compositionally and isotopically distinct types of gases have been identified in the Witwatersrand and Ventersdorp sequences beneath the Transvaal Sequence. Group 1 gases correspond to major fault intersections within the Witwatersrand Supergroup and contain methane that is isotopically depleted in 13C (-43.5 to -59.4 permil), and enriched in 2H (-162 to -214 permil) consistent with either bacteriogenic and/or thermogenic orgins. Group 2 gases discharges in association with saline fissure waters from fractures within the andesitic lava of the Ventersdorp Sequence. They are isotopically depleted in 2H (to -327 permil), and enriched in 13C (to -34.4 permil) falling outside the conventional bacteriogenic or thermogenic isotopic fields. Group 2 gases do however resemble those reported from Precambrian Shield mines in Canada for which an abiogenic origin has been suggested. Differences in the microbial communities associated with these different gas types and geologic strata are under investigation.

B22C MC: Hall D Tuesday 1330h

Carbon, Climate Change, and Disturbance in Northern Forest Ecosystems II *(joint with GC)*

Presiding: **M Apps,** Natural Resources Canada**; A D McGuire,** University of Alaska Fairbanks**; J Caspersen,** Princeton University

B22C-0150 1330h POSTER

Climate-Induced Changes in the Chemical Characteristics of Natural Organic Matter at a Small Freshwater Wetland

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This study investigated the spatiotemporal variability in dissolved organic carbon concentration (DOC), natural organic matter (NOM) weight average molecular weight (Mw), and absorptivity at 280 nm (e280, an estimator of aromaticity) at McDonalds Branch, a first-order stream that is a fen wetland. When ground-water discharge to the stream was predominant, the DOC, the Mw, and the e280 were all relatively low. When soil porewater was more important, not only was the DOC higher, but also the Mw and e280. Hence, the contribution of soil pore water relative to ground water controlled not only the concentration but also the average physicochemical characteristics of the NOM.

Results from this small watershed study provide insight into climatic effects on surface-water NOM characteristics in a small freshwater fen. Low-flow periods resulted in lower Mw, more aliphatic NOM derived primarily from ground-water discharge to the stream whereas higher flow periods resulted in a higher Mw(by 150-500 Da), more aromatic downstream surface-water NOM pool. Hence, during future summer drought periods, as suggested by climate-change models for much of North America, surface-water NOM likely will be lower molecular weight, more aliphatic, and more hydrophilic with lesser metal binding and HOC uptake abilities, along with decreased ability to attenuate UV radiation.

B22C-0151 1330h POSTER

Fire-derived Char-Black Carbon in Siberian Scots Pine Forests - Stocks and Dynamics

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Siberian Scots pine forests comprise the largest part (37 %) of West Siberian forests. Natural fires occur frequently, producing thermally-altered organic matter (char-black carbon, CBC). CBC is considered to resist degradation and accumulate in soils, due to its molecular structure. Thus, CBC may be an important long-term sink for photosynthetically fixed atmospheric carbon dioxide, and play an important role in carbon sequestration of boreal soils. Presently, there are, however, only few studies on CBC stability in soils and none on boreal ecosystems.

To assess the role of CBC in carbon sequestration of boreal forests, we addressed the following questions: How much soil organic carbon (SOC) do natural fires convert to CBC? How do fires (both stand replacing and surface fires) affect SOC and CBC stocks and soil development for 0 to 200 years?

We investigated sandy podzolic soils (Dystrustepts) under monotypic pristine Siberian Scots pine (Pinus sylvestris) forests in Western Siberia near river Yenesei (60 °43'N, 89 °08'E). To measure CBC conversion we sampled five replicates of (un-)burnt forest floor immediately after fire. To assess carbon stocks and soil development, we sampled a chronosequence (0-400 years after stand replacing fire), also including different fire regimes (surface fires every 25-40 years). SOC was quantified with elemental analyzer, CBC via gas-chromatography / atomic emission detector using benzenepolycarboxylic acids as molecular markers, and parameters of soil development via ion coupled plasma mass spectroscopy.

Fire converted 0.7 % of the SOC in the forest floor to CBC. CBC accounted for 1.5 to 3.4 % of SOC stocks (forest floor and 1 m mineral soil), and is mainly located in the forest floor. In the forest floor, SOC stocks increased with time since stand replacing fire, except when surface fires reduced stocks. For CBC, however, no such trend could be observed. Mineral SOC stocks were smaller than those in the forest floor, and followed a typical podzolic pattern 6 and 160 years after fire, but were larger 33 to 96 years after fire. TOC stocks below 0.8 m were always similar, contributing small amounts. As a result, CBC does so not seem to accumulate in soils under boreal forests to a larger extent. The fate of CBC (e.g. chemical degradation, particular or colloidal transport) remains an open question.

B22C-0152 1330h POSTER

The Modeling of Active Layer Thickness and Permafrost Temperature Regime (past, present and future) within East-Siberian Transect, using GIS.

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The active layer is a thin layer, which thaws every summer, stays frozen for the rest of the year and acts like an insulating layer between the permafrost and atmosphere. The active layer is an important component of the northern ecosystem and has a considerable influence on carbon cycle. The contents of free and bounded water and temperature regime within the active layer are primary factors that quantify the magnitudes of summer and winter respiration and carbon fluxes, which are the results of microbial and other biological activities. Any changes in the active layer have a direct impact on the temperature regime and consequently on dynamics of permafrost and permafrost stability. In turn, the active layer thickness and temperature regime depend mostly on combination of climatic parameters such as mean annual air temperature and annual air temperatures amplitude, let alone the mean annual snow cover thickness, soils thermal properties, and moisture content. Our study area encompasses the East-Siberian transect, which is centered on the 135° meridian and expanded from 70 degrees Northern Latitude (N.L.) to 60 degrees N.L. The ecosystem and the permafrost within the transect are especially vulnerable to the positive changes in active layer thickness and temperature. Permafrost in East Siberia contains significant amount of ice in the form of segregated ice, ice wedges and buried layers of ice. If summer thawing will reach the ice horizon, or if the temperature in the permafrost rises, so that the process of permafrost thawing will start, then major changes in the ecosystem may occur; for example, wetlands or grasslands may gradually replace the boreal forest. The purpose of this work is to show the spatial extent and dynamics of the active layer thickness and its influence on permafrost stability for different scenarios of climate changes, with the means of ArcView software. In order to calculate active layer thickness and permafrost temperature, we chose Kudryavtsev's equations. The major parameters in these equations are mean annual air temperature and seasonal air amplitudes. Also, mean annual snow thickness, thermophysical properties of the soils (heat capacity and thermal conductivity) are taking into account. By using different sources, such as: publications, maps and digital maps, the layers representing geology, snow thickness and vegetation have been created. The program for active layer thickness calculations works with a grid of cell dimension 0.5x0.5 degrees, which covers the entire area of the transect. All climatic and thermophysical parameters are set for each grid cell. The program uses GIS Avenue code, which takes input data from all necessary layers, calculates active layer thickness and temperature of permafrost for each grid cell, and then performs the interpolation between grid cells to show the output in the form of digital maps that cover the area of the transect. Several scenarios have been considered: natural dynamics of snow thickness and air temperatures and dynamics with applied trend of global warming. We used data obtained by real-time modeling of air temperatures and snow thickness as input. The results for the natural dynamics case were compared with actual measurements and the results of numerical simulation, for four sites: Chabody3, Chabody8, Yakutsk and Tiksi. For all four sites the detailed information about climate, soil temperature distribution and thermophysical properties is available. Such a comparison will validate the use of Kudryavtsev equations for forecasting the dynamics of the active layer and mean annual temperatures of permafrost.

B22C-0153 1330h POSTER

Boreal Forest Fires and Lightning

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A forest fire experiment called FROSTFIRE (1999) was carried out in the taiga zone of Alaska, U.S.A. in July 8-15, 1999 and was completed successfully.

The first author joined FROSTFIRE as a fire scientist. FROSTFIRE has provided good opportunities to clarify the conditions of boreal forest fires by conducting field research of the vegetation, thunderstorm observations before the fire, and observation of large forest fire areas, etc.

This paper mainly discusses the ignition probability of forest fires by lightning by analyzing lightning data and forest fire data of AFS (Alaska Fire Service) and observation results. Thunderstorm observations by video camera from the Poker Flat top recorded multiple lightning strikes. After the storm, three plumes from forest fires were observed in different directions. The annual, daily, and local ignition probabilities by lightning are calculated and discussed.

Next, the starting mechanism of lightning-caused fires occurring in boreal forests is discussed by considering characteristics of dry thunderstorms.

Finally, a preliminary ignition experiment using impulse voltage generator was carried out to know ignition mechanism by lightning. Experimental results are also briefly discussed.

B22C-0154 1330h POSTER

Interpretation of Remotely Sensed Data in Alaskan tundra-taiga zone based on componential spectral characteristics

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We measured and modeled spectral reflectance factors to the nadir view on an Alaskan north-south transect from tundra to taiga in order to understand possibilities of spectral decomposition of tundra, and forest floors of tundra-taiga transition and forest floors of taiga. Vegetation distribution in tundra zone indicate distribution of methane emission from tundra as well as active layer thickness and vegetation change with climate change. These distributions relate terrestrial carbon budget in tundra. Classification of taiga forest according to forest age after the last fire and to forest viability as well as tree species contributes to carbon, heat, and water budgets. In tundra-taiga transition zone, vegetation classification concerns with both methane emission and forest fire influence. Radiative transfer modeling gives a basis for interpreting remotely sensed data on taiga and tundra vegetation. Tundra vegetation and taiga forest floors are composed by small patch of plant species. Some plant species may be spectrally separated, and others may not. Spectral decomposition of plant species corresponding different methane emission shows usefulness of remote sensing for methane emission distribution mapping. In this research, we showed spectral reflectance characteristics of vegetation components such as leaves, forest floors, and tundra vegetation in Alaskan tundra, Alaskan taiga, and explained the vegetation reflectance characteristics based on the component characteristics and a radiative transfer model.

B22C-0155 1330h POSTER

Vegetation and Fire Patterns in Interior Alaska

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According to a variety of field observations, most forest types in Interior Alaska can be found at unique elevation ranges and topographic slopes and aspects. In this poster, a 1km2-resolution USGS land cover classification was overlaid on a digital elevation model (DEM). The topographic positions of the 37 vegetation types listed in the classificaiton were analyzed and compared with field observations. Fire data for the past 50 years was then overlaid with the vegetation classification and the data was further analyzed for successional sequences and fire patterns. This information can be used to study the large-scale distribution and location of vegetation types in Interior Alaska, succession, as well as the impact of fire on vegetation patterns in the landscape. These current patterns are expected to change with high-latitude warming, but the extent of potential change is unknown.

B22C-0156 1330h POSTER

Modeling the Effects of Soil Thermal Dynamics on the Seasonality of Carbon Fluxes across Northern Temperate and High Latitude Regions

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Understanding the role of soil thermal dynamics on the seasonality of carbon fluxes of ecosystems is critical in clarifying the potential of ecosystems to act as a net source or sink of carbon in the future. The Terrestrial Ecosystem Model (TEM) was coupled to a soil thermal model (STM) and parameterized with observed soil thermal data for sites of the Long Term Ecological Research network in the United States. In addition to the influences of the soil thermal regime on below-ground ecosystem processes, the physical process of freeze/thaw simulated by the STM-TEM also influences the length of growing season. In this study, the STM-TEM was applied to simulate terrestrial carbon dynamics at the global scale from 1859 to 1995. The seasonal dynamics of net primary production (NPP), heterotrophic respiration (RH), and net ecosystem production (NEP, i.e., NPP - RH) for the region between latitudes 60o to 90o N were compared with NPP, RH, and NEP simulated by previous versions of TEM. Simulated NPP by the STM-TEM was similar to that simulated by TEM from January to March and from October to December, was lower from April to May, and higher from July to September; peak NPP was shifted from June to July. Simulated RH by the STM-TEM was similar to TEM but more dynamic from January to April, higher in May, June, September, and October, and lower in July and August. Simulated NEP by the STM-TEM was similar to TEM from November to April, lower in May and June, higher from July to September, and lower in October. The seasonal patterns of NEP simulated by the STM-TEM are similar to the seasonal patterns of net ecosystem exchange estimated from eddy covariance studies of high latitude ecosystems. The next step is to couple the carbon fluxes simulated by the STM-TEM with the Model of Atmospheric Transport and Chemistry (MATCH) and to compare the dynamics of simulated and observed CO2 concentrations at global monitoring stations to further evaluate the effects of soil thermal dynamics on carbon fluxes at regional and global scales.

B22C-0157 1330h POSTER

Relaxation Biodynamics: Experimental Studies and Modeling of Biogeochemical Processes in Northern Terrestrial Ecosystems

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Relaxation phenomenon in physics and chemistry stands for delay between the application of an external stress to a system and its response. When an equilibrated nuclear, atomic or molecular system is subjected to an abrupt physical change (sudden rise in temperature or pressure), it takes time for the system to re-equilibrate under the new conditions. This period (relaxation time) can provide a powerful insight into mechanisms of chemical reaction. Our intention is to extend such approach to analysis of the complex biological phenomena related mainly to microbial growth and activity in the soil. We will show how this information can be used for better understanding the biogeochemical processes in northern terrestrial ecosystems such as aerobic and anaerobic decomposition of organic matter, gas (CO2 and CH4) emission to atmosphere, migration and transformation of biogenic elements, etc.

The major source of experimental data is laboratory soil incubation under controlled environmental conditions with abrupt changes in one of the key parameters: temperature (including the water-to-ice phase transition), soil moisture, light (illumination of planted soil), supply of organic substrate and mineral nutrients. The state of biological component before and after abrupt changes was followed by continuous recording of gas (CO2, CH4) exchange rate and (in some special experiments), chemical analysis of the soil solution, and the characterization of soil community (microbial and plants biomass, species composition, change of life forms, etc.)

The obtained dynamic data were fit to simulation models (sets of differential equations) describing the C- and energy flow through the studied microcosm systems. The comparison of predicted and observed relaxation dynamics allowed us to discard wrong assumptions on the nature of regulatory mechanisms involved in the functioning of the soil community.

Finally, the conclusions derived from the lab experiments are projected to field observations on gas exchange dynamics in tundra and boreal wetlands (Barrow, Alaska; Plotnikovo, West Siberia). It allows us to get better understanding of the ecosystem response to currently observed changing environment as well as to give more reliable prediction of the ecosystem response to anticipated climate changes.

B22C-0158 1330h POSTER

Age, carbon content and climatic stability of West Siberian peatlands

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The West Siberian Lowland (WSL) is the world's largest high-latitude wetland, with a 1.8 X 106 km2 forest-palustrine zone covering nearly 2/3 of western Siberia. Over half of this area consists of peatlands, which since the early Holocene have sequestered atmospheric carbon in the form of undecomposed plant matter. The total carbon pool of the WSL has been roughly estimated at 215 Pg C, suggesting that nearly one-tenth of the world's soil carbon pool lies stored in these peatlands. The region has recently attracted attention from the global change community, owing to recent studies elsewhere that suggest CO2 and methane exchange from peatlands may change dramatically under a warming climate.

Since 1999 an international team of scientists from UCLA, The Russian Academy of Sciences, Tomsk State University and the University of Utah, has conducted a major field and satellite remote sensing study of the role of WSL peatlands in the global carbon cycle. Central to the study is the extraction of peat cores throughout the region, from which peatland age and carbon content are determined from thermal analysis and radiocarbon dating. After successful summer field campaigns in 1999, 2000 and 2001 we have collected nearly 100 cores, as well as thousands of other measurements and samples of peat depth, surface moisture, botany, water geochemistry, river sediment load and land surface cover. The scope and scale of these data are unprecedented in the region. Numerous satellite images of the area have also been compiled, including 150 m MSU-SK visible/near-infrared imagery from the Russian RESURS-01 platform since 1994, ERS synthetic aperture radar and scatterometer products since 1991, DMSP SSM/I passive microwave data since 1987, and 52 Landsat MSS scenes acquired in 1973. These satellite datasets are now being combined with point field observations to determine the Holocene evolution, total carbon content, desiccation susceptibility and contemporary wetness variability of the world's largest peatland. Numerous peat basal dates of 9,000-10,000 radiocarbon years BP indicate that WSL peatlands formed rapidly throughout the region in the early Holocene.

URL: http://lena.sscnet.ucla.edu

B22C-0159 1330h POSTER

Field observations and C-13 NMR characterization of black carbon in forest ecosystems

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Current interest in the role of pyrogenic carbon (also called char, or black carbon (BC)) in the global carbon cycle has stimulated much research into analytical methods and the magnitude of BC stocks and fluxes. Forest fires, especially in boreal forests, are a source of BC, but there is actually little chemical characterization of BC as generated in a forest fire, or after weathering and/or burial. Solid-state C-13 NMR provides a fingerprint of total sample carbon, and for BC, is optimized with Bloch decay and high-speed magic-angle spinning. We characterized BC samples derived from different substrates (e.g., wood, bark, cones), from a range of forest ecosystems (coastal British Columbia, British Columbia Rocky Mountain Trench, the Canadian Boreal Forest Transect Case Study from Prince Albert National Park, Saskatchewan to Churchill, Manitoba, and central Siberia), and of different ages from a few days to >1000 years of burial, or incorporation into soil fractions. In addition to the characteristic aromatic BC signal at 128 ppm, charred samples may reveal varying amounts of unchanged starting material, and of alkyl structures generated at lower temperature ranges. Structural changes with time appear to be small.

B22C-0160 1330h POSTER

Atmospheric Constraints on Carbon Exchange Processes from CO_2 Inversions

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An improved understanding of the biological and biophysical controls on carbon exchange processes is crucial for understanding carbon-climate interactions. We present the results of a relatively new approach to using atmospheric CO_2 data to constrain parameters of carbon exchange processes. CO_2 concentration data collected at remote monitoring stations of the NOAA-CMDL network are combined with a biosphere model and an atmospheric transport model to perform a Bayesian synthesis inversion. Rather than inferring regional-to-continental-scale net carbon fluxes as is typically done, we solve for the light-use efficiency (LUE) of net photosynthesis for broad ecosystem types (e.g. boreal biomes). We further constrain the inversion with local-scale measurements from eddy flux sites (FLUXNET) representative of the broad ecosystem types. Preliminary results suggest higher growing-season mean LUE values for Eurasian boreal regions than North American boreal regions. Also, temperate regions are inferred to have generally higher LUE values than boreal regions. We will discuss the realism of the inversion results, some possible reasons for the apparent longitudinal and latitudinal asymmetries, and their implications for our understanding of the carbon cycle.

B22C-0161 1330h POSTER

Comparison of Soil Respiration Before and After Thinning in a Sierra Nevada Forest

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Soil respiration is controlled by soil temperature, soil moisture, fine root biomass, microbial biomass, and soil physical and chemical properties. The thinning of forests will change soil temperature, moisture and other factors, and thus affect the soil CO2 efflux. Using a LI-6400 Soil CO2 Flux System we measured soil surface CO2 efflux in an 8-year-old ponderosa pine plantation, 58% of which is covered by trees, in the Sierra Nevada Mountains in California from June 1998 to April 2000 before a pre-commercial thinning, and from April 2000 to November 2001 after the thinning. We established two 20m by 20 m sampling plots and measured soil CO2 efflux and soil temperatures and moisture on a 3 by 3 matrix of sampling points in each plot. We found although soil temperature and moisture explain most of the temporal variations in soil CO2 efflux, they explain only a little part of the spatial variation of soil CO2 efflux. A thinning with intensity of 60% of the trees significantly changes the microclimate in the forest, and decreases the spatial variation of soil CO2 efflux, but the magnitude of efflux does not vary significantly before and after the thinning.

B22C-0162 1330h POSTER

Potential carbon cycling implications of boreal forest encroachment on adjacent peatlands in Southeast Alaska

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Because peatlands contain vast stores of potentially mineralizable carbon (C), peatland-forest edges may be especially vulnerable to accelerated C losses if predicted high-latitude warming improves drainage. The peatlands of Southeast Alaska occupy approximately 2 million ha, can be 6 m deep, are not underlain by permafrost, and often abut forests dominated by western hemlock.

Transects were established across 6 peatland-forest ecotones on Mitkof Island to ascertain how soil respiration rates (SRR) varied and whether these SRR coincided with aboveground vegetative discontinuities. At our most intensively studied site, we recorded average SRR ranging from 0.19-0.28 g CO_2 m^{-2} h^{-1} at bog interior, bog edge, and forest edge locations over 3 growing seasons (1998-2000). These rates were significantly lower than the rates at forest interior stations (0.91 g CO_2 m^{-2} h^{-1}) only meters away. At 8 forest edge sites, 7 were described as poorly drained Cryohemists or Cryofibrists and 1 was described as a well drained Haplocryod. Although we found no difference in water table elevations between bog interior and edge sites, water tables at forest interior stations were sharply lower. Soil temperatures recorded during SRR measurements were generally coolest at forest interior stations.

These discontinuities between above- and belowground ecosystem components have at least three implications: 1. Even subtle improvements in drainage at edge locations could result in the mineralization of 29 kg C m^{-2}, the difference in C content between forest edge and forest interior stations. Forest encroachment could accelerate drainage through increased transpiration rates, reduced moss cover, increased pipeflow along roots, or alteration of local slopes due to subsidence. 2. Attempting to obtain insights into belowground processes using aboveground landscape features could produce large errors along ecotones. 3. Modeling efforts to predict the consequences of global warming for this temperate rainforest will need to explicitly consider local soil moisture, which appears to be influenced by topography and rainfall.

URL: http://spodo.ucdavis.edu/tony/poster.jpg

B22C-0163 1330h POSTER

Carbon Storage in Successional Landscapes Following Disturbance by Fire in the Cherskii Region, Northeast Siberia

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The larch (*Larix gmelinii*) forest tundra zone near treeline in northeastern Siberia is a region frequently disturbed by fire. In the summer of 2001 we initiated research on the role of plant functional types in controlling ecosystem exchange and carbon storage in disturbed larch forests in the Cherskii region. In conjunction with ongoing measurements of surface energy exchange and carbon flux using eddy covariance techniques, we measured vegetation characteristics in two vegetation types, one 15 years after fire and one 60 years after fire. Our measurements included plant cover, aboveground biomass and net primary production by species, including non vascular plants, and leaf area index. Grasses and perennial forbs dominated the recently disturbed site. The contribution of these functional types to total cover and biomass decreased as shrubs and mosses became more prominent in the 60 year site. Changes in the relative proportions of functional types would be expected to influence both surface energy exchange and carbon storage. Our measurements will enable us to document plant functional types changes after disturbance and to provide parameters needed to model the impact of disturbance on carbon exchange in this region.

B22C-0164 1330h POSTER

Siberian taiga forest regeneration monitoring with winter LANDSAT ETM+ images

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Monitoring the post-fire regeneration is important for Siberian taiga forest where fires occur frequently. Satellite images taken in summer have been often used in analyses of vegetation. However, in the sparse stands of Siberian taiga forest with varied types of forest floors, it is difficult to extract high trees' conditions and distributions from those images. Instead, we used for the analysis the LANDSAT ETM+ images taken in winter, when almost all high tree species there had fallen their leaves down and the forest floor was covered homogeneously by snow, which had very high reflectance in visible and low reflectance in longer wavelength. Bands 2 (visible), 4 (near-infrared), and 5 (mid-infrared) of the winter ETM+ images are compared with stands' basal area (BA) and height density (HD) that represents a relative congestion of the forest crown above observed from the floor. The results show that the total BA has a correlation with the visible band where the contrast of reflectance between trees and snow is maximum, while total HD has a relationship with the middle infrared band where the contrast is minimum. In addition, the near infrared has a relation ship with the BA of pines that are the only evergreen species of the region. Since HD has a positive correlation with the stand density, HD can be then interpreted to stand density and DBH.

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Factors Controlling CO2 Exchange at Harvard Forest on Hourly to Annual Time Scales

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Carbon dioxide eddy flux measurements at Harvard Forest have revealed annual carbon sequestration ranging from 1.1 to 2.4 MgC/ha (mean 2 MgChayr) from 1991 to 2000. The observed interannual variations reflect short-term (hourly to monthly) response of the ecosystem to environmental forcing (temperature, sunlight, soil moisture) as well as delayed impact of climatic variation on factors such as decay of prior year litter, or mortality or morbidity due to drought stress. Long-term ecological trends (e.g. succession or accumulation of CWD) also likely affect C uptake at Harvard Forest. The role of these processes in controlling carbon exchange at Harvard Forest has been explored through a series of complementary modeling studies.

A simple, ecophysiological based modeling study has been conducted to: (1) quantify the instantaneous ecosystem response to controlling climatic variables (temperature and sunlight), averaged over the decade and (2) identify and quantify the mechanisms responsible for inter-annual deviations of ecosystem carbon exchange from the decadal mean climatic response. A first order empirical model was developed to quantify mean ecosystem response to environmental forcing. An empirical model employing a simple respirationphotosynthesis function for ecosystem response to insolation and temperature accounts for nearly 90% of hourly variance of NEE, but very little of the monthly and inter-annual variances.

To understand the role of soil moisture in controlling NEE variation on the monthly to inter-annual time scale, a two layer bucket type soil hydrology model was developed. Deviations of the ecosystem behavior from the mean short-term ecosystem response, defined as residuals from the ecophysiological based empirical model, were compared with patterns in the simulated surface layer and deep layer soil moisture. Surprisingly, little correlation was found between the empirical model respiration residuals and soil moisture, but deep layer soil moisture and model GEE residuals in the late summer were significantly correlated. When supplemented with a soil moisture correction term, the simple empirical model explains ca. 13 of the observed inter-annual variation in mean GEE for August and September. The empirical model explains only a few percent of the late summer variation in GEE when soil moisture is excluded.

The influence of respiration from short-lived carbon pools (litter-pool and fine debris) on monthly to inter-annual scale variations in NEE was also investigated employing a monthly time step respiration - mass balance litter-pool model. The results of this investigation indicate the decay of short-lived carbon pools contribute to inter-annual variations of NEE. However, the decay of litter and fine - debris was not conclusively established as the driving mechanism behind inter-annual variations in CO2 sequestration at Harvard Forest.

B22C-0166 1330h POSTER

Effects of soil drainage, canopy position, and needle age on leaf area index for a black spruce boreal chronosequence

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Leaf area index (LAI) and vegetation cover are primary drivers of ecosystem models that simulate water and carbon exchange. Along with specific leaf area (SLA), LAI is critical for accurate physiological models at the stand, landscape, and biome levels. Wildfire is the primary disturbance in the boreal forest, producing a mosaic of different-aged stands with different LAI structures. The objectives of this study were to (i) compare several experimental methods for determining SLA; (ii) examine the effects of stand age, soil drainage, canopy position, tree species, and leaf age on specific leaf area (SLA); and (iii) characterize overstory and understory SLA, LAI and foliage biomass for a 130-year boreal black spruce chronosequence. The study was conducted on a 130-year boreal black spruce chronosequence near Thompson, Manitoba. The experimental design was a nested factorial design with soil drainage nested inside of stand age; separate well-drained and poorly drained areas were located within each of the seven sites in the chronosequence. The comparison of two experimental methods for determining leaf area (volume displacement vs. flatbed scanner) produced highly correlated results (N = 50, $R^2 = 0.91$). Preliminary ANOVA results indicate that significant effects for SLA included needle age, stand age, the age * species interaction (all $p < 0.01$), and soil drainage ($p = 0.01$). Canopy position (top, middle, or bottom of canopy) was not significant ($p = 0.16$). Specific leaf area values for black spruce (*Picea mariana* (Mill.) BSP) averaged 5.44 and 4.61 $m^2\ kg^{-1}$ for current-year and older foliage, respectively, and 6.20 and 4.68 $m^2\ kg^{-1}$ for jack pine (*Pinus banksiana* Lamb.). Values for deciduous species were considerably higher. Overstory hemispheric area index (HSAI) varied significantly ($p = 0.02$) across the chronosequence, from 0.22 $m^2\ m^{-2}$ in the young stands to 5.83 $m^2\ m^{-2}$ in the older ones. These LAI figures were in good agreement with previous optically based measurements performed at the older sites on the chronosequence.

B22C-0167 1330h POSTER

Landsat Estimate of Albedo Change from Fire in the Alaskan Boreal Region

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The impact of fire on boreal land cover is substantial with dramatic implications for the exchange of carbon and energy between the land and atmosphere. One of the primary mechanisms through which ecosystems can influence surface-atmosphere energy exchange is by affecting radiation balance. Land surface albedo defines how much shortwave energy is "captured" by the system and is key in determining surface net radiation. The radiation balance and net energy exchange, in turn is an important factor in regulating carbon balance by influencing site temperature, moisture, and , therefore, the biotic exchange of carbon.

The purpose of this study was to quantify and map the change in summertime land surface albedo from fire disturbance in a black spruce dominated landscape in Alaska. The study was conducted at a set of three fire-disturbed sites located near Delta Junction. Five Landsat TM and ETM images from late August/early September for 1986 to 1999 were the primary data used. Albedo change was derived using the six reflective bands of Landsat (bands 1-5 and 7). The images were used to map albedo change at each of the three burn sites from the fire disturbance itself and from vegetation regrowth at the two older burn scars. Field measurements of albedo were also collected and were used to complement the remote sensing-based results.

The results show that fire disturbance can cause an increase, decrease or no significant change in summertime land surface albedo. Albedo change is spatially and temporally variable based on pre-burn vegetation, canopy density, burn severity, and site age. Moderately burned, medium density black spruce, the most typical burn conditions in Alaska, experienced a very small decrease and often insignificant change in albedo. Dense and medium density spruce sites nearly always showed no change in albedo from the fire disturbance. Sparse density spruce and the vegetation types with large amounts of deciduous or herbaceous cover generally decreased or showed no change in albedo in the fist year after burning. In areas of severe burn, albedo increased by up to 9% one year after burning. At all sites albedo increased after several years of vegetation growth (up to 10%) due to the transition to herbaceous and deciduous vegetation.

The albedo changes measured in this study have important implications for net radiation and surface energy exchange. The minimal initial impact of fire-disturbance on albedo means that change in net radiation from fire disturbance is not driven primarily by a change in surface albedo. Separate field-based research has pointed towards longwave energy exchange as the main mechanism for net radiation change directly after burning. Longer-term albedo changes from vegetation regrowth, however, are substantial enough to directly impact net radiation, and therefore site ecology and local and regional climate.

B22C-0168 1330h POSTER

Measuring and Modeling Interspecies Competition of Tree Species in Logged Boreal Mixed Forests

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Forest tree species strongly affect biogeochemical cycles, and the differences are especially pronounced between evergreen and deciduous trees. Many boreal forests are mixed stands containing evergreen and deciduous species. The balance of evergreen and deciduous species changes during succession, yet most biogeochemical field studies and process models ignore mixed stands. The objective of the study was to determine the successional trends of tree species for a boreal logging age sequence in northern Manitoba. The experimental design consisted of eight replicate plots in four different-aged stands that originated from clearcut harvests in 1935 (mature), 1971, 1983, 1990. Dominant tree species were trembling aspen (*Populus tremuloides*), jack pine (*Pinus banksiana*), and black spruce (*Picea mariana*). Six trees of each major tree species were harvested and diameter * height growth relationships were determined by analyzing radial growth of stem disks collected every 0.25 m up the stem. Trembling aspen was the dominant tree species in the younger stands (1983, 1990) while jack pine and black spruce were the dominant tree species in the older stands (1971, mature). Annual growth rings of jack pine and trembling aspen decreased with age and annual radial growth of black spruce increased with stand age. The relationship of annual radial growth with stand age for the three species is discussed in relation to canopy architecture and biogeochemical cycles.

B22C-0169 1330h POSTER

Exploring Relationships Between Vegetation Reflectance and Plant Physiological Parameters on Arctic Wet Sedge Tundra

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We explore vegetation reflectance indices, sampled with a handheld spectroradiometer, to determine the effectiveness of remotely sensed optical measurements in detecting the effects of increased N or P availability, increased temperature, and decreased light intensity on wet sedge tundra near Toolik Lake, Alaska. For the past thirteen years, nutrient availability was increased through fertilization treatments (N, P and N+P) in factorial experiments at three separate field sites. Air temperature was increased using plastic greenhouses at two sites, both with and without N+P fertilizer. Light intensity (photosynthetically active photon flux) was reduced by 50% at the same two sites. All measurements were taken during the growing season of 2001. We have employed two reflectance indices: the normalized difference vegetation index (NDVI), a proxy for chlorophyll content; and the photochemical reflectance index (PRI), a proxy for xanthophyll cycle activity, and thus of Photosystem II radiation-use efficiency. NDVI values for the N+P and P alone treatment plots are consistently higher than both the control and N alone treatment plots throughout the growing season, supporting previous findings that wet sedge tundra is a primarily P limited system. NDVI values for the shade houses are consistently lower than the control plots and all other treatment plots throughout the growing season, suggesting that a reduction in light intensity, as might be expected by increased cloud cover due to global warming, reduces the net primary productivity of wet sedge tundra. NDVI values for both warming treatments show no consistent trends. One especially interesting result is that PRI values for the N+P, warming and the P alone treatment plots are consistently lower than the control plots throughout the growing season, suggesting that these plots have higher carotenoid and zeaxanthin concentrations than the control plots. One hypothesis is that the N+P, warming and P alone treatment plots have higher photosynthetic rates, which enable the plants to produce more blue light receptors (carotenoids and zeaxanthin) in order for them to take full advantage of the shortness and low light intensity that is characteristic of the Arctic growing season.

B

B22C-0170 1330h POSTER

The Effect of Mitochondrial Respiration During Photosynthesis on the Carbon Gain of *Betula nana*

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Assumptions about the rate of dark respiration in the light can have a dramatic effect on the predicted carbon balance of plants. While many models make a simple assumption that the mean respiration rate is constant through both the light and dark period, experimental evidence demonstrates that mitochondrial respiration during the daylight can vary between 25 and 100% of the rate in darkness. Accurately quantifying the rate of mitochondrial respiration during the daylight is particularly important in polar environments that experience continuous daylight during the growing season. Here we report on an experiment to quantify both the rate of dark respiration during the day and the short-term temperature response of respiration of *Betula nana*, a woody tundra species growing near Toolik Lake, Alaska. Mitochondrial respiration during the day was estimated from the Kok effect (change in the slope of the light response curve near the light compensation point), measured on attached leaves at three leaf temperatures from five shrubs in each of two long-term (13 years) temperature treatments (ambient and ambient +4 °C). The rate of mitochondrial respiration in the light varied from 0.49 $\mu mol\ m^{-2}\ s^{-1}$ in the control plants measured at 10 °C to 1.29 $\mu mol\ m^{-2}\ s^{-1}$ in the control plants measured at 20 °C. Mitochondrial respiration in the light was more variable in plants from the elevated temperature treatment ranging from 0.36 $\mu mol\ m^{-2}\ s^{-1}$ when measured at 10 °C to 1.64 $\mu mol\ m^{-2}\ s^{-1}$ when measured at 20 °C. In general, when compared to the control plants, the plants from the elevated temperature treatment had higher rates of mitochondrial respiration in the light (except at 10 °C), higher maximum photosynthetic rates, a higher degree of light inhibition of respiration (except at 20 °C) and lower mitochondrial respiration as a fraction of photosynthesis. The Q_{10} or temperature response of respiration in the light was 36% greater than the Q_{10} of respiration in the absence of light in the elevated temperature plants but 9% lower in control plants. Taken together these results suggest that existing estimates of both the rate of respiration, and the temperature response of respiration could be significant underestimates. Our overall aim in this research is to quantify the components of

the carbon balance in the woody component of this important ecosystem and identify the environmental variables that limit carbon uptake.

B22C-0171 1330h POSTER

Changes in Plant Productivity, Plant Tissue Nitrogen Content, and Decomposition Rates in Shortgrass Steppe Under Elevated Atmospheric CO_2

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An open-top chamber (OTC) elevated atmospheric CO_2 study was initiated in 1997 in shortgrass steppe of northeastern Colorado. In other ecosystems, elevated levels of atmospheric CO have been found to increase plant biomass production and alter rates of biogeochemical cycling. The OTC study in the shortgrass steppe was established to examine the responses of ecosystem dynamics to elevated CO_2 and the potential impacts of elevated CO_2 on ecosystem sustainability. Nine experimental plots were established: 3 chambered plots maintained at twice-ambient CO_2 levels, 3 chambered plots maintained at ambient CO_2 levels, and 3 unchambered plots used to monitor the effects of the chambers.

After 4 years of CO_2 treatment we have found significantly higher aboveground plant biomass production (by 15-35%) and significantly lower plant tissue nitrogen (N) concentrations under elevated CO_2 (0.8%N under ambient CO_2 vs. 0.6%N under elevated CO_2 at peak standing crop in 1999). The combination of these responses results in higher net removal of N from elevated CO_2 plots. The total standing crop of N in aboveground plant biomass at the end of the 1999 growing season was 0.6 g m^{-2} in ambient CO_2 plots versus 1.0 g m^{-2} in elevated CO_2 plots. These changes are expected to limit the stimulation of ecosystem productivity under elevated CO_2 by slowing decomposition rates and by reducing soil N availability. However, field and laboratory studies have thus far shown insignificant differences in decomposition rates of aboveground plant material. Laboratory studies of root tissue have shown significantly **faster** rates of decomposition of roots collected from elevated CO_2 plots. Initial model results using the biogeochemical model DayCent show good model simulation of chamber effects and elevated CO_2 effects on biomass production.

B22C-0172 1330h POSTER

Temporal and Spatial Variations in Patterns of Carbon Release From Burning of Organic Mats in Alaskan Black Spruce Forests

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Fires in the boreal forest region are an important direct source of atmospheric carbon. During high fire seasons, between 15 and 20 million ha of boreal forests can burn. Traditional studies of fire behavior have provided data that can be used to estimate the amounts of carbon released from these fires in many forest types. However, there are many forests which contain deep organic mats (which consist of fine litter, fallen woody debris, moss, lichen and organic soil) where information on the patterns of organic matter consumption during fires is not as detailed. A study was carried out in paired burned/unburned black spruce forests of interior Alaska. Level of carbon consumption was determined by measuring the organic soil depths in each pair, and determining how much organic soil was consumed during the fire. A total of 25 different paired sites from 13 different fires were used in the study. The fires occurred in a variety of different physiographic settings that resulted in three drainage categories - well drained, moderately-well drained, and poorly drained. In addition, the date of burning of each paired set was identified, and the fires were divided into three categories: early season fires, mid-season fires, and late season fires. Results of the study showed that on average, 43 percent of the carbon present in the organic mats of the black spruce forests is consumed during fires, releasing 30.8 t C per ha burned. These are much higher levels of carbon release than reported for Canadian boreal forests. In addition, there were distinct spatial and temporal patterns to the organic mat biomass consumption by fires. In well and moderately-well drained sites, 46 percent of the organic mat was consumed during fires, whereas only 26 percent of this carbon was consumed in poorly drained sites. Seasonally, nearly twice as much carbon was released during late season fires (69 percent of pre-fire carbon) than during early and mid-season fires (35 percent).

B22C-0173 1330h POSTER

Reconstruction of the Dynamics of Mammoth Tundra-Steppe Ecosystem Productivity

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During periods of glaciation, the mammoth tundra-steppe (MTS) ecosystem was the largest biome.The productivity of this ecosystem is under discussion. During the Pleistocene, a thick layer of frozen loess accumulated on the lowlands of northern Siberia. As loess deposited on the surface, the bottom of the soil profile was incorporated into permafrost. Present-day frozen loess soils of Siberia are cryo-preserved soils of the MTS. These soils have little humus but contain large quantities of grass roots and live Pleistocene microorganisms. As the soil melts, they start to respire actively.

Analysis of vertical distribution of respiration in different types of modern soil and permafrost showed that respiration potential of cryo-preserved soil is similar to respiration of low soil horizons. On the basis of the correlation of photosynthesis to respiration, we calculated productivity of the MTS ecosystem and reconstructed its dynamics.

Dynamics of MTS productivity was evaluated through the dynamics of the relative quantities of herbivorous animals. We analyzed the distribution of about 600 ^{14}C dates of mammoths, bison, and rhinoceroses. An estimate of the absolute density of mammoths in the north of Siberia was calculated on the basis of data collected on the density of skeletons buried in the permafrost.

Our investigations showed that vegetation productivity and density of herbivorous animals in the MTS ecosystem varied within a wide range depending on climate. Dynamics of these parameters correlate with data of temperature and atmospheric CH_4 obtained from Greenland cores. During periods of climate warming the quantity of mammoths in the north of Siberia was comparable to the quantity of elephants in present-day undisturbed African savanna.

B22C-0174 1330h POSTER

Postfire Response of North American Net Primary Productivity Derived from Satellite Observations

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Fires influence the carbon cycle through direct emissions of carbon as well as indirect effects on the recovery of ecosystems. In this study we analyzed the impact of fires on net primary productivity (NPP). We used a new, 17-year record of AVHRR satellite observations at 8 km spatial resolution to estimate NPP in North America. We identified fires in the satellite observations using a digitized fire scar data set. We present a case study from a 1991 fire in Quebec; the fire generated a decrease in NPP of 140 g C m-2 yr-1 (60%) after the fire, but NPP nearly recovered after 8 years. An analysis of 61 large fires in the boreal forests of Canada and Alaska revealed that a substantial fraction had NPP decreases immediately following the fire of greater than 100 g C m-2 yr-1 (> 40%). By comparing burned and unburned pixels, we estimated a mean NPP recovery period for boreal forests of about 10 years. The NPP recovery followed an exponential decay curve.

B22C-0175 1330h POSTER

The Role of Woody Debris in Boreal Forest Recovery After Fire

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Boreal forests are an important component of the global carbon cycle due to the large amount of carbon this ecosystem stores and, therefore, can exchange with the atmosphere. The two main pathways of carbon release for this ecosystem, decomposition and fire emissions, are poorly understood. These pathways are related because fire-killed material (i.e., moss and trees) provides a source of nutrients for microbial decomposition and vegetative re-growth. Thus, we are currently studying how fire affects boreal forests, focusing on changes to its carbon storage, both immediately post-burn and over time.

Here we examine the impact of fire on the woody debris of boreal forests. We tracked changes in carbon storage by examining the amount of and relative decomposition rates for fire-killed trees over several stand ages. Woody debris from five different aged burns (1999, 1994, 1987, 1956, and pre-1890), near Delta Junction, Alaska, was inventoried. Because the organic layer of this forest accumulates as stand-age increases, one traditional criterion for measuring woody debris (i.e., counting only woody debris <50% covered by organic material) was modified to include partially (>50%) and entirely buried debris. Thus, the entire woody debris pool was tracked throughout the fire cycle, providing better estimates of decomposition rates and changes in carbon storage. Preliminary results suggest that the largest amount of woody debris is found approximately six years after the burn. This debris slowly 'disappears' as it both decomposes and becomes buried by moss.

Carbon and nitrogen composition of woody debris was also determined in order to gain a better understanding of how C:N changes over size class, decomposition class, and time. These values allow us to track inputs of C and N to the soil from woody debris and assess what impact changes in woody debris has on their storage. These values will be used in models (Harden et al. 2000) that, by varying the fire return interval, can provide insight into the role of fire emissions versus decomposition in the release of these nutrients to the ecosystem.

B22C-0176 1330h POSTER

Controls on Arctic NDVI Patterns: a Zonal Analysis

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Summer temperatures are thought to be the primary control of circumpolar-scale phytomass patterns. The Normalized Difference Vegetation Index (NDVI) is often used as an index of vegetation greenness, and consequently the amount of green phytomass. Understanding the variation in NDVI and phytomass along present-day climate gradients provides key information for predicting responses to global climate change. The Arctic Zone (the tundra region north of the arctic treeline) has been subdivided into five bioclimate subzones, with boundaries at approximately 2°C intervals between 12°C mean July temperature (MJT) at continental treeline areas to 0°C at the ice margin. We estimated total-aboveground-phytomass density (TAPD) within the five arctic bioclimatic subzones using a regression of phytomass against NDVI that was developed along the arctic climate gradient in arctic Alaska with supplementary data from the Canadian High Arctic. Total aboveground phytomass for the Arctic is estimated at 2.42 Gg. TAPD in subzones 1 through 5 was: 51 g m-2, 116 g m-2, 169 g m-2, 454 g m-2, and 796 g m-2 respectively. Circumpolarly, Subzone 3 has anomalously low TAPD values. We investigated three possible causes of this anomaly: (1) greater elevation in Subzone 3 causing relatively lower biomass on average, (2) relatively large areas of low phytomass on limestone substrates in Subzone 3, (3) a greater percentage of barren areas and lakes in Subzone 3 due to late-Pleistocene glaciation. When the NDVI data are broken down according to region, Eurasia has much higher NDVI values than Canada. The lower NDVI values in Canada are the result of a combination of factors. The primary cause is the late-Pleistocene glaciers that covered nearly all of Arctic Canada, and left large areas of barren rock, and lake-covered landscapes . Both rock and water have low NDVI values that lower the mean NDVI values within each subzone. Canada also has large areas of limestone and relatively high elevations, particularly in Subzone 3. Circumpolarly, higher elevation corresponded with lower NDVI values. For areas in both Alaska and Canada, where substrate pH data are currently available, nonacidic substrates had lower NDVI values than acidic substrates.

B22C-0177 1330h POSTER

Interannual variability in carbon flux of arctic tundra detected with combined optical and flux measurements

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Warming is expected to have large impacts on early season biosphere-atmosphere carbon exchange in northern latitude ecosystems, in part through earlier snowmelt, and early season weather conditions could further modulate ecosystem gas exchange. Using spectral reflectance, eddy covariance, and chamber gas exchange from an arctic tundra site in Barrow, Alaska, we explored the interannual variability in whole-ecosystem carbon exchange in 2000 and 2001. Despite an earlier snowmelt and higher light levels, gross carbon uptake in 2001 was substantially lower than in 2000, due in part to a combination of temperature and moisture conditions early in the season. Key uncertainties in this analysis involve accurate accounting of ecosystem respiration and photosynthetic light-use efficiency. Clearly, early season weather events have a disproportionate impact on whole-season carbon exchange, and an earlier growing season is not necessarily associated with enhanced carbon uptake in northern latitude ecosystems. This analysis illustrates the importance of field monitoring for any attempts to derive whole season carbon gain from temporally limited datasets (e.g. satellite remote sensing).

URL: http://vcsars.calstatela.edu

B22C-0178 1330h POSTER

Soils and Carbon Transformations in Northern Michigan Forested Watersheds

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By controlling pH and redox chemistry, organic/inorganic carbon transformations affect important soil processes such as mineral weathering and the transport of trace metals. Carbon cyling was studied using two natural forested sites (Cheboygan and Tahquamenon watersheds) and using results from chambered tree-growth experiments conducted under different treatments of soil fertility and PCO_2. Although both watersheds are established on sandy glacial drift deposits, Cheboygan soils are carbonate-rich, while Tahquamenon soils are carbonate-poor. The occurrence and transformation of organic and inorganic carbon was followed in soils and soil solutions from different forest types: aspen and mixed hardwood forests in the Cheboygan watershed, and conifer and mixed hardwood forests in the Tahquamenon watershed. Geochemical characterization of soils, soil solutions, shallow groundwaters, and streams included major, minor, and trace elements in addition to inorganic and organic carbon concentrations. Soil and soil water chemistries were also followed over the 2 years of chambered tree growth experiments.

Tahquamenon soils lack inorganic carbon to at least a depth of 150 cm, while inorganic carbon is present in Cheboygan soils at depths greater than 80 cm. Tahquamenon soils have higher organic carbon contents than Cheboygan soils. Shallow groundwaters and stream waters of both Tahquamenon and Cheboygan watersheds are Ca-Mg-HCO_3 solutions, but Cheboygan waters are up to twice as concentrated, due to the abundance of reactive carbonate minerals in the soil, higher respiration rates, and higher growing season soil gas CO_2 values. Carbon in both watersheds is present in shallow soil solutions as DOC derived from organic matter decomposition, and is rapidly transformed and replaced by DIC from organic matter oxidation, respiration, and carbonate dissolution with increasing depth in the soil column. The DOC to DIC transition occurs at different depths in different forest soils and is related to the underlying geology and vegetation, both of which influence mineral weathering and soil development. In the two watersheds, a positive correlation exists between DOC and metals such as Pb and Al, and soil solutions with low pH and high DOC contain higher trace metal concentrations than stream waters. Similarly, weathering of silicate minerals is enhanced at shallow depths by organic ligands present in DOC, and carbonate mineral weathering occurs deeper in the soils.

While DOC and DIC maxima generally occur at different soil column depths in natural forests, our work in the tree-growth chambers shows that in disturbed soils, mineral weathering processes facilitated by DOC and DIC may occur together at shallow soil depths. Homogenization of the chamber soils brought reactive carbonate minerals up to shallow depths into the zone of highest PCO_2, allowing for dissolution of carbonate minerals to occur simultaneously with silicate mineral dissolution. Soil disturbance due to development or agriculture in carbonate-rich areas may thereby increase DIC fluxes from the landscape while decreasing transport of trace metals by moderating pH.

B22D MC: Hall D Tuesday 1330h

Biological Mineralization: Early and Extreme Environments I *(joint with OS, P)*

Presiding: **P M Dove,** Virginia Polytechnic Institute and State University**; J J DeYoreo,** Lawrence Livermore National Laboratory

B22D-0179 1330h POSTER

Microorganisms From a Depth of 1350 m in Hawaii

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The Hawaii Scientific Drilling Program recovered cores of igneous rock from the surface to a depth of 3109 m near Hilo, Hawaii. After examining most lithologic units from this site with a petrographic microscope, we concentrated on a single unit of hyaloclastite at 1335 to 1415 m below sea level. For this study we used deep ultraviolet laser-induced native fluorescence imaging, ultraviolet Raman spectroscopy, scanning environmental electron microscopy, DNA-staining, electron microprobe chemical analysis, and microscopic petrographic observation. Each technique revealed a signature consistent with biological activity associated with alteration of glass to clay. Vesicles were surrounded by dark zones of alteration from which smooth, rounded channels extended into the glass similar to those attributed to microorganisms in deep sea basalt glass. Enrichments of phosphorus and carbon were associated with these same regions of the basalt. The rims of vesicles produced laser-induced fluorescence and Raman spectra that indicate the presence of amino acids and nucleic acids. These same rims were examined with an environmental electron microscope and were found to contain microorganisms. This result was confirmed with DNA staining of vesicle rims. These results taken together confirm the presence of microorganisms at the boundary between primary volcanic glass and secondary clays. This boundary is the site of chemical transformations that can provide metabolic energy for microorganisms. The glass can also be a source of nutrients such as phosphorus, however, at this time the physiology of the microorganisms is not known. Although we examined only one lithologic unit in detail, petrographic examination of other samples suggests that microorganisms are, or were, present in over 700 m of the hole.

B22D-0180 1330h POSTER

Facies architecture and sequence-stratigraphic features of the Tumbiana Formation: A depositional setting of late Archaean stromatolites in the Pilbara Craton, northwestern Australia

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The Tumbiana Formation (ca. 2700 Ma) is a succession developed in response to late Archaean crustal extension in the Pilbara Craton, northwestern Australia. The formation is characterized by intercalations of stromatolite carbonates and provides a perspective of evolution of photosynthetic organisms that are interpreted to have been responsible for oxygenation of atmosphere. Here we investigated a depositional setting

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