



**Surface Atmosphere Integrated field Laboratory (SAIL)
Study of Precipitation & Lower-Atmosphere impacts on Streamflow & Hydrology (SPLASH)**

**2021 ARM/ASR PI Meeting
Breakout Session
June 23, 2021**

Coordinators: Daniel Feldman (LBNL); Gijs de Boer (NOAA); Scott Collis (ANL)

Breakout Session Goals and Schedule



- Goals:
 - Foster and facilitate scientific discussions.
 - Identify research and observation opportunities (and gaps).
 - Advance the greatest possible scientific return from the SAIL and SPLASH campaigns.
- Schedule:
 - 11:00 – 11:15: SAIL/SPLASH Campaign Overview
 - 11:15 – 11:25: Precipitation Observations and Science Opportunities
 - 11:25 – 11:35: Aerosol Observations and Science Opportunities
 - 11:35 – 11:50: Surface Flux Measurements and Science Opportunities
 - 11:50 – 12:00: Atmosphere through Bedrock Science Opportunities
 - 12:00 – 12:10: AI4ESP Connections
 - 12:10 – 01:00: Discussion !!!
 - Can include: Modeling activities, Data integration, Outreach, 2nd year hypotheses

Breakout Session Housekeeping

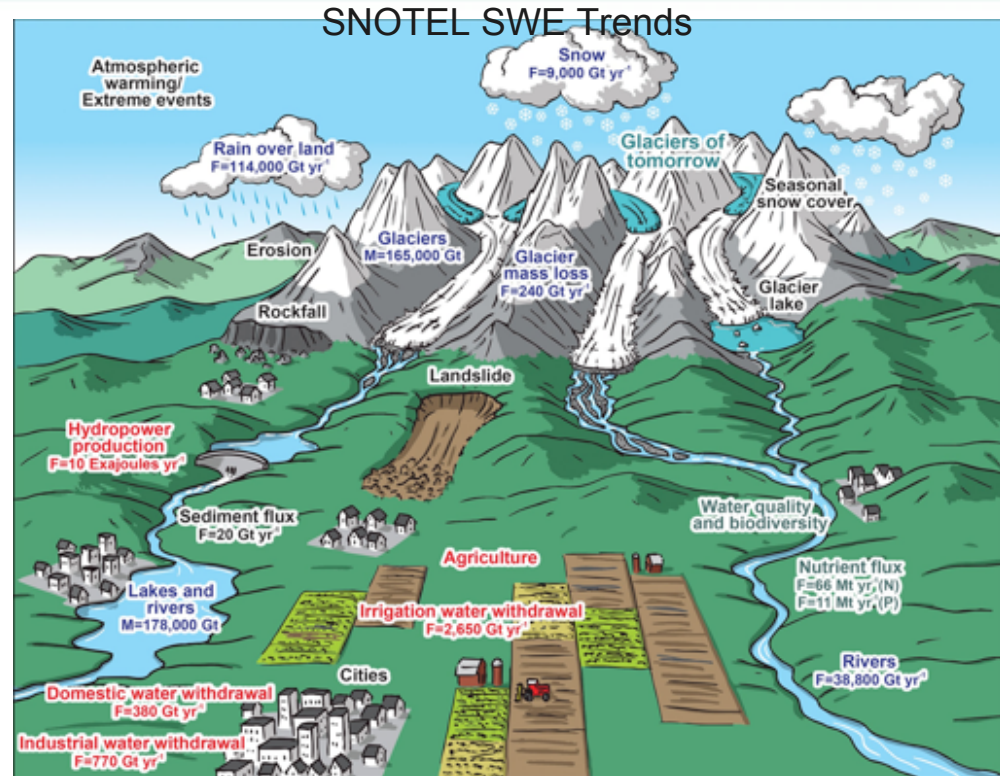


- We will be recording this session for those who cannot make it but are interested.
- Please mute yourself but feel free to ask questions in chat and then we will open it up to discussion
- Please introduce yourself in the chat to everyone:
 - Name, affiliation, what brings you to this meeting.
- Questions?

Background: Water Resources are Threatened



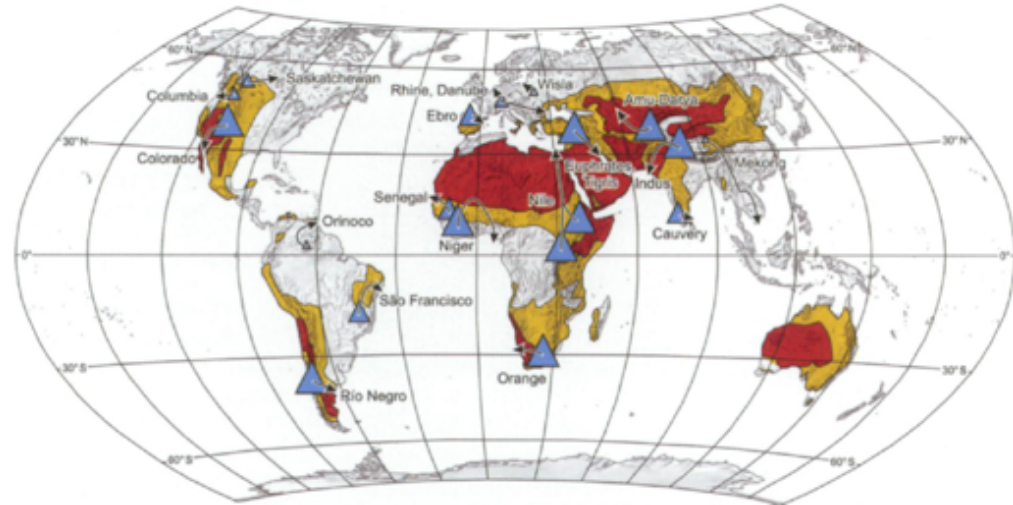
- Half of the world depends on water from mountains, but these resources are dwindling
- The Colorado River is the most hydrologically significant watershed mountain range in North America.
 - Drains 640,000 km²
 - 74 km³ (60 MAF) annual discharge
 - 40 million people rely on its water
 - 53 GW generation capacity
 - \$1.3T economic activity
- Colorado River discharge has decreased 9.3%/K since 1920.



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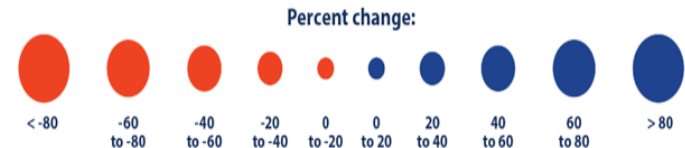
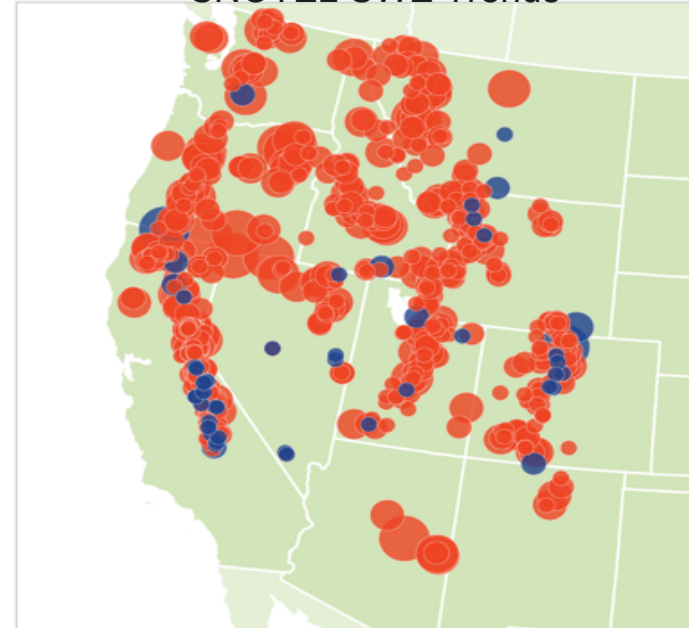


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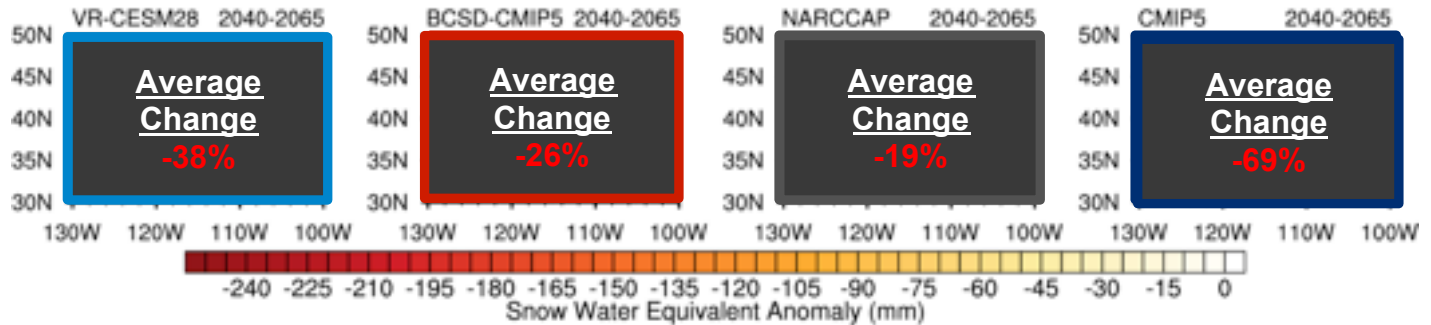


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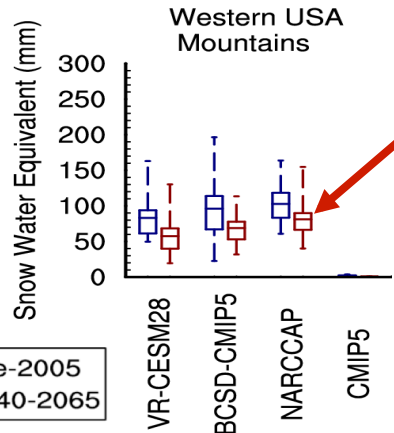
SNOTEL SWE Trends



Background: ESM Development Needed in Complex Terrain



Regional
Downscaling
Ensemble Average
-27%



Western USA mountain
SWE median values fall
at-or-below the 25th
percentile of historical by
2040-2065

Rhoades et al, 2018, Clim. Dyn.

Background: Complex Terrain Stresses Modeling

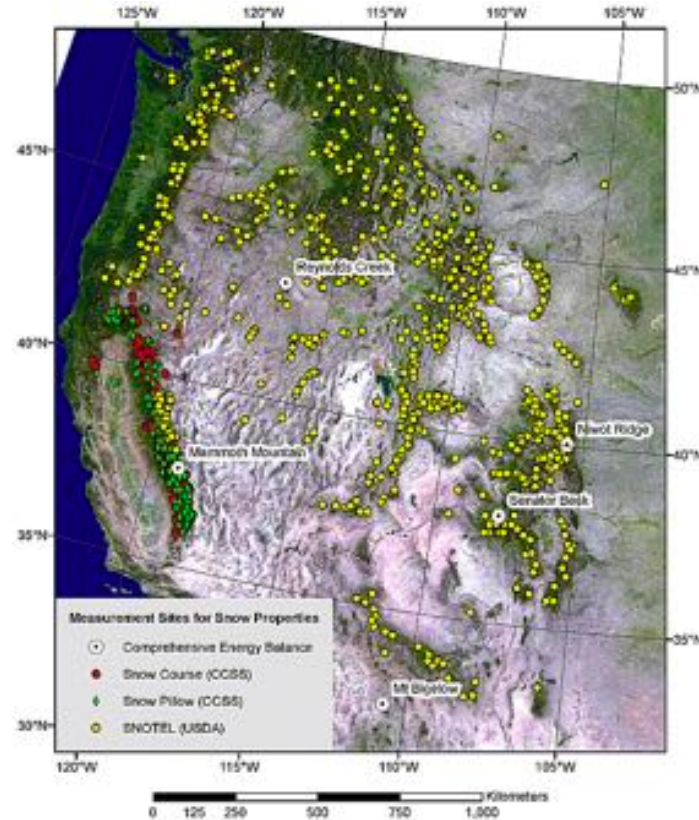


Atmosphere and land-atmosphere interaction process understanding in the Mountain West relies heavily on a sparse network of weather stations to capture processes across scales.

Processes are so under-observed in complex terrain that modeling frameworks sometimes surpass observational products.

OUR SKILL IN
MODELING MOUNTAIN
RAIN AND SNOW IS
BYPASSING THE SKILL OF OUR
OBSERVATIONAL NETWORKS

JESSICA LUNDQUIST, MIMI HUGHES, ETHAN GUTMANN, AND SARAH KAPNICK



Bales et al., 2006, WRR

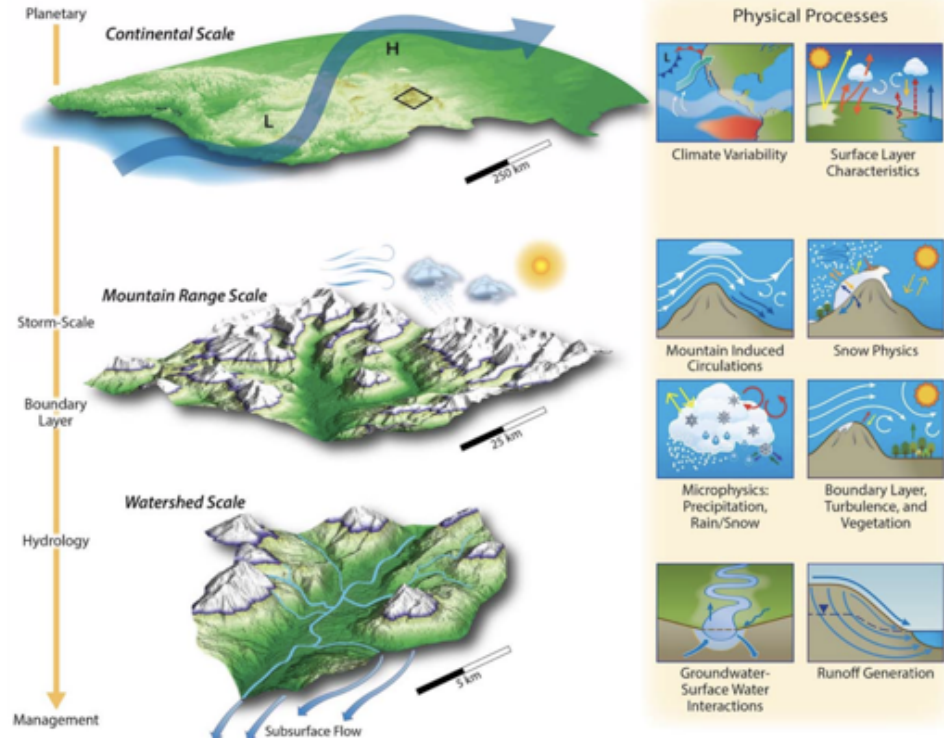
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SAIL: Sending the AMF2 to the East River Watershed



- Uncertainties in atmospheric interactions with watersheds complicate mountainous hydrology research.
- SAIL will directly address these uncertainties by integrating atmospheric observations with surface and surface researchers to achieve atmosphere-through-bedrock observations.
- SAIL will deploy the AMF2 to the East River Watershed near Crested Butte, Colorado from 09/2021 – 06/2023.



Background on Why East River Watershed



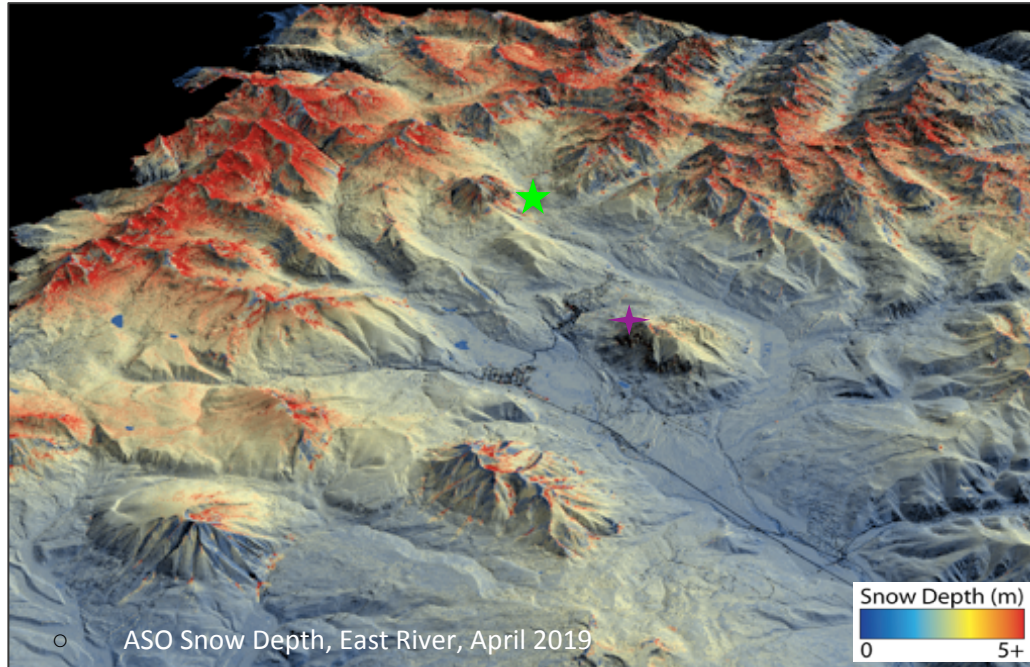
East River Watershed covers 300 km² of the Upper Colorado River Basin, where most of the Colorado River water originates. Elevation 2500-3500 masl, ~500-1000 cm snowfall/yr, ~66-124 cm liquid equivalent precip/yr, DJF DTR (-20°C, -1°C), JJA DTR (3°C, 23°C)

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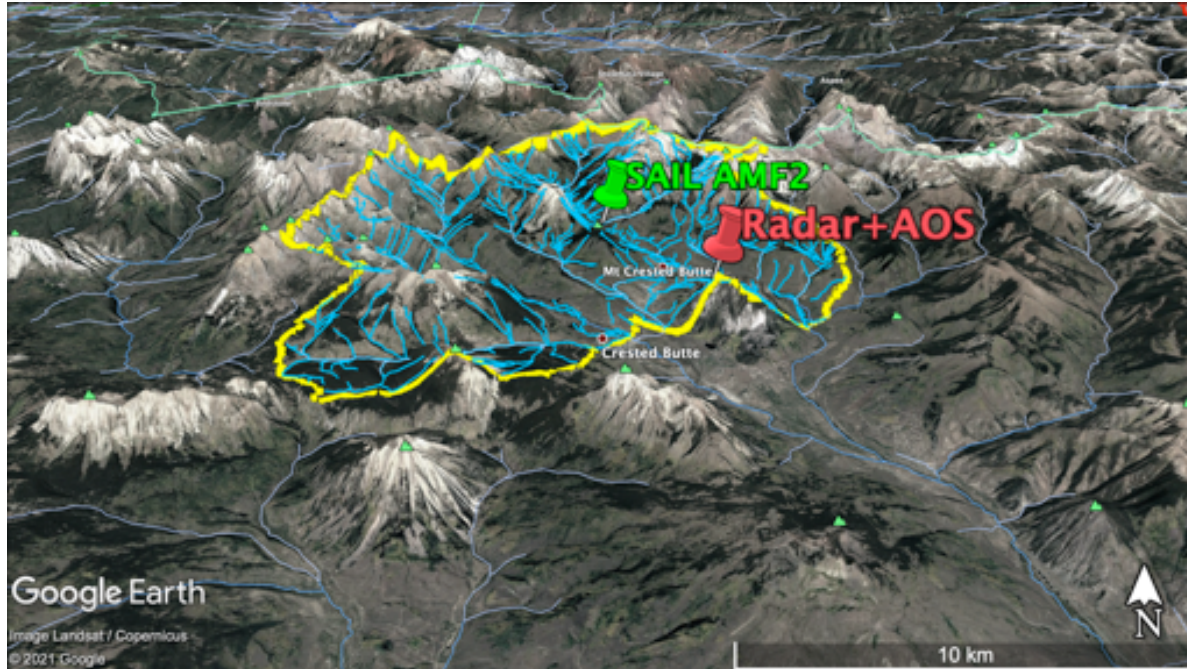
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Deploying the AMF2

- The AMF2 will be deployed to Gothic in the middle of the East River Watershed.
- Installation is now!
- Measurements include radiation, temperature, humidity, winds, precipitation, and clouds.
- Aerosol Observing System will be located 7.7 km away in an elevated location on the Crested Butte Mountain Resort with an X-band precipitation radar.

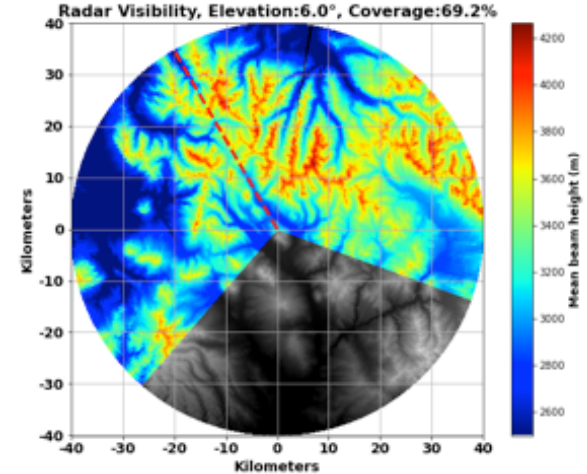
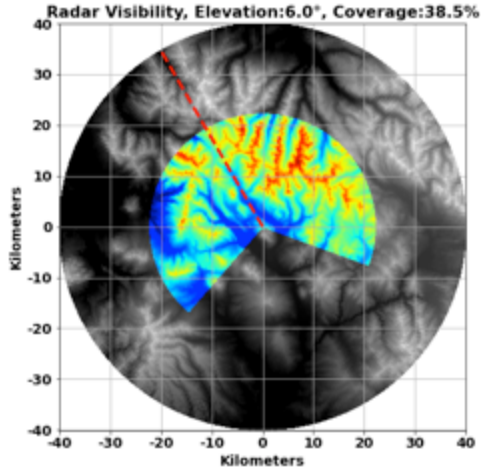


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CSU X-Band Radar



- To characterize precipitation processes, and determine their importance for water resources, SAIL will deploy a scanning X-band precipitation radar from Colo. State. Univ.
 - This will partially fill a major gap in radar coverage over the Upper Colorado River.
- The radar is sensitive to how much it is snowing and/or raining and can tell the difference between snow, rain, and other forms of precipitation.

Tethered Balloon System Possibilities

- There may be the possibility of deploying the ARM Tethered Balloon System (TBS) for a few weeks at a time during different seasons of the SAIL Campaign.
- TBS has temperature and humidity profiling along tether.
- TBS can host instruments up to ~12 kg, including vis/thermal imagers, cloud and aerosol property measurements, and guest instruments.
- May be deployed up to 1.5 km agl. Surface and aloft wind restrictions exist.
- TBS will fly below cloud base.

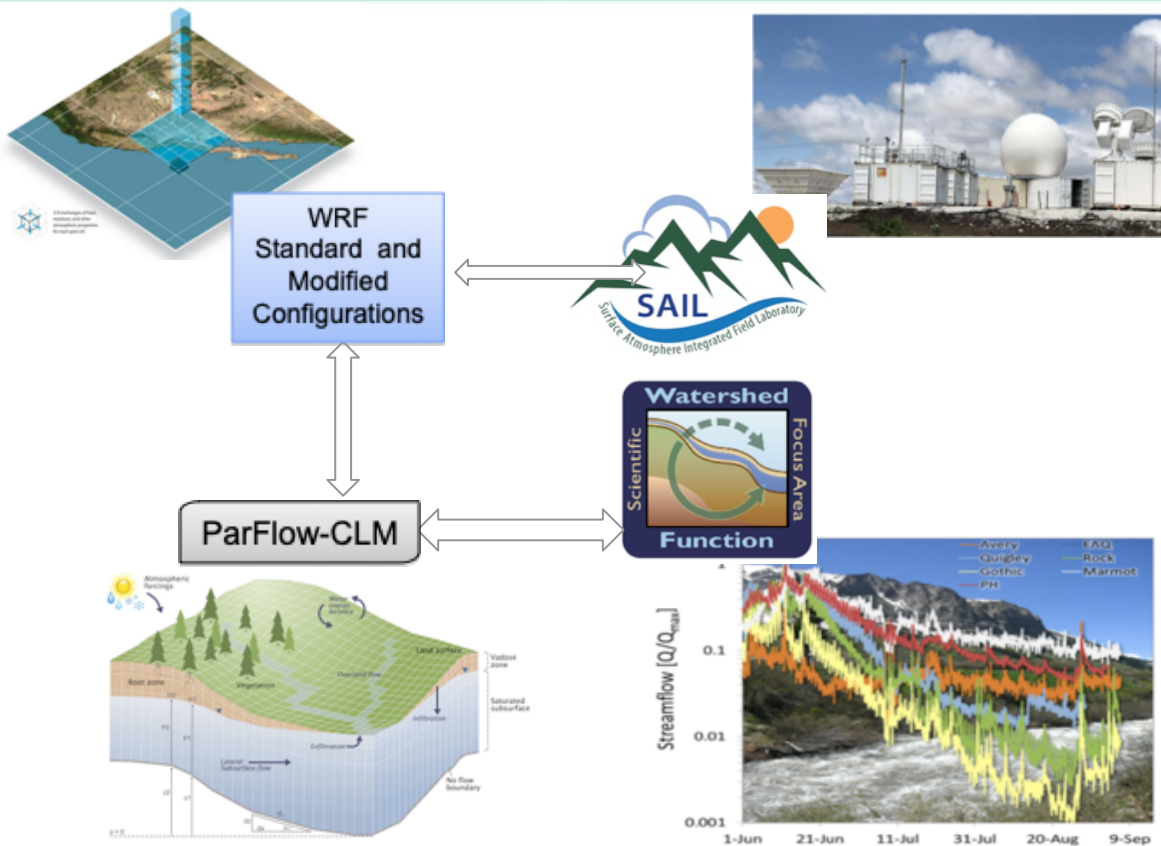


Collaborative Resources



SAIL will leverage resources and expertise from the Watershed Function SFA, which is an SBR-funded research program to characterize surface and sub-surface processes in mountainous watersheds, focusing on the East River

SAIL seeks to advance integrated science comes from crossing disciplinary boundaries to advance mountainous hydrology.



SAIL Core Team



- The science team covers 4 National Labs, 10 universities, and 2 research centers.
- Much larger extended community

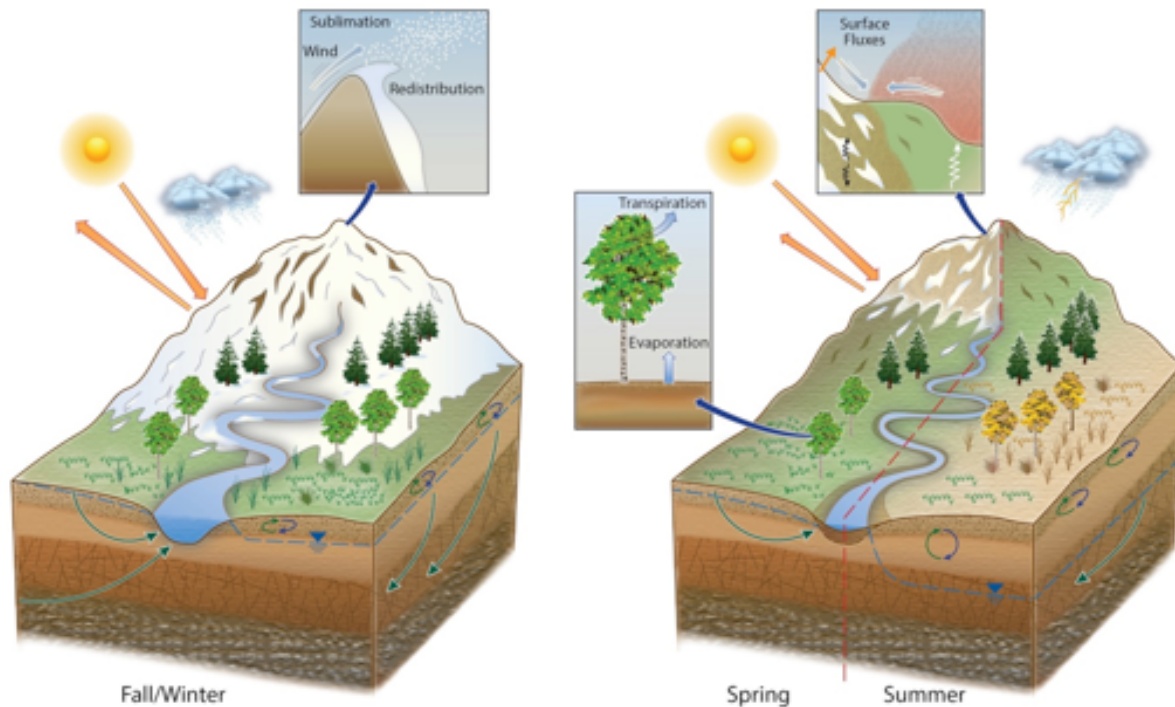


SAIL Science Objectives



SAIL seeks to advance scientific understanding of dominant atmospheric and land-atmosphere processes that impact hydrology of mid-latitude interior mountainous watersheds.

1. Precipitation: how and how much.
2. Winds: sublimation and snow redistribution.
3. Aerosols: surface and atmosphere radiative impacts
4. Aerosols: interactions with precipitation.
5. Surface fluxes: controls on the surface energy and mass balance.



Summary



- SAIL presents an exciting opportunity for vertically-integrated observations and modeling to understand mid-continental water resources. We hope you are interested in helping realize this opportunity.
- Together with the Watershed Function SFA, we will be looking under the hood to look at atmospheric, surface, and sub-surface processes but not forgetting about the big picture.
- Visit <https://sail.lbl.gov> for more SAIL campaign information. Also, the SAIL poster at: https://www.ornl.gov/support_files/2021ARMASR/posters/P002731.pdf
- Email Sara Hefty (shefty@lbl.gov) to join the biweekly science teleconference.
- SAIL has ‘nucleated’ and is ‘nucleating’ other research activities to advance the science of mountainous hydrology, most especially NOAA SPLASH. We will hear about that campaign now.