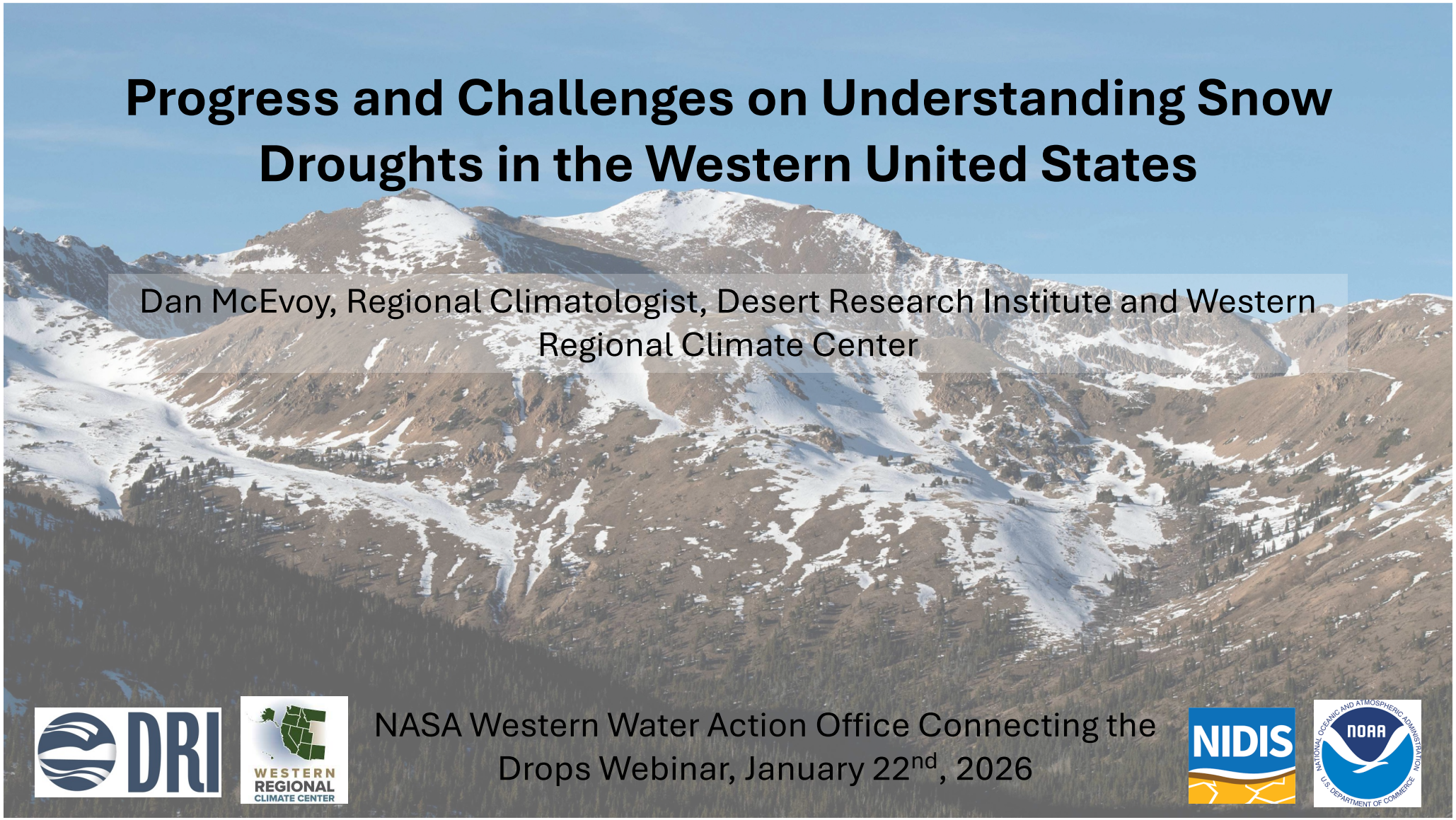
# Progress and Challenges on Understanding Snow Droughts in the Western United States

Dan McEvoy, Regional Climatologist, Desert Research Institute and Western Regional Climate Center



NASA Western Water Action Office Connecting the Drops Webinar, January 22nd, 2026

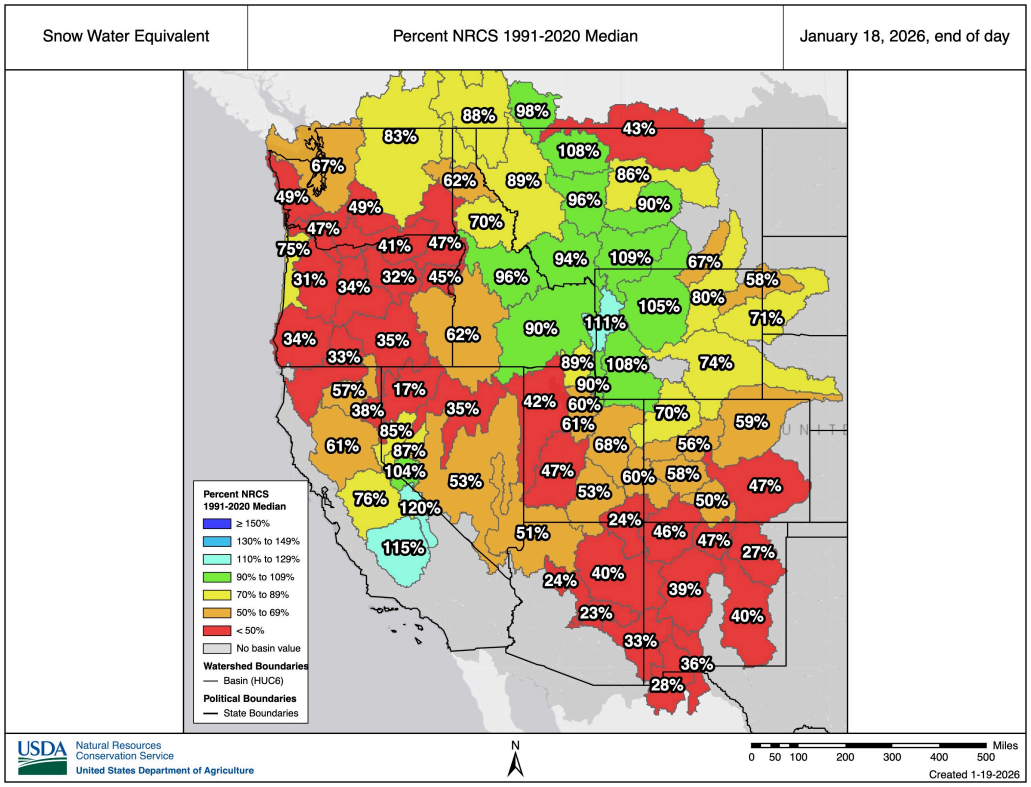
Dr. James Church 1906
Photo: NRCS

# Snow, water supply, and drought in the West have been linked for over a century.


Snow survey in the 1940s.
Photo: NRCS

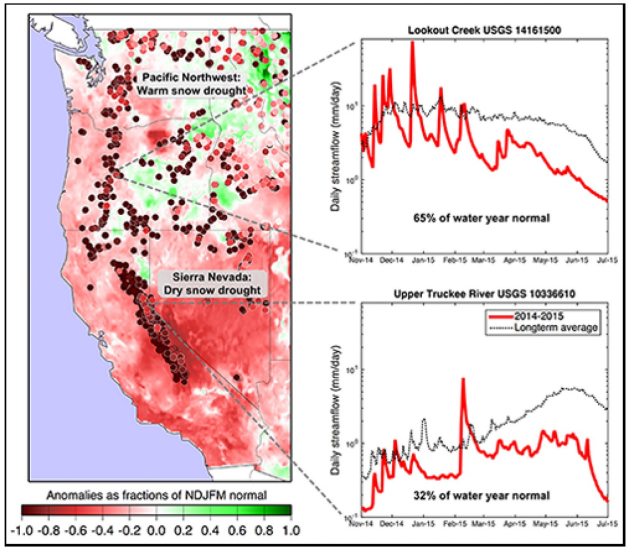
Snow Survey on Mt Rose, NV in 2023. Photo: KOLO8

# Snow Drought?



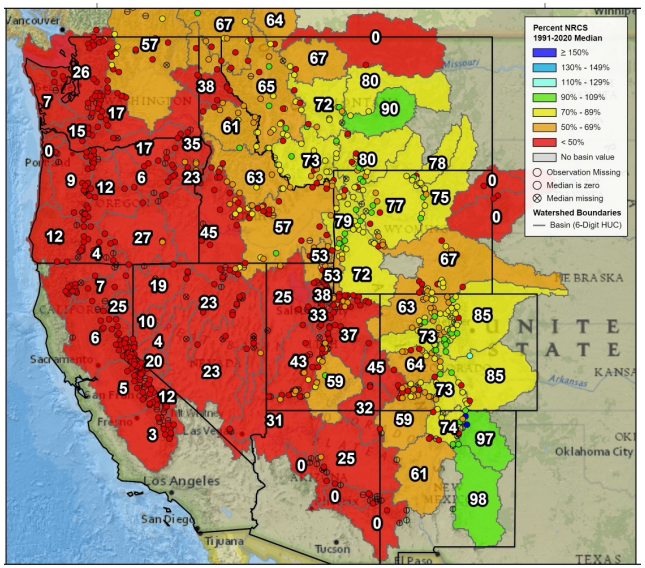

- Why has the term surfaced in just the past decade?
- Snowpack or snow water equivalent (SWE) deficit
- How did we arrive in this situation?
- What are the drivers of the snow drought?

Harpold et al., 2017 Eos

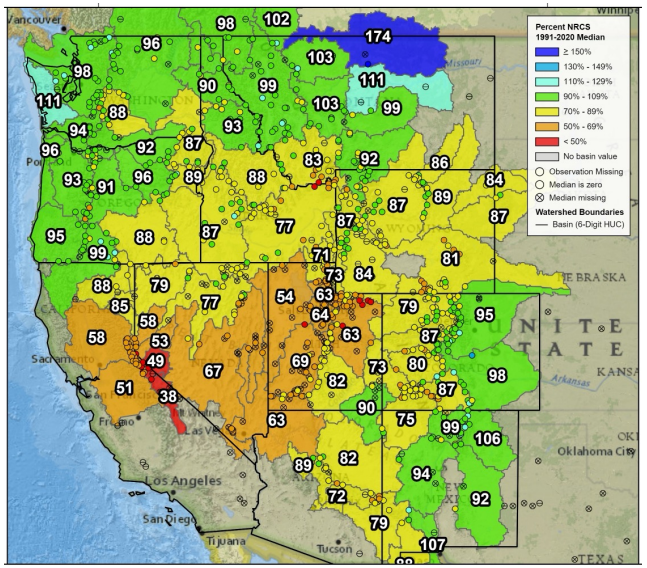



# Mountain snowpack, water cycle, and associated drought impacts in the West have been changing.

April 1, 2015, Snow Water Equivalent % of Normal

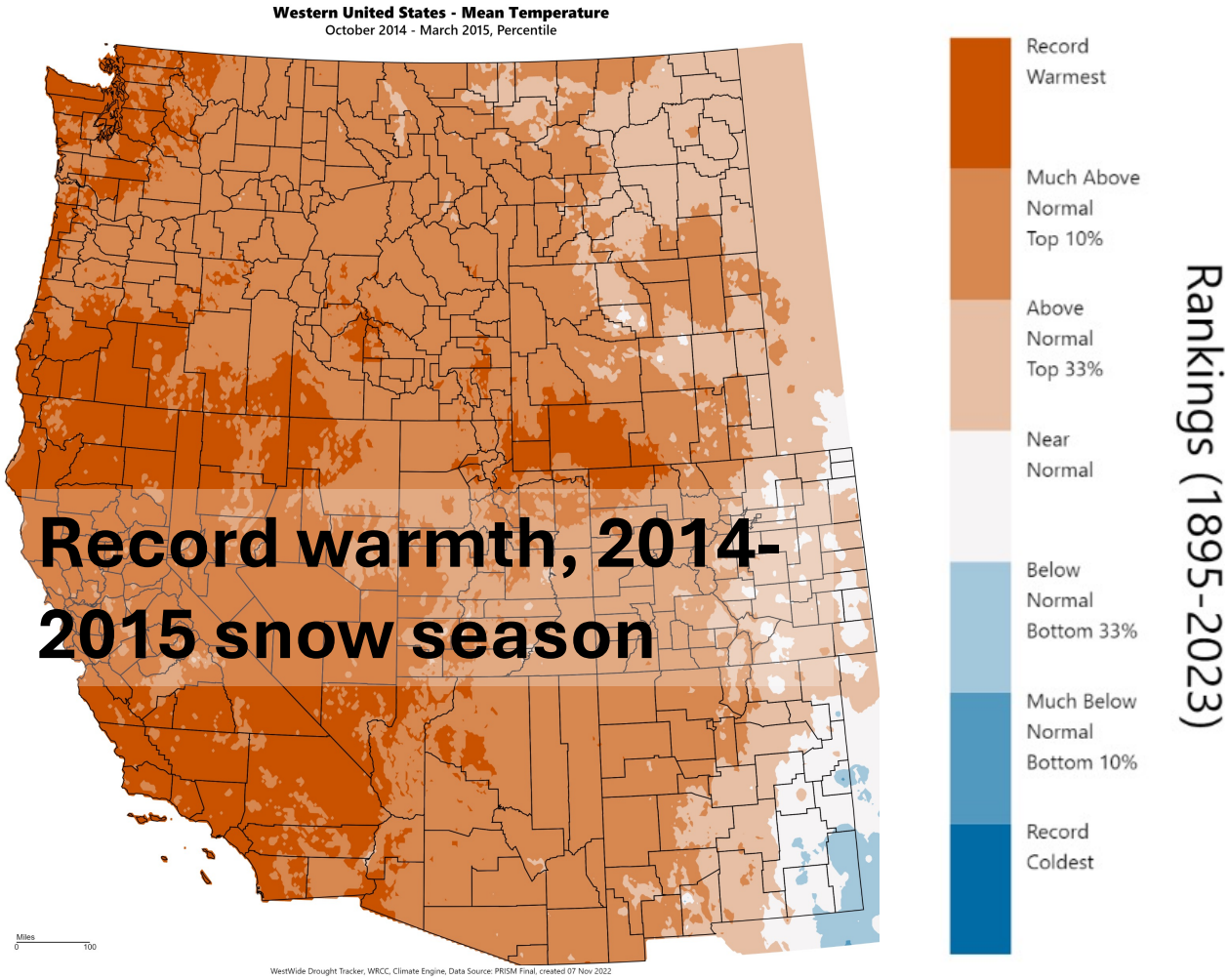



Oct-Mar 2015 Precipitation % of Normal




https://www.nrcs.usda.gov

Need to define different types of snow droughts?




2015 was eye opening:

Snow drought can be much more than lack of precipitation during winter.

https://wrcc.dri.edu/my/climate/wwdt

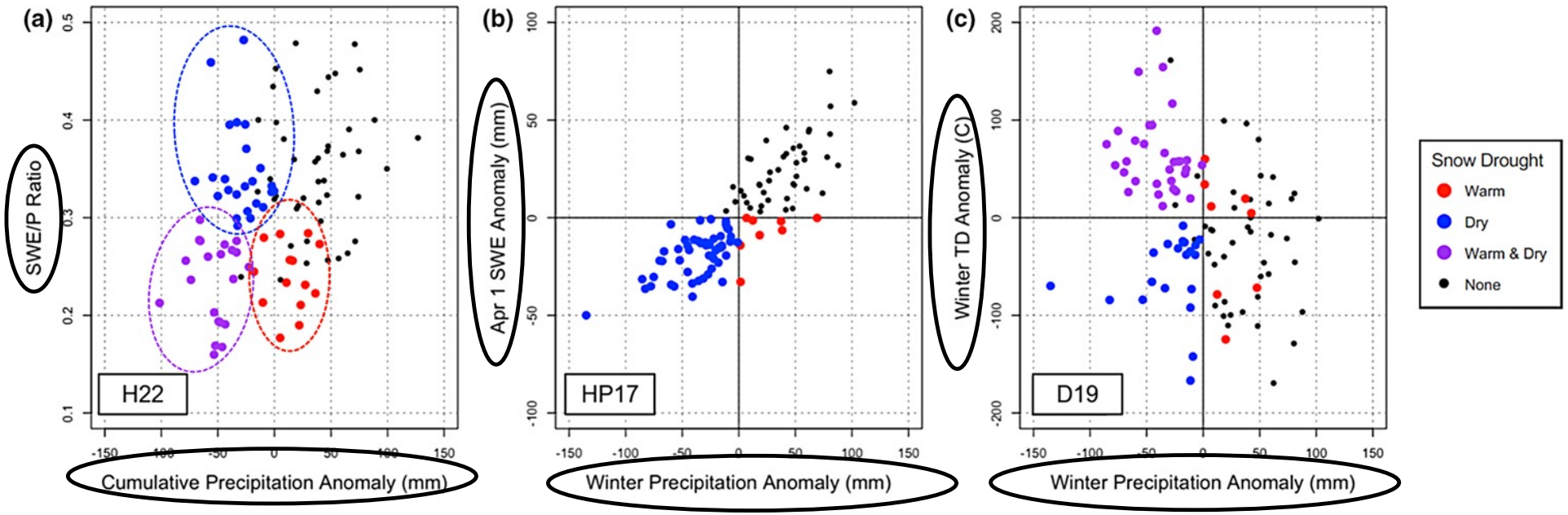
Dry snow drought = result of meteorological drought (low precipitation)

Warm (wet?) snow drought = **result of warm temperatures, not meteorological drought**

Impacts of warm and wet snow droughts are less understood and harder to communicate.

Let's work more on this!

# Need for a unified definition of snow drought?




Harpold et al., 2017

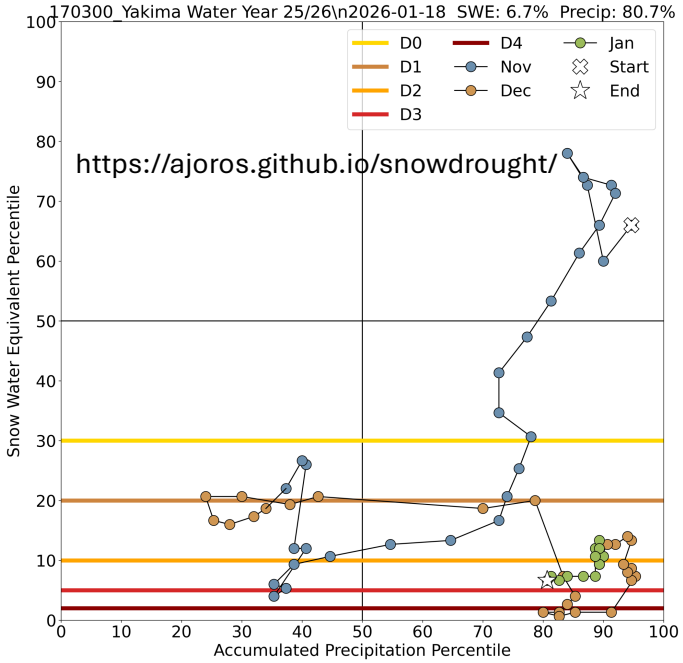
Dierauer et al., 2019

Who will use it?

Figure 3: Heldmyer et al. (2023), *JAWRA*.

# Define once a year or seasonally evolving?

- Track the **daily** progression of SWE and precipitation relationships **together**




https://ajoros.github.io/snowdrought/

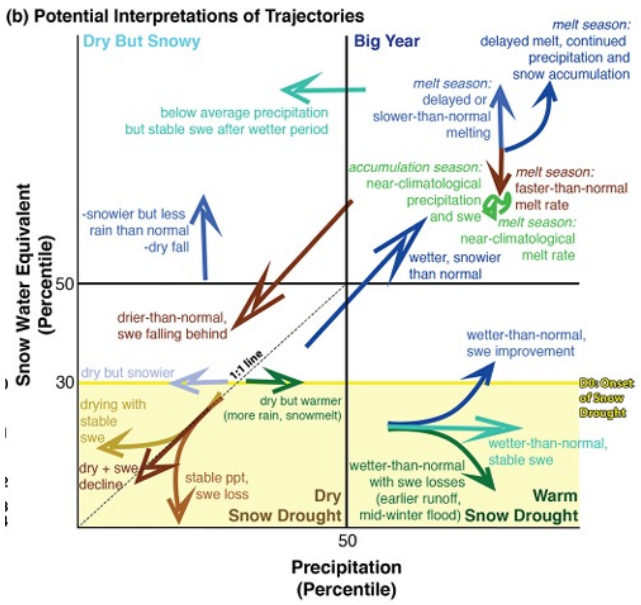
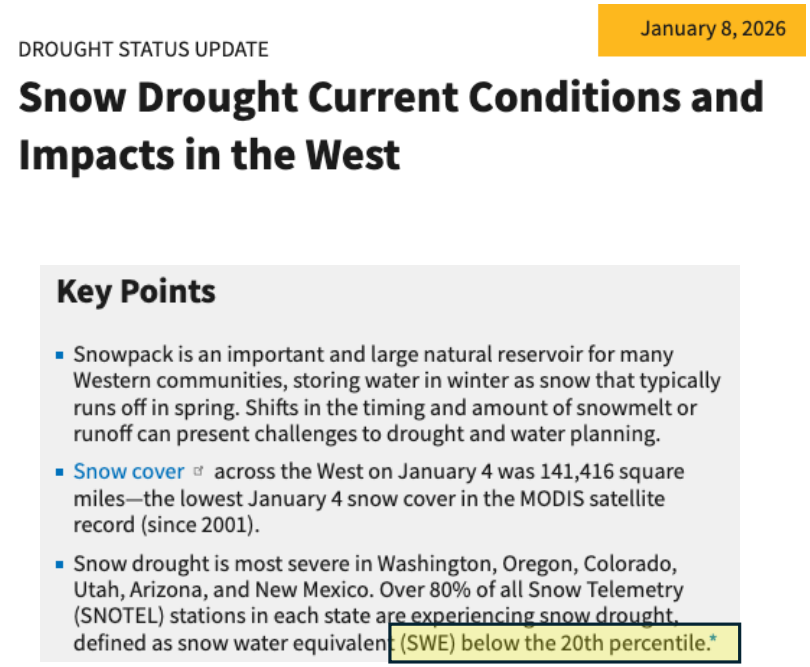



Figure: Hatchett, Rhoades, and McEvoy 2022, NHESS

- Many studies have used April 1 or peak SWE to define snow drought once a season
- Others have developed methods for daily tracking throughout a season

# Outreach and Communication Efforts



DROUGHT STATUS UPDATE

January 8, 2026

**Snow Drought Current Conditions and Impacts in the West**

**Key Points**

- Snowpack is an important and large natural reservoir for many Western communities, storing water in winter as snow that typically runs off in spring. Shifts in the timing and amount of snowmelt or runoff can present challenges to drought and water planning.
- Snow cover across the West on January 4 was 141,416 square miles—the lowest January 4 snow cover in the MODIS satellite record (since 2001).
- Snow drought is most severe in Washington, Oregon, Colorado, Utah, Arizona, and New Mexico. Over 80% of all Snow Telemetry (SNOTEL) stations in each state are experiencing snow drought, defined as snow water equivalent (SWE) below the 20th percentile.*

**76%**
of western CONUS stations have below-median SWE, as of January 4

**54%**
of western CONUS stations have SWE below the 20th percentile*, as of January 4

**Record Warmth, Rain Instead of Snow Intensifies Snow Drought Across the West**

Our snow drought definition:

- SWE <20$^{th}$ percentile
- Overly simplistic but a basic method might be needed to characterize the entire Western US
- How much does the definition really matter?
- Impacts of low/no snow likely most important

https://www.drought.gov/drought-status-updates/snow-drought-current-conditions-and-impacts-west-2026-01-08

# Hydrologic Impacts

Featured Article

**Streamflow timing and magnitude during snow drought depend on snow drought type and regional hydroclimate**

John Hammond, Annie Putman, Theodore Barnhart, Graham Sexstone, Gregory McCabe, David Wolock, Aaron Heldmyer & Stephanie Kampf ...show less

Hydrologic Sciences Journal, 2024

periods in British Columbia (Dierauer *et al.* 2021). In this study, snow droughts caused by low precipitation (warm & dry, cool & dry) were linked to low streamflow in most regions across the hydroclimatically diverse CONUS, whereas snow droughts caused by high temperature (warm & wet) only had low streamflow in dry interior regions. Low precipitation caus-

JAWRA
JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION

AMERICAN WATER RESOURCES ASSOCIATION

RESEARCH ARTICLE | Full Access

**A 21st-Century perspective on snow drought in the Upper Colorado River Basin**

Aaron J. Heldmyer, Nels R. Bjarke, Ben Livneh 2023

Water Resources Research

Research Article | Open Access

**Changes in Snow Drought and the Impacts on Streamflow Across Northern Catchments**

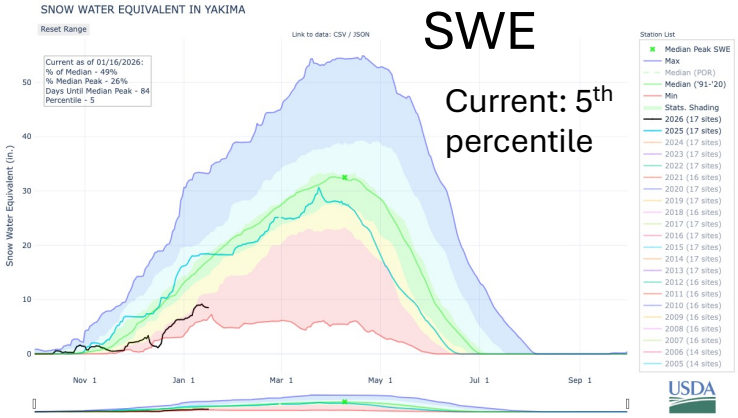
Juntai Han, Yuting Yang, Yuhan Guo, Changming Li, Ziwei Liu, Zhuoyi Tu, Haiyang Xi 2025

both cold and warm seasons, culminating in a significant decrease in annual $Q$. Conversely, warm snow drought increases annual $Q$ in catchments with $\overline{f_s} \leq 0.3$ but decreases annual $Q$ in catchments with $\overline{f_s} > 0.4$, attributable to a trade-off between increased cold-season streamflow ($Q_c$) and decreased warm-season streamflow ($Q_w$).

- Generally, dry snow droughts lead to lower streamflows
- Impacts of warm and wet snow droughts on streamflow is much more complicated and needs more attention!

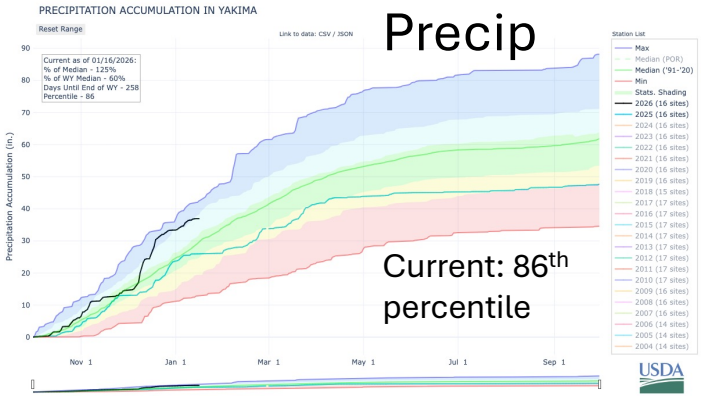
# Water management is region or basin specific

## Yakima Basin SWE




Current: 5th percentile

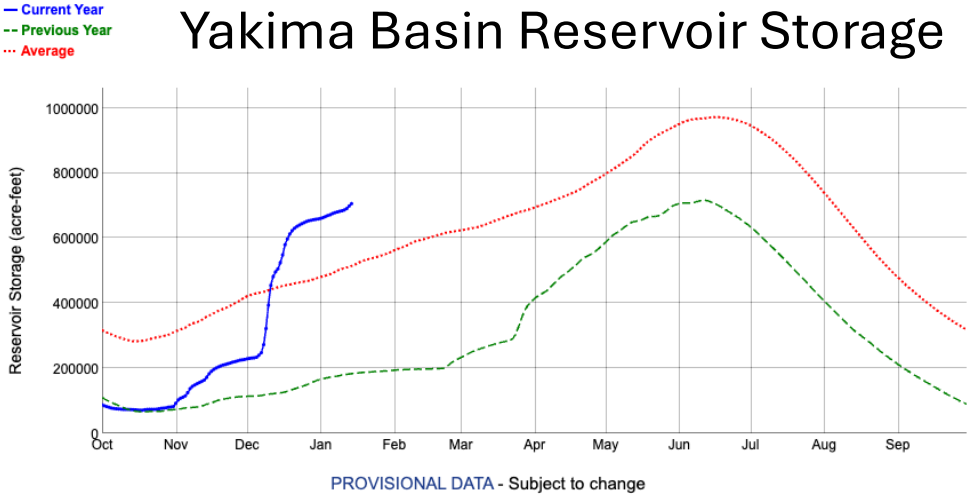
## Precip




Current: 86th percentile

- Huge water management challenge!
- Year-round releases required to meet minimum flows and flood control
- Still want to store as much as possible for summer irrigation season

## Yakima Basin Reservoir Storage



# Recreational Impacts


(Powder Magazine)

**'Huge bummer': Popular Mount Hood ski resort closes Friday, Saturday due to rain-soaked slopes**

(Oregon Live)

Impacts to both snow enthusiasts and local economies!

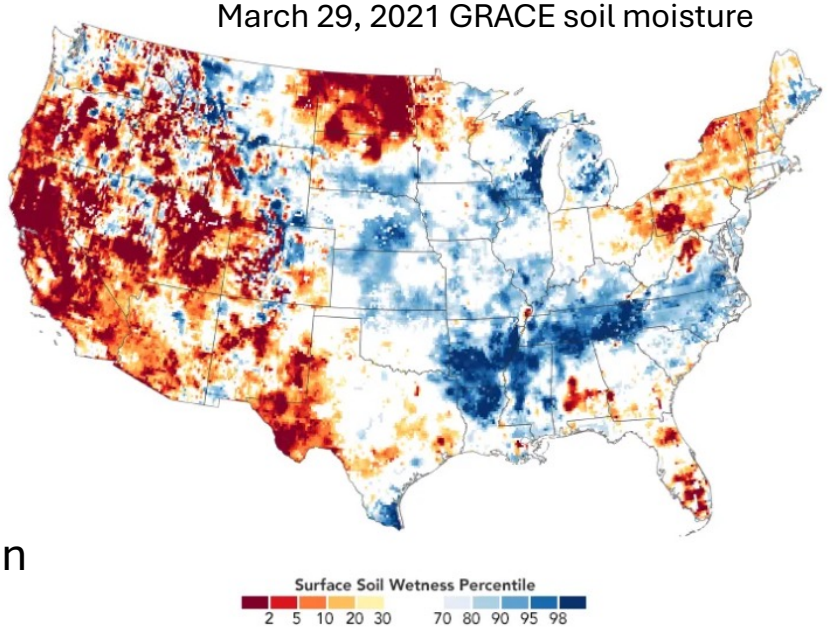
Snow-starved California ski resorts delay openings despite powerful recent storms

- Some California ski resorts have delayed their season openings despite recent storms, as unusually mild temperatures have prevented adequate snowfall.

(LA Times)

# Fire danger and ecosystem health impacts

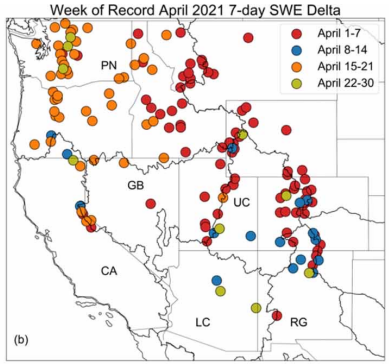
March 29, 2021 GRACE soil moisture

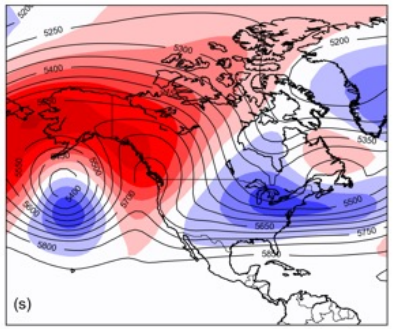



https://science.nasa.gov/

- Early snow disappearance dates often occur in snow drought years
- Impact: reduce summer soil moisture, earlier fire seasons, but more work needed here!

# Ongoing work: Spring heat waves, rapid snowmelt, and connections to snow drought

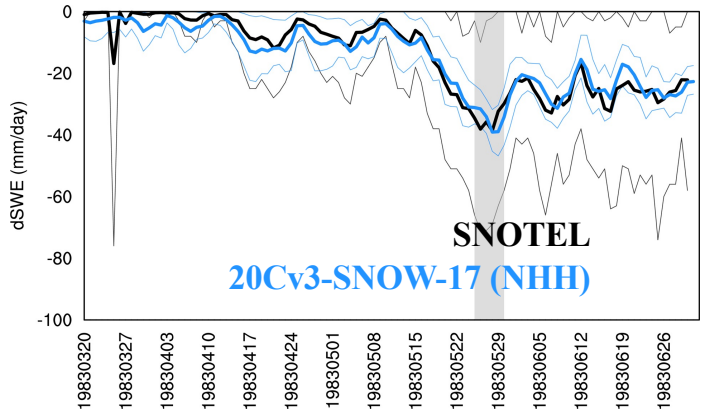


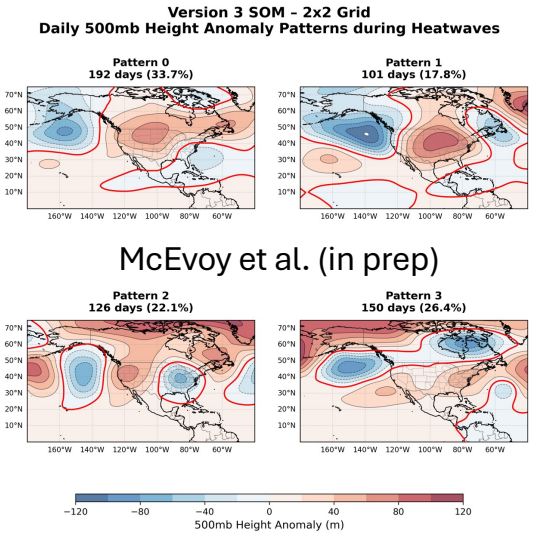




McEvoy and Hatchett, 2021, ERL

## Snow-eater heatwaves of western North America

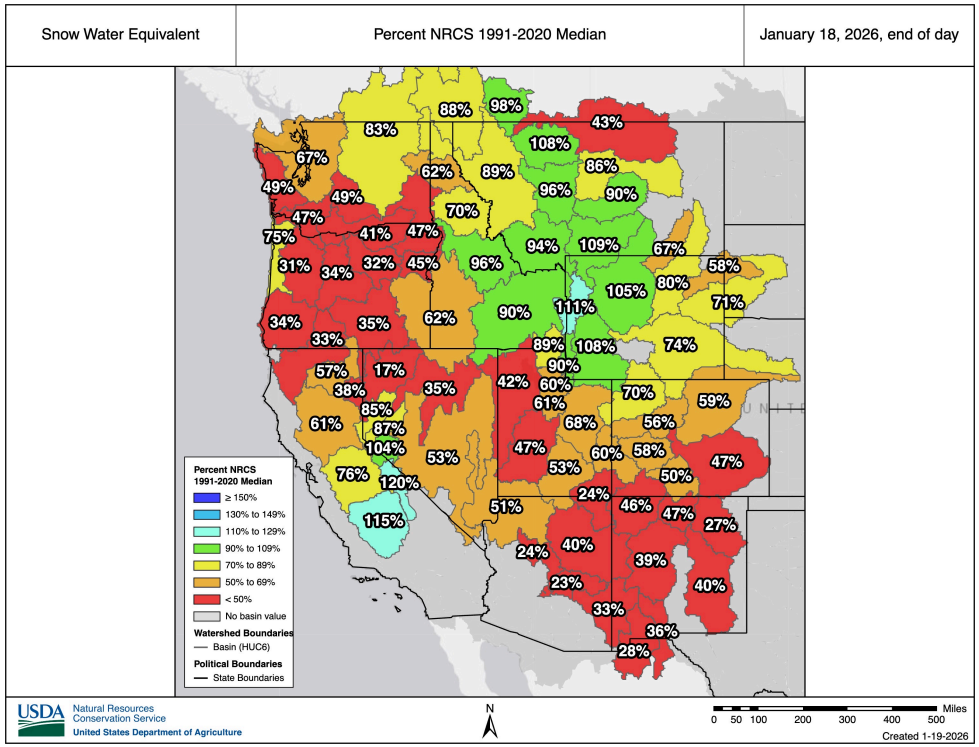
Rhoades et al, Science Advances (in revision)

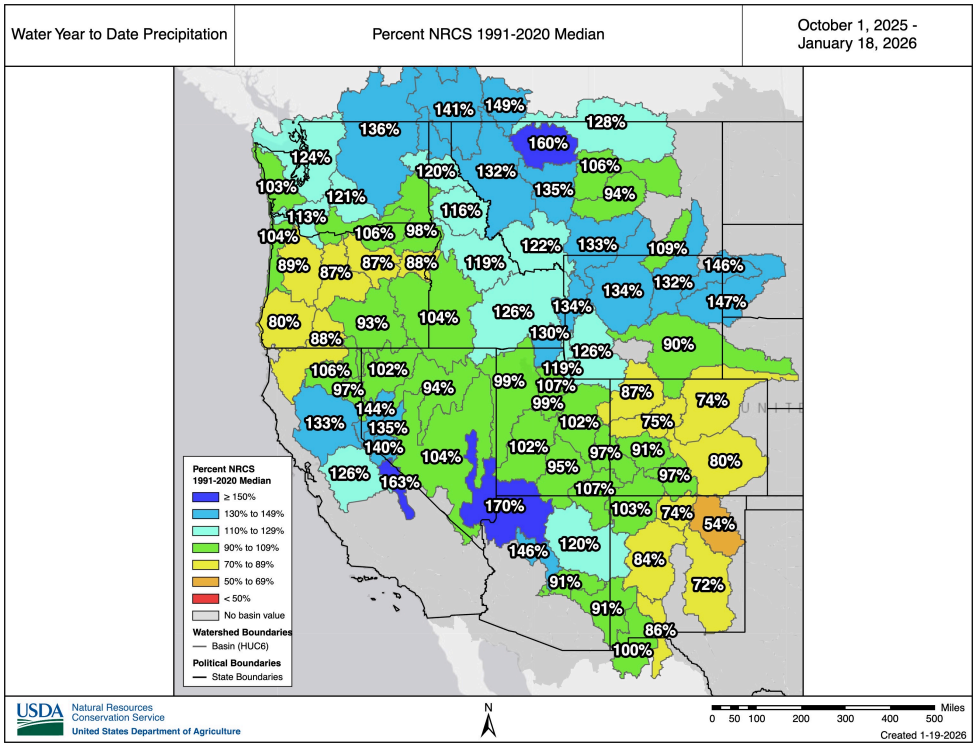



McEvoy et al. (in prep)

# Back to conditions this year




Repeat of 2015? Too soon to tell but warm and wet conditions, as opposed to low precipitation are dominant drivers so far of current snow drought.

# Take home messages

- Snow droughts are periods with less snow than average but there is no agreed upon way to define them
- Snow droughts caused by warm temperatures and above average precipitation remain the biggest challenge for water management
- Future work should try to develop user-specific or application-specific snow drought definitions as impacts remain most important and can vary greatly by end-user

THE DEPICTION OF DROUGHT

A Commentary

BY KELLY T. REDMOND

BAMS, 2002

“It is not likely that there is an easy way out of this depiction dilemma. Drought is a many-headed creature, and its full description requires an equally diverse menagerie of indices and indicators.”

“The problem of defining drought is longstanding and has never been resolved to the satisfaction of all. This fact alone surely tells us something. Drought means many different things to many different audiences."


Photo: Peeking at Lake Tahoe from Mt Rose Ski Resort, December 6, 2025
Credit: D. McEvoy