As we enter our fourth year of our existence, WyCEHG has fully transitioned from “building” mode to “production” mode. We have, for the moment, completed our acquisition of instrumentation, most of our hires, and fine-tuned our scientific goals. We are now enjoying the fruits of that labor, in the form of scientific discovery and productivity. Over the past few months we have had a number of research highlights, including a paper published in *Science*, one of the world’s premier scientific journals, that highlights results of our collaborations with the national Critical Zone Observatory network (see p. 2 of this issue). In addition, our faculty, researchers and students are pushing forward new, interdisciplinary approaches to solving the water balance in mountain watersheds, as many of the articles in this issue will attest.

Looking ahead, we anticipate a flurry of papers and proposals coming out of the various WyCEHG project teams, as we work toward the next big transition for WyCEHG — the end of the five-year NSF grant and the beginning of our next chapter. We have been making plans for that transition, and for WyCEHG’s sustainability going forward. The work you’ll read about in this newsletter shows that we’ve laid solid groundwork for those next steps. Enjoy!

- Steve Holbrook and Scott Miller, Co-Directors

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A New View of the Critical Zone

WyCEHG geoscientists have discovered that the underground water-holding capacity of mountain watersheds may be controlled by stresses in the earth’s crust. The results, which may have important ramifications for understanding streamflow and aquifer systems in upland watersheds, appeared Oct. 30 in Science, one of the world’s leading scientific journals.

The scientists conducted geophysical surveys to estimate the volume of open pore space in the subsurface at three sites around the country. Computer models of the state of stress at those sites showed remarkable agreement with the geophysical images. The surprising implication, says Steve Holbrook, a UW professor in the Department of Geology and Geophysics, is that scientists may be able to predict the distribution of pore space in the subsurface of mountain watersheds by looking at the state of stress in the earth’s crust. That state of stress controls where subsurface fractures are opening up -- which, in turn, creates the space for water to reside in the subsurface, he says.

“I think this paper is important because it proposes a new theoretical framework for understanding the large-scale porosity structure of watersheds, especially in areas with crystalline bedrock (such as granite or gneiss),” Holbrook says. “This has important implications for understanding runoff in streams, aquifer recharge and the long-term evolution of landscapes.”

James St. Clair, a UW doctoral student, is lead author of the paper, titled “Geophysical Imaging Reveals Topographic Stress Control of Bedrock Weathering.” Holbrook, Cliff Riebe, a UW associate professor of geology and geophysics; and Brad Carr, a research scientist in geology and geophysics; are co-authors of the paper. Researchers from MIT, UCLA, the University of Hawaii, Johns Hopkins University, Duke University and the Colorado School of Mines also contributed.

Weathered bedrock and soil together make up the life-sustaining layer at Earth’s surface commonly referred to as the “critical zone.” Two of the three study sites were part of the national Critical Zone Observatory (CZO) network -- Gordon Gulch in Boulder Creek, Colo., and Calhoun Experimental Forest, S.C. The third study site was Pond Branch, Md., near Baltimore.

“The paper provides a new framework for understanding the distribution of permeable fractures in the critical zone (CZ). This is important because it provides a means for predicting where in the subsurface there are likely to be fractures capable of storing water and/or supporting groundwater flow,” St. Clair says. “Since we cannot see into the subsurface without drilling holes or performing geophysical surveys, our results provide the means for making first order predictions about CZ structure as a function of the local topography and knowledge (or an estimate) of the regional tectonic stress conditions.”

The research included a combination of geophysical imaging of the subsurface -- conducted by UW’s Wyoming Center for Environmental Hydrology and Geophysics (WyCEHG) -- and numerical models of the stress distribution in the subsurface, work that was done at MIT and the University of Hawaii, Holbrook says.

The team performed seismic refraction and electrical resistivity surveys to determine the depth of bedrock at the three sites, which were chosen due to varying topography and ambient tectonic stress. At the two East Coast sites, the bedrock showed a surprising mirror-image relationship to topography; at the Rocky Mountain site, the bedrock was parallel to topography. In each case, the stress models successfully predicted the bedrock pattern.

“We found a remarkable agreement between the predictions of those stress models and images of the porosity in the subsurface with geophysics at a large scale, at the landscape scale,” Holbrook says. “It’s the first time anyone’s really looked at this at the landscape scale.”

-University of Wyoming news service
NEW ARRIVALS

Sylvain Pasquet, Postdoc

Sylvain Pasquet joined WyCEHG as a postdoctoral research scholar in October 2015. Sylvain grew up in Paris, France, where he received his bachelor’s and master’s degrees in applied geophysics at the Paris Institute of Earth Physics, and his Ph.D. degree at University Pierre and Marie Curie - Paris VI. Sylvain’s research took place in the framework of the French national project CRITEX, which aims to describe the hydrological, hydrogeological and geochemical behavior of the critical zone using innovative research equipment. His dissertation focused on the contribution of seismic methods for the hydrogeophysical characterization of the critical zone, working both at the field and laboratory scales. He combined travel-time tomography and surface-wave profiling to retrieve both pressure and shear-wave velocities ($V_p$ and $V_s$ respectively) and estimate $V_p/V_s$ and Poisson’s ratio models in the near-surface. In WyCEHG, he will be working mostly with the geophysics team, trying to improve the imaging of the depth of the critical zone with surface waves.

Cassie Nauer, M.S. Student

Catherine (Cassie) Nauer comes to WyCEHG from Sandia Park, NM. Cassie has a B.S. in Earth and Environmental Sciences with a focus in Geology from New Mexico Institute of Mining and Technology, where she was involved in numerous undergraduate field studies: mapping caves in Carlsbad, NM; evaluation of reservoir and seal capabilities in Moab and Green River, UT; and studying microbial inhabitants of lava tubes in El Malpais National Monument, Cibola, NM. Cassie was also active as a K-9 Recreational Leader for Sandia Park, NM. Cassie has joined Janet Dewey and Cliff Riebe to study the geochemistry of granite weathering using field and experimental approaches. She hopes to shed light on relative rates of chemical weathering of a suite of rocks common to the Laramie Range, the potential effects of chemical weathering on water chemistry, and the relationship between lithology and geophysical properties. In the future, Cassie would like to pursue geobiological research, particularly relating to issues of climate change.

CUAHSI Near-Surface Geophysics Short Course

In January, WyCEHG geophysicists Steve Holbrook, Brad Carr, and Andy Parsekian taught a short course with University of Arizona professor Ty Ferré on “Near-Surface Geophysics for Hydrology.” The course, sponsored by CUAHSI, took place in Arizona, at the Rilloto River and the campus of the University of Arizona. The course covered the basics of instrumentation, theory and processing for GPR, seismic refraction, electrical resistivity, magnetics, and electromagnetic induction. Twenty individuals, mostly graduate students and postdocs, from thirteen universities participated in the course.
Chemical Weathering in the Laramie Range

The Laramie Range is composed of a suite of granitic rocks that have variable chemistry and mineralogy. The topography is bimodal, with gently sloped, deeply weathered surfaces adjacent to towering outcrops of granitic bedrock. Differential weathering of these rocks indirectly governs porosity, erosion, and topography, and therefore plays a major part in how water flows, where it is stored, and what solutes it carries.

We are using a controlled, laboratory weathering study to isolate the effects of lithology from other factors that influence chemical weathering rates. Flow-through reactor experiments are being conducted on eight Laramie Range rocks with a range in chemical and mineralogical composition and that vary in their field expression. Reactors have been loaded with rock crushed to a consistent grain size. Reactors incorporate capillary-regulated flow of a water source infused with 5% CO₂ in order to achieve a pH of 5 as a proxy for meteoric water. Leachate is being collected weekly at the capillary outflow and analyzed for approximately 30 elements and 7 anions. Depletion curves constructed from effluent yield and initial bulk chemistry, quantify the proportion of an element remaining in the rock over time after chemical weathering. SEM analysis of mineral phases before and after reaction will characterize mineral degradation.

This is just a portion of a regional study that consists of field mapping, detailed analysis of geo-referenced rock samples, and quantifying basin-scale erosion rates using cosmogenic nuclides. Geophysical measurements have been conducted at key rock boundaries.

Results from weathering studies will be used to inform geophysical data and models that predict critical zone architecture, thickness of the weathered zone, and depth to bedrock.

-Janet Dewey, Dept. of Geology and Geophysics
A Flexible Data Storage System Provides Access to Research Data

WyCEHG has no shortage of data from its group of cutting edge research equipment. By the end of the third year, over 2 TB of data and 4 TB of model outputs have been produced. While many other projects have as much or more data, WyCEHG is unique in the variety of data sources, associated file formats and the spatial extent from which the data are derived. Thus, a relational geodatabase has been created to store, spatially organize, and ultimately query data for investigators within and outside the project. The database ensures that data from disparate sources such as electrical resistance tomography, stream flow, and tree sap flux can be easily combined to answer novel questions about the fate of water across a hillslope.

Our database approach combines the power of relational databases with file, mapping and web servers (see Figure). This hybrid data management approach ensures that data can cross disciplinary borders. For example, data types from research disciplines vary from proprietary geophysics files to plain-text files of vegetation data to internationally agreed standards for hydrology through CUASHI or ecosystem fluxes in FLUXNET can be combined. The key to linking these disparate datasets using queries are spatial location, temporal attribution and metadata that join data into groups that are relevant to the researchers on the project. This process allows for data sharing not only within our research group, but also with the public.

The WyCEHG data discovery tool (http://wycehg.wygisc.org) has been built to facilitate spatial, temporal and textual searches of available data. The discovery tool provides the framework to meet the requirements of open-data policies, provide valuable information to decision makers, and creates an avenue for increased learning opportunities for students and teachers. Future enhancements to the website will include dynamic plot creation, integration of other web services (e.g. http://www.wrds.uwyo.edu/Map/), and increased flexibility to interactive spatial datasets.

- Shannon Albeke and Samantha Ewers, WyCEHG
The Peak of Fluxes: Vegetation and Snow fluxes atop Glacier Peak

This summer, WyCEHG deployed the highest elevation (i.e., 3440 m asl) micrometeorological and snow distribution site in the United States working in collaboration with the Glacier Lakes Ecosystem Experiments Site (GLEES) of the Rocky Mountain Research Station (RMRS). The objective of the Glacier Peak tower site is to understand and parameterize mechanisms of sublimation of snow crystals from the surface of the snowpack while quantify the effects of vegetation and topographic features on snow distributions across alpine ecosystems. Sublimation is a significant water-vapor flux in snow-dominated ecosystems as approximately 50% of total snow precipitation being sublimated; underestimates are further complicated by wind distribution of snow across the terrain (Schlaepfer et al. 2014). Mechanisms of snow distribution and sublimation remain poorly known decreasing predictive power hydrological fluxes in alpine catchments.

The three-meter tall flux tower is equipped with micrometeorological instrumentation including eddy covariance, vertical wind profiles, temperature profiled snow stakes, and sonic vibration sensors quantifying wind distributed snow crystals. Further, energy balance instrumentation has been deployed from the rocky ground surface to the top of the tower giving insight to energy fluxes. Collocating monthly ground penetrating radar snow surveys to estimate snow distribution throughout the tower footprint offers a unique opportunity to model the physical and biological controls of snow distribution and sublimation. Integration of data into snow distribution models improves predictive power while reducing uncertainty in hydrological and ecological fluxes in complex ecosystems.

These data will be used as part of the vast hydrological, ecological, and geophysical effort to understand hydrological fluxes and processes occurring in alpine catchments. This high elevation site allows us to model the effect of high velocity winds and vegetation on snow distributions. Continuous monitoring of snow, energy, and ecological fluxes to help meet the objectives closing budgets requires a collaborative effort between WyCEHG and RMRS research scientists.

-Daniel Beverly, Dept. of Botany
Snowpack partitioning to stream and transpiration: tracking meltwater on the No-Name hill slope

This winter a diverse group of researchers ramped up our monitoring of a hill slope in the mountains above Laramie. Located a few miles from the wind-scoured summits of the Snowy Range, this slope of outcropping metamorphic rock and mixed conifer trees provides an ideal natural laboratory to test theories about snowmelt dynamics and the hydrologic processes that transport meltwater to nearby trees and streams below. The No-Name slope is ideal for the experiment in terms of the slope's complexity and heterogeneity, but a rugged place to deploy equipment.

Last season a group of botany students led by Dan Beverly and Heather Speckman installed a solar array and instrumented dozens of spruce, fir, and lodgepole pine with sap-flux sensors that can measure the skyward movement of sap through these alpine conifers. Quantifying the photosynthetic activity of these trees is an important part of modeling the forest's role in the ecosystem's hydrology, but questions persist as to what water is available in the rocks and soil for these trees to use, and how this distribution of soil moisture varies from winter through the melt season into summer.

To investigate these subsurface patterns, WyCEHG postdoc Kevin Hyde installed an array of electrical resistivity tomography (ERT) transects to measure resistivity profiles beneath the surface. These geophysical measurements are sensitive to water content and can be used to track changes in soil moisture. With winter coming and snow already on the ground, new geophysics student Drew Thayer and hydrogeophysicist Dr. Andrew Parsekian installed an electrode array that spans the slope from bedrock outcrop at the top to a seasonal stream channel at the base.

Hyde, Thayer, and Parsekian embarked on a winter field campaign, hauling equipment and car batteries to the site with snow-shoes and sleds to measure the winter ‘baseline’ conditions. At this time WyCEHG acquired a state-of-the-art MPT autonomous resistivity meter. As snowmelt began in the spring, the team commenced automated time-lapse ERT measurements daily on each ERT transect.

This summer’s data collection has been fruitful. Time-series measurements of tree activity and subsurface moisture provide promising opportunities for investigating the hydrologic processes that control water movement and storage on this slope. We are currently preparing our installations for another winter and are excited to collect a full year of continuous data, which will offer insights into large-frequency seasonal patterns of alpine hill slope hydrology.

-Drew Thayer, M.S. candidate, Geophysics and Water Resources

The geophysical team measures electrode arrays to monitor winter soil moisture conditions. On the trees behind them sensors beneath insulation measure the flow of sap. [Photo Andy Parsekian]
Happenings

Ecohydrogeophysics Field Course, Early Summer 2015

During late May 2015, the WyCEHG inspired Ecohydrogeophysics field course met for the third consecutive summer. This year the sole focus was to study and attempt to solve the water balance equation for a small area in the upper Crow Creek watershed of the WyCEHG Blair-Wallis study area. Previous field courses were unlimited in number and restricted to students from Jackson State University and Univ. of Wyoming. However, this past summer, the course was modified to restrict numbers to a total of 12 students and was opened to students attending any HBCU. At the start of the course, we had participation from UW, Jackson State Univ., Howard Univ., Southern Univ., and North Carolina A&T. Although some slight weather setbacks (i.e. snow and cold temperatures) delayed the leafs from our sampling and subsequent calculations of evapotranspiration components, the students were introduced and collected data for the three primary components of the water balance equation (i.e. evapotranspiration, surface water, and groundwater/saturation).

-Brad Carr, WyCEHG

New Snow Sensors Installed

This fall four new snow measuring arrays were installed in the Snowy Range of SE Wyoming. They are situated from 8800’ to 10,700’ elevation to further delineate the variation in snow accumulation in the Range. Each array includes a set of plates that measure snow-water equivalence by weighing the snow, similarly to SNOTEL snow pillows. However, the plates are easier to install and do not require anti-freeze, thereby lowering environmental risk.

In addition to the plates, each location is equipped with a snow depth sensor, an air temperature probe, and five snow temperature sensors at 30 cm intervals to monitor environmental conditions and snowpack evolution. The arrays are run by 12 v batteries with a solar panel for continuous operation.

These arrays are connected to the GOES satellite system to generate continuous real-time data that can be accessed via multiple websites, including the MesoWest climate portal.

- Elizabeth Traver, WyCEHG
Water Interest Group Meetings: Building Connections

In October 2015, WyCEHG hosted the second Water Interest Group (WIG) meeting at the Gateway Rochelle Center in Laramie, WY. The overall objective of the WIG meetings is to increase communication and collaborations between WyCEHG and water resource researchers, managers and stakeholders at local, state and regional levels. Over 65 participants, including University of Wyoming research scientists and graduate students, and collaborators and stakeholders, attended the meeting. The meeting included a poster session of 21 posters, through which graduate students showcased their research.

The meeting highlighted collaborative research projects and identified pathways to build on existing synergies. Stakeholders and collaborators were from state and federal agencies including the Wyoming State Engineer Office, Wyoming Water Develop Office, National Weather Service, US Forest Service and consulting and engineering firms. The meeting was divided into two distinct sections: formal presentations in the morning and small, roundtable discussions in the afternoon.

In the morning session, WyCEHG directors, Drs. Steve Holbrook and Scott Miller, presented an overview of the research projects and accomplishments over the past 3 years. Additional presentations highlighting collaborations with stakeholders included: 1) Dr. Andy Parsekian (WyCEHG), “Geophysics to quantify return flow” a collaborative project with WY Game and Fish; 2) Dr. Brad Carr (WyCEHG), “Collaborations with Municipalities”; 3) Dr. Kate Dwyer (US Forest Service), Collaborations with USFS/WyCEHG in the Snowy Range. Wyoming State Engineer, Patrick Tyrrell, discussed the positive collaborations that have already been developed between WyCEHG and the State Engineer Office and emphasized the need to expand these collaborations to meet the State’s water resource data needs. Kevin Boyce, Wyoming Water Development office, highlighted the strong collaborations already in place and the advantages of the new resources and facilities in hydrogeophysics that WyCEHG has brought to Wyoming.

In the afternoon, participants were divided into breakout sessions to identify paths to maintain and increase WyCEHG’s capacity to meet water data and research needs of Wyoming. Participants selected two of four topic sessions; snow, surface water, groundwater and climate. In the two break out sessions, people were asked to “identify potential research projects that will help us answer new questions and/or augment our understanding of an ongoing research program.” Many discussions and project ideas were generated during the breakout sessions. Examples include quantifying consumptive use, identifying and quantifying conveyance losses, and increasing collaborations on quantifying snow water equivalency. These ideas and suggestions will be used to guide and expand WyCEHG’s collaborative water resource research moving forward.

The project ideas and needs identified at the WIG meetings are important for WyCEHG to address the state’s water resource needs. However, all participants would agree that the key element to building collaborative relationships is having the WyCEHG researchers, collaborators and stakeholders together for the day. This forum and format promoted both formal and informal discussions among the participants, which we hope will build collaborative relationships that will last beyond the time frame of the grant. A third (and final) WIG meeting is to be held in 2016-17, at the end of the WyCEHG project. At that meeting we plan to highlight the results of ideas and collaborations that were built and or strengthened at this meeting.

-Ginger Paige, Dept. of Ecosystem Science and Management
WyCEHG'S GROWING NUCLEAR MAGNETIC RESONANCE CAPABILITIES

WyCEHG’s Facility for Imaging of the Near-Subsurface Environment (FINSE) is committed to maintaining world-class geophysical instrumentation that can be used to study environmental processes. Recently, researcher Dr. Andy Parsekian, along with a team of WyCEHG collaborators, was awarded an NSF Major Research Instrumentation grant to further bolster the range of instrumentation managed by FINSE. With this grant, WyCEHG is acquiring a logging nuclear magnetic resonance (NMR) tool, a leading edge hydrogeophysical device that leverages NMR physics to quantify water consent and pore environment. This gives the University of Wyoming a unique capability amongst academic institutions in the United States; the US Geologic Survey owns the only other similar instrument.

Logging NMR is an exciting measurement because it unambiguously detects water in the formation outside the zone of disturbance around the well. Furthermore, the received signal is analyzed to resolve how large the pores are that water is in – recent work has shown that this can even be linked to permeability, or how easily water can move through an aquifer. Many geophysical measurements detect properties that are a proxy for water, but NMR measurements are a significant advance in technology because the signal is directly related to the volume of water present.

The new instrument will be available for fieldwork starting in Spring of 2016 where it will be incorporated on several ongoing projects. At the East Fork site near Dubois, WY (see related article in this newsletter) logging NMR will be used to understand infiltration and storage processes on irrigated field. In the Laramie Range, the logging NMR will be used at the Blair-Wallis well field to investigate how water behaves in fractured/weathered rock aquifers. The instrument will even be taken into the NoName watershed to make time-lapse measurements of changing saturation in hill slope soils of the catchment.

As a part of this grant, there are several opportunities to engage a broader audience with geophysics. First, a UW EPSCoR Summer Research Assistant Program (SRAP) student will spend their six-week internship contributing to research using the logging NMR during summer of 2016. Also, a new graduate/undergraduate course in Environmental NMR will be offered during the summer of 2016. Finally, starting in Spring of 2016, there will be an opening in Dr. Parsekian’s lab for an undergraduate research fellow to design their own project around data collected using the logging NMR.

-Andy Parsekian, Dept. of Geology and Geophysics
RETURN FLOW IN NORTHEASTERN WYOMING

Agricultural accounts for 90% of total water withdrawal from streams and aquifers in Wyoming; however the proportion of applied water that is consumptively used by crops remains uncertain. With a decline in available water resources, return flows—the portion of irrigation water that returns to local streams and aquifers—is of increasing interest. Flood irrigation involves the continuous delivery of water to a field. Proponents of this method argue that some systems rely on return flow contributions to aquifers and streams. And with many practitioners moving from flood to more conservative irrigation methods like sprinklers, the role return flows play in recharging local streams and aquifers is all the more relevant.

In Wyoming, the State Engineer’s Office generally assumes that 50% of the water applied through flood irrigation will return to a given stream. The amount and timing of this return flow can vary significantly depending on the soils, geology, and hydrologic behavior of a particular system. Wyoming Center for Environmental Hydrology (WYCEHG) partnered with the Wyoming Game and Fish Department on a section of irrigated fields in northeastern Wyoming to understand the processes governing return flow quantity and timing.

The project unifies “classic” hydrology in terms of hydrograph development and water balance accounting with novel geophysical methods like nuclear magnetic resonance (NMR) and time-lapse electrical resistivity tomography (ERT). The time-lapse ERT allows for a detailed study of the spatial and temporal heterogeneity of the wetting and drying processes. The NMR measurements on the other hand directly quantify the effect on the hydrologic status of the subsurface over a complete irrigation season. This interdisciplinary approach elucidates the suite of hydrological pathways governing the return of irrigated water to the stream (e.g. overland flow, vadose zone flow, flow below the groundwater table).

Globally, increasing and often competing demands for limited water resources fundamentally challenges traditional water management strategies. The implementation of this project’s results add depth and breadth to the tools available for agricultural water managers in Wyoming and beyond.

-Bea Gordon, Dept. of Ecosystem Science and Management
EOD UPDATE: WATER IN A 2ND-GRADE CLASSROOM

Water in various forms and water cycle are part of Wyoming’s core curriculum standards for grade levels two through four. In second grade, students are introduced to water cycle, its different forms, and its movement within the water cycle. They also learn about the importance of water to all living beings and the environment, and how excess or less water can result in floods and droughts. Remotely sensed data collected Earth Observation Satellites (EOS) provide another perspective of where and how water is stored on Earth’s surface. Repeat satellite observations can be used for visualizing natural and man-made changes.

As part of WyCEHG’s k-6 outreach and WyomingView’s Earth Observation Day activity, 36 students in second grade classrooms of the Indian Paintbrush Elementary School (IPES, Laramie, WY), were able to see how water diversion from two rivers is resulting in a sea almost disappearing (Aral Sea); relationship between precipitation and drought on reservoirs in Wyoming; and how runoff from crop fields and other effluents in Lake Erie and Gulf of Mexico. With the help of these images students saw how human actions, small and big, influences both water quantity and quality.

Describing the value of these images as a teaching aid, Genee Witte, one of the second grade teachers in IPES, said, “It was very exciting and extremely helpful for the second graders to see the images … It helped build their background knowledge of the changes the lakes, etc. undergo. … Having the images shown to the students helps them to retain the information! They are able to keep that image in their mind and add to their background knowledge.” Feedback provided by other teachers and students can be found in: http://wyomingview.blogspot.com/2015/04/satellite-images-of-lakes-and.html.

WyCEHG will continue to work teachers in second through fourth grade to incorporate EOS data in their classrooms to illustrate different components of the water cycle.

-Ramesh Sivanpillai, Dept of Botany | WyGISC

Ramesh Sivanpillai brings water research to a second-grade classroom at Indian Paintbrush Elementary School, Laramie, Wyoming.
EOD UPDATE: COMMUNITY COLLEGES AT DUNWOODY GLACIER

In August, Central Wyoming College’s ICCE or Interdisciplinary Climate Change Expedition hiked from Trail Lakes trailhead, near Dubois, WY, and headed for the Dinwoody Glacier located near Gannet Peak—the highest peak in Wyoming. The food re-ration and science gear were sent in by horse packer, and the 19 hikers and horse packers meet on the third day. The ICCE was comprised of several archeology students, a few students looking for black carbon evidence, a couple students using GPR to probe the glacier, and two students focusing on water quality, including macro-invertebrates and E. coli. A Riverton film maker, three professors, an additional outdoor leader, and two scientists from EPSCoR rounded out the group. The trip was a total of 11 days.

These fresh(wo)men and sophomore students are generating cutting edge data and will be presenting their results at national conferences. The archeology folks found new sites, at higher elevations than had previously been found; the GPR students are producing detailed analyses of the receding glacier’s volume. One student is analyzing whether and how much the climbers of the area are leaving behind E. coli in the streams, while another is quantifying the macro-invertebrates in these primary streams that come directly from the glaciers. Other students are looking at black carbon residue on the glacier for both modern, industrial pollution as well as possibly, ancient carbon from indigenous travelers in the area. It was an impressive array of science going on from some very young researchers.

-Elizabeth Traver, WyCEHG
**WyCEHG Presentations at Fall AGU**

**Monday, Dec. 14**

Flinchum, Brady: Exploring Critical Assumptions of Petrophysical Models in Fractured Aquifers by Comparing Estimated Porosity Values Obtained from Surface Nuclear Magnetic Resonance and Shallow Seismic Refraction Surveys. H11A-1320, 8-12:20 MS

Fantello, Nadia: Estimating Trapped Gas Concentrations as Bubbles within Lake Ice Using Ground Penetrating Radar. C11C-0785, 8-12:20 MS

Ewers, Brent: Bark Beetle-Induced Mortality Impacts on Forest Biogeochemical Cycles are less than Expected. B11N-04, 8:45-9 MW 2010


Claes, Niels: Innovative thinking and challenges within our own community: ‘Dare to fail’. Pop Up Talk, 16:00 MS 101

**Tuesday, Dec. 15**

Bush, Caitlin: Assessing spatial and temporal snowpack evolution and melt with time-lapse photography. H21D-1409, 8-12:20 MS

Hall, Jazzlynn: Primary drivers of dust deposition within a small subalpine watershed. H21D-1405, 8-12:20 MS

Albeke, Shannon: Developing a Data Discovery Tool for Interdisciplinary Science: Leveraging a Web-based Mapping Application and Geosemantic Searching. B21D-0508, 8-12:20 MS

Parsekian, Andrew: Bedfast and floating ice lake talik properties measured using surface nuclear magnetic resonance on the North Slope, Alaska. NS21A-1913, 8-12:20 MS

Beverly, Daniel: Snow distribution throughout small subalpine catchment post-insect infestation of spruce and pine beetle. H21D-1403, 8-12:20 MS


**Wednesday, Dec. 16**

Klatt, Alan: Observed Changes in Mountain Hydrology following a Mountain Pine Beetle Epidemic in the Snowy Range of Wyoming. H31H-1525, 8-12:20 MS


Nauer, Catherine: Laboratory Study of Lithologic Controls on Solute Fluxes from Granite Weathering. EP31B-1001, 8-12:20 MS

Kipnis, Evan: Influence of Terrain and Land Cover on the Isotopic Composition of Seasonal Snowpack in Rocky Mountain Headwater Catchments Affected by Bark Beetle Induced Tree Mortality. H31H-1529, 8-12:20 MS

Elwaseif, Mehrez: Joint inversion of Multi-frequency Electromagnetic Induction and Seismic Refraction Data for improved Near Surface Characterization. NS31A-1959, 8-12:20 MS

Frank, John: A Bayesian model to estimate the true 3-D shadowing correction in sonic anemometers. B33A-0626, 13:40-18 MS

Thayer, Drew: Tracking snowmelt in the subsurface: time-lapse electrical resistivity imaging on an alpine hill slope. C33C-0822, 13:40-18 MS

Rogers, Trent: Snowmelt-induced subsurface and overland flows in a hillslope in Noname Watershed, Laramie River Basin, Wyoming. C33C-0843, 13:40-18 MS


**Thursday, Dec. 17**

Traver, Elizabeth: Soil heterogeneity of an East and West facing ridge above timberline due to differences in snow and aeolian deposition. B41A-0415, 8-12:20 MS

Sivanpillai, Ramesh: Distinguishing Bark Beetle-infested Vegetation by Tree Species Types and Stress Levels using Landsat Data. B43C-0571, 13:40-18 MS


Parsekian, Andrew: Controls on infiltration due to spatial heterogeneity in a small recharge basin observed using time-lapse distributed temperature sensing. NS44A-02, 16:20-16:40, MW 3024

**Friday, Dec. 18**

Fullhart, Andrew: Calibration of GEOtop for a Mountainous Watershed—a Hydrological Land-Surface Model. H51N-1604, 8-12:20 MS

Ohara, Nori: Dynamic Equilibrium Inter-annual Snow Modeling for Wyoming using Reconstructed Regional Atmospheric Conditions. C51C-0753, 8-12:20 MS

He, Siwei: Modeling of Sub-grid Variability for Snow Redistribution and Ablation Processes using Fokker-Planck Equation. B31C-0438, 8-12:20 MS

Hein, Annette: Mapping groundwater in an Alpine Drainage with Airborne Electromagnetic Methods and Nuclear Magnetic Resonance. NS52A-06, 11:35-11:50 MW 3024


Taylor, Nicholas: Using Three-Dimensional Passive Seismic Imaging to Capture Near-Surface Weathering and Its Influence on Overlying Vegetation, 13:40-18, MS

Pasquet, Sylvain: Encouraging the use of seismic methods for the hydrogeophysical characterization of the critical zone. H53C-1683, 13:40-18 MS

From the EPSCoR Office

This past summer, Wyoming EPSCoR celebrated three years of research, education, and outreach with the Wyoming Center for Environmental Hydrology and Geophysics (WyCEHG). WyCEHG conducts basic research involving the movement of water through the column of unweathered rock to the atmosphere and along the climate gradient from snowy mountain tops to semi-arid basins. Moving into our fourth year of this five-year $20 million award, we have seen incredible gains made by our research teams as well as increased participation by students of all ages and backgrounds in water-science learning.

In October, WyCEHG gained national recognition with a paper published in Science, one of the world’s leading scientific journals, with lead author, James St. Clair, a PhD student and a member of WyCEHG geophysics team. St. Clair et al. tested a new theory that regional stress from plant tectonics predicts how bedrock fractures at the local scale with implications for how groundwater will flow and be stored. With groundwater storage increasingly imperiled around the U.S. and world, this research is especially relevant to future water allocation policies.

Also in October, the second Water Interest Group Meeting (WIG) was hosted by WyCEHG at the Rochelle Gateway Center at the University of Wyoming. During this all-day event, water resource professionals, faculty, students, and the public listened to presentations by WyCEHG researches and collaborators, participated in break-out sessions to discuss research needs, and then stayed for a reception with an adjacent poster presentation as a part of the combined WyCEHG Roundup research event. The WIG met the goal of bi-directional interactions between WyCEHG researchers and state and regional water managers.

We are taking cutting edge research from WyCEHG and using it in our education programs. Faculty from Central Wyoming Community College in Riverton, WY are using WyCEHG equipment with students to investigate the consequence of glacial retreat in the Wind River mountains. The potentially lower river flows have impacts not only in Wyoming but also to downstream users outside our state. Our water educational programs on the Wind River Reservation have taken off. More than 100 Reservation students have taken part in hands on (and feet wet) water science summer school and retreat classes.

I look forward to reporting more high impact science and education coming out of WyCEHG as we move into the last portion of the grant and the lasting impact of WyCEHG on Wyoming in the years beyond.

-Brent Ewers, Wyoming EPSCoR Program Director

Dr. Brent Ewers
Parting Shot: Glacier Peak, Wyoming

Snow drifts at Glacier Peak and the eddy covariance instrumentation for quantifying energy and water vapor fluxes.

Photo: Daniel Beverly

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