above one of the major land use types, a Cacao plantation, were investigated using the Eddy-Covariance method. Simultaneously meteorological measurements of the variables wind speed and velocity, temperature, humidity, rainfall, soil heat flux and the components of the radiation budget were performed, in order to complete the energy balance and investigate the dependencies of the turbulent exchange processes on the atmospheric boundary conditions. The measurements are being compared to a SVAT model, providing the heat flux into the vegetation. Energy balance closure is used as a means to check the quality of the measured fluxes. The comparison to measurements above undisturbed rain forest by means of the ratio of sensible to latent heat flux, the Bowen ratio, indicates a significantly different boundary layer regime of the atmosphere above the Cacao.

B31G-07 1200h

Local and Long-Distance Effects of Land Use Change on Nutrient Levels in Streams and Rivers of the Conterminous United States

Richard A. Smith[1] (703-648-6870; rsmith1@usgs.gov)

Richard B. Alexander[1] (703-648-6869; ralex@usgs.gov)

Gregory E. Schwarz[1] (703-648-5718; gschwarz@usgs.gov)

[1]U.S. Geological Survey, 12201 Sunrise Valley Drive 413 National Center, Reston, VA 20192, United States

Determining the effects of land use change (e.g. urbanization, deforestation) on water quality at large spatial scales has been difficult because water quality measurements in large rivers with heterogeneous basins show the integrated effects of multiple factors. Moreover, the observed effects of land use changes on water quality in small homogeneous stream basins may not be indicative of downstream effects (including effects on such ecologically relevant characteristics as nutrient levels and elemental ratios) because of loss processes occurring during downstream transport in river channels. In this study we used the USGS SPARROW (Spatially-Referenced Regression on Watersheds) models of total nitrogen (TN) and total phosphorus (TP) in streams and rivers of the conterminous US to examine the effects of various aspects of land use change on nutrient concentrations and flux from the pre-development era to the present. The models were calibrated with data from 370 long-term monitoring stations representing a wide range of basin sizes, land use/cover classes, climates, and physiographies. The non-linear formulation for each model includes 20+ statistically estimated parameters relating to land use/cover characteristics and other environmental variables such as temperature, soil conditions, hill slope, and the hydraulic characteristics of 2200 large lakes and reservoirs. Model predictions are available for 62,000 river/stream channel nodes. Model predictions of predevelopment water quality compare favorably with nutrient data from 63 undeveloped (reference) sites. Error statistics are available for predictions at all nodes. Model simulations were chosen to compare the effects of selected aspects of land use change on nutrient levels at large and small basin scales, lacustrine and coastal receiving waters, and among the major US geographic regions.

URL: http://water.usgs.gov/nawqa/sparrow

B31G-08 1215h

Teleconnections Between Tropical Deforestation and Midlatitude Precipitation

Roni Avissar[1] (919-660-5200; avissar@duke.edu)

David Werth[1] (919-660-5462; werth@duke.edu)

[1]Duke University, Dept. of Civil and Environmental Engineering Box 90287, Durham, NC 27708-0287, United States

Past studies have indicated that total deforestation of Amazonia would result in an important reduction of the rainfall in that region, but that this process had no significant impact on the global temperature or precipitation and had only local implications. Here, we show that deforestation of tropical regions activates Rossby waves, which affect significantly precipitation at mid-latitudes by 'teleconnections'. In particular, we find that the deforestation of Amazonia and Central Africa severely reduces rainfall in the US Midwest during spring and summer, when water is crucial for agriculture in that region. Deforestation of South-East Asia reduces winter precipitation in the Western US and, consequently, the water storage that is released from snow melting later in the spring.

B32A MCC: Level 1 Wednesday 1330h

Modeling Coupled Biogeochemical Cycles in Natural and Contaminated Systems: Linking Hydrogeological, Microbiological, and Geochemical Processes II Posters *(joint with H, OS)*

Presiding: **J T McGuire,** Texas A&M University**; E Roden,** University of Alabama

B32A-0367 1330h POSTER

Modeling the Response of Terrestrial and Aquatic Ecosystems in the Northeastern U.S. to Changes in Atmospheric Deposition

Limin Chen[1] (lchen05@syr.edu)

Charles T Driscoll[1] (ctdrisco@mailbox.syr.edu)

[1]Dept. of Civil and Environmental Engineering, Syracuse University, 220 Hinds Hall, Syracuse, NY 13244, United States

As a result of the Clean Air Act, atmospheric deposition of SO42- has declined significantly across the northeastern U.S. The acid-base status of many surface waters across the northeastern U.S. has significantly improved in response to these decreases. The response of soil and surface waters to changes in atmospheric deposition also varies among different subregions due to the different atmospheric deposition rates, soils, land use and other characteristics. In this study, an integrated biogeochemical model (PnET-BGC) was applied to 145 DDRP (Direct/Delayed Response Program) watersheds across the northeastern U.S. to simulate the changes in soil and surface waters in response to changes in atmospheric deposition at the regional scale. Sites of this study span across the Adirondacks, northern Pennsylvania/Catskills, northern New England, southern New England and Maine. The model simulated surface water chemistry was validated against synoptic surveys in 1984 and 2001. Preliminary modeling results indicated that besides the spatial gradients in S deposition, other factors such as wetland retention, seasalt impaction, land use, surficial and bedrock geology affect spatial variability in lake SO42- concentrations. In response to changes in atmospheric deposition, changes in lake SO42- concentrations were affected by amount of changes in S deposition and the ability of watersheds to retain SO42-. For sites in the Adirondacks and southern New England region, model predictions of changes in acid neutralizing capacity were consistent with measured changes.

B32A-0368 1330h POSTER

Iron mobility in acidic and iron rich sediments: From chemical equilibrium to hydrological controls

Christian Blodau (49 921 552223; christian.blodau@uni-bayreuth.de)

Limnological Research Station University of Bayreuth, Universitaetsstrasse 30, Bayreuth 95444, Germany

Retention of ferrous iron at the interface between ground- and surface water is crucial for the acidity balance of lakes influenced by acid mine drainage. Iron budgets for two sediments with differential groundwater inflow (ca. 1 and 10 L m-2 d-1) were developed studying iron sedimentation, ground- and pore water chemistry, solid phase iron and sulfur chemistry and mineralogy, sulfate and iron turnover, and the corresponding Gibbs free energies of the latter processes. In both areas iron was sedimented as schwertmannite (Fe8O8(OH)x(SO4)y , 8-x = 2y, 1,0<x<1,75) at rates of 5.5-5.9 mmol m-2 d-1 leading to iron(III) enriched sediments (3.9-6.2 mmol g-1 dry weight). Compared to the surface water, the inflowing groundwater had higher pH (4.5 vs. 3), ferrous iron (6-20 mmol L-1 vs. 0.8-2.0 mmol L-1) and sulfate (5-60 mmol L-1 vs. 8-13 mmol L-1) concentrations. The inflow of the groundwater caused a change in sediment pore water chemistry and increased the pH to above 5.5. The pH increase was probably mostly due to decreased transformation rates of schwertmannite to goethite (0.27 mmol m-2 d-1 vs. 5.6 mmol m-2 d-1), also decreasing the production of H+ in the sediment. Compared to the control, in the area with groundwater inflow solid phase iron sulfide (0.011 mmol m-2 d-1vs. 0.0019 mmol m-2 d-1) and carbonate were formed at a higher rate, and more sulfate was reduced in incubation experiments. This finding can be explained by saturation indexes of siderite and sulfate reduction becoming thermodynamically more competitive by about 40 kJ eq-1 compared to iron reduction. However, only a small fraction of the reduced ferrous iron and sulfide was retained in the sediment, emphasizing the importance of reoxidation processes.

B32A-0369 1330h POSTER

Carbonate Dissolution and Precipitation in Coastal Environments

Brian Berkowitz[1] (972-8-934 2098; brian.berkowitz@weizmann.ac.il)

Olga Singurindy[1] (972-8-934 4226; olga.singurindy@weizmann.ac.il)

Robert P Lowell[2] (404-894-9472; bob.lowell@eas.gatech.edu)

[1]Weizmann Institute of Science, Department of Environmental Sciences and Energy Research, Rehovot 76100, Israel

[2]Georgia Institute of Technology, School of Earth and Atmospheric Sciences, Atlanta, GA 30332-0340, United States

In order to better understand and quantify mixing-driven mineral precipitation and dissolution in coastal environments, we conducted laboratory experiments designed to investigate dissolution and precipitation of $CaCO_3$ upon mixing between carbonate-saturated fresh- and salt-water solutions under different CO_2 partial pressures, and for different mixing ratios. Mixing of seawater or saline subsurface water with fresh water can be of major importance in the chemical diagenesis of carbonate rocks and sediments. We used both artificial seawater and NaCl solutions of different strengths. Two-dimensional flow cells filled with glass beads and crushed calcium carbonate rock were used, respectively, to measure calcium carbonate precipitation and dissolution. An important feature of these experiments is that the results are shown to agree well with a relatively simple transport theory describing mineral precipitation and dissolution that results from the non-linear dependence of $CaCO_3$ saturation upon electrolyte concentration. The theory demonstrates that the rate of dissolution or precipitation depends linearly on the dispersivity, specific discharge, and curvature (and sign) of the solubility as a function of salinity, but varies as the inverse square of the mixing zone width. The theory is largely scale independent and depends upon field parameters that can be determined. Analysis of data from three field sites (Yucatan peninsula, Bermuda, Mallorca) demonstrates excellent agreement between field observations and theory.

B32A-0370 1330h POSTER

Hydrocarbon Intrusion From Contaminated Seawater Into Coastal Freshwater Aquifers

Tal Amitay[1] (972-8-934-2542; tal.amitay@weizmann.ac.il)

Ishai Dror[1] (972-8-934-4230; idror@weizmann.ac.il)

Brian Berkowitz[1] (972-8-934-2098; brian.berkowitz@weizmann.ac.il)

[1]Weizmann Institute of Science, Department of Environmental Sciences and Energy Research, Rehovot 76100, Israel

We focus on a recently recognized mechanism which suggests the potential for significant intrusion of organic contaminants from polluted seawater to freshwater aquifers. The solubility of organic compounds in water is inversely related to the concentration of dissolved electrolytes and directly related to the activity coefficients. The solubility of organic molecules is therefore assumed to be very low in marine environments, and the possible contamination of coastal aquifers via transfer from sea water has been ignored so far. This is despite the fact that coastal marine environments may be highly contaminated by toxic organic chemicals. In fact, concentrations of organic pollutants may be much higher than expected only from theoretical considerations of solubility. This is because the total concentration of organic contaminants contained in seawater is given not only by the dissolved contaminant concentration, but also by the presence of mechanically-dispersed organic droplets. Our initial work suggests the existence of a "salt pump" mechanism: while migration of organic compounds is due to chemical gradients, it is significantly enhanced by the presence of salt. Results from laboratory experiments demonstrating the intrusion of hydrocarbon mixtures from contaminated saline water into fresh water are presented.

B32A-0371 1330h POSTER

Transformation of Chlorinated Persistent Organic Pollutants in Groundwater Using Sol-Gel Immobilized Metalloporphyrins

Dana Baram[1] (972-8-934-2542; dana.baram@weizmann.ac.il)

Ishai Dror[1] (972-8-934-4230; idror@weizmann.ac.il)

Brian Berkowitz[1] (972-8-934-2098; brian.berkowitz@weizmann.ac.il)

[1]Weizmann Institute of Science, Department of Environmental Sciences and Energy Research, Rehovot 76100, Israel

We demonstrate the ability of metalloporphyrins, immobilized in sol-gel matrices, to catalytically reduce chlorinated persistent organic pollutants (CPOP) under conditions pertinent to groundwater systems. A large body of information accumulated over the last two decades indicates that chlorinated organic compounds released to the environment have caused considerable damage to ecosystems and to humans. A particularly major concern is contamination of groundwater sources. An important approach to detoxification of CPOP is based on utilization of metalloporphyrins as electron transfer mediators in dechlorination reduction processes under anaerobic conditions. Previous studies have shown that immobilized transition metal macrocycles, formed by intercalation in layered minerals, have in some cases catalyzed electron-transfer-mediated reactions. Such processes provide insight into reactions that can be expected in natural biogeochemical systems. Preliminary results indicate the existence of a reduction process in such systems. Several pollutants, such as PCE and TCE, were transformed into less toxic, nonchlorinated compounds after their exposure to immobilized metalloporphyrins under reducing conditions.

B32A-0372 1330h POSTER

The Role of Sorption in Retention of Dissolved Organic Carbon in Soils Typical of the Lowland Amazon Basin

Sonya M Remington[1] (206 300-1132; sunny9@u.washington.edu)

Vania Neu[2] (bioneu@inpa.gov.br)

Jeffrey Richey[1] (jrichey@u.washington.edu)

[1]University of Washington, School of Oceanography Box 355351, Seattle, WA 98195, United States

[2]CENA - Universidade de Sao Paulo, Av. Centenario, 303, Piracicaba, SP 13400-970, Brazil

The overall question we are addressing is: What role does the evasion (out gassing) of CO_2 from the river system to the atmosphere play in the carbon cycle of moist tropical forests? Recent evidence suggests that the Amazon may be a net sink of atmospheric CO_2 of 1-9 Mg C ha^{-1} y^{-1}. We have made recent calculations that suggest that the evasion of CO_2 from the river system of the central Amazon basin is on the order of 1.2 $\pm$ 0.3 Mg C ha^{-1} y^{-1}. A flux of this magnitude suggests that the ecosystem processes involved in river corridors represent a significant pathway for the export of carbon fixed on land in the humid tropics at a globally significant level. The quantity of dissolved CO_2 (pCO_2) in surface waters of tropical river systems is the product of a long sequence of complex biological, hydrological and geochemical processes. Sorption is an important geochemical process that removes dissolved organic carbon (DOC) from water percolating through soils, which may eventually flow into the river channel (via groundwater and subsurface flow) where it may be respired to CO_2. Soil properties, such as texture, Fe- and Al-oxide content, mineral surface area and soil organic carbon content, are known to affect the concentration of DOC in soil pore water and, therefore, the quantity of DOC transported to river channels. These soil properties vary with soil type. We collected samples from two depths of three different soil types typically found in the lowland Amazon basin for use in equilibrium and kinetic laboratory "batch" experiments, and for analysis of soil properties. We examined relationships between sorption and soil properties in an attempt to estimate the quantity of DOC sorbed based on soil type. Finally, we compared the results of the laboratory experiments to field data. Explaining and quantifying DOC lost to sorption as a function of soil properties is an important step in understanding the export of carbon fixed on land and transported to rivers.

B32A-0373 1330h POSTER

Chromate [Cr(VI)] Reduction Kinetics With *Shewanella oneidensis* MR-1

Sridhar Viamajala[1] ((509) 335-7417; vsridhar@mail.wsu.edu)

Brent M Peyton[1] (bmp@wsu.edu)

James N Petersen[1] (jnp@wsu.edu)

William A Apel[2] (WAA@inel.gov)

[1]WSU/NSF IGERT Center for Multiphase Environmental Research, Department of Chemical Engineering, Washington State University, P.O. Box 642170, Pullman, WA 99164-2710, United States

[2]Biotechnology Department, Idaho National Engineering and Environmental Laboratory, P.O. Box 1625, Idaho Falls, ID 83415-2203, United States

Microbial transformation of Cr(VI) to Cr(III) is a potential technology for remediating sites contaminated with Cr(VI) since chromium, in the trivalent form, is much less soluble, mobile and toxic compared to its hexavalent form. For the successful implementation of this technology, it is important to understand the kinetics of the biotransformation, microbial physiological conditions that enhance or decrease the reaction rate as well as the influence of other in-situ contaminants on kinetics. In the present study, using the well-known metal reducing bacterium *Shewanella oneidensis* MR-1 as a model microorganism, kinetic studies on Cr(VI) reduction were performed under anaerobic conditions with MR-1 grown on fumarate and nitrate as terminal electron acceptors. In addition, inhibition of Cr(VI) reduction rates was studied in the presence of nitrite, which is a potential co-contaminant present in Cr(VI) contaminated sites. Inhibition kinetic studies showed that Cr(VI) reduction is carried out by multiple mechanisms working in parallel and that some of these mechanisms are dependent on the physiological growth conditions of the culture. Based on this hypothesis of multiple Cr(VI) reduction mechanisms in MR-1, a dual enzyme model was developed to describe the kinetics of Cr(VI) reduction by two parallel mechanisms - (1) a rapid Cr(VI) reduction mechanism that was deactivated (or depleted) quickly and (2) a slower mechanism that had a constant activity and was sustainable for a longer duration. Kinetic parameters were estimated by fitting experimental data, and model fits were found to correspond very closely to quantitative observations of Cr(VI) reduction by MR-1.

B32A-0374 1330h POSTER

The Effect of Ion Adsorption on Microbial Dissimilatory Iron-Reduction and the Mobility of Adsorbed As(V)

Brent A Meyer[1,2] (775 747-5197; bmeyer@unr.edu)

Lisa L Stillings[1,2] (stilling@usgs.gov)

[1]Dept. of Hydrologic Sciences, University of Nevada, Reno MS 175, Reno, NV 89557, United States

[2]U.S. Geological Survey, MS 176 University of Nevada, Reno, Reno, NV 89557, United States

The effect of varying environmental conditions on the microbial reduction of Fe(III) and the mobility of adsorbed As(V) was investigated by studying the kinetics of reductive dissolution of synthetic, hydrous ferric oxide (HFO) in three batch-reactor experiments. Growth medium, containing HFO as an electron acceptor (EA) and acetate as an electron donor (ED), was dispensed into 500-ml septum sealed serum bottles. Each bottle was inoculated with an enrichment culture (MEC) containing an anaerobic Fe-reducing bacterium obtained from sediments at Milltown Reservoir near Missoula, MT. Each enrichment culture grew for at least 600 hrs and exhibited both exponential and stationary growth. Microbial reduction was monitored by measuring the production of dissolved Fe(II). Total Fe(II) was calculated by applying a Langmuir adsorption model, developed for each growth condition, to the measured dissolved Fe(II). Total Fe(II) production was modeled by: $x = X_s(1\text{-}e^{-ket})\text{-}[k_L(e^{-ket})]+(k_L/k_e)$ where x is the total Fe(II) concentration (mM) at t, k_e is the exponential production rate constant (hr^{-1}), X_s is the total Fe(II) concentration (mM) at the time of transition between exponential and stationary growth, t is the time since inoculation minus lag time, and k_L is the stationary (linear) production rate constant (mM hr^{-1}). From our experiments we learned that: 1) increasing the concentration of EA from 10-30 mM had no effect on the value of k_e, which remained constant at 0.015 hr^{-1}. However, the maximum production rate, $R_{max} = (k_e\ X_s)+k_L$, did increase with increasing EA, varying from 0.014-0.031 mM hr^{-1}; 2) increasing the concentration of ED from 10-30 mM had no effect on either k_e or R_{max}. These values remained constant as ED increased; 3) sorption of As(V) to the EA (in mM ratios of 1:10 and 1:30, As(V):HFO) affected R_{max} but not k_e. R_{max} increased with increasing EA, as observed earlier, but its value was lower than in cultures without arsenic. In the presence of As(V), R_{max} was unaffected by increasing ED. Microbial reduction of EA did not result in the release of aqueous As(V) or As(III). In all cases, representative blank and kill controls were run concurrent with growth experiments. No Fe(II) production was observed in the controls. The modeling method showed that increases in R_{max}, when observed, were due to an elongated exponential growth phase. We conclude that the availability of surface sites to the culture is the controlling factor in microbial iron reduction. The length of the exponential growth phase depends on the concentration of surface sites available for microbial reduction. Adsorbed Fe(II) or As(V) inhibits reduction by decreasing the concentration of available surface sites. Likewise, increasing the initial concentration of EA increases the concentration of available surface sites thus increasing R_{max}.

B32A-0375 1330h POSTER

Framework for Numerical Simulation of Bacterial Fe(III) Oxide Reduction in Circumneutral Soil and Sedimentary Environments

Eric E Roden[1] (205-348-0556; eroden@bsc.as.ua.edu)

Eva Sedo[1] (205-348-1813; sedo001@bama.ua.edu)

[1]The University of Alabama, Department of Biological Sciences, Tuscaloosa, AL 35487-0206, United States

Studies of synthetic and natural Fe(III) oxide reduction by pure cultures of the dissimilatory Fe(III)-reducing bacteria (FeRB) Shewanella putrefaciens and Geobacter sulfurreducens have been used to develop a framework for numerical simulation of bacterial Fe(III) oxide reduction in circumneutral soil and sedimentary environments. Experimental data show that surface area-normalized rates of electron transfer to Fe(III) oxides are comparable (in the presence of excess electron donor) across a wide range of oxide crystal structure and surface area. These results suggest a rate model in which enzymatic electron transfer is directly dependent on the abundance of reducible oxide surface sites. Studies of the influence of FeRB density on rates of oxide reduction kinetics demonstrate a hyperbolic relationship between total cell density and surface-area normalized reduction rate; additional experiments to assess the relationship between reduction rate and the abundance of FeRB attached or adhered to oxide surfaces are underway. The results of these studies, together with data on FeRB growth yield, provide information required for simulation of oxide reduction kinetics in nonsteady-state systems in which FeRB cell density varies over time. Finally, previous and ongoing studies of Fe(II) sorption to residual Fe(III) oxide and other mineral surfaces during enzymatic reduction permit development of a semi-empirical, reaction-based approach for depicting the influence of surface-bound Fe(II) accumulation on long-term oxide reduction kinetics. The developed model accurately reproduces the results of batch and column studies of synthetic and natural Fe(III) oxide reduction, and can be used to assess the impact of field-scale physical and/or chemical heterogeneity on spatial and temporal patterns of bacterial Fe(III) oxide reduction.

B32A-0376 1330h POSTER

Temperature Acclimation in the Terrestrial Biosphere and Implications for Global Climate-Carbon Cycle Feedbacks

Anthony W King[1] (865-576-3436; kingaw@ornl.gov); Wilfred M Post[1] (postwmiii@ornl.gov); Stan D Wullschleger[1] (wullschlegsd@ornl.gov); Lianhong Gu[1] (lianhong-gu@ornl.gov); David J Erickson[2] (ericksondj@ornl.gov); Starley L Thompson[3] (thompson59@llnl.gov)

[1]Environmental Sciences Division Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831, United States

[2]Cpmputer Science and Mathematics Divison Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831, United States

[3]Atmospheric Science Lawrence Livermore National Laboratory, 7000 East Avenue, Livermore, CA 94550, United States

Simulations with general circulation models that include an interactive global carbon cycle indicate a positive feedback between climate change and atmospheric CO_2 concentration. Both future climate change and CO_2 concentrations are higher in the coupled climate-carbon cycle simulations than in simulations without the coupling. Most of the increase in CO_2 concentration can be attributed to terrestrial biospheric response to changes in climate, with increases in ecosystem respiration in response to increasing temperature being a major factor. However, these simulations do not allow for ecosystem acclimation to warmer temperatures. Field and laboratory observations show that plants and microbial communities often respond (i.e., acclimate) to elevated temperatures with a decline in the rate at which respiration increases with temperature. For the same change in temperature, respiration with acclimation is lower than respiration

without acclimation. Thus temperature acclimation of ecosystem respiration will tend to reduce the magnitude of the climate-carbon cycle feedback. We are investigating the implications of temperature acclimation for climate-carbon cycle feedbacks in coupled climate-carbon models. We identified alternative temperature acclimation responses supported by empirical evidence for both autotrophic (plant) R_a and heterotrophic (microbial) respiration R_h. We implemented these responses in a global terrestrial biogeochemsitry model (GTEC 2.0) and an global integrated terrestrial biosphere model (IBIS 2.5). We present simulations of CO_2 released in ecosystem respiration in response to future climate change simulated by a general circulation model (PCM). Our results raise scientific questions about the rates at which acclimation occurs and the form of temperature response functions. However, they also suggest that acclimation or other differences in temperature dependencies may not be significant in coupled climate-carbon simulations. Rather, dramatic feedbacks in the form of large modeled carbon releases in R_h may indicate extreme temperature increases, catastrophic ecosystem failure, or anomalous accumulation of terrestrial carbon stocks. The choice of temperature dependency should carefully consider temperature response in the range of historically prevailing temperatures. Functional differences in the range of 10-35 C are likely more important than differences under warmer, but rarely experienced, conditions. Differences in how carbon stocks are modeled will also influence model response to temperature, often mitigating differences in temperature dependency. Zero-order models of decomposer respiration will likely show more sensitivity to temperature dependency than first-order models. Model response will also vary in important ways with differences in the partitioning of total soil organic carbon among various soil carbon pools.

B32A-0377 1330h POSTER

Tidal Pumping and the Fate of Wastewater Nutrients in the Florida Keys

Matthew Bachmann[1] (mbachmann@geosc.psu.edu)

Lee Kump[1] (kump@geosc.psu.edu)

[1]Department of Geosciences, The Pennsylvania State University, Deike Building, University Park, PA 16802, United States

Nutrient-rich wastewater from injection wells in the Florida Keys has been implicated in the eutrophication of coastal waters and, through long-distance subsurface transport, the degradation of offshore coral reefs. The flowpath of such wastewater in the saline aquifer system of the Keys is determined not only by the local geology, but more significantly by the differential hydraulic head applied by the two distinct tidal signals on either side of the island chain. While the Atlantic Ocean to the south exhibits typical oceanic tides, the constrained Florida Bay tidal signal to the north is significantly damped as compared to the oceanic tide and has a higher mean value. This system of tides presumably results in a reversing groundwater flow regime in which wastewater plumes are tidally pumped across the Keys with net flow to the Atlantic Ocean the "tidal pumping mechanism" of Halley et al., 1997, Develop. Sedimentol. 54: 217-248. We have performed a quantitative analysis of the tidal pumping mechanism using FEFLOW, a commercially available 3-dimensional finite-element model designed to simulate variable density flow and reactive contaminant transport. We find that the tidal-pumping mechanism does indeed influence the transport of wastewater plumes in the subsurface. However, the buoyancy of the low-salinity wastewater plume dominates transport when injection volumes are large, bringing wastewater to the surface in the near-vicinity of injection and discharging it to nearby canals or coastal zones. Discharging wastewaters have variably reduced nutrient loads depending on travel times (for nitrate) and pathlengths (for phosphate) because of biogeochemical transformation in the subsurface (denitrification and adsorption/precipitation, respectively). The interface between nitrate-rich wastewaters and sulfide-rich groundwaters may be supporting a chemoautotrophic bacterial community in the bedrock of the Florida Keys.

B32B MCC: Level 1 Wednesday 1330h

The Bioatmospheric N Cycle: Emissions, Deposition and Interactions II Posters *(joint with A, H, OS, AE)*

Presiding: **A Mosier,** USDA Agricultural Research Service**; D Ojima,** Natural Resource Ecology Laboratory, Colorado State University**; S B Weiss,** Creekside Center for Earth Observations**; E Holland,** National Center for Atmospheric Research

B32B-0378 1330h POSTER

Impact of Tillage, Crop Sequence and N-fertilization on Trace Gas Exchange in an Irrigated Agroecosystem in Northeastern Colorado

Arvin R. Mosier[1] (970-490-8250; amosier@lamar.colostate.edu)

Ardell D. Halvorson[1] (970-490-8230; adhalvor@lamar.colostate.edu)

[1]USDA/ARS, 301 S. Howes P.O. Box E, Fort Collins, CO 80522

A long-term study was initiated in 1999 to investigate the potential of no-till cropping systems to sequester CO2 while maintaining crop production in irrigated agriculture in northeastern Colorado. As the impact of agricultural management changes on trace gas fluxes are not well understood, we began measuring the soil-atmosphere exchange of CO2, CH4 and N2O during the spring of 2002. Fluxes were measured, using vented chambers, one to three times per week, year round, within plots that are continuously cropped to corn under conventional plow tillage (CT), within no-till continuous corn plots (NT), and within a NT corn-soybean rotation. Plots were fertilized at planting with rates of 0, 134 and 202 kg N ha-1. In 2002, all plots in which trace gas fluxes were measured were cropped with corn that was planted on April 26 and harvested on November 5, 2002. From planting until early April 2003 no tillage or N-fertilization effects on CH4 flux were observed, with the soil serving as a small CH4 source during the irrigation season and a small sink during the winter. Converting to NT did not increase N2O emissions while N2O emissions increased in response to fertilizer N supply. N2O emissions were higher in plots that had been cropped to soybeans the year before. On January 2, 2003 the CT plots were plowed. Even though soil temperature was near zero oC, CO2 fluxes averaged 33+/-5 mg C m-2 hr-1 in CT plots compared to 4.8+/-1.4 in NT plots the day after plowing. The first year of trace gas flux measurements suggest that converting conventionally plowed soils to no-till decreases soil CO2 loss and does not increase N2O or CH4 flux.

B32B-0379 1330h POSTER

Methane Consumption and Production in Desert Ecosystems Experiencing Mesquite Invasion and Control

Jean E.T. McLain[1] (520-670-6381, ext. 138; jmclain@tucson.ars.ag.gov)

Dean A. Martens[1] (520-670-6381, ext. 156; dmartens@tucson.ars.ag.gov)

[1]USDA-ARS, Southwest Watershed Research Center, 2000 E. Allen Road, Tucson, AZ 85719, United States

We are studying the influences of vegetation change on soil fluxes of methane (CH_4) in semi-arid ecosystems. Soils under the natural grass vegetation are a strong sink of atmospheric CH_4 year-round, consuming -35.1 $\pm$ 8.3 μg CH_4 m^{-2} h^{-1} during the monsoon summer and -24.3 $\pm$ 11.2 μg CH_4 m^{-2} h^{-1} during winter, but consumption falls to near zero in June. The depth of maximum CH_4 oxidation varies during the year, corresponding to the presence or absence of surface soil moisture. Invasion of mesquite (*Prosopis* spp.) significantly ($p < 0.001$) reduces the monsoon CH_4 oxidation (-24.4 $\pm$ 8.3 μg CH_4 m^{-2} h^{-1}), possibly due to the formation of a moist litter layer impeding CH_4 diffusion into the soil surface or from ammonium inhibition from the N-rich mesquite litter. CH_4 consumption is equally high in mesquite and grassland during the winter. Historically, ranchers have attempted to control invasion of mesquite onto grazing lands. Our work indicates that mesquite eradication may result in pockets of strong CH_4 production (42.3 $\pm$ 17.6 μg CH_4 m^{-2} h^{-1}) as the mesquite trunk and roots decay. Pool dilution experiments with $^{13}CH_4$ are being performed to ascertain if CH_4 production is from soil methanogens or from termites. This work, when coupled with ecosystem C and N inventories and quantification of net N_2O and CO_2 respired, will help determine the potential for vegetation management in semi-arid ecosystems to mitigate or force potential climate change.

B32B-0380 1330h POSTER

N2O, NO, CO2 and CH4 emissions from Chinese cabbage residues addition in a Japanese Andosol as affected by different soil moisture

Weiguo Cheng[1] (81-29-838-8231; cheng@niaes.affrc.go.jp)

Haruo Tsuruta[1] (htsuruta@xd6.so-net.ne.jp)

Kazuyuki Yagi[1] (81-29-838-8231; kyagi@affrc.go.jp)

[1]National Institute for Agro-Environmental Sciences, 3-1-3, Kannondai, Tsukuba, Iba 305-8604, Japan

It is considered that incorporated crop residues to soil not only affect soil fertility, but also contribute greenhouse gases (N2O, CO2 and CH4) emissions. A laboratory incubation experiment was conducted to examine the effects of Chinese cabbage residues addition and soil moisture on N2O, NO, CO2 and CH4 emissions form Japanese Andosol. Six treatments were designed by residue factors in 2 levels (with and without residue addition) and soil moisture factors in 3 levels (40, 60, and 80% of water filled pore space (WFPS)). Amount of added residues was 0.543% (w/w) of dry soil, equivalent to 200 mg N/kg soil addition. Gas sampling for N2O, NO, CO2 and CH4 fluxes was carried out two or three times a week, and soil sampling for soluble C, NH4, NO3 and extractable organic N measurements was taken up every week during 85 days incubation at 25oC. The results showed that amounts of residue-derived N2O emitted from 40, 60 and 80% WFPS soil moisture conditions were 0.014, 0.019 and 2.86%, respectively, of residue addition N. Residue-derived N2O emitted from 80% WFPS soil moisture condition was 204 and 151 times higher than that from 40 and 60%. NO emissions were only detected in early period of incubation at all treatments. The amounts of residue-derived NO emitted from 40, 60 and 80% WFPS were 0.13, 0.06 and 0.04%, respectively, of residue addition N. The amounts of residues-derived CO2-C were accounted for 29.36, 33.91 and 44.79%, respectively, of the residue addition C from 40, 60, and 80% WFPS soil moisture conditions. CH4 fluxes results indicated that CH4 oxidation was found in all treatments. Calculated global warming potential (GWP) from CO2, CH4 and N2O emission rates during 85days incubation showed that GWP were 3.02 and 2.62 times higher in 80% WFPS soil moisture condition than that in 40 and 60%, because a large amount of residue-derived N2O emitted from 80% WFPS moisture condition.

B32B-0381 1330h POSTER

Effects of Nitrogen Fertilization and Elevated [CO_2] on Wetland Biogeochemistry

Seon Young Kim[1] (82-2-3277-3748; ecosun0@hotmail.com)

Hojeong Kang[1] (82-2-3277-3916; hjkang@ewha.ac.kr)

[1]Department of Environmental Science and Engineering, Ewha Womans University, 11-1 Seodaemoongu, Seoul 120-750, Korea, Republic of

Effects of nitrogen (N) fertilization and elevated [CO_2] on plant growth, microbial activity, and emission of greenhouse gases were assessed using wetland plants (7 species) grown with 2 levels of nitrogen and 2 levels of CO_2 in growth chambers. After 110 days, N fertilization increased shoot biomass by 12.6 $\sim$ 105.0 %, whereas such response was absent for root growth (P>0.1). Elevated [CO_2] increased shoot length, but responses to shoot and root biomass were species-specific. Arylsulfatase, β-glucosidase, *N*-acetylglucosaminidase activities in soil were increased by elevated [CO_2], but reduced enzyme activity under N fertilization was observed. Both N fertilization and elevated [CO_2] increased the quantity of phenolic material and dissolved organic carbon (DOC) in soil. We found elevated [CO_2] decreased soil respiration, while nitrogen enrichment led to an increase of soil respiration. CH_4 emission exhibited no general trends for each treatment or plant species. However, CH_4 emission of *phragmite communis* under elevated [CO_2] was significantly higher (29.5 μmol kg^-) than that of control (2.3 μmol kg^-).