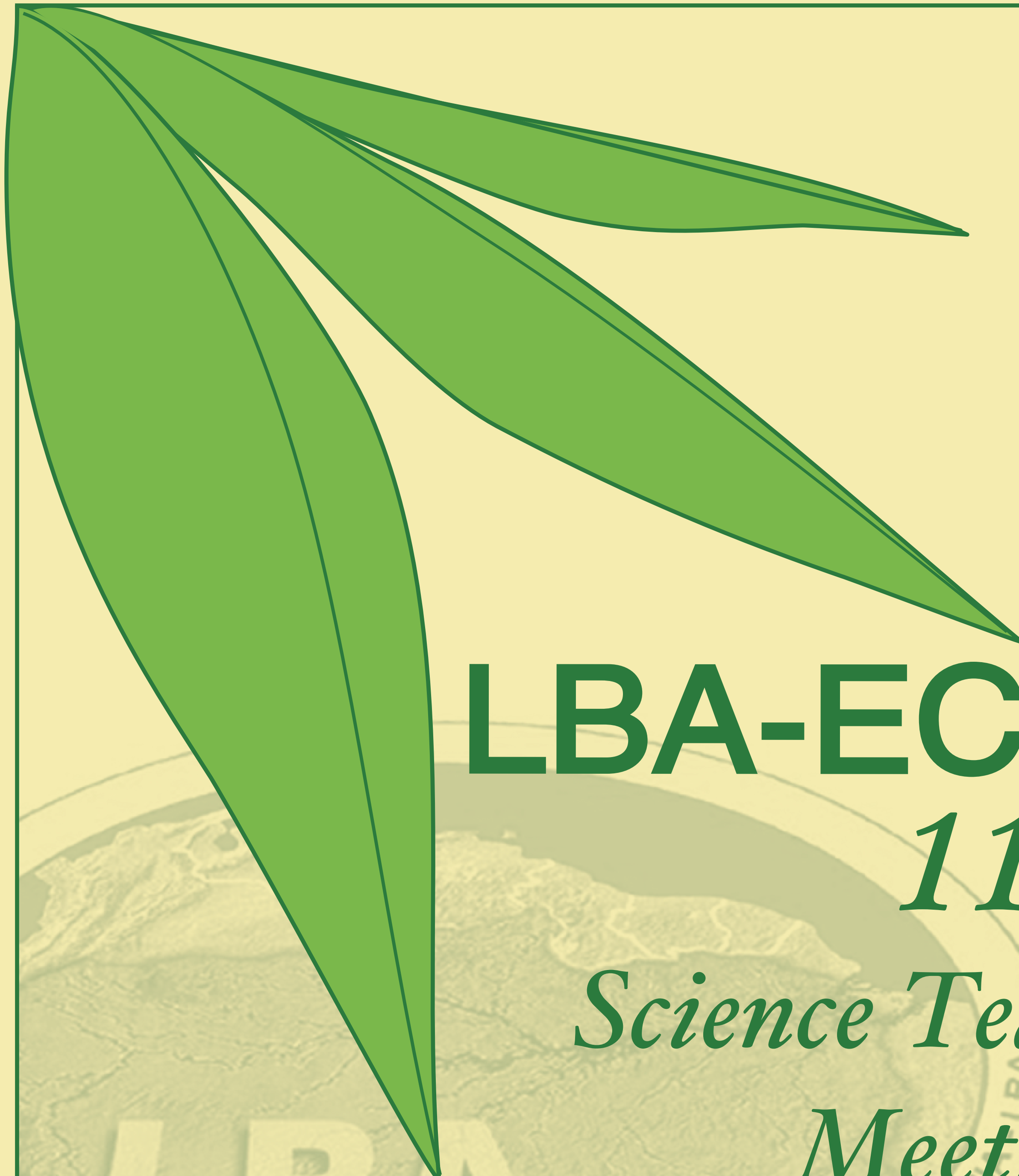

LBA-ECO

11th Science Team Meeting

Book of Abstracts

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About this Book

This Book of Abstracts contains the oral and poster abstracts scheduled to be presented at the LBA-ECO 11th Science Team Meeting.

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Plenary 1

Plenary 1

SP1.1: Towards a new scientific agenda for LBA

Mateus Batistella, Embrapa Monitoramento por Satélite, mb@cnpm.embrapa.br (Presenting)

SP1.2: A New Approach for Estimating Carbon Emissions from Deforestation

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Doug Morton, University of Maryland College Park, douglas.morton@gmail.com
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The UNFCCC policy discussion on carbon credits for reducing deforestation in the post-Kyoto commitment period heightens the need for accurate and repeatable methods to estimate carbon emissions from deforestation. The DECAF model estimates emissions from deforestation fires and subsequent respiration with satellite inputs of deforestation area, NDVI, burned area, active fire, and land cover following deforestation. Application of the model to the state of Mato Grosso indicates that the fate of land use following deforestation strongly determines emissions. Respiration of biomass remaining after the initial fire is a smaller contributor to emissions (~5%) than previous estimates (~20%). Accounting for the timing of deforestation fires, which can span several years, alters the interannual variability of deforestation emissions compared with previous approaches. At the basin- and continental-scale, satellite-derived estimates of biomass burning help identify the major areas contributing to deforestation emissions.

SP1.3: An organic carbon budget for an Amazon floodplain lake

John M. Melack, Univ. of California, melack@lifesci.ucsb.edu (Presenting)
Diana Engle, Univ. of California, drdianaengle@yahoo.com
Bruce Forsberg, INPA, forsberg@vivax.com.br

The fringing floodplain along the 2600 km reach of the Amazon River in Brazil contains about 6500 lakes and inundates up to about 80,000 sq. km of flooded forests, open water and floating macrophytes. These habitats outgas significant amount of carbon dioxide and methane as a result of carbon fixation and exchange on the floodplain and from neighboring uplands. Based on our measurements and those of others, we have assembled sufficient data to characterize the following fluxes and transformations in a representative central Amazon floodplain lake: inputs of litterfall, dissolved organic carbon (DOC) in rainfall, DOC and particulate organic carbon (POC) in streams, DOC in groundwater seepage; exchanges of DOC and POC with the mainstem river; net primary productivity of floating macrophyes, periphyton and phytoplankton; sedimentation; carbon dioxide and methane evasion. These analyses are the basis for models of carbon processing and methane evasion.

SP1.4: Amazon Forest Dynamics and Carbon Balance 1980-2005

Oliver L Phillips and RAINFOR Consortium, University of Leeds and RAINFOR Consortium, o.phillips@leeds.ac.uk (Presenting)

Evidence from long-term permanent plots indicates a number of changes have occurred in the ecological structure and dynamics of mature Amazon forests over at least the last two to three decades. These changes - including changes in dynamic processes (e.g., increased mortality, increased wood production) and static properties (e.g. increased biomass) - are concerted and spatially coherent. As a consequence it appears that mature Amazon forest biomass has been acting as a substantial carbon sink for many years. The exact mechanism(s) driving these changes are not known, but the simplest explanation consistent with the available evidence is that one or more external drivers have enhanced growth.

The 21st century atmospheric setting for Amazon forests may be without precedent for tens of millions of years, but the observational plot network provides a number of clues for how we may expect near-future atmospheric changes to impact those Amazonian forests which survive direct human effects. For example, (1) Amazonian forests are functionally remarkably variable both locally and regionally. This suggests that changing turnover rates could drive changes in the functional composition of forests, with impacts on carbon storage. (2) The recent carbon sink, while significant at the global scale, actually represents at the plot-level a small difference between two large ecological terms (growth and mortality), which in turn are dwarfed by the magnitude of total carbon processed by the system. This suggests that even moderate drought may be sufficient to shut or even reverse the biomass sink. These ideas will be explored using RAINFOR data.

Parallel Oral Session 1

1A: Remote Sensing and the Carbon Cycle

1A.1: Objective Indicators of Pasture Degradation from Spectral Mixed Model Analysis of Landsat Imagery

Eric A. Davidson, Woods Hole Research Center, edavidson@whrc.org (Presenting)
Gregory P. Asner, Carnegie Institute, gpa@stanford.edu
Thomas A. Stone, Woods Hole Research Center, tstone@whrc.org
Christopher Neill, Marine Biological Laboratory, cneill@mbl.edu
Ricardo de O. Figueiredo, Embrapa Amazônia Oriental, ricardo@cpatu.embrapa.br

Degradation of cattle pastures is a major concern for management and for understanding the future land cover/land use consequences of ongoing Amazonian deforestation. Unfortunately, “degradation” is not well defined and may have different meanings for ranchers, ecologists, and policy makers. The objective of this study is to quantify pasture degradation using objective scalars of photosynthetic vegetation (PV), non-photosynthetic vegetation (NPV), and exposed soil derived from spectral mixture analyses of Landsat imagery. The amount of exposed soil and NPV, such as senescent grass foliage, increases as pastures age and as the grasses become less productive. We employed a general, probabilistic spectral mixture model (AutoMCU) for decomposing satellite spectral reflectance measurements into sub-pixel estimates of PV, NPV, and bare soil covers at Fazenda Nova Vida in Rondonia and Fazenda Vitoria in Pará. These two ranches vary by size, age, soils, and management practices. The Nova Vida ranch had higher stocking densities, was more intensively managed, and had larger values of estimated exposed soil than did Fazenda Vitoria. The number of management “treatments” at Nova Vida, which included liming, herbiciding, and disking, was weakly, but significantly positively correlated with exposed soil and negatively correlated with PV across pasture management units. At both ranches, PV and NPV were strongly negatively correlated, and PV values were generally lower at the more intensively managed Nova Vida ranch. Although this analysis demonstrates that Nova Vida ranch shows signs of pasture degradation as defined by these objective criteria, it nevertheless has been maintained as a highly productive pasture system through intensive management and relatively high inputs. This remote sensing technique successfully reveals variation in objectively defined degradation indicators between and within ranches, but these degradation indicators do not necessarily imply reduced current cattle production.

1A.2: Amazon Forests Green-up during 2005 drought

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Natalia Restrepo-Coupe, University of Arizona, ncoupe@email.arizona.edu

Coupled climate-carbon cycle modeling studies indicate that Amazon forests are vulnerable to drought, and some predict substantial carbon loss from tropical ecosystems, including the drought-induced collapse of the Amazon forest and conversion to savanna. The model-simulated future forest collapse is attributable, in part, to a forest physiological feedback mechanism which should be observable as reductions in transpiration and photosynthesis during drought years under current climates.

A widespread drought occurred in the Amazon in 2005, the first such climatic anomaly since the launch of the Terra satellite’s MODIS sensor in 1999, providing a unique opportunity to compare actual forest drought response to expectation on broad spatial scales. Contrary to expectation based on model simulations, satellite observations showed a large-scale green-up in intact evergreen forests of the Amazon in response to the 2005 drought. These findings suggest that Amazon forests, though threatened by human-caused deforestation and fire, may be more resilient to climate changes than ecosystem models assume.

1A.3: MODIS vegetation indices for detecting the 2005 Amazon drought

Liana O. Anderson, Oxford University Centre for the Environment,, lander@ouce.ox.ac.uk (Presenting)
Yadvinder Malhi, Oxford University Centre for the Environment,, ymalhi@ouce.ox.ac.uk
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In the last decades, the detection of drought occurrences and assessment of its severity using satellite data are becoming popular in disaster, desertification, crop production, phenology, land cover change and climate change studies. To detect the drought effects on different vegetation types, many methodologies have been developed, mostly relying on the use of vegetation indices. This communication reports the first attempt to assess the capability of MODIS NDVI, Enhanced Vegetation Index (EVI) and Normalized Difference Water Index (NDWI) time-series to detect the spatial pattern of the 2005 drought in Amazonia. To reach this objective, monthly composites of the MOD13A2 product were generated for the 2000 to 2006, based on maximum NDVI pixel value, for the entire basin. A South American land cover map updated with deforestation until 2005 for the Brazilian Amazon associated with a rainfall anomaly derived from TRMM data were used as basis for the sampling scheme. To identify intensity and duration of the canopy change / stress due to the drought across Amazonia, we calculated vegetation indices anomalies for 2005 and 2006 (NDVIanomaly, EVIanomaly, NDWIanomaly) as the departure from the 2000 - 2006 mean (VI2000 - 2006), normalized by the standard deviation (σ) in a pixel-by-pixel basis, based on 5 samples in 3 distinct areas affected by the rainfall anomaly in 2005. The spatial distribution analyses were based on re-sampling data to 0.25 degrees to diminish cloud coverage and noise in the dataset. Then, vegetation indices anomalies were calculated. To support the data interpretation, literfall data for 2 sites (Southern Colombia and Eastern Brazil) from 2004 to 2006 were used. Our preliminary results showed that despite the high variability in the vegetation indices response in the temporal series, they detected a persistence of an anomalous signal during 2005/2006. The spatial analysis showed NDWI anomaly in Jun/Jul 2005 in a region that is not used to water deficit, suggesting that this areas can be more sensitive to drought events and climate change. Finally, for the first site evaluated (Colombia), vegetation indices seems to not reflect literfall variability, suggesting that shade and other factors might be affecting vegetation indices response.

1A.4: Severe storms and blow-down disturbances in the Amazon forest

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Large (area ≥ 1 ha) natural disturbances in old-growth tropical forests are caused by a variety of processes such as landslides, fires, wind, and cyclonic storms. We analyzed the pattern of large forest disturbances apparently caused by severe winds (blow-downs) in a mostly unmanaged portion of the Brazilian Amazon using a longitudinal transect of Landsat images (27 scenes) between Lat/long 6º43'W 68º50'S and 2º16'W 51º51'S, respectively and daily precipitation estimates based on NOAA satellite data. We found 170 blow-downs with an average area of 3 km2. Most blow-down disturbances occurred in Western Amazon between longitudes 67º and 58º W. A map of heavy rainfall (≥ 20 mm d-1) showed that the maximum frequency of heavy daily rainfall (~80 days y-1) occurred around at the longitude 63º in our study region. We found a close relation between the frequency of heavy storms and the occurrence of blow-down disturbances events. This result suggests a close relation between severe weather and the rate of forest turnover caused by blow-down disturbances. The forest turnover time calculated for these disturbances in 9 Eastern Landsat scenes studied was almost 9000 years whereas for the 18 scences in the Western Amazon, turnover time was closer to only 1200 year. Large disturbance may have a significant influence on spatial pattern of forest dynamics and productivity of the Amazon.

1B: Chemistry of Streams and Rivers

1B.1: Water and solute fluxes in small Amazonian forest and pasture watersheds

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Small watersheds provide discrete landscape units in which to address the central LBA question of how changes to land cover influence the function of Amazonian tropical forest ecosystems. We compared water and solute fluxes in small (~1 ha) forest and pasture watersheds at Rancho Grande in Rondônia. Streamflow accounted for 1% of rainfall in forest but 18% in pasture, and quickflow dominated stream flows in both forest and pasture. Concentrations of Ca2+, Mg2+, NH4+, NO3- and SO42- in rain and throughfall declined several-fold from the dry to wet seasons and within individual rain events, indicating that dry deposition and aerosol rainout are important regional contributors of solute inputs. In forest, annual input of Ca2+, NH4+, NO3-, SO42- and Cl- exceeded export, export of Na+ exceeded inputs, and input and export of Mg2+ and K+ were balanced. In forest, groundwater was the predominant pathway of export of all solutes except NO3-. More than half of NO3- export from forest occurred in stream quickflows during a small number of rain events. In pasture, annual input of Ca2+, NH4+, NO3- and SO42- exceeded exports, export of Na, K+ and Mg2+ exceeded inputs and inputs and outputs of Cl- were balanced. In pasture, solute export occurred predominantly in quickflow. Export of Cl- and NO3- changed most markedly between land covers. Export of Cl- was 5x greater and K+ export was 2x greater from pasture than forest. Export of NO3- from pasture was 1/3 that of forest. Changes in NO3- concentration between soil solution and groundwater (from 130 to 1 μM) led to losses of 17 kg N ha-1y-1 in forest, more than 3x greater than bulk inorganic N deposition. In pasture, no flowpaths contained NO3- concentrations that could lead to large solution N losses. Predicting watershed solute balances over wider areas depends on: 1) regional solute inputs generated in fragmented landscapes, 2) changes to watershed hydrology that control water flowpaths, and 3) changes to solute chemistry within flowpaths caused by land cover.

1B.2: Identifying runoff sources across scales in Amazon watersheds: an LBA synthesis effort

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End member mixing analysis (EMMA) can be used to identify the sources of water that contribute to streamflow and to quantify source dynamics both over seasons and during individual storm events. This approach assumes that the chemistry of stream water is the product of a mixture of discrete "source" solutions within catchments whose solutes behave conservatively as they travel to the stream. We used EMMA to examine sources of streamflow across watersheds of different scales and land covers at various LBA and other Amazon sites, for which stream water and flowpath hydrochemistry data from previous studies were available. These included watersheds at Nova Vida, Nossa Senhora, and Rancho Grande in Rondônia, Juruena in Mato Grosso, Paragominas in Pará and La Cuenca in Perú. We were interested in identifying the hydrological flowpaths that deliver water and solutes from land to streams and rivers of the Amazon Basin, and in changes in flowpaths with changes in land cover and across a range of soil characteristics, particularly the

presence or absence of a layer of low hydraulic conductivity. We identified a consistent pattern across sites in which groundwater and soil solution end members emerged as the main sources to stream flow. The relative contribution of these two sources varied with discharge, as the relative contribution of groundwater increased significantly with increasing discharge during baseflow on most sites. During storm flow, the magnitude of contributions by source was independent of discharge rate. Overland flow contributions to stream flow were identified at most sites, although the relative importance of overland flow diminished in streams draining larger watersheds. Patterns associated with land cover transformation were identifiable at the smaller order watersheds because of an increase in water yields due to increased overland flow in pastures relative to forest. Patterns across soils characteristics could not be clearly established with the current datasets, as they mostly originate at sites under Ultisols, while Oxisols were underrepresented (1 site). Our results show that: 1) the EMMA approach can be applied for multi-site comparisons, and 2) some consistent patterns of hydrological functioning across scales can bolster the predictive power of modeling efforts aimed at quantifying how changes to land cover influence basin-wide hydrological and biogeochemical processes across the Amazon.

1B.3: Dissolved organic carbon fluxes in precipitation, throughfall and overland flow in a riparian forest in Southwestern Amazonia (Rondônia, Brazil)

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Deforestation to pasture is the main type of land use change in Amazonia. In spite of various nutrient cycling studies comparing different land cover (i.e. pasture vs. intact forest), little is known about the fluxes of dissolved organic carbon (DOC) derived from precipitation, throughfall and overland flow in these tropical riparian forest ecosystems. In this study we sampled rainfall, throughfall and overland flow in a riparian fragment of the Urupá River - Rondônia, Brazil, from November 2004 to May 2005. Samples were analyzed for pH, electrical conductivity and DOC concentrations. Results showed that all the samples were acidic, with mean pH of 5.691, 5.818 and 4.520, respectively. Mean DOC concentration in precipitation was 164.8 microM. After washing the forest canopy (throughfall), this value increased to 584.0 microM. However, after moving over the forest floor (overland flow), concentrations showed a decreased, although not statistically significant, to 563.3 microM. Seasonal variations in DOC concentrations were very similar in throughfall and overland flow, increasing after the establishment of the rainy season (after March). The study showed that the concentrations of DOC in precipitation and throughfall that end up as overland flow are not affected by Ultisol soils, and represent additional sources of organic matter to the adjacent river.

Key Words: Amazonia dissolved organic carbon, riparian forest, precipitation, throughfall, overland flow.

1B.4: Storm pulses of dissolved CO2 in a forested headwater Amazonian stream explored using hydrograph separation

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Event water vs. pre-event water contributions to storm hydrographs in the humid tropics have received much less attention than in temperate regions. In research in a forested headwater catchment of the Brazilian Amazon, we collected data in situ using a multiparameter sonde (pH, DO, EC and temperature) and an infrared gas analyzer (dissolved CO2) in addition to hydrometric measurements. We then analyzed 14 storms (11 rainy-season and 3 dry-season storms) for dissolved CO2 dynamics and event water contributions to storm flow. An increase in streamwater CO2 concentration was observed on the falling limb of the storm hydrographs (referred to here as a CO2 pulse), indicating contributions from flowpath(s) with higher CO2 concentrations that lag the storm peak. We applied the transfer function hydrograph separation model (TRANSEP) using specific conductivity as a conservative tracer, and found that pre-event water as a fraction of storm hydrographs was 0.79±0.03 (mean±1SE for n=14 storms). The pre-event water fraction decreased linearly with event size (r= -0.59, p=0.02). The pre-event water fraction was also negatively related to the magnitude of CO2 pulses observed (r= -0.97, p<0.0001). The relationship between CO2 pulses and pre-event water contributions to storm flow suggests a rapid interaction between CO2 in the soil atmosphere and infiltrating storm precipitation, which contributes dissolved CO2 to storm flow as event water late in the events. During most storms, a decline in dissolved CO2 concentrations in streamwater was observed on the rising limb, indicating event water contributions early in the events from quickflow pathways that are low in CO2 including direct precipitation/throughfall and overland flow. These dissolved CO2 trends are superimposed on a background of CO2 concentrations derived from pre-event emergent groundwater that were more than 100 times greater than CO2 concentrations in precipitation, though this CO2 largely outgasses to the atmosphere within the headwater reach.

1B.5: Photochemical production of low molecular-weight organic acids in the Rio Negro

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The Amazon river releases more than ten times the amount of carbon by CO2 evasion from water surfaces than is exported to the ocean as TOC and DIC. High CO2 concentrations driving this evasive flux in river channels are thought to derive mostly from in situ respiration of organic carbon, but the sources of this respired carbon remain unresolved. Beginning with the work of Geller (1986, Limnology and Oceanography, 31: 755-764), photochemical production of biologically labile substrates from aquatic humic substances has been widely recognized. In general, low molecular weight organic acids (LMWOAs) and CO2 are produced 10-20 times faster than all other possible photoproducts (Miller and Moran 1997, Limnology and Oceanography, 42(6): 1307-1316). We measured the photochemical production of LMWOAs in the Rio Negro and found it to be 7.5 uM LMWOA-C hr-1. This rate is an order of magnitude greater than measured respiration rates in this river. These results suggest that labile compounds produced during the photochemical degradation of dissolved humic substances may be fueling in situ respiration in the Rio Negro and possibly other rivers throughout the Amazon basin.

1B.6: The Importance of pH, Particulate Carbon, and Photosynthesis in Controlling Water-Column Respiration Rates in the Central and Southwestern Amazon Basin

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Although water-column respiration has been hypothesized to be the main source of outgassing CO_2 from Amazonian rivers, we lack an understanding of the variability of the observed rates. This study examines the variation of water-column respiration rates as a function of aquatic chemical parameters, bacterial abundance, photosynthetic production, and organic carbon (OC) size fractions (coarse OC, fine OC, dissolved OC and size fractions within the dissolved pool: < 5 kDa, 5-100 kDa, > 100 kDa). Throughout Amazonas and Acre, respiration rates ranged from 0.034 to 1.77 µM/hr of O_2 consumed. Respiration was positively correlated with pH (r^2=0.58) and with bacterial abundance (r^2=0.78). Our results from a partial correlation analysis suggest that pH may indirectly control respiration by limiting bacterial abundance in acidic sites. Further, sites with a pH < 7 (low pH sites) had a higher ratio of respiration to photosynthesis (R:P) (2.3 ± 0.3) than sites with a pH > 7 (high pH sites) (1.1 ± 0.2). This is consistent with the isotopic signature of respired CO_2, which suggests that algae is consumed at high pH sites, whereas C_3 and C_4 vegetation fuel respiration at low pH sites. Out of all size fractions of OC studied, FPOC and the percentage of DOC < 5 kDa were the most positively correlated with respiration rates (r^2=0.70 and r^2=0.29, respectively). Kendall's Coefficient of Concordance indicated that rivers with high respiration rates also have high pH values, high fine particulate OC concentrations and low R:P ratios. Thus the results of this study suggest that pH may control respiration rates by limiting bacterial abundance in acidic conditions, that fine particulate OC is a labile size fraction of OC, and that autochthonous production may play a larger role in riverine carbon cycling in the Amazon than previously thought.

1C: Regional Hydrometeorology

1C.1: Local, regional and global hydroclimatological impacts of Amazon deforestation: An LBA Perspective

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We have performed numerical modeling experiments at the various scales to improve our understanding of the impacts of deforestation of the Amazon on the local, regional and global weather patterns and climate. We have identified key aspects of numerical models that are necessary to simulate accurately wet-season precipitation. We have also identified regional and global teleconnections that have a major impact on the distribution of precipitation at all scales. These new insights, which result from our LBA investigation, will be presented at the meeting.

1C.2: Modelling Land-Climate Interactions in Amazônia under Uncertainty

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Land-climate interactions in the Amazon basin are of mounting concern, given ongoing processes of agricultural conversion in the region, and possible impacts on climate, which could impose serious stressors on the basin's remaining forest. To investigate these possible impacts, we linked a spatial econometric model (SEM) to a regional climate model (RCM), and explicitly incorporated variability into the modelling framework in order to make climate projections that take uncertainty into account. In essence, we treated the basin as a large collection of Bernoulli experiments, and used a Monte-Carlo approach in generating probability distributions of climate variables, as opposed to point estimates, thereby enabling assessments of statistical significance in observed changes. With the SEM, we projected a range of likely land covers for the Amazon, based on two development scenarios - "restraints-on-development" and "business-as-usual" - as well as total forest removal, and generated a set of possible land covers associated with each scenario, using the probabilistic features of the SEM. In this way we were able to explicitly represent variability in future land covers. We then conducted Monte Carlo-type simulations with the RCM (RAMS 4.4) driven by these landscapes for five different years, employed to introduce atmospheric variability. Absent restraints on development, we find that certain areas can expect annual rainfall declines of 3-5% that persist in spite of introduced uncertainty. These declines are strongly tied to key landscape features. Results indicate that land cover and land use change associated with major roads leads to locally reduced rainfall, in a more persistent way than ENSO events or other annual atmospheric features. For the case of total deforestation we found an average annual decline in rainfall of 10-20% across the entire basin.

1C.3: Regional Climate Change Over Eastern Amazonia Caused by Pasture and Soybean Cropland Expansion

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In the last two decades, field observations and numerical studies revealed that large scale deforestation in Amazonia could alter the regional climate significantly, projecting a warmer and somewhat drier post-deforestation climate. This paper evaluates the impacts of the gradual conversion of Amazonia rainforest to pasture or soybean cropland. We used CPTEC-INPE AGCM to assess the effects of Amazonian deforestation on the regional climate, using projected scenarios of land cover change, where the rainforest was gradually replaced by degraded pasture or by soybean cropland following realistic patterns of land use change. The results for eastern Amazonia, where changes in land cover are expected to be stronger, show increase in surface temperature, decrease in evapotranspiration and precipitation. The reduction in precipitation in this area is more evident when the deforested area is larger than 40%, and the relationship between precipitation and deforested area shows an approximated parabolic shape for both case (pasture and soybean). This reduction occurs mainly during the dry season.

1C.4: Shallow Water Model to Simulate the Influence of Amazônia Convection on the Atlantic ITCZ Unstable

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Amazônia is the second most extensive region of deep convection globally, after the West Pacific warm pool region. It is a tropical rainforest of particular interest for numerical simulations because of the influence of its convection on the Atlantic ITCZ (Atlantic Intertropical Convergence Zone) in the austral spring season. A recent modeling study has suggested that the continental heating associated with the Amazônia convention appears to be unimportant. On a day to day basis, the Atlantic ITCZ is sometimes observed angling and breaking down into a series of tropical disturbances along the equator during the March-May (MFM) as seen in animate geostationary satellite images. To assess the influence of Amazônia convection on the Atlantic ITCZ angling, we run a non-linear shallow water model to simulate barotropic aspects of Atlantic ITCZ unstable. In this model, the Atlantic ITCZ unstable was simulated by a prescribed zonally angled mass sink cross the equator. We also add into the Atlantic ITCZ angulations, the effect of particular forcing functions located at three different positions: two heating sources around Amazônia and Central Equatorial Africa and a feature terrain (elliptical idealized Andes Plateau). The model runs for 25 days to reach the steady state. Our simulations show that the Atlantic ITCZ unstable under the influence of the heating sources over the Central Equatorial Africa and Amazônia makes the trajectory of the disturbances become longer and more elongated over the Southern Hemisphere than the Northern Hemisphere. This means the Amazônia convection may contribute to the changes of the Atlantic ITCZ causing it to become unstable during austral autumn.

1C.5: Evaluation of South American LDAS atmospheric forcing datasets for use in regional land surface modeling over the LBA region

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Significant advances have been made in the past few years by the LBA project on towards understanding how the water, energy and carbon cycles function in the Amazon. However, most of these studies have been limited to results from point measurements from strategically located sites in the tropical forest and other LBA-related areas. As the LBA project progresses into its synthesis phase, there is increased interest in using the acquired knowledge to better understand how Amazonia works as a regional entity. The South American Land Data Assimilation System (SALDAS) initiative, which involves NASA/GSFC, CPTEC/INPE and University of Arizona, provides the capability to integrate results within the robust land surface modeling and data assimilation infrastructure that has already been developed at NASA/GSFC and used for regional studies over the LBA region. This study investigates the feasibility of using the SALDAS atmospheric forcing datasets (a 5 years combination of CPTEC reanalysis and surface observations) for land surface modeling over the Amazonia by comparing thse forcing data with seven LBA flux towers observations. The discussion of the results focuses on whether the ranges shown in the evaluation (e.g. standard deviation, bias) are within acceptable ranges for land surface modeling over the region. The results of applying this forcing datasets to force the Noah and SiB3 land surface models over the LBA region are also discussed, with emphasis on the integrated water, energy and carbon budgets.

Plenary 2

Plenary 2

SP2.1: Scale-Dependence in Understanding Deforestation in Amazonia

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This paper comes from long-term field research in Amazonia, complemented with LBA-funded research over the past decade. The paper argues that researchers need to keep in mind that conclusions from studies are scale-dependent. Namely, that analyses at Brazilian Amazon scale provide one view of the dynamics of deforestation and its spatial and temporal trajectories—but that these spatial and temporal trajectories vary a great deal from sub-region to sub-region. These differences are derived from the different histories, initial conditions both cultural and biophysical, and the way that different sub-regions are treated by government policy—whether by receiving priority in road-building, credit policy, or other forms of infrastructure.
The paper examines Amazon-scale dynamics using PRODES data, and compares these results to targeted studies in the regions of Altamira, Santarem and Marajo, and with state-analyses.
A major insight from the paper is that sustainable solutions taking place in some regions are hidden from Basin-scaled studies, and thus that we need to ensure that in our rush to have regional relevant conclusions, we do not lose sight that it is local decision-makers through their management that come up with solutions to environmental challenges.

SP2.2: Amazon Carbon fluxes: seasonality, interannual variability, and the future under climate change

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SP2.3: Interpreting Dynamic Signatures of Land-water Coupling and In-stream Processes from pCO2: from Small Streams to Big Rivers

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The spatial and temporal distributions of dissolved CO2 gas (pCO2, the partial pressure of CO2) in surface waters of tropical river systems is the product of a long sequence of complex biological, hydrological, and geochemical processes. A key gap in our knowledge is how these distributions vary with the hydrograph across a broad range of landscapes and river size. Data from the Rede Beija Rio are extensive, with roughly 20 sites characterizing a wide range of Amazon environments and river orders, from small streams to the Amazon mainstem, with a broad suite of measurements over the period 2004-2006. The results are provocative and have prompted us to rethink the controls that the hydrograph may exert. The distributions of all chemical species are closely associated with the hydrograph. pCO2 tracks the hydrograph almost exactly at all sites. pCO2 at low water ranges from 500 µatm in the Araguaia and Ji-Paraná to 1000 µatm in the Solimões to 2000 µatm in the Rio Negro. High water concentrations exhibit a broader range, from 3000 µatm (Pimento Bueno) to 5000 µatm in the Solimoes and 7000 µatm in the Negro. The highest observed values were 20,000 µatm in the blackwater stream of the Rio Negro, Campinas. Systematic variations in pCO2 relative to other chemical parameters were observed, including O2, DOC, and FPOC. Experiments relating respiration, photo-oxidation, and outgassing to these parameters yield surprises. Initial results of a coupled ydrology/biogeochemistry model provide insight into controlling processes, and a platform for cross-site synthesis and scaling.

SP2.4: Fire and the tipping points of ecological, economics and climatic Amazon systems

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Parallel Oral Session 2

2A: Evapotranspiration and Precipitation

2A.1: Characteristics of precipitation in the Santarém study region

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The eastern Amazon suffers seasonal drought and is thought to be susceptible to conversion from forest to savannah depending were drought to persist for some seasons, even if there were no strong deforestation pressure from encroaching intensive agriculture.

This region is witnessing rapid introduction of intensive rice and soy agriculture. The climate is such that this area is a candidate for savannah to replace rain forest should the duration of the dry season increase. The relatively few surface climate stations in the Amazon play an important role in defining the meaning of remotely sensed data and in constraining large-scale models.

The aims of this work are a) to introduce a new detailed precipitation data set for the region of the eastern Amazon basin near the Tapajós-Amazon river confluence; and b) to examine interannual, seasonal, diurnal, and spatial precipitation patterns in the region. We document the extent to which river breezes or other mesoscale circulations may introduce a bias in the regional rainfall climate record using the new data set with additional gauge data from the operational network, the CPTEC reanalysis data, and the CMORPH microwave rain rate data product from NOAA.

2A.2: Genesis of Cloud Streets and Convection over Pristine Amazon Forest

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Cloud streets are daily phenomena over the pristine Amazon. A modeling approach that includes a mesoscale domain and nested grids up to Large Eddy Simulations (LES) is used to understand their formation and behavior over a particular pristine forest in the Amazon. The modeling approach is supported by meteorological data collected during the COBRA-PARÁ (Caxiuanã Observations in the Biosphere, River and Atmosphere of Pará) field campaign held on November 2006 at the Caxiuanã National Reserve. The modeling simulations show that the interaction between the atmosphere dynamics and the surface creates upward vertical motion aligned with the predominant wind flow. Those moisture rich pathways favor the genesis and movement of the cumulus clouds during the first hours of the day producing the cloud streets. During the late afternoon and early night time, storms move along with the easterly winds and become stronger after crossing water surfaces such as the Caxiuanã Water Bay. Further analysis show that those storms release downdrafts that are probably the cause of strong mixing observed in the instrumented towers located at the Caxiuanã Forest.

2A.3: When different LSMs drive the same dynamic phenology module, which better simulates surface-to-atmosphere fluxes?

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As part of the LBA-ECO Model Intercomparison Project, we evaluate the energy partitioning and carbon fluxes simulated by the Noah Land Surface Model (LSM) and the Community Land Model (CLM). We present fluxes simulated using 3 - 4 years of point-scale meteorological forcing for the three Santarem sites. Unique vegetation covers each of the three locations: the first site sits within moist tropical forest, the second in pasture-agriculture landscape, and the third in a selectively logged moist forest. Both Noah and CLM are augmented with the dynamic phenology module of Dickinson et al. (1998), which allows biomass to vary with changing environmental conditions by partitioning assimilated carbon into stems, leaves, and roots. Looking only at the Santarem 83 site, we use the model evaluation framework of Gulden et al. (2007) by minimizing parameter uncertainty between models before comparing model performance and by using a Monte Carlo approach to assess model robustness and performance within parameter space. We analyze differences between optimal values of parameters for the dynamic penology module and for other physically similar parameters and draw inferences about the dependence of the fluxes simulated by the dynamic phenology module on the underlying structure of the host LSM.

2A.4: The tropical land-atmosphere water flux: Measurements, models and controls for evapotranspiration in the Amazon

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Evapotranspiration is controlled by many climatologically-dependent factors and vegetation dynamics. Generally, climate is the major source of evapotranspiration variation, and the influence of vegetation is minimal. In the tropics, however, the climate is relatively consistent, but the vegetation dynamics are highly complex. Many species fill light-niches within the same vertical profile of leaf area index and they control stomatal water loss at different rates and in response to different stresses. Because of such complexity, modeling evapotranspiration in the tropics becomes rather difficult, and the measurement of it even more so. With the advent of the eddy covariance method, measurement of the land-atmosphere water flux has allowed for integration of these various evapotranspiring components across spatial and temporal scales that were effectively impossible to measure previously. But, evapotranspiration models, which traditionally were designed with temperate agricultural systems in mind, do not reflect tropical dynamics. Recently, a new ecophysiologically based, remote sensing driven model of evapotranspiration was validated across 16 eddy covariance sites globally ($r2 = 0.90$, RMSE = 16 mm/month). Although the model performed well globally, only 1 eddy covariance site was used from the tropics. Here, we test the model in comparison with a suite of traditional evapotranspiration models at 4 new eddy covariance sites in the Large-scale Biosphere-Atmosphere (LBA) experiment in the Amazon. We assess why and how evapotranspiration is controlled in the tropics, how the eddy covariance data respond to these controls, and how the evapotranspiration models perform in response to these controls. We scale-up to the Amazon basin as a whole using remote sensing data and discuss the implications of uncertainty from tropical evapotranspiration model estimates within larger hydrologic and climate change models.

2A.5: Amazon forest hidden water stress

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Over the past 6 years we have been monitoring changes in whole-tree water use in 27 tree individuals per plot, plant available soil water (PAW) and leaf area index (LAI) in the rainfall exclusion experiment (Santarem, Para, Brazil). The study consists of two 1-ha plots, a control and treatment plot from which rainfall wet season (6-mos) water inputs have been reduced by 50% since 2000. Transpiration was estimated on the basis of sap-flow measuring (Granier-type sensors) and tree fluxes were scaled to stand level using the circumference quotients. The daily treatment plot transpiration was correlated with LAI and PAW ($p<.0.01$). Control plot didn't have significant correlation for any variable. After 3 years of exclusion in the 2003 dry season the treatment plot released 77% less water to the atmosphere. The match of LAI and transpiration is remarkable because of the related importance of canopy integrity to maintenance of transpiration patterns. A big lesson from this study is the hidden water stress nature, where forest with 25% less LAI can saturate the vegetation index satellite sensors (as "Normalized Difference Vegetation Index") must be with high transpiration and photosynthesis restriction. Those findings will provide a better tropical rain forest land-cover and vegetation model parameterization.

2B: Forest Dynamics and Disturbance

2B.1: Disturbance and Old-Growth Amazon Forest Carbon Balance

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Whether or not a widespread old-growth forest carbon sink can partially or largely offset the large Amazon deforestation carbon source remains a contentious question hindered by uncertainty. The size, intensity and recurrence interval for various natural forest disturbances can play a large role in determining landscape-scale carbon balance, yet little is known about how these processes vary across the basin. This talk will overview our multifaceted approach toward addressing this question with a synthesis of field data, remote sensing image analysis, and both theoretical and ecosystem modeling approaches. First, a simple cellular model was developed to explore the effects of clumped disturbance on inventory-based estimates of forest carbon balance. Results demonstrate that the appropriate sampling strategy is highly dependent on how disturbance is distributed across the landscape, requiring a total sampled area of 4 to 20 ha to produce unbiased estimates. Next, remote sensing methods for quantifying the distribution of disturbed patches across the landscape are illustrated, demonstrating that wind-induced tree mortality exhibits extreme spatial and temporal patchiness even at the scale of entire Landsat scenes. Finally the Ecosystem Demography (ED) model parameterized for various scenarios demonstrates basin-wide impacts of changes in disturbance regimes.

2B.2: Effects of disturbance on biomass, structure and carbon balance in two Amazonian Forests

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Amazon forests are potentially globally significant sources or sinks for atmospheric carbon dioxide. In this study, we characterize the spatial and temporal trends in carbon storage and fluxes in both live and dead biomass in two central Amazonian forests, the Biological Dynamic of Forest Fragments Project (BDFFP), near Manaus, Amazonas, and the Tapajós National Forest (TNF) near Santarém, Pará. We assessed coarse woody debris (CWD) stocks, tree growth, mortality, and recruitment in ground-based plots distributed across the landscapes at both sites. Carbon dynamics were similar within each site, but differed significantly between the sites. The BDFFP had slightly larger live biomass than the TNF (167 +/- 5 MgC/ha vs. 148 +/- 3 MgC/ha, respectively), but stocks of coarse woody debris (CWD) were 2.5 times larger at TNF (16.2 +/- 1.5 MgC/ha at BDFFP, vs. 40.1 +/- 3.9 MgC/haat TNF). A model of current dynamics suggests that the BDFFP was close to carbon balance, and its size class structure approximated a steady state. The TNF by contrast showed rapid carbon accrual in live biomass (3.19 +/- 0.20 MgC/ha/year in TNF, 2.59 +/- 0.11 MgC/ha/year in BDFFP), more than offset by losses from large stocks of CWD, as well as ongoing shifts of biomass among size classes. This pattern suggests recovery from a significant disturbance, which we argue was likely the ENSO-related drought of 1998, shortly before our measurements began. The net loss of carbon from the TNF will likely last 10-15 years after the initial disturbance (controlled by the rate of decay of coarse woody debris), followed by long term, slow uptake of carbon as the forest evens out remaining imbalances in forest size class structure and composition. The data support the view that strong episodic disturbances such as ENSO droughts create a patchwork of agrading forests in Amazonia, interspersed with much smaller areas that emit carbon to the atmosphere.

2B.3: Effects of selective logging on tropical forest tree growth

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One goal of LBA-ECO is to quantify the effects of selective logging on tropical forest carbon cycling. We combined tree inventories, logging damage surveys, high-temporal-resolution measurements of tree growth, and micrometeorological measurements of CO_2 exchange to investigate the effects of logging at the LBA-ECO km-83 site. We used these data to determine tree growth rates and forest carbon use efficiency before and after selective logging, changes in biomass accumulation according to tree size class, and whether proximity to gaps created by the logging was a factor in determining tree growth rates. Most of the measurements began at least 10 months before logging, and continued at least 36 months after logging.

2B.4: Internal carbon dynamics of Amazonian forest systems

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We review and integrate studies on carbon dynamics from forest sites across Amazonia, focussing in particular on the LBA flux tower sites at Manaus K34, Tapajos km 67, and Caxiuana. We integrate data from flux tower studies, tree and coarse wood inventories, litterfall and fine root turnover studies, and measurements of the respiration of soil, stems and leaves. The components of above- and below-ground productivity are explored and compared, and cross-checked for closure of the interval carbon budgets. At all sites respiration rates are much greater than productivity in leaves, stems and roots, confirming observations of low carbon use efficiency. Data from these sites are compared with new observations of carbon cycling in western Amazonia lowland forests (Peru) and initial observations from an elevation transect in the Peruvian Andes. We conclude by speculating on the causes and variability of carbon allocation patterns across Amazonian forests.

2C: Regional Land Use Change

2C.1: Basin-Wide Assessment of Forest Disturbances by Selective Logging and Forest Fires

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This research involved a comprehensive study of multi-temporal and basin-wide changes of forest disturbances by selective logging and forest fires using remotely sensed data acquired in 1992, 1996, and 1999. Methods for detecting selective logging, burned forests, and estimating forest canopy cover were developed. The results of this study showed a substantial increase in total areas of selectively logged and burned forests, changing from approximately 11800 km2 to 35600 km2 by 1992 and 1999, respectively. Selective logging only was responsible for 60.4% of this forest disturbance in the studied period. Approximately 33% and 7% of forest disturbances detected in the same period were due to impacts of forest fire only and selective logging and forest fire combined, respectively. Most of the degraded forests (~90%) were detected in the States of Mato Grosso and Para. Theses estimates indicate that approximately 5467 km2, 7618 km2, and 17437 km2 were new areas of selective logging and/or forest fires in 1992, 1996, and 1999, respectively. Protected areas seemed to be very effective in constraining these types of forest degradation. Approximately 2.4% and 1.3% of the total detected selectively logged and burned forests, respectively, were geographically located within protected areas. However, it was observed an increasing trend for these anthropogenic activities to occur within the limits of protected areas from 1992 to 1999. Although forest fires impacted the least extent of natural forests, newly burned forests detected in 1996 and 1999 were responsible for the greatest impact on canopy cover, with an estimated loss of 18.8% of forest canopy when compared to undisturbed forests. Selective logging and forest fire combined impacted even more those canopies, with an estimated loss of 27.5% of forest canopy. Selectively logged forest only showed the least impact on canopy cover, with an estimated loss of 5% of forest canopy.

2C.2: SimAmazonia-2, a basin-wide simulation model of Amazon landscape dynamics

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We have integrated into a computer platform - SimAmazonia-2 - a series of models, which simulate the various processes that describe Amazon landscape dynamics. SimAmazonia-2 includes a deforestation model responsive to public policies, migratory movements, infrastructure improvement, and cropland and cattle herd expansions, rent models of soybean crop and cattle raising, an economic model of logging, a fire risk component, and CARLUCC - a model that simulates flows and sinks of carbon within the forest and from the forest to the atmosphere in response to climate change and forest disturbance. All models run simultaneously, exchanging data among themselves and employing together, as input, over a hundred maps at 2x2 km2 raster resolution, each one composed of 2103x1561 cells. To cope with this complexity, we have developed a spatially explicit modeling environment called Dinamica-EGO - acronym for Environment for Geoprocessing Objects. The software holds a series of algorithms called functors. Each functor, performing an algebra map operator, can be sequenced to establish a data flow in the form of a graph. Through this graphical interface, one can create models by simply dragging and connecting functors via their ports, which represent connectors to types of data, such as maps, tables, matrices, mathematical expressions, and constants. Thus, models can be designed as a diagram where execution follows a data flow chain. This friendly interface allows for creative design of spatial models from the very simple to the very complex that are saved in a script language. As a result, Dinamica-EGO favors simplicity, flexibility, and performance, optimizing speed and computer resources, such as memory and parallel processing. Applications of SimAmazonia-2 involve the simulation of future deforestation across the Amazon basin, under a set of policy and economic scenarios, and the assessments of its impacts on habitat loss and fragmentation, fluvial regimes and regional and global climates, as well as the study of the feedbacks between climate change, agricultural expansion, and forest impoverishment due to increasing fire regimes under an warmer and drier Amazon climate. Other applications include the evaluation of the level of endangerment for protected areas, the logging potential of forest concessions, and the calculation of opportunity and marginal costs, taking into consideration an emergent carbon credit market for reduced deforestation.

2C.3: Coupling socioeconomic and demographic dimensions to a spatial simulation model of deforestation for the Brazilian Amazon

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The future of the Amazon forest is at a crossroads. At the same time that the State increasingly moves to curb unrestricted forest destruction, growing national and international agricultural markets encourages the advance of the deforestation frontier towards inner Amazon regions. To assess these opposing trends, we have developed a model that simulates future Amazon deforestation under a set of plausible scenarios, encompassing a range of socioeconomic and demographic contexts, conservation strategies, and public policies. In order to parameterize the simulation, we developed an econometric model that analyzes the influence of a series of socioeconomic and demographic variables - selected from 1996 and 2000 IBGE censuses and other economic and social surveys - on the recent deforestation trend. The model consists of a spatial lag regression that assesses the effect from changes in the socioeconomic context on the 1997-2001 deforestation rates of 399 counties. After spatial autocorrelation removal and heteroskedastic control, the model achieved R2 of 0.64. Proximity to paved roads, increase in cattle herd, cropland expansion, net migration rates, and percent of protected areas were the most important variables to explain the deforestation rates, with only the latter showing a negative effect. We employed the obtained spatial regression equation to project deforestation rates at the county level under scenarios of agricultural and economic growths, expansion of protected area network, and infrastructure improvement. Because this equation incorporates a neighborhood matrix, it can be used to infer the potential for future deforestation from changes in the socioeconomic context, not only within a specific Amazon county, but also from its neighboring counties. The projected rates are passed to a spatially explicit model that integrates the influence of a set of spatial determinants on the location of deforestation. Yearly deforestation rates for the entire Brazilian Amazon from 2002 to 2006 were used to validate the model, which showed a maximum deviation of only 10%. As a result, modeled scenarios show that a large expansion of the protected area network has an immediate effect on lowering regional deforestation rates. However, the effect of this measure alone tends to weaken over time, becoming even less important in a scenario of rapid growth of the national agricultural sector.

2C.4: Settlement Formation and Land Cover and Land Use Change: a case study in the Brazilian Amazon

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Land reform in Brazil has moved into the reaches of the Amazon, affecting the environment in colonization areas throughout the basin. Research addressing the causes of Amazonian deforestation, to which the dissertation seeks to contribute, has implicated many factors, ranging from the role of markets in the south of Brazil to the size of individual farming households. Much remains to be learned, however, about the impact of land reform on this massive process of environmental degradation. As has been pointed out, social theoretic comprehension of land cover and land use change has been limited, both in studies of deforestation in the Amazon basin and elsewhere. This paper seeks to comprehend land cover and land use change in Amazônia by direct reference to the underlying social and institutional circumstances that have contributed to it. Specifically, poor farmers, who have grown disillusioned with the Brazilian government's promise of land redistribution, have taken it upon themselves to form settlements, or assentamentos, in what has been referred to as direct action land reform, or DALR. The paper addresses a particular type of DALR presently affecting the most vulnerable parts of the Amazon forest, which is found on terra devoluta (unclaimed, public lands).

The goal of the paper is to comprehend the social processes leading to spontaneously-formed assentamentos in terra devoluta, and to assess associated impacts on Amazonian deforestation. This entails two specific objectives, namely to (1) undertake a case study of newly formed assentamentos where we have already identified a number of key informants, and to (2) conduct a remote sensing analysis of deforestation occurring in this assentamento and others like it, found in the region.

2C.5: Sustainable pathways of biofuel crop expansion in the Tropics?

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We are in the midst of a major worldwide shift from fossil fuel to renewable bioenergy, and some predict that biofuels could fulfill 25% of global energy needs within the next 15-20 years. This move away from fossil fuels could curb greenhouse gas emissions and be a major positive force for global climate mitigation. Without thoughtful planning, however, the biofuels boom may spur tropical deforestation, which currently accounts for ~20% of annual worldwide emissions of carbon dioxide. Expansion of biofuel crops will undoubtedly increase these emissions, potentially negating a major benefit of bioenergy. Here, we examine the likely sources for newly expanded agricultural land in the Amazon Basin and across the tropics. We also calculate the "carbon payback time", or how long it will take for annual carbon savings of liquid biofuel use to offset emissions from the initial land conversion in the tropics. The carbon payback time for even the most productive crops is ~30 to 400 years if biofuel crops expand into tropical forests.

2C.6: The Effects of Climate Change on Profitability and Land Use in Brazilian Agriculture

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This paper extends Anderson and Reis (2007) on the economic effects of climate change on land uses in Brazilian agriculture in two ways. . Firstly, according to the approach proposed by Deschênes and Greenstone (2007), fixed-effects methods are applied to the panel of Agricultural Census data of Brazilian municipalities in the period 1970-1995 to estimate the effects of random year-to-year variation in temperature and precipitation on agricultural profits. Since this variation is presumed to be orthogonal to unobserved determinants of agricultural profits, the methodology offers a possible solution to the omitted variables bias problems that plague the hedonic approach adopted in previous studies. The estimated coefficients are then used to simulate the impact of the different climate change scenarios proposed by the IPCC Assessment Reports. Preliminary results indicate that climate change decrease annual profits by 19%, with considerable variation across the Brazilian regions. The Center-West region is most negatively affected, whereas the negative impacts on the South region are quite mild. We also find that the hedonic approach which is standard in the previous literature to be unreliable because it produces estimates that are not robust to different model specifications. Secondly, using the same panel data, the derived demand for agricultural land estimated and simulated by Anderson and Reis (2007) will be disaggregated for major land use categories (perennial and annual crops, planted and natural pastures, planted and natural forests, and fallow areas).

Key words: climate change, agriculture, and panel data estimation.

Parallel Oral Session 3

3A: Trace Gases

3A.1: Trace Gas Fluxes From Through-Canopy Measurements in an Upland Forest of the Eastern Brazilian Amazon

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Methane (CH_4) is a radiatively active trace gas whose atmospheric budget has been perturbed by humans. Wetlands have been recognized as the main natural source of CH_4 for the past 30 years. Current inverse models indicate that tropical sources account for the bulk of CH_4 emissions. The largest sources are likely wetlands, agriculture and burning and that these sources may be underestimated.
As part of the LBA experiment, we automatically sampled CH_4 and carbon dioxide (CO_2) mixing ratios in profiles through two forest canopies at sites 67 and 83 km south of Santarém, Pará. CH_4 and CO_2 can have a strong diurnal signal. CH_4 mixing ratios correlated well with CO_2. Both gases had column maxima in the early morning near dawn because of stable nocturnal conditions. However there were differences in the profiles. Highest CO_2 mixing ratios tended to occur near the surface due to the strong respiration source of CO_2. Often the lowest mixing ratios of CH_4 were found near the surface which is consistent with a weak soil sink.
Calculations of the CH_4 flux of example periods from different seasons were made by correlating height weighted averages of the half hourly ambient mixing ratios of CH_4 and CO_2 and relating this correlation to the ratio of coincident nocturnal NEE CO_2 eddy correlation fluxes made during windy nights at two towers at the same sites and automated chamber flux measurements made at the km67 site.
Fluxes were calculated to be between 2.2 and 23.3 mg CH_4 m^{-2} d^{-1}. If the area of the upland forest area of the Amazon basin is 5 x 10^6 km ^{2}, we then estimate a CH_4 source strength of 4 to 43 Tg y $^{-1}$. This estimate is consistent with a flux of 4 to 38 Tg y^{-1} calculated from a survey of profile and flux measurements made during the dry and wet seasons at three other sites across the Amazon basin.

3A.2: CO2 Fluxes Derived for Column Integration Technique Using Aircraft Profiles in Amazônia

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We determine regional scale CO2 fluxes using atmospheric measurements from aircraft profiles over Floresta Nacional do Tapajos (SAN - 02º51'S; 54º57'W, over tower 67km) and Reserva Biologica de Cuieiras (MAN - 02º36'S, 60º12'W, over tower K34). SAN profiles started December 2000 and MAN started December 2004, both running until 2007. Samples are collected aboard light aircraft between the surface and 4 km using the NOAA/ESRL semi-automatic portable flask package (PFP), with 17 flasks samples.
We use a column integration technique to determine the CO2 flux for each vertical profile, where the measured CO2 profile is differenced from the CO2 background. The CO2 background was determined using co-measured SF6 as a transport tracer. Two NOAA/ESRL background sites, Ascension Island (ASC) located in the Atlantic Ocean (8'S, 14'W) and Barbados (RPB) located in the Atlantic Ocean (12'N, 59'W) were used to calculate the fractions of air arriving at the sites studied. Back trajectories from HYSPLIT model were calculated for every profile every 500m of altitude to determine the time the air mass took to travel between the coast and the sites.
The observed flux, that reflects the flux between the coast and measurement sites, showed for SAN an average of -0.4 ± 1.2 gC/m².day for the wet season and 0.8 ± 1.3 gC/m².day for the dry season. At MAN the average for the wet season was 0.6 ± 1.4 gC/m².day and for the dry season, 0.8 ± 2.3 gC/m².day. The variability at each site is high, most likely reflecting a variety of biological and anthropogenic processes.
We will also present regional-scale CO2 fluxes that have been corrected for the influence of biomass burning; using measurements of CO. This approach greatly reduces dry season CO2 emissions and possibly indicates a regional dry season sink of CO2, consistent with the local-scale eddy covariance results of Saleska et al.2003.

3A.3: Study of N2O Flux over Central Amazon

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In this study we estimated regional scale N2O fluxes over two Central Amazon sites through vertical profiles sampled since 2000 over Tapajós National Forest, near Santarém, Pará (SAN), and since 2004 over Cuieiras Biological Reserve, near Manaus, Amazonas (MAN). For this estimation we remove the influence of the tropical background using N2O measurements from the NOAA/ESRL background sites at Barbados and Ascension Island. The relative influence of each site is determined through SF6 measurements, which permitted us to estimate a background concentration for N2O.
Analysis of the seasonality of fluxes shows higher flux during wet season, possibly because of the use of N-fertilizer in the beginning of the wet season and the better conditions for microbial nitrification and denitrification in the soil. At SAN after 2004, we observe an enhancement of N2O flux during wet season, possibly related to enhance N-fertilization in the area. At this site, we calculated wet season averages of 0.45 ± 1.2 mgN2O m^{-2} day^{-1} (2001); -0.44 ± 0.6 (2002); -0.9 ± 1.3 (2003); 1.3 ± 0.8 (2004), 2.7 ± 0.8 (2005) and 0.8

± 0.5 day-¹ for 2006. In 2006 the lower flux may be explained by a reduction in the areas where fertilizer was applied, due to political programs in Pará. Some negative fluxes presented in our calculations may be results of soil uptake or errors in our determination of the difference between Amazonian and background measurements.
The results from MAN also exhibit seasonality, with higher fluxes during the wet season. The average fluxes for each year are 1.9 ± 0.8 mgN2O m-² day-¹ (2005) and 0.6 ± 0.3 mgN2O m-² day-¹ (2006).

3A.4: Do plant species influence soil gas fluxes in tropical forests?

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Large spatial variability of soil gas fluxes remains a cause for significant uncertainty in the global budgets of CO_2 and N_2O. In tropical forests spatial variability can be substantial because soil gas fluxes are dependent on carbon inputs (litter or root components) from the trees into the soil.
To assess whether tree species influence soil gas fluxes, we measured soil gas fluxes close (<3m) to and away (>10m) from the stem of large individuals of 15 tree species at 3 Ultisol and 2 Oxisol sites within the Tapajos National forest south of Santarém, Pará, Brazil. In addition to soil gas fluxes we measured air and soil temperature, bulk density, soil moisture, pH, tree growth rate and total biomass within 3m of each flux location.
We found that site, tree species and soil texture do not influence soil CO_2 fluxes from terra firme soils, though overall and within site soil CO_2 fluxes close to large trees (21.8±0.58 Mg-C ha^{-1} y^{-1}, mean±SE) are 45% higher than away from trees (15.0±1.0 Mg-C ha^{-1} y^{-1}). Site, tree species, and soil texture do influence soil N_2O fluxes. Mean N_2O fluxes at the km 67 and 83 sites were respectively 96 and 147% greater than at the km 72 site and respectively 147 and 211% greater than N_2O fluxes at the sandy sites. Site comparison by species revealed that half of the species and the controls did not differ significantly between the km 67, 72, and 83 sites. On Ultisols mean N_2O fluxes close to *Caryocar villiosum* ($133.4_{21.2}^{25.2}$ µg-N m^{-2} h^{-1}) are ~2.5 times larger than close to *Erisma unicinatum* ($42.2_{5.4}^{6.3}$ µg-N m^{-2} h^{-1}) and *Voychsia maxima* ($36.6_{6.5}^{7.9}$ µg-N m^{-2} h^{-1}) individuals.
We conclude that tree species can influence soil N_2O fluxes within tropical forests and that local biomass or stem proximity influences CO_2 fluxes.

3B: Carbon and Energy Fluxes

3B.1: Resolving systematic errors in estimates of net ecosystem exchange of CO2 and ecosystem respiration in a tall-stature forest: application to a tropical forest biome

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The controls on tropical rainforest CO2 exchange and the likely future responses to a changing climate are among the largest uncertainties in global climate change models. Eddy-covariance measurements potentially provide detailed data on CO2 exchange in these forests, but accurate estimates of the net ecosystem exchange of CO2 (NEE) and ecosystem respiration (R) require careful analysis of data representativity and treatment of data gaps. This study discusses the biases in NEE and R potentially associated with two sources of systematic error in eddy-covariance data, lost nighttime flux and missing canopy storage measurements, and we propose robust approaches to correct for theses biases. Multiple independent estimates for the net carbon balance and ecosystem respiration are presented to validate the analyses, including a carefully constructed bottom-up budget for respiration and extrapolation of daytime data to zero light. We found that lost nocturnal flux can produce a significant bias and, where appropriate, a site-specific u* threshold should be evaluated to avoid systematic bias in estimates of carbon exchange. The inclusion of canopy storage is essential to accurate assessments of net carbon exchange, due to day-night asymmetry in storage and turbulence. We found that short-term measurements of storage may be adequate to accurately model storage for use in obtaining ecosystem carbon balance. The analytical framework utilized in this study could be applied to any eddy-covariance site for validation of methodological techniques.

3B.2: Scaling nighttime turbulence intensity for correcting carbon dioxide fluxes

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The determination of nocturnal ecosystem respiration rates using the eddy covariance technique constitutes a major challenge for both micrometeorological and ecological communities. The difficulty in properly quantifying the total carbon dioxide transfer becomes critical when there is not enough turbulent mixing. For this reason, gap-filling methods have been proposed and are extensively used for the determination of ecosystem carbon budgets. These methods typically consist in replacing the data from nights with low turbulence intensity for those originated in nights with similar soil characteristics, but enough mixing. The turbulence scale used for this classification is the friction velocity, u*.
In a recent study, it was shown that there is organized turbulent mixing in very stable conditions, which can be properly determined if the appropriate averaging windows are used. These windows can be as small as 5 or 10 seconds in the most stable conditions. For larger time scales, the exchange has a more variable character, being generically associated to “mesoscale processes”.
In the present study we call the attention to the fact that the most common scale used to classify nighttime turbulent fluxes, the friction velocity is, indeed, a flux and, therefore is subject to large variability in the mesoscale range. As a consequence, nights with little turbulent exchange can be frequently classified in the traditional gap-filling schemes as turbulent, if the mesoscale transport is large enough. On the other hand, turbulent nights can be classified as non-turbulent if the mesoscale momentum transfer is positive. As a

result, the classification of turbulent fluxes as a function of u* is smoothed: the exchange is overestimated for low turbulence and underestimated for cases with enough mixing. As an alternative, we propose the usage of the standard deviation of the vertical velocity fluctuations for this classification. It is shown that, not constituting a flux, this scale is not subject to the problems associated to the friction velocity.

3B.3: The Effects of Selective Logging on Tropical Forest-Atmosphere Exchange

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We are using long-term biometric and micrometerological measurements at the km 67 and km 83 LBA-ECO sites in Tapajos National Forest, Para, to study the effects of selective logging on carbon exchange. Measurements at both sites began before logging to establish the pre-logging baseline carbon balance. In 2001, the area including the km 83 study site was selectively logged. The km 67 site was not logged and provided the experiment control for evaluating the effects of logging. Measurements at the selectively logged site continued until March 2004 (~30 months after logging), and measurements at the control site continued until late 2006. The logging removed ~3.5 trees ha-1 containing 30 Mg ha-1 of biomass, with 9 Mg ha-1 extracted as bole wood, and an additional 6 Mg ha-1 of bole wood and 10 Mg ha-1 of canopy crown left on the forest floor to decompose. The logging removed canopy, increasing the area of forest gaps by a factor of 3 over nearby undisturbed forest. Compared to the control site, the selectively logged site gross primary production and respiration decreased following logging. Net ecosystem exchange also decreased after logging, and the logged site became a net carbon sink.

3B.4: Carbon and energy fluxes simulated by the Noah LSM and the Community Land Model

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We present carbon and energy fluxes for sites in the Amazon River basin simulated by several versions of two state-of-the-art land surface models (LSMs). Multiple versions of the Community Land Model (CLM) and the Noah LSM are driven at the eight LBA-ECO sites using 3 - 4 years of point-scale meteorological forcing data and are evaluated against energy and carbon fluxes obtained using eddy covariance methods. Uncalibrated results are presented for all sites; optimized model results are presented for Santarem 83. We quantify changes in model performance as the base models are augmented with new, conceptually realistic parameterizations (e.g., a groundwater module, a dynamic phenology module). We assess shifts in model performance across a gradient of vegetation (e.g., ranging from pasture land to savanna to tropical forest) and between wet and dry periods.

3C: Land Use and Fire

3C.1: A basin-wide assessment of the GOES and MODIS active fire products for the Brazilian Amazon

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This LBE-ECO Phase III study is designed to assess the performance of active fire products which have been used to delineate the fire dynamics in the Brazilian Amazon basin and which are routinely used to feed biomass burning emissions models for the region. The initial analyses are focused primarily on the creation of a validated long term (1995-present) record for the WFABBA active fire product using GOES East geostationary satellite data.
For comparison purposes we also included the MODIS/Terra "Thermal Anomalies" (MOD14) data in our validation analyses. We found that at the 50% detection probability mark ($p<0.001$), the GOES fire product requires four times more active fire area than it is necessary for MODIS to achieve the same probability of detection. However, the higher observation frequency of GOES resulted in less than 40% omission error compared to 80% with MODIS. Basin-wide commission errors for MODIS and GOES were approximately 15 and 17%, respectively. Commission errors were higher over areas of active deforestation due to the high thermal contrast between the deforested sites and the adjacent green forests which can cause multiple false detections.
Burnt area estimates were also produced based on ETM+ data to assess the average burnt area size associated with the coarse resolution active fire data above. Burn scar polygons were digitized and intersected with the MODIS/Terra and Aqua active fire data. 50% of all polygons containing active fires in the MODIS imagery showed a burnt area size larger than 300ha. Burnt areas of less than 100ha in size represented 15% of all cases analyzed.
Further work will be pursued to create a unified fire diurnal cycle map that can be used to model time dependent variables (e.g.: emissions). Emission modeling studies will also be addressed at the subsequent phases of this research project by feeding models with the optimized data sets described above.

3C.2: Fire probability maps for the Brazilian Amazonia

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Fire-activity models have several applications in Amazonia. They are used, for example, in warning systems for monitoring the risk of burnings in protected areas, to improve the description of biogeochemical cycles and vegetation composition in ecosystem models, and to help estimate the long-term potential for savannas in biome models. Previous modeling studies for the whole region were produced in units of satellite fire pixels, which complicate their direct use for environmental applications. By reinterpreting similar remote-sensing input data using a statistical approach, we were able to calibrate models for the whole region in units of probability or chance of fires to occur. The application of these models for years 2005 and 2006 provided maps of fire potential at 3-month and 0.25-deg resolution as a function of precipitation and distance from main roads. In both years, the results show best performance for the period from July to September, when most of satellite fire observations were detected in areas with relatively high probability of fire. In addition to reproduce reasonably well the fire dynamics detected by remote sensing, these new results are easier to apply than the results from previous fire-pixel models.

3C.3: Simulating the occurrence of hot pixels along the Amazon forest fringe

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Forest fire models have become an important tool for assessing the resilience of forest environments in anthropogenic landscapes as well as the feedbacks between deforestation and climate, which eventually may lead the Amazon ecosystem into an irreversible cycle of self-destruction. A basic component of such models involves simulating the occurrence of fire ignition sources due to weather conditions and land-use practices. In this work, we have developed a model that simulates the occurrence of hot pixels, representing sources of fire along the Amazon forest fringe, based on the integration of climate and land-use data. The model was calibrated using NOAA-12 night satellite hot pixel data for 2003 and then validated for the years 2002, 2004 and 2005. Firstly, we estimated the Weights of Evidence of a series of spatial variables - e.g. proximity to roads, towns, and deforested areas, land-use, and other biophysical factors - on the location of hot pixels. The resulting probability map was then combined with a climate risk probability map, derived from monthly VPD (vapor pressure deficit) data by means of logistic regression. Assessment of the integrated fire-prone probability map employing the ROC (Relative Operating Characteristic) method yielded fitness values above 0.8 for all months of 2003, greater than the 0.5 value that would be expected due to chance. The model simulates stochastically the quantity and location of hot pixels, alternating for the dry and wet seasons of the southern hemisphere the coefficients used to average the probability maps and two density distribution functions employed to draw random numbers - the Beta (0.985, 0.1) and Weibull (13,0.6) distributions. Simulated hot pixels matched fairly well the NOAA-12 hot pixel data both in terms of spatial and temporal distributions, showing a maximum yearly frequency deviation of only 15%. As a next step, this model will be coupled to a fire spreading mechanistic model in order to incorporate fire regimes into SimAmazonia-2, a basin-wide simulation model of Amazon landscape dynamics.

3C.4: The contribution of fire to forest degradation in the upper Xingu basin

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Fires that burn standing forests are a critical pathway of anthropogenic forest disturbance in Amazonia. Repeated exposure to fire may arrest normal forest succession; high canopy-tree mortality leads to an increase in liana, grass, and fern cover in a low-carbon forest structure maintained through frequent burning. Understorey forest fires are more extensive during drought years, although forests also burn during years with average and above-average precipitation. When does the first fire exposure occur, and what roles do the adjacent land use and prior disturbance history play in rendering forests susceptible to burning? We combine field measurements of burned forest, time series of MODIS and Landsat data, and Landsat-based deforestation and logging extent to characterize the patterns of forest disturbance from fire, logging, and deforestation in the upper Xingu basin. Time series of satellite data for burned forests show a distinct phenological profile of forest damage and recovery. In previous analyses of high-resolution imagery, canopy damage from fire was more frequently mistaken as deforestation than logging. Logging greatly increases the chances that a forest will burn; burned area often matches the spatial extent of logging operations at a time lag of at least one year, confirming previous research showing that unlogged forests are less flammable than logged forests under similar climatic conditions. Following an initial exposure to fire, forests may burn as frequently as every 2-3 years. Thus, the cumulative area of fire-related forest disturbance may increase slowly in non-drought years despite extensive forest burning.

3C.5: A Negative Fire Feedback in a Transitional Forest of Southeastern Amazônia

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Anthropogenic understory fires affect large areas of tropical forest, particularly during severe droughts. Yet, the mechanisms that control tropical forests' susceptibility to fire remain ambiguous. We tested the widely-accepted hypothesis that Amazon forest fires increase susceptibility to further burning by conducting a 150-ha fire experiment in a closed-canopy forest near the southeastern Amazon forest-savanna boundary. Forest flammability and its possible determinants were measured in adjacent 50-ha forest plots that were burned annually for three consecutive years (B3), once (B1), and not at all (B0). Despite increased vapor pressure deficit and decreased litter moisture, burned area declined 50% during the third burn. Leaf litter production in this forest (4.3 Mg/ha*yr) was only half that of other Amazon forests, and appears to have limited forest flammability. Fine fuel loads fell slightly following the second burn, and fire spread rates doubled and burned area increased five-fold in B3 subplots that received fine fuel additions. Annual tree and liana mortality two years after the initial burn was 5.5% (± 0.5%, SE) in B3, nearly double the background rate, but the lowest fire-induced mortality measured in the Amazon. Dead biomass combustion (± SE) was 44.5 (± 21.2), 23.2 (± 9.1), and 15.3 (± 9.3) Mg/ha during consecutive burns. In this forest, where severe seasonal drought removed microclimate and litter moisture constraints on fire propagation, low litter production inhibited intensity and spread of recurrent fire in a negative feedback, with important implications for its vulnerability to fire-induced replacement by scrub vegetation.

3C.6: Climatic seasonality and land use dynamics in the Brazilian Amazonia

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Understand the interplay between climate and land use dynamics is currently a fundamental concern for assessing the vulnerability of Amazonia to climate change. Some models have predicted climate change causing increased drought frequency in Amazonia. Drought may have direct impacts on vegetation phenology, physiology, structure and composition of Amazonian forests. In addition, conditions associated with intense forest degradation by logging and deforestation can dramatically increase the risk of fires in this ecosystem. Here we analyse satellite derived monthly and annual time-series of rainfall, fires and deforestation to explicitly quantify the seasonal patterns of these three variables and their relationships in the Brazilian Amazonia, with a particular focus on the Amazonian drought of 2005. Our results demonstrate a marked seasonality for all variables with the peak of deforestation and fire pixels occurring during the dry season in Amazonia. The majority of the fires in Amazonia are likely to be associated to land use practices, as 60% of the total number of detections in 2005 occurred in deforested areas. The spectral analysis showed for an annual periodicity a correlation >90% among all time series analysed. We found a strong linear relationship ($r2=0.84$, $p=0.004$) between hot pixels counts and the size of the area deforested annually from 1998 to 2004, which may be due to the expansion of pastures and large areas of mechanized agriculture in the southern part of Brazilian Amazonia. However, during the 2005 drought, we found that the number of hot pixels increased 43% in relation to the expected value for a similar deforested area (~19,000 km2). Based on this result we estimated that during an exceptional dry year, such as 2005, the rate of hot pixels detections per km2 of deforested area annually would increase from 8.5 to 14.8. Therefore, the combined effect of land uses, such as deforestation, logging and fire and its interactions with climate is a realistic threat for Amazonian rainforest and consequent stability of the global carbon cycle and the climatic system.

Plenary 3

Plenary 3

SP3.1: Agricultural transitions in the Amazon region: consequences for biogeochemistry and ecosystems services

Jerry M. Melillo, Marine Biological Laboratory, jmelillo@mbl.edu (Presenting)

SP3.2: Forest disturbance and recovery: A synthesis of approaches

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SP3.3: Do secondary forests of Amazonia conform to the soil genesis paradigm of N and P limitation in terrestrial ecosystems?

Eric Davidson, WHRC - Woods Hole Research Center, edavidson@whrc.org (Presenting)

SP3.4: Linking Science to Development and Conservation in SW Amazonia: Activities of the LBA-Acre Group During and After the Drought of 2005

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The worst drought in decades struck SW Amazonia in 2005 and paradoxically provided an opportunity to apply LBA research to development and conservation issues. Since the late 1990s, the LBA research network and scientific meetings had informed the LBA-Acre group of the dangers of extended droughts and associated fires. Consequently, we were able to alert the Acrean society of the danger of forest fires in early August 2005. Colleagues from INPE and University of Maryland began supplying detailed hot pixel and burn scar data as the fires spread during September. In late September and early October, LBA-Acre students and researchers coordinated satellite and airborne remote sensing data for the Acre fire fighting program. We estimated that fires affected over 400,000 ha of tropical moist forests in the region and found that hot pixel satellite data did not effectively detect these forest fires. Smoke levels in late September rose an order of magnitude above maximum permissible levels in eastern Acre. Former students and researchers now occupy leadership roles at the Federal University of Acre, state and municipal government agencies, research institutions and non-governmental organizations where they are applying their accrued experience from LBA for regional development and conservation, as well as educating a new generation of researchers and decision-makers. The LBA-Acre group has also helped in curriculum reform in rural schools. The MAP (Madre de Dios-Peru, Acre-Brasil, Pando-Bolivia) Initiative has expanded the LBA-Acre experience to collaboration between the Civil Defenses, the remote sensing communities, and river basin management groups in the three countries. More recently, this collaboration has extended to a program of adaptation to and mitigation of global environmental change in the MAP Region.

Poster Session

CD (Carbon Dynamics)

CD.1-P: Regional Carbon Flux Simulated using the Simple Biosphere Model (SiB3)

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We simulate Net Ecosystem Exchange of CO2 (NEE) using the Simple Biosphere Model (SiB3; Baker et al 2007) on a regional scale in the Amazon basin. Historically, Landsurface models have had difficulty reproducing the observed annual cycle of NEE (Saleska et al, 2003), wherein there is biospheric uptake during the dry season and efflux during seasonal rains. A number of observational and modeling studies have weighed in on the mechanisms invoked to produce the observed annual cycle, and we have previously found that by including these mechanisms into SiB3 we can obtain a reasonably accurate simulation of the annual cycle of NEE at the Kilometer 83 site on the Tapajos River (Prihodko et al, 2007).

In the current study, we extend the analysis to eight flux tower sites throughout the Amazon basin as part of an LBA Model Intercomparison Program (LBA-MIP). The sites include tropical rainforest, savannah and cropland, and annual precipitation ranges from around 900mm/year to over 2000mm/year. These simulations represent Phase 1 of LBA-MIP, and as such we do not have access to validation data other than at the Santarem Km 34 Tower and Tapajos River Km 83 Tower (from our previous work). However, even ‘blind’ runs have value in that we can evaluate differences in model performance across moisture and vegetation gradients. Ultimately, the goal is to have the ability to model both the stress-free situation in the deep tropics as well as the areas that experience seasonal stress on the dry side of the ecotone. These initial simulations can assist our efforts to determine how model physics interact with the simulation of seasonal stress, which will then lead us toward model mechanisms and parameter values necessary to improve our understanding of the biomechanics of this region of the planet.

CD.2-P: Temporal scale of the nocturnal turbulent CO2 flux at a forested LBA site

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In this study, we determine the nocturnal carbon dioxide fluxes from a forested site in the Amazon region, using the multiresolution decomposition technique.
The commonly used eddy covariance method is successful when the atmospheric flow is characterized by fully developed turbulence. However, when stable conditions exist and

specially in strongly stable cases, the fluxes become largely dependent on many methodology parameters, such as the time period used for mean computations. Usually, this problem leads to flux underestimation.
The usage of the multiresolution decomposition allows the identification of the time scales on which the turbulent transfer occurs, showing the existence of organized fluxes, highly dependent on turbulent intensity. Therefore, its application to the determination of nocturnal fluxes allows the determination of the exact time scale of the turbulent processes, distinguishing them from the more erratic, larger-scale, mesoscale exchange.
The technique has only been used successfully for the nocturnal carbon dioxide flux estimate for data originated at the extremely stable pasture/agricultural LBA site, in Santarém. It remains important to quantify the improvement it will cause when used at more turbulent, forested sites. This is performed in the present study, using data from the Manaus ZF-2 tower.
Results show that the turbulence has a highly intermittent character at the site. The temporal scale of the nocturnal CO2 exchange ranges from tens to hundreds of seconds, a value much smaller than those usually used in eddy covariance studies. There is also evidence of consistently positive mesoscale fluxes, in much larger scales, and this fact may explain why the increase of the averaging window usually leads to larger fluxes.

CD.3-P: Mesoscale Fluxes

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Recent studies show that surface fluxes consist of two distinct types of interactions. In smaller temporal scales, the exchange is performed by turbulent eddies, which are organized and well related to properties such as vertical gradients, so that they are commonly expressed in terms of similarity relationships. On larger scales, the interaction is more erratic, not clearly controlled by the flow characteristics. These larger scale transport have been generically regarded as “mesoscale fluxes”. In most cases, the mesoscale transport is larger in magnitude than the turbulent one, but, in the long term, it averages out, as a consequence of its erratic character. On the other hand, if there are consistent mesoscale circulations, caused by any forcing, the fluxes in these larger timescales may also be consistent and, in this case, they may be responsible for an important portion of the exchange between the surface and the atmosphere. In the present work, we show the existence of consistence mesoscale fluxes at the LBA pasture/agricultural site, in Santarém. These fluxes are shown to be
seasonal: in the wet season they have the same sign as the turbulent portion, while they are opposed to the turbulent exchange during the dry season.

CD.4-P: Climatic implications on carbon cycle using the isotope approach (d13C) at the ecosystem scale in the Amazon tropical forest

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This study was conducted in 2003 and 2004 at the km 67 old growth forest in the Tapajós National Forest (2,85o S; 54,05º W. The objective was measure the carbon isotope ratio (13C/12C) of respired CO2 from the entire ecosystem and isotope composition of organic components leaves, soil, litter and dead wood). The Keeling plot technique and Farquhar’s leaf model was used to examine the physiological drivers of the isotopic composition of these components as well as the seasonal response for them. A variation of respired d13CR - CO2 by the ecosystem was well related with precipitation variation, and a significant seasonal difference was found in 2003. The d13C of leaf organic matter showed a clear stratification along the vertical profile and significant seasonal variation at the top of canopy in 2003. Significant correlations were found between d13CR - CO2 and photosynthetically active radiation (PAR), vapor pressure deficit (VPD). The estimated ci/ca ratio values showed significant differences between heights and seasons. The results indicated that the isotopic composition of respired CO2 and organic matter was sensitive to microclimatic variations; so far the d13C values can be used to understand how environmental changes can affect the carbon cycle at ecosystem scale.

CD.5-P: Preliminary results on dissolved organic carbon fluxes in a primary forest at the headwaters of the Xingu basin, Mato Grosso, Brazil

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The main objective of this study is the assessment of dissolved organic carbon (DOC) fluxes within a tropical primary forest in the headwaters of the Xingu river basin, Mato Grosso, Brasil. The study site is located near the cities of Querencia and Canarana, in the Darro river basin. The vegetation of this transition zone between Cerrados and tropical moist forests shows lower species diversity and smaller trees than the latter. From February to April 2007 (rainy season) bi-weekly samples were taken from collectors of rain, throughfall, stemflow, overland flow, preserved in the field with HgCl2, and latter filtered in the laboratory and analyzed with a Shimadzu TOC-VCPH to determine the concentrations of DOC. Preliminary results show that inputs of DOC are positively correlated with rainfall and with great variation between rain events. Rain inputs vary from 0.06 kg/ha in low rainfall events (5 mm) to 3 kg/ha, which is 6 to 37% of the dissolved carbon that reaches the soils in this basin. After crossing the canopy, rain becomes significantly enriched in DOC, and throughfall inputs vary from 0.09 kg/ha to 43.28 kg/ha respectively, which is 23 to 88%, of the DOC that reaches the soils in this basin. Significantly lower fluxes are observed in stemflow, which contributes with a minimum of 0.005kg/ha and a maximum 0.09kg/ha respectively. A small fraction of these inputs from rain and throughfall is exported as overland flow, respectively, 0.02 kg/ha to 0.07 kg/ha (1 to 3% DOC). When the remaining data from soil and stream water becomes available, we will be able to tell if this basin is retaining these inputs or exporting them to ground or surface water.

CD.6-P: Spatial partitioning of biomass and diversity in a lowland Bolivian forest: linking field and remote sensing measurements

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Large-scale inventories of forest biomass and structure are necessary for both understanding carbon dynamics and conserving biodiversity. High resolution satellite imagery is starting to enable structural analysis of tropical forests over large areas, but we lack an understanding of how tropical forest biomass links to remote sensing. We quantified the spatial distribution of biomass and tree species diversity over four ha in a Bolivian lowland moist tropical forest, and then linked our field measurements to high resolution Quickbird satellite imagery. Emergent and canopy dominant trees, being those directly visible from nadir remote sensors, comprised the highest diversity of tree species, represented 86 % of all tree species found in our study plots, and contained the majority of forest biomass. Emergent trees obscured 1-15 trees with trunk diameters (at 1.3 m, DBH) $\geq$ 20 cm, thus hiding 30-50% of forest biomass from nadir viewing. Allometric equations were developed to link remotely visible crown features to stand parameters, showing that the maximum tree crown length explains 50-70 % of the individual tree biomass. We then developed correction equations to derive aboveground forest biomass, basal area, and tree density from tree crowns visible to nadir satellites. We applied an automated tree crown delineation procedure to a high-resolution panchromatic Quickbird image of our study area, which showed promise for identification of forest biomass at community scales, but which also highlighted the difficulties of remotely sensing forest structure at the individual tree level. Results from this study are pertinent for assessing current and developing future remote sensing approaches of forest biomass and tree diversity. An improved capability for large scale, fine resolution and cost effective quantification of biomass and diversity via remote sensing is relevant for forest management and biodiversity conservation throughout all tropical forests.

CD.7-P: Parameter sensitivity of Amazonian ecosystem processes and vegetation dynamics using the LPJ dynamic vegetation model

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Dynamic vegetation models (DVM) provide spatially continuous information on carbon and water fluxes and vegetation distribution. In tropical regions, DVMs are necessary to resolve large-scale questions related to carbon cycling and disturbance and for evaluating field-based data from eddy covariance or biomass measurements. Current challenges in tropical ecophysiology include determining rooting distributions for deep soils and seasonal patterns of phenology. We evaluate the sensitivity of these parameters in the LPJ-DVM by comparing biomass, plant functional type distribution (PFT), and carbon fluxes against field and remote sensing observations. Based on literature review, we adjusted the range of rooting distributions, sapwood to heartwood turnover rates, and the development of phenology (leaf longevity and response to drought) within LPJ. We found that rooting distributions were most sensitive in the southern and eastern Amazon where water is more frequently limiting. Carbon allocation and phenology were most sensitive in the wetter regions of the Amazon and strongly influenced the competitiveness and biogeography of PFTs. The optimal distribution of parameters is likely more variable than the number of PFTs in use; this suggests that dynamic sub-modules rather than fitted parameters may be required for determining rooting and phenology patterns.

CD.8-P: Deriving GEP seasonality: issues posed by the absence of CO2 profile measurements

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It is widely understood that when the diurnal cycle of Net ecosystem exchange (NEE) is estimated in tall-stature ecosystems using eddy covariance methods, it is essential that the measurements account for changes in the amount of CO_2 in the canopy air space (called the “storage flux”, S_{co2}). Less widely appreciated is the possibility that estimates of S_{co2} may also be important for accurate characterization of the seasonal cycle of components of NEE, Gross ecosystem productivity (GEP) and ecosystem respiration (R_{eco}). Unfortunately, at many EC sites in the Amazon, S_{co2} time series are discontinuous or missing.

This study evaluates the importance of S_{co2} for estimating GEP seasonality, and quantifies biases that rise in its absence, using data from four LBA-flux tower sites (Tapajós Km67, Santarém Km83, Reserva Jarú RJA, and Manaus Km34). Our goal is to establish a reliable dataset of tower-based GEP that can be used to calibrate and test remote sensing indices (the Enhanced Vegetation Index, EVI, from MODIS) and achieve an accurate integrated estimate of basin-wide photosynthetic flux. We found that in the absence of S_{co2} observations, above-canopy flux measurements by themselves underestimate ‘true’ GEP and artificially alter the seasonal trends. Further, the amplitude of the annual cycle, and the onset of low and high GEP periods is affected differently at each site. We also evaluated various models for estimating S_{co2}in the absence of observations, in terms of their ability to recover the amplitude and phasing of the GEP annual cycle. We found that most of the S_{co2}-filling models were able to reduce error in the amplitude of the seasonal cycle and improve annual estimates of GEP in general. Moreover, we were able to determine a 'best' method at each site based on its ability to accurately model the above-mentioned seasonal cycle and the onset of low and high GEP periods.

CD.9-P: CO2 Vertical Advection and its importance on the Eddy Covariance Flux: LBA Multi-site analyses

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Since begin of LBA Project measurement of Net ecosystem exchange of carbon dioxide (NEE) is routinely measured at several sites around the Amazonia. In the recent literature research has indicated that the interpretation of NEE from eddy covariance (EC) measurements may be questionable in night-time stable conditions, particularly in areas of complex terrain. It has been suggested that one cause of the observed underestimation of nocturnal ecosystem respiration by the EC method is vertical and horizontal advection of mass out of the ecosystem. The vertical advection has been reported in subtropical areas in Europe and USA, but there is none information in the literature about the importance of vertical and horizontal advection correction the night time EC CO2 flux in the LBA Project sites in Amazonia. This work examines vertical motion and the importance of vertical advection on EC flux in the Manaus, Santarem and Rondonia LBA sites. The vertical motions found in the Santarem Flona Tapajos have a tendency to downward vertical velocities at nighttime relative to the daytime. This tendency have inverse pattern in the Manaus LBA site. The contribution of the vertical advection seems related with terrain complexity and composition of the ecosystems where the tower-based were place. This pattern may result in vertical advection of CO2-depleted air unaccounted for by EC measurements. There is large part of the time that below-canopy flow (and scalar transport) is decoupled from conditions aloft. These results support arguments that the inclusion of simple advection terms in estimates of ecosystem respiration, based on above-canopy measurements, is specific site-to-site and not universally applicable.

CD.10-P: Sazonalidade dos fluxos de CO2 e energia - Sitio LBA K34 Manaus: Analise multianual

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Medidas de longo prazo das trocas de CO2, H2O e energia entre a vegetacao e a atmosfera, sao extremamente importantes para melhorar o entendimento sobre o papel dos ecosistemas terrestre no ciclo global de carbono. Durante o periodo 1999 a 2006 foram realizadas medidas de fluxos de CO2, agua e energia na Reserva Biologia do Cuieiras (Sitio LBA K34) a 100 km ao norte de Manaus. Com esses dados torna-se possivel avaliar e analisar a sazonalidade das diversas variaveis associadas com a interacao entre solo-vegetacao-atmosfera em uma area de floresta tropical de terra firme. Serao mostrados neste trabalho, uma analise e avaliacao sazonal dos fluxos de CO2, H2O e energia em alta frequencia (10 Hz) e dos dados microclimaticos da torre de baixa frequencia. Padroes sazonais desses dados associados a eventos meteorologicos de mesoescala serao discutidos. Padroes sazonais de CO2, agua e energia associados a eventos de forcantes atmosfericas de grande escala, e.g. El Nino/La Nina, serao tambem discutidos.

CD.11-P: Variação Sazonal da Respiração Edáfica na Floresta Nacional de Caxiuanã, Pará, Amazônia Oriental

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A Floreta Nacional de Caxiuanã possui 330 mil hectares e está situada aproximadamente 400 km a oeste da cidade de Belém, no Estado do Pará. O Museu Paraense Emilio Goeldi administra uma estação de pesquisa a Estação Científica Ferreira Penna (ECFPn) com 33 mil hectares na região. O experimento ESECAFLOR (O impacto da seca nos fluxos de água e dióxido de carbono em uma floresta tropical Amazônica), consiste da simulação de um período de estiagem na floresta para avaliar o seu impacto prolongado nos fluxos de água e dióxido de carbono em uma floresta tropical amazônica, visando investigar a exclusão de água no solo sobre o ciclo da floresta, e as alterações provocadas pelo evento. Em sua estrutura física, o ESECAFLOR será composto por duas parcelas (A e B) de 1 hectare cada. A parcela A foi usada como referência para os experimentos realizados na parcela B, onde foi feito a exclusão de aproximadamente 60% da água da chuva.
O carbono no solo é o componente principal do ciclo de carbono terrestre assim, um aumento ou diminuição de pequenas quantidades de carbono no solo pode gerar um impacto grande na concentração atmosférica de CO_2. As análises apresentadas neste trabalho referem-se a informações obtidas durante os meses de janeiro de 2005 e março de 2006. A estação chuvosa foi considerada como os meses de dezembro a junho e a estação seca os meses de julho a novembro. Observou-se que a respiração média do solo foi maior na estação chuvosa nas parcelas A e B 3,49 $\mu mol.CO_2.m^{-2}.s^{-1}$ e 3,88 $\mu mol.CO_2.m^{-2}.s^{-1}$ respectivamente, e menores na estação seca 3,41 $\mu mol.CO_2.m^{-2}.s^{-1}$ e 2,44 $\mu mol.CO_2.m^{-2}.s^{-1}$ respectivamente.

CD.12-P: Dinâmica do carbono dissolvido no rio Acre: variações espaciais e sazonais

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O objetivo principal deste trabalho é estudar a dinâmica do carbono dissolvido em um trecho do rio Acre (Rio Branco - Acre), levando em consideração a variação espacial provocada pelas mudanças no uso da terra e pela descarga de três de seus tributários, bem como os efeitos das mudanças hidrológicas sazonais.
As amostragens estão sendo feitas mensalmente desde outubro de 2006 e se estenderão até setembro de 2007. Em cada sítio é feita uma coleta no meio do canal onde é coletado 1 litro de água o qual é submetido a filtragens para a determinação do carbono dissolvido total. As alíquotas filtradas são utilizadas para determinar as concentrações de carbono orgânico total em um equipamento da marca Shimadzu (modelo TCO5000A) no CENA/USP.
No mês de outubro, o sítio RA1 apresentou maiores concentrações de carbono orgânico dissolvido (18,63 mg/l), enquanto que os demais sítios apresentaram concentrações entre 5,04 (RA5) e 6,19 mg/l (RA3). No mês de dezembro, as concentrações giraram em torno de 7,5 mg/l. Em janeiro, o sítio RA1 apresentou a concentração mais baixa (5,48 mg/l) e o sítio RA2 a concentração mais alta (7,79 mg/l). O igarapé São Francisco apresentou a concentração mais alta no mês de outubro (8,38 mg/l), enquanto que nos demais meses o Riozinho do Rola apresentou as concentrações mais altas. Com relação ao carbono inorgânico dissolvido, os sítios RA1 e RA2 apresentaram as maiores concentrações no mês de outubro, com 40,13 e 39,97 mg/l, respectivamente. No mês de dezembro, as concentrações não variaram muito entre os sítios e no mês de janeiro, as mesmas variaram de 10,66 (RA2) a 15,63 mg/l (RA1). Nos tributários, as concentrações foram mais baixas e o igarapé São Francisco apresentou as maiores concentrações. Para os demais meses, as análises ainda estão sendo realizadas.

CD.13-P: Fluxos de Dióxido de Carbono na Floresta Tropical Úmida e de Transição Tropical Úmida-Cerrado

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Cada vez mais a degradação humana interfere no clima principalmente por meio do desflorestamento, queimadas, mudanças no uso do solo e queima de combustíveis fósseis, acarretando um distúrbio no clima regional e global. Esses processos geram uma grande emissão de CO_2, o que possibilita o aumento da temperatura mundial, e esse aumento de acordo com o IPCC (2007) se continuar no ritmo atual de emissão de 1.9 ppm por ano fará com que ocorra um aquecimento de 0.2°C por década, e é estimado para a faixa do cenário do SRES. A quantificação das taxas de fluxos de CO_2 em diferentes regiões da Amazônia pode contribuir para elucidar as diferenças que ocorrem quando é contabilizado o estoque anual de carbono em um determinado ecossistema e desta forma, facilitar a construção de modelos válidos para prognosticar mudanças que podem ocorrer na Terra com o crescente acúmulo de CO_2 na atmosfera, e a partir desses resultados adotar procedimentos cabíveis para mitigar esses efeitos. Assim, este trabalho tem como objetivo mostrar o comportamento do fluxo de CO_2 em dois sítios experimentais, sendo um em uma Floresta Tropical Úmida e outro em uma Floresta de Transição Tropical Úmida-Cerrado, nos diferentes períodos definidos como: úmida, úmida-seca, seca e seca-úmida para o ano de 2005. As medidas foram feitas utilizando um analisador de gás por infravermelho de caminho aberto (LI-7500, LICOR Inc., Lincoln USA), instalado em torres micrometeorológica nos dois sítios, um localizado na Reserva Biológica do Jaru (REBIO) a 100 km N da cidade de Ji-Paraná, Rondônia, Brasil (10°05'S,61°35'O), em uma Floresta Tropical Úmida, e o outro localizado na Fazenda Maracaí a aproximadamente 50 km NE de Sinop, Mato Grosso, Brasil (11°24.75'S; 55°19.50'O), em uma Floresta de Transição Tropical Úmida-Cerrado. Em todos os períodos estudados se observou um saldo negativo de CO_2, ou seja, uma provável absorção, fortalecendo que a Floresta Tropical e a de Transição são sorvedouros de carbono. Outro resultado importante foi observar que as duas regiões mostraram padrões de absorção e emissão de CO_2 similares quando comparados os dados de um dia médio para o ano de 2005.

HY (Hydrometeorology)

HY.1-P: Deforestation and Climate of Amazon: simulations using BRAMS coupled to GEMTM

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In order to understand the climate changes caused by deforestation that took over the Amazon in the last decades, we used the Brazilian Regional Atmospheric Modeling System (BRAMS) coupled to a dynamic vegetation model "Energy and Mass Transport Model" (GEMTM) [Chen & Coughenour, 1994].
Two land-cover scenarios were used as surface boundary condition based on the DINAMICA model [Soares-Filho et al, 2005]. The land-cover scenario for the year 2002 was used for a control simulation, while the scenario for the year 2050 was used to estimate the impact of the land-cover change on the climate.
Preliminary analysis show that in the control run the accumulated precipitation was over-estimated as compared to observations, however, the spatial distribution was well simulated as compared to observed maps.
The replacement of forest by pasture shows a decrease of rainfall in some areas and an increase over other areas. At the state of Pará there is reduction of about 25 % during the rainy period and about 15% for the dry period. However, in the state of Amazonas, there is a stronger decrease and over larger areas for the dry period. There is also an increase in the temperature over most of the region. However, during the dry season the higher increase of temperature takes place over the most deforested areas at the east of the state of the Amazonas and the state of Acre.
The major conclusion is that deforestation produces a drier and hotter Amazon, but the results show a lighter effect as compared with the Global Circulation Models (GCMs). This is probably due to the use of the dynamical vegetation model that produces structural changes on its characteristics controlled by the climate conditions, and by the use of more realistic land-cover scenarios.

HY.2-P: Watershed response to rainfall events in the Santarém region

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The watersheds in the eastern Amazon region are characterized by contrasting topography and land use/land cover histories, both of which influence the hydrologic response of these watersheds to precipitation events. We examined the streamflow response to rain events in three mesoscale watersheds in the eastern Amazon region near Santarém. One of these watersheds (Mojui) is in a lowland/plateau landform setting where landuse change has been extensive. Much of the original forest has been converted to secondary forest, pasture, and
croplands. The Moju and Branco watersheds are both in an upland more incised (steeper) topographic setting, with the Rio Branco undergoing moderate forest conversion to secondary forest and croplands and Rio Moju still dominated by intact primary forest. To determine watershed precipitation, we combined data from two sources: measured precipitation from a network of weather stations covering the study area, and precipitation estimated by remote sensing using CMORPH data. Continuous streamflow was determined by recording water level every 15 minutes using pressure transducers for a 90 day period and recording streamflow and water level using current velocity meters. Stream discharge-water level curves were then constructed. Watershed response to rain events was assessed in two parts. First, stream response was determined by analyzing the timing and magnitude of streamflow peaks and streamflow recession times at stream gauges in each of the three watersheds in relation to rainfall events. Second, the shallow soil moisture response to rainfall was assessed by analyzing the characteristic soil moisture values and soil moisture recession times following rainfall as recorded at the weather stations which were located nearby, or in topographic settings with comparable soils and land cover as do the watersheds.

HY.3-P: How representative is the Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) results in comparison to long-term climatology? A study using climate weather stations in Brazil

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The Large-Scale Biosphere-Atmosphere Experiment in Amazonia has already contributed understanding of the flux exchange between the Amazonian rainforest and atmosphere as other significant components of the ecohydrometeorological system, and it will continue to do so. However, when considering LBA-derived information on whether the Amazon is a source or sink of carbon, or whether land use changes in the Amazon are affecting the local and perhaps global climate, it is important to characterize the period during which the LBA project has been carried out in terms of its climatological context. In other words, to address the question "How does the climate during the LBA data collection period compare with the long-term climatology in Amazon." Such information is not only useful for future project planning but is crucial information for modeling purposes: the calibration or validation of models using LBA data may be influenced by the climate conditions prevalent when these data were collected. This investigates the extent to which the actual period of data collection at LBA sites is representative of the long-term climatology for the sites. The research uses long-term weather station data taken from the databases of Brazilian National Water Agency (Agencia Nacional de Aguas - ANA) and National Oceanic and Atmospheric Administration - National Climatic Data Center division (NOAA-NCDC) for stations located near the Sao Gabriel da Cachoeira, Manaus, Santarem, Caxiuana, Jaru, Sinop, and Bananal LBA sites, and compares these weather station data during the LBA data collection period with the entire dataset available for each weather station.

HY.4-P: Estudo comparativo da estrutura da turbulência atmosférica acima de diferentes sítios experimentais na região amazônica

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A turbulência tem um papel decisivo nas trocas floresta-atmosfera. Embora muito já tenha sido pesquisado, algumas de suas características, como a sua organização em estruturas coerentes (ECs), ainda são objeto de muita investigação. No tocante à Floresta Amazônica, poucos estudos procuraram compreender as características das ECs acima da vegetação, e comparar resultados obtidos em distintos sítios experimentais. Tal compreensão é importante para uma parametrização mais realista dos processos de troca próximo ao dossel e sua representação em modelos numéricos que simulem o escoamento na camada limite atmosférica amazônica e se reveste de importância particular no cenário atual de mudanças climáticas globais, problema ambiental que tem se manifestado nas últimas décadas e que pode ter relação com o desmatamento da Amazônia. É importante entender como distintas superfícies existentes nas regiões desmatadas ou cobertas por florestas pode interferir na estrutura da turbulência atmosférica e conseqüentemente nas características das ECs. Para caracterizar ECs será utilizada a transformada em ondeletas (TO), que é uma ferramenta matemática que permite a análise de um sinal turbulento em tempo-escala.A decomposição em escala é obtida dilatando ou contraindo a função ondeleta utilizada, no caso, a ondeleta complexa de Morlet. Adotou-se um critério de detecção baseado nos resultados fornecidos pela teoria. Foram usados dados a 10 Hz, medidos sensores instalados na Rebio - Jarú (Rondônia), em Caxiuanã (Pará), e na pastagem da Fazenda Nossa Senhora (FNS, Rondônia). Observou-se considerável variabilidade entre os períodos diurnos e noturnos no comprimento médio das escalas espaciais das ECs para a Rebio e a FNS, mas não para Caxiuanã, que apresentou escalas espaciais médias pouco variáveis entre os dois períodos. Além disso, o comprimento médio das escalas espaciais das ECs na Rebio chega a ser 2 vezes maior que o da pastagem e 2,5 vazes maior do que o observado em Caxiuanã no período diurno.

HY.5-P: Cloud Condensation Nucleus Activity of Secondary Organic Aerosol Particles Mixed with Sulfate

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Cloud condensation nuclei (CCN) activity of mixed organic-sulfate particles was investigated using a steady-state environmental chamber. The organic component consisted of secondary organic aerosol (SOA) generated in the dark from 22 ppb α-pinene at conditions of 300 ppb ozone and 40% relative humidity at 20°C. CCN analysis was performed for 80- to 150-nm particles having variable SOA-sulfate volume fractions. AMS measurements also determined an effective SOA density of 1.4 ± 0.1 g cm-3. Critical supersaturation, which increased for greater SOA volume fraction and smaller particle diameter, was well predicted by a two-component Köhler model that used ammonium sulfate and SOA as the two components and an effective molecular weight of 230 g mol-1 for the SOA component. Results from this study further imply that, for the range of conditions studied, the particles may not reach a non-liquid state even at very low water activities, which suggests that the effect of limited solubility may not be a necessary consideration in the parameterization of cloud droplet formation in global climate models.

HY.6-P: The use of telematic for data monitoring at the LBA scientific sites

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Telematic environments are comprised of sets of services including hardware, software and interconnected telecommunication networks, aiming to monitor automatic equipment, process data, store large volumes of data and establish a comprehensive communication among users at any time and place. INPA has several scientific experiments in which equipment sample data automatically and remotely. This makes hardware monitoring and maintenance difficult and does not guarantee quality to data collected.
The telematic project developed by the LBA DIS (Data Information System) uses computer and telemetry technologies to collect, store and disseminate data generated by Data Collection Platforms (DCPs), improving performance of the operational work carried out by researchers of the micrometerology laboratory. This practice contributes to reducing logistics costs, increasing data quality and also reduces interruptions of the DCPs activities.
This project develops telematic solutions applied to meteorological equipment installed in towers, located at the ZF2 sampling site, 60 kilometers from INPA Manaus. These solutions adopt a wireless network with an IP protocol, file repositories over the Web, data analysis tools and database management systems. The equipment used includes IP network adapters to dataloggers, wireless networks, Pocket PC and Laptops are connected to DCPs and to telemetry equipment via satellite.
The telematic architecture designed for implementation comprises DCPs assembling, configuration and installation of IP adapters to dataloggers, configuration and transmission via wireless network (Wi-Fi or Wimax), network server, Internet connection via satellite link, web server for receiving and storing data, data repository, DCP database systems

Web applications for equipment and data analyses and dissemination.
The project modules include: (1) data repository using a developed tool, Mo Porã, which functions as a collaborative repository manager (2) DCPs controller, which monitors all sensors and equipment installed at the towers (3) prior data analyses that can indicate data abnormalities of data sets collected recently, aiming to diagnose equipment malfunctions that can affect data quality (4) data and information dissemination that will be made available via a collaborative Web portal, where researchers will get access to several tools, including controlling and monitoring of the DCPs linked to the Web environment. Information security is enforced during all phases of the telematic project development by using backup routines and data cryptography during data transmission over a local network or Internet.

LC (Land Use and Land Cover Change)

LC.1-P: Detecting phenology and relating to turbulent fluxes over an intensive agriculture field in the Amazon

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We present analysis of 5 years of micrometeorological data made in agricultural field in the eastern Amazon. We develop relationships between a remotely-sensed observations (enhanced vegetation index, EVI) and in situ measurements such as the radiometric and turbulent fluxes. There are clear differences that appear in the turbulent fluxes (CO_2, H_2O, and sensible heat), radiative parameters (albedo and PAR-albedo) due to the landscape changing from pasture to crop field. Since September 2000, agricultural practices in the Santarém, Pará, have changed rapidly from cattle grazing, to upland (non-irrigated) rice cultivation, and then to soybean cultivation. The pattern we witnessed in the sampled field is characteristic of the entire region along the BR-163 highway that runs south from the city of Santarém.

Seasonal changes in greenness and reflectivity measured in situ follow the patterns of daytime evaporation and carbon uptake, which depend on crop type. For instance, the lowest values of the Bowen ratio were observed during the wet season during rice plantation. After plowing and tilling, the bare field emits a small efflux of CO_2 comparable to nocturnal respiration rate during pasture conditions. Changes in the albedo depend on crop type, and they not only indicate changes the net radiation regime, but they also mirror changes in energy partition and CO_2 fluxes. Data obtained from MODIS sensor on the Terra satellite indicate that the enhanced vegetation index (EVI) can detect seasonal changes, but it cannot clearly distinguish the crop type nor follow the rapid rate of crop phenology as well as do in situ measurements. Therefore, to estimate NEE based on remote sensing platforms, better techniques for the detection of the field state are needed. However, the in situ radiative parameter PAR-albedo, the ratio between the upward and downward PAR radiation, does not yield a unique pattern for each crop (rice or soil). The relationship between net ecosystem exchange (NEE) and PAR-albedo resulted in different relationships each year, indicating that other parameters than radiative fluxes must be included in parameterizations.

LC.2-P: The Amazon River Mainstem Mapping

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The Amazon River and its tributaries have an extensive floodplain subjected to seasonal inundation, which has a key role in the earth system biodiversity, carbon dynamic and global climate. Information on the open water surface of rivers and lakes and its seasonal changes in response to flooding are crucial to understand and model the hydrological and biogeochemical fluxes in the aquatic ecosystems and contributes to understanding of habitat biodiversity for better conservation practices and for an effective management of Amazon fisheries. Remote sensing images are an effective tool for mapping and delineating the extent of open water and sand banks of vast river basins. This work presents a methodology used to map the Amazon River mainstem based on a Landsat Thematic Mapper (TM) digital mosaic composed of Forty-seven almost cloud-free TM Landsat scenes covering a period from 1985 to 1995 acquired from July to September, at the beginning of high water and ending of receding water. Radiometric normalization was applied to the images to reduce variability of environmental conditions during image acquisition, allowing the production of an almost uniform dataset for the entire Amazon River mainstem. A Linear Spectral Mixture Model was then applied in bands 3, 4 and 5 to produce soil, water and vegetation images. The water and vegetation images were then classified to obtain an open water map that was visually edited to correct some misclassified pixels. The result was a thematic map of the Amazon River mainstem and its tributaries and lakes larger than 90 x 90 meters resolution, from the Andes to its mouth at Pará covering an area 84081 km², which includes open water and sand banks in the rivers. Hence this product is essential for ecological and biogeochemical studies of the Amazon floodplain and for an effective management of várzea ecosystem.

LC.3-P: Mapping of Fractional Forest Cover in Rondonia, Brazil with a Combination of Terra MODIS and Landsat TM Images

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High deforestation rates in Amazonia have motivated considerable efforts to monitor land-cover changes based on satellite images and image processing techniques. Most commonly, MODIS images are used to provide low-cost region-wide coverage at nearly monthly frequencies, but they offer only coarse resolution; Landsat TM has been used in a majority of studies for nearly two decades, but these data are expensive, and provide, at best, yearly coverage because of clouds. Here, a new approach to estimate forest change is proposed based on the integration of TM and MODIS images. TM images are processed using a hybrid approach including spectral mixture, expert rules, and unsupervised classification, to generate a reference forest image. Three fraction images are derived from MODIS surface reflectance data; expert rules are used to generate a refined vegetation image; and a regression model is then developed between the TM-derived forest and MODIS-derived vegetation data to assess the fractional forest area. This approach was

initially applied to 2004 MODIS and TM images from Rondônia, and the regression model was transferred to 2000 and 2006 MODIS images. A similar exercise was made in Pará state for the estimation of forest area in 2005. Compared to TM-derived reference data in Rondônia, the system error for the MODIS-derived forest areas was 1.56% and 4.19% for 2004 and 2000 images, respectively. Compared to INPE Prodes data, the error for total forest area in Rondônia in 2004 and 2000 are -0.97% and 0.81%, respectively. The major advantage of this approach is that coarse spatial resolution images from MODIS and AVHRR can be used to estimate fractional forest cover for large areas in a short time, requiring limited work, but yielding accuracies comparable to Landsat TM-derived results.

LC.4-P: Long-term potential for fires in estimates of the occurrence of savannas in the tropics

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In order to improve the formulation and results of the CPTEC Potential Vegetation Model, we developed a new parameterization for long-term occurrence of fire in regions with potential for the establishment of savannas in the tropics. Fires are important to consider because they may favor grasses and reduce tree coverage due to fast biomass consumption and mortality relatively to slow carbon uptake and growth of the vegetation. To find relations between long-term potential for fires and other environmental factors, we have assumed that at long-term, climate conditions in savannas support both the presence of fuel and flammability, and thus fire activity in these regions may be limited primarily by the presence of ignition sources. Following other studies indicating that lightning is the most important source of ignition for natural fires, we built the long-term fire parameterization for savannas based on large-scale potential for lightning activity during transitions between dry and wet seasons. The application of this new relation improved the formulation and the results of the CPTEC-PVM. In particular, important commission errors in allocating savannas instead of seasonal forests are now substantially lower than in previous studies.

LC.5-P: Análise Espacial das Mudanças na Cobertura e Uso da Terra em Santarém e Belterra, Pará, Brasil. Armadilhas Metodológicas Associadas

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Através de um estudo de caso, indicamos como a delimitação da área de estudo pode influenciar o resultado de análises multiescalares em processos espaciais de mudanças na cobertura e uso da terra na Amazônia. Partindo dos limites dos municípios de Santarém e Belterra no oeste do Estado do Pará, definimos três níveis de delimitação da área de estudo. O primeiro nível abrange uma região que foi arbitrariamente definida e denominada sub-região de Santarém e Belterra. O segundo nível, uma parte do primeiro, corresponde ao limite do entorno de lotes estabelecidos pelo INCRA na década de 1970, tratando-se portanto de uma área de ocupação consolidada. O terceiro nível corresponde às zonas de influência de quatro eixos viários inseridos dentro da área de ocupação consolidada, subdivididos em subáreas norte e sul, num total de oito subáreas do segundo nível de delimitação. Para cada nível, aplicamos métricas de paisagem sobre mapeamentos temáticos do satélite Landsat obtidos para os anos de 1986 a 2005 e as associamos com dados sociodemográficos obtidos em levantamentos realizados em 2003. Os resultados mostram que as peculiaridades da dinâmica de ocupação em cada nível permitem melhor identificar padrões e processos na composição da estrutura da paisagem. Os dados obtidos para os três níveis de delimitação são complementares, possibilitando uma compreensão mais abrangente do que aquela que se poderia obter pelo estudo de um único nível.

LC.6-P: Obtenção de modelos ópticos de aerossóis para a região amazônica

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O presente trabalho insere-se em um projeto que consiste na obtenção de profundidade ótica de aerossóis (AOD) com alta resolução espacial na região amazônica. Serão utilizados medidas de radiância do sensor MODIS, a bordo dos satélites Aqua e Terra da NASA, e modelos ópticos de aerossóis especificos para a região de estudo, escolhidos de forma dinâmica utilizando o conceito de reflectância crítica. Para compreender os processos de interação entre a radiação solar e as partículas de aerossóis, e assim determinar o efeito dos aerossóis sobre o balanço radiativo da atmosfera é essencial definir um modelo de aerossol que caracterize a pluma de material particulado na atmosfera. Deste modo, o desenvolvimento de modelos mais apropriados reduz as incertezas das profundidades ópticas obtidas por observações com satélites.
Através da análise das propriedades ópticas dos aerossóis atmosféricos obtidas com o radiômetro CIMEL, da rede AERONET (Aerosol Robotic Network) , definiu-se modelos de aerossol para os sites de Abracos Hill (RO), Rio Branco (AC), Alta Floresta (MT), Balbina (AM) e Belterra (PA), durante o período maio a outubro. Os modelos foram baseados em intervalos de albedo, utilizando análise de clusters na tentativa de caracterizar a composições típicas de aerossóis da região, seguido de testes para a validação através da simulação de radiâncias, utilizando o aplicativo SBDART (Santa Barbara DISORT Atmospheric Radiative Transfer), e comparação com dados obtidos pela AERONET . Para o site Alta Floresta foram identificados 2 modelos de aerossóis e para os demais sites 3 modelos. A determinação destas quantidades baseou-se no número de grupos identificados nas médias mensais das distribuições de tamanho. Os testes de validação apresentaram desvios dentro do limite aceito para a determinação de AOD em alta resolução, conforme definido através de testes de sensibilidade entre AOD e a variação nos valores de radiância.

LC.7-P: Regional Emissions of Nitric Oxide (NO) and Carbon Dioxide (CO_2) in Agroecosystems in Central West Region, Brazil

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The Central West Region in Brazil has been the focus of intense agricultural expansion since the 1970s and, nowadays, a large area of native cerrado has been converted to agricultural use. The expansion was accompanied by intensive use of fertilizer, irrigation and management practices. However, the consequences of these agricultural practices on NO and CO2 emissions from soil to atmosphere are still unclear. Here, we present estimates of regional emissions of NO and CO2 in a Latosol cultivated with corn, soybean, cotton and irrigated bean, under a no till system. The measurements were made from August,2003 to August,2005. NO and CO2 fluxes were measured before and after planting, after nitrogen fertilization, during the growing season and before and after harvesting. The regional emissions were estimated considering the area occupied by the crops and the cropping cycle (corn 173, soybeans 134, cotton 258 and irrigated beans 135 days). The field cotton had the highest N-NO emission per unit area (0.8 kg ha-1), followed by irrigated beans and corn (0.3 kg ha-1) and soybeans (0.2 kg ha-1). Per hectare, the field cotton and corn contributed 34.6 and 32.0 tons C-CO2, the irrigated beans 25,4 tons and the soybeans 19.4 tons C-CO2. Integrated over all cultivated fields, the highest soil emissions of NO and CO2 came from soybeans which emitted 4.6 Gt N-NO and 0.12 Tg C-CO2 from 22,854,000 ha, followed by corn with 3.7 Gt N-NO and 0.11 Tg C-CO2 from 12,297,000 ha, irrigated beans with 1.2 Gt N-NO and 0.03 Tg C-CO2 from 3,910,000 ha, and cotton with 0.9 Gt N-NO and 0.01 Tg C-CO2 from 1,152,000 ha. The results show that it is necessary for government policies to stimulate management systems that enhance sustainability and that take into account the impacts of agricultural on soil emissions of NO and CO2.

LC.8-P: Using MODIS Near Real Time Deforestation Detection and Daily Thermal Anomalies Product for Land Cover Change Monitoring

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The detection of deforestation and thermal anomalies in a near real time is of fundamental importance for Government policy and surveillance of forest areas. A near real-time detection would allow control of the increase of new clearings and monitoring of the deforestation pattern and carbon emissions. In this context, this work has the objective to propose a methodology to detect deforestation in near real time using MODIS - Moderate Resolution Imaging Spectroradiometer images. The study area is located in the Mato Grosso State, Brazilian Amazonia, encompassing three micro regions (Arinos, Teles Pires e Sinop) that has been characterized by high deforestation rates in the last years. The methodology consists on to characterize and detect deforested areas using near real time daily MODIS images. The MOD02 product used in this work has 250 m of spatial resolution (red and near infrared-NIR bands), while the other band, Mid Infra-Red- MIR have 500 m resampled to 250 m of spatial resolution. The MODIS Thermal Anomalies product 1km spatial resolution were used for to characterize fire activities on new deforested areas. The total of 114 images, acquired in 2005 to 2006 time period, were used in this analysis. The linear spectral mixture model was applied to the MODIS reflectance images of RED, NIR and MIR spectral bands acquired and processing near real time. The method uses forest map and temporal crisp classification based on vegetation and soil fraction. The daily classification of deforestation hotspot are showed in probability intervals. The field campaign data, PRODES and DETER information, and Landsat TM and CBERS CCD images were utilized as ground truth for validation of the methodology. The use of multitemporal images of MOD02 product presented a global accuracy of 92.72 % to detect the deforestation when compared with ground truth. The initial analysis shows temporal lags from 0 to 300 days between deforestation detect and thermal anomalies product. In another's hands, the analysis shows that there are hotspots located in forest areas before deforestation detection. This suggest the use of fire in the initial deforestation phase.

LC.9-P: MODIS-based estimates of row-crop agricultural expansion in Rondônia and Mato Grosso

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Rapid changes in land use in the southwestern Amazon, particularly conversion of native vegetation to mechanized row-crop agriculture, have many ecological consequences, including changes in biogeochemical cycles. Quantifying the patterns and magnitude of changes in row-crop agriculture is a first step in estimating regional-scale environmental impacts. We used five years of MODIS data to identify annual changes in row-crop agriculture, focusing on expansion and intensification of croplands in Mato Grosso and Rondônia. Our approach involved a wavelet-smoothing methodology for processing and analyzing MODIS time series data. We checked our results against crop histories from farms in both states. From annual statistics of phenology, we distinguished areas of cropland from other land covers. Results show increases in area of row-crop agriculture of 1% in Rondônia and 6% in Mato Grosso between 2001-2005. Within row-crop agriculture, we calculate the timing and number of crops per year (single or double cropping). Between 2001 and 2005, farmers in Mato Grosso have intensified from single to double cropping on more than 11,000 square kilometers, while in Rondônia, farmers have transitioned to double cropping on over 20 square kilometers. As next steps, we will modify the Terrestrial Ecosystems Model (TEM) to incorporate these new remote sensing results and then estimate the impacts of land use change on greenhouse- gas emissions, particularly nitrous oxide.

LC.10-P: Evolution of Land Use in Amazonia During 1940-1995

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Several studies have demonstrated that changes in land cover and land use cause important modifications in the quantity and quality of water resources, in addition to changes in climate. Despite the important relationships among land cover, water resources and climate, there are still relatively few studies that evaluate these relationships, mainly in a long term time scale (several decades), necessary to define the climate or the hydroclimate. One of the reasons for this is the reduced availability of time series of land use. This work presents historical representation of the spatial variability in land use in Amazonia between 1940 and 1995, derived from agricultural census data. The results show the land use proportion in each administrative unit (municipio) of the studied area. The states that present the largest and smallest planted area growth rate of the are the states of Goiás and the Federal District (4,185 km^2/year and 25 km^2/year, respectively). Between 1975 and 1995 the area of natural pasture in the State of Acre decreased, while the area of planted pasture increased considerably (about 6,380.86 km^2). From 1950 to 1995, the area of planted pasture in the State of Goiás increased about 122,047.27 km^2 and in the State of Mato Grosso it increased in 151,352.93 km^2 in the same period. The State of Mato Grosso also presents the largest increment in the area of cropland, from 565.95 km^2 in 1950 to 29,517.46 km^2 in 1995.

LC.11-P: Mapping Burned Areas in the Brazilian Amazon Using Modis Data

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Although global algorithms (e.g. Globscar, GBA2000, MCD45) were frequently used to identify burned areas in specific parts of the Amazon region, no basin-wide map has yet been carried out. The aim of this work is to map burned areas in the Brazilian Amazon using images from MODIS aboard Terra platform. The study area includes the States of Acre, Rondonia, Mato Grosso and Pará, sometimes referred to as the "arch of deforestation". The image classification approach is based on INPE's Digital PRODES project that applies image segmentation to the fraction images derived from a linear spectral mixture model. MODIS data (MOD09) at 250 m spatial resolution were acquired between July and November 2005. A dataset from the DETER (Detection of Deforested Areas in Real Time) project from year 2004 was used to classify the land cover types affected by the fires. Landsat-TM and CBERS-CCD images, acquired during 2005, along with field observations were used as reference data to validate the results derived from MODIS images. The map of burned areas was submitted to a visual interpretation to reduce commission and omission errors originated during the digital classification procedure. Results from this multitemporal MODIS images analysis showed that during the year of 2005 a total of 76,200 km2 (3% of study area) was burned in these four states. From this total, 27,400 km2 (36%) corresponded to areas deforested prior to 2004, 30,179 km2 (40%) occurred in the Cerrado biome, and 27,400 km2 (26%) was associated to new deforestations and/or burned forested areas. Cloud-free time series of multitemporal MODIS images are a viable option to map scars of burned areas in the Brazilian Amazon. Regional maps of burned areas, classified by land cover type, are an initial and crucial step to estimate carbon emissions from fires during the drought of 2005 in the Amazon region.

LC.12-P: Avaliação de Tecnicas de Recuperação de Mata Cilar Visando Redução de Custos

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Segundo o Código Florestal a mata ciliar é considerada como área de preservação permanente (APP), não sendo permitido qualquer alteração em seu ecossistema. No entanto muitas dessas matas foram substituídas por práticas agropecuárias. Neste trabalho objetivamos restaurar a cobertura arbórea em áreas de APP degradadas com custo mínimo refazendo artificialmente o ecossistema original. A pesquisa está sendo realizada na Fazenda Tanguro, localizado na cidade de Querência MT, projeto Boas Práticas na Agropecuária_IPAM. Para a introdução das técnicas de recuperação fizemos o preparo do solo traves da descompactação do solo e eliminação seletiva de competidores, principalmente gramíneas exóticas como a Brachiaria brizantha(coroamento). Dividimos a APP em parcelas e em cada parcela introduzimos diferentes técnicas de recuperação: (1) plantio de mudas (cova simples e cova enriquecida com adubo), (2) semeadura direta , (3) transposição de folhiço da floresta e (4) união das técnicas 2 e 3. Foi feito um inventário de toda regeneração existente nas parcelas demarcadas nove meses depois, onde todas as plântulas foram identificadas e tiveram seu diâmetro à altura do solo e altura total mensurados. Resultados mostram que: taxa de mortalidade (técnica 1) foi de 15% na cova enriquecida e 38% na cova simples; taxa de germinação de sementes arbóreas nos pontos de coroamento.(técnica 2) foi de 55%, (técnica 3), 30%, e (técnica 4) 78%. O crescimento relativo das plântulas provenientes do folhiço (técnica 1) foi maior do que o crescimento das plântulas provenientes da semeadura direta (técnica 3). No entanto, a diversidade de espécies do folhiço foi pequena. Esses dados sugerem que a união do folhiço à semeadura direta é uma técnica promissora, pois apresenta boa eficiência no processo de recuperação de APP além custar 75% menos do valor investido no plantio de mudas.

LC.13-P: Malaria and changing landscapes step one: malaria and precipitation patterns

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According to the World Health Organization, 42% of malaria cases are "associated with policies and practices regarding land use, deforestation, water resource management, settlement siting and modified house design". This estimate was drawn from expert opinion and studies performed at small scales, but little research has investigated the cumulative impacts of land use and land cover changes occurring in the Amazon Basin on malaria. As the first step in understanding how land use practices may alter malaria patterns in the Basin we present an analysis of municipio (n=755) malaria case data and monthly precipitation patterns between 1996 and 1999. Climate data originated from the CRU TS 2.1 half-degree grid resolution climate data set. We apply the MARA/ARMA malaria climate suitability model in the Basin, and report its poor performance in predicting the observed cases of malaria. At the Basin scale precipitation and cases show strong relationships. Precipitation and cases are asynchronous across the period of observation, but detailed inspection of states and individual municipios reveal geographic dependencies of precipitation and malaria incidence.

LC.14-P: Preliminary Results in the Detection of Amazonian Black Earth Sites using Hyperspectral Satellite Imagery

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The pre-Columbian indigenous population estimates of the Amazon Basin lowlands are highly uncertain and the subject of considerable controversy. Proponents of the low population density suggest that the forest is pristine, delicate, and sensitive to human disturbance. If populations were high, it is likely that Amazonian forest vegetation had been significantly altered and may be thought of as a cultural artifact, resilient to human disturbance and not an undisturbed forest. One of the archaeological sources used in reconstruction of Amazonian societies are Amazonian black earths (ABE) or in Portuguese, terra preta soils. The immense size of Amazonia, remoteness of many areas, forest vegetation, and lack of archaeological field surveys, make remote sensing beneficial to archaeological studies in this region. Remote sensing allows for comparison and analysis of vegetation across vast areas. Previous research has shown that hyperspectral image data can detect vegetation canopy chemistry differences, associated with soil nutrients and chemistry. This literature suggests that the high nutrient content of ABE soils will cause detectable changes in vegetation structure, phenology, and/or foliar chemistry. Hyperspectral remote sensing with dense coverage of the spectral reflectance of vegetation canopies will provide a key to detection of high nutrient ABE sites. The broad spatial coverage afforded by the proposed research allows for the unique opportunity to begin to quantify the Pre-Columbian human impact in Amazonia through the analysis of the distribution of ABE sites across the region. We conducted a preliminary analysis to demonstrate our conceptual plan and identify potential spectral differences between ABE sites and non-ABE sites using hyperspectral data from the Hyperion satellite. Our preliminary analysis indicates that, at three pairs of sites near Santarem, there are spectral differences between ABE and non-ABE sites. There are nine portions of the spectrum where the three ABE sites are completely separable from the three non-ABE sites. This limited demonstration analysis highlights the important opportunity that Hyperion data provide for identifying and mapping ABE sites. As much as our current knowledge of this forest expands, it is still limited by ignorance of past disturbance and dynamics as well as the populations and agricultural practices of previous human societies.

LC.15-P: Climatic Change Consequences on Biome Distributions in South America: Simulations With Two Versions of the CPTEC Potential Vegetation Model (CPTEC-PVM)

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We studied the consequences of projected climate change on biome distribution in South America in the 21st century by forcing two versions of the CPTEC potential vegetation model (CPTEC-PVM and CPTEC-PVM2 that include Carbon cycle) with climate scenarios from 15 climate models for two emission scenarios (A2 and B1). For current climate conditions, the two versions of the model successfully simulate the natural geographic distribution of biomes. Among the scenarios of climate change, the consensus of the results for each model version, show different patterns, due to the effect of the Carbon cycle feedback. The larger impacts of the climate change in biome distributions are concentrated in Amazonia and Northeast Brazil. The experiment with the model that not considers carbon cycle (CPTEC-PVM) indicates reduction of tropical forest cover areas which would be replaced by savannas. This reduction of tropical forest increase with the time through the 21st century, mostly over Southearn Amazonia. The CPTEC-PVM2 shows that in Southeastern Amazonia not exists consensus between the models about the future condition of the tropical forest. This result shows the effect of CO_2 fertilization in support tropical forest in areas where temperature increase, so the decreasing of precipitation need to be greater to replace tropical forest by savanna. In this experiment the Net Primary Production (NPP) increase up to 100%. When limiting the NPP up to 25%, the areas with not consensus of the future condition of the tropical forest increase in relation with the experiment without limitations in the NPP. The insertion of the CO_2-vegetation interaction mechanism (carbon cycle) results in prognostic different, less catastrophic, than those pointed by the CPTEC-PVM. The above results show that the response of the tropical forest to elevated CO_2 is a critical question, and need to be more studied.

LC.16-P: Challenges of a coupled climate-biosphere model to reproduce vegetation dynamics in Amazonia

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We investigate how well a fully coupled atmosphere-biosphere model, CCM3-IBIS, can reproduce vegetation dynamics in Amazonia. We conduct an experiment with three ensembles of the global climate, with fixed climatological sea-surface temperatures and with dynamical vegetation, for a period of 30 years. Two climate variables, precipitation and incident solar radiation, and four vegetation dynamics variables, aboveground live biomass (AGLB), leaf area index (LAI), net primary production (NPP) and land cover, are compared to observations. Precipitation is compared with data from NCEP/NCAR reanalysis, ERA-40 project, CMAP (CPC Merged Analysis of Precipitation), GPCP (Global Precipitation Climatology Project), TRMM (Tropical Rainfall Measuring Mission), CRU, Legates and Willmott (1990) and Leemans and Cramer (1990) databases. Incident solar radiation is compared with GOES algorithm GL1.2. Both climate variables are analyzed for the entire South America. AGLB is compared with the recent map by Saatchi et al. (2007). LAI and NPP are compared with in situ measurements done by LBA researchers. Land cover is compared with land use map from SAGE (Center for Sustainability and the Global Environment). The vegetation variables are analyzed for Amazonia Tropical Forest. Results indicate that the Amazon climate (annual mean and seasonality) is extremely well simulated for both precipitation and incident solar radiation. Vegetation cover patterns reproduce well the observed patterns. Although the climate variables are well represented, there are some differences in the AGLB simulated. These errors in simulated AGLB are probably because the allocation coefficient and resident time of wood, leave and root need to be better represented.

LC.17-P: Land use impacts on stream water quality in the Brazilian Cerrado

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The Brazilian Cerrados are one of the main vegetable formations of the country, being second bigger national bioma. Some studies point that the quality of fluvial waters is influenced by the climate, geology, physiography, ground and biological activity in the basin. The Cerrados do not count on studies that show the geochemistry of surface water and ground waters. The goal of this work is to investigate the effect of the land use in the biogeochemistry and processes that occur in gallery forests. First-order streams had been selected in basins that drain natural, agricultural and urban areas in the adjacencies of the Brasilia City. During dry and rainy season water samples of streams had been collected for the determination of potassium, magnesium, calcium, sodium, ammonium, chloride, sulphate, nitrite and nitrate. The results had shown that the smaller average annual concentrations, in mg L-1, had been found in natural areas (K - 0,08 ± 0,13; Ca - 0,09 ± 0,11; Mg - 0,04 ± 0,02; Na - 0,14 ± 0,07; NO2 - 0,07 ± 0,05; NO3 - 0,12 ± 0,03 and NH4 - 0,05 ± 0,05). The urban areas had presented the bigger concentrations in this study (K - 0,54 ± 0,55; Ca - 1,03 ± 0,72; Mg - 0,25 ± 0,16; Na - 1,10 ± 0,65; NO2 - 0,20 ± 0,09; NO3

- 0,98 ± 0,78 and NH_4 - 0.11 ± 0,15). The seasonality of the urban areas had not presented differences between the two seasons, except to NO_2, which was bigger during the dry season. The agricultural areas had shown differences only for K, Mg and Ca, which had been bigger during the rainy season, whereas natural areas K, Ca, Cl and NO_3 also had shown different between the stations, being K and Ca bigger in the dry season and the two last ones during the rainy season. The results show that the anthropic alterations had created a trend differentiation in the water quality of the studied streams, therefore the agricultural and urban areas were more enriched than the natural ones.

LC.18-P: Quantifying changes in ecosystem goods and services from land-use change in the Amazon basin

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The Amazon basin delivers an array of ecosystem goods and services to recipients at local, regional and global scales. As an increasing amount of land is converted from natural vegetation to cropland, pasture, biofuel and timber production, the social, economics and biophysical changes have yet to be fully quantified. There are inherent trade-offs of these goods and services with changes in land-use that occur across scales. Here, we begin to calculate the impact of land-use changes for commodity production across the Amazon and identify user groups that benefit or lose from such changes. This work leverages the previous LBA research by Foley, Costa, Coe and Patz along with economic and statistical data on commodity production and trade to deliver spatially explicit estimates of the changes in ecosystem goods and services across the Amazon basin.

LC.19-P: Removing Vegetation Canopy Bias from the Shuttle Radar Topography Mission Digital Elevation Model

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We use the 90-meter horizontal resolution Shuttle Radar Topography Mission (SRTM) elevation data (Farr et al., 2007) to represent the surface morphology of the Amazon within our numerical modeling system. The absolute vertical accuracy of the SRTM data is estimated to be about +/- 6 m with relative errors believed to be less (Smith and Sandwell, 2003). The height reported in the data is a measure of the center of scattering within the vegetation canopy. It is not a direct measurement of the bald land surface, unless no vegetation is present. The height reported is therefore a complex function of canopy density and structure, and other land surface characteristics (Kellndorfer et al., 2004). Abrupt vegetation discontinuities, such as patchwork clear-cutting, produce errors that are clearly visible upon close regional inspection. The purpose of this study is to remove the absolute error imparted by the vegetation canopy to create a more accurate map of land surface elevation. Here we present the results of two attempts within the Xingu River basin at two resolutions. The first method is a direct correction of the 90-m resolution data on the 84000 hectare Fazenda Tanguru in the Upper Xingu River basin. We use 6 vegetation classes derived from year 2000 LandSat TM imagery, representing direct and indirect measurements of vegetation height to remove vegetation canopy bias for a sub-image containing the Fazenda. The second method uses 1-km resolution single-class forest data from Eva et al. (2002) and ground-based measurements of forest height throughout the Xingu Basin in Mato Grosso to remove the vegetation canopy bias. Both methods clearly improve the representation of land surface topography but errors are still visible, particularly along roads and where forest regrowth is active. Our next step is application of more explicit vegetation classification techniques to the entire Amazon basin.

ND (Nutrient Dynamics)

ND.1-P: Produção de Serapilheira e Retorno de Nutrientes em um Fragmento Ciliar na Bacia do Rio Urupá, Rondônia

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Este estudo teve por objetivos avaliar a deposição de nutrientes através da serapilheira produzida em um fragmento ciliar na bacia do rio Urupá, RO e comparar a produção de serapilheira com resultados obtidos em outras florestas ciliares da Amazônia Brasileira. Para o experimento, foi selecionada uma parcela de 2 ha, sendo esta subdividida em 3 principais trilhas, onde, em cada uma delas, foram alocados cinco coletores quadrados (confeccionados a partir de tubos de PVC de 50 cm de lado), forrados com tela de náilon com 1 mm^2 de malha, colocados a 60 cm da superfície do solo. As coletas de serapilheira foram realizadas quinzenalmente, durante o período de um ano, de setembro de 2005 a novembro de 2006. Em laboratório, o material depositado nos coletores foi triado nas frações folhas, galhos/ramos e miscelânea, seco em estufa a 65ºC e pesado em balança de precisão. A produção total de serapilheira foi de 6.036,6 kg.ha-1 (folhas: 63,4%, galhos: 24,9% e miscelânea: 11,7%). Os maiores valores de produção ocorreram durante a estação seca, atingindo valor máximo em agosto. O teor de elementos na serapilheira apresentou variações significativas durante o ano estudado, demonstrando que a serapilheira influencia o fornecimento de nutrientes ao solo de forma sazonal, em função de sua qualidade e de sua quantidade. Através da serapilheira foram devolvidos ao solo, 2.723,4 kg.ha-1 de C e 97,2 kg.ha-1 de N, demonstrando o grande potencial da serapilheira na manutenção da sustentabilidade da floresta.

Palavras-chave: Serapilheira, mata ciliar, ciclagem de nutrientes, Amazônia.

ND.2-P: Quantificação do Teor de Nitrogênio Foliar Utilizando a Área Foliar Específica Para Brosimum Sp., Inga sp. e Mabea sp. na Amazônia Central

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O nitrogênio (N) tem sido considerado um importante nutriente na regulação do crescimento das plantas, seu conteúdo é correlacionado positivamente com a capacidade fotossintética e com a produtividade. A área foliar específica (AFE) tem sido utilizada para quantificar o teor de nitrogênio foliar. A AFE e a concentração de N são peculiaridades que têm sido estudadas porque presumem ou demonstram a relação folha com trocas gasosas. A AFE é uma adaptação ao nível de folha e reflete o princípio da produtividade, modelos ecológicos predizem que, quanto maior for a AFE mais as plantas acumulam carbono. Existe ainda, uma correlação entre a eficiência do uso do nitrogênio das espécies com sua AFE. A AFE está relacionada com variáveis como fotossíntese líquida, taxa de crescimento relativo, produção e nitrogênio. Objetivou-se correlacionar: o teor de nitrogênio foliar e a AFE. O estudo foi realizado na Estação Experimental de Silvicultura Tropical do Instituto Nacional de Pesquisas da Amazônia em Manaus-AM. Foram escolhidas três espécies: Brosimum sp. com 06 indivíduos arbóreos (IA), Inga sp. 10 IA e Mabea sp 05 IA. Para cada IA foram coletadas três folhas completamente expandidas, expostas a radiação solar e em bom estado fitossanitário. Após a coleta das folhas, foram retirados discos foliares. Os discos foliares foram secos em estufa, pesados, triturados e analisados no Analisador Elementar Carlo Erba. Verificou-se que para todas as espécies AFE apresentou correlação negativa. Para Brosimum sp. a AFE apresentou coeficiente de determinação (r2) (r2=0,67), probabilidade (P) (P< 0,001) e equação (n=-0,0205afe+3,9358); Inga sp. apresentou (r2=0,64), (P< 0,001) e (n=-0,0068afe+3,1341) e Mabea sp. apresentou (r2=0,70), (P< 0,001) e (n=-0,016afe+3,8305). Os resultados indicam que para estas espécies a AFE é um bom indicador para a quantificação do teor de N.

ND.3-P: Watershed studies in a region mainly occupied by small holder farms in the eastern Amazon

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In three small watersheds of the Cumaru, São João and Timboteua streams (3600, 2300, and 6800 hectares, respectively) close to Igarapé-Açu, Pará, in the eastern Amazon, several studies have been conducted at different spatial scales. In this region, mainly occupied by small-holder farms (less than 50 ha), slash-and-burn agriculture is the dominant economic activity, with many young secondary forests as temporary fallow phases within the agricultural cycle. These small agricultural fields and fallows, along with small pastures, cover most of the landscape. Previous studies have shown the positive biogeochemical and hydrological aspects of alternative fallow vegetation management by chop-and-mulching instead of slash-and-burning. This result motivated our research team to detail and expand agriculture watershed studies, measuring water chemistry across hydrological cycles of different land uses, as well as simulating pesticide contamination and characterizing fish species assemblies. Our more important findings include: 1- Although showing a negative correlation, partial pressures of dioxide carbon and dissolved organic carbon concentrations in stream water were higher than in some other Amazonian catchments; 2- Low stream water pH indicates that cation inputs have been not enough to buffer the effects of organic compounds from riparian and secondary forests that enter into stream water; 3- Nutrient loads in runoff are smaller from mulched agriculture fields than from burned fields, reducing nutrients and sediments entering into streams; 4- Shallow water table together with soil and geological characteristics increase the risk of contamination of groundwater by pesticides used in small farms; 5- A high fish species diversity, with 43 species of 12 families, is more expressive downstream than in upstream headwater areas. Finally, this ongoing research is part of an interdisciplinary effort to understand agriculture watersheds within the scope of Amazonian small farming, endeavoring to support river basin management and sustainable development planning in the eastern Amazon.

ND.4-P: Water Optical Properties Changes due to Land-Water Interactions in Mamiraruá Reserve, AM, Brazil

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Intense land-water interactions occur along the annual flood-pulse producing changes in the direction and velocity of water fluxes. Biogeochemical processes will differ in time and space according to the floodplain hydrology, geomorphology and biological structure. During high water the over-bank flow entering inundated forest will tend to create conditions for the suspended sediments deposition. The water also becomes enriched with dissolved organic matter (DOM) derived from the decomposition of high loads of detritus from the forest. These effects will also trigger other biochemical processes, which result in modifications of water physical-chemical properties. The optical properties will also be significantly altered, once suspended inorganic matter (SIM) scatters radiance mainly towards 550nm and DOM absorbs radiance towards the lower wavelengths in the visible range of the electromagnetic spectrum. We used Landsat/ETM+ images acquired during high water in September 2002 to map 5 classes of water, over lotic and lentic systems in the Mamirauá Reserve for Sustainable Development. Bands from the visible spectral range ETM1, 2 and 3 were used for an unsupervised classification. Water transparency (Secchi depth) samples measured in September 2006 were spatially interpolated by the weighted average method. The result from digital classification and spatial analysis of water transparency were compared. Further analysis with data expressing water fluxes, bathymetry and vegetation structure are being carried out in order to build a database for hydrodynamic modeling.

ND.5-P: Tree growth and soil response to P fertilization in a 24-year-old tropical forest on an Oxisol

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Mature, humid, lowland tropical forests are generally considered to be P limited and to cycle P efficiently. Whether this P limitation extends to younger secondary tropical forests that are re-growing on a large portion of the lowland tropics, however, remains uncertain. As such, there is a knowledge gap between expectations of P limitation and direct observations of such limitations. The objective of the current study was to fill this gap by fertilizing a natural secondary tropical forest that was 24-years-old. In February 1999 six 20x20 m plots were randomly established in the secondary forest area of Fazenda Vitoria Ranch in Paragominas. After one year of pre-treatment tree measurement, 50 kg ha-1 of phosphorus as simple super-phosphate was supplied in January 2000 and 2001. Measurements over the following six years (age 25 to 31) demonstrated no increased tree growth. Over the seven years of measurements (age 24 to 31) rates of biomass accumulation average 3.9±1.3 kg ha-1 yr-1. Most sequential P fractions (Resin, HCO3-Pi, NaOH-Pi, NaOH-Po, and 1M HCl) demonstrated significant increases shortly after fertilization and could account for nearly all the 50 kg ha-1 of added P at each date. By January 2002, concentrations of P were declining in all pools other than Resin P and by June 2006 concentrations had returned to initial levels. Interestingly, during this same period, P concentrations in all pools of the control plots declined. P fixation capacity in the surface 0-20 cm layer is relatively low (~120 ug g-1) while fixation increases to ~180 ug g-1 at 20-50 cm and approaches ~500 ug g-1 for all layers below 50 cm. This fertilization trial clearly demonstrated no growth limitation from low soil P within this secondary forest.

TG (Trace Gases)

TG.1-P: Deriving refined land-cover information for the core Cerrado region based on the analysis of combined satellite and agricultural census data

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Recent estimations show that about 47% of the Cerrado biome has been already converted. Most of this conversion has taken place in the last 40 years, mainly in the State of Goias, the only State thoroughly located within the Cerrado limits. According to the most updated land use / land cover map available, based on 2001-2002 Landsat data, agriculture fields and pastures occupy approximately 18 and 45% of the State, respectively. Although this information is instrumental in assessing environmental impacts and trends at regional scales, detailed information on the spatial distribution of the distinct agricultural systems are still needed for accurate and precise estimations of CO2 and trace gases fluxes. Thus, in this study, thematic information based on satellite imagery was combined with 2001 - 2005 IBGE agricultural surveys at the municipality level in order to derive geographically explicit land cover information. Such analysis provided a new insight on the temporal and spatial dynamics of the dominant agriculture classes in the State of Goias at the landscape scale, which will certain contribute to improved biophysical models.

TG.2-P: Fluxes of Nitrous Oxide and Methane in Commercial Soybean, Rice, and Maize Crops on the Santarem-Belterra Plateau, Para State

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The western portion of the state of Para has been the scene of accelerated development of commercial mechanized agriculture with rice and soybean as the main cultivars. After 2004, maize is an important crop, too. Planted area exploded from only 500 ha in 2000 to 110,000 ha in 2005. Thereafter, in 2006 a fall in the price of grains led to a reduction of planted area to only 50,000 ha in 2006. In light of this explosive change in land use, we initiated studies of the soil-atmosphere exchange of the greenhouse gases nitrous oxide and methane in the Santarem and Belterra municipalities. We used established static chamber methods to measure fluxes with gas chromatographic analysis of gas samples. In 2005 and 2006 we sampled rice and soybean in conventional system, where farmers used 8kg N ha-1 for both crops. In 2007 we collected sample to maize and soybean in low till system too, with the same fertilizer application. The samples were take every day by the first week after fertilizer applications and one week so on. We take 10 samples by crops x systems. The values are averages of the 10 samples during the cropping period. Fluxes varied widely depending upon the crop and the managements system employed. Rice planting under conventional tillage with the addition of 8 kg-N ha-1) resulted in an average soil-atmosphere flux over the season cropping of 34 (convert to kg-N ha-1 y-1 for comparison with fertilizer additions) over the 107 day season. Under conventional tillage, soil under soybeans fertilized with 8 kg-N ha-1 emitted only 7 (convert to kg-N ha-1 y-1 for comparison with fertilizer additions). In comparison, under low-tillage emissions were four times higher (with the same fertilization) over the course of the crop season. Methane fluxes showed little difference among crops although variation under upland rice was considerable ranging from consumption of -8 mg CH4 m-2 d-1 to emission of 9 mg CH4 m-2 d-1 (in 2005).

TG.3-P: Modeling aerosol optical properties in Amazonia obtained by AERONET and preliminary radiative forcing study

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This study presents the first results of a model of aerosol optical properties based on aerosol optical depth (AOD) ranges for Amazonian AERONET/NASA (Aerosol Robotic

Network) sites such as Abracos Hill (RO), Alta Floresta (MT), Rio Branco (AC), Cuiabá (MT) and Campo Grande (MS). The biomass burning emissions in Amazonia are very important in the global radiative balance and understanding how it changes the atmospheric composition during the year can let us estimate better the radiative impact. We distinguish 3 main seasons: wet, dry and biomass burning. In each season the data were separated in 13 AOD cases (0.1 AOD 500nm steps until AOD higher than 1.6). The studied optical properties include single scattering albedo, complex refractive index, asymmetric factor, column water vapor, volume size distribution, radiative forcing and forcing efficiency. A comparison was made too with model based on single scattering albedo instead optical depth.
These results contribute to a better regional parameterization used in look up tables such as from MODIS and regional models of transport and dispersion of pollutants.

TG.4-P: Modeling the Effects of Climate and Land Use Change on Carbon and Trace Gas Budgets over the Amazon Region using NASA Satellite Products

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As part of the LBA-ECO Phase III synthesis efforts for remote sensing and predictive modeling of Amazon carbon, water, and trace gas fluxes, we are evaluating results from the regional ecosystem model called NASA-CASA (Carnegie-Ames Stanford Approach). The NASA-CASA model has been formulated to run at monthly time intervals for the years 2000 to the present using NASA satellite data inputs from the MODIS and CERES sensors. Our preliminary results point to the importance of better understanding and mapping the influence of incident solar radiance, rainfall amounts, and land cover changes at the basin scale to reduce model uncertainties in relation to LBA tower flux records.
For more information, go to http://geo.arc.nasa.gov/sge/casa/

TG.5-P: Sugar-cane areas in the core Cerrado region: Current and near-future occupation scenarios

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In face of the global warming crisis, the search for alternative fuels has been intensified. In particular, the sugar-cane based ethanol production, which, besides the very competitive prices, offers lower GHG emissions, is undergoing a substantial expansion in Brazil, especially in the central portion of the country where most of the Cerrado biome is located. Thoroughly within the Cerrado limits, the State of Goias is certainly the one most severely threatened by this new agricultural frontier. In addition to the environmental impacts already observed (e.g. slash and burn practices, more land conversion, etc), significant changes in the land tenure structure and human dimensions are also expected, as new sugar cane plantations expands over previously established crops (e.g. soy bean), inducing labor migration, demand for new agricultural areas, urban growth, etc. In this study, the spatial distribution patterns of the areas occupied with sugar cane in the State of Goiás, as well as the ongoing expansion trends are investigated. Likewise, the possibility of identifying and monitoring these areas based on moderate resolution imagery is also being assessed. Preliminary results indicate an expansion trend in the pristine Vão do Paraná region (northeastern portion of the Goiás State) and temporal vegetation index signatures slightly distinct from the other dominant annual crops.

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LC.16-P Challenges of a coupled climate-biosphere model to reproduce vegetation dynamics in Amazonia (Mônica Senna)

LC.17-P Land use impacts on stream water quality in the Brazilian Cerrado (José Salomão Silva)

LC.18-P Quantifying changes in ecosystem goods and services from land-use change in the Amazon basin (David Zaks)

LC.19-P Removing Vegetation Canopy Bias from the Shuttle Radar Topography Mission Digital Elevation Model (Michael Coe)

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1B.2 Identifying runoff sources across scales in Amazon watersheds: an LBA synthesis effort (Joaquin Chaves)

SP3.3 Do secondary forests of Amazonia conform to the soil genesis paradigm of N and P limitation in terrestrial ecosystems? (Eric Davidson)

ND.1-P Produção de Serapilheira e Retorno de Nutrientes em um Fragmento Ciliar na Bacia do Rio Urupá, Rondônia (Giovana Cabianchi)

ND.2-P Quantificação do Teor de Nitrogênio Foliar Utilizando a Área Foliar Específica Para Brosimum Sp., Inga sp. e Mabea sp. na Amazônia Central (Cristina Felsemburgh)

ND.3-P Watershed studies in a region mainly occupied by small holder farms in the eastern Amazon (Ricardo Figueiredo)

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TG (Trace Gases)

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3A.2 CO2 Fluxes Derived for Column Integration Technique Using Aircraft Profiles in Amazônia (Luciana Gatti)

3A.3 Study of N2O Flux over Central Amazon (Monica Tais Siqueira D'Amelio)

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TG.1-P Deriving refined land-cover information for the core Cerrado region based on the analysis of combined satellite and agricultural census data (Marlon Pontes)

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