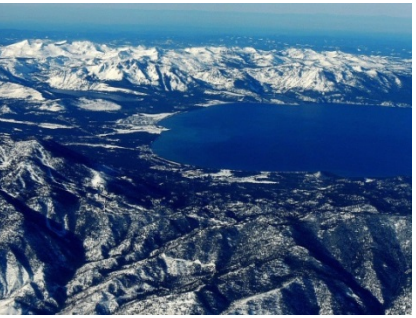
California Climate/Water Update

California Drought Workshop Report



Kelly T. Redmond

Western Regional Climate Center

Desert Research Institute

Reno Nevada

Remote Sensing for Drought Monitoring and Response

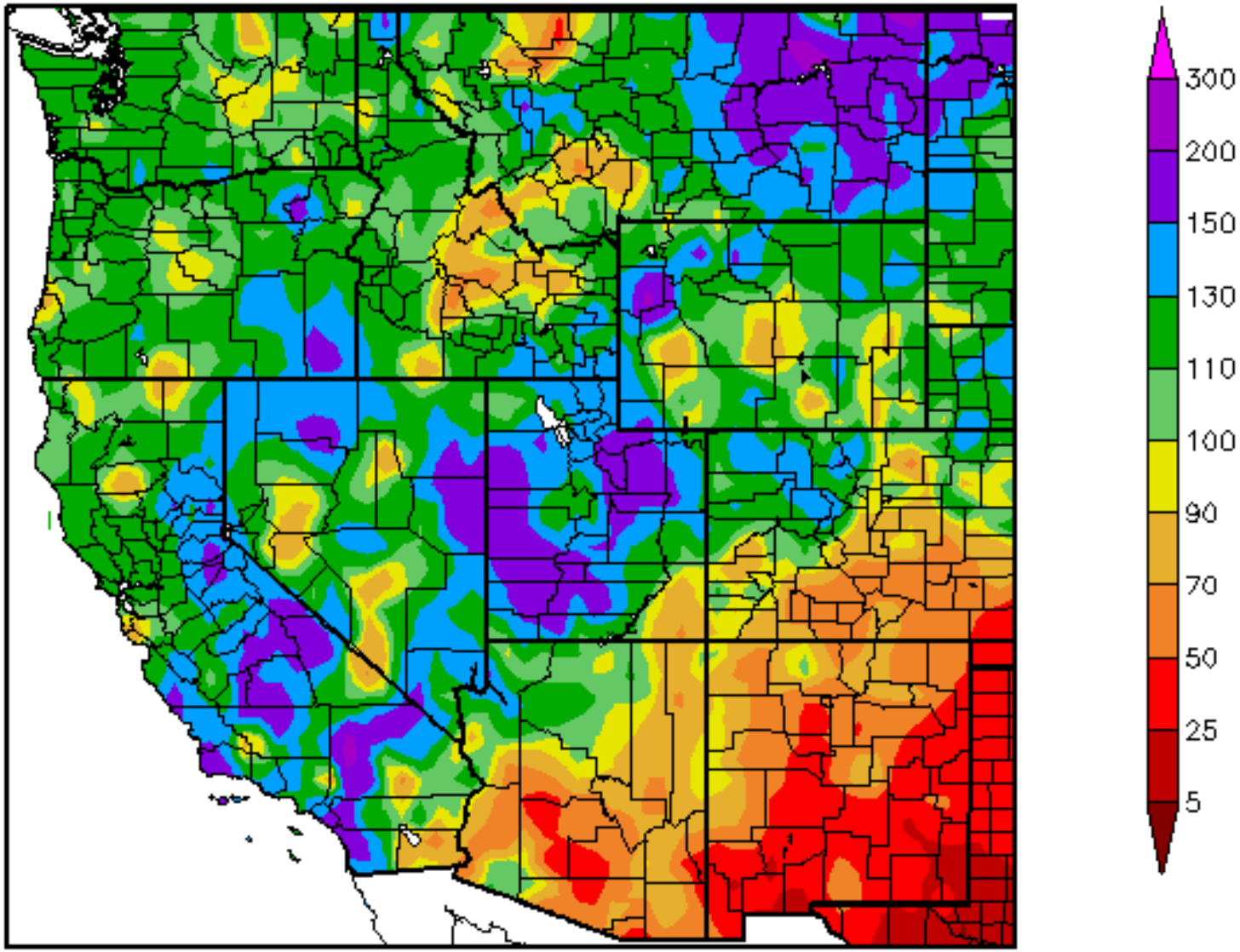
Sacramento CA, 2014 February 25-26

Western Regional Climate Center

California Nevada Applications Program CNAP

Water Year
2010-11
01 Oct 2010
Thru
30 Sep 2011

Percent of Normal Precipitation (%)
10/1/2010 – 9/30/2011

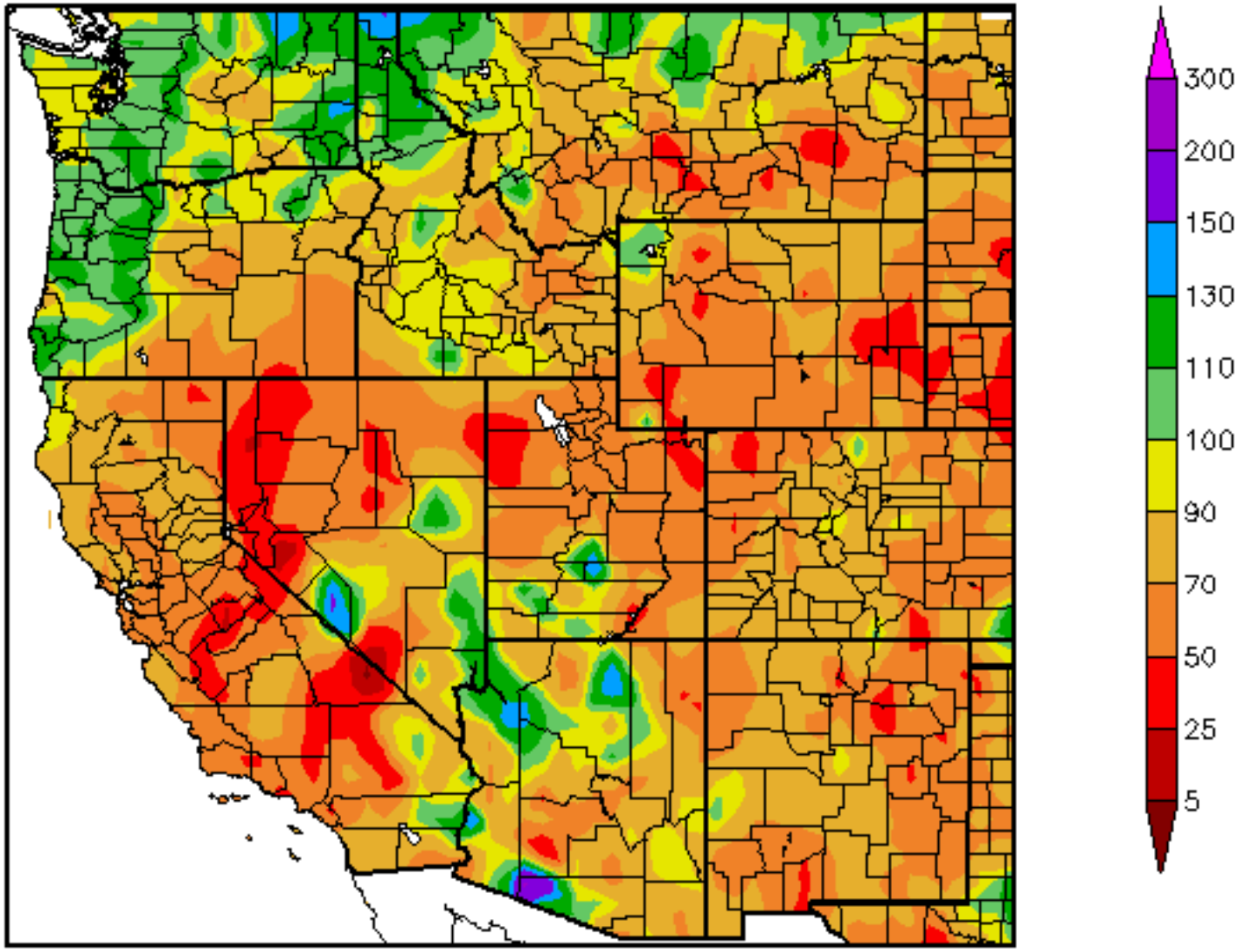


Generated 6/15/2012 at HPRCC using provisional data.

Regional Climate Centers

Water Year
2011-12
01 Oct 2011
Thru
30 Sep 2012

Percent of Normal Precipitation (%)
10/1/2011 – 9/30/2012

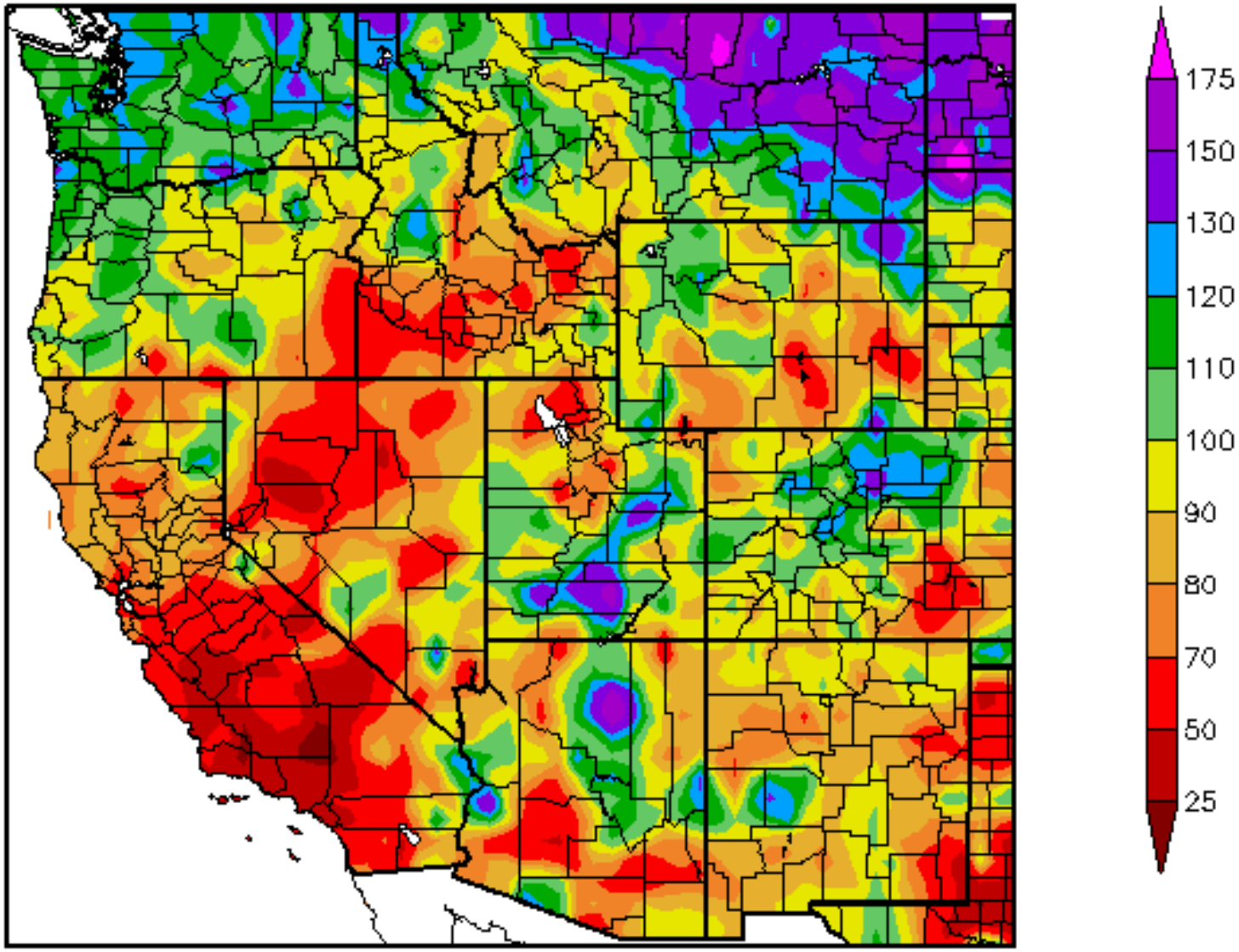


Generated 10/11/2012 at HPRCC using provisional data.

Regional Climate Centers

Water Year
2012-13
01 Oct 2012
Thru
30 Sep 2013

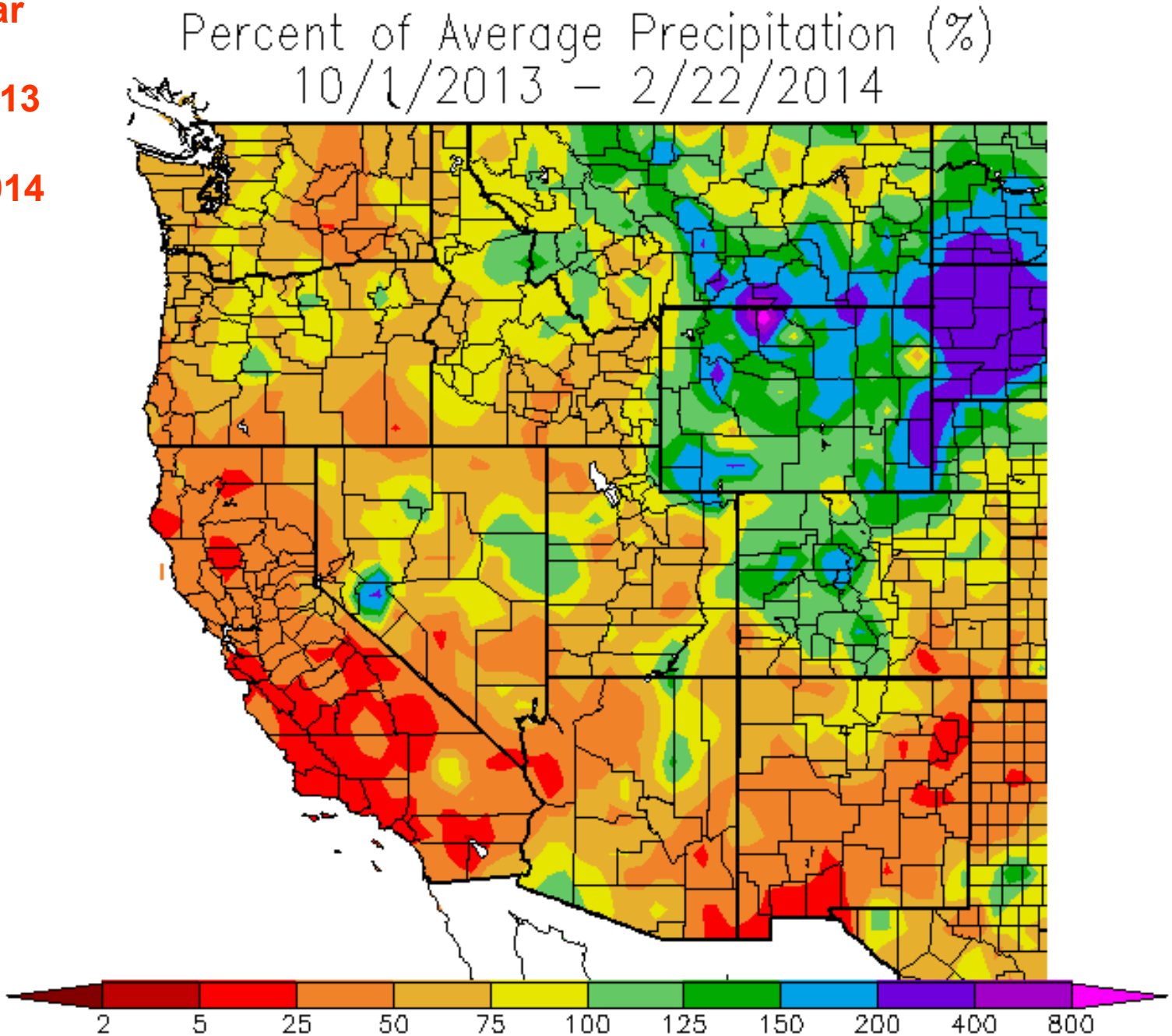
Percent of Normal Precipitation (%)
10/1/2012 – 9/30/2013



Generated 10/11/2013 at HPRCC using provisional data.

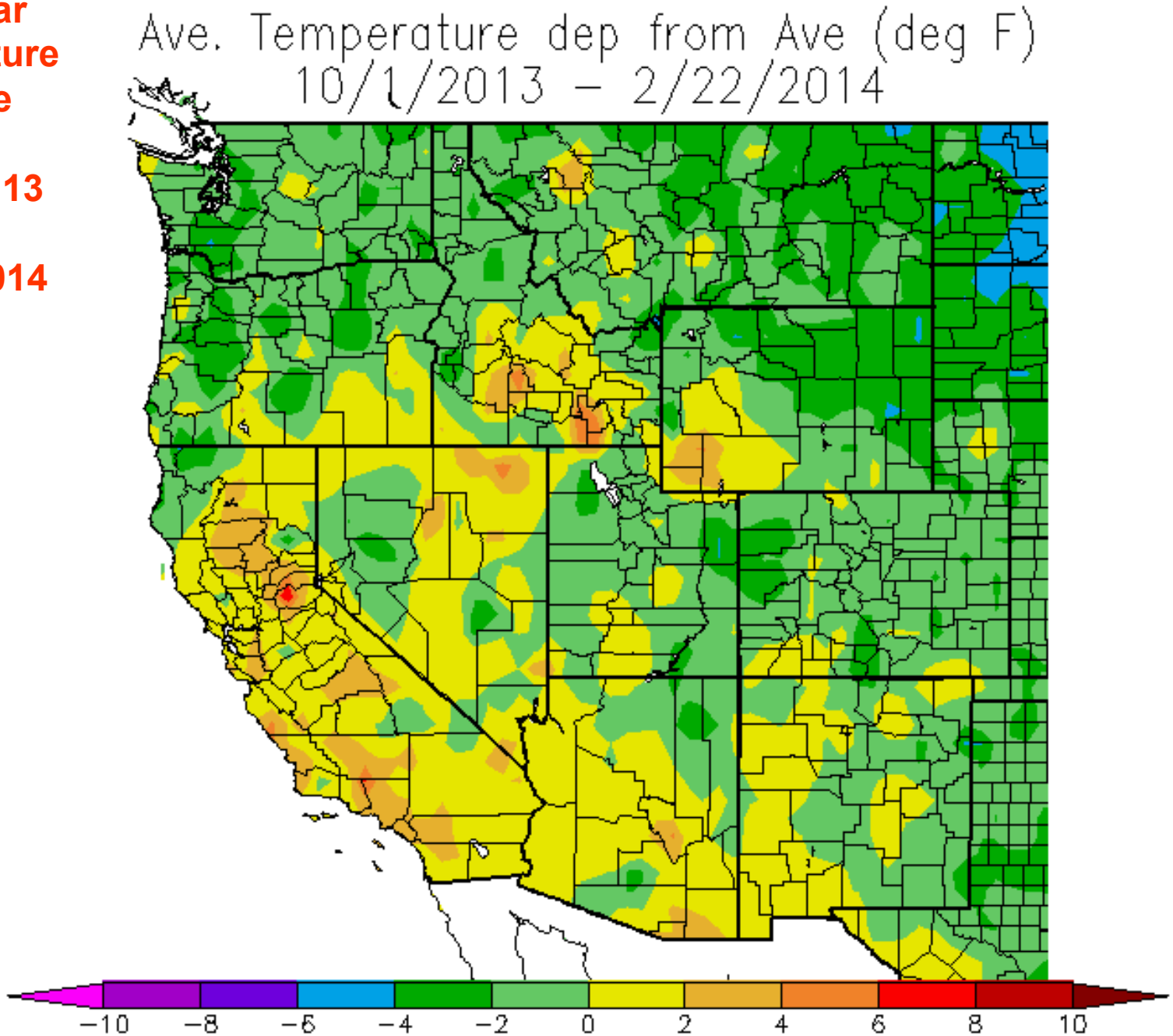
Regional Climate Centers

Water Year
2013-14
01 Oct 2013
Thru
22 Feb 2014

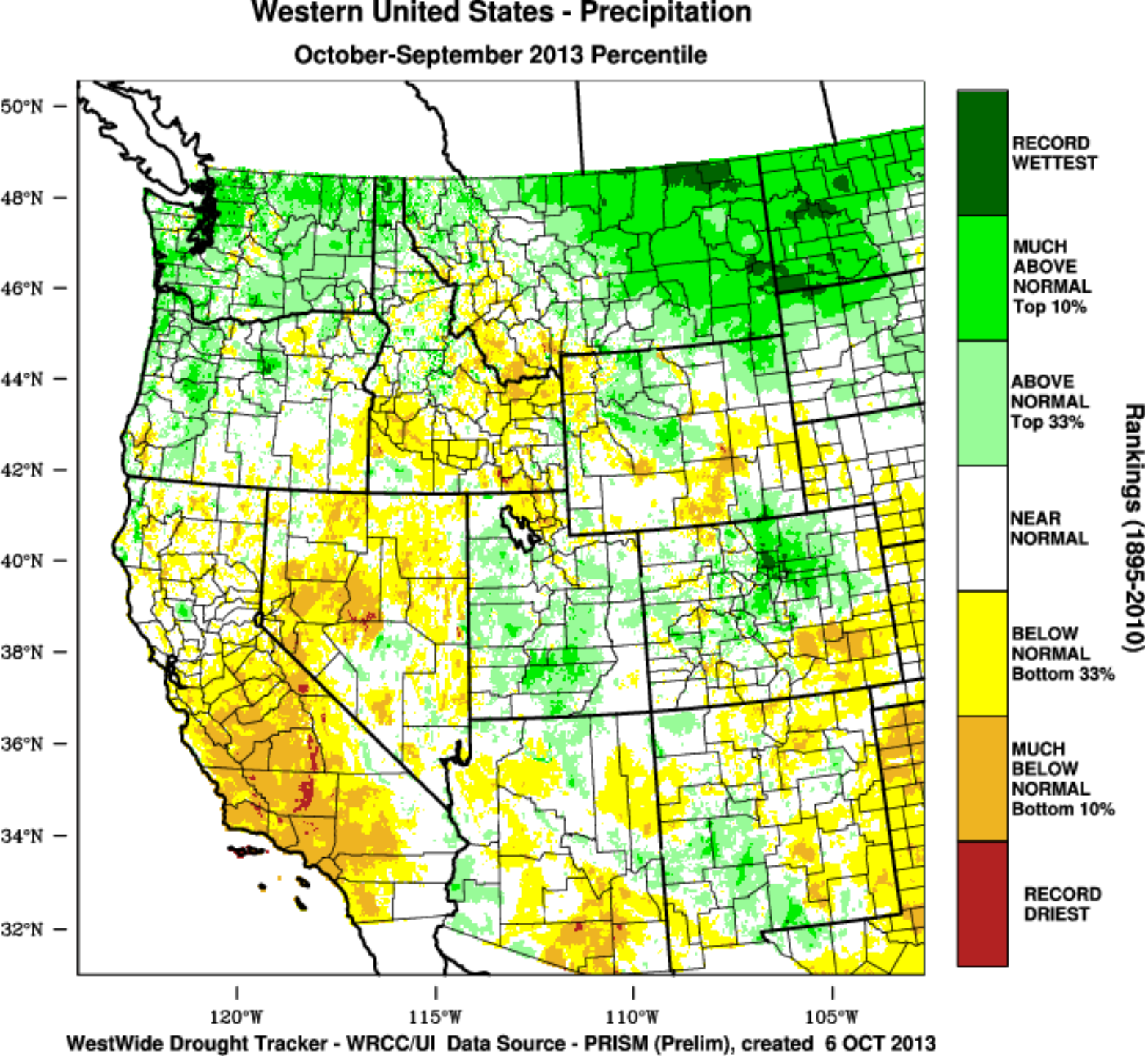


Generated 2/23/2014 at WRCC using provisional data.
NOAA Regional Climate Centers

Water Year Temperature Departure 2013-14
01 Oct 2013 Thru 22 Feb 2014



Generated 2/23/2014 at WRCC using provisional data.
NOAA Regional Climate Centers



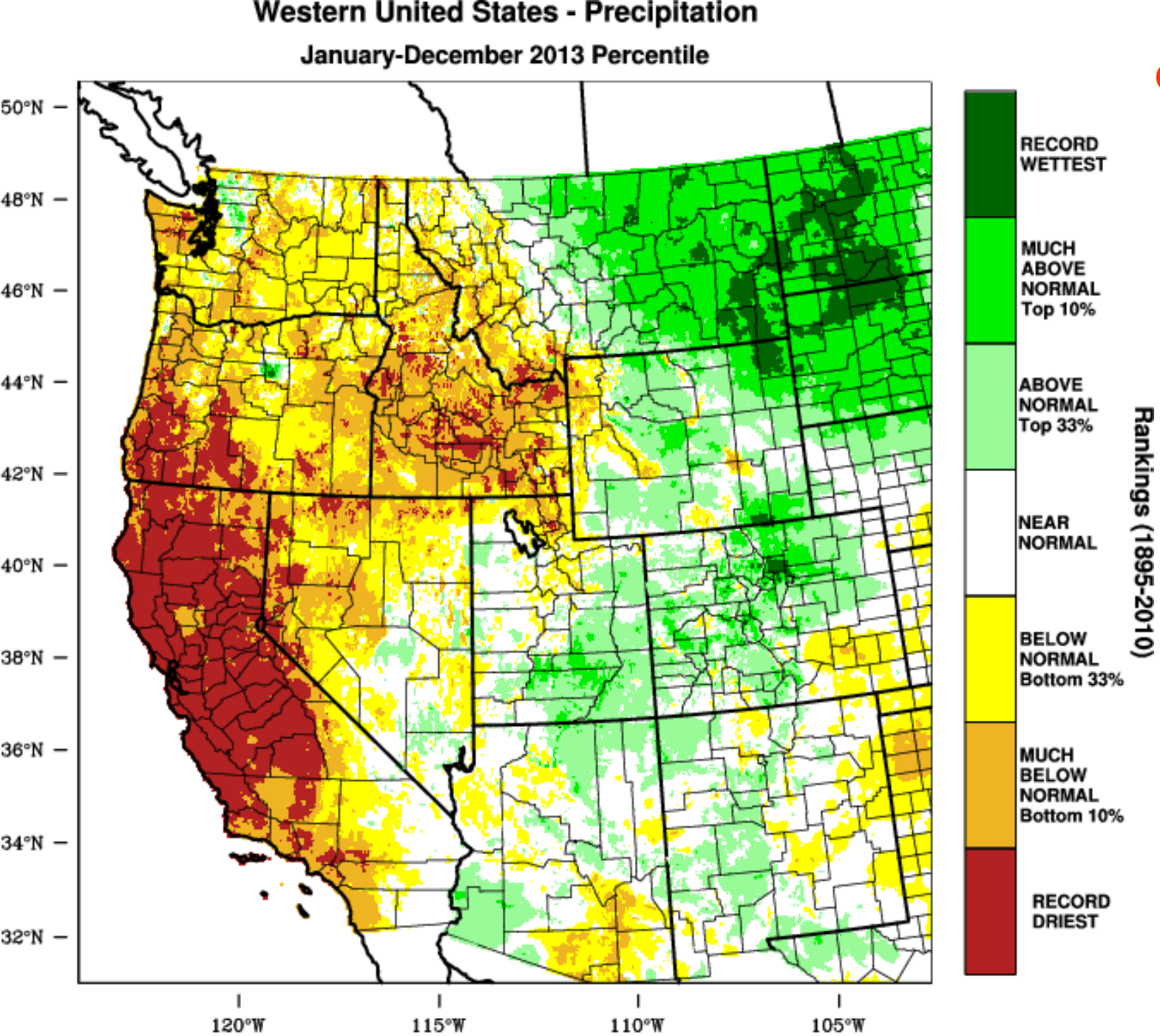
Water Year Oct - Sep 2012-13 Precipitation Rank

since 1895

PRISM

Lowest 10 %

Record Driest



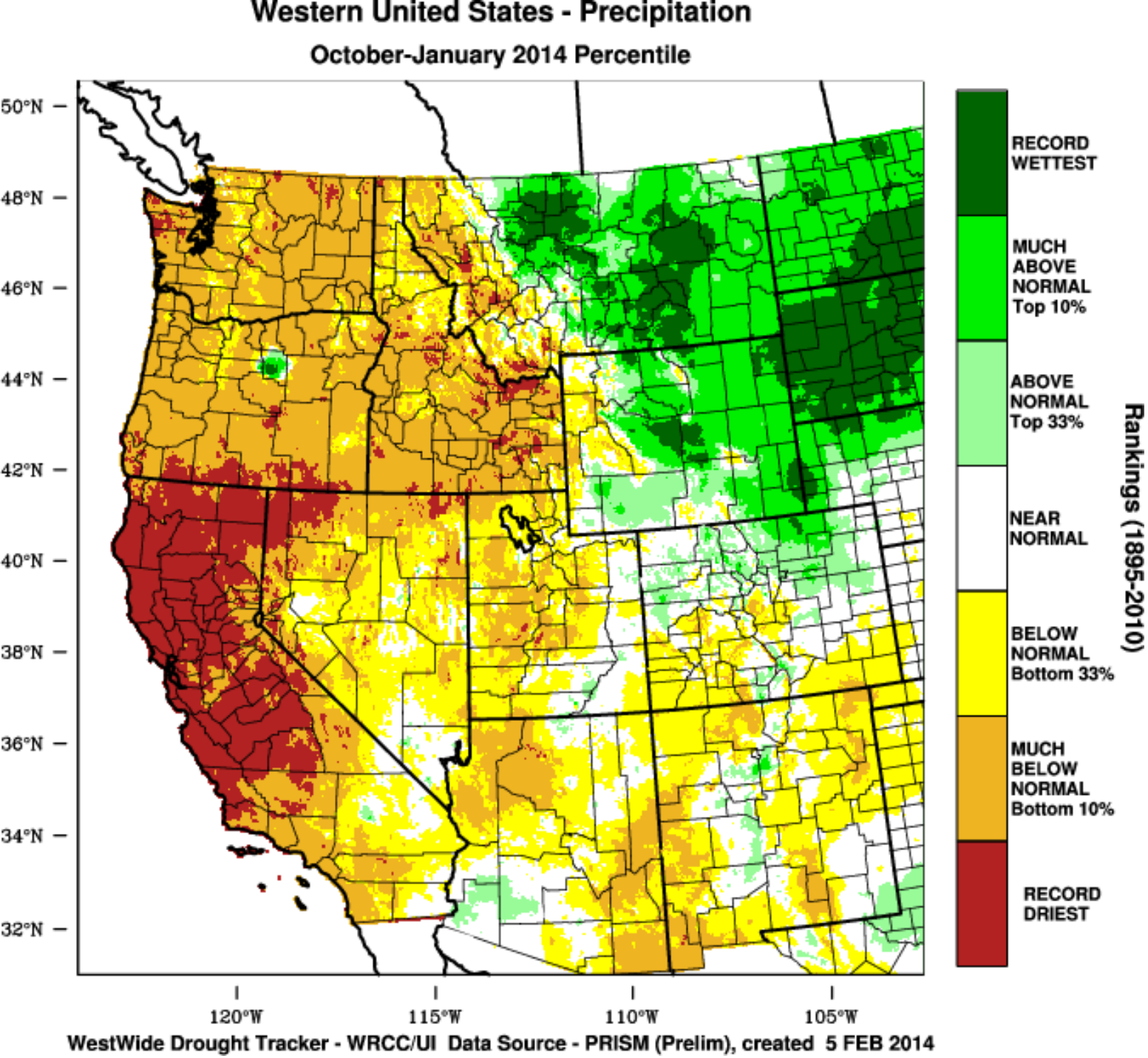
Calendar Year Jan - Dec 2013 Precipitation Rank

since 1895

PRISM

Lowest 10 %

Record Driest



Oct - Jan 2013-2014

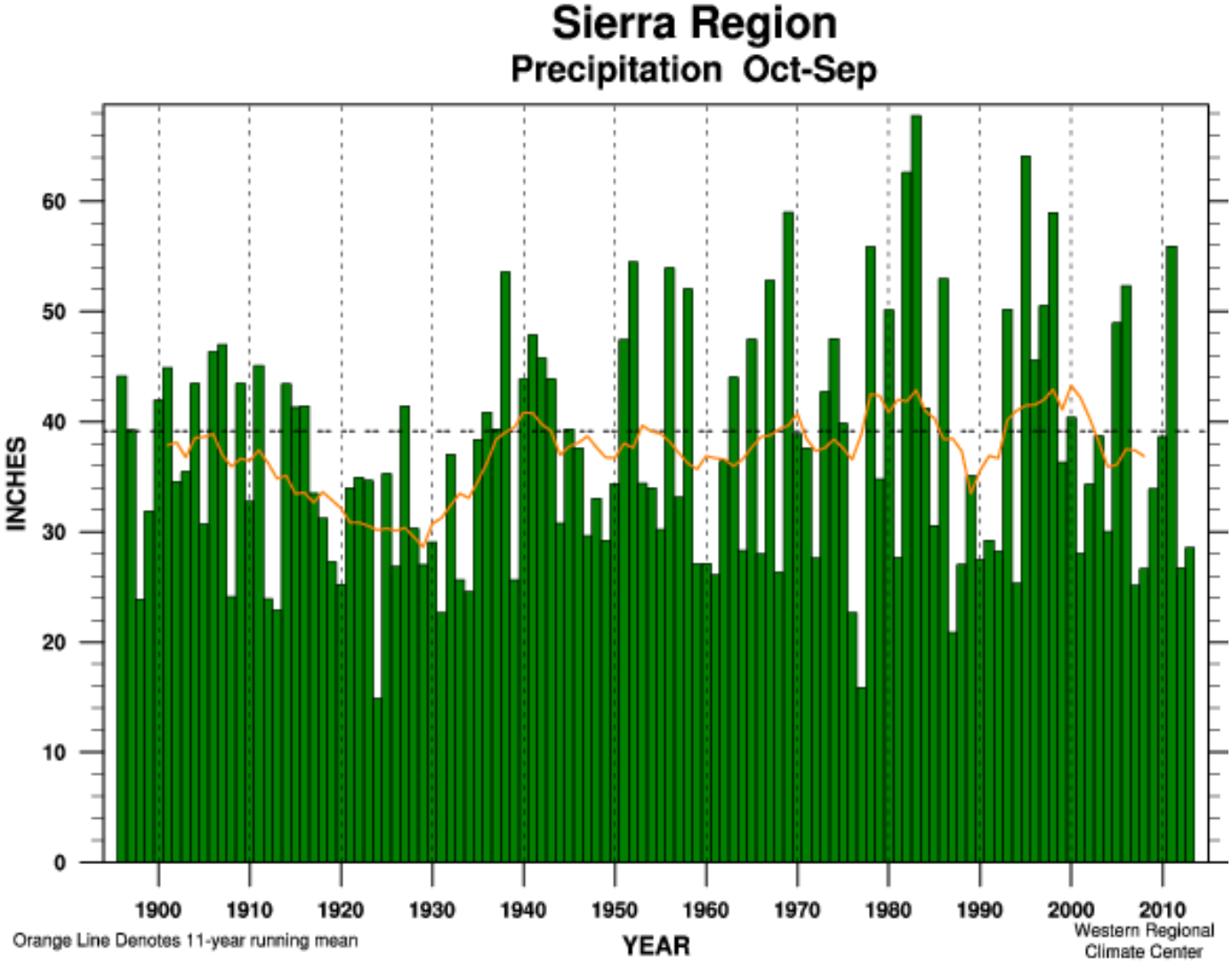
Precipitation Rank

since 1895

PRISM

Lowest 10 %

Record Driest



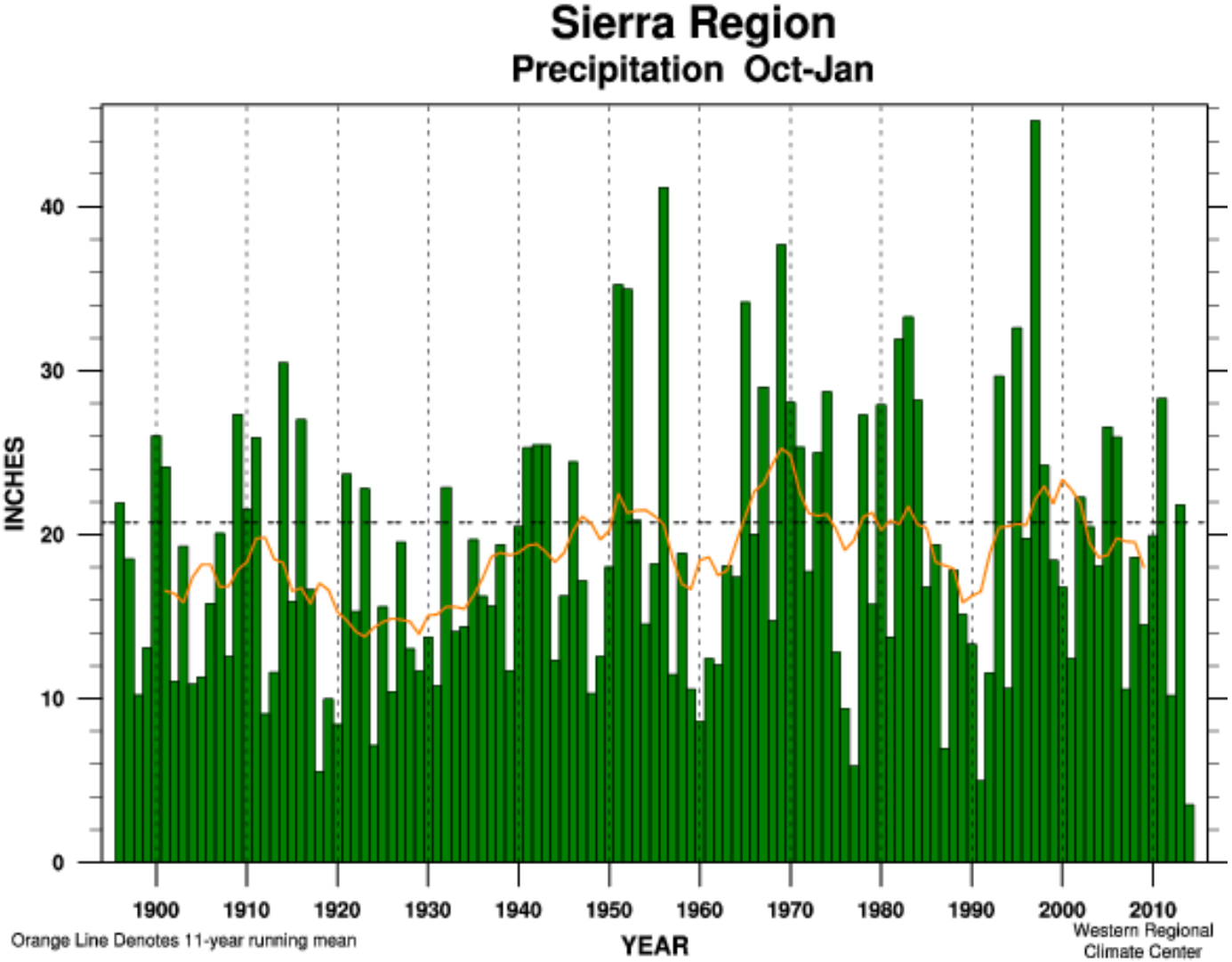
Linear Trend 1895-present		+ 4.11 ± 5.72 in.	(+ 10 ± 14%) per 100 yr		
Linear Trend 1949-present		- 1.37 ± 16.66 in.	(- 3 ± 42%) per 100 yr		
Linear Trend 1975-present		- 5.10 ± 41.09 in.	(- 13 ± 104%) per 100 yr		
Wettest Year		67.79 in. (173%)	in 1983	MEAN	39.15 in.
Driest Year		14.89 in. (38%)	in 1924	STDEV	12.33 in.
Oct-Sep	2013	28.55 in. (72%)		RANK	33 of 118

Sierra Nevada Precipitation

Water Year Oct - Sep

1895-96 thru 2012-13

California Climate Tracker



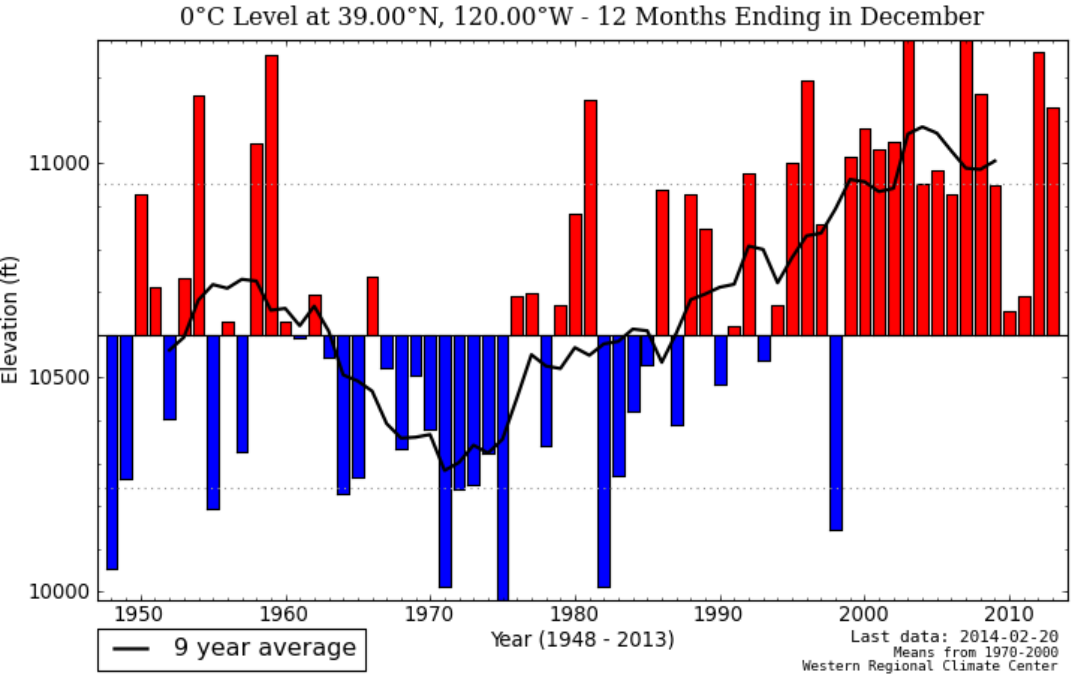
Linear Trend 1895-present		+ 3.15 ± 4.24 in.	(+ 15 ± 20%) per 100 yr		
Linear Trend 1949-present		- 6.03 ± 12.09 in.	(- 29 ± 58%) per 100 yr		
Linear Trend 1975-present		- 2.73 ± 26.37 in.	(- 13 ± 127%) per 100 yr		
Wettest Year		45.24 in. (217%)	in 1997	MEAN	20.75 in.
Driest Year		3.51 in. (16%)	in 2014	STDEV	9.23 in.
Oct-Jan	2014	3.51 in. (16%)		RANK	1 of 119

Sierra Nevada Precipitation

Oct - Jan

1895-96 thru 2013-14

California Climate Tracker



Sierra Nevada
Lake Tahoe

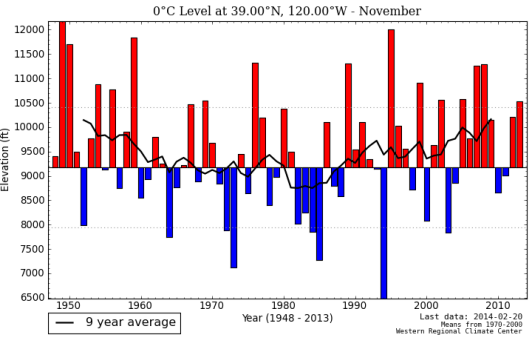
Freezing Level

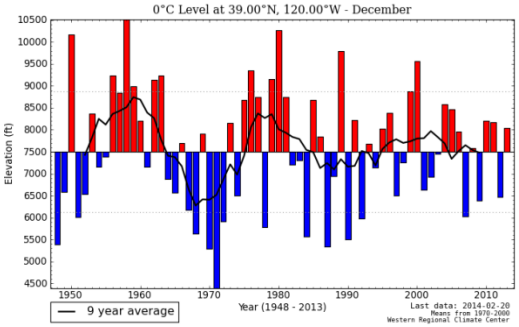
Annual

1948-2013

Annual
Water Year
Oct-Sep

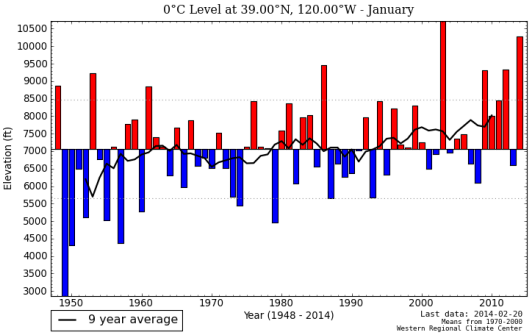
1948
thru
2014 Feb 20

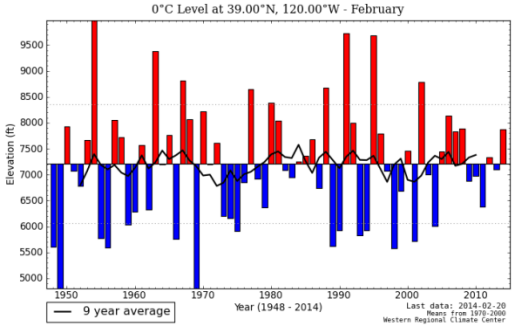




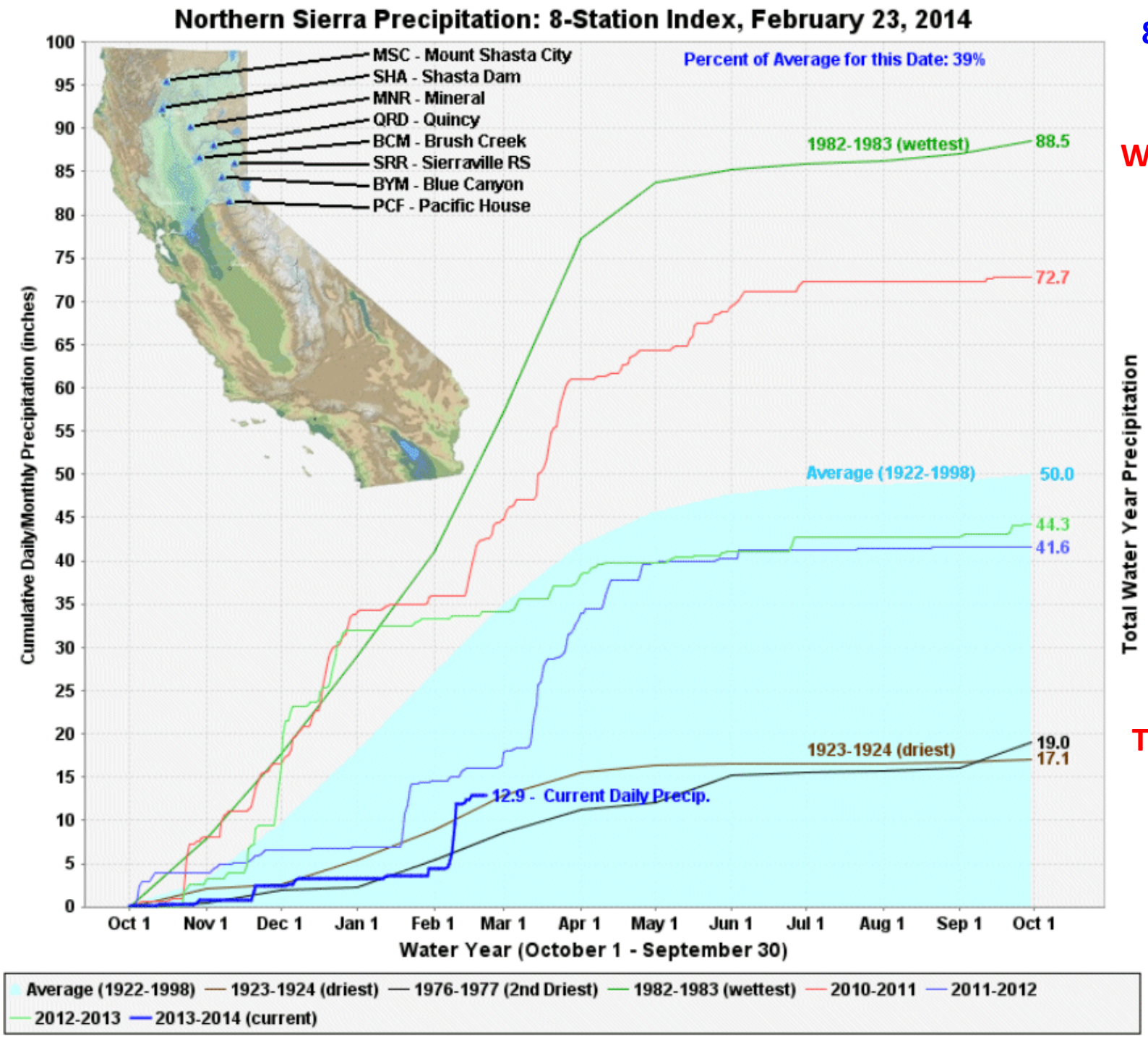
Nov Dec

WRCC
North America
Freezing Level
Tracker





Jan Feb



8-Station Index Precipitation

Wettest (1982-83)

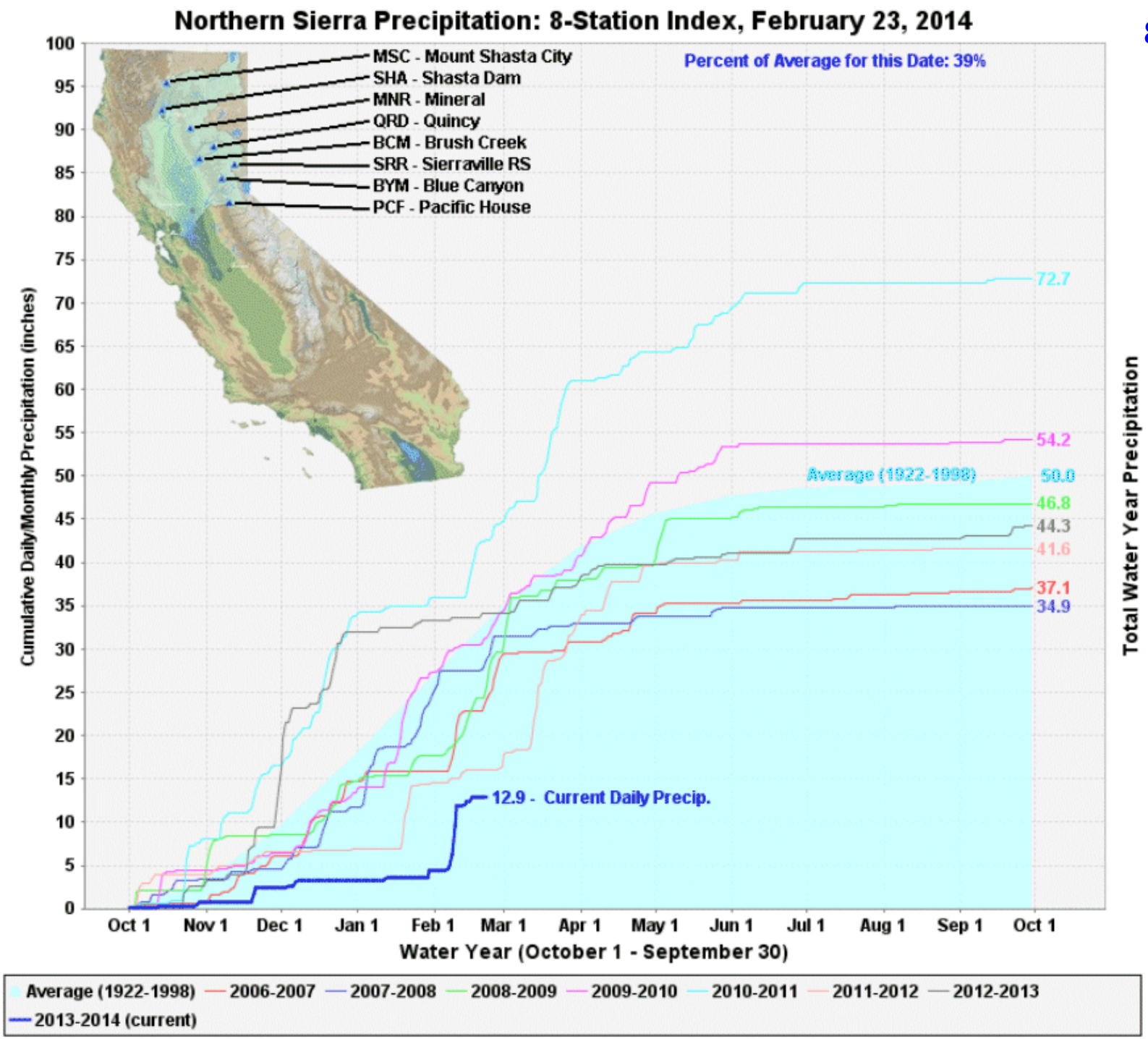
2010-11

2012-13
2011-12

Two driest years

Current year

CA - DWR



8-Station Index Precipitation

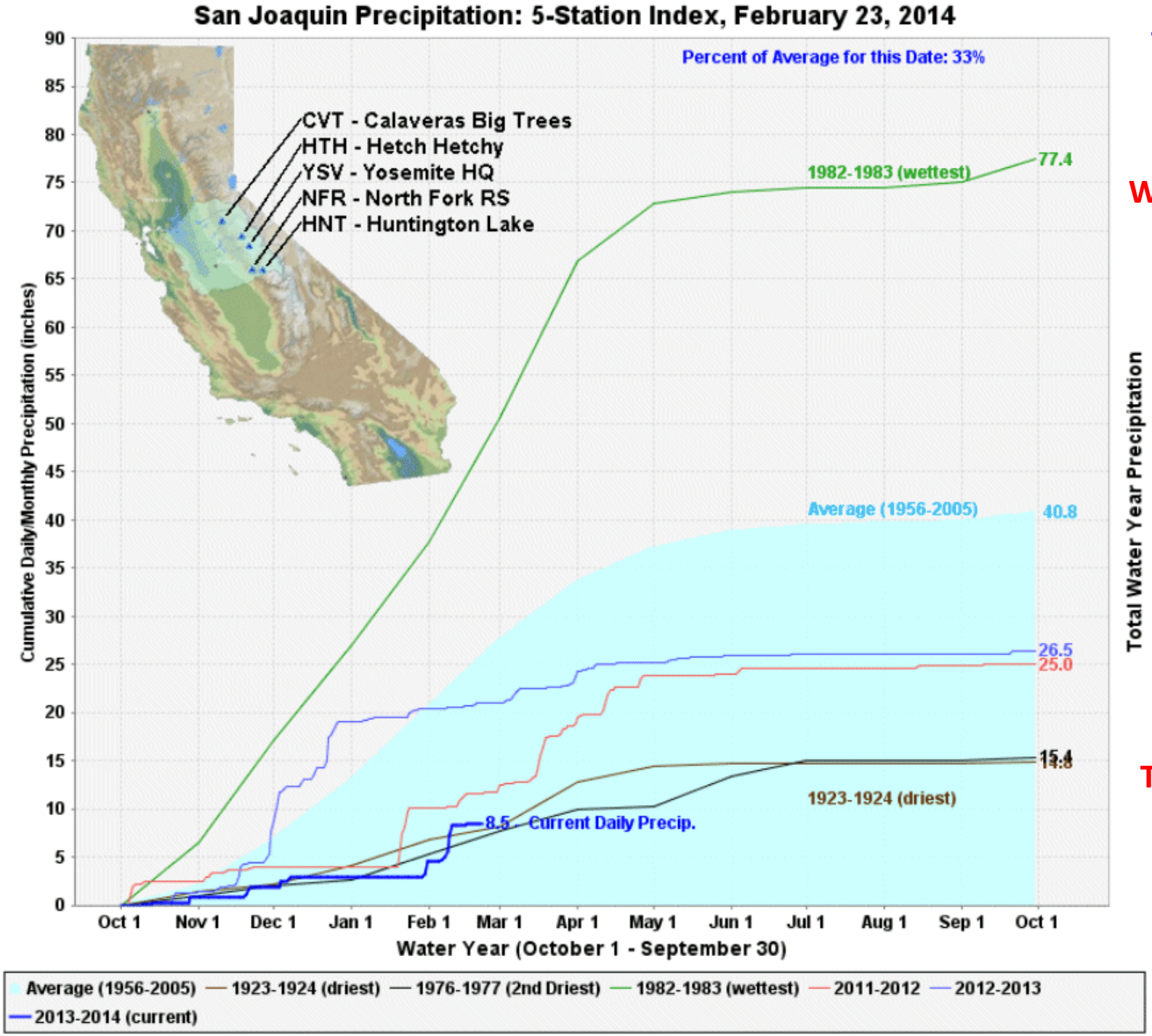
Since 2006-07

2010-11

2009-10
2008-09
2012-13
2011-12
2006-07
2007-08

Current year

CA - DWR



5-Station Index Precipitation

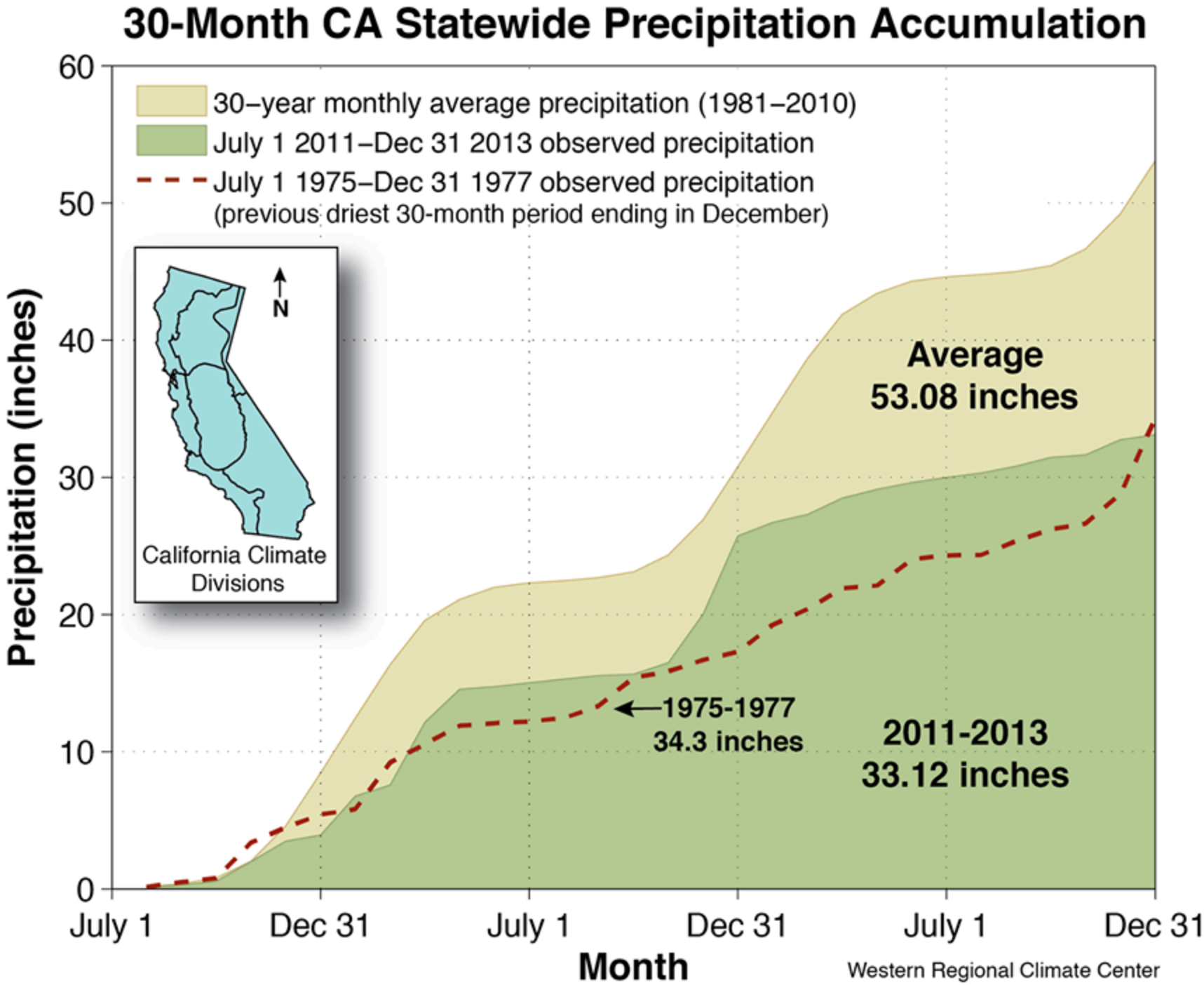
Wettest (1982-83)

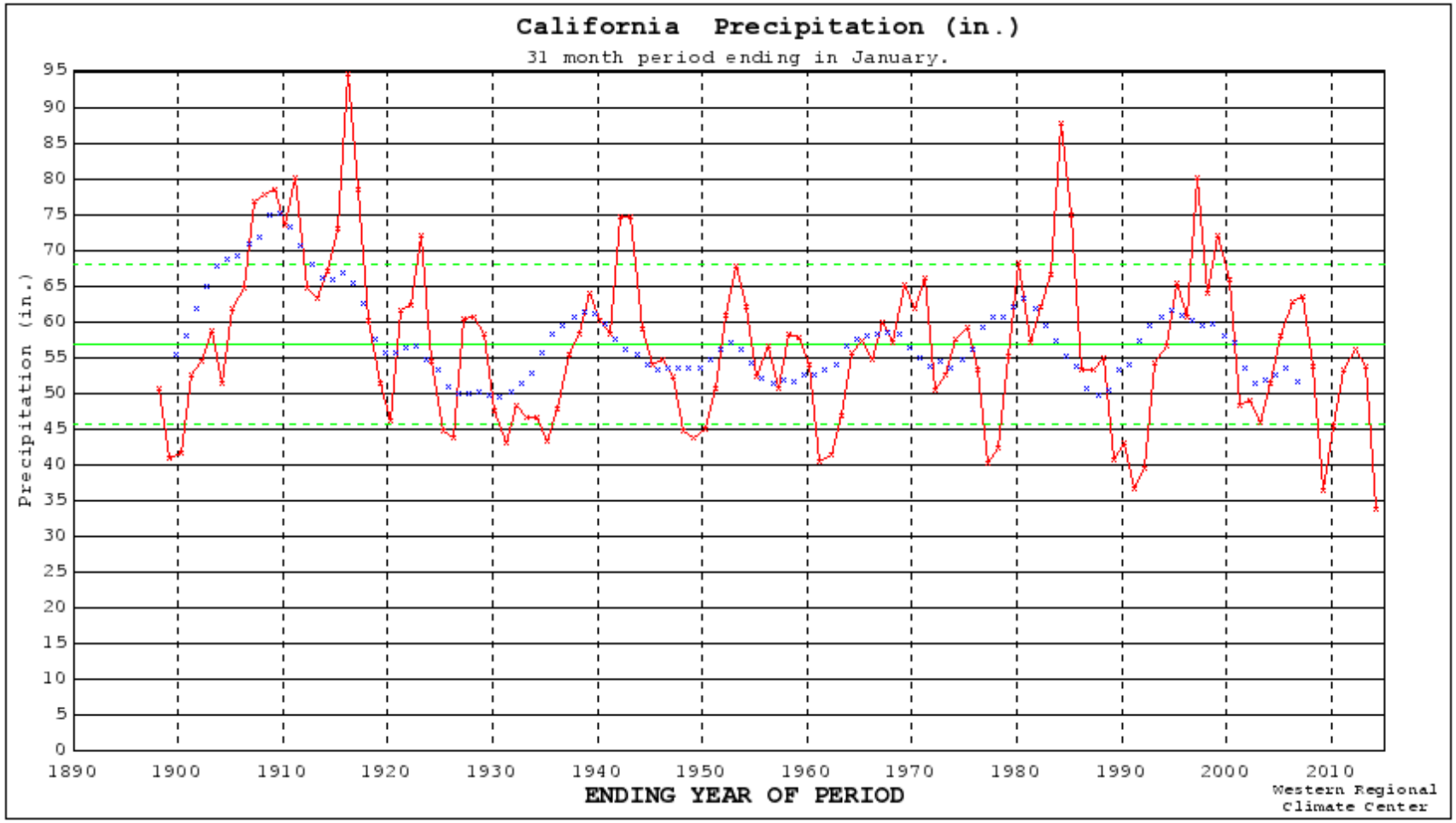
2012-13
2011-12

Two driest years

Current year

CA - DWR


30-Month CA Statewide Precipitation Accumulation
30–year monthly average precipitation (1981–2010)
July 1 2011–Dec 31 2013 observed precipitation
July 1 1975–Dec 31 1977 observed precipitation
(previous driest 30-month period ending in December)
N
California Climate Divisions
Average
53.08 inches
1975-1977
34.3 inches
2011-2013
33.12 inches
Precipitation (inches)
0
10
20
30
40
50
60
July 1
Dec 31
July 1
Dec 31
July 1
Dec 31
Month
Western Regional Climate Center



red - 31 month period
blue - 10 year running mean
green - average (solid), ± sigma (dashed)

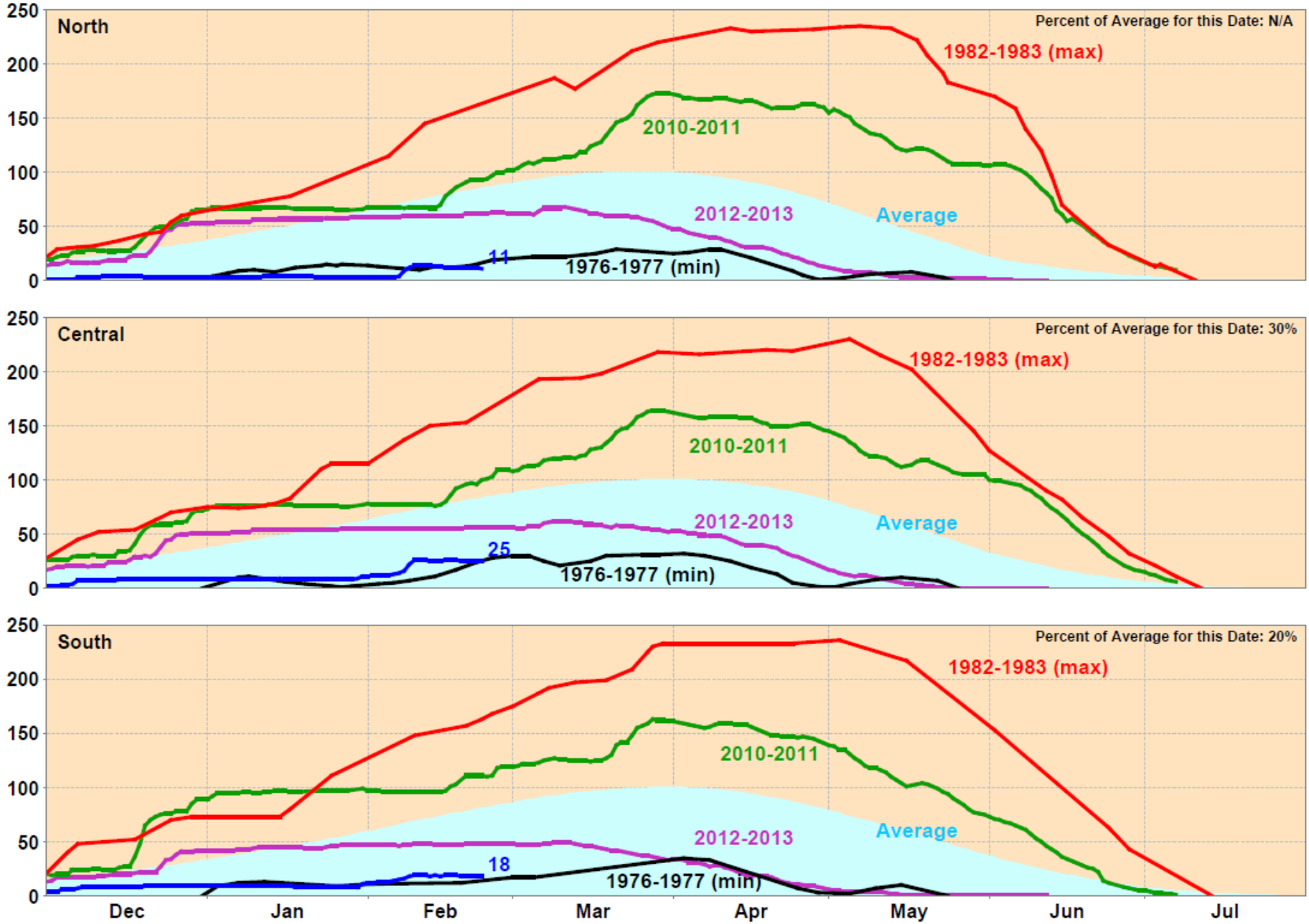
```
Total Precipitation          31-Month Period Ending in Month  1
   YEARS : 1890 - 2015
  AVERAGE            56.837
  SIGMA (RMS)        11.237
  COEFF OF VAR        0.198
  SKEWNESS            0.574
  MEDIAN             56.120
  MAXIMUM VALUE      94.550
  MINIMUM VALUE      33.690
  NUMBER OBS           117.
```

California Statewide Precipitation
31-month period thru Jan
1895-98 thru 2011-14

Blue is 10-year running mean

From NOAA Divisional Data

California Snow Water Content, February 23, 2014, Percent of April 1 Average

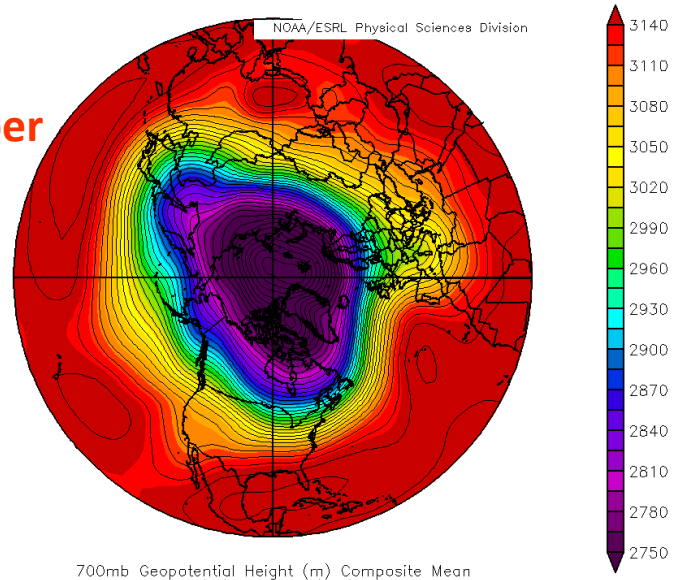


Statewide Percent of April 1: 20%

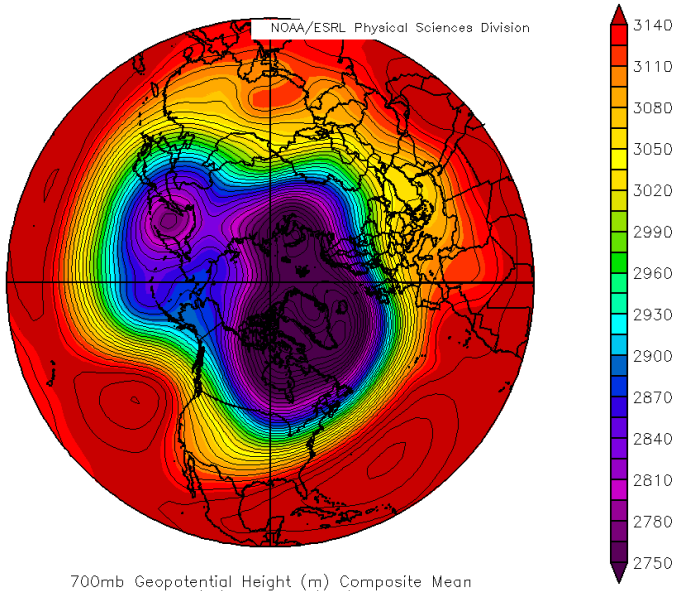
Statewide Percent of Average for Date: 25%

2013-2014 700 mb Pattern (~10,000 feet)

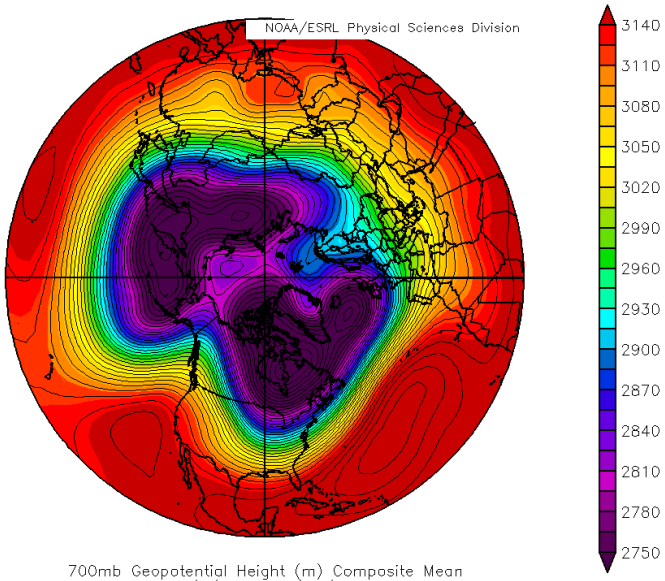
November 2013



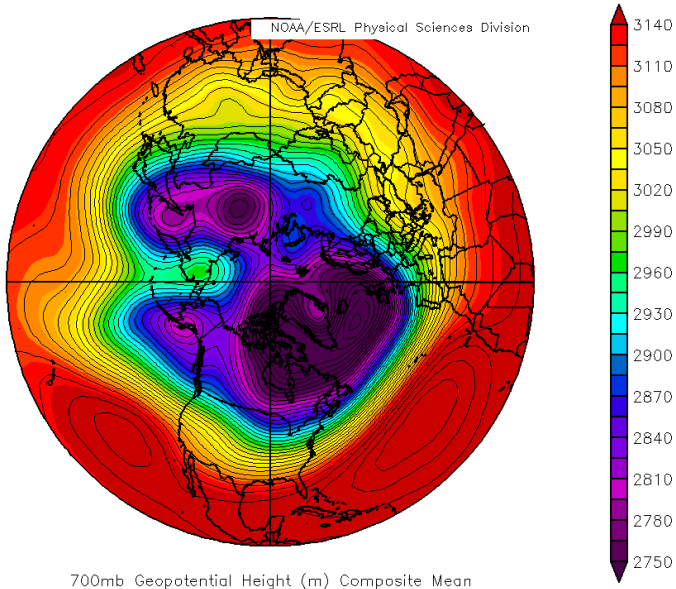
December 2013



January 2014

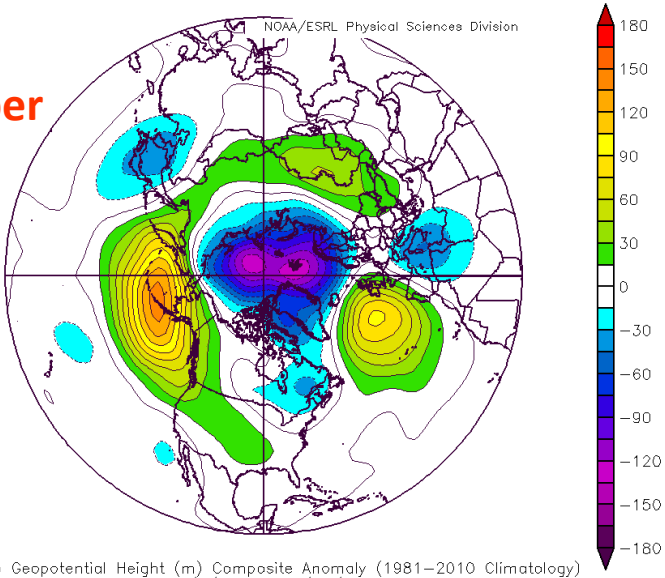


February 2014 (thru 21st)



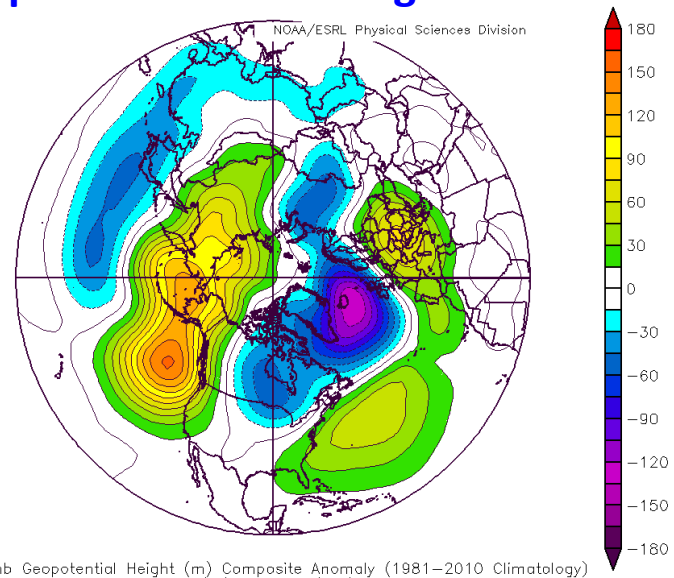
2013-2014 700 mb Pattern (~10,000 feet) Departure from Average

November 2013



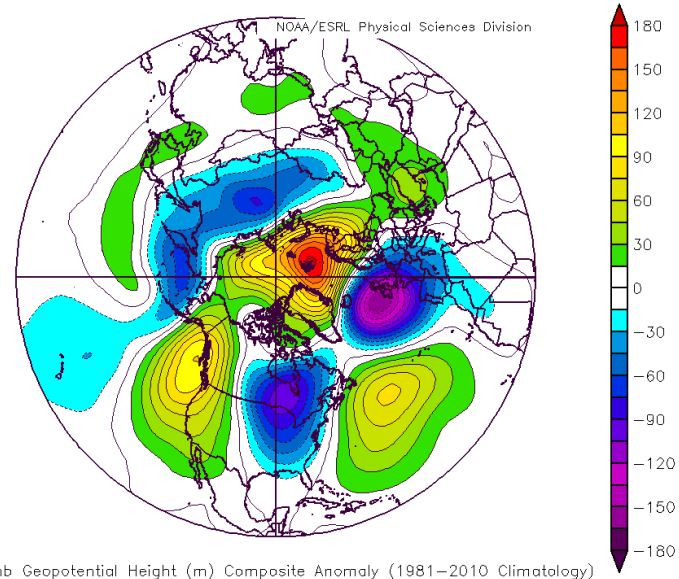
700mb Geopotential Height (m) Composite Anomaly (1981–2010 Climatology)
11/1/13 to 11/30/13
NCEP/NCAR Reanalysis

December 2013



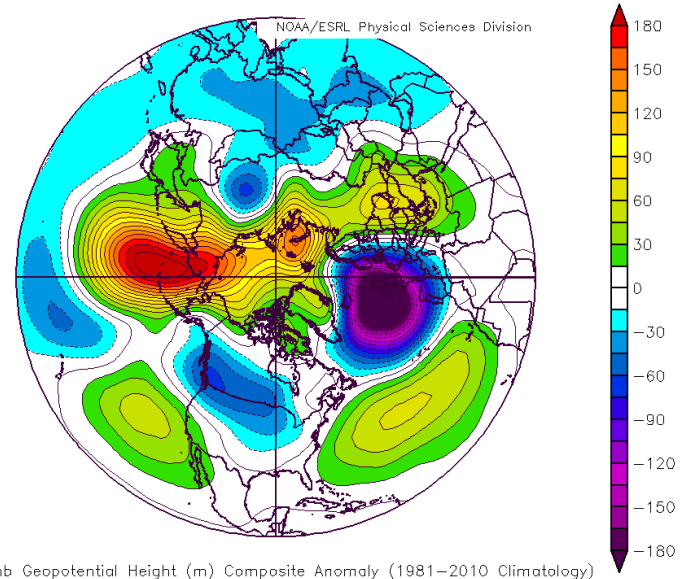
700mb Geopotential Height (m) Composite Anomaly (1981–2010 Climatology)
12/1/13 to 12/31/13
NCEP/NCAR Reanalysis

January 2014



700mb Geopotential Height (m) Composite Anomaly (1981–2010 Climatology)
1/1/14 to 1/31/14
NCEP/NCAR Reanalysis

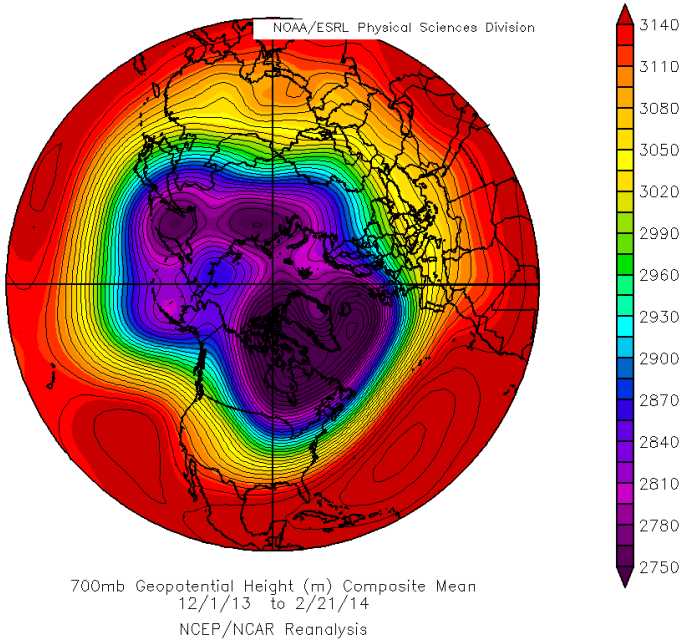
February 2014 (thru 21st)



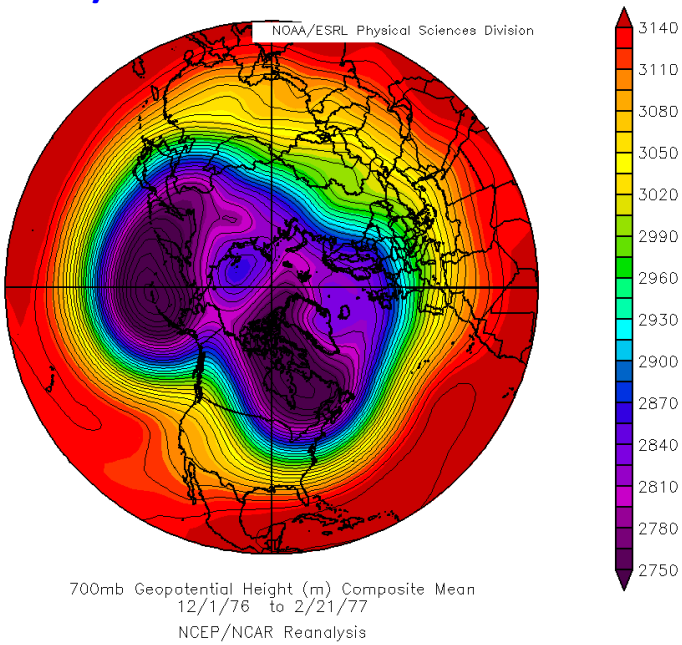
700mb Geopotential Height (m) Composite Anomaly (1981–2010 Climatology)
2/1/14 to 2/21/14
NCEP/NCAR Reanalysis

A Tale of Two Winters. 700 mb Pattern (~10,000 feet) 2013-14 vs 1976-77

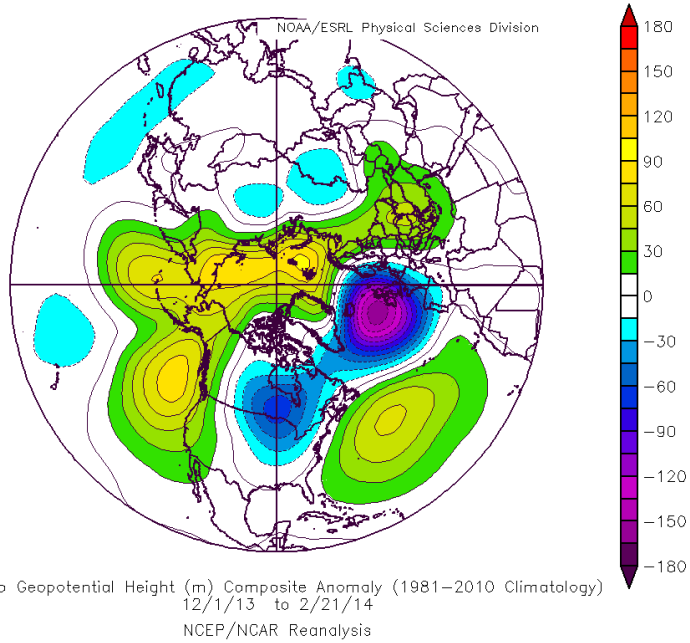
Dec 2013 thru Feb 2014 (21st) Full Pattern



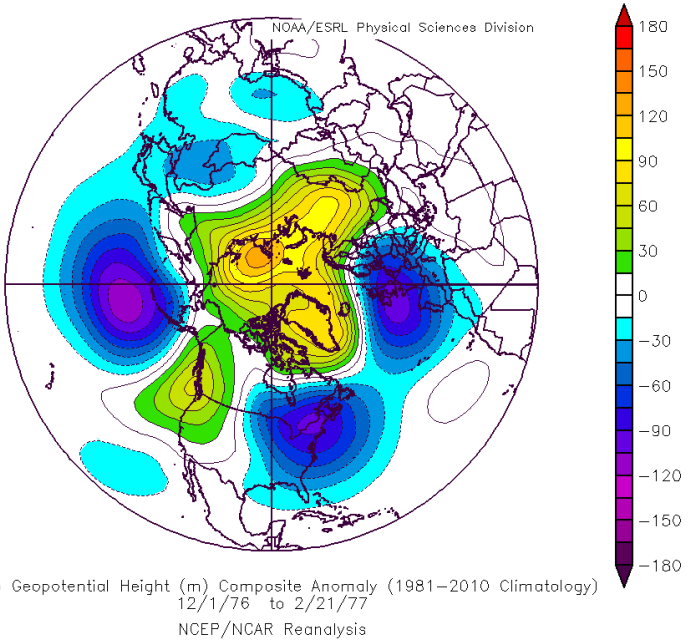
Dec 1976 thru Feb 1977 (21st) Full Pattern

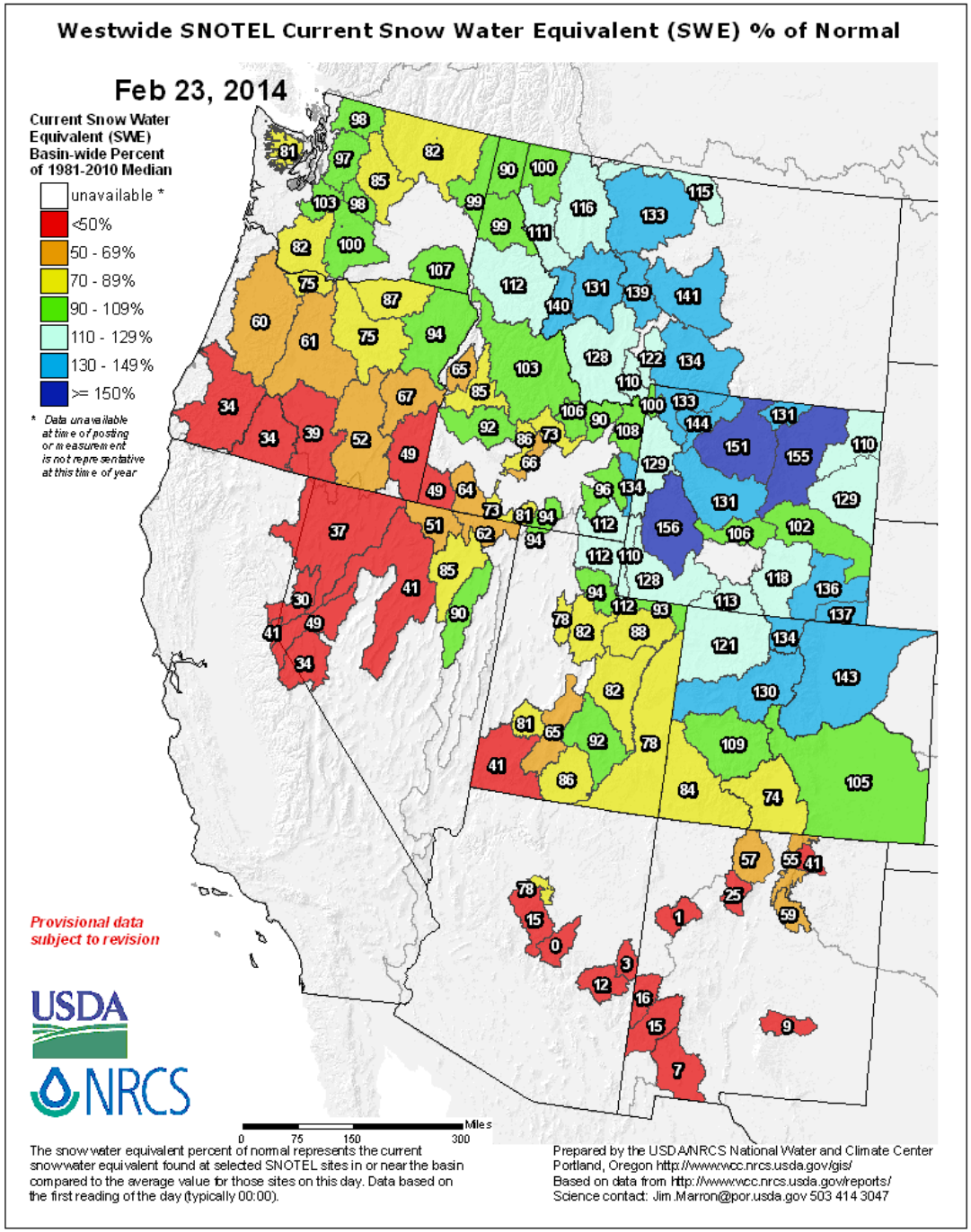


Dec 2013 thru Feb 2014 (21st) Departure From Average



Dec 1976 thru Feb 1977 (21st) Departure From Average



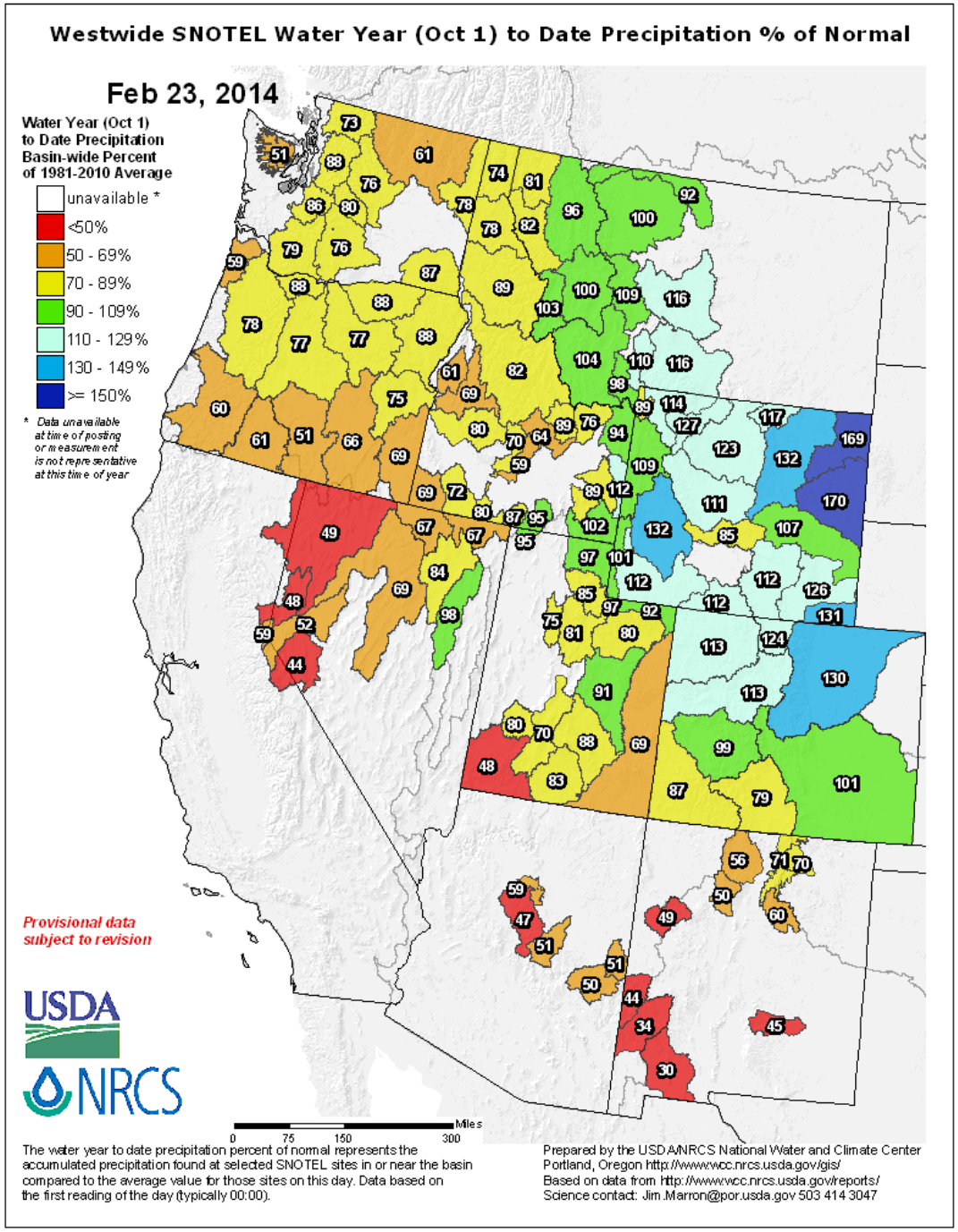


NRCS - Snotel Stations

Snow Water Content

Percent of Average

2014 February 23

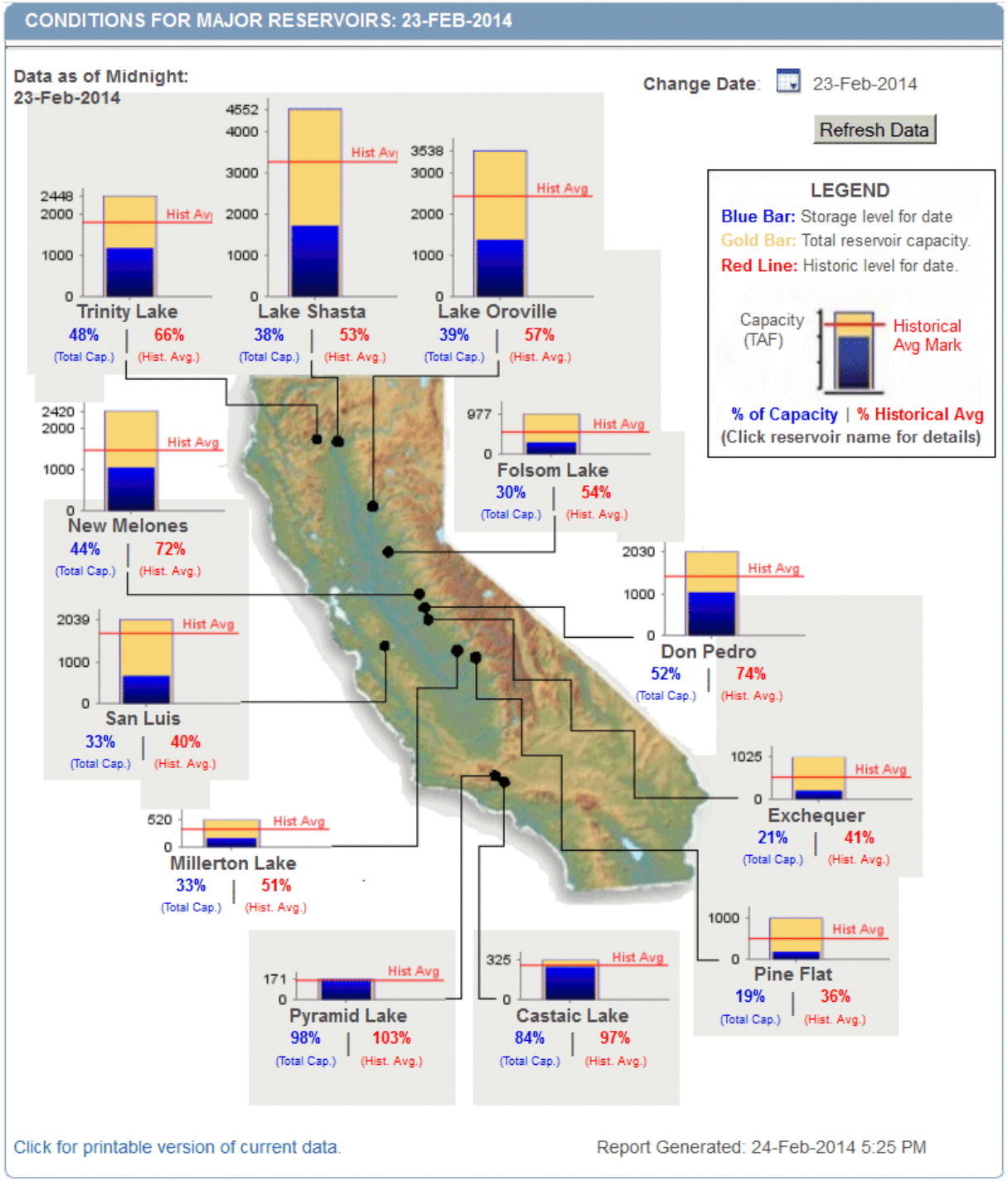


NRCS - Snotel Stations

Precipitation
Water Year to Date
Since
2013 October 01

Percent of Average

2014 February 23



Major Reservoir Status

2014 February 23

With respect to

Today's average

Capacity

CA DWR

Daily Drought Information Summary (02/24/2014)

Report generated: 02/24/2014 13:05

Reservoir Storage as of 02/23/2014 at midnight

Reservoir	River	Storage (in Acre Feet)	% of Capacity	% Average	Storage Year Ago This Date	% of Capacity Year Ago This Date	% Average
Trinity Lake	Trinity	1,180,196	48	66	1,981,350	81	110
Shasta Lake	Sacramento	1,730,766	38	53	3,589,145	79	109
Lake Oroville	Feather	1,388,506	39	57	2,826,095	80	116
New Bullards Bar Res	Yuba	471,479	49	76	779,282	81	126
Folsom Lake	American	290,077	30	54	559,077	57	104
New Melones Res	Stanislaus	1,057,926	44	72	1,607,279	66	110
Don Pedro Res	Tuolumne	1,055,208	52	74	1,398,696	69	98
Lake McClure	Merced	213,924	21	41	452,793	44	86
Millerton Lake	San Joaquin	172,068	33	51	325,694	63	96
Pine Flat Res	Kings	185,805	19	36	319,540	32	62
Isabella	Kern	59,340	10	33	82,482	15	45
San Luis Res	(Offstream)	678,066	33	40	1,201,459	59	70

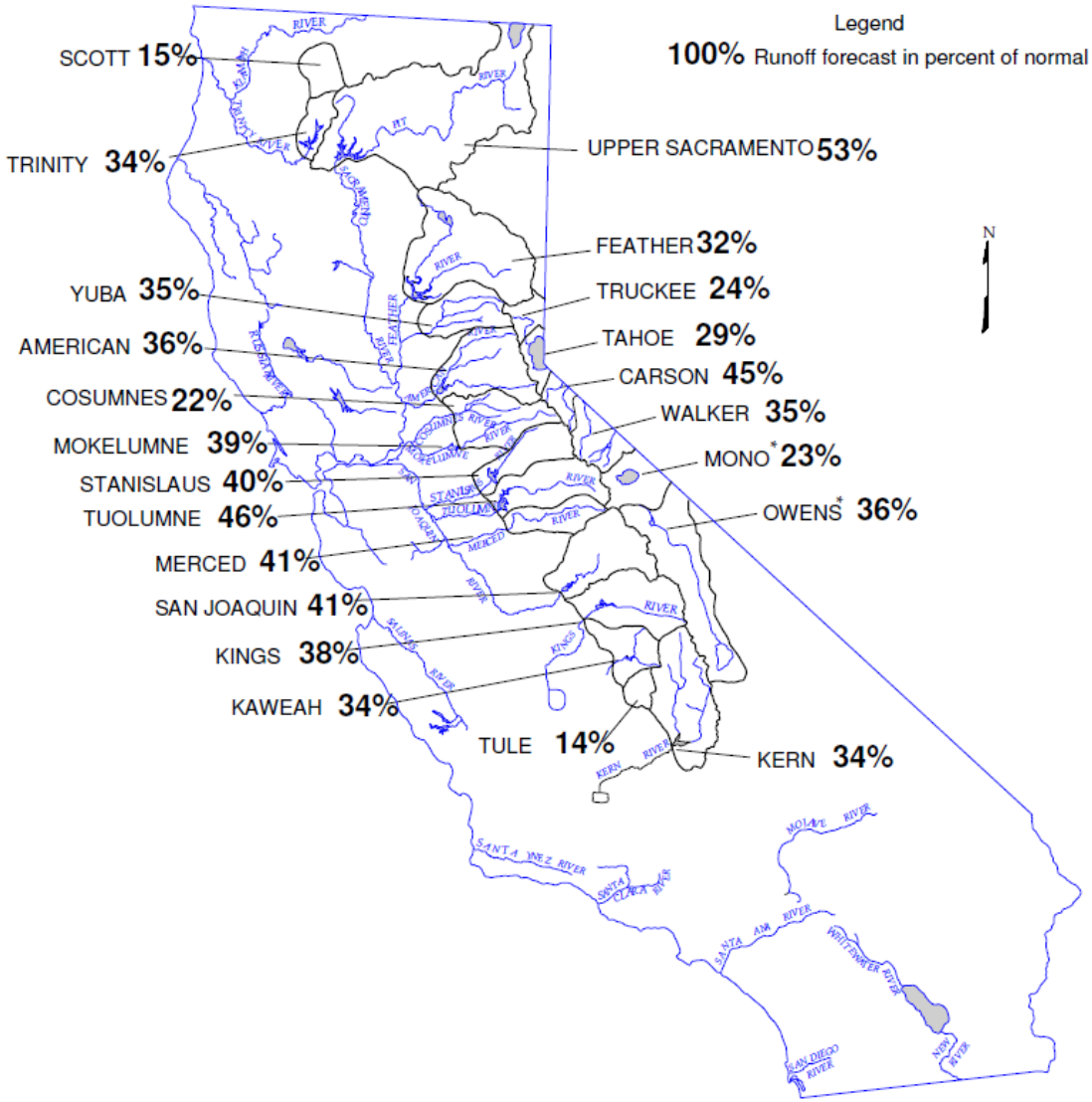
Snowpack Water Content as of 02/24/2014

Region	Water Content (in inches)	% Average to Date	% of Apr 1 Average	Water Content (in inches) Last Year This Date	% Average Last Year This Date
Northern Sierra	3.20	13	11	17.50	72
Central Sierra	7.60	30	25	17.30	67
Southern Sierra	4.40	21	17	12.10	59
Statewide	5.50	23	19	15.80	67

Precipitation Index Accumulation as of 02/24/2014

Index	Season to Date	% of Average	Season to Date Last Year	% of Average Last Year
Northern Sierra	12.90	38	34.10	101
Southern Sierra	8.51	32	21.04	79

DEPARTMENT OF WATER RESOURCES
CALIFORNIA COOPERATIVE SNOW SURVEYS
FORECAST OF APRIL – JULY
UNIMPAIRED SNOWMELT RUNOFF
February 1, 2014



* FORECAST BY DEPARTMENT OF WATER AND POWER, CITY OF LOS ANGLES

Water Supply Forecasts

April through July

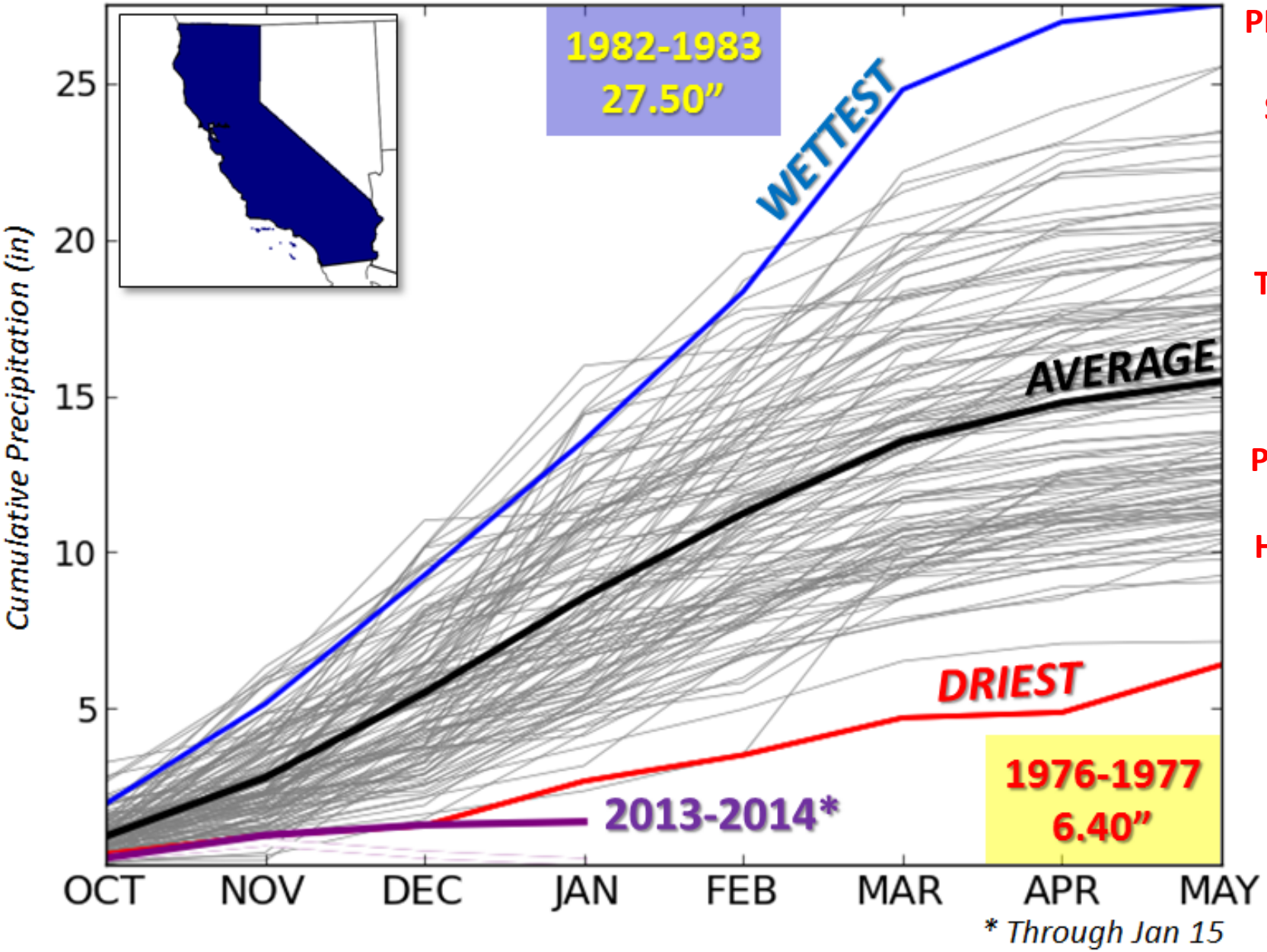
Issued 2014 Feb 1

1000 acres of almonds removed for lack of water. Firebaugh CA. 2014 February 25.

Barry Baker, Baker Farming. NBC News .

Water Year Precipitation in California

1895-96 through 2013-14



PRISM-based

Statewide Spatial Average

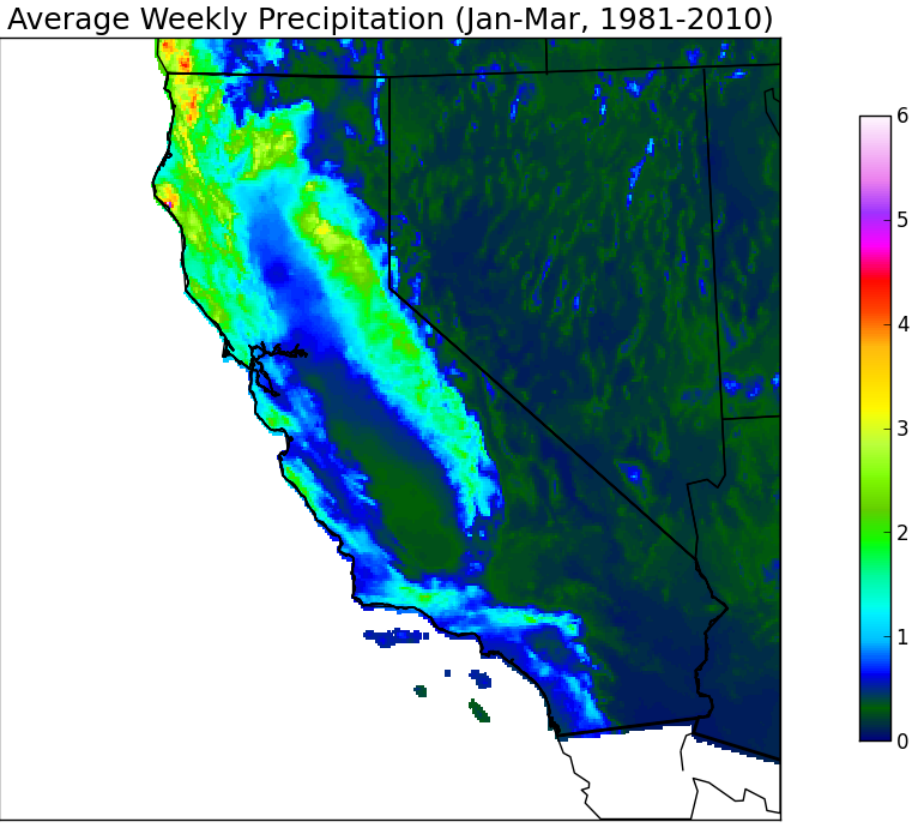
Thru Jan 15

Graphic courtesy Paul Iniguez NWS Hanford CA

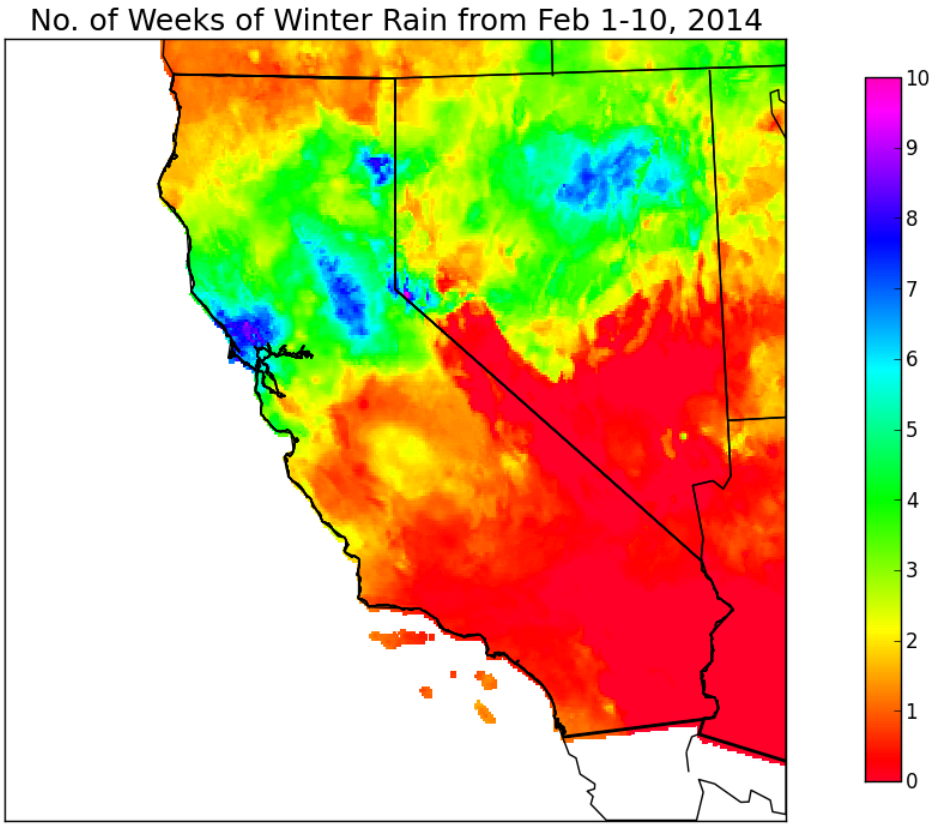
```
Correlations:
Feb-Mar: 0.14
Feb-Apr: 0.02
Feb-May: 0.07
Mar-Apr: 0.14
Mar-May: 0.01
Apr-May: 0.05
```

Spatial extent and effect of early February 2014 Atmospheric River Event

Average Weekly Precipitation (inches)
Based on PRISM Climatology
Jan-Mar 1981-2010

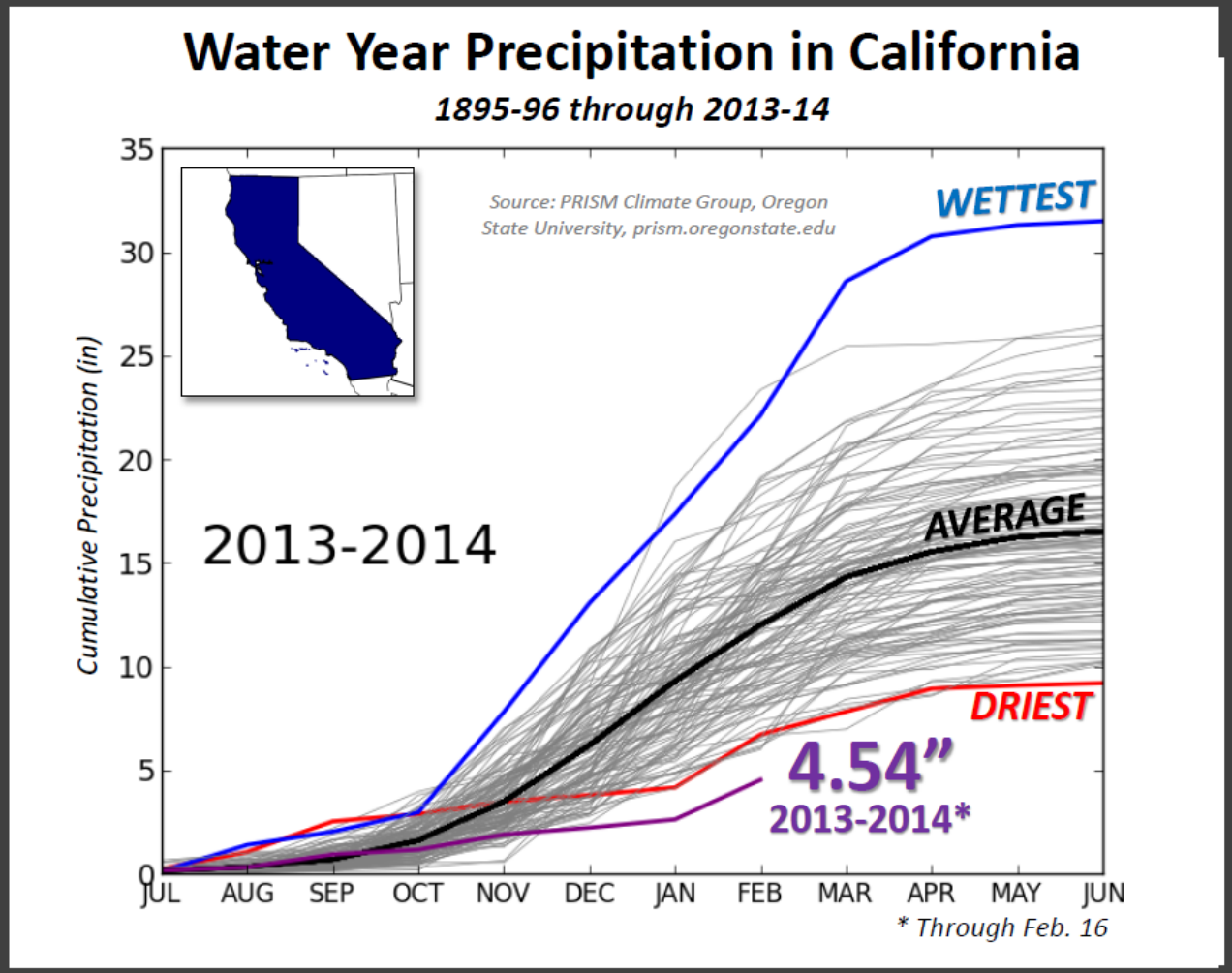


Precipitation totals up to 20 inches
How many weeks of typical Jan-Mar precipitation did this represent ?



Graphics courtesy of
Paul Iniguez
NWS Hanford CA

Water Year 2013-2014 Accumulation



PRISM-based

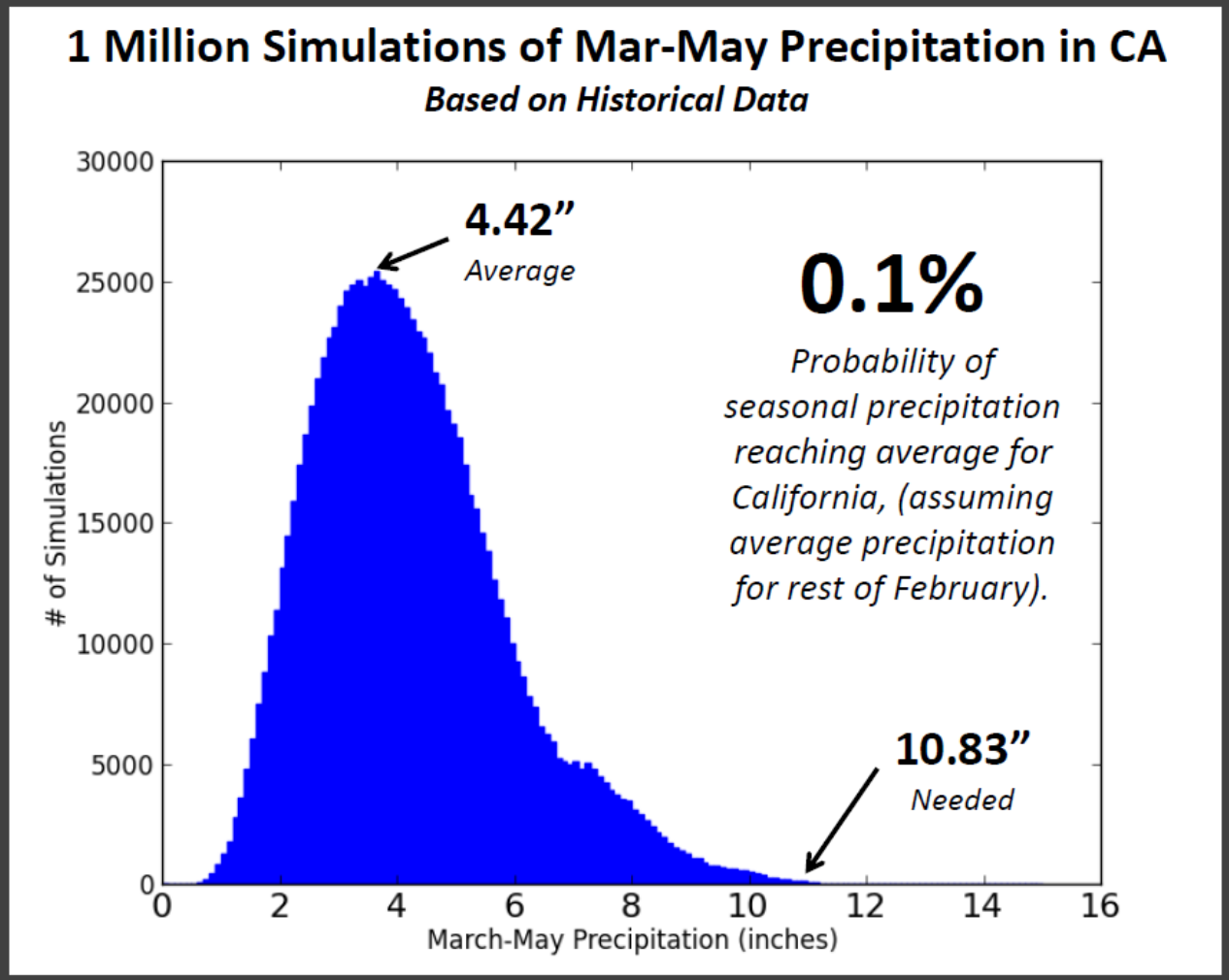
Statewide Spatial Average

Thru Feb 16

after recent Atmospheric River Event

Graphic courtesy Paul Iniguez NWS Hanford CA

Is "average" possible this year in CA?



PRISM-based

Statewide Spatial Average

Monte Carlo Precipitation Estimate: Remainder of Winter Feb-May knowing Oct-Feb 15

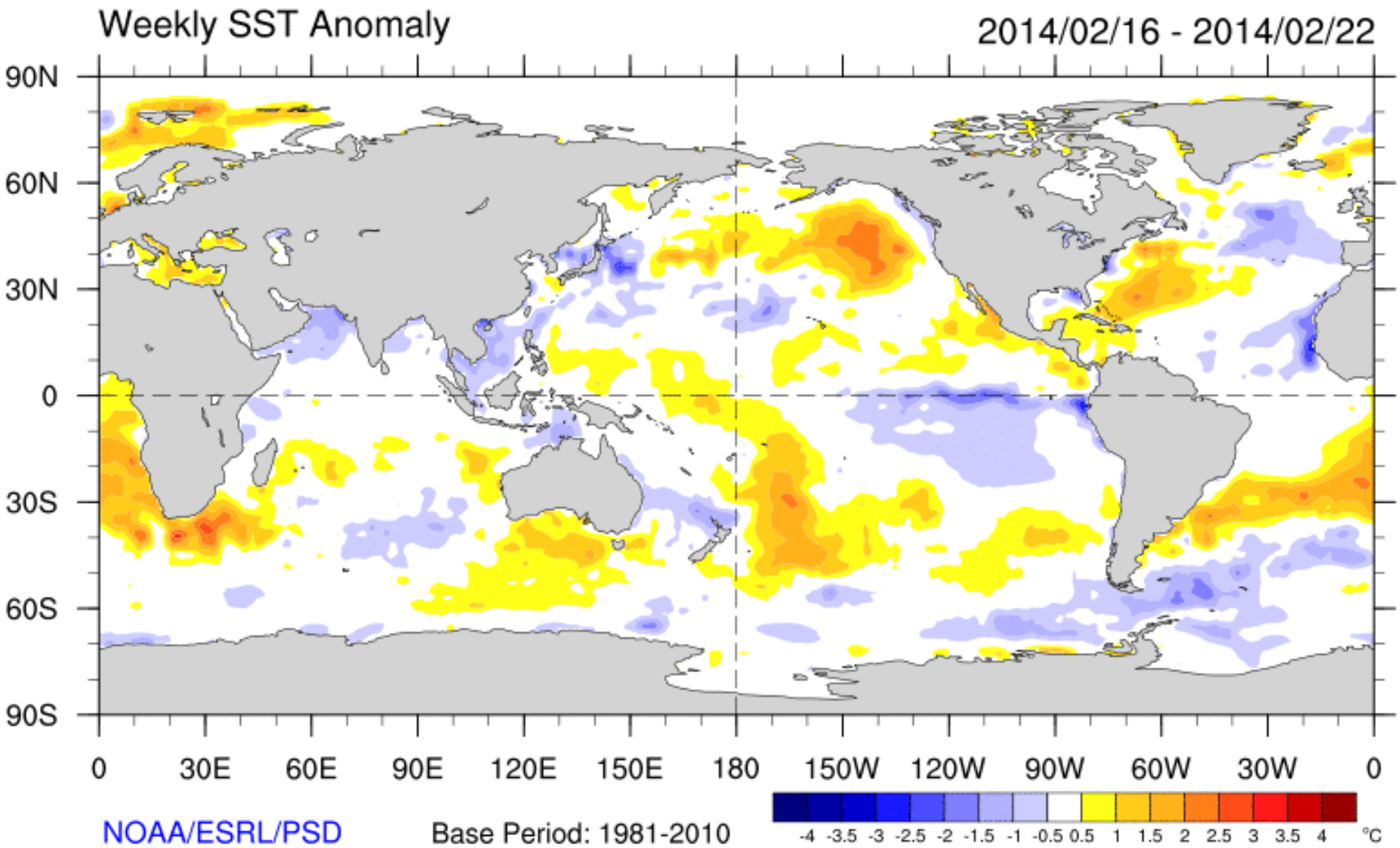
One Million Simulations

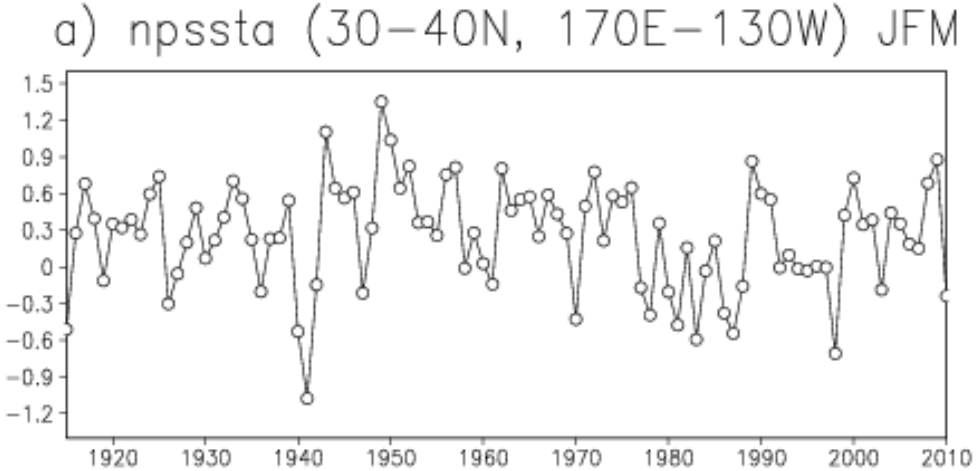
Graphic courtesy Paul Iniguez NWS Hanford CA

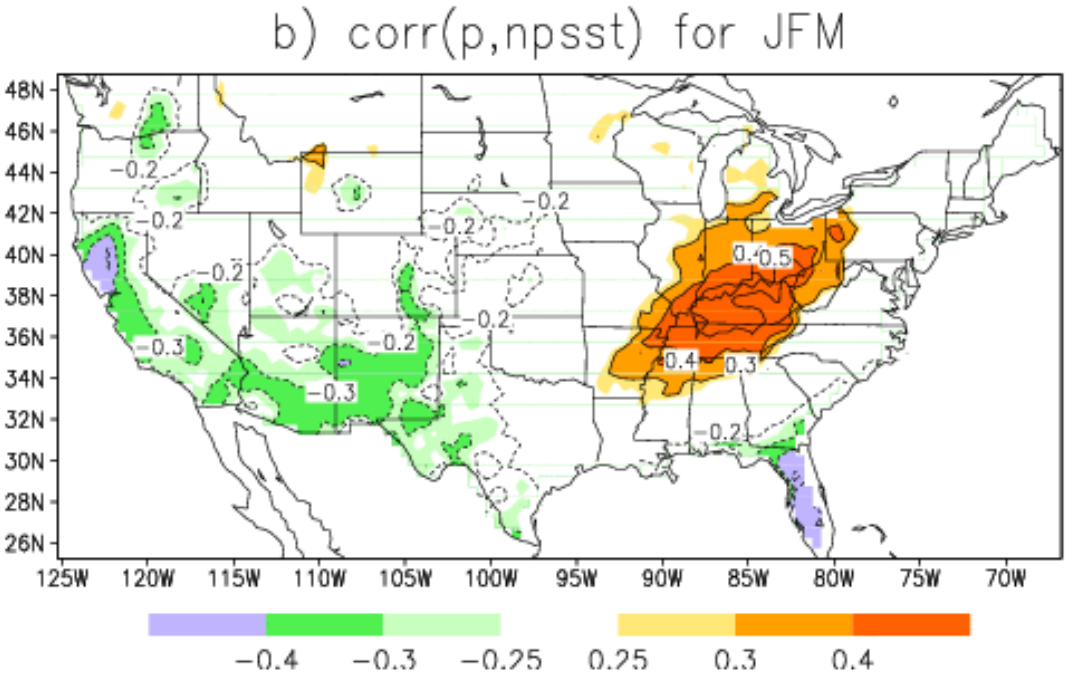
? Why Dry ?

Not a lot to go on.

Ocean Departures from Average Temperature (C) 16-22 Feb 2014







North Pacific Ocean Temperature and relation to West Coast Late Winter Precipitation (Jan-Feb-Mar)

SST source: ERSST
Precipitation: U Washington
0.5 degree grid
1915-2010

P<0.05 if r > 0.2

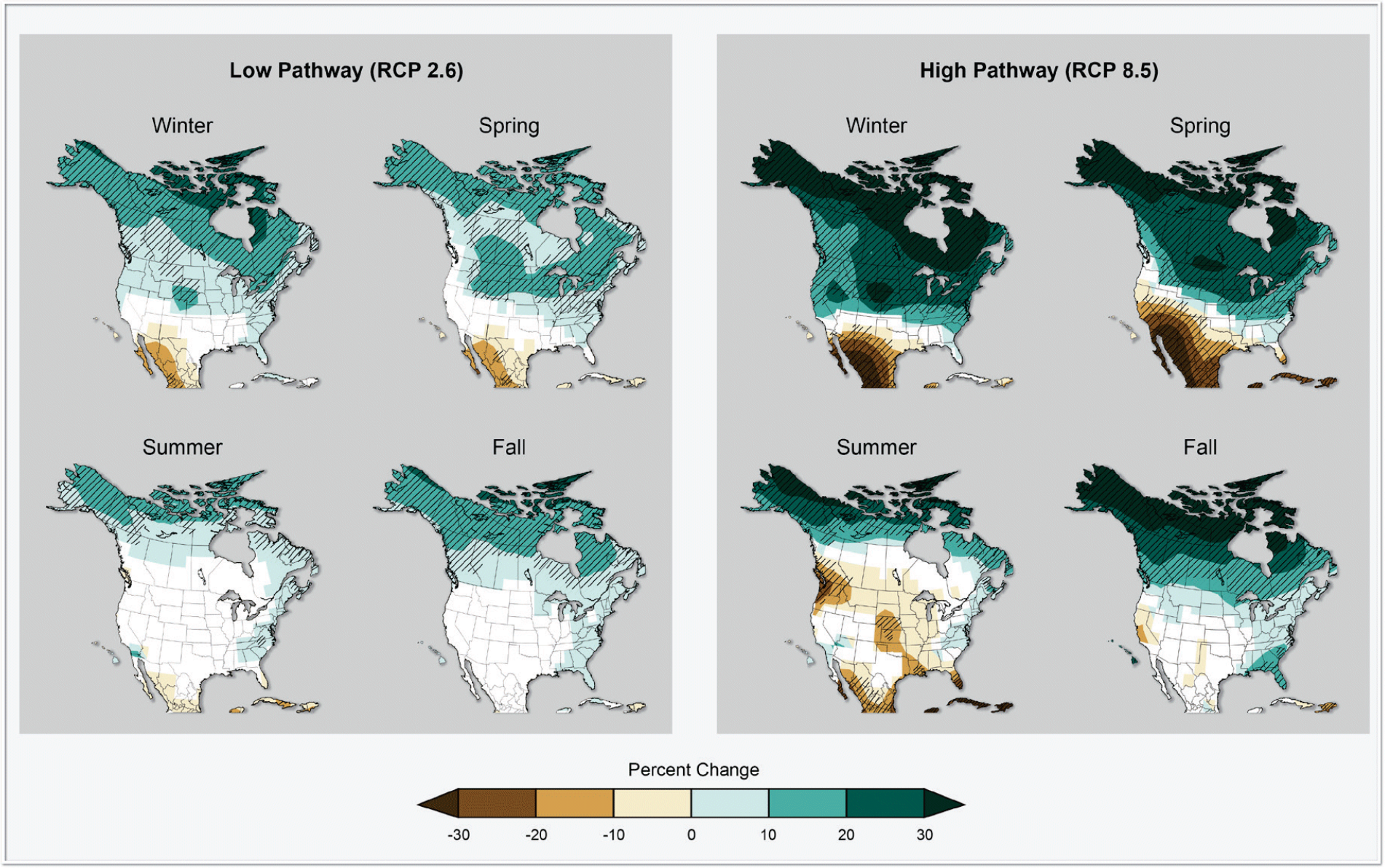
Warm Ocean Temperatures correlate with Jan-Feb-Mar dryness in CA and Southwest

courtesy
Kingtse Mo
Climate Prediction Center

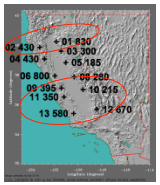
CMIP 5 Models. Seasonal Precipitation.

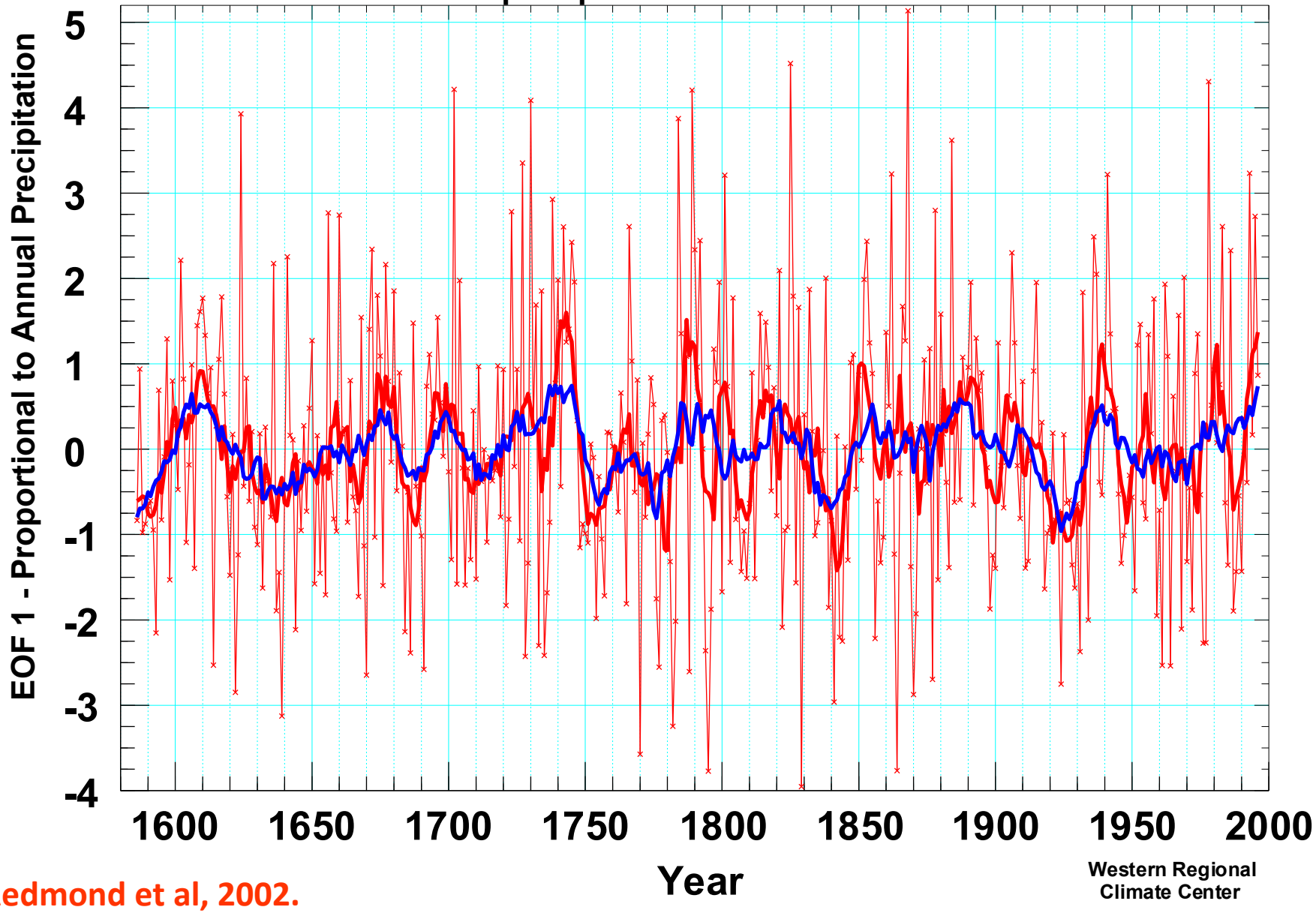
2070 - 2099 / 1901 - 1960.

Small increase. Greenhouse Gasses. Large increase.



California Blue Oak EOF1 of Tree-ring Chronologies. 47.9 %
Run C, 5 sites (1,2,11,12,13) from 1586-1996.
Running Mean: Red - 7 Years, Blue - 15 Years.
Correlation with annual precip = 0.86. Data: Dave Stahle.





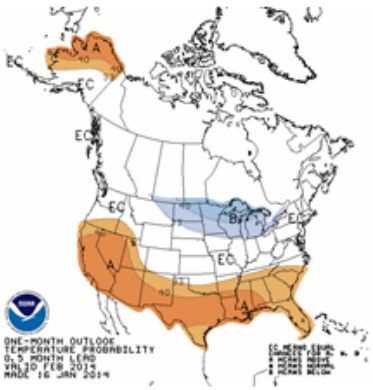
Western Regional Climate Center

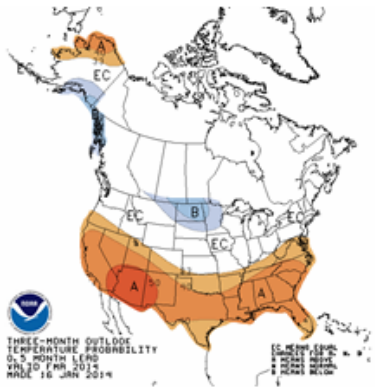
Redmond et al, 2002.

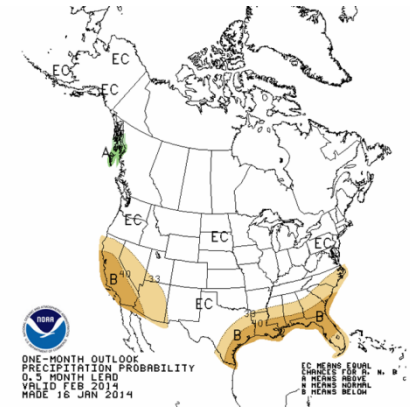
Temperature & Precipitation
Official Outlooks

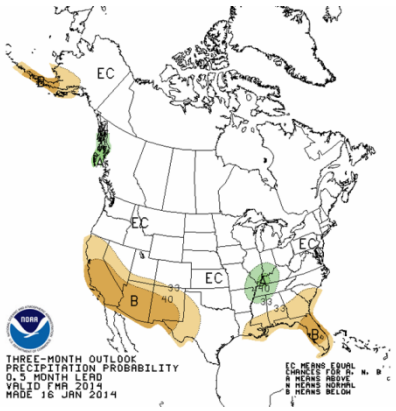
Temperature 2014 Precipitation

February **Feb-Mar-Apr** **February** **Feb-Mar-Apr**









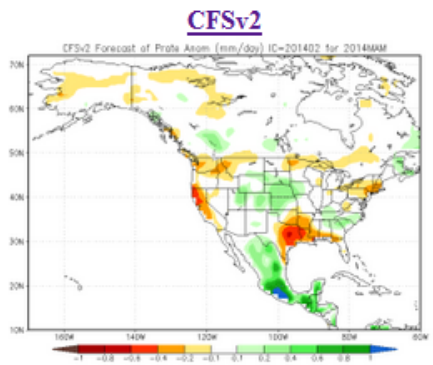
Orange / Red - Higher likelihood of drier than usual
Green - Higher likelihood of wetter than usual

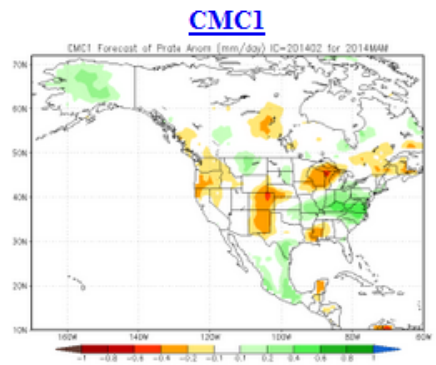
NOAA Climate Prediction Center

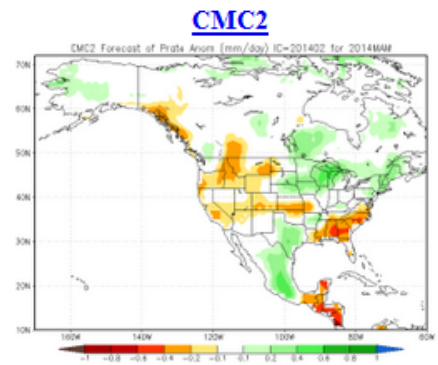
Six experiments in near-term climate forecasting Mar-Apr-May 2014. Precipitation.

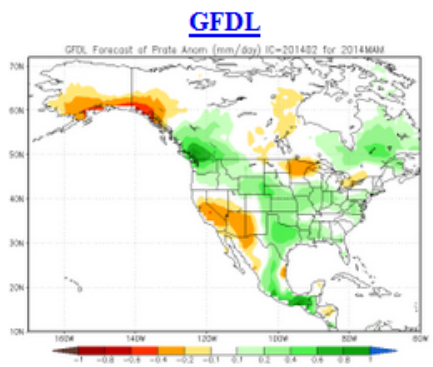
NMME (National Multi-Model Ensemble).

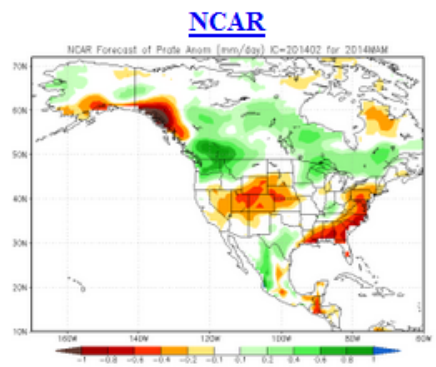
IMME (International Multi-Model Ensemble).

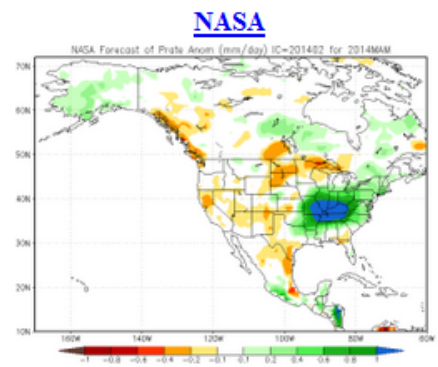


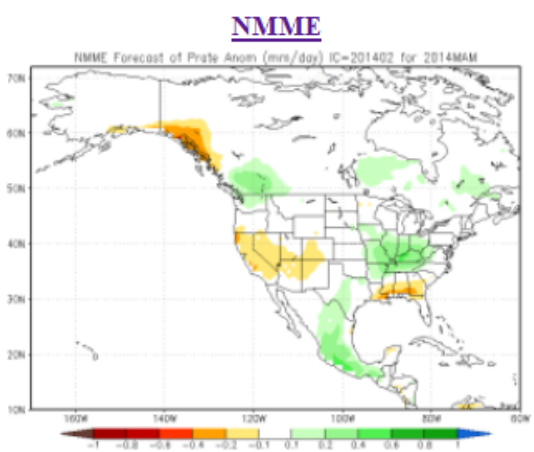


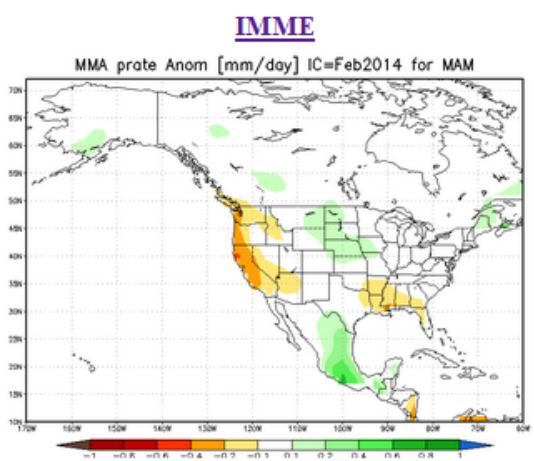












Dynamical Models

CFSv2: US Climate Forecasting System version 2

CMC1: Canadian Meteorological Center version 1

CMC2: Canadian Meteorological Center version 2

GFDL: US Geophysical Fluid Dynamics Laboratory

NCAR: US National Center for Atmospheric Research

NASA: US National Aeronautics and Space Administration

NMME: National Multi-Model Ensemble

IMME: International Multi-Model Ensemble

2014 Feb 12

Six experiments in near-term climate forecasting Mar-Apr-May 2014. Temperature.

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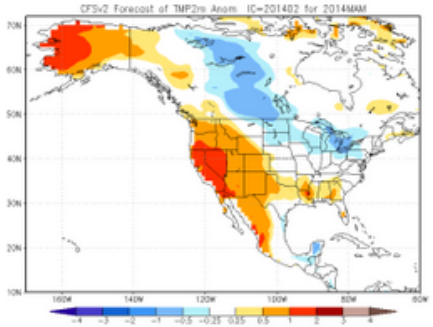
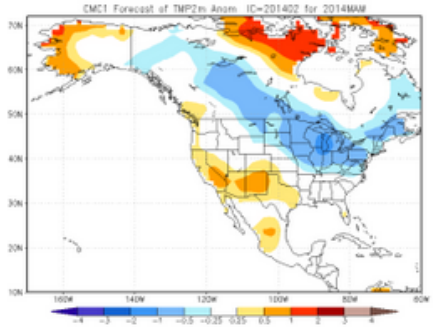
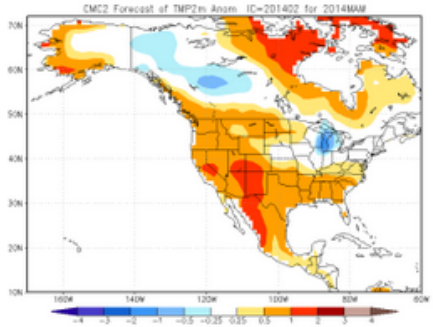
CFSv2



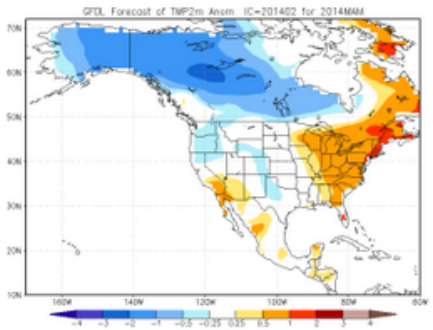
CMC1



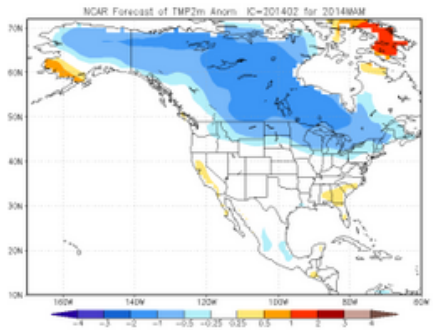
CMC2



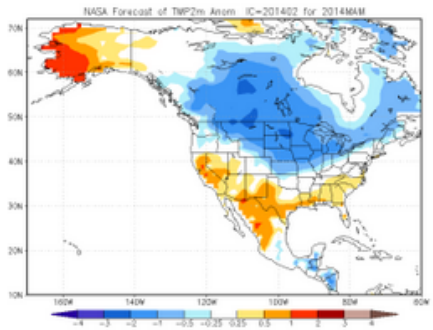
GFDL



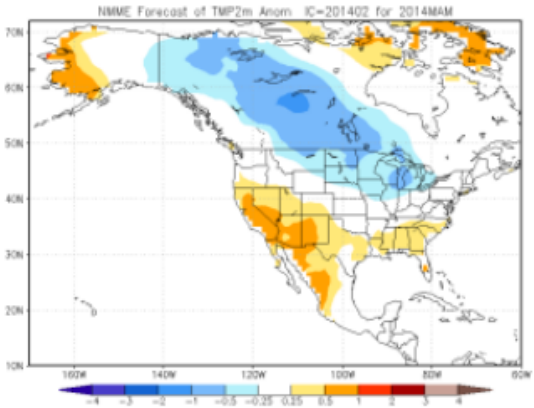
NCAR



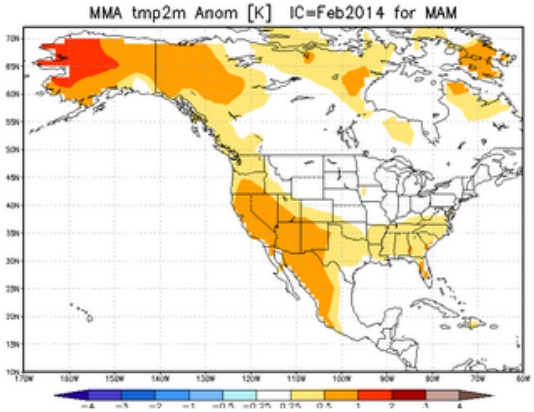
NASA



NMME



IMME



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2014 Feb 12

Western Regional Climate Center

PROVIDING CLIMATE SERVICES SINCE 1986

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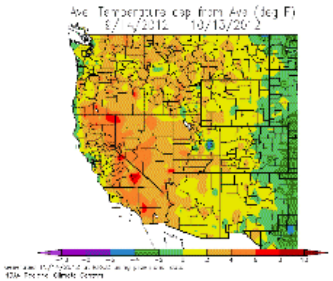
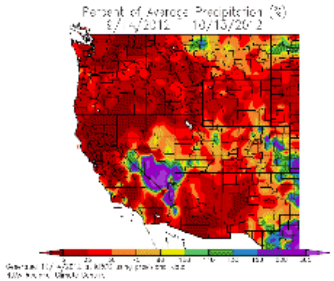
Recent Climate in the West

Temperature departure from Average and Percent of Average Precipitation for the past 30 days





→ More climate anomaly maps

Our New Look

Welcome to the new WRCC website! We've updated our look and all our content is still available, but may be in a different place.
If you like, you can still visit our previous home page.

Most Popular

- RAWS
- CEMP
- CalClim
- Climate Summaries
- Comparative Summaries

Help Us Improve

Take our 5 minute survey. We appreciate your feedback.

Western Regional Climate Center
2215 Raggio Parkway
Reno, NV 89512-1095
Tel: 775-674-7010
Fax: 775-674-7001
Email: wrcc@dri.edu
Open Monday - Friday
8am - 4pm Pacific Time
WRCC on facebook

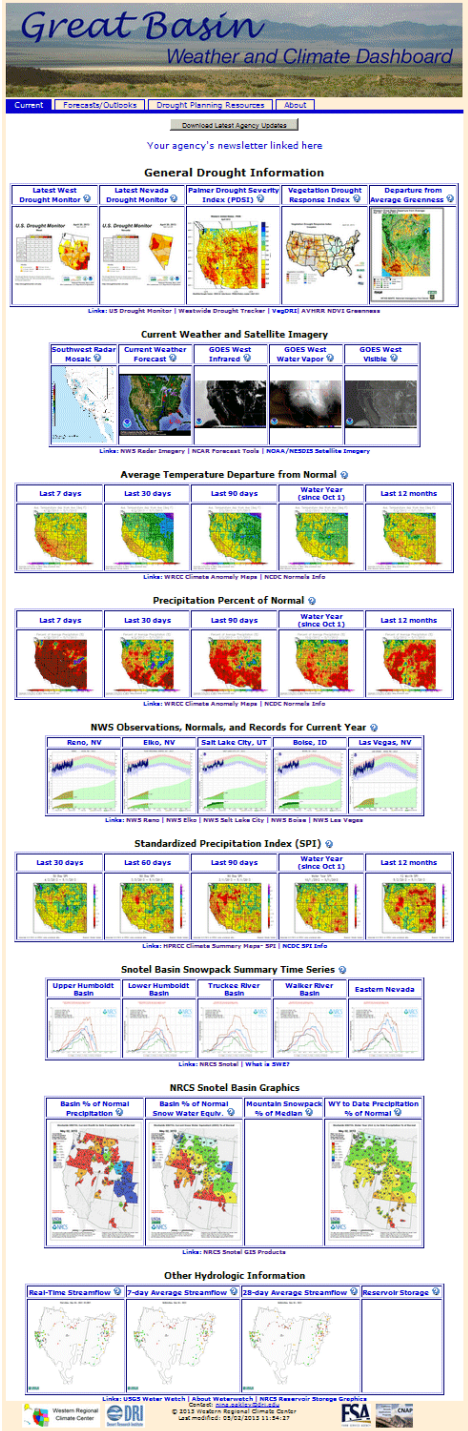
The Western Regional Climate Center is a partner in a suite of interconnected services that includes:
NOAA National Climatic Data Center (NCDC)
Regional Climate Centers (RCCs)
State Climate Offices
NOAA Regional Integrated Sciences and Assessments (RISA)
USDI Climate Science Centers (CSCs)

Desert Research Institute

Many products and tools reachable at or through WRCC web pages

Another set under way as part of Southwest Climate Science Center

We'd like your help in making this information more accessible, useful, and usable.

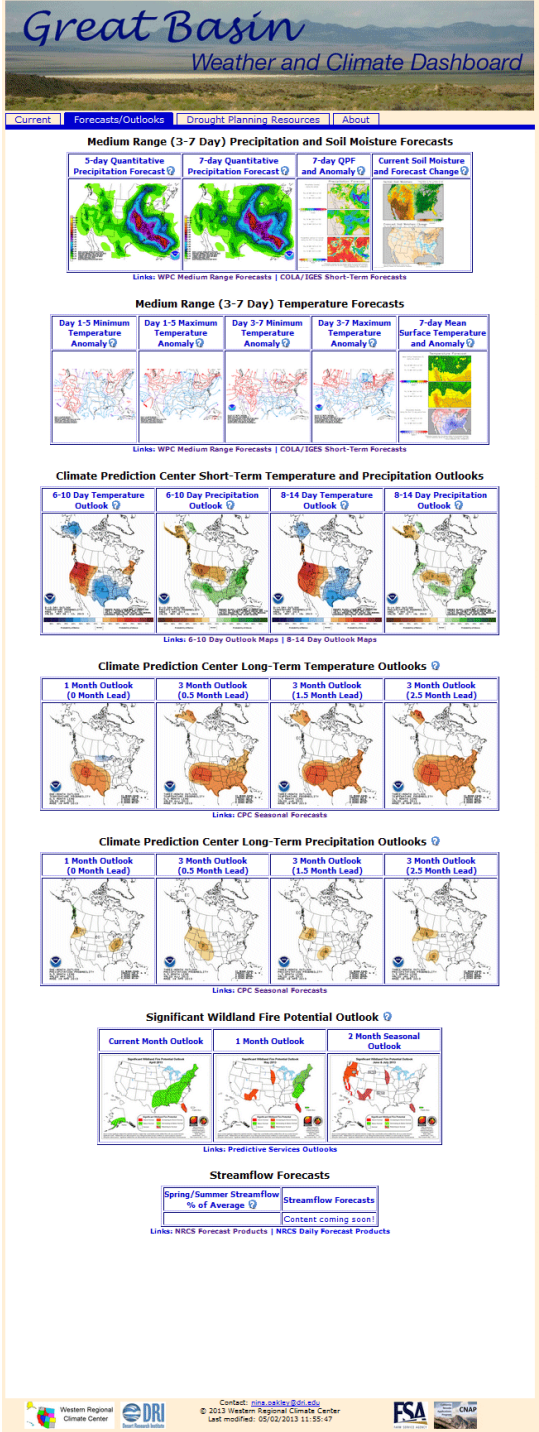


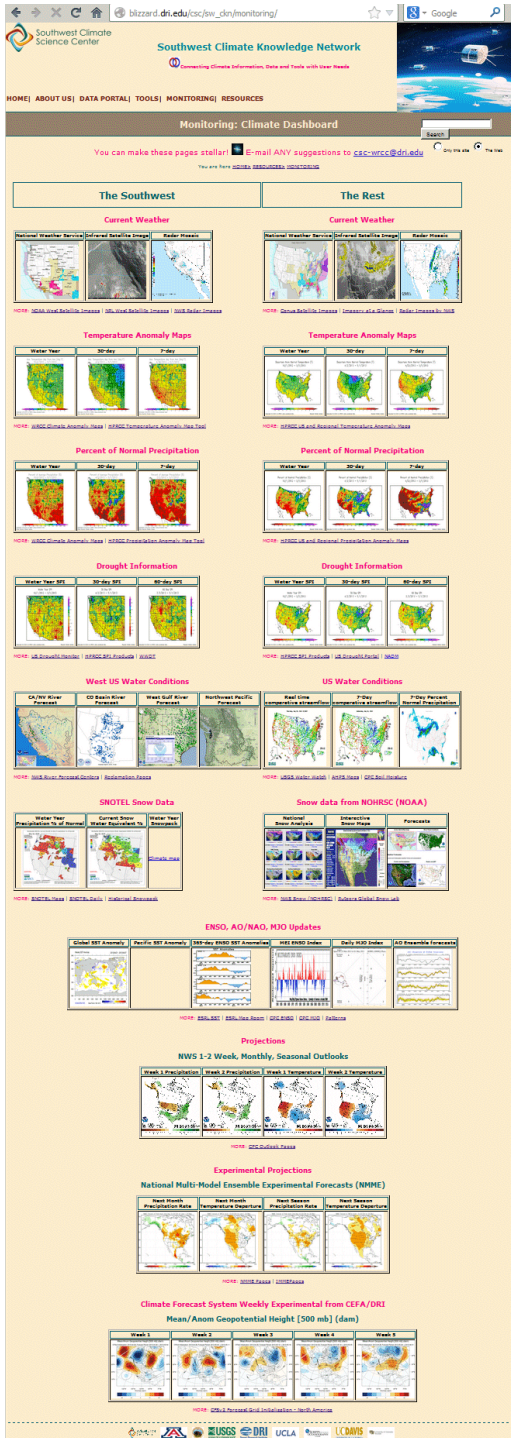
Great Basin Weather and Climate Dashboard

In support of

USDA Farm Services Agency and other Drought Activities

gbdash.dri.edu





Also

Department of Interior

Southwest Climate Science Center

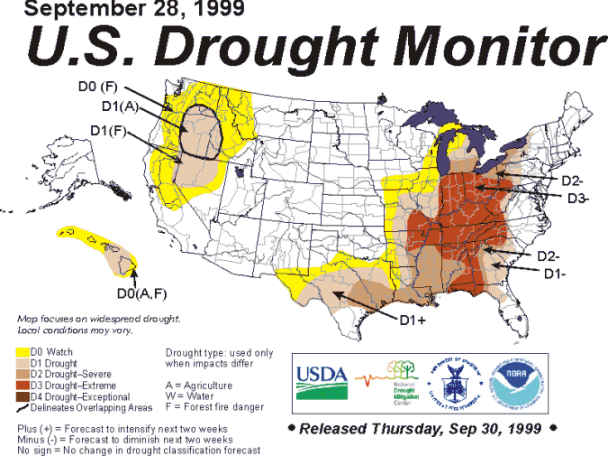
Climate Monitoring Dashboard

A quick glance of recent, current, future conditions, with access to more detail.

For

Southwest (left) Rest of USA (right)

www.wrcc.dri.edu/csc/sw_ckn/monitoring/



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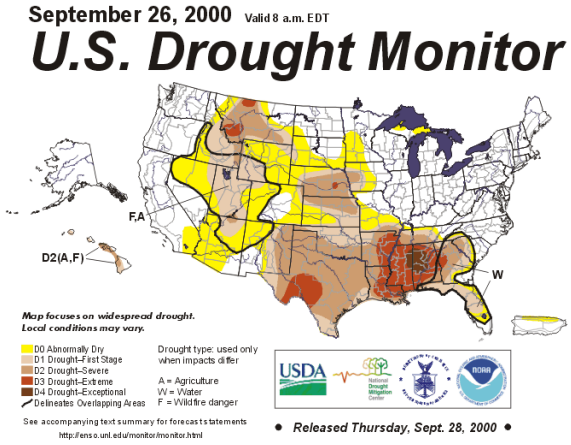

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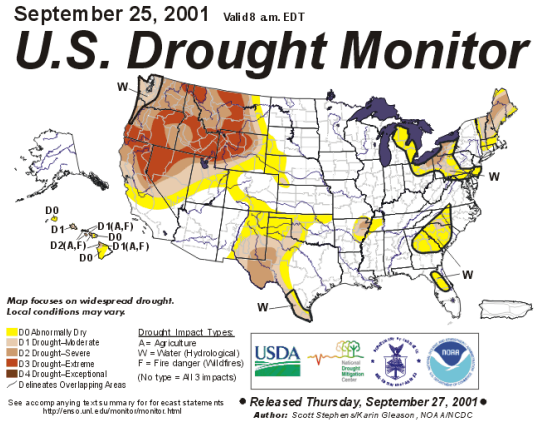

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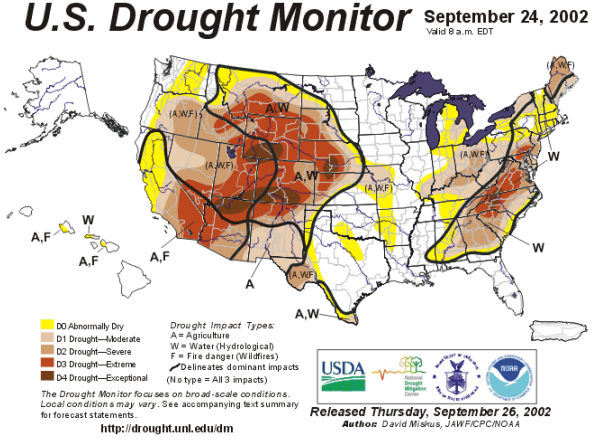

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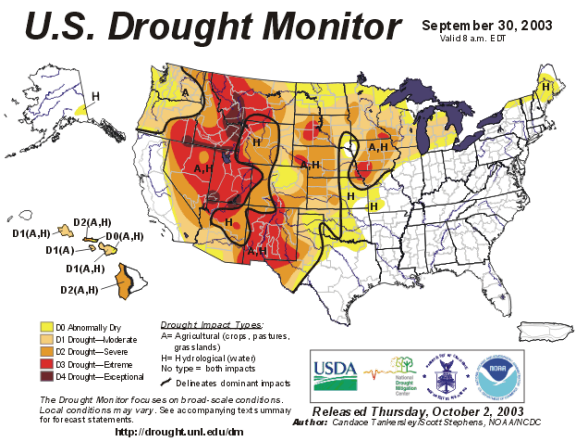

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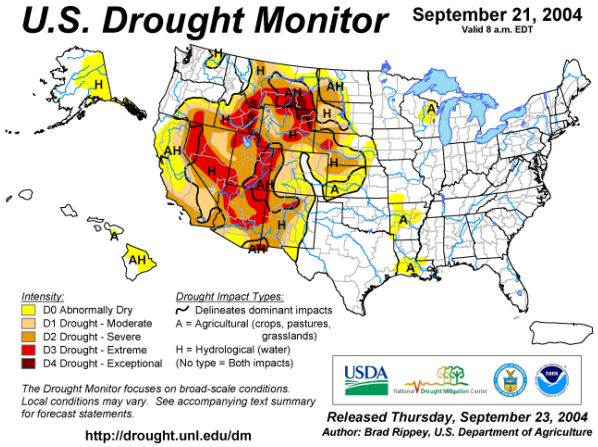

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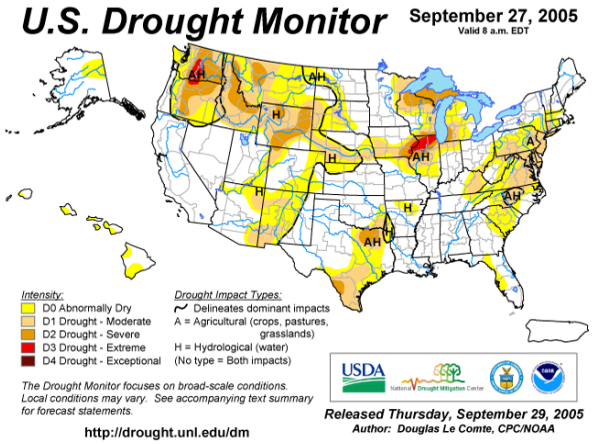

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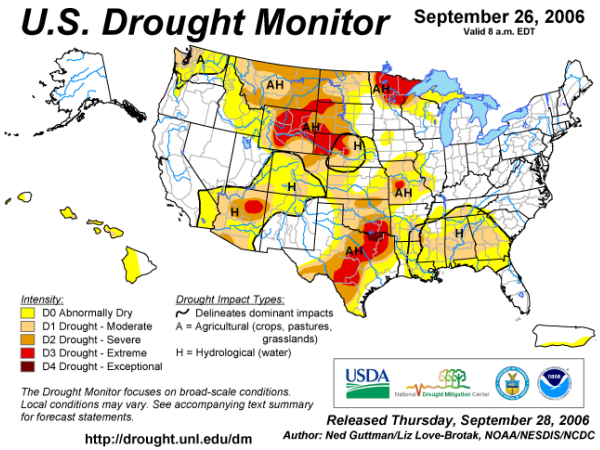

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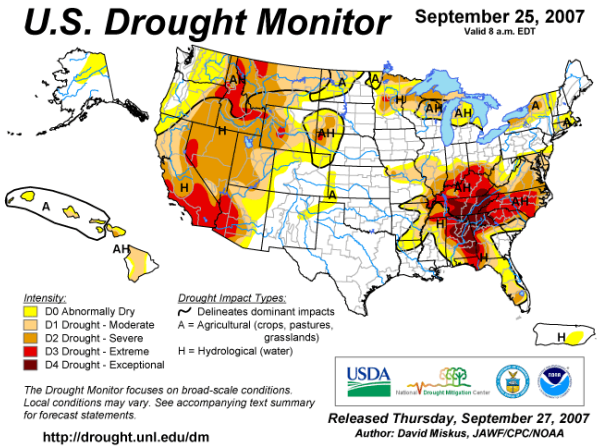

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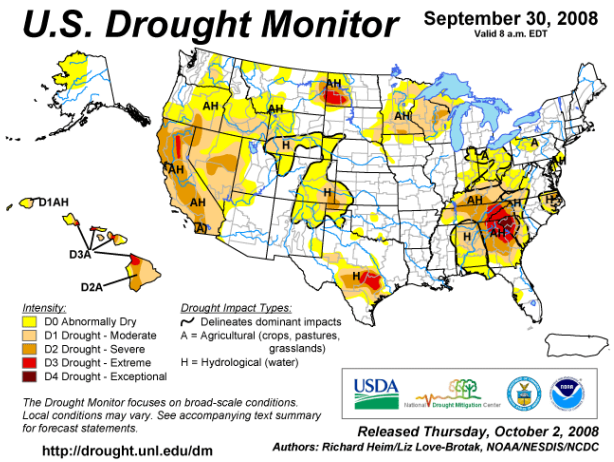

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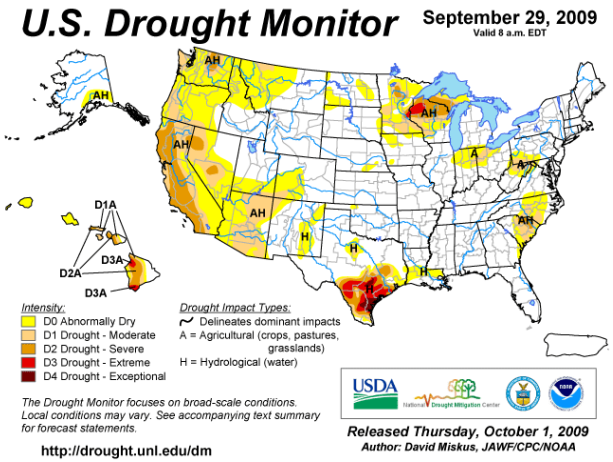

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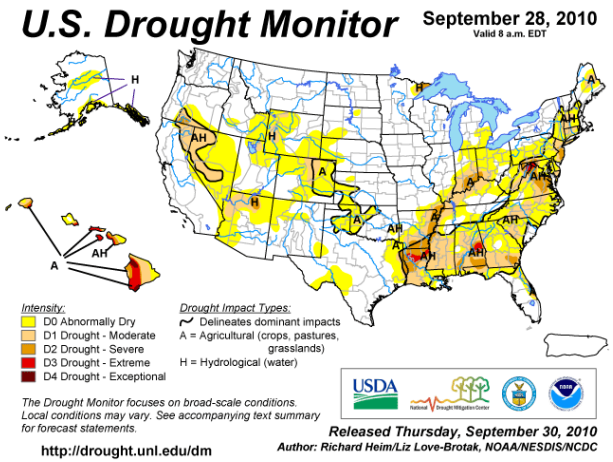

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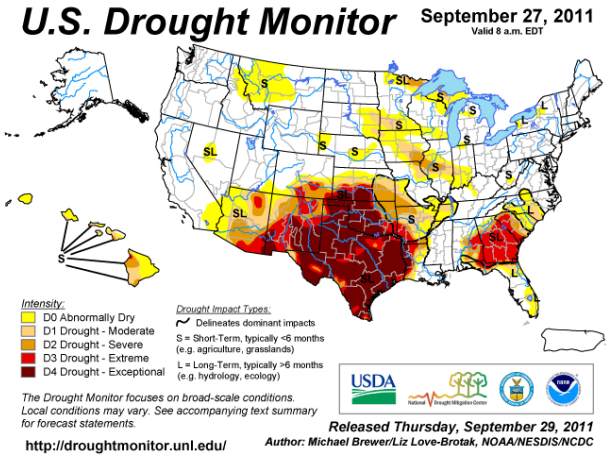

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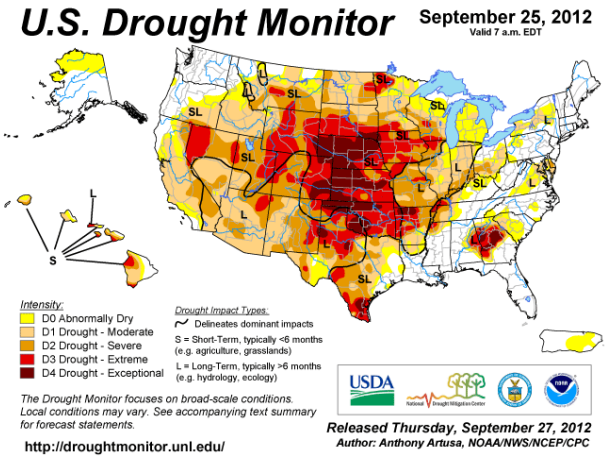

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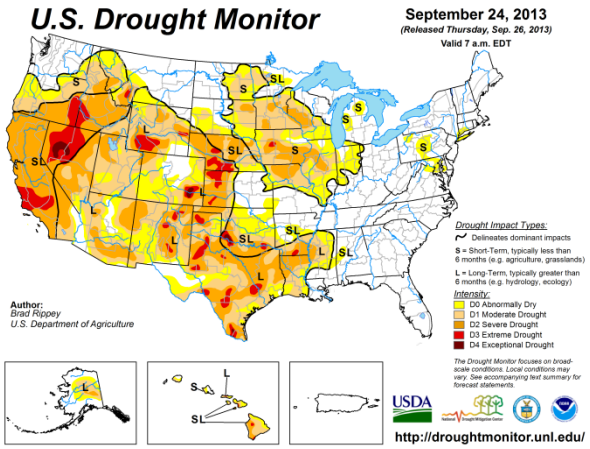

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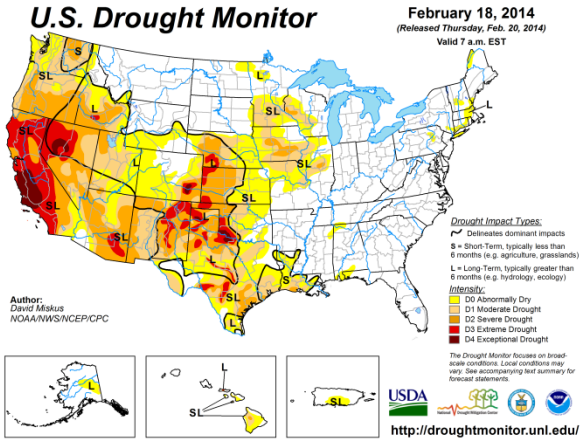


Feb 18, 2014

NIDIS organization
NIDIS and state partners

NIDIS Program Office → NIDIS Implementation Team

↓

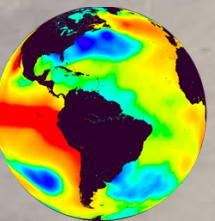
REGIONAL
NIDIS Technical Working Groups

↓

- Public Awareness And Education
- Engaging Preparedness Communities
- Integrated Monitoring and Forecasting
- Interdisciplinary Research and Applications
- U.S./NIDIS Drought Portal Drought.gov

↓ ↑

Regional Drought Early Warning Systems
Information Clearinghouse, Prototypes, and Implementation



NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

California Drought Outlook Forum:

What's Ahead and What We Can Do

Thursday, February 20, 2014
Sacramento Convention Center
Sacramento, CA

AGENDA

9:30 a.m. **Welcome and Opening Remarks**
Mark Schaefer, Ph.D.
Assistant Secretary of Commerce for Conservation and Management
Deputy Administrator, NOAA

9:45 a.m. **Forum Objectives and Outcomes**

9:50 a.m. **Current Drought Conditions and Outlook for 2014**
Panel will provide an assessment of the present situation in California, the outlook for continuing drought, and sources of drought monitoring and forecast information.
moderator: Paul Iñiguez, NOAA National Weather Service
Michael Anderson, California Department of Water Resources
Pete Fickenscher, NOAA California-Nevada River Forecast Center
Martin Hoerling, NOAA Earth System Research Laboratory

10:50 a.m. **Drought Impacts, Responses, and Preparedness**
Panel will discuss impacts, responses and strategies, and longer-term preparedness activities across the public and private sectors.
moderator: Anne Jackson, PG&E
Melissa Crandell, Bureau of Reclamation
Danielle Blacet, Association of California Water Agencies
Lisa Maddaus, American Water Works Association

12:00 p.m. **Lunch**
Keynote Speaker: Undersecretary Sandra Schubert,
California Department of Food and Agriculture

1:30 p.m. **Drought Early Warning Information in California**
Panel will present activities and resources for drought early warning and preparedness, including assessments, predictions, and impact information.
moderator: Robert Webb, NOAA Earth System Research Laboratory, NIDIS
Anne Steinemann, Scripps Institution of Oceanography / CIRES, NIDIS
Lee Johnson, CSU Monterey Bay / NASA Ames
Jay Jasperse, Sonoma County Water Agency

2:00 p.m. **Drought Programs and Assistance**
Panel will describe resources for drought assistance, preparedness, and recovery.
moderator: Karissa Kruse, Sonoma County Winegrape Commission
Val Dolcini, USDA - Farm Service Agency
Carlos Suarez, USDA - Natural Resources Conservation Service
David Hartwell, USDA - Rural Development, California
Krista Reger, California Rural Water Association
George Faggella, California Department of Public Health

3:15 p.m. **Information Needs for Drought Early Warning and Preparedness**
An open discussion, with all Forum attendees, will identify key information and resource needs for improving drought early warning and response, and will develop a list of action items for improving preparedness.
moderator: Kelly Redmond, Western Regional Climate Center

4:00 p.m. **Concluding Remarks**

4:15 p.m. **Adjourn**

California Drought Outlook Forum - Outcomes and Observations (KTR)

Good attendance, all day. Approximately 150 plus another 100 webinar/phone.

California has an impressive array of internal capabilities and resources.
- Huge economy, talent-rich in technical and scientific expertise.
- Each state has its own culture, but California just seems a little more ... "different"

An extensive portfolio of federal, state, and NGO programs is now in place to provide individuals and communities with resources for drought assistance, preparedness, recovery

Drought has a wide diversity of regional and sectoral impacts within the state

Small and rural water systems have special challenges

Essentially zero possibility of recovery within current water year.

Projected eventual cost of this drought at least five times 1975-76, 1976-77 episode.

Much interest in climate and hydrology status and projections.
- California drought is the result of planetary-scale phenomena.
- Weather and climate research remain fundamental to progress.
- Significant opportunities for federal-state partnering.

Many opportunities remain to better optimize early warning and preparedness activities.

That's Enough.

Thank You

Kelly Redmond

Regional Climatologist
Western Regional Climate Center

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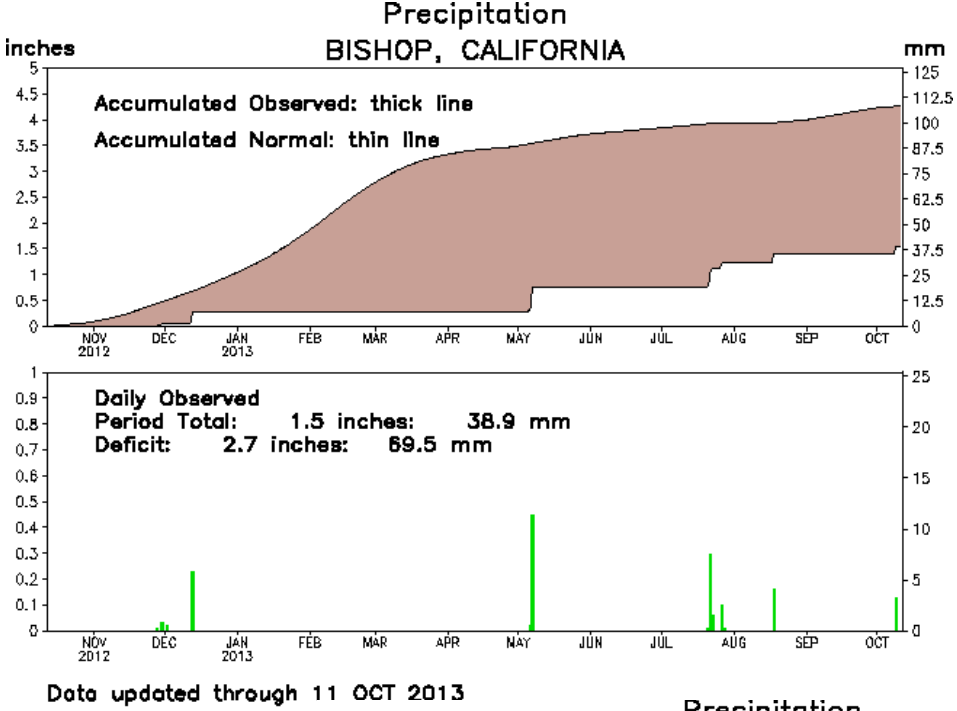
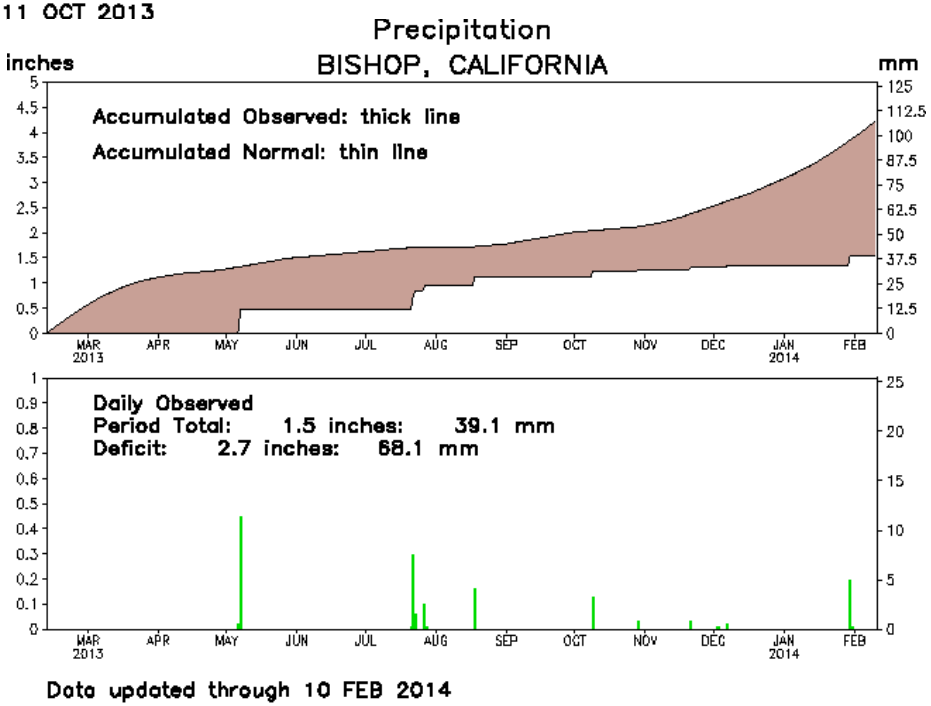
775-674-7011

YOUNG
Thank
You !
20101008

Bishop California
365 Day precipitation

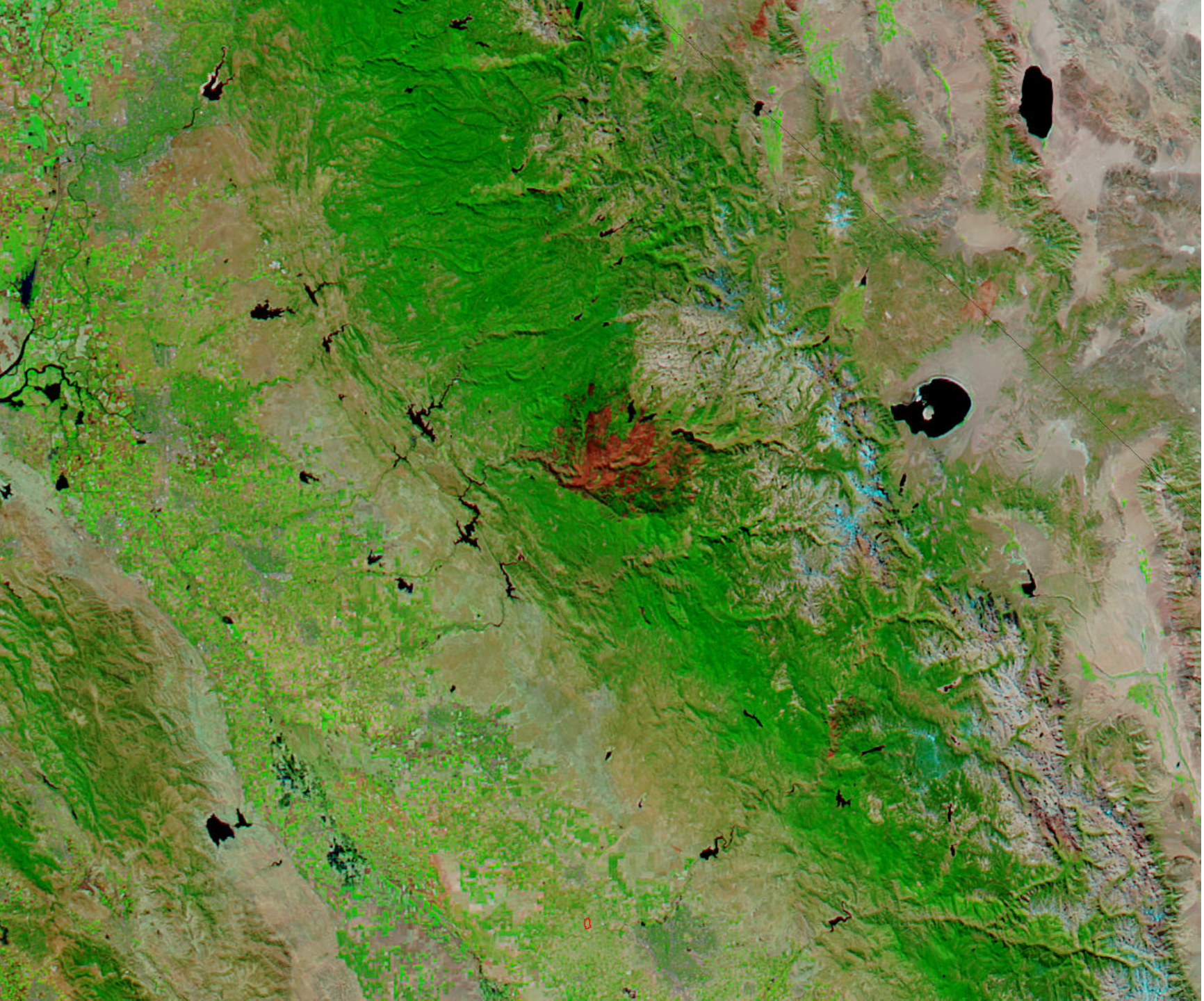


Departures thru 2013 Oct 11



Departures thru 2014 Feb 10

CLIMATE PREDICTION CENTER/NCEP

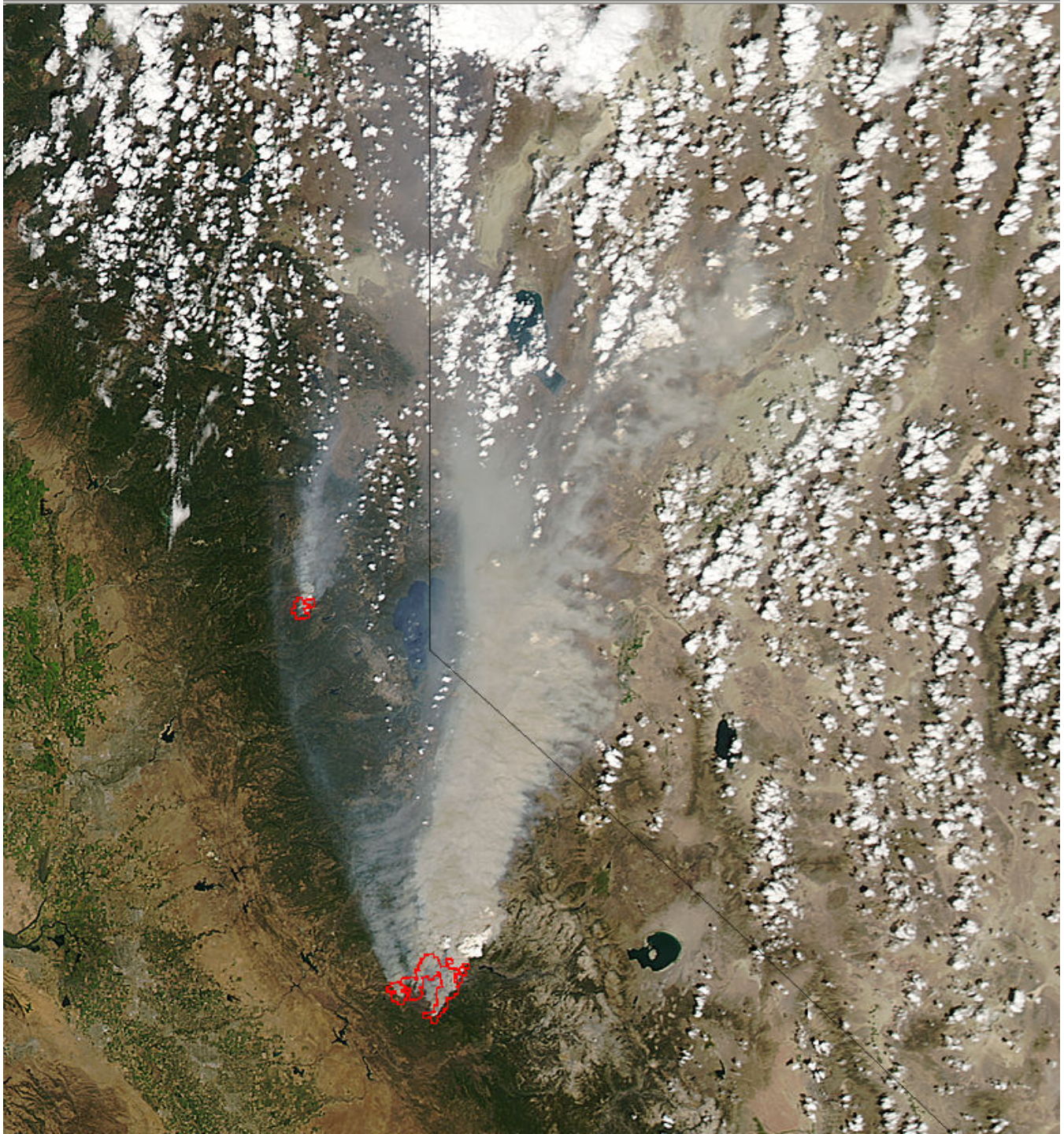


MODIS
250 m

2013
27 Sep

Rim Fire

False
Color



MODIS
500 m

2013 Aug 22

Rim Fire
(south)

American
Fire
(north)