drop was due to enhanced carbon uptake by the terrestrial biosphere during the two years following the volcanic eruption. The surface cooling scenario suggests that the enhanced terrestrial carbon uptake is caused by reduced soil and plant respiration in response to the volcanic cooling. This explanation is questionable for two reasons. First, estimates put the volcanic cooling on the order of 0.5K. This is small and well within the natural range of temperature variability. Second, carbon cycle model estimates of terrestrial responses based on the surface cooling scenario led to direct contradictions with atmospheric inverse models in terms of regional patterns of carbon uptake after the Pinatubo eruption and with atmospheric oxygen measurements. Here we suggest that the increased diffuse radiation is the primary factor for the enhancement in terrestrial biosphere carbon uptake and therefore the dip in the rate of atmospheric carbon dioxide rise during the two-year period following the Pinatubo eruption in 1991. Using tower flux measurements from a variety of vegetation sites, we will demonstrate that plant canopies have higher quantum use efficiencies for diffuse radiation than for direct beam radiation. The superiority of diffuse radiation over direct beam radiation for canopy photosynthesis increases with radiation level. We will show that under a turbid atmospheric environment where part of the reduction in direct beam radiation is converted into diffuse radiation, terrestrial ecosystem productivity can be enhanced. In addition, we will discuss how clouds can increase terrestrial carbon sequestration.

B51A-0195 0830h POSTER

Pressure Pumping Effects on Fluxes and Release of Trace Gases From Soils

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New evidence, obtained at the Glacier Lakes Ecosystem Experiments Site in the Rocky Mountains of southern Wyoming, is presented that supports the hypothesis that turbulent pressure fluctuations can affect the flux of CO_2 and other trace gases from soils and snowpacks. First, half-hourly measurements of CO_2 mole fraction taken between December 2000 and March 2001 at the soil/snowpack interface under a 1.1 m snowpack show significant variations with a dominant period of about 8 days and an amplitude of about 100 ppmV. These variations are strongly correlated with fluctuations in both wind speed and pressure. Second, simultaneous CO_2 fluxes, taken as part of the AmeriFlux network, increase with increasing wind speed and decreasing CO_2 mole fraction at the soil/snow interface. These eddy covariance fluxes are greater than purely diffusional fluxes through the snowpack. Third, an analytical model of CO_2 fluxes throught the snowpack is used to distinguish between the effects of low frequency barometric pumping and the relatively higher frequency turbulent pressure pumping and stationary pressure waves forced by topography. Comparison of the observations and the modeling results suggest that turbulent pressure pumping can significantly enhance purely diffusional CO_2 fluxes on a half-hourly basis and that the intensity of the turbulent pressure pumping is modulated by the low frequwncy synoptic scale.

B51A-0196 0830h POSTER

SEASONALITY OF ECOSYSTEM RESPIRATION AND GROSS PRIMARY PRODUCTION AS DERIVED FROM FLUXNET MEASUREMENTS

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Differences in the seasonal pattern of assimilatory and respiratory processes are responsible for divergences in seasonal net carbon exchange among ecosystems. Using FLUXNET data (http://www-eosdis.ornl.gov/FLUXNET) we have analyzed seasonal patterns of gross primary productivity (GPP), and ecosystem respiration (RE) of boreal and temperate, deciduous and coniferous forests, mediterranean evergreen systems, rainforest, temperate grasslands, and C3 and C4 crops. Based on generalized seasonal patterns classifications of ecosystems into vegetation functional types can be evaluated for use in global productivity and climate change models. The results of this study contribute to our understanding of respiratory costs of assimilated carbon in various ecosystems.

Seasonal variability of GPP and RE increased in the order tropical, Mediterranean, temperate coniferous, temperate deciduous, boreal forests. Together with boreal forests, managed grasslands and crops show the largest seasonal variability. In temperate coniferous forests, seasonal patterns of GPP and RE are in phase, in temperate deciduous and boreal coniferous forests RE was delayed compared to GPP, resulting in the greatest imbalance between respiratory and assimilatory fluxes early in the growing season.

Gross primary productivity adjusted for the length of the growing season decreased across functional types in the order C4 crops, and temperate and boreal deciduous forests (7.5-8.3 g C m-2 d-1), temperate conifers, C3 grassland and crops (5.7-6.9 g C m-2 d-1), rainforest and boreal conifers (4.6-4.9 g C m-2 d-1). Annual GPP and NEP decreased across climate zones in the order tropical, temperate, boreal. However, the decrease in NEP was greater than the decrease in GPP, indicating a larger contribution of respiratory (especially heterotrophic) processes in boreal systems.

B51A-0197 0830h POSTER

Preliminary Results of the Carbon, Heat, and Moisture Turbulent Measurements over a Pasture in Eastern Amazon.

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This study presents preliminary results from a 10 years old pasture site located in the Amazon Region as a part of the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA). In this location a 20 m tower was installed to monitor micrometeorological and trace gases measurements. An eddy covariance system was installed at 8.75 m, composed by a 3D sonic anemometer (SATI/3K), and a CO2/H2O gas analyzer (licor 6262). Wind (CATI/2 - 12.25, 5.73, and 3.12 m), temperature and humidity (Vaysala Humitter, CS500, at 6.09, 4.14, 2.20 m), and CO2 (licor 6262 at 11.81, 5.29, 2.71, and 0.5 m) profiles have also been measured. At the top of the tower (17.76 m) upward and downward solar (Kipp and Zonen, CM11/14) and terrestrial (CG2) radiation is also collected. Soil temperatures (Campbell 108 at 0.10, 0.24, 0.50,1.50, and 2.0 m), soil heat flux (Campbell HFT3 at 0.30 m), and soil moisture (Campbell CS615 at 0.30 m) have also been installed. A Linux based PC machine records all data, and the are processed and stored at nearly real time. The site is powered by a solar panel that can provide continuously 500 W/m2. The data have been collected since September 2000.

In eastern Amazon the climate can be divided in dry (about July to December) and wet (about December to June) seasons. We present the seasonal changes of the turbulent fluxes (momentum, heat, moisture, and CO2). Also, we are going to present the seasonal differences for other related parameters such as albedo, bowen ratio, and the canopy photosynthesis as a function of the photosynthetically active radiation (PAR) curves for both seasons. The turbulent kinetic energy budget and the surface energy are evaluated to determine the accuracy of flux measurements.

B51B MC: Hall D Friday 0830h

Carbon and Nitrogen Interactions in Terrestrial Ecosystems

Presiding: **H Sievering,** Colorado University at Denver**; D Hollinger,** USDA Forest Service

B51B-0198 0830h POSTER

The Relationship Between DOC Partition Coefficient and Mineral Soil C:N Ratio

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Since our recent publication showing that soil C:N predicts DOC flux at local and global scales, an effort has been made to understand mechanisms controlling the relationship between the two variables. We have approached this at multiple scales, using soil batch experiments, soil column experiments, and long-term field manipulations. We present here the results from our batch adsorption experiment. Mineral soils from tropical (wet and moist) and temperate (coniferous and hardwood) forests were used to assess DOC adsorption by the initial mass isotherm approach. We found that the DOC partition co-efficient (m) which represents a soil's tendency to adsorb DOC is strongly and inversely related to mineral soil C:N ratio ($R2 = 0.99$ $n = 10$ $p < 0.001$). The intercept of the mass isotherm, or the desorption term, was positively related to mineral soil C:N ratio ($R2 = 0.80$ $n = 10$ $p < 0.01$), but we found that desorption of DOC was more closely correlated with equilibrium DOC concentration ($R2 = 0.97$ $n = 10$ $p < 0.001$) than with mineral soil C:N. The mass isotherm approach is also useful in calculating the reactive soil pool (RSP), the fraction of the soil pool of organic carbon that may be lost to leaching. The RSP was not significantly related to mineral soil C:N, but tropical soils tended to have a larger RSP than temperate soils. Although some of the tropical soils came from areas where the natural forest had been cleared, used for plantations and then abandoned, the relationship between DOC adsorption and mineral soil C:N was not compromised. Watershed soil C:N ratio is an excellent predictor of DOC export because soil C:N is related to physiochemical adsorption processes in mineral soils and biotic production of DOC in organic soil horizons. It appears that soil C:N is a relatively robust predictor of soil solution DOC concentration and surface water DOC export for ecosystems undergoing environmental stress.

B51B-0199 0830h POSTER

Effects of Forest Management on CO2 and N2O Emissions From Beech Forest Ecosystems in Germany

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The effects of forest management practice (partial clear cutting) on greenhouse gas emissions (CO2, N2O) and total gaseous N-losses by denitrification from soils of beech forest ecosystems was studied since April 1999 at two beech stands stocking on slopes exposed to the NE located at the Schwäbische Alb in SW Germany. One beech stand remained untreated and served as a control, while the other beech stand had been partially clear cutted in April 1999 (by removing approx. 50 % of the trees) for studies on the effect of forest management on greenhouse gas fluxes. The following parameters were determined during 6 field campaigns (April 1999-October 2000) and in laboratory studies: in situ N2O- and CO2 emission rates from soils were followed at c. 2-hourly resolution by the static chamber technique using fully automated measuring systems; denitrification losses of N2O and N2 were quantified in the lab using intact soil cores taken at the measuring sites during the measuring campaigns. For quantification of these N-losses a newly developed method was used.

The following results were obtained: Effect of forest management (comparison: partial clear cutted site vs. control site): for the first year of observation (1999) in situ N2O and CO2 emissions as well as total gaseous

N-losses by denitrification (N2O + N2) were dramatically higher from the soil of the partially clear cutted site as compared to the control soil. Thus, the removal of part of the plant sink for N had lead to enhanced availability of N for microbial turnover, which in turn did lead to enhanced gaseous soil emissions of N2O + N2. In addition, the enhanced mineralization of organic matter from tree residues was the cause for the increased CO2 emissions from soils observed. However, in the second year of observation (2000) the picture completely changed, i.e. N- and C-emissions were significantly reduced at the partially clear cutted site as compared to the control site. Analysis revealed that the upcoming soil flora, which was negligible in 1999, was a stronger competitor for available N in the soil than soil microbes, thus leading to a shortage of nitrogen available for microbes for gaseous N production and emission. The reduction in net CO2 emission from the soil into the atmosphere was due to the photosynthetic CO2 consumption by the soil flora.

B51B-0200 0830h POSTER

Fast response inlet and converter for nitric acid concentration and eddy correlation flux measurements

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A fast response inlet system for the detection of atmospheric nitric acid is described, and preliminary field results are presented. The inlet is constructed of PFA Teflon components and is thermostatted at 50 C to retain rapid and efficient HNO3 transmission, independent of humidity. Laboratory spike tests with HNO3 reveal instrument rise and fall times shorter than 1 second, with minimal tailing. The inlet allows for calibration by standard addition or by complete replacement of the ambient flow, and for addition of gas flows with zero HNO3. Following this inlet, ambient air flows into quartz tubes where the gas is heated to 600 C and HNO3 undergoes gas-phase thermal dissociation to yield NO2, which is detected by laser induced fluorescence. Power spectra of HNO3 field measurements taken near at the University of California Blodgett Forest Research Station (Georgetown, CA) compare well with power spectra of temperature fluctuations from a sonic anemometer located on the same sampling tower, and with the theoretical -5/3 power fall-off expected for turbulent fluctuations in the boundary layer. Preliminary analyses of fluxes determined by eddy covariance will be presented.

B51B-0201 0830h POSTER

Biotic Effects on an Abiotic Process: Factors Controlling Transport of Dissolved Organic Matter Through Soils of Contrasting Forest Types

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The process of sorption in forest soils has been shown to control the flux of dissolved organic matter (DOM) through the soil profile, redistributing carbon and nitrogen, as well as altering the DOM that is leached from the soil to ground and surface water. We studied lodgepole pine and aspen, two common forest types found throughout the Intermountain West, to determine both the controls on DOM sorption to mineral soil and how soil solution DOM reflects the sorption trends. In addition to the bulk DOM, fractions of hydrophilic (non-humic) and hydrophobic (humic) DOM were determined to further examine the differences between forest types in DOM and the subsequent sorption potential of those fractions. While mineralogy in part controls the strength of the sorption potential, factors such as soil C:N ratios and the quality of the DOM are also important. We found that the B horizon of the lodgepole pine sorbed stronger than the lodgepole pine A horizon, but that the aspen soil sorbs much stronger than the lodgepole pine and with no horizon difference. We will also present data to suggest that the sorption potential is sensitive to the quality of the DOM pool, which changes seasonally and may be altered from enhanced nutrient availability (e.g., N deposition, fertilization).

B51B-0202 0830h POSTER

Fate of Precipitation-borne N in a Maine Spruce-Hemlock Forest: Results of First-year Ammonium Nitrate Canopy Fertilization

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Nitrogen oxides emitted as a result of fuel combustion and ammonia volatilization due to agriculture account for a large increase in N available to temperate forests in the northern hemisphere. Northern forests are thought to be limited in growth by the availability of N and increased inputs have coincided with increased carbon contents reported in northern forest inventories. The fate of anthropogenic N, residence time and the significance of an N-fertilization effect upon forest growth, however, remains unknown. We report throughfall findings from an ecosystem-level nitrogen addition made as wet precipitation to the canopy of a spruce-hemlock forest in central Maine. Ammonium nitrate and potassium nitrate were sprayed on 21 hectares of canopy by helicopter in six applications throughout the growing season; a final addition rate of 18 kg N per hectare per year. We measured N in canopy needles, senesced needles, throughfall (TF) and soils and soil water throughout this first-year application. TF-N in precipitation events following fertilization suggested retention to be highly variable but removing substantial N from the canopy addition. Moreover, while inorganic N in TF remained similar in ratio, 33% ammonium and 66% nitrate, as that added to the canopy; the single largest flux of N to the forest floor was in the form of DON. TF data from subsequent rain events were often indistinguishable from non-fertilized controls. The retention of N in the canopy and the preponderance of DON in TF should be considered when investigating effects of anthropogenic N on forest growth.

B51B-0203 0830h POSTER

Quantifying the Principal Components of Stormflow in a Forested and Developed Headwater Catchment with End-Member Mixing Analysis and Continuous Water Quality Measurements

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Several studies have been conducted to quantify the components of stormflow in forested headwater catchments. There appears to be a lack of information, however, describing stormflow components in heavily developed catchments. We have monitored stream water quality and flow every 15 minutes during the summer of 2001 at two watersheds - one forested and one developed - in the rapidly-developing north shore of Massachusetts. Observations from this data, particularly electrical conductivity, suggest that hydrologic flowpaths differ significantly between the two catchments during stormflow events. In the heavily developed 3.7 km2 watershed, low conductivity (typically <30 S/cm) precipitation appeared to be the dominant component of stormflow, with a consistent but short-duration (less than 1 hour) pulse of higher conductivity water from surface runoff (i.e. roads, parking areas) during the rising limb of the hydrograph. Peak stormflow conductivity was approximately 25-95 % lower than pre-event baseflow conductivity with higher magnitude events causing the greatest dilution. Conductivity typically remained 60-80 % below pre-event baseflow values throughout the entire falling limb. Conversely, conductivity in the 4.7 km2 forested catchment stream was only slightly diluted (10-15 % lower than pre-event baseflow) or even increased during the rising limb of the hydrograph. Conductivity values were also approximately 1.5 - 2 times higher than pre-event baseflow values throughout the duration of the falling limb of the hydrograph. This implies that higher conductivity pre-event water (i.e. soil water and groundwater) is likely the principal component of stormflow in the forested catchment.

We will present a multi-component end-member mixing analysis model to describe principle stormflow components from these two catchments. In addition, the model will be used to determine if continuous stream water quality measurements can be used as a simple tool for monitoring contributing areas during stormflow events.

B51B-0204 0830h POSTER

Spatial Relationships Between Patterns of Woody-Plant Taxonomic Richness and Environmental and Bioclimatic Variables in North America

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Spatial patterns of plant species richness vary greatly at continental scales. The environmental and bioclimatic controls on these patterns are still not fully understood. A recently completed data set of the distributions of over 500 species of trees and shrubs in North America (U.S. Geological Survey Professional Paper 1650A-D) allows us to explore the relationship between spatial patterns of plant taxonomic richness and environmental variables at a continental scale. Ranges of woody plant species were digitized from the atlases of E.L. Little and gridded onto a 25-km target grid of North America for the region north of 25 degrees latitude. Only those species whose entire range fell within the 25-km target grid were included in this study. Continental patterns of taxonomic richness by species, genus, and family were evaluated using environmental and bioclimatic variables, such as mean temperature of the coldest month, growing degree days, and plant-available moisture indices, calculated from a climate data set on the same 25-km grid. These analyses reveal spatially complex relationships between species richness and environmental and bioclimatic variables at the continental scale. For example, patterns of species richness at middle latitudes vary with available moisture, while at higher latitudes winter temperatures have a greater impact on richness patterns. The results of this study contribute to current debates on the controls of species richness as well as to our understanding of the potential impacts of future climate change on patterns of plant species richness in North America.

B51B-0205 0830h POSTER

Non-Controlled Emission of Inorganic Toxic gas Components (CO, H_2S, NH_3 and Hg_0) to the atmosphere from Aricos landfill, Tenerife, Canary Islands, Spain

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Landfill gas is mainly constituted by CO_2 and CH_4. However, other inorganic toxic gas components such as CO, NH_3, H_2S and Hg_0, are also present. Reduced gas species are produced and released during the anaerobic decomposition of urban waste, while Hg_0 is originally present in the waste and it is released as a volatile. Significant amounts of non-controlled emission of these components could be released to the atmosphere in the form of diffuse degassing, The goal of this study is to evaluate the "non-controlled" emissions of these inorganic toxic gas components from Arico's landfill, Tenerife.

Arico's landfill (0.35 Km^2) holds about 1,200 t/d of urban solid waste with an average organic matter content of 48%. Diffuse CO_2 emission has been measured at the surface of Arico's landfill by means of a NDIR according with the accumulation chamber method. Landfill gases were also collected at 40 cm depth using a metallic probe and analyzed within 24 hours for CO_2 and CO composition by means of a VARIAN micro-GC QUAD. H_2S and Hg_0 were analyzed by means of a Polytron-II electrochemical sensor and a JEROME 431-X mercury analyzer, respectively. NH_3 was fixed in a boric acid solution and determined by means of a selective electrode. CO concentration ranged from non-detectable to 2,531 ppmv, with a median of 24.3 ppmv. The highest observed Hg_0 concentration in the surface landfill gas is 0.004 ppbv, while H_2S concentration reached levels up to 12 ppmv. NH_3 contents were lower than 1 ppmv. CO, Hg_0, H_2S and NH_3 fluxes have been estimated by multiplying CO_2 efflux times (Tox.I.C.)i/CO_2 where (Tox.I.C.)i is the concentration of CO, Hg_0, H_2S and NH_3. The highest efflux values for CO, Hg_0, H_2S and NH_3 were 6.8 $gm^{-2}d^{-1}$, 0.04 $gm^{-2}d^{-1}$, 1.7 $mgm^{-2}d^{-1}$ and 0.23 $gm^{-2}d^{-1}$, respectively.

B51B-0206 0830h POSTER

Recognition of Time-Equivalent Leaf-Based Signals of Atmospheric CO_2 and El Niño Variability in Florida Wetland Species

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Trees are equipped with a plastic phenotype, capable of sustained adjustment of numbers of leaf stomata to changes in atmospheric CO_2 concentration. With high temporal resolution and accuracy, stomatal frequency data demonstrate that Holocene climate evolution has been influenced by century-scale CO_2 fluctuations.

Apart from adapting to changes in atmospheric CO_2, leaf-epidermal properties are known to be sensitive to environmental factors such as water availability. In long-lived hygrophilous plants, epidermal tissue expansion is likely to be significantly influenced by changes in water availability.

Concurrent analysis of the leaf morphology in CO_2 sensitive trees (*Myrica, Quercus, Acer*) and a water-stress sensitive fern species (*Osmunda regalis*) from leaf assemblages preserved in peat deposits in Florida (USA), reveal distinct temporal changes in epidermal properties over the past 130 years.

Stomatal frequency changes in the deciduous trees reflects the human induced CO_2 increase. Epidermal-cell density changes in fern leaves, could well be interpreted in terms of El Niño / La Niña related precipitation trends.

By quantifying the leaf morphological adaptation to known environmental conditions during historical times, a new paleobotanical proxy for past precipitation changes is introduced.

Hence, in ENSO-sensitive regions, analysis of buried leaf assemblages offers the unique possibility of a direct recognition of time-equivalent leaf-based signals of paleo-atmospheric CO_2 and El Niño variability.

B51B-0207 0830h POSTER

Atmospheric Chemistry Modeling Coupled with Biospheric Feedbacks for Non-methane Hydrocarbons

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Surface biogenic emissions play a major role in determining the chemical composition of the atmosphere. In addition to atmospheric conditions, emissions of non-methane hydrocarbons are governed by spatial and temporal variations of terrestrial vegetation. Hence, coupling of surface emissions from terrestrial vegetation with atmospheric processes is an important issue concerning biospheric feedbacks on atmospheric chemistry and climate. In this study we model the terrestrial biogenic isoprene and monoterpene fluxes using ecosystem variables derived from a dynamic ecosystem model and incorporate these surface fluxes in a 3-dimensional global chemistry-transport model to analyze the chemical composition of the atmosphere. We use version 2 of the Integrated Biosphere Simulator (IBIS) to derive the state of the ecosystem and Model for Ozone and Related Tracers (MOZART) to determine the atmospheric chemistry resulting from these emissions. Evaluation of surface fluxes for isoprene and monoterpenes is based on algorithms developed for the Global Biosphere Emissions and Interactions System (GLOBEIS). We also compare derived surface fluxes of isoprene and monoterpenes with existing database.

B51B-0208 0830h POSTER

Estimating Carbon Losses through Combustion during Peatland Wildfires.

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Lightning-initiated forest fires are common to the western boreal forest, and have important consequences for ecosystem carbon (C) storage in upland systems. Despite the importance of peat-accumulating lowlands to soil C stocks, little is known about contemporary fire frequencies in peatlands or the effects of wildfire on peat accumulation. Our objectives are to estimate annual C losses from organic matter combustion during peatland wildfires across continental western Canada (Alberta, Saskatchewan, and Manitoba). We describe a direct approach to quantifying the amount of organic matter consumed in peatlands during individual fire events, based on differences in ash concentrations between burned peat at the surface and underlying unburned peat. Using the Large Fire Database (Stocks *et al., J. Geophys. Res.*, in review) and detailed peatland inventories for western Canada, we provide the first regional estimate of contemporary fire frequencies in boreal peatlands. Our results suggest that 1470 km^2 of peatland potentially burned annually between 1980-1995 across Alberta, Manitoba, and Saskatchewan. We estimate that these fires release approximately 4.7 Tg C yr^{-1} to the atmosphere through organic matter combustion. This C loss represents 53% of long-term net annual C accumulation as peat across western Canada, suggesting that wildfires may substantially reduce ecosystem C storage in boreal lowlands.

B51B-0209 0830h POSTER

Elevated Carbon Dioxide Alters Soil Nitrogen Dynamics in an Intact Mojave Desert Ecosystem

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Arid ecosystems are predicted to be among the most responsive to elevated carbon dioxide because of projected increases in plant water-use efficiency. Increases in net primary production will also be regulated by available nitrogen because nitrogen is the primary resource limiting net production once water is available. Plant-available nitrogen has decreased 40 to 50 % under elevated carbon dioxide. We hypothesize this is due to an increase in microbial activity caused by increased carbon input into the soil, because the decrease in inorganic nitrogen is accompanied by significant increases in soil respiration and plant nitrogen isotope composition. The increase in plant nitrogen isotope composition is likely the result of increased microbial fractionation of inorganic nitrogen during immobilization. Experimental manipulation of soil labile carbon also increased soil respiration and decreased gaseous nitrogen loss and plant-available nitrogen. This study suggests that while elevated carbon dioxide may increase available water in arid ecosystems, it might also decrease available nitrogen.

B51B-0210 0830h POSTER

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On land, nitrous oxide (N_2O) is mainly produced in soils by bacterial processes such as nitrification and denitrification. Once in the atmosphere N_2O contributes to the greenhouse effect and stratospheric ozone destruction. Nitrification and denitrification are strongly dependent on soil moisture content, amongst other soil parameters. At Biosphere 2 Center we have begun to test the utility of meso-scale closed systems for understanding the relationship between soil properties and trace gas production at larger scales.

We investigated the relationship between soil moisture content and soil N_2O efflux in two large experimental closed systems (Tropical Rainforest (TR) and Intensive Forestry (IF) Mesocosms) at Biosphere 2 Center. N_2O was measured every hour with an automated GC system. The daily N_2O production rate was calculated as the rate of increase of N_2O during the daytime, when the mesocosm was materially closed. We furthermore measured N_2O and nitrate concentrations in the soil, as well as nitrate and N_2O production rates in local areas.

In the Rainforest Mesocosm, we found a very reproducible relationship between soil moisture content and N_2O efflux, including the transient spikes in production rate upon wetting. In the Forestry Mesocosm the relation between soil moisture and N_2O efflux was less clearcut.

B51B-0211 0830h POSTER

Interaction effects of CO_2 and nutrient supplies on carbon cycling and sequestration in a pine forest

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Under elevated CO_2, the enhancement in the amount of carbon (C) sequestered in woody biomass of forests is controlled by availability of other resources that influence growth, such as nutrients and water. At the Duke Forest FACE site, a large growth response of woody tissue in a loblolly pine forest was transient, settling after three years at a marginal gain. Yet photosynthesis continued at a higher rate under elevated CO_2. Greater availability of carbohydrates supports a large increase in forest floor CO_2 flux. Forest floor CO_2 flux decreases under both ambient and elevated atmospheric CO_2 when nutrients are added to the soil. Most of the reduction in forest floor flux can be accounted for by the increased in wood production once nitrogen limitation is alleviated. Thus, nitrogen acts to switch the forest from a large carbon sponge to a strong carbon pump that quickly cycles CO_2 from the atmosphere to the soil and forest floor, and back to the atmosphere.

B51B-0212 0830h POSTER

The Impacts of Increasing Atmospheric Nitrogen Deposition on Forest Carbon Accumulation in the U.S. Mid-Atlantic Region

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The global carbon assessments have suggested that the mid-latitude forests are likely the primary places where carbon sequestration has been enhanced because of increasing anthropogenic N deposition. In this paper, we examine the idea with a regional study of the U.S. mid-Atlantic and present the estimate produced by a dynamic and process-based forest ecosystem model, PnET-CN. For the U.S. mid-Atlantic region, forests cover about 56% of the total land area. The pattern of N deposition varies across the region because of complicated landscape features and land-use types. High wet deposition generally occurs in the northern lake and high elevation areas, as well as urban/suburban especially metropolitan areas. The N deposition data used for the modeling were from the 1999 scenario that was generated by a research group at Penn State University using interpolation algorithms based on concentration data collected at National Atmospheric Deposition Project/ National Trends Network monitoring sites and precipitation data from a denser network of National Atmospheric and Oceanic Administration Cooperative climatic sampling sites. We assumed that N deposition in 1930 was about 25% of the 1999 level and interpolated this level linearly back to 1930 for each 1-km square pixel within the region. Our simulations based on the ramped N increase and controlled N level in the past 70 years indicate that the growth effect of a sustained increase of N deposition could vary in different locations and forest types. For example, some mountain coniferous forests are likely N saturated and the increased N deposition had little effect on forest growth. Deciduous forests in the region seemed to respond more positively to N deposition. The annual growth rate could be up to 4.7% higher after a long-term exposure to additional N inputs. It is unclear what is the threshold in which additional nitrogen may degrade forest ecosystem function in terms of reducing net photosynthesis, N use efficiency and forest growth. The results reported here are only preliminary because (1) we only simulated the growth impacts from additional wet N deposition due to the lack of dry deposition data, and (2) the assumption of a ramped increase of N deposition may fail to count the growth effect of inter-annual variations of N deposition that can change tremendously in wet and dry years. The modeling results will be improved along with our on-going research and new data.

B51B-0213 0830h POSTER

Testing watershed size and slope, soil C:N and carbon storage as indicators of riverine dissolved organic carbon concentration and export

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Several predictors of riverine dissolved organic carbon export have been presented over the last decade. The relationship between dissolved organic carbon export and a) watershed size and slope, b) mean watershed carbon storage and c) mean biome soil C:N ratio have all had measurable success as predictors of riverine DOC export. We tested each of these major predictors within a cool temperate conifer biome in Nova Scotia and New Brunswick, Canada. Soil cores were taken from thirteen watersheds, and the organic and mineral soil horizons were analyzed for carbon and nitrogen. The number of soil cores taken from each watershed depended on the size of the watershed. We retrieved 12 cores from the smallest and 35 from the largest watersheds. Bulk density was calculated for each soil sample so that watershed carbon storage could be derived. Watershed area, forest cover, slope and altitude were also logged for each soil sample point.

Watershed size ranged from 6.3 x 10^3 ha to 1.25 x 10^5 ha. Altitude from 88 to 1458 ft. Individual soil C:N ratios ranged from 16.5 to 48.9 in organic soil horizons and from 6.1 to 29.8 in mineral soil horizons. Dissolved organic carbon export for each of the watersheds was calculated and range between 29.9 and 123.5 kg DOC ha^{-1} yr^{-1}. Ten watersheds were used to derive empirical relationships between DOC export and each of aforementioned major predictors of DOC export. The remaining three watersheds, not included in empirical modeling were used for testing each model.

B51B-0214 0830h POSTER

Nitrogen and Carbon Cycling in Deforested and Pristine Upland (2400m) Forest Catchments in the Peruvian Andes

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Nitrogen and carbon cycling were examined within two upland (2400m) forest catchments in the Peruvian Andes. One catchment was partially deforested within the last 3 years, while the other has remained untouched. Tracer amended samples were analyzed to determine the pathways and rates of nitrogen cycling in streams draining each catchment. Both streams exhibited very low inorganic nitrogen levels, on the order of 1 to 2 uM. A large percentage (>1/3) of the total fixed nitrogen flux from these systems was in the form of particulates. Preliminary results suggest a very high rate of nitrogen cycling in these systems. Isotopic measurements of plant samples from both catchments also suggest that these forests are highly efficient in trapping and using atmospheric nitrogen sources. The partially deforested catchment had significantly more species using C4 and CAM carbon fixation pathways. Leaf litter from both streams and leaves from trees in the area were also analyzed for carbon and nitrogen isotopes to compare and contrast nitrogen and carbon cycling between the two sites. This and other data to be presented suggest that deforestation has subtle but significant effects upon the ability of tropical upland forests to retain and use nutrients.

B51C MC: 122 Friday 0830h

Water, Energy, and Carbon Cycles in Terrestrial Systems: Measuring and Modeling From Site to Region II

(joint with H)

Presiding: **B Law,** Oregon State University**; P Thornton,** National Center for Atmospheric Research

B51C-01 0830h

Assessing Interannual Variation in Net Ecosystem Production over a Coniferous Forest Landscape

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Spatial estimates of net ecosystem production (NEP) can be attained by constraining ecosystem process models with remote sensing and hierarchical plot data (intensive measurements and survey data). In temperate coniferous forests, NEP varies widely 1) over the course of secondary succession, 2) in response to environmental gradients associated with elevation, and 3) in response to interannual variation in climate. These factors should therefore be included in spatially explicit estimates of NEP that are of interest in relation to assessing current biologically driven carbon flux. In the Pacific Northwest (PNW) region we are using a combination of satellite remote sensing, gridded meteorological data, and ecosystem process models to account for these factors. The Landsat ETM+ sensor, with a spatial resolution of about 30 m, generally captures the scale of the spatial heterogeneity associated with disturbances such as fire and logging. In PNW forests, ETM+ can resolve multiple age classes, and multiyear analysis that employs change detection permits dating of clearcuts generated since the 1970s. This fine temporal resolution early in succession is important because of the rapid changes in NEP with stand age. ETM+ is also effective in mapping leaf area index, although the algorithms tend to be asymptotic at the high LAIs found in some coniferous forests. Multiyear gridded meteorological data, based on interpolated meteorological station observations, provides the basis for model spin ups which bring simulated soil organic matter pools into near equilibrium with the local climate. Opportunities for validating NEP surfaces or component fluxes include georeferenced forest inventory data for bole wood carbon storage and production, eddy covariance flux data for daily gross primary production and net ecosystem exchange, and chronosequence studies in a variety of bioclimatic zones for characterizing carbon pools and fluxes over succession. Results of multiyear simulations at landscape to regional scales will help in understanding biospheric responses to climatic phenomena such as ENSO events.

B51C-02 0850h

Inverse Modelling of Carbon and Oxygen Isotopic Discrimination During CO_2 Assimilation Within a Forest Canopy

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Inverse modelling techniques were used with a Lagrangian model of turbulent dispersal to infer vertical profiles of carbon and oxygen isotope discrimination during photosynthesis from concentration measurements within a Siberian coniferous forest canopy. Profiles of leaf-level fluxes of CO_2, H_2O and heat, as well as ground fluxes, were also determined.

Concentrations of five scalar quantities, CO_2, $^{13}CO_2$, $C^{18}O^{16}O$, H_2O and temperature, were measured at up to nine heights within and above a mixed fir and spruce forest in central Siberia over several days during snow melt in May 2000. Eddy covariance measurements of CO_2, H_2O and heat fluxes were made above the canopy over the same period, providing independent verification of the model flux estimates.

Photosynthesis, transpiration, heat loss and isotope discrimination during CO_2 assimilation were modelled for sun and shade leaves throughout the canopy through a combination of inversion of the concentration data and principles of biochemistry, plant physiology and energy balance. Parameters relating to photosynthetic capacity, stomatal conductance, radiation penetration and turbulence structure were optimised simultaneously by the inversion to provide the best fit of modelled to measured concentration profiles of the five scalars.

A sensitivity analysis was undertaken to determine the robustness of the parameter solutions. Different parameter combinations were investigated to extract the maximum possible information from the available data with the highest confidence levels for optimised parameter values. Parameters that were not sufficiently independent were assigned best-guess values and the model error resulting from uncertainty in these estimates was investigated.

Modelled carbon isotope discrimination for the snow-melt period was lower than has previously been measured or modelled for boreal ecosystems, corresponding to low intercellular CO_2 concentration and stomatal conductance, both decreasing significantly during the day. The effect of low temperatures and high viscosity of water on plant hydraulics may explain these low values. Modelled oxygen isotope discrimination was consistent with other estimates for boreal regions. There was no clear trend with time of day because of the conflicting influences of vapour pressure deficit. This increases during the day causing an