ecosystem exchange of CO_2, RH_s surface relative humidity and C_s surface CO_2-concentration. We are especially interested to see whether this leaf-level relationship holds true on a canopy scale for a wide range of different canopies and ecosystems as it could be used to scale tower measurements across larger spatial scales with the aid of remote sensing products. For our calculations mid-day data were used for the whole year in evergreen and for growing season only in deciduous and crop canopies. The resulting relationships were highly linear with an average slope a = -10.45 and intercept b = 0.32 with some degree of variation for different types of ecosystems and functinal types.

B42D-07 1745h

A Challenge to the Flux-Tower Upscaling Hypothesis? A Multi-Tower Comparison From the Chequamegon Ecosystem-Atmosphere Study

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The "flux-tower upscaling hypothesis" asserts that flux tower measurements of representative ecosystems can be upscaled to regional fluxes via ecosystems mapping and process models. Collecting an integrated set of measurements to attempt upscaling is challenging. The required sampling density is also uncertain, and at minimum depends on local soil and vegetation cover, land use patterns, and climate gradients. Measurements that can be used to evaluate upscaling efforts are similarly difficult to obtain. Thus the basic hypothesis behind the flux tower approach of studying regional and global carbon (and hydrologic) cycles remains difficult to implement and test. The Chequamegon Ecosystem-Atmosphere Study (ChEAS) has endeavored to create a distributed set of stand-level flux tower and supporting measurements that can be used to upscale carbon and water flux measurements to the regional scale. The flux measurements collected at the 447m WLEF TV tower are proposed as a regional integral that can be used to evaluate the stand-level upscaling. Though more exhaustive analyses are warranted, the results to date bear a mixed message for tower-based upscaling. The absolute magnitude of the fluxes from two stand-level towers cannot be simply aggregated to explain the observations from the WLEF tower. Decomposition implies that while photosynthesis may upscale, respiration does not. Potential explanations will be discussed, including comparisons to chamber respiration data, wetland water table, and flux measurements across young, mature and old-growth stands. The data from WLEF show a regional source of carbon to the atmosphere, counter to most temperate forest data and counter to the stand-level towers in the region. Upscaling interannual variability, however, appears to be a more tractable problem. Though the temporal extent of the multiple flux tower system is limited, a tent caterpillar outbreak in 2001 provides an example of a strong, coherent perturbation to the regional ecosystem that is captured by the available sampling. Stand-level measurements upscale reasonably well to explain the changes in regional fluxes measured at WLEF. Climatic variability from more recent data will also be presented, in addition to recommendations for future upscaling efforts.

B42E MCC: 3010 Thursday 1600h

Aqueous Microbial Geochemistry III

(joint with H, OS, V)

Presiding: **E Shock ,** Arizona State University**; L A Warren,** School of Geography and Geology, McMaster University

B42E-01 1600h

Pyrite oxidation by microbial consortia

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Acid mine drainage (AMD) is formed through pyrite oxidation, which produces acidity and releases toxic metals associated with pyrite and other sulfide minerals. Microbes accelerate pyrite oxidation markedly, thereby playing a major role in the production of AMD. Here, we probe pyrite oxidation by consortia of Thiobacillus ferrooxidans and thiooxidans using surface-sensitive photoelectron spectroscopy and X-ray absorption spectroscopy and compare them with surfaces oxidized through chemical and single species cultures. Microbial oxidation resulted in the formation of distinct oxidized surface species distributed nonuniformly over the pyrite surface; consortia produced a surface both more heterogeneous and more oxidized. In contrast, chemical oxidation proceeds without the build-up of passivating oxidation products. Surface morphology was not correlated with sites of nucleation or oxidation in any obvious manner. These results demonstrate that microbial oxidation occurs through a similar mechanism to chemical oxidation, but that the presence of complex microbial communities may impact the manner by which pyrite oxidation proceeds.

B42E-02 1615h

Sulfur Oxidation, Microbes And Acidity In A Mine Tailings Lake

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Disposal of tailings (waste rock) aqueously is a common approach at mine sites to minimize oxidation of the associated sulfur minerals (pyrrhotite, pyrite) and the associated generation of acidity that accompanies this process. The study site, Moose Lake, receives tailings runoff at a nickel mine in Northern Ontario, which has rendered the lake highly acidic (surface pH values less than 3.5) with high metal loads and on-going acid export to off-site, downstream systems. To investigate the potential influence of microbial processes for acid generation, as well as characterizing any attendant influences for metal behaviour, the biogeochemistry of Moose Lake was characterized on a seasonal and a diel basis during the summer of 2002. Physico-chemical profiles were used to identify the area of strong redox gradient across the thermocline (typically 1 to 2 metres across this zone) on each sampling day. Samples at five depths within this redox gradient, were then collected for Fe^{3+}/Fe^{2+}, $SO_4{}^{2-}/H_2S$, metal and microbial samples, in addition to more highly resolved Hydrolab profiling. Samples were collected both during the lighted portion of the day (10am-12pm) and at dusk (6pm-8pm) to evaluate any contributions to S and Fe cycling attributed to photosynthetic activity. Results indicate a clear seasonal increase in acidity in the upper waters of the lake: pH values dropped from 3.19 in May to 2.90 in September. Further, a strong diel trend of increasing acidity (lower pH) from mid morning to dusk was also observed for each sampling period. Biotic control on S processes appears to be important associated with the thermocline region of the lake, whilst surficial processes occurring in the upper one to three meters are more consistent with a dominant abiotic control. Both pathways contribute to acidity generation, however the controls and rates differ. These results and implications for mitigation strategies will be presented.

B42E-03 1630h

Effects of Long-Term Acid-Mine Drainage Contamination on Diversity and Activity of Sulfate-Reducing Bacteria in a Natural Salt Marsh.

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Constructed wetlands have been studied as sites or analogs for *in situ* bioremediation of metal contaminants from acid mine drainage (AMD) or industrial sources (e.g. Webb et al. 1998). Wetlands bioremediation necessarily invokes the ubiquity and robustness of sulfate-reducing bacteria (SRB) to sequester dissolved metals into various poorly soluble metal-sulfides (e.g. PbS, CdS). However, few studies of natural wetlands under long-term ecological forcing by AMD or other contaminant sources are available for context. We are investigating the microbial diversity, mineralogy and geochemistry of a highly contaminated salt marsh along the East Central San Francisco Bay. For nearly a half-century, areas within this marsh have received acidic and/or metal-rich groundwaters from near-surface pyrite tailings (transported there from Iron Mountain Mine, near Redding, CA) and local industrial sources (e.g. paint and explosives manufacturers). Sediment cores (30-40 cm long) were taken from six contaminated sites in the marsh with pH range of ~2 to ~8. Previous analyses (URS Corp. 2001) reported As, Cd, Cu, Se, Zn, and Pb present in sediments at extremely high concentrations (100s of ppm), yet our ICP-AES analyses of pore waters showed only As present at concentrations of 10-50 ppb. We infer, from high-resolution transmission electron microscope (HRTEM) studies of biogenic (SRB biofilm) ZnS (Moreau et al. 2003, in review) and marsh sediments, that contaminant metals have been sequestered into aggregates of nanocrystalline metal-sulfides. Continuous-flow isotope ratio mass spectrometer (CF-IRMS) analyses of pore-water sulfate and sedimentary sulfides allow resolution of contributions to dissolved sulfate and sulfide from tailings oxidation and dissimilatory sulfate reduction. Sulfate analyses from subsections of three cores (pH 2-3, 6-7, 7-8, respectively) all yield $\delta^{34}S$ values consistent with bacterial sulfate reduction. We note that all three cores also contain very fine-grained black muds that are distinguishable from coarser pyrite cinders, and exhibit a noticeably strong sulfide odor. Aero- and halo-tolerant SRB were enriched from circumneutral pH cores, and we hypothesize that acido-tolerant SRB may also be present. Analysis of restriction fragment length polymorphism of whole community 16S rDNA extracted from each core shows an expected increase in diversity between acidic and circumneutral sediments, and clone libraries from both contaminated and uncontaminated marsh sediments are being compared to assess the impact of long-term contamination. *References:* Webb et al. 1998, *J. Appl. Microbio., 84,* 240-248; Moreau et al. 2003, *Amer. Min.*, in review; URS Corp. 2001, *Report 51.09967067.00.*

B42E-04 1645h

Sulfur Isotopic Analysis of Water and Sediment From Lake Hoare, Antarctica

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Lake Hoare is a perennially ice-covered lake located in the McMurdo Dry Valleys of east Antarctica. Benthic microbial mats containing sulfate reducing and sulfide oxidizing bacteria are present in anoxic waters at depths greater than 27 m. Extreme cold and dry conditions in the valleys make them compelling analogs for possible paleolake systems on Mars. Sediment samples from 9 to 39 cm core depth were taken from cores collected from the anoxic zone. Water column samples from 6 to 22 m depth were analyzed for sulfate content. Sulfur isotopic values (δ^{34}S) were determined for sequentially extracted sulfur species in sediment and for sulfate precipitated from the water samples. Sulfur fractions recovered from water samples show δ^{34}S values of about 14 per mil. Sulfate recovered from sediments show sulfate δ^{34}S values ranging from -1 to -19 per mil and pyrite δ^{34}S values ranging from -2 to -22 per mil. Sulfate and pyrite δ34S values show synchronous shifts with depth. Sulfate δ^{34}S values exhibit a positive offset of about 5 per mil from pyrite δ^{34}S. Given concentrations of sulfate mostly less than 1mM in Lake Hoare and the ^{34}S-enriched sulfate present in the water column, this small positive offset is inferred to reflect porewater sulfate present in the sediments combined with labile sulfides that were oxidized to sulfate in the lab. Upward decreasing values of δ^{34}S for sediment pyrite combined with increasing pyrite contents near the sediment-water interface are consistent with enhanced bacterial sulfate reduction due to an expanding reservoir of anaerobic water within Lake Hoare.

B42E-05 1700h

Nitrogen isotope evidence of ammonia vapor assimilation by cave wall microbial biofilms in a sulfidic cave, a novel mechanism of nutrient acquisition

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Ammonia volatilization provides a source of fixed nitrogen to the microorganisms living at low pH on the walls of Lower Kane Cave. Sulfuric acid speleogenesis is actively enlarging this cave; hydrogen sulfide dissolved in ground water is oxidized to sulfuric acid both in the cave streams and after volatilization to the cave walls. The result of this process is replacement the host limestone with a rind of gypsum on the cave walls upon which droplets with pH values of 1-2 sulfuric acid accumulate. The radically different pH values of the cave stream and cave wall habitats results in an unusual mechanism of fixed nitrogen acquisition by the cave wall microbial community, accumulation of volatilized ammonia. The spring water entering the cave has 25 to 40 μM NH_4^+ and circum-neutral pH allowing a small but significant amount this ammonium to volatilize as NH_3. This gaseous ammonia may then partition into the acidic cave wall droplets accumulating to concentrations of up to 800μM where it serves as a nitrogen source to the cave wall microorganisms. The effects of this ammonia volatilization may be seen in the extremely low δ^{15}N value of the cave wall biofilms, as low as -16$^o/_{oo}$. These δ^{15}N values are among the lowest observed in organic materials. Therefore nitrogen isotope ratios represent a marker of ammonia volatilization in subaerial sulfuric acid speleogenesis that may be applied to cave systems that were once sulfidic to delineate regions of subaerial versus subaqueous cave formation.

B42E-06 1715h

Kinetic Fractionation of Carbon Isotopes During Carbonate Weathering in Glaciated Catchments: Implications for the Detection of Subglacial Microbial Activity

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Microbes are abundant at the water-rock-ice interface beneath valley glaciers at Haut Glacier d'Arolla, Switzerland (HGA) and at John Evans Glacier, Ellesmere Island Nunavut, Canada (JEG). However, the importance of in-situ microbial activity in driving subglacial weathering reactions remains unknown. This is a key question when considering the potential role of microbes in mediating subglacial weathering and carbon cycling on a continental scale beneath the Pleistocene mid-latitude ice sheets. This study measured the chemical composition of meltwaters, including $\delta^1$3C-DIC at the two glaciers to quantify microbial CO_2 inputs to the DIC budget using isotope mass balance techniques. However, PCO_2 data indicates that most of the glacial meltwaters are far from equilibrium with respect to atmospheric CO_2 and thus kinetic processes are important in determining the water chemistry. Consequently, conventional equilibrium isotope mass balance techniques were inappropriate in this case. Hence, laboratory experiments were conducted with calcium carbonate and carbonate rich glacial sediments from JEG under simulated subglacial conditions (< 63 micron size fraction, sediment concentrations 0.01 to 5 g/l, 5^{o}C) to investigate potential kinetic isotopic effects and aid in interpretation of the field data ($\delta^1$3C-DIC values ranging from -2.4 to -15.7 $^o/_{oo}$). The laboratory experiments demonstrate previously unreported kinetic fractionation of carbon isotopes during the initial hydrolysis (closed system conditions) and early stages of carbonate dissolution driven by atmospheric CO_2 (open system conditions). Preferential dissolution of $Ca^{12}CO_3$, results in $\delta^1$3C-DIC values that are significantly isotopically lighter than the bulk carbonate. This kinetic isotopic effect (KIE) is more pronounced at higher sediment concentrations and can be up to -17.4 $^o/_{oo}$ for glacial sediments under closed system conditions and sediment concentrations of 5g/l. The KIE is also significant during the first 6 hrs of carbonate dissolution driven by atmospheric CO_2. Incorporating KIE into the geochemical weathering models and isotopic mass balance calculations allows identification of significant (> 10 %) microbial CO_2 contributions to the DIC budget in glacial meltwaters. However, where weathering processes producing KIE dominate the DIC budget, small microbial CO_2 contributions may be masked. Examples of subglacial environments from JEG and HGA exhibiting these contrasting weathering processes and differing levels of microbial CO_2 input will be presented.

B42E-07 1730h

Field Experiment to Stimulate Microbial Urease Activity in Groundwater for *in situ* Calcite Precipitation

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Groundwater contamination by radionuclides and metals from past weapons processing activities is a significant problem for the United States Department of Energy. Removal of these pollutants from the subsurface can be prohibitively expensive and result in worker exposure, and therefore *in situ* containment and stabilization is an attractive remediation alternative. One potential approach for the immobilization of certain radionuclides and metals (e.g., ^{90}Sr, ^{60}Co, Pb, Cd) is to induce geochemical conditions that promote co-precipitation in calcite. Many aquifers in the arid western US are calcite-saturated, and calcite precipitated under an engineered remediation scheme in such aquifers should remain stable even after return to ambient conditions. We have proposed that an effective way to promote calcite precipitation is to utilize native microorganisms that hydrolyze urea. Urea hydrolysis results in carbonate and ammonium production, and an increase in pH. The increased carbonate alkalinity favors calcite precipitation, and the ammonium serves the additional role of promoting desorption of sorbed metal ions from the aquifer matrix by ion exchange. The desorbed metals are then accessible to co-precipitation in calcite, which can be a longer-term immobilization mechanism than sorption. The ability to hydrolyze urea is common among environmental microorganisms, and we have shown in the laboratory that microbial urea hydrolysis can be linked to calcite precipitation and co-precipitation of the trace metal strontium. As a next step in the development of our remediation approach, we aimed to demonstrate that we can stimulate the native microbial community to express urease in the field. In 2002 we conducted a preliminary field trial of our approach, using a well in the Eastern Snake River Plain Aquifer in Idaho Falls, Idaho, USA. A dilute molasses solution (0.00075%) was injected to promote overall biological growth, and then urea (50 mM) was added to the aquifer. Results from the field experiment indicated that following the molasses addition, total cell counts and ureolytic cell numbers increased by one to two orders of magnitude. Ureolysis rates increased from <100 pmol $L^{-1}hr^{-1}$ to >25,000 pmol $L^{-1}hr^{-1}$. DNA extracted from groundwater was analyzed for 16S rRNA and urease gene diversity, and indicated that distinct changes in the microbial community resulted from our substrate additions. Following urea injection, calcite precipitation in the formation occurred. These results are promising with respect to the potential of this approach for remediation of radionuclides and metals in groundwater.

B

B42E-08 1745h

The Role of Aquifer Heterogeneity on Metal Reduction in an Atlantic Coastal Plain Aquifer as Determined by Push-Pull Tests

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Field-scale push-pull experiments were conducted to determine the factors controlling Fe(III) and Mn(IV) reduction in the well-characterized, shallow, coastal plain aquifer near Oyster, VA. Sixty push-pull experiments were simultaneously conducted in 5 wells equipped with multi-level samplers (MLSs), each with 12 ports equally spaced from 4.4 to 8 m below ground surface; a zone that sampled a heterogeneous portion of the aquifer. Four distinct treatments, one treatment across the twelve ports of each MLS, were utilized to determine the effect of an electron donor and humics on metal reduction. The treatments were 1) control, 2) humics, 3) lactate (conducted twice), and 4) lactate and humics. Microbially mediated Fe(III) reduction caused the aqueous Fe and Mn concentrations to increase at every depth in the lactate treatment with significant increases within 1 day even while nitrate was present in the aquifer. Peak Fe concentrations reached 0.252±0.113 mM in the lactate treatment but only 0.031±0.026 mM in the control treatment with peak values varying by over a factor of 4 with depth in the lactate treatment. Humics may have acted as an electron shuttle to increase Fe(III) reduction in the presence of lactate. The amount of Mn(IV) reduction was significantly lower than Fe(III) reduction with peak Mn values only reaching 17.24±37.67 μM in the lactate treatment as compared to 0.75±0.42 μM in the control treatment. Mass balance and thermodynamic calculations indicated that sorbed sulfate was probably reduced and that significant amounts of Fe(II) sorbed to mineral surfaces and precipitated. Geochemical modeling suggested that conditions were favorable for the precipitation of Fe-carbonates, Fe-sulfides, and

Fe-silicates. In the lactate treatment protist concentrations increased by over an order of magnitude to 2914±1482 protists/ml before decreasing and planktonic cell concentrations increased almost two orders magnitude to $1.4 \pm 1.3 \times 10^7$ cells/ml whereas no change in protist and cell concentrations occurred in the control treatment. Increased rates of Fe(III) reduction may have occurred in the low permeability non-peat rich zones but the correlations with the physical and chemical descriptions of aquifer heterogeneity were weak, probably as a result of Fe precipitation, Fe sorption, and the abundance of Fe(III) bearing minerals and bacteria at all depths. This work has important implications for developing methods to remediate subsurface sites contaminated with metals and radionuclides.

B51A MCC: 3014 Friday 0800h

An Ecohydrological Perspective on Woody Plant Encroachment in Semiarid Regions I *(joint with H)*

Presiding: **R L Scott,** USDA Agricultural Research Service**; B P Wilcox,** Texas A&M University

B51A-01 0805h

Ecohydrology and Woody Plant Encroachment: a Conceptual Framework for Evaluating Landscape Consequences

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Increases in the abundance or density of woody plants in historically semiarid and arid grassland ecosystems have important implications for hydrology, ecology, and society. Using a simplified water-balance model, we propose a framework for conceptualizing how woody plant encroachment is likely to affect components of the water cycle within these ecosystems. In these systems, shrub removal has been proposed as mechanism for increasing watershed yield, but such increases are likely only in systems with shallow bedrock, riparian systems, or climatic systems where precipitation exceeds potential evapotranspiration for extended periods. In semiarid and arid systems abiotic controls on evaporation overwhelm biotic control of streamflow. In these systems, the predominant effects of woody plant encroachment that promote ecohydrological feedbacks are changes in: infiltration, depth of plant water removal, generation of transient overland flow and near-ground energy budgets that affect the ratio of evaporation (E) to transpiration (T). In these more xeric areas, the ratio of E:T is critical because it indicates the biological use of water which influences landscape structure. Increasing woody plant cover is associated with larger open interspaces, at the landscape scale the differential contribution of canopy versus interspaces may change landscape E:T. Alterations of spatial structure and ecohydrology likely influence other biogeochemical processes, such as carbon cycling. At the landscape scale, total respiration depends on the magnitude of canopy/interspace respiration flux scaled by the spatial extent of interspaces and canopy space. Canopy respiration is strongly correlated to T, while interspace respiration is largely driven by soil water availability and therefore is driven by factors that control E. Resolving the partitioning of E:T should help resolve the net effect of woody plant encroachment on other biogeochemical cycles at the landscape scale. This framework for considering the effects of woody plant encroachment highlights important ecological and hydrological interactions that serve as a basis for predicting other ecological aspects of vegetation change.

B51A-02 0820h INVITED

Trees, Water, Space and Time

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Woody plant proliferation in grasslands and savannas over the past century has been a globally widespread phenomenon. Rates and patterns of woody community development in arid and semi-arid grasslands are often regulated by a hydrological process mediated by soils, topography and disturbance. Once established, woody plant communities have the potential to alter hydrological processes either directly or indirectly. This presentation will focus on hydrological mediation of woody plant establishment and community development. Though not widely documented, rates, patterns and dynamics of shifts from grass to woody plant domination, appear to be strongly influenced by the amount and seasonality of rainfall, operating against a backdrop of topoedaphic heterogeneity. Disturbances may override or amplify climate/soil effects. Establishment of woody seedlings is a critical first-step in woody plant encroachment. How do seedlings gain a foothold in grasslands? How important is episodic vs. continuous recruitment? How do hydrological factors affecting woody plant recruitment differ from those affecting stand development and stand dynamics at landscape levels of resolution? To what extent are woody plant communities self-regulating and subject to hydrologically mediated density dependence? These questions will be addressed in the context of vegetation inertia and lag effects which make it difficult to assign primacy to driving forces.

B51A-03 0840h

Scale Issues in Ecohydrological Processes in Grassland-Shrubland Transitions, Jornada, NM

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Rainfall-simulation experiments have proved invaluable in developing our understanding of ecohydrological processes relating to grassland-shrubland transitions in the American Southwest and elsewhere. Grassland communities are effective at buffering the runoff and erosional response, whereas shrublands accelerate runoff and erosion rates leading to local concentrations of resources. Further feedbacks occur in terms of nutrient redistribution both dissolved in overland flow and adsorbed onto transported sediment. Field experiments at the Jornada LTER site over the last ten years have evaluated these processes on undisturbed and grazed black grama grassland, and creosotebush and mesquite shrubland communities. More recently, investigations have been carried out to evaluate the behaviour of these systems at the landscape scale. Low-cost sampling designs have been used so that relatively large spatial samples can be collected. Currently, 96 of these samplers are in operation at Jornada, evaluating water, sediment and nutrient transfers in the interrill zone. A smaller number of samplers are used to characterize rill transfers of water and dissolved nutrients. The samplers are located along ecotones so that the spatial relationship of grassland-shrubland and shrubland-shrubland transitions can be evaluated. An interesting initial result of the use of these samplers is that they provide different relative patterns of fluxes from those that would be estimated using the plot-based studies. These results contribute to the growing body of evidence that the scaling properties of landscape-degradation processes in these environments are non-linear. Further instrumentation of watersheds is being carried out in order to evaluate these non-linearities at larger scales. At the same time, intensive spatial sampling of hydrological, sedimentary and nutrient characteristics of the surfaces of the different vegetation communities is being carried out. The rationale for this sampling is to be able to generate multi-scale databases that can be used to parameterize a range of models that investigate the transition processes and process interactions. These models work at a range of levels of abstraction, albeit all with a process base. Furthermore, the spatial measurements themselves give clues to the cause of the non-linearities in scaling and the processes that may generate them. This paper concludes by looking at the relative advantages and disadvantages of the different approaches that can be used to evaluate ecohydrological interactions.

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Spatio-temporal Variation in Soil Water in a Semiarid Woodland: Implications for Woody Plant Encroachment

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Woody plant encroachment in dryland ecosystems is an issue of global concern, yet mechanisms related to encroachment are poorly understood. Mechanisms associated with woody plant encroachment likely relate to soil water dynamics, yet few long-term data sets exist to evaluate soil water heterogeneity. Here we highlight how soil water varies both temporally (wet vs. dry years and snow vs. rain dominated months) and spatially (vertically with depth and horizontally beneath vs. between the canopies of woody plants). We measured soil water content using neutron probe over a 15-year period in a pinyon-juniper woodland at the Mesita del Buey Research Site in northern New Mexico. Our objectives included assessing (1) the temporal variability of soil water, both as a function of depth and as a function of cover (canopy patches beneath trees, intercanopy patches between trees, and edges between the two patch types); and (2) implications for the vertical and horizontal distributions of plant-available water. Our results highlight (1) large temporal variations in soil water availability, driven largely by differences in winter precipitation, and (2) the potential importance of considering horizontal as well as vertical heterogeneity in soil moisture. The spatio-temporal variation in soil water that we quantify highlights the potential complexity of changes in the water budget that could be associated with woody plant encroachment and emphasizes the importance of considering horizontal as well as vertical heterogeneity in soil water in improving our understanding of mechanisms associated with woody plant encroachment.

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Interactions Among Water, Carbon, And Nutrient Cycles With Woody Plant Encroachment Into Grasslands

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The expansion of woody plants into deserts, grasslands, and savannas alters water and nutrient cycling, affecting some one-fifth of the world's population. In this talk, research along precipitation gradients in North and South America will be used to examine interactions among water, carbon and nutrients in the southwestern U.S. and in grasslands of Argentina and Uruguay. Those interactions include groundwater uptake, carbon sequestration, changes in salinity and pH, and new evidence for the direct uptake of nutrients at depth using stable isotopes. The talk will end with a discussion of key unanswered research questions at the boundary of hydrology, biology, and geochemistry associated with woody plant encroachment.

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