

Western Regional
Climate Center



Western Regional Climate Center California Update

Kelly Redmond

Western Regional Climate Center

Desert Research Institute

Reno NV

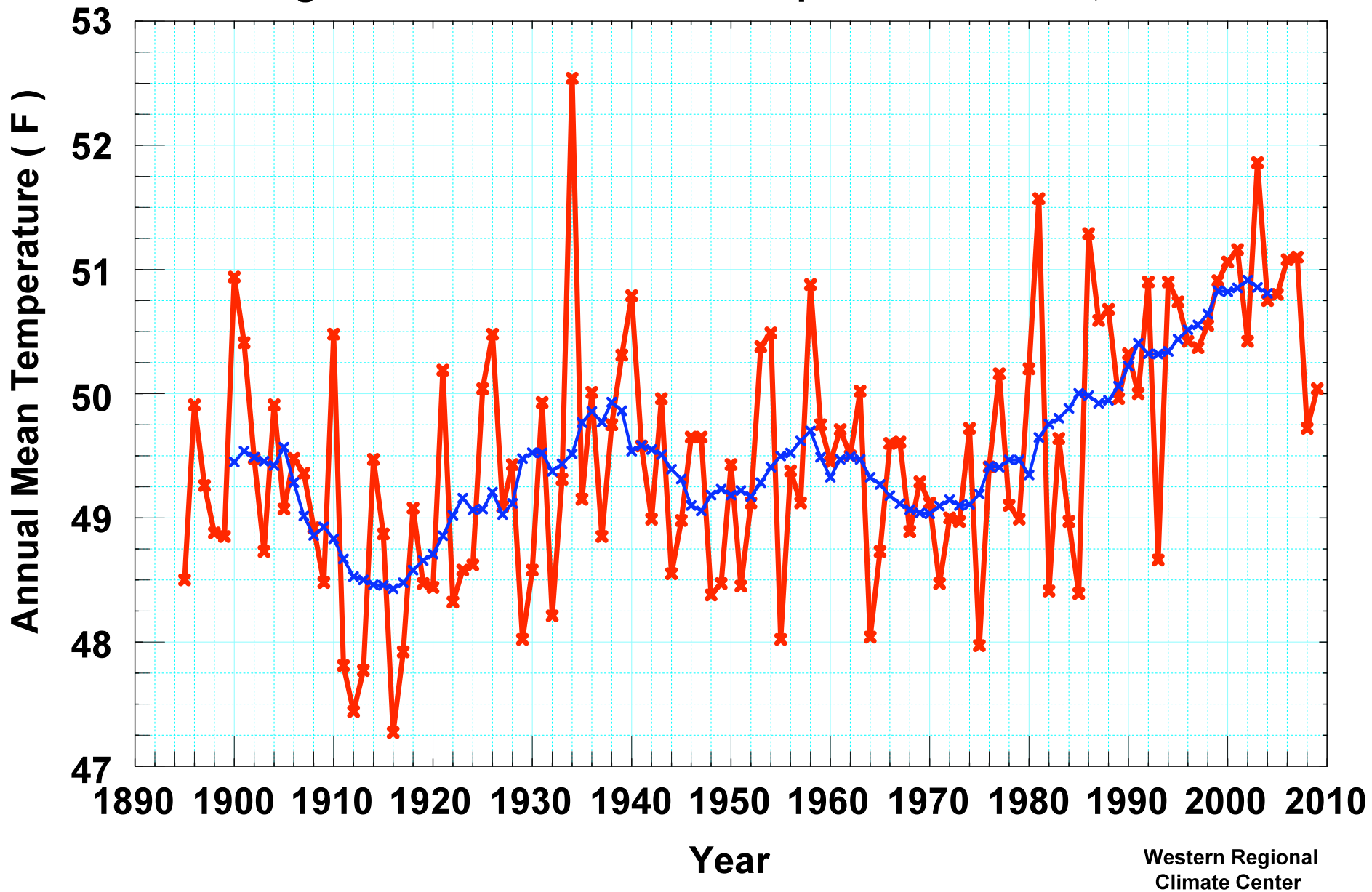
8th Annual Climate Prediction Applications Science Workshop

San Diego, California, 2010 March 2-4

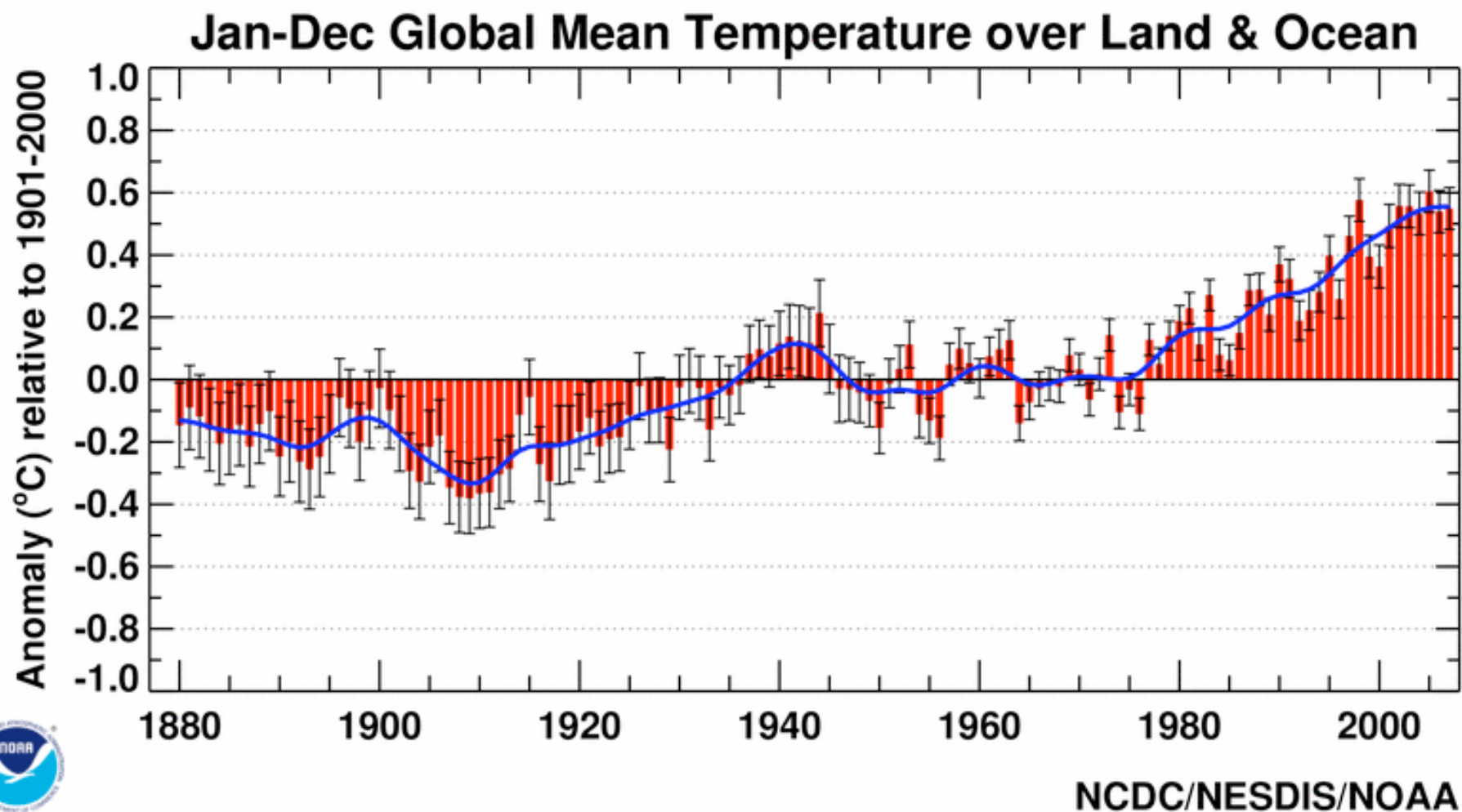


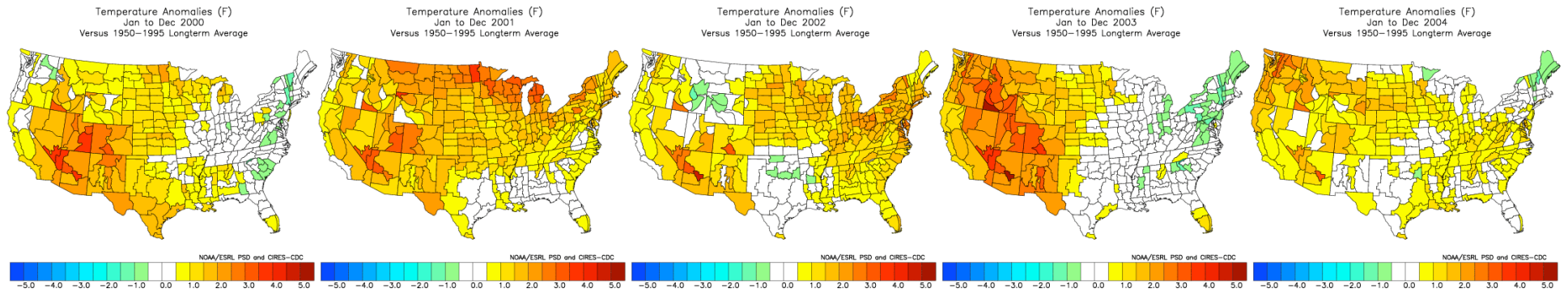


Western United States (11 states) Annual Jan-Dec Temperature
Provisional data from NCDC / CPC. Blue: 11-year running mean.
Units: Deg F. Data source NOAA cooperative network, thru Dec 2009.



Global Surface Temperature 1880-2008





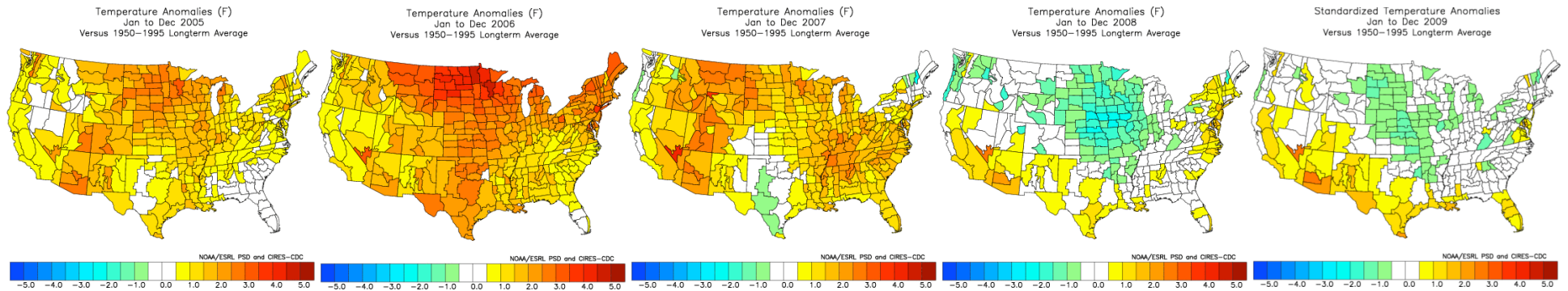
2000

2001

2002

2003

2004



2005

2006

2007

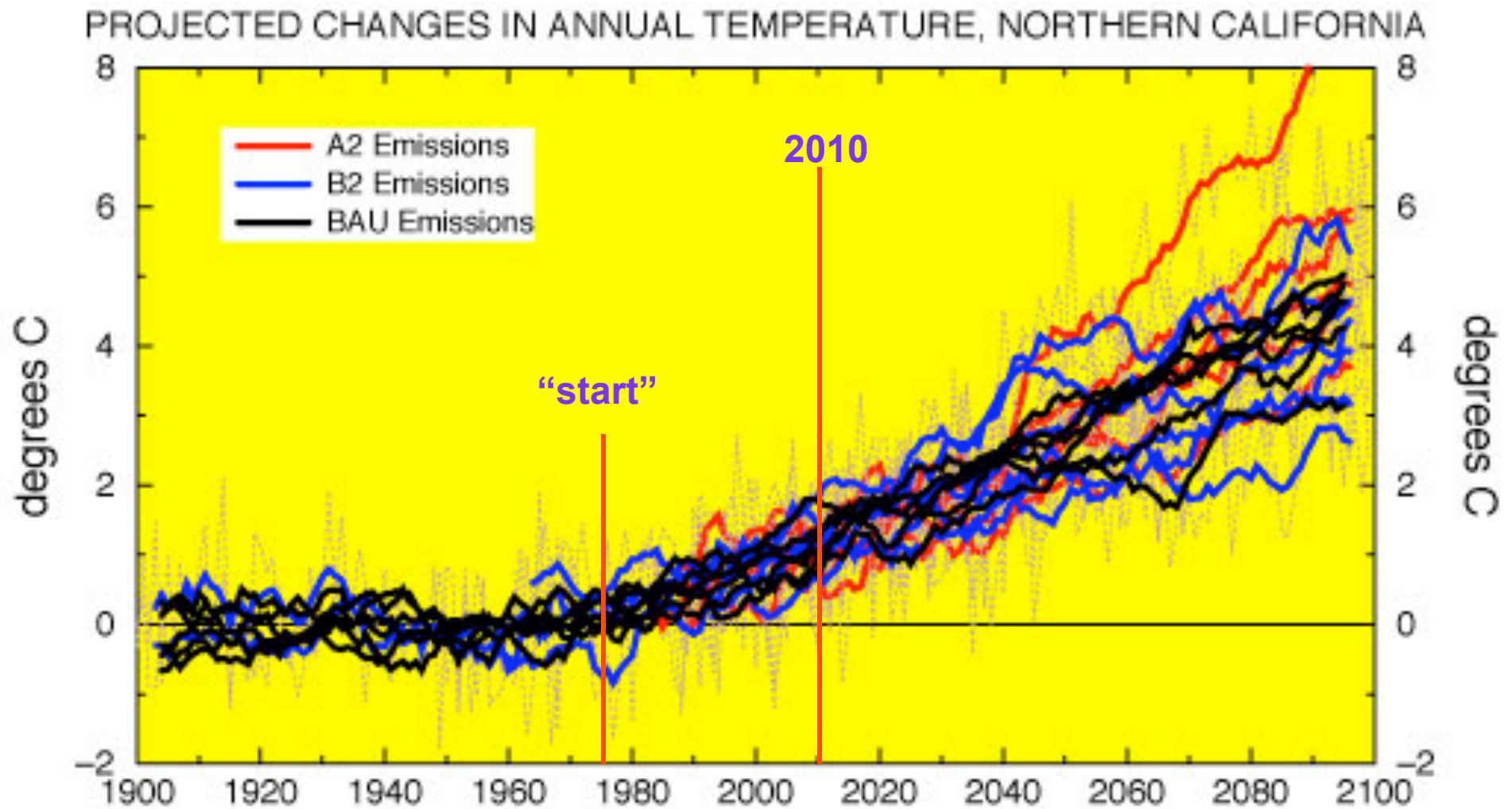
2008

2009

United States Annual Temperature Departure from 1950-1995 Mean

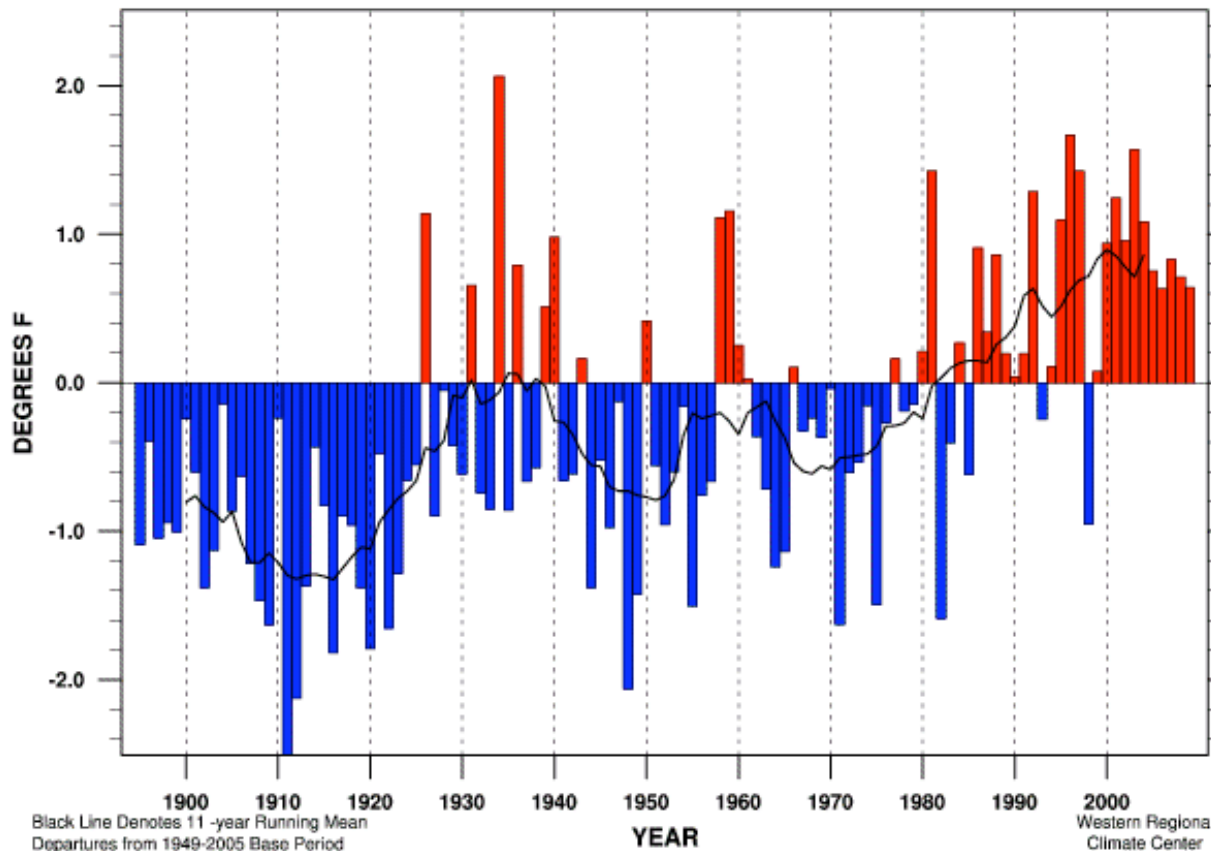
NOAA Divisional Data, Western Regional Climate Center, Plotted by ESRL PSD

Courtesy of Mike Dettinger, USGS / Scripps.



Dettinger MD. 2005. From climate change spaghetti to climate-change distributions for 21st Century California. *San Francisco Estuary and Watershed Science*. Vol. 3, Issue 1, (March 2005), Article 4. <http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art4>

California Statewide Mean Temperature Departure Jan-Dec



Linear Trend 1895-present	+ 1.56 ± 0.42 °F/100yr		
Linear Trend 1949-present	+ 2.73 ± 1.03 °F/100yr		
Linear Trend 1975-present	+ 4.13 ± 2.37 °F/100yr		
Warmest Year	58.1°F (+ 2.1°F) in 1934	MEAN	56.1°F
Coldest Year	53.6°F (- 2.5°F) in 1911	STDEV	0.87°F
Jan-Dec	2009	RANK	93 of 115
	56.7°F (+ 0.6°F)		

[Get Data \(or right-click, "Save As"\)](#)

California Climate Tracker

Latest Graphics

Select Region

Select Element

Select Data Type

Select Time Period

Select

Time Series

Statewide

Mean Temperature

Calendar Year (Jan-Dec)

Select

Summary of the Past 12 Months

Select Region GO

[Climate Regions](#)

[Plot Data](#)

[Page 1](#)

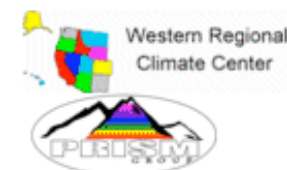
[More Info](#)

[List Entire History](#)

[Page 2](#)

[Back to the California Climate Tracker](#)

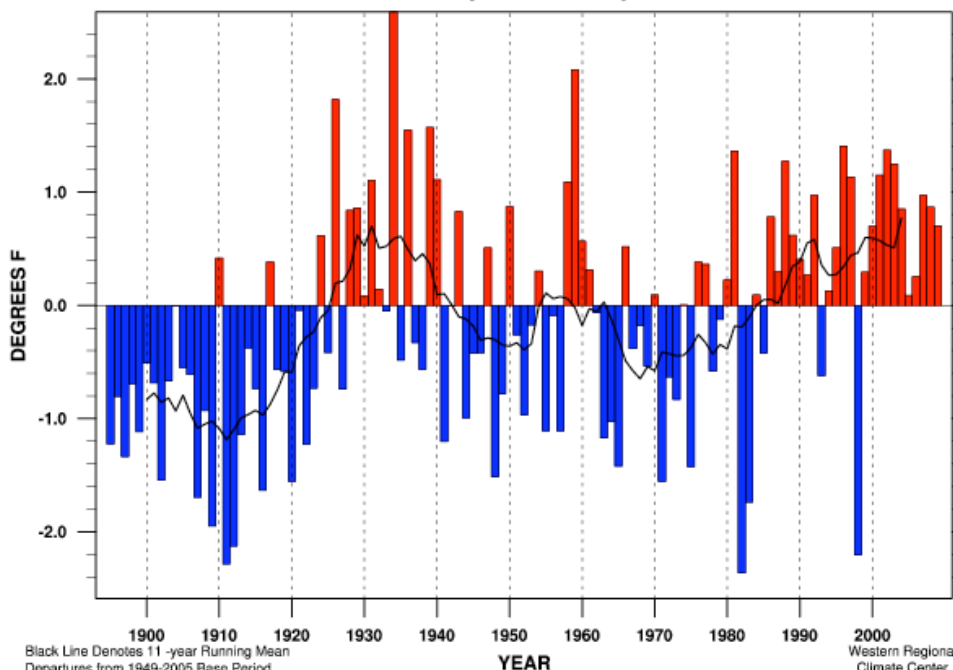
[Non-Frames Version](#)



California Statewide Annual Temperature 1895-2009

Tmax

California Statewide
Maximum Temperature Departure Jan-Dec

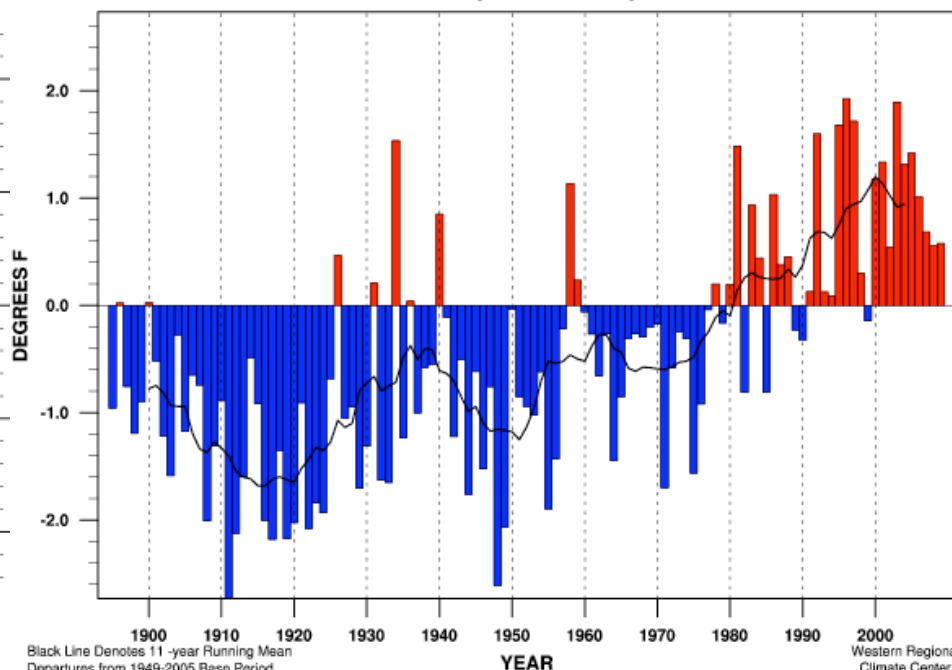


Black Line Denotes 11-year Running Mean
Departures from 1949-2005 Base Period
Western Regional Climate Center

Linear Trend 1895-present	+ 1.10 ± 0.52 °F/100yr	MEAN	69.0 °F
Linear Trend 1949-present	+ 1.76 ± 1.31 °F/100yr	STDEV	0.95 °F
Linear Trend 1975-present	+ 3.70 ± 3.07 °F/100yr	RANK	91 of 115
Warmest Year	71.6 °F (+ 2.6 °F) in 1934		
Coldest Year	66.6 °F (- 2.4 °F) in 1982		
Jan-Dec	2009		69.7 °F (+ 0.7 °F)

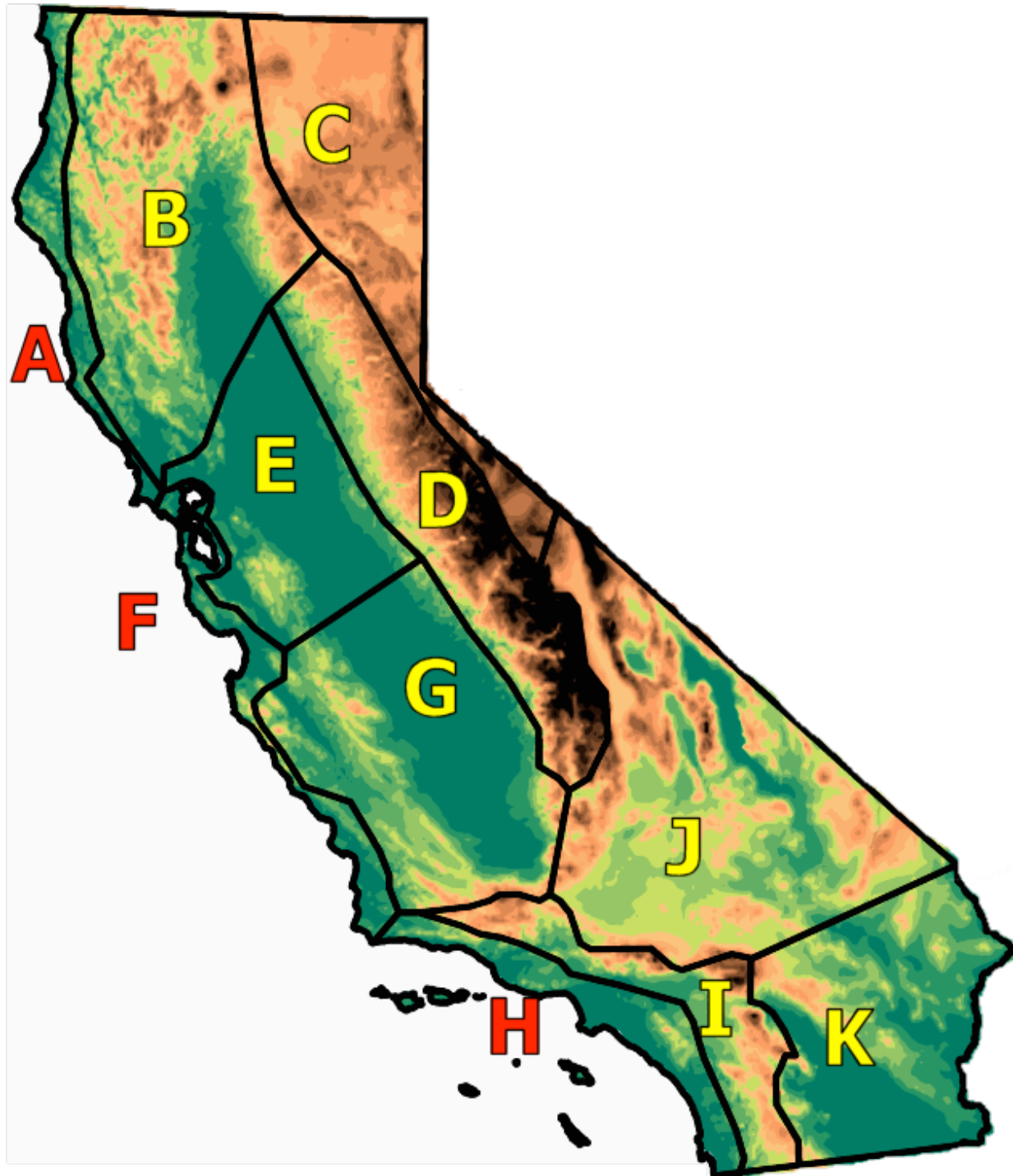
Tmin

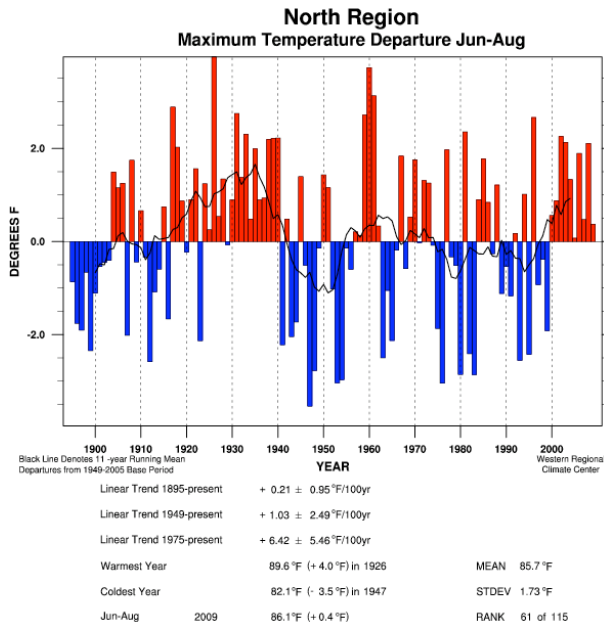
California Statewide
Minimum Temperature Departure Jan-Dec



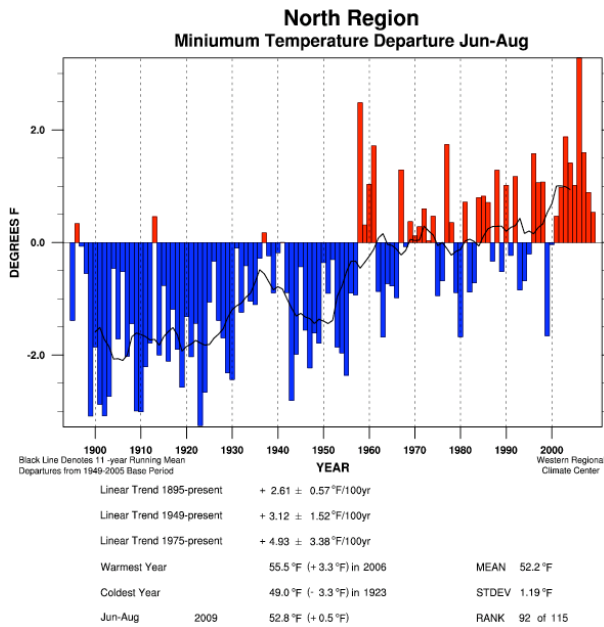
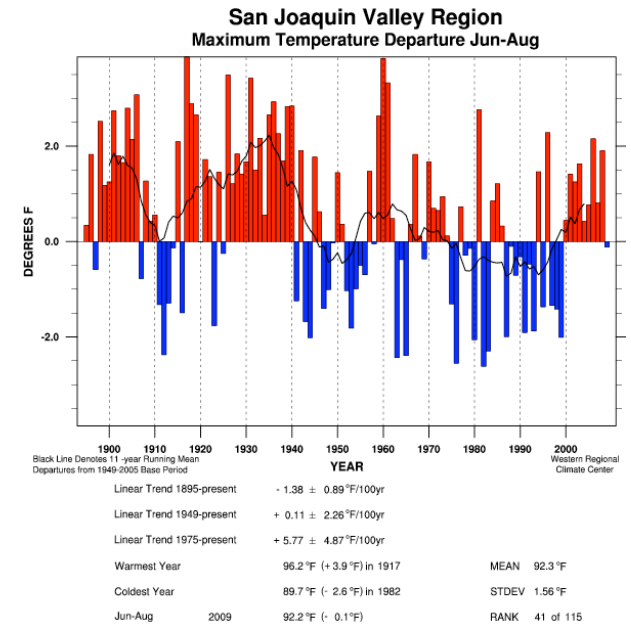
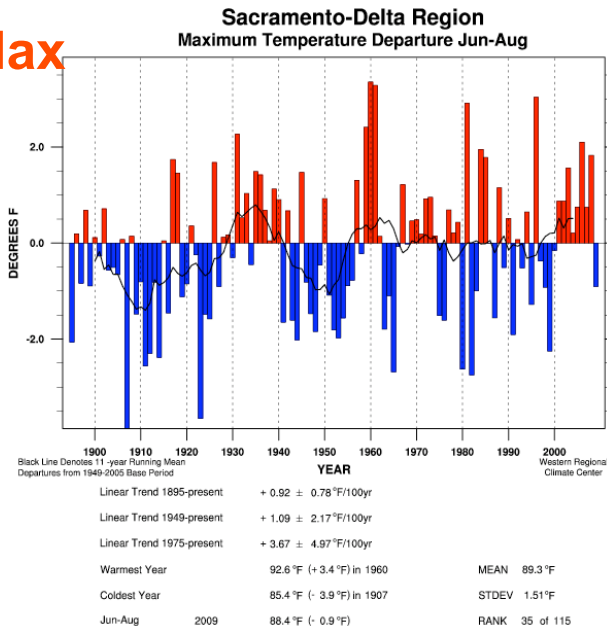
Black Line Denotes 11-year Running Mean
Departures from 1949-2005 Base Period
Western Regional Climate Center

Linear Trend 1895-present	+ 2.01 ± 0.46 °F/100yr	MEAN	43.1 °F
Linear Trend 1949-present	+ 3.69 ± 1.04 °F/100yr	STDEV	0.98 °F
Linear Trend 1975-present	+ 4.57 ± 2.49 °F/100yr	RANK	98 of 115
Warmest Year	45.1 °F (+ 1.9 °F) in 1996		
Coldest Year	40.4 °F (- 2.7 °F) in 1911		
Jan-Dec	2009		43.7 °F (+ 0.6 °F)

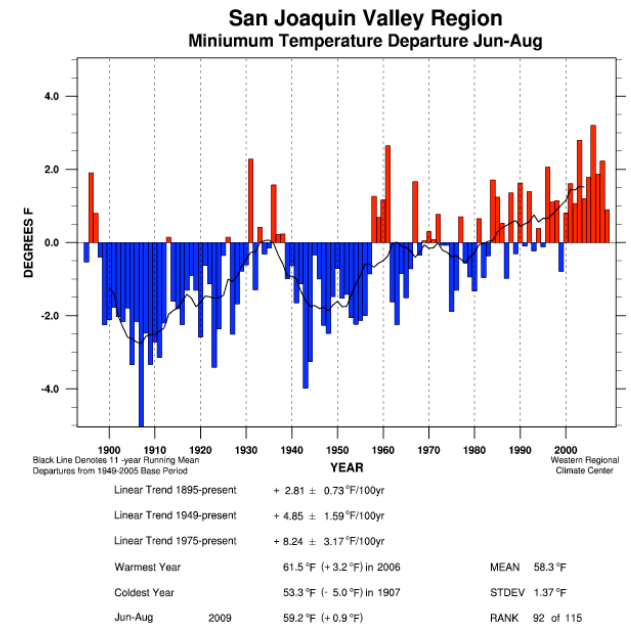
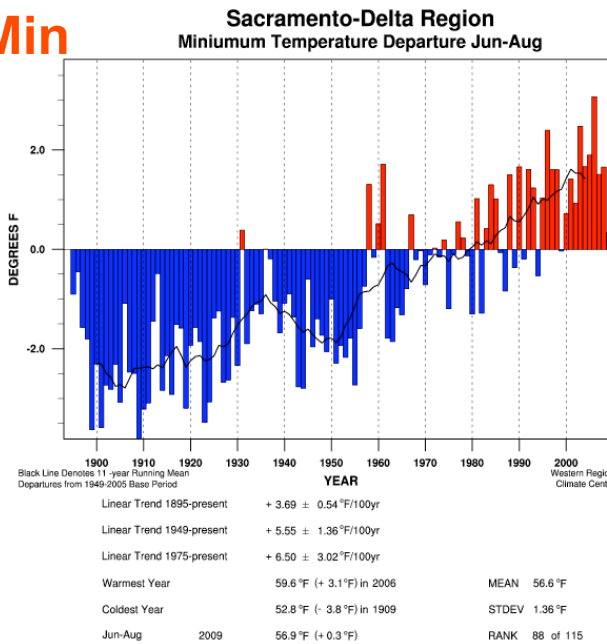




Max



Min



**Interior California Summer (JJA) Max and Min Temperature
Northern / Sacramento R Bay-Delta Southern / San Joaquin R**



WestMap

Climate Analysis & Mapping Toolbox

[WestMap Home](#)

TOOLBOX

Map & Graph

[Create Time Series](#)

[Create Map](#)

[Tutorial](#)

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Climate 101

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[Climate Links](#)

WestMap

[Overview](#)

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[Publications](#)

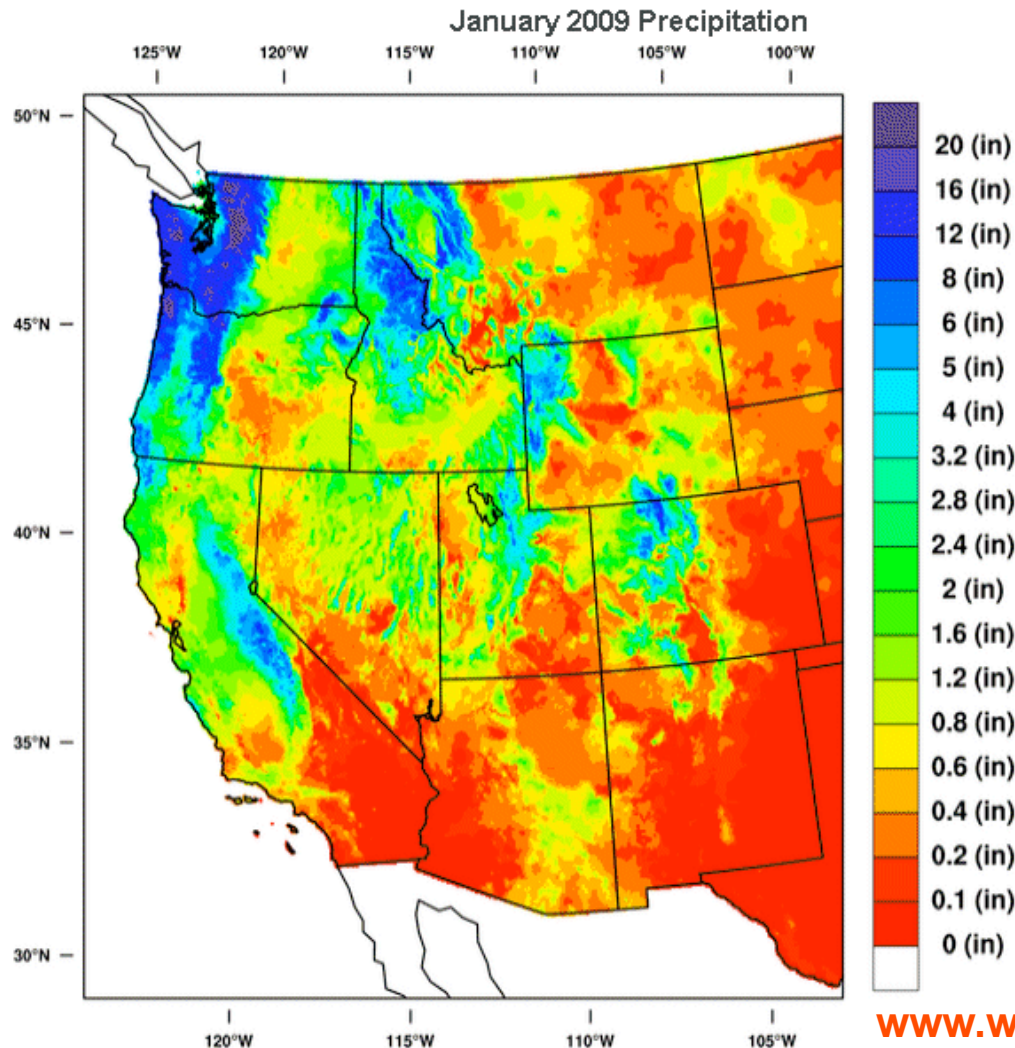
[Applications](#)

FAQs



CONTENTS
UNDER
CONSTRUCTION

Select Element:
 Select Region By:
 Select Record:
 Map Click:



Westmap

**Joint project
between**

U Arizona

DRI / WRCC

OSU PRISM Grp

**NOAA – NCTP
(now TRACS)**

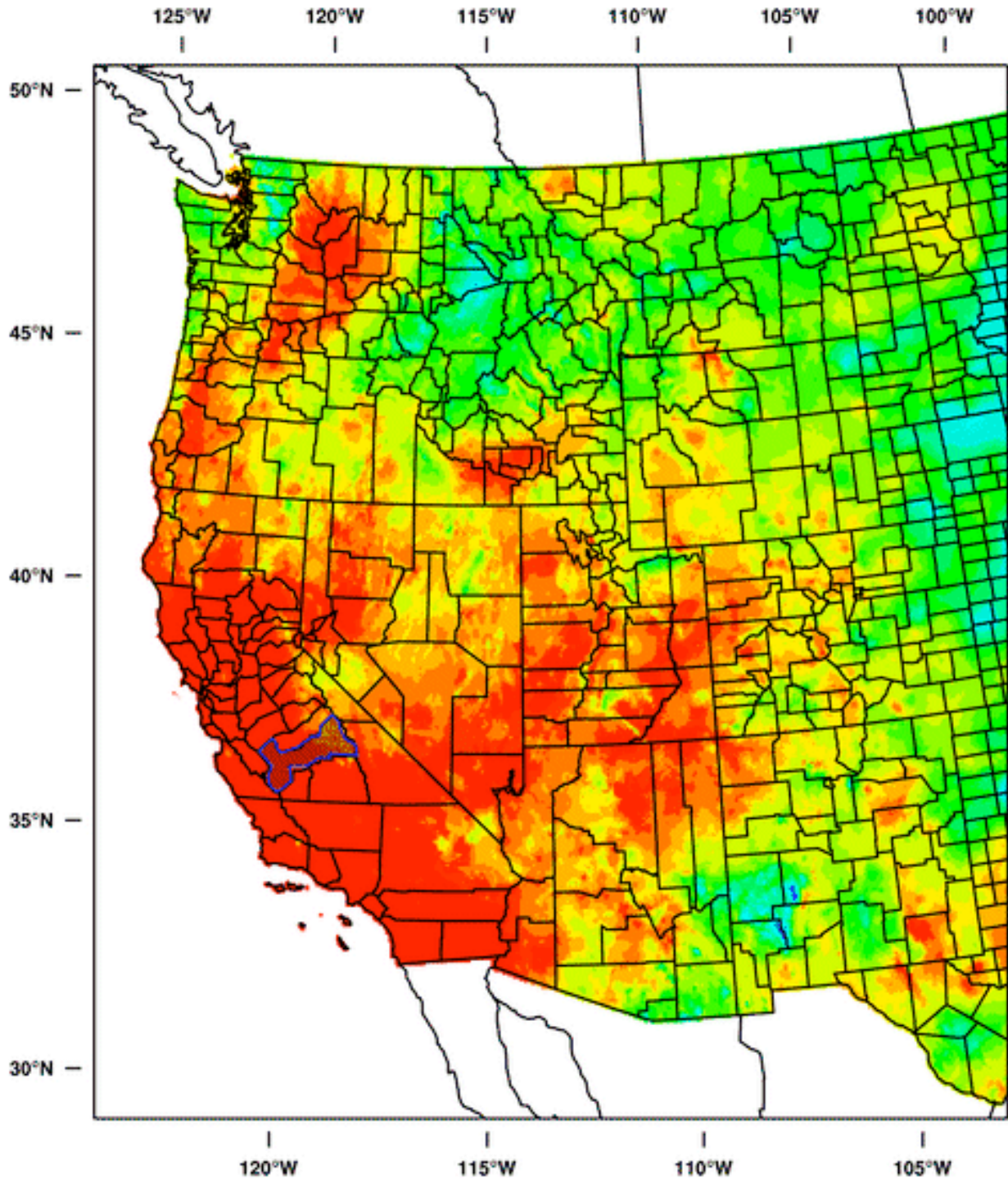
CLIMAS

WRCC

CAP

**At present is
restricted to just
the western
United States**

www.wrcc.dri.edu/PROJECTS.html



Areas:

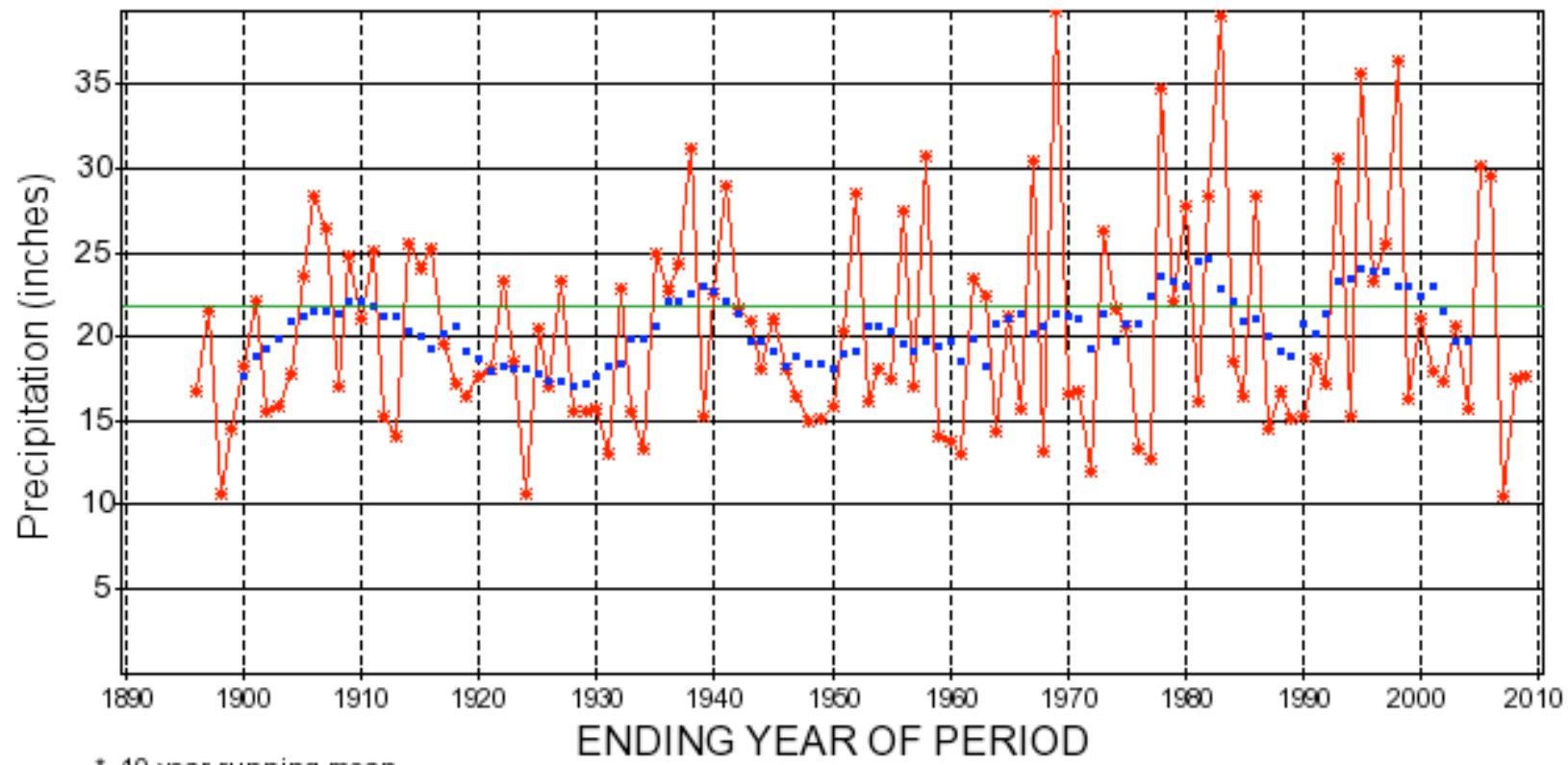
- States**
- Counties**
- Hydrobasins**
- Climate Divisions**
- Grid squares**
- Individual Pixels**

Uses 4 km PRISM Monthly Data

1895 through the latest month

Total Precipitation for California -- Fresno County

12 month period ending in June



* 10 year running mean

[Back](#)

* Previous page with saved values.

12-Month Period Ending in June

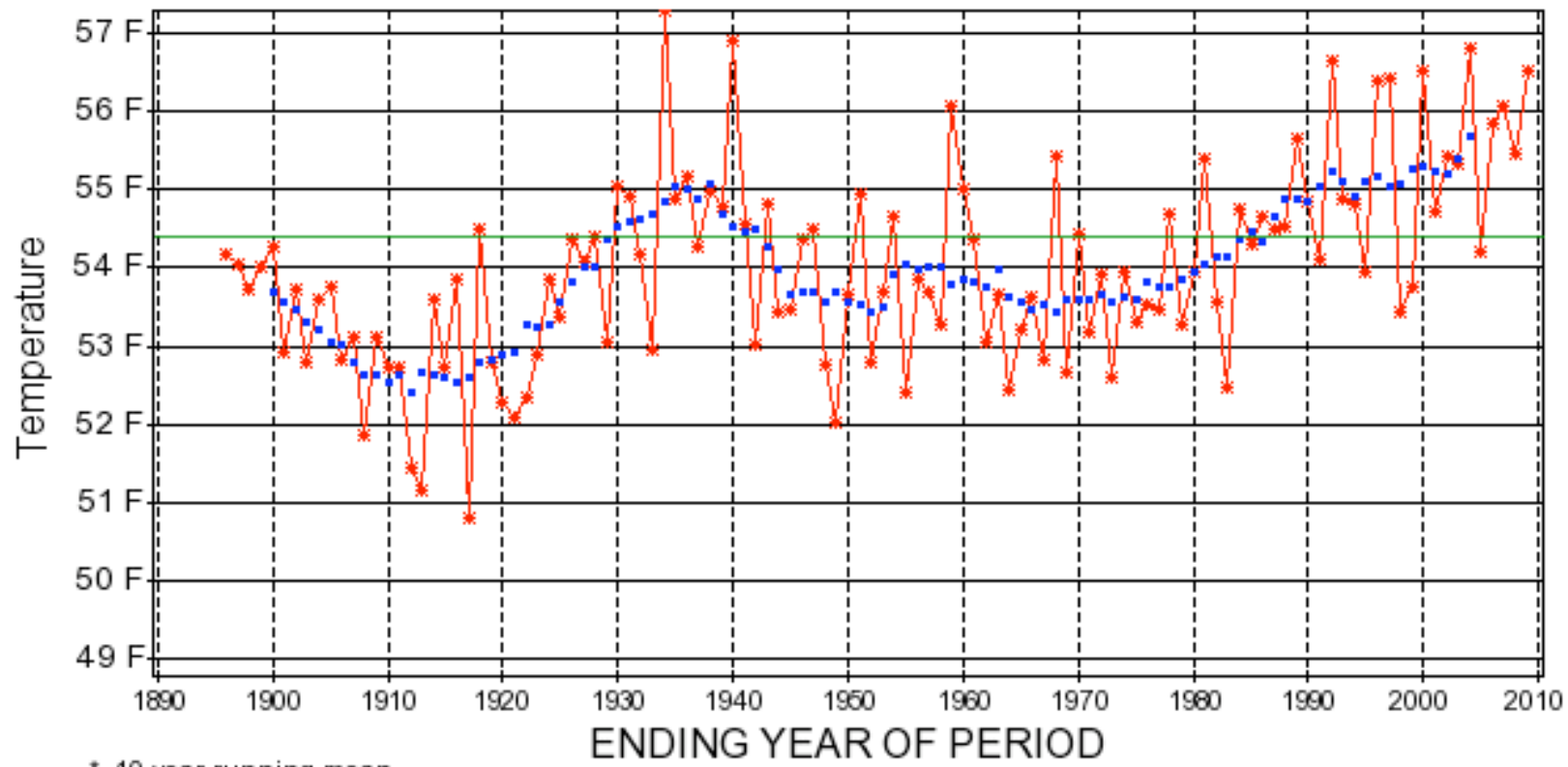
AVERAGE	20.311
MEDIAN	18.100
MINIMUM	10.420
MAXIMUM	39.520
SKEWNESS	0.971
COEFF OF VAR	0.304
SIGMA (RMS)	21.233
NUMBER OBS	114.000

Precipitation
July-June
1895-1896
Thru
2008-2009

Mean: 1971-2000

Mean Temperature for California -- Fresno County

12 month period ending in June



* 10 year running mean

[Back](#)

* Previous page with saved values.

12-Month Period Ending in June

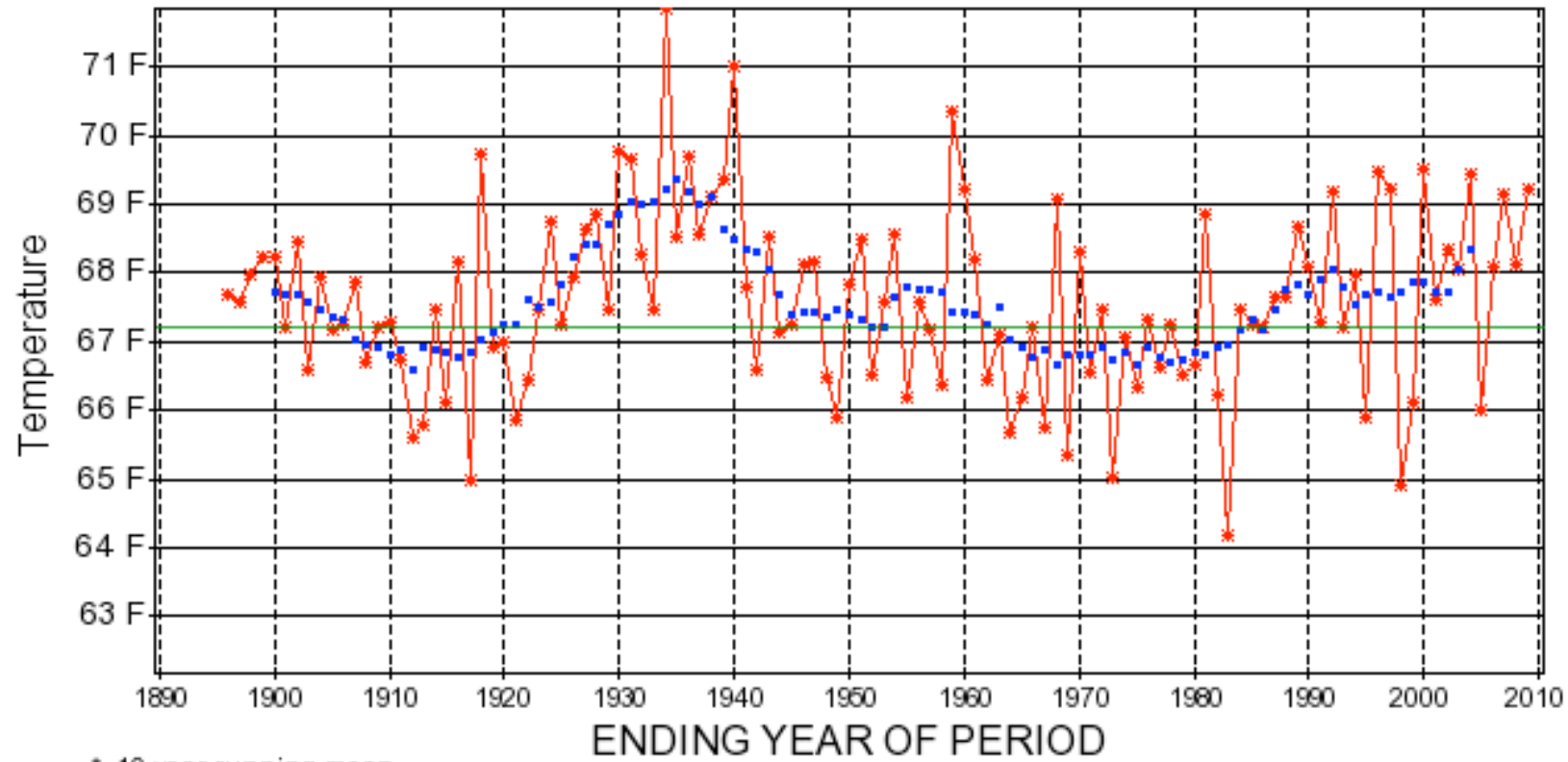
AVERAGE	54.008
MEDIAN	53.921
MINIMUM	50.800
MAXIMUM	57.317
SKEWNESS	0.290
COEFF OF VAR	0.023
SIGMA (RMS)	54.022
NUMBER OBS	114.000

**Mean Temperature
July-June
1895-1896
Thru
2008-2009**

Mean: 1971-2000

Mean Maximum Temperature for California -- Fresno County

12 month period ending in June



* 10 year running mean

[Back](#)

* Previous page with saved values.

12-Month Period Ending in June

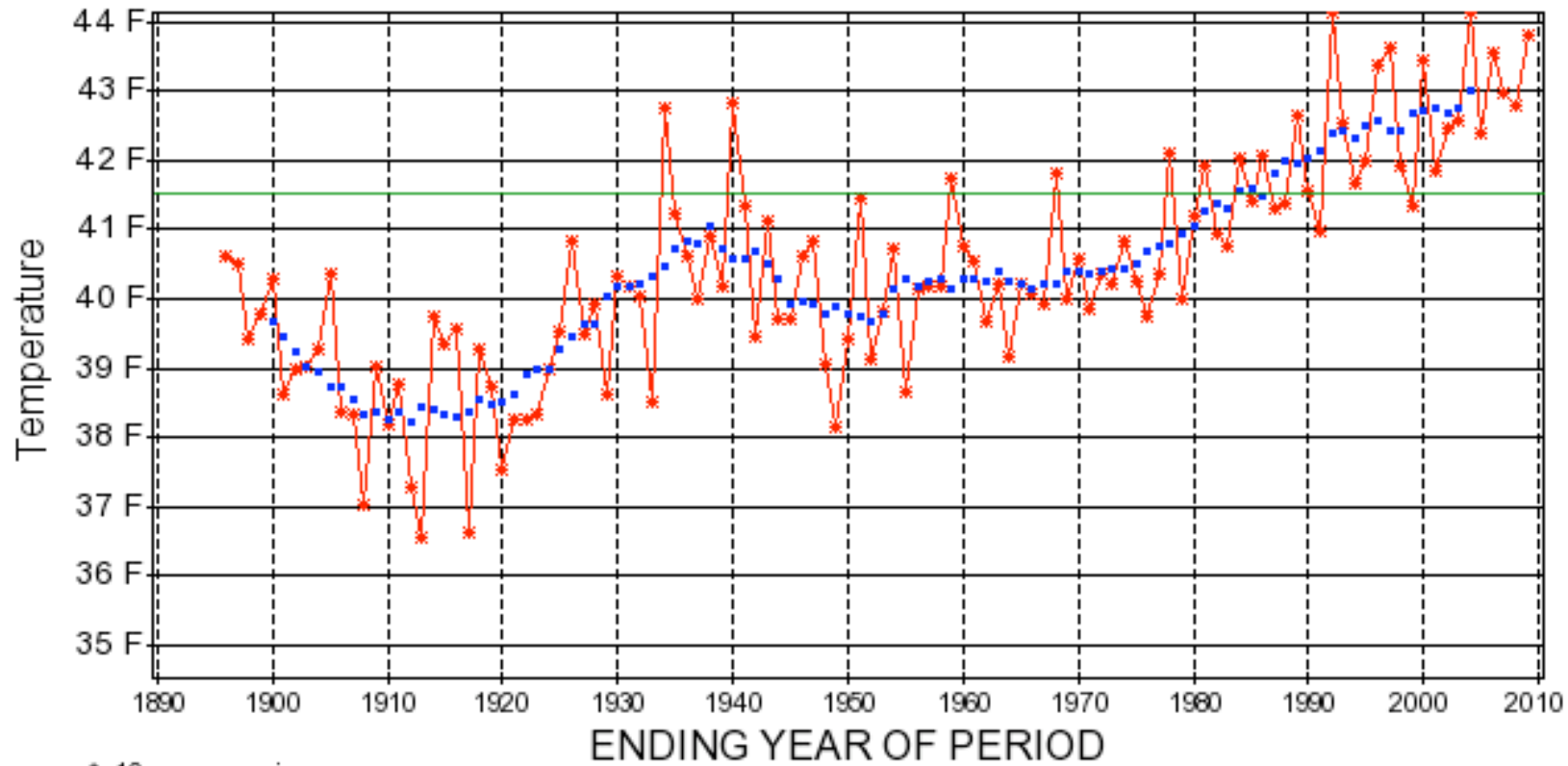
AVERAGE	67.595
MEDIAN	67.479
MINIMUM	64.192
MAXIMUM	71.883
SKEWNESS	0.244
COEFF OF VAR	0.019
SIGMA (RMS)	67.608
NUMBER OBS	114.000

Mean Maximum Temperature
July-June
1895-1896
Thru
2008-2009

Mean: 1971-2000

Mean Minimum Temperature for California -- Fresno County

12 month period ending in June



* 10 year running mean

[Back](#)

* Previous page with saved values.

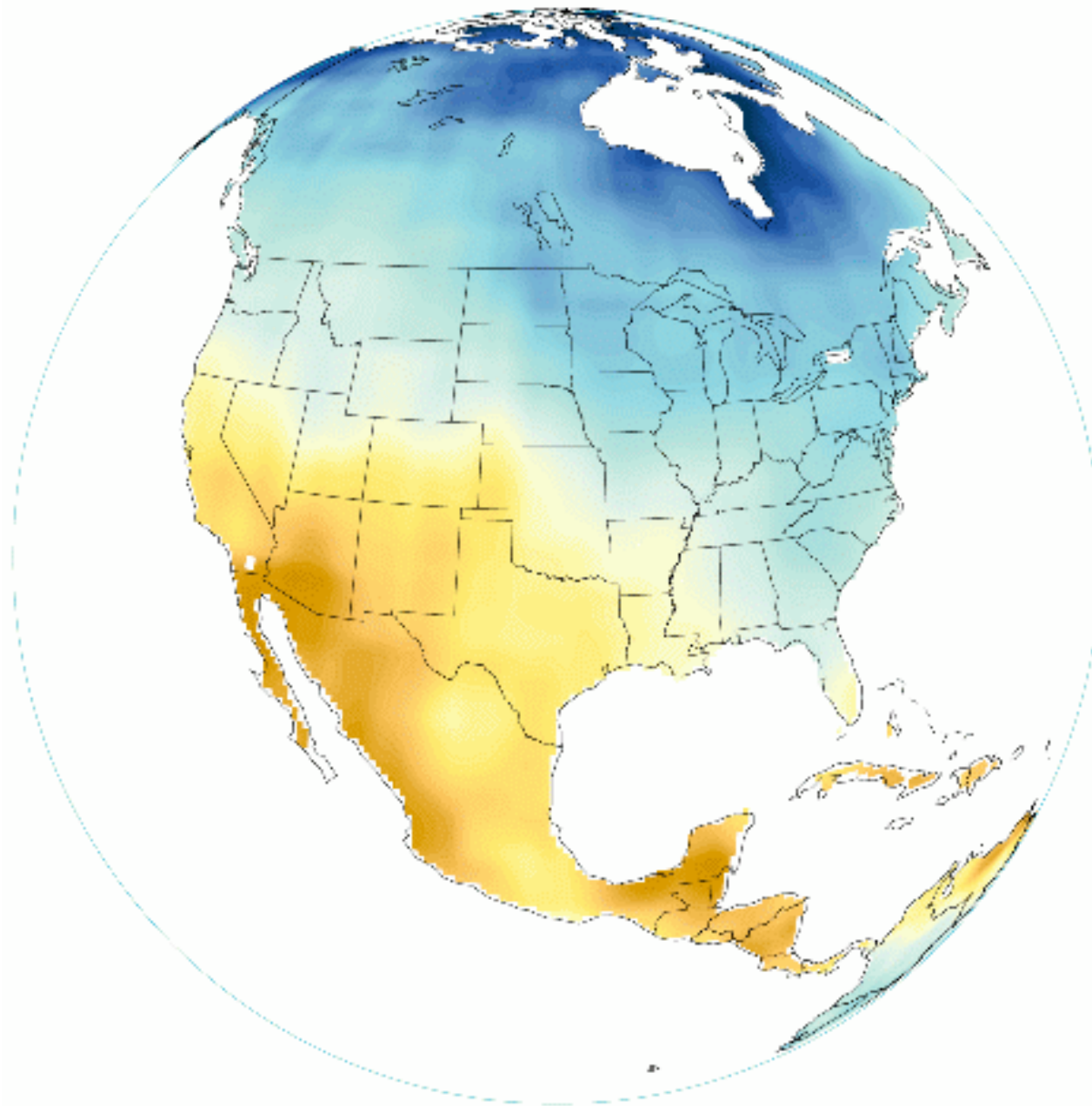
12-Month Period Ending in June

AVERAGE	40.421
MEDIAN	40.246
MINIMUM	36.533
MAXIMUM	44.175
SKEWNESS	0.146
COEFF OF VAR	0.039
SIGMA (RMS)	40.453
NUMBER OBS	114.000

Mean Minimum Temperature
July-June
1895-1896
Thru
2008-2009

Mean: 1971-2000

Projected Change in Precipitation 1950-2000 to 2021-2040 (Percent of 1950-2000)



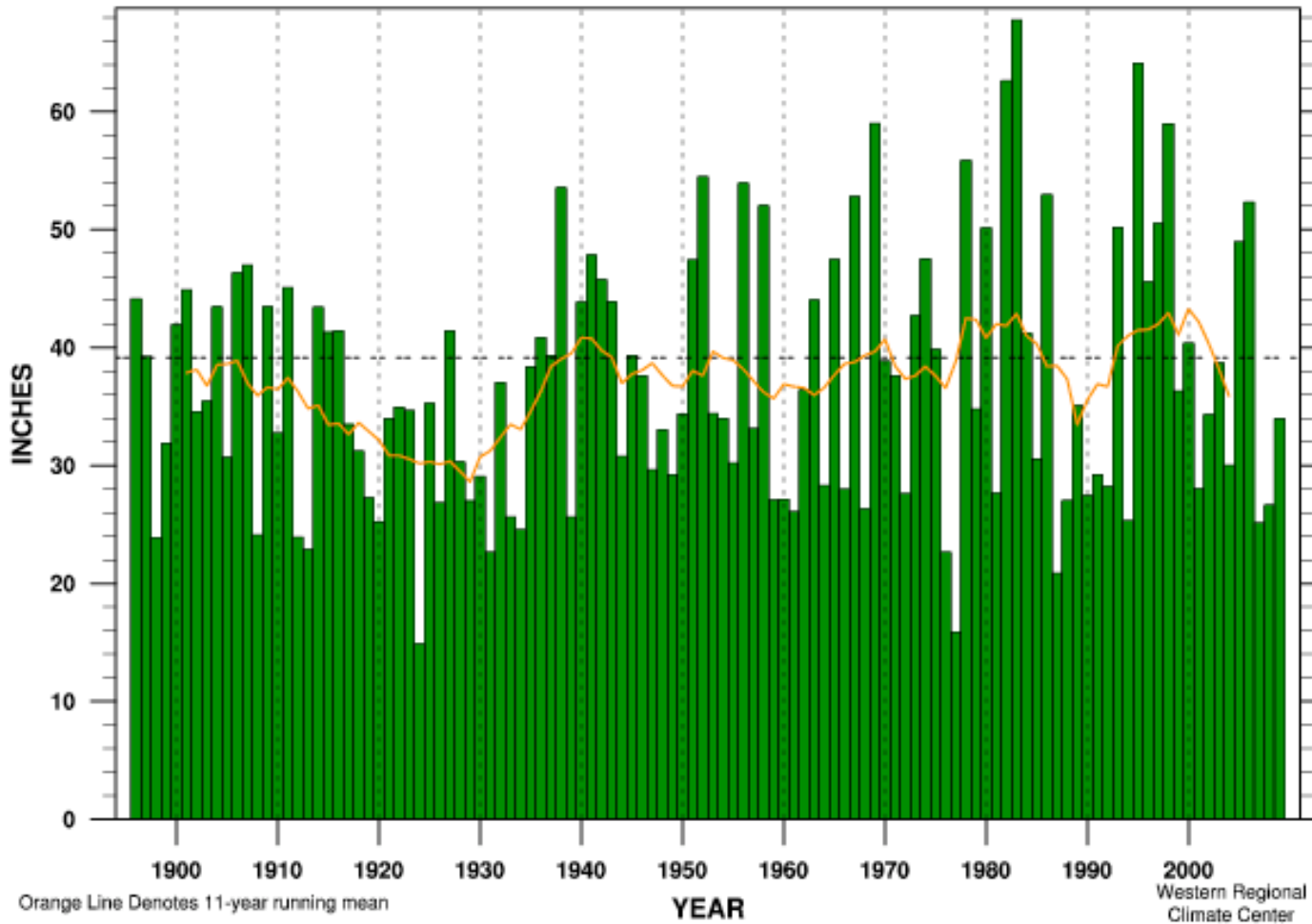
**Average of 19
climate models.
2007.**

**Figure by
Gabriel Vecchi.**

[www.ideo.columbia.edu/
res/div/ocp/drought/
science.shtml](http://www.ideo.columbia.edu/res/div/ocp/drought/science.shtml)

**R. Seager, M.F. Ting, I.M. Held,
Y. Kushnir, J. Lu, G. Vecchi, H.-
P. Huang, N. Harnik, A.
Leetmaa, N.-C. Lau, C. Li, J.
Velez, N. Naik, 2007. Model
Projections of an Imminent
Transition to a More Arid
Climate in Southwestern North
America. *Science*, DOI:
10.1126/science.1139601**

Sierra Region Precipitation Oct-Sep



Orange Line Denotes 11-year running mean

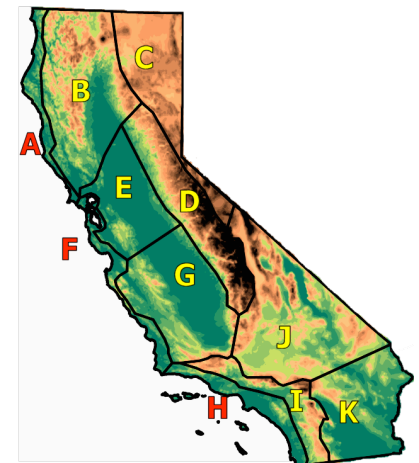
Western Regional
Climate Center

Linear Trend 1895-present	+ 4.52 ± 6.00 in.	(+ 11 ± 15%) per 100 yr		
Linear Trend 1949-present	- 0.56 ± 18.45 in.	(- 1 ± 47%) per 100 yr		
Linear Trend 1975-present	- 3.35 ± 49.60 in.	(- 8 ± 126%) per 100 yr		
Wettest Year	67.79 in. (173%)	in 1983	MEAN	39.15 in.
Driest Year	14.89 in. (38%)	in 1924	STDEV	12.33 in.
Oct-Sep	2009	33.98 in. (86%)	RANK	48 of 114

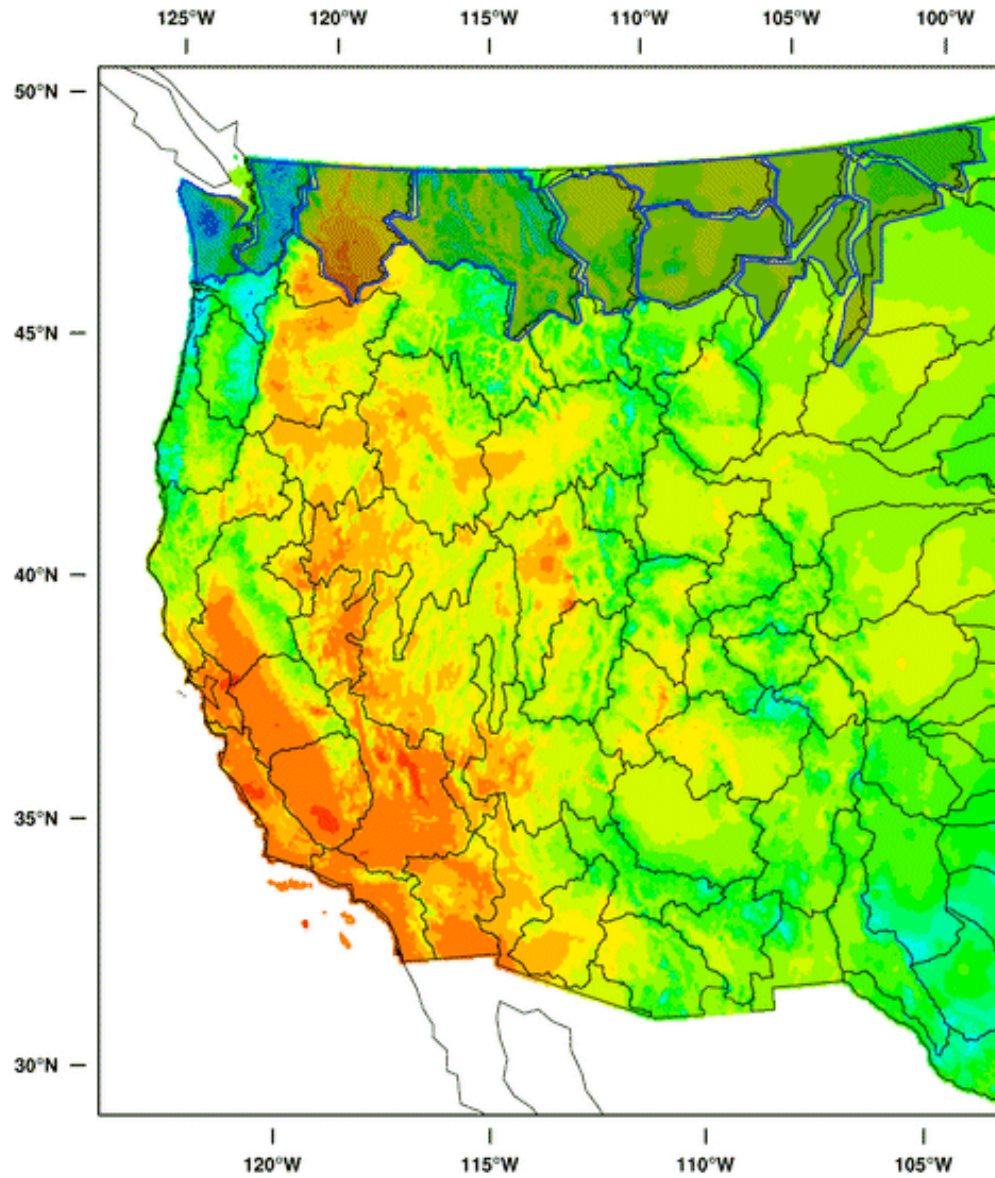
**Water Year
Oct-Sep
Precip**

**Sierra
Nevada**

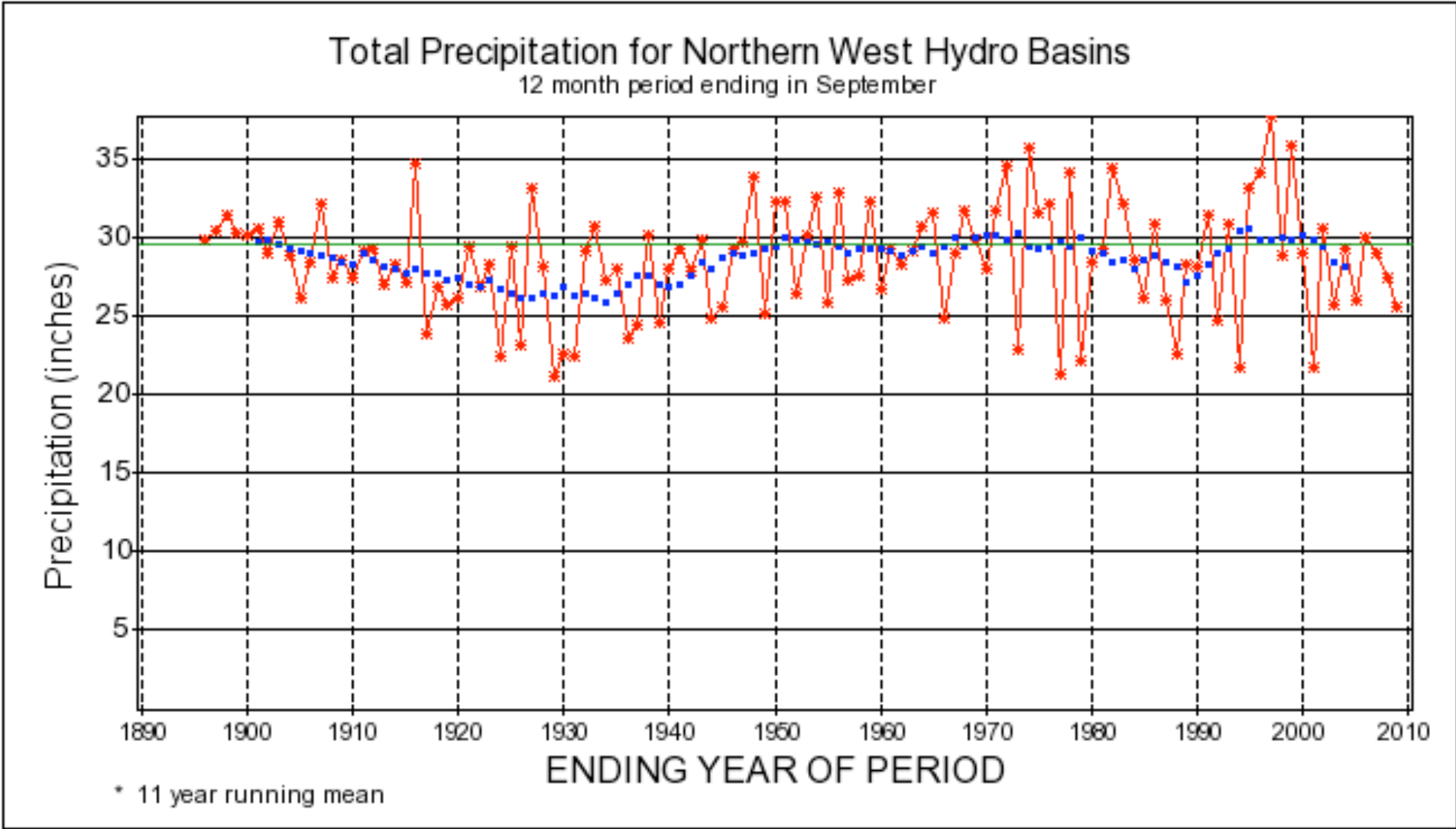
**1895/96
thru
2008/09**



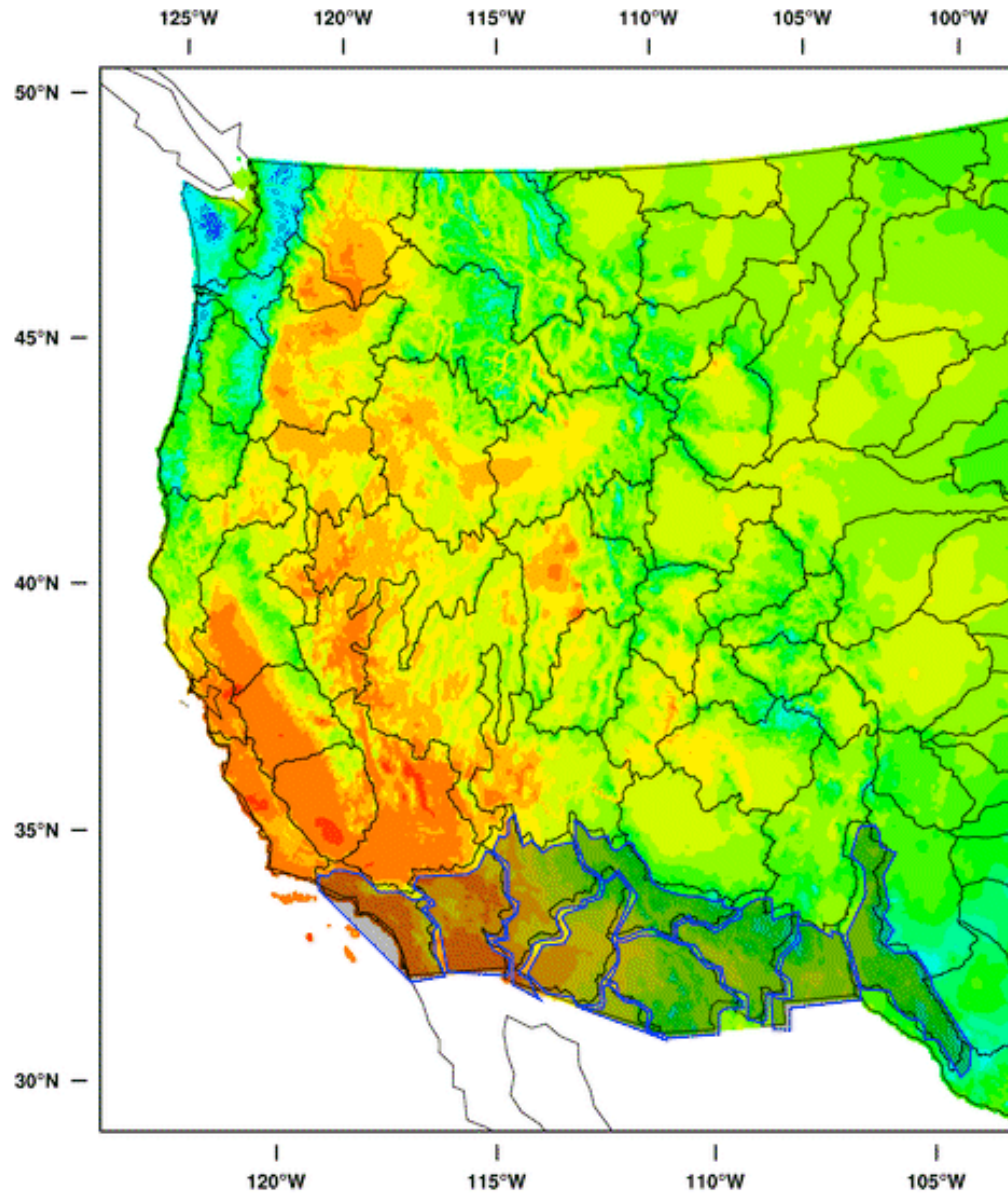
Northern West Hydro Basins



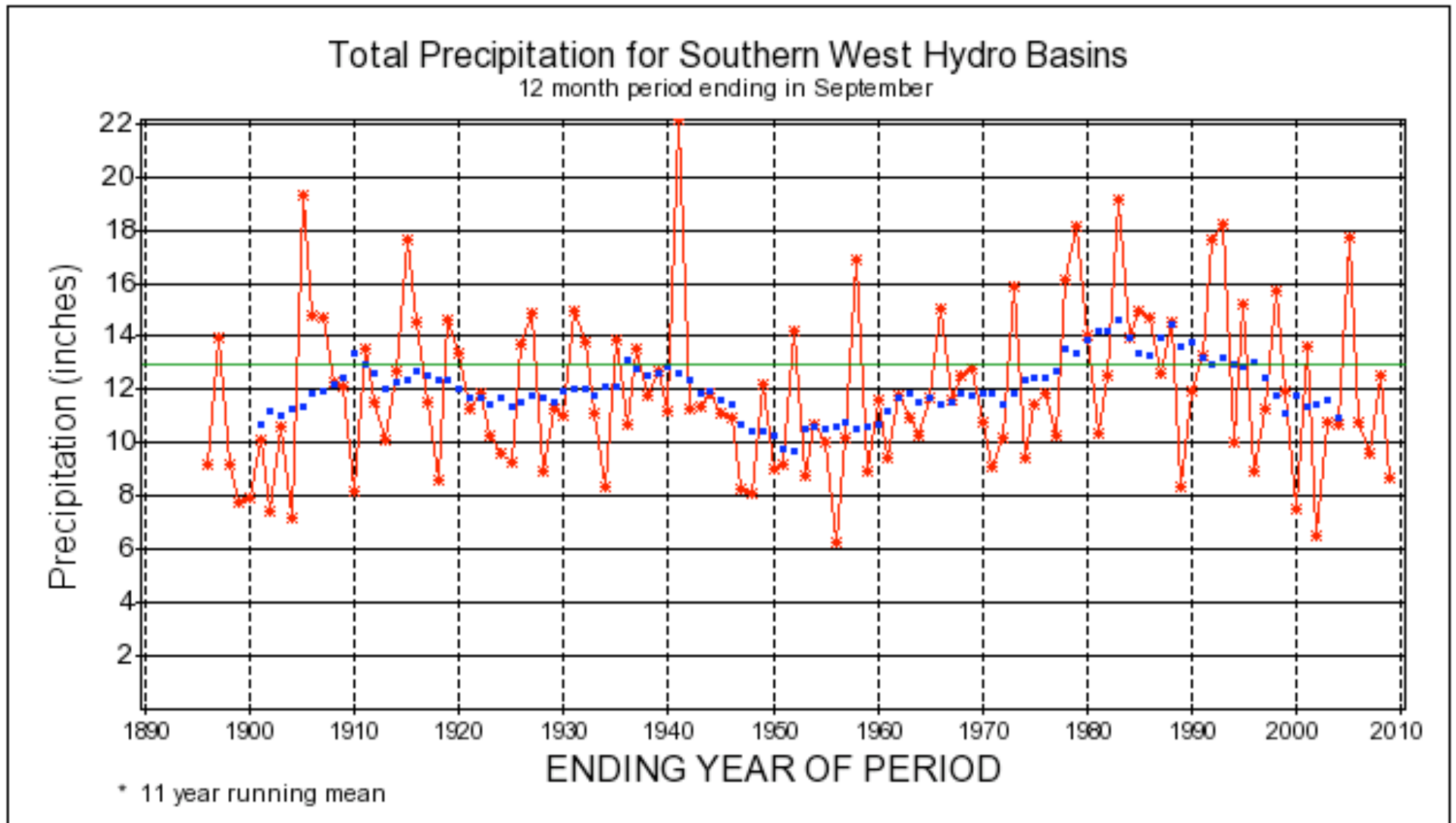
Northern West Water Year (Oct-Sep) Precipitation 1895/96 - 2008/09



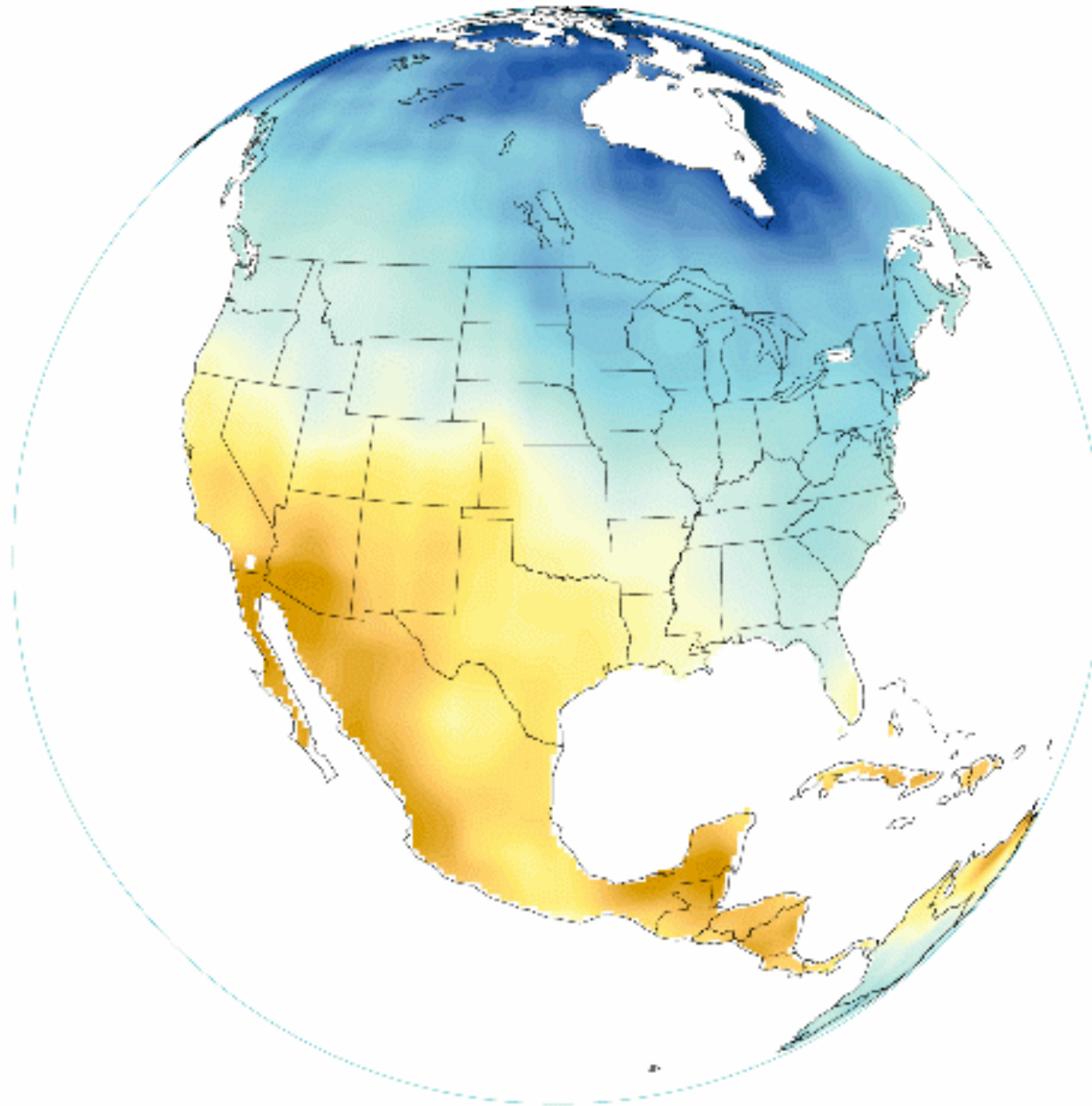
Southern West Hydro Basins



Southern West Water Year (Oct-Sep) Precipitation 1895/96 - 2008/09



Projected Change in Precipitation 1950-2000 to 2021-2040 (Percent of 1950-2000)



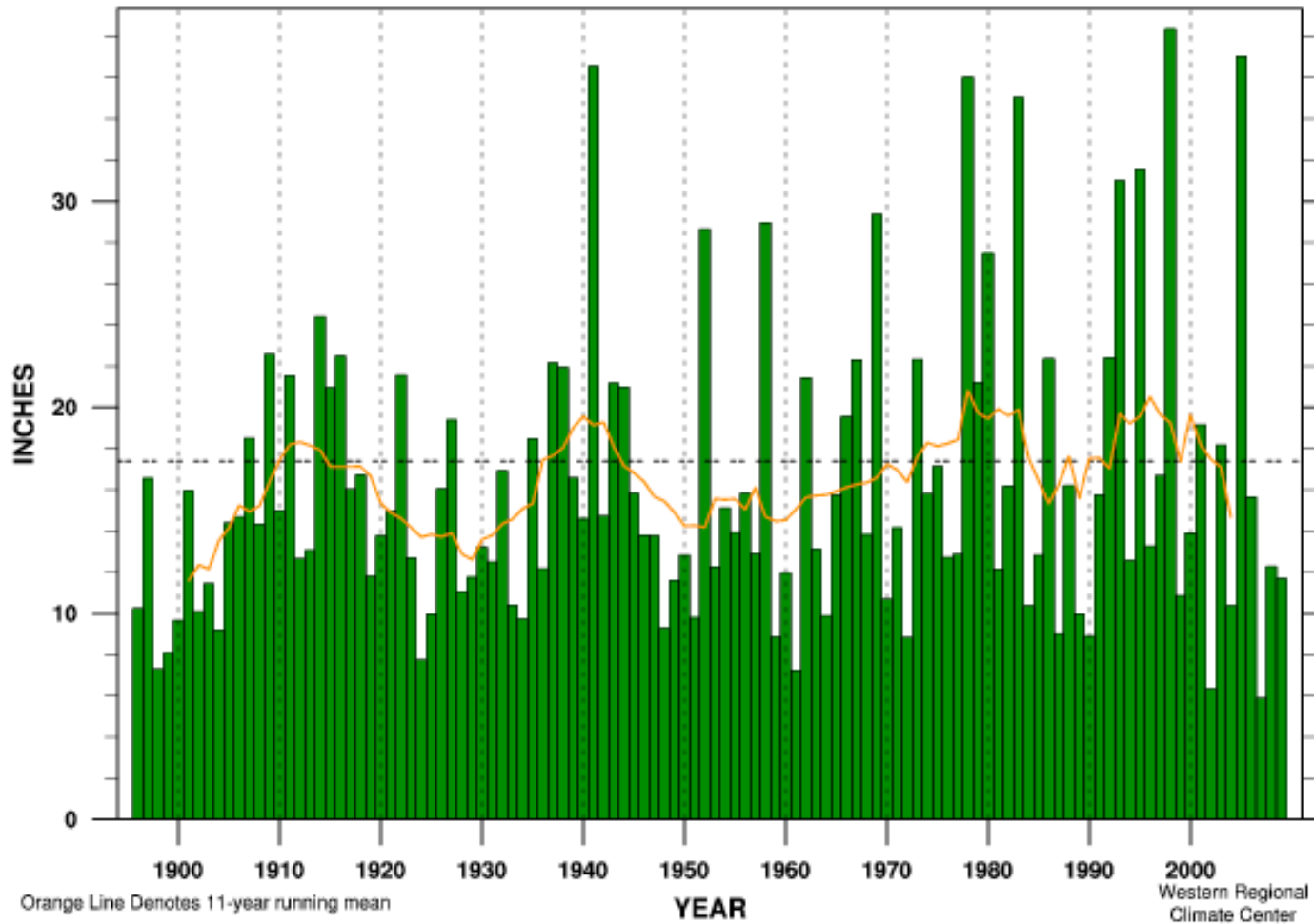
**Average of 19
climate models.
2007.**

**Figure by
Gabriel Vecchi.**

[www.ideo.columbia.edu/
res/div/ocp/drought/
science.shtml](http://www.ideo.columbia.edu/res/div/ocp/drought/science.shtml)

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Projections of an Imminent
Transition to a More Arid
Climate in Southwestern North
America. *Science*, DOI:
10.1126/science.1139601**

South Coast Region Precipitation Oct-Sep



Orange Line Denotes 11-year running mean

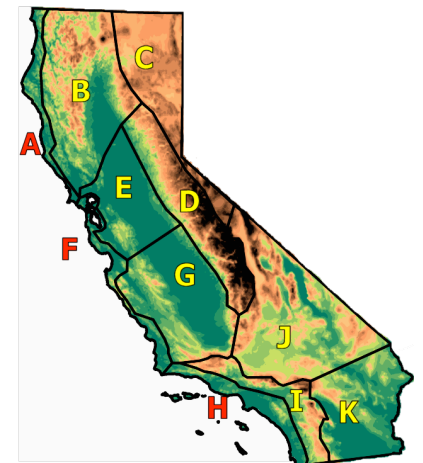
Western Regional
Climate Center

Linear Trend 1895-present	+ 3.44 ± 3.88 in.	(+ 19 ± 22%) per 100 yr	
Linear Trend 1949-present	+ 2.88 ± 12.18 in.	(+ 16 ± 70%) per 100 yr	
Linear Trend 1975-present	-13.78 ± 33.10 in.	(- 79 ± 190%) per 100 yr	
Wettest Year	38.39 in. (220%)	in 1998	MEAN 17.38 in.
Driest Year	5.87 in. (33%)	in 2007	STDEV 8.13 in.
Oct-Sep	2009	11.68 in. (67%)	RANK 29 of 114

**Water Year
Oct-Sep
Precip**

**South
Coastal
California**

**1895/96
thru
2008/09**



WestWideDroughtTracker

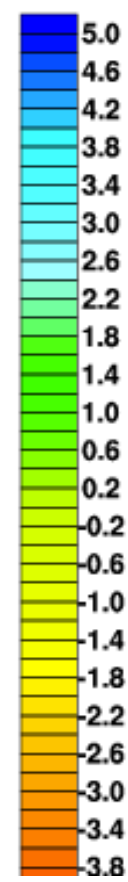
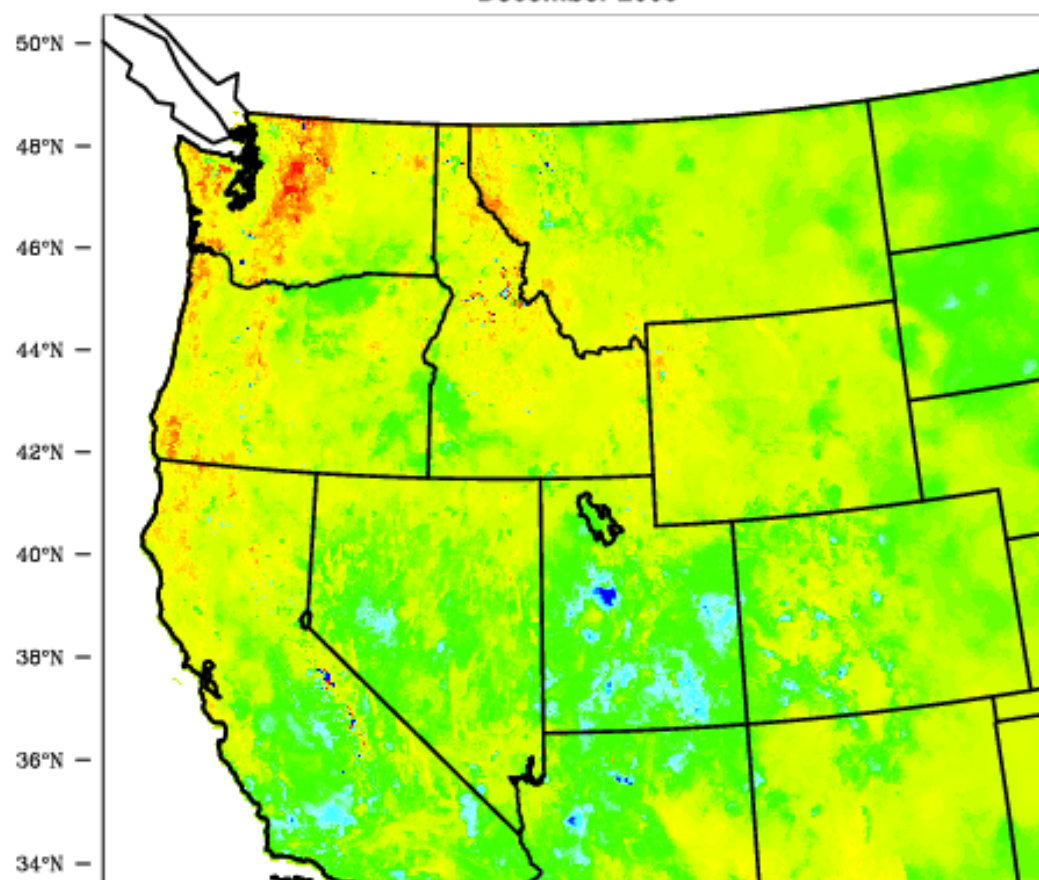
NOAA TRACS

Home SPI▾ Precipitation▾ Temperature▾ Palmer▾ Snowpack▾ Soil Moisture▾ About

To access maps, first select from the suite of drought indices and climate variables listed in the menu bar above. Second, detailed maps at state and county levels are available by progressively clicking on the region of interest.

Western United States Palmer Z-Index

December 2009



Derived from
PRISM
On 4-km grid

Mostly
John Abatzoglou
Laura Edwards
Grant Kelly

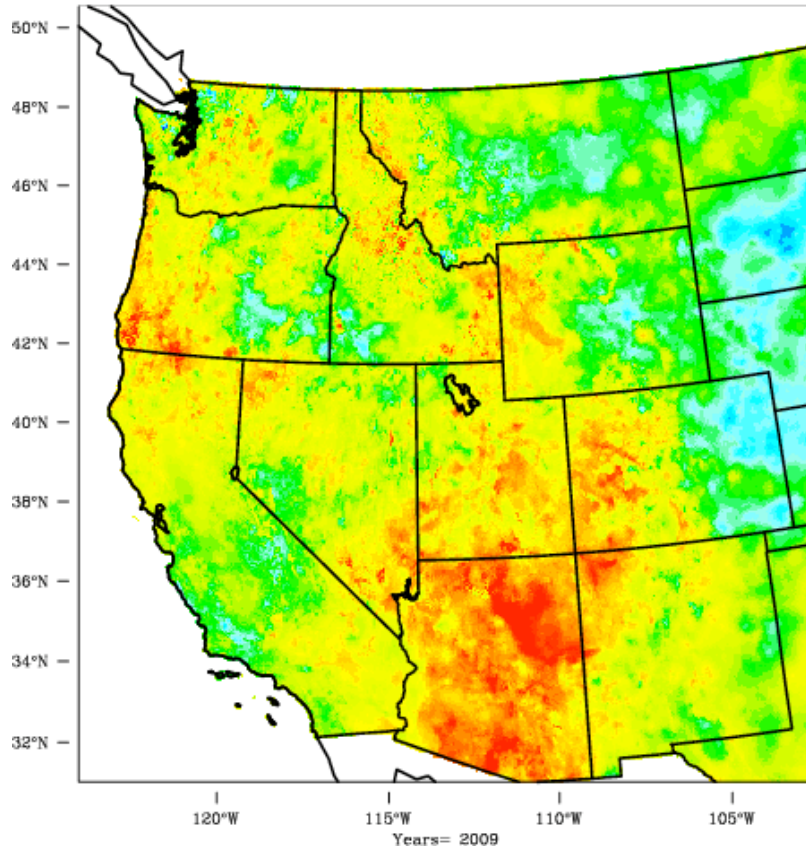
Standardized Precipitation Index (from 4-km PRISM)

6-Month

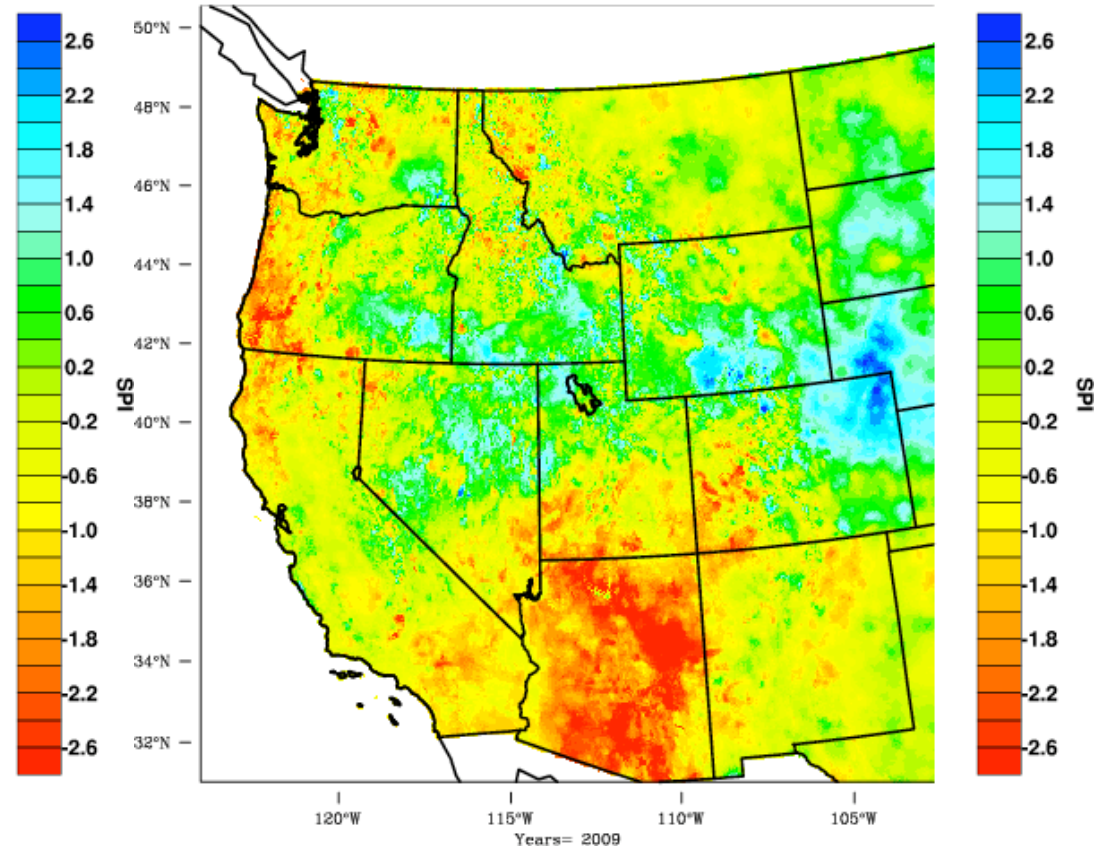
Ending Dec 2009

12-Month

Western United States 6 month SPI
December 2009



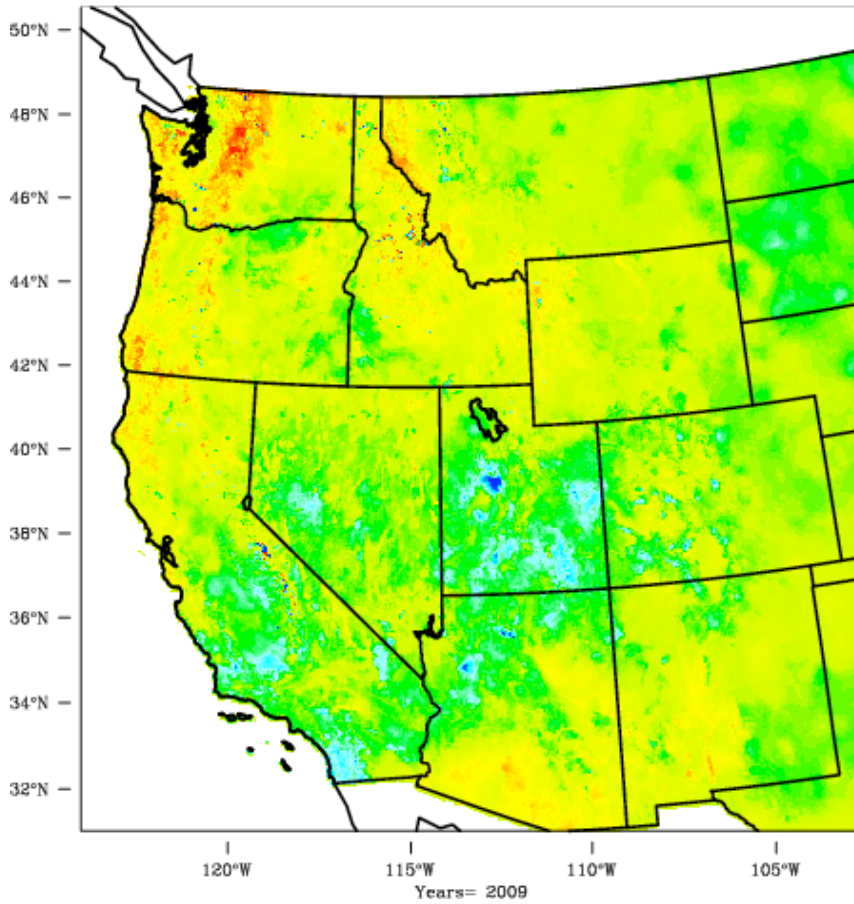
Western United States 12 month SPI
December 2009



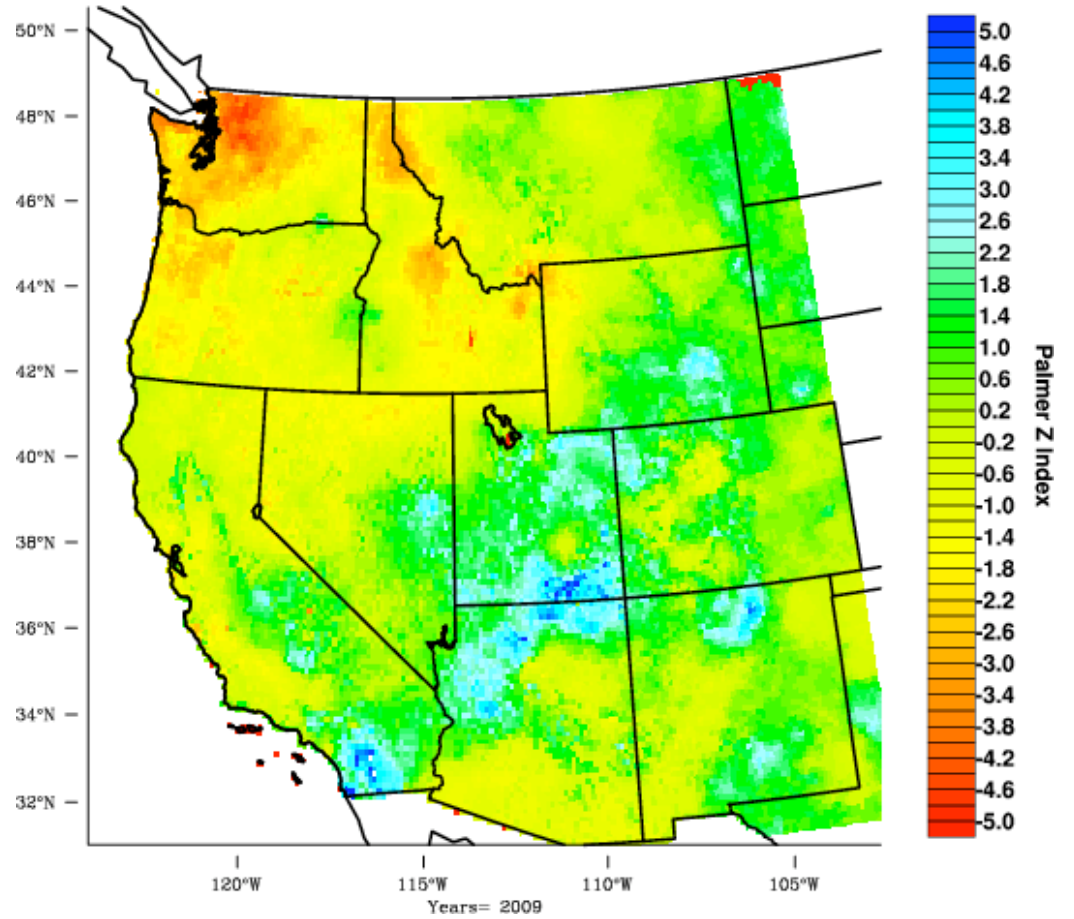
Monthly Palmer Z-Index December 2009

PRISM VIC

Western United States Palmer Z-Index
December 2009



Western United States Palmer Z-Index
December 2009

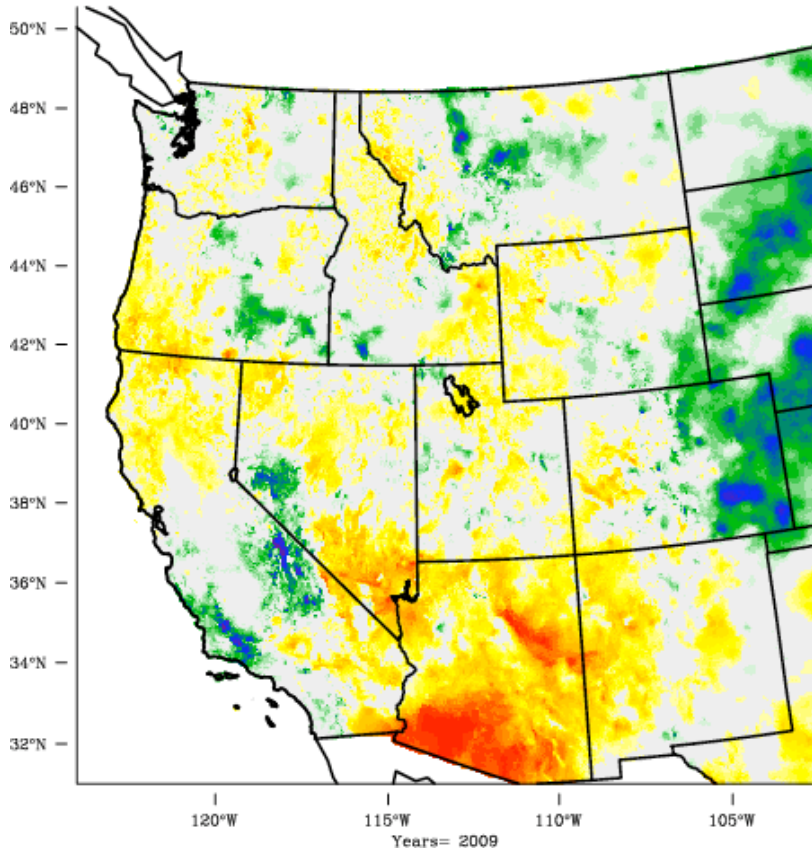


Precipitation Percent of Average Oct-Dec 2009

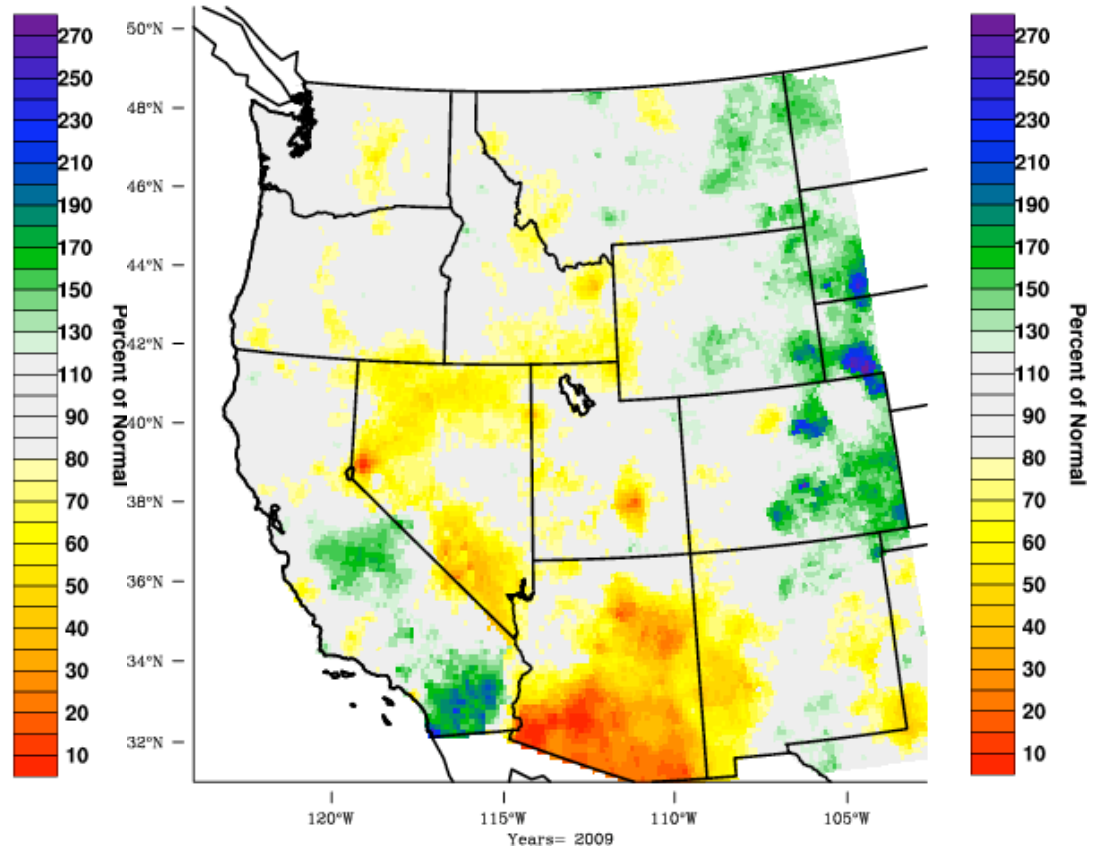
PRISM

VIC

Western United States Precipitation Percent of Normal
October-December Departure from 1971-2000 Mean



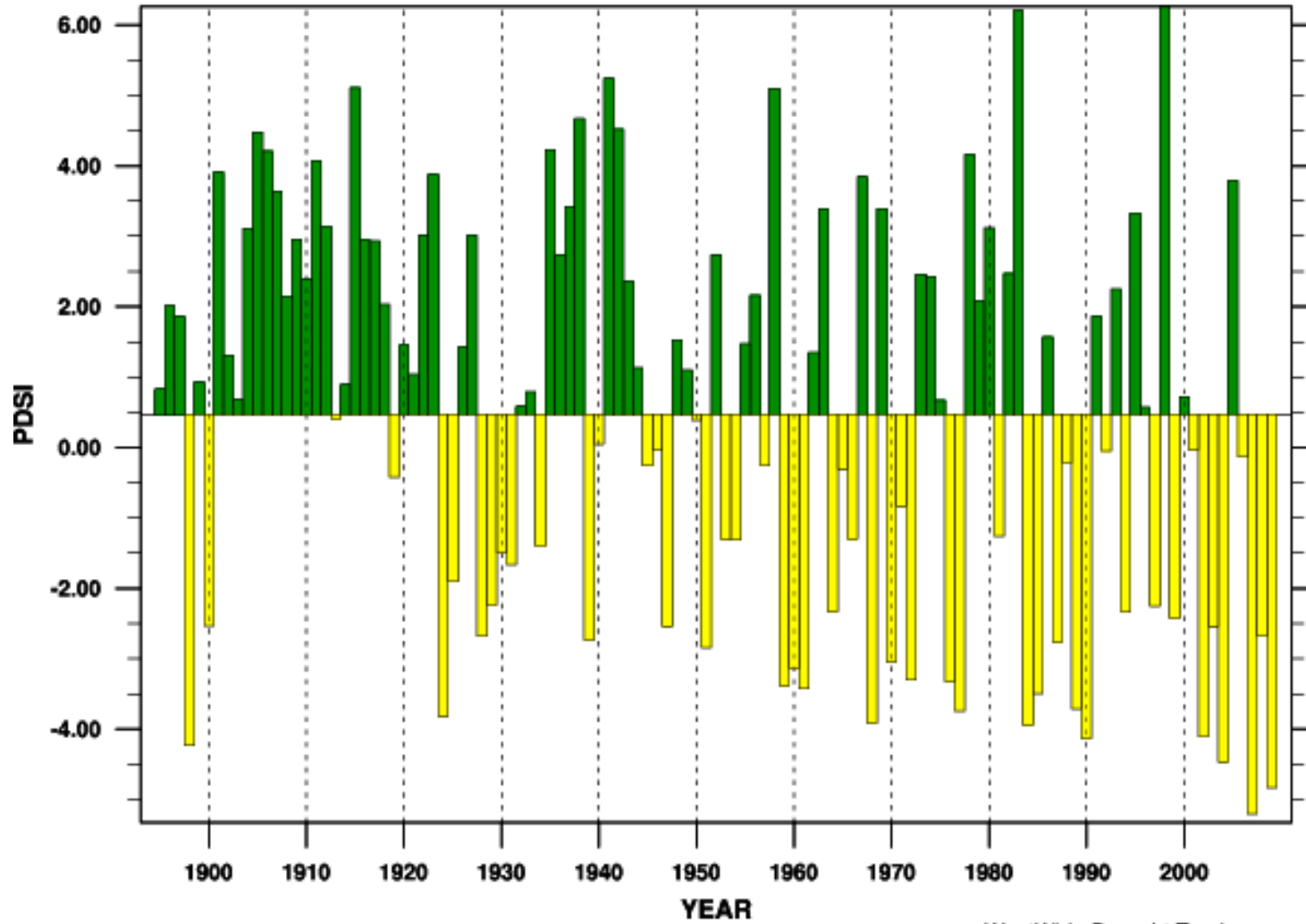
Western United States Precipitation (VIC) Percent of Normal
October-December Departure from 1971-2000 Mean



PDSI 35.65°N , -120.63°W July

Paso Robles, CA

PRISM Pixel

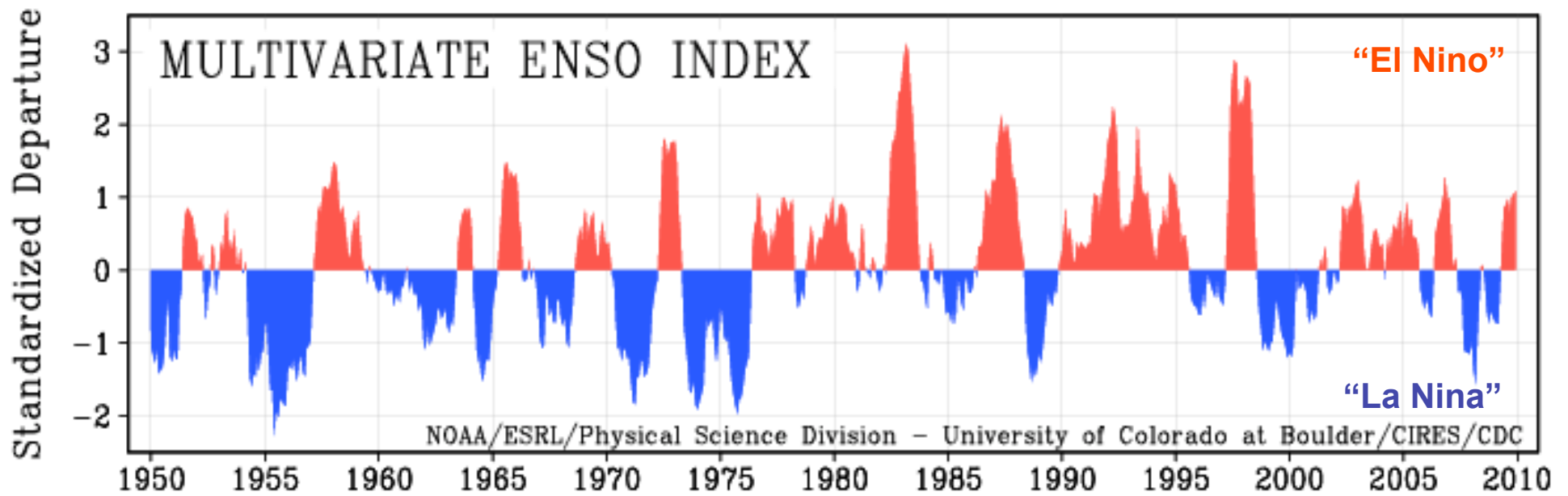


WestWide Drought Tracker
NOAA TRACS

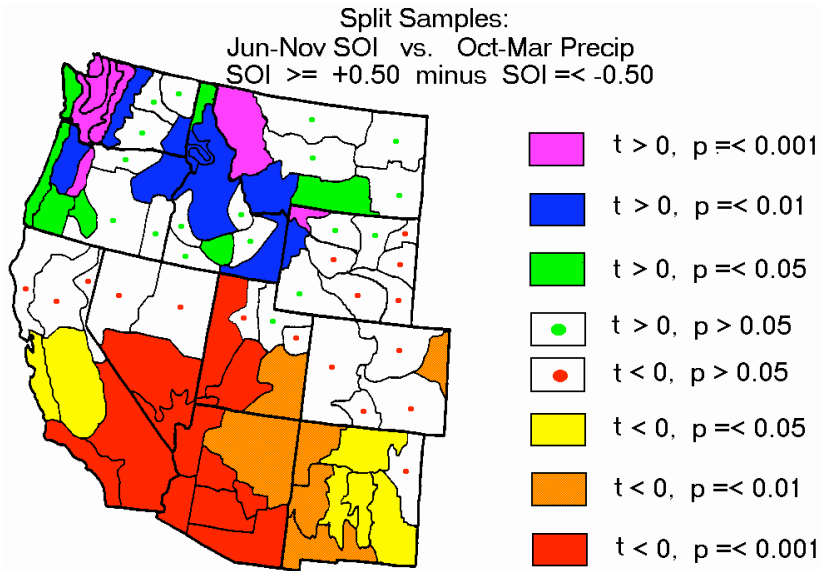
Linear Trend 1895-2009	- 0.28± 0.02 /10yr
Wettest Year	6.20 (+ 5.73) in 1983
Driest Year	-5.20 (- 5.66) in 2007
2009	-4.83 (- 5.30)

Base Period Statistics 1895-2009	
MEAN	0.47
STDEV	2.86
RANK	2 of 115

Through December 2009



NOAA ESRL (“CDC”), Wolter and Timlin

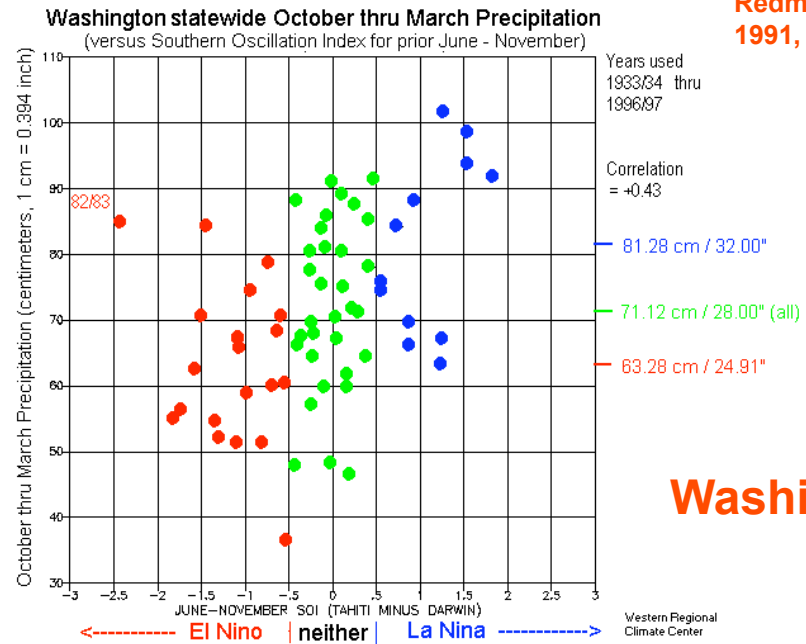


Updated from Redmond and Koch (1991). Winters of 1933/34 - 1994/95.
Reddish: Composite El Nino winters are wet, La Nina winters are dry.
Bluish/greenish: Composite El Nino winters are dry, La Nina winters are wet.

Redmond, K.T., and R.W. Koch, 1991. Surface climate and streamflow variability in the western United States and their relationship to large-scale circulation indices. *Water Resources Research*, 27(9), 2381-2399.

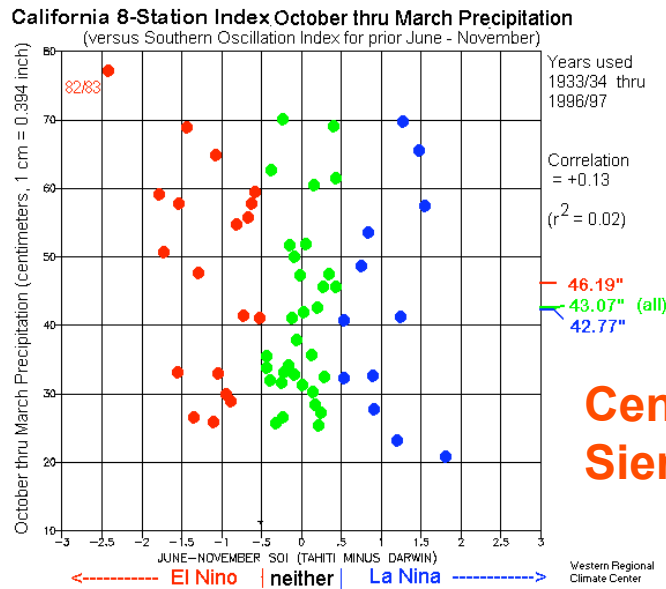
Redmond & Koch, 1991, updated.

ENSO

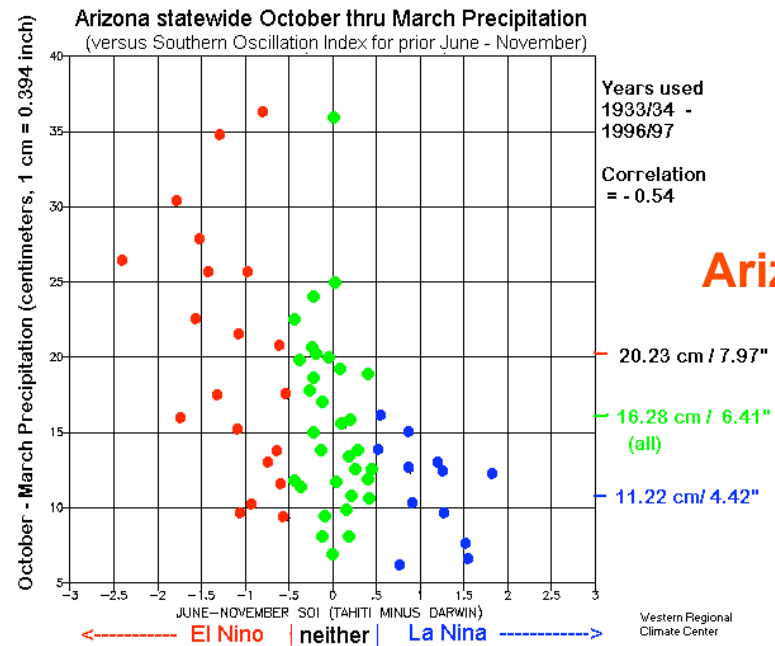


Redmond & Koch, 1991, updated.

Washington

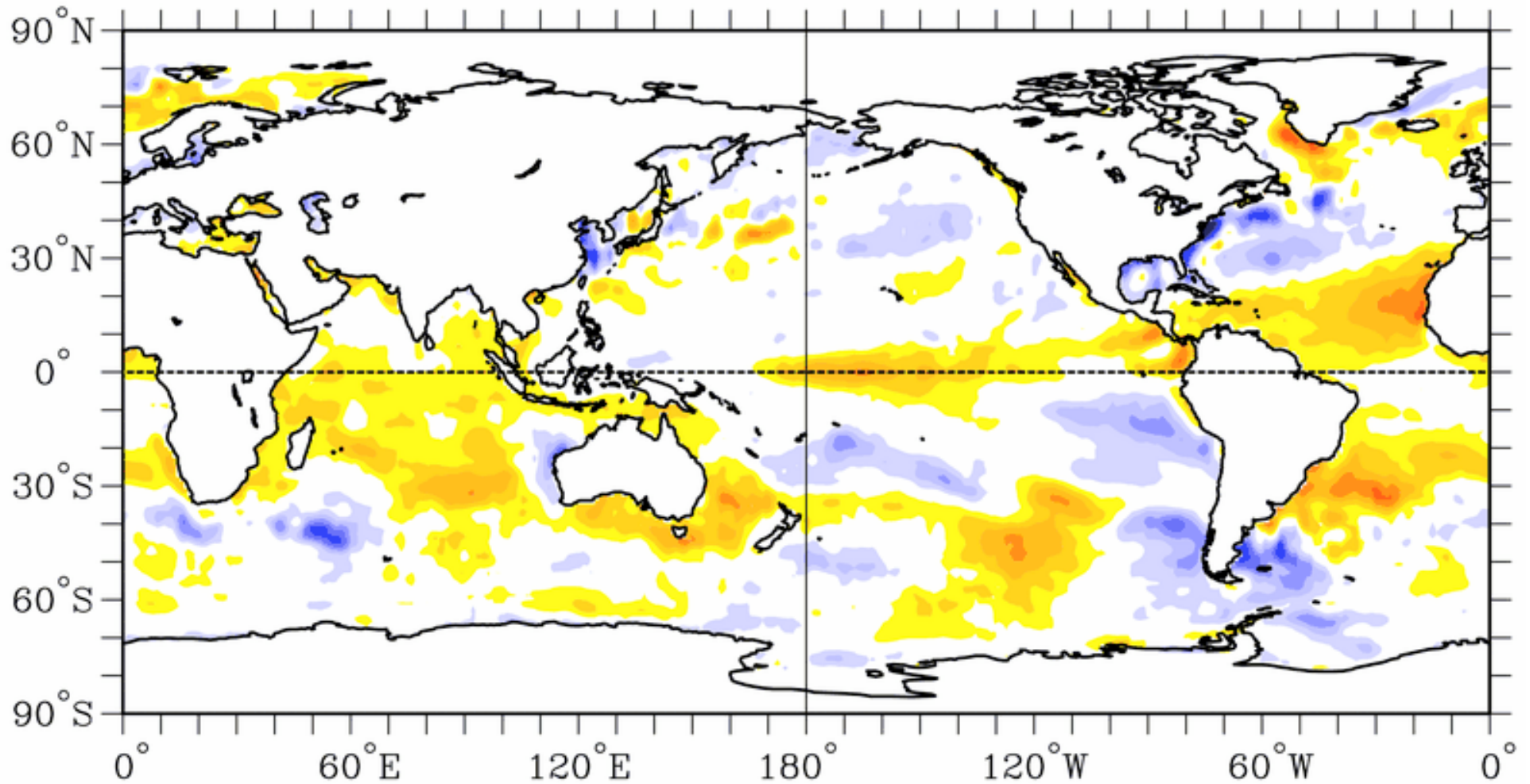


Central Sierra



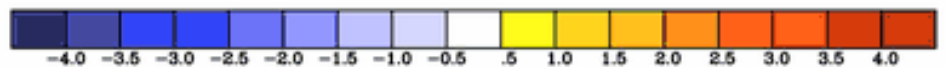
Arizona

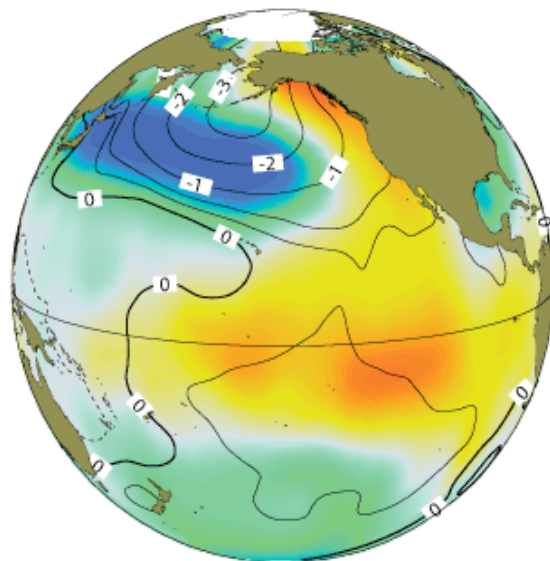
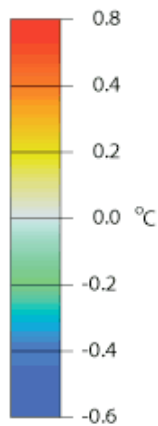
Global Sea Surface Temperature Departures 2010 Feb 14-20



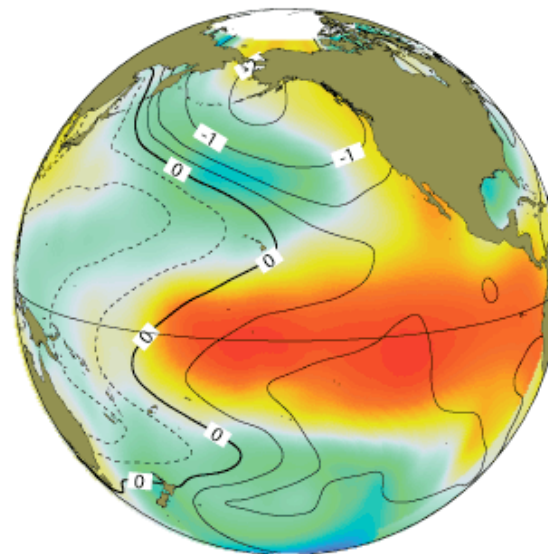
SST ANOM 2/14/10- 2/20/10

Base Period: 1982-96



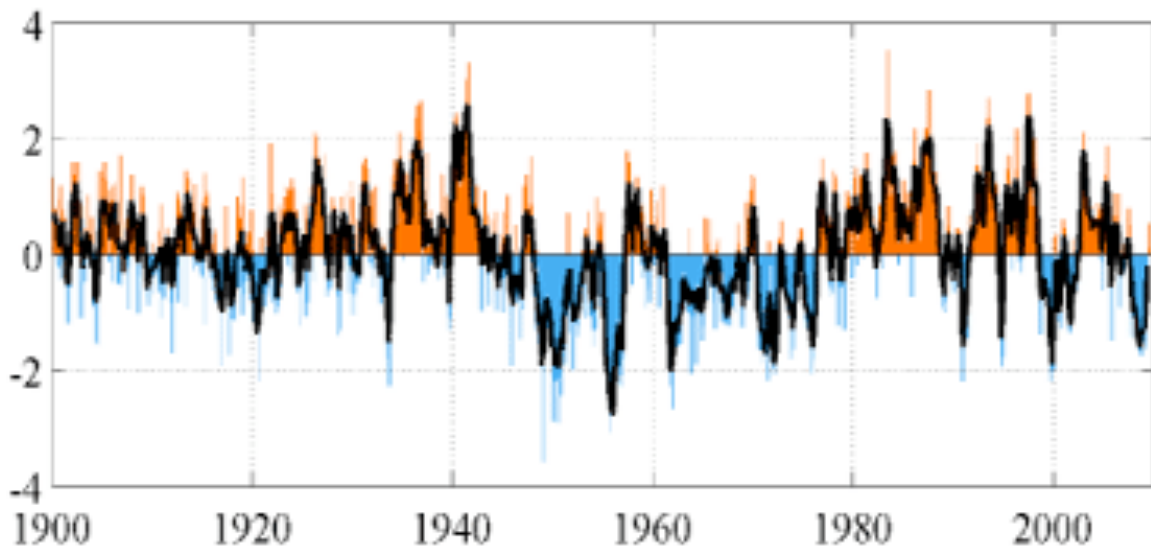


Warm Phase PDO



Warm Phase ENSO

monthly values for the PDO index: 1900-September 2009



Source: Climate Impacts Group, University of Washington

2009

- Jan -1.40
- Feb -1.55
- Mar -1.59
- Apr -1.65
- May -0.88
- Jun -0.31
- Jul -0.53
- Aug +0.09
- Sep +0.52
- Oct +0.27
- Nov -0.40
- Dec +0.08

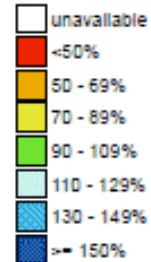
2010

- Jan +0.83
- Feb
- Mar
- Apr
- May
- Jun
- Jul
- Aug
- Sep
- Oct
- Nov
- Dec

Westwide SNOTEL Water Year (Oct 1) to Date Precipitation % of Normal

Feb 28, 2010

Water Year (Oct 1) to Date Precipitation Basin-wide Percent of 1971-2000 Normal



* Data unavailable at time of posting or measurement is not representative at this time of year

Provisional data subject to revision



The water year to date precipitation percent of normal represents the accumulated precipitation found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by the USDA/NRCS National Water and Climate Center Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Tom.Pagano@por.usda.gov 503 414 3010

Water Year Precipitation

Snotel System

2009 Oct 01
Thru
2010 Feb 28

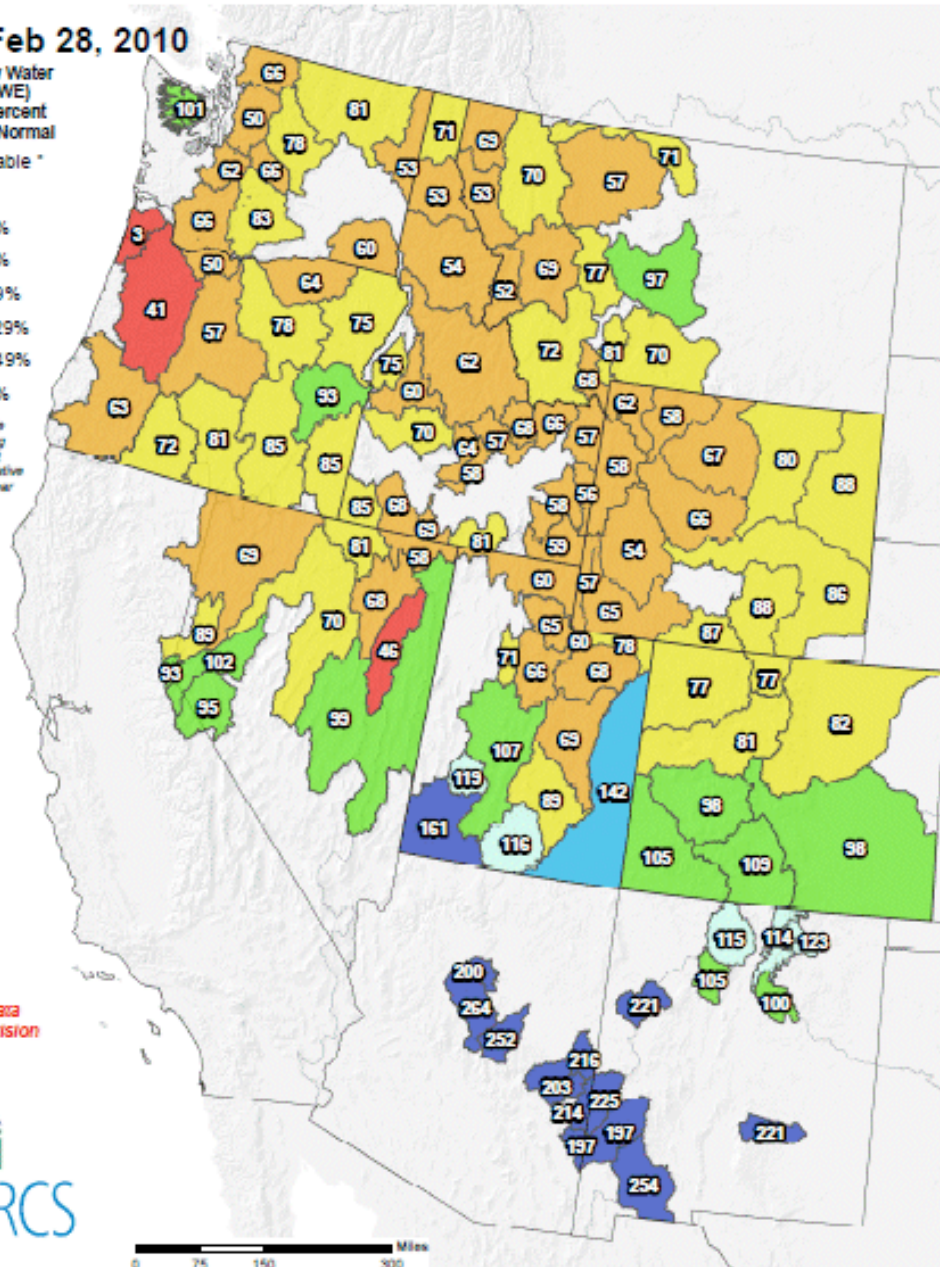
Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Feb 28, 2010

Current Snow Water Equivalent (SWE) Basin-wide Percent of 1971-2000 Normal

- unavailable *
- <50%
- 50 - 69%
- 70 - 89%
- 90 - 109%
- 110 - 129%
- 130 - 149%
- >= 150%

* Data unavailable at time of posting or measurement is not representative at this time of year



Provisional data subject to revision



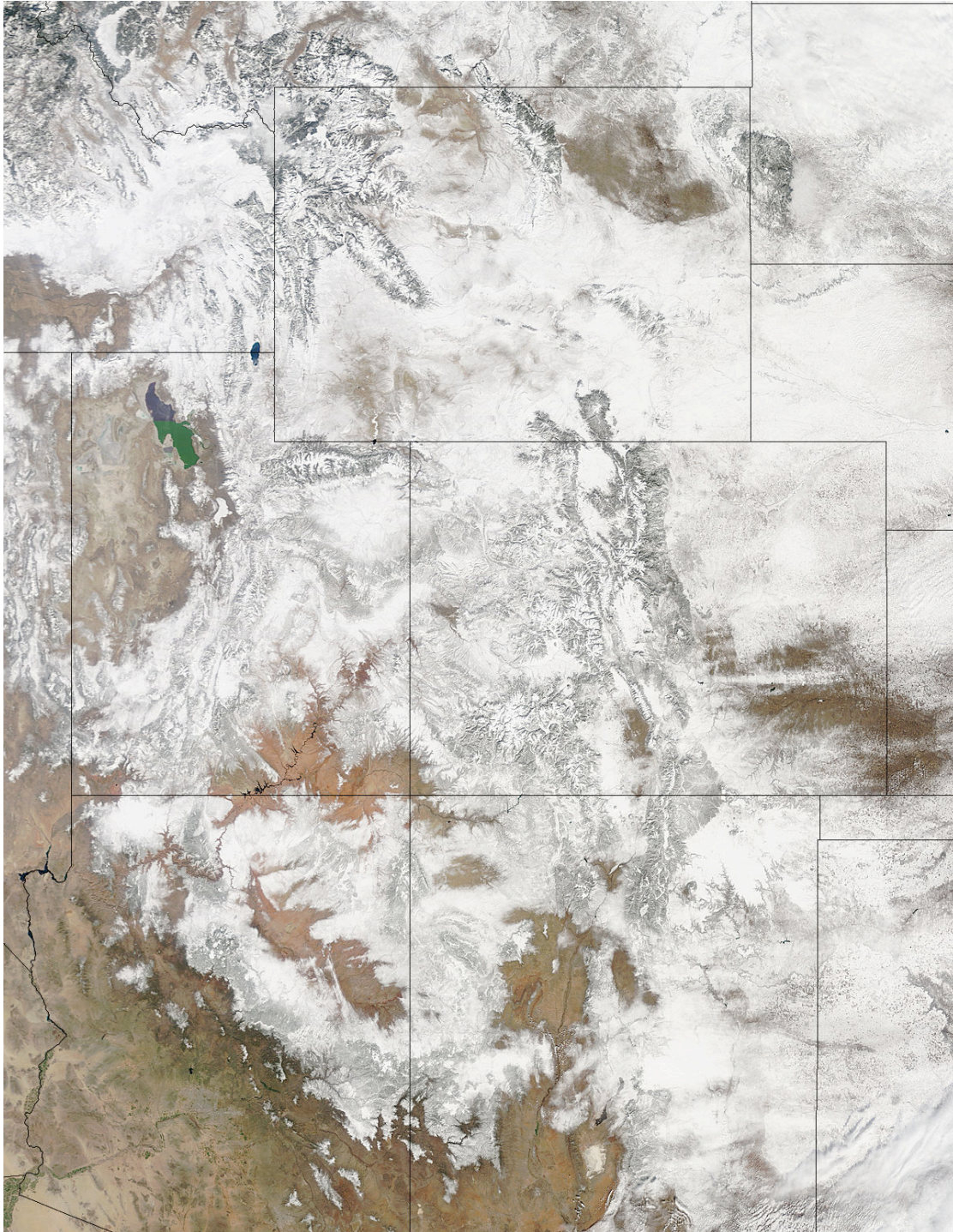
The snow water equivalent percent of normal represents the current snow water equivalent found at selected SNOTEL sites in or near the basin compared to the average value for those sites on this day. Data based on the first reading of the day (typically 00:00).

Prepared by the USDA/NRCS National Water and Climate Center Portland, Oregon <http://www.wcc.nrcs.usda.gov/gis/>
Based on data from <http://www.wcc.nrcs.usda.gov/reports/>
Science contact: Tom.Pagano@por.usda.gov 503-414-3010

Snow Water Equivalent

Snotel system

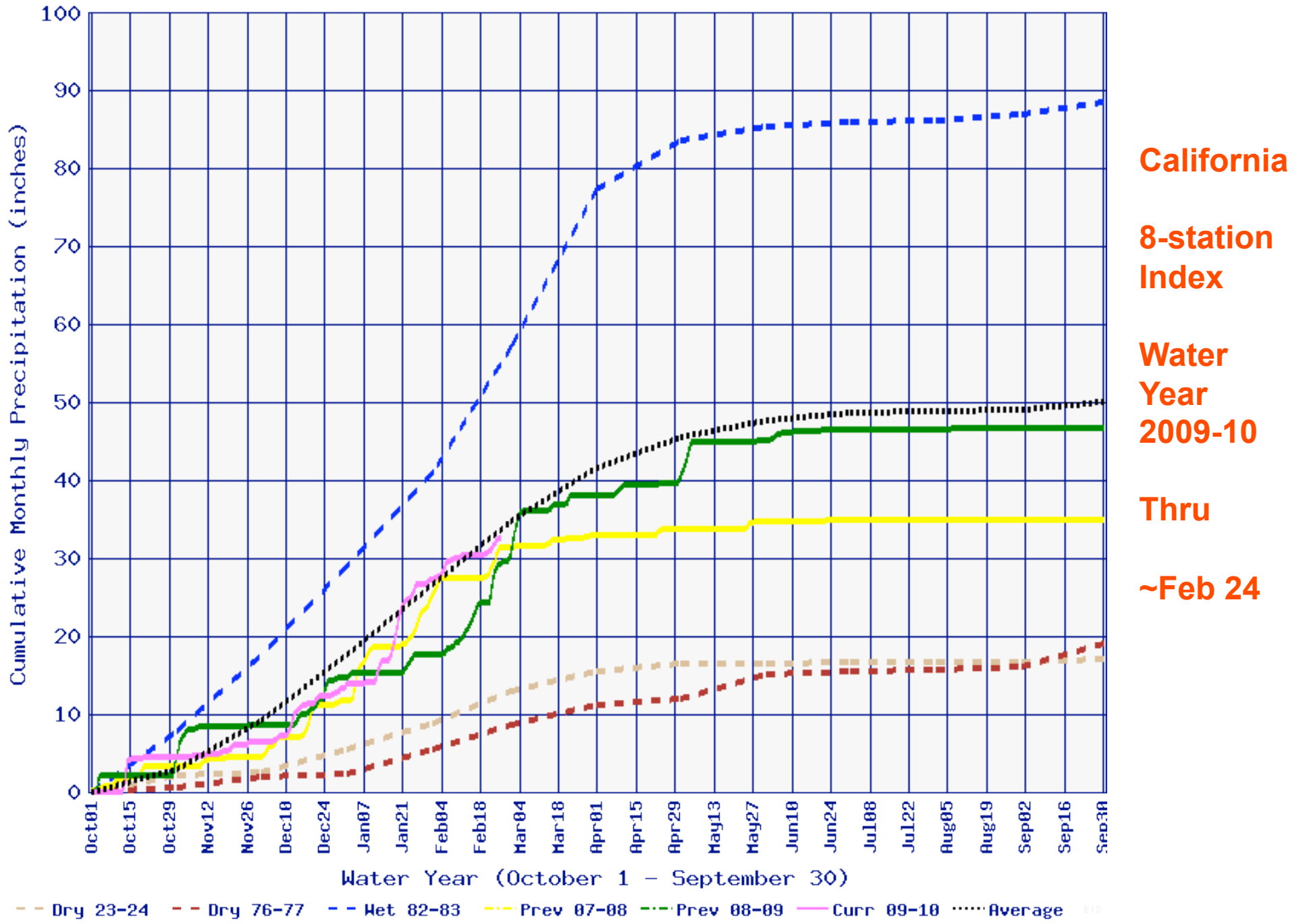
2010 Feb 28



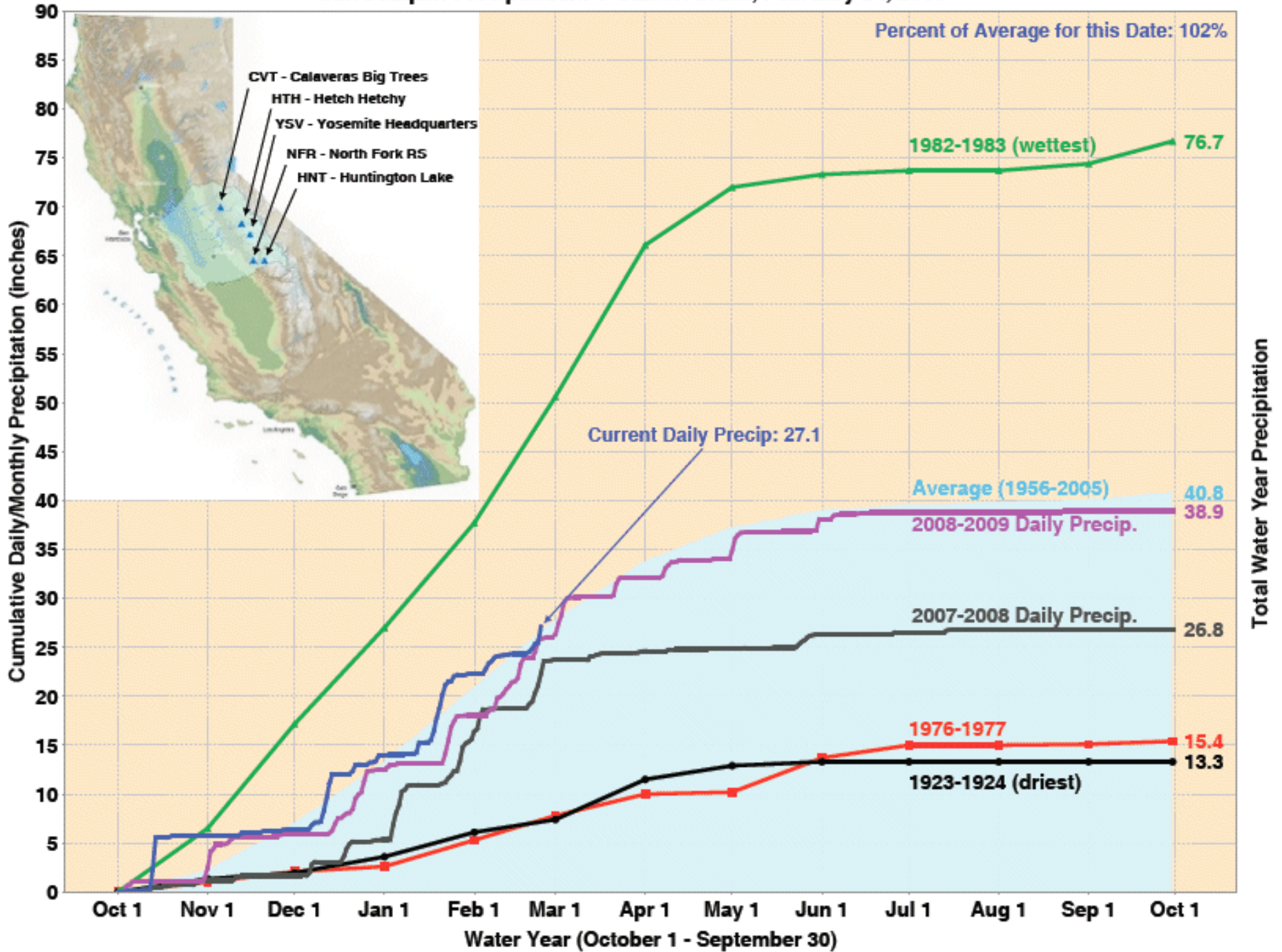
MODIS Snow

2010 Feb 23

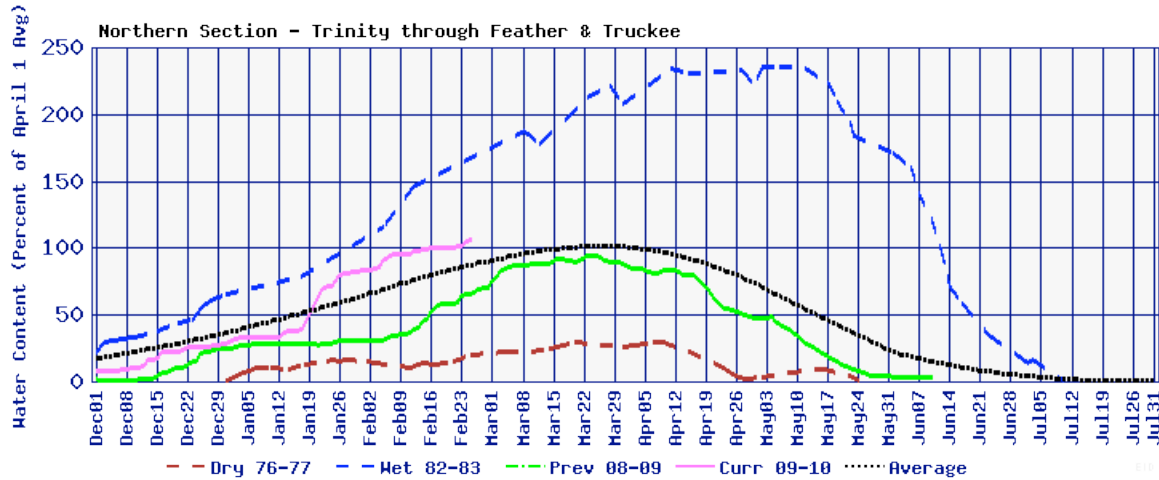
**Lots of it,
but not very deep**



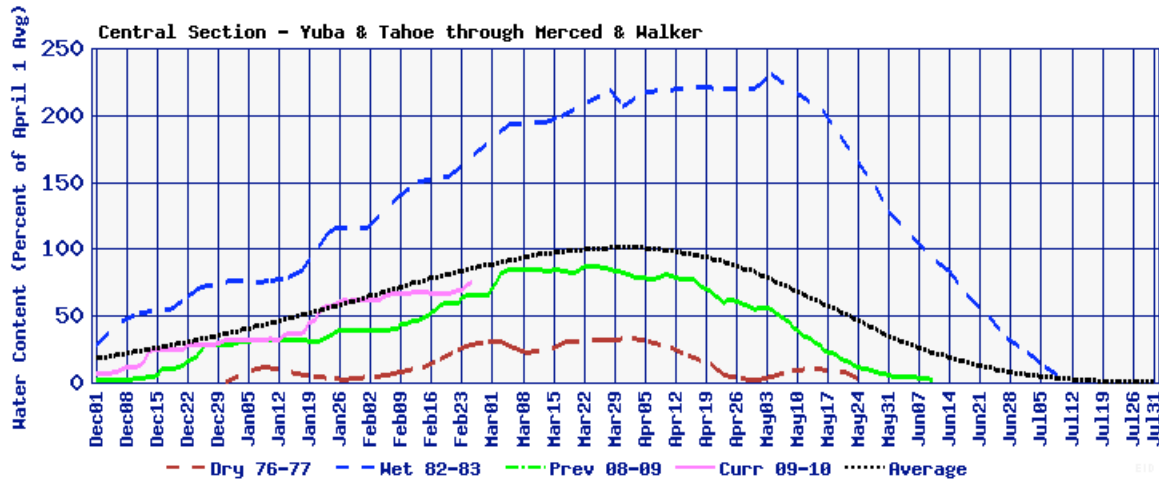
San Joaquin Precipitation: 5-Station Index, February 24, 2010



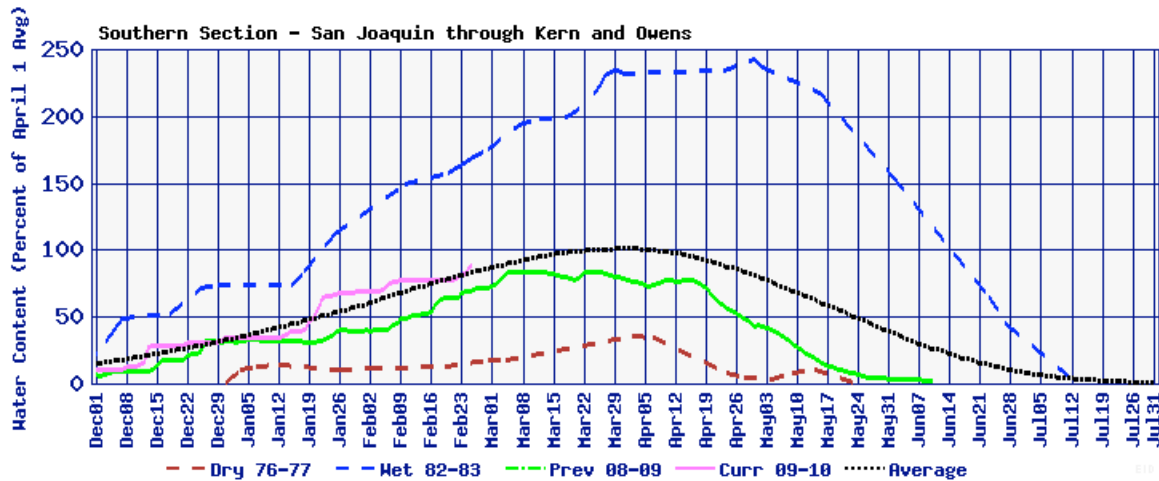
California Snowpack Thru ~Feb 25, 2010



North



Central



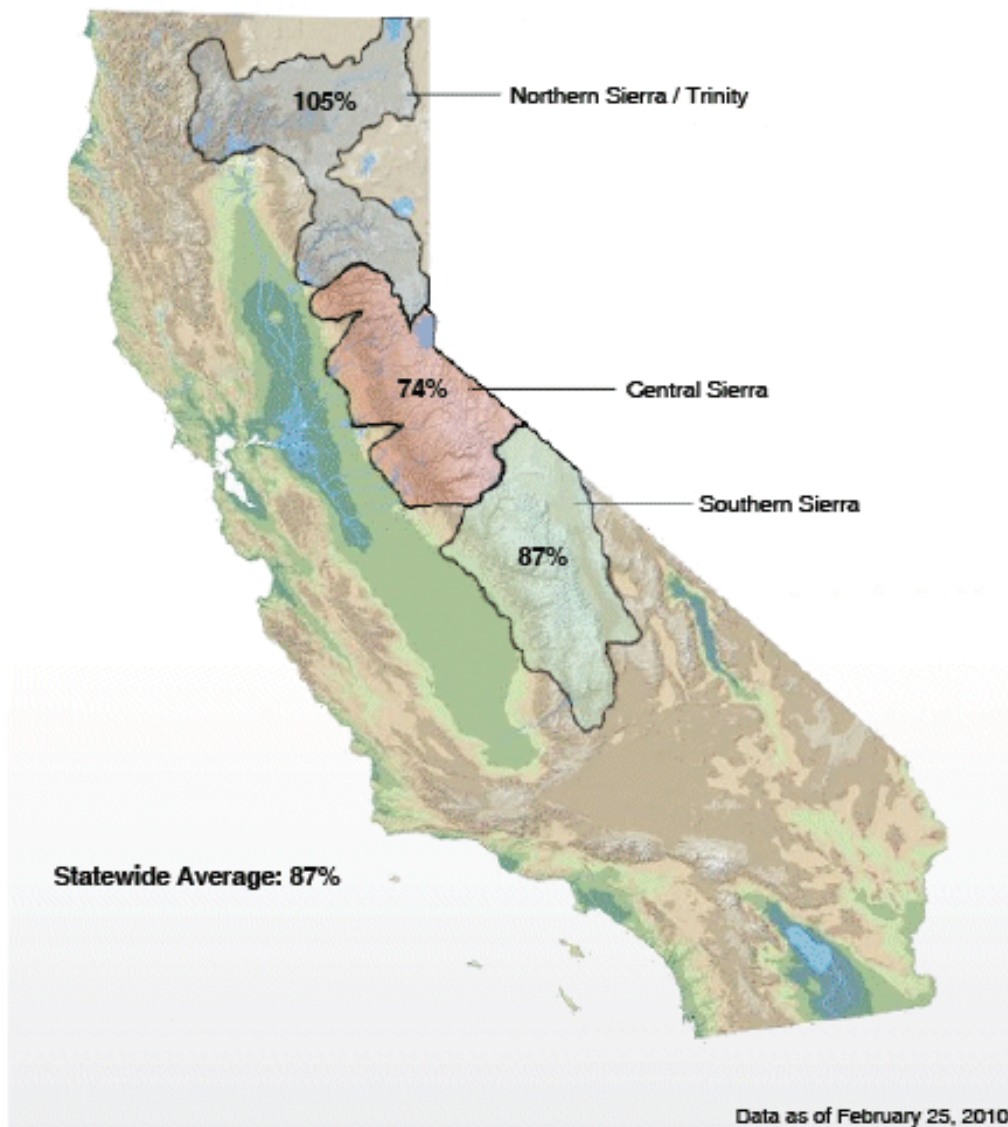
South

CDWR



Statewide Summary of Snow Water Content

Current Regional Snowpack from Automated Snow Sensors - % of April 1 Average



2010 Feb 25

Percent of

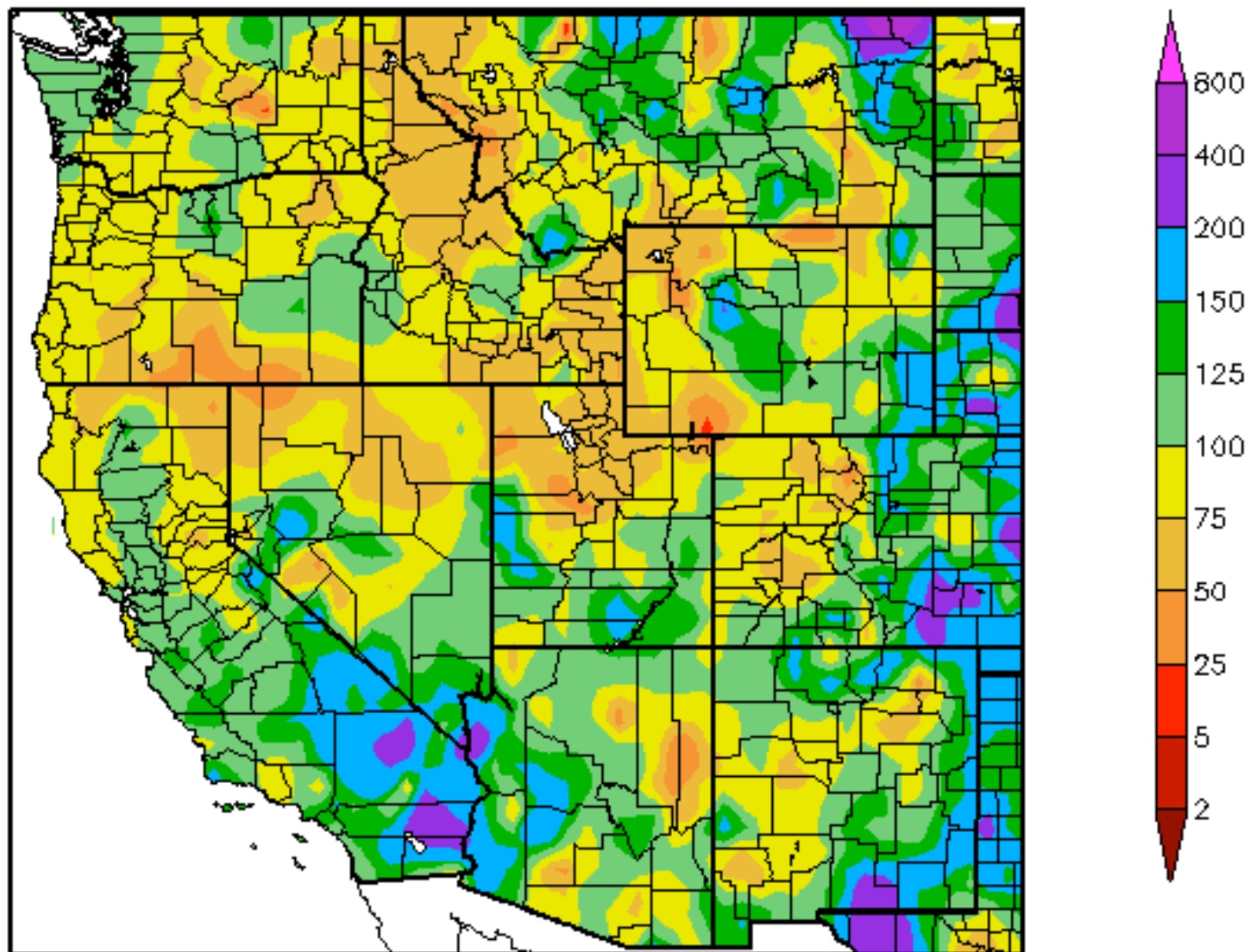
April 1 Average

("goal")

Water Year
2009-10
thru
Feb 27

Percent of Normal Precipitation (%)

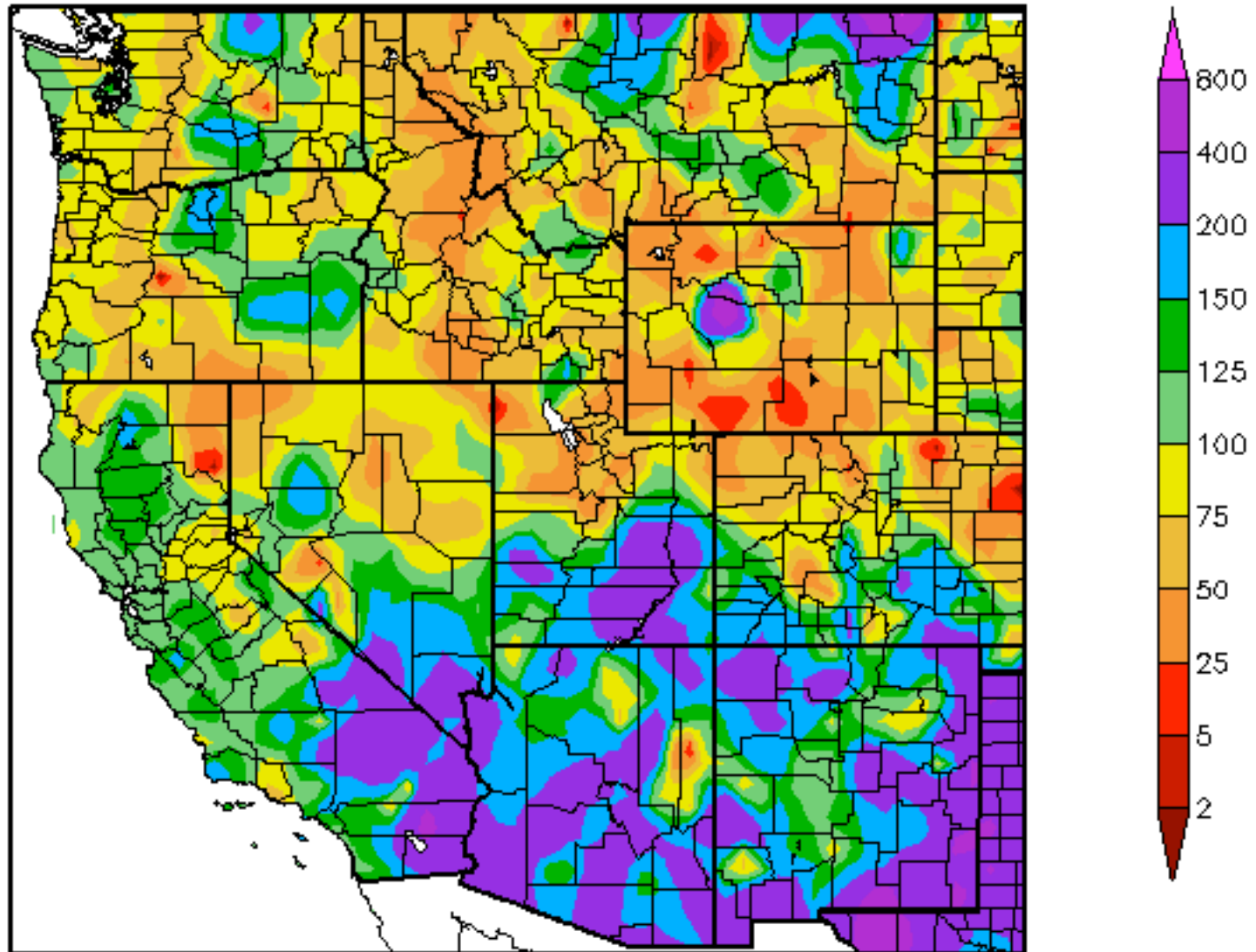
10/1/2009 – 2/27/2010



Calendar Year
2010
thru
Feb 27

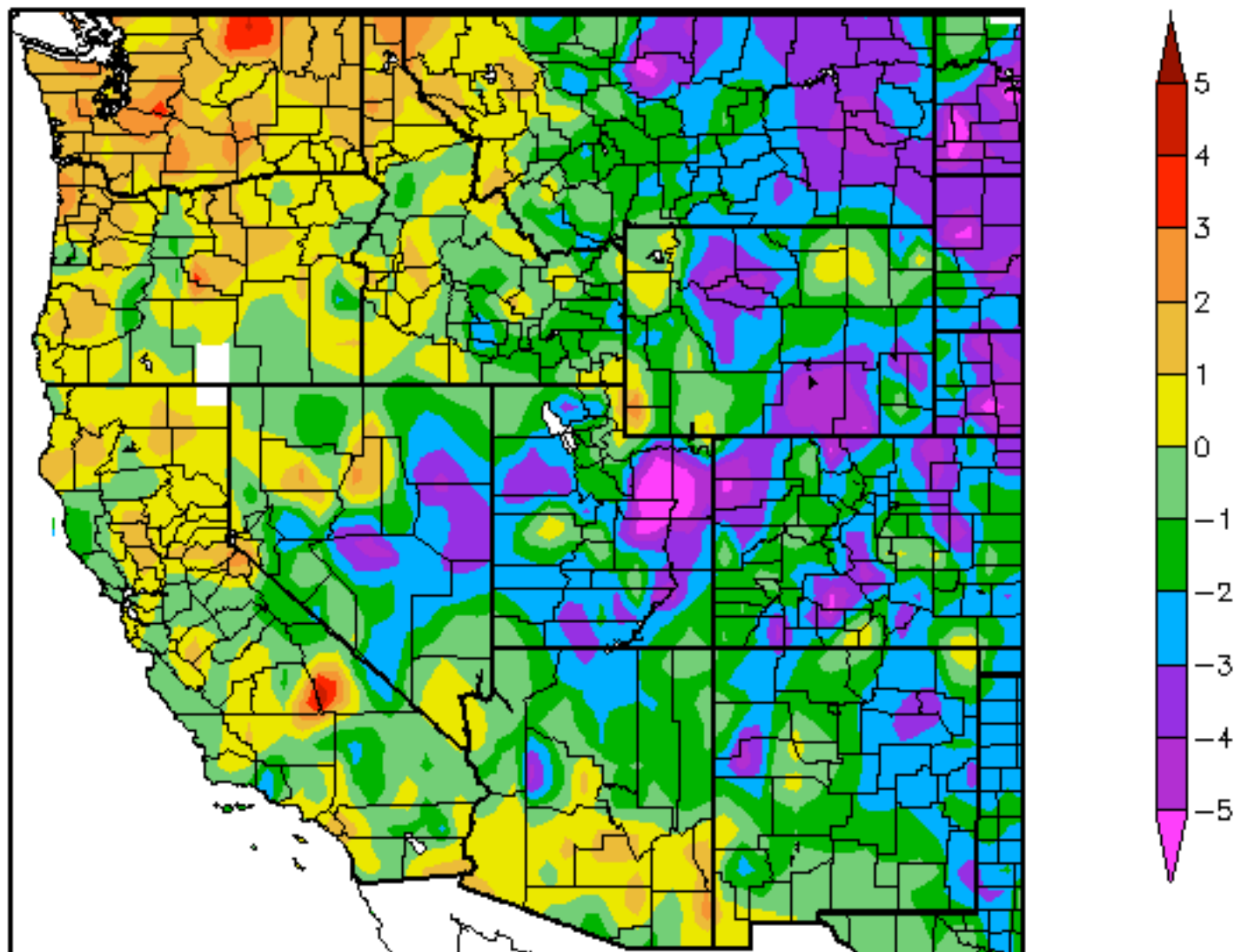
Percent of Normal Precipitation (%)

1/1/2010 – 2/27/2010



Water Year
2009-10
thru
Feb 27

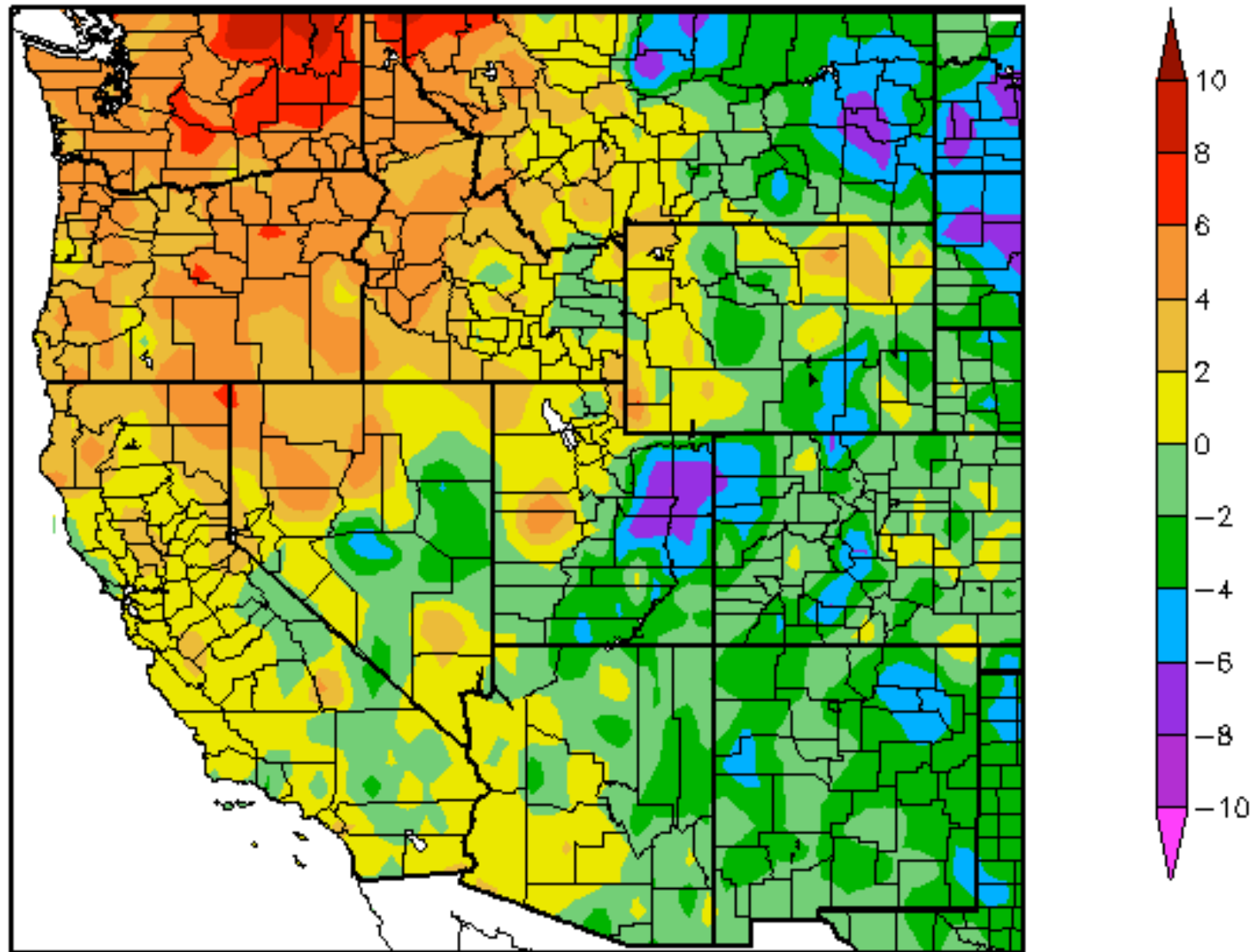
Departure from Normal Temperature (F) 10/1/2009 - 2/27/2010

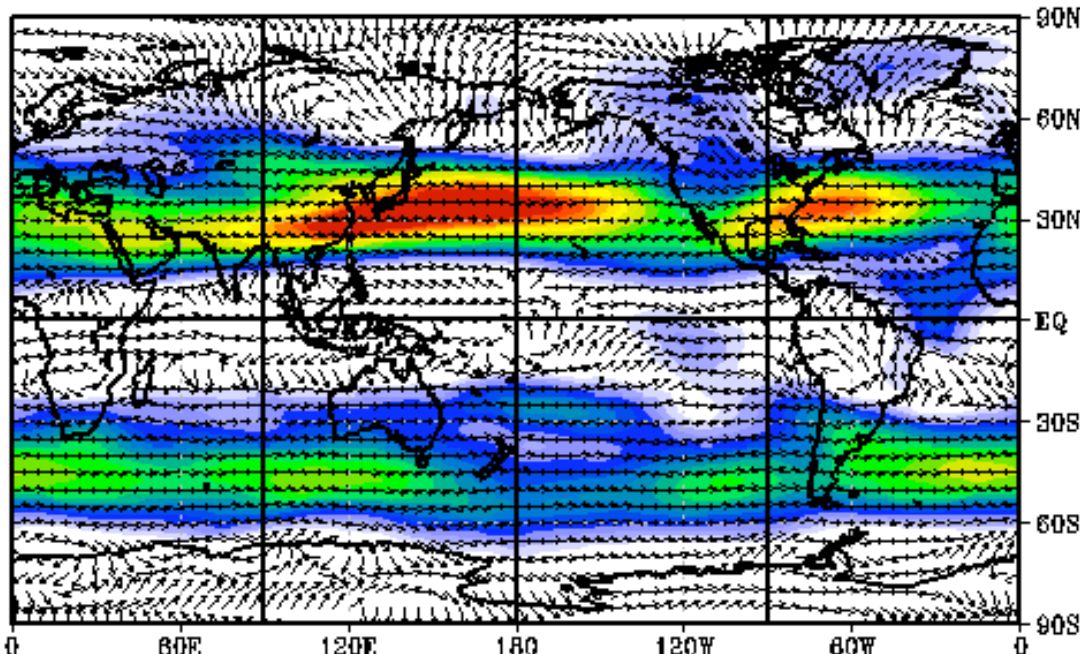
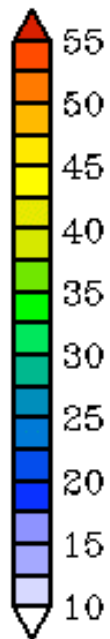


Calendar Year
2010
thru
Feb 27

Departure from Normal Temperature (F)

1/1/2010 – 2/27/2010



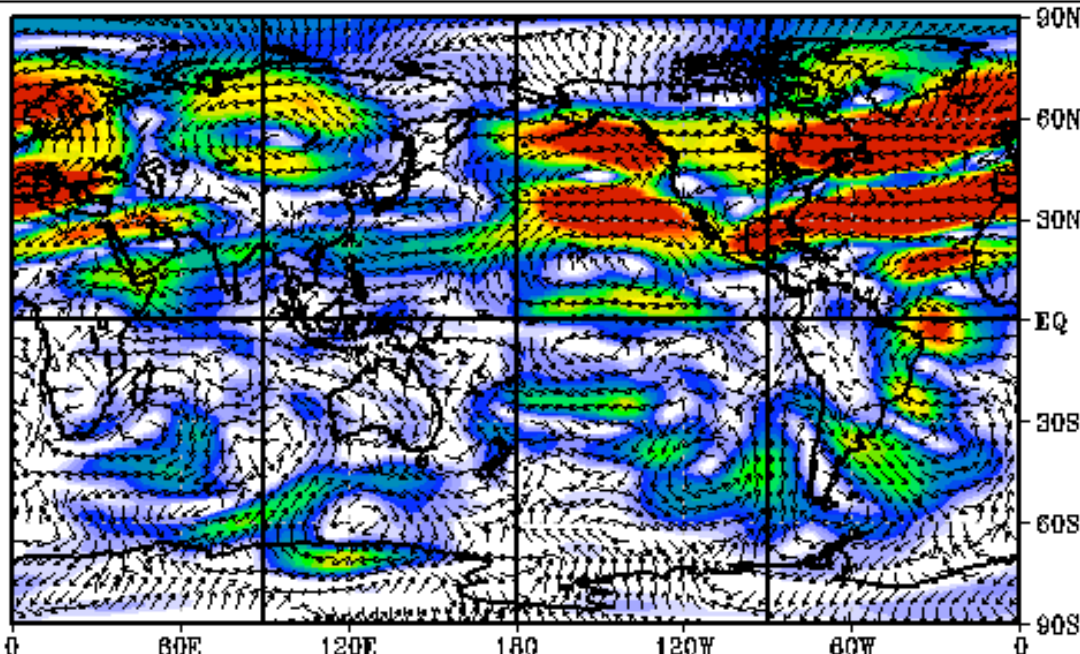


**250 mb Winds
(~35,000 ft)
90 days**

**2009 Nov 29
thru
2010 Feb 26**

Period average

REANALYSIS DATA 250mb WINDS (m/s) 90-DAY MEAN FOR: Sun NOV 29 2009 - Fri FEB 26 2010

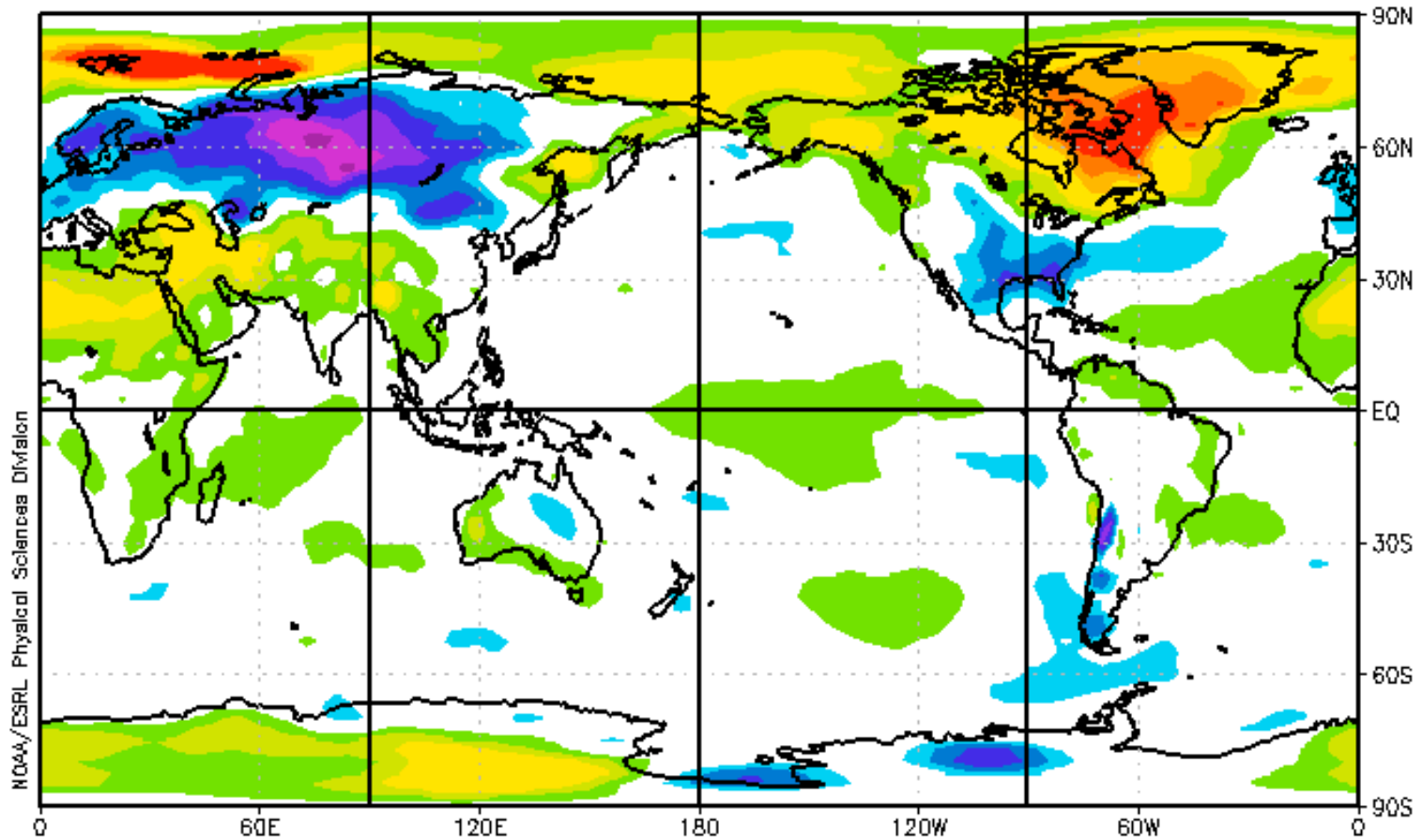


**Departure from
Climatology**

REANALYSIS DATA 250mb WINDS (m/s) 90-DAY ANOMALY FOR: Sun NOV 29 2009 - Fri FEB 26 2010

(NCEP Reanalysis climatology data: 1988-1996, smoothed with 5-day running mean)

90-Day Temperature Departures 2009 Nov 29 - 2010 Feb 26

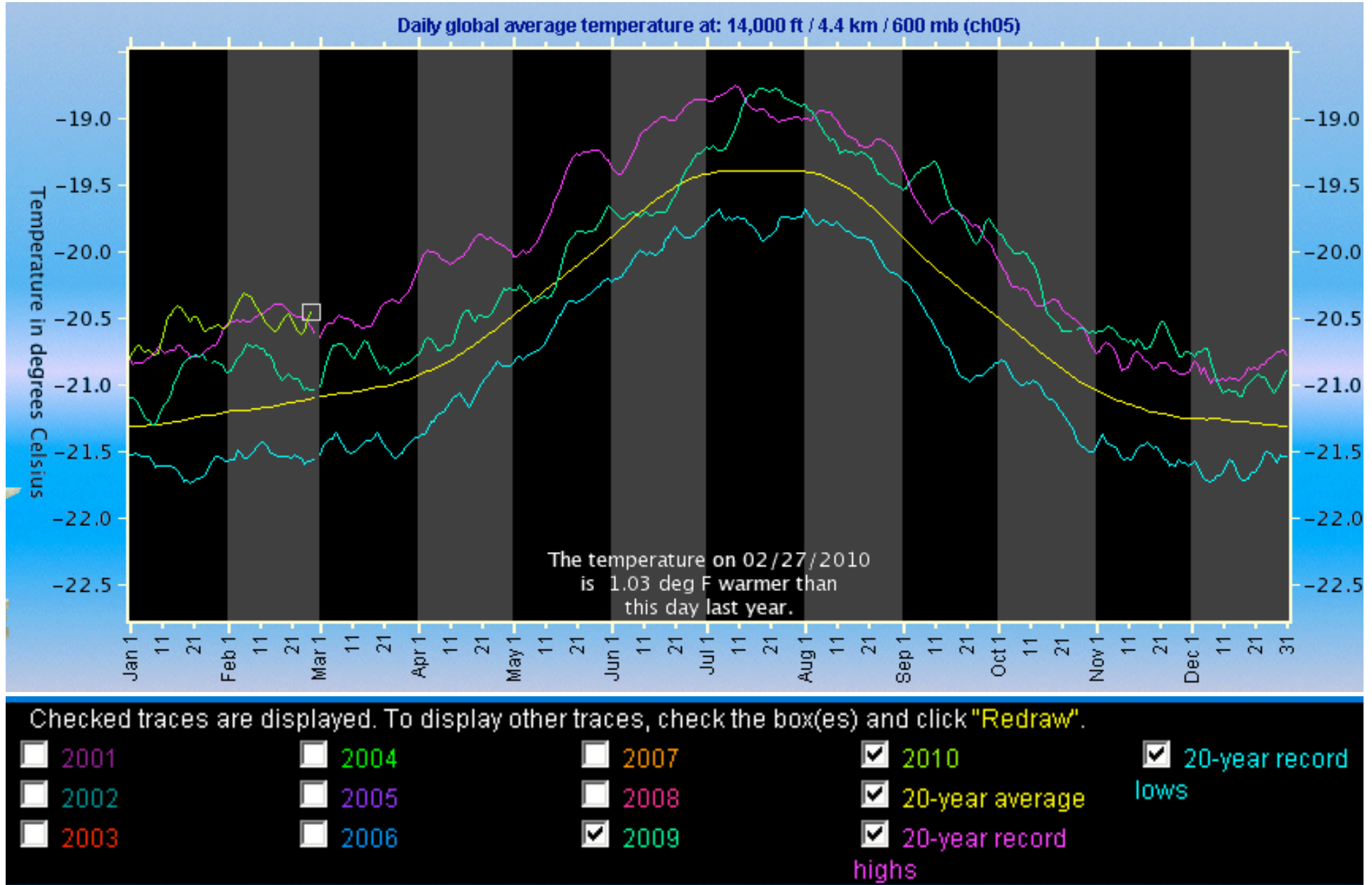


NOAA/ESRL Physical Sciences Division

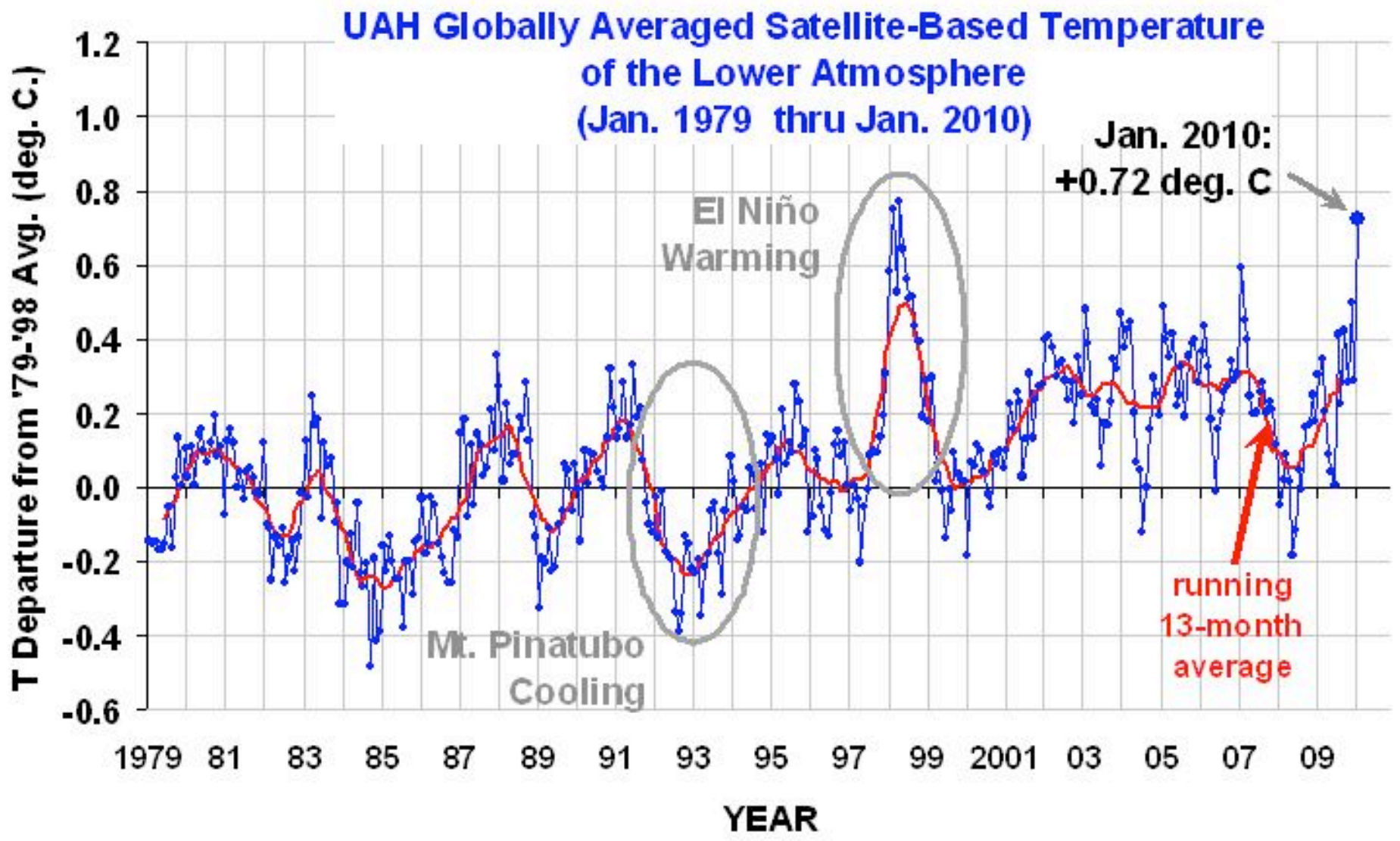
REANALYSIS DATA
SURFACE TEMPERATURES (C) 90-DAY ANOMALY FOR:
Sun NOV 29 2009 - Fri FEB 26 2010

(NCEP Reanalysis climatology data: 1986-1996, smoothed with 5-day running mean)

Global Daily MSU (Ch 5) Temperature. Average, Highest, Lowest. 2009. 2010.



Courtesy Roy Spencer



Select: Lake Tahoe area, 12 months ending in Jan, Temperature 0 C, 9-year running mean.

North American Freezing Level Tracker

About <<

Description -

Click anywhere on the map to place a marker. It can then be dragged around the map. Use the Products panel on the right to generate products for the marker's location.

Settings +

Map

Map Satellite Hybrid

Map data ©2009 Google, INEGI, [Terms of Use](#)

Products >>

Monthly Bar Graph -

Lat:

Lon:

Span: ▾

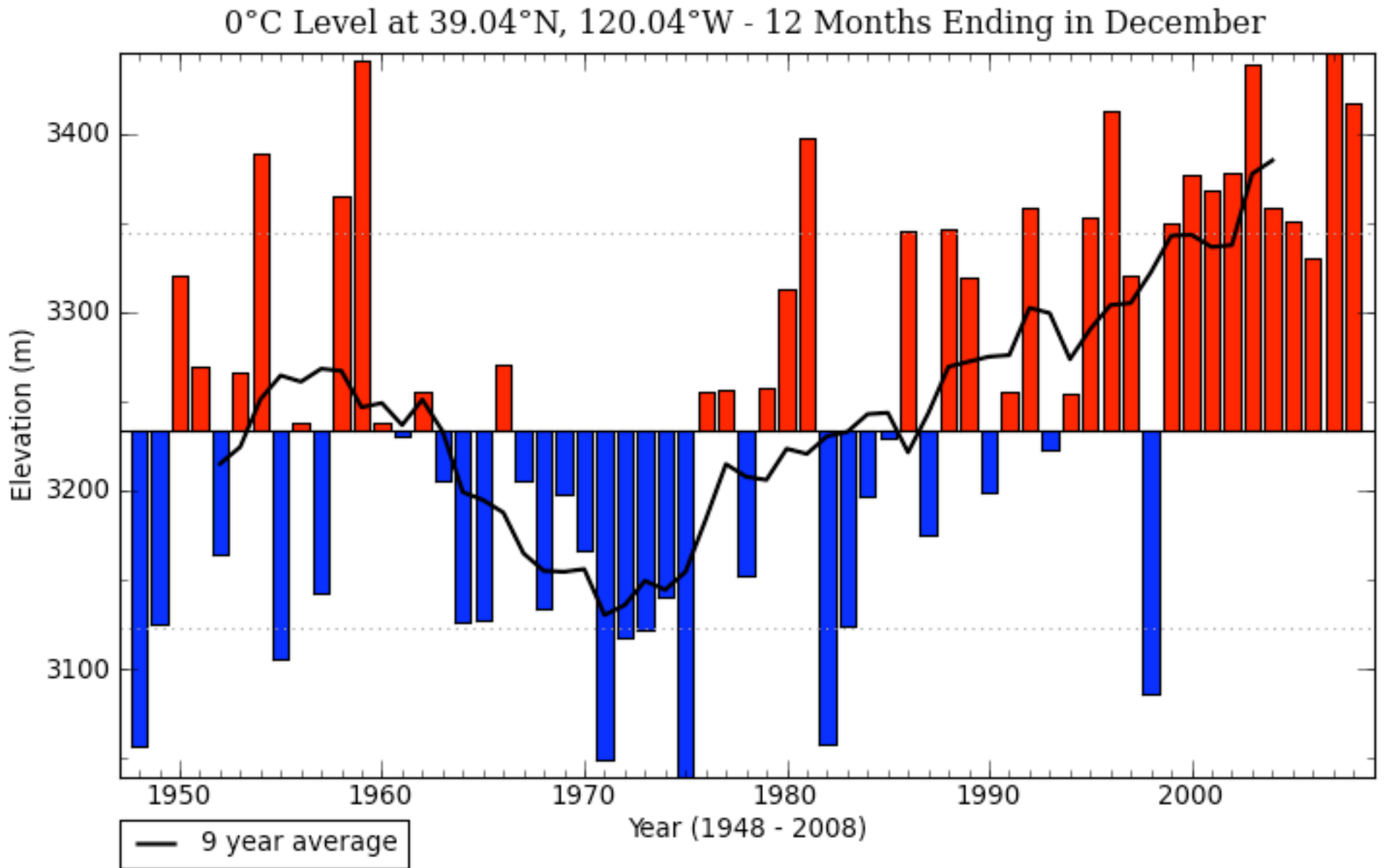
End Month: ▾

Level: ▾

Running average: ▾

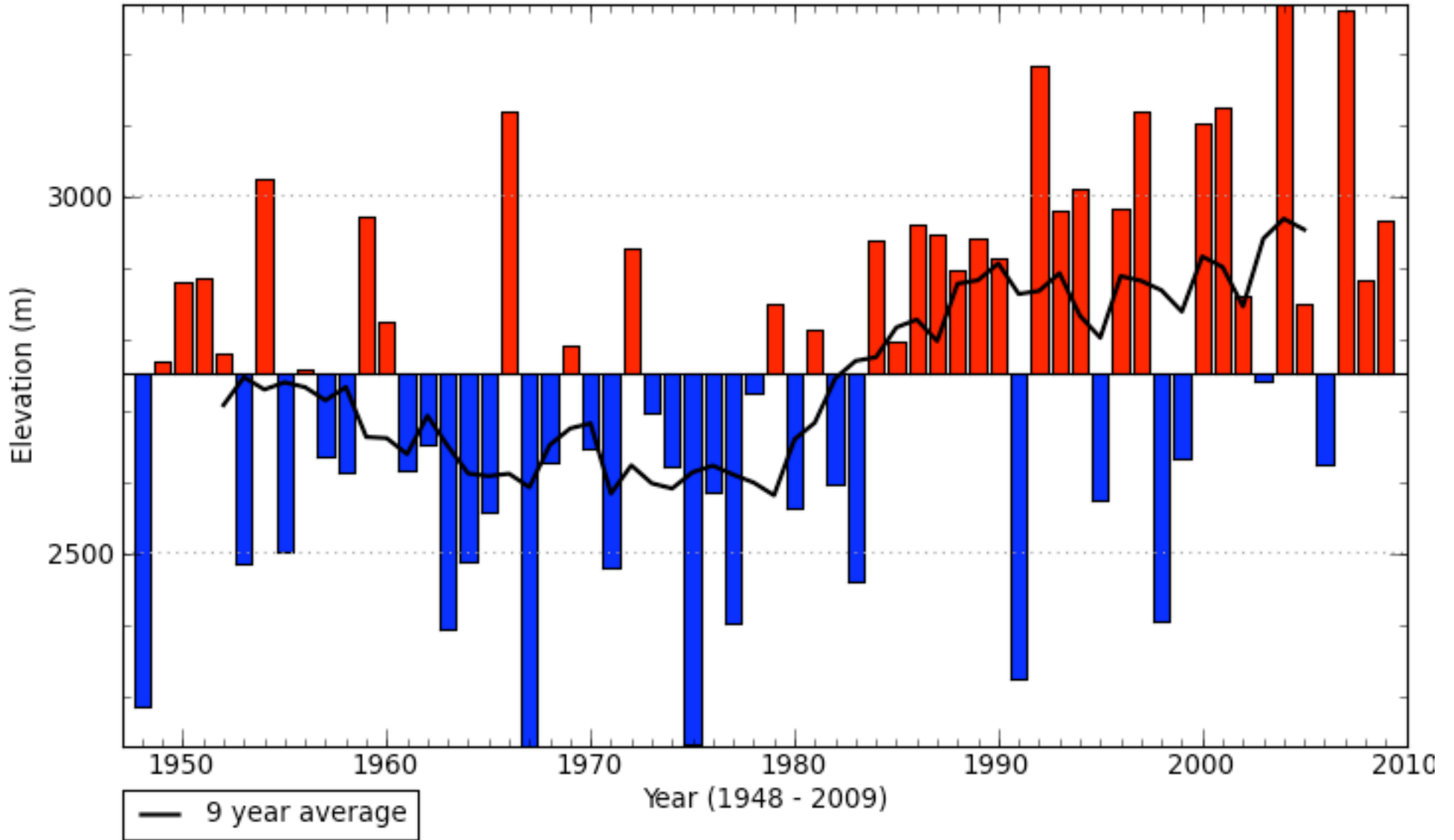
Last 12 Months +

Elevation of Freezing Level over Lake Tahoe. Annual. 1948 through 2008.



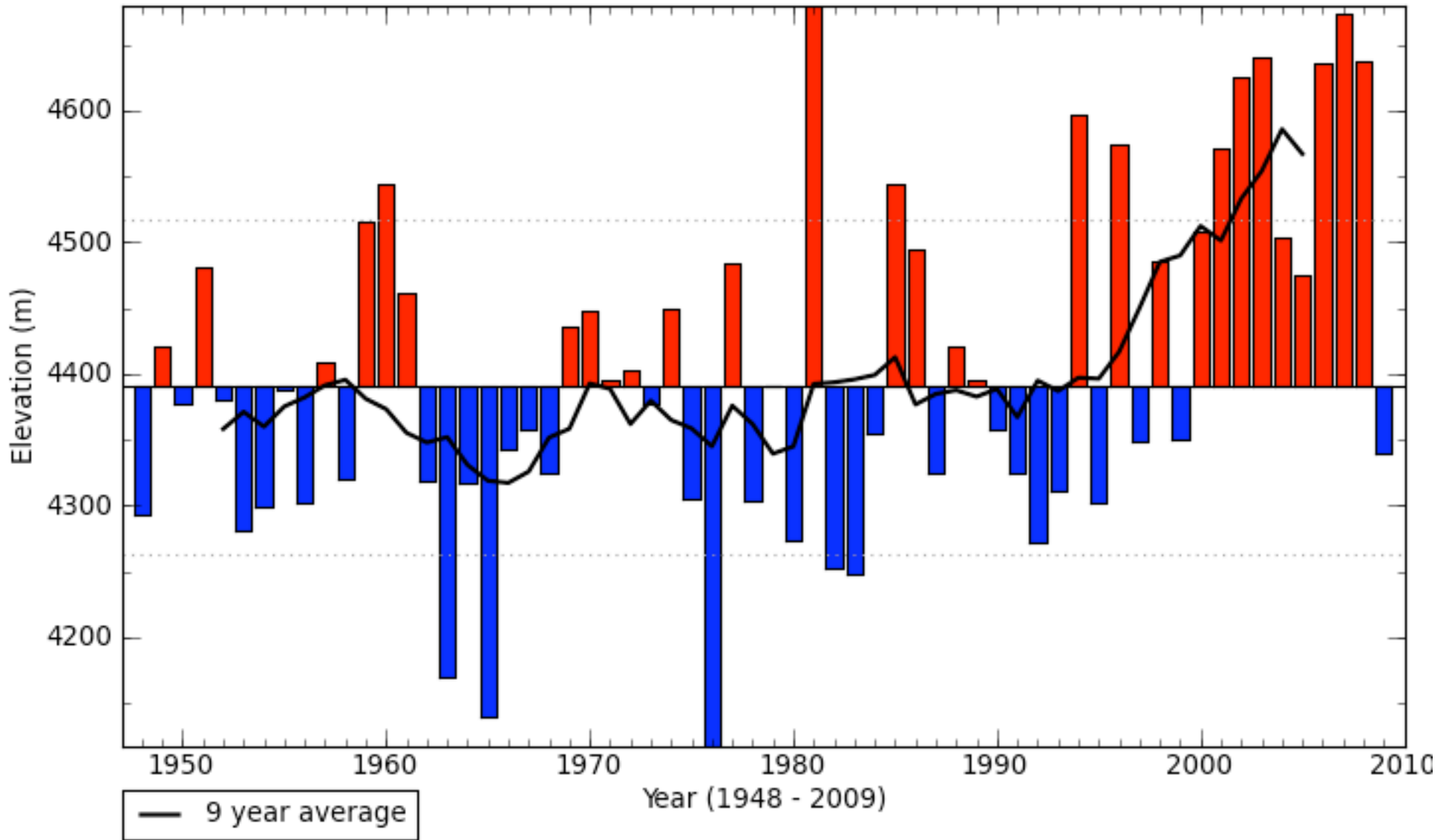
Elevation of Freezing Level over Lake Tahoe. Spring. 1948 thru 2009.

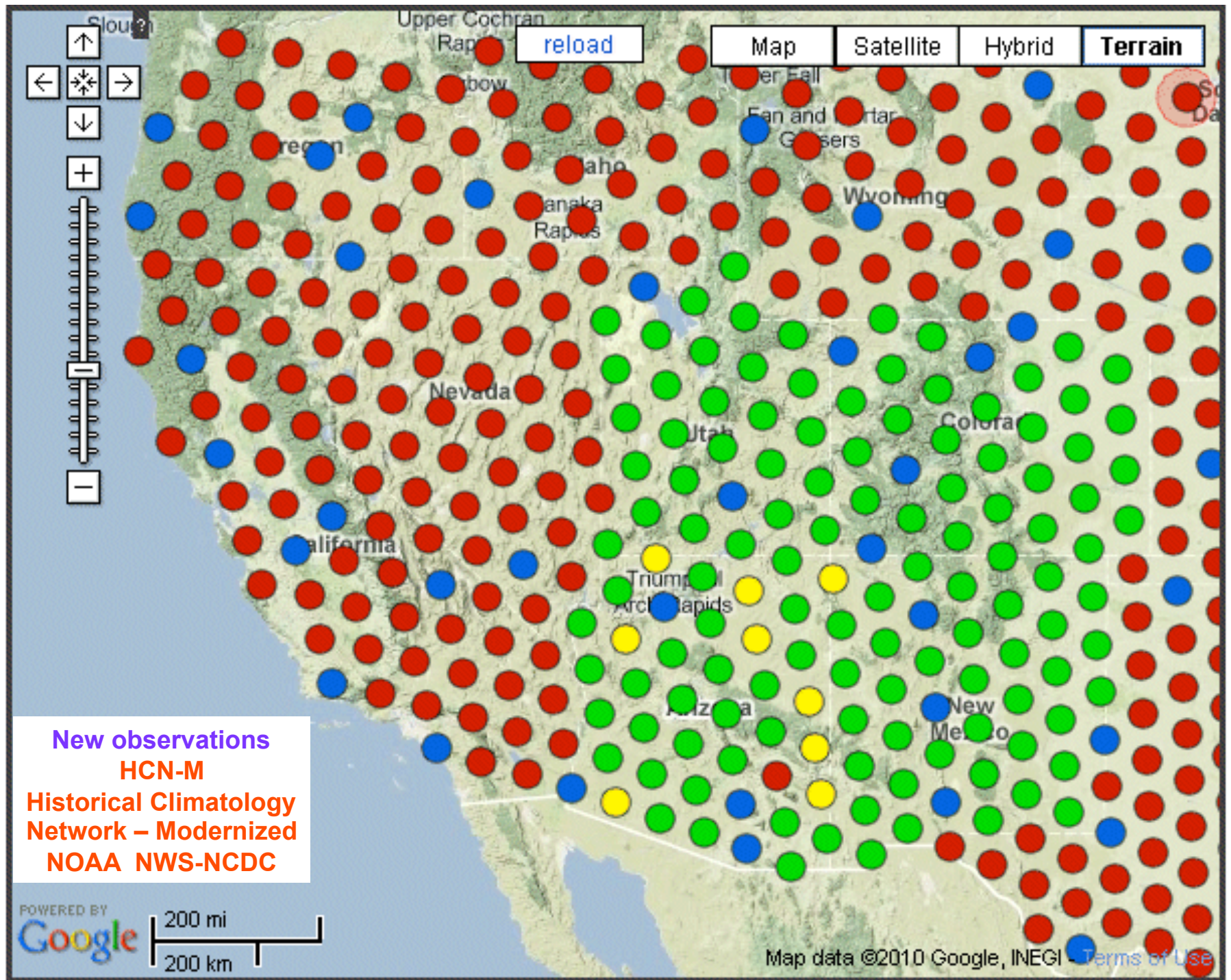
0°C Level at 39.04°N, 120.04°W - 3 Months Ending in May



Elevation of Freezing Level over Lake Tahoe. Summer. 1948 thru 2009.

0°C Level at 39.04°N, 120.04°W - 3 Months Ending in August



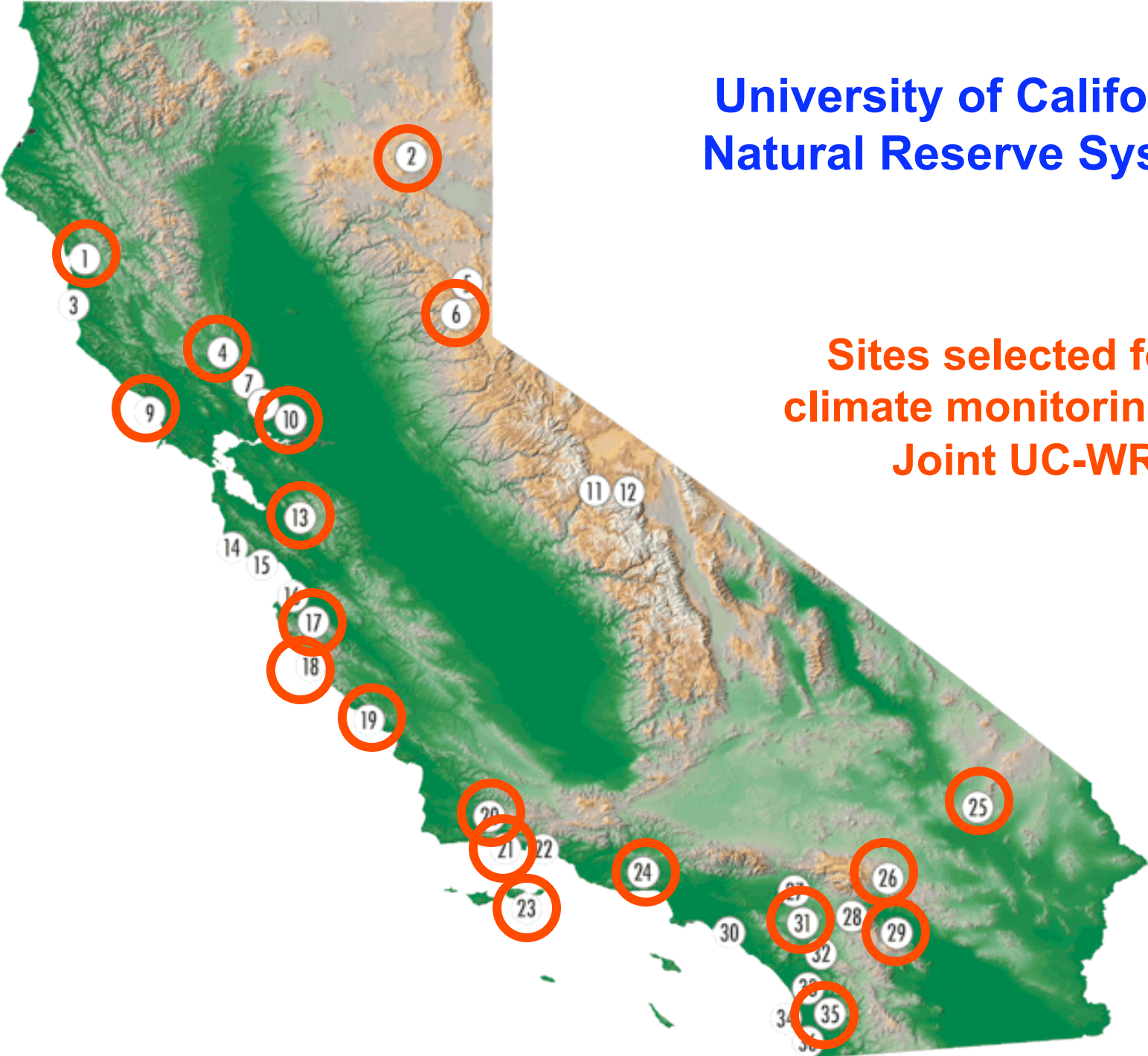


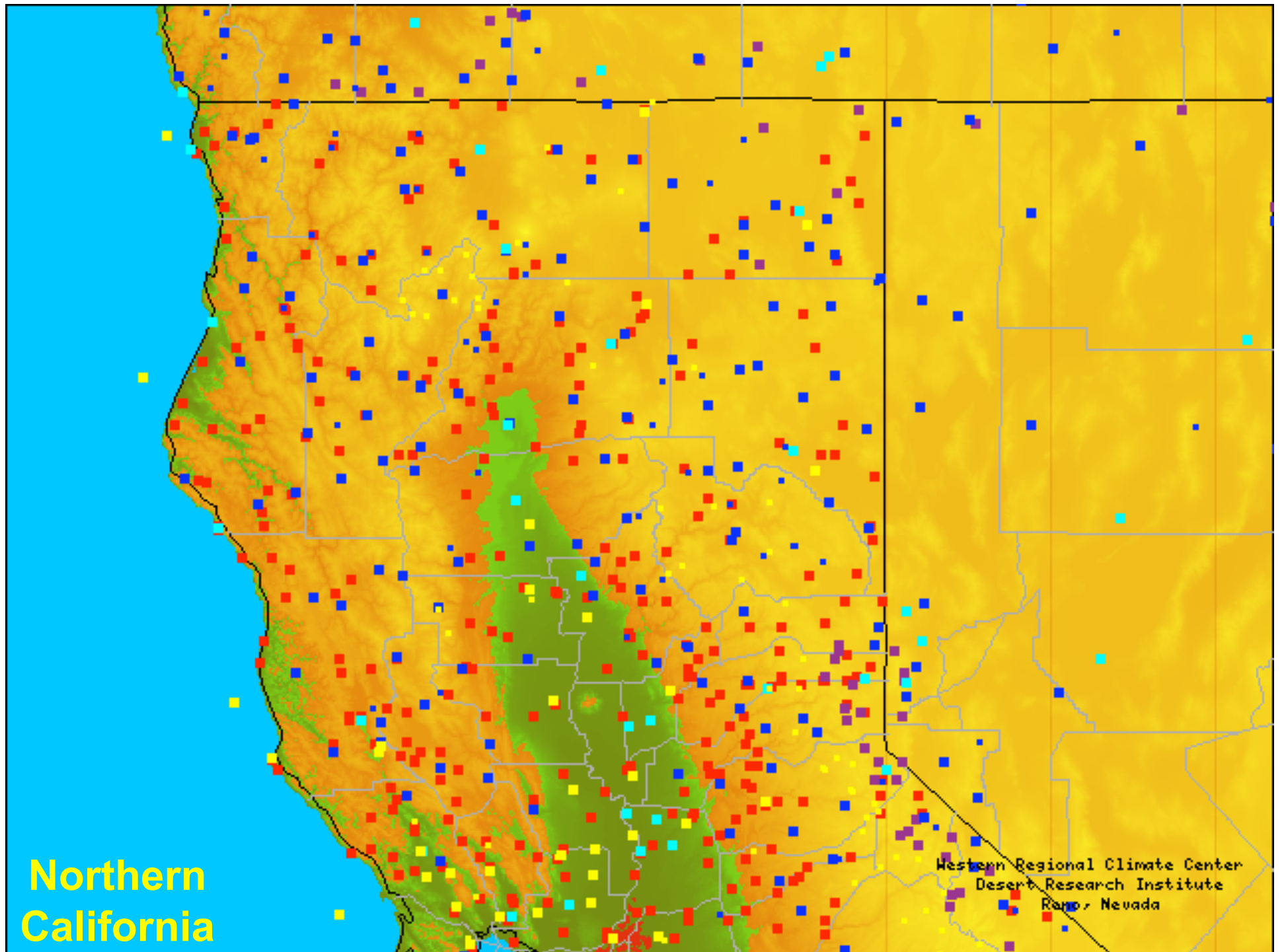
New observations
HCN-M
Historical Climatology
Network - Modernized
NOAA NWS-NCDC

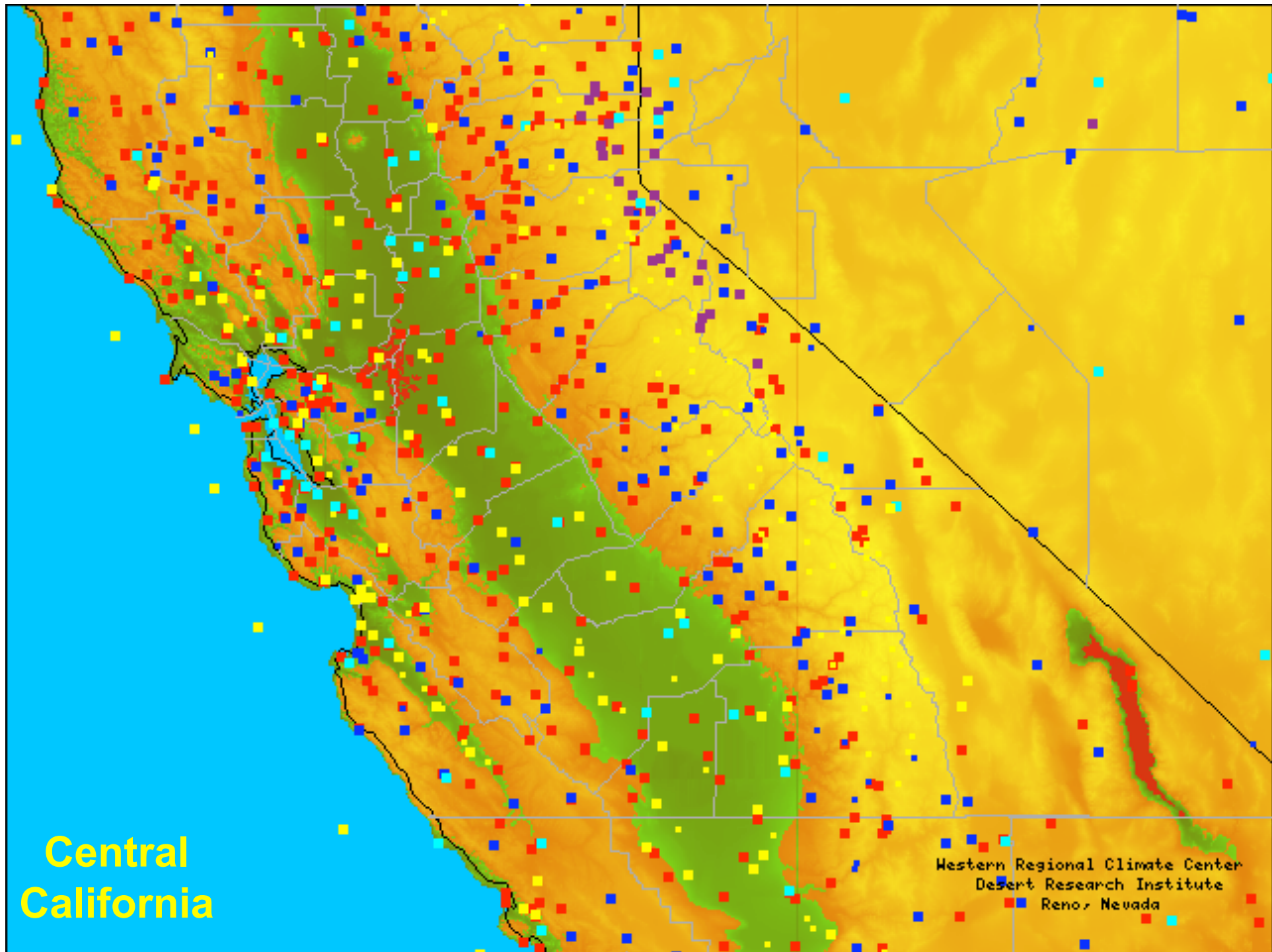
POWERED BY
 200 mi
200 km

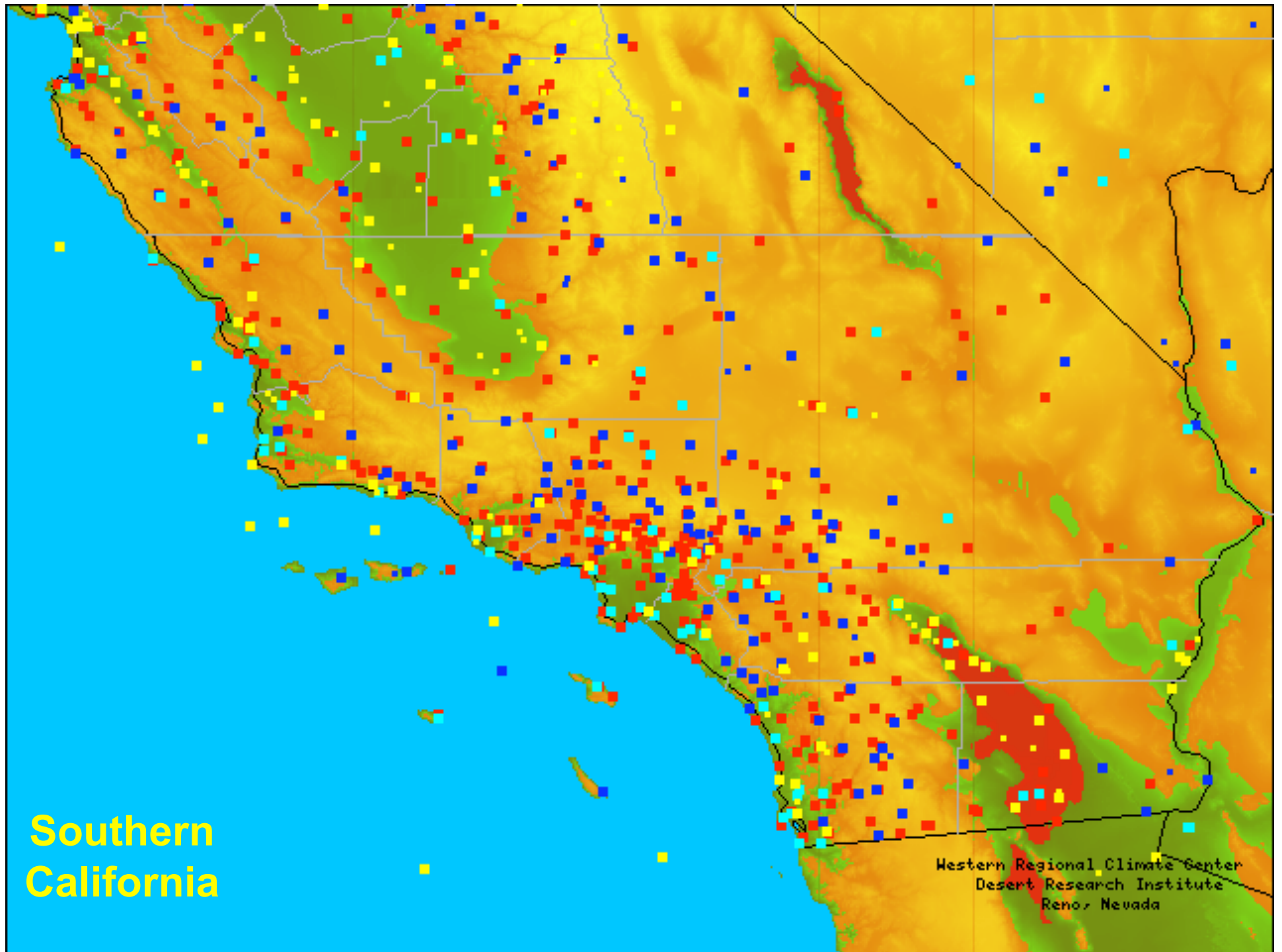
University of California Natural Reserve System

Sites selected for NSF
climate monitoring project
Joint UC-WRCC









**Southern
California**

Western Regional Climate Center
Desert Research Institute
Reno, Nevada

SC-ACIS with California State Climate Office

Ingest of stations uniquely available only from CDEC (Cal Data Exchange Center)

About a hundred stations of primary interest, a few hundred more also available

Ability to summarize data in a variety of ways

Climatologies

Time Series

Usefulness for quality control

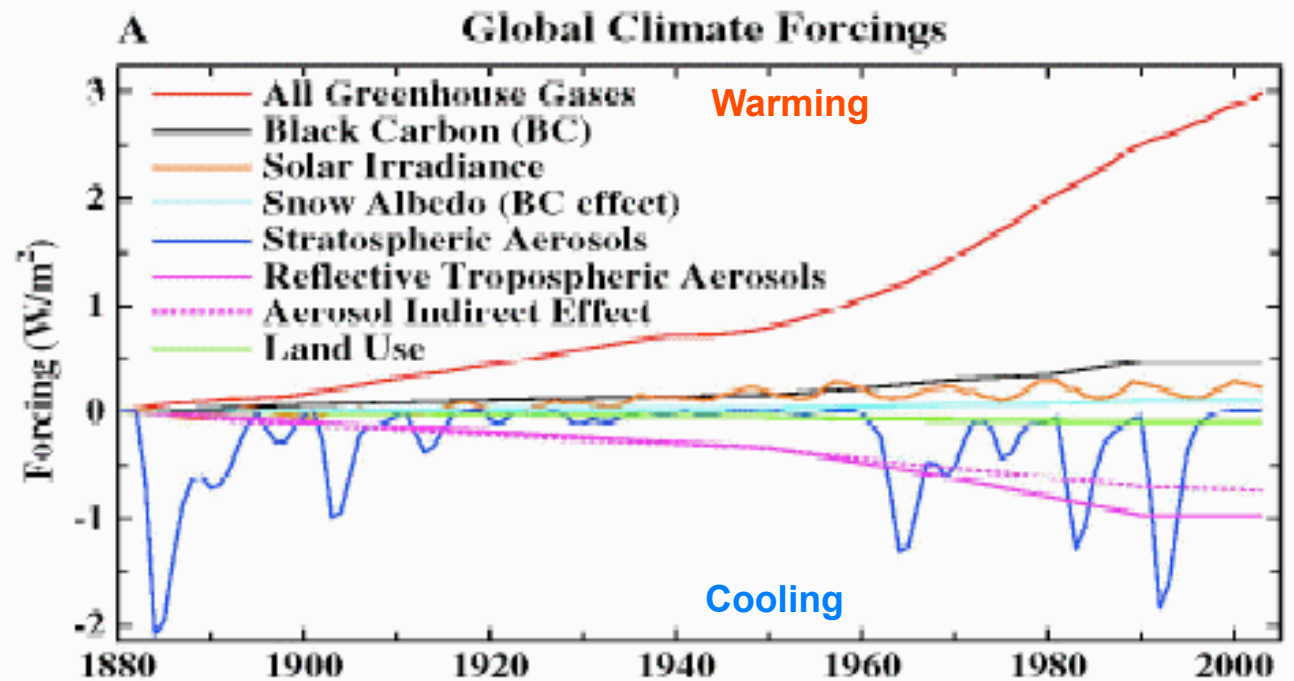


Thank You

20 February 2007

History of Atmospheric Forcings

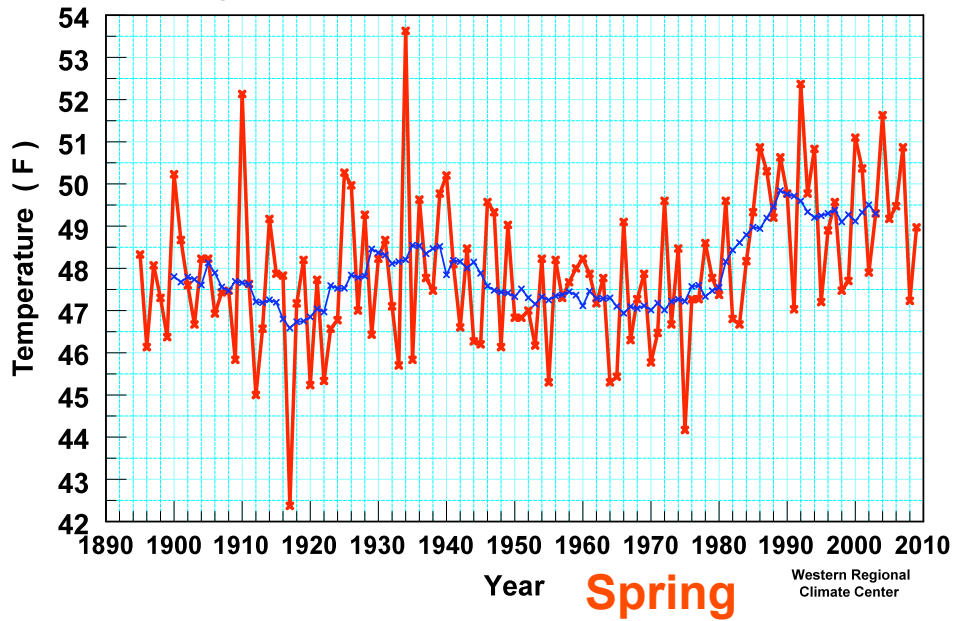
Hansen et al, 2005.
Earth's energy
imbalance: Confirmation
and implications.
Science, 308, 1431.



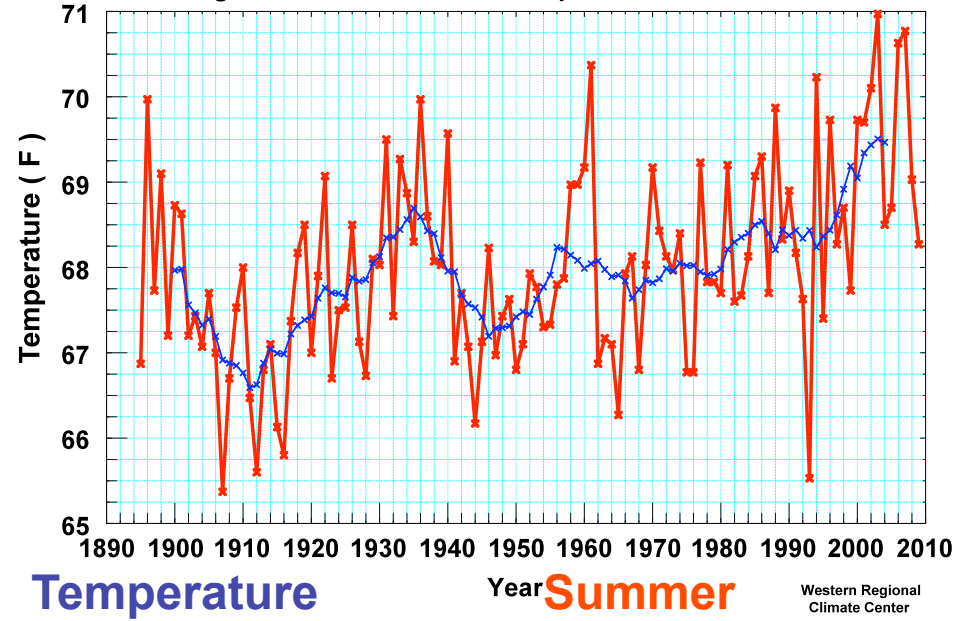
1880 1900 1920 1940 1960 1980 2000

Radiative Factors that Control Global Climate

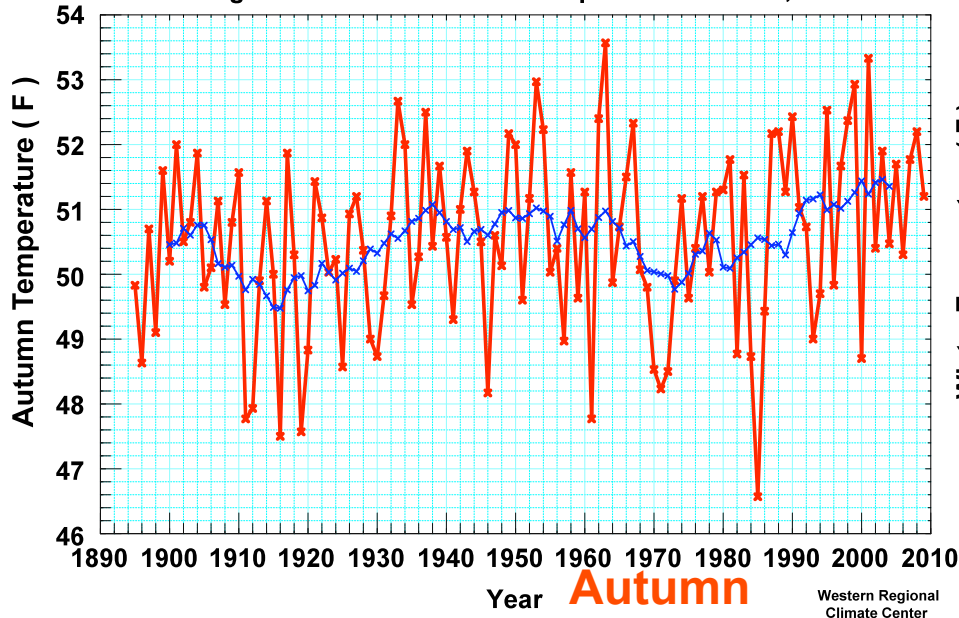
Western United States (11 states) Mar-Apr-May Temperature
 Provisional data from NCDC / CPC. Blue: 11-year running mean.
 Units: Deg F. Data source NOAA cooperative network, thru Nov 2009.



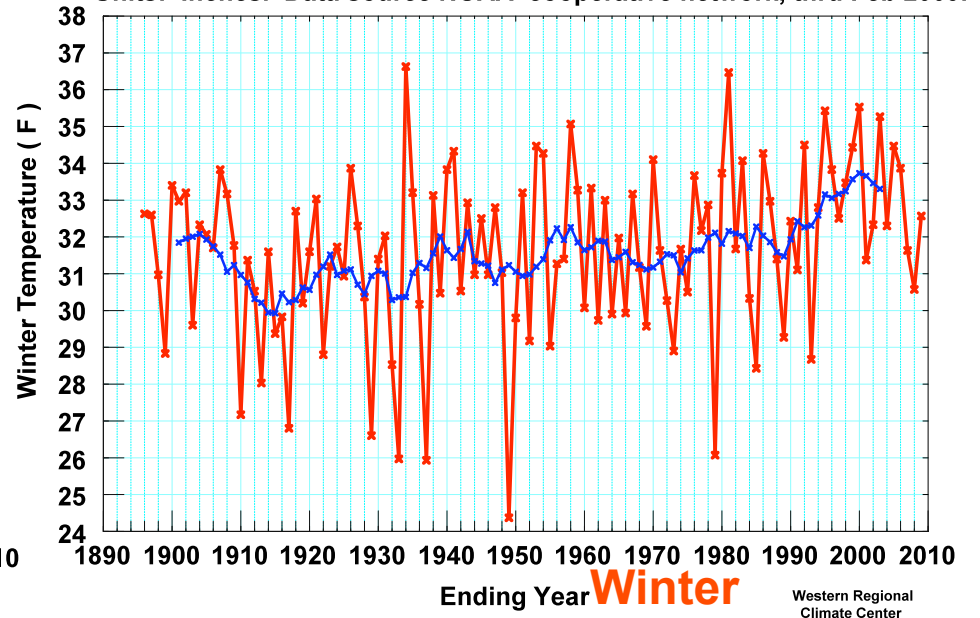
Western United States (11 states) June-July-August Temperature
 Provisional data from NCDC / CPC. Blue: 11-year running mean.
 Units: Deg F. Data source NOAA cooperative network, thru Nov 2009.

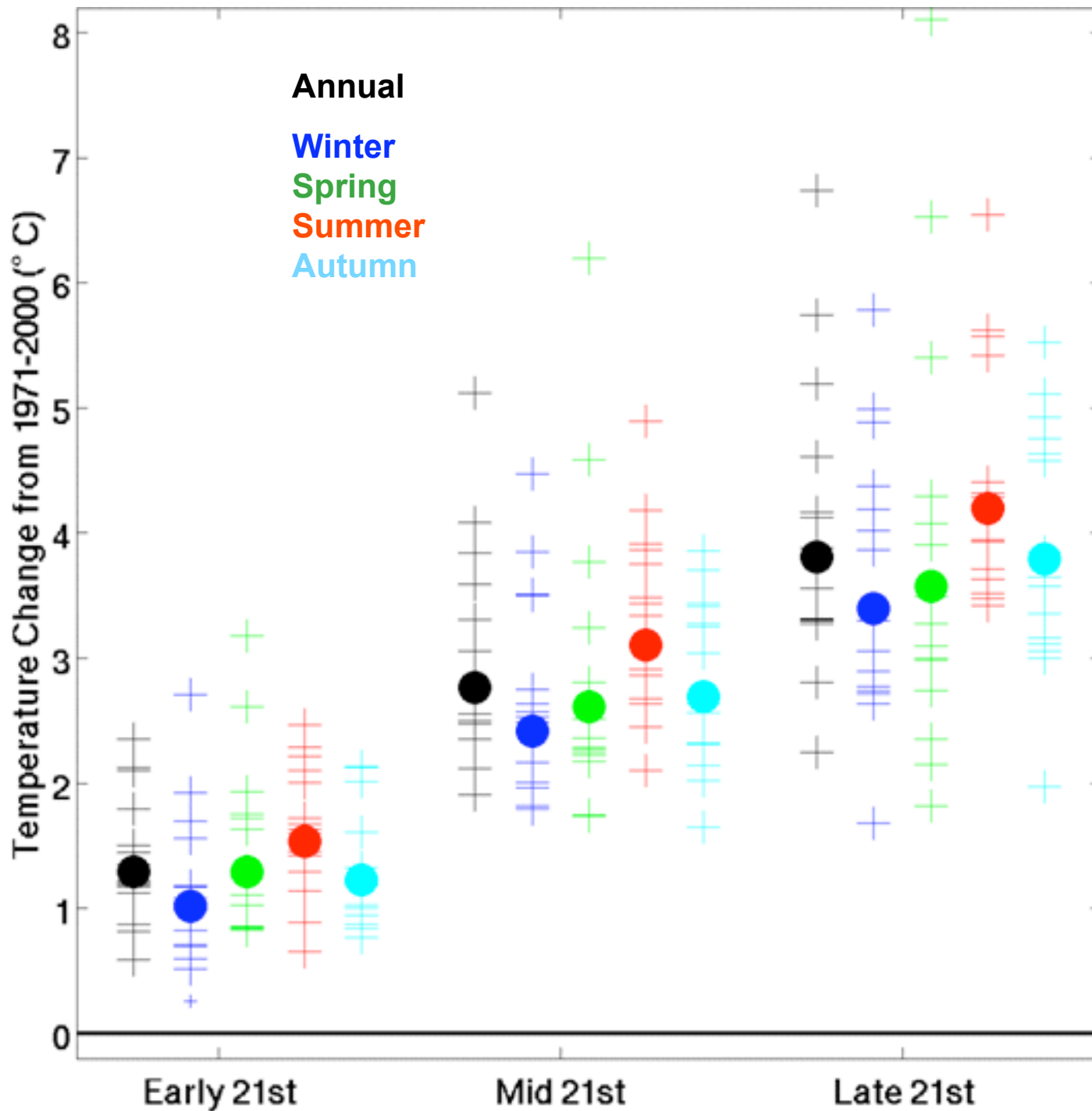


Western United States (11 states) Sept-Oct-Nov Temperature
 Provisional data from NCDC / CPC. Blue: 11-year running mean.
 Units: Deg F. Data source NOAA cooperative network, thru Nov 2009.



Western United States (11 states) Dec-Jan-Feb Temperature
 Provisional data from NCDC / CPC. Blue: 11-year running mean.
 Units: Inches. Data source NOAA cooperative network, thru Feb 2009.





**East Central
Nevada**

**Projected
Temperature
Changes (C)**

Early 21st

2011-2040

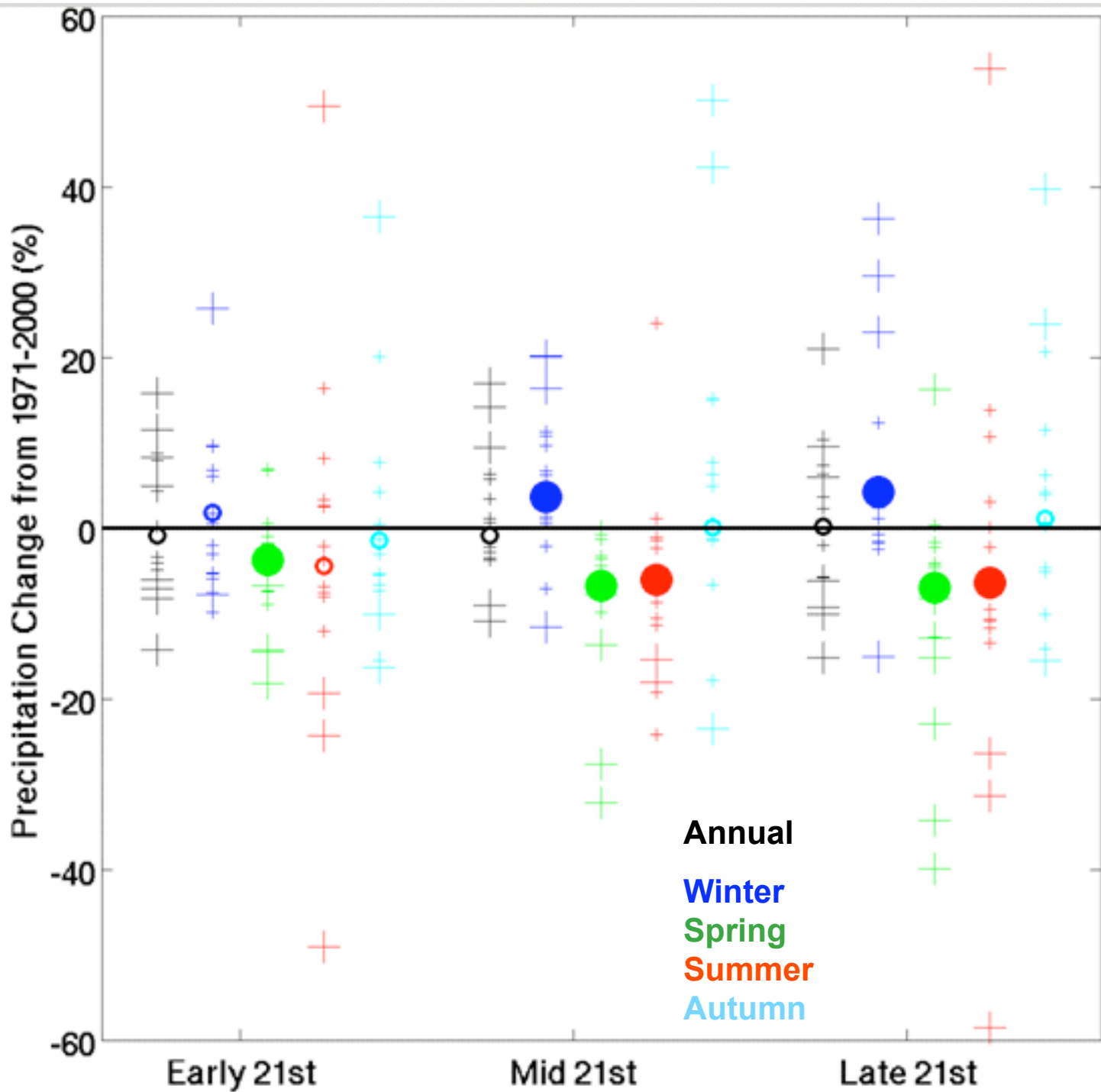
Middle 21st

2041-2070

Late 21st

2071-2100

**Thanks to
John Abatzoglou**



**East Central
Nevada**

**Projected
Precipitation
Changes (%)**

Early 21st

2011-2040

Middle 21st

2041-2070

Late 21st

2071-2100

Annual

Winter

Spring

Summer

Autumn

**Thanks to
John Abatzoglou**

OPTIONS FOR IMPROVING CLIMATE MODELING
TO ASSIST WATER UTILITY PLANNING
FOR CLIMATE CHANGE



December 2009

Denver Water
Metropolitan Water District of SoCal
NYC Dept Environmental Protection
Portland Water Bureau
San Diego County Water Authority
San Francisco Public Utilities Comm
Seattle Public Utilities
Southern Nevada Water Authority

Authors

Joe Barsugli, WWA, UC-Boulder
Chris Anderson, Iowa St Univ
Joel Smith, Stratus Consulting
Jason Vogel, Stratus Consulting

Actionable Science:

“Data, analysis, and forecasts that are sufficiently predictive, accepted, and understandable to support decision-making, including capital investment decision-making.”

**- David Behar
San Francisco Public Utilities Commission**

Thank You



2005 February 13. DRI Storm Peak Lab. Dave Simeral.