0.001 day-1. Because methyl-BSA concentrations did not exceed the quantitation limit, the rate of xylene degradation could not be calculated. The formation of BSA and methyl-BSA was coupled with the utilization of nitrate, presumably due to denitrification. Transformation of toluene and xylene to BSA and methyl-BSA, respectively, was observed for wells characterized by low concentrations of toluene and xylene relative to total BTEX. To the best of our knowledge, this is the first report to document the use of deuterated BTEX surrogates in field-tracer experiments.

B42B-0145 1330h POSTER

Fumarate as a Probe and Stimulant for In Situ Reductive Dechlorination of Trichloroethene

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There is evidence that fumarate and trichloroethene (TCE) undergo reduction reactions under similar redox conditions and that microbial strains capable of utilizing both TCE and fumarate as electron acceptors exist. Thus, we propose that fumarate can be used in reactive-tracer tests in TCE-contaminated groundwater to (a) determine if favorable conditions for TCE reduction are present and/or (b) stimulate growth of fumarate/TCE-utilizing microorganisms as a means of increasing TCE bioremediation rates. Five separate series of single-well push-pull tests were conducted in wells with different background contaminant and biogeochemical profiles at a TCE-contaminated site. In test series I and V, in situ reduction rates for injected trichlorofluoroethene (TCFE), a TCE-surrogate, were determined. In test series II, III, and IV, in situ reduction rates for injected fumarate were determined. TCFE reduction rates varied between wells in test series I but were consistent with expected results based on background TCE reduction product profiles. In test series II, fumarate reduction occurred in those wells where TCFE had been reduced and not in those where TCFE had been reduced slowly or not at all, indicating that fumarate may be used to determine if TCE-reducing conditions are present. In test series III and IV, fumarate reduction occurred in several of the wells in which it had not occurred in test series II. In addition, fumarate reduction rates increased in those wells where reduction had occurred in series II, indicating that fumarate additions stimulated the growth of fumarate-reducing microorganisms. TCFE reduction rates were higher in test series V than in test series I, indicating that fumarate additions led to increased TCE reduction rates. These findings are significant since there is a need for methods that (a) probe for TCE reducing conditions and (b) increase TCE bioremediation rates.

B42B-0146 1330h POSTER

Comparison of Microcosm Tests and a Field Demonstration of Cometabolic Air Sparging With Propane for the Bioremediation of Trichloroethylene and cis-Dichloroethylene

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Cometabolic air sparging (CAS) is an innovative form of conventional air sparging, and is designed to degrade or remove chlorinated aliphatic hydrocarbon compounds (CAHs) in groundwater and to potentially treat these contaminants in the vadose zone. A CAS demonstration was conducted at McClellan AFB, California, for removal of chloroethenes (TCE, cis-DCE) from groundwater using propane as the cometabolic substrate. In support of this field demonstration both groundwater and vadose zone microcosm studies were performed. The microcosms were created with groundwater and aquifer materials from the demonstration site. Concentrations of compounds in the microcosms were created to mimic conditions where the demonstration was performed. The microcosms were used to test the potential of the propane-utilizers to transform the CAHs of interest, and determine their nutrient requirements while transforming these compounds.

Results from the first season of field-testing showed propane-utilizers could be effectively stimulated in the saturated zone with repeated intermediate sparging of propane and air. The lag time for effective propane utilization to be observed in the field was about 30 to 40 days, while in laboratory microcosms the lag period was about 12 days. Consistent with the field tests the groundwater microcosms showed cis-DCE was more rapidly transformed than TCE. Microcosm tests also indicated that propane inhibited the transformation of cis-DCE and TCE, and as observed in the field, most of the transformation of these compounds occurred after propane was reduced to low concentrations. In the field demonstration propane utilization rates and rates of CAH removal slowed after three to four months of repeated propane additions, which coincided with the depletion of nitrogen (as nitrate) in the treatment zone. Similar results were obtained with repeated additions of propane to the microcosms. In the field test ammonia was added to the propane/air mixture to provide a bioavailable nitrogen source. This resulted in enhanced rates of propane utilization and CAH transformation in the saturated zone. Microcosm results also showed ammonia was effective in enhancing propane utilization and CAH transformation rates, and the transformations caused a toxic effect that significantly increased the propane-utilizers requirements for nitrogen. A 2 to 4-fold increase in nitrogen consumption was observed when CAHs were transformed.

Propane utilization was observed to be much slower in the vadose zone of the field demonstration, compared to the saturated zone, and very limited CAH transformation was observed. Propane utilization rates in the vadose zone microcosms were an order of magnitude lower than what was observed in the saturated microcosms. Bioavailable nitrogen was required to maintain propane utilization rates. Higher CAH concentrations were found to inhibit the stimulation of the propane-utilizers under these conditions. Thus the vadose microcosms yielded results that were consistent with the field demonstration.

B42B-0147 1330h POSTER

Development of a Conceptual Model for Monitored Natural Attenuation of Methyl t-Butyl Ether

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Monitored natural attenuation (MNA) has become a common remediation strategy for groundwater contamination. This strategy has extended to MTBE despite the fact that its higher solubility, higher mobility, and slower degradation rate compared to other gasoline constituents could make demonstrating natural attenuation more difficult for this compound.

Given the increasing focus on natural attenuation by mass removing processes such as biodegradation, we must be able to separate the magnitude of attenuation attributable to degradation from that resulting from dilution, dispersion, or sorption. In order to determine field attenuation rates, and specifically biodegradation rates, the plume structure must be well understood. Furthermore, geochemical footprints must be identified and properly interpreted. The sampling network must be appropriate to provide representative data and that data must be properly analyzed to make a defensible demonstration. Existing field studies of MTBE attenuation rates have left unanswered questions about the role of source dissolution behavior, the usefulness of geochemical data, and the adequacy of traditional monitoring network designs.

The research presented here incorporates a controlled large-scale dissolution experiment, a natural gradient tracer test, and numerical simulations to address these questions. The dissolution study captures the source behavior from the moment of the initial spill. The tracer study demonstrates that significant complexity can arise in the dissolved plume structure despite relatively simple hydrogeology. The modeling illustrates the potential errors contributed by sampling network design. The combination represents an unprecedented approach to dissecting monitored natural attenuation in order to understand where the greatest challenges to MNA for MTBE lie. This work evaluates how increasing complexity in the source function, hydrogeology or attenuation processes translates into uncertainty in the natural attenuation demonstration. Furthermore, it quantifies the error attributable to sampling network design. The result is a conceptual model for MNA of MTBE that can be used to improve existing protocols.

B42C MC: Hall D Thursday 1330h

Synthetic Analyses of Large-Scale Ecological Processes I

Presiding: **C Potter,** NASA-Ames Research Center**; G Hurtt,** University of New Hampshire**; J Foley,** University of Wisconsin**; J Coughlan,** NASA Ames Research Center

B42C-0148 1330h POSTER

Modeling Lidar Waveforms Using a Radiative Transfer Model

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In the past, obtaining reliable measurements of key forest canopy metrics has been difficult, even after the development of remote sensing technology. Fortunately, next-generation lidar systems are proving to be useful tools for deriving critical canopy measurements, such as height, structure and biomass. These studies have all focused on comparisons between basic lidar-derived and field-sampled measurements. The results of these studies have shown that lidar remote sensing instruments can successfully measure forest canopy characteristics. However, physically-based remote sensing models are necessary to more fully understand and interpret the interactions of the laser energy with the forest canopy. In this study the Geometric Optical and Radiative Transfer (GORT) model is used to model lidar waveforms. GORT is capable of modeling lidar returns from canopies with clumped multiple layers and multiple species. For this study, GORT was used to model waveforms over the Sierra National Forest in California. Field data input into GORT are a representative sample of the different vegetation types found in the forest. The modeled waveforms are then validated against actual lidar data collected by the Laser Vegetation Imaging Sensor (LVIS) which mapped the area in October 1999. By modeling lidar waveforms based on the physical principles of radiative transfer, GORT fills a missing link between the remotely sensed and actual canopy structure. The results of this study will also aid in future large-scale land surface mapping by developing a link between lidar and other remote sensing data.

B42C-0149 1330h POSTER

Forest Disturbance Monitoring Using Multi-satellite Data

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The forests in Northeastern China have been undergoing dramatic changes during the last several decades due to forest fire, insect infestation, massive logging, agricultural conversion, and afforestation. These changes affect the climate, the ecosystem, the economy and living heritage in the region and the carbon balance. For example, a forest fire, which burned from 6 May to 2 June 1987, destroyed nearly one million ha of forest in Northeastern China. Following the fire,

various human activities affect the natural recovery of forests. To investigate these effects and the potentials to monitor the forest dynamics using remote sensing data, various satellite data including MODIS, Landsat 5 and 7 data, ERS SAR and JERS-1 SAR data were used in this study. The results are reported in this paper.

B42C-0150 1330h POSTER

Operational retrieval of accurate biogeophysical information from space sensors

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The characteristics of plant canopies and ecosystems have been inferred from spectral measurements made in space for decades. These estimates often were derived from the Normalized Difference Vegetation Index (NDVI), which is simple to compute but very sensitive to perturbations and prone to yield misleading or erroneous results. Advances in the understanding of radiation transfer and availability of higher performance instruments have lead to the development of a new generation of optimized geophysical products poised to provide reliable, accurate information on the state and evolution of terrestrial environments. Specifically, a series of algorithms have been developed to estimate the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) for various modern sensors. Examples of applications using SeaWiFS, VEGETATION and MISR will be shown. Similar algorithms for the upcoming Earth Observation sensors such as MERIS on ESA's Envisat and GLI on NASDA's ADEOS-II have already been developed. Software codes are publicly available to implement and exploit these new technologies for all these instruments.

URL: http://www.gvm.sai.jrc.it/stars/

B42C-0151 1330h POSTER

Interannual Variability in Amazonian Net Ecosystem Production: Implication for Regional Carbon Cycle.

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Interannual variability in Amazonian terrestrial ecosystems functioning during the past two decades is examined in order to estimate the range of variations in biogenic sources and sinks of CO2 as well as the changes in the biophysical conditions affecting regional climate. We simulated interannual patterns of vegetation characteristics using Ecosystem Demography (ED) model. This is a mechanistic terrestrial biosphere model which simulates both the fast time scales (hours) of carbon and water fluxes and the longtime scales of ecosystem dynamics. The NCEP/NCAR reanalysis climate data set and regional precipitation data sets drive the simulations of ED model. We explore sensitivities of tropical ecosystem photosynthetic production and respiration to variation in temperature, precipitation, atmospheric humidity, radiation and wind conditions. The simulated inter-annual variations in the state of Amazonian ecosystems suggests that short -term changes in the state of vegetation could have salient effect on the global carbon cycle as well as regional climatic conditions.

B42C-0152 1330h POSTER

Forest Fragmentation Effects on Simulated Biomass Accumulation Using Remotely-sensed Data with Varying Spatial Resolution

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Land-use change can fragment landscapes, making it possible that remotely-sensed biophysical parameters (e.g. NDVI) could vary depending on the spatial resolution of the sensor and the spatial extent of the observation. This can lead to scale-dependent estimates of fPAR, which influence biomass accumulation rates in forests predicted by radiation interception models of carbon uptake. Previous efforts to examine this issue have involved aggregating fine-scale pixels to coarse scale pixels, or used simultaneous data collected by different sensors.

Spatial variability related to fragmentation has been quantified using both textural and contextural information. We examined the effects of forest fragmentation in New Zealand on biomass accumulation by using contextural data derived from SPOT-4 multispectral (XS) images (20 x 20 m resolution) to modify NDVI estimates from the simultaneously-acquired 1km VEGETATION pixels. This imagery is collected at exactly the same time under identical conditions - only spatial resolution differs. Three methods were used to correct for sub-pixel fragmentation effects: 1) a simple linear regression relating 1km NDVI values to mean (aggregated) NDVI derived from the XS NDVI values, 2) using contextural information (forest vs. non-forest fragmentation) from XS NDVI pixels to derive a single coefficient (based on the entire XS scene) to adjust the 1km NDVI values, and 3) calculation of fragmentation within each 1km pixel to reduce NDVI based on the proportional area coverage of each land cover class. In this case, we used three mixed cover types: forest-water, forest-non forest, forest-bright land (urban and cleared land), and forest-pasture. For each mixed cover type, the relationship between forest area and percent change in fPAR was non-linear. Using a canopy radiation interception model (3-PGS), simulated biomass accumulation based on NDVI estimates from the 1km VEGETATION sensor were higher than those predicted using adjusted 1 km NDVI values. Application of either correction method led to about a 30% reduction in predicted biomass accumulation rate (10 to 7 Mg/ha/yr). This fragmentation effect could alter spatially extensive estimates of carbon uptake and storage by forests in fragmented landscapes.

B42C-0153 1330h POSTER

A Moderate Growth Trend in Global Net Primary Productivity Superimposed on High Interannual Variability: Results of Satellite Data Analysis1980-2000

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The temporal dynamics of net primary production (NPP) is of great importance in understanding of the global carbon budget yet is subject to many different ecological processes. The atmospheric warming, increased CO2 concentration and the strong El Ni?o Southern Oscillation (ENSO) behavior over the 1980s and 1990s provide a 'natural experiment' that enables NPP and its dynamics to be studied. We have used the 1981-2000 time series of NOAA AVHRR satellite observations to measure NPP at 8km and 10 days resolution over 20 years. In spite of various problems associated with sensor calibration, satellite orbital drift, and variations in the atmosphere, with appropriate care the consistent satellite record provides a unique means of assessing spatio-temporal variations. The GLObal Production Efficiency Model (GLO-PEM) was used to estimate NPP for which all the inputs were obtained from satellite observations at high spatial resolution. The results show a moderate increasing trend in NPP superimposed on the high seasonal and interannual variability associated with the ENSO cycle. The increases in NPP were mainly manifested in the 1990s, and were stronger in the tropics than in northern temperate regions. While the seasonal and interannual variations in NPP were closely correlated with climate variability, the decadal increasing trend seemed to correlate mainly with increases in atmospheric CO2. This study indicates strong agreement between atmospheric transport, biogeophysical and satellite-driven models such as GLO-PEM in the global fluctuations in NPP. The satellite data analysis also makes a unique contribution by identifying the geographic areas with high and low NPP at a scale finer than 1x1 degree, which allows detailed, local models to be interfaced with the global carbon cycle.

B42C-0154 1330h POSTER

A Satellite Based Assessment of the Impact of Urban Sprawl on Carbon Balance (NPP) of the United States

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For the first time, diurnal observations from two Earth imaging satellites were used to measure the extent of urban sprawl and estimate the photosynthetic capacity of the land surface inside and outside urbanized areas and assess the impact of urbanization on the terrestrial carbon cycle. Night-time data from the Defense Meteorological Satellite Programs Operational Linescan System were used to map urban areas and monthly maximum NDVI values from1-km AVHRR data were used with the Carnegie Ames Stanford Approach biophysical model to estimate net primary production (NPP). Seasonal profiles of NPP for urban and non-urban areas describe a variable effect on production depending upon the prevailing local climate and a strong urban warming signal can be seen. A comparison between a simulated pre-urban landscape and current conditions indicates that urbanization has reduced the productivity of the US land surface by about 0.012 PgC per year - about 0.5% of the estimated annual total. In terms of human requirements, this loss translates to enough energy to feed 105 million persons per year. The impact on biological systems therefore may be significant.

B42C-0155 1330h POSTER

A Model-Based Assessment of the Physiological Potential of Vegetation Response to Environmental Changes and Implications for the North America Carbon Sink

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We used the Global Terrestrial Ecosystem Carbon (GTEC V2.0) model to analyze North American terrestrial carbon storage and exchange with the atmosphere over the period 1930 to present. In this model the carbon dynamics of each vegetated land cell is described by a mechanistic soil-plant-atmosphere model of ecosystem carbon cycling and exchange. Net ecosystem production (NEP), net carbon sequestration, is the difference between canopy photosynthesis and ecosystem (plant plus decomposer) respiration. Representations of C3 and C4 photosynthesis are coupled to a description of the dependence of stomatal conductance on assimilation rate, temperature, and moisture to form a "big-leaf" canopy photosynthesis model. Maintenance

respiration is a function of tissue nitrogen concentration and temperature, while growth respiration is proportional to the change in biomass. Canopy photosynthesis and maintenance respiration are calculated hourly; carbon allocation, growth, and growth respiration are calculated daily. Carbon in dead organic matter is partitioned as in the Rothamsted model with litter inputs assigned to decomposable and resistant plant material compartments. The model is thus capable of responding to interactions among climate, rising atmospheric CO_2 concentration, soil moisture, and solar radiation. This detailed physiological model is considerably more sensitive to rising atmospheric CO_2 concentration than most biogeochemical terrestrial ecosystem models. The average net C sequestration rate calculated with this model for the 1980's and early 1990's is less than 0.6 Pg C y^{-1} for North America. Nearly all of this is calculated to be sequestered by woody biomass growth. This result suggests that ecosystem physiology might account for 30% of the approximately 2 Pg C y^{-1} North American carbon sink inferred from regional inversion studies, with the remainder a consequence of other factors including forest regrowth following clearing or other disturbance.

B42C-0156 1330h POSTER

Estimating CO2 Evolution from Woody Debris in Boreal Black Spruce Post-fire Successional Forests

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The objectives of this study were: (1) to develop CO2 flux models against temperature and moisture content for black spruce woody debris; (2) to model woody debris temperature dynamics in boreal black spruce forests in northern Manitoba, Canada; and (3) to examine short- and long-term dynamics of CO2 evolution from woody debris for the post-fire successional stands at both well-drained and poor-drained sites. Woody debris (WD) samples were collected from the post-fire black spruce stands and incubated in growth chambers under various temperature-moisture conditions. CO2 flux from the WD samples was repeatedly measured using a Li-Cor 6200 equipped with a cylindrical sample chamber of 15 cm in diameter and 125 cm in length. In addition, both air temperature and temperature inside WD in the field were continuously measured using thermocouples and Campbell dataloggers. CO2 flux was positively correlated to WD temperature and moisture content ($p < 0.001$). Based on these models and WD mass measurements, we estimated that the CO2 evolved from woody debris ranged from 14 to 569 kg C ha-1 year-1 for the well-drained stands, and 4 to 405 kg C ha-1 year-1 for the poorly-drained stands.

B42C-0157 1330h POSTER

Carbonate Mineral Equilibria and DIC Fluxes: Watershed Case Studies From the Great Lakes Region

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Carbonate mineral equilibria arguably are the single most important set of reactions regulating the compositions of natural waters. Because of their reactivity and solubility, carbonate mineral contributions can even dominate waters draining silicate terrain. In this century, carbon emissions from fossil fuel burning are projected at between 1000 and 2000 Gt, a large mass to distribute among near surface C reservoirs over a relatively short time interval. As organic matter decomposition is closely coupled to carbonate dissolution due to influence on soil zone PCO_2, this large pulse of "human respiration" very likely will affect the carbonate geochemistry of surface waters. The carbonate weathering flux from North America is largely derived from the glacially influenced Upper Midwest region. Here glacial drift aquifers commonly contain Paleozoic rock fragments composed of calcite and dolomite. As a result these watersheds have among the highest dissolved inorganic carbon (DIC) concentrations and fluxes in the world.

Our group has investigated the role of organic carbon cycling on carbonate dissolution rates and mechanisms, focussing on field geochemical studies of watersheds in the Great Lakes region coupled with USGS data on stream discharge and geochemistry. Major ion geochemistries of groundwaters and stream waters at baseflow conditions were compared among the various watersheds. Shallow groundwaters within glacial drift aquifers are Ca-Mg-HCO_3 solutions that have dissolved inorganic carbon concentrations controlled by calcite and dolomite dissolution in systems open to CO_2. Calcite is usually supersaturated and dolomite is near equilibrium. Importantly, at the relatively low temperatures of surface waters and groundwaters in the upper Midwest, dolomite solubility is enhanced relative to calcite, whose solubility constant has a weaker dependence on temperature. There are large differences in shallow groundwater PCO_2 values among various watersheds suggesting landscape level influences. However, the Mg:HCO_3 mole ratio of most groundwaters consistently falls near a value of 0.2.

Stream water chemistries provide an important measure of how efficiently the high dissolved inorganic carbon contents generated in groundwater are exported from the watershed. Streams draining these glaciated landscapes generally are much more supersaturated with respect to calcite than are groundwaters due to warming and CO_2 degassing. Some watersheds discharge waters that are more than 10x supersaturated with respect to calcite, at CO_2 values near equilibrium with the atmosphere. Potentially, calcite could precipitate from such streams. Inspection of the major ion chemistries of streams versus groundwaters shows that some watersheds lose significant amounts of DIC to calcite precipitation, although most do not. The best indicator of carbonate precipitation is an increase in the Mg:HCO_3 mole ratio, as low-Mg calcite is the dominant carbonate mineral deposited in the fens and lakes associated with these watersheds. Mass balance calculations on cation and DIC fluxes to the Great Lakes system from these watersheds suggest that carbonate back precipitation in watershed drainage systems is not a volumetrically significant process and has little influence on the net DIC fluxes from these glaciated landscapes.

B42C-0158 1330h POSTER

Aircraft Eddy Covariance Measurements of Regional CO2 Fluxes in Arctic Alaska

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Intensive aircraft flux measurements on the North Slope of Arctic Alaska have been conducted for several years over the full Arctic growing season. In 2001 over 115 hours of flight measurement time were logged. The aircraft, a Sky Arrow ERA 650 was instrumented with eddy covariance and remote sensing (e.g. ADAR, hyperspectral, surface infrared temperature, and true color video) capabilities. In this paper we present the large scale (ca. 100 km) fluxes derived from direct aircraft measurements at ca. 10 m height above ground level, and show the correlation of net ecosystem fluxes with environmental conditions, NDVI, and other remotely sensed indices along the flight path. Aircraft fluxes are compared to permanent eddy covariance tower measurements made at Barrow and Atqasuk, AK, and with portable tower measurements in the flight line from Barrow to south of Atqasuk. Footprint size and correlation with remotely sensed surface conditions and features are discussed.

URL: http://www.sci.sdsu.edu/GCRG

B42C-0159 1330h POSTER

Carbon Dynamics of a Boreal Logging Age Sequence in Northern Manitoba

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Increasing pressure has been put on boreal forests to meet the growing demand for timber products. Boreal forests contain a disproportionately large amount of carbon in the soil and are believed to play an important role in carbon sequestration, but the effects of disturbance, such as harvesting, on the carbon budget are poorly understood. The objective of this study was to compare the carbon content and aboveground net primary production for a mixed species (Picea mariana, Pinus banksiana, and Populus tremuloides) boreal forest logging age sequence in northern Manitoba. The age sequence consisted of replicated, even-aged stands that originated from clear-cut harvests in 1990, 1983, 1971, and 1935. Carbon content of aboveground vegetation increased significantly during stand recovery, and was significantly greater than similar-aged black spruce stands recovering from wildfire. Distribution of coarse woody debris (CWD) was bimodal, with greater mass per hectare at the 1990 and 1935 sites, and a minimum at the 1971 site. Trends in CWD distribution, as well as forest floor carbon and soil carbon content are used to establish decomposition rates and consequences for the carbon budget.

B

B42C-0160 1330h POSTER

A Collaboration in Support of LBA Science and Data Exchange: Beija-flor and EOS-WEBSTER

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The University of New Hampshire (UNH) has developed a Web-based tool that makes data, information, products, and services concerning terrestrial ecological and hydrological processes available to the Earth Science community. Our WEB-based System for Terrestrial Ecosystem Research (EOS-WEBSTER) provides a GIS-oriented interface to select, subset, reformat and download three main types of data: selected NASA Earth Observing System (EOS) remotely sensed data products, results from a suite of ecosystem and hydrological models, and geographic reference data.

The Large Scale Biosphere-Atmosphere Experiment in Amazonia Project (LBA) has implemented a search engine, Beija-flor, that provides a centralized access point to data sets acquired for and produced by LBA researchers. The metadata in the Beija-flor index describe the content of the data sets and contain links to data distributed around the world. The query system returns a list of data sets that meet the search criteria of the user. A common problem when a user of a system like Beija-flor wants data products located within another system is that users are required to re-specify information, such as spatial coordinates, in the other system.

This poster describes methodology by which Beija-flor generates a unique URL containing the requested search parameters and passes the information to EOS-WEBSTER, thus making the interactive services and large diverse data holdings in EOS-WEBSTER directly available to Beija-flor users. This "Calling Card" is used by EOS-WEBSTER to generate on-demand custom products tailored to each Beija-flor request. Through a collaborative effort, we have demonstrated the ability to integrate project-specific search engines such as Beija-flor with the products and services of large data systems such as EOS-WEBSTER, to provide very specific information products with a minimal amount of additional programming. This methodology has the potential to greatly facilitate research data exchange by enhancing the interoperability of diverse data systems beyond the two described here.

B42C-0161 1330h INVITED POSTER

Projecting the Future of the U.S. Carbon Sink

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Atmospheric and ground-based methods agree on the presence of a carbon sink in the coterminous U.S. (U.S. minus Alaska and Hawaii), and the primary causes for the sink have recently been identified. Projecting the future behavior of the sink is necessary for projecting future net emissions. Here we use two models, the Ecosystem Demography Model (ED) and a second simpler empirically-based model (Miami-LU), to estimate the spatio-temporal patterns of ecosystem carbon stocks and fluxes from 1700 to 2100. Our results are compared to other historical reconstructions of ecosystem carbon fluxes, and to a detailed carbon budget for the 1980s. Our projections indicate that the ecosystem recovery processes that are primarily responsible for the contemporary U.S. carbon sink will slow over the next century resulting in a significant reduction of the sink unless other new sink mechanisms compensate. Key uncertainties in model estimates and priorities for reducing uncertainties will be highlighted and discussed in the context of both the U.S. carbon budget and the likely future of the U.S. carbon sink.

B42C-0162 1330h POSTER

U.S. Timber Harvest from 1750 to 1997

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Understanding the impact of climate change and the role that carbon sequestration in forests can have on the global carbon cycle will require a fuller understanding of the impact of land use on forests. Ecological models examining the impact of climate change have, until recently, focused on potential vegetation. This inability to incorporate land use data is related to a lack of information on the historical land use patterns. We accumulated the reported historical information on harvested acres, the harvest practice, volume of growing stock inventory, and removals. Land management has had a significant impact on the volume per acresince 1955, volume per acre has increased in nearly all of the 50 states. Forest management for softwoods has traditionally involved harvests that remove most, if not, all of the trees. Hardwood management involves more selective cutting; thus harvest is not a stand-resetting event typically. Data on harvested acres is biased towards recent years, 1970 to present, where as growing stock and removal volume data are available to 1955. To develop harvest information further back in time, we developed two approaches to estimate harvested acres using the available data: 1) an analytical approach based on volume, removals and timberland acres, and 2) a statistical model based on reported harvested acres and their relationship to removals. To extrapolate to 1750, we used settlement information and assumptions about land use. We explore within-state spatial patterns generated by these methods for North Carolina. The methods we used provide a means of assessing uncertainty in historical patterns of land use and of volume of timber removed from forestland across the United States.

B42D MC: 122 Thursday 1330h

Water, Energy, and Carbon Cycles in Terrestrial Systems: Local-Scale Observations Through Fluxnet and Other Micrometeorological Tower Sites II *(joint with H)*

Presiding: **L Gu,** University of California at Berkeley**; D Baldocchi,** University of California, Berkeley**; S W Running,** University of Montana

B42D-01 1330h

How Different are Carbon Cycling and Micrometeorology in Amazon Tropical Forests Compared to Those in Temperate Forests?

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Tropical rain forests, so far poorly represented within FLUXNET, are often considered 'special' among the forests of the world. Often cited distinguishing aspects are their height, species richness, density, darkness, or humidity. While many of these observations are beyond doubt, we ask the more restrictive question whether these forests are essentially different from temperate ones in their interaction with the atmosphere.

The Large Scale Biosphere-Atmosphere experiment in Amazonia (LBA) and its predecessors are providing some insight into forest-atmosphere exchange, carbon and water cycling. Multi-year flux measurements at several sites so far suggest a (controversially) high net rate of annual carbon uptake and clear seasonality. If compared to other FLUXNET forest sites, variation in uptake seems to be controlled by rainfall as opposed to by radiation in other forests. If we consider in-canopy turbulence and micrometeorology from earlier work, Amazon forest appears somewhat extreme in damping turbulence at best. Finally, if we compare in-canopy photosynthetic properties and physiology, those forests seem fairly ordinary compared to temperate forests.

URL: http://lba.cptec.inpe.br/lba/indexi.html

B42D-02 1345h

Net CO_2 Exchange Over Contrastive Deciduous Forest Ecosystems in Japan: Responses to Temperature Variability

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The deciduous broadleaf forests dominated by oak species are widely spread in Japan, Korea, and northeastern China. Deciduous conifer forests consisting of larch species are broadly distributed on the Eurasian Continent, especially in eastern Siberia. These ecosystems are two of the major vegetative constituents of eastern Asia, and they are considered to be important ecosystems that exhibit strong seasonality of terrestrial carbon sink and source in the Eurasian Continent.

The main objective of this study is to estimate the sensitivity of the carbon budget of the ecosystems to climatic conditions. Fluxes of CO_2, water vapor, and sensible heat are measured by the eddy covariance method over two different forest ecosystems: a cool-temperate deciduous broadleaf forest in a mountainous region of Takayama (central Japan), and a larch (deciduous conifer) forest in a flat region of Tomakomai (northern Japan). The Takayama site (36° 08' N, 137° 25' E, elevation 1,420 m) was established in 1993 with the cooperation of the National Institute of Advanced Industrial Science and Technology and Gifu University. The Tomakomai site (42° 44' N, 141°31' E, elevation 115-140 m) was established in 1999-2000 by the National Institute for Environmental Studies and the Hokkaido Regional Forest Office.

Analyses are mainly focused on environmental controls of nighttime and daytime CO_2 exchanges at the different forest ecosystems. An unusually high air temperature anomaly was widely observed at East Asia in 1998, and it caused 20-25 days earlier leaf emergence of most deciduous forests in Japan. However, increased temperature in 1998 summer resulted in the less carbon uptake at Takayama site. It was also suggested that the larch forest in Tomakomai had a high sensitivity to temperature, and the daytime decline in CO_2 uptake with temperature above the optimum was greater in Tomakomai (a larch forest in a flat ground) than in Takayama (a broadleaf forest in a mountainous region).

B42D-03 1400h

Biometric and Eddy-covariance Based Estimates of Ecosystem Carbon Storage in Five Eastern North American Deciduous Forests.

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Quantifying net carbon (C) storage by forests is a necessary step in the validation of C sequestration estimates and in assessing the possible role of these ecosystems in offsetting fossil fuel emissions. In eastern North America, five sites were established in deciduous forests to provide measurements of net ecosystem CO_2 exchange using micro-meteorological methods (NEE), and measures of major C pools and fluxes, using a combination of forest mensurational, eco-physiological, and other biometric methods. The five study sites, part of the AmeriFlux network, ranged across 10° of latitude and 18° of longitude, but were all of similar age, canopy height, and stand basal area. Here we present a cross-site synthesis of C storage estimates, comparing meteorological and biometric approaches, and also comparing biometric estimates based on analyses of autotrophic C pools and heterotrophic C fluxes (net ecosystem production, NEP) versus those based on measurements of change in two major C pools (ΔC). Annual aboveground net primary production varied nearly two-fold among sites and was strongly correlated with average annual temperature and with annual soil nitrogen mineralization (N_{min}). Estimates of NEP ranged from a low of 0.3 Mg C ha^{-1} yr^{-1} in northern Michigan to a high of 3.5 Mg C ha^{-1} yr^{-1} in central Indiana, and were also well correlated with N_{min}. There was less variation among sites in estimates of ΔC (range, 1.8 3.2 Mg C ha^{-1} yr^{-1}). In general, ΔC more closely matched NEE than did NEP, but there was no systematic pattern among sites in over- versus underestimation of the biometric compared to the meteorologically based measures. Root and soil C dynamics were significant sources of uncertainty in our biometric measures and represent a prerequisite area of study needed for accurate estimates of forest C storage.