



Scientific Findings from the First Year of SAIL and SPLASH Observations and Directions for the Coming Year

ARM/ASR PI Meeting
October 26, 2022

Dan Feldman, drfeldman@lbl.gov, PI of SAIL,
Gijs de Boer, gijs.deboer@colorado.edu, PI of SPLASH

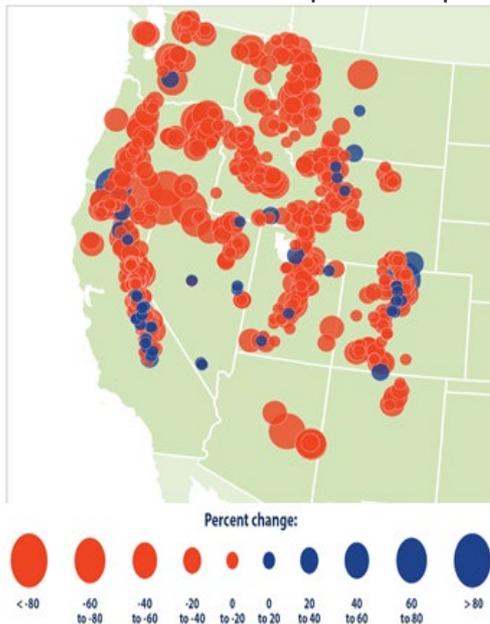
Breakout Session Agenda

- 14:00 – 14:10 Intro to SAIL (Dan Feldman)
- 14:10 – 14:20 Intro to SPLASH (Gijs de Boer)
- 14:20 – 14:25 SAIL data and products overview (Damao Zhang)
- 14:25 – 14:30 SAIL snowfall retrieval products (Scott Collis)
- 14:30 – 14:40 SAIL guest instruments (open mic)
- 14:40 – 14:47 Precipitation process insights from SAIL (V. Chandrasekar)
- 14:47 – 14:55 Aerosol process insights from SAIL (Allison Aiken)
- 14:55 – 15:02 SAIL ice nucleating particle data (CSU)
- 15:02 – 15:10 Aerosol-precipitation interactions at SAIL (Jiwen Fan)
- 15:10 – 15:15 Overview of what's new for SAIL for 2022 (Dan Feldman)
- 15:15 – 15:30 Presentation on aerosols findings to date (UCI and BNL)
- 15:30 – 16:00 Discussion !!!
Open mic to present research on SAIL/SPLASH data to date
Growth areas and upcoming research opportunities for 2022/2023
Questions from the audience about SAIL and SPLASH
Connections between SAIL, SPLASH, and the IMHC Workshop Report

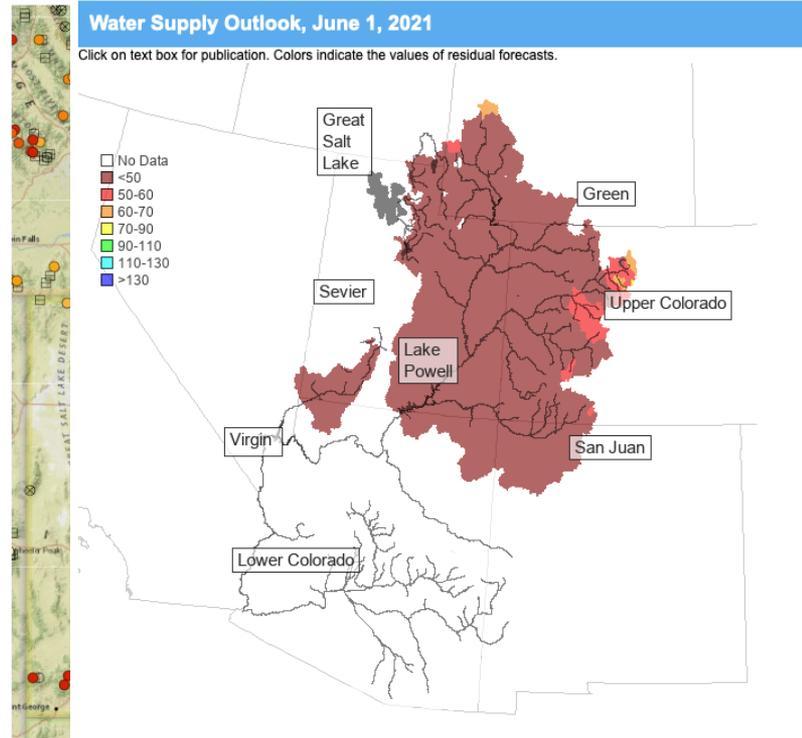
The Colorado River Watershed is Changing



1955-2016 trends in April Snowpack



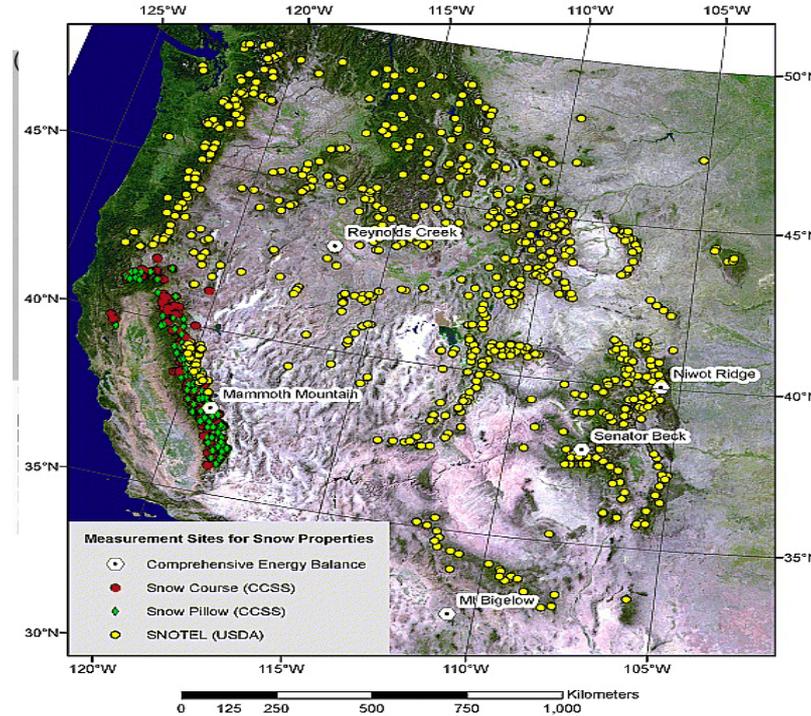
Mote and Sharp, 2016



Sparse Data in the Western United States

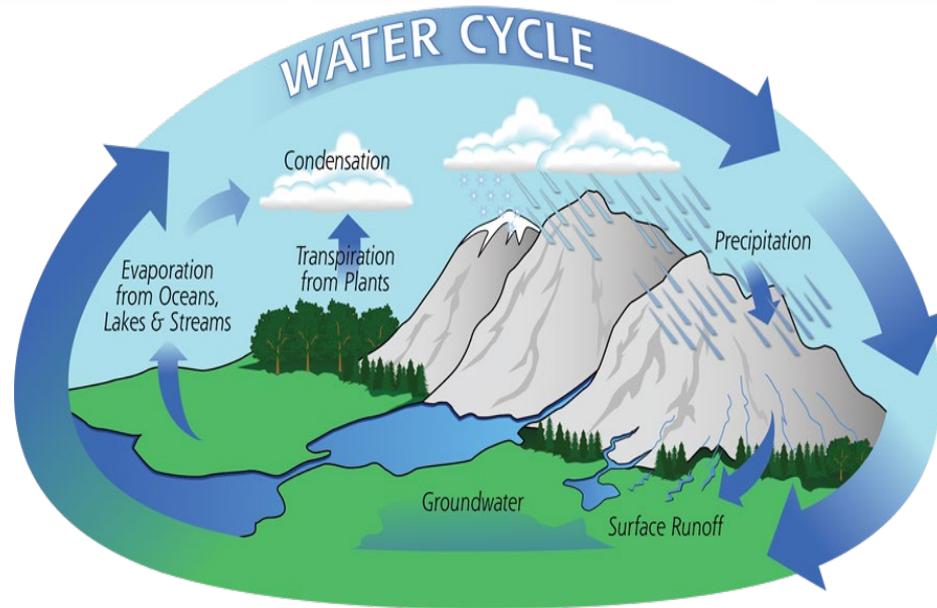
2020 SNOTEL Station #:

- AZ: 23
- CA: 34
- CO: 115
- ID: 82
- MT: 91
- NM: 28
- NV: 56
- OR: 81
- UT: 132
- WA: 75
- WY: 89



- Precipitation information in the Mountain West relies heavily on a sparse network of weather stations.
- Access, permission, and safety issues limit optimal sampling for stations.
- Gaps highlighted in IMHC

Although Partitioning of Water is Conceptually Simple...



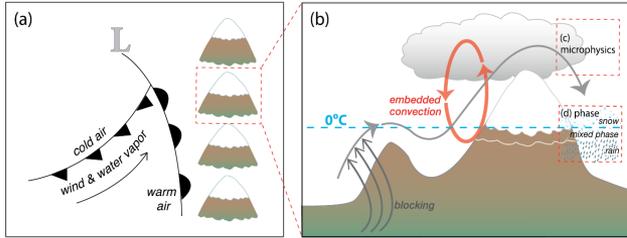
$$P = ET + R + I + \Delta S$$

Precipitation Evapotranspiration Runoff Infiltration Storage

....But, Predicting Future Water Is Hindered by Atmosphere-Watershed Complexity

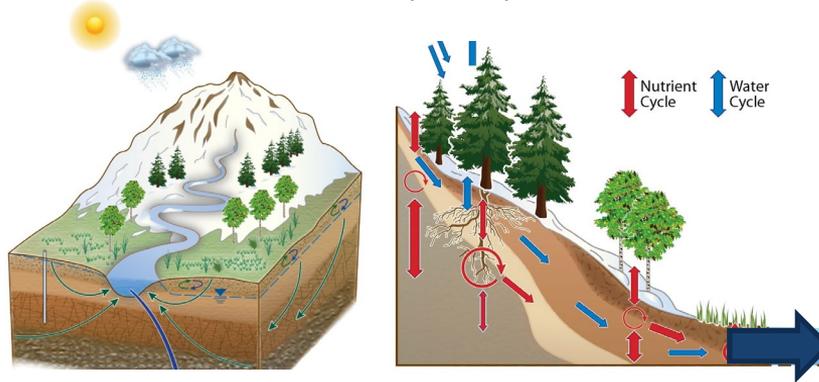
Climate Trends

Atmospheric Frontal Systems Blocking and Cloud Microphysics-> Precipitation, Temperature

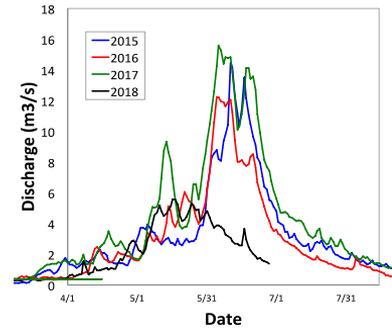


Lundquist et al., 2020

Watershed bedrock-canopy processes-> Spatiotemporal Variable Runoff, Infiltration to Groundwater, Evapotranspiration



Water Managers need Accurate Prediction of Integrated Water Discharge to River



The Details of Atmospheric Processes Matter in the Upper Colorado River Basin



Objective

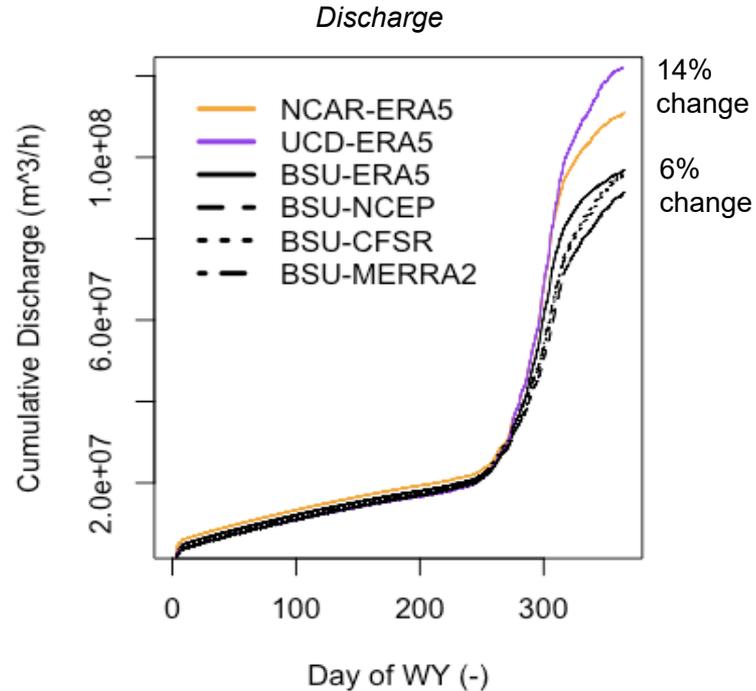
- Determine if the details of atmospheric processes matter for surface/subsurface hydrology in Upper Colorado.

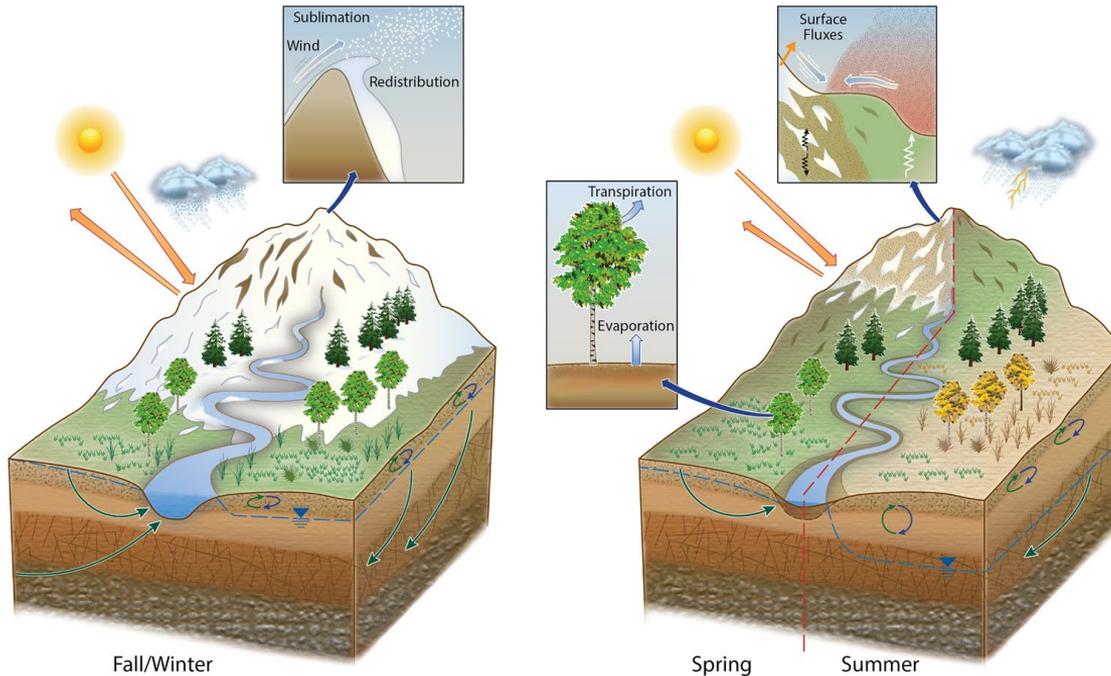
Approach

- Explore sensitivities of coupled WRF-ParFlow-CLM model to range of synoptic forcings and WRF model physics parameterizations.

Impact

- Uncertainty in WRF physical parameterizations dominates ParFlow-CLM uncertainty..



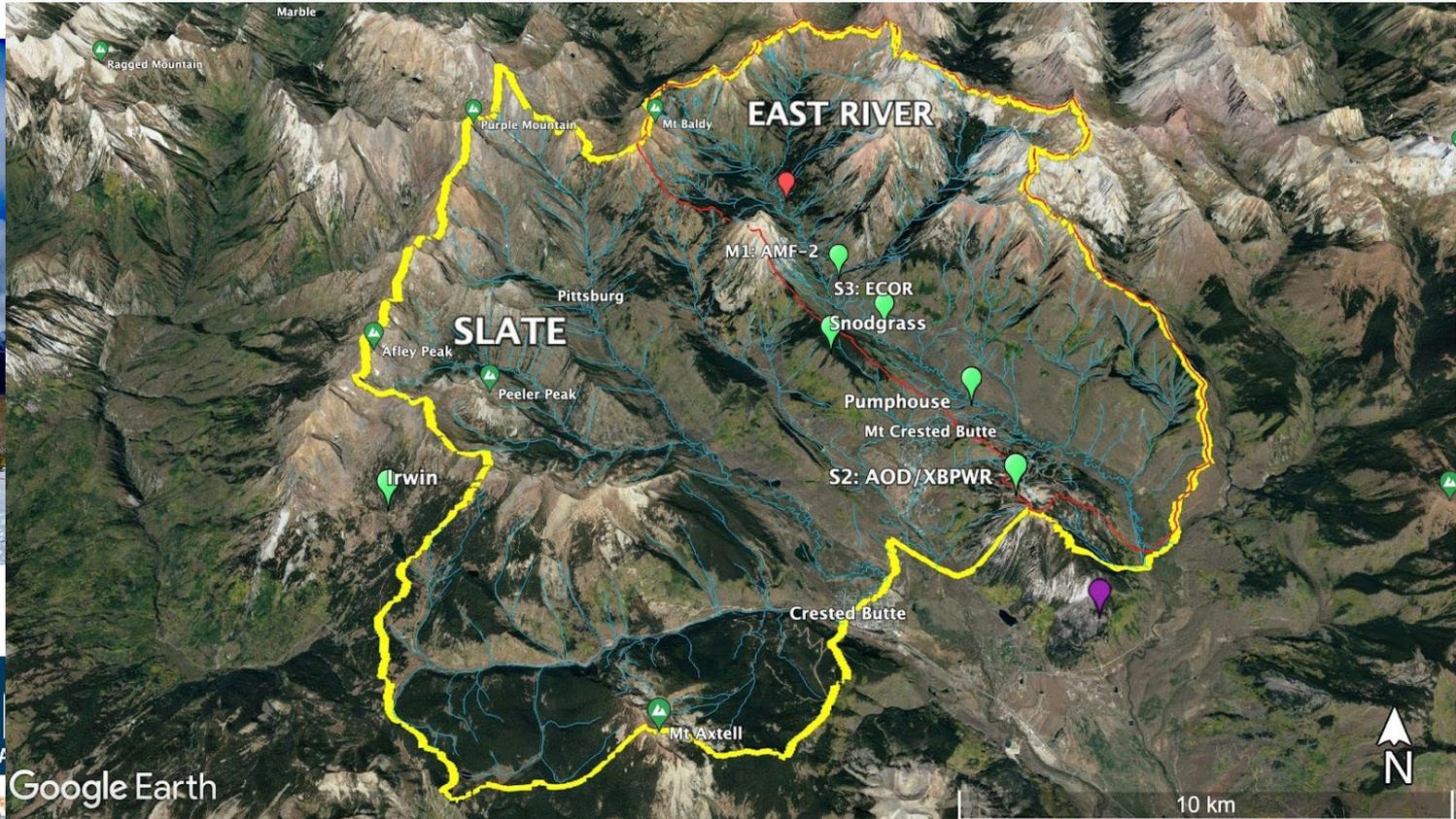


- Precipitation variability and processes
- Losses of water from evapotranspiration and sublimation
- Impacts of aerosols on radiation and water.
- Controls on the surface energy budget.

Goal:

- Develop the minimum-but-sufficient level of atmospheric and surface process understanding to predict water resources from mountainous watersheds.

SAIL Campaign in a Nutshell



U.S. DEPARTMENT OF ENERGY
Pacific North

Google Earth



DEPARTMENT OF COMMERCE

Precipitation, Clouds, Winds, Aerosols, Radiation Temperature, Humidity ...



- Numerous data-streams being collected.
- <https://sail.lbl.gov/what-we-measure>



Images
courtesy of
ARM Flickr
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Tethered Balloon System

- The Tethered Balloon System represents an aerial capability of SAIL. It can be deployed to an altitude above 1 km agl.
- 3 deployments so far: September 2021, April/May 2022, and July 2022.
- 3 upcoming deployments in FY23 to support 2 FICUS proposals (Aiken and Zawadowicz).



SAIL in the News!



Science

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NEWS EARTH

High in the Colorado Rockies, scientists launch search for causes of western water woes

New study of snow, ice, and rain aims to improve Colorado River flow forecasts

24 AUG 2021 · 5:00 PM · BY ERIK STOKSTAD



DISPATCHES 489

Atmospheric research seeks to inform water policy

Tom Oates

At a time of critical concern about climate change and federally declared water shortages, a Surface Atmosphere Integrated Field Laboratory (SAIL) site began operations on September 1, close to the headwaters of the Colorado River, near Crested Butte, Colorado. Called the first-ever “bedrock-to-atmosphere” observation system, the SAIL project’s primary objective is to monitor and predict rain, snowfall, and water availability in the Col-

orado River basin. “Precipitation occurs to eventual flows of water”, says Ken Williams, SAIL co-investigator and LBNL’s water resources program lead (Crested Butte, CO). “When should we release water from a dam? How much should we release and how much should we hold? We believe the data we gather will be very useful for those policy-making decisions.”

“The threats are multidimensional; it’s not just temperature”, says Alejandro Flores, an eco-hydrologist with SAIL and associate professor at Boise State University (Boise, ID). For example, “dark aerosols influence how quickly snow melts and are linked back to human activity.

Also, “plants mountain hillslopes move from the sky to ground. That’s of the climate instrumentation our ability to use the pumps, which Steltzer, co-principal investigator of the LBNL’s US DOI SEA and professor at the University of Colorado (Durango, CO).

“As scientists place where water I think they will r

Eos Science News by AGU

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Collaboration in the Rockies Aims to Model Mountain Watersheds Worldwide

As Earth’s climate changes at an unprecedented rate, the Surface Atmosphere Integrated Field Laboratory is studying precipitation on an unprecedented scale.

By Saima Sidik 21 September 2021



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The Washington Post
Democracy Dies in Darkness

He spent almost 50 years alone at 10,000 feet. His hobby helped shape climate research in the Rockies.

An amateur scientist began logging snowfall to keep busy. Along the way, he became an unwitting chronicler of climate change in a region known as the water tower for the drying American West.

By Karin Brulliard

November 27, 2021 at 7:00 a.m. EST

Collaborative Resources: Guest Instruments and ASR-funded Science

There is a significant and growing number of guest instruments at SAIL.

There are also exciting ASR-funded science activities!

Please check out SAIL-related posters!



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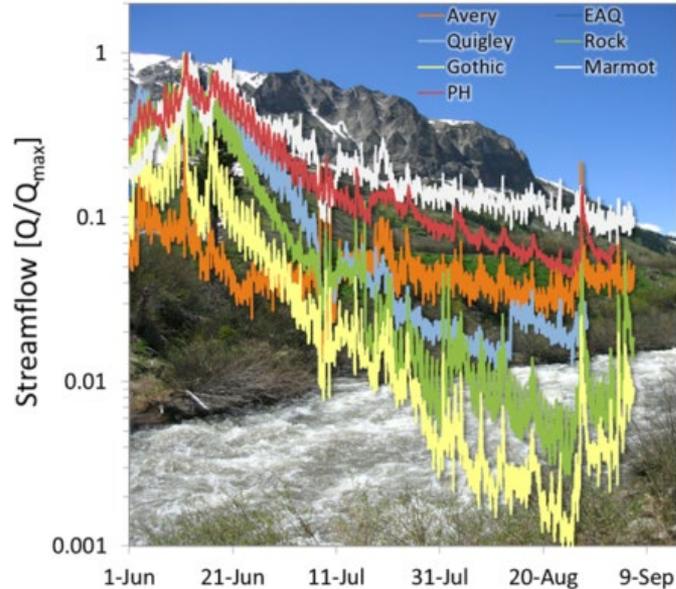
THE UNIVERSITY OF
NEW MEXICO.

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SCIENTIFIC

Collaborative Resources: Watershed Function SFA



SAIL is leveraging resources and expertise from the Watershed Function SFA, which is an ESS-funded research program to characterize surface and sub-surface processes in mountainous watersheds.



April 21, 2022

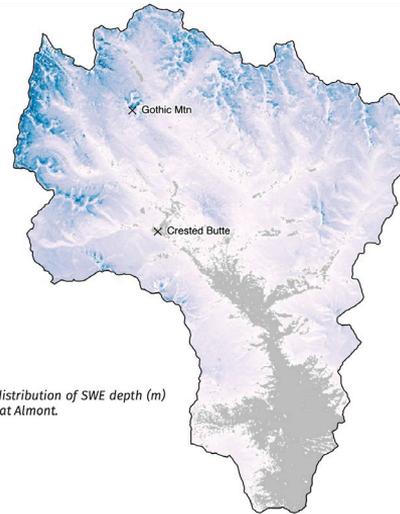


Figure 1. Spatial distribution of SWE depth (m) for the East River at Almont.

May 18, 2022

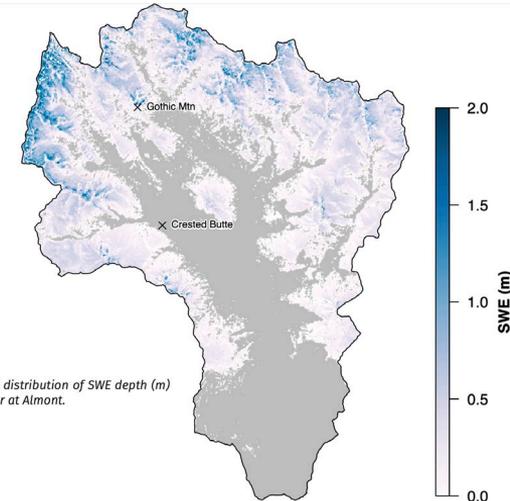
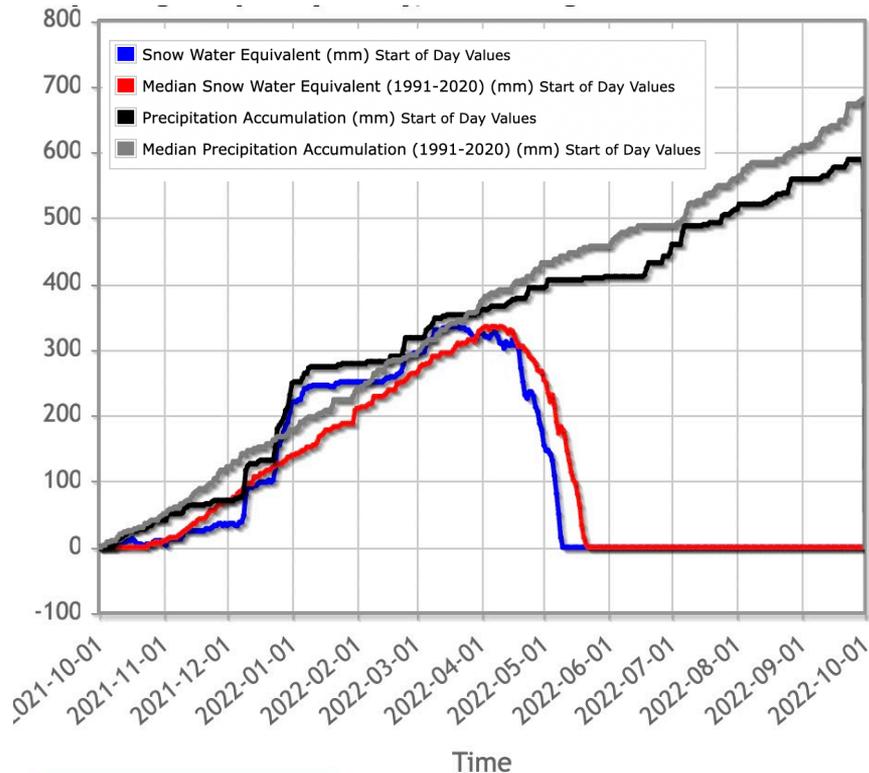


Figure 1. Spatial distribution of SWE depth (m) for the East River at Almont.

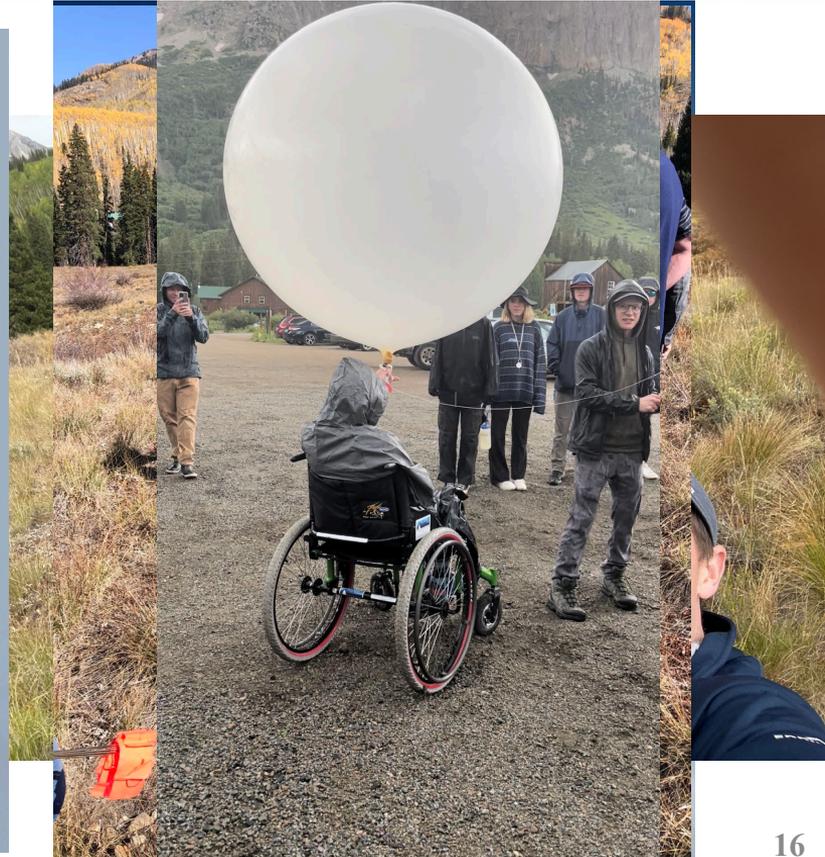
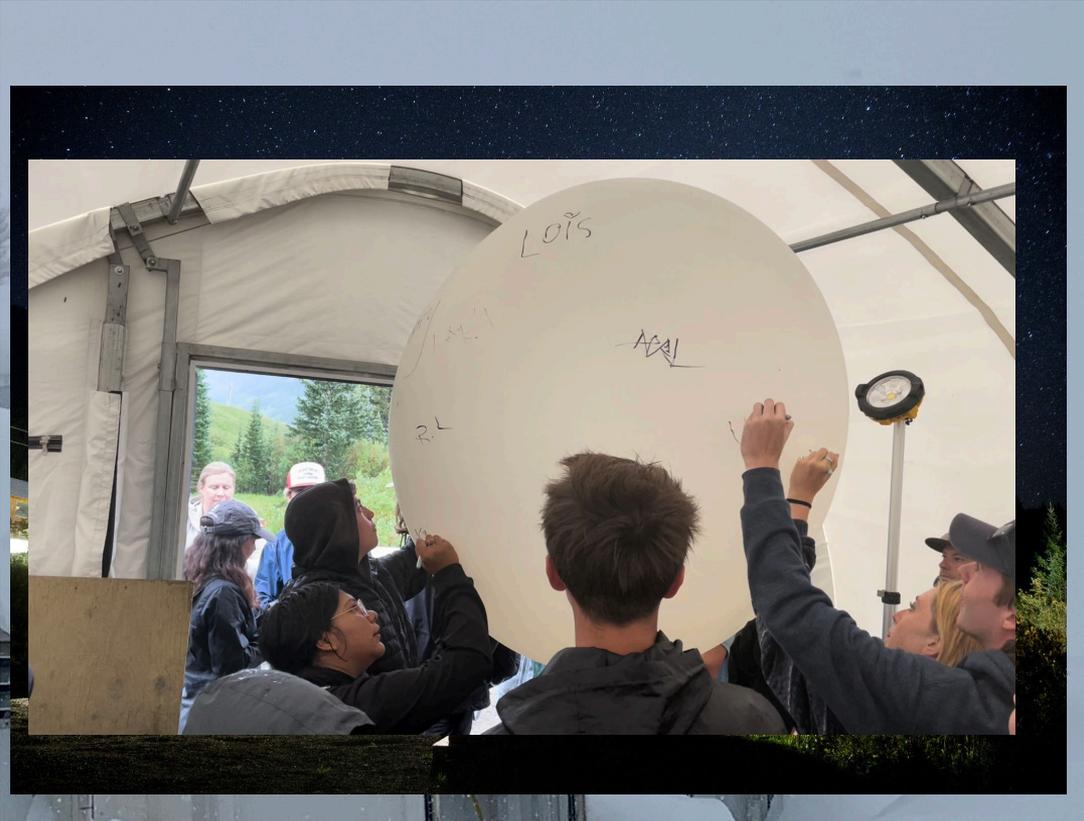
Water Year Summary

- Peak snow was very similar to 30-year median.
- About half of the snowfall fell in one storm (Santa Slammer).
- Extended mid-winter dry spell, followed by late-season storms.
- More rapid melt than median likely due to dusty and windy conditions.
- Large number of summer thunderstorms (>38 days of measured precipitation), likely associated with summer monsoon.

Butte SNOTEL Station for Water Year 2022



Pictures!



Opportunity

Convergence of Projects and Extreme Collaborations
provide Opportunity for Sum>Parts

Substantively address needs expressed in IMHC

Now onto SPLASH, science results, and discussion

Email me: drfeldman@lbl.gov

More importantly, email Sara Hefty (shefty@lbl.gov)
to join/participate in SAIL/SPLASH telecon

