Janel Banks[1] (banksj@onid.orst.edu)

[1]Department of Fisheries and Wildlife, Oregon State University , Nash Hall 104, Corvallis, OR 97331, United States

As part of a research project investigating the effects of forest harvest practices on stream macroinvertebrates, we compiled existing data for Western Oregon headwater forest streams. The compiled database consists of 168 sites with watershed areas less than 10 square km that had measurements of stream macroinvertebrates, fish, physical habitat, water chemistry, and watershed land cover. The source of the data is from surveys conducted for EPA's EMAP program, the state of Oregon's Salmon Plan monitoring, and our own sampling efforts between 1994 and 2000. Almost all sites in the database were selected using the randomized EMAP survey design so they constitute a representative sample of all streams in this population. The streams in our dataset typically had mean wetted widths of 1-5 m, mean thalweg depths of 8-34 cm, and channel slopes of 1-15%. Watersheds for these sites were delineated and data on forest condition and logging history were clipped from available GIS layers. There were 189 macroinvertebrate taxa at the 168 sites with richness at individual sites ranging from 7 to 71 taxa. Ordination of the macroinvertebrate assemblages using NMS resulted in a 3 dimensional solution which accounted for 78% of the variation in the similarity among sites and demonstrated clear patterns in taxonomic composition with Baetis, Epeorus and Chironominae having the highest correlations with the ordination axes. Axes 1 and 2 each explained about 30% of the variation and were strongly correlated with substrate size, site slope and elevation. The third axis explained 17% of the variation and was correlated most strongly with watershed indices of forest logging history.

B32C-07 1525h

Forest Disturbance Through Alpine Ski Area Development: Results of a Paired Watershed Study in the Northeastern U.S.

Beverley Wemple[1] (802-656-2074; bwemple@zoo.uvm.edu)

Jamie Shanley[2] (802-828-4466; jshanley@usgs.gov)

Scott Waichler[3] (509-372-4423; scott.waichler@pnl.gov)

[1]Dept. of Geography, Univ. of Vermont, 202 Old Mill, Burlington, VT 05401

[2]U.S. Geological Survey, P.O. Box 628, Montpelier, VT 05602

[3]Pacific Northwest National Laboratory, P.O. Box 999, MSIN: K9-36, Richland, WA 99352

Disturbance to forested watersheds through suburbanization and resort development is increasingly common, particularly in densely populated regions. We are examining the effects of ski resort development on flow dynamics and water quality through a paired watershed study in northern Vermont. Our watersheds include the West Branch basin (11.7 km2), which encompasses an alpine ski resort, and the Ranch Brook basin (9.6 km2), which serves as our undeveloped control. Our analysis includes empirical interpretation of three years of streamflow and water quality data, as well as model simulations of flow dynamics under current and proposed future conditions, including proposed development of expanded snowmaking, ski trails and slope side village amenities in the West Branch basin. Our results show distinct differences in hydrologic response between the two watersheds, including elevated streamflows and delayed peaks during snowmelt in the developed watershed that may be attributable to trail clearing and snowmaking. Water quality data suggest that runoff from parking lots and other disturbed surfaces result in higher suspended sediment concentrations in the developed West Branch, particularly during the early part of snowmelt and during intense summer rains. Salting of parking lots and roadways within the West Branch basin resulted in elevated chloride concentrations year round (up to 700 ueq L-1 during snowmelt). Nitrate peaked near 70 ueq L-1 in both basins during snowmelt, but generally remained somewhat higher at West Branch. Otherwise, stream chemistry at both sites was dominated by weathering solutes (Ca, Mg, Si). We argue that disturbance to forested watersheds through this form of development may be more persistent than disturbance associated with traditional forest management activities (e.g. forest harvesting) and suggest that the results of our study may provide improved insight into the effects of new forms of human disturbance in the alpine environment.

B32D MCC: 3014 Wednesday 1600h

Isotopic Indicators of Biological Processes: From Soils to the Ocean

(joint with A, H, OS, GC)

Presiding: **J R Brooks,** National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency**; E Sulzman,** Oregon State University

B32D-01 1600h INVITED

Investigating Ecosystem Functional Development Along a Temperate Rainforest Chronosequence Using Stable Isotope Techniques

Margaret M Barbour[1] (+64 3 325 6701 extn 2220; barbourm@landcareresearch.co.nz)

John E Hunt[1] (huntj@landcareresearch.co.nz)

Sarah J Richardson[1] (richardsons@landcareresearch.co.nz)

Duane A Peltzer[1] (peltzerd@landcareresearch.co.nz)

David Whitehead[1] (whiteheadd@landcareresearch.co.nz)

[1]Landcare Research, PO Box 69 Gerald St, Lincoln 8152, New Zealand

Soil chronosequences are valuable systems for investigating ecosystem development by natural substitution of space for time. The Franz Josef chronosequence in New Zealand comprises temperate mixed conifer/hardwood rainforests formed on glacial surfaces of varying age. It is particularly useful as it includes both early build-up and decline phases over a relatively short time period (ca. 120 k years). Along the sequence, soil phosphorus decreases 8-fold, from 778 to 8 mg kg^{-1} soluble P. In contrast, nitrogen availability increases to peak at about 500 years, due to early successional N_2-fixing shrubs, after which it slowly declines. Ecosystem development along the sequence is characterised by marked changes in both plant species richness and tree height, with progression up to 5 k years and retrogression at older sites (ie > 14 k years). The carbon isotope ratio ($\delta^{13}C_L$) of sunlit canopy leaves from three dominant species sampled from within each of six sites, representing the full length of the sequence, decreased from -26.2 to -31.0 per mil with increasing ecosystem age. Independent measurements of photosynthetic capacity confirmed that the decrease was due to declining maximum photosynthetic rate: N_2-fixers > early successional angiosperms > late successional angiosperms > late successional conifers. Stable oxygen and nitrogen isotope ratios of canopy leaves are interpreted in terms of stomatal regulation of water loss and changing nitrogen source, respectively. Carbon isotope analysis of CO_2 sampled at night at different heights within the canopy allowed estimation of ecosystem discrimination ($\delta^{13}C_R$) using Keeling plots. Similarly to $\delta^{13}C_L$, $\delta^{13}C_R$ decreased with increasing soil age, suggesting that in high rainfall environments $\delta^{13}C_R$ is a good integrator of ecosystem photosynthetic capacity.

B32D-02 1615h

Decomposition and Stabilization Dynamics of C and N from Fine Roots Versus Needles

Jeffrey A Bird[1] (510-486-7794; jabird@socrates.berkeley.edu)

Margaret S Torn[2] (510-495-2223; mstorn@lbl.gov)

[1]University of California, Berkeley, Dept. of Integrative Biology, 3060 Valley Life Sciences Building, University of California, Berkeley, CA 94720-3140, United States

[2]Lawrence Berkeley National Laboratory, One Cyclotron Road Bldg. 90R-1116, Berkeley, CA 94720, United States

Do fine roots or needles ultimately produce the most C sequestered as stable soil organic matter (SOM)? How does the soil microclimate/soil horizon influence the efficiency of decomposition and C and N humification dynamics? We present the first 1.5 yr results of a study using ^{13}C- and ^{15}N-labeled *Pinus ponderosa* litter to track the short- and long-term fate of fine root vs. needle C and N inputs to soil. Labeled substrates were placed into either the O or A horizons of an Ultic Haploxeralf in the Sierra Nevada, CA. We determined the amount of label respired as CO_2 and the amount remaining in the soil. The movement of the ^{13}C and ^{15}N into and through the microbial community (PLFA/CFE) and SOM fractions was determined to compare the humification rates and pathways of the added ^{13}C and ^{15}N. Total soil recovery of fine root C far exceeded that of needles after 1 yr (76.9 vs. 52.4%). Twice as much of the needle C was reduced to a smaller size class (less than 2 mm) than for fine roots. Soil ^{15}N retention was high and unaffected by soil depth or substrate type (88%) after 1 yr. The proportion of ^{15}N recovered in microbial biomass was twice as great from needles as from fine roots (10.2 vs. 5.1%). Leaching losses of ^{13}C and ^{15}N were apparently very low with only 1-2% of ^{13}C or ^{15}N transported from the O to the A horizon after 1 yr. Due to moisture limitation in the surface soil during the summer, $^{13}CO_2$ respiration was faster for both substrates in the A horizon, while during the winter and spring, substrates in the O horizon had faster rates of $^{13}CO_2$ respiration than those in the A horizon. Although soil depth and microclimate influenced seasonal C loss by respiration, it did not affect total soil C recovery after 1 yr. The C quality of the substrates appeared to be more important than soil placement depth in affecting C residence time after the first year.

B

B32D-03 1630h

Refinement of Isotopically Derived Fine Root Lifespans Using A Locally Released Radiocarbon Label in Oak Ridge, TN.

Julia B Gaudinski[1,2] (831 459 4994; gaudinsk@ucsc.edu)

William J Riley[2] (WJRiley@lbl.gov)

Margaret S Torn[2] (mstorn@lbl.gov)

John D Joslin[3] (jdjoslin@esper.com)

[1]University of California Santa Cruz, Department of Environmental Studies, Santa Cruz, CA 95064, United States

[2]Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, CA 94720, United States

[3]Belowground Forest Research, 112 Newcrest Lane, Oak Ridge, TN 37830

Isotopic techniques (^{13}C and ^{14}C) are relative newcomers among the approaches used to quantify fine root (< 2 mm diameter) dynamics in a field setting. Direct measurements of the isotopic content of root tissues, used as a proxy for root age, have shown that at least some portion of the fine root system lives for 5-10 years or more. In this work we take advantage of a local radiocarbon (^{14}C) release in Oak Ridge, TN in summer 1999, to examine (1) the influence of stored C in new root growth and (2) the lifespan of fine roots from a mature, temperate deciduous forest. This release provides a local ^{14}C pulse of similar magnitude to the peak of the ^{14}C bomb spike. However, since we have been able to make ecosystem wide measurements within one year of the local ^{14}C release we have much greater time resolution than we do with the standard bomb-^{14}C technique applied today (which is 1-2 years). We have constructed a new multi-compartment model of root growth and decay, whose structure was developed using data from field sampling at Oak Ridge, TN. Model results, constrained with a ^{14}C time series of new root growth, show that fine roots are grown with 10% of their carbon coming from stored C sources. Additionally, a three-year time series of root cores shows that at least two pools are required to account for ^{14}C changes in live and dead fine roots. Testing this ^{14}C data set with our model shows that the shorter-lived root pool has a turnover time (mean lifetime) of a few months and the longer-lived pool has a turnover time of 5 years.

B32D-04 1645h

Decomposition of ^{14}C-Labeled Roots in a Pasture Soil Exposed to 10 Years of Elevated CO_2

Kees-Jan van Groenigen[1,2,5] (Kees.JanvanGroenigen@wur.nl); Ton Gorissen[3] (ton.gorissen@wur.nl); Johan Six[1] ((530) 752-1212; jwsix@ucdavis.edu); Dave Harris[4] (dharris@ucdavis.edu); Peter Kuikman[5] (peter.kuikman@wur.nl); Jan Willem van Groenigen[5] (janwillem.vangroenigen@wur.nl); Chris van Kessel[1] (cvankessel@ucdavis.edu)

[1]Department of Agronomy and Range Science, One Shields Avenue University of California, Davis, CA 95616, United States

[2]Laboratory for Soil Science and Geology, Wageningen University, Wageningen 6700 AA, Netherlands

[3]Plant Research International, Wageningen University, Wageningen 6700 AA, Netherlands

[4]Stable Isotope Facility, One Shields Avenue University of California, Davis, CA 956161, United States

[5]Alterra, Soil Science Center, P.O. Box 47, Wageningen 6700 AA, Netherlands

The net storage of soil C is determined by the balance between microbial decomposition rates and soil C input, both of which might be altered under prolonged elevated atmospheric CO_2. Here we report on a study to determine the effect of elevated CO_2 on root mineralization through changes in substrate quality, and the subsequent soil microbial response. ^{14}C-labeled *Lolium perenne* root material, produced under ambient and elevated CO_2 was incubated in soil for 64 days. The soils used for the incubation had been exposed to ambient and elevated CO_2 under FACE-conditions for 10 years. Fertilizer N was applied at a rate of 140 and 560 kg N ha^{-1} yr^{-1} and the CO_2 concentration was increased to 60 Pa pCO_2. *Lolium perenne* root material grown under elevated CO_2 significantly decreased microbial respiration in high N soils, whereas it enhanced microbial C assimilation in low N soils. The amount of $^{14}CO_2$ respired per amount of ^{14}C incorporated in the microbial biomass was significantly lower for high CO_2 roots compared to low CO_2 roots. We suggest that this is the result of an increased fungal:bacterial ratio, causing an increased metabolic efficiency. Soils exposed to elevated CO_2 respired more native SOC, both with and without the addition of the root material. During the first stage of the incubation experiment, root material decomposed slower in high CO_2 soils. Overall, the addition of root material decreased the decomposition of native SOC, thus causing a negative priming effect. Our results suggest that priming effects might obscure CO_2 data in incubation experiments in which unlabeled substrate is applied. From the results obtained, we suggest that limited net C storage might occur through a slower turnover of root material grown under elevated CO_2

B32D-05 1700h

Heterotrophs Dominate Soil Respiration From Boreal Black Spruce Forest: Using Isotopes to Partition Sources of Soil CO_2 Flux

Edward A Schuur[1] (352-392-7913; tschuur@ufl.edu)

Susan E Trumbore[2] (949-824-6142; setrumbo@uci.edu)

[1]University of Florida, Department of Botany 220 Bartram Hall, Gainesville, FL 32611, United States

[2]University of California, Department of Earth System Science 220 Rowland Hall, Irvine, CA 92697, United States

Most carbon that enters terrestrial ecosystems via photosynthesis is returned to the atmosphere by the process of respiration. Of total ecosystem respiration, 40-80% occurs below ground as soil respiration, a combination of root metabolism (autotrophic respiration) and the decomposition of organic matter (heterotrophic respiration) by soil organisms. While the major factors affecting autotrophic and heterotrophic respiration are known, predictions of soil respiration are limited primarily by the difficulty of measuring these two belowground respiration sources independently. We used radiocarbon measurements to estimate the partitioning of carbon between heterotrophic and autotrophic respiration in three mature black spruce (Picea mariana) forests in interior Alaska. We measured radiocarbon from soil respiration in the field, in laboratory soil incubations, and in the atmosphere. These measurements were combined with a two-pool mixing model in order to estimate partitioning between sources. Soil respiration radiocarbon signatures in the mature forest ranged from $+112^o/_{oo}$to $+122^o/_{oo}$and differed significantly from soil incubations that ranged from $+135^o/_{oo}$to $+145^o/_{oo}$. These values were significantly higher than the current atmospheric radiocarbon at $+78^o/_{oo}$due to the residence time of carbon in plants and soil. Using soil incubations as an end member for heterotrophic respiration and the atmospheric value for the autotrophic end member, we estimated that 58-72% of soil respiration was derived from heterotrophic decomposition of organic matter. This estimate did not differ among the three stands and is significantly larger than the 50% estimate commonly used in model parameterization.

B32D-06 1715h

Measuring The Flux of Nitrogen From Watersheds, Errors and The Temporal Resolution Problem

William J. Showers[1] (919 515 7143; w_showers@ncsu.edu)

Brian Usry (919 515 7911; rugosa1@yahoo.com)

Bernie Genna (919 515 3689; bernie_genna@ncsu.edu)

[1]N. Carolina State Univ., Dept MEAS, Raleigh, NC 27695, United States

Agricultural and urban land use has increased the fluxes of nutrients and sediments into surface waters and ground waters. Transport of nitrogen through watersheds into coastal waters has resulted in eutrophication and water quality degradation. Management actions aimed at reducing nitrate contamination of surface waters need a better understanding of fundamental processes that control water quality on a watershed scale. RiverNet, a high resolution (hourly) in situ nitrate monitoring program has found significant concentration variations associated with point sources in the Neuse River Basin, NC. Nutrient inputs from agricultural watersheds are highly correlated to discharge. Nutrient inputs from waste application fields are variable and most important during falling hydrographs. Nitrogen, carbon and oxygen isotopes of nitrate and POM indicate that in-stream nutrient consumption is not an important process in riverine nutrient transport to the estuary in the river mainstem, but can be important in smaller streams and creeks. This water depth/nitrogen in-stream loss data indicates that the contribution of point sources have been underestimated on a watershed scale. In addition large fluxes of nitrate from contaminated groundwater to surface waters adjacent to WAF occur over a 1 to 3 day period after large rain events. The flux of contaminated groundwater has not been taken into account in the NPDES permitting process. ^{17}O of river and groundwater nitrate indicates that atmospheric deposition can be a significant contributor (90 %) to nitrate flux in urban watersheds and to a lesser extent in forested watersheds, but contributes less than 10% of the nitrate flux exported from the basin as a whole. Nitrate fluxes calculated from hourly measurements differ from daily calculated fluxes by up to 20% during high flow conditions and 80% during low flow conditions. These findings indicate that significant errors can be produced by monitoring programs that try to determine long term trends of basin scale nitrogen flux without high resolution data sets produced by in situ monitoring. These data indicate that current monitoring efforts have tremendously underestimated the amount of nitrogen that is exported from watersheds to the coastal ocean.

URL: http://rivernet.ncsu.edu

B32D-07 1730h

Geochemical Records of Bleaching Events and the Associated Stressors From the Great Barrier Reef

E. Brendan Roark[1] (510-642-2381; ebroark@socrates.berkeley.edu)

Malcolm McCulloch[2] (Malcolm.McCulloch@anu.edu.au)

B. Lynn Ingram[3] (ingram@socrates.berkeley.edu)

John F. Marshall[2] (John.Marshall@anu.edu.au)

[1]Department of Geography, University of California,, Berkeley, CA 94720-4740, United States

[2]Research School of Earth Sciences, Australian National University, Canberra, ACT 0200, Australia

[3]Department of Earth and Planetary Science, University of California,, Berkeley, CA 94720-4767, United States

The health of coral reefs world-wide is increasingly threatened by a wide array of stressors. On the Great Barrier Reef (GBR) these stressors include increased sediment flux associated with land use changes, increased sea surface temperatures (SST) and salinity changes due to large floods, the latter two of which are factors in an increased number of bleaching events. The ability to document long-term change in these stressors along with changes in the number of bleaching events would help discern what are natural and anthropogenic changes in this ecosystem. Here we present results of an initial calibration effort aimed at identifying bleaching events and the associated stressors using stable isotopic and trace element analysis in coral cores. Three ∼15-year time series of geochemical measurements (δ^{13}C, δ^{18}O, and Sr/Ca) on *Porites* coral cores obtained from Pandora Reef and the Keppel Islands on the GBR have been developed at near weekly resolution. Since the δ^{13}C of the coral skeletal carbonate is known to be affected by both environmental factors (e.g. insolation and temperature) and physiological factors (e.g. photosynthesis, calcification, and the statues of the symbiotic relationship between corals and zooxanthellae) it is the most promising proxy for reconstructing past bleaching events. The first record (PAN-98) comes from a coral head that had undergone bleaching and died shortly after the large-scale bleaching events on Pandora Reef in 1998. A second core (PAN-02) was collected from a living coral within 10m of PAN-98 in 2002. Sr/Ca ratios in both cores tracked even the smallest details of an *in situ* SST record. The increase in SST that occurred three to four weeks prior to bleaching was faithfully recorded by a similar decrease in the Sr/Ca ratio in PAN-98, indicating that calcification continued despite the high SST of 30-31^{o}C. The δ^{13}C values decreased by about $5^o/_{oo}$, one week after the SST increase, and remained at this value for about 4 weeks until the coral died. In 1994 and 1995, there are decreases in the δ^{13}C values of $3^o/_{oo}$. In 1994, a flood plume from the Burdekin River reached Pandora Reef and bleaching was reported. In 1995 we note a 4-5 week period of elevated SST based on the Sr/Ca results, which may have been sufficient to cause stress or bleaching of the coral. No clear decreases in δ^{13}C values associated with any bleaching event was evident in the PAN-02 record, however there is a clear growth hiatus that lasted several months during the 1998 bleaching event. δ^{18}O results in both records show many of the same details as the Sr/Ca and SST record, suggesting temperature changes as the dominant control. However, during flooding events (1996, 1997, and 1998), the δ^{18}O values were decreased by increased freshwater input to the reef. The associated salinity changes were determined by subtracting the temperature component from the δ^{18}O signal using Sr/Ca ratios and compared with the weekly average flow records from the Burdekin River and a Ba/Ca record (McCulloch et al. 2003) of sediment flux to the reef. Similar results were obtained in a third record from the Kepple Islands which included one of the largest floods of the century and a bleaching event in 1991.

B32D-08 1745h

Subterranean Groundwater Nutrient Input to Coastal Oceans and Coral Reef Sustainability

Adina Paytan[1] (650-724 4073; apaytan@pangea.stanford.edu)

Joseph H Street[1] (650-736 0655; jstreet@stanford.edu)

[1]Stanford University, Geological and Environmental Sciences, Stanford, CA 94305-2115, United States

Coral reefs are often referred to as the tropical rain forests of the oceans because of their high productivity and biodiversity. Recent observations in coral reefs worldwide have shown clear degradation in water quality and coral reef health and diversity. The implications of this are severe, including tremendous economic losses mostly though fishing and tourism. Nutrient loading has been implicated as one possible cause for the ecosystem decline. A previously unappreciated potential source of nutrient loading is submarine ground water discharge (SGW). Ground water in many cases has high nutrient content from sewage pollution and fertilizer application for agriculture and landscaping. To better understand the effect of this potential source of nutrient input and degrading water quality, we are exploring the contribution of SGW to the nutrient levels in coral reefs. A key to this approach is determining the amount and source of SGW that flows into the coast as well as its nutrient concentrations. The SGW flux and associated input of chemical dissolved load (nutrient, DOC, trace elements and other contaminants) is quantified using naturally occurring Ra isotopes. Radium isotopes have been shown to be excellent tracers for SGW inputs into estuaries and coastal areas (Moore, 1996; Hussain et al., 1999; Kerst et al., 2000). Measurements of Ra activity within the coral reef, the lagoons and the open waters adjacent to the reef provide valuable information regarding the input of Ra as well as nutrients and possibly pollutant from groundwater discharge. Through this analysis the effect of SGD on the delicate carbon and nutrient balance of the fragile coral reef ecosystem could be evaluated. In addition to quantifying the contribution of freshwater to the nutrient mass balance in the reef, information regarding the length of time a water parcel has remained in the near-shore region over the reef can be estimated using the Ra isotope quartet.