



Interstate Consortium for Ecohydrology in Cold Region Mountain Environments (ICECRME)

Climate and Natural Hazards, Snow-Covered and Mountain Environment Sensing

Objective The University of California Santa Barbara (UCSB) and the Desert Research Institute (DRI) seek to establish the Interstate Consortium for Ecohydrology in Cold Region Mountain Environments (ICECRME) to serve as an interdisciplinary hub for collaborative research and education, focused on scientifically and economically driven questions that address climate and natural hazards related to climate change, water supply and storage, wildfire, mining legacies, and biodiversity in the snow-covered and mountain region of the Sierra Nevada, colloquially known as the Range of Light.

Need Of the likely effects of climate change on California and Western Nevada, consequences in this iconic mountain range are the most important. In a warmer future, some precipitation that now falls as snow will fall as rain instead, thus becoming a flood hazard rather than a water resource. A smaller snowpack constrains outdoor recreation and groundwater recharge. Earlier snowmelt provides water before agricultural demand and deprives forests of soil moisture during the summer. Increasing year-to-year variability of precipitation combines with higher elevation of the rain-snow transition and earlier snowmelt to cause more severe fire season with an earlier start and longer duration.

Sixty million people in the Western U.S. and nearly two billion people worldwide depend on water from mountain snow. Water from the Sierra Nevada provides two-thirds of the water supply for California's Central Valley where a quarter of the nation's food is grown. More than 1 million Californian and Nevadan jobs are tied to the reliability of the water supply, and drought conditions have cost California agriculture nearly \$2 billion and over 10,000 jobs.

The impacts of the spatial distribution of precipitation, elevation of the rain/snow line, and timing of snowmelt on water resources and water quality, mountain ecosystems, and fire potential and intensity raise profound questions for the natural and social sciences. Understanding and managing these complex interactions requires monitoring and measurement networks as well as analysis and modeling tools to elucidate their relationships with climatic trends and their likely trajectories over time. These outcomes have important consequences for the environment, for national security particularly as it relates to the Army's Modernization Priorities and sensing on snow-covered environments and improving terrain reasoning, for the economy, for human health, and for quality of life of millions of Californians and Nevadans.

Vision for the Consortium

As a collaborative platform for science, education and stewardship, the Consortium will advance the missions of the University of California and the Nevada System of Higher Education. The Consortium will be physically headquartered at UCSB's Sierra Nevada Aquatic Research Laboratory (SNARL) near Mammoth Lakes and DRI's facilities in Reno. Existing and new snow and water science research, monitoring, and educational programming will be supported under the Consortium. It will organize symposia to integrate research by people in different disciplines, and it will provide fellowships for K-12 and university-level students, postdoctoral scholars, and visiting scientists. An important component of the Consortium will be outreach and engagement with stakeholders and planning agencies such as the Nevada Department of Conservation and Natural Resources, U.S. Forest Service, and the California Department of Water Resources.

Research Direct measurements of all water balance variables are scarce, especially at high-altitude sites. The focus of the Consortium will be to leverage existing human and physical infrastructure to stand a premier measurement and monitoring network for the Range of Light. Measurements within the network will specifically target the energy and water balance of the snow and soil, factors controlling the rain/snow transition, transport of pollutants from snowmelt, ecological and hydrological impacts of snow drought and a rising snow line, and the interplay between the fire hazard and the timing, intensity, and type of precipitation.

Findings from the research support a broad array of applications ranging from military to commercial, including new technologies for travel in complex mountain environments, sensing in visually degraded environments, and remote sensing analyses of snow and landscape properties.

Education and Training ICECRME will host university-level courses and student scholarships to support immersive field-based research and training opportunities, and it will serve the communities of the Eastern Sierra by integrating SNARL's active Outdoor Science Education Program (OSEP) with DRI's Citizen Science and K-12 STEM efforts. Since 1995, OSEP has provided field-based learning opportunities for over 2,000 K-12 students per year from Eastern California and Western Nevada. In partnership with DRI, ICECRME can deliver outreach programs to residents of our rural communities with culturally diverse backgrounds, mainly Hispanic and Native American people who are underrepresented in the sciences. Programs that begin with childhood and extend through the teenage years provide learning experiences that promote college readiness.

Background and Existing Infrastructure

UCSB, DRI, and the U.S. Army Engineer Research and Development Center's (ERDC) Cold Regions Research and Engineering Laboratory (CRREL), have partnered since 1991 to address many of the most challenging issues in mountain climate, hydrology, and ecology. These partnerships have led to the development of long-term climate sensing infrastructure and world-renowned research in satellite-based remote sensing of snow, precipitation, evapotranspiration, and forest health.

The CRREL/UCSB Energy Site (CUES) The CUES collaborative research environmental sensor platform supports a full suite of energy balance monitoring capabilities at 9,650 feet on Mammoth Mountain. Attracting researchers from all over the world, and one of only five high-altitude sites of its kind in the Western U.S., CUES has demonstrated utility for basic and applied research, water management in the agricultural, commercial and recreational sectors, and military training, research, and development.

Sierra Nevada Aquatic Research Laboratory (SNARL) Part of the network of 41 protected sites of the UC Natural Reserve System, SNARL, located at 7,100 feet in the Mammoth Lakes region, has facilitated long-term research and education focused on climate change, phenology, atmospheric deposition, element flux, biodiversity, ecosystem services, design, engineering, technology and instrumentation, remote sensing, hydrology, water quality, human health, and snow science. Since 1973, SNARL has hosted over 15,000 research and education user days per year, through the provisioning of scientific data and expertise, K-12 and university-level educational programming, and extensive field and laboratory facilities. ERDC already has in place education partnership- and cooperative research and development agreements with UCSB and DRI

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