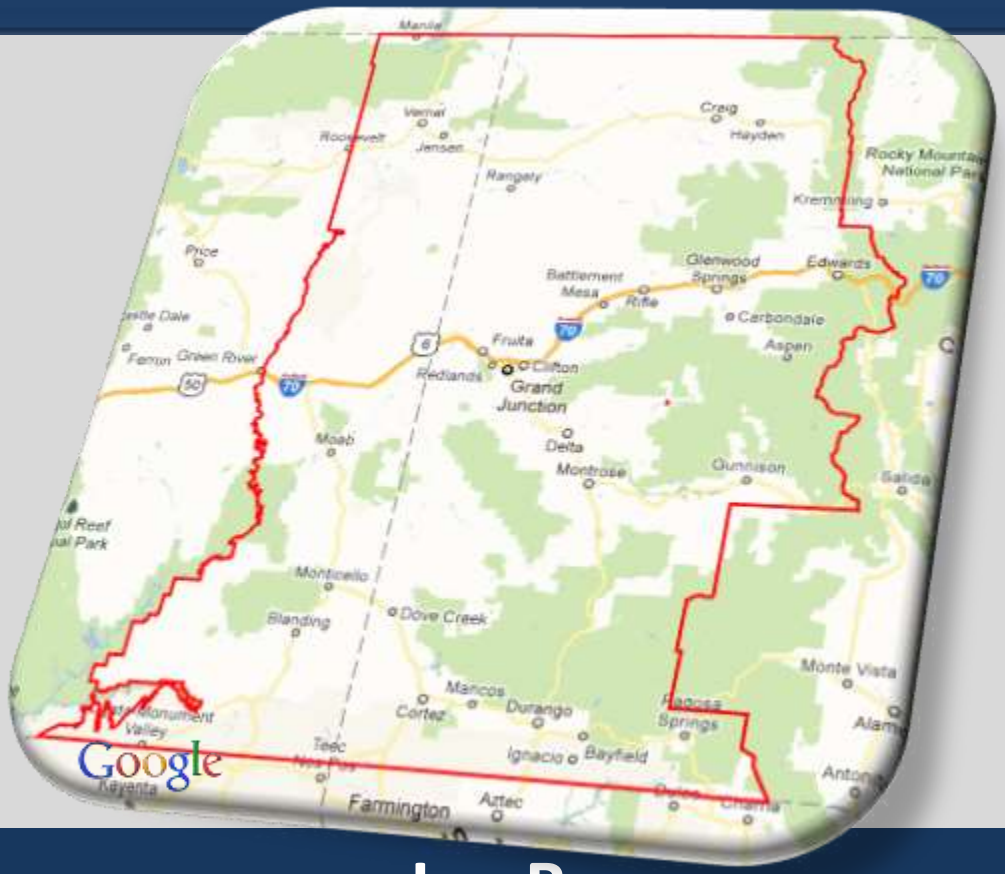
Climate of Western Colorado



Joe Ramey

National Weather Service

Grand Junction, CO

http://www.weather.gov/gjt

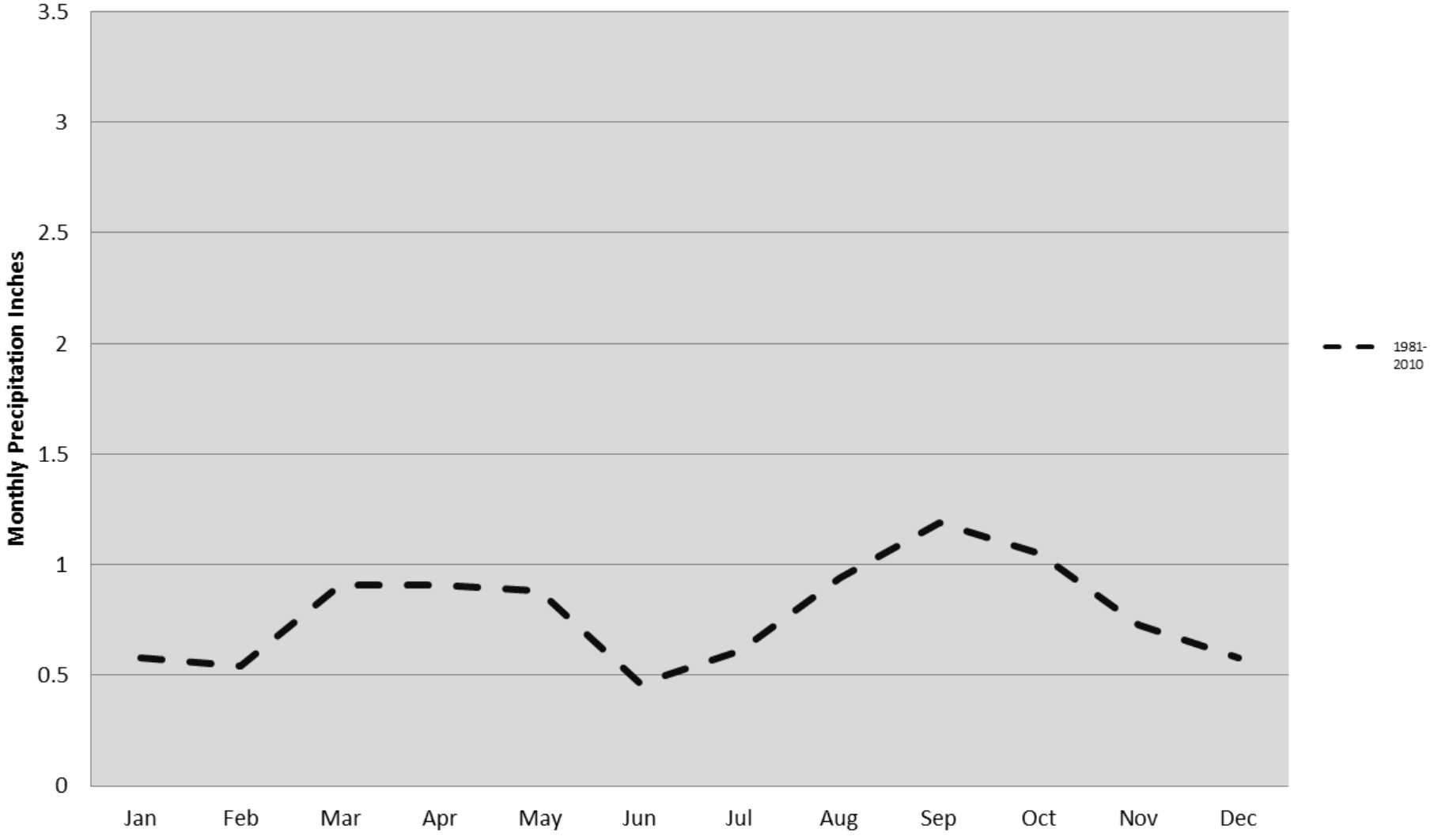
Outline

- **Present**
  - What is the nature of climate in western Colorado?
  - Where are we now?
- **Past** Temperature and Precipitation Trends
  - for the last 100 years
  - for the last 5 years
- **Future**
  - El Nino Southern Oscillation (ENSO)
  - Climate Prediction Center's Outlook into 2017
    (new CPC outlooks were issued today!)

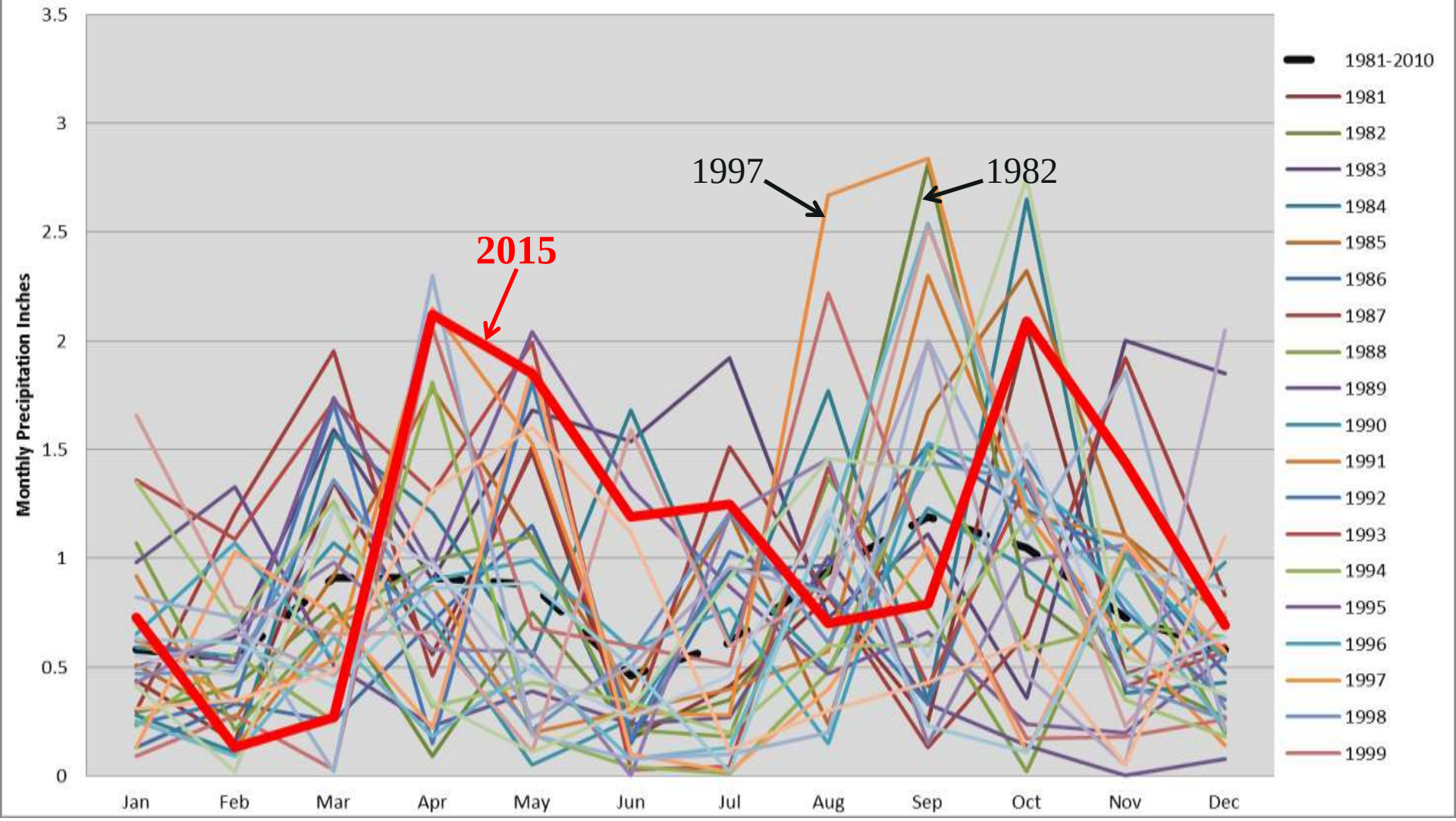
What is Climate Normal?

- Answer: 30 Year Average, updated every 10 years.
- The latest climate normal is 1981-2010.
- Now we are half way to a new climate normal period that will be 1991-2020.

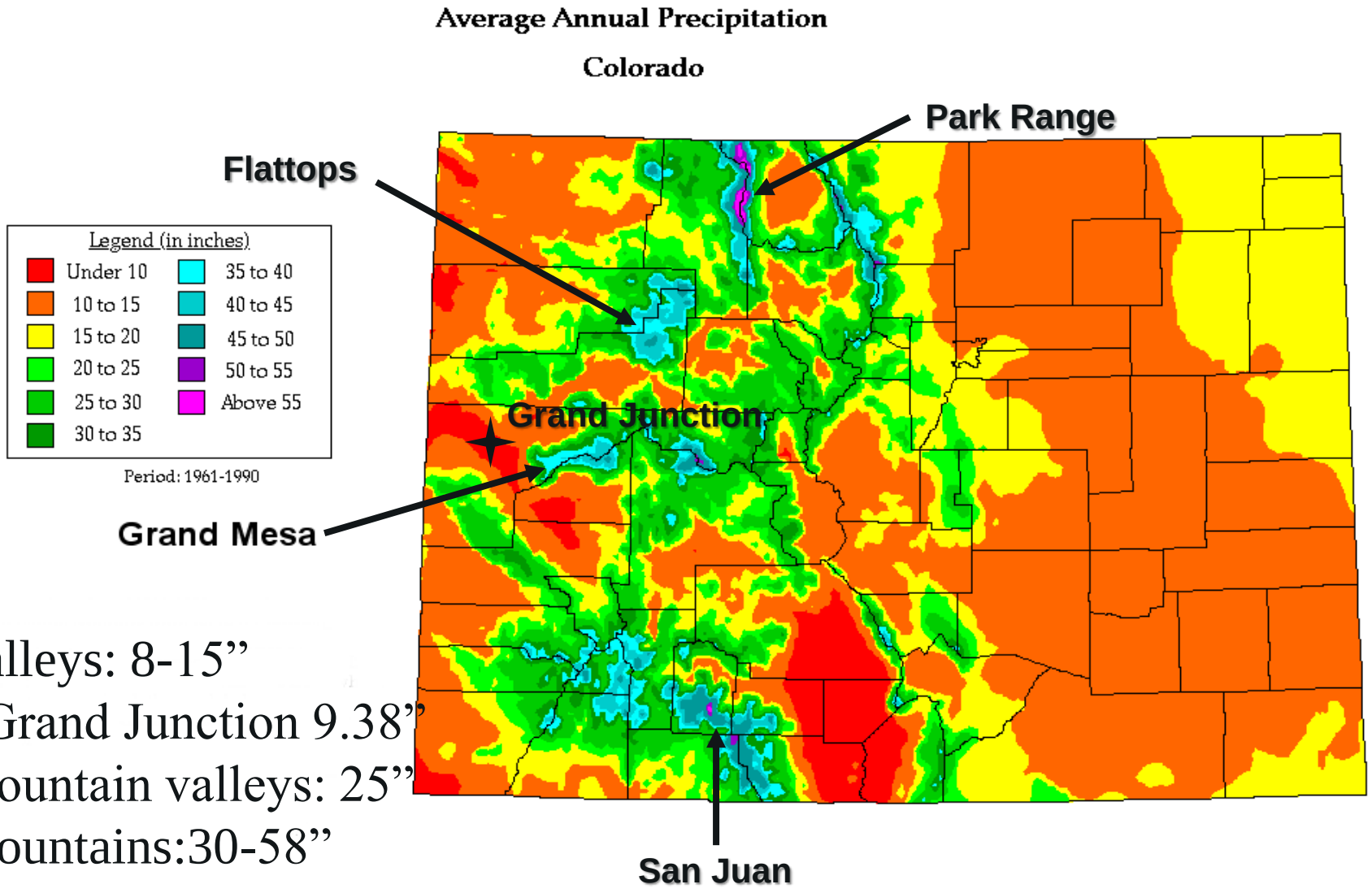
What is Normal?
Grand Junction Precipitation - 30 Year Average



What is Normal?
Grand Junction Precipitation - 30 years and 2015



Colorado Precipitation Patterns

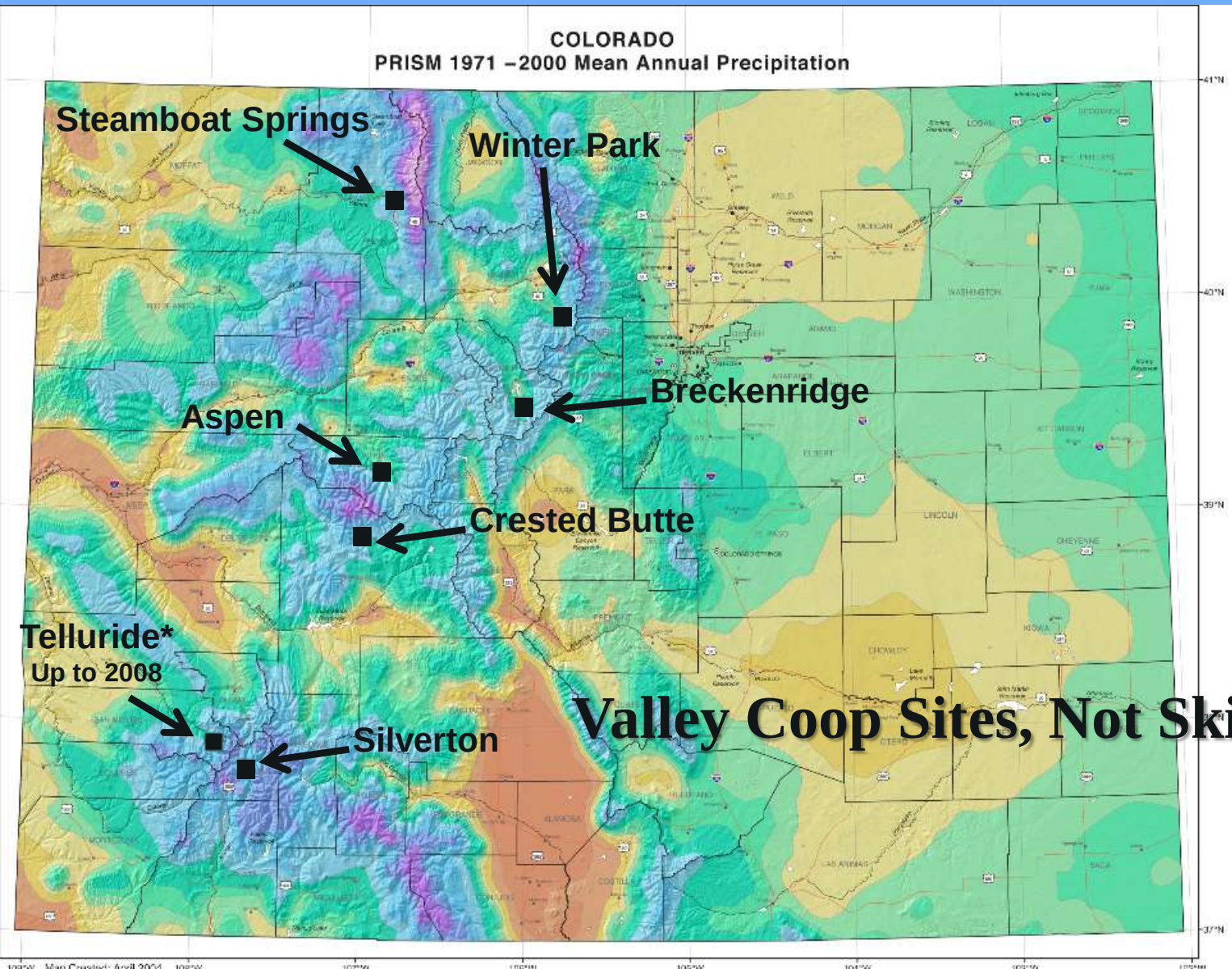


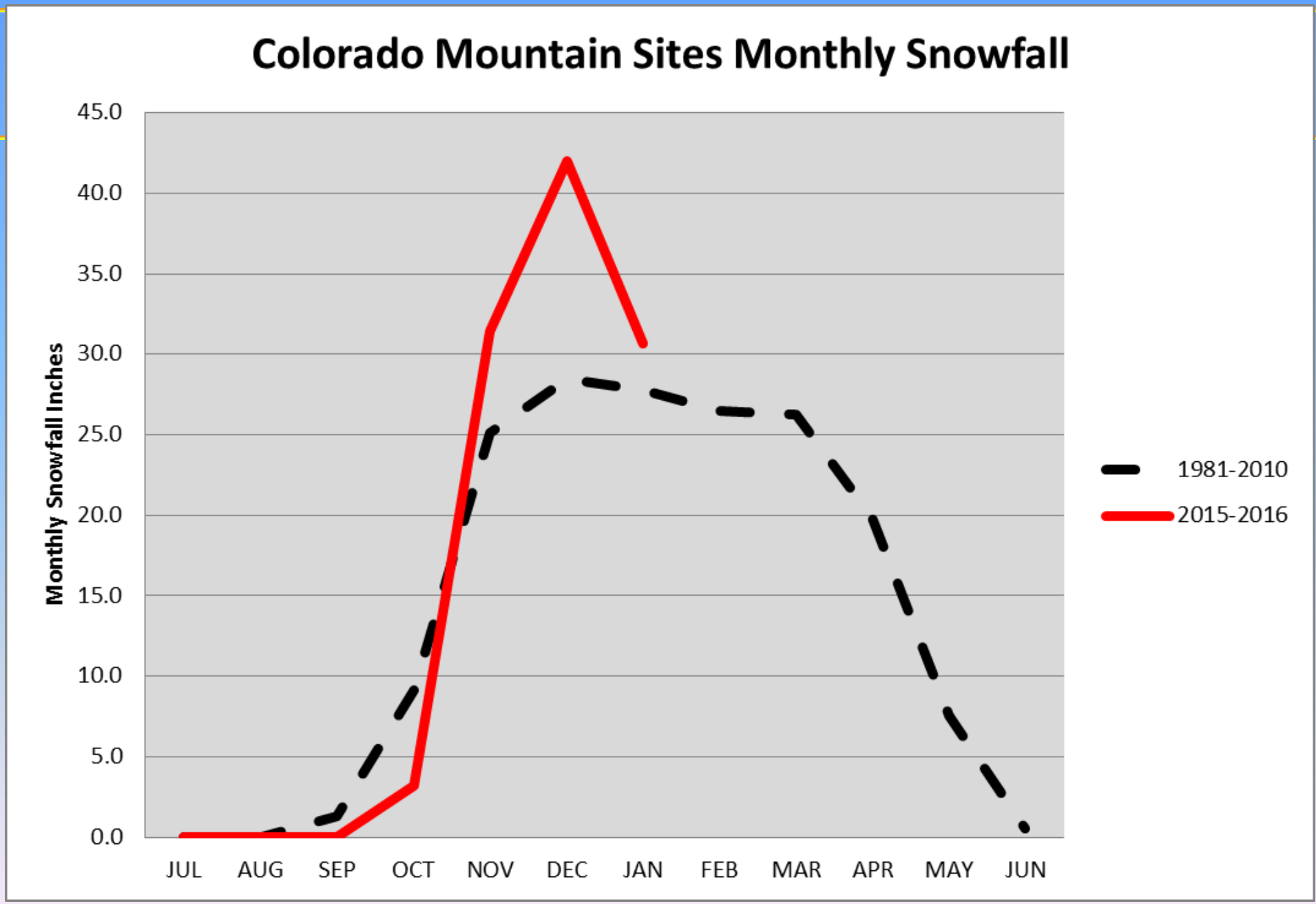
Valleys: 8-15”
- Grand Junction 9.38”
Mountain valleys: 25”
Mountains:30-58”

Western Colorado Climate

- Colorado has a continental, semi-arid climate.
  - Experiences large temperature and precipitation variation at all time scales.
- Our precipitation falls mainly in the high country.
  - Snowpack is a natural reservoir.
  - All Colorado rivers, but the Green, originate here and flow out of state.

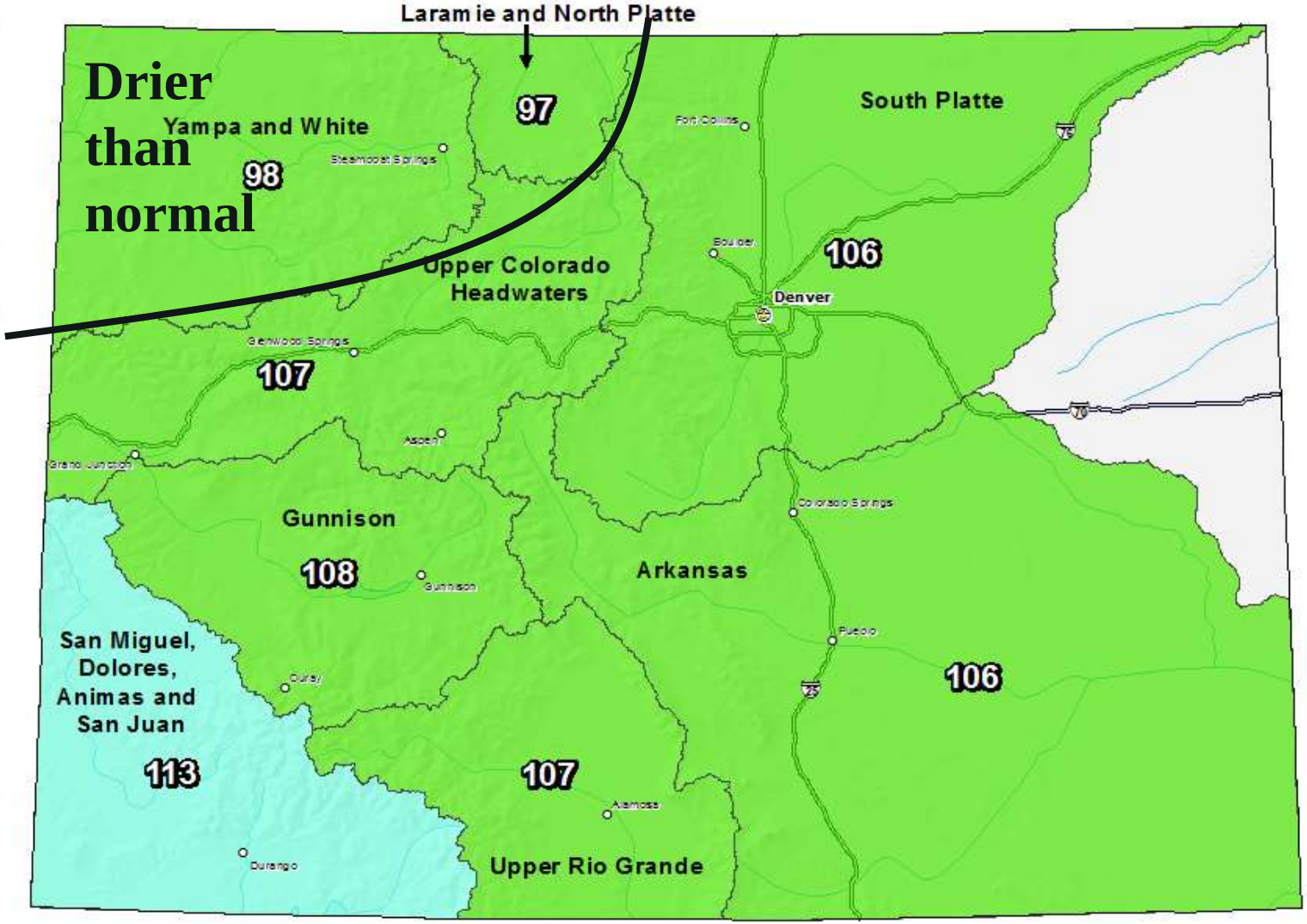
-Seven Snow Study Sites-
Chosen for their long climate records




Colorado Mountain Sites Monthly Snowfall
Monthly Snowfall Inches
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
1981-2010
2015-2016

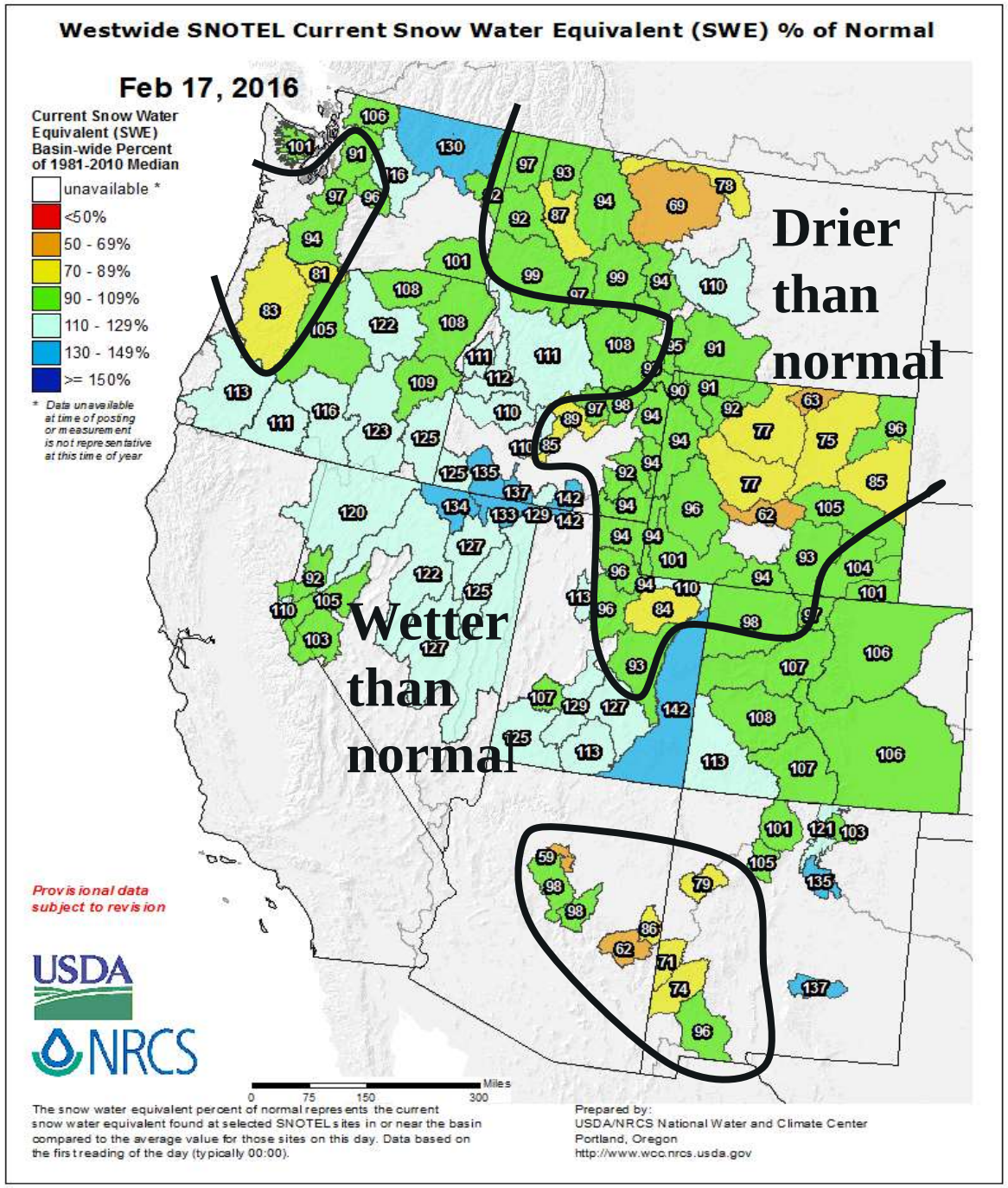
Colorado
SNOTEL Current Snow Water Equivalent (SWE) % of Normal

Feb 17, 2016



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


Westwide SNOTEL Current Snow Water Equivalent (SWE) % of Normal
Feb 17, 2016
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
Drier than normal
Wetter than normal
Provisional data subject to revision
USDA
NRCS
0 75 150 300 Miles
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

Western Colorado Climate History

- Colorado has enjoyed a wet year.
- What about the previous five years?
  - How does 2011-2015 compare to the current 30 year average 1981-2010?
- What about the last 100 years?

Changes in Monthly Average (1981 to 2010)-(2011 to 2015) in degrees F or inches of Precipitation (positive values mean 2011-2015 years are warmer/wetter)

Station	Elevation (ft)	Tmax	Tmin	Tave	Precipitation
Dinosaur N.M.	5900	-0.7	1.6	0.5	-2.56
Steamboat Springs	6960	-0.1	1	0.4	0.37
Colorado N.M.	5660	-0.7	2.4	0.9	0.47
Grand Junction	4858	-0.4	-1.1	-0.8	1.01
Paonia	5645	-0.3	-0.4	-0.4	0.15
Crested Butte	8860	1.3	0.5	0.9	-3.43
Montrose	5760	0.8	1.3	1.1	-0.28
Gunnison	7640	0.2	0.4	0.2	-1.1
Silverton	9320	0.8	0.6	0.5	-2.2
Hovenweep N.M.	5210	0.6	1.8	1.3	0.11
Cortez	6153	1.7	2	1.8	-0.26
Mesa Verde N.P.	7115	0.9	2.1	1.5	-2.21
Flaming Gorge N.R.A.	6040	0.7	2.9	1.9	-2.52
Vernal	5278	-0.6	2.1	0.7	-0.54
Moab	4026	-1.1	0.3	-0.4	0.35
Canyonlands The Neck	5930	0.2	1.6	0.9	0.48
Canyonlands The Needles	4998	-0.4	0	-0.2	-0.21
Natural Bridges N.M.	6500	0.3	0.3	0.4	-0.82
Blanding	6039	-0.6	2	0.7	-2.02
Mexican Hat	4130	1.2	1.1	1.1	-0.56
Total Average	6101	**0.2**	**1.1**	**0.7**	**-0.8**

- In the last 5 years, the region has been drier and warmer, especially in our low temperatures.
- Grand Junction, wetter and cooler.

Changes in Monthly Average (1981 to 2010)-(2011 to 2015) in degrees F or inches of Precipitation (positive values mean 2011-2015 years are warmer/wetter)

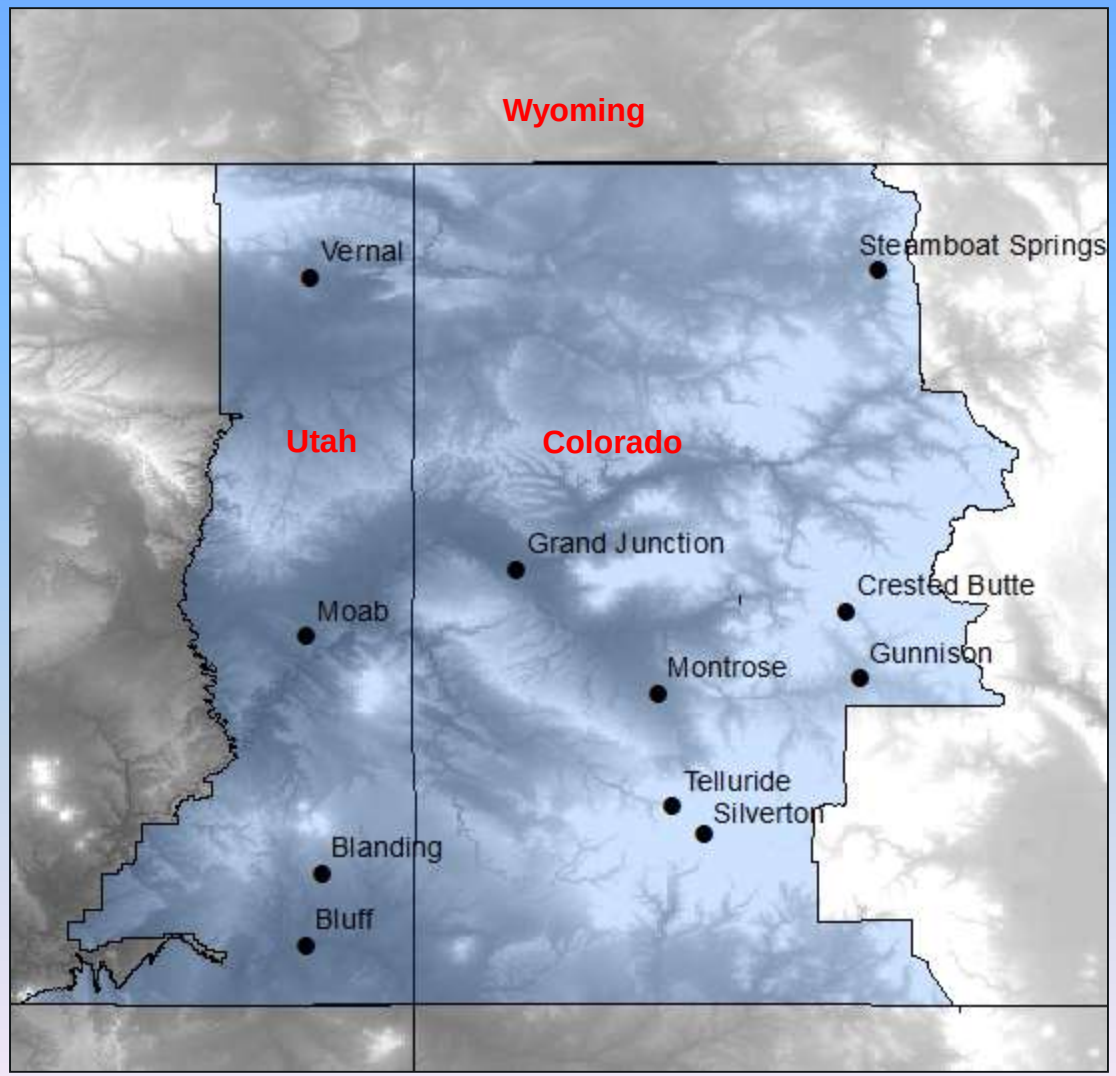
Stations Below 6000 ft	Tmax	Tmin	Tave	Precipitation
Dinosaur N.M.	-0.7	1.6	0.5	-2.56
Colorado N.M.	-0.7	2.4	0.9	0.47
Grand Junction	-0.4	-1.1	-0.8	1.01
Paonia	-0.3	-0.4	-0.4	0.15
Montrose	0.8	1.3	1.1	-0.28
Hovenweep N.M.	0.6	1.8	1.3	0.11
Vernal	-0.6	2.1	0.7	-0.54
Moab	-1.1	0.3	-0.4	0.35
Canyonlands The Neck	0.2	1.6	0.9	0.48
Canyonlands The Needles	-0.4	0	-0.2	-0.21
Mexican Hat	1.2	1.1	1.1	-0.56
Low Elevation Average	**-0.1**	**1.0**	**0.4**	**-0.14**

Stations Above 6000 ft	Tmax	Tmin	Tave	Precipitation
Steamboat Springs	-0.1	1	0.4	0.37
Crested Butte	1.3	0.5	0.9	-3.43
Gunnison	0.2	0.4	0.2	-1.1
Silverton	0.76	0.64	0.52	-2.2
Cortez	1.7	2	1.8	-0.26
Mesa Verde N.P.	0.9	2.1	1.5	-2.21
Flaming Gorge N.R.A.	0.7	2.9	1.9	-2.52
Natural Bridges N.M.	0.3	0.3	0.4	-0.82
Blanding	-0.6	2	0.7	-2.02
High Elevation Average	**0.6**	**1.3**	**0.9**	**-1.58**

Stations Above 8500 ft	Tmax	Tmin	Tave	Precipitation
Crested Butte	1.3	0.5	0.9	-3.43
Silverton	0.76	0.64	0.52	-2.2
Highest Elevation Average	**1.0**	**0.6**	**0.7**	**-2.82**

For 2011-2015, the drying trend has been stronger in higher elevations.

Study Sites with Climate Data back to 1911



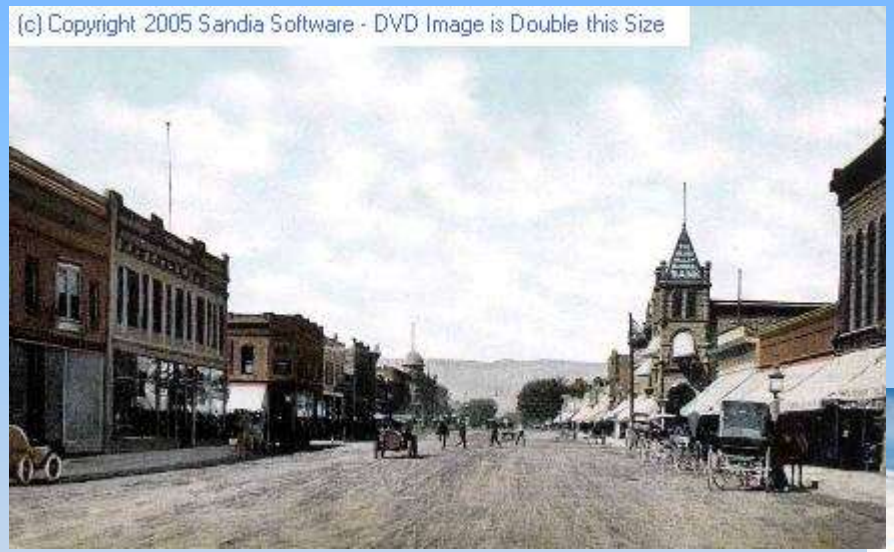
Eleven sites, average elevation 6558 feet

Problems with Climate Sites (Grand Junction Example)

- The site could have moved

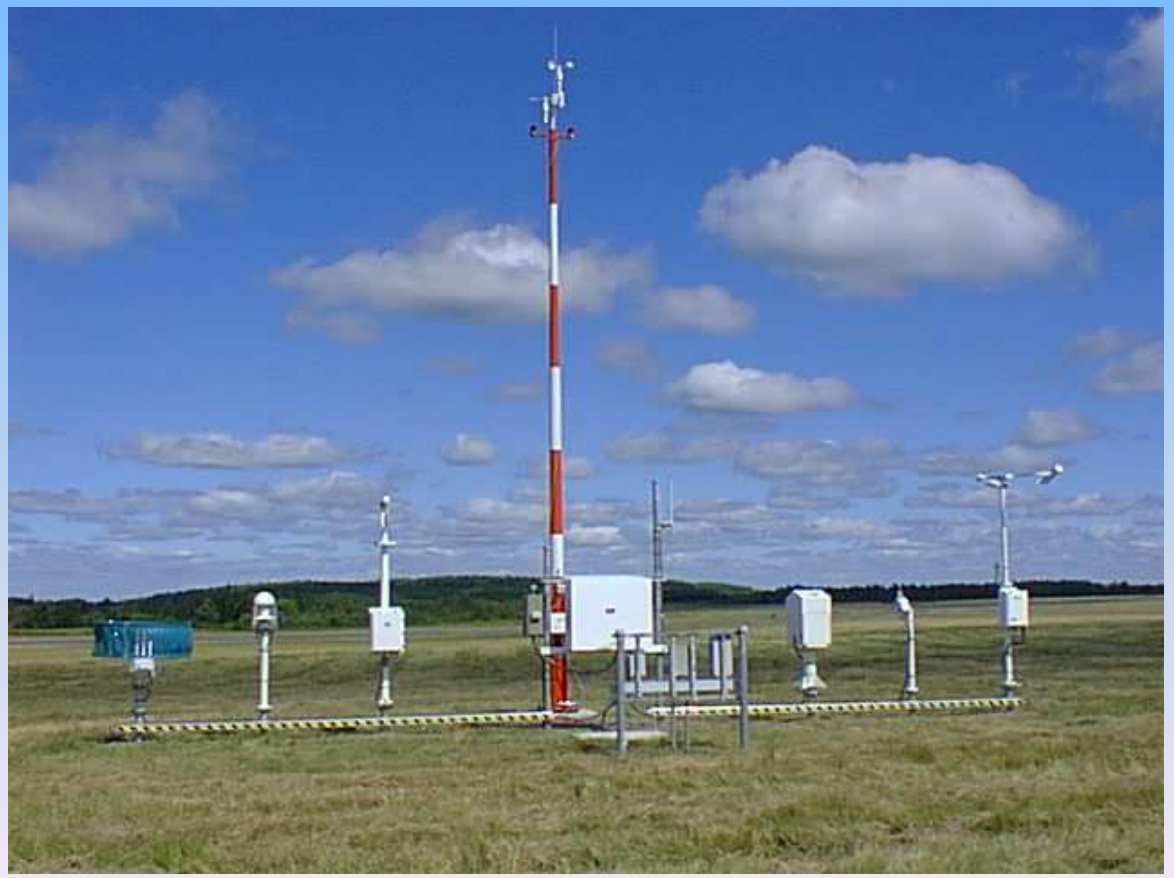
Problems with Climate Sites (Grand Junction Example)

- Urbanization can create local warming



Problems with Climate Sites (Grand Junction Example)

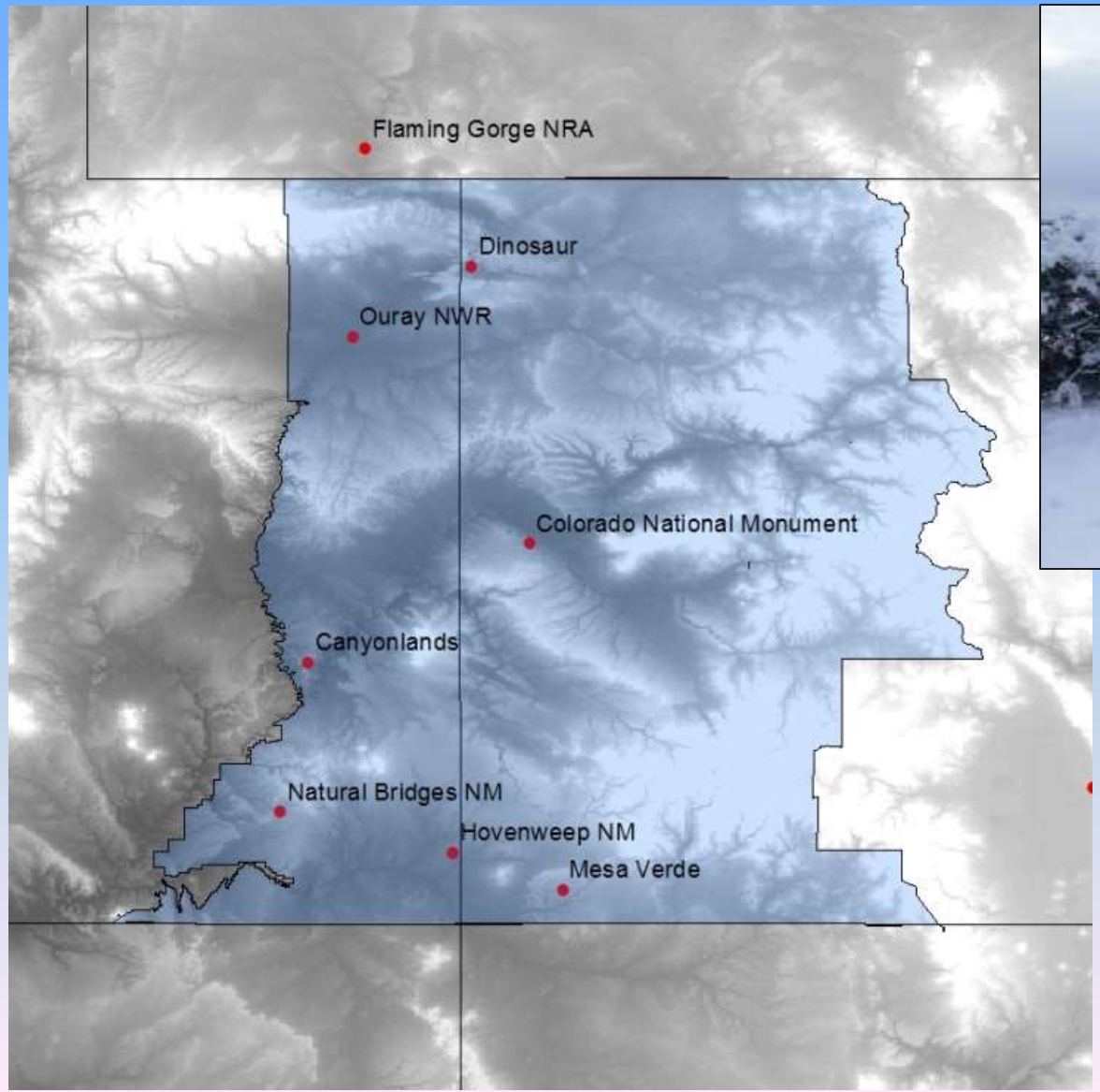
- Instrumentation has changed



Where Are These Site Problems Minimized?

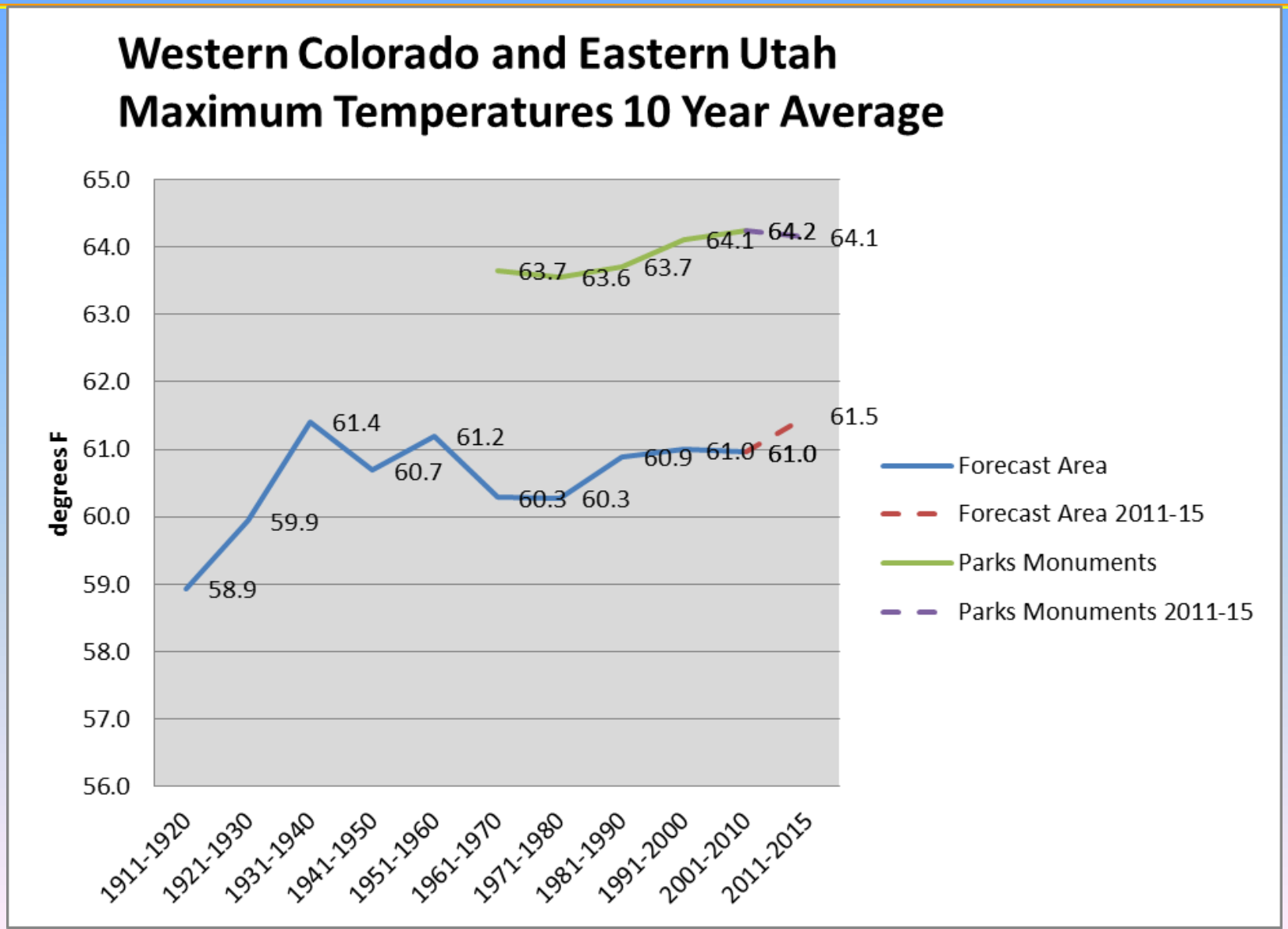
- National Parks and Monuments
- Faming Gorge NWR 1958
- Dinosaur NM 1964
- Ouray NWR 1956
- Colorado NM 1940
- Canyonlands (Neck and Needles) 1965
- Natural Bridges NM 1965
- Hovenweep NM 1957
- Mesa Verde NP 1924

National Parks and Monuments with Climate Data back to 1961

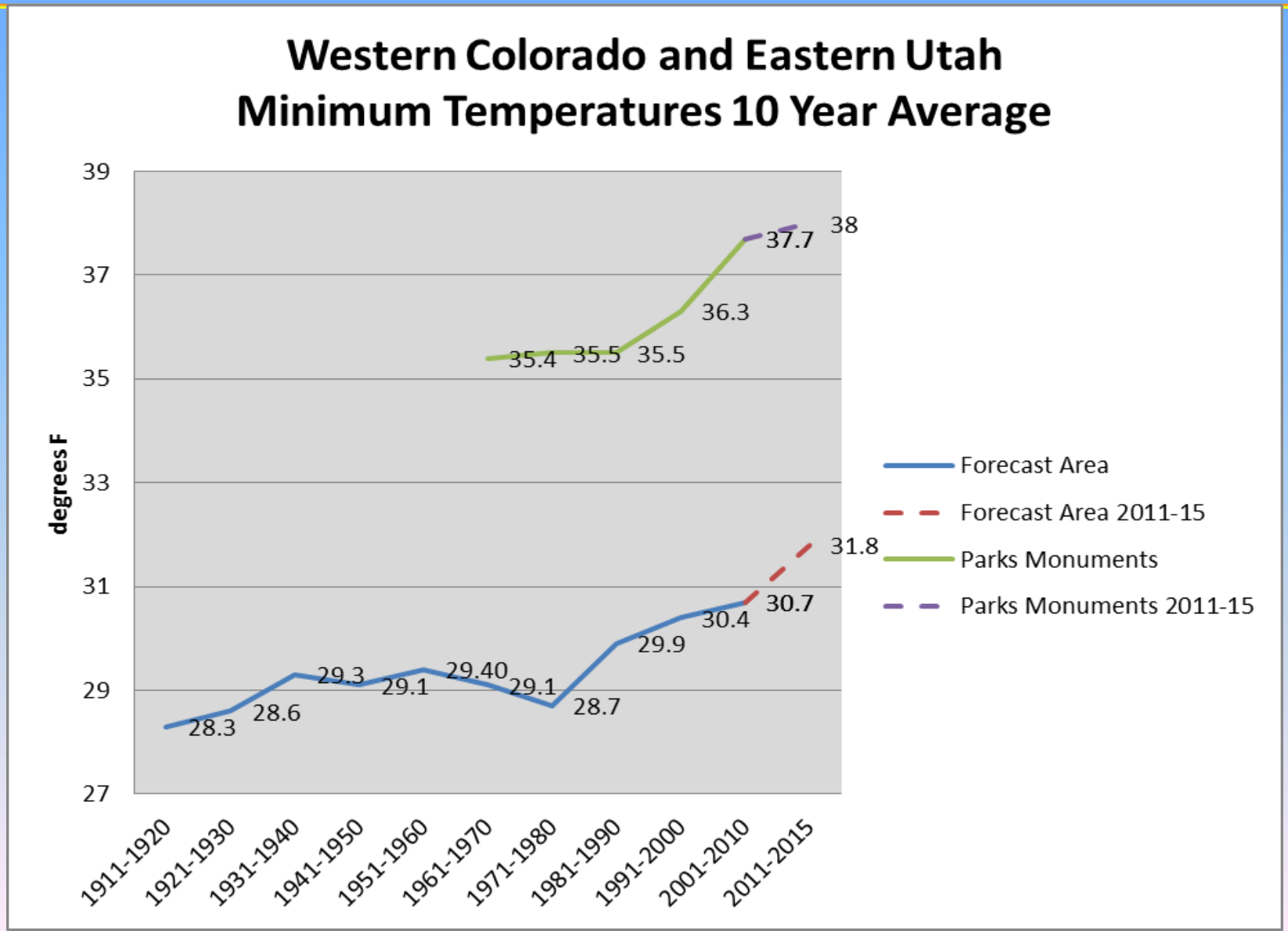


Nine sites,
Average elevation:
5839 feet

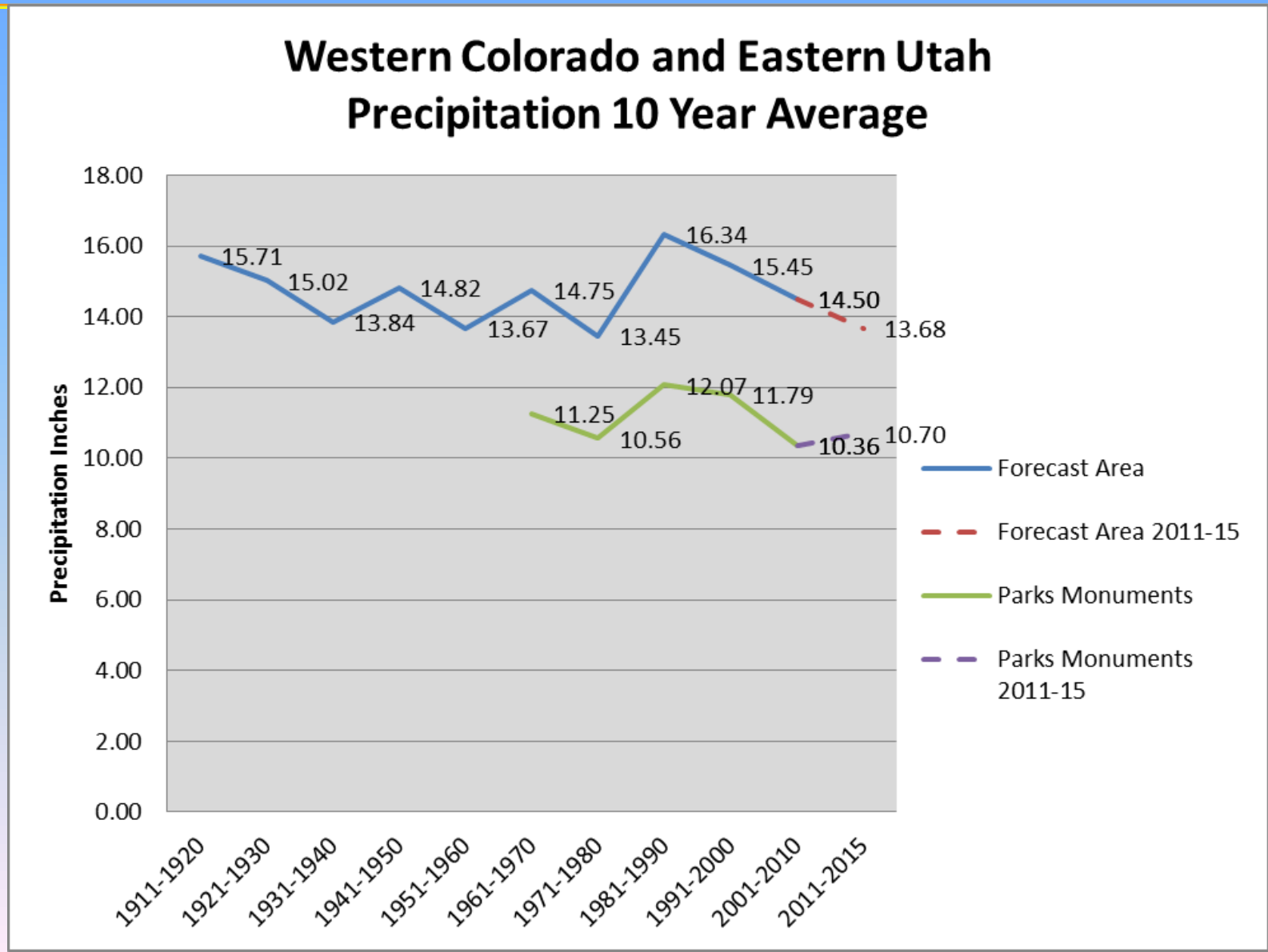
Maximum Temperatures per Decade since 1911



Minimum Temperatures per Decade since 1911



Precipitation per Decade since 1911



Western Colorado Climate History

- The last five years have showed a drying and partial warming trend.
- The last 100 years have shown large variations in precipitation.
- The last 100 years have shown little change in maximum temperatures.
- Minimum temperatures have shown a warming trend since the 1970s.

Climate Future

- A climate outlook for the El Niño spring season.
- Who knows for summer!
- An outlook into a La Niña winter.

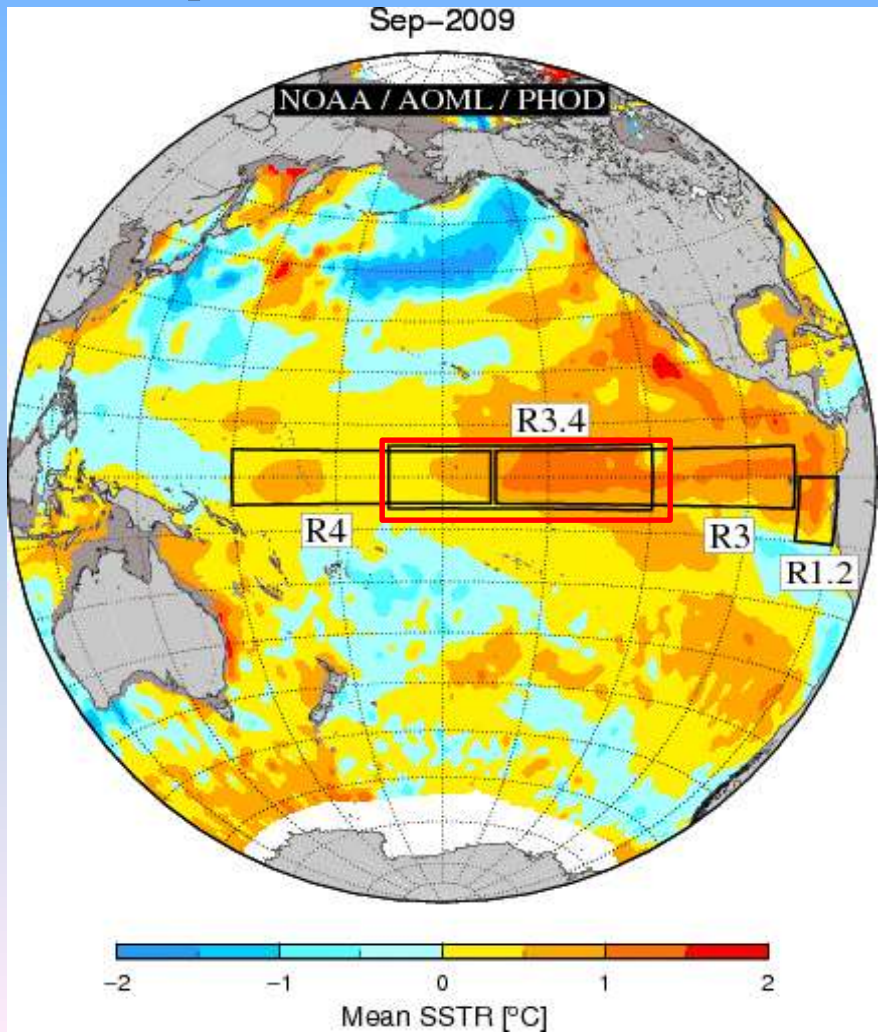
- El Niño Southern Oscillation

El Niño Southern Oscillation (ENSO)

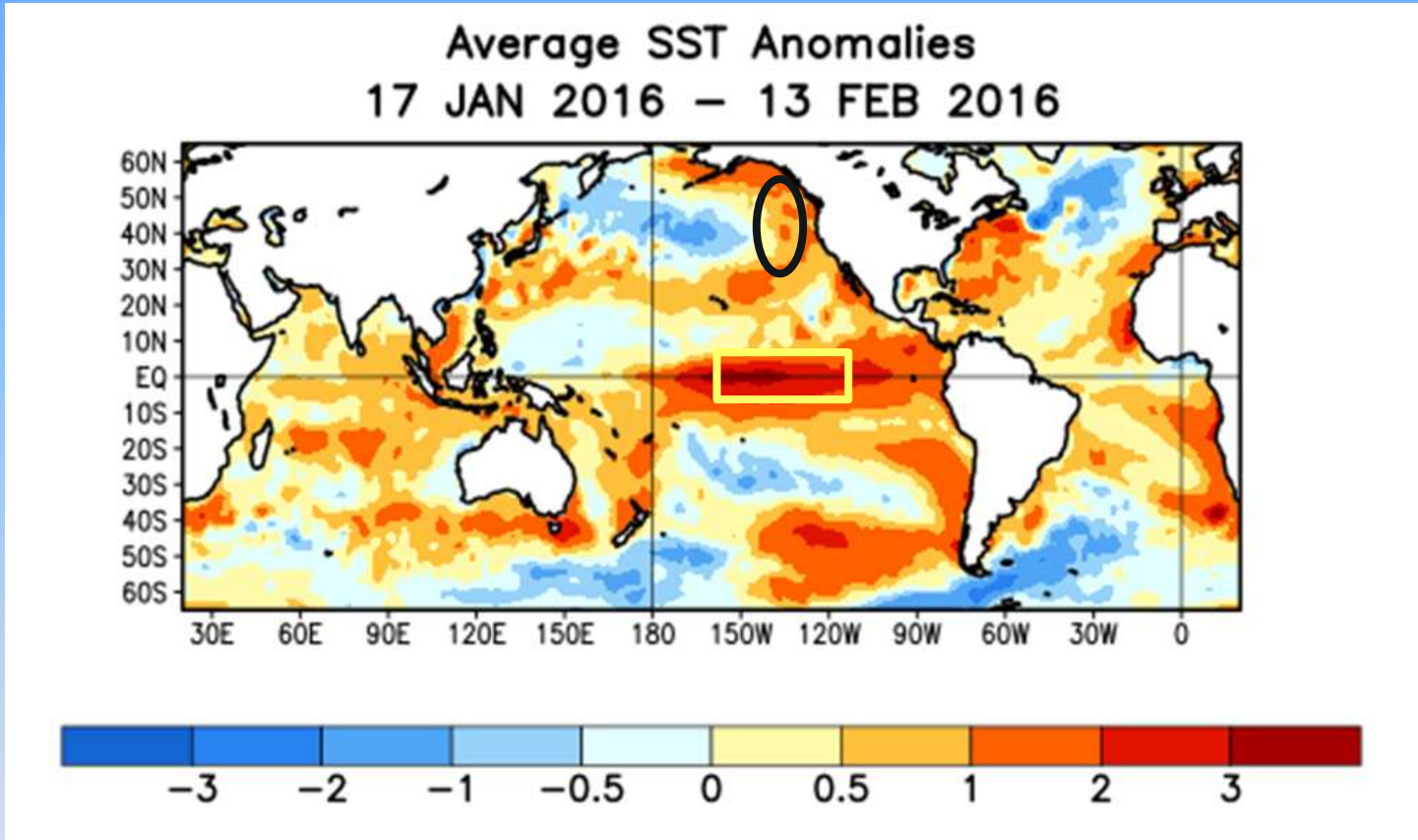
- Simple Definition: variance from normal sea surface temperatures (and sea level pressure and winds) in the eastern equatorial Pacific Ocean.
  El Niño: a warm change (+ENSO)
  La Niña: a cold change (-ENSO)

- ENSO changes the jet streams (winds aloft) which changes the storm track with resulting predictable effects

- ENSO effects are felt mainly in the cold season
- ENSO: primary winter outlook tool



Current Pacific Conditions:



Current Ocean Niño Index 2.3 (strong), this week 2.5,
Current Pacific Decadal Oscillation 1.53 (also quite warm)

ENSO Events Since 1950

La Niña tend to follow El Niño

El Nino (22 events)

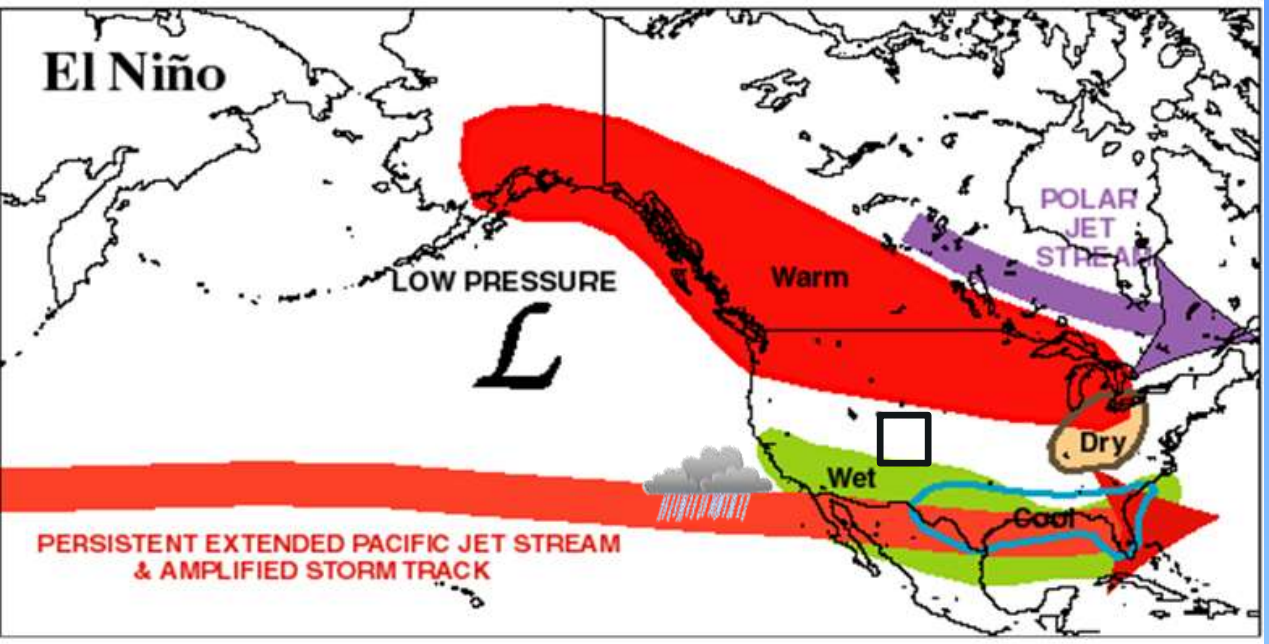
2015-2016
2009-2010
2006-2007
2004-2005
2002-2003+
1997-1998++
1994-1995+
1991-1992+
1987-1988
1986-1987+
1982-1983++
1977-1978
1976-1977
1972-1973+
1969-1970
1968-1969
1965-1966+
1963-1964
1958-1959
1957-1958+
1952-1953
1951-1952

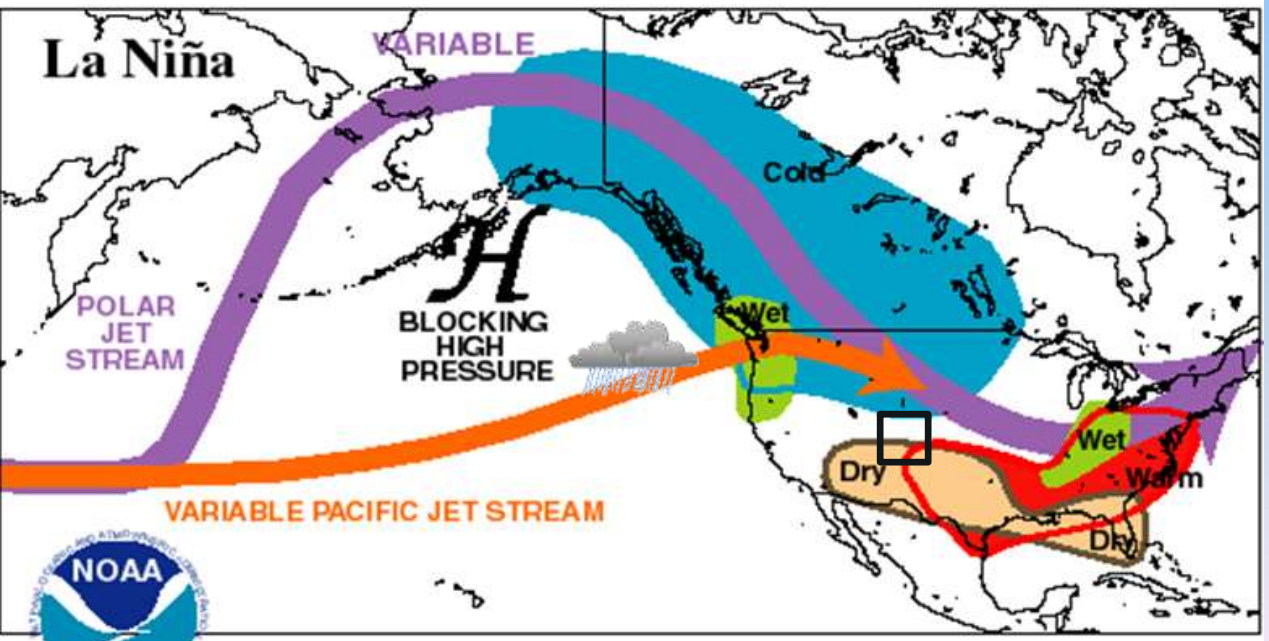
La Nina (23 events)

2011-2012
2010-2011
2008-2009
2007-2008+
2005-2006
2000-2001
1995-1996
1988-1989+
1984-1985
1983-1984
1975-1976+
1974-1975
1973-1974+
1971-1972
1970-1971
1967-1968
1964-1965
1956-1957
1955-1956+
1954-1955
1950-1951+

ENSO Neutral (21 events)

2014-2015
2013-2014
2012-2013
2003-2004
2001-2002
1996-1997
1990-1991
1989-1990
1985-1986
1981-1982
1980-1981
1979-1980
1978-1979
1967-1968
1966-1967
1962-1963
1961-1962
1960-1961
1959-1960





Climate Prediction Center/NCEP/NWS

- **El Niño**

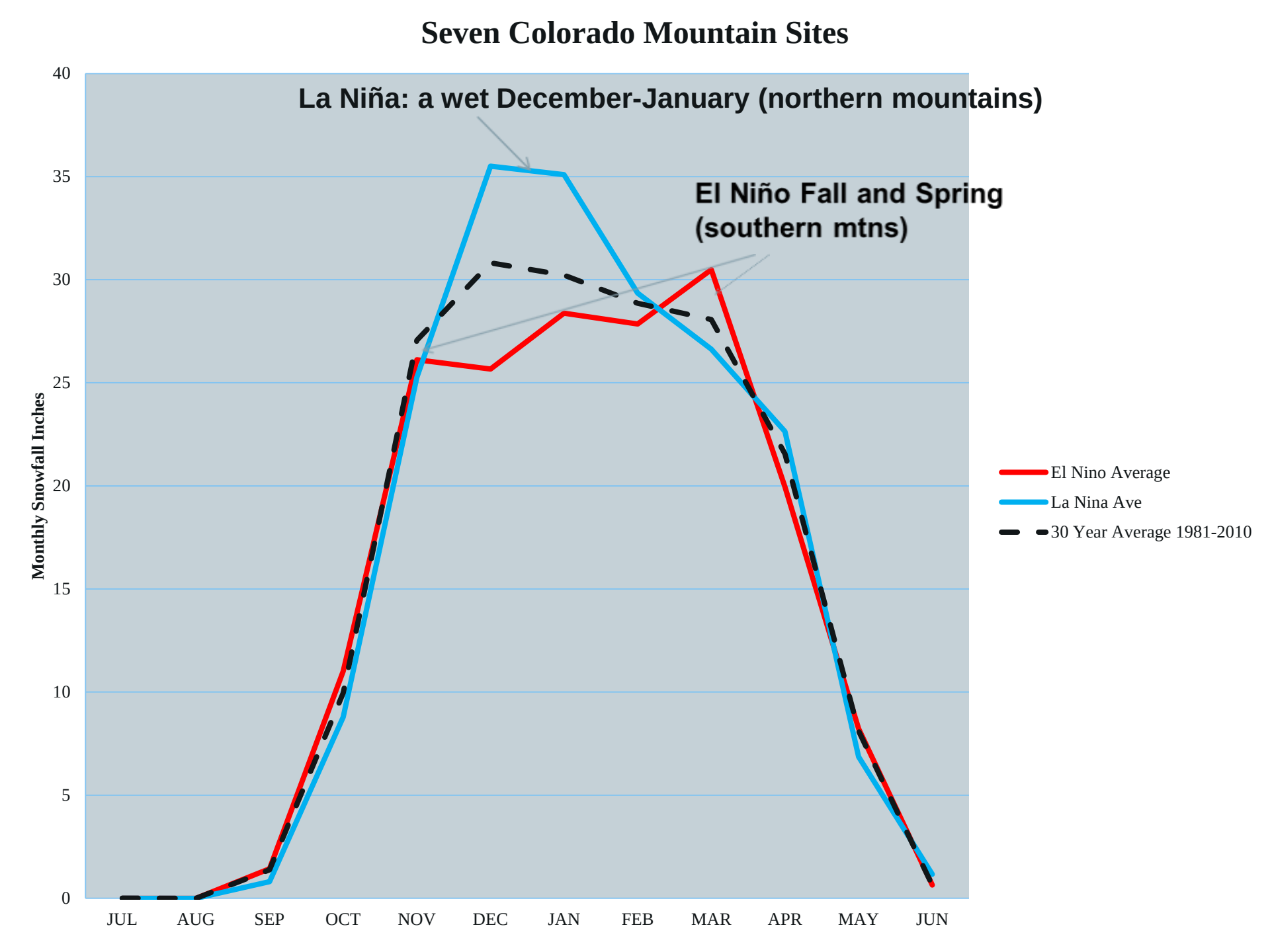
Dry and Warm
North of Colorado

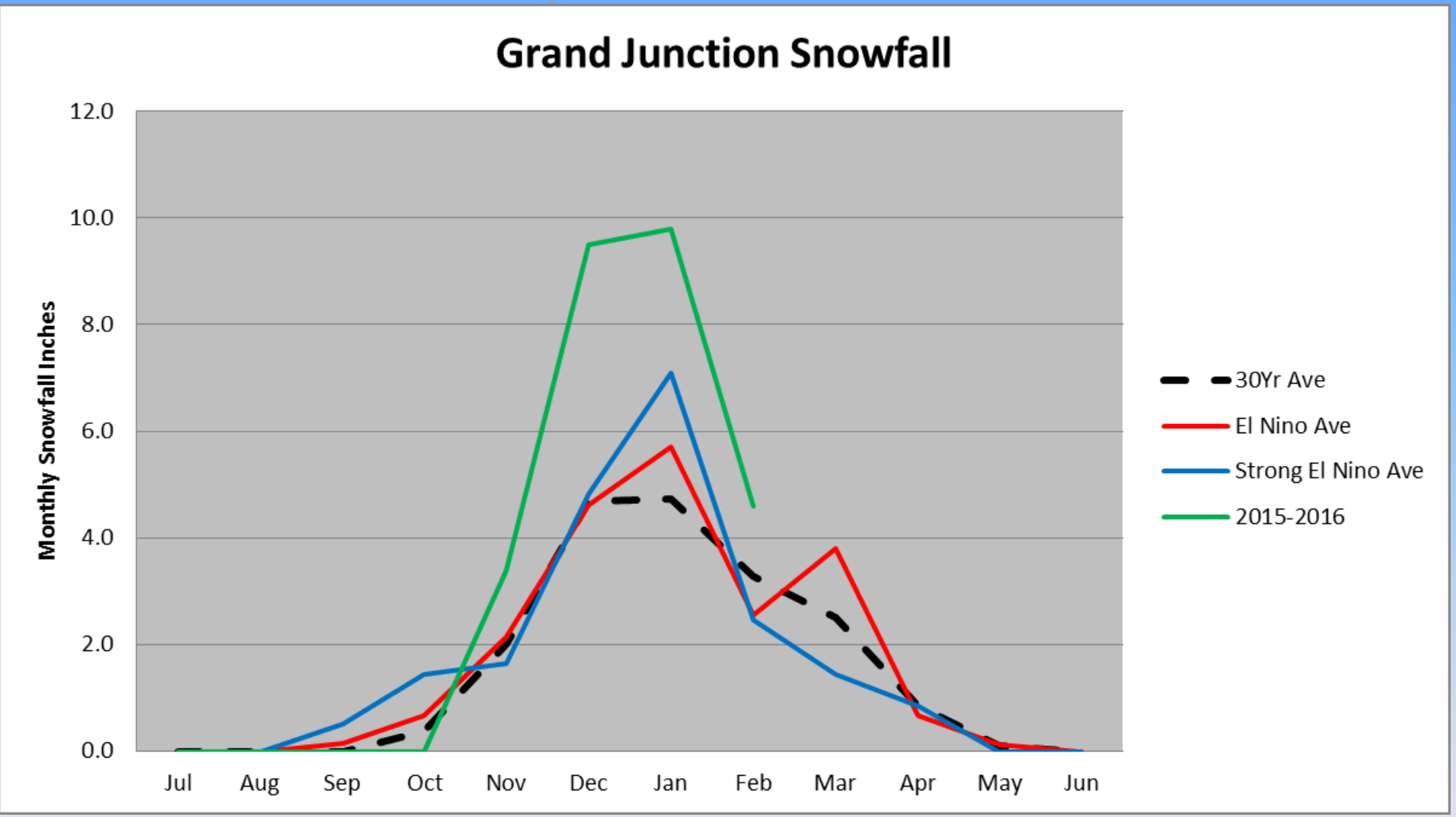
Wet and Cool
South of Colorado

- **La Niña**

Wet and Cold
North of Colorado

Dry and Warm
South of Colorado


Seven Colorado Mountain Sites
La Niña: a wet December-January (northern mountains)
El Niño Fall and Spring
(southern mtns)
Monthly Snowfall Inches
40
35
30
25
20
15
10
5
0
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
El Nino Average
La Nina Ave
30 Year Average 1981-2010

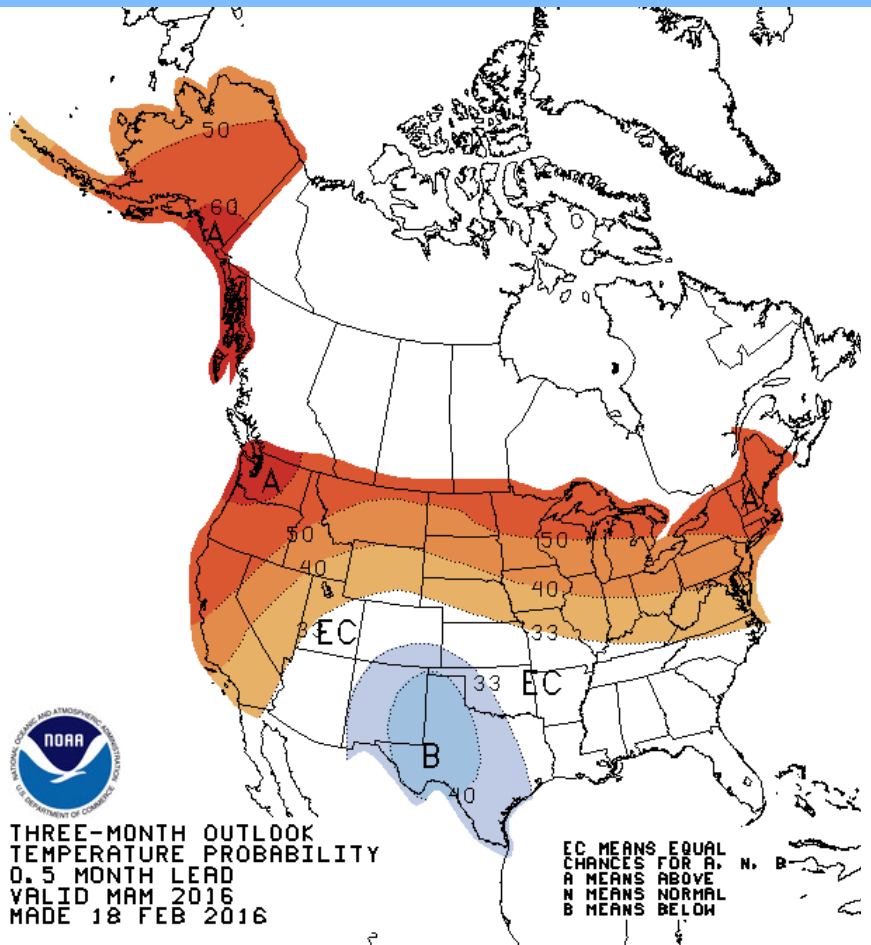

Grand Junction Snowfall
Monthly Snowfall Inches
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
30Yr Ave
El Nino Ave
Strong El Nino Ave
2015-2016

ENSO Review

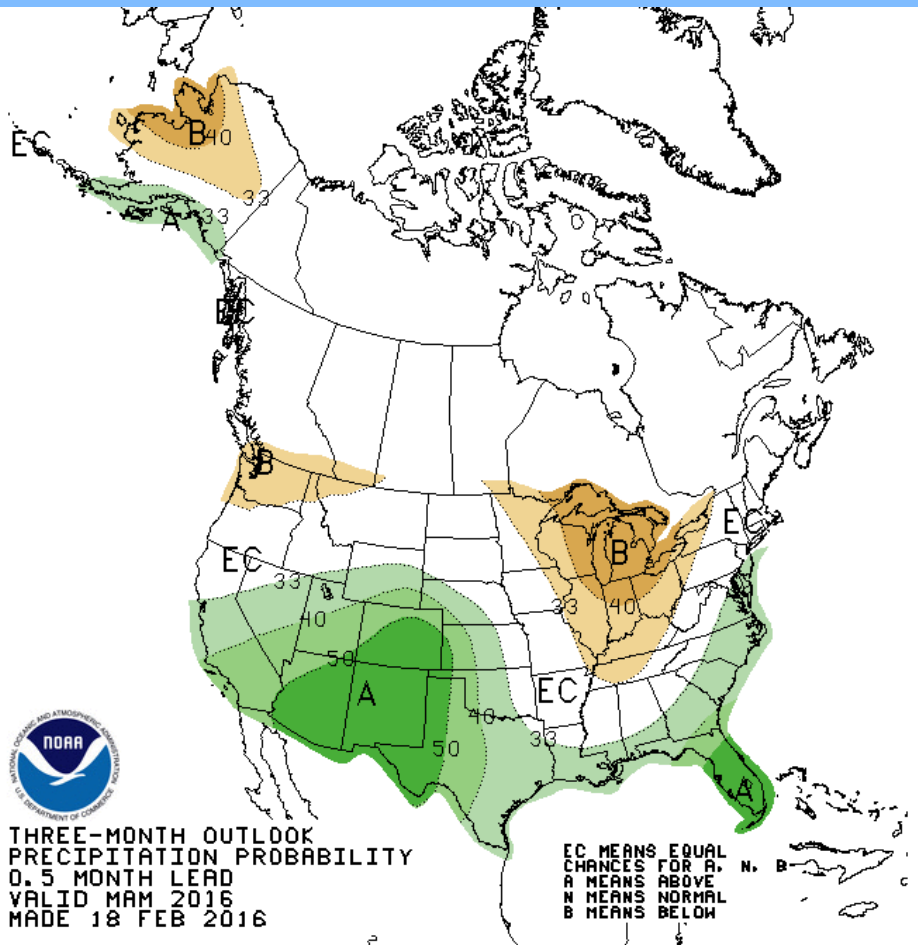
- ENSO is an important part of long-range national forecasts
- Colorado precipitation is highly variable and has some subtle cold season response to ENSO
- El Niño tends to produce a wetter spring and fall.
- El Niño years are wetter south, drier north.
- La Niña produces a snowier heart of winter, centered on January, wetter north, drier south.
- The ENSO dividing line is roughly the I-70 corridor.

Climate Prediction Center's Outlook For Spring Season March-April-May

Temperature

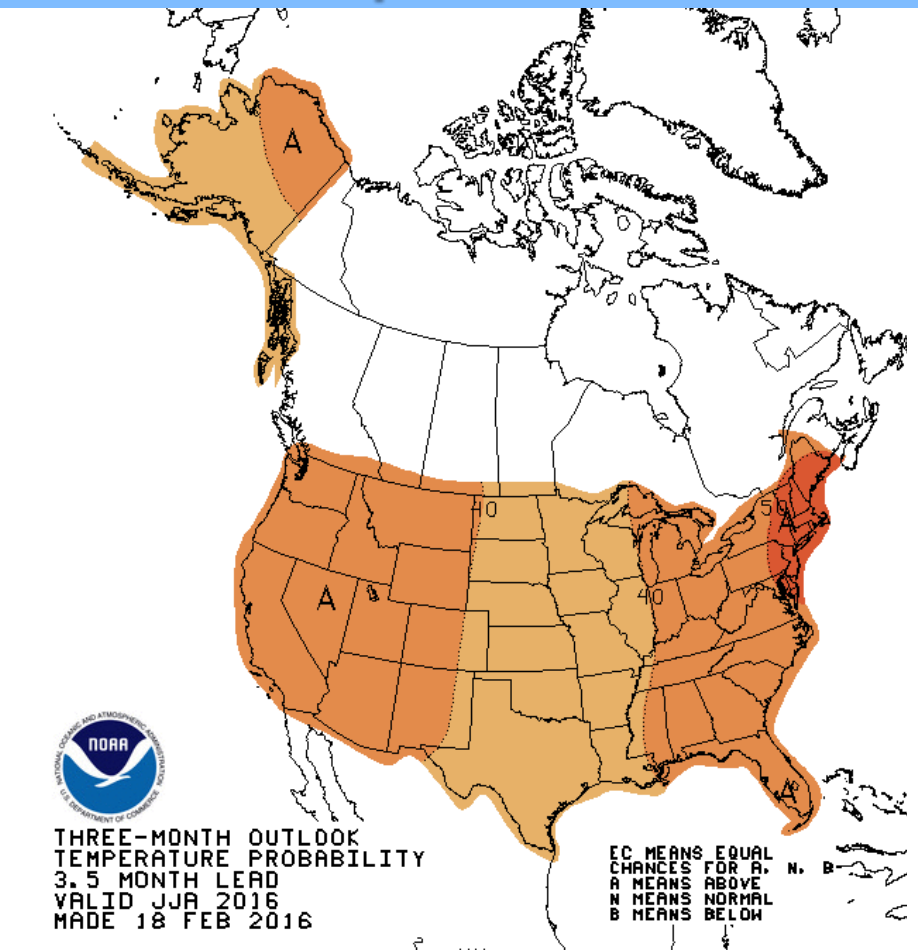


Precipitation

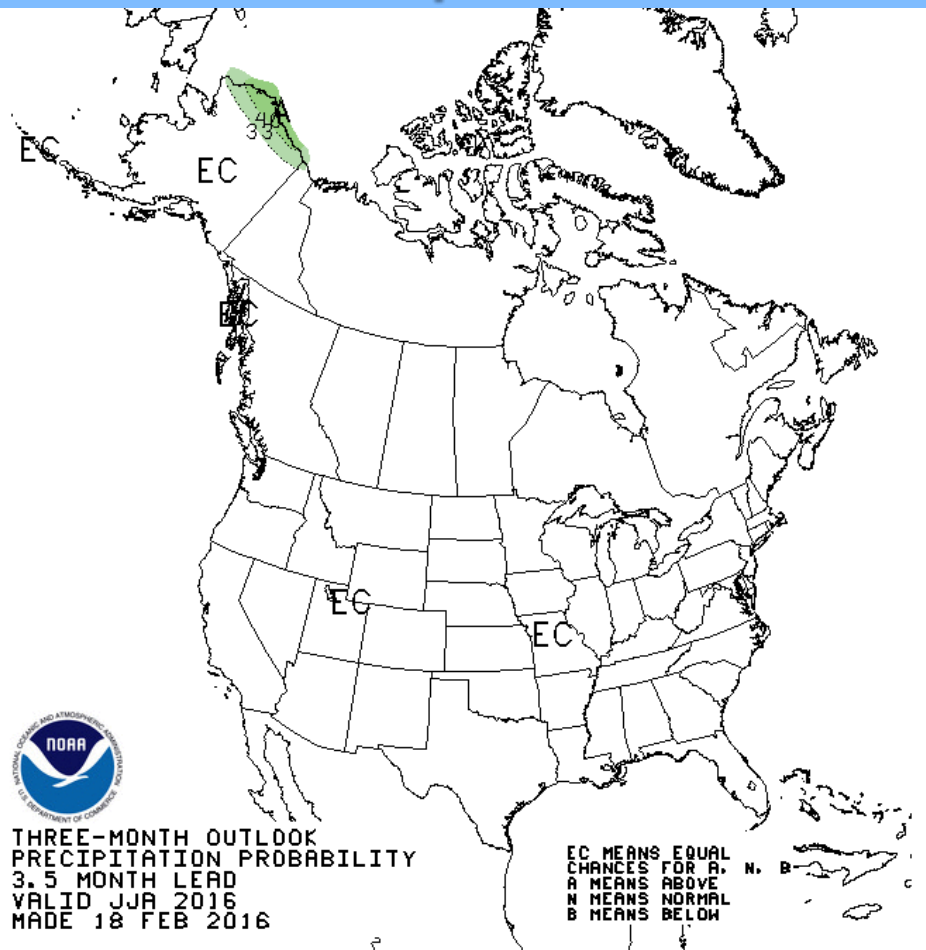


Climate Prediction Center's Outlook For Summer Season June-July-August

Temperature

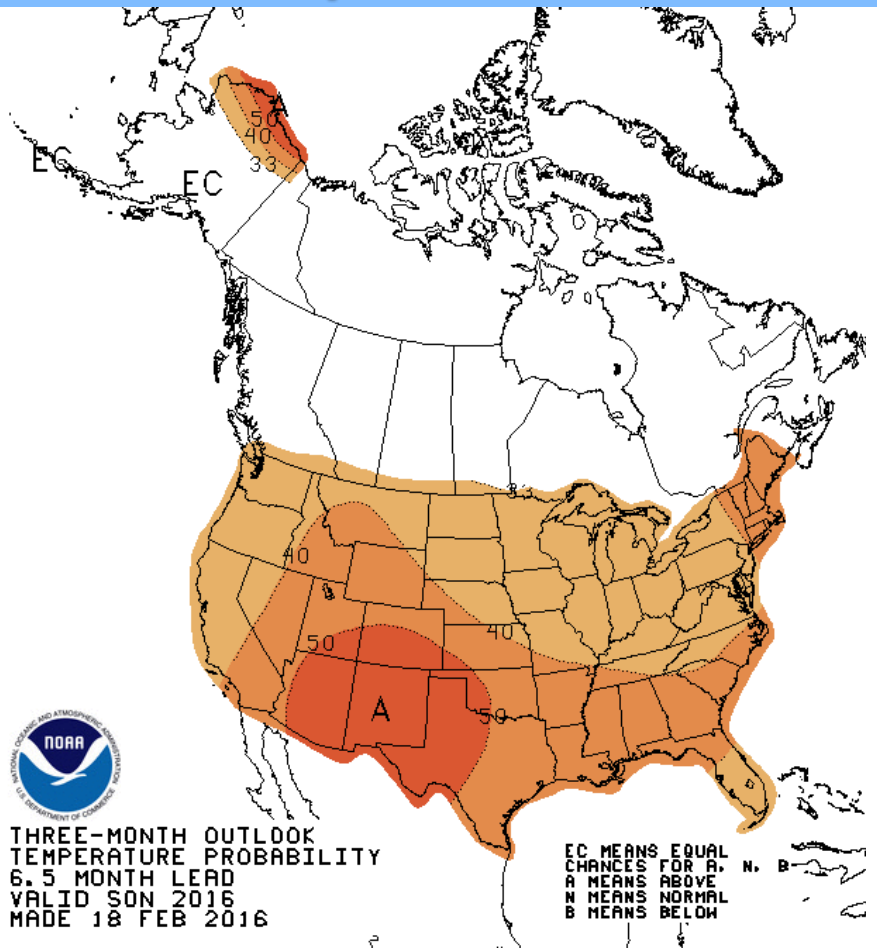


Precipitation

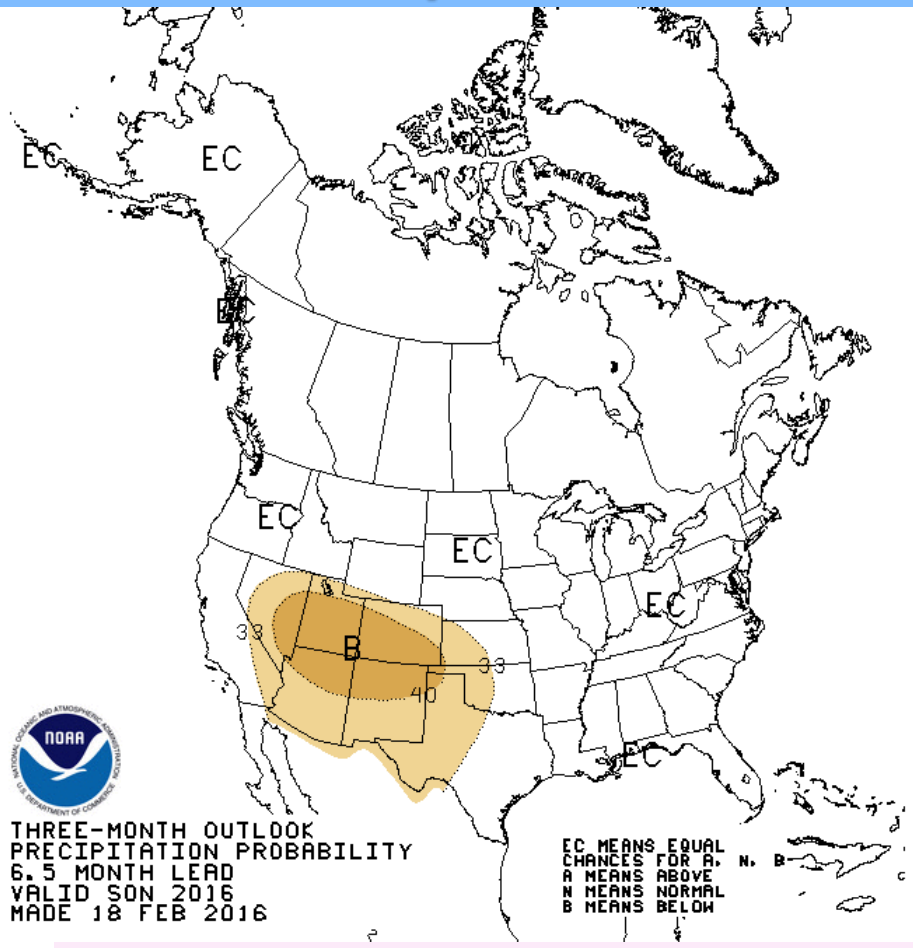


Climate Prediction Center's Outlook For Fall Season Sep-Oct-Nov

Temperature

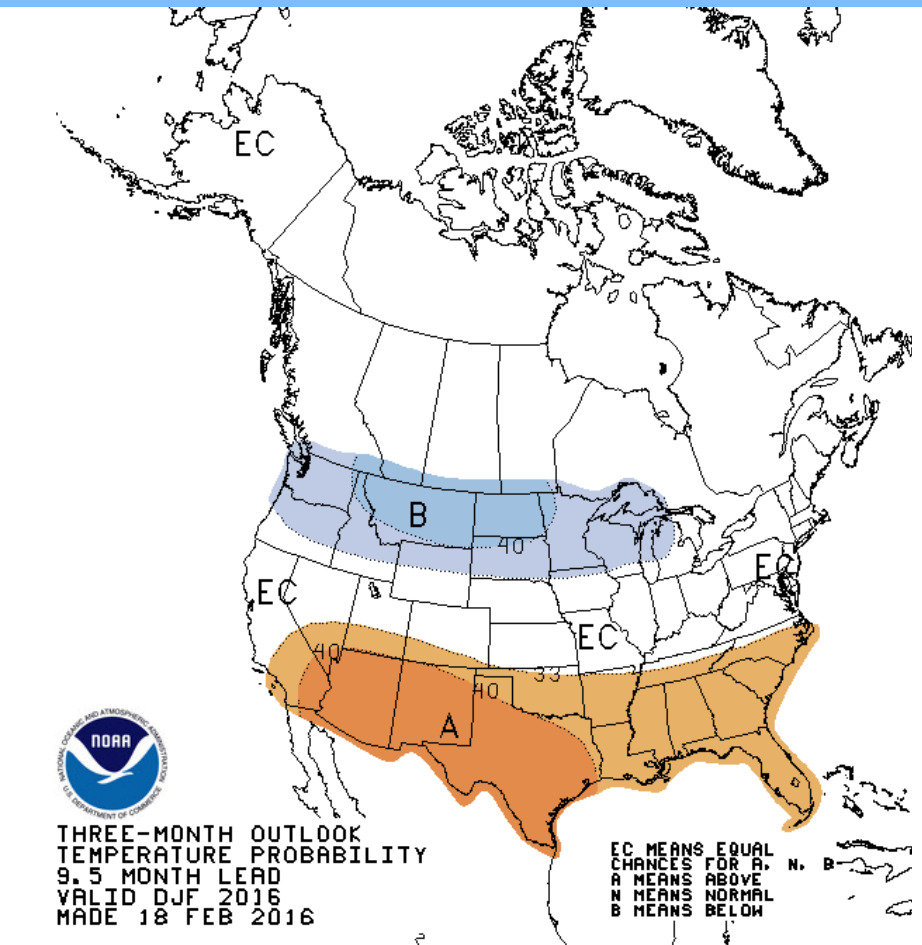


Precipitation

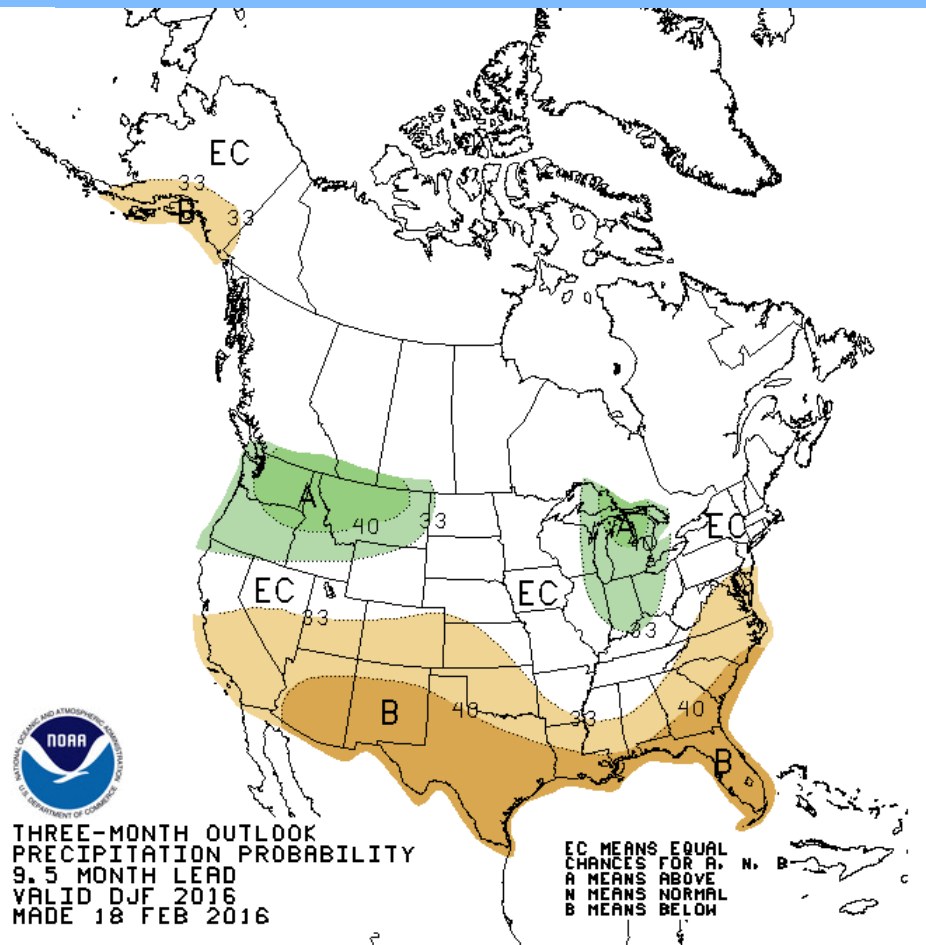


Climate Prediction Center's Outlook For Winter Season Dec-Jan-Feb

Temperature



Precipitation



Climate Outlook Review

- El Niño has produced a wet winter season for Colorado so far.
- El Niño springs are typically wet.
- Summer climate signals are weak for precipitation, but with a shift towards warmer then normal.
- La Niña may develop next fall and winter.
- La Niña tends to produce a dry autumn.
- La Niña tends to produce a snowy heart of winter mainly across northwest Colorado.


Questions?