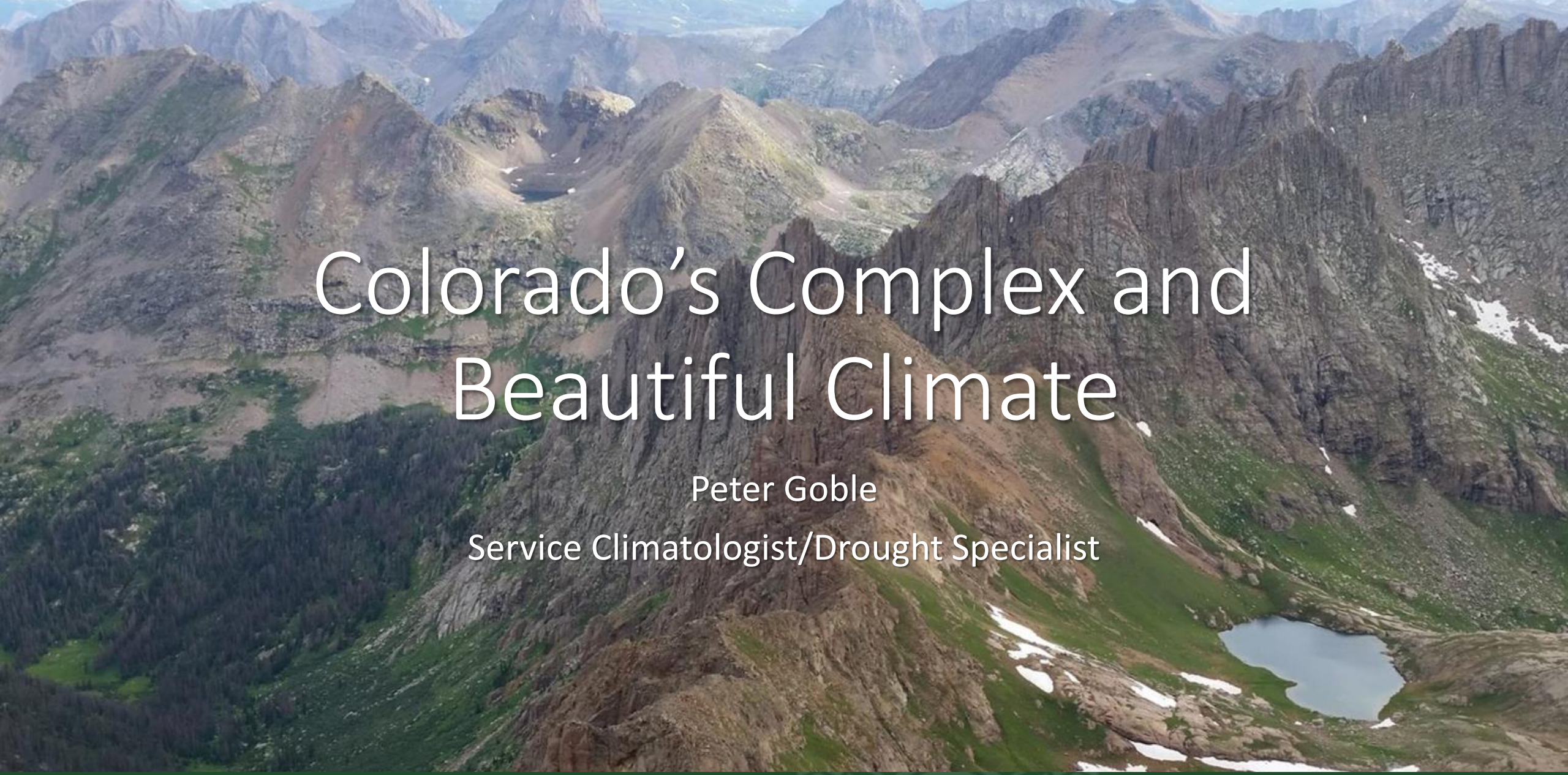


Colorado's Complex and Beautiful Climate

Peter Goble

Service Climatologist/Drought Specialist

COLORADO STATE UNIVERSITY | COLORADO CLIMATE CENTER

Providing information and expertise on Colorado's complex climate

Today's Roadmap

- **Some history: what have we learned about Colorado's climate in the last 150 years?**
- **What's going on with Climate Change? How does it impact us here?**
- **How can you help?**

Our Mission

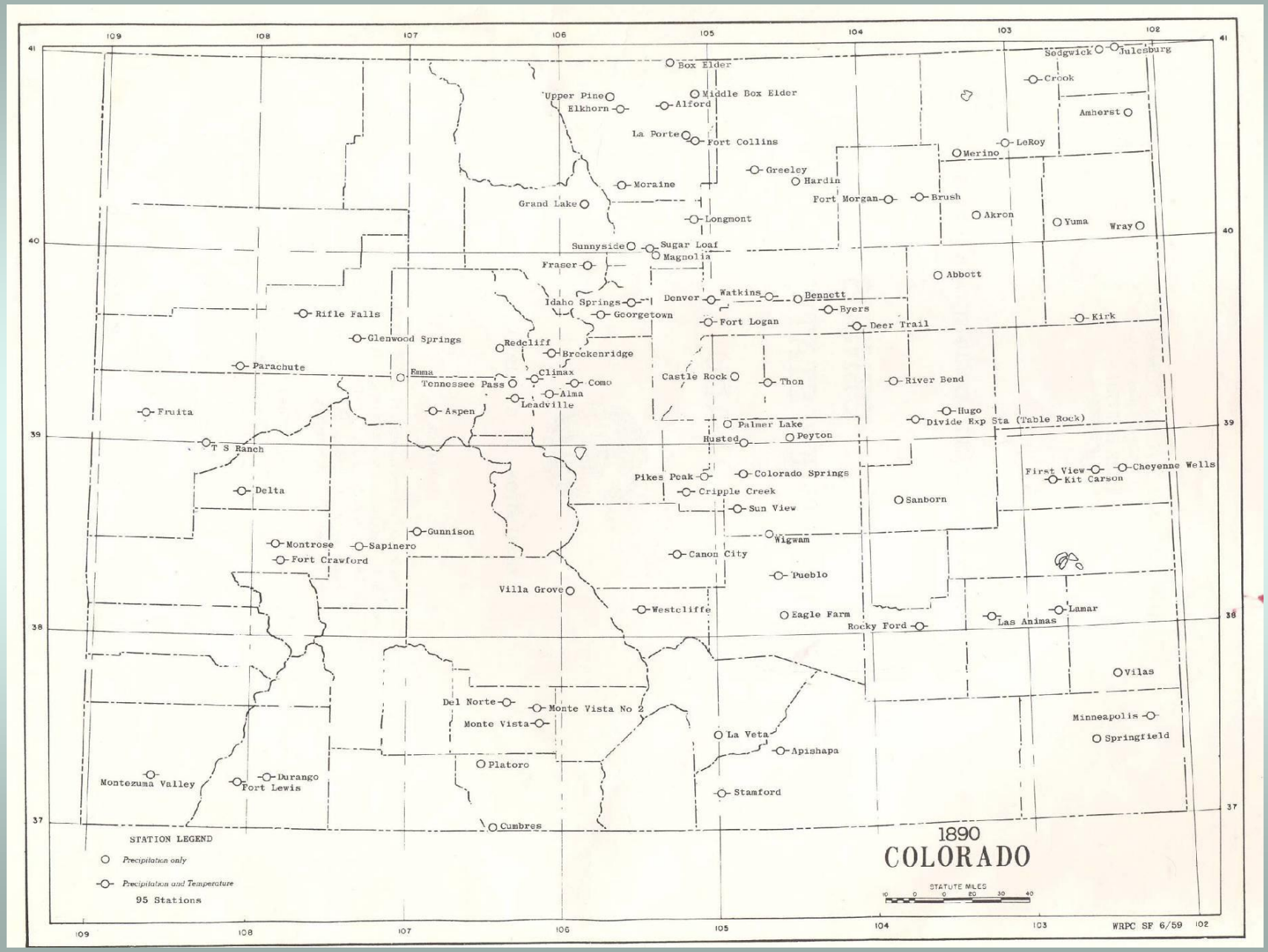
- The Colorado Climate Center at CSU, in partnership with the state and federal Agricultural Experiment Stations provides climate expertise to the residents of the state through its threefold program of:

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

  2) ***Climate Research***

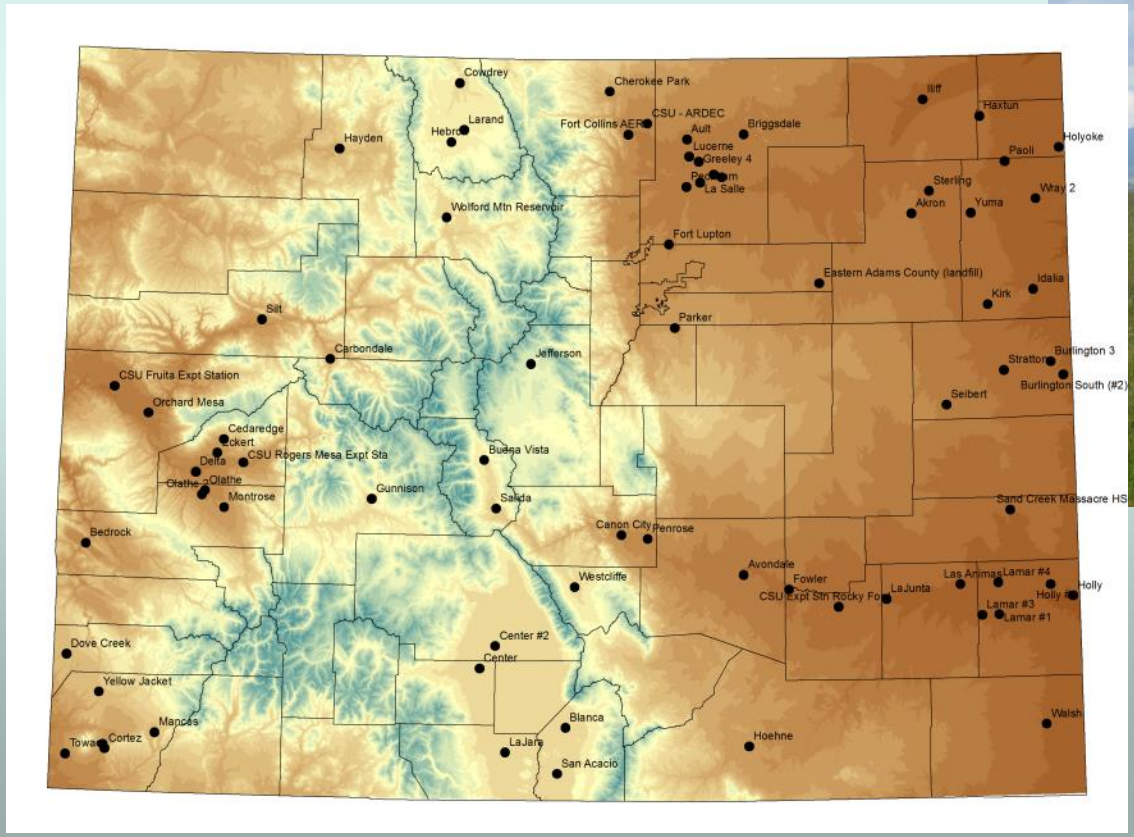
  3) ***Climate Services***.(providing data, analysis, climate expertise, education and outreach)

Weather Data in W.Colorado go back 130 years



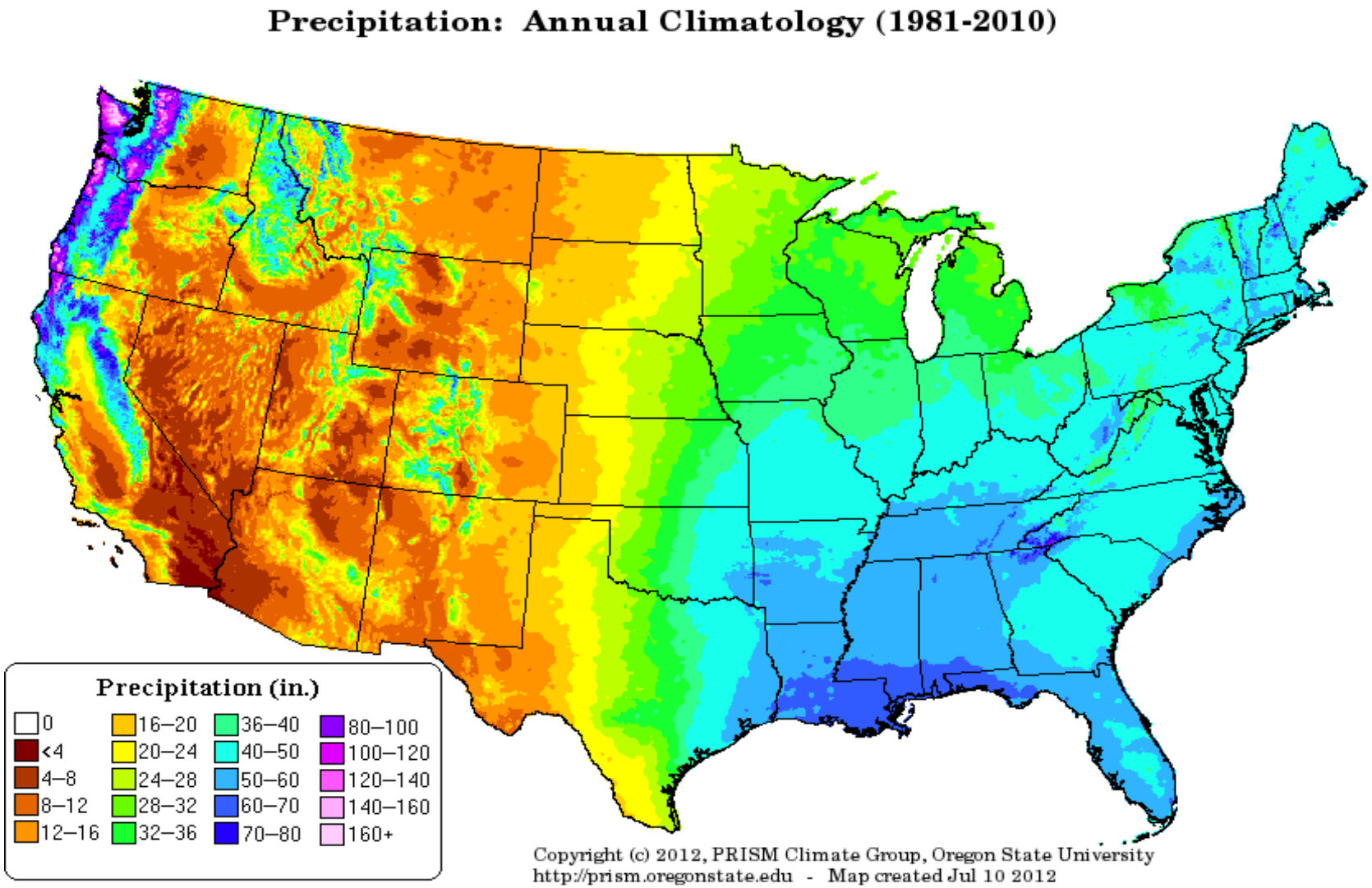
Snow surveys began in the 1930s to help predict seasonal streamflow

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

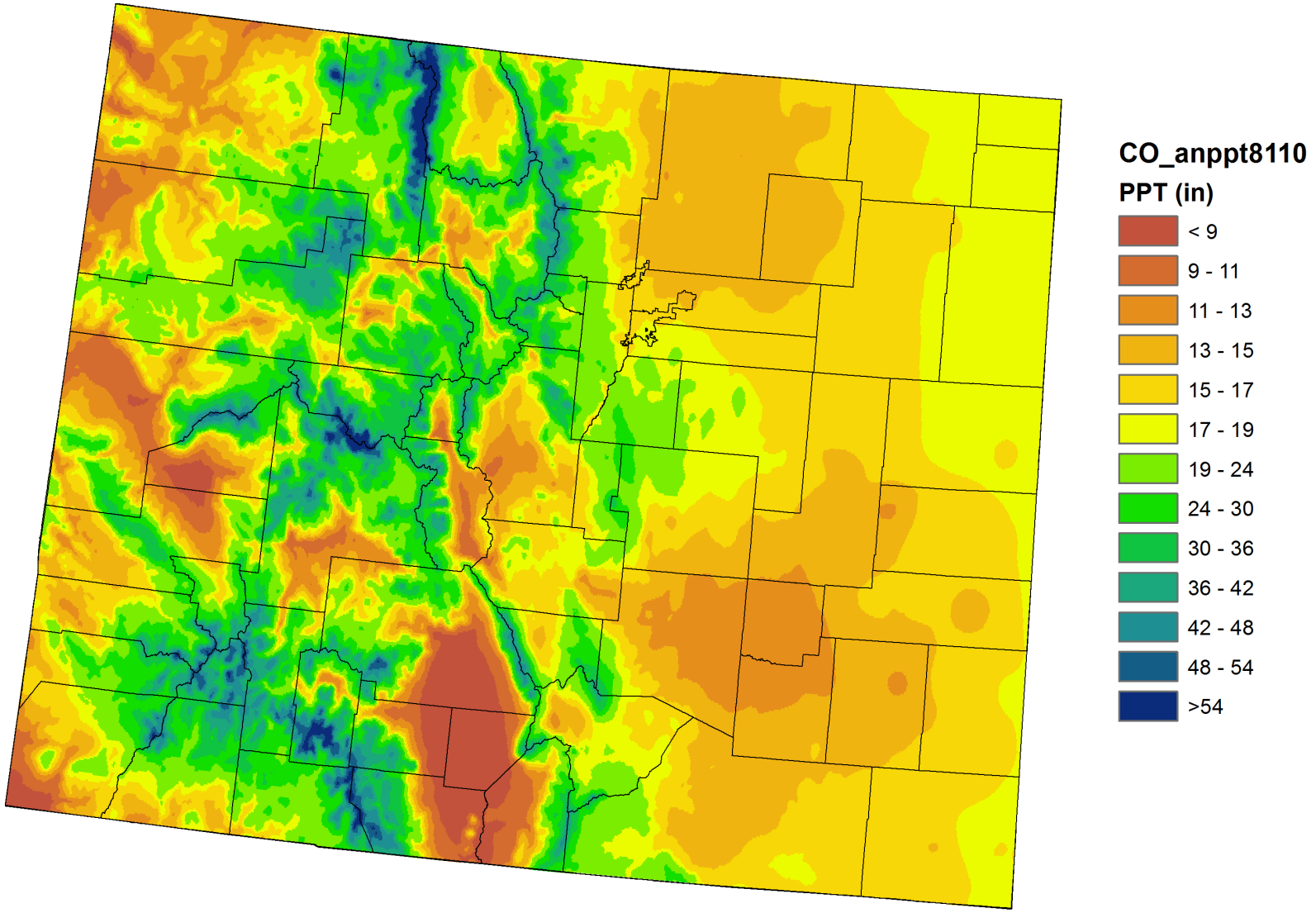


THANKS!! to those of You who help support CoAgMET

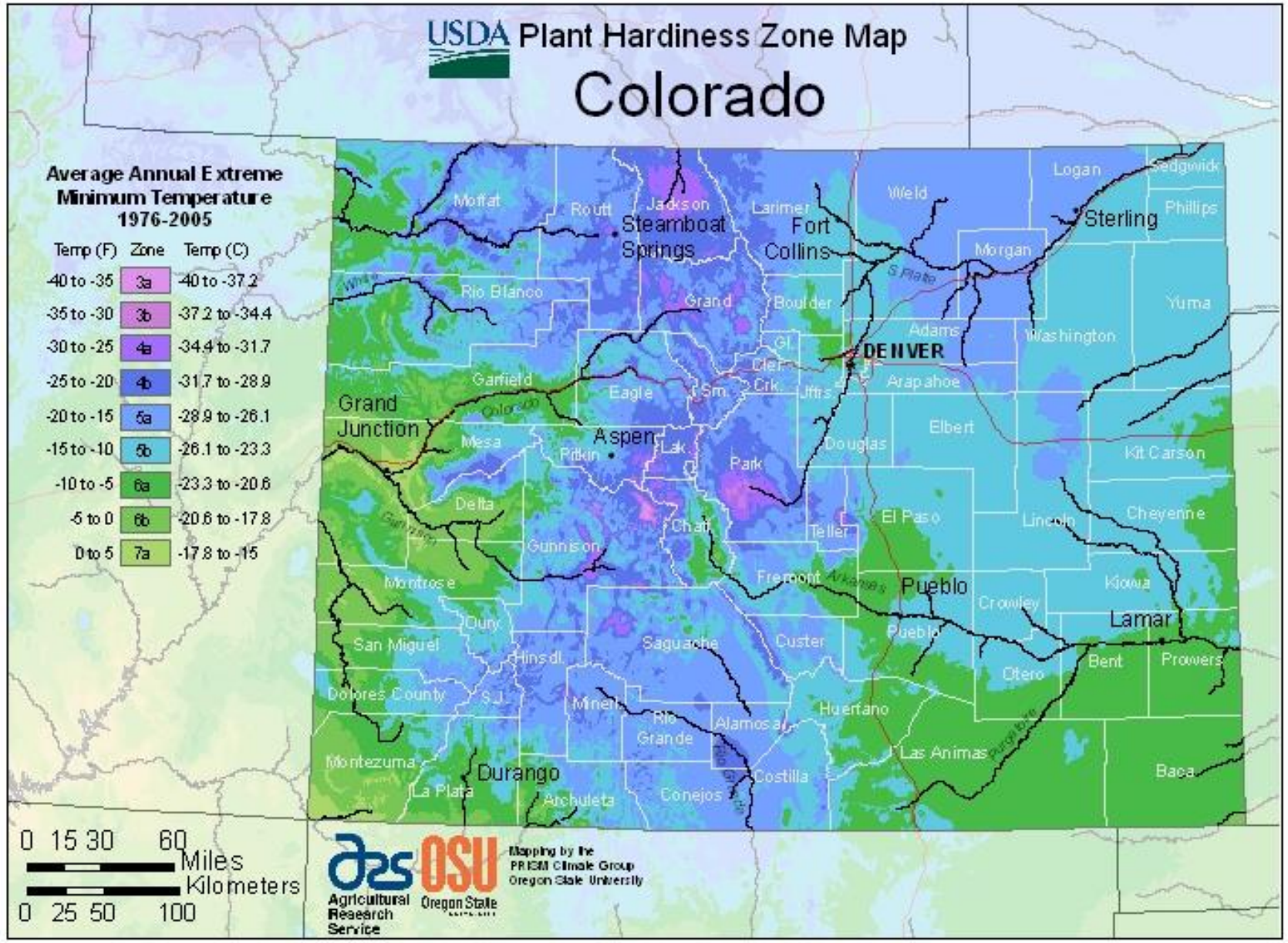
Here's what we expect



Colorado Annual Average Precipitation (in) 1981-2010



“Copyright © 2011, PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu


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
0 15 30 60 Miles
0 25 50 100 Kilometers
Agricultural Research Service
Oregon State
Mapping by the PRISM Climate Group Oregon State University
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
Grand Junction
Mesa
Aspen
Pitkin
Douglas
Elbert
Kit Carson
Park
Delta
El Paso
Cheyenne
Lincoln
Teller
Gunnison
Montrose
Fremont
Pueblo
Crowley
Kiowa
Lamar
Ouray
San Miguel
Saguache
Custer
Hinsdale
Otero
Bent
Prowers
Dolores County
Huerfano
Alamosa
Rio Grande
Las Animas
Montezuma
Durango
La Plata
Archuleta
Conejos
Costilla
Baca

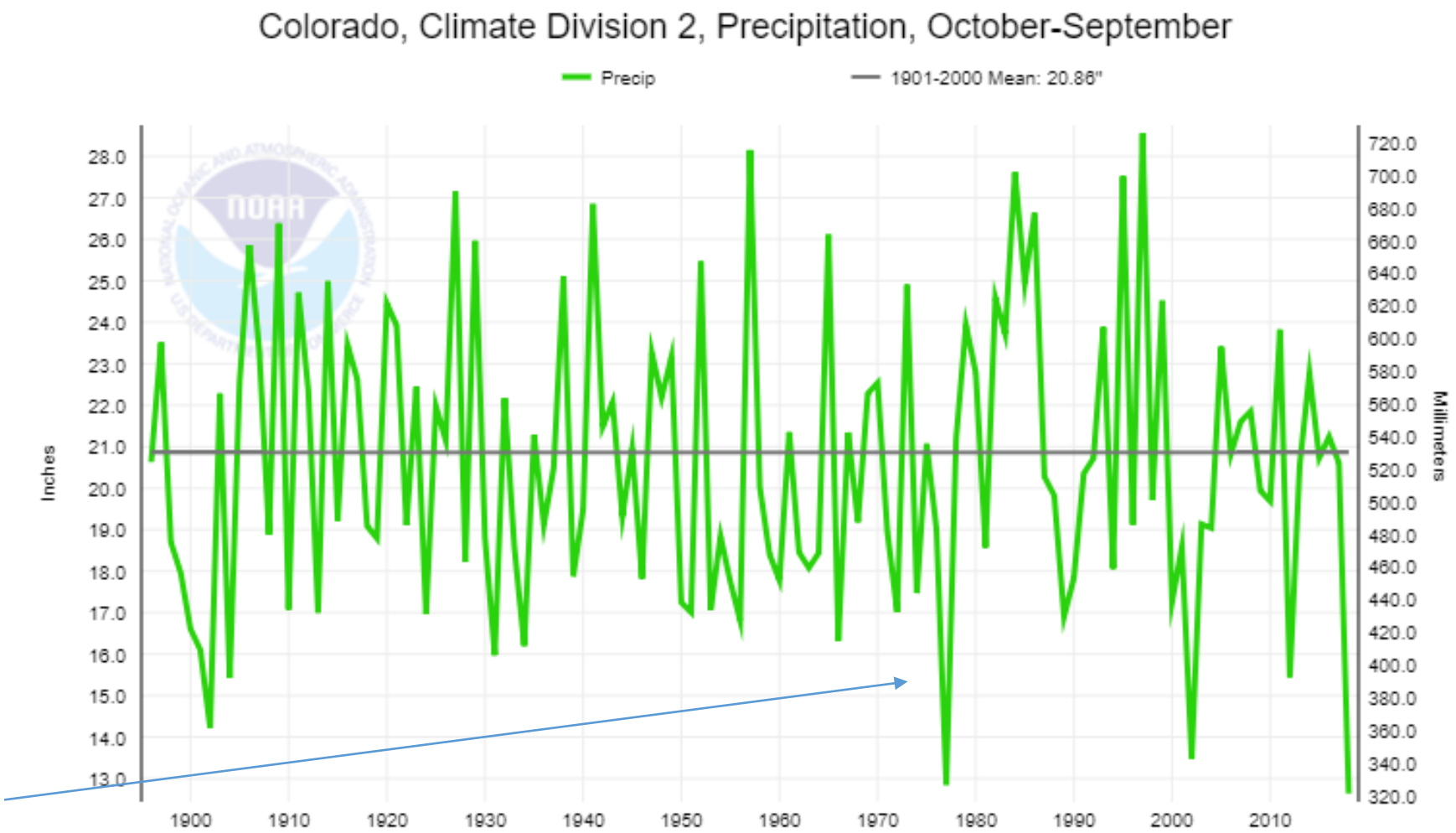
Places warm enough to grow are too dry, and places wet enough to grow are too cold…
Thank goodness for rivers!

What makes Colorado Climate so different from place to place?

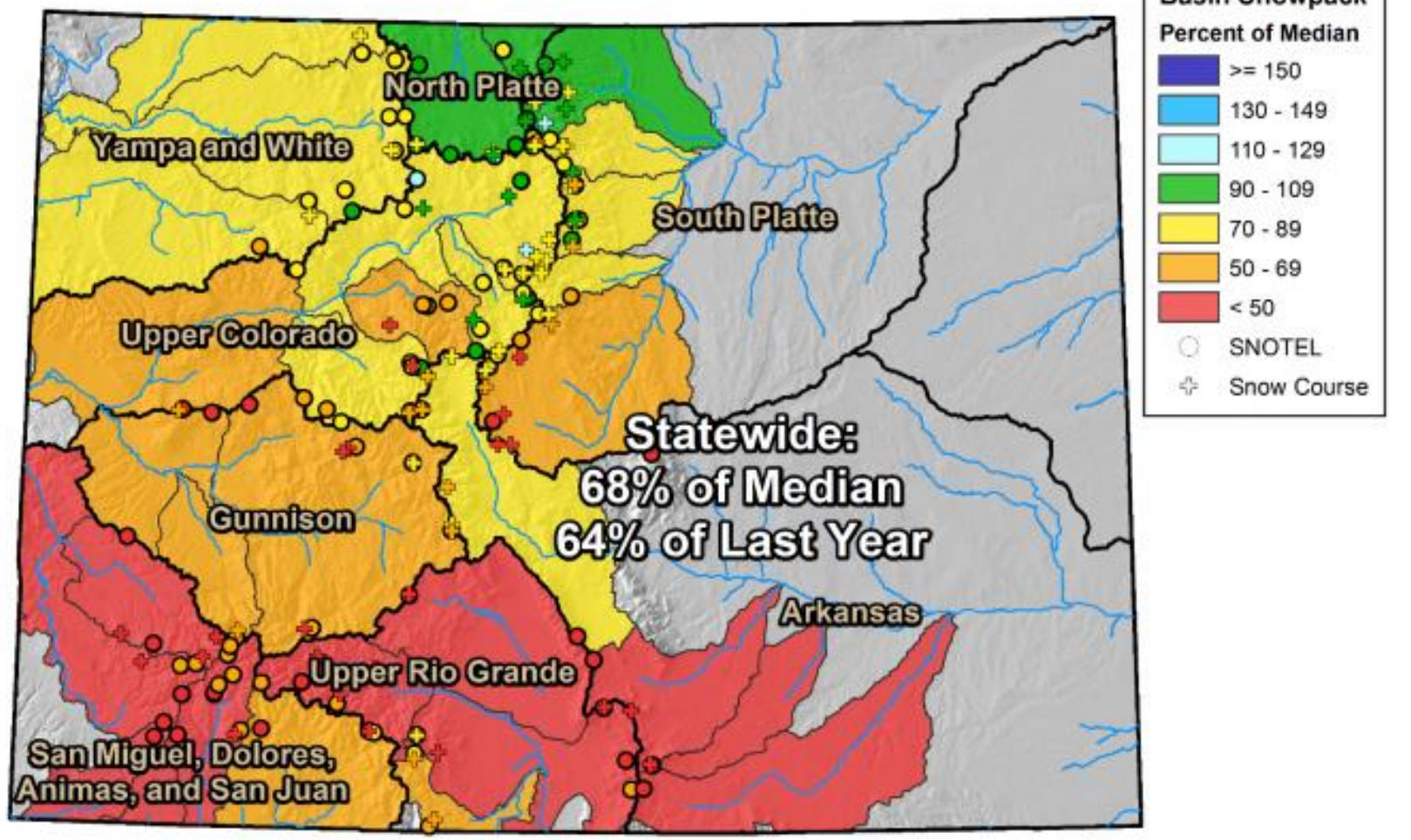
1. Altitude
2. Windward vs Leeward side of mountain
3. Latitude

…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!

This year to year variability keeps life interesting, and sometimes challenging



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

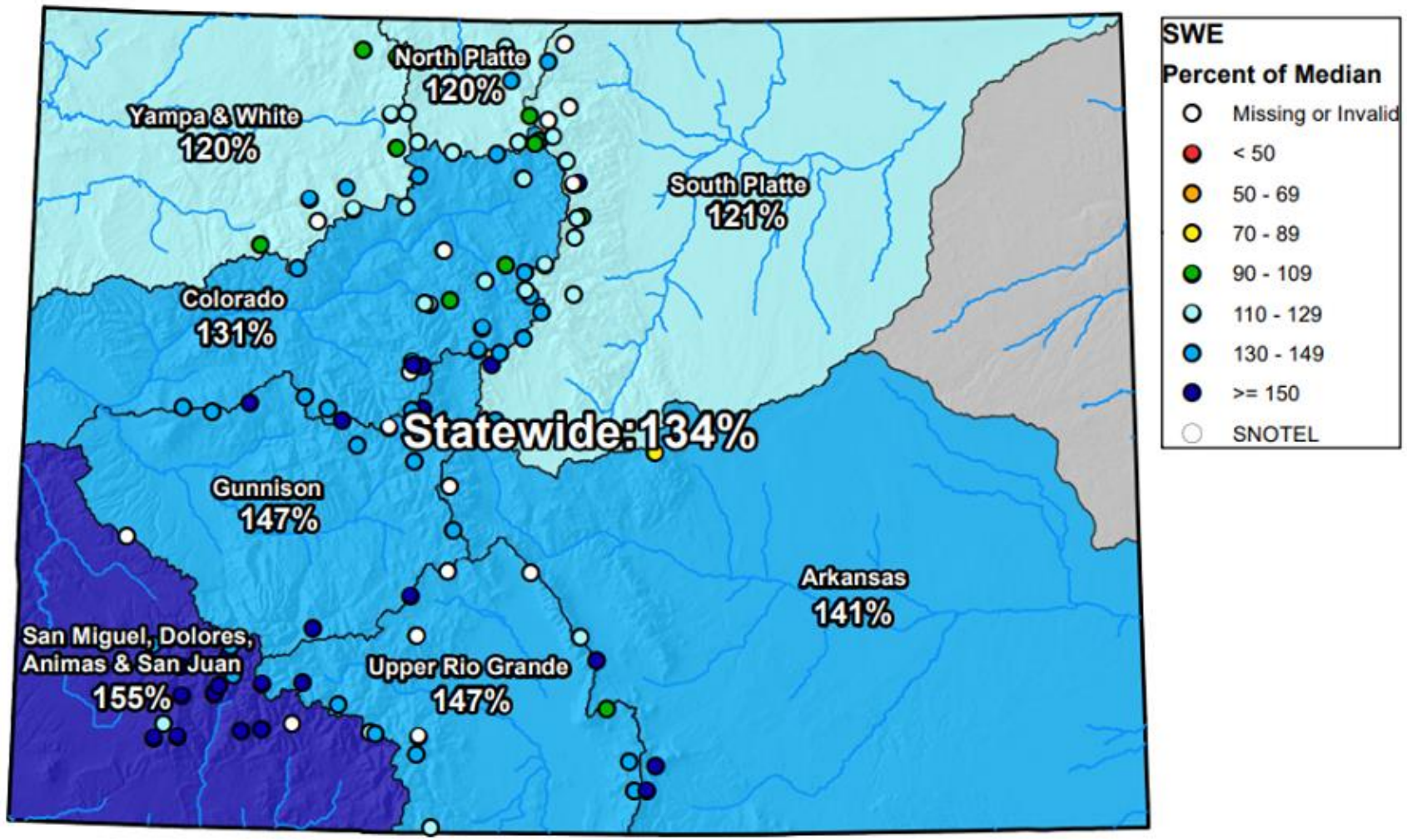
0 25 50 100 150 200 Miles

USDA United States Department of Agriculture
Natural Resources Conservation Service

Image from Colorado Public Radio

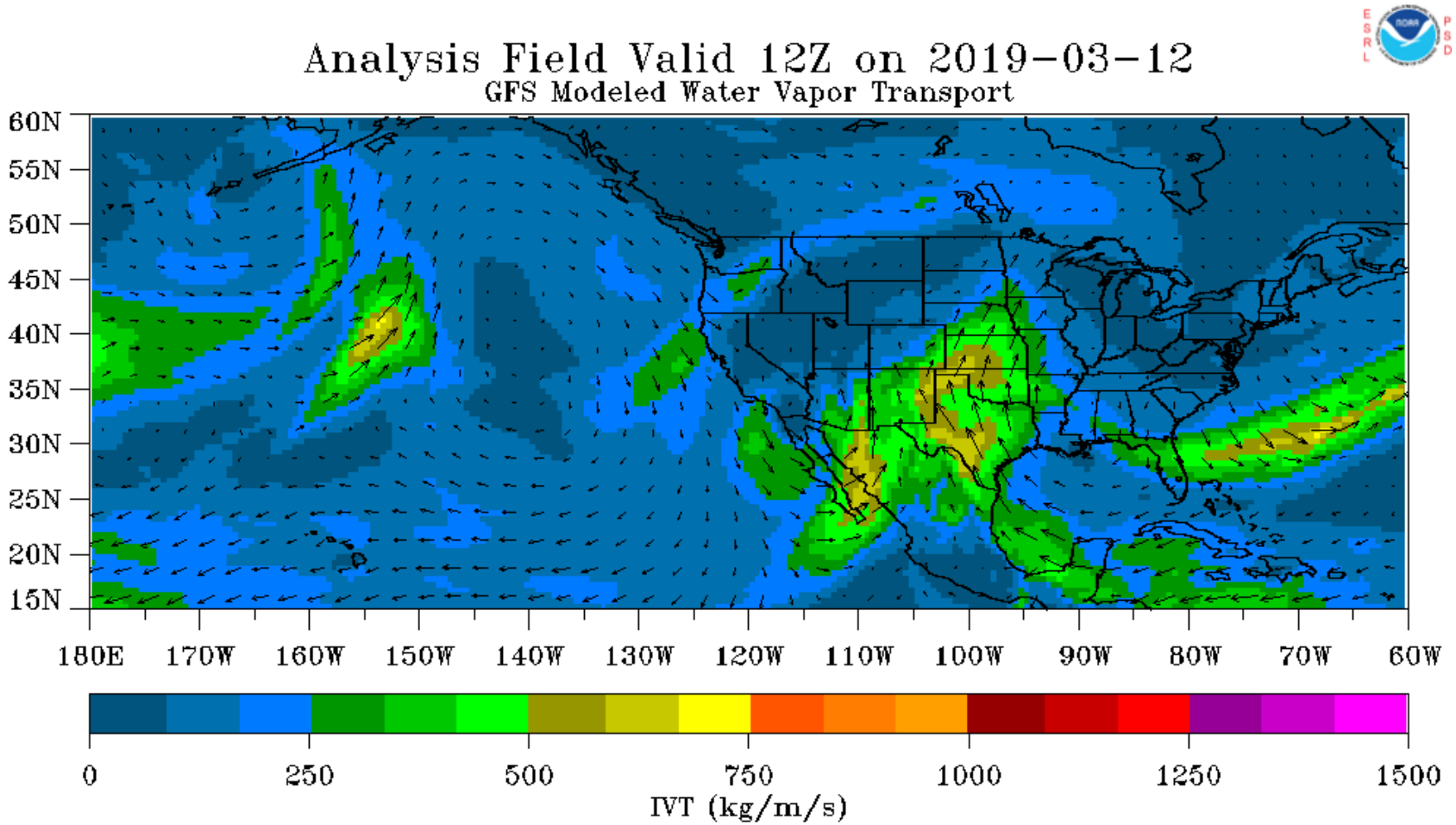
Colorado SNOTEL Snow Water Equivalent (SWE) Update Map with Site Data

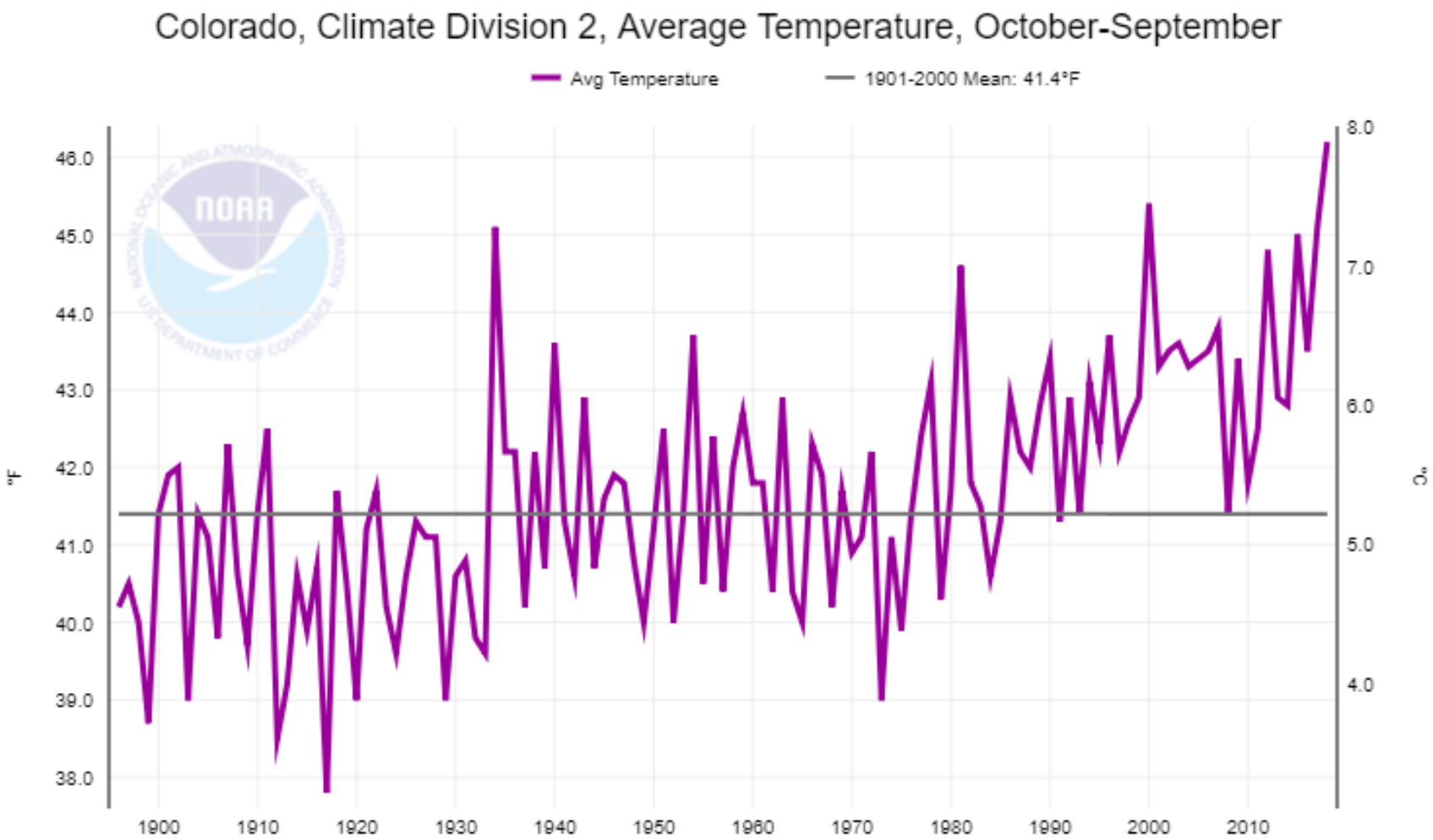
Current as of Apr 01, 2019



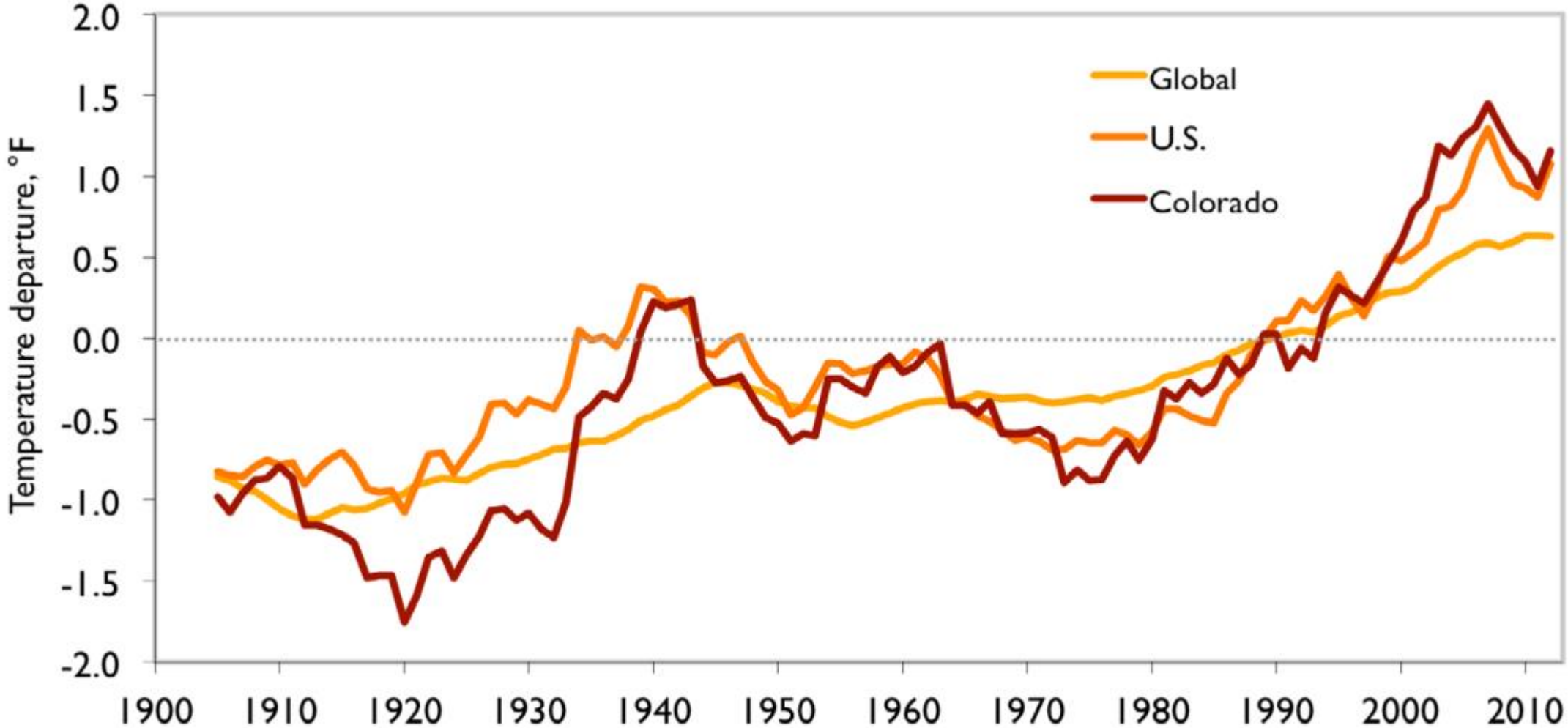
USDA United States Department of Agriculture

Natural Resources Conservation Service

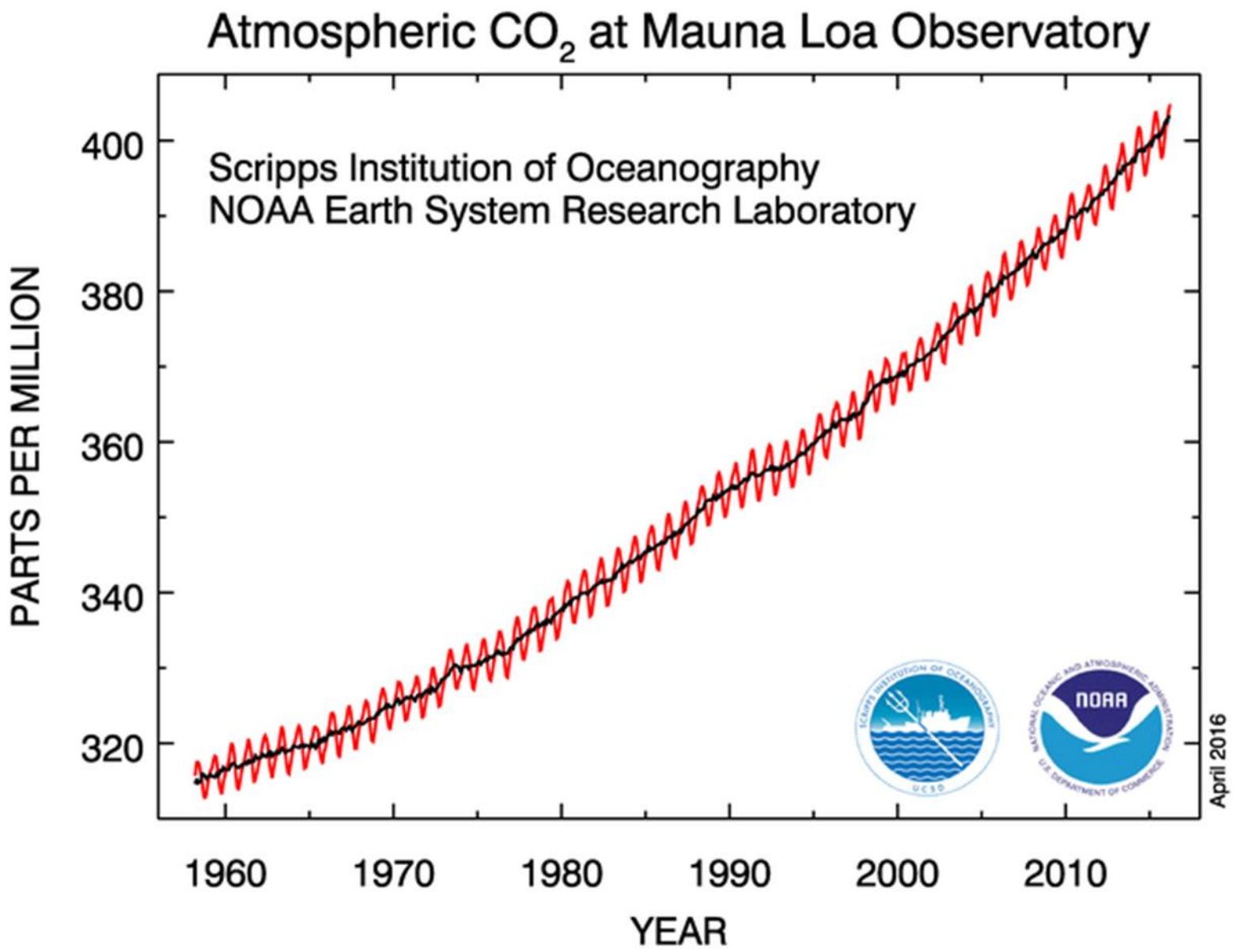

Analysis Field Valid 12Z on 2019-03-12
GFS Modeled Water Vapor Transport
60N
55N
50N
45N
40N
35N
30N
25N
20N
15N
180E
170W
160W
150W
140W
130W
120W
110W
100W
90W
80W
70W
60W
0
250
500
750
1000
1250
1500
IVT (kg/m/s)



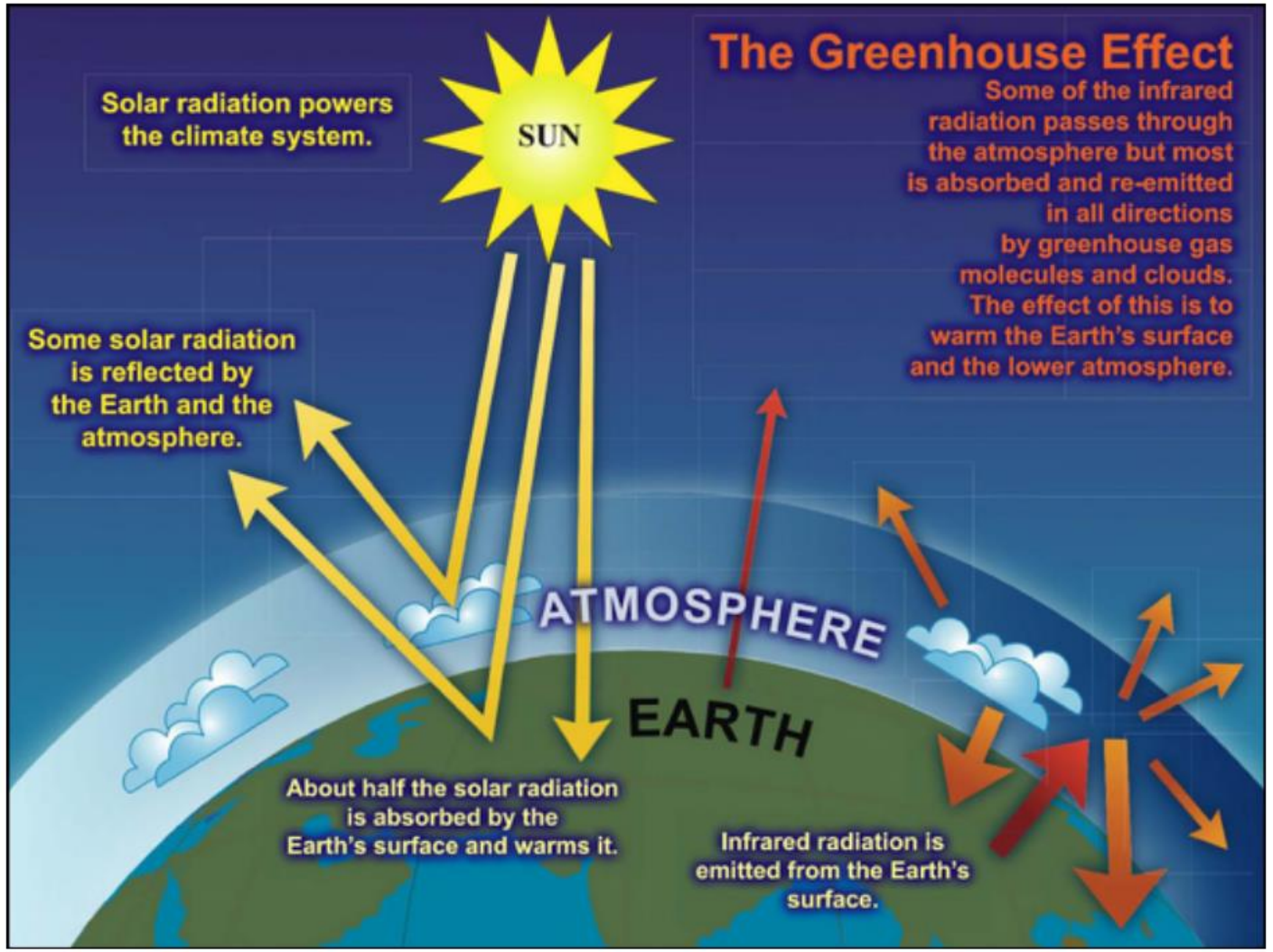
Temperatures vary naturally from year-to-year too, but they are getting consistently warmer



This warming pattern is not unique to Colorado


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

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

Why is this such a hard problem?

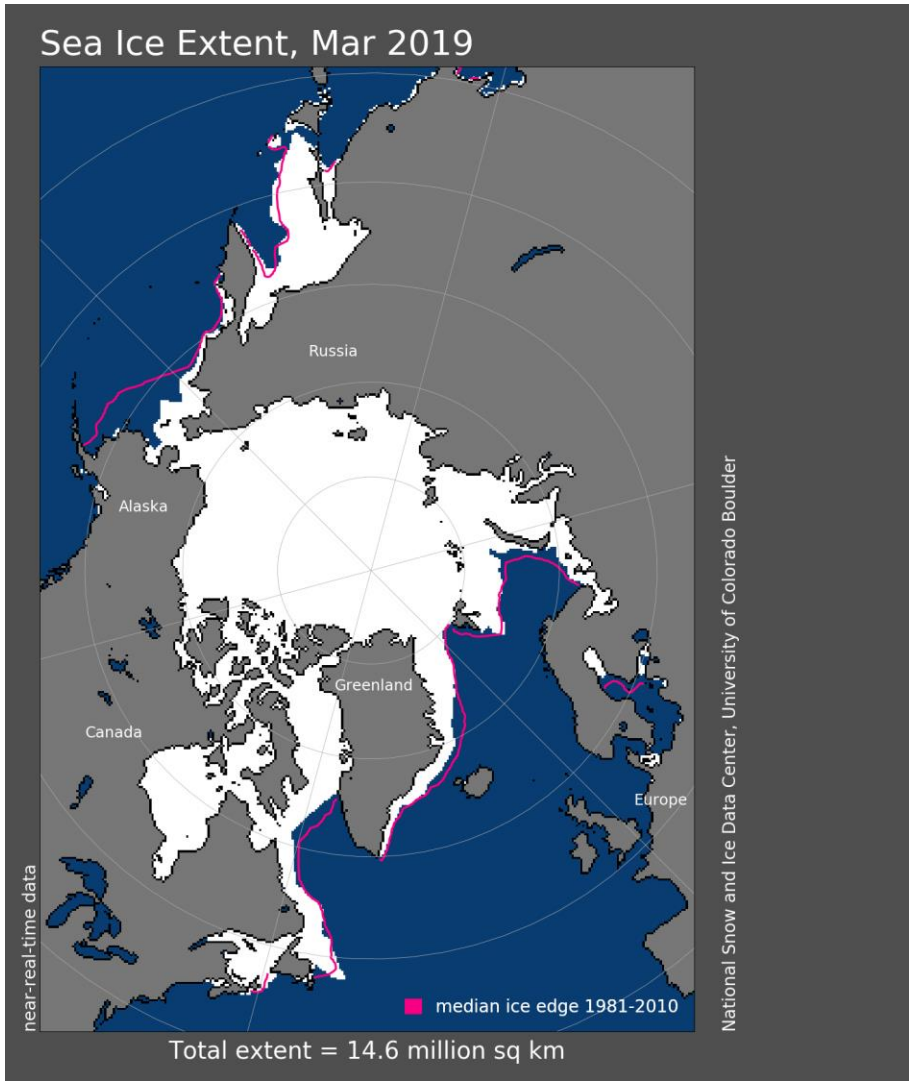
The main answer: climate feedbacks

Our earth system may respond in a number of ways to an induced change. Cloud coverage, and cloud types can change with temperature, ice extent changes, biomass changes, and the concentration of other greenhouse gasses changes

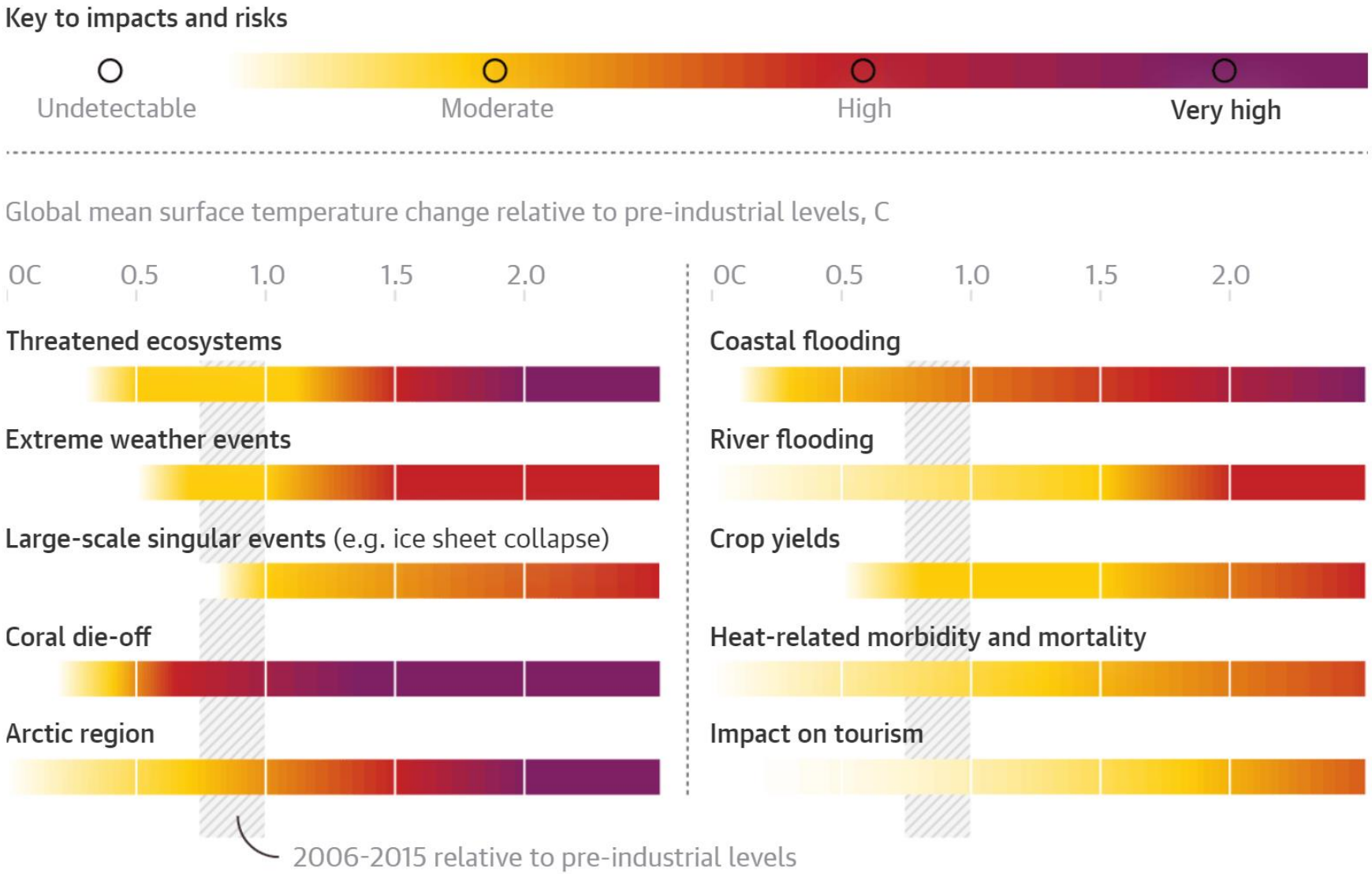
Some of these changes add to the initial warming push, others might mitigate it, but ultimately, what wins?

Positive feedback: + CO_2 -> + temperature -> - ice cover -> - surface reflection -> + temperature

Negative feedback: + CO_2 -> + temperature -> + precipitation -> + vegetation -> - CO_2 -> - temperature

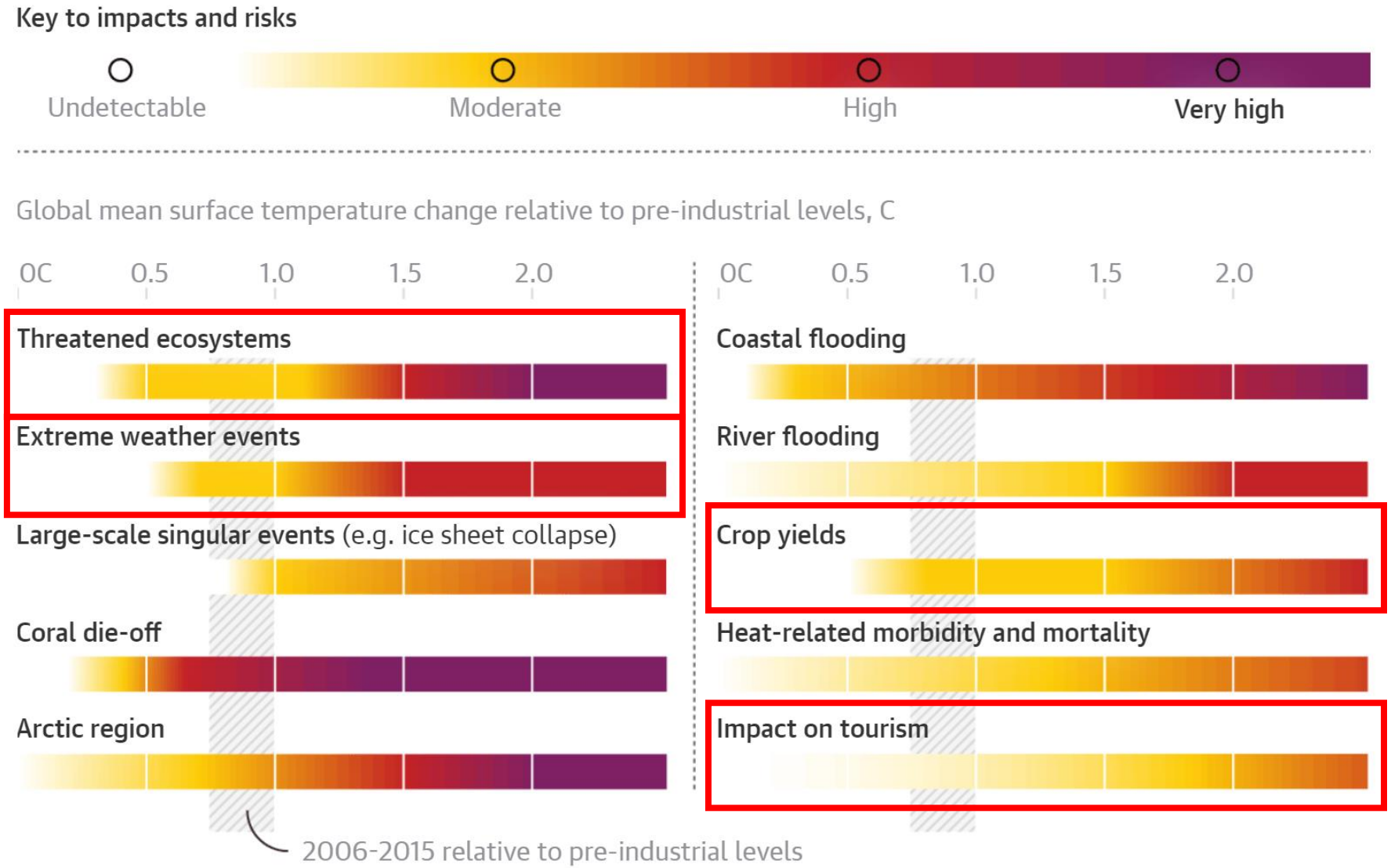


Rising temperatures, rising risks



Guardian graphic. Source: IPCC Special Report on Global Warming of 1.5C

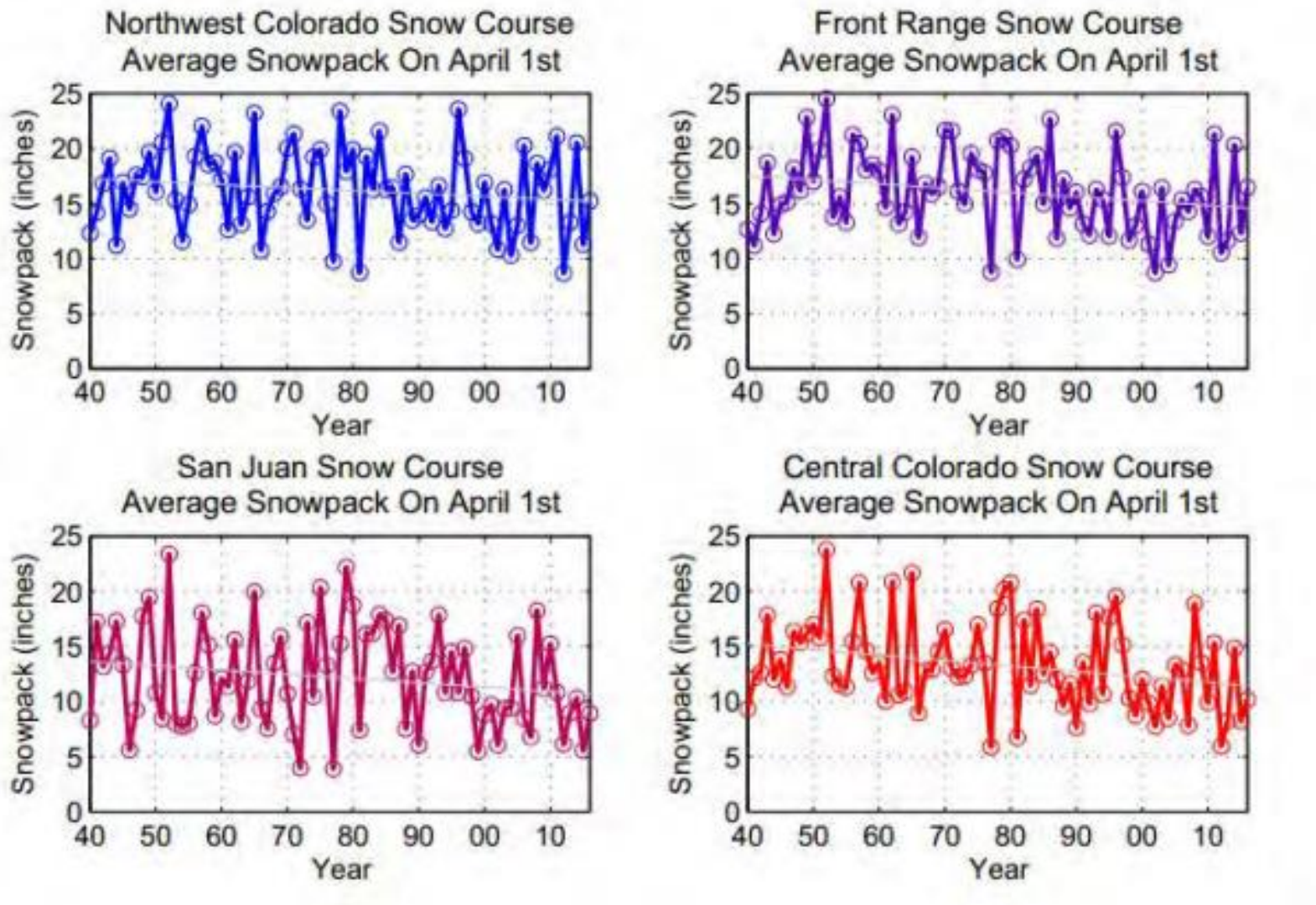
Rising temperatures, rising risks



Guardian graphic. Source: IPCC Special Report on Global Warming of 1.5C

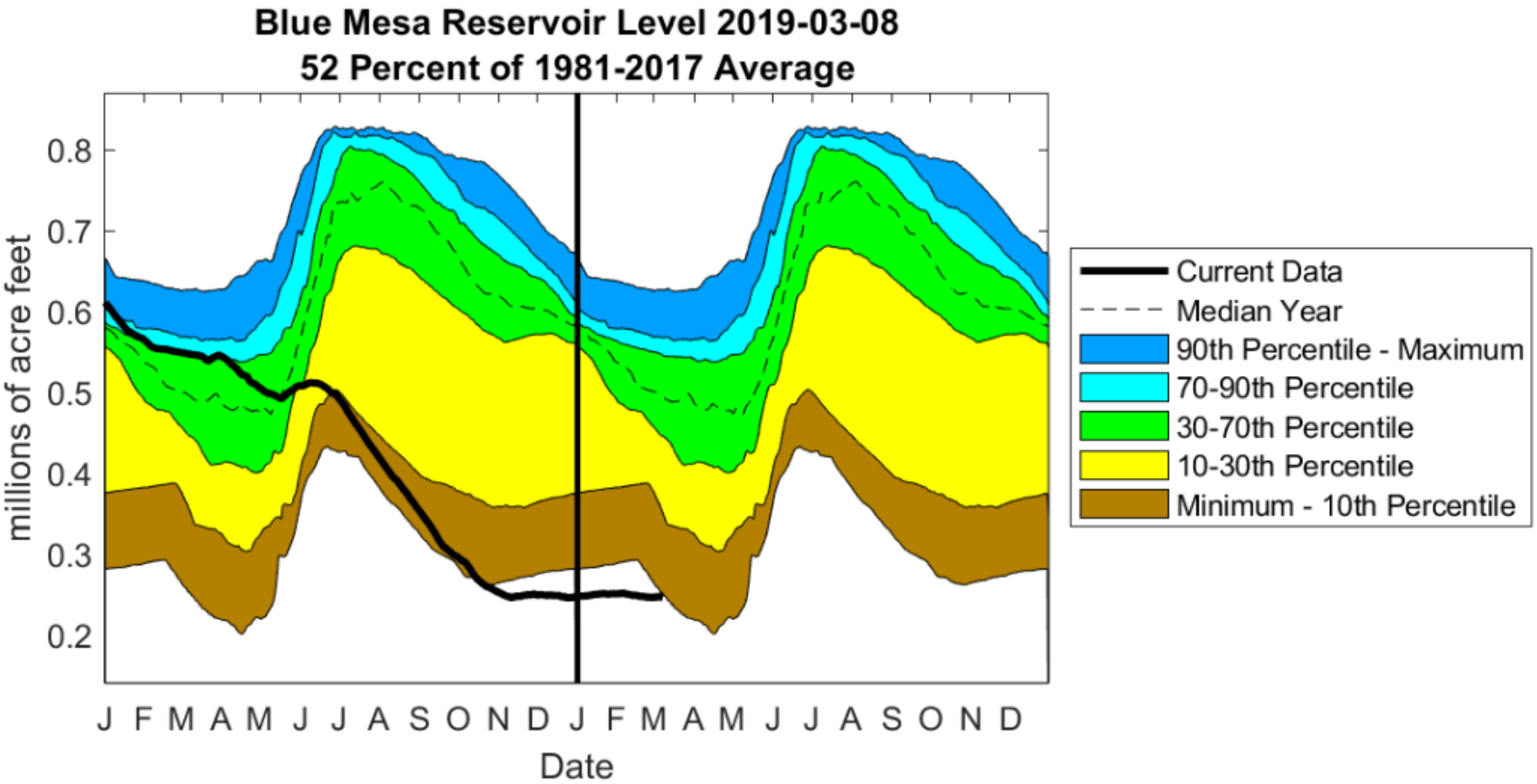
Warming has not been good for our snowpack

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

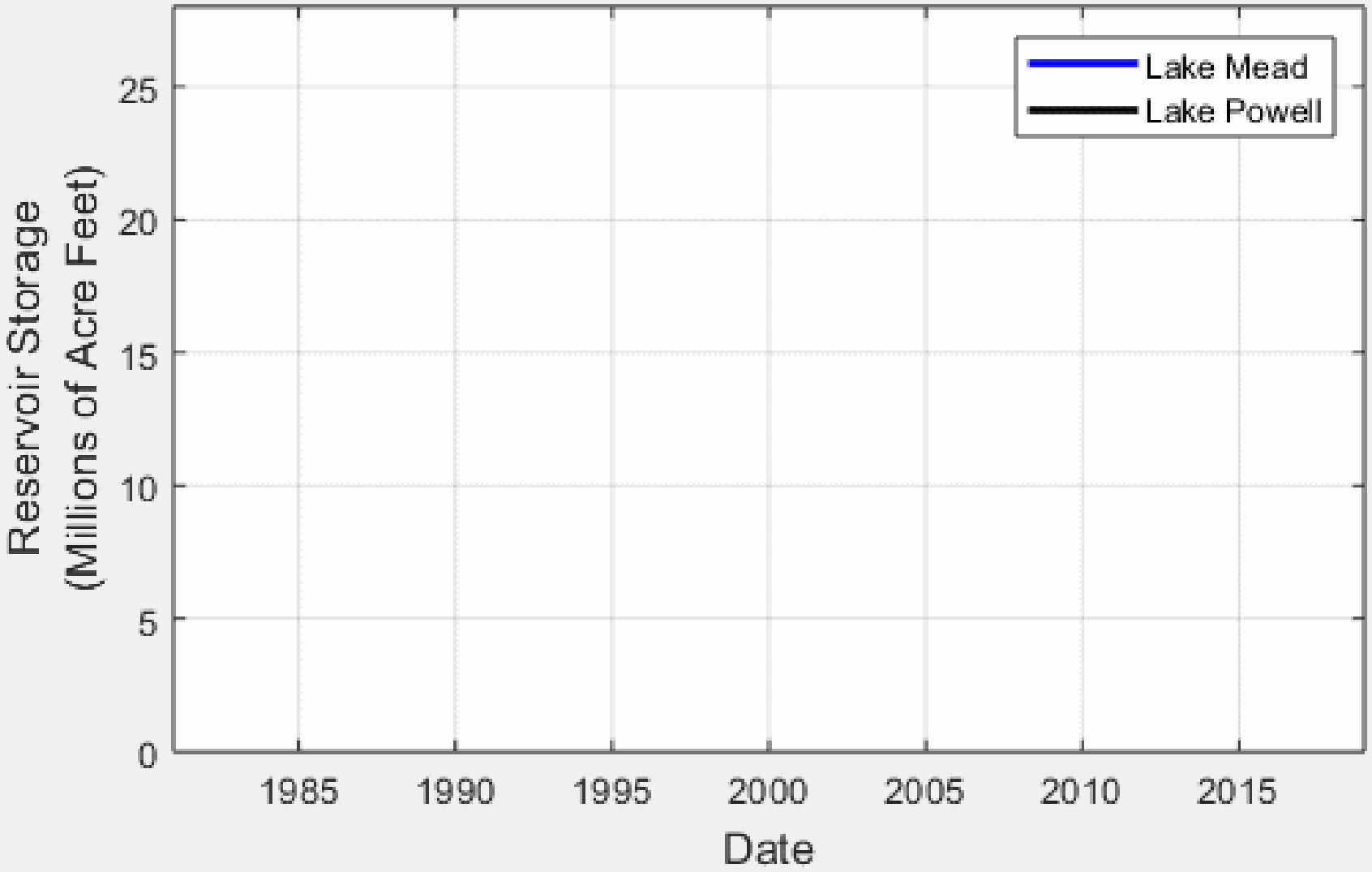


Our Big Concern Locally and Regionally: ***Water***

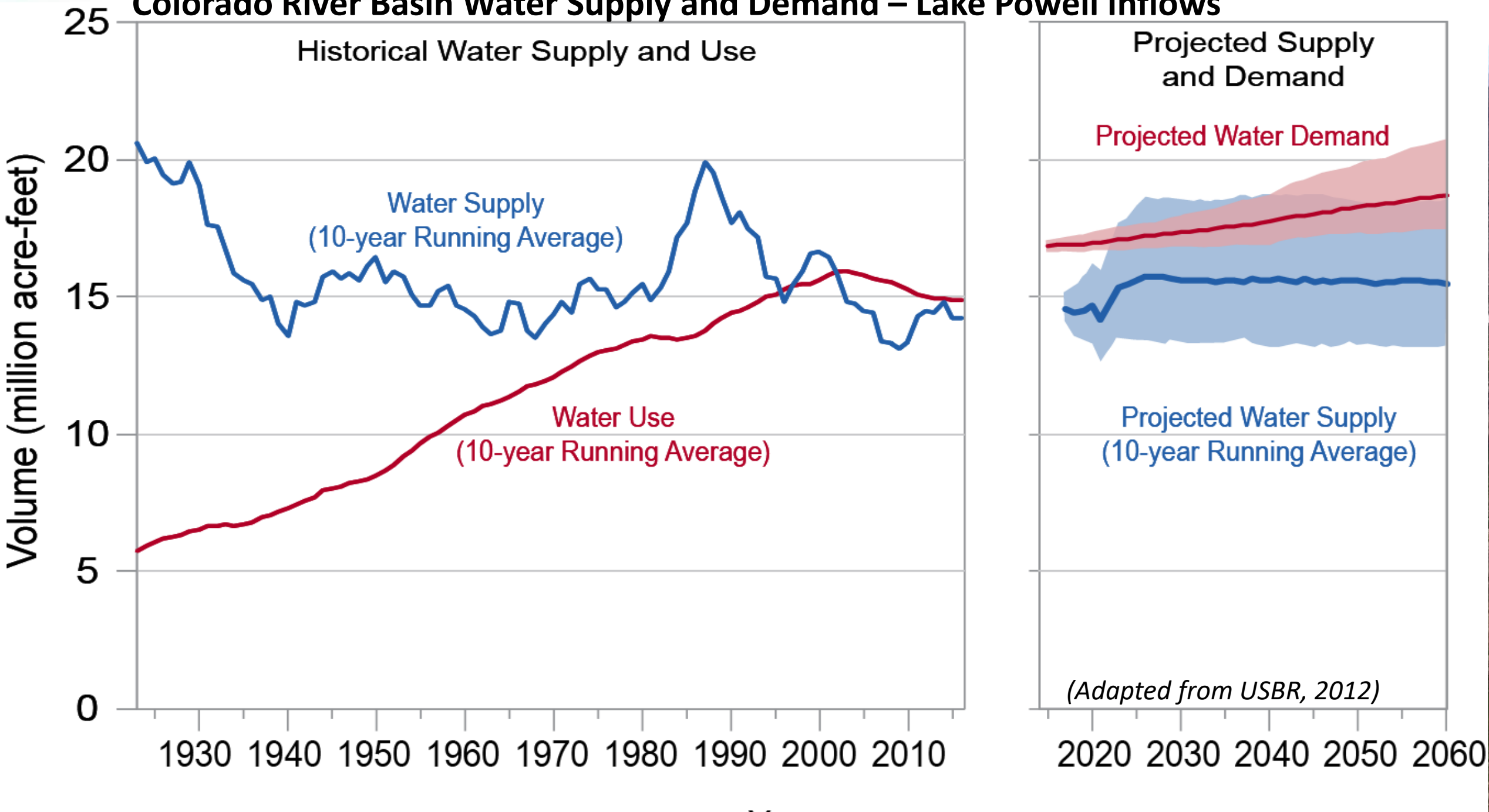
- The supply and demand balance for water is shifting in the Colorado River Basin with more people moving into the region every year.
- Hotter than historic conditions are contributing to reductions in streamflow in the Colorado River Basin (Udall and Overpeck 2014)

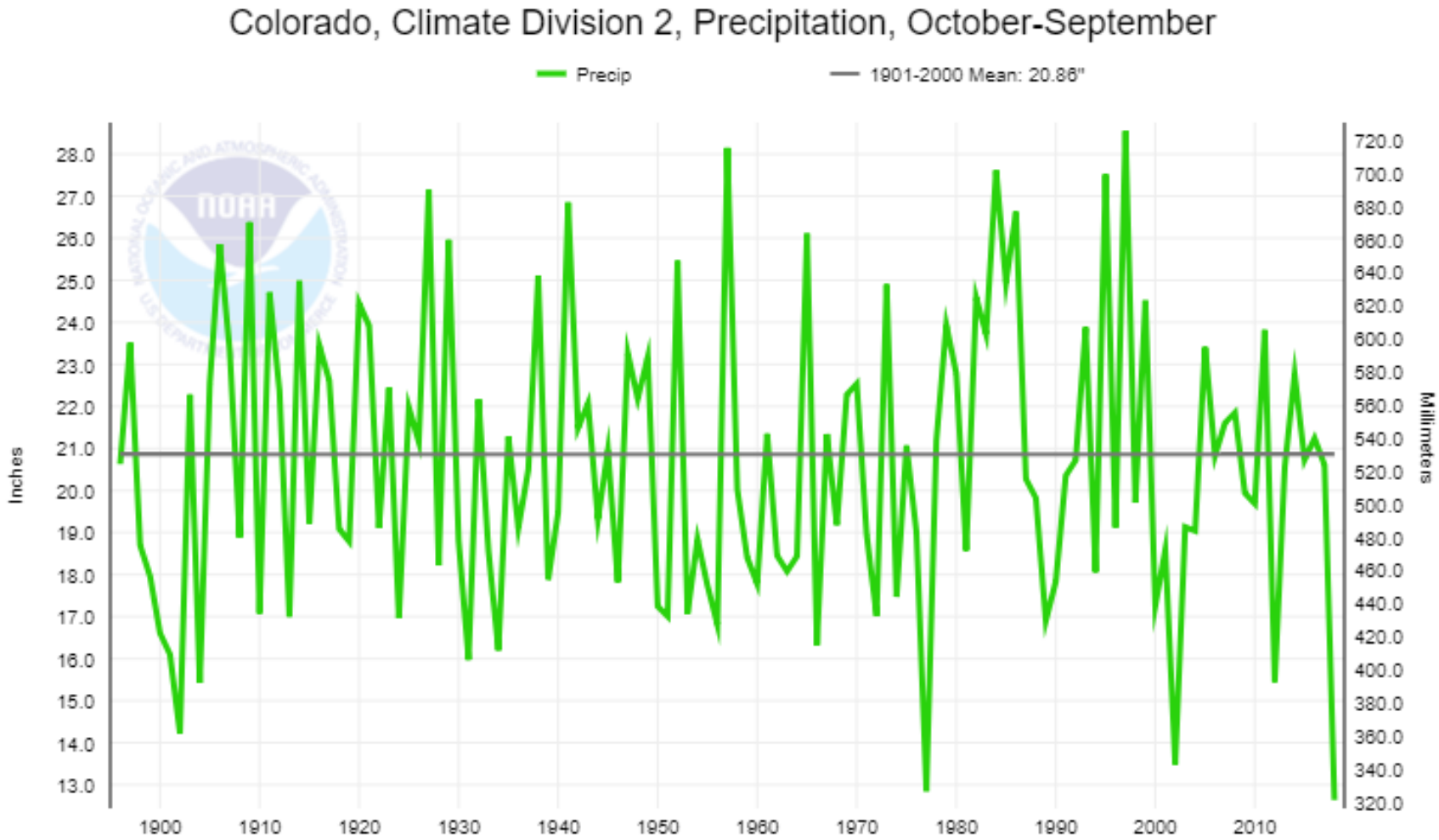


Hot, dry conditions severely damage our water supplies


Reservoir Levels on the Colorado River
Jan 1981
Lake Mead
Lake Powell
Reservoir Storage
(Millions of Acre Feet)
0
5
10
15
20
25
1985
1990
1995
2000
2005
2010
2015
Date

Colorado River Basin Water Supply and Demand – Lake Powell Inflows





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

Change in Growing Season Length

And the growing season is lengthening. That's good when we have the water to sustain it.

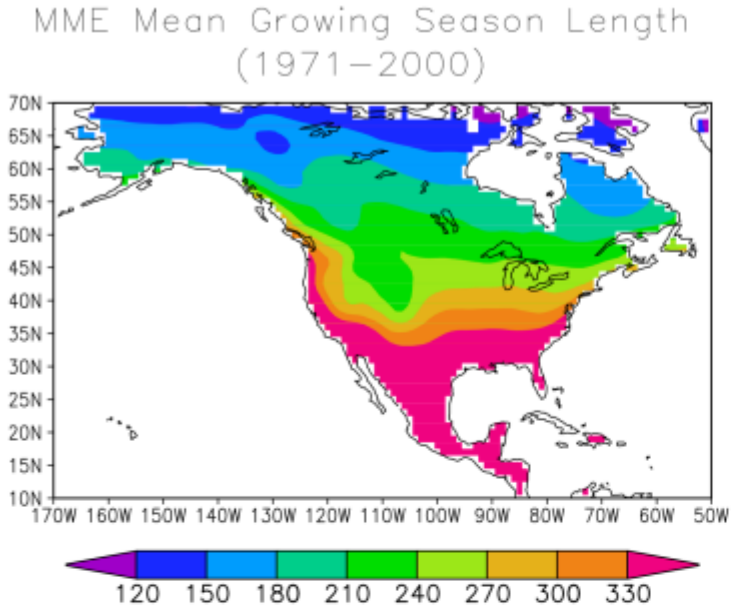
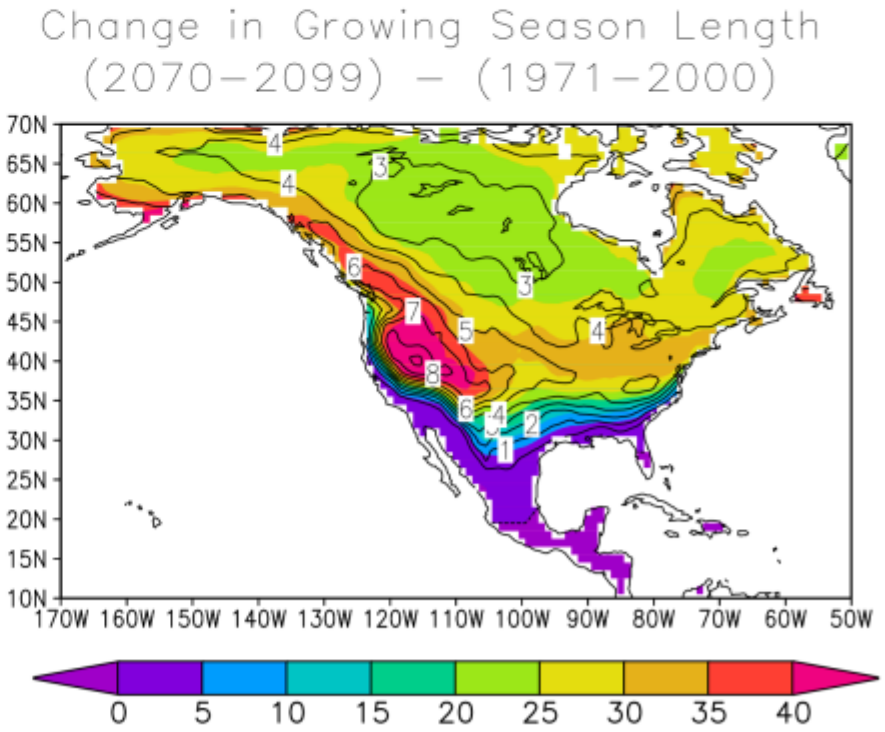


Figure 29.9

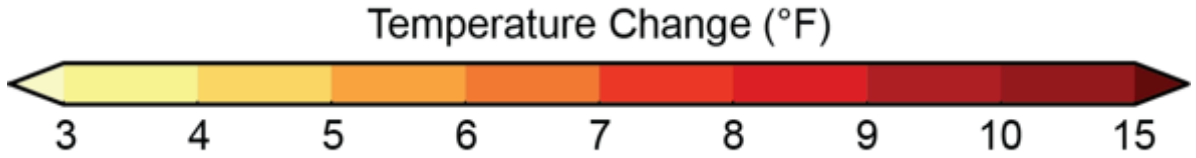


Projected Temperature INCREASE by our Grandchildren's Time – this is BIG

Significant Emissions Reduction

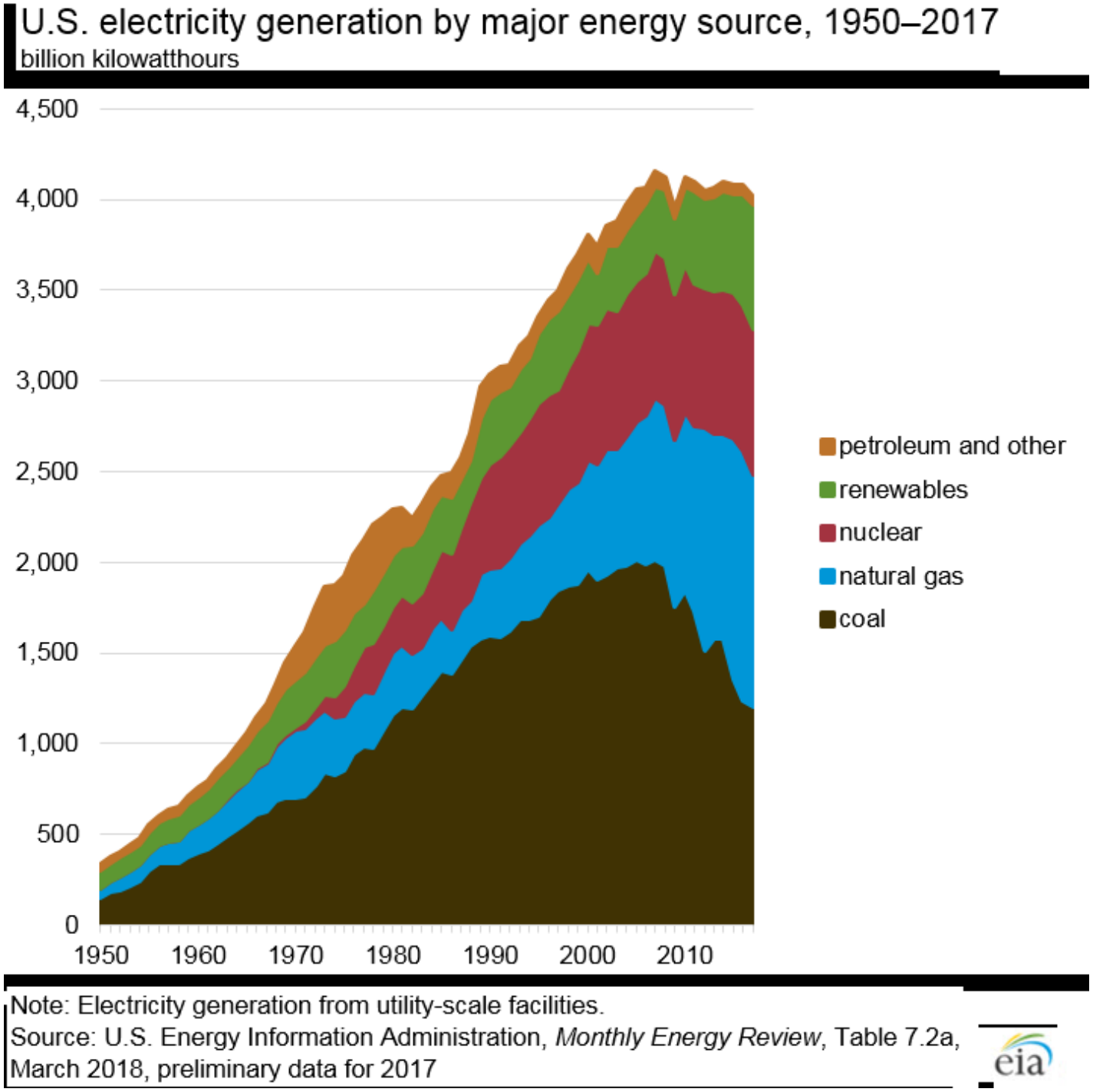
Current Emissions Continue

2071-2099 relative to 1970-1999

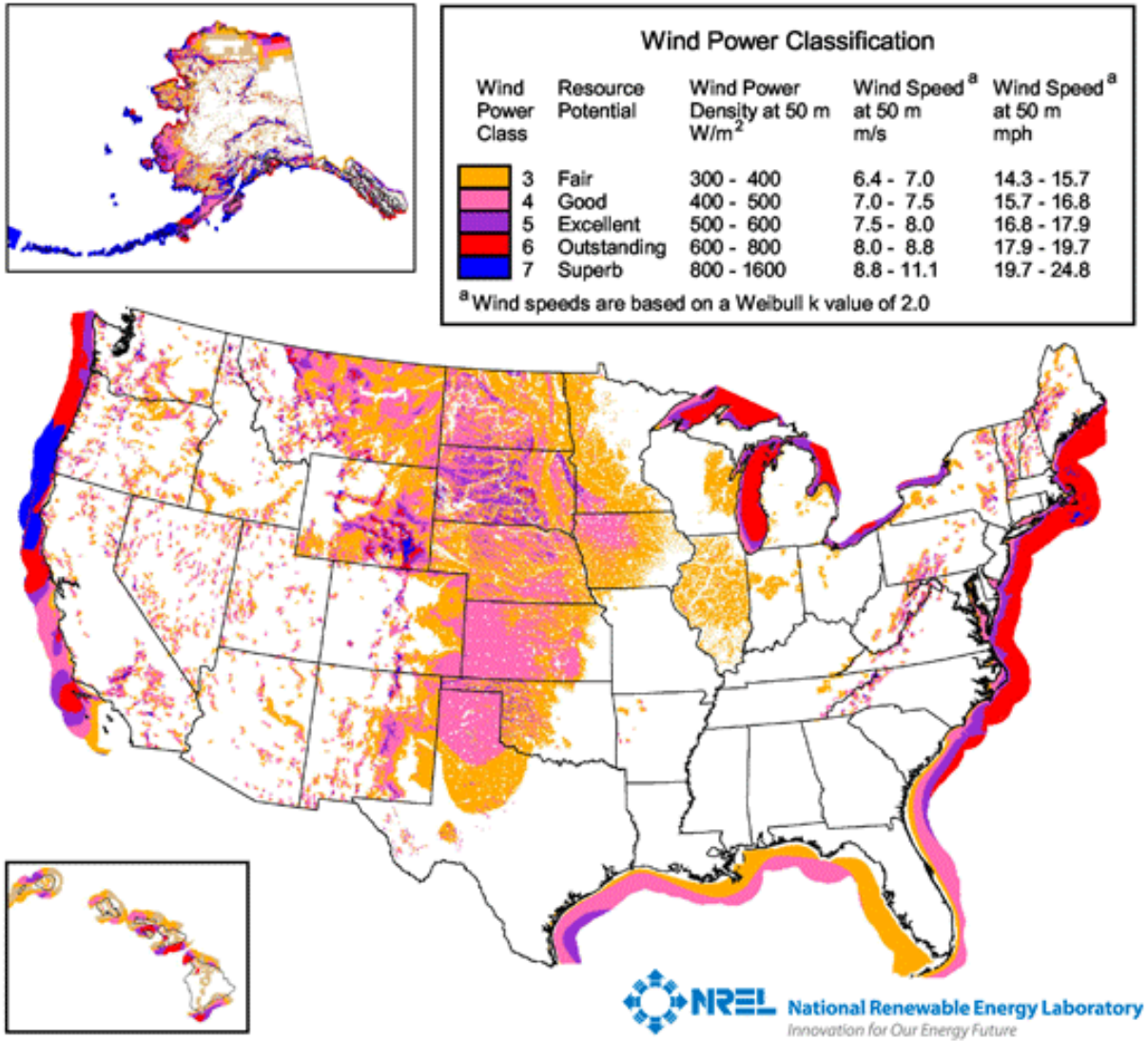


It’s not a hopeless situation, but we do have to keep trying

The fraction of energy generated from renewable sources is on the rise in the US



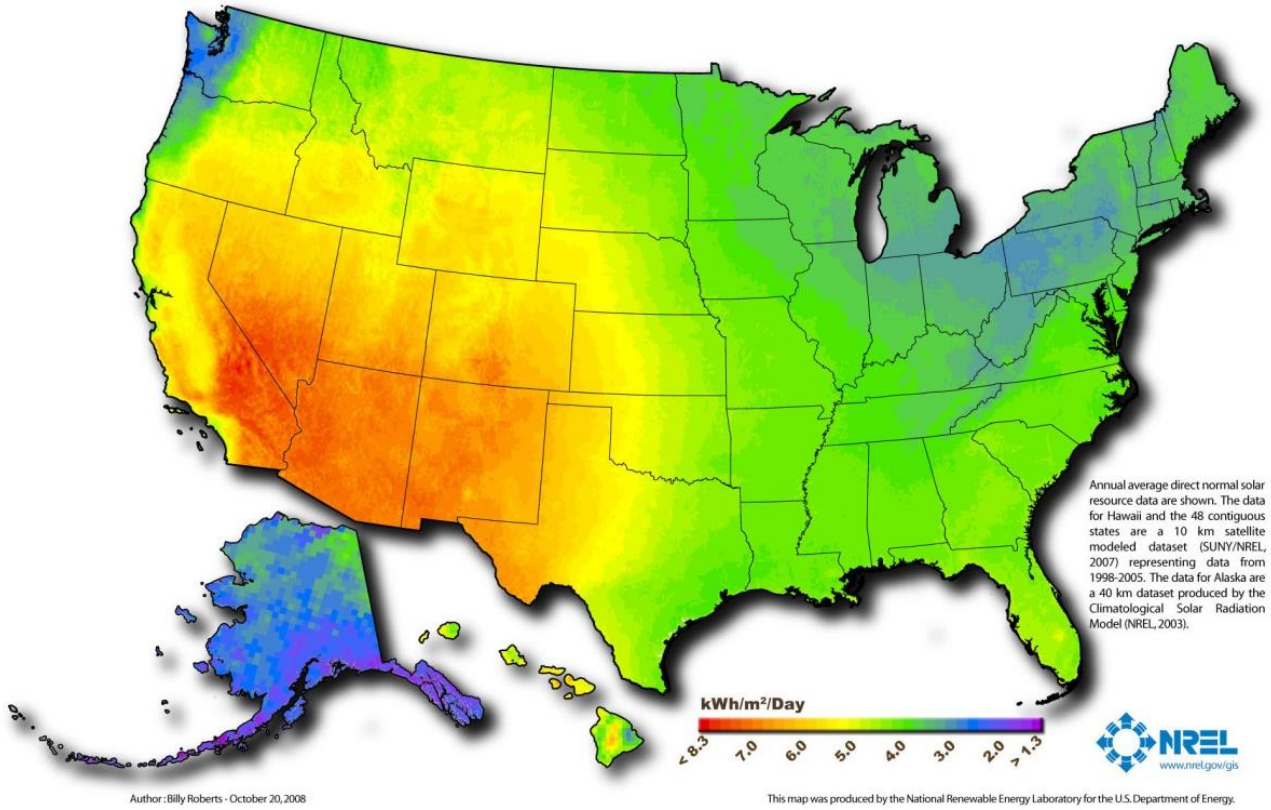
Wind is now generating 17% of all power in Colorado



Colorado is a sunny place.

Sunshine is Energy. People like sunshine!

Crops like sunshine, too. We are also 11th in the US in Solar energy and can do more



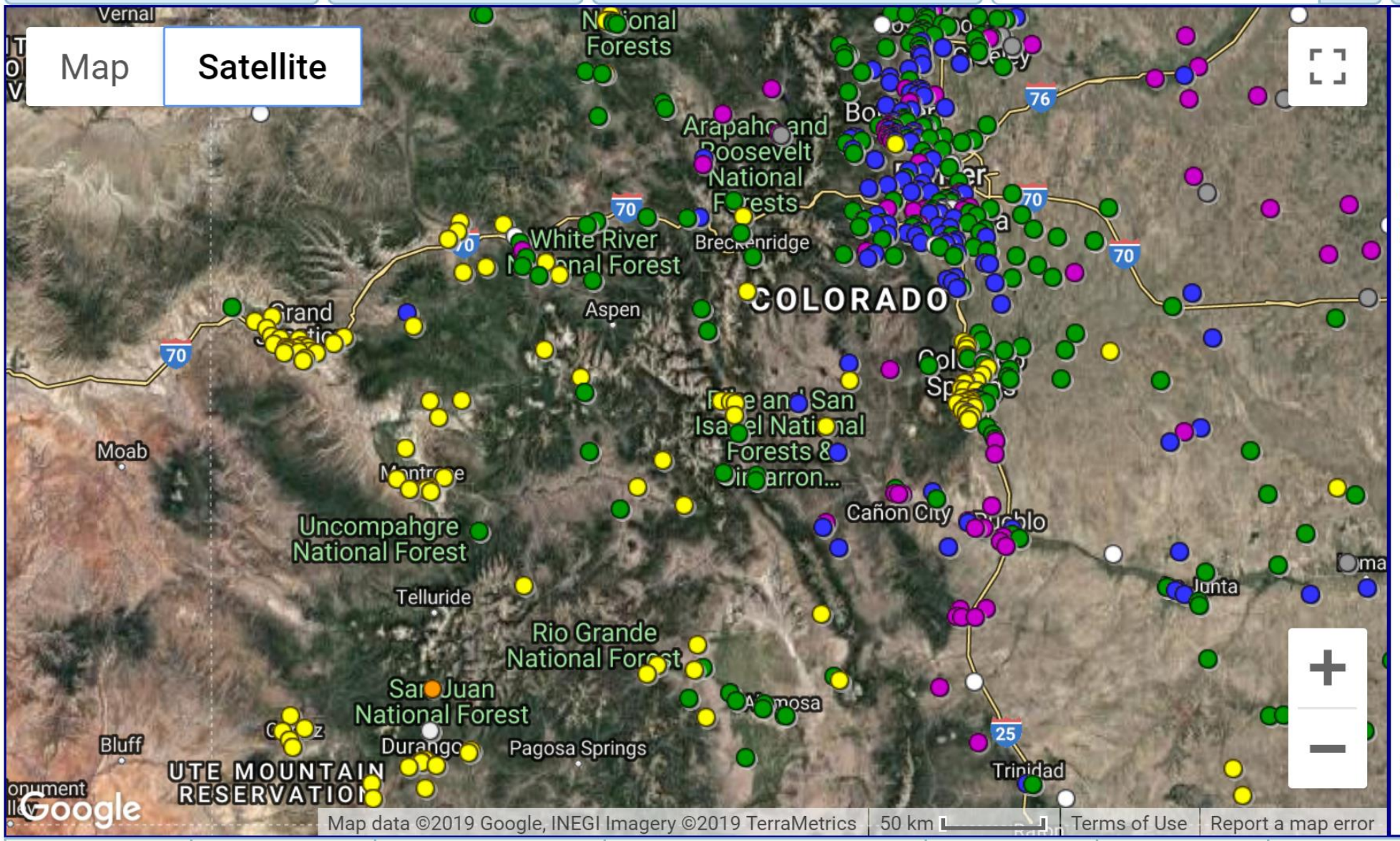
National Renewal Energy Laboratory: www.nrel.gov

Get a rain gauge,

and join CoCoRaHS.

You'll be glad you did. ☺

Precipitation | USA | Colorado | 3/13/2019 | US Units | Update



CoCoRaHS Precipitation Map

Date: 03/13/2019
Country: USA
State: CO
Units: US Units

- Zero
- Trace
- 0.01 - 0.10 in.
- 0.11 - 0.20 in.
- 0.21 - 0.49 in.
- 0.50 - 1.18 in.
- 1.19 - 1.77 in.
- 1.78 - 1.95 in.

Show US Active Fire Perimeters

Source: GEOMAC. GEOMAC wildfire data layers courtesy of the U.S. Geological Survey.

Conclusions

- Colorado is a beautiful and diverse landscape where the climate varies dramatically over short distances based on topography
- In over 100 years of measuring weather conditions, we see that wild swings in weather are part of what makes Colorado special. The sun will continue to shine, and every year will be unique based on what the winds blow in
- The climate is warming, largely because we are changing the chemistry of the atmosphere. This will have profound impacts on our state and our planet. How much things change is uncertain, but it's largely up to us
- Producing more of our energy from sustainable resources can help us preserve this beautiful land for generations to come

Thanks, and let's keep in touch!

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Nolan Doesken –State Climatologist Emeritus – nolan.doesken@colostate.edu