

B11C-0711 0830h POSTER

Estimating Paleoflood Magnitude From Tree-Ring Anatomy and the Height of Abrasion Scars

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Evidence of floods preserved in the growth rings of trees can be used to extend the historical record of flooding or to estimate the magnitude of extraordinary floods on ungaged streams. Floods that damage the aerial parts of trees during the growing season sometimes induce striking anatomical changes in subsequent growth of rings in the lower trunk. In ring-porous species, this growth most commonly produces concentric bands of atypically large vessels within the latewood. The number and diameter of anomalous vessels seem positively related to the amount of flood damage, and thus can be used to refine estimates of flood magnitude when also considering the position of the tree relative to the channel and its approximate height during the flood. Floods of long duration on low-gradient streams are less likely to damage trees directly, but prolonged root flooding often results in the formation of narrow rings with atypically small vessels; shorter-duration floods, sometimes inundating roots for as little as several days, are followed by the production of fibers (non-conducting cells) with large lumens and thin walls that appear as light-colored bands compared to earlier-formed tissue. In these instances, a series of trees increasingly distant from the channel can be used to estimate a minimum flood elevation. Abrasion scars from flood-borne debris often are the most easily observed evidence of flood damage and, like anatomical abnormalities, can be precisely dated. The relation between the heights of scars and maximum flood stages depends in part upon channel slope. Previous studies have indicated that scar heights along low-gradient streams are the same or slightly lower than maximum flood elevations. Along the high-gradient (6% maximum slope) Buffalo Creek, Colorado USA, scar heights measured in 102 trees following a flood in 1996 ranged from -0.6 to +1.5 m relative to the actual crest elevation. Scar elevations exceeding flood elevations by 3-4 m, however, were observed following a flood in 2002 along a small Colorado stream with slopes ranging from 6 to 15%.

B11C-0712 0830h POSTER

Tropical Cyclone Activity and Climate Fluctuations Captured by Oxygen Isotopes in Tree-Ring Cellulose From the Southeastern US

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Tropical cyclone activity in the Atlantic Ocean and Gulf of Mexico fluctuates on seasonal to century scales. Large climate oscillations, such as the El Niño Southern Oscillation, Atlantic Multidecadal Oscillation, and the Pacific Decadal Oscillation may affect this tropical cyclone activity. To better discern and understand factors influencing long-term trends in hurricane occurrence, proxies are needed that extend the record beyond historical documents. Tree rings preserve excellent records of climate that can be tracked on an intra-annual scale. Two trees in southern Georgia, slash and longleaf pine, were collected and dated using dendrochronological techniques and a 156-year record (1840-1997) was examined. The tree rings were processed to alpha cellulose, with intra-annual resolution, for examination of oxygen isotopes from both earlywood (EW) and latewood (LW) growing seasons. In the southeastern U.S., temperature variation across the growing season for slash and longleaf pines is modest (27-33°C) and oxygen isotope compositions largely reflect the composition of precipitation. Tropical cyclones produce precipitation that is significantly depleted in ¹⁸O compared to average seasonal rainfall and

generally occur during the LW growing season. The relatively depleted oxygen isotope ratios are incorporated into LW cellulose and thus the annual ring set is marked by a large difference between EW and LW $\delta^{18}\text{O}$ values. For years without a significant event, EW-LW differences are expected to be nominal. The 156-year long tree-ring oxygen isotope record of major hurricane occurrence corresponds well with known tropical cyclone occurrence in the study area. The record also captures evidence of EW drought. The tropical cyclone record appears to be overprinted upon a much larger climate oscillation that is characterized by periods of relative separation (i.e., apart from the larger differences due to hurricanes) vs. coincidence of the EW/LW oxygen isotope compositions. The frequency of tropical cyclones appears to be much greater during the EW/LW separation phase of this larger climate oscillation, in particular the decades of 1840 to mid-1920's and mid-1940 to mid-1970's.

B11D MCC: Level 2 Monday 0830h

Disturbance, Climate, and Management Impacts on Carbon Budgets of Forested Ecosystems I Posters (joint with A, GC)

Presiding: K A Hibbard, Oregon State University; M Apps, Canadian Forest Service; D J Barrett, CSIRO Plant Industry

B11D-0713 0830h POSTER

Climatic versus biotic constraints on carbon uptake in ponderosa pine forests

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An assessment of the trade-offs between climatic versus biotic controls on carbon uptake in forests is critical to developing a clearer understanding of disturbance on carbon cycling in terrestrial ecosystems. We used a detailed, process-based simulation model to investigate the effects of interannual variation of precipitation on carbon assimilation in ponderosa pine (*Pinus ponderosa* var. *Lawsonii*) forests in the Cascade Mountains of central Oregon, USA, characterized by cool, wet winters and hot, dry summers that result in seasonal drought stress. We selected three ponderosa pine stands representing a range of ages since the previous stand-initiating disturbance, clearcut logging. In 2002, the young stand (YS) was about 25 years old and had a mean total leaf area index (LAI) of about 1.1. The mature stand (MS) was around 90 years old with a mean LAI of about 3.0, and the old stand (OS) was never logged and had a mean LAI of about 2.3. Simulations of carbon and water fluxes at each site were performed using the Soil-Plant-Atmosphere (SPA) model (Williams et al. 2001) using stand and meteorological data. Comparisons between simulations and eddy flux measurements at each site indicated generally good agreement, with relative differences between the model and measurements across the three sites of about 25% for tree transpiration, 30% for total latent energy fluxes, and 25% for gross carbon uptake, GPP. Four years of climate data (1999-2002) for the sites showed three- to four-fold variation in winter precipitation, nearly five-fold variation in summer precipitation, and over 50% variation in total annual precipitation. Based on the simulations, mean annual carbon uptake across the four years was 850 gC m⁻² y⁻¹ at the YS, 1260 gC m⁻² y⁻¹ at the OS, and 1530 gC m⁻² y⁻¹ at the MS. Despite the substantial interannual variation in precipitation, the interannual variation in GPP at each of the three sites was only about 5%, suggesting that variation in precipitation across the four years was not a major constraint on GPP, whereas soil CO₂ efflux measurements at the OS and YS showed large interannual variation that could be attributed to soil moisture availability in the deeper soil horizons (OS) and

the quantity of summer precipitation (YS), suggesting that interannual variation in net ecosystem production (NEP) is largely due to the respiration responses to moisture availability. Additional simulations, eliminating summer drought conditions, indicated that annual GPP could increase by up to 20% at the sites if soil moisture was not limiting. Moreover, the large differences in annual GPP among the three sites, suggest that stand development following disturbance probably plays the largest role in limiting carbon uptake in these forests. Finally, sensitivity tests involving maximum rooting depth at each site, suggests that this factor may be crucial to enabling these semi-arid forests to minimize the effects of summer drought.

B11D-0714 0830h POSTER

Interannual variability of carbon fluxes from forest ecosystems and other regions

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A dynamic vegetation model is used to study the interannual CO₂ variability in relation to climate variability and disturbance. The tropical forest ecosystem plays a major role in the global total land fluxes, particularly in relation to ENSO. The boreal forests varies at amplitude comparable to tropical forests, but with high spatial variability. The mechanisms are distinctly different in the tropics and at the boreal regions in that the precipitation and temperature effects on NPP and respiration have the same or opposite effects due to the difference in climate characteristics. Fire also plays an important role in the interannual carbon flux variability.

B11D-0715 0830h POSTER

Impacts of 130 years of grazing on ecosystem carbon dynamics in the subalpine zone of the Wasatch Plateau

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Intensive grazing by domestic livestock likely began in the subalpine region of the Wasatch Plateau by 1870, and has been a continuous disturbance since then. Eight sites within the Great Basin Experimental Range were identified, with each site containing an area that has been protected from livestock for 80-90 years and a continuously grazed area. I specifically evaluated the impacts of long-term protection from grazing on soil C dynamics, N-availability, and aboveground net primary production. I found that grazing leads to an accumulation of actively cycling soil organic matter (SOM); isotopic evidence suggests that the accumulation of active SOM may be due to lower soil moisture in long-term grazed areas compared to protected areas. While there is higher labile SOM C in grazed areas than in protected areas, in situ soil respiration rates were significantly higher in protected areas. This evidence of an environmental constraint on decomposition in grazed areas indicates that lower primary production in grazed sites is being offset by lower decomposition rates, with total ecosystem C storage remaining nearly unchanged between grazed and ungrazed plots. However, it does suggest that historically grazed areas have a larger pool of potentially mineralizable C that could be lost from this system if these subalpine areas become warmer and wetter with climate change.

B11D-0716 0830h POSTER

Health Assessment of the White Pine Community in the Lincoln National Forest of New Mexico through Spectral Reflectivity Variance

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The health of forests worldwide has become of greater interest to the scientific community in the last decades. Catastrophic events such as wild fires, insect infestations, and diseases all point to a less than ideal state in these areas. In the last fifteen years the Forest Health Protection office of the Forest Service identified and has been monitoring the distribution and effects of white pine blister rust (*Cronartium ribicola*) in the white pine community in the stands of the Lincoln National Forest. The Lincoln National Forest covers an area of approximately 1,196,419 acres in parts of four counties in southeastern New Mexico. It consists of three ranger districts: Sacramento, Smokey Bear and Guadalupe. The Lincoln National Forest attracts visitors because of its natural beauty and recreational areas. It is also home to several endangered and threatened species such as the Mexican Spotted Owl, the Sacramento Prickly Poppy, and the Sacramento Mountain Thistle. Loss of white pine stands is detrimental not only from a human perspective but would also result in loss of natural habitats for already rare species. According to Conklin (1994) there are nearly 500,000 acres of forests in the Sacramento Mountains, the adjoining White Mountains and the nearby Capitan Mountains that contain southwestern white pine. Starting in 1990 Conklin established several infected plots within this area and monitors them on a 3-year rotation period. In an attempt to further analyze the effects of the disease, samples from the different localities were obtained and their spectral responses studied by using a GER spectroradiometer with data acquisition capabilities in the 350 to 2500 nm range. The interaction of an object with electromagnetic energy is unique for each target and is based on its physical characteristics. We are able to note spectral differences in areas other than the visible range which are not accessible to the human eye. Plants stressed by such factors as drought, infestation, differences in soil composition, and alkalinity show a distinct difference in spectral response to that of healthy vegetation. By studying the samples from the Conklin plots we hope to be able to classify the condition of the infected trees. Preliminary results show that there is indeed a significant difference in the spectral response of the different plots. The stands in consideration have been identified as low, moderate, and high infestation based on the number of cankers visible in the spring months. We hope to be able to establish a connection between the differences in spectral signature and the severity of the infestation as more data is analyzed.

B11D-0717 0830h POSTER

Geophysical Characterization of the Borax Lake Hydrothermal System in the Alvord Desert, Southeastern Oregon.

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We are conducting a detailed geophysical characterization of an active hydrothermal system as part of an interdisciplinary project aiming to study the link between the physical characteristics of hydrothermal systems and biota that occupy those systems. The Borax Lake Hydrothermal System (BLHS), consisting of Borax Lake and the surrounding hot springs, is located near the center of the Alvord Basin in southeastern Oregon. As a result of Basin and Range extension, the Alvord Basin is a north-south trending graben bounded by the Steens Mountains to the west and the Trout Creek Mountains to the east. We are using several geophysical techniques to generate both basin-wide and high-resolution local characterizations of the Alvord Basin and the BLHS. To date we have completed two scales of seismic reflection surveys: an east-west trending basin scale survey and a shallow (10 - 300 m depth) 3D survey of the BLHS. The basin scale seismic survey consists of 11 km of 2D, 60 fold CMP data acquired with a 200 lb accelerated weight drop. We acquired the 3D survey of the BLHS using a 7.62x39 mm SKS rifle and 240 channel recording system. The 3D patch covers 90,000 sq. m with a maximum inline offset aperture of 225 m, crossline aperture of 75 m, and 360 degree azimuthal coverage. Additionally, we have completed a regional total-field magnetic survey for a large portion of the Alvord Basin and a 3D transient electromagnetic (TEM) survey of the BLHS. The 3D TEM survey covers the central portion of the 3D seismic survey. Initial results from the regional magnetic and seismic surveys indicate a mid-basin basement high. The basement high appears to correlate with the northeast trending BLHS. Additionally, the cross-basin seismic profile clearly shows that recent deformation has primarily been along an eastward dipping normal fault that bounds the basement high to the east. This suggests that both spatial and tempo-

ral characteristics of deformation control hydrothermal activity within the BLHS.

B11D-0718 0830h POSTER

How the Winter Arctic Oscillation Influences Spring Terrestrial Carbon Fluxes in the Northern Hemisphere

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We explored how the winter Arctic Oscillation (AO) influences spring carbon fluxes from the terrestrial biosphere in the Northern Hemisphere. We used the Simple Biosphere model, Version 2 (SiB2) using the European Centre for Medium-range Weather Forecasts (ECMWF) reanalysis and the NCEP reanalysis as input to estimate terrestrial Gross Primary Production (GPP) and respiration fluxes for the 1980s and 1990s. The AO influences winter temperatures and precipitation throughout the mid- and high-northern latitudes. The winter AO signal persists into spring and early summer as snow cover and soil temperature anomalies. Temperature correlations with the winter AO peak at later lags at deeper soil depths as temperature anomalies penetrate into the soil over a period of several months. Shallow soil layer temperatures respond quickly to atmospheric forcing, so the correlations start strong and drop off within 3-4 months. The deepest soil layers do not respond to winter AO temperature anomalies until April and May, and can persist throughout the summer and even into the next winter. As a temperature anomaly descends through the soil, its influence on respiration declines since most of the soil carbon available for respiration lies near the surface. The influence of winter AO on respiration tapers off by April and May, when winter temperature anomalies have sunk below most of the soil carbon. Spring Gross Primary Productivity (GPP) depends primarily on the timing of snowmelt: reduced snow cover and warmer temperatures indicate early snowmelt and budburst and thus increased GPP. Throughout Eurasia, the date of snowmelt and spring GPP correlate strongly with the winter AO, indicating winter AO temperature and precipitation anomalies influence the timing of spring.

B11D-0719 0830h POSTER

The El Niño Drought and its Consequent Peatland Fires Changed CO₂ Exchange of a Tropical Peat Swamp Forest in Central Kalimantan, Indonesia

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Peatlands existing in the tropics have accumulated a large amount of carbon as organic matter. Indonesia contains the largest area of tropical peatlands, and the peatlands usually coexist with tropical peat swamp forests. Recently, however, deforestation and drainage are in progress on a large scale owing to a growing demand for timber and farmlands. In addition, the El Niño drought and its consequent large-scale fires are accelerating the devastation of the peatlands. The devastation promotes the decomposition of organic matter stored in peatlands, and consequently increases carbon release to the atmosphere as CO₂. This suggests that tropical peatlands will be a major CO₂ source in the near future. To evaluate the CO₂ balance of tropical peatlands, we have measured CO₂ flux above a tropical peat swamp forest left in a devastated area in Central Kalimantan, Indonesia since November 2001. In 2002 the El Niño event occurred, and the consequent drought caused large-scale peatland fires in Central Kalimantan. The fires, which surrounded the forest, emitted smoke and decreased solar irradiance on the forest in September and October. Consequently, GPP decreased rapidly and NEE increased up to 8 mol m⁻² month⁻¹ in September, although NEE had been around zero until August, before the El Niño fires. Relatively large positive NEE continued until December. Annual NEE, ecosystem respiration, GPP in 2002 was 27.3 (= 3.28 tC ha⁻¹), 326.6 and -299.3 mol m⁻² respectively. In 2002 the tropical peat swamp forest was a large CO₂ source, although the forest was not burnt by the fires.

B11D-0720 0830h POSTER

Remote Sensing and Modeling of Boreal Forest Regrowth Dynamics

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We are modeling net primary production at high resolution across North America for the time period 1982-2001 on a 10-day interval, and validate the results using an extensive network of compiled and ongoing field measurements. These major determinants of terrestrial carbon dynamics are being analyzed in the context of interannual variability in carbon sequestration by vegetation regrowth across a wide range of burned areas, including intensively studied sites in interior Alaska. The carbon model is driven by AVHRR observational data sets, which we have corrected for orbital drift and various other attenuating factors. The dynamics of vegetation activity and carbon sequestration, as provided by the NPP maps, is being analyzed in the context of linkages between fire, climate, vegetation recovery, and carbon sequestration across the study domain. At the intensively studied sites, measurements of canopy light interception (Fpar), spectral reflectance, and indirect estimates of LAI were made at numerous regrowth sites. Fire severity varied depending on a number of conditions including forest type, topography and site conditions, which affected the regrowth patterns. Aspen, willow, spruce and herbaceous vegetation has regrown in heterogeneous mixtures, heights and densities. Fpar and LAI estimates were made in order to characterize spatial and temporal variability in regrowth and to improve estimates of annual PAR absorption (APAR) at multiple scales, with the intent of modeling net primary production (NPP) from the plot level to Landsat, MODIS and AVHRR resolution. Field measurements were made using a Licor LAI2000, a Decagon model PAR-80 linear ceptometer, "fisheye" photographs, and a set of custom manufactured solar cells which operated nearly continuously through the active growing season. The relationship between the biophysical variables and canopy spectral vegetation indices varies between vegetation types and regrowth stage. The temporal and spatial variability in Fpar and LAI was large across the sites, resulting in a wide range of modeled NPP across scales. The results of these measurements and scaling activities are being assessed in the context of NPP mapping over large areas using satellite estimates of canopy APAR. The linkages between fire disturbance and associated regrowth carbon dynamics have direct relevance numerous ongoing research programs, including the USGCRP North American Carbon Program.

B11D-0721 0830h POSTER

Using MODIS Thermal Anomaly Data To Locate And Identify Natural And Anthropogenic Disturbance

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Forest disturbance in the boreal forest is important for ecosystem dynamics and carbon balance studies. NASA's Terra satellite provides useful data for characterizing vegetation cover and disturbance over large area and is well suited for studies of the Siberian taiga. Time series data sets from Terra MODIS fire (MOD14) and NDVI (MOD13) products were used identify disturbance. MODIS fire product data, composited over

8 days to reduce cloud cover effects, was able to differentiate industrial thermal anomalies from land cover thermal anomalies (e.g., wildfires or agricultural burning) when combined with DMSP stable city lights data. Persistence in thermal anomaly and change in forest cover indicated by normalized difference vegetation index were used to isolate fire disturbance from industrial activities and estimate disturbance severity. ASTER image data was used to verify and quantify the disturbance for a few cases.

B11D-0722 0830h POSTER

Interannual Variation in the Response of Forest Productivity to Elevated Carbon Dioxide

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Photosynthesis and respiration of forests contribute to the regulation of atmospheric carbon dioxide. To determine the capacity of forests to respond to increasing concentrations of atmospheric CO₂ derived from anthropogenic sources, we exposed large replicated plots in a loblolly pine forest to atmospheric plus 20 Pa CO₂ for seven years. While the average growth rate of trees has declined with time, the stimulation caused by elevated CO₂ has remained between 15 and 25 percent. The biomass increment of wood and litterfall, the two major components of net primary production in this forest, also were stimulated by elevated CO₂. A preliminary analysis indicates that net primary production is correlated with growing season precipitation and the rate of nitrogen mineralization, but the magnitude of the stimulation caused by CO₂ is related to temperature. In one year the trees exposed to elevated CO₂ sequestered an additional 174 gC/m² relative to trees under ambient conditions. As trees grow larger more N is immobilized in plant tissues suggesting that the growth response to CO₂ may abate in the future. The stimulation of forest productivity by elevated CO₂, while locally significant, is not likely to reduce the accumulation of C in the atmosphere as the cover of forests continues to decline globally.

URL: <http://www.life.uiuc.edu/delucia/>

B11D-0723 0830h POSTER

Impacts of Forest Management, Climate, and Productivity on Soil CO₂ Efflux from Loblolly Pine (*Pinus taeda* L.) Stands Located on the Virginia Piedmont and the South Carolina Coastal Plain

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Managed loblolly pine (*Pinus taeda* L.) forests occupy over 13 million hectares or nearly 1.5% of the total land area in the United States. Typically, over 70% of stored carbon (C) in forests resides in soils, emphasizing the need to better understand the impact forest management has on belowground processes affecting C storage. We measured soil CO₂ efflux (E_C) from loblolly pine stands located on the Virginia Piedmont (VA_P) and SC coastal plain (SC_{CP}) in efforts to quantify soil C loss from sites differing in climate, productivity, and common management practices. VA_P sites were less productive and subjected to a cooler climate than SC_{CP} sites. VA_P sites were burned prior to planting as a form of weed and slash reduction while SC_{CP} sites were bedded to raise planting rows above the water table. E_C

was measured monthly for one year in four replicated age classes (1 to >20 years) on both VA_P and SC_{CP} sites using a closed dynamic chamber. Spatial variability for a given site was accounted for by taking measurements both near the base of the tree and between rows. Concurrent with E_C measurements, soil temperature (top 10 cm), soil moisture (top 10 cm), stand age, and site index were recorded. Empirical models were developed for the VA_P and SC_{CP} sites to assess the relationship between E_C and potential drivers. Soil temperature (top 10 cm) was the major E_C driver on both VA_P and SC_{CP} sites, explaining half or more of the variance. Stand age was positively correlated with E_C on VA_P sites, but we observed no relationship between stand age and E_C on the SC_{CP} sites. Using the empirical models developed from small chamber measurements, we scaled up soil C losses to the stand level for a 20-year rotation. We estimate a total efflux rate of 278.6 Mg C/ha over a 20-year rotation for SC_{CP} and 210.9 Mg C/ha over the same time period for VA_P. The contribution of heterotrophic respiration to E_C was greatest early in the rotation on the SC_{CP} sites, where soils were tilled and organic matter was integrated into the mineral soil. The more minor soil disturbances on VA_P sites had less of an impact on heterotrophic respiration early in the rotation. Our results indicate that management intensity impacts soil C efflux by affecting microbial driven C turnover. In a collaborative effort, empirical models developed from small chamber measurements will be incorporated into process-based models currently being developed to predict net C fluxes in response to a variety of management regimes. Further efforts are ongoing to remote sense input variables.

B11D-0724 0830h POSTER

Above- and Below-ground Biomass, Net Ecosystem Carbon Exchange, and Soil Respiration in a Poplar *Populus deltoides* Bartr.) stand : Changes after 3 years of Growth under Elevated CO₂

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Stands of cottonwood (*Populus deltoides* Bartr.) trees were grown as a coppiced system under ambient (40 Pa), twice ambient (80 Pa), and three times ambient (120 Pa) partial pressure CO₂ for the past three years in the Intensively-managed Forest Mesocosm (IFM) of the Biosphere 2 Center. Over three years Net Ecosystem CO₂ exchange (NECE) was measured continuously and in the third year, nine whole trees were harvested from each CO₂ treatment over the growing season. Both above- and below-ground parameters were measured. Three years of growth under elevated CO₂ showed the expected stimulation in foliar biomass (8.7, 11.9, and 13.1 kg for the 40, 80, and 120 Pa treatments, respectively). Rates of NECE also followed an expected increase with elevated atmospheric CO₂ concentrations, with maximum CO₂ uptake rates reaching 10.5, 15.6, and 19.6 μmoles m⁻² s⁻¹ in the 40, 80, and 120 Pa treatments, respectively. However, above ground woody biomass and root biomass were not much stimulated beyond 80 Pa CO₂. Wood/foilage and above/below ground biomass ratios reflect this decline. Under conditions of non-limiting nutrients and water, we found consistent increases in the above/below ground biomass ratio and wood to foliage biomass ratios in the 80 compared to the 40 Pa pCO₂. Woody biomass production and the above/below ground biomass ratio were lower under the 120 Pa than any other treatment. Although biomass production did not change appreciably between 80 and 120 Pa CO₂ treatments, both substrate induced and in-situ soil respiration values are also significantly higher in the 120Pa treatment, though no differences were present prior to CO₂ treatments (Murthy et al. 2003). The unique closed-system operation of the IFM allowed for measures of soil CO₂ efflux to be measured at both the soil collar and stand scales using a box model that takes into account all inputs and outputs from the stand. In-situ soil respiration rates increased significantly with increased atmospheric CO₂ concentrations (8.4, 11.8, 14.3 for the 40, 80, and 120 Pa treatments, respectively). Stands of cottonwoods grown at elevated CO₂ concentrations showed expected CO₂ "fertilization" in terms of foliage, wood, and root biomass responses at 80 Pa, but little further response at 120 Pa. Instead, respiration of the plantation soil was greatly stimulated at 120 Pa, suggesting increased carbon sequestration to the soil, or respiration associated with more rapid fine root turnover. From a system perspective,

more rapid carbon acquisition in response to elevated CO₂ concentrations appears to saturate, possibly due to more rapid carbon cycling.

URL: <http://www.bio2.edu/Research/agroforestry.htm>

B11E MCC: 3002 Monday 1020h

Molecular Biogeochemical Processes of Terrestrial Environments II (joint with H, V, MR)

Presiding: J Cervini-Silva, University of California, Berkeley; J Chorover, University of Arizona

B11E-01 1020h

Probing the Nanoscale Architecture of Mineral Surfaces

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Soil minerals have been shown recently to have an unexpectedly high affinity for certain types of organic molecules including pesticides, explosives and related environmental contaminants. Recent laboratory and field studies, for example, have shown that nitroaromatic compounds are strongly sorbed to certain types of expandable clay minerals. For these compounds, sorption by clay minerals may exceed that of soil organic matter and the molecular mechanisms underlying this preference have been the subject of recent investigation. Expandable clay minerals with a low surface charge density and exchanged with potassium ions have been shown to have the highest affinity for these types of organic solutes. Expandable clay minerals have generally been viewed as hydrophilic materials based on their high affinity for water. Recent evidence, however, has shown that the siloxane surface itself has some hydrophobic character. For exchangeable cations with lower hydration enthalpies, such as potassium, the sorbed organic solutes have an opportunity to interact with both the hydrophilic hydrated cation and with nonpolar regions of the siloxane surface. The combined interaction of these two types of surface sites appears to be important for the sorption of both large and small organic solutes. We have recently combined spectroscopic, structural, and quantum chemical methods with sorption isotherms to examine these types of solute-surface interactions in aqueous media for both specimen and soil clays. Examples of solute-hydrophilic and solute-hydrophobic surface site interactions using different probe molecules will be presented.

B11E-02 1035h

Surface modification of lattice dynamics in ZnS nanoparticles

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Ligand binding is frequently observed to limit the growth and aggregation of both synthetic and environmental nanoparticles. Surface ligands can have significant consequences on nanoparticle structure, either driving transformations to alternate structures, or modifying the detailed structure relative to the equivalent bulk phase. The shortest interatomic distances in a structure are bond-lengths, accurately measured by extended X-ray absorption fine structure (EXAFS) spectroscopy. Bond-length expansions and contractions have been observed, depending on the choice of ligand. However, a more complete description of nanoparticle