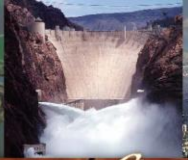
Hydrologic Conditions Overview and Drought Status

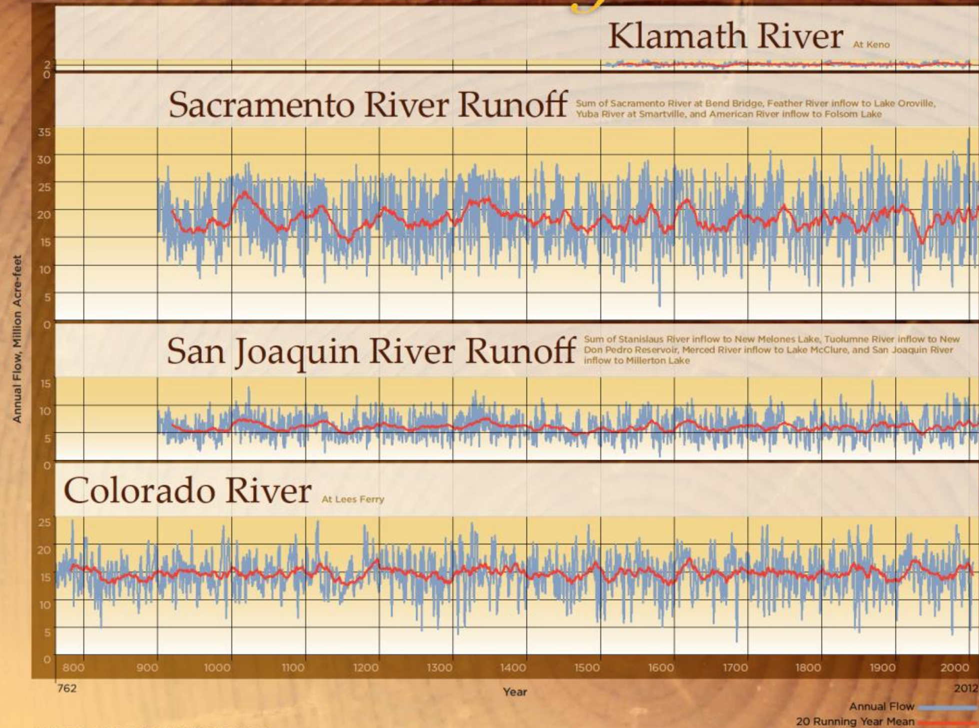
Jeanine Jones, California Department of Water Resources








Reconstructed Streamflows & Drought Periods



USING TREE-RINGS TO RECONSTRUCT STREAMFLOW

A tree-ring reconstruction is a set of tree-ring width data that have been calibrated with an instrumental or gaged record of a hydrologic or climatic variable such as annual streamflow or precipitation. The reconstruction, based on a statistical model that describes the relationship between tree growth and the gage record, extends that record back hundreds of years into the past.

Tree growth in dry climates is limited by water availability. Trees that provide the best information about hydroclimatic variability are those particularly sensitive to variations in moisture. These include species such as blue oak, ponderosa pine, Douglas fir, and western juniper, usually growing at lower elevations in sparse stands on dry and rocky sites where soil moisture storage is minimal.

Tree-ring reconstructions of hydroclimatic variables are developed from tree-ring chronologies. A tree-ring chronology is a time-series of annual values derived from the ring-width measurements of 10 or more trees of the same species at a single site. To create a tree-ring chronology, cores from the sampled trees at each site are cross-dated (i.e., patterns of narrow and wide rings are matched from tree to tree) to account for missing or false rings, so that every annual ring is absolutely dated to the correct year. Then all rings are measured to the nearest thousandth of a millimeter using a computer-assisted measuring device. After growth-related trends unrelated to climate are statistically removed, the ring width values from all sampled trees for each year are averaged to create a time series of annual ring width indices. The complete series of ring width indices from a site is called a tree-ring chronology.

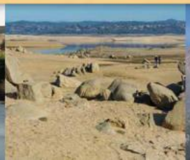
Once a gaged record of interest is selected for reconstruction, a set of tree-ring chronologies from the region near the gage is calibrated with the gage record to form a reconstruction model. A statistical technique called multiple linear regression is commonly used. The reconstruction is evaluated by comparing the observed gage values with the reconstructed values by assessing the amount of variance in the gage record that is explained by the reconstruction.

DROUGHTS PRIOR TO THE HISTORICAL RECORD

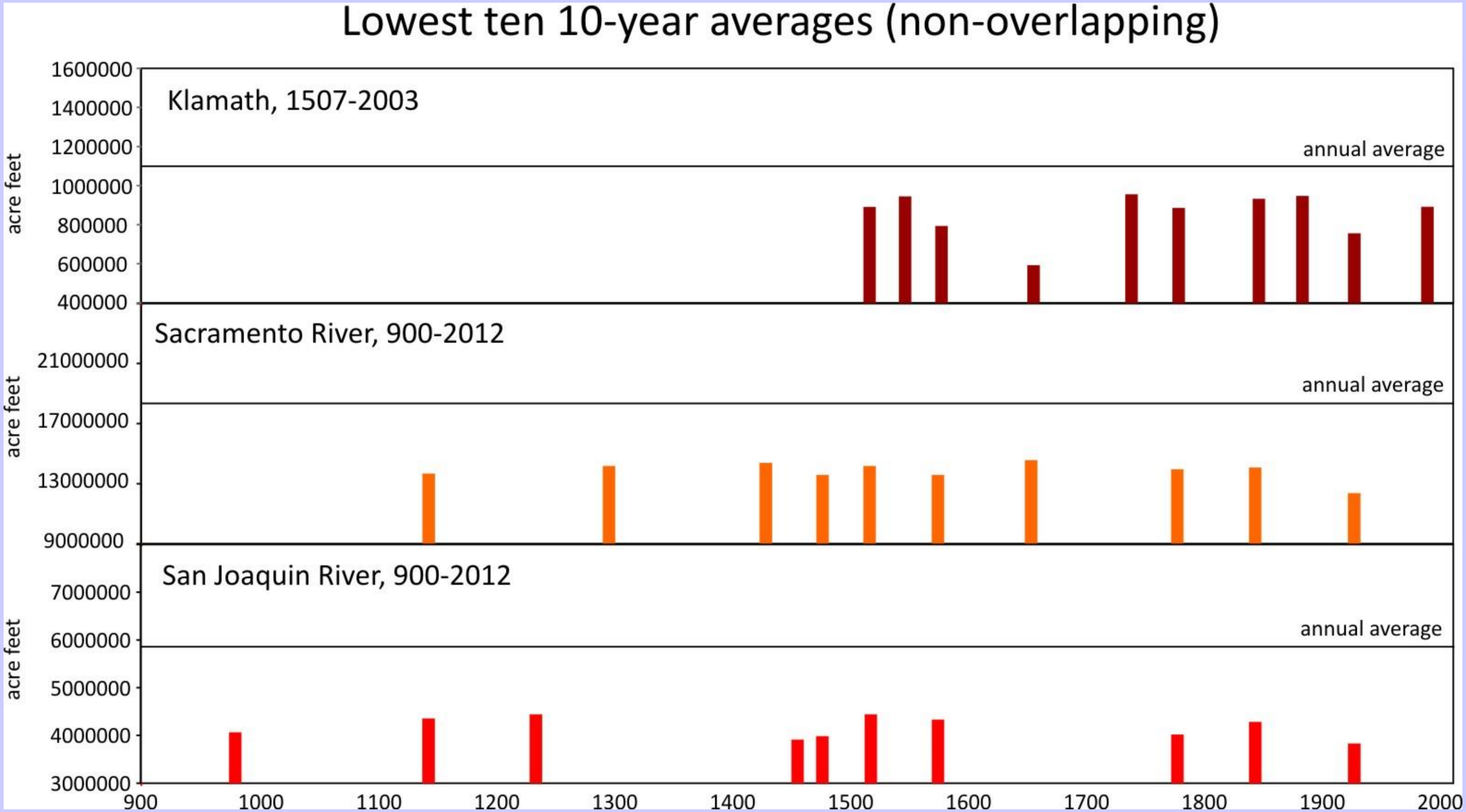
The period of reliably measured streamflows for rivers throughout the West seldom reaches beyond 100 years, which represents only a fraction of climatologically modern time. As these streamflow reconstructions show, there have been droughts prior to the historical period that were more severe – particularly in duration – than those in the measured record. The reconstructed record captures a broader range of hydrologic variability than does the historical record, making reconstructions useful for drought preparedness planning. Of particular interest from a scientific perspective is the Medieval Climate Anomaly, a time during which sustained severe drought gripped much of the western United States, as exemplified illustrated in the Sacramento, San Joaquin, and Colorado River reconstructions.

Data source: Work performed by the University of Arizona under contract to the California Department of Water Resources. CDWR Agreements 4600003882 (David Meko, 2006) and 4600008850 (David Meko, Connie Woodhouse, Ramzi Touchan, 2014)



Historical Drought in Perspective

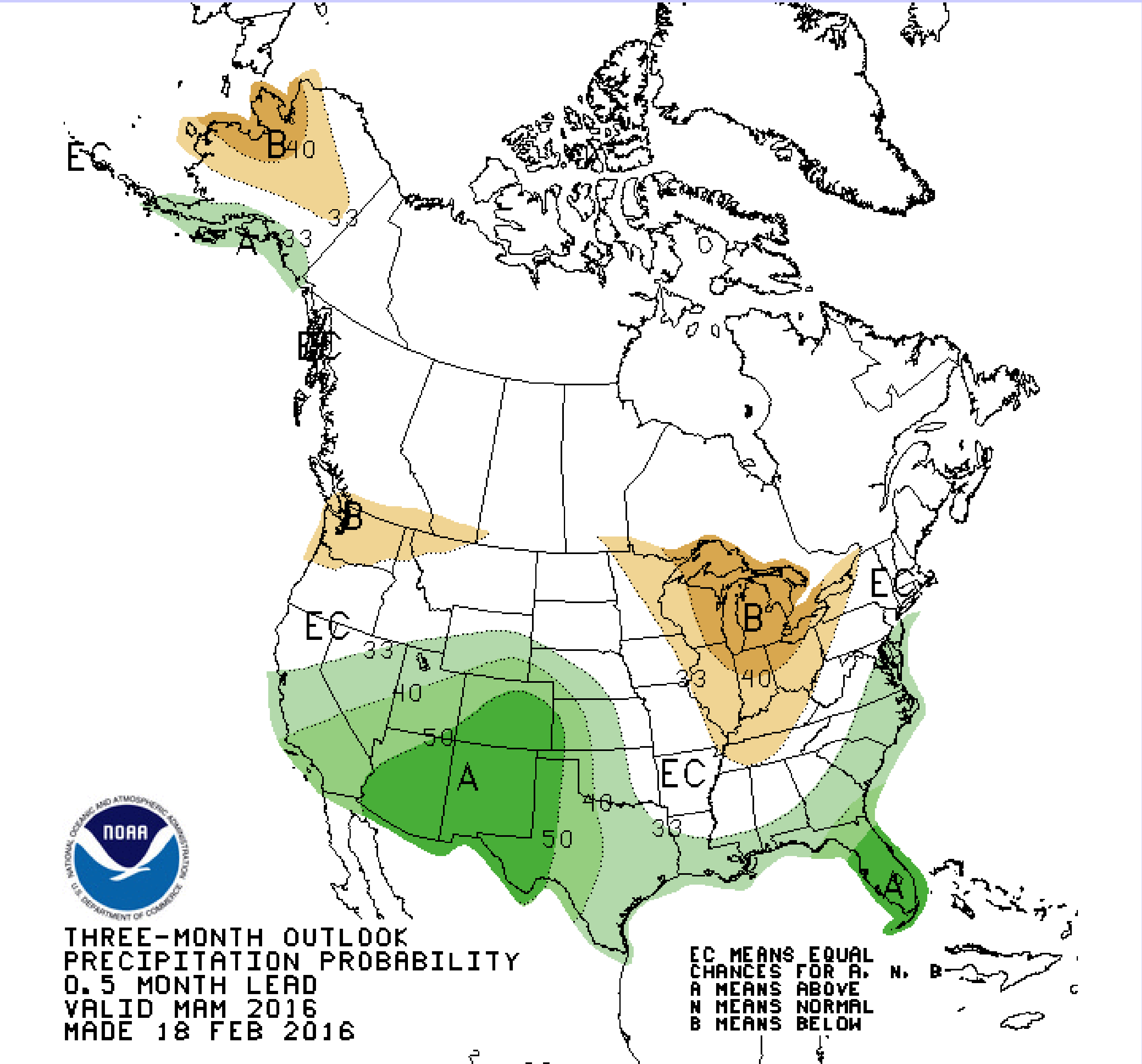


Courtesy of Connie Woodhouse

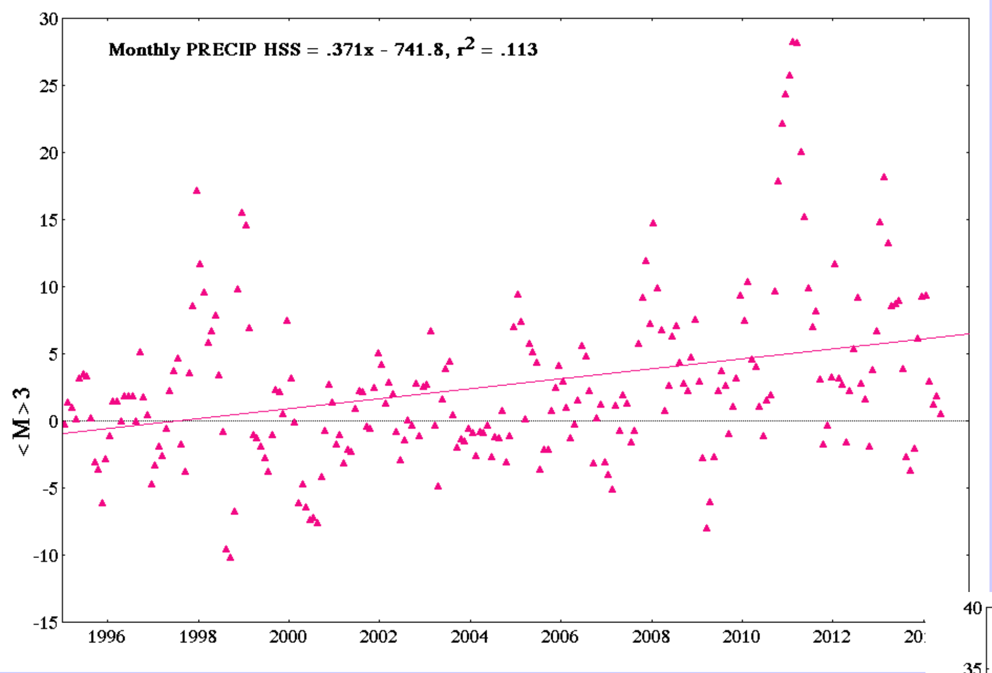
Where We've Been in Past Water Years

- 2007 – dry
- 2008 – dry
- 2009 – dry
- 2010 – normal
- 2011 – wet
- 2012 – dry
- 2013 – dry
- 2014 – dry
- 2015 – dry
- 2016 – ?

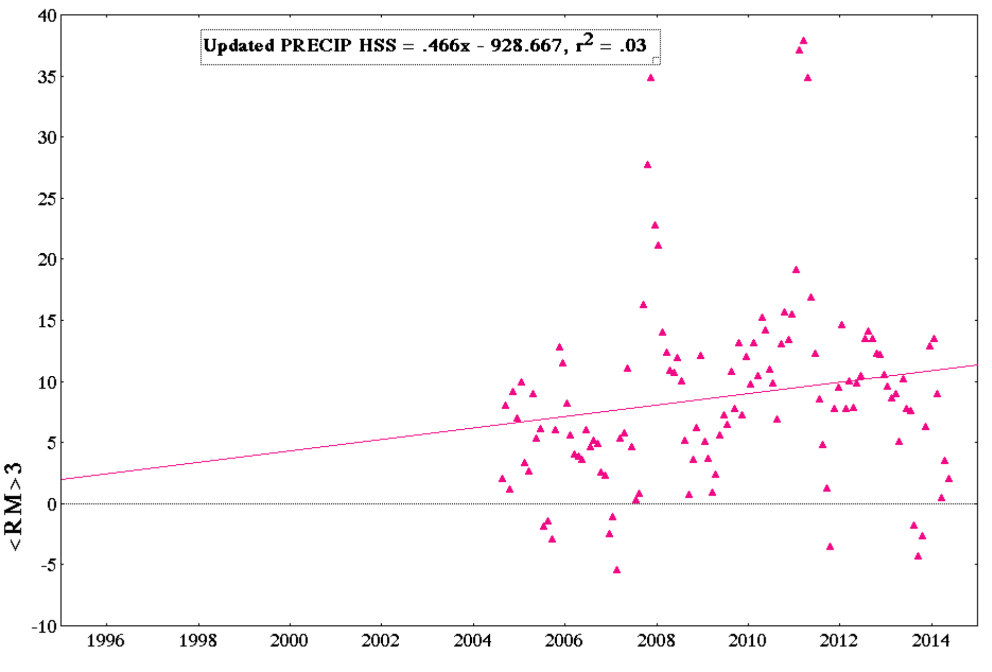
And Where We're Going???



CPC Forecast Skill – Monthly Precipitation



http://www.cpc.ncep.noaa.gov/products/predictions/long_range/tools/briefing/mon_veri.grid.php

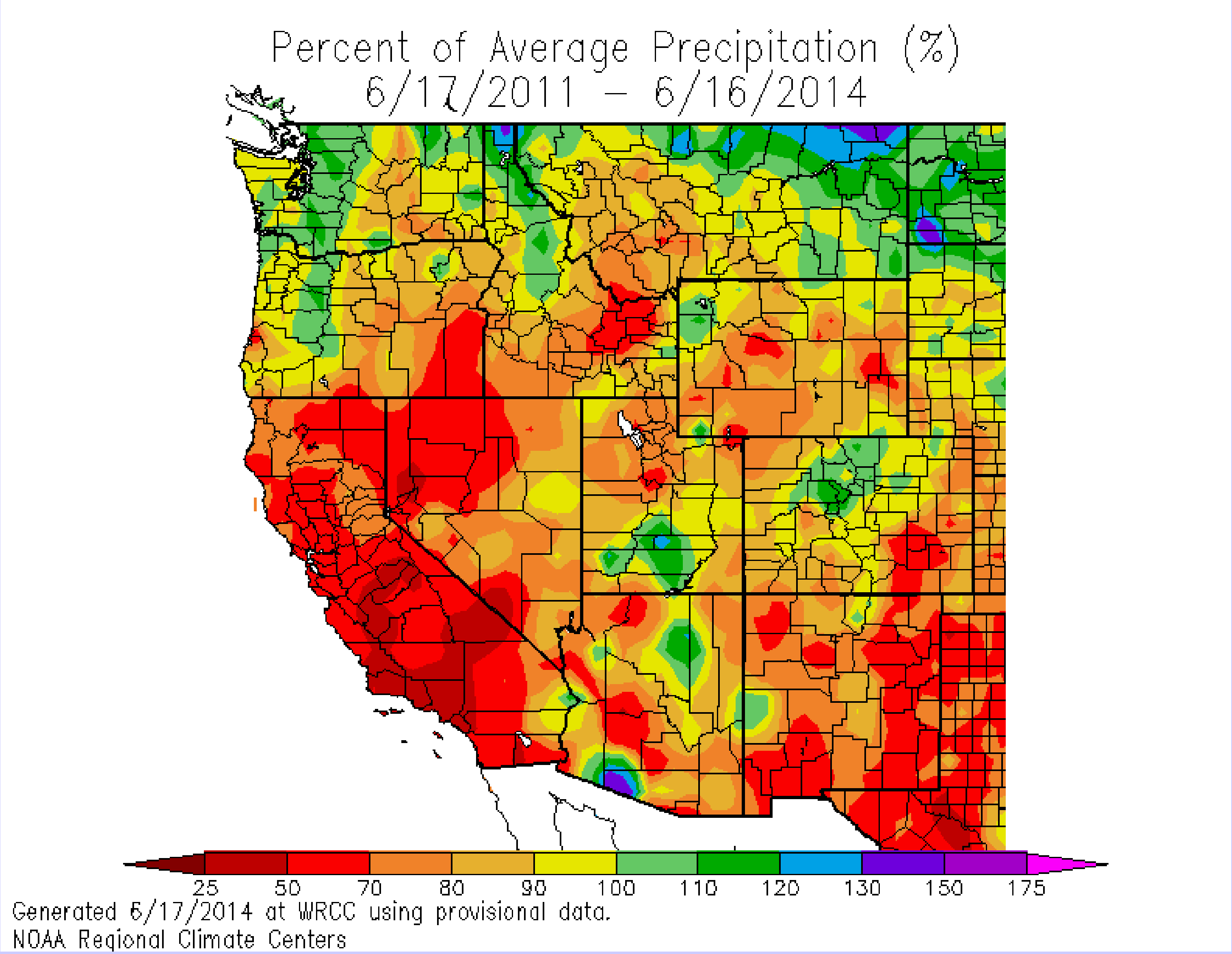


CPC operational precipitation forecast skill (Heidke Skill scores) for monthly forecasts (top) and updated monthly forecasts (right).

Skill has improved over time, but less so than for temperatures.

Slide courtesy of Klaus Wolter

2012-14



Percent of Average Precipitation (%)
6/17/2011 – 6/16/2014
25 50 70 80 90 100 110 120 130 150 175
Generated 6/17/2014 at WRCC using provisional data.
NOAA Regional Climate Centers

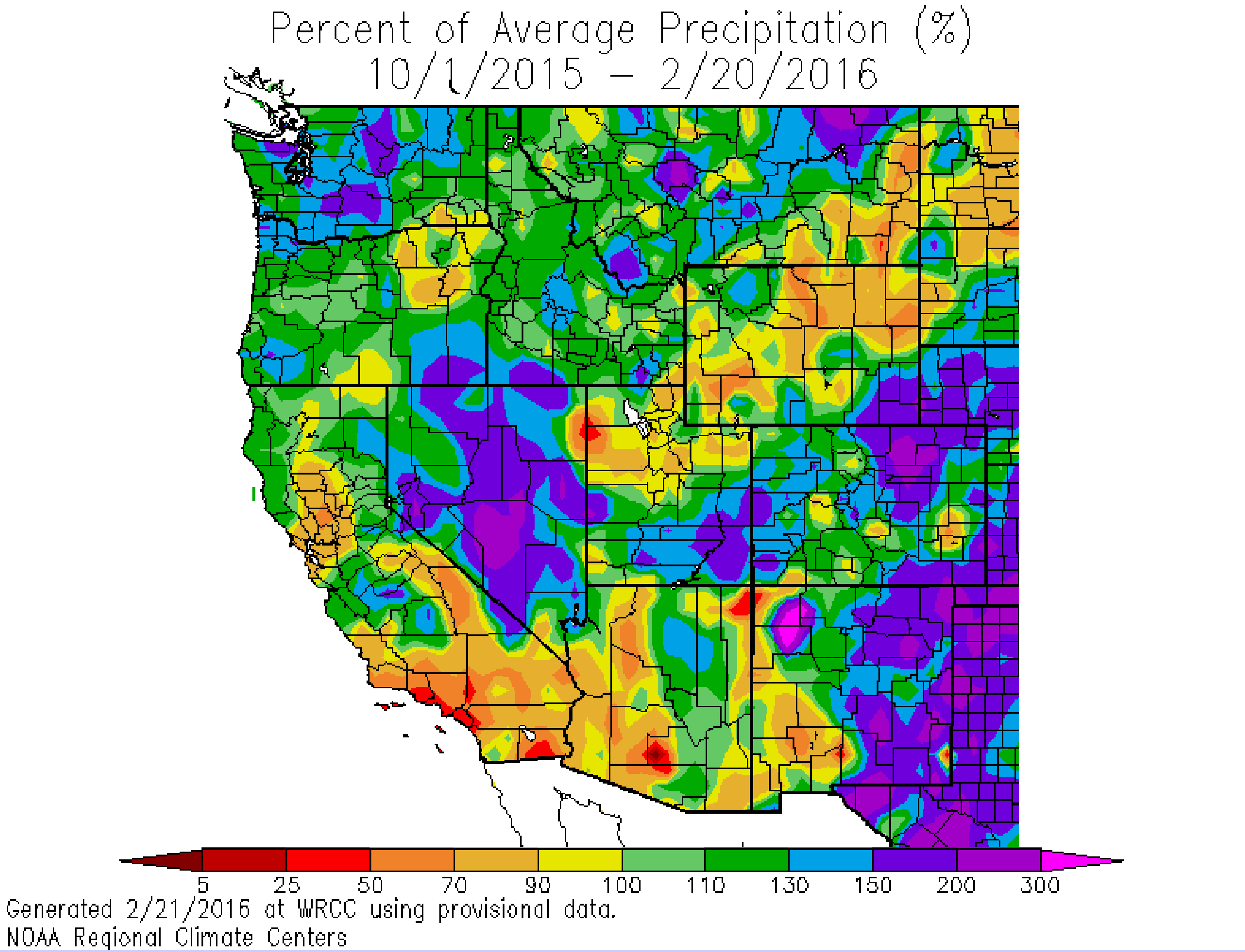
Driest Three Consecutive Water Years, Based on Statewide Precipitation

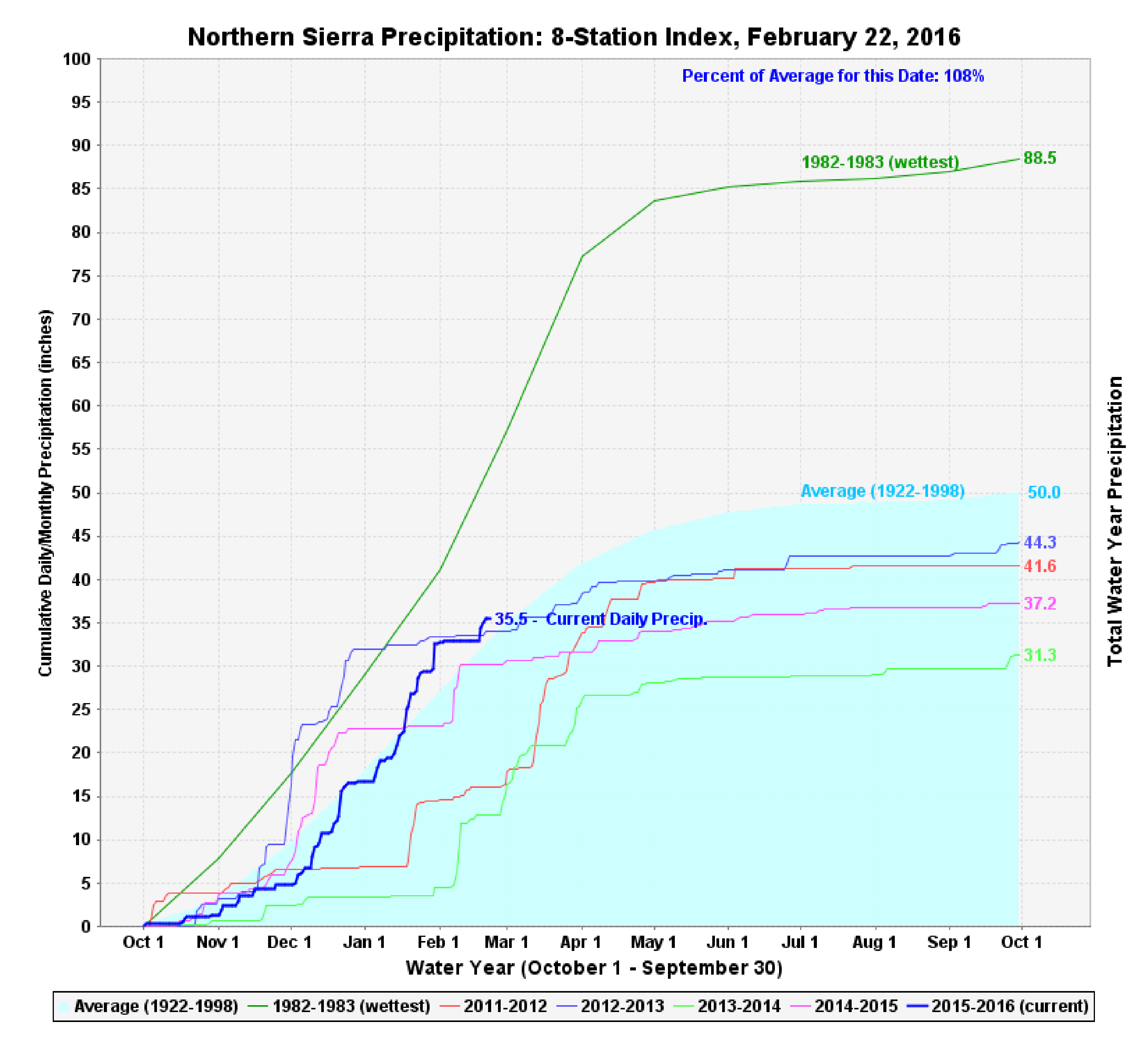
Years	Total Statewide Precipitation, inches
2012-14	44.5
1922-24	45.1
1918-20	46.1
1924-26	46.5
1929-31	46.7
1923-25	46.9
2007-09	48.2
1917-19	49.6
1975-77	49.8
1931-33	50.1

Data from Western Regional Climate Center

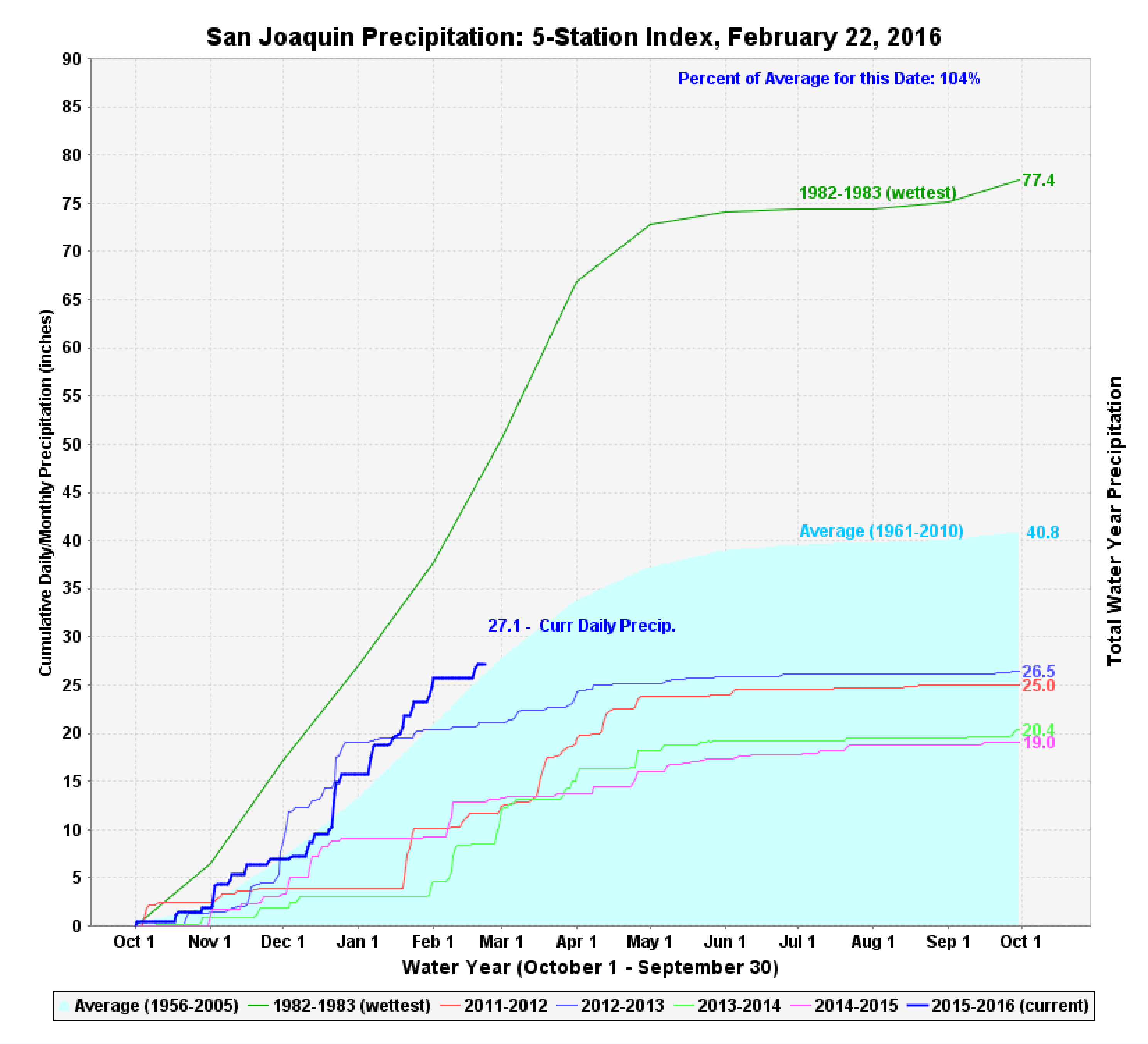
USGS Computed CA WY Runoff
Dozen Driest years -- (rank out of 114)

1. 1977 114th
2. 1931 113th
3. 1924 112th
4. 2014 111th
5. 1991 110th
6. 1994 109th
7. 1990 108th
8. 2001 107th
9. 1934 106th
10. 1992 105th
11. 1976 104th
12. 1929 103rd

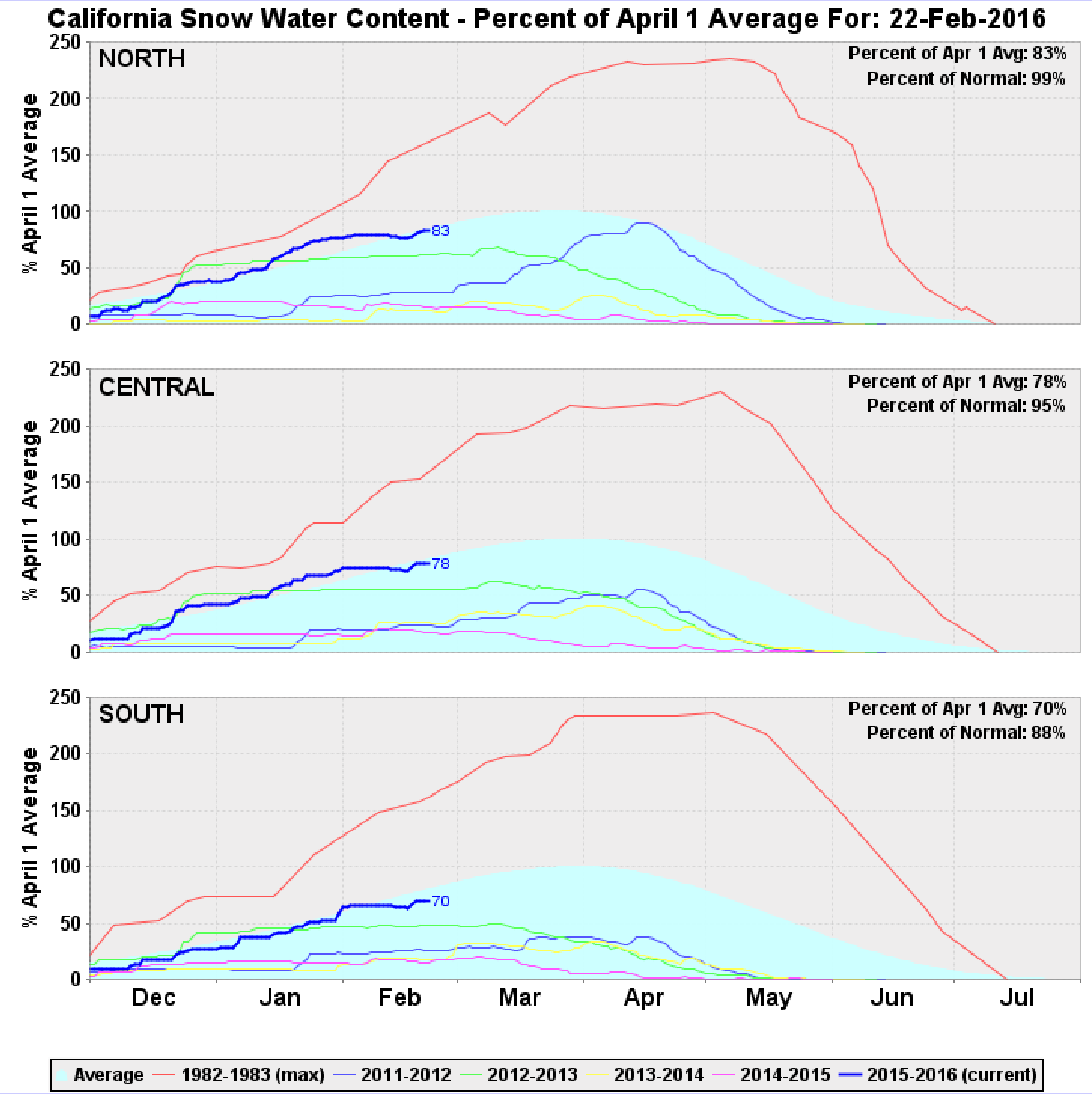

Percent of Average Precipitation (%)
10/1/2015 – 2/20/2016
5
25
50
70
90
100
110
130
150
200
300
Generated 2/21/2016 at WRCC using provisional data.
NOAA Regional Climate Centers



Northern Sierra Precipitation: 8-Station Index, February 22, 2016
Percent of Average for this Date: 108%
1982-1983 (wettest)
88.5
Average (1922-1998)
50.0
44.3
41.6
37.2
31.3
35.5 - Current Daily Precip.
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)
Average (1922-1998)
1982-1983 (wettest)
2011-2012
2012-2013
2013-2014
2014-2015
2015-2016 (current)



San Joaquin Precipitation: 5-Station Index, February 22, 2016
Percent of Average for this Date: 104%
1982-1983 (wettest)
77.4
Average (1961-2010)
40.8
27.1 - Curr Daily Precip.
26.5
25.0
20.4
19.0
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)
Average (1956-2005)
1982-1983 (wettest)
2011-2012
2012-2013
2013-2014
2014-2015
2015-2016 (current)



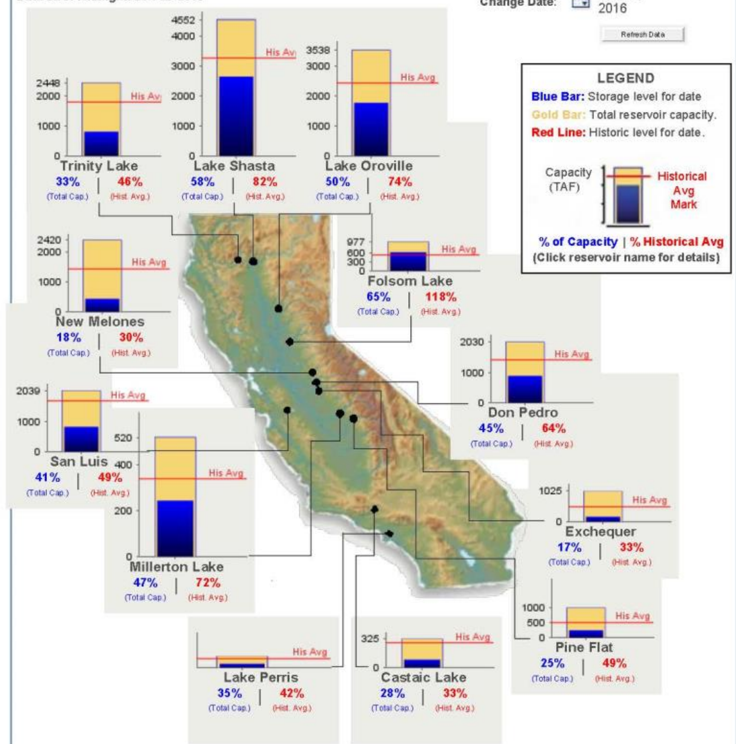
California Snow Water Content - Percent of April 1 Average For: 22-Feb-2016
NORTH
Percent of Apr 1 Avg: 83%
Percent of Normal: 99%
83
CENTRAL
Percent of Apr 1 Avg: 78%
Percent of Normal: 95%
78
SOUTH
Percent of Apr 1 Avg: 70%
Percent of Normal: 88%
70
% April 1 Average
0
50
100
150
200
250
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Average
1982-1983 (max)
2011-2012
2012-2013
2013-2014
2014-2015
2015-2016 (current)

CONDITIONS FOR SELECTED RESERVOIRS

Data as of Midnight: 21-Feb-2016

Change Date: 21-Feb-2016

Refresh Data



Click for printable version of current data.

Report Generated: 22-Feb-2016 10:22 AM

State Drought Response Actions

- May 2013 Executive Order on water transfers
- Dec 2013 formation of Governor’s Drought Task Force
- Jan 2014 Governor’s emergency proclamation
- March 2014 drought relief legislation
- April 2014 proclamation of continued state of emergency
- Sep 2014 Executive Order for emergency drinking water assistance
- Dec 2014 Executive Order continuing CEQA waiver for specified actions
- March 2015 drought relief legislation
- April 2015 Executive Order
- October 2015 emergency proclamation on tree mortality
- November 2015 Executive Order, continuing conservation/small water systems

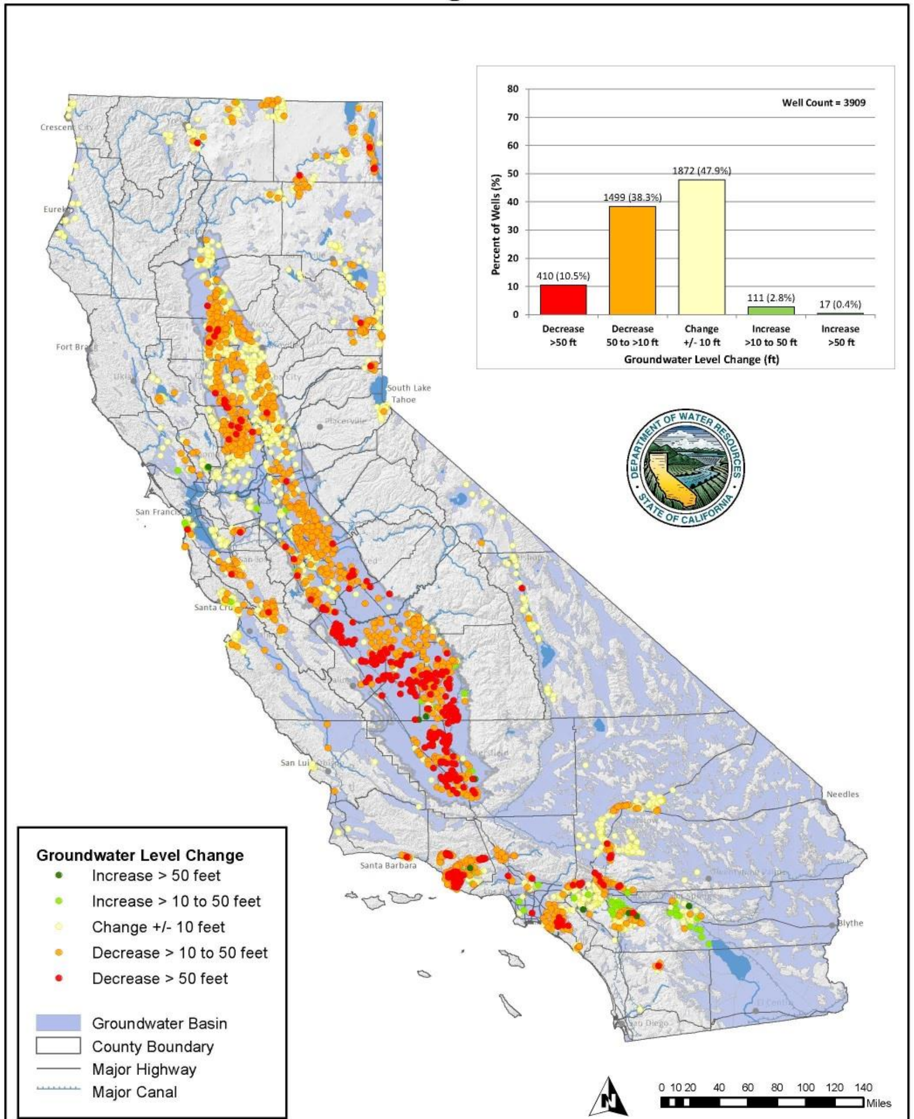
Drought Impacts

- Reduced surface and groundwater supplies
- Water shortages for small water systems & private well owners
- Declining groundwater levels and land subsidence
- Agricultural land fallowing
- Increased urban water costs
- Tree mortality, wildfire risk
- Fishery impacts

Comparison of Water Project Allocations in Dry Years

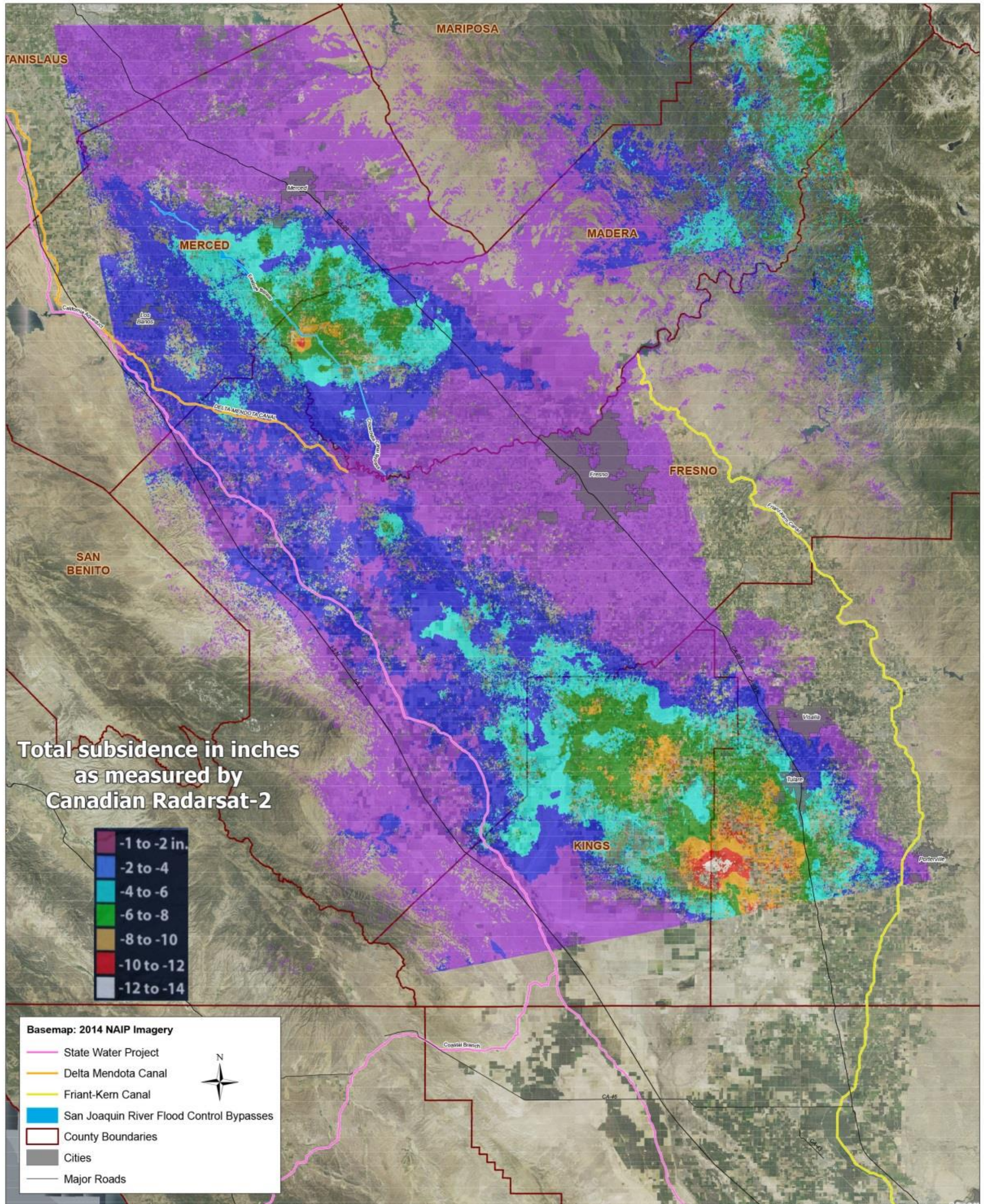
	1991	2009	2014	2015
SWP	30%/0	40%	5%	20%
CVP N of Delta Ag	25%	40%	0	0
CVP S of Delta Ag	25%	10%	0	0
Friant	100%	100%	0	0
CVP Sac water rts	75%	100%	75%	75%
CVP SJ water rts	75%	100%	65%	75%

Groundwater Level Change* - Fall 2011 to Fall 2015



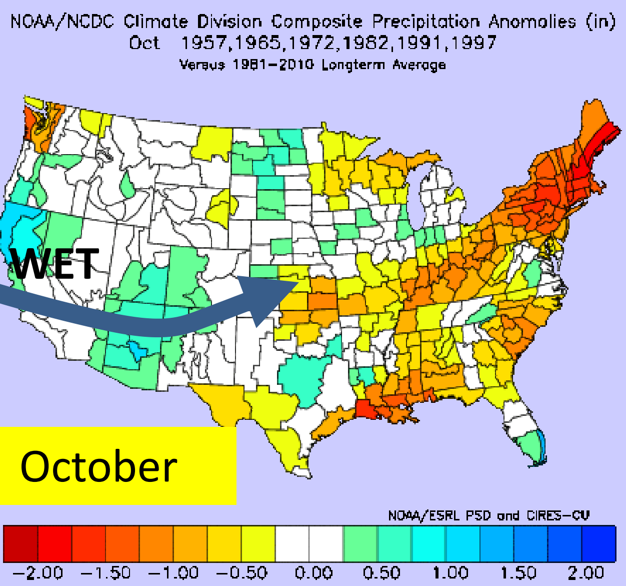
*Groundwater level change determined from water level measurements in wells. Map and chart based on available data from the DWR Water Data Library as of 12/31/2015. Document Name: DOTMAP_F1511_JJ_50 Updated: 2/1/2016 Data subject to change without notice.

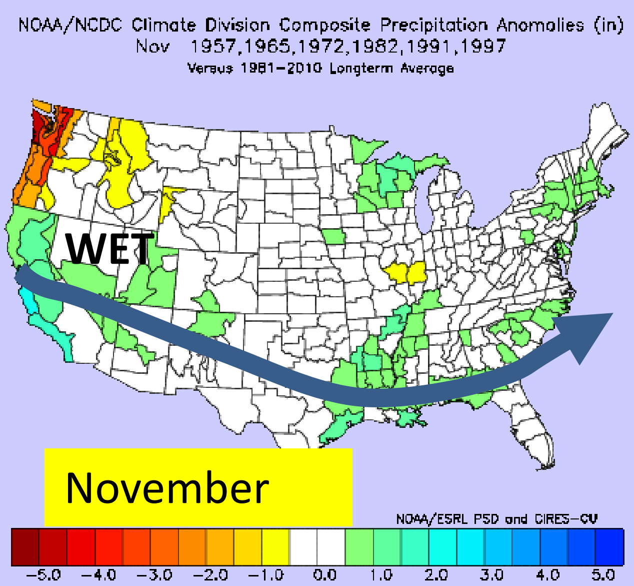
San Joaquin Valley Subsidence
May 2014 to January 2015

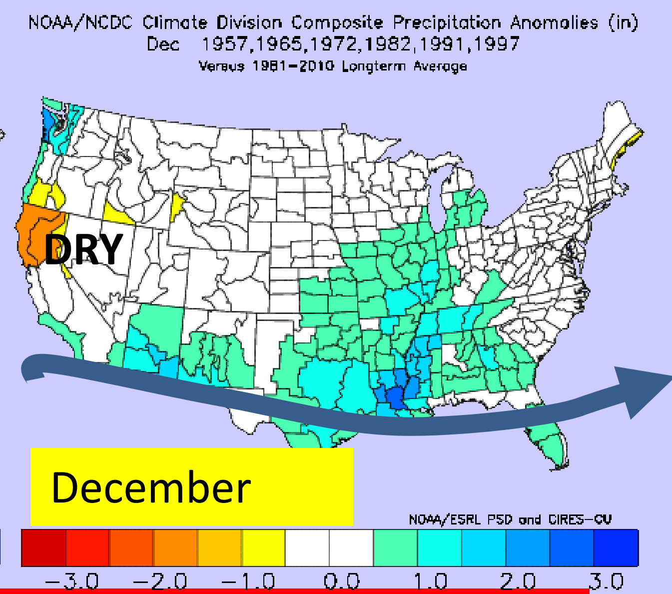


1:350,000   1 in = 6 miles

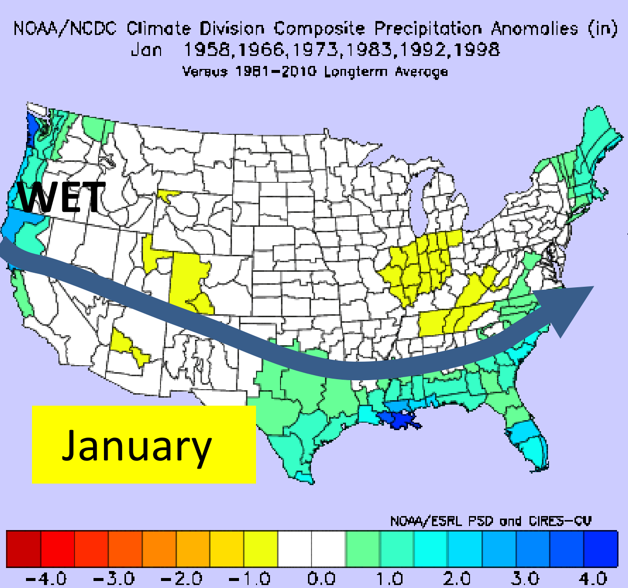
NASA JPL, 2015

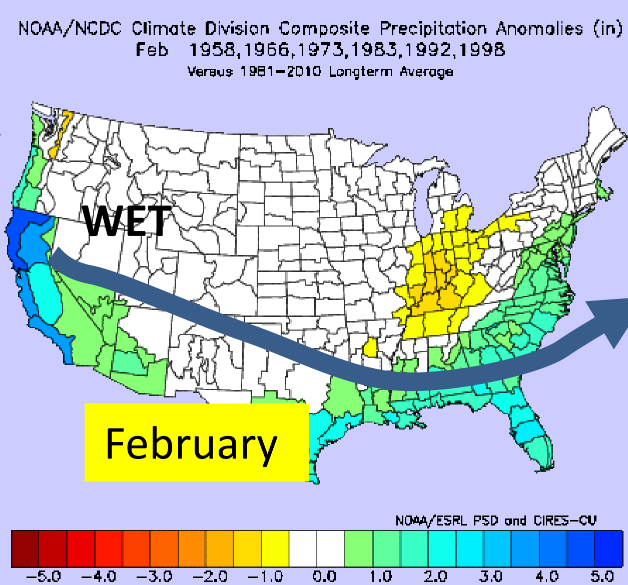


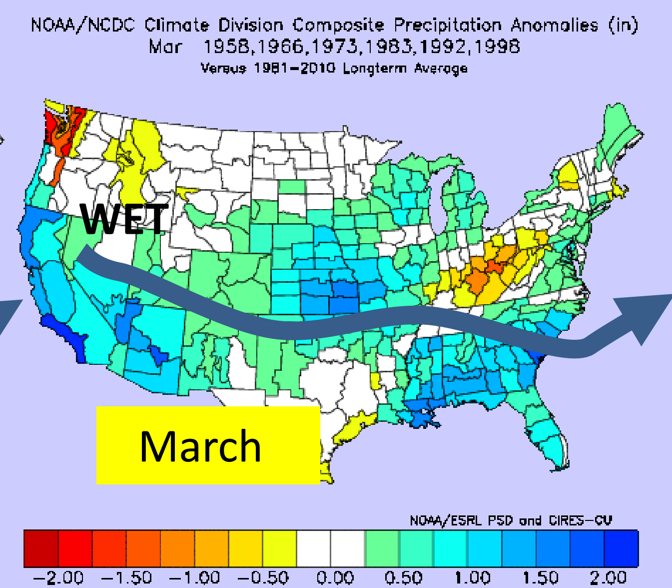


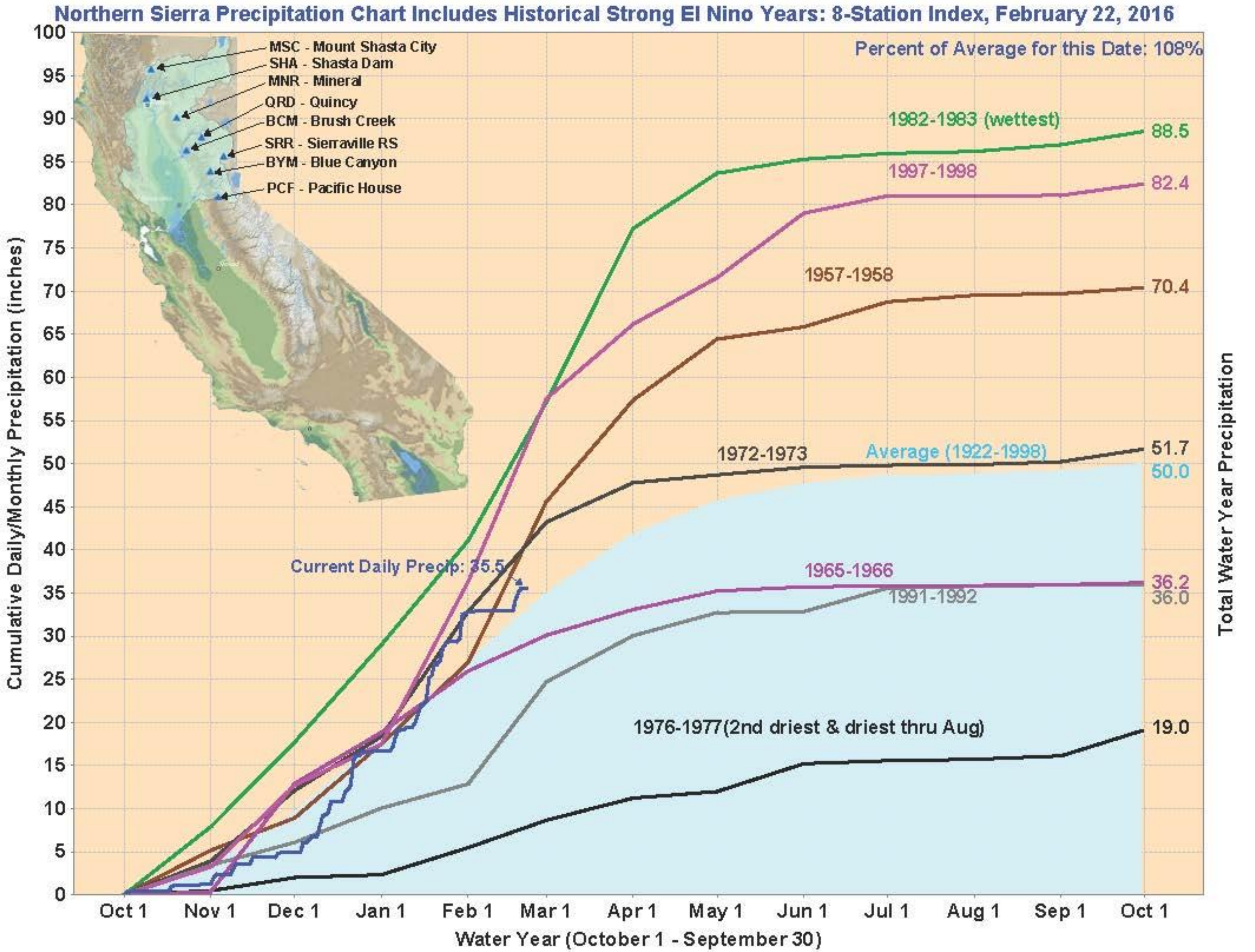


Precipitation All *Strong* El Nino Month by Month








Northern Sierra Precipitation Chart Includes Historical Strong El Nino Years: 8-Station Index, February 22, 2016
Percent of Average for this Date: 108%
MSC - Mount Shasta City
SHA - Shasta Dam
MNR - Mineral
QRD - Quincy
BCM - Brush Creek
SRR - Sierraville RS
BYM - Blue Canyon
PCF - Pacific House
1982-1983 (wettest)
88.5
1997-1998
82.4
1957-1958
70.4
1972-1973
Average (1922-1998)
51.7
50.0
Current Daily Precip: 35.5
1965-1966
36.2
1991-1992
36.0
1976-1977(2nd driest & driest thru Aug)
19.0
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
Water Year (October 1 - September 30)
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

And What If 2017 Is Dry?