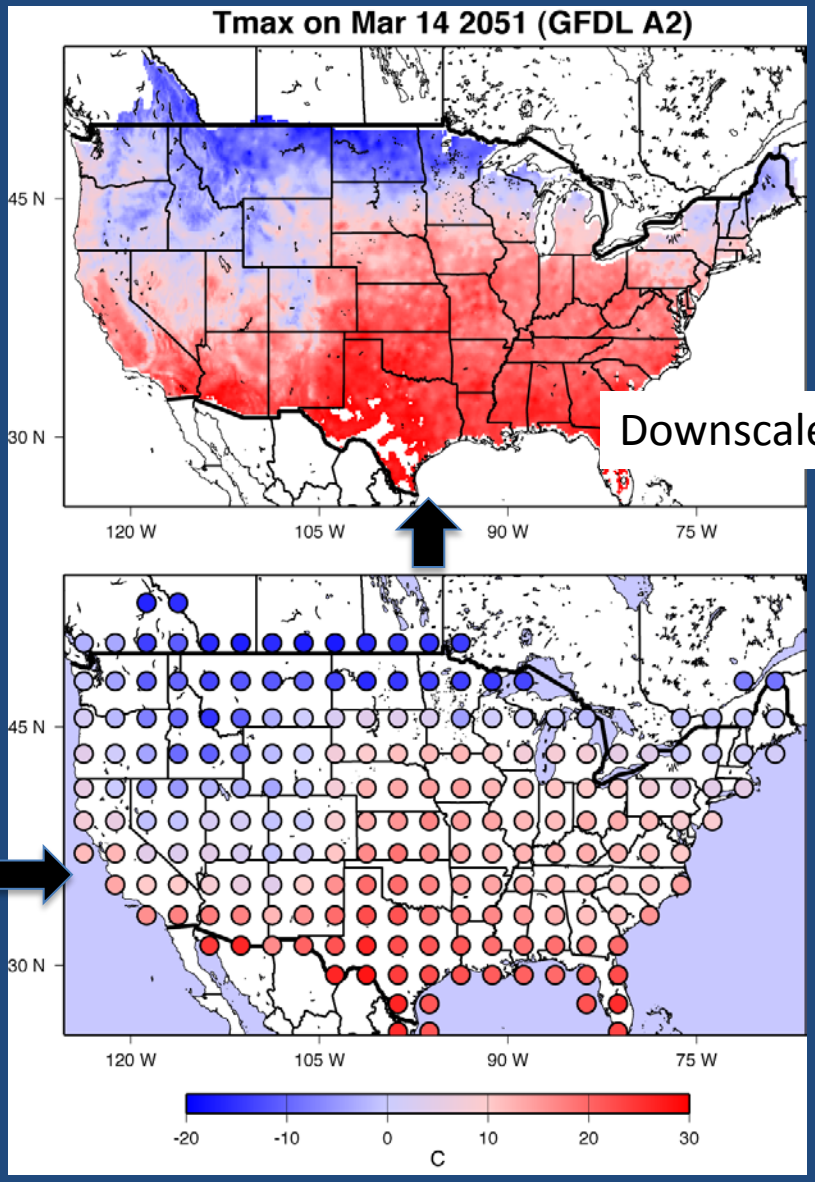
Associated Impacts

From CNAP RISA



The "downscaling" problem

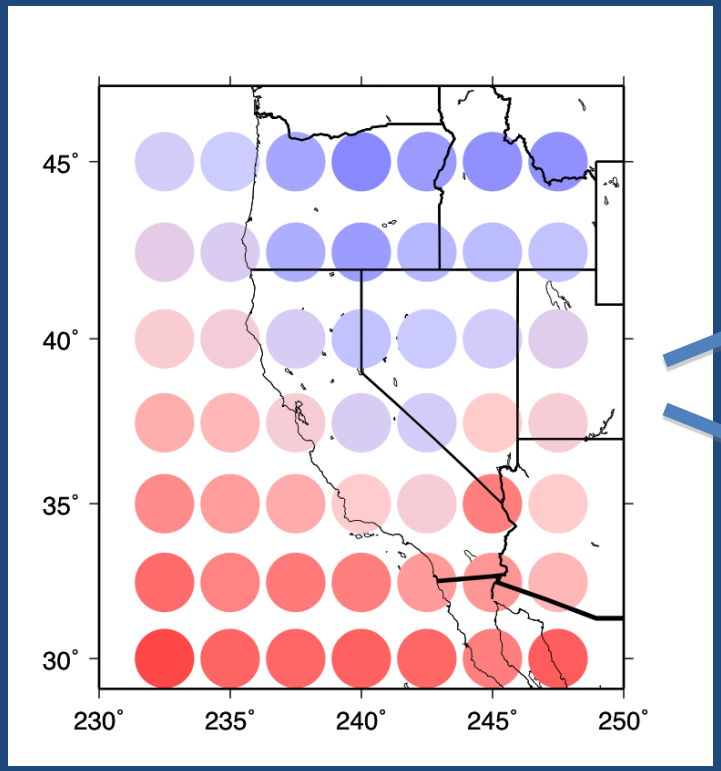




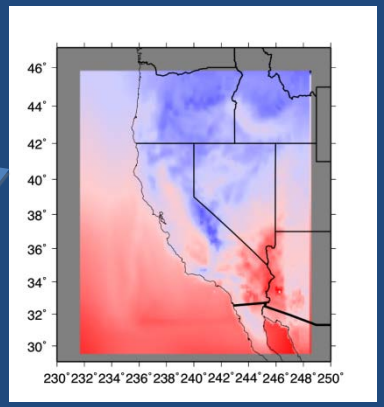
Original GCM values

Slide from
Mike Dettinger SIO/USGS

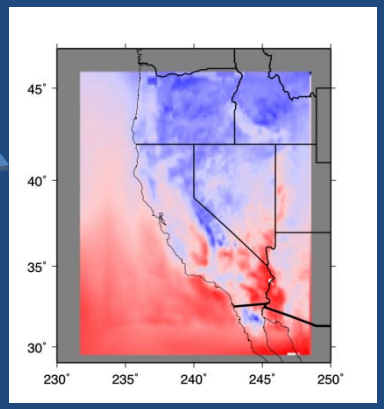
Downscaling Methods

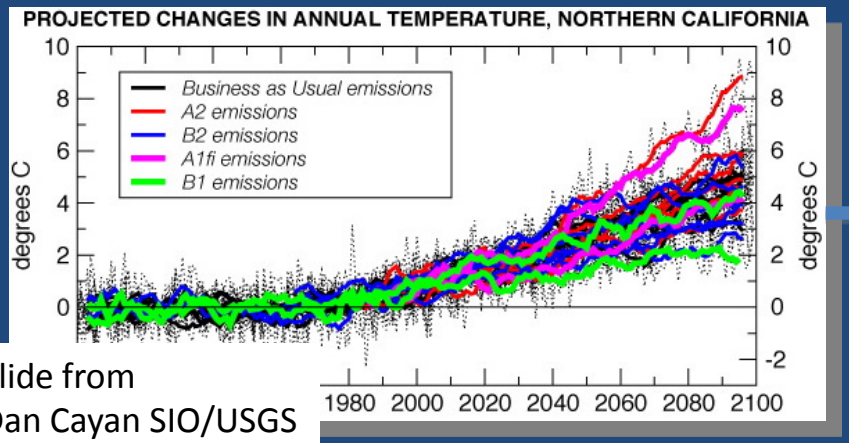


Dynamical:

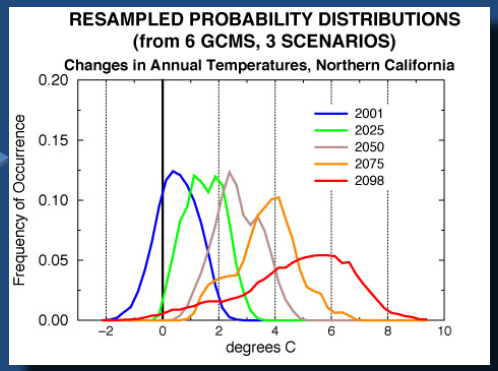


Statistical:



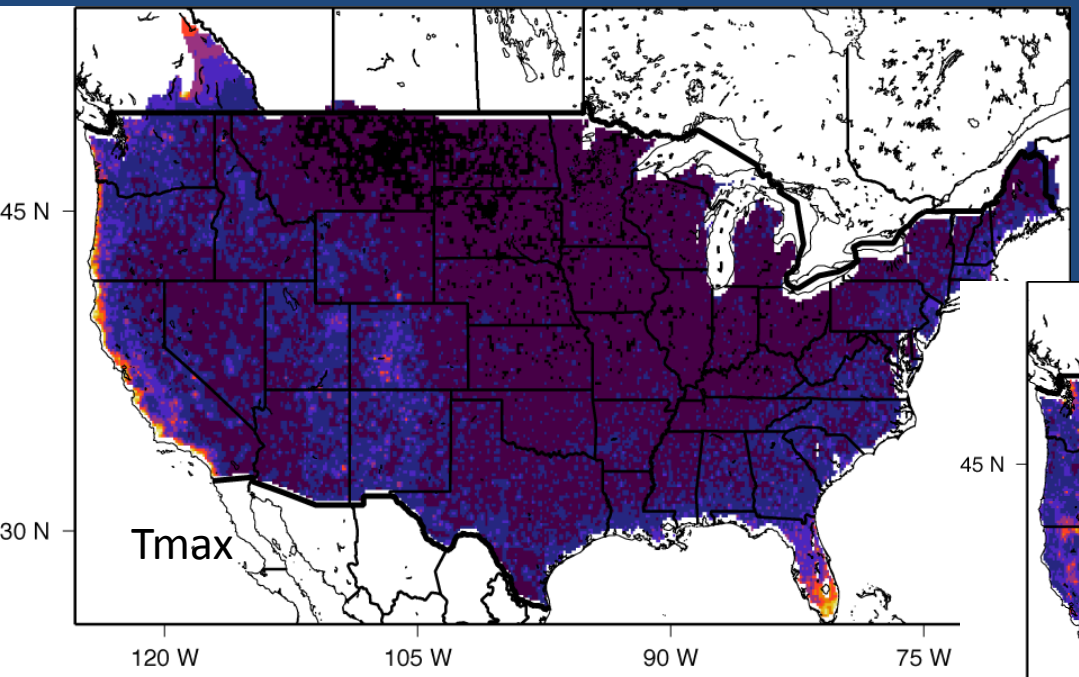


Resampling by Dettinger et al

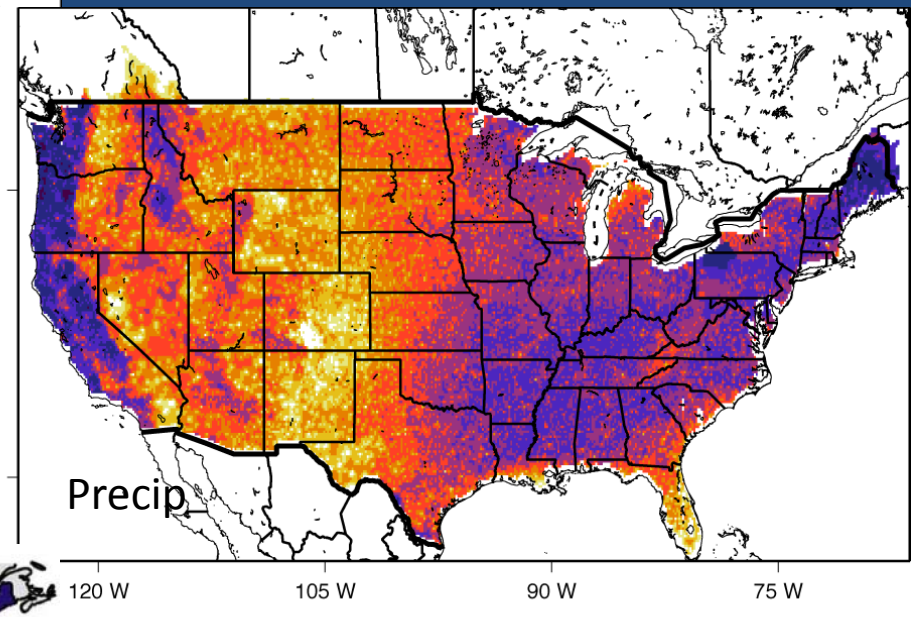


Slide from
Dan Cayan SIO/USGS

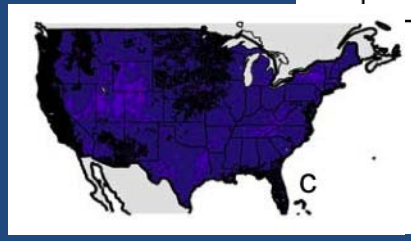
Skill of downscaling as indicated by application of method to historical OBSERVATIONS



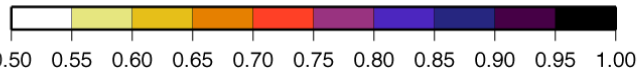
Anomaly Correlations for Daily Tmax's (all years)



Precip Skill at monthly average scale



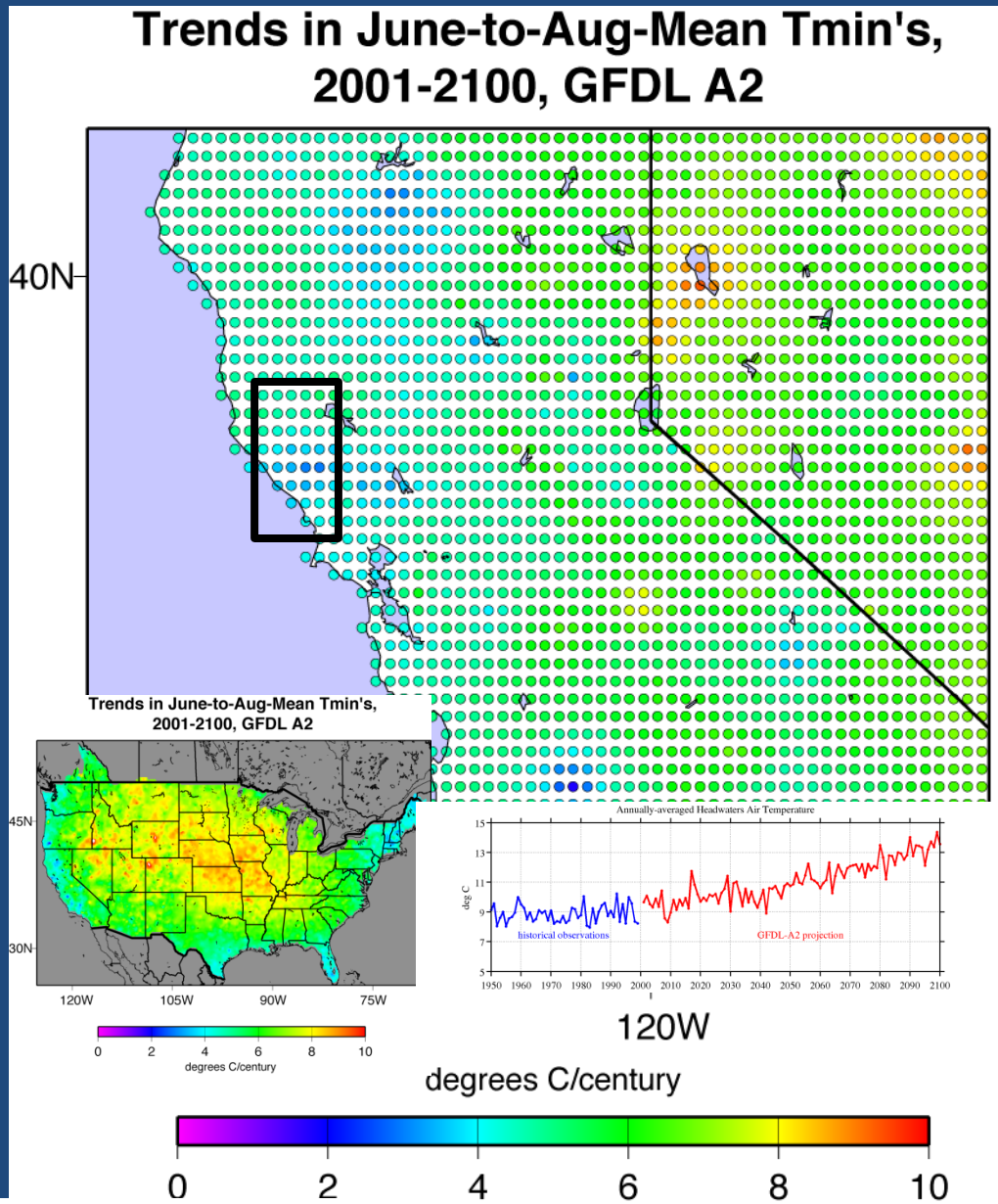
Anomaly Correlations for Daily Root-Precipitation (all years)

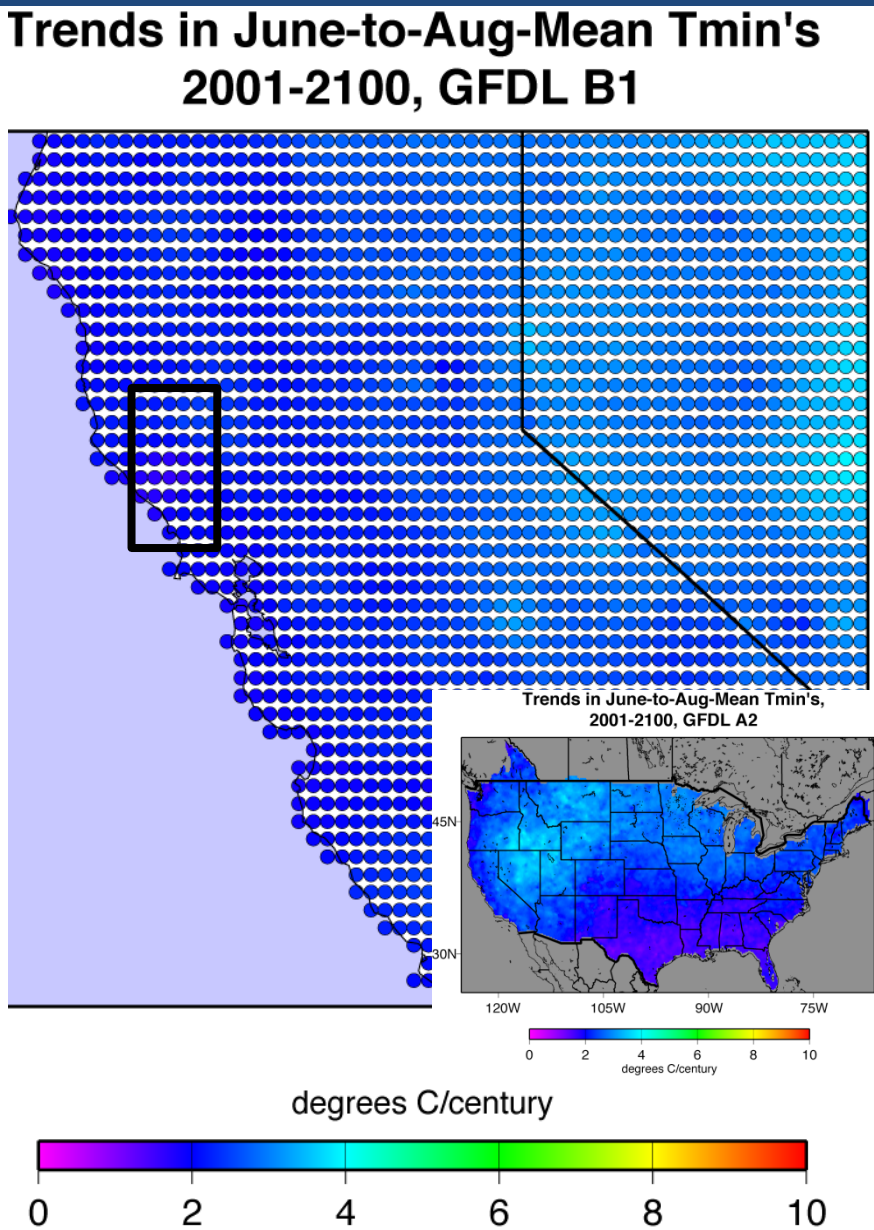


Slide from
Mike Dettinger SIO/USGS

A2 Tmin Trends

B1 Tmin Trends

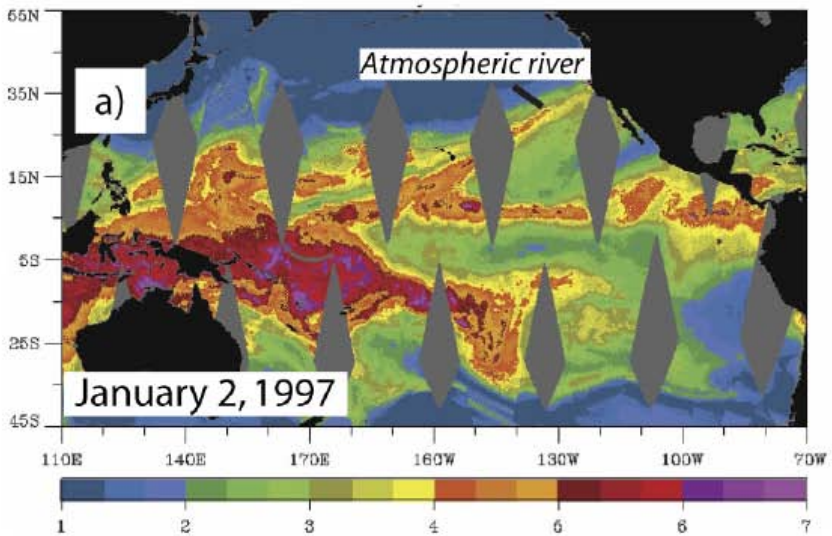


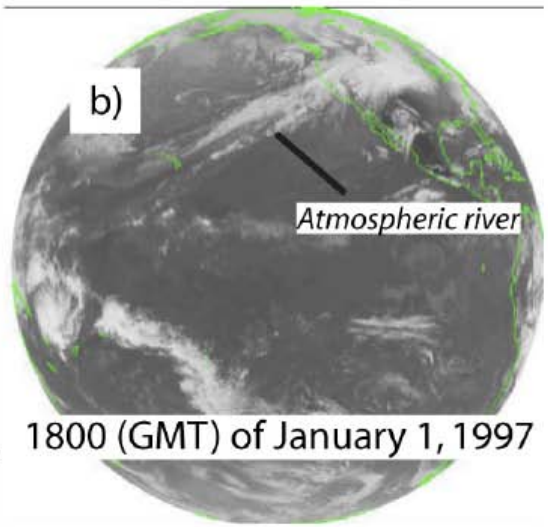


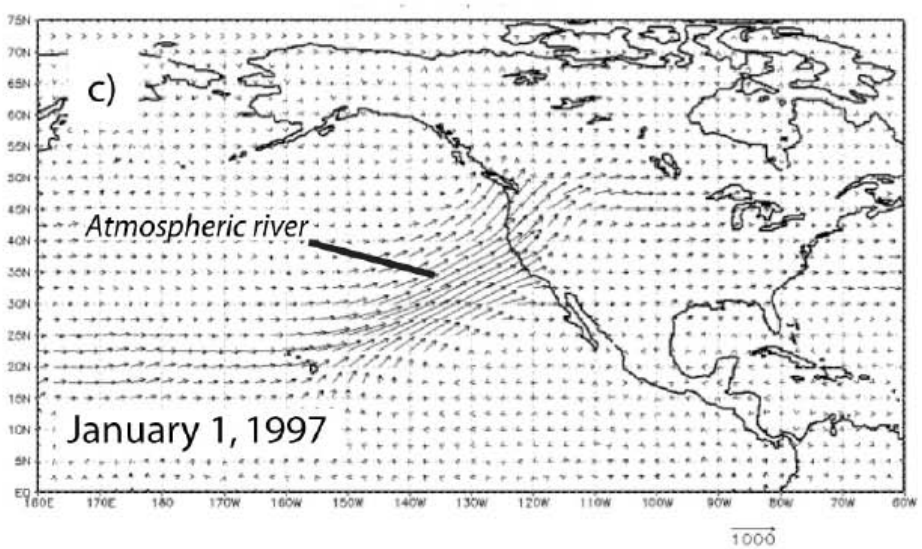
Slide from
Mike Dettinger SIO/USGS

http://cascade.wr.usgs.gov/data/Task1-climate/

Precipitation Extremes – Atmospheric Rivers





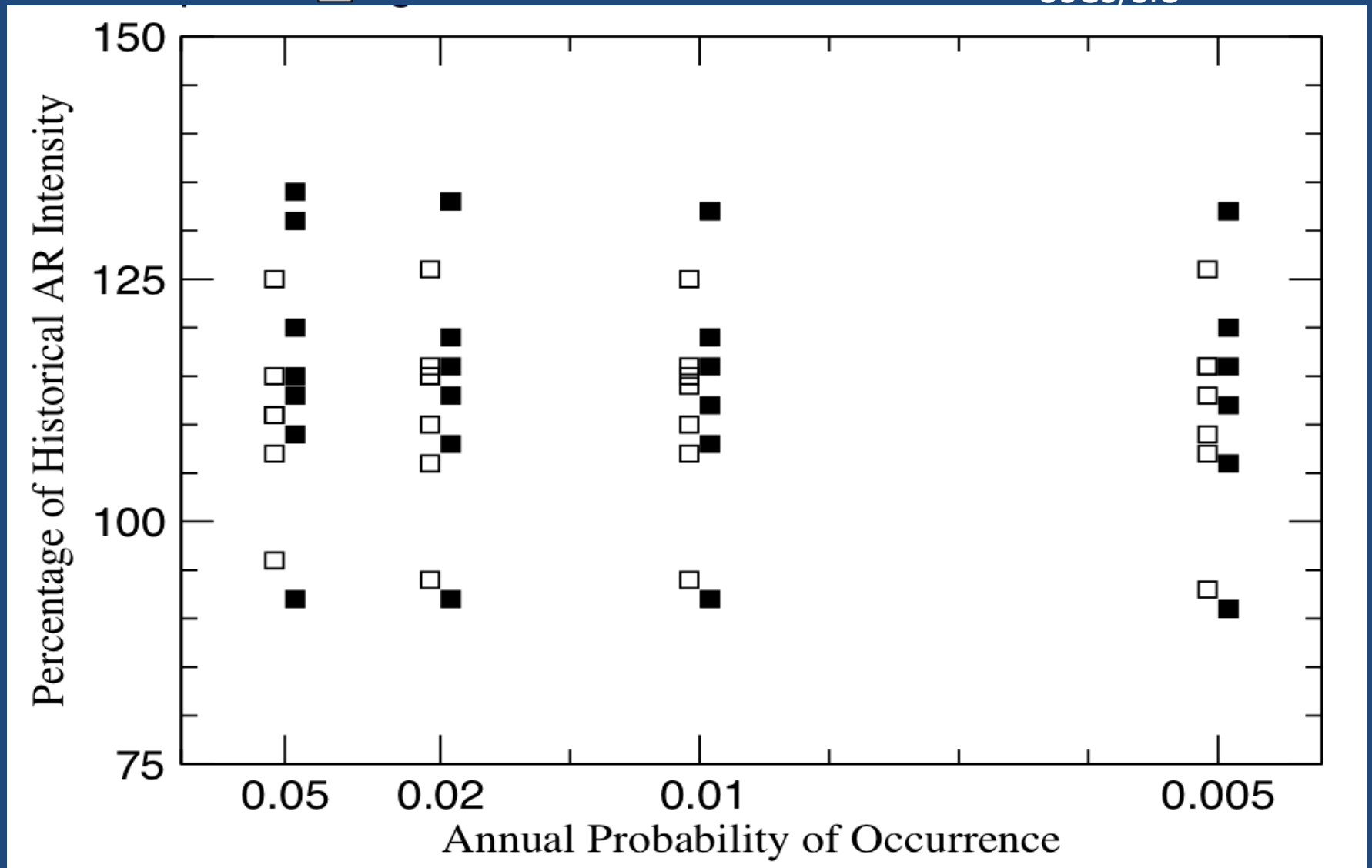


Changes in Atmospheric River Intensity

■ = 2081-2100 vs 1961-2000

□ = 2046-2065 vs 1961-2000

From M. Dettinger
USGS/SIO



Take Home Points

- Warm/Dry Summers Cool/Wet Winters
- Temperature Gradients Across Basin (cooler north warmer east)
- High Precipitation Variability
- Flashy Runoff with High Variability
- Observations of Change Occurring
- Projections show higher sea level, higher temperatures, possible bigger extremes

Questions?

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