Abstract Book

Seventh LBA-ECO
Science Team
Business Meeting
Fortaleza, Ceará, Brazil
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Presenter: Ted Feldpausch

Carbon and Nutrients in Terrestrial Ecosystems

1.1: Carbon and nutrient accumulation in secondary forests regenerating from degraded pastures in central Amazonia, Brazil

Ted R. Feldpausch (1), Marco A. Rondon (2), Erick C.M. Fernandes (1), Susan J. Riha (1), Elisa V. Wandelli (3)

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(2) Centro Internacional de Agricultura Tropical, Cali, Colombia
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Large expanses of forest in the Amazon Basin have been converted to pasture, many of which later degraded to woody fallows and were abandoned. We examined post-pasture forest recovery in ten secondary forests (SFs) abandoned up to 14 years in central Amazônia. We measured aboveground biomass and soil nutrients to 45 cm depth and computed total site carbon (C) and nutrient stocks. Aboveground biomass accrual (11.0 Mg/ha/yr) in the young SFs produced up to 128.1 Mg ha-1 of dry aboveground biomass, equivalent to 25 to 50% of primary forest biomass in the region. Extractable soil P stocks declined as forest age increased. Soil stocks of exchangeable Ca (207.0±23.7 kg/ha) and extractable P (8.3±1.5 kg/ha) were low in the first 45 cm as both were rapidly translocated from soil to plant pools. Soil N stocks increased with forest age (117.8 kg/ha/yr). Total soil C storage to 45 cm depth ranged between 42 and 84 Mg/ha, with the first 15 cm storing 40 to 45% of the total. Total C accrual was similar or higher than values reported in other studies. Tropical SF regrowing on lightly to moderately-used pasture rapidly sequester C and rebuild total nutrient capital following pasture abandonment. Translocation of some nutrients from deep soil (>45 cm depth) may be important to sustaining productivity and continuing biomass accumulation in these forests. The soil pool represents the greatest potential for long-term C gains; however, soil nutrient deficits may limit future productivity.

Presenting Author: Ted Feldpausch (Oral)

Science Theme: ND (Nutrient Dynamics)

Session: Carbon and Nutrients in Terrestrial Ecosystems

1.2: The GEF-SOC Project Assessment of Soil Organic Carbon Stocks and Change at National Scale: Project Overview and Preliminary Modeling Results within the Brazilian Amazon

E. Milne (1), C.E.P. Cerri (2), M. Bernoux (3), K. Paustian (4), K. Coleman (5), C.C. Cerri (6)

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(2) Post-doctoral of the GEF-SOC project at Centro de Energia Nuclear na Agricultura (CENA), Universidade de São Paulo, CP.96. Piracicaba, Brazil.

(3) Institut de Recherche pour le Dévelopement, UR041-SeqC at CENA.

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Soil organic carbon is highly sensitive to changes in land use and land management. Methods of predicting changes in soil C stocks under varying land-use and climate scenarios need to be developed to allow national and global estimates of C flux to be made. Tropical regions hold ~26% of the world soil C pool making the potential for C sequestration/release from land-use change in this area immense. A Global Environment Facility co-financed project is currently working towards the development of generic tools to quantify the impact of land use on C sequestration in soils. Case study areas being considered include Amazon-Brazil, which covers an area of 5 million km2, and has the highest rate of deforestation in the world. Land use changes in the region have major implications for carbon cycling regionally and globally. Over the past two decades deforestation occurred at a rate of 15,000 - 29,000 km2 year-1 and the total deforested area now exceeds 500,000 km2. Cattle pasture now dominates the deforested area. Previous studies examining soil C changes brought about by converting Brazilian Amazon forest to pasture have found that pasture soils can be a net sink or source of C, depending on management. The objective of this study was to examine the dynamics of soil C when forest is converted to pasture, using the Century and RothC models and data collected from site-specific chronosequences within the region. Preliminary results suggest modeling techniques can be successfully used for monitoring soil C stocks and changes.

Presenting Author: Eleanor Milne and Carlos Eduardo Cerri (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Carbon and Nutrients in Terrestrial Ecosystems

1.3: CO_2 flux from soil in pastures and forests in southwestern Amazonia

C.I. Salimon , E.A. Davidson, R.L. Victoria, A.W.F. Melo
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Stocks of carbon in Amazonian forest biomass and soils have received considerable research attention because of their potential as sources and sinks of atmospheric CO_2. Fluxes of CO_2 from soil to the atmosphere, on the other hand, have not been addressed comprehensively in regard to temporal and spatial variation and to land cover change, and have been measured directly only in a few locations in Amazonia. Considerable variation exists across the Amazon Basin in soil properties, climate, and management practices in forests and cattle pastures that might affect soil CO_2 fluxes. Here we report new data from an area of rapid deforestation in the southwestern Amazonian state of Acre. Specifically we addressed (1) the seasonal variation of soil CO_2 fluxes, precipitation, and temperature; (2) the effects of land cover (pastures, mature and secondary forests) on these fluxes; (3) annual estimates of soil respiration; and (4) the relative contributions of grass-derived and forest-derived C as indicated by $\delta^{13}CO_2$. Fluxes were greatest during the wet season and declined during the dry season in all land covers. Soil respiration was significantly correlated with soil water-filled pore space but not correlated with temperature. Annual fluxes were higher in pastures compared to mature and secondary forests, and some of the pastures also had higher soil C stocks.. The $\delta^{13}C$ of CO_2 respired in pasture soils showed that high respiration rates in pastures were derived almost entirely from grass root respiration and decomposition of grass residues. These results indicate that the pastures are very productive and that the larger flux of C cycling through pasture soils compared to forest soils is probably due to greater allocation of C belowground. Secondary forests had respiration rates similar to mature forests, and there was no correlation between soil respiration and either forest age or forest biomass. Hence, belowground allocation of C does not appear to be directly related to the stature of vegetation in this region. Variation in seasonal and annual rates of soil respiration of these forests and pastures is more indicative of flux of C through the soil rather than major net changes in ecosystem C stocks.

Presenting Author: Cleber Salimon (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Carbon and Nutrients in Terrestrial Ecosystems

1.4: Soil-Atmosphere Flux of Carbon Dioxide at km67, FLONA, Tapajos, Brazil

Patrick M. Crill (1), Ruth Varner (1), Michael Keller (1,2), Hudson Silva (1), Jadson Dias (3), Eraclito Sousa Neto (3), Raimundo Cosme de Oliveira Junior (4)

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We have made semi-continuous measurements of the soil-atmosphere flux of carbon dioxide (CO2) at the undisturbed forest site at km 67 in the Tapajos National Forest, Para, Brazil since April 2001 with automated chambers. This is a mature forest site on clay textured oxisols. A set of 18 aluminum chambers were installed in a 0.5 ha area close to the flux tower. Green surface was excluded. Eight chambers are sampled 5 times per day (closed 7% of the day). The other 10 chambers are sampled once per day (closed 1.5% of the day). After 817 days more than 2.0 kg C m-2 were released. The maximum daily average flux was 4.3 and the minimum was 1.3 μmol CO2 m-2 s-1. There are at least two scales of variation in the fluxes. The first is on an annual scale with minimum flux rates (daily average fluxes less than 2 μmol CO2 m-2 s-1) at the end of the dry season. Flux rates increase immediately at the onset of the wet season to daily average flux rates generally greater than 3.2 μmol CO2 m-2 s-1. The second is on a daily scale. The daily variability in the flux magnitudes differs between the dry and wet seasons. In the wet season, maxima occur in early to late afternoon in concert with air temperatures. In the dry season, daily flux minima occurred during the warmest times of day implying a surface moisture control and/or a shift to a source deeper in the soil profile.

Presenting Author: Patrick Crill (Oral)

Science Theme: TG (Trace Gases)

Session: Carbon and Nutrients in Terrestrial Ecosystems

1.5: Radon-222 determination of respiration rates in a Tropical Rain Forest Canopy, Brazilian Amazonia

Christopher S. Martens, Thomas J. Shay, Howard P.Mendlovitz, Michael Goulden, Scott Miller, Patrick M. Crill, José M.S. Moura ,Mary C. Menton1, W. Stephen Woodward, Osvaldo L.L. de Moraes, Risonaldo L. Lima

Radon-222 is used as a physical tracer of forest canopy-atmosphere CO2 transport and canopy versus soil respiration at a selectively-logged forest site near km 83 of the Tapajós National Forest, Pará, Brazil. The site had been subjected to low impact, selectively logging during September through December, 2001, as part of a study of the impacts of logging on carbon exchange processes and rates. The radon measurements at the km83 tower were made in collaboration with studies of heat, momentum, CO2, H2O and other gas transport by other LBA investigators. Radon and CO2 canopy air and soil flux measurements from July, 2002 at the end of the wet season yield rate constants for gas exchange between the canopy and the atmosphere that are used to calculate canopy air residence times that range from minutes during the daytime to over ten hours during calm nighttime conditions. The behavior of radon can be used to infer the flux of CO2 or any canopy gas arising from physical transport mechanisms. When physical transport processes are accounted for, the remaining CO2 production should approximate total nighttime soil and canopy respiration rates. If little exchange with the atmosphere is occurring during calm nighttime conditions total respiration values should approximate net ecosystem exchange (NEE) values.

Presenting Author: Christopher Martens (Oral)

Science Theme: TG (Trace Gases)

Session: Carbon and Nutrients in Terrestrial Ecosystems

1.6: Diurnal Changes in Nitric Oxide Emissions from Conventional Tillage and Pasture sites in the Amazon Basin: Influence of Soil Temperature.

Caio C. Passianoto(1),Toby Ahrens(2,3), Brigitte J. Feigl(1),Paul A. Steudler(2), Jerry M. Melillo(2),Janaina B. do Carmo(1)
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Brazil has an estimated 100 million ha of cultivated pasture, with vast tracts of planted grasses in various parts of the Amazon Basin including the State of Rondônia. These pastures have been in use for several decades and productivity has declined in many of them. Management options exist to restore the productivity of these pastures that include tillage and fertilizer application may also affect the flux rates of CO2 and N-containing gases such as nitric oxide (NO).
We are studying a subset of restoration practices applied to a degraded pasture at Fazenda Nova Vida, a 22.000 ha cattle ranch in Rondônia, Brazil. Nitric oxide emissions from soils were measured in conventional tillage and existing pasture sites to access N losses.
Mean daily NO emissions from tilled plots were twice those from the pasture. Nitric oxide emissions from the tilled plots showed a strong diurnal pattern, while those from the pasture did not. Mean daytime NO emissions from the tilled plots were more than three-times lower than at night. However in the pasture, NO emissions were nearly the same during the day or night. Surface soil temperature was a good inverse predictor (r2=0.75) of NO emissions from the tilled plots. We found that the very high temperatures measured during the daytime in the soil surface of the tillage plots, those in the range of 40 to 45C, reduced the rate of NO emission. The reduction in NO emissions may be because of the sensitivity of autotrophic nitrifiers to high temperatures. This study provides the first insights on how land use change may alter regional NO fluxes by exposing certain microbial communities to extreme environmental conditions.

Presenting Author: Paul Steudler (Oral)

Science Theme: TG (Trace Gases)

Session: Carbon and Nutrients in Terrestrial Ecosystems

Forest Degradation and Logging: Detection and Effects

2.1: Micrometeorology, CO2 and H2O Exchange of a Tropical Rainforest Before and After Selective Logging

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We are using long-term eddy covariance to study the effects of selective logging on the energy and trace gas exchange at km 83 in the Tapajos National Forest, Para, as a component of LBA. In addition to the core flux measurements of carbon dioxide, water vapor, momentum and heat, sensors were installed to measure vertical profiles of CO2, H2O, wind velocity, and temperature within and above the forest. Continuous tower and biometric measurements began a year before logging (June 2000) when the forest was still considered primary, and these data served as the basis for three companion papers on forest physiology (Goulden et al. 2003), the exchange of water and energy (Rocha et al. 2003), and the annual carbon balance (Miller et al. 2003). A similar tower in an unlogged area of the same forest (km 67) provides a control for the logged site measurements. Data from both towers prior to the logging were compared to establish site comparability. Selective logging in fall 2001 was conducted by a local firm using reduced impact procedures, and included ~400-ha of forest that extended ~2-km upwind of the tower. The loggers removed ~6% of the biomass in large trees, left another ~18% of the biomass in large trees as slash, and eliminated ~13% of the canopy on an area basis. Tower and biometric measurements at both sites continued throughout the 3 month logging period and up to the present. After the logging, a second 65 m tall tower was installed in a large gap created by the logging, and similarly instrumented, in order to address the role of gaps in affecting forest atmosphere exchange. Preliminary analysis of the tower observations indicate that canopy photosynthesis declined following logging, and that ecosystem respiration increased in the subsequent wet season.

Presenting Author: Scott Miller (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Forest Degradation and Logging: Detection and Effects

2.2: Effect of Selective Logging on the Soil-Atmosphere Exchange of Trace Gases at the Tapajos National Forest

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We studied the effects of selective logging activity in the Tapajos National Forest near Santarem, Para, Brazil on the soil-atmosphere fluxes of nitrous oxide (N2O), nitric oxide (NO), carbon dioxide (CO2), and methane (CH4). Chamber measurements were made over 2 years in undisturbed forests and in forests following logging on two soils, a clay textured Oxisol and a sandy loam textured Ultisol. Selective logging causes a range of ground and canopy damage in the forest, therefore, we stratified sampling according to decreasing damage intensity from log decks, skid trails, felling gaps, and relatively undisturbed forest. We quantified the area disturbed based on a ground map of a 100 ha harvest block of tropical moist forest on Oxisol logged in December 1999. Sampling for each began about 2 months following logging through the wet season and into the following dry season for about 1 year. For N2O and CH4, static, vented chambers were used to sample emissions using syringes to transport samples to the laboratory for analysis by gas chromatography within 36 hours of sampling. NO and CO2 fluxes were measured with field portable instruments using infra-red and chemiluminescent detection. Average annual fluxes over two years from the clay Oxisol were 8.2 ng-N2O-N cm-2 h-1, 9.0 ng-NO-N cm-2 h-1, 3.8 micro-mol CO2 m-2 s-1, and 0.0 mg-CH4 m-2 d-1. On the Oxisol, logging had no significant effect on soil-atmosphere fluxes of N2O, NO, and CO2. CH4 fluxes from log decks were greatly elevated over background. Results from the Ultisol were similar although NO emissions were also significantly elevated for decks. Given the relatively small area of the highly disturbed log decks, it seems unlikely that logging could result in significant perturbations to regional N2O, NO, and CH4 budgets.

Presenting Author: Michael Keller (Oral)

Science Theme: TG (Trace Gases)

Session: Forest Degradation and Logging: Detection and Effects

2.3: Characterization of Forest Fragments in Rondônia through Remote Sensing and Forest Transects

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Forest fragments have been recognized as one of the major landscape components of deforested areas in the Brazilian Amazônia. Forest fragmentation partially modifies the original forest structure, composition and biomass, in particular along forest edges. In contrast, deforestation replaces the original forest with introduced pasture and agricultural lands. In this study, we investigated the synergistic effects of forest fragmentation, selective logging and fire on forest degradation in Ji-Paraná and Ouro Preto do Oeste in Rondônia state. Thirteen forest transects and a time-series data set of Landsat data encompassing 25 years (from 1978 to 2002) were combined to answer the following questions: i) Are there significant difference on structure, composition and biomass between forest fragments and intact forests?; ii) Is there a spatiotemporal signature of forest fragments?; and iii) Is it possible to establish an empirical relationship between field measurements and Landsat data to characterize the biophysical changes on forest fragments? Our approach involves the application of a robust radiometric calibration methodology developed in the early stages of our LBA project, followed by temporal intercalibration of the Landsat TM/ETM+ data set and spectral mixture analysis (SMA). Next a forest inventory protocol, which was already tested in three other of our research sites (Paragominas-PA, Santarém-PA and Sinop-MT), was applied to survey ten forest fragments and three intact forests. To answer our questions we will integrate the forest biophysical measurements with remotely sensed reflectance and fraction data using simple regression methods. Our preliminary findings show that at the field scale forest fragments differ from intact forests in terms of species composition (i.e., by absence of high value timber species and an increase in palm tree species), and forest structure (i.e., decreased tree diameter and increased canopy openness). Forest degradation due to forest fragmentation was not confined to forest edges because most of the forest fragments had been selectively logged and burned. However, the spatial patterns that are commonly associated with selective logging, created by roads and logging patios were not present at field and Landsat TM/ETM+ scales. We are now investigating the fractional changes observed in the SMA time-series data set to evaluate if there is a spatiotemporal unique signature for forest degradation associated with forest fragmentation in the region. Fragment size, shape and time since isolation represent important contextual information that may also be required to develop in an automated classification algorithm to map forest degradation in the region.

Presenting Author: Carlos M. de Souza Jr. (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Forest Degradation and Logging: Detection and Effects

2.4: Remote Sensing of Selective Logging: Early Results of a Basin-wide Analysis

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Selective logging is a dominant form of land use in the Brazilian Amazon. Several LBA studies are quantifying the effects of logging on carbon dynamics, including the role of fire as an agent of continued change following timber harvest. Despite ongoing efforts, surprisingly little is known about the extent, intensity or biogeochemical effects of logging in Amazon forests. At the scale of the entire Basin, the extent of logging is hotly contested, with current estimates ranging from 2,000-15,000 km2 yr-1. Even less is known about the intensity of logging, where intensity is defined here as canopy structural damage caused by the harvest operation. During the past two years, we have tested a method to quantify both the extent and intensity of selective logging using Landsat ETM+ data with a Monte Carlo spectral mixture model. The method produces coverages of fractional canopy, bare soil and surface necromass (slash) cover, along with statistical uncertainty maps for each cover fraction. The canopy fractional cover results have proven highly correlated with field-measured forest gap fraction, which in turn, is spatially correlated with the volume (and biomass) of wood removed from the forest and the coarse woody debris remaining in the harvest sites. This approach opens the door to regional-scale studies of logging extent and intensity as well as the resulting changes in carbon and nutrient stocks. We are currently extending our remote sensing approach to a much larger region of the Amazon, and are developing new linkages between our satellite analyses and measured carbon and nutrient changes.

Presenting Author: Gregory Asner (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Forest Degradation and Logging: Detection and Effects

Biogeochemistry and Aquatic Systems

3.1: Using multi-temporal JERS-1 SAR and SRTM Imagery to derive an absolute ground level DEM for the Central Amazon Floodplain

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Accurate digital elevation models of the Amazon floodplain are needed to model the spacial vatiation in flooding dymamics, vegetation cover and trace gas emissions in this environment. The recently released South American SRTM radar mosaic has provided a preliminary DEM with a horizontal resolution of 90 m and a vertical resolution of 1 m. However to obtain an absolute ground level DEM these data must be corrected for vegetation height. We used SRTM and multitemporal JERS-1 SAR imagery together with elevation-corrected river stage data to correct for vegetation height and develop an absolute ground level DEM for a 350 km reach of the central Amazon floodplain. The resulting DEM had an absolute vertical acuracy of aproximately 1 m and is now being used to model vegetation cover and flooding patterns in the region.

Presenting Author: Bruce Forsberg (Oral)

Science Theme: TG (Trace Gases)

Session: Biogeochemistry and Aquatic Systems

3.2: Dissolved CO2 in Rivers of Amazônia: A Preliminary basin-Scale Model of Sources and Fate

Jeffrey E. Richey, Alex Krusche, Victoria Ballester, Emilio Mayorga, Anthony Aufdenkempe,Mariza Cabral

"What role does the evasion (outgassing) of CO2 from the river system to the atmosphere play in the carbon cycle of moist tropical forests?" That is the question. The deceptively simple expression of dissolved CO2 gas (pCO2) in Amazonian surface waters (typically at concentrations far exceeding equilibrium with the atmosphere) is the product of a long sequence of complex biological, hydrological, and geochemical processes. If we can explain the sequence of processes that eventually lead to the observed pCO2, we will gain significant insight into not only how bioactive elements are spiraled down a continuum of rivers, but how terrestrial and aquatic systems are coupled. Here we present a preliminary coupled model of hydrology and biogeochemistry that provides a framework for evaluating our lead question.

Presenting Author: Jeffrey Richey (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Biogeochemistry and Aquatic Systems

3.3: Regionalization of Methane Emissions in the Amazon Basin with Microwave Remote Sensing

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Wetlands of the Amazon River basin are globally significant sources of atmospheric methane. Satellite remote sensing (passive and active microwave) of the temporally varying extent of inundation and vegetation was combined with field measurements to calculate regional rates of methane emission for Amazonian wetlands. Monthly inundation areas for the fringing floodplains of the mainstem Solimões/Amazon River were derived from analysis of the 37-GHz polarization difference observed by the Scanning Multichannel Microwave Radiometer from 1979 to1987. L-band synthetic aperture radar data (Japanese Earth Resources Satellite-1) were used to determine inundation and wetland vegetation for the Amazon basin (

Presenting Author: John Melack (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Biogeochemistry and Aquatic Systems

3.4: Soil Nitrogen Transformations and Soil Solution Fluxes Following Clearing of Amazonian Tropical Forest for Pasture

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The changes to soil nitrogen (N) cycling and ecosystem N losses that follow severe disturbances may be particularly important in tropical forests where rates of N cycling are high and where forest clearing occurs on a large scale. We evaluated the effects of forest clearing by experimentally cutting and burning forest in Rondônia and following changes to soil N cycling, soil solution N concentrations and N gas emissions. Clearing increased soil extractable NH4+ and NO3- concentrations for less than 1 yr but did not increase net N mineralization or nitrification rates. Newly cleared forest had higher soil solution NO3- concentrations, but the difference between the cleared and control forests declined with time after the start of the first post-clearing rainy season. Established pastures had lower solution NH4+ and NO3- concentrations than the original forest. Greater inorganic N made available by forest clearing led to greater solution fluxes below 1 m and to greater soil N oxide emissions. Total annual dissolved inorganic N (DIN) fluxes to below 1 m were 2.5 kg/ha in forest, 24.4 kg/ha in newly cleared forest and 0.8-2.1 kg/ha in established pastures. This compared with total annual gaseous N oxide losses of 3.4 kg/ha in forest, 7.0 kg/ha in newly cleared forest and 1.4-1.9 kg/ha in established pastures. At the scale of watersheds, the processes that control the losses to streamwater of these elevated inorganic N concentrations produced by forest clearing remain poorly understood. We found that riparian zones can reduce shallow groundwater NO3- concentrations from >200 μM to near zero within several meters of small stream channels. Better understanding the denitrification capacity of forest riparian zones in forest, how riparian N losses are influenced by deforestation, and how deforestation might alter hydrological flowpaths to that could potentially bypass riparian zones are required to quantify how changes in soil solution caused by the disturbance of forest clearing ultimately influence solution N losses at watershed scales.

Presenting Author: Christopher Neill (Oral)

Science Theme: ND (Nutrient Dynamics)

Session: Biogeochemistry and Aquatic Systems

3.5: Key Connections in Amazon Stream Corridors: Using 15N to Trace N Transformations and Transport

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Small streams act as important sites in the landscape where nutrients arriving from adjacent upland areas are transformed, retained or released downstream where they are transported to larger rivers. We are using 15-N additions to examine the transformations and downstream transport of N in small streams and how N cycling is altered with a change in land use from forest to pasture. Addition of 15-ammonium to a second order forest stream showed that ammonium was nitrified in the stream channel and that the 15-nitrate produced traveled long distances downstream without further transformation. This indicates that N uptake is controlled more by microbial energy demand than by requirements for N. This was consistent with our measurements of high oxygen concentrations, very high ratios of inorganic N:P and low availability of easily respirable carbon in forest streams. Under these conditions, forest streams serve to rapidly convert ammonium to nitrate and to transport nitrate long distances downstream. Forest conversion to pasture changes conditions in small streams in important ways, including lowering oxygen concentrations, raising N:P ratios and increasing available respirable particulate and dissolved organic matter. We hypothesize that because of these conditions, small pasture streams will have long transport distances for ammonium and short transport distances for nitrate. We have also found that oxygen and N:P ratios tend to increase in larger (3+ order) pasture streams. This suggests that there will be a rapid switch in the form and potentially the magnitude of downstream N transport at those key "breakpoints" in streams networks draining deforested landscapes where stream physical and chemical conditions change. We are testing these hypotheses with 15-N additions to small (2nd order) and larger (3rd order) pasture streams comparable to the site of the forest 15-N addition. These data are being combined with information on the kilometers of channels of different orders and characteristics passing through forest and pasture land-use to model N export at the watershed level.

Presenting Author: Linda Deegan (Oral)

Science Theme: ND (Nutrient Dynamics)

Session: Biogeochemistry and Aquatic Systems

3.6: Loss of Nutrients from Terrestrial Ecosystems to Streams and the Atmosphere following Land Use Change in Amazonia -- An Integrated Review

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Essential plant nutrients are lost from or redistributed within terrestrial ecosystems when forests are cut and burned. Losses include harvest products, volatilization and ash transport following fire, trace gas emissions from soils, soil erosion, and leaching to surface and ground waters. Redistribution includes incorporation of slash and ash material into soils and sedimentation of eroded soil. These processes are affected both by soil mineralogy and by changes in soil and landscape properties resulting from land use history. Soils of the Amazon region range in texture from nearly 100% sand to over 80% clay. The abundance of weatherable primary minerals ranges from practically none to very significant quantities. Although this huge variability appears daunting, some identifiable patterns have emerged from LBA studies. Here we investigate this broad variation in soil properties as they influence transfers of plant nutrients from terrestrial ecosystems to aquatic ecosystems and to the atmosphere.

A common feature in most mature Amazonian forests is a conservative P cycle and excess N availability. Equally common are low rates of internal terrestrial N cycling and N export to streams and to the atmosphere in pastures and secondary forests. Export of P to streams may increase or remain nearly undetectable after forest-to-pasture conversion. Oxisols have shown very low P export, whereas Ultisols in western Amazonia showed increased P export to pasture streams. Calcium is mostly retained in terrestrial ecosystems following deforestation, although inputs to streams can be detected when background fluxes are naturally low. Mineralogy, soil texture, and hydrologic flow paths are very important for determining exports of nutrients to streams. Hence, the effects of land use change on stream chemistry vary locally and regionally, depending upon variation in soil properties.

Presenting Author: Eric Davidson (Oral)

Science Theme: ND (Nutrient Dynamics)

Session: Biogeochemistry and Aquatic Systems

Forest Dynamics

4.1: Coarse Woody Debris Fallen and Standing in Logged and Undisturbed Forests from two Amazonian Forests

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Death and decay of trees play a vital role in forest ecosystem carbon cycling. Both the fallen dead wood (fallen CWD) and standing dead wood (snags or standing CWD) pools are important for quantification of the forest carbon cycle. We studied CWD stocks at both the Tapajos National Forest, Para, Brazil (3.08° S, 54.94° W) and at Juruena, Mato Grosso, Brazil (10.48° S, 58.47° W). These areas included two treatment types; area that was selectively logged using Reduced-Impact Logging (RIL) methods and undisturbed forest (UF). Volume estimation for standing dead used strip plots (total area sampled was 23.3 ha) and for CWD fallen used line intercept sampling (total line length sampled was 23.3 km). We classified CWD in five decay classes. Wood density by decay class was determined using a plug extraction technique for diameters greater than 10 cm. All samples less than 10 cm diameter were lumped into two smaller classes, 2-5 and 5-10 cm. We analyzed digitized photographs of radial log sections in order to estimate void spaces for all density samples > 10 cm diameter. Average wood density (not adjusted for void volume) for five decay classes ranged from 0.71 to 0.28 g cm-3 at Tapajos and from 0.73 to 0.46 g cm-3 at Juruena. The proportions of void space for decay classes 1 to 5 ranged from 0.01 to 0.27 at Tapajos. Juruena site void estimation is being analyzed. At Tapajós, the average mass (+/- S.E.) of fallen CWD was 50.7 (1.1) Mg ha-1 for UF and 76.2 (10.2) Mg ha-1 for RIL for duplicate sites. The average mass of fallen CWD at Juruena was 44.4 (est. 16.3) and 64.1 (est. 33.4) Mg ha-1 for duplicate UF and RIL sites. Small and medium sized material (< 10 cm dia.) accounted for 8-18% of the total fallen CWD mass. Standing dead average mass is currently being examined. Logging sites generate a larger amount of CWD fallen then that of standing dead in proportion to the total for a site and treatment. Comparison of the proportions of different CWD pools will be conducted as a possible vehicle for estimating disturbances that may have resulted in previously high mortality.

Presenting Author: Michael Palace (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Forest Dynamics

4.2: Spatial Variation of Forest Structure and Aboveground Biomass from long transect data in Brazilian Amazon

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Spatial variation in tropical rain forest structure is an important factor in quantifying the aboveground biomass (AGB) and carbon stock and extrapolating plot measurements to regional or global scales. We analyzed structural data collected in 25 ha area in an intact lowland forest around the flux tower at the Jaru Reserve in Rondonia, Brazil to address the spatial variability in stem density, basal area, canopy roughness, and AGB. The transects were designed prior to the field survery with the help of a one meter resolution IKONOS image over spectrally homogeneous regions away from disturbances. Five permanent 50 m x 1000m transects were installed and Live trees with diameter at breast height (dbh) ≥ 35 cm were collected within the 50 m wide transect with an addition of trees ≥ 5 cm in a narrower transect (5 m x 1000 m) in the middle of wider transects. Among the total of 3626 trees measured on all transects, trees with dbh ≥ 5 cm had average frequencies of 1015 ha-1 and whereas the trees ≥ 35 cm had a frequency of 48 ha-1. Allomertic equations based on dbh were used to compute canopy height and above ground biomass for various segments of the transect to estimate the effect of spatial scales from 100 m to 1 km for roughness and biomass estimation. The results for five transects are compared and the scaling criteria are discussed within and across transects.

Presenting Author: Sassan Saatchi (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Forest Dynamics

4.3: Biomass Dynamics in Amazonian Forest Fragments

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Habitat fragmentation affects aboveground biomass in Amazonian forests, with potentially important implications for carbon storage and greenhouse gas emissions. We assessed the dynamics of aboveground-biomass stocks by combining long-term (10-19 years) data on mortality, damage, growth, and recruitment of large (>10 cm diameter-at-breast-height [dbh]) trees with measurements of nearly all other live and dead plant material (seedlings, saplings, small trees, palms, lianas, downed wood debris, snags, litter) in 50 1-ha plots in fragmented and continuous Amazonian forests.

The key process altering biomass dynamics in fragmented forests is the chronically elevated mortality of large trees, which apparent results from microclimatic changes and increased wind turbulence near forest edges. This in turn accelerates the production of necromass and leads to significantly increased wood debris and litter on the forest floor. Near forest edges, frequent canopy disturbance increases the amount of light in the understory, resulting in accelerated tree recruitment, significantly higher biomass of small (5-10 cm dbh) trees, and higher liana densities. Surprisingly, the estimated annual turnover of wood debris increases significantly near forest edges, suggesting that decomposition is occurring more rapidly in fragmented than continuous forests.

These results reveal that habitat fragmentation fundamentally alters the distribution and dynamics of aboveground biomass in Amazonian forests. The rate of carbon cycling probably increases sharply, both because long-lived canopy and emergent trees decline in favor of shorter-lived successional trees and lianas, and because necromass production and turnover both appear to increase. Carbon storage in live vegetation also declines because small successional trees and lianas (which typically have low wood density) store substantially less carbon than do large, old-growth trees. Finally, the decline and rapid decay of live biomass in forest fragments may produce substantial atmospheric carbon emissions, above and beyond that resulting from deforestation per se.

Presenting Author: William Laurance (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Forest Dynamics

4.4: Variation of forest biomass, dynamics and structure across the Amazonian forest: results from the RAINFOR project

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The RAINFOR project has collected information on forest structure, composition and dynamics from over 100 forest plots in eight Amazonian countries. We find that (i) forest wood productivity and turnover is lowest in lowland central and eastern Amazonia, and up to three times higher in western Amazonia; (ii) this gradient in productivity appears to be driven by soil fertility rather than climate; (iii) mean wood density is inversely correlated with productivity, and s highest in lowland eastern Amazonia; (iv) forest basal area is invariant across most of Amazonia, but declines in extreme dry conditions; (v) spatial variation in biomass therefore seems mainly driven by wood density, and is highest in lowland eastern Amazonia; (vi) the rate of growth and death of forest trees as greatly accelerated in recent decades, (viii) there appears to be a net accumulation of biomass in old growth Amazonian forests. We use soils and climatic maps to interpolate these plot measurements, and arrive at new estimates of the wood productivity, biomass and carbon residence time of the Amazonian forest. We also report on initial findings of variations in leaf area index and soil and leaf nutrient content across Amazonia.

Presenting Author: Yadvinder Malhi (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Forest Dynamics

4.5: Carbon balance in seasonally-dry Amazon forest: unexpected seasonal fluxes and disturbance-induced net loss

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Net ecosystem exchange of CO2 was estimated using eddy covariance for 2.3 years in two old-growth rainforest sites (km 67 and km 83) in the Tapajós National Forest near Santarém, Brazil. Carbon was lost in the wet season and gained in the dry season, opposite to seasonal cycles of tree growth and to model predictions. Annual carbon losses were 1.4 (-0.5 to 2.5) Mg C ha-1 at Km 83, and 1.5 (0.3 to 2.6) Mg C ha-1 at Km 67. Carbon losses averaged across both sites were 1.5 (0.0 to 2.4) Mg C ha-1 yr-1. Biometric observations confirmed net loss, but indicate that it is a transient effect of recent disturbance superimposed on long-term approximate balance. Episodic disturbances are characteristic of old-growth forests, implying: (1) that regional carbon sequestration is less than might be inferred from direct extrapolation of recent eddy covariance studies at undisturbed sites, and (2) that realistic extrapolation of flux measurements to landscape and regional carbon balances requires knowledge of both disturbance history of study sites and the distribution of such disturbance histories across the landscape.

Presenting Author: Scott Saleska (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Forest Dynamics

4.6: Uncertainty in Ecosystem Production and Biomass of Amazonia Attributable to Remotely Sensed Vegetation Characteristics

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Models simulating regional ecosystem production of the Amazon basin depend on various climate and surface environmental variables such as soil texture, land cover type, and vegetation photosynthetic activity. Any uncertainty in input variables can influence the model predictions and creates uncertainty in magnitude and spatial distribution of the model results. To quantify this uncertainty, simulations of NASA-CASA (Carnegie-Ames-Stanford-Approach) are performed for five different land cover maps derived from remote sensing data over the Brazilian Amazon in recent years. Land cover classifications produced by JPL, USGS, UMD, TREES, and Woods Hole Research Center (WHRC) are compared in types and spatial patterns and resampled to 8-km resolution as model inputs. NASA-CASA model results are produced for total biomass carbon of woody vegetation and net ecosystem production (NEP) during two extreme climate conditions of 1983 dry and 1990 wet years. Our results indicate that major differences in land cover types are primarily in classifying deforested areas (crops and pasture), secondary forests, and woody savanna. Pixel-by-pixel comparison of NEP results also show that major differences occur in the most dynamic region of Amazonia over the arc of deforestation, transitional and seasonal woody savanna. The differences can change the magnitude of NEP and its interannual variability such that, for maps with larger area of deforestation and secondary forests, the source and sink of flux are enhanced respectively for 1983 and 1990. The results also show that impact of land cover maps on the total woody biomass carbon stock is small because the main contribution is from the area of evergreen forest. However, the difference can be the same magnitude as the interannual changes due to deforestation and regeneration.

Presenting Author: Christopher Potter (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Forest Dynamics

Physiology of Drought and Atmospheric Implications

5.1: High drought-tolerance of an eastern Amazon forest: results from a large scale rainfall exclusion experiment.

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Our understanding of a forest's capacity to tolerate water shortage is crucial to evaluate the impact of climate change on forest metabolism and flammability. An important part of this understanding is to determine how long-term drought influences plant and forest water balance, as well as to identify threshold levels of water stress beyond which ecosystem recovery is impossible. We are conducting measurements within the context of a rainfall exclusion experiment in primary tropical rainforest (Amazon/Brazil). The study consists of two 1-ha plots, one of which has been subjected to exclusion of ~50% of incoming precipitation since 2000. We are measuring sapflow rate (Jv), predawn leaf water potential (Ψp), xylem-specific conductivity (Ks), stem growth and phenology for the four most common tree species in the study area. Jv was reduced by ~50% in the treatment plot during the dry season of 2001 and 2002. Pre-dawn Ψp was approximately 1.5 times more negative for the treatment plot in the dry season of both years, but recovered during subsequent wet seasons. No significant loss of Ks was observed. However, changes in plant-soil water relations reduced canopy leaf area by as much as 25% and annual stem wood production by >50%. The effects of persistently reduced levels of rainfall were not as profound as expected at first, suggesting that the forest is relatively tolerant to reductions in rainfall. Nevertheless, changes in soil-plant-atmosphere water relations, in particular an increment in forest flammability, represents a serious risk.

Presenting Author: Gina Cardinot (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Physiology of Drought and Atmospheric Implications

5.2: Micrometeorological and Canopy Structure Controls on Rainforest Fire Susceptibility of Mature and Disturbed Forests in an East-Central Amazon Landscape

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Fire is playing an increasingly important role in shaping the structure, composition, and function of vast areas of seasonally-dry tropical rainforest. The influence of these fires is magnified during El Nino years when drought conditions become severe, and perhaps also as a result deforestation-induced rainfall inhibition, killing 0.2 to 0.4 Pg of tree biomass. Our understanding of the biophysical factors that control fire susceptibility and fire spread through Amazon forests remains largely anecdotal, however. We examined the effect of rainfall history, canopy structure (average canopy height and leaf area index (LAI)), understory microclimate, and fuel characteristics on fire susceptibility using experimental fires in three typical ecosystem types in the eastern Brazilian Amazon. Fire spread rates (FSR, m min-1) were measured in an eight-year-old secondary forest, previously logged and burned forest, and mature forest during the last two months of the 2002 dry season. Vapor pressure deficit (VPD) at the forest floor, litter moisture content (LMC), wind velocity, and LAI combined to explain 61% of the variability in FSR. In combination, canopy structure and a weighted measure of recent precipitation history could account for ~70% of the variability in VPD, the single most important predictor of FSR. Half of the observed variability in FSR could be explained by these same variables. Using logistic regression we were able to correctly predict the success or failure of 72% of our experimental fires based on canopy structure and precipitation history. A strong threshold in fire susceptibility was detected at LMC of ~20%, higher than previously reported (~15%). FSR increased with reductions in average canopy height and LAI, and over time as the influence of the most recent rain event became diminished.

Presenting Author: David Ray (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Physiology of Drought and Atmospheric Implications

5.3: Effects of experimental drought on carbon cycling in an Eastern Amazon rain forest

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What are the physiological responses by rain forest to drought? How might the carbon cycle of rain forest respond to the moisture stress associated with El Niño events? The answers to these questions are important for our understanding of how Amazon rain forest may interact with variation and secular change in climate . We present results from a rainfall exclusion experiment in the Eastern Amazon, at Caxiuanã Reserve, Pará, Brazil. One hectare of forest at Caxiuanã has been experimentally droughted for nearly two years and we present initial results considering the responses during this time in soil moisture, soil carbon efflux, tree growth, sap flux, leaf and canopy physiology, and canopy structure. The behaviour of each component and the timescale of the response is considered in the context of the changes in the carbon and water cycles at the canopy scale.

Presenting Author: Patrick Meir (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Physiology of Drought and Atmospheric Implications

5.4: Use of a Soil-Plant-Atmosphere model to infer reductions in GPP from decreased water use in a throughfall exclusion experiment

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At our throughfall exclusion experiment at Caxiuana, (Para), we have observed that sapflow in the droughted plot is reduced by up to a factor of 3.5 in the dry season, compared to the undroughted control. We would like to know the impact of this change on forest carbon assimilation, however, due to the one ha scale of the experiment, we cannot directly measure forest carbon exchange using micrometeorological techniques. If we are to predict the effect of drought on photosynthesis, we must first estimate the reduction in stomatal conductance (Gs) caused by the drought. Unfortunately, it is impossible to adequately measure Gs, and prediction of Gs based on sapflow patterns is complicated by heterogeneous atmospheric moisture demand.

To integrate the environmental heterogeneity we used the Soil-Plant-Atmosphere Model (SPA), a process based canopy simulator model. The model produces multi layer predictions of Gs, which are optimised to give maximum photosynthesis without reducing leaf water potential (LWP) below the critical minimum value. LWP is calculated from the atmospheric moisture demand, and the water supply from the soil

We tested the ability of this model to reproduce our measured sapflow, LWP, and porometry data. The extent of the drought stress was simulated by optimising the soil-leaf hydraulic resistance and water capacitance parameters. In the dry season, we were able to adequately simulate all the measured data, and estimated that the droughted plot was losing 25% of possible assimilation as the result of stomatal closure. However, in the wet season, the actual LWP recovery in the afternoon was faster than that predicted by the model, suggesting a more conservative water use strategy than that embedded in SPA.

Presenting Author: Rosie Fisher (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Physiology of Drought and Atmospheric Implications

5.5: Plants physiological responses to precipitation in the Amazon forest, an isotopic approach

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Stable isotope ratio analyses of atmospheric CO2 and bulk carbon on plant tissue provide useful information regarding the balance between photosynthetic carbon gain and respiratory carbon loss in forest ecosystems. We have been applying the isotopic methodology to study carbon cycling in terra-firme forests in Santarém (Flona) and Manaus (ZF2) regions. Measurements of The isotopic ratio of the ecosystem respired CO2 (δ13CR) showed a seasonal change correlated with variation in the observed monthly precipitation, suggesting that the major portion of recently respired carbon dioxide in these forests was metabolized carbohydrate fixed by the sun leaves, with lower ci /ca ratio, at the top of the forest canopy (ci/ca , ratio of intercellular to ambient CO2 concentrations). The seasonal distribution of precipitation also appears to contribute to the δ13C variability of tree leaves, especially in areas with a longer dry season like Santarém. There is an interesting "lag" on the isotopic signal of the respired CO2 and of the bulk leaf organic carbon in Santarém, when the physiological responses to changes in the water availability are first identified on the δ13CR. The ci /ca ratio on the middle and lower forest canopy differ between Santarém and Manaus related to different length of the dry season in these two regions. These differences also explain average lower δ13C values at Flona sites in comparison with the average values at ZF2. At the lower layers of the canopy there is also a higher isotopic discrimination, which can be interpreted as lower rate of photosynthesis compared to stomatal conductance caused by decreasing in light availability throughout the canopy.

Presenting Author: Jean Ometto (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Physiology of Drought and Atmospheric Implications

5.6: Simulated Interactions of Soil Moisture, Drought Stress, and Regional Climate in the Amazon Basin

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The effects of seasonal and interannual drought on tropical forests vary by location, age, composition, and the duration and severity of the drought. We have investigated the ability of a land-surface carbon and hydrologic model (SiB2) to simulate the response of Amazonian forests to seasonal and interannual drought, and the effects of these responses in a fully interactive global climate model. Multiyear simulations of ecosystem carbon and water cycling were performed at a number of sites across climate gradients in the Amazon, and the results were compared to available observations. The model reproduced observed seasonality well at some sites that experience moderate seasonal drought, with net uptake during the dry season due to relatively unstressed photosynthesis and transpiration but ecosystem respiration depressed by dry surface soils and litter. At sites with longer or more severe dry seasons, simulated soil moisture was excessively dry and extreme physiological stress develops. When SiB2 was coupled to a fully interactive climate model, Amazon soils progressively dried out, the planetary boundary layer became unrealistically deep, and moisture recycling through precipitation was cut off. Photosynthesis rates declined and respiration increased due to very hot temperatures.

The unrealistically strong positive feedback between forest ecophysiology and regional climate in SiB2 was found to be due to the model's inability to simulate vertical gradients of soil moisture within the root zone. A new parameterization of soil hydrology and root zone water stress was introduced that allowed much more realistic simulation of seasonal and interannual variations. In the coupled climate model, the new parameterization allows for a much more resilient regional climate that is less likely to lead to catastrophic positive feedback.

Presenting Author: Scott Denning (Oral)

Science Theme: CD (Carbon Dynamics)

Session: Physiology of Drought and Atmospheric Implications

Land Use Changes and the Future of the Amazon

6.1: Aerosol spatial distribution, composition and effects on the Amazonian ecosystem

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After several years of aerosol measurements in Amazonia, we are starting to have a comprehensive view of the distribution, seasonal variability, effects on nutrient cycling, effects on the radiation balance and many other ecological implications of the atmospheric aerosol particle loading in Amazonia.
It is clear that the Amazonian forest emits large amounts of biogenic particles to the atmosphere that are a critical ingredient of the cloud formation mechanisms. Critical trace nutrients such as P, Ca, K and many others elements are cycled and redistributed trough the aerosol phase. Aerosols also strongly affect the radiation budget, absorbing as much as 360 watts /m2, with daily averages as high as 80 w/m2 in the dry season. The ratio of diffuse to direct radiation changes from 25% in the wet season to 80% in the dry season for some areas. These important changes in the radiation balance have important consequences for the carbon assimilation by the forest. A significant fraction of critical nutrients are exported from the ecosystem by the biomass burning emissions. Health effects on the Amazonian population from the exposure of up to 600 ug/m3 of aerosol loading are very significant, and a burden for the population living in the deforestation arc. Aerosol composition in the wet season shows a biogenic aerosol composition that is quite homogeneous in composition and physical properties along several sites. In the dry season, biomass burning aerosols dominates over large areas, affecting the ecosystem functioning over areas of 3-4 millions square kilometers.

Presenting Author: Paulo Artaxo (Oral)

Science Theme: TG (Trace Gases)

Session: Land Use Changes and the Future of the Amazon

6.2: Using experimental fires to quantify the accuracy of the MODIS fire product and distinguish between conversion and maintenance land cover dynamics

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This paper describes initial results from an ongoing research effort between the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), National Aeronautics and Space Administration (NASA), and the University of Maryland (UMd) within the Large Scale Biosphere-Atmosphere Ecology (LBA-Eco) project. The two primary objectives of the project are to:

1. Assess the accuracy of the 1 km fire product from the Moderate Resolution Imaging Spectroradiometer (MODIS), and

2. Distinguish between "conversion" fires, the result of recent clear-felling of forest in preparation for agriculture or pasture, and "maintenance" fires, used to maintain or restore degraded pasture and agricultural areas.

We are using a series of controlled burns to assess the accuracy of the 1 km MODIS fire product. For controlled burns in Roraima and Pará, we compare coincident field data, airborne imagery, ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer), and MODIS data to explore the MODIS and ASTER spectral response for these active fires. In this analysis, a multispectral algorithm is applied to the ASTER data to produce a high-resolution map of fire size and temperature. The fire temperature map is then used to assess the accuracy of the MODIS fire product. ASTER and MODIS fire detections show a strong agreement for the prescribed burn locations. In each ASTER scene, additional fires were also detected. For these locations, the agreement between ASTER and MODIS is weaker. The lack of agreement between ASTER and MODIS for these additional fires was due to the MODIS point spread function and difficulties in separating real fires from highly reflective clouds in the ASTER fire detection algorithm.

To classify MODIS active fire detections as either conversion or maintenance fires, we compared active fire locations in Roraima, as observed by MODIS between May 2000 and August 2003, to three vegetation maps. Fire locations were compared to INPE's (National Institute for Space Research) Landsat-based PRODES (Projeto de Estimativa de Desflorestamento da Amazônia) map of deforestation, the MODIS NDVI (Normalized Difference Vegetation Index) time series (MOD13, 250m resolution), and the MODIS vegetation continuous fields (VCF) product at 500m resolution. Of the nearly 5,500 MODIS active fire locations, roughly 42% were over areas classified as forest in the PRODES map. Likewise, half the observed fires were classified as greater than 60% tree cover in the MODIS VCF. MODIS NDVI time

series provides 16-day temporal resolution of vegetation characteristics. We used the time series to investigate the NDVI signature before and after fires to help classify fires as conversion or maintenance.

The accuracy of MODIS fire detection, as established through the first objective, is used to determine the likelihood of MODIS fire product omission and commission errors. This uncertainty in the MODIS fire product is then used to establish error bars on the estimated number of "conversion" and "maintanence" fire. We demonstrate the approach here for the state of Roraima.

Presenting Author: Jeffrey Morisette (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use Changes and the Future of the Amazon

6.3: Quantifying spatial and temporal patterns of land use transitions from pasture to cropland in Mato Grosso

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One of the predominant land use transitions occurring in Mato Grosso is conversion of previously cleared pasture to large-scale, mechanized cropland. Current techniques to monitor land cover change with Landsat data generally identify new forest clearings rather than secondary conversions from pasture to cropland. With the availability of daily observations from the Moderate Resolution Imaging Spectroradiometer (MODIS), pastures can be distinguished from cropland based on vegetation phenology observed through temporal dynamics of NDVI. We use 250 field observations obtained in June and July 2003 along the southern portion of the Cuiabá-Santarém corridor to test the ability of MODIS data to distinguish pasture from cropland. The ability to differentiate among land use types enables monitoring of land use transitions over large areas after initial forest or cerrado clearing. The pasture to cropland conversion often requires piling and burning any remaining woody vegetation; understanding the timing and location of these secondary transitions provides insight into the dynamics of burning activities in the region. The resulting classification also enables understanding of the biophysical factors, such as topography and soil type, that control the location of different land use types.

Presenting Author: Ruth DeFries (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use Changes and the Future of the Amazon

6.4: Agribusiness expansion into the Brazilian Amazon

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In recent years, the agribusiness sector has become one of the main economic driving forces behind agricultural frontier expansion process in the Brazilian Amazon. In the 2001-2003 period soybean production reached 13 million tons per year in the north of Mato Grosso state, with the area under cultivation increasing from 31,000 to 42,000 km2. This expansion has been stimulated by several factors the growth in international demand (and prices) for soybean, devaluation of the Brazilian Real, reduction of transport cost due to new routes for commercialization, high productivity in the Cerrado area, and development of new soybean varieties suited to humid climatic conditions in the Amazon. The objective of this work is to identify the possible areas of agribusiness expansion in the Brazilian Amazon considering physical and economic variables such as infrastructure, topography, climatic conditions, soils, markets, production, prices, and transport cost.
Preliminary results indicate that the soybean agro-industry is expanding into rain forest regions in easter-central Amazonia, near Santarém, Belterra, and Alenquer, where the Belterra clay formation provides flat topography and physical structure suitable for mechanized agriculture. Conditions for production expansion are being promoted mainly by grain trading companies, such as Cargill, Bunge, ADM and Maggi Group that are investing strongly in these regions by providing production financing, building storage units and ports, and participating directly in the pavement of roads as Cuiabá-Santarém through of roads consortia.

Presenting Author: Maria del Carmen Diaz (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use Changes and the Future of the Amazon

6.5: System architecture of a spatially explicit model to simulate deforestation in the Amazon basin

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A model to simulate deforestation in the Amazon Basin is proposed as a means to integrate scientific knowledge about this region as well as to help in the conservation of its natural heritage. Its architecture embodies coupled models structured in two spatial levels: 1) subregions defined from socioeconomic stratification and 2) cartographic model using raster data set. Demographic models are established and linked with economic and agrarian systems to project the anthropic pressure and its effect on the deforestation rate trend within each subregion. The subregions' systems communicate among themselves through the flow of people, information, and economic resources. These systems are modeled using differential equations implemented in a "system-thinking" software, which passes on dynamic deforestation rates to a spatially explicit simulation model. Each subregion has a unique spatial model with its own set of parameters, which are calibrated for the various stages of the deforestation process, to produce deforestation probability maps by combining cartographic layers comprising information on infrastructure, administrative units, and physiographic settings. The subregions are spatially integrated by computing chorographic variables, such as distances to roads and to previously deforested land, continuously over the entire landscape raster map. Cartographic algebra and cellular automata technique are used in order to develop the spatially explicit simulation model that features multi-scale vicinity-based transition functions, the concept of phases, subregion approach, feedback through the calculation of dynamic spatial variables, calculation of spatial transition probabilities using weights of evidence method, and a component that drives the expansion of the road network. The model incorporates the major infrastructure investments planned for the Amazon region, and may therefore be employed to assess the impacts of regional development policies.

Presenting Author: Britaldo Soares Filho (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use Changes and the Future of the Amazon

6.6: Science and public participation in regional Amazonian development: The case of the MAP process in the frontier region of Brazil, Bolivia and Peru.

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A critical challenge facing scientific programs in Amazonia involves making scientific research relevant to regional development and conservation efforts. The Department of Madre de Dios, Peru, the State of Acre, Brazil and the Department of Pando, Bolivia -- jointly known as the MAP region -- cover 300,000 km2 and have 700,000 residents in the heart of highly diverse and energy-rich southwestern Amazonia. The accelerating pace of infrastructure development has raised concerns among regional societies on how to maximize the benefits and to minimize the adverse impacts of expanding access to natural resources. This interest consolidated in a series of meetings partially supported by LBA-ECO and PPG7, beginning in 1999 with a meeting of universities to discuss regional land use and global change (35 participants and 17 institutions represented). The most recent meeting, MAP IV, was hosted in August 2003 by the frontier municipalities of Brasileia and Epitaciolandia, Acre, and involved over 600 participants and 160 institutions. The conclusions of this meeting were presented in a seminar of the Peruvian Congress on regional public policy. Results of LBA-and PPG7-related land use research permeated many of the discussions and presentations: trinational logging studies, hot pixel data, MODIS, SRTM and Landsat imagery, and regional climate models. Key factors in increasing public participation and assimilation of science in the MAP process for regional development were: 1) a trinational network of professionals sharing the same concerns; 2) the use of recent scientific results and technology to help participants expand their perspectives; and 3) trust that grew from frequent encounters between persons of different nationalities and social backgrounds.

Presenting Author: Foster Brown (Oral)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use Changes and the Future of the Amazon

Aquatic Systems and Biogeochemistry

7.1: Estimates of Greenhouse Gas Emissions (CO_2 and CH_4) from Balbina Hydroelectric Dam, Central Amazon, Brazil.

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The relatively constant temperature of the Earth is due to greenhouse gases present in the troposphere which retain solar energy and thus regulate the global climate, a natural phenomenon called the greenhouse effect. Large hydroelectric reservoirs are responsible for major increases in two of these atmospheric gases: CO_2 e CH_4. In reservoirs, these are both a result of methanogenesis, though CO_2 is also generated by cellular respiration and by bacterial oxidation in anaerobic wetland environments. The hydro site with the greatest potential for generating greenhouse gases (GGs) in Amazonia is the Balbina Reservoir, located in the municipality of Presidente Figueiredo, in the central Amazon, this dam inundated an area of 2360 Km2. Static chambers and inverted funnels will be used to estimate surface gase emissions due to diffusion and bubbling, respectively. A bathymetric map of the reservoir derived from sonar transects and multi-temporal JERS-1 radar imagery will be used together with hydrological and limnological data to develop dynamic inundation and gas emission models for the system. Strong emissions of GGs are expected both above and below the dam and the water depth is expected to be strongly correlated with local emission rates. The study should help us to evaluate the contribution of this and other Amazonian reservoirs to global atmospheric pollution and contribute to the development of ecologically sustainable strategies for energy generation at the regional and national levels. Quantifying the negative impacts of dam construction should also contribute to the conservation of enormous areas of tropical forest, which are destroyed when reservoirs are created.

Presenting Author: Alexandre Kemenes (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Aquatic Systems and Biogeochemistry

7.2: Amazon Floodplain lake shape assessment using remote sensing data

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The geomorphology of lakes is deeply related to its biogeochemistry. Lake shape and size controls the interaction between aquatic and terrestrial ecosystems. It also affects the exchanges between water and atmosphere which in turn acts upon the vertical and horizontal mixing processes. Several researchers have already recognized the uppermost role played by lake shape in temperature stratification in Amazon region. Previous researches have shown that Amazon River floodplain is occupied by complex lake system which covers around 11 % of its entire area. This complex lake system is fundamental to the hydrologic and biogeochemical functioning of the floodplain.

In previous research Amazon lakes were mapped using RADAMBRASIL 1:250 000 mosaics. It is widely known, however, that Side Looking Airborne Radar images are subjected to large geometric distortion derived primarily from radar viewing geometry. The objective of the present study is to update and assess information of lake shape by mapping them at several selected floodplain reaches. A Landsat TM digital mosaic available for the entire Amazon River floodplain will be used and the results will be compared to lake shape derived from RADAM mosaics. In order to assess the impact of remote sensing data on lake shape retrieval, a series of lake shape indexes will be tested.

Presenting Author: Andreia Maria França (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Aquatic Systems and Biogeochemistry

7.3: A Simulation Model of Carbon Cycling and Methane Emissions in Amazon Wetlands

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An integrative carbon study is investigating the hypothesis that measured fluxes of methane from wetlands in the Amazon region can be predicted accurately using a combination of process modeling of ecosystem carbon cycles and remote sensing of regional floodplain dynamics. A new simulation model has been build using the NASA-CASA concept for predicting methane production and emission fluxes in Amazon river and floodplain ecosystems. Numerous innovations are being made to model Amazon wetland ecosystems, including: (1) prediction of wetland net primary production (NPP) as the source for plant litter decomposition and accumulation of sediment organic matter for two major vegetation classes -- flooded forests (varzea or igapo) and floating macrophytes, (2) seasonal profile retrieval of MODIS version 4 vegetation index values for characterization of differences in leaf greenness phenology among major vegetation classes, (3) representation of controls on carbon processing and methane evasion at the diffusive boundary layer, through the lake water column, and in wetland sediments as a function of changes in floodplain water level, (4) inclusion of surface emissions controls on wetland methane fluxes, including variations in daily surface temperature and of hydrostatic pressure linked to water level fluctuations. Our remote sensing and modeling method overviews are presented together with early simulation results.

Presenting Author: Christopher Potter (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Aquatic Systems and Biogeochemistry

7.4: Geostatistic application to spatial modelling of water quality variables as support for understanding the linkages between vegetative cover and inundation

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The biogeochemistry of floodplain lakes is closely related to the seasonal fluctuation of the Amazon river. In large lakes wind is also an important forcing function explaining both spatial and vertical stratification. The input of nutrients from both river overflow and lake bottom is closely related to the spatial distribution of water quality variables which in turn affect and are affected by the mosaic of vegetative cover. In order to investigate those connections and to model the water circulation between the Amazon river and floodplain, a field campaign was carried out at Lago Grande de Curuai, a 2000 km2 oval floodplain lake located south of Obidos. During the mission 150 stations were sampled for the following variables: water spectral reflectance, total suspended solids (TSS), chlorophyll a + phaeophytin (CLH) and dissolved organic carbon (DOC) concentrations, pH, conductivity, turbidity, dissolved-oxygen, nitrogen, phosphorus, Secchi depth and absolute depth. Sample location was based upon spectral classes derived from Landsat TM images.
This paper assesses the use of geostatistical methods for modelling the spatial distribution of those variables as well as to investigate the spatial correlation between them. Preliminary results show strong anisotropy in some variables such as turbidity displaying directional effects related to Amazon river inputs to the lake. Other variables such as Nitrogen do not display directional effects which should be further investigated.

Presenting Author: Claudio Barbosa (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Aquatic Systems and Biogeochemistry

7.5: Remote sensing application to monitor seasonal white water input into floodplain (várzea lakes) in Central Amazon: Mamirauá Sustainable Development Reserve (1)

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The objective of this research is assess the relationship between the biotic and abiotic limnological variables in Focal Area of Mamirauá Sustainable Development Reserve - RDSM (260,000 ha) using the spectral response to map white water input to the lakes. The RDSM is located at the confluence of the Solimões and Japurá river basins and covers an area of 1,124,000 ha. Ten images Landsat-TM and ETM+ (Path/Row 001/62) corresponding to water level amplitude varying between 3 and 14 m were selected. A preliminary analysis of IDSM's database revealed that the Mamirauá and Jarauá lake systems are the ones for which the largest volume of limnological data exists. At the end of this project, we expect (1) to produce an estimate of the area occupied by the white water of the rivers Solimões and Japurá based on the amplitude of the water level at the Reserve, (2) to produce an estimate of the distribution of suspended sediment concentration, which we consider the main indicator of the seasonal dynamics of water between the floodplain of the river system to the várzea lakes, and (3) to correlate the spectral characteristics of the images with the limnological parameters of water bodies.

Presenting Author: Dayson Jardim-Lima (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Aquatic Systems and Biogeochemistry

7.6: MODIS performance for assessing seasonal changes in floodplain lake size and shape

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Use of satellite image data to investigate floodplain river systems interaction has not achieved its full potential mainly due to the low revisit rate of the available systems. The currently operating Terra - MODIS data meet the needs of large river basin monitoring, but the spatial resolution is thought to be too coarse for fluvial applications. High resolution Landsat-TM Image data often are not spectrally tuned for quantitative study river – lake interactions. Advancements in critical sensor capabilities such as improved signal-to-noise ratio, spectral, radiometric and geometric resolutions may compensate for the lack of appropriated spatial resolution. The hypothesis under investigation in this research is that MODIS image data can be an efficient tool to study the interaction between Amazon River and floodplain lakes. To investigate this hypothesis concurrent acquisition of Landsat-ETM and Terra MODIS images were processed. First of all, a water/land mask was generated for each data set to generate maps of water bodies for both data sets. The raster maps were converted into vector files and each polygon was characterized in terms of area and perimeter. Polygons were assigned to two distinct categories: island and lakes. The number of polygons of each category omitted or included for each data set was computed and the degree of discrepancy between MODIS and ETM performance assessed. Preliminary results show that MODIS images allowed mapping 252 polygons. The minimum and maximum area mapped were equivalent to 0, 18 km2 (~ 3 MODIS pixels) and 3 357 km2 (~51 250 MODIS pixels), respectively. ETM images allowed mapping 516 polygons. The minimum and maximum area mapped were equivalent to 0.01 km2 (~ 11 pixels) e 3 744 km 2 (~4 167 000 ETM pixels), respectively. The total lake area mapped using ETM images was 4731 km2, whereas total lake area mapped using MODIS was 4 205 km2. These differences are being analyzed and will be discussed further in the paper.

Presenting Author: Evlyn Novo (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Aquatic Systems and Biogeochemistry

7.7: Location of telemetric monitoring sites in Amazon floodplain lakes with Landsat-TM

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The present work shows the application of remote sensing and image processing for defining appropriate sites to install buoy moored telemetric systems in the surface of Amazon floodplain lakes for limnologic-micrometeorologic data acquisition. The technique is straightforward consisting essentially of Boolean operations over historic flood and Amazon plume maps obtained in distinct stages of the hydrologic cycle. The buoy moored telemetric system will be installed in the Curuai Lake, in the vicinity of Santarém and Óbidos. The data collected will be of fundamental importance to the development of air-water trace gas exchange models in the Amazon floodplain.

Presenting Author: Ivan Lima (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Aquatic Systems and Biogeochemistry

7.8: Isotopic composition of CH4 from river sediments in eastern Amazonia

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Tropical wetlands are recognized as significant sources of methane (CH4) to the atmosphere. As the concentrations of this gas in atmosphere has increased considerably during the last centuries, to measure the flux and to analyze its composition became an important issue in defining terrestrial sources of this greenhouse gas. To trace the sources, we measured the variations in isotopic composition (δ13CH4) of methane trapped in bubbles from three streams in eastern Amazonia, for two years. These streams have similar seasonal temperature and rainfall patterns, however, the riparian vegetation influence and hydrological patterns are different. Two of these streams, Igarapé Açu and Igarapé Maicá, are located in typical floodplain area in the Amazon River basin. The third one, Igarapé Jamaraquá, is located in a primary forest and flows into the Tapajos River. The isotopic values found on the methane were in a range of -87 to -43, with a significant difference on the δ13C between the dry and the wet seasons. In general, when the streams were rising (Feb. – Aug.) δ13C values of the bubbles did not vary significantly. Nevertheless, during the falling water period (Sep. – Jan.), the floodplain streams showed enriched methane (δ13C -46,95‰). The opposite trend was observed at the Igarapé Jamaraquá which showed δ13C maximum value of -78,20‰ in the same season. In order to explain the differences between the streams we must investigate process of organic matter decomposition in the sediments, the mechanism of methane oxidation and bubble gas emission for each site.

Presenting Author: José Mauro Moura (Poster)

Science Theme: TG (Trace Gases)

Session: Aquatic Systems and Biogeochemistry

7.9: Controls on stream DOC flux and composition in the Amazon region, Tapajos national forest

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To improve predictive capabilities of water, carbon and nitrogen gas fluxes in the Amazon region, we are examining the influence of land cover, topography and soil on stream dissolved organic carbon (DOC) flux and composition. Using 90-m SRTM digtal elevation (DEM) data and land cover/land use maps derived from Landsat-TM we have selected several catchments in the Tapajos national forest drainage area with contrasting land use, topography, and soils. Field sampling of throughfall, lysimeter and stream water components will provide insight into flow path dynamics and a better understanding of the chemical nature of DOC under contrasting land use patterns. DOC samples will be characterized and compared using Nuclear Magnetic Resonance (NMR). In addition to parameterizing model simulations of carbon and nitrogen dynamics, monitoring of DOC flux across select streams will be used for model validation.

Presenting Author: Marc Kramer (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Aquatic Systems and Biogeochemistry

7.10: Low-flow headwater stream nutrient concentrations controlled by weathering in four forested Amazonian watersheds

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A hydrologic study of four headwater watersheds is being conducted in an undisturbed forest near Juruena, Mato Grosso in the seasonally dry, southern Amazon. The micro-watersheds range in size from 0.7 to 1.7 ha. Soils in two of the watersheds contain a sharp increase in clay content with depth in the upper 50 cm, corresponding to a sharp decrease in hydraulic conductivity. In each watershed, stream discharge is monitored continuously at a V-notch weir instrumented with a pressure transducer and data logger. Water table depths are monitored continuously in 6 m deep piezometers. A suite of tipping buckets have been installed in each watershed to measure timings and volumes of throughfall, overland flow, and percolating water in each watershed. Water quality parameters will be collected for rainfall, throughfall, shallow and deep ground water, surface runoff and percolating water following the 2003 dry season.

Stream water samples were collected biweekly for the four headwater streams during the 2003 wet to dry season transition and throughout the dry season. Decreasing stream flows during this period corresponded with increases in stream water concentrations of calcium, magnesium, sulfate, silica, sodium, electrical conductivity, and alkalinity. Chloride concentrations decreased during this period, with no discernible relationship determined for pH, nitrate and potassium. While there is variation among the watersheds, the elemental concentration trends with respect to decreasing stream flow were consistent for each of the four watersheds. During the period reported here, the groundwater contribution to stream flow increased from being the predominant source during the wet to dry transition, to being the exclusive source during the dry season. Decreases in the mineral weathering index [Na/(Na + Ca)] corresponded with decreases in stream flow for each of the four watersheds throughout the 2003 low-flow period, indicating that mineral weathering is the primary source of cations exported from these watersheds.

Presenting Author: Mark Johnson (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Aquatic Systems and Biogeochemistry

7.11: Improving the HYDRA Freshwater Systems Model of Amazonia

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Here we summarize and validate our improvements of the HYDRA freshwater systems model. The improvements are designed to increase the accuracy of the simulated magnitude and timing of the water transport and seasonal flooding. We have incorporated data on river sinuosity to better represent the river flow length in each grid cell. Additionally, we have used data of river height as a function of discharge from 287 sites in order to derive a functional relationship between height and discharge throughout the basin. This explicit representation of water height coupled with observed data on hydraulic radius as a function of discharge is used to more accurately calculate flow velocity. Measurements of stream cross-sectional area have been included in the determination of stream bank-full volume to derive a better understanding of the physical aspects governing flood initiation. Finally, we have improved the simulated communication between river, groundwater, and floodplain reservoirs within HYDRA to include the floodplain in the overall water yield calculation and in calculating stream flow velocity.

Presenting Author: Michael Coe (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Aquatic Systems and Biogeochemistry

7.12: TM, ETM and MODIS Data for Multitemporal Wetland Analysis in Large-Scale Studies

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This poster reports the preliminary findings of a science training research project carried out as part of the LBA-Ecology Investigation (LC-07). The experiment performed to assess the effect of image spatial resolution for the identification and mapping of the various wetland ecosystems found in the Amazon River floodplain. A Landsat TM digital mosaic was generated with 29 scenes, selected using as basic criteria the cloud cover. To get satisfactory results, was necessary collect data from 10 years. These scenes were radiometrically rectified and resampled to 100 x 100 m and 250 x 250m resolution to simulate the Moderate Resolution Imaging Spectroradiometer (MODIS). Both data sets were then submitted to the same digital processing procedure as follows: a) application of the mixing algorithm to generate "pure endmembers" and to obtain as result the fraction images of soil, vegetation and shadow. These endmembers were segmented and classified using the unsupervised classification algorithm. The results were statistically analyzed leading to the conclusion that the 250 x 250m resolution does not allow the correct assessment of the area occupied by the floodplain habitats.
The next step of the research focused on the use of the actual MODIS images that improves on the radiometric and spectral resolution which might compensate for the spatial resolution. For this analysis MOD09 products BANDS 1,2,3,4,6,7, were applied. MODIS and ETM georreferenced data base were created for Curuai Lake, Para State, Brazil test site. The images were submitted to the following processes: a) generation of a water mask; b) application of the Spectral Linear Mixing Model; c) Segmentation; and d) Region Unsupervised Classification after thematic info layers were submitted to statistical analysis. Preliminary results are still under analyzes.

Presenting Author: Ramon Morais de Freitas (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Aquatic Systems and Biogeochemistry

7.13: Effects of land use change on stream water chemistry in Eastern Amazonian watersheds

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This work addresses the effects of land use change on stream water chemistry. In previous studies, we showed significantly lower soil nitrate concentration in pasture soils compared to forest soils and significant leaching of cations from pasture soils to the stream. Our new project emphasizes the interface of terrestrial and aquatic exchanges of nutrients and carbon, the retentive capacities of soils, and the buffering effect of riparian zones for stream inputs. We used satellite imagery and field surveys to identify three meso-scale (100's of km2) hydrologic basins near Paragominas, Pará. Since March 2003 we began monthly measurements of stream chemistry along three first-order streams from their headwaters in remnant mature forests, through pastures, secondary forests, and agricultural fields. We measure pH, conductivity, temperature, turbidity, alkalinity, Ca, Mg, K, Na, NH4, NO3, PO4, Cl, SO4, total N and P, DOC, and O2 concentrations. We are also sampling above and below reservoirs, which are commonly constructed by ranchers, to determine if sediment loads, oxygen concentrations, and nitrate concentrations diminish as a result of these impediments. Preliminary results indicate decreased O2 concentrations in these reservoirs and a tendency of lower pH close to the stream headwaters draining the mature forests. From January 2004 we will also be sampling runoff, soil solution and groundwater at these watersheds and measuring stream discharge at pressure transducer locations. In addition, storm events will be sampled four times on each stream during the rainy season to evaluate hydrologic flow paths during storm events.

Presenting Author: Ricardo Figueiredo (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Aquatic Systems and Biogeochemistry

7.14: Dissolved CO2 in the Bacia Ji-Parana: A Preliminary Nested Model of Sources and Fate

Simone Alin, Alex Krusche, Jeffrey Richey, Daniel Victoria, Nei Kavaguichi Leite

A central question in elucidating the coupling between terrestrial and aquatic systems in Amazônia is, "what role does the outgassing of CO2 from the river system to the atmosphere play in the carbon cycle?" Ultimately, this is a problem in scaling, from determinations of soil CO2 through riparian transformations, down stream and river channels, and to the atmosphere and ocean. As part of an analysis of the overall basin, we examine here the dynamics of a "nested, mesoscale basin, the Ji-Paraná River Basin, located in the State of Rondônia, Western Amazônia. The diversity of landcover in this 75 thousand km2 provides a diverse environment in which to develop models of how carbon signals change during transport through a river system. Here we present a preliminary coupled model of hydrology and biogeochemistry that begins to provide a bridge from local measurements to regional patterns.

Presenting Author: Simone Alin (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Aquatic Systems and Biogeochemistry

Carbon Cycling and Meteorology

8.1: Rainfall Variability in Rio Branco-AC, Brazilian Amazonia: Is it a Consequence of Deforestation?

Alejandro Fonseca Duarte

Variability in regional climate that may be attributable to human activities over the past 30-50 years deserves particular interest. In the present work a signal of rainfall variability is presented. A time series of daily rainfall values in the interval from 1970 to 2000, observed at a surface meteorological station in Rio Branco, Acre, Southwestern Brazilian Amazonia, was analyzed. The rainfall plot corresponds to a non-stationary time series of length 11,323. The trend of the series fits the data to a quadratic polynomial. Local rainfall varied from a mean of about 4.5 mm/day at the beginning of the measurement period (~1970), reached a maximum of 5.6 mm/day (~1990), and now there is in a decreasing stage with a value of 5.2 mm/day (~2000). At the same time large scale deforestation occurred in eastern Acre. A relation between rainfall variability and deforestation may exist.

Two main components were identified in the time series: a slowly varying trend across three decades and the day-to-day fluctuations defining the time series itself. To remove the fluctuations and obtain the trend of the time series a smoothing process was used and a quadratic polynomial fit was derived by using linear least squares method. Removal of the trend allowed us to investigate the fluctuation behavior of the time series (Yu He, 1999).

Presenting Author: Alejandro Fonseca Duarte (Poster)

Science Theme: TG (Trace Gases)

Session: Carbon Cycling and Meteorology

8.2: Estimating site level differences in ecosystem process parameters using eddy flux data and a toy model

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Several LBA investigations are generating a large amount of continuous data on net ecosystem carbon exchange and other micrometeorological variables. Most terrestrial biogeochemical models assume that plant and soil ecophysiological parameters vary little or none within functional types (e.g. tropical forest). This assumption forms the basis of a working hypothesis that we have tested with a very simple statistical model of hourly ecosystem carbon fluxes, and a Bayesian statistical data assimilation technique. We will present parameter estimates and their associated uncertainties. Site-level differences in parameters will be discussed in the context of seasonal scale exchanges of carbon in the Amazon forests.

Presenting Author: Bobby Braswell (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.3: Calibrating the carbon and energy-water exchange processes represented in the SiB2 model for the natural forest ecosystem in the Amazon

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Over the last decade, carbon exchange processes have been introduced into some of the more realistic and important land-surface models used in General Circulation Models (GCMs). In particular, carbon exchange is now calculated (albeit in an appropriately simple way) in the second-generation Simple Biosphere Model (SiB2). This paper discusses automatic calibration of the description of the carbon and energy-water exchange processes represented in SiB2 using state-of-the-art multi-parameter estimation techniques and long-term measurements of fluxes over undisturbed Amazon forest. In this first paper uses data from the km 67 primary forest tower site in Santarem. Optimization of the parameters in SiB2 was made by simultaneously minimizing the Root Mean Square Error (RMSE) between time series of observed and modeled latent- and sensible-heat fluxes and CO2 exchange. This procedure provides values of preferred sets of the many model parameters used in SiB2 in the different conditions for which extended time series of undisturbed forest data are available through the LBA Experiment. In most cases the optimization algorithm defines preferred parameters that lie comfortably within the predefined range of plausible values, but in some cases the preferred values are close to the edge of this range. The RMSE between modeled and measured fluxes was significantly reduced when the optimized parameters were used over the "default" values of parameters that would otherwise be assigned in SiB2 for the tropical forest biome. It should be noted that model calibration also (implicitly) provides an extra level of quality control on the LBA data by flagging times when individual data points are inconsistent with the remainder of the data.

Presenting Author: Eleanor Burke (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.4: Variation photosynthetic radiation in a primary forest in western Pará, Amazonia

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The principal goal of our study is to characterize the solar radiation regime in the subcanopy enviromen for a rain forest.
The experimental site is located at Tapajós national forest (2,51180 S, 54,57290 W) in a primary tropic forest. At this site a micrometeorological tower of 65m was installed with a set of pyronameters (Kipp a Zonen, model CNR1) and PAR sensors (LIQUOR model LI 191AS) photosynthetic active radiation. They take solar radiation measurements of total incident and reflected. A network of 16 pyronameters (LIQU Li-190 model) was installed around tower to measure total radiation incident upon the forest floor. For comparison between total radiation and PAR, one PAR sensor was include in the network.
The meassument took place 07 to 14 July of 2003, at 10:00 to 14:00 and total showed that the rate of PAR (photosyntetic active radiation) and incident solar radiation the canopy was 36,24% while in the subcanopy it was 4,26%.
In the canopy, the Par-Albedo (ratio of PAR radiation reflected and radiation incident PAR) is 0.02134 .T average of PAR incident radiation is 1226 mol/m2/s.
In the subcanopy, the maximum average of PAR radiation was of 40.285 mol/m2/s, and minimum average was of 1.148 mol/m2/s.
The PAR incident radiation on the canopy is approximately 8 times greater than in the subcanopy. The average PAR radiation absorption of 97.457% is explained by high-density of the vegetation.

Presenting Author: Irene Sampaio (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.5: Energy balance and CO2 fluxes in a cerrado area after fire

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* In Memoriam

This study was conducted at in the RECOR, Brasília, DF, with the objective to measure the recovery of phytomass and the evapo-transpiration rates and CO2 and water vapor fluxes. The eddy covariance technique was monitored from August/2000 to October/2002. The slope of the energy balance equation in three years wasn't significantly different. The variation in the components of the energy balance equation for the rainy season was: 451 to 716 Wm-2 for solar radiation (St); 240 to 433 Wm-2 for liquid radiation (Rn); 111 to 216 Wm-2 for sensible heat (H) and 120 to 189 W m-2 for latent heat (lE). In the dry season the values varied from 394 to 742 Wm-2 for St; 187 to 433 Wm-2 to Rn; 119 to 262 Wm-2 for H and 74 to 111 Wm-2 for lE. About 45% of the radiation balance was used in the evapotranspiration process during the rainy season. The values of fluxes in the ground (g) varied from 17 (rainy season) to 14 wm-2 (dry season). The slope of the energy balance was 0,93. The sensible heat represented 46% of Rn during this period. The stomata resistance varied from 158 to 278 sm-1 in the wet season and 391 to 259 sm-1 in the dry season. The values of maximum photosyntheses had varied from 5,9 mmolm-2s-1 (dry season) to 10,7 mmol.m-2.s-1 (wet season). During August and September, when the area functioned as carbon source for the atmosphere, the maximum value of absorption was -3,46 and -3,33 mmolm-2s-1, respectively.

Presenting Author: Jair Maia (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.6: Surface CO2 Spatial variability over logging and primary Old Growth Forest: topography effects

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The investigation of advective effects in complex terrain requires an experimental setup, which is capable to precisely measure the horizontal concentration gradients of a property (i.e. CO2). This work show some informations about dynamics pattern of the CO2 horizontal gradients during day and nigth time in two differents stand tropical forest. Some spatial and topographical aspects and its effects in the CO2 horizontal gradients are discussed.

Presenting Author: Julio Tota (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.7: Horizontal Advection of CO2 in the Old Growth Forest: LBA preliminarily results

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At night time a shallow thermal inversion develops near the surface and deepens with time, under low wind speed conditions and radiational cooling. In this case, if terrain is not level, a drainage flow (katabatic wind) will develop. In the forest ecosystem the flow above the canopy become decoupled from the flow just above and within canopy. Therefore, drainage flow will carry respiration from foliage, boles, and soil downslope. Eddy covariance systems above canopy will not detect this flux and subcanopy sensors are likely to grossly underestimate it. A horizontal gradient in CO2 coupled with a persistent flow in a certain direction, can create non-zero horizontal advection terms of the form (u)(dc/dx), which are commonly assumed to be zero.
In this work we try to show preliminarily results from measurements of the horizontal advection of CO2, which may explain the missing vertical CO2 fluxes on calm nights, when the eddy covariance technique fails to properly detect nocturnal respiration. The aim is to actually measure this term to determine its significance. Will be present and discusses some spatial and temporal variability aspects.

Presenting Author: Julio Tota (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.8: The Influences of fresh water co2 effluxes and mesoscale circulations on regional carbon balance in the Tapajos Region, Para, Brazil

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We have investigated mesoscale variations of atmospheric co2 over a heterogeneous landscape of forests, pastures, and large rivers during Santarem Mesoscale Campaign (SMC) during August 2001. We simulated the variations of surface fluxes and atmospheric concentration of co2 using the CSU Regional Atmospheric Modeling System (RAMS) on 4-level nested grids which including a 1-km finest grid centered on the Flona Tapajos. Surface fluxes of co2 were prescribed in the model using idealized diurnal cycles over forest and pasture vegetation, and over surface water using a value suggested by in-situ measurements in the Amazon River. Heterogeneous vegetation types were derived from the 1-km International Geosphere-Biosphere Programme (IGBP) land-cover dataset version 2.0. Our simulation ran from 1 through 15 August 2001, which was concurrent with our SMC. The results demonstrated that the local topography, the roughness length, the "T" shape juxtaposition of Amazon and Tapajos Rivers, and the resulting horizontal and vertical wind shears, all facilited the generation of local mesoscale circulations. The explanation for the mechanisms producing the lower level convergence line on the east bank of Tapajos River during the strong trade-wind days will also be presented. Meanwhile, we investigated the effects of surface water co2 effluxes on the regional carbon balance. The simulations with and without specifying co2 fluxes from the rivers and inundated land were performed. The result demonstrated that surface water co2 fluxes modify simulated co2 concentrations, especially at night. We are currently collecting and processing SMC measurement data, and hope that our modeling study can help the interpretation of [co2] distribution observed by towers and light aircraft.

Presenting Author: Lixin Lu (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Carbon Cycling and Meteorology

8.9: Case study of a gravity wave event above Amazonian Forest at Jaru Biological Reserve, Rondonia, during dry-to-wet season

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Increasing number of observations in the Brazilian/European/US LBA Project show that the Amazon forest have a key influence on the regional and global climate system, both by generating an important part of global surface evapotranspiration, and by acting as an important sink of atmospheric carbon. CO2 fluxes, as well as water, heat and momentum fluxes and other meteorological variables have been measured in an undisturbed rain forest site in the Jaru Biological Reserve, Rondônia State, Brazil, since early 1999. Flux calculations used in these observations often rely on the Eddy-Correlation (EC) method, but it is still subject to large amount of uncertainties, especially under non-stationary conditions. From the tower measurements framework, non-stationary conditions present phenomena with temporal scales larger than the familiar turbulent scales, like gravity waves, for example. In this study a gravity wave case was detected in the 10.4Hz sampled data collected at 62m height, above the Amazonian forest canopy. The phase difference between the velocity vertical component and the temperature was analysed to understand the influence of such phenomena in the turbulent exchange process. Preliminary phase difference results have shown a possible gravity wave – turbulence interaction. In order to compare with a typical turbulent situation, the analysis was performed on a "downdraft" event, a phenomenon that occurs almost in different scales that the ones of the gravity wave event. In this case the phase difference values were concentrated around pi (radians), the expected value for the phase difference in a turbulent situation with negative fluxes in the Nocturnal Boundary Layer. The turbulent signals were also decomposed in scales using the Wavelet Transform, so that specific scales could be visualized separately. For the future, we expect to find another gravity wave event and perform the same analysis for signals measured inside the canopy.

Presenting Author: Luis Marcelo de Mattos Zeri (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.10: Determination of air parcel trajectories associated with an Amazonian storm

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This work aims at analysing the circulations inside clouds of an Amazonian storm in a lagrangean point of view. The lagrangean model allows the determination of forward and backward trajectories, and it can be used to determine both the origin and destination of some materials, such as trace-gases and biomass burning products. The analysed storm was formed close to Pará State coast on August 10th 2001 afternoon, and propagated inland, reaching Santarém on the 11th early morning. In spite of small amount of rain, this storm induced changes in atmospheric features, especially close to the surface.
Trajectories were determined from RAMS numerical model outputs. This model contains a soil and vegetation model which is coupled to the atmosphere. Three nested domains were considered, including most of the Amazon basin. The region affected by the system was simulated with higher horizontal resolution. The trajectories which were originated in the mixed layer during the developing stage leave the cloud in different heights (between 3 and 12 km above ground), indicating high variability in the destination. On the other hand, during the later stages, the system neither transport air parcels to the higher levels, nor has much direction variability.
The backward trajectories in the mixed layer show mainly a low-level origin of air parcels, and rarely come higher than 3km. This transport is associated to small-scale downdrafts, which are normally associated with mixing between environment and inside-cloud air.

Presenting Author: Marcos Longo (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.11: Impact of soil moisture on tropical dryline storm formation and development

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Convection on Amazon basin represents an important link between surface features and the atmosphere, while playing a major role in the trace-gas and biomass burning product budgets. The aim of this work is to evaluate the impact of spatially heterogeneous soil moist field on formation and development of a tropical dryline, of which dependence on surface conditions for the development is known to be important.
The soil moisture determination is derived from antecedent precipitation estimative by satellite, associated with a simple hydrological model. On the other hand, the water storage in soil can be well represented provided that both biophysiologic and soil features are adequately described. This was achieved including in the model current available land use and soil textural class maps for the entire South America. The storm simulation was performed by the RAMS model. This model contains a soil and vegetation model which is coupled to the atmosphere.
The analysed dryline was formed in Goiás state on October 16th, 2002, and moved towards Mato Grosso state, reaching the Amazon southern part. Simulation results show that the introduction of realistic soil moisture was fundamental to reproduce both the storm position and structure. When homogeneous soil moisture was considered, the system was not confidently reproduced: the simulated clouds were scattered, without the typical squall line organization.

Presenting Author: Rodrigo Gevaerd (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

8.12: Atmospheric CO2 Budget over Amazon Basin: The Role of the Convective Systems

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This work study the CO2 budget in atmosphere on Amazon basin focusing the role of the shallow and deep convective systems. The vertical redistribution of the trace gases by these systems is numerically simulated using a Eulerian transport model coupled to a regional atmospheric model. The transport model includes advection at grid scale, diffusion in the planetary boundary layer (PBL) and convective transport by sub-grid shallow and deep moist convection. Two tracers are simulated: carbon monoxide and carbon dioxide. Source emissions of CO and CO2 associated with biomass burning activities in tropical forest, savanna and pasture are parameterized and introduced in the model. The sources are spatially and temporally distributed and daily assimilated according to the biomass burning spots obtained by remote sensing. The biogenic surface flux of CO2 is parameterized by correlation between NEE and surface net radiation using flux tower data at Santarem. The model is applied to the 2 cases. July 2001 and November 2002. At the first case, we compare the model results with CO2 observations collected on Amazon basin during CLAIRE experiment, foccusing the model validation and PBL budget. In the second case, we introducce also the biomass burnning CO and CO2 emissions, present the simulated vertical profile of both gases and discute the rectifier effect on the CO2 concentration.

Presenting Author: Valdir Herrmann (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Meteorology

Carbon Cycling and Physiology

9.1: Differences in decomposition rate of leaves at the Tapajós National Forest.

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The Amazon forest is an ecosystem that stores a large quatinty of Carbon (C) and is in constant interaction with the atmosphere. Significant pertubations such as deforestation can modify the C cycle and cause environmental consequences on regional and global scales. Decomposition of vegetation is an essential process in the nutrient cycle and can influence the acumulation of C and nutrients in various layers of the soil. Thus, differences in decomposition rate of leaves can determine differences in the rate of C release into the atmosphere. Factors such as temperature, precipitation and nutrient quatity, and activity of micro and meso fauna, among others, can effect rates of litter decomposition. We present results from an experiment at the Tapajós National Forest, Pará, Brazil, designed to contrast litter decomposition rates in undisturbed areas with rates in areas where selective logging occurs. Decomposition of dehyrdated deciduous and evergreen leaves was estimated by measuring biomass lost in litterbags randomly distributed in selectively logged and undisturbed areas over 12 months. Litterbags included microfauna but excluded mesofauna. Decomposition rates were highly variable; there was no significant difference between selectively logged and undisturbed areas. We conclude that selective logging in itself does not effect the rate of decomposition of leaf litter. More work is required to determine whether selective logging has an effect of overall C release: several mechanisms not examined in this study (e.g. increased litter quantitiy due to logging; presence of mesofauna) could strongly influence the overall C budget.

Presenting Author: Cleilim Sousa (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.2: Coarse woody debris in the Tropical Forest of the Bananal Island Region, Tocantins State

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Coarse woody debris (CWD) represents an important component of the carbon cycle in the tropical forests. We measured the volume and dry weight of fallen coarse woody debris at the region of Bananal Island, 02´12"). We worked at two areas (9 58´41" W 50 02´12") in the east of Tocantins State. The areas are divided according to the likelihood of inundation (Rarely Inundated (RI) and Annually Inundated AI). We sampled in the months of October and November 2002 using the line intercept method. Dead standing trees were not included. We divide the material into three classes according to diameter: 2-5 cm, 5-10 cm and >10 cm.
In the RI areas the dry weight of CWD was 16.17 Mg ha–1, approximately 100% greater than in the AI areas where we found 7.74 Mg ha–1. A one-way analysis of variance did not detect statistical differences (P=0.245) between the areas. In the RI areas the majority of the CWD (61%) had a diameter greater than 10 cm, whereas in the AI areas, the small and middle diameter groups predominated. In the two areas no CWD in decomposition class 1 (newly fallen wood) was found. The study show that's CWD represent approximately 10% of the total living biomass in the forest of Bananal Island region. This percentage is similar to the data obtained in the Central Amazon. The CWD in the forest region of the Bananal Island is five times less when compared to the primary forest areas near Santarém and Paragominas.

Presenting Author: Dariusz Kurzatkowski (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.3: Evaluating MODIS Land Products at a Tropical Moist Forest Site

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The satellite-borne Moderate Resolution Imaging Radiometer (MODIS) is operationally producing estimates of land cover, leaf area index (LAI), 8-day gross primary production (GPP), and annual net primary production (NPP) for each 1 km2 of the Earth's terrestrial surface. Validation of these products requires a combination of ground measurements, modeling, and fine resolution remote sensing. The BigFoot Project is carrying out validation studies using a consistent scaling protocol at 9 sites representing different biomes. The tropical moist forest site is at Km 67 in the Tapajos National Forest in Brazil, and ground measurements were begun in June of 2003. Fifty plots were established over a 5 km x 5 km area centered on an eddy covariance flux tower and measurements of forest cover, LAI, litterfall, and bolewood production are on-going. Flux tower measurements of net ecosystem exchange will be used to estimate daily GPP. The MODIS land cover classification for the 25 km2 study area is Evergreen Broadleaf Forest and the mean LAI is about 5.0. For 2002, the MODIS GPP in the area was 2,200 gC/m2/yr. New MODIS products for 2003 will be compared to the BigFoot products. The BigFoot scaling approach permits analysis of the multiple components of the MODIS GPP/NPP algorithm and will be used in efforts to refine its parameterization.

Presenting Author: David Turner (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Carbon Cycling and Physiology

9.4: Physiological responses of tree species growing under different site conditions in the Central Amazon

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The forest management research group at INPA (National Institute for Research in the Amazon, Manaus, AM, Brazil) was initiated in 1980 to study the impact of selective logging on ecosystem structure and functioning. Logging was carried out in 1987, and the field experiment (three replications; three different felling intensities and control plots) covers an area of 72 hectares. So far, several studies related to environmental impacts have been carried out. Fifteen years after logging, due to a continuous decrease in growth rates, silvicultural treatments will be required to maintain stand productivity if the planned cutting cycle is followed. Unique physiological characteristics of individual tree species play an important role in defining when, and to which individuals, to apply silvicultural treatments. Additional studies focused on physiological measurements of tree trunks and canopy leaves. There was a significant negative correlation ($r = -0.86$, $p < 0.001$) between height (h) and specific leaf area (SLA), which could be described by the following function: $SLA = -3.23h + 149.6$. On average, photosynthesis during the dry season was 30% lower than during the wet season. Trunk respiratory fluxes (R) in managed forests were dependent on growth rates (G) as well as on diameter at breast height (DBH); this relation was described by $Ln(R) = -2.549 + 0.545\ Ln(DBH) + 0.315G$. In pristine forests, trunk respiration averaged 0.78 g C m-2 day-1, with seasonal differences that varied with topography.

Presenting Author: Edgard Tribuzy (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.5: Scaling up woody-tissue respiration at the Tapajos National Forest

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The carbon balance of tropical forests is very uncertain. It is believed that autotrophic respiration accounts for approximately 50% of the total respiration and 25% of annual assimilated carbon by photosynthesis in tropical forests. Woody tissue respiration (sum of stem and branches) is estimated to consume 10% of the gross primary productivity (GPP) in temperate and boreal forests. It is expected that in tropical forests this value is proportionally greater because of the greater biomass. Fluxes of woody-tissue respiration have been measured at the Tapajos National Forest (TNF) since 2000 using an open system consisting of infrared gas analyzer, where the average flux 1.5 mmol m-2 s-1 (for tree surface area). The biggest uncertainty of these numbers is the extrapolation of the flux to the stand level. Currently sapwood volume is used to extrapolate wood respiration at high latitudes. However, in the tropics it is difficult or impossible to measure sapwood thickness using conventional methods of dying live cells. Recent studies in Amazon and other tropical sites around the world have used tree surface area to extrapolate the fluxes. The purpose of this study is to establish a stem area index to extrapolate flux of stem and branches for the trees of the TNF based on measurements of harvested trees at the km 83 during the dry season of 2003. After tree are felled the following values are recorded: dbh, tree height, minimum stem diameter, minimum and maximum diameter of branches, bulk density of wood, and branch dry weight using statistical sampling. Surface area of wood will be calculated using a combination of Valentine's and Yoda's equations.

Presenting Author: Evilene Lopes (Poster)

Science Theme: TG (Trace Gases)

Session: Carbon Cycling and Physiology

9.6: Coarse woody debris-atmosphere flux of CO2 at the FLONA Tapajos, Brazil

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Much uncertainty in the global carbon budget is associated with the role of vegetation. Examining the contribution of individual carbon pools to forest respiration will enhance our knowledge of structure and dynamics of forests and improve our understanding of ecosystem-atmosphere carbon exchange. One pool of carbon that is insufficiently quantified is coarse woody debris (CWD), especially for tropical forests. CWD production is correlated to living biomass as it increases with forest age and productivity. CWD respiration was measured at the FLONA Tapajos, Brazil in undisturbed forest at the km 67 and in selectively logging areas at the km 83 to compare the rates of respiration from different levels of disturbance. At the km 67 we observed average respiration rates (on a wood area basis) of 2.5 ±0.3 micro-mol CO2 m-2 s-1 while the fluxes observed at selective logging areas were 3.9 ±1.5 micro-mol CO2 m-2 s-1. CO2 fluxes from CWD were strongly correlated to wood water content.

Presenting Author: Hudson Silva (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.7: A Contribuição da Queda e Decomposição de Liteira na Respiração de uma Floresta Tropical de Transição em Sinop/MT

Luciana Sanches; Marcelo Sacardi Biudes ; Nicolau Priante Filho; Kelli Cristina Aparecida Munhoz; Anderson Ortiz Alves; José de Souza Nogueira; Fernando Raiter; Jansen Luiz Trierweiler; Wander Hoeger; George Louis Vourlitis

O objetivo principal deste trabalho foi estimar as produções mensais e a decomposição de liteira acumulada sobre o solo, taxa e dinâmica de liteira numa área de floresta de transição na região de Sinop-MT.Este estudo foi desenvolvido em uma área localizada a aproximadamente 50 km NE de Sinop, Mato Grosso, Brasil (11°24.75'S: 55°19.50'W), próximo a uma torre equipada com sistema de medição de fluxos de massa e de energia numa floresta nativa daquela região. Foram estimadas: a variação sazonal na produção de liteira (queda de liteira), a taxa decomposição pelo método proposto por Wieder & Wright (1995) e a dinâmica da decomposição pela coleta em "litter bags". O monitoramento dos fatores ambientais, foi feito através de equipamentos de medidas micrometeorológicas (HMP-35, Vaisala, Inc., Helsinki, Finland; 2501 Sierra-Misco, Inc., Berkeley, CA, USA).
Conclui-se para os três anos em estudo que a maior fração da composição da queda de liteira é composta por folhas, seguida de galhos e flores e frutos.
Que durante os intervalos de baixa precipitação e de temperaturas elevadas, houveram os maiores acúmulos de liteira no solo, entretanto não houve uma acelerada velocidade de decomposição na mesma.

Presenting Author: Luciana Sanches (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.8: Throughfall reduction on the seasonal canopy physiology of an Amazon forest

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We are studying the effects of partial throughfall exclusion on the photosynthetic capacity (Amax), specific leaf area (SLA) and foliar nitrogen of twenty tree species (representing 15 families and different ecological groups) in a primary forest area, in the State of Pará, Brazil. Light response curves are being measured, at least four times a year, on undamaged, mature leaves, using an infrared gas analyzer with an attached red LED light source. The same leaves are used for SLA and leaf nitrogen measurements. For all species curves are being measured for attached leaves, between 8 and 12 h local time, at between 10 and 25 m. Amax was significantly lower in the rainfall exclusion plot. For most species, SLA was also lower in the rainfall exclusion plot. We also observed a positive and significant correlation between foliar nitrogen and SLA, during the peak of the dry season, in the throughfall exclusion treatment.

Presenting Author: Moacyr Dias-Filho (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.9: The effects of partial throughfall exclusion on phenological patterns of Coussarea racemosa (Rubiaceae)

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Severe drought episodes provoked by El Niño Southern Oscillation (ENSO), and possibly through deforestation-driven reductions in rainfall, are having an increased impact on tropical rainforests in Amazonia and elsewhere. Alterations in the phenological patterns of some species are a likely consequence of these changes. This work focuses on a common mid-canopy tree species Coussarea racemosa to test the hypotheses that (1)drought would inhibit physiological processes, limiting reproductive events over the long-term; and (2) fruits become more susceptible to predation under drought stress. The experiment is being carried out within two structurally and floristically similar 1-ha forest plots, a treatment (T) and control (C). Fifty percent of incoming precipitation is excluded from the T plot during the ~6 mo wet season using a system of plastic panels located in the forest understory. Fruit production was measured every 15 days using ~100 0.5m2 litter traps in both plots. This analysis concentrates on collections made over a 3 yr period between April 2000 and August 2003. Seeds and fruits were identified to species, oven dried, and weighed. Phenological observations of individual C. racemosa trees (T=15, C=9) were also carried out monthly from catwalks . Preliminary results indicate that fruit production of this species has been reduced by 30% in the T plot relative to the C plot. Moreover, when these fruits were opened on July 2003, only six percent contained seeds in the T plot, and 70 percent showed signs of herbivory, contrasting with 70% and 46%, respectively, in the C plot. Persistent drought has resulted in dramatic changes in the fruiting phenology of this abundant species.

Presenting Author: Paulo Brando (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Carbon Cycling and Physiology

9.10: Effects of throughfall exclusion on herbivory in the National Forest of Tapajós, Amazônia, Brazil

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Reduction in soil water availability induces dramatic changes in plant physiology, such as changes in the quality and concentration of nutrients and other compounds of leaf. Under soil water deficit the nutrient concentration in leaves may be reduced, making them less attractive to insect herbivores. On the other hand, the water stress can also reduce the concentration of defense compounds (e.g. alkaloids) making leaves more susceptible to herbivores. In this study, we evaluated the patterns of herbivory of tree leaves submitted to water stress. The field work was carried out at the Tapajós National Forest (mean annual rain 2000 mm), near Santarém, Para State, during 2002. We used a throughfall exclusion experiment established in 1999 in which plastic panels exclude between 50-60% of throughfall in a one-hectare treatment plot during the exclusion period (early January through late May) of 2000, 2001 and 2002. A control plot has no panels. In each plot, we collected leaves from five branch selected from trees of a common tree species, Coussarea racemosa (Rubiaceae). We ranked the level of herbivory for each leaf. Leaf herbivory was significantly lower in the treatment plot (20% of all leaves inspected) than the control plot (40%). The relationship between soil water stress and leaf susceptibility to herbivores for more tree species is now under investigation.

Presenting Author: Paulo Moutinho (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Carbon Cycling and Physiology

9.11: Isotopic signature of litter in primary tropical forest

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Samples of litter were collected and separated into fractions during one year in Flona Tapajos, Santarem and analyzed for isotopic composition. The 13C signatures showed little
difference between the fractions and with season.

14C values of leaf litter collected in baskets are consistent with elapsed times of 2-3 years between photosynthesis and leaf abscission. The 14C signatures of young leaves from various tree species suggest that some new leaves may grow using nonstructural carbohydrate with higher 14C values.

Presenting Author: Plinio Camargo (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.12: Soil Water Contents in Caxiuanã Forest LBA Site; PARÁ, BRAZIL.

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This study have been carried in Ferreira Penna Scientific Station (1º43' S; 51º32' W) with area of 33,000 hectares from Museu Paraense Emilio Goeldi (MPEG), into the Caxiuanã National Forest Reserve, with an area of 3300 km-2 belonging to the Brazilian Institute of Environmental Resources (IBAMA) far from about 400 km Westward of city of Belém, Pará, Brazil. For the soil water content measurements was used the TDR (Time-Domain Reflectometer) system, using Tektronic 1502B/C equipment with WATTDR 3.11 software (Waterloo Centre for Groundwater Research). The experimental site was separated in three different areas; Plot A, Plot B (with 1 ha each) and Plot T, where is installed the micrometeorological LBA tower. In the Plots A and B were made four trenches in each one (with 1x2x5 meters width/length/depth each) where were installed the soil water probes, in two sides, at different levels, from surface to 5 meters deep. In the Plot T were made two trenches like the others. The Plot B is being used for the ESECAFLOR Experiment, and was covered by plastics panels (December 2001), to simulate a drought period in the forest for analysis of them influences. The soils at Caxiuanã are from moderately drained to well-drained, sandy to clay, acidic and poor of nutrients, with a pH ranging from 3.5 (highly acidic) to 5.5 (moderately acidic). Monthly soil water content measurements are being made since September 2000.The analysis indicated large variation in the soil water volumetric contents among the plots A, B and T. Before to be closed, the Plot B registered +1.1% in July 2001, and +8.4% in December 2001 (B>A). After to closed the plastic cover in the Plot B, this area reached – 27.8% in July 2002, and –34.6% in July 2003 soil water content, when compared with Plot A. This characterisation is important for assessment of the soil in view of the expected changes in soil characteristics during and after the ESECAFLOR Experiment. It is very important to assess the impact of drought on water balance, carbon dioxide fluxes and carbon stock in the soil to investigate future sustainability of the Amazon forest ecosystem.

Key words: ESECAFLOR, Soil Water Content, Forest and Amazônia.

Presenting Author: Rafael Ferreira da Costa (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.13: Methods to define the individual growth patterns of the principals tree species in the Manaus region, Amazonas, Brasil

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This study deals with the analysis of individual growth patterns for tree species distributed over two transects (East-West and North-South) measuring 20 by 2500 m. Two different approaches were used: (1) In each tree a metal "dendrometer" band was fixed to the trunk, and growth in circumference was measured with a digital caliper, and (2) automated dendrometers composed of four sensors and data logger were used to monitor the radial development of three different species (Dipteryx odorata (Aubl.) Willd., Scleronema micranthum Ducke and Eschweilera coriacea (DC) Mart. Ex Berg). In approach (1), measurements were carried out for 36 months, from October/1999 to September/2002. In approach (2), the monitoring was done hourly during 12 months (June/2001 to May/2002). Based on approach (1), individual growth patterns varied significantly over time ($p < 0,001$), and when the following interactions were included: months and transects ($p = 0.02$) and months and diameter classes ($p = 0.002$). On the other hand, the signal was very weak ($p = 0,83$) when the interaction months and topographical classes were considered. Mean annual increment in diameter considering all 272 monitored trees was 1,77 ± 0,27 mm yr-1 (CI 95%), falling within the interval estimated for BIONTE and Tapajós National Forest which are 1,5 and 2 mm per year, respectively. Approach (2) confirmed ($p < 0.001$) the monthly growth patterns obtained by the metallic bands when growth over time (monthly) and the interaction months and species were considered; however, when the variable hour was included in the interactions with months, species and growth types, the results were not statistically significant.

Presenting Author: Roseana P. da Silva (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.14: Global changes and tree growth rate in the Amazon Forest

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

Presenting Author: Simone Vieira (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

9.15: Relationships among photosynthesis, foliar nitrogen and stomatal conductance in tropical rain forest vegetation

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Significant physiological correlations have been observed in leaves of tropical forest trees between maximum photosynthetic carbon assimilation rate and foliar nitrogen concentration. We are conducting photosynthetic measurements of forest and pasture species in order to characterize potential functional response changes between wet and dry seasons. Stomatal conductance is a function of both carbon assimilation rates and environmental factors, including ambient relative humidity and carbon dioxide concentration. Our work concentrates in obtaining physiological parameters from several plant species belonging to primary forest and pasture ecosystems close to Santarém (PA), Brazil in order to parameterize canopy-scale photosynthesis models. To facilitate physiological characterization of rainforest canopies, we adopted a functional group approach based on the hypothesis that plants acclimate to the environment that they are experiencing. The species evaluated on our study have been distributed among the following groups: top canopy lianas, top canopy trees, mid canopy trees and understory trees. So far, we have not detected common trends concerning photosynthetic changes between wet and dry season. The available evidence indicates that lianas differ in their general gas-exchange characteristic from trees at the top of the canopy, justifying the separation of these life forms into two distinct groups with different impacts on canopy productivity.

Presenting Author: Tomas Domingues (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Carbon Cycling and Physiology

Land Use and Land Cover Change

10.1: A Progress Report on the Basin-scale Econometric Model

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Regional landscape projections constitute a valuable tool for identifying policies that can address the development needs of Amazonian populations while minimizing loss of ecosystem integrity. By observing land-cover changes under historical conditions and projecting them into the future, we can evaluate impacts of policies and of economic changes upon Amazonian forest dynamics.

Our basin-scale model relies on economic theories of land use emphasizing profit maximization. By estimating the probability of forest clearing as a function of the factors that affect profitability, including infrastructure, prices and policy, we generate projections of land cover across the basin. One way we will advance beyond past analyses is through the use of data at the census-tract level.

Special attention will be given to the roles of roads in affecting transport costs and deforestation.
The poster "Roads: cause or consequence of land-use change?", a progress report on fieldwork in this project, conveys evidence from multiple regions to inform econometric exploration of roads.

As conveyed within the accompanying figures, we are starting to work with the census-tract data. We will continue to explore the economic dynamics at this level, with a focus on changing roads and transport costs. We are overlaying remotely sensed data for forests on the census-tract maps, to complement the agricultural census data shown here. Further, we are matching census tracts over time and collaborating to improve the data on ecological explanatory factors. All of these types of data will be combined with recent techniques in the empirical application of our model.

Presenting Author: Alexander Pfaff (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.2: The Impact of Understory Fires in the Amazon Transitional Forest: A Remote Sensing Perspective

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Understory forest fires are becoming more frequent events in Amazon landscapes. Depending on the forest type, the intensity of the drought, the landscape fragmentation and the potential for ignition sources, these fires can affect larger areas each year. The transitional forest structure and its location in one of the most accelerated frontier expansion of Amazon make the understory fire scenario even worse in this type of forest. To test the feasibility of using remote sensing techniques to estimate the impact and extent of understory fires in the transitional forest areas, Landsat ETM+ for northeast of Mato Grosso were combined with forest canopy openness and biomass, measured in the field. The analyses were conducted for images taken one and two years after the fire event for three unlogged transitional forest plots that had burned once and twice, respectively, and a pristine primary forest plot used as a control. Preliminary results indicate that after one year of the fire the ETM+ sensor was not able to detect the damage in areas that were only burned once, due to the similarity with the spectral data variability of the primary forest. For the twice-burned area the level of disturbance and tree mortality was high enough to enhance the difference between primary and burned forest even two years after the last burn. The difficulty of mapping areas of transitional forest that burned only once creates a barrier to the monitoring of forest impoverishment and CO2 emissions estimation and identification of forests under high risk of future understory fires.

Presenting Author: Ane Alencar (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.3: Hyperion data for ecosystem and land cover change studies in the Brazilian Amazon

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Hyperspectral observations of vegetation canopies provide information about their structure and chemical composition, and therefore potentially give insight into ecosystem state and function. A large number of EO-1 Hyperion acquisitions have been requested, targeted, and archived in support of LBA-ECO research. We present the characteristics of the data and an overview of the data that have been collected so far. Potential preprocessing and cooperative activities will also be discussed.

Presenting Author: Bobby Braswell (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.4: An index of anthropic pressure to estimate the deforestation potential in the Brazilian Amazon municipalities

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Socioeconomic dynamics drive the deforestation process that has deeply affected the Brazilian Amazon region. Thus, the planing for use and conservation of the natural resources of any particular Amazonian region must consider these socioeconomic dynamics both within this region and exerted from the surrounding regions to better evaluate their potential environmental outcome. To address this issue, we have developed a synthetic anthropic pressure index for the Brazilian Amazon municipalities based on demographic and agriculture census data. The fuzzy logic classification method (GOM - Grade of Membership) was applied to stratify the data into a four-dimensional space with axes named 1) demographic occupation, 2) gross domestic production, 3) agrarian infrastructure, and 4) agriculture and timber production, which were combined to produce the anthropic pressure index. Maps of these indices shows the spatial distribution of a hierarchy of municipios in Amazonia. Analyses of these indices together with the deforestation data provided by PRODES from INPE are being used to estimate the potential of deforestation as a function of regional socioeconomic growth.

Presenting Author: Britaldo Soares Filho (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.5: Software for Multi-Temporal Radiometric Correction, SMA and Image Classification: towards a generalized classification approach for monitoring the Amazon Forests

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In the first phase of our LBA research program, techniques for radiometric correction, illumination and atmospheric normalization, and image classification were developed (Roberts et al. 1998; 2002). A series of studies benefited from the use of these techniques to map land-cover change in deforested areas and forest degradation due to selective logging and burning (Roberts et al. 2002, Souza Jr. and Roberts 2002; Souza Jr. et al. in press; Numata et al., in press). This approach has the power to map large areas over time and space using standardized variables and generalized classifications rules applied to multiple sensor types. However, a single software package that includes all of these techniques is missing, thereby inhibiting their use in operational forest monitoring programs in the Amazon. To facilitate end-users, we have implemented two programs written using the Interactive Data Language (IDL) to be run in conjunction with ENVI. The objective of this manuscript is to describe these software tools. The first software package was developed to perform atmospheric correction using an empirical line regression approach. The program requires two spectral libraries, one derived from the image and the other a reference library in reflectance. Both libraries require a control file, which assigns a class to each spectrum (e.g., soil = 1, vegetation = 2, water = 3, etc.). All possible regression models are evaluated based on a minimum correlation coefficient and minimum RMS, and on the spectral shape of derived path radiance. A visualization tool was created to inspect the model results including the capability to view spectra of regression coefficients, modelled reflectance, residuals or path radiance. The second software package was developed to perform relative radiometric calibration using temporally invariant targets. The user can visualize the regression lines for each band, the calibration coefficients and the RMS of each invariant target and toggle invariant targets interactively to improve output models. Finally, the software allows users to apply the inter-calibration to the whole image, to a spectral library or to endmembers used in spectral mixture analysis. Two independent programs have also been developed to apply the atmospheric haze correction developed by Carlotto (Carlotto, 1999) and to implement multi-endmember spectral mixture analysis (MESMA; Roberts et al., 1998). Although this program suite currently requires IDL and ENVI, in the near future they will be compiled to run independently as Virtual IDL Machines. Future software developments include a program to implement a decision tree classification tool, currently available in S-Plus and R, and illumination correction routines to take advantage of SRTM data. To test the program suite, it is being applied to a mosaic of 20 Landsat TM/ETM+ scenes acquired in the Midland regions of the State of Pará, and being used to map land cover and quantify change.

Presenting Author: Carlos, Jr. de Souza (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.6: Deforestation and Malaria Incidence in Jacundá (Pará) Municipality Between 1973 and 1996

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Although deforestation happens in the entire Amazon region, its rates are the highest in Brazil, due to integration policies implemented mainly in the late 60?s of the twentieth century. The most deforested areas coincide with agricultural front towards the north of Para, Tocantins, Mato Grosso, Rondônia and Acre states, forming the so called ?deforestation arc?. The regions where the deforestation was more intense are located in states of Mato Grosso (approximately 60.000 Km2), Pará (57.000 Km2) and Rondônia (23.000 Km2). The Brazilian Amazon deforestation can be associated with several factors: increase of non native population since 1960 when between 2 and 20 million people migrated to the region attracted by fiscal incentive policies to implement agricultural projects and settlements; increase of logging and mining industry followed by highway network increased connectivity; dam construction related to the increased energy demand for the region?s water potential. For these reasons the deforestation advanced into the Amazon basin, enlarging the interface among forested areas and areas populated malaria no resistant population. In this research the relationship between deforestation rates in Jacundá municipality and malaria spatial distribution will be investigated. Malaria incidence data provided by the National Health Foundation for the period between 1973 and 1996 is being used. Deforestation data is being generated by satellite images Landsat (MSS in scale 1:250.000 for the years 1973 and 1979), digital images (TM for 1984 and 1996). This data is being integrated in GIS and will be submitted to spatial analysis. The results will permit to test the hypothesis that there is high spatial positive correlation between deforestation and malaria incidence, caused by the increase of man-vector contact. It will be possible to model the impact of the building of Tucuruí dam on malaria incidence. The hypothesis is that the reservoir causes an increase of infected people and of mosquito habitats.

Presenting Author: Cintia Vasconcelos (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.7: Mapping changes in forest canopy cover in Amazonia between 2000-2003 using MODIS VCF

Douglas Morton (1), Matthew Hansen (1), Marcelo Latorre (2), Yosio Shimabukuro (2), Ruth DeFries (1,3), Liana Anderson (2), Ellen Jasinski (1)

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The spatial and temporal dynamics of land cover change in Amazonia have important ramifications for local ecosystem function and regional climate modification. The most comprehensive deforestation monitoring system for the Brazilian Amazon is the INPE Projeto de estimativa de desflorestamento da Amazônia (PRODES), an annual analysis of Landsat imagery for 229 scenes covering the Brazilian Amazon and a rapid assessment of 50 scenes along the "arc of deforestation." PRODES provides a detailed understanding of the location and size of new forest clearings, but is unable to assess the temporal dynamics of land use changes. The Moderate Resolution Imaging Spectroradiometer (MODIS) sensors provide more frequent repeat coverage of the entire Amazon Basin than Landsat, thereby minimizing interference from clouds and providing the opportunity to assess land cover changes on a more frequent basis. Based on the 2000 and 2001 PRODES analyses, 82% of the area of new deforestation occurs in patches that are larger than one 500m MODIS pixel (25 ha). To test the ability of MODIS to detect deforestation, we compare the MODIS vegetation continuous fields (VCF) product at 500m resolution to PRODES for 2000, 2001, and 2002. We assess the change threshold of percent tree cover necessary to identify deforestation patches of various sizes in the VCF and errors of omission and commission at each threshold. Finally, we validate the 2003 VCF product with field measurements of canopy cover from June and July 2003 for 26 forest, cerrado, and disturbed forest sites in the Brasília Federal District, Mato Grosso, and Rondônia. Using the change threshold derived from the 2000-2002 PRODES and VCF comparisons, we identify deforestation between 2002 and 2003 in the MODIS VCF product.

Presenting Author: Douglas Morton (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.8: O LBA e comunidades rurais da região de Santarém: Experiência piloto de apresentação e discussao de resultados oriundos pesquisas efetuadas com agricultores da região

Eliazar Brait, Escritorio do LBA de Santarém
Ryan Adams, Departamento de Antropologia, Indiana University

Neste poster relatamos nossa experiência na organizaçao de encontros comunitários para apresentação e discussao de dados sócio-econômicos e ambietais resultante de pesquisas e entrevistas efetuadas com agricultores da região durante os últimos dois anos. Os dados resultam do projeto "Estratégias Humanas relacionadas com El Niño nas Florestas da Amazônia", financiado pela agencia americana NOAA. As pesquisas foram feitas à partir de uma colaboração entre o Centro Antropológico de Pesquisa e Treinamento em Mudanças Ambientais Globais (ACT) da Universidade de Indiana (Estados Unidos), a EMBRAPA (Empresa Brasileira de Pesquisas Agropecuárias), o IPAM (Instituto de Pesquisas Ambientais da Amazônia), e o LBA (Programa de Cooperação Internacional para pesquisas na região Amazônica) com a colaboração da população rural da região. Três encontros foram realizados nas regiões de Belterra, Mojui dos Campos, e Sao Jorge. O poster mostra um sumário dos dados apresentados e assuntos discutidos com e pelos participantes (na sua maioria pequenos produtores rurais). O poster conclui com reflexões sobre o papel do LBA na disseminação de informacões científicas sobre a região Amazônica.

Presenting Author: Eduardo S. Brondizio (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.9: Variabilidade inter- e intra-regional nas trajetorias de uso da terra entre differentes regioes Amazônicas

Francisco Oliveira, IBAMA, Brasil

Este trabalho examina a variabilidade na taxa, extensão, e direção nas mudanças no uso e cobertura da terra em dois níveis: inter-regional e intra-regional. Inter-regionalmente comparamos as regiões de Altamira, Alta Floresta, e Ponta de Pedras, tendo como base trajetórias de desmatamento, regeneração e manutenção de áreas abertas. Intra-regionalmente, comparamos estas trajetórias ao nível de comunidades localizadas dentro de cada região. Dados sensoriamento remoto e levantamentos sócio-econômicos são utilizados e apresentados. Imagens, fotografias aéreas e mapas históricos são utilizados para captar mudanças no uso e cobertura da terra de 1970 ao final dos anos 90, representando intervalos de aproximadamente três anos. O poster mostra o alto nível de variabilidade inter e intra-regioes e argumenta a importância de captar estas variações informar modelagem e políticas públicas relacionadas a questões de desmatamento. Estas variações são discutidas em função de diferencas históricas, situação fundiária, e ondas migratórias.

Presenting Author: Eduardo S. Brondizio (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.10: Evolution of timber management in southwestern Amazonia (MAP region – Brazil, Bolivia and Peru)

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Within southwestern Amazonia, the region of the Department of Madre de Dios, Peru, the State of Acre, Brazil, and the Department of Pando, Bolivia – called the MAP region – exists approximately 12 billion dollars' worth of high-quality timber. In 2001, about 500,000 cubic meters (Madre de Dios 130.000, Acre 340,000, and Pando 45,000) were extracted, an increase of 100,000 cubic meters over the previous year. Public policy announcements suggest that these values will increase greatly in the coming years and come from certified logging activities. In Acre during 2002, 80% percent of the timber came from clear-cutting for agricultural activities, only 5% from legal timber management plans and 15% of unknown origin. In Pando, all logging should come from concession areas, but 15% comes from private areas and probably clear-cutting. In Madre de Dios until 2001, all timber came from private areas; in 2002 Peruvian authorities began using timber concessions as the basis of legal logging. Only five tree species are being effectively commercialized in the MAP region. Loggers and representatives of enforcement agencies in joint meetings estimated that an average of 70% of the current timber comes from illegal sources in the MAP region. Such illegal activity needs to be reduced to make viable the certification of 'MAP wood,' a proposal of loggers from the three countries. Representatives of enforcement agencies of the three countries have proposed joint activities to reduce illegal logging and commercialization. The integrated participation of logging firms, government and non-government organizations, researchers, universities, and local societies has become a new alternative to promote long-term timber management in the MAP region.

Presenting Author: Elsa Mendoza (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.11: The Spatial Evolution of Road Systems: A poster reporting on a simulation for the project A Basin Scale Econometric Model for Projecting Future Amazonian Landscapes

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This poster addresses the spatial process of logging road extension and the resulting spatial architecture of expanding road networks in the Brazilian Amazon forest. Logging is one of the most important economic activities in many parts of the tropics. However, predatory, unsustainable harvest of trees is often associated with ecological disturbances such as loss of biodiversity, landscape fragmentation, occurrence of fire, and even climatological impacts. The ex-post impact of logging in the landscape has been well documented by satellite image analysis and by extensive fieldwork. Yet the literature has not considered in a formal theoretical statement the ex-ante factors and logic behind the spatial outcomes observed in the field. These spatial outcomes result from a combination of ecological (distribution of trees, density), geographical (relief, rivers), political (highways, settlement pattern), and economic factors (price of timber, transportation costs). Consequently, in this poster we provide a theoretical statement of how logging road networks evolve by solving an optimization problem in which a logging firm maximizes profits subject to capital constraints and geographical characteristics. We apply our model to a section of the Transamazon Highway in Pará State, Brazil, in an effort to provide validation for the theoretical statements of logger behavior.

Presenting Author: Eugenio Arima (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.12: Carbon and nutrients cycling in soil associated of selective logging in eastern Amazonia

Everaldo de C. C. Telles*, Mercedes Maria Bustamante and Geraldo Boaventura1; Gregory Asner and Lydia Olander2; Susan E. Trumbore3, Plinio B. de Camargo e Luis A. Martinelli4; Jose Natalino da Silva5 . *1 Universidade de Brasília-DF, 70.919-970 – Brazil, ectelles@unb.br, 2Stanford University, Stanford, CA, 3University of California, Irvine, CA, USA, 4CENA, Universidade de São Paulo, Piracicaba, SP, 13416-000; 5 Embrapa Amazônia Oriental/Brazil

Selective logging is a dominant form of land use in the Brazilian Amazon. We studied the soil dynamics of carbon and nutrients in primary forests subjected to reduced impact logging near Santarém (Pará). The soils are Oxisols. Soil samples were collected following landscape units such as logging decks, roads, skid trails, and tree-falls. The recovery of the logged areas is linked to the reequilibrium of the carbon and nutrient stocks that determines forest regrowth and the long-term sustainability of the ecosystem. The impacts depend on soil texture, mineralogy, topography and land use history. The differences in soils are associated with the compaction of layers and mixture of superficial soil horizons. In the decks and roads, usually there is the removal of the superficial horizon and its deposition in lateral areas. The most important variations in carbon and nutrient dynamics are associated with these landscape units. Carbon dynamics will be studied with C-13 and radiocarbon measurements and modeled using Century biogeochemistry model.

Presenting Author: Everaldo Telles (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.13: Energy and transport scenarios for southwestern Amazonia, including Acre, Brazil, and their implications for regional land cover and land use change

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Southwestern Amazonia of Brazil, Bolivia and Peru has become a potential nexus for large-scale energy generation from hydroelectric, fossil fuel, and biomass sources. Current development of road infrastructure connecting this region via all-weather, high speed roads to Atlantic and Pacific ports may be complemented by hydroelectric dams (~ 8 Gigawatts, GW) along the Madeira River that will allow barge access to 4,000 km of navigable rivers in lowland Bolivia and Peru, altering transport costs for commodity goods. Within 400 km of Acre State are 1.4 GW of hydroelectric generators, a small fraction of the hydroelectric potential of Bolivia (40 GW) and Peru (60 GW). Active gas and petroleum exploration projects in Peru, many along the border with Acre, may complement the existing Camisea gas fields (0.2 trillion cubic meters). The planned road and river transport systems coupled with growing Brazilian demands for electrical and natural gas energy will create multiple economic corridors and consequently affect forest conversion in southwestern Amazonia. At present, the Brazilian State of Acre has little potential for large-scale hydroelectric or fossil fuel energy production within its borders. However, in addition to becoming the beneficiary of large-scale regional electrical energy generation and a potential conduit for gas transport, Acre has a major program to supply 25,000 isolated rural units with electrical energy during the coming decade. Acre also has the potential to become a major site for biodiesel generation and a pilot plant for such generation will soon be installed in Rio Branco. The interaction of planned transport and energy generation systems needs to be incorporated in models of regional land cover and land use change and in public policies to maximize the benefits and minimize the adverse impacts of these systems.

Presenting Author: Foster Brown (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.14: Performance of an Object-Based Neural Network Classifier on Land Cover Characterization in Amazon, Brazil

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In line with the object-oriented approach in the development of the Amazon Information System, an object-based neural network classifier is implemented with the new system architecture. This research compares the performance of a neural network classifier to that of a conventional classifier. The project analyzed three images at different spatial resolutions to examine the results from the two classifiers on images at different scales. The data subsets used are from IKONOS (4 meters), ASTER (15 meters), and Landsat TM (30 meters), for Altamira, Brazil, a typical eastern Amazon tropical area with a collage of cultivated land, forest, river and city. A series of pre-processing procedures, such as registration and cloud masking, were applied to assure that the actual subsets cover exactly the same area. Research results confirm that a neural network classifier, using multiple source data, yields superior results compared to a maximum likelihood classifier. The object-oriented approach to the implementation adds flexibility in interface, interaction, versioning and porting. Future studies will focus on the development of a parallel-based strategy to shorten training time and the time for constructing alternative neural networks.

Presenting Author: Genong Yu (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.15: An Object-Oriented Approach to Integrate Remote Sensing, GIS and Statistics in the Amazon Rainforest Study

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The challenges of handling diverse environmental data and complex technologies in image analysis, spatial modeling and data mining led to the development of an integrated system, the Amazon Information System (AIS). The system aims at (1) integrating a variety of spatial data associated with the Amazonian ecosystems, including soils, forests, species, land use, spectral library, satellite remotely-sensed images and related thematic maps, and (2) facilitating sophisticated functions of neural network analysis, generic modeler, radiometric correction, biomass modeling and statistical analysis. The AIS is developed using an object-oriented approach and builds upon a three-tier architecture. Object-oriented techniques and properties have been adopted extensively in the system, including encapsulation, inheritance, polymorphism, dynamic method binding, web-enablement, and component-based embedding/linking. The use of the system under the current architecture showed the advantages in versioning management, program-reuse and sharing, distribution over Internet, and extension support.

Presenting Author: Genong Yu (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.16: Topography of the Amazon Floodplain: Fusion of the Shuttle Radar Topography Mission Digital Elevation Model with Synthetic Aperture Radar, Optical, and Laser Altimetry Data

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The recently released SRTM (Shuttle Radar Topography Mission) digital elevation model (DEM) of South America provides an unprecedented view of the physiography of the Amazon basin. The increase in information relative to previously available datasets such as GTOPO30 is especially notable in flatter areas such as large river floodplains, where fine-scale, complex topographic features can now be visualized regionally for the first time. Accurate floodplain DEMs are a prerequisite for modeling the movement of water through the floodplain, and the associated fluxes of nutrients and sediments. However, the SRTM DEM cannot immediately be used for floodplain applications since elevations represent positions ranging from the ground surface to the top of the vegetation canopy, depending on vegetation structure and height. Here we present results of procedures to both correct for vegetation height and extend the range of the SRTM DEM to floodplain elevations that were below the water surface on the SRTM imaging date, using the Cabaliana reach of the Solimoes floodplain as a test case. Vegetation height was subtracted by combining SAR- and Landsat-derived vegetation cover maps with height estimates derived from laser altimetry. Low-elevation floodplain topography was modeled using multi-date JERS-1 data and a kriging procedure. Although further field validation is necessary, the procedures yield a reasonable, internally consistent modified DEM.

Presenting Author: Laura Hess (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.17: Multitemporal fraction images derived from ETM+ and MODIS daily data to detect deforestation in the Amazon Region

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This work reports the preliminary findings of the use of multitemporal fraction images derived from MODIS daily data for detecting and evaluating deforestation in the Amazon region, as part of the LBA project LC-22. The ETM+ scenes acquired in the same days of MODIS were used as ground truth for training and validation phases. The information available from the PRODES project was also used to validate the methodology and the results. The emphasis is given for integrating data from different sensors at multiple resolutions to develop a methodology to be as automated and practicable as possible.
The linear mixing model was applied to 8 sequential ETM+ scenes (path/row 227/68), collected during the dry season of 2002, and to the corresponding MODIS data. The fraction images generated by this model enhance some specific information about the land cover: The soil fraction image highlights mainly non-vegetated areas (clear cuts, bare soil, etc.); the vegetation fraction image, such as NDVI or EVI, shows the vegetation cover condition; and the shade fraction image enhances the water bodies, burned areas, and also the vegetation cover types.
The land cover change was analyzed and compared with two MODIS products processed by the same spectral mixing analysis: daily surface reflectance images and vegetation index product. All these data are being analyzed and the deforested area detected by MODIS data using this methodology encourages us to develop a deforestation alert system, due the high temporal resolution and the accuracy of the preliminary results.
The importance of this study is increasing due to the temporary absence of Landsat data to monitor the deforestation in the Amazon region since it is used as basis for the PRODES methodology. Then the approach described here can be seen as an alternative to this operational project.

Presenting Author: Liana Anderson (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.18: Effects of Interannual Climate Variability in Secondary Forests and Crops Under Traditional and Alternative Shifting Cultivation

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Regenerating forests play an important role in long-term carbon sequestration and sustainable landuse as they act as potentially important carbon and nutrient sinks during the shifting agriculture fallow period. The long-term functioning of secondary forests (capoeira) is increasingly threatened by a shortening fallow period during shifting cultivation due to demographic pressures and associated increased vulnerability to severe climatic events. Declining productivity and functioning of fallow forests of shifting cultivation combined with progressive loss of nutrients by successive burning and cropping activities has resulted in declining agricultural productivity. In addition to the effects of intense land use practices, droughts associated with El Niño events are becoming more frequent and severe in moist tropical forests and negative effects on capoeira productivity could be considerable. In Igarapé-Açu, Pará, we hypothesize that experimental alternative landuse/clearing practices (mulching and fallow vegetation improvement by planting with fast-growing leguminous tree species) may make capoeira and crops more resilient to the effects of agricultural pressures and drought. This experimental practice has resulted in increased soil moisture during the cropping phase, reduced loss of nutrients and organic matter, and higher rates of secondary-forest biomass accumulation. We present preliminary data on water relations during the dry season of 2001 and 2002 in capoeira and crops for both traditional slash-and-burn and alternative chop-and-mulch practices. These data are being used to test IKONOS 2001 and 2002 data for the detection of moisture status differences. The principal goal of the research is to determine the extent to which capoeira and agricultural fields are susceptible to extreme climate events (drought) under contrasting landuse/clearing practices.

Presenting Author: Liane Guild (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.19: Carbon and nutrient transfer due to selective logging in the Amazon using remote sensing data.

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Until recently it was thought that remotely sensed data was not sensitive enough to detect and quantify selective logging damage in tropical forests. Spectral mixture analysis of multispectral remote sensing data resolves fractions of surface covered by photosynthetic vegetation (PV), non-photosynthetic vegetation (NPV = litter and woody debris), and bare soil. We have successfully applied this method to detect selective logging in the Amazon and have developed an equation to estimate canopy gap fraction in selectively logged areas using a combination of field and satellite data.

The Tapajos National Forest in Para is the site of a controlled logging experiment where reduced impact logging (RIL) has been measured and monitored. In RIL, vines and lianas are cut before trees are felled. This practice should reduce damage to surrounding areas and thus may result in logging damage that correlates to the size and number of trees removed. We tested how well an estimate of gap fraction from EO-1 Advanced Land Imager data correlated with harvested wood volume in logging blocks. Percent gap ranged from 9-22%, while volume harvested ranged from 26-54 m3/ha. Remote sensing derived canopy gap fraction data can also be used to quantify green canopy biomass and nutrients transferred to the ground during logging. Canopy biomass transferred averaged 25.07 kg/ha for 5 logging blocks immediately following timber harvests in 2001. Canopy carbon and nitrogen transfers were estimated at 12.56 kg C/ha and 0.44 kg N/ha for the same year. Our results suggest that remotely sensed data can provide valuable information about the spatial characteristics and quantity of C and nutrients altered by selective logging.

Presenting Author: Lydia Olander (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.20: CD-17: Validating, Scaling, and Parameterizing a Forest Regrowth Model for the Amazon Region - Field and Remote Sensing Results

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Our project seeks spatially explicit modeling and mapping of forest regrowth potential for the Amazon region, with incremental steps producing valuable products and results for understanding ecosystem response to disturbance at regional scales. Predicting forest regrowth potential has considerable implications for our understanding of carbon dynamics in a future characterized by continued conversion of old-growth Amazonian forests and the subsequent abandonment of many areas originally cleared for agricultural activities. Here, we summarize our remote sensing approaches for quantifying vegetation recovery and changes in biomass following disturbance, field results on biomass accumulation, and modeling approaches for data synthesis and integration.

Presenting Author: Mark Ducey (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Land Use and Land Cover Change

10.21: Human and Physical Dimensions of Land Use/Land Cover in Amazonian landscapes: a comparative approach

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The analysis of human and physical dimensions of land use/land cover in Amazônia requires the use of a georeferenced and multi-scalar approach. Within the Large Scale Biosphere-Atmosphere Experiment in Amazônia (LBA), distinct landscape mosaics have been studied, from the Amazon estuary and the Bragantina region to northeastern Rondônia. To illustrate the potential of such studies, we present comparative results for Machadinho d'Oeste and Vale do Anari, State of Rondônia. The multitemporal analysis included Landsat images and fieldwork. Land owners and other local actors were interviewed about their production systems and land-use history. The calculation of spatial metrics supported our conclusions. The results indicate that settlement design and institutional aspects play a central role in the process of landscape change. The combination of private lots with communal forest reserves, managed by local populations, produces positive outcomes in mantaining larger patches of forest. The methods used contribute to the analysis, integration, and monitoring of the variety of observed situations subsidizing public policies in the region.

Presenting Author: Mateus Batistella (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.22: Litterfall and Leaf Area Index Before and After Selective Logging in the Tapajos National Forest – Santarém -Pará -Brazil

Adelaine Michela Figueira (1), Humberto Ribeiro da Rocha (2), Michael Goulden (3), Scott D. Miller (3), Albert Sousa (1), Mary Menton (3), Augusto Maia (1)

Surface fluxes of water, energy and CO2 between ecosystems and the atmosphere are largely controlled by the physical structure of the canopy and the amount of green biomass (i.e. leaf area index (LAI)). Measurements of litterfall and LAI in a selectively logged site in the Tapajós National Forest were studied as a component of the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA). We installed 30 litter traps (1 m2) in an 18-ha block upwind of an eddy covariance tower and collected litter bi-weekly beginning in September 2000. Selective logging occurred in September 2001, and observations prior to this point indicated litterfall dynamics of an undisturbed forest. Litterfall varied seasonally with comparatively high rates beginning in May and continuing through the dry season (July – November). The onset of leaf fall before the dry season,suggests the increase is not a direct result of drought. Annual litterfall rates before and after logging were 4,41 MgC ha-1 and 3,96 MgC ha-1, respectively (a decrease in litter production of approximately 10% after logging). Integrated litterfall observations prior to logging estimate an average LAI of 5,3 m2m-2, which is lower than results from independent assessments of LAI made by fisheye photography during 2001 (6m2m-2). Preliminary post-logging results suggests an overall LAI of 4,4. The decrease in LAI and litterfall production are in accord with the expected results due to the increase in canopy gaps.

Presenting Author: Michela Figueira (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Land Use and Land Cover Change

10.23: Forest biomass reduction by logging and fire in the Eastern Amazon

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Logging and fire are the most important events that are degrading forest in eastern Amazonia. They alter the composition and structure of forests by provoking tree mortality. Changes in the biomass of Amazon region forest represent an important component of the global carbon cycle. The purpose of this study was to determine the impact of logging and fire on forest biomass. Field data in forests ranging from intact to logged and burned were collected in plots of 1 and 1,2 ha located on 14 sites in Paragominas, Pará. Live above ground biomass was estimated as: 382 t/ha (±21,3) in intact forests, 322 t/ha (±122,3) in logged forest and 198 t/ha in logged and burned forests. Time since fire event was one of the most important sources of variation in forest biomass. The biomass of logged and burned forest was 38% lower than logged forest biomass following recent fires and 6% lower 3 to 5 years following fire. In addition to the carbon emitted from burned forest, these forests also may have lower capacity to accumulate carbon.

Presenting Author: Oswaldo Carvalho Jr (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.24: Roads: Cause or Consequence of Land Use Change? A poster reporting on fieldwork for the project "A Basin Scale Econometric Model for Projecting Future Amazonian Landscapes"

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Transportation investments are often viewed by planners and policy analysts as essential to economic development. At the same time, many in the environmental community consider roads to be a two-edge sword that can cut both ways, bringing development benefits, but at the greater cost of forest degradation. Early studies of roads and deforestation often drew attention to a strong casual impact. Be this as it may, the literature no longer presents a purely black and white picture, with roads functioning as the hegemonic spark to massive changes in regional vegetation cover. Recently, it has been argued that roads have not been responsible for much deforestation in the Amazon, a position that has generated discussion. This poster presents findings from a project that is attempting to forecast basin-scale land-use and land-cover changes with an econometric model that uses roads as a variable (See poster entitled "A Progress Report on the Basin-Scale Econometric Model"). Specifically, this poster considers whether roads should be treated as an exogenous or an endogenous variable in econometric estimation. Consequently, we present findings from fieldwork addressing the road development process in the Amazon basin, for both the federal highway system and settlement roads built by private individuals and local government. The intent is to comprehend how the spatial patterns of the roads emerged, in the interest of providing information for the econometric modeling effort. The poster shows that the federal highway system is largely exogenous to land use change in the basin, with routes that follow pre-existing settlements and drainage patterns. On the other hand, the settlement roads that were constructed in the aftermath of the federal system may be regarded as endogenous to the land use changes sparked by initial development. These findings have implications for econometric estimation.

Presenting Author: Robert Walker (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.25: Assessing the Utility of a Landsat ETM+ Images for Identifying Areas of Traditional Logging in West Para, Brasil

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Traditional logging is one of the most common economic activities practiced on small holder properties in Amazonia. Due to the high degree of selectivity and the low volumes extracted, areas logged in this way (few threes logged per area per year, without planned roads and logging decks) are difficult to identify using satellite images. To assess the capability of Landsat ETM+ images to detect this type of logging we combined data collected in a field survey with a remote sensing analysis of two small holders' properties located 100 km south of Santarém. In the field survey we mapped the location of all the old logging roads and cut stumps. For each stump we also recorded their diameter, species, height, and stage of decomposition. We assessed the variability of spectral characteristics between two logged areas and an undisturbed control. Preliminary results suggest that the variability in the spectral data were too high to allow differentiation between traditionaly logged and primary forest areas. This result has negative implications to the monitoring of this type of activity using this remote sensing product. Inventory data collected from the logged sites showed that an average of 36% of the harvested trees were abandoned inside the forest. Of these, 52% were not utilized because they were hollow, or broke as they were cut. These findings indicate there is a high degree of wastefulness associated this type of traditional logging activity.

Presenting Author: Sanae Hayashi (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.26: Characterizing land cover change in Amazonia by synthesis of data at multiple spatial scales

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In order to evaluate the implication of land use change on ecosystems, biogeochemistry, and the atmosphere, those changes and their uncertainties must first be quantified. This task is especially challenging at regional to global scales, where tradeoffs exist between spatial resolution and temporal coverage. Several existing approaches involve the use of both high-resolution and moderate-resolution imagery, and their combination, to identify dominant land cover types within a pixel or grid cell. Other approches are based on the notion of mixing of functional or structural types within landscape elements. The Amazon region of Brazil presents a set of unique challenges for these methods. In this presentation we review current approaches for characterizing land cover and change in this region, and present the results of an analysis that combines MODIS nadir-adjusted reflectances, landsat ETM reflectance data, and extensive field validation. We provide a statistical estimate of upper and lower bounds of basin-wide coverage of cleared land for pastures or agriculture and secondary vegetation. We define limits to precision in our ability to detect changes in these total areas over this region.

Presenting Author: Stephen Hagen (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.27: Digital Library of Control Points

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The size of the Amazon basin (6 million km2) and the remoteness of many of its habitats make remote sensing a primary tool for mapping and monitoring their space and time dynamics.. As an example, information on wetland extent derived from remote sensing imagens were uttermost important for estimating CO2 outgassing . Amazon forest deforestation monitoring and fire warning programs are other key examples of the importance of remote sensing technology.
Spatial information acquired from remote sensing techniques, however, depends on the accurate absolute location of geographical references.. These geographical references, called control points, are used to put together multi-temporal and/or multi-sensor image data sets in the same reference. The acquisition of control points, however, requires that maps of the study area must be available at the appropriate scales.
In order to avoid the time consuming task of manually acquiring control points each time a new data set is about to be geocoded, this study presents the development of a digital library of control points for the Amazon region available on the WEB.
Each control point is stored in the database with the following information: latitude and longitude, a clipping of image or scanned map containing a visible feature and other relevant information. The digital library is a user-friendly system and registered users can add control points in the library at any time.

Presenting Author: Sueli Castellari (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

10.28: Multitemporal analysis of Soybean expansion in Santarém Region

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The soybean agro-industry is rapidly expanding from Cerrado towards the Amazon forest in recent years. One of the current barriers to their further expansion is the high transport costs associated with bad road conditions linking the highway and the exportation port. In this context, the imminent paving of Cuiabá-Santarém highway will represent a significant reduction in soybean transport costs from Northern Mato Grosso to the Santarém port, prompting more investments in soy production along this road. One of the areas that is already experiencing this expansion is the Belterra clay plateau formation just outside of Santarém. However, little is known about how much this expansion has affected primary forest areas in this region. To address this question we used annual satellite images to develop a multitemporal analysis of the change in primary forest area from 1999 to 2002 of the Santarém-Belterra region. The soybean areas were identified based on their size and presence of associated grain crops (e.g. rice). The results indicate that the area devoted to soy production increased threefold since 1999. We found that most of the new soybean plantations were located in areas of secondary forest, agriculture, and pastures, and that only 10% of the new soybean areas had resulted in the clearing of primary forest areas . The soybean industry has established itself as an important source of land use change, having implications for the ecological and socio-economic dynamics of the Santarém region.

Presenting Author: Wanja Lameira (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Land Use and Land Cover Change

Terrestrial Systems and Biogeochemistry

11.1: Effect of soil physical characteristics on carbon stocks and dynamics in Southwestern Amazonia, Acre, Brazil

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Soils are an important carbon reservoir in many biomes. It is estimated that Amazonian soils store 66 Pg C. Acre State soils are under the influence of the on-going uplift of the Andes. Its soils are quite distinct from the most dominant soils in Brazilian Amazonia, such as Inceptisols, Alfisols, and Ultisols, usually eutrophic, pedogenetically young and comparatively unweathered. Little is known about the impacts of land use change on soil organic matter under these circumstances. The present study focused on: (1) evaluating the land cover change effect on carbon stocks and delta 13C on these soils, and (2) estimating carbon stocks on the most common soil classes occurring in the State of Acre. We determined the C content, delta 13C and bulk soil density in pastures of 5, 12-15, and 20 years, and in 2 intact forests in depths from 0 to 100 cm, in Ultisol (well drained) and Alfisol (poorly drained). A carbon stock map up to one meter depth was created using soil map (scale 1:1.000.000) and also data from soil surveys undertaken previously in the region. Eutrophic soils presented smaller C stocks when compared with dystrophic soils at the same soil class. Soils in Acre store about 1 Pg C up to 1m depth. Poorly drained and eutrophic soils present greater C stocks than well drained dystrophic soils. Therefore, in this region, besides the effect of land cover change, drainage condition is an important factor controlling productivity and soil organic matter decomposition rates.

Presenting Author: Antonio Melo (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Terrestrial Systems and Biogeochemistry

11.2: Impact assessment of land-cover change on soil nutrient levels at multiple scales

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Intensive field research in the Amazon and elsewhere has greatly improved our understanding of the physical processes and biogeochemical cycles affected by land-cover change, but the implications of these changes over very large areas are not as well understood. The natural controls on soil variability, and the spatial scales at which correlations exist among soil and environmental variables are critical base line information for land-cover change studies. We analyzed a soil profile database from Rondônia, Brazil, to identify the scales that best characterize relationships among soil properties from local to regional scales, including an area of hundreds of thousands of kilometers. Statistical relationships among physical drivers of soil formation, namely geology, precipitation, terrain attributes, classified soil types, and land cover, were used to determine which factors are related to soil biogeochemistry at each spatial scale. Spatial variation, rather than temporal or dynamic variation, were emphasized as a first-order approach toward detecting, describing, and potentially explaining spatial patterns in soil nutrients in this environment.
Our study had three main components: 1) determination of local and regional correlation structures by means of coregionalization modeling; 2) interpolation of the soil properties at each spatial scale using factorial kriging; and 3) regression of the soil spatial components against potential drivers of soil formation (e.g. precipitation, rock type). While the finest observable scale was fixed by the field sampling density, the coarser scales were determined from relationships in the data, rather than being imposed by the researcher. The results from the regression analysis were used to evaluate potential environmental controls on soil nutrient variability at discrete spatial scales derived from soil data across the state of Rondônia, and the relative influence of land-cover change within this context.

Presenting Author: Dar Roberts (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Terrestrial Systems and Biogeochemistry

11.3: Nitrogen dynamics during till and no-till pasture reformation sequences in Rondônia, Brazil

Janaina Braga do Carmo,Caio César Passianoto, Christopher Neill3, Diana C. Garcia-Montiel, Carlos C. Cerri, Paul A. Steudler3, Jerry M. Melillo, Brigitte J. Feigl, Marisa de Cássia Piccolo, Cristiano Alberto de Andrade

The clearing of tropical rain forest since 1970 has created large area s of cattle pasture that are now declining in productivity. Practices adopted by ranchers to restore producivity to degraded pastures have the potential to alter soil N availability and gaseous N losses from soils. We examined how soil inorganic N pools, net N mineralization and net nitrification rates, nitrification potential, and NO and N2O emissions from soils of a degraded pasture responded to different reformation treatments: 1) soil tilling followed by replanting of grass and fertilization, 2) no-till application of non-selective herbicide, planting of rice, harvest followed by no-till replanting of grass and fertilization, 3) the same no-till sequence with soybeans instead of rice, and 4) application of a selective herbicide and fertilization without grass replanting. Tilling increase soil NH4+ and NO3- pools but NH4+ and NO3- pools remained relatively constant in the control and no-till treatments. Emissions of NO and N2O fluxes increased with tillage and with N fertilization. Cumulative rates of net N mineralization and net nitrification during the first six months varied widely but were the hightest in the tilled treatment. There were no clear relationships among rates of N fertilizer application, net Nmineralization, net nitrification, NO, N2O, and total N oxide emissions. Our results indicate that pasture reformation sequences involving tilling and fertilizing will increase emissions of N oxides, but the magnitude of the increase is likely to differ based on timing of fertilizer application relative to the presence of plants and the magnitude of plant N demand. Emissions of N oxides can be decreased by the use of reformation sequences that minimize reductions in pasture grass cover.

Presenting Author: Janaina Carmo (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Terrestrial Systems and Biogeochemistry

11.4: Two-dimensional resistivity profiling: a potential tool to monitor the below-ground environment in ecosystem studies.

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The two-dimensional resistivity profiling technique is widely used to detect variation in soil electric resistivity caused by differences in structure of materials, texture and water content along a soil profile. Injecting continuous current into the ground through two current electrodes and measuring the resulting voltage difference in two other potential electrodes measure resistivity. An apparent resistivity is calculated by knowing the intensity of the injected current, the difference in voltage and the geometric positions of the electrodes. A computerized inversion program then determines the true resistivity value. Our goal is to test the use of this technology as a tool for making reasonable estimates of changes in soil water content and to detect heterogeneity along depth profiles. We report results from a Cerrado located at the Ecological Station of Águas Emendadas, 45 km east of Brasilia. Annual precipitation is 1453 mm. Soils are Latossolos Vermelhos. TDR was used to monitor seasonal changes in volumetric soil water content (VWC), which was then compared to soil resistivity values obtained from measurements along transects passing near the TDRs. We observed large variation in resistivity at the end of the dry season in the upper 300 cm of soil (3308-32860 ohms.m), but little variation in resistivity was observed within 300 to 800 cm of depth, independently of the season. These results were consistent with a significantly inverse relationship of resistivity as function of VWC (R2= 0.78; p

Presenting Author: Joice Ferreira (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Terrestrial Systems and Biogeochemistry

11.5: Land-use changes and wet deposition in Amazon Basin

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In tropical regions convective clouds produce abundant rainfalls which are the main sink of water-soluble gases and aerosols emitted into the atmosphere through wet deposition processes. Wet deposition plays an essential role in controlling the biogeochemical cycles of carbon and nitrogen and as a source of nutrients to ecosystems. In the LBA experiment (Large Scale Biosphere Atmosphere Experiment in Amazônia), rainwater chemistry composition has been studied in three different sites in Amazon Basin (Rondônia, Balbina and Santarém), with different degrees of anthropogenic activities. Rondônia site is located in the western part of Amazônia, and is a heavily disturbed site with significant land-use changes, Balbina is located in Central Amazônia, about 150 Km North of Manaus and represents a remote area and Santarém is the closest site to the sea.
For the three sampling sites H+ was the most abundant ion. However, the sequence of the other most abundant ions was not the same for the sites, indicating that there are differences in the composition of the rainwater in these sites. In fact, due to the anthropogenic activities, N deposition was significantly higher in Rondônia while DOC deposition was significantly lower in this site. By the other hand, in Balbina the VWM concentration of organic acids was significantly higher than the other sites, which is probably associated with biogenic emissions. Principal component analysis results showed that there are different sources of rain acidity in each site, which are associated with land cover. The main source of compounds in the rainwater composition are also different in these three sites. Biomass burning and biogenic emissions appears to control the rainwater chemistry over the Amazon Basin.

Presenting Author: Luciene Lara (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Terrestrial Systems and Biogeochemistry

11.6: Regional patterns in inorganic nutrient losses across the central Amazon Basin: preliminary results

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Nutrient losses have important implications for sustainability, productivity and carbon balance of forest ecosystems. Losses are particularly important in ecosystems where mineral nutrient inputs from weathering processes and atmospheric deposition are limited. The traditional notion that ecosystem losses of biotically available nutrients (e.g., inorganic forms such as NO3- and PO4 3-) are a consequence of nutrient limitation are being expanded by the new idea that losses of biotically unavailable forms (organically bound forms) can control nutrient-carbon interactions in forests over time. We examined patterns in nutrient loss across geographically broad variations in state factors (e.g., parent material, climate, and soil development as an index of time). Controls over nutrient losses are fundamental to the question of ecosystem sustainability of native forests and how these processes might respond to land use and land cover change. Moving from Altamira in the southeast to study sites north of Manaus in the northwestern end of our transect we characterized hydrologic losses of major anion and cation nutrients from primary forests in both dry and wet seasons (October- November 2002 and April 2003). Chloride (Cl-), potassium (K+) and calcium (Ca2+) all decreased significantly across the transect as we moved inland (Cl: 6.2 to 1.0 ppm, K: 0.7 to 0.1 ppm, and Ca: 4.4 to 1.0 ppm) . In contrast, the highest concentrations of nitrogen as nitrate (NO3--N) and total phosphorus (Ptot) were found in Manaus the westernmost site (0.2 ppm and 1.4 ppb respectively). Santarém showed the most significant effects of seasonality especially for nitrogen as ammonium (NH4+-N) and sulfate (SO42-). At all three sites significantly higher NO3 concentrations were measured in the wet season. The higher concentrations of rock nutrients in Altamira may reflect the younger soils found there (Alfasols as compared to Ultisols and Oxisols at the other two sites). More intensive sampling in the coming year will allow us to better disentangle the importance of state factors that co-vary across the transect.

Presenting Author: Megan McGroddy (Poster)

Science Theme: LC (Land Use and Land Cover Change)

Session: Terrestrial Systems and Biogeochemistry

11.7: Effects of cover plants on the soil P fractions in tillage and no-tillage systems in the Cerrado Region

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The *cerrado* region is experiencing high rates of land conversion in the last four decades. The management of soil organic matter is crucial to improve productivity and to minimize the impacts of cultivation. Phosphorus is very limiting as most of the *cerrado* are Oxisols, with high P sorption. Cover crops have been utilized, in tillage and no-tillage systems, to increase the soil organic matter content. We evaluated the effects of cover plants and tillage systems on the P availability and dynamics in a clay textured Oxisol. Phosphorus was extracted by sequential fractionation in samples collected in dry and wet seasons. The studied cover plants were Canavalia brasiliensis M. and Benth, Cajanus cajan (L.) Millsp, and Raphanus sativus L.. The results were compared to weed controls. Plots were fertilized with NPK, CaSO4 and micronutrients. After sequential extraction, the highest P concentrations were found in the NaOH fraction in the 5-10 cm layer due to the placement of the fertilizer. Organic P was higher in the dry season while inorganic P was higher wet season. The soil under Canavalia brasiliensis (0-5cm) showed higher inorganic P in no-tillage system, probably due to mycorhizal associations. As for the organic P, the plot with Raphanus sativus showed higher concentrations during the dry season, under the no-tillage system. In general, the use of cover plants increased the inorganic P availability during the wet season.

Presenting Author: Mercedes Bustamante (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Terrestrial Systems and Biogeochemistry

11.8: Deposition fluxes of trace elements in Western Amazon Basin during 20th century inferred from aerosol deposits in Illimani ice core, Bolivian Andes

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A 137 m ice core drilled in 1999 from the summit of Nevado Illimani (16°37' S, 67°46' W, 6350m asl, Bolivian Andes) allows the investigation of Western Amazon Basin atmospheric chemistry changes for about 80 years (1919-1999) during the 20th century. The ice core extraction site is located downwind from moist air masses coming from the Amazon Basin. The upper 50 m of the ice core were dated by multi-proxy analysis (delta18O, delta D, 137Cs, Ca+2 content, electrical conductivity, and insoluble microparticle content). Elemental concentrations for 45 chemical species (from Li to U) in 744 ice and snow samples along the 50 m ice core section were determined by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS), providing a complex database with sub-annual to annual resolution, which was analyzed under several statistical methodologies to yield a full chemical characterization of the aerosol deposits in the ice core. This allowed retrieving estimates of effective deposition fluxes of trace elements over the Andes during the 20th century. For phosphorous, a key element participating in biogeochemical cycles in the Amazon Basin, the excess (non-terrigenous) contribution for the average annual deposition rate between 1919-1969 was about 0,016 x 10-6 kg m-2 yr-1, and about 1,2 x 10-6 kg m-2 yr-1 for 1970-1999. Considering the total deposition of chemical species during the whole 20th century, one notices that for several trace elements linked to anthropogenic emissions, such as nickel, copper, zinc, cadmium, etc. the natural deposition fluxes represent only a minority fraction of the total deposited over the Andes.

Presenting Author: Paulo Artaxo (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Terrestrial Systems and Biogeochemistry

11.9: The Role of Sorption in Retention of Dissolved Organic Carbon in Soils Typical of the Lowland Amazon Basin

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The overall question we are addressing is "What role does the evasion (out gassing) of CO2 from the river system to the atmosphere play in the carbon cycle of moist tropical forests?" Recent evidence suggests that the Amazon may be a net sink of atmospheric CO2 of 1-9 Mg C ha-1 y-1. We have made recent calculations that suggest that the evasion of CO2 from the river system of the central Amazon basin is on the order of 1.2 +- 0.3 Mg C ha-1 y-1. A flux of this magnitude suggests that the ecosystem processes involved in river corridors represent a significant pathway for the export of carbon fixed on land in the humid tropics at a globally significant level. The quantity of dissolved CO2(pCO2) in surface waters of tropical river systems is the product of a long sequence of complex biological, hydrological and geochemical processes.

Sorption is an important geochemical process that removes dissolved organic carbon (DOC) from water percolating through soils, which may eventually flow into the river channel (via groundwater and subsurface flow) where it may be respired to CO2. Soil properties, such as texture, Fe- and Al-oxide content, mineral surface area and soil organic carbon content, are known to affect the concentration of DOC in soil pore water and, therefore, the quantity of DOC transported to river channels. These soil properties vary with soil type. We collected samples from two depths of three different soil types typically found in the lowland Amazon basin for use in equilibrium and kinetic laboratory “batch” experiments, and for analysis of soil properties. We examined relationships between sorption and soil properties in an attempt to estimate the quantity of DOC sorbed based on soil type. Finally, we compared the results of the laboratory experiments to field data. Explaining and quantifying DOC lost to sorption as a function of soil properties is an important step in understanding the export of carbon fixed on land and transported to rivers.

Presenting Author: Sonya Remington (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Terrestrial Systems and Biogeochemistry

11.10: The age of carbon respired from tropical forest soils

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The residence time of carbon in different components of ecosystems determines the degree to which they can act as temporary carbon sources or sinks.. The radiocarbon content of CO2 respired from soils can be used to determine the average time elapsed between C uptake by photosynthesis and release by respiration or decomposition. In tropical forests, where decomposition rates are rapid, the residence time is dominated by the time C resides in living leaf and root pools. We compare measurements of 14C in leaf and root tissues, soil CO2 and CO2 generated from microbial respiration for comparison with the 14C signature of atmospheric CO2. Living roots and leaves have f' values consistent with mean tissue lifetimes of several years up to decades, with some root tissues living for decades. Soil respired carbon has 14C signatures that vary from values close to those expected for recent photosynthetic products, to a mixture of recent photosynthetic products and decomposition of dead leaf and root tissues. The overall time lag estimated for ecosystem respiraiton is 2-5 years, a time lag that could lead to significant year-to-year differences in net ecosystem exchange.

Presenting Author: Susan Trumbore (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Terrestrial Systems and Biogeochemistry

Trace Gases and Aerosols

12.1: Climate Data Records of aerosols and surface flux at distributed sites in the Amazon Basin

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Climate trends may be assessed from long term observations of key parameters. Our project has amassed several important data sets, termed Climate Data Records (CDR), that address aerosol loading and optical properties and radiation flux at the surface both broadband and PAR at key locations in the Amazon Basin. Recent access to MODIS data allows regional characterization of the aerosol properties anchored by the point CDRs. We report here the summary to date of the CDR data-base derived from a decade of AERONET aerosol observations and new analysis of four years of coincident pyranometer and PAR observations.

In Brazil, we now have a data set of broadband flux measurements at several sites distributed across the Amazon basin, with a record spanning more than 4 years at some locations. Pyranometers, PAR sensors (400-700nm), and filtered pyranometers (PAR+UV) have been operated with varying lengths of data record. This network represents one of the few such long-term flux data-bases available for this region, and provides an opportunity to characterize the nature of atmospheric effects on surface, broadband irradiance.

Smoke from biomass burning has a profound impact on PAR and UV flux. We have examined the disproportionately greater reductions in sub 700nm irradiance relative to the full solar spectrum in previous papers. PAR irradiance can be modeled reasonably well from total broadband flux for low and moderate AOT conditions, but much less confidently during heavy smoke conditions. Here we present an empirical relationship for estimating PAR+UV flux from only total broadband flux and AOT, and test its effectiveness for predicting PAR+UV for independent data sets of pyranometer and AOT data in Brazil.

We found that we were able to predict with reasonable accuracy even the daily integrated PAR+UV irradiance from daily integrated total broadband flux during high AOT months, despite the variations in cloud conditions that exists over this timeframe. Monthly averaged CDRs of AOD, SSA, broadband flux, PAR flux and PAR +UV flux and modeled PAR+UV flux will be presented.

Presenting Author: Brent Holben (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.2: Impact of green manuring and nitrogen fertilization on trace gas fluxes (NO, N2O, CO2) in a cornfield in the Cerrado Region of Brazil

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Tillage practices can affect microbial communities and, consequently, trace gas fluxes. However, this interaction is still unclear in the Cerrado (Brazilian savanna) region. Our objective was to investigate the impact of green manuring and nitrogen fertilization on NO, N2O and CO2 fluxes in a cornfield at the EMBRAPA-Cerrados (Planaltina-DF). The soil is classified as Oxisol, and the system was characterized by a rotation of corn and cover plants: Crotalaria juncea L. and Mucuna pruriens (L.) DC were planted in the plots (April 2002). Each plot was divided into two subplots: with and without (no-tillage) incorporation of cover plants residues. Corn was planted in November 2002 and fertilized with 20, 150 and 80-kg ha-1 of N, P2O5, and K2O, respectively. Nitrogen fertilization with 50-kg N ha-1 was done at 15, 30, and 90 days after planting. Four polyvinyl chloride (PVC) rings (20cm diameter) were inserted 2 cm into the soil in each subplot. Soil surface fluxes of N2O, NO and CO2 were measured after incorporation of residues, two days after corn planting, and two days after the first and the third nitrogen fertilization. Lower CO2 fluxes were observed in the subplots with incorporated cover plants compared to no-tillage plots. NO and N2O fluxes were affected by nitrogen application associated to rain events: they tended to increase after the third nitrogen fertilization, which was a period of large rainfall. In addition, measurements of these gases showed higher variability after nitrogen fertilization and elevated precipitation (This abstract of a proposed presentation has been approved by the US EPA. Mention of trade names or commercial products does not constitute endorsement or recommendation for use).

Presenting Author: Flávia Alcântara (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.3: Title: Experimental effects of drought on soil emissions of carbon dioxide, methane, nitrous oxide, and nitric oxide in a moist tropical forest in Santarém–Pará–Brazil.

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Precipitation changes in the Amazon Basin resulting from deforestation, global warming, and El NiÑo events may affect emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and nitric oxide (NO) from soils. Results are reported from a large-scale rainfall exclusion experiment (1 hectare) conducted in an evergreen forest near Santarém, Brazil. This experiment lowered annual N_2O emissions by a factor of about 2 and increased rates of consumption of atmospheric CH_4 by a factor of >3. No treatment effect has been detected for NO and CO_2 fluxes yet. These emissions recorded after three rainy seasons excluded, showed characteristics of the direct effect of microbial processes on theses gases, such: effects of soil aeration on denitrification, methanogenesis, and methanotrophy. An anticipated secondary response in which drought-induced plant mortality is followed by increased mineralization of C and N substrates from dead fine roots and by increased foraging of termites on dead coarse roots, has not been detected until now. The diffusivity model to N_2O and CO_2 concentrations along a soil profile revealed: most of the wet season production of N_2O occurs in the top 25 cm of soil; CO_2 production occurs down to 100 cm in both seasons; and a small production of CO_2 occurs down to a depth of 1100 cm. Diffusivity-based estimates of CO_2 production as a function of soil depth were strongly correlated with fine root biomass, indicating that trends in belowground C allocation may be inferred from monitoring and modeling profiles of soil H_2O and CO_2.

Presenting Author: Francoise Yoko Ishida (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Trace Gases and Aerosols

12.4: Long-term Measurements of Carbon Dioxide and Carbon Monoxide Concentrations to Help Constrain Regional Carbon Budgets.

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In order to supplement the network of detailed process studies based on direct small-scale to canopy level measurements being made a the LBA tower sites we have established a pair of carbon dioxide and carbon monoxide observatories within the Amazon basin and at the coastline.
The interior site is located in the Tapajos Forest at the km67 flux tower site. Carbon dioxide and carbon monoxide concentrations have been measured continuously since April 2001. The coastal station is located in Maxaranguape, approximately 50km NW of Natal. Carbon monoxide has been measured there since December 2002 and carbon dioxide measurements began in August 2003. Observations at this site are useful to establish the boundary conditions for tropical marine air that enters the basin.
At both sites, carbon dioxide is measured using a modified Licor 6262 infra-red gas analyzer. Carbon monoxide is measured using a Thermo Environmental Instruments 48CTL gas-filter correlation IR absorption analyzer that has been modified by including a cold trap to remove water, pressure control, and frequent zeroing. Concentrations of CO distinguish combustion sources from biological activity affecting the carbon dioxide concentrations and provide constraints on estimates of regional biomass burning estimates. Concentrations of CO during the well mixed mid-day period at Tapajos are near 70 ppb during the wet season and increase to near 300 ppb during the dry season as burning influence increases. In the onshore flow at Maxaranguape CO is around 50 ppb. At the Tapajos site, diel cycles of carbon dioxide have amplitude of 50 ppm. Seasonal and annual cycles have much smaller amplitudes; mid-day values exceeded 370 ppm at the end of dry season and declined to about 365 ppm during the wet season.

Presenting Author: J. William Munger (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.5: Soil-Atmosphere Flux of Nitrous Oxide and Methane Measured Over Two Years on Sand and Clay Soils in Undisturbed Forest at the FLONA Tapajos, Brazil

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Nitrous oxide (N2O) and methane (CH4) are important greenhouse gases. Tropical forest soils account for the largest natural source of N2O. Most upland tropical forest soils studied so far consume CH4. We measured soil-atmosphere flux of N2O and CH4 using static chambers during 30 minute long emplacements. Four samples were removed at equal time intervals in nylon syringes and transported to our laboratory in Santarem for analysis within about 24 hours of collection. We analyzed N2O and CH4 using gas electron capture and flame ionization gas chromatography. To determine concentrations, integrated sample peak areas were compared to peak areas for commercially prepared standards that had been calibrated against the LBA-ECO standards. We calculated fluxes by linear regression of 3-4 concentration-time pairs. Our sampling points were randomly selected at intervals of 2-4 weeks at mature undisturbed forest sites near the km 83 IBAMA base in the Tapajos National Forest (FLONA Tapajos). Approximately 8 chamber measurements were made during each sampling period on both sandy Ultisols and clayey Oxisols. Soil and air temperature and soil moisture were measured at the same time as gas fluxes. N2O emissions from clay greatly exceeded the emissions from sand. Over 2 years of measurement, N2O emissions from clay soils averaged 7.09 (+ 5.14) ng-N cm-2 h-1 while emissions from sand soils averaged only 1.67 (+ 1.44) ng-N cm-2 h-1. Sand soils generally consumed more CH4 than clay soils (-1.24 (+ 4.16) mg-CH4 m-2 d-1 vs. 0.11 (+ 4.23) mg-CH4 m-2 d-1). Seasonal variation of both N2O and CH4 fluxes appeared to be controlled primarily by soil moisture. For N2O, wet season (January-June) emissions greatly exceeded dry season (July – December) emissions. In the case of CH4, fluxes were near zero during the wet season but notably negative (indicating consumption of methane in the soil) during the dry season.

Presenting Author: Jadson Dezincourt Dias (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Trace Gases and Aerosols

12.6: Vertical Profiles of Trace Gases Above Santarem and Fortaleza

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Since December 2000 we have measured vertical profiles of CO2, CH4, CO, H2, N2O, SF6, δ13C and δ18O above Santarem and Fortaleza. Although the frequency of sampling has been highly irregular due to import/export problems, some patterns are starting to emerge from our data. Most of the CO2 profiles above Santarem show an average of 2-3 ppm depletion of CO2 in the boundary layer relative to values aloft. The few profiles we have taken at similar times for both Fortaleza and Santarem do not show a great difference in the column integral, which would indicate net uptake of carbon by the biota between the Atlantic coast and Santarem. In contrast to CO2, CH4 profiles consistently show boundary layer enhancements of 30-150 ppb relative to free troposphere values, indicative of a surface methane source. CO values are always enhanced near the surface, but this ranges from 5 to 100 ppb, with the highest values in the dry season due to biomass burning. H2 profiles show some evidence for surface uptake, and N2O shows some boundary layer enhancement but is highly variable. There is an indication of an N2O seasonal cycle, but it is not well defined. As expected, SF6 profiles show vertical gradients of less than 0.1 ppt. Vertical profiles of CO2 isotopes are of inconsistent quality, because our samples are currently not dried as they are collected. Vertical profiles of all species from Fortaleza tend to show smaller vertical gradients than those from Santarem.
In order to regularize and increase the frequency of our sampling, we plan to have samples analyzed in the laboratory of Luciana Gatti at IPEN. A copy of the NOAA/CMDL analysis system has recently been jointly built by the groups and will be installed at IPEN by the end of the year. By the end of 2004, we plan to have samples analyzed for isotopic ratios at CENA, transferring technology from the University of Colorado, Stable Isotope Laboratory. Analyzing samples in Brazil and thus avoiding import and export of samples should allow us to dramatically increase the frequency of our measurements.

Presenting Author: John Miller (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.7: Concentrations Variability of Trace Gases during Dry and Wet Seasons in Amazon Basin

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Several intensive experiments were performed in 1999, 2000, 2001 and 2002, in different regions such as Ouro Preto do Oeste (pasture site - Rondonia), Balbina (forest site at 180 km north of Manaus) and Floresta Nacional (FLONA) do Tapajós (Pará) . In the wet season in Amazônia, the ozone concentration during daytime at the radiation peak is almost the same for the 3 places studied; the average concentration is between 12 ? 14 ppb. The difference is in the nighttime. Balbina is the lower averages concentration for the night around 2 ppb, Rondonia is 5ppb and in FLONA tapajos the night concentration is near than diurnal concentration, where the value is 9 - 11 ppb. The high ozone concentrations during the night time can be explained for two processes, one is the clean air composition in this site, in the other hand it was observed very frequently nocturnal episodes of high ozone concentrations during the wet season. During the dry season, the ozone average concentration in the nighttime was similar for every site, around 12 ppb and in the daytime (14:00 - 15:00 LT) the average concentration was variable between 25-50 ppb. Rondonia is the worse situation for the 3 studied sites. There average there was 50 ppb and in FLONA tapajos is 25 ppb, where the biomass burning impact is lower. Similarly to O3, the NOx concentrations differ significantly between wet and dry seasons, due to biomass burning emissions. The average concentration for the wet season for NO was 0.23 ppb and NO2 was 0.69 ppb, while for the dry season NO averaged at 0.04 ppb and NO2 at 2.73 ppb.
Typical levels of CO in the Amazon basin during the wet season were 100 - 150 ppb, the variation occurs in the places, for example, Rondonia where this is a place with high human activities and the average for wet is around 150ppb, but in FLONA tapajos, where have less human impacted, the average is less than 100 ppb. The average for Rondonia, during the nighttime, was between 1000-1200ppb and the daytime was 600 ppb and in FLONA tapajos during the nighttime was 500 ppb during the peak of burning season (Oct-Dec) and 200ppb during the dry season without local fires sources. During the day time was around 200 ppb, where the average concentrations were similar for both seasons.

Presenting Author: Luciana Gatti (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.8: Seasonal variations of isoprene concentrations at the Tapajós National Forest - Para and Biological Reserve of Jarú - Rondônia in Amazonia

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Tropical forests are an important global source of volatile organic compounds (VOCs) and other atmospheric trace gases. The high biodiversity in tropical rainforests complicates the extrapolation of biogenic volatile organic compound (BVOC) emissions from leaf-level measurements to landscape and regional or global scales. The isoprene concentrations were measured at two sites near Santarém, Para State, and Reserva Biological Reserve of Jaru. The two sites are located in the National Forest of Tapajós, the first corresponding to primary forest and the second to a forest that was selectively logged. The samples were collected simultaneously at heights of 65 and 55 m (20 and 10 meters above forest canopy, respectively). The average isoprene mixing ratio was 2.2-2.5 ppb at the two sites and the standard deviations within a site ranged from 1 to 1.2 ppb. A strong seasonality of isoprene mixing ratio was observed and associated with the wet and dry seasons. The lowest mixing ratios were found during the transition between the wet to dry season, while at the start of the biomass burning season the mixing ratios increase. A qualitative analysis of a one dimensional model demonstrates that the seasonal cycle in concentrations reflects changes in isoprene production by the ecosystem, not changes in dynamics or chemistry. The magnitude of the cycle indicates that the physiological capacity of the ecosystem to emit isoprene may depend on water availability although phenological changes could also contribute to the observed variations. A simple 1-D model that assumes mean isoprene fluxes of 1.5 mg m-2h-1 and 0.9 mg m-2h-1 at the primary forest and selectively logged sites, respectively, is able to reproduce the observed vertical gradients.

Presenting Author: Luciana Gatti (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.9: Long term measurements of aerosol composition for Santarem, Manaus, Alta Floresta and Rondonia

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Fine and coarse aerosol particles have been measured during several years in Santarem, Manaus, Alta Floresta and Rondonia. Sampling was performed using stacked filter units that collects fine mode particles (dp<dp
Elemental analysis was performed with Particle Induced X-ray Emission (PIXE) at the University of São Paulo. Ionic components were measured by ion chromatography at CENA, USP. Data analysis was performed using multivariate statistical techniques.

For the wet season, aerosol concentrations and very low, averaging about 10 ug/m3 for particles less than 10 micrometers. The elemental composition is dominated by organic compounds that accounts for about 70% of the aerosol mass. The major trace elements are K, Ca, S, Si, Fe and other minor trace elements such as P, Zn, Mg and other biogenic elements. Phosphorus is present only in the coarse mode fraction and is emitted mostly at nighttime. P is present in low concentrations, typically around 10-30 ng/m3 in the wet season. Very low sulfur is observed for all sites. During the dry season, very high concentrations were observed, with concentrations up to 600 ug/m3. More than 75% of the aerosol mass in the dry season is organic. From the inorganic component, potassium and sulfur dominates, with significant concentrations of Ca, Cl, Si, Fe, Al, Zn and other elements. Factor analysis shoes the presence of only three major aerosol sources: natural biogenic aerosol, soil dust and biomass burning particles.

Presenting Author: Maria Antunes (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.10: Trace gas emissions (NO, N2O and CO2) in managed pasture soils of Brazilian Savanna

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We assessed the effects of the management of degraded pastures in the Cerrado region on soil-atmosphere fluxes of soil N oxides (NO and N2O) and CO2. Sampling was done from November 2001 to April 2002. Three areas of dense cerrado were converted to pasture (Brachiaria brizantha) in 1991 and had significantly degraded after 8 years. To evaluate different management practices for restoring fertility to this land, the three areas were managed since 1999 as follows: 1) N and P fertilized plot (N = 60 kg ha-1, P = 12 kg ha-1), 2) legume-grass plot, Brachiaria associated with a legume (Stylosanthes guianensis) with addition of P (12 kg ha-1), and 3) a traditional plot without management. A fourth area of cerradão was converted to pasture in 1999 and was left without management (young pasture). Although during the wet season, the NO and N2O soil fluxes were near zero at most of the chamber sites, the highest average NO flux (3.6 ng N cm-2 h-1) and N2O flux (6.7 ng N cm-2 h-1) were observed in this period. Despite these peaks, the average N emissions observed at all the pastures sites could be considered low. The results of a water addition experiment made in September 2002 indicated that the transition of dry-wet season is an important period for the production of N gases in the fertilized pasture and particularly in the young pasture. The CO2 fluxes were similar at the various pasture sites included in this study. In January/2002 the grass-legume treatment had the highest CO2 fluxes (9.2 µmol m-2 s-1) and the young plot had lowest fluxes (6.7 µmol m-2 s-1). The variability of CO2 fluxes decreased within and between plots at the end of wet season (April 2002).
(This abstract of a proposed presentation has been approved by the US EPA. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.)

Presenting Author: Mercedes Bustamante (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Trace Gases and Aerosols

12.11: Quantification and chemical characterization of the rainwater and throughfall in the Tapajós National Forest, Belterra-Pará

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The objective of the study was to quantify the chemical composition of rainwater and throughfall in the Tapajós National Forest, Belterra municipality, Pará State. A one hectare site (100m x 100m) in the vicinity of the km 67 flux tower was marked with 10m x 10m grid where collectors for throughfall were randomly re-located during each of 18 weeks from April through August 2003. The collectors consist of a polyethylene bottle with a polyethylene funnel (115 mm diameter). The dissolved ions (Ca+2, Mg+2, K+, NH4+, Na+, F-, Cl-, NO2-, NO3-2, PO4-3 e SO4-2) were analyzed by ion chromatography, with a Dionex DX-120. We found very high variation in throughfall amount from week to week (CV=79%), and high concentrations of the nutrients, principally, nitrogen (nitrate, nitrite and ammonium), potassium and sulfur, with amounts of the 96, 46 e 44 kg ha-1 y-1, respectively.

Presenting Author: Raimundo Cosme Oliveira Junior (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.12: Monitoring soil radon-222 flux at selectively logged and primary forest sites in the Tapajós National Forest and in an agricultural field at km77 Santarém-Cuiabá highway.

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Radon222 is a chemically inert radioactive noble gas that is emitted exclusively from the soil. As a result, it can act as a tracer of the physical processes that influence the biosphere-atmosphere exchange rates of reactive trace gases. R222 soil-air fluxes are a critical component of the Radon budgets used to study these processes.
Three sites are included in this study: a Logged Forest and Primary Forest in the Tapajós National Forest, and an agricultural field undergoing periodic crop rotation (rice and soybeans) (km77). Ground flux samples were collected three times a week using portable detectors placed on permanent PVC soil collars in areas around the LBA flux towers.
Preliminary results from July-August 2002 showed fluxes in Primary Forest and Logged Forest of 1.90 ± 0.41 atoms.cm-2s-1 and 1.68 ± 0.70 atoms.cm-2s-1, respectively. In July-August 2003, however, the fluxes were 0.87 ± 0.33 atoms.cm-2s-1 and 0.77 ± 0.28 atoms.cm-2s-1. In July-August 2002, the soil flux at Km77 was 1.83 ± 1.03 atoms.cm-2s-1 in untilled soil and 2.63 ± 1.42 atoms.cm-2s-1 in soil tilled in preparation for rice cultivation, while in the same period of 2003 the soil flux in untilled soil was 1.08 ± 0.52 atoms.cm-2s-1 and 2.27 ± 2.44 atoms.cm-2s-1 in an adjacent soybean plantation. Differences in flux rates at all sites are thought to be due, at least in part, to higher precipitation in July-August 2003.

Presenting Author: Risonaldo Lima (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.13: Chemistry and Production of Smoke in Brazil: CAPOS-2004-BRASIL

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Airborne FTIR, PTR-MS, and PM instrumentation will be deployed on the INPE Bandeirante during August-September of 2004 for the first comprehensive measurements of the initial emissions from Brazilian fires. These fires should include well-characterized savanna fires (near Brasilia) carried out by the research group of H. Miranda and well-characterized deforestation fires (near Alta Floresta) carried out by the research group of J. Carvalho. The latter fires will feature time-resolved fuel consumption measurements coupled with ground-based and airborne emissions measurements to determine the contribution of residual smoldering combustion to overall emissions. The airborne component will also focus on time-resolved measurements of post-emission changes in the smoke chemistry due to photochemistry and cloud processing. In-plume OH may be measured. CO profiles will be measured during satellite overpasses and the potential value of acetonitrile as a tracer for Brazilian biomass burning will be investigated. If possible, we will measure trace gas and particle emissions from cooking fires and sugar cane fires.

Presenting Author: Robert Yokelson (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

12.14: High near surface CO concentrations at the Santarem km 67 site

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Measurements of CO mixing ratios at two sites, Santarem, PA and Maxaranguape, RN, in Brazil, have shown considerably higher values at the former. This is a priori unexpected, since in the forest region it was thought that the environment would be relatively pristine. Satellite measured fire pixels are compared for 2001 and 2002 at several sites in Brazil. In terms of observed fire pixels, the Santarem site at km 67 is comparable to sites such as Cuiaba, MT and Campo Grande, MS, but below levels seen at Maraba, PA. The year to year variability is quite large. From 1995 to 2002 the relative sums of fire pixels are respectively: 380;99;85;145;180;90;220; and 340. The distribution of fire pixels over the years is also quite irregular, but always more packed from July to November. In addition to the local production of biomass burning CO, polluted air may be transported over the site from the city of Belem, PA. Backward air mass trajectories for Santarem show typical origins from the north-east. At the lower heights, trajectories have a tendency to bend slightly towards north, and it takes only about one day for air masses passing over or near the city of Belem to reach Santarem. For heights around 2-3 km, the origin of the air masses is from the east, passing over large extensions of the continent (2 to 3 days), over the site of Maxaranguape near Natal (4 to 5 days), and then reaching the Atlantic ocean (some 5 to 6 days back).

Presenting Author: Volker Kirchhoff (Poster)

Science Theme: TG (Trace Gases)

Session: Trace Gases and Aerosols

Vegetation Structure and Function

13.1: Coarse root biomass of a Cerrado sensu stricto in central Brazil

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Most carbon in Cerrado are concentrated into soil organic matter and root biomass. The Cerrado has a root:shoot ratio which greatly exceeds 1.0. Roots can account for up to 70% of Cerrado sensu stricto (a savanna woodland with abundant trees and shrubs and an herbaceous layer) biomass. Good estimates of root biomass for Cerrado are still lacking. This information is fundamental for our understanding of the carbon cycle in this ecosystem. Our objective was to estimate coarse root (> 2mm) biomass and its distribution in the soil profile to 1 m. Previous estimates have shown that 95% of the root biomass is concentrated into the first meter of soil. We sampled 34 soil monoliths (1.0 x 0.5 m). Root biomass was quantified by excavating from layers 0-10, 10-50, and 50-100 cm. Materials were sieved in the field. Roots were dried at 70oC for 72 h and weighed. Total average root biomass was 27.7 ±13.4 Mg ha-1. Roots in the top 10 cm comprised 32% of the total (8.7 ± 5.63 Mg ha-1); the layer 10-50 cm comprised 46% (12.7 ± 9.18 Mg ha-1) and the layer 50-100 cm 23% (6.2 ± 5.70 Mg ha-1). Biomass distribution was significantly different between layers ($F = 7.23$, $p < 0.001$), the 10-50 cm layer was significantly larger than 50-100 layer ($p< 0.001$). Estimates of root biomass are important to determine carbon stocks. However in order to fully comprehend the carbon cycle of Cerrado we need information on fine root biomass, root productivity and turn-over. We are also estimating these parameters in Cerrado ecosystems.

Presenting Author: Patricia Rodin (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Vegetation Structure and Function

13.2: A phytosociological analysis of trees in a "Terra Firme" forest in northern Mato Grosso

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Results are presented of a preliminary phytosociological study that was conducted in a "Terra Firme" forest in northern Mato Grosso. The study area is located at the Caiabi Farm, Alta Floresta, MT (90 58.3' S, 560 20.8' W). A tree census was conducted in a 1/4 hectare for individuals greater than 15 cm diameter at breast height (DBH). This work consisted of the first trial in the region that the research group intends to sample in a more extensive way in future field campaigns. The purpose of the study is to learn the tree patterns that are characteristic of the forest of the region and how this can affect the regeneration and forest recovery patterns of stands that are affected by fire.

The tree inventory included the following characteristics: species, DBH, height, and whether the tree was dead or alive. Within the plot, the location of each tree was recorded. This was achieved by locating several trees with a GPS. Those trees were used as reference points for the rest of the trees within the plot. Then, distance to the two nearest trees was recorded for each tree. A map with tree location and characteristics is presented. Also a preliminary spatial statistic analysis and tree association is presented.

This site is part of a 4-hectare patch where UNESP, INPE, UnB, UW, and USDA FS are conducting a multi-year set of studies on combustion of tropical biomass, carbon emissions, and forest flammability. After the plot was inventoried, all the trees and lower vegetation were slashed, let dry for three months, and then burned.

Presenting Author: Ralf Gielow (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Vegetation Structure and Function

13.3: Recruitment and mortality rates, and biomass changes in the primary forest in Manaus-am region

Rosana de Miranda Rocha (1), Niro Higuchi (1), Joaquim dos Santos (1), Roseana Pereira da Silva (1), Alberto Carlos Martins Pinto (1), Edgard Siza Tribuzy (2), Jeffrey Quintim Chambers (3), Susan Trambore (4), Plínio Barbosa de Camargo (2)

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This study deals with issues related to recruitment and mortality rates, and changes in aboveground biomass of an undisturbed tropical forest. This information is important for a better understanding of natural forest dynamics, and it could be used as a reference for forest management. Rates were estimated based on measurements carried out in 1996 and 2000 over two transects measuring 20 by 2500 m (5 hectares) each, located between km-30 and km-35 at a secondary road called ZF-2, within the limits of the agriculture district of Manaus. In 1998, the study area was dry because of El Niño, and suffered heavy rainfall the following year, thanks to La Niña. As a result, during the studied period, rates of mortality and recruitment were almost the same, 0.86% and 0.9% respectively. Nevertheless, when both transects were analyzed together, the studied area accumulated biomass during the monitored period at a rate of 1.12 t.ha-1.yr-1 or 0.34 tC. ha-1.yr-1, i.e., the studied area functioned as a carbon sink.

Presenting Author: Rosana Rocha (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Vegetation Structure and Function

13.4: A spatial analysis of tree pattern distribution using a geographical information system in an Amazonian "Terra Firme" forest in northern Mato Grosso

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Preliminary results are presented of an analysis of the tree spatial distribution in a "Terra Firme" forest in northern Mato Grosso. The study site was located at the Ouro Verde Farm, near the city of Alta Floresta, MT (100 28' 12" S, 560 31' 12" W). All the trees at least 10 cm DBH were inventoried in May 2003 in a one-hectare plot. This work was the second trial in the region that the research group intends to sample in a more extensive way in future field campaigns. The purpose of the study is to learn the spatial tree patterns that are characteristic of the region's forests and how this can affect the regeneration and forest recovery patterns of stands that are affected by fire.

The following tree characteristics were measured during the inventory: species, DBH, height, crown diameter and height, and whether the tree was dead or alive. Within the plot, the geographical coordinates of each tree were recorded through a survey conducted in ten 10x100 m2 contiguous plots, where the XY position of each tree was measured within the plot. Each plot was referenced relative to its preceding neighbor, while the first one was referenced relative to known geographical coordinates obtained by a GPS. A map with location and characteristics of each tree is presented in a GIS framework. A descriptive statistical analysis of the spatial tree patterns is presented. Also, preliminary phytosociological indices are presented. Comparisons are made with similar data obtained in two one-hectare plots located in the same region.

This site is part of a 4-hectare patch where UNESP, INPE, UNEMAT, UnB, UW and USDA FS, starting in May 2003, are conducting a multi-year set of studies on combustion of tropical biomass, carbon emissions, and forest flammability. After the inventory, all the trees and lower vegetation of the plot were slashed, let dry for three months, and then burned. The other two sites are still standing.

Presenting Author: Samuel Jorge Leite (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Vegetation Structure and Function

13.5: Carbon dynamics and Landscape-scale vegetation patterns in an old-growth Amazonian rainforest

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Accurate extrapolation of local carbon balance measurements to the landscape and regional scale in old-growth forests requires knowledge of large-scale natural disturbance patterns. Here we describe preliminary results from spatially-distributed ground-based measurements of vegetation structure to assess (1) variability of landscape-scale disturbance patterns (e.g. live:dead biomass ratios and species composition) and (2) the representativity of individual sites of ongoing intensive biometric and eddy flux measurements in the context of the broader landscape.

In 1999, 2001, and 2003, we surveyed 20-ha of well-drained old-growth upland forest in the footprint of an eddy covariance tower measuring net CO2 fluxes, in order to assess carbon pool sizes, fluxes, and climatic controls on carbon balance. This site, near the km 67 access road of the Tapajós National Forest near Santarém, Pará, Brazil (54°58'W, 2°51'S), showed exceptionally high levels of both coarse woody debris (CWD) stocks (48.7 +/- 5.5 Mg C ha-1, in pieces > 2cm) and small-tree recruitment rates (4.8 +/- 0.9%), both indicators of recent disturbance. In order to assess how representative such indicators of disturbance are at the landscape-scale, we established four new large transects (2500-m by 40-m) between km-72 and km-117 in the northern Tapajós in June-August 2003. Initial measurements during this period included aboveground live biomass (trees > 10cm DBH), tree species to common name, liana biomass (vines > 7.5cm), and CWD stocks (pieces > 2cm).

Presenting Author: Scott Saleska (Poster)

Science Theme: CD (Carbon Dynamics)

Session: Vegetation Structure and Function

13.6: Light and Water Resource Capture by Post-Pasture Abandonment Vegetation North of Manaus, Amazonas: Effects of Time, Management, and Nutrients

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In the Amazon region conversion of forest to pasture followed by pasture decline and subsequent abandonment on a large scale has potential to affect the hydrological cycle by changing both light and water resource capture dynamics. Restoration of the forest hydrological properties by subsequent vegetation communities is not well quantified. This study compares light and water resource capture dynamics of various landuses (LU) including forests, pasture and post pasture vegetation communities using simultaneous environmental monitoring of adjacent parcels with different vegetative covers and management regimes. 3 experiments were conducted to evaluate the effects of time, management, and nutrients on resource capture dynamics by post-pasture vegetation.
1-"Time of Pasture Abandonment and Secondary Forest Establishment" compares post-pasture SF of 6, 9 and 12 years of abandonment to primary forest (F) and active grass pastures (AP). Light interception was monitored using hemispheric images to determine LAI: rainy season LAI was greater than dry seasons in all landuses. Annual averages for each LU were AP=2.2, SF=3.4, F>4.5. Neutron probe measured soil water dynamics to depth of 3 m. Depth of depletion of soil water by each LU was AP3.7 m.
2-"Management of Polycultures: Agroforestry Systems (AFS)" incorporates a long-term experiment of AFS, implanted on degraded abandoned pastures in 1991. Current light interception and soil water dynamics of 2 AFS and 2 Sylvopastures (SP) were compared with a control of adjacent secondary forest (SF). LAI for each LU were ranked SF (3.3)>Palm AFS (3.1)>Timber/Fruit AFS (2.8)> Medium-input SP (2.7)>Low-input SP (2.4). LU were ranked similarly for depth of SWC depletion with SF>both AFS>both SP. Ranking between AFS and between SP fluctuated due to periodic harvests and grazing which reduced LAI and ET.
3-"Nutrients: Calcium and Phosphorus Amendments to Pasture Grasses and Legumes" concerned Brachiaria humidicola, the dominant Amazon pasture grass, and Desmodium ovalifolium, a pasture legume, which were evaluated for resource capture and biomass accrual responses to 3 fertilizer treatments: CO=control with no amendments; LP=Standard Lime and Phosphorus; LPG= LP + Gypsum. Grass biomass and light interception responses at 6 months were CO=2.9 mg/ha, 2.6 LAI; LP=4.1mg/ha, 2.9 LAI; LPG=3.5 mg/ha, 2.8 LAI.

Presenting Author: Steven Welch (Poster)

Science Theme: ND (Nutrient Dynamics)

Session: Vegetation Structure and Function

13.7: Pre-harvest Tree and Vine Biomass in a Forest in NW Mato Grosso, Brazil

Ted R. Feldpausch (1), Stefan Jirka (1), Susan Riha (1), Carlos A. Passos (2), Johannes Lehmann (1), Franklin Jasper (3), Maria Jose Miranda de Souza Noquelli (2), Pericles de Aquino Botelho (2), Daniela Pauletto (2), Elenara Gandini (2), Erick C.M. Fernandes (1)

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Selective logging has become a dominant land-use in Brazilian Amazonia. As part of a larger study to evaluate the effect of reduced impact logging on C dynamics and nutrient stocks, forest structure, and forest regeneration potential, we conducted a pre-harvest campaign to estimate tree and vine biomass in a parcel of forest managed by Rohden Industia Ltda in northwestern Mato Grosso (MT). The diameter at breast height (DBH) of all commercially harvestable trees ≥30 cm DBH was measured in 50x50 m cells in a 1000 ha management unit. We calculated biomass, stem density, and basal area for each cell, and then used kriging interpolation to generate contour and three dimensional wire-frame maps for the area. Commercial biomass, 211.9±102.7 Mg/ha, was highly variable across the 1000 ha area. To more intensively compare pre- and post-logging biomass and forest structure, we used these maps to locate stratified sampling transects (10x1000 m) within the management units and measured all stems ≥10 cm DBH. Our preliminary results indicate a total live tree biomass of 319.4±46.1 Mg/ha. Commercial biomass (≥30 cm DBH) is on average 66% of the total tree biomass (≥10cm DBH). In nested transects (2x1000 m) we measured DBH of all vines and estimated biomass (17.1±9.5 Mg/ha) as 5.1% of the total measured biomass. We are using geostatistical analysis to determine the relationship between undisturbed forest biomass and structure, and soil and topographic landscape features. Based on this analysis, we plan to estimate tree biomass as a function of DBH size classes, as well as vine biomass, over a larger area of the forest.

Presenting Author: Ted Feldpausch (Poster)

Science Theme: ND (Nutrient Dynamics)

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2.3	Carlos M. de Souza Jr.	Characterization of Forest Fragments in Rondônia through Remote Sensing and Forest Transects
2.4	Gregory Asner	Remote Sensing of Selective Logging: Early Results of a Basin-wide Analysis
4.6	Christopher Potter	Uncertainty in Ecosystem Production and Biomass of Amazonia Attributable to Remotely Sensed Vegetation Characteristics
5.1	Gina Cardinot	High drought-tolerance of an eastern Amazon forest: results from a large scale rainfall exclusion experiment.
5.2	David Ray	Micrometeorological and Canopy Structure Controls on Rainforest Fire Susceptibility of Mature and Disturbed Forests in an East-Central Amazon Landscape
6.2	Jeffrey Morisette	Using experimental fires to quantify the accuracy of the MODIS fire product and distinguish between conversion and maintenance land cover dynamics
6.3	Ruth DeFries	Quantifying spatial and temporal patterns of land use transitions from pasture to cropland in Mato Grosso
6.4	Maria del Carmen Diaz	Agribusiness expansion into the Brazilian Amazon
6.5	Britaldo Soares Filho	System architecture of a spatially explicit model to simulate deforestation in the Amazon basin
6.6	Foster Brown	Science and public participation in regional Amazonian development: The case of the MAP process in the frontier region of Brazil, Bolivia and Peru.
7.2	Andreia Maria França	Amazon Floodplain lake shape assessment using remote sensing data
7.4	Claudio Barbosa	Geostatistic application to spatial modelling of water quality variables as support for understanding the linkages between vegetative cover and inundation
7.5	Dayson Jardim-Lima	Remote sensing application to monitor seasonal white water input into floodplain (várzea lakes) in Central Amazon: Mamirauá Sustainable Development Reserve (1)
7.6	Evlyn Novo	MODIS performance for assessing seasonal changes in floodplain lake size and shape
7.7	Ivan Lima	Location of telemetric monitoring sites in Amazon floodplain lakes with Landsat-TM
7.11	Michael Coe	Improving the HYDRA Freshwater Systems Model of Amazonia
7.12	Ramon Morais de Freitas	TM, ETM and MODIS Data for Multitemporal Wetland Analysis in Large-Scale Studies

8.8	Lixin Lu	The Influences of fresh water co2 effluxes and mesoscale circulations on regional carbon balance in the Tapajos Region, Para, Brazil
9.3	David Turner	Evaluating MODIS Land Products at a Tropical Moist Forest Site
9.9	Paulo Brando	The effects of partial throughfall exclusion on phenological patterns of Coussarea racemosa (Rubiaceae)
9.10	Paulo Moutinho	Effects of throughfall exclusion on herbivory in the National Forest of Tapajós, Amazônia, Brazil
10.1	Alexander Pfaff	A Progress Report on the Basin-scale Econometric Model
10.2	Ane Alencar	The Impact of Understory Fires in the Amazon Transitional Forest: A Remote Sensing Perspective
10.3	Bobby Braswell	Hyperion data for ecosystem and land cover change studies in the Brazilian Amazon
10.4	Britaldo Soares Filho	An index of anthropic pressure to estimate the deforestation potential in the Brazilian Amazon municipalities
10.5	Carlos, Jr. de Souza	Software for Multi-Temporal Radiometric Correction, SMA and Image Classification: towards a generalized classification approach for monitoring the Amazon Forests
10.6	Cintia Vasconcelos	Deforestation and Malaria Incidence in Jacundá (Pará) Municipality Between 1973 and 1996
10.7	Douglas Morton	Mapping changes in forest canopy cover in Amazonia between 2000-2003 using MODIS VCF
10.8	Eduardo S. Brondizio	O LBA e comunidades rurais da região de Santarém: Experiência piloto de apresentação e discussao de resultados oriundos pesquisas efetuadas com agricultores da região
10.9	Eduardo S. Brondizio	Variabilidade inter- e intra-regional nas trajetorias de uso da terra entre differentes regioes Amazônicas
10.10	Elsa Mendoza	Evolution of timber management in southwestern Amazonia (MAP region – Brazil, Bolivia and Peru)
10.11	Eugenio Arima	The Spatial Evolution of Road Systems: A poster reporting on a simulation for the project A Basin Scale Econometric Model for Projecting Future Amazonian Landscapes
10.12	Everaldo Telles	Carbon and nutrients cycling in soil associated of selective logging in eastern Amazonia
10.13	Foster Brown	Energy and transport scenarios for southwestern

		Amazonia, including Acre, Brazil, and their implications for regional land cover and land use change
10.14	Genong Yu	Performance of an Object-Based Neural Network Classifier on Land Cover Characterization in Amazon, Brazil
10.15	Genong Yu	An Object-Oriented Approach to Integrate Remote Sensing, GIS and Statistics in the Amazon Rainforest Study
10.16	Laura Hess	Topography of the Amazon Floodplain: Fusion of the Shuttle Radar Topography Mission Digital Elevation Model with Synthetic Aperture Radar, Optical, and Laser Altimetry Data
10.17	Liana Anderson	Multitemporal fraction images derived from ETM+ and MODIS daily data to detect deforestation in the Amazon Region
10.18	Liane Guild	Effects of Interannual Climate Variability in Secondary Forests and Crops Under Traditional and Alternative Shifting Cultivation
10.19	Lydia Olander	Carbon and nutrient transfer due to selective logging in the Amazon using remote sensing data.
10.21	Mateus Batistella	Human and Physical Dimensions of Land Use/Land Cover in Amazonian landscapes: a comparative approach
10.23	Oswaldo Carvalho Jr	Forest biomass reduction by logging and fire in the Eastern Amazon
10.24	Robert Walker	Roads: Cause or Consequence of Land Use Change? A poster reporting on fieldwork for the project "A Basin Scale Econometric Model for Projecting Future Amazonian Landscapes"
10.25	Sanae Hayashi	Assessing the Utility of a Landsat ETM+ Images for Identifying Areas of Traditional Logging in West Para, Brasil
10.26	Stephen Hagen	Characterizing land cover change in Amazonia by synthesis of data at multiple spatial scales
10.27	Sueli Castellari	Digital Library of Control Points
10.28	Wanja Lameira	Multitemporal analysis of Soybean expansion in Santarém Region
11.3	Janaina Carmo	Nitrogen dynamics during till and no-till pasture reformation sequences in Rondônia, Brazil
11.4	Joice Ferreira	Two-dimensional resistivity profiling: a potential tool to monitor the below-ground environment in ecosystem studies.

11.5	Luciene Lara	Land-use changes and wet deposition in Amazon Basin
11.6	Megan McGroddy	Regional patterns in inorganic nutrient losses across the central Amazon Basin: preliminary results

ND (Nutrient Dynamics)

1.1	Ted Feldpausch	Carbon and nutrient accumulation in secondary forests regenerating from degraded pastures in central Amazonia, Brazil
3.4	Christopher Neill	Soil Nitrogen Transformations and Soil Solution Fluxes Following Clearing of Amazonian Tropical Forest for Pasture
3.5	Linda Deegan	Key Connections in Amazon Stream Corridors: Using 15N to Trace N Transformations and Transport
3.6	Eric Davidson	Loss of Nutrients from Terrestrial Ecosystems to Streams and the Atmosphere following Land Use Change in Amazonia -- An Integrated Review
7.10	Mark Johnson	Low-flow headwater stream nutrient concentrations controlled by weathering in four forested Amazonian watersheds
7.13	Ricardo Figueiredo	Effects of land use change on stream water chemistry in Eastern Amazonian watersheds
11.2	Dar Roberts	Impact assessment of land-cover change on soil nutrient levels at multiple scales
11.7	Mercedes Bustamante	Effects of cover plants on the soil P fractions in tillage and no-tillage systems in the Cerrado Region
11.8	Paulo Artaxo	Deposition fluxes of trace elements in Western Amazon Basin during 20th century inferred from aerosol deposits in Illimani ice core, Bolivian Andes
12.3	Francoise Yoko Ishida	Title: Experimental effects of drought on soil emissions of carbon dioxide, methane, nitrous oxide, and nitric oxide in a moist tropical forest in Santarém–Pará–Brazil.
12.10	Mercedes Bustamante	Trace gas emissions (NO, N2O and CO2) in managed pasture soils of Brazilian Savanna
13.6	Steven Welch	Light and Water Resource Capture by Post-Pasture Abandonment Vegetation North of Manaus, Amazonas: Effects of Time, Management, and Nutrients
13.7	Ted Feldpausch	Pre-harvest Tree and Vine Biomass in a Forest in NW Mato Grosso, Brazil

TG (Trace Gases)

1.4	Patrick Crill	Soil-Atmosphere Flux of Carbon Dioxide at km67, FLONA, Tapajos, Brazil
1.5	Christopher Martens	Radon-222 determination of respiration rates in a Tropical Rain Forest Canopy, Brazilian Amazonia
1.6	Paul Steudler	Diurnal Changes in Nitric Oxide Emissions from Conventional Tillage and Pasture sites in the Amazon Basin: Influence of Soil Temperature.
2.2	Michael Keller	Effect of Selective Logging on the Soil-Atmosphere Exchange of Trace Gases at the Tapajos National Forest
3.1	Bruce Forsberg	Using multi-temporal JERS-1 SAR and SRTM Imagery to derive an absolute ground level DEM for the Central Amazon Floodplain
6.1	Paulo Artaxo	Aerosol spatial distribution, composition and effects on the Amazonian ecosystem
7.8	José Mauro Moura	Isotopic composition of CH4 from river sediments in eastern Amazonia
8.1	Alejandro Fonseca Duarte	Rainfall Variability in Rio Branco-AC, Brazilian Amazonia: Is it a Consequence of Deforestation?
9.5	Evilene Lopes	Scaling up woody-tissue respiration at the Tapajos National Forest
12.1	Brent Holben	Climate Data Records of aerosols and surface flux at distributed sites in the Amazon Basin
12.2	Flávia Alcântara	Impact of green manuring and nitrogen fertilization on trace gas fluxes (NO, N2O, CO2) in a cornfield in the Cerrado Region of Brazil
12.4	J. William Munger	Long-term Measurements of Carbon Dioxide and Carbon Monoxide Concentrations to Help Constrain Regional Carbon Budgets.
12.6	John Miller	Vertical Profiles of Trace Gases Above Santarem and Fortaleza
12.7	Luciana Gatti	Concentrations Variability of Trace Gases during Dry and Wet Seasons in Amazon Basin
12.8	Luciana Gatti	Seasonal variations of isoprene concentrations at the Tapajós National Forest - Para and Biological Reserve of Jarú - Rondônia in Amazonia
12.9	Maria Antunes	Long term measurements of aerosol composition for