Colorado Climate Update

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http://ccc.atmos.colostate.edu

Presented to the Colorado Farm Show

Wednesday, January 30, 2013

Prepared by Wendy Ryan and Zach Schwalbe

Colorado State University
Knowledge to Go Places

COLORADO CLIMATE CENTER

Topics we will cover today

- Background
- A review of state climate conditions over the past year
- Where 2012 fit in the historic perspective
- Recent climate and snowpack conditions
- 2013 climate predictions
- CoAgMet status report
- CoCoRaHS – Appeal for more rain gauge volunteers – more help still needed!

First -- A short background

- In 1973 the federal government abolished the “State Climatologist” program nationwide leaving Colorado without
- Later that same year, Colorado established the Colorado Climate Center at Colorado State University with support through the Colorado Agricultural Experiment Station.

Colorado State University
Knowledge to Go Places

Colorado
Agricultural Experiment Station

COLORADO CLIMATE CENTER

Our Mission

- The Colorado Climate Center at CSU provides valuable climate expertise to the residents of the state through its threefold program of:

  1) ***Climate Monitoring*** (data acquisition, analysis, and archiving),

  2) ***Climate Research***

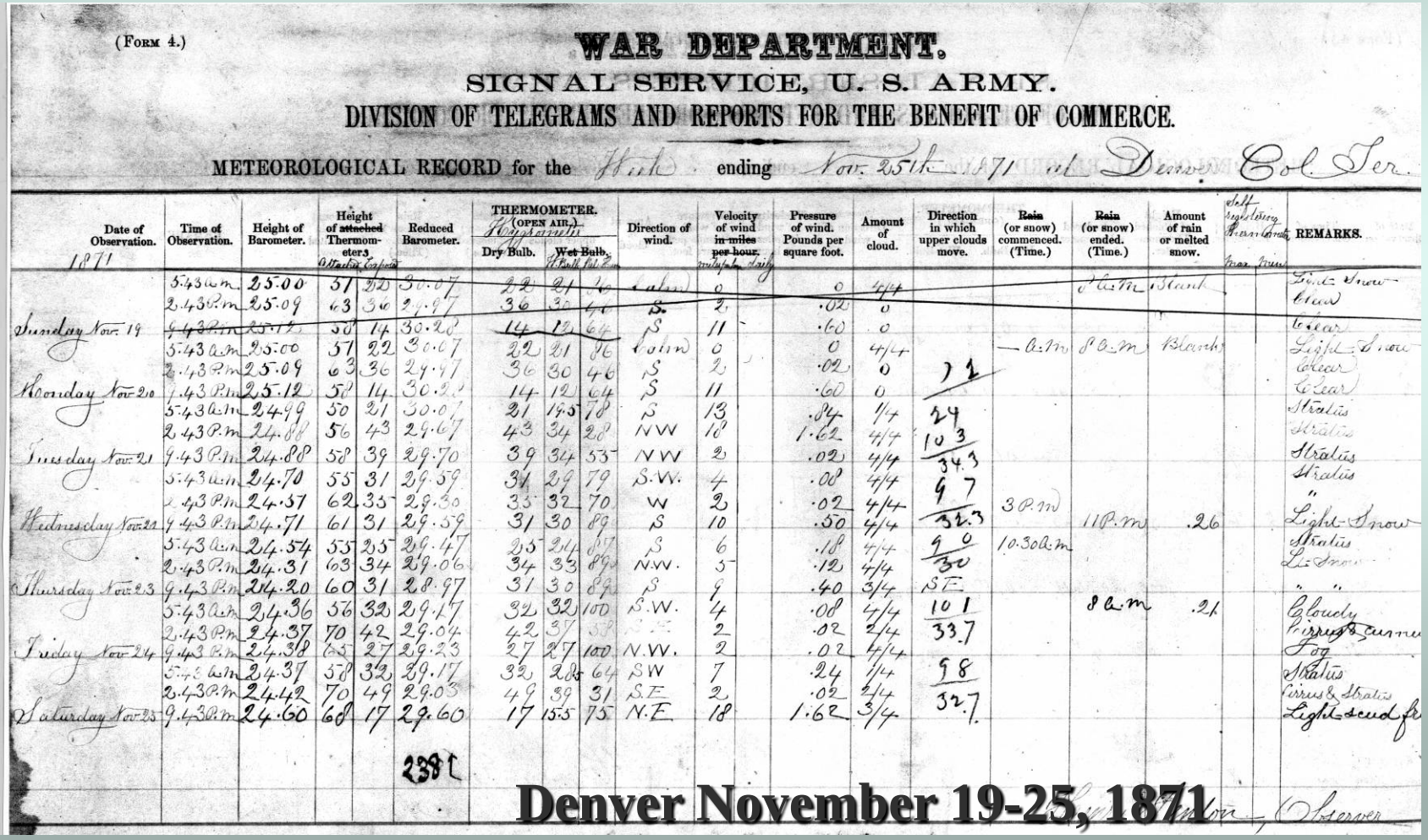
  3) ***Climate Services***.(providing data, analysis, climate expertise, education and outreach)

Monitoring our Climate

- Elements: temperature, precipitation, snow, wind, solar, evaporation, soil temperatures, humidity, clouds, etc.

Fort Collins CSU Historic Weather Station

Systematic weather data collection began in Colorado in the 1870s and 1880s



(Form 4.)

WAR DEPARTMENT.

SIGNAL SERVICE, U. S. ARMY.

DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

METEOROLOGICAL RECORD for the Week ending Nov. 25th 1871 at Denver Col. Ter.

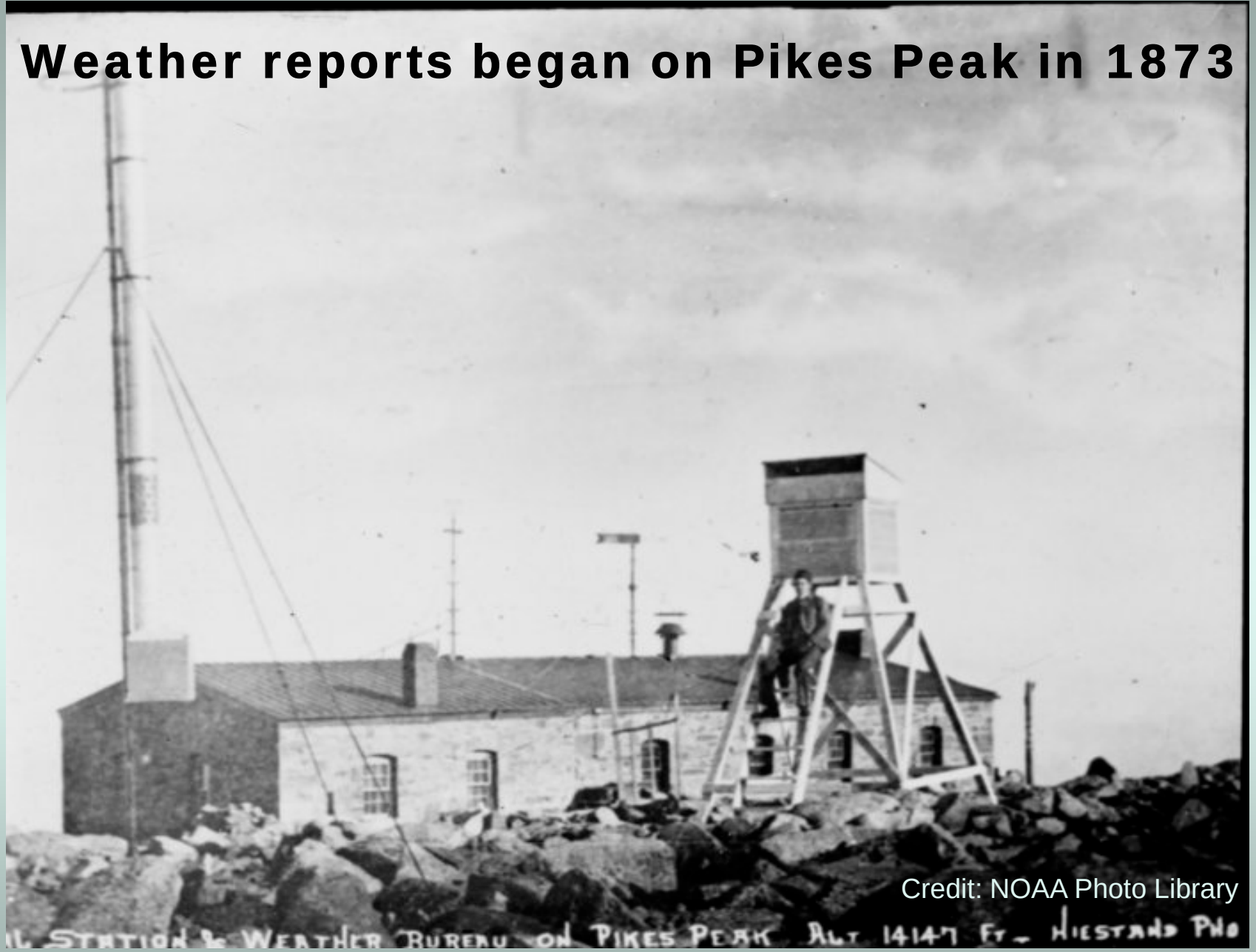
Date of Observation. 1871	Time of Observation.	Height of Barometer.	Height of ~~attached~~ Thermometer3 Attached Cistern		Reduced Barometer.	THERMOMETER. (OPEN AIR.) Fahrenheit Dry Bulb.	Wet Bulb. Fl. Bulb Pol. Bar.		Direction of wind.	Velocity of wind ~~in miles per hour.~~ Miles per day	Pressure of wind. Pounds per square foot.	Amount of cloud.	Direction in which upper clouds move.	~~Rain~~ (or snow) commenced. (Time.)	~~Rain~~ (or snow) ended. (Time.)	Amount of rain or melted snow.	Self registering Thermometers Max. Min.	REMARKS.
	5.43 a.m.	25.00	37	22	30.07	22	21	86	Calm	0	0	4/4			4 a.m.	Blank		Fine Snow
	2.43 P.m.	25.09	63	36	29.97	36	32	46	S.	2	.02	0						Clear
Sunday Nov. 19	9.43 P.m.	25.12	58	14	30.28	14	12	64	S	11	.60	0						Clear
	5.43 a.m.	25.00	37	22	30.07	22	21	86	Calm	0	0	4/4		— a.m.	8 a.m.	Blank		Light Snow
	2.43 P.m.	25.09	63	36	29.97	36	30	46	S	2	.02	0	72					Clear
Monday Nov. 20	9.43 P.m.	25.12	58	14	30.28	14	12	64	S	11	.60	0						Clear
	5.43 a.m.	24.99	50	21	30.07	21	19.5	78	S	13	.84	1/4	24					Stratus
	2.43 P.m.	24.88	56	43	29.67	43	34	28	NW	18	1.62	4/4	103					Stratus
Tuesday Nov. 21	9.43 P.m.	24.88	58	39	29.70	39	34	53	NW	2	.02	4/4	34.3					Stratus
	5.43 a.m.	24.70	55	31	29.59	34	29	79	S.W.	4	.08	4/4	97					Stratus
	2.43 P.m.	24.57	62	35	29.30	33	32	70	W	2	.02	4/4	32.3	3 P.m.				"
Wednesday Nov. 22	9.43 P.m.	24.71	61	31	29.59	31	30	89	S	10	.50	4/4	90		11 P.m.		.26	Light Snow
	5.43 a.m.	24.54	55	25	29.47	25	24	87	S	6	.18	4/4	30	10.30 a.m.				Stratus
	2.43 P.m.	24.31	63	34	29.06	34	33	89	N.W.	5	.12	4/4						Lt. Snow
Thursday Nov. 23	9.43 P.m.	24.20	60	31	28.97	31	30	89	S	9	.40	3/4	SE					" "
	5.43 a.m.	24.36	56	32	29.17	32	32	100	S.W.	4	.08	4/4	101		8 a.m.		.21	Cloudy
	2.43 P.m.	24.37	70	42	29.04	42	37	38	[illegible]	2	.02	2/4	33.7					Cirrus & Cumu
Friday Nov. 24	9.43 P.m.	24.38	65	27	29.23	27	27	100	N.W.	2	.02	4/4						Fog
	5.43 a.m.	24.37	58	32	29.17	32	28	64	SW	7	.24	1/4	98					Stratus
	2.43 P.m.	24.42	70	49	29.03	49	39	31	S.E.	2	.02	2/4	32.7					Cirrus & Stratus
Saturday Nov. 25	9.43 P.m.	24.60	68	17	29.60	17	15.5	75	N.E.	18	1.62	3/4						Light scud fr

238 C

Observer

Denver November 19-25, 1871

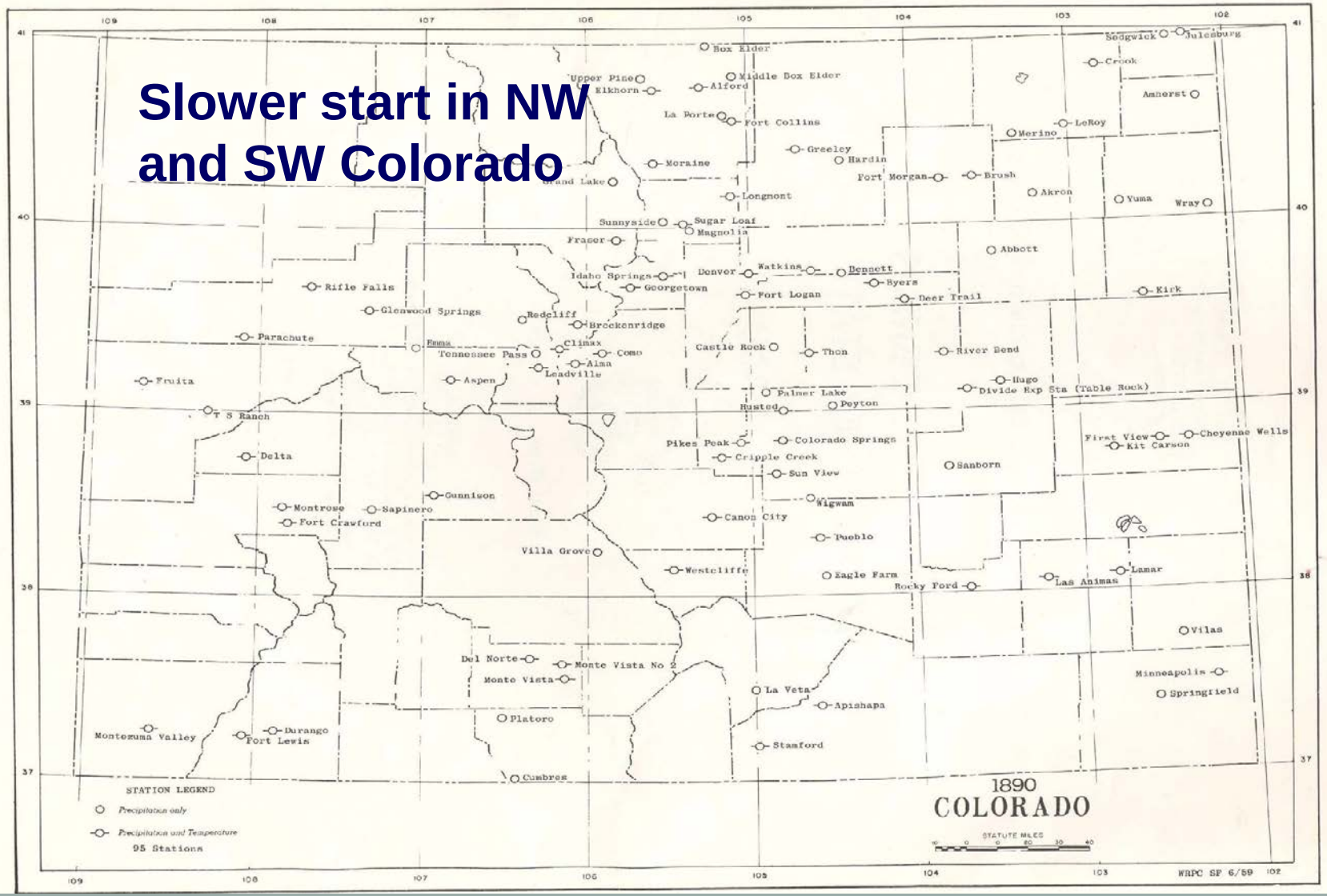
Weather reports began on Pikes Peak in 1873



Reports were sent by telegraph every few hours

Stories abounded in the national media of the rigors of Colorado Climate

Colorado Weather Stations in 1890

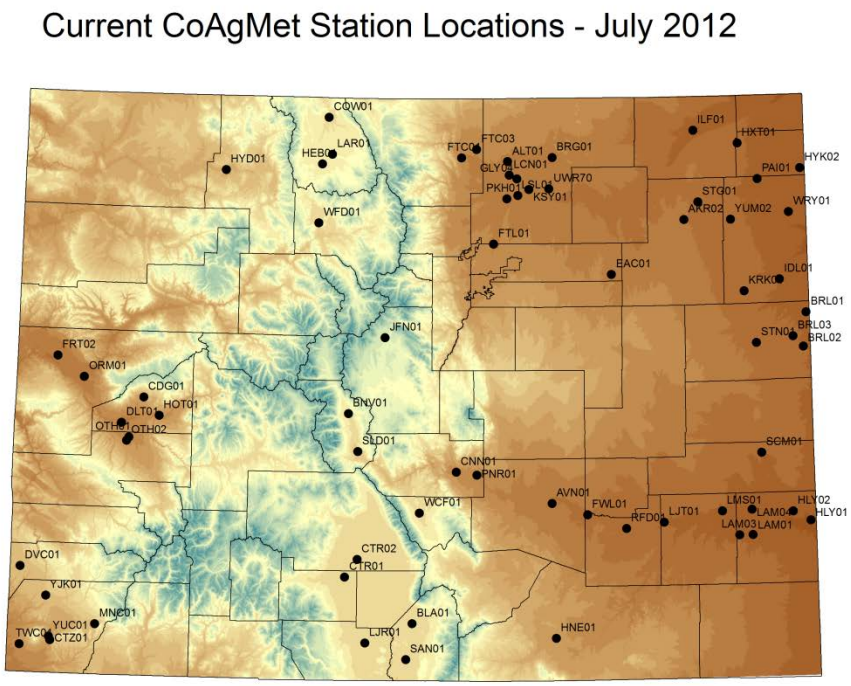


Since then, the U.S. Weather Bureau/National Weather Service has faithfully maintained an oft taken for granted network of weather stations in Colorado and across the country – the Cooperative Observer Network

Photo by Christopher Davey

Many other sources of weather data have been added since the 1970s

CSU's Colorado Agricultural Meteorological Network "CoAgMet"



What have we learned from over 120 years of continuous climate monitoring?

Bulletin 245 June, 1918

The Agricultural Experiment Station

OF THE

Colorado Agricultural College

COLORADO CLIMATOLOGY

By ROBERT E. TRIMBLE

PUBLISHED BY THE EXPERIMENT STATION
FORT COLLINS, COLORADO
1918

the mean temperature of any section of the country.

Colorado being an arid state, the amount of precipitation is at all times a vital question. Liability to a marked deficiency in rainfall in any region is a matter of grave concern to those engaged in agriculture and other interests. We often hear it stated that the rainfall is changing, that the settling up of the country and the planting of trees and building of reservoirs, forming lakes and wet places throughout the country, is causing an increase in the amount of our precipitation, but long series of observations taken at different places over the world, do not bear out that claim.

YEARS OF STUDY SHOWS CLIMATE NOT CHANGING

We often hear the statement made that the climate is changing, and the popular belief that such is the case can only be explained by the generally short and defective memories of people who through exposure to a few severe storms in the past, or inconvenience, or perhaps loss from a few of them, unintentionally exaggerate the severity and frequency of their occurrence. Although large fluctuations occur in different years with some indication of periodical terms, especially in Colorado, where the range of temperature is great, there seems to be no progressive change. These fluctuations are large and often in the same direction for several successive years.

In the meteorological data for the last one hundred years, the record of some places extending still further back, there

We Have a Fascinating Climate

- High elevation (highest state in the Union – by far)
- Mid-Latitude location (lively seasonal changes)
- Interior Continental Location far from atmospheric moisture sources
- Complex Mountain topography

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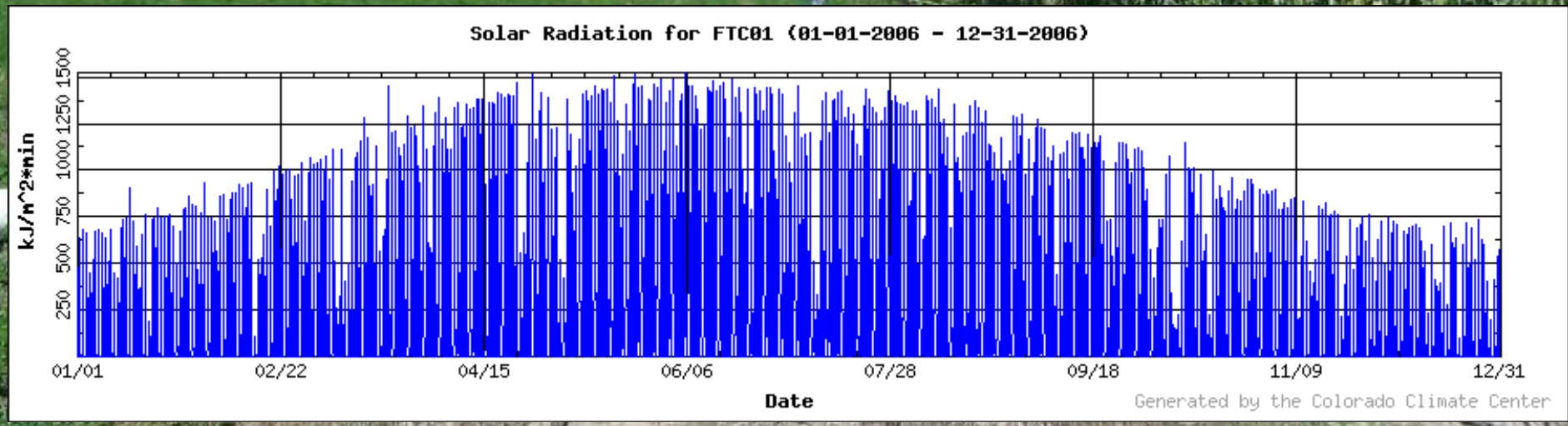
The Result?

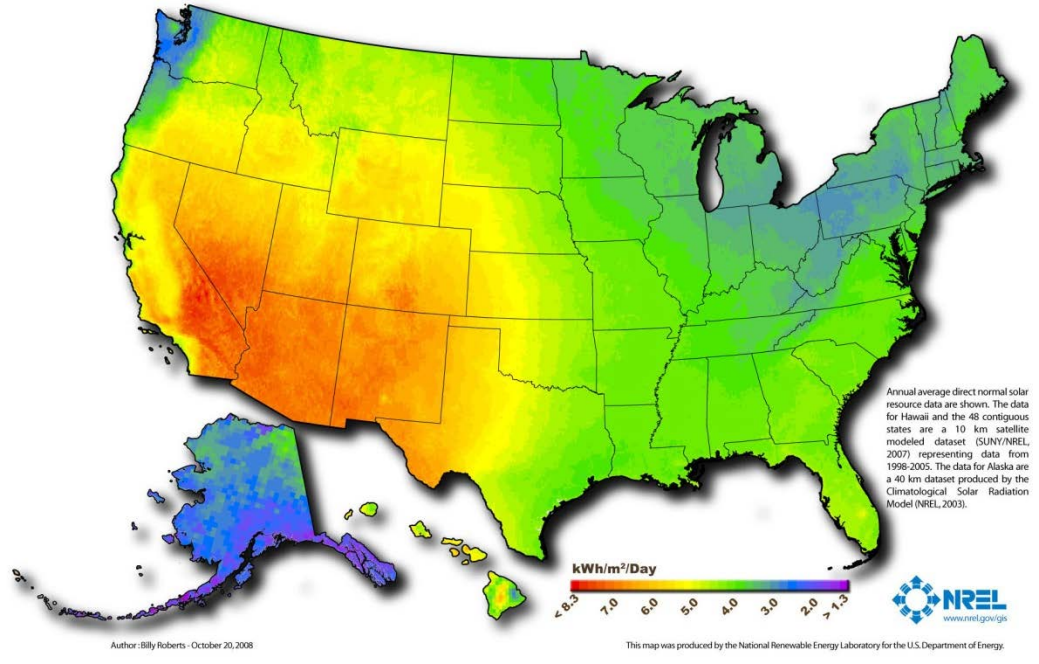
Generous sunshine, low humidity, and moderate temperatures much of the time

people like it here



Annual Average Solar Radiation

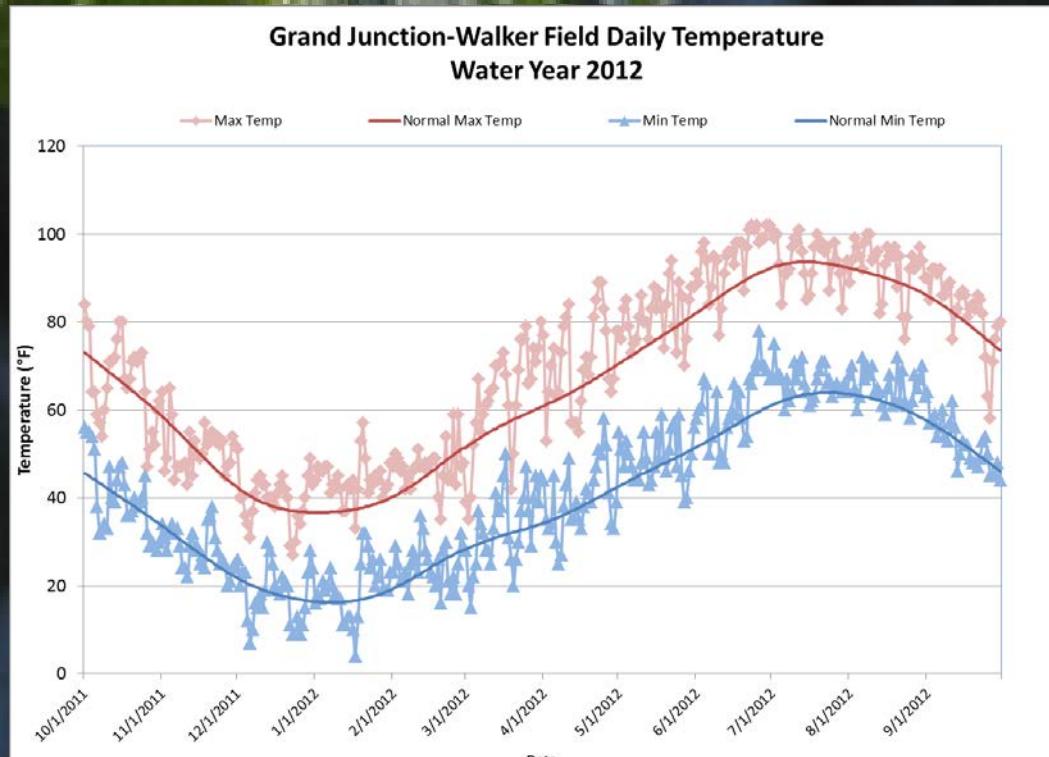
Colorado is a part of the Southwest “Sunbelt” ---- especially southern Colorado



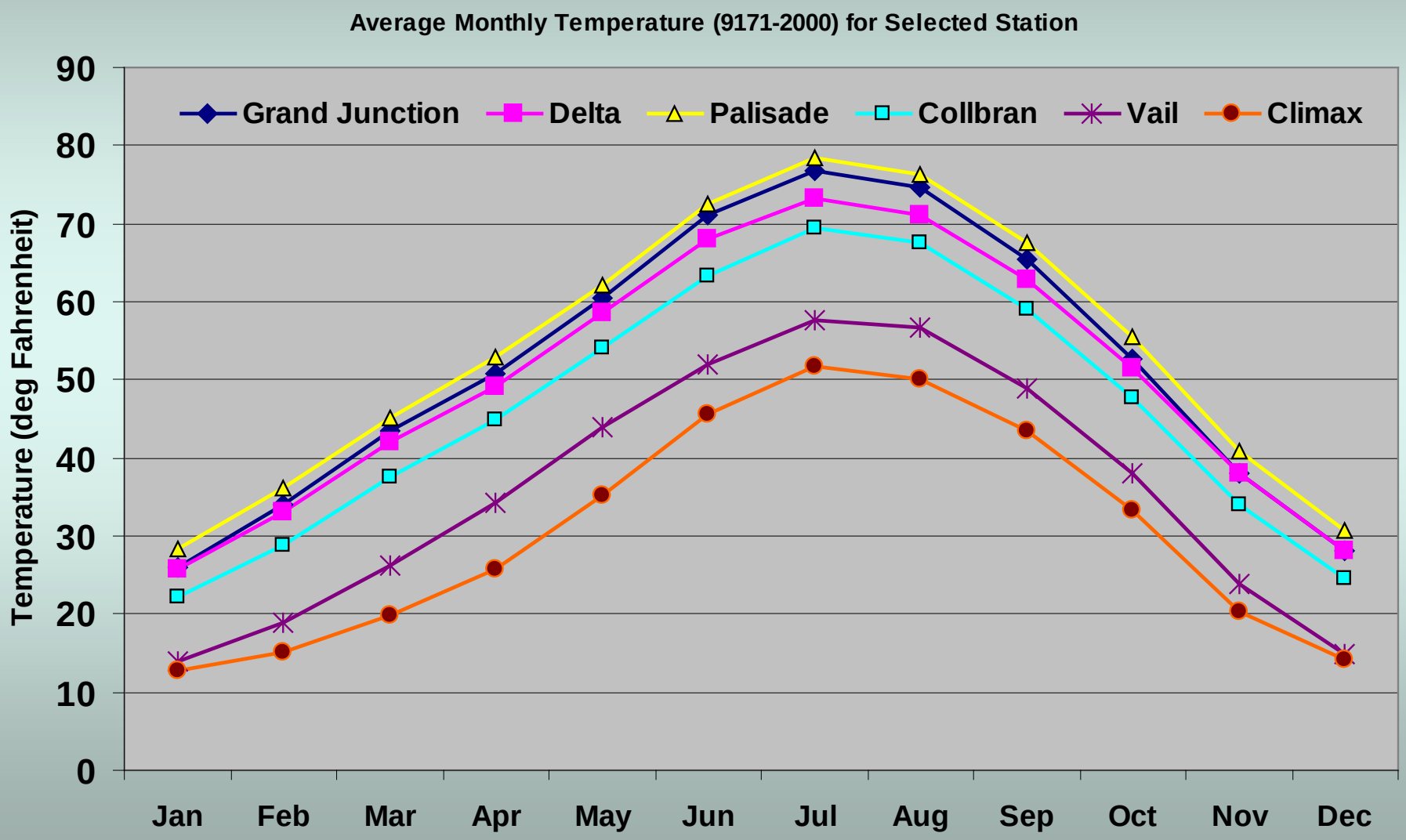
National Renewal Energy Laboratory: www.nrel.gov

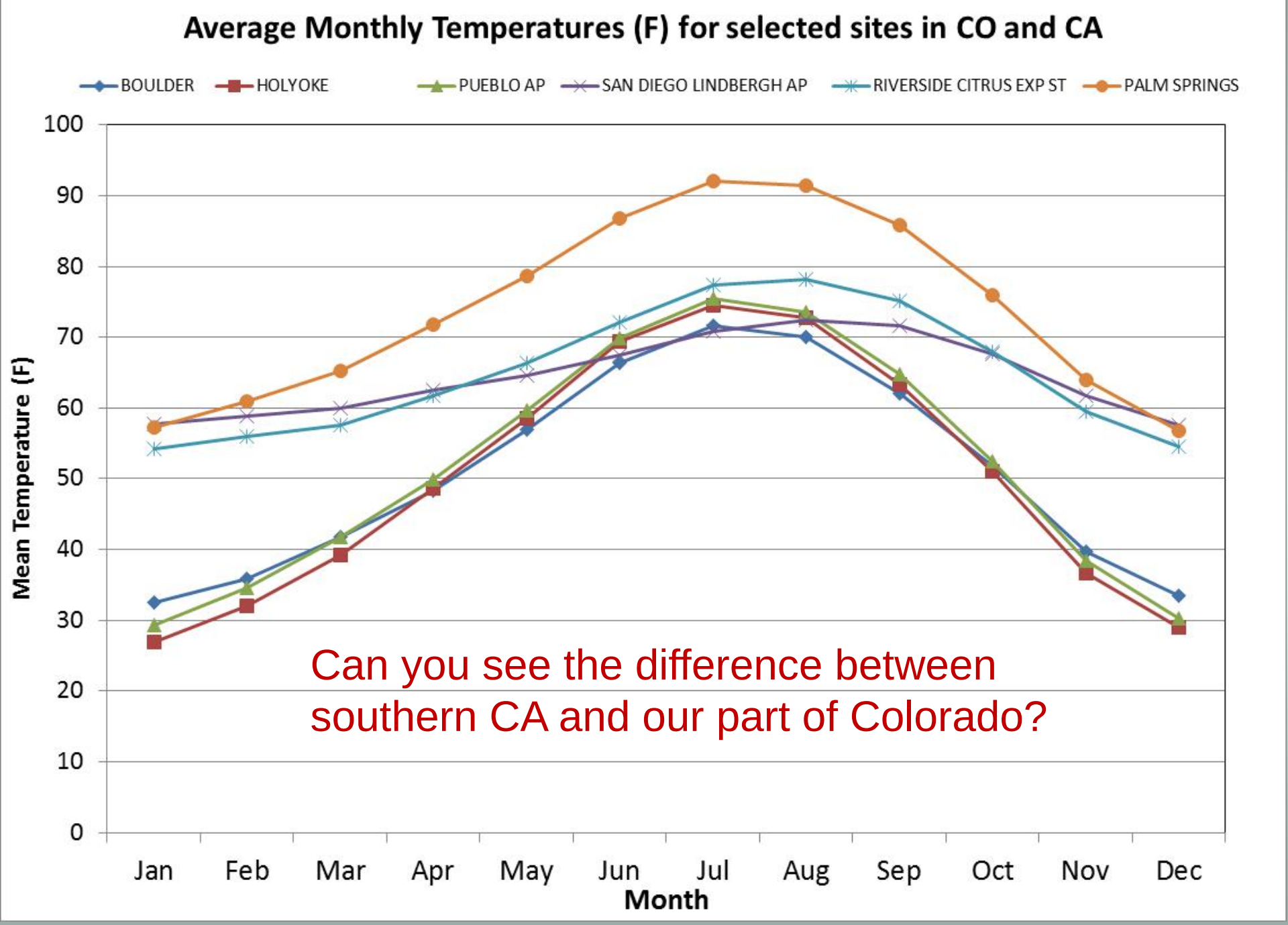
Large Seasonal Temperature Variations

Fruita, Colo.

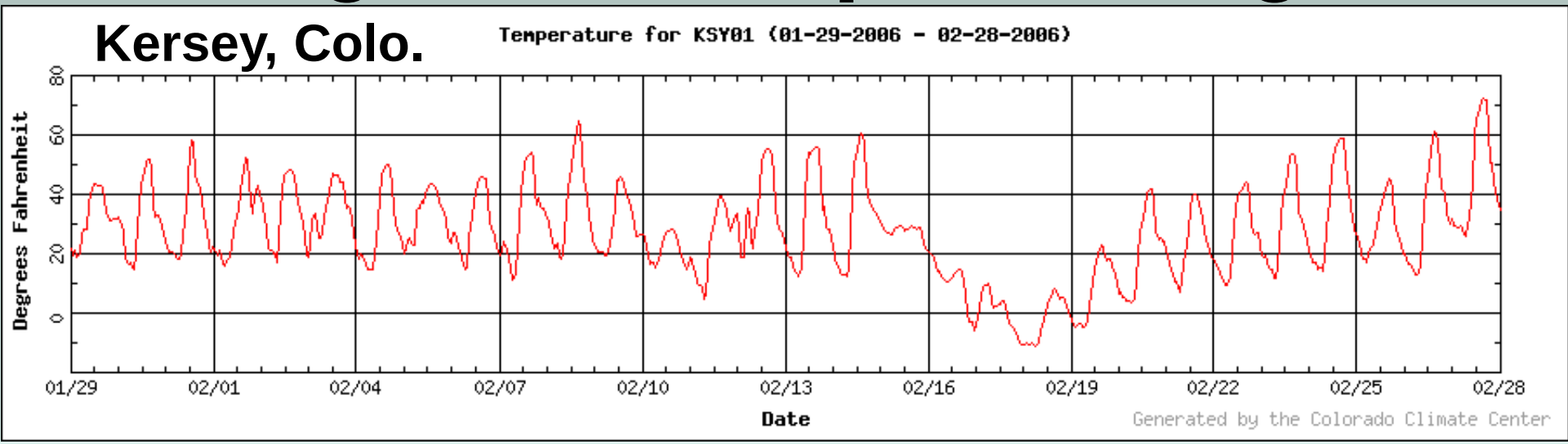


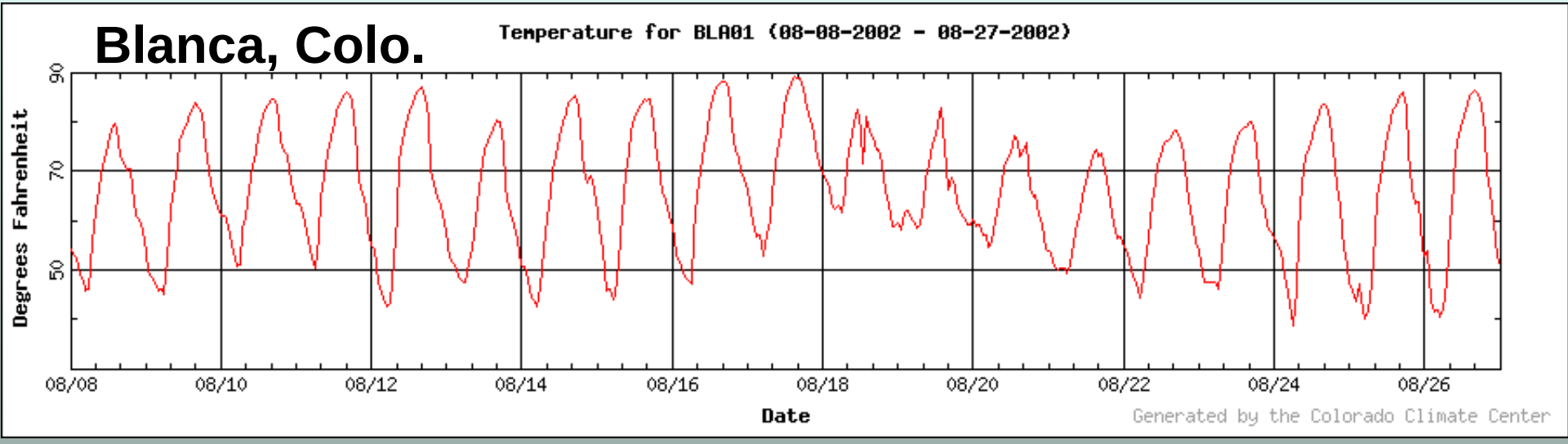
Winters are consistently colder than summers – ☺



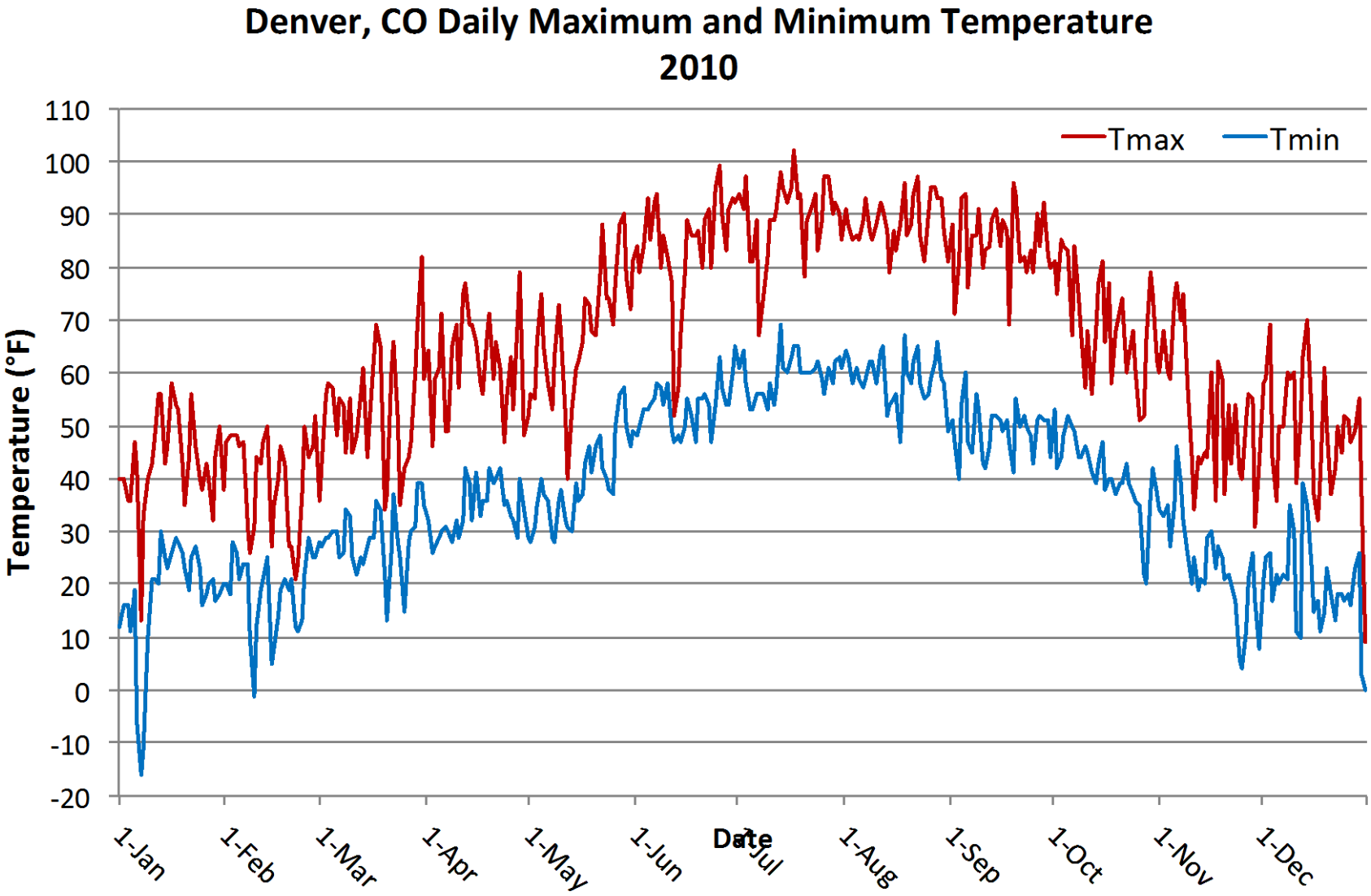

Average Monthly Temperatures (F) for selected sites in CO and CA
BOULDER
HOLYOKE
PUEBLO AP
SAN DIEGO LINDBERGH AP
RIVERSIDE CITRUS EXP ST
PALM SPRINGS
Mean Temperature (F)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Can you see the difference between southern CA and our part of Colorado?

Large diurnal temperature ranges and rapid changes

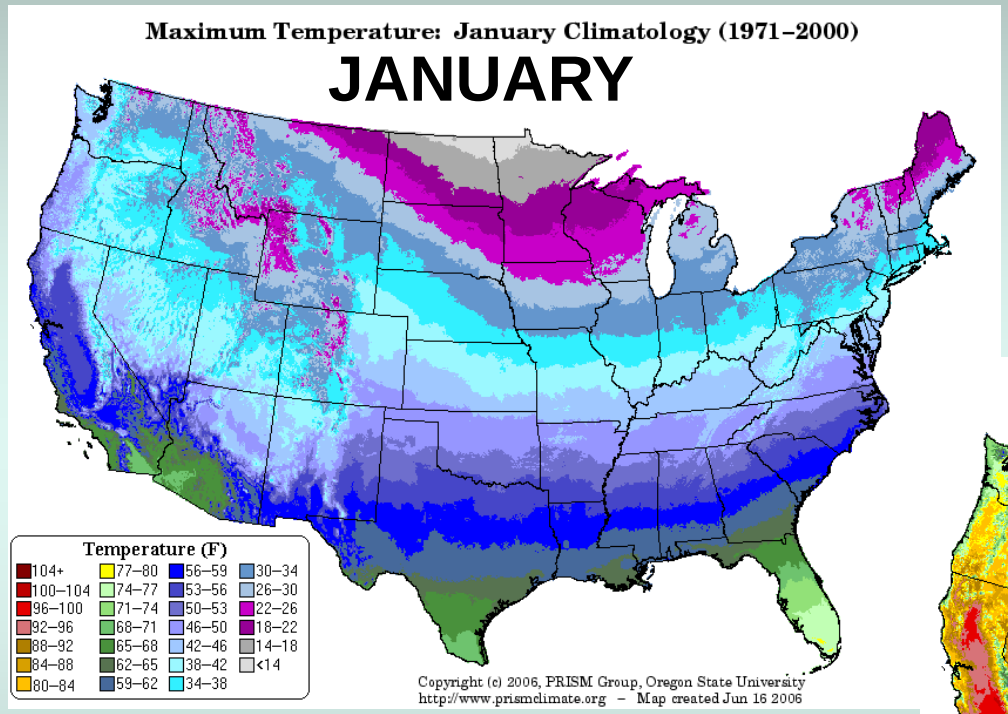


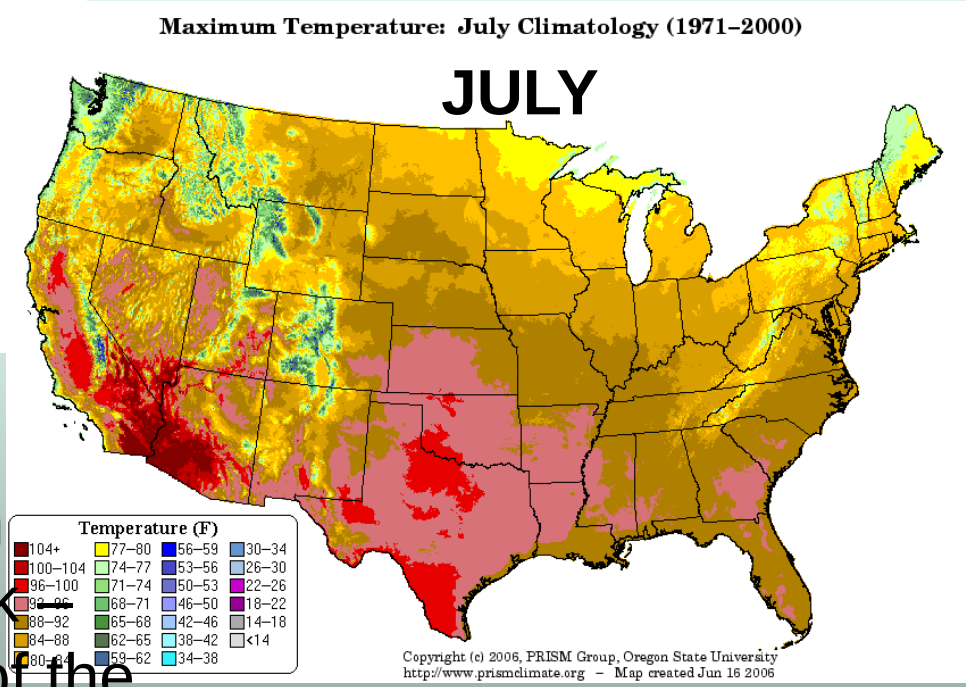


And this is how daily weather, over time, defines our climate



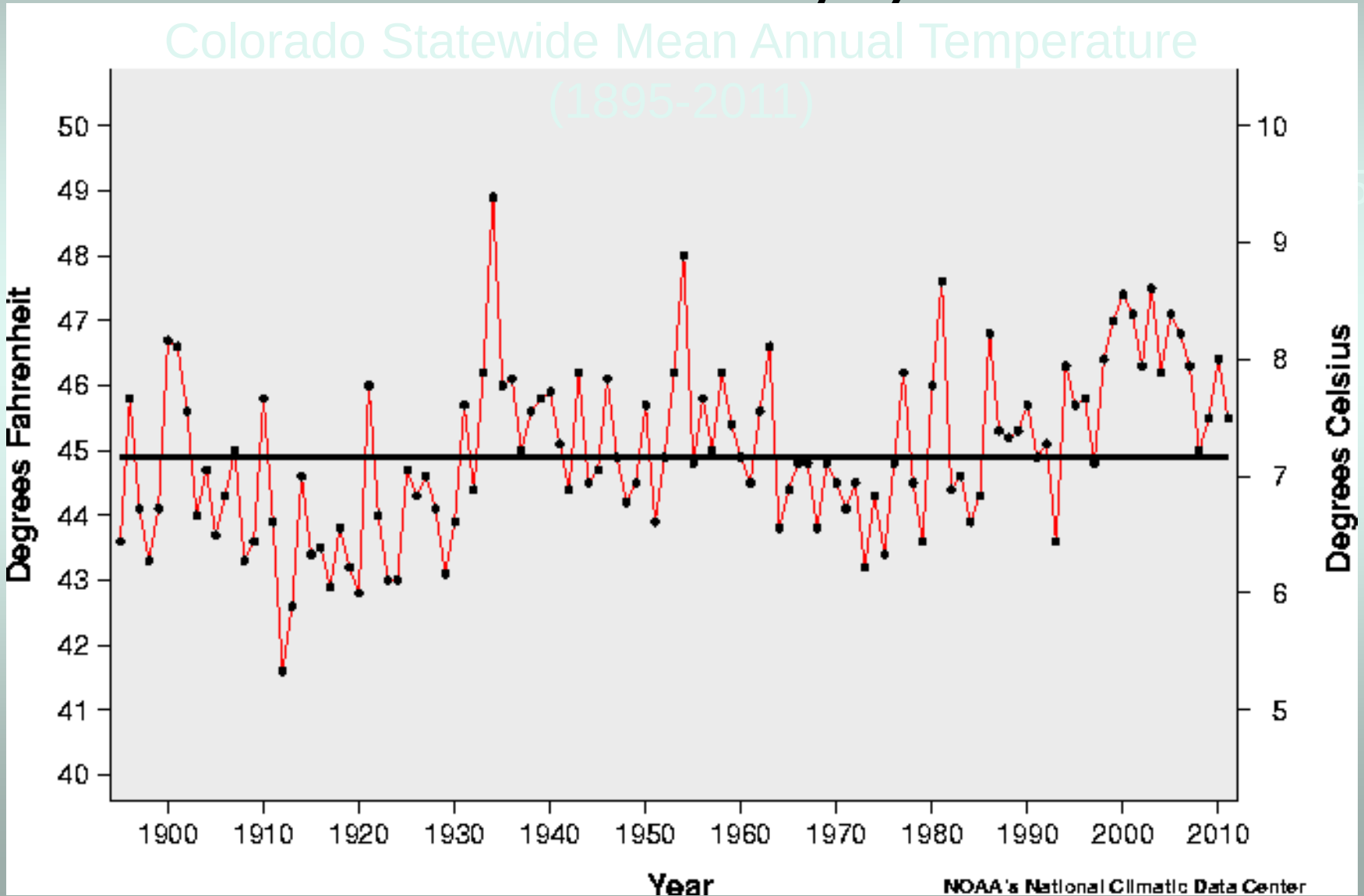
Complex local variations due to elevation and topography

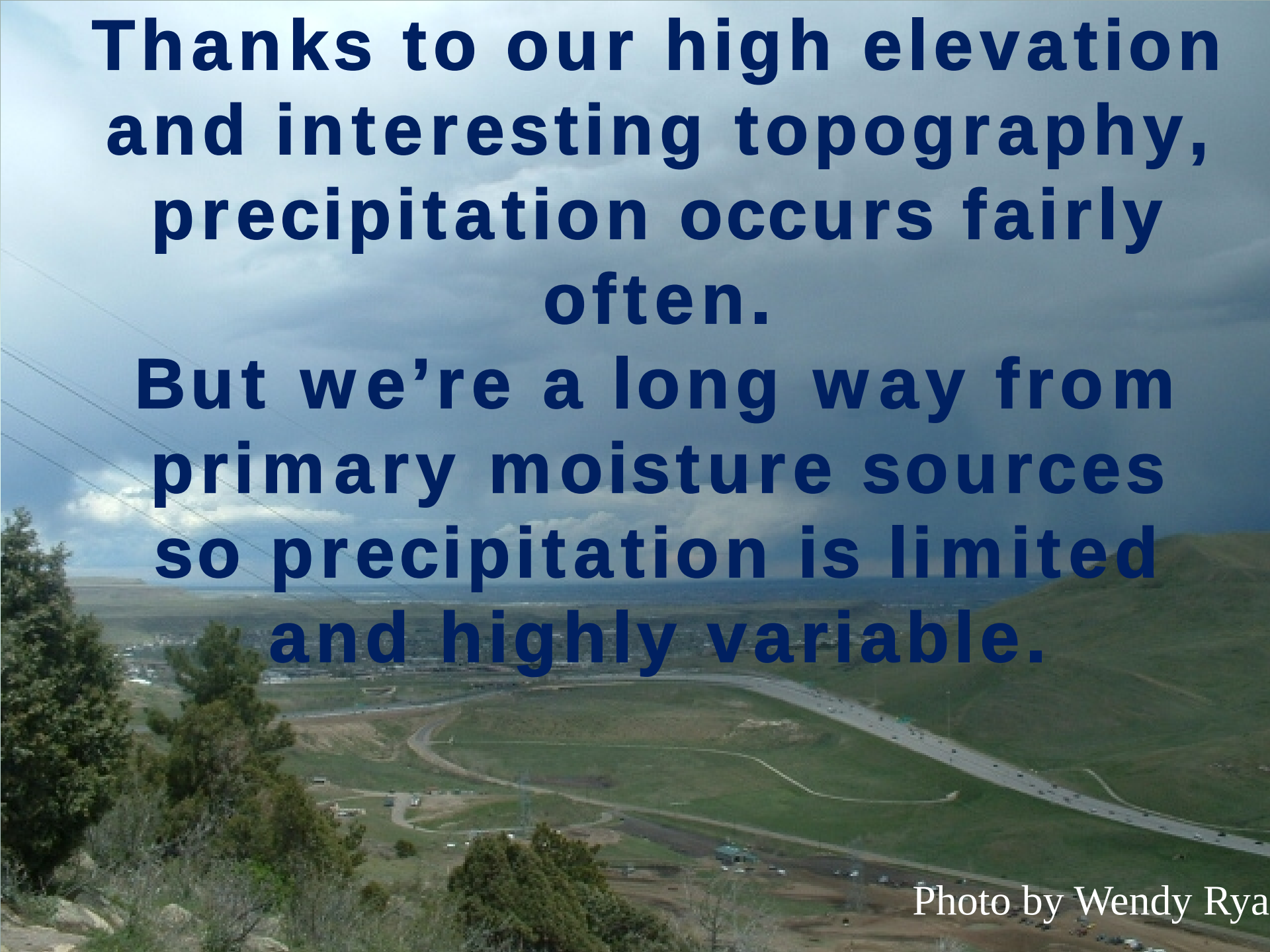




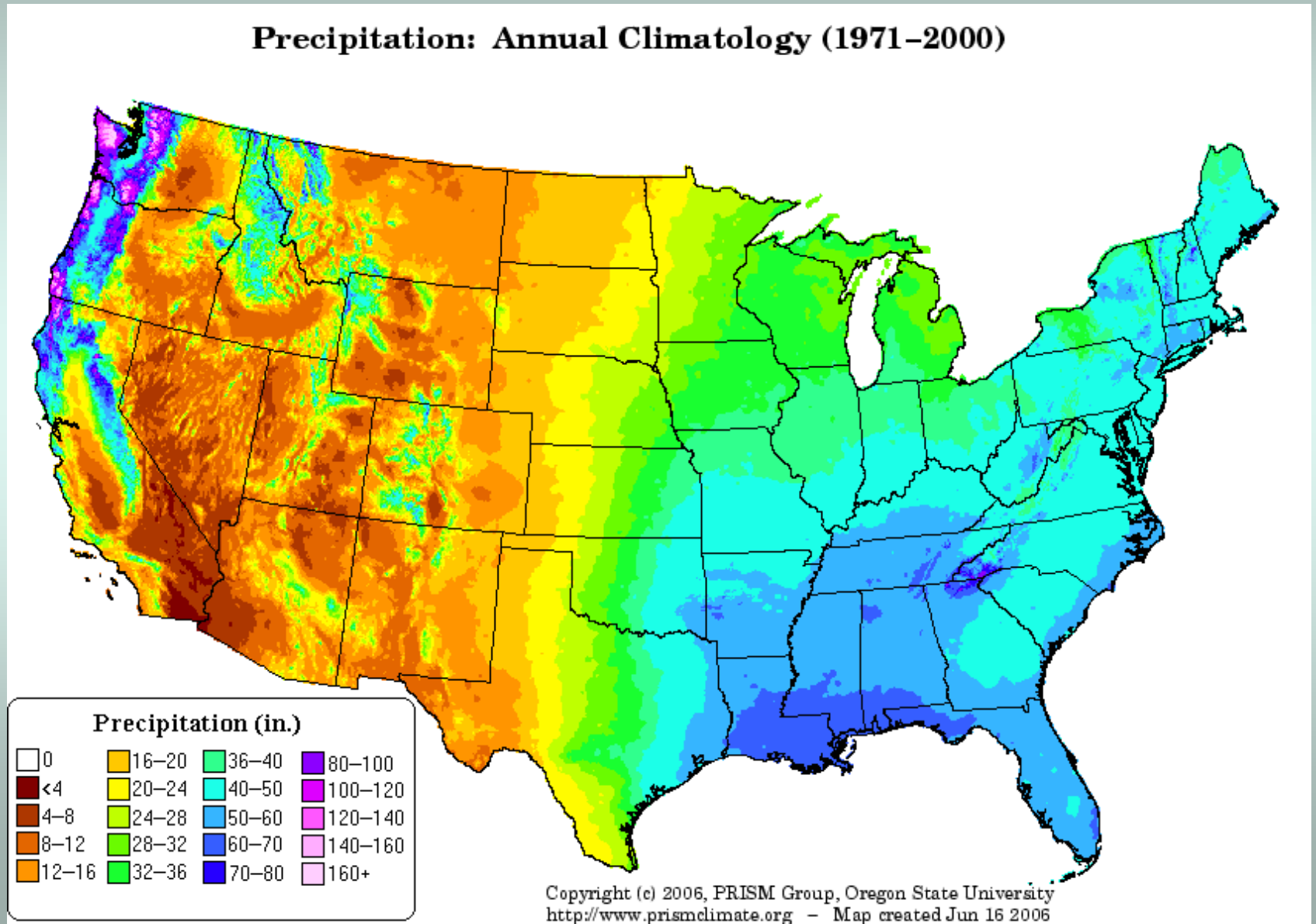
For example, variations within Rocky Mountain National Park. Totally different climate west of the Continental Divide than east even

Relatively Large Year to Year Variations ("Interannual Variabililty")

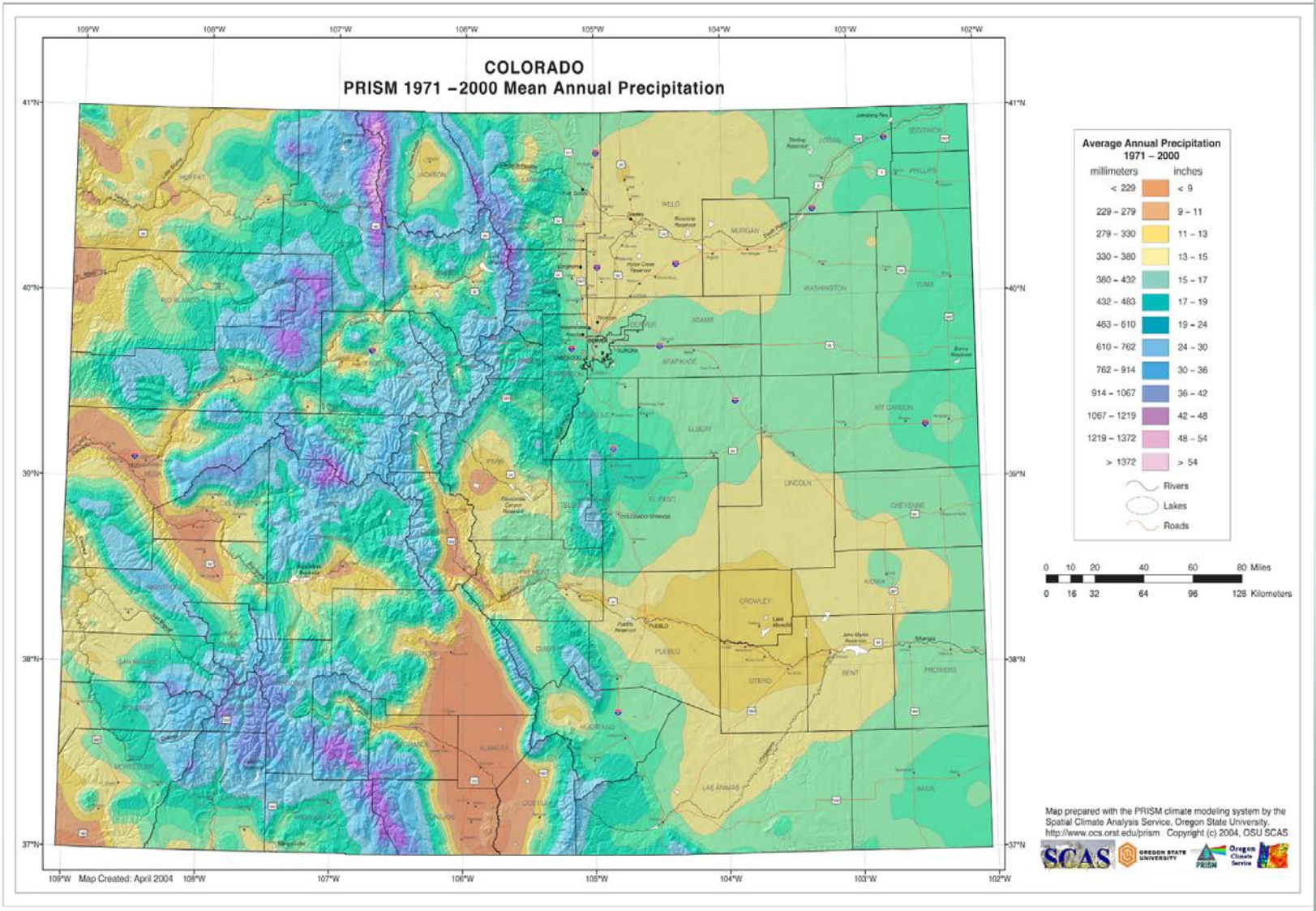



Thanks to our high elevation and interesting topography, precipitation occurs fairly often.
But we're a long way from primary moisture sources so precipitation is limited and highly variable.
Photo by Wendy Rya

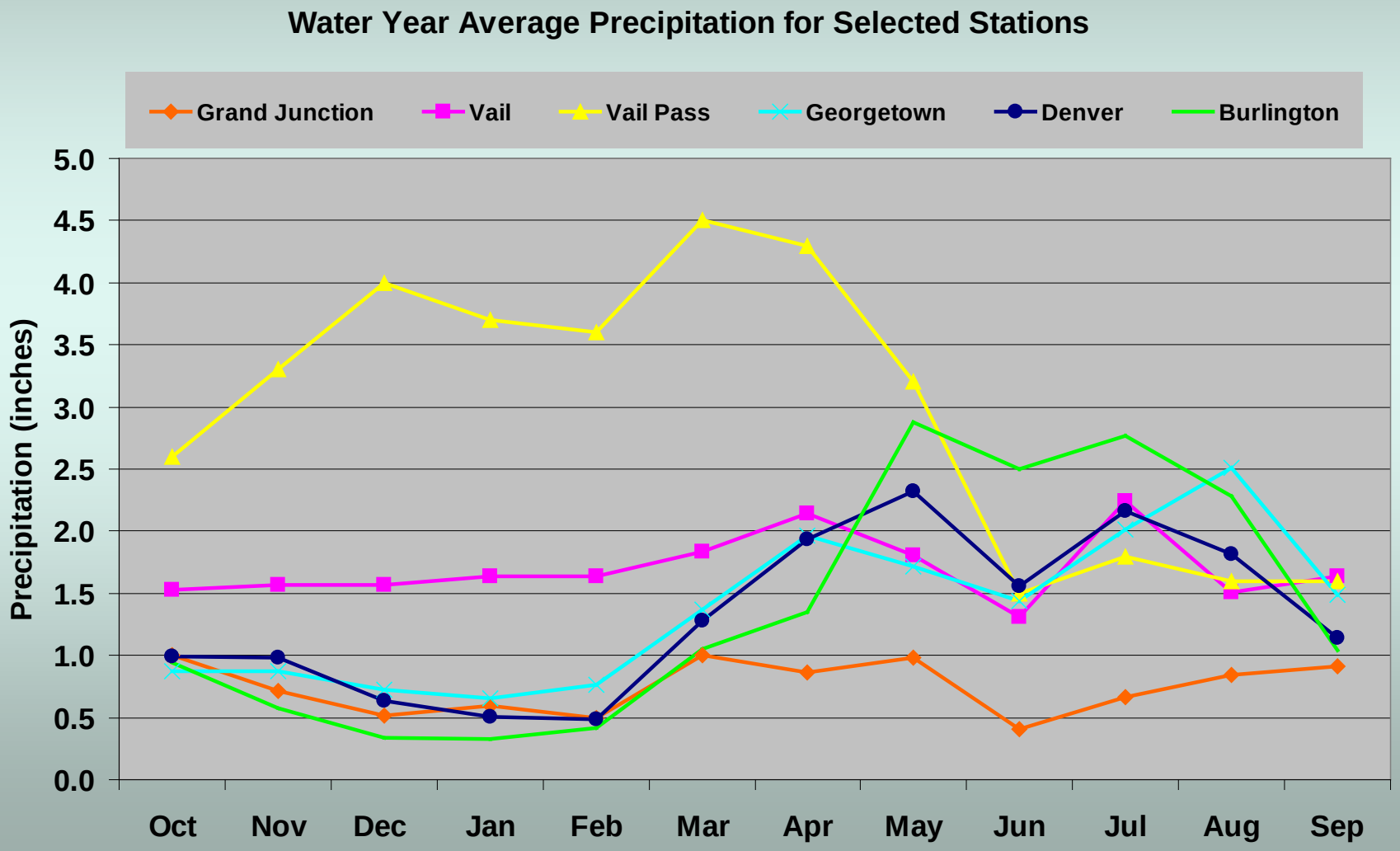
Where we fit in the national picture



Except for our mountains, we're already very dry most of the time.

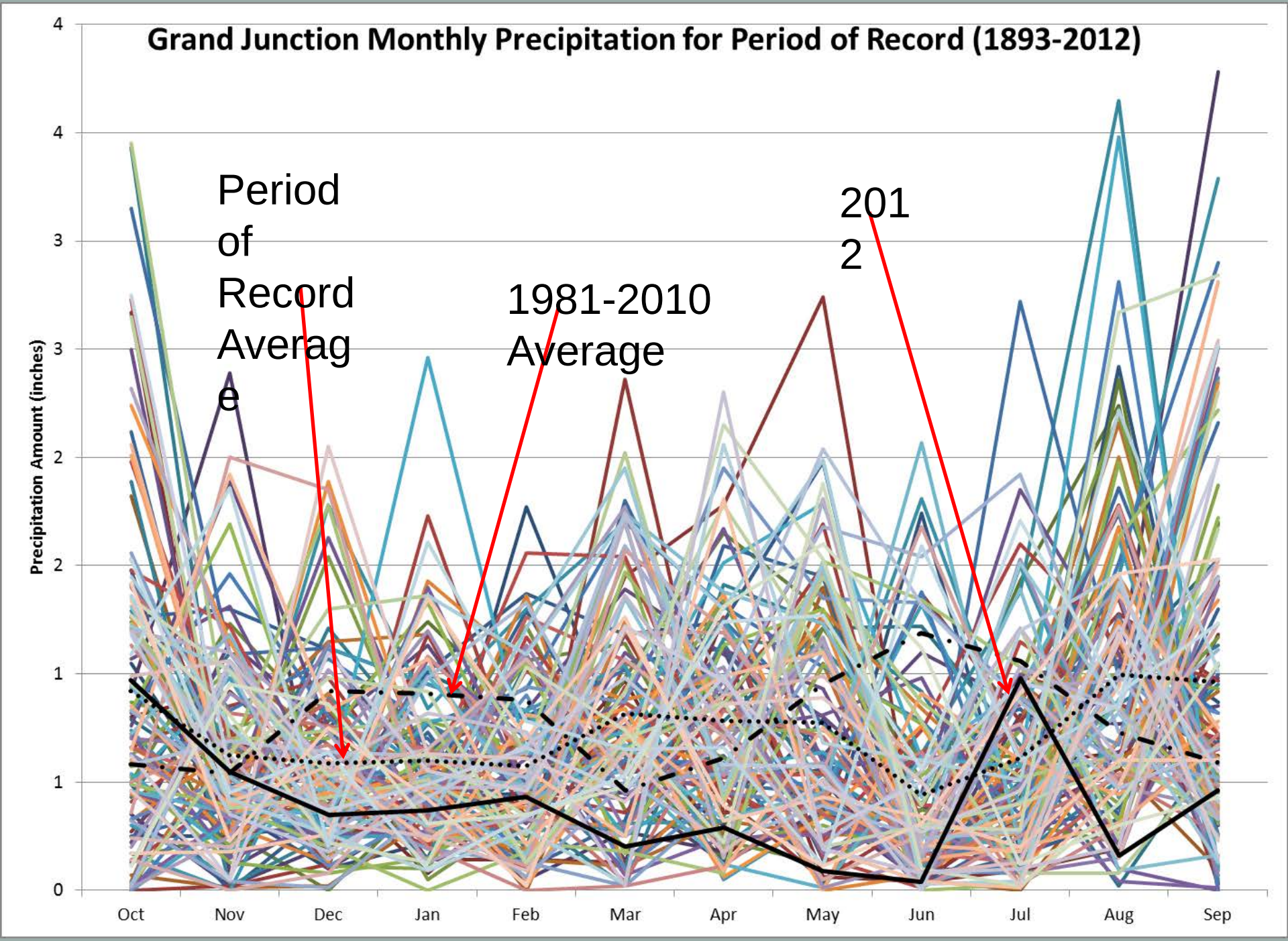


Highly seasonal precipitation patterns with considerable geographic diversity in “seasonality”

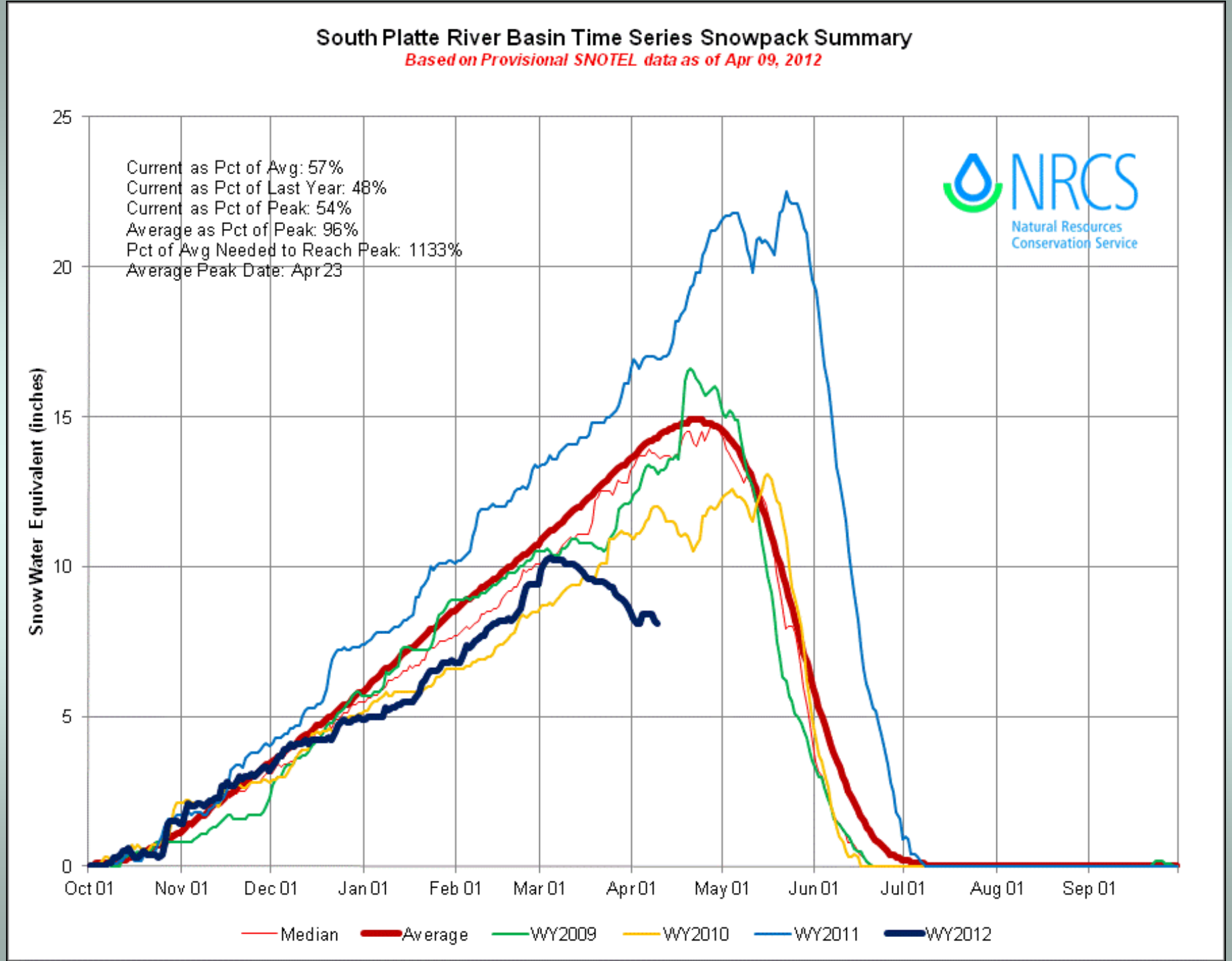


Large (actually "Huge") Year-to-Year Variations in Precipitation

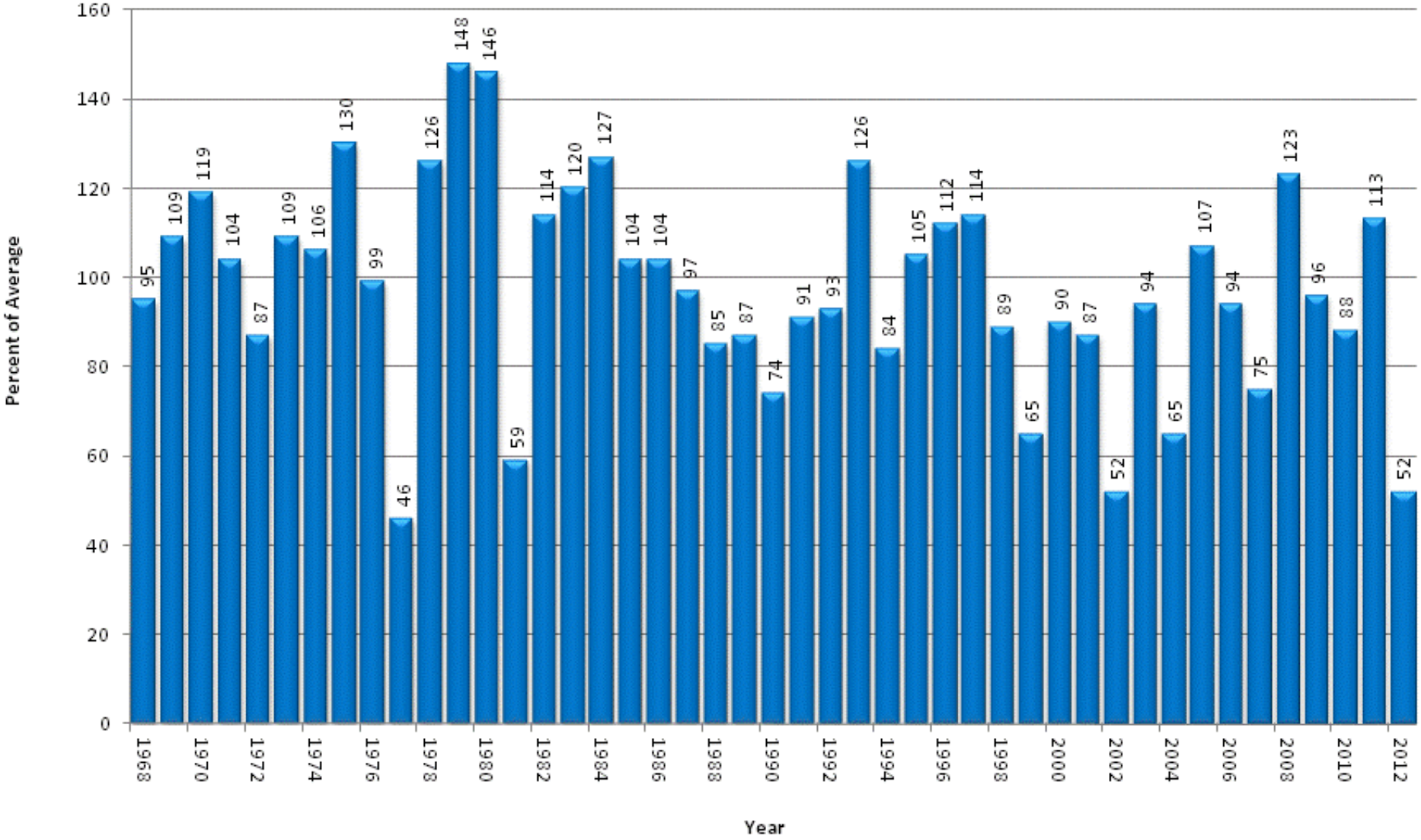
Are we ever "Average"? Probably not.


Grand Junction Monthly Precipitation for Period of Record (1893-2012)
Precipitation Amount (inches)
4
4
3
3
2
2
1
1
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Period of Record Average
1981-2010 Average
2012

Snow is “Way Important” in our climate and hydrology


South Platte River Basin Time Series Snowpack Summary
Based on Provisional SNOTEL data as of Apr 09, 2012
Current as Pct of Avg: 57%
Current as Pct of Last Year: 48%
Current as Pct of Peak: 54%
Average as Pct of Peak: 96%
Pct of Avg Needed to Reach Peak: 1133%
Average Peak Date: Apr 23
NRCS
Natural Resources Conservation Service
Snow Water Equivalent (inches)
25
20
15
10
5
0
Oct 01
Nov 01
Dec 01
Jan 01
Feb 01
Mar 01
Apr 01
May 01
Jun 01
Jul 01
Aug 01
Sep 01
Median
Average
WY2009
WY2010
WY2011
WY2012

April 1 Colorado Statewide Snowpack

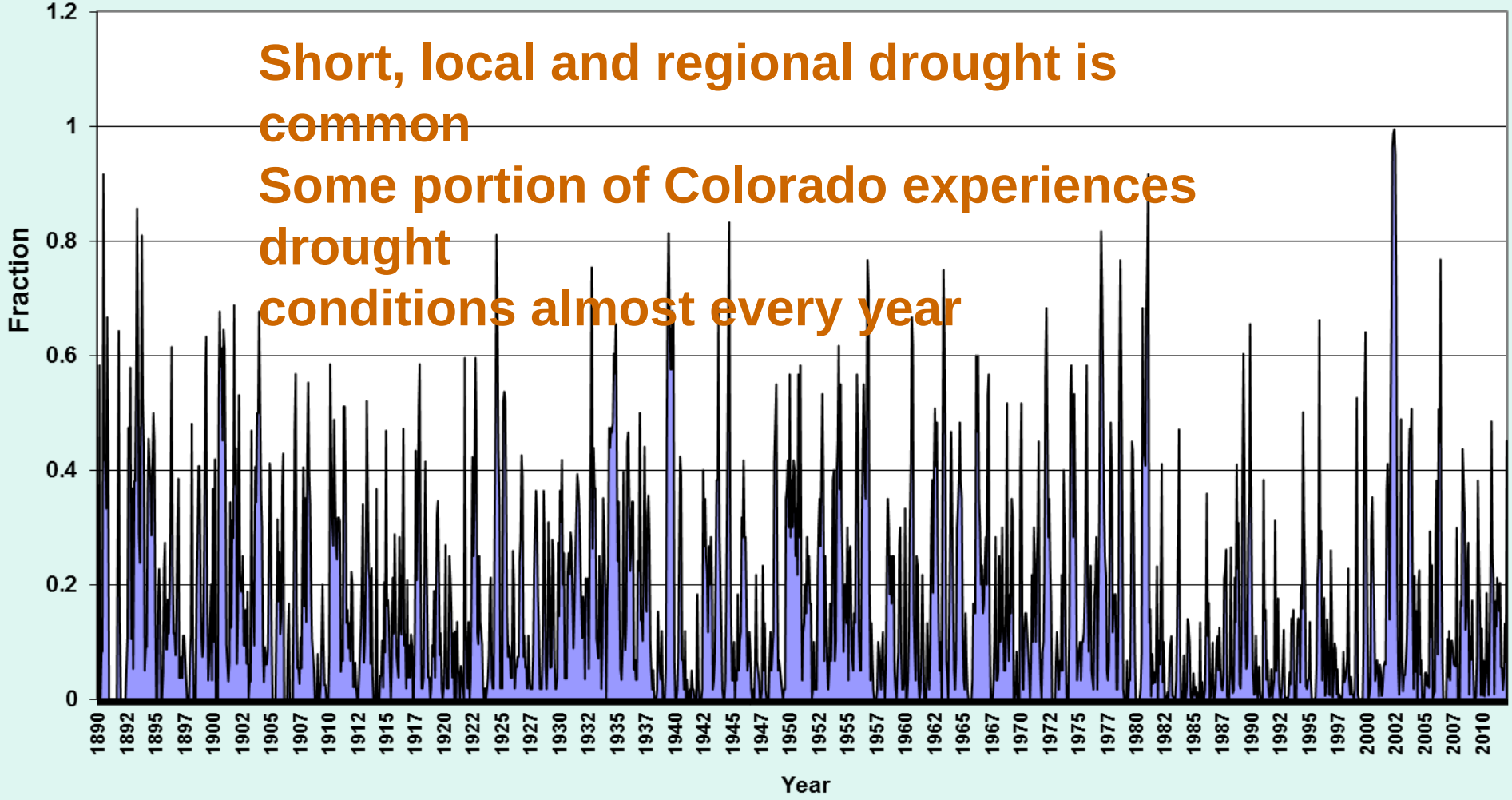


rought is an unwelcome but
requent visitor to Colorado

Fraction of Colorado in Drought

Based on 3 month SPI

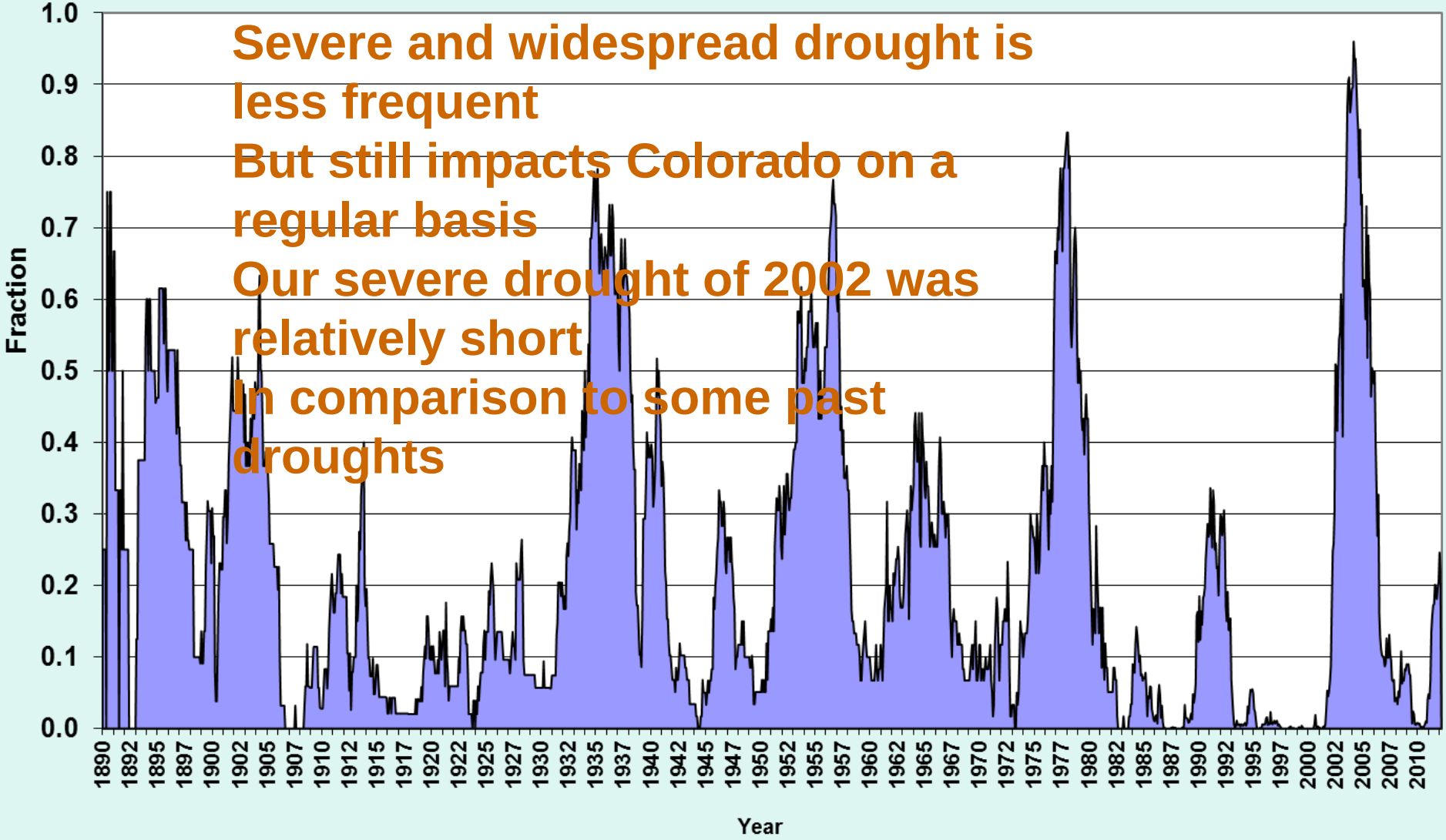
(1890 - March 2012)



Fraction of Colorado in Drought

Based on 48 month SPI (SPI <-1)

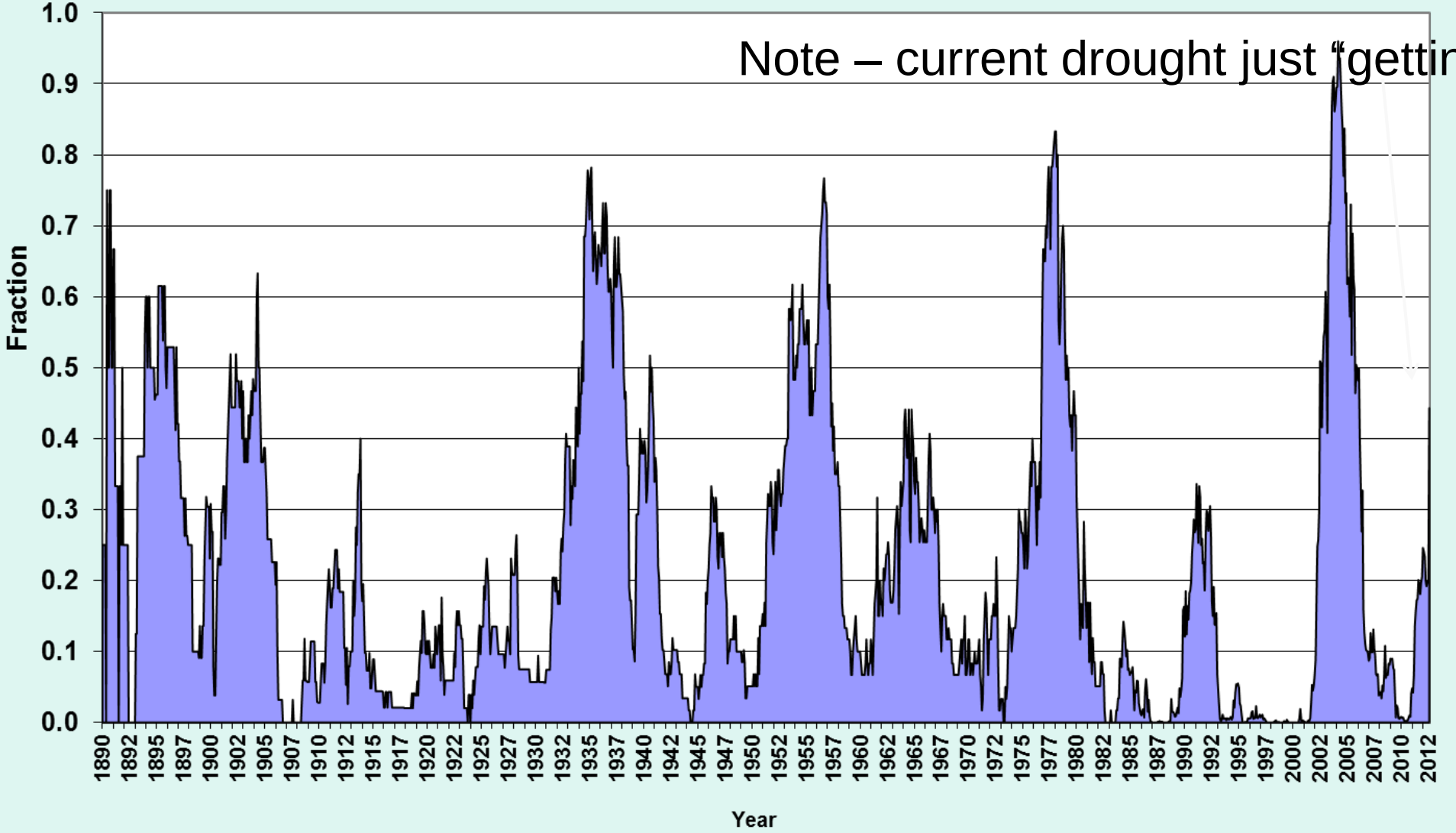
(1890 - March 2012)



Fraction of Colorado in Drought

Based on 48 month SPI (SPI <-1)

(1890 - August 2012)

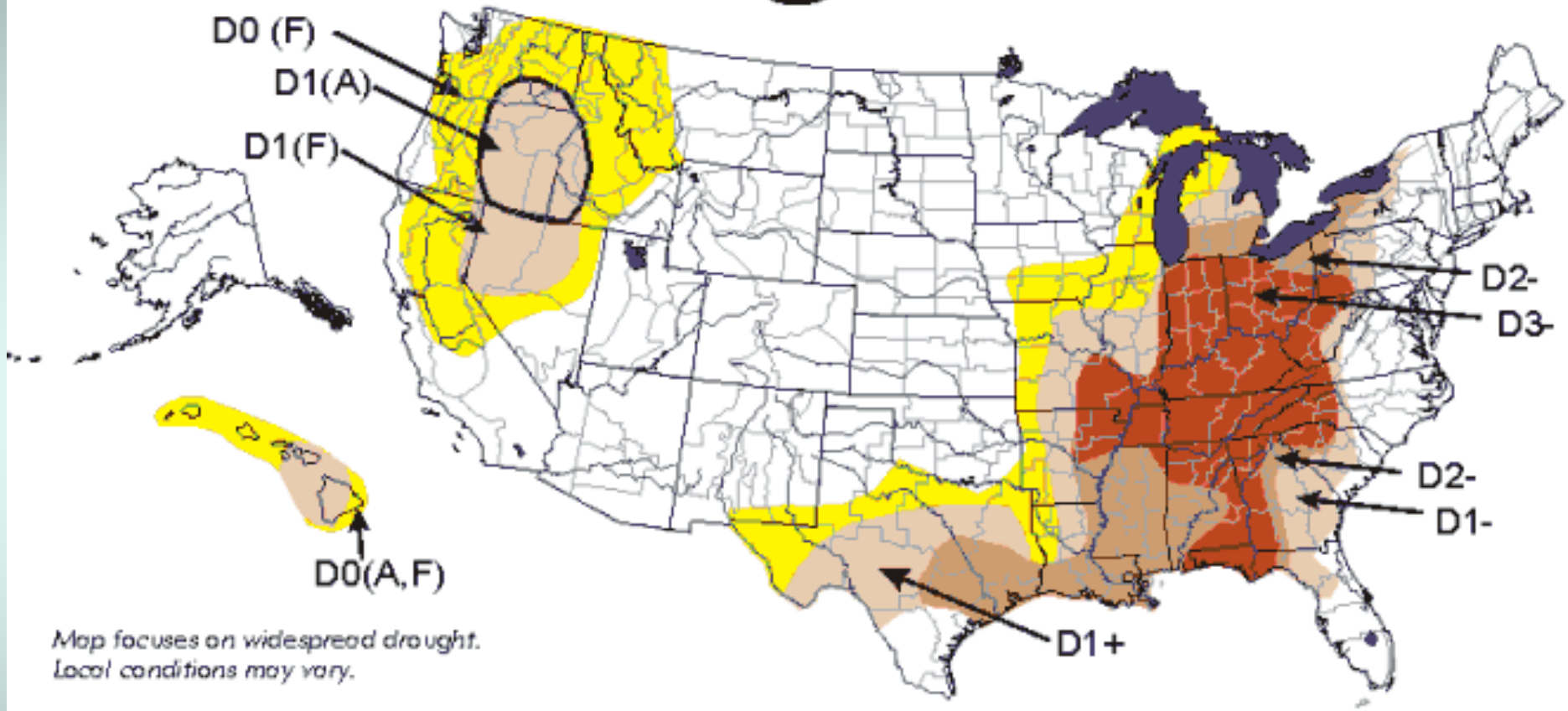


Recent upward trends in temperatures, especially in spring and summer, are only making matters worse.

Evolution of Drought Conditions Leading up to 2012

September 28, 1999

U.S. Drought Monitor



Map focuses on widespread drought.
Local conditions may vary.

- D0 Watch
- D1 Drought
- D2 Drought–Severe
- D3 Drought–Extreme
- D4 Drought–Exceptional
- Delineates Overlapping Areas

Drought type: used only when impacts differ

A = Agriculture
W = Water
F = Forest fire danger

Plus (+) = Forecast to intensify next two weeks
Minus (-) = Forecast to diminish next two weeks
No sign = No change in drought classification forecast

USDA

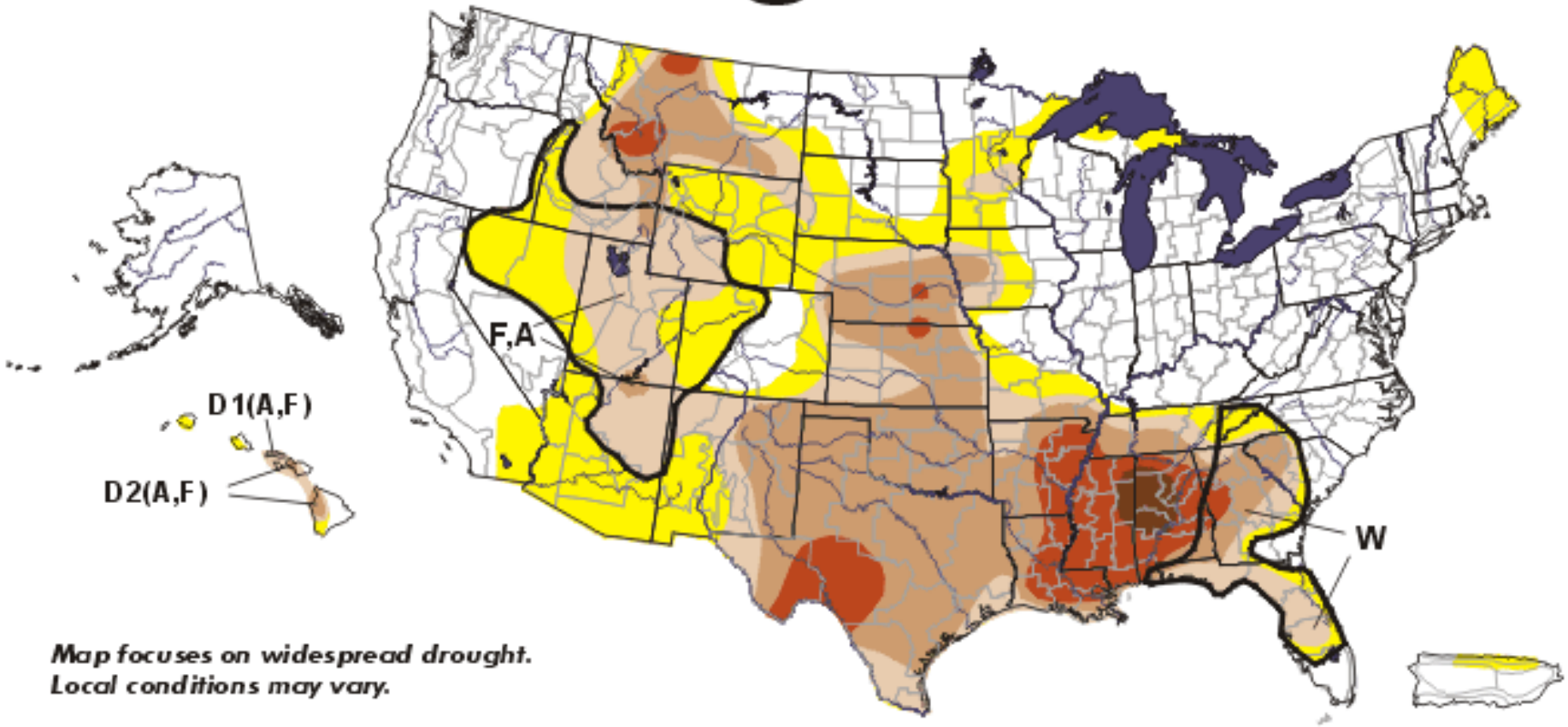
National Drought Mitigation Center

NOAA

• ***Released Thursday, Sep 30, 1999*** •

October 3, 2000 Valid 8 a.m. EDT

U.S. Drought Monitor



Map focuses on widespread drought. Local conditions may vary.

- D0 Abnormally Dry
- D1 Drought–First Stage
- D2 Drought–Severe
- D3 Drought–Extreme
- D4 Drought–Exceptional
- Delineates Overlapping Areas

Drought type: used only when impacts differ

A = Agriculture
W = Water
F = Wildfire danger

See accompanying text summary for forecast statements

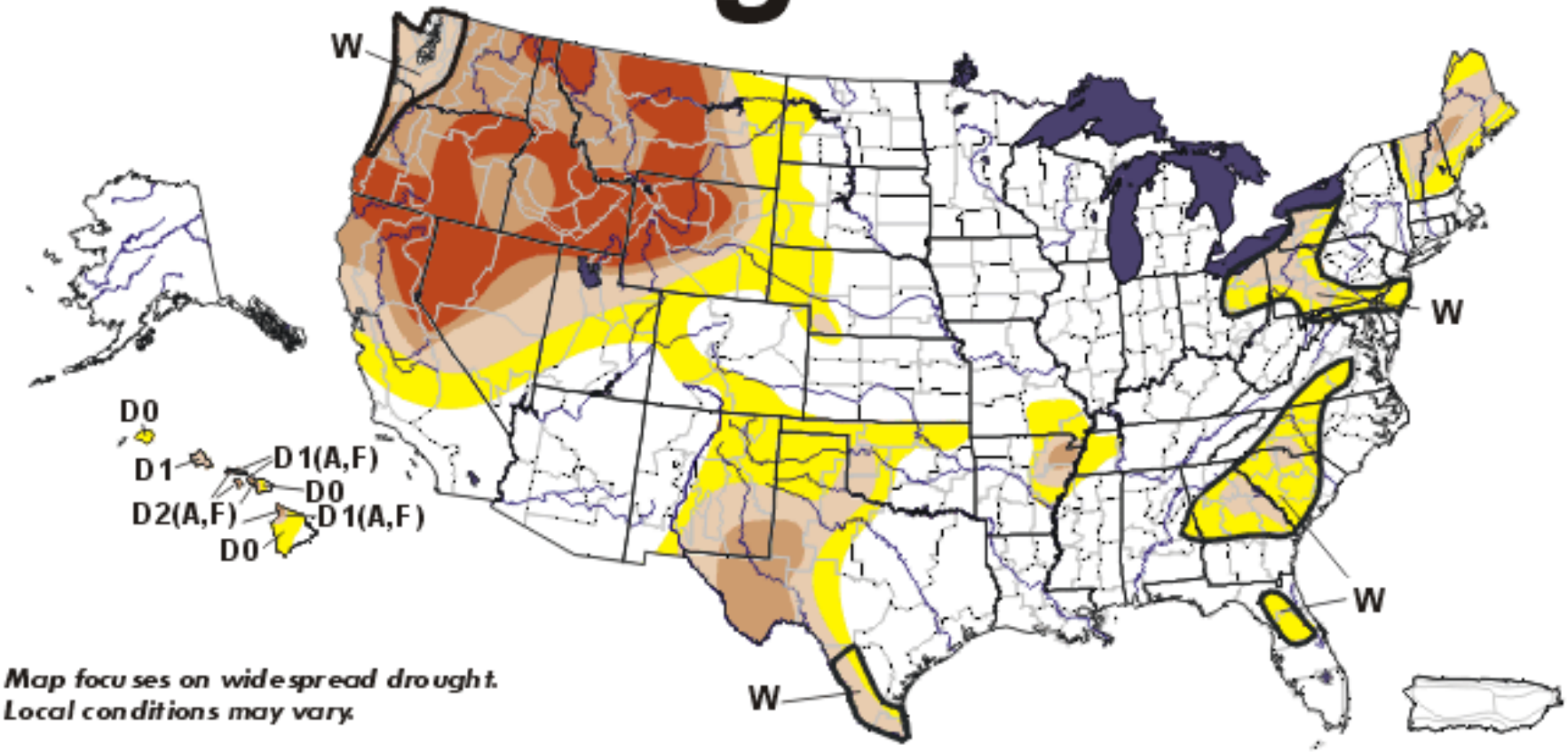
http://enso.unl.edu/monitor/monitor.html

USDA · National Drought Mitigation Center · NOAA

• *Released Thursday, Oct. 5, 2000* •

October 2, 2001 Valid 8 a.m. EDT

U.S. Drought Monitor



Map focuses on widespread drought.
Local conditions may vary.

- D0 Abnormally Dry
- D1 Drought–Moderate
- D2 Drought–Severe
- D3 Drought–Extreme
- D4 Drought–Exceptional
- Delineates Overlapping Areas

Drought Impact Types:
A = Agriculture
W = Water (Hydrological)
F = Fire danger (Wildfires)

(No type = All 3 impacts)

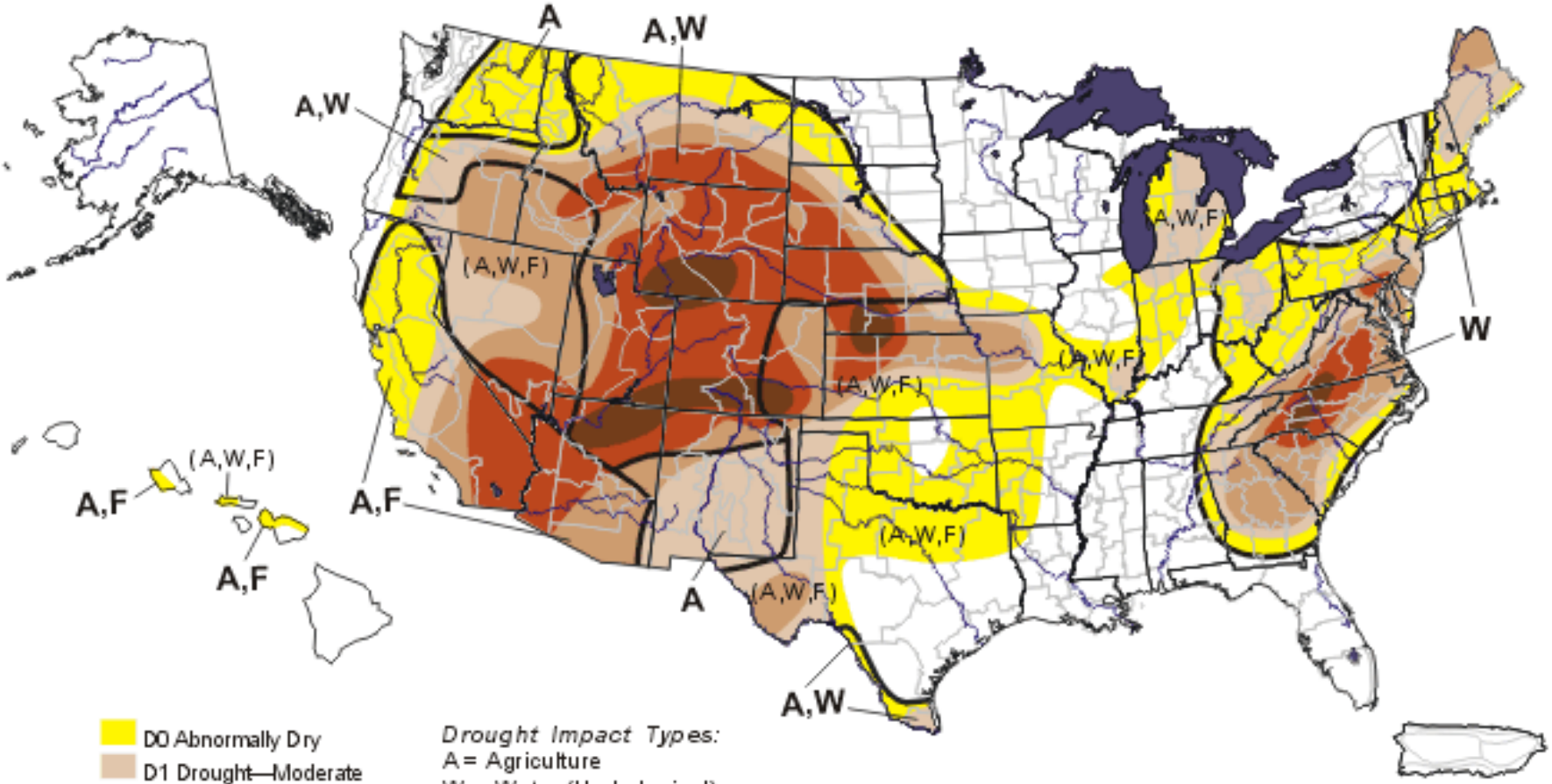
See accompanying text summary for forecast statements
http://enso.unl.edu/monitor/monitor.html

• *Released Thursday, October 4, 2001* •

Author: *Douglas Le Comte, NOAA/CPC*

U.S. Drought Monitor

October 1, 2002
Valid 8 a.m. EDT



D0 Abnormally Dry
D1 Drought—Moderate
D2 Drought—Severe
D3 Drought—Extreme
D4 Drought—Exceptional

Drought Impact Types:
A = Agriculture
W = Water (Hydrological)
F = Fire danger (Wildfires)
Delineates dominant impacts
(No type = All 3 impacts)

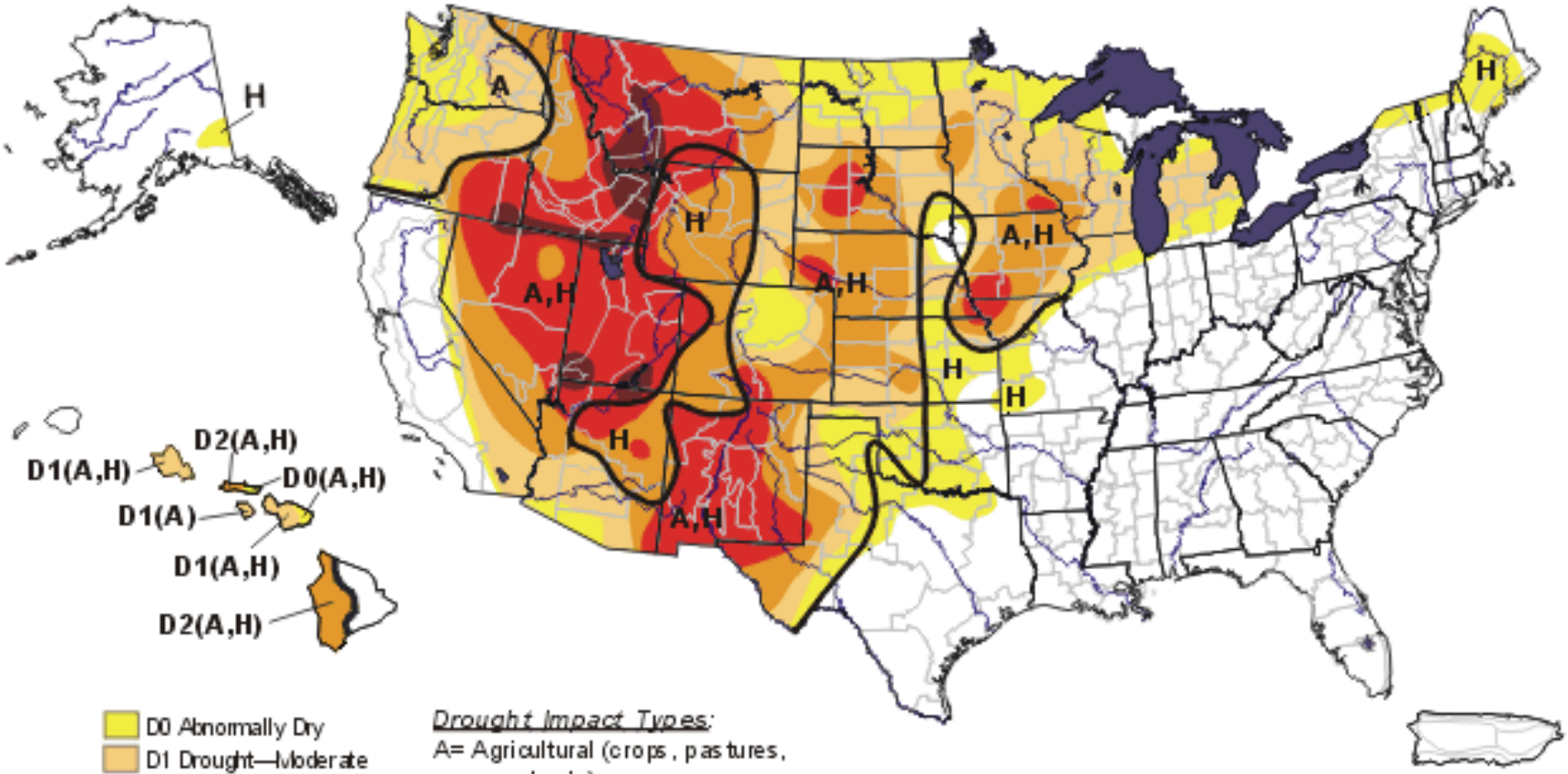
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, October 3, 2002
Author: *Rich Tinker, CPC/NCEP/NWS/NOAA*

U.S. Drought Monitor

September 30, 2003
Valid 8 a.m. EDT



D0 Abnormally Dry
D1 Drought—Moderate
D2 Drought—Severe
D3 Drought—Extreme
D4 Drought—Exceptional

Drought Impact Types:
A= Agricultural (crops, pastures, grasslands)
H= Hydrological (water)
No type = both impacts
Delineates dominant impacts

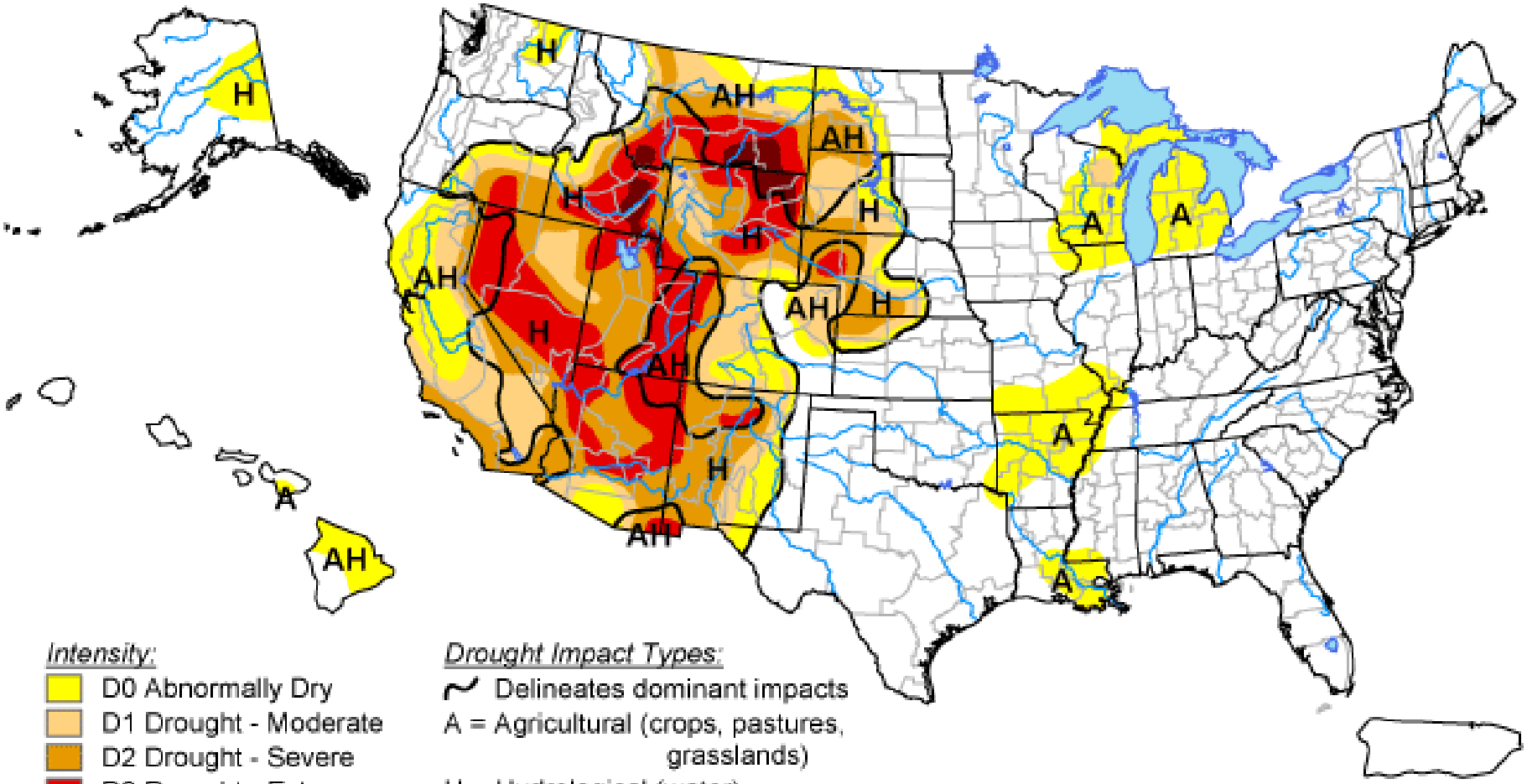
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, October 2, 2003
Author: *Candace Tankersley/Scott Stephens, NOAA/NCDC*

U.S. Drought Monitor

September 28, 2004
Valid 8 a.m. EDT



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

~ Delineates dominant impacts
A = Agricultural (crops, pastures, grasslands)
H = Hydrological (water)
(No type = Both impacts)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

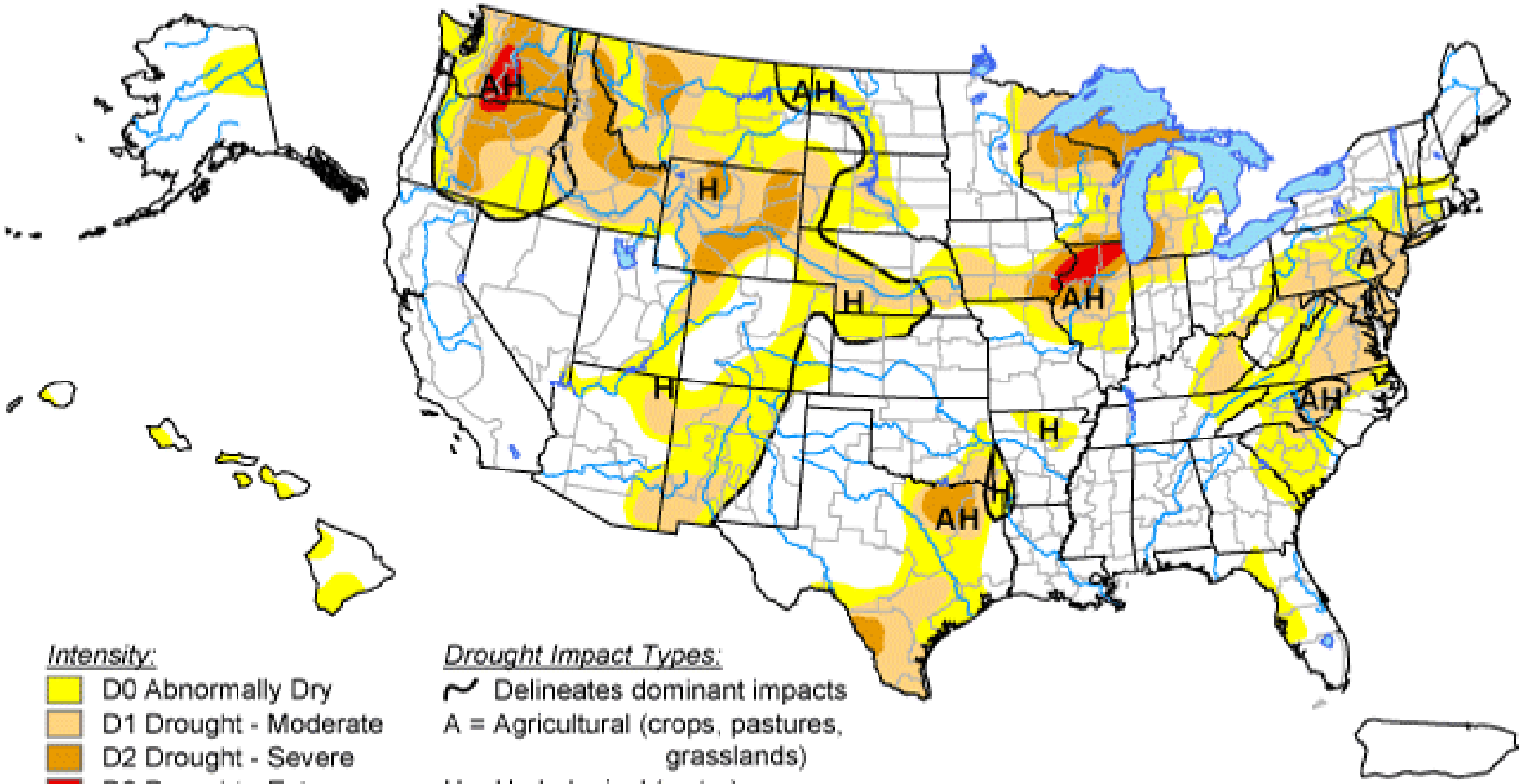
USDA National Drought Mitigation Center

Released Thursday, September 30, 2004

Author: Brad Rippey, U.S. Department of Agriculture

U.S. Drought Monitor

September 27, 2005
Valid 8 a.m. EDT



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The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

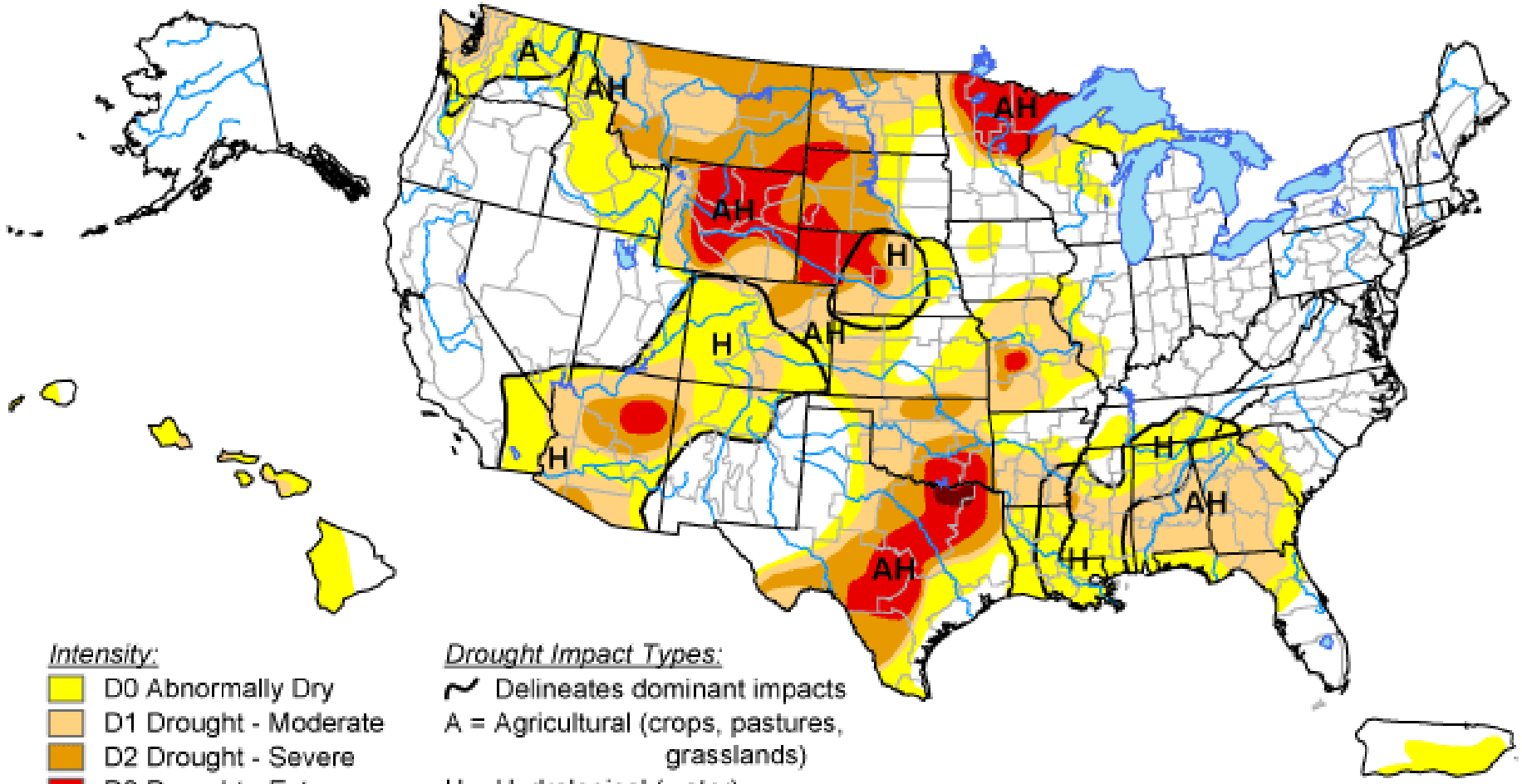
USDA National Drought Mitigation Center

Released Thursday, September 29, 2005

Author: Douglas Le Comte, CPC/NOAA

U.S. Drought Monitor

October 3, 2006
Valid 8 a.m. EDT



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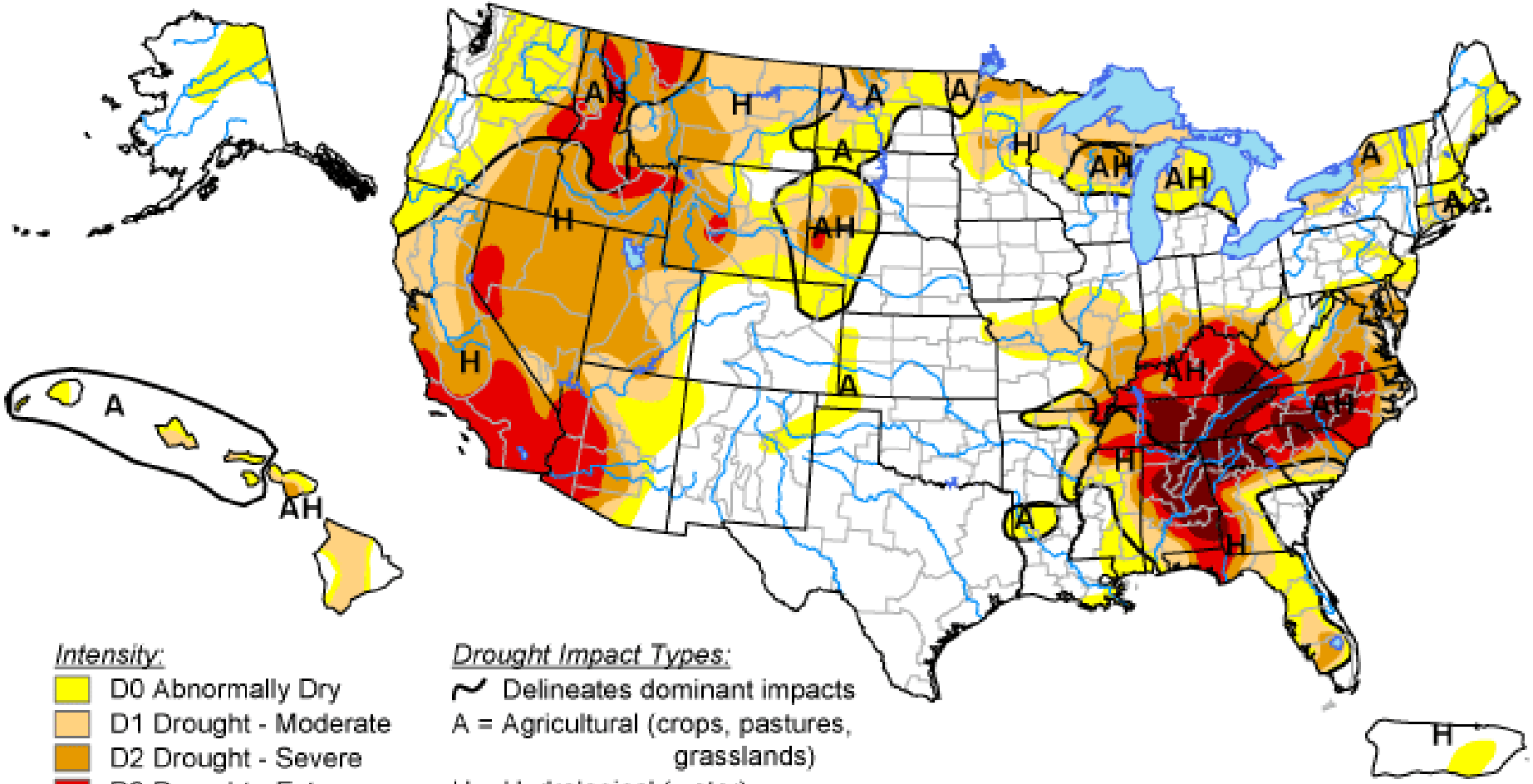
http://drought.unl.edu/dm

Released Thursday, October 5, 2006
Author: Rich Tinker, Climate Prediction Center, NOAA

U.S. Drought Monitor

October 2, 2007
Valid 8 a.m. EDT



Intensity:
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- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

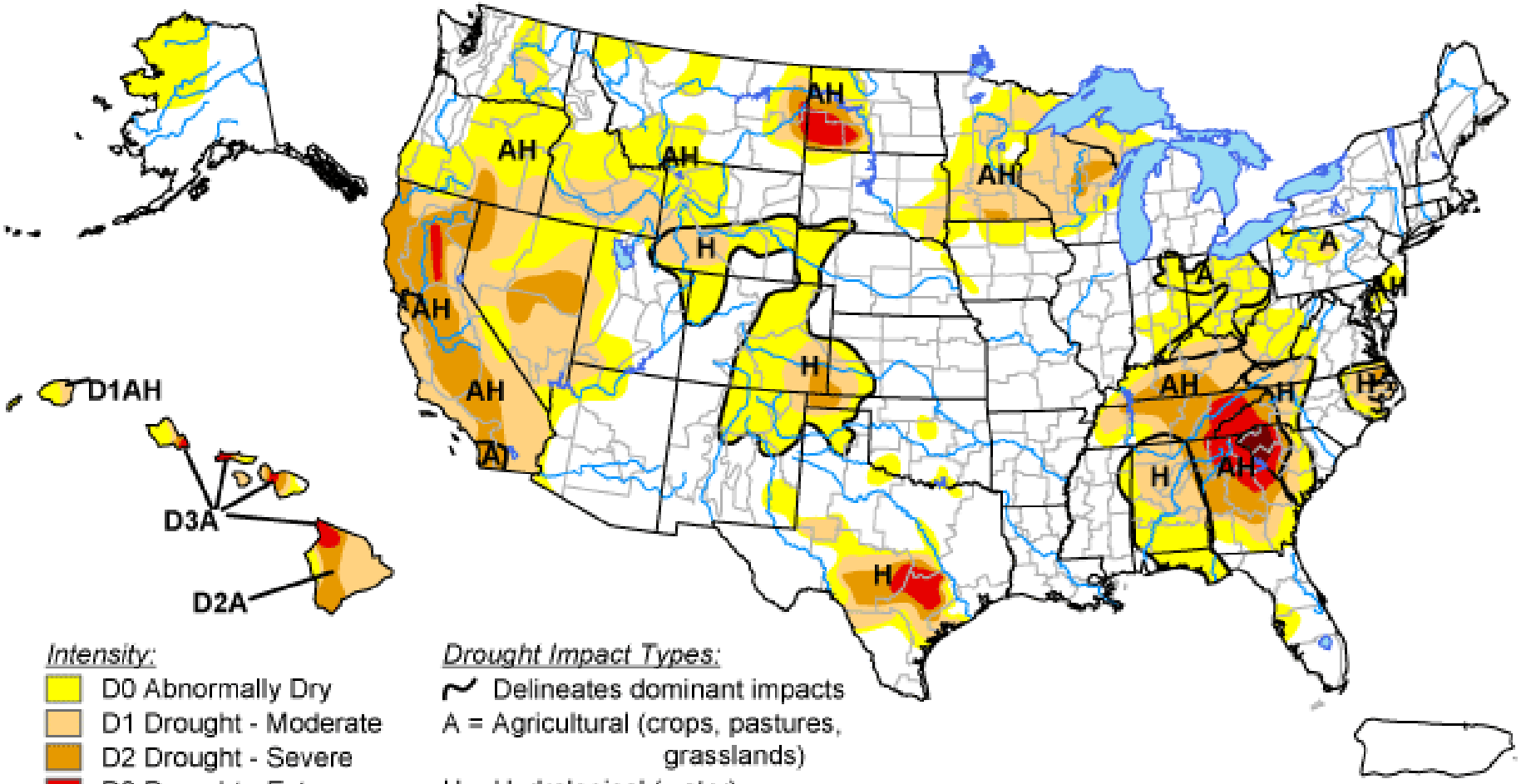
http://drought.unl.edu/dm

Released Thursday, October 4, 2007

Author: Jay Lawrimore/Liz Love-Brotak, NOAA/NESDIS/NCDC

U.S. Drought Monitor

September 30, 2008
Valid 8 a.m. EDT



Intensity:
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- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

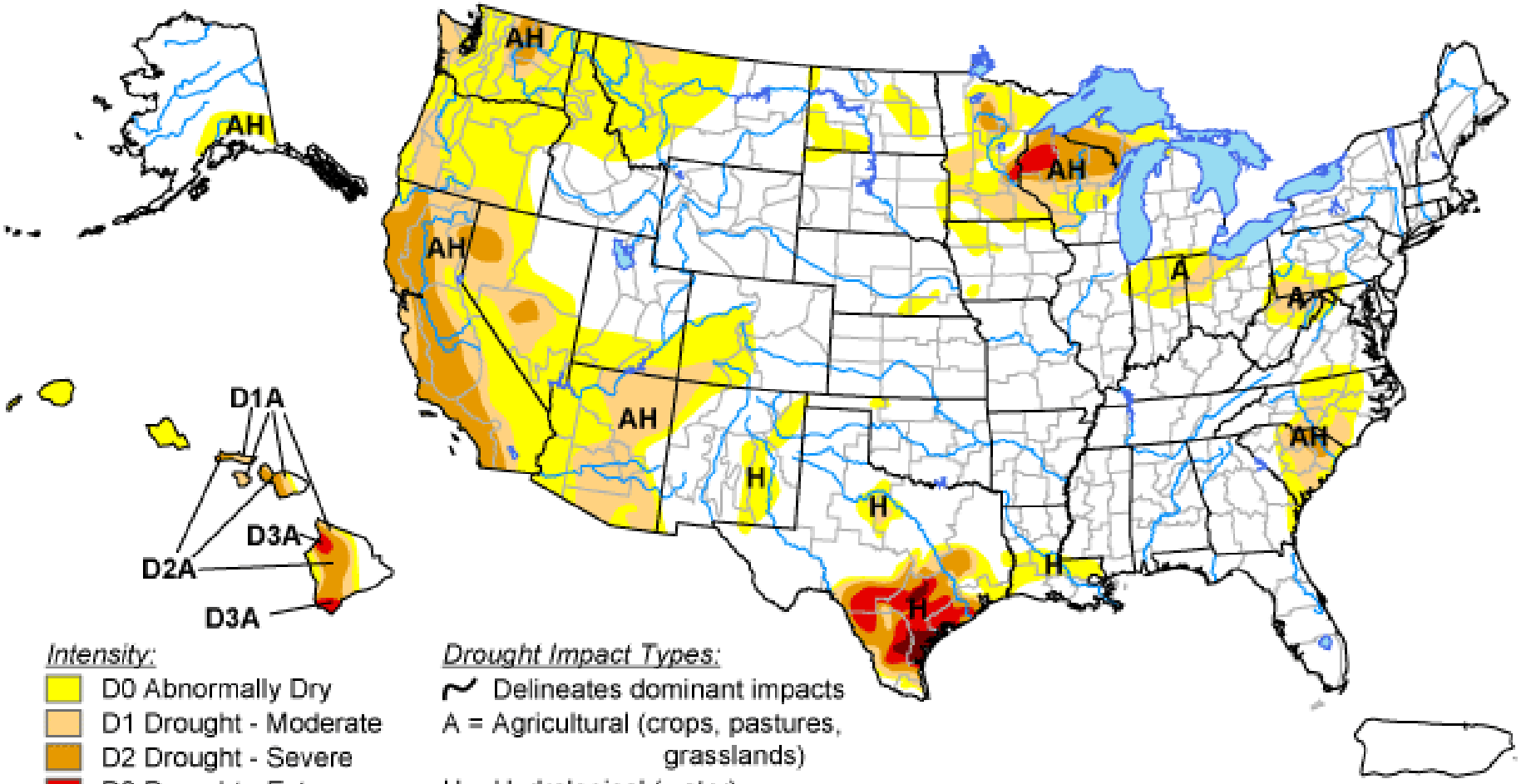
http://drought.unl.edu/dm

Released Thursday, October 2, 2008

Authors: Richard Heim/Liz Love-Brotak, NOAA/NESDIS/NCDC

U.S. Drought Monitor

September 29, 2009
Valid 8 a.m. EDT



Intensity:

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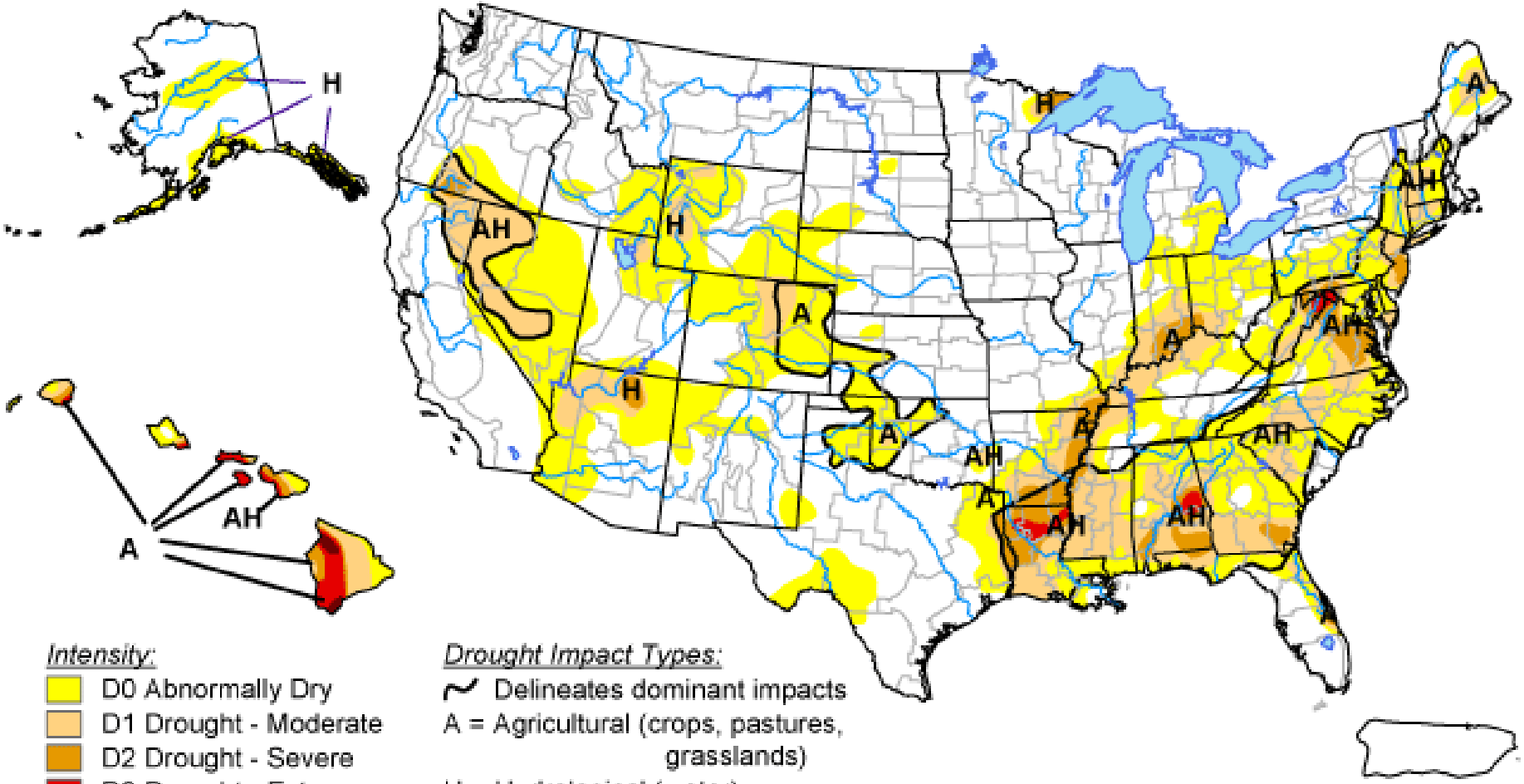
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, October 1, 2009
Author: David Miskus, JAWF/CPC/NOAA

U.S. Drought Monitor

September 28, 2010
Valid 8 a.m. EDT



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The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

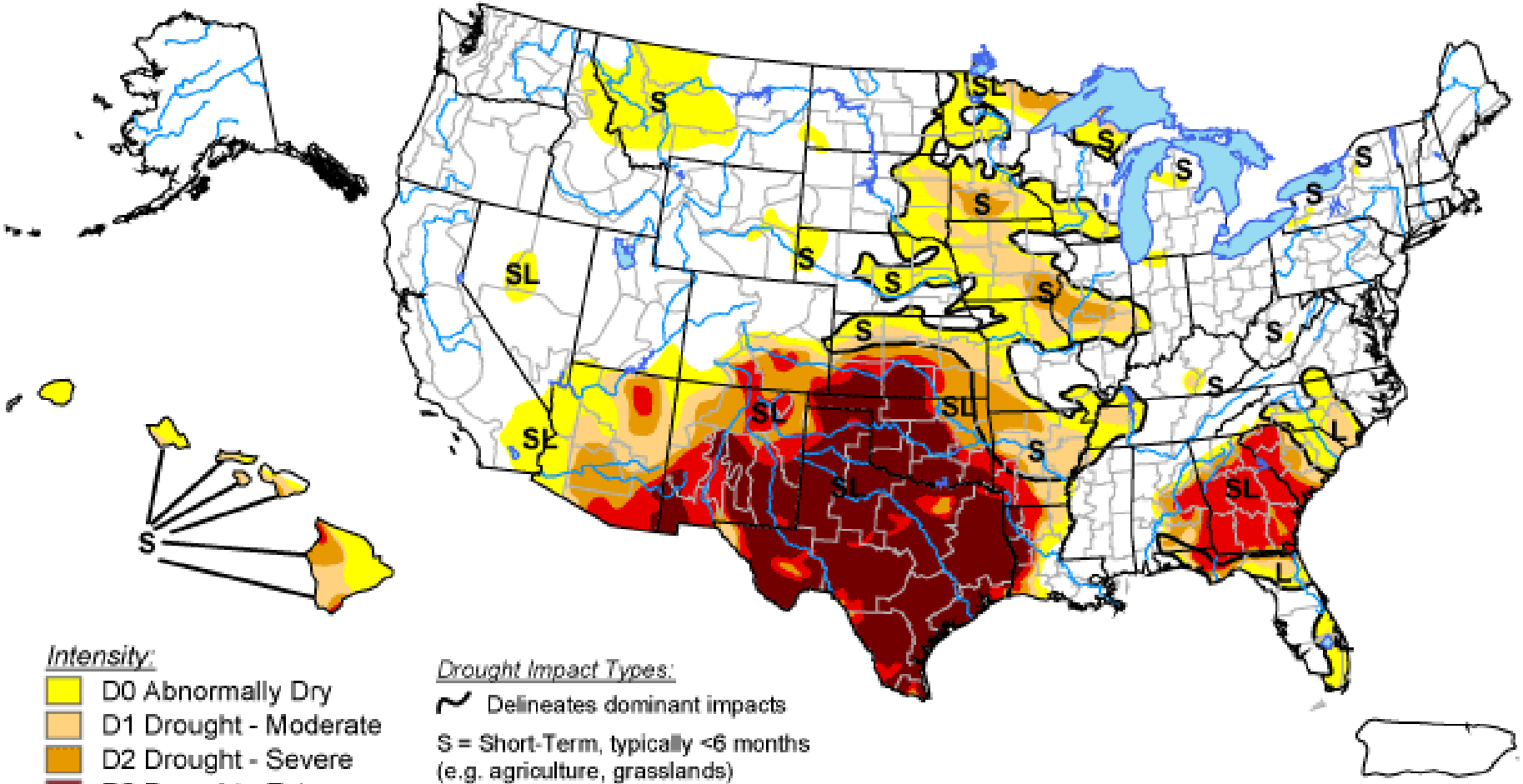
http://drought.unl.edu/dm

Released Thursday, September 30, 2010

Author: Richard Heim/Liz Love-Brotak, NOAA/NESDIS/NCDC

U.S. Drought Monitor

October 4, 2011
Valid 8 a.m. EDT



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- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

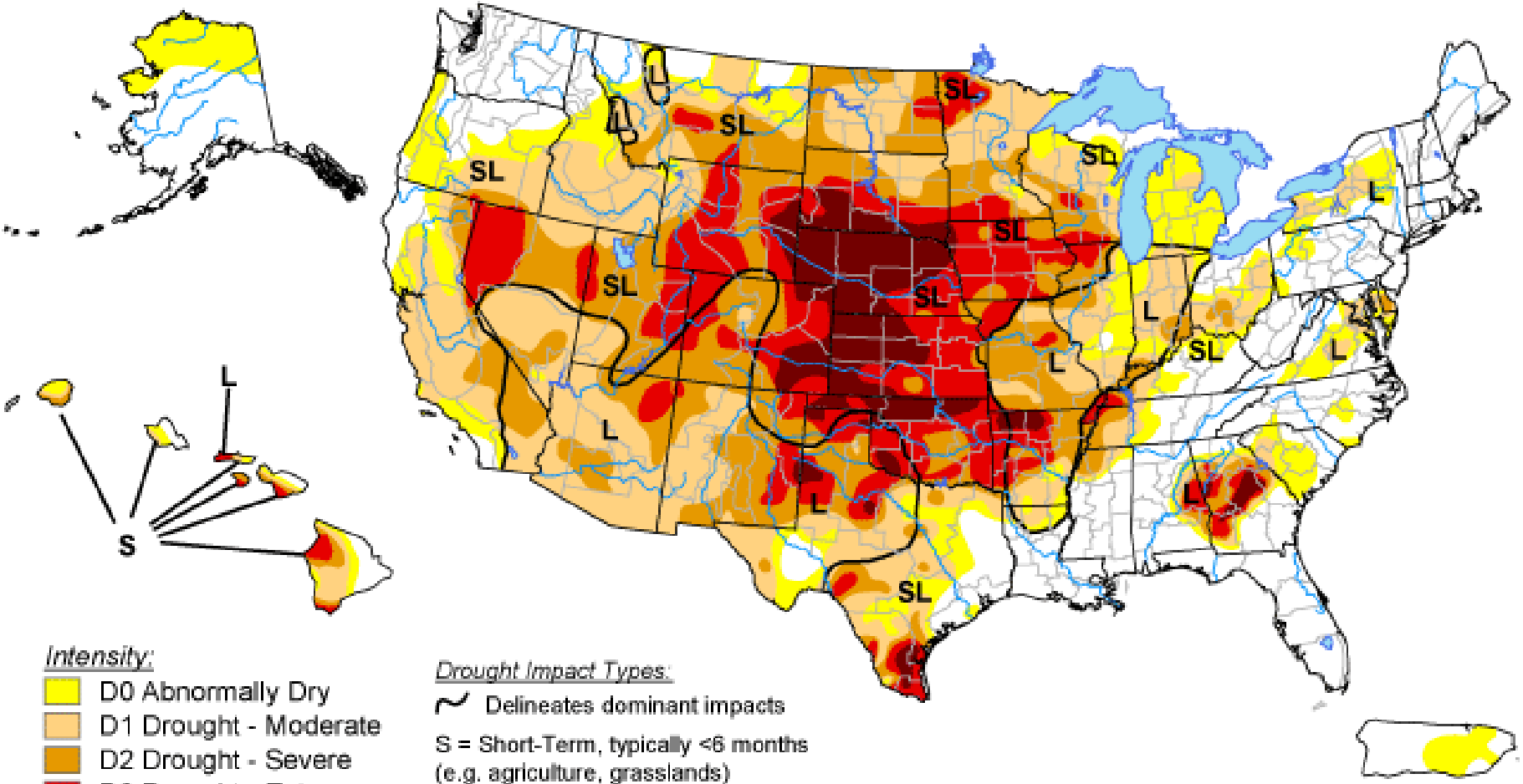
http://droughtmonitor.unl.edu/

USDA National Drought Mitigation Center

Released Thursday, October 6, 2011
Author: Rich Tinker, CPC/NCEP/NWS/NOAA

U.S. Drought Monitor

October 2, 2012
Valid 7 a.m. EDT



Intensity:

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- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

USDA National Drought Mitigation Center

Released Thursday, October 4, 2012

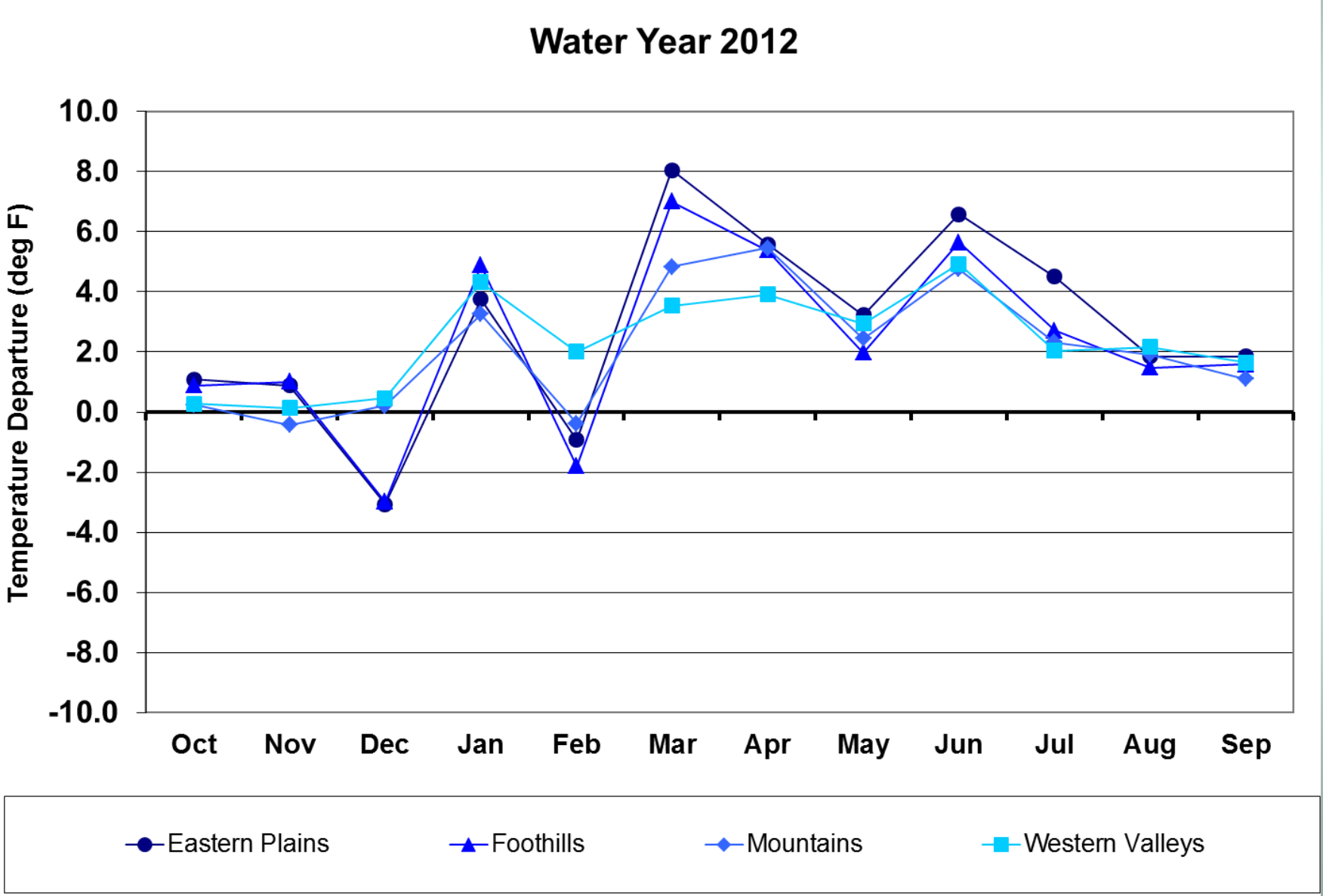
Author: Anthony Artusa, NOAA/NWS/NCEP/CPC

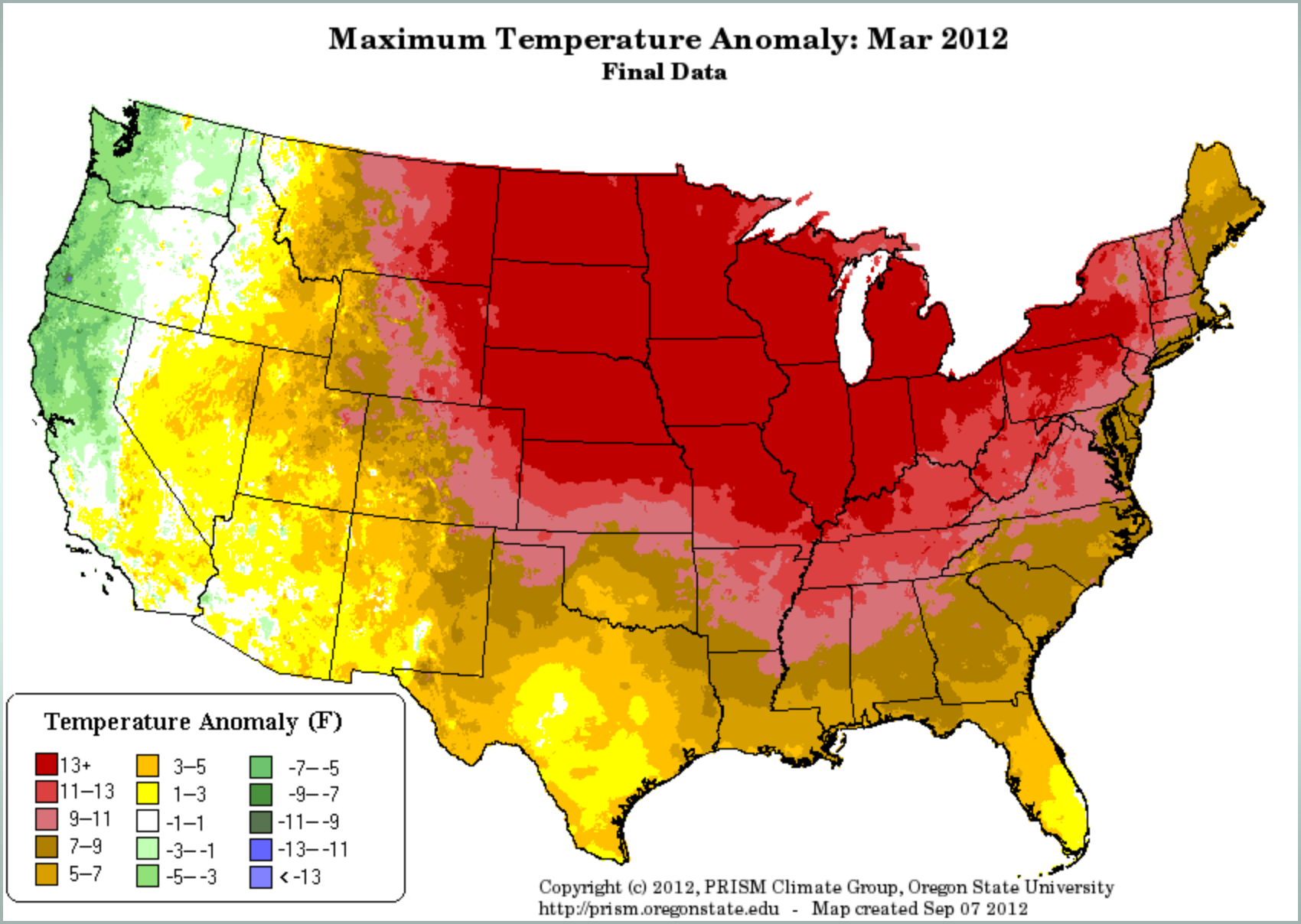
A closer look at the 2012 Water Year in Colorado

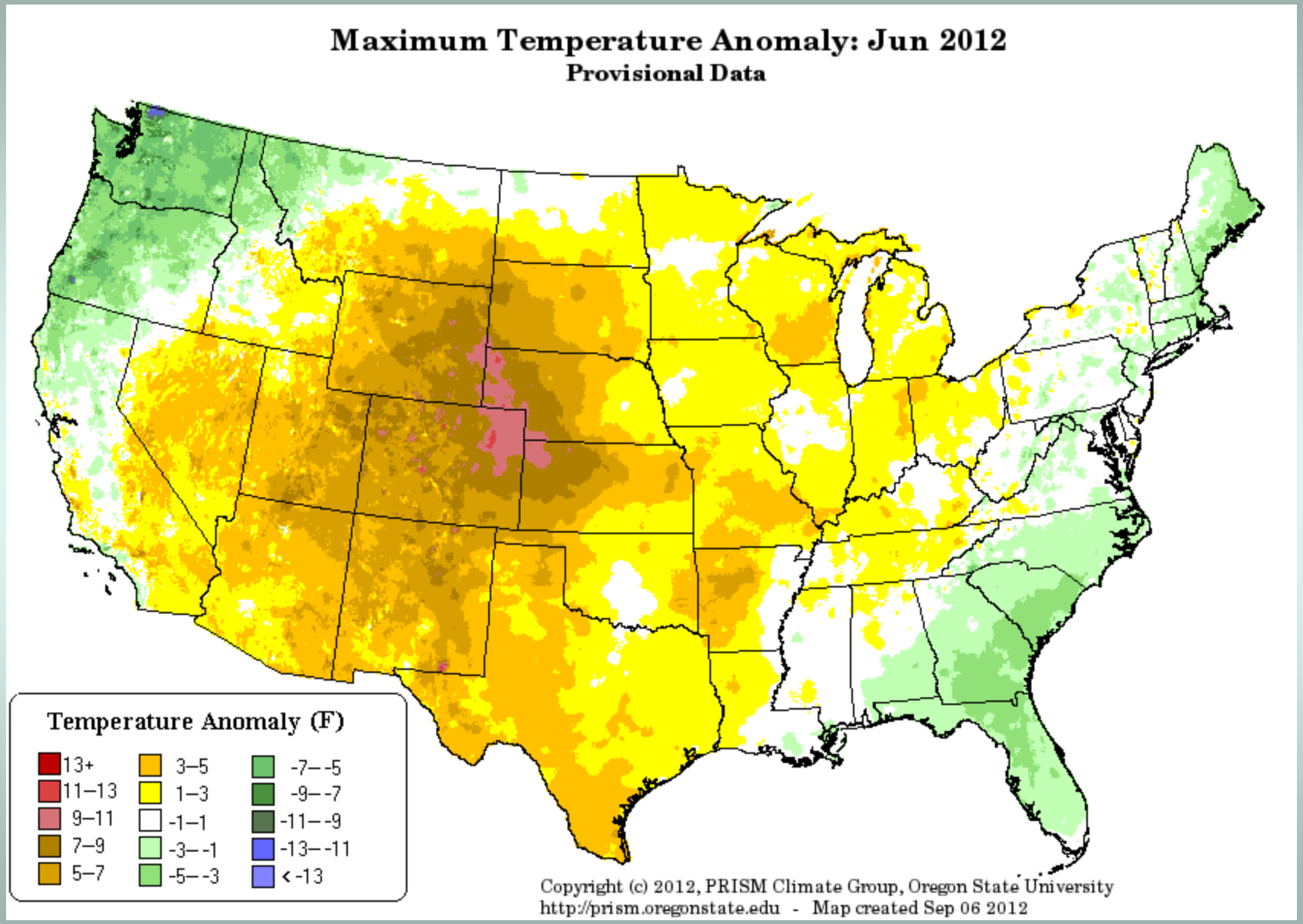
Highlights of the 2012 Water Year in Colorado

- Relatively wintry start
- Very mild/dry January but a snowy February east of the mountains
- Remarkable March – warm and almost no snow
- Later spring storms ineffective
- Fiery hot, dry June
- Some localized relief in July
- August drought expanded again
- Enough fall moisture to plant wheat and pray
- Whimpy 2013 winter so far

Water Year 2012 Temperature Departures From 1971-2000 Average

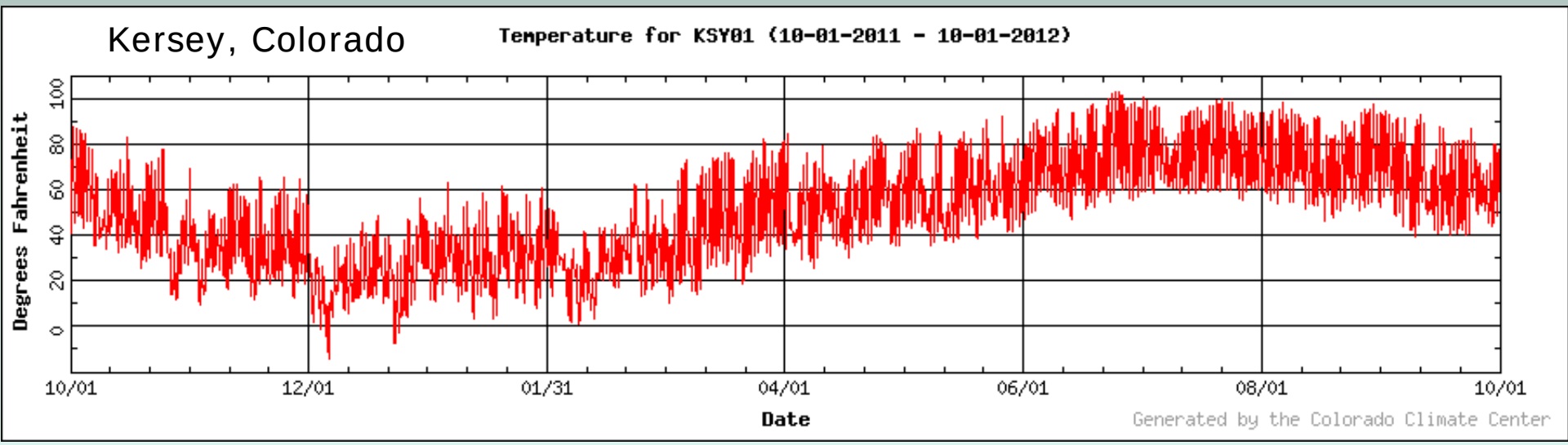



Maximum Temperature Anomaly: Mar 2012
Final Data
Temperature Anomaly (F)
13+
11–13
9–11
7–9
5–7
3–5
1–3
-1–1
-3–-1
-5–-3
-7–-5
-9–-7
-11–-9
-13–-11
< -13
Copyright (c) 2012, PRISM Climate Group, Oregon State University
http://prism.oregonstate.edu - Map created Sep 07 2012

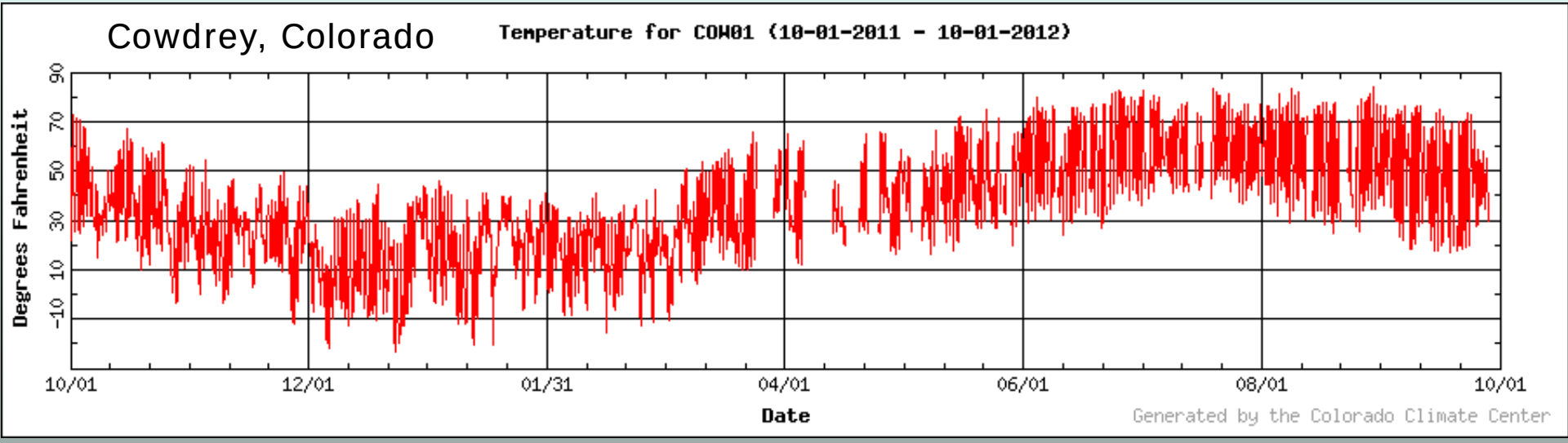

Maximum Temperature Anomaly: Jun 2012
Provisional Data
Temperature Anomaly (F)
13+
11–13
9–11
7–9
5–7
3–5
1–3
-1–1
-3–-1
-5–-3
-7–-5
-9–-7
-11–-9
-13–-11
< -13
Copyright (c) 2012, PRISM Climate Group, Oregon State University
http://prism.oregonstate.edu - Map created Sep 06 2012

CoAgMet Temperatures

Kersey, Colorado

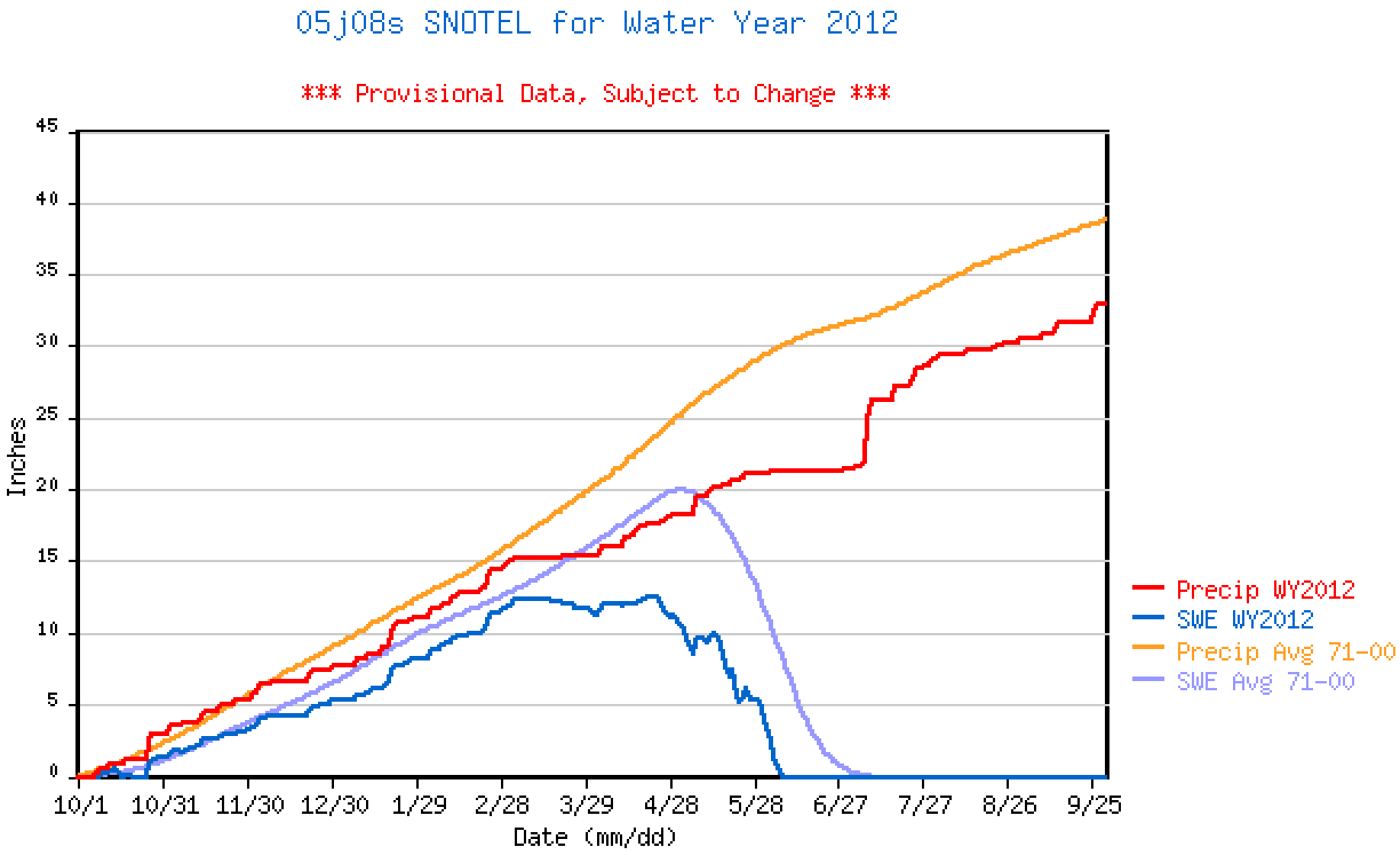


Cowdrey, Colorado

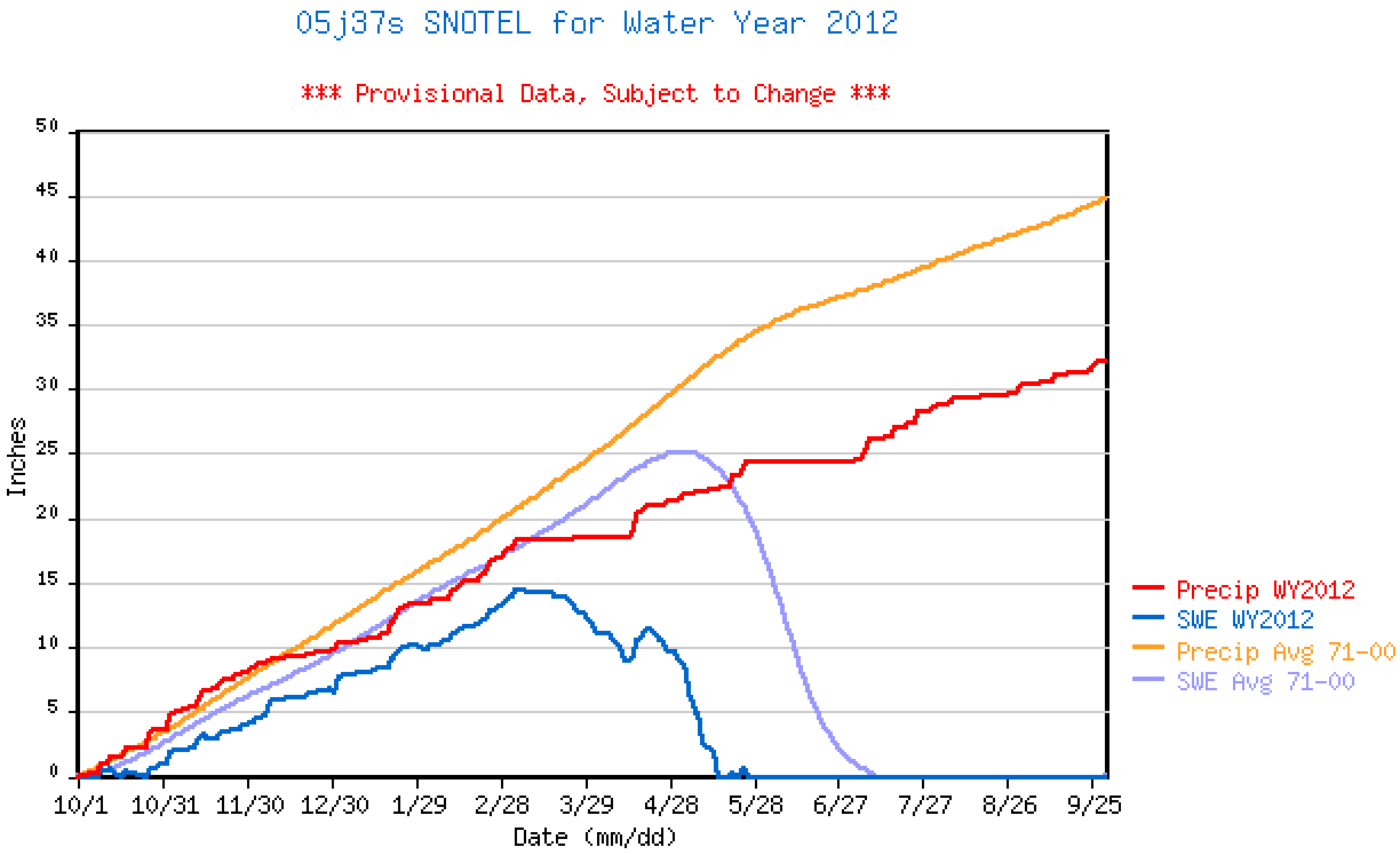


WY2012 Snowpack Accumulation and Meltout

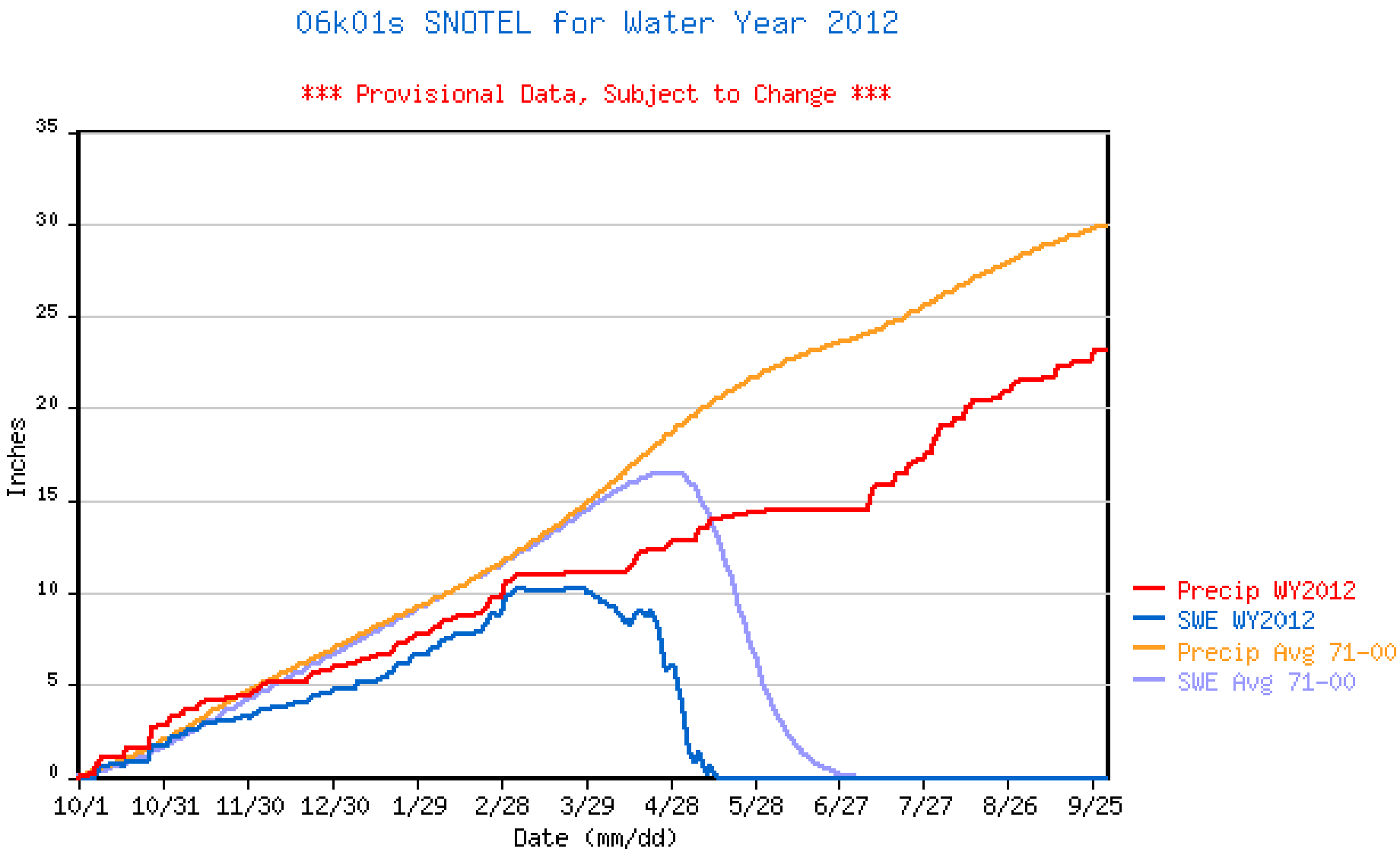
University Camp – 10,300’



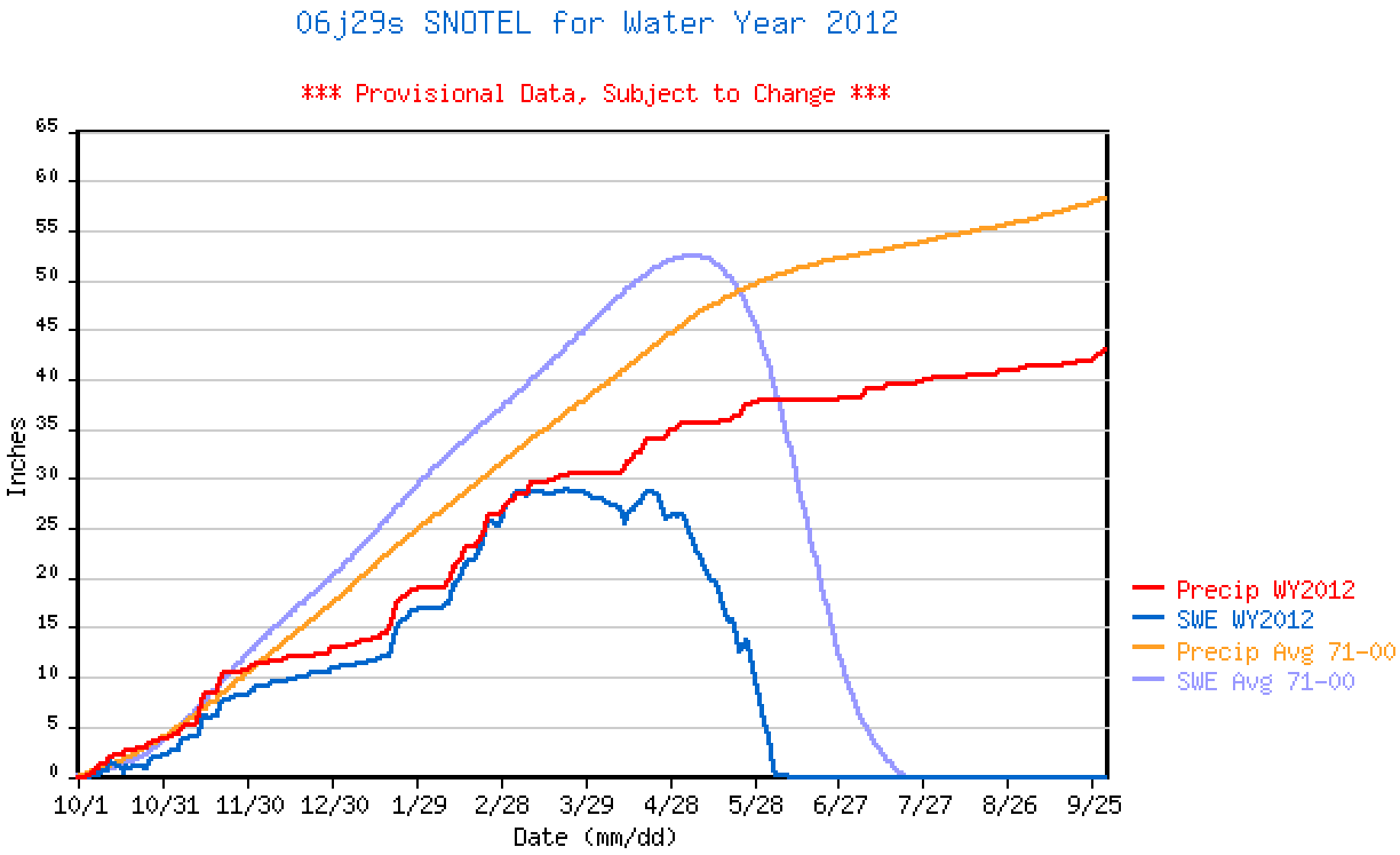
Joe Wright Reservoir - 10,120’



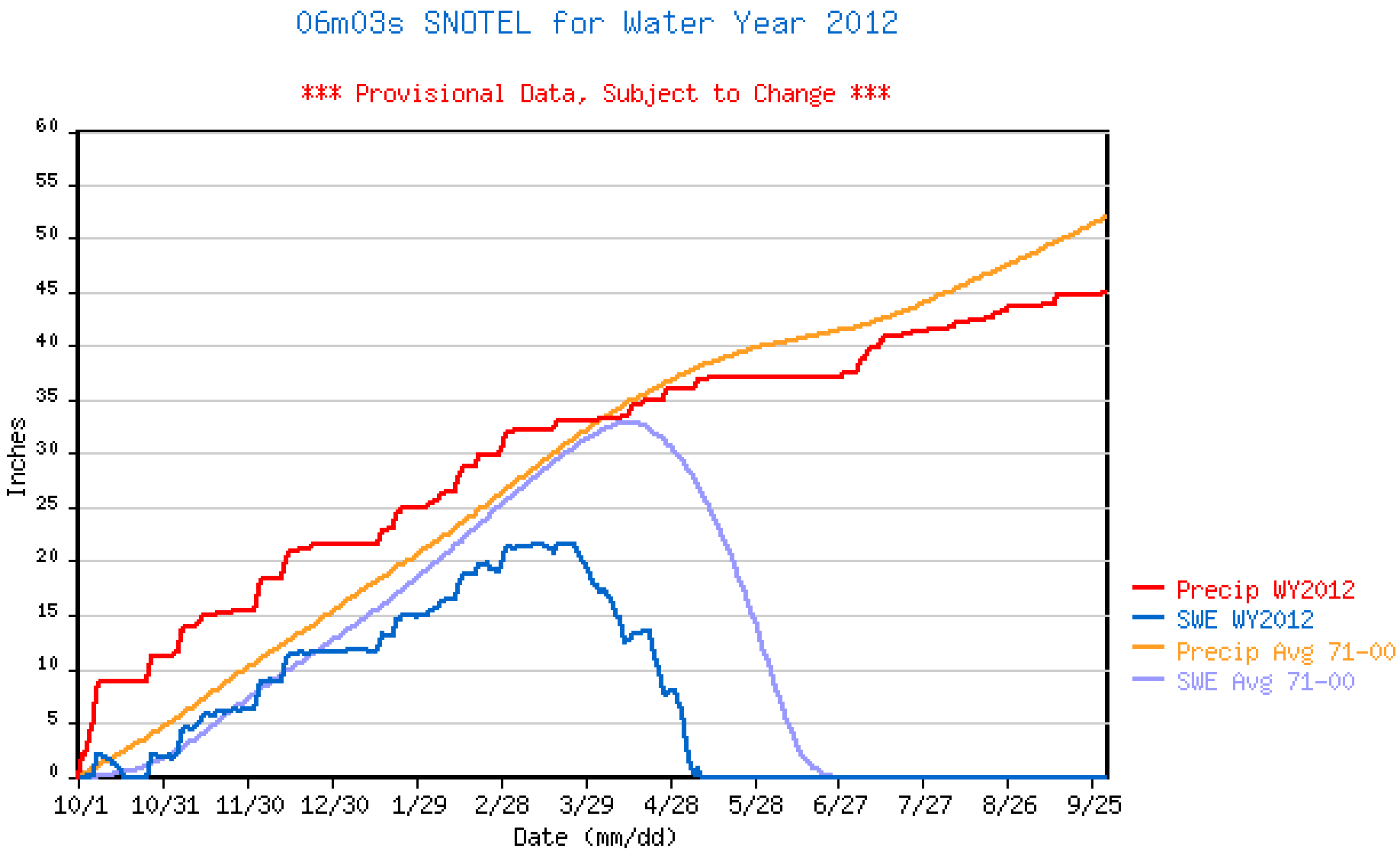
Hoosier Pass – 11,400’



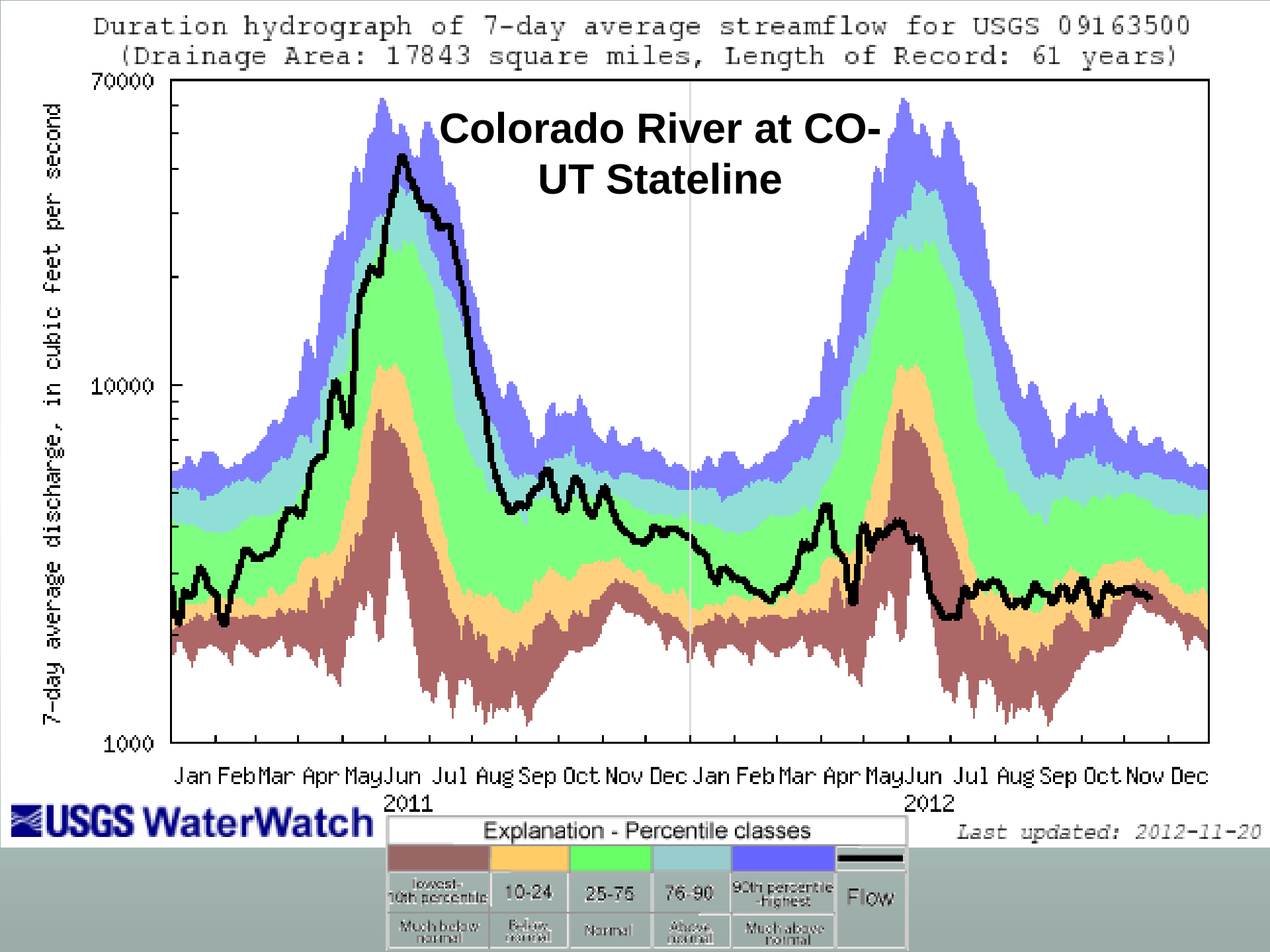
Tower- 10,500’


06j29s SNOTEL for Water Year 2012
*** Provisional Data, Subject to Change ***
Inches
65
60
55
50
45
40
35
30
25
20
15
10
5
0
10/1
10/31
11/30
12/30
1/29
2/28
3/29
4/28
5/28
6/27
7/27
8/26
9/25
Date (mm/dd)
Precip WY2012
SWE WY2012
Precip Avg 71-00
SWE Avg 71-00

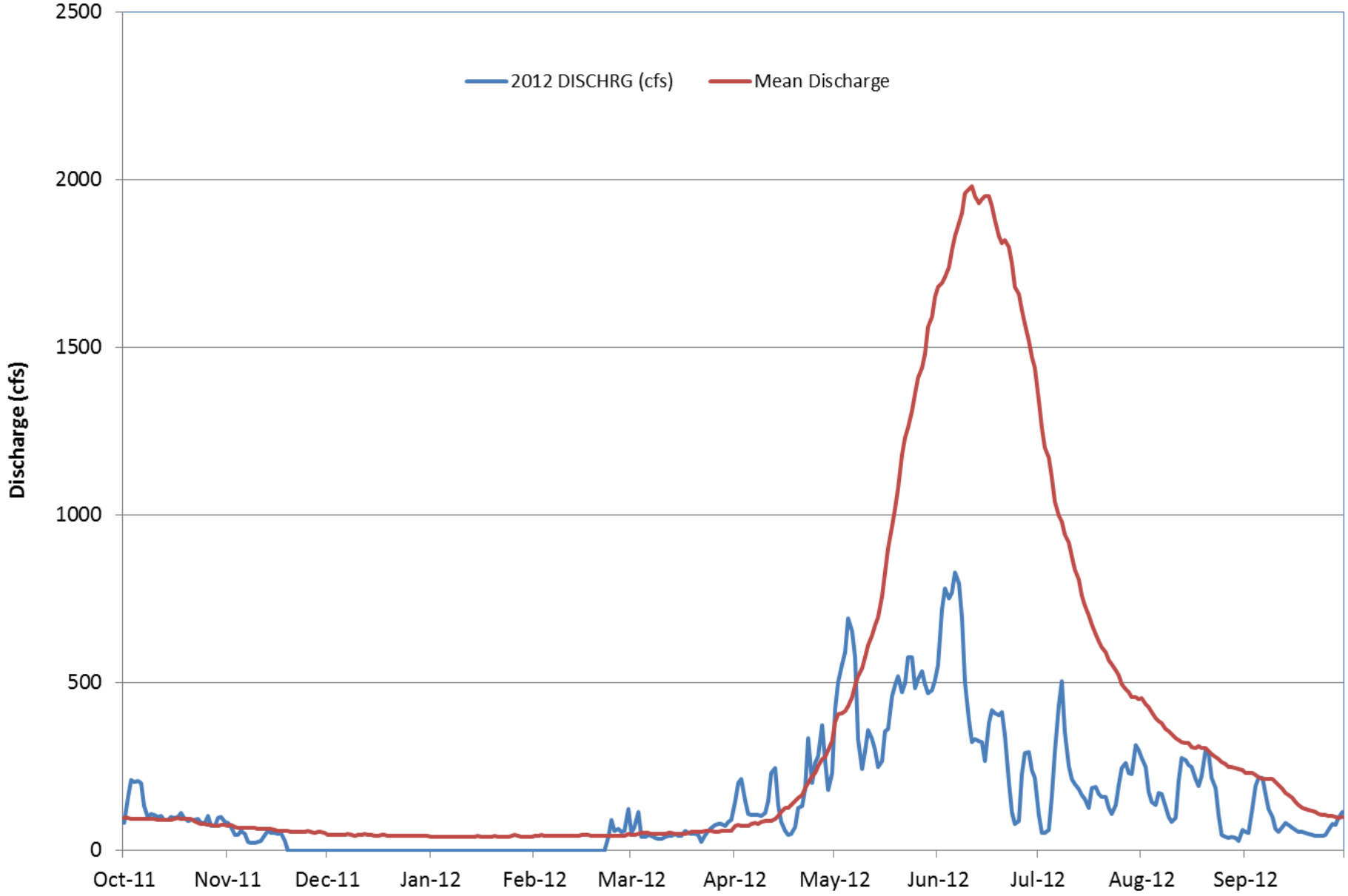
Upper San Juan- 10,200’

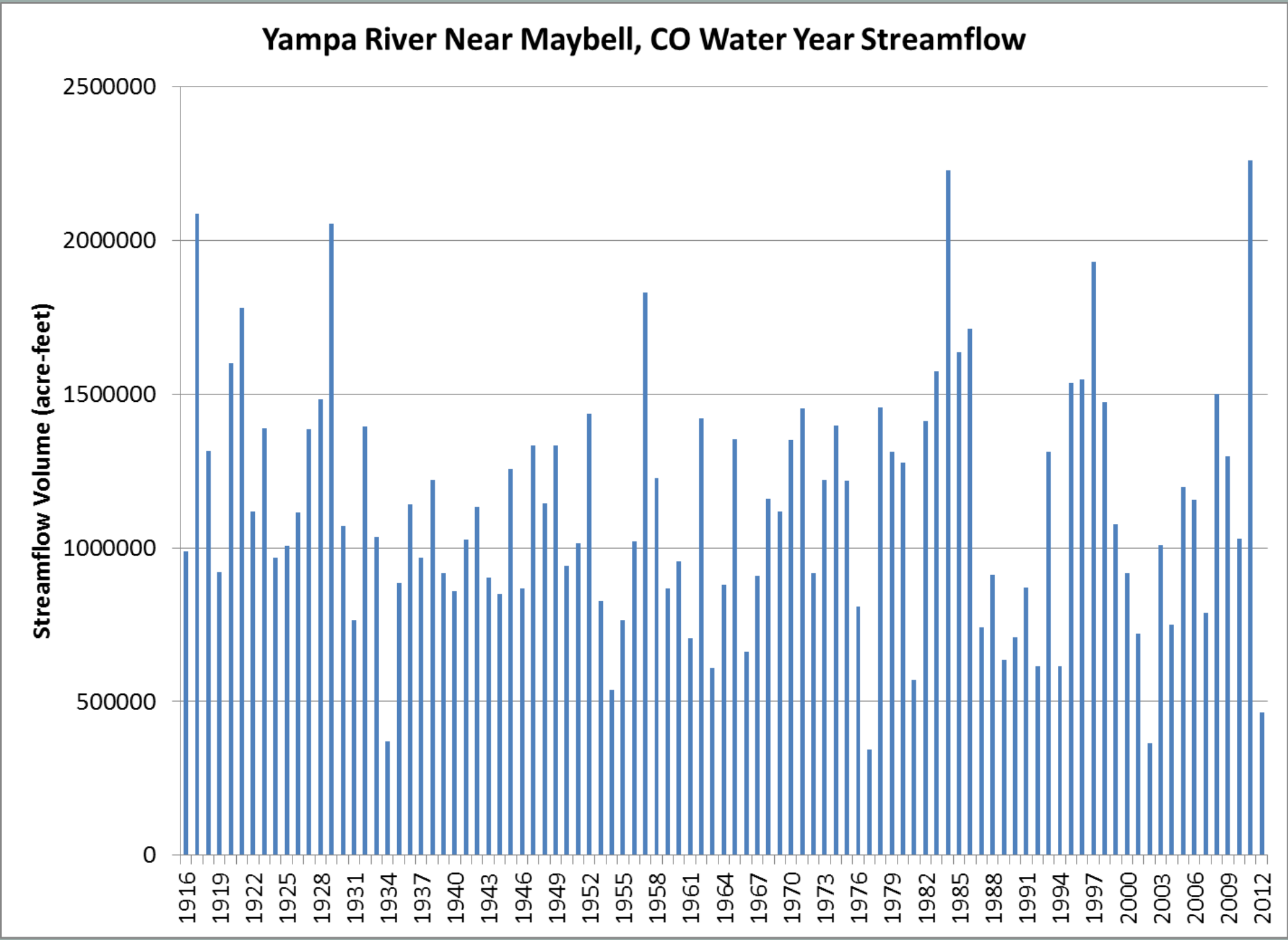


Streamflow


Duration hydrograph of 7-day average streamflow for USGS 09163500
(Drainage Area: 17843 square miles, Length of Record: 61 years)
Colorado River at CO-UT Stateline
7-day average discharge, in cubic feet per second
70000
10000
1000
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
2011
2012
USGS WaterWatch
Explanation - Percentile classes
lowest-10th percentile
10-24
25-75
76-90
90th percentile -highest
Flow
Much below normal
Below normal
Normal
Above normal
Much above normal
Last updated: 2012-11-20

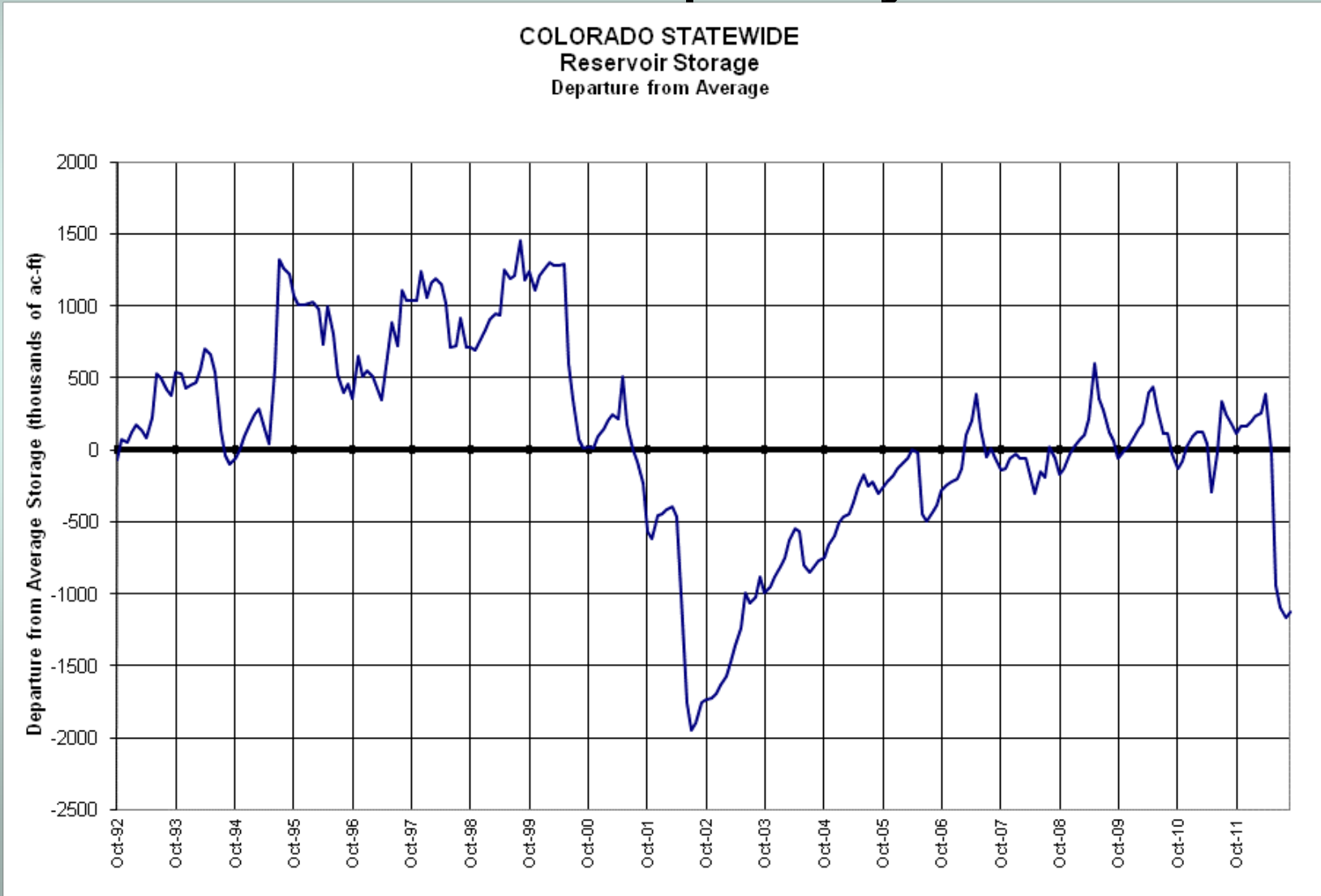
Cache La Poudre River: Water Year 2012 and Mean Daily Discharge (cfs)



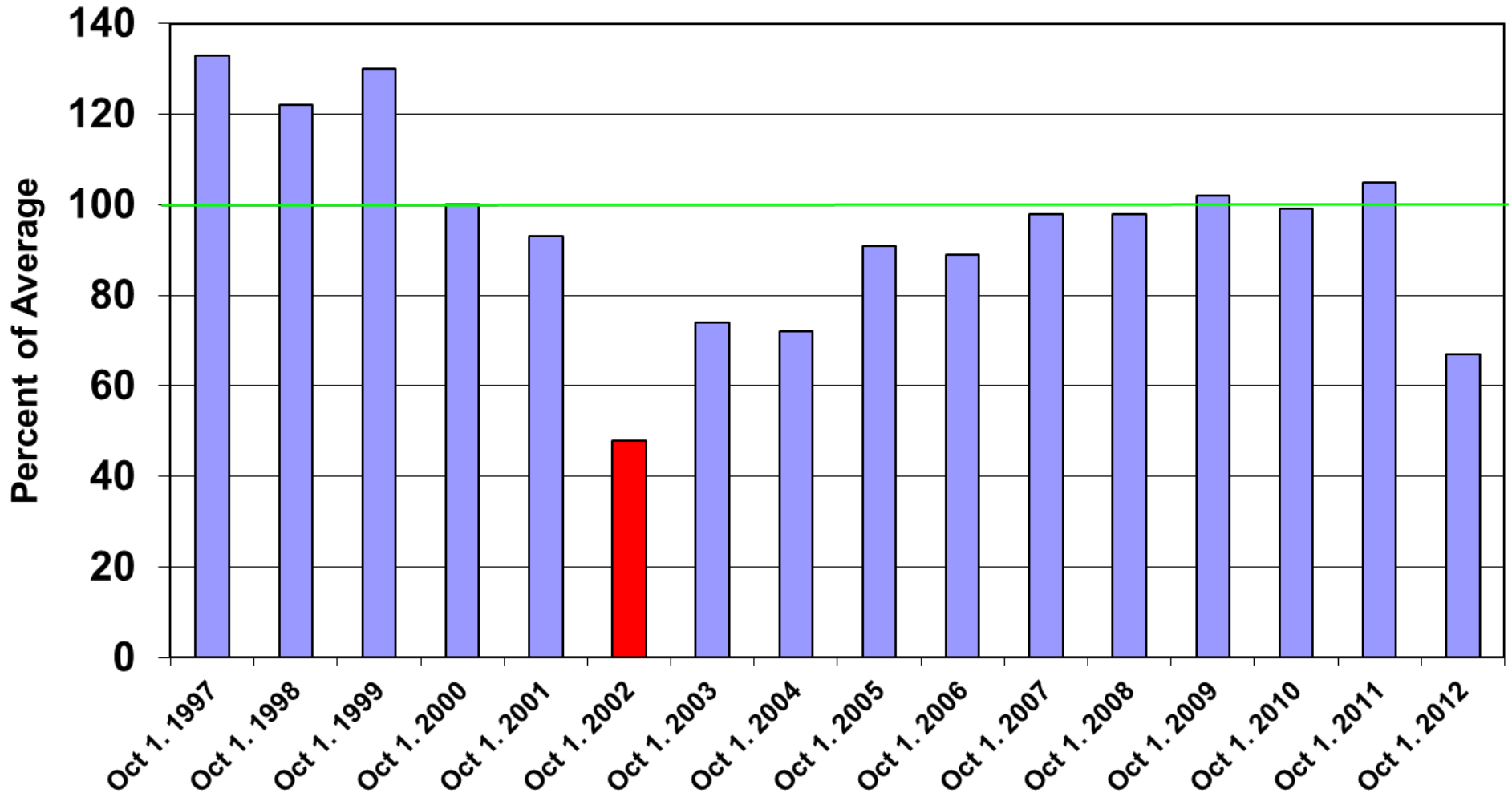

Yampa River Near Maybell, CO Water Year Streamflow
Streamflow Volume (acre-feet)
2500000
2000000
1500000
1000000
500000
0
1916
1919
1922
1925
1928
1931
1934
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012

Reservoirs – our drought insurance

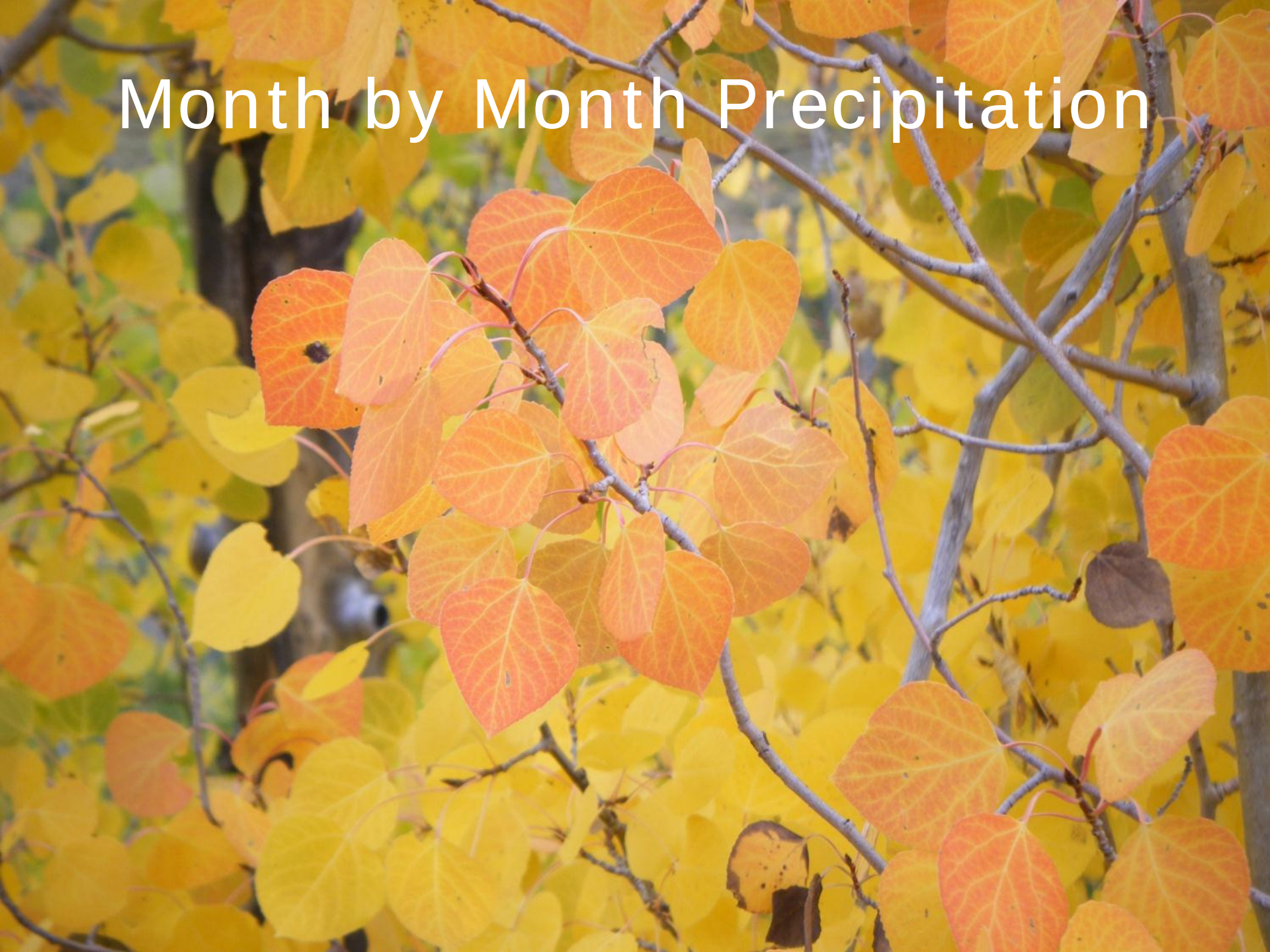
Imagine 2012 without reservoirs -- on the way down but not in deep trouble quite yet



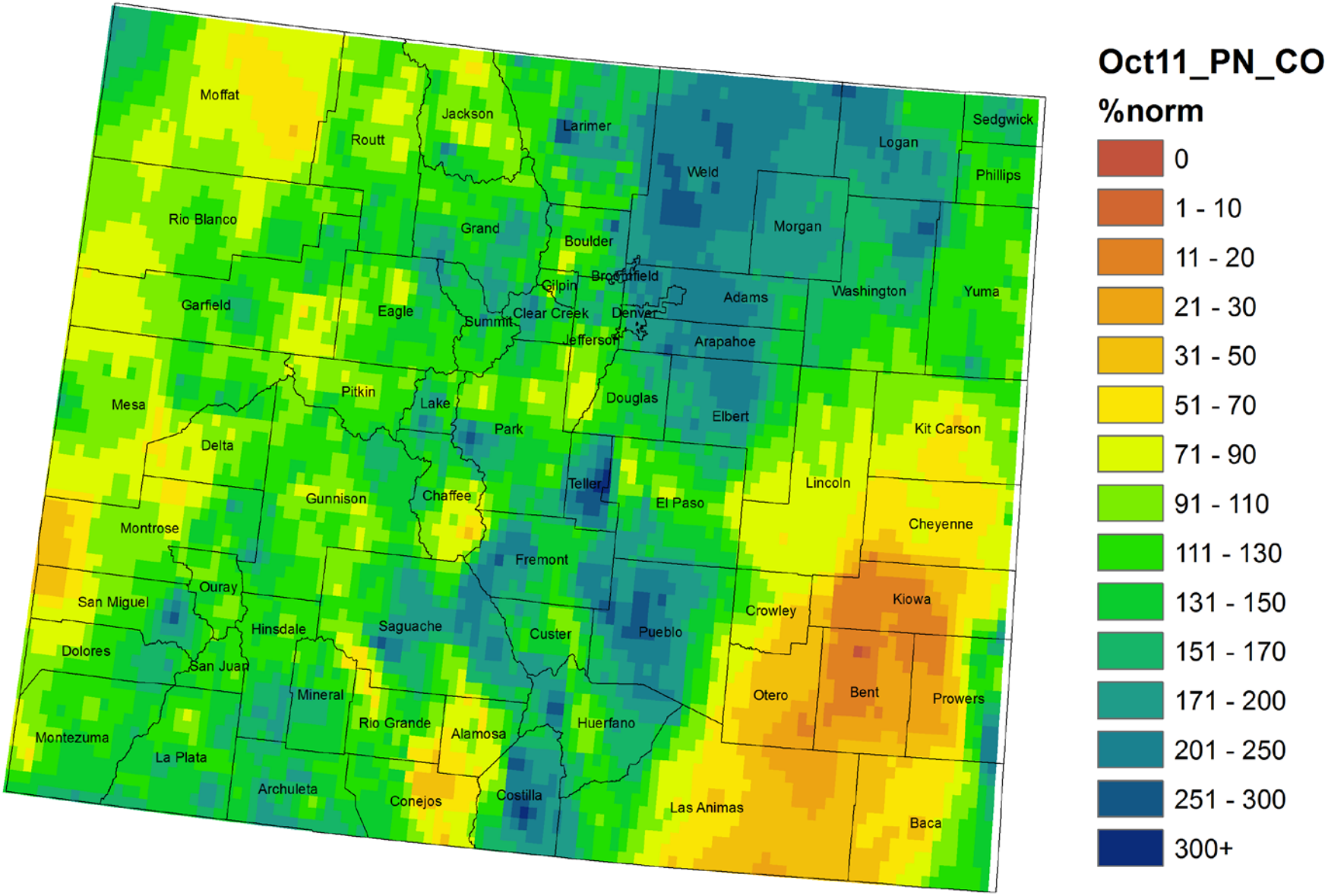
Colorado Statewide Reservoir Levels on October 1st for Years 1997- 2012



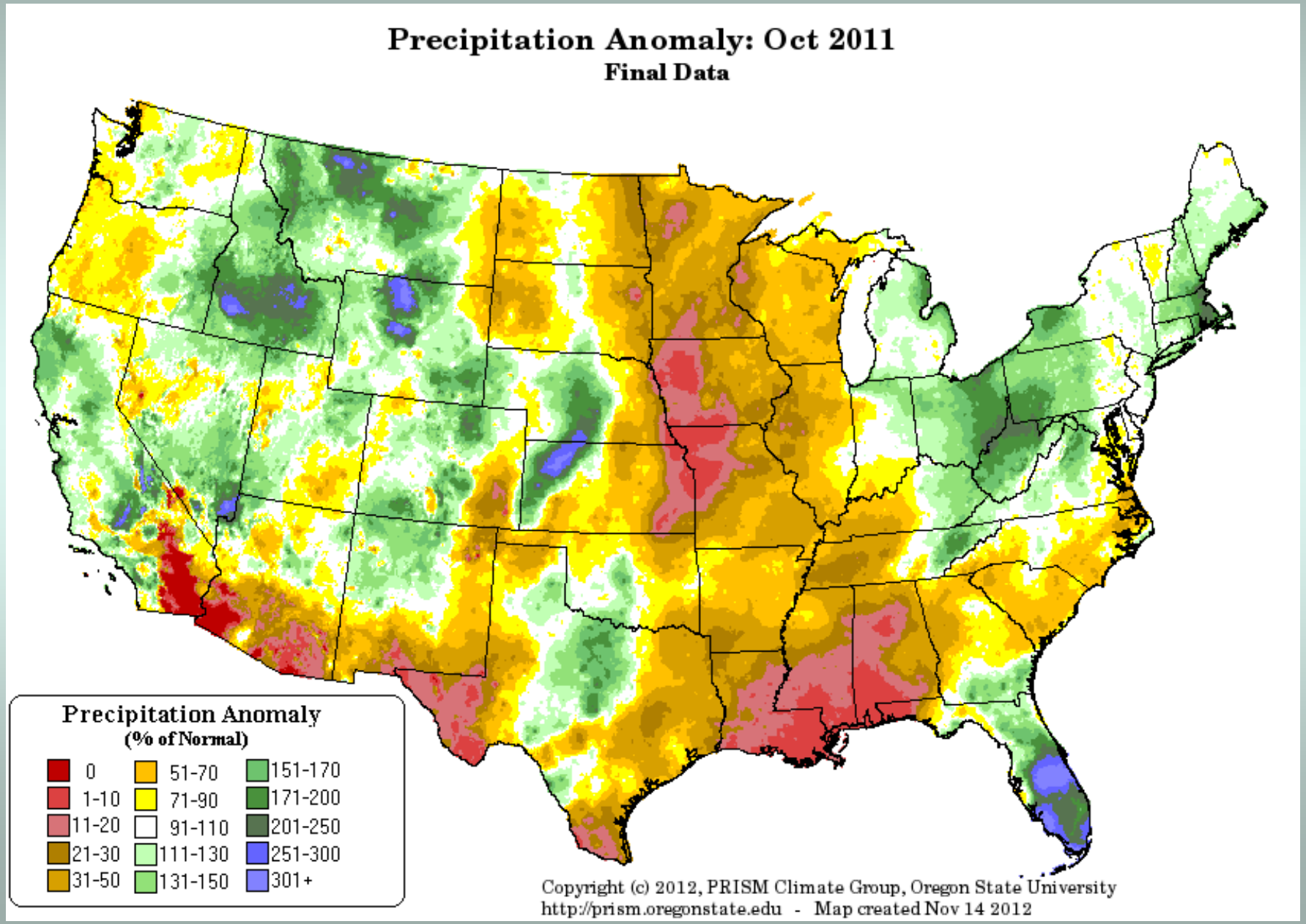
Month by Month Precipitation



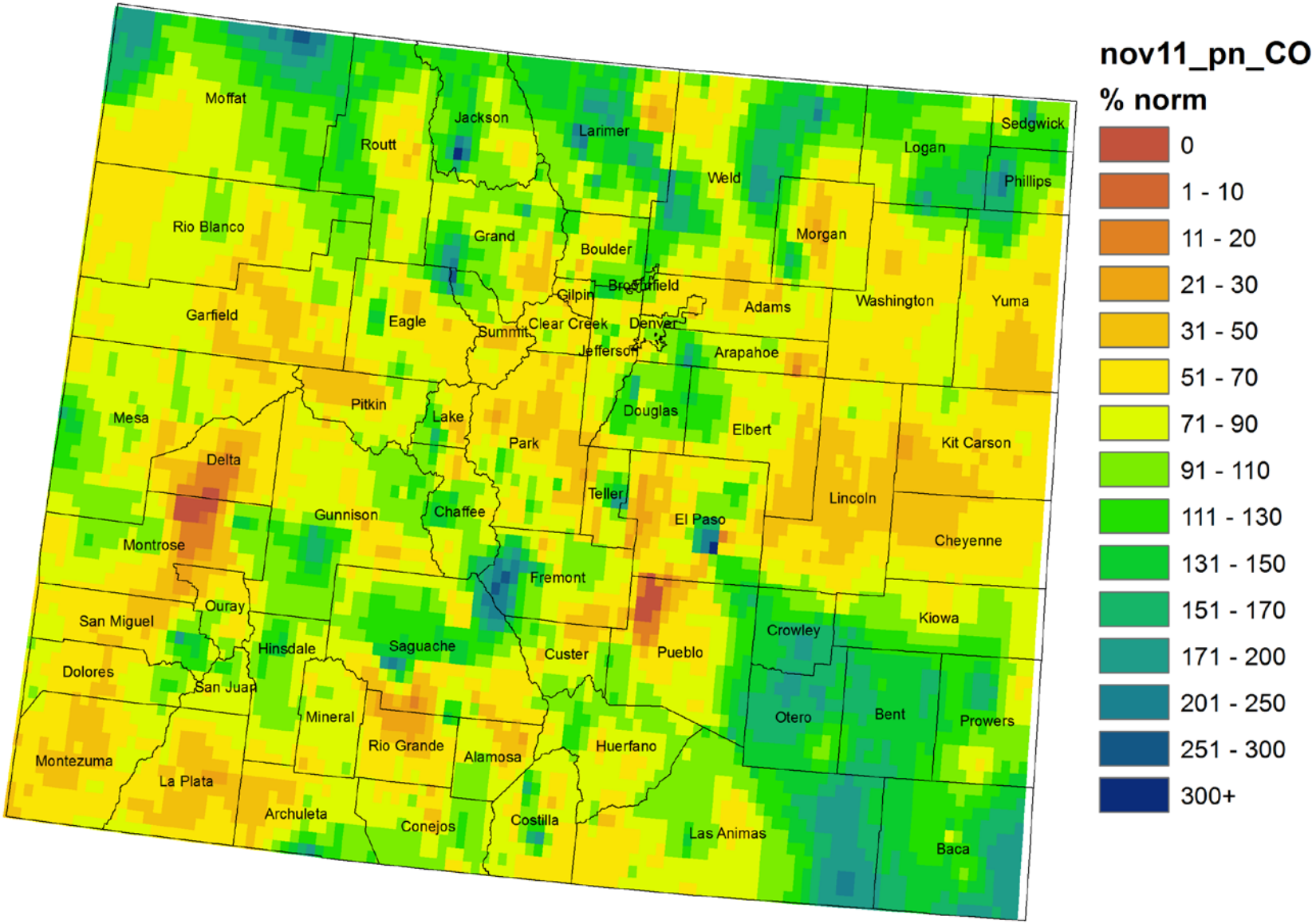
Colorado October 2011 Precipitation as Percentage of Normal



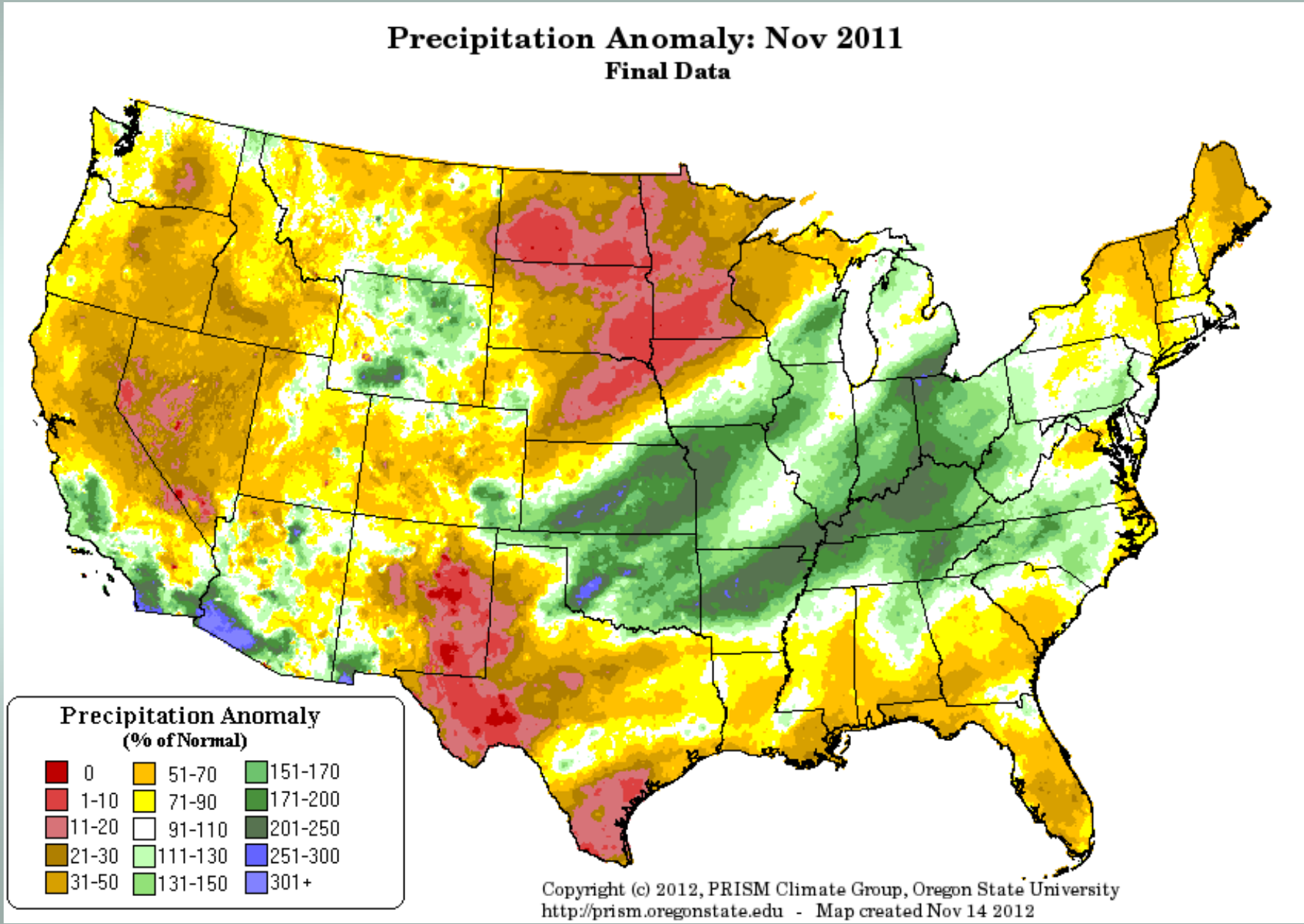
Oct 2011 Percent of Normal



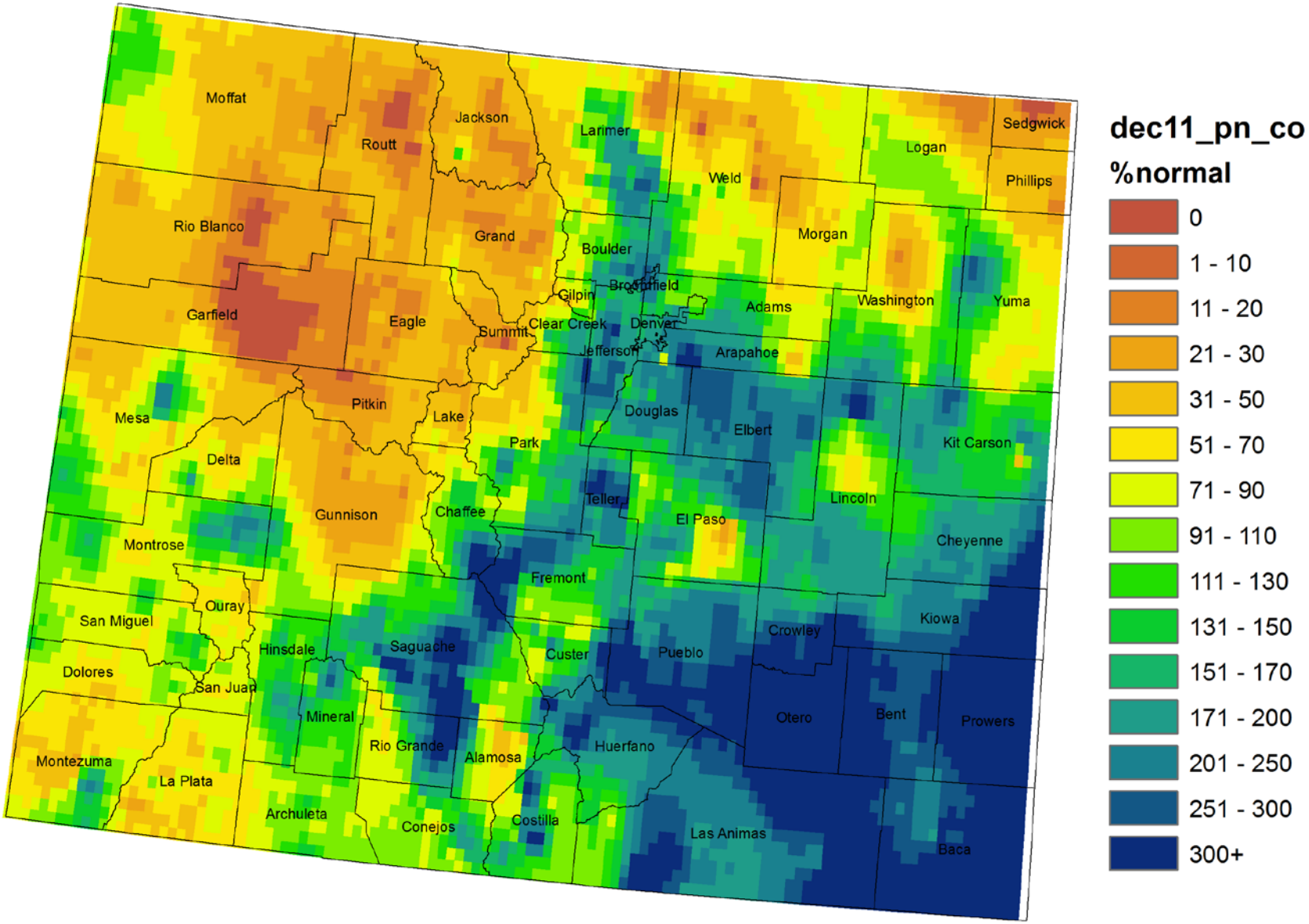
Colorado November 2011 Precipitation as Percentage of Normal



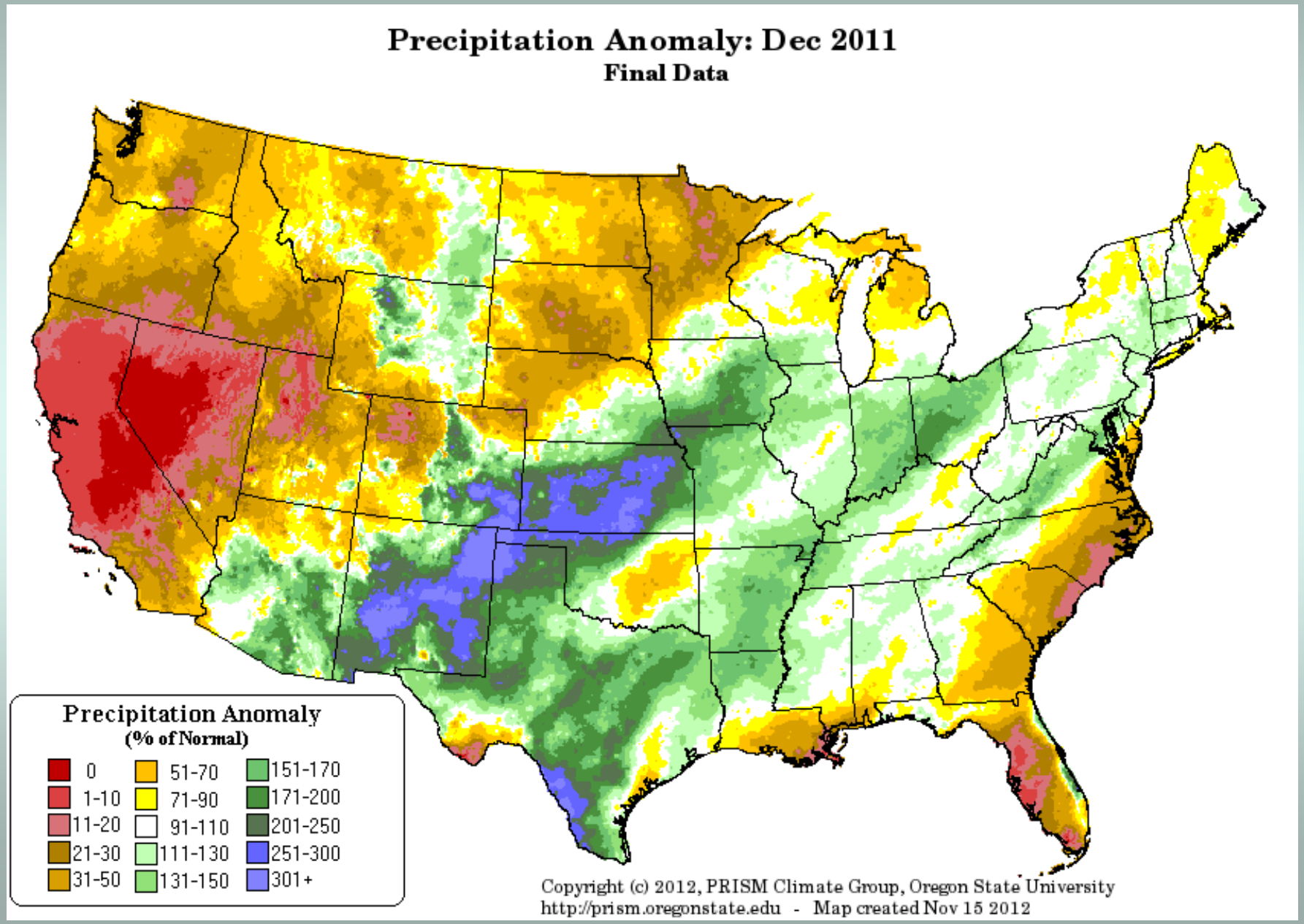
Nov 2011 Percent of Normal



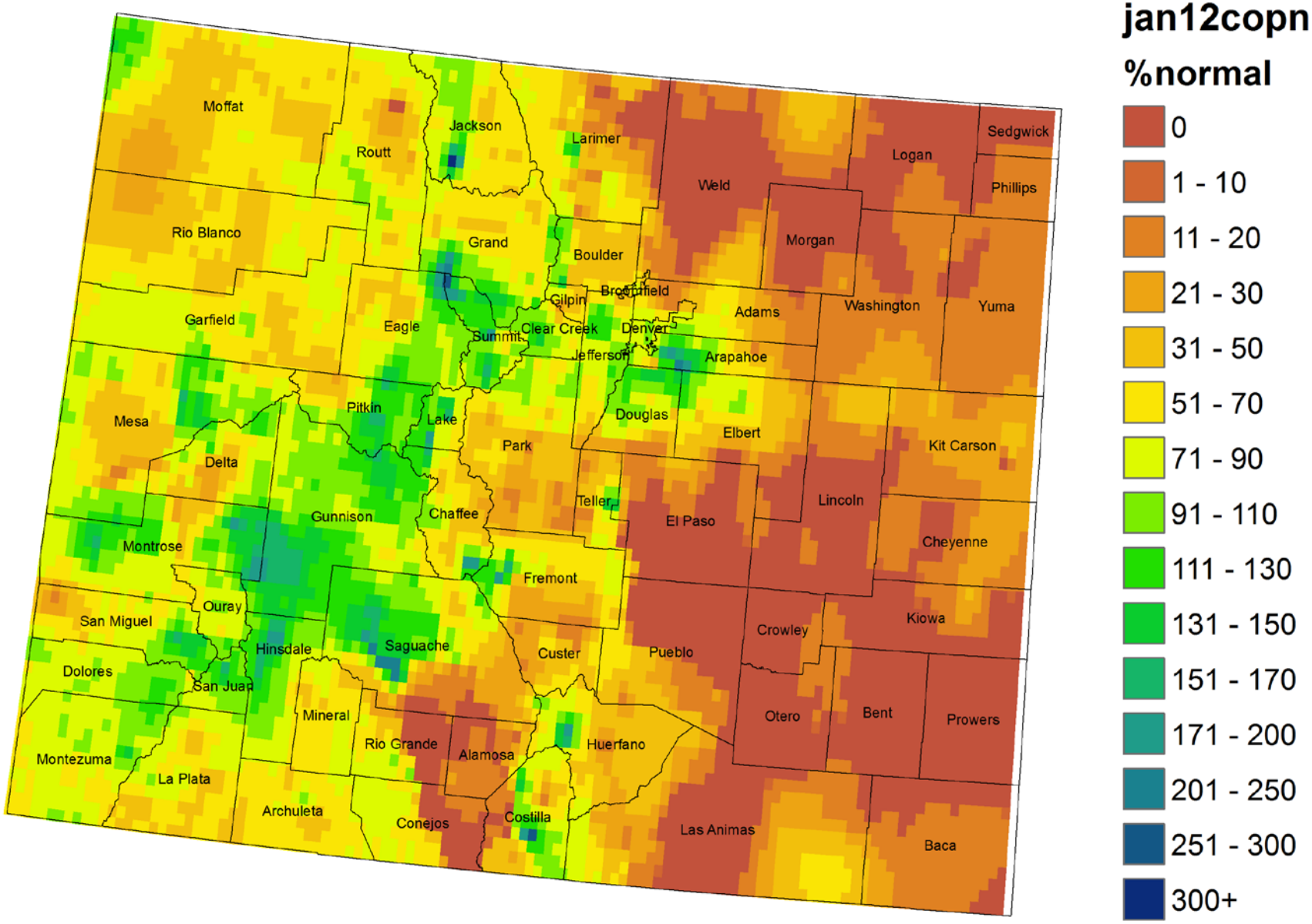
Colorado December 2011 Precipitation as Percentage of Normal



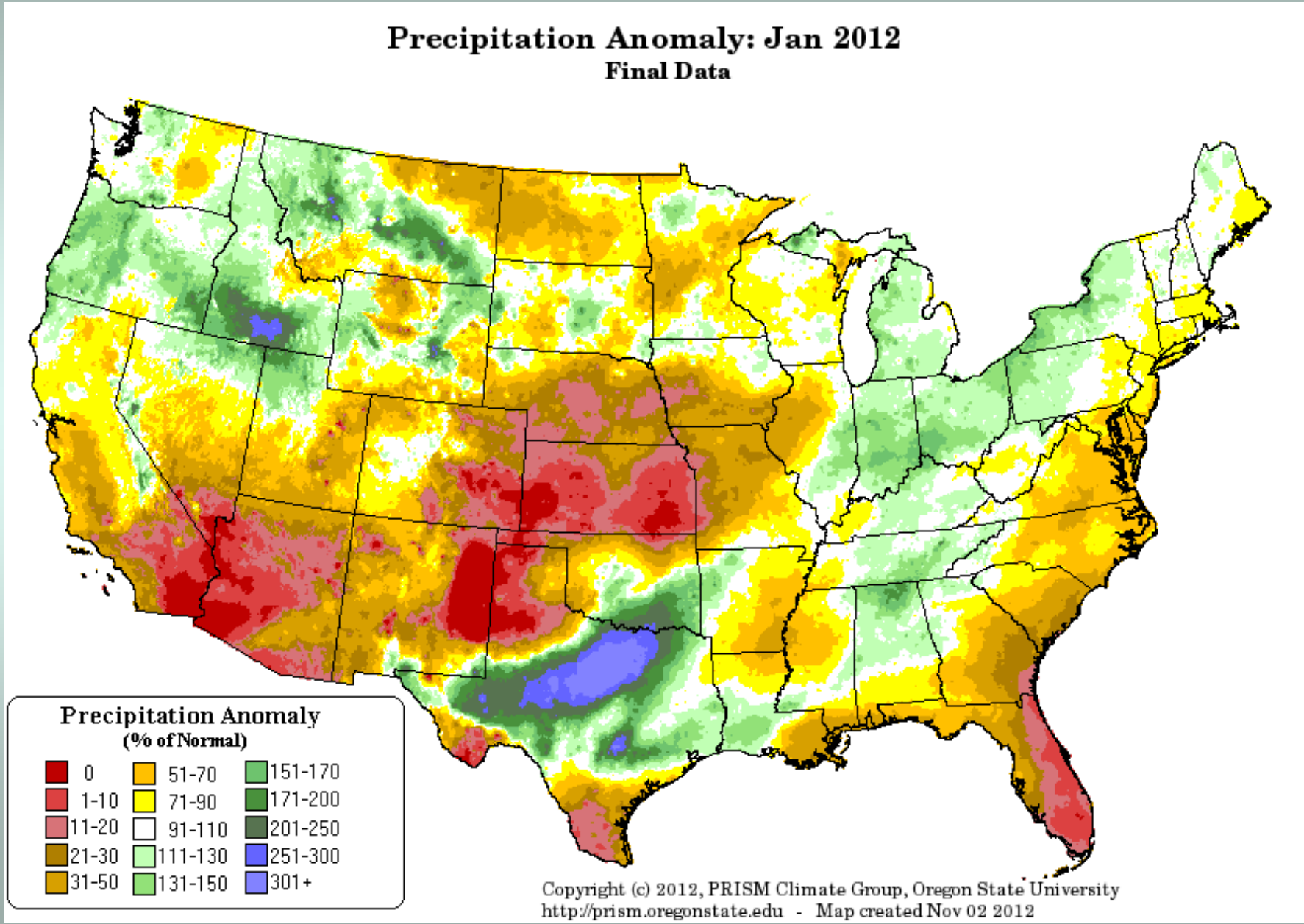
Dec 2011 Percent of Normal



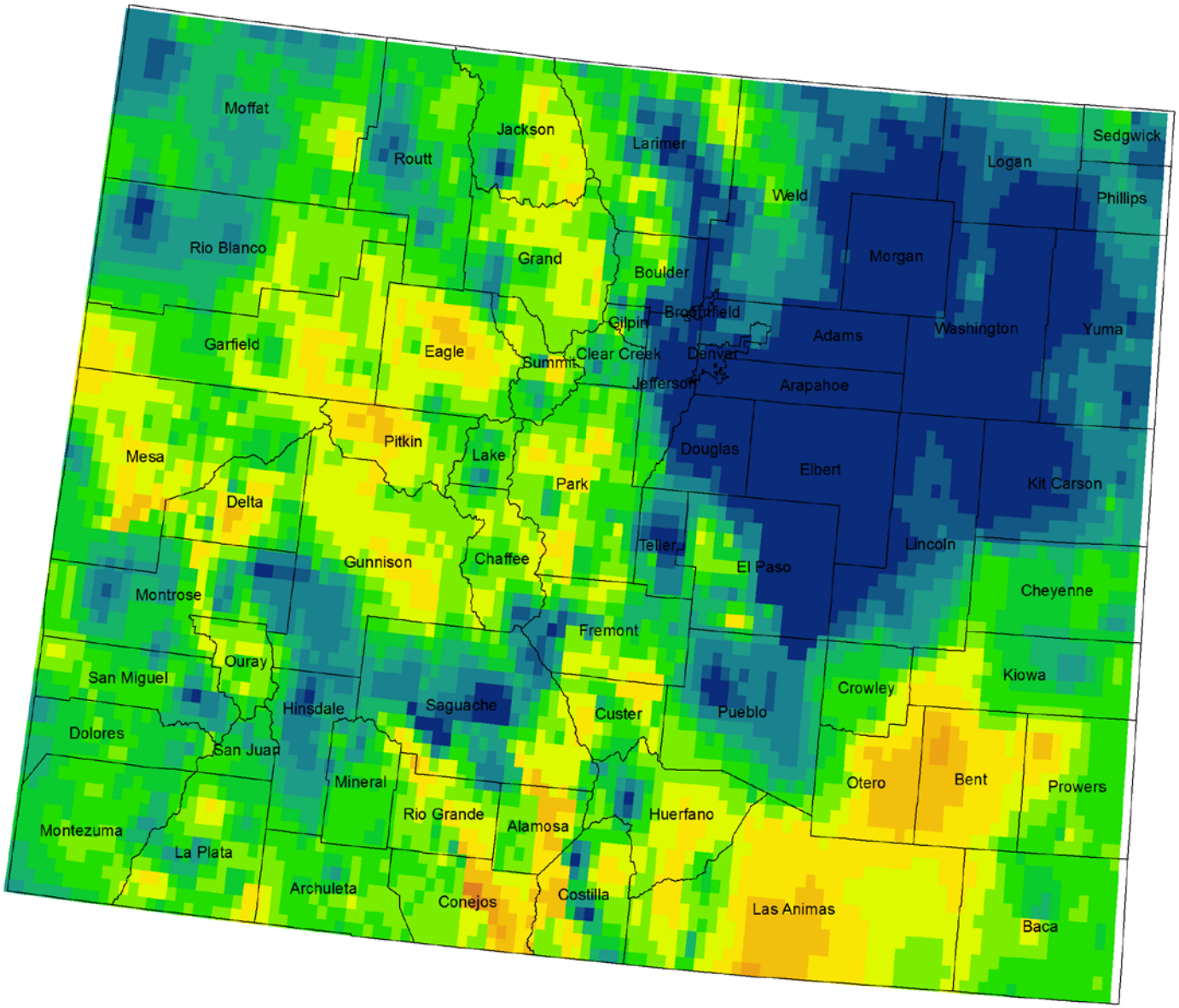
Colorado January 2012 Precipitation as Percentage of Normal



Jan 2012 Percent of Normal



Colorado February 2012 Precipitation as Percentage of Normal

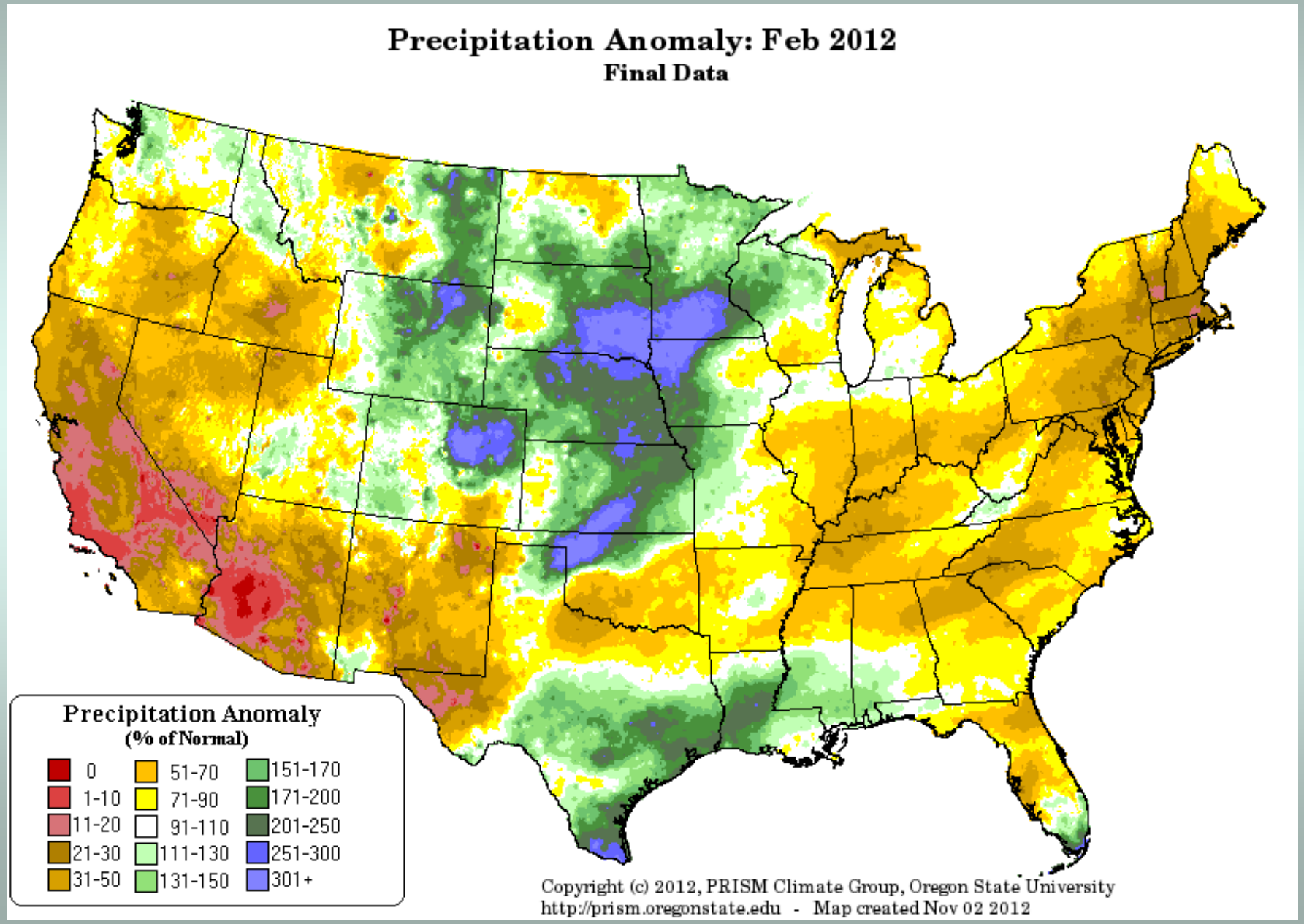


feb12_pnCO

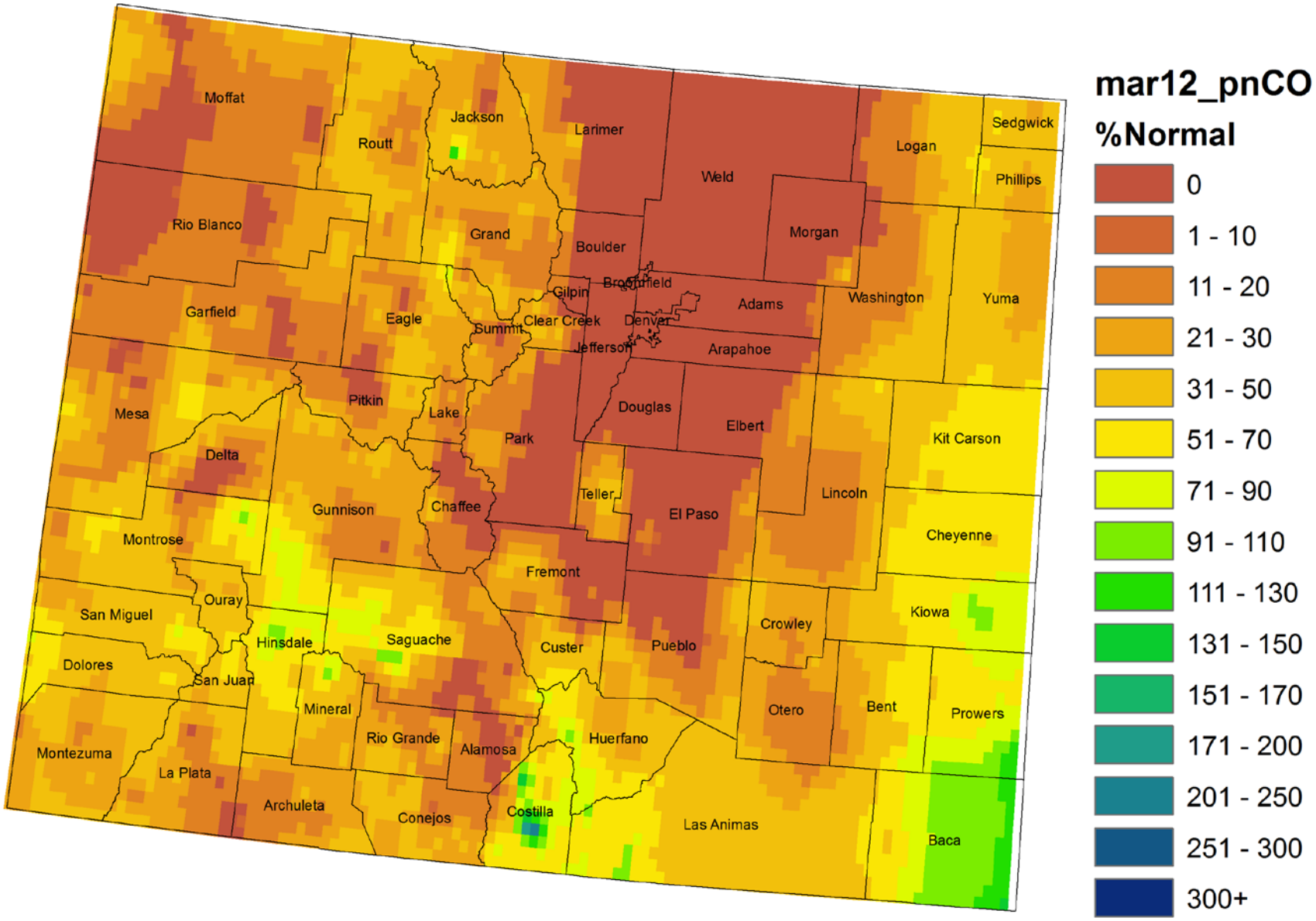
%Normal

- 0
- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 50
- 51 - 70
- 71 - 90
- 91 - 110
- 111 - 130
- 131 - 150
- 151 - 170
- 171 - 200
- 201 - 250
- 251 - 300
- 300+

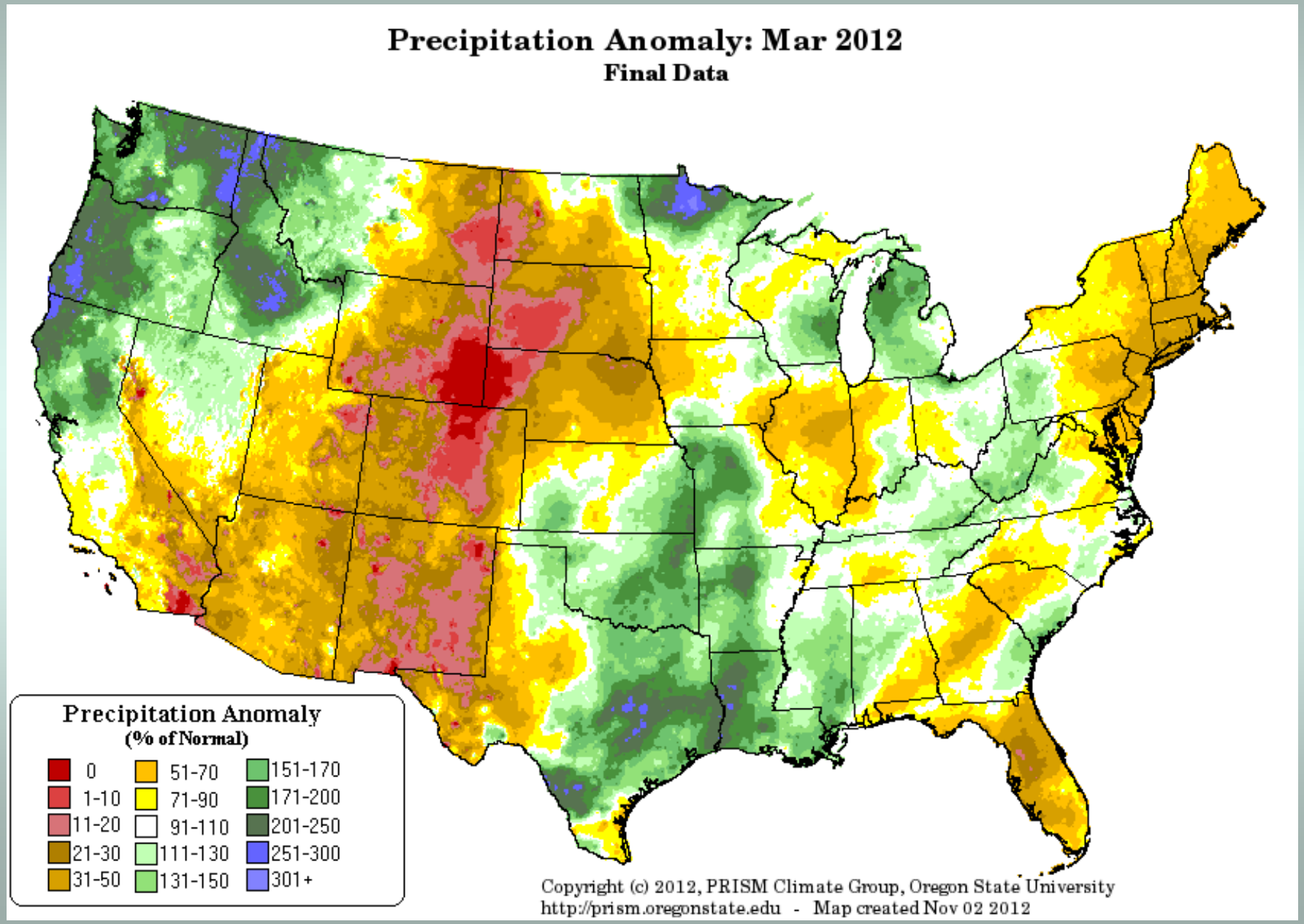
Feb 2012 Percent of Normal



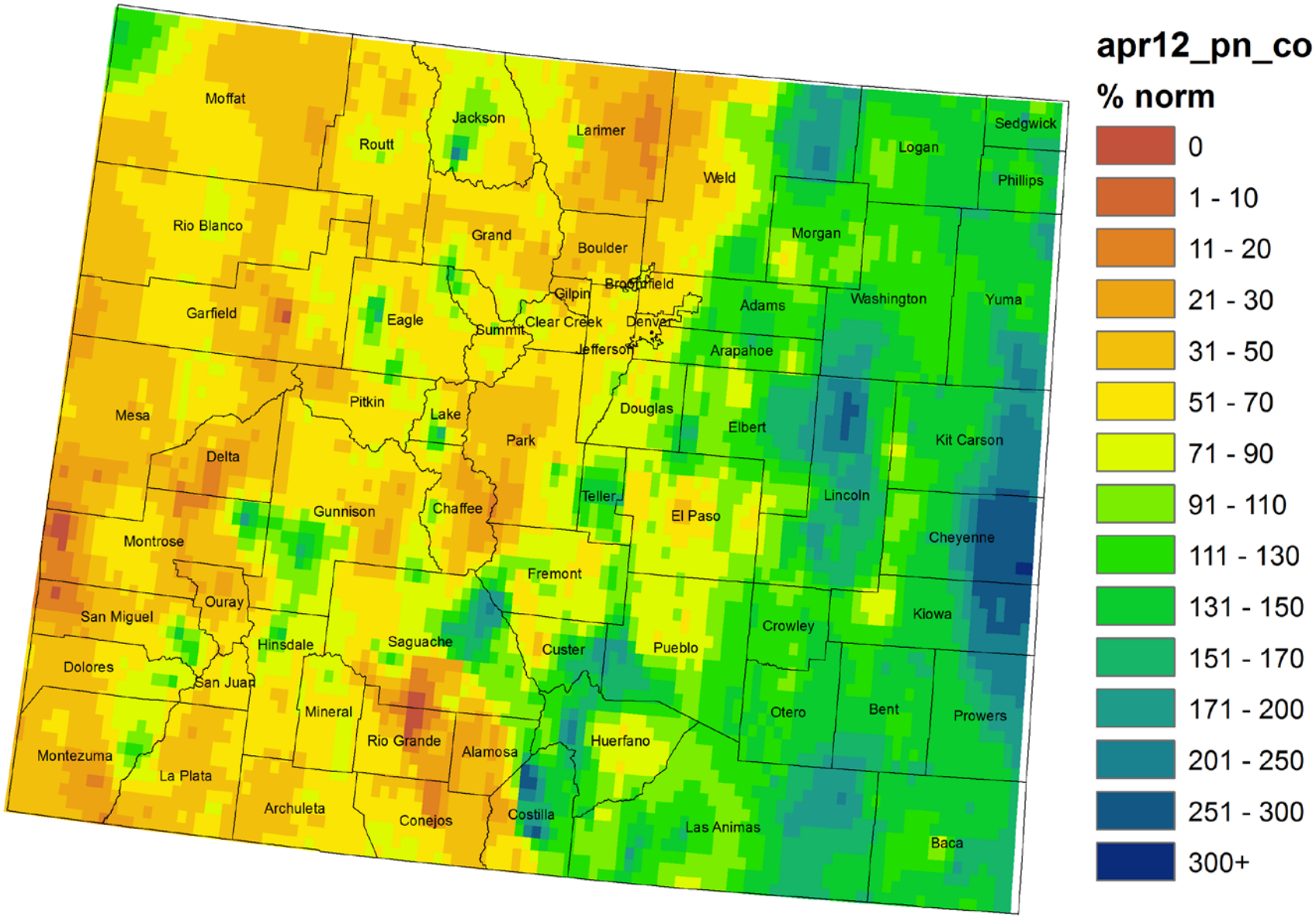
Colorado March 2012 Precipitation as Percentage of Normal



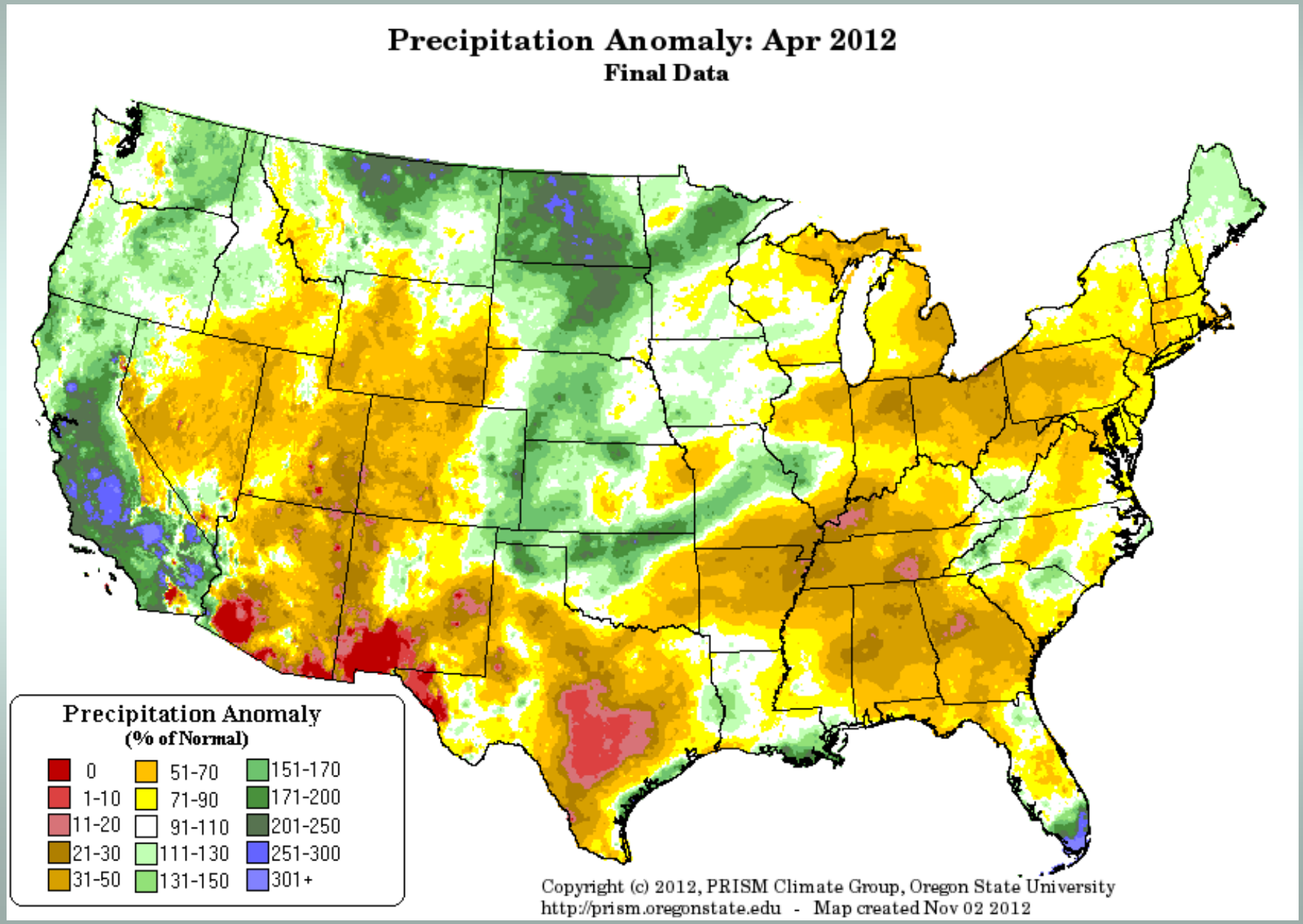
Mar 2012 Percent of Normal



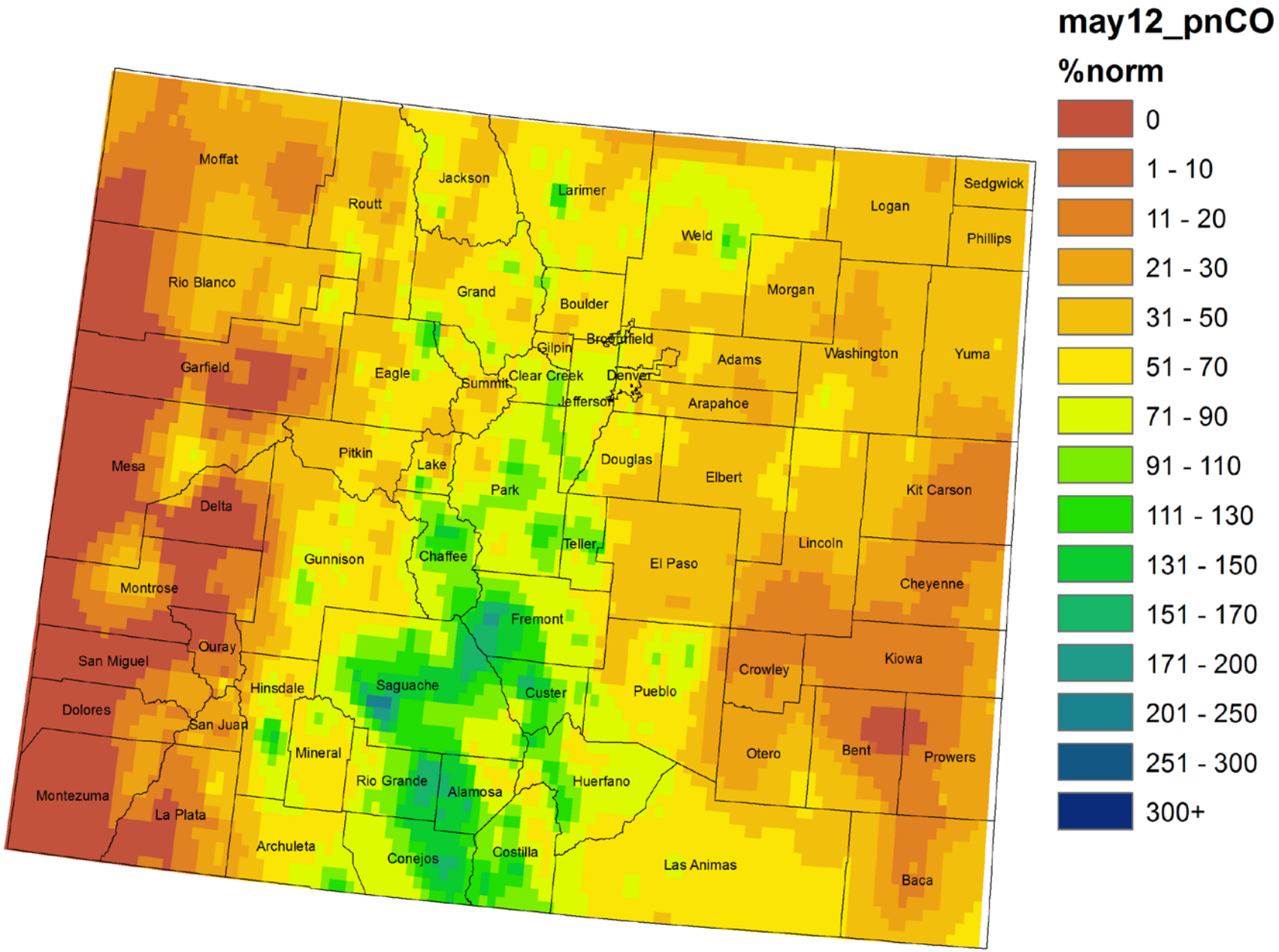
Colorado April 2012 Precipitation as Percentage of Normal



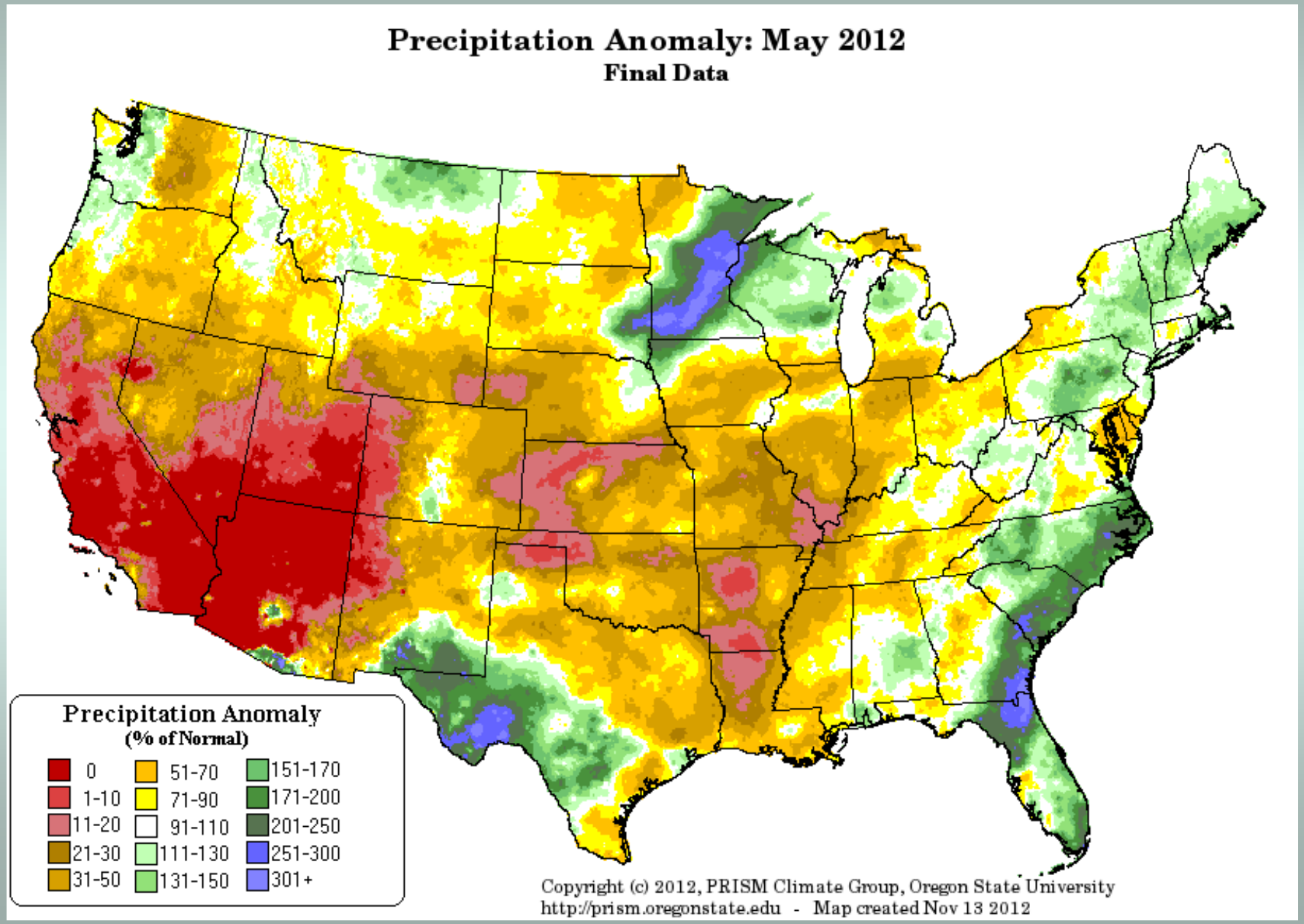
Apr 2012 Percent of Normal



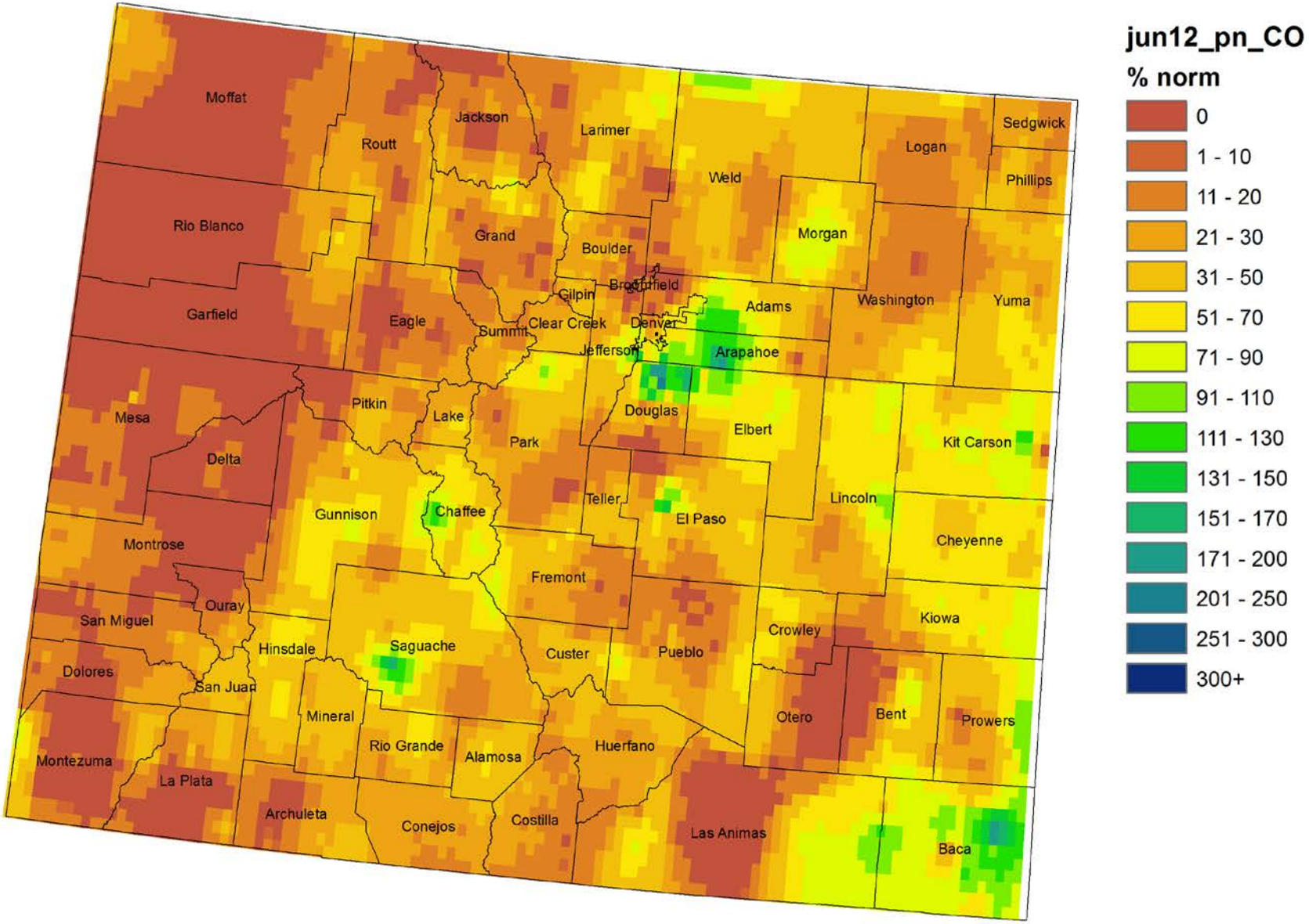
Colorado May 2012 Precipitation as Percentage of Normal



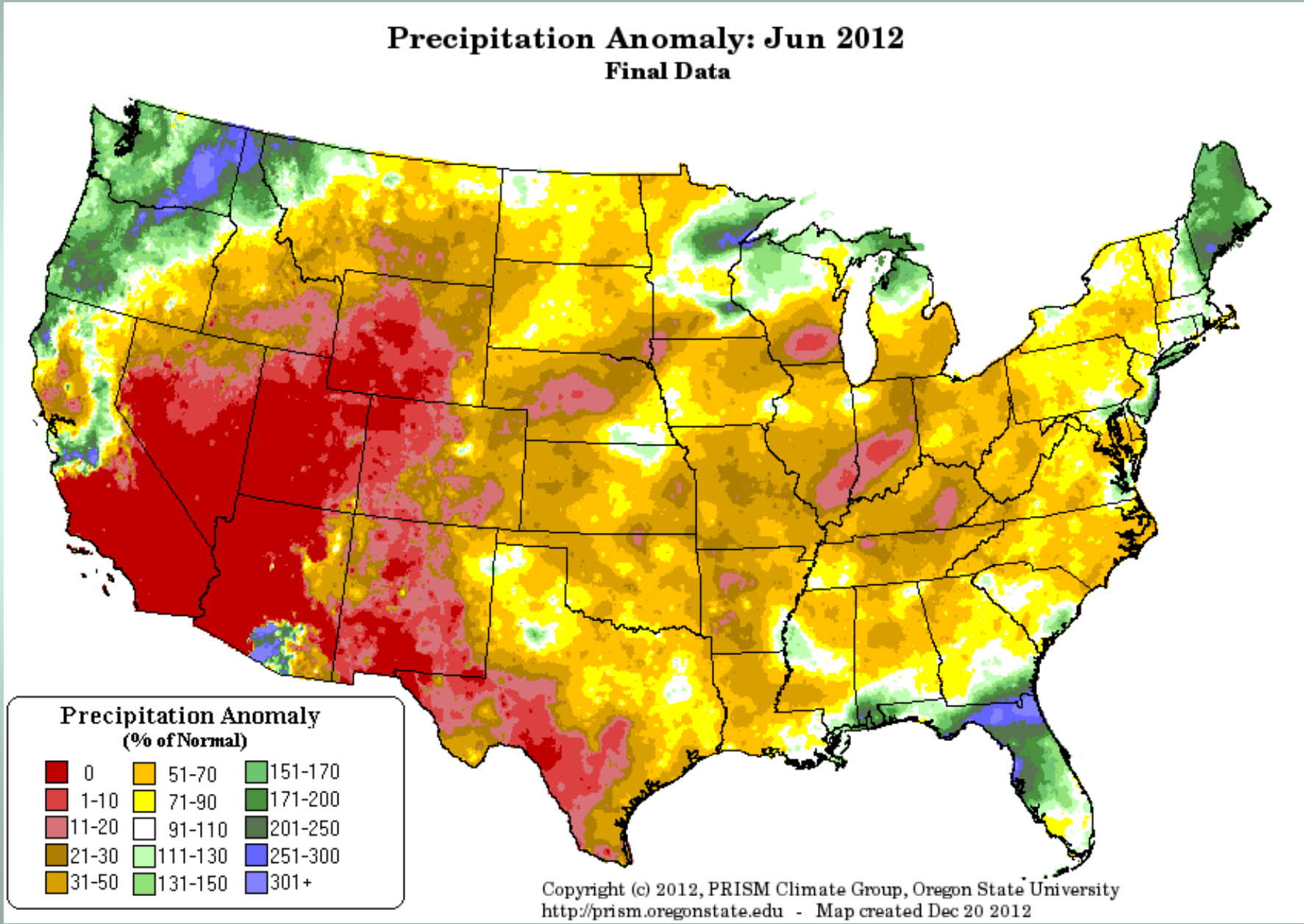
May 2012 Percent of Normal



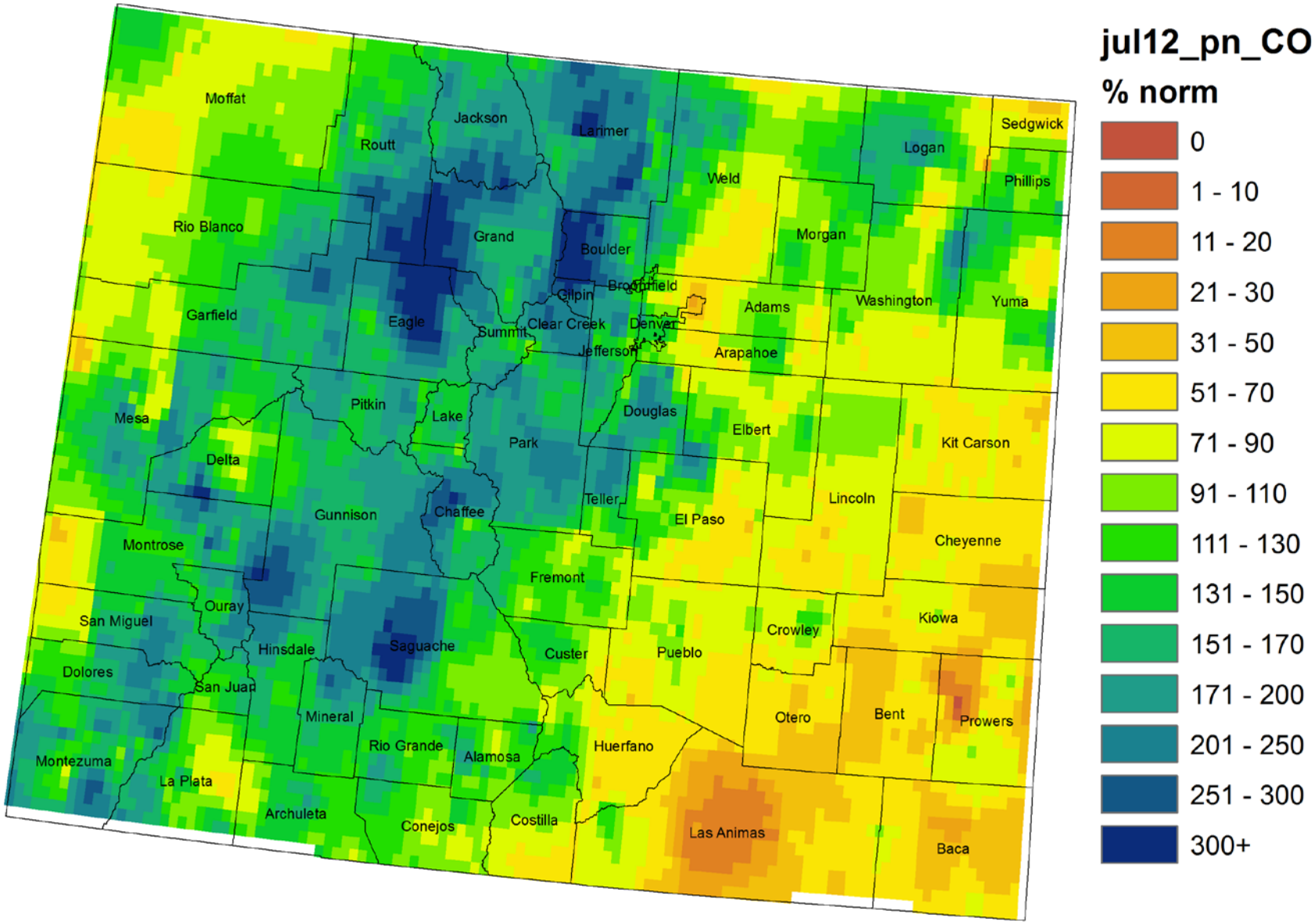
Colorado June 2012 Precipitation as Percentage of Normal



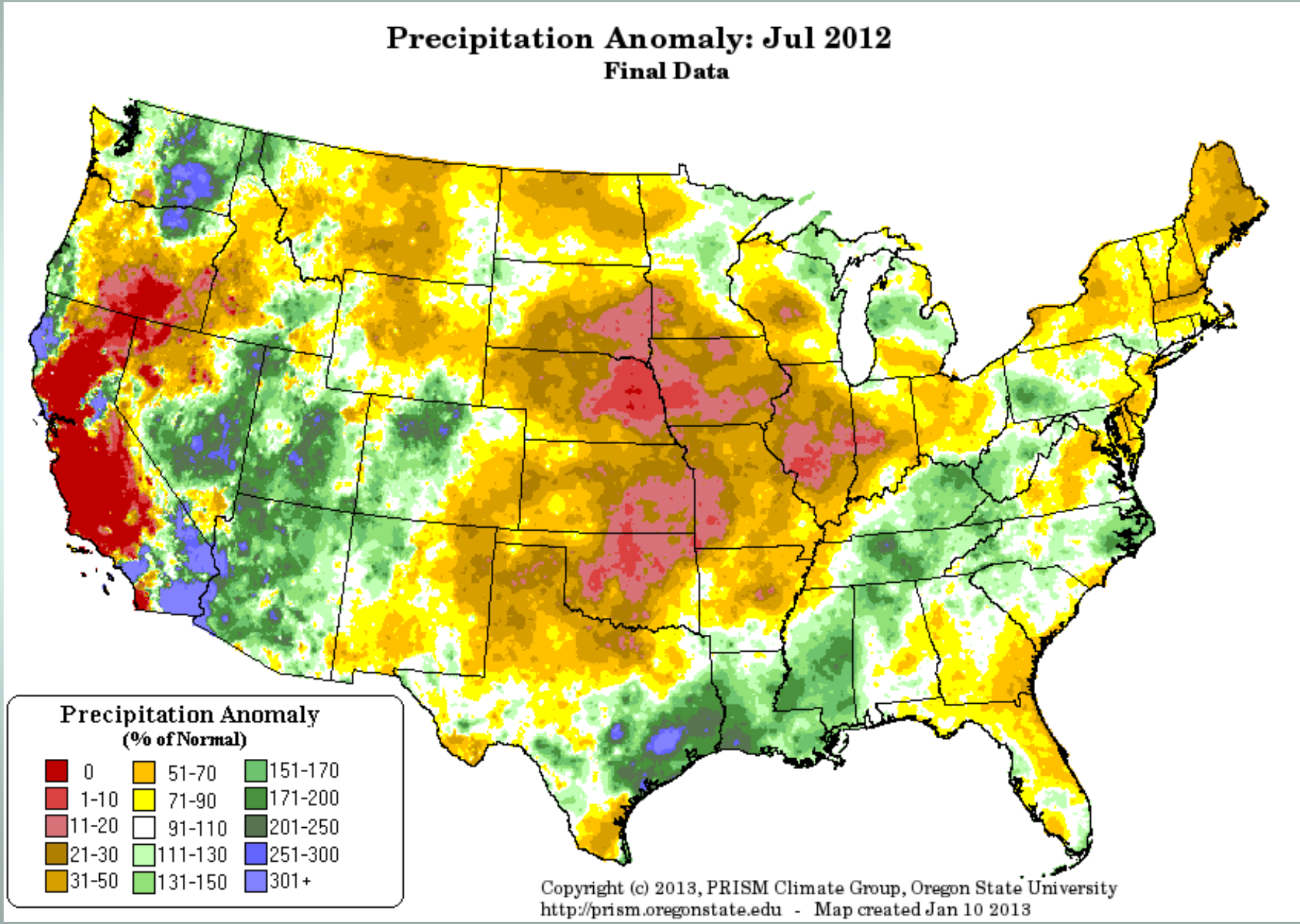
Jun 2012 Percent of Normal



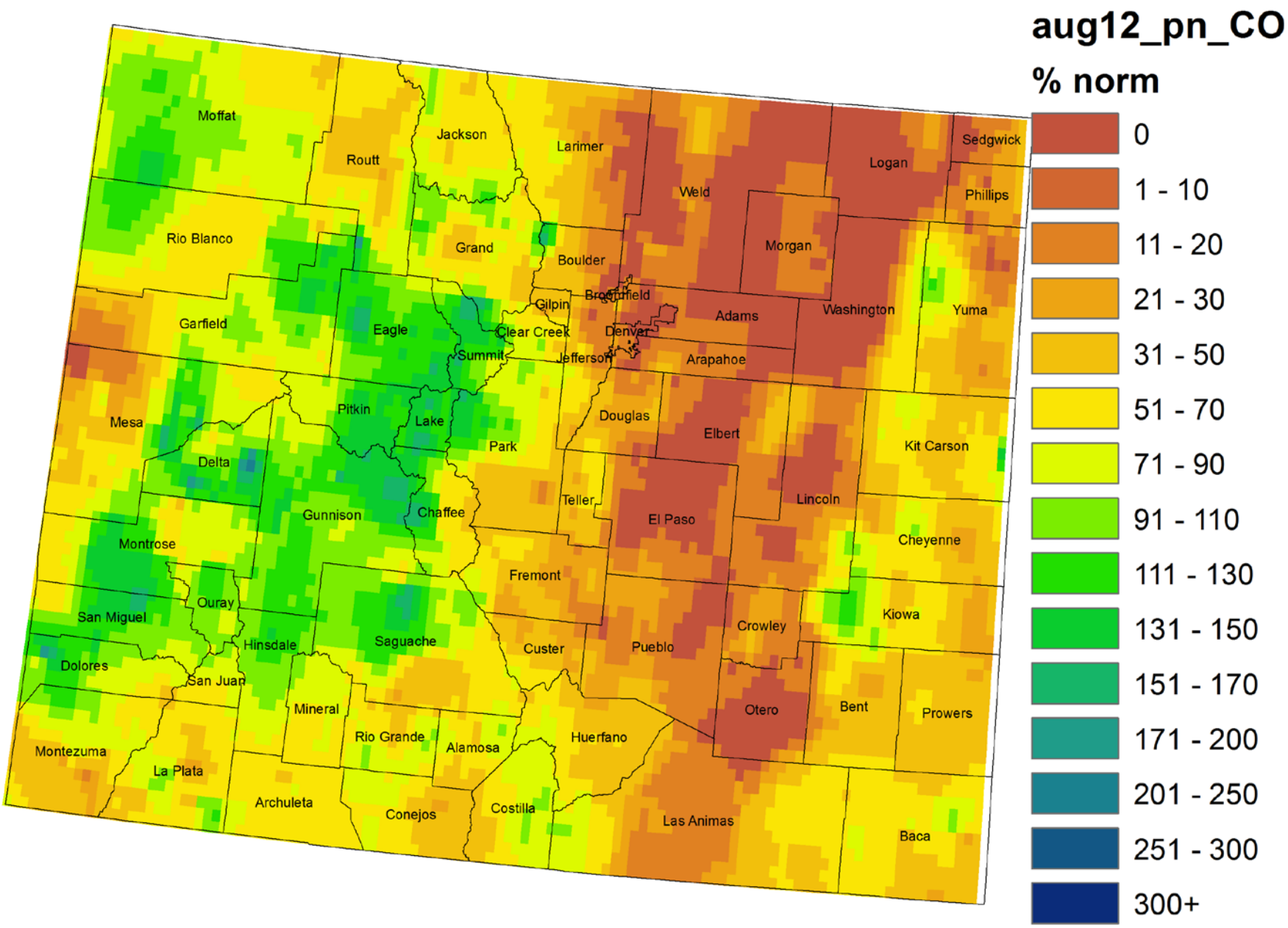
Colorado July 2012 Precipitation as Percentage of Normal



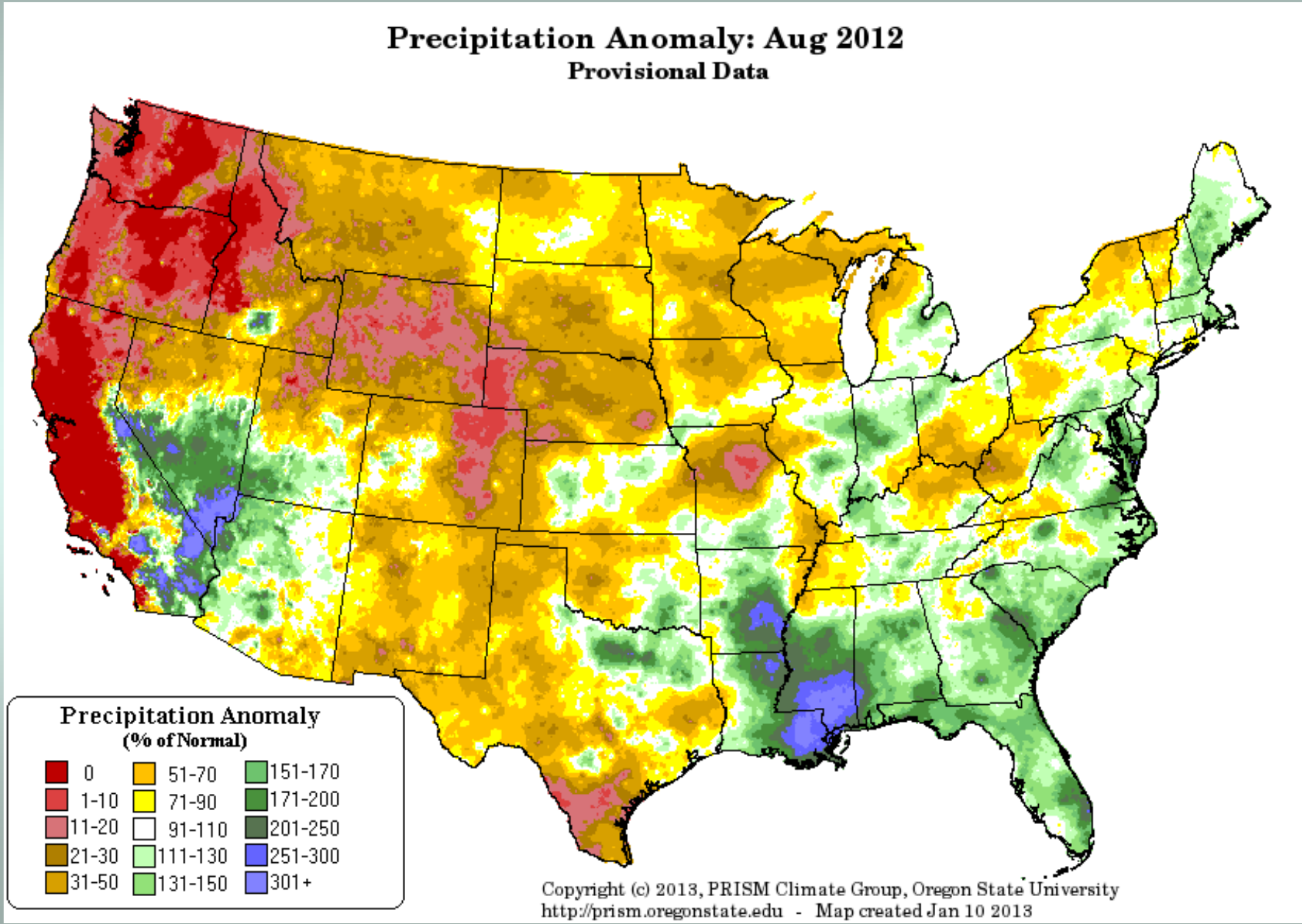
Jul 2012 Percent of Normal



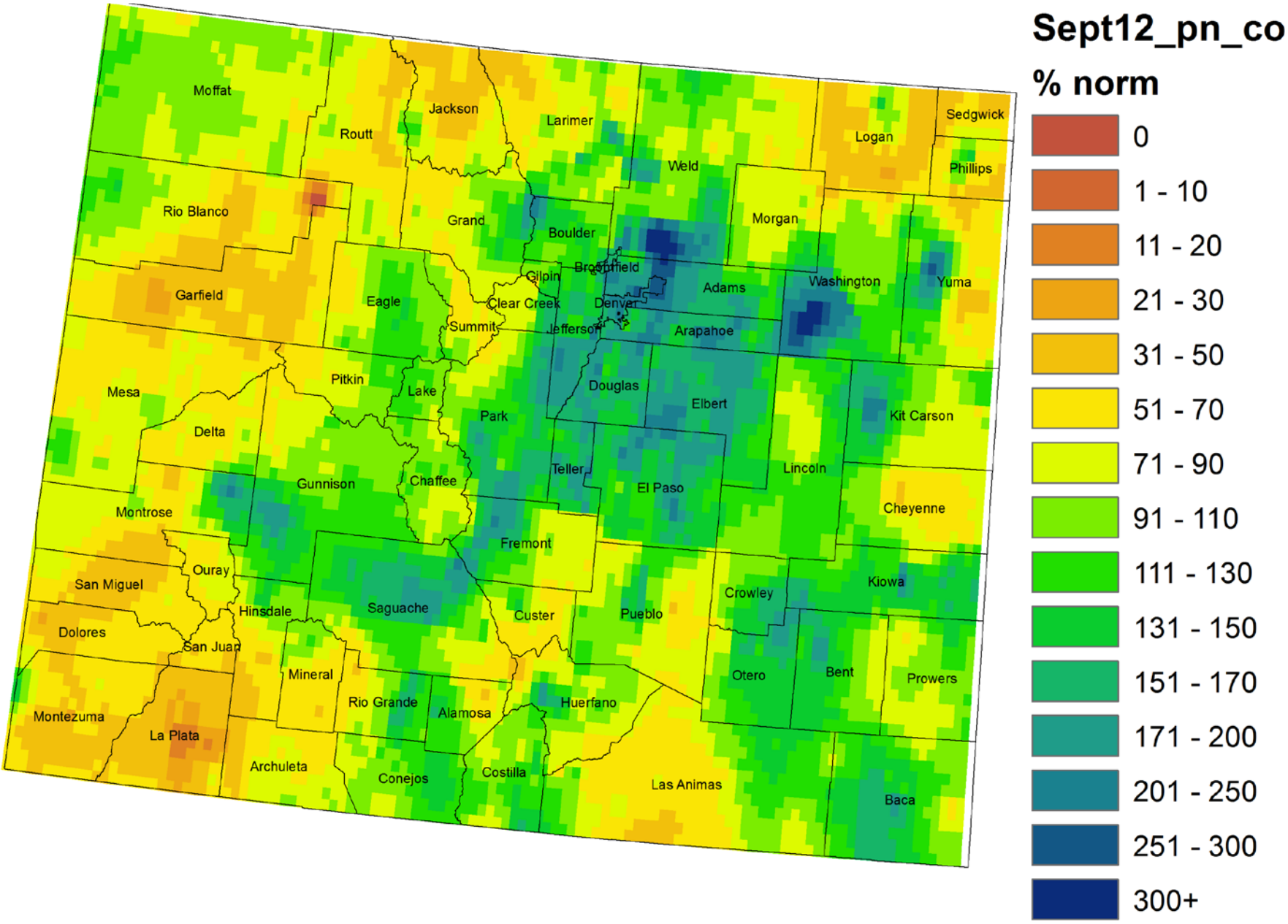
Colorado August 2012 Precipitation as Percentage of Normal



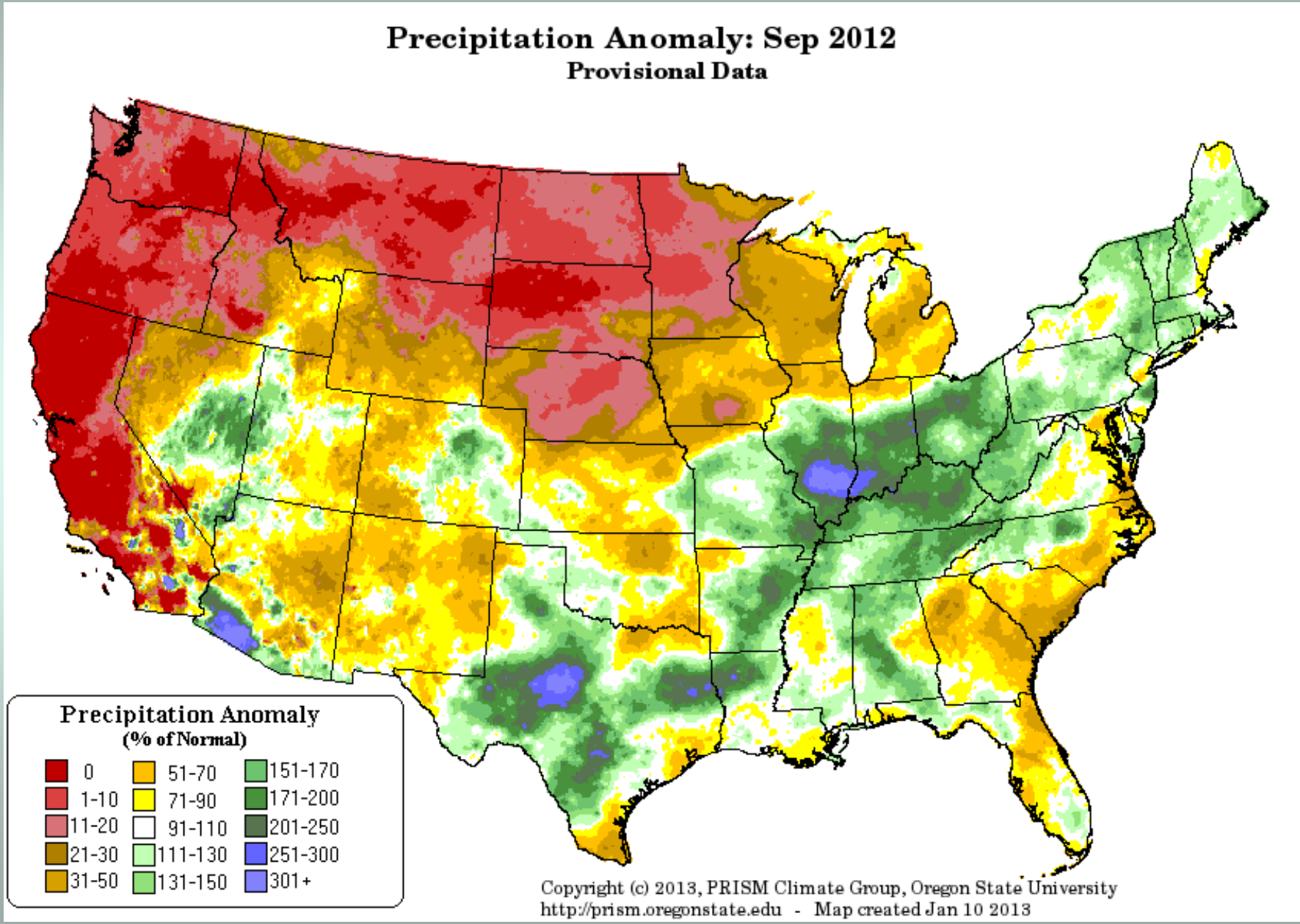
Aug 2012 Percent of Normal



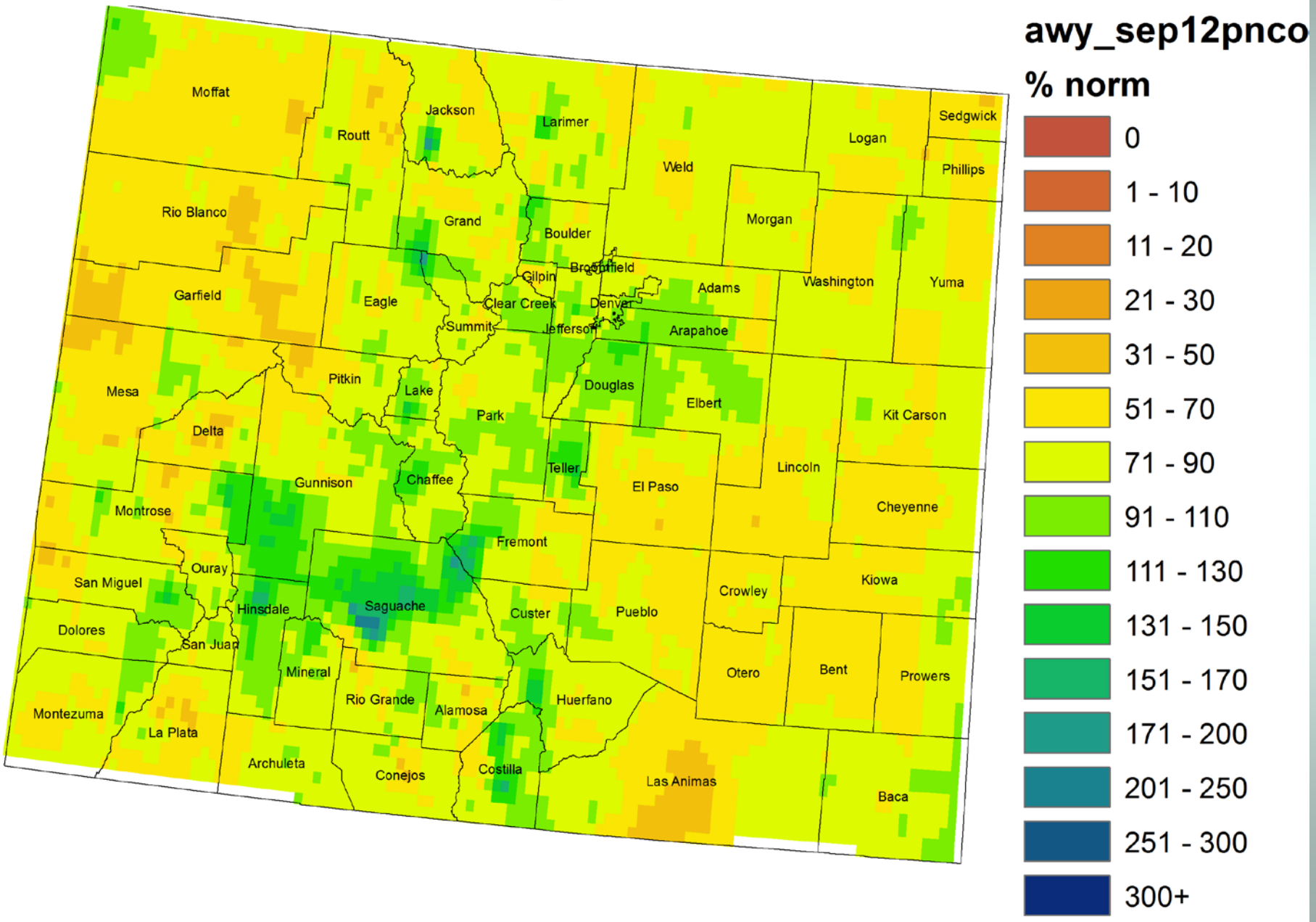
Colorado September 2012 Precipitation as Percentage of Normal



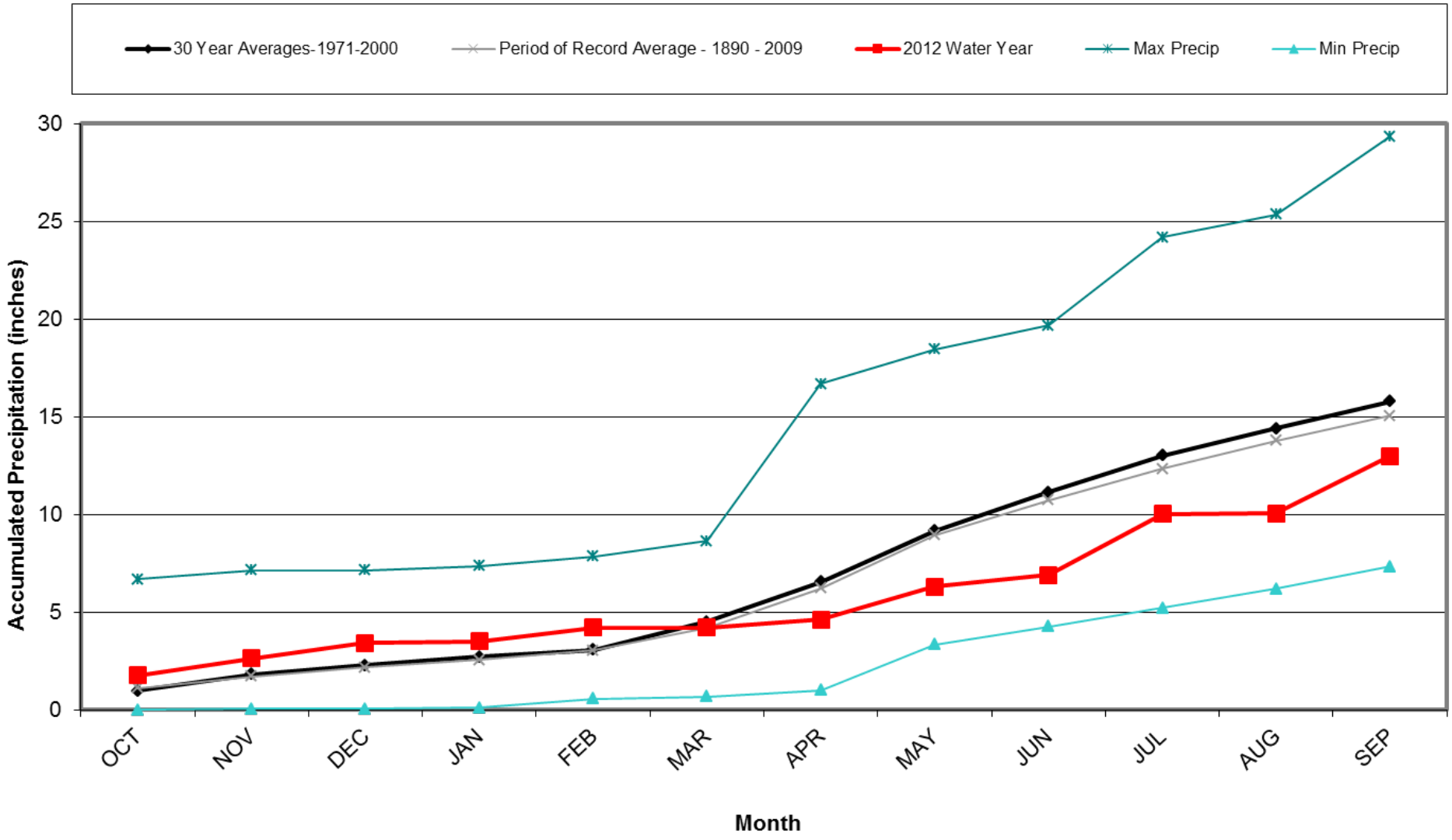
Sep 2012 Percent of Normal



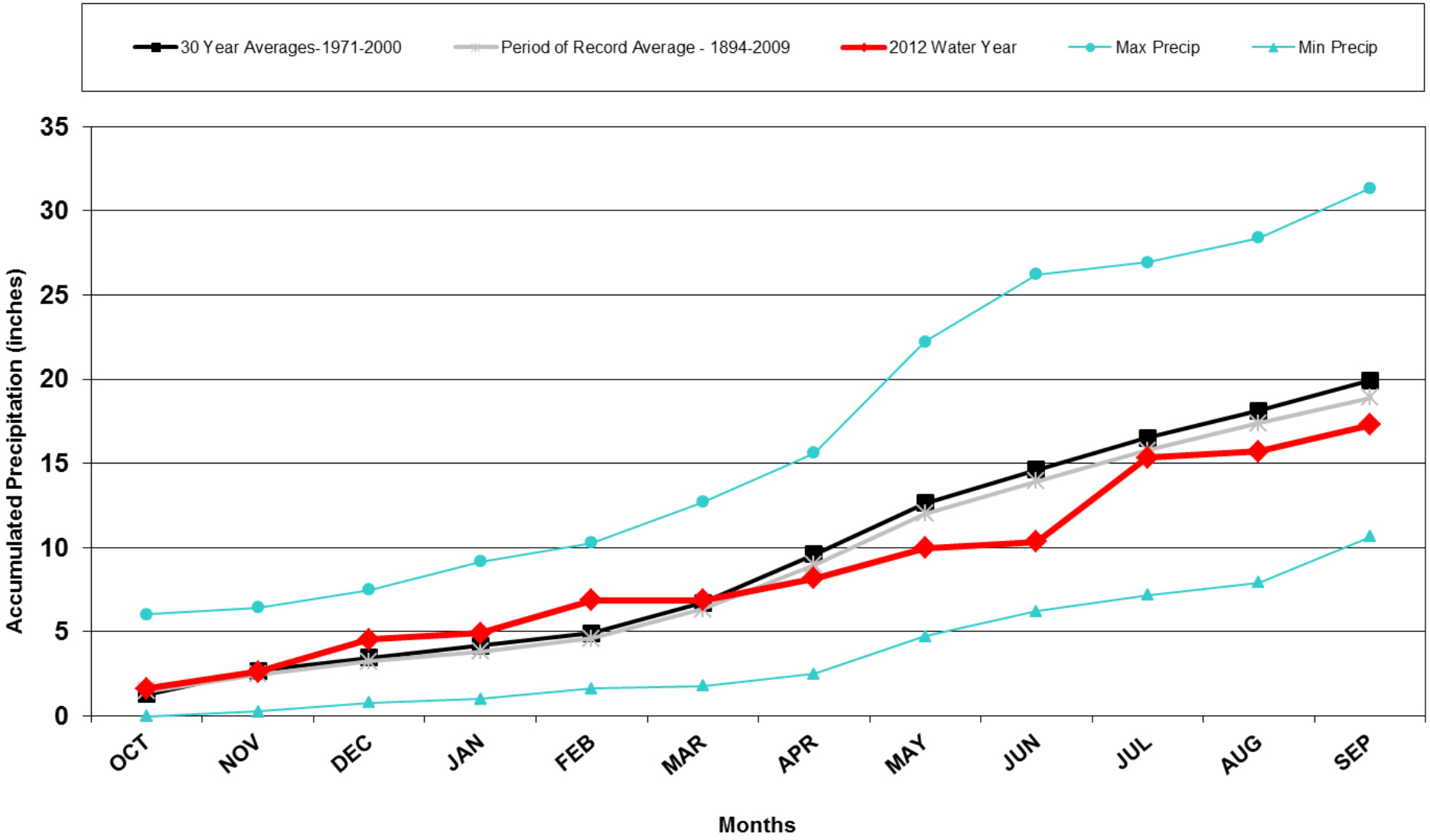
Colorado Water Year 2012
Precipitation as Percentage of Normal (Oct 2011 - Sep 2012)



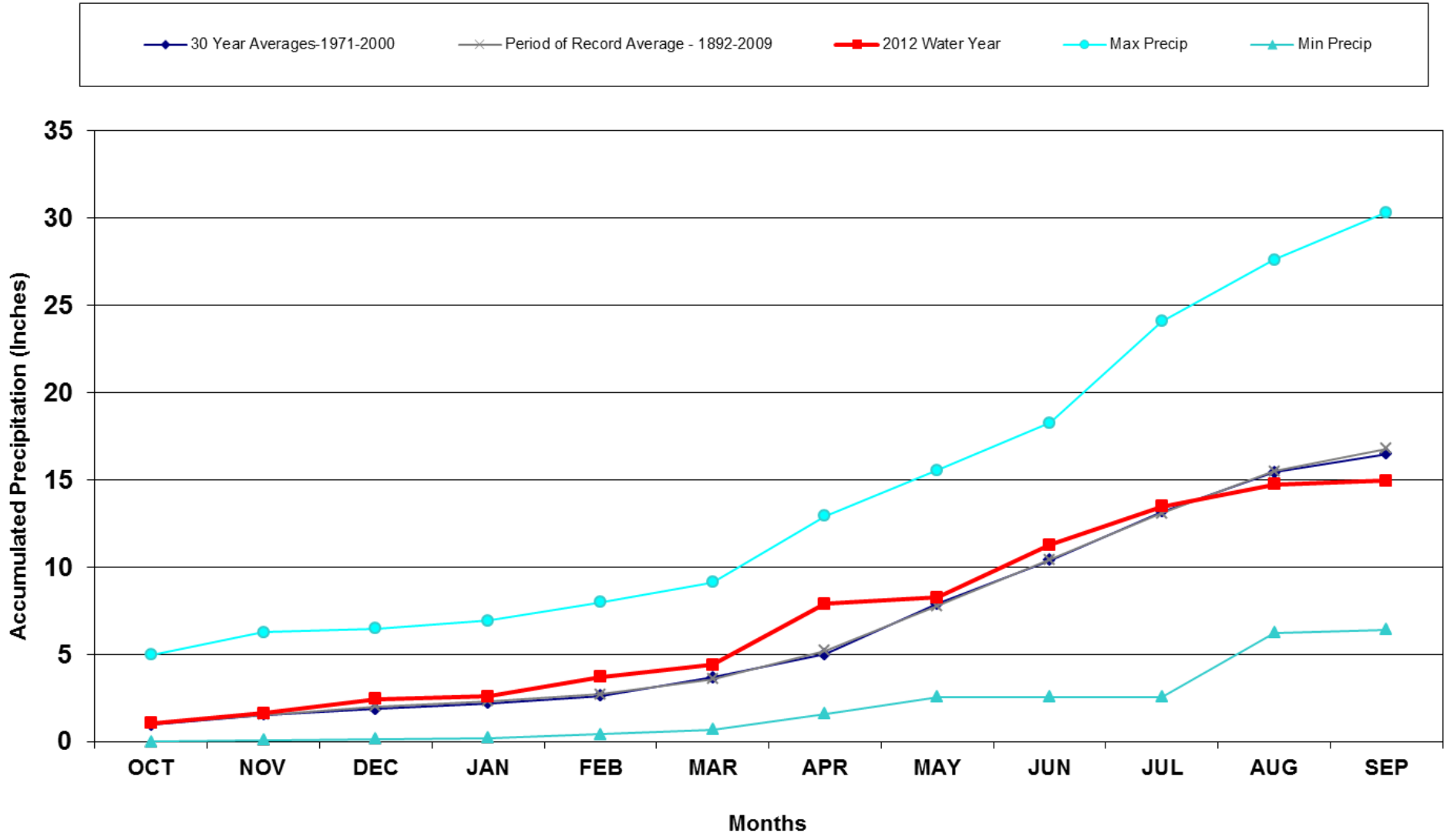
Fort Collins
2012 Water Year



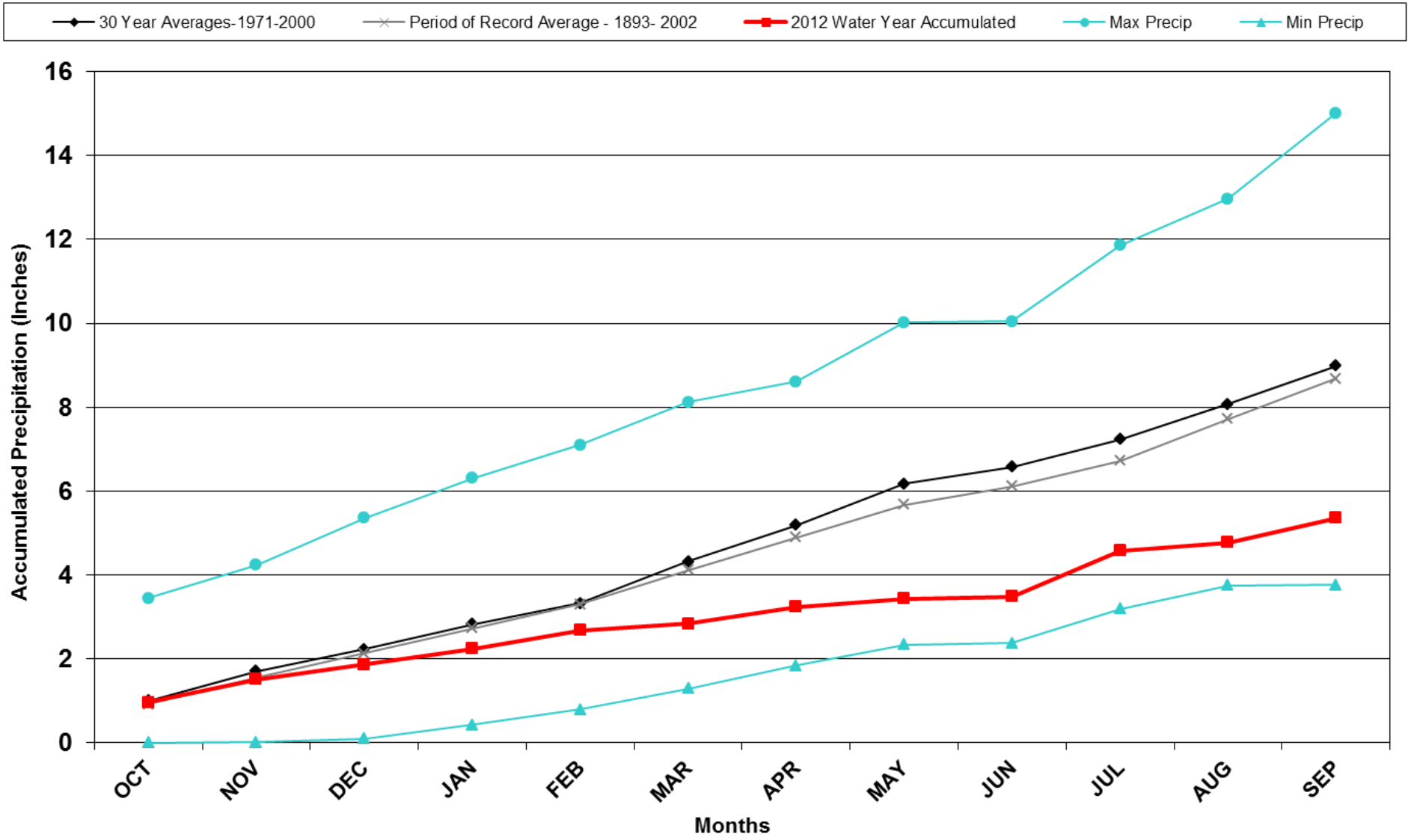
Boulder
2012 Water Year



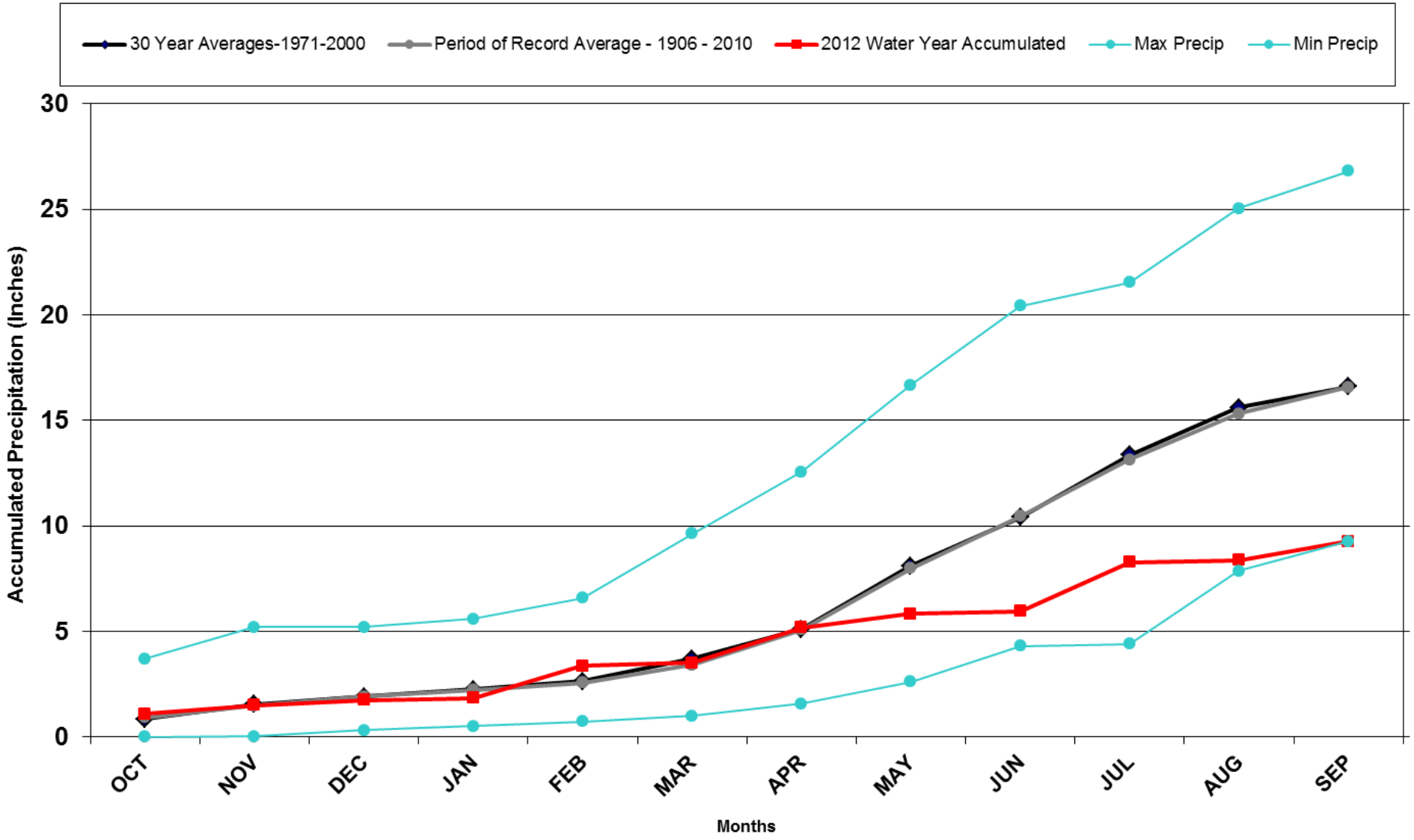
Burlington
2012 Water Year



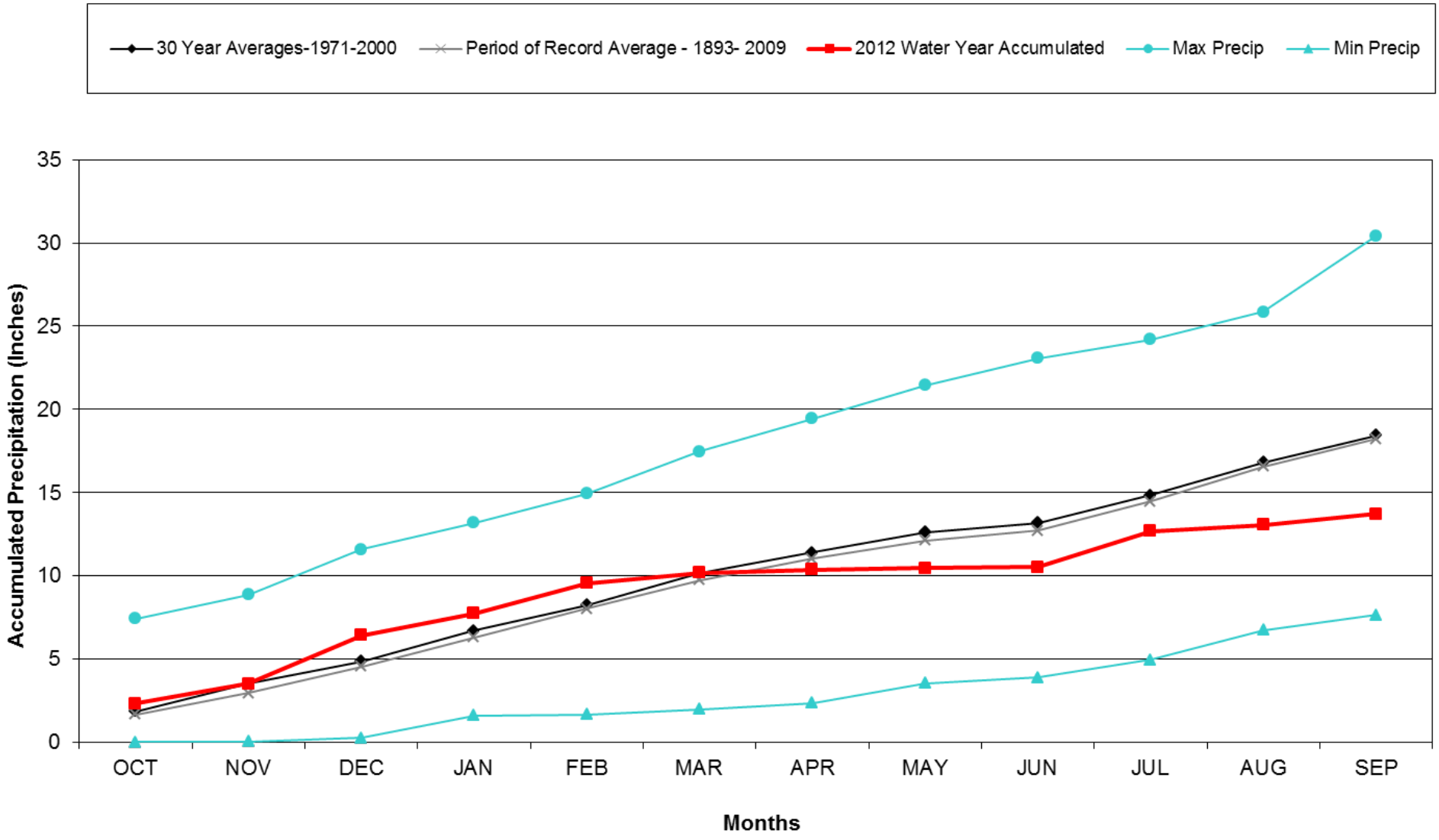
Grand Junction WSFO
2012 Water Year



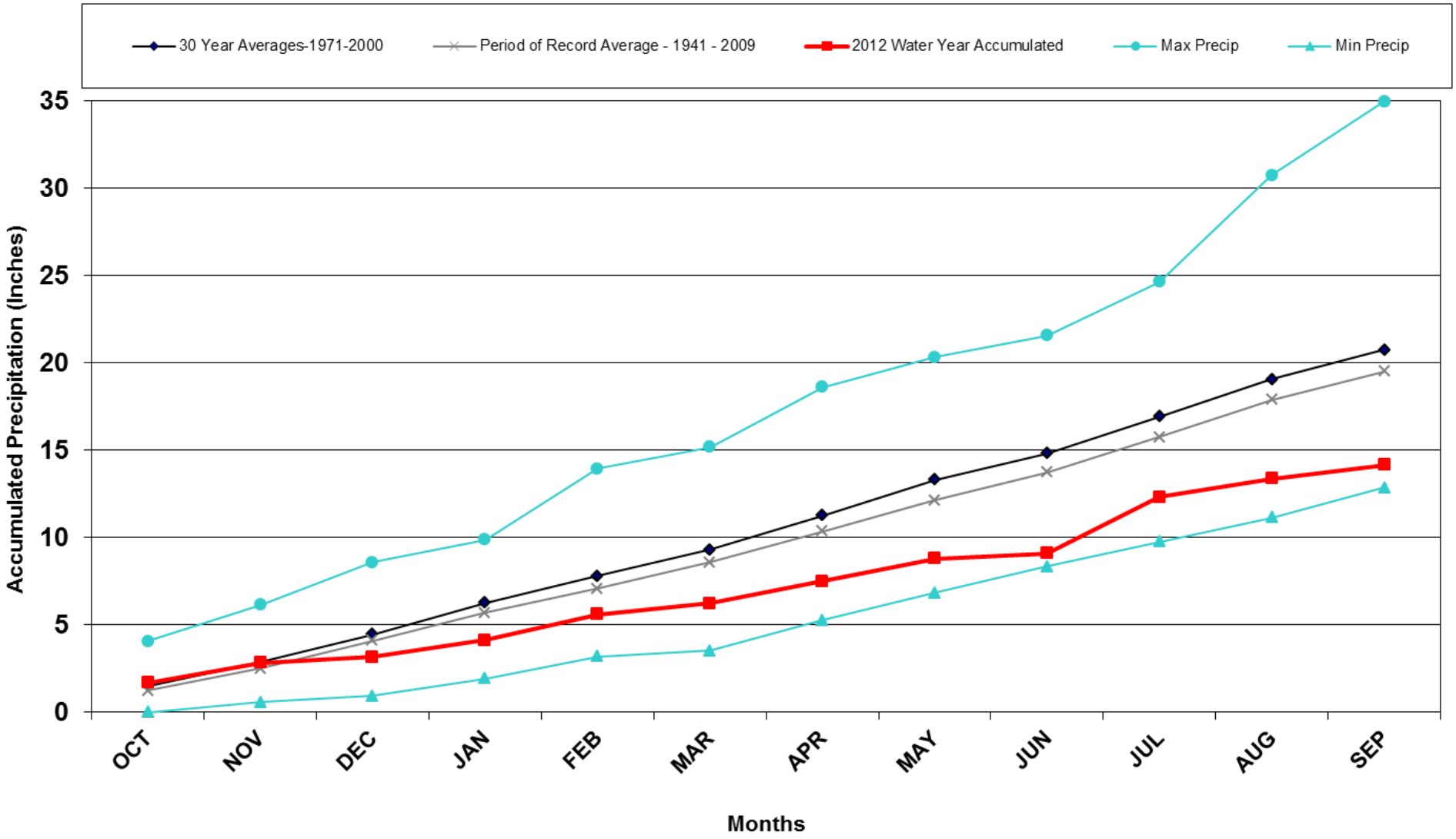
Akron 4E
2012 Water Year



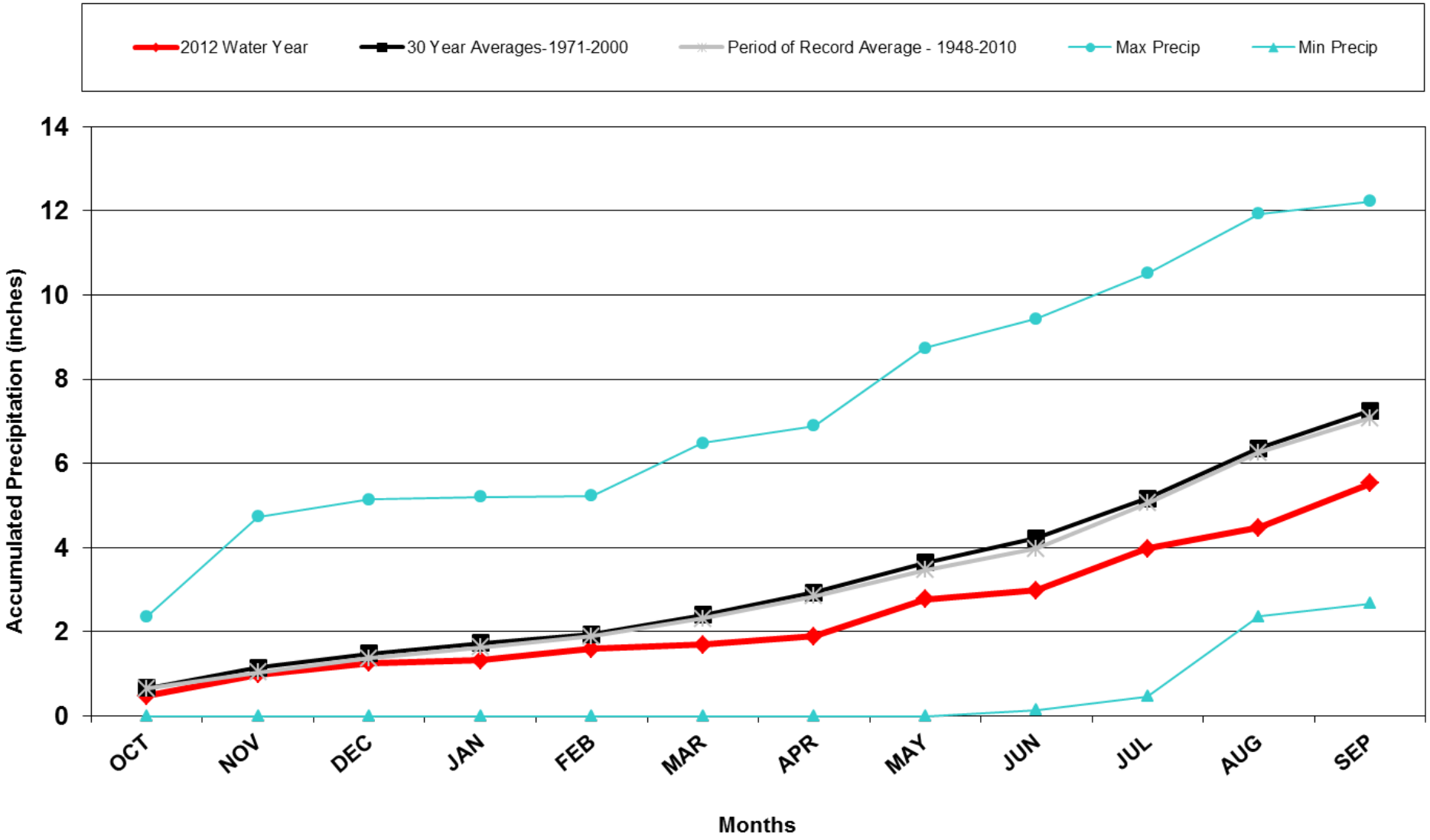
Mesa Verde NP
2012 Water Year



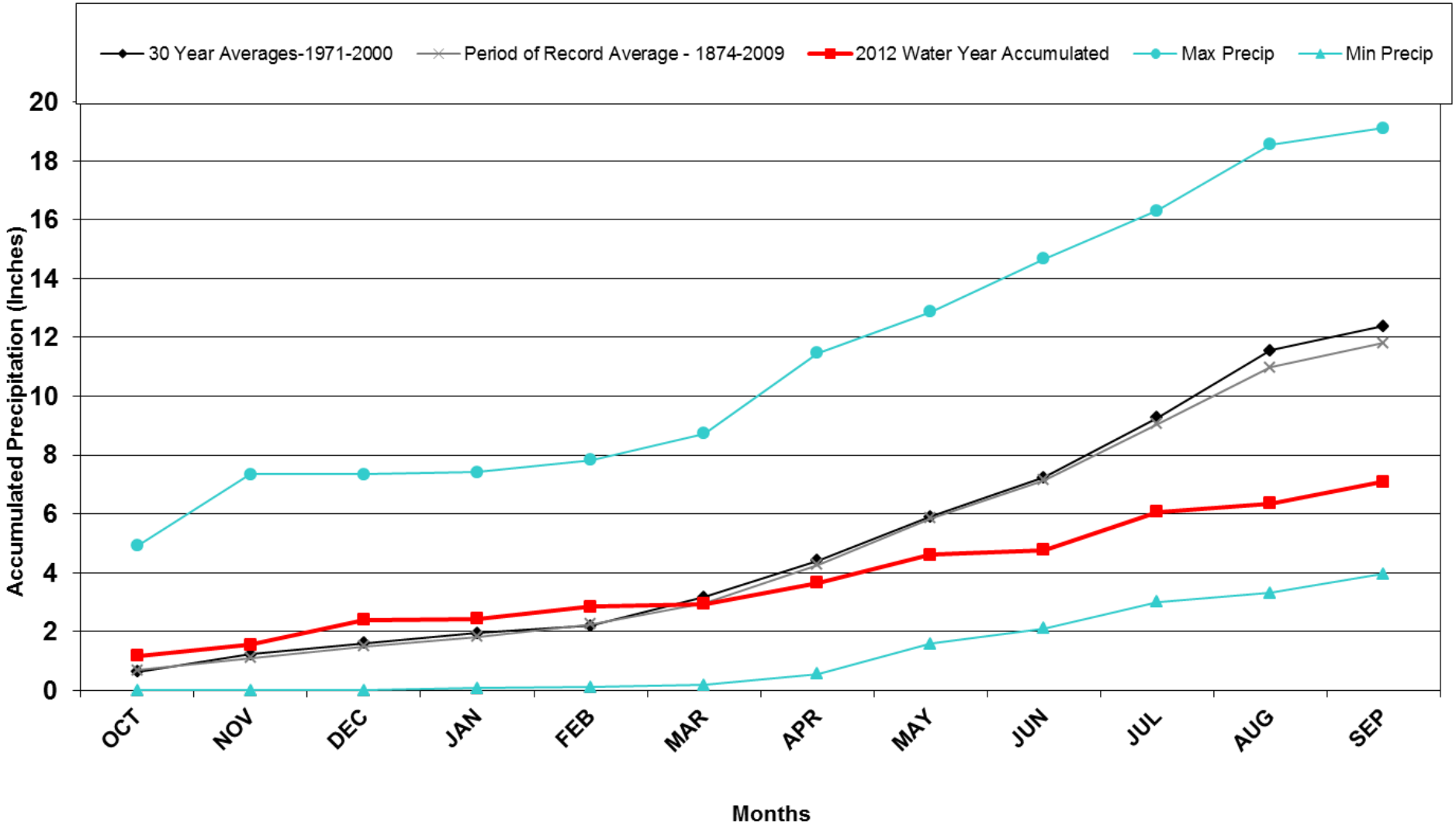
Grand Lake 1 NW
2012 Water Year



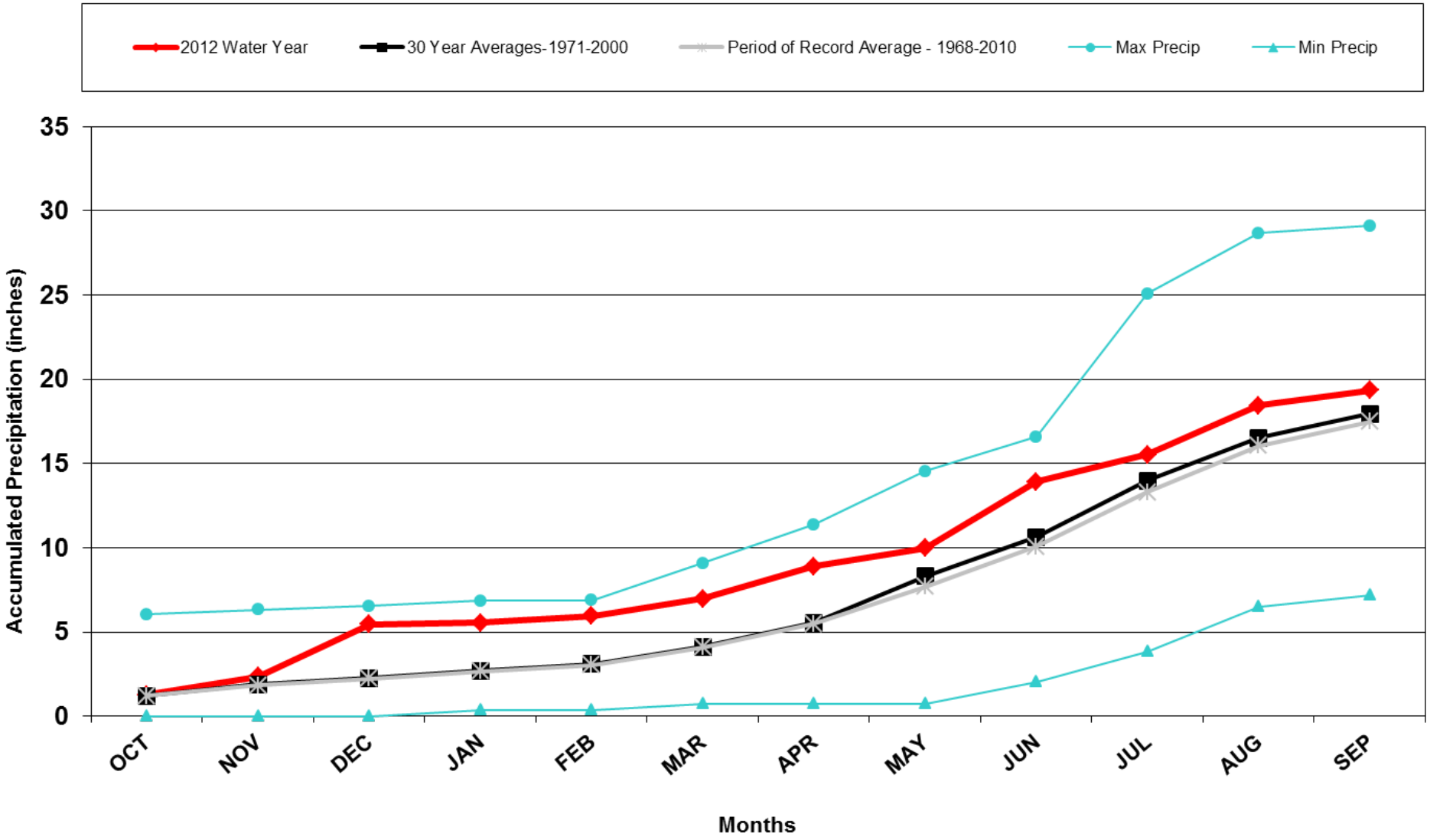
Alamosa WSO
2012 Water Year



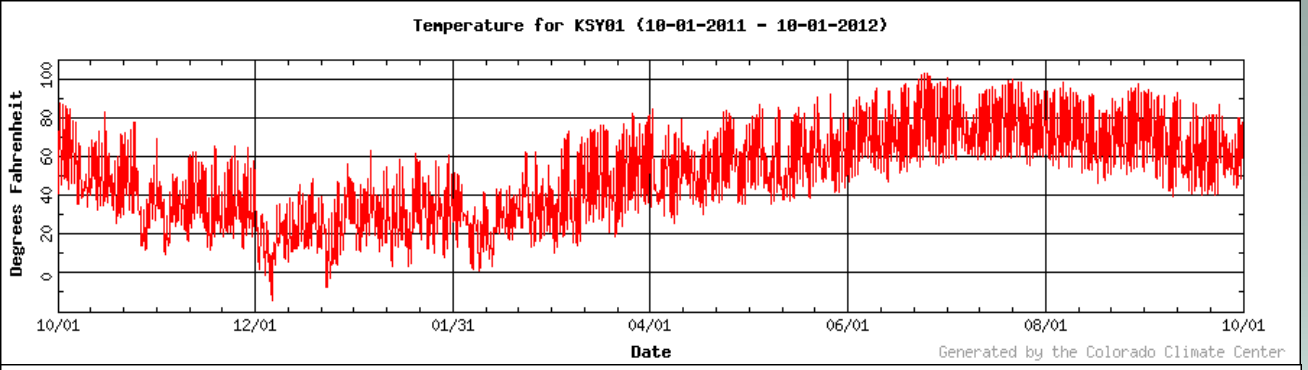
Pueblo WSO
2012 Water Year



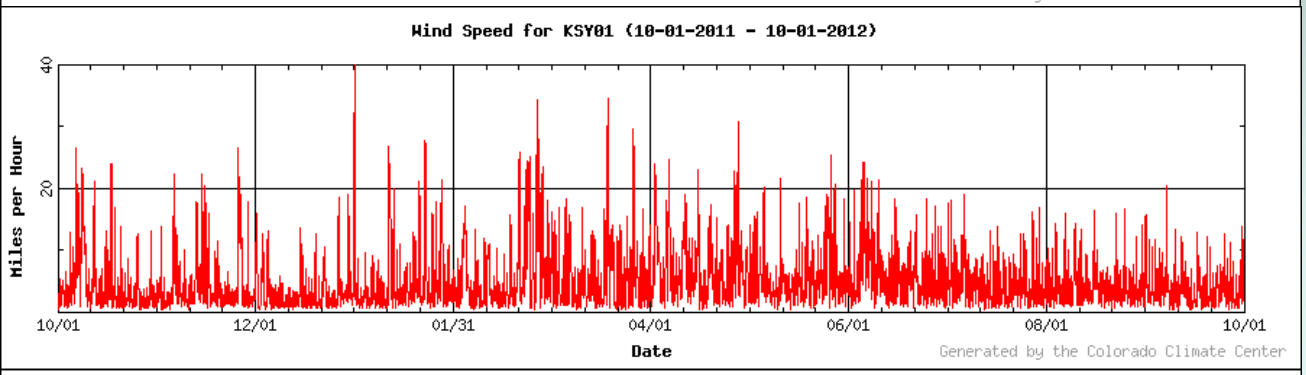
Walsh
2012 Water Year



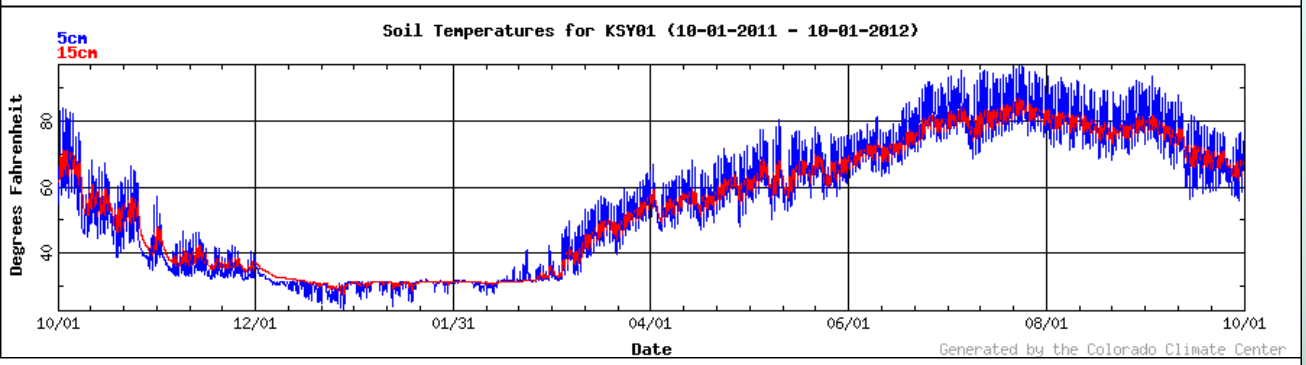
Kersey CoAgMet Water Year 2012



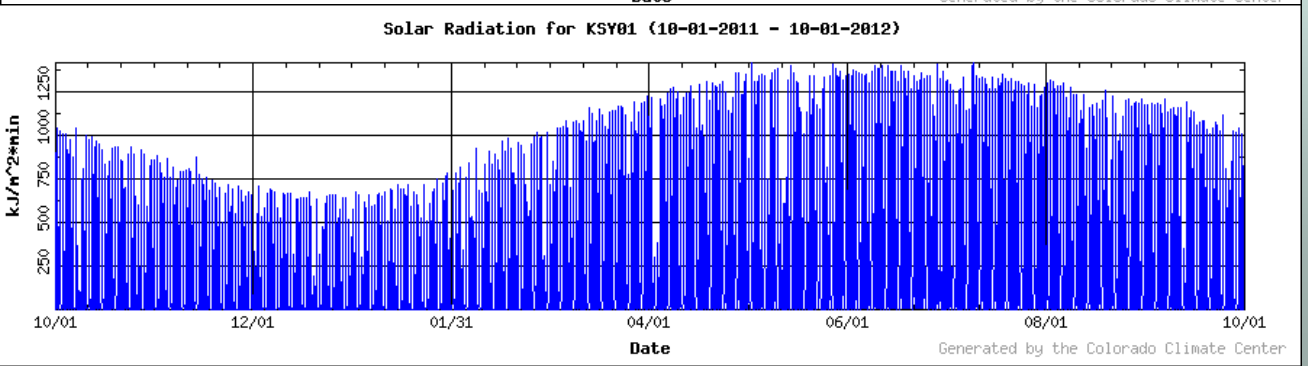
Temperature



Wind Speed

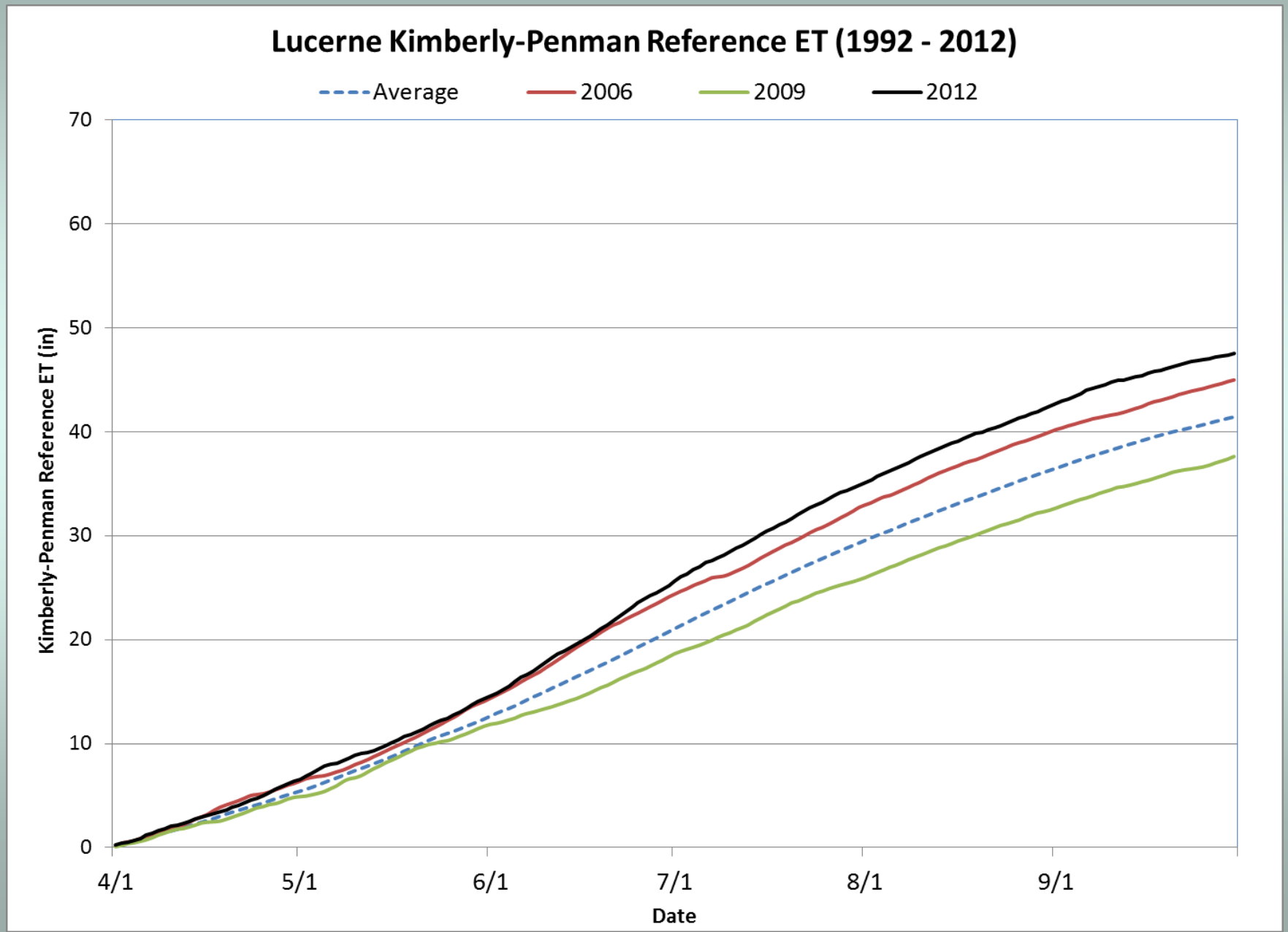


Soil Temperatures

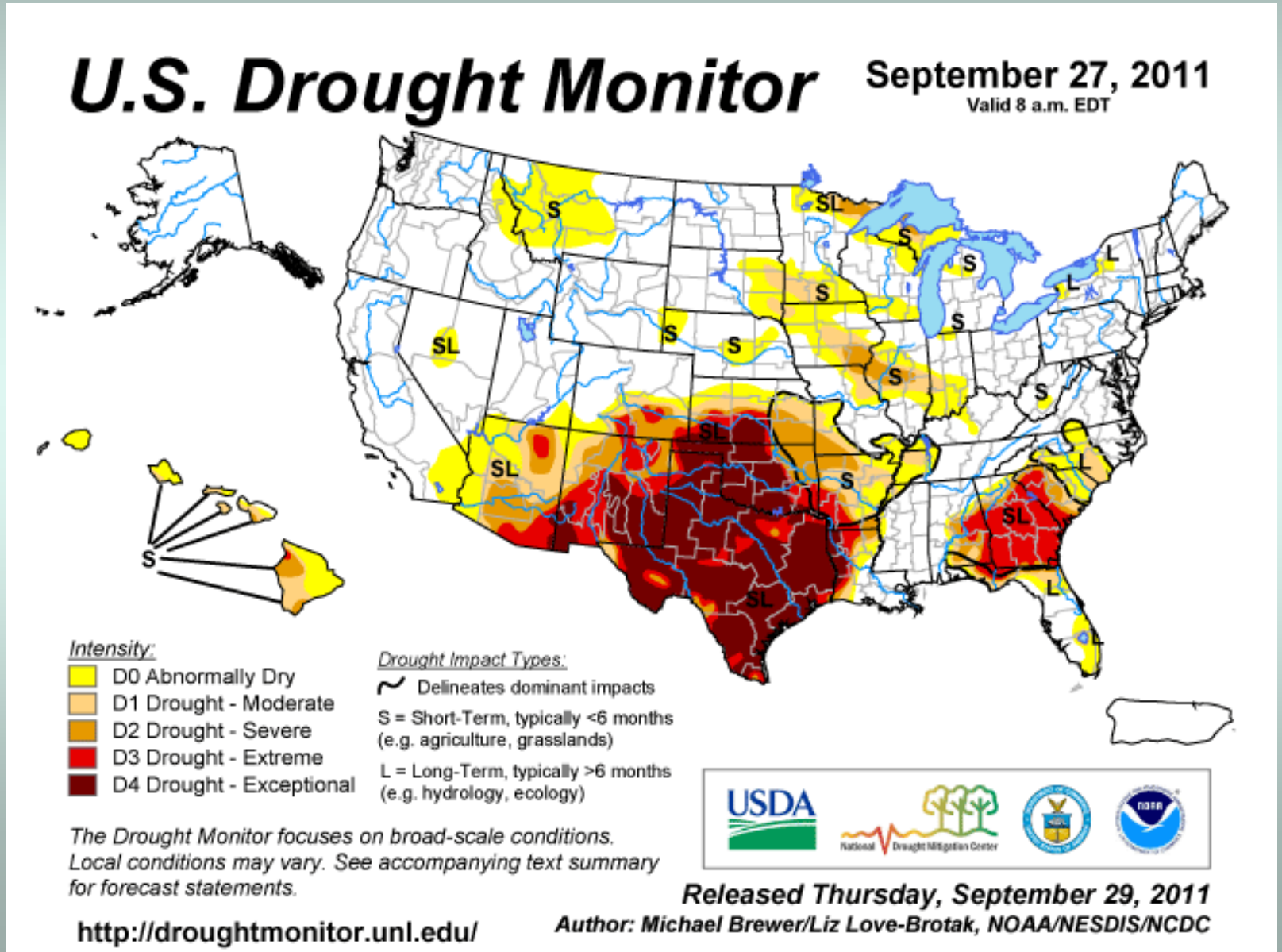


Solar Radiation

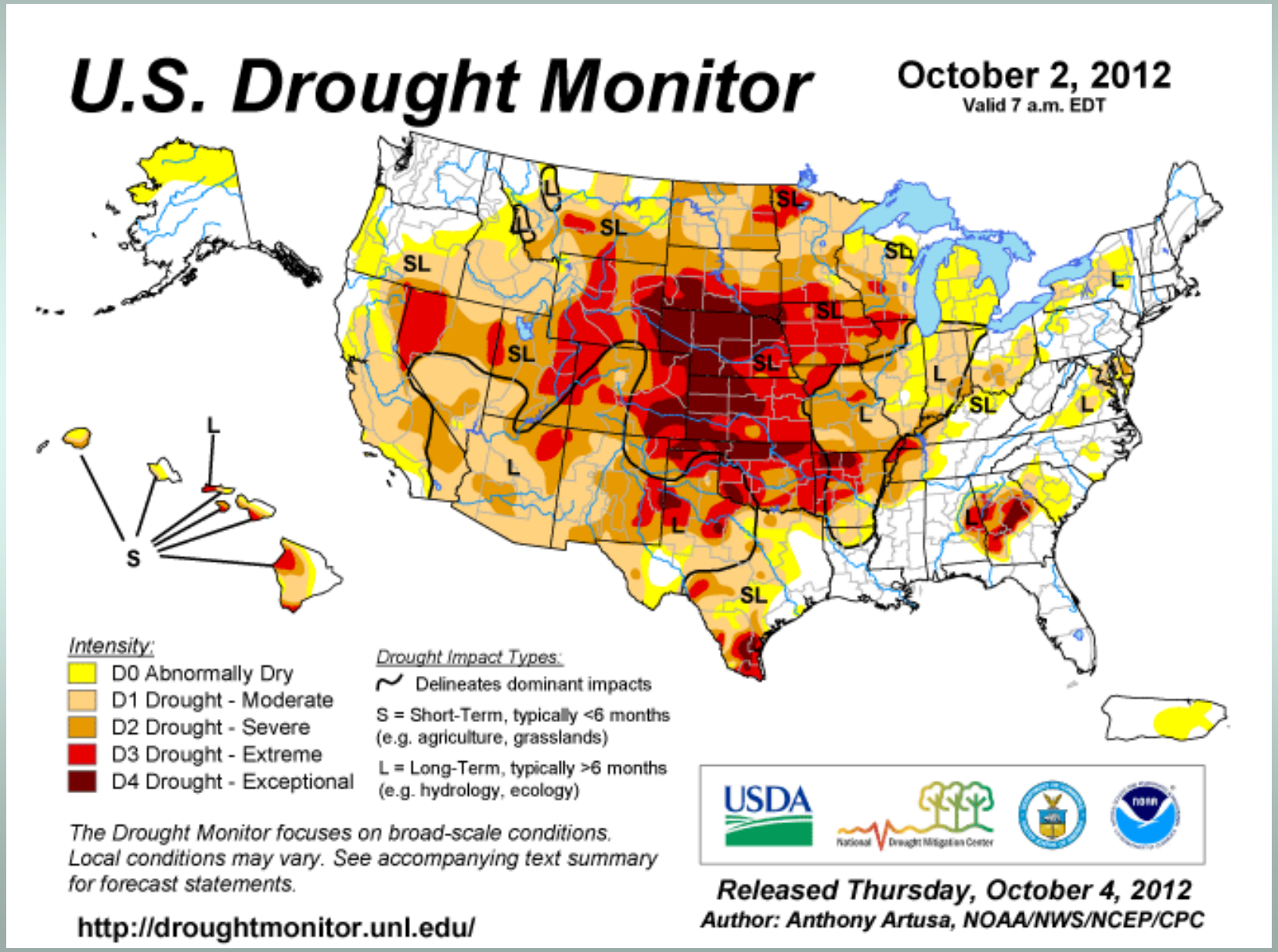
Lucerne Reference ET



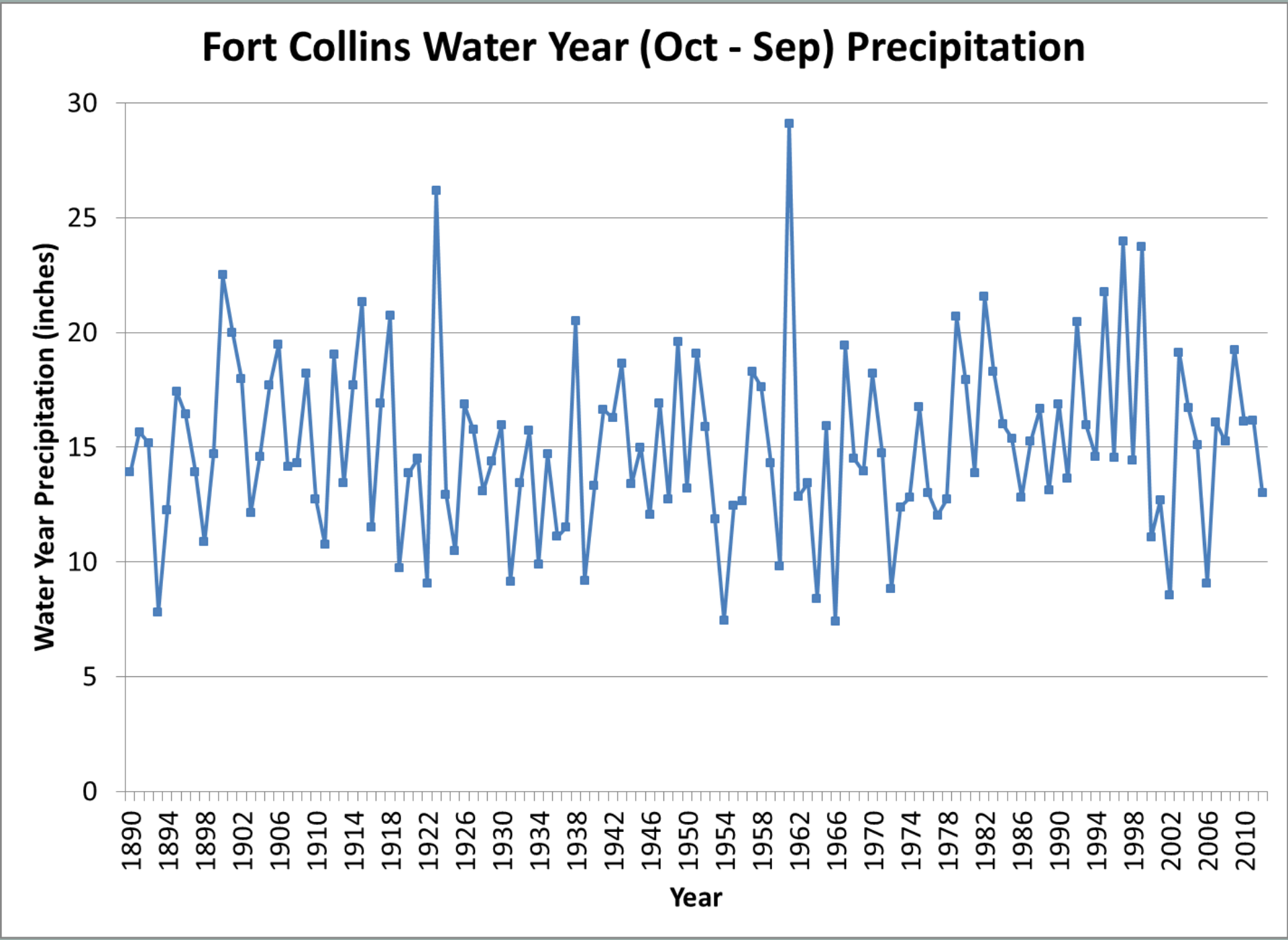
Status at beginning of 2012 Water Year

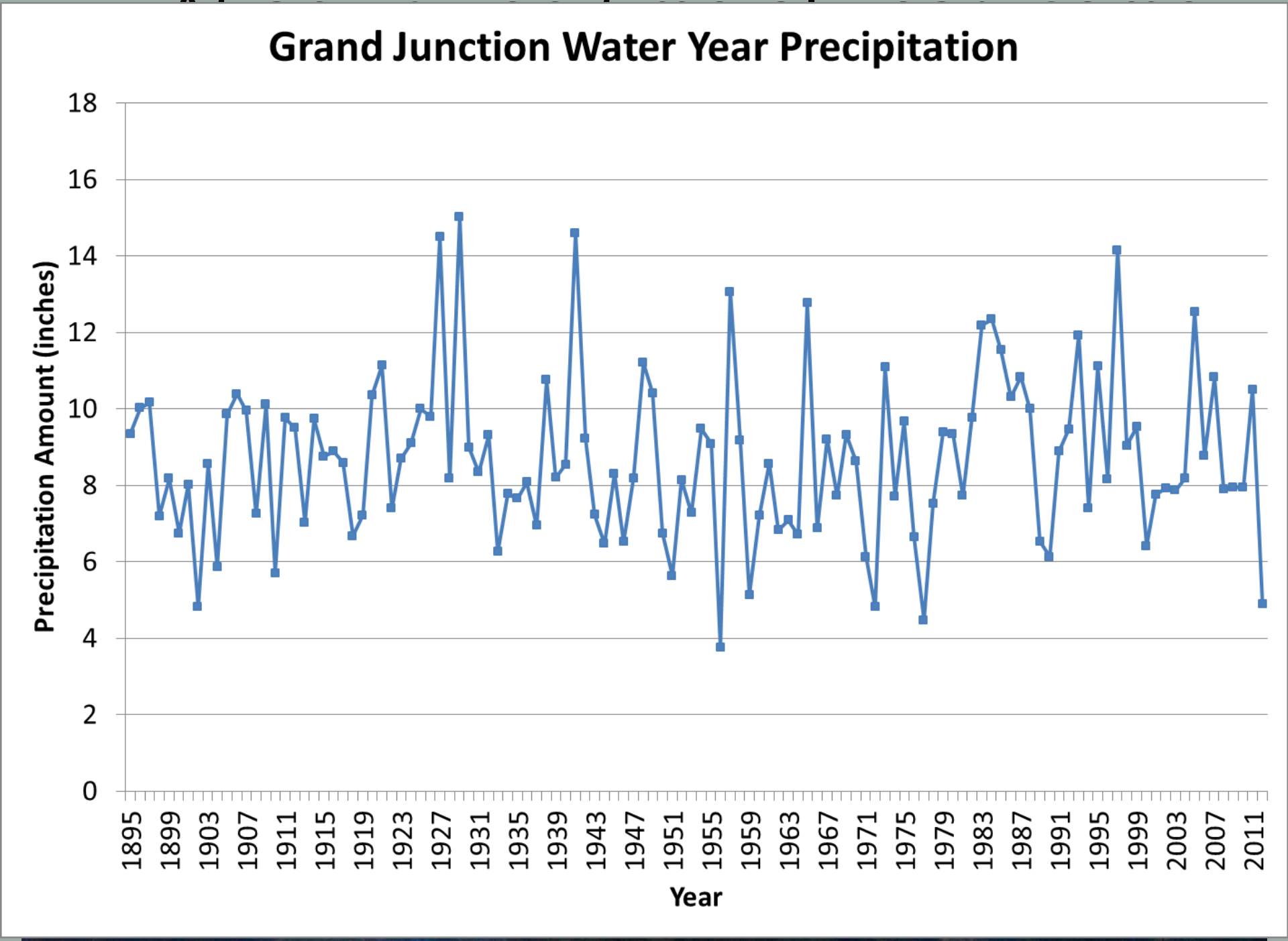


Drought Status at the end of 2012 Water Year

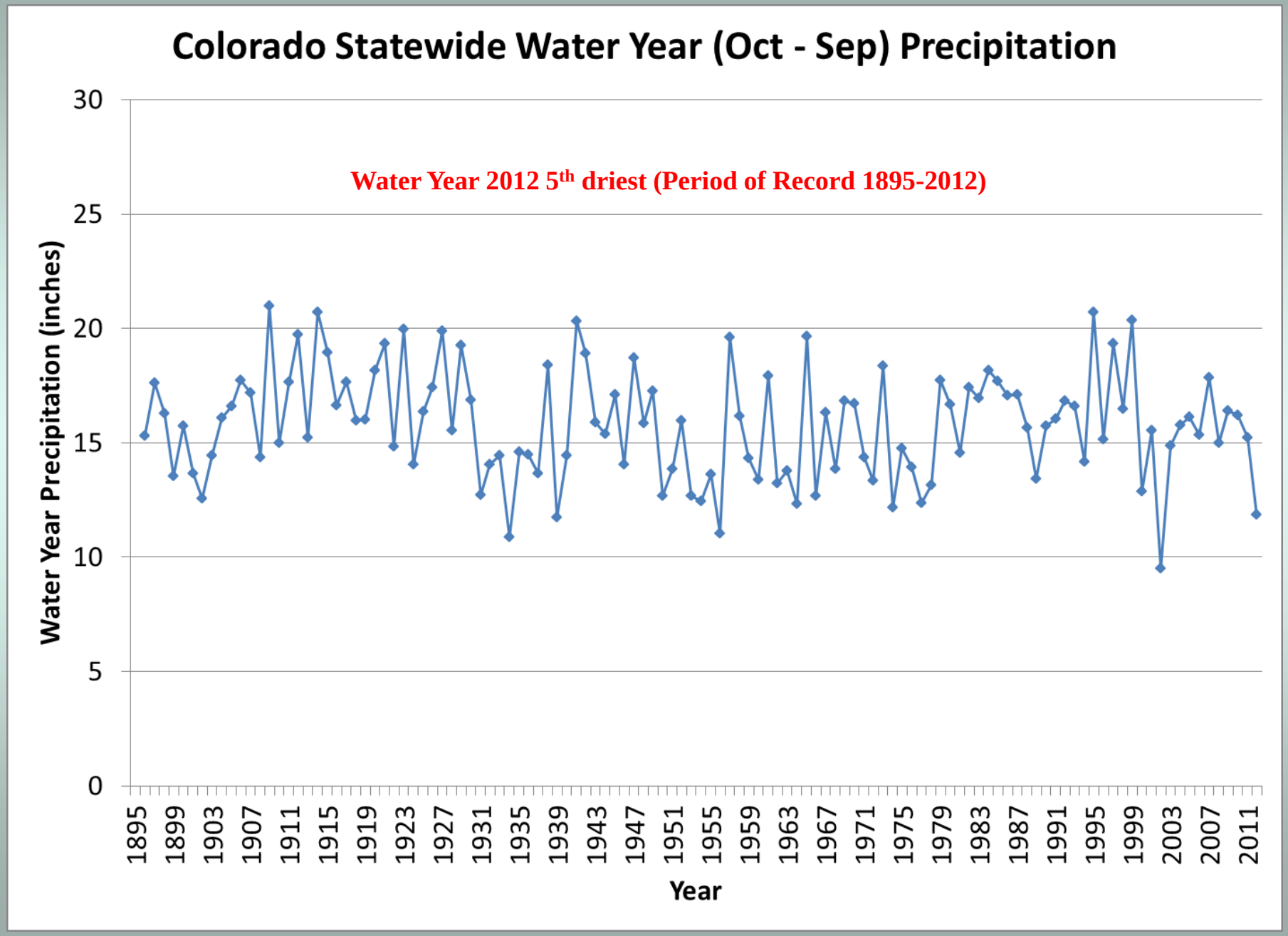


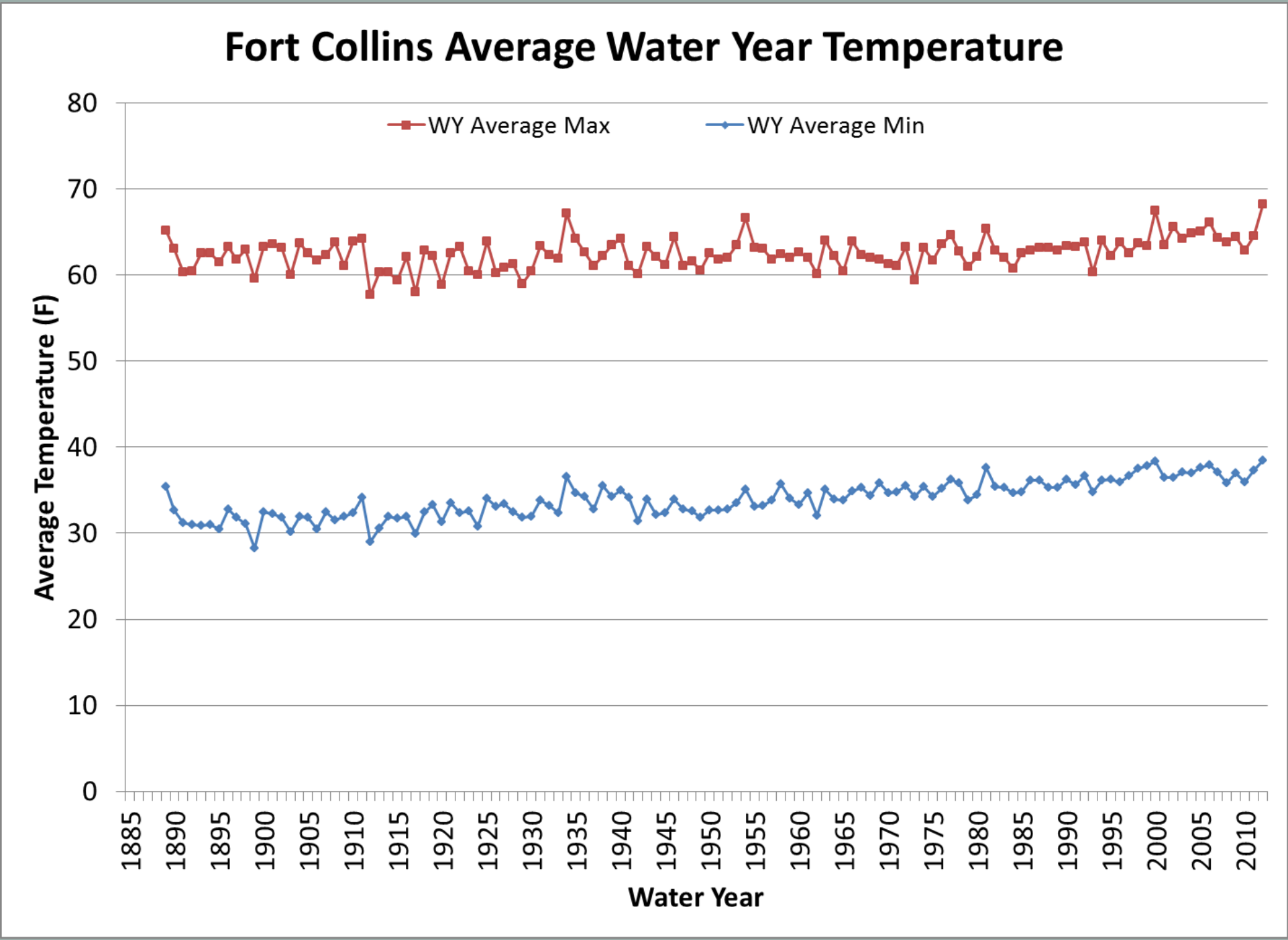
2012 in Historical Perspective

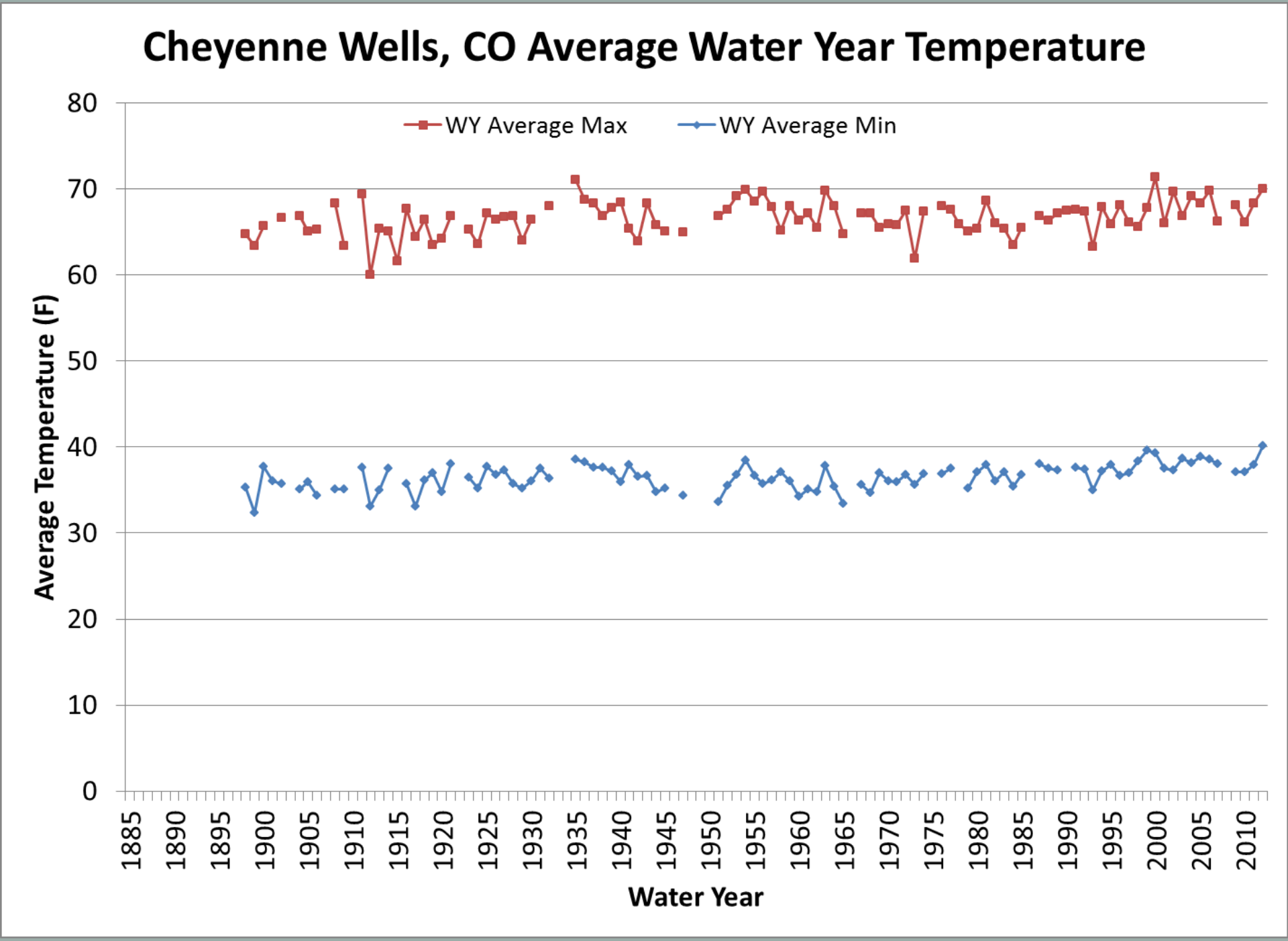

Fort Collins Water Year (Oct - Sep) Precipitation
Water Year Precipitation (inches)
30
25
20
15
10
5
0
1890
1894
1898
1902
1906
1910
1914
1918
1922
1926
1930
1934
1938
1942
1946
1950
1954
1958
1962
1966
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
Year

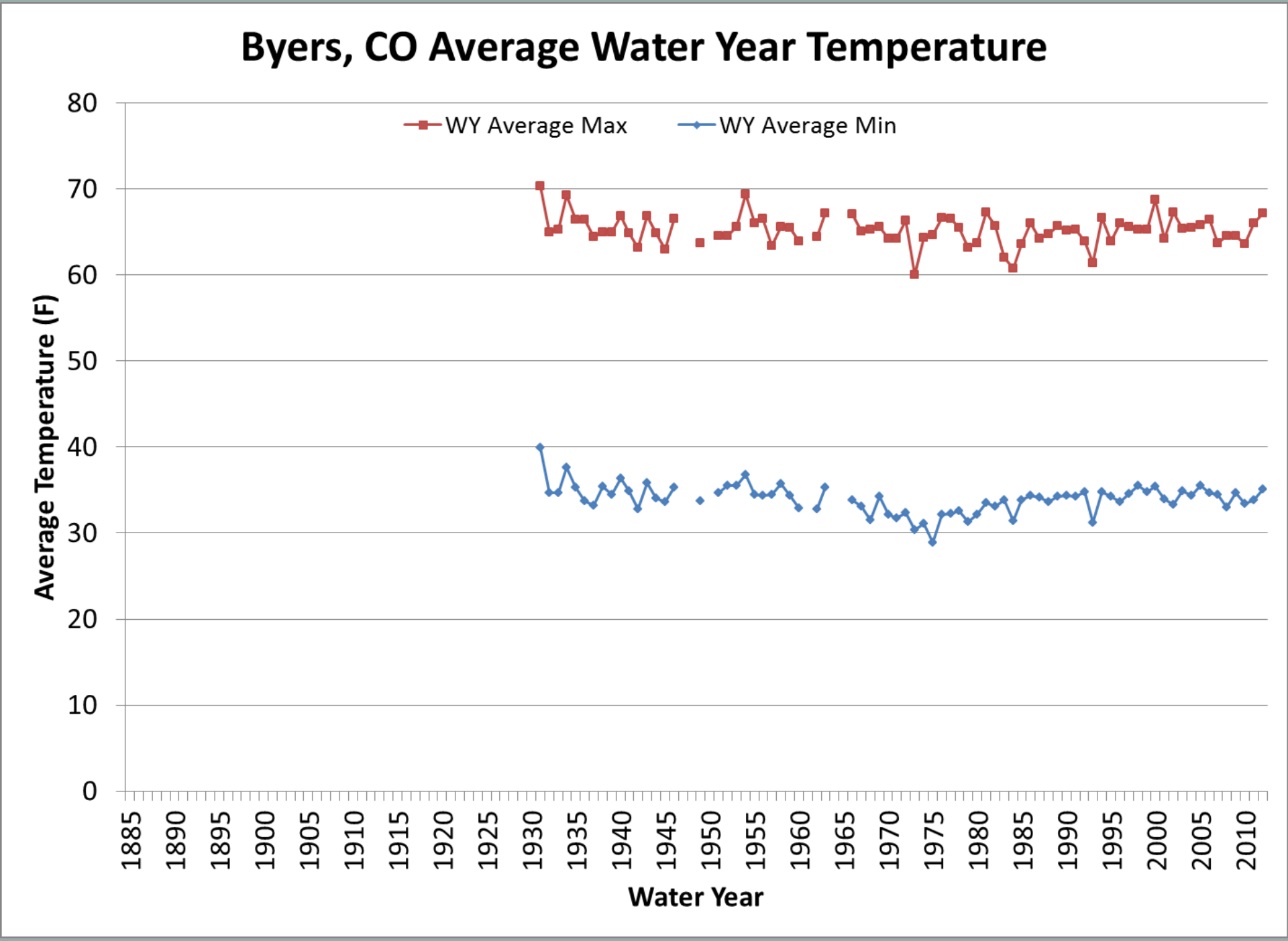

Grand Junction Water Year Precipitation
Precipitation Amount (inches)
0
2
4
6
8
10
12
14
16
18
1895
1899
1903
1907
1911
1915
1919
1923
1927
1931
1935
1939
1943
1947
1951
1955
1959
1963
1967
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
Year

Colorado Precipitation in Historic Perspective

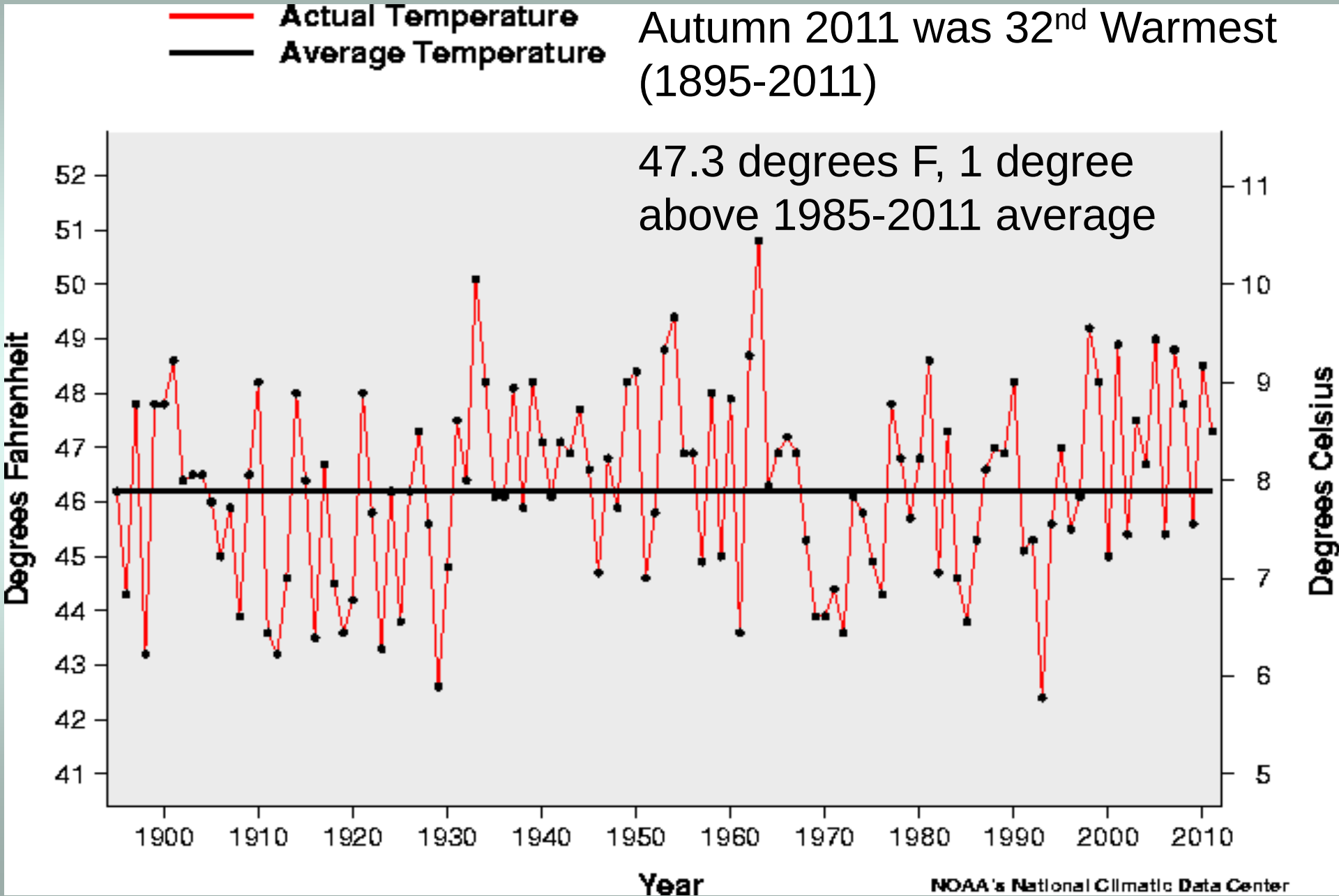



Fort Collins Average Water Year Temperature
WY Average Max
WY Average Min
Average Temperature (F)
80
70
60
50
40
30
20
10
0
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Water Year

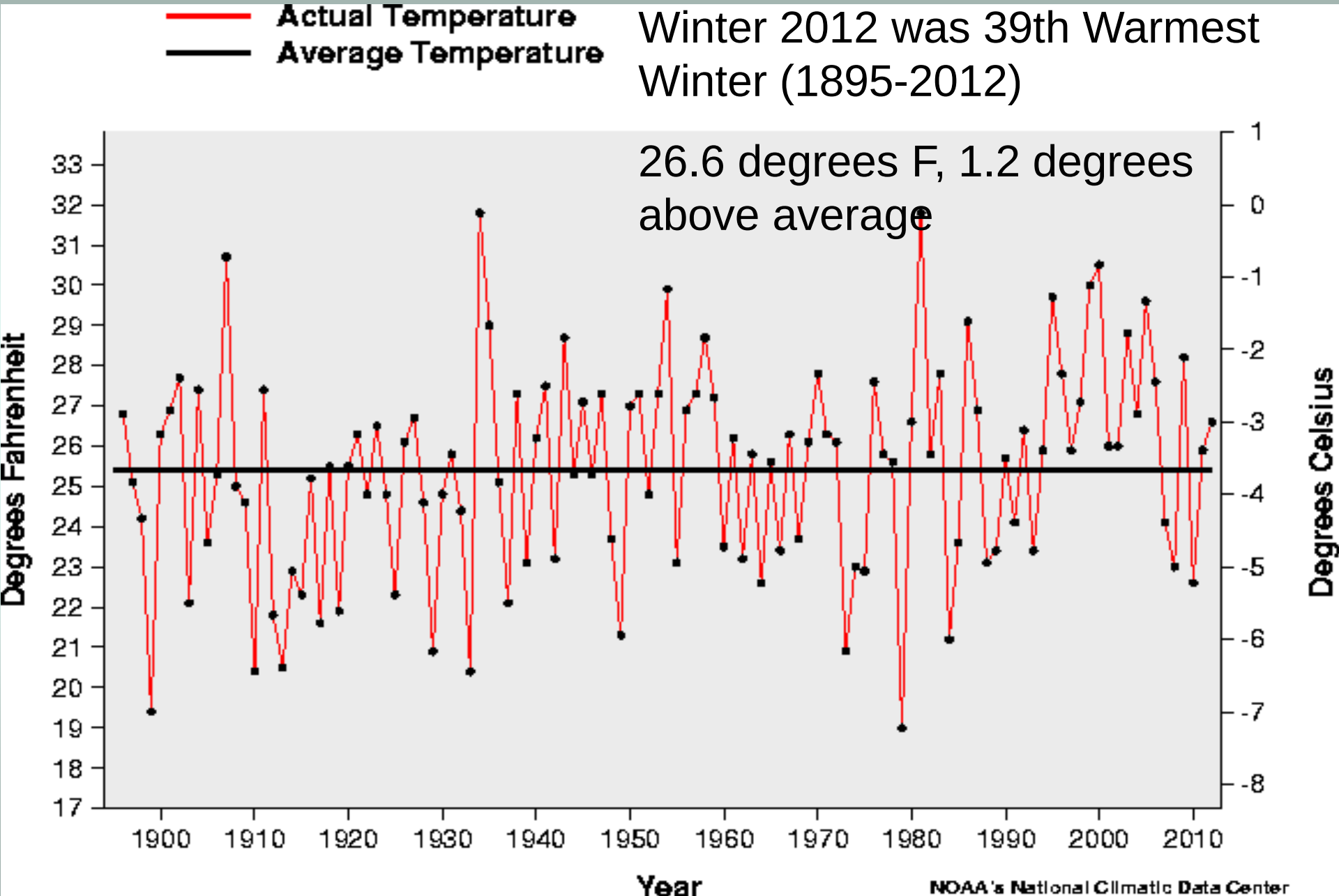

Cheyenne Wells, CO Average Water Year Temperature
WY Average Max
WY Average Min
Average Temperature (F)
80
70
60
50
40
30
20
10
0
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Water Year


Byers, CO Average Water Year Temperature
WY Average Max
WY Average Min
Average Temperature (F)
80
70
60
50
40
30
20
10
0
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Water Year

Colorado Mean Autumn (SON) Temperatures

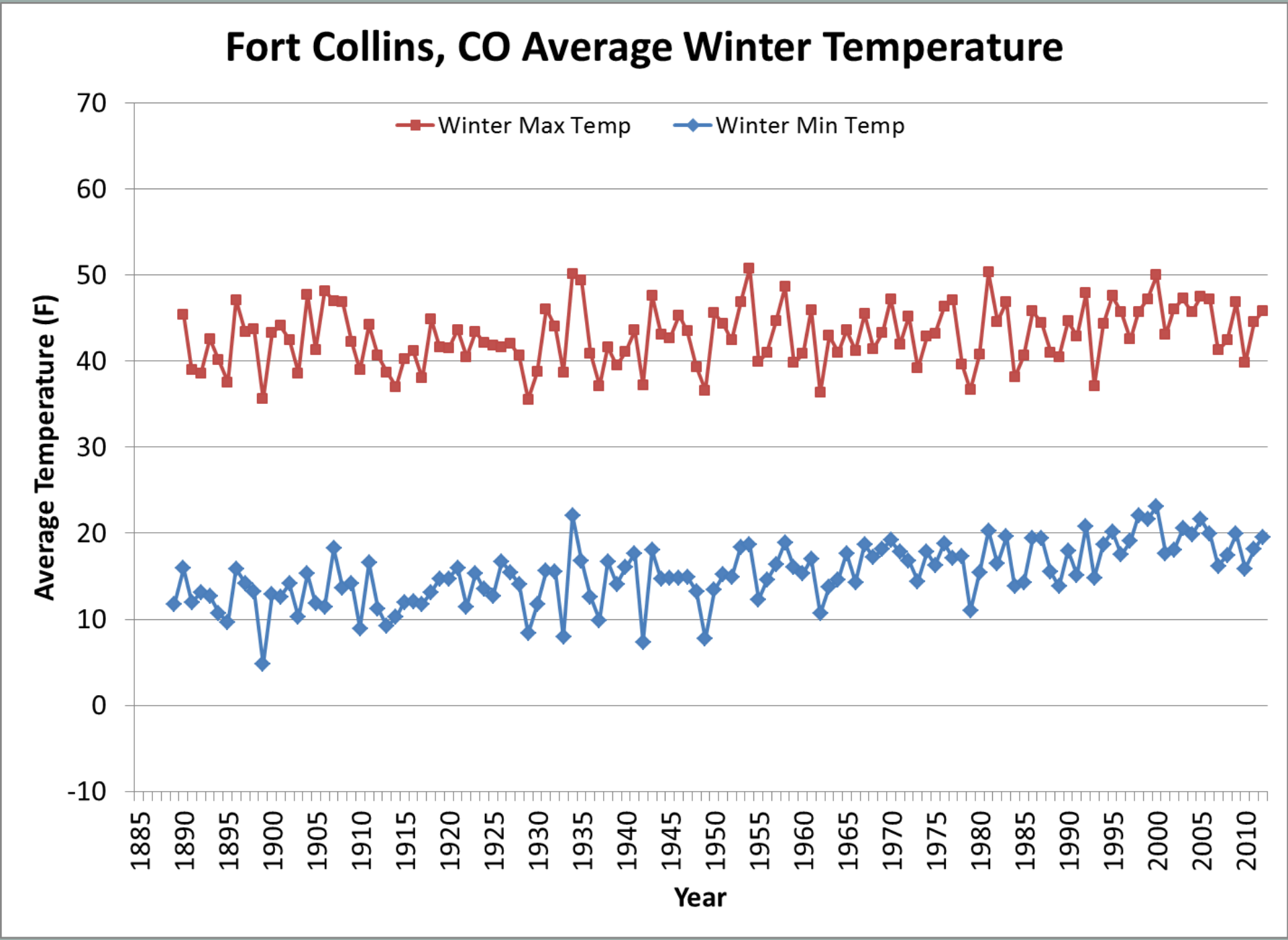


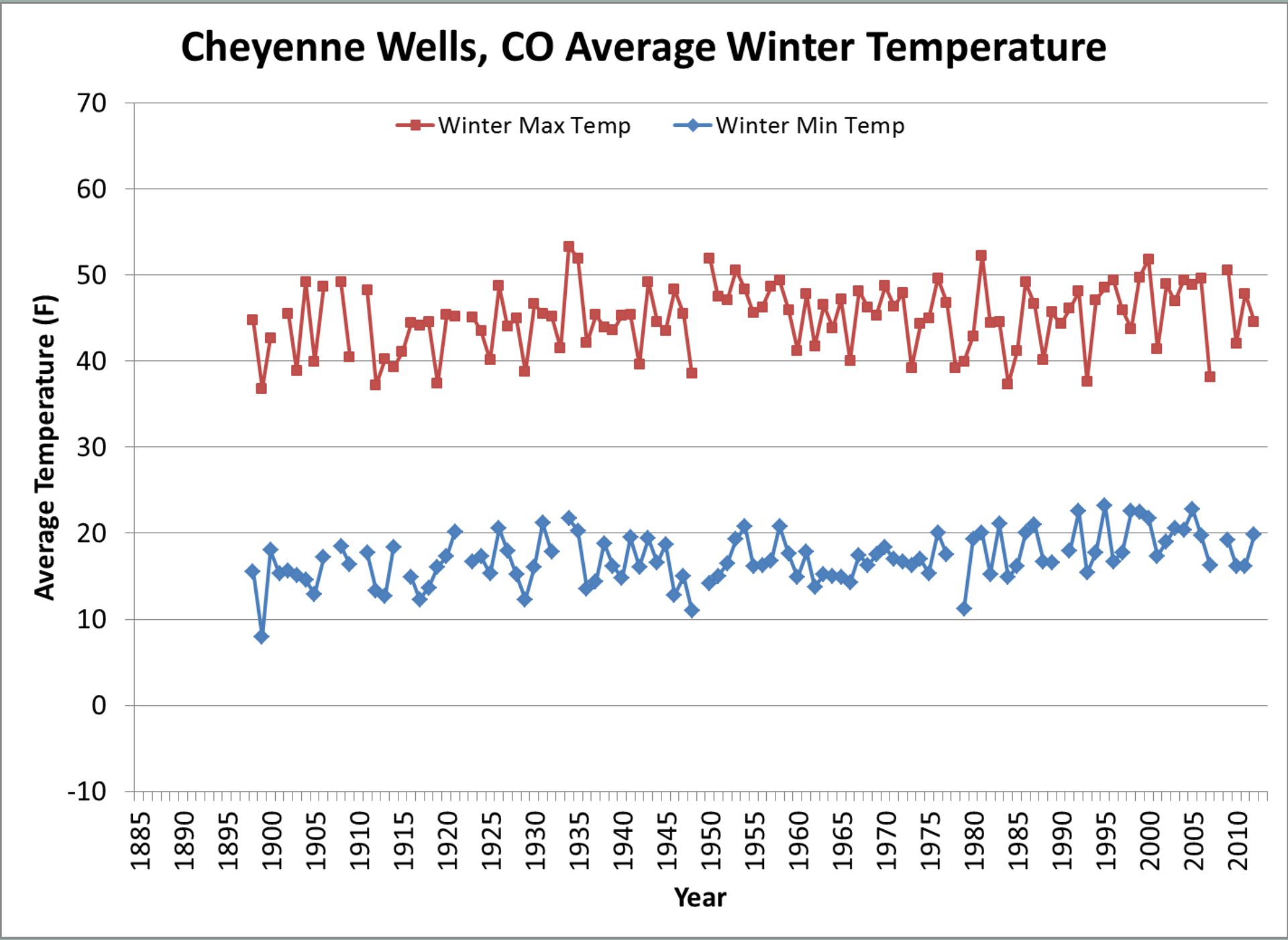
Colorado Mean Winter (DJF) Temperatures

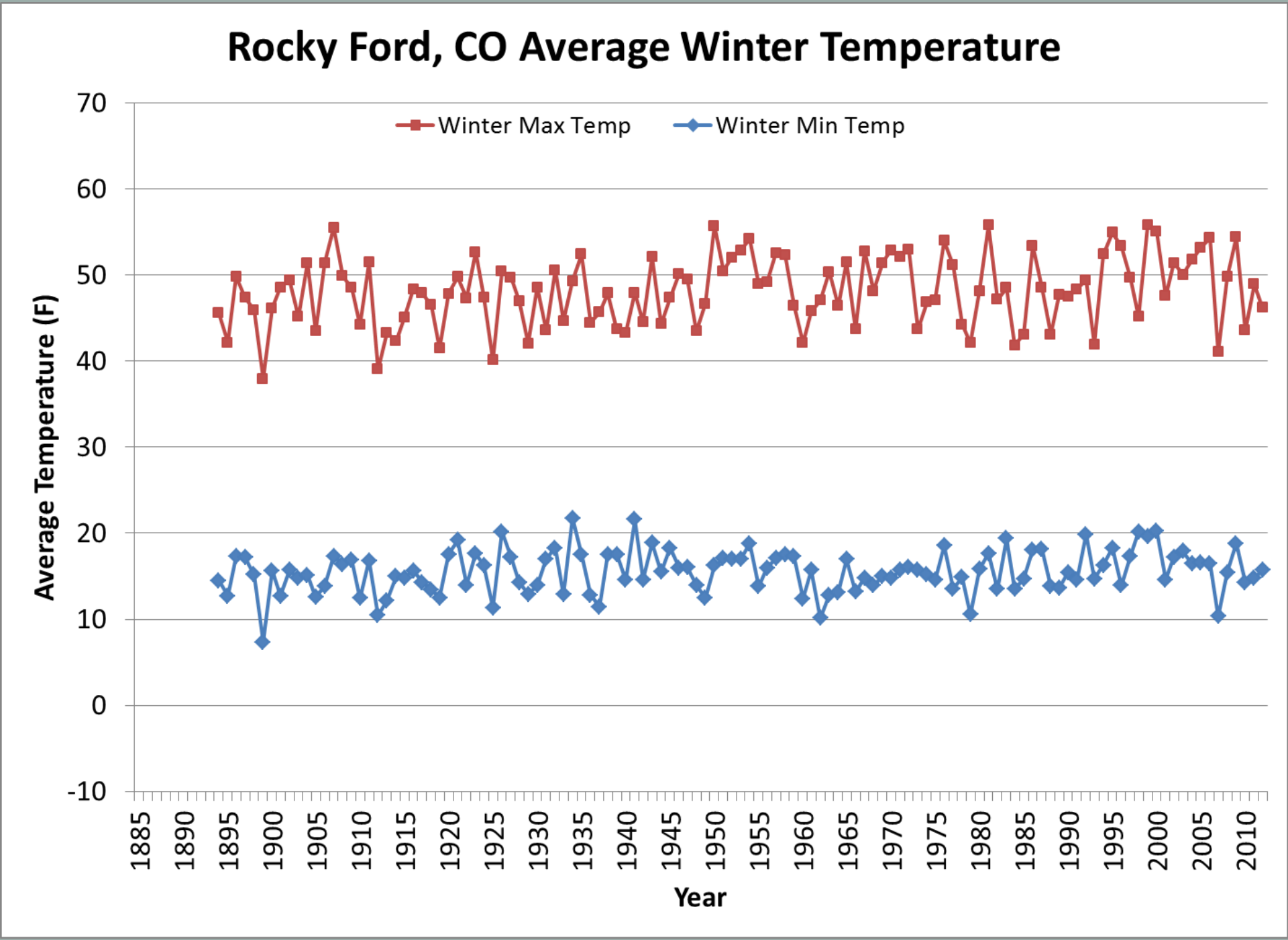


Winter 2012 was 39th Warmest Winter (1895-2012)

26.6 degrees F, 1.2 degrees above average

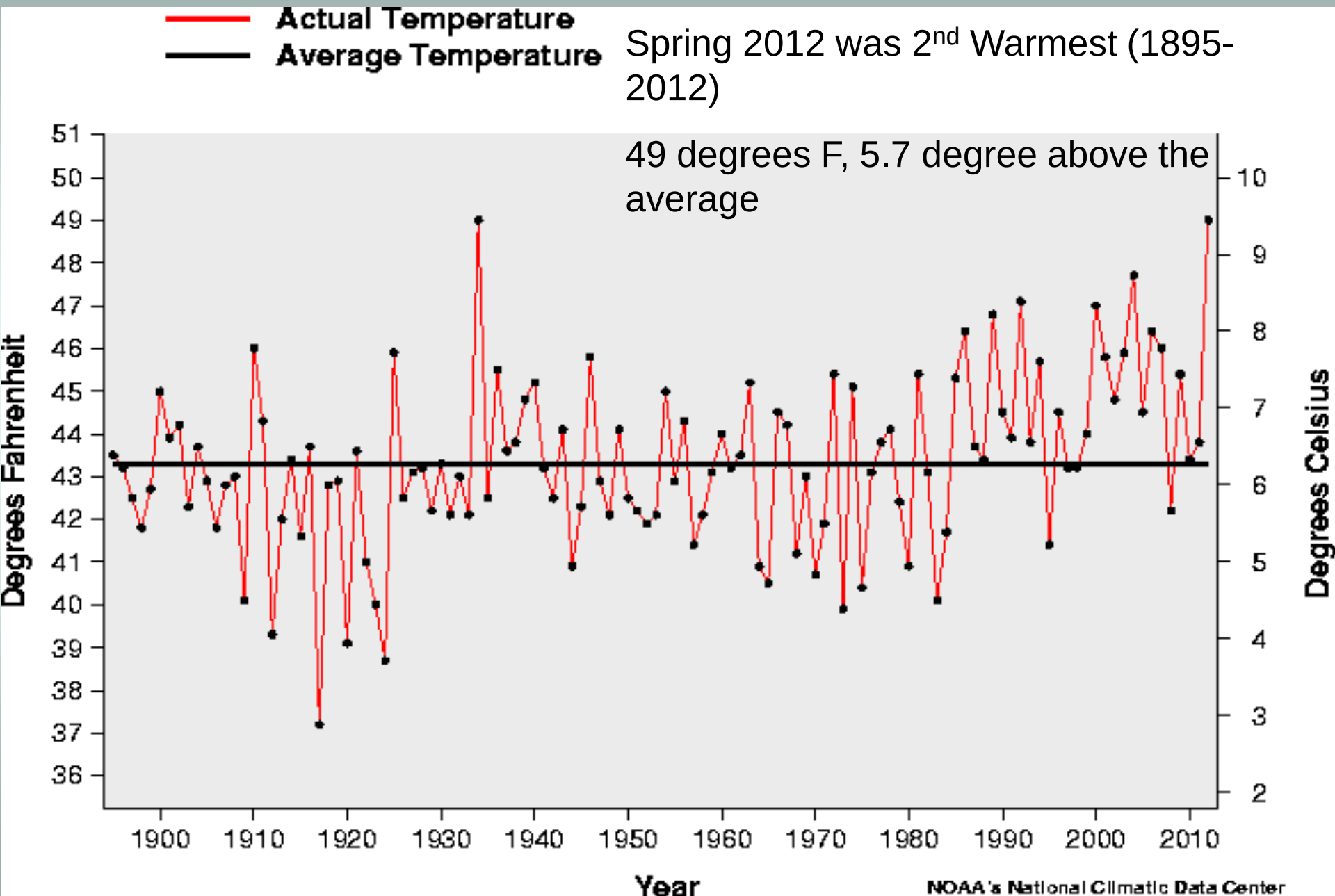

Fort Collins, CO Average Winter Temperature
Winter Max Temp
Winter Min Temp
Average Temperature (F)
70
60
50
40
30
20
10
0
-10
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year


Cheyenne Wells, CO Average Winter Temperature
Winter Max Temp
Winter Min Temp
Average Temperature (F)
70
60
50
40
30
20
10
0
-10
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

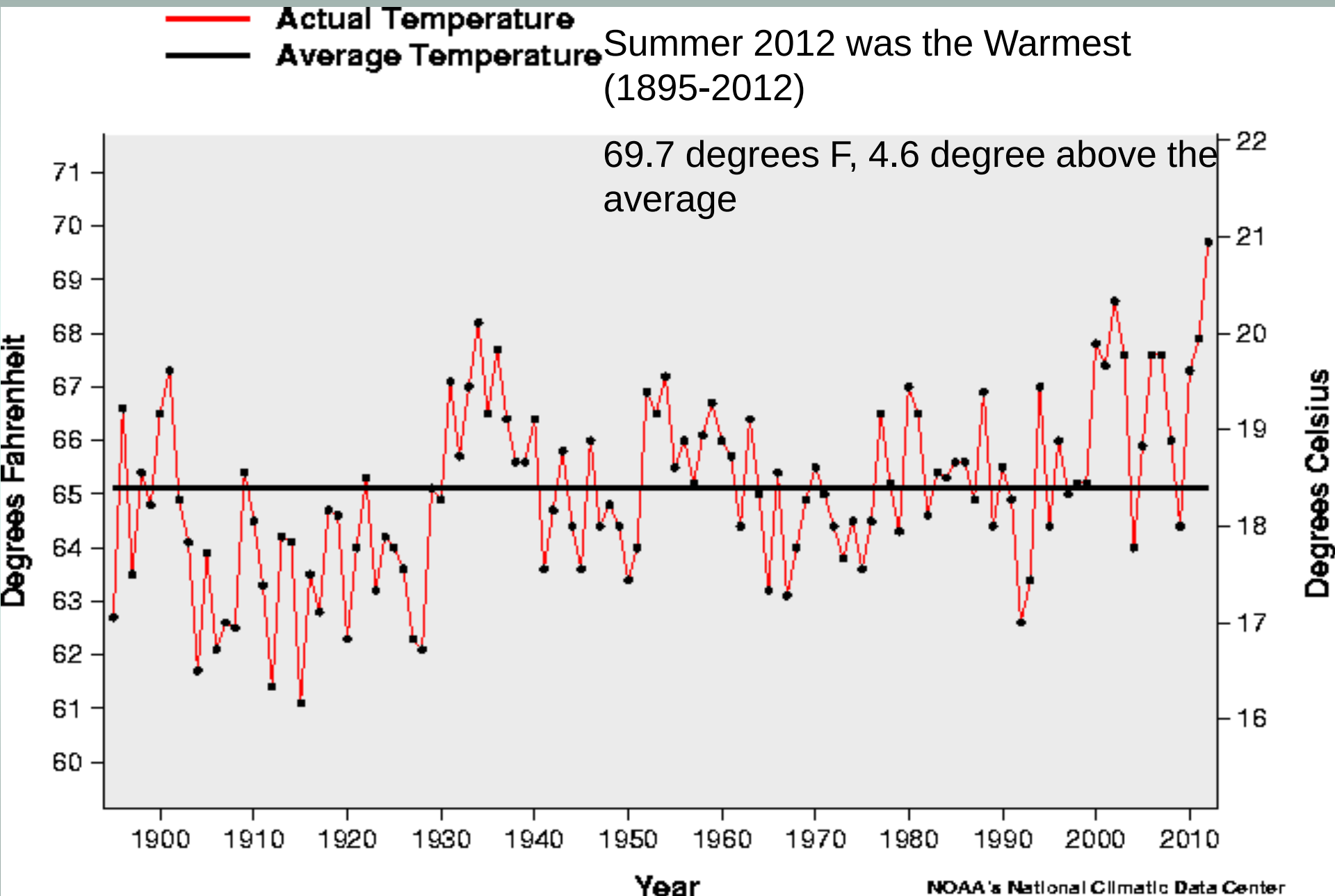

Rocky Ford, CO Average Winter Temperature
Winter Max Temp
Winter Min Temp
Average Temperature (F)
70
60
50
40
30
20
10
0
-10
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

Colorado Mean Spring (MAM) Temperatures

Spring 2012 was 2nd Warmest (1895-2012)

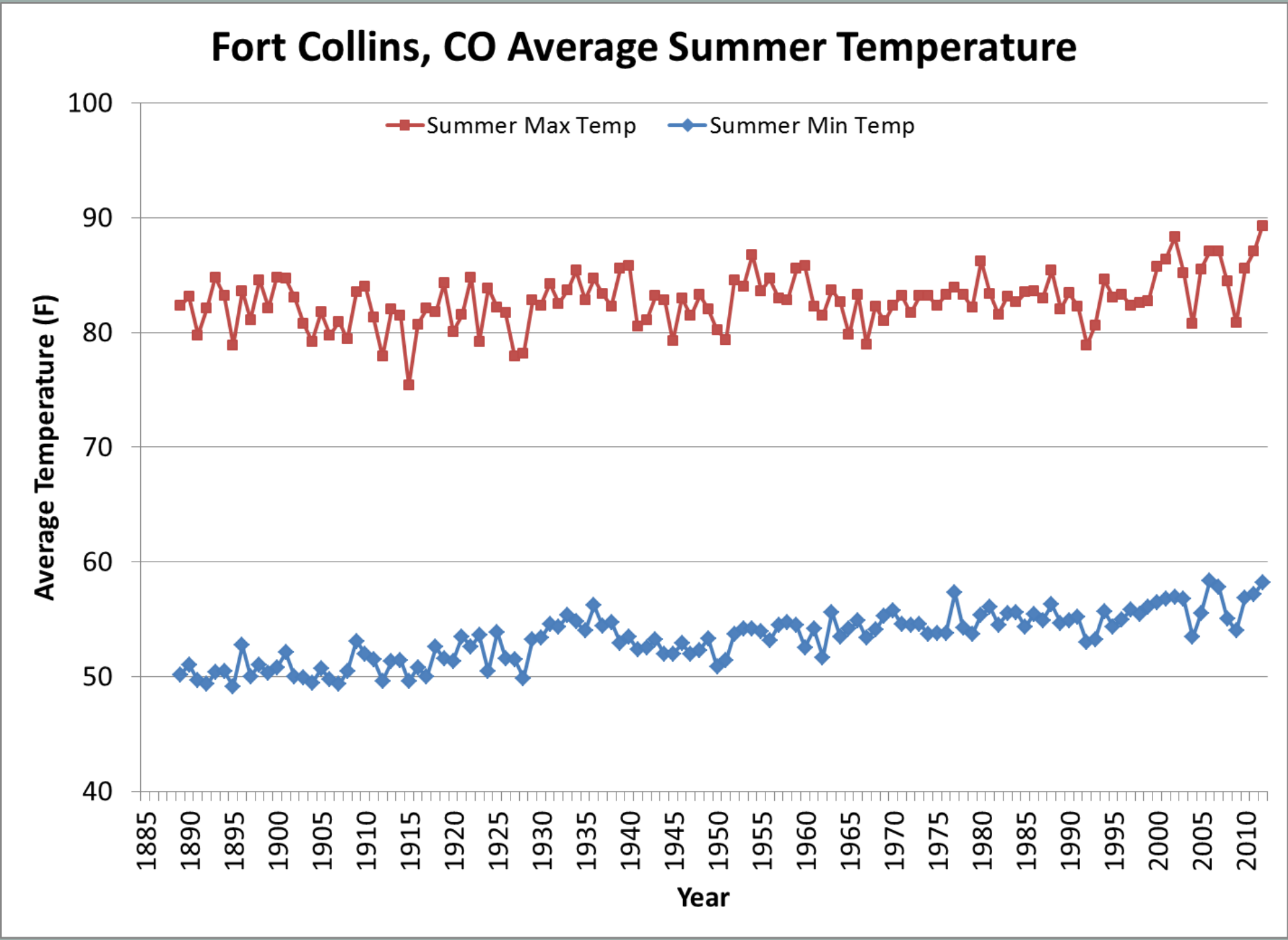


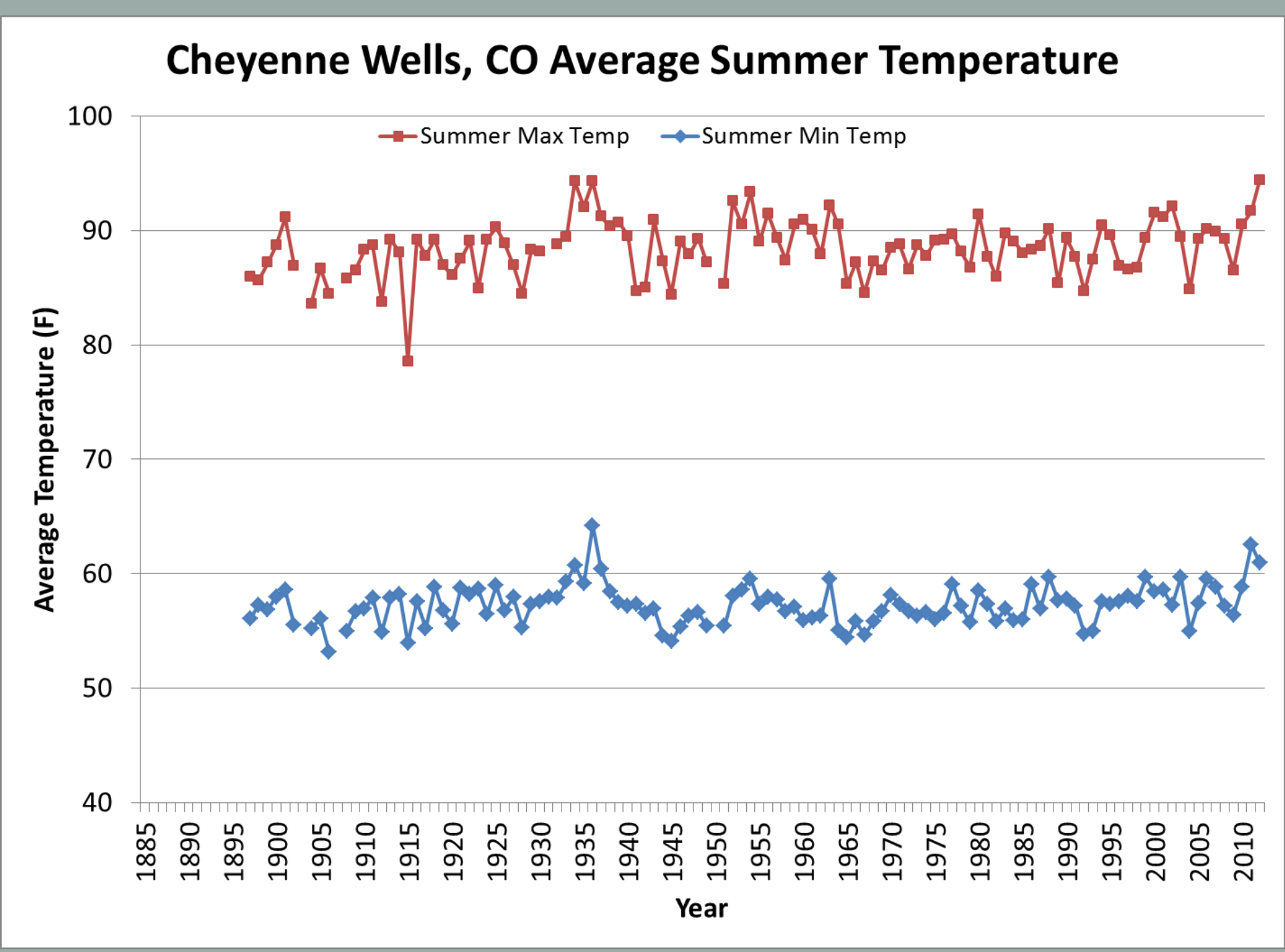
Colorado Mean Summer (JJA) Temperatures



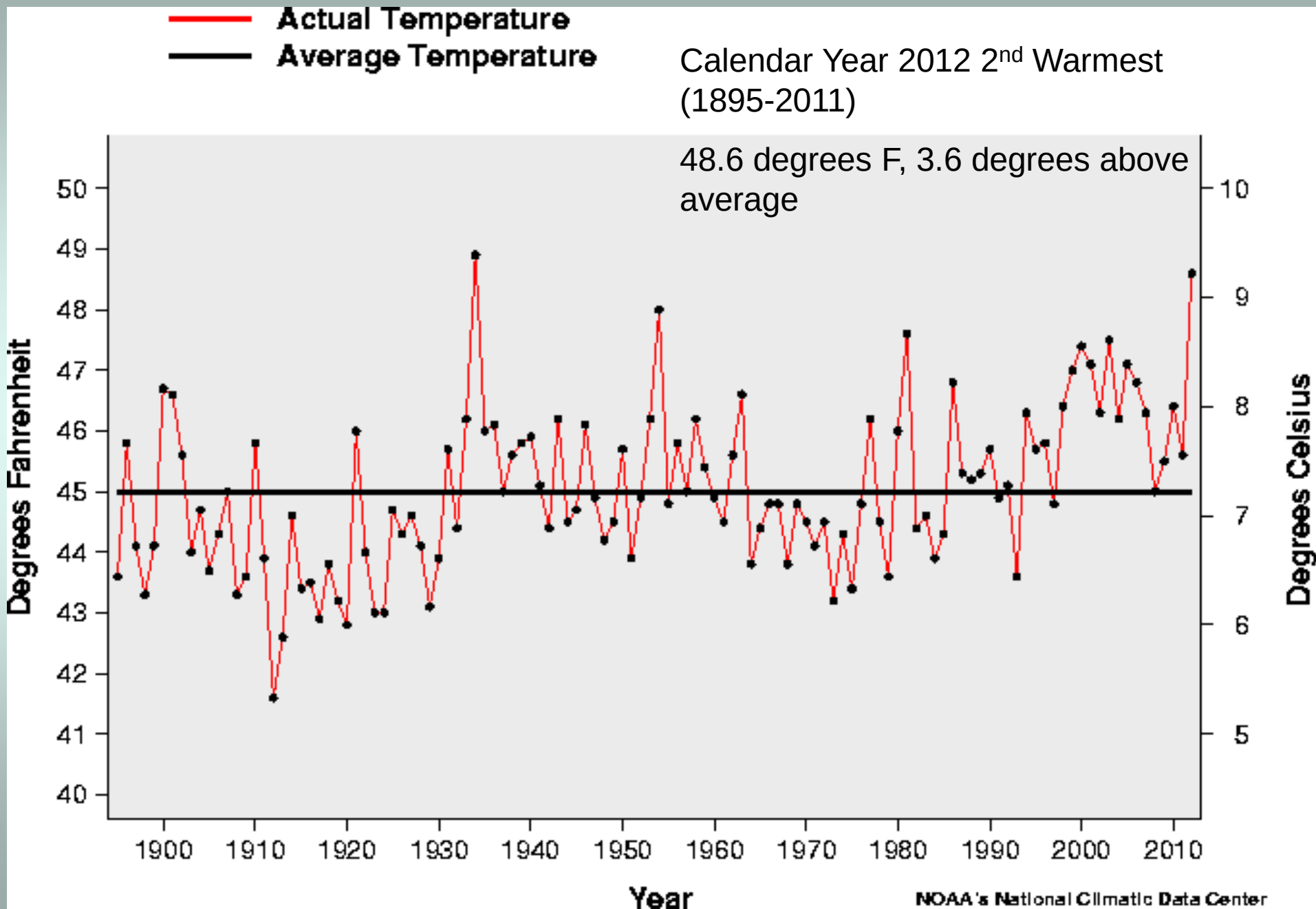
Summer 2012 was the Warmest (1895-2012)

69.7 degrees F, 4.6 degree above the average


Fort Collins, CO Average Summer Temperature
Summer Max Temp
Summer Min Temp
Average Temperature (F)
100
90
80
70
60
50
40
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

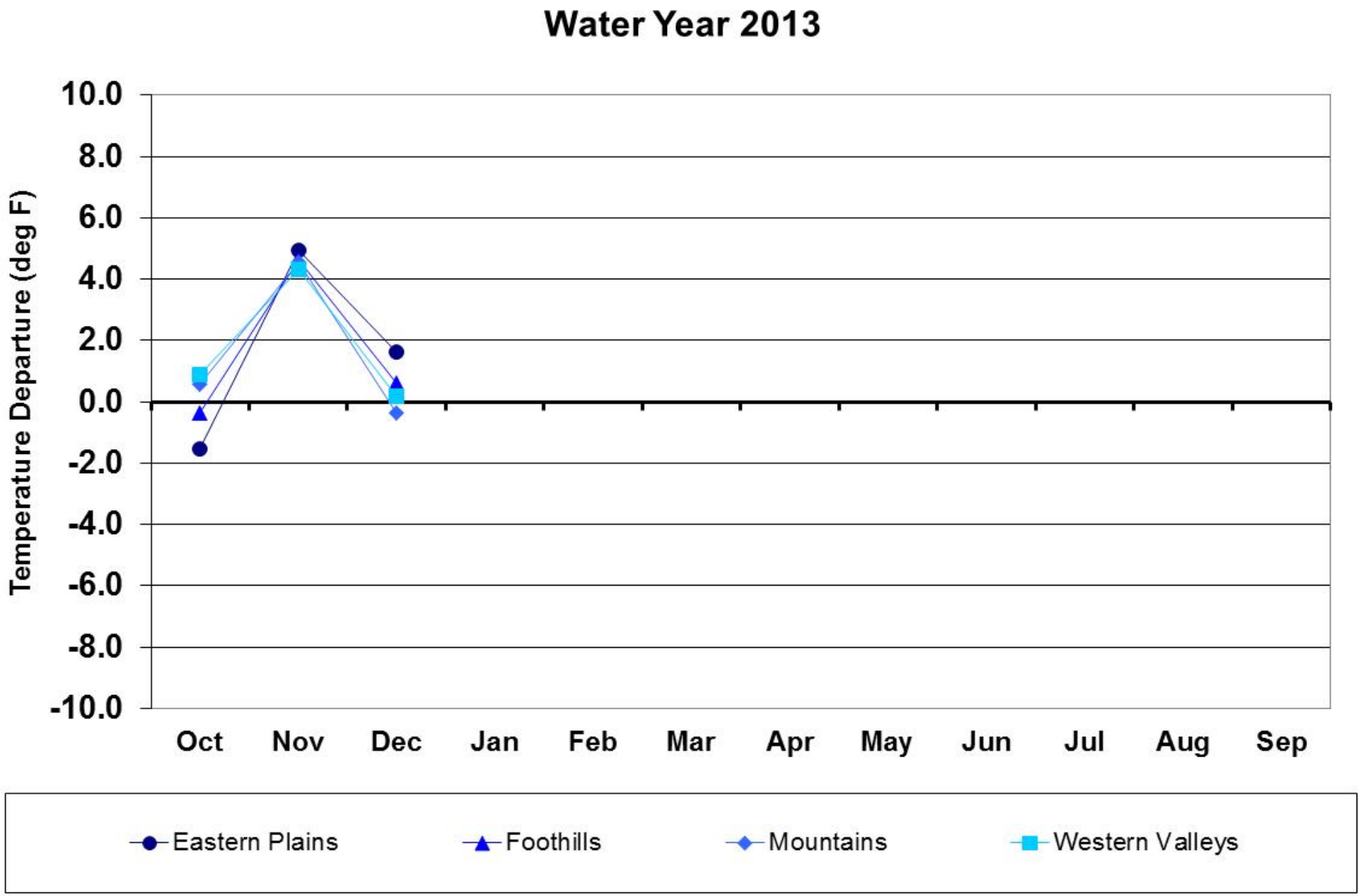

Cheyenne Wells, CO Average Summer Temperature
Summer Max Temp
Summer Min Temp
Average Temperature (F)
100
90
80
70
60
50
40
1885
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year

Average Annual Temperature History for Colorado (NCDC)



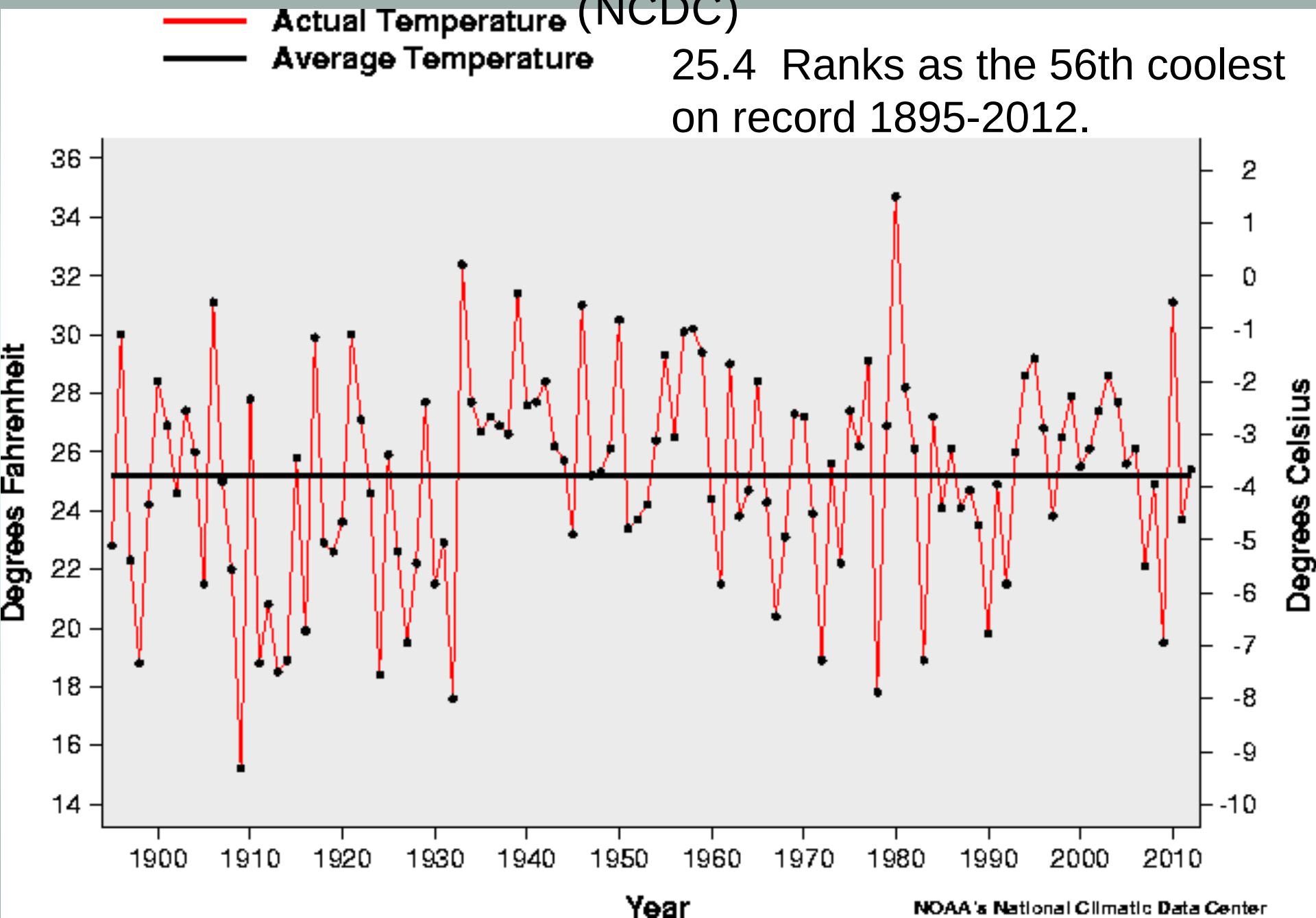
Water Year 2013 so far

Water Year 2013 Temperature Departures

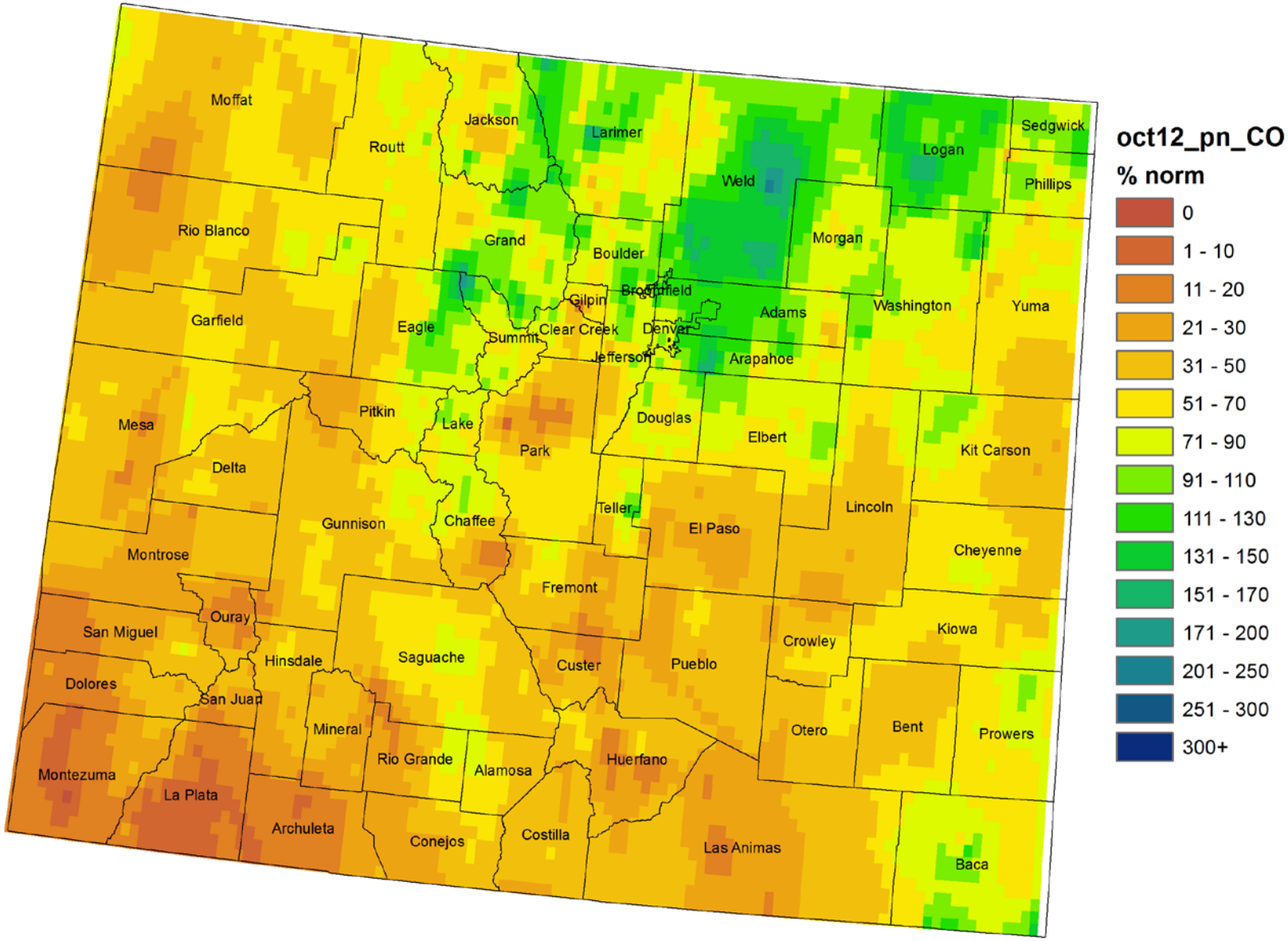


December Average Temperature History for Colorado (NCDC)

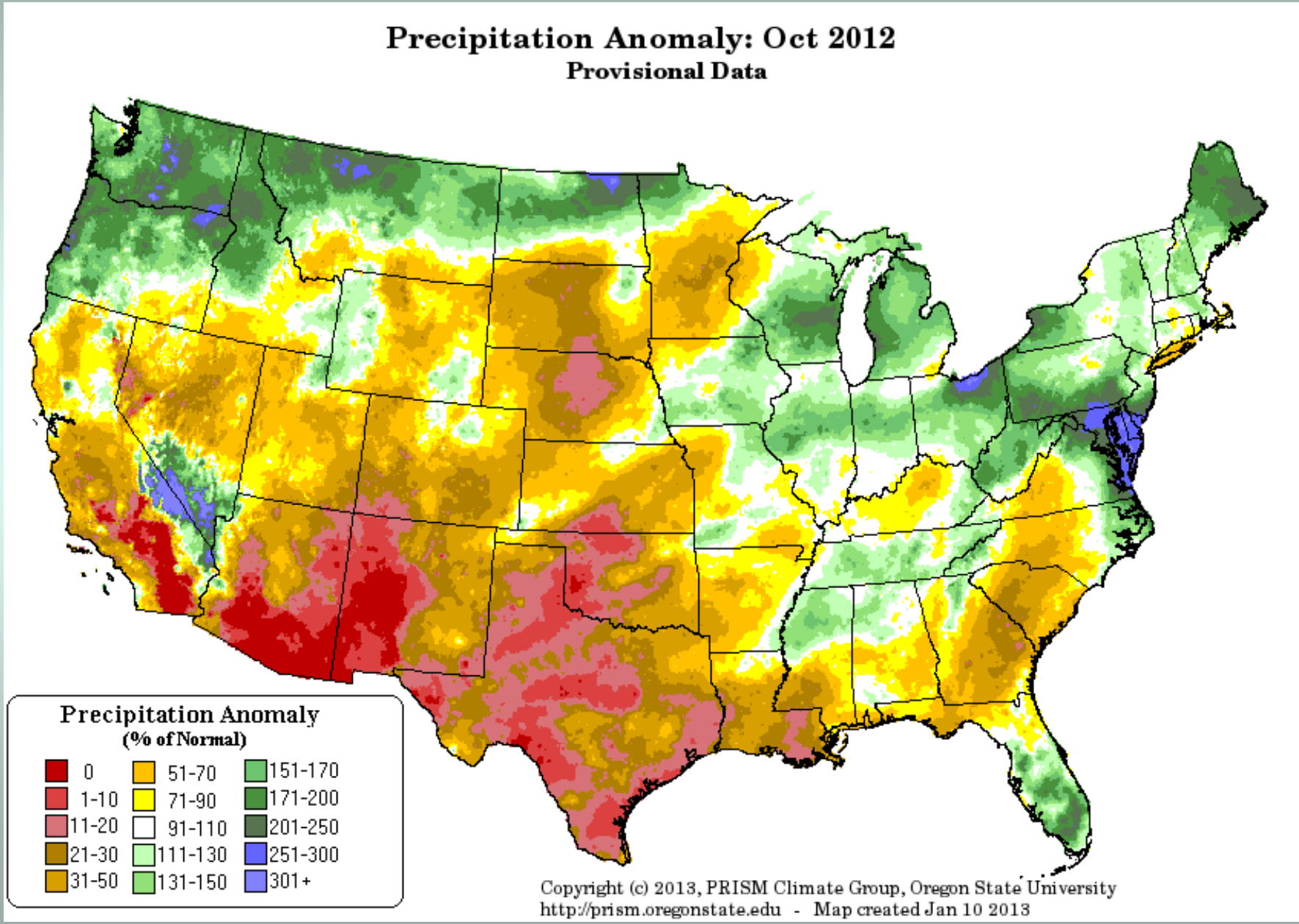
25.4 Ranks as the 56th coolest on record 1895-2012.



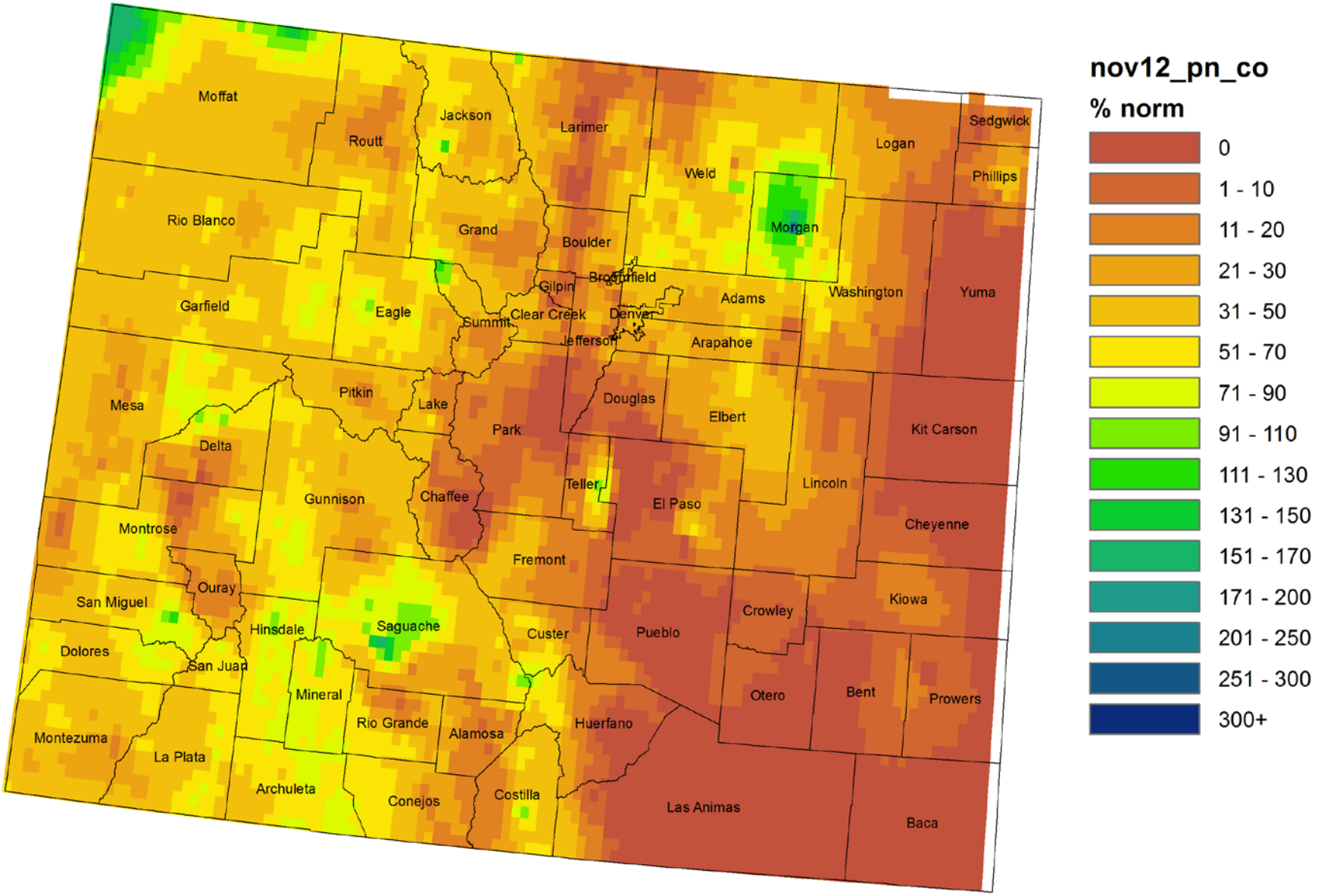
Colorado October 2012 Precipitation as Percentage of Normal



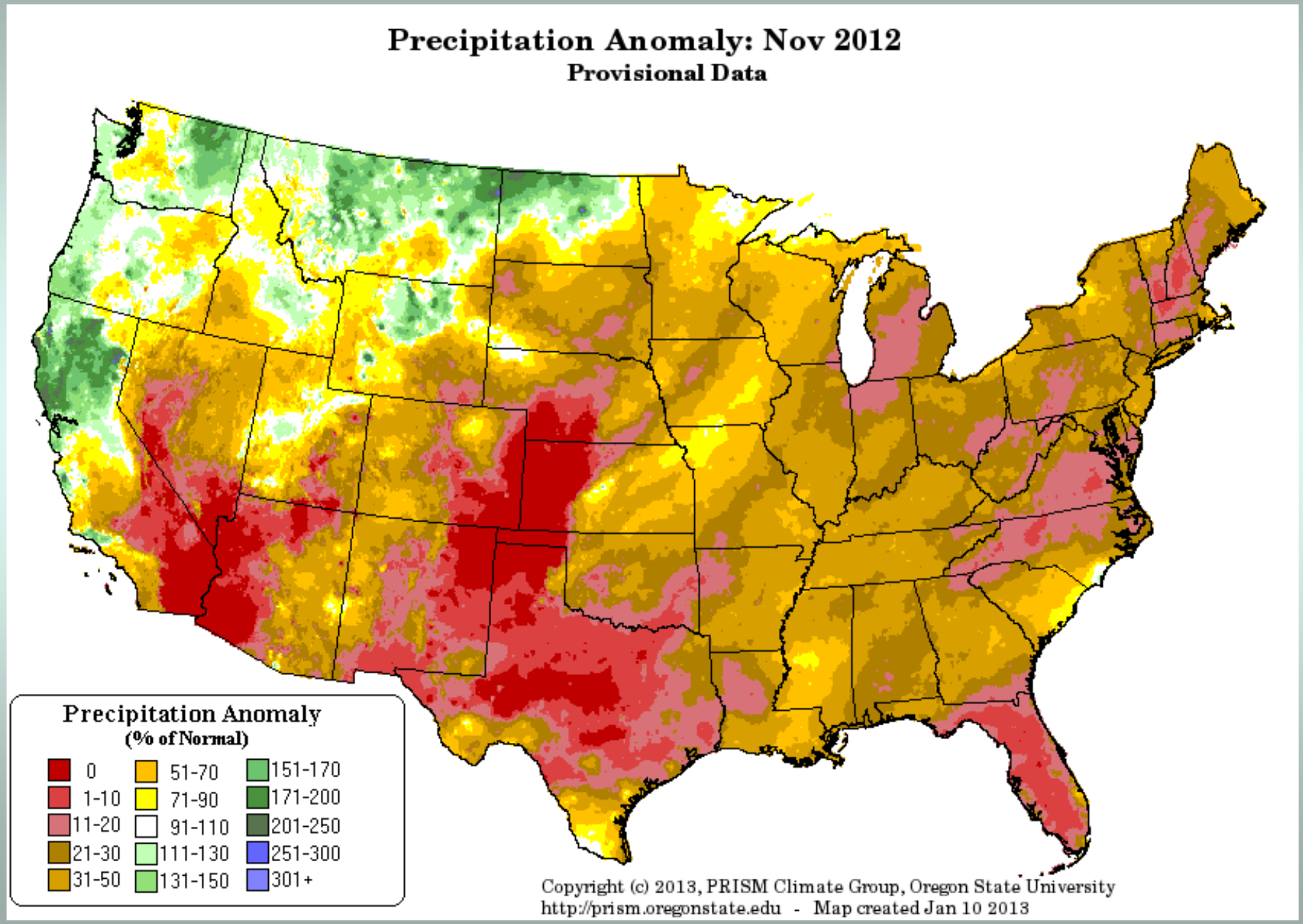
Oct 2012 Percent of Normal



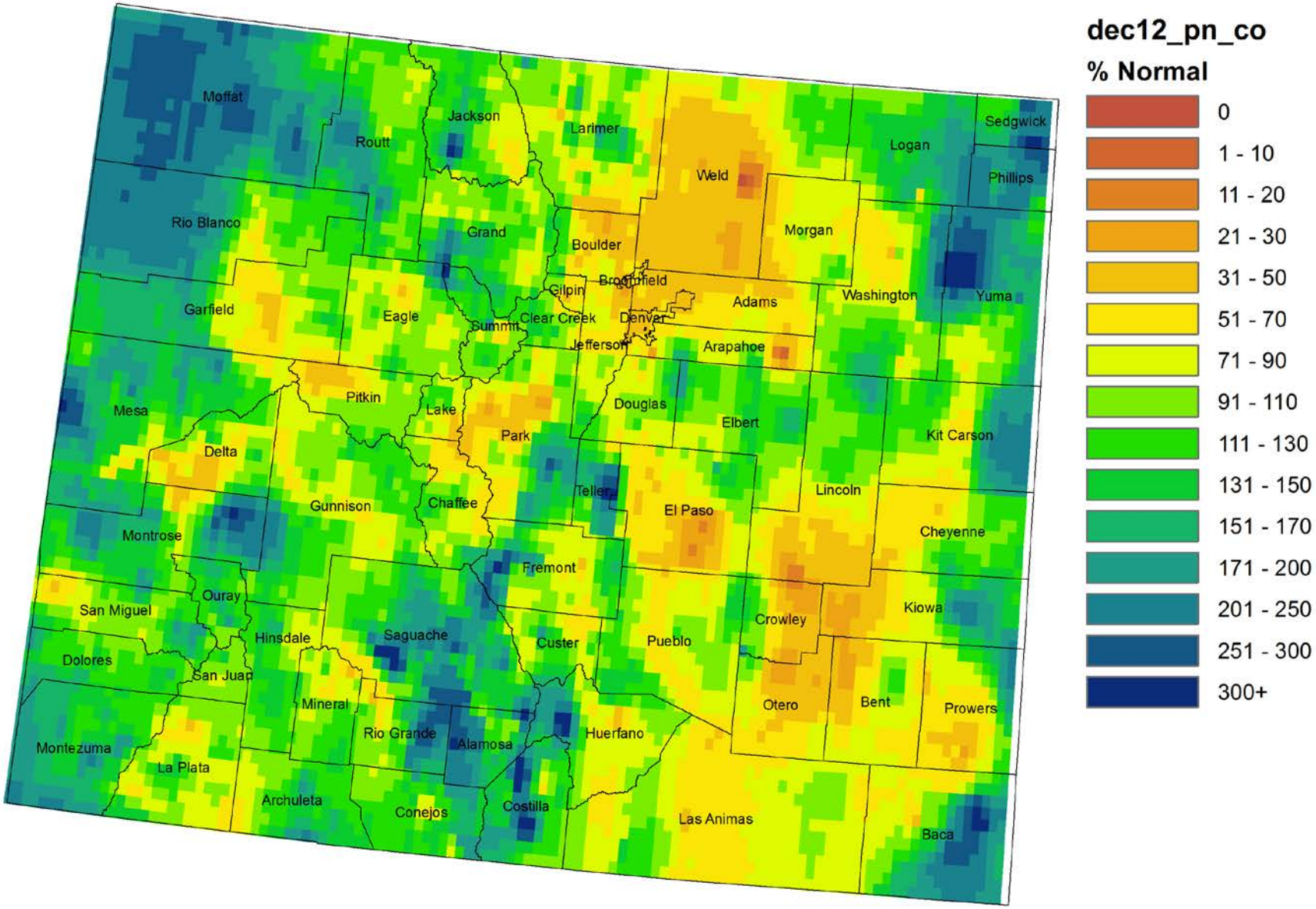
Colorado November 2012 Precipitation as Percentage of Normal



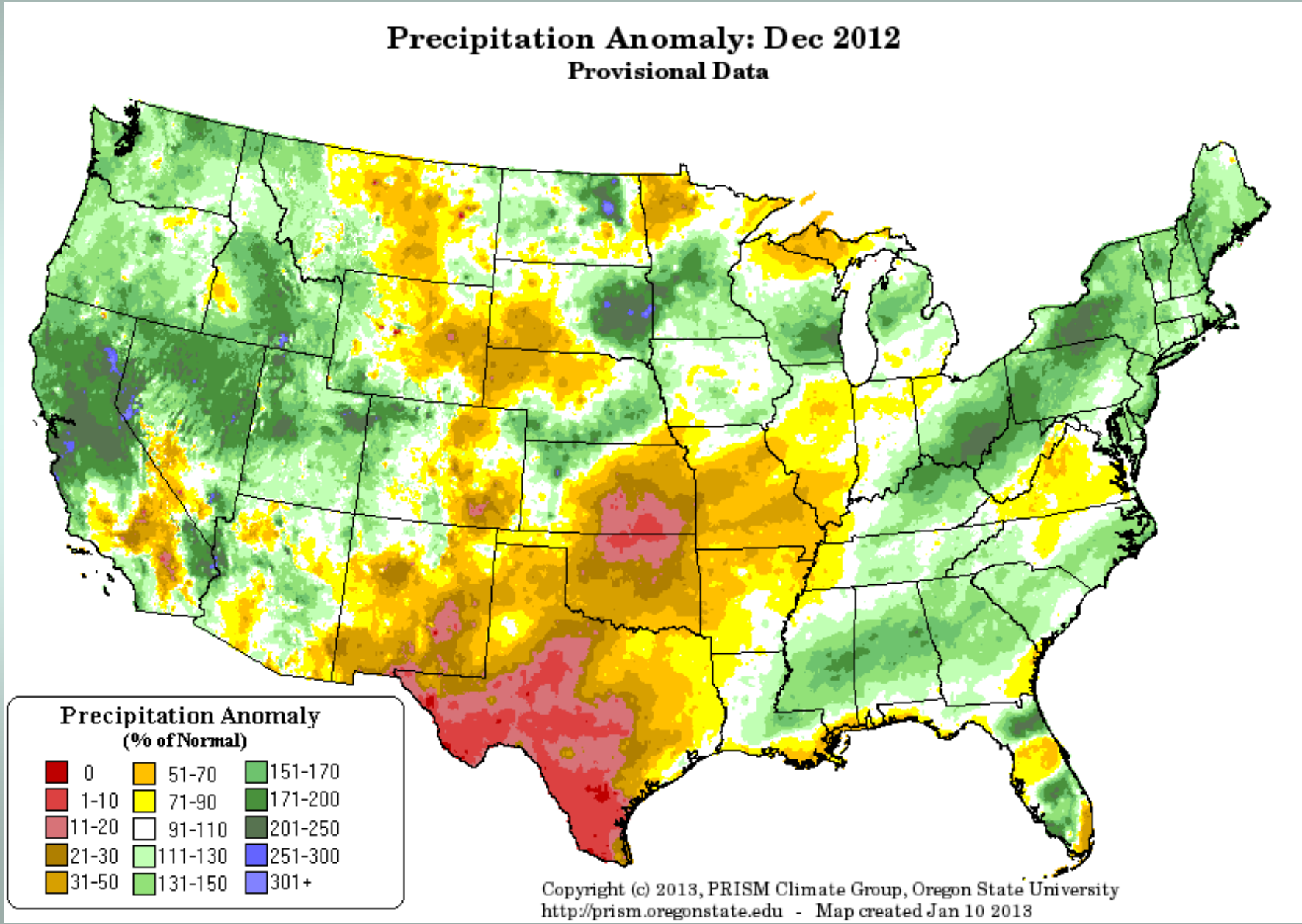
Nov 2012 Percent of Normal



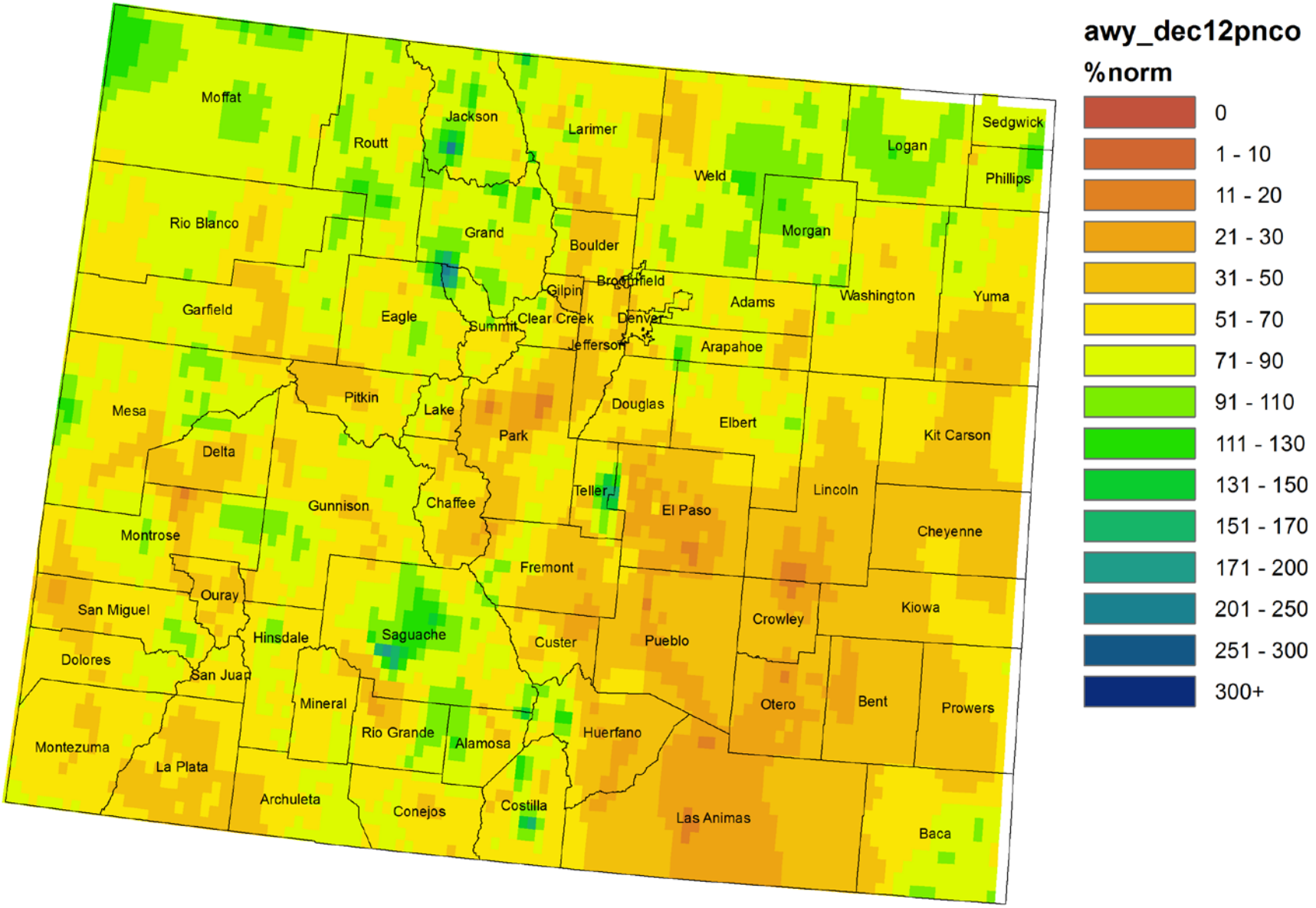
Colorado Precipitation as Percentage of Normal
December 2012



Dec 2012 Percent of Normal

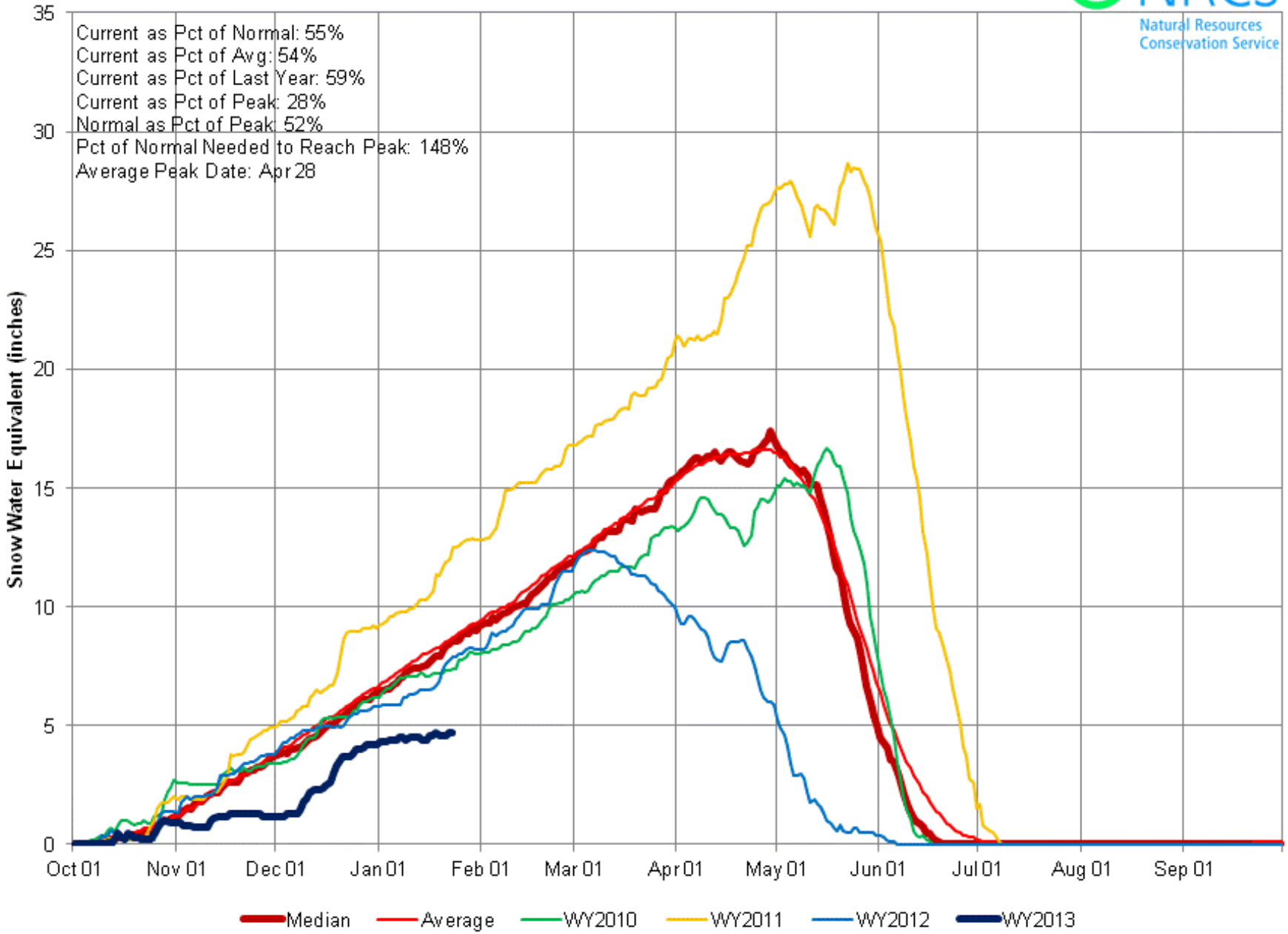


Colorado Water Year 2013 Precipitation as Percentage of Normal
October 2012 - December 2012



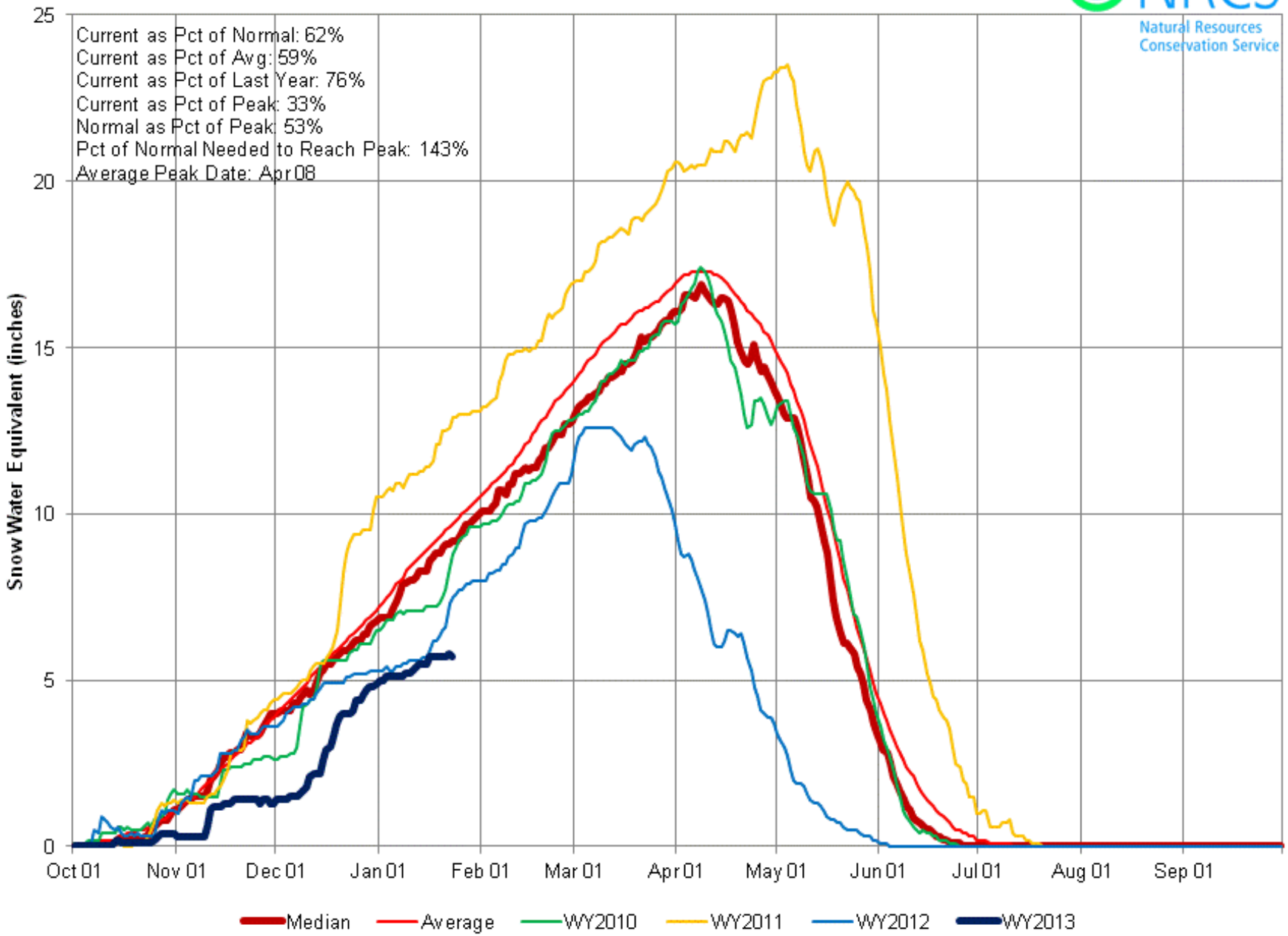
South Platte River Basin Time Series Snowpack Summary

Based on Provisional SNOTEL data as of Jan 23, 2013



Colorado State-Wide Time Series Snowpack Summary

Based on Provisional SNOTEL data as of Jan 23, 2013

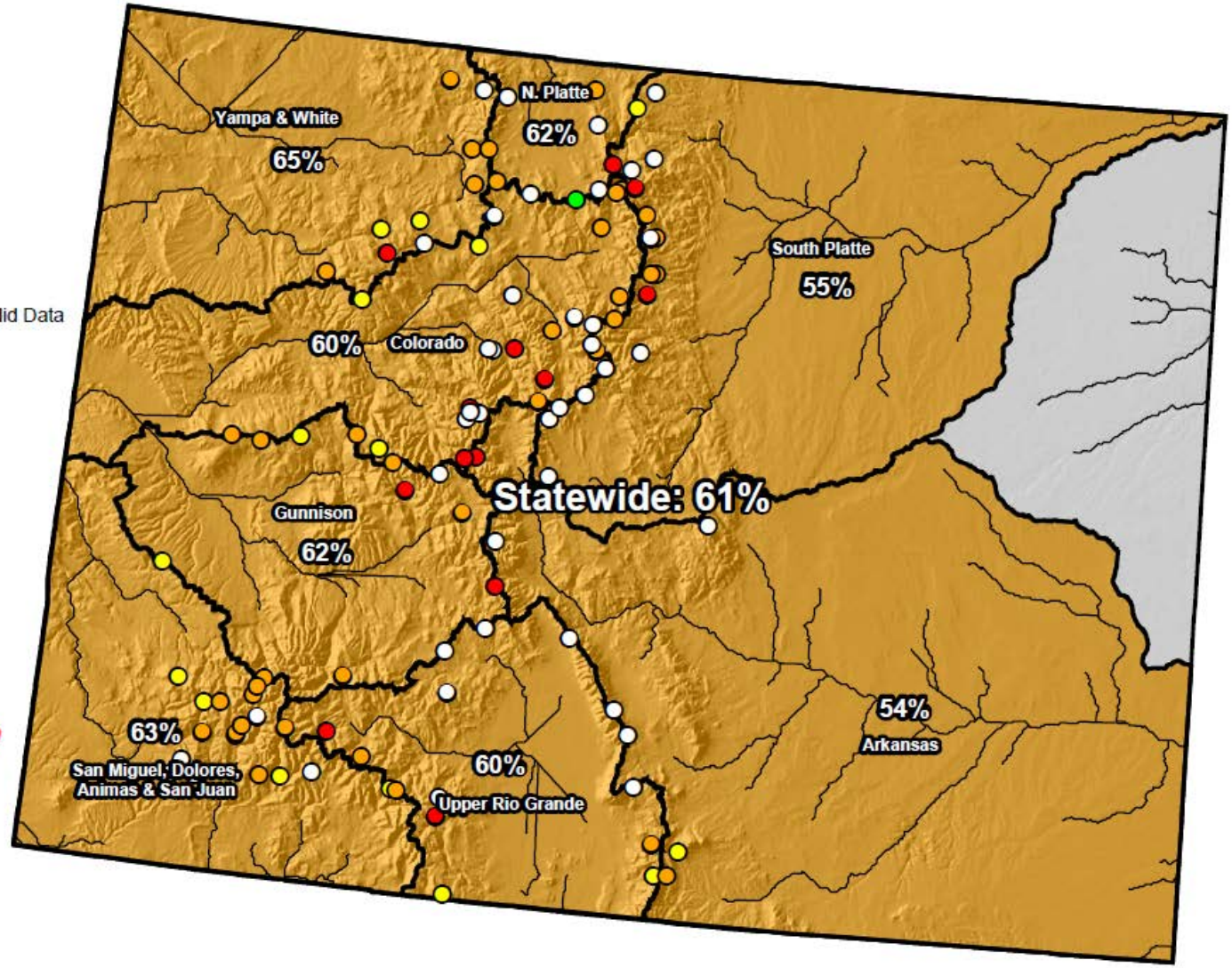


Colorado SNOTEL Snowpack Update Map with Site Data

Percent of Average

- >= 150
- 130 - 149
- 110 - 129
- 90 - 109
- 70 - 89
- 50 - 69
- < 50
- Missing or Invalid Data
- < 50
- 50 - 69
- 70 - 89
- 90 - 109
- 110 - 129
- 130 - 149
- >= 150

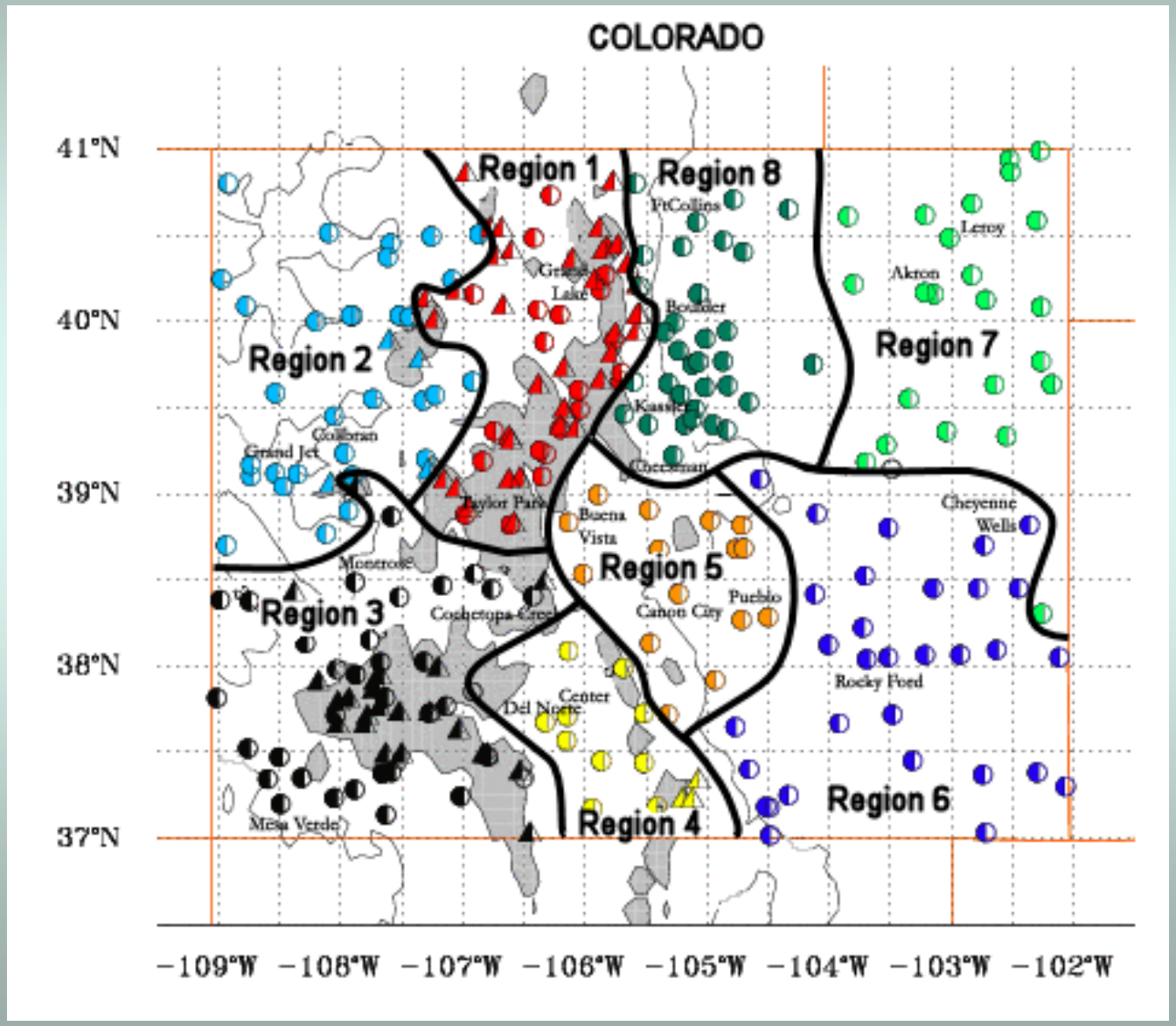
Provisional Data Subject to Revision



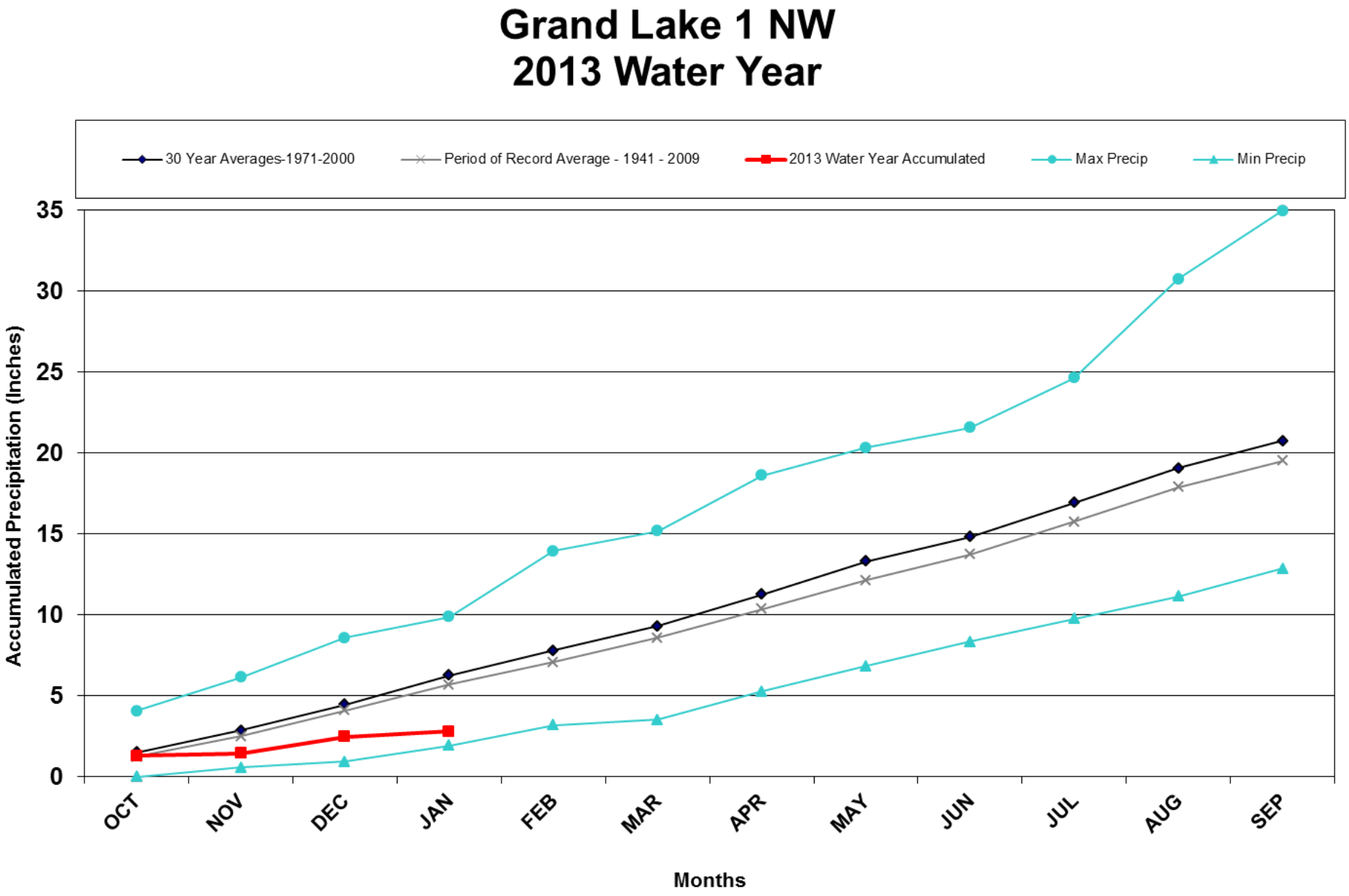
Current as of Jan 23, 2013

*Data may not provide a valid measure of conditions

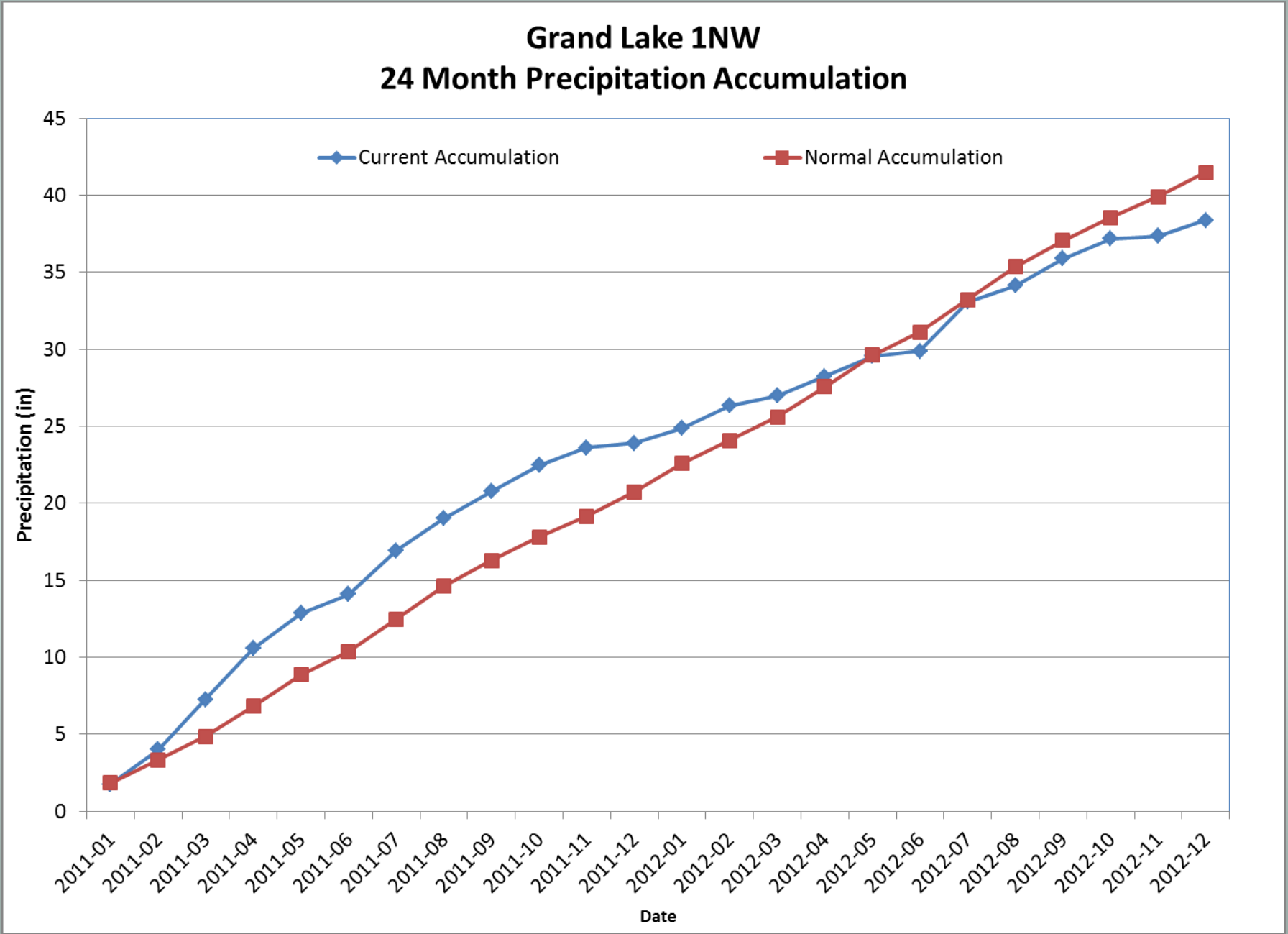
Climate divisions defined by Dr. Klaus Wolter of NOAA's Climate Diagnostic Center in Boulder, CO



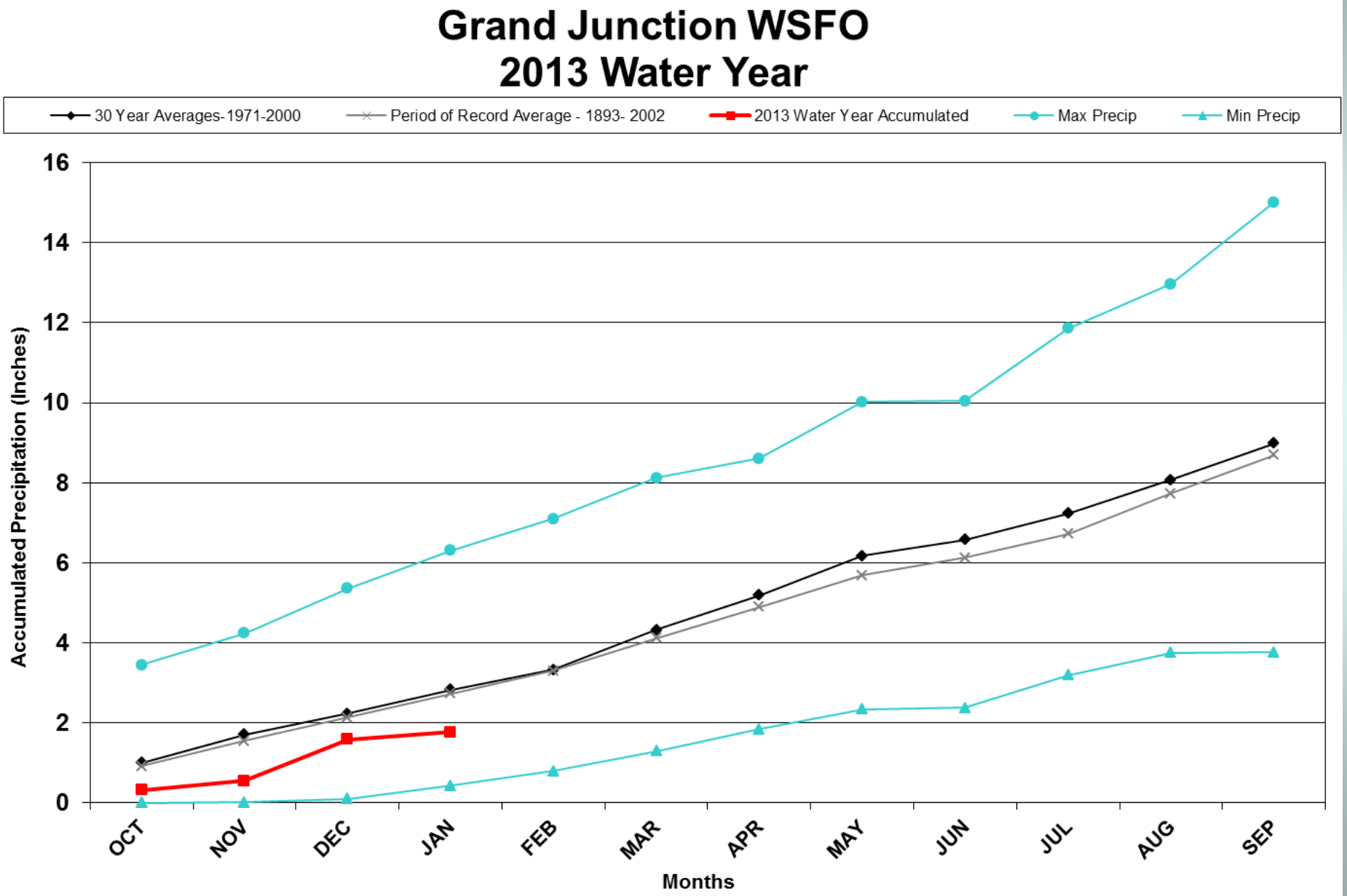
Division 1 – Grand Lake 1NW



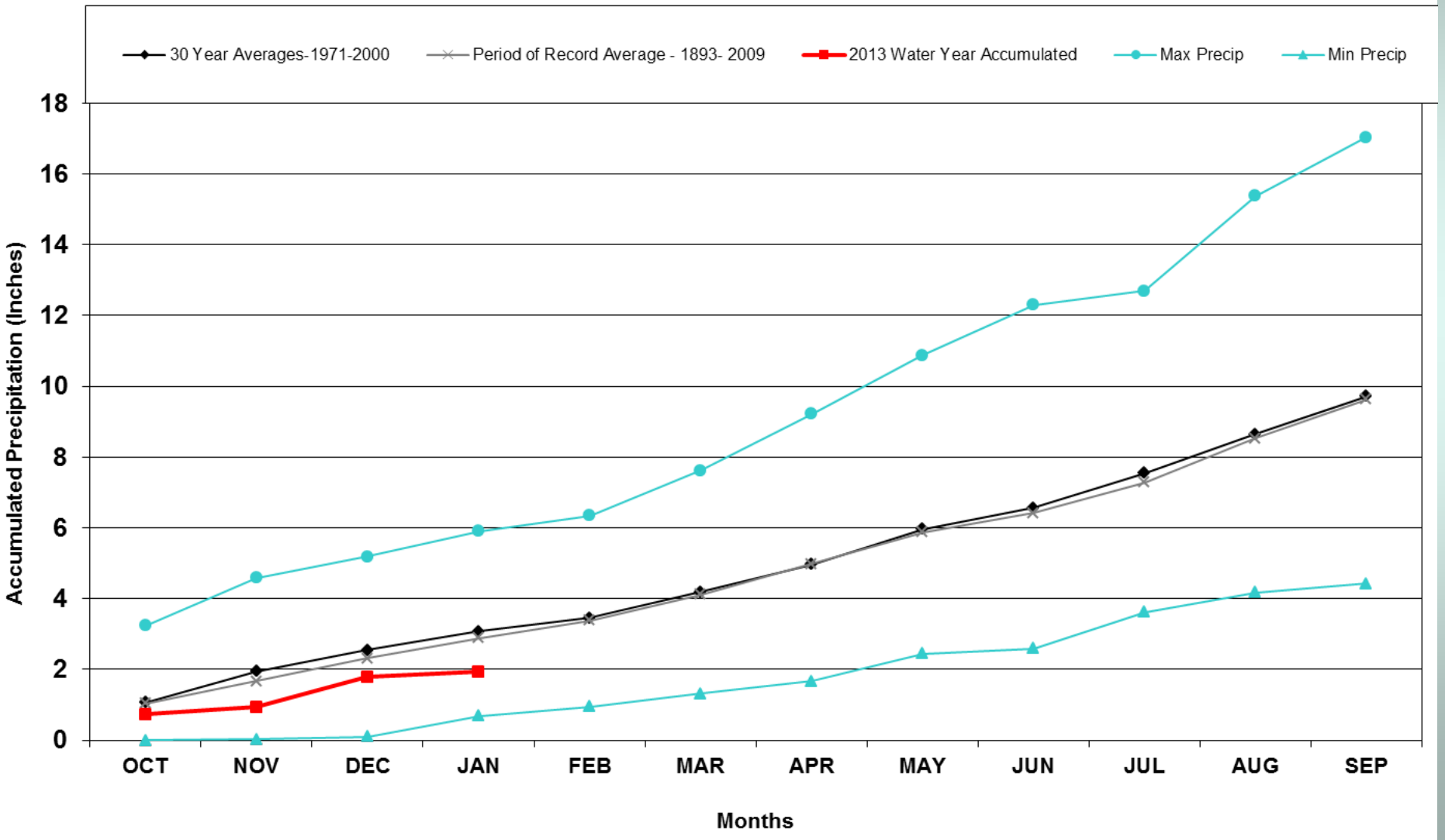
Division 1 – Grand Lake 1NW



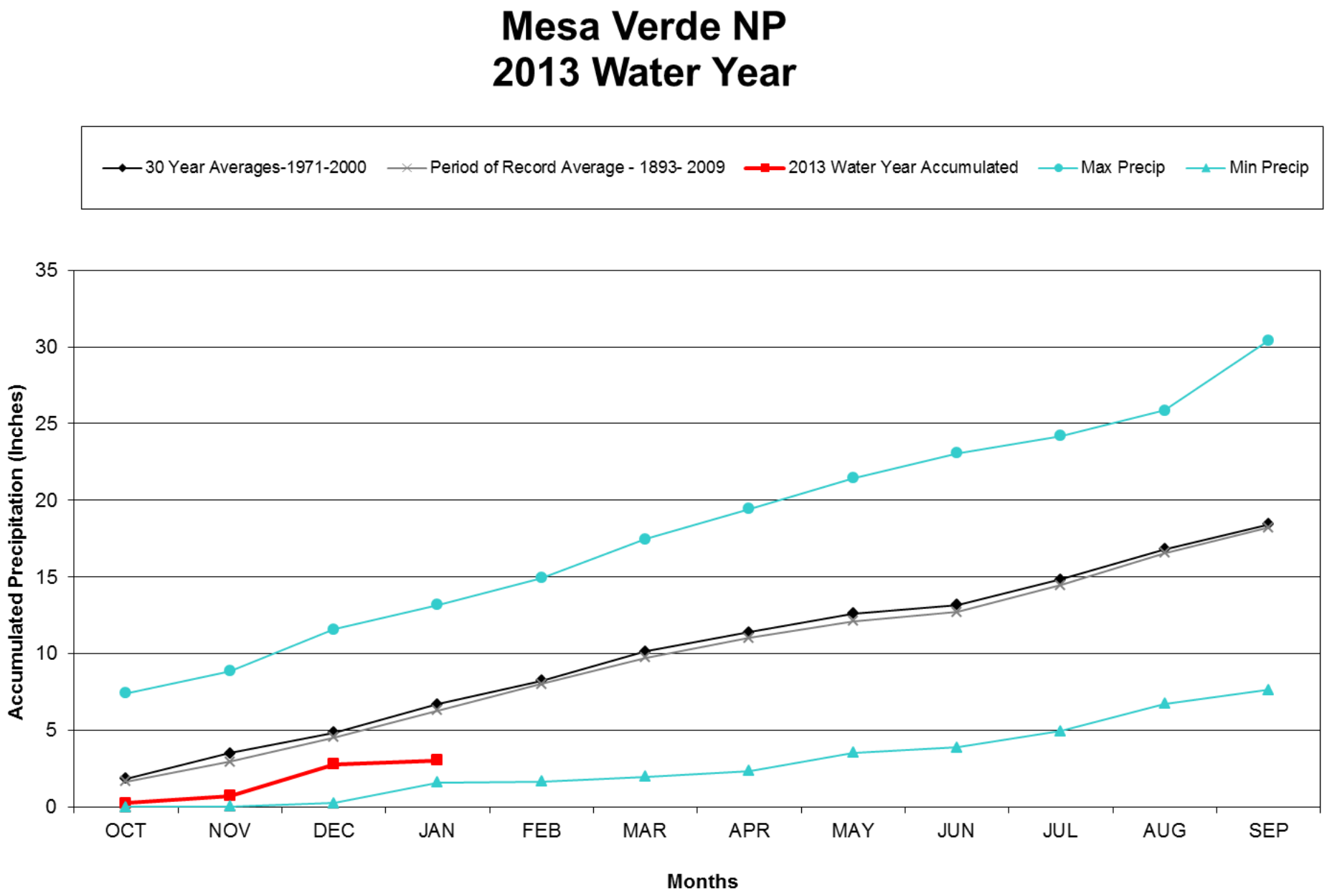
Division 2 – Grand Junction



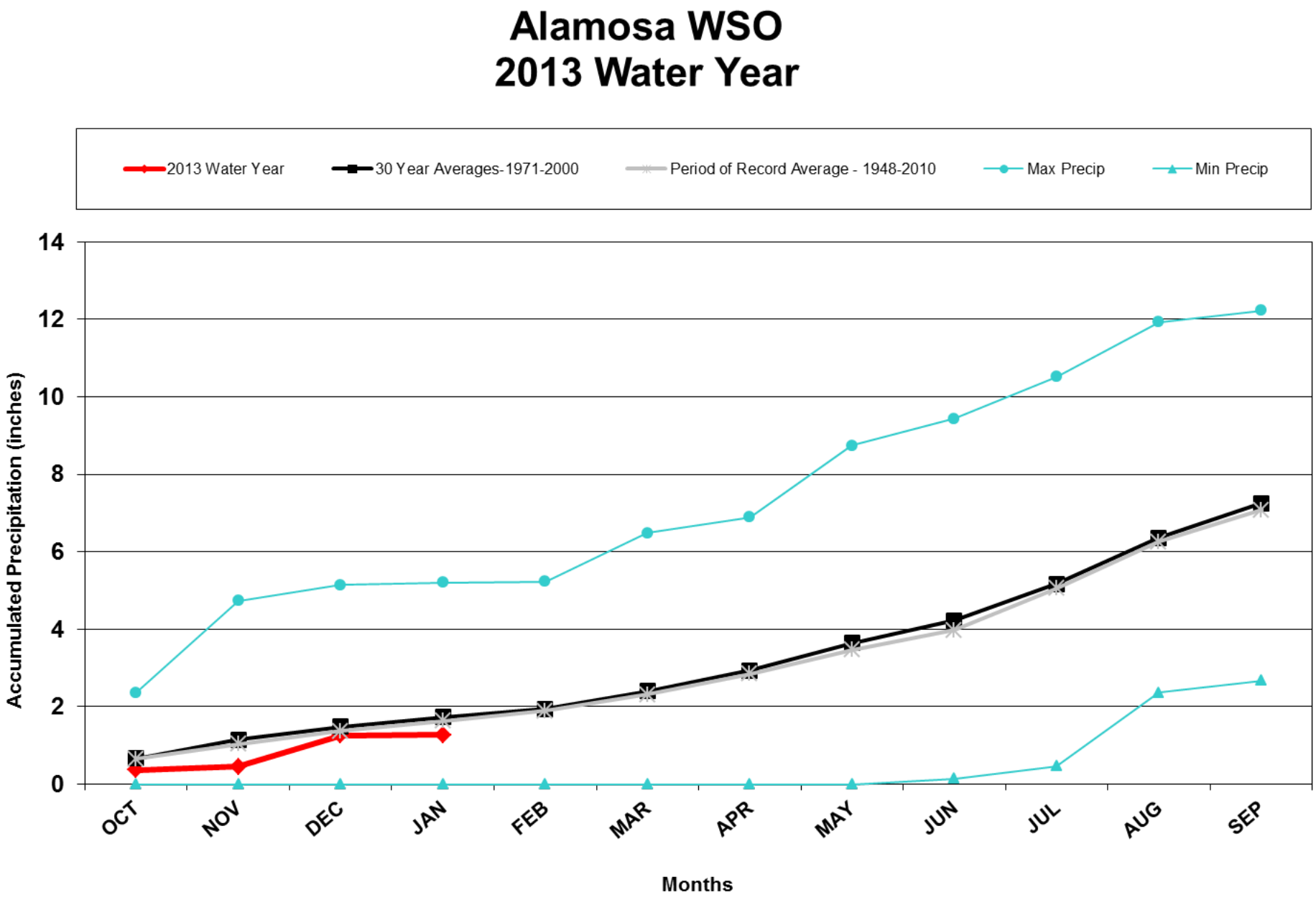
Division 3 – Montrose



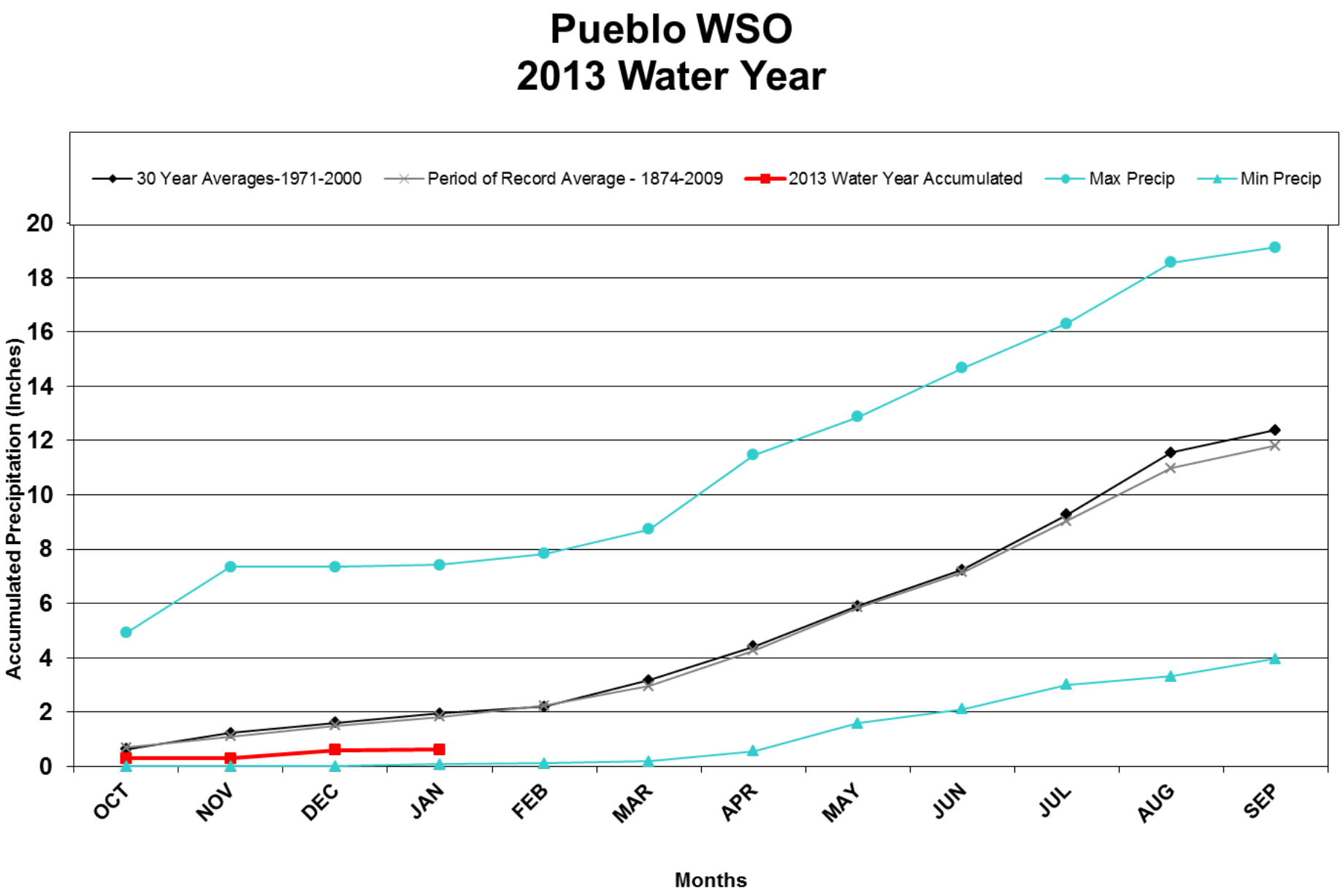
Division 3 – Mesa Verde NP



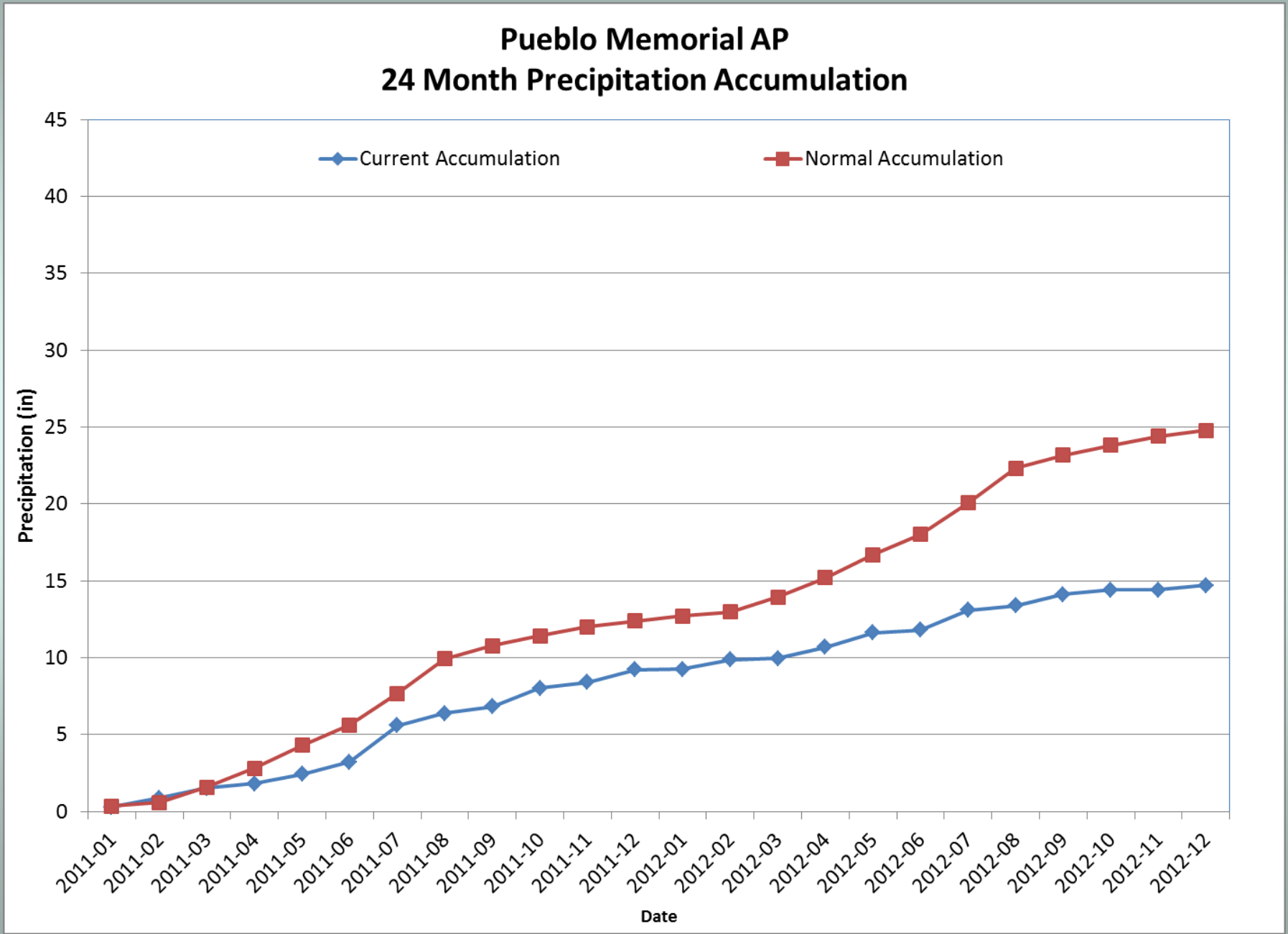
Division 4 – Alamosa



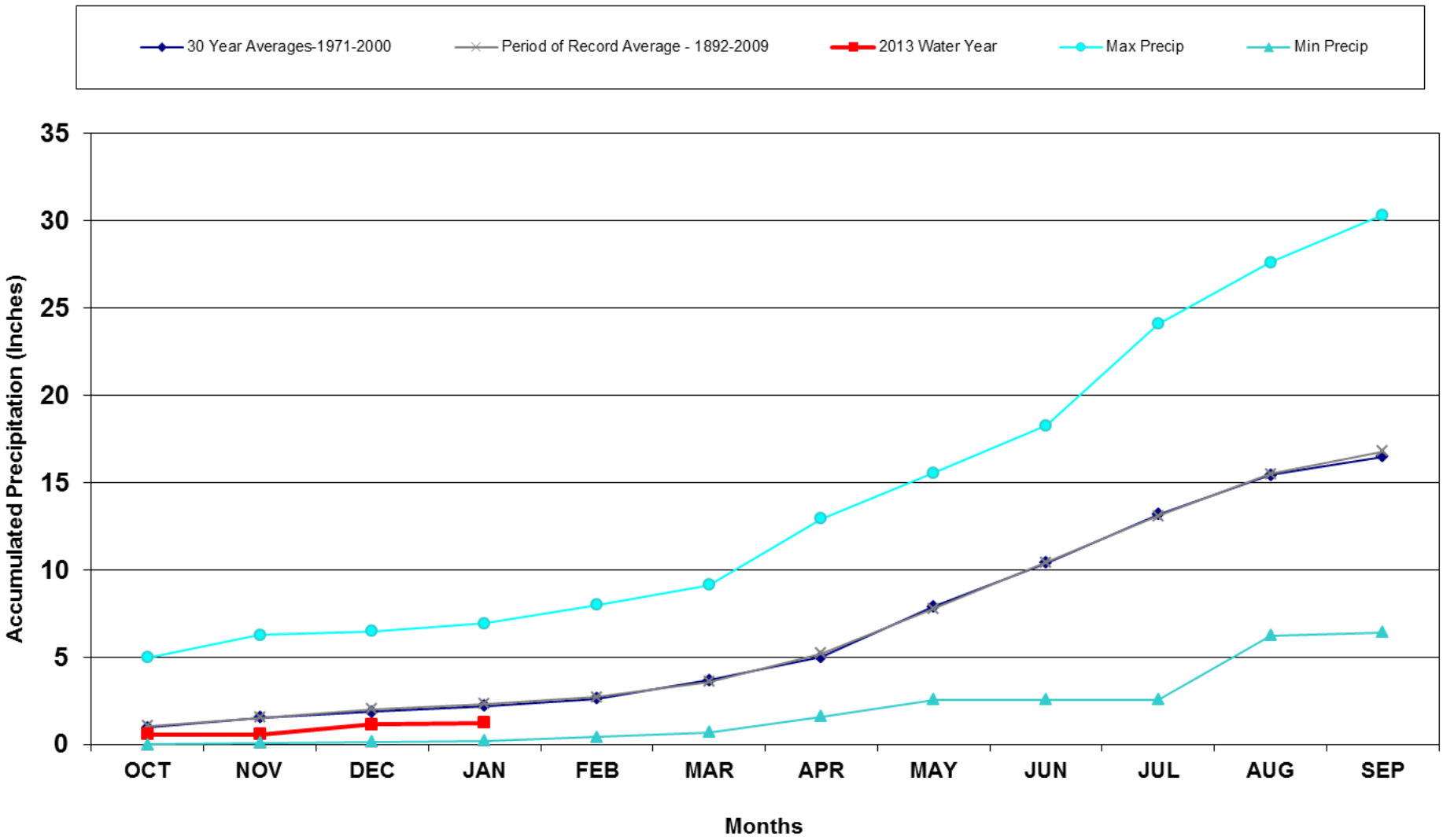
Division 5 – Pueblo



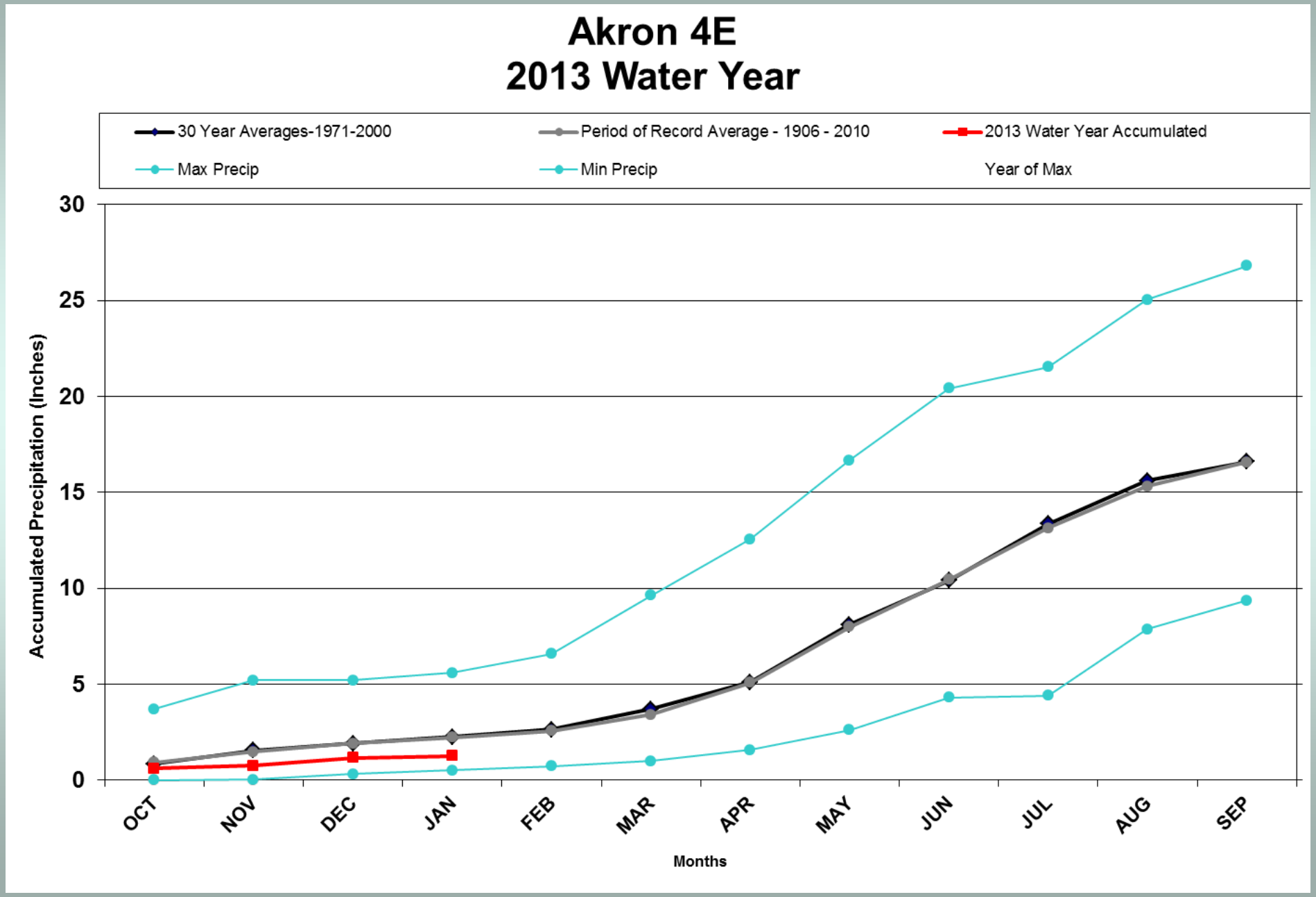
Division 5 – Pueblo



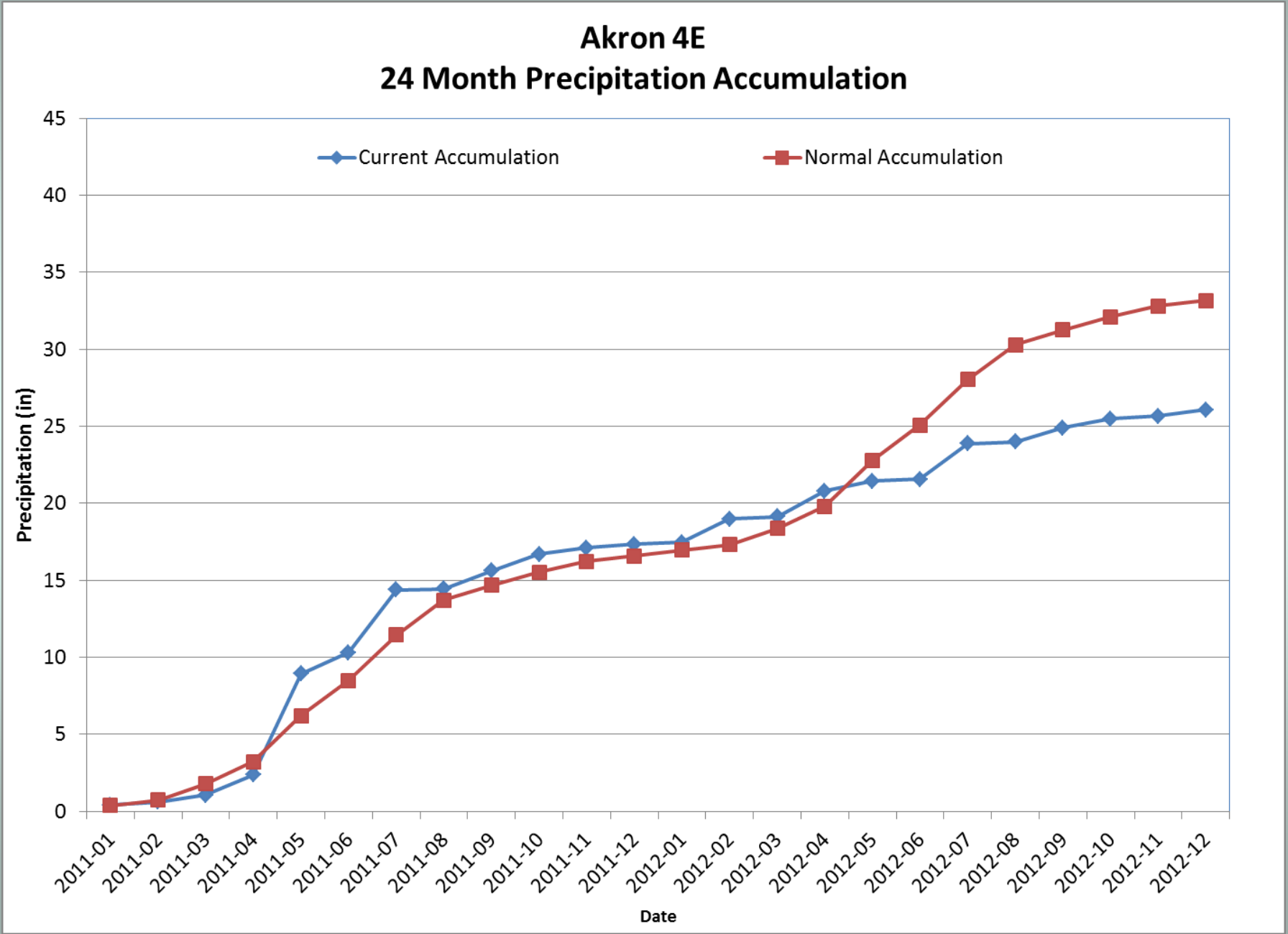
Division 6 - Burlington



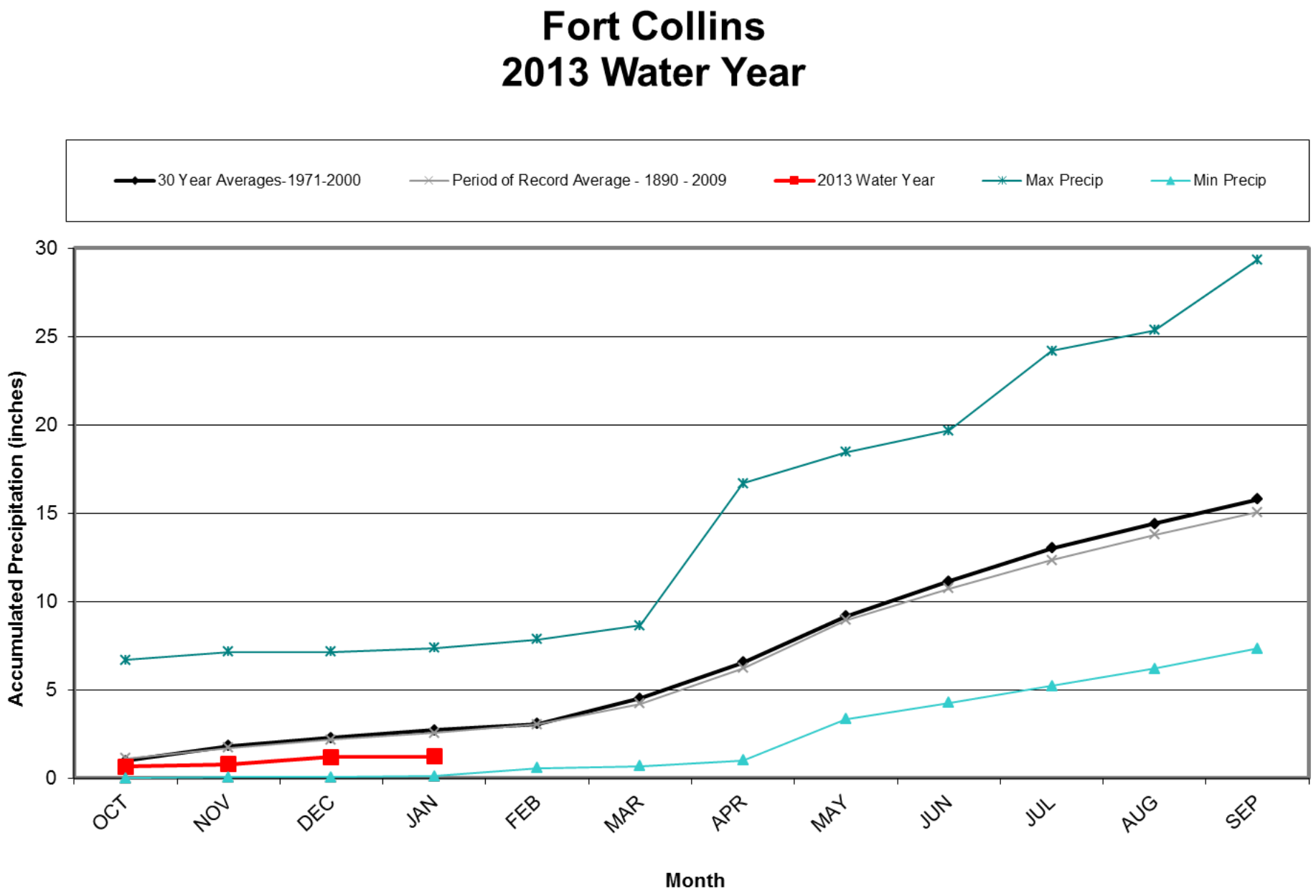
Division 7 – Akron



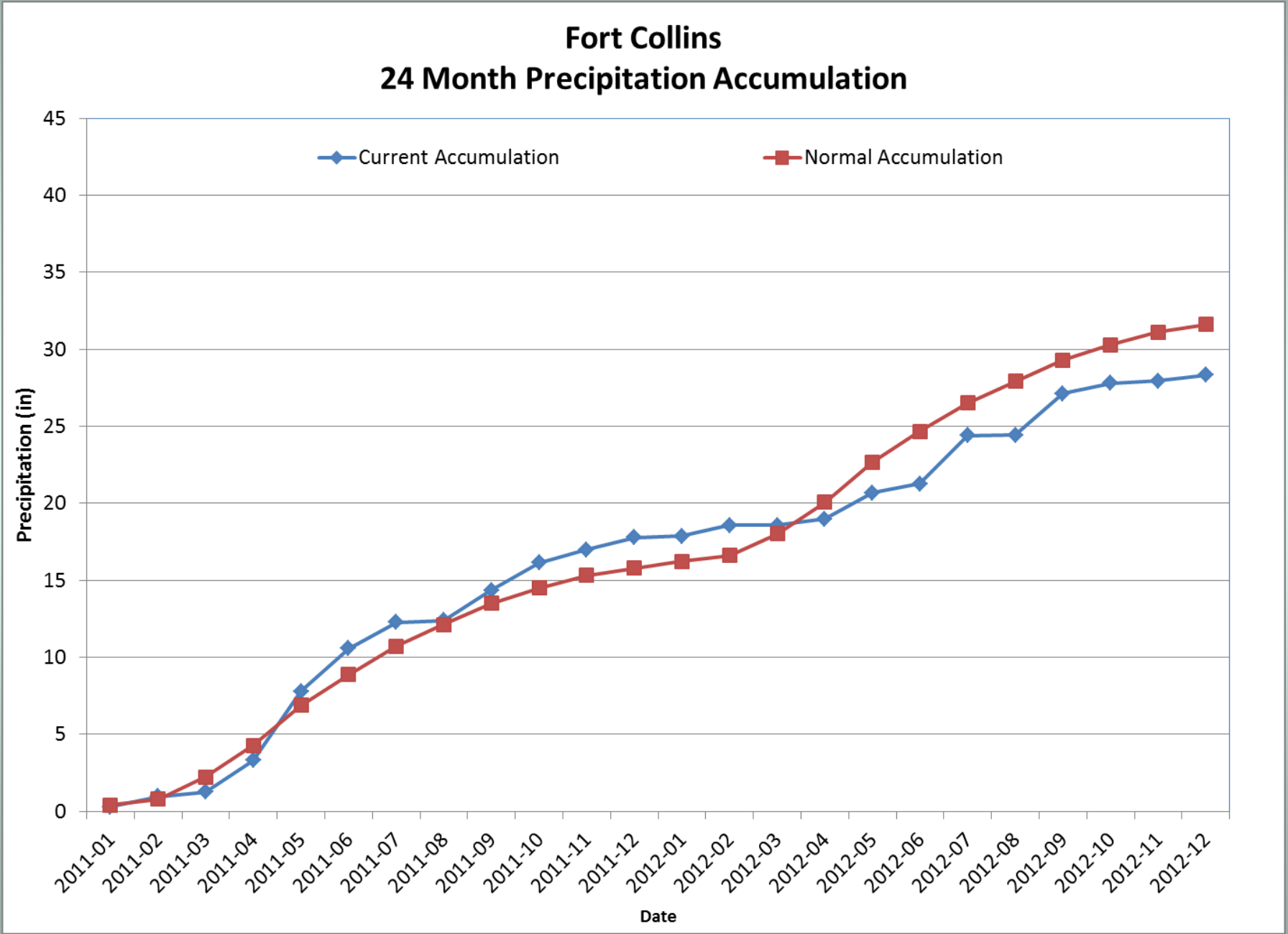
Division 7 – Akron



Division 8 – Fort Collins

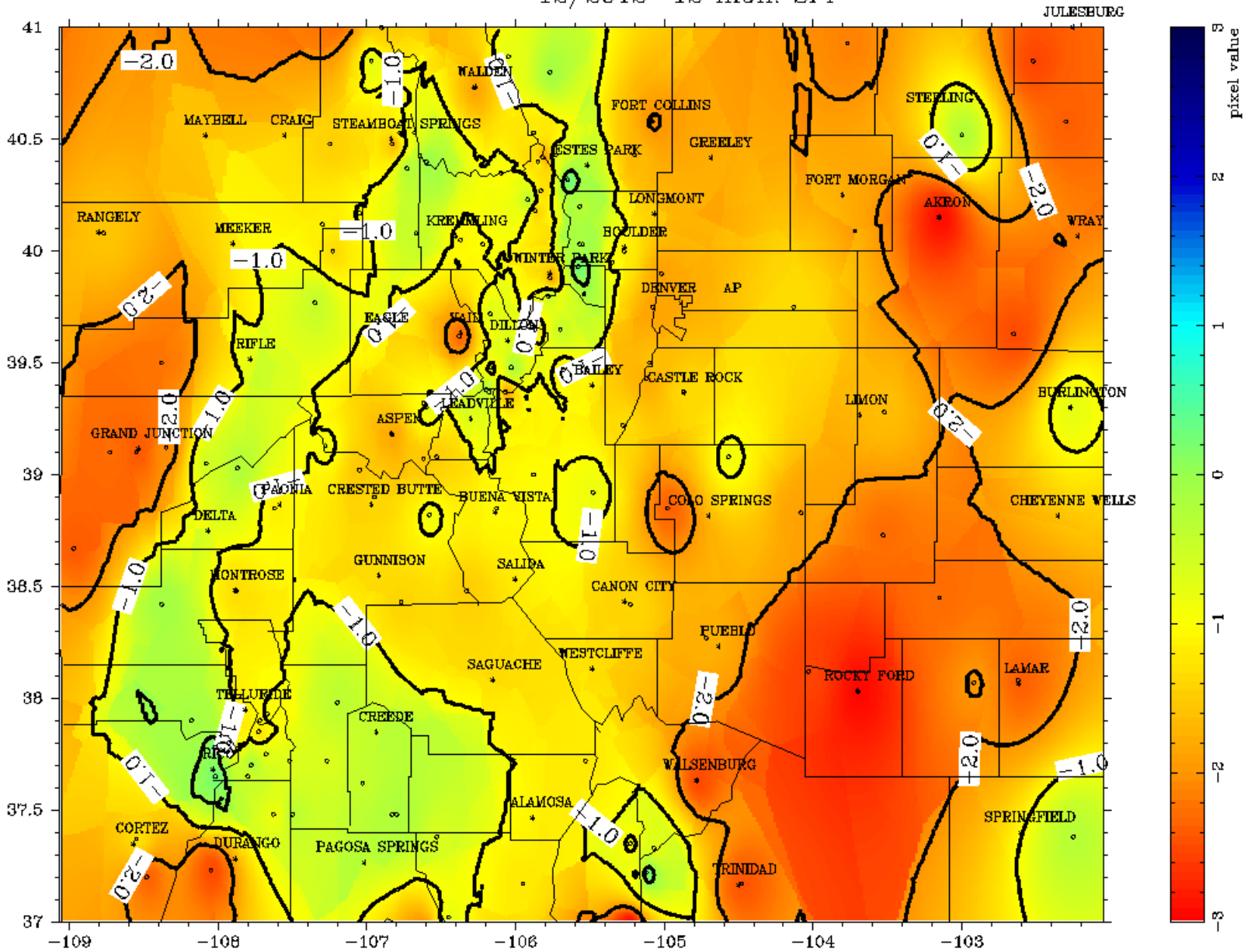


Division 8 – Fort Collins



Colorado

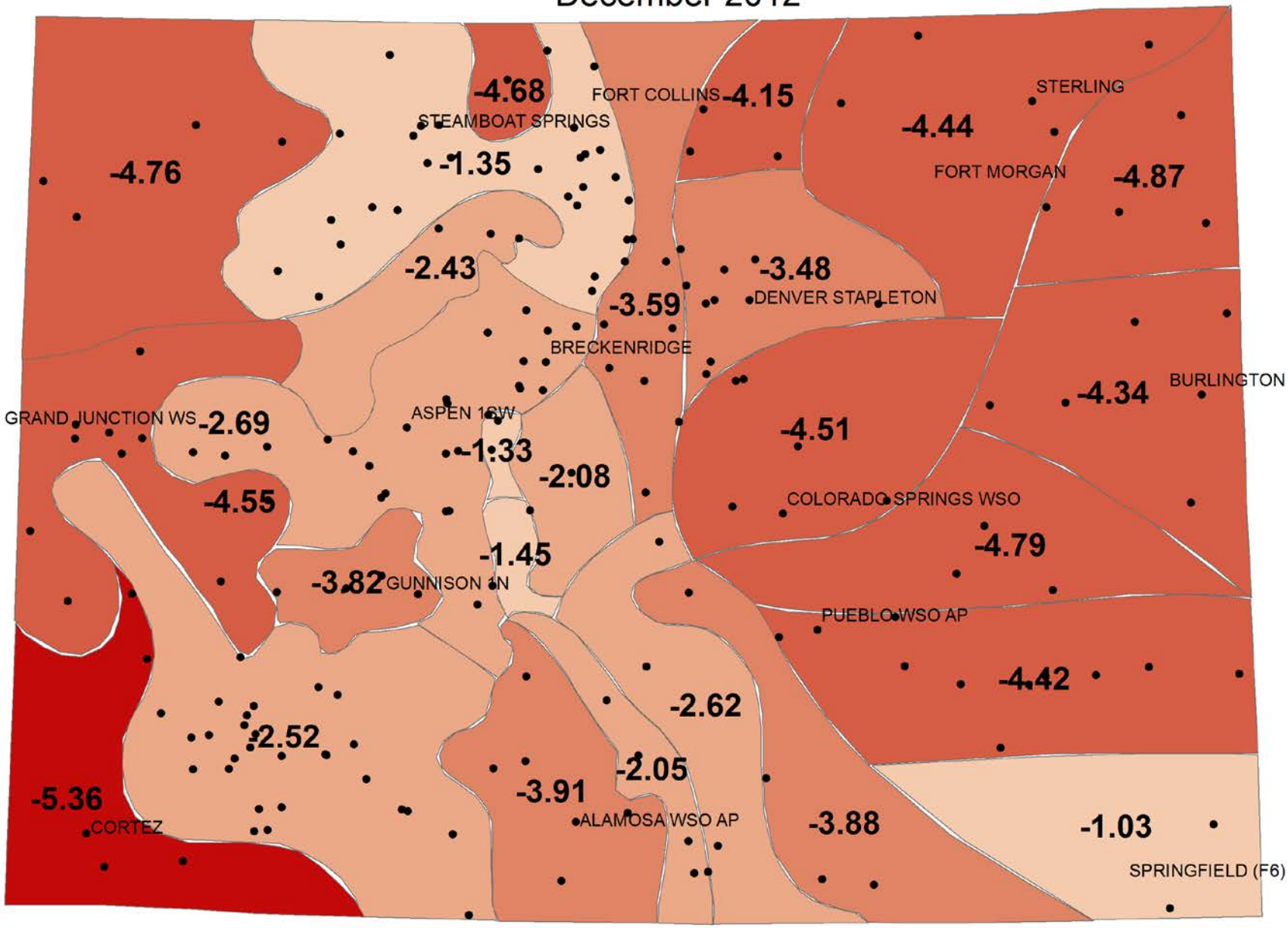
12/2012 12 mon. SPI



100 % < 2.0 78 % < −1.0
100 % < 1.0 23 % < −2.0
100 % < 0.0 0 % < −3.0

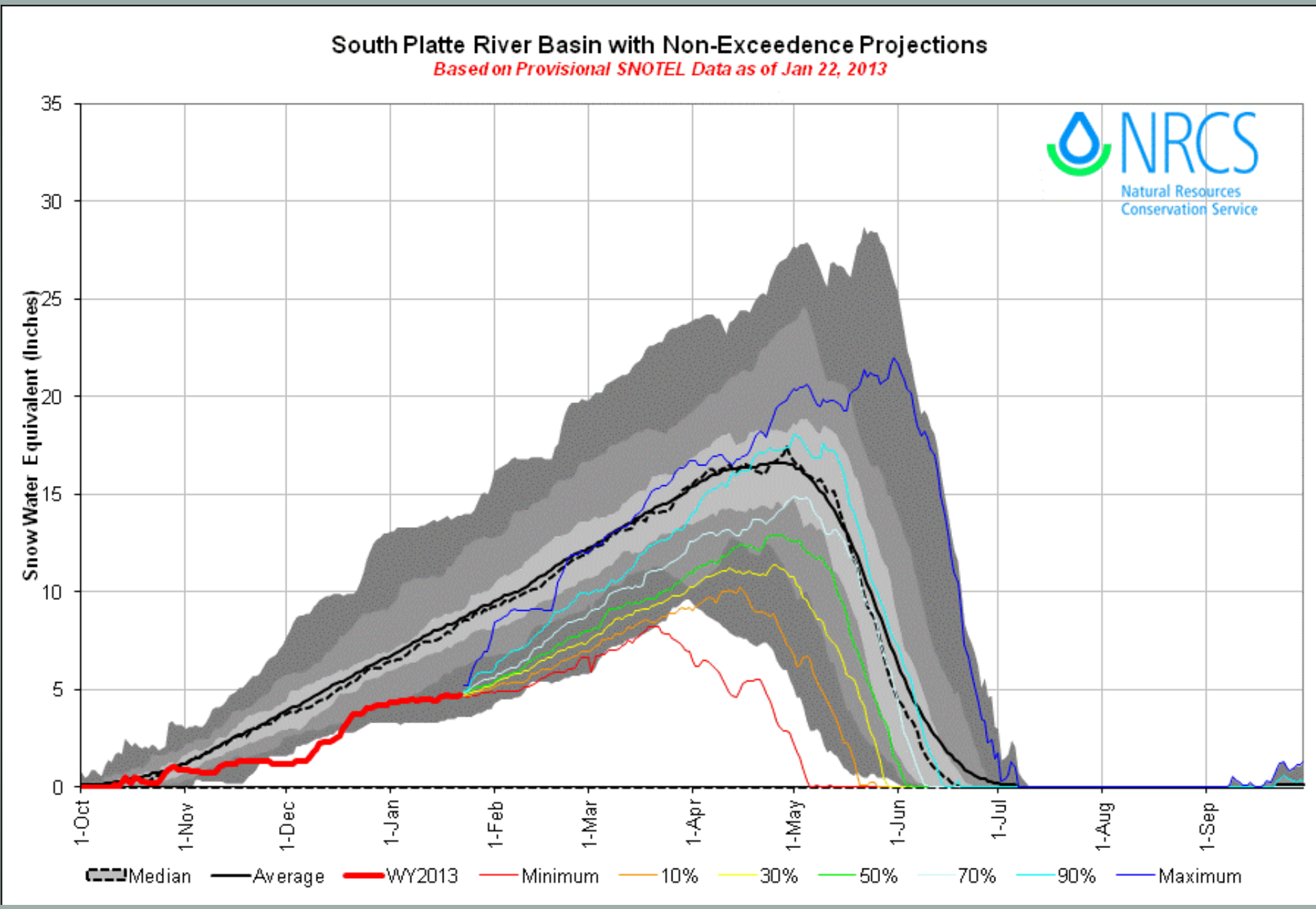
Produced by:
Colorado Climate Center
Fort Collins, CO

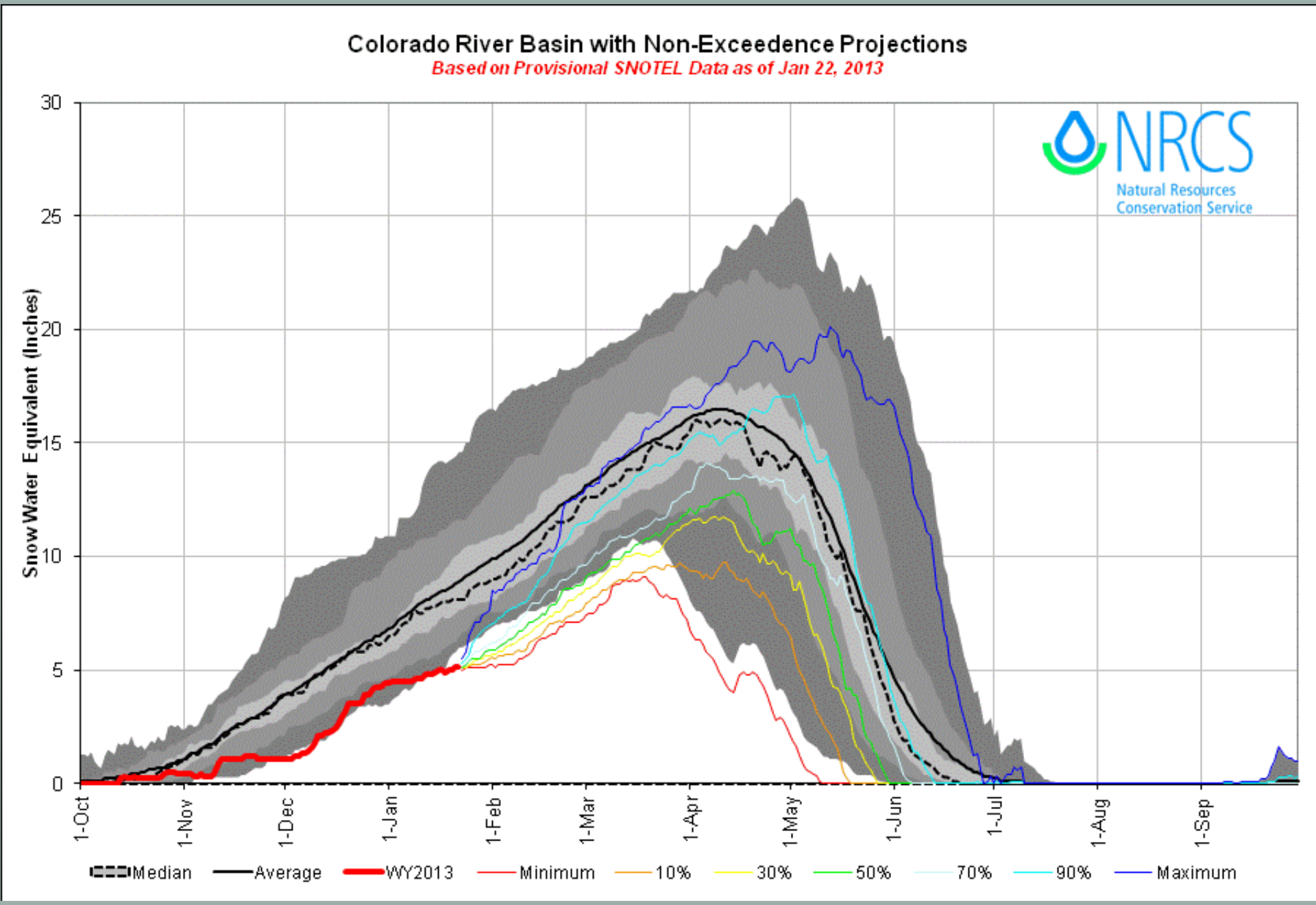
Modified Palmer Drought Severity Index for Colorado
December 2012

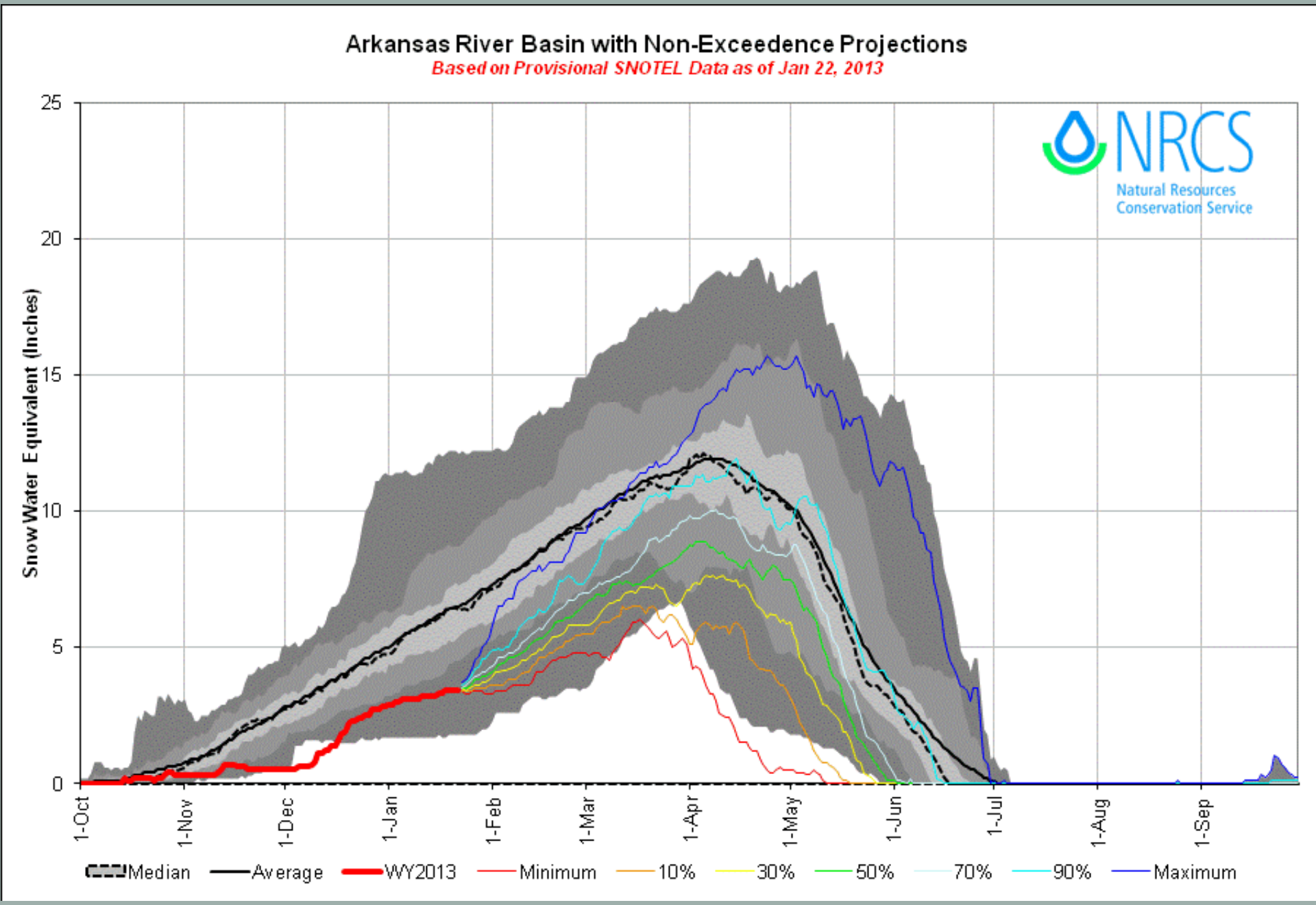


What Comes Next for Colorado?

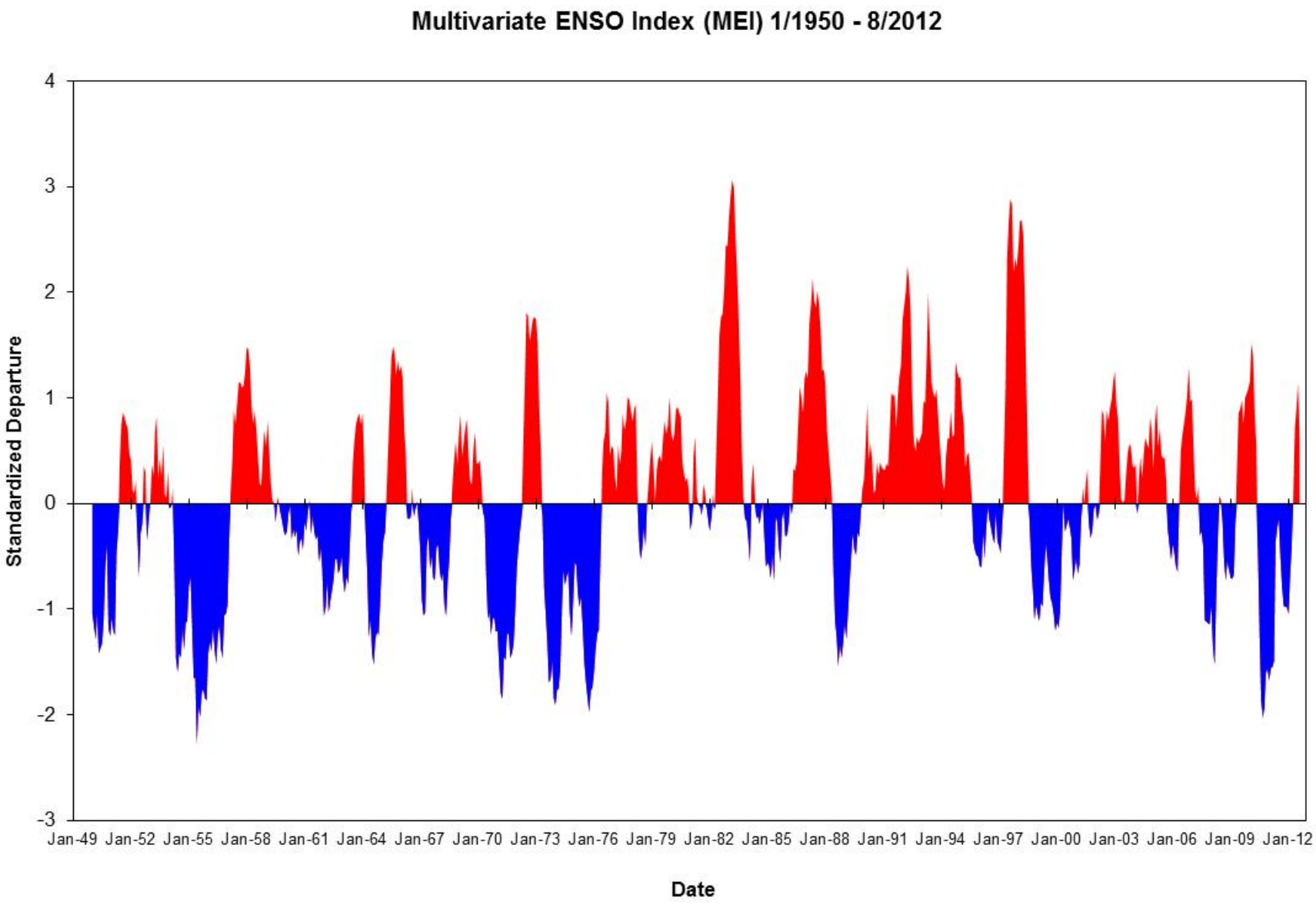
- Let’s look at our current basin snowpack conditions and non-exceedence probabilities.

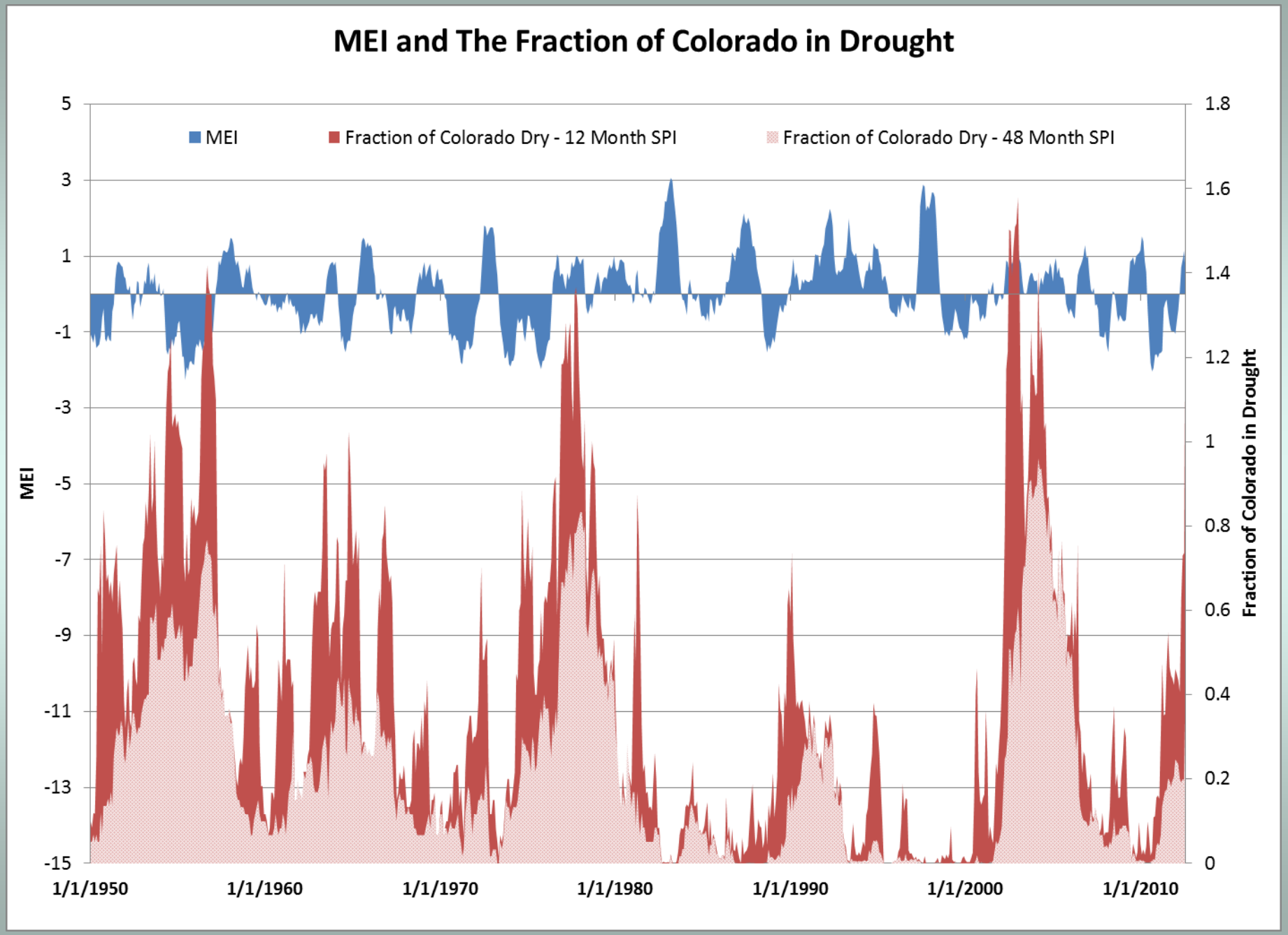

South Platte River Basin with Non-Exceedence Projections
Based on Provisional SNOTEL Data as of Jan 22, 2013
NRCS
Natural Resources Conservation Service
Snow Water Equivalent (Inches)
35
30
25
20
15
10
5
0
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
Median
Average
WY2013
Minimum
10%
30%
50%
70%
90%
Maximum


Colorado River Basin with Non-Exceedence Projections
Based on Provisional SNOTEL Data as of Jan 22, 2013
NRCS
Natural Resources Conservation Service
Snow Water Equivalent (Inches)
30
25
20
15
10
5
0
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
Median
Average
WY2013
Minimum
10%
30%
50%
70%
90%
Maximum


Arkansas River Basin with Non-Exceedence Projections
Based on Provisional SNOTEL Data as of Jan 22, 2013
NRCS
Natural Resources Conservation Service
Snow Water Equivalent (Inches)
25
20
15
10
5
0
1-Oct
1-Nov
1-Dec
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
Median
Average
WY2013
Minimum
10%
30%
50%
70%
90%
Maximum

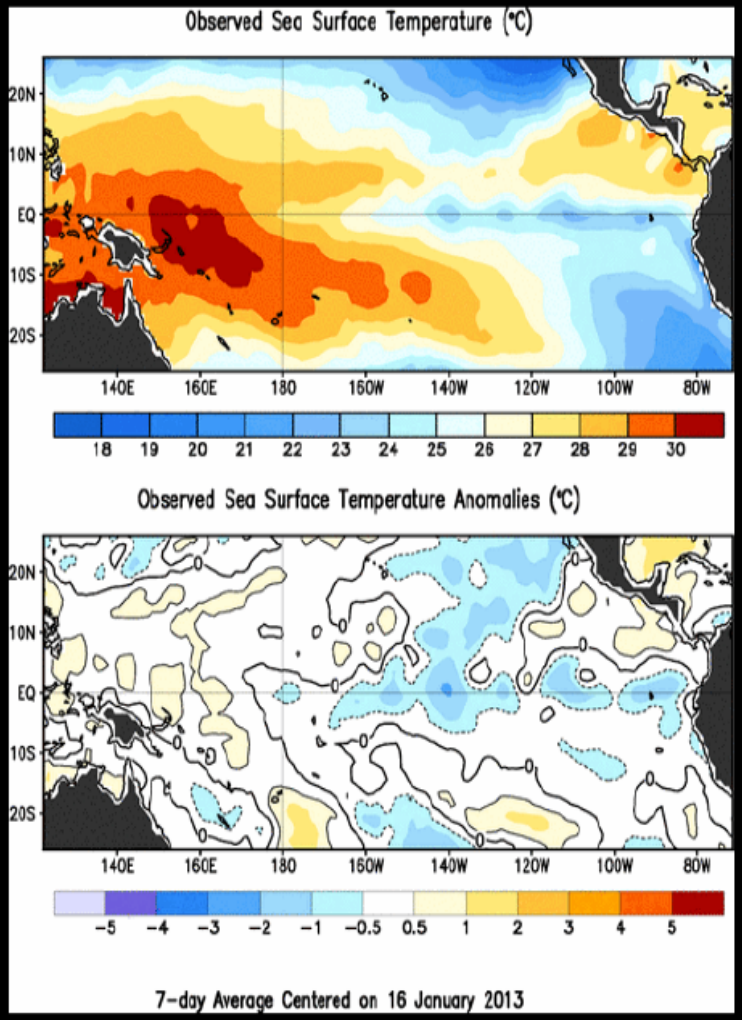
What about El Nino?




MEI and The Fraction of Colorado in Drought
MEI
Fraction of Colorado Dry - 12 Month SPI
Fraction of Colorado Dry - 48 Month SPI
5
3
1
-1
-3
-5
-7
-9
-11
-13
-15
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1950
1/1/1960
1/1/1970
1/1/1980
1/1/1990
1/1/2000
1/1/2010
Fraction of Colorado in Drought

Pacific Ocean Sea Surface Temperatures As of Mid-January 2013

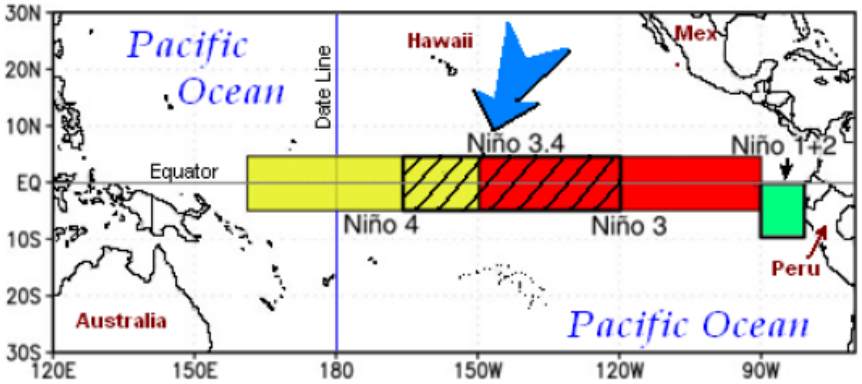
ENSO-neutral conditions continue in the tropical Pacific Ocean even though equatorial sea surface temperatures east of the International Date Line have recently become colder than average. This anomalous cooling is partially due to an active Madden Julian Oscillation (MJO) in the western Pacific which has strengthened the easterly trade winds and as a consequence has enhanced the upwelling of colder deep ocean waters along the west coast of South America.

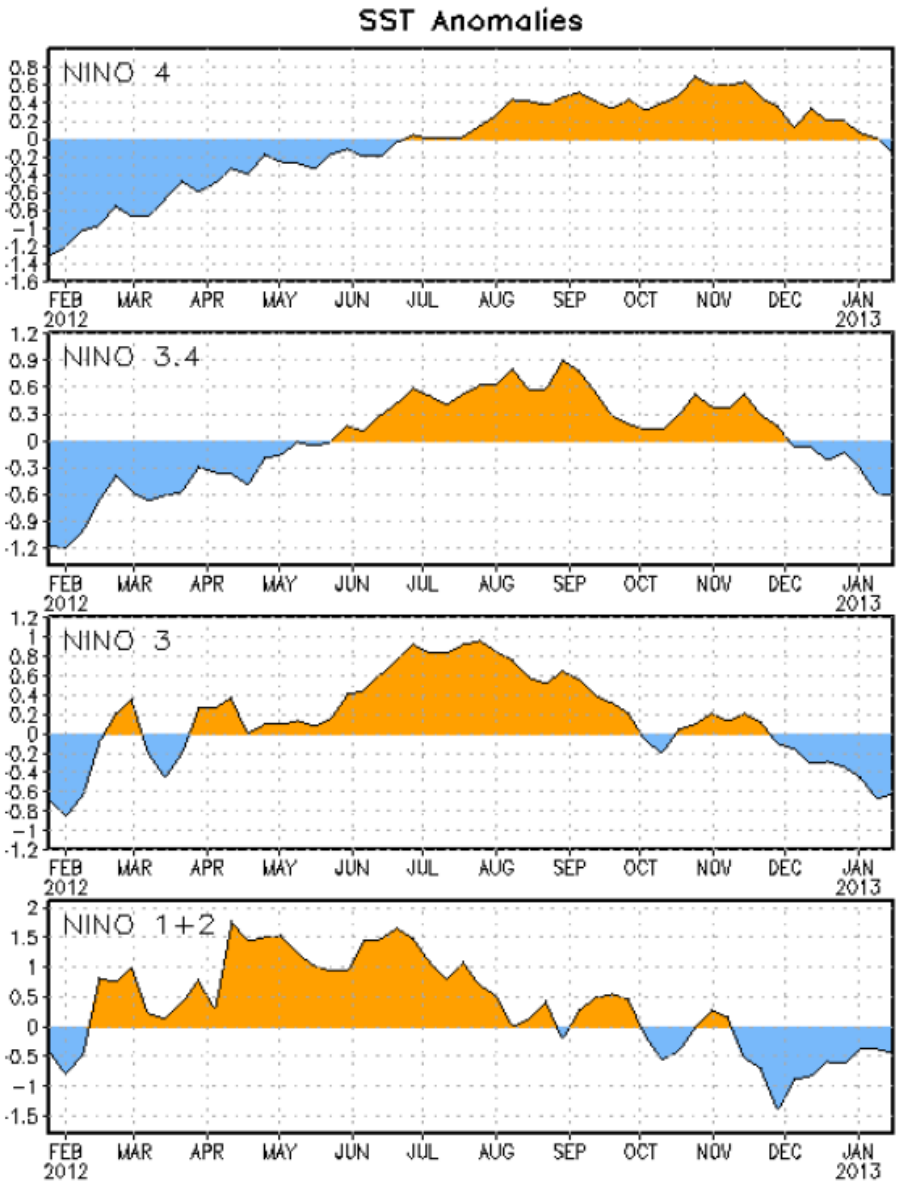


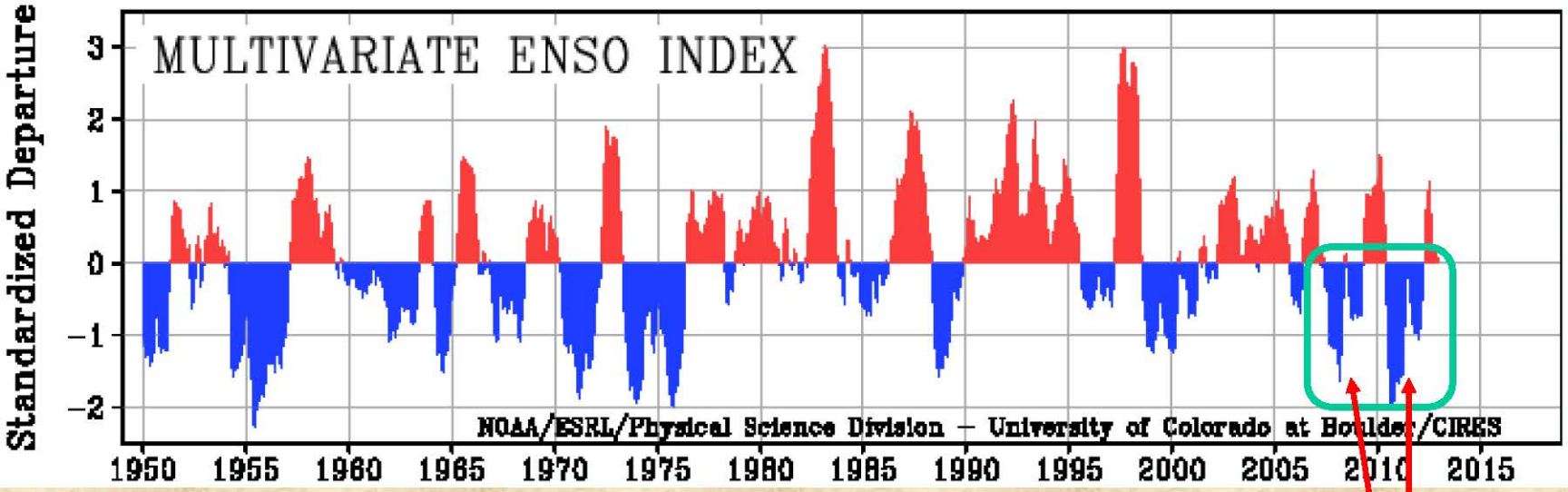
Niño Region SST Departures (C) for Mid-January 2013

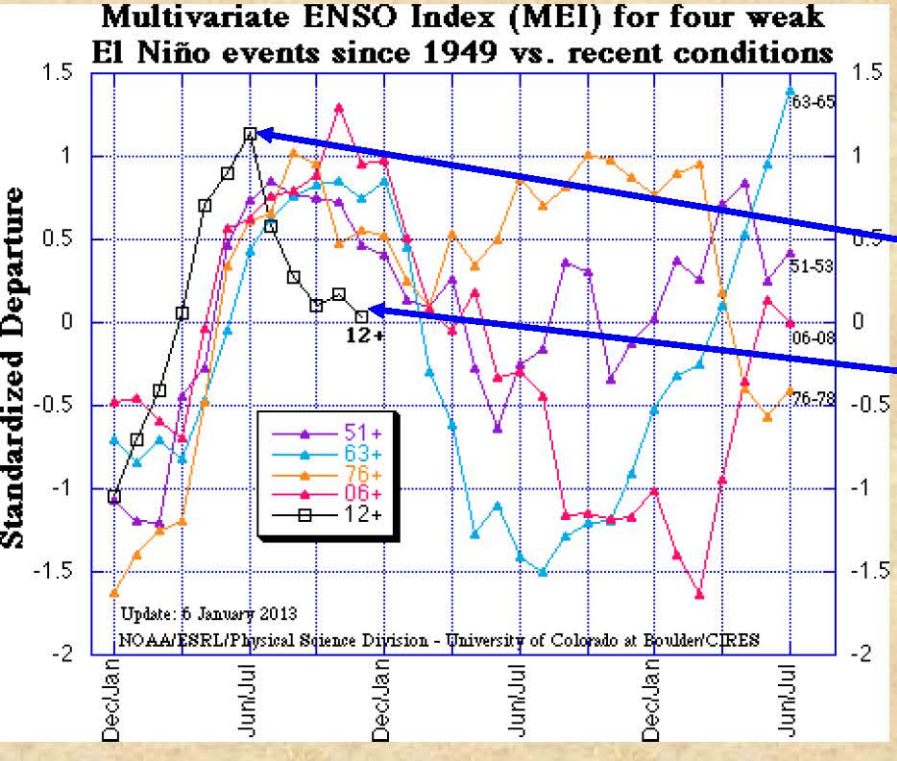
The latest weekly SST departures are:

Niño 4	**-0.2 C**
Niño 3.4	**-0.6 C**
Niño 3	**-0.6 C**
Niño 1+2	**-0.4 C**



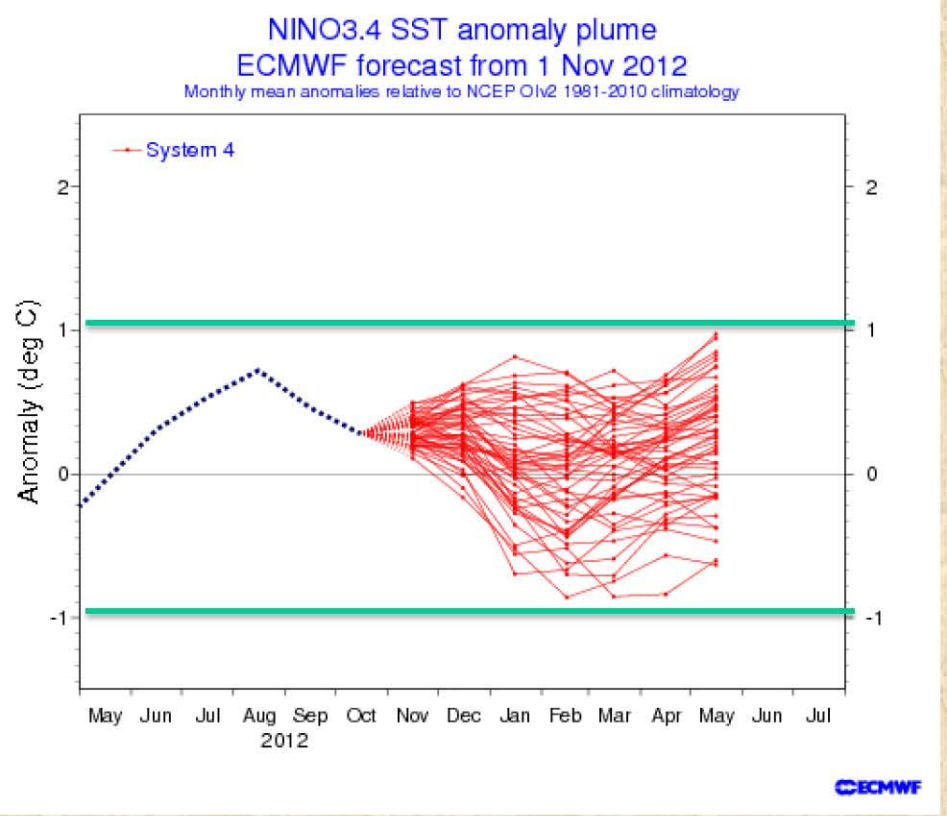




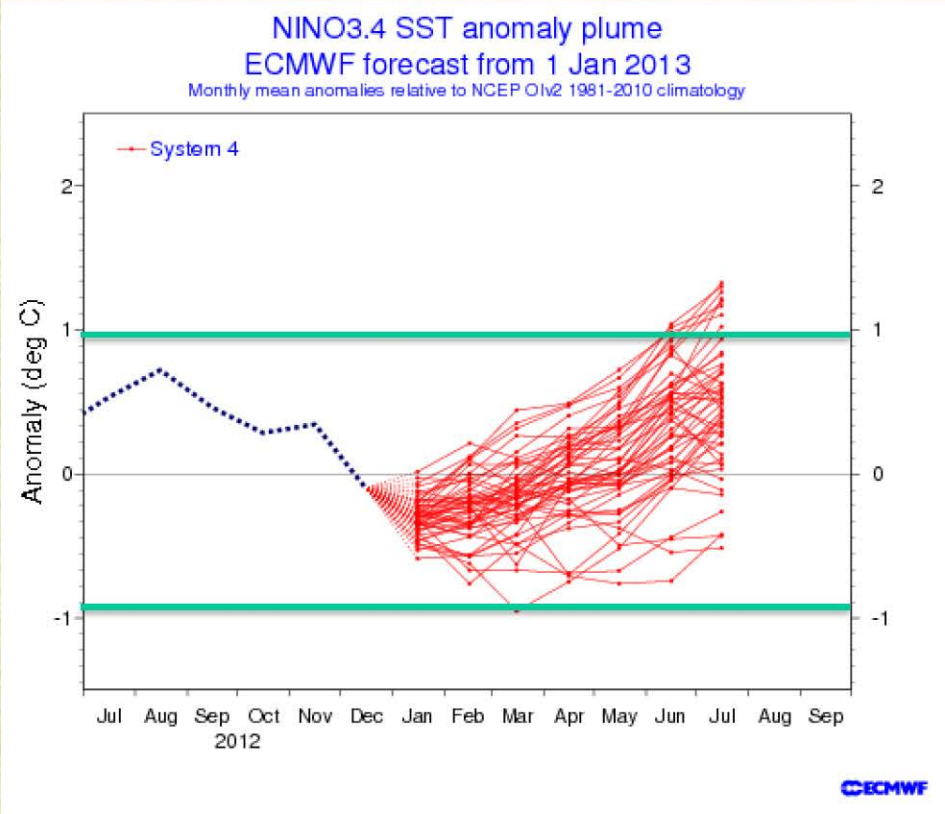


Last six years have seen two 'double-dip' Las Niñas in a row, followed by a brief excursion to what looked like an El Niño event in mid-2012, and a return to ENSO-neutral conditions in late 2012 – highly unusual behavior, but not completely unprecedented (1953 featured a similar aborted El Niño event).

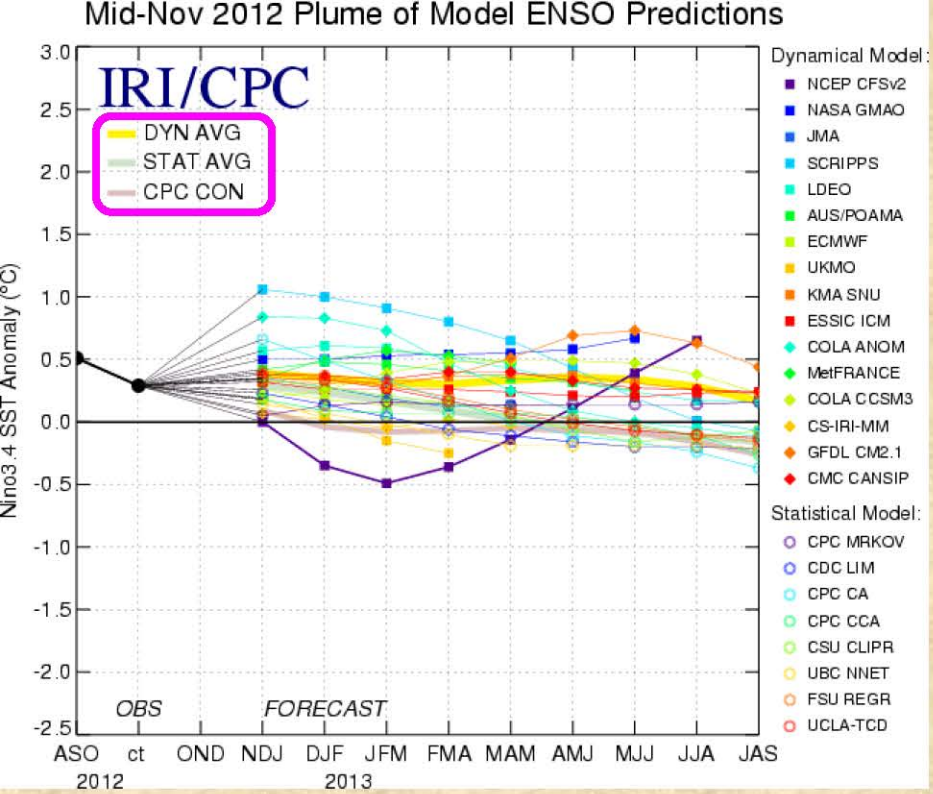
http://www.esrl.noaa.gov/psd/enso/mei



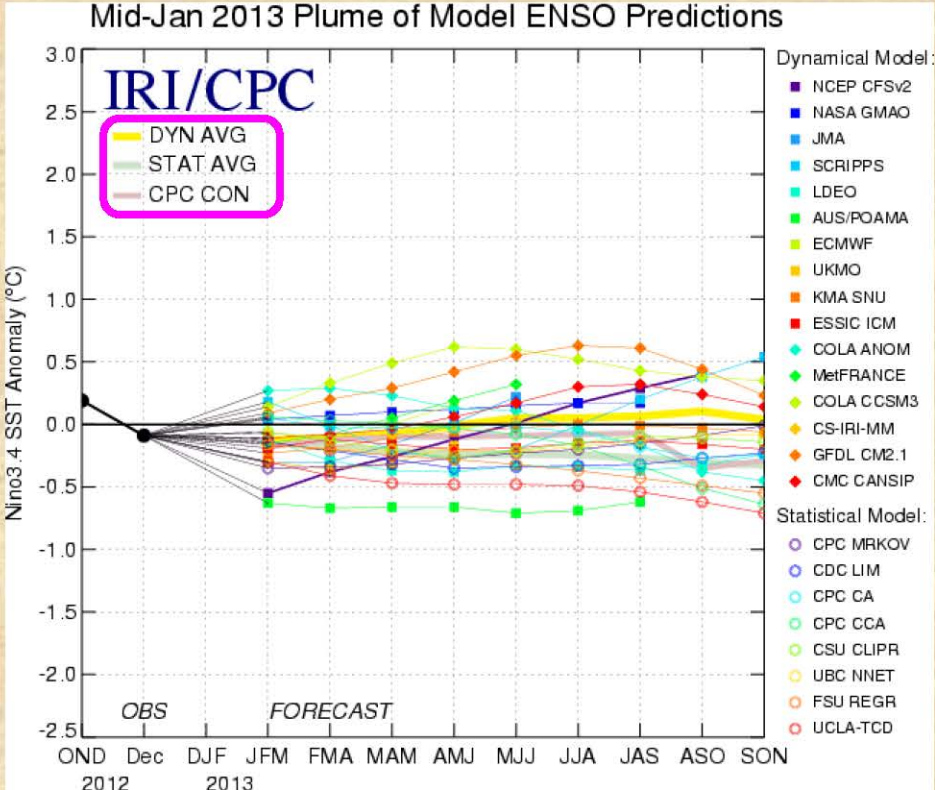
The ECMWF November 2012 forecast (left) settled on an ENSO-neutral outlook for this winter, with no ensemble member outside the +/-1°C range. *There was a small hint of drifting towards El Niño again next spring.*



The ECMWF January 2013 forecast (right) shows a drift from weakly-negative / neutral conditions towards El Niño by mid-2013. However, there are still a few ensemble members that show weak La Niña conditions to persist into the summer.



ENSO forecasts from 16 dynamical & 8 statistical forecast models in November 2012 (left): Dynamical models showed pretty much the same ENSO-neutral outlook as statistical models. The most interesting model output was the drop into weak La Niña territory by the CFS2 (CPC).



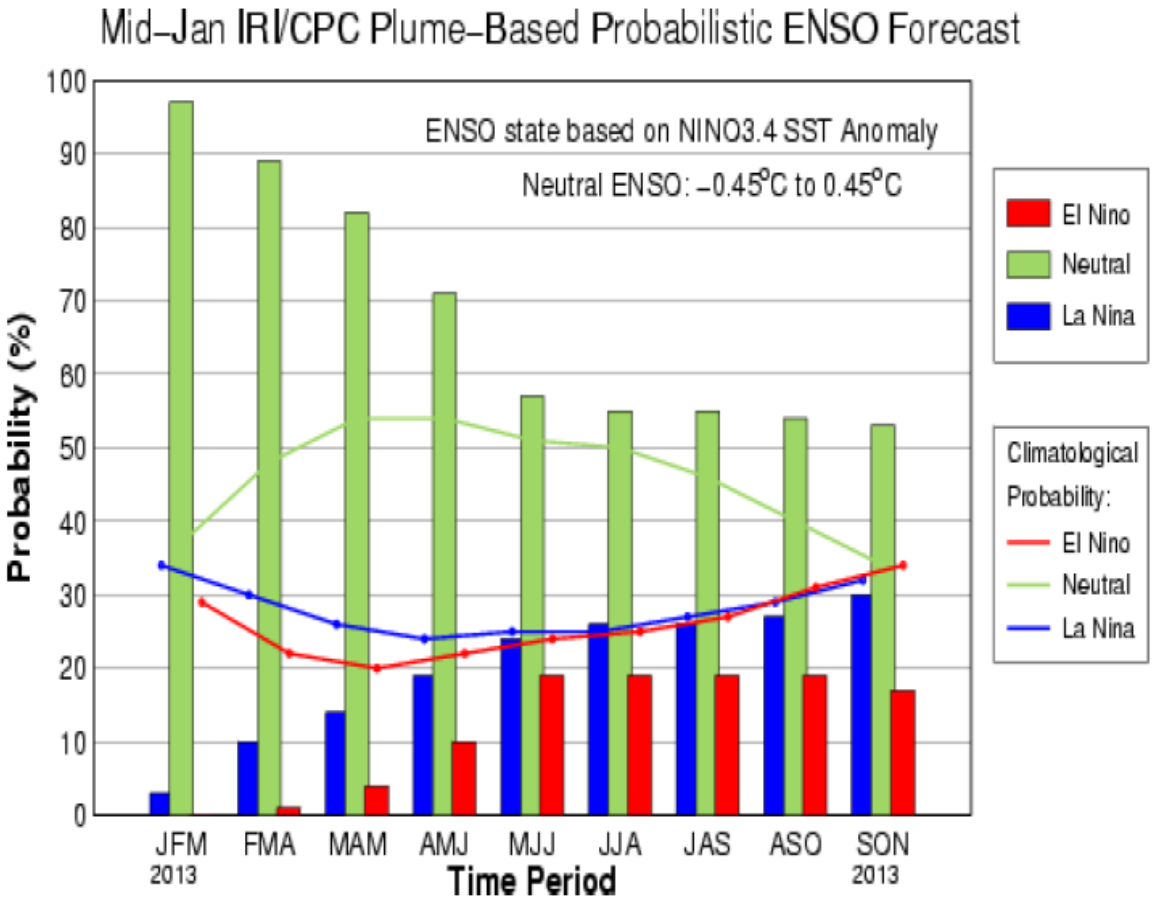
In its latest update (right), the difference between statistical and dynamical models is growing again – the former are slightly more positive (El Niño-ish) than the statistical models (which are all negative by JJA)...

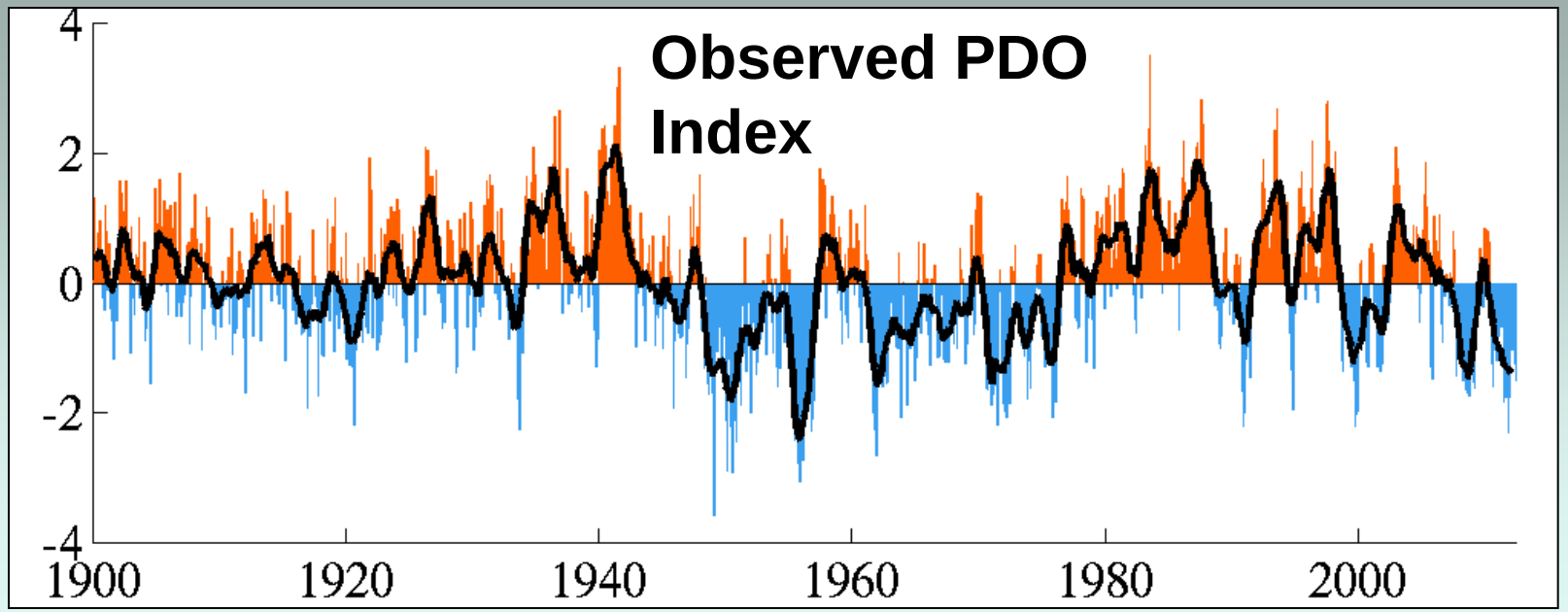
My own forecast drifts from ENSO-neutral in mid-'13 to weak La Niña in late '13.

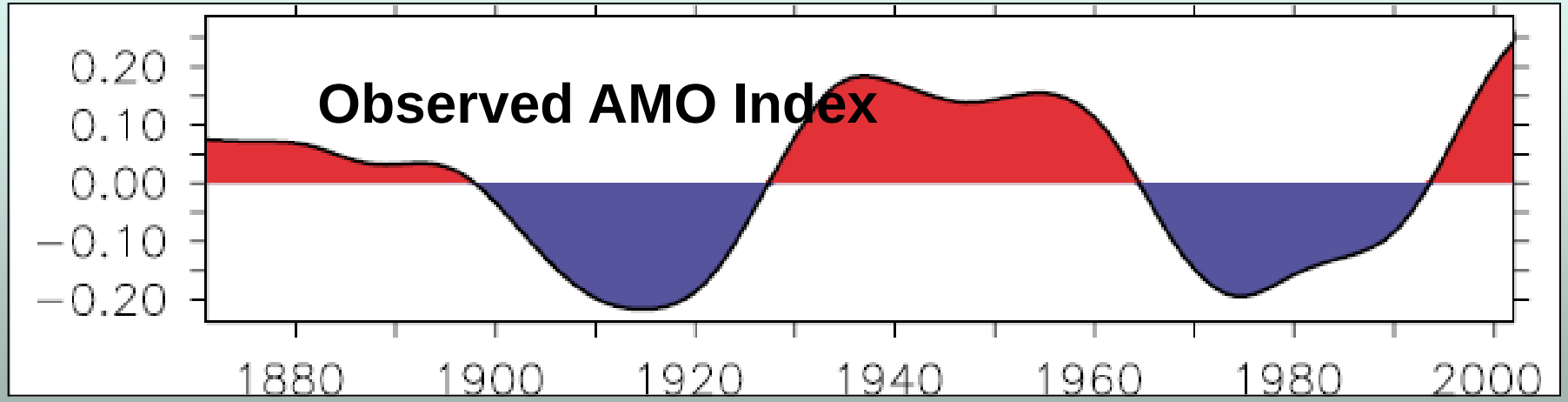
ENSO Model Probabilities as of Mid-January 2013

There is approximately a 55 percent probability of ENSO-neutral conditions this spring and about a 55 percent chance during the summer of 2013.

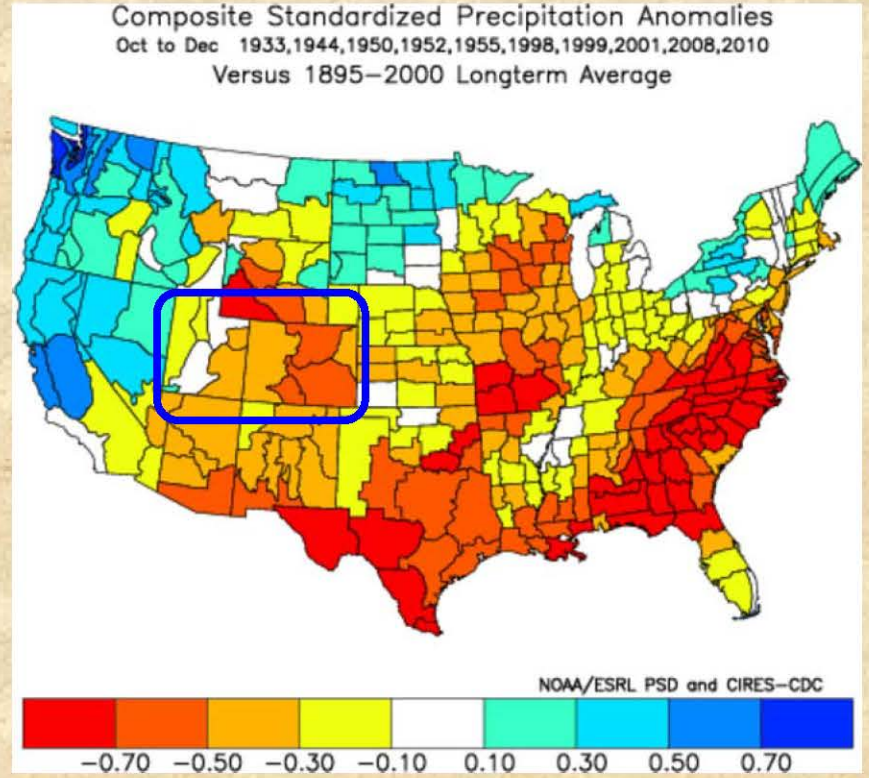
Models also indicate increasing chances of a La Niña developing this fall.

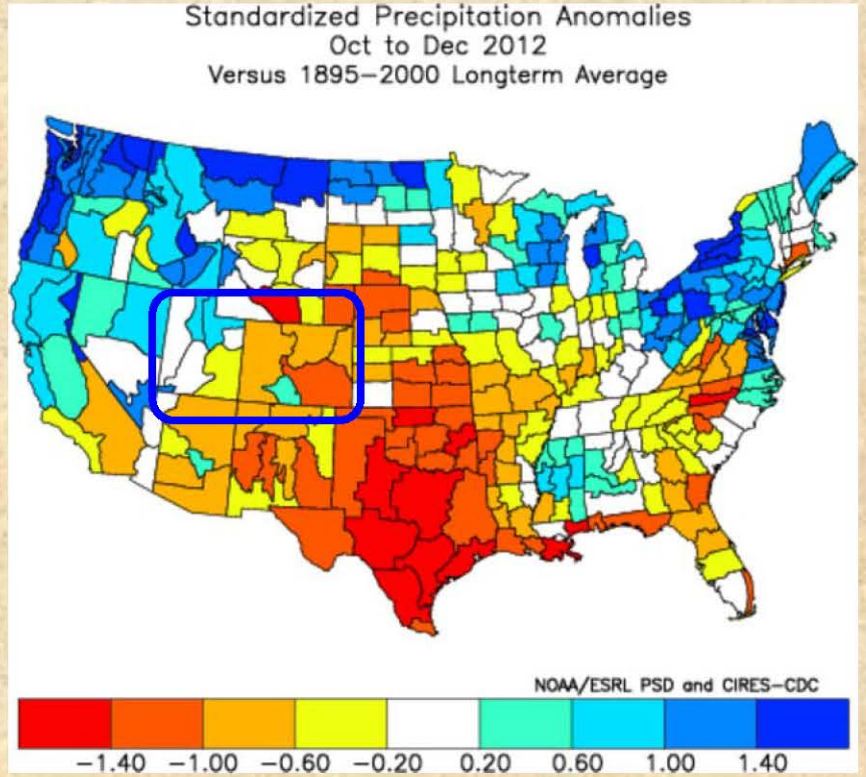



Observed PDO Index
4
2
0
-2
-4
1900
1920
1940
1960
1980
2000


Observed AMO Index
0.20
0.10
0.00
−0.10
−0.20
1880
1900
1920
1940
1960
1980
2000

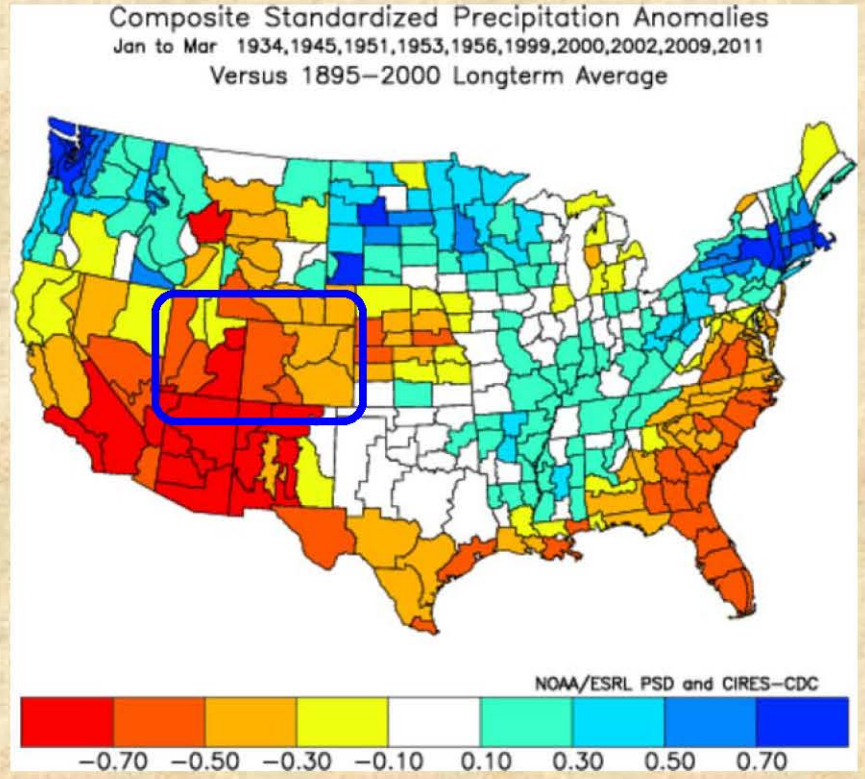
How did the low <PDO-AMO> composite work out in late 2012?

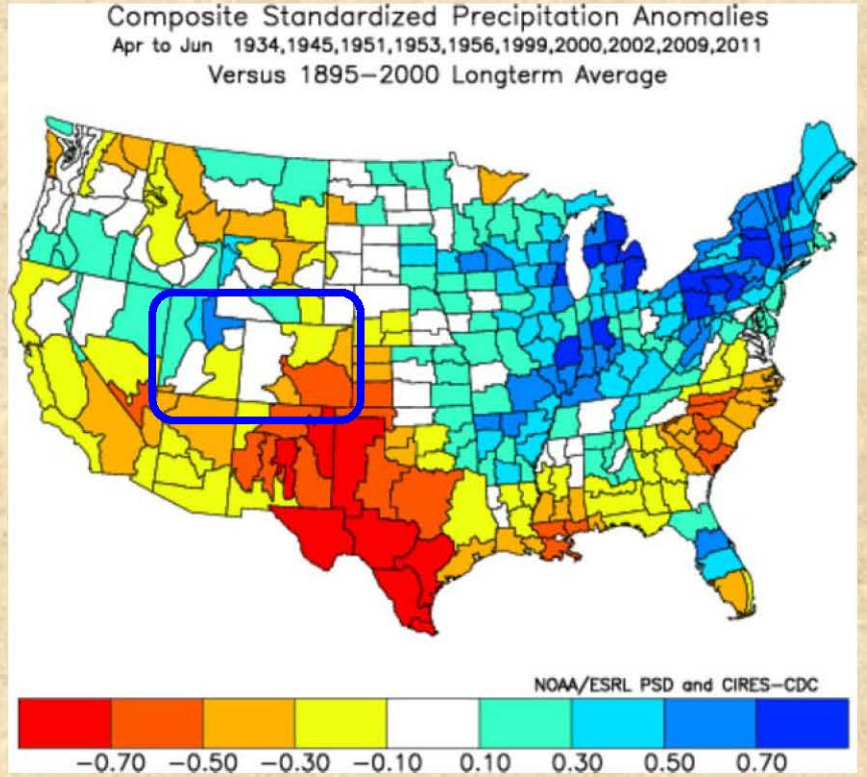




After being consistently low for much of the last decade, the difference in normalized anomalies between PDO and AMO reached its lowest value on record last summer. In the wake of that, late fall precipitation (left) tends towards the dry side in all of Colorado. In 2012, dry conditions prevailed as expected not just in Colorado, but also AZ&NM, from TX into MO, and from FL north to VA, while the greater Pacific Northwest wound up wet, as expected...

What can we expect in next half year with low summer <PDO-AMO>





After being consistently low for much of the last decade, the difference in normalized anomalies between PDO and AMO reached its lowest value on record last summer. In the wake of that initial condition, late winter (left) precipitation tends towards the dry side in all of Colorado, especially west of the divide. Late Spring (right) is neutral for the West slope, but still dry for the eastern plains, especially in the Arkansas Valley.

Put it all together and what do we get?

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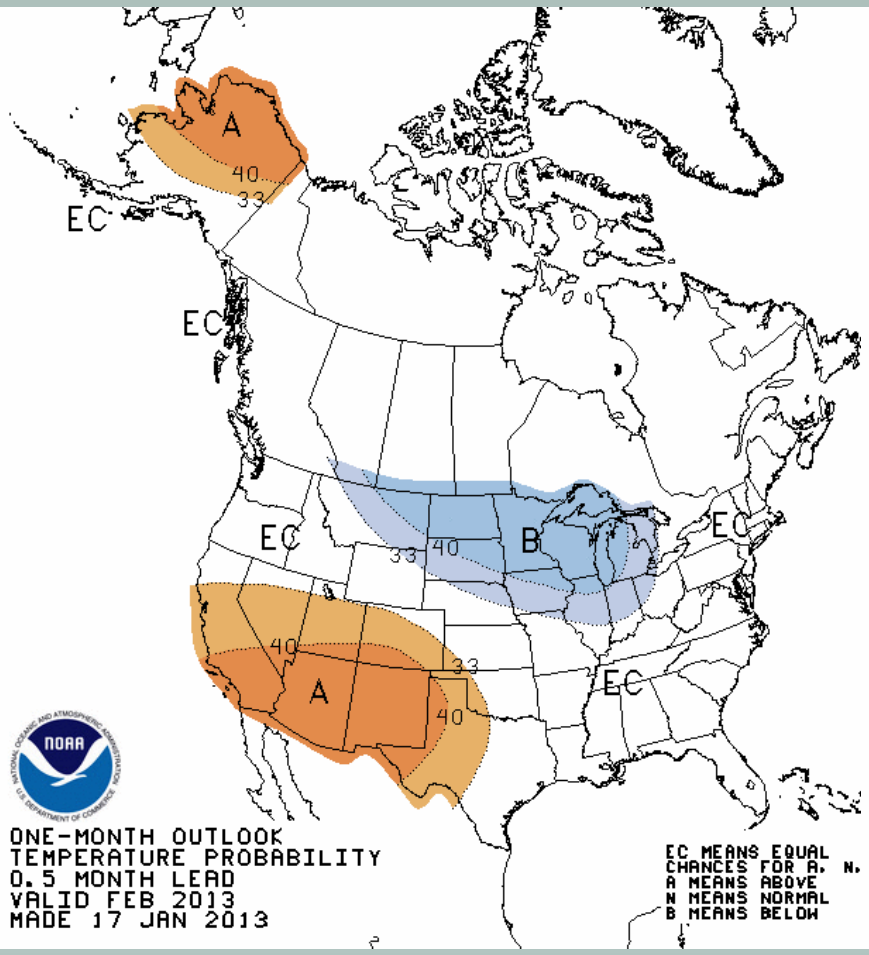
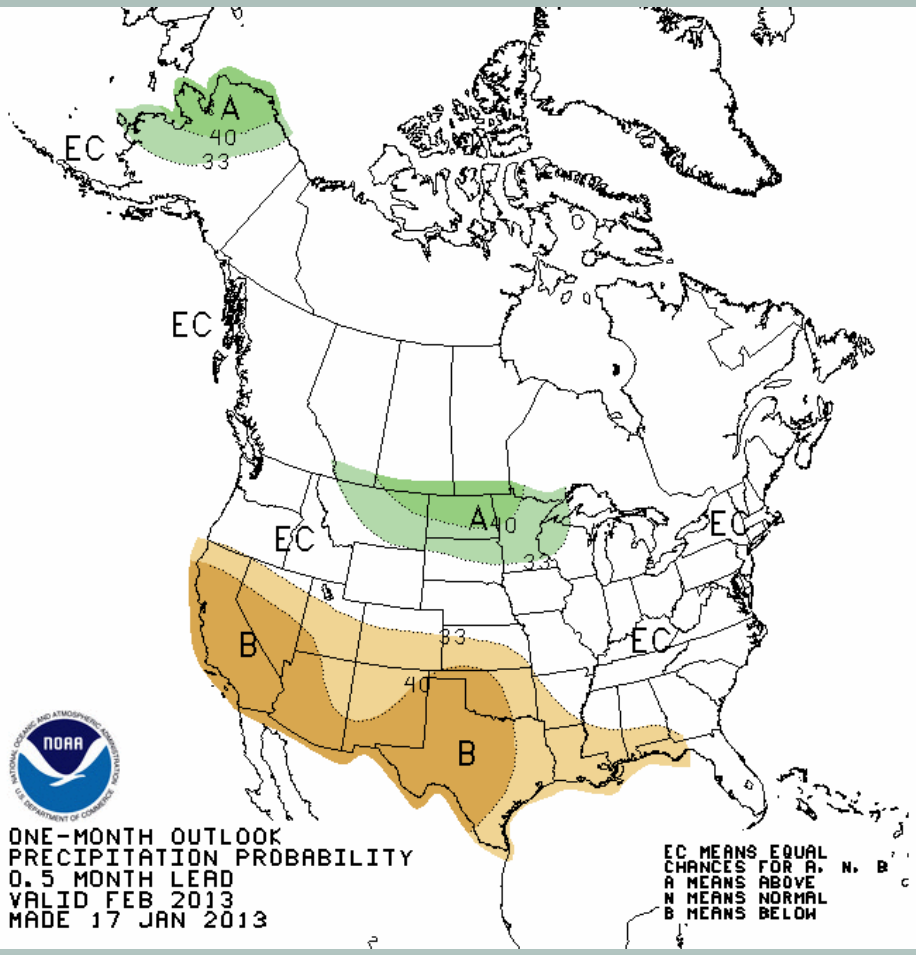
February Outlook



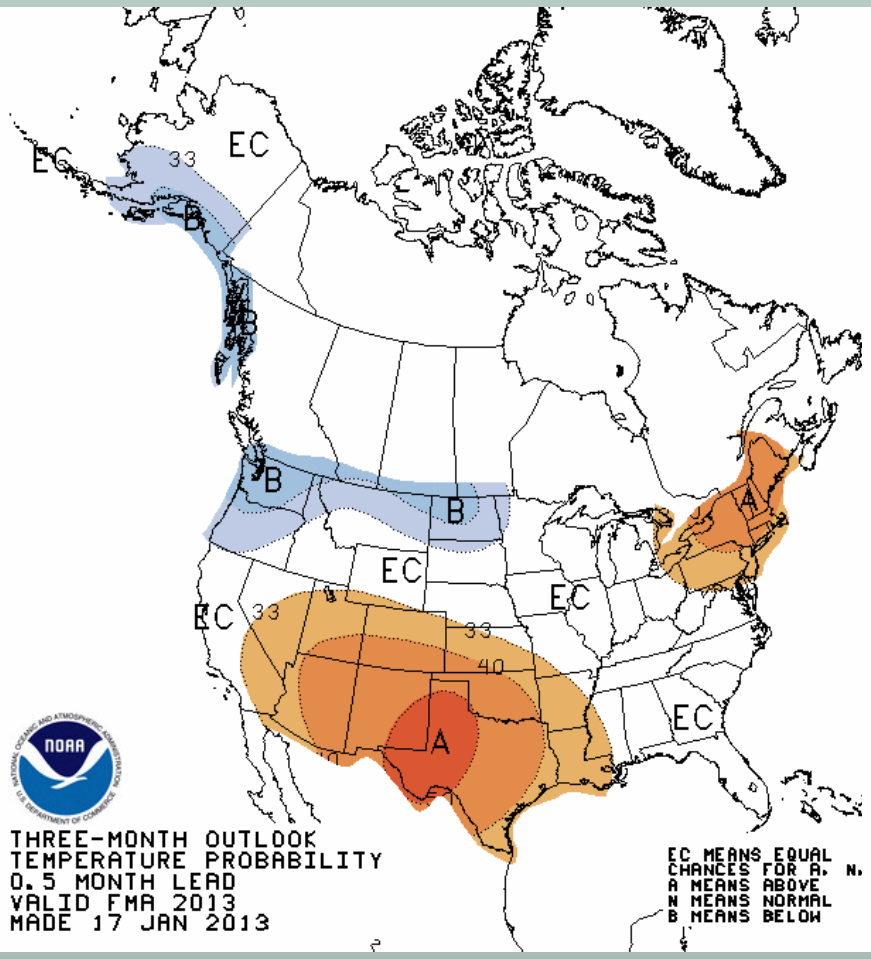
Temperature



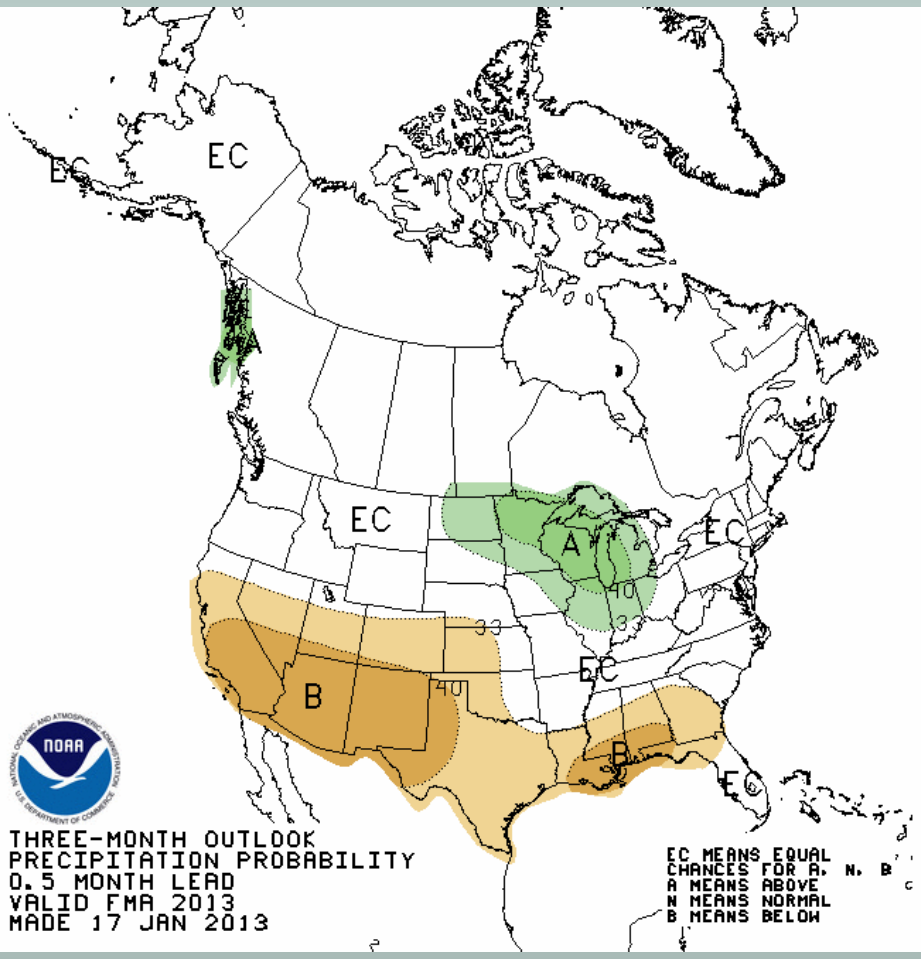
Precipitation

3 Month Outlook

February, March ,April

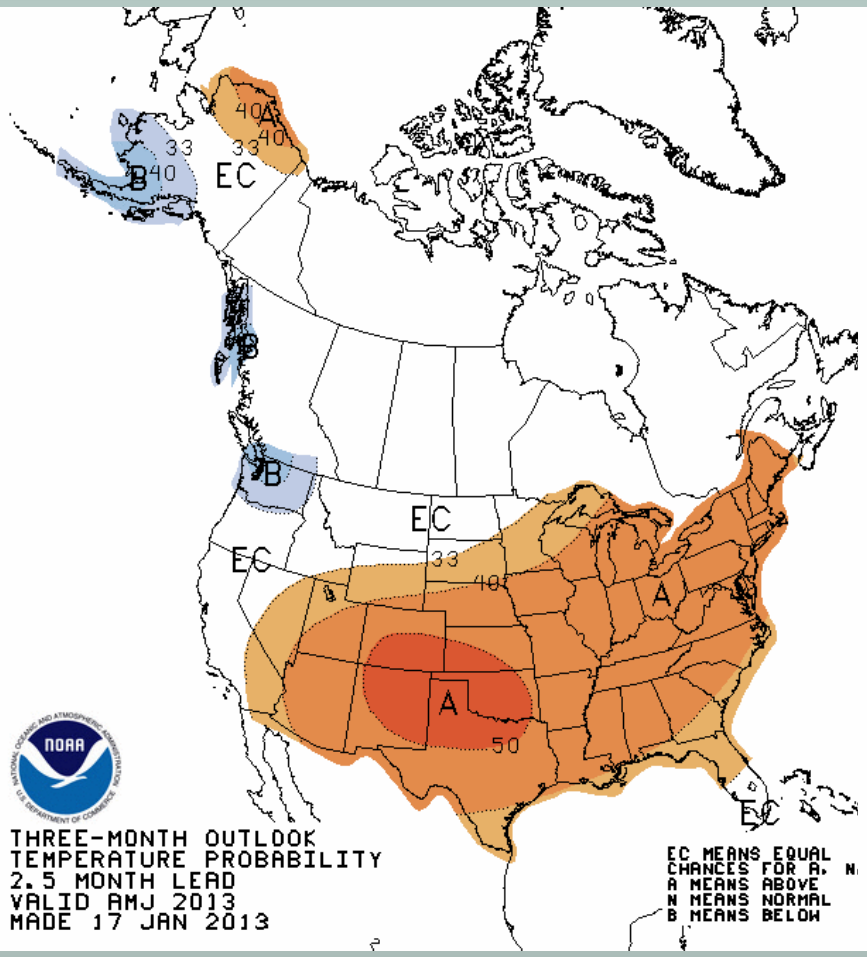


Temperature

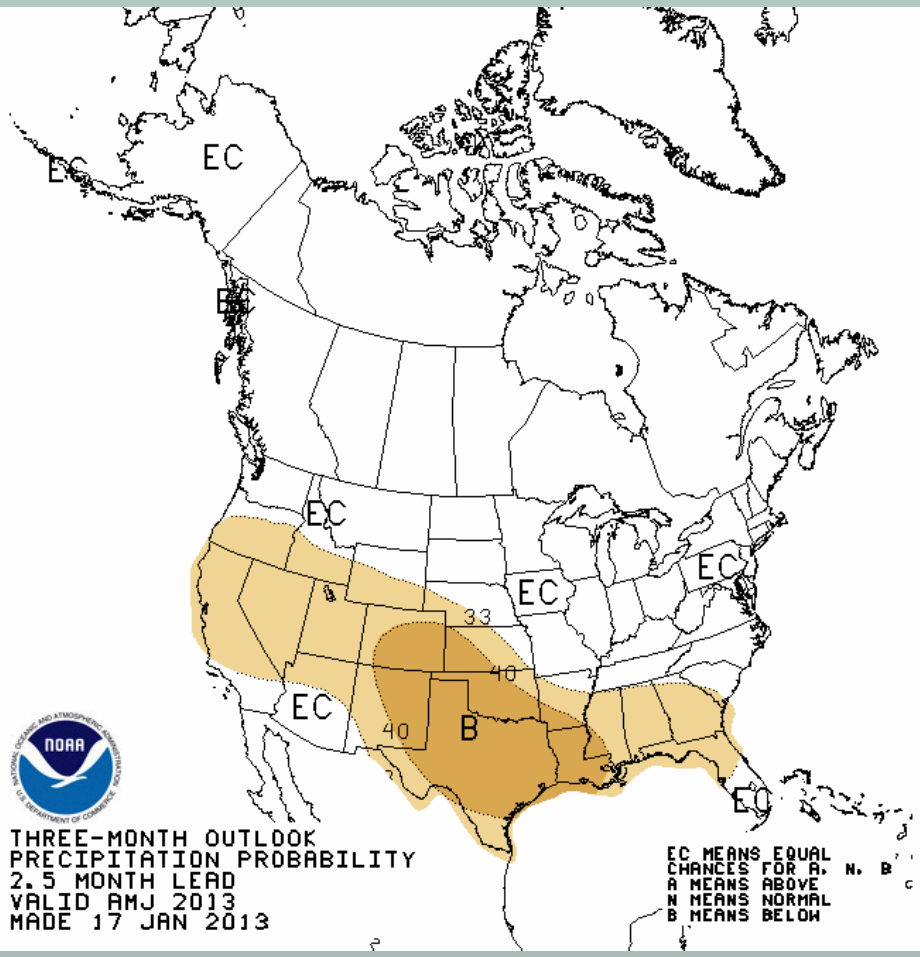


Precipitation

April, May, June Outlook



Temperature



Precipitation

Summer 2013 Outlook

Probably on the Warm side again

???
Definitely Uncertain
???

And don’t rule out Flooding!

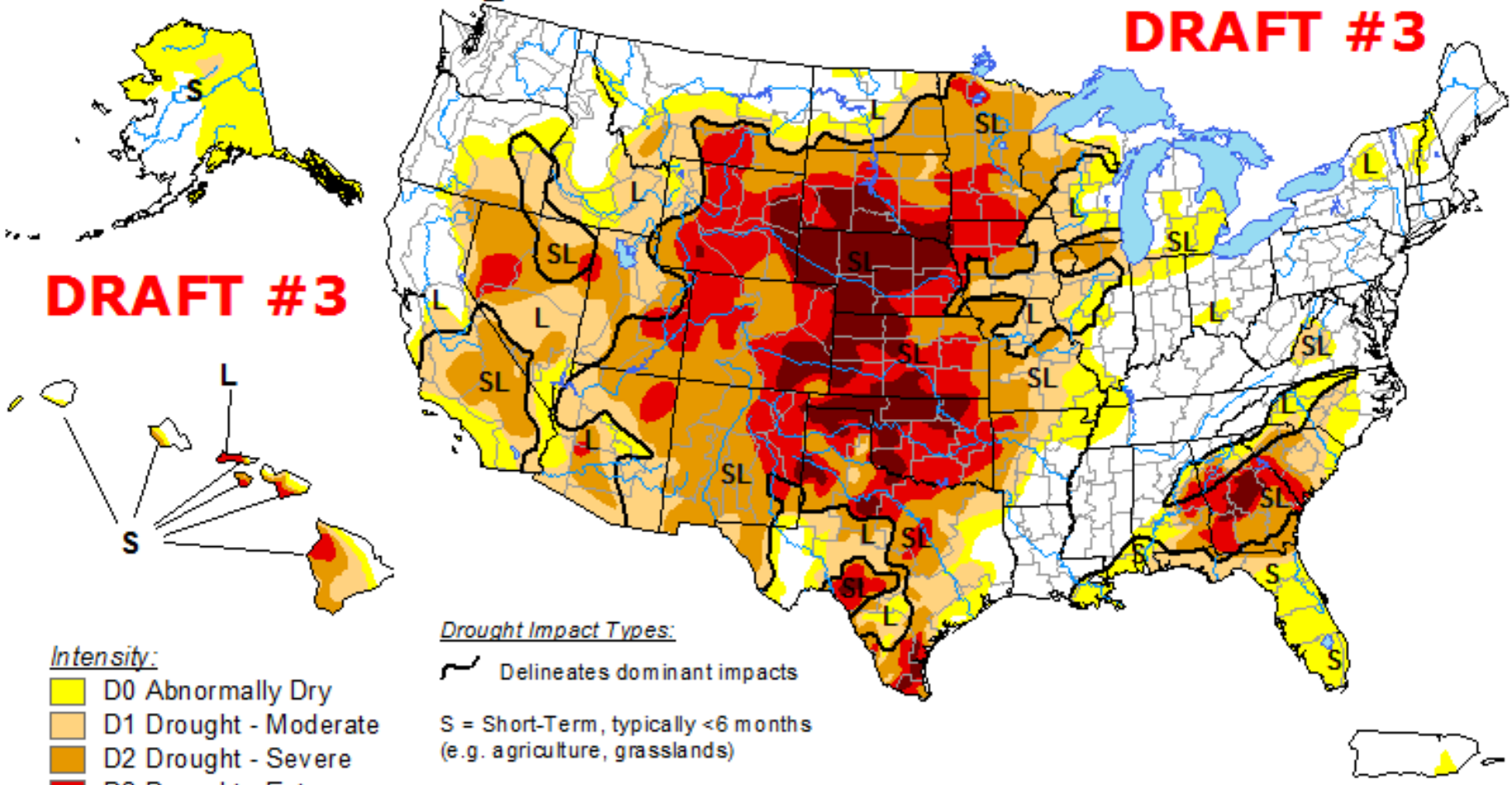
Temperature

Precipitation

U.S. Drought Monitor

January 29, 2013
Valid 8 a.m. EST

DRAFT #3



DRAFT #3

Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

Released Thursday, January 31, 2013

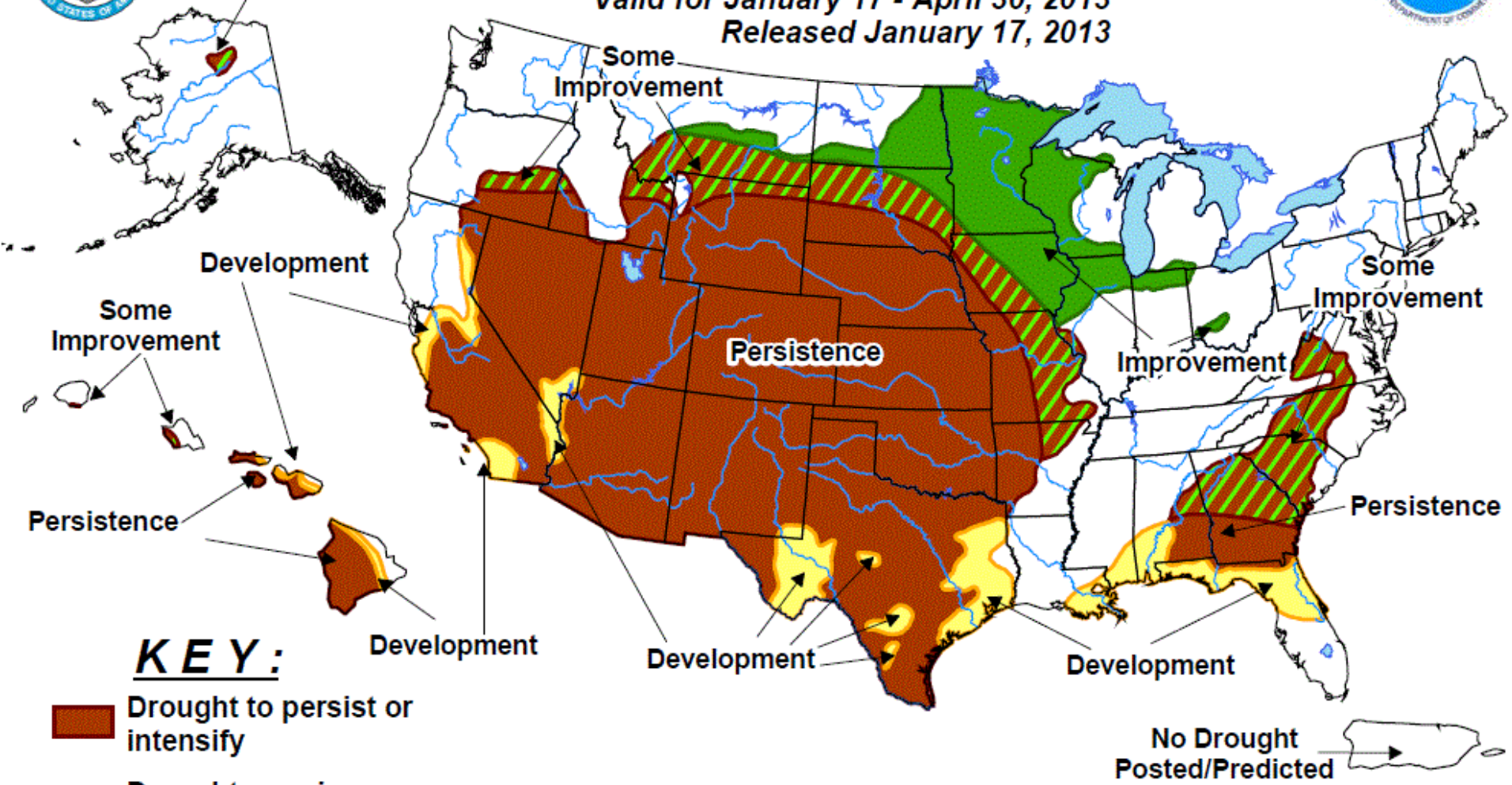
Author: Mark Svoboda, National Drought Mitigation Center

U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for January 17 - April 30, 2013

Released January 17, 2013



KEY:

- Drought to persist or intensify
- Drought ongoing, some improvement
- Drought likely to improve, impacts ease
- Drought development likely

Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance. Use caution for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are approximated from the Drought Monitor (D1 to D4 intensity). For weekly drought updates, see the latest U.S. Drought Monitor. NOTE: the green improvement areas imply at least a 1-category improvement in the Drought Monitor intensity levels, but do not necessarily imply drought elimination.

If you are interested in weather and the variations in precipitation, please join the Community Collaborative Rain, Hail and Snow Network

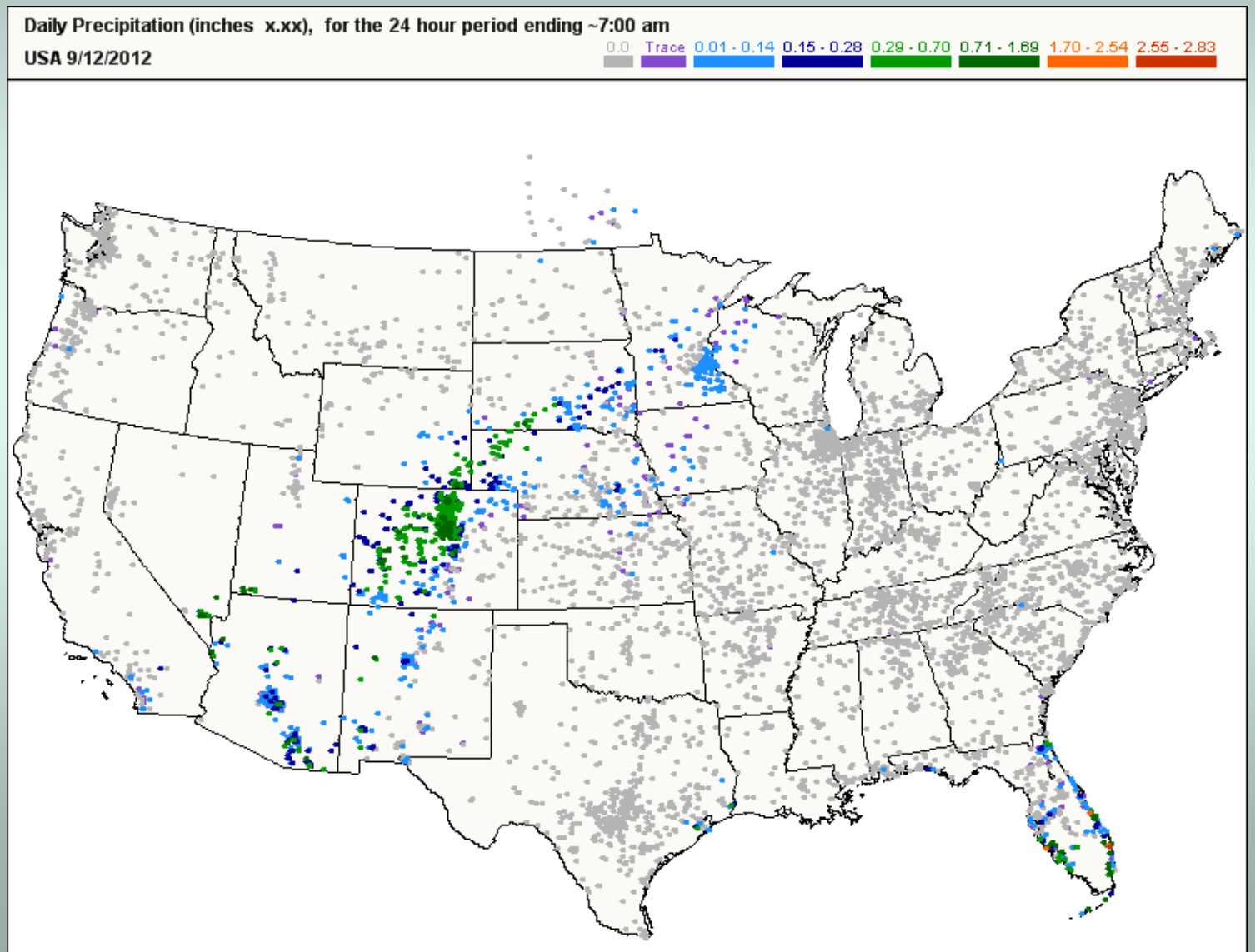
http://www.cocorahs.org

or see me today

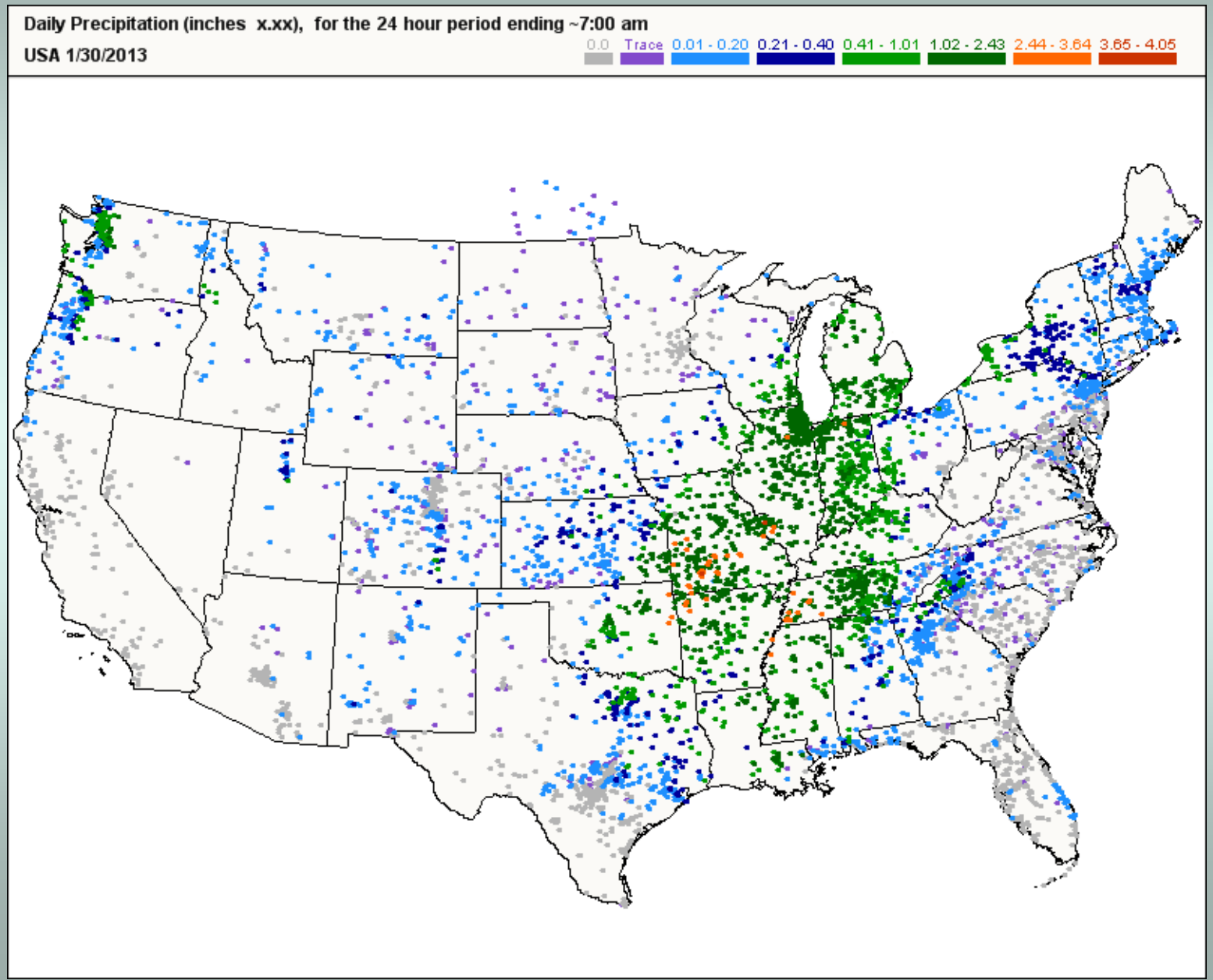
Please Help Us Monitor Colorado's Climate!

Photos by H. Reg

U.S. Rainfall 9/12/2012 – based on CoCoRaHS volunteers



Today's Precipitation



Please see me today if you're interested

- Or sign up online at

http://www.cocorahs.org

http://www.cocorahs.org

Is there time for a short story?

Nolan.Doesken@colostate.edu

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Data and Power Point Presentations available for downloading

http://ccc.atmos.colostate.edu

- Click on “Presentations”