River floodplain in southeastern Arizona. The growing season in the upper San Pedro River basin is punctuated by a very hot, dry period in early summer followed by monsoon rains that stimulate prolific growth of under story C4 grasses. Our general objectives are to determine the impact of summer rains on net ecosystem CO2 exchange (NEE), evapotranspiration (ET), energy fluxes and soil nutrient cycling, and to understand and model component fluxes in these two-layered canopies. We are continuously monitoring NEE and ET using an eddy covariance system mounted on a 14-m tall tower at the site. Three intensive field campaigns (pre-, mid-, and post-monsoon) included measurements of eddy fluxes beneath the mesquite canopy, mesquite sap flow, mesquite leaf area index, mesquite and grass water sources and stomatal conductance, soil moisture distribution, soil respiration, soil carbon and nitrogen pools, and isotopic composition of CO2 and water vapor within and above the canopy boundary layer. This talk will highlight some of the important findings from the first year of this project.

URL: http://www.tucson.ars.ag.gov/˜russell/mesquitehome.htm

B41A-08 1050h

Seasonal Carbon Dioxide Exchange of a Grazed Grassland in California

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An new Ameriflux site was established in late 2000 to study the exchange of carbon dioxide over an oak/grass savanna and a nearby grazed grassland at the foothill of Sierra Nevada in California. Only data from the grazed grassland will be presented here. The flux measurement, along with measurements of meteorological and soil parameters, were start at the end of October 2000. Results from almost one years data indicated that most of variance of the CO2 flux can be explained by changes in soil water content and leaf area index (LAI). The grass started to growth around middle of October after receiving substantial rainfall. Midday net ecosystem CO2 exchange (NEE) increased slowly from near zero in early November to about 10 μmol m^{-2} s^{-1} (downward flux is negative) in the middle of March. While the nighttime NEE was around 1 to 3 μmol m^{-2} s^{-1}. In the spring, there was a peak growth period when photosynthesis and respiration both accelerated. The maximum LAI was 2.0, reached at this peak period. Midday NEE reached a maximum value of -18 μmol m^{-2} s^{-1}, and averaged nighttime NEE ranged from 2 to 5 μmol m^{-2} s^{-1}. Then as the soil dried out in the early summer, both daytime photosynthesis and night respiration plummeted to near zero. In the dry summer, small value of soil CO2 efflux during daytime only was observed. From almost one seasons data, we found that nighttime ecosystem respiration followed closely to the daytime photosynthetic rate, indicating the importance of photosynthetic assimilates allocation for respiration. Annual integrated carbon exchange over this grazed grassland was estimated to be around -120 g C m^{-2}. Results also show that the seasonality of NEE and growth of grasses are quite different from those mid-western grasslands.

B41A-09 1105h

Carbon, Water and Energy Fluxes in an African Savanna Ecosystem

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Eddy covariance measurements of the turbulent fluxes of CO_2, water and energy, and associated micrometeorological and biophysical measurements, have been made at a site in the Kruger National Park (KNP), South Africa, since April 2000. The study site is located in the southern region of KNP in a gently undulating landscape on granite substrate, with drainage lines 2-3 km apart and ridge tops 30-40 meters above the valley floors. The climate is semi-arid subtropical, with hot, rainy summers, warm dry winters and annual average rainfall of 550-650 mm. The soils of the catena vary between coarse-textured sand near the ridge-tops and finer-textured loamy-sand on the mid-slope and valley floors. The vegetation also differs along the catena, with broad-leaved tree species and low palatability grasses on the sandy soil and bi-pinnate tree species and more palatable grasses on the loam soils. The natural disturbance regime of the site includes fire, at return intervals of 3-8 years, as well as grazing and browsing by numerous species of wild ungulate. Results from the first 18 months of flux measurements are presented, contrasting an unusually wet growing season (1999-2000), followed by a dry-season fire, and a growing season with more average rainfall (2000-2001). The functional and phenological differences between broadleaf and fine-leaf savanna are explored, and the carbon and water dynamics of the savanna systems interpreted in the context of seasonal weather variation, soil type and nutrient status.

URL: http://nrel.colostate.edu

B41A-10 1120h

Interannual and Spatial Variability of Carbon Fluxes and Soil Respiration Within the Understory of a Pacific Northwest Old-Growth Forest

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We present results of 3 years of long-term measurements of carbon fluxes in the forest understory at the Wind River Canopy Crane AMERIFLUX site. The Crane is located in a Pacific Northwest Old-growth Forest with trees up to 500 years old and 65 meters tall. A permanent eddy covariance station consisting of a Gill-Solent HS Research sonic anemometer and a LiCor LI6262 closed-path InfraRed Gas Analyzer (IRGA) has been operated for over 3 years at a height of 2.5 meters to complement an identical system measuring total ecosystem exchange at a height of 70 meters. A vertical profile of 8 micro-meteorological stations as well as a 3-dimensional CO2/H2O profile system provide additional data. The forest structure at the is complex with seven gymnosperm and two angiosperm tree species in the 2.3 ha. crane circle, large amounts of woody debris on the forest floor, and a diverse understory. Soil respiration is a major contributor to the carbon budget at the site. The long-term understory Eddy-covariance data indicate the release of carbon from the soil to be as large as 11 tC ha^{-1} yr^{-1} with maximum values of 6 to 8 $\mu molm^{-1}$ s^{-1}. The Net ecosystem carbon exchange (NEE) estimated by eddy-covariance is 1.5 to 1.9 10 tC ha^{-1} yr^{-1}. In this study we investigate the partitioning and temporal dynamics of carbon fluxes within the canopy. Summers can either be hot and dry (1998) or wet and relatively cool (1999). By September 1998, soils were at their driest state on record, and air temperature and atmospheric vapor pressure deficit (VPD) were both large. NEE may be significantly reduced or even turn to a net loss of carbon as water availability declines during the summer. The main period of carbon uptake is limited to the months March through May when respiration is low. Stand-level light response functions show optima for low temperatures and diffuse light conditions. In addition, we will present data and analysis on the spatial heterogeneity of understory fluxes measured by 2 additional eddy covariance systems.

B41A-11 1135h

Carbon and Water Cycles in a New Zealand Peat Bog

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Peat soils represent globally significant stores of carbon and an understanding of carbon exchange processes between peat wetland ecosystems and the atmosphere is important for understanding the effects of, and impacts upon, global climate change.

Eddy covariance measurements of CO_2, water vapour and energy fluxes were made during 1999 and 2000 at a remnant oligotrophic raised peat bog in North Island, New Zealand. The bog's hydrology has been modified by drainage of surrounding agricultural land, so that the water table is relatively deep compared to that of unmodified bogs in the region. Vegetation is dominated by two indigenous species of rush-like vascular plants belonging to the Southern hemisphere family Restionaceae.

Maximum daytime CO_2 fluxes were commonly -9 μmol m^{-2} s^{-1} and averaged -1.3 μmol m^{-2} s^{-1} over the 24-hour period in summertime. The ecosystem was a sink of atmospheric carbon for most of the year, with wintertime characterised by 12–15 weeks of carbon neutrality or slight carbon loss. Average carbon uptake by the ecosystem was 196 gC m^{-2} yr^{-1} for the two-year period. Modelling suggests that the key factor determining inter-annual variability of the carbon budget is seasonal soil temperature, whereas ecosystem respiration is relatively insensitive to the position of the lowered water table.

The bog vegetation acts as a major control over water vapour loss and energy partitioning favors sensible heat production with mean summertime Bowen ratios of approximately 2.0. Water use efficiency was highest in the morning, indicating that the vegetation maximizes CO_2 assimilation while the saturation vapour pressure deficit and transpiration rates are low. The dense canopy structure also restricts penetration of solar radiation to the peat surface, which minimizes evaporation and soil respiration.

B41A-12 1150h

Estimating Nocturnal Respiration from Profile Measurements in a Subalpine Forest

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Estimates of nocturnal respiration of forest ecosystems derived from vertical profile measurements of carbon dioxide (CO_2) concentration and wind velocity offer an effective means of supplementing, or at times, replacing eddy covariance and chamber measurements. For example, under near calm conditions, stable atmospheric stratification leads to situations in which application of eddy covariance methodology is ill-suited. An alternative approach under these conditions is to sum changes in subcanopy airspace storage and advection of CO_2 to estimate ecosystem respiration.

Profile measurements of wind velocity and CO_2 concentration were conducted in a subalpine forest (mostly lodgepole pine, ingleman spruce, and aspen) on sloping (6-7%) terrain, about 8 km east of the continental divide, northwest of Boulder, Colorado. The profiles were measured from three locations at multiple levels, ranging from 1m above ground to 33m (more than twice canopy height). All measurements were averaged over half-hour intervals. A single infrared gas analyzer, located 73m from either profile location, measured concentrations from which change in storage and advection were calculated. Under typical nocturnal conditions during the growing season (May-Sept.), katabatic winds develop near sunset and strengthen during the night reaching 0.5-0.9 m/s. Due to considerable temporal variability in wind speed and in CO_2 concentration, advective and storage fluxes were highly variable. Mid-summer concentration differences with downslope distance typically averaged about 0.1 ppm/m between heights of 1-6m. Advective flux was typically several times larger than storage flux, ranging from about 5-15 micromole/m^2/s shortly after drainage (katabatic) flow began, then decreasing through the night with temperature. On nearly calm nights during the May-August 2001 growing season, advective flux often reached about one-third the daytime uptake by the forest.

B42A MC: Hall D Thursday 1330h

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

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

B42A-0106 1330h POSTER

Discriminating and quantifying root respiration into soil carbon dioxide flux of Guandaushi forest ecosystem by stable carbon isotope ratio analysis and inferred detection methods

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Carbon cycle in forest ecosystem is an important part of global carbon budget. To better understand the carbon cycle of ecosystem, we have been investigating the soil carbon and flux of CO_2 of Guandaushi Forest Ecosystem in central Taiwan. The contribution of soil flux to ecosystem is dependent of soil constituent activities. To discriminate root respiration into soil carbon dioxide flux, we used direct and indirect methods to distinguish different sources of soil ingredients. The root-excised flux of soil surface was determined *in situ* by inferred detection method comparative to whole soil carbon dioxide efflux. The root respirations contributed 24.6 to 50.0 % of the total soil respirations, which were determined by inferred method and calculated from different of bulk and root-excised soil flux. The percent of root respiration to bulk soil was higher in warm seasons and lower in cool seasons, respectively. It was suggested that root respiration is a critical contribution to soil carbon dioxide dynamics. $\delta^{13}C$ values of the soil samples range from -24.0 to -27.3 per mil, generally differ from that of the plant material of the forest, expect for the surface samples. The $\delta^{13}CO_2$ of soil air at 45 and 90cm depth was -22.0 $\pm$ 0.3 and -22.4 $\pm$ 0.4 per mil, respectively. The root respiration at 45 cm depth contributes 85% of carbon dioxide of the soil section, which was calculated with two end members by assumption of steady state of CO_2 movement in the pedon. These results suggest that root activity features largely importance role in soil CO_2 flux. However, the fractionation factors of carbon isotope in reactions coupled with CO_2 flux will be needed to confirm by additional studies.

B42A-0107 1330h POSTER

A Large Daylight Geodesic Dome for Quantification of Whole-Ecosystem Carbon Dioxide and Water Vapor Fluxes

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We developed, tested, and ultimately used a large-scale static chamber a 4 meter diameter geodesic dome as a way to (1) overcome the problems of scaling leaf-level gas exchange to estimate ecosystem-level CO_2 and water vapor fluxes, (2) maintain the ability to quantify plot level responses to experimental treatments that would be impossible to assess with eddy correlation methods which require relatively large footprints, and (3) avoid the problems of chamber over-pressurization commonly associated with open flow gas exchange systems. Our primary scientific objective was to quantify the consequences of post-fire alien plant succession on CO_2 and water vapor fluxes in native intact sagebrush steppe and adjacent post-fire successional areas over the course of a year. By quickly sealing the 12.3 m^2 dome (16.4 m^3) over individual experimental plots established in each area (six plots in burned and six plots in adjacent intact sagebrush communities) onto wooden baseplates we were able to accurately measure net ecosystem CO_2 fluxes (NEE) as small as 0.1 μmol CO_2 m^{-2}land area s^{-1} and water vapor fluxes of 0.1 mmol H_2O m^{-2}land area s^{-1} within two minutes of placing the dome on a plot. Changes in dome CO_2 and water vapor concentrations were measured using an open-patch IRGA (LICOR 7500), and two window fans were used to mix the air. The translucent dome with its skin of reinforced polyethylene allowed transmission of more than 70% of photosynthetically active radiation. Its large area allowed accurate representation of key ecosystem elements (shrubs and inter-shrub spaces). The change in air temperature within the dome during the 2 minute measurement was small and physiologically inconsequential, ranging from zero at night to $+2^{\circ}$C at midday in the summer. One year after the wildfire leaf areas index in the burned plots with successional herbaceous vegetation at peak biomass averaged 0.1 while in intact sagebrush communities about 3. Surprisingly, however, NEE and water vapor fluxes (weighted average of five measurements on each plot over 24 hours) were similar in the two communities. The similarity appears to be due to low photosynthetic CO_2 uptake and low respiratory CO_2 emissions in successional communities and relatively high photosynthetic CO_2 uptake balanced by high plant and soil respiratory losses in intact sagebrush communities. Daytime NEEs in the late spring and summer in both plant communities ranged from 1 to 4 μmol CO_2 m^{-2} s^{-1}, while nighttime values (ecosystem respiration) ranged from 0.1 to 2 μmol CO_2 m^{-2} s^{-1}. Water vapor fluxes over the same period ranged from 0 to 1.0 mmol H_2O m^{-2} s^{-1} during the daytime and 0 to 0.1 mmol H_2O m^{-2} s^{-1} at night. Both NEE and water vapor fluxes declined in late summer and fall months with relatively large loss of leaf area and less strong decreases in plant and soil respiration. Thus, our inexpensive extension of standard static chamber techniques to a very large cuvette geodesic dome permits us to directly and accurately measure ecosystem level gas fluxes in two adjacent communities which can be integrated over time to calculate annual net ecosystem productivity and evapotranspiration.

B42A-0108 1330h POSTER

Observations and Modeling of the Fluxes of Energy, Water and Carbon of a Tropical Rainforest at Caxiuana, Brazil

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Observations of fluxes of energy, water and carbon were collected for 160 days in 1999, using an eddy correlation system, at the Forest Reserve of Caxiuana, in Northeastern Amazonia, Brazil. Previous work by our collaborators has shown some characteristics of this ecosystem: local albedo is about 0.11, which is smaller than the generally accepted value of 0.13 for the Amazonian rainforest; latent heat flux varied between 50 and 85 % of the total energy balance; daily evapotranspiration oscillated between 2.0 and 4.6 mm/day in the observation period; the average Net Ecosystem Exchange for the period was 2.0 g C/m2/day, which is consistent with an observed increase in the leaf area index from 4.5 to 6 in the measurement period. In this work, we modeled the hourly fluxes of water vapor and carbon over the canopy using the Simple Tropical Ecosystem Model SITE. SITE is a dynamic model that integrates land surface processes and carbon balance. It includes the treatment of long wave and short wave radiation fluxes, canopy water balance, tree physiology and transpiration, canopy aerodynamics, transport of mass and energy inside and above the canopy, soil physics and soil carbon dynamics. Although physically rigorous, SITE is simple enough to be used in intermediate level courses of ecosystem modeling. The model is forced by meteorological data collected above the canopy. Most biophysical parameters used by the model were measured at the site, although some parameters were taken from the literature. The model was calibrated to reproduce about one third of the time series collected, and the simulation results were validated against the remainder two thirds of the flux series. The water vapor flux simulations reproduce very well the observed fluxes, including unusual evening peaks. The carbon flux simulations also reproduce well the observed fluxes, including the before noon peak of carbon assimilation and the decreased assimilation when the forest is shaded by clouds. The use of a process-based model contributed significantly to understand the functioning of this ecosystem during this period.

B42A-0109 1330h POSTER

Seasonal Analysis of Spatial Variability in Radiation Components Over a Deciduous Mid-Latitude Forest

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Seasonal trends in spatial variability of radiation components across a forested area of heterogeneous terrain, using a topographic surface radiation budget model are examined. Radiation components provide fundamental inputs to the surface energy budget and photosynthesis. Changes in magnitude over space, both within the footprint of turbulent flux measurements and within the broader ecosystem provides an important constraint on spatial extrapolation of estimates of carbon and energy exchanges. This constraint is also important for sub-grid scale radiation fluxes estimated by numerical models ranging in scale from meso- to global.

Analysis is based on simulations of diurnal mean radiation budgets under both clear sky and cloudy conditions for the Morgan-Monroe State Forest in south-central Indiana. Comparisons between modeled values and observations from a 46 m instrumented tower show very close agreement. Spatial variability is assessed under different seasonal and cloud conditions, and estimates of the influence of variability of photosynthetically active radiation on carbon budget estimates are presented. The importance of spatial resolution in modeling of spatial variability of radiation fluxes is also investigated.

B42A-0110 1330h POSTER

Modeling the Effects of Fertilization on Net Ecosystem Exchange of Carbon, Water, and Energy.

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We investigated the effects of increased leaf area index (LAI) due to fertilization on net ecosystem carbon exchange (NEE), energy balance, and water fluxes of a 6-year old southern pine forest. Fertilization doubled LAI and increased leaf carboxylation capacity by 20% in this experiment. Increased LAI with higher mean leaf nitrogen content as a result of fertilization should increase gross CO_2 assimilation and water uptake by the canopy. Yet, increased LAI is associated with larger amount of respiring biomass and increased N increases leaf specific respiration, both increase total ecosystem respiration. Furthermore, increased transpiration can lead to more frequent cavitation in the root-xylem system thereby inducing more stomatal shutdown and sensitivity to drought. In short, assessing the degree to which terrestrial carbon sinks are enhanced by fertilization is complicated by many nonlinear and processes that act to enhance and dampen NEE. Using a detailed multilevel canopy transport model and measurements at scales ranging from leaf to ecosystems, we found that the combination of large LAI and high temperatures during the growing season limits fertilization-caused enhancement in NEE. Enhancement in annual NEE is shown to be restricted to periods of specific combinations of LAI and air temperature.

B42A-0111 1330h POSTER

Partitioning the Controls on Carbon Flux Between Light Absorption and Light Use Efficiency: Insights From High Spatial and Temporal Resolution Remote Sensing.

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Comparisons between eddy covariance measurements of CO2 flux and remotely sensed spectral reflectance are often limited by mis-matches in temporal and spatial scales. Eddy flux measurements are made continuously through time whereas satellite sensors typically measure only once per day or less and many days may be lost because of cloud cover. In addition, satellite sensors such as MODIS have pixel sizes as large as a whole eddy flux footprint, making precise spatial correlation difficult. In order to better match the temporal and spatial scales of remote sensing measurements to those of eddy flux, we installed automated systems (optical sampling instruments on a tram system) within eddy covariance tower footprints at Sky Oaks field station near San Diego, CA. This system measured hyperspectral (narrow-band) reflectance over a 100 m transect throughout diurnal and seasonal cycles. These data were used to explore the controls on carbon flux and to develop models for scaling eddy flux measurements to the surrounding region. Fractional absorbed radiation (estimated from NDVI) varied dramatically over the diurnal cycle but was relatively constant across seasons in this evergreen shrub dominated system. By contrast, seasonal carbon flux

varied more closely with optical signals of light-use efficiency. Consequently, large seasonal changes in carbon flux were primarily a function of light-use efficiency rather than light absorption. These data suggest that models based solely on light absorption by vegetation may miss large fluctuations in carbon exchange resulting from downregulation of photosynthesis. Although this ecosystem may be an extreme case, there are many evergreen ecosystems in which photosynthetic downregulation could play a large role. Application of this optical measuring system at other FLUXNET sites would greatly increase our understanding of the role of photosynthetic downregulation in global carbon cycles.

B42A-0112 1330h POSTER

Modeling Regional Carbon Fluxes in Agriculture with New Remote Sensing Observations

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The uptake of carbon dioxide (CO2) in crop growth and the subsequent removal of carbon (C) through harvesting and soil decomposition determine the annual C balance of agroecosystems. While many small-scale experiments have studied C dynamics within fields, the most relevant scales for large-scale biogeochemical processes, as well as for land-use policies related to the Kyoto Protocol, are at the field to regional level. At these scales, models represent a useful alternative to direct measurements for quantifying C fluxes, yet they require information on climate, soil properties, and management that can vary greatly in space and time. In this study, we have developed a simple C model for agricultural systems that utilizes satellite remote sensing inputs to constrain both input and output fluxes of carbon. A sensitivity analysis was first performed to identify the most important parameters to constrain from satellite, and methodologies were then developed and/or adapted to fulfill these needs. A sample application of the model is given for an intensive wheat system in Northwest Mexico, where five Landsat 7 Enhanced Thematic Mapper Plus (ETM+) images were collected in 2001. Future development and testing of this integrated modeling-remote sensing approach should greatly improve efforts to quantify local and regional C fluxes that are critical to climate change and land-use policy.

B42A-0113 1330h POSTER

Measured Midsummer Spatial Heterogeneity in Ecosystem-Atmosphere CO2/H2O Exchange for Selected Crop Systems of the Southern Great Plains

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Patterns of land use and management are likely to dominate the spatial heterogeneity in cycles of energy, carbon, and water in ecosystems of the Southern Great Plains. They may couple to regional climate and hence feedback to ecosystem performance. We report recent progress on measuring and modeling spatial heterogeneity in land surface-atmosphere exchange for different crops in the footprint of a flux system mounted on a 60 m high tower.

For three weeks in July 2001 we measured energy, CO2 and water vapor fluxes in four agricultural fields containing senescing sorghum, senescing soy, mowed pasture, and tilled wheat near the DOE Atmospheric Radiation Measurement Program central facility near Lamont, Oklahoma (36.605 N, 97.485 W). Following an initial inter-comparison of three eddy covariance flux systems in the sorghum field, two flux systems were moved so that the other fields were observed for at least four days each. During the observations we also measured soil microclimate, plant biomass, and leaf area index, and collected air, water, and soil samples for physical, chemical, and stable isotope analyses.

There were large differences in the diurnal cycles of carbon and water fluxes. Net pre-noon CO2 exchange in the sorghum (a C4 plant), soy (a C3 plant), pasture, and tilled wheat fields were roughly 20-35, 4-6, 0, and -1 (umol m-2 s-1) respectively. Water limitation was readily apparent in the sorghum and soy fields where afternoon net carbon exchange were reduced to about 10 and -2 (umol m-2 s-1) respectively. We will also present a comparison of the field scale measurements with the continuous flux measurement record from the instrument located on the ARM central facility 60 m tower.

B42A-0114 1330h POSTER

Contributions From a Deciduous Forest and Shrub Wetland to Regional Carbon Fluxes in Northern Wisconsin

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Long-term observations of CO2 exchange between terrestrial ecosystems and the atmosphere are currently being collected from locations throughout the Americas, Europe, Asia, and Africa using the eddy-covariance technique. Most of these studies, however, are limited to local-scale flux measurements within a single vegetation type. This study is unique because we have combined both stand-level and regional-scale eddy covariance measurements of CO2 exchange within a localized area. We selected two distinctly different ecosystems, an upland deciduous forest and alder-willow wetland, which comprise a substantial portion of the landscape in the northern Great Lakes region and the area surrounding a 400 m eddy covariance tower near Park Falls, WI. We found that the summer rate of uptake of CO2 for the region was substantially smaller than that of a mature deciduous upland forest. It appeared that this difference in net ecosystem exchange (NEE) was due to greater respiration, and gross photosynthesis was similar. Measurements at the wetland site will allow us to examine this portion of the regional flux signal independently. If the regional to upland forest comparison is correct, we expect to find large respiration rates from the wetland flux tower. Another possible cause is respiration from recently logged or thinned forest within the regional flux footprint.

URL: http://cheas.psu.edu

B42A-0115 1330h POSTER

Comparison of Potential Evapotranspiration Methods Based on Results from FLUXNET Sites in the United States

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Evapotranspiration is the largest single component of the terrestrial hydrological cycle and its accurate estimation is important in water resource management and understanding the links between land use change and climate (Wallace 1995). Evapotranspiration regulates the links between stomatal conductance, carbon exchange, and water use efficiency (Vorosmarty et al 1998). However, estimation of evapotranspiration is difficult, and a process-based understanding of evapotranspiration is needed to quantify likely changes in evapotranspiration due to climate and land surface change (Choudhury and DiGirolamo 1998; Hutjes et al 1998). One current approach for estimating evapotranspiration is to calculate potential evapotranspiration (PET) using methods driven by meteorological data and/or vegetation characteristics, and to scale this estimate down to actual evapotranspiration (AET) based on limitations in available water (i.e., soil moisture) (Stannard 1993, Federer et al. 1996, Vorosmarty et al. 1998). The primary objective of this study is to compare a suite of PET methods at the fetch scale in a variety of forest ecosystems. PET methods under investigation include Turc (1961), Hamon (1963), Jensen and Haise (1963), Priestley and Taylor (1972), McNaughton and Black (1973), and Shuttleworth and Wallace (1985). In order to parameterize and compare these PET methods, we use data from a variety of FLUXNET sites within the United States. This study allows comparison of PET methods at the fetch scale in a variety of ecosystem types. We critique the methods based on parameterization issues and a direct comparison of modeled versus measured AET estimates. The findings may facilitate the use of PET methods in larger scale modeling efforts.

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B42A-0116 1330h POSTER

Estimating Regional Nitrogen Oxide Fluxes From Northeastern Costa Rican Soils With An Ensemble Modeling Approach

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Our research objective was to estimate contemporary, historical and scenario-based future N2O and NO emissions over a 391,000 ha area of northeastern Costa Rica. This is a region of lowland terrain, wet tropical climate and relatively fertile soils. It has undergone rapid change in land use from forest to pasture and various kinds of crops, mostly since since 1950.

Field measurements made over full seasonal cycles for forests, pastures and croplands provided the basis for structuring and parameterizing an ecosystem model, CENTURY, that could simulate gas emissions over the range of land use types and soil conditions occurring in the modeling domain. Domain heterogeneity in space and time was represented by a series spatial data sets developed by us and a joint Dutch-Costa Rican agricultural research project, REPOSA. These GIS coverages included land cover/landuse (a categorical data set), mean monthly temperature and precipitation; soil fertility, organic matter and drainage (continuous, or semi-continuous variables). These last five variables were represented within map units as means with statistical distributions. All spatial data sets were formatted as co-registered 100 m raster cells.

The raster data layers were overlayed and cells having common combinations of all the spatial variables were organized as about 1,100 cohort classes. Joint frequency distributions of the environmental drivers were established for each class and the CENTURY model run 20 times with variable values derived from these distributions. Multiple model outputs produced means and standard distributions for each cohort. The mean values for each cohort were multiplied by the cohort areas, the means summed between cohorts and the variances pooled to produce estimates of flux for the entire area with standard errors. This process led to an estimate of 3,354 t N2O-N/yr with 95% confidence range of 2,907 to 3802 t N/yr for the entire area in 1996. Analogous estimate for NO was 1,899 t NO-N/yr with a 95% confidence range of 1,616 to 2,183 kg N/yr.

B42A-0117 1330h POSTER

The Coupling of the Common Land Model (CLM) to a Regional Climate Model

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In this study, a recently-developed land surface parameterization, the Common Land Model (CLM), is coupled with the Regional Climate Model (RegCM2). The CLM comprises a ten-layer soil model, a snow model of up to five layers, and a one-layer canopy model with a photosynthesis-conductance model. This land surface scheme replaces the existing land surface scheme in the RegCM, the Biosphere Atmsophere Transfer Scheme (BATS), which includes a three-layer soil model, one soil layer, and one vegetation layer. An offline, single-point study compares the CLM prognostic variables with those from BATS using the Cabauw dataset. Then, coupled RegCM/CLM simulations over East Asia during the summer of 1994 are compared with simulations using the BATS land surface scheme. Effects of the change in land surface parameterizations on the regional climate will be discussed.

B42A-0118 1330h POSTER

Land-Atmosphere Interactions at the Regional Scale: Measurements and Models

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The arctic region provides a unique opportunity for modeling land-atmosphere interactions because its surface is characterized by a mosaic of a small number of vegetation types. Recent micrometeorological campaigns have documented spatial patterns and biogeophysical controls of land-atmosphere fluxes at numerous individual sites. However, eddy flux measurements do not provide information about horizontal flows of energy and mass between ecosystems within a landscape or region. In this study, we used a version of the RAMS regional atmospheric model that was developed for seasonal to interannual simulations (ClimRAMS) as a tool for spatially and temporally integrating the effects of land-cover heterogeneity on the annual hydrologic cycle and climate of arctic Alaska. In addition to the growing-season effects of vegetation, we simulated effects on seasonal permafrost evolution, snow accumulation, snow melt, and the resulting changes in surface water and energy exchange. A nested configuration of two-way interactive model grids at 60-, 20-, and 5-km allowed detailed representation of atmospheric dynamics and terrestrial processes for model integrations spanning a full year. The climate-system model was sensitive to the representation of terrestrial processes and to changes in the distribution of land-cover types. While this work has focused on an arctic domain, the approaches developed are valuable for other regions characterized by heterogeneous vegetation distributions.

B42A-0119 1330h POSTER

Surface Evaporation Index Derived from Satellite Remote Sensing

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An algorithm for estimating surface evaporation index (EI), which is defined as a ratio of actual evapotranspiration rate (AET) to potential evapotranspiration rate (PET), was developed for a global periodic product by the Agua/MODIS sensor. It depends on a simple 2-source model of evaporation and transpiration over vegetated surfaces. EI of full vegetation is estimated from the canopy conductance model of Jarvis (1976), whereas EI of soil is estimated by the vegetation index brightness temperature slope concept (VI-Ts). The actual EI for each pixel is determined by weighting average of these two. We produced prototype products by using NOAA/AVHRR conterminous US 14-day composites and validated them with field observations over the continent carried out by the AmeriFlux towers.

B42A-0120 1330h POSTER

Satellite-based albedo, sea surface temperature and effective land roughness maps used in the HIRLAM model for weather and climate scenarios

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A study is conducted on the effect of introducing maps of geophysical parameters retrieved from satellite Earth Observation data into the atmospheric model HIRLAM (HIgh Resolution Limited Area Model). . The HIRLAM system was developed by the HIRLAM project group, a cooperative project of the national weather services in Denmark, Finland, Iceland, Ireland, the Netherlands, Norway and Sweden. It is currently used by weather services in several European countries. The exchanges of sensible heat, water vapour and momentum between the land- and ocean surface and the atmosphere are very important dynamical processes in this type of model.

The results from the HIRLAM model when using the improved surface boundary conditions is validated from wind and temperature data at synoptic weather stations and surface flux data from land- and ocean meteorological masts in Denmark. The results from a set of scenarios covering the hurricane in Denmark in December 1999 and several springtime cases in 2000 show improved weather forecasts.

The methodology on retrieving improved boundary conditions is based on satellite image data. Maps on the geophysical parameters albedo and sea surface temperature are retrieved at a 1 km spatial resolution from NOAA AVHRR. Furthermore, land cover maps based on Landsat TM satellite data are used to assess the regional roughness. The high-resolution land roughness map (Areal Systems Information in a 25 m pixel resolution) is area-averaged into effective roughness values (15 km grid) by using a non-linear aggregation technique (QJRMS 1999, vol 125, 2075-2102). The area-averaging is highly non-linear due to the turbulent physical processes involved. Thus the effective surface conditions cannot be obtained by simple averaging but only by a flow model taking horizontal advection into consideration. The effect of hedges in the landscape is included as a correction index based on a vector-based map.

The land surface fluxes of heat and water vapour is also estimated from a new concept using vegetation state and surface temperatures from either NOAA AVHRR satellite data or HIRLAM model results. Furthermore, a one-year climate simulation will be carried out with the seasonal land surface effects included in the input conditions. This work is basic to improvements in global climate change predictions.

Funding from Danish Research Agency to the SAT-MAP-CLIMATE project (5006-00-0063) is acknowledged.

B42A-0121 1330h POSTER

Deconvolution of Soil CO_2 Efflux from Root, Litter, and SOM Components in a Ponderosa Pine Mesocosm Experiment Exposed to Elevated CO_2 and O_3

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Stable isotopes have become an important tool for determining the relative importance of CO_2 sources and sinks contributing to the global carbon budget. Of particular importance is estimating the terrestrial CO_2 flux which is difficult to decipher without determining the relative importance of autotrophic and heterotrophic respiration from below-ground sources. Whereas increased SOM respiration could indicate reduced C storage ultimately creating a stronger terrestrial CO_2 source, increased autotrophic respiration could indicate greater NPP and therefore an overall stronger terrestrial sink. Here, we used the dual isotope, three equation mixing model approach of Lin et al. 1999 to determine the relative importance of root, litter, and SOM respiration in a closed chamber Ponderosa pine (*Pinus ponderosa*, Doug. Ex Laws.) mesocosm experiment exposed to elevated CO_2 and ozone. This approach uses the $\delta^{13}C$ and $\delta^{18}O$ signatures of surface CO_2 efflux and the component litter, root and SOM fluxes to provide a system of three equations to solve for the three unknown source fluxes. To enhance our ability to determine the relative contribution of the different sources: 1) Keeling plots were used to measure $\delta^{13}C$ and $\delta^{18}O$ signatures of surface CO_2 efflux, 2) mininert vials were used to measure signatures of root, soil, and litter respiration, and 3) the biomass-, volume- and respiration- weighted mean $\delta^{18}O$ signatures were calculated for roots versus soils across the evaporative gradient. Our results indicate that root and SOM respiration made up the bulk of CO_2 flux, root respiration was higher under elevated CO_2, and there was no effect of elevated ozone. Future experiments will determine the potential for using the dual isotope, three equation mixing model approach to determine the relative importance of root, litter, and SOM respiration under ambient CO_2 conditions.

B42A-0122 1330h POSTER

Measurement of Forest Leaf Area over an Extensive Transect with Airborne Laser Altimetry for Global Change Studies

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The climate warming resulting from increasing anthropogenic carbon dioxide and other greenhouse gasses is expected to be most prominent in the subarctic-boreal region of the Northern Hemisphere. With an objective of setting up a baseline to monitor possible vegetation change in terms of change in leaf area index in this region, a continuous vegetation profile extending 600 km from Edmonton, Alberta to Cluff Lake, Saskatchewan, Canada was measured using an airborne infrared laser altimeter mounted on a helicopter. The ground truth survey at some 30 plots located directly under the airborne laser profiling track revealed that leaf area index correlated well with standing stock, which further in turn correlated well with the area of vegetation profile. Thus, using regression of leaf area index and standing stock respectively upon stand stock and vegetation profile, a continuous distribution of leaf area index over the same 600 km laser profiling track was estimated. The distribution of leaf area index not only corresponded well with biome type, but also showed characteristic change in accordance with environmental gradient within a given biome, thus confirming that airborne laser altimetry is a powerful tool for measuring and monitoring such important vegetation characteristics as standing volume, leaf area index, etc. over an extensive area.

B42A-0123 1330h POSTER

Estimation of Carbon Stock in Boreal Forest of Northern Alberta Using Airborne Laser Altimetry

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With the carbon sequestrated by forests having been officially acknowledged at COP6 in Bonn, expedient yet accurate estimation of forest carbon stock over an extensive range becomes ever more important. Here, we present such a method using airborne laser altimetry based on our experience involving a 600-km airborne laser profiling transect in northern Canada. The continuous forest canopy profile obtained by airborne laser altimetry extending from Edmonton, Alberta to Cluff Lake, Saskatchewan, Canada was calibrated for aboveground forest biomass and carbon stock using ground truth data from 55 sample plots located directly under the laser profiling flight path. In the ground survey, stand biomass was obtained from stem diameter (DBH) censused in each plot using regressions of stem, branch and leaf biomasses on DBH, all directly measured on some 110 sample trees. Then, using another regression of the stand biomass on the canopy profile, continuous distributions of forest biomass and carbon stock along the entire length of the laser profiling transect were obtained, in which the latter was found to be in a range of 2 to 180 ton/ha.

B42A-0124 1330h POSTER

A Survey of California Plant Species With a Portable VOC Analyzer for Biogenic Emission Inventory Development

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An accurate estimate of the magnitude of biogenic volatile organic compound (BVOC) emissions relative to anthropogenic VOC emissions in California's airsheds is critical for formulating effective strategies to reduce concentrations of fine particles, ozone, and other secondary air pollutants which affect human health and reduce yields of agricultural crops. However, California's natural landscapes contain more than 5800 listed species, and urban landscapes contain hundreds more. A taxonomic method has been proposed to assign BVOC emission rate measurements to unmeasured species, but data were needed for additional plant families and genera to further develop the taxonomic approach. Replicate samples of live foliage of more than 250 plant species were placed in plastic bags, in both light and darkened conditions, and the BVOC emissions measured with a calibrated portable analyzer unit (PAU), and categorized as low, medium or high. To validate the PAU approach we compared our PAU-measured BVOC emissions for approximately 60 plant species with published values based on gas chromatography (GC) and GC-mass spectrometry and found them to be well correlated. For approximately 200 plant species not previously measured, the PAU data indicated that plant taxonomy served as a useful method for characterizing the magnitude and nature of emissions (either light or dark, or both). The method employed was more suited for detecting isoprene emissions, due to their relatively higher magnitudes, than emissions of monoterpenes or oxygenated compounds. The results provide further evidence that plant taxonomy can serve as a useful guide for generalizing the emissions behavior of many, but not all, plant families and genera.

B42A-0125 1330h POSTER

A Systematic Analysis of the Influence of Vegetation on Local and Global Climate Using a Coupled Atmosphere-Biosphere Model, CCM3-IBIS.

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A coupled atmosphere-biosphere model, CCM3-IBIS, is used to systematically determine the influence of vegetation on the local and global climate through the removal of specific vegetation types and examination of how the climate system responds to changes in the surface properties through climate feedbacks.

CCM3-IBIS consists of a biosphere model, IBIS (Foley et al., 1996; Kucharik et al., 2000), and the NCAR CCM3 Community Climate Model. IBIS is a vegetation model that represents the physical, physiological, and ecological processes at work in vegetation and the soils. A suite of eight simulations (and a control run of current vegetation cover) were run for 11 years each at a resolution of T31 (3.75 x 3.75 degrees). Each of the eight simulations had a specific vegetation type completely removed. The specific vegetation types removed include tropical forest, temperate forest, boreal forest, savanna, grassland/steppe, shrubland/tundra, and desert. Each of the simulations were performed with fixed vegetation, a fixed atmospheric CO2 concentration, and fixed sea-surface temperatures.

By removing the vegetation of a particular type we assess its role on influencing the local and global climate through comparison with the control run. While completely removing the vegetation of a particular type is unrealistic, it does represent a theoretical maximum signal of the vegetations influence on the climate.

Our results show that the surface properties responsible for forcing the climate system are different for different vegetation types and geographic regions. For example, vegetation in the tropics is influenced primarily by the latent heat flux while the boreal forest regions influence the climate through the sensible heat flux and the surface albedo. From these results it can be shown that specific vegetation types play different roles through different processes in influencing both the local and global climate. Altering the vegetation through land use change may contribute to significant long term climate change through land surface and climate feedbacks.

B42A-0126 1330h POSTER

Dynamics of non-Controlled Emission of Biogas From Landfills

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Landfills are important sources of CH_4 and CO_2 as well as other toxic gas components to the atmosphere. A significant amount of gases could be released to the surrounding environment as a "non-controlled" emission in a diffuse form. To understand the dynamics of non-controlled emission of biogas from landfills several soil gas and CO_2 efflux surveys were performed at Arico's landfill (Tenerife, Canary Islands).

Estimated diffuse CO_2 emission for Arico's landfill (0.33 Km^2) were 507 td^{-1} (1998) and 131 td^{-1} (2000), showing different spatial CO_2 efflux patterns that can be explained in terms of new waste disposal and covering materials as well as the action of the biogas extraction system. Secular variations of diffuse CO_2 efflux and meteorological and soil variables were measured hourly at one site in the center of the landfill for 11 months. Diffuse CO_2 efflux ranged from 9.9 to 433.3 $gm^{-2}d^{-1}$ with a median value of 242.7 ± 73.3 $gm^{-2}d^{-1}$. Diffuse CO_2 efflux showed a temporal behavior that could be divided in two different periods: (a) a quasi-stationary period with minor fluctuations due to the influence of meteorological and soil variables, and (b) a non-stationary period with changing CO_2 efflux level and major variations related to the preliminary tests on the biogas extraction system for Arico's landfill. Air and ground temperatures exhibit significant positive correlation with the observed CO_2 efflux. Peaks of maximum inverse correlation between barometric pressure and CO_2 efflux are found at semi-diurnal and diurnal frequencies. Wind speed and wind direction are cross-correlated with CO2 efflux by 12 hours. These results suggest that (i) minor fluctuations in the CO_2 efflux could be driven by meteorological variations (solar radiation cycles and local wind patterns), and (ii) sudden and major fluctuations in the CO_2 efflux cannot be explained sufficiently in terms of the observed meteorological and soil variables' fluctuations.

B42A-0127 1330h POSTER

Isotope-Dendrochronological Investigation of Tropical Trees from Brazil: A preliminary analysis

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In order to improve our understanding of paleoclimatic change, it is important to have methods that allow for investigation in all regions, permitting better correlations of significant events among different locations. Trees having a global distribution ranging from the tropics to the subarctic are potentially an ideal medium to develop isotopic records equivalent to those from ice cores. Here we present the preliminary results of an oxygen isotopic investigation of *Araucaria angustifolia* trees in the State Park of Campos de Jordao, in the State of Sao Paulo, Brazil. With this work we hope to establish the first high-resolution terrestrial isotopic proxy record of climate change from the tropics of Brazil, and to pave the way for future work. The species chosen for this investigation, Auraucaria angustifolia, is one of the few trees in the tropics which has annual rings. Our approach fully exploits this fact, and isotopic analysis of the rings were conducted at a yearly resolution over the last hundred years. Recent work in Europe has demonstrated that trees in temperate settings can record the isotopic composition of precipitation in their ring cellulose, transferred from rain fall to soil water, which the plants access. Our exploratory project will employ this new approach, using trees as isotope-hydrology archives, and apply it for the first time to a tropical species. Additionally, more traditional calibration work will be conducted over the last 30 years when climate parameters (relative humidity, temperature, precipitation, etc.) are available from a weather station within the park. Monthly precipitation samples are currently being collected for isotopic analysis from within the park, for later calibration with our records. Last August we also recovered two soil profiles from the same open and closed forest site where tree rings were recovered the year before. From these samples, an isotopic soil water profile will be constructed to investigate how the isotopic composition of precipitation is transferred to the soils in our study area. In turn, the calibrated oxygen and carbon isotopic time series can be used as a proxy of important climate parameters such as temperature, humidity, and potentially atmospheric circulation.

B42A-0128 1330h POSTER

Biogeochemical cycles in a tropical lowland rainforest (La Reunion Island) developed on a basaltic flow : first results

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La Reunion (Indian Ocean) is one of the last volcanic island that supports a lowland rainforest relatively unaffected by man. Contrary to other well known spots such as Hawaii, the biodiversity is still high. A project financed by the French Government (IRD and PNSE) is undertaken to determine the biogeochemical cycles of C and major elements in the Marelongue Natural Reserve. The studied site is located along the Piton de la Fournaise Volcano, on basaltic flows dated approximately around 500 y. The aim of the project is to better constrain the biogeochemical models of rainforest ecosystems. Here we present preliminary results on the relations between biodiversity and ecosystem productivity and mineral cycling. We measure, in a 1 ha permanent plot, the element content stored in the above ground biomass and the return of these elements to the soil. A total of 1079 trees (DBH ⋆ 10 cm) were identified and measured in the permanent plot. The biomass was estimated by an indirect method based on allometric relations from trees harvested in previous studies elsewhere. The calculated above ground biomass ranged from to 267 to 300 tha and only three species (Labourdonnaisia calophylloides, Nuxia verticillata and Agauria.salicifolia) represent more than 60% of that biomass. The litter production was measured by collecting every 15 days the fine litterfall on a 0.5 ha plot, from August 2000 to July 2001 and the estimated annual mean was 6.6 t/ha of which 74% were leaves. Again, two of the species (Labourdonnaisia calophylloidesa and Nuxia verticillata) contribute to nearly 60% of the total fine litterfall. Over the year, seasonal variations were observed and showed two peaks, one in January and one during the months of March and April. The first one can be attributed to the occurrence of a cyclone at 200km from the coast. The annual litterfall pattern is dominated

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by the litterfall of the two dominant canopy trees. The leaf mineral content was determined for 15 of the dominant species. The highest contents were found for Ca, Mg, K, Na and Si. Calculated annual fluxes of these elements were respectively 81 kghay; 24 kghay; 16 kghay; 11 kghay and 6 kghay kgha, and are highly dependent on the productivity of the two dominant tree species.

B42A-0129 1330h POSTER

Development and Application of a Carbon Sequestration Model in Forest Ecosystem in Taiwan

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IPCC tables were used to estimate the carbon emission or removal of land-use change and forestry sector of Taiwan in 1990-2000, and transfer to net carbon dioxide. Its about 2,000Gg, and C sequestration increases over the years. There are 3 problems to deal with when calculate the sink and source of CO2 in the sector of forestry and land-use. The first is the lack of updated annual data of changed area of forest types and communities gotten from forest inventory in the period of 10-20 years. Second, there is a requirement of compromised land classification system of all kinds of forest types, and a complete growth and yield model system for annual increment volume counting. Finally, the study of soil carbon circulation is still unclear.

The Holdridge Life Zone Classification Model and Forest Gap Model are used to approach the vulnerability and adaptation assessment of the impacts of climate change on forest vegetation. To adapt the models, we gathered meteorological data from 26 Climate observation stations and 816 precipitation stations; in addition, land-use maps made from interpolating 32,720 aerial photos and 4,002 plots ground surveys 40mX40m DEM are also used in our spatial analysis. Trend and Kriging spatial analysis modules of GIS are used to interpolate the grid-surface information from point data of precipitation and average temperature. The two primary parameters of Holdridge life zone classification model are bio-temperature and annual average precipitation. Using this model, we then classify Taiwan Life Zone into rain forest, moist forest and wet forest ecoregions and 10 sub-ecoregions. The forest types, species compositions of the 10 sub-ecoregions are obtained from overlapping the ecoregions map and land-use map by using Arcview GIS. The environmental changes of Taiwan were simulated by using Holdridge life zone classification model as doubly increasing CO2 density and incrementing temperature from $1^{\circ}C$, 2°C and $4^{\circ}Cscenarios.$

Forest Gap model were applied to estimate the growth of China-fir and Japan-fir plantation in Taiwan annually. We integrated and analyzed the data of climate, forest growth and land use for developing the diminish strategy of greenhouse gas emission and increasing sink carrying capacity in forest and land-use sector in the future.

URL: http://fm4sem.nchu.tw

B42A-0130 1330h POSTER

Momentum Transfer by a Mountain Meadow Canopy: a Simulation Analysis

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Using a mountain meadow as a case study it is the objective of the present paper to test Massmans (1997) model of momentum transfer by vegetation and several parameterisation options for the required within-canopy variation of the phytoelement drag (Cd) and sheltering (Pm) coefficient. A constant ratio between Cd and Pm is found to overestimate and underestimate non-dimensional wind speed in the upper and lower canopy, respectively. A simple parameterisation of Cd/Pm as a function of plant area density is developed, using values optimised by least squares regression between measured and predicted within-canopy wind speeds. In a further step, a separate parameterisation of Cd and Pm is developed: Cd is simulated to decrease exponentially with increasing cumulative plant area index; Pm is modelled as a saturation-type function of plant area density. A validation with independently measured data indicates, that both parameterisations work reliably for simulating wind speed in the investigated meadow. Model predictions of the normalised zero-plane displacement height and the momentum roughness length fall only partly within the range of values given in literature, which may though be explained by the accumulation of plant matter close to the soil surface specific for the investigated canopies. The seasonal course of the normalised zero plane displacement height and the momentum roughness length are discussed in terms of seasonal variation of the amount and density of plant matter.

Massman W.J. (1997) An analytical one-dimensional model of momentum transfer by vegetation of arbitrary structure. Boundary-Layer Meteorology 83, 407-421.

B42A-0131 1330h POSTER

Multidecadal Variability of the Climate, the Biosphere and the Carbon Cycle in a Coupled Atmosphere-Biosphere Model, CCM3-IBIS.

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We analyze a 400-year run of the coupled atmosphere, vegetation and soil model CCM3-IBIS to detect different modes of variability in the climate, vegetation and carbon cycle. IBIS (Foley et al., 1996; Kucharik et al., 2000) is a dynamic vegetation model that describes the physical, physiological and ecological processes occurring in vegetation and soils in a coherent and mechanistic way. The model includes land-surface physics, canopy physiology, plant phenology, vegetation dynamics and competition, and carbon cycling. We coupled IBIS to the NCAR CCM3 at a T31 resolution (3.75 x 3.75). We ran a 400-year equilibrium simulation of the 'present day' climate imposing a constant atmospheric CO2 concentration of 350 ppm and fixed sea-surface temperatures. Modeled values of NPP, biomass and leaf area index, total soil carbon, standing litter, and total soil CO2 flux compare favorably with field measurements and with results from other vegetation models driven with observed climatology.

A spectral analysis shows that the total continental precipitation, the net primary productivity and the heterotrophic respiration present slow modes of variation with timescales of roughly 3, 8 and 25 years. Because CCM3-IBIS operates with fixed sea-surface temperatures, this detected variability can only be attributed to changes in vegetation structure and functioning. Semi-desertic regions contribute the most to the 25-year mode.

This study shows that feedbacks between vegetation dynamics and the atmosphere alone can produce internal variability at decadal scale.

B42A-0132 1330h POSTER

Decreased Carbon Storage in the Ocean as a Biogeochemical Consequence of Sequestration on Land

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We describe a previously uncharacterized mechanism mediated by the transport of dust through the atmosphere, in which land use is linked with biological productivity in the open ocean. As a simple corollary to the influential "iron hypothesis", any *reduction* in the present-day levels of dust supply to the ocean can be expected to produce an additional limitation of marine productivity. Recognizing that historical changes in land use have given rise to globally important sources of dust, it logically follows that should such changes be partly reversed or ameliorated, the availability of mineral dust for deflation by wind action will be reduced, and with it, marine productivity. Just such a reduction in dust supply might arise with any future enactment of carbon sequestration activities involving reduced disturbance and increased stabilization of soils, as allowed under the Kyoto Protocol.

We employ a numerical model of the ocean-atmosphere carbon cycle incorporating explicit iron biogeochemistry to demonstrate that the effectiveness of carbon removal from the atmosphere via certain sequestration measures on land will be diminished by a reduction in the quantity of carbon taken up by the ocean.

B42B MC: Hall D Thursday 1330h

Assessing Bioremediation II *(joint with H)*

Presiding: **J P McKinley,** Pacific Northwest National Laboratory**; F S Colwell,** Idaho National Engineering and Environmental Laboratory

B42B-0133 1330h POSTER

Chemical Evidence for Uranium Bioreduction at Shiprock, New Mexico

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The Department of Energy Uranium Mill Tailings (UMTRA) site at Shiprock, New Mexico includes a mill tailings disposal cell on a mesa overlooking the floodplain of the San Juan River. A plume of contaminated groundwater extends across the floodplain to the river. Although organisms that can reduce uranyl have been identified at the site, the extent of intrinsic reduction is difficult to assess. Uranyl concentrations vary due to mixing between three components: the contaminant plume, river water, and water from a flowing well of deep origin. Chloride and ^{3}H were used to construct a three-component mixing model for floodplain groundwaters. The fraction of each component at each sampling point was used to estimate the uranyl concentration expected from dilution of the plume source by the other components. A much lower concentration than expected was taken to indicate bioreduction. Experimentation indicated that uranyl would only be bioreduced where nitrate was first completely removed; the model results showed evidence for uranyl reduction only where nitrate had been markedly and significantly removed, also by bioreduction. Low nitrate concentrations in these zones may have resulted from post-reduction mixing with nitrate-bearing water.

B42B-0134 1330h POSTER

Partial Transformation Products as Indicators of Microbial Hydrocarbon Degradation in Soils

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Monitored natural decay (intrinsic bioremediation), a cost-effective method for remediating contaminated property, is widely applied to fuel contaminated sites. If an intrinsic bioremediation approach could be supported for the clean up of polynuclear aromatic hydrocarbon (PAH) contaminated properties, millions of dollars in clean-up costs could potential be saved, especially in transfers of industrial properties that will continue to be used for industrial purposes. Proving intrinsic biodegradation of polynuclear aromatic hydrocarbons (PAHs) is problematic. Slow PAH biodegradation rates in contaminated soils mean that oxygen mass transfer rates into the soil exceeds bacterial oxygen demand. Likewise carbon dioxide production during degradation is sufficiently slow that carbon dioxide will not accumulate in the soil gas to levels exceeding background, uncontaminated soils. Therefore, oxygen depletion and carbon dioxide accumulation, typical indicators of intrinsic remediation activity at fuel contaminated sites, are of little use in demonstrating intrinsic PAH remediation. Additionally, direct measurement of PAH loss over time is of limited use in the absence of extensive historical records, especially at sites that are still emitting PAHs as part of their operations. PAH loss rates may be in the order of 10% per year, whereas combined sampling and analytical error can be greater than 50%. It is our hypothesis that PAH degradation products, such as aromatic carboxylic acids and