

uptake and back diffusion of CO₂ that has undergone isotopic exchange in the leaves, details of the processes which govern the interannual variability in carbon exchange can be exposed with isotopic analysis. Using a sophisticated model of biospheric exchange of water and CO₂ isotopes, we contrast interannual variability of modeled CO₁₈O fluxes for the period 1947-2002 with measurements from the CMDL flask network. Our analysis focuses on attributing the changes in CO₁₈O fluxes to changes in the plant physiology during times of drought stress, and changes in the isotopic state of water during those times. Water within leaves, with which the CO₂ equilibrates, changes at the same time as the physiological response, the fluxes contain a commingled signal of the two. Specifically, during times of drought, precipitation and soil water are enriched relative to the climatology due to a greater dominance of evaporation, and without consideration can mask the contributions from changes in leaf level exchange. Within the model these two components may be quantified explicitly, though testing the sensitivity to the isotopic content of precipitation. Further complications arise when the net ecosystem exchange is considered due to changes in the partitioning of CO₂ fluxes between plant processes and soil respiration. This partitioning is quantified in the model simulations. In discussion we consider the contribution to the interannual variability associated with enhanced fire activity, also in phase with ENSO, and thus the importance of fire in the global CO₁₈O variability.

B41B-03 0910h

Stable Carbon Isotope Composition and Stomatal Density of the Conifer Genus *Frenelopsis*: Effect of pCO₂, Species and Soil Salinity

Anne-Marie Aucour¹ (aucour@univ-lyon1.fr)

Bernard Gomez² (Bernard.Gomez@univ-lyon1.fr)

Frederic Thevenard¹ (frederic.thevenard@univ-lyon1.fr)

Simon Sheppard³ (Simon.Sheppard@ens-lyon.fr)

¹CNRS UMR 5125, Universite Lyon1, Villeurbanne Cedex 69622, France

²School of Earth Sciences, University of Leeds, Leeds LS2 9JT, United Kingdom

³CNRS UMR 5570, ENSL, Lyon 69007, France

Experimental studies indicate that some modern conifers adjust their stomatal numbers in response to variations of atmospheric pCO₂, suggesting that fossil conifer leaves may provide a proxy of pCO₂. The stable carbon isotope composition of plants provides an additional constraint on the conditions during plant growth as it is known to vary, for a single species, with the δ¹³C of the source CO₂, and environmental factors such as soil salinity and water content. Our objectives were to document the variation of the stable carbon isotope composition of the fossil *Coniferale* *Frenelopsis* through the Cretaceous and to decipher the effect of pCO₂, environmental and genetic factors on the fossil record. The leaf cuticles of *Frenelopsis* present a large variation in δ¹³C values from 27‰ for *F. ugnensis* growing on freshwater lake shores to 21‰ for species growing on brackish to marine environments. The species growing on freshwater lake shore presents an increase in ¹³C through the Barremian that is consistent with an increase in aridity. It presents a low stomatal density (SD) and index (SI: stomates over stomates plus epidermal cells). Comparison of the SD and SI within a single population shows that the variability in SD essentially reflects that of the cellular size and growth rate. The δ¹³C values of species growing in brackish to marine environment are all similar but higher than freshwater ones in the late Albian. They decrease in the Cenomanian, with a much larger intrapopulation variability. This shift can be related to a switch from marine to brackish conditions as well as to more global change. SD and SI are higher for the late Albian-Cenomanian cuticles and appear not sensitive to the environmental change (presumably a switch from marine to more brackish conditions) recorded in the δ¹³C. The large variability in both SD and SI within the studied populations in the marine-brackish environment appears to be related to change in the stomates over epidermal cells ratio during the leaf growth.

B41B-04 0925h

Implementation of a New Isotopic Tool (18O/16O in dissolved O₂) for the Management of Oxygen in the Grand River, an Impacted Watershed in S. Ontario

Terra S Jamieson¹ (519-888-4567 ext. 7284; tsjamies@uwaterloo.ca)

Sherry L Schiff¹ (519-888-4567 ext. 2473; sschiff@uwaterloo.ca)

William D Taylor² (519-888-4567 ext. 2556; wdtaylor@uwaterloo.ca)

¹Department of Earth Sciences, University of Waterloo, 200 University Ave. W., Waterloo, ON N2L 3G1, Canada

²Department of Biology, University of Waterloo, 200 University Ave. W., Waterloo, ON N2L 3G1, Canada

Oxygen (O₂) is essential for supporting life in aquatic ecosystems, and mediates the geochemistry of the aquatic environment. Recent analytical development now permits rapid analysis of the 18O/16O ratio of dissolved oxygen (DO) in water. The 18O/16O ratio provides insight into the main processes controlling DO concentrations in rivers: gas exchange, photosynthesis and respiration. Previously, this information was only available using indirect methods that involved laborious point scale measurements that are not amenable to routine sampling. The focus of this study is the Grand River, a Canadian Heritage River that drains into Lake Erie. The receives organic and nutrient inputs from sewage treatment plants, non-point agricultural sources, and serves as a source of drinking water and supports a significant recreational fishery. Dissolved oxygen concentrations in the Grand River can cycle from 2 mg/l to 14 mg/l in the summer during a 24 hour period. The concurrent shift in 18O/16O is greater than 10 permil on a diel basis. Rigorous sampling regimes are needed in dynamic systems that experience large fluxes in O₂. Diurnal curves were analyzed for DO and 18O/16O in DO during different seasons. Gas exchange is an important constraint on the diurnal flux of DO. Currently, gas exchange coefficients for the Grand River are typically obtained using empirical estimates based on results from other rivers. Analysis of 18O/16O offers a new method to allow for the direct determination of the gas exchange coefficient for DO in rivers with diurnal cycles.

B41B-05 0940h

Evaluation of Stream Metabolism by Integration of Chemical, Isotopic, and Modeling Approaches

Craig R. Tobias¹ (703 648 5827; crtobias@usgs.gov)

JohnKarl Böhlke¹ (703 648 6325; jkbohlke@usgs.gov)

Judson W. Harvey¹ (703 648 5876; jwharvey@usgs.gov)

Karen L. Casciotti¹ (703 648 5818; kcasciot@usgs.gov)

Mary A. Voytek¹ (703 648 6894; mavoytek@usgs.gov)

¹US Geological Survey, MS 431 12201 Sunrise Valley Dr., Reston, VA 20192, United States

Robust estimates of stream metabolism are essential for understanding the mechanisms controlling turnover and downstream export of carbon, nitrogen, and other bioelements on watershed scales. Although reach-scale metabolism estimates have become fairly common in streams, the widely used "open-channel diel O₂-change approach" has uncertainties involving some assumptions that have not been evaluated fully. For example, metabolism estimates in small shallow streams may be particularly sensitive to variability in gas transfer rates (which are not typically measured simultaneously with the O₂ concentration change), and may be subject to diel changes in respiration (which is typically assumed to be constant). In an effort to improve reach-scale metabolism estimates, we combined O₂-change measurements with simultaneous SF₆ gas transfer measurements and isotopic analyses of dissolved O₂ and inorganic carbon (DIC). In-stream tracer experiments and measurements were conducted in a first-order stream in an agricultural watershed during June and September, 2003. Closed-system water and sediment incubation experiments were also conducted to determine the stream-specific δ¹⁸O₂ isotope fractionation factor for respiration. Diel variation in O₂ and DIC concentration were reach-specific likely reflecting the size of the algal community, stream orientation (e.g. irradiance), and water depth. Stream reaches that supported high primary production were also characterized by large diel swings in δ¹⁸O₂ (12 ‰) and δ¹³C-DIC (3.5 ‰). DIC concentration and isotopes mirrored changes in O₂ and δ¹⁸O₂ but lagged by up to 2 hours. Gas transfer rates varied approximately 20% during the study in response to changes in windspeed. Rates of photosynthesis (P) and respiration (R) were estimated by various methods involving different combinations of data. Steady state models included the diel O₂-change method with tracer gas transfer data to determine P and R, and a combination of O₂ and δ¹⁸O₂ data to determine steady-state P:R ratios. The steady-state models were compared with numerical simulations using O₂, δ¹⁸O₂, DIC, CO₂, and δ¹³C-DIC data that accounted for non-steady-state conditions such as gas transfer, temperature, and reaction rates.

B41B-06 0955h

Isotopic Fractionation of Selenium Oxyanions in Wetlands

Scott K Clark¹ (1-217-244-6048; skclark@uiuc.edu)

Thomas M Johnson¹ (1-217-244-2002; tmjohnsn@uiuc.edu)

¹University of Illinois Dept. of Geology, 1301 W. Green Street, Urbana, IL 61801, United States

As oxic surface waters pass through aquatic macrophytes and over anoxic sediments in wetlands and lakes, the dissolved Se load often decreases; and, Se isotope ratio measurements can provide information about the mechanisms involved. Previous work on microbially induced isotopic fractionation of Se oxyanions under nearly natural conditions using wetland sediments shows consistent Se isotopic shifts during reduction of Se(VI) and Se(IV) to insoluble Se(0). However, previous isotopic studies of total dissolved selenium in wetlands found little to no isotopic shift as dissolved selenium concentrations decreased. This suggests that plant/algal uptake, followed by deposition and degradation, is the primary route of Se transfer into sediments. However, it is possible that the effective isotopic fractionation between Se in the surface water and Se deposited into sediments is somehow much less than the fractionation induced by the reduction reaction, or that cycling of organically bound Se is involved. In this study, we report Se isotope data for Se(VI), Se(IV) and total dissolved Se, Se(T), in surface waters from three wetland/lake sites: Sweitzer Lake, CO; 33-Mile Reservoir, WY; and, a small pond adjacent to Benton Lake, MT. We isolated Se(IV) via hydride generation, and Se(VI) via ion exchange. Se(T), including any organic components, was also analyzed. Isotope analysis was performed on an Isoprobe MC-ICPMS, using a method modified from that of Rouxel et al. (2002). We used the ⁸²Se + ⁷⁴Se double spike approach, and spiked samples before species separation. Our results for all three locations indicate similar trends in concentration changes and isotopic shifts between the inflow and outflow waters. Se(T) concentrations decrease by 45-70%, and Se(VI) concentrations decrease by 60-90%, whereas Se(IV) concentrations increase by 60-150%. Concomitant ⁸⁰Se/⁷⁶Se shifts are +0.5-0.8‰ for Se(T); -0.1-0.5‰ for Se(VI); and +0.4-6.5‰ for Se(IV). These data provide greater species-specific information than those from previous studies, but they similarly suggest that Se(VI) uptake is dominated by plant or algae assimilation: a process that involves little or no isotopic fractionation. On the other hand, Se(IV) is likely reduced by microbes or abiotic reductants in the sediments. The slight shift toward isotopically lighter Se(VI) is enigmatic, but could be due to oxidation of isotopically light dimethylselenide to Se(VI) in the water column.

B42A CC: 524 A Thursday 1030h
Isotopes in Biogeochemistry: Plant Organic Matter and Soils

Presiding: S Trumbore, University of California, Irvine; **E Hobbie**, University of New Hampshire

B42A-01 1030h

Pre-Pollution Levels of Lead in Pristine Boreal Forest Soils

Jonatan Klaminder¹ (jonatan.klaminder@eg.umu.se)

Ingemar Renberg¹ (ingemar.renberg@eg.umu.se)

Richard Bindler¹ (Richard.Bindler@eg.umu.se)

¹Department of Ecology and Environmental Science, Umea University, Umea 90187, Sweden

Atmospheric lead pollution has an over 3500 year long history in Europe. Most of the emitted pollution lead originates from ores or coal mines having lead with low 206Pb/207Pb ratios typically between 1.05-1.19. In contrast, lead found in naturally occurring minerals in forest soils, i.e. geogenic Pb, in Sweden have 206Pb/207Pb ratios mainly above 1.30. The significant difference in isotope ratios of airborne lead pollution and natural soil lead provide excellent conditions for tracing lead cycling in boreal forest ecosystems. Previous stable lead isotope studies in Sweden have demonstrated extensive spatial and temporal pollution; even in quite remote areas there are no natural reference conditions to found. This lack of a natural reference values for lead, and for other pollutant metals, in the mor layer, i.e. the organic horizon overlying forest mineral soil of podsol type, make it difficult to assess the extent of modern soil pollution and the natural cycling of geogenic lead in forest ecosystems. We have simulated pre-pollution conditions and estimated a natural

background' level for lead in the mor layer using; i) the atmospheric pre-pollution deposition rate of lead, i.e. the deposition rate between 3500 yr BP and 6000 yr BP, estimated from radiocarbon-dated ombrotrophic peat cores in south Sweden; ii) the redistribution rate of lead from the mineral soil to the mor layer as a result of plant uptake, estimated from lead concentration measurements and stable isotope analysis of common forest plants; and iii) the residence time of lead in the mor layer, estimated using both ^{210}Pb -lead and stable lead isotopes as tracers. Our calculations suggest that the lead inventory in the mor layer was typically around 2 mg Pb m⁻² (maximum and minimum range of 1 to 20 mg m⁻²) during pre-pollution times. As a comparison, the present-day inventory of lead in a common Swedish boreal forest mor layer is mainly in the range of 300 to 1000 mg Pb m⁻². Our results illustrate the magnitude of diffuse atmospheric lead pollution of forest soils and the need of viewing metal pollution of soils in a long-term perspective.

B42A-02 1045h

Effects of Forest Clearing on Soil Organic Carbon Dynamics in Central Panama: Evidence from Natural ^{13}C Abundance, Physical Soil Fractionation and Carbon Mineralization

Luitgard C. Schwendenmann¹ (1-307-766-2484; lschw@uwyo.edu)

Elise G. Pendall¹ (1-307-766-2484; pendall@uwyo.edu)

¹University of Wyoming, Department of Botany, 3165 1000 E. University Avenue, Laramie, WY 82071, United States

Tropical ecosystems play an important role in the global carbon budget. About 44% of global soil organic carbon (SOC) is located in tropical areas. Forest clearing in tropical regions is estimated to contribute about 23% to human-induced CO₂ emissions. We use natural ^{13}C abundance coupled with soil fractionation techniques and incubation studies to evaluate SOC dynamics following forest clearing in Central Panama. Soil samples were taken at 0-5, 5-10, 10-15, 15-20, 20-30, 30-40 and 40-50 cm depths from an undisturbed forest site and an adjacent clearing where the forest was cut approximately 80 years ago. Carbon concentration throughout both profiles is highest in the macro-aggregate fraction (250-2000 μm). ^{13}C values of the macro-aggregate fraction of the undisturbed forest ranged from -25.9‰ to -21.1‰ in the topsoil to -21.1‰ to -18.3‰ in the subsoil. Carbon in the topsoil of the clearing was more enriched in ^{13}C (-18.3‰), reflecting the input of C4 vegetation with ^{13}C values of -16.8‰. The macro-aggregate fraction at both sites showed comparatively high ^{13}C values in the subsoil, suggesting that microbial fractionation enriched the older/deeper soil organic carbon. Particle-size and density fractionation will help elucidate this pattern. Mineralizable carbon from bulk soil was measured in an incubation experiment. The CO₂ flux and $^{13}\text{CO}_2$ signal of respired carbon were determined over time. On the first days of incubation the amount of CO₂ evolved did not differ between sites. However, $^{13}\text{CO}_2$ values from the clearing were more enriched compared to those from the forest site, indicating that the initial respiration is dominated by the actual, labile carbon pool. The values of ^{13}C for soil organic carbon and $^{13}\text{CO}_2$ will be used to determine the soil carbon pool sizes and to calculate the turnover time of soil organic carbon in this moist humid ecosystem. These experiments will contribute to parameterization of carbon cycle models for tropical ecosystems.

B42A-03 1100h

Partitioning Sources of Soil Respired CO₂ and Their Response to Moisture and Temperature Changes Using a Whole-Ecosystem Radiocarbon Tracer

Luz Maria Cisneros Dozal¹ (cisnerol@uci.edu)

Susan Trumbore¹ (setrumb@uci.edu)

Paul Hanson² (hansonpj@ornl.gov)

¹Department of Earth System Science, 3200 Croul Hall University of California, Irvine, Irvine, CA 92697-3100, United States

²Environmental Sciences Division, Oak Ridge National Laboratory, Bethel Valley Road, Building 1062, Oak Ridge, TN 37831-6422, United States

We use an isotope mass balance approach to estimate autotrophic (root respiration) and heterotrophic (decomposition of soil organic matter) sources of soil respiration. To partition the different components we take advantage of an atmospheric release of $^{14}\text{CO}_2$

that took place in the summer of 1999 at the Oak Ridge Reservation, Oak Ridge, Tennessee. ^{14}C analysis of tree ring cellulose in 1999 and leaves formed in the spring of 2000 showed the highest incorporation of the label in the western side of the reservation compared to the eastern side (Trumbore et al., 2002). A reciprocal leaf litter manipulation experiment (where litter values varied from +952 to +1055‰ and +215 to +230‰) replaced natural litter fall in 2001-2003 for soils that had a gradient in 1999 isotope label to roots thus allowing us to estimate the contributions of labeled leaf litter and root decomposition to the heterotrophic respiration component. During the growing seasons of 2002 and 2003, we measured total soil respiration and its ^{14}C signature using closed dynamic chambers and the ^{14}C signatures of heterotrophic (soil cores and leaf litter samples) and autotrophic (live roots) respiration using laboratory and field incubations. The highest total soil respiration flux measured was 480 ± 77 mg C/m²-hr in September of 2003 after rain and the lowest was 65 ± 11 mg C/m²-hr in March of 2003. The estimated fraction of total soil respiration coming from root respiration (FRR) across sites and growing seasons ranges from 20 to 80% with the highest contribution in early spring. The higher fluxes of root respired C however take place during the summer with a maximum estimated of 150 ± 20 mg C/m²-hr. Variations in FRR during the growing season seem to be linked more to phenology rather than to changing environmental conditions. Most of the seasonal variability in total soil respiration seems to be linked to heterotrophic sources. The contribution from the decomposition of the labeled leaf litter to total soil respiration varied from 2 to 40% with the variation strongly controlled by changes in moisture content. Incubations of leaf litter and 0-5 cm soil cores at different temperature and moisture levels will help elucidate the effect of these factors on the heterotrophic component.

Trumbore S., Gaudinski J., Hanson P., Southon J. (2002). Quantifying ecosystem-atmosphere carbon exchange with a ^{14}C label, EOS 83, 265-268

B42A-04 1115h

Microbial Substrate Usage Indicated by C-14 Contents of Phospholipid Fatty Acids From Soil Organic Matter

Janet Rethemeyer¹ (+49-431-880-7399; jrethemeyer@leibniz.uni-kiel.de)

Marie J Nadeau¹ (+49-431-880-7390; mnadeau@leibniz.uni-kiel.de)

Pieter M Grootes¹ (+49-431-880-3894; pgrootes@leibniz.uni-kiel.de)

Christiane Kramer² (+49-3641-576145; ckramer@bgc-jena.mpg.de)

Gerd Gleixner² (+49-3641-576172; gerd.gleixner@bgc-jena.mpg.de)

¹Leibniz Laboratory for Radiometric Dating and Isotope Research, Max-Eyth Str. 11, Christian Albrecht University, Kiel 24118, Germany

²Max Planck Institute for Biogeochemistry, Winzerlaer Strasse 10, Jena 07745, Germany

Phospholipid fatty acids (PLFAs) are generally associated with viable (bacterial) cell membranes. They are thought to be short-lived under normal soil conditions. We compare the C-14 levels in PLFAs obtained from soil samples from the "clean" experimental site at Rothalmünster (Germany) with those from the agricultural research station at Halle (Germany), where the soil is contaminated with "old" carbon from lignite mining and industry. The most abundant PLFAs were isolated via preparative capillary gas chromatography of their methyl-esters at the Max-Planck Institute, Jena, and their C-14 concentration was determined via accelerator mass spectrometry at the Leibniz-Labor, Kiel. The C-14 levels of three mono-unsaturated fatty acids (n-C17:1, n-C18:1 (and n-C16:1)) are not statistically significant different from those of the contemporaneous atmosphere, indicating these fatty acids were derived from fresh plant material. C-14 levels significantly above those of the atmosphere in three saturated fatty acids (i/a-C15:0, n-C16:0 and cy-C18:0) from the surface soil of Rothalmünster must derive from carbon fixed from the atmosphere several years earlier, when levels of bomb-C-14, remaining from the atmospheric nuclear weapons tests, especially of the early 1960s, were still higher. Lower C-14 levels in the same compounds from the Halle surface soil indicate the incorporation of "old" contaminant carbon. A below-atmospheric C-14 concentration in n-C18:0 in Rothalmünster surface soil may reflect the partial incorporation of carbon from older, pre-bomb times. The C-14 concentrations show these PLFAs were synthesized predominantly from recent to sub-recent photosynthetic compounds, while the significant differences in C-14 concentration, observed between the PLFAs, indicate their production from soil organic matter fractions of different (recent) age and C-14 content. The Halle results show "old" carbon may be incorporated into PLFAs and thus reenter the soil carbon cycle.

B42A-05 1130h

A Theoretical Analysis of Steady State $\delta^{13}\text{C}$ Profiles of Soil Organic Matter

Michael A. Poage¹ (724-357-5627; mpoage@iup.edu)

Xiahong Feng² ((603)646-1712; xiahong.feng@dartmouth.edu)

¹Indiana Univ. of Pennsylvania, Department of Geosciences, Indiana, PA 15705, United States

²Dartmouth College, 6105 Fairchild, Hanover, NH 03755, United States

Soil organic matter (SOM) represents the largest carbon pool affecting the short-term global carbon cycle, and understanding its dynamics is important for predicting the future climate. Carbon isotopic composition of soil organic matter has been shown to be useful for understanding soil carbon turnover rates and processes affecting soil carbon accumulation and decomposition. However, there have been few process-oriented attempts to quantify carbon isotope variations in soil organic matter. Particularly, there have been very limited efforts to couple carbon isotope distribution in soils with variations in carbon concentration. Here we present a process-based theoretical model of steady state carbon isotopic composition in soil organic matter ($\delta^{13}\text{C}_{\text{SOM}}$) vs. depth profiles, which is coupled with a carbon concentration model. The model is defined by a number physical and biological parameters that can be related to the process of organic matter decomposition. Our model assumes that carbon isotope fractionation takes place only during microbial assimilation and predicts that the isotopic enrichment of down-profile soil organic matter is generally controlled by the isotopic fractionation factor, the rate of decomposition, and the transport velocity of carbon. This model connects carbon isotopic compositions of organic matter with ecological processes having important implications for the terrestrial carbon cycle. We show that incorporation of $\delta^{13}\text{C}_{\text{SOM}}$ into a carbon concentration model provides additional constraints on model parameters; combining carbon concentration with carbon isotope variations may allow for a better quantification of how environmental and ecological factors influence the rate of carbon cycling in soils. We explore the advantage of this coupled model by comparing simulations using carbon concentration alone and carbon concentration coupled with carbon isotopes. We also point out that vertical transport velocity of soil carbon may be the limiting parameter in quantitative understanding of soil carbon processes using this model.

B42A-06 1145h

^{15}N Content Reflects Development of Mycorrhizae and Nitrogen Dynamics During Primary Succession

Erik A Hobbie¹ (1-603-862-3581; erik.hobbie@unh.edu)

Ari Jumpponen² (1 785 532 6751; ari@ksu.edu)

¹University of New Hampshire, Morse Hall CSRC-EOS, Durham, NH 03824, United States

²Kansas State University, 125 Ackert Hall Division of Biology, Manhattan, KS 66506, United States

Mycorrhizal fungi are ubiquitous symbionts on terrestrial plants that are particularly important for plant nitrogen nutrition. ^{15}N content appears to be a useful marker of the mycorrhizal role in plant nitrogen supply because of an apparent fractionation against ^{15}N during transfer of nitrogen from mycorrhizal fungi to host plants. Because plants developing during primary succession are gradually colonized by mycorrhizal fungi, such situations provide good opportunities to study interactions between mycorrhizal colonization and plant ^{15}N content. Here, we present results of a study of nitrogen isotope patterns in ecosystem components during the first 100 years of ecosystem development after glacial retreat, and compare those patterns with those on adjacent mature terrain. Soils in primary succession were depleted in ^{15}N relative to nitrogen-fixing plants. Nonmycorrhizal plants and plants generally colonized by ectomycorrhizal, ericoid, or arbuscular fungi showed similar ^{15}N content very early in succession (-4 to -6‰), corresponding to low colonization levels of all plant species. Subsequent colonization of evergreen plants by ectomycorrhizal and ericoid fungi led to a 5-6‰ decline in ^{15}N content, indicating transfer of ^{15}N -depleted N from fungi to plants. The values recorded (-10 to -14‰) are among the lowest yet observed in vascular plants. Nonmycorrhizal plants and plants colonized by arbuscular mycorrhizal fungi did not decline in ^{15}N content. Most ectomycorrhizal and saprotrophic fungi were similar in ^{15}N content in early succession (-1 to -3‰), with the notable exception of ectomycorrhizal fungi suspected of proteolytic capabilities, which were ^{15}N enriched relative to all other fungi. ^{15}N contents in both plants and soil from the

mature site were 5^o/100 greater than in recently exposed sites. We conclude that 1) the primary nitrogen source to this ecosystem must be atmospheric deposition, 2) low plant ¹⁵N content generally corresponds with greater influence of mycorrhizal fungi on plant N supply, and 3) ¹⁵N content of mycorrhizal fungi may be a marker of proteolytic capabilities, and may therefore indicate the importance of organic nitrogen cycling to plant nitrogen supply.

B43A CC: 220 C-E Thursday 1330h

Dissolved Organic Carbon in the Biogeochemical Functioning of Systems IV Posters (joint with H, GC)

Presiding: T Moore, McGill University; K Bishop, Swedish University of Agricultural Sciences

B43A-01 1330h POSTER

Dissolved organic carbon and C cycling in Canadian forests

Tim Moore (514-398-4961; tim.moore@mcgill.ca)
McGill University, 805 Sherbrooke St. W., Montreal, QC H3A 2K6, Canada

Although the export of DOC from temperate - boreal forested catchments ranging from 1 to 10 g C m⁻² yr⁻¹ is small compared to the overall flux of C, the internal transfers of DOC are larger, with leaching from the forest floor and organic soil horizons ranging from 10 to 85 g C m⁻² yr⁻¹ with subsurface fluxes ranging from 1 to 40 g C m⁻² yr⁻¹. This suggests considerable internal cycling of DOC within the forest litter and soil, affecting processes such as CO₂ flux and the availability and transport of nutrients. To address this issue, I am starting a project on fluxes of DOC in Canadian forests, utilizing natural and disturbed sites that are part of the Fluxnet Canada network. In addition to determining fluxes, the project will also examine patterns of DOC bio-availability, production, sorption and mineralization across the sites and provide information to calibrate models. Based on incubations of organic and mineral soil samples from the sites, I present initial results on net DOC production potential, its dependence on temperature and soil properties and the partitioning of C mineralization between DOC and CO₂.

B43A-02 1330h POSTER

Spatial and Temporal Variability of Dissolved Organic Carbon and Nitrogen Fluxes in the Hermine, a Forested Watershed of the Canadian Shield

Julie Turgeon¹ (514-274-6228; julie.turgeon.2@umontreal.ca)

Francois Courchesne¹ (514-343-8027; francois.courchesne@umontreal.ca)

Marie-Claude Turmel¹ (514-343-8026; mc.turmel@umontreal.ca)

¹Département de Géographie, Université de Montréal, C.P. 6128 Succursale Centre-ville, Montréal, QC H2S 2H8, Canada

Recent studies have established the essential role of carbon (C) and nitrogen (N) in the biogeochemical cycles of elements in forested ecosystems (McDowell and Likens, 1988). Carbon and N are essential nutrients for biological processes and growth (Kalbitz et al. 2000; Buffam et al. 2001), and they play a key role in soil acidification, pedogenesis, trace metal and nutrient transport and mineral weathering (Likens and Bormann, 1995; Williams et al. 2001). However, there is a gap in knowledge regarding the spatial and temporal variability of C and N fluxes in forested ecosystems. Moreover, the factors controlling the fluxes of dissolved C and N at the event scale is poorly understood (Prechtel et al. 2000; McHale et al. 2000; Buffam et al. 2001). In this context, the first objective of this study is to quantify the fluxes of dissolved organic carbon (DOC) and of dissolved N (NO₃, NH₄ and DON) between the biogeochemical compartments of a forested watershed (Hermine) at a range of temporal scales. The second objective is to identify the role of antecedent soil moisture conditions on the hydrochemistry of the stream, at the event scale. The results show that there is a significant difference ($\alpha = 0.05$) in the concentrations of dissolved C and N between the five compartments (precipitation, throughfall, soil solution in the organic and mineral horizons and, stream). The fluxes of dissolved C and N increase as the water flows through the forest canopy to reach a maximum in the

organic horizons. The decrease of dissolved C and N concentrations as the soil solution percolates through the mineral horizons is significant ($\alpha = 0.01$) and is explained by the physico-chemical retention reactions (Guggenberger and Kaiser, 2003) and biological processes (Qualls and Haines, 1992). In all compartments, the speciation of total dissolved nitrogen is dominated by dissolved inorganic nitrogen (DIN). As water flows through the soil profile, the absolute dissolved organic nitrogen (DON) concentration increases, but its proportion remains smaller than that of DIN ($\alpha = 0.05$). The temporal variability of DOC and dissolved N is strongly influenced by climatic factors. For example, significance seasonal variations ($\alpha = 0.01$) are observed for DOC, DON and DIN in organic horizons. This is explained by the biological activity that allows the uptake inorganic nitrogen compounds and the production of organic compounds (Qualls, 2000). The high concentrations of NO₃ in the meltwater in the stream of both years is explained by the reduced microbial activity during winter (Brooks and Williams, 1999). No temporal trends ($\alpha = 0.10$) are observed for dissolved C and N in the mineral horizons notably because the retention reactions there are driven by non-climatic factors (Qualls, 2000). At the annual scale, the relationship between the concentrations of DOC and streamflow is poorly significant ($R^2 = 0.03$; $\alpha = 0.05$; $n = 431$). However, at the event scale, this relationship becomes much more significant ($R^2 = 0.95$ to 0.35 ; $\alpha = 0.05$). The various dissolved N species in the stream present weaker links to discharge at the event scale ($R^2 = 0.010$ to 0.804 (DON); 0.014 to 0.646 (NO₃); 0.016 to 0.197 (NH₄); $\alpha = 0.10$). Moreover, the concentrations of DOC and dissolved N in the stream differ significantly as a function of the antecedent soil moisture conditions ($\alpha = 0.05$).

B43A-03 1330h POSTER

Controls on DOC Export and DOM Character in a Cutover and a Recently Restored Peatland

James M Waddington¹ (905-525-9140; wadding@mcmaster.ca)

Karola Toth¹ (905-525-9140; tothk@mcmaster.ca)

Rick Bourbonniere² (rick.bourbonniere@ec.gc.ca)

¹McMaster University, 1280 Main Street West, Hamilton, ON L8S 4K1, Canada

²Environment Canada, 867 Lakeshore Rd., Burlington, ON L7R 4A6

Dissolved organic matter (DOM) dynamics were examined at a restored cutover peatland in the context of its changing hydrology before and after restoration and also with respect to variations in DOM character that are related to hydrology and restoration. The study, which covered three growing seasons, compared results from a portion of the peatland that was cutover to another portion that was cutover and later restored. In addition a nearby peatland that was not harvested (natural) was also studied for comparison. DOC concentrations increased post restoration while DOC export decreased because of decreased runoff caused by the blockage of drainage ditches. Compared to the natural peatland both the restored and the cutover sites exhibited a greater humic DOM character. No differences in DOM character were evident in the water released from both the restored and cutover sites. The most active layer for DOM production was the upper 75 cm within the range of seasonal water table fluctuation. Water storage units such as pools and ditches also played an important role in DOM export from the site. The most significant DOC export event is the spring snowmelt when export was significantly larger than those measured during the growing season. Differential solubility of the DOM fractions is a factor that controls their mobility and impacts on the DOM character found at the outflows. Storm events contributed significantly to the summer DOC output. Summer DOC dynamics were affected by antecedent moisture conditions and differences emerged between the restored and cutover site during this period. The results of this study emphasize the importance of managing water table fluctuations and the restoration (re-establishment) of Sphagnum species in order to improve the retention of DOM within cutover peatlands.

B43A-04 1330h POSTER

Factors of influencing dissolved organic carbon stabilization in two cambic forest soils with contrasting soil-forming processes

Masatoshi Kawasaki¹ (kawasaki@kais.kyoto-u.ac.jp); Nobuhito Ohte¹; Yuko Asano²; Taro Uchida³; Naoki Kabeya⁴; Su-jin Kim⁵

¹Kyoto University, Kitashirakawa-Oiwake, Sakyo, Kyoto 6068284, Japan

²The University of Tokyo, 1-1-1, Yayoi, Bunkyo, Tokyo 1138657, Japan

³National Institute for Land and Infrastructure Management, 1, Asahi, Tsukuba 3050804, Japan

⁴Forestry and Forest Products Research Institute, 1, Matsunosato, Tsukuba 3058687, Japan

⁵Seoul National University, Kwanak-gu, Shinlim-dong, Seoul 151742, Korea, Republic of

Stabilization of Dissolved Organic Carbon (DOC) in forest soil is a major process of soil organic carbon formation. However, the factors influencing DOC stabilization are poorly understood. To clarify the factors that affect the stabilization of DOC in forest soil mantle, we measured DOC concentrations and soil properties which were DOC adsorption efficiency at two adjacent cambic forest soils with contrasting forest management histories in Tanakami Mountains, central Japan. Matsuzawa was devastated about 1,200 years ago by excessive timber use and remained denuded for a long period. Hillside restoration and reforestation work have been carried out over the last 100 years and soil loss has been reduced. Fudoji is covered with undisturbed forest (mixed stands of cypress and oaks) with developed forest soils (more than 2,600 years old). There was no apparent seasonal variation in DOC concentration in the soil solution in either catchment. In addition, there were no significant relationships between the DOC concentration, soil temperature, and new water ratio. These results indicate that temporal variation in biological activity and rainfall-runoff process have little effect on temporal variation in DOC. The vertical variation in the DOC adsorption efficiency and DOC concentration differed between Matsuzawa and Fudoji, and the highest DOC removal rate occurred at the lowest DOC adsorption efficiency in the 0 to 10-cm soil layer at Fudoji. These results suggest that DOC removal rate is independent of DOC adsorption efficiency. Below 60 cm soil depth, DOC fluxes were constant and dissolved organic Al concentrations were little or zero in either catchment. These results suggest that abiotic precipitation of DOC is a major mechanism for stabilization of DOC. Therefore, DOC content which is able to form metal complexes may be the most important factor of influencing DOC stabilization in cambic forest soil.

B43A-05 1330h POSTER

Spatial Flux Variations of Dissolved Organic Carbon (DOC) Along Streams in two Boreal Catchments in Northern Sweden

Kevin Bishop¹ (Kevin.Bishop@ma.slu.se)

Johan Temnerud² (Johan.Temnerud@nat.oru.se)

¹Kevin Bishop, Department of Environmental Assessment, Swedish University of Agricultural Sciences, Box 7050, Uppsala SE-75007, Sweden

²Johan Temnerud, Man-Technology-Environment Research Centre, Department of Natural Sciences, Orebro University, Orebro SE-70182, Sweden

To evaluate spatial variability in DOC amount and quality within two Swedish boreal catchments (sub-catchment areas 0.01-78 km²), samples were taken at every junction (103 in total) of the stream network during June 2000 when flows were stable and low. There was a very large variation in DOC-concentrations in the headwaters, and less variation downstream where the different headwater sources have mixed. The standard deviation (s.d.) of DOC in the subcatchments smaller than 15 km² was 7.2 (mean 17.1 mg l⁻¹, n = 78), while the s.d. for larger catchments was 4.1 (mean 14.1 mg l⁻¹, n = 25). Volume-weighted concentrations of DOC were higher in headwaters than downstream. Conservative mixing of downstream inflowing water could explain this DOC-pattern. This does not, of course, rule out in-stream processing. There are, however, only a few hours for in-stream processes to occur, and no consistent change in quality (SUVA = 254 nm / DOC, C/N ratio, and apparent molecular weight) was found that might indicate such in-stream processing. The apparent concentration of DOC in downstream runoff was 18 to 63 percent of the headwater DOC concentrations. Headwaters contribute to 40 percent of total catchment size but could contribute up to 65 percent of total DOC-flux at the outlet, although most water volume enters downstream from the headwaters. A more detailed sampling in 2002, gave results similar to those from the 2000 sampling.

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Sources and Quantity of Dissolved Organic Matter Released From Flooding Upland Boreal Forests for Reservoir Creation

Sherry L Schiff¹ (519-888-4567 x 2473;

sschiff@uwaterloo.ca); Jason J Venkiteswaran¹;

Grant A Ferguson¹; Maren Oelbermann¹;

Richard J Elgood¹; James P. Hurley²; Kristofer R

Rolfhus³; Kenneth G Beaty⁴; R A Bodaly⁴