Colorado Climate Update for WATF

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Director, Colorado Climate Center
Department of Atmospheric Science, Colorado State University

Along with: Zach Schwalbe, Becky Bolinger, Peter Goble, Dani Talmadge, Nolan Doesken

COLORADO CLIMATE CENTER

Water Availability Task Force meeting
March 2019

ATMOSPHERIC SCIENCE
COLORADO STATE UNIVERSITY

COLORADO
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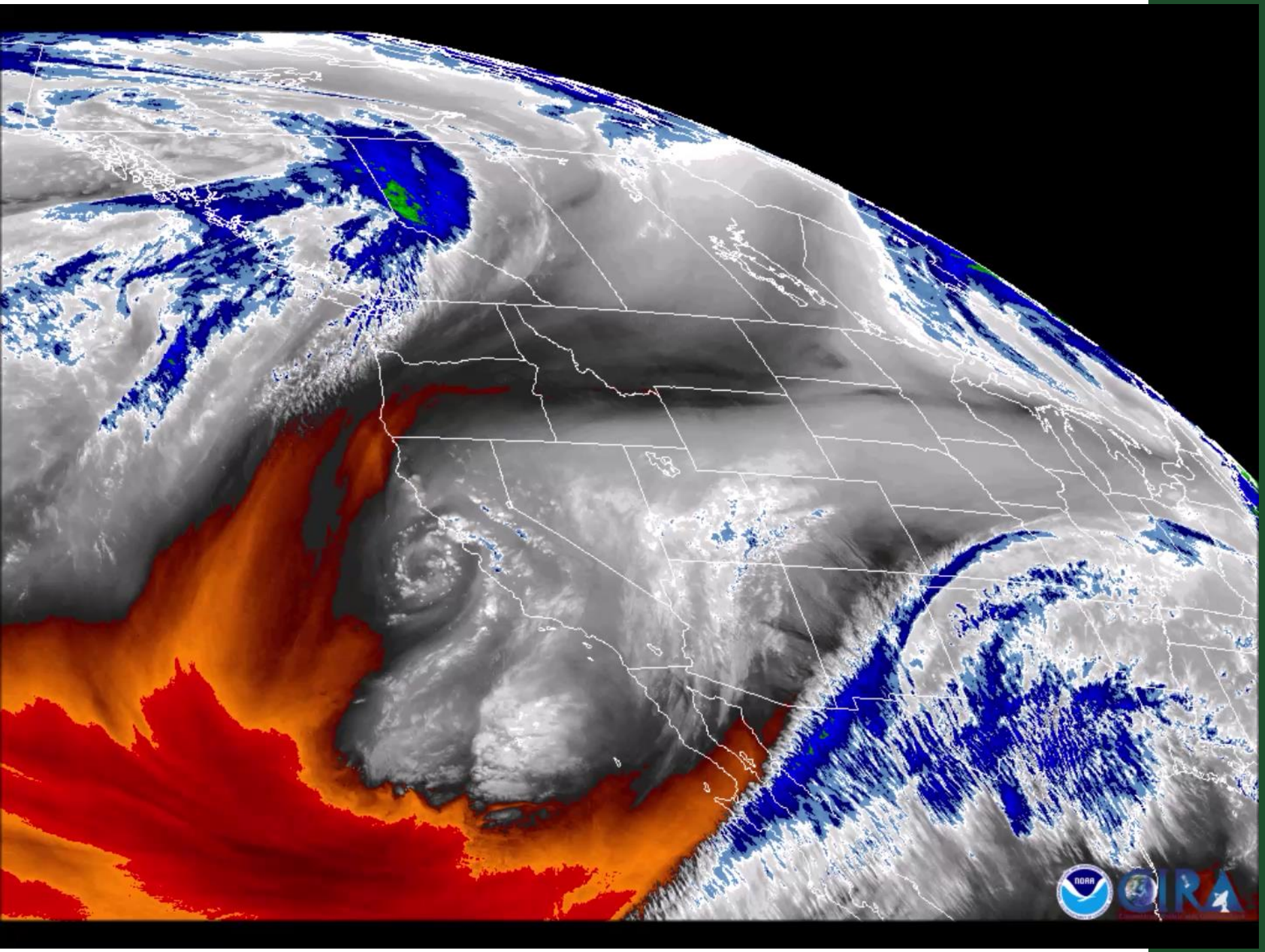
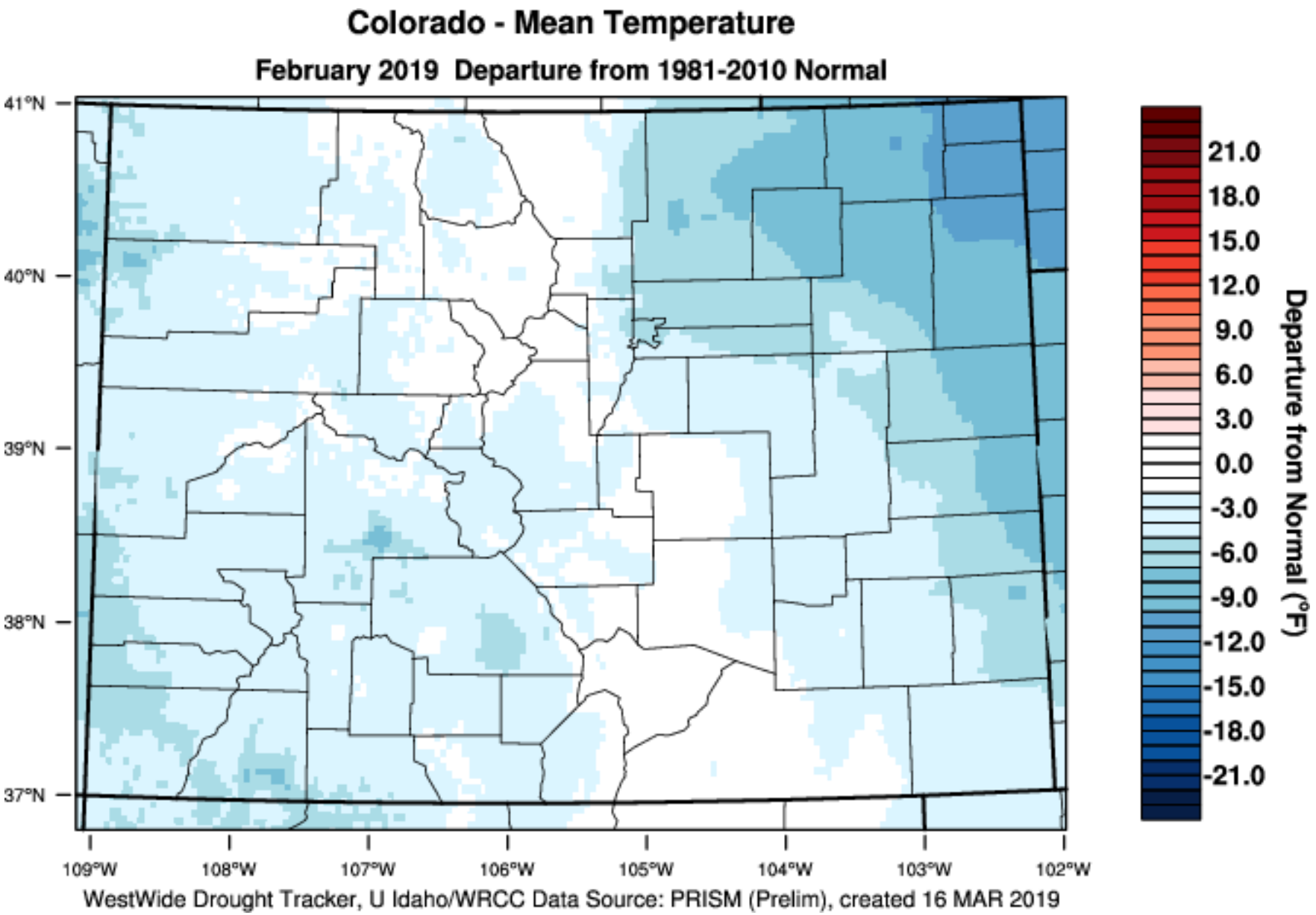
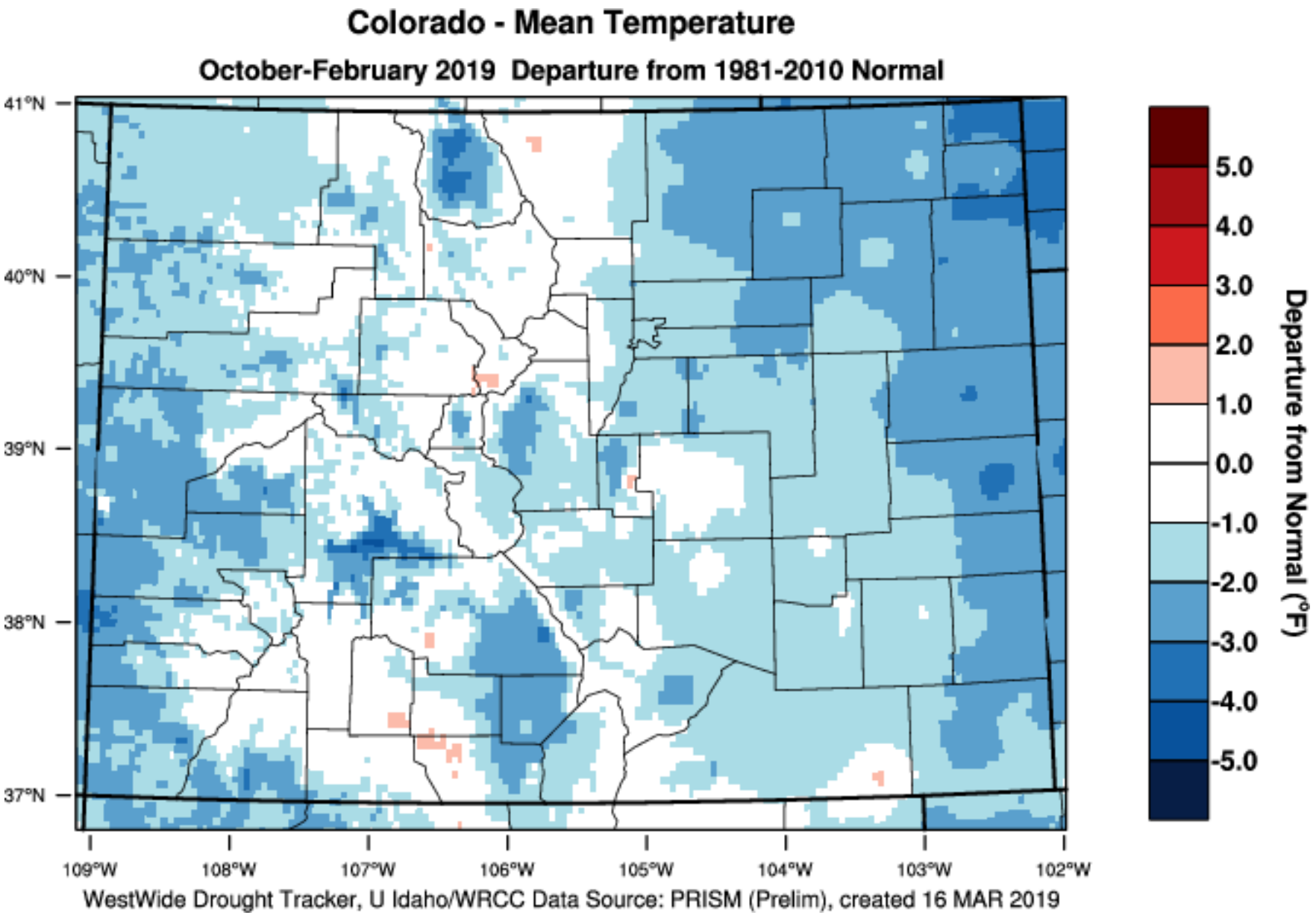
CENTER



Water Year 2019 – Temperature


Colorado - Mean Temperature
February 2019 Departure from 1981-2010 Normal
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
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0.0
-3.0
-6.0
-9.0
-12.0
-15.0
-18.0
-21.0
Departure from Normal (°F)
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 MAR 2019


Colorado - Mean Temperature
October-February 2019 Departure from 1981-2010 Normal
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
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
Departure from Normal (°F)
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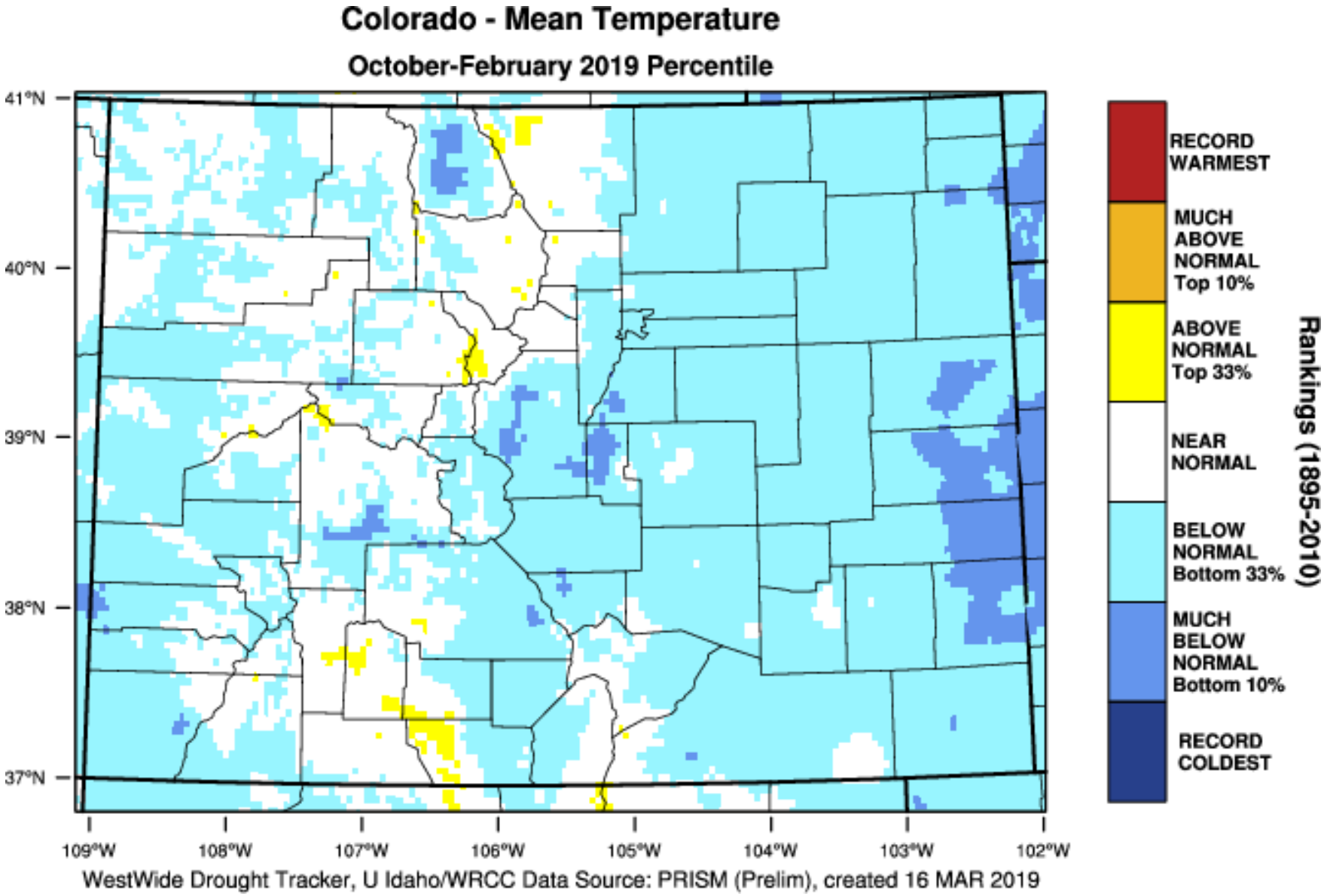
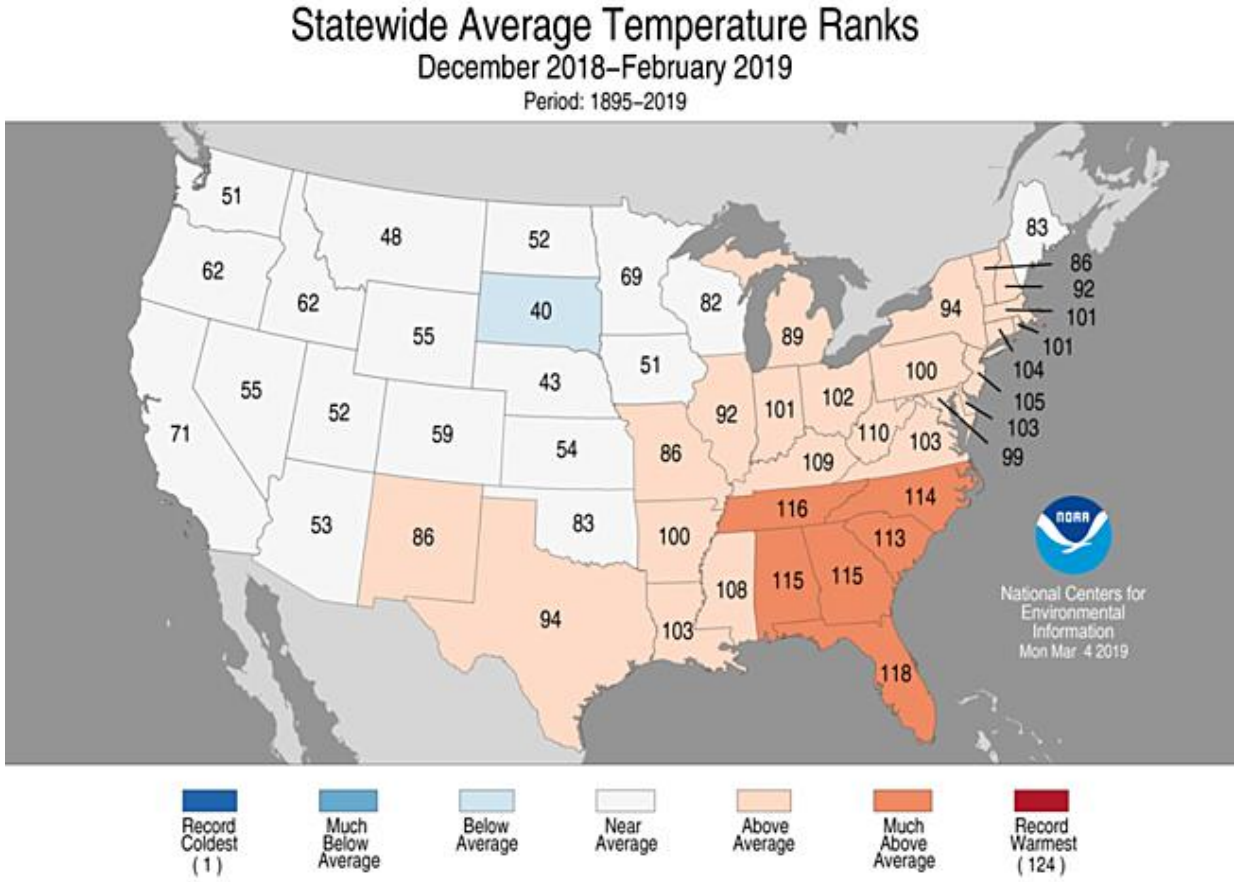
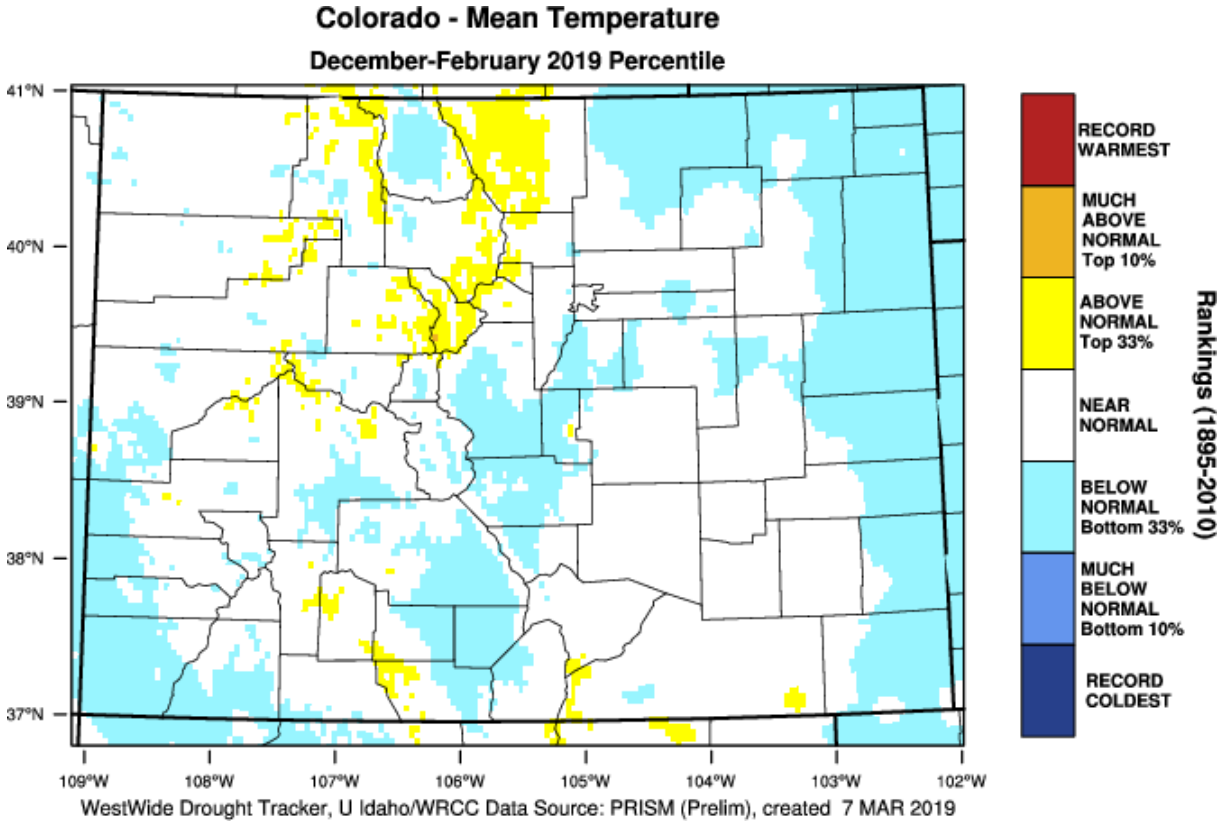
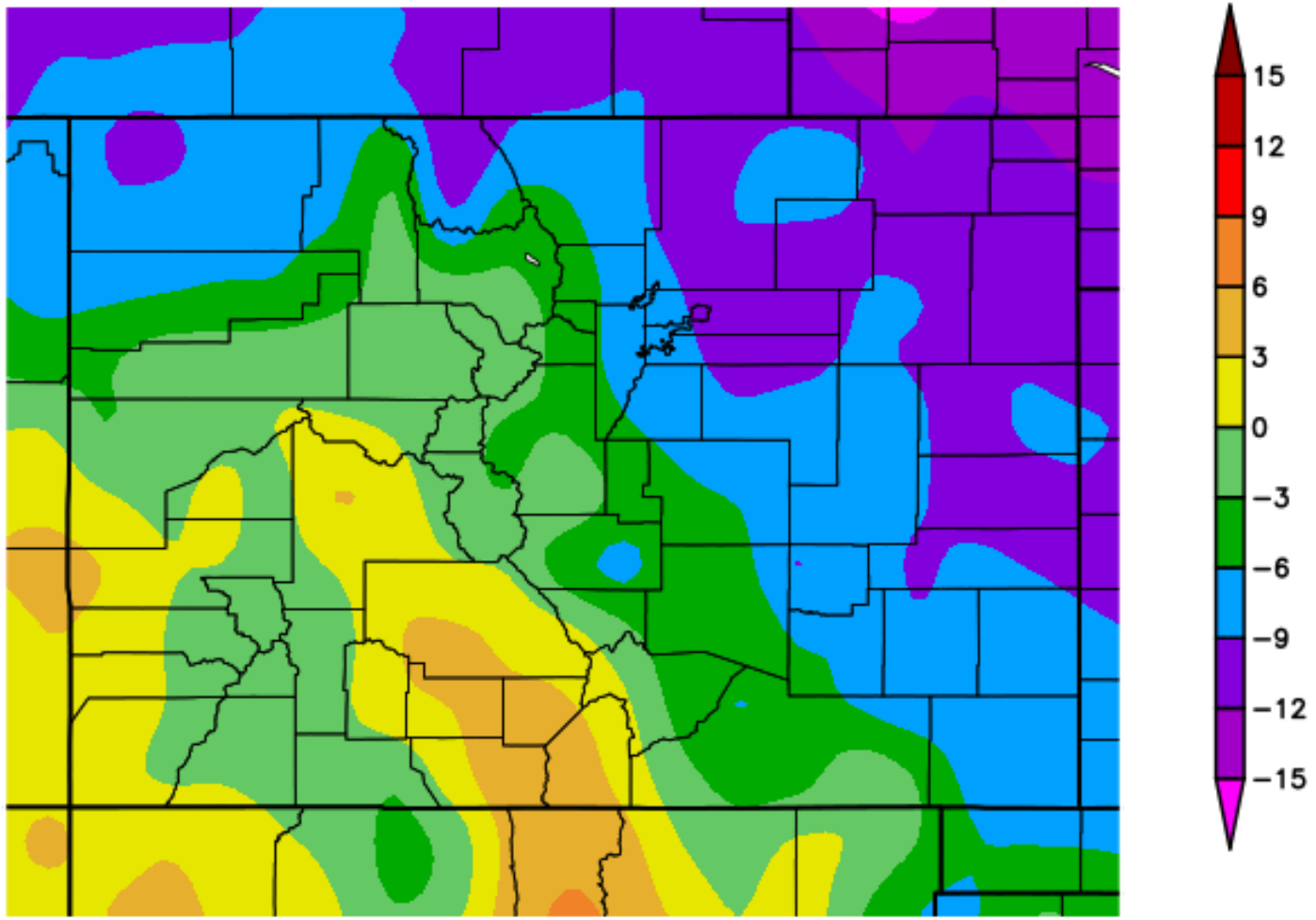

Colorado - Mean Temperature
October-February 2019 Percentile
41°N
40°N
39°N
38°N
37°N
109°W
108°W
107°W
106°W
105°W
104°W
103°W
102°W
RECORD WARMEST
MUCH ABOVE NORMAL Top 10%
ABOVE NORMAL Top 33%
NEAR NORMAL
BELOW NORMAL Bottom 33%
MUCH BELOW NORMAL Bottom 10%
RECORD COLDEST
Rankings (1895-2010)
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 MAR 2019

Winter summary





Departure from Normal Temperature (F)
3/1/2019 – 3/17/2019



Generated 3/18/2019 at HPRCC using provisional data.

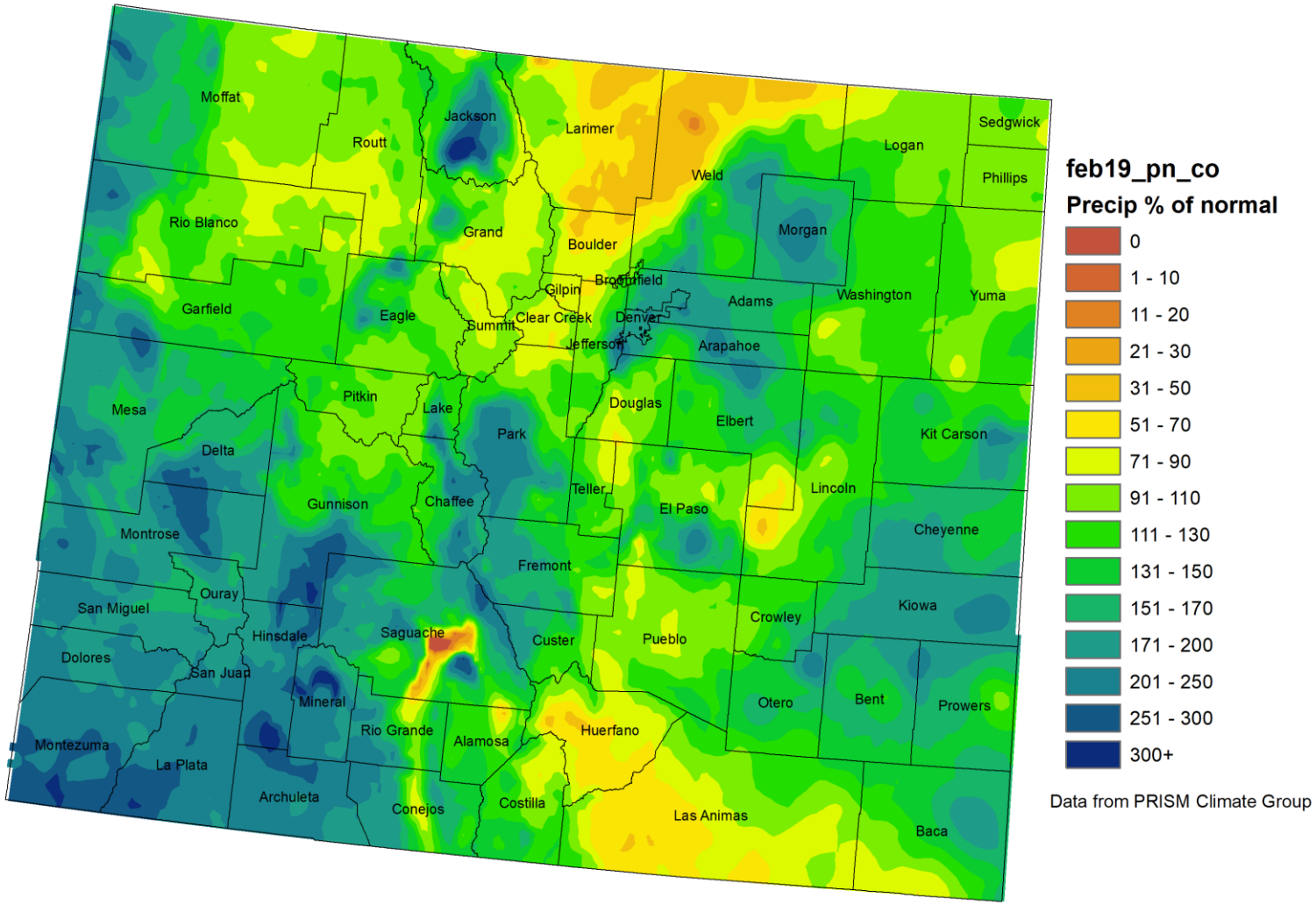
NOAA Regional Climate Centers

COLORADO CLIMATE CENTER

Water Year 2019 – Precipitation

https://bloximages.newyork1.vip.townnews.com/gazette.com/content/tncms/assets/v3/editorial/9/f2/9f22e48a-45d0-11e9-827f-034e3efb093d/5c896b61a8f4f.image.jpg?resize=1200%2C786

Colorado February 2019 Precipitation as a Percentage of Normal

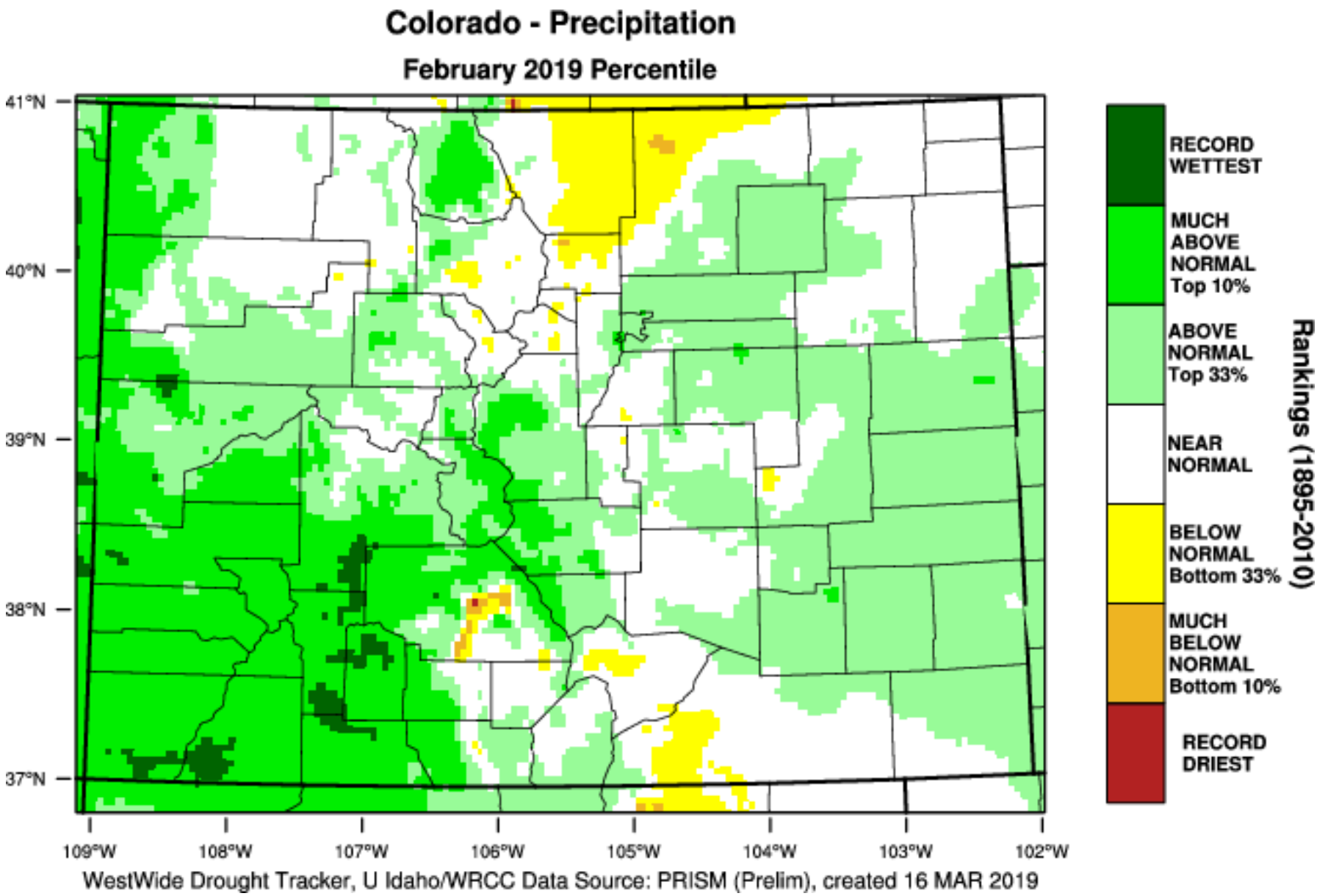


feb19_pn_co

Precip % of 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+

Data from PRISM Climate Group


Colorado - Precipitation
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RECORD WETTEST
MUCH ABOVE NORMAL Top 10%
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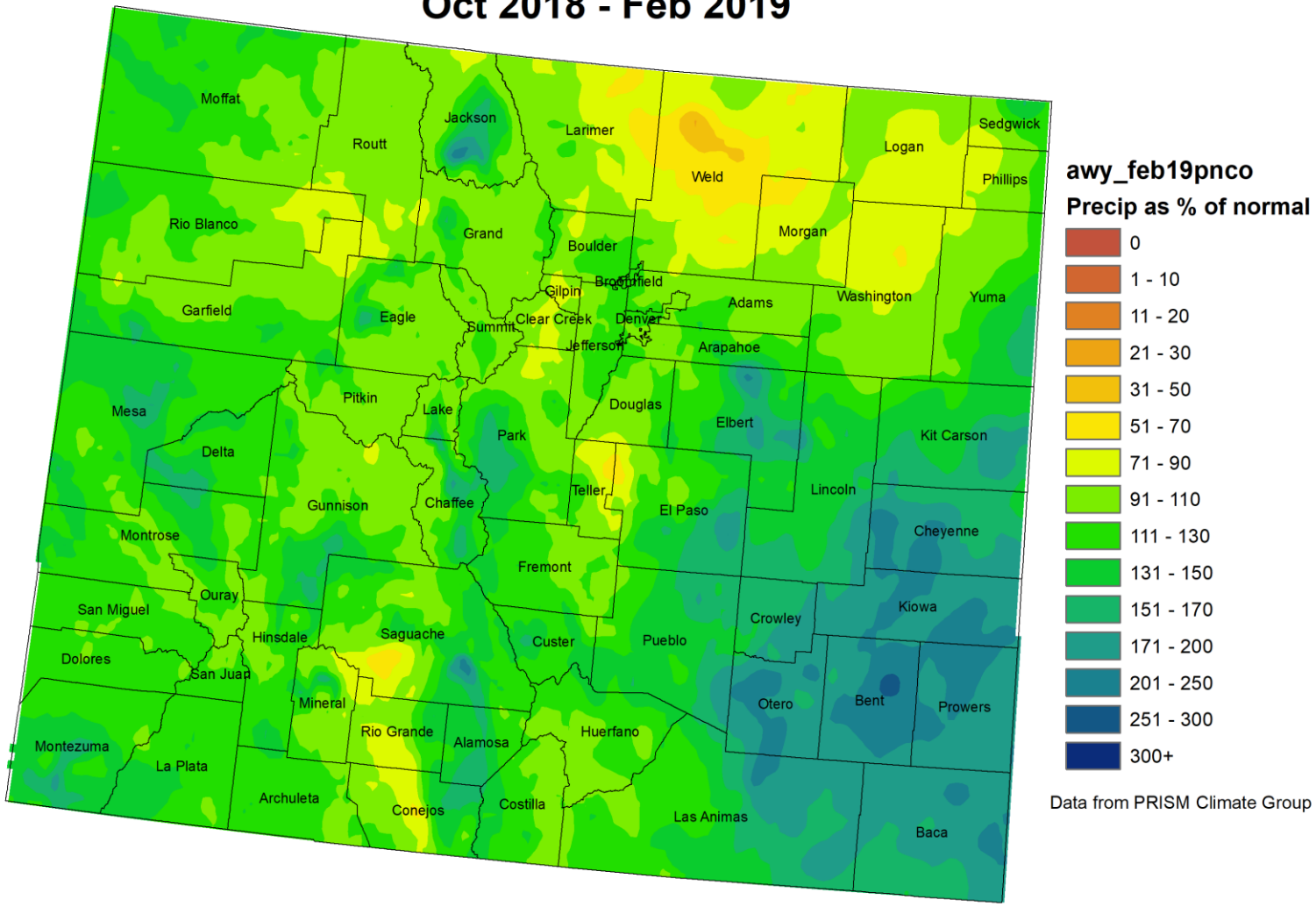
NEAR NORMAL
BELOW NORMAL Bottom 33%
MUCH BELOW NORMAL Bottom 10%
RECORD DRIEST
Rankings (1895-2010)
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 MAR 2019

Colorado Water Year 2019 Precipitation as a Percentage of Normal Oct 2018 - Feb 2019



awy_feb19pnco

Precip as % of normal

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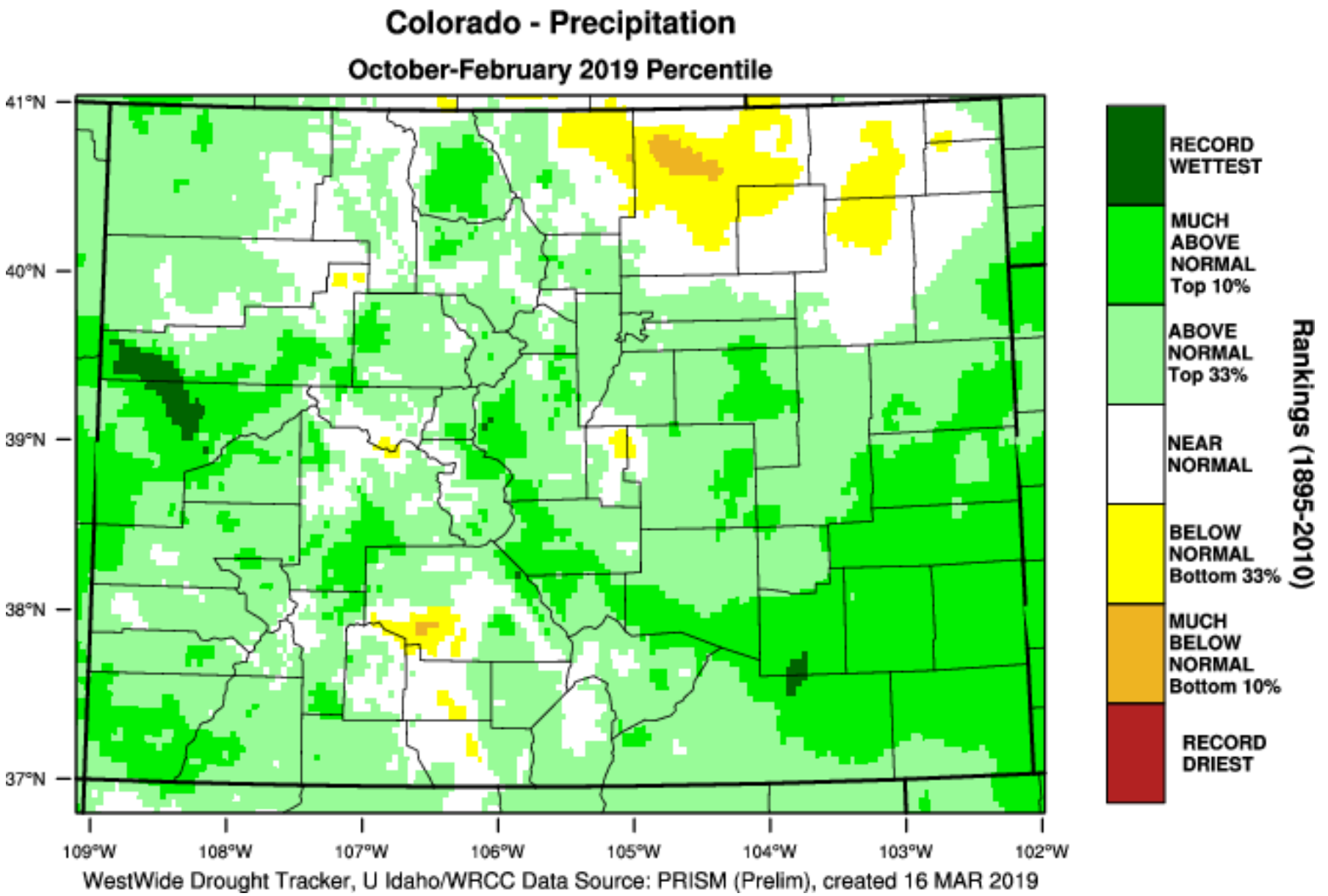
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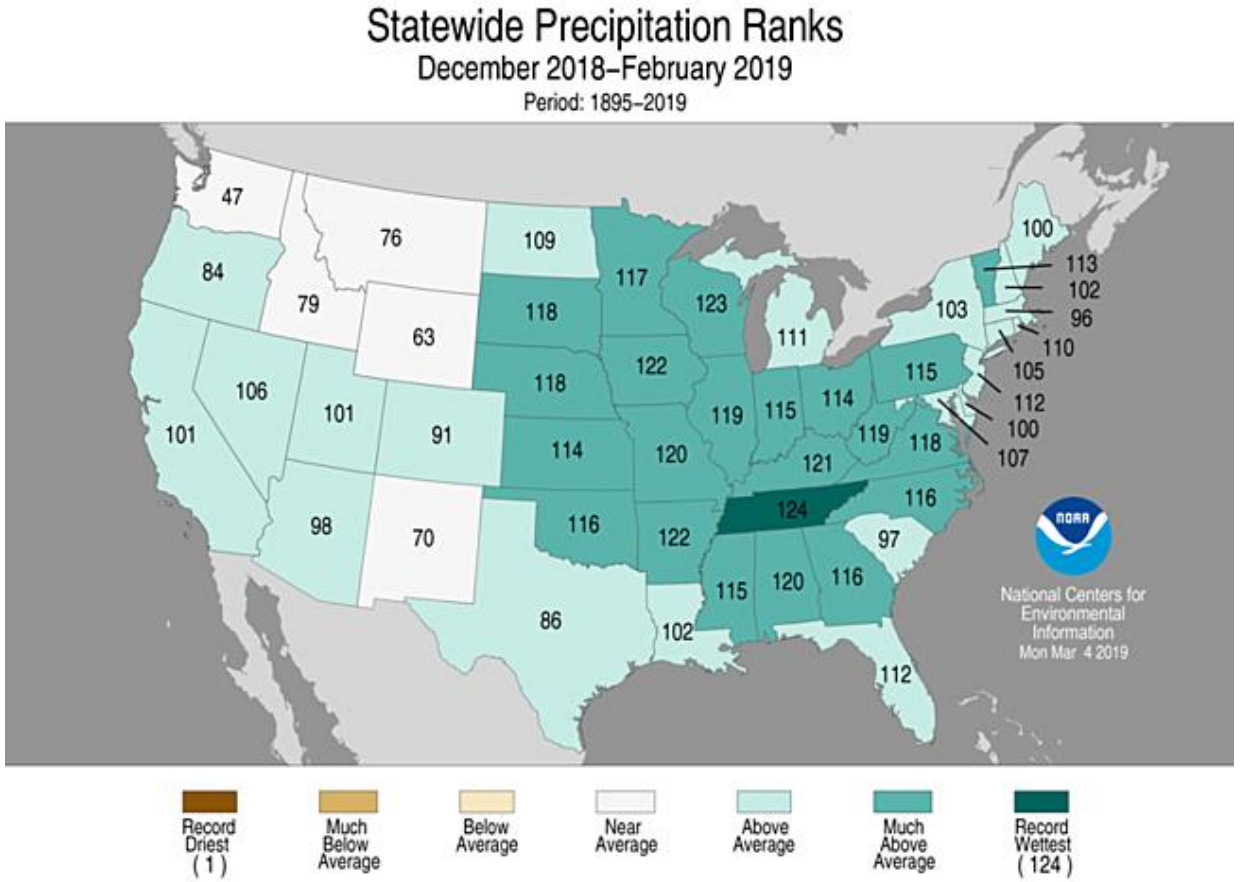
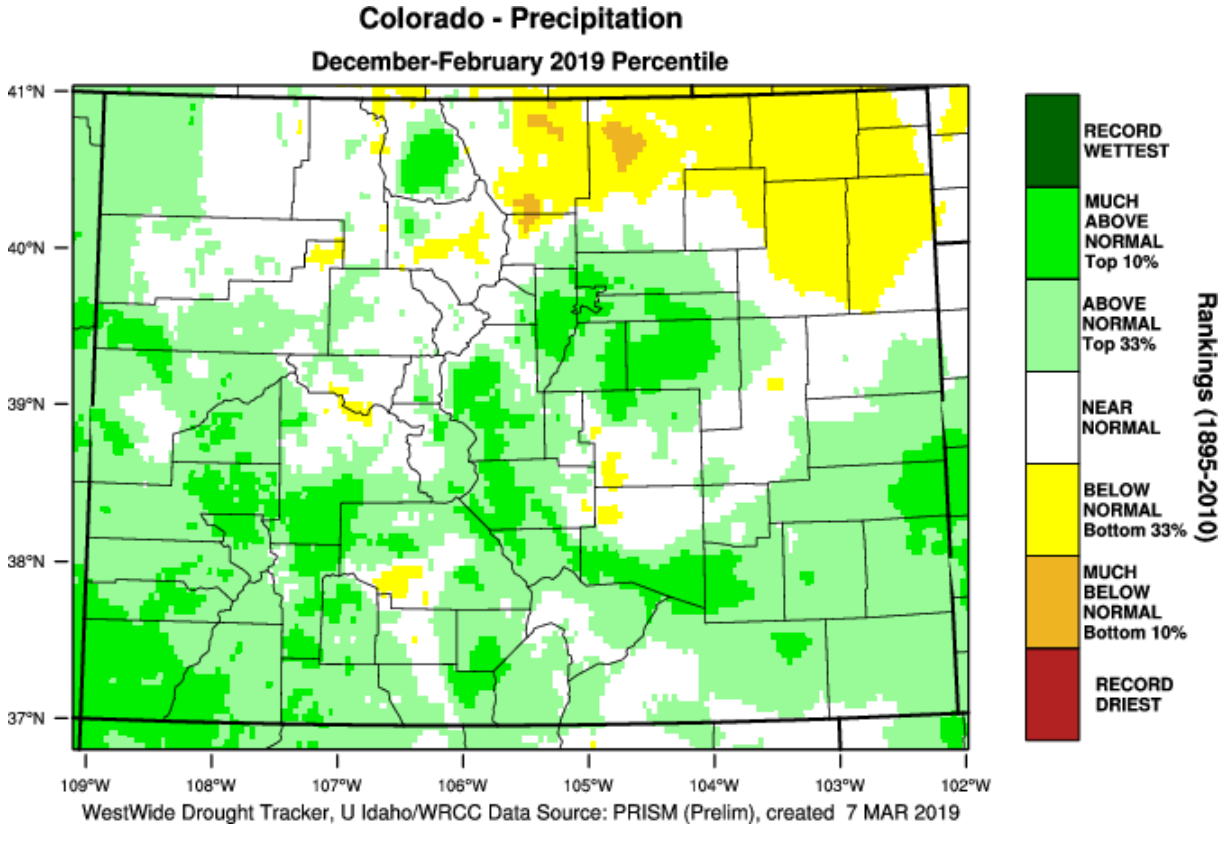
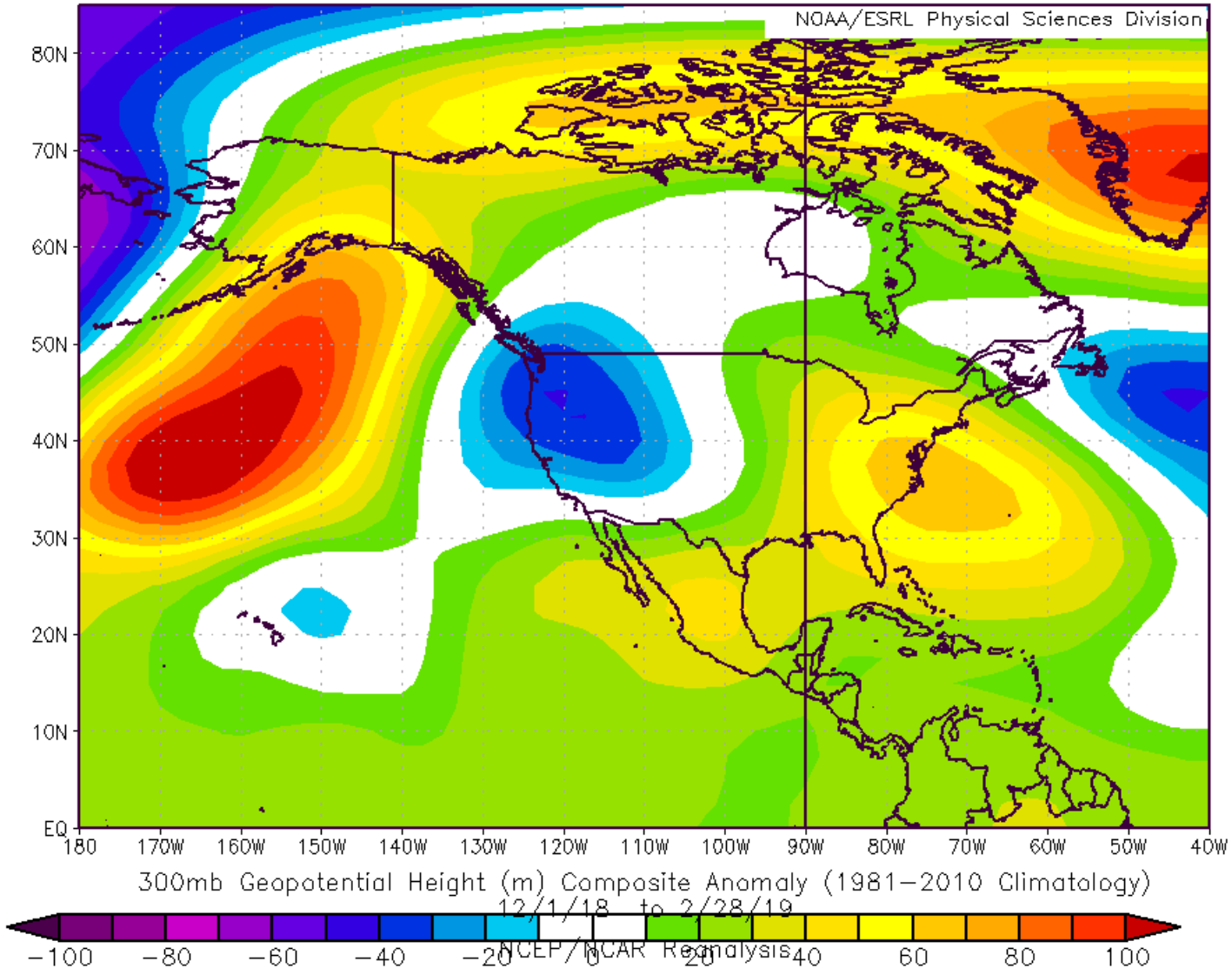




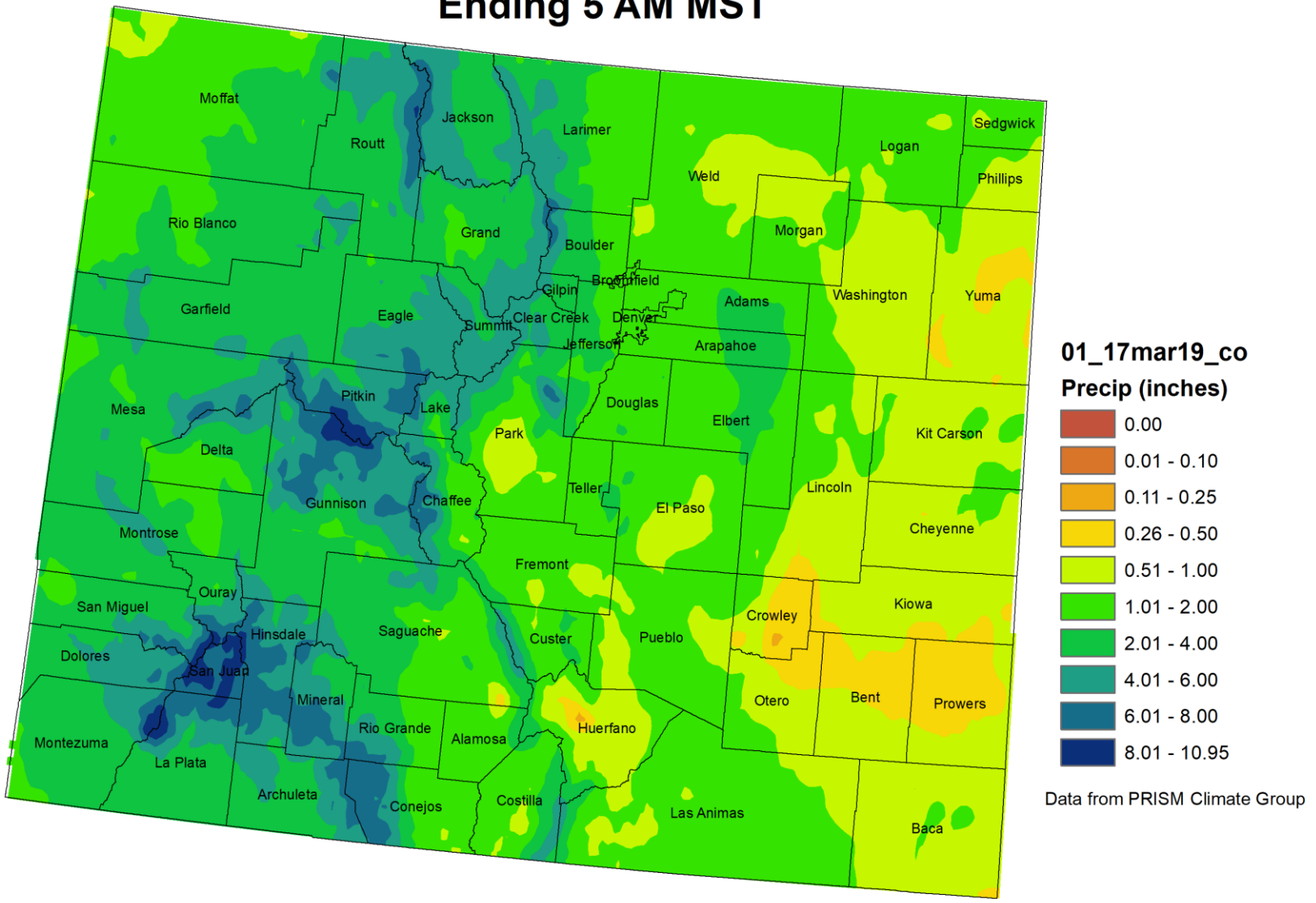
For continental US as a whole, wettest winter on record

Upper-level meteorology: how did the jet stream compare to typical winter?

Position of upper-level waves supported a very active storm track through Colorado



Colorado Month to Date Precipitation
1 - 17 March 2019
Ending 5 AM MST



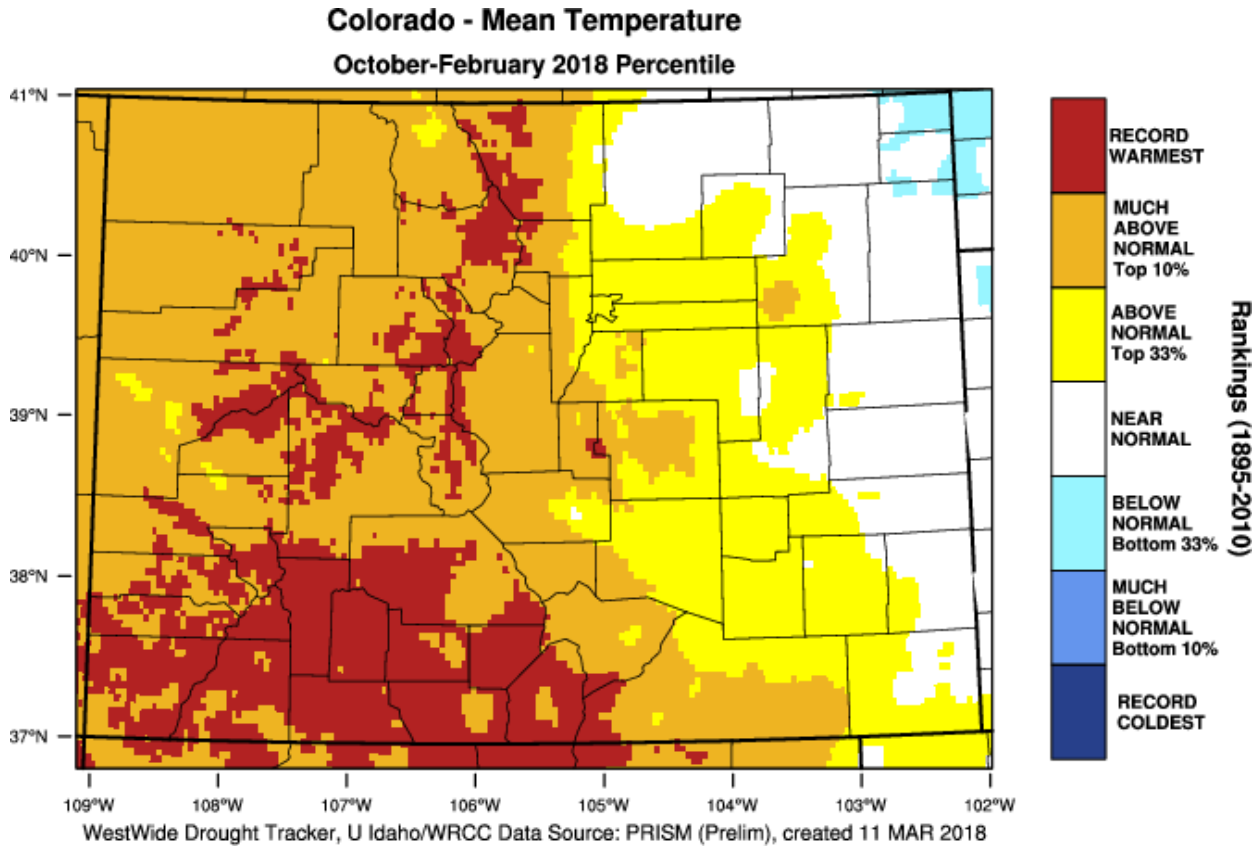
01_17mar19_co

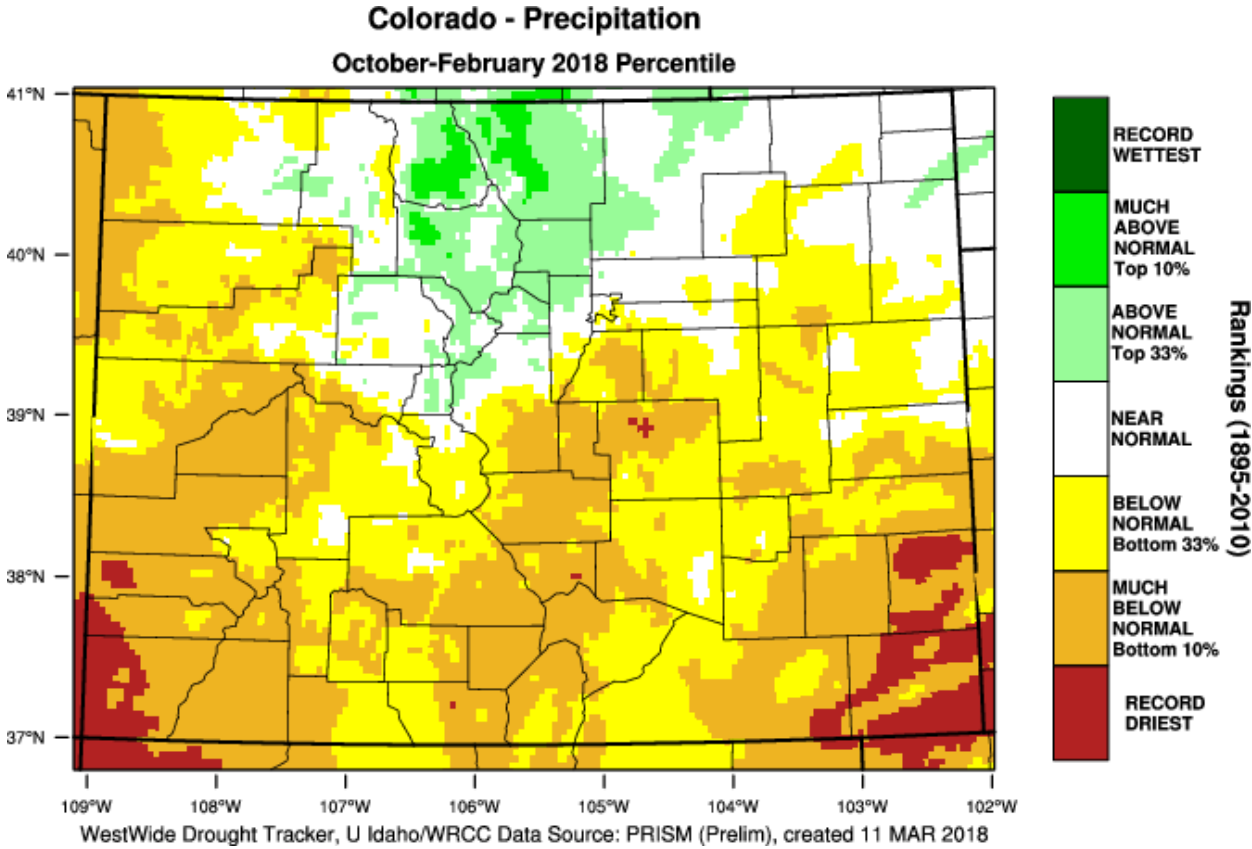
Precip (inches)

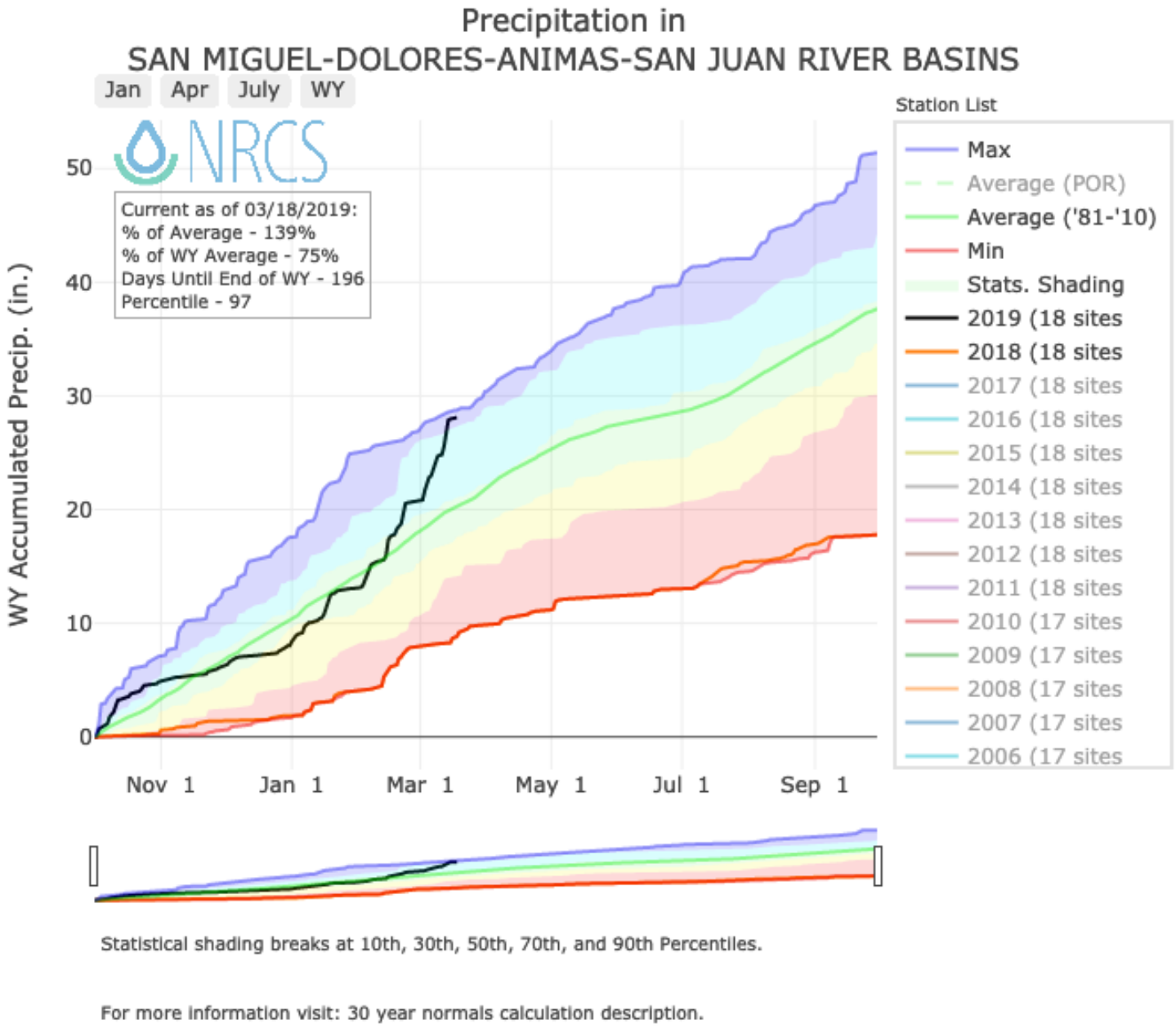
- 0.00
- 0.01 - 0.10
- 0.11 - 0.25
- 0.26 - 0.50
- 0.51 - 1.00
- 1.01 - 2.00
- 2.01 - 4.00
- 4.01 - 6.00
- 6.01 - 8.00
- 8.01 - 10.95

Data from PRISM Climate Group

Last year this time...



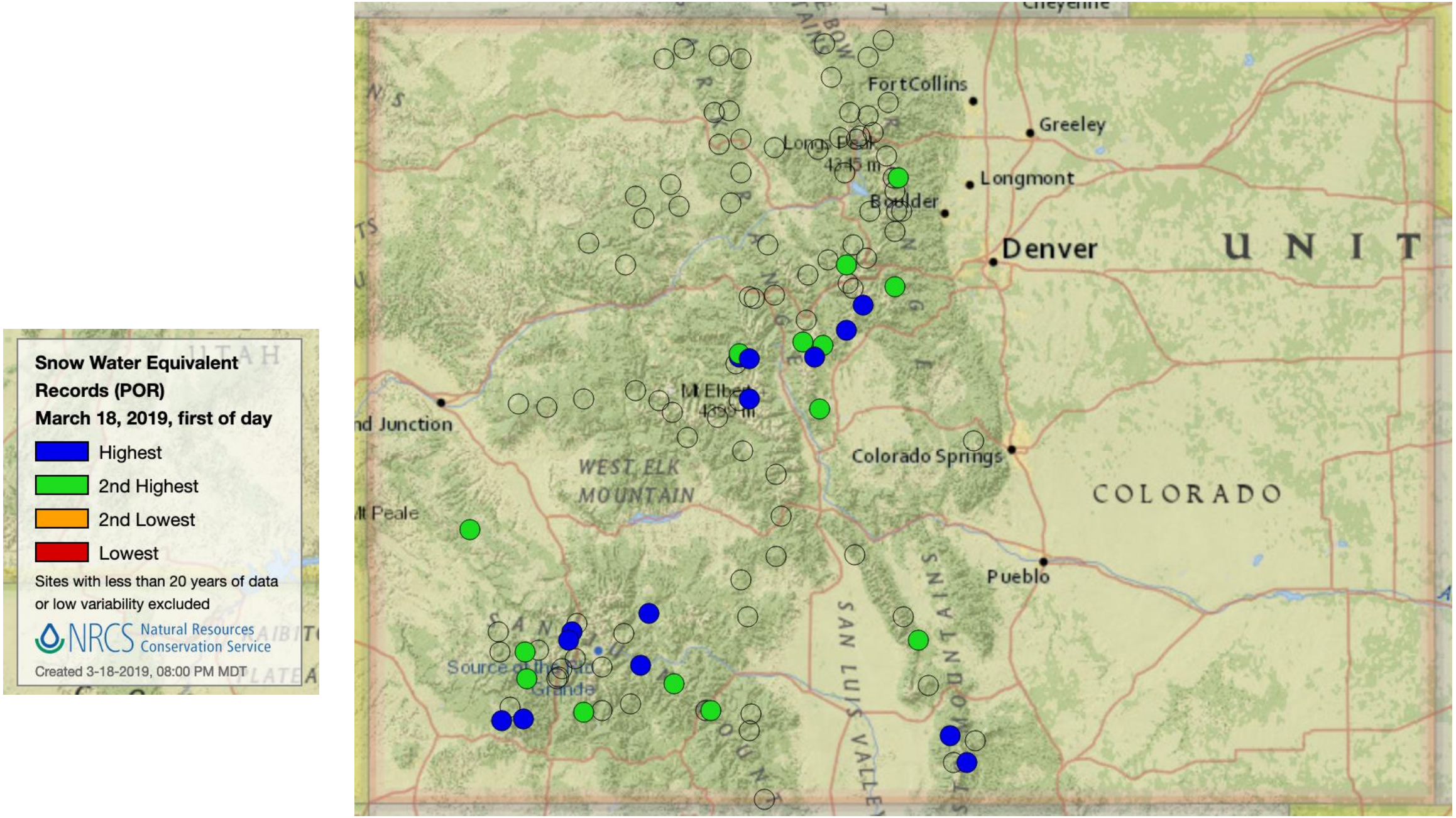




Basin average of 15” since February 1

28.1” since October 1

Last year: 17.6” for the entire water year


Snow Water Equivalent
Records (POR)
March 18, 2019, first of day
Highest
2nd Highest
2nd Lowest
Lowest
Sites with less than 20 years of data
or low variability excluded
NRCS Natural Resources Conservation Service
Created 3-18-2019, 08:00 PM MDT
Fort Collins
Greeley
Longmont
Boulder
Denver
UNIT
Colorado Springs
COLORADO
Pueblo
WEST ELK
MOUNTAIN
SAN LUIS VALLEY
SAN JUAN MOUNTAINS
Source of the Rio Grande

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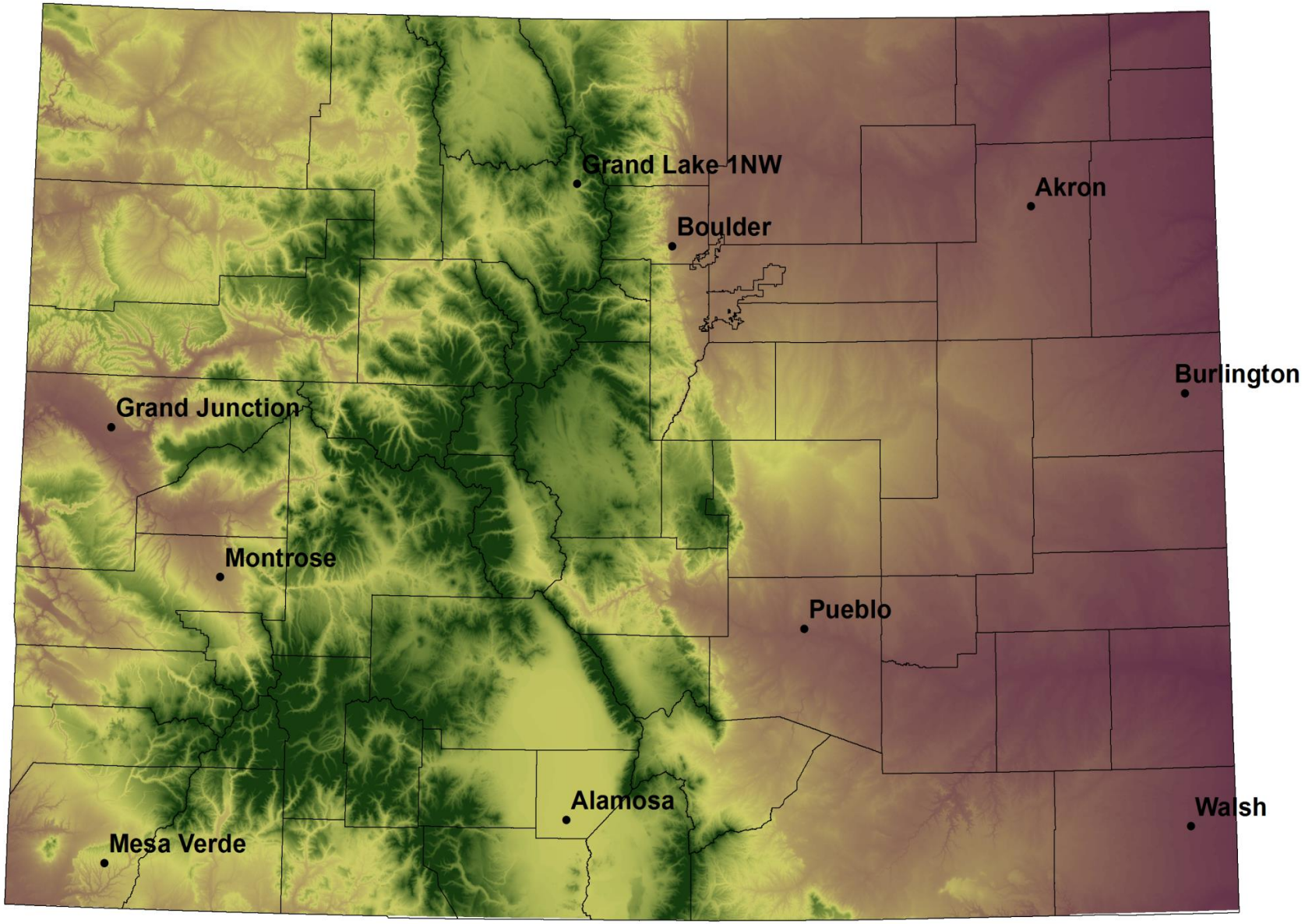
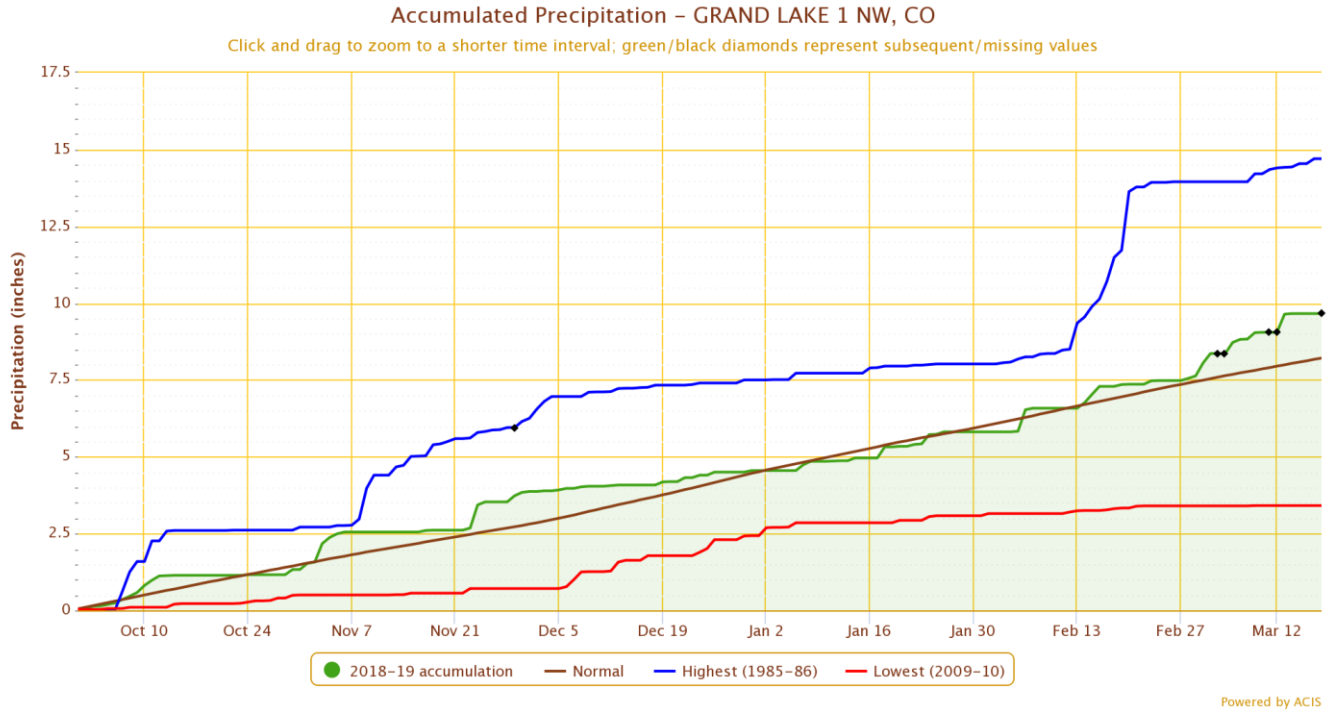
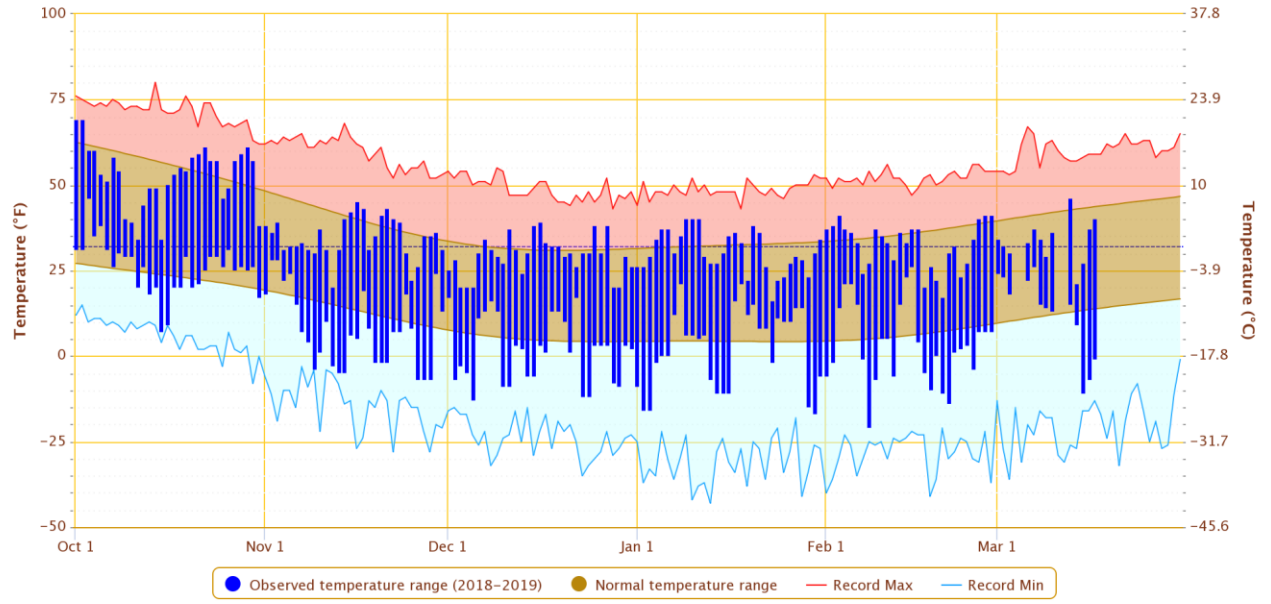
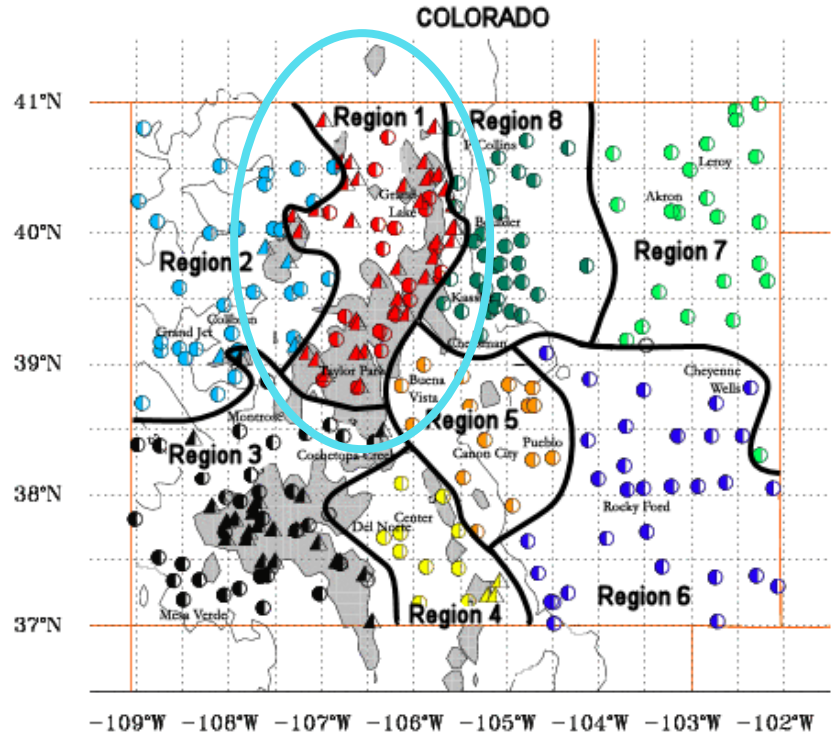
NWS Cooperative Stations for WATF

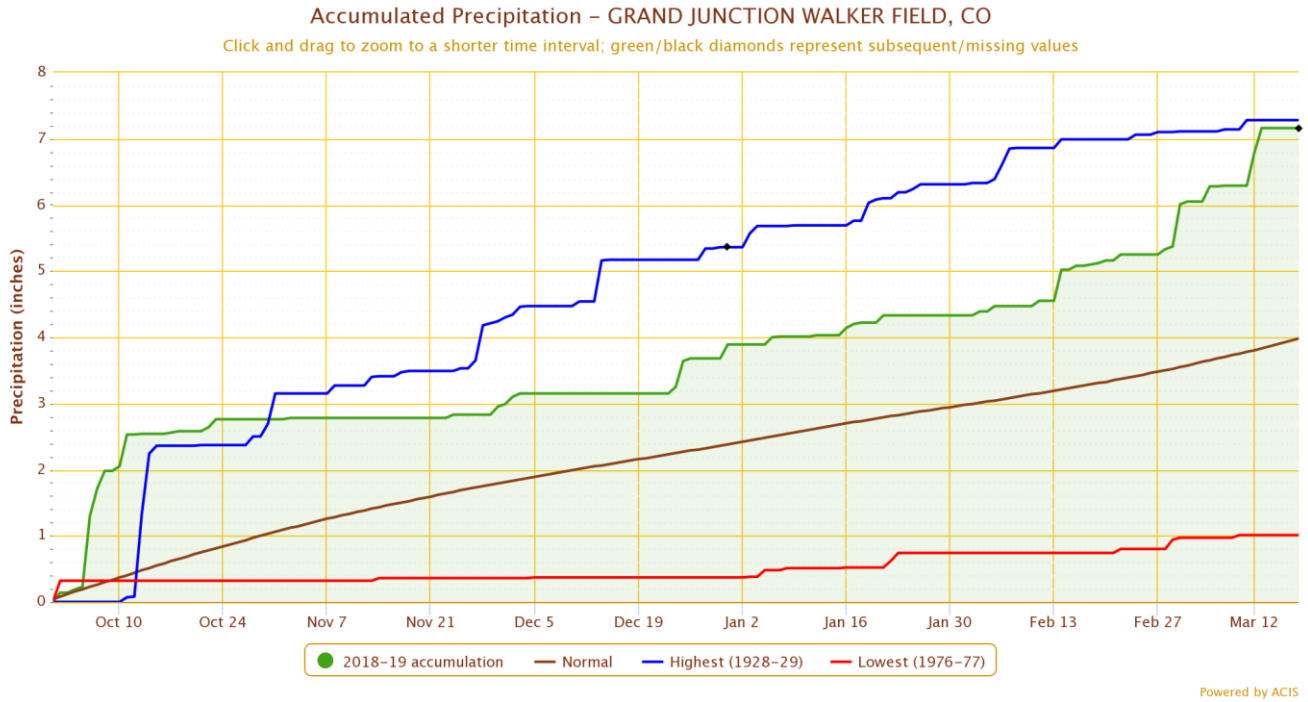


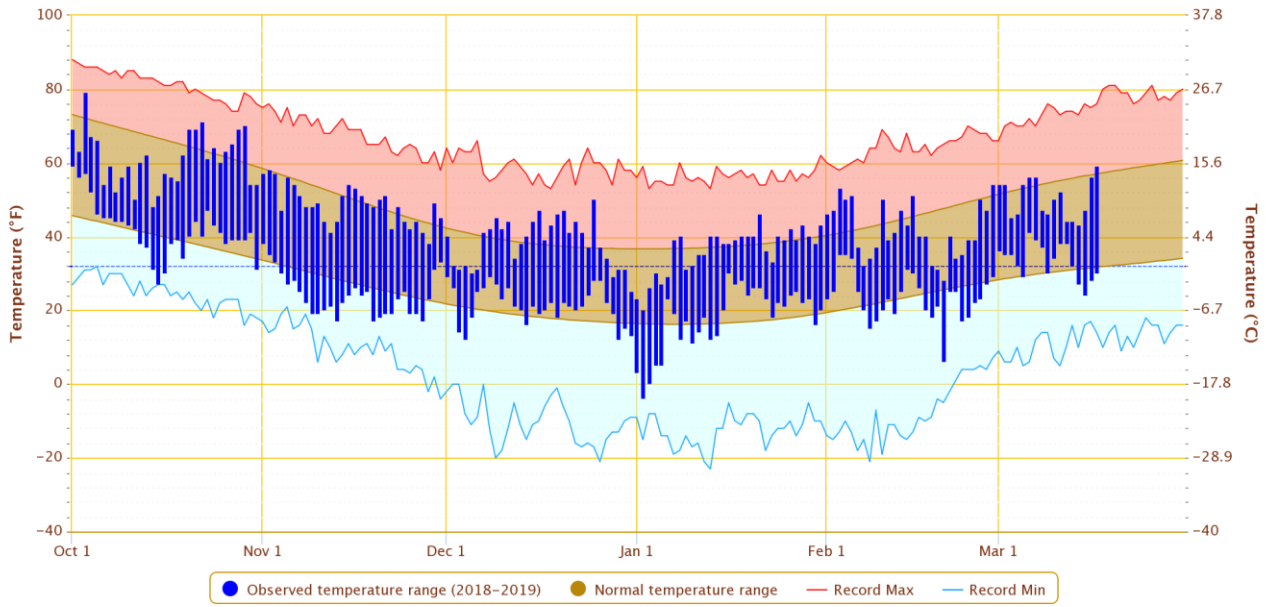
Water Year 2019 – Station Updates

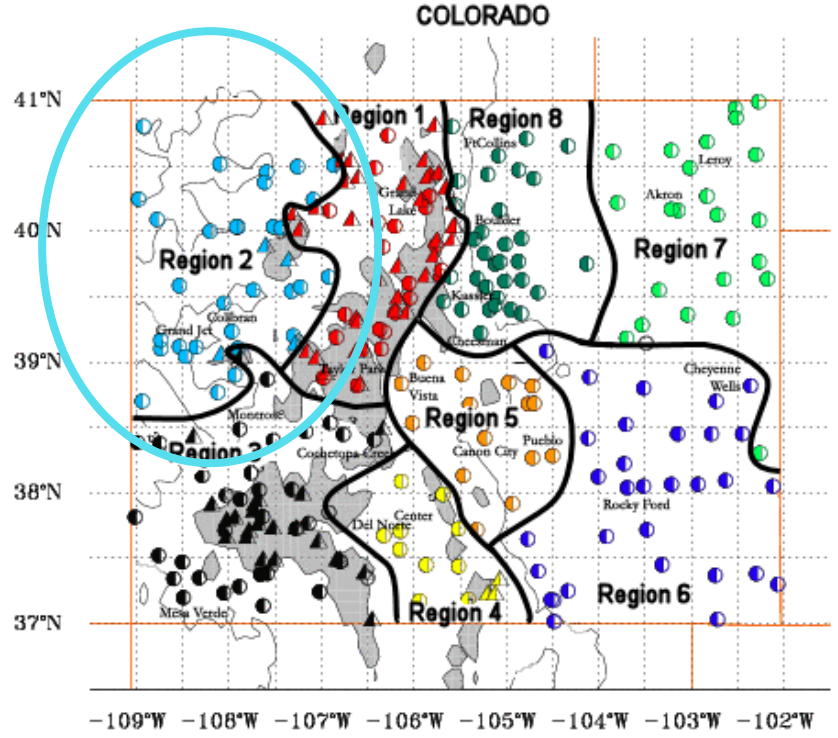

Accumulated Precipitation – GRAND LAKE 1 NW, CO
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values
Precipitation (inches)
17.5
15
12.5
10
7.5
5
2.5
0
Oct 10
Oct 24
Nov 7
Nov 21
Dec 5
Dec 19
Jan 2
Jan 16
Jan 30
Feb 13
Feb 27
Mar 12
2018-19 accumulation
Normal
Highest (1985-86)
Lowest (2009-10)
Powered by ACIS


Daily Temperature Data – GRAND LAKE 1 NW, CO
Period of Record – 1939-10-01 to 2019-03-17. Normals period: 1981-2010. Click and drag to zoom chart.
Temperature (°F)
100
75
50
25
0
-25
-50
Temperature (°C)
37.8
23.9
10
-3.9
-17.8
-31.7
-45.6
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Observed temperature range (2018-2019)
Normal temperature range
Record Max
Record Min
Powered by ACIS


COLORADO
41°N
40°N
39°N
38°N
37°N
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6
Region 7
Region 8
Fort Collins
Greeley
Akron
Leroy
Grand Lake
Boulder
Grand Junction
Taylor Park
Buena Vista
Cheyenne Wells
Montrose
Cañon City
Pueblo
Rocky Ford
Del Norte
Center
Mesa Verde
−109°W
−108°W
−107°W
−106°W
−105°W
−104°W
−103°W
−102°W


Accumulated Precipitation – GRAND JUNCTION WALKER FIELD, CO
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values
Precipitation (inches)
0
1
2
3
4
5
6
7
8
Oct 10
Oct 24
Nov 7
Nov 21
Dec 5
Dec 19
Jan 2
Jan 16
Jan 30
Feb 13
Feb 27
Mar 12
2018-19 accumulation
Normal
Highest (1928-29)
Lowest (1976-77)
Powered by ACIS

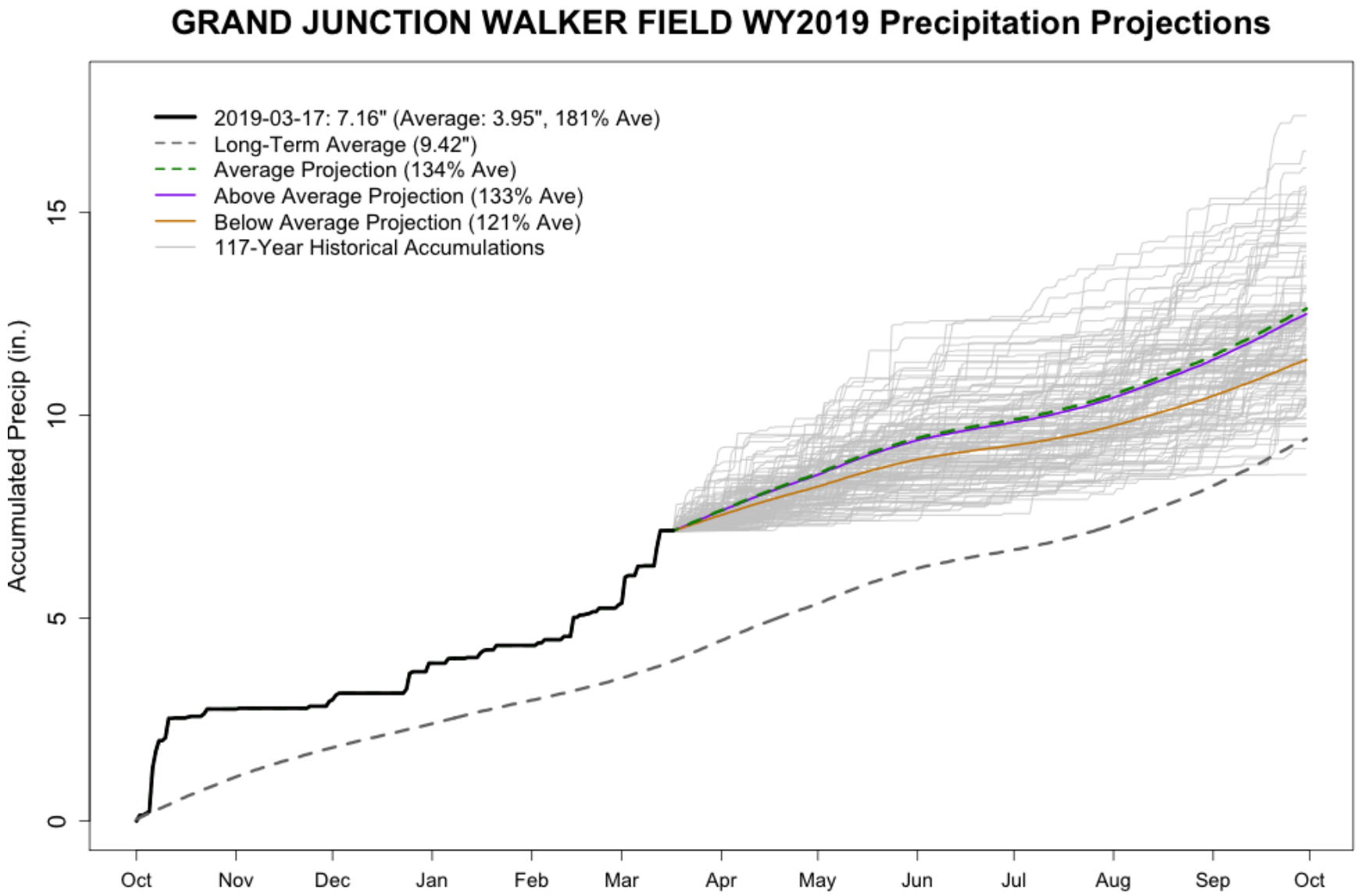

Daily Temperature Data – GRAND JUNCTION WALKER FIELD, CO
Period of Record – 1900-01-01 to 2019-03-17. Normals period: 1981-2010. Click and drag to zoom chart.
Temperature (°F)
100
80
60
40
20
0
-20
-40
Temperature (°C)
37.8
26.7
15.6
4.4
-6.7
-17.8
-28.9
-40
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Observed temperature range (2018-2019)
Normal temperature range
Record Max
Record Min
Powered by ACIS


COLORADO
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
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6
Region 7
Region 8
Fort Collins
Greeley
Akron
Leroy
Boulder
Grand Lake
Glenwood Springs
Grand Junction
Gunnison
Crested Butte
Buena Vista
Cheyenne Wells
Montrose
Cañon City
Pueblo
Coshetopa Creek
Del Norte
Center
Rocky Ford
Mesa Verde

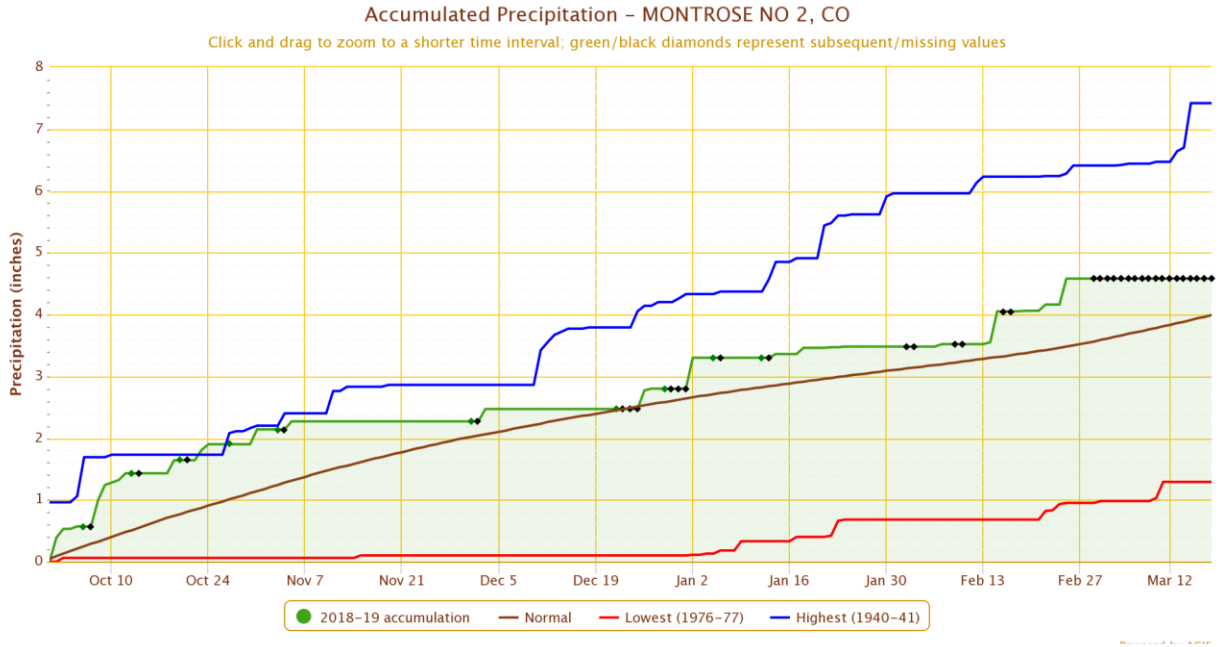
“Projections” of water year precipitation based on historical data

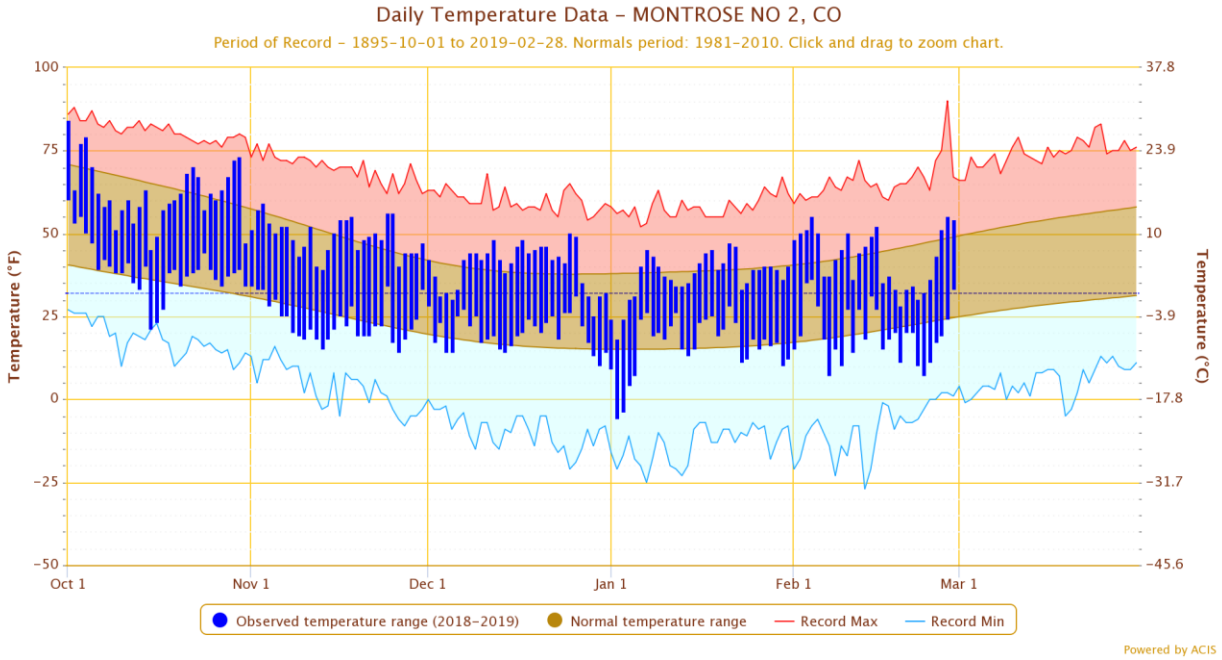
Even if Grand Junction was record dry from this point forward (which looks quite unlikely), they would be just barely below average for the water year

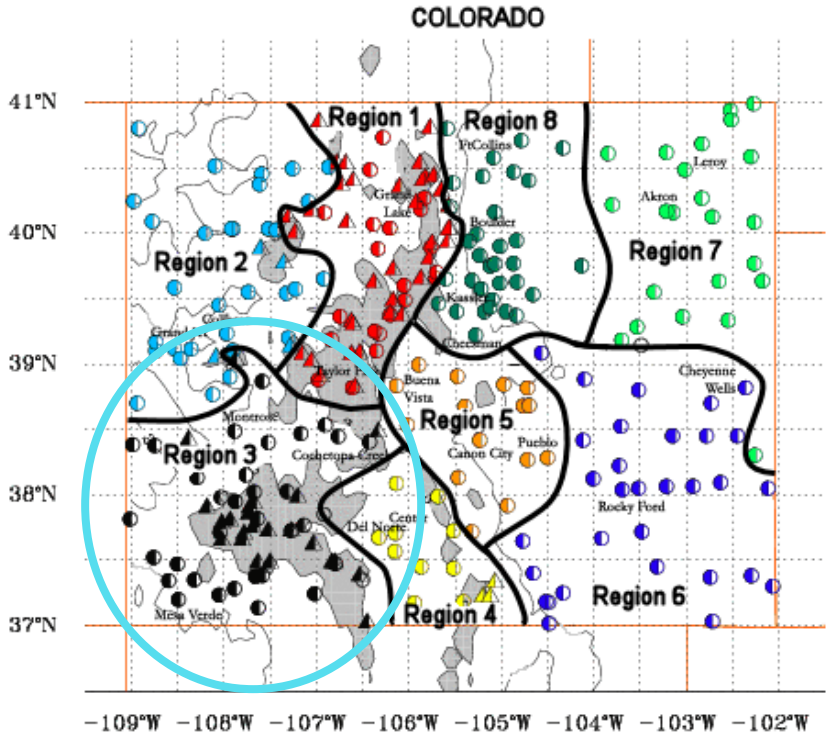
Last water year, only 4.65”



http://climate.colostate.edu/precip_proj.html

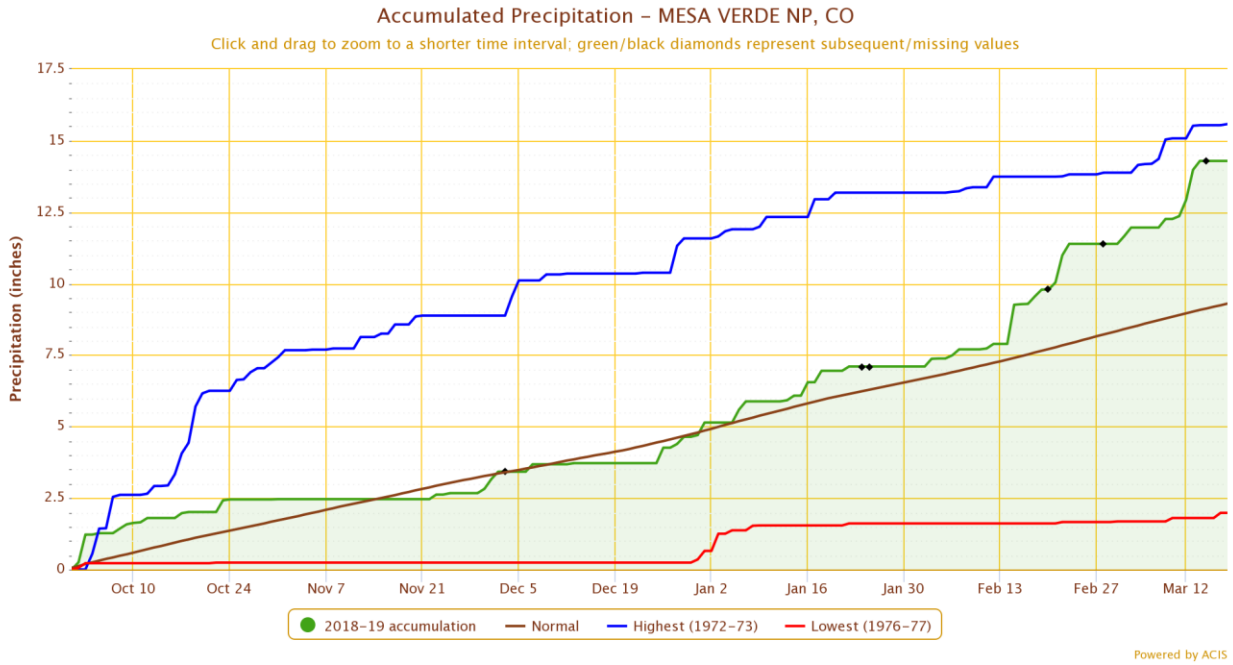


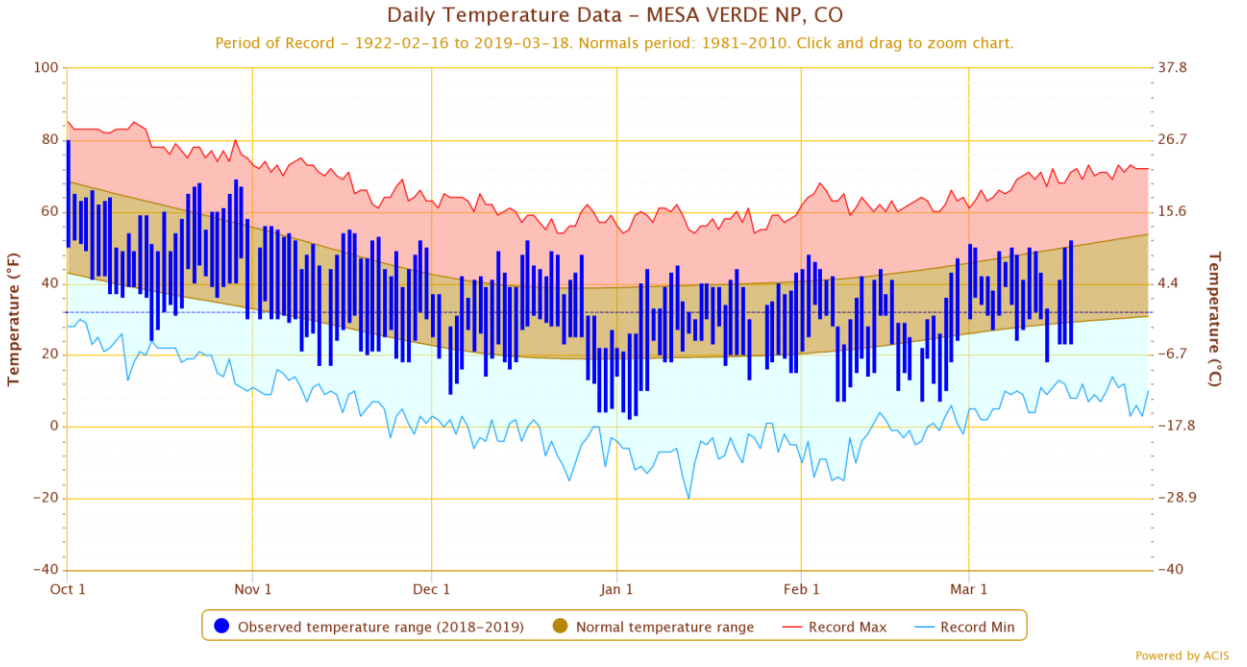


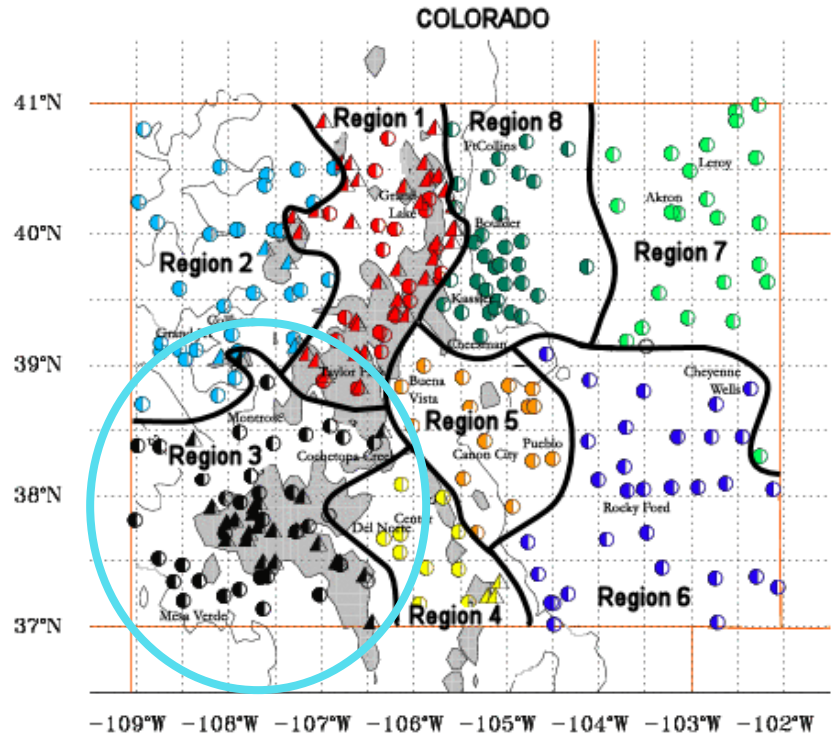


Montrose airport has received over 1.5” in March so far

Likely already exceeded their full WY2018 precip





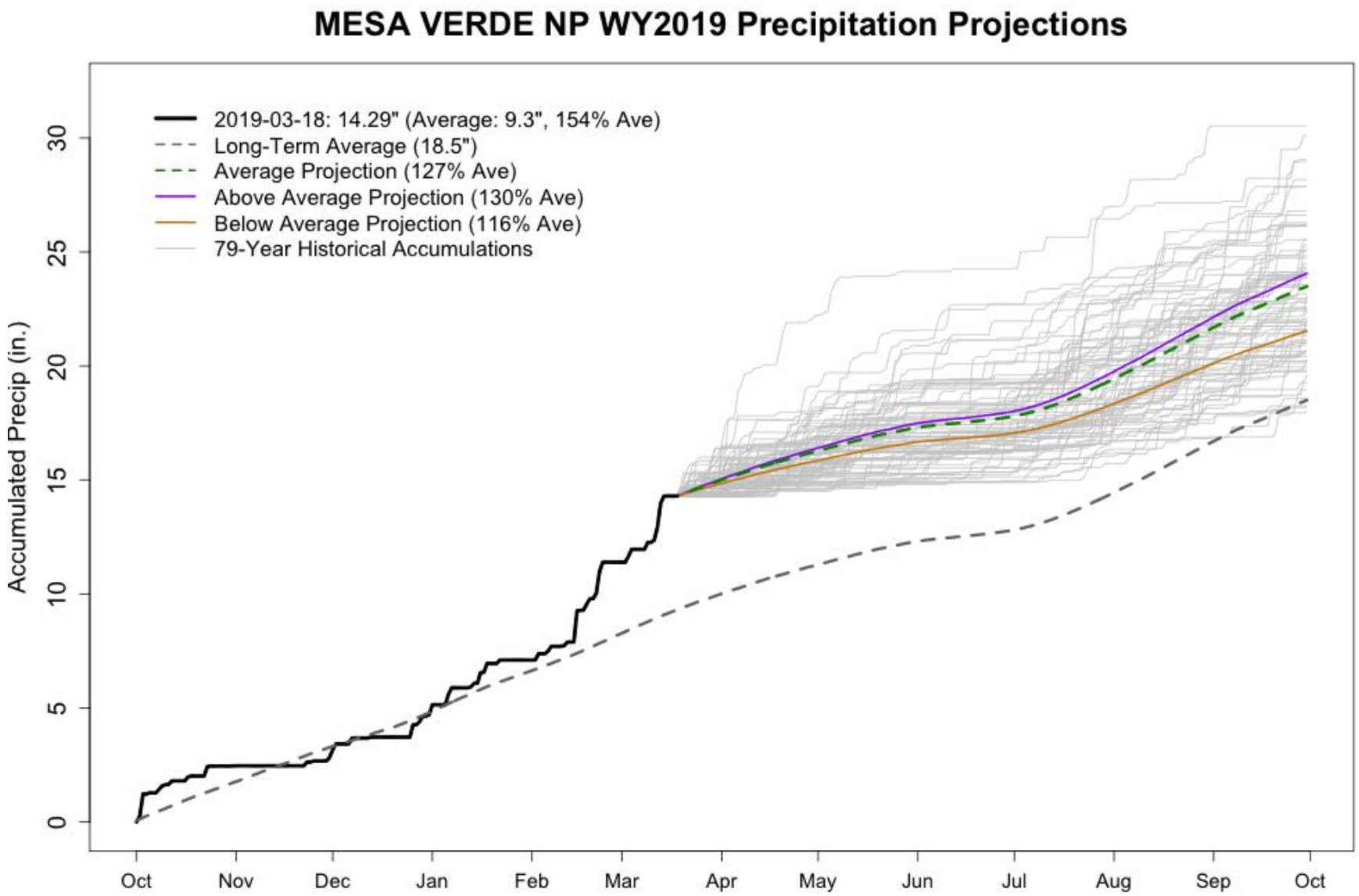


Mesa Verde has far surpassed their precip from all of last water year (14.29” through March 17; 8.06” all of WY2018)

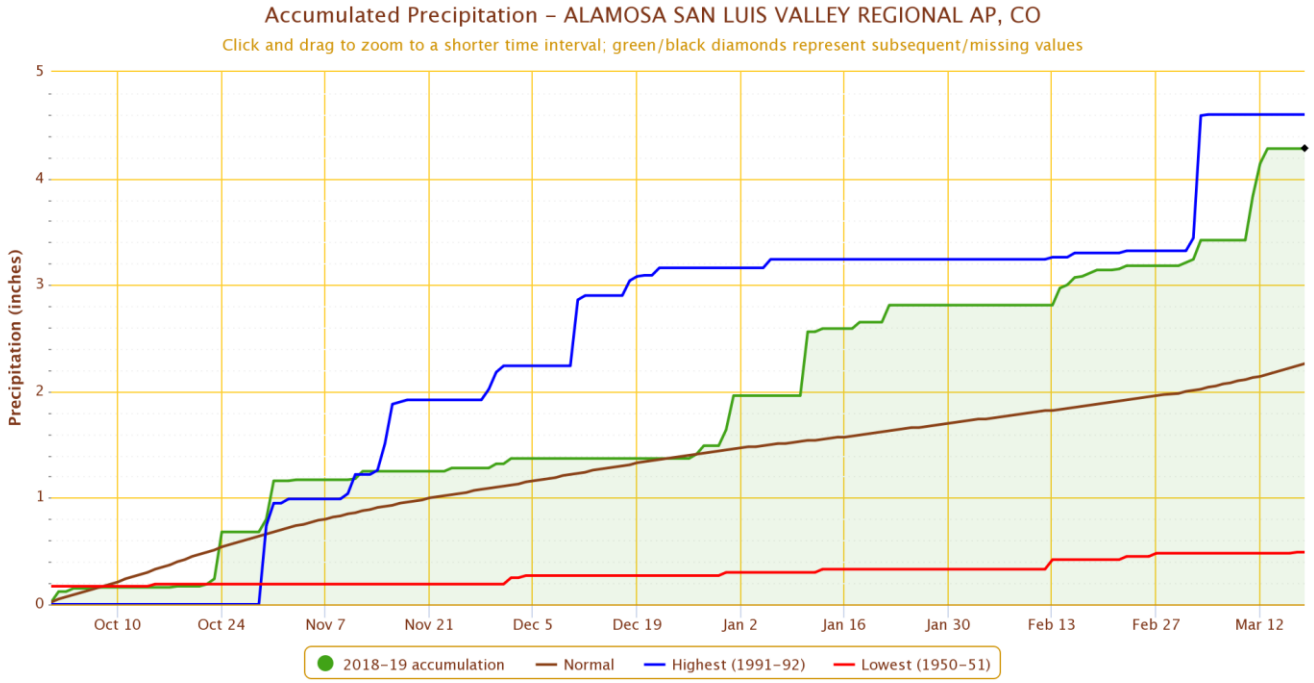
“Projections” of water year precipitation based on historical data

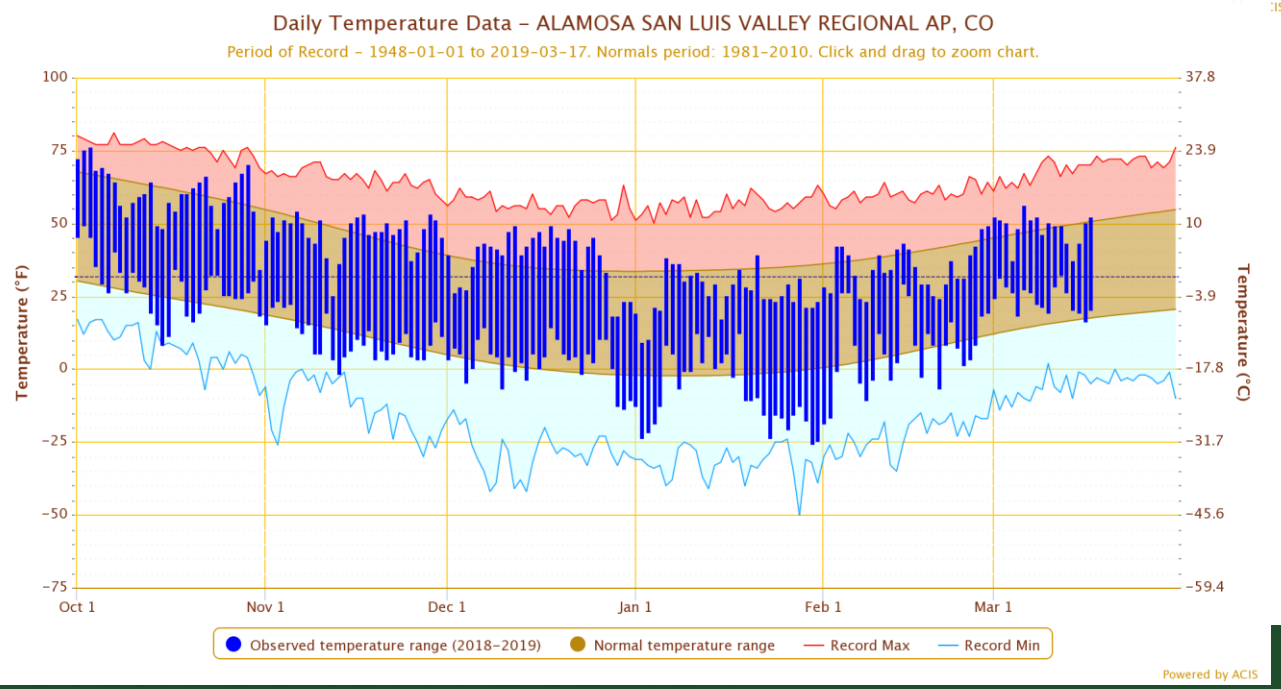
Mesa Verde is nearly past the “no chance of below-normal water-year precip” mark

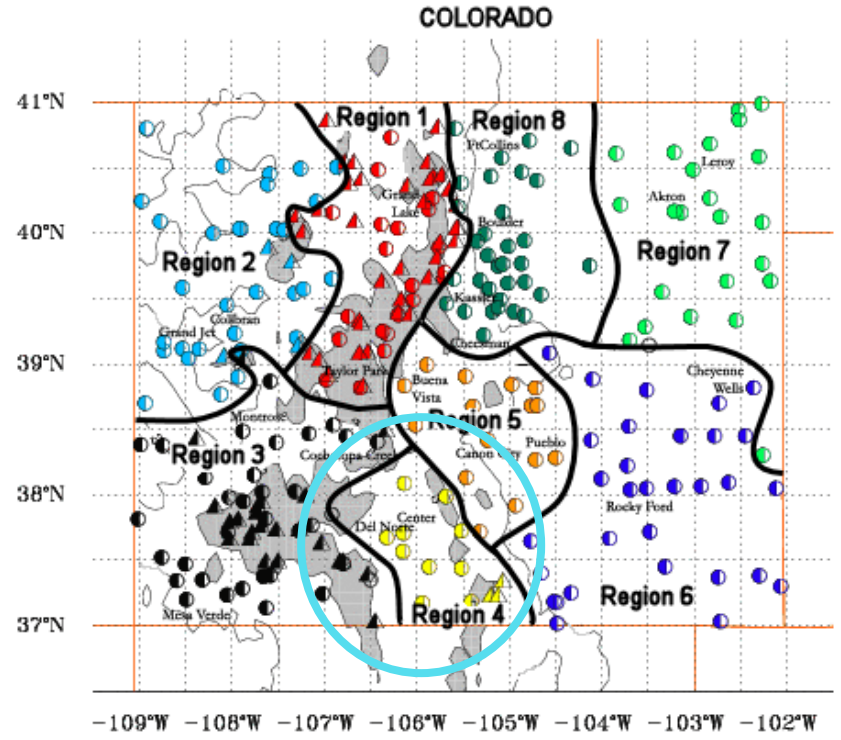
Last water year, only 8.06”



http://climate.colostate.edu/precip_proj.html



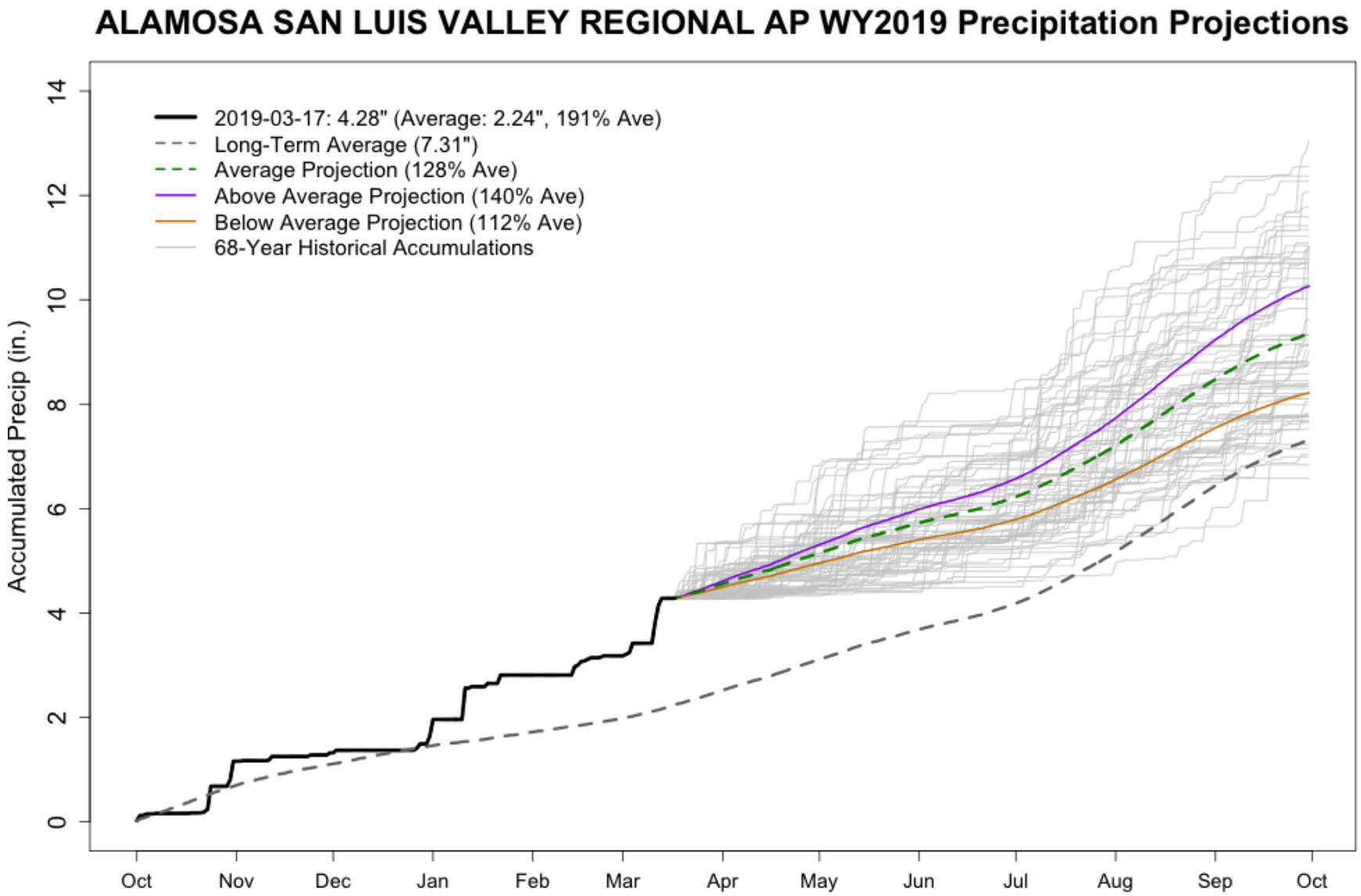




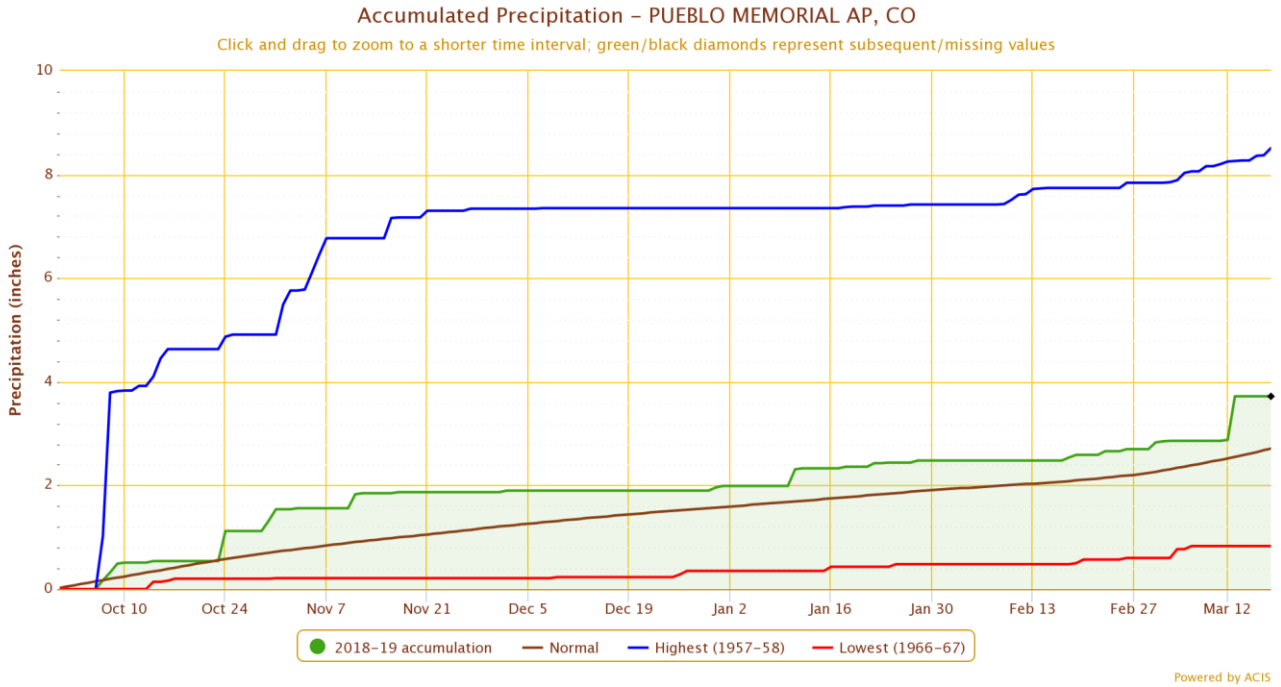
Alamosa has nearly surpassed their full WY2018 precip: 4.28” so far, 4.38” all of WY2018

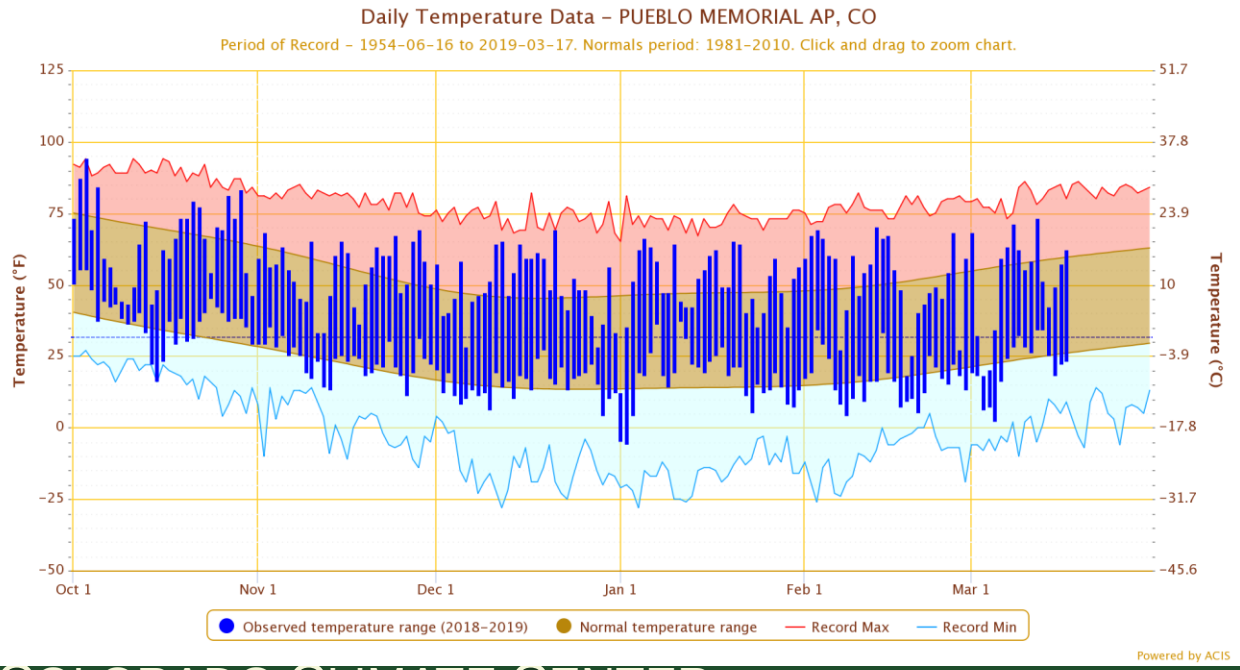
“Projections” of water year precipitation based on historical data

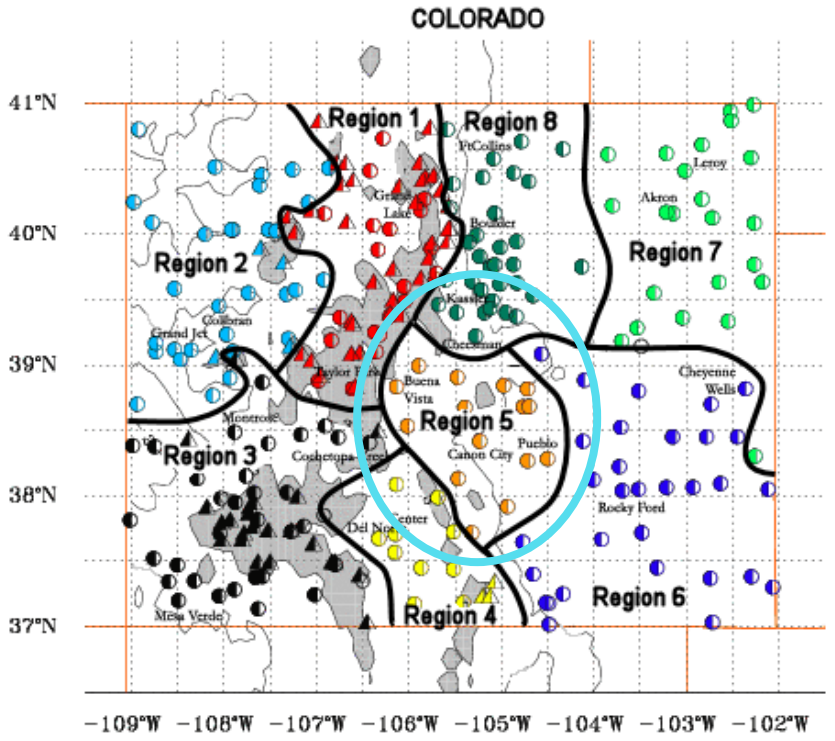
With summer being the ‘wet season’ for the San Luis Valley, and highly variable, still a wide range of possible outcomes (but most still finish the water year above average)

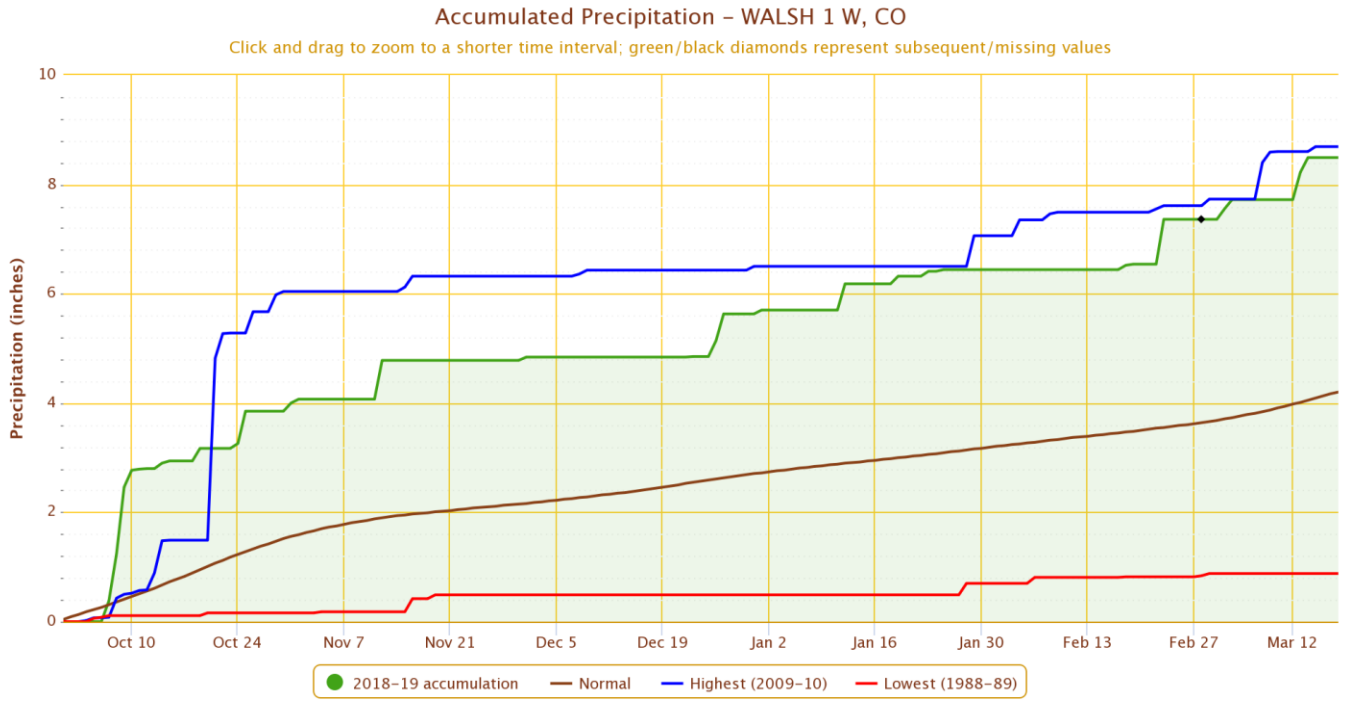


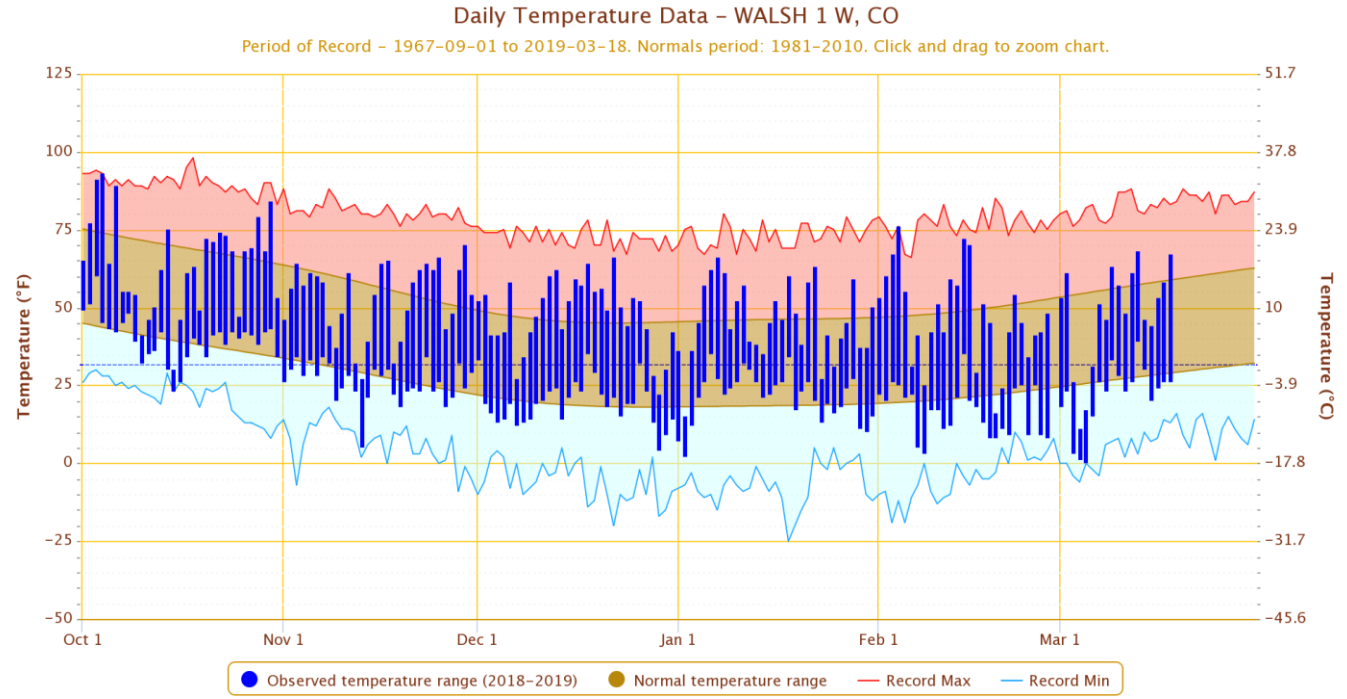
http://climate.colostate.edu/precip_proj.html

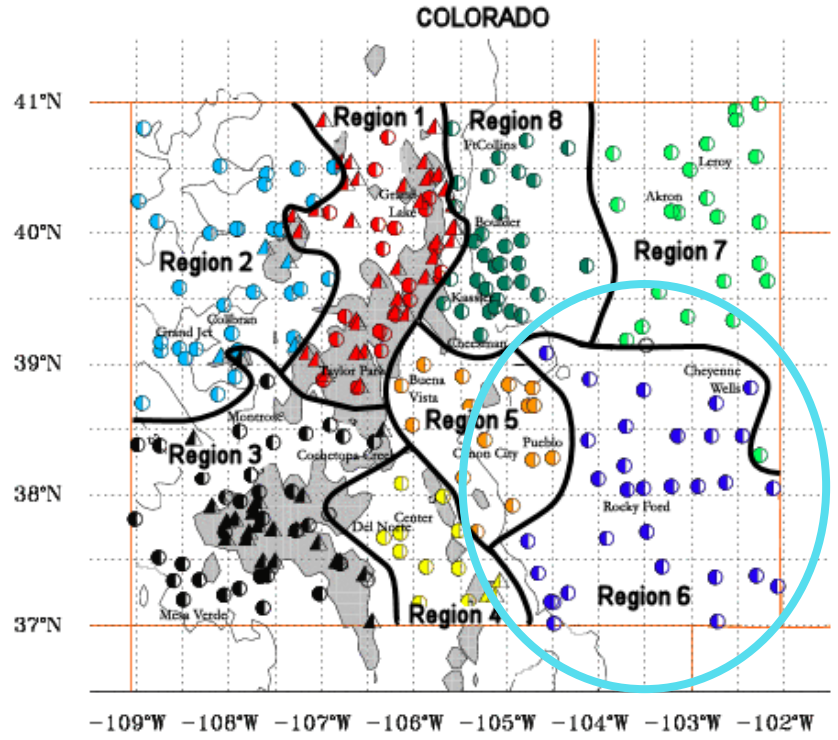

Accumulated Precipitation – PUEBLO MEMORIAL AP, CO
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values
Precipitation (inches)
0
2
4
6
8
10
Oct 10
Oct 24
Nov 7
Nov 21
Dec 5
Dec 19
Jan 2
Jan 16
Jan 30
Feb 13
Feb 27
Mar 12
2018-19 accumulation
Normal
Highest (1957-58)
Lowest (1966-67)
Powered by ACIS


Daily Temperature Data – PUEBLO MEMORIAL AP, CO
Period of Record – 1954-06-16 to 2019-03-17. Normals period: 1981-2010. Click and drag to zoom chart.
Temperature (°F)
125
100
75
50
25
0
-25
-50
Temperature (°C)
51.7
37.8
23.9
10
-3.9
-17.8
-31.7
-45.6
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Observed temperature range (2018-2019)
Normal temperature range
Record Max
Record Min
Powered by ACIS


COLORADO
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
Region 1
Region 2
Region 3
Region 4
Region 5
Region 6
Region 7
Region 8
Fort Collins
Greeley
Lake
Boulder
Leroy
Akron
Grand Jct
Gunnison
Buena Vista
Cheyenne Wells
Monrose
Canon City
Pueblo
Rocky Ford
Mesa Verde



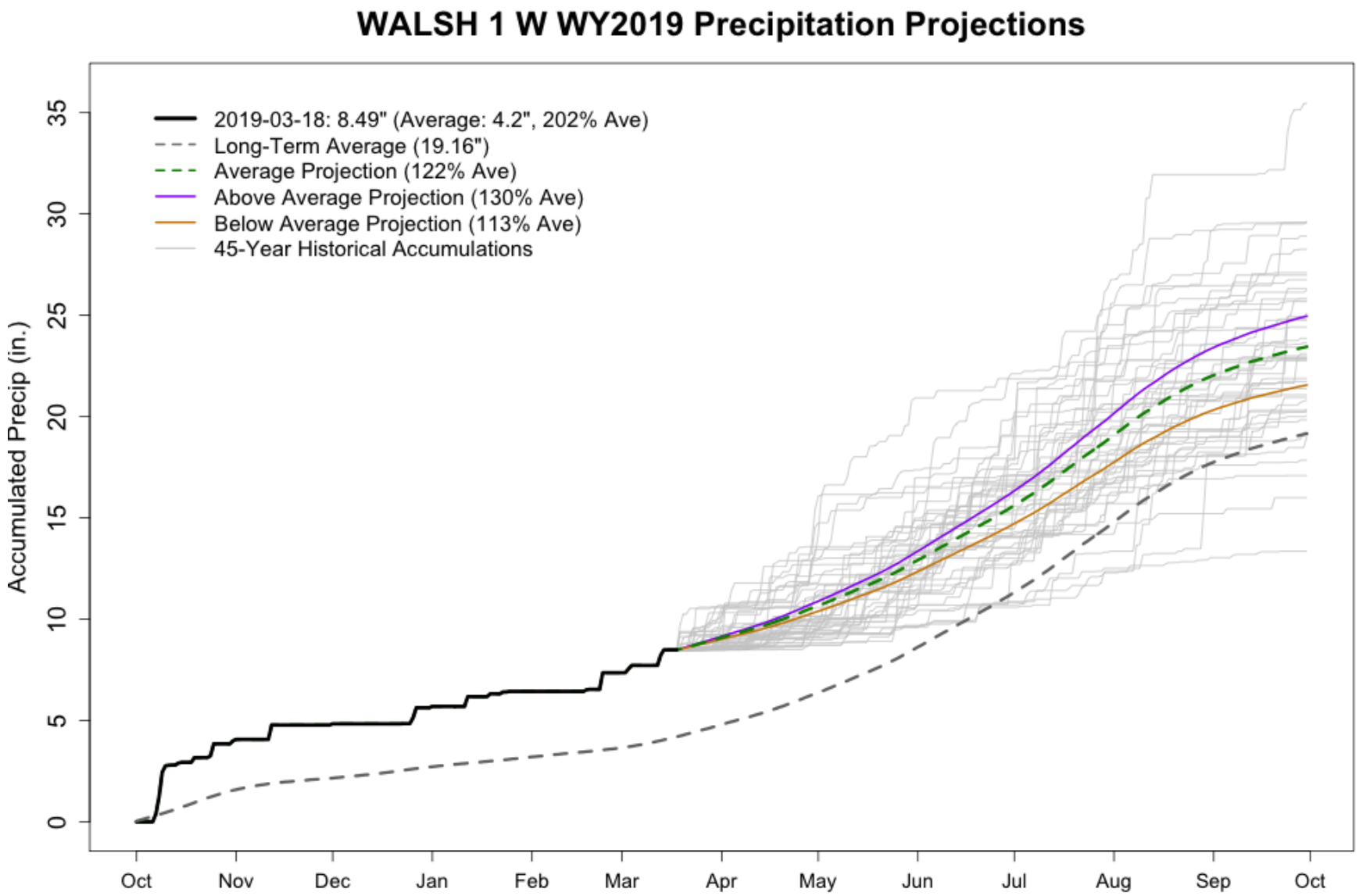




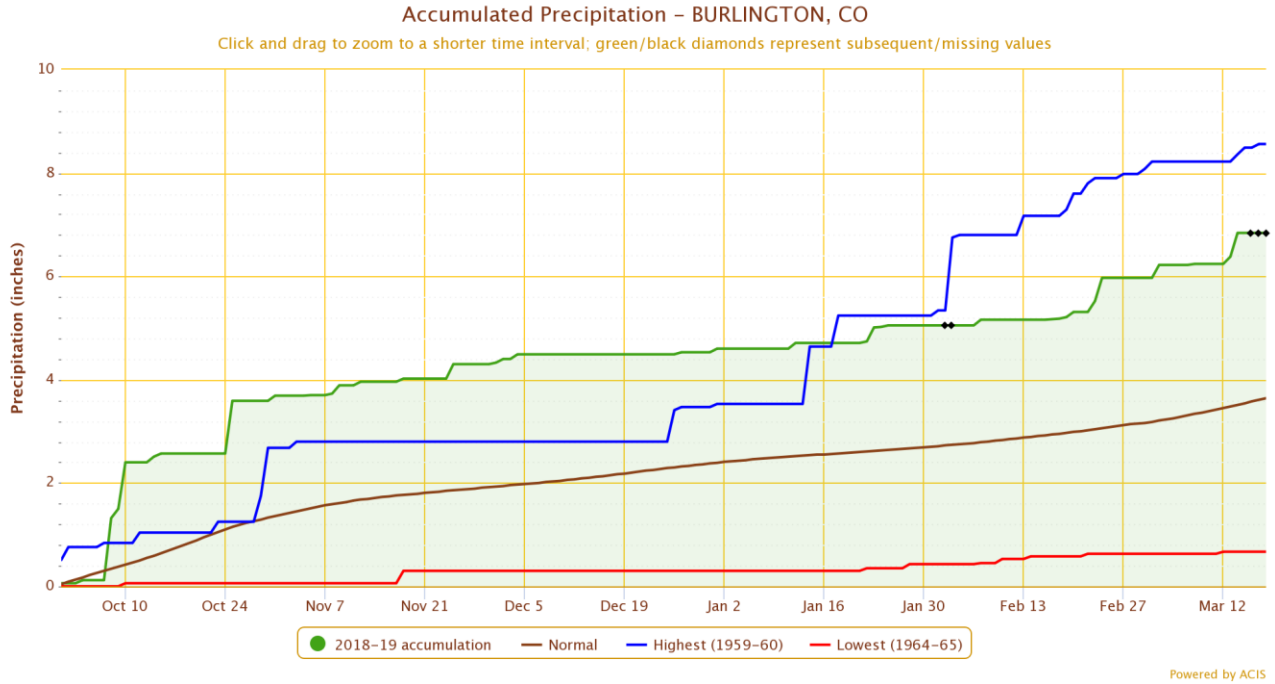
Walsh over double the normal precip for this point in the water year!

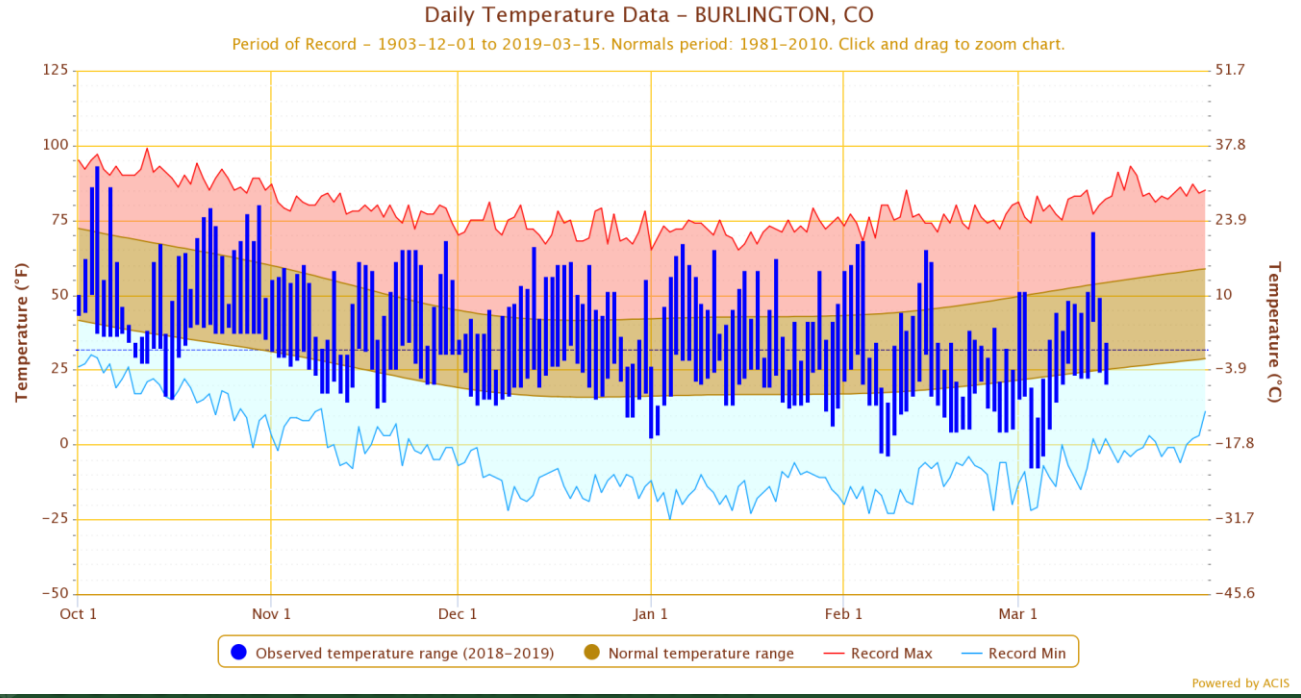
“Projections” of water year precipitation based on historical data

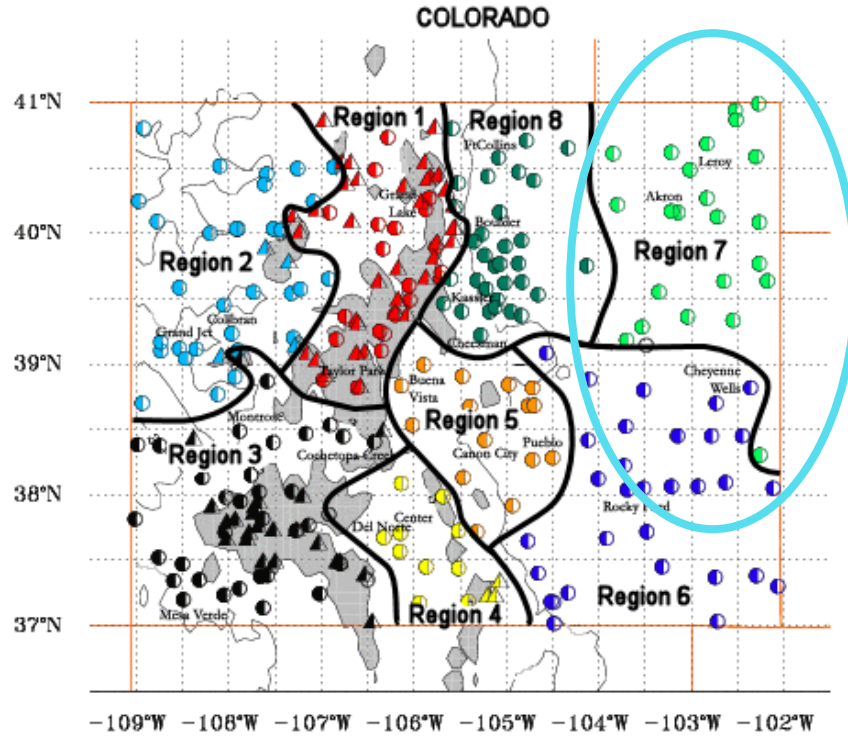
Wide range of possible outcomes with the wet months still to come



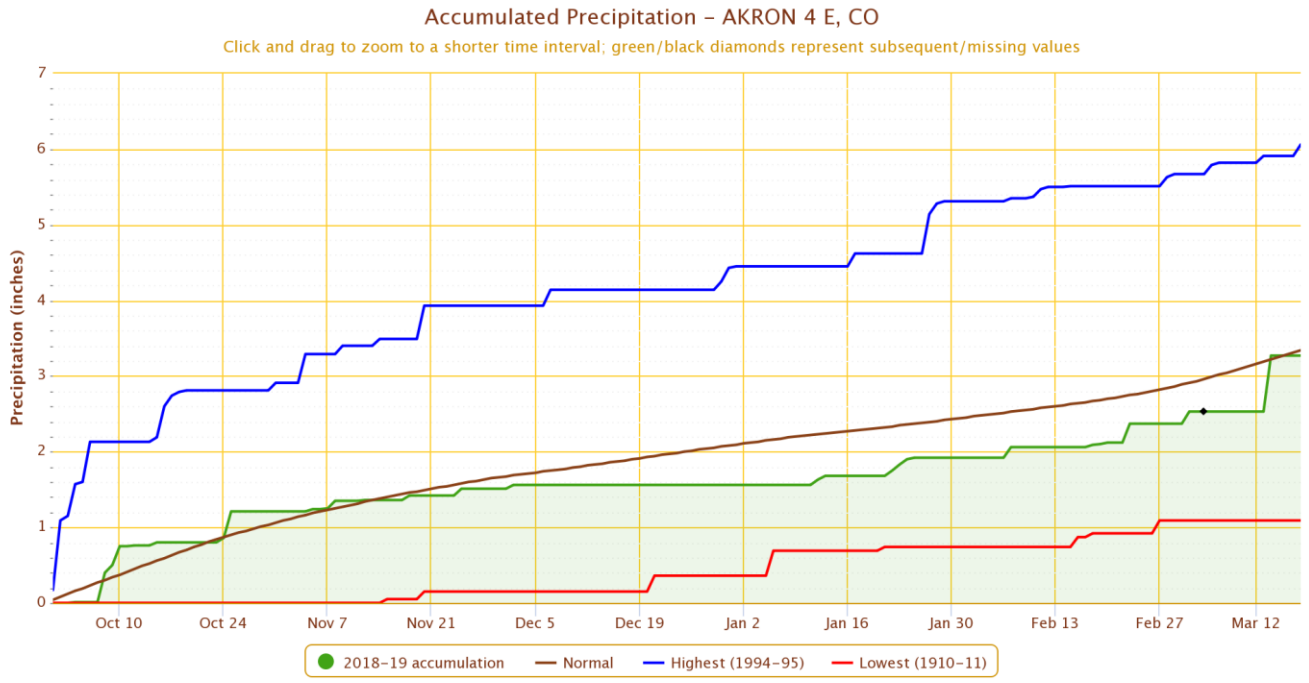
http://climate.colostate.edu/precip_proj.html

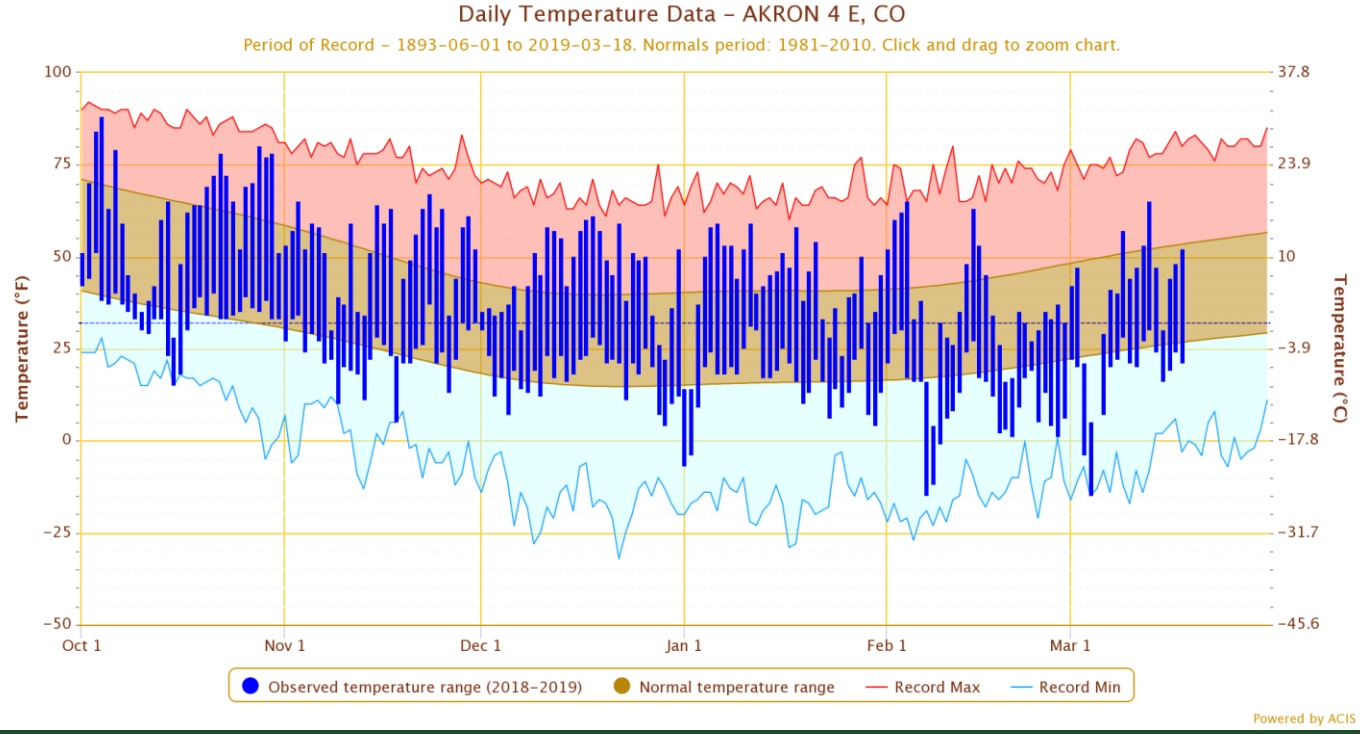


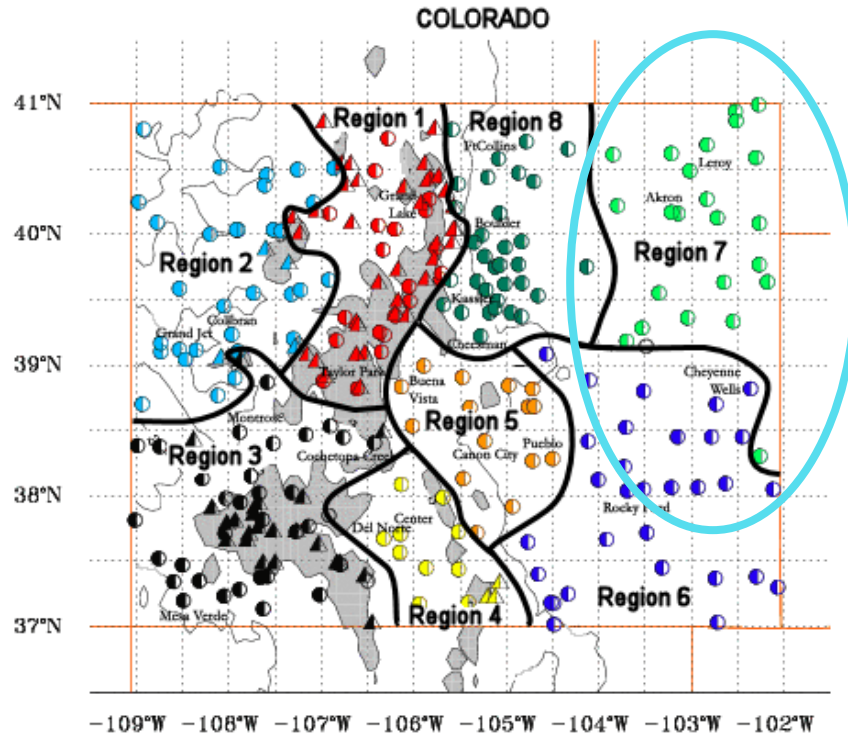




2nd half of Feb and first half of March have been much cooler than average on the eastern Plains



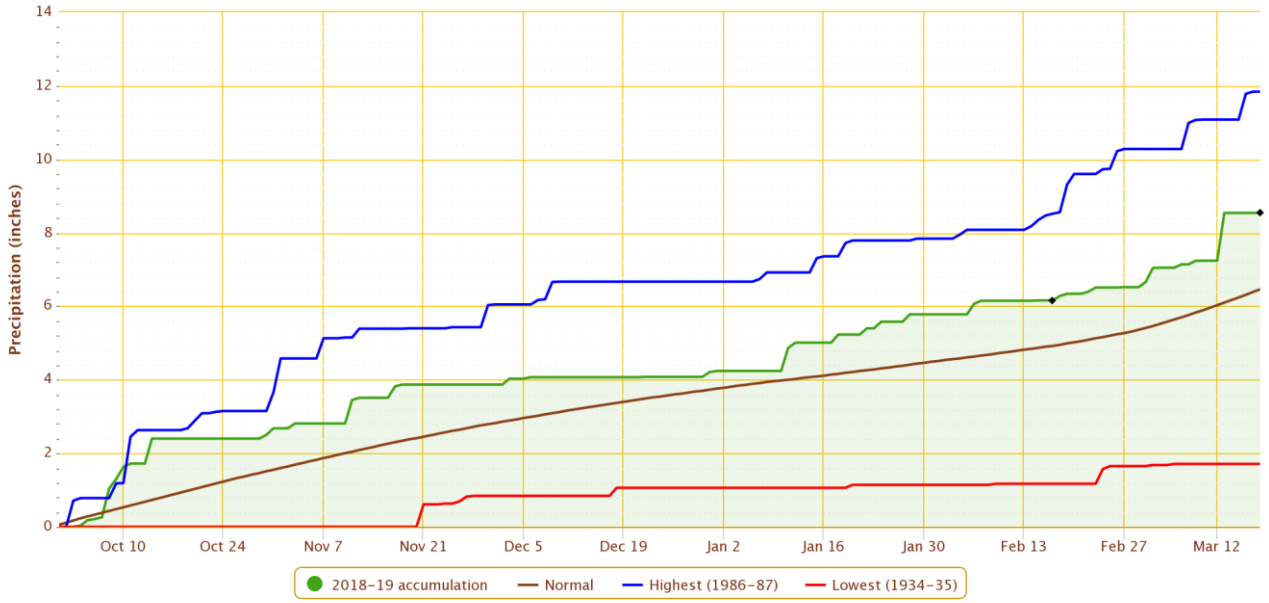




Akron now back to near-normal precip after last week's storm

Accumulated Precipitation – BOULDER, CO

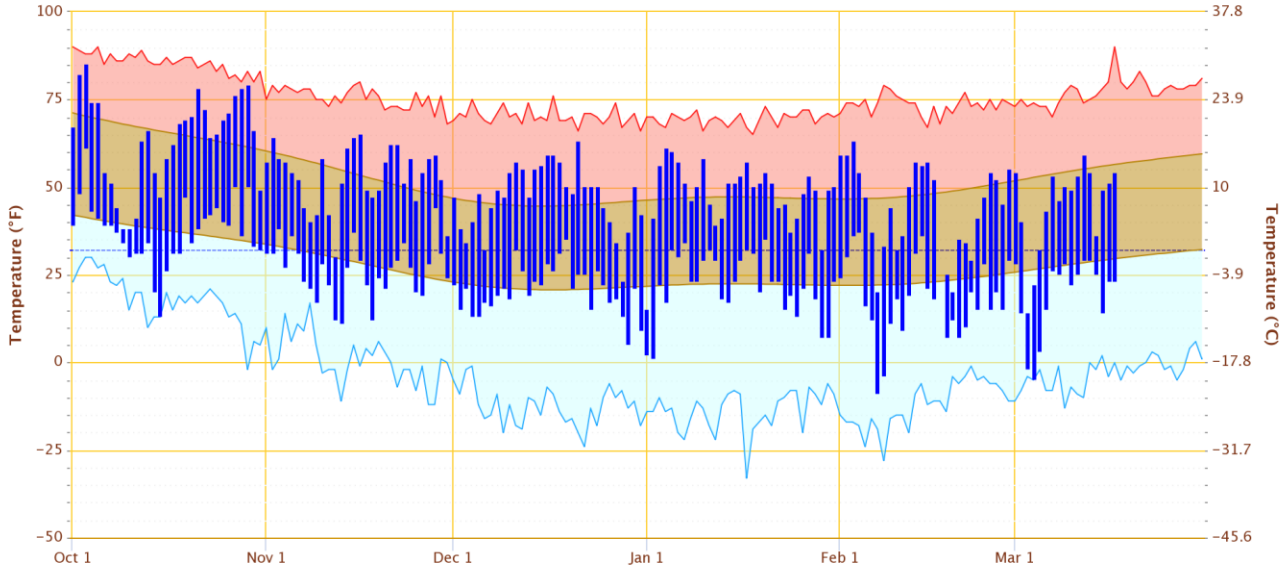
Click and drag to zoom to a shorter time interval; green/black diamonds represent subsequent/missing values



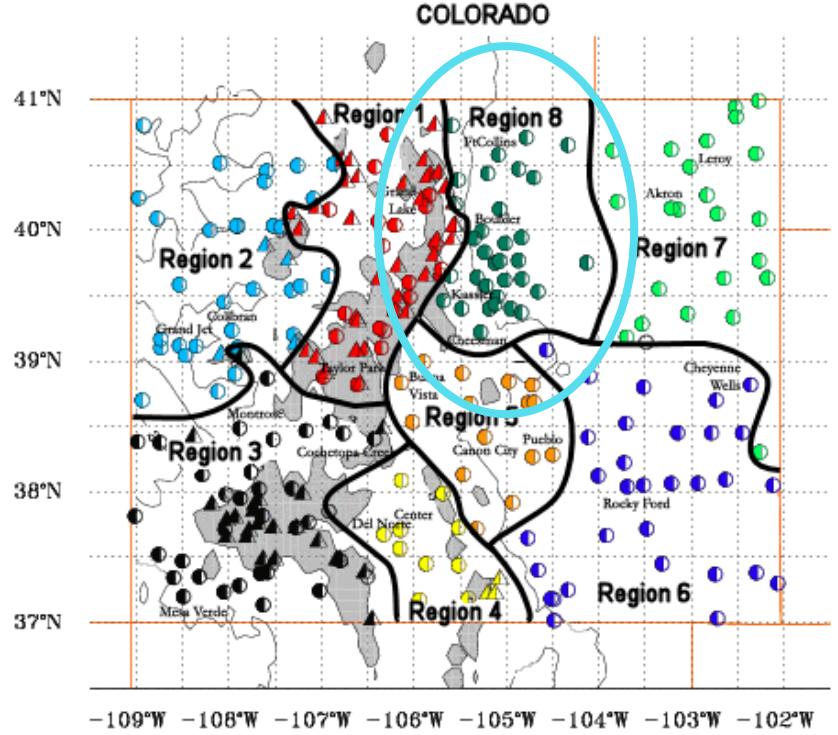
Powered by ACIS

Daily Temperature Data – BOULDER, CO

Period of Record – 1893-10-01 to 2019-03-17. Normals period: 1981-2010. Click and drag to zoom chart.



Powered by ACIS

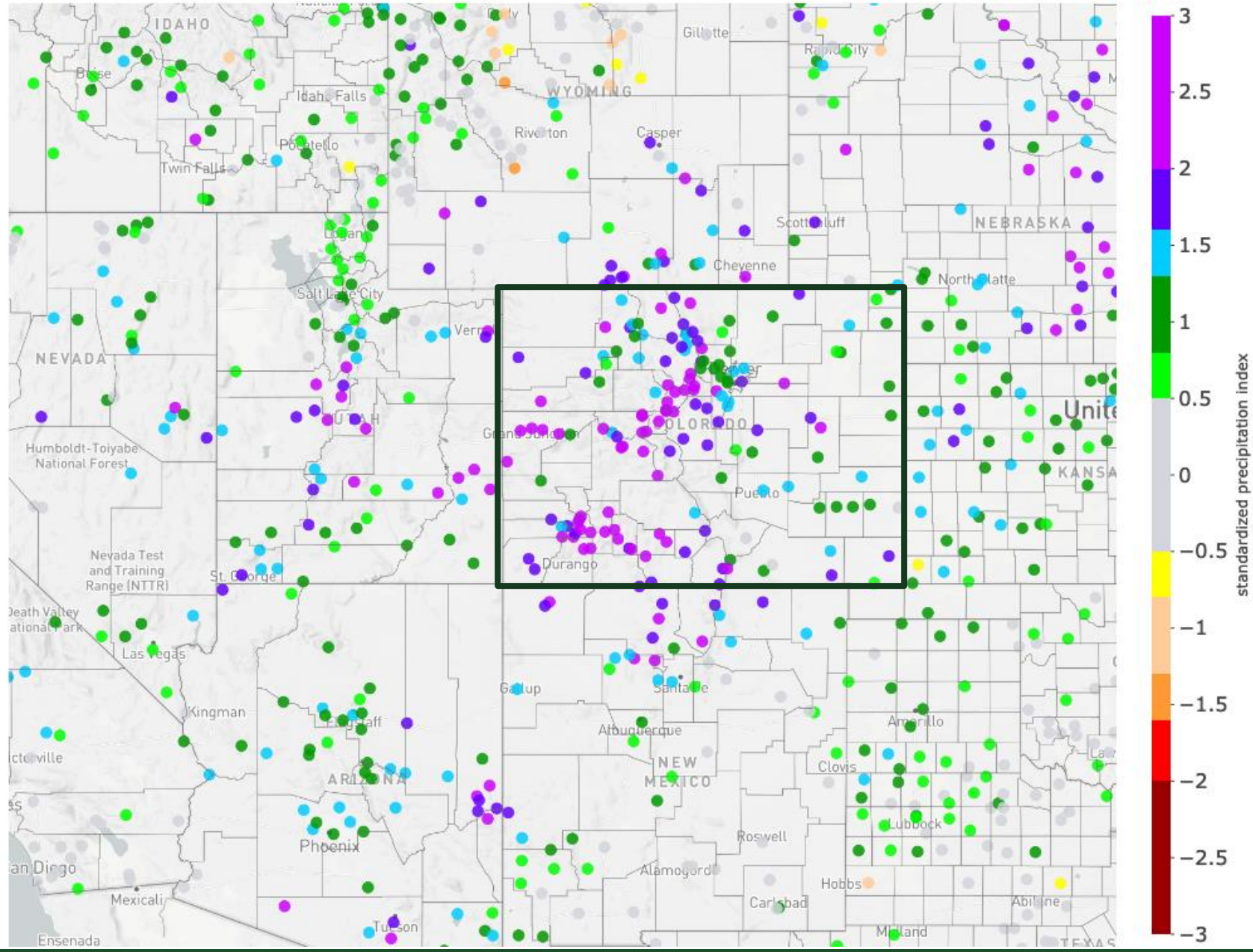


COLORADO
CLIMATE
CENTER

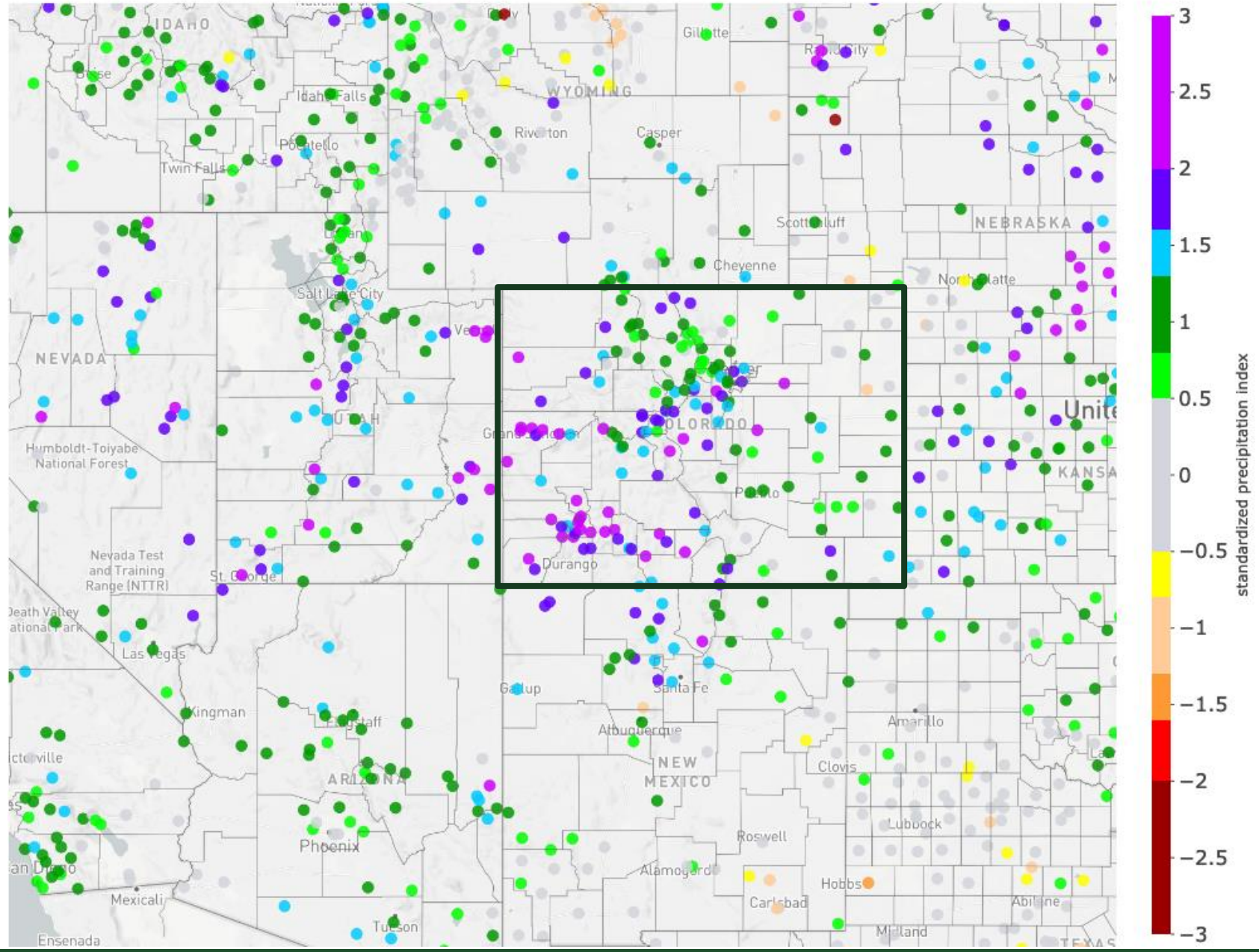
(photo: CAIC)

Colorado Drought

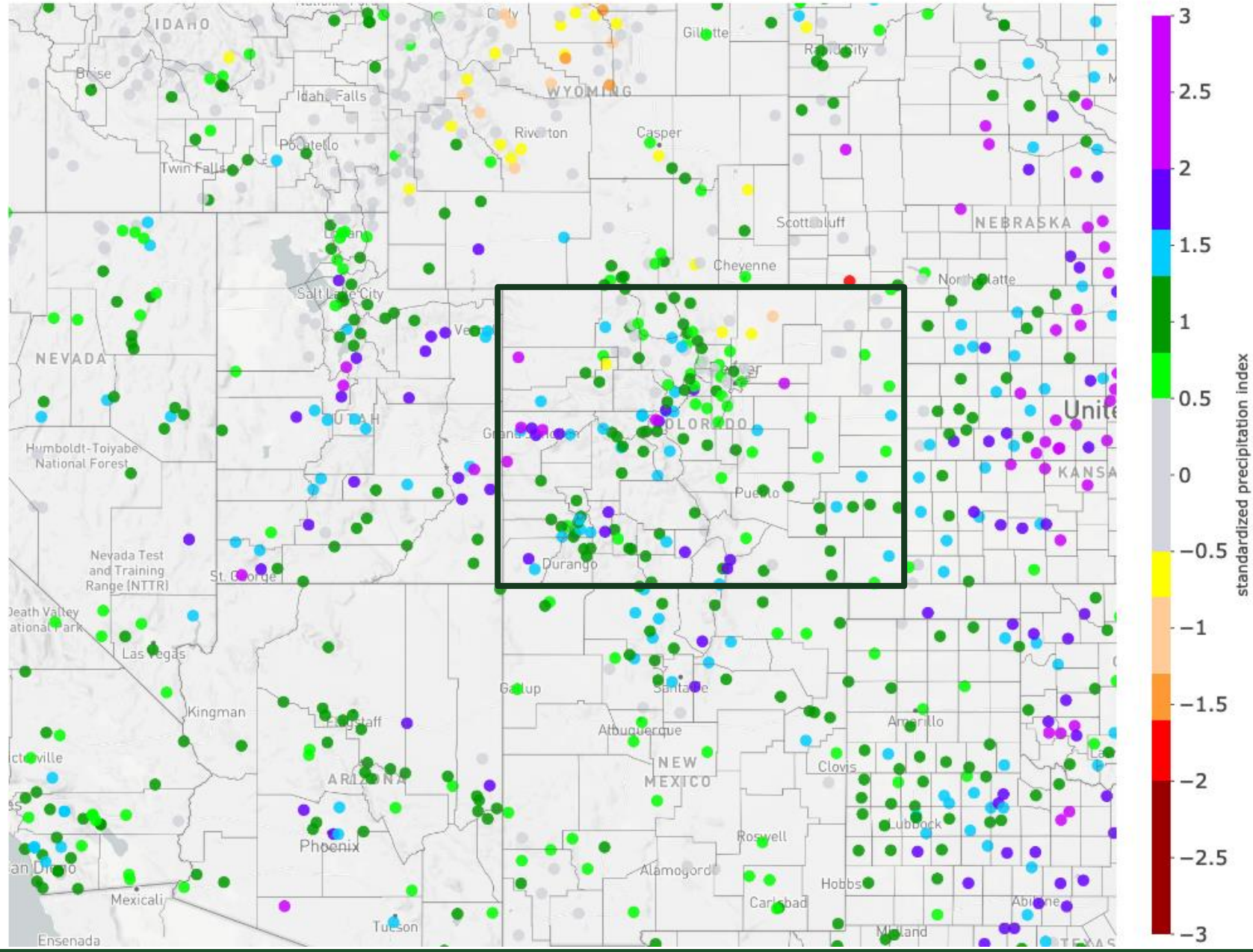
30-day Standardized Precipitation Index: 2/16/2019 - 3/17/2019



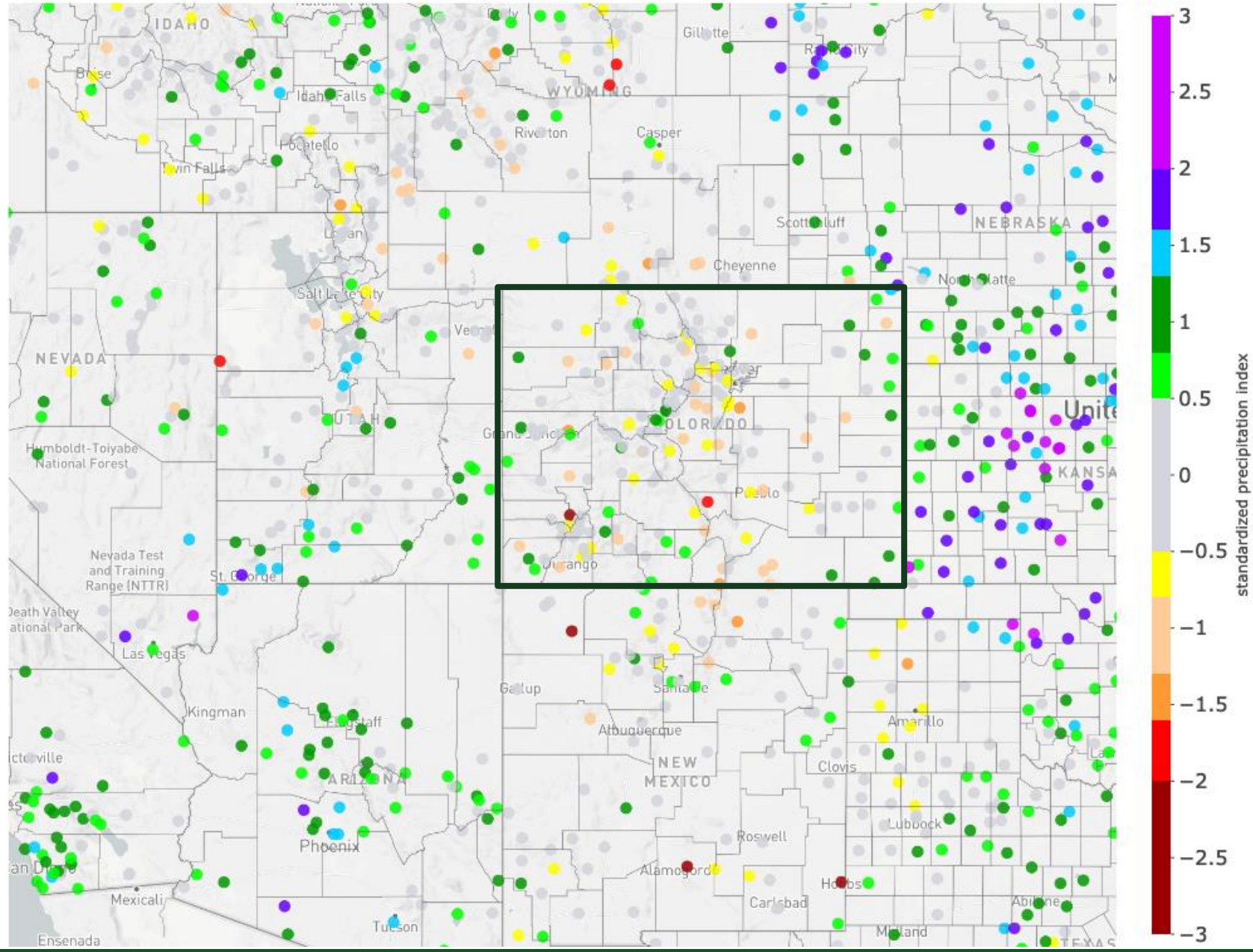
90-day Standardized Precipitation Index: 12/18/2018 - 3/17/2019

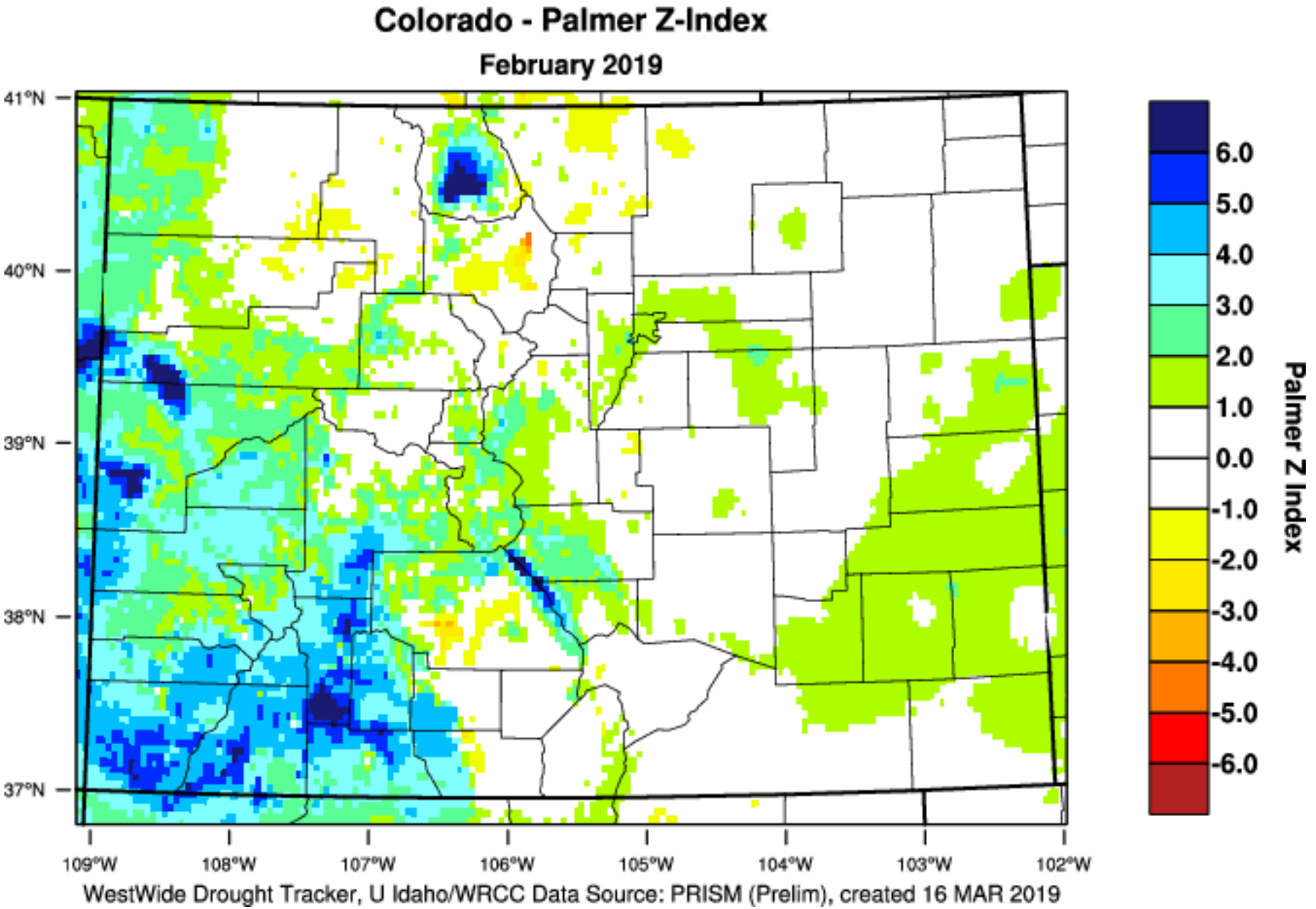


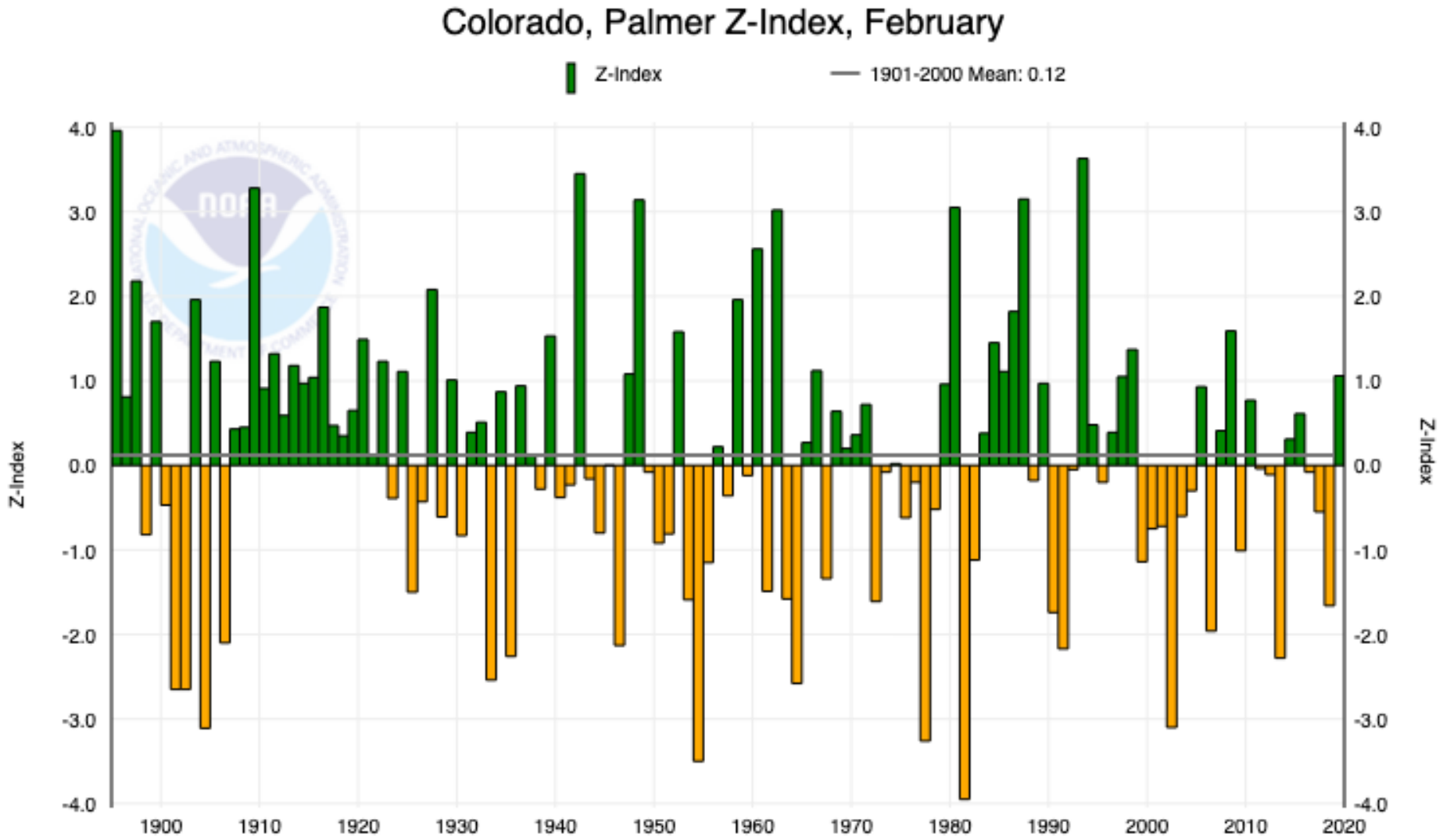
6-month Standardized Precipitation Index: 9/18/2018 - 3/17/2019



12-month Standardized Precipitation Index: 3/18/2018 - 3/17/2019




Colorado - Palmer Z-Index
February 2019
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
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
Palmer Z Index
WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 16 MAR 2019

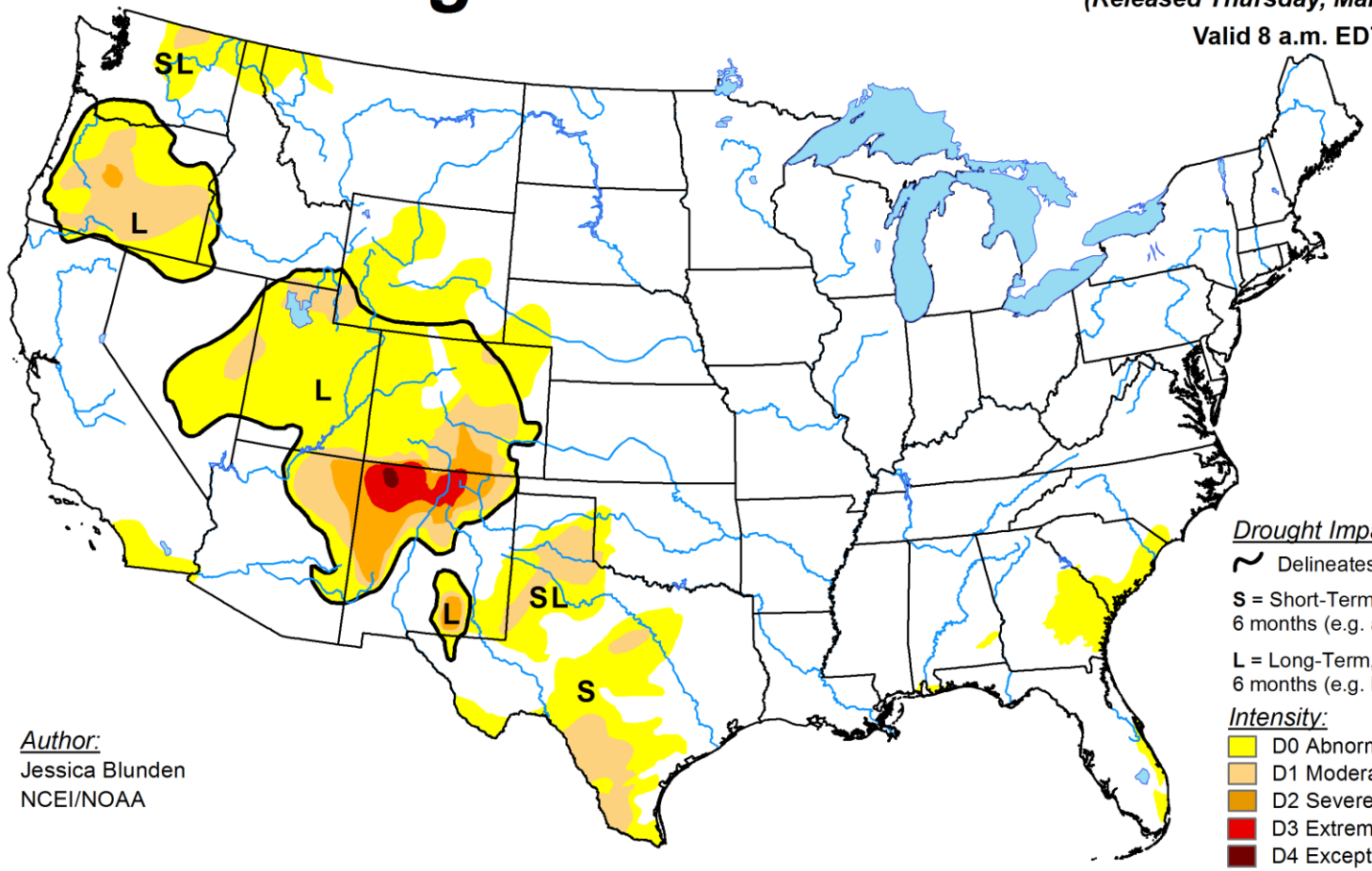

Colorado, Palmer Z-Index, February
Z-Index
1901-2000 Mean: 0.12
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
Z-Index
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020

U.S. Drought Monitor

March 12, 2019

(Released Thursday, Mar. 14, 2019)

Valid 8 a.m. EDT



Author:
Jessica Blunden
NCEI/NOAA

Drought Impact Types:

Delineates dominant impacts

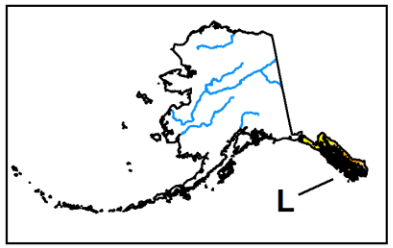
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

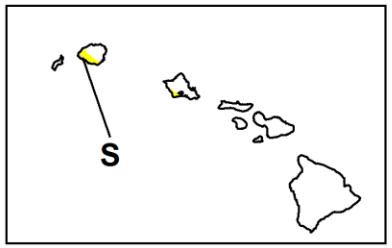
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

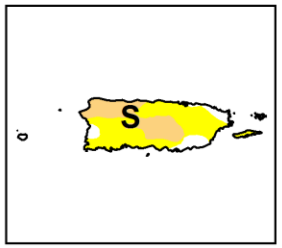
Intensity:

- 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.







USDA NDMC

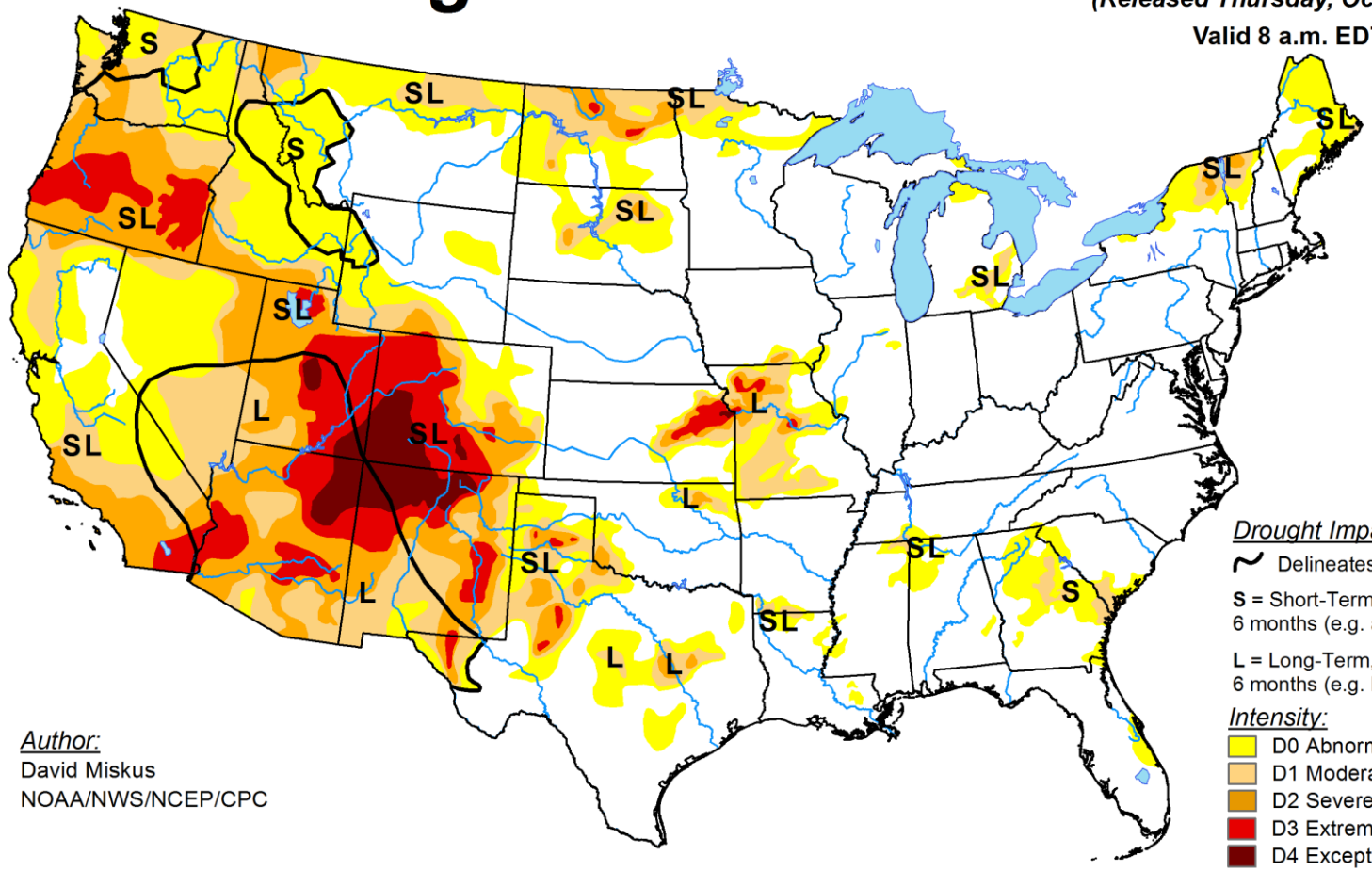
http://droughtmonitor.unl.edu/

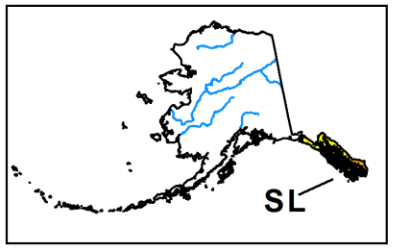
U.S. Drought Monitor

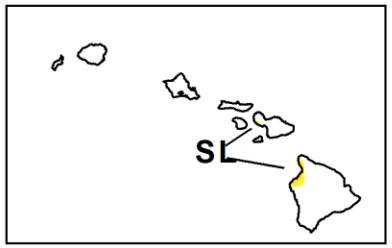
October 2, 2018

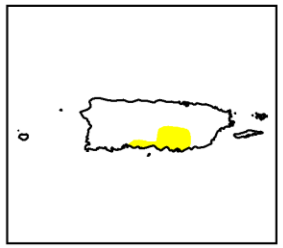
(Released Thursday, Oct. 4, 2018)

Valid 8 a.m. EDT









Author:
David Miskus
NOAA/NWS/NCEP/CPC

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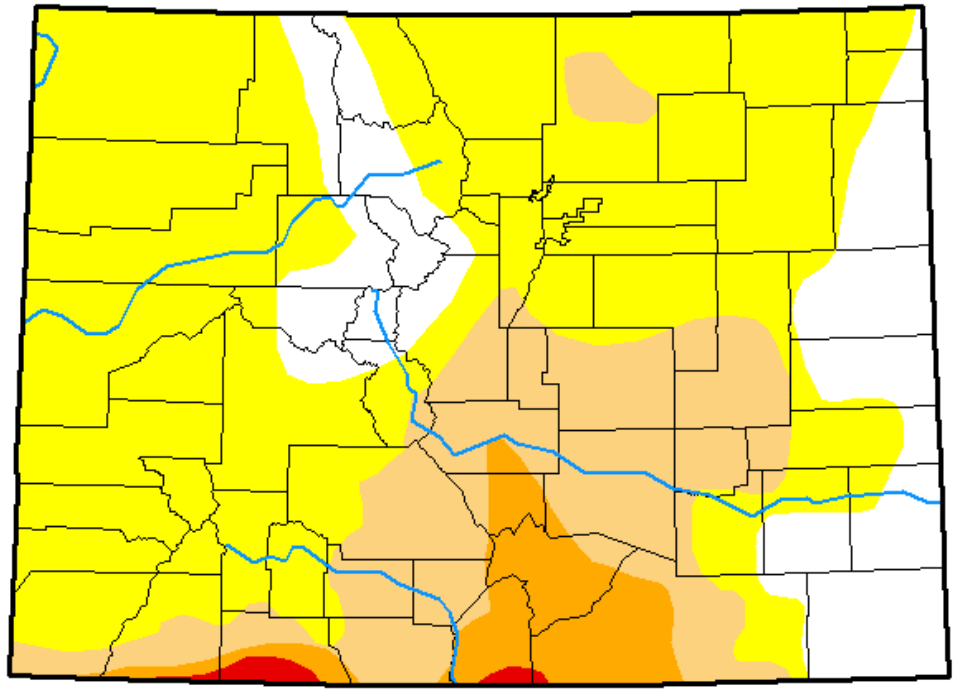
USDA NDMC NOAA

http://droughtmonitor.unl.edu/

U.S. Drought Monitor
Colorado



March 12, 2019
(Released Thursday, Mar. 14, 2019)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	17.00	83.00	25.44	6.26	0.58	0.00
Last Week *03-05-2019*	10.64	89.36	58.05	12.08	0.58	0.00
3 Months Ago *12-11-2018*	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 *03-13-2018*	10.16	89.84	70.75	47.44	13.44	0.00

Intensity:

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

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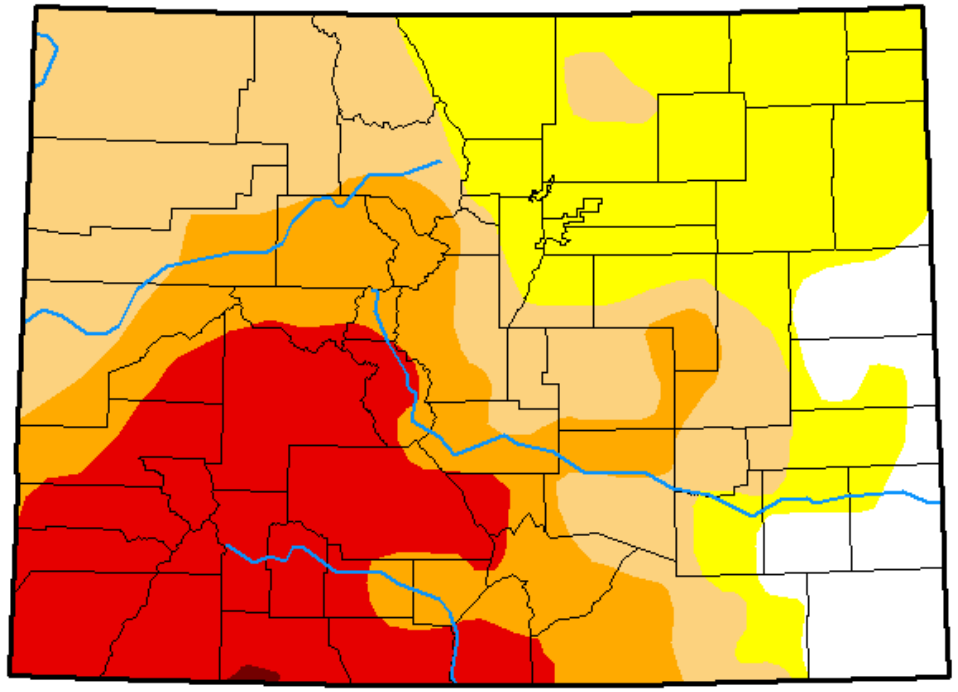
Author:
Jessica Blunden
NCEI/NOAA

http://droughtmonitor.unl.edu/

U.S. Drought Monitor
Colorado



February 12, 2019
(Released Thursday, Feb. 14, 2019)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	8.15	91.85	67.16	39.69	21.84	0.11
Last Week *02-05-2019*	8.14	91.86	67.16	40.83	22.05	2.96
3 Months Ago *11-13-2018*	16.64	83.36	66.26	54.82	34.13	13.35
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 *02-13-2018*	8.59	91.41	71.18	33.51	0.00	0.00

Intensity:

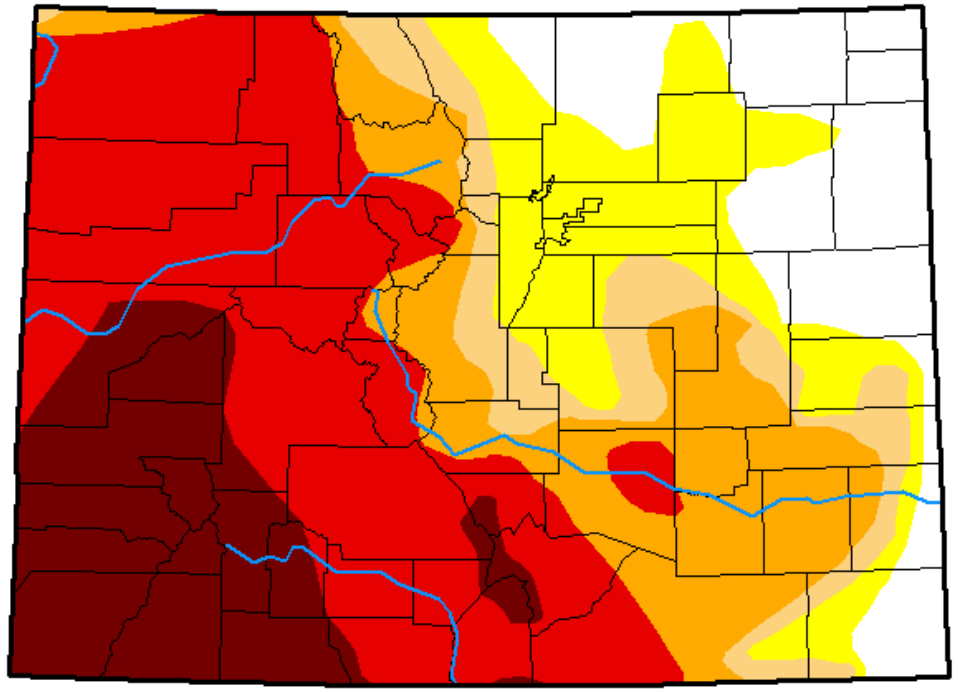
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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

Author:
Richard Tinker
CPC/NOAA/NWS/NCEP

http://droughtmonitor.unl.edu/

U.S. Drought Monitor
Colorado



October 2, 2018
(Released Thursday, Oct. 4, 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 *09-25-2018*	14.19	85.81	72.30	64.41	48.47	16.21
3 Months Ago *07-03-2018*	20.46	79.54	67.30	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 *09-25-2018*	14.19	85.81	72.30	64.41	48.47	16.21
One Year Ago *10-03-2017*	70.54	29.46	3.70	0.00	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
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- D3 Extreme Drought
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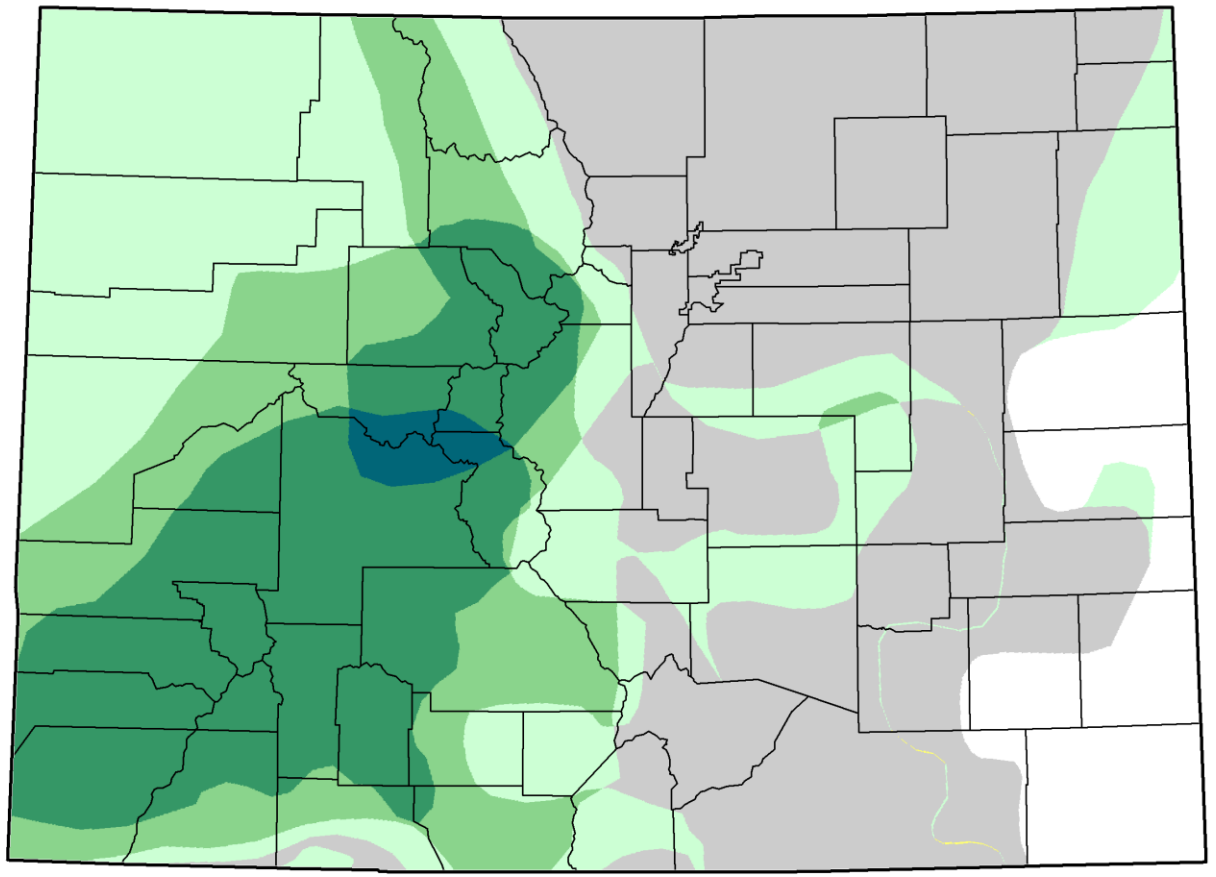
Author:
David Miskus
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

U.S. Drought Monitor Class Change - Colorado

1 Month



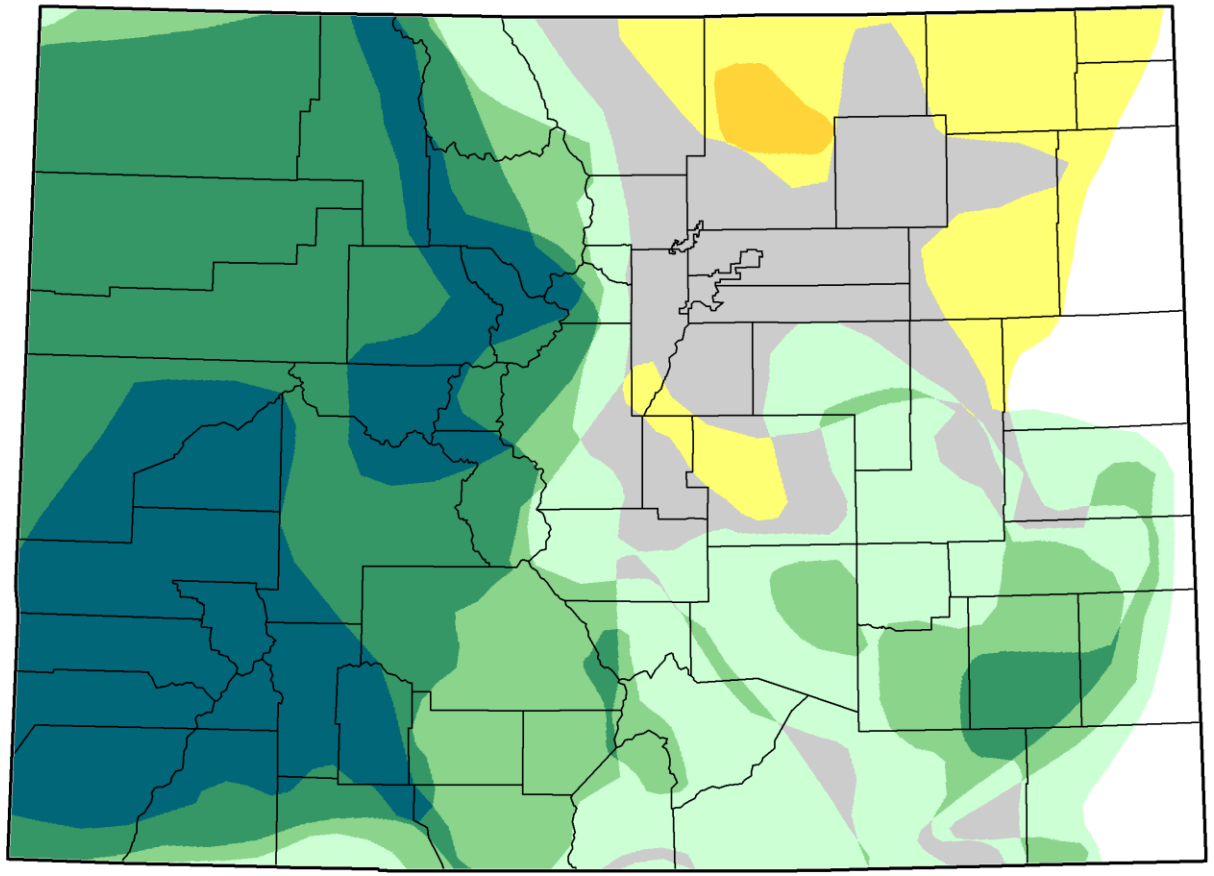
March 12, 2019
compared to
February 12, 2019

http://droughtmonitor.unl.edu

- 5 Class Degradation
- 4 Class Degradation
- 3 Class Degradation
- 2 Class Degradation
- 1 Class Degradation
- No Change
- 1 Class Improvement
- 2 Class Improvement
- 3 Class Improvement
- 4 Class Improvement
- 5 Class Improvement

U.S. Drought Monitor Class Change - Colorado

Start of Water Year

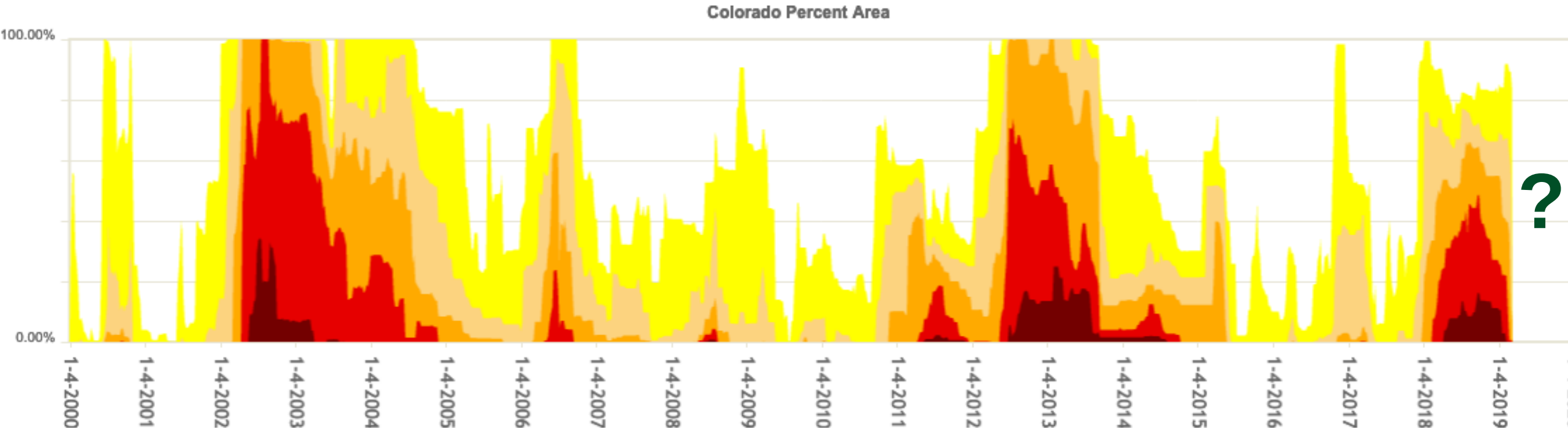


March 12, 2019
compared to
September 25, 2018

http://droughtmonitor.unl.edu

- 5 Class Degradation
- 4 Class Degradation
- 3 Class Degradation
- 2 Class Degradation
- 1 Class Degradation
- No Change
- 1 Class Improvement
- 2 Class Improvement
- 3 Class Improvement
- 4 Class Improvement
- 5 Class Improvement

US Drought Monitor: Colorado



Intensity:

- D0 Abnormally Dry
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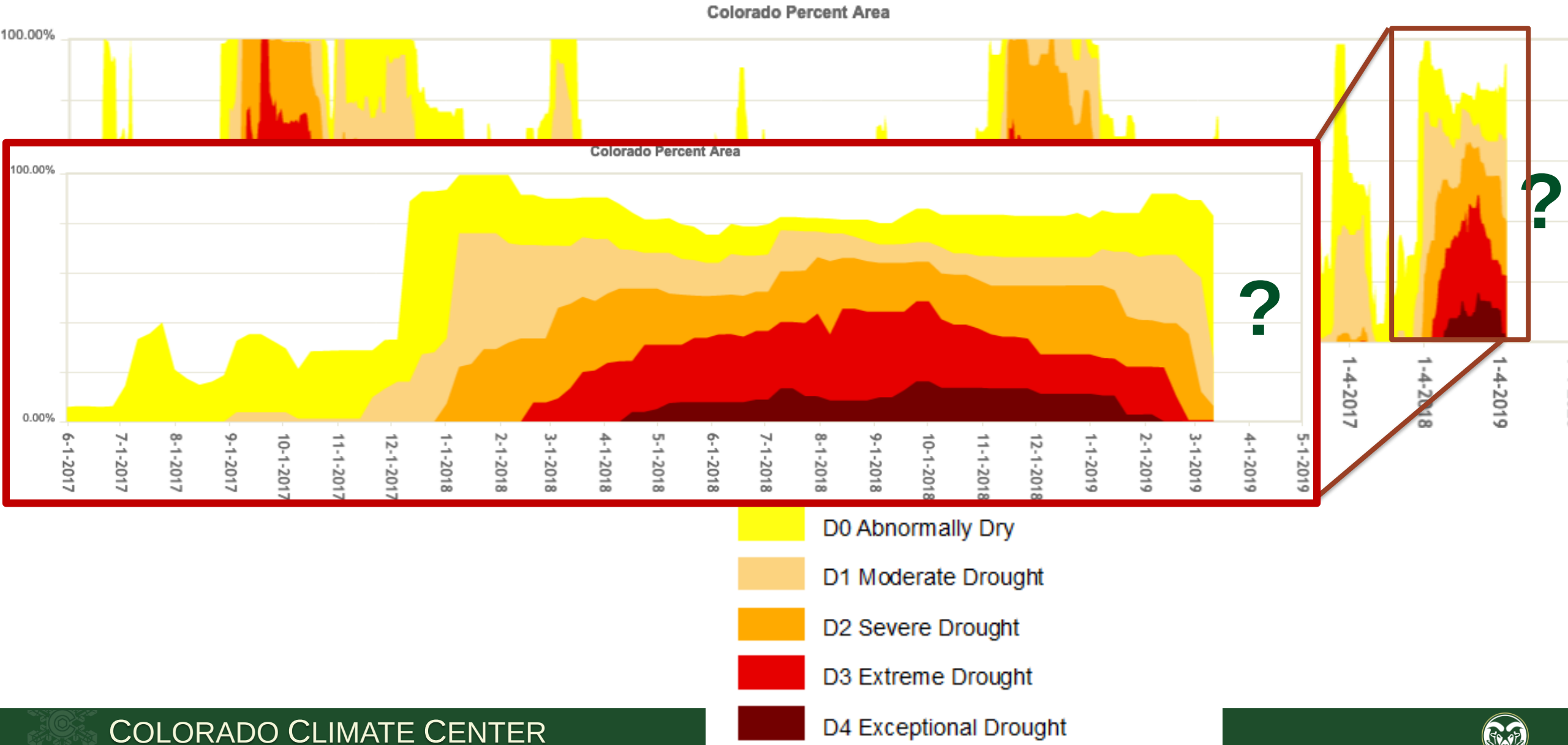
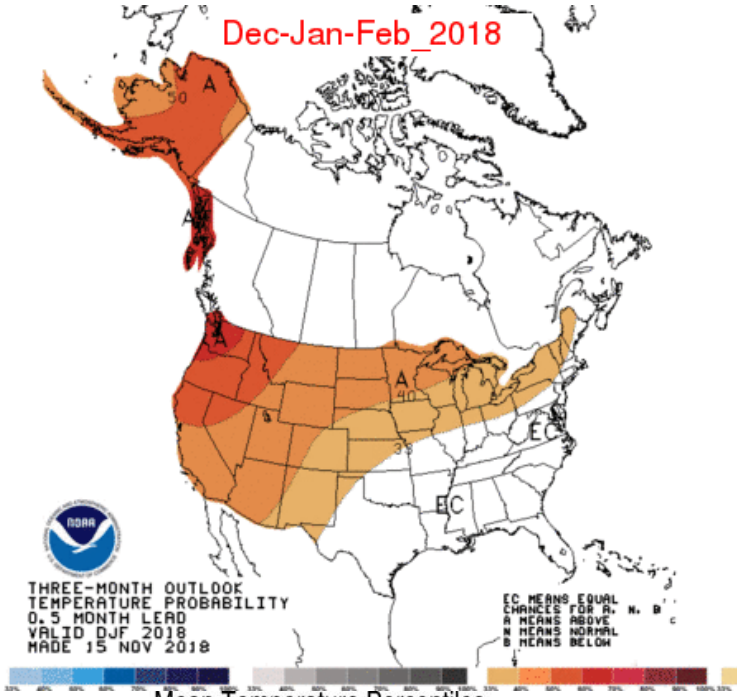
US Drought Monitor: Colorado

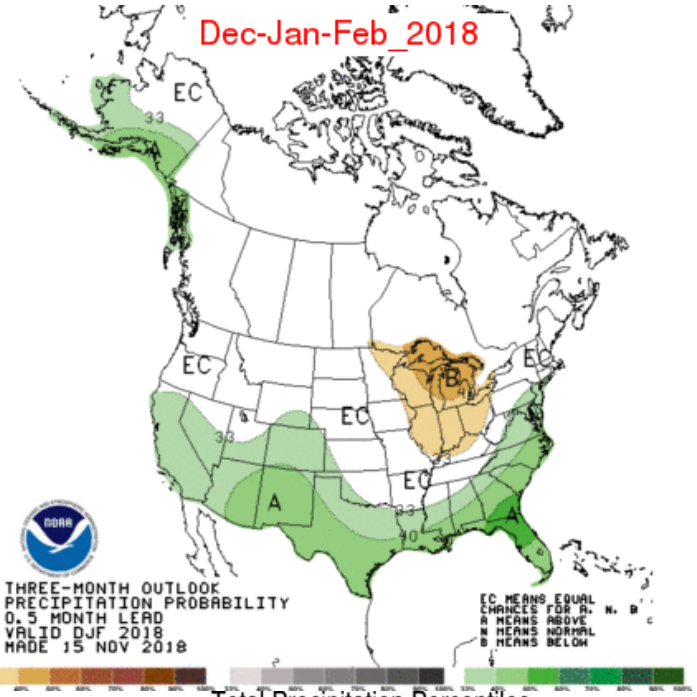


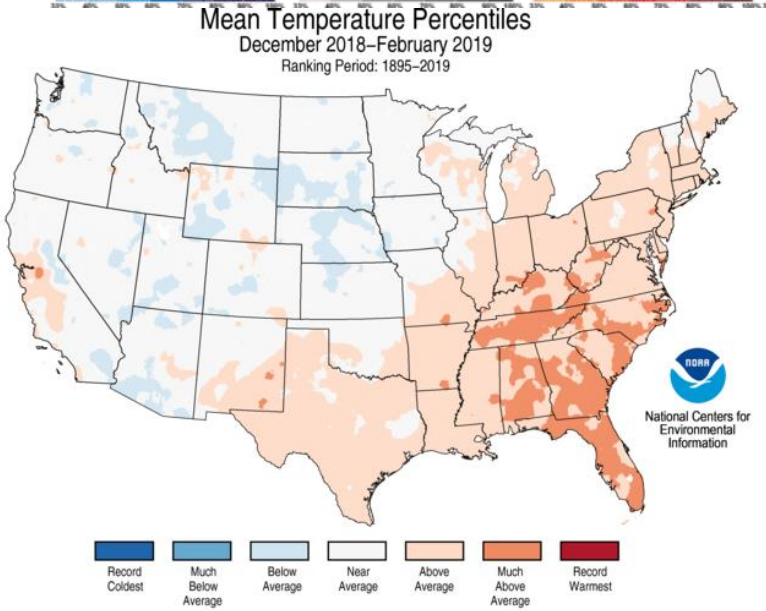
COLORADO
CLIMATE
CENTER

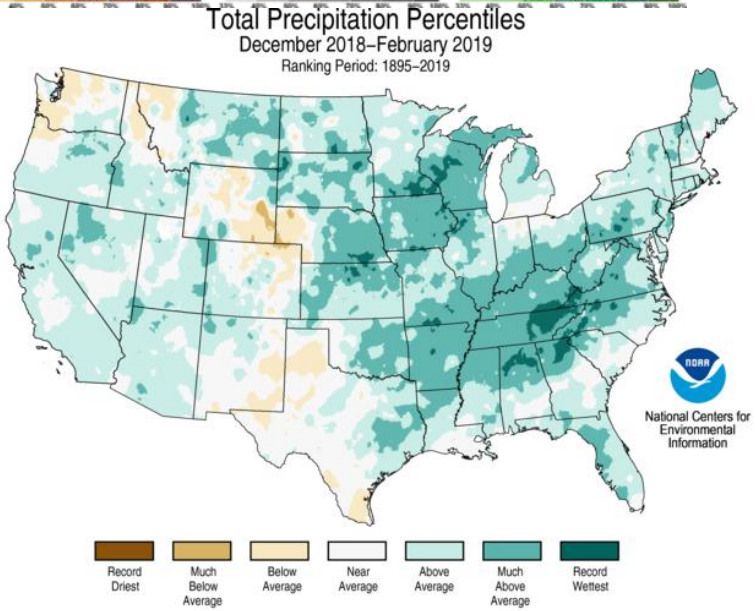
Outlook

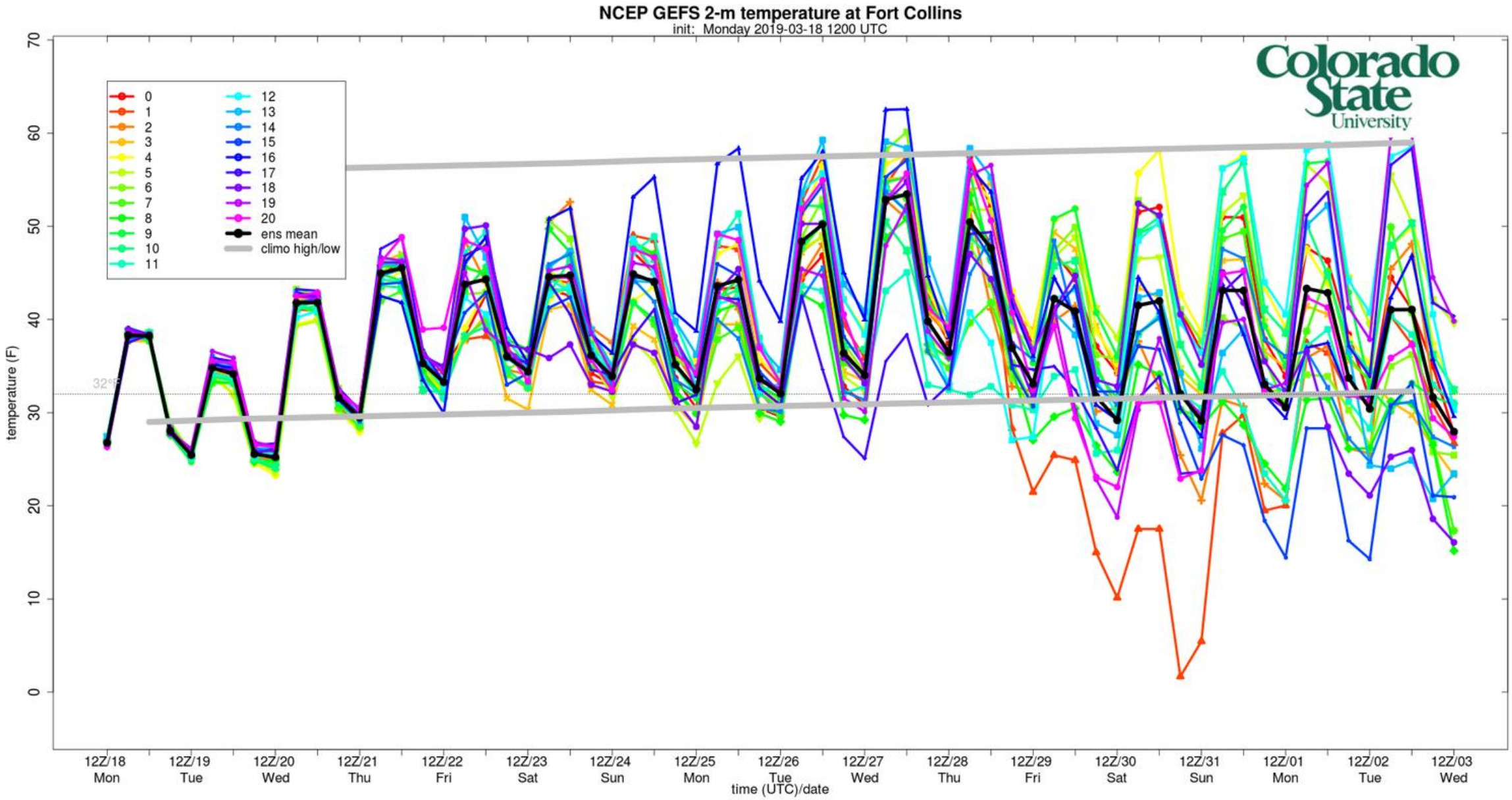
Looking back...





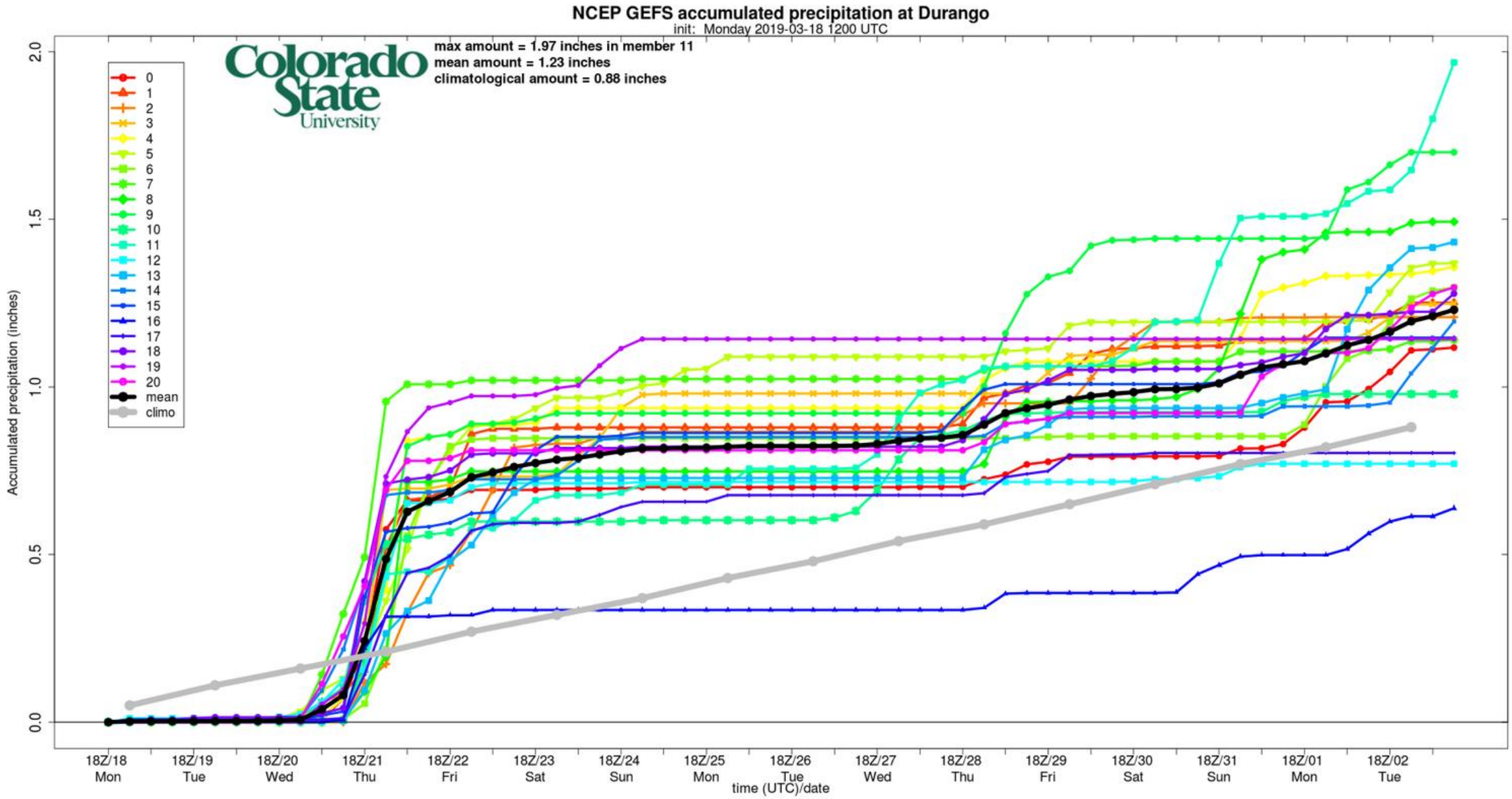






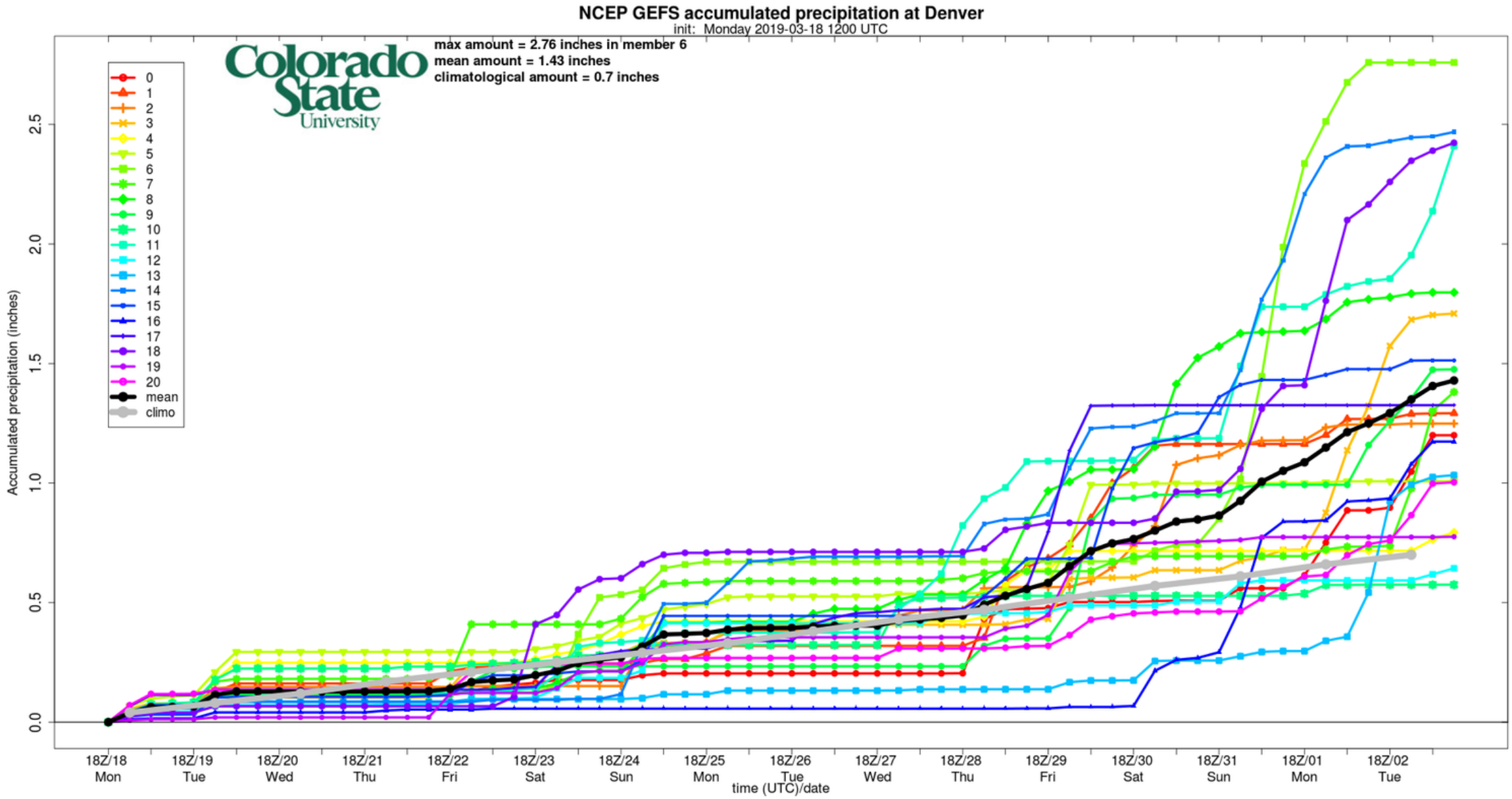
(April 3)

http://schumacher.atmos.colostate.edu/weather/ens.php



(April 3)

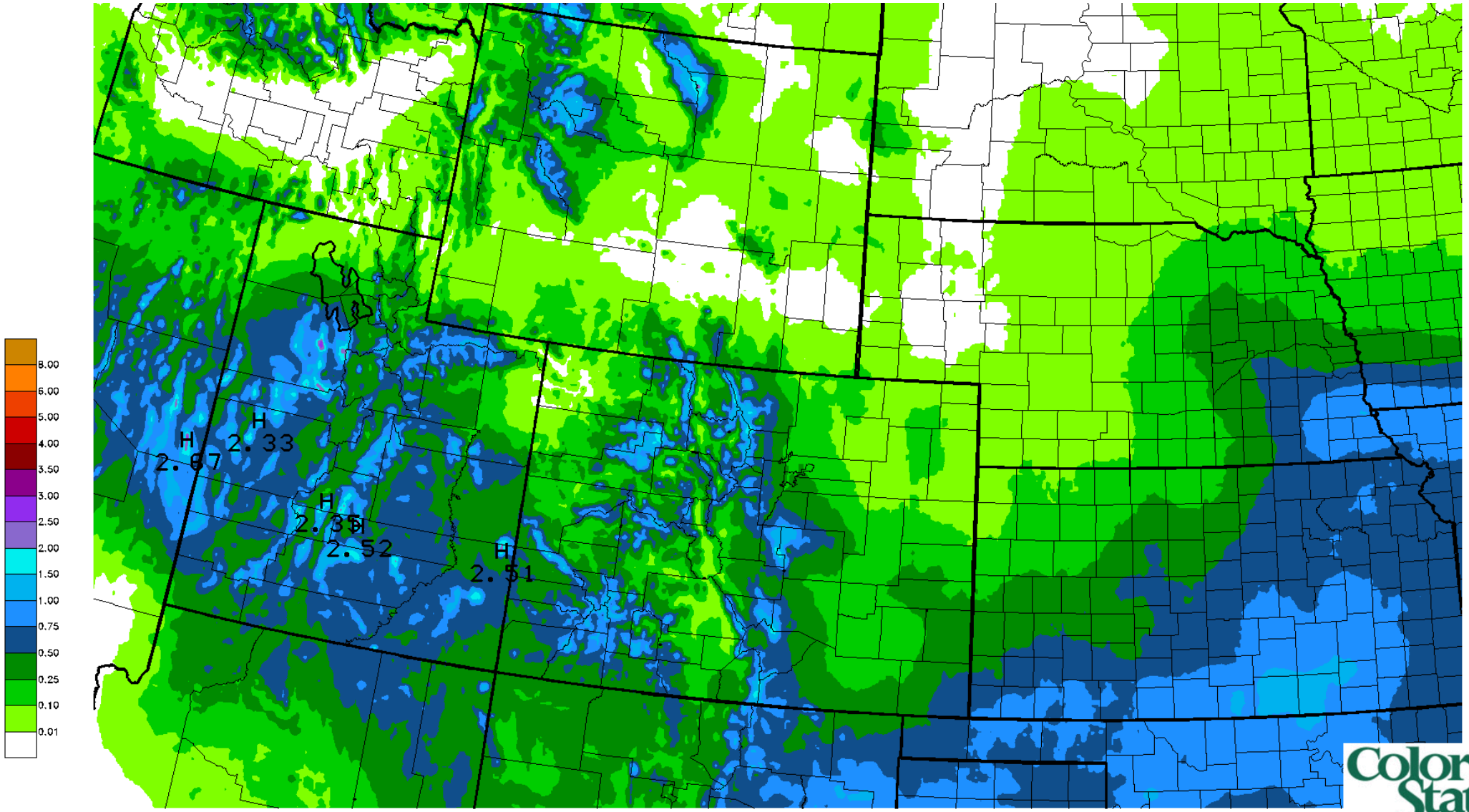
http://schumacher.atmos.colostate.edu/weather/ens.php



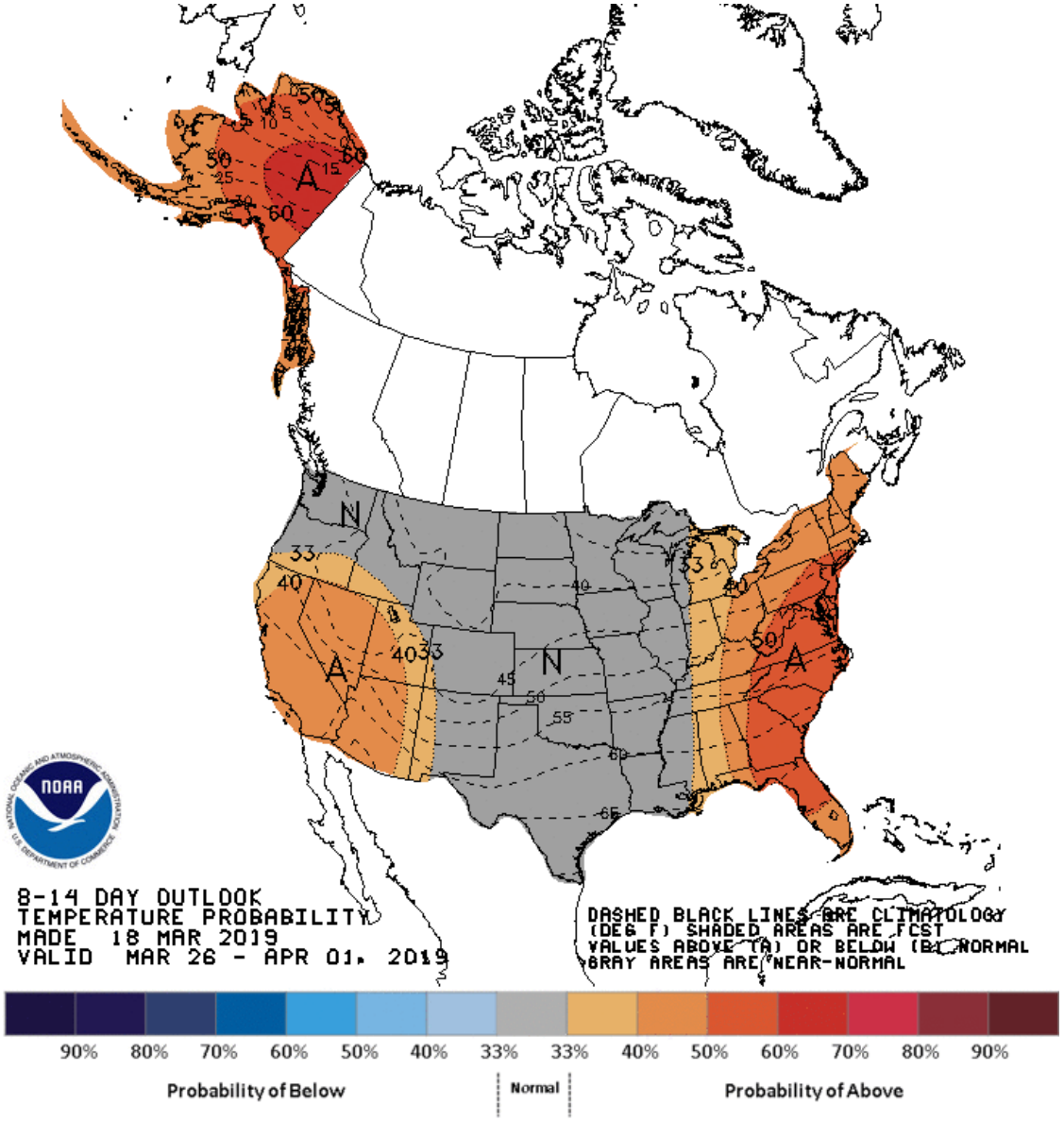
(April 3)

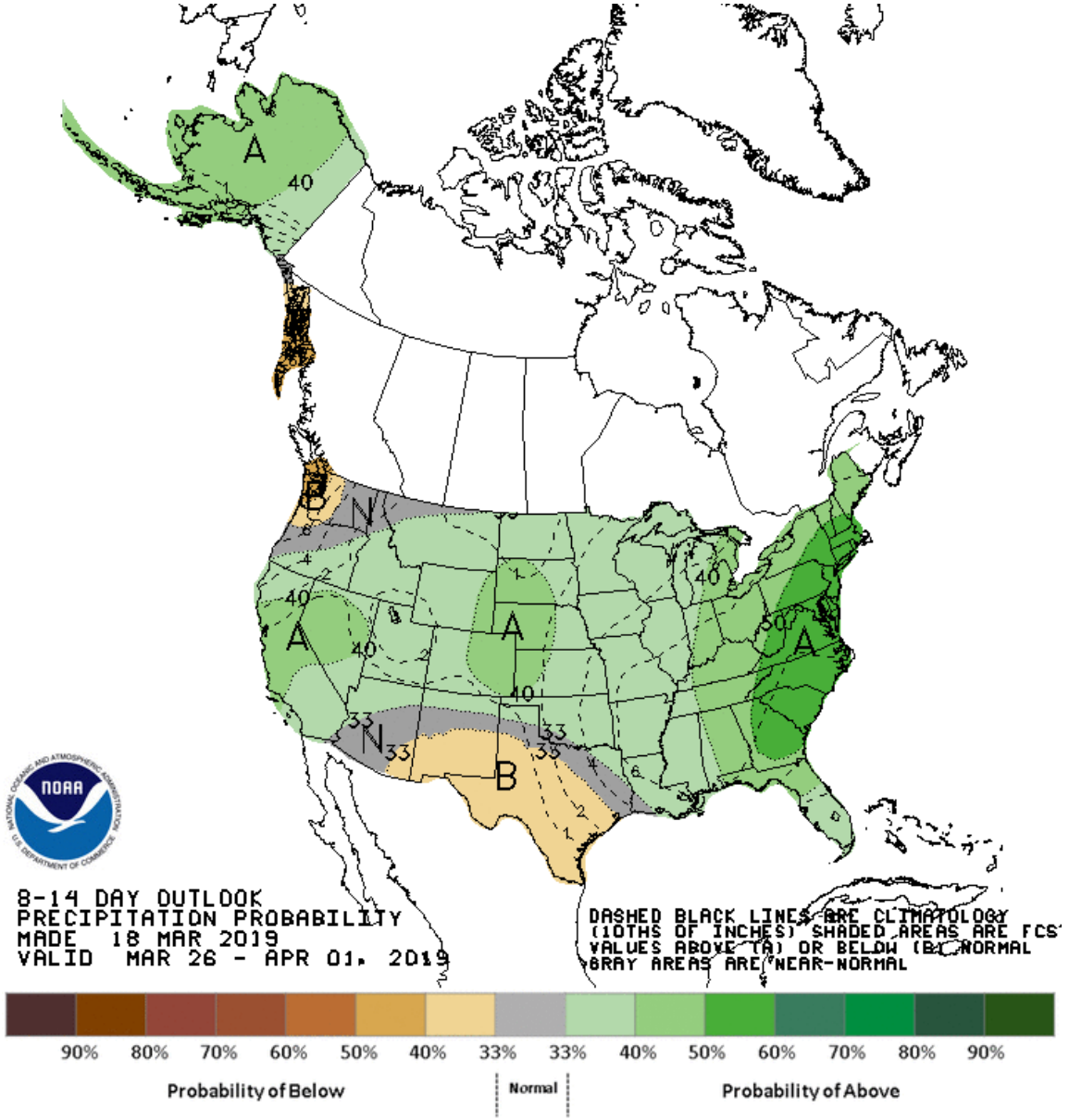
http://schumacher.atmos.colostate.edu/weather/ens.php

7-day precipitation outlook from NOAA Weather Prediction Center



Colorado State University


8-14 DAY OUTLOOK
TEMPERATURE PROBABILITY
MADE 18 MAR 2019
VALID MAR 26 - APR 01. 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 18 MAR 2019
VALID MAR 26 - APR 01. 2019
DASHED BLACK LINES ARE CLIMATOLOGY
(10THS OF INCHES) SHADED AREAS ARE FCS
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

El Niño-Southern Oscillation (ENSO)

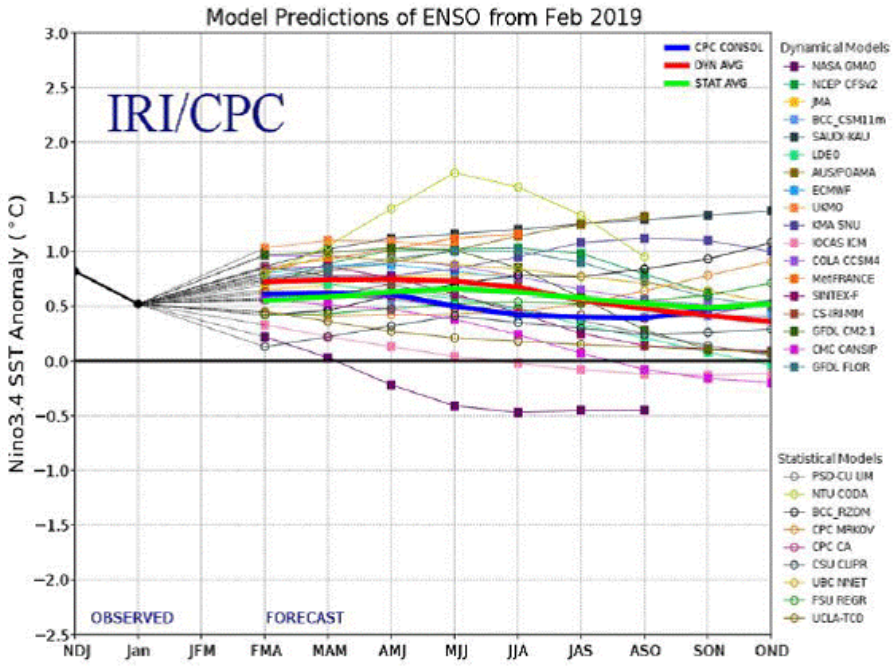
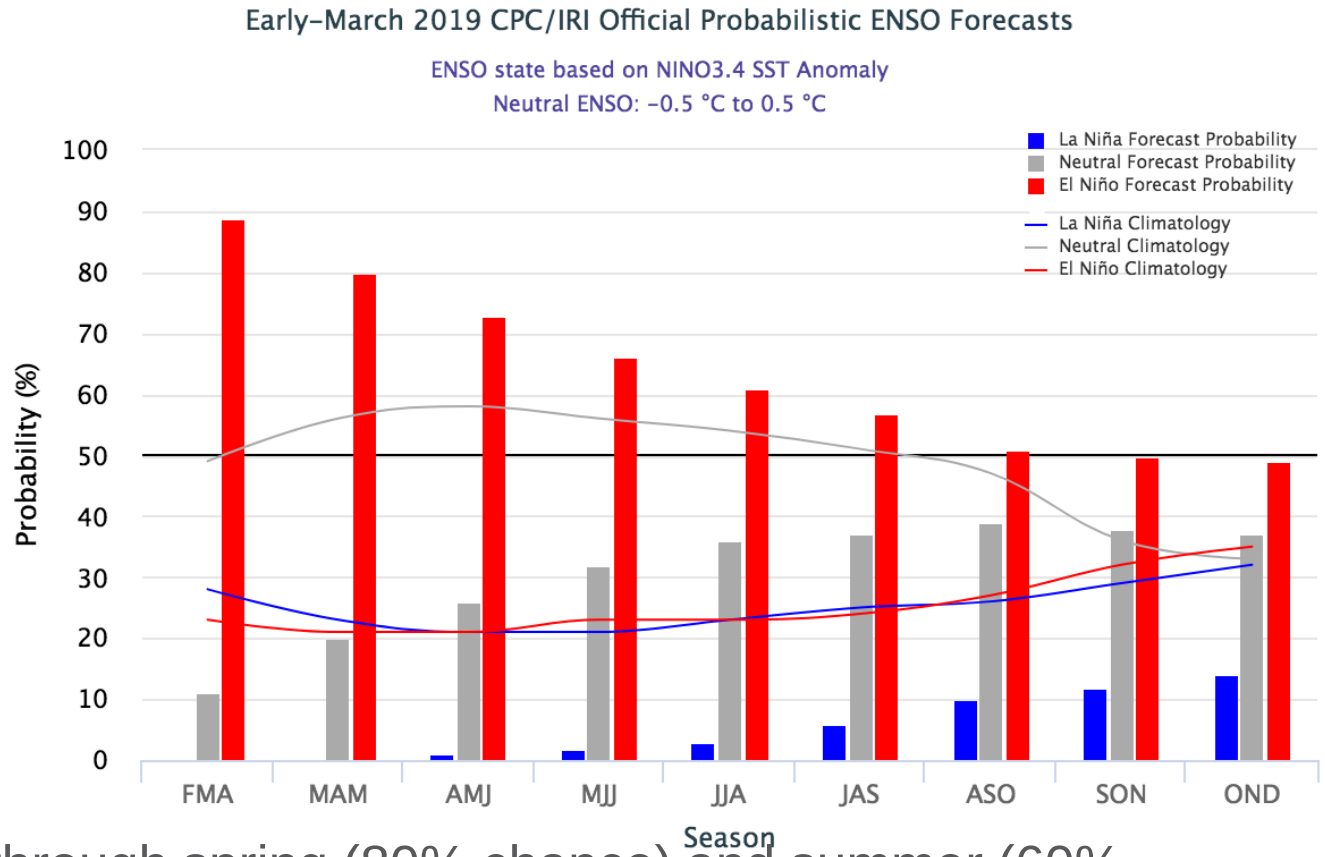


Figure 6. Forecasts of sea surface temperature (SST) anomalies for the Niño 3.4 region (5°N-5°S, 120°W-170°W). Figure updated 19 February 2019.

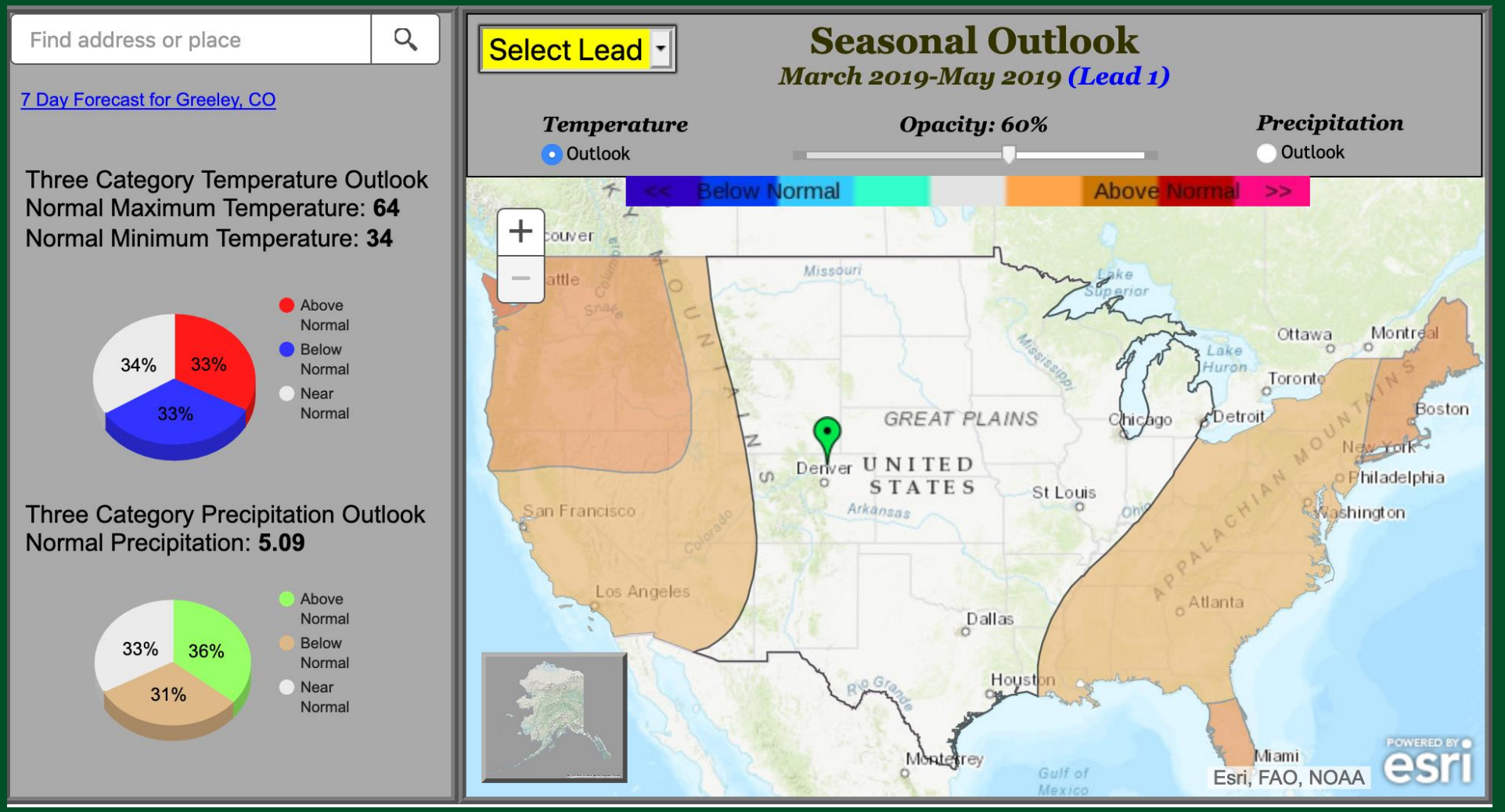


Weak El Niño in place, likely to continue through spring (80% chance) and summer (60% chance)

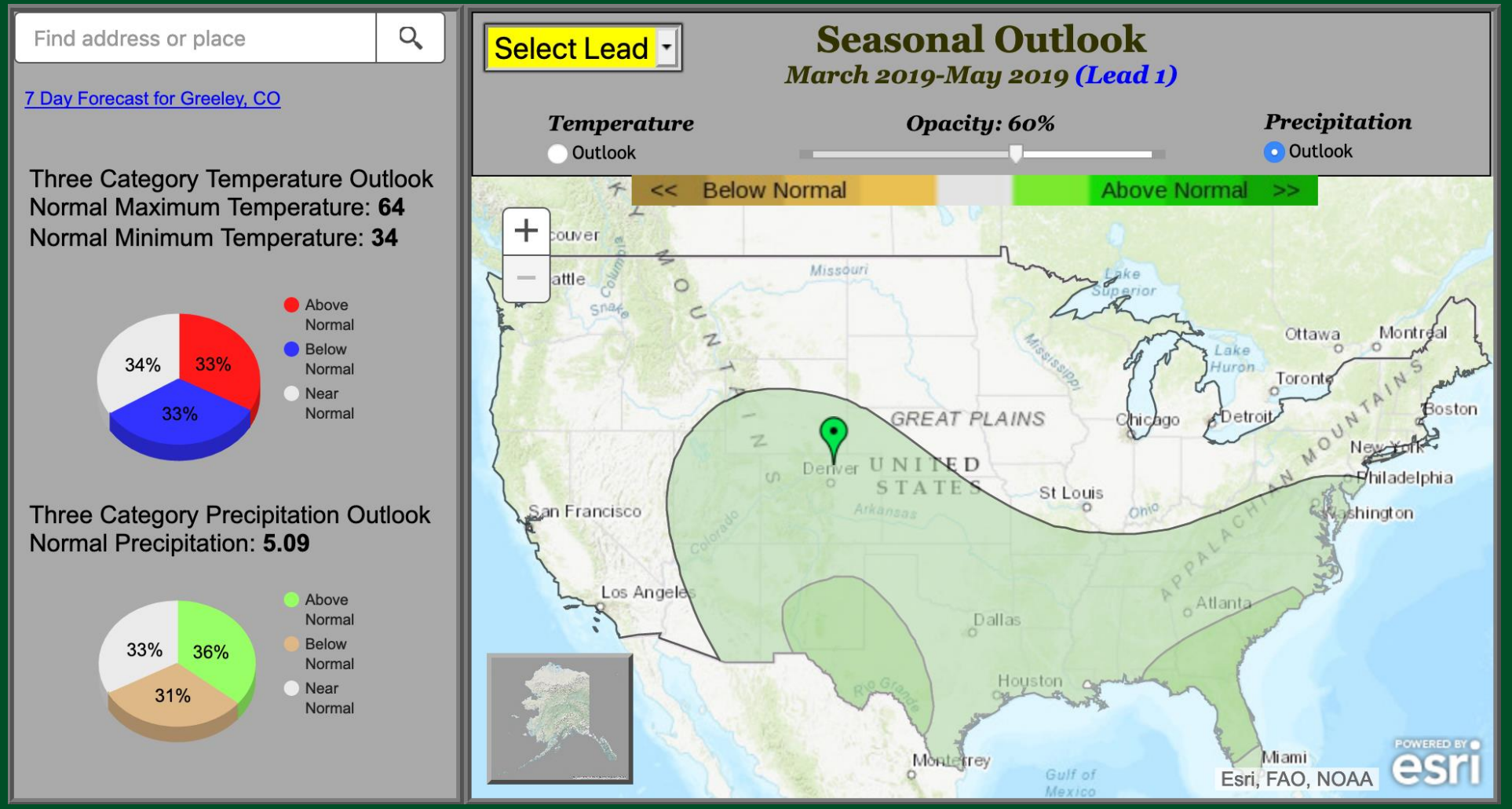
Through the winter, the Madden-Julian Oscillation (MJO) was a bigger player than ENSO, though current pattern is more aligned with El Niño

Wet springs in eastern CO are somewhat common during El Niño; summer influences not that strong

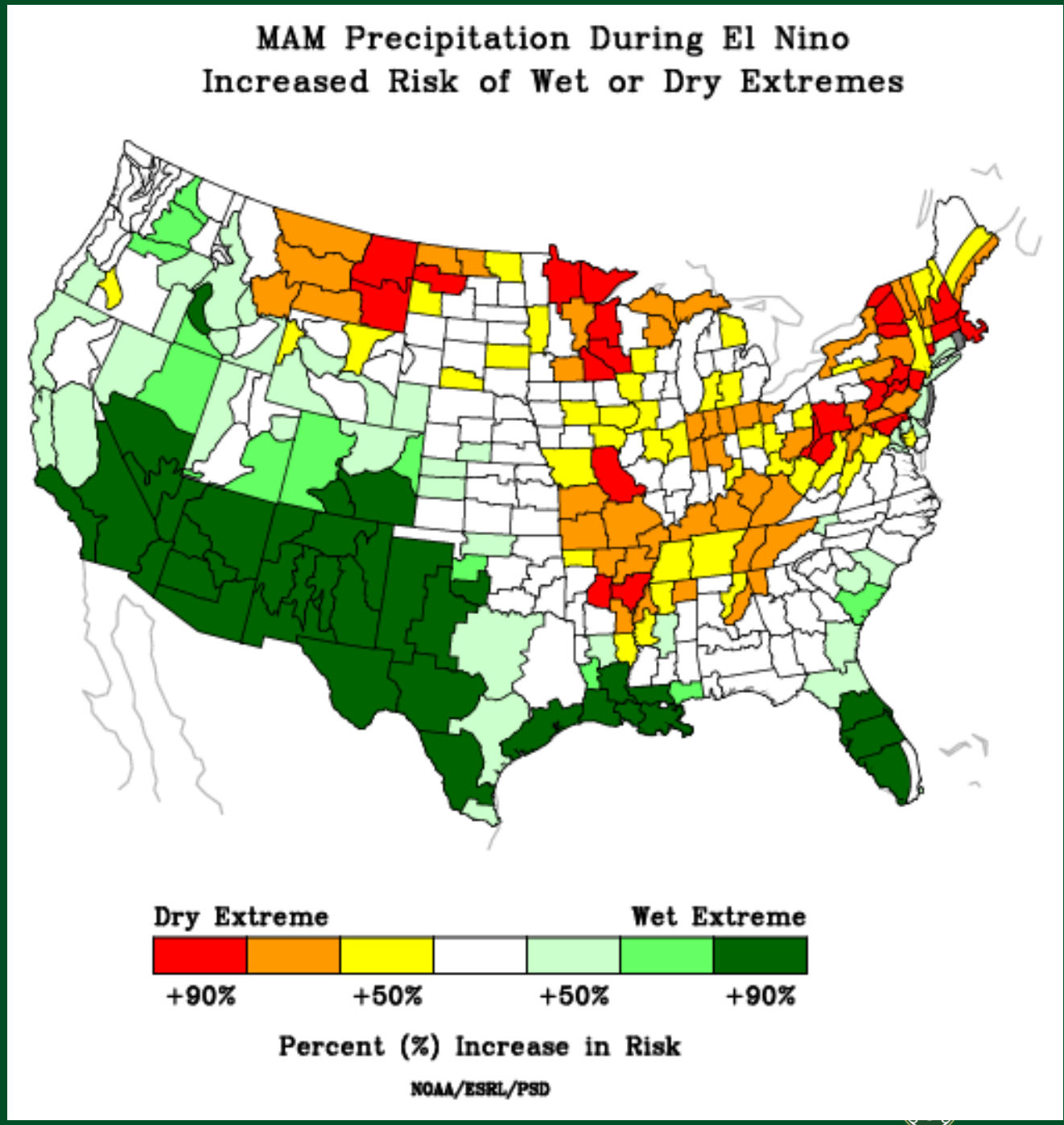
Spring (March-April-May) outlook



Spring (March-April-May) outlook



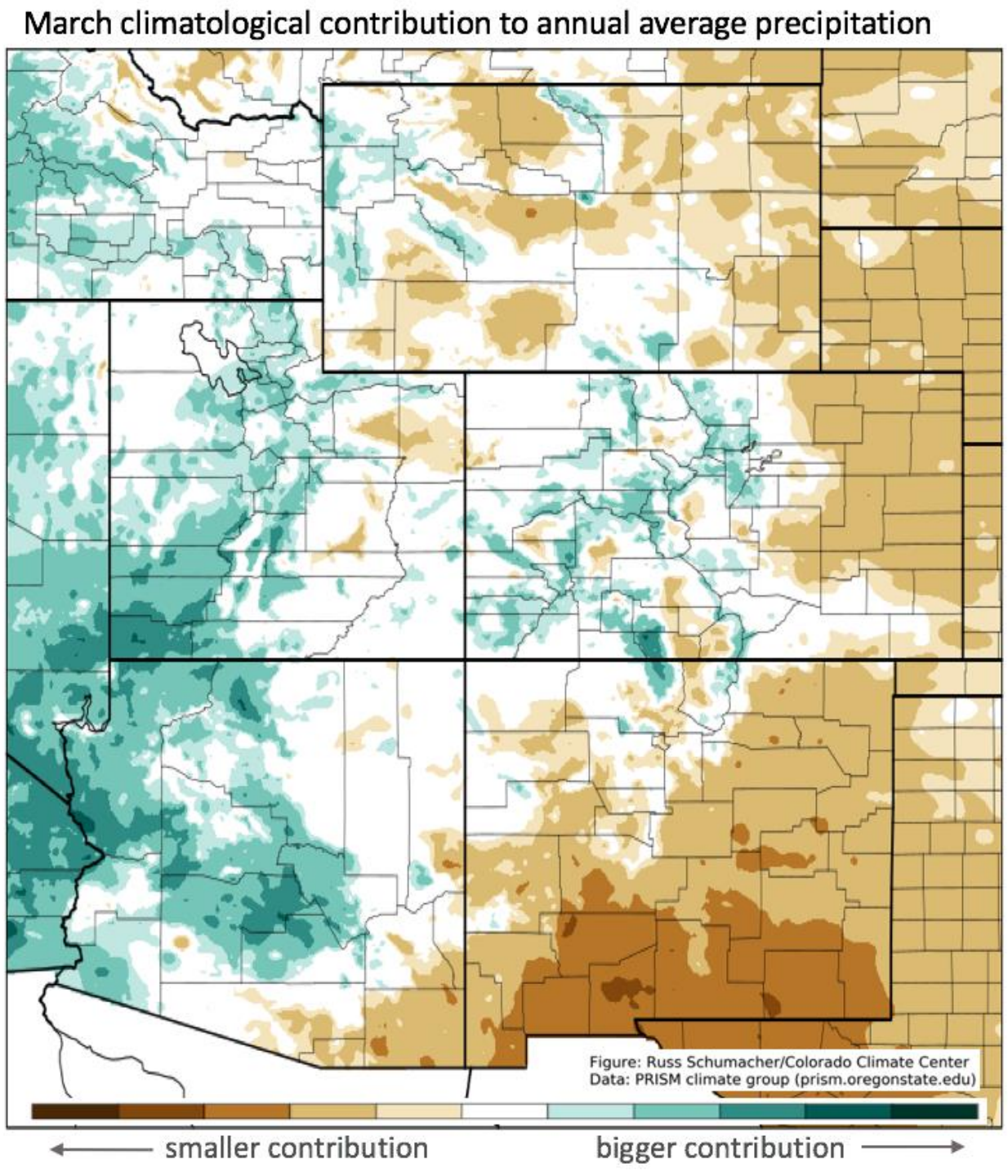
Chances of increased wet or dry extremes in spring during El Niño



How important are the spring months to the total annual average precipitation?

March

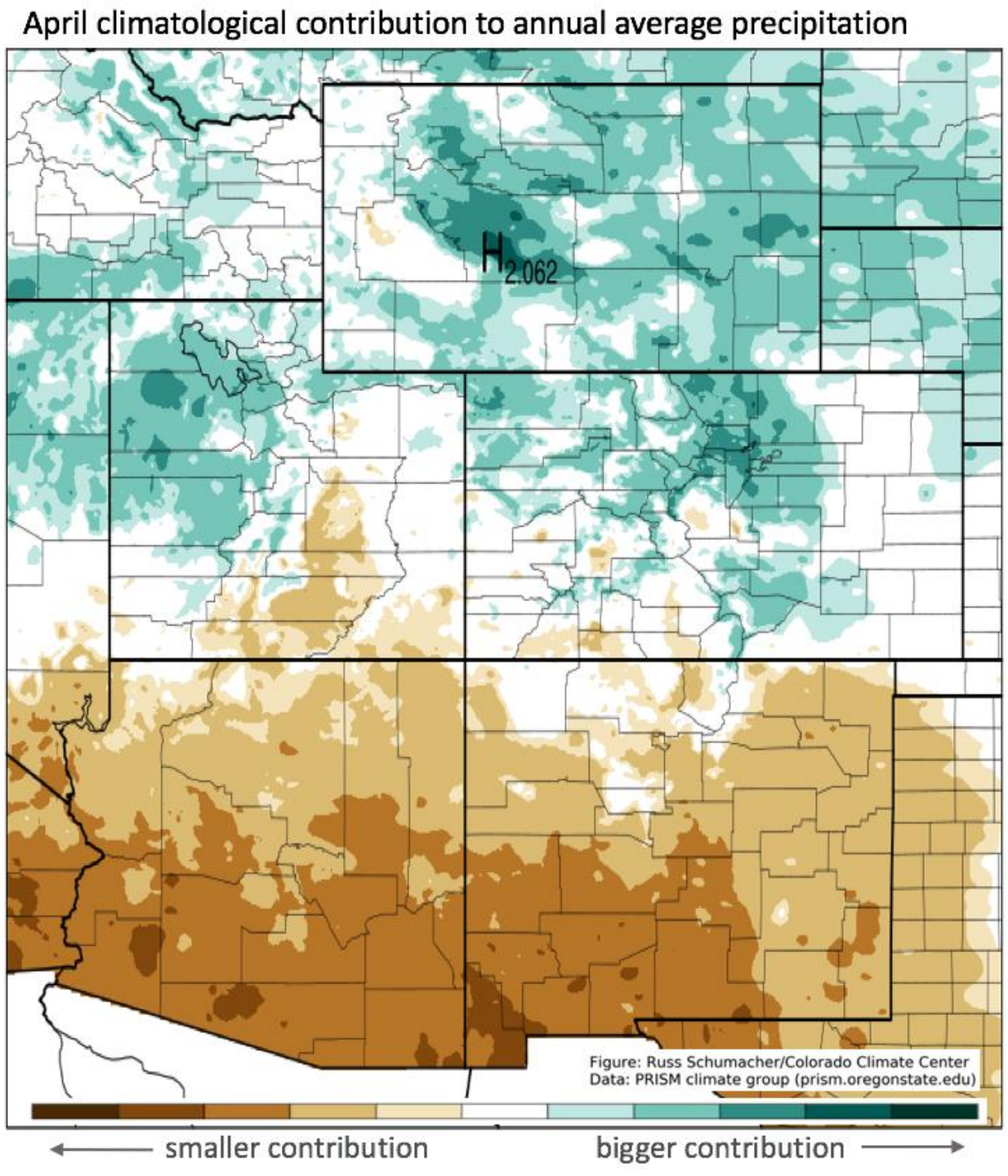
Brown: much less than 1/12th of the annual precip
Green: much more than 1/12th of the annual precip



How important are the spring months to the total annual average precipitation?

April

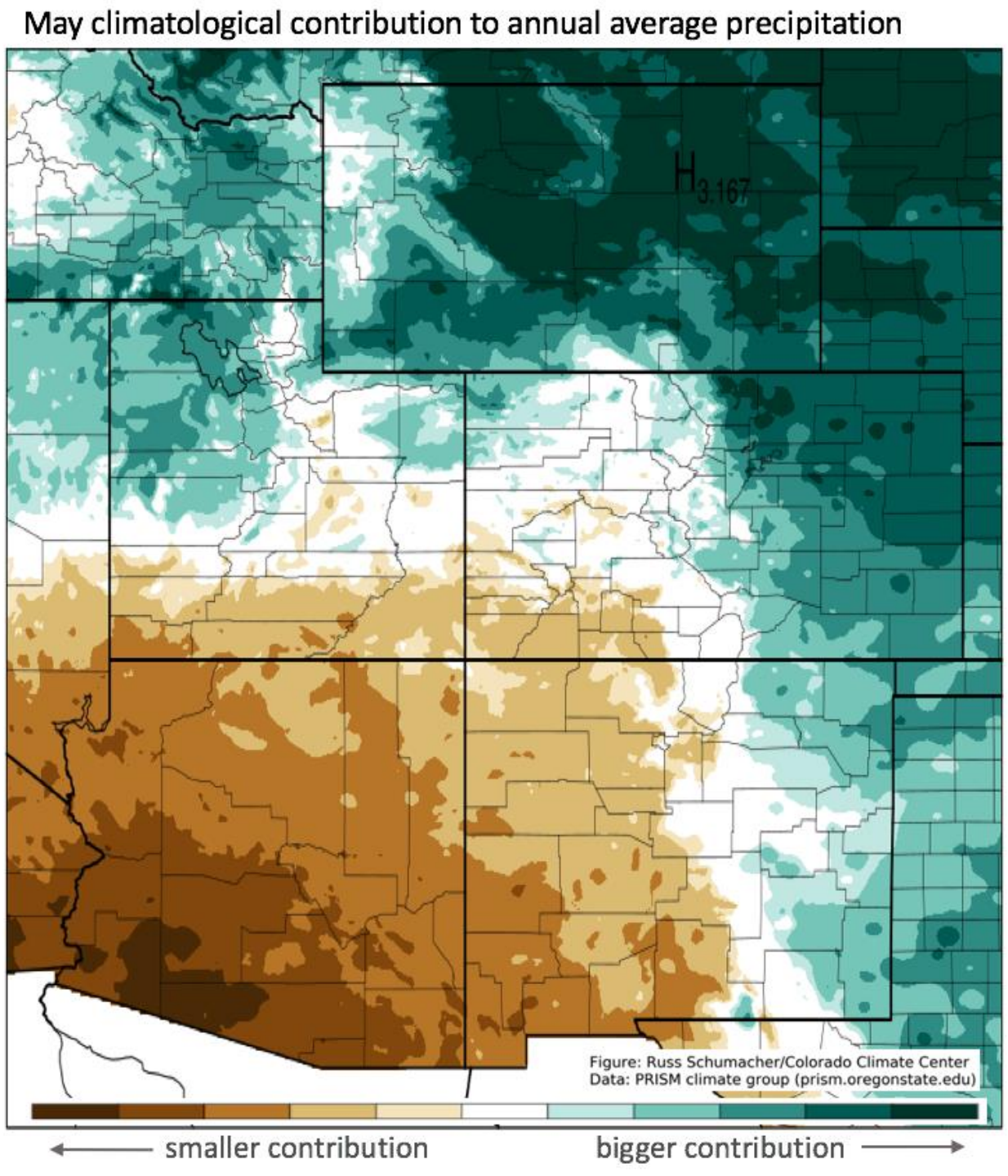
Brown: much less than 1/12th of the annual precip
Green: much more than 1/12th of the annual precip



How important are the spring months to the total annual average precipitation?

May

Brown: much less than 1/12th of the annual precip
Green: much more than 1/12th of the annual precip



Summary

- February was a huge month for snow in the mountains, and March has also been huge thus far
- Drought conditions have been drastically reduced across Colorado – now only 6% of the state in D2 (severe) drought or worse, with more improvements likely
- Furthermore, temperatures since the beginning of the water year have been near normal to a bit cooler than normal
- Still awaiting reservoir and soil recharge in the spring/summer snowmelt and runoff season
- Flood concerns are likely in spring, but will depend in large part on the weather over the next month or two

Thank you!

russ.schumacher@colostate.edu

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