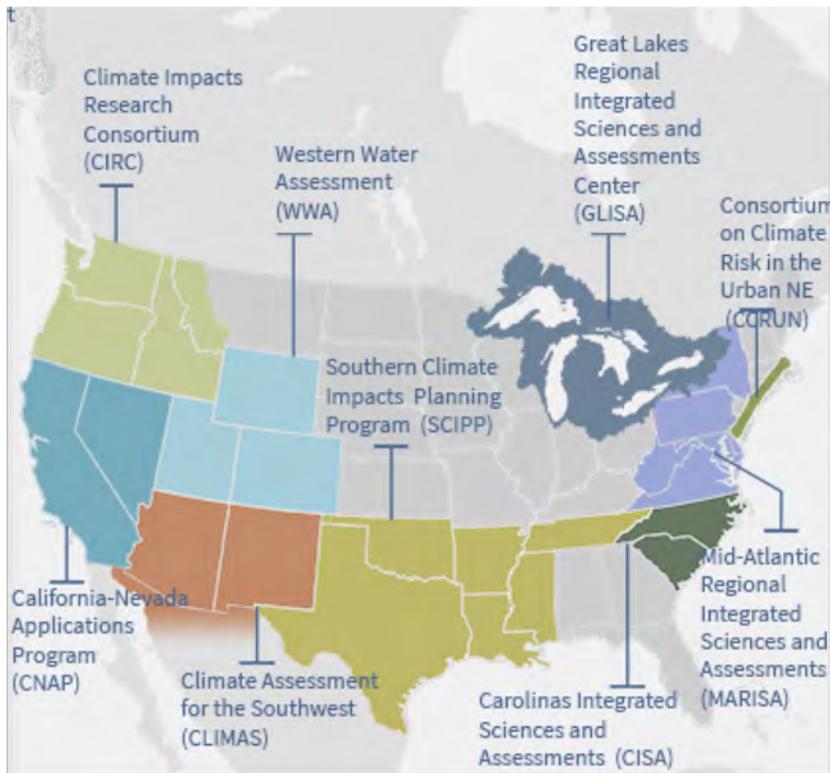




# 2018 Stakeholder Meeting

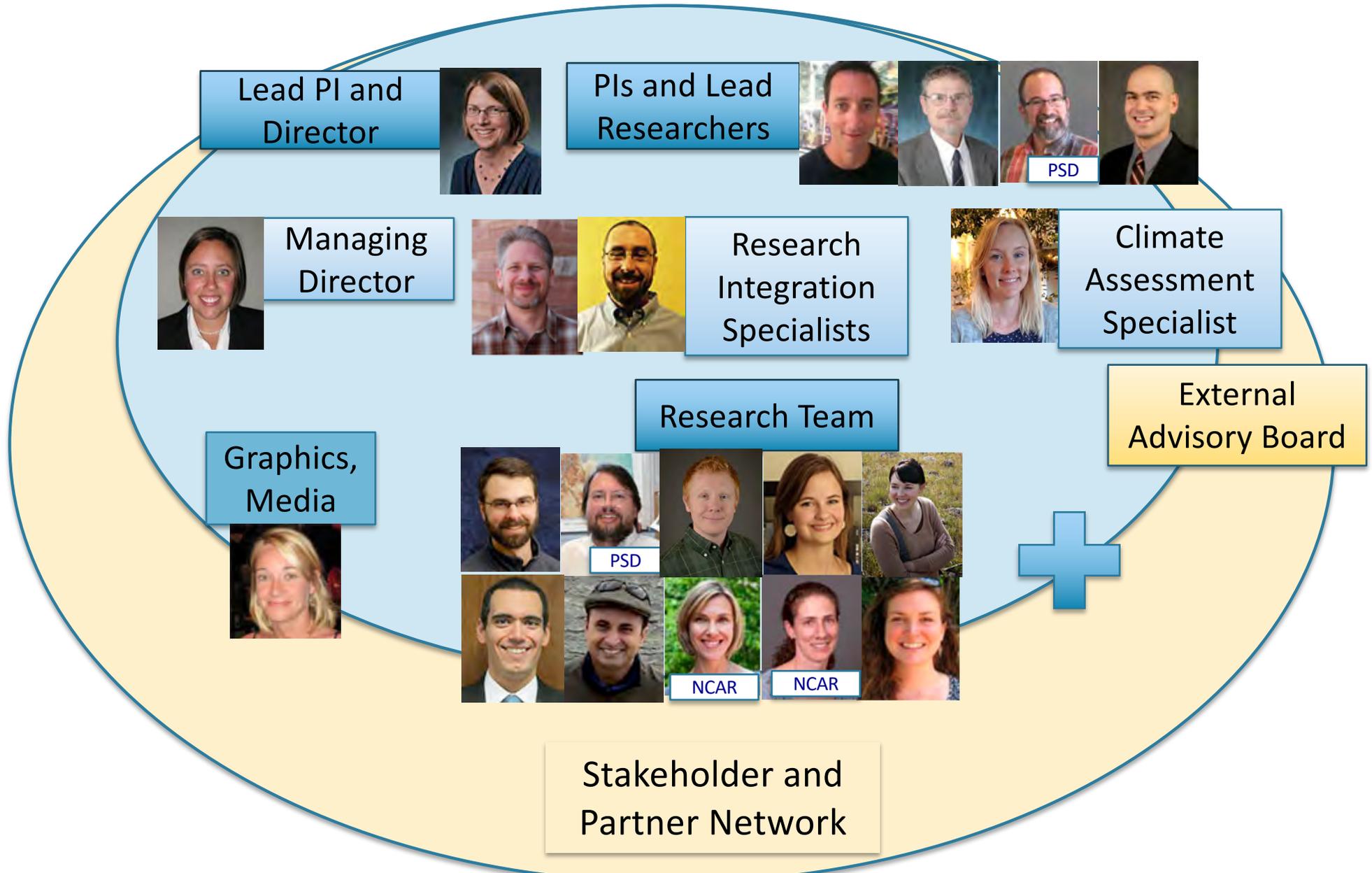
Tuesday, October 9, 2018

# Part of the NOAA RISA Network



- Established in 1999 by CIRES researchers at CU-Boulder and NOAA Physical Sciences Division
- Serves stakeholders in Colorado, Wyoming and Utah
- 20+ researchers with expertise in hydrology, climate modeling, social sciences, ecology, policy, and social sciences

# WWA Team and Partners



# WWA's Working Principles

We conduct our projects following these principles:

1. Begin with the decision context
2. Prioritize use-inspired science (that is, science that is responsive to and inspired by user needs for decision making)
3. Follow the principles of co-production by directly interacting with stakeholders; and
4. Work in interdisciplinary teams

# Stakeholder Meeting Purpose

- Give you an overview of our recent and upcoming work
- Give an update on and learn from you the impacts of this year's drought
- Understand how you see WWA and what about it you value - will inform our next rebid
- Learn what key issues related to climate, drought and weather that you are facing in the near future

# Select Project Overview (more in-depth to come later)

# Usable Science Guide

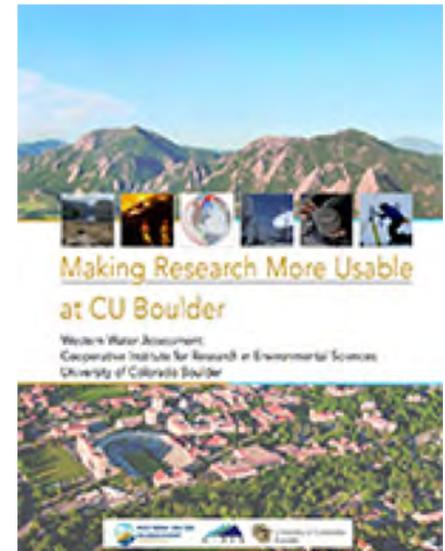
**Lisa Dilling, Katie Clifford, Bets McNie, Jeff Lukas, Ursula Rick**

Goal: Encourage the production of usable science at CU Boulder

Partners: Part of an internal project with Earth Lab

Support: CU Boulder Office of Research and Innovation

Presents a spectrum of ways to engage with users to produce useful information and gives several examples from CIRES, CU Boulder



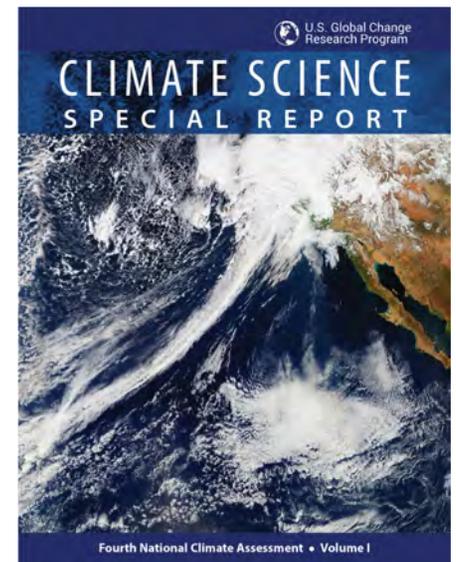
# Facilitating Ongoing Climate Assessment for the US Southwest

**Benét Duncan, Ursula Rick, Lisa Dilling**

Goal: Recommendations for a regional, ongoing assessment process in the Southwest

Partners: CLIMAS and CNAP (other RISAs in the US Southwest)

Case studies on successful assessments in the SW to understand best practices for producing useful climate information



# Drought Planning on the Wasatch Front

**Seth Arens, Jeff Lukas**



Goal: Provide paleo-drought and future climate information for a drought contingency plan

Partners: Weber Basin Water Conservancy District, Utah State University, Utah DWR

Seth will provide tree ring data along with climate projections to help WBWCD better understand their risk of future drought

# UT State Drought Planning

**Seth Arens, Elizabeth Weight (NIDIS)**

Goal: Provide information for Utah's effort to update their drought plan

Partners: NIDIS, UT Division of Water Resources

- Stakeholder meeting in Utah in July 2018 including three state drought coordinators (CO, AZ and NM)
- Meetings with several UT state offices and outreach

# Dynamics of Vulnerability in the Arkansas River Valley

**Jen Henderson, Lisa Dilling, Rebecca Morss, Olga Wilhelmi, Ursula Rick**

Goal: Understand how adaptation decisions interact across sectors, time and space

Partners: CWCB, CO Dept. of Agriculture plus many more



- Interviews of water users in the valley including: ag, utilities, pot farmers, fishing, rafting, and more
- Survey of Colorado agricultural producers for CO drought plan update

# Dynamics of Vulnerability in the Arkansas River Valley

## Findings:

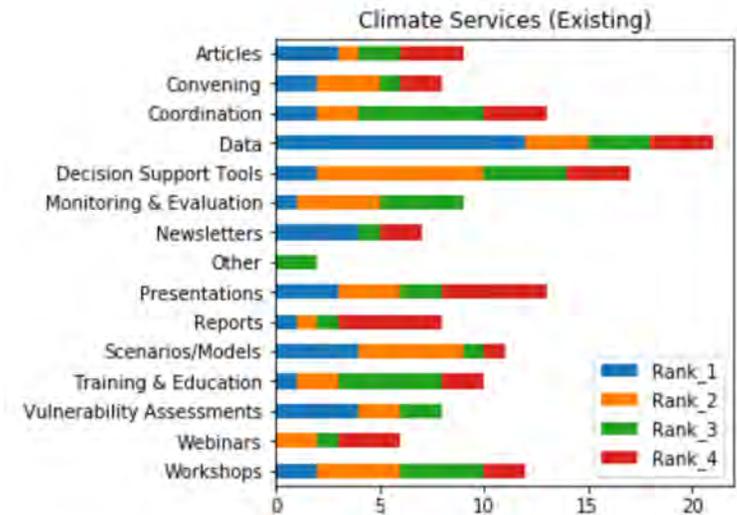
- Interviews of water users in the valley including: ag, utilities, pot farmers, fishing, rafting, and more
- Survey of Colorado agricultural producers for CO drought plan update

# Climate Services in the Western US

Benét Duncan, Bets McNie

Goal: Clarify the network of climate service provision across the West

Partners: NOAA West RCC, CLIMAS

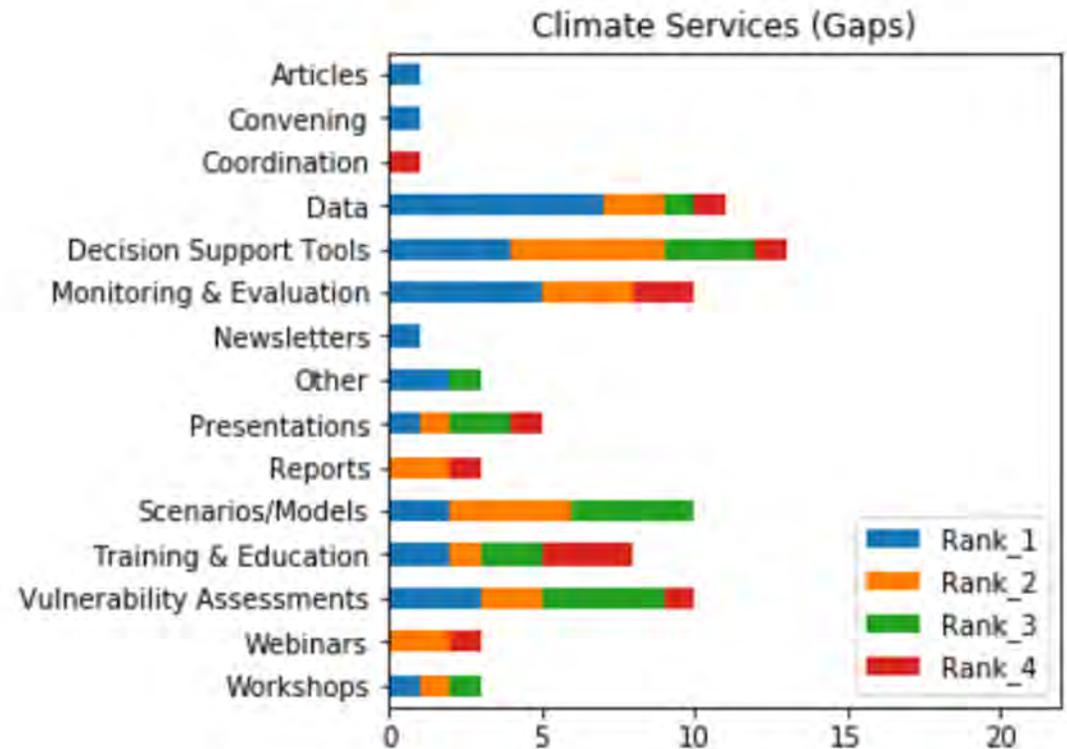


- Follow-on to the creation of a database of public and non-profit climate service providers.
- Network analysis of who is providing what information to which users.
- <https://wrcc.dri.edu/ClimSvcProviders/>

# Climate Services in the Western US

## Findings:

- Some high-demand areas aren't being filled.
- Some **top-ranked services include capacity-building and broad information sharing**, like workshops, coordination, training, and newsletters.
- Respondents identified **gaps in many services that serve as direct inputs into decision making**, such as data, evaluation, and decision support tools.

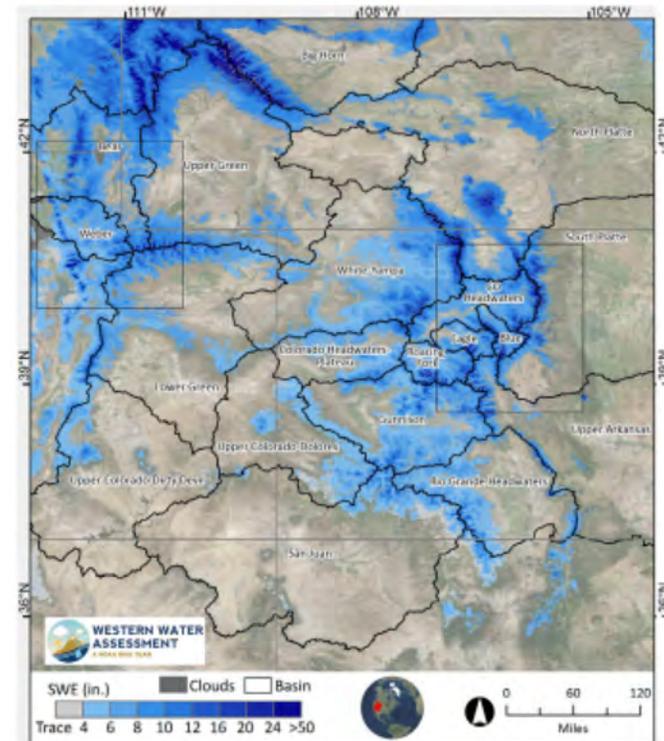


# Testing a Spatial SWE Product

Noah Molotch, Leanne Lestak, Jeff Lukas, Heather Yocum, Ursula Rick

Goal: Can a MODIS-based spatial SWE product be useful for water managers across our region?

- Released 4 reports throughout the winter/spring 2018 to small group of beta testers
- Difficulty getting cloud free images, even in a drought year
- Desire for an interactive, map-based web product
- Current analysis of how this compares to SNOTEL, ASO, etc.



# Advancing the Use of the IMW DEWS

**Lisa Dilling, Ben Livneh, Rebecca Page, Andrew Badger, Bill Travis**

- Goals:
- Clearer understanding of decision and risk management process for water entities facing drought
  - Identify barriers to introducing new indicators into the drought management process
  - Evaluate the usefulness of drought indicators under a changing climate

Partners: Nolan Doeskin, Eric Kuhn, several West Slope water providers

# Advancing the Use of the IMW DEWS

## Findings:

- For information use: *Appropriate scale, good skill, understandable, capacity (technical, staff time), past experience, generational turnover*
- Very little engagement with university-based boundary orgs - We can't expect most small-system managers to engage with us and participate in activities
- For these small water systems, lack of capacity is a key constraint on information uptake
  - Looking for new info is a low priority
  - Can't pay consultants to provide additional capacity
- We can capitalize on water managers' strong community of practice by strategically engaging with early adopters (typically larger systems relative to peers, but not too large)

# Research to ... in the RISA Network

**Bobbie Klein, Bets McNie**

Goals: How does research move to applications and/or operations in the RISA network? Can NOAA use similar practices to bring research to operations?

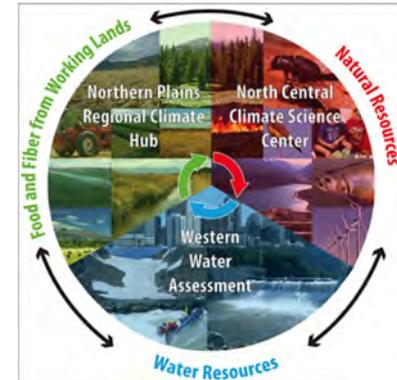
Partners: RISA programs

Success: buy-in from recipient organization, filled need, significant involvement with users

Unsuccessful: lack of human and monetary resources, lack of planning, lack of social capital with users

## Partnership with Northern Plains Regional Climate Hub and North Central Climate Adaptation Science Center

- Joint projects
  - Drought decision-making
  - Climate & agriculture tools
  - EDDI and LERI
- Joint retreats twice per year to facilitate collaboration
- Regional Climate Response Collaboratives:  
<https://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-17-0183.1>
- Next NC CASC moving to Earth Lab at CU Boulder
  - Lisa Dilling and Bill Travis involved



## Connecting with WWA

- Intermountain West Dashboard –WY, CO, UT, AZ and NM  
<http://wwa.colorado.edu/climate/dashboard.html>
- Rocky Mountains - High Plains Dashboard – All of the above plus MT, ND, SD, NE and KS  
<http://wwa.colorado.edu/climate/dashboard2.html>
- Webinars:
  - EDDI Applications and New Developments, March 14, 2018
  - Exploring the Use of MOEAs for Long-term Planning by Front Range Water Managers, February, 2018
  - Decision-making in the Face of Drought by Western Range Livestock Producers, May 31, 2017
  - EDDI: Tracking the “Atmospheric Demand” Side of Drought for Monitoring and Early Warning, May 11, 2017
  - UPCOMING: Snow series

# **Applying Science to Decision-making: Science for Management of the Colorado River**

**Dr. James Prairie, US Bureau of Reclamation**

**Break**



# The 2018 Drought: A truly awful Water Year in review

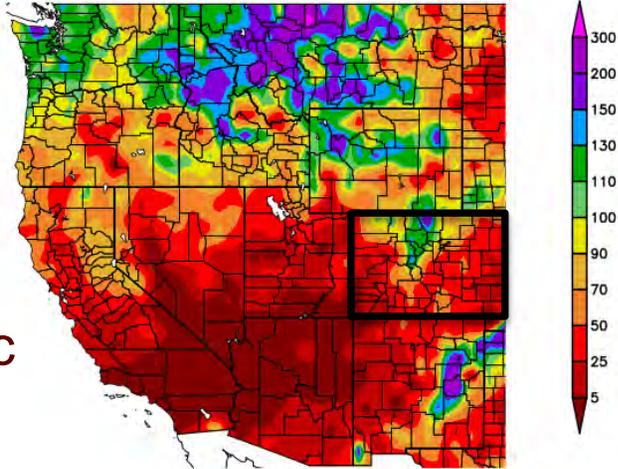
Jeff Lukas  
And many others

*WWA Stakeholder Meeting  
October 9, 2018*

# Water Year 2018: Storm tracks to north, monsoon to south

Percent of Normal Precipitation (%)  
10/1/2017 - 12/31/2017

Oct-Dec  
2017

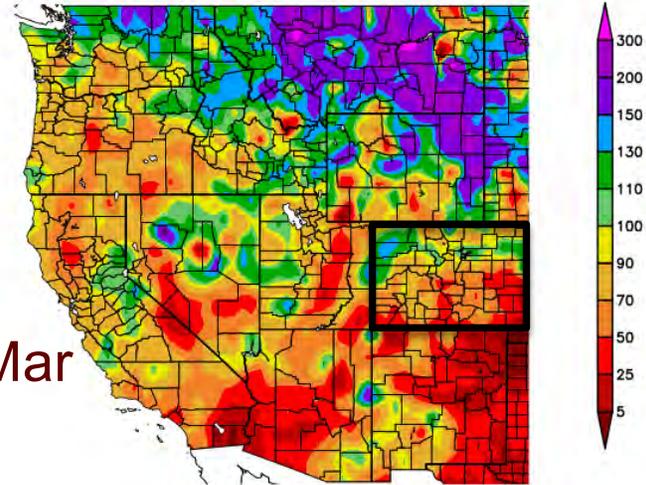


Generated 1/20/2018 at HPRCC using provisional data.

NOAA Regional Climate Centers

Percent of Normal Precipitation (%)  
1/1/2018 - 3/31/2018

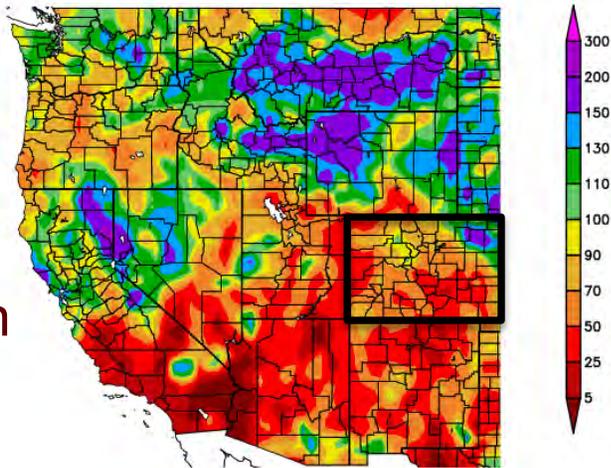
Jan-Mar  
2018



Gen

Percent of Normal Precipitation (%)  
4/1/2018 - 6/30/2018

Apr-Jun  
2018

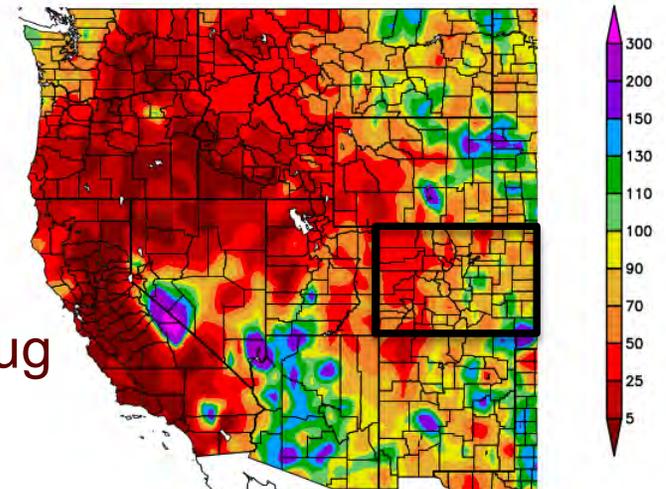


Generated 7/20/2018 at HPRCC using provisional data.

NOAA Reg

Percent of Normal Precipitation (%)  
7/1/2018 - 9/30/2018

Jun-Aug  
2018

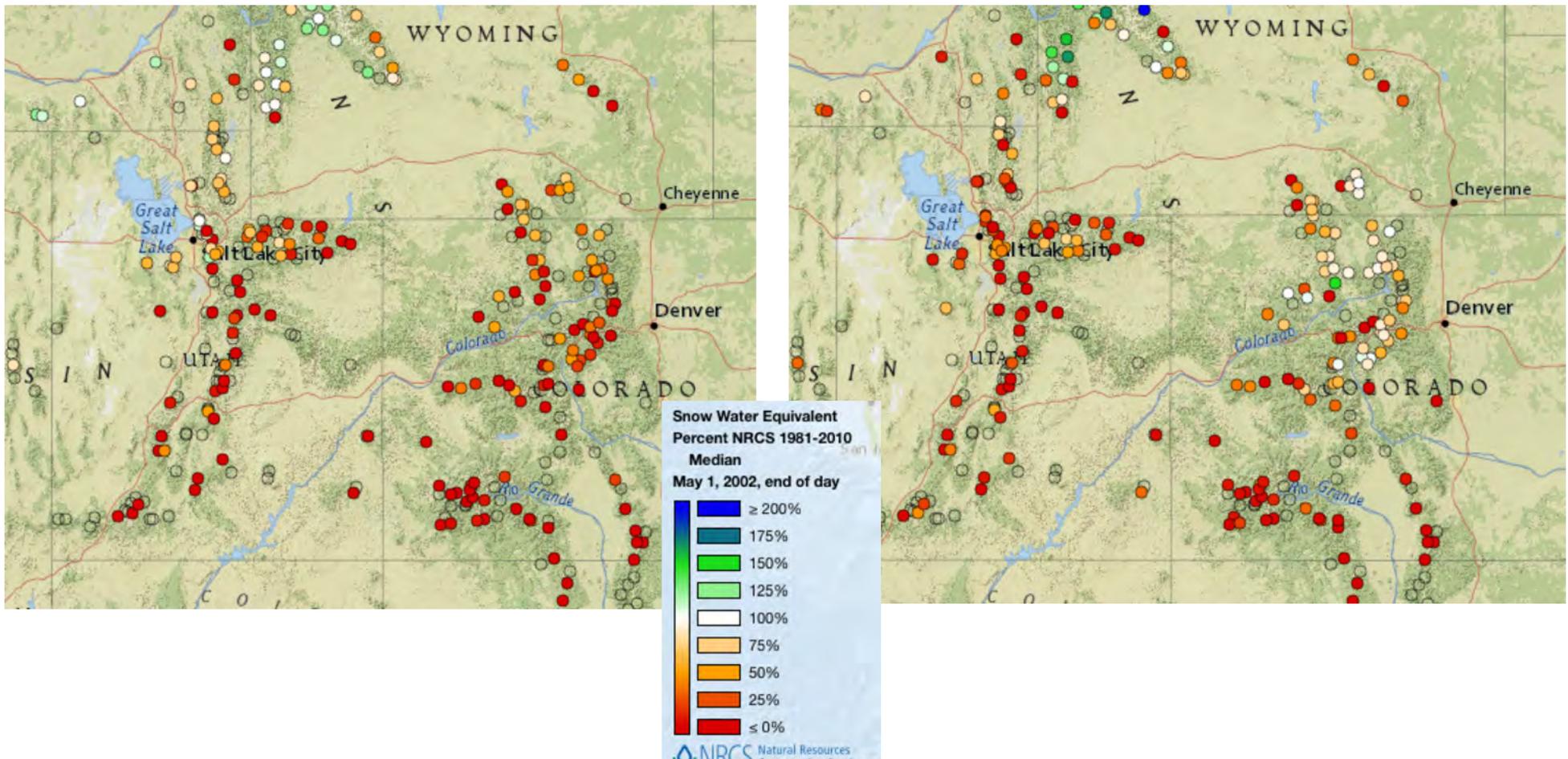


NOAA Regional Climate Centers

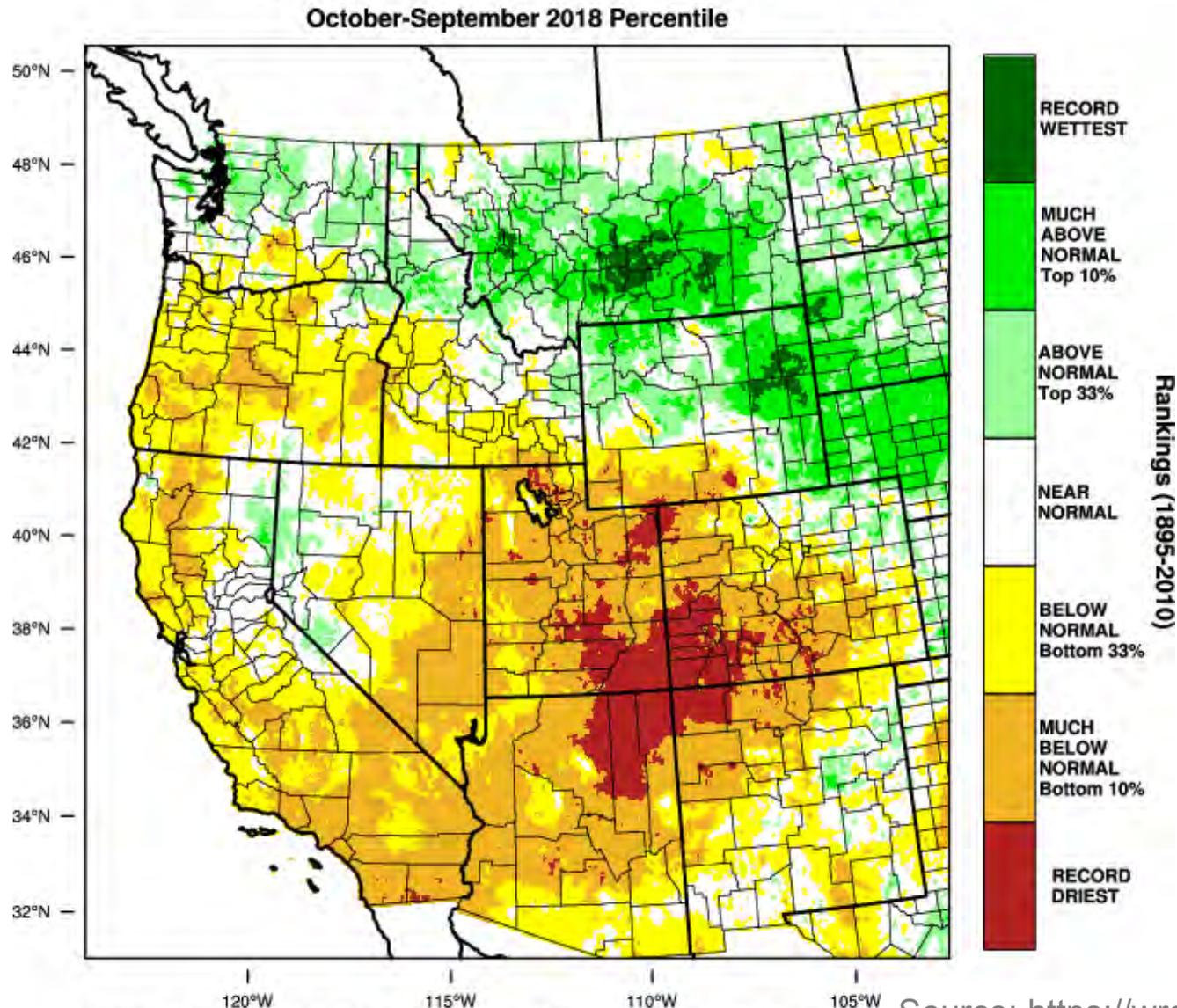
# For most basins in CO and UT, the 2018 spring snowpack was in the ballpark of 2002 and 2012

% Median SWE – May 1, 2002

% Median SWE – May 1, 2018

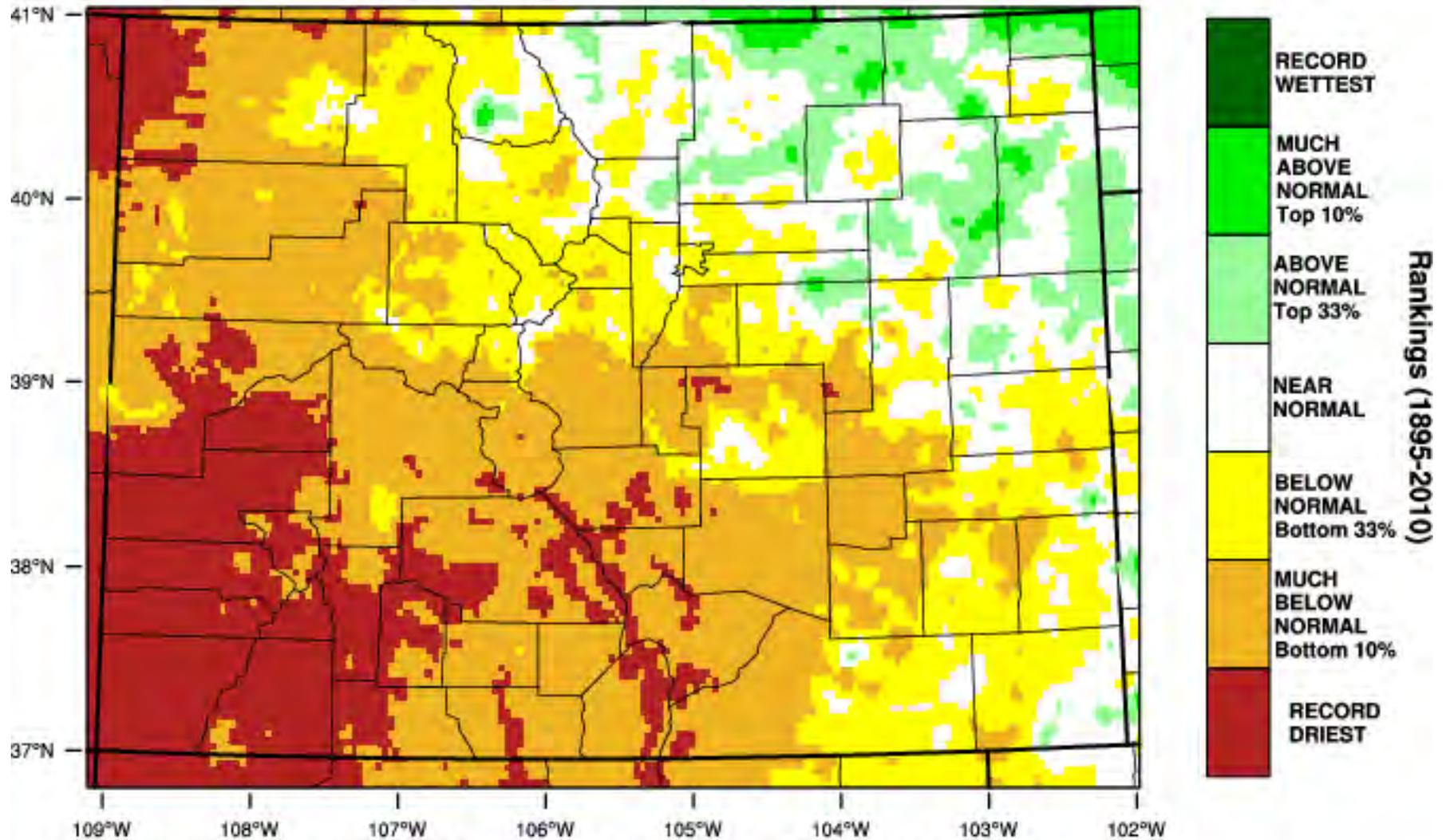


# Westwide precipitation Water Year 2018, relative to 1895-2010



# Colorado precipitation Water Year 2018, relative to 1895-2010

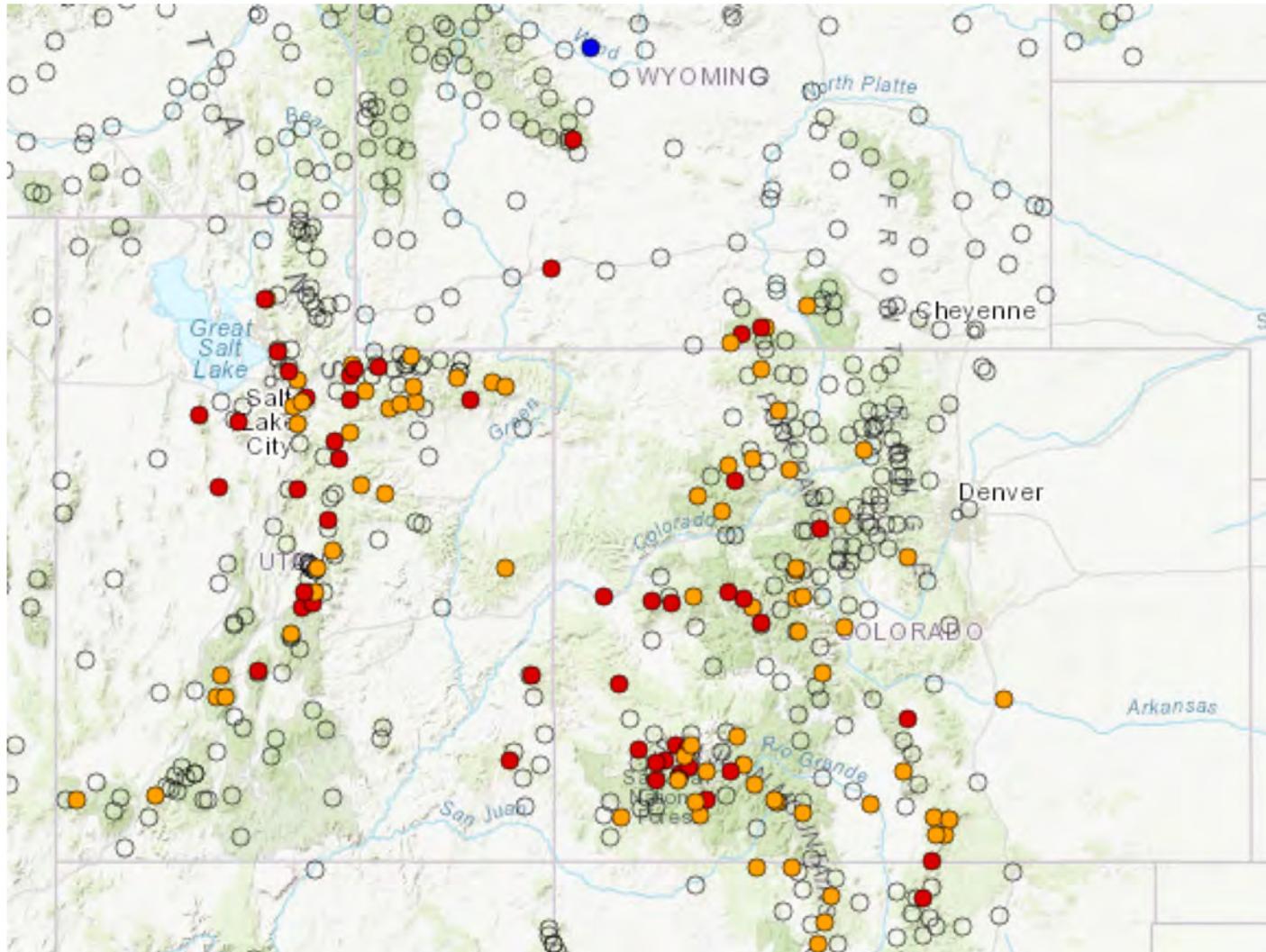
October-September 2018 Percentile



WestWide Drought Tracker, U Idaho/WRCC Data Source: PRISM (Prelim), created 7 OCT 2018

Source: <https://wrcc.dri.edu/wwdt/>

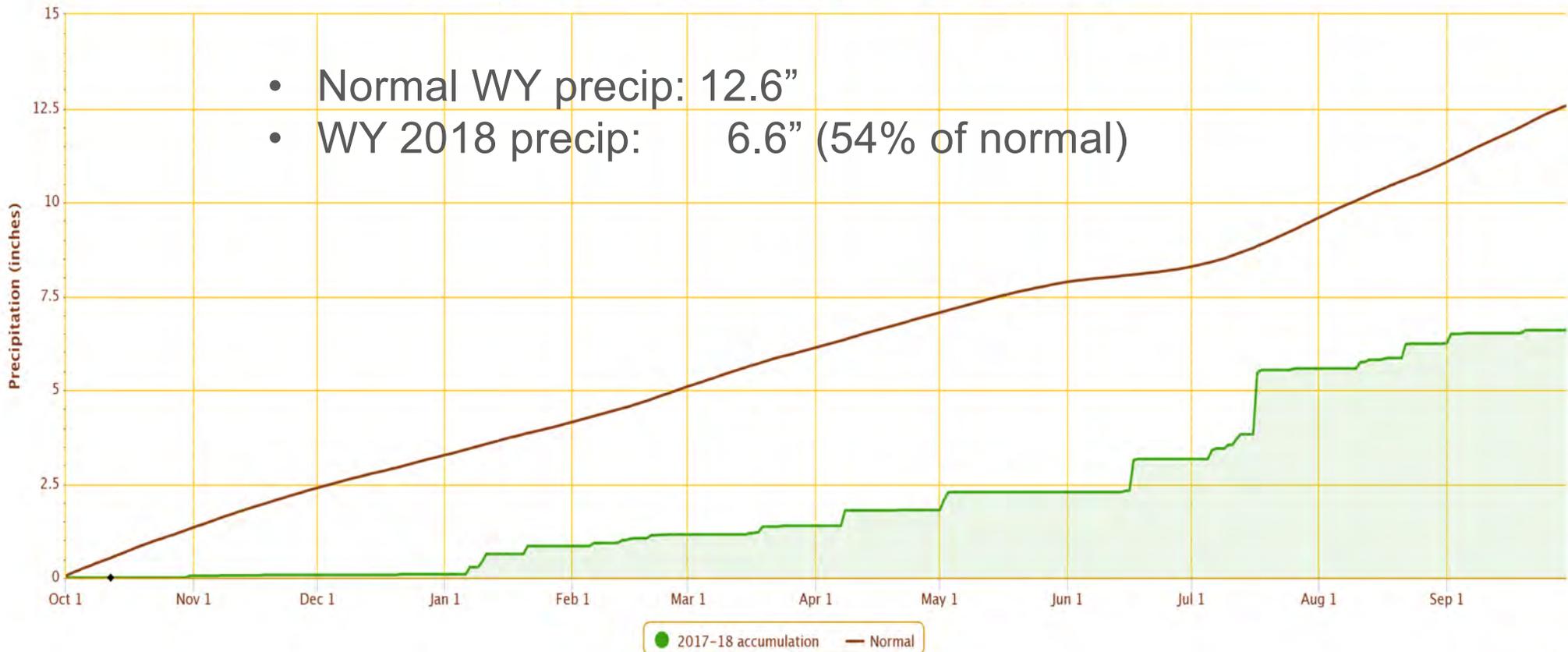
# SNOTEL site precipitation Water Year 2018, Lowest or 2<sup>nd</sup>-lowest on record (>20 years)



# Cortez, CO cumulative precipitation Water Year 2018 compared to 1981-2010 normal

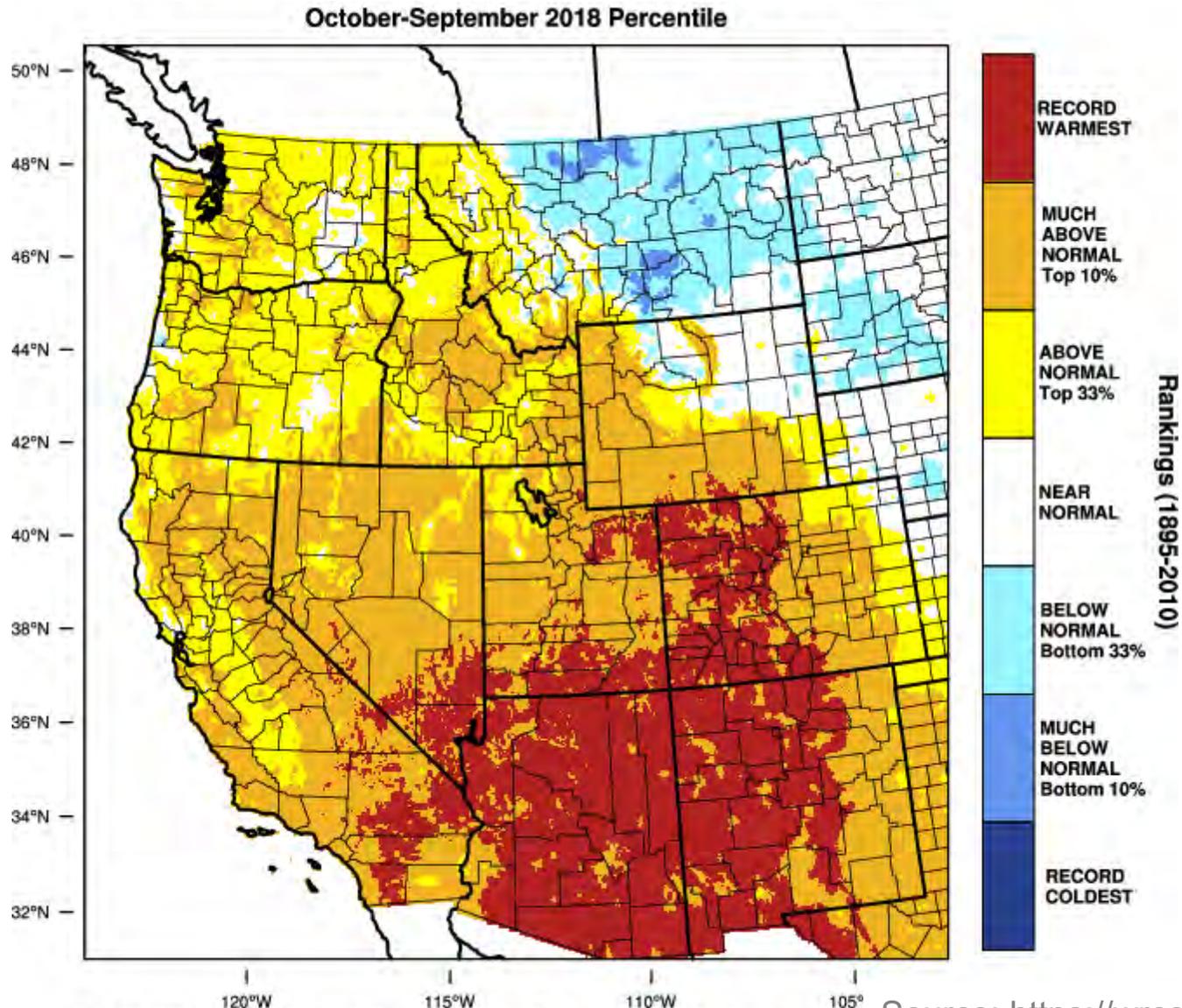
Accumulated Precipitation - CORTEZ, CO

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



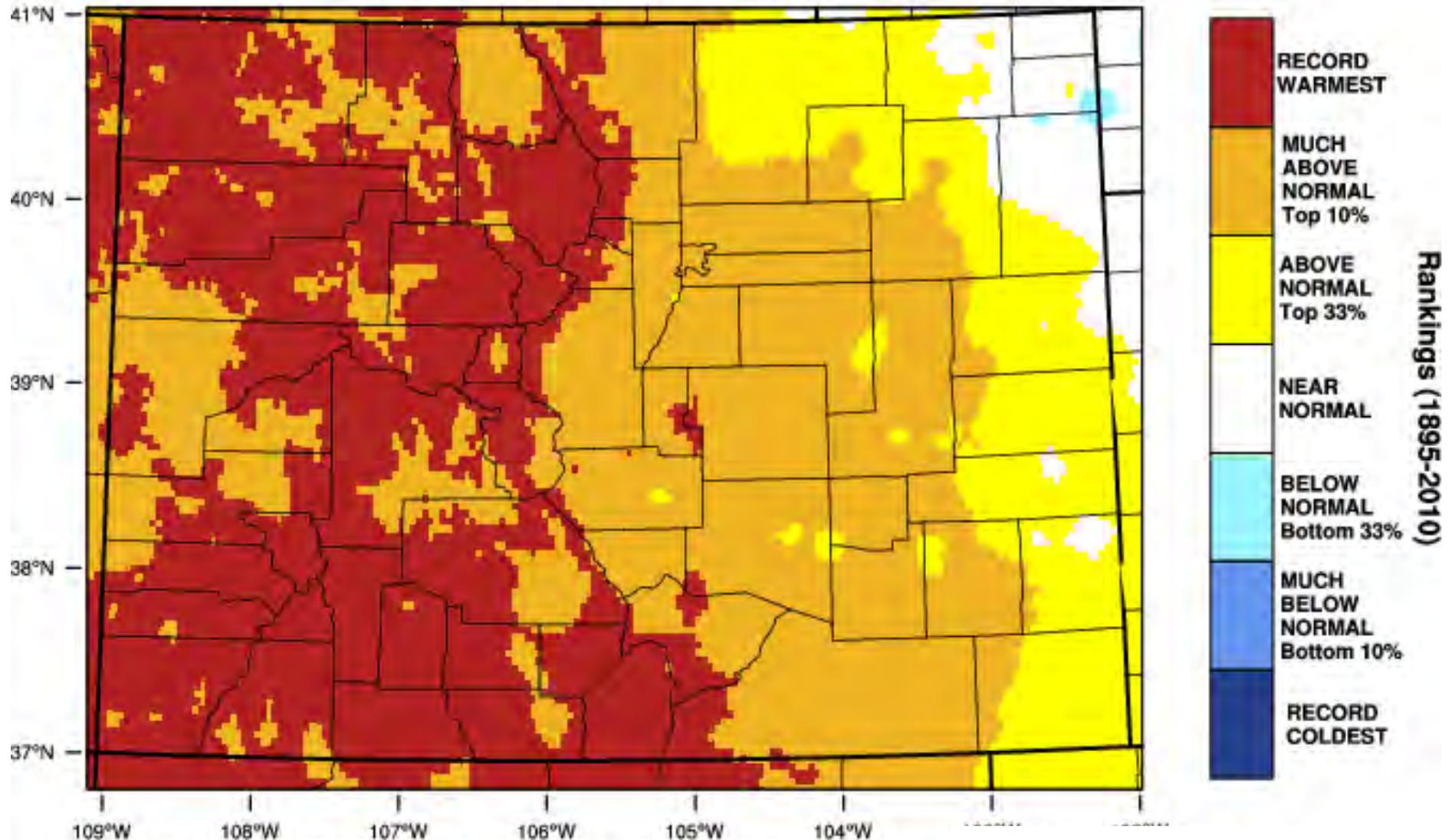
Powered by ACIS

# Westwide temperatures Water Year 2018, relative to 1895-2010

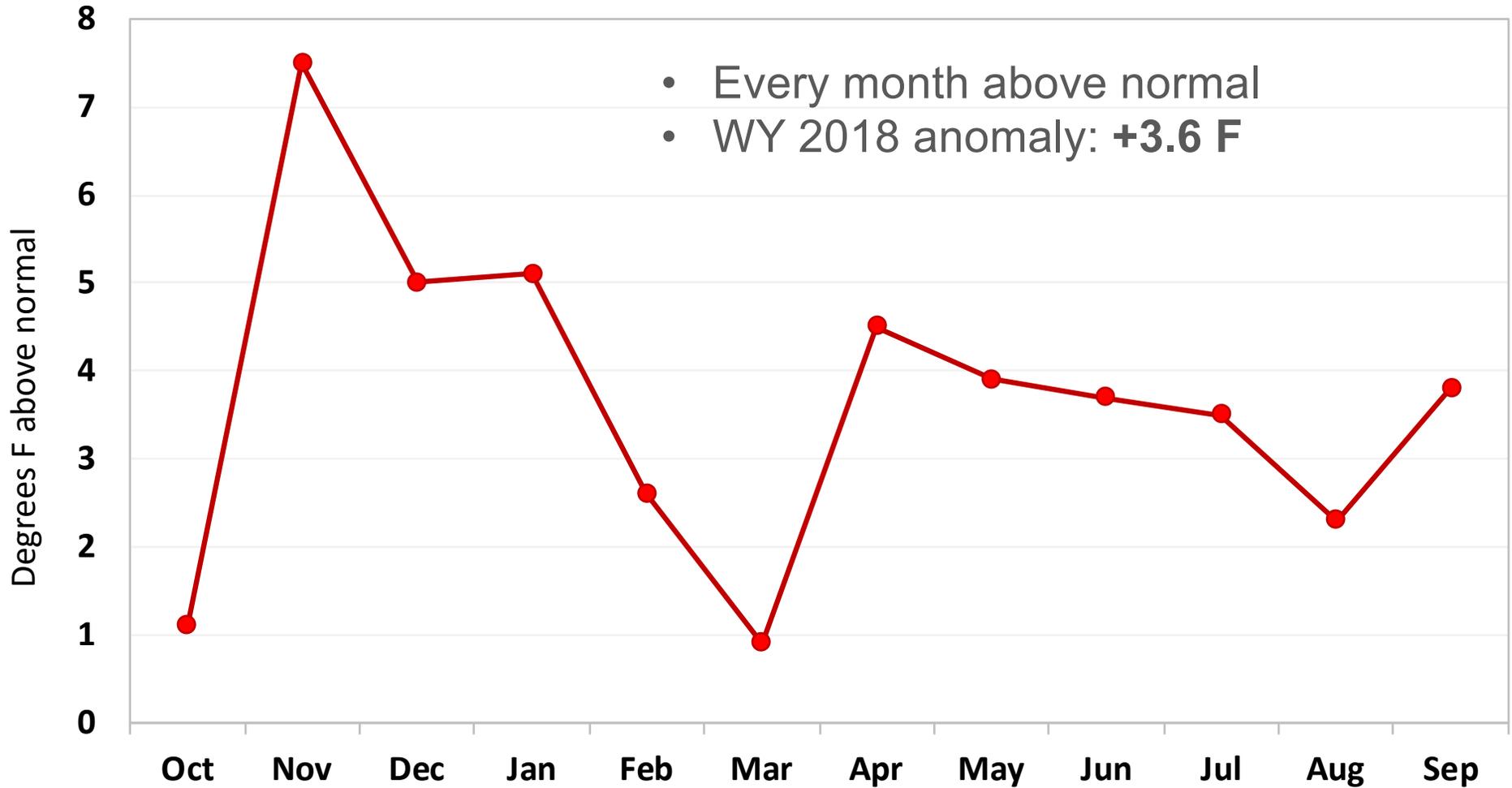


# Colorado temperatures Water Year 2018 relative to 1895-2010

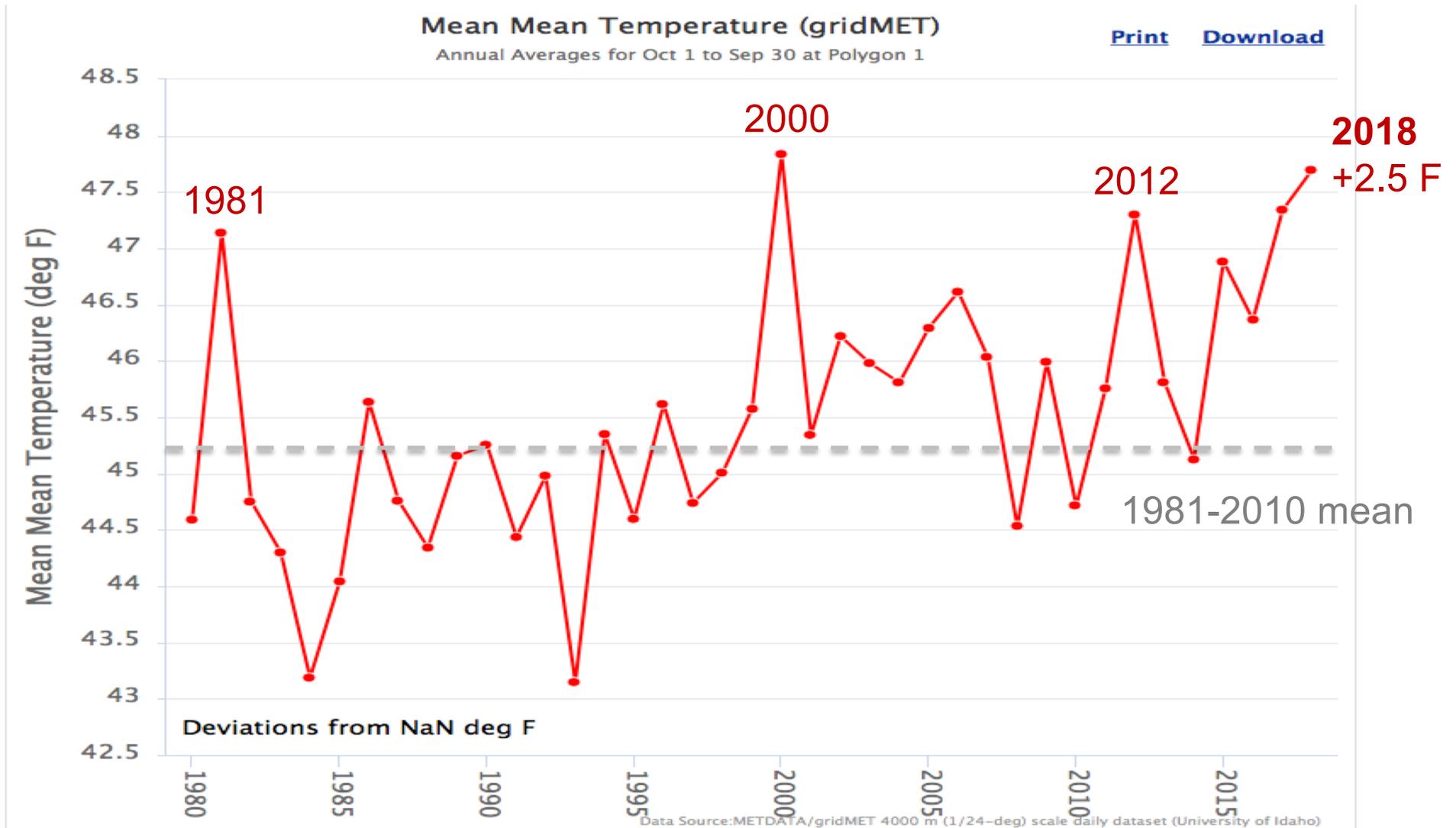
October-September 2018 Percentile



# Cortez, CO monthly temperature anomalies WY 2018 relative to 1981-2010 normal



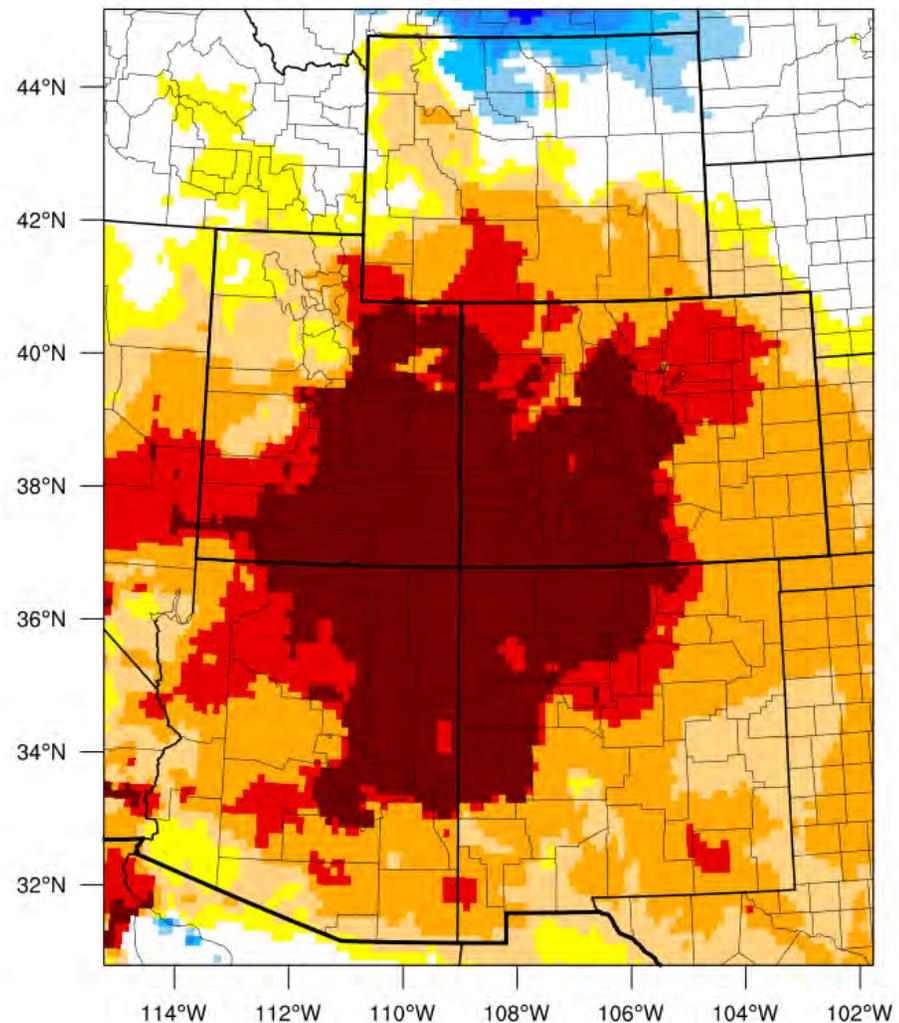
# Colorado statewide average annual temperature Water Years 1980-2018



# Intermountain West evaporative demand anomaly (EDDI) Water Year 2018

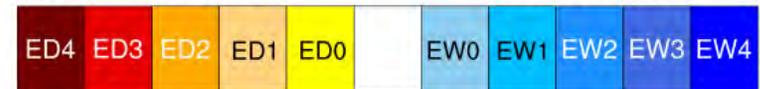
- Highest water-year average evaporative demand on record (1980- ) over eastern UT, and most of CO western slope, plus central CO
- 2<sup>nd</sup>-highest over much of northern Front Range

12-month EDDI categories for October 3, 2018



Drought categories

Wetness categories



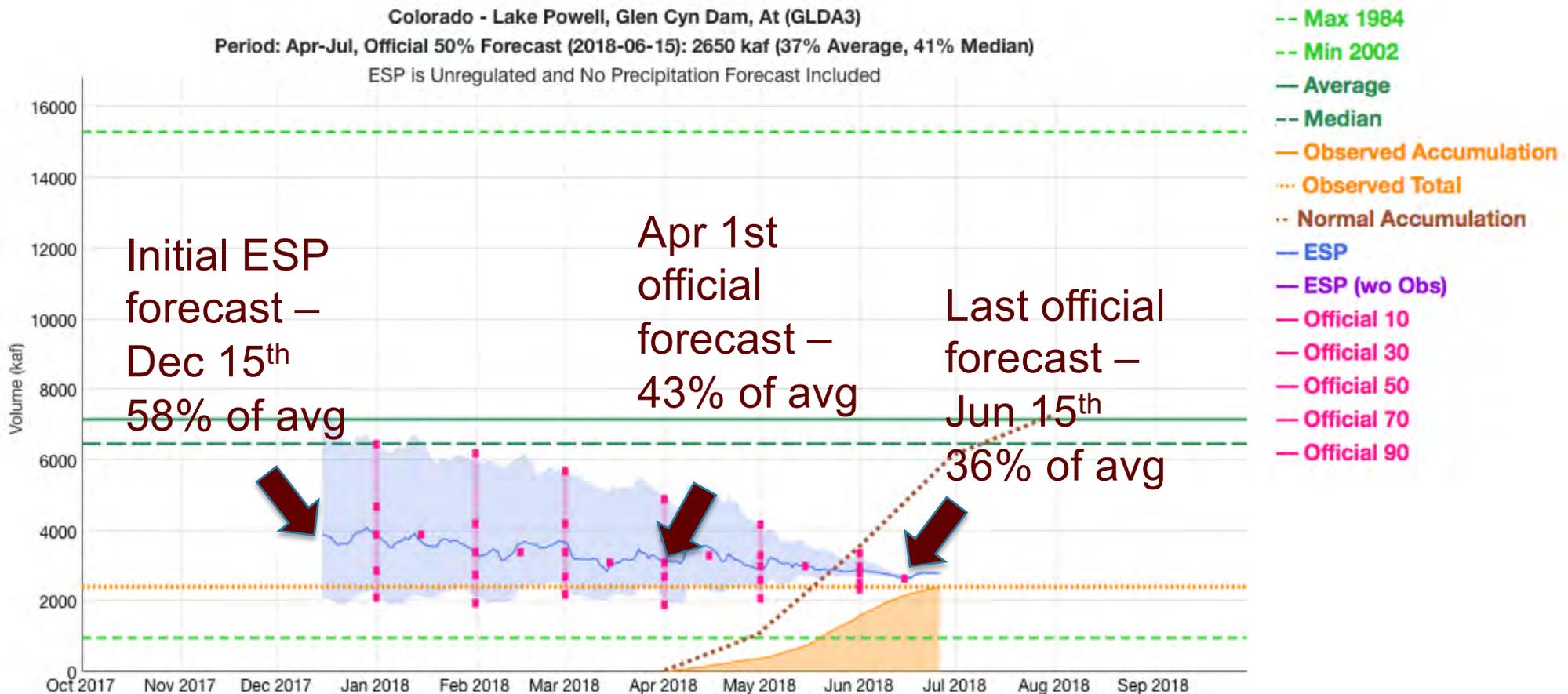
100% 98% 95% 90% 80% 70% 30% 20% 10% 5% 2% 0%  
(EDDI-percentile category breaks: 100% = driest; 0% = wettest)

Source: <https://www.esrl.noaa.gov/psd/eddi/>

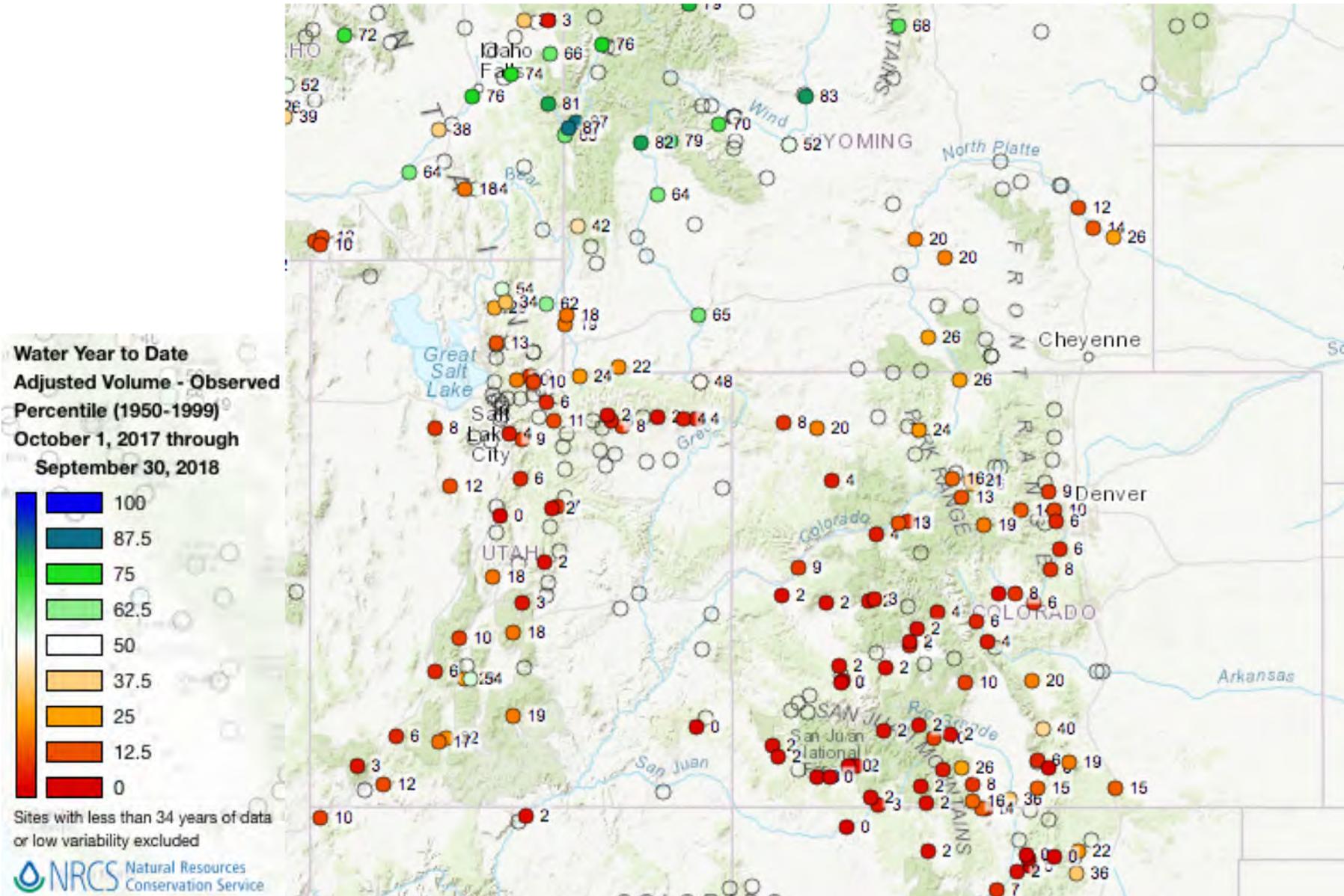
Generated by NOAA/ESRL/Physical Sciences Division

# Starting in December, water supply forecasts called for much-below-normal runoff—then got even worse

## Forecasted Lake Powell inflows – NOAA CBRFC

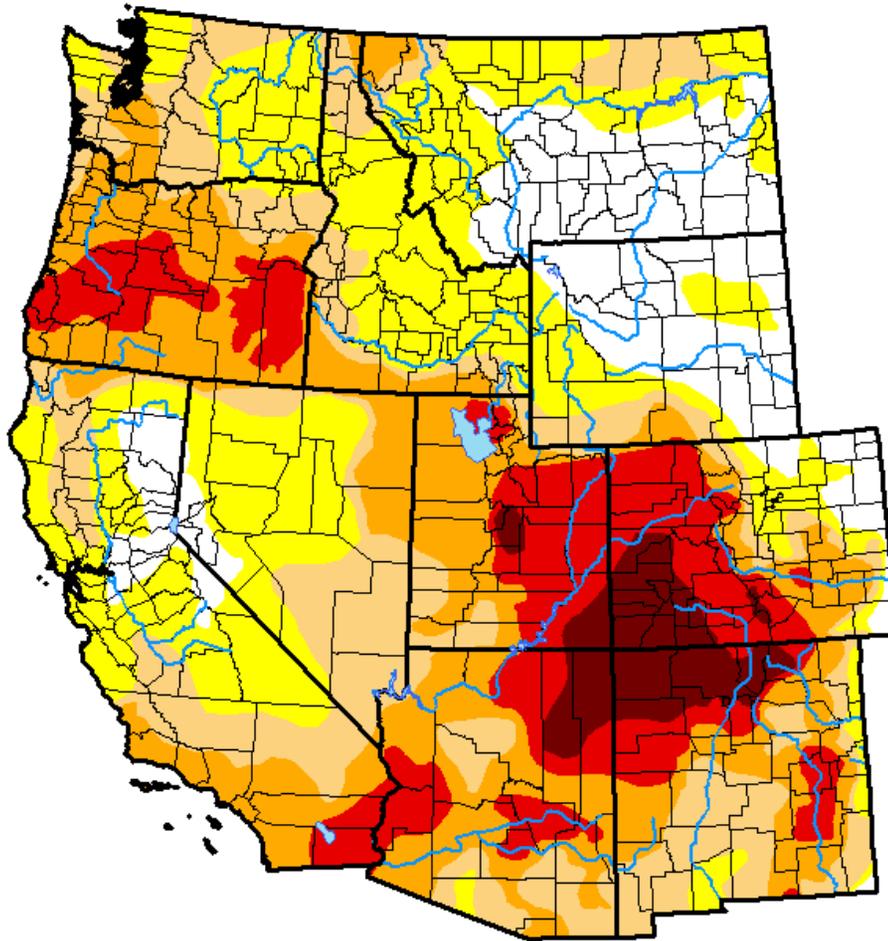


# Water-Year 2018 streamflow, percentiles



Source: NRCS Interactive Map, [https://www.wcc.nrcs.usda.gov/webmap\\_beta/](https://www.wcc.nrcs.usda.gov/webmap_beta/)

# US Drought Monitor – 2 October 2018



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
<b>Current</b>	14.15	85.85	59.29	38.88	17.58	4.36
<b>Last Week</b> <i>09-25-2018</i>	13.91	86.09	59.57	39.68	18.15	4.36
<b>3 Months Ago</b> <i>07-03-2018</i>	30.32	69.68	48.13	31.39	18.70	4.65
<b>Start of Calendar Year</b> <i>01-02-2018</i>	48.76	51.24	29.03	8.60	1.52	0.00
<b>Start of Water Year</b> <i>09-25-2018</i>	13.91	86.09	59.57	39.68	18.15	4.36
<b>One Year Ago</b> <i>10-03-2017</i>	55.65	44.35	19.71	8.24	2.90	1.26

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:

David Miskus  
NOAA/NWS/NCEP/CPC



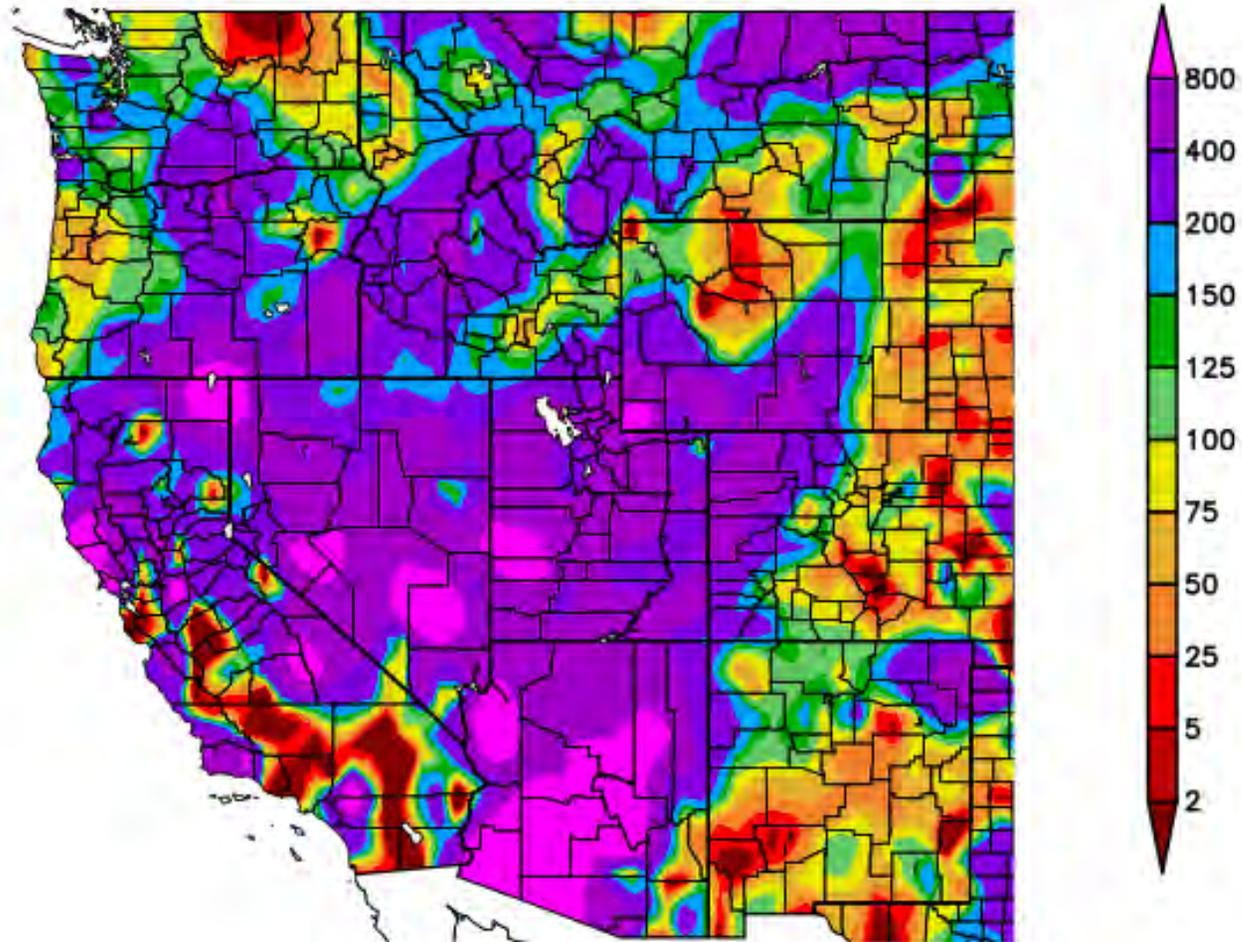
<http://droughtmonitor.unl.edu/>

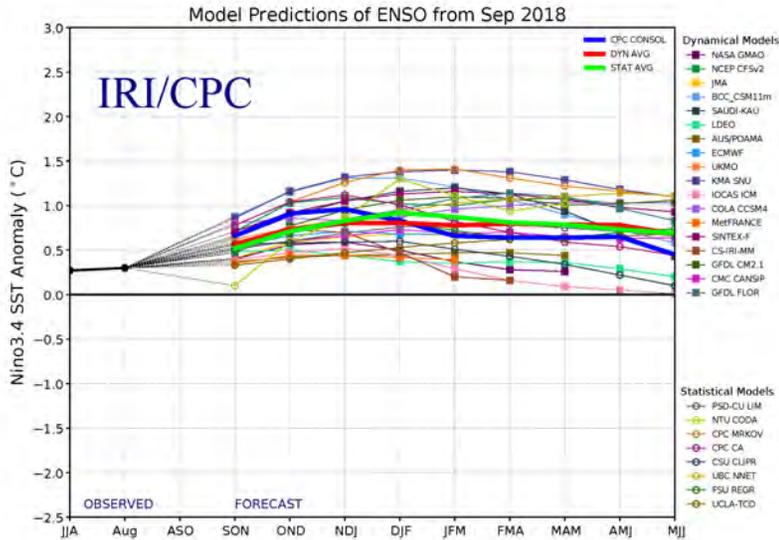
## Other unusual/unprecedented drought impacts

- **Fires** - Five of the 20 largest Colorado wildfires on record, including #2
- **Low flows** - Record-low September monthly flows (<1977, 2002): Yampa, Eagle, Roaring Fork, Gunnison, San Miguel, Dolores, San Juan, Rio Grande
- **Reservoir depletion** – Now 57% chance of Lower Basin shortage condition in 2020 (Mead <1075')
- **Ag impacts** - July cattle sales in La Junta (3,000 head) for first time in years

# What about Water Year 2019?

Percent of Normal Precipitation (%)  
10/1/2018 – 10/7/2018





# What about Water Year 2019?

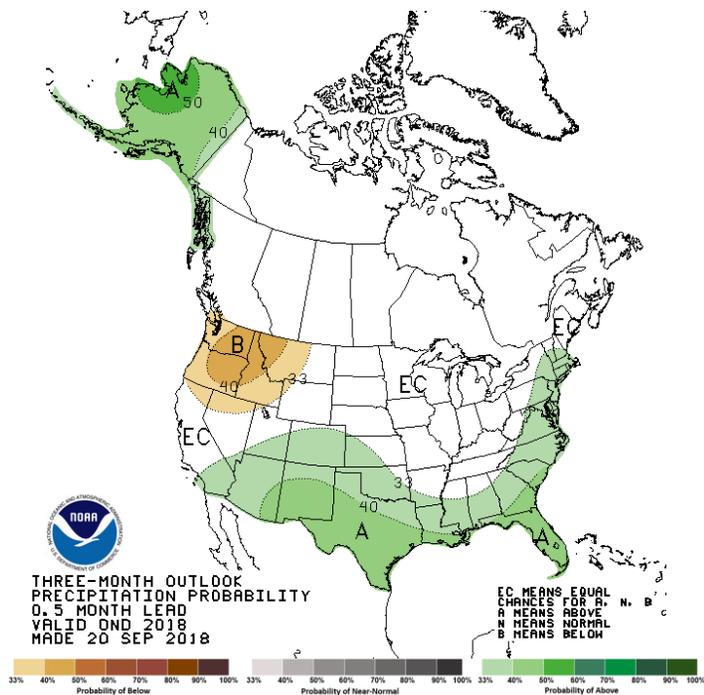


Strong likelihood (70%) of weak-moderate El Nino conditions

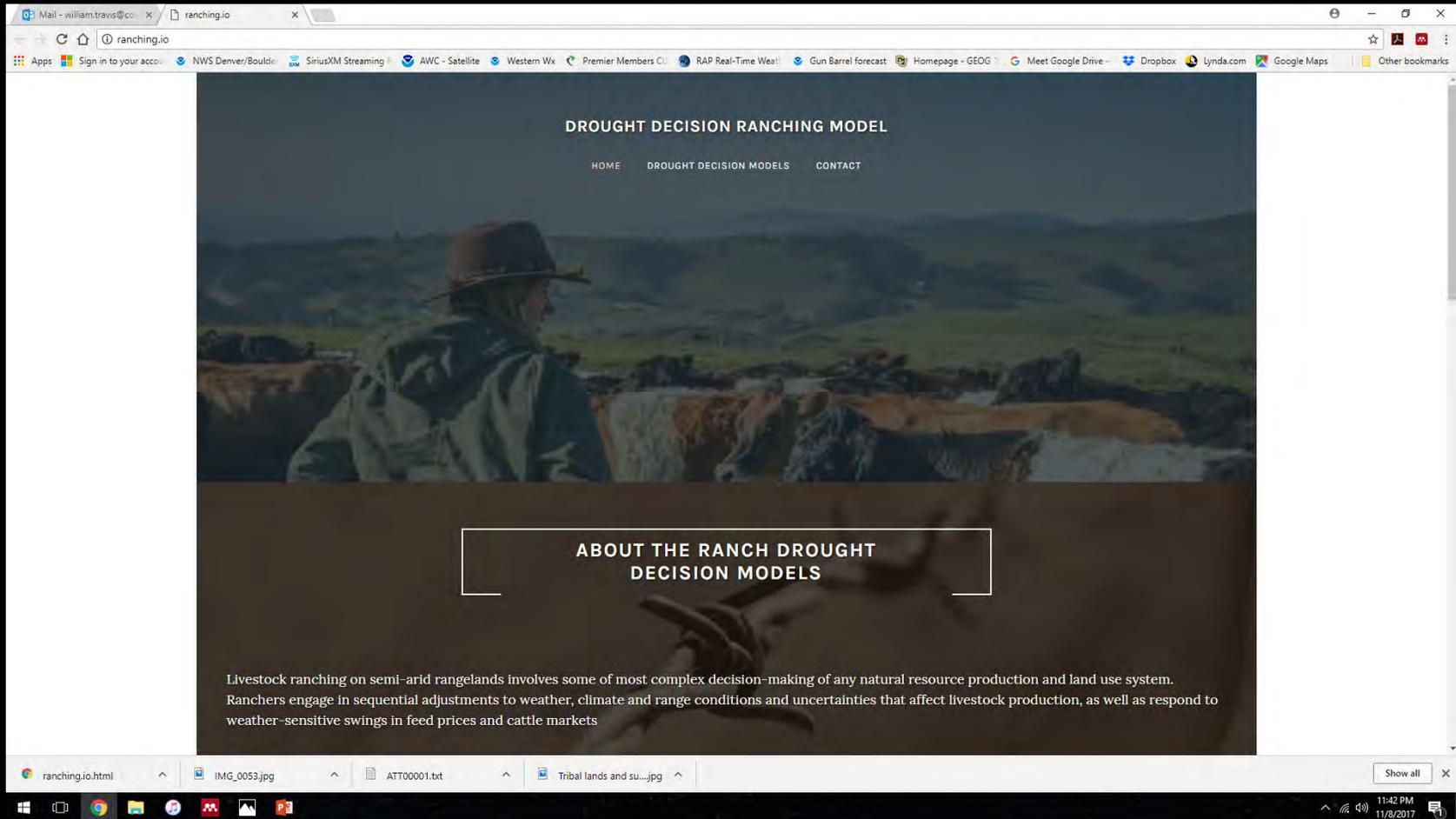


CPC precip forecasts reflect historical El Nino pattern – but modest signal/skill for Colorado

- Large soil-moisture deficits likely to reduce runoff efficiency next spring
- I'd hedge towards below-normal runoff for West Slope and UCRB



# Online Ranch-Drought Decision Model Try it out! <http://ranching.io/>



The screenshot shows a web browser window displaying the website [ranching.io](http://ranching.io/). The page title is "DROUGHT DECISION RANCHING MODEL". The navigation menu includes "HOME", "DROUGHT DECISION MODELS", and "CONTACT". The main content area features a large background image of a person in a cowboy hat looking out over a landscape. Below the image, the text reads: "ABOUT THE RANCH DROUGHT DECISION MODELS". The text below this heading states: "Livestock ranching on semi-arid rangelands involves some of most complex decision-making of any natural resource production and land use system. Ranchers engage in sequential adjustments to weather, climate and range conditions and uncertainties that affect livestock production, as well as respond to weather-sensitive swings in feed prices and cattle markets". The browser's address bar shows "ranching.io" and the taskbar at the bottom indicates the date and time as 11:42 PM on 11/8/2017.

## Hypothesis Testing with Randomized Control Online Ranch-Drought Decision Model Experiments

Phase 1: 500+ general audience (non-ranchers)

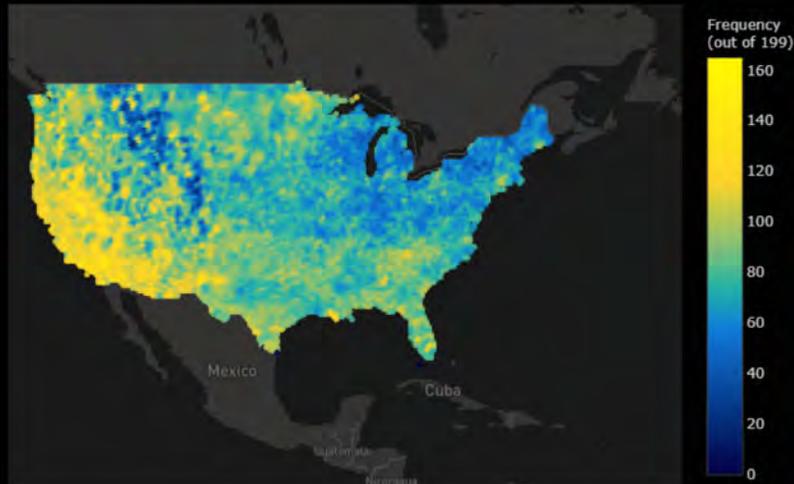
Phase 2: 100 ranchers recruited with USDA Hub's help

- How much do ranchers invest in drought adaptation given recent conditions and future expectations?
- Does insurance affect investment in drought adaptation?
- Does insurance affect the intensity of grazing through larger herds?
- Examine the value of additional information (VAI) in decision-making (SDO & other forecasts, alternative drought indices)

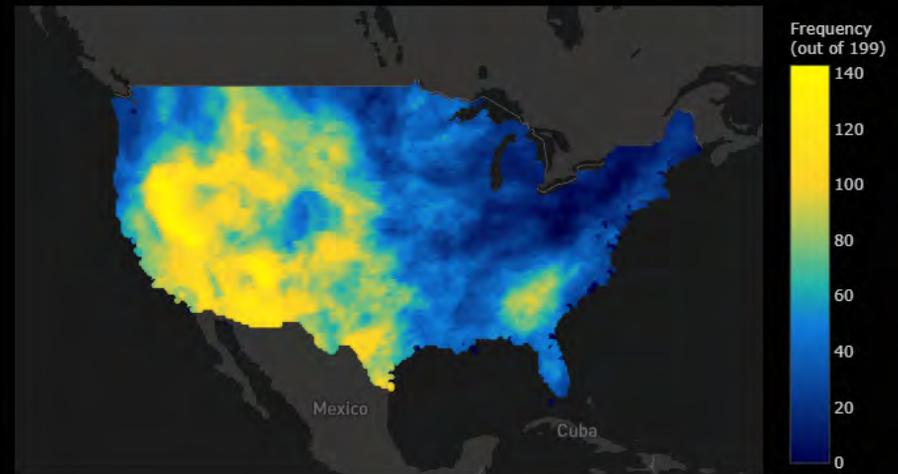
- Assess outcomes when the PRF insurance payouts are pegged to different drought indices (Palmer, SPEI, USDM, EDDI)

<https://www.earthlab-riskappone.org/>

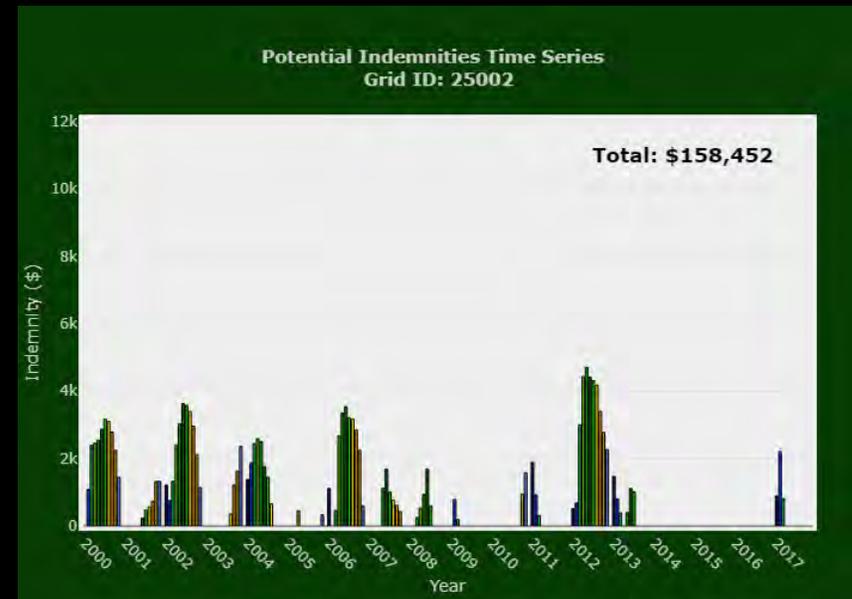
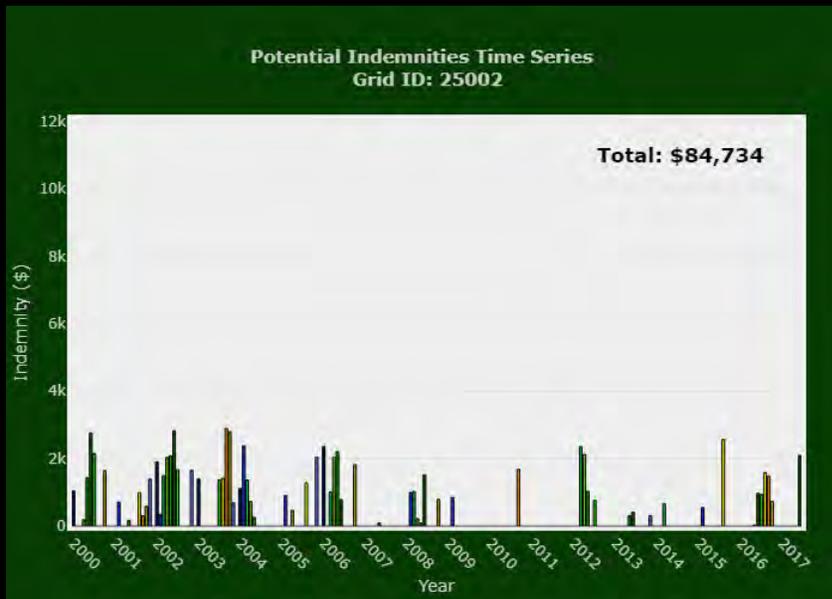
Rainfall Index | Sub 85% Frequency



USDM | D1+ Drought Frequency



- Assess outcomes when the PRF insurance payouts are pegged to different drought indices (Palmer, SPEI, USDM, EDDI)
- <https://www.earthlab-riskapptwo.org/>



# 2018 WWA VCAPS Pilot Program

(stands for Vulnerability, Consequences Adaptation Planning Scenarios)

- Partnered with CISA (Carolinas RISA) to learn VCAPS method
- Staff teams of 4 or 5 people
- How does our experience with VCAPS in the Rocky Mountain West compare to past VCAPS efforts in coastal areas?
- **Summer 2018:**
  - Durango, CO
- **Fall 2018:**
  - Carbondale, CO
  - Cortez, CO
  - Routt County, CO
  - Springdale, UT

## VCAPS supports communities to:

- **Engage in dialogue** about future weather and climate threats
- Summarize and **integrate local knowledge** and experience about how the community may be impacted
- **Identify gaps** in data, knowledge, or understanding
- **Think strategically** about how to prevent harm by taking action in the short and long term

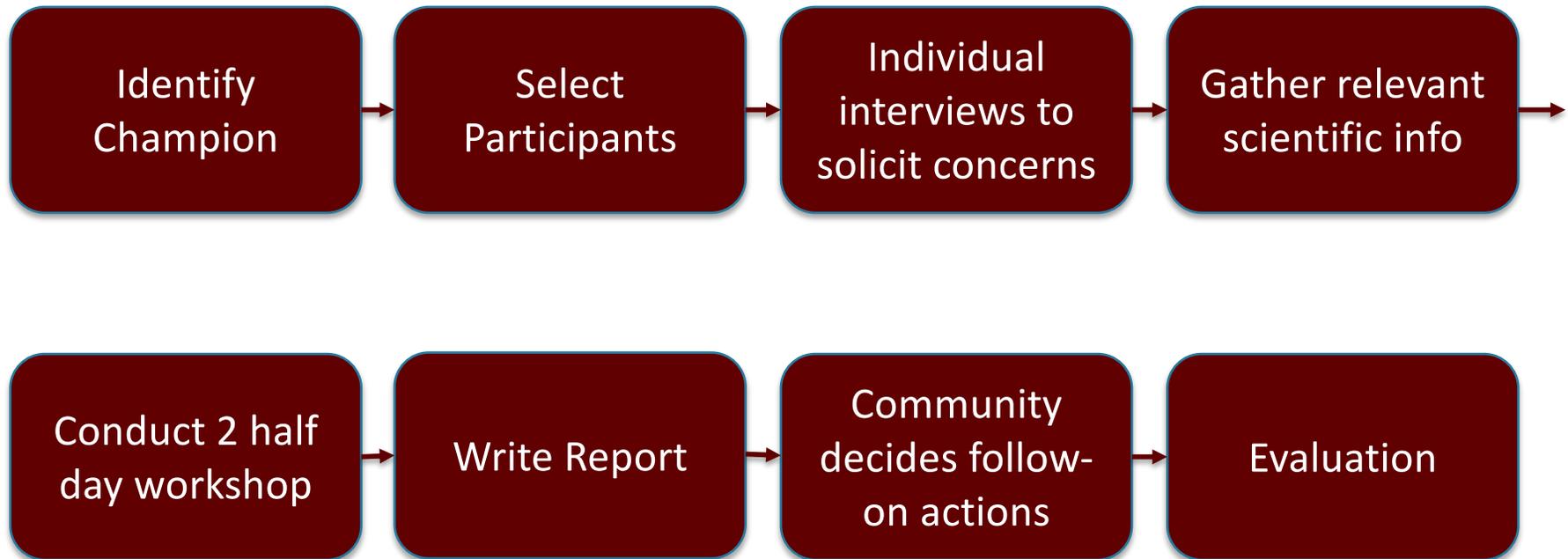
*...through a facilitated group diagramming process*

## What is VCAPS?

- Structured, facilitated dialogue and diagramming process
- Engages participants to think through causal model of hazards and outcomes
- Focuses on actions
- Participants develop ideas for action within the context of their own community
- Goal: *to help communities become more resilient to weather and climate change*



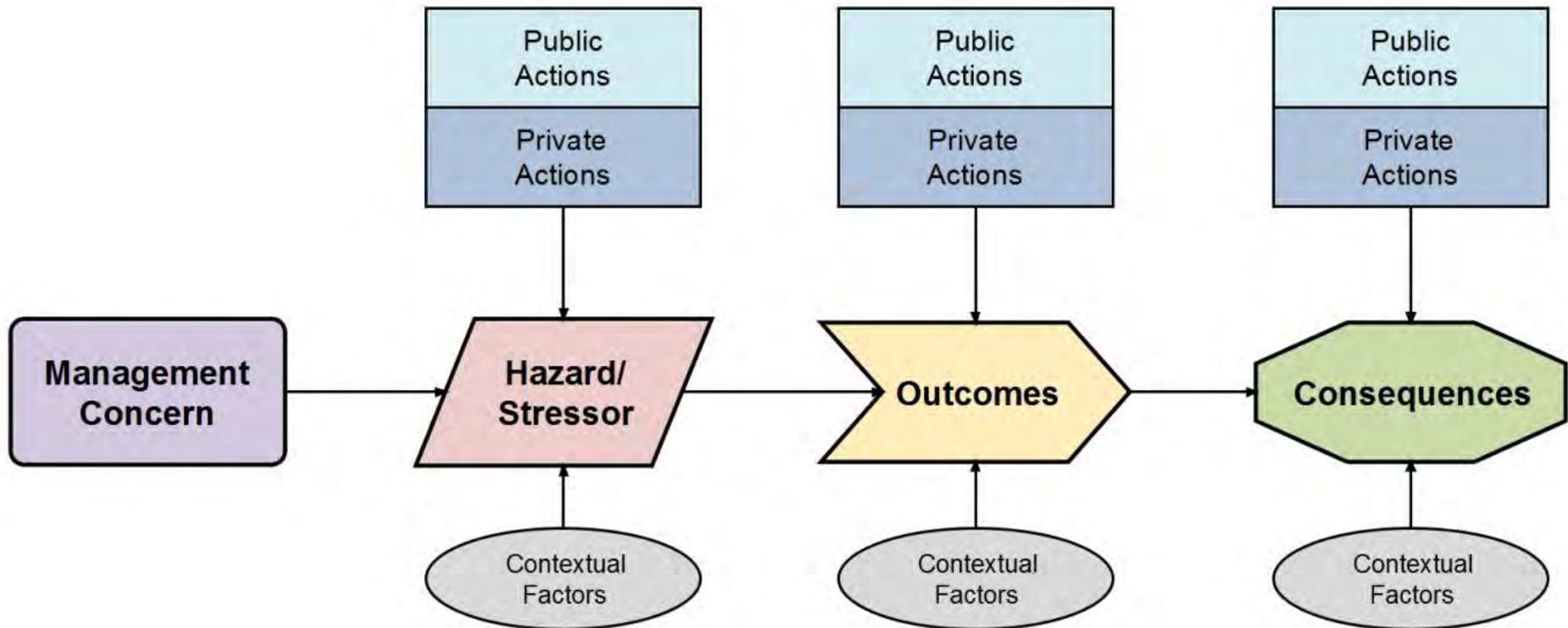
# VCAPS Process

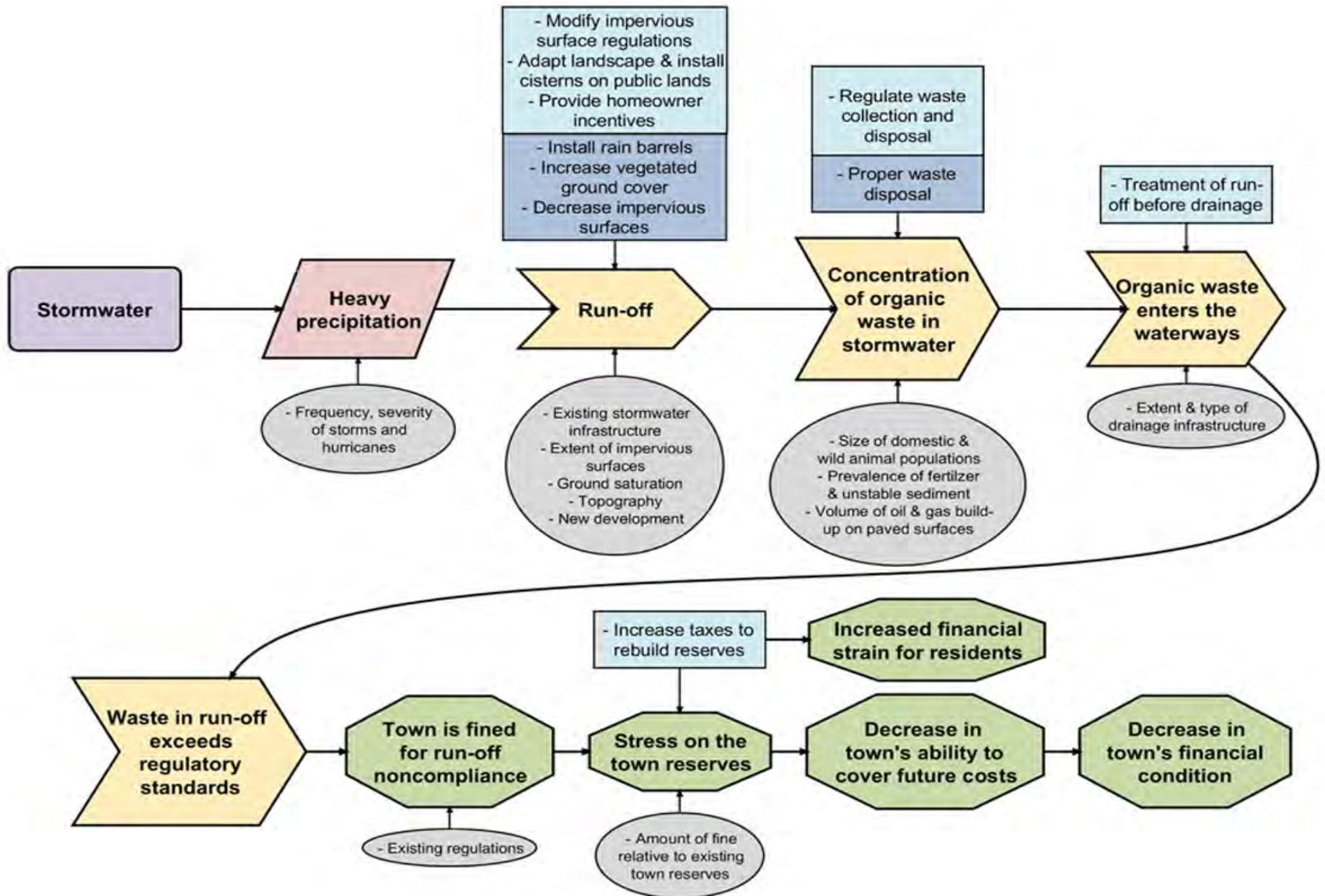


## Goals for VCAPS Communities

- Use a **systems-thinking approach** to make sense of how climate and weather hazards are linked to social, economic, and other community consequences
- Create an **inventory of public and private actions** that can reduce vulnerability to a hazard of concern
- **Generate dialogue and shared understanding** about collective tolerance/concerns for climate risks

# VCAPS Building Blocks





## Why VCAPS for WWA?

- Committed to **make science more usable** for communities to prepare for climate impacts
- **Testing new techniques** for providing effective decision support and supporting local adaptation
- Interested in **expanding** the range of stakeholders we work with, e.g. local municipalities

# **Applying Science to Decision-making: The CO-NM Regional Extreme Precipitation Study**

**Bill McCormack, Chief, Colorado Office of Dam Safety**

# Lunch

## 2018 Drought Discussion

- RSVP question: Biggest impact of the drought
  - Increased interest in planning and in drought information
  - More meetings, calls and workshops
  - More concern and discussions about the CO River shortage
  - Economic impacts: high water bills, selling herds, hauling water
  - Low flows, muddy water, lack of flushing flows
- How has this year changed (or not) things for
  - You?
  - your organization?
  - others in your network?
- Have there been surprises?

## **RSVP Question: What WWA info do you use the most? (no particular order)**

- Dashboards
- Climate Change in CO and other climate reports
- Drought information
- Expertise of the staff
- Extreme events information

## Breakout Group Questions

- What do you value in WWA? What would you like us to continue doing? Please give recent examples of when WWA helped you.
- What “climate services” do you need that you are currently unable to get?
- Are there any new (within last few years) tools or information that you use? Why are they helpful?