

**Oral Session B21D: The Bioatmospheric N Cycle: N Emissions, Transformations,
Deposition, and Terrestrial and Aquatic Ecosystem Impacts**

Presiding: M.M. Savard, Geological Survey of Canada; S. Weiss, Creekside Center for Earth Observation

B21D-01 INVITED

Sources of Atmospheric Pollutants Impacting Air and Water Quality in the Lake Tahoe Basin

* Gertler, A.W., alang@dri.edu, Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512, USA

Cahill, T.A., tacahill@ucdavis.edu, University of California, One Shields Avenue, Davis, CA 95616, USA

Gillies, J., jackg@dri.edu, Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512, USA

Kuhns, H., hkuhns@dri.edu, Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512, USA

Starting in the second half of the 20th century, decline in Lake Tahoe's water clarity and degradation in the basin's air quality have become major concerns due to its unique scenic features. Gaseous and particulate nitrogen (N) and particulate phosphorus (P) loading via direct atmospheric deposition and sediment transport to the lake have also been implicated as responsible for its eutrophication and decline in water clarity. Estimates suggest that atmospheric N deposition contributes 55% of the total N loading to the lake, while atmospheric P deposition contributes 15% of the total P loading. In order to improve both air quality and, as a consequence, water quality, it is necessary to develop an understanding of the sources of the atmospheric pollutants. Once this is accomplished, it is possible to implement cost-effective strategies to reduce this impact. This paper summarizes the findings of a series of studies performed to determine the levels and sources of ambient air pollutants in the basin. Projects have included the development of a Tahoe-specific emissions inventory, long-term measurements of road dust resuspension, modeling to determine the fraction of pollutants coming from in-basin vs. out-of-basin sources, particulate source apportionment, and estimates of nitric acid deposition. These studies found that the pollutants most closely connected to the decline in water quality come largely from within basin sources, as opposed to those coming from the Central Valley and upwind urban areas of California. These results indicate regulators need to control pollutant emissions within the Tahoe basin in order to reduce the impact of atmospheric pollutants on both air and water quality.

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

B21D-02

Soil emissions of gaseous reactive nitrogen from North American arid lands: an overlooked source.

* Sparks, J.P., jps66@cornell.edu, Ecology and Evolutionary Biology, Cornell University, E149 Corson Hall, Ithaca, NY 14853, USA

McCalley, C.K., ckm27@cornell.edu, Ecology and Evolutionary Biology, Cornell University, E149 Corson Hall, Ithaca, NY 14853, USA

Strahm, B.D., bds92@cornell.edu, Ecology and Evolutionary Biology, Cornell University, E149 Corson Hall, Ithaca, NY 14853, USA

The biosphere-atmosphere exchange and transformation of nitrogen has important ramifications for both terrestrial biogeochemistry and atmospheric chemistry. Several important mechanisms within this process (e.g., photochemistry, nitrogen deposition, aerosol formation) are strongly influenced by the emission of reactive nitrogen compounds from the Earth's surface. Therefore, a quantification of emission sources is a high priority for future conceptual understanding. One source largely overlooked in most global treatments are the soil emissions from arid and semi-arid landscapes worldwide. Approximately 35-40% of global terrestrial land cover is aridland and emission of reactive nitrogen from soils in these regions has the potential to strongly influence both regional and global biogeochemistry. Here we present estimates of soil emission of oxidized (NO, total NO_y including NO₂ and HONO) and reduced (NH₃) forms of reactive nitrogen from two North American arid regions: the Mojave Desert and the Colorado Plateau. Soil fluxes in these regions are highly dependent on soil moisture conditions. Soil moisture is largely driven by pulsed rain events with fluxes increasing 20-40 fold after a rain event. Using field measurements made across seasons under an array of moisture conditions, precipitation records, and spatially explicit cover type information we have estimated annual estimates for the Mojave Desert (1.5 ± 0.7 g N ha⁻¹ yr⁻¹), the shale derived (1.4 ± 0.9 g N ha⁻¹ yr⁻¹), and sandy soil derived (2.8 ± 1.2 g N ha⁻¹ yr⁻¹) regions of the Colorado Plateau. The chemical composition of soil emissions varies significantly both with season and soil moisture content. Emissions from dry soils tend to be dominated by ammonia and forms of NO_y other than NO. In contrast, NO becomes a dominant portion of the flux post rain events (~30% of the total flux). This variability in chemical form has significant implications for the tropospheric fate of the emitted N. NO and other nitrogen oxides are likely to participate in photochemistry, ozone production, and production of organic nitrates and nitric acid. In contrast, NH₃ is likely to locally redeposit or form secondary aerosols in the presence of sulphate. Given the vastly different influence of oxidized versus reduced forms of N on atmospheric chemistry, the variable chemical partitioning of soil emissions based on season and water availability observed in this study is likely to improve the performance of regional photochemistry models.

B21D-03

Kudzu (*Pueraria montana*) Invasion Doubles Emissions of Nitric Oxide, a Precursor to Tropospheric Ozone.

* Hickman, J.E., hickman@life.bio.sunysb.edu, Stony Brook University, Department of Ecology and Evolution 650 Life Sciences, Stony Brook, NY 11794-5245, USA

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

Wu, S., wu18@fas.harvard.edu, Harvard University, School of Engineering and Applied Sciences 29 Oxford Street, Cambridge, MA 02138, USA

Mickley, L.J., mickley@fas.harvard.edu, Harvard University, School of Engineering and Applied Sciences 29 Oxford Street, Cambridge, MA 02138, USA

Lerdau, M.T., mlerdau@virginia.edu, Blandy Experimental Farm, 400 Blandy Farm Lane, Boyce, VA 22620, USA

Lerdau, M.T., mlerdau@virginia.edu, University of Virginia, Departments of Environmental Sciences and Biology Clark Hall, Charlottesville, VA 22904-4123, USA

Nitrogen-fixing plants can increase rates of nitrogen (N) cycling in soils, fluxes of the greenhouse gas nitrous oxide (N₂O), and fluxes of the ozone precursor nitric oxide (NO). Invasion by the nitrogen-fixing legume kudzu (*Pueraria montana*) across millions of hectares in the southeastern USA could be contributing to increased ozone concentrations. Ozone formation in the Southeast is broadly limited by atmospheric NO concentrations, so perturbations to the N cycle by kudzu have the potential to increase ozone concentrations in the region. At three sites in Madison County, Georgia, kudzu invasion increased rates of net N mineralization by up to an order of magnitude and rates of net nitrification and soil pools of NO₃⁻ and NO₂⁻ by up to 500%. Emissions of NO from soils invaded by kudzu averaged 2.81 ng NO-N cm⁻² h⁻¹, significantly higher than emissions from soil dominated by native vegetation, which averaged 1.24 ng NO-N cm⁻² h⁻¹. Emissions of N₂O display a trend towards increasing under kudzu invasion, but N₂O emissions at these sites were three orders of magnitude smaller than emissions of NO. Atmospheric chemical modeling suggests that these higher NO emissions could increase ozone concentrations in the region by up to 2 ppb. We propose that kudzu invasion in the southeastern USA represents a novel threat to air quality and could increase the frequency with which federal ozone standards are exceeded.

B21D-04

Nitrogen deposition budgets for Rocky Mountain National Park

* Collett, J.L., collett@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

Beem, K., kbeem@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

Raja, S., sraja@clarkson.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

Taylor, C., ctaylor@ensr.aecom.com, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

Carrico, C., carrico@lamar.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

Schwandner, F, fschwand@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

Lee, T., thlee@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

Sullivan, A., sullivan@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

Day, D., day@cira.colostate.edu, CIRA/NPS, Colorado State University, Fort Collins, CO 80523
McMeeking, G., gavin@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,
Mack, L., lmack@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,
Kreidenweis, S.M., sonia@atmos.colostate.edu, Atmospheric Science Department, Colorado State University, Fort Collins, CO 80523,
Hand, J., hand@cira.colostate.edu, CIRA/NPS, Colorado State University, Fort Collins, CO 80523,
Schichtel, B., schichtel@cira.colostate.edu, CIRA/NPS, Colorado State University, Fort Collins, CO 80523,
Malm, W., malm@cira.colostate.edu, CIRA/NPS, Colorado State University, Fort Collins, CO 80523,

The Rocky Mountain Airborne Nitrogen and Sulfur (RoMANS) study was conducted to improve our understanding of the sources and transport of airborne nitrogen and sulfur species within Rocky Mountain National Park (RMNP) as well as their deposition pathways. Two field campaigns were conducted, in spring and summer 2006, to characterize pollutant transport and deposition during seasons with historically high nitrogen inputs. Measurements at the RoMANS core study site included daily wet deposition fluxes (nitrate, ammonium, organic nitrogen and sulfate) and daily concentrations of key particle (ammonium, nitrate, and sulfate) and trace gas (ammonia, nitric acid, and sulfur dioxide) species. From these measurements and dry deposition velocities derived from co-located CASTNet data, deposition flux budgets were determined for the spring and summer measurement campaigns. During both spring and summer, wet deposition of ammonium was the largest contributor to nitrogen deposition followed by wet deposition of nitrate. The next most important pathways were wet deposition of organic nitrogen and dry deposition of ammonia. Nitric acid dry deposition was fifth in importance. Dry deposition of fine particle nitrate and ammonium made only minor contributions to total nitrogen deposition fluxes. Neither wet deposition of organic nitrogen nor dry deposition of ammonia are measured by existing monitoring networks. These two pathways together comprise approximately 30 percent of RMNP nitrogen deposition measured during RoMANS, suggesting that their contributions need to be better quantified in the future in order to fully define nitrogen inputs to the park. Dry deposition of organic nitrogen, which was not measured even during RoMANS, is an even larger unknown.

B21D-05

Nitrogen Isotopes in Tree Rings: A Record of Atmospheric Deposition or Tree Physiology?

* Showers, W J w_showers@ncsu.edu, North Carolina State University, Dept. of Marine, Earth & Atm. Sciences 1125 Jordan Hall, Raleigh, NC 27695, USA
Genna, B bjgenna@ncsu.edu, North Carolina State University, Dept. of Marine, Earth & Atm. Sciences 1125 Jordan Hall, Raleigh, NC 27695, USA
Coon, M m_coon@ncsu.edu, North Carolina State University, Dept. of Marine, Earth & Atm. Sciences 1125 Jordan Hall, Raleigh, NC 27695, USA

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

Dendroisotopic analysis of nitrogen in tree rings has suggested that changes in nitrogen availability can be determined over time. These records match lake sediment and stream N flux measurements. Other studies suggest that tree ring nitrogen isotope data match foliar samples and not soil isotope data. In this study we compare the nitrogen isotope record from loblolly pine and American beech tree rings to a 10 year rainfall record and groundwater samples taken in isolated forested areas, next to a roadway and adjacent to agricultural fields. The influence of atmospheric nitrogen was determined by O17 analysis on groundwater nitrate. In areas where nutrient availability was low and O17 in groundwater nitrate was high, the tree ring nitrogen isotope record was similar to the nitrate nitrogen isotope trend. In areas where there was increased amounts of nitrate in groundwater due to local land use and O17 in groundwater nitrate was low, the nitrogen isotopic record in tree rings did not correlate to the atmospheric deposition record and probably represent internal recycling of nitrogen in the tree. These results suggest that nitrogen isotopes in tree rings can be used to monitor long term trends of atmospheric deposition of nitrogen in areas of low nutrient availability.

B21D-06 INVITED

Empirical and modeling approaches to setting critical loads for N deposition in southern California shrublands

* Allen, E B edith.allen@ucr.edu, Edith B. Allen, Dept. Botany and Plant Sciences, Univ. of California, Riverside, Riverside, CA 92521, USA
Rao, L E lrao001@student.ucr.edu, Leela E. Rao, Dept. Environmental Sciences, Univ. of California, Riverside, Riverside, CA 92521, USA
Fenn, M E mfenn@fs.fed.us, Mark E. Fenn, Andrzej Bytnerowicz, USDA Forest Fire Lab 4955 Canyon Crest Dr., Riverside, CA 92507, USA
Bytnerowicz, A abytnrowicz@fs.fed.us, Mark E. Fenn, Andrzej Bytnerowicz, USDA Forest Fire Lab 4955 Canyon Crest Dr., Riverside, CA 92507, USA
Tonnesen, G gail.tonnesen@ucr.edu, Gail Tonnesen, College of Engineering, Center for Environmental Research and Technology, Univ. of California, Riverside, Riverside, CA 92521, USA

Southern California deserts and coastal sage scrub (CSS) are undergoing vegetation-type conversion to exotic annual grassland, especially in regions downwind of urban areas that receive high N, primarily as dry deposition. To determine critical loads (CL) of N that cause negative impacts, we measured plant and soil responses along N deposition gradients, fertilized vegetation at different N levels, and used biomass production output from the DayCent model. N deposition gradients were identified from the CMAQ model and compared with measured N deposition values. CSS receives N deposition as high as 30 kg ha⁻¹yr⁻¹, while the desert has levels up to 16 kg ha⁻¹yr⁻¹. Unlike more mesic ecosystems where critical loads are determined by changes in soil chemistry or biogeocycling, these arid and semiarid ecosystems are subject to increases in exotic species production, loss of native species diversity, and increased fire risk at relatively low CL's for N of 5 - 10 kg ha⁻¹yr⁻¹. For instance, a gradient survey in CSS showed that exotic grass increased and native plant species and arbuscular mycorrhizal species richness declined by almost half above 11 kg N ha⁻¹yr⁻¹. Fertilization studies in desert creosote bush scrub showed a significant increase in exotic species biomass with 5 kg N ha⁻¹yr⁻¹ in a wet year,

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

and biomass output from DayCent modeling indicated an increased fire risk from exotic grasses with 1 T per ha production during years with moderate to high precipitation at 5 kg N ha⁻¹yr⁻¹. The difference in CL between desert and CSS may be related to the responsiveness of native vs. exotic plant species to N, as well as the degree to which precipitation and soil N limits plant growth in the two vegetation types.

B21D-07

**Quantifying Nitrogen Fluxes and Their Influence on the Greenhouse gas Balance-
Research Strategy and new Findings From the NitroEurope Integrated Project**

Sutton, M ms@ceh.ac.uk, Centre for Ecology and Hydrology, Bush estate, Penicuik, EH26 0QB, United Kingdom

* Nemitz, E en@ceh.ac.uk

Reis, S srei@ceh.ac.uk

Beier, C claus.beier@risoe.dk

Butterbach-Bahl, K klaus.butterbach@imk.fzk.de

Cellier, P cellier@bcgn.grignon.inra.fr

Cotrufo, M F mfrancesca.cotrufo@unina2.it

Erisman, J W erisman@ecm.nl

Skiba, U M ums@ceh.ac.uk

de Vries, W wim.devries@wur.nl

Zechmeister-Baltenstern, S sophie.zechmeister@bfw.gv.at

Bleeker, A a.bleeker@ecm.nl

Calanca, P pierluigi.calanca@art.admin.ch

Dalgaard, T Tommy.Dalgaard@agrsci.dk

Dragosits, U ud@ceh.ac.uk

Duyzer, J H jan.duyzer@tno.nl

Gundersen, P PGU@life.ku.dk

Hensen, A hensen@ecm.nl

Kros, H Hans.kros@wur.nl

Leip, A adrian.leip@jrc.it

Obersteiner, M oberstei@iiasa.ac.at

Olesen, J E JorgenE.Olesen@agrsci.dk

Phillips, G gjph@ceh.ac.uk

Rees, R M Bob.Rees@sac.ac.uk

Smith, P E pete.smith@abdn.ac.uk

Soussana, J soussana@clermont.inra.fr

Tang, Y yst@ceh.ac.uk

Theobald, M R mrtheo@ceh.ac.uk

van Amstel, A Andre.vanAmstel@wur.nl

van Oijen, M mvano@ceh.ac.uk

Bakker, M martha.bakker@wur.nl

Vesala, T timo.vesala@helsinki.fi

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

The human-driven production of reactive nitrogen to stimulate agricultural productivity and its unintended formation in combustion processes both have major impacts on the global environment. Effects of excess reactive nitrogen include reductions in air quality, water quality, soil quality and biodiversity. One of the most controversial impacts of nitrogen, however, is on the greenhouse gas balance. While recent papers have highlighted a possible benefit of nitrogen in enhancing rates of carbon sequestration, there remain many trade-offs between nitrogen and greenhouse gas exchange. The result is that the net effect of reactive nitrogen on the global radiative balance is currently far from clear. To better quantify these relationships requires measurement data and modelling that make the link between different nitrogen forms and their fate in the environment. It is essential to measure fluxes for a wide range of ecosystems considering the biosphere-atmosphere exchange each of the reactive nitrogen components and greenhouse gases, as well as the fixation and denitrification of di-nitrogen. Long term observations are needed for representative ecosystems, together with results from experiments addressing the responses of the key nitrogen and greenhouse gas fluxes to different global change drivers. The NitroEurope Integrated Project of the 6th Framework Programme of the European Commission European has developed a strategy to quantifying these different terms on multiple scales. This paper presents the experimental approach including a) a 3-tier flux network, combining process level measurements and new method development with low-cost measurements at many sites, b) a network of manipulation experiments with different global change drivers, c) a network of contrasting European landscapes for analysis of land- use and land management interactions assessing the multiple nitrogen fluxes within and between air, land and water. The paper illustrates the new datasets emerging, and shows how these are being used to support the development of site, landscape and regional-scale models of nitrogen fluxes and net greenhouse gas exchange. Finally, the paper describes how independent verification activities are providing the basis to analyze the uncertainty in regional-scale nitrogen and greenhouse gas fluxes.

B21D-08 INVITED

Nitrogen Cascade: An Opportunity to Integrate Biogeochemistry and Policy

* Galloway, J N jng@virginia.edu, University of Virginia, 291 McCormick Road, Charlottesville, VA 22904, USA

Moomaw, W R william.moomaw@tufts.edu, Tufts University, 160 Packard Ave, Medford, MA 02155, USA

Theis, T L theist@uic.edu, University of Illinois at Chicago, 2121 West Taylor Street, Chicago, IL 60612, USA

It began with micro-organisms millions of years ago, was enhanced by the burning of fossil carbon in the last several hundred years, and was magnified by a patent filed one hundred years ago. Today, the combined actions of cultivation-induced biological nitrogen fixation, fossil fuel combustion and the Haber-Bosch process have exceeded natural terrestrial processes in converting N₂ to nitrogen compounds that are biologically, chemically or physically reactive (reactive nitrogen, Nr). While the benefits of Nr are well understood, many of the adverse consequences of excessive Nr are invisible from a policy perspective. Over the past century, the fundamental knowledge on nitrogen processes has advanced to the point where we have a good

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

understanding of nitrogen's biogeochemical cycle, the role of humans in altering the cycle, and the consequences of the alterations. This knowledge has collectively led us to two conclusions: the consequences of intensive human influence on the nitrogen cycle leads to a cascade of ecosystem and human effects which need to be managed. Secondly, the management is complicated by the facts that it not only has to be integrated, but it also has to take into account that the management should not lower the ability of managed ecosystems to produce food for the world's peoples. The framework of the nitrogen cascade provides us with a structure for better identifying intervention points, and more effective policies, technologies and measures to prevent or mitigate the adverse impacts of reactive nitrogen, while enhancing its beneficial uses. We can now begin to use our understanding of science to set priorities and craft new policy strategies. For many regions of the world, the science is strong enough to manage nitrogen and there are existing tools to do so. However, the tools are not integrated, critical tools are missing and most importantly, there are nitrogen-rich regions of the world where the science is lacking, and nitrogen-poor regions where there is inadequate supply of nitrogen. After a brief review of the nitrogen cycle and the associated nitrogen cascade, this paper will identify control points in the cycle where management would be optimum, review the possible tools that are available for management, and suggest a process by which an integrated management approach might be developed.

Poster Session B23A: The Bioatmospheric N Cycle: N Emissions, Transformations, Deposition, and Terrestrial and Aquatic Ecosystem Impacts II

Presiding: S. Weiss, Creekside Center for Earth Observation; P. Rich, Creekside Center for Earth Observation

B23A-0391

Pre-Anthropocene nitrogen cycle: balanced mass and isotope fluxes

* Joo, Y yjoo@earth.northwestern.edu, Northwestern University, Department of Earth and Planetary Sciences, Northwestern University, Evanston, Il 60208, USA
Lerman, A alerman@northwestern.edu, Northwestern University, Department of Earth and Planetary Sciences, Northwestern University, Evanston, Il 60208, USA

One of the features of the present-day global nitrogen cycle is the return to the atmosphere (taken as $\delta^{15}\text{N} = 0 \text{ ‰}$) and surface waters of isotopically lighter N ($\delta^{15}\text{N} < 0$) primarily from denitrification on land and in the ocean. With the N residence time in the atmosphere of about 18 million years, the N mass and isotope fluxes were likely to be balanced at geologically longer time scales if the isotopic composition of the atmosphere did not vary. For Pre-Anthropocene time, we construct a balanced N cycle model of mass and isotopic fluxes, based on 14 nitrogen reservoirs in the domains of the atmosphere, land, and ocean. Atmosphere, the largest N reservoir, supplies N to land and ocean domains mainly by nitrogen fixation, deposition, and dissolution, and these fluxes are balanced by denitrification and volatilization back to the atmosphere. The land and ocean biotic reservoirs (N-fixing plants, non-N-fixing plant, and marine biota) interact with atmospheric N_2 and dissolved inorganic nitrogen (DIN, consisting of

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

N₂, NO₃⁻, and NH₄⁺) in soil and ocean waters through N fixation and DIN uptake. Remineralization of dissolved organic N and particulate organic N in water and sediments produces nitrate and ammonia of DIN. Land and ocean domains are linked by river transport that carries both dissolved and particulate nitrogen to the oceanic coastal zone. As the reported $\delta^{15}\text{N}$ values of reservoirs and fractionation factors ($\epsilon = \delta^{15}\text{N}_{\text{product}} - \delta^{15}\text{N}_{\text{source}}$) in natural systems vary greatly, the isotope-mass balances and fractionation factors in the cycle were obtained by numerical iteration of the flux equations. Within the mass-balanced N cycle model, the isotope fractionation factors of the interreservoir fluxes are sensitive to the $\delta^{15}\text{N}$ reservoir values. The resultant fractionation factors (ϵ) are mostly within the reported ranges. In general, culture studies of N isotope fractionation suggest that the magnitude of fractionation is smaller (less negative) under N-limited growth conditions where biota utilizes the heavier nitrogen, making the isotopic fractionation smaller. Our balanced, integrated N-cycle model shows faster turnover times and greater isotopic fractionation in biologically mediated processes, consistent with the data on individual reservoirs and processes.

B23A-0392

Modeling the effects of N deposition, precipitation variability, and soil texture on winter annual production and fire risk in Southern California deserts

* Rao, L E, University of California, Riverside, Department of Environmental Sciences, Riverside, CA 92521, USA

Allen, E B, University of California, Riverside, Department of Botany and Plant Sciences, Riverside, CA 92521, USA

Meixner, T , University of Arizona, Department of Hydrology and Water Resources, Tucson, AZ 85721, USA

Fire risk in deserts is increased by high production of annual grasses and forbs that create a continuous fine fuel bed in the interspaces between shrubs. Interspace production is influenced by many factors including water and N availability and soil texture, and so the DayCent model was used to investigate how production of herbaceous annuals change along gradients of these production-forcing factors. DayCent was calibrated on the interspace vegetation from a creosote bush scrub site in Joshua Tree National Park and validated on a second creosote site within the Park with different soils and climate. The DayCent model was well calibrated on the first site, but validation on the second site showed that the model is sensitive to soil clay content such that soils with low clay contents lose soil C and N during model equilibration. Despite discrepancies between modeled and observed soil C and N pools, relative response of production to N fertilization was well represented by the model. Thus, DayCent can be used to determine conservative estimates of fire risk in the desert under increased precipitation and N deposition. Fire risk simulations indicate that interspace vegetation is strongly limited by water availability when mean annual precipitation is less than 21 cm yr⁻¹. Under simulated N deposition of 8 kg-N ha⁻¹, approximating the most polluted regions in these deserts, fire risk increases to 62-76% under a range of soil textures indicating that under increased N deposition fire risk is high in years of average to above-average rainfall.

B23A-0393

Coupled isotopic and simulation modeling of gaseous nitrogen losses from tropical rainforests

* Bai, E ebai@ucdavis.edu, Department of Land, Air, and Water Resources, University of California, Davis, One Shields Avenue, Davis, CA 95616, USA
Houlton, B bzhoulton@ucdavis.edu, Department of Land, Air, and Water Resources, University of California, Davis, One Shields Avenue, Davis, CA 95616, USA

Gaseous nitrogen (N) losses remove fixed N from the biosphere and play an important role in regulating Earth's climate system. Current techniques for directly measuring gaseous N fluxes are still limited, however, and many uncertainties remain. We combined natural isotopic and simulation modeling (DAYCENT; daily version of CENTURY) to examine the extent to which N isotopes offer meaningful constraint to estimates of large-scale gaseous N emissions from terrestrial ecosystems. The isotope model considers two scenarios: in the first, soil $\delta^{15}\text{N}$ is a linear function of fraction of gaseous N losses; in the second, underexpression of the isotope effect of denitrification is considered and soil $^{15}\text{N}/^{14}\text{N}$ is determined by both the fraction of gaseous losses and the proportion of nitrate consumed locally by denitrification. We examined the coupled simulation and isotope-based model along two Hawaiian rainforest gradients which span a range of tropical rainfall climates, soil biogeochemical ages and ecosystem $^{15}\text{N}/^{14}\text{N}$. Under most conditions (MAP < 4050 mm and age > 2100 yr), modeled soil $^{15}\text{N}/^{14}\text{N}$ ratios agreed reasonably well with measurements ($r^2 = 0.53$), consistent with full expression of a field-calibrated isotope effect (scenario 1). In very wet sites (MAP > 4050 mm), locally complete consumption of nitrate appears to lower the effective isotope effect of denitrification at ecosystem levels, resulting in soil $^{15}\text{N}/^{14}\text{N}$ ratios that approach those of the N inputs (i.e., scenario 2). Replacing DAYCENT simulation results with field-based measures of N gas fluxes ($\text{NO}_x + \text{N}_2\text{O}$) yielded consistently lower estimates of soil $^{15}\text{N}/^{14}\text{N}$ ratios across the forests, pointing to a missing gas N loss term (i.e., N_2), inadequate coverage of spatial and temporal heterogeneity by empirical measures or both. These results demonstrate the potential for soil N isotopes to constrain N gas fluxes at large geographic scales, implying a quantitative tracer for gaseous N losses from terrestrial ecosystems.

B23A-0394

Trade-offs between nitrous oxide emission and C-sequestration in the soil: the role of earthworms

* Van Groenigen, J JanWillem.vanGroenigen@wur.nl, Dept. of Soil Quality, Wageningen University, Droevendaalsesteeg 4, Wageningen, 6700 AA, Netherlands
Lubbers, I M Ingrid.Lubbers@wur.nl, Dept. of Soil Quality, Wageningen University, Droevendaalsesteeg 4, Wageningen, 6700 AA, Netherlands
Giannopoulos, G Georgios.Giannopoulos@wur.nl, Dept. of Soil Quality, Wageningen University, Droevendaalsesteeg 4, Wageningen, 6700 AA, Netherlands

The rapidly rising concentrations of the greenhouse gas carbon dioxide (CO_2) in the atmosphere has spurred the interest in soils as a potential carbon (C) sink. However, there are many reports

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

indicating that C- sequestration is often negated by elevated emissions of the potent greenhouse gas nitrous oxide (N₂O). It is not yet clear what the driving factors behind this trade-off are, nor how it can be avoided. We suggest that earthworm activity may be partly responsible for the trade-off. Earthworm activity is increasingly recognized as being beneficial to C-sequestration through stabilization of SOM. We report experimental results suggesting that they can also lead to strongly elevated N₂O-emissions. In a first experiment, dried grass residue (*Lolium perenne*) was applied at the top of a loamy soil or mixed through the soil, and N₂O-emission was followed for three months. Treatments included presence of the epigeic earthworm *Lumbricus rubellus* and the anecic earthworm *Aporrectodea longa*. Cumulative N₂O-emissions increased significantly for both species. The strongest effect was measured for *L. rubellus*, where N₂O-emissions significantly increased from 55.7 to 789.1 micro g N₂O-N kg⁻¹ soil. This effect was only observed when residue was applied on top of the soil. In a second experiment we determined the effect of epigeic (*L. rubellus*) and endogeic (*Aporrectodea caliginosa*) earthworms on N₂O-emissions for two different soil types (loam and sand) in the presence of ¹⁵N-labeled radish residue (*Raphanus sativus* subsp. *oleiferus*). Both species showed significant increases in N₂O-emissions, which differed with residue application method and soil type. N₂O-emissions were generally larger in loamy soils and the strongest effect was measured for *A. caliginosa* when residue was mixed into the soil, increasing emissions from 1350.1 to 2223.2 micro g N₂O-N kg⁻¹ soil. *L. rubellus* only resulted in elevated N₂O-emissions when residue was applied on top. These studies make it clear that elevated N₂O-emissions due to earthworm activity is a widespread phenomenon, and that the nature of earthworm-induced effect is largely controlled by its feeding habit and interactions with other species. Our results contribute to understanding the important but intricate relations between (functional) biodiversity and the soil greenhouse gas balance.

B23A-0395

Aridland Emissions of Reactive Nitrogen Gases: The Importance of Abiotic Processes

* McCalley, C K ckm27@cornell.edu, Cornell University, Corson Hall Rm E149, Ithaca, NY 14853, USA

Sparks, J P jps66@cornell.edu, Cornell University, Corson Hall Rm E149, Ithaca, NY 14853, USA

Gaseous reactive nitrogen compounds play an important role in the atmospheric chemistry defining climate and air quality. Our current understanding of the production of trace N gases at the soil surface is largely based on the microbial processing of soil N. However, measurements in the Mojave Desert show substantial soil emissions of nitrogen oxides and ammonia under conditions that are unlikely to support biological activity: extremely high temperature and low moisture conditions. Summertime patterns of trace N gases efflux show strong diurnal patterns, on average midday maximum fluxes were 75 times higher than nighttime lows. Diurnal flux patterns appear to most closely match daily changes in the intensity of solar radiation and not soil temperature, suggesting a direct role of solar radiation in driving abiotic formation of reactive nitrogen gases. Experimental blocking of incoming radiation resulted in rapid and dramatic reductions in fluxes of both nitrogen oxides (NO + NO_y) and ammonia. On average, midday fluxes dropped by 70 and 35% for nitrogen oxides and ammonia, respectively. The chronology

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

of this response closely matched changes in surface soil temperature (1cm) indicating that extreme surface soil temperatures (65-80° C) caused by incoming solar radiation may contribute to reactive N gas loss from these soils. Following a simulated 20 mm precipitation event, fluxes increased 40-fold, yielding total reactive N gas losses of $175 \pm 23 \text{ ng N m}^{-2} \text{ s}^{-1}$ composed of an equal mixture of nitrogen oxides and ammonia. Responses to blocking incoming radiation were even stronger in irrigated soils with 65-70% reductions in emissions for all gas species. Results suggest that under high light and temperature conditions a series of abiotic processes yield considerable reactive N gas production, especially following pulse rain events. Such abiotic processes likely dominate reactive N gas loss from the Mojave Desert and these non-biological sources release approximately 0.5 kg N ha^{-1} of reactive N into the atmosphere during summer months. Given the relevance and sensitivity of trace N gases to global climate change, characterization of abiotic mechanisms driving reactive N gas loss in arid environments will be essential to understanding and predicting current and future biosphere-atmosphere exchange of reactive nitrogen gas species.

B23A-0396

Nitrous Oxide From Fertilized Cropland in the New York State as Affected by Different Practices

* Molodovskaya, M mm433@cornell.edu, Biological and Environmental Engineering, Cornell University, Riley Robb Hall, Ithaca, NY 14853, USA
Singurindy, O osinguri@eos.ubc.ca, Earth and Ocean Sciences, University of British Columbia, 6339 Stores Road, Vancouver, BC V6T 1Z4, Canada
Richards, B K bkr2@cornell.edu, Biological and Environmental Engineering, Cornell University, Riley Robb Hall, Ithaca, NY 14853, USA
Warland, J jwarland@uoguelph.ca, Land Resource Science, University of Guelph, Richard's Building, Office 034, Guelph, ON N1G 2W1, Canada
Steenhuis, T S tss1@cornell.edu, Biological and Environmental Engineering, Cornell University, Riley Robb Hall, Ithaca, NY 14853, USA

The detrimental loss of N from N fertilizers is a serious environmental problem of modern agriculture. Amongst the threats that elevated N use poses to the environment, the increase in net N₂O production is of special concern, due to its persistent atmospheric effect as a greenhouse gas and as a contributor to ozone destruction. Long-term monitoring of N₂O flux was conducted on a mid-size dairy farm in central New York to determine N₂O emission levels from agricultural practices that are common for the region. The technique used was Tunable Diode Laser Absorption Spectrometer (TDLAS) coupled with 3D sonic anemometer; continuous eddy flux observations were conducted throughout three years on an alfalfa field in 2006, corn field in 2007, and on a split alfalfa/corn site in 2008 (ongoing). All fields were fertilized after/before growing seasons with dairy manure only. The results showed highly variable, instantaneous nature of N₂O flux, with peak values reached after strong and sharp increases in both soil moisture and temperature. Manure spreading affected N₂O fluxes only when factors of temperature and moisture were not limiting: at temperatures below 5°C, manure spreading had no pronounced effect on the N₂O release. Average flux values were higher for corn ($0.059 \mu\text{g m}^{-2} \text{ s}^{-1}$) than for alfalfa ($0.045 \mu\text{g m}^{-2} \text{ s}^{-1}$), which was possibly related to manure application

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

during spring thaw and its further incorporation with the plowing on the corn field. The greatest flux value for 2006-2007 of $0.76\mu\text{g m}^{-2} \text{ s}^{-1}$ was also observed for the corn field during a spring thawing event.

B23A-0397

A Coupled Land Surface-Subsurface Biogeochemical Model for Aqueous and Gaseous Nitrogen Losses

* gu, C cgu@berkeley.edu, University of California, Berkeley, 413 O'Brien Hall, Berkeley, CA 94720,

Maggi, F fmaggi@berkeley.edu, University of California, Berkeley, 413 O'Brien Hall, Berkeley, CA 94720,

Riley, W wjriley@lbl.gov, Lawrence Berkeley National Laboratory, 1 cyclotron Road, Mail Stop 90-1139, Berkeley, CA 94720,

Pan, L lpn@lbl.gov, Lawrence Berkeley National Laboratory, 1 cyclotron Road, Mail Stop 90-1139, Berkeley, CA 94720,

xu, t tianfu_xu@lbl.gov, Lawrence Berkeley National Laboratory, 1 cyclotron Road, Mail Stop 90-1139, Berkeley, CA 94720,

oldenburg, c cmoldenburg@lbl.gov, Lawrence Berkeley National Laboratory, 1 cyclotron Road, Mail Stop 90-1139, Berkeley, CA 94720,

Miller, N nlmiller@lbl.gov, Lawrence Berkeley National Laboratory, 1 cyclotron Road, Mail Stop 90-1139, Berkeley, CA 94720,

In recent years concern has grown over the contribution of nitrogen (N) fertilizers to nitrate (NO₃), water pollution and atmospheric pollution of nitrous oxide (N₂O), nitric oxide (NO), and ammonia (NH₃). Characterizing the amount and species of N losses is therefore essential in developing a strategy to estimate and mitigate N leaching and emission to the atmosphere. Indeed, transformations of nitrogen depend strongly on water content, soil temperature, and nitrogen concentration. Land surface processes therefore have to be taken into account to properly characterize N biogeochemical cycling. However, most current nitrogen biogeochemical models take the land surface as the upper boundary by lumping the complex processes above the surface as known boundary conditions. In this study, an extant subsurface mechanistic N cycle model (TOUGHREACT-N) was coupled with the community land model (CLM). The resulting coupled model extends the modeling capability of TOUGHREACT-N to include the important energy, momentum, and moisture dynamics provided by CLM. The coupled model showed a significant impact of land-surface diurnal forcing on soil temperature and moisture and on nitrogen fluxes. We also discuss field applications of the model and discuss how temporal dynamics of nitrogen fluxes are affected by land surface processes.

B23A-0398

Relationship between N₂O Fluxes from an Almond Soil and Denitrifying Bacterial Populations Estimated by Quantitative PCR

* Matiasek, M mgmatiasek@ucdavis.edu, University of California, Davis, Dept. of Land, Air and Water Resources, One Shields Ave., Davis, CA 95616, USA

Suddick, E C ecsuddick@ucdavis.edu, University of California, Davis, Dept. of Plant Sciences, One Shields Ave., Davis, CA 95616, USA

Smart, D R drsmart@ucdavis.edu, University of California, Davis, Dept. of Viticulture and Enology One Shields Ave., Davis, CA 95616, USA

Scow, K M kmscow@ucdavis.edu, University of California, Davis, Dept. of Land, Air and Water Resources, One Shields Ave., Davis, CA 95616, USA

Cultivated soils emit substantial quantities of nitrous oxide (N₂O), a greenhouse gas with almost 300 times the radiative forcing potential of CO₂. Agriculture-related activities generate from 6 to 35 Tg N₂O-N per year, or about 60 to 70% of global production. The microbial processes of nitrification, denitrification and nitrifier denitrification are major biogenic sources of N₂O to the atmosphere from soils. Denitrification is considered the major source of N₂O especially when soils are wet. The microbial N transformations that produce N₂O depend primarily on nitrogen (N) fertilizer, with water content, available carbon and soil temperature being secondary controllers. Despite the fact that microbial processes are responsible for N₂O emissions, very little is known about the numbers or types of populations involved. The objective of this study was to relate changes in denitrifying population densities, using quantitative PCR (qPCR) of functional genes, to N₂O emissions in a fertilized almond orchard. Quantitative PCR targeted three specific genes involved in denitrification: nirS, nirK and nosZ. Copy numbers of the genes were related back to population densities and the portion of organisms likely to produce nitrous oxide. The study site, a 21.7 acre almond orchard fitted with micro-sprinklers, was fertigated (irrigated and fertilized simultaneously) with 50 lbs/acre sodium nitrate in late March 2008, then irrigated weekly. Immediately after the initial fertigation, fluxes of N₂O and CO₂, moisture content, inorganic N and denitrification gene copy numbers were measured 6 times over 24 days. Despite the fact that N₂O emissions increased following fertigation, there was no consistent increase in any of the targeted genes. The genes nirK and nirS ranged from 0.4-1.4 × 10⁷ and 0.4-1.4 × 10⁸, whereas nosZ ranged from 2-8 × 10⁶ copy numbers per g soil, respectively. Considerable variation, compounded by the small sample sizes used for DNA analysis, made it difficult to discern trends over time. High spatial variability was also observed with one of the field replicates have a substantially higher flux of N₂O. This replicate also had the highest water filled pore space (WFPS) and water content, factors that likely favored denitrification. Water saturation of soil air space, optimal at >60% for denitrification to occur, was relatively low in the other field replicates. Thus, the low N₂O flux measurements and gene copy numbers agreed in supporting the hypothesis denitrification was relatively low under the environmental conditions of these particular almond soils.

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

B23A-0399

Tree-Ring Nitrogen Isotopes As Environmental Monitoring Tools: Inferring Air Quality Changes And Climate Effects

* Savard, M M msavard@nrcan.gc.ca, Geological Survey of Canada, 490 de la Couronne, Quebec, QC G1K 9A9, Canada

Begin, C cbegin@nrcan.gc.ca, Geological Survey of Canada, 490 de la Couronne, Quebec, QC G1K 9A9, Canada

Smirnoff, A asmirnoff@nrcan.gc.ca, Geological Survey of Canada, 490 de la Couronne, Quebec, QC G1K 9A9, Canada

Marion, J jmarion@nrcan.gc.ca, Institut national de la recherche scientifique, Centre ETE, 490 de la Couronne, Quebec, QC G1K 9A9, Canada

Anthropogenic emissions of atmospheric nitrogen greatly increased over the last 150 years, however the monitoring of nitrous oxide concentration in North America started only recently, generally during the last 30 years. Could the geochemical characteristics of tree rings be used to infer past changes in nitrogen cycles of temperate regions? To address this question we use long-term series (125 years) of nitrogen stable isotopes ($\delta^{15}\text{N}$) obtained from rings of pine (*Pinus strobus*) and beech (*Fagus grandifolia*) trees in the Montreal region (western Quebec), and of beech specimens in the Georgian Bay Islands National Park (central Ontario). Reliability tests of N concentrations in wood treated for removal of soluble materials reveal that the reproducibility from tree to tree is poor, and that the concentrations in both Pine and Beech trees change in the heartwood-sapwood transition zones. We therefore reject N concentration as environmental indicator. Alternatively, the N stable isotopes pass all reliability tests. In Montreal, short-term $\delta^{15}\text{N}$ fluctuations correlate directly with precipitation and inversely with temperature. A long-term decreasing isotope trend suggests progressive changes in soil chemistry after 1951. A pedochemical change is also inferred for the Georgian Bay site on the basis of a positive $\delta^{15}\text{N}$ trend initiated after 1971. At both sites, the long-term $\delta^{15}\text{N}$ series correlate with a proxy for NO_x emissions, and the $\delta^{13}\text{C}$ values of the same ring series suggest that all studied trees have been stressed by phytotoxic pollutants. We propose that the contrasted long-term $\delta^{15}\text{N}$ changes of Montreal and Georgian Bay reflect deposition of NO_x emissions from cars and coal-power plants, with higher proportions from coal burning in Georgian Bay. This interpretation is conceivable because recent monitoring indicates that coal-power plant NO_x emissions play an important role in the annual N budget in Ontario, but they seem negligible on the Quebec side. This research suggests that tree-ring nitrogen isotopes may record regional climatic conditions and anthropogenic perturbations of the N cycle.

B23A-0400

Foliar Uptake of Atmospheric Reactive Nitrogen Pollution Along an Urban-Rural Gradient in New York State

* Vallano, D dmv24@cornell.edu, Cornell University, Ecology and Evolutionary Biology, 149E Corson Hall, Ithaca, NY 14853, USA

Sparks, J P jps66@cornell.edu, Cornell University, Ecology and Evolutionary Biology, 149E Corson Hall, Ithaca, NY 14853, USA

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

Vegetation is an important sink for atmospheric reactive nitrogen (N) pollution in terrestrial ecosystems, and when soil N is limiting, foliar N uptake can be a source of plant-available N. A proxy for pollution derived N, and in particular foliar assimilated N, would be useful to quantify the impact of the foliar uptake pathway on plant metabolism. Nitrogen stable isotope ratios ($^{15}\text{N}/^{14}\text{N}$) are practical for this purpose because forms of plant-available N often have varying isotopic compositions. However, the mechanisms driving differences in foliar N isotopic composition ($\delta^{15}\text{N}$) are still unresolved. Current understanding of foliar $\delta^{15}\text{N}$ suggests these values primarily represent the integration of the soil water solution $\delta^{15}\text{N}$, direct foliar uptake of atmospheric reactive N, within-plant fractionations, and fractionation due to the fungus to root transfer in mycorrhizae. In this study, we investigated the influence of direct foliar uptake, soil solution $\delta^{15}\text{N}$, and mycorrhizae on foliar $\delta^{15}\text{N}$ in seedlings of two dominant Northeastern tree species, red maple (*Acer rubrum*) and red oak (*Quercus rubra*), along an N deposition gradient in New York State. Using a potted plant mesocosm system, we compared foliar $\delta^{15}\text{N}$ values directly to soil solution $\delta^{15}\text{N}$ values while controlling for mycorrhizal associations. Both species showed higher foliar $\delta^{15}\text{N}$ when exposed to fractionation by mycorrhizal associations. Overall, *A. rubrum* showed higher foliar $\delta^{15}\text{N}$ than *Q. rubra* across all sites. In both species, patterns of foliar $\delta^{15}\text{N}$ values were coupled with soil solution $\delta^{15}\text{N}$ values across the N deposition gradient. Additionally, increasing atmospheric N deposition was correlated with higher foliar $\delta^{15}\text{N}$ values in *Q. rubra*, but not in *A. rubrum*. Using a mixing model, we estimated that *Q. rubra* seedlings incorporated up to 7% of their assimilated N via direct foliar uptake of atmospheric N pollution. However, foliar uptake was not detectable in *A. rubrum* seedlings. Results suggest that the use of foliar $\delta^{15}\text{N}$ values may be an effective tool to estimate the magnitude of foliar uptake of pollutant N compounds under some circumstances.

B23A-0401

$\delta^{15}\text{N}$ Nitrogen in Tree Rings of Temperate Forest Trees: Indicators of Past Changes in Soil Nitrogen Cycling

* Templer, P H ptempler@bu.edu, Boston University, Department of Biology, Boston, MA 02215, USA

Pardo, L H lpardo@fs.fed.us, USA Forest Service, 705 Spear St, South Burlington, Vt 05403, USA

Wheatley, S susanrw@bu.edu, Boston University, Department of Biology, Boston, MA 02215, USA

Rolph, M rolphme@bu.edu, Boston University, Department of Biology, Boston, MA 02215, USA

McLaurin, C luvdaboom@hotmail.com, Jackson State University, 1400 Lynch Street, Jackson, MS 39217, USA

Siccama, T thomas.siccama@yale.edu, Yale University, School of Forestry and Environmental Studies, New Haven, Ct 06511, USA

Fahey, T tjf5@cornell.edu, Cornell University, Department of Natural Resources, Ithaca, NY 14850, USA

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

Forest disturbances can result in a temporary increase in soil nitrification and nitrate (NO₃-) losses from forest soils to nearby streams. Nitrate leaching can alter soil nutrient balances, cause soil acidification and contribute to declines in biodiversity of nearby aquatic ecosystems. Previous studies have shown that clear-cutting induced nitrification, followed by NO₃- losses from soils, can lead to elevated $\delta^{15}\text{N}$ values of remaining nitrogen in soils and foliage. As trees reforest an area following a clear-cut, nitrification rates tend to decline, bringing soil and foliar $\delta^{15}\text{N}$ values to background levels. In this study, we sought to determine whether $\delta^{15}\text{N}$ values of bole wood of trees could be used as an indicator of past pulses of elevated nitrification followed by NO₃- leaching. Since trees obtain nitrogen from the soil, we expected that immediately following a clear-cut, $\delta^{15}\text{N}$ in tree rings would spike and then return to pre-disturbance levels. We sampled bole wood from individuals of American Beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*), two dominant tree species of northeastern hardwood forests. Wood was collected from mature trees growing in forest sites without recent disturbance and from trees growing in a previously clear-cut forest at the Hubbard Brook Experimental Forest in New Hampshire. Our results show that for both species, $\delta^{15}\text{N}$ values were greater in wood from the previously cut watershed compared to the undisturbed sites for the first three years following the forest cut. After three years, there was no significant difference between the disturbed and undisturbed forested watersheds. These results suggest that $\delta^{15}\text{N}$ of bole wood from sugar maple and American beech trees can be used as indicators of past pulses of nitrification followed by NO₃- losses, illustrating that $\delta^{15}\text{N}$ within tree rings can be used as an indicator of past disturbances and changes in soil nitrogen cycling in temperate forest ecosystems.

B23A-0402

Concentrations and Fluxes of Water-Soluble Reactive Nitrogen Gases and Aerosol Compounds Above a Forest Canopy

* Wolff, V wolff@mpch-mainz.mpg.de, Max Planck Institute for Chemistry Biogeochemistry Department, Joh.-J.-Becherweg 27, Mainz, 55128, Germany
Trebs, I, Max Planck Institute for Chemistry Biogeochemistry Department, Joh.-J.-Becherweg 27, Mainz, 55128, Germany
Moravek, A, Max Planck Institute for Chemistry Biogeochemistry Department, Joh.-J.-Becherweg 27, Mainz, 55128, Germany
Zhu, Z, Max Planck Institute for Chemistry Biogeochemistry Department, Joh.-J.-Becherweg 27, Mainz, 55128, Germany
Meixner, F X meixner@mpch-mainz.mpg.de, Department of Physics University of Zimbabwe, P.O. Box MP 167 Mount Pleasant, Harare, ZW-167, Zimbabwe
Meixner, F X meixner@mpch-mainz.mpg.de, Max Planck Institute for Chemistry Biogeochemistry Department, Joh.-J.-Becherweg 27, Mainz, 55128, Germany

In summer 2007 we measured concentration gradients of NH₃, HNO₃, HONO and related aerosol species NH₄⁺ and NO₃⁻ as well as SO₂, and aerosol SO₄²⁻ above a spruce canopy in south-east Germany (50° 09"N, 11° 52"E, 775m asl). Measurements were performed as part of an intensive observation period within the framework of the EGER (ExchanGE processes in mountainous Regions) project. NH₃, HNO₃, HONO, SO₂, aerosol NH₄⁺, aerosol NO₃⁻, and aerosol SO₄²⁻ were measured using the Gradient Analyzer for Aerosols and Gases, mounted on

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

a tower. Water-soluble gases and aerosol species were collected simultaneously at two different heights by two rotating wet-annular denuders and two Steam-Jet Aerosol Collectors, respectively. Samples were analysed on-line via ion chromatography and flow injection analysis. To our knowledge this was the first time that these gas and aerosol species were measured simultaneously and with high time resolution (30 min) above a forest canopy. Data accuracy and precision is provided by a rigorous data screening, including the use of an internal standard, careful error estimation and repeated in- field blanks. Gradient precision of the measurements are derived from extended periods of side-by-side sampling of the sample boxes (n = 257). NH₃ mixing ratios reached their maximum in the late afternoon with 2 to 3 ppb and their minimum in morning hours with 0.25 ppb, whereas aerosol NH₄⁺ mirrored this behaviour with maximum values late night and early morning with 4 up to 8 ppb and minimum values in the afternoon, around 0.5 ppb and less. HNO₃ and aerosol NO₃⁻ diel cycles also mirrored each other, HNO₃ maxima during late afternoon (above 1 ppb) and minimum during night and early morning with less than 0.2 ppb and aerosol NO₃⁻ maxima during night (around 2 ppb, up to 6 ppb) and minima during afternoons with 0.5 ppb. Patterns of aerosol NH₄⁺ and aerosol NO₃⁻ in the time series are apparently closely related. NH₃ gradients indicate bidirectional fluxes, whereas HNO₃ gradients are indicating net deposition. These gradients may be biased by micrometeorology and chemistry. For example, gradients in NH₃ and HNO₃ may be product of a phase change in the thermodynamic equilibrium between NH₃, HNO₃ and particulate NH₄NO₃, induced by a temperature and/or humidity gradient above the forest canopy. The equilibrium will be investigated for the pure NH₃- HNO₃- NH₄NO₃ triad as well as for more complex inorganic aerosol mixtures and chemical timescales will be compared to turbulent timescales, to estimate the potential of chemical interferences affecting the gradient. If compounds react sufficiently slow and may therefore be treated as passive tracers, prerequisites for the application of micrometeorological methods to derive fluxes from gradients will be investigated.

B23A-0403

Use of Laboratory and Remote Sensing Techniques to Estimate Vegetation Patch Scale Emissions of Nitric Oxide From an Arid Kalahari Savanna

* Feig, G T feig@mpch-mainz.mpg.de, Max Planck Institute for Chemistry, Biogeochemistry Department, PO Box 3060, Mainz, 55020, Germany

Mamtimin, B mamtimin@mpch-mainz.mpg.de, Max Planck Institute for Chemistry, Biogeochemistry Department, PO Box 3060, Mainz, 55020, Germany

Meixner, F X meixner@mpch-mainz.mpg.de, Department of Physics, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, ZW-167, Zimbabwe

Meixner, F X meixner@mpch-mainz.mpg.de, Max Planck Institute for Chemistry, Biogeochemistry Department, PO Box 3060, Mainz, 55020, Germany

The biogenic emission of nitric oxide (NO) from the soil has an important impact on a number of environmental issues, such as the production of tropospheric ozone, the cycle of the hydroxyl radical (OH) and the production of NO. Arid regions cover a significant proportion of the earth's surface; however there have been relatively few studies on the biogenic emissions of NO from these ecosystems. In this study we collected soils from four differing vegetation patch types (Pan, Annual Grassland, Perennial Grassland and Bush Encroached) in an arid savanna

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

ecosystem in the Kalahari (Botswana). A laboratory incubation technique was used to determine the net potential NO flux from the soils as a function of the soil moisture and the soil temperature. The net potential NO emissions were then up-scaled for the year 2006 and a region (185km x 185km) of the southern Kalahari. For that we used (a) the net potential NO emissions measured in the laboratory, (b) the vegetation patch distribution obtained from Landsat NDVI measurements, (c) estimated soil moisture contents obtained from ENVISAT ASAR measurements, and (d) the soil surface temperature estimated using MODIS MOD11A2 8 day land surface temperature measurements. There are differences in the net potential NO fluxes between differing vegetation patches which range from 0.27 ng m⁻² s⁻¹ in the Pan patches to 2.95 ng m⁻² s⁻¹ in the Perennial Grassland patches. Up-scaling results in NO fluxes of up to 323 g ha⁻¹ month⁻¹, where the highest up-scaled NO fluxes occurred in the Perennial Grassland patches, and the lowest in the Pan patches. A marked seasonal pattern was observed where the highest fluxes occurred in the austral summer months (January and February 2006) while the minimum fluxes occurred in the austral winter months (June and July 2006) where the up-scaled NO fluxes were less than 1.8 g ha⁻¹ month⁻¹. Over the course of the year the mean NO emission for the up-scaled region was 0.54 kg ha⁻¹ yr⁻¹, which accounts for a loss of up to 7.4% of the nitrogen input to the region through atmospheric deposition and biological nitrogen fixation. The biogenic emission of NO from the soil is therefore an important mechanism of N loss from this arid savanna ecosystem and has the potential to play an important role in the production of tropospheric ozone and the OH cycle.

B23A-0404

A Mechanistic, Globally-Applicable Model Of Plant Nitrogen Uptake, Retranslocation And Fixation

* Fisher, J B joshbfisher@gmail.com, Oxford University, Environmental Change Institute School of Geography and the Environment South Parks Road, Oxford, OX1 3QY, United Kingdom

Tan, S Su-yin.tan@ouce.ox.ac.uk, Oxford University, Environmental Change Institute School of Geography and the Environment South Parks Road, Oxford, OX1 3QY, United Kingdom
Malhi, Y yadvinder.malhi@ouce.ox.ac.uk, Oxford University, Environmental Change Institute School of Geography and the Environment South Parks Road, Oxford, OX1 3QY, United Kingdom

Fisher, R A rosie.fisher@sheffield.ac.uk, University of Sheffield, Department of Animal and Plant Sciences, Sheffield, S10 2TN, United Kingdom

Sitch, S stephen.sitch@metoffice.gov.uk, Met Office (JCHMR), Maclean Building Crowmarsh Gifford, Wallingford, OX10 8BB, United Kingdom

Huntingford, C chg@ceh.ac.uk, Centre for Ecology and Hydrology, Maclean Building Crowmarsh Gifford, Wallingford, OX10 8BB, United Kingdom

Nitrogen is one of the nutrients that can most limit plant growth, and nitrogen availability may be a controlling factor on biosphere responses to climate change. We developed a plant nitrogen assimilation model based on a) advective transport through the transpiration stream, b) retranslocation whereby carbon is expended to resorb nitrogen from leaves, c) active uptake whereby carbon is expended to acquire soil nitrogen, and d) biological nitrogen fixation whereby

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

carbon is expended for symbiotic nitrogen fixers. The model relies on 9 inputs: 1) net primary productivity (NPP), 2) plant C:N ratio, 3) available soil nitrogen, 4) root biomass, 5) transpiration rate, 6) saturated soil depth, 7) leaf nitrogen before senescence, 8) soil temperature, and 9) ability to fix nitrogen. A carbon cost of retranslocation is estimated based on leaf nitrogen and compared to an active uptake carbon cost based on root biomass and available soil nitrogen; for nitrogen fixers both costs are compared to a carbon cost of fixation dependent on soil temperature. The NPP is then allocated to optimize growth while maintaining the C:N ratio. The model outputs are total plant nitrogen uptake, remaining NPP available for growth, carbon respired to the soil and updated available soil nitrogen content. We test and validate the model (called FUN: Fixation and Uptake of Nitrogen) against data from the UK, Germany and Peru, and run the model under simplified scenarios of primary succession and climate change. FUN is suitable for incorporation into a land surface scheme of a General Circulation Model and will be coupled with a soil model and dynamic global vegetation model as part of a land surface model (JULES).

B23A-0405

Patterns in Nitrogen Cycling Across Diverse California Soils Subjected to Nitrogen Inputs

* Yang, W H wendy_yang@berkeley.edu, Department of Environmental Science, Policy, and Management, Ecosystem Sciences Division, University of California 137 Mulford Hall, MC #3114, Berkeley, CA 94122,

Ryals, R bryals@nature.berkeley.edu, Department of Environmental Science, Policy, and Management, Ecosystem Sciences Division, University of California 137 Mulford Hall, MC #3114, Berkeley, CA 94122,

Cusack, D dcusack@nature.berkeley.edu, Department of Environmental Science, Policy, and Management, Ecosystem Sciences Division, University of California 137 Mulford Hall, MC #3114, Berkeley, CA 94122,

Silver, W wsilver@nature.berkeley.edu, Department of Environmental Science, Policy, and Management, Ecosystem Sciences Division, University of California 137 Mulford Hall, MC #3114, Berkeley, CA 94122,

California receives the highest rates of anthropogenic nitrogen (N) deposition in the western USA. Changes in N cycling with N deposition are likely to be strongly influenced by native soil C and N content. We performed a ten-month long laboratory incubation using soils from 33 California ecosystems, including deserts, wetlands, grasslands, shrublands and forests, which ranged widely in soil C (0.07-5.40%) and N (0.009-0.35%) content. Plant-free soils were maintained at field capacity and four treatment levels of N (0, 5, 20, 80 kg-N/ha/y equivalent) were added as ammonium nitrate solution weekly. We measured gross N cycling rates, dissimilatory NO₃ reduction to NH₄ (DNRA), and soil C and N content initially and after ten months. Soil N cycling rates did not respond to the N addition treatments but differed by ecosystem both initially and after incubation. Initially, wetlands and forests had the highest gross mineralization rates, and shrublands had the highest gross nitrification rates. After ten months, desert soils exhibited lower gross nitrification rates and wetland soils exhibited higher DNRA rates compared to all other ecosystems ($p < 0.001$). Inorganic N pools and soil C content were strongly predictive of N cycling rates though the controls on N cycling rates generally differed

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

before and after incubation. Across biomes, initial gross mineralization rates were best predicted by soil NH₄ and NO₃ concentrations whereas final rates were best predicted by final C content (R²= 0.39 and 0.43, respectively). Initial gross nitrification rates were best predicted by the combination of soil NH₄ concentrations, total soil N content, and DNRA rates (R²= 0.49). However, final gross nitrification rates were best predicted by initial C content and final NO₃ concentrations (R²= 0.73). In contrast, both initial and final DNRA rates were best predicted by final soil NH₄ and NO₃ concentrations (R²= 0.83 and 0.73, respectively). Neither final soil NH₄ and NO₃ concentrations nor final soil C content were correlated with N addition. These results suggest that microbial processes were relatively insensitive to N inputs in the long-term laboratory incubation.

B23A-0406

Topographic Controls of CH₄ and N₂O Fluxes from Deciduous Forest Soils, southern Quebec

* Ullah, S sami.ullah@mcgill.ca, Department of Geography, and Global Environmental & Climate Change Centre, McGill University, 805 Sherbrooke St. W, Montreal, QC H3A 2K6, Canada

Moore, T R tim.moore@mcgill.ca

Forest landscapes are not homogenous, but consist of a mosaic of well and poorly drained soils determined by topography. Variation in topography and drainage classes influences biogeochemical controllers of CH₄ and N₂O fluxes from soils such as moisture, N mineralization and production and decomposition of organic carbon. We measured N₂O and CH₄ fluxes from two deciduous forests near Montreal, along transects running from high-elevation, well-drained to low-elevation, poorly-drained soils. One site is an old-growth and the other, a mature semi-managed forest dominated by American beech and sugar maple trees. In-situ gas fluxes were measured bi-weekly using static chambers from May 2006 to May 2008. Well-drained soils consume 13:1 while poorly-drained soils emit 92:22 g CH₄ m⁻² y⁻¹. CH₄ consumption in well-drained soils in the old-growth forest site was more than twice as large than in the semi-managed forest due mainly to higher soil porosities in the old-growth forest supporting faster diffusion of CH₄ into consumption sites. Soil moisture, temperature and CO₂ emission rates were the main controllers of hourly CH₄ fluxes at plot scale both in well and poorly-drained soils. Well-drained soils emitted 37:8 and poorly-drained soils emitted 115:35 mg N₂O-N m⁻² y⁻¹. On certain sampling dates, atmospheric N₂O was consumed ranging from -237 to -9 mg N₂O-N m⁻² y⁻¹. N₂O consumption was mainly driven by higher soil organic C substrate, low soil NO₃ contents under anoxic conditions. Background, seasonal and even-based N₂O fluxes were apparent from these sites. Hourly N₂O flux rates at plot scale were highly variable and did not correlated with any environmental variable; however, averaged annual emission rates were markedly controlled by soil C:N ratios, N mineralization rates and soil NO₃ contents. Our data shows that seasonal CH₄ fluxes at watershed scale can be estimated using soil moisture, temperature and drainage class, while annual N₂O fluxes can be estimated using soil C:N ratios. Topographic position need to be accounted when modeling CH₄ and N₂O fluxes from forested landscapes in Canada.

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

B23A-0407

Using The Ecosys Mathematical Model to Simulate Topographic Effects on Spatial Variability of Nitrous Oxide Emissions from an Agricultural Soil

* Metivier, K metivier@ualberta.ca, Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3, Canada

Grant, R F robert.grant@ales.ualberta.ca, Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3, Canada

Pattey, E pattey@agr.gc.ca, Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, Ottawa, ON K1A 0C5, Canada

Calculation of emission factors (EFs) for nitrous oxide (N₂O) is complicated by their large spatial variability. The objective of this study was to test the hypotheses that spatial variation in N₂O emissions can be explained by (1) spatial and temporal variation in soil water-filled pore space (WFPS) among topographic positions that shed or collect water according to topographically-driven water movement, and (2) spatial variation in soil properties which may themselves be caused by topographically driven water movement. These hypotheses have been incorporated into a detailed processed-based, three-dimensional mathematical model of terrestrial ecosystems, ecosys. We simulated emissions using ecosys at different spatial scales □ meter, fetch and field, using a 20 x 20 matrix of 36m x 36m grid cells from a digital elevation model (DEM) to represent topography of a fertilized agricultural field in Ottawa, Canada. Modeled results were compared to fluxes measured with chambers placed at different topographic positions to measure spatial variability of N₂O emissions at the meter scale, and with stationary and mobile flux towers with tunable diode lasers (TDL) and a flux-gradient technique to assess spatial N₂O variability at the fetch scale. Most modeled and measured emissions occurred during a 10-day interval during late spring/early summer, due to a combination of fertilizer N application, rainfall and rising soil temperatures. Coefficients of spatial variation (CSVs) amongst 4 chamber replicates (2 x 3 m grid) during emission events were 28 to 195%, indicating that spatial variation of N₂O occurs at a very small spatial scale. Modeled annual CSVs at the field scale rose from 25% (uniform soil) to 101% when soil properties in the model were allowed to vary according to results from a field soil survey. The modeled EF (uniform soil properties) assumed for 112 kg N ha⁻¹ was larger in an area of the field with lower topography (0.3%) compared to one with higher (0.1%). EFs were comparatively low because nitrification of fertilizer N occurred in slightly cooler soil temperatures compared to long-term normals for this site. These results show the importance of the use of 3-dimensional models such as ecosys at an hourly time-step with input from DEMs, to fully capture the large spatial and temporal variability of N₂O at different spatial scales even in seemingly flat (0.2% slope) landscapes.

B23A-0408

Climate warming and N deposition in a temperate ecosystem: does winter warming increase N losses?

* Henry, H A hhenry4@uwo.ca, University of Western Ontario, Department of Biology, London, ON N6A 5B7, Canada

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

Turner, M mturne27@uwo.ca, University of Western Ontario, Department of Biology, London, ON N6A 5B7, Canada

Changes in soil freezing dynamics caused by climate warming may reduce the retention of atmospheric N deposition over winter in temperate ecosystems as a result of either increased rates of N mineralization at a time when plants roots are largely inactive or as a consequence of increases in the intensity and frequency of soil freeze-thaw cycles. We examined the recoveries of trace amounts of ¹⁵N-labeled nitrate and ammonium added to the soil surface at spring thaw in the context of a factorial warming and N addition experiment designed to simulate future climate and N deposition rates in a temperate old field. We sampled plant shoots, roots and bulk soil the fall after the addition of the label and again the next spring to examine both the fate of N added at spring melt and the retention and redistribution of this N over winter, respectively. In the fall, recovery of ¹⁵N from the added ammonium was approximately double that of the added nitrate in both roots and soil but there were no significant effects of either the warming or nitrogen addition treatments on recovery of the added ¹⁵N. Over winter, there was a net loss of the label from soil in the N addition plots but a net increase of the label in soil from control plots that received no added nitrogen, whereas losses of the label from roots and shoots were equal for both the treatment and control. In spring, both roots and shoots contained approximately one quarter more of the label in warmed plots than in ambient temperature plots, whereas both plant shoots and soil contained approximately one quarter less label in nitrogen addition plots than in control plots. Overall, these results reveal that contrary to our hypothesis that warming would enhance ecosystem losses of nitrogen by disrupting soil freezing dynamics, increased N retention in warmed soil instead offset N losses in nitrogen enriched soils after one year.

B23A-0409

Source Apportionment of Sulfur and Nitrogen Species at Rocky Mountain National Park using Modeled Conservative Tracer Releases and Tracers of Opportunity

* Schichtel, B A schichtel@cira.colostate.edu, National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO 80523-1375, USA
Malm, W C malm@cira.colostate.edu, National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO 80523-1375, USA
Barna, M G Barna@cira.colostate.edu, National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO 80523-1375, USA
Gebhart, K A Gebhart@cira.colostate.edu, National Park Service, Cooperative Institute for Research in the Atmosphere, Colorado State University, Fort Collins, CO 80523-1375, USA
Collett, J L collett@atmos.colostate.edu, Colorado State University, Department of Atmospheric Science, Fort Collins, CO 80523-1371, USA
Kreidenweis, S M sonia@atmos.colostate.edu, Colorado State University, Department of Atmospheric Science, Fort Collins, CO 80523-1371, USA

Visibility degradation and changes in ecosystem function in Rocky Mountain National Park (RMNP) are occurring because of emissions of nitrogen and sulfate species along the Front Range of the Colorado (CO) Rocky Mountains, as well as sources farther east and west. The nitrogen compounds include oxidized, reduced, inorganic, and organic nitrogen. The Rocky

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

Mountain Atmospheric Nitrogen and Sulfur study (RoMANS) was initiated to better understand the origins of sulfur and nitrogen species as well as the complex chemistry occurring during transport from source to receptor. This included a source apportionment assessment to identify the relative contributions to atmospheric sulfur and nitrogen species in RMNP from within and outside of the state of CO; from emission sources along the Colorado Front Range; as well as the relative contributions from mobile sources, agricultural activities, and large and small point sources within CO. As part of the study, a monitoring program was conducted for two 5-week periods, one during the spring, the other during late summer. Monitoring data of ammonium/ammonia, nitrogen oxide/nitrates, and sulfur dioxide/sulfates were combined with tracers of opportunity and modeled releases of conservative tracers from source regions around the USA to apportion these species to their respective sources, using a variety of receptor modeling tools. The preliminary results show that during the spring a larger fraction of nitrogen and sulfur species came from sources within CO than during the summer. Specifically, during the spring, sources within CO contributed more than 80% of the ambient NH₃, NH₄⁺, HNO₃, and particulate NO₃⁻; 50% of SO₂ and 30% of particulate SO₄ came from sources within CO. During the summer period CO sources contributed to about 75% of the ambient NH₃ and 55-60% of the NH₄⁺ and HNO₃; 30% of SO₂, and 20% of particulate SO₄.

B23A-0410

The Nitrogen Budget for a Mediterranean Chamise (*Adenostoma fasciculatum* L.) Dominated Watershed, Sierra Nevada, CA

* Homyak, P M peter.homyak@email.ucr.edu, University of California, Riverside, 900 University Avenue Department of Environmental Sciences, Riverside, CA 92521, USA
Sickman, J O james.sickman@ucr.edu, University of California, Riverside, 900 University Avenue Department of Environmental Sciences, Riverside, CA 92521, USA
Miller, A E Amy_E_Miller@nps.gov, National Park Service Inventory and Monitoring Program, 240 West 5th Ave, Anchorage, AK 99501, USA
Melack, J M melack@bren.ucsb.edu, University of California, Santa Barbara, Donald Bren School of Environmental Science & Management, Santa Barbara, CA 93106, USA
Skeen, K kskeen@wildblue.net, University of California, Santa Barbara, Donald Bren School of Environmental Science & Management, Santa Barbara, CA 93106, USA

Chaparral ecosystems in Southern California receive among the highest rates of atmospheric N deposition in the country. Elevated N additions are known to induce deleterious effects to both terrestrial and aquatic ecosystems such as direct effects on plant physiology, soil acidification, and eutrophication. We studied N dynamics in a 4.3-hectare Chamise dominated watershed located in the foothills of the western Sierra Nevada to document the response of seasonally dry Mediterranean catchments to elevated rates of N deposition. During our study, we monitored stream water DIN, DON, DOC, base cations, and chloride during the 2003 and 2004 water years. Preliminary results suggest that despite elevated N inputs of approximately 10 kg N ha⁻¹ yr⁻¹ based on Fenn collectors, only about 0.02 kg N ha⁻¹ yr⁻¹ were exported in streamwater. DIN export patterns were typical of Mediterranean ecosystems exhibiting a strong nitrate flush during storms at the onset of the wet season, but with DIN concentrations remaining elevated regardless

American Geophysical Union Meeting 2008
Biogeosciences [B]: The Bioatmospheric N Cycle

of decreases in stream discharge. Further research will provide a better understanding of N dynamics as we integrate measurements of DON, DOC, base cations, and chloride.

B23A-0411

Riparian Invasive Alters Stream Nitrogen Dynamics.

* Mineau, M minemade@isu.edu, Idaho State University, Department of Biological Sciences, Stream Ecology Center, 605 Memorial drive, Pocatello, ID 83201, USA

Baxter, C baxtcold@isu.edu, Idaho State University, Department of Biological Sciences, Stream Ecology Center, 605 Memorial drive, Pocatello, ID 83201, USA

Marcarelli, A Marcamy@isu.edu, Idaho State University, Department of Biological Sciences, Stream Ecology Center, 605 Memorial drive, Pocatello, ID 83201, USA

Minshall, G minswayne@isu.edu, Idaho State University, Department of Biological Sciences, Stream Ecology Center, 605 Memorial drive, Pocatello, ID 83201, USA

Invasive species may be most likely to have strong effects on the ecosystem they invade when they contribute a new function such as nitrogen (N) fixation. Russian olive (*Eleagnus angustifolia*) is a non-native invasive tree which is rapidly spreading along riparian corridors in the American West. Russian olive is a nitrogen fixing plant due to a symbiotic relationship with Actinomycetes and is invading systems that frequently lack a strong native N fixer. The contribution of reactive N by these invasive riparian plants to soils may also be altering N cycling and processing in the adjacent streams. We measured nutrient limitation via periphyton growth on nutrient diffusing substrates and nitrate uptake using short term nitrate additions in Deep Creek, ID. Measurements were made in three reaches along a Russian olive invasion gradient, with an upstream reference reach that has no Russian olive and two downstream invaded reaches, one with moderate density and one with high density. Periphyton growth in Deep Creek was significantly N limited in the reference reach while the moderately invaded reach showed no significant limitation and the highly invaded reach was significantly P limited. The nitrate uptake velocity (V_f) for both of the invaded reaches was an order of magnitude less than the reference reach, implying that biological demand for nitrate is significantly less in the invaded reaches than the reference. Considering the current extent of Russian olive invasion and its continued rapid spread, possible alteration of N cycling in waterways may have important implications for the management of both this invasive species and management of nutrient pollution in waters of the western U.S.