samples from nearby pond, creek, precipitation, a underground aquifer were also collected monthly for comparison. The hydrogen isotope compositions from sediment waters in Horizon 2B are distinct from other environmental waters in the following two ways: (1) They differ from pond, creek, and ground water by up to 36 per mil and from meteorological water by up to 72 per mil. (2) The hydrogen isotope ratios remain stable throughout the year with little fluctuation (within error range). The D/H ratios along the vertical section vary slightly by about 20 per mil. The hydrogen isotope values of sediment water offset D/H ratios determined from different lipid compounds derived from Clarkia sediments by 122-196 per mil. Although the precise age of the sediment water can not be determined, a source other than modern environmental water is highly likely. Further information regarding its mobility and resident time is critical to elucidate the role that these water molecules have played in degradation of abundant labile ancient biomolecules and their isotope signatures preserved in Clarkia fossils and sediments.

B51C-0983 0830h POSTER

Compound Specific Isotope Analysis of Fatty Acids in Southern African Aerosols

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This study, conducted as a part of the Southern African Regional Science Initiative (SAFARI 2000), applied compound specific isotope analysis to describe aerosols at source regions and rural locations. Stable carbon isotopic compositions of individual fatty acids were determined for aerosol samples collected at four sites throughout southern Africa. Mongu, Zambia and Skukuza, South Africa were chosen for their location within intense seasonal Miombo woodland savanna and bushveld savanna biomass burning source regions, respectively. Urban aerosols were collected at Johannesburg, South Africa and rural samples were collected at Sua Pan, Botswana. Fatty acid isotopic compositions varied temporally. Urban aerosols showed significant isotopic enrichment of selected short chain fatty acids ($C < 20$) compared to aerosols produced during biomass combustion. Sua Pan short chain fatty acid signatures were significantly different from the other non-urban sites, which suggests that sources other than biomass combustion products, such as organic eolian material, impact the Sua Pan aerosol profile. However, a high degree of correlation between Sua Pan and Skukuza long chain fatty acid $\delta^{13}C$ values confirm atmospheric linkages between the two areas and that isotopic signatures of combusted fatty acids are unaltered during atmospheric transport highlighting their potential for use as a conservative tracer.

B51D MCC: Level 2 Friday 0830h

Estimating Terrestrial Carbon, Water, and Energy Fluxes From Site to Region III Posters *(joint with A, H)*

Presiding: **J Styles,** Oregon State University**; M Arain,** McMaster University

B51D-0984 0830h POSTER

Advection and Thermotopographic Flows Near A Flux Tower: Coupled or Not?

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Ecosystem-atmosphere exchange of carbon, water, and heat is routinely measured at numerous sites around the world, using the eddy-covariance technique. However, recent research has questioned the interpretation of some of these measurements, particularly at night and in areas of complex terrain. Much of this research has focused on horizontal and vertical advection, resulting from thermotopographically driven horizontal flow divergence (drainage flows). This paper examines horizontal and vertical flow patterns above and below the forest canopy at the Morgan-Monroe State Forest (MMSF) AmeriFlux site in south central Indiana. Mean vertical motions above canopy were investigated using data from a 46 m ridge-top tower. We found a tendency toward downward vertical velocities at night relative to the daytime. Some evidence suggests that this vertical convergence is driven by nocturnal thermotopographic flows. To examine sub-canopy flow through a small gully located near the main tower, a small (8 m) mast was installed. Flow direction in the gully was generally well correlated with the along-gully component of the above-canopy wind, indicating dynamic coupling. However, there were periods when wind in the gully was decoupled from flow aloft and was consistent with thermotopographic flow. Details of thermotopographic flows, in both the leaf-off and vegetative seasons, will be discussed; these include temporal patterns, relationships to likely drivers such as radiation and temperature gradients, and relationships with above canopy vertical velocities. It was found that the three-dimensional flow structure at MMSF is more complex than in non-forested terrain, particularly during the vegetative season. This research supports arguments that the inclusion of simple advection terms in calculations of NEE, based on above-canopy measurements, is not generally applicable. The results suggest a need for further investigation into the flow patterns at MMSF and at other forests in complex terrain. Furthermore, additional study of thermotopographic flows in forested terrain is needed.

B51D-0985 0830h POSTER

Observing Subcanopy CO_2 Advection

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Underestimation of nocturnal CO_2 respiration under calm conditions remains an unsolved problem at many forest flux stations. In this paper, the hypothesis is tested that horizontal mean transport of CO_2, not previously measured, may account for the missing CO_2. A systematic methodology was developed that comprises characterizing the subcanopy motions, determining the appropriate size of the subcanopy network required to make the measurements, developing a method of integrating the measurements in the vertical, and determining the required averaging time. Measurements were performed at the Harvard Forest (Petersham, MA), over 4 years. Subcanopy flows were decoupled from the flows aloft 75% of the time. While stress divergence contributed 38% of the daytime forcing of subcanopy flows, negative buoyancy dominated nocturnal forcing 58% of the time, generating drainage flows 51% of the time. The drainage flow direction was dictated by the length of the slope, not its angle. Pressure gradient forcing across the lee side of the hills was predicted to be significant, but the simple flow reversals expected were not observed. The appropriate horizontal size of the network of wind and CO_2 sensors was shown to be on the order of 100 m, ensuring that sensors were generally observing coherent processes on this scale or larger and thus displaying some correlation. Horizontal transport of CO_2 at Harvard Forest was found to be restricted to the bottom 10 m of the forest. The fraction of the negative buoyancy force in the sum of dynamic driving forces described nights with missing flux problems ("deficit nights") significantly better than the commonly used friction velocity criterion. Including the measured horizontal transport terms did not on average fully account for the observed difference in NEE of 1.2 ± 0.3 μmoles $m^{-2}s^{-1}$ between deficit and non-deficit nights, but decreased the difference to 0.7 ± 0.5 μmoles $m^{-2}s^{-1}$.

B51D-0986 0830h POSTER

Large Uncertainties in Estimating Grassland Carbon Fluxes: Can Net Ecosystem Production Be Inferred?

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Despite interest in estimating ecosystem carbon budgets based on easily collected field data, no previous study to our knowledge has compared various methods of estimating total above- and belowground net primary production (NPP) and net ecosystem production (NEP, the annual carbon accumulated by an ecosystem) from commonly measured biomass and soil surface CO_2 flux data in grasslands. Here we used field data from two grassland restorations and a row-crop agriculture treatment enrolled in the Conservation Reserve Program as a model for an analysis of methodological uncertainty in estimating ecosystem carbon budgets over a short time period. The goal of this study was to investigate how a range of methods for estimating NPP and NEP suggested in the literature might be used to predict ecosystem carbon budgets based on short-term field measurements. We conclude that it is extremely difficult to close the carbon budget of a temperate grassland using flux-based methods that account for plant-derived carbon inputs and soil surface CO_2 losses. Current uncertainties in (1) estimating aboveground NPP, (2) determining belowground NPP, and (3) splitting soil respiration into heterotrophic and autotrophic components strongly affect the magnitude, and even the sign, of NEP. A comparison of these estimates, across a treatment of different plant species mixes and land management, cannot reliably distinguish differences in NEP, nor the absolute sign of the overall carbon budget. These uncertainties likely exist in all grassland carbon budget studies using this approach, so conclusions about whether these systems are truly carbon sinks, or how they should be managed to sequester carbon, must be made with extreme care. Longer-term stocks methods, periodically linked to flux-based measurements of individual processes, may be the only way to close the carbon budget in these systems with any reasonable degree of certainty at the present time.

B51D-0987 0830h POSTER

A global relationship between hetero-/autotrophic respiration and total soil surface CO_2 flux?

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Soil surface CO_2 flux (R_S) is overwhelmingly the product of respiration by roots (autotrophic respiration, R_A) and soil organisms (heterotrophic respiration, R_H), two source fluxes with different carbon sources and temperature dynamics. Many studies have attempted to partition R_S into these two components, with highly variable results. An analysis of all published data reporting annual R_S and the R_A/R_H partitioning, encompassing 54 primarily forested sites, suggests that the heterotrophic and autotrophic source fluxes are each strongly ($R^2 > 0.8$) related to total annual CO_2 flux across a wide range of ecosystems. Study biome, measurement method, mean annual temperature, and leaf habit had no significant effect on these relationships. Because belowground measurements are difficult to perform but measuring annual R_S is straightforward and common, these relationships may provide a useful method with which to estimate the heterotrophic and autotrophic contributions to soil surface CO_2 flux for undisturbed terrestrial ecosystems.

B51D-0988 0830h POSTER

The Joint Influences of Climate, Litter Quality, and Soil Fauna in Regulating above- and Belowground Decomposition: a Pan-Tropical Study

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I report on the results of a collaborative study investigating the joint influences of climate, litter quality, and soil fauna in regulating above- and belowground decomposition in tropical forest ecosystems. We have assembled a network of 15 collaborators working in 22 tropical forests including sites in Hawaii, Central America, South America, India, Madagascar and Papua New Guinea. In general, most lowland tropical forests experience continually warm climates but vary greatly in the amount and seasonal distribution of precipitation. We predicted that tropical dry and wet forests differ in the degree to which decomposition processes are controlled by soil fauna and litter quality. We developed a standardized litter bag protocol that is being implemented by each collaborator at his or her field site. Preliminary results suggest that litter quality,

soil fauna, and decomposition environment (above- or belowground) all influence decomposition rates among our sites, which span an order of magnitude gradient in mean annual precipitation. However, which factors are most important in each forest is idiosyncratic and cannot be predicted from climate data alone. This study is the first of its kind to simultaneously evaluate both biotic and climatic controls on litter decomposition in tropical forests at the global scale.

B51D-0989 0830h POSTER

Carbon Flux Partitioning in an Old-Growth Forest: Study of Seasonal and Interannual Variation

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We investigate the decompostion of eddy flux measurements of net ecosystem exchange (NEE) into gross primary productivity (GPP), ecosystem respiration (R_{eco}) and the temporal dynamics of component fluxes for 4 years of data from long-term measurements of carbon fluxes above and within Old-growth Forest at the Wind River Canopy Crane AMERIFLUX site. Trees at the site are up to 500 years old and 65 meters tall. The forest structure at the site is complex for a temperate conifer stand with seven gymnosperm and two angiosperm tree species in the 2.3 ha crane circle, large standing biomass and large amounts of woody debris on the forest floor. Soil respiration is a major contributor to the carbon budget at the site with roughly 75% of total respiration on average. The annual estimates of net ecosystem exchange (NEE) of carbon range from a strong sink (2.1 tC/ha per year) to a source (-0.5 tC/ha per year). Summers are usually warm and dry (1998, 2001) but relatively wet and cool ones have been observed (1999). Precipitation levels throughout the observation period varied from 1600 to 2600 mm with the latter close to the 25-year average. The main period of maximum carbon uptake is limited to the months March through May when ecosystem respiration and water stress are low. Stand-level light response functions show optima for low temperatures and diffuse light conditions. R_{eco} also shows a clear seasonal pattern but lags significantly behind NEE with a maximum in late summer and has a range of 13 - 16 tC/ha per year. GPP shows a similar lag against NEE but is relatively invariant on an annual basis (16 tC/ha).

B51D-0990 0830h POSTER

Soil Carbon Sequestration After Six Years of Experimental CO2 Enrichment at the Duke Forest

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Over the first six years of the Duke Forest Free-air CO2 Enrichment (FACE) experiment the forest floor under the elevated CO2 treatment accumulated more carbon than did the control at a steady rate of 50 g m-2 yr-1. However, there were no detectable changes in the carbon content of the mineral soil. Increased carbon inputs to the forest floor associated with CO2-enhanced primary productivity entirely account for this increase in forest-floor carbon content, suggesting that the rate of gross decomposition has not changed under the treatment. Estimates of gross decomposition are consistent with this result. These findings suggest that the CO2-induced productivity enhancement may be sustained over the long term. However, estimates of steady-state soil carbon pools based on the results of the first six years of the experiment show that less than 1 Pg of additional carbon could be expected to be sequestered in forest soils in the eastern U. S. in response to CO2 fertilization.

B51D-0991 0830h POSTER

Sixteen-year stimulation of sedge density by elevated CO_2 reaches 100% and is salt-stress enhanced.

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Increased atmospheric CO_2 concentration produces a short-term stimulation of plant growth across terrestrial ecosystems. However, the long-term response remains uncertain and is thought to depend on environmental constraints. In the longest experiment on natural ecosystem response to elevated CO_2, we observed for the wetland sedge *Scirpus olneyi* that the shoot-density stimulation by elevated CO_2 increased from 16% during the first four years to more than 100% in the 16th year. While most of the inter-annual variability of the stimulation was explained by this steady increase with time (r2 = 0.89), the residuals of this variability were positively correlated with the salinity of the marsh (r2 = 0.44). These results demonstrate that the inter-annual variability of plant response to elevated CO_2 is coupled to environmental stress and indicate that experiments based on more than a decade of measurements are necessary to ascertain such effects.

B51D-0992 0830h POSTER

MVP: A Simple and Effective Model to Simulate the Mean and Variation of Photosynthetically Active Radiation Under Discrete Forest Canopies

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The spatial patterns of Photosynthetically Active Radiation (PAR) under forest canopies, including both its mean and spatial variation, are critical factors that determine numerous ecophysiological processes in plant ecosystems. Though numerous models have been developed that can accurately simulate PAR transmission through plant canopies, Beer's law remains the primary model used in ecological models to describe PAR transmission through plant canopies due to the fact that the more accurate models are too complicated to be used operationally. This study developed a simple and computationally efficient model to simulate both the Mean and Variation of PAR (MVP) under the forest canopy. The model provides a careful description of the effects of gaps on the variable light environment under forest canopy, while it simplifies the simulation of multiple scattering of photons. The model assumes that a forest canopy is composed of individual crowns distributed within upper and lower boundaries with two types of gaps: the between- and within-crown gaps. The inputs to the model are canopy structural parameters, including canopy depth, tree count density, tree crown shape, and foliage area volume density (m^2/m^3, leaf areas per unit crown volume). The between-crown gaps are simulated with geometric optics, and the within-crown gaps are described by Beer's law. The model accounts for the covariance of PAR in space through time, making it possible to simulate both instantaneous variation of PAR and variation of daily accumulated PAR. Validation with observed PAR using ten quantum sensors under the Old Black Spruce stand at the Southern Study Area of the BOREAS project indicates the model captures the mean and variation of PAR under forest canopy reasonably well. The model is simple enough that it can be used by other ecological models, such as ecosystem dynamics and carbon budget models. Further validation and testing of the model with other types forest are needed in the future.

B51D-0993 0830h POSTER

Transpiration: A Test of Optimality Hypothesis

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The argument is that the fundamental mechanisms behind bare soil evaporation are also responsible for plant transpiration except that stomata affect the exchange of water vapor between the evaporating surface and the atmosphere. It is hypothesized that the system of liquid water in leaf tissues and the water vapor in the atmosphere tries to evolve towards a potential equilibrium as quickly as possible by maximizing transpiration. In the proposed theory, CO_2 flux is used as a non-parametric equivalent of stomatal conductance as CO_2 and water vapor diffuse in and out of leaves through the same path. It is further assumed that stomatal aperture is directly controlled by guard cell turgor (or leaf water potential). Transpiration is formulated as a function of leaf temperature, leaf water potential/stomatal conductance (or CO_2 flux as the surrogate), and sensible heat flux (characterizing transport mechanism) at a given level of radiative energy input. Optimization of transpiration constrained by the energy balance equation leads to vanishing derivatives of transpiration with respect to leaf temperature and CO_2 flux. Effect of vapor pressure deficit on transpiration is also investigated. Preliminary tests using field experimental measurements lead to encouraging evidence in support of the hypothesis. It is found that transpiration is fairly insensitive to atmospheric humidity as suggested by several earlier studies.

B

B51D-0994 0830h POSTER

Rigidity and Plasticity of Leaf Carbon and Nitrogen Systematics in California Oaks

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Mapping photosynthesis from space requires an understanding of photosynthetic efficiency. Current data sets prescribe global maps of photosynthetic parameters and relate them to greenness. It is the seasonality of greenness, and not of photosynthetic efficiency itself, which is presumed to drive photosynthesis. In fact, both greenness and photosynthetic efficiency convolve to produce seasonality in photosynthesis. If the scientific community is to globally retrieve photosynthetic rates from space, it must take this seasonality into account. We examine the rigidity and plasticity of photosynthetic capacity, its correlation to leaf nitrogen, and other leaf properties across geographic gradients of precipitation, soil moisture, air temperature, relative humidity and other measurables. In particular, these measurements focus on different species of oaks: blue oak (Quercus douglasii), coast live oak (Quercus agrifolia), black oak (Quercus velutina), and valley oak (Quercus lobata). Leaf chamber measurements with infrared gas analyzers and measurements of leaf specific mass, carbon isotope composition, and nitrogen content were performed in three Mediterranean ecosystems in California: Russell Reservation (coastal hills; oak woodland), Quail Ridge Reservation (near Lake Berryessa; Northern Coast Ranges; oak woodland), and Ione (Central Valley; oak savanna). Oaks of the same species adapted to more temperate microclimates such as shaded, north-facing slopes showed less pronounced seasonality in leaf nitrogen content and photosynthetic capacity. The comparison of evergreen and deciduous oak species yields relationships among leaf life span, specific leaf mass, and photosynthetic capacity that are consistent with the results of Reich. Our results confirm that oaks exhibit plasticity in their adaptation to more and less extreme environments. These results also explain why the deciduous oaks are less successful than the evergreen oaks near the coast and more successful in the interior. In addition, we examine the interactions between mesophyll conductance and leaf properties such as thickness and nitrogen content in driving the seasonality of apparent photosynthetic capacity. A new understanding of mesophyll conductance in relation to leaf thickness, leaf life span, and isotopes content will be important to the study of isotopes.

B51D-0995 0830h POSTER

Global Changes And Tree Growth Rate In The Amazon Forest

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A better understanding of the variations in the dynamics and structure of trees in tropical forests is necessary for predicting the potential for these ecosystems to lose or store carbon. In general, tropical forests have been treated as if all trees behaved similarly, and little is known about how forests vary across the large extent of the Amazon basin. Our data show large differences in forest structure, biomass, and tree growth rates among plots under study in three locations in Brazil: ZF-2 Bionte/Jacaranda plots $Manaus$, Catuaba Reserve $RioBranco$, and Tapajós National Forest $Santarém$. These locations span an east-west transect of the Amazon basin with different dry-season lengths. The number of stems >10cm diameter and stocks of C in aboveground biomass are the highest in Manaus $626ha-1, 180.1Mg.C.ha-1$, than Rio Branco $466ha-1, 122.1Mg.C.ha-1$ or Santarém $460ha-1, 140.6Mg.C.ha-1$. Estimates of mean annual accumulation of C ranged from 1.6 $Manaus$ and 2.5 $RioBranco$ to 2.8Mg.C.ha-1.yr-1 $Santarém$. Trees in the 10-30cm diameter-size showed the highest accumulation of C $38\%, 55\%, and 56\% - Manaus, RioBranco, and Santarém, respectively.$ Our results showed marked seasonal growth, with the highest growth rates in the wet-season and the lowest growth rates in the dry-season. This effect was most evident for trees with diameter >50cm. The comparison of the three areas investigated suggests that forests experiencing a longer dry-season have larger annual diameter growth increments for individual trees. Tree average age was larger in Manaus where the increment was smaller. In all the three areas it was found specimens with DBH smaller than 30cm, but with ages over 200 years. It was found a specimen of 17 cm of DBH and age of 920 years. The fact that small trees can reach old ages may alter the scope of the present forest management planning whose focus is tree species of economical interest and the time the take to reach a commercial diameter.

B51D-0996 0830h POSTER

Influences of prolonged drought and high temperature on carbon exchange of an oak/grass savanna in California

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We present a long-term study on carbon flux over an oak/grass savanna, located at the lower foothill of Sierra Nevada in California. The ecosystem is consisted of overstory of blue oak (*Quercus douglasii*) and understory of C_3 annual grass. It has a Mediterranean climate with wet and cold winter, dry and hot summer. Strong seasonality in soil moisture and large day-to-day temperature and VPD changes make the site a unique laboratory to investigate the roles of drought, high temperature, and plant functional type on the carbon exchange between ecosystems and atmosphere. Continuous measurements of carbon fluxes over and under the oak/grass savanna ecosystem started in April 2001. Meteorological and soil parameters (air temperature, radiation, VPD, precipitation, soil moisture etc.) were also measured. Grass leaf area index (LAI), predawn water potential were measured at 1-2 week intervals. Gas exchange (A/Ci curve) of oak leaf were also measured at weekly intervals to quantify the seasonal variations in stomatal conductance (g_s) and maximum photosynthetic capacity (V_{cmax}). The growing season for the understory grass is limited in the wet season, which is from late Oct to early May. Oak leaf out at the end of March and quickly reach its maximum LAI of 0.6. Results show that daytime carbon uptake for the understory grass followed closely its LAI, which in turn was controlled by soil moisture content. For oak trees, besides soil moisture, changes in V_{cmax} need to be taken into account to explain its seasonal canopy carbon uptake. Results also show a strong VPD effect on NEE. We observed large pulse ecosystem respiration after rain events, especially those during dry seasons. In our ecosystems with very low NEE, such rain events could be one of major environment forcings that cause larger inter-annual variability in NEE. Severe water stress didn't alter water-use efficiency (WUE) of the savanna. WUE was much higher when compared with data from other AmeriFlux forest sites. Despite the prolonged drought and low LAI, the annual net carbon exchange in 2002 was -193 gC m^{-2}.

B51D-0997 0830h POSTER

Contribution of Climatic variables to Seasonal and Interannual Variability in Net Ecosystem Exchange at Eight AmeriFlux Forest Sites

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Seasonal and interannual variabilities in net ecosystem CO_2 exchange (NEE) have been well documented at many FluxNet sites. These variabilities have been linked to direct effect of climatic variations and climatic-induced functional changes. However, we still lack quantitative understanding of climatic effects on NEE variations. With a recently developed homogeneity-of-slopes model approach, variation in NEE can be partitioned into climatic variability and functional change. We applied this method to eight AmeriFlux forest sites with 37 site years eddy covariance measurements. Results showed that photosynthetic active radiation was the most important climatic variable at all sites. Climatic interannual variability contributed 5-10% of variations in NEE. Functional change contribution varied among sites from 0 to 10%. More than 50% of the variation in NEE could be explained by seasonal climatic variability. The considerable contributions by the functional change and climatic interannual variability in NEE necessitate long-term measurements to develop predictive understanding of ecosystem carbon exchange.

B51D-0998 0830h POSTER

Inter-annual variations of GPP and NEP above a cool-temperate deciduous forest at Takayama (AsiaFlux) in the last decade

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Broadleaf deciduous forest is one of the major vegetative constituents of the main island of Japan. Natural ecosystem dominated by oak is widespread in Japan, Korean Peninsula, northeastern China, and eastern Mongolia. Studying the environmental controls on gross primary production (GPP) and net ecosystem exchange (NEE) of the ecosystem is, then, one of the main subjects for understanding the carbon cycle of terrestrial ecosystems in eastern Asia. The study site is about 15 km east of Takayama City, in the central part of Japan. Flux of CO_2 has been measured since September 1993 by the aerodynamic method using the vertical gradient of CO_2 concentration and diffusion coefficient (Yamamoto et al., 1999). Fluxes of sensible heat, water vapor, and CO_2 have been measured continuously since July 1998 by the eddy covariance method (Saigusa et al., 2002) using a three-dimensional ultrasonic anemometer and a closed-path infrared gas analyzer. The nighttime NEE was estimated with and without correction, depending on the atmospheric stability. The annual carbon uptake for 1999, 2000, and 2001 were estimated as 198, 309, 290 gC m^{-2} $year^{-1}$ with the correction, and 251, 376, and 342 gC m^{-2} $year^{-1}$ without the correction, respectively. The nocturnal correction is responsible for the uncertainty in annual NEE in this site of about 52-67 gC m^{-2} $year^{-1}$. The NEP has been calculated for almost ten years, and it is the longest record at any particular site in Asia as a result of the flux measurements. The annual NEP was 224 $\pm$ 82 gC m^{-2} $year^{-1}$ (mean $\pm$ SD; 1994-2001). A large year-to-year variability of up to 158 gC m^{-2} $year^{-1}$ was observed in NEP. The annual NEP was highest in 1998, mainly caused by high CO_2 uptake observed during the first half of the growing period. The air temperature was significantly higher in April 1998 than in a usual year. The result in the present study suggests that the increase in CO_2 uptake due to a long growing period in 1998 was more remarkable than the enhancement of the respiration. References Saigusa et al., Agric. For. Met., 112, 203-215, 2002. Yamamoto et al., Tellus 51B, 402-413, 1999.

B51D-0999 0830h POSTER

Seasonal Variations in Night-time NEE from EUROFLUX

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Night-time temperatures and net ecosystem exchange (NEE) during 1997 measured by eddy covariance techniques from 14 FLUXNET towers in Europe were analyzed to identify the factors controlling ecosystem respiration. Empirical orthogonal function/principle component analysis of temperature and NEE identifies the 5 sites where night-time NEE shows no coherent seasonal variations or detectable climate control on respiration. Temperature proved to be the principle control on night-time NEE at nine of fourteen sites. These nine sites show a residual distinct seasonal cycle in NEE peaking in the fall. The residual does not correspond with variations in soil moisture or precipitation. We hypothesize that NEE variations at the EUROFLUX sites capture variations in the quality, quantity and microclimate of the litter beneath the canopy.

B51D-1000 0830h POSTER

FLUXNET: A Global Network of Eddy-Covariance Flux Towers

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The FLUXNET global network was established to aid in understanding the mechanisms controlling the exchanges of carbon dioxide, water vapor, and energy across a variety of terrestrial ecosystems. Flux tower data are also being used to validate ecosystem model outputs and to provide information for validating remote sensing based products, including surface temperature, reflectance, albedo, vegetation indices, leaf area index, photosynthetically active radiation, and photosynthesis derived from MODIS sensors on the Terra and Aqua satellites. The global FLUXNET database provides consistent and complete flux data to support global carbon cycle science. Currently FLUXNET consists of over 210 sites, with most flux towers operating continuously for 4 years or longer. Gap-filled data are available for 53 sites. The FLUXNET database contains carbon, water vapor, sensible heat, momentum, and radiation flux measurements with associated ancillary and value-added data products. Towers are located in temperate conifer and broadleaf forests, tropical and boreal forests, crops, grasslands, chaparral, wetlands, and tundra on five continents. Selected MODIS Land

products in the immediate vicinity of the flux tower are subsetted and posted on the FLUXNET Web site for 169 flux-towers. The MODIS subsets are prepared in ASCII format for 8-day periods for an area 7 x 7 km around the tower.

URL: http://daac.ornl.gov/fluxnet/

B51D-1001 0830h POSTER

Carbon and Water Exchanges in a Chronosequence of Temperate White Pine Forest

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Quantification of carbon sink or source strengths of temperate forest ecosystems, growing in northern midlatitudes, is essential to resolve uncertainties in carbon balance of the world's terrestrial ecosystems. Long-term flux measurements are needed to quantify seasonal and annual variability of carbon and water exchanges from these ecosystems and to relate the variability to environmental and physiological factors. Such long-term measurements are of particular interest for different stand developmental stages. An understanding of environmental control factors is necessary to improve predictive capabilities of terrestrial carbon and water cycles. A long-term year-round measurement program has been initiated to observe energy, water vapour, and carbon dioxide fluxes in a chronosequence of white pine (Pinus Strobus) forests in southeastern Canada. White pine is an important species in the North American landscape because of its ability to adapt to dry environments. White pine efficiently grows on coarse and sandy soils, where other deciduous and conifer species cannot survive. Generally, it is the first woody species to flourish after disturbances such as fire and clearing. The climate at the study site is temperate, with a mean annual temperature of 8 degree C and a mean annual precipitation of about 800 mm. The growing season is one of the longest in Canada, with at least 150 frost-free days. Measurements at the site began in June 2002 and are continuing at present. Flux measurements at the 60 year old stand are being made using a close-path eddy covariance (EC) system, while fluxes at the three younger stands (30, 15 and 1 year old) are being measured over 10 to 20 day periods using a roving open-path EC system Soil respiration is being measured every 2-weeks across 50-m transects at all four sites using a mobile chamber system (LI-COR 6400). The mature stand was a sink of carbon with annual NEP value of 140 g C m-2 from June 2002 to May 2003. Gross ecosystem productivity (GEP) and ecosystem respiration (R) for 2002-03 were 1290 and 1150 g C m-2, respectively. A processed-based carbon simulation model was created by incorporating canopy physiology (photosynthesis - sunlit and shaded leaf, conductance), plant phenology (leaf out, senescence), and carbon balance (plant and soil respiration, ecosystem productivity) algorithms in the Canadian Land Surface Scheme. In this study, we compare observed and simulated energy, water vapour, and carbon dioxide fluxes of the mature stand with those of the younger stands. This comparison will help to resolve scaling issues for estimating water and carbon budgets from stands to regions.

URL: http://www.science.mcmaster.ca/geo/faculty/arain/research/index.htm

B51D-1002 0830h POSTER

Vegetated terrestrial ecosystems are large sources of Hg to the atmosphere

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Industrial processes, especially coal combustion and metal refining, have led to significant releases of Hg to the atmosphere during the last century. It has been hypothesized that a large percentage of this Hg has been deposited to terrestrial ecosystems via wet and dry deposition. Recent measurements of net Hg exchange between soils and the atmosphere indicate that terrestrial ecosystems are a source of Hg to the atmosphere, rather than the hypothesized sink, but very few measurements have been performed over vegetated terrestrial ecosystems. The objective of this study was to continuously measure net Hg exchange between a grassland ecosystem and the atmosphere during an entire year using the Ecologically Controlled Enclosed Lysimeter Laboratory (EcoCELLs) at Desert Research Institute. The EcoCELLs are unique open flow gas exchange systems that allow for the measurement of whole-ecosystem gas fluxes from large soil-plant monoliths under precisely controlled environmental conditions. Our results indicate that daily net ecosystem Hg exchange was positive (i.e., net Hg loss from the ecosystem to the atmosphere) during most of the year with the exception of the winter months when we observed net deposition of Hg to the ecosystem. Soil Hg fluxes only contributed between 10 % and 25 % of measured ecosystem Hg emissions. Ecosystem Hg fluxes showed pronounced diel patterns with higher daytime Hg emissions compared to nighttime Hg fluxes indicating that solar radiation, temperature, and evapotranspiration are important factors controlling Hg emissions. The cumulative annual Hg budget over one year indicated that the grassland ecosystem in our study was a relatively large Hg source to the atmosphere, ranging from 20 to 100 μ g Hg m^{-2}. Based on this study it appears that grassland ecosystems are sources of Hg to the atmosphere during most of the year, with vegetation greatly enhancing total emissions, possibly through transpiration, and that vegetated terrestrial ecosystems are large, yet still poorly quantified, sources of Hg to the atmosphere.

B51E MCC: Level 2 Friday 0830h

Estimating Terrestrial Carbon, Water, and Energy Fluxes From Site to Region IV Posters *(joint with A, H)*

Presiding: **M Falk,** University of California, Berkeley**; C Song,** University of North Carolina at Chapel Hill

B51E-1003 0830h POSTER

Quantifying Representation and Using Representation Weights to Interpolate Flux Tower Measurements across the United States

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We are using a new multivariate statistical technique to quantitatively divide the lower 48 United States into a series of flux-relevant ecoregions. On the basis of these flux-relevant ecoregions, we will quantify the representativeness of the existing network of AmeriFlux towers, showing how well each ecoregion is represented by the current stations in the AmeriFlux network. Quantifying AmeriFlux representation will indicate the best locations where additional AmeriFlux towers should be placed. Using a "paint-by-number" approach, we are attempting to use the flux ecoregions as the statistical basis for extrapolating measurements made at the 52 actively-reporting AmeriFlux towers into a continuous 1-km grid across the United States seasonally. We will use the similarity of the suite of flux-relevant ecosystem characteristics to modify existing flux measurements and estimate fluxes within unmeasured flux ecoregions. Weights calculated for each environmental gradient will allow us to mix new "paint-by-number" colors, extending the process beyond the palette of existing flux measurements. The map of 2000 to 5000 flux ecoregions will produce a highly-resolved national map of estimated fluxes, and will be equivalent to creating thousands of new "virtual" flux towers across the nation. Once flux ecoregions and representation weights have been determined, it may be possible to use them to obtain an interpolated grid of the estimated flux at any point in time across the United States.

URL: http://research.esd.ornl.gov/~hnw/networks2

B51E-1004 0830h POSTER

Towards Constraining Regional Carbon Exchange In The Southern Great Plains With DOE ARM and COBRA Data And Tools

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Long term measurements of CO2 concentration and flux from tower sites may be effective for use in inversion estimates of regional land surface-atmosphere CO2 exchange. To explore the potential for application of tower data we have combined measurements from the 60m tower at the Atmospheric Radiation Measurement Program (ARM) Central Facility (36.61N, 97.49W) in the U.S. Southern Great Plains with a Stochastic Time-Inverted Lagrangian Transport (STILT) model [Lin et al., 2003] using a receptor oriented modeling (ROM) framework (Gerbig et al., 2003) developed for CO2 Budget and Regional Airborne Study (COBRA). We first investigate the uncertainties in the influence functions obtained from STILT: 1) STILT estimates of PBL heights show good correlation with those estimated from the radio sound profiles in May-June 2002 and 2003; 2) The measured mean concentrations on the 60 meter tower are independent of the flow directions patterns summarized from STILT particle trajectory statistics. Then we regress the observed CO2 concentration on the STILT/ROM simulated CO2 signals of different vegetation and emission sources in the growing season 2002 to obtain the scaling factors. The residuals are modeled as an autoregressive process to resolve the temporal correlation and calculate the uncertainties associated with the estimated coefficients. We find that: 1) STILT /ROM captures 60-80% of the variance in the observations; 2) Crop and shrub are the most important vegetation types that affect the regional carbon exchange; 3) Phenology and land use management cause significant seasonal variation in the scaling factors. Progress toward Bayesian inversion of the annual cycle of regional ecosystem-atmosphere CO2 exchange constrained by measurements from the 60m tower and aircraft flights, incorporating uncertainties in PBL heights, will be discussed.

B51E-1005 0830h POSTER

Characterizing Diurnal CO_2 Cycles in the Continental Boundary Layer Using Precise Concentration Measurements and a Simple Numerical Model

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In continental regions, atmospheric CO_2 profiles are strongly influenced by atmospheric dynamics as well as ecosystem and anthropogenic fluxes. Relating site level measurements or atmospheric profiles to regional CO_2 budgets may require methods to represent or evaluate these influences. At the Southern Great Plains ARM-CART, we are measuring precise CO_2 concentrations continuously at 2-60 m and weekly at 300 and 3300 m agl. CO_2 flux is measured in individual fields (4 m towers) and at 60 m. The precise CO_2 concentrations show strong continental influence in both diurnal and seasonal cycles. There is a vertical gradient in CO_2 concentration, with annual average CO_2 concentration at 2 m being 7 ppm higher than at 60 m, and flasks showing a 1-2 ppm difference between free troposphere and 60 or 300 m samples. To characterize the continental, diurnal cycle in CO_2, we have made a box model with three well mixed compartments for the surface layer,