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

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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

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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

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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

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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

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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^{-}).

B32B-0382 1330h POSTER

Dissolved Nitrogen and Phosphorus Export to the Coastal Zone: Early Results From a Global, Multi-element, Multi-form Modeling Approach

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In watersheds, spatial variation in nutrient sources and sinks results in spatial variability of nutrient export ratios and nutrient forms, with important implications for estuarine ecosystem response. However, past attempts to model global or regional nutrient exports to the coastal zone in a spatially explicit manner have focused on just one element at a time, and have generally ignored nutrient form. A new modeling initiative, Global NEWS (Global (N)utrient (E)xport from (W)ater(S)heds), constitutes the first attempt to develop an internally consistent, spatially explicit estimate of coastal nutrient loading by multiple elements (N, phosphorus (P), C, and silica (Si)) and multiple element forms (Particulate N, P, C, and Si, dissolved inorganic N, P, and Si, and dissolved organic N, P, and C). Early model results indicate significant regional differences in form and amount of nutrients exported. In this presentation we focus on Global NEWS-based estimates of coastal dissolved inorganic and organic N (DIN and DON) and dissolved inorganic P (DIP) loading, and on how DIN:DIP and DIN:DON ratios both vary by region and are influenced by human, edaphic, biotic, and climatic factors. Early model results are consistent with the hypothesis that DIN exports constitute the majority of dissolved N export from regions with heavy human influence while DON dominates the dissolved N exported from regions with relatively little human influence. Model results also show a strong correlation between DIN and DIP export ($R^2 = 0.67$).

B32B-0383 1330h POSTER

Influence of Plant and Microbial Interactions on Nitrogen Retention and Loss in Puerto Rican Forest Soils

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Understanding nitrogen (N) retention mechanisms in tropical forests is important because these systems currently have high potential for N losses. They have the greatest nitrous oxide flux compared to other ecosystems and often exhibit large nitrate losses to groundwater. A significant amount of research on N biogeochemistry has been conducted in north temperate ecosystems where N limitation to net primary productivity (NPP) is common, and where anthropogenic N deposition is altering N cycling. Much less research has been conducted in the tropics, which are generally characterized by rapid rates of N cycling and the lack of strong N limitation to NPP. We conducted a field experiment using ^{15}N tracers and root ingrowth cores to compare and contrast the relative importance of N loss pathways (denitrification, nitrous oxide production via nitrification, and N leaching) versus N retention mechanisms (dissimilatory reduction of nitrate to ammonium (DNRA) and assimilatory N uptake by plants and soil microbes) in a subtropical forest in Puerto Rico. DNRA rates were detectable and within a range comparable to gross mineralization and gross nitrification. Plant roots at all sites took up significantly greater amounts of N as ammonium than nitrate and were a relatively strong sink for N as indicated by the relatively large amount of ^{15}N that they took up. This supports our hypothesis that DNRA is a N conserving mechanism within tropical forests because the ammonium that is produced from this process is likely to be taken up by plants rather than re-nitrified and potentially leached or lost as nitrous oxide gas from the ecosystem.

B32B-0384 1330h POSTER

Declines in Soil pH due to Anthropogenic Nitrogen Inputs Alter Buffering and Exchange Reactions in Tropical Forest Soils

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Anthropogenic nitrogen (N) inputs may alter tropical soil buffering and exchange reactions that have important implications for nutrient cycling, forest productivity, and downstream ecosystems. In contrast to relatively young temperate soils that are typically buffered from N inputs by base cation reactions, aluminum reactions may serve to buffer highly weathered tropical soils and result in immediate increases in aluminum mobility and toxicity. Increased nitrate losses due to chronic N inputs may also deplete residual base cations in already weathered base cation-poor soils, further acidify soils, and thereby reduce nitrate mobility through pH-dependent anion exchange reactions. To test these hypotheses, I determined soil pH and cation and anion exchange capacity (CEC and AEC) and measured base cation and aluminum soil solution losses following first-time and long-term experimental N additions from two Hawaiian tropical forest soils, a 300 year old Andisol and a 4.1 million year old Oxisol. I found that elevated base cation losses accompanied increased nitrate losses after first time N additions to the young Andisol whereas immediate and large aluminum losses were associated with increased nitrate losses from the Oxisol. In the long-term, base cation and aluminum losses increased in proportion to nitrate losses. Long-term N additions at both sites resulted in significant declines in soil pH, decreased CEC and increased AEC. These results suggest that even chronic N inputs resulting in small but elevated nitrate losses may deplete residual base cations, increase mobility and toxicity of aluminum, and potentially lead to declines in forest productivity and acidification of downstream ecosystems. These findings also suggest that AEC may provide a long-term mechanism to delay nitrate losses in tropical forests with significant variable charge that are experiencing chronic anthropogenic N inputs.

B32B-0385 1330h POSTER

Nitrogen Oxide Trace Gas Efflux and Soil N Dynamics in Response to N Inputs in Temperate Forests of the Northeastern U.S.

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Forests in the northeastern U.S. continue to receive elevated inputs of nitrogen (N) in the form of atmospheric deposition. N deposition rates in this region have remained essentially constant over the past decade. Persistent N inputs to temperate forests may have impacts on local water quality, regional air quality, and the capacity of forest productivity to increase in response to increasing atmospheric carbon dioxide. Responses that become evident at the ecosystem scale may be traceable to process-level alterations in N cycling within the forest soil. During 2000 - 2001, we measured soil N cycling rates and soil-to-atmosphere exchange of N oxide trace gases at five forest sites situated along a gradient in atmospheric N deposition from West Virginia to Maine. Four of the five sites were located within long-term N addition studies. The most consistent response was an elevation in soil nitric oxide (NO) emissions, which we measured using closed-chambers. We found evidence that differences in predominant forest vegetation and/or land-use history may have resulted in differential responses with respect to NO emissions and also enhanced rates of gross and net nitrification. The data also supported the idea that atmospheric deposition of N and acidity may both combine synergistically to promote elevated rates of NO emissions due to a sequence of soil biotic and abiotic reactions.

B32B-0386 1330h POSTER

Long-term Trends in Soil CH_4 Consumption at the Harvard Forest Chronic Nitrogen Addition Experiment: Implications for the Future Growth in Atmospheric CH_4.

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For the past 15 years we have been conducting a field experiment designed to examine the short- and long-term effects of chronic N additions to temperate forests on a number of biogeochemical processes including soil CH_4 consumption. The N additions were begun in 1988 in a 50+ year-old mixed hardwood stand and a 70+ year-old red pine plantation. Nitrogen was applied as NH_4NO_3 at annual rates of 0, 50 and 150 kg N/ha over the six- month growing season. Forests in this region receive about 8 kg N/ha/yr from dry and wet deposition. During the first year of treatment we observed an immediate decrease in the rate of soil consumption of atmospheric CH_4 of about 23% in all of the amended plots compared to the controls. Over the next four years the overall decrease in consumption stabilized at about 36% and 62% in the hardwood and pine high N plots, respectively. We re-measured the consumption rates at these sites in 2003, after 15 years N addition. Preliminary results indicate that consumption rates have not remained constant at the levels measured in 1993, but have continued to decrease dramatically in all treatments. The greatest change was in the high N pine plot where the consumption rate was reduced by 82%, while the rate in the low N plot was reduced by 59%. The hardwood plots showed a similar pattern with a reduction in the rates in the low and high N plots by 39% and 63%, respectively. These findings are consistent with CH_4 consumption measurements in forests that have high N deposition rates in the United States and Europe. These results have important long-term implications for the CH_4 consumption capacity of temperate forest soils. It appears that even moderate levels of chronic N deposition may diminish the potential for these soils to slow the future growth in atmospheric CH_4.

B32B-0387 1330h POSTER

DAYCENT Simulated Greenhouse Gas Fluxes for the US Agricultural Sector Under Current and Improved Land Management

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Agricultural soils are major sources of N2O and CH4, two important non-CO2 greenhouse gases, and can be sources or sinks of CO2. Conversion of native soils to cropping usually results in net CO2 emissions from soil but enhanced crop production resulting from irrigation and fertilization can sequester CO2 in soil organic matter in areas that were C depleted after decades of dryland agriculture. Although irrigation and fertilizer addition often lead to C storage in soils, these practices also increase net CH4 and N2O emissions. The DAYCENT ecosystem model was used to estimate net CO2, N2O, and CH4 fluxes form agricultural soils in the US under current and improved land use. Improved land use practices included conversion to no till cultivation and reduction of the summer fallow

period in regions dominated by dryland winter wheat cropping. These land use changes were implanted in regions in which they have been shown to be economically viable. Global warming potentials for N2O and CH4 and molecular stoichiometry were used to convert all fluxes into a common unit of CO2-C equivalents. Net GHG flux for the agricultural sector was estimated by summing the CO2-C equivalents for simulated CO2, N2O, and CH4 fluxes. The US was divided into 63 regions and a sufficient number of crop rotations within each region were simulated such that at least 85% of the area within each region was included. Simulated crop yields and N gas emissions were compared with field data and with gas fluxes estimated using IPCC emission factors.

B32B-0388 1330h POSTER

Controls on Gross Process Rates in Terrestrial Ecosystems: A Literature Synthesis

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Isotope pool dilution studies are increasingly reported in the soils and ecology literature as a means of measuring the gross rates of mineralization, nitrification, and inorganic N assimilation in soils. We assembled data on soils factors and gross rates from forest, grassland, and agricultural systems to attempt to answer three general questions, using regression and other analytical approaches. First, what factors appear to be the major drivers for production and consumption of inorganic N as measured by isotope dilution studies? Second, do rates, and the relationships between drivers and rates, differ among ecosystems? Finally, do methodological issues inherent to the isotope dilution technique affect results? Our review of the literature indicates the importance of soil C and N as primary drivers for mineralization. Nitrification rate is primarily driven by ammonium supply, but does not keep pace with mineralization to the same extent as heterotrophic uptake. While substrate supply generally determines gross production rates, differences in organic matter quality between ecosystem types also influences the production and fate of mineralized N. Soil organic matter from grassland sites appears to be inherently more mineralizable than that from wooded sites, while soil organic matter depletion in agricultural systems is an important determinant of gross process rates. The isotope dilution technique is a valid approach that produces results congruent with what we already know about N cycling, while extending and refining our knowledge of actual production rates and fates of mineralized N.

B32B-0389 1330h POSTER

Global Patterns in Dissimilatory Nitrate Reduction: A Latitudinal Gradient in Nitrogen Retention and Loss

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Increased nitrogen (N) deposition in humid environments has the potential to significantly increase nitrous oxide (N_2O) emissions via nitrification and denitrification. This potential N loss may be significantly offset by N retention from dissimilatory nitrate reduction to ammonium (DNRA). In this study, we report on rates of dissimilatory nitrate reduction to N_2O and ammonium along a latitudinal gradient from the tropics to the boreal forest. We conducted laboratory experiments with forest soils from Costa Rica, Puerto Rico, California, and Alaska to determine maximum potential rates of DNRA and N_2O production. We also conducted field experiments in Costa Rica, Puerto Rico, and Alaska to estimate in situ rates. Maximum potential rates of DNRA ranged from 10 ug/g/d in fertilized poplar forests in Alaska to 0.3 ug/g/d in unfertilized polyculture plantations in Costa Rica. At all sites, rates of DNRA appeared to be nitrate limited. On average, temperate and boreal forests had greater potential rates of DNRA (5 ± 1 ug/g/d) than tropical forests (3 ± 1 ug/g/d). Nitrogen fertilization significantly increased rates of DNRA in Alaska. Rates of maximum potential N_2O flux were generally lower than DNRA rates (0.16 to 4 ug/g/d). In field experiments, rates of DNRA were greatest in tropical rain forests in Puerto Rico, followed by wet forests in Costa Rica, and black spruce forests in Alaska. Although field DNRA rates were low in Alaska, they accounted for up to 13 % of gross mineralization and 24 % of gross nitrification. At all sites, rates of N_2O flux via denitrification and nitrification were significantly lower than N retention via DNRA. Our results suggest that this previously unmeasured N cycling pathway effectively competes with processes resulting in N-trace gas loss from a range of forested ecosystems.

B32B-0390 1330h POSTER

A coordinated approach to investigating human perturbations to the Nitrogen cycle

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Nitrogen is essential to the survival of all life forms yet the natural abundance of useable nitrogen is so low that massive human alteration of the nitrogen cycle has been required to sustain the feeding of the world's burgeoning population. The alteration has been made even greater by the release of nitrogen oxides to the atmosphere during fossil fuel combustion. Changes in the nitrogen cycle due to human action have exacerbated a number of environmental issues, including smog, acid deposition, climate change, coastal eutrophication, stratospheric ozone depletion, all of which have impacts on people and ecosystems on a regional or global basis. Because of the cascading nature of the effect's on nitrogen, understanding of the effects, their underlying causes and their interactions must be studied in an integrated fashion from both science and policy perspectives. Toward that end, a coordinated effort is being made to integrate the diverse scientific, policy, industrial, and other stakeholder communities in an "International Nitrogen Initiative" (INI) with the goal of placing the global community in a position to optimize nitrogen's beneficial role in sustainable food production and minimize nitrogen's negative effects on human health and the environment resulting from food and energy production. Preliminary results suggest that novel approaches to fertilizer application can have a profound effect on excess nitrogen that enters surface and ground water, and that eutrophication of lakes and the coastal zone can be ameliorated by more efficient practices. In addition, as the processes involved in denitrification are more fully understood, it is becoming possible to better assess the partitioning of nitrogen between the ground/surface water and the atmosphere. As the coordinated study of the nitrogen cycle progresses, the assessment of nitrogen fluxes will make it possible to develop region-specific solutions to local N-related environmental problems, and ultimately to apply the appropriate scientific, engineering, and policy tools to implement these solutions.

B32B-0391 1330h POSTER

Organic Nitrogen in Atmospheric Drops and Particles: Concentrations, (Limited) Speciation, and Chemical Transformations

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While quite a bit is known of the concentrations, speciation, and chemistry of inorganic forms of nitrogen in the atmosphere, the same cannot be said for organic forms. Despite this, there is growing evidence that organic N (ON) is ubiquitous in the atmosphere, especially in atmospheric condensed phases such as fog/cloud drops and aerosol particles. Although the major compounds that make up organic N are generally unknown, as are the sources of these compounds, it is clear that there are significant fluxes of ON between the atmosphere and ecosystems. It also appears that organic N can have significant effects in both spheres. The goal of our recent work in this area has been to better describe the atmospheric component of the biogeochemistry of organic nitrogen. Based on particle, gas, and fogwater samples from Northern California we have made three major findings: 1) Organic N represents a significant component, approximately 20%, of the total atmospheric N loading in these samples. This is broadly consistent with studies from other locations. 2) Amino compounds, primarily as combined amino acids, account for approximately 20% of the measured ON in our condensed phase samples. Given the properties of amino acids, these compounds could significantly affect the chemical and physical properties of atmospheric particles. 3) Organic nitrogen in atmospheric particles and drops is transformed to inorganic forms - primarily ammonium, nitrate, and nitrogen oxides (NOx) - during exposure to sunlight and/or ozone. These chemical reactions likely increase the bioavailability of the condensed phase nitrogen pool and enhance its biological effects after deposition to ecosystems.

B32B-0392 1330h POSTER

The Bio-atmospheric N Cycle: A Story of Multiple Element Interactions, N, C, S, Atmospheric Chemistry and the Climate System

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The bio-atmospheric N plays a key role in the climate system through regulation of atmospheric greenhouse concentrations, including nitrous oxide, carbon dioxide, methane, and tropospheric ozone, as well as impacting aerosol abundance. I will examine the evidence for including the full bio-atmospheric nitrogen cycle into earth system models. The most obvious is the impact of the bio-atmospheric nitrogen cycle on nitrous and nitric oxide emissions. Nitrogen deposition significantly impacts terrestrial carbon dioxide uptake, as well as influencing leaf level nitrogen concentrations that in turn impact stomatal conductance. The importance of this interaction has been recognized by the atmospheric chemistry community and a modeling project is underway to quantify and compare global estimates of N deposition, including ammonia(um) and NOy and its impact on the carbon cycle. Ammonia impacts sulfate aerosol abundance as well as reacting with nitrate form aerosols that act as cloud condensation nuclei to he potential to significantly impact the water cycle. The SRES emission projections and an accumulating body of evidence suggest that sulfur dioxide emissions will decline over the next century, while carbon and nitrogen emissions, carbon dioxide, methane, carbon monoxide, and VOCs, and NOx are all projected to continue to increase. The long-term goal is an Earth System model that allows examination of the complex interactions of biology, climate, atmospheric chemistry and humans.

B32B-0393 1330h POSTER

Plants Dominate Initial Sequestration of Excess Nitrogen in Alpine Tundra

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Despite recent interest in understanding the effects of nitrogen (N) deposition on alpine ecosystems, we lack key mechanistic understanding of what controls N retention and loss in these systems and how these processes will change with chronic N deposition. Research from forested ecosystems in the eastern United States and Europe that have received high levels of N deposition suggests that added nitrogen is initially sequestered in soil organic matter; yet, our data point to plants as the major initial, though likely ephemeral, N sink. This finding, along with others at our study site, implies that amount and timing of biological N uptake is likely to be a significant control over in the fate of increasing N inputs to alpine tundra. Therefore, changes in plant or microbial community composition resulting from N enrichment could exacerbate losses of N from the tundra. Clarifying the partitioning between biotic and abiotic sinks for N is essential to understanding terrestrial capacity for N sequestration, and for predicting

how continued N enrichment will influence future N uptake and loss from this system.

B32C MCC: 3014 Wednesday 1340h

The Effects of Forest Disturbance on Watershed Processes: Hydrology, Soils, Biota, and Water Chemistry *(joint with H, GC)*

Presiding: **M R McHale,** U.S. Geological Survey**; N Ohte,** Kyoto University

B32C-01 1345h INVITED

Effects of Forest Disturbance on Chronic and Episodic Hydrogeomorphic Processes

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Dominant hydrogeomorphic processes in forest environments differ in relation to climate and biogeography, but also with respect to location within drainage basins. For example, in steep headwaters, episodic geomorphic processes (e.g., landslides, debris flows) are typically the major supplier of sediment to streams, and sediment and woody debris are routed through steep channels by a combination of mass wasting and episodic fluvial processes. Tributary junctions play a key role in storing and releasing materials. In gentler reaches further downstream, such sediment and wood are typically supplied and transported by chronic processes such as surface wash, litter and tree fall, and bedload and suspended sediment transport. Additionally, subsurface flow processes often dominate in upper catchment reaches while saturated overland flow controls much of the storm runoff in lower reaches where riparian corridors are wide. Subsurface and surface hydrologic pathways are strongly affected by antecedent moisture, especially in steep headwaters. Thus, effects forest land uses, such as roads and trails, harvesting, and conversion to agriculture, exert different influences depending on when and where they occur within the catchment. Hydrogeomorphic responses to forest management in steep terrain are compared between temperate catchments, where sediment is supplied largely by landslides, and tropical catchments, where organic horizons are thin and surface erosion follows disturbance. Management effects on chronic versus episodic hydrogeomorphic processes are stressed, including feedback between these processes.

B32C-02 1405h INVITED

Effects of Harvesting Intensity and Herbivory by White-tailed Deer on Vegetation and Nutrient Uptake in a Northern Hardwood Forest

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We quantified the response of vegetation and nutrient uptake in a northern hardwood forest in southeastern New York for three to four years after three intensities of harvesting: clearcutting, heavy timber stand improvement (TSI), light TSI (97, 29, and 10% basal area reductions, respectively). We also quantified effects of white-tailed deer (*Odocoileus virginianus*) herbivory on nutrient retention by vegetation. Total biomass and nutrient accumulation in vegetation was higher after TSI than clearcutting in the first two years but was highest in the fenced clearcut in subsequent years, indicating that TSI or partial harvesting is a viable management tool for harvesting timber while consistently maintaining high rates of nutrient retention. After clearcutting, biomass and nutrient retention were initially dominated by woody stems <1.4 m tall and herbaceous vegetation, but saplings 0.1-5.0 cm DBH became the most important contributors to biomass and nutrient accumulation within four years. However, after both intensities of TSI, trees >5.0 cm DBH continued to account for most biomass and nutrient accumulation whereas understory vegetation accumulated little biomass or nutrients. Heavy TSI resulted in increased regeneration of only two tree species (*Acer pensylvanicum*, *Fagus grandifolia*), but clearcutting allowed these two species, mature forest species (*A. saccharum*, *Betula alleghaniensis*), and the early successional *Prunus pensylvanica* to regenerate. Several early successional shrub and herbaceous species were also important to nutrient retention after clearcutting, including *Polygonum cilinode*, *Rubus* spp., and *Sambucus racemosa*. Herbivory by white-tailed deer dramatically reduced biomass and nutrient accumulation by woody stems <5 cm DBH after clearcutting (5.5 vs. 0.7 Mg biomass/ha and 30.4 vs. 6.3 kg N/ha on fenced and unfenced clearcut sites, respectively, after four years), indicating the important influence this herbivore can have on nutrient retention in recently disturbed forests.

B32C-03 1425h

Biological and hydrological controls of streamwater nitrate concentration in a forested catchment with a natural disturbance

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In Matsu-zawa catchment, central Japan, nitrate concentrations in stream water increased following a small-scale, natural disturbance involving an outbreak of pine wilt disease that affected approximately 25 per cent of the forested catchment. In order to clarify controls of nitrogen dynamics in the soil and its relationship with stream water nitrate, we investigated soil nitrogen transformations and soil water chemistry in disturbed and undisturbed, water-unsaturated and -saturated plots. The highest values for nitrification rate, nitrate concentration in soil solution, and nitrate exported from the root zone were observed for the disturbed plot. The rate of nitrification in surface soil of the disturbed plot increased dramatically compared to prior to the disturbance. Root zone leachate from the disturbed area showed gradually increasing groundwater nitrate concentrations in the temporarily saturated zone during lateral, matrix flow. The catchment's deep soils and associated hydrologic processes limited the degree of plant uptake of the nitrate generated in the disturbed area. It was inferred that the persistent high levels of nitrate observed in the stream water resulted largely from the stable high nitrate concentrations observed in the saturated groundwater of this catchment. Stream water nitrate loads discharged following the disturbance were more than ten times greater than prior to it.

B32C-04 1440h

Upland wildfires and fluvial processes: the response of tree populations along a gravel-bed watershed in the Canadian Rocky Mountains.

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In order to better predict the influence of upland processes on watershed responses, we must first understand how forested systems change along drainage basins. Riparian vegetation studies tend to only consider fluvial disturbances to be of importance and ignore the impact of other disturbances, such as wildfires. This is partly due to the fact that riparian research typically only focus on high-order reaches, while little is known about larger, basin-scale processes. The objective of our research was to determine the relative importance of floods and fires on riparian forests along a drainage basin. The study was conducted along a gravel-bed river in a small mountainous watershed of the Canadian Rocky Mountains. Sites were chosen to represent first, second, and third order reaches. At each site, we constructed flood and fire frequency distributions as well as age structures of the vegetation. The results show that location within the watershed and reach type (straight or meandering) both dictate whether fires or floods dominated. First, fires dominate on all low-order reaches, creating even-aged forests. With an increase in drainage area and the onset of meandering, point bars are formed and the relative importance of floods is increased. Floods dominate on meandering reaches, where bi-modal age distributions are observed, with young trees found on fluvially-disturbed bars and old trees on older, fire-disturbed surfaces. Along straight reaches, even-aged distributions tend to occur since floods are typically not large enough to overflow the banks and fires therefore dominate. The shift in the relative importance of disturbances along the basin indicates that terrestrial processes differ along a basin, causing changes in forest structure and composition. Incorporating these changes in watershed models will lead to better predictions of large-scale hydrological processes.

B32C-05 1455h

Forest Fire Effects on Mercury and Other Trace Metal Concentrations in a Rocky Mountain Forest Ecosystem

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The impacts of forest fires on pools of major elements including carbon, calcium, and sulfur, have been extensively studied while their effects on potentially toxic trace metals are not as well understood. We examined the effect of the summer 2001, 4470 acre Green Knoll Fire (GKF) in northeastern Wyoming on mercury (Hg) and other trace metal concentrations in forest ecosystem pools. A paired watershed study was conducted using a burned and unburned watershed of similar stand age, climate, vegetation, and geology to investigate wildfire effects on the evolution and dispersal of pools of Hg and trace metals in forests. Mercury and other trace metal concentrations were determined through a 15 cm soil profile as well as in vegetation. Atmospheric sampling suggests that possibly due to geothermal inputs, ambient atmospheric and soil mercury concentrations are elevated in this region compared to other rural areas in the US, with typical concentrations of vapor phase mercury >5 ng/m^3. The burned watershed soil profile had much lower mercury concentrations than that of the unburned watershed, suggesting Hg volatilization by wildfires. Previous studies have suggested that leaf litter releases 97-100% of its mercury content, while this study suggests that the Hg release from soil organic matter may not be as complete. Mercury concentrations in the unburned soil column decreased from an average of 158 ppb at the surface to 38 ppb at 10-15 cm. In contrast, average concentrations in the burned soil were near 30 ppb from 0-15 cm. This result indicates the GKF released only $\sim$ 85% of the mercury present in the organic soil horizon, which may be attributed to relatively low fire intensity. Extrapolations from our results indicate that this relatively small fire released $\sim$ 0.1 Mg of Hg from the soil. On average, 4.2 million acres are burned yearly in the US, suggesting that soil burning releases an approximate 100 Mg annual Hg flux into the atmosphere, 70% of the estimated US anthropogenic flux of 144 Mg. Past fire suppression practices in the US have caused a buildup of flammable materials, which combined with the legacy of pollution in the 20th century, suggests that modern fires may release more mercury than in the past. This study reinforces the importance of wildfires to the global mercury cycle and indicates that forests in the Rocky Mountain region may contain large reservoirs of Hg that can be released during fires and add to the global budget of mercury emissions.

B32C-06 1510h

The Effects of Forest Disturbance on Macroinvertebrates in Western Oregon Headwater Streams - Patterns in Existing Databases

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