Preview of Award 1331408 - Annual Project Report

Cover

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Project Title:	Transformative Behavior of Energy, Water and Carbon in the Critical Zone II: Interactions between Long- and Short-term Processes that Control Delivery of Critical Zone Services
PD/PI Name:	Jon D Chorover, Principal Investigator David D Breshears, Co-Principal Investigator Jennifer C McIntosh, Co-Principal Investigator Jon D Pelletier, Co-Principal Investigator Craig Rasmussen, Co-Principal Investigator
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Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Jon D Chorover

Accomplishments

*** What are the major goals of the project?**

The Catalina-Jemez (C-J) CZO project aims to improve our understanding of the mechanisms underlying quantitative relations between climatic forcing and critical zone evolution in water-limited systems by focusing on linkages between long time-scale climate/lithology interactions and short time-scale ecological/geological feedbacks, and how both affect CZ services.

This goal motivates the proposal's central thematic questions:

1) How do the long-term drivers of CZ structure and function (EEMT and tectonics) alter parent material to control current CZ structure and response to perturbation?

2) How is long-term CZ evolution affected by ecosystem process controls, including especially localized plant and microbial activities?

3) What is the impact of CZ structure on buffering climate- and disturbance-driven variability in water, soil and vegetation resources and how does this translate into changes in CZ services?

We postulate that the climatic forcing of subsurface CZ evolution is predicted on the basis of effective energy and mass transfer (EEMT), which combines into a single climatic term the energy transferred to the CZ as effective precipitation (precipitation in excess of evapotranspiration) and reduced carbon (i.e., net primary production).

The CZO site focus is on the water-limited (semi-arid to sub-humid) southwestern US. A broader impact of our research is, therefore, to improve societal understanding of processes that govern water resource delivery and quality in this region. Mountain block and mountain front recharge serves as the principal source of all freshwater resources to human inhabitants in this part of the world, and hence our project focuses strongly on factors affecting this aspect of the water cycle, including the partitioning of water delivered (as a result of orogenic forcing) to higher elevation catchments, and the influence of hydraulic throughput on CZ geochemical and geomorphic evolution. We are investigating how event-based partitioning of water and carbon feeds back to affect the development of hydrologic flow paths, landscape structure and (bio)geochemical heterogeneities.

Our approach involves a combination of field-based observational measurements, controlled experimentation, and conceptual/numerical modeling at each of two principal research sites in the water-limited southwestern US - Santa Catalina Mountains (SCM, AZ) and Jemez River Basin (JRB, NM). In year 4 of the CZO grant, we have initiated and completed several activities and made substantive progress in each of these areas.

Our transdisciplinary research approach interrogates CZ process dynamics and structure along four integrated lines of inquiry: (i) Ecohydrology and Hydrologic Partitioning; (ii) Subsurface Biogeochemistry; (iii) Surface Water Dynamics; and (iv) Landscape Evolution. By building bridges across these four lines of inquiry, we address linkages between short time-scale (e.g., hydrologic) events and long time-scale (e.g., geomorphic) evolution of the CZ.

In addition to the goals we have for testing hypotheses given in the proposal, the Catalina-Jemez CZO is active in pursuit of CZO network goals. Transformative, network-level science findings should result from comparably quantified structural properties and process rates at multiple sites. By doing so, we can, as a network, assess CZ coupled-process trends and test response hypotheses across the wider climate-lithology parameter space afforded by the network. For these reasons, Chorover has led cross-CZO (X-CZO) development of "common measurements" conceptual frameworks for the CZO network, along with several collaborators.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: **1. Ecohydrology and Hydrologic Partitioning**

- Upgrade and maintain sap flux measurements associated with Bigelow Tower (SCM).
- Monitor plant physiological performance on North- versus South-facing aspect across five seasonal periods.
- Measure transpirational water loss and photosynthetic carbon uptake across seasonal periods of variable precipitation to examine interspecific differences in rates of water loss and carbon uptake efficiency.

- Extensive snow survey in the MC zob (JRB) by the spring 2017 snow hydrology class at UU in collaboration with researchers at UA and UNM. Observations were made immediately preceding melt initiation and will be used to evaluate the longer term effects of fire on snowpack accumulation.
- Existing phenocams, established by Papuga and colleagues, were incorporated into a snow ablation monitoring array providing sub-daily resolution on the timing and amount of snowmelt across the MC ZOB.
- Distributed snow samples collected immediately prior to peak accumulation and returned to UU campus for hydrochemical and isotopic analyses. These data will be used in concert with soil, groundwater, and stream samples in a multi-investigator collaboration to quantify interactions between hydrologic flowpaths and CZ structure and function.
- Swetnam et al. (2017) quantified the role of topographically driven hydrologic subsidy on biomass accrual using high resolution LiDAR data obtained as part of cross CZO research.
- Building on work from previous CZO contributions, Harpold and Brooks (in revision) evaluated the response of western snowpacks to simultaneous warming and changes in humidity.

2. Subsurface Biogeochemistry

- 98 subsamples from the MCZOB boreholes were analyzed for total elemental chemistry (UA, ALEC), bulk and fine fraction mineralogy.
- 35 drill core subsamples analyzed for uranium-series and strontium isotopic composition in the U-series Isotope Laboratory at the University of Texas at El Paso.
- Select subsamples were analyzed at SSRL to identify iron speciation in bulk samples using X-ray absorption spectroscopy (XAS) techniques (beamlines 11-2 and 4-3).
- Select thin sections mapped for elemental concentrations using uXRF and multiple energy XANES techniques at SSRL to assess redox status of iron and manganese along weathered surfaces.
- Ongoing annual post-fire analysis of pedons distributed throughout MCZOB to assess fate of bioaccumulated lithogenic solutes and black carbon.
- Drill cores were shipped to the National Lacustrine Core Facility (LacCore) at the University of Minnesota for non-destructive analysis (e.g. p-wave velocity, gamma density, magnetic susceptibility, natural gamma radiation, and electrical resistivity) by UA students who visited LacCore to split cores and describe the lithology, mineralogy, and structure with the assistance of LacCore personnel. Cores will be archived at LacCore.
- Established an international collaboration with Aqua Diva CZO and Max Planck Institute for Biogeochemistry in Jena, Germany, to train on handling, processing and extracting DNA from deep CZ core samples.
- Conducted bench scale experiments on forest floor DOM with subsoil surfaces under live soil conditions.
- Geostatistical techniques were used to integrate point-scale functional measurements of microbial activity with landscape topography to translate microbial activity to the landscape scale. Enzyme activity best corresponds to NDVI, SAGA wetness index, and total N availability, indicating important landscape controls on soil moisture, vegetation cover and microbial activity (Fairbanks et al., in prep.)

3. Surface Water Dynamics

- Slug tests conducted in October 2017 in the eight boreholes in the MCZOB in the JRB CZO to determine hydrologic parameters; however, it was discovered that the wells were silted up and required cleaning before repeating hydrologic tests. A first attempt at removing the silt from the wells was completed in October 2017 with inertial pumps.
- Each monitoring well contains a vibrating wire piezometer pressure transducer to monitor water levels at 15-minute intervals.
- Monitoring wells were sampled by field staff every two to four weeks for major ions, trace metals, stable isotopes, uranium isotopes, strontium isotopes, and carbon content.
- Increased groundwater sampling frequency (weekly) was initiated during the spring of 2017 to capture water chemistry and isotopic changes that result from the snow melt period to test hydrologic through flow at both vertical and horizontal scales. Groundwater samples are being analyzed for U-series and Sr isotopes at UTEP, in addition to the full suite of CZO analyses.
- All water samples are analyzed for field parameters (pH, Temp, EC, DO), major and minor ions, trace metals, REE, DOC, DIC, TN, and stable water isotopes).
- ISCO automatic samplers were installed on the shallowest monitoring well, MCZOB flume, and La Jara flume for diurnal sampling during the spring snowmelt.
- Bi-weekly sampling of stream waters in the MCZOB, La Jara, History Grove, Upper Jaramillo catchments for time-series hydrologic and biogeochemical data were continued throughout the year. Similar samples were collected in the SCM CZO sites (Marshall Gulch weir, Granite ZOB, Schist ZOB, Oracle Ridge, B2 Desert Sites).
- Water samples from ten springs in the JRB CZO, for which water transit time based on tritium analysis are already known, were collected during the dry seasons of 2015 and 2016 and analyzed for U-series and Sr isotopes.
- Springs, soil water, and stream water in the Marshall Gulch catchment were collected quarterly and analyzed for tritium to determine their residence time.
- Hydrochemical modeling was conducted to understand how recent forest fires in the Valles Caldera Preserve (JRB-CZO) have altered water sources and quality of streamflow.
- Expanding on the importance of topography on coupled water and biogeochemical cycles, Weintraub et al. (2016) examined N cycling in paired forest and meadow sites across a topographical gradient.

Specific Objectives: Overarching objectives of the CZO research is unchanged from prior year reports. Specific objectives pertaining to this year of CZO activities included a strong focus on:

- Developing predictive relations between EEMT and forest NPP and ET.
- Borehole drilling and groundwater well installations in locations indicated by geophysical surveys to be most beneficial to our studies.
- Core sample analyses for geochemistry and mineralogy as a function of depth.
- Elucidation of impacts of fire on surface water dynamics, including changes in chemistry and source of streamwater.
- Utilizing stable and radiogenic isotopic tracers to assess relations between water transit time and geochemical weathering.

- Linking microbial activity to geochemical and geomorphic conditions in the MC ZOB.
- Leading on collaborative cross-CZO studies of aspect-induced variation in landscape evolution.
- Leading on cross-CZO studies of concentration-discharge relations in the CZ.

Significant Results:

1. Ecohydrology and Hydrologic Partitioning

- We further developed the Terrestrial Integrated Modeling System (TIMS) with a scheme of topographic shading and scattering effects on insolation. We applied the model over a small sub-humid catchment (1.55 km^2), the Marshall Gulch, Arizona to explore the impacts of topographic shading and scattering of insolation on energy and water partitioning as well as the impacts on snowmelt and river discharge. The topographic shading effect is dominant over the scattering effect, resulting in more river discharge by up to 40%.
- We have applied TIMS over the Marshall Gulch (1.55 km^2) to investigate the impacts of rainfall redistribution through lateral subsurface flow over complex terrain on partitioning of evapotranspiration (ET) into evaporation (E) and transpiration (T). The results show that convergence of rainfall through lateral subsurface flow enhances the ratio of T to ET, suggesting that more water is used for plants over a mountainous catchment. The mountains over the Western US may provide the ecosystems a great buffer to the warming and drying climate.
- Building on work from previous CZO contributions, Harpold and Brooks (in revision) evaluated the response of western snowpacks to simultaneous warming and changes in humidity. They showed that the dual nature of latent energy exchange where sublimation cooling under a drier atmosphere will differentially counteract the effects of warmer temperatures while a simultaneous increase in atmospheric humidity will greatly exacerbate warming (**Figure 1**).
- In a cross CZO paper Swetnam et al. (2017) quantified the role of topographically driven hydrologic subsidy on biomass accrual using high resolution LiDAR data obtained as part of the cross CZO research. Surprisingly, analyses indicate that the influence of lateral water (or nutrient) distribution is greater either aspect or elevation in explaining standing forest biomass (**Figure 2**). Although this result has been observed before in hot/ dry systems (although not this well quantified), the pattern held at cold, wet high elevation locations as well. These observations, combined with similar work at Shale Hills by colleagues there, suggest a complex interaction between below ground processes that influences above ground vegetation.
- Seasonal tritium and geochemical results in Marshall Gulch (SCM-CZO) show that older groundwater from the fractured bedrock aquifer contributes to streamflow during the spring snowmelt period, while draining of younger groundwater from shallow, perched aquifers sustains streamflow during drier periods (**Figure 3A,C**). Water stable isotopes and water balance calculations show that the majority of water loss to the atmospheric in Marshall Gulch catchment occurs as transpiration, rather than evaporation (**Figure 3B,D**).

2. Subsurface Biogeochemistry

- Wet-dry cycles affect interactions between DOM and subsurface soils by enhancing the interactions between carboxyl functional groups and soil particle surfaces. Interactions of these functionalities were dominated by Ca^{2+} bridging to soil surfaces (**Figure 4**). Nanoscale spatial fractionation of DOM on soil organo-mineral surfaces was diminished relative to DOM fractionation on specimen mineral phases. This is likely due to the heterogeneous composition of the weathered soil surfaces and pre-existing metal oxide and OM films coating soil particle surfaces.
- Data collected from instrumented pedons shows time variation in physical parameters associated with seasonal dependencies (**Figure 5**). Soil $CO_{2(g)}$ followed the temperature trend, but CO_2 pulses during wetting events were pronounced. These events, starting with a rapid increase in soil moisture are followed by initial decrease then increase in CO_2 concentration. CO_2 concentration was positively correlated with K and Si, suggesting dissolution of mica/illite or K-Feldspar.
- In excavated deep CZ boreholes from the ZOB, weathering does not produce monotonic elemental depletion profiles as observed at other CZOs (**Figures 6 and 7**). Heterogeneous vertical distribution of immobile element ratios (e.g. Ti/Zr) in the three boreholes suggest multiple depositional events comprise the relatively short depth interval (down to 50 m below ground surface) investigated during drilling in 2016. As a result, weathering may be confined to certain lithologies with significant primary porosity soon after deposition. However, this is confounded by tectonically induced fracturing, which may have increased preferential flow paths and concentrated weathering around fracture surfaces.
- The upper 10 meters of the eastern mid-slope borehole has significant smectite and zeolite (clinoptilolite and mordenite) content (**Figure 6**). This mineral assemblage is common in other parts of the Valles Caldera and has been identified, by Chipera et al. 2008, as precipitates from an alkaline caldera lake that formed soon after caldera eruption. This constrains the age of the upper portion of this profile to 1.25 MA. The other boreholes in the ZOB do not have smectites or zeolites present in their profiles and clays in these borehole locations are likely as a result of incongruent dissolution of primary minerals (**Figure 7**).
- Perched groundwater appears to be controlled by the distribution of clay on the western portion of the ZOB.
- Pyrogenic C increases relative to total organic C with depth in soil profiles throughout the MC ZOB (JRB), which was burned by a wildfire in 2013.
- Data and analyses from Weintraub et al. (2016) demonstrate the interactive effects of vegetation and topography on N cycling where lateral hydrologic flowpaths transport N downslope. Their results identified a much more open soil N cycle in low topographic positions indicative of N subsidy from higher elevations (**Figure 8**). Only deeper rooted forest vegetation accesses this N, resulting in N rich biomass and litter, which falls and increases N in surface soils.

3. Surface Water Dynamics

- U-series (1.97 to 2.06) and Sr isotope (0.70737 to 0.70844) values of stream waters in three catchments in the JRB-CZO (La Jara, Upper Jaramillo and History Grove) vary by season in WY 2015; however, those changes are not constant between catchments suggesting that differences in the mineralogy and structure of the deep CZ likely also drive isotopic

variability. Springs and streams within the same catchment also have distinct isotopic signatures, which are likely controlled by local geology.
- Water transit times do not explain variability of U (1.60 to 3.09) and Sr isotope (0.70704 to 0.70817) values in springs throughout the JRB-CZO suggesting that 1) the relatively short length of time water interacts with rock in the JRB-CZO is not a good indicator of U isotope composition or 2) springs should be reanalyzed for tritium content because low flow (fall 2013) conditions are not representative of low flow pre-monsoon conditions when streams were analyzed for U and Sr isotope composition. Further investigation of seasonality controls on U isotopes should clarify these explanations in a summer 2017 sampling campaign.

4. **Landscape Evolution**

- Documented dependence of slope aspect on topography in several SW US sites, and developed a theoretical model that explains the deviation of slope-aspect asymmetry from N-S to SW-NE (Pelletier and Swetnam, 2017).
- Quantified coevolution of soil and landform development as a function of landscape age and slope aspect in volcanic landforms from Oregon to Arizona (Rasmussen et al., Catena, 2017).
- Quantified the relationships among soil production rates, topographically induced stresses, and climate in the San Gabriel Mountains (Pelletier, ESurf, accepted pending minor rev.).
- Documented and modeled global patterns of slope asymmetry in CZ variables (Pelletier et al., ESPL, 2017).

Key outcomes or Other achievements: Discussed above.

*** What opportunities for training and professional development has the project provided?**

- We have trained undergraduate students to deliver hands-on science education activities for the CZ Discovery program. We are working with graduate and undergraduate students to continue to refine the CZD curriculum. The CZ Discovery program successfully launched in fall 2016 and has already reached hundreds of students from underserved schools, grades 3rd through 6th.
- A new interdisciplinary Hydrology and Water Resources Graduate Certificate program was developed at the University of Utah, informed by the successful cross campus CZO activities at UA. This program is open to both matriculated graduate students as well as non-matriculated professionals from the community who are seeking advanced training without needing or wanting a degree. The program is housed under the office of sustainability and incorporates coursework from six departments across four colleges providing the diverse training and exposure that defines CZ science.
- Three new courses have been developed at University of Utah that bring the diverse CZ perspective to hydrologic partitioning and landscape structure. These courses are cross listed among multiple departments.

*** How have the results been disseminated to communities of interest?**

- Successfully launched the CZD Field Trip Program bringing in 957 students ranging 3rd to 6th grades to engage in hands-on earth science activities and learn about the concept of the Critical Zone (See attached letters from participants).
- Successfully opened the “Welcome to the Critical Zone” exhibit in July 2016 to take visitors on a journey through the Critical Zone, exploring CZ science along the way through interpretive signage, hands-on exhibits and games, and dynamic illustrations and diagrams. Since opening the exhibit has already impacted over 36,119 visitors.

- The “Mt. Lemmon Science Tour” app, a free smartphone audio science tour for the drive/bike up the scenic Catalina Highway from Tucson to the top of the Santa Catalina Mountains, has proven increasingly popular. The Tour has been downloaded by more than 115,000 users since its debut in November 2015, and introduces listeners to the concept of the Critical Zone in addition to related earth science exposition.
- Recorded photos and video of CZO PI presentations focused on how their research ties into the overall picture of critical zone research. We hope to share several of these presentations via our Flandrau Science Center YouTube channel.
- Worked with CZO scientist, grad student, and NASA Space Grant awardee Chris Shepard to produce videos about Seismic Reflectivity research, the SCM/JRB CZO’s Scientific Drilling Project, and profiles of grad students and faculty researchers. Videos are on YouTube and have been posted on Social Media to help promote the exhibit “Welcome to the Critical Zone.” Select videos are currently on display in the exhibit.
- A new Facebook page for the Santa Catalina Mountains/Jemez River Basin CZO at the University of Arizona will help disseminate CZ science and reach a broad public audience with updates on Critical Zone Science.
- Brooks continues to serve on the science advisory teams for Healthy Headwaters Initiative, Salt River Project, Salt Lake Public Utilities, Mountain Accord, and Carpe Diem West. These groups represent public utilities, natural resource managers, and NGO’s focused on improving resource management in western North America
- Results from our forest, water, and climate work are being incorporated into forest management activities within the watersheds of the Salt River Project (SRP) and the Wasatch Front (Salt Lake Public Utilities) in partnership with local water utilities. We recently began to collaborate with western ski areas on snow management for the critically important early season (Thanksgiving to Christmas Holidays).
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*** What do you plan to do during the next reporting period to accomplish the goals?**

- CZO field-based sensor and sampler network array will continue to be operated through continuous data acquisition and field technician sensor maintenance and sampler collection for the remaining duration of the current CZO cooperative agreement.
- Detailed investigations of groundwater-surface water couplings are underway in both SCM and JRB locations.
- Deep CZ investigations in the JRB will focus on developing a detailed understanding of water geochemical evolution during transport through the fractured bedrock network.
- Geophysical, geochemical and microbiological data sets are being combined for the drill cores to assess microbial role in porosity development.
- Molecular spectroscopy studies will be pursued to resolve surface coatings on weathered geomedia and their formation mechanisms.
- Propagation of the post-fire solute pulse will be tracked in the MC ZOB.
- A new hydrologic model for Marshall Gulch is being developed to incorporate emerging understanding of deep groundwater flowpaths and their contribution to surface water flows.
- The new exhibit about Critical Zone science and research, “Welcome to the Critical Zone,” will remain open to the public through 2017. We are currently working on a new “Virtual Flux Tower” exhibit that will allow visitors to experience the view from the Bigelow Flux Tower above the canopy.
- In August 2017, we will train our new student Instructional Specialists to deliver the activities for the CZ Discovery program. We will continue to promote the program to regional Title 1 schools, schedule school field trips, and deliver programming starting in September 2017.
- We will begin work on the “Critical Zone Tour” podcast that will build on the science concepts in the MLST app and provide a more complex look at CZ science for users with a higher level of education and interest.
- We will continue to release and promote videos about CZO research and scientists on YouTube for the “CZO Journey” series, working with Chris Shepard. The production and release of new CZ videos will continue through 2017.
- Faculty research associate Nesbitt will continue to expand empirical and modeling activities associated with terrain mediated energy, water, and carbon partitioning.

- Cosmogenic erosion rates have been measured for 7 drainage basins in the SCM. In the next year we will perform modeling studies aimed at interpreting the cosmogenic data and the distribution of slope angles in the SCM with climate/elevation. This work will be a fundamental contribution to our understanding of controls on soil production rates and its influence on hillslope form in semi-arid environments.
- Results from the 2017 spring snow survey will be analyzed in conjunction with observations from previous years to document the longer term effects of fire on snow accumulation and ablation.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Figures File to accompany Catalina-Jemez annual report.pdf	Figures file to accompany Catalina-Jemez annual report ("significant results" section).	Jon Chorover	07/09/2017

Products

Books

Book Chapters

Heckman, K, LT Strand, C Rasmussen (2017). Role of mineralogy and climate in the soil carbon cycle. *Developments in Soil Science* 35. WR Horwath and Y Kuzyakov. Elsevier. . Status = UNDER_REVIEW; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Wilcox, BP D Le Maitre, E Jobbagy, L Wang, DD Breshears (2016). Ecohydrology: Processes and Implications for Rangelands. Rangeland Systems. *Rangeland Systems: Processes, Management and Challenges.* D.D. Briske, ed. Springer. 85. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Inventions

Journals or Juried Conference Papers

Adams H.A., Barron-Gafford G.A., Minor R.L., Gardea A.A., Bentley L.P., Breshears D.D., Dowell N.G., and Huxman T.E. (2016). Linear reduction in time-to-tree-mortality across rising temperatures yields nonlinear. *Proceedings of the National Academy of Sciences*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Balogh Z., Brantley S., Dawson T., Eissenstat D., Evaristo J., Godsey S.E., Marshall J.A., McDonnell J.J., Papuga S.A., Roering J., and Weathers K. (2016). On the role of trees in building and plumbing the Critical Zone.. *Frontiers in the Ecology*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Barron-Gafford G.A., Hendryx S., Minor R.L., Colella T., Murphy P., Lee E., Scott R.L., and Kumar P. (2017). A multi-metric assessment of the impacts of hydraulic redistribution on carbon and water fluxes in a semiarid savanna.. *Global Change Biology*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Barron-Gafford G.A., Sanchez-Cañete E.P., Minor R.L., Hendryx S., Lee E., Sutter L., Tran N., Parra E., Colella T., Murphy P., Hamerlynck E., Kumar P., and Scott R (). Photosynthetic phenological variation may promote coexistence among co-dominant tree species in a Madrean sky island mixed conifer forest. *Tree Physiology*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Breshears D. D., A. K. Knapp, D. J. Law, M. D. Smith, D. Twidwell, and C. L. Wonkka (). Rangeland Responses to predicted increases in drought extremity. *Rangelands*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Chang L.-L., R. Dwivedi, Y. Fang, G.-Y. Niu, G. A. Barron-Gafford et al. (2017). Controls of Lateral Subsurface Flow, Topographic Shading, and the Resulting Plant Dynamics on the Partitioning of Evapotranspiration.. *Water Resources Research*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Chorover, J., L. Derry, and W. H. McDowell (2017). Concentration-discharge relations in the critical zone: Implications for resolving critical zone structure, function and evolution. *Water Resources Research*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Elshall A.S., Ye M., Niu G-Y, and Barron-Gafford G.A. (2017). Impacts of Residual Models on Bayesian Inference and Predictive Performance of Soil Respiration Models. *Journal of Geophysical Research – Biogeosciences.*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Elshall A.S., Ye M., Niu G-Y, and Barron-Gafford G.A. (2017). Relative Model Score: A Multi-Criteria Metric for Measuring Relative Predictive Performance of Multiple Models.. *Water Resources Research.*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Fairbanks D., Shepard C., Murphy M., Rasmussen C., Chorover J., Rich V., Gallery R. (2017). Topographic controls on soil microbial enzyme activity following wildfire disturbance in a sub-alpine catchment. *Soil Biology and Biochemistry*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Fang Y., P. Broxton, G.-Y. Niu, M. Barlage et al. (2017). Effects of Topographic Shading and Scattering of Insolation on Snow Mass Distributions and River Discharge over a Mountainous Catchment.. *Water Resources Research*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Fang, Y. H., G.-Y. Niu, W. Zeng, X. Zhang, P. Wang, and P. Troch (2017). Terrestrial water storage change over the Upper Colorado River Basin caused by climate and land cover changes. *Water Resources Research*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Finley, B, P Dijkstra, C Rasmussen, E Schwartz, R Mau, X Liu, N van Gestel, and BA Hungate (). Soil mineral assemblage and substrate quality effects on microbial priming.. *Biogeochemistry*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Froend R.H., Breshears D.D., Law D.J., and Barron-Gafford G.A. (2017). Phreatophytes in the Anthropocene: State and Transition Models for Climate Change and Land Use Pressures. *Earth's Future*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Harpold A.A. and P.D. Brooks (). Humidity will determine snowpack response to climate change.. *Nature Climate Change.*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Huckle, D., L. Ma, J. McIntosh, A. Vázquez-Ortega, C. Rasmussen, J. Chorover (2016). U-series isotopic signatures of soils and headwater streams in a semi-arid complex volcanic terrain.. *Chemical Geology*. (445), 68. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1016/j.chemgeo.2016.04.003

Lee E., Kumar P., Barron-Gafford G.A., Hendryx S., Sanchez-Cañete E.P., Minor R.L., Colella T., and Scott R.L. (). Impact of hydraulic redistribution on multispecies vegetation water use in a semi-arid savanna ecosystem: An experimental and modeling synthesis.. *Water Resources Research.*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Li L., Maher K., Navarre-Sitchler A., Druhan J., Lawrence C., Meile C., Moore J., Perdrial J., Sullivan P., Thompson A., Jin L., Bolton E., Brantley S., Dietrich W., Mayer U., Steefel C.I., Valocchi Al., Zachara J., Kocar B.,

McIntosh J., Bao C., Tutolo B.M., Beisman J., Kumar M., Sonnenthal E. (2017). Expanding the role of reactive transport modeling in earth and environmental sciences.. *Earth Science Reviews*. 165 280. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Lybrand, R, K Heckman, and C. Rasmussen (2017). Soil organic carbon partitioning and residence time variation in desert and conifer ecosystems of southern Arizona. *Biogeochemistry*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

McIntosh J.C., Schaumberg C., Perdrial J., Harpold A., Vázquez-Ortega A., Rasmussen C., Vinson D., Zapata-Rios X., Brooks P.D., Meixner T., Pelletier J., Derry L., and Chorover J. (2017). Geochemical evolution of the Critical Zone across variable time scales informs concentration-discharge relationships: Jemez River Basin Critical Zone Observatory. *Water Resources Research*. (53), 1. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2016WR019712

Minor J., Falk D.A., and Barron-Gafford G.A. (). Fire severity and regeneration strategy influence shrub patch size and structure following disturbance. *Forests*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Mitra B., Papuga S.A., and Swetnam, T. (2017). Observations of species-specific shifts from energy-limited to water-limited transpiration in subalpine mixed-conifer: a seasonal analysis.. *Water Resources Research*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Mitra B., Papuga S.A., Swetnam T.L., Alexander M.R., and Abramson N. (2017). Allometric relationships of primary size measures to sapwood area for six common southwestern USA tree species.. *PLOS One*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Olshansky, O., R. Root, and J. Chorover (). Wet-dry cycles effects on sequential reaction of dissolved organic matter with subsurface soils.. *Biogeosciences*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Olyphant, J., J.D. Pelletier, and R. Johnson (2016). Topographic correlations with soil and regolith thickness from shallow-seismic refraction constraints across upland hillslopes in the Valles Caldera, New Mexico. *Earth Surface Processes and Landforms*. (14), 1684. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/esp.3941

Orem, C.A. and J.D. Pelletier (2016). Constraining frequency–magnitude–area relationships for rainfall and flood discharges using radar-derived precipitation estimates: Example applications in the Upper and Lower Colorado River basins, USA. *Hydrology and Earth System Science*. (20), 4483. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5194/hess-20-4483-2016

Orem, C.A., and Pelletier, J.D. (2016). The predominance of post-wildfire erosion in the long-term denudation of the Valles Caldera, New Mexico. *J. Geophys. Res. Earth Surf*. (121), 843. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/2015JF003663

Pelletier, J. D., and Swetnam, T. L. (2017). Asymmetry of weathering-limited hillslopes: The importance of diurnal covariation in solar insolation and temperature. *Earth Surface Processes and Landforms*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1002/esp.4136

Pelletier, J.D. (2017). Quantifying the controls on potential soil production rates: A case study of the San Gabriel Mountains, California. *Earth Surface Dynamics*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Pelletier, J.D., M.H. Nichols, and M.A. Nearing (2016). The influence of Holocene vegetation changes on topography and erosion rates: a case study at Walnut Gulch Experimental Watershed, Arizona. *Earth Surface*

Dynamics. (4), 471. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5194/esurf-4-471-2016

Perdrial, J. et al. (2017). A net ecosystem carbon budget for snow dominated forested headwater catchments: linking water and carbon fluxes to critical zone carbon storage. *Biogeochemistry*. . Status = OTHER; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Potts D.L., Minor R.L., Braun Z., and Barron-Gafford G.A. (2016). Seasonally-dynamic, species-specific variation in leaf physiological performance in a Madrean sky island mixed-conifer forest.. *Tree Physiology*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Potts D.L., Minor R.L., Braun, Z., and Barron-Gafford G.A. (). Photosynthetic phenological variation may promote coexistence among co-dominant tree species in a Madrean sky island mixed conifer forest.. *Tree Physiology*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Rasmussen, C., L.A. McGuire, P. Dhakal, and J.D. Pelletier (2017). Coevolution of soil and topography across a semiarid cinder cone chronosequence,. *Catena,*. (156), 338. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Sanchez-Canete E.P., Scott R.L., van Haren J., and Barron-Gafford G.A. (2017). Improving the accuracy of the gradient method for determining soil carbon dioxide efflux.. *Journal of Geophysical Research-Biogeosciences*. 122 50. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Shepard, C., M.G., Schaap, J.D. Pelletier, and C. Rasmussen (2017). A probabilistic approach to quantifying soil property change through time integration of energy and mass input. *SOIL*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5194/soil-2016-63.

Swetnam T., Brooks P.D., Barnard H.R., Harpold A.A., Gallo E. (). Revisiting environmental gradient ecology: how topography trumps climate in determining forest carbon reservoir size.. *Ecosphere.*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Sánchez-Cañete E.P., Barron-Gafford G.A., and Chorover J. (). A considerable fraction of soil-respired CO2 is not emitted directly to the atmosphere. *Geophysical Research Letters.*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Sánchez-Cañete E.P., Scott R.L., van Haren J., and Barron-Gafford G.A. (2017). Improving the accuracy of the gradient method for determining soil carbon dioxide efflux. *Journal of Geophysical Research - Biogeosciences.*. 122 50. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Tai, X., D. S. Mackay, W. R. L. Anderegg, J. S. Sperry, P. D. Brooks (). Incorporating Plant Hydraulics and Lateral Groundwater Subsidy Improves Prediction of Tree Mortality across the Landscape. *Ecohydrology*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Tenant, C. J., A.A. Harpold, K.A. Lohse, S.E. Godsey, B.T. Cosby, L. G. Larsen, P. D. Brooks, and R.W. Van Kirk (2017). Regional sensitivities of seasonal snow cover to elevation, aspect, and vegetation structure in western North America. *Water Resources Research*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Trostle, K. D., J. Ray Runyon, M. A. Pohlmann, S. E. Redfield, J. Pelletier, J. McIntosh, and J. Chorover. (2016). Colloids and organic matter complexation control trace metal concentration-discharge relationships in Marshall Gulch stream waters. *Water Resources Research.*. 52 7931. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Villegas J.C., Law D.J., Stark S.C., Minor D.M., Breshears D.D., Saleska S.R., Swann A.L.S., Garcia E.S., Bella E.M., Morton J.M., Cobb N.S., Barron-Gafford G.A., Litvak M.E., and Kolb T.E. (2017). Prototype campaign assessment of disturbance-induced tree loss effects on surface properties for atmospheric modeling. *Ecosphere*. 8:3 . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Vázquez-Ortega, D. Huckle, J. Perdrial, M.K. Amistadi, M. Durcik, C. Rasmussen, J. McIntosh, J. Chorover. (2016). Solid-phase redistribution of rare earth elements in hillslope pedons subjected to different hydrologic fluxes. *Chemical Geology*. (426), 18. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Wehr R. and Papuga S.A. (2017). Long-Term Precipitation Trends of Two Uniquely Water-Limited Ecosystems: Implications for Future Soil Moisture Dynamics. *Water Resources Research.*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Weintraub S.R., Brooks P.D., and Bowen G.J. (2016). Interactive effects of vegetation type and topographic position on nitrogen availability and loss in a temperate montane ecosystem.. *Ecosystems*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10021-016-0094-8

Zapata-Rios X., Brooks P.D., Troch P.A., McIntosh J., and Rasmussen C. (2016). Influence of climate variability on water partitioning and effective energy and mass transfer (EEMT) in a semi-arid critical zone.. *Hydrology and Earth System Sciences*. (20), 1103. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.5194/hess-20-1103-2016.

Licenses

Other Conference Presentations / Papers

Sánchez-Cañete, E.P., Barron-Gafford G.A., and J. Chorover (2017). *A large fraction of soil respiration is not exchanged with the atmosphere through the CO2 effluxes*. European Geophysical Union Annual Meeting. Vienna, Austria. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Dwivedi, R., T. Meixner, J. McIntosh, P. A. T. Ferre, and J. Chorover (2016). *A multi-tracer approach coupled to numerical models to improve understanding of mountain block processes in a high elevation, semi-humid catchment*. Geological Society of America annual meeting. Denver, CO. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Dwivedi, R., T. Meixner, J. McIntosh, P. A. T. Ferre, and J. Chorover (2016). *A multi-tracer approach coupled to numerical models to improve understanding of mountain block processes in a high elevation, sub-humid catchment.*. American Geophysical Union Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Sanchez-Cañete EP, Barron-Gafford GA, van Haren J, Scott RL. (2016). *Accurate long-term soil respiration fluxes based on the gradient method in a semiarid ecosystem*. University of Arizona Arid Lands Poster Session. Tucson, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Lee E, Kumar P, , Barron-Gafford GA, Scott RL (2016). *An Experimental and Modeling Synthesis to Determine Seasonality of Hydraulic Redistribution in Semi-arid Region with Multispecies Vegetation Interaction.*. American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Sutter L, Sanchez-Cañete EP, Barron-Gafford GA (2016). *Aspect as a Driver of Soil Carbon and Water Fluxes in Desert Environments*. . American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Fairbanks, D.F., M. Caballero-Reynolds, J. Chorover, R. Gallery, V. Rich (2017). *Assessing seasonal, aspect, and spatial dynamics of microbial community composition and function in response to pulse precipitation inputs in two adjacent, high-alpine catchments in northern New Mexico*. In Abstracts, SWESx,. Tucson, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Rasmussen, C. (2016). *Beyond clay - using selective extractions to improve predictions of soil carbon content.*. American Geophysical Union Annual Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Chorover, J. (2017). *Biogeochemical transformations of metal(loid)s in a disturbed critical zone*. Annual Spring Meeting of the American Chemical Society. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Chorover, J. (2017). *Biogeochemistry of the semi-arid critical zone*. Biogeochemistry and Environmental Sustainability Seminar Series, Cornell University. Ithaca, NY. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

McIntosh, J.C., X. Zapata-Rios, C. Rasmussen, P. Brooks, R. Gallery, J. Pelletier, and J. Chorover (2016). *Changing energy inputs at Earth's surface translates to differences in water availability, weathering rates, and biotic activity at depth*. American Geophysical Union Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Moravec, B.G., A. White, B. Paras, A. Sanchez, C. McGuffy, D. Fairbanks, J. McIntosh, J. Pelletier, R. Gallery, C. Rasmussen, W.S. Holbrook, B. Carr, and J. Chorover (2016). *Coring the Deep Critical Zone in the Jemez River Basin Critical Zone Observatory, Valles Caldera National Preserve, Northern New Mexico.*. American Geophysical Union Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Colella T, Mann SN, Murphy P, Minor J, Pearl J, Barnes M, Gallery R, Swetnam T, Barron-Gafford GA. (2016). *Critical Zone Science in the Anthropocene*. Association of American Geographers Annual Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kobayashi. T., P. Dhakal, H. Sumida and C. Rasmussen (2017). *Distribution of Perylenequinone Pigments in Several Soils in the United States.*. Soil Science Society of America Annual Meetings,. Phoenix, AZ. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Hingley R, Juarez S, Dontsova K, Hunt E, Le Galliard J-F, Chollet S, Cros A, Llavata M, Massol F, Barré P, Gelabert A, Daval D, Troch PA, Barron-Gafford GA, Van Haren JLM, Ferrière R. (2016). *Effects of Climate Change and Vegetation Type on Carbon and Nitrogen Accumulation during Incipient Soil Formation.*. American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Moravec, B.G., A. White, B. Paras, A. Sanchez, C. McGuffy, D. Fairbanks, J. McIntosh, J. Pelletier, C. Rasmussen, B. Carr, W.S. Holbrook, and J. Chorover (2017). *Exploring the deep Critical Zone: Geochemical dynamics in a complex lithologic terrain.*. SWESx Colloquium. Tucson, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Pohlmann, M. (2016). *Fate of rapidly deposited carbon and lithogenic solutes onto surface soils within a mixed conifer catchment severely burned by wildfire.*. SWESx Colloquium. Tucson, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Barron-Gafford GA, Minor RL, Hendryx, S, Lee E, Sutter L, Colella T, Murphy P, Sanchez-Cañete EP, Hamerlynck EP, Kumar P, Scott RL (2016). *Impacts of hydraulic redistribution on overstory-understory interactions in a semiarid savanna.*. American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Hendryx S, Minor RL, Colella T, Murphy P, Lee E, Scott RL, Kumar P, Barron-Gafford GA. (2016). *Impacts of hydraulic redistribution on plant and soil carbon and water fluxes in a dryland savanna.*. University of Arizona Arid Lands Poster Session. Tucson, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Scott RL, Barron-Gafford GA, Biederman JA. (2016). *Insights from a network of long-term measurements of biosphere-atmospheric exchanges of water vapor and carbon dioxide in southern Arizona*. American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Finley, B., C. Rasmussen, E. Schwart, P. Dijkstra and B. Hungate (2017). *Is Clay-Bound Soil Organic Carbon Vulnerable to Priming?*. Soil Science Society of America Annual Meeting. Phoenix, AZ. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Fairbanks, D. F., C. Shepard, J. Chorover, C. Rasmussen, V. Rich, R. Gallery (2017). *Landscape position controls on soil microbial activity at the Jemez River Basin Critical Zone Observatory*. In Abstracts, CZO All-Hands Meeting. Arlington, VA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kerr, Amanda L., Shepard, Christopher and Rasmussen, Craig (2016). *Linking soil chronosequence properties ot the paleoclimate record in Southern Arizona.*. Geological Society of America Meetings. Denver, CO. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Fairbanks, D.F., C. Cook, J. Chorover, V. Rich, R. Gallery (2016). *Microbial community recovery post-fire in a high elevation mixed-conifer catchment in response to varied precipitation regime*. American Geophysical Union Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Elshall AS, Ye M, Niu G-Y, Barron-Gafford GA. (2016). *Numerical Demons in Monte Carlo Estimation of Bayesian Model Evidence with Application to Soil Respiration Models*. American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Shepard, C., and C. Rasmussen (2017). *Paleoclimatic Constraint on Soil Formation and Survival*. Soil Science Society of America Annual Meetings. Phoenix, AZ. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Gallery, R.E. (2017). *Plant-soil feedbacks influence forest community diversity and recovery.*. (Invited) Department of Plant Biology, Michigan State University. East Lansing, MI, USA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Murphy P, Minor RL, Sanchez-Cañete EP, Potts DL, Barron-Gafford GA. (2016). *Seasonal and Topographic Variation in Net Primary Productivity and Water Use Efficiency in a Southwest Sky Island Forest*. American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Olshansky, O., R. Root, J. Chorover (2016). *Sequential reaction of dissolved organic matter with subsurface soils, effect of dry and wet cycles.*. Soil Science Society of America Annual Meeting. Phoenix, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Rasmussen, C. (2017). *Soil Processes in the Southwestern United States*. Soil Science Society of America Annual Meetings. Phoenix, AZ. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Murphy P, Minor RL, Potts DL, Barron-Gafford GA. (2016). *Studying Topographic Controls on Primary Productivity.*. University of Arizona Arid Lands Poster Session. Tucson, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Sanchez-Cañete EP, Scott RL, Van Haren JLM, Barron-Gafford GA (2016). *The Necessity of Determining the Gas Transfer Coefficient In-situ to Obtain More Accurate Soil Carbon Dioxide Effluxes Through the Gradient*

Method.. American Geophysical Union's Annual Fall Meeting. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Barron-Gafford GA, Allen N, Minor RL, Pavao-Zuckerman M. (2016). *The Photovoltaic Heat Island Effect: Larger solar power plants increase local temperatures.*. American Geophysical Union's Annual Fall Meeting,. San Francisco, CA. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Lybrand, R, and C. Rasmussen (2017). *The Role of Dust on the Development of Granitic Soils in Southern Arizona.*. Soil Science Society of America Annual Meetings. Phoenix, AZ. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Gallery, R.E. (2016). *The ecology of soil microbes*. (Invited) Department of Biological Sciences, Universidad de los Andes. Bogota, Colombia. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gallery, R.E. (2016). *The ecology of soil microbes: feedbacks in semi-arid and tropical forests.*. (Invited) Department of Microbiology and Immunology, Montana State University. Bozeman, MT. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Gallery, R.E. (2017). *The ecology of soil microbes: predicting activity and feedbacks in semi-arid and tropical forests.*. (Invited) Department of Biology, Northern Arizona University. Flagstaff, AZ. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Rasmussen, C. (2017). *Using Energy and Mass Transfer to Model Pedogenic Environments and Process.*. Soil Science Society of America Annual Meetings. Phoenix, AZ. Status = ACCEPTED; Acknowledgement of Federal Support = Yes

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Balocchi, F. *, "Soil behavior during freeze-thaw processes at a snow-dominated forest site simulated with the physically-based numerical water flow and heat transport Soil in Cold Regions Model (SCRM)"*. (2016). Hydrology & Water Resources University of Arizona. Acknowledgement of Federal Support = Yes

White, A.. *"Examining the Impacts of Wildfire on Throughfall and Stemflow Chemistry and Flux at Plot and Catchment Scales"*. (2016). Hydrology & Water Resources, University of Arizona. Acknowledgement of Federal Support = Yes

Murphy, M. *"Interaction of wildfire and landscape position on soil microbial community nitrogen cycling"*. (2016). Soil, Water & Environmental Science, University of Arizona. Acknowledgement of Federal Support = Yes

Zapata-Rios, X.. *"The influence of climate and landscape on hydrological processes, vegetation dynamics, biogeochemistry and the transfer of effective energy and mass to the critical zone"*.. (2016). Hydrology and Water Resources, University of Arizona. Acknowledgement of Federal Support = Yes

Sanchez-Romero, A.,. *"Understanding Process Information Using End-Members in the Critical Zone. Case Study: Valles Caldera, New Mexico."*. (2016). Hydrology & Water Resources, University of Arizona. Acknowledgement of Federal Support = Yes

Websites

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Chorover, Jon	PD/PI	1
Breshears, David	Co PD/PI	1
McIntosh, Jennifer	Co PD/PI	1
Pelletier, Jon	Co PD/PI	1
Rasmussen, Craig	Co PD/PI	1
Barron-Gafford, Greg	Co-Investigator	1
Ferré, Ty P.A.	Co-Investigator	1
Meixner, Thomas	Co-Investigator	1
Niu, Guo-Yue	Co-Investigator	1
Papuga, Shirley	Co-Investigator	1
Schaap, Marcel	Co-Investigator	1
Brooks, Paul	Faculty	1
Gallery, Rachel	Faculty	1
Johnson, Roy	Faculty	1
Litvak, Marcy	Faculty	1
McKisson, Michael	Faculty	2
Plant, Bill	Faculty	1
Potts, Daniel	Faculty	1
Reed, Shipherd	Faculty	1
Rich, Virginia	Faculty	1
Biederman, Joel		12

Name	Most Senior Project Role	Nearest Person Month Worked
	Postdoctoral (scholar, fellow or other postdoctoral position)	
Field, Jason	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Harpold, Adrian	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Maurer, Gregory	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Mitra, Bhaskar	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Nesbitt, Lindsey	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Sanchez-Canete, Enrique	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Swetnam, Tyson	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Trostle, Kyle	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Villegas, Juan	Postdoctoral (scholar, fellow or other postdoctoral position)	12
Abramson, Nathan	Other Professional	12
Castle, Richard	Other Professional	12
Dhakal, Prakash	Other Professional	12
Evans, Michael	Other Professional	12
Fields, Jen	Other Professional	12
Fontes, Shiloe	Other Professional	12
Kobilka, Sara	Other Professional	12
Long, Robert	Other Professional	12

Name	Most Senior Project Role	Nearest Person Month Worked
Losleben, Mark	Other Professional	12
McNamee, Gergory	Other Professional	12
McSweeney, Neil	Other Professional	12
Parmenter, Robert	Other Professional	12
Ruiz, Ruben	Other Professional	12
Minor, Rebecca	Technician	12
Durcik, Matej	Staff Scientist (doctoral level)	12
Furst, Jonathan	Staff Scientist (doctoral level)	12
Hensley, Noel	Staff Scientist (doctoral level)	2
Scott, Russell	Staff Scientist (doctoral level)	12
Balocchi, Francisco	Graduate Student (research assistant)	12
Barnes, Mallory	Graduate Student (research assistant)	12
Coe, Michelle	Graduate Student (research assistant)	12
Colella, Tony	Graduate Student (research assistant)	12
Dwivedi, Ravindra	Graduate Student (research assistant)	12
Fairbanks, Dawson	Graduate Student (research assistant)	12
Fang, Yuanhao	Graduate Student (research assistant)	12
Fenerty, Brendan	Graduate Student (research assistant)	12
Kidder, Amy	Graduate Student (research assistant)	12
Kopp, Emily	Graduate Student (research assistant)	12
Logie, Cianna	Graduate Student (research assistant)	12
Lybrand, Rebecca	Graduate Student (research assistant)	12

Name	Most Senior Project Role	Nearest Person Month Worked
McClure, Brianna	Graduate Student (research assistant)	12
Murphy, Margretta	Graduate Student (research assistant)	12
Murphy, Patrick	Graduate Student (research assistant)	12
Olyphant, Jared	Graduate Student (research assistant)	12
Orem, Caitlin	Graduate Student (research assistant)	12
Paras, Ben	Graduate Student (research assistant)	12
Pohlmann, Michael	Graduate Student (research assistant)	12
Sanchez, Rodrigo	Graduate Student (research assistant)	12
Sanchez-Romero, Andres	Graduate Student (research assistant)	12
Shepard, Christopher	Graduate Student (research assistant)	12
White, Alissa	Graduate Student (research assistant)	12
Williams, Zachary	Graduate Student (research assistant)	6
Wilson, Zinnia	Graduate Student (research assistant)	12
Wu, Runjian	Graduate Student (research assistant)	12
Yuanhao, Fang	Graduate Student (research assistant)	12
Zapata-Rios, Xavier	Graduate Student (research assistant)	12
Law, Darin	Non-Student Research Assistant	12
Bergeron, Hannah	Undergraduate Student	12
Blackett, Daniel	Undergraduate Student	4
Blum, Aidan	Undergraduate Student	12
Bohlman, Melissa	Undergraduate Student	12
Bojorquez Ochoa, Mirsa	Undergraduate Student	12

Name	Most Senior Project Role	Nearest Person Month Worked
Boyer, Jessica	Undergraduate Student	12
Braun, Zev	Undergraduate Student	12
Caballero-Reynolds, Marci	Undergraduate Student	8
Cagle, Curtis	Undergraduate Student	4
Callahan, Nick	Undergraduate Student	12
Carrera, Anahi	Undergraduate Student	12
Chen, Zhao	Undergraduate Student	4
Cook, Chelsea	Undergraduate Student	12
Espinosa, Noelle	Undergraduate Student	12
Fennie, Elizabeth	Undergraduate Student	12
Garlant, James	Undergraduate Student	12
Green, Katlyn	Undergraduate Student	12
Guan, Janelle	Undergraduate Student	12
Hall, Becky	Undergraduate Student	12
Hamann, Lejon	Undergraduate Student	12
Harders, Sara	Undergraduate Student	12
Heard, Maggie	Undergraduate Student	12
Herndon, Carly	Undergraduate Student	12
Heydorn, Katherine	Undergraduate Student	12
Hoskinson, Joshua	Undergraduate Student	12
Kelley, Andrew	Undergraduate Student	12
Kerr, Amanda	Undergraduate Student	4

Name	Most Senior Project Role	Nearest Person Month Worked
Kobida, Tessa	Undergraduate Student	12
Koch, Lauren	Undergraduate Student	12
Landa, Charlie	Undergraduate Student	4
Matos, Katarena	Undergraduate Student	12
Moreno, Alex	Undergraduate Student	12
Orman, Kelly	Undergraduate Student	12
Pedron, Shawn	Undergraduate Student	12
Reynoso, Erick	Undergraduate Student	12
Riedel, Catherine	Undergraduate Student	12
Rincon, Michelle	Undergraduate Student	12
Smith, Rebecca	Undergraduate Student	12
Snyder, Maria	Undergraduate Student	4
Sorrentino, Lexie	Undergraduate Student	4
Sutter, Leland	Undergraduate Student	12
Swartz, Samantha	Undergraduate Student	4
Tritz, Claire	Undergraduate Student	12
Van Dop, Molly	Undergraduate Student	12
Ward, Lauren	Undergraduate Student	12
Weber, Adam	Undergraduate Student	4
Weber, Nicole	Undergraduate Student	12
Wehr, Rachel	Undergraduate Student	12
Wilson, Charles	Undergraduate Student	12

Name	Most Senior Project Role	Nearest Person Month Worked
Wolsiffer, Sarah	Undergraduate Student	12
Yang, Julia	Undergraduate Student	12

Full details of individuals who have worked on the project:

Jon D Chorover
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Most Senior Project Role: PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: theme lead

Funding Support: NSF

International Collaboration: No
International Travel: No

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Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: theme lead

Funding Support: NSF

International Collaboration: No
International Travel: No

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Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: theme lead

Funding Support: NSF

International Collaboration: No
International Travel: No

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Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: theme lead

Funding Support: NSF

International Collaboration: No
International Travel: No

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Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: theme lead

Funding Support: NSF

International Collaboration: No
International Travel: No

Greg Barron-Gafford
Email: gregbg@email.arizona.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Assistant Professor and Ecosystem Ecologist

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Ty P.A. Ferré
Email: tyferre@gmail.com
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Professor and Hydrogeophysicist

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Thomas Meixner
Email: tmeixner@email.arizona.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Professor and Catchment Hydrologist/Biogeochemist

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Guo-Yue Niu
Email: niug@email.arizona.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Assistant Professor and Land-Atmosphere Exchange Modeler

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Shirley Papuga
Email: papuga@email.arizona.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Associate Professor and Ecohydrologist

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Marcel Schaap
Email: mschaap@cals.arizona.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Associate Professor and Soil Physicist

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Paul Brooks
Email: paul.brooks@utah.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Performed observations, analysis, and modeling on snow cover, water balance, carbon and nutrient cycling and CA evolutuion.

Funding Support: DOE and this award

International Collaboration: Yes, Sweden
International Travel: No

Rachel Gallery
Email: rgallery@email.arizona.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Theme lead

Funding Support: NSF

International Collaboration: No
International Travel: No

Roy Johnson
Email: johnson6@email.arizona.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Theme lead (Geosciences)

Funding Support: NSF

International Collaboration: No
International Travel: No

Marcy Litvak
Email: mlitvak@unm.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Has performed work in the area of keeping the flux towers running and data processed.

Funding Support: Ameriflux Core support (160 hours), DOE TES (80 hours), NSF LTER (80 hours)

International Collaboration: No
International Travel: No

Michael McKisson
Email: mckisson@email.arizona.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 2

Contribution to the Project: writer

Funding Support: NA

International Collaboration: No
International Travel: No

Bill Plant
Email: wplant@email.arizona.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Education and outreach

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Daniel Potts
Email: pottsdl@buffalostate.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Daniel has performed work in the area of plant ecophysiology - developing an understanding of the physiological constraints of the tree community around the Mt. Bigelow eddy covariance towar site.

Funding Support: Daniel is faculty of Buffalo State College

International Collaboration: No
International Travel: No

Shipherd Reed
Email: shipherd@email.arizona.edu
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Appointed Personnel

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Virginia Rich
Email: virginia.isabel.rich@gmail.com
Most Senior Project Role: Faculty
Nearest Person Month Worked: 1

Contribution to the Project: Theme lead

Funding Support: NSF

International Collaboration: No
International Travel: No

Joel Biederman
Email: joel.biederman.ua@gmail.com
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: Graduate student/postdoc associate

Funding Support: NSF & Other

International Collaboration: No
International Travel: No

Jason Field
Email: jpfield@email.arizona.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: postdoc

Funding Support: NSF

International Collaboration: No
International Travel: No

Adrian Harpold
Email: adrian.harpold@gmail.com
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: postdoc associate

Funding Support: NSF

International Collaboration: No
International Travel: No

Gregory Maurer
Email: gregmaurer@gmail.com
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: Has performed work in the area of keeping the flux towers running and data processed.

Funding Support: Ameriflux Core support

International Collaboration: No
International Travel: No

Bhaskar Mitra
Email: bhaskar.mitra6@gmail.com

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: postdoc

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Lindsey Nesbitt
Email: lindseychr@gmail.com
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: Coupled water and biogeochemical modeling

Funding Support: DOE and other NSF

International Collaboration: No
International Travel: No

Enrique Sanchez-Canete
Email: enripsc@ugr.es
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: staff scientist

Funding Support: NSF

International Collaboration: No
International Travel: No

Tyson Lee Swetnam
Email: tswetnam@email.arizona.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: postdoc

Funding Support: NSF

International Collaboration: No
International Travel: No

Kyle Trostle
Email: ktrostle@email.arizona.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: CZO postdoc leading concentration-discharge analyses and aqueous geochemistry.

Funding Support: NSF

International Collaboration: No
International Travel: No

Juan Camilo Villegas
Email: villegas@email.arizona.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 12

Contribution to the Project: postdoc

Funding Support: NSF

International Collaboration: No
International Travel: No

Nathan Abramson
Email: nabramso@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Research Specialist

Funding Support: NSF

International Collaboration: No
International Travel: No

Richard Castle
Email: rcastle@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: exhibit support (Flandrau Science Center and Planetarium)

Funding Support: NSF

International Collaboration: No
International Travel: No

Prakash Dhakal
Email: dhakal@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Laboratory Director

Funding Support: Other funding

International Collaboration: No
International Travel: No

Michael Evans
Email: maevans@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Media technician (School of Journalism)

Funding Support: NSF

International Collaboration: No
International Travel: No

Jen Fields
Email: fieldsj@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Giving advice as Staff, Director of Education for CZ Discovery development meetings, we provided CZ activities for some of the UA Fusion summer camps that she manages. Has performed work by providing advice and expertise on K-12 educational activities for the CZ Discovery program.

Funding Support: Staff at Flandrau Science Center, no CZO funding, volunteered her time.

International Collaboration: No
International Travel: No

Shiloe Fontes
Email: sfontes@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: graphic design/exhibit support (Flandrau Science Center and Planetarium)

Funding Support: NSF

International Collaboration: No
International Travel: No

Sara Kobilka
Email: kobilka@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Provided coordination with schedule and camp counselors to pilot some of the CZ Discovery activities. She is staff, summer camp coordinator.

Funding Support: Staff at UA Fusion Camp (Flandrau summer camp), no CZO funding. Volunteers time.

International Collaboration: No
International Travel: No

Robert Long
Email: bobby@nearsightgraphite.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: exhibit support/illustration

Funding Support: NSF

International Collaboration: No
International Travel: No

Mark Losleben
Email: losleben@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Research Technician

Funding Support: NSF

International Collaboration: No
International Travel: No

Gergory McNamee
Email: gregorymcnamee@gmail.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Science writer (Economics Dept)

Funding Support: NSF

International Collaboration: No
International Travel: No

Neil McSweeney
Email: mcsweene@email.arizona.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: exhibit support (Flaundrau Science Center and Planetarium)

Funding Support: NSF

International Collaboration: No
International Travel: No

Robert Parmenter
Email: bparmenter@vallescaldera.gov
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: Project Site coordination, presentation of results from CZO group to agencies and general public.

Funding Support: As a Federal Employee (Director, Scientific Services Division VCNP) salary is covered by the U.S. Government.

International Collaboration: No
International Travel: No

Ruben Ruiz
Email: rubelruiz@gmail.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 12

Contribution to the Project: classified part-time staff - videography

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Rebecca Minor
Email: rlminor@email.arizona.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: Research Technician

Funding Support: NSF

International Collaboration: No
International Travel: No

Matej Durcik
Email: mdurcik@email.arizona.edu
Most Senior Project Role: Staff Scientist (doctoral level)
Nearest Person Month Worked: 12

Contribution to the Project: Staff scientist

Funding Support: NSF

International Collaboration: No
International Travel: No

Jonathan Furst
Email: jfurst@unm.edu
Most Senior Project Role: Staff Scientist (doctoral level)
Nearest Person Month Worked: 12

Contribution to the Project: Has performed work in the area of keeping the flux towers running and data processed.

Funding Support: Ameriflux Core support

International Collaboration: No
International Travel: No

Noel Hensley
Email: mnhensley@email.arizona.edu
Most Senior Project Role: Staff Scientist (doctoral level)
Nearest Person Month Worked: 2

Contribution to the Project: Education Program Coordinator

Funding Support: NA

International Collaboration: No
International Travel: No

Russell Scott
Email: Russ.Scott@ARS.USDA.GOV
Most Senior Project Role: Staff Scientist (doctoral level)
Nearest Person Month Worked: 12

Contribution to the Project: Research Hydrologist

Funding Support: NSF

International Collaboration: No
International Travel: No

Francisco Balocchi
Email: fbalocchi@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Is working on understanding the hydrologic processes operating during snowmelt that induce either infrilatration or runoff.

Funding Support: Funded by the nation of Chile.

International Collaboration: Yes, Chile
International Travel: No

Mallory Barnes
Email: mallorybarnes@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Michelle Coe
Email: macoe@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Michelle Coe has performed work towards our Broader Impacts in terms of leading in-class activities with elementary students.

Funding Support: NASA Space Grant Fellowship

International Collaboration: No
International Travel: No

Tony Colella
Email: tonycolella@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Ravindra Dwivedi
Email: ravindradwivedi@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Has worked on understanding the origins and mechanisms for residence time distribution functions in fractured rock systems

Funding Support: This award and teaching assistantship

International Collaboration: No
International Travel: No

Dawson Fairbanks
Email: dawsonfairbanks@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Has contributed outreach experience and topic expertise to the development of the CZ Discovery activities, will give time to activity delivery. Also has performed work in the area of soil microbial ecology including a number of field campaigns to CZO sites to characterize and collect soils samples, laboratory assays of microbial exoenzyme activity, microbial biomass Carbon and Nitrogen quantification, DNA extractions and quality control, data analysis, and manuscript preparation.

Funding Support: She is a grad student on CZO. Sloan Indigenous Graduate Partnership Fellowship.

International Collaboration: No
International Travel: No

Yuanhao Fang
Email: yhfang@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Has perfromed modeling of the topgraphic shading effects on snow and runoff

Funding Support: Chinese National Science Foundation (CNSF) visiting scholar

International Collaboration: Yes, China
International Travel: No

Brendan Fenerty
Email: bfenerty@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Amy Kidder
Email: akidder@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Ecohydrological assessment of changes in distribution of endangered Pima Pineapple Cactus, including potential migration across Catalinas of Jemez-Catalina gradient.

Funding Support: Raytheon

International Collaboration: No
International Travel: No

Emily Kopp
Email: ekopp@optics.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: SWES graduate student

Funding Support: NSF

International Collaboration: No
International Travel: No

Cianna Logie
Email: clogie@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: M.S. student

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Rebecca Lybrand
Email: rlybrand@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Ph.D. student

Funding Support: NSF

International Collaboration: No
International Travel: No

Brianna McClure
Email: briannamcclure@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Has worked on impact of fire on DOM indices and whether fire effects DOM quality and quantity.

Funding Support: This award and from teaching assistantship

International Collaboration: No
International Travel: No

Margretta Murphy
Email: mamurphy@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Has performed work in the area of soil microbial ecology including a number of field campaigns to CZO sites to characterize and collect soil samples, laboratory assays of microbial biomass Carbon and Nitrogen quantifications, DNA extractions and quality control, and troubleshooting protocols for quantitative PCR.

Funding Support: N/A

International Collaboration: No
International Travel: No

Patrick Murphy
Email: murphyp@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Jared A. Olyphant
Email: jolyphant@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Ph.D. student

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Caitlin A. Orem
Email: orem@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Ph.D. student

Funding Support: NSF

International Collaboration: No
International Travel: No

Ben Paras
Email: bkp@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Subsurface imaging with geophysics

Funding Support: NSF

International Collaboration: No
International Travel: No

Michael Pohlmann
Email: mapohlmann@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: M.S. student

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Rodrigo Andres Sanchez
Email: andressanchez@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: MS student

Funding Support: Other

International Collaboration: No
International Travel: No

Andres Sanchez-Romero
Email: adressanchex@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Christopher Shepard
Email: cbs9h@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Has performed work in the area of soil modeling

Funding Support: University Fellows program through UA graduate college

International Collaboration: No
International Travel: No

Alissa White
Email: alissawhite@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: M.S. student

Funding Support: NSF

International Collaboration: No
International Travel: No

Zachary Williams
Email: zwilliams@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Zinnia Wilson
Email: zinnia.wilson@utah.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Runjian Wu
Email: wurunjian@email.arizona.edu

Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: graduate student

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Fang Yuanhao
Email: yuanhao.fang@outlook.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Ph.D. student

Funding Support: NSF and other

International Collaboration: No
International Travel: No

Xavier Zapata-Rios
Email: xavierzapata@email.arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: Ph.D. student

Funding Support: NSF

International Collaboration: No
International Travel: No

Darin Law
Email: dlaw@email.arizona.edu
Most Senior Project Role: Non-Student Research Assistant
Nearest Person Month Worked: 12

Contribution to the Project: Co-author on critical zone services papers (Vadose Zone Journal and Eos); led installation of microclimate array at Mt. Bigelow

Funding Support: Arizona Agricultural Experiment Station

International Collaboration: No
International Travel: No

Hannah Bergeron
Email: hlberg12@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate research technician

Funding Support: NSF

International Collaboration: No
International Travel: No

Daniel Blackett
Email: dblackett@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Aidan Blum
Email: aidanblum@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Processing water samples for the CZO project. Also raqn samples for water stable isotopes on the isotope analyzer.

Funding Support: TRIF and HWR

International Collaboration: No
International Travel: No

Melissa Bohlman
Email: mbohlman1@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Mirsa Bojorquez Ochoa
Email: m.holly.boom@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Undergraduate student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Jessica Cait Boyer
Email: jcboyer@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Zev Braun
Email: braunzev@grinnell.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergrad student

Funding Support: NSF

International Collaboration: No
International Travel: No

Marci Caballero-Reynolds
Email: marcicr@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 8

Contribution to the Project: Research

Funding Support: NSF

International Collaboration: No
International Travel: No

Curtis Cagle
Email: curtiscagle@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Nick Callahan
Email: nrcallahan@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Anahi Carrera
Email: anahicarrera@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Zhao Yang Chen
Email: chenzhaoyang@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Chelsea Cook
Email: cmcook@email.arizona.eu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Noelle Espinosa
Email: noellee@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Elizabeth Fennie
Email: efennie@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

James Garlant
Email: garlant@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Undergraduate contributing to Ecohydrology Theme - looking at sources of plant water use in our SCM Mixed Conifer Site at Mt. Bigelow.

Funding Support: This research is suppported in salary by NSF Career Award

International Collaboration: No
International Travel: No

Katlyn Green
Email: katlyngreen@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Janelle Guan
Email: jguan@email.arizona.edu

Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate student

Funding Support: NSF

International Collaboration: No
International Travel: No

Becky Hall
Email: beckyh@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: post B.S. volunteer

Funding Support: other

International Collaboration: No
International Travel: No

Lejon Hamann
Email: lejonhamann@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Sara Harders
Email: saraharders@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Maggie Heard
Email: maggieheard@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Undergraduate Student and Accelerated MS on CZO

Funding Support: NSF

International Collaboration: No
International Travel: No

Carly Herndon
Email: carlyherndon@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Katherine Heydorn
Email: kheydorn@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergrad student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Joshua Hoskinson
Email: jhoskinson@emai.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Has performed work in the area of soil minerology

Funding Support: NASA Space Grant

International Collaboration: No
International Travel: No

Andrew Kelley
Email: akelley2@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Amanda Kerr
Email: kerr.a@husky.neu.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Tessa Kobida
Email: tkobida@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Lauren Koch
Email: laurenkoch@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Charlie Landa
Email: landa1@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Katarena Matos
Email: katarenamatos@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate student

Funding Support: NSF

International Collaboration: No
International Travel: No

Alex Moreno
Email: amoreno@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Kelly Orman
Email: kellylynnorman@yahoo.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Shawn Pedron
Email: sped398@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Erick Reynoso
Email: edreynoso@miners.utep.edu

Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Catherine Riedel
Email: catherineridel@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Michelle Rincon
Email: michellerincon@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Rebecca Smith
Email: rkramersmith@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Laboratory and data analyses

Funding Support: DOE and other NSF

International Collaboration: No
International Travel: No

Maria Snyder
Email: msnyder2@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Lexie Sorrentino
Email: lexiesorrentino@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Leland Sutter
Email: lelandsutter@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate student who has performed work in the area of soil CO2 and water fluxes in the SCM CZO sites, particularly the Mt. Bigelow eddy covariance tower site. Leland also compiles datasets for analysis.

Funding Support: NSF

International Collaboration: No
International Travel: No

Samantha Swartz
Email: skswartz@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Claire Tritz
Email: ckat@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Worked on processing water samples for the CZO project.

Funding Support: TRIF

International Collaboration: No
International Travel: No

Molly Van Dop
Email: mvandop@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Lauren Ward
Email: laurenward@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Adam Weber
Email: adamweber@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 4

Contribution to the Project: research

Funding Support: NSF

International Collaboration: No
International Travel: No

Nicole Weber
Email: nweber@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Rachel Wehr
Email: rachelwehr@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: Undergraduate contributing to Ecohydrology Theme - looking at precipitation and soil moisture trends in SCM at Marshall Gulch.

Funding Support: This research is supported in salary by NSF Career award.

International Collaboration: No
International Travel: No

Charles Wilson
Email: cawilson@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Sarah Wolsiffer
Email: sarahwolsiffer@email.arizona.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

Julia Yang
Email: juj.yang@gmail.com
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 12

Contribution to the Project: undergraduate student researcher

Funding Support: NSF

International Collaboration: No
International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Arizona State University	Academic Institution	Tempe, AZ
Cornell University	Academic Institution	Ithaca, NY
University of New Mexico	Academic Institution	Albuquerque, NM
University of Utah	Academic Institution	Utah
Valles Caldera National Preserve	Other Organizations (foreign or domestic)	Jemez Springs, NM
Hartwick College	Academic Institution	Hartwick, NY
Kyoto Prefecture University	Academic Institution	Kyoto, Japan
Los Alamos National Laboratory	Other Organizations (foreign or domestic)	Los Alamos, NM
Los Alamos National Laboratory	Industrial or Commercial Firms	New Mexico
State University of New York	Academic Institution	Buffalo, NY
Tucson Unified School District	School or School Systems	Tucson, AZ
USDA-Agricultural Research Services Southwest Watershed	State or Local Government	Southwest
USGS	State or Local Government	New Mexico

Full details of organizations that have been involved as partners:

Arizona State University

Organization Type: Academic Institution
Organization Location: Tempe, AZ

Partner's Contribution to the Project:
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: ASU personnel including Arjun Heimsath and coworkers are conducting collaborative research in the SCM CZO.

Cornell University

Organization Type: Academic Institution
Organization Location: Ithaca, NY

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: Through PI Louis Derry, Cornell University is conducting geochemical research at the SCM-JRB CZO.

Hartwick College

Organization Type: Academic Institution
Organization Location: Hartwick, NY

Partner's Contribution to the Project:
Personnel Exchanges

More Detail on Partner and Contribution: Dr. Zsuzsanna Balogh-Brunstad, Associate Professor in Geosciences and Chemistry, is conducting her sabbatical at the University of Arizona, working in the CZO. Her research focus is on fungal mediated weathering processes.

Kyoto Prefrecture University

Organization Type: Academic Institution
Organization Location: Kyoto, Japan

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: Dr. Atsushi Nakao, professor from the Department of Geosciences at KFU is conducting his sabbatical at University of Arizona and focusing his research on the CZO. His focus is on the role of climate in mica weathering processes.

Los Alamos National Laboratory

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Los Alamos, NM

Partner's Contribution to the Project:
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Los Alamos National Laboratory loans field based equipment to the JRB-SCM CZO that is associated with our eddy covariance and ecohydrologic studies.

Los Alamos National Laboratory

Organization Type: Industrial or Commercial Firms
Organization Location: New Mexico

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution:

State University of New York

Organization Type: Academic Institution
Organization Location: Buffalo, NY

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution:

Tucson Unified School District

Organization Type: School or School Systems
Organization Location: Tucson, AZ

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution:

USDA-Agricultural Research Services Southwest Watershed

Organization Type: State or Local Government
Organization Location: Southwest

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution:

USGS

Organization Type: State or Local Government
Organization Location: New Mexico

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution:

University of New Mexico

Organization Type: Academic Institution
Organization Location: Albuquerque, NM

Partner's Contribution to the Project:
Financial support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Professor Marcy Litvak is a subcontracted PI focusing on eddy covariance research at the JRB site.

University of Utah

Organization Type: Academic Institution
Organization Location: Utah

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution:

Valles Caldera National Preserve

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Jemez Springs, NM

Partner's Contribution to the Project:
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Dr. Robert Parmenter of VCNP (US Forest Service) is a subcontractor on the project and assists through provision of hydrologic technician support and collaborative research.

What other collaborators or contacts have been involved?
Nothing to report

Impacts

What is the impact on the development of the principal discipline(s) of the project?

Catalina-Jemez CZO collaborators meet biweekly to present research results and integrate findings into an evolving shared framework of coupled-process understanding. We are training students who work seamlessly across disciplines (geochemistry-microbiology-geophysics-hydrology) that were previously segregated.

Several of our graduates are now faculty at institutions with programs that contain the title "critical zone" and cut across these fields of study.

We have developed two new courses in critical zone science at the University of Arizona.

What is the impact on other disciplines?

Our approach to drilling the CZ involved methodologies developed during an NSF-funded workshop that Cliff Riebe and Jon Chorover organized three years ago that highlighted the importance of informing on drilling selection on the basis of pre-assessments by geophysical methods. Geophysical methods are increasingly becoming a central component and took kit associated with CZ research.

The convergent research approach that is central to CZ science is increasingly recognized as exemplary by other interdisciplinary efforts.

CZ research is strongly impacting the ecosystem science community. By integrating ecologists into our CZO teams, we have developed an improved understanding of the impacts of deep time and deep subsurface geo-processes (e.g., soil formation and regolith depth) on sustaining ecosystem productivity (e.g., carbon fixation and organic matter stabilization).

What is the impact on the development of human resources?

The principal use of CZO funds is support for graduate and undergraduate students and postdoctoral scientists. These individuals range in the demographics of higher education training from those just entering college to those on the job market for professorial or agency/industry positions. Through this project, all of them are developing the recognition of that taking an integrated and transdisciplinary approach to Earth surface science is essential to not only understanding how the Earth functions as a system, but to sustaining the capacity of that system to provide services to society.

What is the impact on physical resources that form infrastructure?

The CZO project has motivated technological developments in our laboratories, including the establishment of high throughput geochemical, mineralogical and microbiological methods, and the application of state-of-the art techniques (e.g., borehole NMR, molecular ecology, LC-MS/MS and X-ray absorption spectroscopy) to studies of the critical zone.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?

- More than 100 million data values are currently stored in the database.
- To present, 55 datasets have been published on the Catalina-Jemez website (http://criticalzone.org/catalina-jemez/data/). Published datasets contains 410 data files in the CZO data display format and GIS standard formats such as ArcGIS shapefile and GeoTIFF. All published datasets are periodically updated after data are processed and quality controlled.
- Eight new datasets were added from 7/1/2016 to 6/30/2017.
- 830 unique users downloaded ca. 10k data files from the Catalina-Jemez datasets published on the website for one year period from 7/1/2016 to 6/30/2017.
- To present, more than 20 million data values have been harvested to the CZO Central data and metadata depository hosted by the San Diego Supercomputer Center (SDSC). These data are available for download via the CUAHSI Water Data Center services (http://hiscentral.cuahsi.org/pub_services.aspx). These are direct links for 2 Catalina-Jemez services: http://hiscentral.cuahsi.org/pub_network.aspx?n=158 and http://hiscentral.cuahsi.org/pub_network.aspx?n=177.

Website Usage

The CZO website (http://criticalzone.org/catalina-jemez/) had 6500 visits by 4200 users for one year period from 7/1/2016 to 6/30/2017. Users viewed 15,765 pages.

What is the impact on technology transfer?

- Near completion of the development of a mapping tool (hosted on OpenTopography.org) that computes solar insolation and EEMT in complex landscapes for any time range over the past 30 years, or as a long-term average. Will provide a measure of energy driving critical zone processes for any landscape at any spatial resolution. The user needs only to specify his/her area of interest.
- Developed a "smart" vadose zone pore water sampling system that can be programmed to collect pore water samples for geochemical analysis over a time series with pre-established constraints on physical conditions (e.g., soil moisture or water potential) in the unsaturated zone.

What is the impact on society beyond science and technology?

Our CZO has taken a leading role in the discussion and publication of current thinking on the concept of "critical zone services". Translation of cutting-edge research from CZ science into an improved understanding of how the critical zone provides services to society is key to impacting society beyond science and technology.

Specifically, we have articulated (e.g., Field et al., 2015, 2016) how CZ services are distinguishable from what has been described previously as "ecosystem services", and how a geosciences perspective can deepen the temporal and process-level understanding of how coupled geological and biological processes enable human societies to thrive on the Earth's surface. CZ services include, e.g., storing and purifying water, producing nutritional soils for food and fiber, and stabilizing carbon in the subsurface.

Changes/Problems

Changes in approach and reason for change

As of the time of writing this report, a wildfire is burning in the Santa Catalina Mountains (SCM) in very close proximity to our principal instrumented field site in mixed conifer forest (Bigelow Tower site). Yesterday we rescued the above ground equipment that we could. It is not yet clear what the impact of this fire will be on our operations there, but if it burns through the field site, operations will be affected.

Actual or Anticipated problems or delays and actions or plans to resolve them

None at this point.

Changes that have a significant impact on expenditures

None at this point.

Significant changes in use or care of human subjects

None at this point.

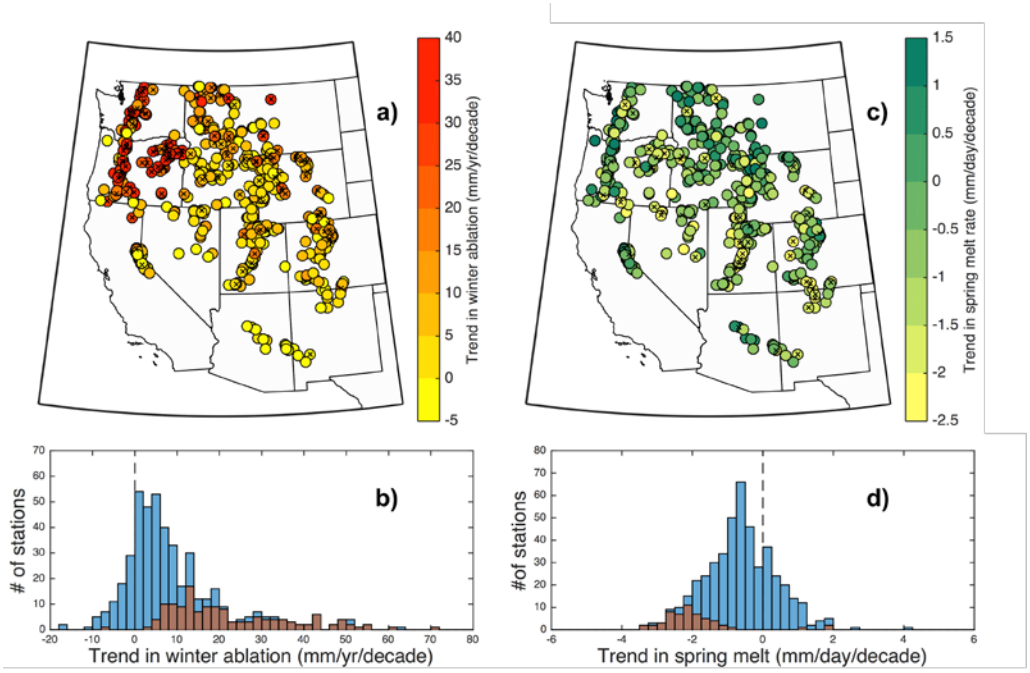
Significant changes in use or care of vertebrate animals

Not applicable.

Significant changes in use or care of biohazards

None at this point.

Figures to accompany results section of Catalina-Jemez CZO Fourth Annual Report.



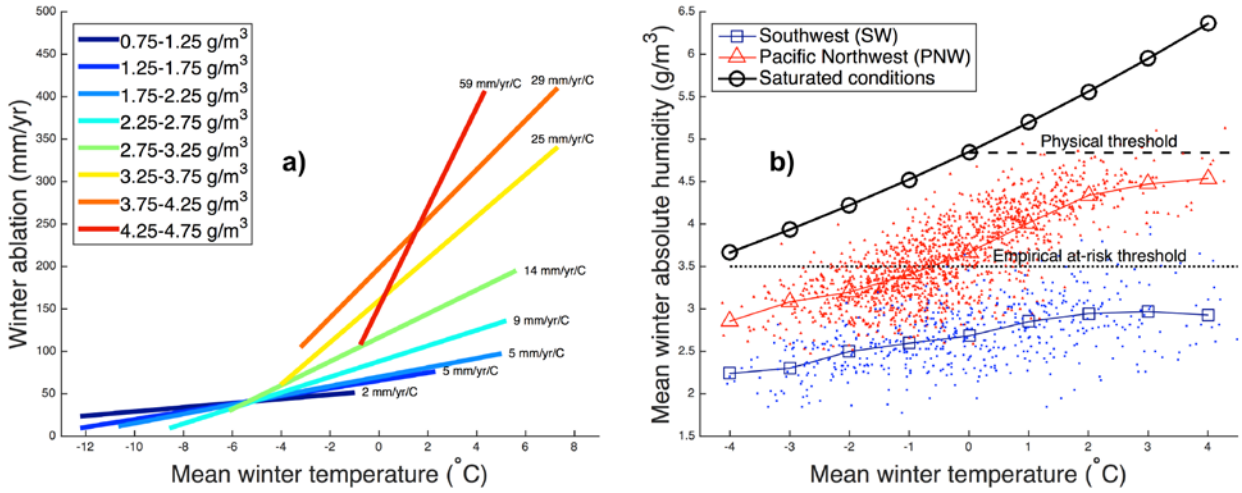
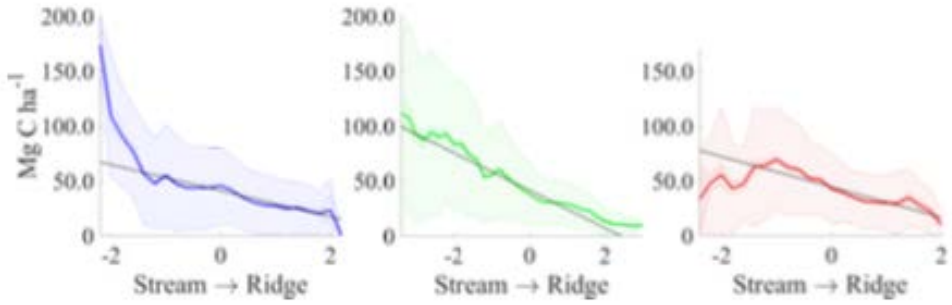
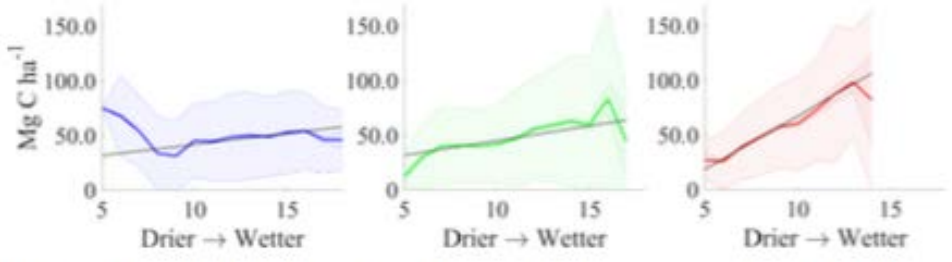


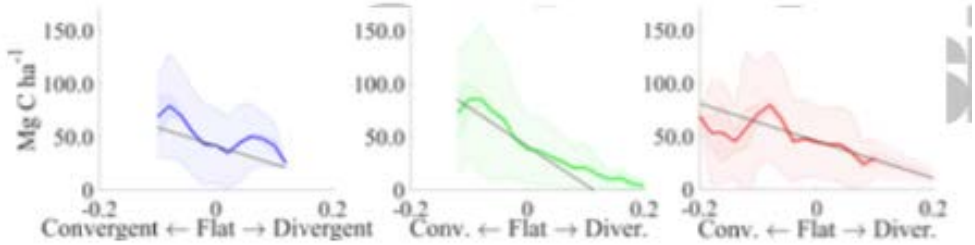
Fig. 1. Trends in winter and spring ablation over the last 30+ years place the snow work at Jemez and other western CZO's in broader context (Harpold and Brooks). Trends in winter ablation (a, b) and spring melt rate (c, d) from prior to 1985 through 2015 at 462 sites. Symbol colors (a, c) represent magnitude of change and crosses denote sites with significant trends ($p<0.05$). Histograms (b, d) show the number of sites with trends at varying magnitudes (blue bars), red bars are significant trends ($p<0.05$).



Topographic Position Index vs C. Linear regressions (black line) reported in SI Table 8.



Topographic Wetness Index versus C. Linear regressions (black line) reported in SI Table 6.



General Curvature vs C. Linear regressions (black line) reported in SI Table 5.

Fig. 2. The role of topographically driven hydrologic subsidy on biomass accrual using high resolution LiDAR data obtained as part of the cross CZO research. Surprisingly, analyses indicate that the influence of lateral water (or nutrient) distribution is greater either aspect or elevation in explaining standing forest biomass (Swetnam et al., 2017).

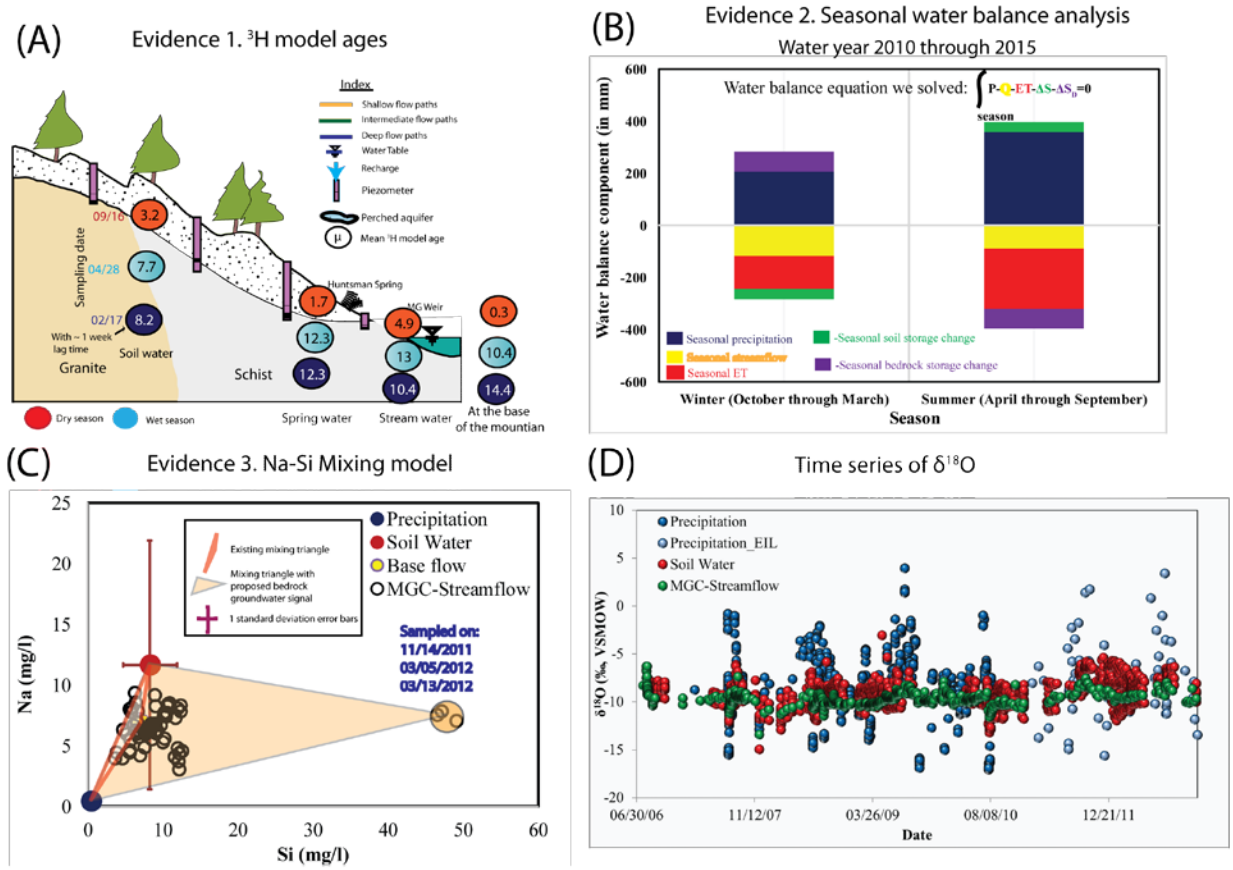


Fig. 3. Flowpaths and transit times of water through the deep CZ into Marshall Gulch stream. Seasonal streamflow transit times (A), water balance (B), source water contributions to streamflow (C), and temporal pattern of isotopic composition of precipitation, soil water, and streamflow (D) (Dwivedi et al., in prep.).

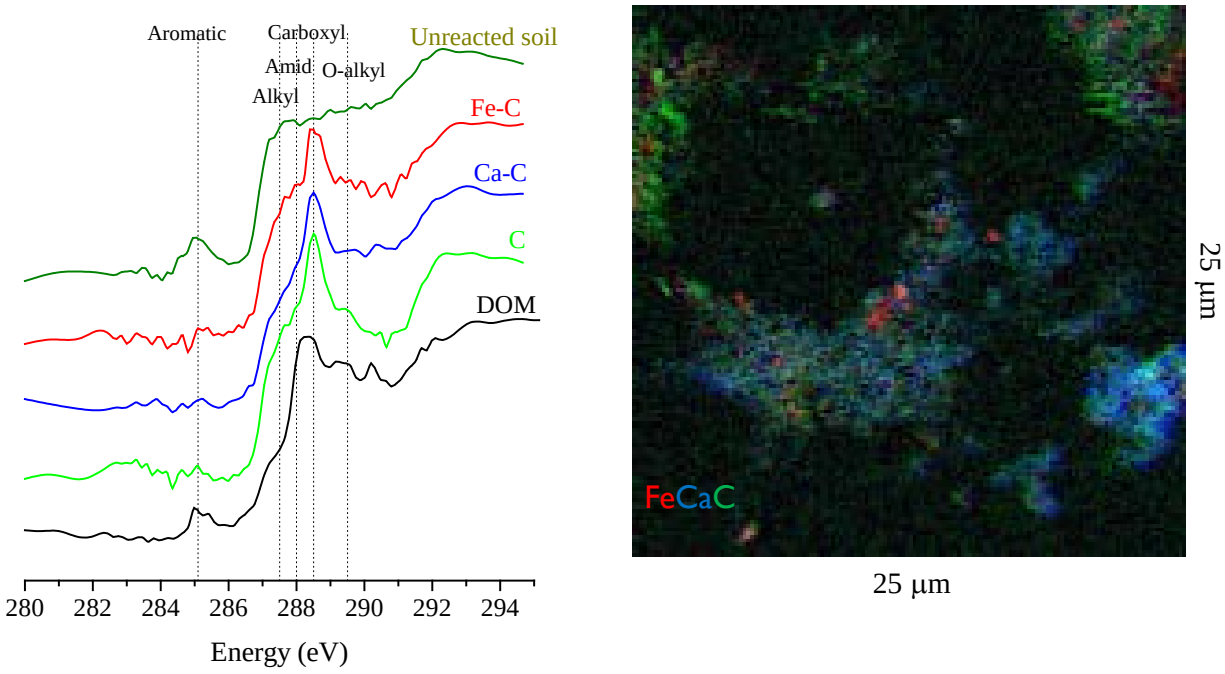


Fig. 4. Carbon NEXAFS spectra of JRB subsoil following reaction with influent DOM from forest floor, under wet-dry cycling. Left, carbon NEXAFS spectra extracted from C, Ca, and Fe regions of STXM map. Spectra of unreacted soil (top) and DOM solution (bottom) are presented. Dashed vertical lines point out C species. Right, tri-colored STXM map of fine fraction from JRB soil reacted four times with DOM under wet-dry cycling; Fe (red), Ca (blue) and C (green). Image size 25 x 25um (Olshansky et al., in review).

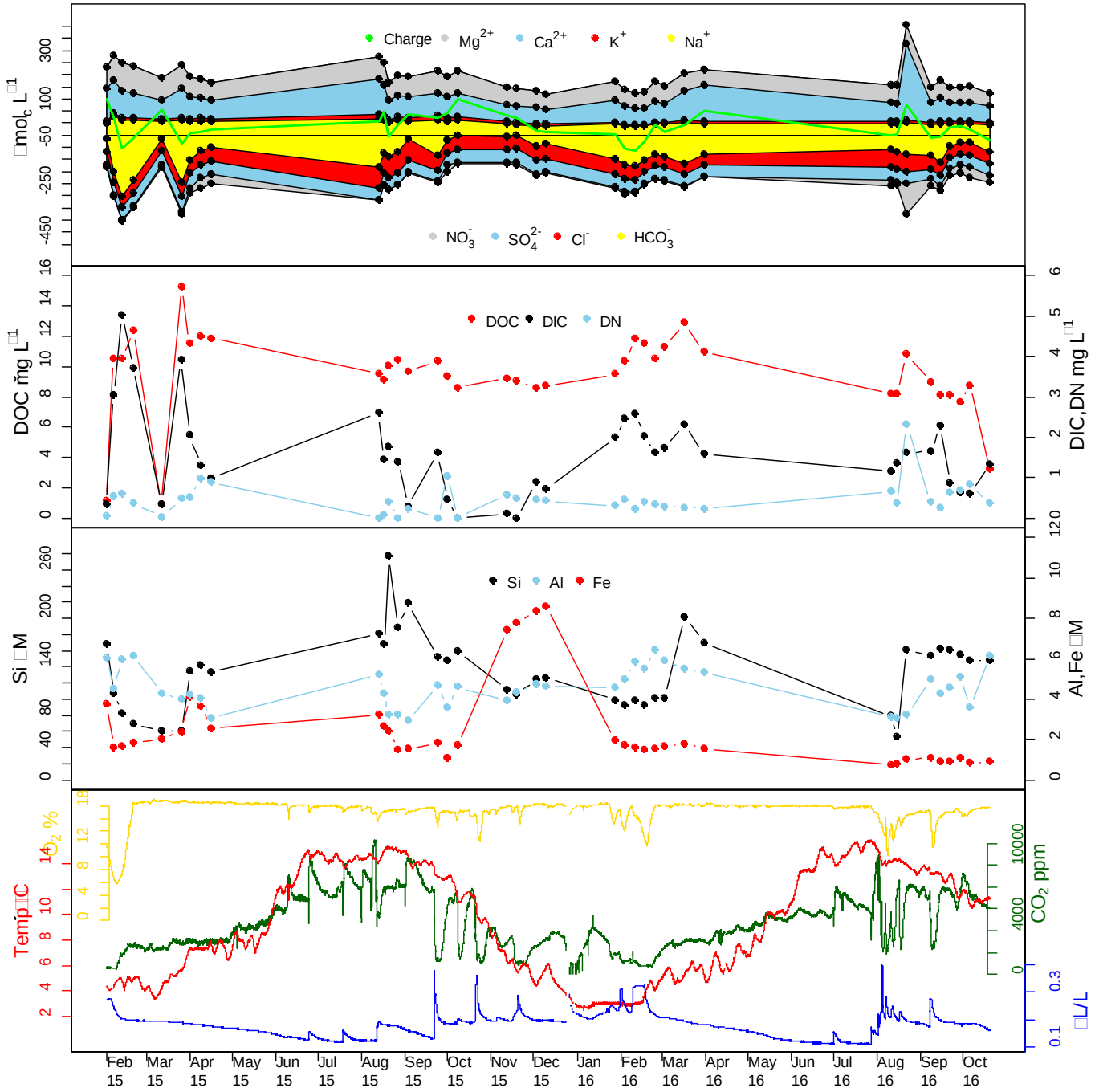


Fig. 5. Data collected from instrumented pedons in Bigelow ZOB show that seasonal dependence of moisture and temperature drive soil $CO_{2(g)}$ production from subsurface respiration that, in turn, promotes associated releases of K and Si, suggesting biologically-induced dissolution of mica/illite or K-feldspar (Olshansky et al., in prep.).

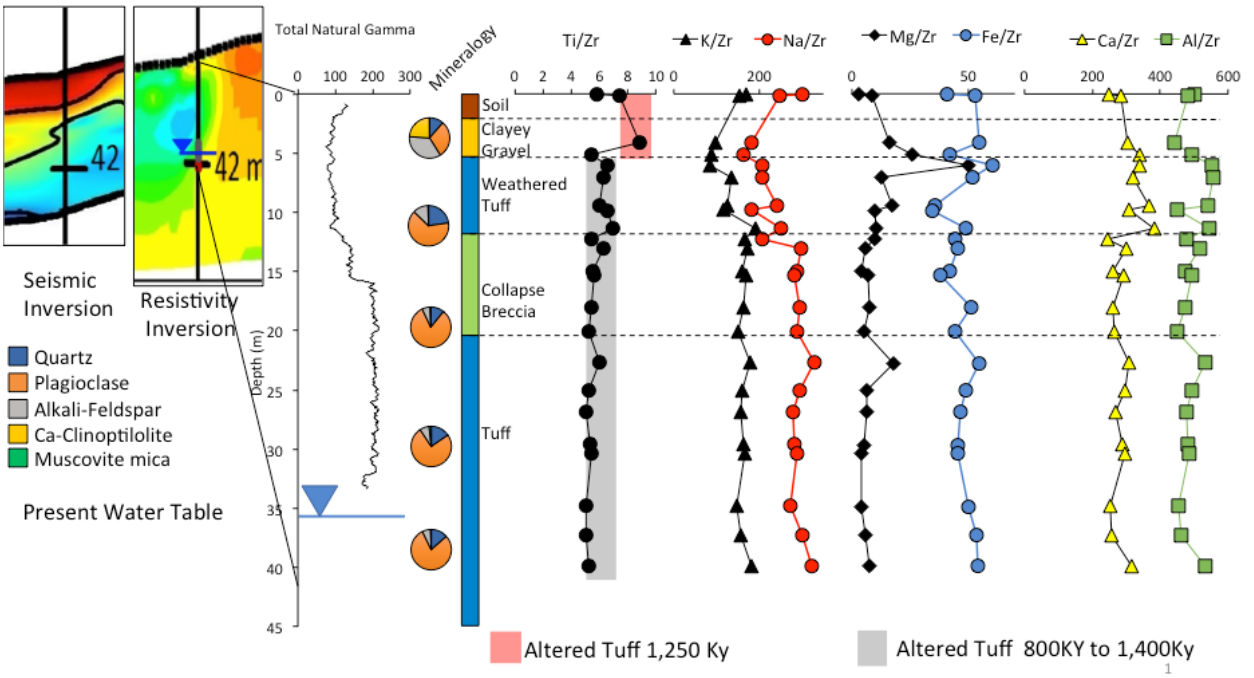


Fig. 6. Elemental chemistry of core materials (site 1 borehole; eastern mid-slope of MCZOB) combined with geophysical survey. Differences in immobile elements (e.g. Ti or Zr) and mineralogy with depth suggest multiple depositional events. Smectite and zeolite (clinoptilolite and mordenite) in the upper 10 m were precipitated in an alkaline caldera lake that formed soon after caldera eruption (1.25 Ma).

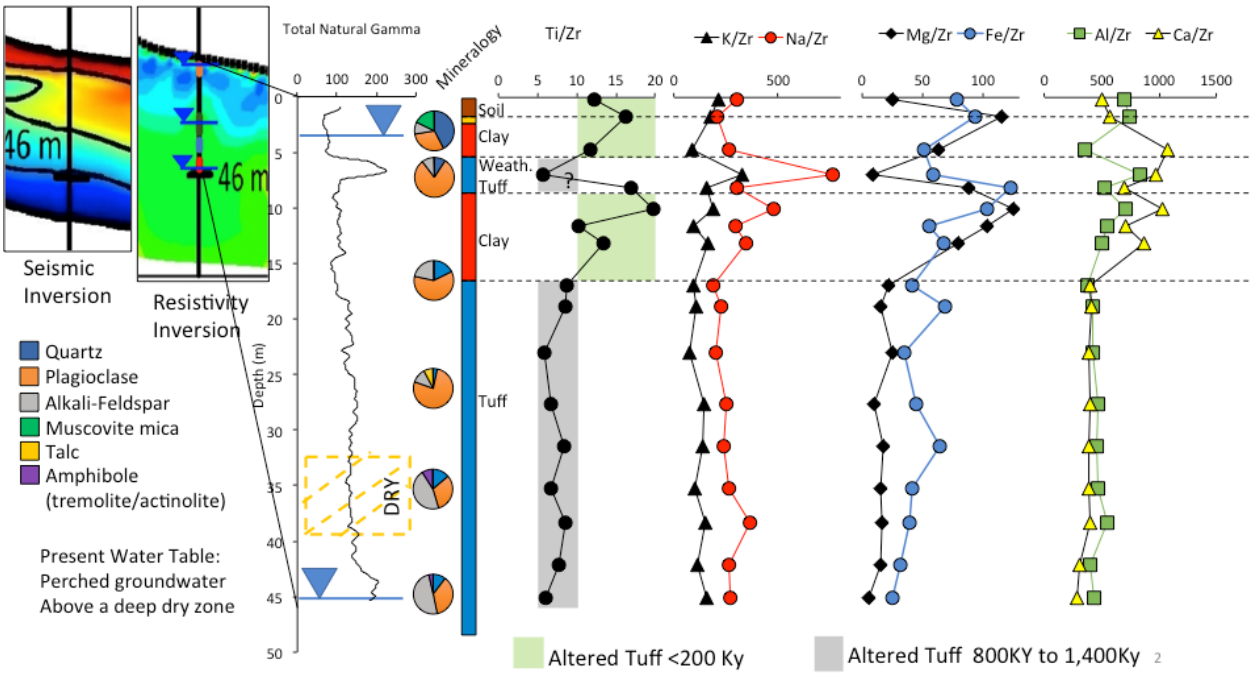


Fig. 7. Elemental chemistry of core materials (site 2 borehole; western mid-slope of MCZOB) combined with geophysical survey. Results reveal non-monotonic weathering profiles, perched aquifers corresponding to clay zones (likely formed from incongruent dissolution of primary minerals), and differences in parent materials with depth in the complex volcanic terrain. There is no evidence of smectite and zeolite from the alkaline lake, as seen in Borehole 1.

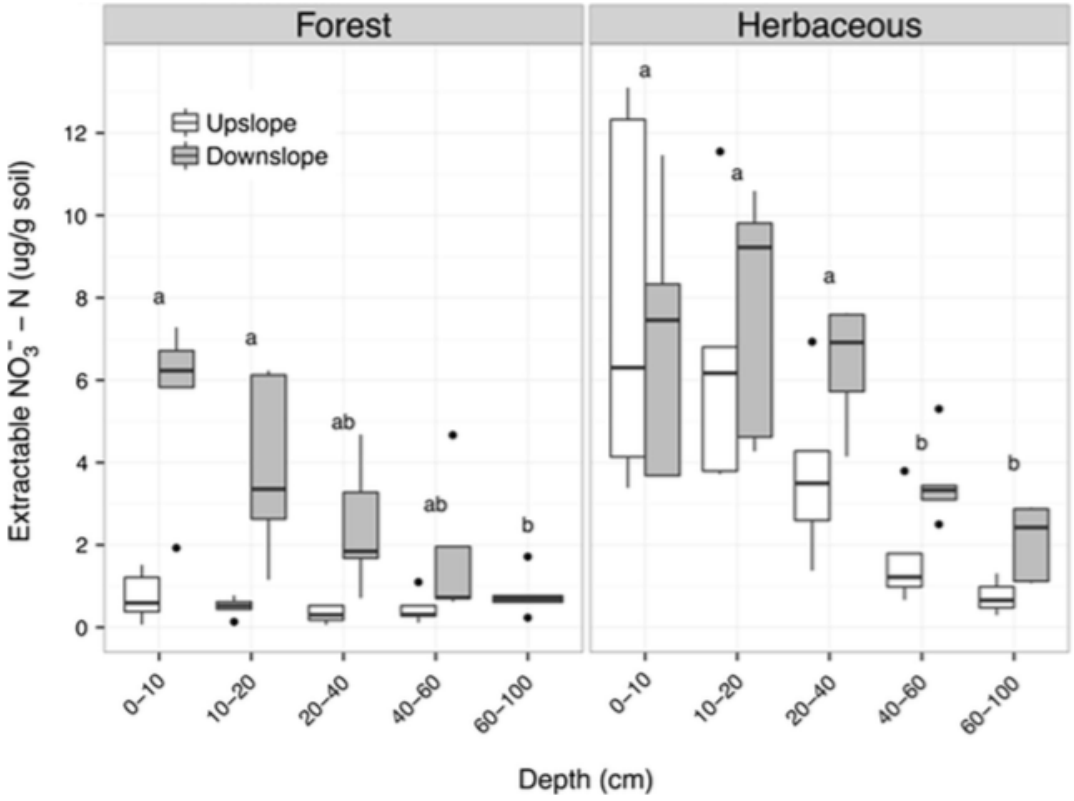


Fig. 8. Soil extractable NO_3^- as a function of depth below the surface in spring soil samples. Downslope sites had significantly more NO_3^- compared to upslope sites under both forest ($F_{1,39} = 45.85$, $P < 0.001$) and herbaceous ($F_{1,41} = 6.79$, $P = 0.013$) vegetation. Depth was also a significant predictor of [NO_3^--N] under both forest ($F_{4,39} = 4.65$, $P = 0.004$) and herbaceous ($F_{4,41} = 16.51$, $P < 0.001$) vegetation. Letters indicate statistical groupings between depth horizons within each vegetation type according to Tukey honest significant differences.