How state climate offices contribute to climate services and engage with local communities

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Colorado State Climatologist

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US CLIVAR Summit
July 2025

COLORADO CLIMATE CENTER

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ATMOSPHERIC SCIENCE
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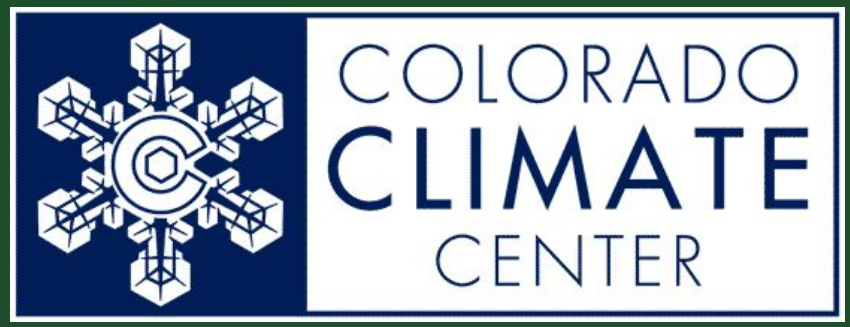
Brief history of the Colorado Climate Center

- Until 1973, the federal government operated a “state climatologist” program – but in in 1973 this was abolished
- Later that same year, Colorado established the Colorado Climate Center at CSU with support through the Colorado Agricultural Experiment Station



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)

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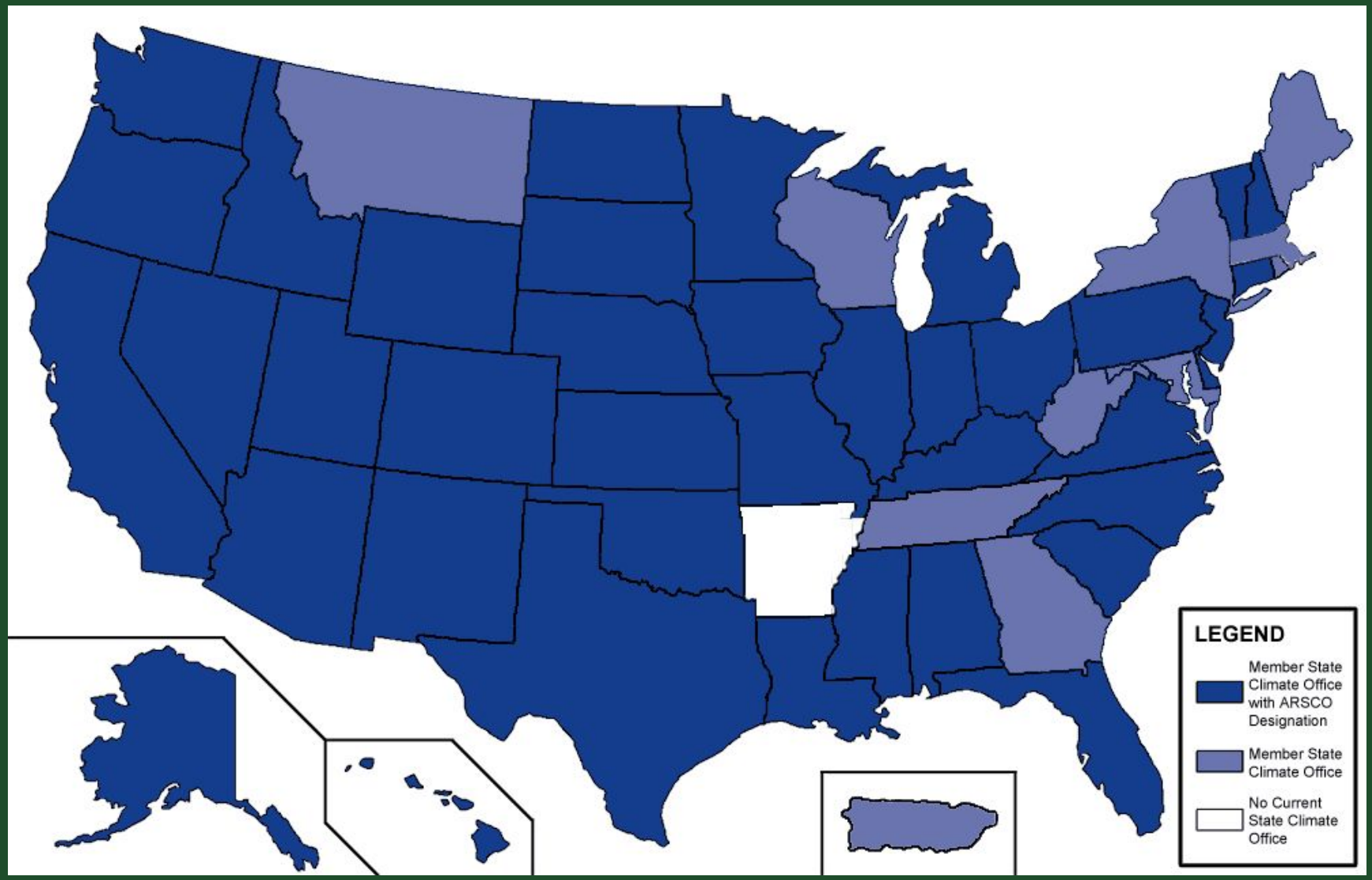
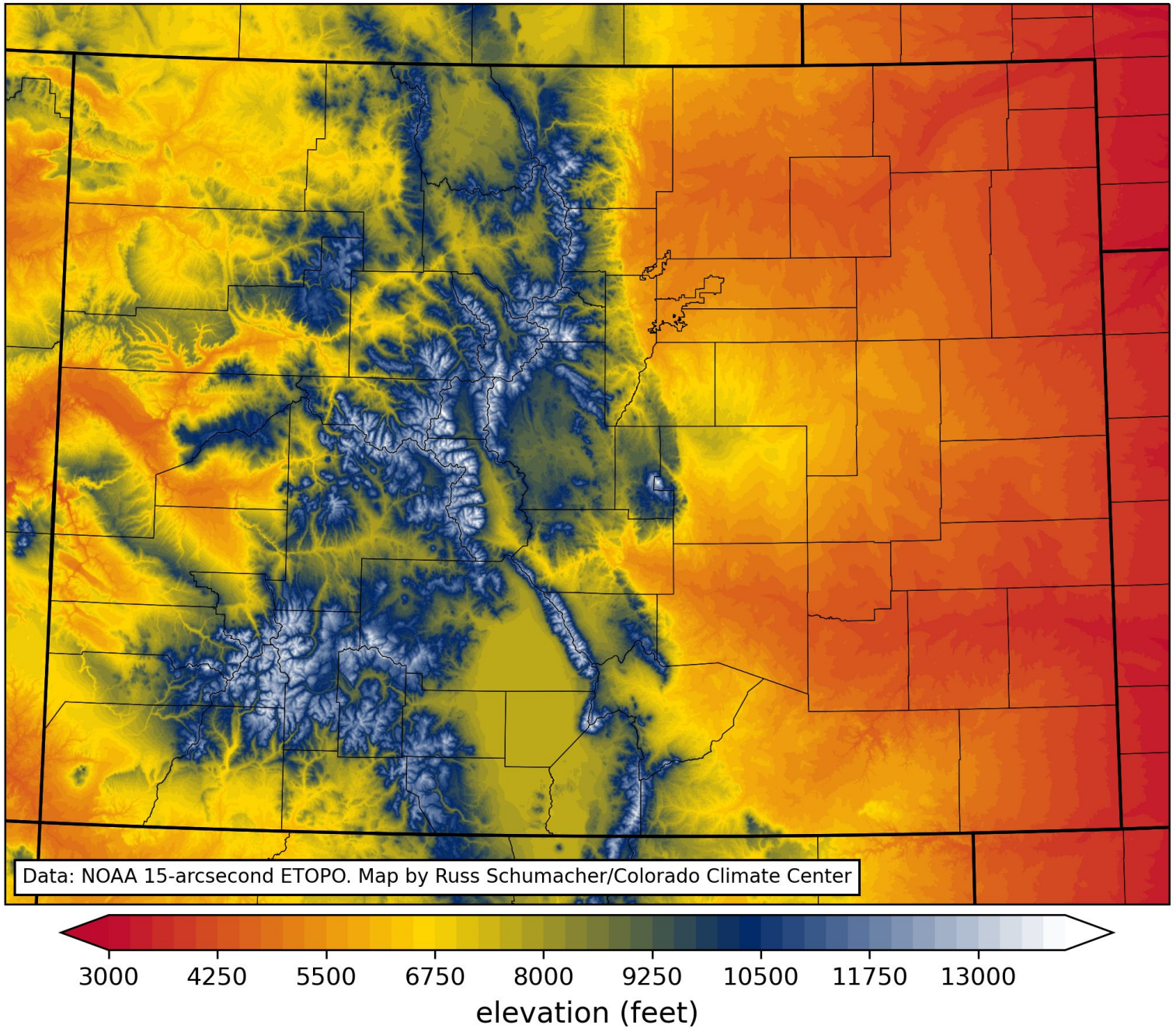
AASC
AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS



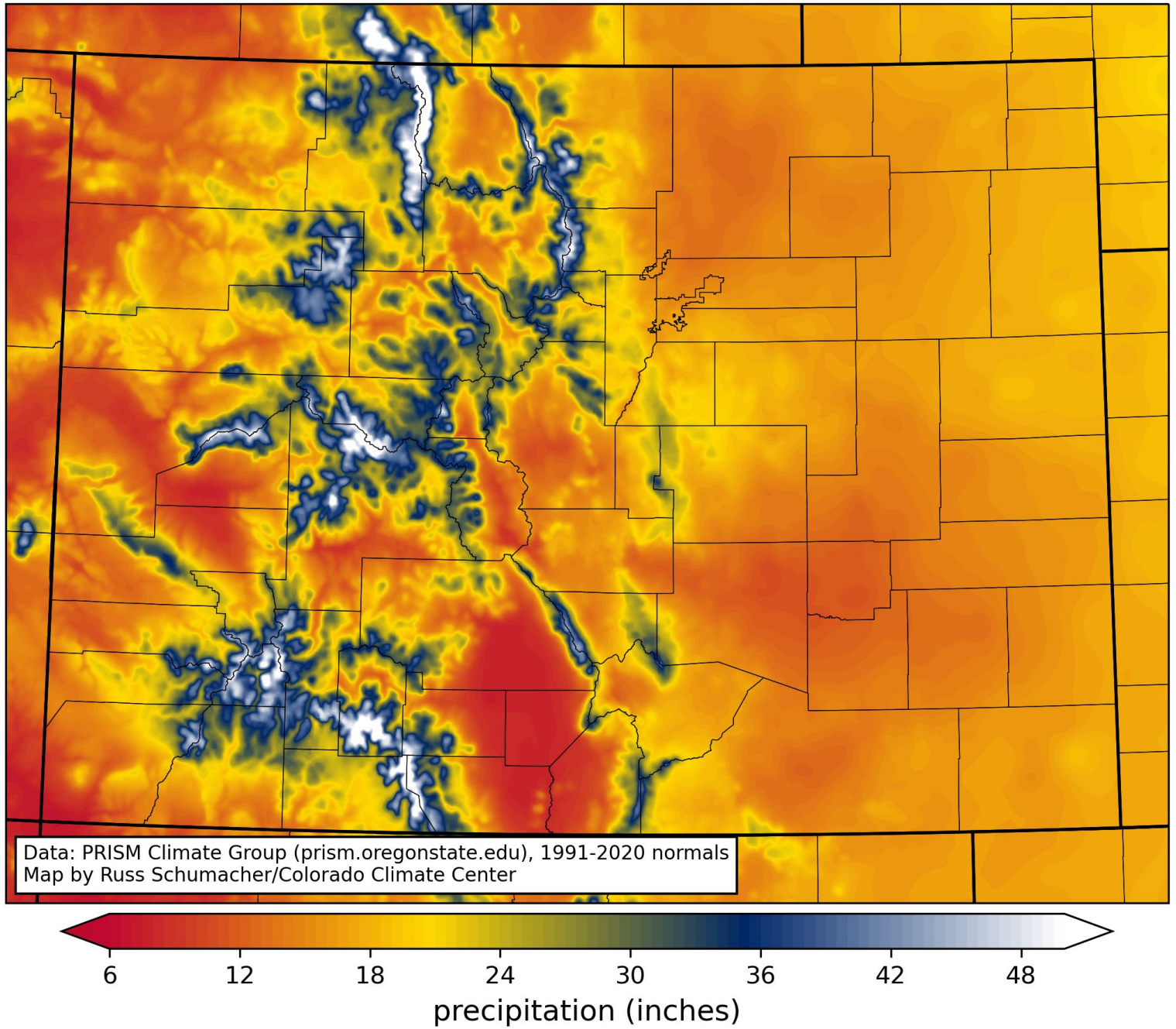
https://stateclimate.org

Topography


Data: NOAA 15-arcsecond ETOPO. Map by Russ Schumacher/Colorado Climate Center
3000
4250
5500
6750
8000
9250
10500
11750
13000
elevation (feet)

Annual average precipitation

Data: PRISM Climate Group, prism.oregonstate.edu, 1991-2020 normals



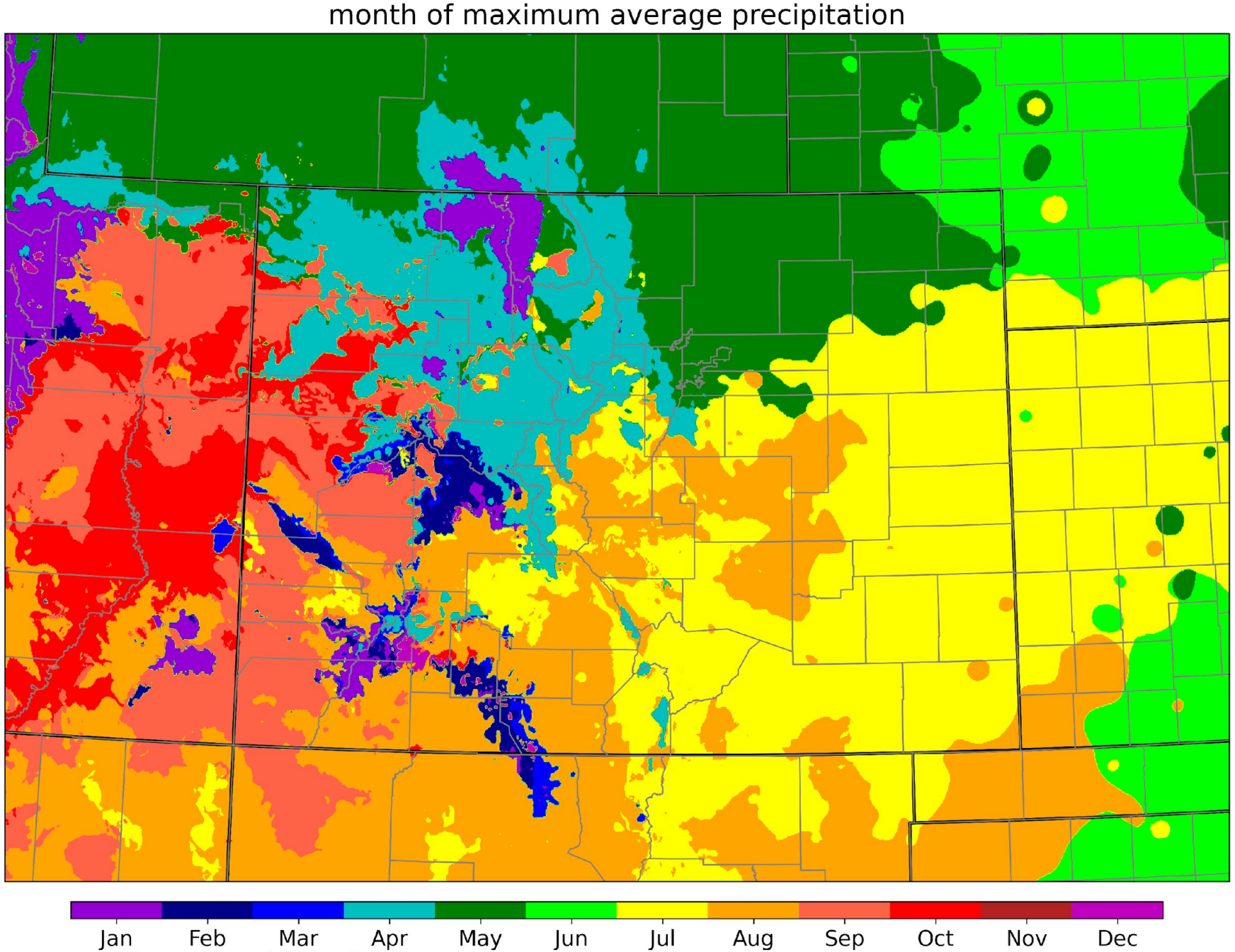


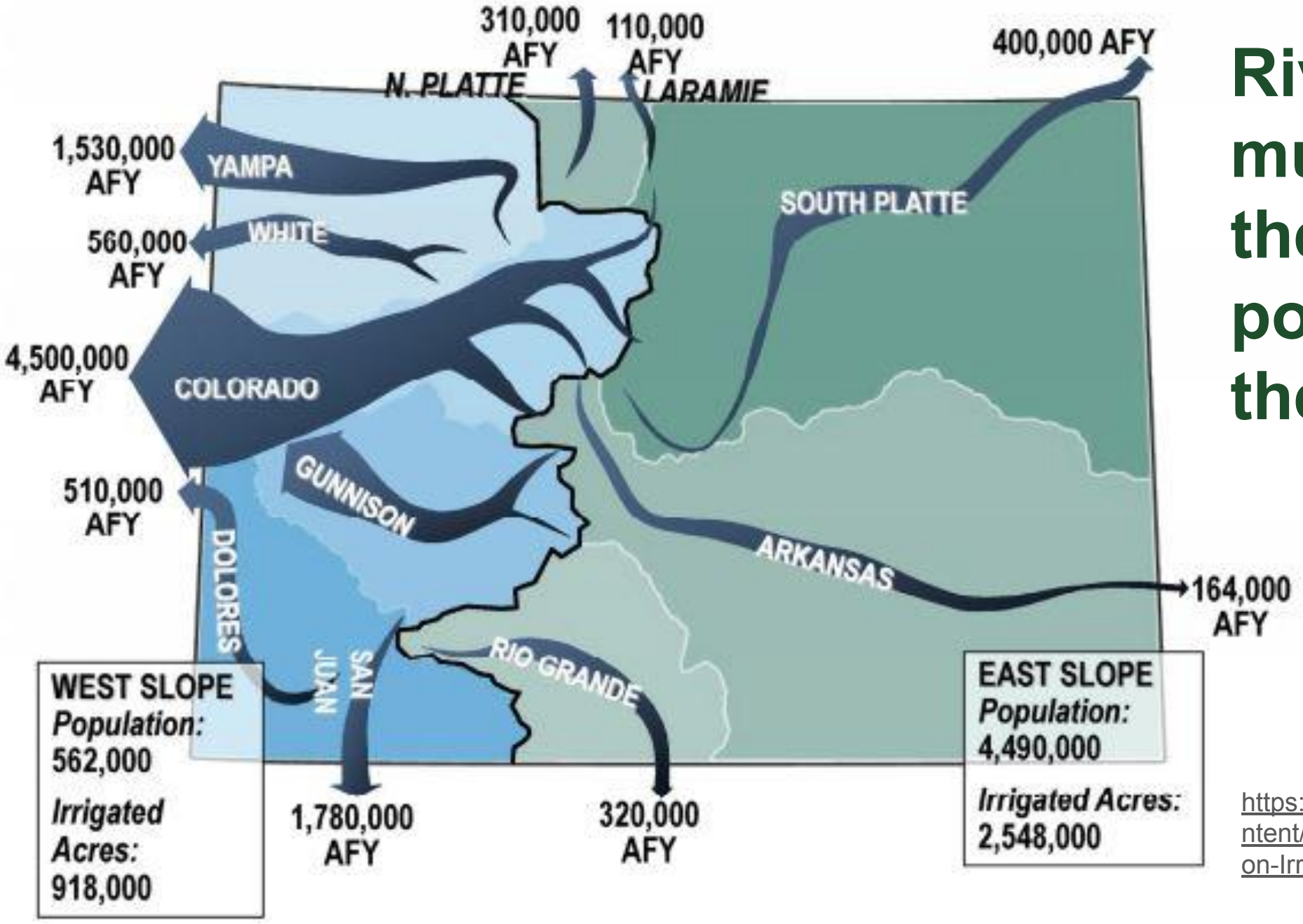
Figure: Russ Schumacher/Colorado Climate Center
Data: PRISM climate group (prism.oregonstate.edu), 1991-2020 normals

Colorado: the only state where every month is the wettest month on average somewhere

Month of maximum average precip
Data: PRISM Climate Group, prism.oregonstate.edu, 1991–2020 normals

“What kind of information is needed for decision makers on the subseasonal and longer timescales, and how does the use of this climate information change across timescales?”

In Colorado, it’s all about water.



River flows are much larger to the west; population to the east

https://waterknowledge.colostate.edu/wp-content/uploads/sites/32/2018/04/CO-Population-IrrigatedAcres-Flows-CWCB-2011.jpg

Hydrologic extremes in Colorado

High Park Fire, June 2012 (from CSU-ATS)

“Great Colorado Flood of September 2013”

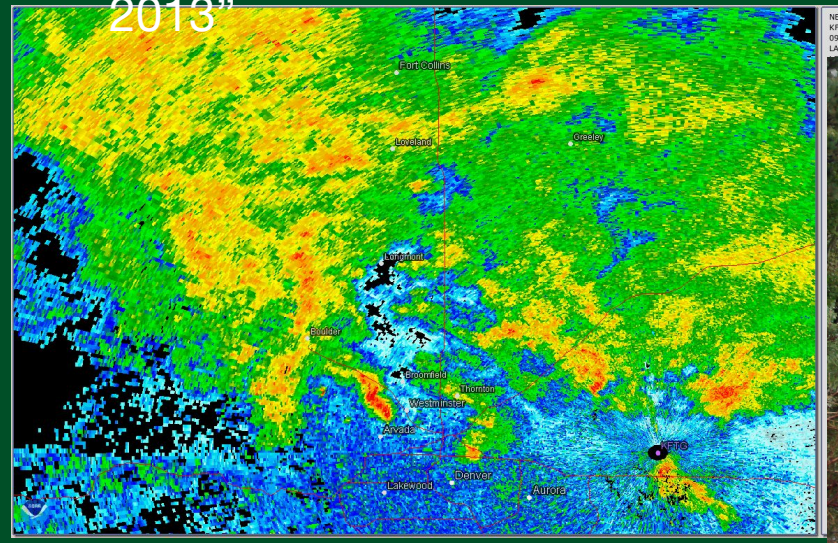


Photo courtesy of Noel Bryan

Phillips County, CO
August 2022

Cameron Peak Fire, Oct 2020
Photo by Henry Reges

COLORADO

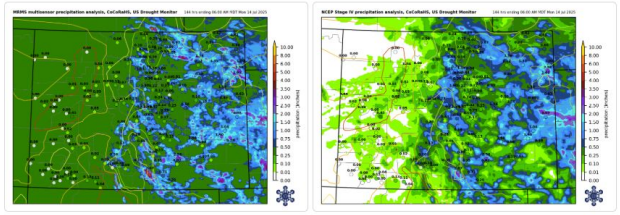
Drought monitoring

COLORADO CLIMATE CENTER

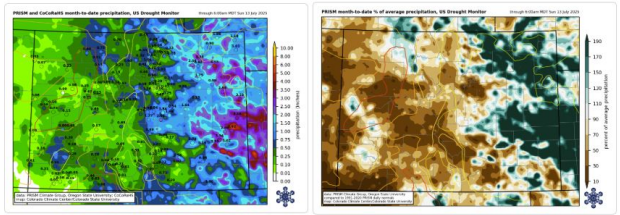
- Home
- Precipitation
- Temperature
- Soil & Vegetation
- Evaporative Demand
- Streamflow
- Reservoirs
- Outlook
- US Drought Monitor

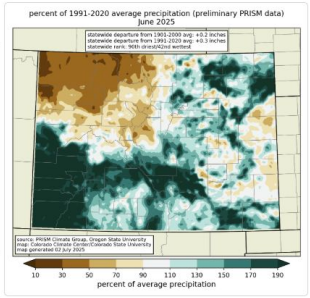
precipitation

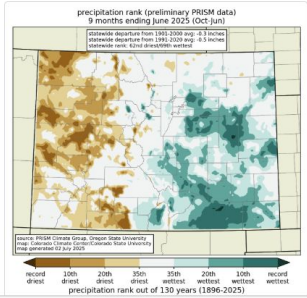
this week's USDM period

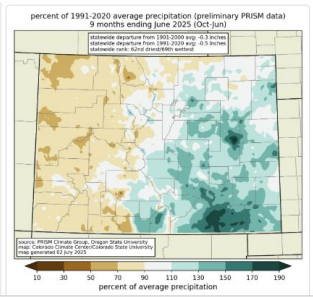


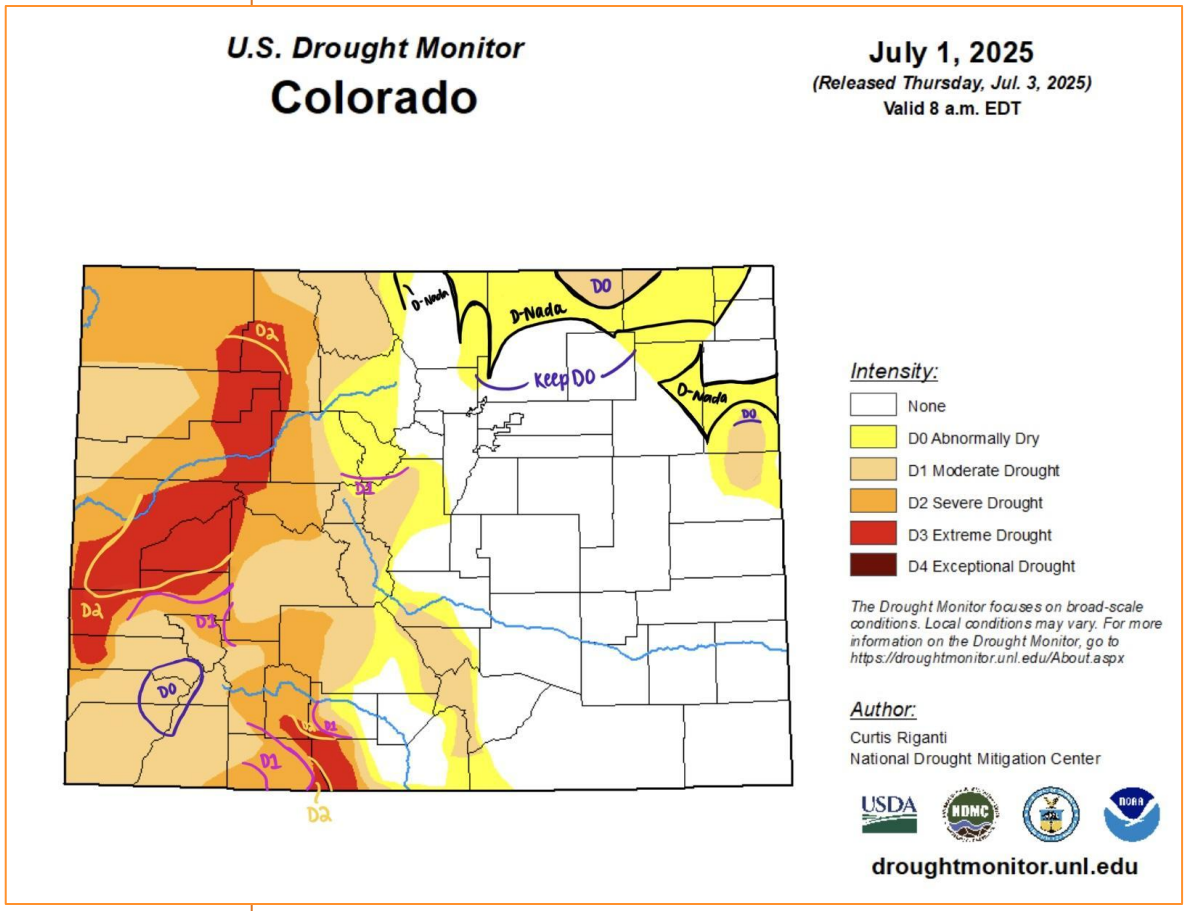
recent precipitation











Example recommendations to USDM author

Drought monitoring

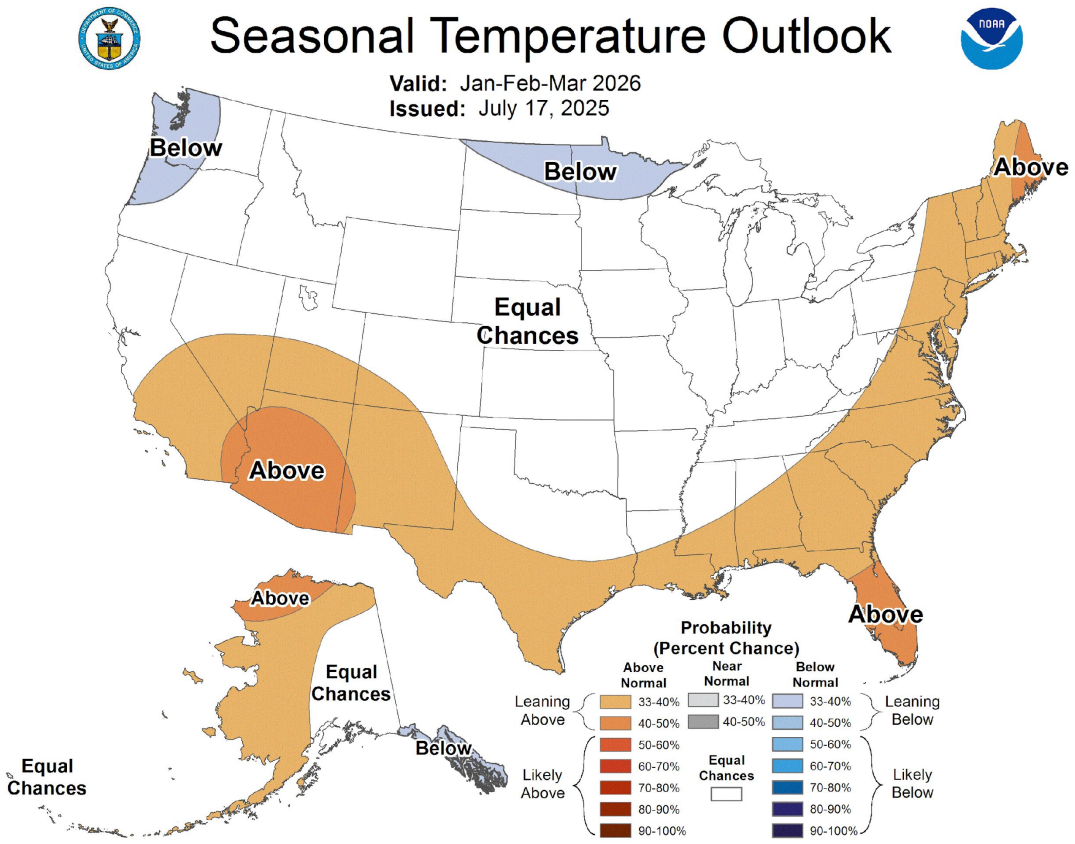
- The US Drought Monitor is a collaborative effort between NOAA, USDA, National Drought Mitigation Center, state climate offices, and many others
- It uses ”convergence of evidence” to determine the map each week
- The USDM was not designed to drive financial relief to those impacted by drought, but it now does so
- For example, the USDM is used to determine eligibility for the USDA Livestock Forage Program

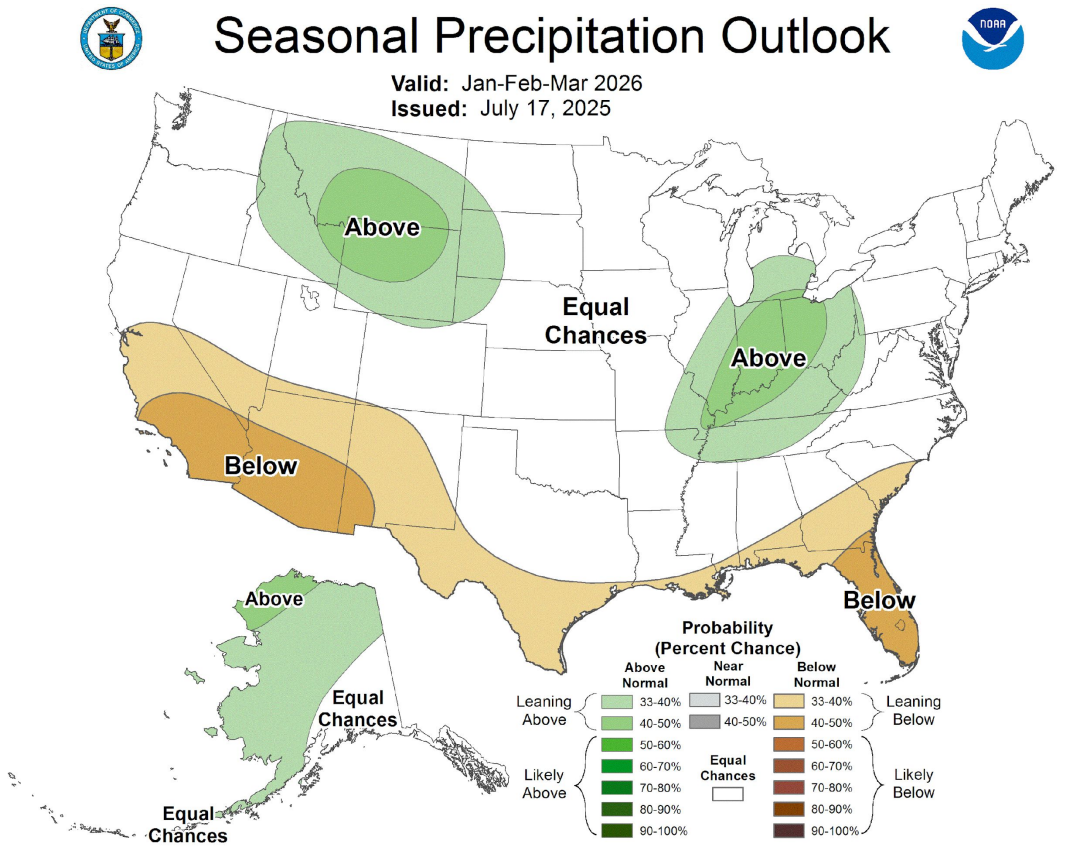
Slide from Laura Edwards, South Dakota State Climatologist

USDA Livestock Forage Program

	SD	MT	ND	WY	CO	U.S.
Highest year	2012 $172.6M	2022 $102.3M	2021 $83.4M	2013 $78.9M	2012 $82.5M	2012 $2.623B
# of years with no payments	6	3	6	4	1	0
2008-2024 total indemnities	$609.3M	$465.9M	$235.8M	$384.3M	$393.2M	$26,950,651,414

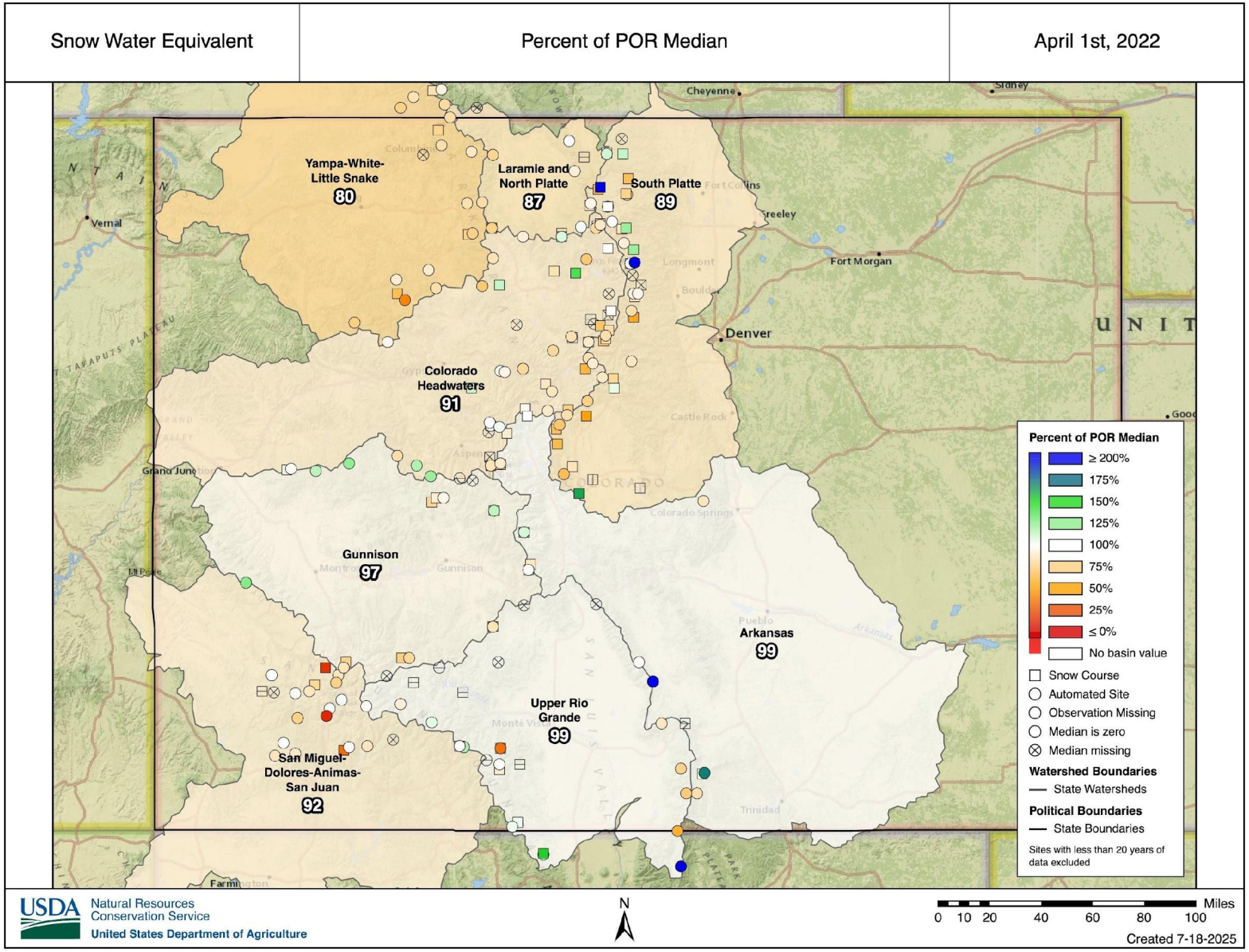
Perhaps the most valuable S2S forecast advance for Colorado would be accurate predictions of the next winter's snowfall and snowpack





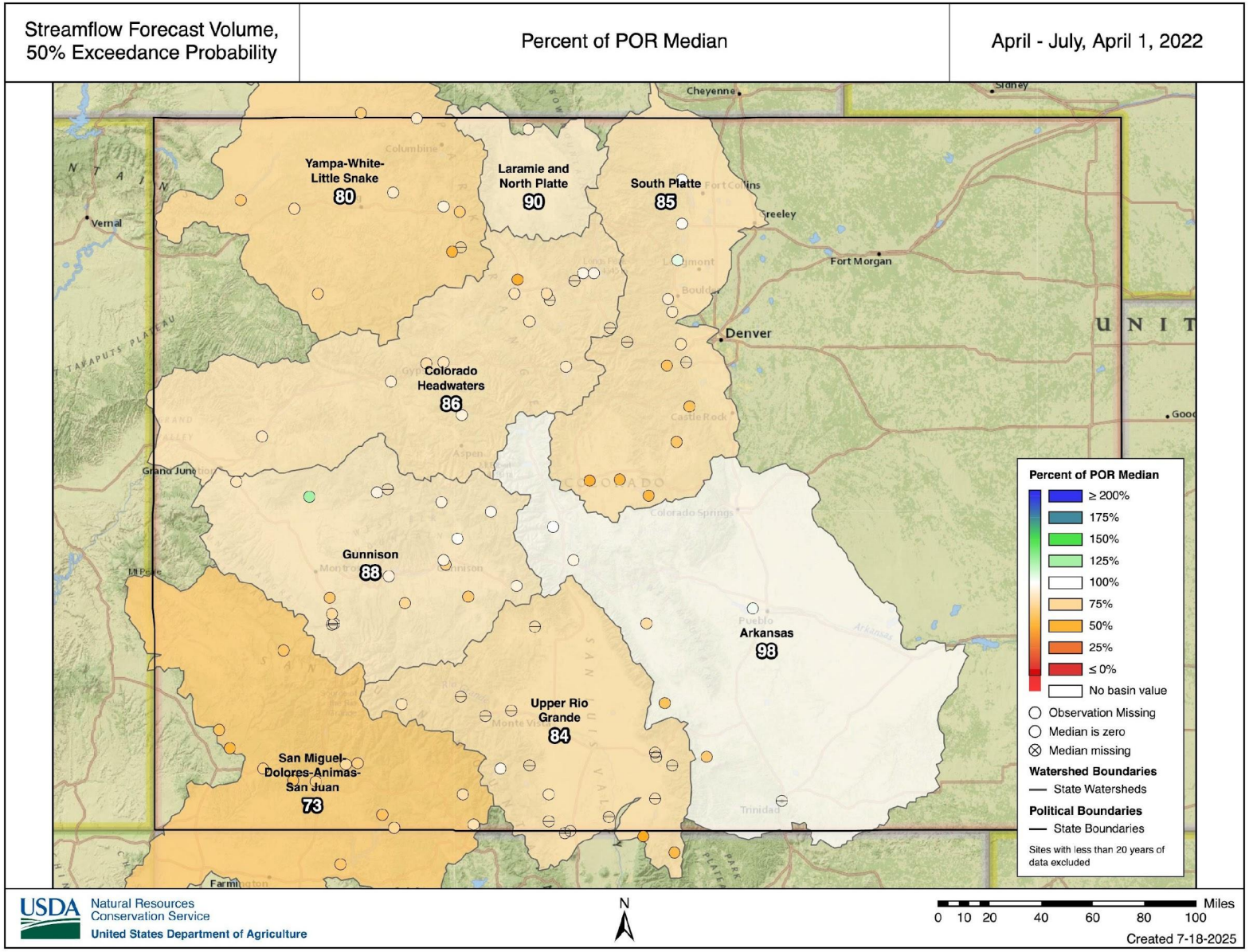
SNOTEL snowpack percent of median, 1 April 2022

Even by April, when snowpack is mostly locked in, water supply forecasts may still have large errors



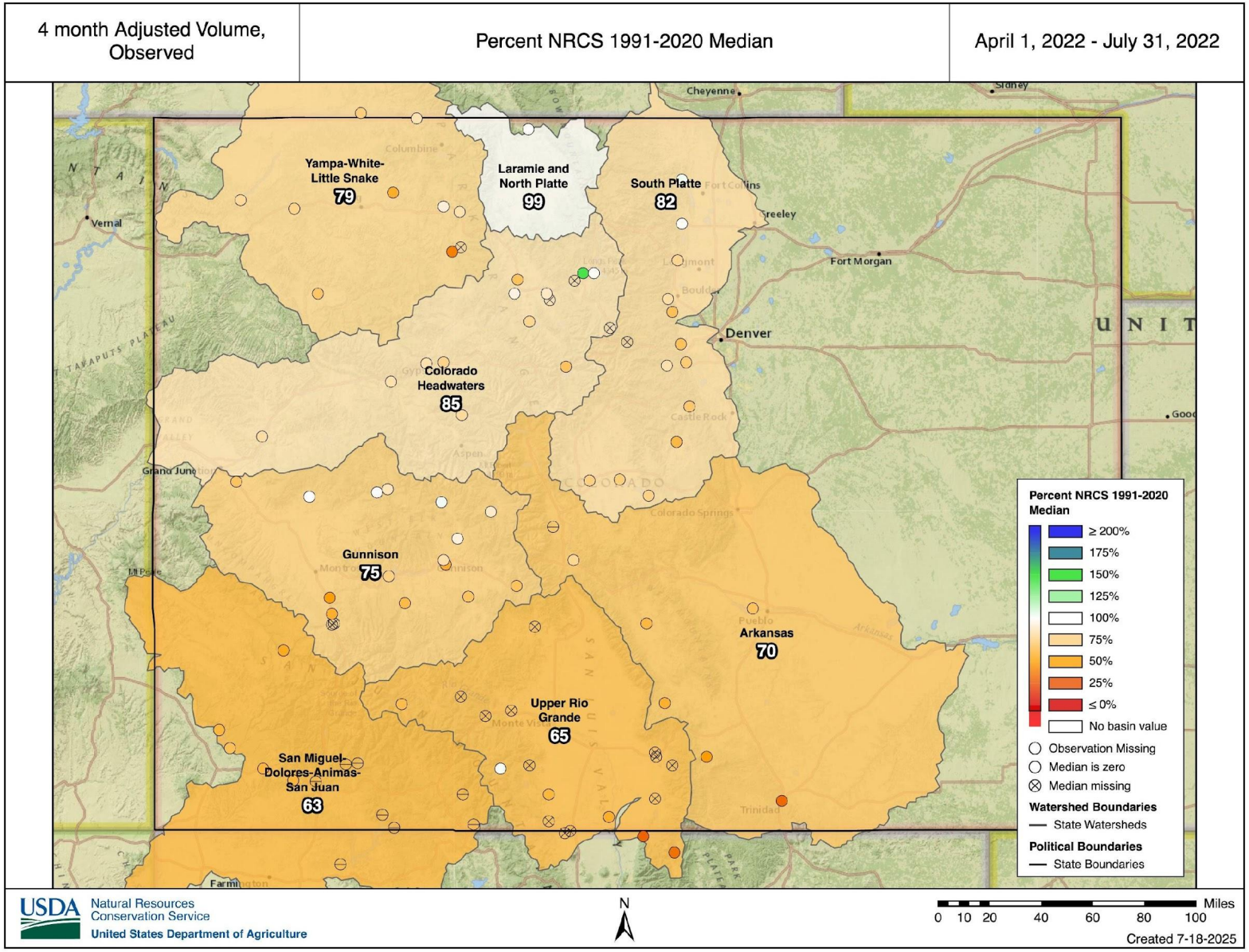
NRCS April-July streamflow forecast, issued 1 April 2022

Even by April, when snowpack is mostly locked in, water supply forecasts may still have large errors



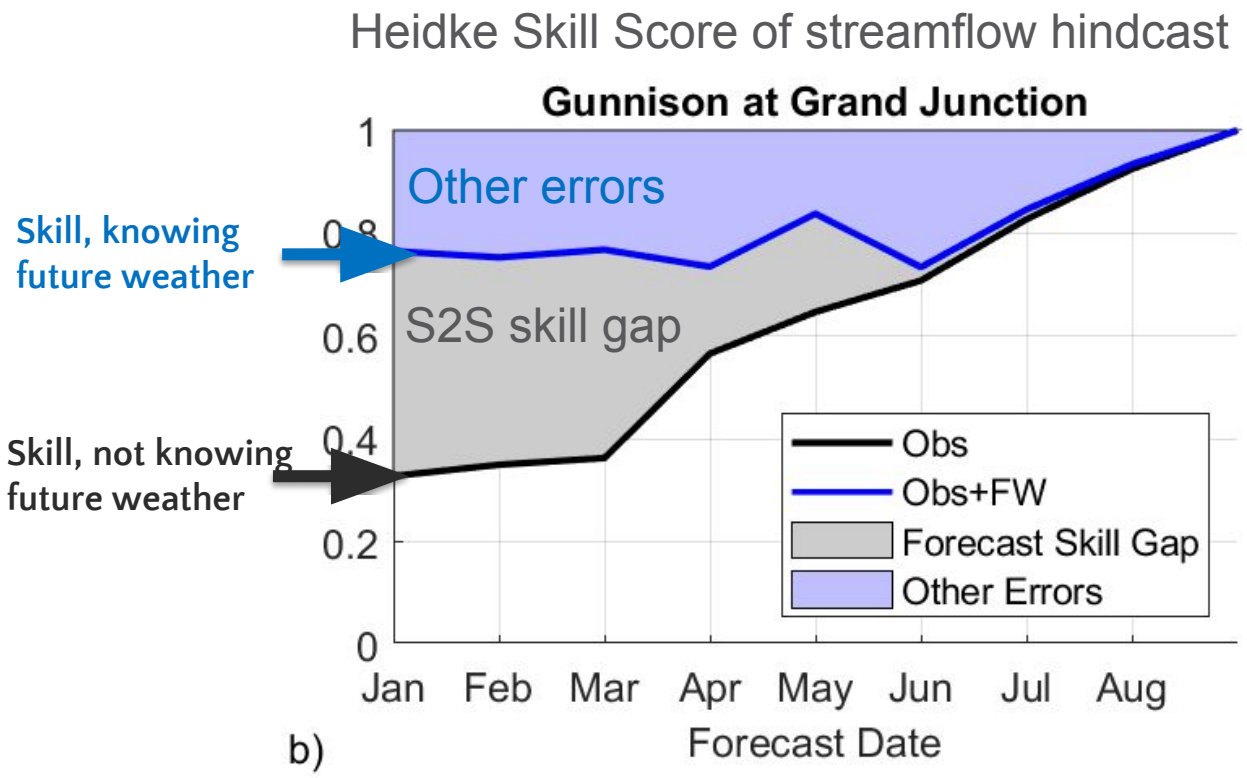
Observed April-July streamflow, 2022

Even by April, when snowpack is mostly locked in, water supply forecasts may still have large errors



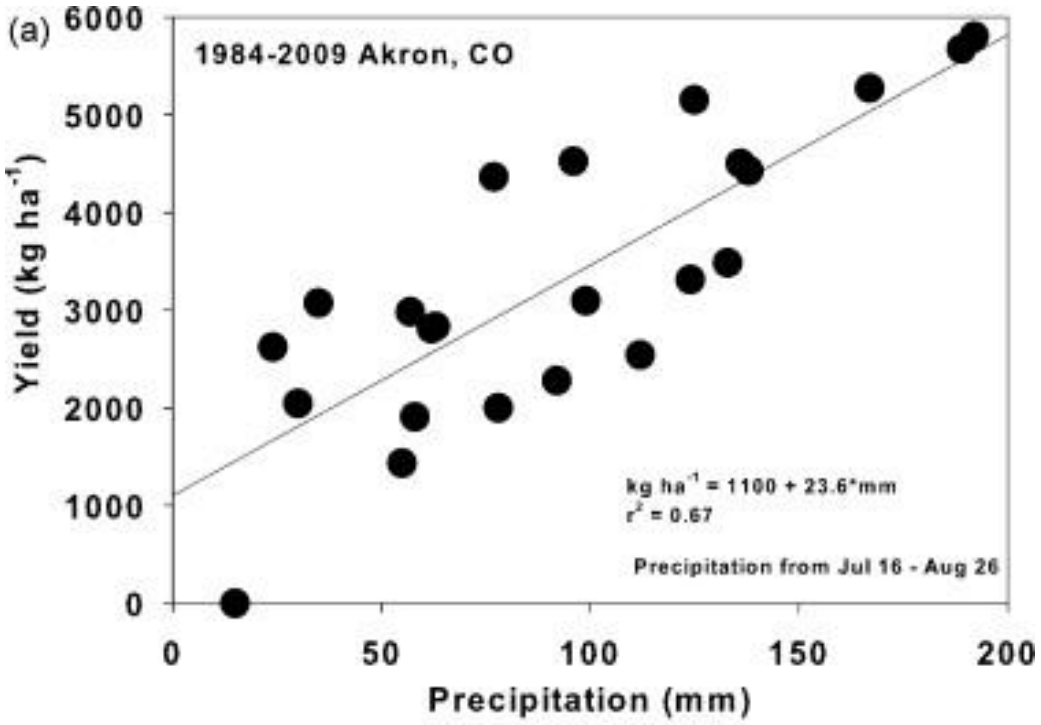
A big reason: we don't know the future weather!

- We developed simple machine-learning based hindcasts of streamflow based on typical predictors (precipitation, snowpack, soil moisture, ground water)
- These hindcasts were run with and without the foresight of observations, which reveals the gap in forecast skill associated with not having accurate S2S forecast information
- "…results from this study indicate that the largest source of uncertainty in western Colorado runoff forecasts is future weather. **Therefore, improved subseasonal-to-seasonal weather forecasts for western Colorado are what is most needed to improve regional water supply forecasts…"**



Goble and Schumacher (2023), J. Hydrometeorology

Eastern Colorado dryland corn



From Nielsen et al. (2010)

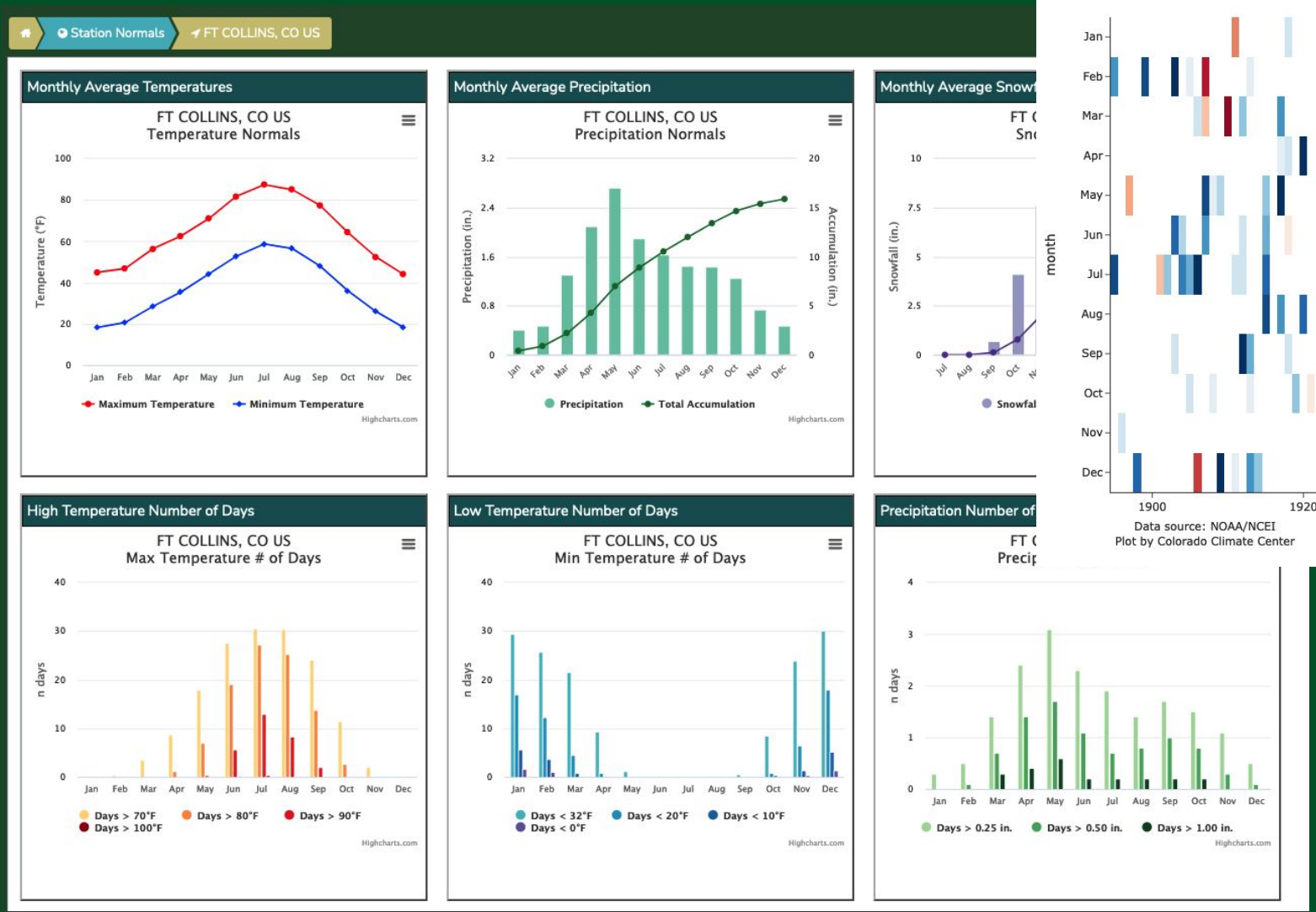
- Dryland maize (corn) yields in eastern Colorado are most highly correlated with precipitation from 16 July to 26 August.
- Naturally, corn growers are very interested in this 6-week window
- Is it possible to make accurate S2S precipitation forecasts for a 6-week period?

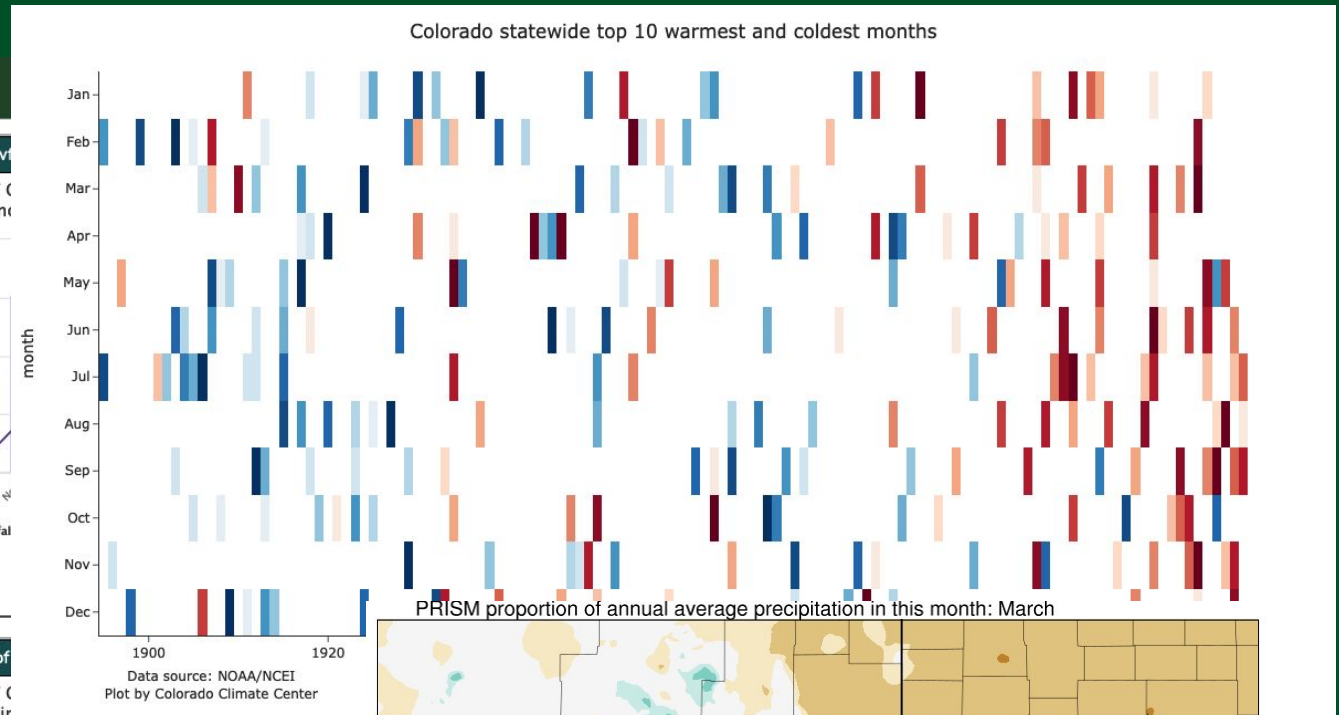
  (I get asked this question most years.)

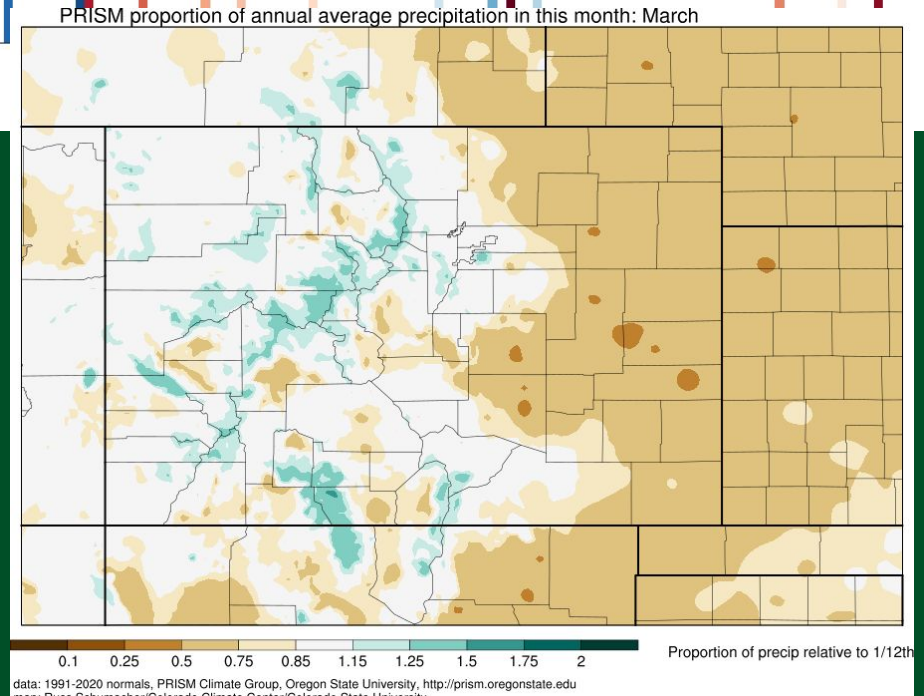
“How do we ensure equal access to data, resources, and forecasts for weather and climate extremes across different communities?”

This is hard, but it’s what state climate offices are here to help with.

Data and value-added products through our website







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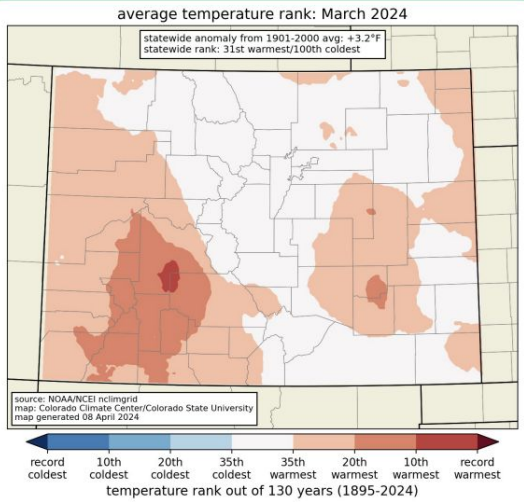
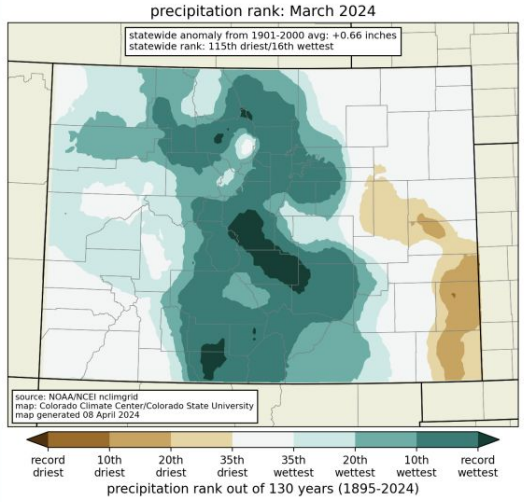
Monthly summaries & blog

temperature



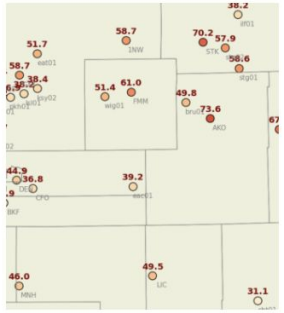
The warm anomalies in March 2024 were not as large as in previous months, but much of Colorado still ended the month warmer than average. Much of southwest Colorado ranked in the top 20 warmest Marches, while the central third of the state was closer to average. It was the the 9th straight month that was warmer than the 20th century average statewide.

precipitation



Colorado's foothills and mountain areas had a wet March, largely driven by the major "Pi Day 2024" snowstorm that dumped feet of snow along and east of the continental divide. In contrast, the southeast corner of the state missed out on heavy precipitation in March and ended the month drier than average.

Colorado Climate Blog

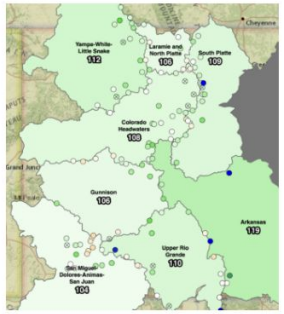


wind

An impressive April windstorm

Russ Schumacher · April 9, 2024

Colorado is a windy place (although generally not quite as windy as our neighbors to the north in Wyoming). And April is typically a windy month: in much of Colorado…



climate context · precipitation · snow · water

Snowpack status as we close in on the peak

Becky Bolinger · April 3, 2024

It's the beginning of April, which signifies the beginning of the end of our snowpack season. In Colorado, our southern basins typically reach their peak snowpack in the next few…

climate context · cocorahs · forecast · observations · precipitation · snow · water

The Community Collaborative Rain, Hail, and Snow Network "Precipitation Absurdity"

About this blog

The Colorado Climate Center provides climate monitoring, climate research, and climate services for Colorado. We are based in the Department of Atmospheric Science at Colorado State University. With this blog and newsletter, we will take deeper dives and provide insights into topics related to our state's fascinating climate.

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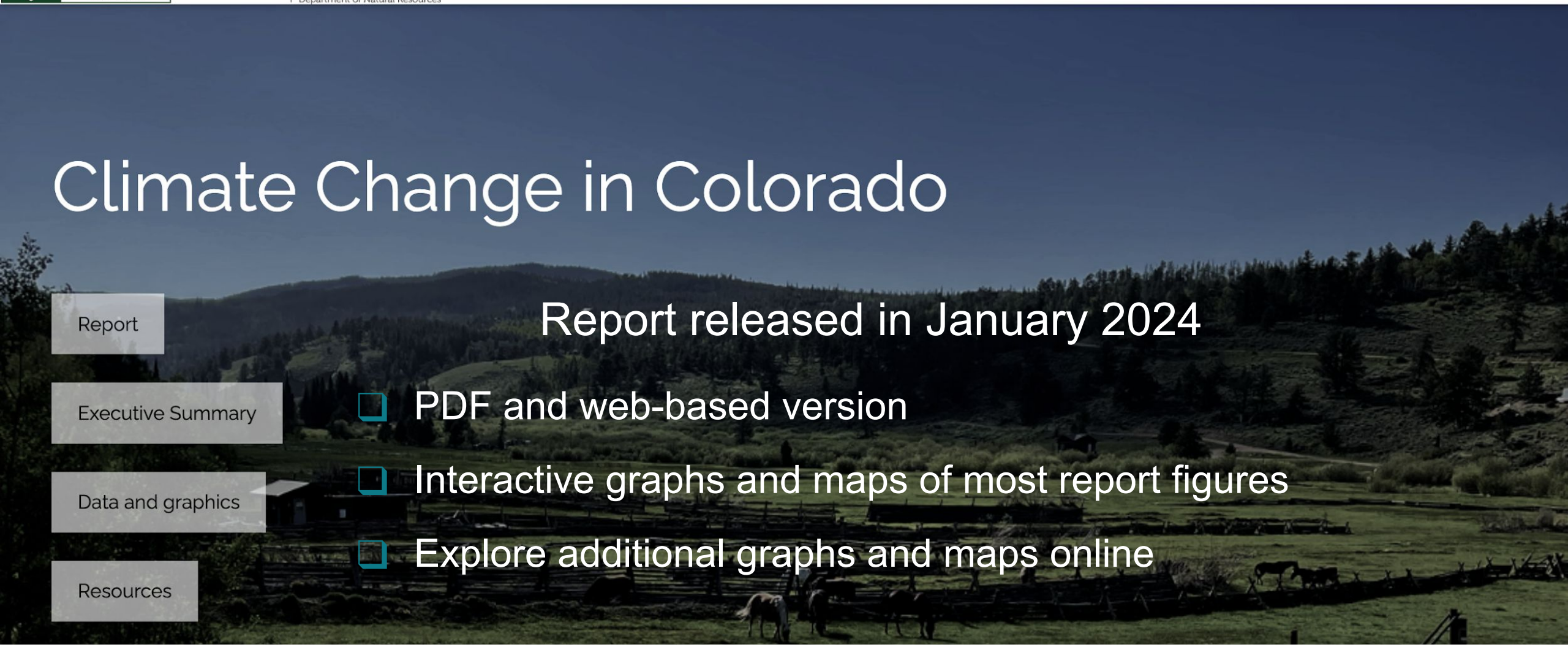
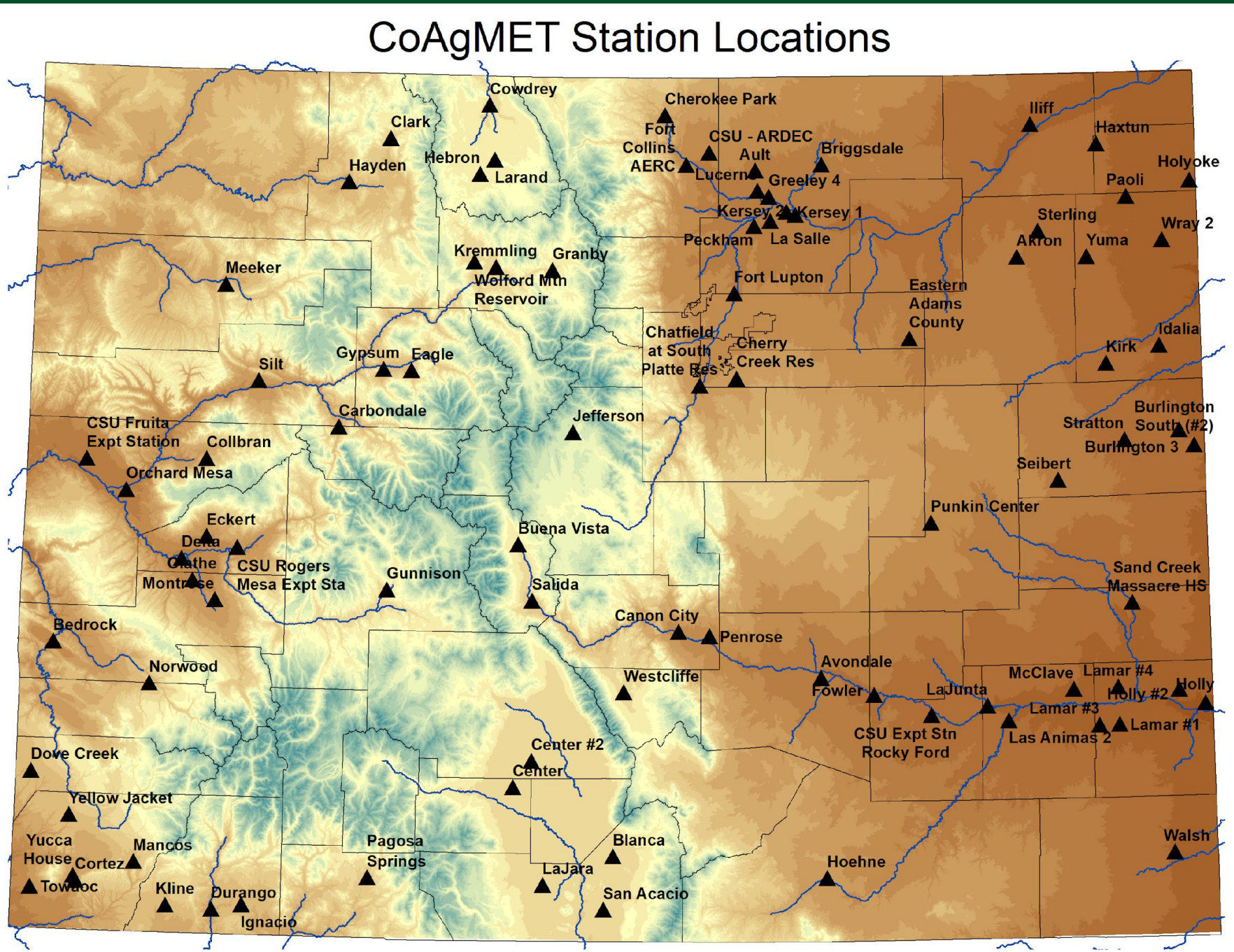


https://climatechange.colostate.edu

Colorado Agricultural Meteorological Network (CoAgMET), aka "Colorado's Mesonet"

Funding sources: National Mesonet Program, CWCB, station sponsors, Reclamation, Northern Water

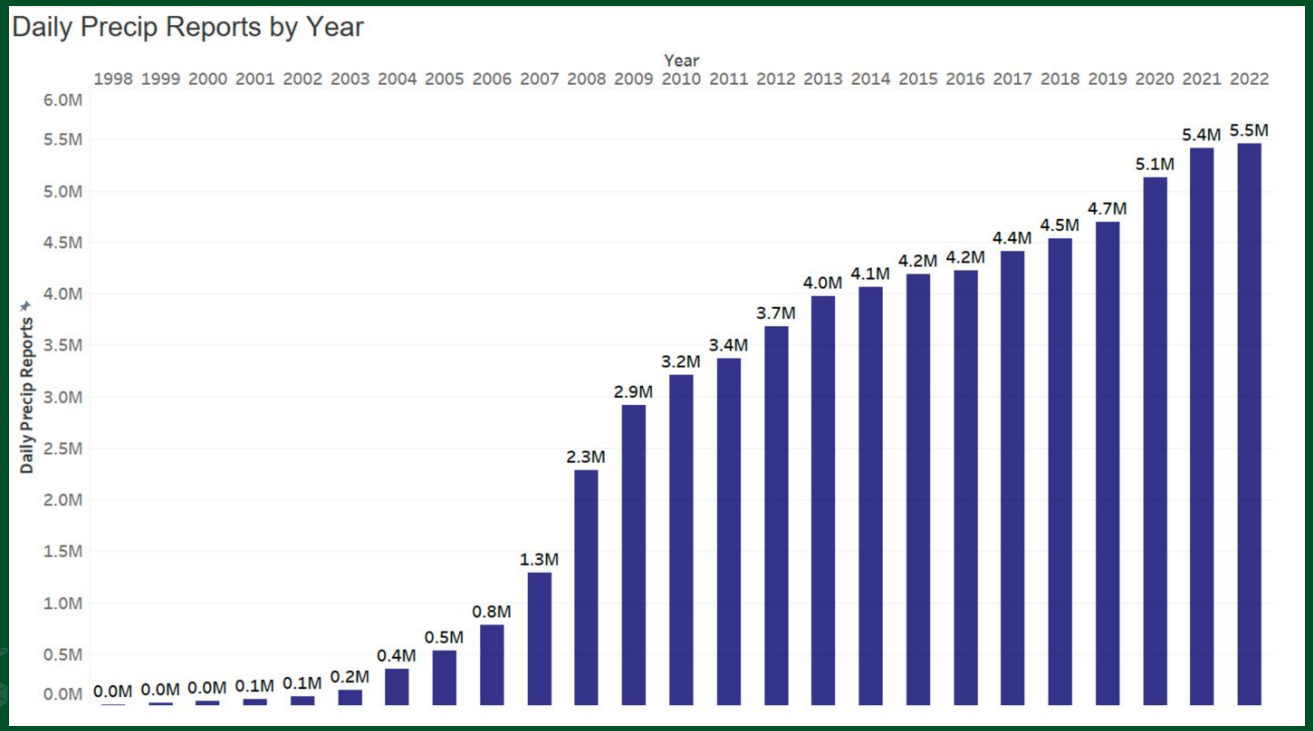


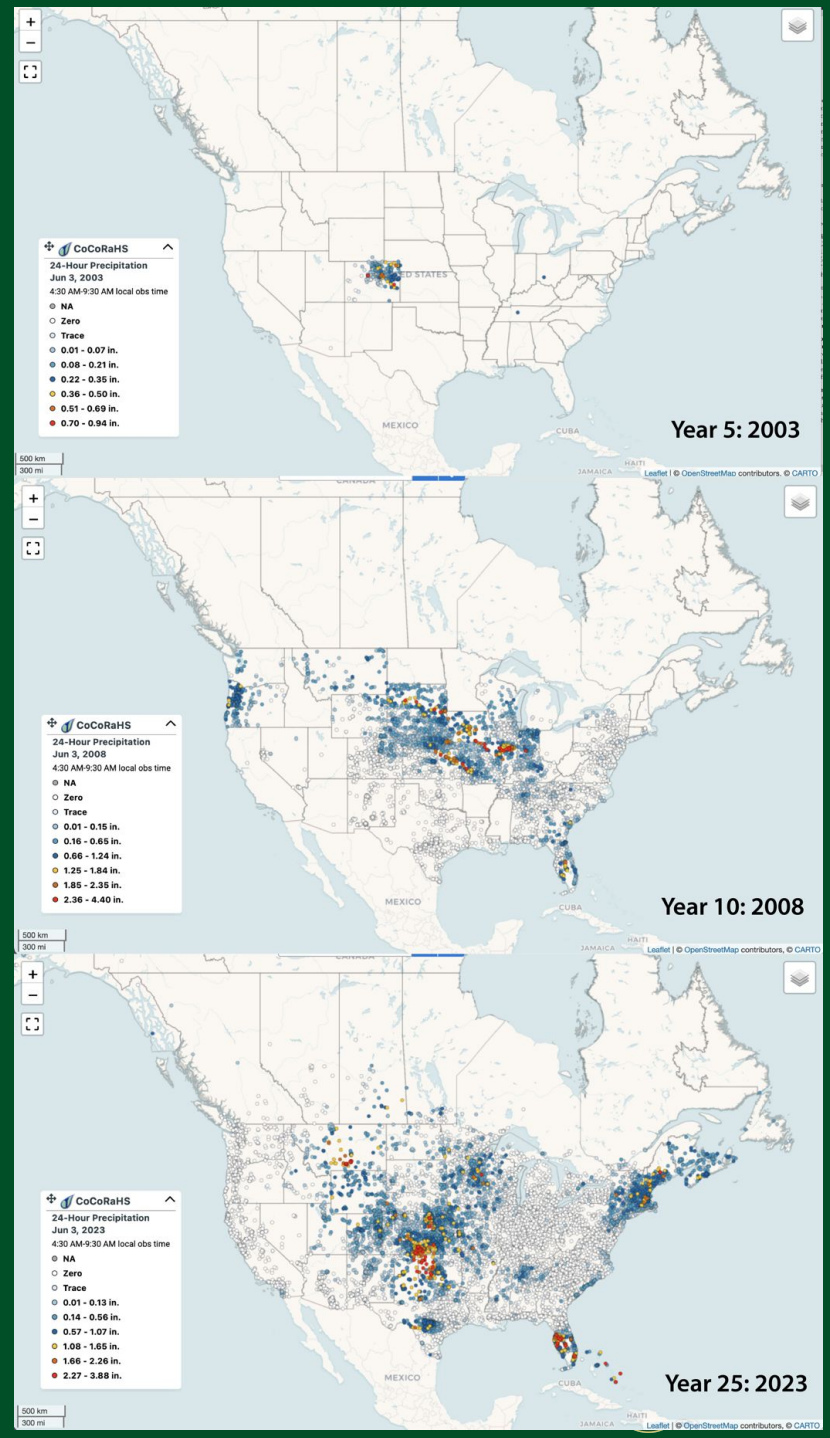
The Community Collaborative Rain, Hail and Snow Network

www.cocorahs.org

CoCoRaHS celebrated 25 years in 2023

In NOAA's precipitation dataset, 2/3 of the observations in 2022 came from CoCoRaHS observers!

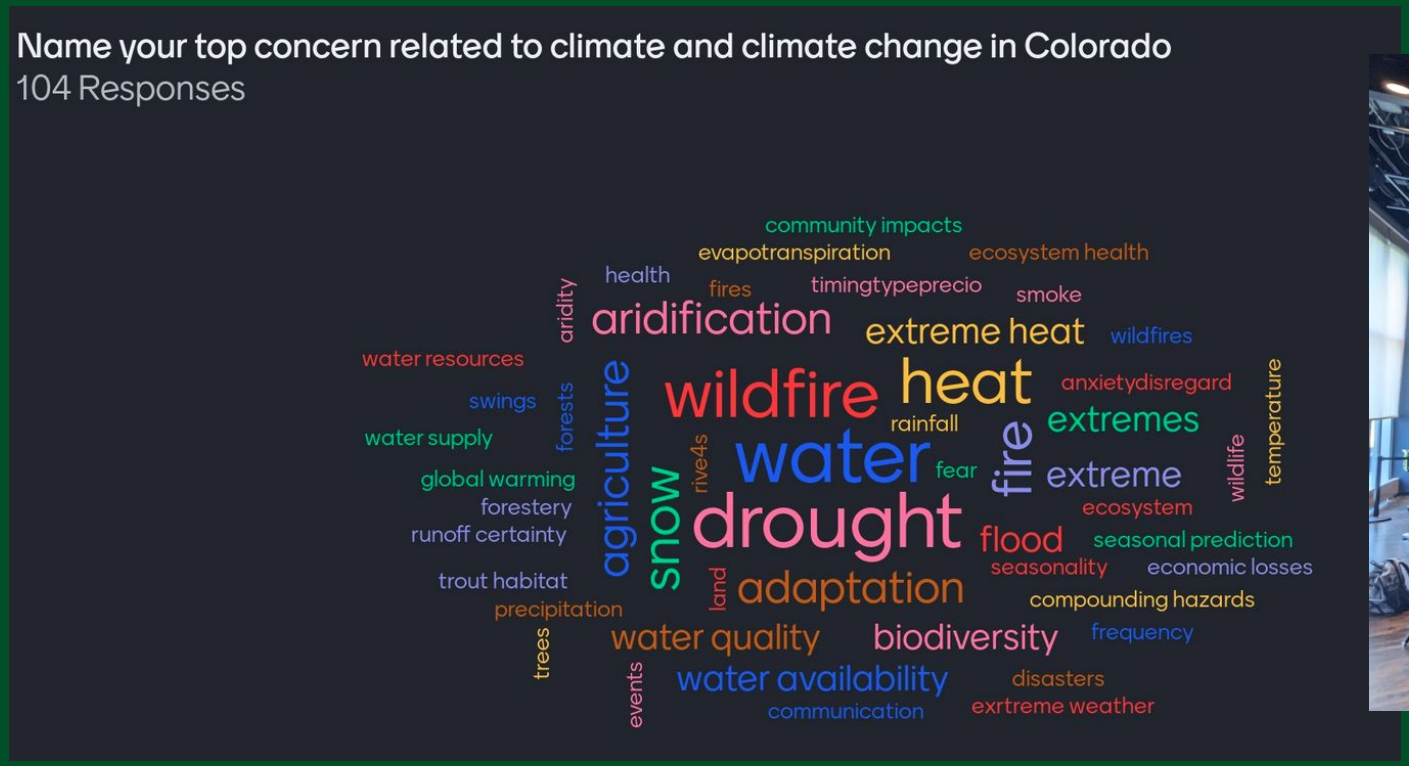




“What steps can scientists do to bridge the gap between climate research and forecasts to address community needs and values?”

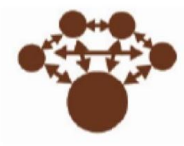
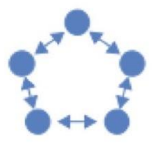
- Build relationships
- Work with openness and honesty, including about what you don’t know and what isn’t possible
- Maintain continuity – not just an endpoint when the 3-year grant is over (always difficult, even more difficult these days…)

Colorado Climate Services Summit
August 8-9, 2023



Continuum of Engaged Scholarship – The What and Why



	Inform	Consult	Involve	Collaborate	Co-Creation
Goal	Provide the public with objective, empirically-based information ***Starts with an answer***	Work directly with the community* to include diverse perspectives, understand needs/opportunities and share knowledge for improved outcomes		Joint production of mutually-valued and inclusive outcomes by university and community	***Ends with an answer***
Value to the Community	Access to new information that can be applied to a given need, problem or opportunity		Improved knowledge, recommendations and outcomes from sharing of expertise Mutual respect is demonstrated and sustained	Greater resources – from sharing (including student support) and discovery of new funding opportunities	New perspectives emerge that were impossible before Trust enables greater level of innovation - whole is greater than sum of its parts Capacity-building: community is heard and empowered
Value to the University	Dissemination of work to a broader audience	Work takes on new meaning as resolution of community problems/needs becomes priority	Work becomes more practical, applicable and impactful. New tools are learned or developed Community relationships are strengthened	Community-based knowledge and skills complement work New solutions are discovered Students gain practical experience	New methods of knowledge-making are explored and developed Attracts new and unforeseen opportunities and resources University sees its place and role within larger ecosystem

University goes to community → University and community come together

OUTREACH — **ENGAGEMENT**

Continuum adapted from the International Association for Public Participation (IAP2)

*Community is defined broadly to encompass stakeholders or partners outside of academia that may include (but is not limited to) the general public, private industry, government and nonprofit agencies.

https://learn.colostate.edu/wp-content/uploads/sites/2/2025/01/Continuum-of-Engaged-Scholarship-updated-1-6-25.pdf

If you're at a land-grant institution, get to know and work with extension specialists and agents!

Thank you!

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ATMOSPHERIC SCIENCE
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Outreach and engagement activities

Presentations in 2024:

CCC staff gave presentations to a wide range of audiences during the reporting period, as diverse stakeholders across the state view the CCC's information as useful and trustworthy. In addition to our regular monthly presentations at the state Water Conditions Monitoring Committee, presentations were given at: Colorado Air Quality Symposium, National Weather Service Public Health and Weather symposium, Colorado State University REU Program in Earth System Science, National Center for Atmospheric Research, CSU Hydrology Days, Larimer County Environmental Science Advisory Board, Colorado Crop Insurance Workshop, CIRES Science Show and Share (for K-12 classrooms), Four Corners Air Quality Group, Ditch and Reservoir Company Alliance, Blevins Middle School, Colorado Cooperation Conference, Four States Irrigation Council, Colorado Farm Show, Front Range Urban Forestry Council, Poudre River Water Users Association, Pleasant Valley Ditch and Reservoir Company, University of Denver Osher Lifelong Learning Institute, Larimer County Climate Smart and Future Ready initiative, City of Fort Collins, Longmont Public Library, Colorado Community Bankers conference, Colorado State University Fulbright Scholars forum, Estes Park Water Symposium, State of the River meetings in Silverthorne and Grand Lake, among others.

Russ Schumacher briefed Governor Jared Polis about hail in Colorado, presented to the Water Resources and Agriculture Review Committee of the Colorado Legislature, and the CCC hosted US Senator John Hickenlooper to the CSU Department of Atmospheric Science to share information about our activities and Colorado's climate.

We also gave guest lectures in ANEQ 472 (animal sciences) and ATS 350 (atmospheric science) undergraduate courses at CSU. Furthermore, our staff led numerous tours of the Campus Weather Station, with some specific to the Tour Tuesday series for CSU employees and the general public. Other tours were provided to K-12 field trips and college-level classes.

- A key role in the state Water Conditions Monitoring Committee
- Regular media interviews (~6-8 per month) with local, national, and international outlets
- CoCoRaHS has over 26,000 active volunteer observers in the US, Canada, and the Bahamas
- Hosted 2024 American Association of State Climatologists meeting here at CSU