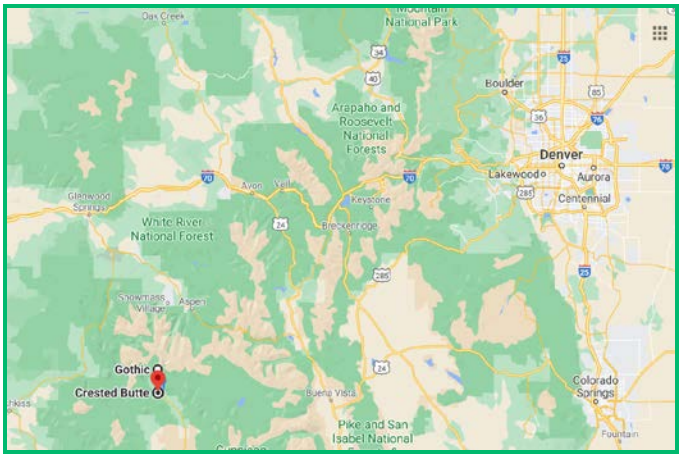
Surface Atmosphere Integrated Field Laboratory

Half of the world relies on water from the mountains, but in a warming world, it is difficult to predict what these resources will look like. The ability to predict future water requires a deep scientific understanding not only of snow and rain, but also of solar and thermal energy, evaporation and transpiration of water, sublimation of snow, impacts of aerosols, and subsurface hydrological processes that control the ultimate discharge from mountainous watersheds.

To help improve understanding and modeling of processes connected to mountain hydrology, the Atmospheric Radiation Measurement (ARM) user facility will operate the **Surface Atmosphere Integrated Field Laboratory (SAIL)** field campaign in central Colorado. From September 2021 to June 2023, an ARM Mobile Facility will collect measurements with a focus on the 300-square-kilometer (116-square-mile) East River Watershed within the Upper Colorado River Basin.

SAIL will combine atmospheric measurements from ARM, a U.S. Department of Energy (DOE) scientific user facility, with existing surface and subsurface data from partner research organizations. Researchers will develop detailed measurements of mountainous water-cycle processes as they pertain to the Colorado River, which supplies water for 40 million people in the American West.



This map shows the central Colorado area where the SAIL campaign will be located.

The East River Watershed, in Colorado's Elk Mountains, will be the focus of the SAIL field campaign. Here is a view of that watershed from Crested Butte Mountain.

Through SAIL, researchers from DOE national laboratories, universities, and research centers and agencies will enable an atmosphere-through-bedrock understanding of mountainous water cycles. By observing what is happening above and below ground to influence hydrology at various scales across the East River Watershed, SAIL will provide insights into how Upper Colorado River watersheds interact with the atmosphere to produce water.

Science Objectives

The main science goal of SAIL is to develop a quantitative understanding of the atmosphere and land-atmosphere interaction processes, at their relevant scales, that affect mountain hydrology in the midlatitude continental interior of the United States.

SAIL measurements will pursue the following science objectives:

- Characterize the spatial distribution of orographic and convective precipitation processes on diurnal to seasonal timescales and how those processes interact with large-scale circulation.

- Quantify cold-season land-atmosphere interactions that alter snowpack mass balance through wind redistribution and sublimation and the spatial scaling of those processes.
- Establish aerosol regimes and the processes controlling the life cycle of aerosols in those regimes, and quantify the impacts of aerosols in those regimes on the atmospheric and surface radiative budget.
- Quantify the sensitivity of cloud phase and precipitation to cloud condensation nuclei and ice-nucleating particle concentrations.
- Quantify the seasonally varying surface energy balance, the land-surface and atmospheric factors controlling it, and the spatial variability in those factors.

By measuring the inputs to, outputs from, and processes within the East River Watershed, SAIL will produce a benchmark data set for atmospheric and surface process representation studies. Those studies, in turn, will be used to build a strong foundation for models that can better predict threats to water resources in the American West.

Research Instrumentation

This campaign will use the second ARM Mobile Facility, operating 24 hours a day, seven days a week. Onsite technicians monitor and maintain approximately 50 instruments to ensure that the best and most complete data set is acquired.

Key instruments include a zenith-pointing Ka-band radar to measure profiles of cloud particles. Depolarization lidars will monitor elevated aerosol layers and thin clouds. A radar wind profiler will measure vertical wind profiles, while an infrared spectral radiometer, a microwave radiometer, and radiosondes (weather balloons) will combine to provide continuous information on atmospheric thermodynamic structure, water vapor, and cloud liquid water path. Various gauges and disdrometers will collectively measure precipitation, while radiometers and an eddy correlation system will measure surface radiative and turbulent heat fluxes. A suite of aerosol instrumentation will be used to collect measurements of aerosol radiative properties, composition, size distribution, and cloud activity, as well as information on key trace gases.

For SAIL, this ARM Mobile Facility will return to Colorado, where it collected measurements during the 2010–2011 Storm Peak Lab Cloud Property Validation Experiment (STORMVEX).

Collaborations

SAIL will combine ARM atmospheric observations with long-standing collaborative resources, including ongoing surface and subsurface hydrologic observations from DOE's Watershed Function Scientific Focus Area. The campaign will also use an X-band scanning radar from Colorado State University to measure the amount and type of precipitation. Other collaborators include the Rocky Mountain Biological Laboratory, Crested Butte Mountain Resort, the U.S. Geological Survey, the Upper Gunnison Water Conservancy District, the National Center for Atmospheric Research, and NOAA.

The SAIL team hopes to further enhance the campaign's scientific impact with additional collaborations as the campaign planning continues.

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Additional information is available on the ARM website at www.arm.gov.