A Climatologists view of the North Fork of the Gunnison

Peter Goble

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Colorado State University

Delta Conservation District
Drought Meeting
13 March 2019
Paonia, CO

Topics for Today

- Some history
- Climate of Colorado – basics
- What's going on with Climate Change?
- Precipitation whiplash. October of 2017 through today
- What's around the corner
- You can help, too.

History of the Colorado Climate Center

- 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

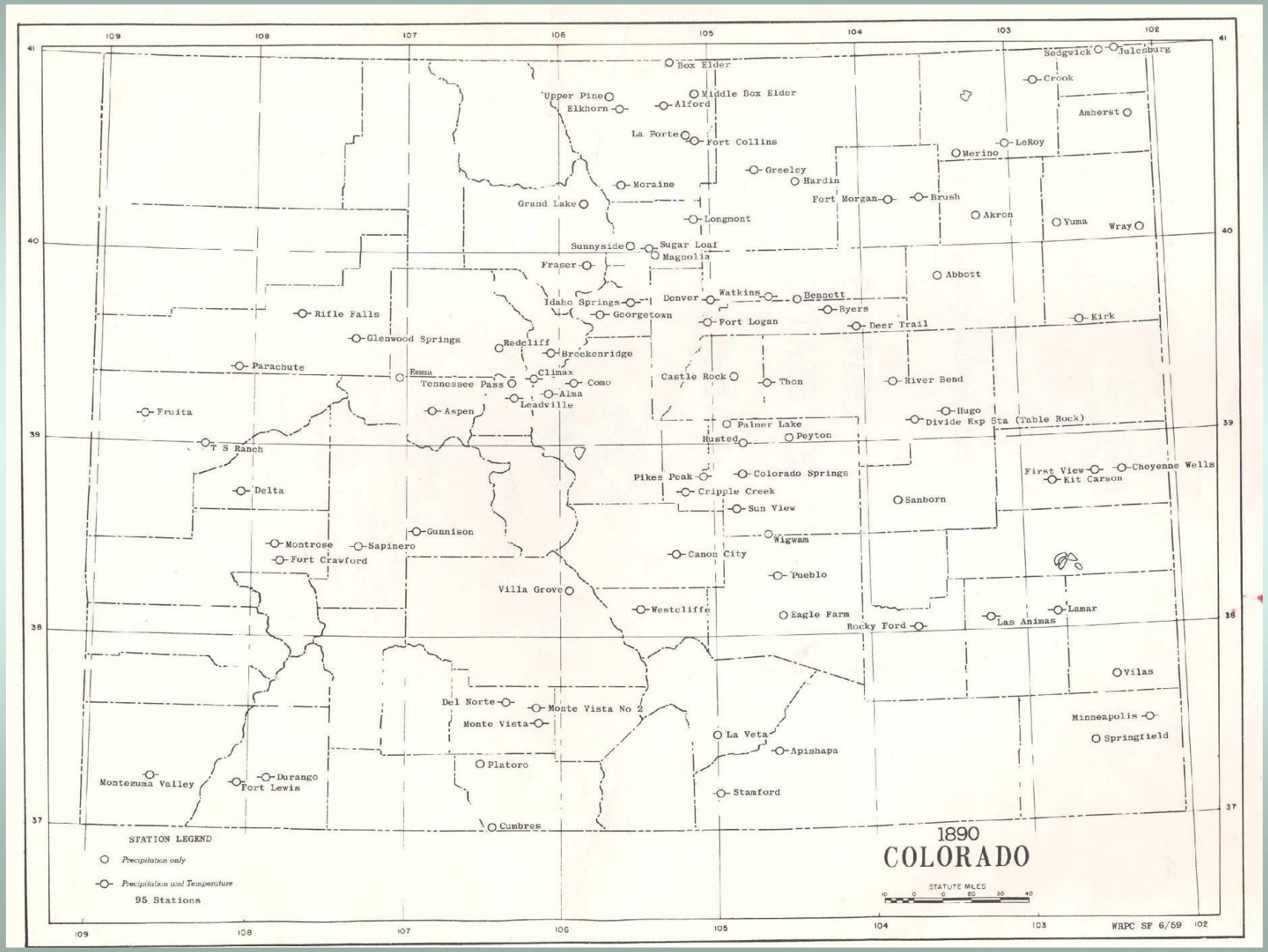
- The Colorado Climate Center at CSU provides valuable climate expertise to the residents of the state through its threefold program of:

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

  2) ***Climate Research***

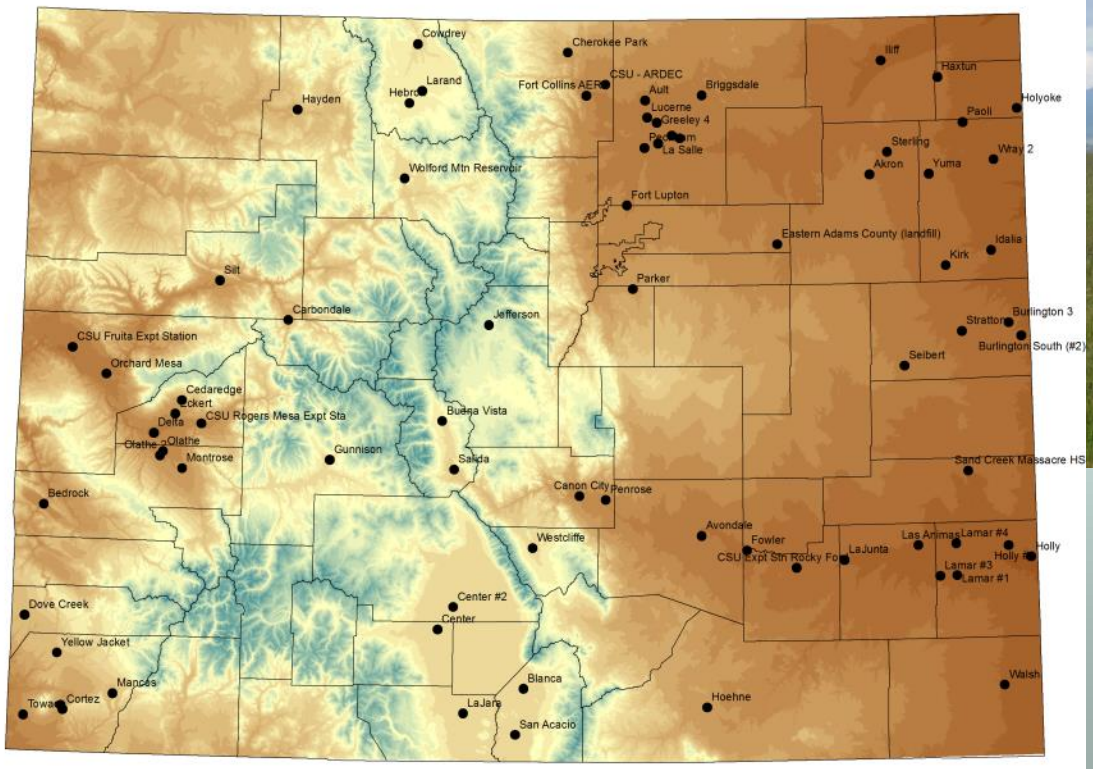
  3) ***Climate Services***.(providing data, analysis, climate expertise, education and outreach)

Weather Data in W.Colorado go back 130 years



Snow surveys began in the 1930s to help predict seasonal streamflow

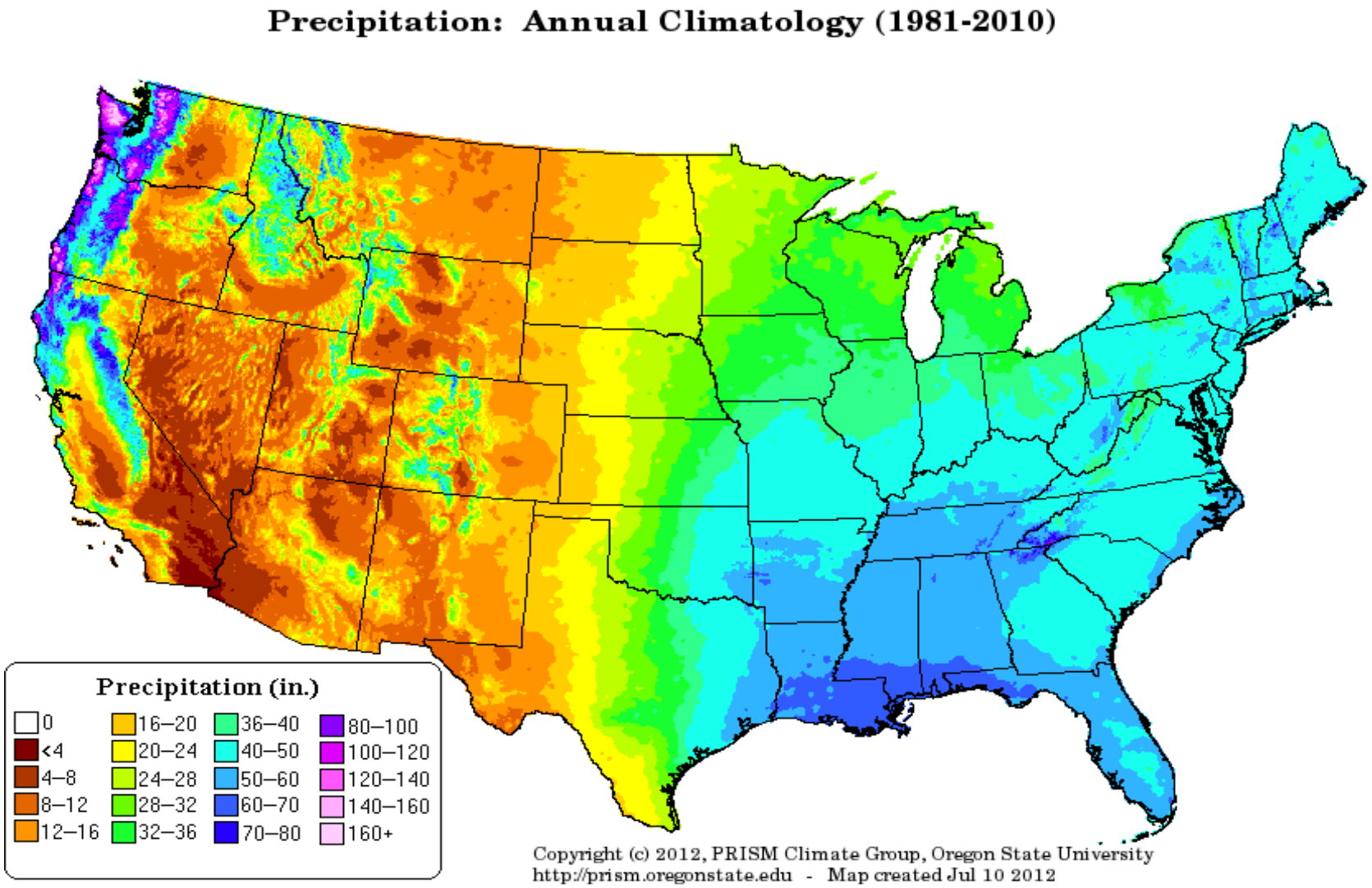
CSU's **Colorado Agricultural Meteorological Network "CoAgMet" goes back over 25 years --**



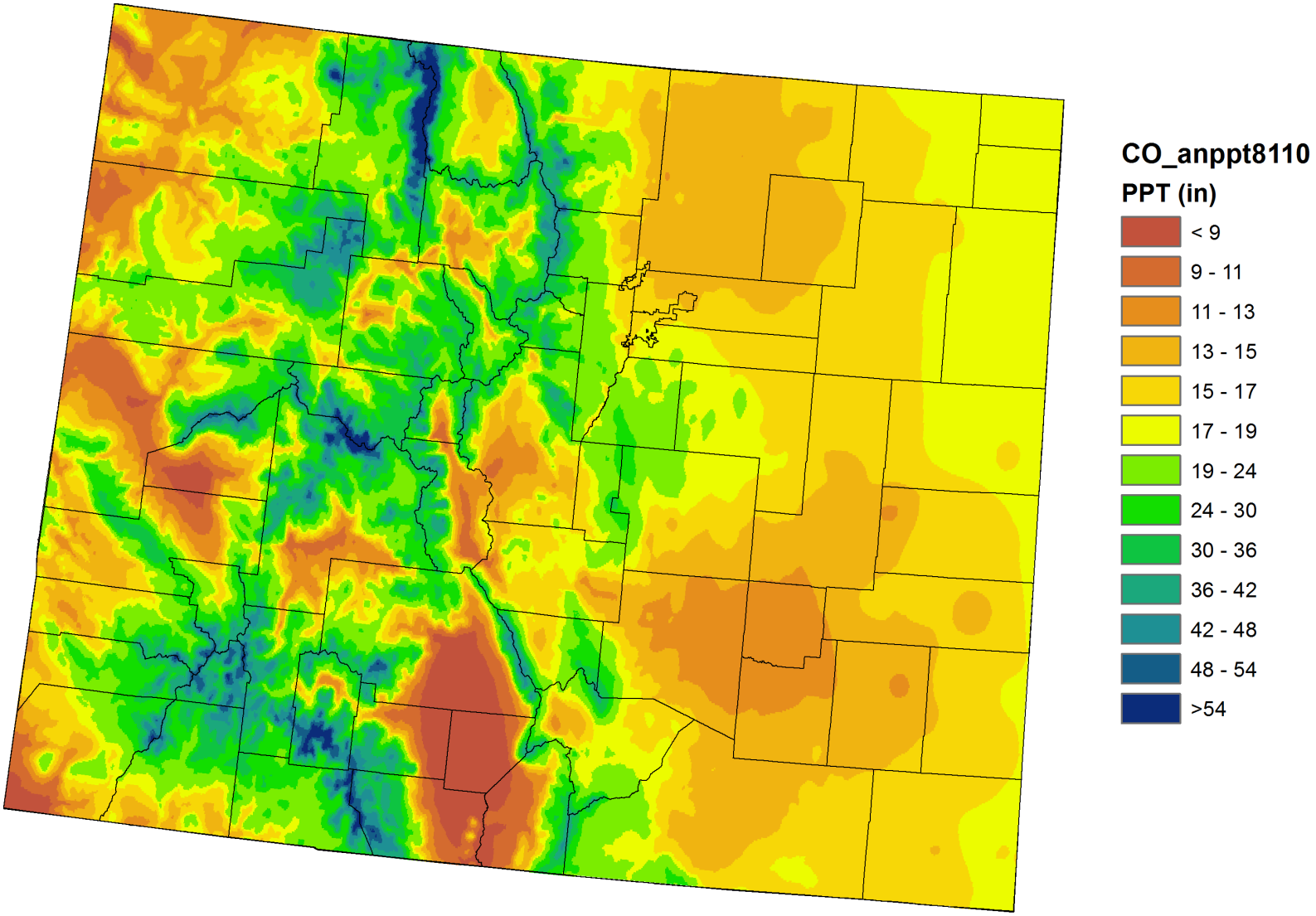
THANKS!! to those of You who help support CoAgMet

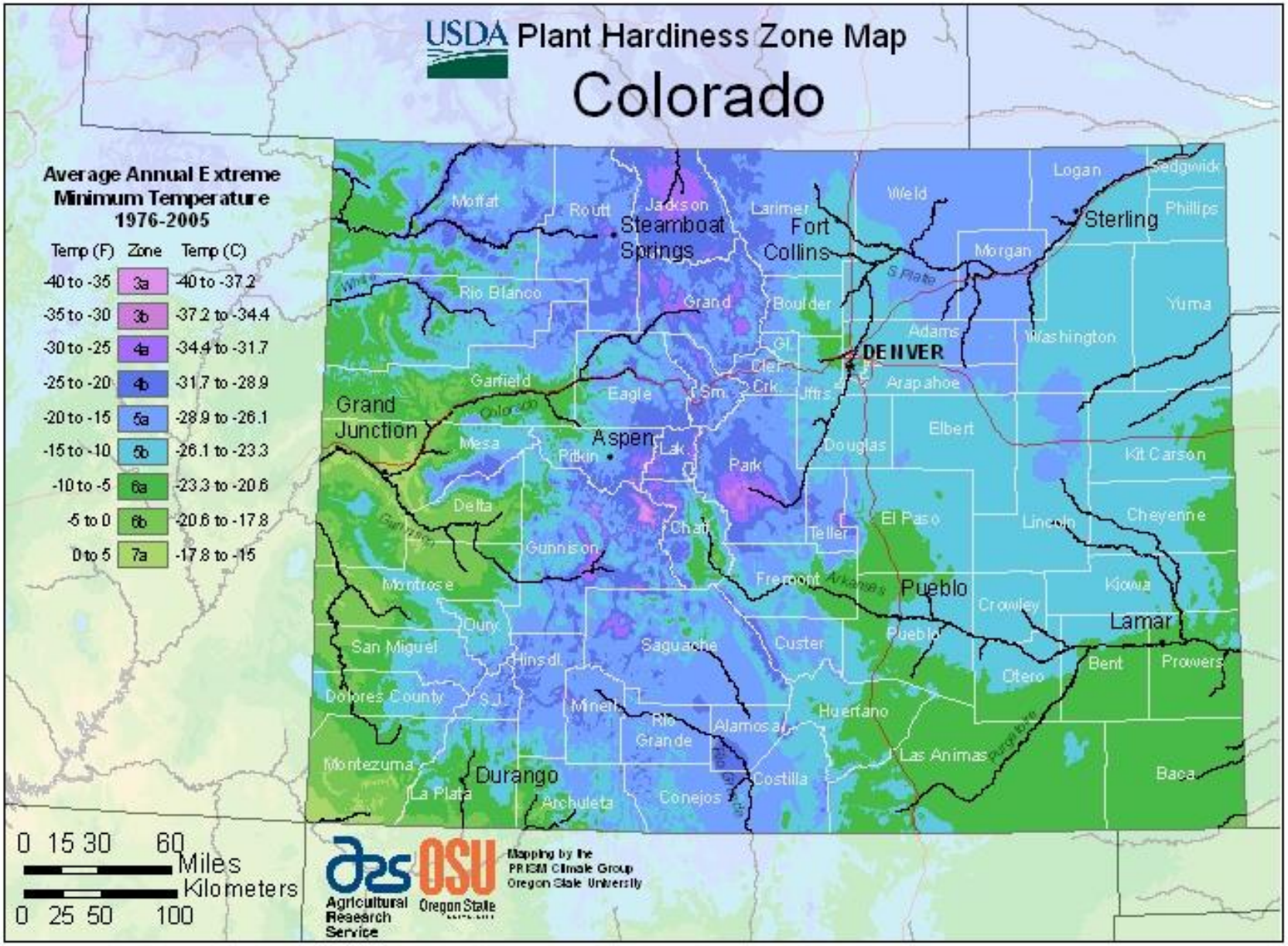

Colorado State University
Paonia Reservoir
August 2012

Here's what we expect



Colorado Annual Average Precipitation (in) 1981-2010




USDA Plant Hardiness Zone Map
Colorado
Average Annual Extreme Minimum Temperature 1976-2005
Temp (F) Zone Temp (C)
-40 to -35 3a -40 to -37.2
-35 to -30 3b -37.2 to -34.4
-30 to -25 4a -34.4 to -31.7
-25 to -20 4b -31.7 to -28.9
-20 to -15 5a -28.9 to -26.1
-15 to -10 5b -26.1 to -23.3
-10 to -5 6a -23.3 to -20.6
-5 to 0 6b -20.6 to -17.8
0 to 5 7a -17.8 to -15
Moffat
Routt
Jackson
Steamboat Springs
Larimer
Fort Collins
Weld
Logan
Sedgwick
Phillips
Sterling
Morgan
Rio Blanco
Grand
Boulder
Yuma
Adams
Washington
DENVER
Arapahoe
Garfield
Eagle
Clear Crk.
Jeffs.
Grand Junction
Mesa
Aspen
Pitkin
Lak.
Douglas
Elbert
Kit Carson
Park
Delta
Chaf.
Teller
El Paso
Lincoln
Cheyenne
Gunnison
Montrose
Fremont
Pueblo
Crowley
Kiowa
Lamar
Ouray
San Miguel
Saguache
Custer
Hinsdl.
Bent
Prowers
Otero
Dolores County
S.J.
Mineral
Rio Grande
Alamosa
Huerfano
Las Animas
Montezuma
Durango
La Plata
Archuleta
Conejos
Costilla
Baca
0 15 30 60 Miles
0 25 50 100 Kilometers
Agricultural Research Service
Oregon State
Mapping by the PRISM Climate Group Oregon State University

What makes Colorado Climate so different from place to place?

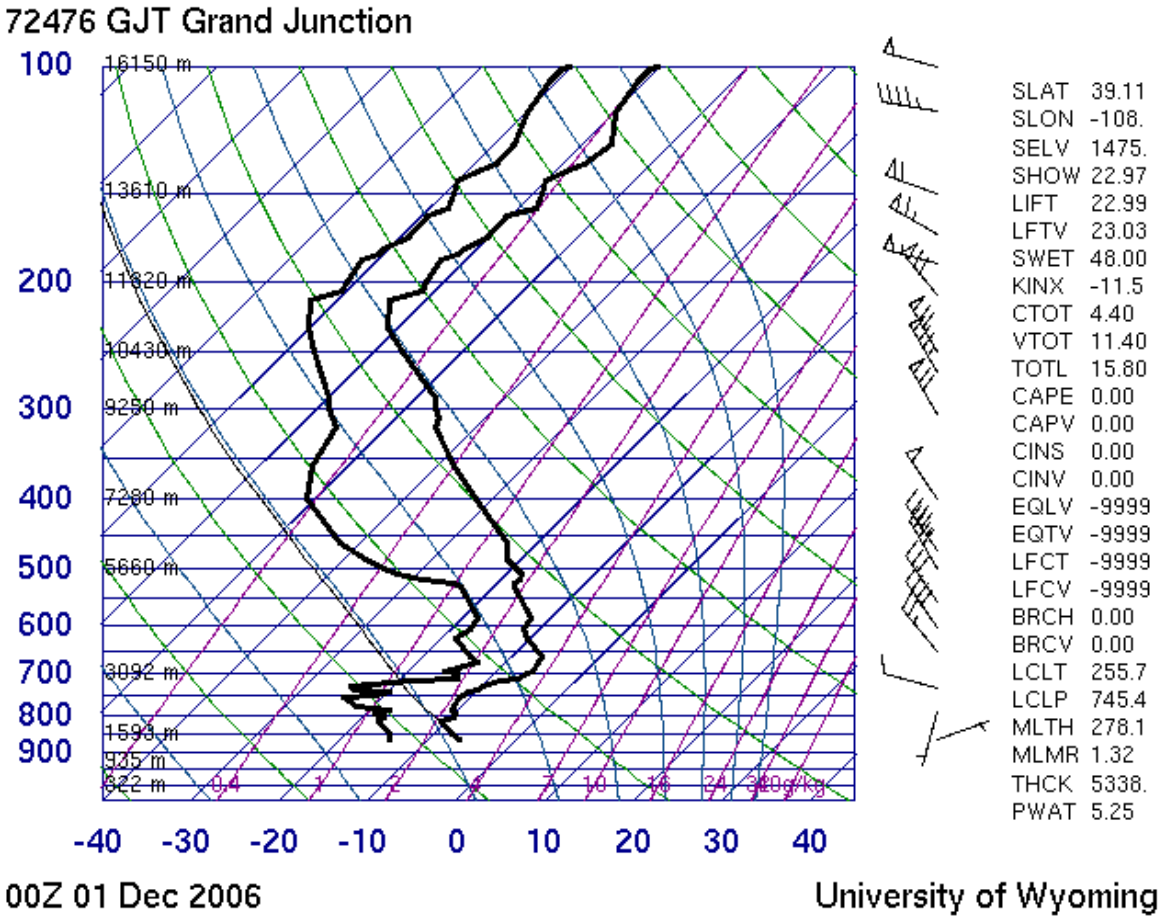
1. Altitude
2. Windward vs Leeward side of mountain
3. Latitude

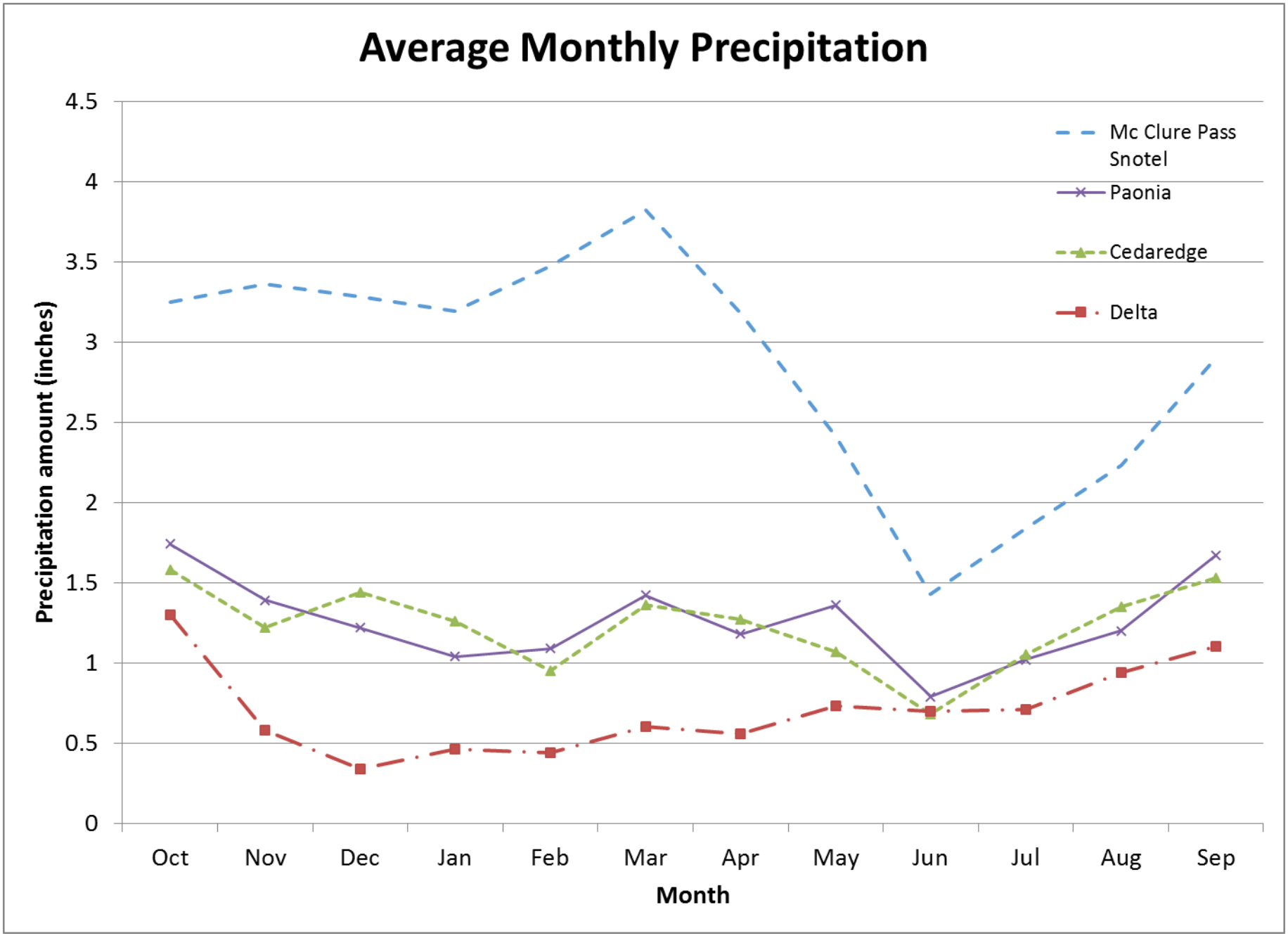
…and in that order. The difference in average temperature between Las Animas and Pike's Peak is roughly the same as between Florida and Iceland!

Places warm enough to grow are too dry, and places wet enough to grow are too cold…
Thank goodness for rivers!

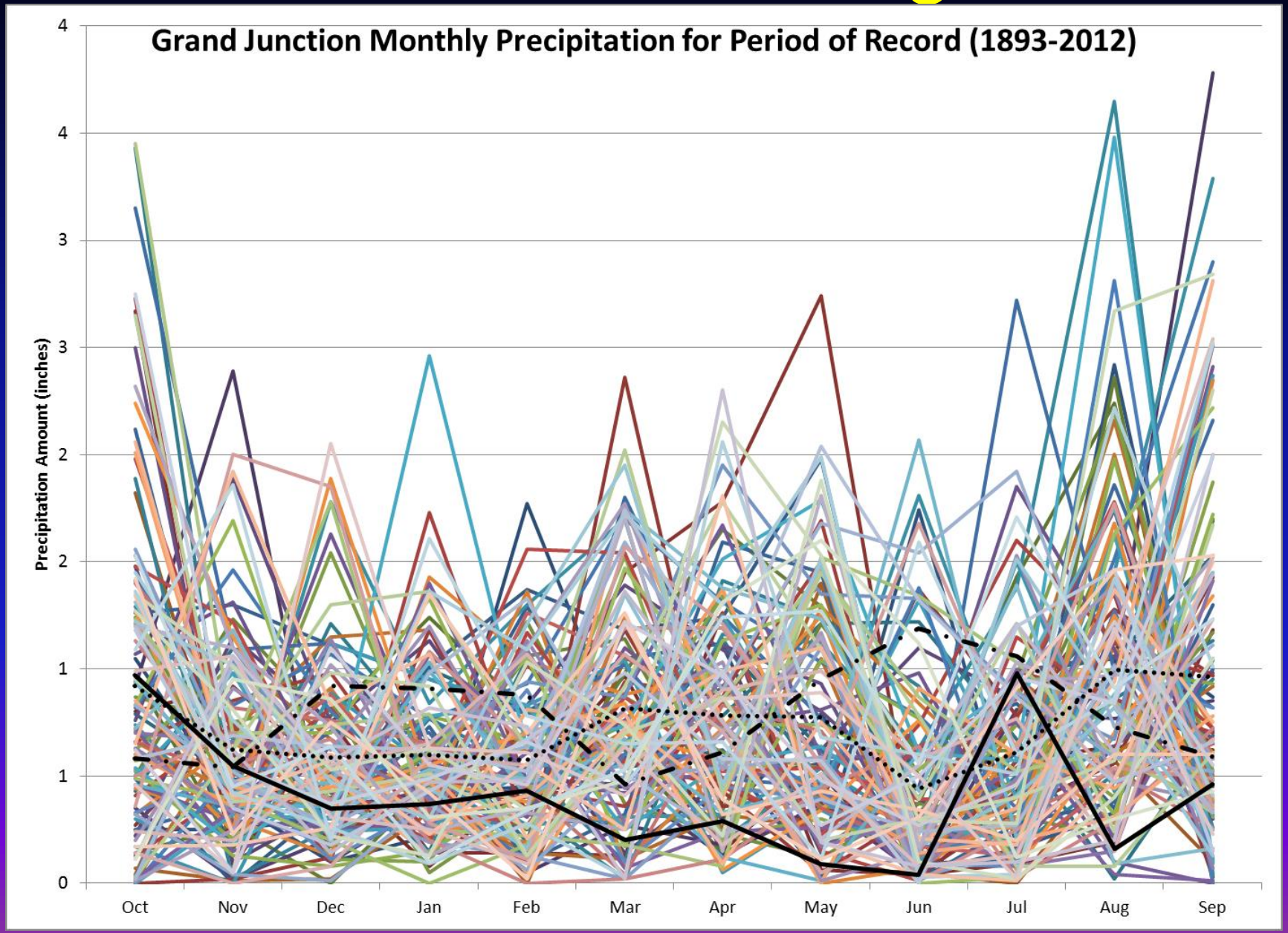
Why are some mountain valleys okay for horticulture and viticulture?

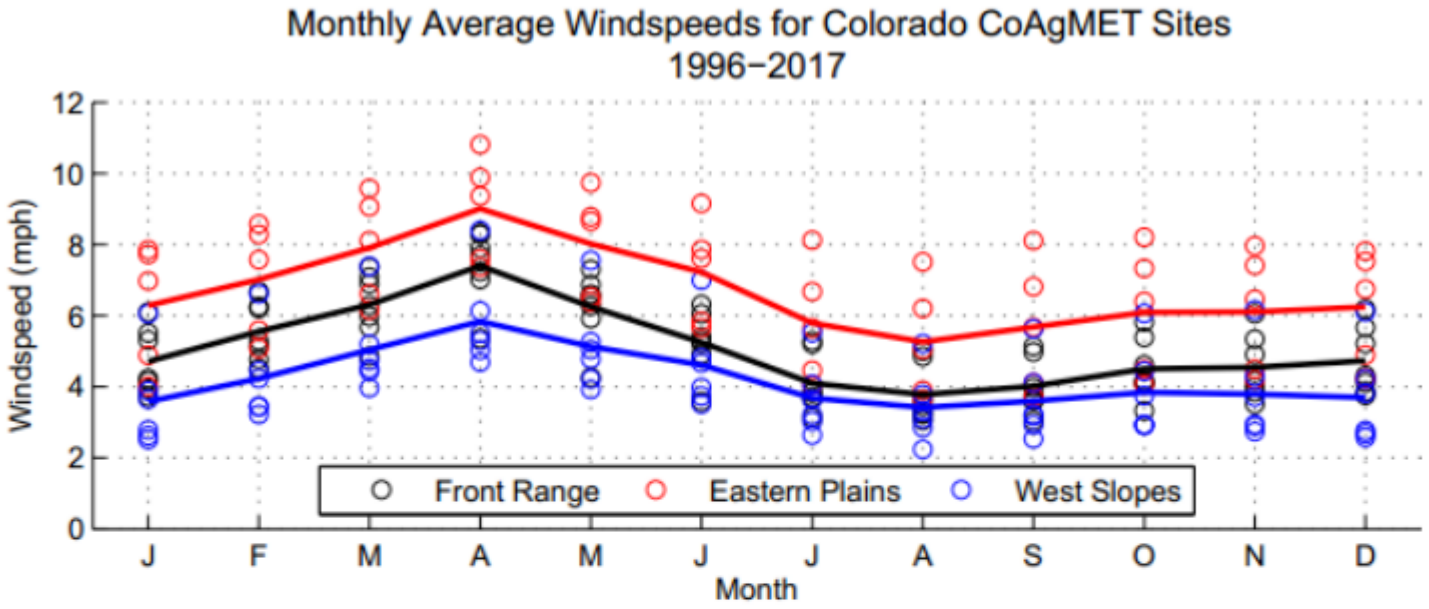
- Firstly, Colorado climate varies most notably with elevation. Higher = cooler and wetter, lower = warmer and drier
- Some valleys stay much warmer on cold winter nights than others. Very cold air becomes more dense than its environment, and sinks into the valleys
- Valleys where cool air continues to flow and does not pool at night are better places to grow

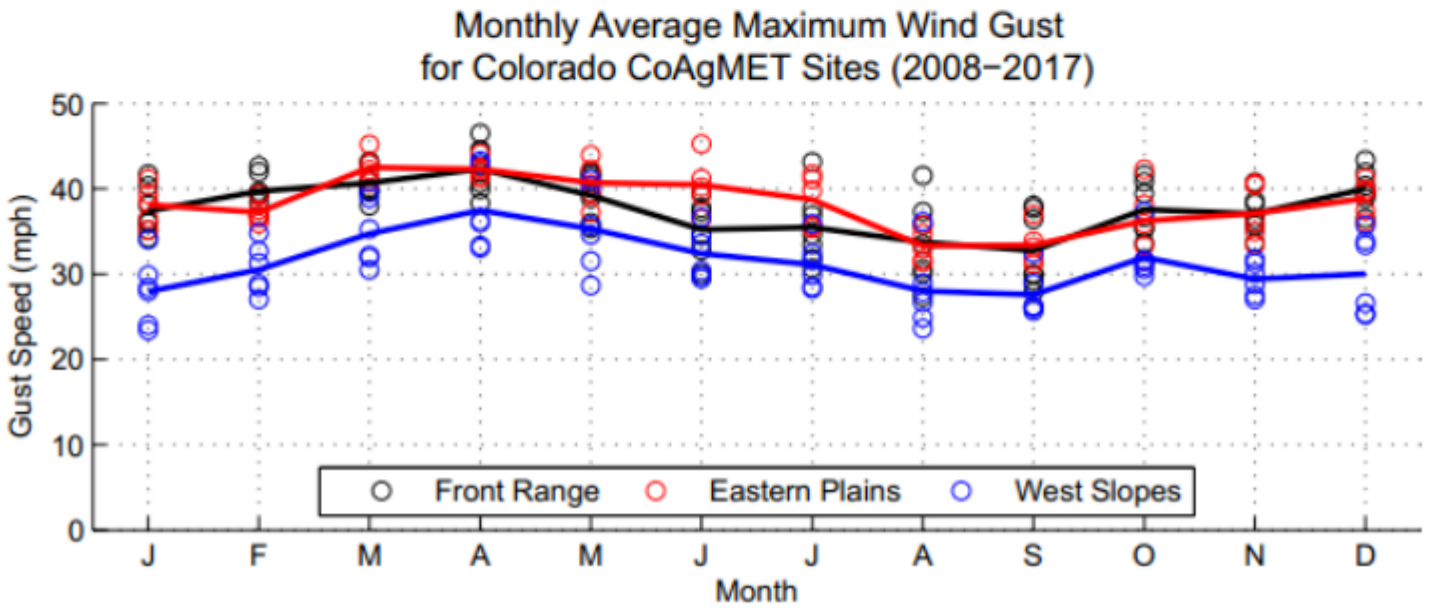


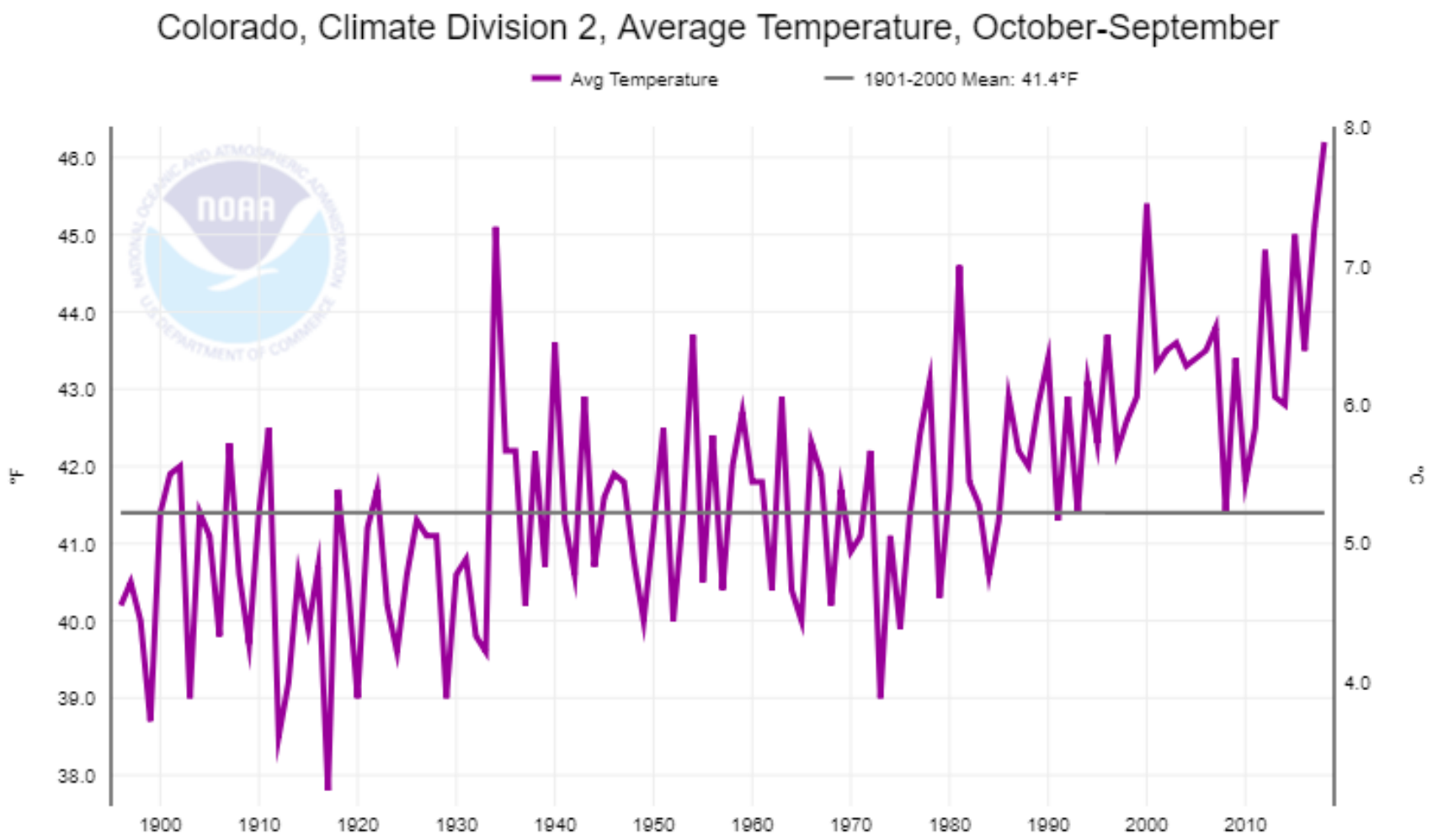

Average Monthly Precipitation
Precipitation amount (inches)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month
Mc Clure Pass Snotel
Paonia
Cedaredge
Delta

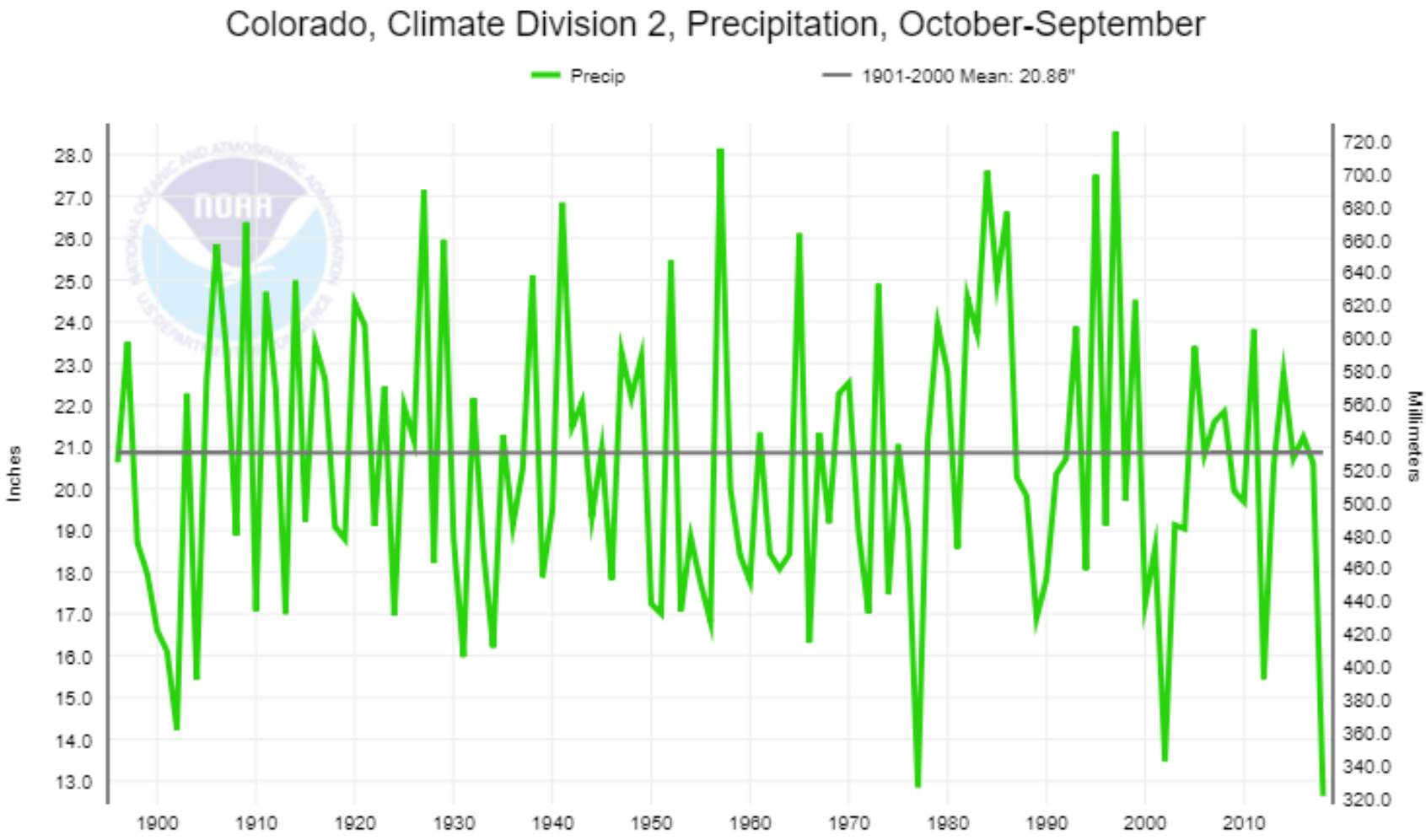
But what will we get?




Monthly Average Windspeeds for Colorado CoAgMET Sites
1996−2017
Windspeed (mph)
0
2
4
6
8
10
12
J
F
M
A
M
J
J
A
S
O
N
D
Month
Front Range
Eastern Plains
West Slopes

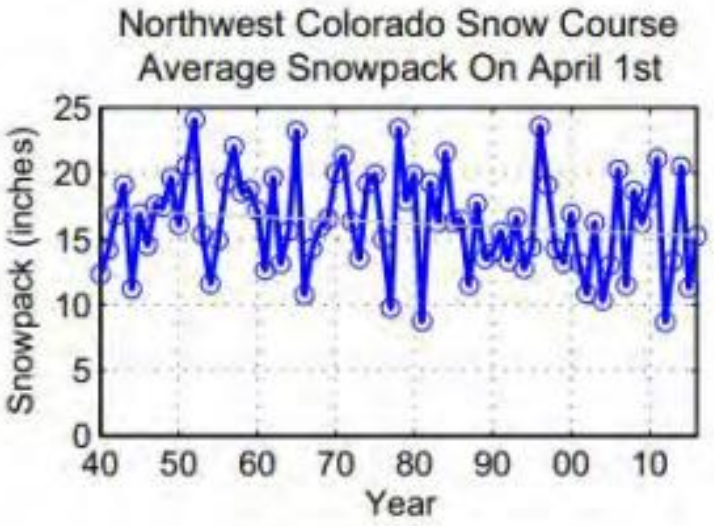

Monthly Average Maximum Wind Gust
for Colorado CoAgMET Sites (2008−2017)
Gust Speed (mph)
0
10
20
30
40
50
J
F
M
A
M
J
J
A
S
O
N
D
Month
Front Range
Eastern Plains
West Slopes

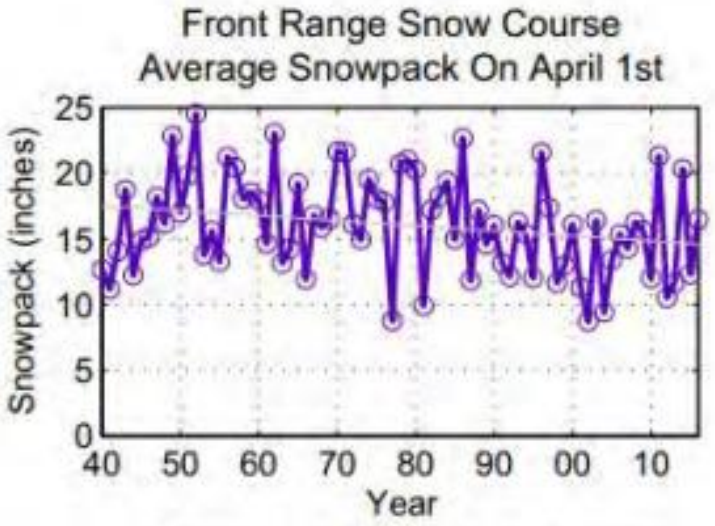

Colorado, Climate Division 2, Average Temperature, October-September
Avg Temperature
1901-2000 Mean: 41.4°F
°F
°C
46.0
45.0
44.0
43.0
42.0
41.0
40.0
39.0
38.0
8.0
7.0
6.0
5.0
4.0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

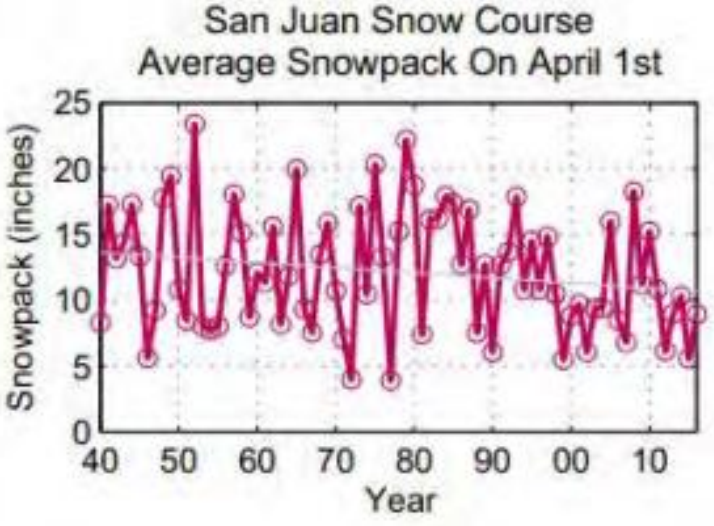

Colorado, Climate Division 2, Precipitation, October-September
Precip
1901-2000 Mean: 20.86"
Inches
Millimeters
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
720.0
700.0
680.0
660.0
640.0
620.0
600.0
580.0
560.0
540.0
520.0
500.0
480.0
460.0
440.0
420.0
400.0
380.0
360.0
340.0
320.0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

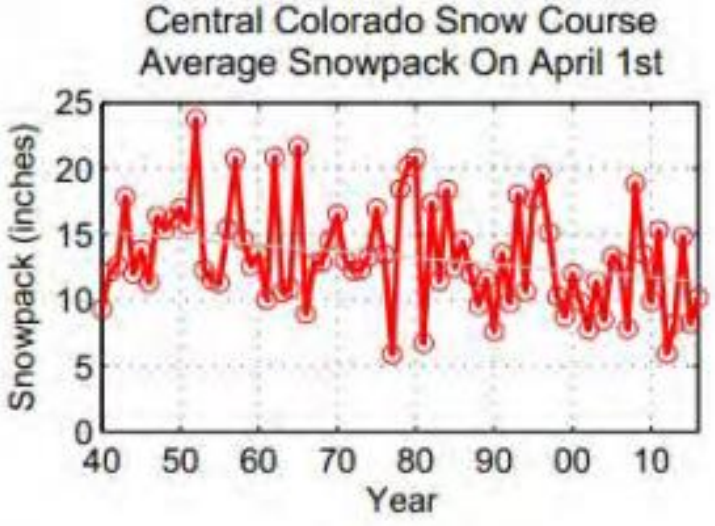
Warming has not been good for our snowpack

There's still loads of variability from one year to the next!

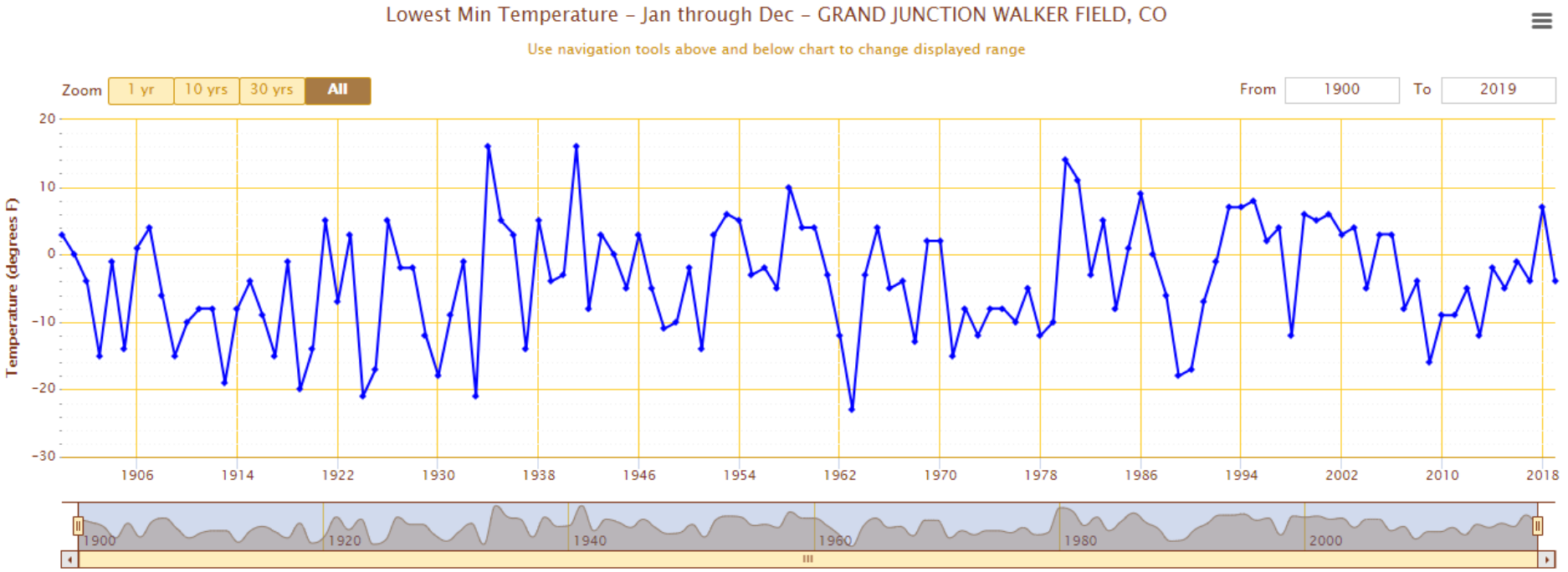




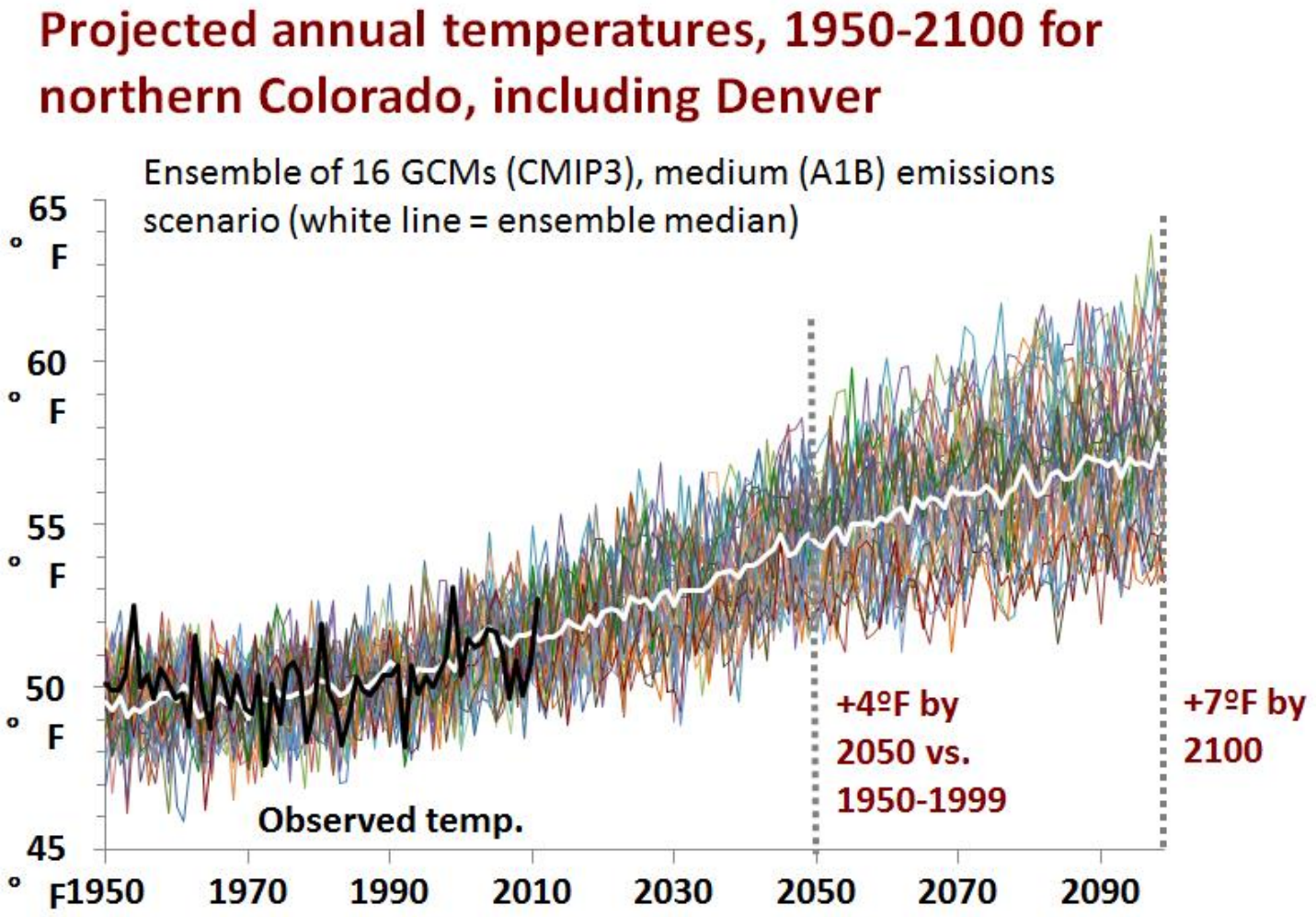




The coldest of the cold is getting warmer, which has its positives!



What about the Future?



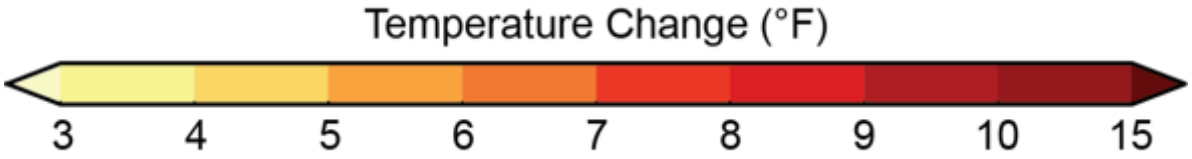
Source: Jeff Lukas, Western Water Assessment; Projections data available from http://gdo-dcp.ucllnl.org/; Observed data available from PRISM, http://www.cefa.dri.edu/Westmap/

Projected Temperature INCREASE by our Grandchildren's Time – this is BIG

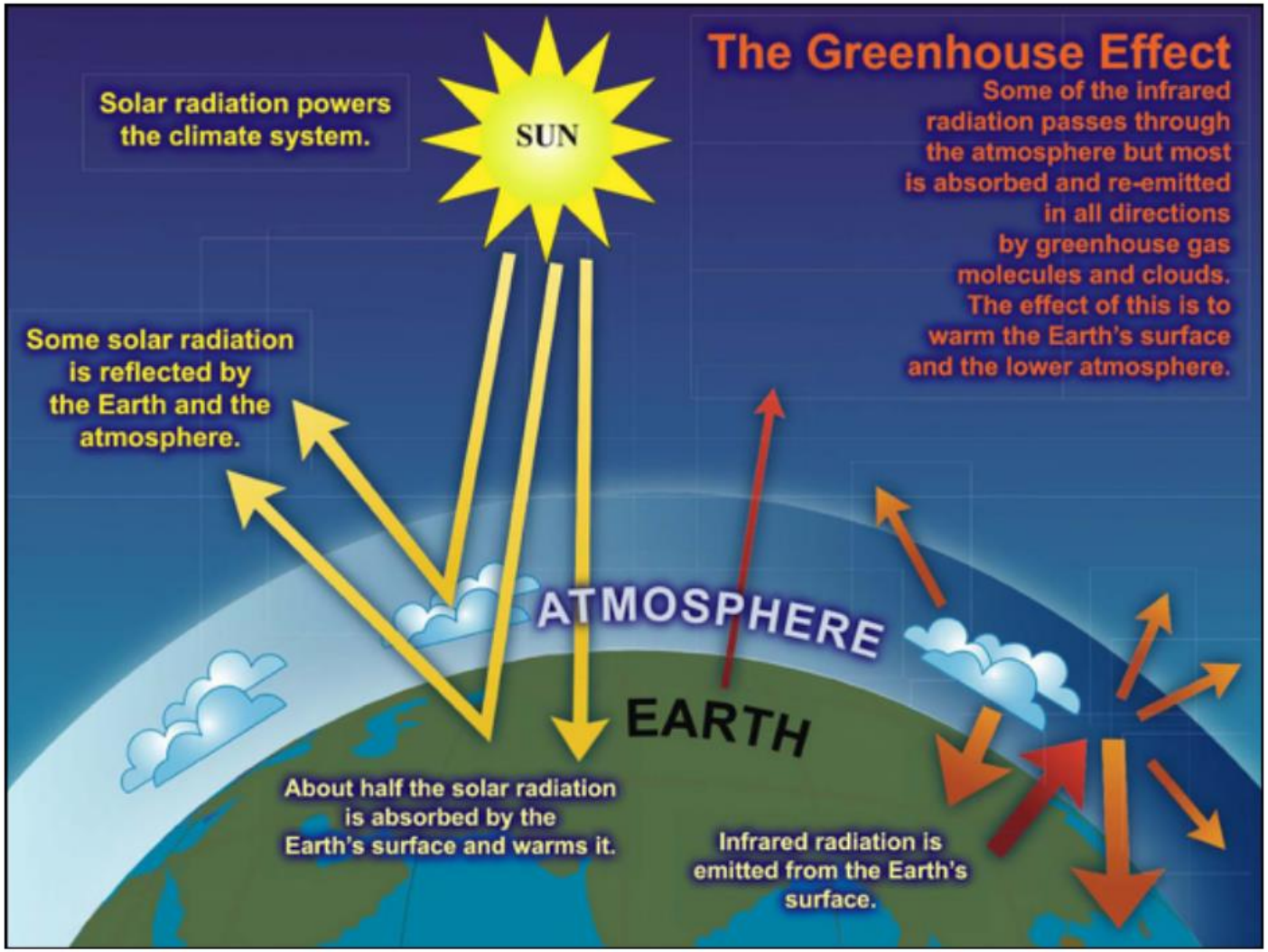
Significant Emissions Reduction

Current Emissions Continue

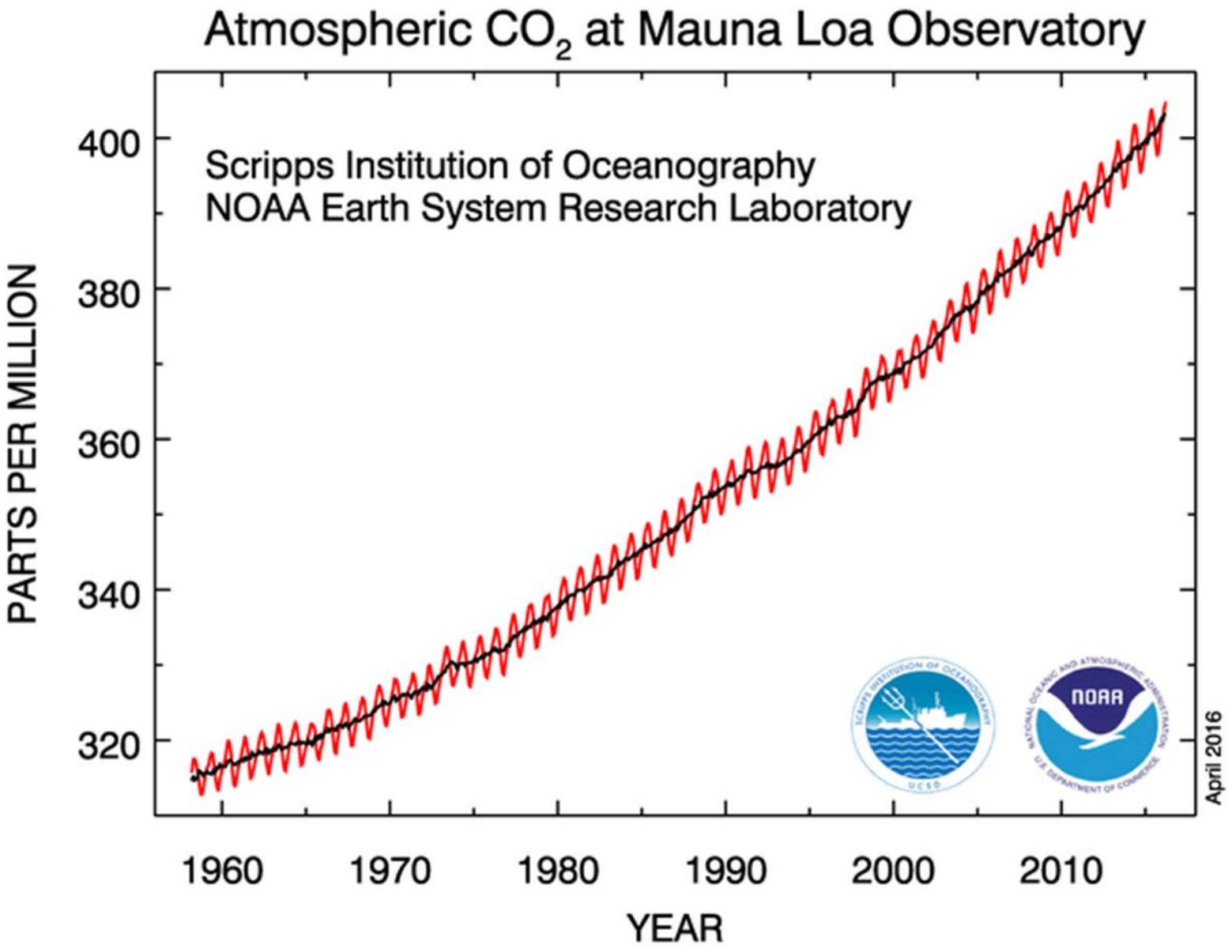
2071-2099 relative to 1970-1999



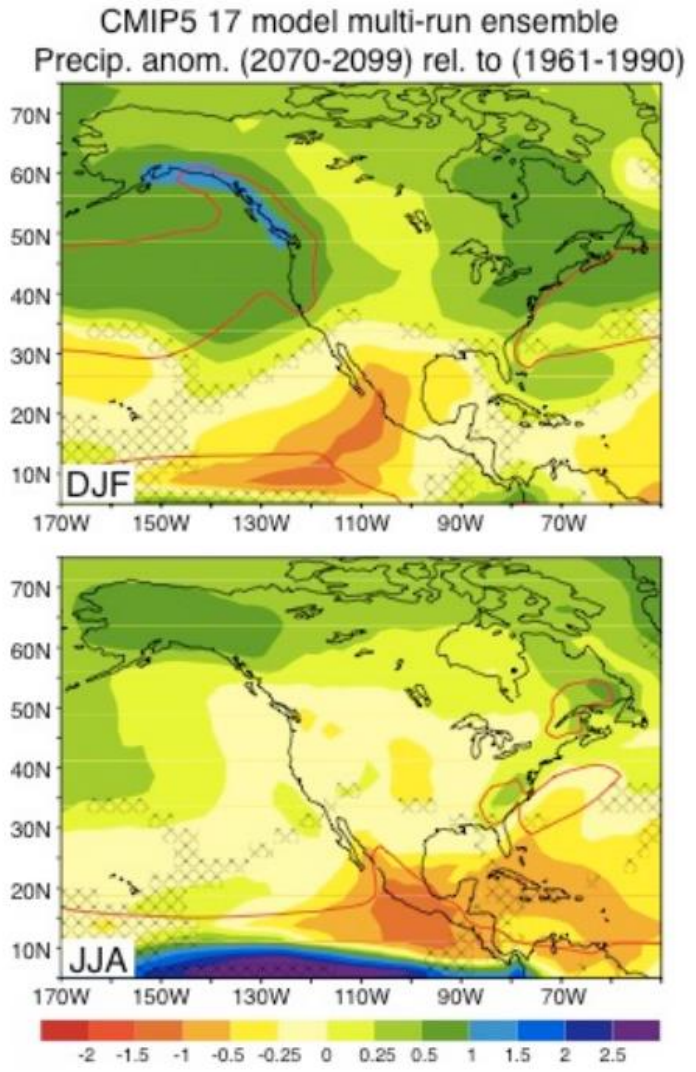
What underlies these long-term temperature changes? A Changing Greenhouse Effect

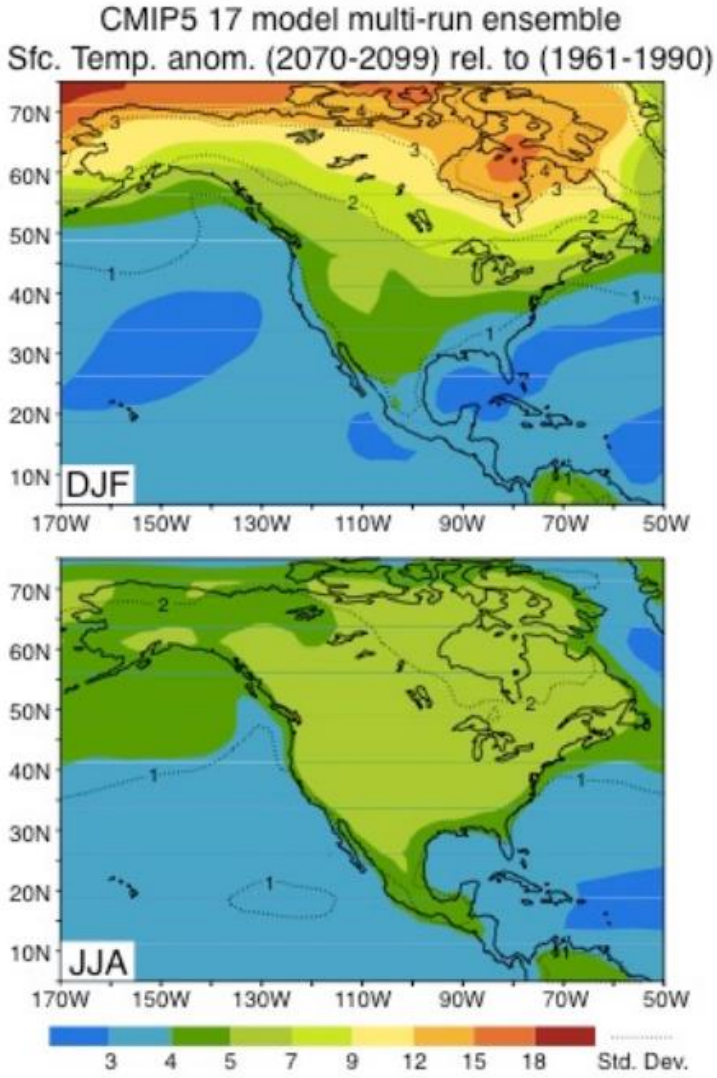


- Earth's equilibrium temperature is 57 F. Without GHGs it would be 0 F.
- Our best piece of evidence for the greenhouse effect: we survive at night


Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
400
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
April 2016

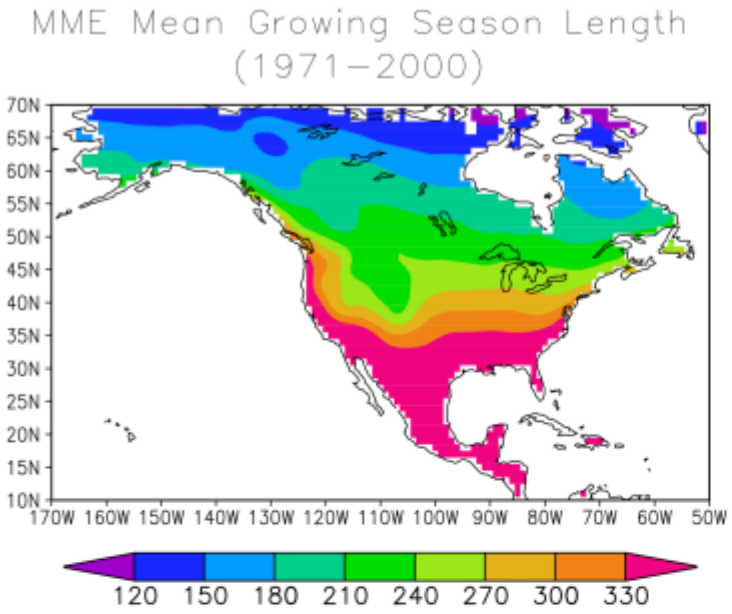
Changes to Winter and Summer Temperature/Precipitation

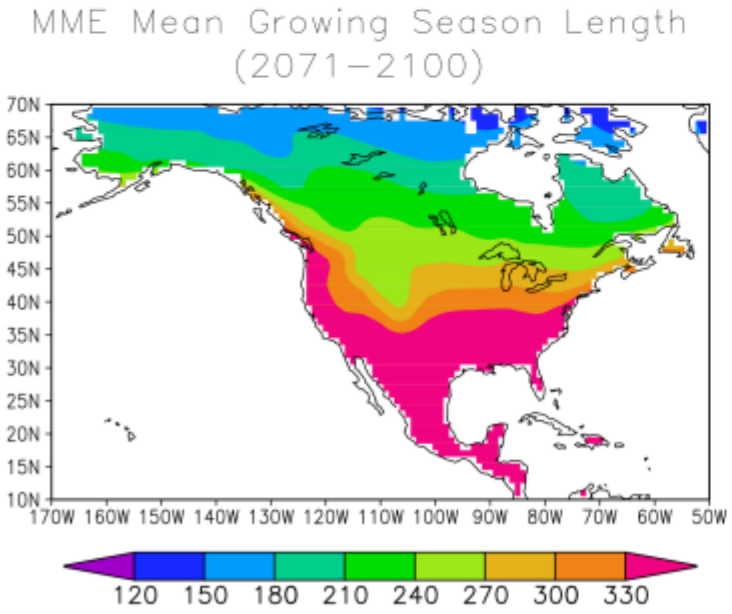


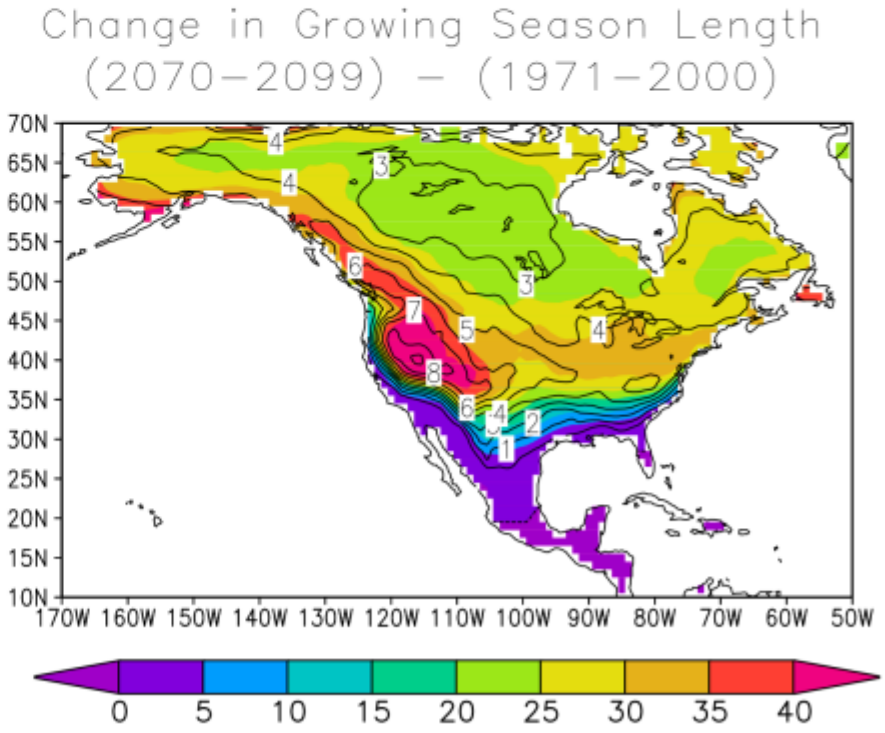


Change in Growing Season Length

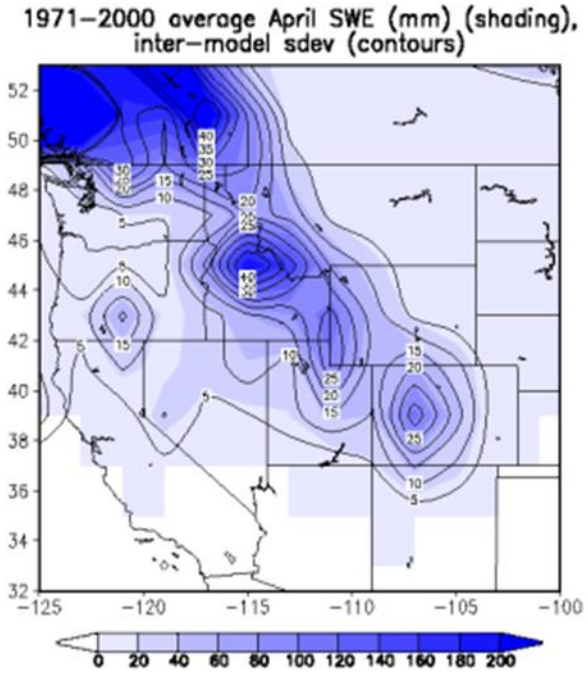
Figure 29.9

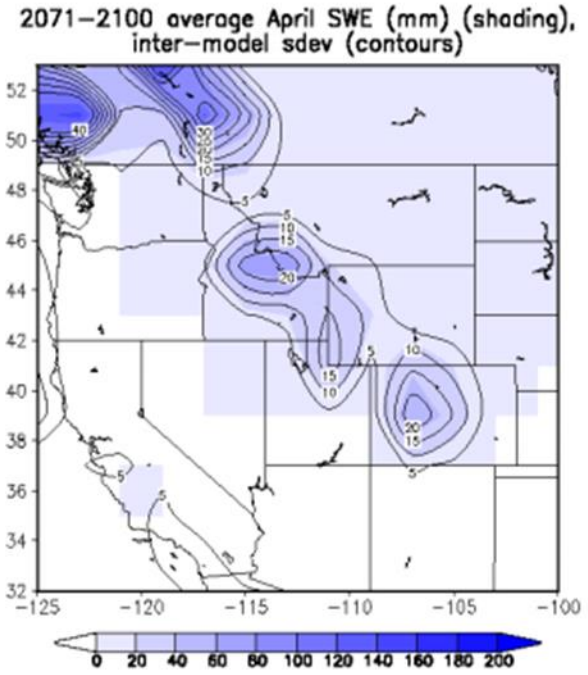


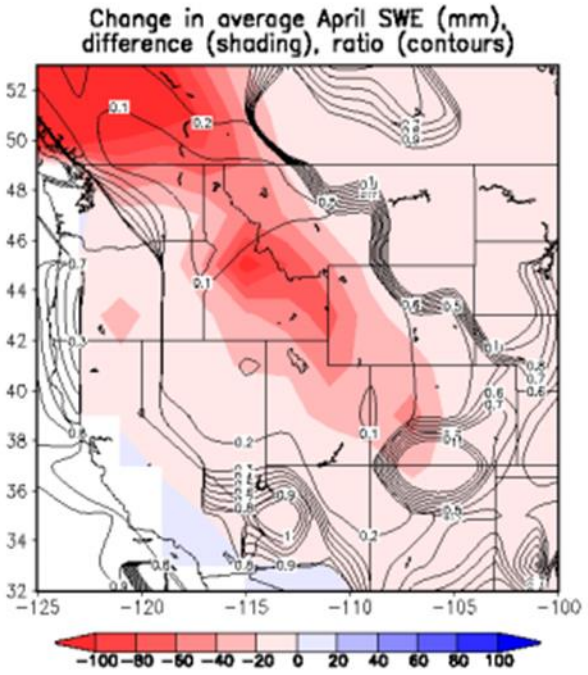


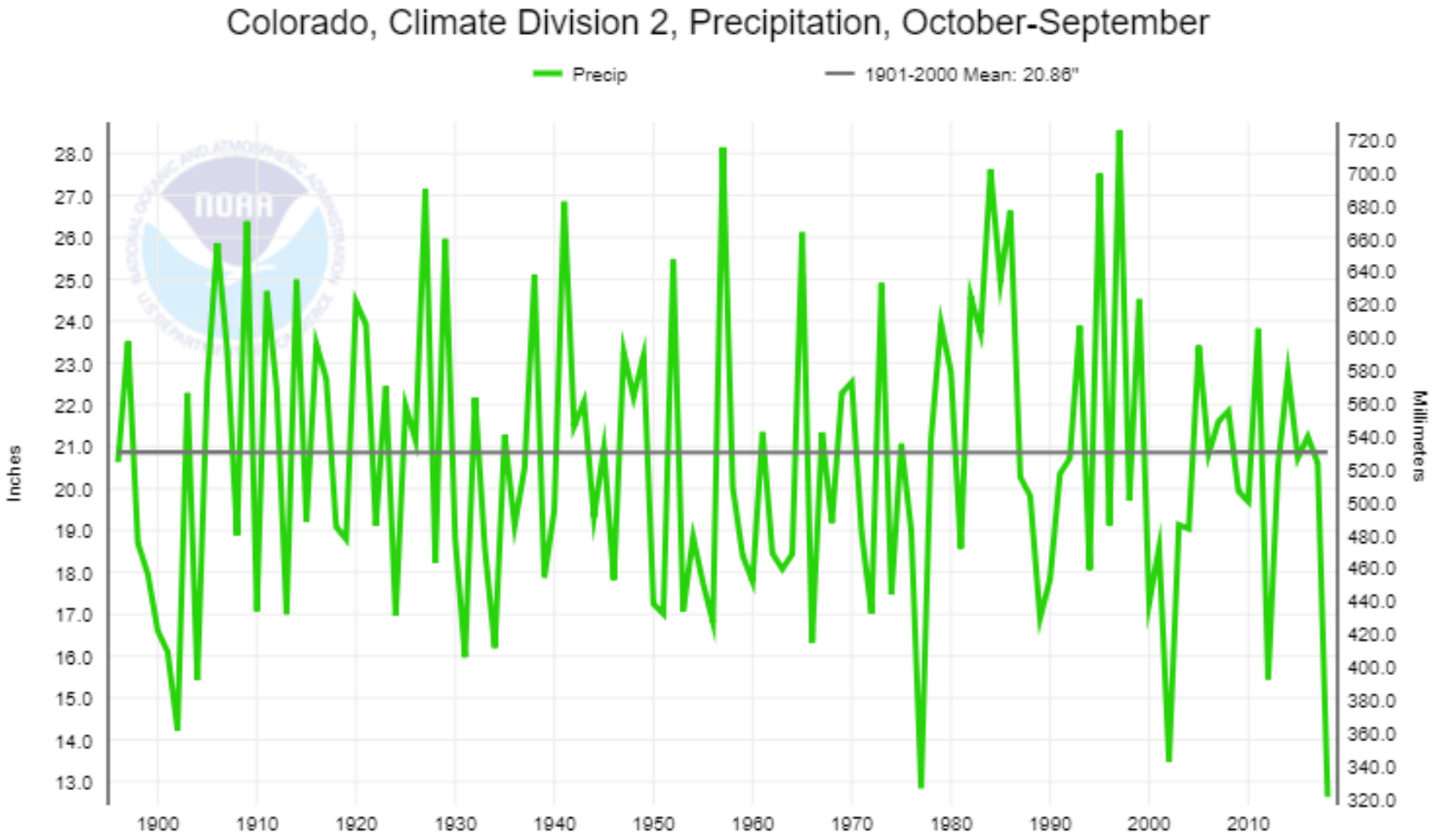


April Snow Water Equivalent









Is the climate naturally variable too? Yes! Even in a warmer climate, there will be big differences from one year to the next just like today

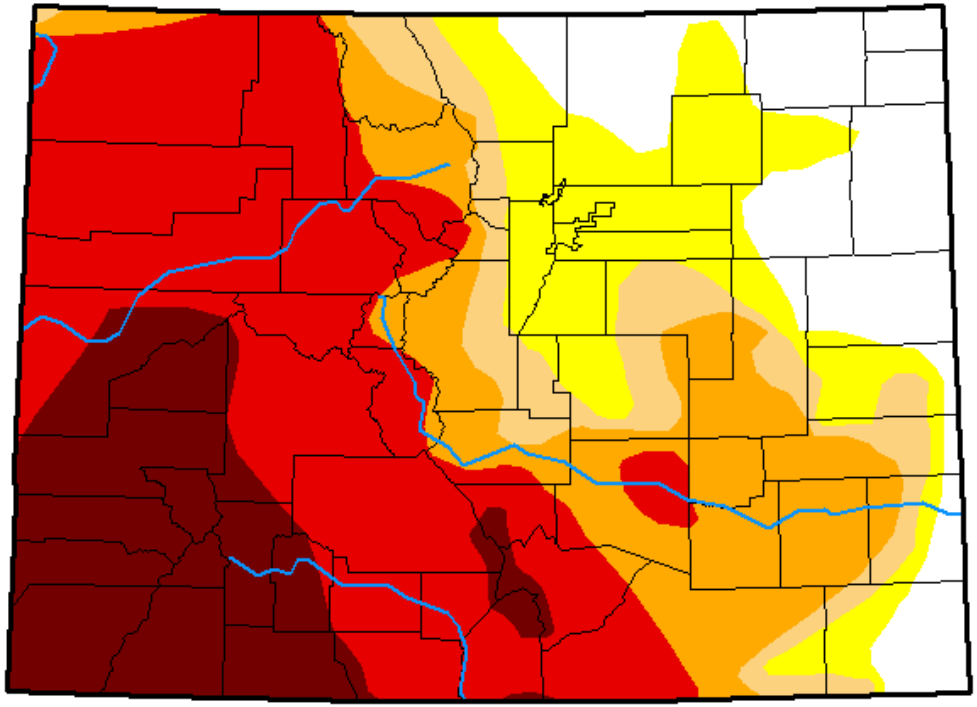
Summary: Oct 2017 – Now

- 2018 was one of our warmest and driest years on record
- 2019 temperatures have been much more normal, and it's been snowing to beat the band!


Drought never leaves us alone for long
Photo by Lyric Lucero
2013 Manzanola, CO

U.S. Drought Monitor

Colorado



September 25, 2018

(Released Thursday, Sep. 27, 2018)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	14.19	85.81	72.30	64.41	48.47	16.21
Last Week *09-18-2018*	16.89	83.11	71.59	63.93	44.29	12.62
3 Months Ago *06-26-2018*	21.33	78.67	66.90	52.31	36.46	8.81
Start of Calendar Year *01-02-2018*	6.57	93.43	33.53	7.27	0.00	0.00
Start of Water Year *09-26-2017*	67.63	32.37	3.72	0.00	0.00	0.00
One Year Ago *09-26-2017*	67.63	32.37	3.72	0.00	0.00	0.00

Intensity:

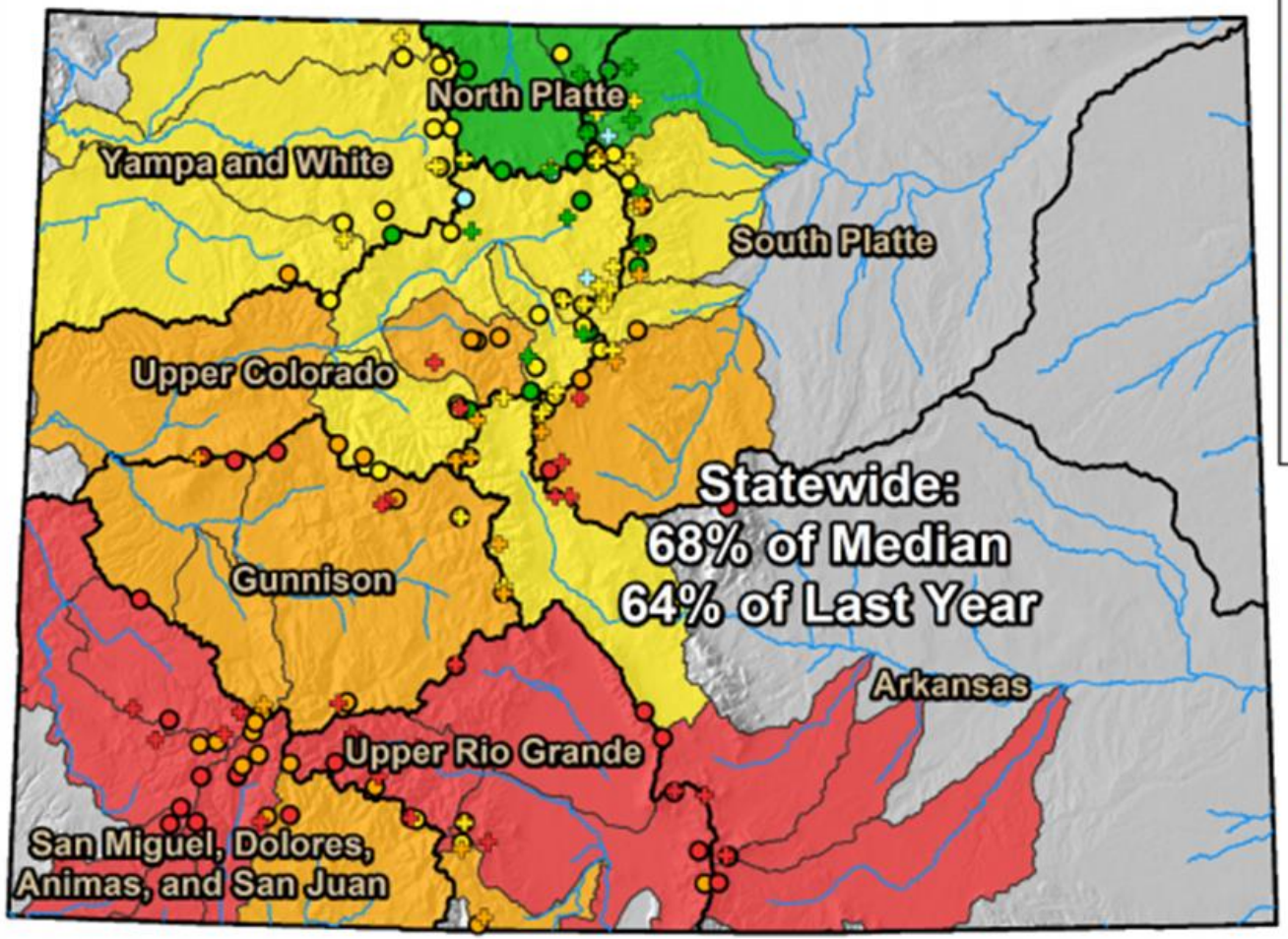
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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

Author:
Jessica Blunden
NCEI/NOAA

http://droughtmonitor.unl.edu/

Colorado Monthly Snowpack Summary
April 1, 2018



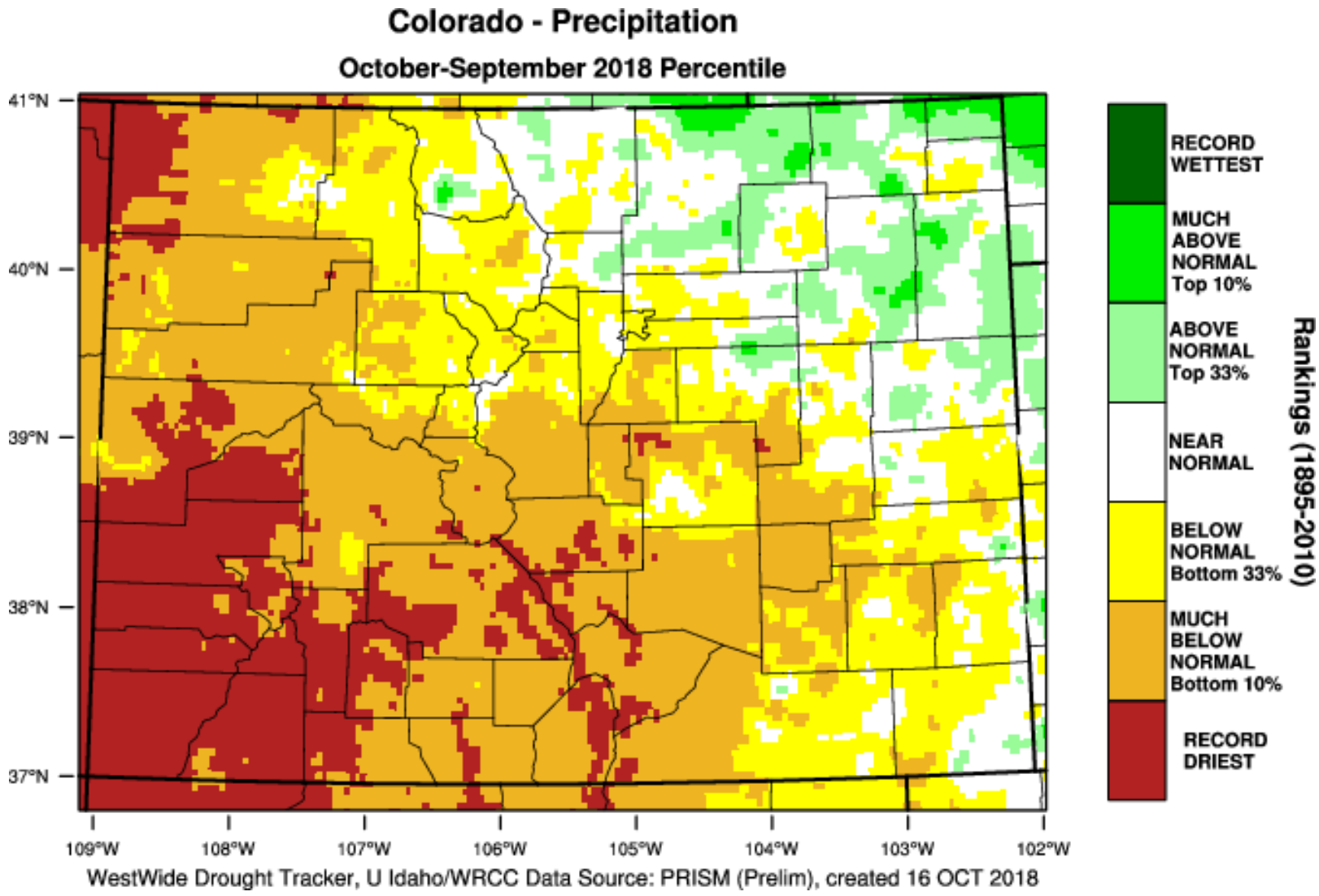
Basin Snowpack
Percent of Median

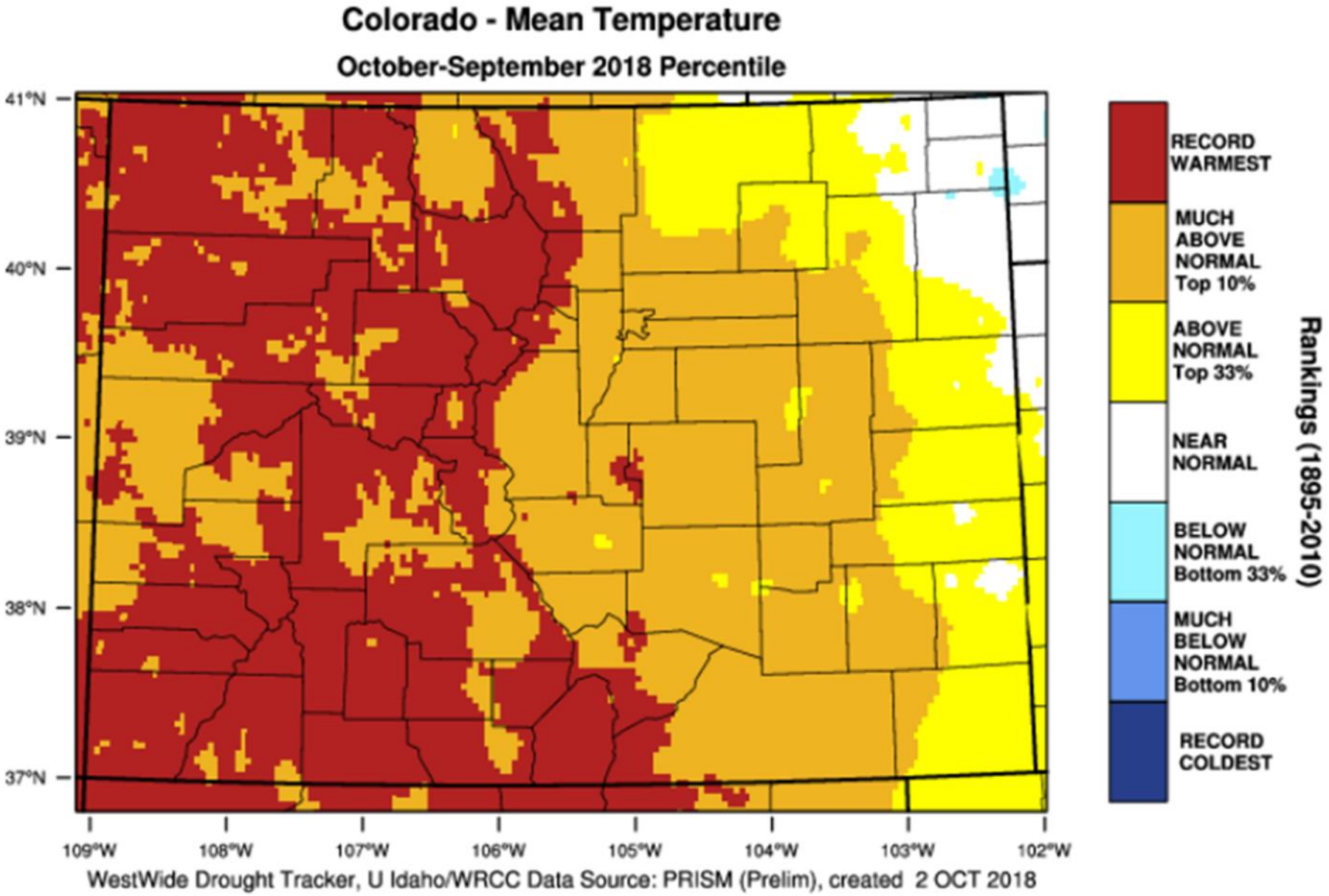
- >= 150
- 130 - 149
- 110 - 129
- 90 - 109
- 70 - 89
- 50 - 69
- < 50
- SNOTEL
- Snow Course

N

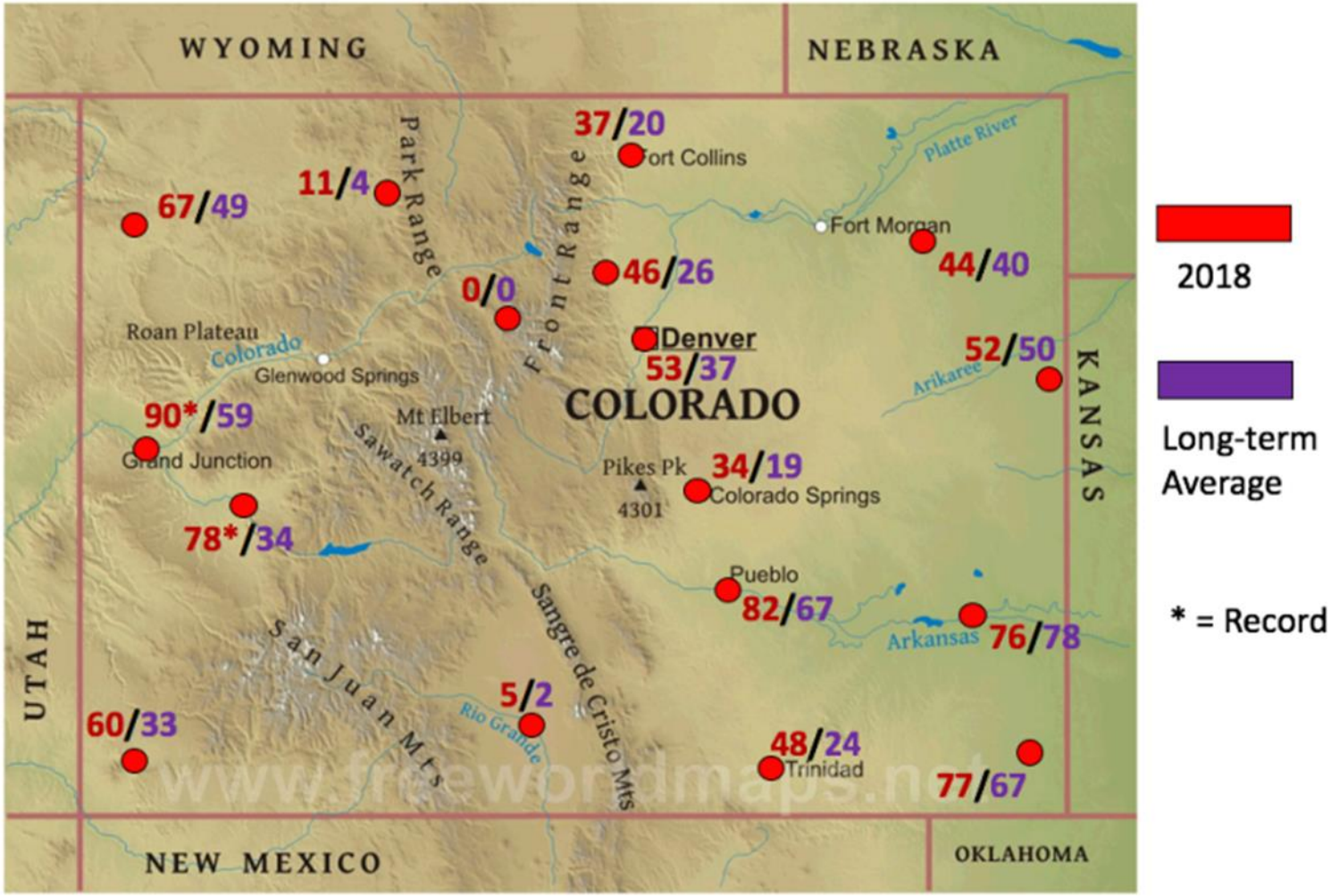
0 25 50 100 150 200 Miles

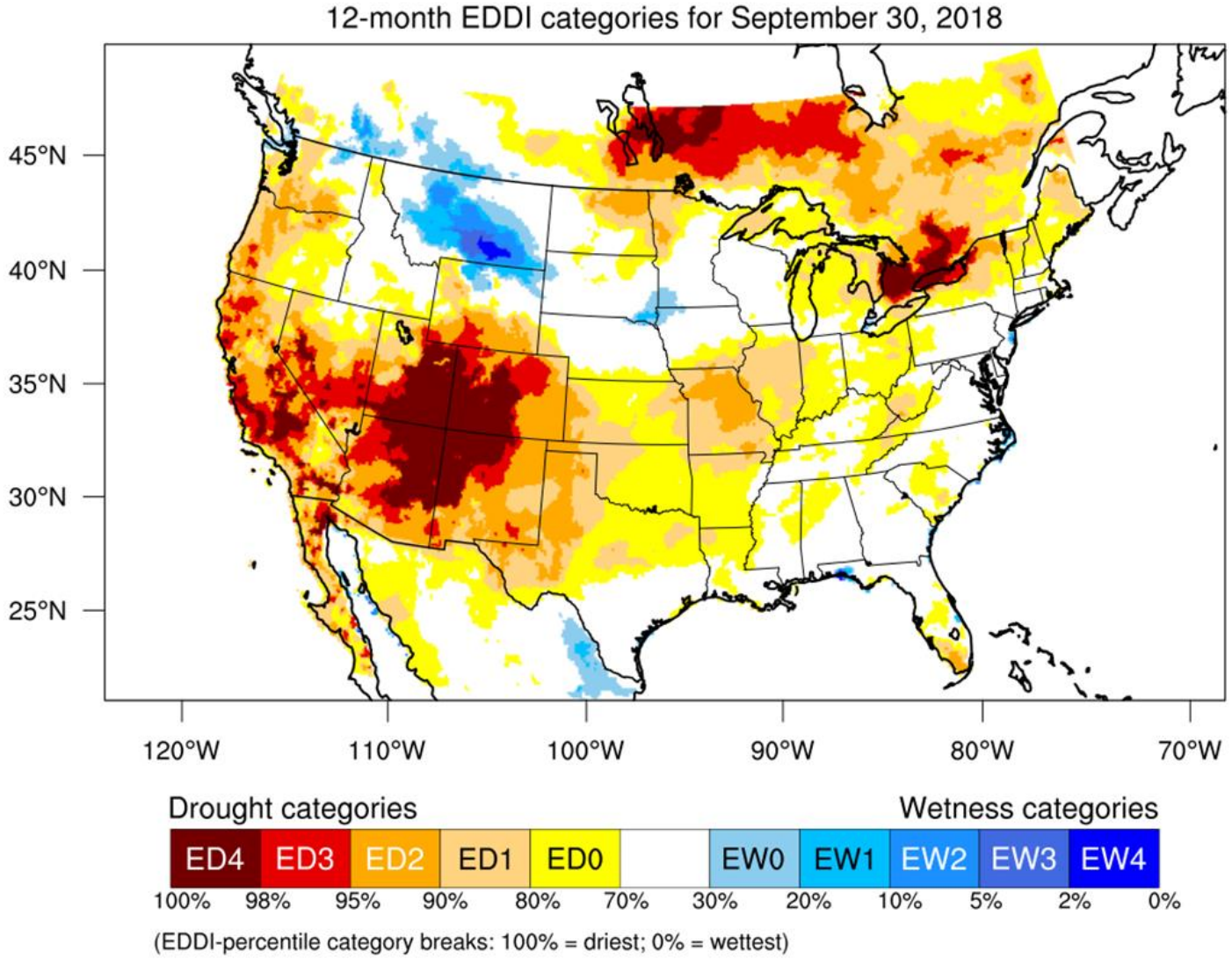
USDA United States Department of Agriculture
Natural Resources Conservation Service

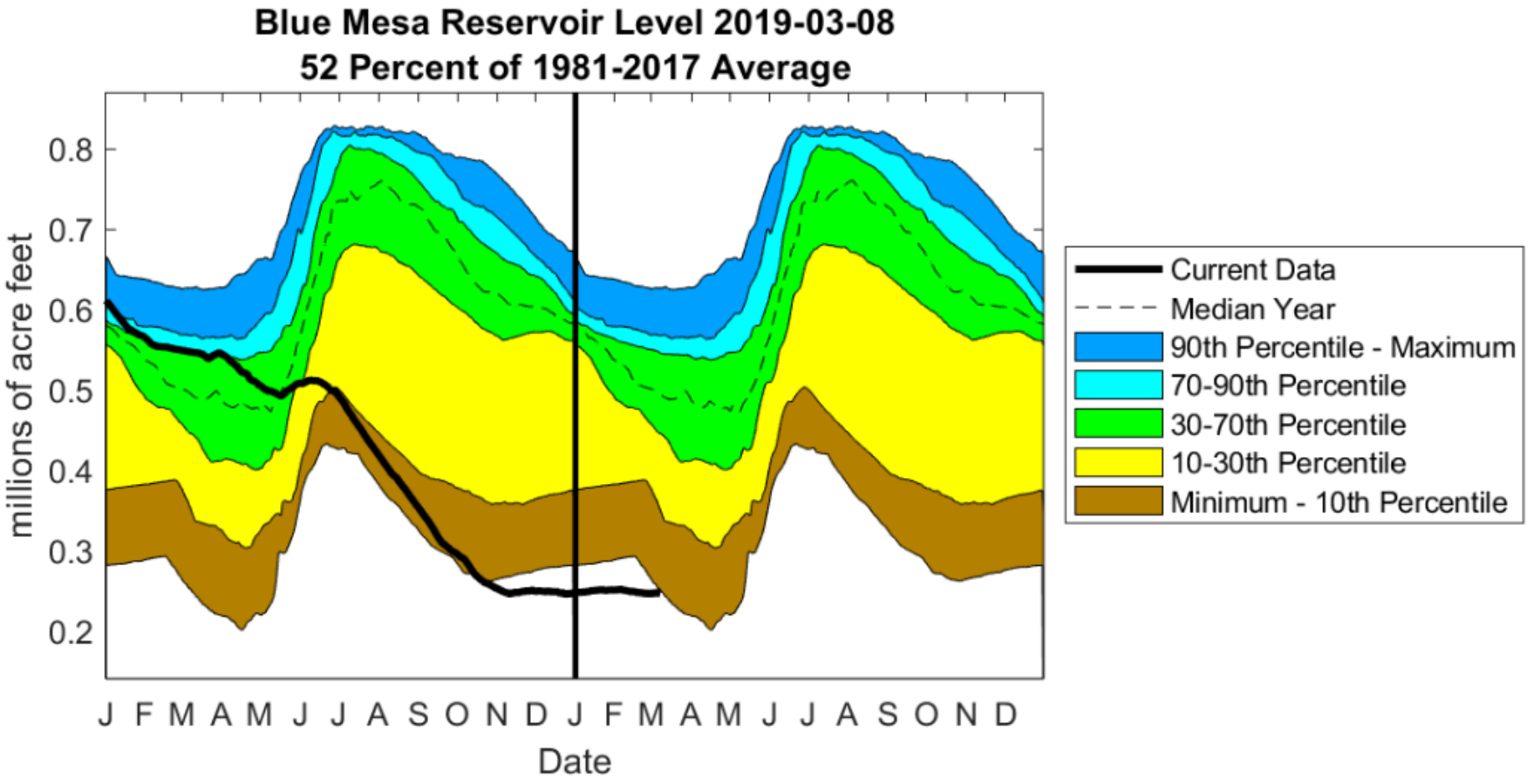

Colorado - Precipitation
October-September 2018 Percentile
41°N
40°N
39°N
38°N
37°N
109°W
108°W
107°W
106°W
105°W
104°W
103°W
102°W
RECORD WETTEST
MUCH ABOVE NORMAL Top 10%
ABOVE NORMAL Top 33%
NEAR NORMAL
BELOW NORMAL Bottom 33%
MUCH BELOW NORMAL Bottom 10%
RECORD DRIEST
Rankings (1895-2010)
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 OCT 2018


Colorado - Mean Temperature
October-September 2018 Percentile
41°N
40°N
39°N
38°N
37°N
109°W
108°W
107°W
106°W
105°W
104°W
103°W
102°W
RECORD WARMEST
MUCH ABOVE NORMAL Top 10%
ABOVE NORMAL Top 33%
NEAR NORMAL
BELOW NORMAL Bottom 33%
MUCH BELOW NORMAL Bottom 10%
RECORD COLDEST
Rankings (1895-2010)
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 2 OCT 2018

Number of 90 Degree Days



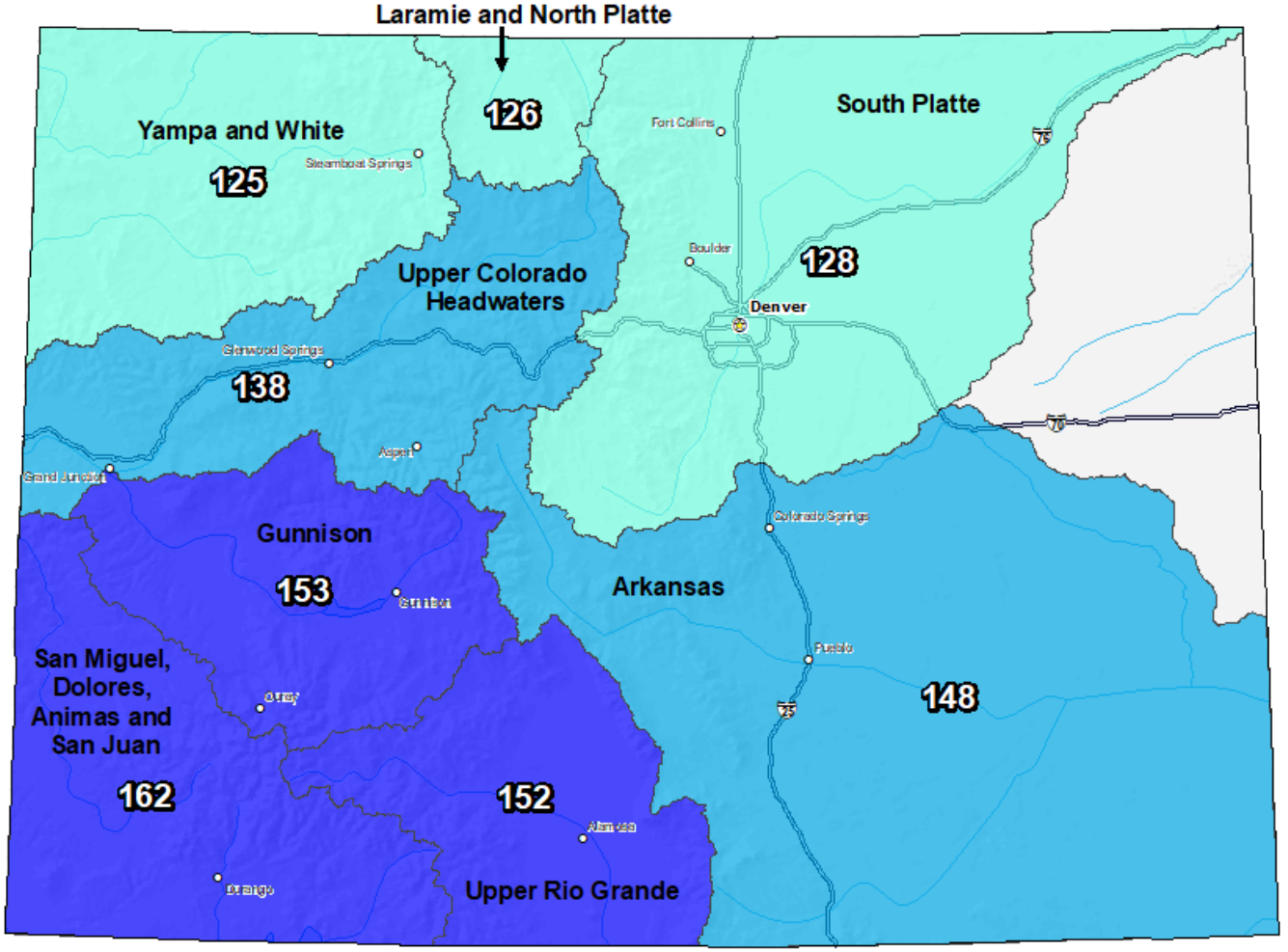

12-month EDDI categories for September 30, 2018
45°N
40°N
35°N
30°N
25°N
120°W
110°W
100°W
90°W
80°W
70°W
Drought categories
Wetness categories
ED4
ED3
ED2
ED1
ED0
EW0
EW1
EW2
EW3
EW4
100%
98%
95%
90%
80%
70%
30%
20%
10%
5%
2%
0%
(EDDI-percentile category breaks: 100% = driest; 0% = wettest)
Generated by NOAA/ESRL/Physical Sciences Division


Blue Mesa Reservoir Level 2019-03-08
52 Percent of 1981-2017 Average
millions of acre feet
0.8
0.7
0.6
0.5
0.4
0.3
0.2
J F M A M J J A S O N D J F M A M J J A S O N D
Date
Current Data
Median Year
90th Percentile - Maximum
70-90th Percentile
30-70th Percentile
10-30th Percentile
Minimum - 10th Percentile


But snows have
answered the call

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

Mar 22, 2019



Current Snow Water Equivalent (SWE) Basin-wide Percent of 1981-2010 Median

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

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

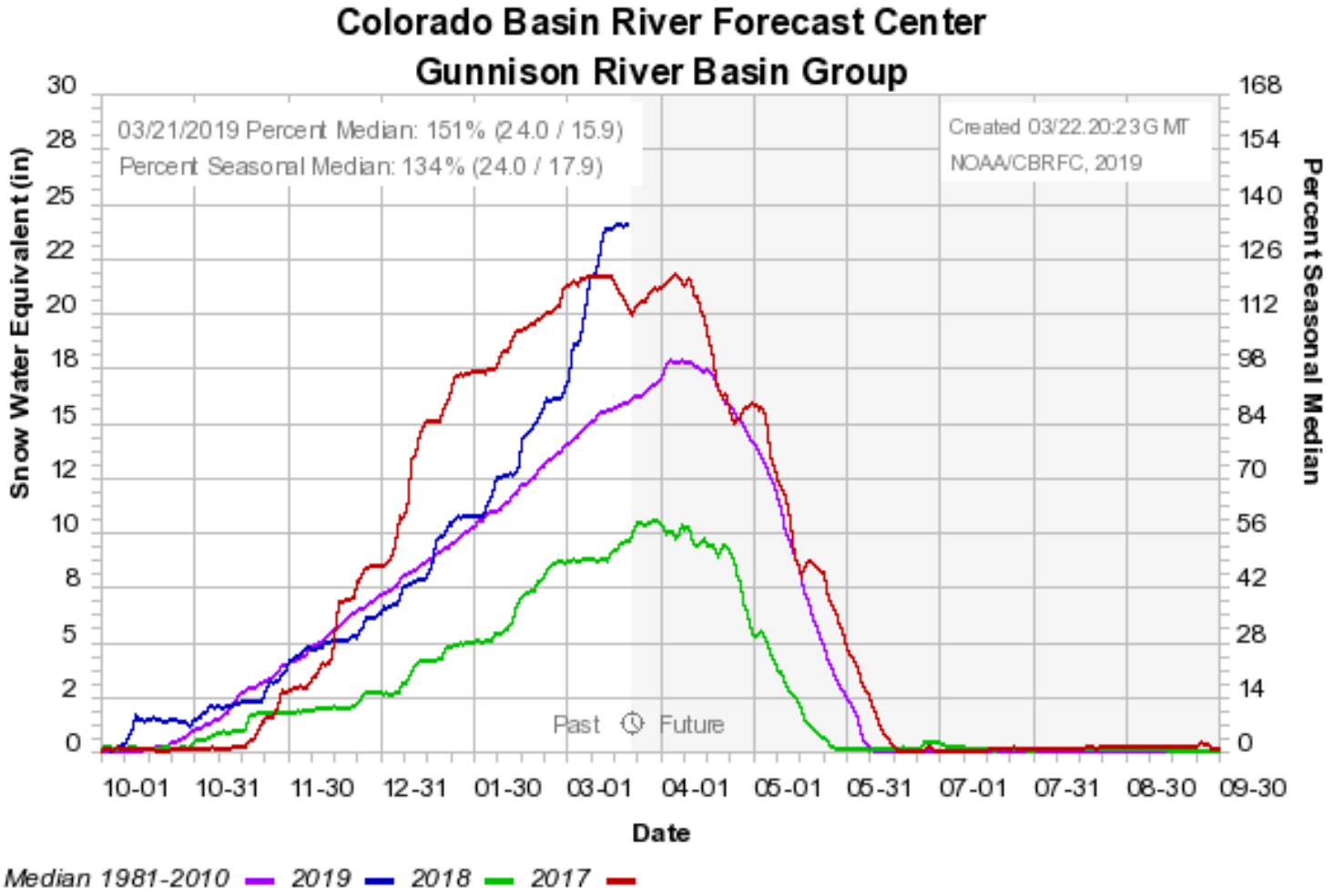
Provisional Data Subject to Revision

USDA NRCS

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

Prepared by:
USDA/NRCS National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov

Snowpack in the Gunnison Basin is its highest since May, 2011.
The San Juan Basin the highest it has been in over a decade!



Snowpack in the Gunnison Basin is its highest since May, 2011.
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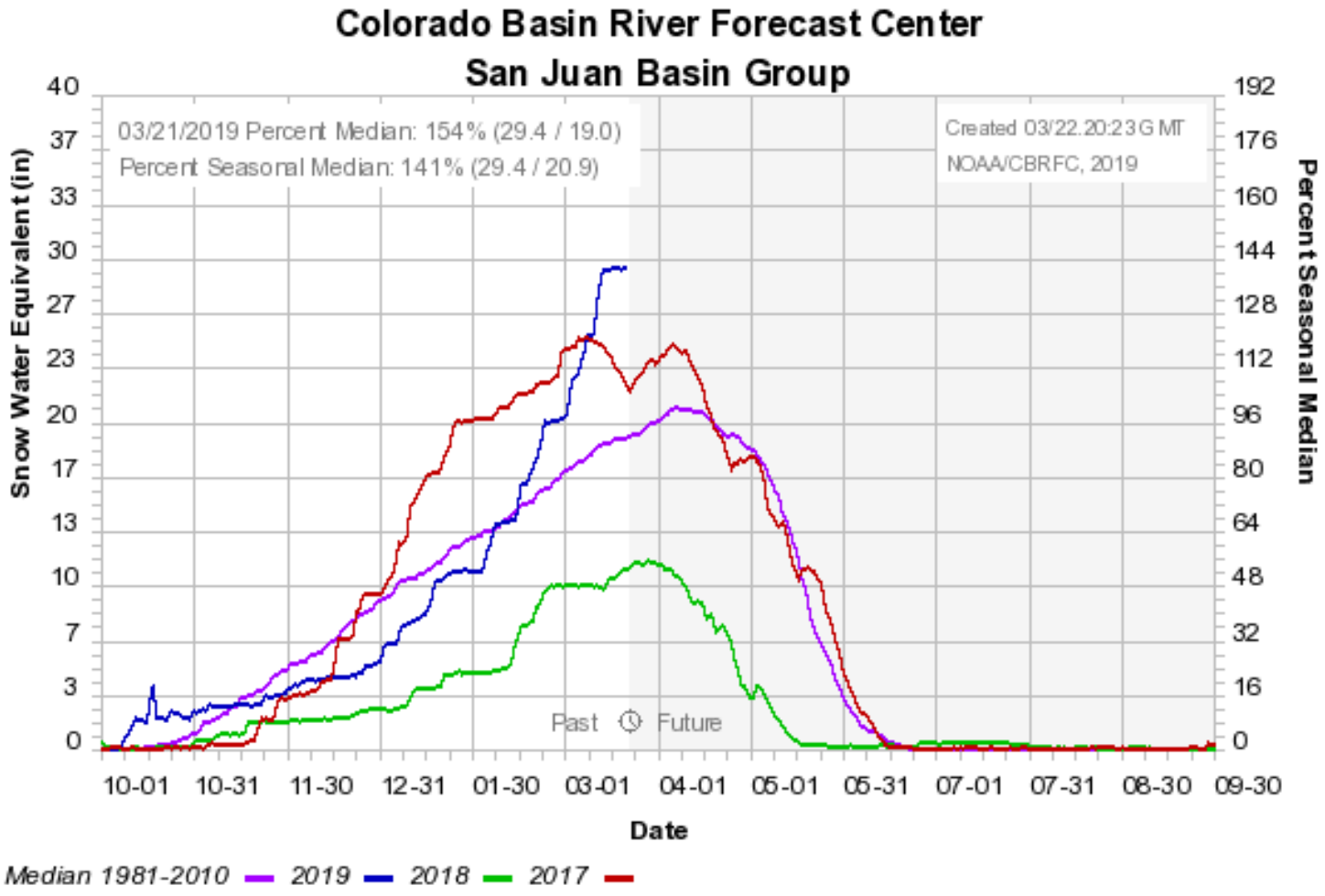
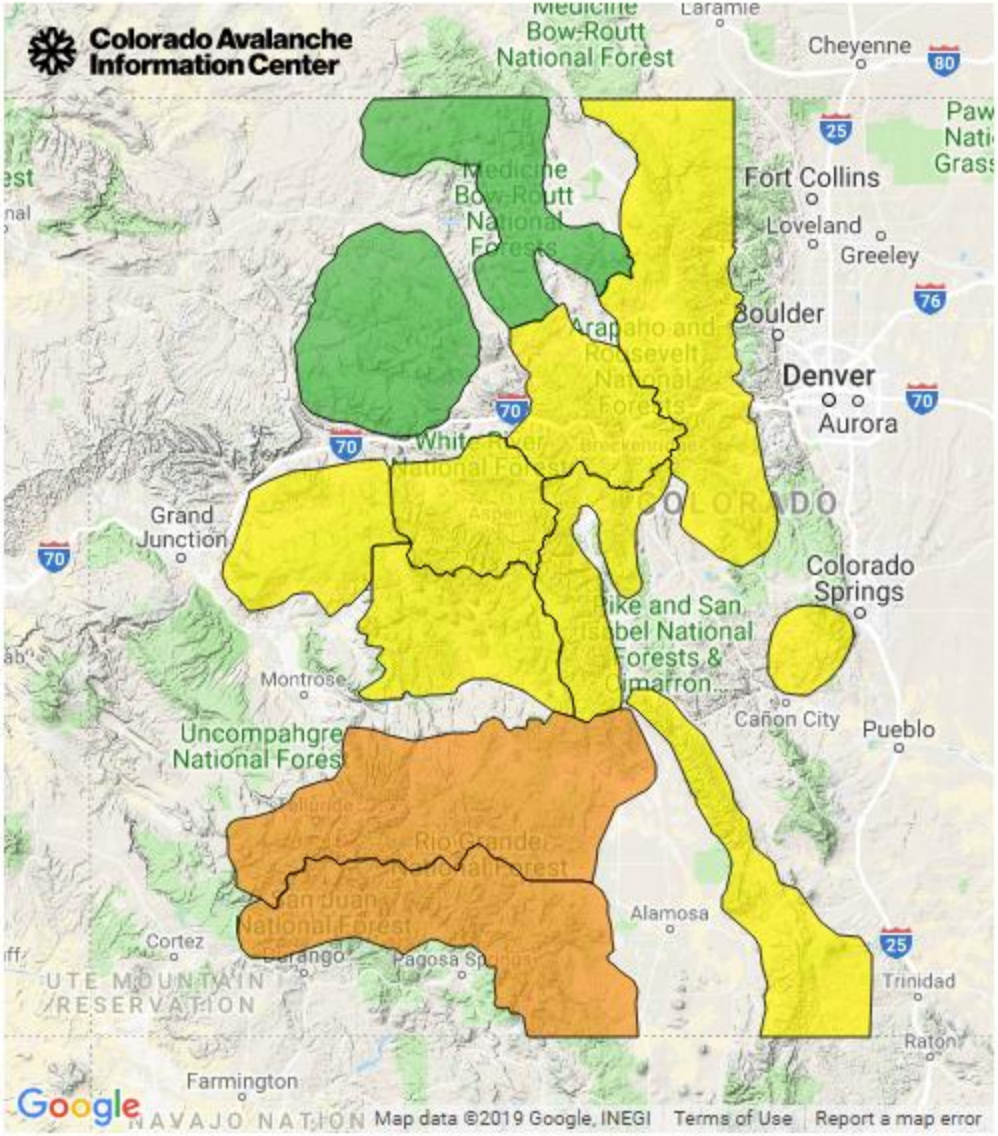
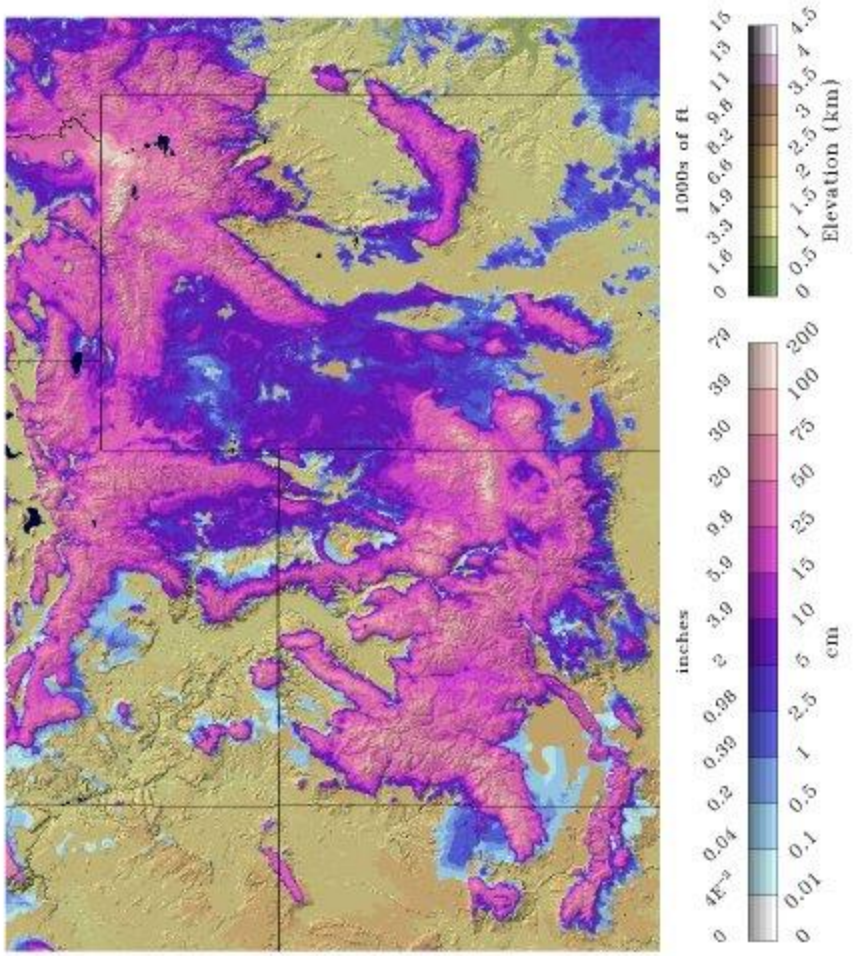



Colorado Avalanche Information Center
Medicine Bow-Routt National Forest
Laramie
Cheyenne
80
25
Fort Collins
Loveland
Greeley
76
Boulder
Denver
70
Aurora
Grand Junction
Colorado Springs
Montrose
Uncompahgre National Forest
Cañon City
Pueblo
Alamosa
Cortez
Durango
Trinidad
UTE MOUNTAIN RESERVATION
Raton
Farmington
NAVAJO NATION
Google
Map data ©2019 Google, INEGI
Terms of Use
Report a map error
— No Rating
1 Low
2 Moderate
3 Considerable
4 High
5 Extreme

Snow Water Equivalent

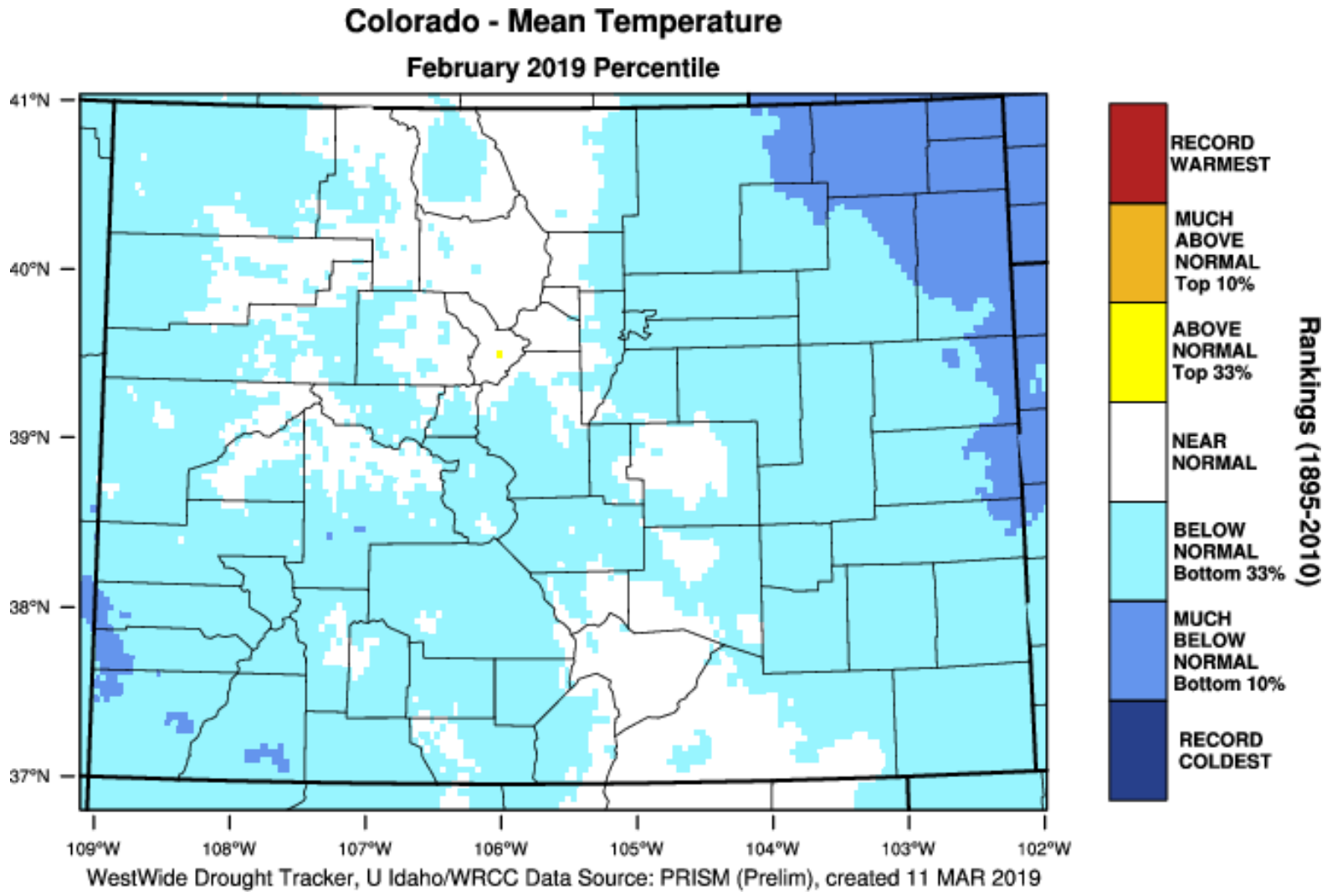
2019-03-22 06 UTC

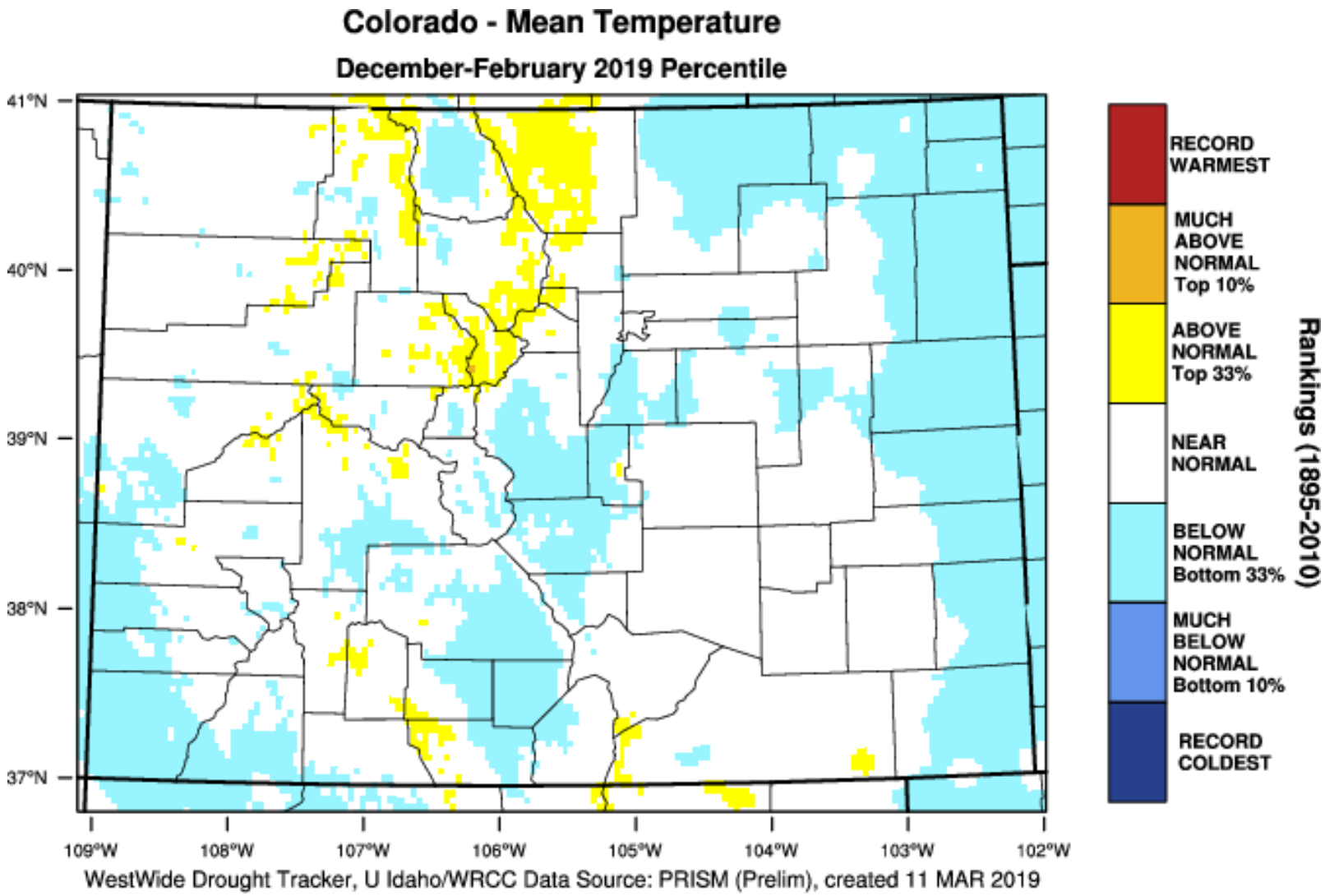


OWP | OFFICE OF WATER PREDICTION

National Snow Analysis 2018-2019

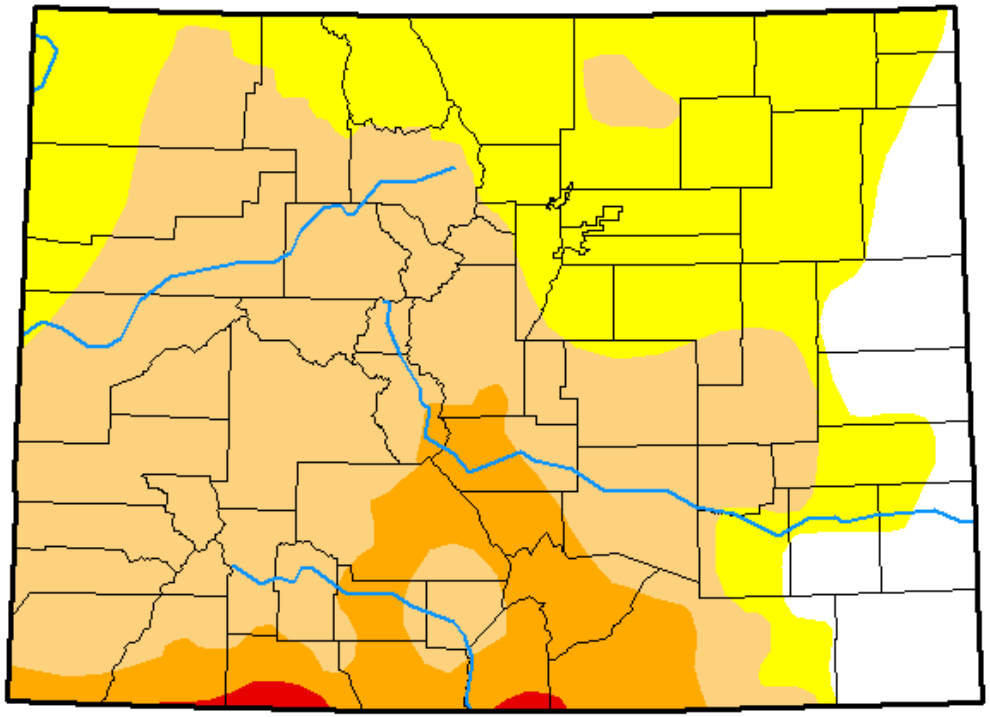
https://www.youtube.com/watch?v=_HJ1P2F4anc


Colorado - Mean Temperature
February 2019 Percentile
41°N
40°N
39°N
38°N
37°N
109°W
108°W
107°W
106°W
105°W
104°W
103°W
102°W
RECORD WARMEST
MUCH ABOVE NORMAL Top 10%
ABOVE NORMAL Top 33%
NEAR NORMAL
BELOW NORMAL Bottom 33%
MUCH BELOW NORMAL Bottom 10%
RECORD COLDEST
Rankings (1895-2010)
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 11 MAR 2019


Colorado - Mean Temperature
December-February 2019 Percentile
41°N
40°N
39°N
38°N
37°N
109°W
108°W
107°W
106°W
105°W
104°W
103°W
102°W
RECORD WARMEST
MUCH ABOVE NORMAL Top 10%
ABOVE NORMAL Top 33%
NEAR NORMAL
BELOW NORMAL Bottom 33%
MUCH BELOW NORMAL Bottom 10%
RECORD COLDEST
Rankings (1895-2010)
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 11 MAR 2019

U.S. Drought Monitor

Colorado



March 5, 2019

(Released Thursday, Mar. 7, 2019)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	10.64	89.36	58.05	12.08	0.58	0.00
Last Week *02-26-2019*	10.64	89.36	62.26	35.26	0.59	0.00
3 Months Ago *12-04-2018*	17.10	82.90	66.26	54.82	27.11	11.22
Start of Calendar Year *01-01-2019*	17.94	82.06	66.26	54.91	27.11	11.22
Start of Water Year *09-25-2018*	14.19	85.81	72.30	64.41	48.47	16.21
One Year Ago *03-06-2018*	10.16	89.84	70.89	45.80	9.28	0.00

Intensity:

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

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

Author:

Eric Luebehusen

U.S. Department of Agriculture

http://droughtmonitor.unl.edu/

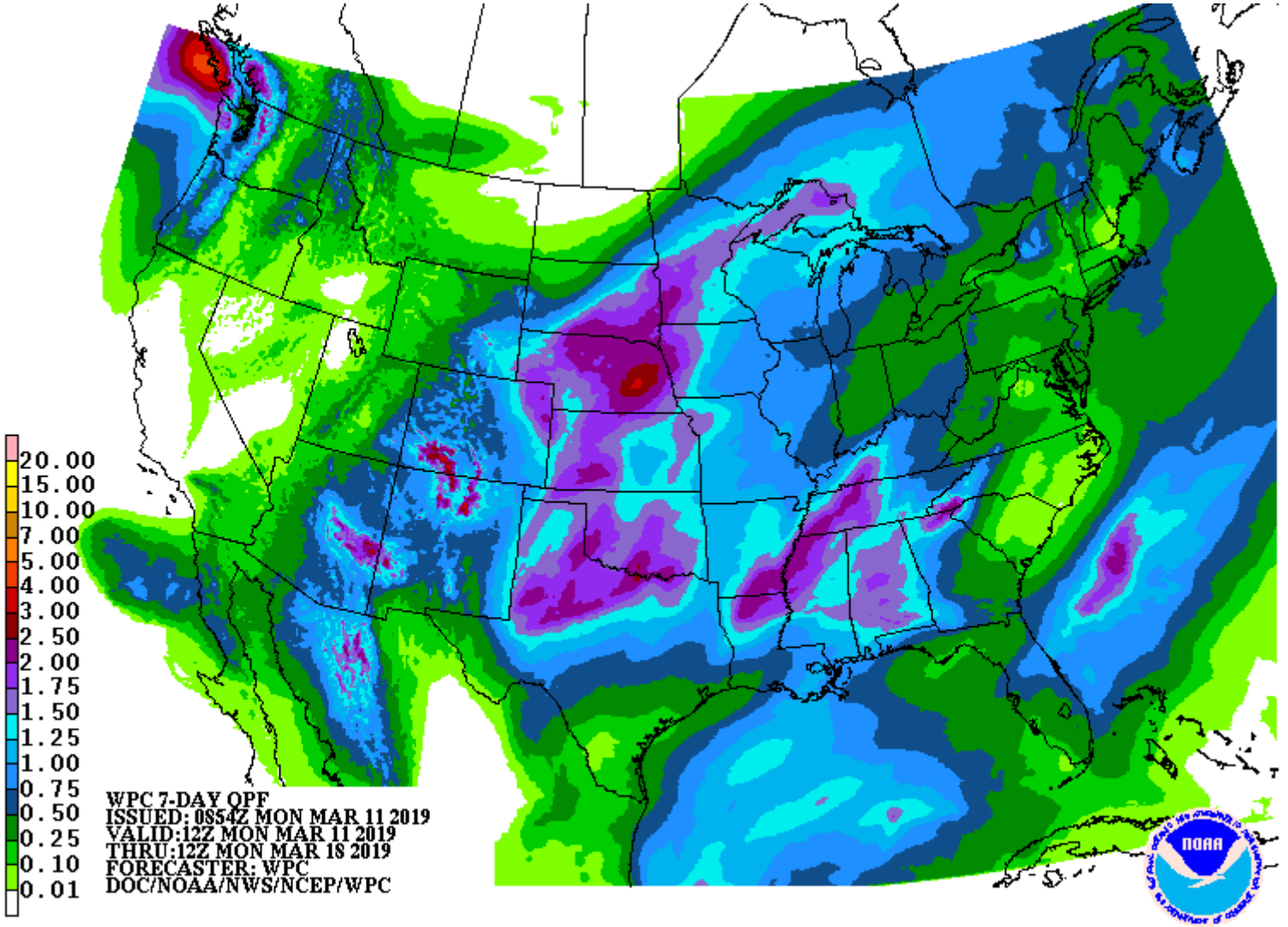
So, what comes next?

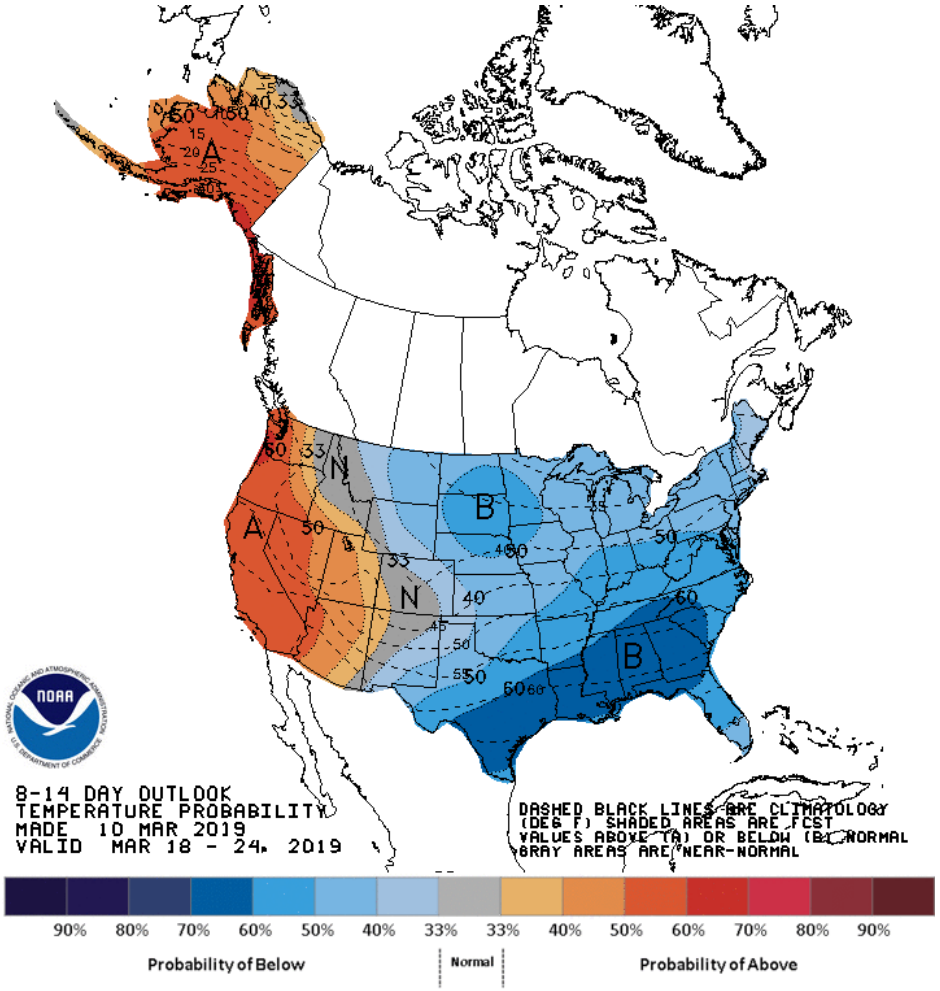
What's hiding around the corner?

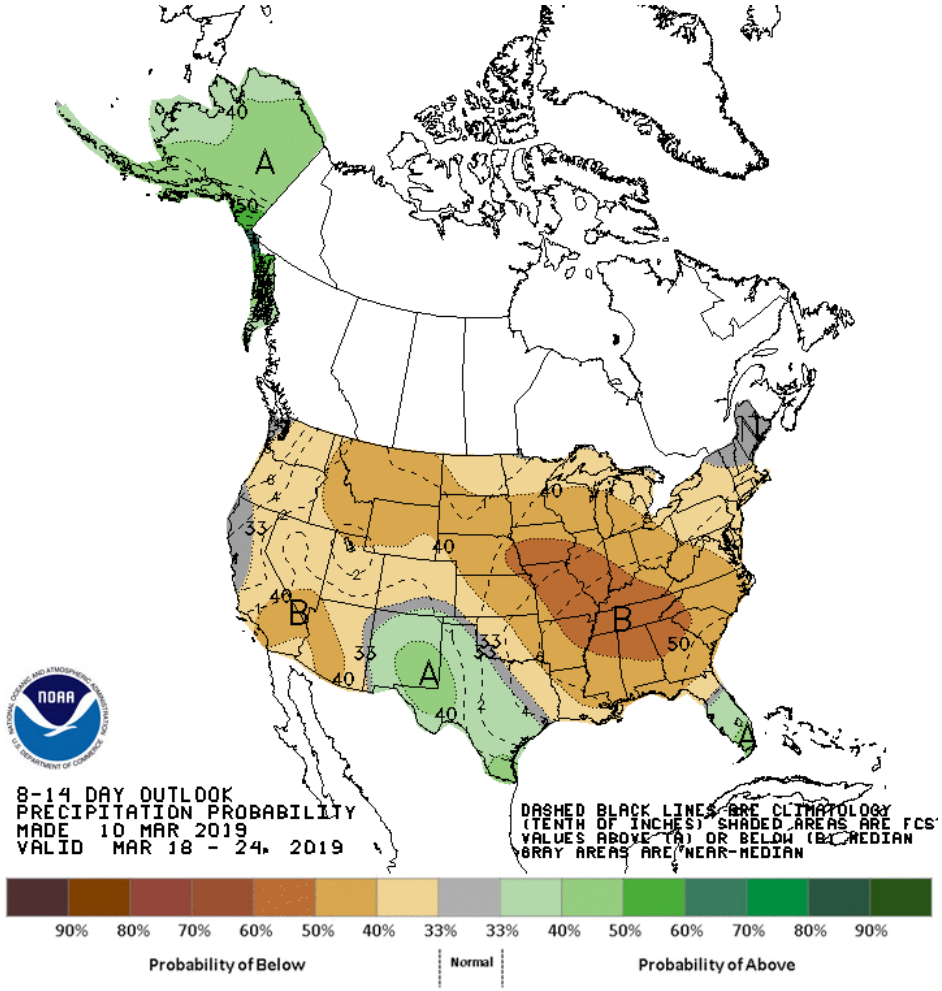
Oh Darn – I forgot.

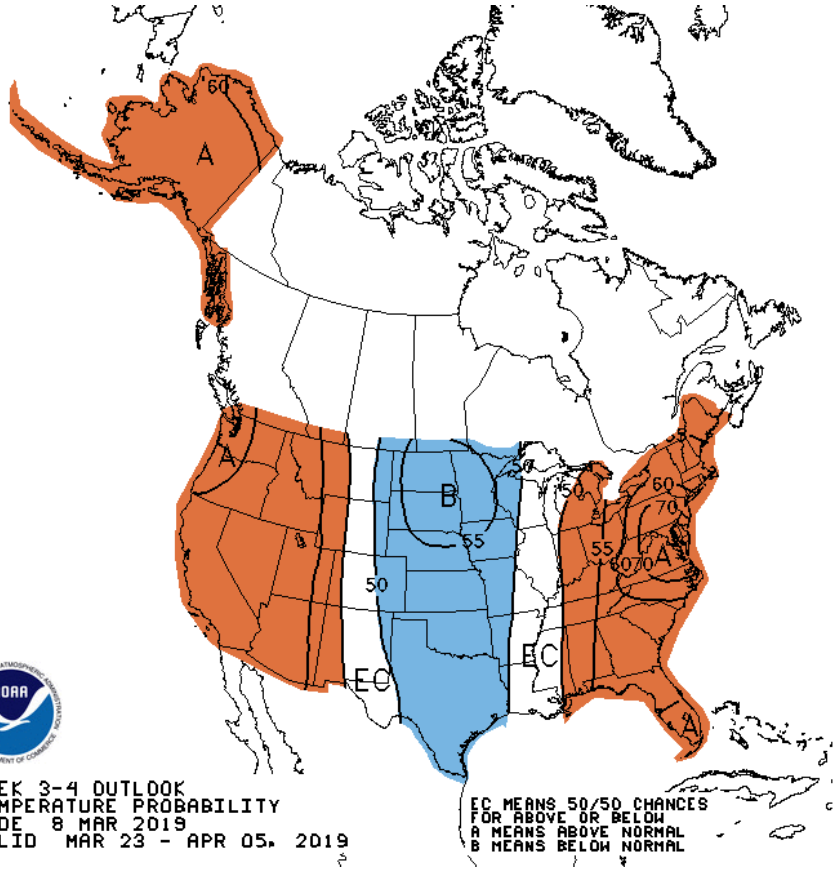
There are no corners

7-day Precipitation Forecast



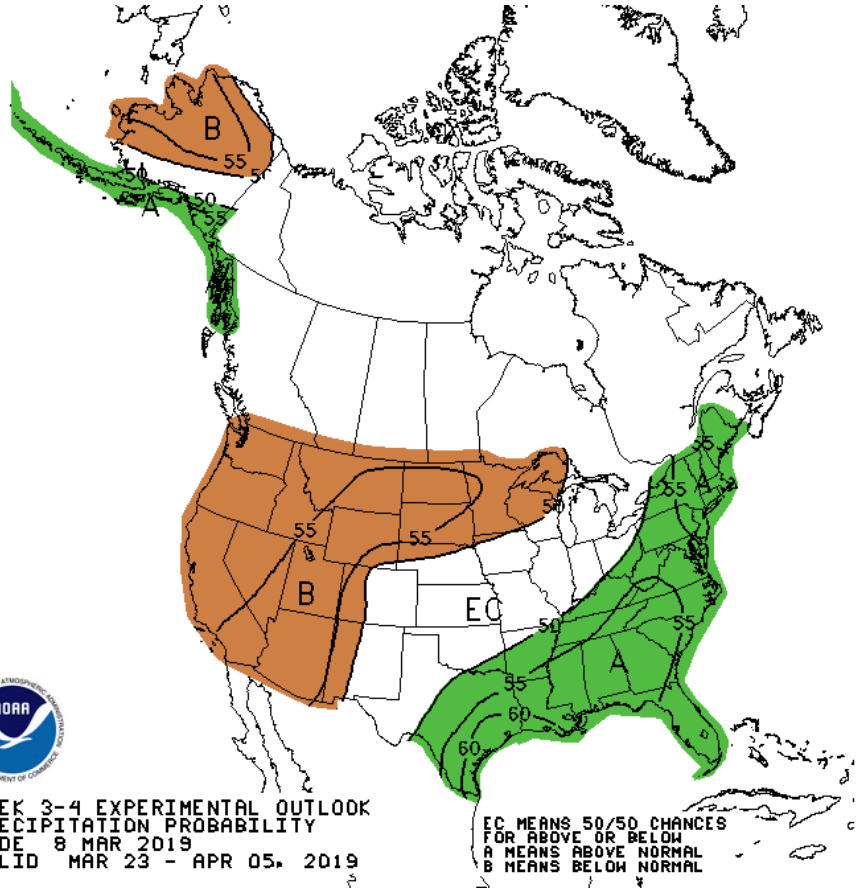

8-14 DAY OUTLOOK
TEMPERATURE PROBABILITY
MADE 10 MAR 2019
VALID MAR 18 - 24, 2019
DASHED BLACK LINES ARE CLIMATOLOGY
(DEG F) SHADED AREAS ARE FCST
VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL
90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%
Probability of Below
Normal
Probability of Above


8-14 DAY OUTLOOK
PRECIPITATION PROBABILITY
MADE 10 MAR 2019
VALID MAR 18 - 24, 2019
DASHED BLACK LINES ARE CLIMATOLOGY
(TENTH OF INCHES) SHADED AREAS ARE FCS
VALUES ABOVE (A) OR BELOW (B) MEDIAN
GRAY AREAS ARE NEAR-MEDIAN
90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%
Probability of Below
Normal
Probability of Above



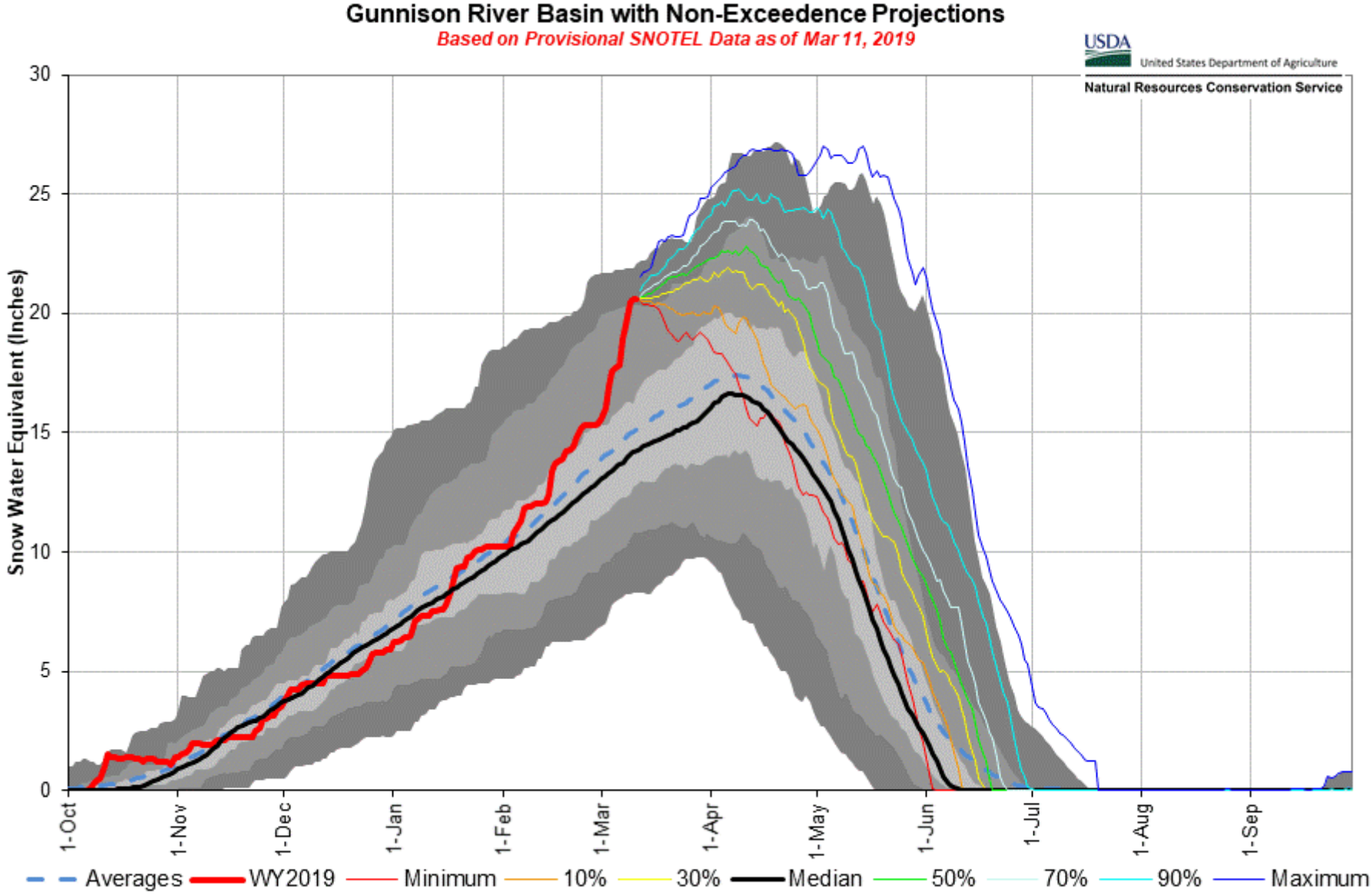
WEEK 3-4 OUTLOOK
TEMPERATURE PROBABILITY
MADE 8 MAR 2019
VALID MAR 23 - APR 05, 2019

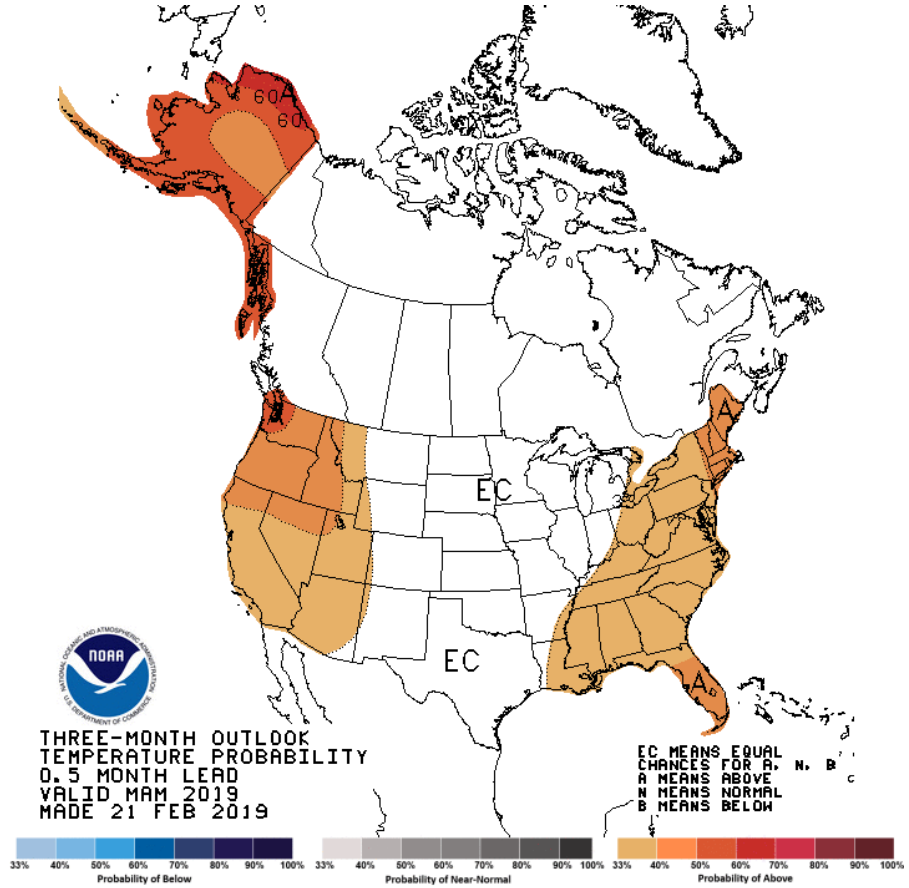
EC MEANS 50/50 CHANCES
FOR ABOVE OR BELOW
A MEANS ABOVE NORMAL
B MEANS BELOW NORMAL

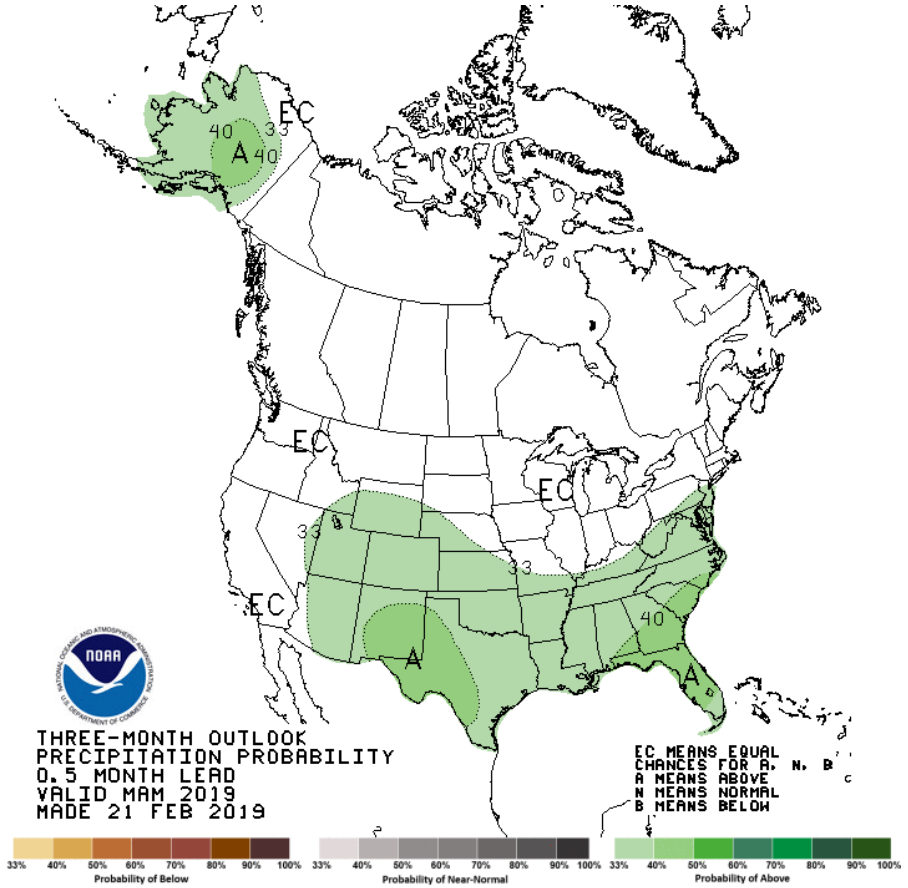


WEEK 3-4 EXPERIMENTAL OUTLOOK
PRECIPITATION PROBABILITY
MADE 8 MAR 2019
VALID MAR 23 - APR 05, 2019

EC MEANS 50/50 CHANCES
FOR ABOVE OR BELOW
A MEANS ABOVE NORMAL
B MEANS BELOW NORMAL


Gunnison River Basin with Non-Exceedence Projections
Based on Provisional SNOTEL Data as of Mar 11, 2019
USDA
United States Department of Agriculture
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
Averages
WY2019
Minimum
10%
30%
Median
50%
70%
90%
Maximum


60A
60
A
EC
EC
A
THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
0.5 MONTH LEAD
VALID MAM 2019
MADE 21 FEB 2019
EC MEANS EQUAL
CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Below
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Near-Normal
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Above


EC
40
33
A
40
EC
EC
33
33
EC
40
A
A
THREE-MONTH OUTLOOK
PRECIPITATION PROBABILITY
0.5 MONTH LEAD
VALID MAM 2019
MADE 21 FEB 2019
EC MEANS EQUAL
CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Below
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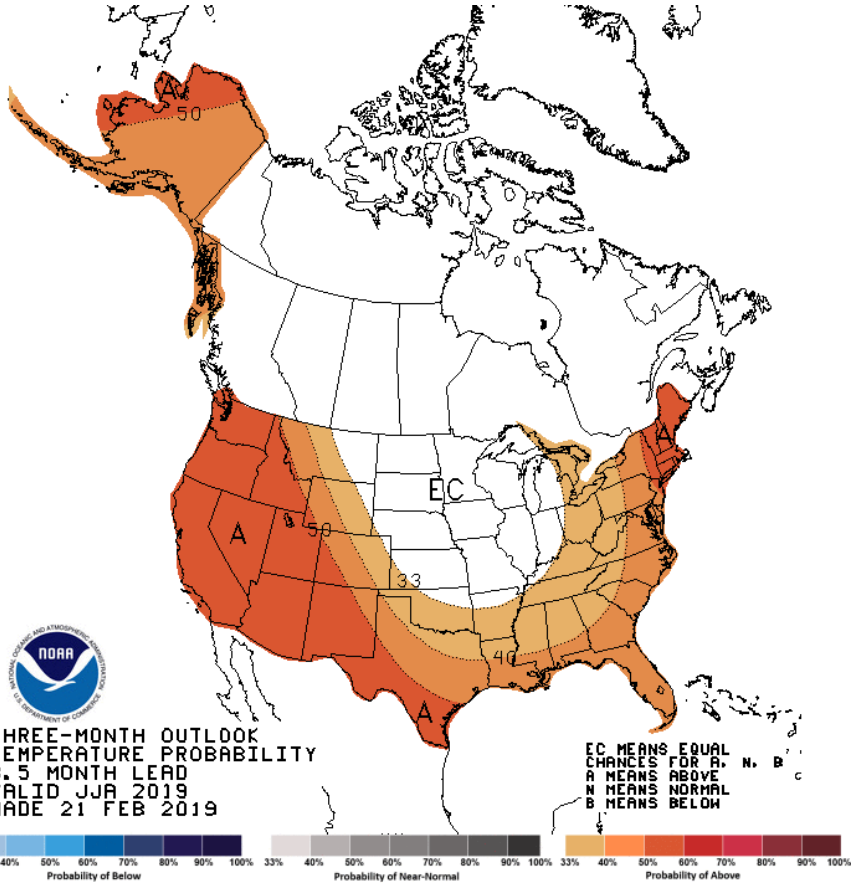
A
50
A
50
EC
33
40
A
A
THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
3.5 MONTH LEAD
VALID JJA 2019
MADE 21 FEB 2019
EC MEANS EQUAL CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Below
33% 40% 50% 60% 70% 80% 90% 100%
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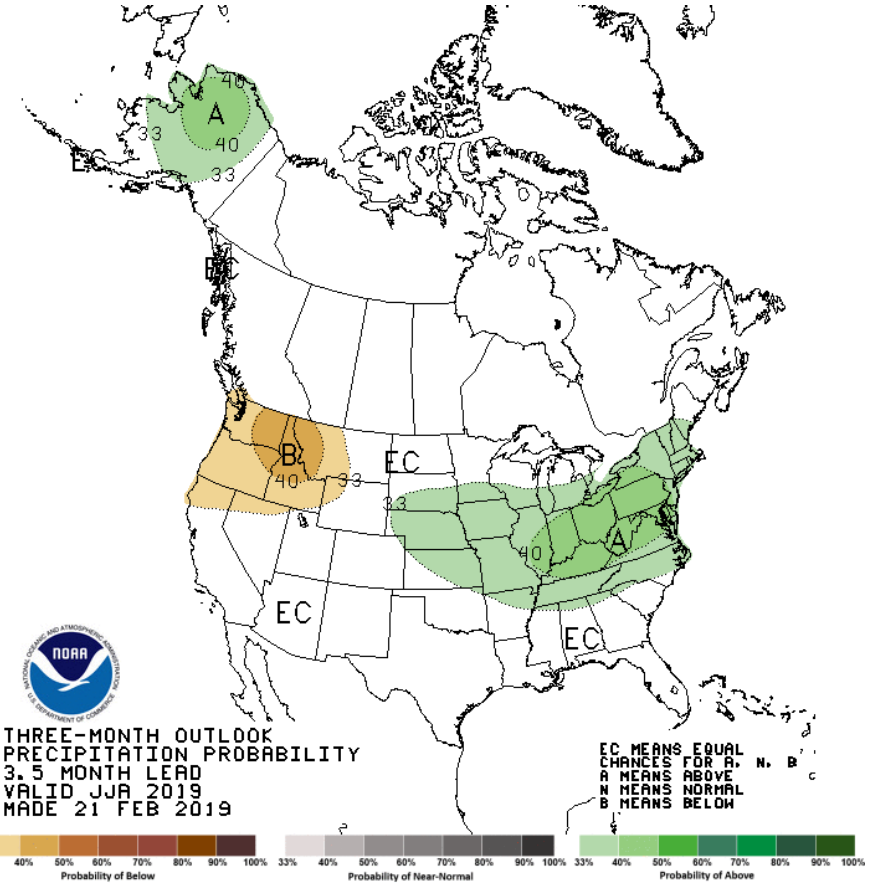
A
40
33
33
EC
B
40
33
EC
33
40
A
EC
EC
THREE-MONTH OUTLOOK
PRECIPITATION PROBABILITY
3.5 MONTH LEAD
VALID JJA 2019
MADE 21 FEB 2019
EC MEANS EQUAL CHANCES FOR A, N, B
A MEANS ABOVE
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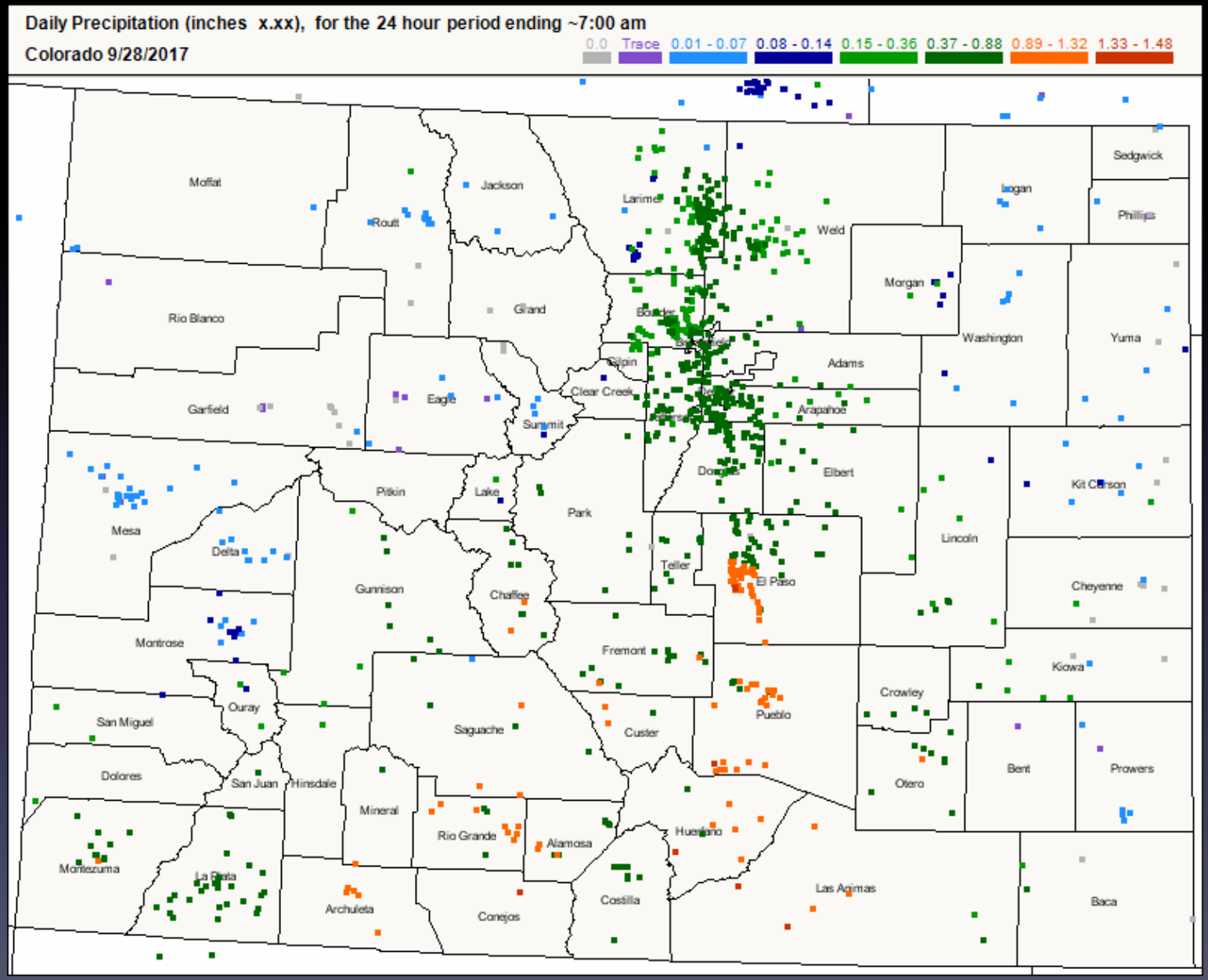
Probability of Below
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Near-Normal
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Above

Precipitation is incredibly important and perplexingly variable

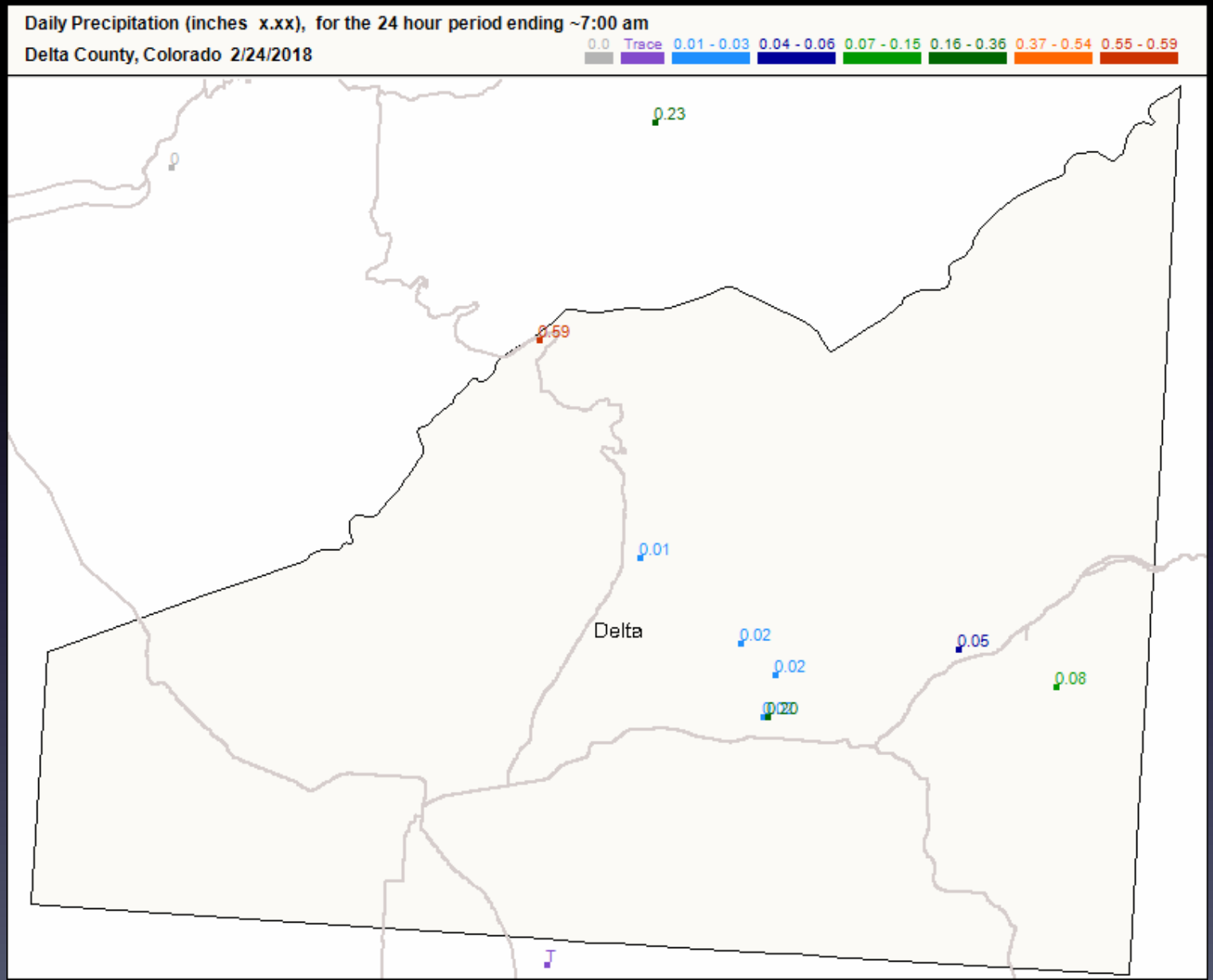
Photo Credit: Henry Reges

And we could use your help!

28 Sep 2017 The Power of Volunteers with gauges



Delta County CO -- CoCoRaHS Precipitation stations.



When in doubt, help us out!
Help measure and report rainfall!

THANKS to you who measure or provide support

Photos by H. Reges

If you are interested in contributing your DOT ON THE MAP, please join the Community Collaborative Rain, Hail and Snow Network

http://www.cocorahs.org

or see me today

For information and to volunteer, visit the CoCoRaHS Web Site

www.cocorahs.org

OR SEE ME TODAY!

Support for this project provided by
NSF Informal Science Education Program,
NOAA Environmental Literacy Program
and
many local charter sponsors.

Our website:

- http://ccc.atmos.colostate.edu/

Colorado State University