White River Update
Water Year 2024

Bob Dorsett, MD
White River Alliance and Colorado River Watch

Image credit: Western Colorado Outdoors

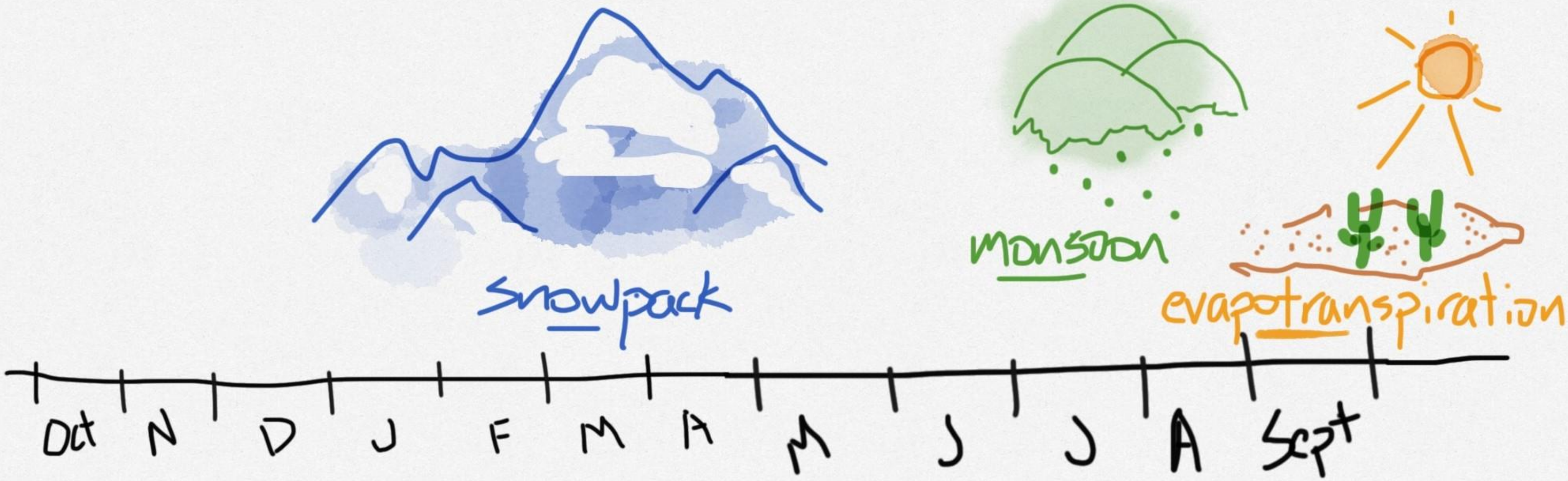
Water year 2024 snapshot

- White River runoff was about average, following average precipitation
- drought persists and soils are dry
- algae
  - no algae bloom
  - increased sediment from Avery and ponds may dump extra nutrients into the river
- climate outlook remains grim

Outline of this presentation:

- Main factors influencing White River discharge
- Overview of regional water year 2024
- Trends on the White River
- Climate projections

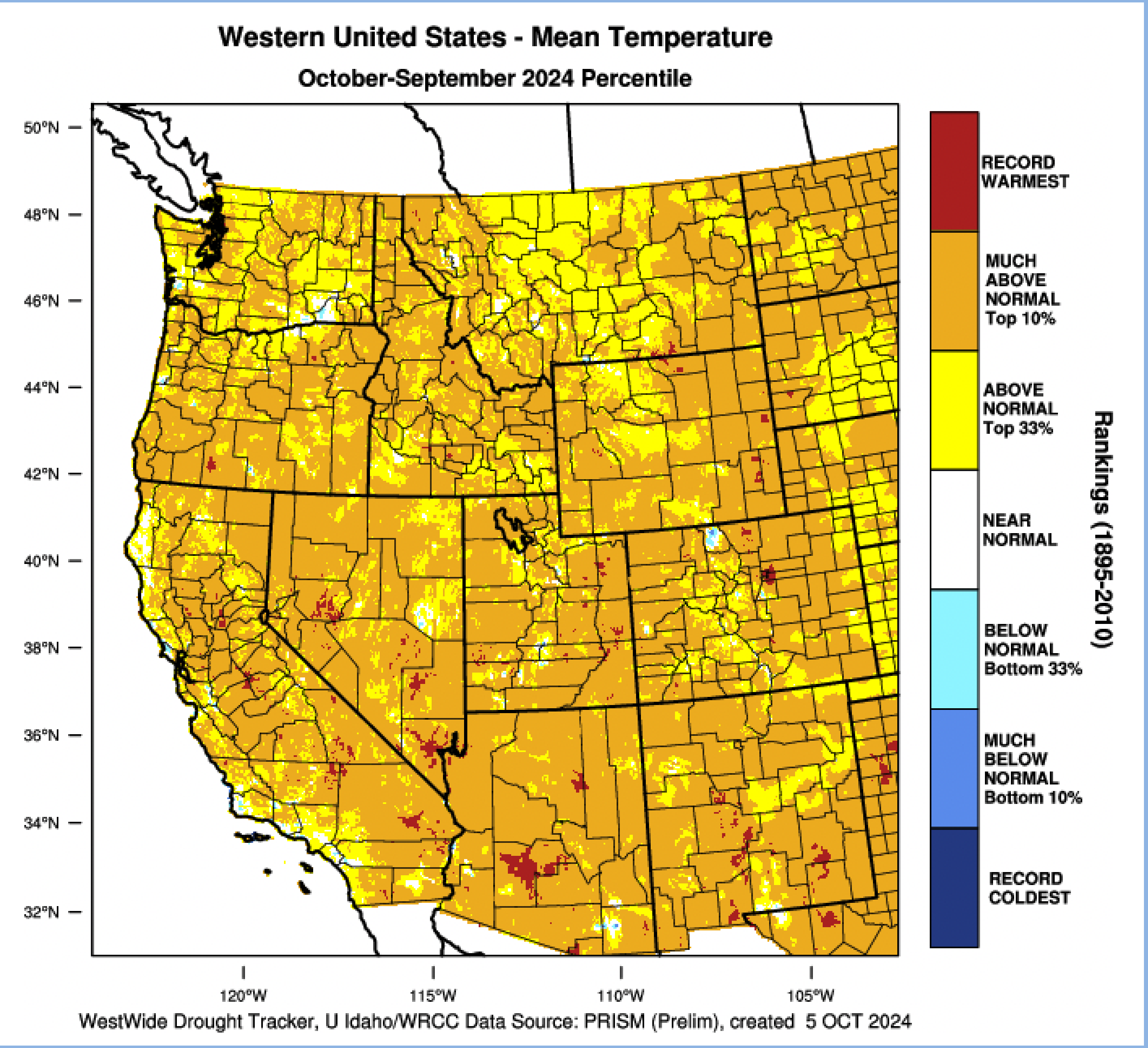
The main contributions to river discharge



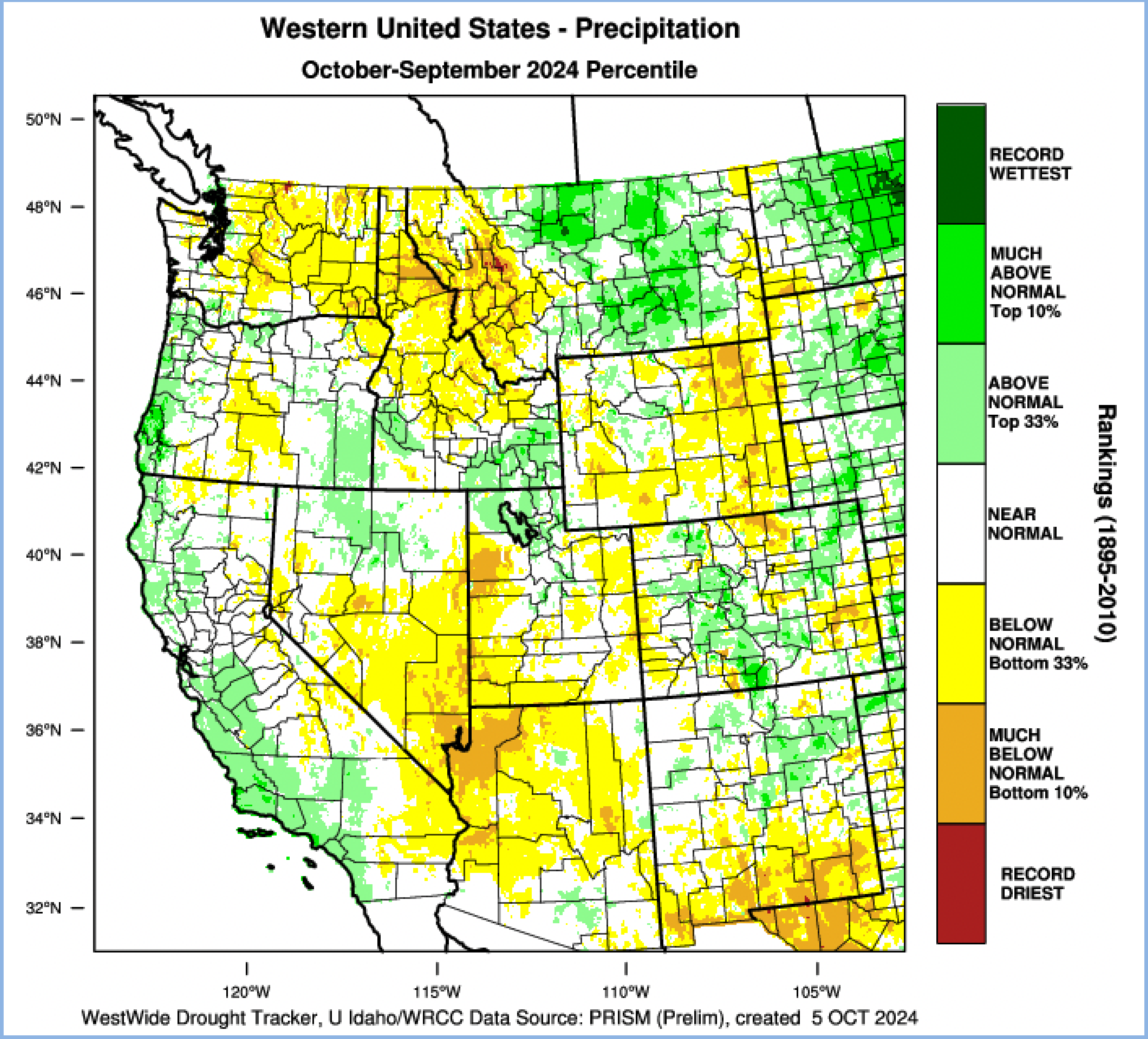
Regional water year summary (CIRES / NOAA)

- Average daily temperatures were much above the historical average for the region.
- Precipitation in 2024 was near normal, with snowpack near average.
- Regional runoff efficiency was relatively high.
- The 2024 water year began with only 9% of the region in drought, largely due to the above average 2023 water year. By the end of water year 2024, 36% of the region was in drought.
- By the end of the 2024 water year, surface soil moisture across most of the region was very low with most locations in the 5th percentile of all years of observation.
- Regional reservoir storage declined slightly from the beginning of the 2024 water year, but reservoirs remain near median capacity.

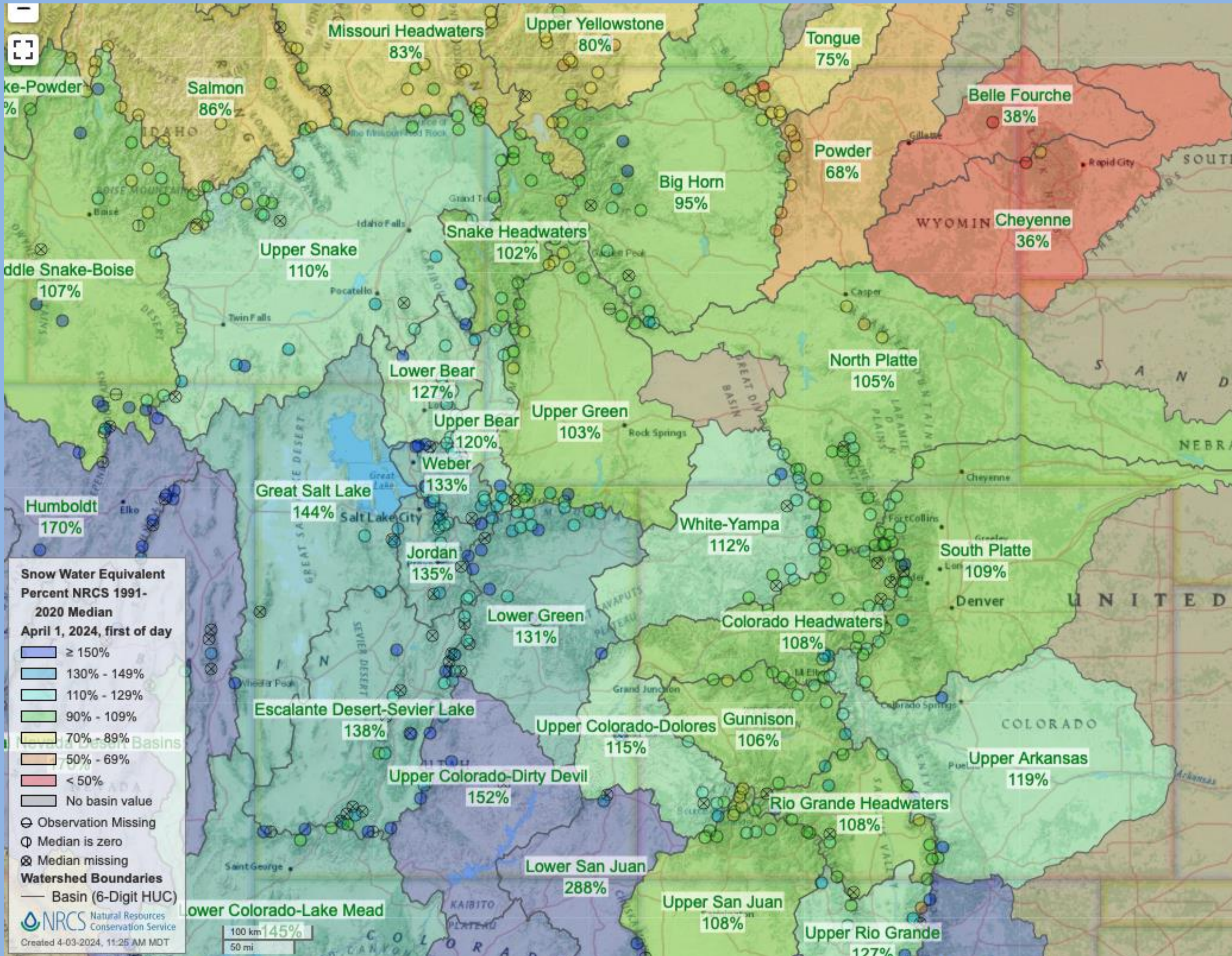
Temperatures ran above average over the entire region.



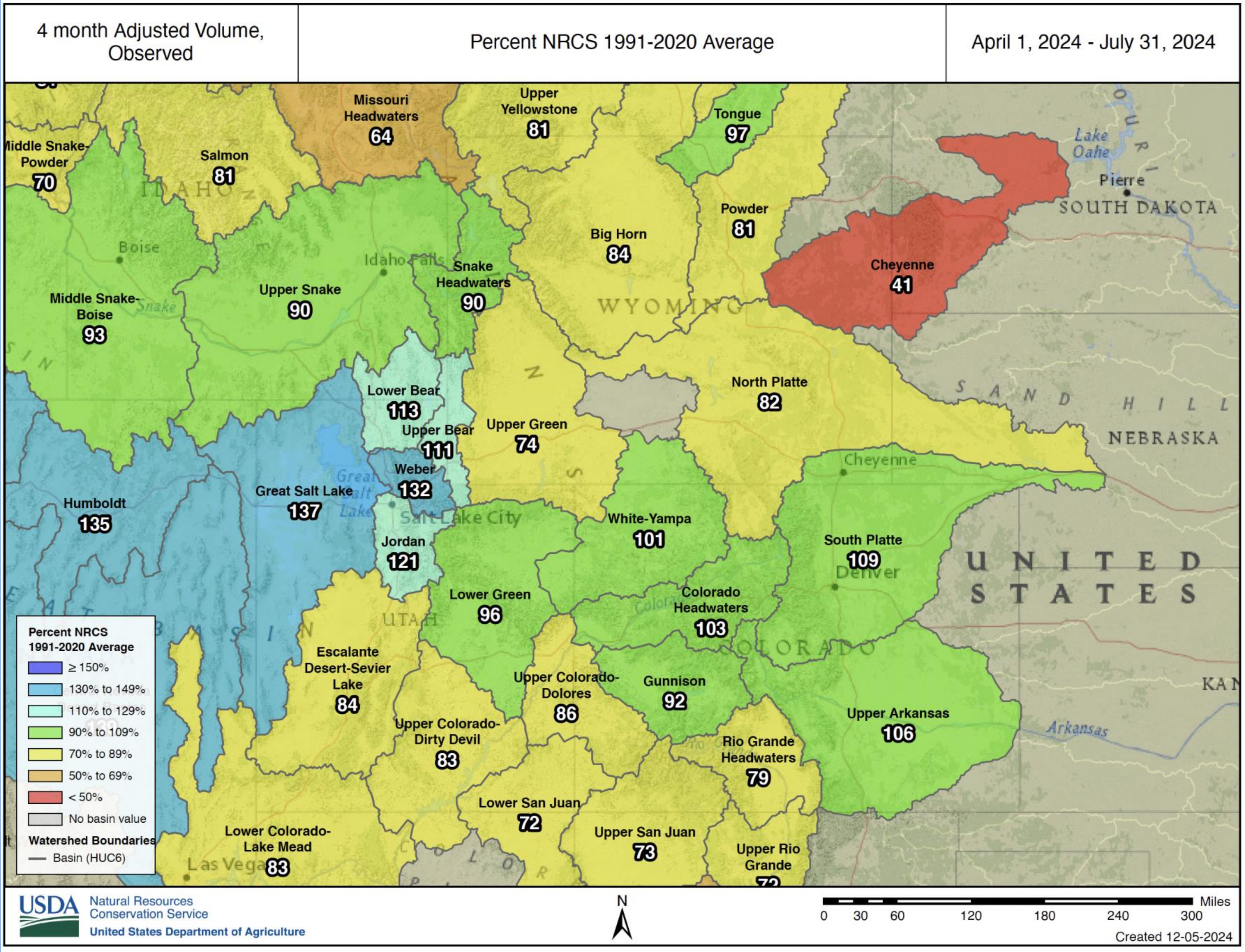
Regional 2024 water year precipitation was near normal.



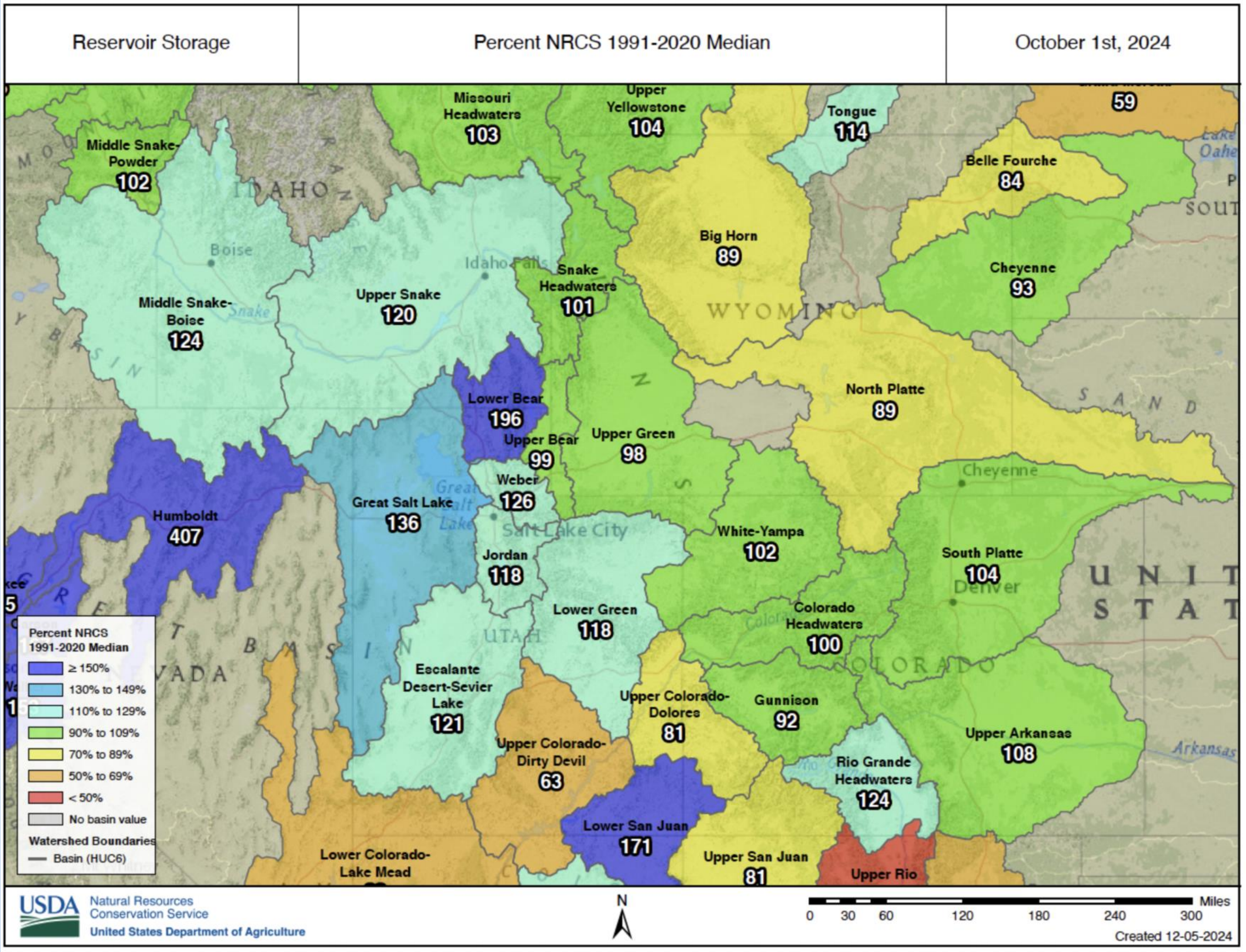
2024 snowpack was near average.



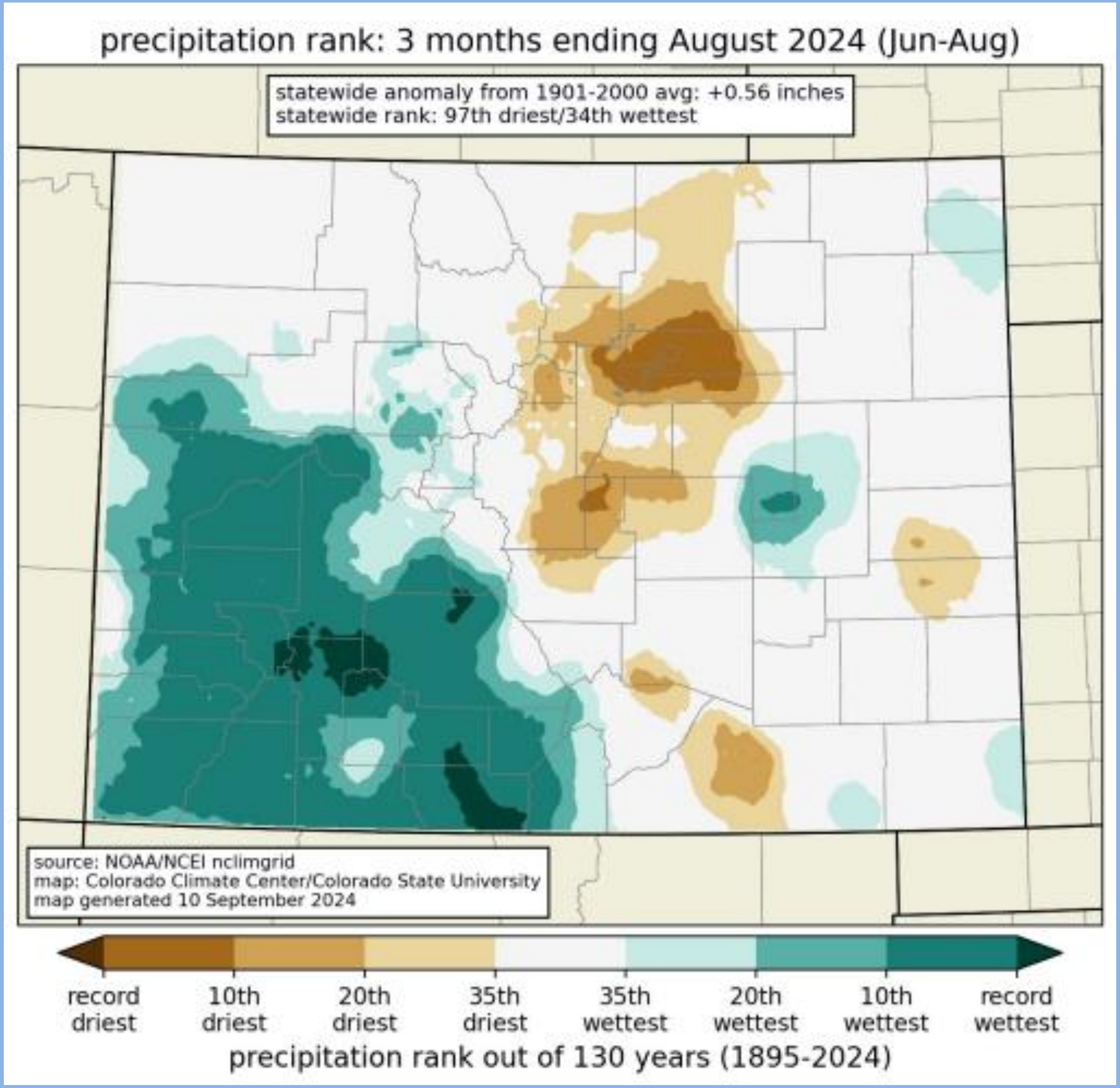
Runoff near normal here. April – July mean stream flow vs. 1991 – 2020 mean.



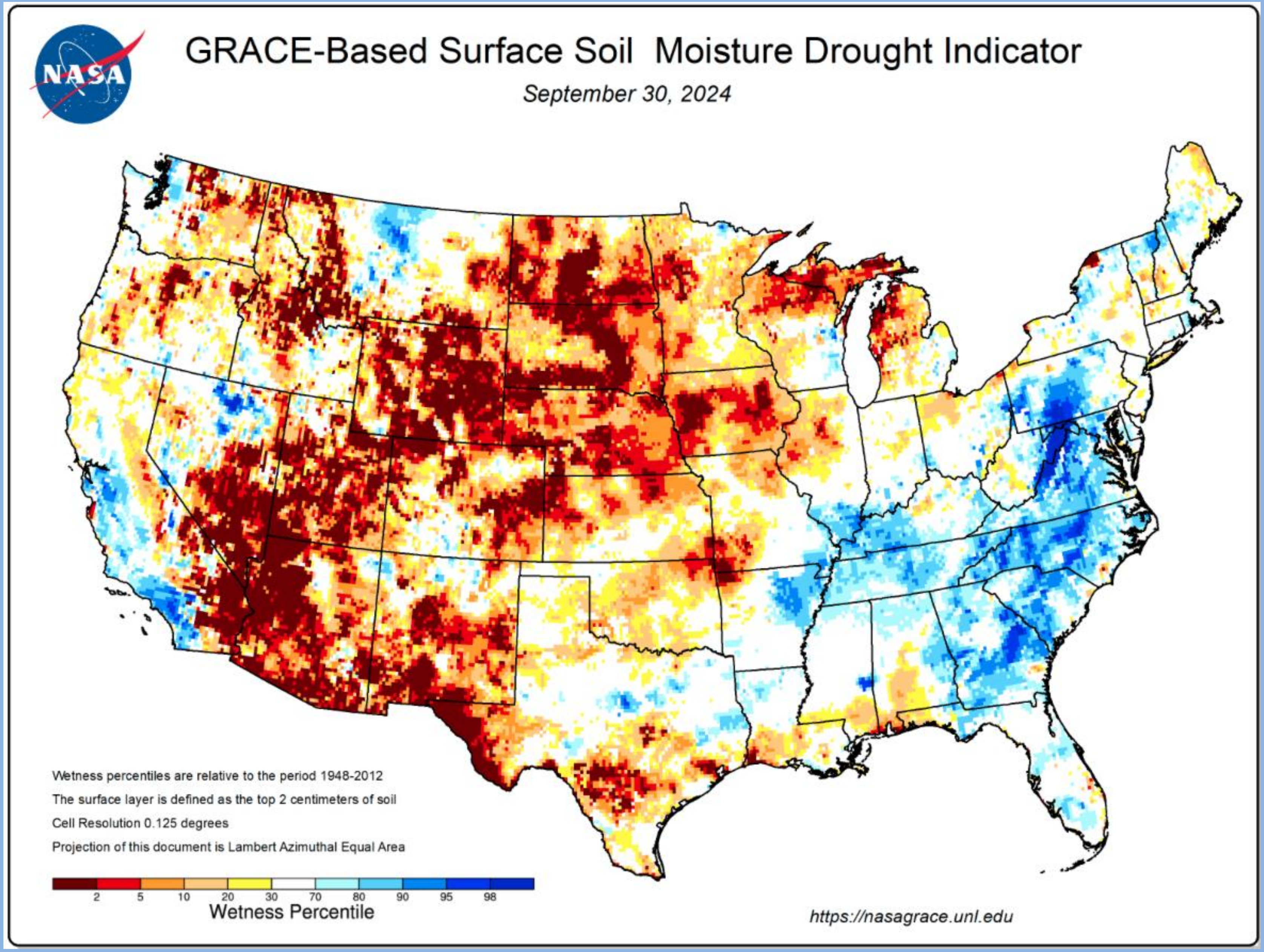
Reservoir storage at the end of the water year.



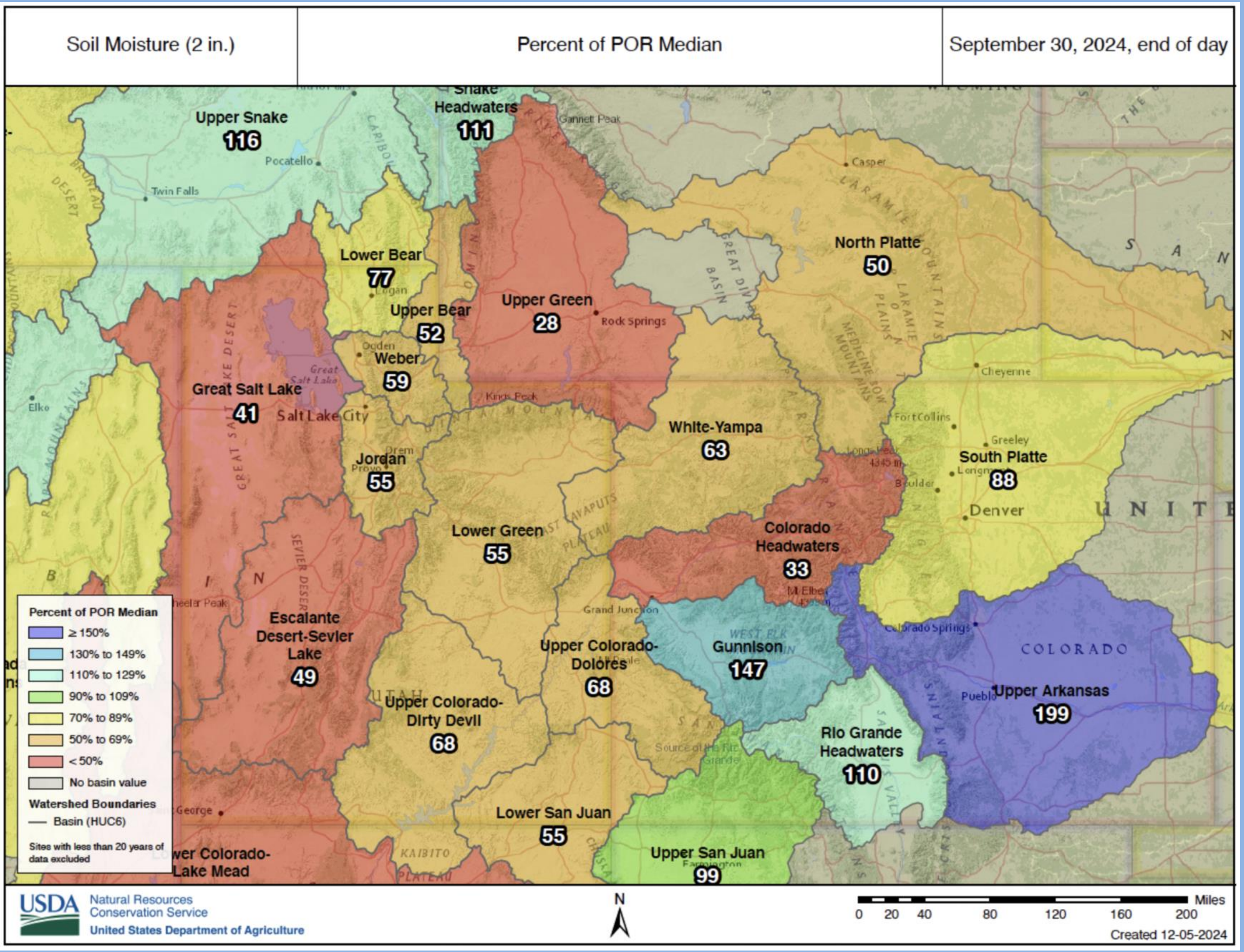
The monsoon pattern was typical of El Nino.



Despite normal snowpack, water year 2024 ended dry.

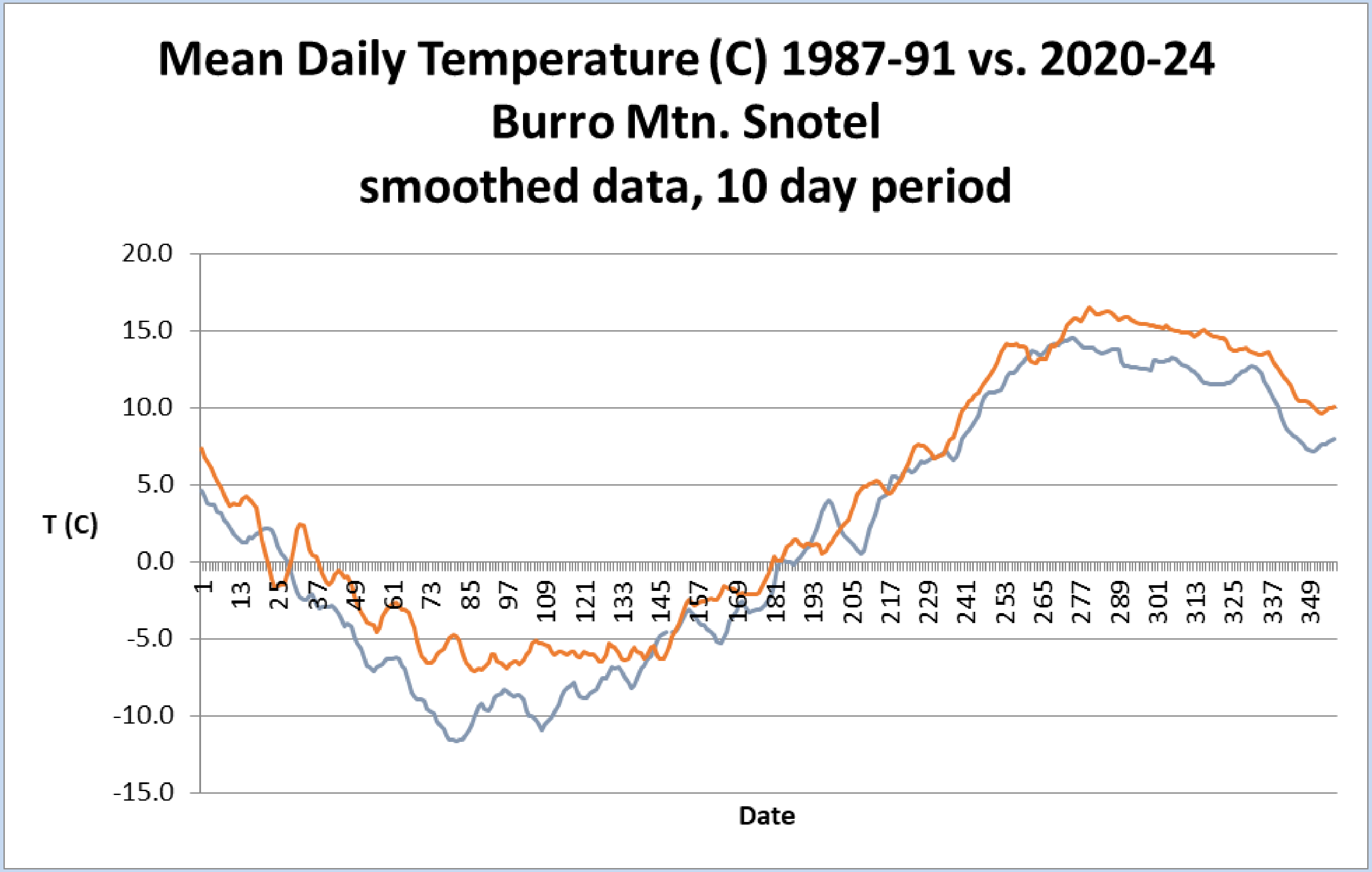


Soil moisture at the end of the water year.

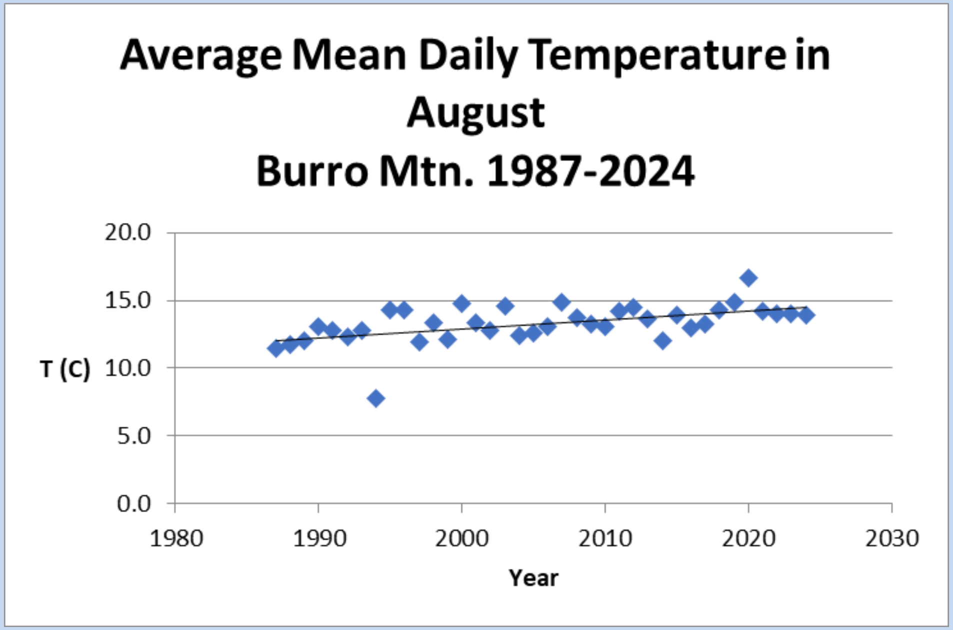


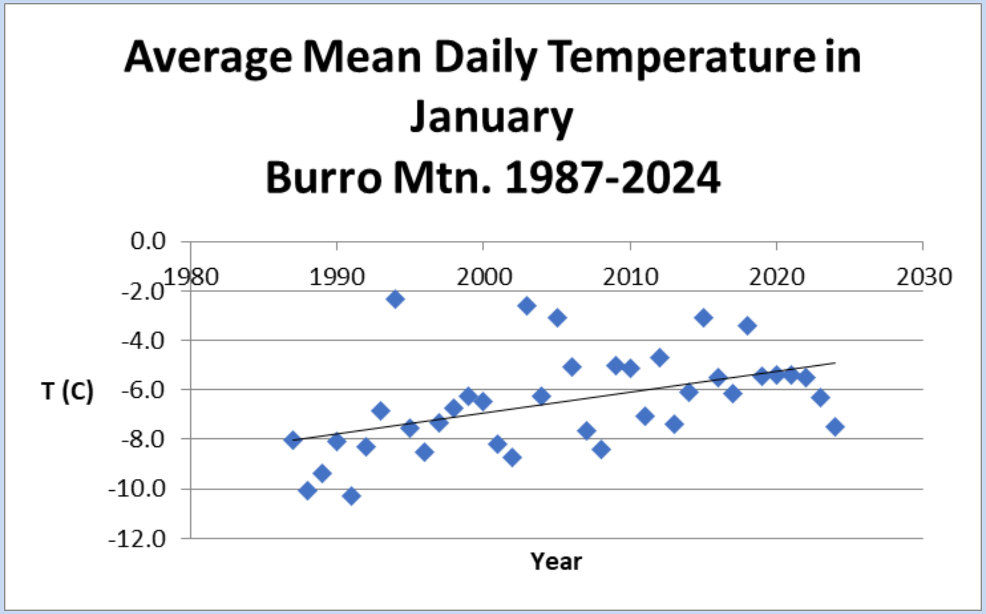
Trends on the upper White River

Mean daily temperatures on the Flat Tops have increased significantly, especially mid-winter and late summer.



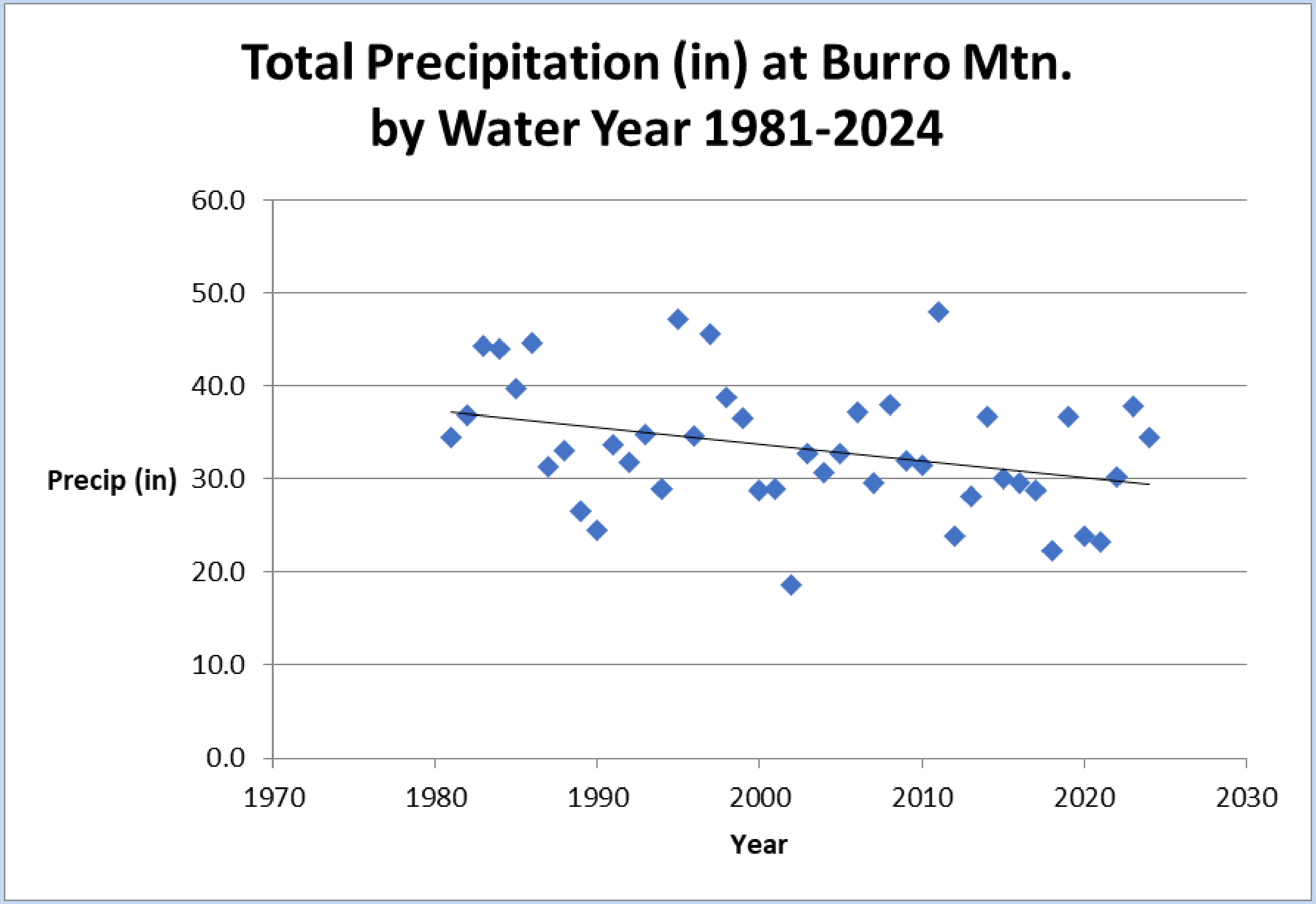
January and August temperatures have increased by about 3.5 C (6.5 F) on the Flat Tops over the past 35 years.



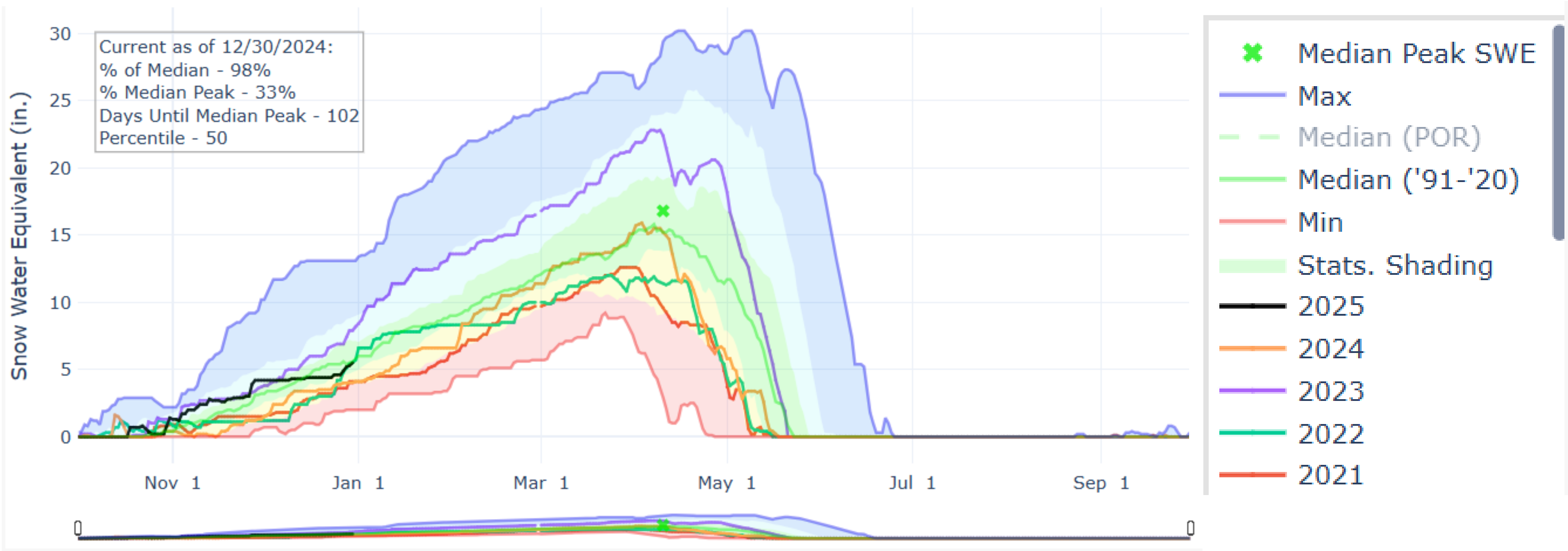


Data from Burro Mtn. Snotel.

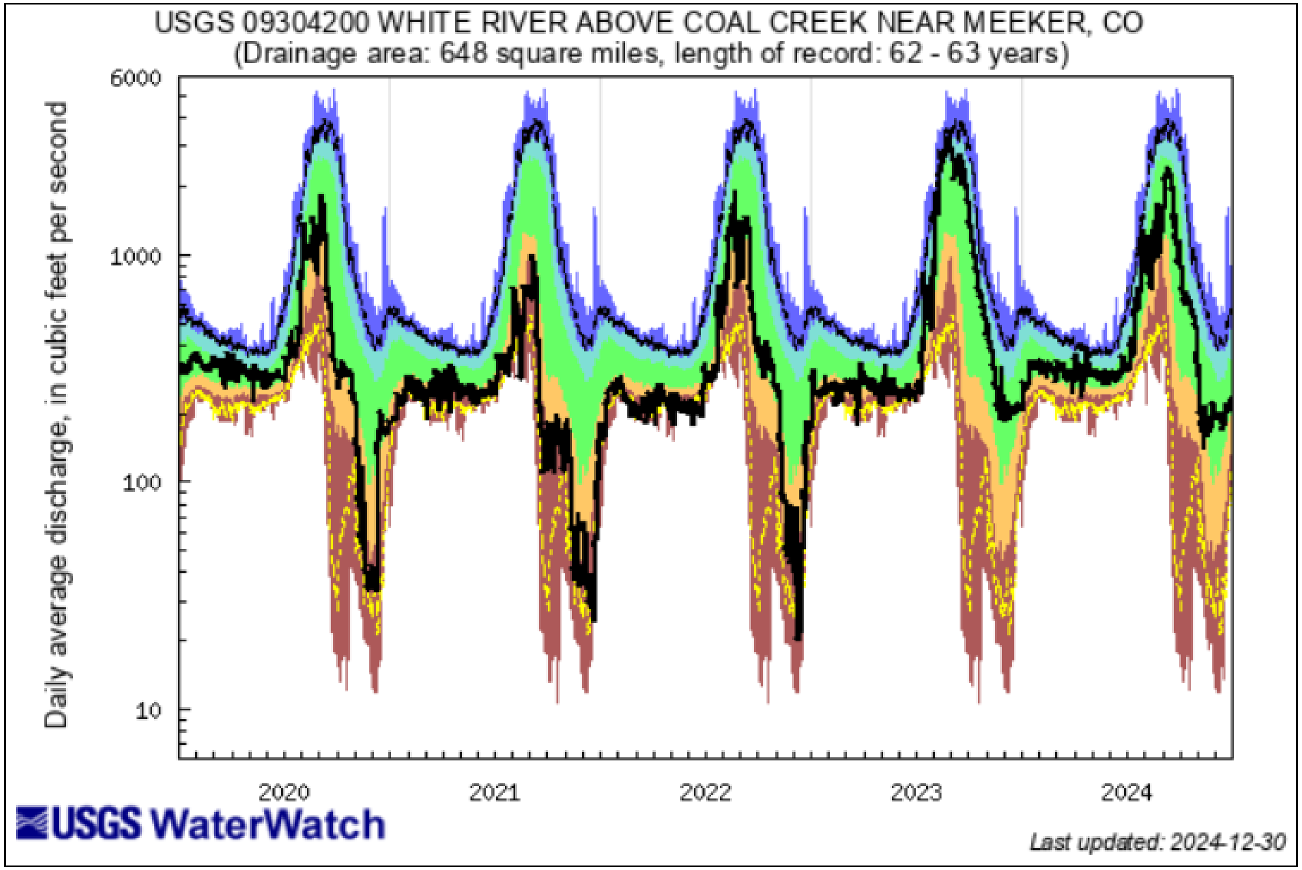
Precipitation on the Flat Tops , mostly available in snow pack, is decreasing. There is less water for runoff into the headwaters of the White River.



Variability in snowpack: Figure shows snow water equivalent at Burro Mtn. Snotel water years 2021-24.



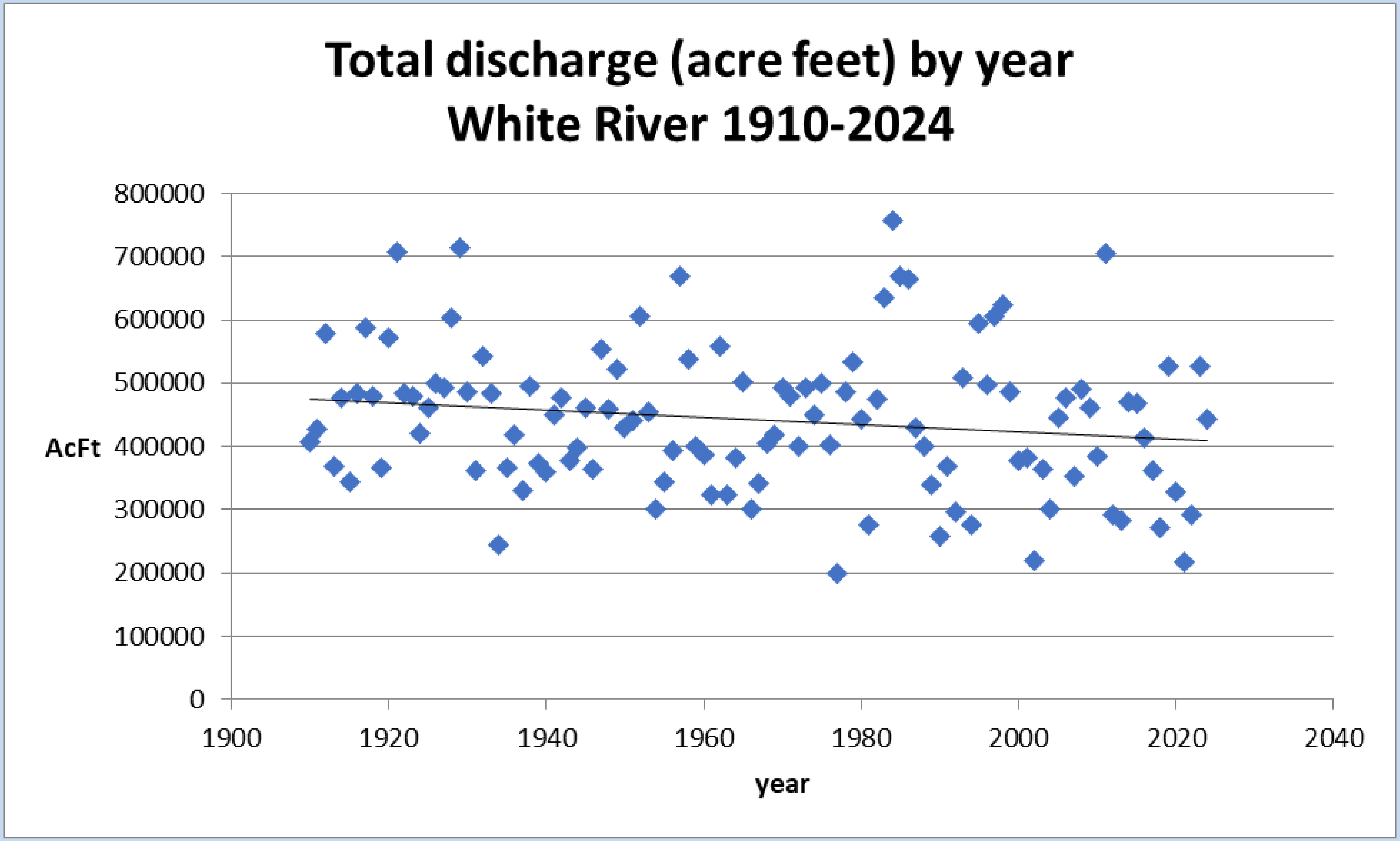
Daily flows reflect snowpack.



Explanation - Percentile classes							
lowest-10th percentile	5	10-24	25-75	76-90	95	90th percentile -highest	Flow
Much below Normal		Below normal	Normal	Above normal	Much above normal		

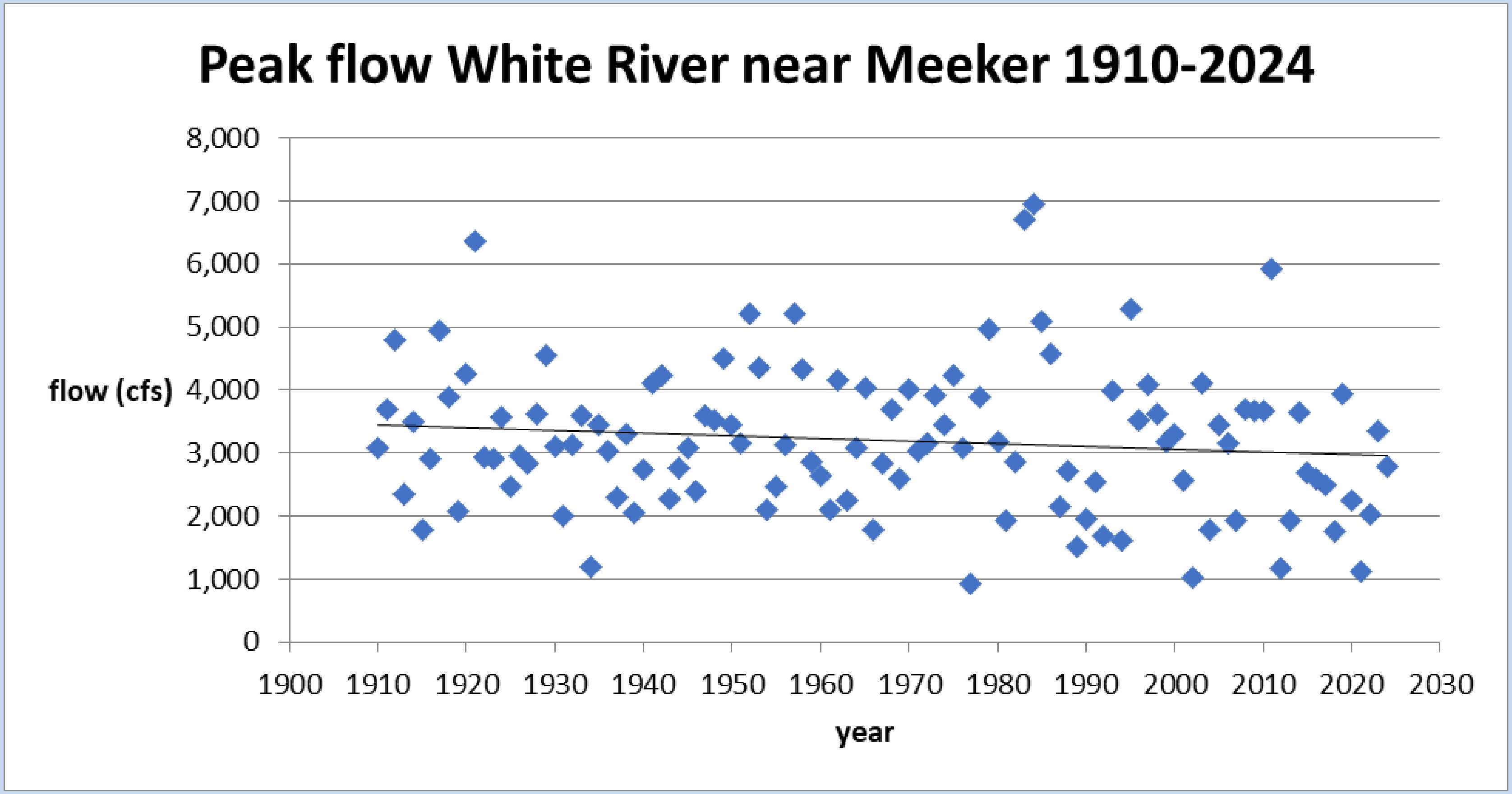
Flow in water years 2020-24 (black line) vs. historical record. Note log scale.

Total yearly runoff in the White River is decreasing, down by about 70,000 acre feet on average over the period of record. That represents about a 14% loss in water volume.

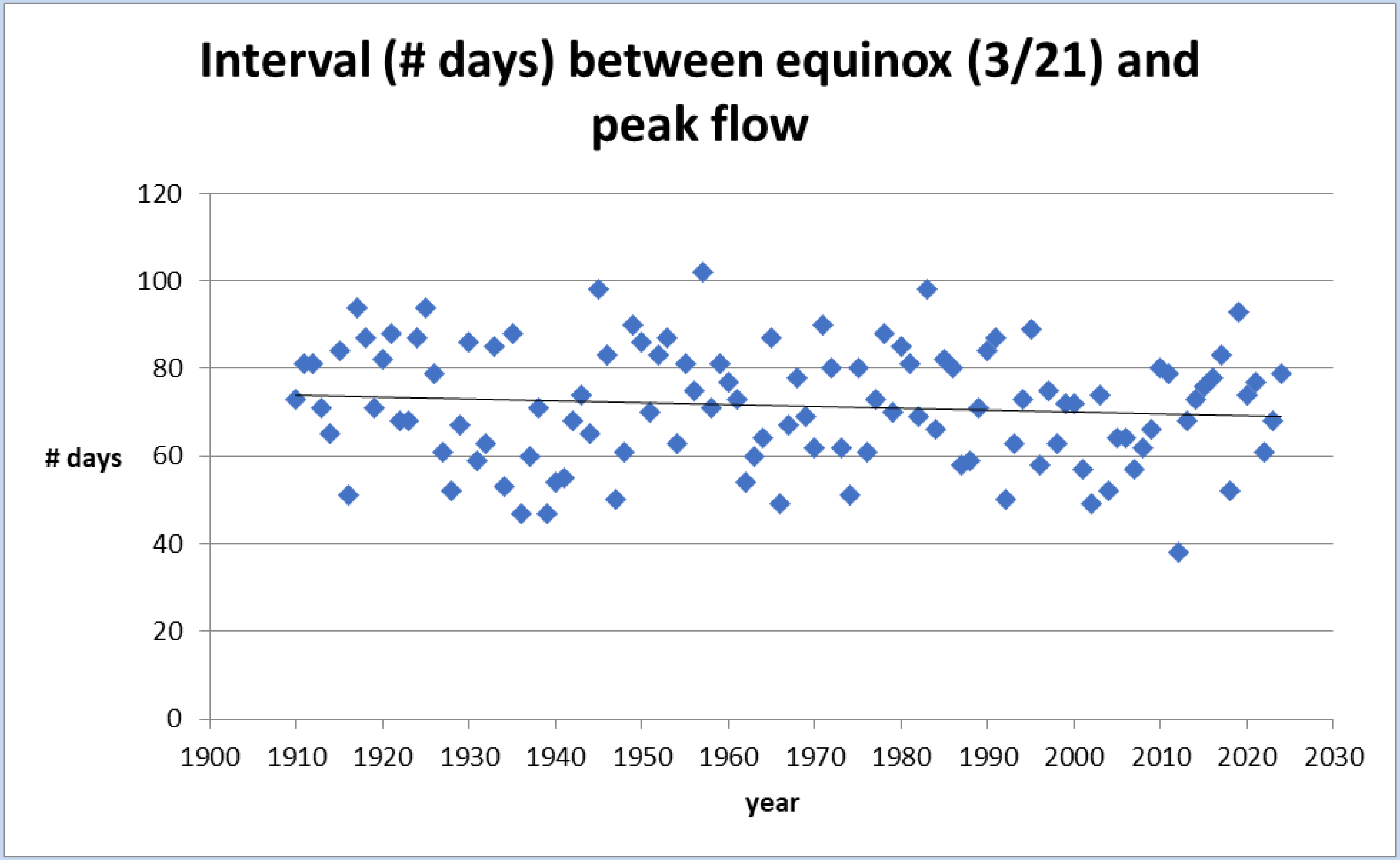


This and following flow data from USGS gauge station 09304500, Near Meeker

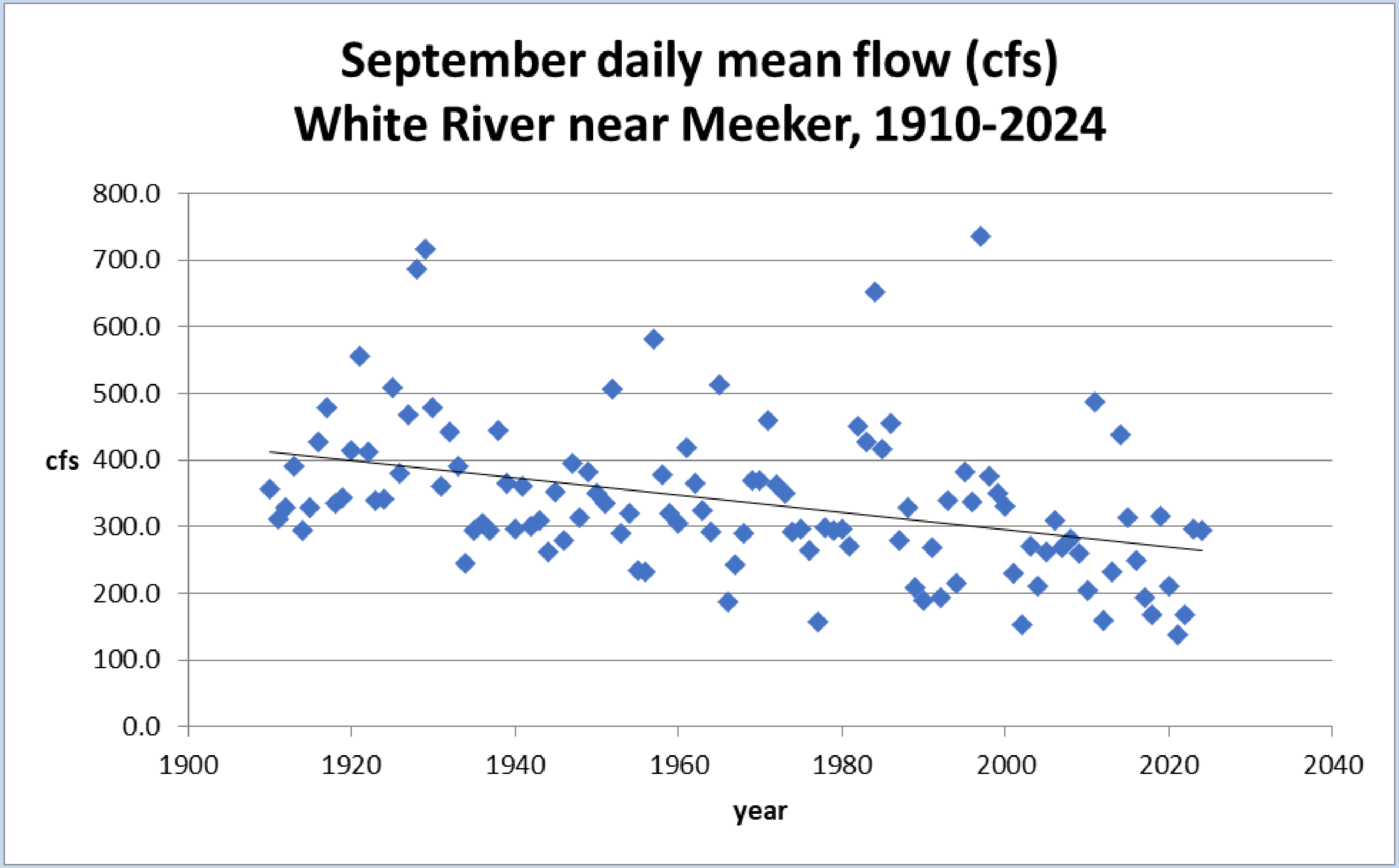
Peak flow is decreasing, now roughly 500 cfs lower on average than it was in 1910. Lower peak flow is less effective at scouring algae off the stream bed, so algae remains on the substrate from one year to the next. Decreased flow has other effects on the river ecosystem as well, including changes in sediment transport and fish habitat.



Spring runoff today occurs earlier than it did in the past. Earlier peak flow results in longer period of low flow in the summer and, potentially, higher water temperatures. Both effects may contribute to algae bloom and to fish stress.



Daily mean flow is decreasing in all months except April (reflecting shift of Spring runoff earlier into April). Decrease in September mean flow is particularly striking.

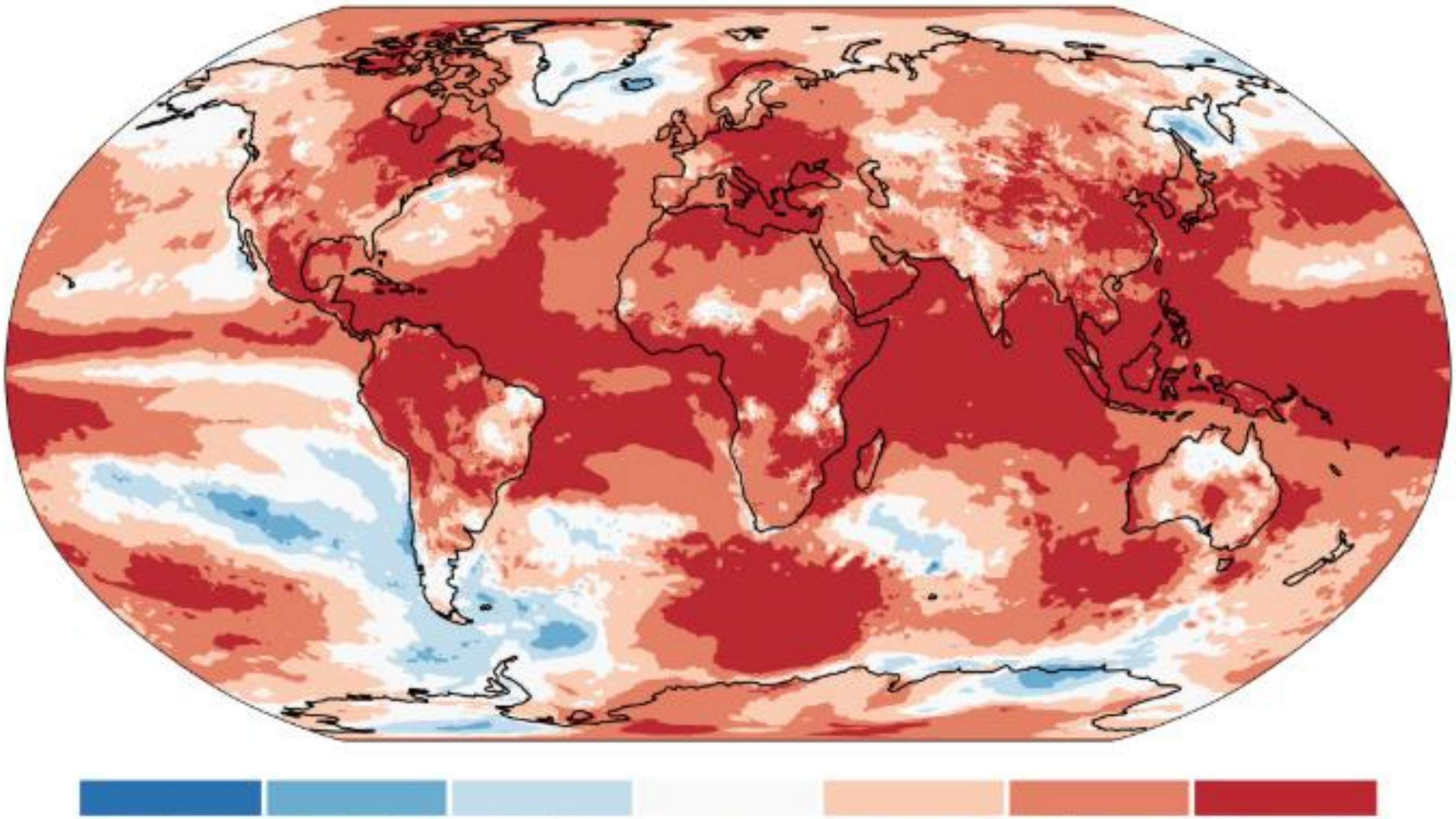


The climate future

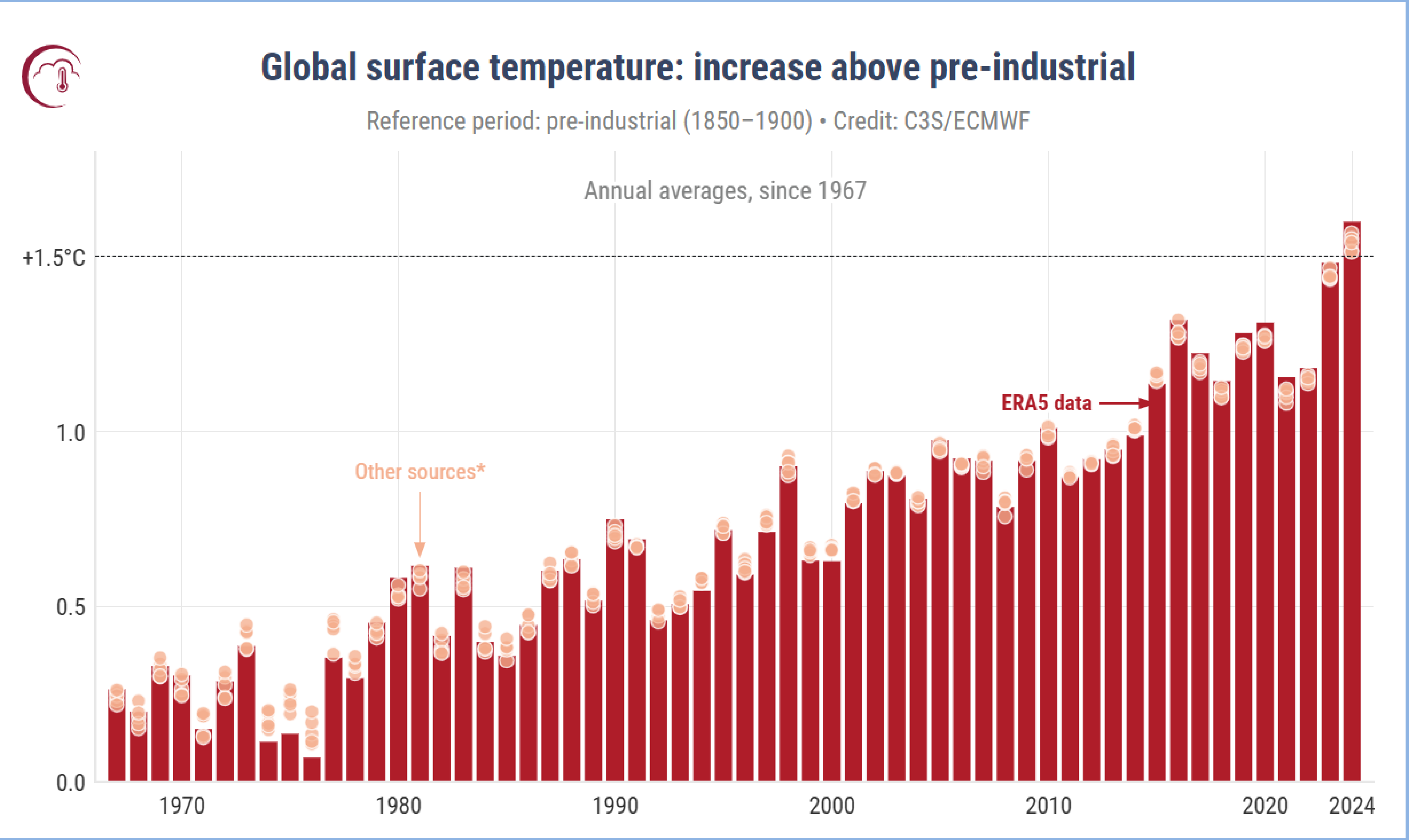
- 2024 was the warmest year on record, warmer than any period in human history.
- Global climate is changing more rapidly, and in more ways, than climate models predicted.
- It is highly likely that we will see greater variability in temperature and precipitation at regional scales and more extreme weather events.
- We are very likely approaching several tipping points, any one of which could change the global climate even more dramatically.
- We are nowhere near any "new normal."

Anomalies and extremes in surface air temperature in 2024

Data: ERA5 1979–2024 • Reference period: 1991–2020 • Credit: C3S/ECMWF



Temperature anomalies (C) relative to preindustrial global average temperature. Source: EU Copernicus Climate Center.



Climate trends in Colorado

Climate variable/event	Recent trend	Projected future change	Confidence in change
Spring Snowpack	**Lower**	Lower	Medium
Runoff timing	**Earlier**	**Earlier**	**High**
Annual Streamflow	**Lower**	Lower	Medium
Summer soil moisture	**Lower**	**Lower**	**High**
Evaporative demand	**Higher**	**Higher**	**Very High**

Table 3.1 Summary of the observed and projected changes in hydrology and water resources for Colorado, as detailed in the following sections. "Confidence in change" reflects the judgment of the authors, based on both the assessments in higher-level climate reports (NCA, IPCC), as well as relevant literature and model output for Colorado. In general, there is higher confidence in the changes in variables that are driven mainly by warming and less by the more uncertain change in annual precipitation.

Bolinger, R.A., J.J. Lukas, R.S. Schumacher, and P.E. Goble, 2024: Climate Change in Colorado, 3rd edition. Colorado State University, https://doi.org/10.25675/10217/237323

Snowpack

- April 1 SWE (snow water equivalent) during the 21st century has been 3% to 23% lower than the 1951-2000 average across Colorado's major river basins.
- Future warming will lead to further reductions in Colorado's spring snowpack. Most climate model projections of April 1 SWE in the state's major river basins show reductions of -5% to -30% for 2050 compared to 1971-2000; the individual projections that show increasing snowpack assume large increases in fall-winter-spring precipitation.
- The seasonal peak of the snowpack is projected to shift earlier by a few days to several weeks by 2050, depending on the amount of warming and the precipitation change. This warming-driven shift could be accelerated by increases in dust-on-snow events.

Streamflow

- Since 2000, annual streamflow in all of Colorado major river basins has been 3% to 19% lower than the 1951-2000 average.
- Modeling studies have attributed up to half of the observed decrease in streamflow since 1980 in Colorado river basins to warming temperatures.
- Future warming will act to reduce annual streamflows. Most climate model projections of annual streamflows in the state's major river basins for 2050 show reductions of 5% to 30% compared to 1971-2000.
- Higher future streamflow would require large overall increases in precipitation to offset the effects of warming, an outcome that appears unlikely.
- Summer and fall streamflows are projected to decline significantly by 2050 as the seasonal runoff peak shifts earlier, by 1-4 weeks, due to warming.

Soil moisture

- Modeled soil moisture based on meteorological observations suggests overall declines in high-elevation soil moisture from 1980-2022.
- Future warming will lead to declines in summer (June-August) soil moisture throughout the state. Spring (March-May) soil moisture will likely increase at higher elevations as snowmelt shifts earlier.
- Rapid depletion of soil moisture under warm conditions exacerbates warming. When summer sunshine hits a landscape with dry soil a greater fraction of solar energy directly heats the surface, leading to even warmer conditions.

Evapotranspiration

- The evaporative demand ("thirst") of the atmosphere—as measured by potential evapotranspiration (PET) and Reference ET—has increased across Colorado since 1980, mainly due to the warming trend. Statewide, growing-season PET increased by 5% from 1980-2022.
- Additional future warming will drive greater evaporative demand; all climate model projections show statewide annual PET increasing by 8-17% by 2050, compared to 1971-2000.

Bluff, UT 2022.   Meeker, CO 2060?

What we can do

- Confronting climate change requires action at global scale.
- A key contribution in our region would be to stop methane leaks in the Uinta and Piceance Basins
- Individual efforts to decrease greenhouse gas emissions are important but nowhere near sufficient.
- Prepare for the worst.

Thank you!

References

CIRES / NOAA, CU Boulder. 2024. Water Year 2024 Summary.
https://wwa.colorado.edu/resources/intermountain-west-climate-dashboard/briefing/water-year-2024-summary