

# BOOK OF ABSTRACTS

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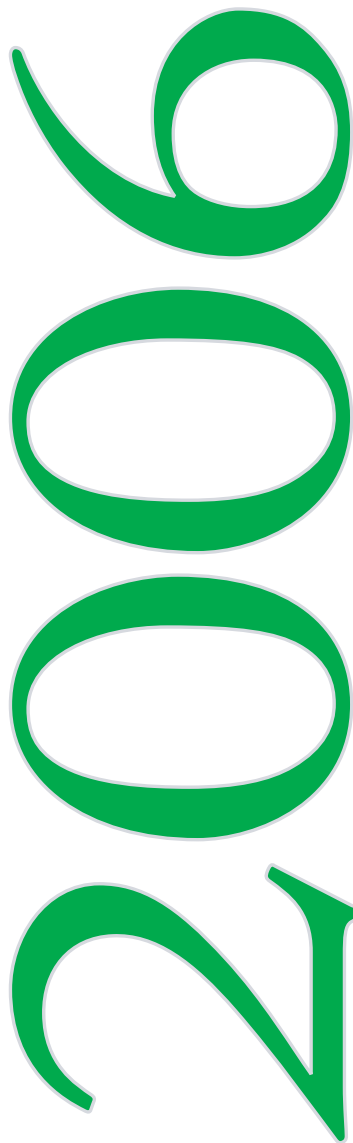
10th

LBA-ECO

Science Team

Meeting

2006



Synthesis  
Integration  
Modeling



Ministério da  
Ciência e Tecnologia



## About this Book

This Book of Abstracts contains the oral and poster abstracts scheduled to be presented at the LBA-ECO 10th Science Team Meeting.

The book is organized as follows:

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This book is available online: [http://www.lbaeco.org/lbaeco/meeting10/ab\\_intro.htm](http://www.lbaeco.org/lbaeco/meeting10/ab_intro.htm)

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- 13.24-P **A Multitemporal MOD13Q1 "Ready-to-Use" Databasis for the Brazilian Cerrado** (*Noely Vicente Ribeiro*, Levindo Cardoso Medeiros, Rubens Vicente Mesquita, Nilson Clementino Ferreira, Laerte Guimarães Ferreira, Alfredo Huete)
- 13.25-P **Responses of Central Amazon Biodiversity and Carbon Storage to Altered Disturbance Regimes** (*Amanda L. Robertson*, Jeffrey Q. Chambers, Giuliano P. Guimarães, Vilany C. Carneiro, Matthew A. Robertson, Liliane M. Texeira, Niro Higuchi)
- 13.26-P **Monitoring the development of carbon uptake and turbulent fluxes changes over an Agricultural Field in Western Amazon.** (*Ricardo K. Sakai*, David R. Fitzjarrald, Osvaldo L. Moraes, Otavio C. Acevedo, Matt Czikowsky, Rodrigo Silva, Troy Beldini)
- 13.27-P **Interação entre índice de área foliar e conteúdo de água no solo em uma floresta de transição Amazônia Cerrado** (*Luciana Sanches*, *George Sanches Suli*, José de Souza Nogueira, Nicolau Priante Filho)
- 13.28-P **Quantifying the impact of cloud obscuration on remote sensing of active fires in the Brazilian Amazon** (*Wilfrid Schroeder*)
- 13.29-P **Effects of prescribed fires on bacterial communities of savanna soils from Cerrado region** (*Maria Regina Sartori Silva*, Joana Dias Bresolin, Mercedes Cunha Bustamante, Ricardo Henrique Kruger, Fábio Bueno Reis Jr.)
- 13.30-P **FPAR estimada pelo produto do MODIS e por observações de campo em uma floresta de transição Amazônia Cerrado** (*Maricéia Tatiana Vilani*, *Luciana Sanches*, Camila Isabel de Menezes Fraga, José de Souza Nogueira)
- 13.31-P **New Hybrid Estimate of Tropical Deforestation Rates in the 1980s and 1990s** (*Holly Gibbs*, Jonathan Foley, Navin Ramankutty, Ruth DeFries, Frédéric Achard)
- 13.32-P **Assessment of satellite-derived vegetation indices across the Amazon forest** (*Humberto Alves Barbosa*, Marcos Daisuke Oyama, Luis Gustavo Gonçalves)

## ND (Nutrient Dynamics)

- 14.1-P **Turbidity Scalar Trend and Flood Pulse at the Curuai Lake Floodplain System** (*Enner H Alcântara*, Claudio C Barbosa, José L Stech, Yosio E Shimabukuro, Evelyn M Novo)
- 14.2-P **Channel Sensitivity Between Amazon River and Lake Curuai System** (*Claudio Clemente Faria Barbosa*, Conrado Rudorff, Jose Luiz Stech, Evelyn Marcia Leao de Moraes Novo)
- 14.3-P **Caracterização Biogeoquímica do rio Urupá, Rondônia** (*Marcos Alexandre Bolson*, Nei Kavaguichi Leite, Sergio Candido Gouveia Neto, Alex Vladmir Krusche, Nilton Bonelle, Beatriz Machado Gomes)
- 14.4-P **Dissolved organic and inorganic carbon in small streams in Eastern Amazonia** (*Fabiola Fernandes Costa*, Ricardo de Oliveira Figueiredo, Daniel Markewitz, Eric Atlas Davidson)
- 14.5-P **Análise Interanual da Produção, do Acúmulo e da Taxa de Decomposição da Serrapilheira na Floresta de Transição Amazônia-Cerrado** (*Andera Carla Dalmolin*, Paulino Bambi, Francisco de Almeida Lobo, Segundo Durval Pereira Rezend, Carmen Eugenia Rodrigues Ortiz)
- 14.6-P **Biochemical characterization and nutritional quality of soil under secondary forest succession in central Amazonia** (*Fabiane Lima de Oliveira*, Regina Costa Luizão, Flavio Jesus Luizao)
- 14.7-P **APLICAÇÃO DA RAZÃO K/Si(OH)<sub>4</sub> PARA A SEPARAÇÃO DAS HIDRÓGRAFAS EM MICROBACIAS DO ESTADO DE RONDÔNIA.** (*Adriane Colombo Liberale*, Alex Vladimir Krusche, Sérgio Candido Gouveia Neto, Christopher Neill, Helmut Elsenbeer)
- 14.8-P **Pathways of nutrient flow in an eastern Amazonian watershed.** (*Daniel Markewitz*, Ricardo de O Figueiredo, Marysol E Schuler, Eric A Davidson)
- 14.9-P **Integration of biogeochemical and hydrological data in pasture and forest covered catchments in Eastern Amazonia** (*Livia G. Turbay Rangel-Vasconcelos*, Ricardo de Oliveira Figueiredo, Marysol A.E. Schuler, Daniel Markewitz, Eric Atlas Davidson)
- 14.10-P **Hydrologic Processes Modeling and Watershed Management - developing tools for Amazonian**

**region.** (*Marysol Azeneth Schuler*, Ricardo de Oliveira Figueiredo, Livia G.T. Rangel-Vasconcelos, Luciene Mota Leão, Andrea dos Santos Coelho, Clariça Cacciamali Souza, Adriano Venturieri, Amintas Rosseti, Cláudia Mazza Dias, Orlando Watrin)

- 14.11-P **Identificação dos fatores responsáveis pelas características biogeoquímicas de um lago meandrônico situado em uma planície de inundação na transição entre Cerrado e Floresta Amazônica.** (*Carlos Ferreira Silva*, Eduardo Pereira Marques, Liliana Pena Naval, Laura De Simone Borma, Alex Vladimir Krusche)

## TG (Trace Gases)

- 15.1-P **Emissão de Gases em Agroecossistema com Milho e Plantas de Cobertura no Cerrado** (*Arminda Moreira de Carvalho*, Marcedes Cunha Bustamante, Danielle Matias Sousa)
- 15.2-P **Including the sub-grid scale plume rise of vegetation fires in low resolution atmospheric transport models.** (*Saulo R. Freitas*, Karla M. Longo, Robert Chatfield)
- 15.3-P **The Coupled Aerosol and Tracer Transport Model to the Brazilian developments on the Regional Atmospheric Modeling System: model validation using direct and remote sensing observations.** (*Saulo R. Freitas*, Karla M. Longo, Maria A S Dias, Pedro L S Dias, Robert Chatfield, Alvaro Fazenda, Luiz F. Rodrigues)
- 15.4-P **Determination of Soil Radon-222 Flux at Tree Area With Different Activity Related When use of the Soil in the Eastern Amazon** (*Risonaldo Leal Lima*, Christopher Martens, Howard Mendlovitz, José Mauro Moura, Irene Cibelle Sampaio, Carlos Eduardo Guerra, Rodrigo Silva)
- 15.5-P **Isotopic composition of methane (CH<sub>4</sub>) sources in a tropical Amazon forest: A preliminary data set** (*Jose Mauro S Moura*, Reynaldo L Victoria, Marcelo Z Moreira, Christopher S Martens, Howard P Mendlovitz, Risonaldo L Lima, Irene Cibelle G Sampaio)
- 15.6-P **Preliminary measurements of N<sub>2</sub>O partial pressures in the Negro and Solimões Rivers, Amazon Basin, Brazil** (*Carolina Barisson Marques Oliveira*, Maria Fátima Rasera, Hilandia Brandão Cunha, Jonismar Souza, Alex Vladimir Krusche)
- 15.7-P **Variations in the Concentrations of Nitrous Oxide in the Soil Pore Space at the Tapajós National Forest** (*Raimundo Cosme Oliveira Jr*, Michael Keller, Patrick Michael Crill, Plinio Camargo, Hudson Silva, Risonaldo Lima, Cleuton Pereira, Kemeson Oliveira, Kadson Oliveira, Augusto Maia)
- 15.8-P **SF<sub>6</sub>, CO and H<sub>2</sub> mixing rate since 2000 in vertical profile over Central Amazon** (*Monica Tais Siqueira D'Amello*, Luciana Vanni Gatti, John Bharat Miller, Andrew Crotwell, Lillian Polakiewicz, Elaine A J Martins, Pieter Tans)

## Parallel Oral Session 1

### 1A: Land Surface, Climate, and Hydrology

#### 1.1: The hydrometeorology of the Amazon basin and its global teleconnections

**Roni Avissar**, Duke University, avissar@duke.edu (Presenting)

**Renato Ramos da Silva**, University of Sao Paulo, renato@duke.edu

**David Werth**, Duke University, werth@duke.edu

**Natalia Hasler**, Duke University, natalia.hasler@duke.edu

Regional and global climate models are used in conjunction with socio-economic scenarios of land use / land-cover change in the Amazon basin, to estimate potential changes in the water cycle inside and outside of the basin. Four ensembles of six realizations, twelve years each, are produced with the NASA-GISS Global Climate Model (GCM): (1) a “current land cover” ensemble, which also serves as the “control” ensemble; (2) a “scenario for 2030” ensemble; (3) a “scenario for 2050” ensemble; and (4) a “total deforestation” ensemble that simulates the land cover in the Amazon basin after all the tropical forest has been eliminated. The same experiments were reproduced with the NCAR and with the GISS AM global climate models to produce a “superensemble.” In addition, The Regional Atmospheric Modeling System (RAMS) is used at a high resolution (20 km grid size) and very-high resolution (1 km grid size) over the Amazon Basin and using the same four land-cover scenarios but with the NCEP reanalysis for four different years (wet - 1997, dry - 1998, and two “normal” years - 1999 and 2000 that have similar domain-average precipitation but different spatial distributions) forcing its lateral boundaries. Thus, the combined impacts of deforestation and El Niño and La Niña years are also explored as part of this numerical experiment. The combination of these different simulations reveals significant impact of deforestation on the regional and global hydroclimate.

#### 1.2: Scenarios of Deforestation and their Impact on the Amazon Basin Hydrometeorology

**Renato Ramos-da-Silva**, UFPA, renato@duke.edu (Presenting)

**David Werth**, Duke University, werth@duke.edu

**Roni Avissar**, Duke University, avissar@duke.edu

State-of-the art socio-economic scenarios of land-cover change in the Amazon Basin for the years 2030 and 2050 are used together with the Regional Atmospheric Modeling System (RAMS) to anticipate the hydrometeorological changes caused by deforestation expansion in that region assuming a four-year sequence (1997-2000) of meteorological conditions that include both El Niño and La Niña events. The basin-average rainfall decreases progressively with the increase of deforestation from the current state to 2030, 2050 and on to total deforestation. However, the spatial distribution of rainfall is significantly affected by the land-cover type and topography. While the massively deforested region experiences an important decrease of precipitation, the areas at the edge of that region and at elevated regions receive more rainfall. Propagating squall-lines over the massively deforested region dissipate before reaching the western part of the basin, causing a significant decrease of rainfall in that region.

The horizontal gradient of surface heat fluxes created by the deforestation pattern generates important circulations that are not resolved by global climate models (GCMs). An analysis of moist convergence and net energy shows that GCMs are more sensitive to deforestation than RAMS, mostly because of this lack of feedback.

#### 1.3: Climate change in Amazonia caused by soybean cropland expansion, as compared to caused by pastureland expansion

**Marcos H Costa**, UFV, mhcosta@ufv.br (Presenting)

**Silvia N M Yanagi**, UFV, smonteiro@vicosa.ufv.br

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**Aristides Ribeiro**, UFV, ribeiro@ufv.br

**Edson Rocha**, UFPA, eprocha@ufpa.br

In the last 15 years, the strong increase of pasturelands over former rainforest areas has raised concerns about the climate change that such change in land cover might cause. In recent years, though, expansion of soybean croplands has been increasingly important in the agricultural growth in Amazonia. In this paper we use the climate model CCM3 to investigate whether the climate change due to soybean expansion in Amazonia would be any different from the one due to pastureland expansion. The land component of the model has been updated with new findings from the Large-Scale Biosphere Experiment in Amazonia (LBA), and a new soybean micrometeorological experiment in Amazonia. Results show that the decrease in precipitation after a soybean extension is much higher when compared to the change after a pastureland extension, a consequence of the very high albedo of the soybean cropland. A large spreading out of soybean over Amazonia may cause regional precipitation to decrease below the rainforest-savanna climate border, compromising the sustainability of the remaining patches of rainforest.

#### 1.4: An Econometric Approach to Amazon Landscapes and Assessing Their Hydroclimatological Impacts

**Nathan Moore**, Michigan State University, moorena@msu.edu (Presenting)

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**Eustaquio Reis**, IPEA, ejreis@ipea.gov.br

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**Claudio Bohrer**, Universidade Federal Fluminense, bohrer@vm.uff.br  
**Juan Andrés Robalino**, Columbia University, jar101@columbia.edu

This paper presents initial findings from the implementation of a linked land-climate model that can predict Amazonian climate as a function of possible development scenarios. The model uses two sub-components, an econometric land cover model capable of linking land cover changes to spatial and temporal variation in factors that drive human behavior, and a regional climate model (RCM) capable of assessing the effects of land cover change (and external climate forcing) on region-scale climate. As is well known, land cover in the Amazon Basin is undergoing rapid transformation due to agricultural expansion, logging, and road building effects. This transformation is accompanied by alterations in albedo, leaf area index, and fractional cover. Shifts in such biophysical characteristics affect the partitioning of energy in the surface energy budget, and therefore surface temperature, convective precipitation, and latent and sensible heat fluxes. The methodology implemented provides a way to causally link these various processes. It exploits the probabilistic nature of an econometric approach by generating multiple stochastic landscapes associated with possible development scenarios. By serving as inputs to the RCM, these landscapes then enable the prediction of probabilistic outcomes for climate, with a natural representation of uncertainty by the computational production probability distribution functions for key climate variables - e.g. precipitation, temperature, wind, etc. In the simulation presented, we used the econometric model to generate sets of land covers for three cases: (1) a best-case scenario, or BCS, with reduced forest removal due to minimal infrastructure investment associated with Avana Brasil, strong enforcement of protected areas, and high rates of out-migration from the region; a worst base scenario, or WCS, with high forest removal due to the completion of Avana Brasil projects, lax enforcement of protected areas, and low rates of out-migration; and (3) the bracketing case of complete forest removal, with replacement by agriculture. We adapted these land covers for use in RCM simulations, using the Regional Atmospheric Modeling System (RAMS) for 4 years, 1998-2001. For each year we simulated the impacts of each land cover scenario under a variety of atmospheric conditions. The results presented show that WCS simulations produce less rainfall within the basin than BCS simulations, and that these reductions in rainfall occur in close proximity to deforested areas. Total deforestation simulations yield lower domain-averaged rainfall particularly during the rainy season.

### 1.5: Is it deforestation affecting the discharge of the major Amazon Rivers?

**Ralph Trancoso**, INPA, ralph@inpa.gov.br (Presenting)  
**Arnaldo Carneiro Filho**, INPA, carneiro@inpa.gov.br  
**Javier Tomasella**, CPTEC - INPE, javier@cptec.inpe.br

A large part of the world's tropical deforestation is presently concentrated along the southern and eastern margins of the Amazon basin, an area known as the "deforestation arc". This region might play a fundamental hydrological role since it includes the headwaters of three large southern tributaries of the Amazon, the Xingu, Tapaj s and Madeira rivers. We looked for trends in the hydrological cycle in 30 watersheds of these three rivers. Historical records for discharge and precipitation since the 1970's, when rapid deforestation began in the Amazon Basin, were obtained from Brazil's Hydrological database (Hidroweb). Watersheds areas were delineated using a Digital Elevation Model (SRTM 30). Seasonal Mann-Kendall, a non-parametric statistical test, was chosen due to the skewness of the time series, and Sen-slope estimator was applied to obtain trend magnitudes. Watershed size ranged from 4,409 to 1,324,195 km<sup>2</sup>, and deforestation levels were 0.68 % to 60.55 %. Although a discharge increase was expected as a consequence of deforestation (evapotranspiration reduction and overland flow increase), we actually observed discharge decrease at 40% of river gauge stations. Even in watersheds with more than 50% deforested area, no discharge increase was detected. We did not find any relation between watershed deforestation levels and streamflow changes. Precipitation trends were similar to streamflow, with decreases observed in 40% of catchments surveyed. Simple regression between discharge and precipitation revealed a positive relationship ( $R^2 = 0.449$ ;  $p = 0.006$ ). Despite small-scale experiments having demonstrated that deforestation leads to an increase in streamflow, this effect is not replicated in large Amazon watersheds. We conclude that it is difficult to detect a deforestation signal in the hydrology of large tropical basins over the noise of natural climate trends and a scale effect. Furthermore, little is known about the hydrological impacts of forest fragmentation and open land mosaics, which are the prevailing land cover in the headwaters of the three rivers.

### 1.6: Numerical analysis of the Hydrology of Amazonia 1939-1998

**Michael T Coe**, The Woods Hole Research Center, mtcoe@whrc.org (Presenting)  
**Marcos Heil Costa**, The Federal University of Viosa, mhcosta@ufv.br  
**Erica A Howard**, Center for Sustainability and the Global Environment, University of Wisconsin-Madison, eahoward@wisc.edu

In this paper we analyze the hydrology of the Amazon River system for the latter half of the 20th century with our recently completed model of terrestrial hydrology (Terrestrial Hydrology Model with Biogeochemistry, THMB). We evaluate the floodplain inundation of the Central Amazon basin against observations of river discharge, inundation, and water height and analyze the spatial and temporal variability of the hydrology for the period 1939-1998. We compare the simulated discharge and floodplain inundated area to the simulations by Coe et al., 2002 using a previous version of this model. The new model simulates the discharge and flooded area in much better agreement with the observations than the previous model. The coefficient of correlation between the simulated and observed discharge for the greater than 27000 monthly observations of discharge at 120 sites throughout the Brazilian Amazon is 0.9698 compared to 0.9361 for the previous model. The coefficient of correlation between the simulated monthly flooded area and the satellite-based estimates by Sippel et al., 1998 exceeds 0.7 for 8 of the 12 mainstem reaches. Comparison to the seasonal data on flooded area by Hess et al., 2004, indicates good agreement of the spatial distribution of wetlands in the Central Amazon basin but with weaker seasonal variability. Additionally, the seasonal and inter-annual variability of the water height compares favorably to the satellite altimetric measurements of height reported by Birkett et al., 2002.

## 1B: Nutrient Cycling in Terrestrial and Aquatic Systems

### 2.1: Effects of land use change on stream water chemistry in three meso-scale catchments in Eastern Amazonia

**Ricardo de Oliveira Figueiredo**, Embrapa Amaz nia Oriental, ricardo@cpatu.embrapa.br (Presenting)  
**Daniel Markewitz**, University of Georgia, DMARKE@warnell.uga.edu  
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**L via Gabrig T. Rangel-Vasconcelos**, Embrapa Amaz nia Oriental, livia@amazon.com.br  
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**Lilianne Maia Lima**, Embrapa Amazônia Oriental, lilianne@cpatu.embrapa.br

We are measuring changes in water chemistry by upstream-downstream sampling along three streams from their headwaters in remnant mature forests, through pastures, secondary forests, and large fertilized fields of soy bean, rice and corn in the Paragominas region, in Eastern Amazonia. These three catchments have the following areas and percentages of forested cover: Cinquenta e quatro (Cq) watershed (130 km<sup>2</sup>) with 18% forest; Sete (St) watershed (150 km<sup>2</sup>) with 34% forest; and Pajeú (Pj) watershed (45 km<sup>2</sup>) with 45% forest. Field campaigns of stream chemistry measurements were conducted monthly from April 2003 to October 2005, including discharge, pH, conductivity, turbidity, alkalinity, DO, DOC, DIC, Ca<sup>2+</sup>, Mg<sup>2+</sup>, K<sup>+</sup>, Na<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, NO<sub>3</sub><sup>-</sup>, PO<sub>4</sub><sup>3-</sup>, SO<sub>4</sub><sup>2-</sup> and Cl<sup>-</sup>. Among the three streams, turbidity (Cq= 66.7; St=14.9; Pj=14.2 FTU) and pH (Cq=5.6; St=4.5; Pj=4.6) are highest in the most deforested watershed. Results from the watershed containing significant cropland at the lower reaches of the stream reveal higher nitrate concentrations near the cropland, which increase nitrate mean concentration in Cq (Cq=256; St=146; Pj= 84 µg L<sup>-1</sup>). Because soils are relatively similar within the study area, we suspect land use conversion is an important factor affecting the observed trends in stream chemistry. In addition to the effects of land-uses on inputs of nutrients to the streams, in-stream processes are also important. In-stream dissolved oxygen concentration consistently decreased in on-farm retention ponds, and nitrate concentrations generally followed a similar pattern as DO concentrations. In Pajeú, for instance, average measured DO was 3.69 mg L<sup>-1</sup>, while in free flowing stream it was 5.04 mg L<sup>-1</sup>. Similarly, nitrate in Pj decreased from 95 µg L<sup>-1</sup> in free flowing areas to 67 µg L<sup>-1</sup> in retention ponds. In phase III of our project we are investigating the role of the riparian zones as a filter of nutrients and sediments arriving from upslope land covers of forest, pasture, or agricultural land and whether riparian zones and/or in-stream processes significantly modify or uncouple the upslope soil solution chemistry and the stream chemistry.

## **2.2: Watershed Scale and the Importance of Riparian Zones in Modifying Solute Inputs from Land to Streams**

**Christopher Neill**, MBL, cneill@mbi.edu (Presenting)

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**Joaquin Chaves**, MBL, jchaves@mbi.edu

The conversion of large areas of the Amazon Basin from natural vegetation to human uses is intimately linked to the movement of water and materials from land to water. There is growing evidence that near-stream riparian zones contribute different amounts of water to streams and that the hydrological importance of riparian influences varies with watershed scale. Riparian zones can also exhibit strong control over the concentrations of solutes reaching streams. Deforestation has the obvious potential to alter these relationships by increasing the total volume of water arriving from hillslopes in surficial flowpaths. We use hydrological measurements and chemical techniques to examine the flowpaths by which water reaches streams across different soils watershed scales and land uses in watersheds in Rondônia and within a larger set of watershed studies within LBA. The influence of flowpaths through riparian zones increases with stream size and extent of riparian development. For some solutes, for example nitrate, the influence of riparian zones on stream concentrations is higher in forest than in pasture because conversion to pasture tends to decrease and homogenize the large variability in solute concentrations among flowpaths that existed in the former forest. Because each landscape element has different areal extent and hydrologic and geomorphic characteristics that can be assessed through field investigations and remote sensing, this approach of quantifying flowpaths provides a new way of linking plot and reach scale process information on hydrology and biogeochemistry to whole catchments in the Amazon. It also indicates that management practices that maintain riparian zones can be effective in moderating the influence of watershed land use change on stream chemistry and physical characteristics.

## **2.3: Nutrient dynamics in nested catchments at nested time scales: trends in hydrologic exports from 1st and 2nd order watersheds in the seasonally dry Southern Amazon**

**Mark S Johnson**, Cornell University, msj8@cornell.edu (Presenting)

**Eduardo Guimarães Couto**, Universidade Federal de Mato Grosso, couto@ufmt.br

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**Susan J Riha**, Cornell University, sjr4@cornell.edu

Water quality data can present difficulties for assessing trends and patterns among parameters and between study units due to sheer volumes of data and nested time scales. Here we present analysis of three years of data from baseflow and stormflow samples collected from four 1st order streams and one 2nd order stream near Juruena, Mato Grosso in the seasonally dry southern Amazon. Data was grouped by catchment, coded by season (wet, dry, and transition seasons), and analyzed by CHAID (Chi-squared Automatic Interaction Detection). Since more than 90% of annual stream discharge occurs as baseflow after interacting with the soil profile, hydrologic exports would be expected to reflect variability in soil properties. For baseflow conditions, stream water concentrations of base cations derived primarily from mineral weathering (Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup>) were found to vary by location, thereby reflecting soil variability between catchments. However, elemental cycles with significant biogenic components (DOC, K<sup>+</sup>, Si) were found to be more strongly dependent upon season than location. Of this latter group, both DOC and K<sup>+</sup> were found to increase with discharge during storms, while Si, Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> decreased with discharge during storms. Nevertheless, concentrations of both groups were inversely related to discharge at a seasonal scale for both 1st and 2nd order streams.

## **2.4: Scaling changes in biogeochemistry of small streams to the landscape: Using 15N to Trace N Transformations and Transport**

**Linda A Deegan**, The Ecosystems Center, Marine Biological Laboratory, ldeegan@mbi.edu (Presenting)

**Chris Neill**, The Ecosystems Center, Marine Biological Laboratory, cneill@mbi.edu

**M. Victoria Ballester**, CENA -Universidade de São Paulo, vicky@cena.usp.br

**Alex Krusche**, CENA -Universidade de São Paulo, Alex@cena.usp.br

**Reynaldo Victoria**, CENA -Universidade de São Paulo, reyna@cena.usp.br

Our work suggests that deforestation for pasture around small streams has disproportionately altered N budgets in river networks. Small streams act as important sites in the landscape where nutrients arriving from adjacent uplands are retained, transformed, or released to larger rivers. Our work has shown that the uptake lengths for NO<sub>3</sub><sup>-</sup> and PO<sub>4</sub><sup>3-</sup> were shorter in pasture streams compared with forest streams. Forest streams exported N, mostly in inorganic form (87%), while the same size pasture stream (2nd order) was highly retentive of N, storing almost 88%, primarily in the riparian grasses, and exporting less than 15% predominately as suspended particulate N. The overall effect of this change was to make small pasture watersheds more retentive of these nutrients than the original forested watersheds. In the Ji-Paraná watershed, current deforestation of less than 30% of basin area increased total basin N uptake in first- and second-order streams by 720% and total N retention

by 1,630%. This occurred primarily because of 4x greater uptake rates of N in pasture streams compared with forest streams. More than 14,000 kg of N that would have been delivered to third-order streams are now retained in headwater pasture streams in the Ji-Paraná Basin. The ecological consequences of reduced delivery of inorganic N to larger rivers are largely unknown, but the changes caused by deforestation have potentially important consequences for stream ecological function.

## 2.5: Atmospheric deposition (wet and dry) and nutrient cycles in Amazon Basin

**Luciene Lara**, Instituto de Física, Universidade de São Paulo, [luciene@if.usp.br](mailto:luciene@if.usp.br) (Presenting)

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**Paulo Artaxo**, Instituto de Física, Universidade de São Paulo, [artaxo@if.usp.br](mailto:artaxo@if.usp.br)

Wet and dry deposition plays an essential role in the functioning of the biogeochemical cycles of carbon and nitrogen since it acts as a source of nutrients to ecosystems. This paper describes the relationship between biogenic emissions from tropical forests and the concentration organic acids and nitrogen in rainwater and aerosols. We also addressed how the anthropogenic activities are changing the concentration and deposition patterns of carbon and nitrogen in Brazil. For that, it was collected rainwater and aerosol (fine and coarse mode) samples in different sites in Brazil. Land cover and land-use changes are probably responsible for the spatial variability found in precipitation and aerosol chemistry. The origin of the free acidity in rainwater is different in each site and come out to be linked to the land cover. Organic acids appear to control the acidity in remote areas while in other sites inorganic acidity has been detected. In addition, land-use changes, mostly the conversion of primary forest to pasture or croplands by biomass burning, are altering the concentration and the pattern of organic acids in rainwater. The composition of rainwater and aerosols in the disturbed sites appears to be controlled mostly by two sources: biomass burning and industrial emissions, and in the remote areas by biogenic emissions and marine influence. Additionally, nitrogen deposition was significantly higher in the disturbed sites and organic carbon deposition was significantly lower in these sites. Indeed, N wet deposition increases from an annual rate of 3.0 kg.N.ha<sup>-1</sup>.yr<sup>-1</sup> in pristine areas to an annual rate of 5.6 kg.N.ha<sup>-1</sup>.yr<sup>-1</sup> in disturbed regions. Moreover, the pattern of organic acids such as the rate of formate to acetate also has been changed due to biomass burning. We can anticipate that these large perturbations in the nitrogen and carbon deposition patterns have important deleterious consequences for the ecosystem functioning.

## 2.6: Organic Material Decomposition and Mineral Nutrient Dynamics in a Leguminous Tree-Enriched Mulch System in Amazon

**José Henrique Cattanio**, UFPA, [cattanio@yahoo.com](mailto:cattanio@yahoo.com) (Presenting)

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The new technique proposed for Amazonian agriculture includes rotational fallow systems with planted leguminous trees and replacing burning by mulching of biomass. Decomposition and nutrient release from mulch were studied using fine-mesh litterbags with five different leguminous enrichment species and the natural fallow vegetation as the control. The samples from each treatment were analysed for total C, N, P, K, Ca, Mg, lignin, cellulose content and soluble polyphenol at different sampling times during the course of one year. The decomposition rate constant varied with species and time. Weigh losses from the decomposed litter bag material after 96 days was 30.1% for *A. angustissima*, 32.7% for *S. paniculatum*, 33.9% for *I. edulis* and the Fallow vegetation, 45.2% for *A. mangium* and 63.6% for *C. racemosa*. All studied treatments exhibited immobilisation of N and P. N mineralisation showed a negative correlation with phenol, C-to-N ratio, lignin + phenol-to-N ratio, and phenol-to-phosphorus ratios and with nitrogen content in the litterbags material. After 362 days of field incubation, on average (pooled over all treatments), 3.3% of the K, 32.2% of Ca and 22.4% of Mg remained in the mulch. The result confirms that low quality and high amount of organic carbon as mulch application limits the quantity of energy available for microorganism and it increases de immobilisation of nutrient for biomass decomposition. The increase of agriculture productivity needs cannot be met by a major expansion of cultivated areas so intensification and improvement of currently managed land is unavoidable. Enriched fallow management with slash and mulch system can be an option to restore soil organic matter and maintain nutrients in the humid tropic ecosystem

# 1C: Carbon Fluxes in Upland Ecosystems

## 3.1: Drought induced reductions in the Aboveground NPP of a east-central Amazon forest: results from a large-scale partial throughfall exclusion experiment.

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Global and regional climatic changes are predicted to reduce precipitation in Amazonia, potentially reducing the net primary productivity (NPP) of extensive areas of moist tropical forests. However, the nature of these responses and their underlying mechanisms are poorly understood. Our investigation sought to clarify the issue by posing the following questions: (1) How will tropical moist forests respond to increased drought? (2) What are the limits of this forest ability to cope with drought? And, (3) To what extent will the forest be able to recover after the drought stress is removed? To address these questions we established a large-scale throughfall reduction experiment located in the Tapajos National Forest, which comprised two 1-ha parcels: a “dry” plot from which approximately 50% of the incoming precipitation was diverted from the soil during five wet seasons from January 2000 to August 2004, and a “wet” plot that received natural rainfall inputs. The forests capacity to recover was assessed on the basis of measurements collected over a 1.5-yr period after the removal of drought stress. Following the second partial throughfall exclusion period NPP was reduced by 50% in the dry plot relative to the wet plot. The greatest difference in NPP between parcels (67%) was observed in 2003, during the period of lowest soil moisture levels. The component of NPP most affected by the drought was stem growth. However, after the drought stress was removed, NPP in the dry plot recovered substantially, being only 14% lower in the dry plot; mainly due to increased stem growth. These results suggest that increased drought has the potential to greatly reduce the NPP of moist tropical forests, yet the surviving trees also appear to exhibit some resilience following cessation of drought.

### 3.2: Necromass Creation in an Amazon Forest: Examination of Undisturbed and Logged Forest Sites

**Michael Palace**, Complex Systems Research Center, Morse Hall, University of New Hampshire, Durham, NH 03824 USA, palace@kaos.sr.unh.edu (Presenting)  
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The forests of the Amazon region are undergoing vast changes in land use that result in alterations to terrestrial carbon storage and exchange with the atmosphere. Necromass accounts for up to 20% of carbon stored in tropical forests and yet it is infrequently measured. We examined the creation of fallen necromass over four and a half years using repeated surveys in forest areas that had been subjected to reduced impact logging and in undisturbed forest at the Tapajos National Forest, Belterra, Brazil. We also estimated fallen coarse woody debris and standing dead stocks at two times during our study. For both creation and stock estimates of fallen necromass, we identified the source of each piece of necromass as either trunk, branch, or unidentifiable. We grouped fallen necromass into three diameter size classes: large ( $>10$  cm), medium (5-10 cm) and small (2-5 cm) for both creation and stock estimates. We found significant differences in the source proportion between the stock and creation estimates, as well as differences between undisturbed forests and forests that had been logged with reduced impact techniques. The annual flux into the necromass pool in undisturbed forest sites of  $6.7 (0.8) \text{ Mg ha}^{-1} \text{ y}^{-1}$  was not significantly different from the flux in a RIL sites of  $8.5 (1.3) \text{ Mg ha}^{-1} \text{ y}^{-1}$ . With the assumption of steady-state, we estimated decay rates for fallen necromass in undisturbed forests to be  $0.10 \text{ y}^{-1}$  for large,  $0.30 \text{ y}^{-1}$  for medium and  $0.42 \text{ y}^{-1}$  for small size classes.

### 3.3: The Effects of Selective Logging on Tropical Forest-Atmosphere Exchange

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We are using long-term micrometeorological measurements to study the effects of selective logging on carbon exchange at km 83 in the Tapajos National Forest, Para, as a component of LBA. Direct flux and concentration profile measurements of carbon dioxide and water vapor from a 67-m tall tower began a year before logging when the forest was still considered primary. The logging removed  $\sim 3.5$  trees  $\text{ha}^{-1}$ , and increased the incidence of gaps by a factor of 3 over nearby undisturbed forest. The tower measurements continued for 2.5 years after the logging. The tower observations at the selectively logged site indicate that canopy photosynthesis declined following logging, and that ecosystem respiration increased in the subsequent wet season, presumably due to decomposition of slash from the logging operation. Compared to the pre-logging period, the forest understory was drier and warmer during daytime after the logging, which would be expected to increase flammability. A third tower was installed in a large gap created by the logging to investigate whether gaps preferentially vent  $\text{CO}_2$ , potentially biasing flux measurements. Comparison of data from the tower in the gap with data from the original tower in an intact patch of forest within the selectively logged area suggest that during daytime there was horizontal transport into the gap, and subsequent vertical transport out of the gap, of high- $\text{CO}_2$ , humid, cool air from the forest understory. Estimates of this  $\text{CO}_2$  “venting flux” indicate the potential for high rates of subcanopy scalar emissions out the gap; however, these estimates were uncertain because the contribution of the gap to the flux footprint is not well constrained.

### 3.4: What is the role of climate in controlling the exchange of carbon and water in an Amazonian rainforest?

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The stability of Amazonian equatorial forests, and the fate of their immense stores of organic carbon, depend on the ecosystem response to climate and weather. This study presents 4+ years of eddy covariance measurements of carbon and water fluxes and their response to environmental conditions in an Amazonian old-growth tropical forest. Contrary to expectations, this forest does not show signs of seasonal water limitation on growth despite a 5-month dry season.  $\text{CO}_2$  uptake responds primarily to light on hourly time scales, but photosynthesis overall maximizes in the middle of the dry season, responding to ecophysiological (flushing of new leaves) and atmospheric (high aerosol loading) changes. Annual carbon balance was very sensitive to weather anomalies, particularly the timing of the dry-to-wet seasonal transition, with mean net loss of  $939 \text{ kg C ha}^{-1} \text{ yr}^{-1}$  (observed range of  $-221$  (uptake) to  $2677$  (loss)  $\text{kg C ha}^{-1} \text{ yr}^{-1}$ ). The climatic sensitivity has significant implications for Amazonian carbon balances on annual to decadal time scales.

### 3.5: Long-term evolution of nighttime turbulent carbon flux at the LBA pasture/agricultural site

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The LBA deforested site at km 77 is characterized by strong stable stratification at night. It determines a large reduction of the nocturnal turbulent mixing, making it difficult to apply filtering techniques, such as the  $u^*$  correction to the analysis of the nocturnal data. A number of recent studies have shown that the temporal scales of the turbulent exchange under very stable conditions can be properly identified by the multiresolution decomposition. In a previous work, we showed that this process can be applied to the very stable conditions of km 77, leading to the determination of the amount of carbon dioxide transferred by turbulent exchange from the surface to the atmosphere. Consequences of this result are that a larger portion of the eddy correlation data can be used for the determination of the nocturnal respiration rates, and that the amount transferred by other processes, such as drainage flows can be quantified.

Now, we apply this technique to the long-term observations conducted at the site. The main purpose is to determine the seasonal and year-to-year evolution of the turbulent carbon exchange under very stable conditions. The physical processes responsible for the nocturnal transfer of carbon at the site and their temporal evolution



along the 7 years of observations will be discussed.

### **3.6: Some Interesting Features of the Nocturnal Boundary Layer Above Caxiuanã Amazonian Rain Forest Using High Resolution Simulation**

**Daniele Santos Nogueira**, Universidade Federal do Pará - UFPA, danielesn84@yahoo.com.br (Presenting)

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Interesting characteristics of the nocturnal boundary-layer (NBL) above the Caxiuanã Forest, Pará, are investigated. Rawinsonde, cup anemometer and tower fast-response data obtained during dry season have been used. One of these characteristics is the existence, in some situations, of relative maxima in the wind velocity vertical profiles, the “low level jets” (LLJ), in regions less than 1 km distant from the surface. They may contribute to intensify the mixture in the surface and in the region where they occur. It is possible that the presence of such phenomenon introduce additional difficulties in the parameterization of forest-atmosphere exchange processes.

BRAMS (Brazilian developments on the Regional Atmospheric Modeling System) was used to evaluate the LLJ's origin. Although the numerical simulations did reproduce the LLJs, they did not generate all the flow characteristics. The origin of the jets was revealed by the model to be associated to a phenomenon of canalization of the flow above a region of great rivers in the Northeast of Pará.

Another observed phenomenon is the wind gust. Turbulent series of wind velocity components, CO<sub>2</sub> concentration, specific humidity and temperature, showed the importance of these episodes upon the variability patterns of the forest-atmosphere interaction. Like-ramp coherent structures were also observed during the wind gusts. Integration calculations have demonstrated that wind gusts are responsible for considerable parcels of the nocturnal total forest-atmosphere scalar exchanges, particularly in CO<sub>2</sub> releasing.

These results are interesting to understand physical processes which stabilize NBL and probably generate favourable conditions for low level jets occurrence.

## **1D: Rates and Patterns of Land Use Change**

### **4.1: Demographic dynamics in the Brazilian Amazon region**

**Daniel Joseph Hogan**, Núcleo de Estudos de População, Universidade Estadual de Campinas, hogan@nepo.unicamp.br (Presenting)

**Roberto Luiz do Carmo**, Núcleo de Estudos de População, Universidade Estadual de Campinas, roberto@nepo.unicamp.br

Recent demographic change has transformed the human face of Amazônia. In ways not expected thirty years ago, Amazonian population has evolved rapidly, now approximating patterns prevalent in the rest of Brazil. The analysis presented here seeks to place population growth, population density and population distribution in perspective, allowing a more nuanced view of the relation between population dynamics and deforestation. The rapid urbanization of the region and the concentration of population in selected locations have shifted concern from overall population growth rates to questions of the distribution of population in space. At this point in time, it is necessary to separate the impact of such major economic activities as cattle-raising, gold mining and soybean production from demographic growth. The population questions which must be asked concern the consequences for land use and land cover change of the new demographic regime.

The paper first characterizes Amazônia in comparison with other Brazilian regions, briefly presenting mortality and fertility trends, showing the tendency for convergence to national patterns. The main part of the paper presents the most volatile aspects of population dynamics - migration, urbanization and changing population densities. The georeferenced data bank used, with municipal level data, refers to the biome and not the “Legal Amazon” generally used in population analysis. The Index of Human Development, part of the municipal level data base, complements the demographic analysis.

Two case studies are presented to illustrate the contribution which the analysis of demographic data may make for the understanding of complex man-environment relationships: (1) a study of migration in Pará and Mato Grosso (with 1991 census data) focusing on immigration, emigration, net migration and the net migration rate; (2) a study of the corridor formed by the BR 163 highway between Cuiabá and Santarém (with 2000 census data).

### **4.2: Landscape fragmentation in the Brazilian Amazon - An analysis based on deforestation data derived from Landsat imagery**

**Diogenes S Alves**, INPE, dalves@dpi.inpe.br (Presenting)

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**Emilio F Moran**, Indiana University, moran@indiana.edu

Deforested area in the Brazilian Amazon increased from 10 million hectares in the 1970s to some 70 million hectares today. Most of the deforestation is known to be concentrated near major roads and areas of pioneer colonization, producing important landscape fragmentation. However, few studies have focused on how this process has evolved during the last decades. In this paper we evaluate spatial effects of forest fragmentation based on two landscape metrics - percent cleared and percolation (a measure of landscape connectivity) - for two relatively extensive areas in Pará and Rondônia investigated under the Milênio-LBA and LBA-ECO (LC-34) projects. Land cover data included two major data sets, one derived from Landsat MSS imagery for the 1970s and a second one derived from Landsat TM imagery for the 1990s and the 2000s. After land cover maps were intersected with regular 1/4-degree grid cells, the progression of the percent-cleared metric was analyzed for the period of study. The percolation metric was calculated for two sub-areas of pioneer colonization projects with similar spatial designs around the Cuiabá-Porto Velho highway in Rondônia and the Transamazon highway in Pará. The results can be perceived as an attempt to develop a measure for the pace of deforestation that would capture the effects of concentrated forest clearing, the relatively slow diffusion of deforestation into new frontiers, and the different patterns of forest and cleared areas within the transformed landscape.

#### 4.3: From the Landscape to the Region: Scaling up Approaches in Human and Physical Dimensions of Land-Use and Land-Cover Change in the Amazon

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As LBA progressed, the key importance of understanding human and physical factors behind land-use and land-cover change in the Amazon became apparent. In particular, differentiating and analyzing processes such as deforestation, land abandonment, land degradation, and land use intensification has been recognized as of critical importance. Our project in LBA (LC-34) builds on selected case studies to propose a multiscale synthesis about these processes, to Census units and meso-regions in Pará and Rondônia. Remote sensing techniques and inputs from social sciences are embedded in our approaches. Our goal is to differentiate high Carbon content non-forest vegetation (NFV) such as secondary succession, agroforestry, and perennial agriculture from all other land-cover (LC) classes within the deforested areas in 1997, 2000, and 2004, as mapped by Prodes. TM data are being used for calibration of MODIS/AVHRR data to derive pure pixels and fractions of LC within mixed pixels. The stages of occupation have been divided into old and new areas, inferred for grid cells of 1/4 degree. An alternative approach is to classify TM data for selected areas through a stratified sampling strategy based on landscape structure information. The sample areas are being defined to tentatively reconstruct deforestation patterns. We also analyze human distributions and their relation with the rearrangement of the agrarian structure and socio-demographic dynamics (e.g., lot turnover, population mobility, household reorganization). This presentation shares some preliminary results and represents an opportunity for interaction with the LBA community.

#### 4.4: Distinguishing Between Conversion and Maintenance Fires in the Amazon

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Fire is a critical management tool for forest conversion and maintenance of existing pastures in Amazonia. Varying patterns of fire use control the timing and magnitude of carbon emissions from land management. Quantifying the relative contribution of conversion and maintenance fires to satellite-based fire detections has proven elusive due to uncertainties in instrument sensitivity, poor geolocation and low spatial resolution of remotely sensed data products, and the rapid pace of land cover conversion at the forest frontier. We develop a simple approach to identify conversion fires based on the frequency of fire detections from the MODIS sensors. We then combine active fire detections with data on deforestation and post-clearing land use to quantify the frequency of fire events and duration of the clearing process associated with conversions of forest to pasture and cropland in Mato Grosso State. Conversion fires account for at least 57% of the MODIS active fire detections in Mato Grosso during 2003-2005. Deforestation for cropland occurs at a higher mean fire frequency than conversions to pasture in the years following forest clearing (up to 40 fire days per year). Repeated burning of trunks, stumps, and woody roots in preparation for mechanized agriculture commonly occurs over two or more years following deforestation. Fire use for pasture creation is less intensive; only 1/3 of recent forest to pasture conversions resulted in high-frequency fire detections in more than one year. Finally, we provide basinwide estimates of conversion fire activity during 2001-2005 to highlight inter-annual and regional differences in land use fire. The dynamics of the conversion process, as evident from satellite-based detection of fires, provides critical new information for determining the nature of carbon emissions from fire activity in Amazonia.

#### 4.5: Spatial variability of the deforestation along the Amazon River main stem floodplain

**Evlyn M. Novo**, INPE, evlyn@ltd.inpe.br (Presenting)

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The importance of flooded areas for understanding the ecological functioning of the Amazon region has already been acknowledged. Previous studies have also demonstrated striking differences in the state of cover types along the Amazon River main stem. However, challenging question is to distinguish between natural and human driven differences in those cover types. It is well documented that the floodplain is being intensively used for cattle in both Pará and Amazonas states, but it is still missing information on the spatial variability of this occupation. Since floodplain forest is traditionally converted into pasture, it is expected that the impact of this activity on floodplain ecology will increase as the proportion of wetland within a given region increases. In order to access the impact of cattle ranching on the Amazon River floodplain, we quantified: 1) the proportion of wetland for each municipality in the Amazonas (33) and Para (17) States using the non-validated Amazon wetland mask; 2) the deforested area for each municipality using the digital deforestation data base provided by PRODES project; 3) the deforested area within a 2 km buffer from the Amazon River bank, assuming that the floodplain is mainly used for owners living nearby the river banks. Preliminary results showed that for the Amazonas state, changes in the percentage of deforestation within the 2 km buffer zone explains almost 60 of the variation in the size of the herd among the municipalities. Data for Para are under evaluation. In the trend holds for Para, we will be able to use this percentage as a proxy for human impact on the floodplain which will help to distinguish between natural and human driven changes in floodplain biogeochemistry.

## Parallel Oral Session 2

### 2A: Hydrological and Meteorological Processes

#### 5.1: The leaf water uptake role in the water economy of Amazonian tropical trees.

**Gina Knust Cardinot**, IPAM/UFRJ, cardinot@ipam.org.br (Presenting)

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Early studies have shown the importance of dew absorption by leaves in regions where fog is an important component. However, the importance of water uptake by leaves of trees in tropical forests has not been previously considered. We hypothesize here that leaf water absorption in tropical trees might be responsible for the drought tolerance exhibited by Amazonian forest trees, allowing them to maintain physiological function despite the marked seasonality in Eastern Amazon rainfall. Application of deuterium ( $\delta D$ ) labeled water and leaf water potential ( $\Psi$ ) measurements were carried out in three common primary forest tree species at Tapajós National Forest (Pará State-Brazil): *Coussarea racemosa*, *Miconia egensis* and *Eschweilera pedicellata* to test whether their leaves or stems absorb water directly. Two leaf irrigation treatments were carried out: leaves were sprayed with deuterated water and branches were exposed to deuterated water with a moist cotton band about 1m from the branch tip. After five days of the irrigation treatment *Coussarea* and *Eschweilera* showed significant response to the spray treatment increasing predawn and/or midday leaf water potential as well as on their  $\delta D$  abundance. Changes in the *Miconia*  $\Psi$  although in the right direction were not significant. The leaf water  $\delta D$  abundance in the sprayed leaves were significantly above background for all three species and followed the water potential response with species having the greatest  $\Psi$  response also having the greatest  $\delta D$  abundance. These results confirm the role of water absorption by leaves in the recovery of water-stressed plants.

#### 5.2: Local circulations and climate data in the eastern Amazon region

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We present recent efforts studying the effects of local circulations on climatic observations in the Amazon, with emphasis on the accumulating data from eight automatic weather stations and three flux towers in the LBA-ECO Santarém study area. To generalize certain findings for a wider region we compare in situ data with reanalysis and gridded data products. We assess the hypothesis that largest biases occur for stations for which the river is oriented parallel to the mean wind vector. Several themes are emphasized:

**Precipitation:** We compare precipitation measurements from the Santarém mesoscale network with the CPTEC reanalysis, the Liebman gridded data, and the NOAA CMORPH inferred rainfall and identify the breeze bias. At Santarém, published results indicate that nocturnal rainfall associated with organized flows originated in the coastal sea breeze dominate. Measurements from only a few kilometers inland show the overlooked second afternoon convective peak.

**Radiative flux measurements:** We compare direct observations among the sites with the CPTEC reanalysis product. Through reference to ceilometer and GOES images, we link in situ global radiative fluxes to cloud type and cover fraction. We test whether or not simple global short wave flux extremes can indicate the effects of smoke and haze during the dry season. We present the temporal statistics incident radiation, cloud fraction. By forming temporal ensembles of eddy covariance data, we study how clouds affect CO<sub>2</sub> uptake at the Tapajós tower sites.

**Breeze circulation near Santarém:** We quantify the observed mesoscale and larger scale pressure gradients associated with the breeze and compare both to the CIRSAN modeling studies and the CPTEC reanalysis. The aim is to determine the critical large-scale pressure gradient that leads to wind direction reversal in the afternoon. We identify the frequency of these conditions over longer time periods.

#### 5.3: The origin of stream flows in small Amazon forest and pasture watersheds: an end-member mixing analysis approach

**Joaquín E. Chaves**, Marine Biological Laboratory, Woods Hole MA, USA, jchaves@mbi.edu (Presenting)

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**Sonja Germer**, Institute of Geoeology, University of Potsdam, Germany, sgermer@rz.uni-potsdam.de

**Sérgio Candido de Gouveia Neto**, Laboratório de Ecologia Isotópica, CENA, USP, Piracicaba, SP, sneto@cena.usp.br

Soil compaction and reduced soil infiltration in cattle pastures on deforested lands enhance quick lateral flows and increase the stream channel responses to precipitation. We quantified how deforestation for pasture changes the amount and timing of sources of water that moves from watersheds to streams using an end member mixing analysis. We evaluated contributing sources to storm flow during an entire rainy season in forest and pasture watersheds drained by 0-order, intermittent streams. Water yield was 17 % of precipitation in the pasture and 1 % of precipitation in the forest. During the early rainy season, canopy throughfall contributed 77% to total forest stream flow, groundwater contributed 20% and shallow soil water contributed 3%. As moisture increased towards the late rainy season and the forest catchment became more responsive to precipitation, throughfall remained the single most important source of stream flow (51%), however shallow soil water (24%) and groundwater (25%) became more important sources. In the pasture, sources to stream flow varied less between early and late rainy, with an overall

contribution of 60% overland flow, 45% groundwater, and 5 % soil water. These results suggest that: 1) there is great potential for the alteration of the hydrological budgets of larger watersheds as the proportion of deforested land in the Amazon increases, and 2) the potential to deliver water with higher solute concentrations increases as more rainfall is diverted into fast flowpaths, which increases solute delivery by erosion and bypasses active sites of solute removal.

#### **5.4: Hydrological impacts of forest conversion to grassland in small catchments in Brazilian Amazonian**

**Ralph Trancoso**, INPA, ralph@inpa.gov.br (Presenting)  
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In order to assess the hydrological impact of forest to pasture conversion, a paired micro-catchments experiment (1.2 km<sup>2</sup>) was set in Central Amazonia. During the study period, total rainfall was very similar in both catchments. In spite of this, significant differences were found in the other water balance components. Evapotranspiration was 1.1 mm.day<sup>-1</sup> less in the pasture catchment compared to the forest. Streamflow and water storage were respectively 0.98 mm.day<sup>-1</sup> e 0.25 mm.day<sup>-1</sup> higher in the pasture catchment. Stormflow yield was 15.28% within forest and 26.41% in the pasture. Runoff coefficients (relation Q/P) were 0.17 and 0.32 for forest and pasture respectively. The analysis of individual events revealed significant differences between forest and pasture in terms of the rainfall/runoff response. The flow duration curves showed more irregular behavior in the pasture catchment. Forest loose a great part of available water by evapotranspiration, it exercises an important ecological role in the balance of hydrological cycle. Observations suggest that forest conversion might have significant impacts on the ability to regularize floods during the wet season and droughts in dry seasons on larger scales.

#### **5.5: Land-Water Synthesis: Controls on the Regional Water Balances of Amazonia 1970-2005**

**Michael T Coe**, The Woods Hole Research Center, mtcoe@whrc.org (Presenting)

The land surface of the Amazon is coupled to its rivers, streams and wetlands, through both hydrological and biogeochemical processes. Multiple factors, including, climate, land cover and land use, soil type, and topography influence the quantity and quality of surface water resources by determining: 1) how incoming precipitation and radiation are partitioned among sensible and latent heat fluxes, runoff, and river discharge; 2) soil water infiltration rates and surface and sub-surface flow; and 3) the biogeochemical properties of the land surface and solute leaching rates from soils. A better understanding of how regional differences in these factors influence soil moisture, water yield, and runoff is vital for understanding and predicting how local processes scale-up to observed regional patterns of stream transport and transformation of water and chemical constituents. Therefore, as part of the LBA Land-Water synthesis group we are combining data and models from various LBA groups to clarify the roles of individual factors in influencing the observed differences in water yield at regional and continental scales. This exercise will help us determine the tools and data required for cross-scale analysis of stream hydrology and chemistry.

#### **5.6: Water circulation dynamics in Amazon river/Curuai floodplain system: a remote sensing approach**

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This paper describes a remote sensing methodology for assessing the changes in water composition and volume of Amazon floodplain aquatic system in response to the annual flood pulse. The spatiotemporal dynamics of water composition was assessed through an integrated analyze of in situ (limnological and high resolution water reflectance spectra) and orbital data (multispectral Landsat/TM images). The spatiotemporal patterns of different water types were identified applying spatial analysis (ordinary kriging) to the limnological data. The effect of changes in water composition, along the hydrological cycle, on the water spectral response was assessed using spectral angle mapper and derivative analysis algorithms. Image segmentation and unsupervised classification of Landsat/TM images were applied to map and quantify the water types which were also characterized by the limnological parameters measured at four water stages. Bathymetric data, obtained from a high-resolution bottom topography survey was used to study the dynamic of flooded area and stored water volume in the floodplain. Regression models to predict flooded area and water volume from water level were constructed. As a result, a detailed conceptual model of the water circulation in the Curuai floodplain was proposed.

## **2B: The Changing Amazon Landscape**

#### **6.1: Myths and Perspectives on Land-Use and Land-Cover Change in the Amazon**

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The Amazon has often been associated with exaggerated myths about its biophysical and human landscape. Its vast extension is partly responsible; the eagerness to know it while having incomplete information is also involved; and both visioning it as a “paradise” and the desire of its “conquest” have led to myths with a life of their own, eventually making their way into policy for the region, even in the absence of supporting evidence. In this paper, a product of a LBA synthesis workshop on human dimensions held in Manaus in May 2006, selected myths are identified and discussed. Examples of myths include: the Amazon as El Dorado, a place rich in resources waiting to be taken; population growth as the main driving force of environmental degradation; inversely, a demographically empty region that needs large flows of immigrants to be developed; the assumption that urban growth and development has little impact on the forest; the view that small farmers only use archaic

technology and are incapable of adopting new ideas and technological advances to contribute to economic development; or, in reverse, that small farmers are the answer to environmental conservation while medium and large farmers destroy the environment; that Amazonian soils are uniformly poor and thus biophysical limiting factors impede the success of substantial and permanent agropastoral activities. The paper examines each of these myths and their relation to the perception of environmental degradation and sustainability in the region.

## **6.2: Tracking the Fate of Deforested Land in the Tropics: Critical New Inputs for Ecosystem Service Evaluation**

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Tracking the fate of cleared land in the tropics is critical to reducing the uncertainty in estimates of deforestation rates and to fully evaluating ecosystem services such as carbon storage, biodiversity, and disease regulation. Land use following deforestation is highly dynamic and often rapidly cycles between classes following deforestation, allowing secondary forests to regrow for varying periods of time. We have tracked the changing fate of deforested land across the tropics using ~600 manually-classified Landsat scenes from the FAO and TREES projects. The land use following deforestation varies across the seven major tropical regions and through time. We have identified statistically significant changes in the fate of deforested land between the 1980s and 1990s. Preliminary analysis indicates patterns of agricultural intensification in South America are reducing forest regrowth and fallow while simultaneously increasing the amount of mature forest cleared for permanent agriculture.

## **6.3: Are Amazon cattle ranchers becoming better land stewards?**

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Roughly three fourths of Amazon deforestation is related to cattle pasture formation. Any change in the way in which cattle ranchers manage their land could have tremendous consequences for the health of the region's terrestrial and aquatic ecosystems. We report on the potential for promoting land stewardship among the region's cattle sector. Ranchers are being pushed towards stewardship by the growing strength of command-and-control environmental agencies, but also by the stronger signals from markets and financial institutions that are nervous about the environmental and social risks of buying from, or extending credit to, Amazon producers. In an international war of protectionism that ground world trade negotiations to a halt, environmental and social risks are now almost as important as health risks in determining the agricultural commodities and the regions that are allowed to sell into the most lucrative markets, such as the European Union. In a network of "socioenvironmentally responsible" producers that IPAM and the Aliança da Terra are building in Mato Grosso, some of the most inexpensive conservation measures (anti-erosion bunding, fire-breaks, riparian forest conservation) are common on cattle ranchers, while more expensive conservation measures (pumped groundwater supplies for cattle, compliance with the 80% legal forest reserve requirement) are rare. These more expensive conservation measures may also become affordable. Landholders wishing to comply with forest reserve regulation can do so over a 30-yr period by contributing to a fund that is used to purchase private inholdings in state parks. Eliminating cattle access to streams may become less onerous if lending institutions develop the graded lines of credit that they are currently investigating. The forces of globalization may lead to better land stewardship if transparent, accurate systems for tracking property-level environmental performance translates into improved market access.

## **6.4: Assessing the Effect of Madera's Energy and Transportation Infrastructure Projects on Soybean Expansion**

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Precarious transportation network and natural barriers have kept the region of High Madera River at the Bolivia, Brazil and Peru tri-border geographically and economically isolated. Its development potential lies in the possibilities of accessing the Atlantic and Pacific Oceans through the Madeira River and/or through the construction and pavement of roads. Madera's River Hydroelectric and Navigation Mega-project includes the construction of two hydroelectric power stations (HPS) - Jirau and Santo Antonio - (Brazil), a third HPS between Abuná (Brazil) and Guayaramerín (Bolivia). These investments would allow the navigation through more than 4,000 km of waterways. Another transportation project is the pavement of Yucumo- Guayaramerín Bolivian road. One of the main benefits expected from these mega-projects is the expansion of soybean crops in the area influenced directly by the future navigable waterways and by the roads to be paved. We predict land use changes that would occur in Brazil, Bolivia, and Peru as a result of Madera's projects. We use an interdisciplinary model to estimate soybean yields based on climatic, edaphic, and economic determinants. It allows us to assess spatial variations in the economic viability of soybean production and the degree to which expanded plantings can be influenced by the infrastructure bi-national investments.

## **6.5: The Effects of Climate Change on Brazilian Agricultural Profitability and Land use**

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This paper estimates an econometric model of the relationship between climate and Brazilian agricultural activity to simulate the impacts of climate change on land use and on agricultural profitability. Elsewhere, researchers are studying how human behavior is likely to influence land cover change and how various future land use scenarios will affect regional climate. This paper describes the feedback of climate change on human behavior, directly, by predicting how changes in temperature and

precipitation will affect the share of land in various use categories, and indirectly, by simulating the effects on net agricultural profits. To do this, we employ município-level hedonic cross-sectional models that exploit the spatial co-variation across Brazil between climate and agricultural profits, and between climate and land use patterns, allowing for a rich complement of control variables. The database integrates socio-economic data from the agricultural and demographic censuses with geo-referenced edaphic and geographic data produced by Embrapa and IBGE, and temperature and precipitation data from the Climate Research Unit (CRU). Simulations of spatially differentiated climate scenarios are based upon the HadCM3 and four other general circulation models (GCMs). Findings show that predicted land use and agricultural profitability are quite sensitive to the climate scenario simulated, in particular in the Amazon Basin.

## 2C: Trace Gases and Aerosols

### 7.1: Amazon forest tree species composition influences soil fluxes of CO<sub>2</sub> and N<sub>2</sub>O

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Carbon dioxide (CO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O) are important greenhouse gases, but the mechanisms controlling their emissions from tropical systems are still poorly understood. For example, models using soil microclimate variables typically fail to capture large spatial and temporal variability, especially in N<sub>2</sub>O. We tested the hypothesis that tree species composition influences trace gas emission, possibly through its effects on local litter chemistry, root chemistry, and root exudation. We established a spatially distributed sampling scheme (across 50 ha in the Tapajós National Forest near Santarém, Brazil) with flux measurement points located near a stratified sample of 10 different canopy and emergent tree species. Our initial results indicate that the species identity of individual trees significantly influenced the magnitude of nearby N<sub>2</sub>O fluxes, and that soil parameters like bulk density, moisture and temperature could not by account for observed flux variability. We also found evidence that species-specific leaf hyperspectral reflectance spectra that have been used to predict leaf nitrogen variations may also be useful in predicting the magnitude of N<sub>2</sub>O fluxes observed near different species. These results suggest that information on species distributions may improve estimates of ecosystem scale fluxes of important trace gases, and that hyperspectral remote sensing techniques may be useful in acquiring the relevant ecosystem-scale information to make such estimates.

### 7.2: An integrated assessment of soil and fire emissions of greenhouse gases from slash-and-burn and chop-and-mulch agriculture in the eastern Amazon

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The sustainability of agricultural systems must be considered at both local scales, where soil fertility and crop yield are paramount, and at global scales, where unsustainable increases in greenhouse gas concentrations are occurring in the atmosphere due, in part, to agricultural activities. Management practices designed to improve or maintain soil fertility could alter several sources and sinks of greenhouse gases and thus have unintended consequences for sustainability at global scales. Alternatives to slash-and-burn practices, such as chop-and-mulch technology, can avoid significant losses of essential plant nutrients and emissions of radiatively important trace gases by eliminating the use of fire for site preparation. On the other hand, additions of mulch to the soil could significantly increase denitrification and methanogenesis, thus possibly increasing soil emissions of CH<sub>4</sub> and N<sub>2</sub>O. The objective of this study was to measure soil emissions of N<sub>2</sub>O, CH<sub>4</sub>, CO<sub>2</sub>, and NO throughout an entire cropping cycle in slash-and-burn, chop-and-mulch, and continuous fallow fields in the eastern Amazon region. The soils were a net sink for CH<sub>4</sub> in the burned area and in the continuous fallow and were a net source of CH<sub>4</sub> in the mulch treatment, causing a net increase of soil emissions of about 15 kg CH<sub>4</sub>/ha over slightly more than two years of the study. Mulching also increased NO and N<sub>2</sub>O soil emissions, but the differences among treatments were modest. However, based on estimates of biomass burned during site preparation and literature values of emission factors, the fire in the slash-and-burn treatment released more than ten times as much CH<sub>4</sub> and NO than can be attributed to increased soil emissions in the mulching treatment. Only by complete accounting of greenhouse gas emissions throughout the cropping cycle is it possible to assess the overall impacts of the common practice of slash-and-burn tropical agriculture and the mulching technology that has been developed as an alternative. Chop-and-mulch management appears to be a win-win option from the perspectives of both local soil fertility and avoided greenhouse gas emissions.

### 7.3: Spatial and seasonal variations in the carbon isotopic composition of methane over a five-year period in stream sediments of eastern Amazonia

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In this study, we analyzed the isotopic composition of methane trapped in gas bubbles formed in the sediment of streams. We also analyzed the isotopic composition of sedimentary organic matter (SOM) from the surrounding vegetation, from bottom sediments (cores), and stream shorelines. The studied sites were two “várzea” floodplain streams (Açu and Maicá) and one “terra-firme” stream (Jamaracá), located near Santarém-PA and Belterra-PA, in Eastern Amazon. Carbon and nitrogen

contents and C:N ratio from the material deposited in the bottom streams were higher in “terra-firme” stream (C= 14.6%, N= 0.9% and C:N= 17.4) than in “várzea” stream (C= 1.1%, N= 0.1%, and C:N= 8.8). Mean  $\delta^{13}\text{C}$  value of SOM was lower in “terra-firme” stream (-29.6‰) than in “várzea” (-23.8‰). The  $\delta^{13}\text{C}$ -CH<sub>4</sub> varied seasonally and spatially among the ecosystems and this variation is probably associated with: 1) changes in the inputs of organic matter (C<sub>2</sub> and C<sub>3</sub> plants); 2) changes in fractionation processes during its decomposition; 3) methane oxidation mechanisms, and 4) environmental factors at each site. The “várzea” streams, where the CH<sub>4</sub> tends to be more enriched in  $^{13}\text{C}$  during the dry season, showed higher values of  $\delta^{13}\text{C}$ -CH<sub>4</sub> than “terra-firme” stream, with mean values varying from -57.9‰ to -55.0‰ at Açú stream and from -58.5‰ to 52.8‰ at Maicá stream. The Jamaráquá stream showed the largest seasonal variation in  $\delta^{13}\text{C}$ -CH<sub>4</sub> ranging from -62.8‰ to -75.1‰ and tending to be depleted in  $^{13}\text{C}$  during the dry season

#### 7.4: CO<sub>2</sub> Profiles Over Central Amazon

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Since December 2000, vertical profiles of CO<sub>2</sub> have been measured above central Amazônia, over Tapajós National Forest (02°51'S; 54°57'W), and since 2004 over Cuieiras Biological Reserve (02°36'S, 60°12'W). Samples are collected aboard light aircraft between the surface and 4 km using the NOAA/CMDL semi-automatic portable flask package (PFP).

We have compared our vertical profiles to the NOAA/CMDL background site Ascension Island (ASC) located in the Atlantic Ocean (7°56'S, 14°22'W). Comparing the Dry Season of 2004 with the Wet Seasons of 2004 and 2005, in the Pará State, after subtraction of global influence, through the subtraction of the CO<sub>2</sub> concentration of Ascension, obtained in the average 2 ppm more concentrations in the Wet season. CO<sub>2</sub> profiles at this site, showed both lower and higher concentrations below boundary layer than above, indicating CO<sub>2</sub> sinks and sources, respectively, but in the average is more sources in the wet season.

In the Amazon State, the wet season of 2005, after subtraction, show 10 ppm higher concentration below PBL than above, indicating source behavior. During the Dry season, the average concentration was 7 ppm higher above PBL than below, showing sink behavior.

Comparing both states during wet season of 2005, it was observed 2 ppm higher concentration above and 5 ppm below PBL in Amazonas state, in the average. General, we observed higher CO<sub>2</sub> concentration in the Amazônia comparison with Ascension, showing contribution of continent emissions.

#### 7.5: Nitrous oxide mixing ratio during dry and wet seasons in vertical profile over the central Amazon

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Vertical Profiles of nitrous oxide (N<sub>2</sub>O) have been measured above central Amazônia, on undisturbed forest and disturbed area at Floresta Nacional do Tapajós (Flona Tapajós), Pará state and at Reserva Biológica de Cuieiras (Cuieiras), Amazonas state. Samples are collected aboard light aircraft between the surfaces (300 m) until 4000 m, using the NOAA/CMDL semi-automatic portable flask package (PFP). The PFP consists of 17 glass flasks with 700 mL volume that are pressurized to about 3 bar to enable measurements of all the gases mentioned above. These studies were made since 2000 at Flona Tapajós, and since 2004 at Reserva Biológica de Cuieiras.

Comparing N<sub>2</sub>O mixing rates over Central Amazon and remote place over South Atlantic Ocean, we noted Central Amazon agrees to global trend until 2003. After this, we observed enhancement in N<sub>2</sub>O concentration due fertilization in agricultural activities. The wet season for 2004 and 2005 shows 1 ppb more than Dry Season at Flona Tapajós for all profile, after subtracted global influence. Besides the N fertilization that occurs during this season, the contribution during the dry season is biomass burning.

#### 7.6: Aircraft measurements show strong enhancements of methane above central Amazonia.

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Recent results at chamber [Keppler, 2006], field [Melack, 2004; do Carmo, 2006] and satellite scales [Frankenburg, 2005] suggest the presence of large methane emissions from the Amazon basin. Here we present regionally integrating trace gas observations from two aircraft sites that confirm the presence of large enhancements of methane above Amazônia. Air samples collected on aircraft near Santarém (2 deg S) and Manaus (2 deg S) in eastern and central Amazônia since 2001 show large enhancements of CH<sub>4</sub> compared to those collected at the NOAA/ESRL site at Ascension Island (8 deg S) in the tropical Atlantic Ocean. From the surface to 3500 m, enhancements averaging 30 ppb and up to 120 ppb occur throughout the year. Wet season profiles are more uniformly enhanced from the surface to 3500 m above sea level, while dry season profiles tend to show stronger enhancements closer to the surface. To assess the validity of using Ascension Island CH<sub>4</sub> measurements as proxies we examine differences in SF<sub>6</sub> between Ascension and Amazônia. This analysis suggests that while Ascension is representative of source air, some of the observed continental enhancement, especially during the wet season, results from air of more northerly origin. The remaining elevation above background can be most easily explained as wetland emissions during the wet season and biomass burning emissions during the dry season. Direct emissions from plants in oxic



environments can also not be ruled out as a source but are not required to explain the observations. While existing measurements cannot distinguish between the various sources, we will discuss strategies to separately account for biomass burning, wetland and putative direct plant emissions at the basin scale. Our measurements represent a substantial gradient between South America and adjacent oceans and a tropical bulge in the global north-south methane gradient that are not captured by sampling sites in the marine boundary layer.

#### **7.7: Is size distribution or chemical composition the key parameter to aerosols act as CCN?**

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Biomass burning is a subset of aerosols that have an important role on cloud particles. Smoke plumes typically have high particle concentration, small size (concentrated in fine mode, i.e.  $dp < 2.5 \mu\text{m}$ ) and rich in organic soluble compounds. Many papers deal with the ability of these particles to nucleate cloud drops, and if size distribution or chemical composition of particles is the critical feature of aerosols to act as CCN. In this work we discuss size distribution and hygroscopic properties of aerosols observed during the LBA/SMOCC 2002 campaign already published by Rissler et al. (2004). We purpose a new analysis of those data, and we conclude that size distribution was the key parameter for particles act as CCN, and not chemical composition. To conclude it we compared dry activation diameter of particles (as a function of supersaturation), which is calculated by its hygroscopic properties, and size distribution measurements for different aerosol loadings situations. For all aerosol loading condition analyzed (beginning and the mid of dry season, and the transition from dry to wet season, directly related to biomass burning emissions) size distribution was the more important parameter in determine the ability of particles to act as CCN. This conclusion is based on the fact that differences in aerosol loading were mainly related with particles bigger than the activation diameter. In other words, these particles are always activated because minimum activation diameter is always reached.

## Parallel Oral Session 3

### 3A: Carbon, Rivers, and Wetlands

#### 8.1: Dissolved inorganic carbon dynamics in a highly seasonal river in Southwestern Amazonia: Upper Purus River

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In order to broaden our knowledge of the spatial variability and also of seasonal patterns of dissolved inorganic carbon dynamics, we have studied the Upper Purus river in Acre State, Brazil; which is one of the major tributaries of the Solimões river. Our objectives were to (1) characterize the seasonal patterns of physical and chemical parameters such as pH, water temperature, dissolved oxygen and water electrical conductivity, (2) determine the seasonal variation in DIC concentration and the contribution of each of its components ( $\text{CO}_2$ ,  $\text{HCO}_3^-$  and  $\text{CO}_3^{2-}$ ).

The seasonal patterns for the physical and chemical parameters were inversely related to precipitation. Dissolved oxygen, pH and water electrical conductivity present higher values during the dry season (from May to October), and the highest values were observed in the month of September 2005, where pH, dissolved oxygen and electrical conductivity were 8.61, 104% and  $385 \mu\text{S cm}^{-1}$ , respectively. During the rainy season these values decrease (from November to March), and the lowest values were observed in February 2005 (6.84, 30.5% e  $79 \mu\text{S cm}^{-1}$ , for pH, dissolved oxygen and electrical conductivity respectively).

Dissolved inorganic carbon also presented a very seasonal pattern, with highest concentration in October 2004 in the dry season ( $3,460 \mu\text{M}$ ) and the lowest concentration was in January 2005 ( $1,194 \mu\text{M}$ ). In the driest months, when pH is more basic,  $\text{CO}_2$  partial pressure ( $p\text{CO}_2$ ) is lower ( $780 \pm 152 \text{ ppm}$ ) and the pattern reverts during the rainy months when pH is lower ( $p\text{CO}_2 4029 \pm 511 \text{ ppm}$ ).

From these results, we conclude that seasonality has a major impact in dissolved inorganic carbon dynamics in upper Purus.

#### 8.2: Dissolved $\text{CO}_2$ in Waters of the Amazon : Deconvolving Signals of Land-Water Coupling and In-Stream Processes as Indicative of Ecosystem Dynamics

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What controls regional differences in the  $p\text{CO}_2$  of Amazonian waters?" By analyzing results across the multiple water types sampled through the sampling network Rede Beija Rio, we see that variability in the predictable annual regime of  $p\text{CO}_2$  (essentially, increasing and decreasing in synchrony with the hydrograph) at any point in a river network across regions is functionally governed by the relative distributions of the ecosystem state variables controlling pH, water movement (infiltration and runoff on land, current velocity in channels), production and mobilization of LMW DOC fractions, and suspended sediment loads:

(1) With rising water, the primary source term for  $p\text{CO}_2$  in small streams is groundwater, but as that source degasses, in-river mineralization of (near-) contemporary low molecular weight ( $<5\text{kDa}$ ) dissolved organic compounds derived from the local mix of terrestrial  $\text{C}_3$  and, preferentially,  $\text{C}_4$  plants becomes the dominant source. DOC export amount and composition by region is determined by soil type and flushing (which also drives pH). With falling water, depletion of terrestrial sources and reduction in sediment load promotes a higher ratio of aquatic primary productivity to respiration (to a greater extent than previously thought), leading to a sink of  $p\text{CO}_2$  (but subsequent export of labile organic matter from in situ sources).  $p\text{CO}_2$  during rising water is more aged and depleted in  $^{13}\text{C}$  than during falling water, reflecting the greater terrestrial sources

(2) pH, responding to the stage of the hydrograph and set initially by weathering and then with feedbacks from biological processes, affects not only the distribution of dissolved inorganic carbon among carbonate system species, but also the bioavailability of dissolved substrates for respiration.

(3) The primary  $p\text{CO}_2$  sink term in flowing waters is outgassing, where scale of habitat and river current-induced turbulence are the primary controlling factors, and weather factors (wind speed, air-water temperature gradients) are secondary.

#### 8.3: The role of aquatic macrophytes in the carbon dynamics of Amazon floodplains

**John Michael Melack**, Univ. of California, Santa Barbara, melack@lifesci.ucsb.edu (Presenting)

**Thiago Sanna Freire Silva**, Univ. of Victoria, thiago@uvic.ca

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The high productivity and rapid turnover of biomass by floating aquatic macrophytes indicates that these plants are likely to be an important source of organic carbon fueling the production of carbon dioxide and methane that evades from floodplains and rivers of the Amazon basin. Remote sensing with radar and optical sensors combined with field measurements permit regional estimates of the role of floating aquatic macrophytes in the carbon dynamics of Amazon floodplains. Floating aquatic macrophytes cover approximately 1,400,000 ha at high water in the floodplain of the mainstem Solimões/Amazon in Brazil. Monthly radar data from the Santarem area indicate considerable seasonal variability in area and biomass. Three years of data from L. Calado, a floodplain lake west of Manaus, did not show a consistent seasonal pattern in biomass, but the mixed *Paspalum* - *Echinochloa* stands had high net productivity productivity ( $0.6 \text{ Mg dry weight per ha per day}$ ) and monthly biomass turnover of about 50%. If these rates are extrapolated to the central Amazon floodplain, macrophyte-derived organic carbon can account for the majority of the annual flux of carbon dioxide to the atmosphere.

#### 8.4: Spatial and Temporal Patterns of Aquatic Biogeography in the Amazon

**Erica Akiko Howard**, SAGE, University of Wisconsin - Madison, eahoward@wisc.edu (Presenting)

**Michael T. Coe**, Woods Hole Research Center, mtcoe@whrc.org

**Jonathan A. Foley**, SAGE, University of Wisconsin - Madison, jfoley@wisc.edu

**Marcos Heil Costa**, The Federal University of Viçosa, mhcosta@ufv.br

We combined a hydrological model (Terrestrial Hydrology Model with Biogeochemistry, THMB), remote sensing observations, and empirical data to identify the distribution of aquatic and wetland biogeographic types throughout the central Amazon basin. We calibrated monthly simulation results with remotely sensed observations of flooded area and extent of different wetland categories for high and low water periods over a 1.7 million km<sup>2</sup> region of the central Amazon. Two additional dimensions of floodplain biogeography (river size and color) were added to provide insight into the geographic distribution of key ecosystem types and their flooding seasonality. Although the edaphic characteristics that control river color (e.g., black vs. white) are well known, the distribution of these types across the landscape has not been mapped, largely because of a lack of fine-scale maps of soil heterogeneity. We present a first attempt to categorize river color type based on existing maps of soils and geologic provinces and on river connectivity to upstream sediment sources. Model results reproduced regional differences in seasonal flood extent and timing north and south of the Amazon mainstem, reflecting the dominant climatic regimes. Black-water streams and medium-sized rivers, followed by large white-water rivers, were the most extensive types across the study region. However much of the black water was in areas likely to be influenced by white-water rivers while flooded. The monthly extent of flooded areas dominated by woody vegetation was consistently more strongly seasonal than non-woody areas. Also, the extent of flooding in muddy and semi-muddy rivers and floodplains tended to be more highly seasonal than in black- and clear-water areas. Regional flooding variability has disproportionate effects on different ecosystem types, suggesting that persistent, long-term changes to flooding regimes may have long-lasting consequences for floodplain vegetation, wildlife, and human residents.

#### 8.5: Spectral Mixture Analysis of Amazon Floodplain Water Surface Reflectance Using Hyperion/EO-1 for the Comprehension of Temporal Variability of Water Composition

**Conrado de Moraes Rudorff**, INPE, cmr@ltid.inpe.br (Presenting)

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**Lênio Soares Galvão**, INPE, lenio@ltid.inpe.br

The Amazon floodplain water composition undergoes intense variations along the year as a response to the annual flood pulse. The present study analyses the spectral mixtures of the optically active substances (OAS) in the Amazon floodplain waters by using spaceborne hyperspectral images. The test site was located upstream the confluence of Amazon (white water) and Tapajós (clear-water) rivers, where two EO-1 Hyperion sensor images were acquired. The first image was acquired September 16, 2001, during the period of the outflow of water from the floodplain lakes to the Amazon River, due to its receding level. The second image was acquired June 23, 2005, at the end of the high water period. A field campaign was carried out between June 23 and 29, 2005 to collect radiometric and limnological data almost simultaneously to the acquisition of this image. The images were pre-processed to remove stripes of abnormal pixels and were converted from radiance to surface reflectance values, thus, correcting the effects of atmospheric absorption and scattering. A sequential procedure with the techniques of Minimum Noise Fraction (MNF), Pixel Purity Index (PPI) and n-dimensional visualization of the MNF feature space was employed, within the spectral range of 457-885 nm, to select end-members from both images. A single set of end-members was gathered to represent the following spectrally unique water masses: clear-water; dissolved organic matter; suspended sediments; and phytoplankton. The Linear Spectral Unmixing (LSU) algorithm was applied to the images to map the spatial distribution of the four types of water masses, in terms of sub-pixels fractional abundances. The suspended sediment and phytoplankton concentrations in floodplain lakes showed a general tendency to increase towards the receding period, which was clearly evidenced by the results. Important non-linear spectral mixture effects were observed in the complex Amazon floodplain waters, which should be accounted for to achieve better estimates.

## 3B: Modeling LCLUC

#### 9.1: Projecting Future Amazonian Landscapes: An Econometric Approach

**Robert Walker**, Michigan State University, rwalker@msu.edu (Presenting)

**Alex Pfaff**, Duke University, ap196@columbia.edu

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**Marcellus Caldas**, Michigan State University, caldasma@msu.edu

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**Juan Robalino**, Columbia University, jar101@columbia.edu

**Stephen Aldrich**, Michigan State University, aldrich30@msu.edu

This presentation gives details of a methodology for projecting future Amazonian landscapes, based on an econometric estimation of the factors associated with deforestation. Regression models were fit using an extensive data base with information on natural resources, including rainfall and soils, the spatial distribution of human populations, the historical development of the transportation system, and time series of deforestation for three intervals (1976-87, 1987-92, and 1992-2000). Taking deforestation at census tract level over the entire basin as the dependent variable, equations were estimated to identify relationships between magnitude of forest loss and variables in the data base. These equations also controlled for so-called, fixed spatial effects at municipal level, since the actual observations implemented consisted of census tracts, for which there are multiple cases per municipio. The use of census tract observations allowed for a large number of statistical observations which, together with the fixed effects specification, enabled an estimation achieving high explanatory power. To undertake the projections, two possible development scenarios were defined based on infrastructure developments, possible trends in population growth, and status of protected areas. The scenarios were defined in terms of the variables used in the estimation of the econometric model, so that projections could be made by using anticipated variable values associated with the two scenarios. One scenario, referred to as the worst case scenario, assumed an early completion of Avança Brasil projects, continued population growth with little out-

migration, and negligible enforcement of protected areas. The other scenario, the best case, assumed no more infrastructure investments in the region, reduced population growth with increased out-migration, and effective protection of the areas so designated. The presentation gives results for both cases out to 2050, and contrasts the impacts of the two development scenarios. In addition, it gives an update on the status of Avana Brasil projects in the Amazon region.

## **9.2: Pattern-Process Relationships in Coupled Human-Natural Systems: Modeling Land Use/Land Cover Dynamics in the Northern Ecuadorian Amazon**

**Stephen J. Walsh**, University of North Carolina, swalsh@email.unc.edu (Presenting)

**Carlos F. Mena**, University of North Carolina, mena@email.unc.edu

Relying upon a longitudinal socio-economic survey of colonists, a community survey, a remote sensing image time-series, and GIS coverages of resource endowments and geographic accessibility, the causes and consequences of land use/land cover (LULC) dynamics are examined in the Northern Ecuadorian Amazon, a region undergoing pronounced social and ecological changes that have implications for forest fragmentation, biodiversity, vulnerability of protected areas, food security, and the interactions among diverse stakeholder groups. Framed within the context of a coupled human-natural system, the questions that motivate the research include: (1) what are the reciprocal pattern-process relations between population change and landscape dynamics? and (2) what are the scale dependent and non-linear relationships among people, place, and the environment that influence LULC change patterns? To address these questions, modeling approaches from the social, natural, and spatial sciences are integrated that draw from household life cycle theory, multi-phasic response theory, hierarchy theory, and complexity theory. Statistical (e.g., spatial lag models, neutral models, and multi-level models) and spatial simulation models (e.g., cellular automata and agent-based models) are integrated to examine scenarios of LULC change that involve population-environment interactions, a dynamic set of actors, a changing environment, formalized rules of behavior, and an emphasis on pattern-process relationships. Results are presented that describe the interactions and feedbacks among people, place, and the environment that are exhibited in our studies of land fragmentation, secondary forest succession, patterns of land use change, conservation forests and land tenure, simulations of LULC change, and household decision-making and land use change at the farm level. Emphasis is placed on the integration of statistical and spatial models for examining scenarios of LULC change under uncertainty.

## **9.3: The economics of fire management in communities of the Tapajos National Forest**

**Maria Bowman**, Virginia Tech, msbowman@vt.edu (Presenting)

**Gregory Amacher**, Virginia Tech, gamacher@vt.edu

**Frank Merry**, Woods Hole Research Center, fmerry@whrc.org

Slash-and-burn fires set by migrant settlers in the Brazilian Amazon give rise to large scale wildfires that threaten mature forests, agricultural plantations, and settlement areas. Our purpose is to examine labor devoted to fire prevention (firebreak establishment) and burning for crop production for subsistence smallholders in the Tapajos National Forest in Par, Brazil. Both the decision to engage in each activity and the scale of the activity are examined. A household model addressing decision making under risk is estimated using survey data from 220 households. We find economic variables such as the opportunity cost of household time, market conditions, and the hiring wage to be important predictors of both decisions (often these are more important than household or demographic considerations), as is household reliance on standing forest resources for non-timber products. We also find that the involvement of NGOs and the government plays an important role in encouraging fire prevention behavior. Our results provide support for programs that emphasize economic parameters and for considering smallholder productivity in policies that target accidental fire prevention or reduction in burning activity.

## **9.4: A policy-sensitive, spatial-dynamic model of logging for the Brazilian Amazon**

**Britaldo Silveira Soares-Filho**, Universidade Federal de Minas Gerais, britaldo@csr.ufmg.br (Presenting)

**Frank Merry**, Woods Hole Research Center, fmerry@whrc.org

**Hermann Oliveira Rodrigues**, Universidade Federal de Minas Gerais, hermann@csr.ufmg.br

**Daniel Curtis Nepstad**, Woods Hole Research Center, dneptad@whrc.org

The future of the timber industry in the Amazon is at a crossroads. At the same time that the State increasingly moves to curb unrestricted forest destruction, wood demand from growing national and international markets encourages the expansion of logging to new Amazon frontiers. To assess these interacting trends, we have developed a spatially explicit model that simulates the future of the Amazon logging industry. The model produces dynamic rent surfaces based on sawn wood prices, harvest and milling costs collected for 588 milling centers located across the Amazon. For each cell at 2km resolution, the model calculates the transportation cost to the closest milling center, allocating to this center the cell commercial wood volume (estimated from biomass data). Thus each milling center competes against neighboring centers for its area of influence as new roads are built and deforested and logged areas expand. For each time step, a milling center attempts to match its current harvest capacity collecting wood in cells that become profitable after deducting transportation, harvest, milling, tax, and investment costs from sawn wood prices at the milling center gate. These parameters are updated as a milling center ages and road access to it is improved. Also wood volume can be restored after a forest regrowth sojourn time. A center's harvest capacity is allowed to increase or decrease annually according to the profitable wood volume available within its area of influence. As a result, milling centers have a boom and burst lifecycle as they gradually exhaust profitable forests located in accessible regions. When a center approaches its demise, it gives birth to new centers located in inner Amazon regions, perpetuating the way the logging frontier evolves. Deforestation and infrastructure data come from SimAmazonia 1. In this version, both models run simultaneously exchanging data. As a result, deforestation and road expansion lower logging transportation costs, and in turn logged areas present higher probability of deforestation. Hence this simulation platform is designed to assess the economic cost and benefits as well as environmental impacts in short to long terms from a range of scenarios, including various levels of law enforcement, deforestation trends, infrastructure expansion and improvement, markets for wood, and forest policies, such as the creation of logging concessions in state and federal forests.

## **9.5: An economic model of the Amazon timber industry**

**Frank Merry**, Woods Hole Research Center, fmerry@whrc.org (Presenting)

**Britaldo Soares**, Universidade Federal de Minas Gerais, britaldo@csr.ufmg.br

**Daniel Nepstad**, Woods Hole Research Center, dneptad@whrc.org

**Gregory Amacher**, Virginia Tech, gamacher@vt.edu

Two of the most important tropical forest conservation accomplishments in history took place in 2004 and 2005. Twenty million hectares of protected areas and public forest lands were created in hotly disputed frontier regions of the Amazon Basin and new legislation removed further large tracts of forest from private land markets. We report that the hidden economic costs of these acts may, however, ultimately undermine their success, and while they provide much needed protection services, they will redistribute logging pressure to an unprepared and still ungoverned private land sector. Using an economic model of the Amazon timber industry, we estimate the costs of the new protected areas to the industry. We also estimate the potential of concessions to supply current demand and estimate the harvest volume that will remain in private or State government lands. Our results suggest that in order to buffer these conservation achievements against illegal logging and offset the costs of successful long term implementation we continue to require a system for managed access to private land and State forests for the timber industry and a mechanism by which worldwide beneficiaries pay Amazon societies for the economic cost of conservation.

### 9.6: Econometric Estimation of Deforestation Impacts from Roads and Other Drivers

**Alexander Pfaff**, Columbia University, ap196@columbia.edu (Presenting)

**Eustaquio Reis**, IPEA/Rio, ejreis@ipea.gov.br

**Juan Robalino**, Columbia University, jar101@columbia.edu

**Robert Walker**, Michigan State University, rwalker@msu.edu

Drawing on several papers, we will present an econometric estimation of the effects of a suite of factors that drive deforestation. We will in part focus on investments in roads and we note that road investment and other driving factors may also respond to deforestation (for instance, others show that the climate may respond and so may development patterns determined by private migration decisions as well as locations of various public policies). Further, it seems important to recognize that impacts of interventions may depend on the location and time period in which they occurred. Our analyses reflect all of these issues. Starting with a description of our data, we emphasize its temporal and spatial high quality with deforestation observed for census tracts and for three periods covering 1976 to 2000. The spatial resolution permits much improved statistical controls for unobserved drivers, while the temporal coverage with multiple observations of not only forests but also roads permits analysis of dynamic interaction between forest clearing and the building of roads. Further, deforestation can be examined for changes in driving process across the periods and for an effect of drivers across the census tracts, i.e. spatial interaction in the process. Key results are summarized in analyses that use all locations and periods. While details of any prior development affect their impacts, investments in paved and unpaved roads increase deforestation not only in the period when they occur but also in future periods.

## 3C: Vegetation Structure and Disturbance

### 10.1: Using ground-based LIDAR surveys to estimate Amazon forest canopy structure, biomass, and carbon fluxes

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The present-day status of Amazonian forests remains very poorly characterized, with significant uncertainties associated not only with deforestation, but also with intact forests. The literature vigorously debates whether reports of substantial carbon uptake in study plots present sufficient evidence to reject the null hypothesis that primary forests of the Amazon have a landscape-scale carbon balance of zero, and recent work suggests that plot-level Amazon forest carbon balance is acutely sensitive to local disturbance history (e.g., time since the formation of the treefall gaps), implying that inferences of Amazon-wide uptake could be wrong if disturbed areas experiencing large carbon losses have been undersampled.

LIDAR remote sensing methods have the potential to decisively address this question by large-scale sampling of forest disturbance patterns. We tested the feasibility of this approach by comparing ground-based surveys of forest canopy structure (using a portable LIDAR instrument) with biomass and components of carbon balance in spatially distributed network of survey plots in the Tapajós Forest near Santarém Brazil. We found correlations between LIDAR-derived indices of canopy structure and direct observations of biomass and components of carbon balance, suggesting that aircraft or satellite-based remote sensing LIDAR surveys could help resolve questions about Amazon carbon balance.

### 10.2: Vegetation structure and species diversity coupled to soil water heterogeneity in a Cerrado core area

**Joice Ferreira**, University of Brasília, joiceferreira@unb.br (Presenting)

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**Eric Davidson**, The Woods Hole Research Center, edavidson@whrc.org

Cerrado landscapes are experiencing fast changes that threaten its rich plant diversity. However, very little is known about the factors maintaining such diversity. Also, the main factors related to its large structural heterogeneity are debated. Here we investigate how plant available water (PAW) heterogeneity is related with spatial variation in vegetation structure and species diversity in a Cerrado area. PAW (down to 10m depth) was assessed by a geophysical tool, soil electrical resistivity profiling. Interpolated data of soil resistivity were converted into volumetric water content, and then into PAW. We have estimated PAW along three 275-m transects placed at Águas Emendadas Ecological Station (Distrito Federal). Resistivity profiling has revealed strong PAW spatial variability among and within transects. Vegetation was surveyed within 22 100m<sup>2</sup>-plots centered on the resistivity transect. All woody plants were identified to species level and were measured in height, basal circumference, crown depth and volume. Leaf area index was estimated every 10m using hemispherical photographs. Strong co-organization was found between structural attributes and PAW. Despite their similar species richness, the three transects showed differences in species diversity. Species richness, as well as plant density, was positively correlated with PAW 0-400 cm depth. Simpson's diversity, however, was negatively related to PAW beneath 700cm. Dominance of one species, as more soil water became available at depth, contributed to this decline in species diversity. These links suggest that shifts in soil water resources, from

changes in hydrological cycles, for example, may provoke important changes in structural patterns and woody species diversity of the Cerrado.

### **10.3: Landscape Disturbance from Hyperspectral Imagery and Field-Based Tree Mortality Estimates for a Central Amazon Forest**

**Jeffrey Q Chambers**, Tulane University, chambers@tulane.edu (Presenting)

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Tree mortality events impact a number of ecosystem attributes in tropical forests including tree species recruitment dynamics and landscape carbon balance. Mortality rates in the Central Amazon vary from the slow death of standing tree to the instant razing of large areas from microburst blowdown events associated with strong convective storms. Most tropical forest mortality studies are logistically limited to relatively small spatial scales, with observed intensity rarely exceeding 0.5% (stems ha/yr), and event (gap) size generally limited to < 0.10 ha per event. This study takes advantage of a number of scattered blowdowns that occurred in a Central Amazon forest in 2005. A 5000 ha area from the impacted region was extracted from a Hyperion image, and spectral mixture analysis (SMA) methods were used to classify the landscape into five disturbance classes. A total of 30 plots of 20x20 m each, distributed among the disturbance classes, were randomly located across a large portion of this area. Tree mortality rates within these plots were quantified in the field and varied across a gradient of most to least disturbed plots. Tree mortality rates were correlated with independently calculated SMA disturbance metrics. Scaling this relationship across the 5000 ha area allowed development of a unique landscape-scale tree mortality rate map. This disturbance map was used to develop a probability distribution function to aid in modeling landscape carbon balance.

### **10.4: Recurrent fire in the Amazon's transitional forest: Changes in fuel dynamics and consequences for future fire susceptibility**

**Jennifer K. Balch**, Yale University, School of Forestry and Environmental Studies, jennifer.balch@yale.edu (Presenting)

**Daniel C. Nepstad**, Instituto de Pesquisa Ambiental da Amazônia and Woods Hole Research Center, dneptad@whrc.org

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**Paul Lefebvre**, Woods Hole Research Center, paul@whrc.org

Increasing ignition sources, forest degradation, and a conducive climate in the Amazon's transitional forests are resulting in widespread anthropogenic forest fires at a frequency beyond that recorded historically. We have established a once-burned and a twice-burned plot (50-ha each) in intact transitional forest - one of the largest experimental burns in the tropics - to test the effects of repeated fires on fuel combustion, accumulation, and consequent future fire susceptibility. The fires of the initial and second burn, set in August 2004 and September 2005, were low intensity, slow-moving surface fires that rarely crowned. Total downed biomass combustion associated with the first and second burns was comparable; mean biomass consumption was 22.8 Mg/ha (range: 14.3 to 32.3 Mg/ha) and 21.0 Mg/ha (range: 9.9 to 32.1 Mg/ha) for the initial and second burns, respectively. One year after the initial burn accumulation of downed woody and fine fuels replaced surface fuel stocks in all but the 1000-hr fuel size class. Fire-induced changes in stem mortality substantially augment standing fuel stocks, but these fuels may not be available immediately to recurrent fires. These results highlight that available surface fuels do not necessarily immediately increase after an initial fire event. Rather, the rate at which fuels accumulate from fire-induced changes in stem mortality, NPP, regeneration, and grass invasion must be considered for accurately predicting future fire susceptibility.

### **10.5: Estimating Interannual Variability of Carbon Emissions from Land Use-Related Fires in the Southern Amazon**

**Ruth DeFries**, University of Maryland, College Park, rdefries@mail.umd.edu (Presenting)

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Fires from deforestation and pasture maintenance are major pathways for carbon emissions to the atmosphere. There are large uncertainties in the total carbon flux from land-use related fires, contributions from different types of land use, and interannual variability in emissions. We combine MODIS-derived information on the fate of deforestation (pasture or cropland) and active fire observations in an ecosystem model (DECAF) to estimate carbon emissions from land-use fires for 2001 to 2005 for the state of Mato Grosso. Model results allow partitioning of fire emissions according to fate of deforestation and provide annual estimates of emissions from deforestation fire and decomposition of remaining slash. Initial results indicate that fires for pasture clearing are the largest source of emissions in Mato Grosso overall but deforestation for cropland results in higher emissions on a per area basis. Fire emissions continue to occur several years after detection of initial deforestation due to repeated burning for clearing. Because of this offset between carbon emissions from deforestation fires and reported deforestation rates, we estimate that 2005 has relatively high emissions although deforestation rates dropped. Model estimates at 250m MODIS resolution in Mato Grosso provide insights into approaches for scaling across the entire basin at coarser resolution.

### **10.6: Synthesis Studies of Intensive Agriculture Impacts in the Amazon/Cerrado: Field Data, Remote Sensing, Modeling Approaches**

**Christopher Potter**, NASA Ames, cpotter@mail.arc.nasa.gov (Presenting)

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The expansion of intensive agricultural practices into former Cerrado and seasonal forests of the eastern Amazon has increased markedly over the past several years. Over the last 30 years an estimated 37 percent of Cerrado natural vegetation has been transformed, with more than 12 million hectares planted to crops consisting mostly of soybeans, maize, and rice. We are synthesizing measurement data and MODIS remote sensing observations at locations that represent conversion of Cerrado types and Amazon forests to intensive agricultural land use. A principal objective is to improve calibration of the NASA-CASA model and subsequently evaluate and refine a series of regional model simulation runs for these transformed ecosystems.



## Poster Session

### CD (Carbon Dynamics)

#### 11.1-P: Carbon dynamics along small streams in agriculture catchments in Eastern Amazonia

**Maria Beatriz Silva da Rosa**, Embrapa Amazônia Oriental, mbeatrizrosa@yahoo.com.br (Presenting)

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Carbon dioxide evasion from aquatic ecosystems in Amazonia has been shown to be important in the regional carbon balance. It has been suggested that the main source of the evaded CO<sub>2</sub> in a river basin is the particulate and dissolved organic matter that is exported from the forest at headwaters and along the river and stream edges. In this context studies have been conducted to trace dissolved organic carbon (DOC) and pCO<sub>2</sub> fluxes at the water-atmosphere interface, searching to identify the main sources of carbon responsible for the carbon input to water bodies in the Amazon region. The work presented here has been developed in three small catchments (Cumaru, São João and Pachibá) in northeast of Pará state, in Brazil. These catchments are mainly occupied by small farms where cassava, corn, rice, cow pea, passion fruit and pepper are planted after slash-and-burn of the secondary vegetation (capoeira), which together with small pastures cover the rest of the catchments. Sampling for DOC and pCO<sub>2</sub> began in January 2006 and May 2006 respectively. We plan to sample until April 2007 but present here the first results. A trend of increasing DOC downstream has been identified. DOC concentrations ranged from 0.50 to 3.24 mg L<sup>-1</sup> in headwaters and from 1.92 to 9.00 mg L<sup>-1</sup> downstream in Cumaru. In the São João stream DOC concentrations ranged from: 0.21 to 3.69 mg L<sup>-1</sup> (headwaters) and 1.18 to 3.61 mg L<sup>-1</sup> (downstream). In the Pachibá stream the DOC range was: 0.79 to 4.32 mg L<sup>-1</sup> (headwaters) and 1.05 to 4.10 mg L<sup>-1</sup> (downstream). After complete surveys in soil characterization, land use and land cover, we will try to relate DOC spatial patterns to variation with physical properties of the catchments.

#### 11.2-P: Biometric Measures of Carbon Cycling Before, During, and After Selective Logging in Tapajós National Forest

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Long-term biometric measurements began in 2000 at the km 83 site of the Tapajós Forest that was selectively-logged in Fall 2001, and have continued to present. The measurements were focused in a 600 by 300-m block upwind of the eddy covariance tower, including leaf litterfall measured bi-weekly (30 litter traps), and 800 dendrometer bands (400 before logging and an additional 400 after logging) measured at 6 week intervals. Intensive tree surveys were also conducted before and after the selective logging. Litterfall varied seasonally from September 2000 to September 2001, with comparatively high rates beginning in May and continuing through the dry season. The May leaf drop preceded the beginning of the dry season, implying that it was not a direct result of drought. The May increase coincided with a decline in daytime CO<sub>2</sub> uptake measured by eddy covariance, indicating that both LAI and canopy photosynthesis decreased beginning in May. The integrated litterfall observations prior to logging suggest an overall LAI of 5, which agrees with independent assessments of LAI made by fish-eye photography during the 2000 wet season. The dendrometer observations prior to the logging are being used to determine the seasonal pattern of stem increment in the absence of disturbance. The dendrometer observations following the logging are being used to gauge the regrowth of the forest, and to determine the relative impact of logging on tree growth in patches of intact forest vs gaps vs the edges of gaps.

#### 11.3-P: Coarse woody debris and Carbon Supply in the Eastern Amazonia, Brazil.

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This study compares the volumes of coarse woody debris produced in an area, with the another one logged forest by reduced impact logging methods, in called property Farm Saint Marta (3°04'S, 49°14'W). This locates-itself in the hidrográfico basin of the medium river Moju, city homonym, Northeast of the State of Pará, Eastern Amazônia, Brazil. The studies had been carried through in total area of 426Ha, referring the 4 Units of Work immediate of forest management areas. Two of these units had been explored by reduced impact logging, totalizing 217Ha, and the others two in undisturbed forest totalizing 209Ha. It was used line intercept sampling for as method to quantify the coarse woody debris in 6,000 m of lines for each situation, totalizing 12,000 m of sampling lines. The fallen woody debris was measured on the forest floor, with superior diameter 10 cm, considering the diameter and the state of decomposition of the measured parts, for the calculation of the volume and necromassa, associates to the indices of density of the specific wood for each decay class. It was demonstrated with the results, through statistical tests, to have significant difference of estimates of volume and necromassa, and highly significant difference in the carbon supply, between the studied situations. In the primary forest the volume was estimated about 80 m<sup>3</sup>ha<sup>-1</sup> and the carbon supply about 28,30 Mgha<sup>-1</sup>. In the forest logged using reduced impact methods the volume was estimated about 137 m<sup>3</sup>ha<sup>-1</sup> and the carbon supply about 43,23 m<sup>3</sup>ha<sup>-1</sup>. The estimates of necromassa and carbon will serve to contribute towards the monitoring of the emissions of greenhouse gases emitted by the coarse woody debris as well for calculations for the commercialization of carbon credits.

Key words: coarse woody debris, Amazonia, reduced impact logging, line intercept sampling, volume, necromassa, carbon supply

#### **11.4-P: Spatial calibration of the NOAH model parameters in the South American Land Data Assimilation System over the LBA/Amazon area using similarity-based measures**

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Land surface models (LSM) have been extensively used to better represent hydrological and land surface processes, providing lower boundary conditions for numerical climate and weather simulations. The determination of the spatially distributed LSM optimal parameters would greatly impact such numerical simulations. Parameter calibration techniques however rely on data availability which in general is provided by point measurements. We use the Shuffled Complex Evolution (SCE-UA) optimization algorithm and similarity concepts to estimate distributed parameter values for the NOAH LSM, incorporated into the Land Information System (LIS), a distributed framework developed at NASA/GSFC for Land Data Assimilation System (LDAS) applications. Flux towers from the Large-Scale Biosphere Atmosphere Experiment in Amazonia (LBA) are used as point ground measurements for the model calibration. This paper investigates the feasibility of combining the parameters estimated at the LBA sites, a similarity-based measure, the Hausdorff Norm (HN), and MODIS/AQUA ground surface temperature fields for calibration of parameters in the surrounding areas. This study is part of the group CD-36 of the LBA Synthesis Phase III and the South American LDAS (SALDAS) initiative at the GSFC/NASA Hydrological Sciences Branch.

#### **11.5-P: Exportação e balanços de carbono orgânico dissolvido em pequenas bacias do estado de Rondônia: uma comparação entre floresta e pastagem**

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O carbono orgânico dissolvido (COD) constitui em uma das principais formas de carbono dissolvido depositado via precipitação atmosférica e exportado pelos rios em bacias de drenagem. Cálculos de deposições e exportações pode indicar alterações na ciclagem do carbono em bacias de drenagem. Portanto, o objetivo deste estudo é avaliar as deposições e exportações de COD e consequentemente o balanço deste, tanto durante eventos de precipitação quanto anualmente em duas bacias no estado de Rondônia, sendo uma com floresta e outra com pastagem. O estudo foi conduzido na fazenda Rancho Grande, próximo à cidade de Cacaulândia, entre Agosto e Novembro de 2004 e Janeiro a Abril de 2005. As concentrações de COD foram determinadas em um analisador de carbono orgânico total (Modelo TOC 5000A da marca Shimadzu).

Os resultados demonstraram que houve uma deposição de  $162,34 \text{ kg.ha}^{-1}.\text{ano}^{-1}$  de COD. Na bacia da pastagem e da floresta foi observado, via igarapés, uma exportação de  $72,61 \text{ kg.ha}^{-1}.\text{ano}^{-1}$  e  $4,36 \text{ kg.ha}^{-1}.\text{ano}^{-1}$ , respectivamente. Os maiores valores de exportação na pastagem está relacionada a maiores fluxos de água, sendo que do total que entrou pela precipitação (2286 mm) e precipitação interna (2053 mm) anualmente, 18% e 2% saíram pelos igarapés da pastagem e floresta.

Considerando os valores de deposição e exportação, os balanços para a floresta e pastagem são  $157,98 \text{ kg.ha}^{-1}$  e  $89,73 \text{ kg.ha}^{-1}$ , respectivamente. Analisando os eventos individuais de precipitação, foi observado na pastagem maiores exportações no período chuvoso (Janeiro a Abril) do que deposições, sendo na transição do período seco para o chuvoso (Agosto a Novembro) foi observado o inverso. Na floresta, as deposições nos eventos de precipitação foram sempre maiores do que as exportações nos dois períodos.

Embora os balanços da floresta e pastagem sejam diferentes, saídas do sistema não quantificadas neste estudo, como por exemplo, pela água subterrânea pode ocorrer. Contudo, pode-se concluir que a conversão de floresta para pastagem, através da ação humana, resultou em mudanças significativas na exportação de COD nestas bacias em Rondônia.

#### **11.6-P: Applications of the LBA-ECO Metadata Warehouse**

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The LBA-ECO Project Office has developed a system to harvest and warehouse metadata resulting from the Large-Scale Biosphere Atmosphere Experiment in Amazonia. The harvested metadata is used to create dynamically generated reports, available at [www.lbaeco.org](http://www.lbaeco.org), which facilitate access to LBA-ECO datasets. The reports are generated for specific controlled vocabulary terms (such as an investigation team or a geospatial region), and are cross-linked with one another via these terms. This approach creates a rich contextual framework enabling researchers to find datasets relevant to their research. It maximizes data discovery by association and provides a greater understanding of the scientific and social context of each dataset.

For example, our website provides a profile (e.g. participants, abstract(s), study sites, and publications) for each LBA-ECO investigation. Linked from each profile is a list of associated registered dataset titles, each of which link to a dataset profile that describes the metadata in a user-friendly way. The dataset profiles are generated from the harvested metadata, and are cross-linked with associated reports via controlled vocabulary terms such as geospatial region. The region name appears on the dataset profile as a hyperlinked term. When researchers click on this link, they find a list of reports relevant to that region, including a list of dataset titles associated with that region. Each dataset title in this list is hyperlinked to its corresponding dataset profile. Moreover, each dataset profile contains hyperlinks to each associated data file at its home data repository and to publications that have used the dataset.

We also use the harvested metadata in administrative applications to assist quality assurance efforts. These include processes to check for broken hyperlinks to data files, automated emails that inform our administrators when critical metadata fields are updated, dynamically generated reports of metadata records that link to datasets

with questionable file formats, and dynamically generated region/site coordinate quality assurance reports. These applications are as important as those that facilitate access to information because they help ensure a high standard of quality for the information.

This presentation will discuss reports currently in use, provide a technical overview of the system, and discuss plans to extend this system to harvest metadata resulting from the North American Carbon Program by drawing on datasets in many different formats, residing in many thematic data centers and also distributed among hundreds of investigators.

#### 11.7-P: Índice de mortalidade e necromassa em áreas atingidas por blowdown na Amazônia central

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Os distúrbios que alteram a composição e a estrutura da floresta amazônica por ações antropogênicas vêm sendo estudados e quantificados ao longo do tempo. Porém os efeitos das catástrofes naturais ainda são pouco conhecidos já que estes são consequências de diversos fatores climáticos e ocorrem muitas vezes em áreas remotas. Por esta razão a evolução dos sistemas de geoprocessamento aprimorou a detecção destes danos de causas natural em especial micro-explosões causadas por tempestades naturais convectivas denominadas de “blowdown”.

Neste trabalho foram analisadas imagens da reserva ZF-2 do INPA Manaus-Brasil obtidas por meio do sensor hiperespectral (HYPERION) acoplado ao satélite EO-01 e selecionados 5 blowdowns que ocorreram em Janeiro/2005. O objetivo desta pesquisa é comparar os valores de NPV (non-photosynthetic vegetation) da imagem com os dados medidos em campo. Áreas mais severamente afetadas foram identificadas por meio de 4 endmember spectral mixing analysis (SMA). Desta análise foi calculada a coordenada de 6 diferentes respostas espectrais dentro de cada blowdown formando um gradiente de dano ao dossel variando de 0-100% em um intervalo de 20%. Nas 30 coordenadas foram instaladas parcelas de 20x20m, identificadas em nível de gênero e medido o DAP de todos os indivíduos vivos e mortos acima de 10 cm.

Resultados preliminares indicam uma relação positiva entre o volume de necromassa, índice de mortalidade e as diferentes classes de danos. Com este trabalho será possível validar a relação entre atributo espectral e a verdade de campo gerando informações mais confiáveis para os modelos de dinâmica de carbono.

#### 11.8-P: Forest Structure at Five LBA Study Sites

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Insufficient knowledge of the spatial distribution of forest biomass in the Amazon limits the accuracy of estimates for carbon release resulting from deforestation. Recent research has attempted to improve the estimation of Amazon forest biomass through detailed analysis of extensive plot studies, remotely sensed variables, and knowledge of regional soils and climate. Because plot surveys are scarce, remote sensing offers an alternative approach to improve our knowledge of regional biomass. Remotely sensed variables are sensitive to underlying forest structural properties. We measured forest structure variables during field studies at five old growth forest sites in the Brazilian Amazon. The data collected included the frequency of stem diameters, tree heights, and crown diameters. Above-ground biomass at the sites ranged from 155 to 297 Mg ha<sup>-1</sup> using an allometric equation developed by Chave et al. (2005) based on tree diameter at breast height (DBH), total height, and wood density. A single Weibull function based on DBH for 1539 trees fit total tree height with a small uncertainty (RMS error = 1.2 m) and a minimal bias (mean of residuals = -0.2 m) for all sites. These results suggest that remotely sensed tree height may be a useful predictor of forest biomass at a regional scale.

#### 11.9-P: Landscape-Scale Dynamics of Carbon in Live and Dead Biomass Pools

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Carbon sequestration dynamics in Amazonian forests remain controversial. Inventories tend to be spatially and/or temporally limited and often fail to integrate coarse woody debris (CWD) in their estimates. A set of four 10-ha transects were established across the Tapajós National Forest (TNF) to determine whether the 19.75-ha plots in the eddy flux tower footprint (km67) were representative of the TNF as a whole. Analysis revealed that the km67 site was indistinguishable from the TNF, with live biomass estimates (trees  $\geq 10$ cm DBH) of  $152.8 \pm 6.0$  MgC/ha/yr and  $156.1 \pm 7.0$  MgC/ha/yr, respectively. The net increase in carbon stored in live wood biomass at km67 was  $1.68 \pm .68$  MgC/ha/yr (1999-2001) and  $0.59 \pm .29$  MgC/ha/yr (2001-2005), comparable to the net average increase of  $1.59 \pm 0.32$  MgC/ha/yr across the Tapajós. Gains in live wood biomass, however, were exceeded by decomposition losses from CWD at km67, resulting in a net carbon source to the atmosphere of -1.6 MgC/ha/yr during the 1999 to 2001 period and a net zero or small source of -0.47 MgC/ha/yr during the 2001 to 2005 time-step. Between 2003 and 2005, a net zero or small source of -0.21 MgC/ha/yr was observed as the landscape mean across the Tapajós. Dynamics across the Tapajós were compared to established Amazonian

forest plots at the BDFFP project near Manaus, Brazil. The BDFFP plots showed a mean live biomass increase of 0.27 MgC/ha/yr from 1998 to 2002. When decomposition losses from CWD were estimated, the sites were a carbon sink of 1.18 MgC/ha/yr. While mortality at the Tapajós and BDFFP were comparable, the decay states of the CWD differed substantially accounting for the low carbon losses through decomposition at the BDFFP plots. This reiterates the importance of CWD and decomposition in carbon sequestration measurements as an analysis of live biomass without CWD would suggest that both the Tapajós and the BDFFP plots were carbon sinks.

#### **11.10-P: Ecophysiological Responses to Seasonal Variation at the Ecosystem Scale in the Amazon Basin: An Isotopic Approach**

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This study was conducted in 2003 and 2004 at the km 67 old growth forest in the Tapajós National Forest (2,85°S; 54,05°W). The objective was to measure the carbon isotope ratio ( $\delta^{13}\text{C}/^{12}\text{C}$ ) of respired  $\text{CO}_2$  from the entire ecosystem and leaf isotopic composition along profiles through the canopy. We used the Keeling plot technique and Farquhar's leaf model to examine the physiological drivers of the isotopic composition of several components in the system as well as the seasonal response for these components. Variations of respired  $\delta^{13}\text{C}$   $\text{CO}_2$  by the ecosystem was related with precipitation variation, but not significantly different either seasonally or temporally. The  $\delta^{13}\text{C}$  of leaf organic matter showed a clear stratification along the vertical profile with significant seasonal variation. A positive correlation was found between photosynthetically active radiation (PAR) and  $\delta^{13}\text{C}$  of leaves from the top of the canopy where high PAR favored photosynthetic activity. The ci/ca ratio values did not show significant differences between heights and seasons. Our study indicated that the isotopic composition of respired  $\text{CO}_2$  and leaf organic matter was sensitive to microclimatic variations.

#### **11.11-P: Controls on Stream DOC Flux and Composition in the Amazon Region, Tapajós National Forest**

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

#### **11.12-P: CO<sub>2</sub> Eddy-Correlation Fluxes Estimation and Associated Errors Above Caxiuanã Rain Forest, Eastern Amazonia**

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Eddy-correlation  $\text{CO}_2$  turbulent fluxes and their estimated errors have been calculated for data collected at Caxiuanã Reserve, in Eastern Amazônia. The data were measured in a 55m height tower at sampling rate of 10 Hz, during 2005 dry and wet seasons. The results have shown that the forest basically a carbone sink. Wyngaard (1983) method has been used to calculate sampling errors in eddy-correlation turbulent flux estimation. Besides, such error estimations provide also useful information to investigate some statistical characteristics of turbulent eddies, as the determination of integral time-scale  $\lambda$ . It has been observed a wide range in  $\text{CO}_2$  flux error estimation (from 20% to 500%) depending of stationary conditions are prevailing or not. During the day-time convective conditions, the errors were, in general, lesser than 50%. However, during early evening periods, the errors were often greater than 100%, mainly during dry season. We used statistical tools such correlation coefficients and integral time-scales to investigate the physical origin of the error variability along the day.

#### **11.13-P: Spatial and temporal variations of dissolved carbon at the riparian zone of a forest fragment in Rondônia, Brazil.**

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#### **ABSTRACT:**

Nutrient dynamics in riparian zones play an important role in terrestrial and aquatic ecosystems coupling. With the expansion of deforestation in the Amazon, in the last decades several mosaics of degraded landscape have appeared, mainly in places where small segments of riparian zone used to form buffer zones between areas of varied land uses and the watercourses. Due to this new landscape framework, it's essential to identify the main nutrient flowpaths within these systems. In this context, the main goal of this study is the quantification of carbon fluxes in a fragment of riparian zone of the Urupá River basin, Rondônia state. In order to achieve that, since December of 2005 we have been sampling biweekly the main flowpaths of this system: rain water, throughfall, litterfall, overland flow, soil solution, groundwater, and the main channel of the Urupá River. In all these samples, in addition to physical-chemical parameters (pH, temperature and electric conductivity) measured in the field, aliquots are taken for the analysis of Organic and Inorganic Dissolved Carbon (DOC and DIC) concentrations. The highest concentrations of DOC were found in

overland flow (average = 555,44 mM (micromolar)) and throughfall (average = 474,86 mM (micromolar)), respectively. For DIC, the highest concentrations were observed in soil solution, mainly in the deepest lysimeter (100 cm), with an average of 430,22 mM (micromolar). These preliminary results indicate that the transport of C in solution may be an important pathway transferring this element from terrestrial to aquatic systems in this riparian fragment.

Keywords: Amazon, carbon, nutrient cycling, riparian.

#### **11.14-P: Boat-Based Eddy Covariance Measurements of CO<sub>2</sub> Exchange Over Amazon and Tapajos Rivers and Lakes**

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Recent reports based on floating chamber measurements suggest that gas evasion of carbon dioxide from the Amazon River and its tributaries to the atmosphere may play an important role in the regional carbon budget (Richey et al., 2002). Chamber techniques have inherent uncertainties due to their effect on the near-surface air turbulence. The micrometeorological technique of eddy covariance is attractive since it is a direct measurement of gas exchange and samples over a much larger area. In August 2004, we mounted equipment on a small riverboat and measured CO<sub>2</sub> and H<sub>2</sub>O fluxes from rivers and lakes near Santarem, Para, over a 10-day period. Our sampling strategy included both "under-way" measurements and stationary (moored) 24-hour measurements, and floating chambers were deployed in situ with the eddy flux measurements. The CO<sub>2</sub> concentration in the Amazon river and a connected lake were high (3000-5000 ppm) compared to the Tapajos River and a connected lake (400-1200 ppm). The calculated piston velocity for the Amazon data agrees with over-ocean parameterizations for air-water gas exchange. The piston velocity calculated from the Tapajos data were several times as large as those on the Amazon, possibly due to a shallow upwind fetch while the boat was moored on the Tapajos.

#### **11.15-P: Dissolved Inorganic Carbon in Rivers Teles Pires and Cristalino**

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The rivers are extremely important in the carbon cycle, either in the CO<sub>2</sub> outgassing flows or carbon exporters to the oceans. Direct measuring of CO<sub>2</sub> exchanges between the terrestrial ecosystems and the atmosphere should consider the aquatic systems flows, not overestimating the carbon terrestrial accumulation. The Amazon basin has the largest and more complex system of fresh water in the world, so that it holds an important place in the global carbon cycle. The objective of this work was to evaluate, during the period between September 2004 and August 2005, the dynamics of the species of the carbonate system ( $\text{DIC} = \text{"free"} \text{ CO}_2 + \text{HCO}_3^- + \text{CO}_3^{2-}$ ), dissolved in the waters of Teles Pires and Cristalino rivers, components of the Amazon basin, in the district of Alta Floresta, MT. Fortnightly were determined the inorganic carbon concentration dissolved total, pH and temperature of the rivers. Based in those results and applying the thermodynamic balance equations, it was possible to estimate the pCO<sub>2</sub> and the carbonate system fractions. The rivers presented a seasonal variation in the pH values, being closer to the neutrality in the drought period. The concentration of HCO<sub>3</sub><sup>-</sup> it was significantly larger in the drought than during the flood season. Both studied rivers were oversaturated in CO<sub>2</sub> related to the atmosphere.

#### **11.16-P: Forest structure and the relationship between light environment above and below the canopy in the Tapajós National Forest.**

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Canopy structure influences the balance, spatial and temporal distribution, and spectral quality of radiation incident on the forest. To understand the details of these interactions in primary moist forest at km67 in the Tapajós National Forest, Brazil (2°51' S, 54°58' W), we combined continuous high-frequency pyranometer and quantum sensor measurements above and below the canopy (an array) with observations of canopy structure made with a portable LIDAR system deployed from the forest floor. We describe the whole canopy budget of Photosynthetic Photon Flux Density (PPFD), the canopy reflectance and understory transmittance of PPFD, and the balance of direct and diffuse fractions. We examine the dependence of transmittance, sunfleck probability and duration on solar elevation angle, season, and sky conditions.

From co-located measurements of PPFD and LIDAR structure along a 1000m transect we show the relationship between transmittance and overhead cover, surface area density, and local canopy height. From the distribution of local maximum heights (the hypsograph) we estimate the mean vertical pattern of within-canopy transmittance and absorbance. We constructed "transfer functions" to describe the light environment and budget at km67. The brightness classes are 1 (<30%), 2 (30-60%), 3 (60-90%), and 4 (>90%) - percentage of incoming light relative to modeled clear conditions. We depict penetrance to the understory as well as reflectance from the top. For this analysis half-hour averages of the calibrated subcanopy array means were used.

#### **11.17-P: Efluxo de CO<sub>2</sub> e Área Basal na Floresta Transição Amazônica Cerrado**

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Estudos de dinâmica de carbono vêm sendo realizados em ecossistemas como as florestas tropicais úmidas, temperadas, decíduas, superfícies oceânicas entre outros. Estes estudos têm indicado que estes ecossistemas comportam-se como sumidouros de carbono e por isso desempenham um papel fundamental na incorporação do carbono emitido pela atmosfera. Medidas de área basal são de fundamental importância para estimar os modelos de crescimento e produção, assim como no cálculo de volume/ha, dando idéia de estoque de matéria na floresta. O objetivo foi relacionar o efluxo de CO<sub>2</sub> do solo com a área basal de uma floresta de transição Amazônia Cerrado, localizada no Noroeste de Mato Grosso (11°24.75'S: 55°19.50'O). As medidas de efluxo de CO<sub>2</sub> na floresta foram realizadas mensalmente entre as 10:00 e 14:00 horas no período de Maio de 2005, à Maio de 2006, em 20 caixas coletoras de serrapilheira. O efluxo de CO<sub>2</sub> do solo foi realizado com aparelho de absorção de CO<sub>2</sub> por infravermelho, acoplado a uma câmera de retenção de CO<sub>2</sub>. A área basal foi calculada em função das caixas coletoras de serrapilheira, perfazendo uma área de 314,15 m<sup>2</sup> em cada caixa, levando em conta árvores com DAP 1,30 m, com diâmetro > 31,4 cm. Os resultados mostraram que o efluxo de CO<sub>2</sub> encontrado nas caixas coletoras foi de 5,46±1,22 Mmolm<sup>-2</sup>s<sup>-1</sup> de CO<sub>2</sub>, a área basal foi de 41,96 m<sup>2</sup> ha<sup>-1</sup>. A correlação entre o efluxo de CO<sub>2</sub> e a área basal encontrada foi baixa, mostrando que estes parâmetros não se correlacionam. A área basal neste caso age de maneira indireta, pois quanto maior a área basal, maior a quantidade nutrientes e no solo carbono, promovendo maior efluxo de CO<sub>2</sub>.

#### **11.18-P: Synthesis Studies of Secondary Forest Productivity in the Amazon: Field Data, Remote Sensing, Modeling Approaches**

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We are using measurement data and MODIS remote sensing observations at locations that represent conversion patterns of primary forests to regrowing secondary forests in Amazonia. A principal objective is to improve calibration of the NASA-CASA productivity and soil biogeochemistry modeling and subsequently evaluate and refine a series of regional model simulation runs for transformed forest ecosystems. We have implemented the aboveground biomass accumulation (ABA) rate model of Zarin et al. (2001) on the CASA 8-km regional grid as an initial representation of potential secondary forest regrowth for the Legal Amazon. Our next objective is to evaluate the NASA-CASA model predicted ABA rates over several forest clearing and regrowth cycles with simulated nitrogen (loss) limitations on secondary forest NPP patterns.

#### **11.19-P: Role of CO<sub>2</sub> outgassing from small rivers in local and regional net carbon emission in the southwestern Amazon River Basin**

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A recent estimate of CO<sub>2</sub> outgassing from Amazonian wetlands suggests that an order of magnitude more CO<sub>2</sub> leaves rivers through gas exchange than is exported to the ocean as organic or inorganic carbon. However, the contribution of smaller rivers, is still poorly understood, mainly due to limitations in mapping their exact extent. Considering that the largest portion of the Amazon River network is composed of small rivers, our objective was to elucidate their role in air-water CO<sub>2</sub> exchange, combining estimated CO<sub>2</sub> outgas (using the boundary layer equation) and a GIS-based methodology to calculate the surface area covered by rivers with channels less than 100 meters wide in the Ji-Paraná River Basin, Western Amazon. The estimated CO<sub>2</sub> outgas was the main carbon export pathway for this river basin, totalizing 316 Gg C yr<sup>-1</sup>, about 2.8 times the amount of carbon exported as dissolved inorganic carbon (113 Gg C yr<sup>-1</sup>) and 1.8 times dissolved organic carbon (176 Gg C yr<sup>-1</sup>). The relationships established here between drainage area and channel width provide a new model for determining surface area of these rivers, thus making it possible to perform regional extrapolations of air-water gas exchange. Extrapolated CO<sub>2</sub> outgas from Ji-Paraná rivers lower than 100 meters wide from small rivers to the entire Amazon basin, totalizes 124.8 ± 42 Tg C yr<sup>-1</sup>, about 71 Tg yr<sup>-1</sup> higher than previous results. These ecosystems are playing an important role in the regional carbon balance, contributing with 17% (low water) to 38% (high water) of the total Amazon basin CO<sub>2</sub> outgassing.

#### **11.20-P: Chamber adaptations for CO<sub>2</sub> flux measurements in small streams: making them smaller and lighter**

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CO<sub>2</sub> outgassing from rivers in the Amazon basin has been given great attention in the last five years, since it plays a major role in the regional carbon balance, and might be one of the flowpaths that could be “invisible” to eddy covariance and towers methodology. The usual chamber and floating apparatus used for CO<sub>2</sub> flux measurements in water are quite large and heavy, with a total volume of 30 liters (maximum length 100 cm and maximum width 50 cm) and were designed for ocean measurements, which restricts the distance that can be traveled by feet when measuring flux in small streams in forests or pastures where no road can be used (specially in the rainy season). We propose here to adapt usual soil chambers, which are smaller and lighter and therefore require smaller floating apparatus, with total volume of 5 liters (maximum length 50 cm and maximum width 30 cm). In order to estimate the performance in these two chambers we will be measuring CO<sub>2</sub> fluxes with both systems in small streams and medium size rivers in Southwestern Amazonia (Acre State) to compare the differences between them. Results will be available in late September for the LBA-ECO meeting.

#### **11.21-P: Methane flux analyze in the interface soil-atmosphere at a rice plantation, a soybean plantation and a tropical forest, in Oriental Amazônia.**

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The goal of this research was to quantify soil methane ( $\text{CH}_4$ ) flux in a convectional rice and soybean plantation, identify impact factors, beside to compare these fluxes with those measured in an undisturbed forest. The research sites were: mature tropical forest, rice plantation and soybean plantation. Methane flux was measured by vented static camera and correlated with volumetric moisture and temperature of soil. The average of all soils researched showed negative  $\text{CH}_4$  flux. The flux in the forest was quantitatively higher ( about  $-0.3 \pm 0.2$  e  $-0.1 \pm 0.9 \text{ mg CH}_4 \text{ m}^{-2} \text{ d}^{-1}$ ) than those sites under plantation ( $-1.1 \pm 3.2 \text{ mg CH}_4 \text{ m}^{-2} \text{ d}^{-1}$  e  $-1.2 \pm 1.7 \text{ mg CH}_4 \text{ m}^{-2} \text{ d}^{-1}$ , at rice and soybean plantation respectively). There was no difference between the two sites under plantation. At the three sites, moisture and soil temperature did not control efficiently the methane flux. The fertilizers and pesticides, used in the sites under plantation, did not influenced methane flux.

#### **11.22-P: Tree Survey Along a Chronosequence of Six Years of Selective Logging at The Tapajós National Forest**

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Long term permanent plots provide valuable data on growth and mortality of tropical forests. In Brazil, there are few long term plots established specifically to study logging impacts and fewer still dedicated to the study of reduced impact management. At the Tapajós National forest, a tropical forest, 83 km south of Santarém, Pará, Brazil, we surveyed 60 ha of forest that had been selectively logged with reduced impact management over 6 different years during the period 1997 through 2003. We measured diameter at breast height (dbh) for all trees above 35 cm and for a 5% sub-sample of the area for all trees > 10 cm. In addition, we registered data on canopy condition and crown integrity. Two control plots (10 ha) were also established for comparison to the logged sites. In the 70 ha, a total of 7261 trees were measured and tagged, separated into two size classes categories: trees > 10 cm DBH (3572 individuals), and trees > 35 cm DBH (3689 individuals). The average DBH for trees > 10 cm was 21 cm and 51.8 cm for trees > 35 cm at DBH. We will present additional data on the comparative structure of the plots. These studies offer the tools to develop more precise models about forest productivity and basin-scale carbon balance.

#### **11.23-P: Observational Evidence of Sub-Canopy Drainage Flow in Amazonia**

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**David Fitzjarrald**

**Ralf Staebler**

**Ricardo Sakai**

Systematic errors from measurements using the eddy covariance methodology over complex terrain and vegetation are a recognized problem. The goal of this work was to evaluate qualitatively and quantitatively the contribution of the sub-canopy horizontal transport in the Amazon ecosystem carbon balance. We used a very fine scale methodology (called the Drains System) to measure sub-canopy wind and  $\text{CO}_2$  fields in order to estimate horizontal transport of  $\text{CO}_2$  and its importance on the ecosystem carbon balance. The results indicated that the system was able to capture a consistent and persistent wind field at night following the topography obtained from high resolution SRTM image over the locale of the measurements. At night, about 60% of the time the wind was calm ( $u^* < 0.25$ ). For the first period evaluated (Jul-Ago/2003), the NEE + storage data from the CD-10 group was, on average,  $5.6 \text{ micromol m}^{-2} \text{ s}^{-1}$ , and total ecosystem respiration was  $8.2 \text{ micromol m}^{-2} \text{ s}^{-1}$ , indicating an difference of the  $2.3 \text{ micromol m}^{-2} \text{ s}^{-1}$  (missing). The results from Drains System indicate an horizontal transport of the  $1.5 \text{ micromol m}^{-2} \text{ s}^{-1}$  for the same period. During a second period (Oct/2004 until Jan/2005) the missing differences were  $1.8 \text{ micromol m}^{-2} \text{ s}^{-1}$ , while the Drains System indicated a horizontal transport of the  $1.1 \text{ micromol m}^{-2} \text{ s}^{-1}$ . These results show the importance of sub-canopy horizontal transport to the carbon balance for the Flona Tapajós LBA Site.

#### **11.24-P: Subcanopy flow in Central Amazonia - Manaus LBA Site**

**Julio Tota Silva**, INPA, tota@inpa.gov.br (Presenting)

Under low wind speed conditions and radiational cooling, and terrain is not level, a drainage flow can develop. Above forests the flow above the canopy becomes decoupled from the flow just above and within canopy. It is possible that the drainage flow will carry respiratory  $\text{CO}_2$  from foliage, boles, and soil downslope. If this flow advects  $\text{CO}_2$  away from observation tower, some  $\text{CO}_2$  emission goes unmeasured. Eddy covariance systems above canopy will not detect this flux. A horizontal gradient in  $\text{CO}_2$  coupled with a persistent flow in a certain direction, can create non-zero horizontal advection terms of the form  $(u)(dc/dx) + (v)(dc/dy)$ , terms commonly assumed to be zero. We report preliminary results from measurements of the horizontal advection of  $\text{CO}_2$  in the Manaus LBA Site. The aim is to actually measure this term to determine its significance.

#### **11.25-P: Influence of meteorological variables in litter production and decomposition at Ferreira Penna Scientific Station, Caxiuanã, PA.**

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The evaluation of influence of exclusion of rainwater on the variation in litter production was made at the forest reserve of Caxiuanã-Ferreira Penna Scientific Station (10 42' S; 51 31' W) during the period of March, 2001 to February, 2003, to identify the main meteorological and monthly water balance variables that affected the production and the decomposition of litter. This work is part of a sub-project drought experiment in the forest (ESECAFLOR) which aims to study the long term impact of drought on the mass and energy fluxes in the forest. The seasonality of litter production and its components (leaves, twigs and reproductive parts) was well characterized, with the occurrence of greater production during the months of less wet season. The total monthly production of litter ranged during the experimental period from 297.78 kg ha<sup>-1</sup> to 1,758.69 kg ha<sup>-1</sup>, with an average value of 777.70 kg ha<sup>-1</sup> distributed in the fractions of leaves, twigs and reproductive parts in 61.40%, 18.45% and 20.14%, respectively. The results obtained in the plot under natural conditions were approximately 25% higher than the litter production values obtained in the plot under drought stress due to the rainwater excluded in the plot. The litter decomposition rates for the wide, average and thin mesh were described satisfactorily by the exponential model submitted by Olson (1963). The variables more strongly correlated with the litter production and/or its components were the wind speed, the global radiation, the photosynthetic active radiation, the soil temperature (at 5 cm depth) and the precipitation. Among the water balance variables the better correlations were obtained with the soil moisture content, water surplus and water deficit. The regression analysis between total litter production and its components with the meteorological and/or monthly water balance variables were not satisfactory for prediction purposes.

#### **11.26-P: Dinâmica do carbono no rio Acre: variações espaciais e sazonais**

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Estima-se que a descarga anual de carbono orgânico total (COT) e carbono inorgânico dissolvido (CID) dos rios para o oceano é de cerca de 0,4 - 0,8 e 0,4 Gt C ano<sup>-1</sup>, respectivamente. O objetivo principal do presente trabalho é estudar a dinâmica do carbono em um trecho do rio Acre (Rio Branco - Acre), levando em consideração a variação espacial e sazonal. As amostragens terão início em setembro de 2006 e serão realizadas mensalmente em um período de doze meses. A determinação do carbono inorgânico dissolvido (CID) será feita pelo método conhecido como análise da fase gasosa (headspace analysis). Para o carbono orgânico (CO), as análises serão feitas em um analisador Shimadzu, modelo TCO5000A. Parâmetros como pH, temperatura, oxigênio dissolvido e a condutividade elétrica também serão mensurados. Através de dados físico-químicos da água, obtidos junto ao Serviço de Água e Esgoto de Rio Branco (SAERB) a partir de 1999, serão feitas regressões para estabelecermos relações empíricas entre os parâmetros físico-químicos coletados e a pCO<sub>2</sub>. A partir desta relação empírica e da série histórica de dados dos parâmetros, faremos uma estimativa da variabilidade interanual das concentrações de pCO<sub>2</sub> e se possível da evasão de CO<sub>2</sub> para atmosfera, além de verificar, através das análises das concentrações de carbono, como este elemento se comporta espacialmente e sazonalmente. Este trabalho está inserido dentro do Projeto Milênio/LBA e será apresentado como dissertação ao Programa de Pós-Graduação em Ciências Ambientais (UFPA/MPEG/EMBRAPA), em parceria com a Universidade Federal do Acre.

#### **11.27-P: Relação entre incremento diamétrico mensal e as mudanças fenológicas de indivíduos arbóreos de dossel de uma floresta de terra-firme, na região de Manaus.**

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A fenologia tem por finalidade analisar o ritmo das fases biológicas da floração, frutificação e mudança foliar. As fenofases das espécies arbóreas possibilitam fornecer maiores informações acerca da biologia das espécies, bem como da interação com o ambiente. Este trabalho teve como objetivo relação as mudanças fenológicas de indivíduos arbóreos de dossel, relacionando essas fases ao incremento médio mensal diamétrico. O trabalho está sendo conduzindo na EEST/INPA, km14 da vicinal ZF-2, na BR-174, Manaus/AM. Noventa árvores foram selecionadas ao redor de uma torre de 40m de altura a um raio de aproximadamente 150m. O critério de seleção foi a visualização das copas, que mensalmente, desde 2004, são fotografadas e observadas com auxílio de binóculos. Em cada árvore foi instalada uma fita diamétrica para acompanhar o incremento médio mensal. Os dados apresentados correspondem ao ano de 2005. Dos indivíduos observados, 8,8%, 8,7% e 19,5% floresceram, frutificaram e apresentaram mudança foliar, respectivamente, ao longo do ano. A floração e a frutificação ocorreram com menor intensidade no período seco quando comparadas à mudança foliar, que foi mais intensa nesse período. A mudança foliar foi correlacionada negativamente tanto ao incremento médio mensal ( $r = -0,69; p = 0,18$ ) quanto à precipitação ( $r = -0,81; p = 0,02$ ), cuja relação foi mais forte. Para os demais parâmetros, o incremento não apresentou correlação ( $p > 0,99$ ). A floração também foi negativamente correlacionada à precipitação ( $r = -0,73; p = 0,10$ ). Os resultados parciais sugerem que a mudança foliar e a floração são mais efetivas no período de menor precipitação, comportamento inverso ao incremento que não se mostrou diretamente relacionado às mudanças fenológicas.

#### **11.28-P: REGIONALLY APPLICABLE EQUATIONS FOR ESTIMATING ABOVEGROUND BIOMASS IN THE AMAZON BASIN FROM GEOSCIENCE LASER ALTIMETER SYSTEM WAVEFORM METRICS**

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**Maria Hunter**, Complex Systems Research Center, University of New Hampshire

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**Plínio B. de Camargo**, Lab. De Ecologia Isotópica, CENA/USP

Lidar remote sensing has a unique capability for estimating forest canopy height, which has a direct and increasingly well-understood relationship to aboveground carbon storage. In our LBA work, we are using lidar waveforms from the Geoscience Laser Altimeter System (GLAS) to estimate canopy height and aboveground

forest carbon storage for each GLAS waveform in the Amazon basin and combining those point estimates with images from the MODIS sensor to develop spatially continuous datasets. We will compare the new biomass estimates with spatially explicit data layers from previous studies in the region and use an existing bookkeeping C flux model to evaluate the sensitivity of C flux estimates associated with land cover change in the region to the new biomass estimates.

Three problems must be addressed to accurately estimate aboveground carbon storage for each GLAS waveform. First, equations representing the waveforms to the physical structure of the forest must be developed, so that estimates of forest canopy height can be made. Next, an equation relating forest canopy height to field estimates of aboveground biomass must be developed. We have previously published on these two topics for field plots in the Tapajos National Forest, near Santarem, Brazil. We have extended this analysis to two other sets of field sites in the vicinity of Manaus and Tanguro, Brazil. These sites were picked to increase the range of variability in climate that we considered. Simple regression analysis using SRTM slope indices and GLAS waveform height metrics indicates that a single equation estimates maximum canopy height at all three sites with 87% of variance explained, and RMSE of 6.8 m, and no statistically significant biases at any site. Similarly, there is a single equation that relates maximum canopy height to field estimated aboveground biomass that fits all three sites. Combining the two, a single equation relating GLAS estimates of maximum height and field estimated aboveground biomass has been created which explains 72% of variance, and an RMSE of 54.7 Mgha-1. At one site (Manaus) there exists a statistically significant bias (+ 31.3 Mgha-1 or 12.5% of the site mean) in the estimates of aboveground biomass.

#### 11.29-P: Detecting leaf phenology of seasonally moist tropical forests with multi-temporal MODIS images

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Leaf phenology of seasonally moist tropical evergreen forests affects carbon and water fluxes. Because mature tropical forests are rich in species (hundreds of species), tall in tree heights (tens of meters) and high in leaf area index (LAI, 4 m<sup>2</sup>/m<sup>2</sup> and more), phenological studies in the field are extremely challenging. Consequently, there are a limited number of field-based phenological studies for evergreen forests in tropical region. Satellite remote sensing at moderate spatial resolution provides frequent observations that may reveal seasonal changes of vegetation. Here we present image analyses of evergreen forests in the tropical region at site- and regional-scales. At the site-scale for a seasonally moist tropical forest site in the Amazon basin, time series data of Enhanced Vegetation Index (EVI) from the VEGETATION and Moderate Resolution Imaging Spectroradiometer (MODIS) sensors showed an unexpected seasonal pattern, with higher EVI in the late dry season than in the wet season. The results from the regional-scale analysis that used time-series data of EVI from MODIS in 2002 show a large dynamic range and spatial variations of annual maximum EVI for evergreen forest canopies in the region. In seasonally moist tropical forests, maximum EVI in 2002 typically occurs during the late dry season to early wet season. This suggests that leaf phenology in seasonally moist tropical forests is not determined by the seasonality of precipitation. Instead, leaf phenological process may be driven by availability of solar radiation and/or avoidance of herbivory.

#### 11.30-P: Modeling Aboveground Biomass Regrowth Rates in Tropical Forests

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Understanding the dynamics of tropical land-use / land-cover change is needed to balance the global carbon budget. While the rates and patterns of deforestation are becoming better constrained, the fate of the cleared land is still highly uncertain. It is estimated that 20-50% of deforested land is in some stage of regrowth. This study uses climate and soils data at a pan-tropical scale to model aboveground biomass regrowth in tropical secondary forests. Data from primary literature studies from throughout the tropics are used to fit models using biophysical variables such as growing-season degree-years, and percent of sand content in the soil. Results are shown as biomass accumulation through tropical forests at 1,10,20,50 and 200 years. Validation of the model is attempted using a previously published dataset of global biomass.

## HY (Hydrometeorology)

#### 12.1-P: Variação temporal de umidade relativa e do déficit de pressão de saturação em uma floresta de transição Amazônia Cerrado.

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O equilíbrio da natureza pode ser claramente percebido, quando estimadas as diversas grandezas físicas intrínsecas a ela, tais como temperatura, umidade, pressão de vapor de água e outras. O objetivo deste trabalho foi analisar a variação diária e mensal de umidade relativa (RH) e do déficit de pressão de saturação (VPD) em uma floresta de transição Amazônia Cerrado (11°24,75'S; 55°19,50'O) com dados do período de 2001 a 2003. O VPD foi estimado pelas medidas de temperatura e umidade. As medidas de temperatura e umidade do ar foram realizadas por um psicrômetro (HMP-35, Vaisala, Inc., Helsinki, Finland) instalado na altura de 42 m. Para as análises foram utilizados dias médios e médias mensais, onde verificou-se que nos meses de março (estação úmida) e agosto (estação seca), os valores de RH foram de 97,8% e 32,8% enquanto o VPD apresentou valores de 4,23 kPa e 0,64 kPa, respectivamente. Nos meses de estação seca houve uma maior variação diária nos valores de RH e VPD que nos meses na estação úmida. A RH na estação úmida foi aproximadamente 22% maior que na estação seca, enquanto o VPD apresentou um incremento de aproximadamente 100% da estação seca a úmida. Conclui-se que as duas grandezas analisadas apresentam comportamento inversamente proporcional, em que com o aumento da temperatura e diminuição de RH, ocorre um aumento do VPD durante o dia. O conhecimento da interação entre componentes do ciclo

hídrico em florestas tropicais são de fundamental importância para a compreensão da dinâmica destes ecossistemas.

#### 12.2-P: Impact of deforestation on Hydrological Cycle in Eastern Amazonia

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The objective of this work was to evaluate the impact of deforestation on the hydrological cycle of the eastern Amazon basin, using BRAMS (Brazilian developments on the Regional Atmospheric Modeling System) including the GEMTM model (General Energy and Mass Transport Model).

The eastern Amazonia is an area of primarily native tropical rain forest, but also comprises several other natural ecosystems such as mangroves and savannah-like vegetation. It is also the most densely populated area in Amazonia, and has been significantly affected by deforestation. In this study, numerical simulations were performed with a high spatial resolution regional model that allows for consideration of mesoscale aspects such as topography, coastlines and large rivers.

In order to evaluate the present situation and to predict potential future effects of this process on the climatic conditions of this region, two model simulation runs, each conducted over a one-year period, were made. In the first run, designated "control simulation", an attempt was made to match the existing surface vegetation. In the second simulation designated "deforestation" was running using scenarios derived from results of Soares-Filho (2002).

The higher-resolution regional modelling revealed important climatic features of the deforestation process, displaying some associated mesoscale effects that are not typically represented in similar Global Circulation Model simulations. Near coastal zones and along large rivers, deforestation resulted in reduced precipitation.

However, it was predicted increased precipitation over mountainous areas, especially on mountain slopes facing river valleys.

Then, these higher-resolution simulations showed that, in general, orography, coastline profile and large river distribution play important roles in determining anomaly patterns of precipitation in eastern Amazonia.

#### 12.3-P: A New Method for Observing Interception Over an Old-Growth Forest in the Eastern Amazon Region

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Conventional methods of estimating rainfall interception have yielded a wide range of results for tropical rain forests, with interception estimates ranging from 9 to 25% of total precipitation for the Amazon. There are now many more long-term eddy flux measurement sites than sites at which the individual forest water budget components (total precipitation, throughfall, and stemflow) are measured. It is worthwhile to pursue a method for estimating interception using eddy-covariance data from the flux sites.

We introduce and describe a new, alternate method for observing interception using eddy-covariance data that could be applied to other flux tower sites worldwide in varying forest types. The approach is to estimate the 'excess' evaporation that occurs following individual events, using baseline diurnal evaporation time series obtained from long time series of flux data. We examine nearly 400 cases during the period between April 2001 and July 2003 at the Km67 old-growth rain forest site of LBA-ECO in the Tapajós National Forest near Santarém, Brazil. A ceilometer was used to identify the exact starting and ending times of the precipitation as high temporal resolution rainfall data (beyond 30 minutes) were not available. We compare our interception estimates to those reported from conventional methods, as well as the interception calculated from commonly-used models, including the interception model of Gash. To show how the method is applicable to other forest types, we compare interception for the Amazon with data obtained in a boreal forest in Manitoba, where similar eddy-covariance and ceilometer measurements were made during BOREAS.

#### 12.4-P: Ajuste de Polinômio Para Dados do Índice de Área Foliar da Floresta de Transição Amazônia-Cerrado

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As folhas são órgãos fundamentais nos estudos do intercâmbio gasoso e do ciclo de carbono nos ecossistemas, uma vez que são responsáveis pelos processos fotossintéticos, de transpiração e são os maiores contribuintes na composição da serrapilheira. Nesse sentido, a análise da dinâmica anual do índice de área foliar, por meio de ajustes de curvas de regressão, se apresenta como uma ferramenta de análise de grande utilidade prática. Considerando esses aspectos, o presente trabalho teve como objetivo verificar a possibilidade de ajustes de curvas de regressão aos dados originais do índice de área foliar, obtidos a partir da interceptação da radiação fotossinteticamente ativa, de acordo com o método proposto por Monsi & Saeki (1953), para uma área de floresta de transição entre a Amazônia e o Cerrado, em Sinop, Mato Grosso. A análise dos dados obtidos revelou que foi possível ajustar um polinômio do quarto grau para a estimativa do índice de área foliar (IAF) em função do dia juliano (t) tanto para o ano de 2002 ( $IAF = -33,58 \times 10^{-10} t^4 + 23,12 \times 10^{-7} t^3 - 43,36 \times 10^{-5} t^2 + 17,08 \times 10^{-3} t + 3,12$ ;  $R^2 = 0,8567$ ), quanto para o de 2003 ( $IAF = -42,02 \times 10^{-10} t^4 + 29,12 \times 10^{-7} t^3 - 54,36 \times 10^{-5} t^2 + 21,11 \times 10^{-3} t + 3,91$ ;  $R^2 = 0,8371$ ). Estes resultados possibilitam o emprego destas curvas para posteriores trabalhos, sobretudo de modelagem, que necessitem de dados instantâneos do índice de área foliar nesse ecossistema.

#### 12.5-P: Analyzing LBA datasets within a climate framework for land surface modeling applications

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Measurements of surface exchanges have been made at several flux towers throughout the Large Scale Biosphere-Atmosphere (LBA) Experiment in Amazonia. These measurements provide substantially improved documentation and potentially greater understanding of the true role of the Amazon as a regional entity within the energy, water, and carbon cycles at local and global scale. Flux tower data are also important in the context of calibrating and validating the Land Surface Models (LSMs) which simulate the biosphere's responses to near surface atmosphere conditions (e.g., solar radiation, temperature, precipitation) and which are used to provide the lower boundary conditions in weather and climate models. However, the flux tower measurements made during LBA not only provide a sample of surface exchanges that is sparsely distributed in space, they are also available for different time periods at the various tower sites. It is therefore important to investigate the extent to which the actual period of data collection at each LBA site is representative of the longer-term climatology for that site. Such climatological characterization will aid the development of a better understanding of the meteorological conditions to which each site was exposed during data collection relative to the regional climatology, and is also important in the context of LSM calibration studies using automatic model parameter estimation methods because the resulting model parameters may be correlated with the microclimate of the study site. This poster will report the first results of a study in which precipitation and temperature data from weather stations nearby (within 100 km) of the LBA flux tower sites are used to investigate the climatology during the period of data collection at each LBA flux tower site relative to the long-term regional climatology.

#### **12.6-P: Biomass Burning in the Cuiabá-Santarém Area and Precipitation**

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**Pedro L. da Silva Dias**, University of São Paulo, pldsdias@model.iag.usp.br

Numerical experiments with BRAMS were performed with two nested grids (50 and 10 km horizontal resolution, respectively) with and without the effect of biomass burning in 8 different situations for 96 hour integrations. Only the radiative effect of aerosols is included. The results were analyzed in large areas encompassing the Cuiabá-Santarém road in the north (A), two in the middle section (B1 and B2) and the southern area C where most of the burning takes place. In addition the whole area average was also analyzed. The precipitation change due to the radiative impact of biomass burning is generally negative. However, there are a few cases with a positive impact (up to 80% in one case). Two opposite forcing mechanisms were explored: (a) the thermodynamic forcing that is generally negative in the sense that the aerosol tend to stabilize the lower atmosphere and (b) the dynamic impact associated with the low level horizontal pressure gradients produced by the aerosol plumes. In order to understand the non-linear relationship between the two effects, experiments were performed with double emissions. In these cases, the dynamic effect overcomes the stabilization produced by the radiative forcing and precipitation increase is observed in comparison with the control experiment. This result is robust in the sense that an ensemble of 8 cases were performed. The conclusion is that in the mean, the biomass burning radiative forcing tends to decrease the precipitation. However, very large concentrations of aerosols may lead to an increase in the precipitation due to the dynamical forcing associated to the horizontal pressure gradients.

## **LC (Land Use and Land Cover Change)**

#### **13.1-P: Dynamics of the Water Table in Pasture Area and Transitional Forest Amazonia Cerrado in Brazil**

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In last two decades, in the Amazonia South, the conversion of native vegetation has been a constant by crops or pastures, changing the regional hydrologic cycle with effects also in the underground water resources. The present work is evaluate the recharge time and the water deficit in the water table dynamics in transitional forest Amazonia Cerrado and pasture area in Brazil (11°24.75'S; 55°19.50'O). The climate present dry and wet seasonal water characteristic with seasons defined. 6 water table monitoring wells had been installed under forest and under pasture in the radio of 30 km, where they had been carried through measured monthly of the water level (October/2004 to August/2005). The water level variety seasonality in both ecosystems, presenting minor level in months of dry-wet transitional season in forest (-3.38m, August) and pasture (-3.53m, October), respectively. Larger water deficit in forest and pasture area occurred, respectively, 5 and 7 months after finished precipitation, while the forest presents minor period of recharge. The differences of water deficit and recharge time between the study areas are attributed to fact of the pasture area, presents bigger sun incidence, bigger superficial temperature and consequently bigger lost of water for evaporation than forest, apart from the pasture presents a soil with minor capacity of infiltration than forest, were has bigger biologic activity, soil more porously and more depth roots, favors the water penetration in the soil. Studies of underground waters contribute with the understanding of the hydrological characteristics that are intrinsically attached with the vegetation.

#### **13.2-P: Análise do Efeito do Fotoperíodo Sobre a Dinâmica do Índice de Área Foliar da Floresta de Transição Amazônia-Cerrado**

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Considerando que as plantas respondem a estímulos ambientais, sobretudo aqueles com maior estabilidade, pretendeu-se analisar o grau de associação entre a dinâmica anual do índice de área foliar e o fotoperíodo de uma área situada na floresta de transição entre a Amazônia e o Cerrado, em Sinop, Mato Grosso. Os dados diários do índice de área foliar (IAF) foram obtidos a partir das curvas de regressão polinomial obtidas previamente pelos autores. Os dados diários do fotoperíodo (F) foram calculados para a latitude local (11° 24,75' S) com correção para o ângulo horário do nascer do sol, acrescentando 0,83°, e somando 1,2 horas à duração astronômica do dia. Analisando-se os pares de dados diários das variáveis por correlação cruzada, verificou-se que o IAF está correlacionado com o F, com um tempo de atraso de seis dias para o ano de 2002 ( $r = 0,8325$ ) e de sete dias para o de 2003 ( $r = 0,8626$ ). Esses resultados sugerem que o fotoperíodo estimula as variações do índice de área

foliar e que as respostas desta última variável são verificáveis aproximadamente uma semana após esse estímulo para o ambiente estudado.

### **13.3-P: Scale-dependency of socio-demographic data in a colonization settlement area in Pará, Brazil**

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Studies of population and environment have linked social surveys and satellite data to understand the role of human demography in land cover change. In both data sources, scale and scale-dependency are significant factors affecting data analyses and interpretation. In this work, we analyze issues of scale-dependency in population-environment relationships using primary (socio-demographic and economic data from structured field surveys) and secondary socio-demographic data sources (IBGE and IPEA) in a colonization settlement area along the Transamazon Highway between the municipalities of Uruará and Altamira, in the state of Pará. Data about population (including size, composition, and distribution); agrarian structure (size of rural properties and land tenure); economics (characteristics of rural production); availability of infrastructure and services; and land cover are overlaid in a geographic information system (GIS) at four different levels: property, settlement, census tract, and municipality.

Focusing on spatial organization/distribution of people and land uses, the data are used to show that analysis at each one of the four levels, alone, shows an incomplete picture that could lead to misinterpretation of the process of change in place in this region.

The results indicate the relevance of linking case studies and regional studies in order to improve understanding of land use trajectories in the Brazilian Amazon.

### **13.4-P: Dinâmicas de Fronteira e Ecologia de Paisagem, uma Análise Multitemporal do Uso e Cobertura da Terra em Santarém e Belterra, Pará.**

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As mudanças de uso e cobertura da terra na Amazônia têm atraído a atenção da comunidade científica pelas altas taxas de conversão da floresta e por suas implicações em relação ao sistema climático global e regional. Este trabalho pretende caracterizar a evolução da paisagem em Santarém e Belterra entre 1986 e 2005. Nos últimos anos, a expansão da cultura de soja nestes municípios tem produzido efeitos diferenciados na estrutura da paisagem. Mapeamentos temáticos utilizando imagens de média resolução espacial (Landsat TM) estão sendo conduzidos visando a análise espaço-temporal da área, e inclui dados para floresta, floresta explorada, savana, campinarana, agricultura, agricultura e capoeira, agricultura e pastagem, pastagem, pastagem e capoeira, pastagem e agricultura, área urbanizada, capoeira, áreas arenosas e corpos d'água. Métricas de análise espacial de paisagem estão sendo calculadas. A base de dados gerada permitirá avaliações detalhadas sobre as dinâmicas de fronteira observadas. Em particular, a localização, taxas e padrões espaciais de conversão de floresta e os condicionantes de mudança do uso das terras serão avaliados. A integração dos resultados com as informações disponíveis para o zoneamento ecológico econômico da área de influência da rodovia BR-163, fornecerá uma contribuição à gestão e ordenamento territorial nos municípios estudados.

### **13.5-P: Fire in the Brazilian Amazon: a household behaviour model and policy implications.**

**Larissa Steiner Chermont**, UFPA, [larissa@ufpa.br](mailto:larissa@ufpa.br) (Presenting)

Fire destruction in the Brazilian Amazon is causing serious negative impacts on the proper functioning of its ecosystems. This is mainly due to its effects on land cover, land use, biodiversity, climate changes and forest ecosystems. Fire is regularly used in the Amazon to deforest and prepare agricultural land and pasture. Due to its low cost, fire is strongly linked to land use patterns adopted in the region. Paradoxically fire itself is also one of the greatest threats to the Amazon ecosystems when, having escaped from human control, it accidentally burns forests, animals and material goods. This paper focuses on human activity in the Brazilian Amazon land use systems as the main source of fire ignition. More specifically, the presented models assess the decision-making process for land use and the implications of fire as a chosen technique as well as how it is seen as a risk to be prevented or not. Agriculture and extensive cattle ranching are the activities to be assessed in the context of household economic, physical and social context, in order to reveal the rationale that lies at the roots of Amazonian household behaviour with respect to fire. Additionally, this paper aims to contribute to regional public policies discussions where intensification is touted as a *raison d'être*. Old frontiers should benefit from government investments in infrastructure, preventing the opening of new frontiers and the expansion of extensive land use practices. An alternative for Amazonian landholders is to engage in the environmental services market, more specifically carbon sequestration activities.

### **13.6-P: A multi-platform technique to validate active fire detections from the GOES Imager**

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One of the goals of the LBA-ECO Phase III study LC-35 is to evaluate fire detections from the GOES Imager as part of the generation of a fused multi-sensor active fire product in the Amazon. The principles of the validation procedure used in this study were developed and tested in the Amazon within the Phase II project LC-23 for MODIS and ASTER on the Terra satellite. For the GOES Imager, the burning and non-burning areas within the pixel were mapped using near-coincident fire masks from Terra/ASTER and Landsat-7/ETM+ and detection probabilities were derived as a function of summary statistics of the high resolution fire pixels. To evaluate the impact of the time difference between the GOES and high resolution fire observations, we estimated the short-term change of the summary statistics at the scale of the GOES pixel, using pairs of fire masks from same-day imagery from ETM+ and ASTER, flown on Landsat-7 and Terra ~ 25 minutes apart. We found that, while the progression of the fire front was observable, in some biomes the change in summary statistics was small and did not impact substantially the derived

detection probabilities. This configuration of geostationary and polar data also allows for the evaluation of the scan angle effects of the detection performance. However, as ASTER and ETM+ fly on sun-synchronous platforms, further sensors will need to be considered to cover a fuller range of the local time of fire observations.

### **13.7-P: Analysis Of Land Cover Change in Eastern Para, Brazil Based On Four Dates Of Landsat Data From 1984 To 2002**

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The objective of this research is to spectrally characterize the vegetation and the land use of the region and to evaluate the current trends. The goal is to understand the change dynamics in an area that is highly fragmented and where most of the area is successional pasture in various stages of regrowth or reformation, perennial and permanent agriculture and secondary or successional forests. There are few large fragments of mature forest (floresta ombrofila densa) remaining. The study covers a period of 18 years and uses data from Landsat/MSS and TM from 1984, 1994, 1999 and 2002. All data were geometrically coregistered and were converted from digital numbers (DNs) to reflectivity.

Over the 18 yr. time period, landcover types showing the largest declines include mature forest (floresta ombrofila densa) and selectively logged forest (mata explorada). Land covers showing the largest increases include intermediate aged secondary forest (capoeira intermediária), young secondary forest (capoeira jovem), and shrubby pasture (pasto sujo). Additionally, the amount of exposed soil has approximately doubled, indicating an increase in cultivated land. Although the initial wave of deforestation occurred several decades ago in this region, the process of transforming the landscape from high-biomass forests to low-biomass fields of cultivation, pastures, and young secondary forests has continued during the last two decades.

Transition matrices for these land cover are being developed for four points in time and at random locations. The matrices should reveal typical cover change pathways. Additionally, we will examine the validity of classification signatures across the larger region.

### **13.8-P: Gap Fraction for Detection and Mapping of Canopy Opening in Undisturbed and Selectively Logging Forests**

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Tree mortality in tropical forests often leads to canopy openings or gaps that are critical to regeneration and the dynamics of tropical forests. If measures of canopy gaps could be collected using remote sensing, then tropical forest dynamics could be investigated at the regional scale. We ask whether it is possible to detect canopy gaps by using of remotely sensing data gathered on the ground and whether there is a relation between forest disturbance age and canopy opening? To answer these questions, we collected an intensive set of gap fraction measurements in the Tapajos National Forest, Pará. The data were measured using the Licor LAI-2000 instrument in 10 plots with dimensions of 50 m × 200 m distributed in areas with different forest disturbance ages (forests logged in 1997, 1999, 2000, 2001, 2002 and 2003) and undisturbed forest (control plots). For each one of these treatments, two plots were installed. All plots were subdivided in 10 m × 10 m grids where pipes marked corner points. Gap fraction data were collected for each of these grid points (126 per plot). A geostatistical analysis showed that gaps < 200 m<sup>2</sup> could be detected and differentiated from medium (200 - 400 m<sup>2</sup>) and large (400 m<sup>2</sup>) gaps. A preliminary analysis indicated that after at least three years of forest regeneration, there was no detectable difference in gap fraction between the logged areas and the undisturbed forest.

### **13.9-P: Efeito da Fertilização Nitrogenada Sobre a Emissão de no e N2O em Solos Cultivados com Milho na Região dos Cerrados de Goiás-Brasil**

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Nas últimas duas décadas a expansão da agricultura em áreas de cerrado ocorreu com utilização intensiva de fertilizantes, especialmente os nitrogenados cujo consumo aumentou de 779.000 para 2.245.000 Ton entre 1990 e 2004. No entanto, o efeito do uso desses fertilizantes sobre a emissão de gases traço é pouco conhecido. Este trabalho objetivou mensurar o efeito da fertilização nitrogenada sobre emissões de NO e N2O em solos cultivados com milho. Os fluxos dos gases foram mensurados num cultivo comercial e num experimental, antes do plantio, após o plantio com fertilização no sulco, após as fertilizações em cobertura e após a colheita. No cultivo comercial as fertilizações ocorreram no plantio (33,7 kg N ha-1 na forma de fosfato mono-amônico), 16 e 30 dias após a emergência (103,2 e 18,4 kg N ha-1 na forma de uréia), enquanto no cultivo experimental as fertilizações ocorreram no plantio (9 kg N ha-1 na forma de uréia) e 22 dias após a emergência em duas doses de N (22,5 e 45 kg N ha-1 na forma de uréia). Os fluxos de NO mensurados no cultivo comercial (3,9 e 8,8 ng cm-2 h-1) e no experimental (7,9 e 6,0 ng cm-2 h-1) após as fertilizações em cobertura foram significativamente maiores que os mensurados após o plantio com fertilização no sulco, tanto no cultivo comercial (0,37 ng cm-2 h-1) quanto no experimental (1,3 e 2,7 ng cm-2 h-1), e após a colheita (média de 0,41 ng cm-2 h-1). Observou-se discretos incrementos nos fluxos de N2O apenas após as fertilizações em cobertura, no cultivo comercial (1,1 ng cm-2 h-1) e no experimental (3,2 ng cm-2 h-1). Os resultados mostram que os fluxos de NO dependem da quantidade e da forma do nitrogênio adicionada no solo via fertilização e que esses tendem a estabilizar, enquanto que os fluxos de N2O, nas condições estudadas, são menos influenciados pela fertilização nitrogenada.

### **13.10-P: Deforestation and Land Concentration in Brazilian Amazonian Forest**

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The rapid changes in land cover in the Amazon region, driven by governmental projects aimed to foster land occupation and economic activities, have been taking place over the Amazon ecosystems.

Although these deforestations have been closely monitored since 1978 with the help of remote sensing technology (e.g. Skole and Tucker, 1993), and significant attempts have been made in order to understand their causes and possible trends (e.g. Pfaff, 1999; Alves et al., 2003), the relationship between deforestation and land tenure remains largely unexplained.

Within this context, and assuming that land appropriation is a major driving force behind deforestation, a major goal of this study was to understand, on a large scale basis and through the integrated analysis of social and economical variables and deforestation data obtained via remote sensing imagery, the role of the land ownership structure on the Amazon deforestation. In particular, the deforestation distribution patterns along the years, and their spatial dependence on land appropriation, land concentration, and land use were investigated. Likewise, the current institutional context (i.e. governance) of the Amazon region and its geographical relation to potential deforestation hotspots was also evaluated.

This study, conducted in an area comprising 221 municipalities, in which 90% of the deforestation in the legal Amazon takes place, was to understand the role of the agrarian structure in the conversion of forest into pasture and agriculture fields. Linear regression results indicate that 54% to 62% of the variation in deforestation occurred between 1997 and 2004, respectively, are explained as a function of changes in the amount of appropriated land in 1995. Likewise, up to 80% of the deforestation can be well explained by the variation in land concentration. In fact, strong spatial correlations were found between deforestation hotspots and land appropriation and land concentration. On the other hand, these critical areas have insufficient governance, particularly at the federal level. As our results clearly demonstrate, strong governance and institutional integration, with emphasis on the territorial ordainment, are mandatory in order to reduce the rapid pace of deforestation in the Brazilian Amazon.

### **13.11-P: Data rejection and gap filling in micrometeorology measures of an Amazonian transitional forest**

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Sensor and/or infrastructure (i.e., power) failures caused unavoidable gaps in the data collection, while short-term events such as driving rainfall and/or poor turbulent mixing lead to the rejection of data. The goal of this work was (a) to quantify of data rejection, (b) to quantify gap filling, and (c) to analyze the monthly average ( $\pm$ SD) between gap filled and gap not filled of micrometeorology measures of an Amazonian transitional forest. We use micrometeorology measures (air temperature, humidity, radiation and wind speed) of the tower-based installed in an Amazonian transitional forest (11°24.75'S; 55°19.50'W) on the period 2001 to 2003, concluding a total of 20 months ( $n=7847$ ). Gaps in data were filled using different interpolation treatments, according to gaps minor than 3 hours; or gaps between 3 hours and 24 hours; or gaps greater than 24 hours. The monthly average of micrometeorology measures were assumed as a diurnal average calculated by averaging each 30 min measurement for a particular time (e.g., 10:00-10:30 hours). These results of analysis of gap filling for treatment interpolation in micrometeorological data suggest that including in months where data recovery was on the order of 66% the monthly average ( $\pm$ SD) was satisfactory when compared with monthly average ( $\pm$ SD) of gap not filled data. Studies of data rejection and gap filling contribute with the use of models of CO<sub>2</sub>, water vapor and energy fluxes developed to study the response of tropical ecosystems related to the environmental conditions.

### **13.12-P: Using Wavelet Transform for MODIS Time-Series Analysis**

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The Normalized Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index - EVI are widely accepted as good indicators of vegetation properties at regional scale. This work reports preliminary findings of a science training research project carried out as part of the LBA-Ecology program. The experiment was performed to assess the suitability of wavelets transform for Moderate Resolution Imaging Spectroradiometer - MODIS time-series filtering and analysis in the Amazon Region. In that, MOD13 Vegetation Indices product, 1km spatial resolution, 16-Days composite images from 2000 to 2005 were used as input data. The test site was a west - east transect (75° W to 35° W at 6° South latitude) encompassing several landscape types as tropical forest, deforestation area, transitional forest and semi-arid vegetation ("caatinga"). The Discrete Wavelets Transform (DWT) were used for filtering MODIS time-series and Continuous Wavelets Transform (CWT) for time-series analysis. The results showed that wavelets transform provides a gain in multitemporal analysis and visualization on interannual NDVI and EVI variability patterns.

### **13.13-P: Effects of seasonality and timing of image acquisition on remote observation of regenerating vegetation in the seasonally-dry tropical forests in Rondonia, Brazil**

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This study examines how the timing of the remote observations of the land surface affects the resultant land cover characterizations. Specifically, we document the spectral properties of the land surface in a dynamic area of the Brazilian tropical rainforest at the beginning and end of the dry season. Over the course of a season, the biophysical properties of the vegetation and, correspondingly, the spectral signature of the vegetation can change for many reasons. These reasons include human directed land use change, as well as growth, mortality, and stress of vegetation. Studies conducted on the ground, and more recently with high temporal resolution (e.g. MODIS) data, have documented phenological changes in tropical vegetation from the wet to dry season.

The analysis is separated into two parts. In the first part, using atmospherically corrected Landsat reflectance data acquired over Rondonia, Brazil in May and August 2003, we analyze the spectral dynamics of several land cover features, with a focus on regenerating vegetation. In the second part, we extend this analysis by exploring the consequences that seasonal differences in spectral signatures have on thematic land cover mapping. With a better understanding of the seasonal dynamics of the tropical land surface, specifically regenerating vegetation, we can improve our ability to monitor changes in this ecologically important region.



### **13.14-P: Assessment of multi-scale optical and microwave imagery for mapping biodiversity surrogates at an Amazon floodplain site**

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The Amazon River floodplain, or varzea, is remarkable in its extent and in the spatial complexity of its habitats. Although species diversity for most taxonomic groups is lower in floodplain than in upland communities, rates of endemism are high. The ecological integrity of varzea habitats, and the traditional livelihood of its human inhabitants, are threatened by a variety of extractive activities. Since the current extent of protected areas is inadequate, additional reserve areas must be delineated. However, conservation planners face a severe lack of data on species distributions. Appropriate surrogates for biodiversity are needed as a basis for location and management of protected and sustainable use reserves.

This study assessed the feasibility of using remote sensing datasets to delineate geographical units to serve as biodiversity surrogates. The surrogates, to be input to the C-Plan and MARXAN decision support systems for conservation planning, were proposed by a multi-disciplinary working group of scientists with expertise in the várzea environment. They include vegetation types, inundation extent and duration, extent of interface between várzea and upland, and catchment effects. Time series of high-resolution active microwave (JERS-1, RADARSAT, Envisat) and optical data (Landsat) were assembled and coregistered for a floodplain reach west of Manaus. A three-year time series of MODIS data was analyzed to determine the utility of these globally available products for mapping surrogate units. The potential for continental-scale mapping with ScanSAR products from the recently launched ALOS PALSAR was tested using JERS-1 scenes.

The results show that integration of high-resolution optical and SAR data, and analysis of floodplain environments in conjunction with their catchments, allow optimal mapping of biodiversity surrogates for varzea environments. The lower spatial resolution of simulated ALOS ScanSAR resulted in lower accuracies in mapping floodplain units, but the scale and temporal frequency are appropriate for regional-scale surrogate mapping.

### **13.15-P: Proposal of a Protocol to Post-Process Micrometeorological Data**

**Hewley Acioli Imbuzeiro**, Federal University of Viçosa, hewley@vicosa.ufv.br (Presenting)

**Marcos Heil Costa**, Federal University of Viçosa, MarcosHeil

Data collected at micrometeorological sites may have a variety of uses, from the micrometeorological characterization of an ecosystem to the improvement of numerical weather forecast models. The final release of micrometeorological data is strongly influenced by the post-processing of the raw data collected and, in a network of stations, they may differ considerably among them, because of different post-processing techniques used. As the network grows, the series get longer, and we move from datalogging to data streaming, there is an increased need of a standard, automatic procedure to post-process the data. To reduce differences and inconsistencies across sites, improve data quality and repeatability, and facilitate future re-processing, we propose a protocol to post-process data from a network of micrometeorological towers. The protocol defines six levels of increased data quality that should be achieved by all data involved: Level zero data is the raw data out the sensors; level one is the data after the application of the instrument calibration curves; level two data is processed to eliminate errors that are related to a single instrument, while level three data is processed to correct for errors that may be noticed only with the use of multiple sensors, like conservation of energy and vertical gradients; level four data is processed to gap fill the meteorological station data using simple interpolation procedures, to prepare a dataset ready for micrometeorological model driving; and level five is the data with the gaps filled by a mechanistic micrometeorological model, ready to improve weather forecast models.

### **13.16-P: Use of the Mixture Model in the attainment of the training data futures to be employed in the integration method of Multi Resolutions Remote Sensing data, for the representation of the land covering**

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This work had objective to establish an analysis of the training data use viability, gotten through the mixture technique, in the elaborated model to monitoring the vegetation dynamic cover in Amazonia. This process is based on the techniques developed and applied for the team of the Maryland University, where to larger emphasis is in the integration of different sensory spatial data with different resolutions (Terra/MODIS, Landsat/TM, ETM+ and CBERS 2/CCD). The study area, it was chosen one region in Mato Grosso State, will be presenting great representativity of the Brazilian Amazonia in terms of land to cover characteristics. The process elaboration occurred, jointly, with the application of several tests, using different training dates (ETM+, TM and CBERS/CCD scenes) obtained through the same technique, individually or in group. Through its preliminary results and its comparison with the dates obtained from PRODES Project (to year of 2002), the feasibility of the mixture application was verified. It is expected that with this analysis, the methodology of the monitoring of vegetation cover dynamics contribute, especially, to projects already developed for the Brazilian Amazonia, as it is the case of PRODES project.

### **13.17-P: REAL CONSERVATION SCENARIOS FOR THE MATO GROSSO STATE Analysis of landscape structural indexes for the microregions of Alto Teles Pires and Aripuanã.**

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The state of Mato Grosso has been the historical entry route for occupation of the Brazilian Amazon. This process has been accelerated since the 1960s, and natural habitats were intensively converted into pasture and agricultural systems. This transformation, however, is not homogenous; varying degrees of anthropization can be found within the regions of Mato Grosso. Two areas were selected from the state's land cover map, corresponding to the microregions of Alto Teles Pires (ATP) and Aripuanã (ARI). These were selected as they present distinct levels of degradation. The following classes compose the LC map: 1. Forest, 2. Cerrado, 3. Anthropized Area-I (pasture/ vegetation on initial succession stages), 4. Anthropized Areas-II (soybean cultures). In order to compare the spatial structure of these sites, two landscape metrics were selected: percent of class cover (PLAND) and distance from nearest neighbor (ENN). Sampling points were selected randomly at both study sites for statistical analysis. For each sampling point, were calculated initially for the forest class. Normality and ANOVA tests were applied considering location as the source of variation. Preliminary results show that mean PLAND for the Forest class were significantly different between regions ( $p < 0.05$ ):  $PLAND(ARI) = 58.75\%$  and  $PLAND(ATP) = 16.20\%$ . Similar results were observed for ENN (U - test,  $p < 0.001$ ) for the Forest class:  $ENN(ARI) = 1900m$  and  $ENN(ATP) = 14,051m$ . This result confirms the higher degree of anthropization at the ATP site and the good conservation status of ARI. ATP indexes indicated the presence of few remaining forest patches presenting a large degree of isolation. This scenario implies in loss of biodiversity by high habitat reduction and genetic flow impediment by isolation. In general, these results suggest that ARI may offer good conditions for maintenance of biodiversity, and that means should be established to prevent degradation of this site as observed for ATP. The latter region requires restoration practices, as it exhibits natural cover percentages and fragmentation worse than what is considered appropriate to maintain local biodiversity levels. A more comprehensive analysis considering metrics for all cover classes is being presently evaluated, to better understand the landscape structure of both sites and fully support the present conservation status hypothesis.

### 13.18-P: Land-Cover Classification in the Brazilian Amazon with Satellite Images: Towards Increasing Accuracy

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**Emilio F. Moran**, Indiana University, [moran@indiana.edu](mailto:moran@indiana.edu)

This presentation summarizes our research on land-cover classification, especially vegetation classification, in the Brazilian Amazon. Our research has involved in the comparison of different classification approaches (e.g., minimum distance classifier (MDC), maximum likelihood classifier (MLC), ECHO, and decision tree classifier (DTC)), multisensor data fusion (e.g., Landsat ETM+ and Radarsat data, Landsat TM and SPOT HRG data), combination of spectral and textural images, and modeling of forest stand parameters. This research has indicated the complexity of land-cover classification, especially successional vegetation stages and agroforestry. Selection of a suitable classifier and use of textures are effective for improving land-cover classification accuracy. The ECHO and DTC classifiers have significantly better classification performance than MDC and MLC. Incorporation of multisensor data fusion and textures provides better classification accuracies than single sensor data with pure spectral signatures. However, the classification accuracy for successional vegetation stages is still poor, no matter what spectral or textural information is used during image classification. A forest stand structure based approach benefits successional vegetation classification. An entropy measure, calculated using tree height distribution from field vegetation inventory data and then modeled with the integration of Landsat spectral signatures and field measurements, can effectively classify successional vegetation into three stages with overall accuracy greater than 80%, which is significantly better than direct classification of remotely sensed data.

### 13.19-P: Analysis of the Transformed of Wavelet of Morlet in Signs of Temperature, Humidity and CO2 in the Experimental Site of Santarém

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The nocturnal boundary layer (NBL) presents a challenge to the researchers due to its complexity. In stable conditions turbulence intensity is weak and the eddy covariance (EC) flux calculation is inadequate. Also, nonstationary and intermittent processes, including gravity waves makes the parameterization of the NBL in terms of time and space scales difficult. One of the most important outstanding problems in NBL studies is the correct determination of the turbulent fluxes. To calculate the turbulent fluxes correctly one needs to know the structure of the turbulent fields and their singularities that affect the fluxes themselves. These singularities present themselves in the form of coherent structures and wave motions. In this work the nocturnal turbulent eddies will be studied through wavelet analyses of the time series of temperature, humidity and CO<sub>2</sub>. The main purposes of this study are to find singularities in these variables and to obtain the relative intensity of the singularities at different scales. The data set used here was collected in the pasture site of the LBA-ECO (3.012° S, 54.537° W) located near the km 77 of the Cuiabá-Santarém highway. This site has an EC system comprised of a 3D sonic anemometer and an infrared gas analyzer to measure CO<sub>2</sub> and H<sub>2</sub>O concentrations. Our results show that particular criteria used to define coherent structures could be a useful task to determine its time life and its contribution to the turbulent fluxes.

### 13.20-P: Socioeconomic development and forest fragmentation in the state of Mato Grosso, in the 1986-2000 period

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The recent changes on the Brazilian Amazônia, a consequence of deforestation, increase the discussion and preoccupation of scientists, politicians and the society for the environmental issues. The different types of occupation intensities, land use and economic activities lead to distinct levels and patterns of forest fragmentation. The cleared areas have been converted into agricultural crops, pastures or simply abandoned after logging. Most studies on the problem emphasized the quantification of deforestation, without associate it to regional economic questions. Therefore, it is important to relate socioeconomic factors into the forest cover change analyses. These changes on landscapes are characteristic of the state of Mato Grosso, part of the so called 'arc of deforestation', where higher rate of clearing has occurred. The preliminary work aims to discuss the results and spatial pattern analyses, done by use of landscape metrics, and their possible relationships with socioeconomic factors during the 1986-2000 period. IBGE population and agricultural census data at municipal level and land cover spatial data from TRFIC-MSU (1986-1996) and

PRODES-INPE (2000) were used. The identification of consistent relationships between the different factors could help the development of prediction models of the future impacts resulting from the regional development process.

### 13.21-P: Spatial patterns of nocturnal surface-to-atmosphere decoupling over the Amazon

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At nighttime, when there is enough surface cooling, often the surface layer decouples from the upper atmosphere. In this case, surface processes, such as ecosystem respiration, water evaporation or dew deposition, accumulate on a very shallow layer, near the surface. Regional surface fluxes are seriously affected in these conditions, as decoupling is a highly localized process. The average fluxes over a given area, important for the surface parameterization of weather and climate numeric models depend on an accurate knowledge of the temporal and spatial patterns of surface decoupling. Observations carried out during LBA indicate that, over deforested regions in the Amazon, there is large nighttime radiative loss, leading to strongly stable temperature stratification, and significant nighttime decoupling.

In the present study, we use 7 years of data collected by 9 meteorological stations scattered over the confluence region of the Amazon and Tapajós rivers to infer decoupling occurrence and how it is affected by land use type (forested or clear) and proximity to the rivers. The impact of surface heterogeneity on average regional fluxes is then estimated. Focus is given to the importance of the deforestation and its spatial patterns on the average surface-to atmosphere exchange.

### 13.22-P: The impact of scaling-up on biophysical variable estimation

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This study employed regression and artificial neural network techniques to model leaf area index (LAI) dynamics in the Santarem, Brazil area using ASTER, ETM+, MODIS and IKONOS satellite data to determine the effect of scaling-up with different satellite sensor resolutions. LAI values were gathered at 76 field locations characteristic of many different cover types: mature forest, secondary succession, pasture, cropped land, barren land, and urban area. The field data were used with satellite data to assess multiple regression and artificial neural network LAI predictive abilities. Assessments of model accuracy were determined by calculating RMSE. Results demonstrated that neural networks perform better than multiple regression for LAI modeling. In addition, ASTER data provided the most accurate LAI models - probably because its spatial resolution was characteristic of the 20 x 20 m sampling scheme. The poorest modeler of LAI was found to be MODIS with its 250 and 500 m resolutions indicating that much biophysical detail is lost when using coarser remote sensing data. New and expanded research is being conducted in the Altamira area of Brazil that builds upon the positive results of the Santarem study. Much more intensive neural network classification and modeling has begun in the Altamira area using multi-temporal and multi-resolution remotely sensed data supported by detail field measurements. Improved neural network modeling of selected bio-parameters using lower resolution spectral data informed by samples of higher resolution spectral and field data is anticipated.

### 13.23-P: Ajuste de Polinômio para Dados do Índice de Área Foliar da Floresta de Transição Amazônia-Cerrado

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As folhas são órgãos fundamentais nos estudos do intercâmbio gasoso e do ciclo de carbono nos ecossistemas, uma vez que são responsáveis pelos processos fotossintéticos, de transpiração e são os maiores contribuintes na composição da serrapilheira. Nesse sentido, a análise da dinâmica anual do índice de área foliar, por meio de ajustes de curvas de regressão, se apresenta como uma ferramenta de análise de grande utilidade prática. Considerando esses aspectos, o presente trabalho teve como objetivo verificar a possibilidade de ajustes de curvas de regressão aos dados originais do índice de área foliar, obtidos a partir da interceptação da radiação fotossinteticamente ativa, de acordo com o método proposto por Monsi & Saeki (1953), para uma área de floresta de transição entre a Amazônia e o Cerrado, em Sinop, Mato Grosso. A análise dos dados obtidos revelou que foi possível ajustar um polinômio do quarto grau para a estimativa do índice de área foliar (IAF) em função do dia juliano (t) tanto para o ano de 2002 ( $IAF = -33,58 \times 10^{-10} t^4 + 23,12 \times 10^{-7} t^3 - 43,36 \times 10^{-5} t^2 + 17,08 \times 10^{-3} t + 3,12$ ;  $R^2 = 0,8567$ ), quanto para o de 2003 ( $IAF = -42,02 \times 10^{-10} t^4 + 29,12 \times 10^{-7} t^3 - 54,36 \times 10^{-5} t^2 + 21,11 \times 10^{-3} t + 3,91$ ;  $R^2 = 0,8371$ ). Estes resultados possibilitam o emprego destas curvas para posteriores trabalhos, sobretudo de modelagem, que necessitem de dados instantâneos do índice de área foliar nesse ecossistema.

### 13.24-P: A Multitemporal MOD13Q1 "Ready-to-Use" Databasis for the Brazilian Cerrado

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The Brazilian Cerrado, the largest tropical savanna region in the world, covering approximately 45% of South America, is marked by a pronounced contrast in precipitation, a large land cover and floristic diversity and rapid human induced changes.

Due to its geographical extension and strong seasonality of the main physiognomies, remote sensing based assessments and mapping of the Cerrado landscapes is a major challenge.

Within this context, moderate resolution imagery datasets, as those provided by the MODIS sensor onboard the Terra and Aqua platforms are certainly the best alternative available for systematic land cover monitoring. The MODIS data is made available, in HDF format and at no cost, atmospherically corrected, cloud screened, and geocoded, through different standard data products, including the “MOD13” vegetation indices (VI). The MOD13 comprises two vegetation indices, the normalized difference vegetation index (NDVI) and the enhanced vegetation index (EVI), which are indeed a compositing of multiple observations within a 16 days period. In addition, the MOD13 product includes a set of reflectance bands (blue, red, NIR, and MIR) and is accompanied with Science Data Sets (SDS) of ancillary information, including solar zenith angle, sensor view angle, and quality assurance (QA) metadata layers that describe on a per pixel basis, the quality of the reflectance input data and computed VI output data.

Although its “ready-to-use” format, the MOD13, particularly concerning its QA layer decoding, require some cautious prior to its utilization. With this respect, and as part of its mission to be a geographical data and information provider for the Cerrado biome, the Image Processing and GIS Lab of the Federal University of Goiás (LAPIG / UFG), is compiling MOD13Q1 (250m resolution) QA screened GeoTiff mosaics for the entire Cerrado biome, considering every compositing period of the 2001 - 2005 timeframe.

The expectation is that these datasets, though primarily focused on the “Modeling and Synthesis of the Effects of Land Use Change on Carbon and Trace Gas Budgets over the Amazon and Cerrado Regions” (LBA - III / TG 30), will be instrumental for a better monitoring and understanding of the Cerrado landscapes.

### **13.25-P: Responses of Central Amazon Biodiversity and Carbon Storage to Altered Disturbance Regimes**

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Quantifying ecophysiological and structural responses of Amazon forests to global change, although intrinsically difficult, is of urgent concern due to the region’s high biodiversity, carbon budget, and productivity. Global circulation models predict increased storm intensity and drought across Amazonia, resulting in higher occurrence of natural disturbances. Convective storms with powerful microburst winds can damage forests up to 2000 ha per event. Combined with anthropogenic deforestation, the area of secondary forests in Amazonia will increase. This project utilizes an interdisciplinary approach to discern how increasing disturbance regimes in Amazonia will affect biodiversity, species turnover, and carbon storage.

We use hyperspectral-remote imaging to locate landscape-scale (e.g. 0.1-30 ha) forest disturbances near Manaus, Brazil. Four endmember spectral mixing analysis (SMA) of non-photosynthetic vegetation (NPV) was used to detect natural forest-canopy damage. Percent canopy damage, stratified into five classes, ranges from 0-100% in 20% intervals. Thirty 400-m<sup>2</sup> vegetation plots were established across this canopy disturbance gradient in which stems greater than 5-cm diameter-at-breast-height were measured and identified. Species richness, alpha-diversity, and beta-diversity were calculated between all plot combinations.

Species composition, diversity and turnover vary as a function of canopy-damage intensity and gap size. The cost of woody-tissue production is expected to vary with canopy disturbance with the more disturbed plots displaying lower levels of autotrophic respiration. Large-scale natural disturbances initiate a carbon sink, yet frequent and intense disturbances will reduce diversity and carbon-storage potential as low wood-density, early-successional species proliferate. Future projections of Amazon biodiversity and carbon storage must account for altered disturbance regimes.

### **13.26-P: Monitoring the development of carbon uptake and turbulent fluxes changes over an Agricultural Field in Western Amazon.**

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We present results from a micrometeorological point of view of the land-use change in Santarém, BR, located in the Western Amazon (3.0120S, 54.5370W). In recent years, there has been an increase of the area of rice and soybean plantation in the Santarém region. During the last 6 years this field has been transformed from a pasture to a rice and soybean plantation. We will show the changes in turbulent fluxes, radiative parameters, and other parameters due to changing landscape from a pasture to crop fields.

For instance, greenness of the vegetation, and differences in land cover type are clearly detected from changes in the PAR-albedo. Seasonal changes in these parameters follow those of the daytime evaporation and carbon uptake. These changes in the albedo do not only indicate changes the net radiation regime, but they also mirror changes in energy partition and CO<sub>2</sub> fluxes. Ongoing efforts try to connect these in situ radiative changes to remote sensing products, such as NDVI from MODIS and microwave band.

Lowest values of the Bowen ratio (b) were observed during wet periods, principally during rice plantation. There is net uptake of carbon in this field and it is bigger than adjacent forest. Carbon exchange depends on the agricultural practices (figure 1). Therefore, the decision to have one or both crops or none, rice and soybean, and its fallow in one year will impact on the annual carbon uptake. We will present the estimated annual NEE for several scenarios.

### **13.27-P: Interação entre índice de área foliar e conteúdo de água no solo em uma floresta de transição Amazônia Cerrado**

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O Índice de Área Foliar (IAF) é uma importante variável biofísica da vegetação usada em modelos globais de clima, hidrologia, biogeoquímica e ecologia. O IAF depende da composição de espécies, estágio sazonal da floresta, conteúdo de água no solo (SWC) entre outros. O objetivo deste trabalho foi analisar a interação entre o IAF e o SWC em uma floresta de transição Amazônia Cerrado (11°24.75'S; 55°19.50'O) no período de 2001 a 2003. O método foi baseado na relação entre a área foliar e a transmitância da radiação, descrita pela equação de Lei de Lambert-Beer (Monsi e Saeki, 1953). O coeficiente de extinção da luz foi estimado da extinção da densidade de fluxo fotossinteticamente ativo pelo dossel da floresta (Goudriaan, 1988). O SWC foi medido por meio de sensor de reflectometria no domínio do tempo (CS615, Campbell Scientific, Inc., Ogden, UT, USA). O IAF variou sazonalmente apresentando menores valores nas estações seca (J-J-A) e seca-úmida (S-O-N) e maiores nas estações úmida (D-J-F) e seca-úmida (S-O-N), variando entre 2,28 m<sup>2</sup>m<sup>-2</sup> a 5,43 m<sup>2</sup>m<sup>-2</sup>. O SWC variou sazonalmente apresentando valores mínimos (aproximadamente 0,050 m<sup>3</sup>m<sup>-3</sup>) nos meses de estação seca e seca-úmida e valores maiores (aproximadamente 0,149 m<sup>3</sup>m<sup>-3</sup>) nos meses de estação úmida e úmida-seca. Houve correlação significativa entre o IAF e SWC nos meses de estação úmida, e não significativa nos meses de estação seca, provavelmente nos meses de seca quando cessam as chuvas há uma diminuição do SWC, certas espécies arbóreas neste período perdem folhas no intuito de economizar água, diminuindo o IAF em maior proporção que o decréscimo de SWC. Na estação seca, pode-se concluir pelo teste de significância que aproximadamente 80% da variância da regressão depende de outras variáveis não estudadas neste trabalho.

### 13.28-P: Quantifying the impact of cloud obscuration on remote sensing of active fires in the Brazilian Amazon

**Wilfrid Schroeder**, University of Maryland, schroeder@hermes.geog.umd.edu (Presenting)

Vegetation fires continue to play a significant role in land and atmospheric processes globally. Their occurrence is particularly important in tropical regions where human activity is still heavily based on the use of fires for land use management and land cover change. Correct quantification of fire events is needed primarily for understanding the dynamics of land use and land cover change, as well as for providing information for modeling of emission estimates from biomass combustion. A major factor influencing fire numbers derived from remotely sensed data is the effect caused by cloud obscuration. Current methods used to compensate satellite active fire detection numbers to account for fires missed due to cloud obscuration tend to rely on the assumption that fires occur with the same frequency under cloud covered areas as they do in the open. The simplicity of this assumption will often cause an overestimation of fire omission due to clouds, especially in areas where fires are unevenly distributed in space. Here I present an alternative approach that uses physical (precipitation) and social (fire use history) information to more precisely quantify the potential omission error associated with the cloud obscuration affecting satellite active fire detection products. The proposed approach is applied to a geostationary satellite fire data set, in order to characterize the cloud effect on fire detection over the entire diurnal cycle. The analyses are focused on the Brazilian Amazon basin where intense fire activity and frequent cloud cover are prevalent.

### 13.29-P: Effects of prescribed fires on bacterial communities of savanna soils from Cerrado region

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The functioning of Cerrado ecosystems may be altered by the replacement of vegetation cover and fire to convert native areas to pasture. Soil microbial communities could be used as indicator of soil changes and consequences on nutrient turnover and gas emissions from soil to atmosphere. The objective of this work was to determine the effects of prescribed fires in native Cerrado areas on soil bacterial communities. Native areas are located at Reserva Ecológica do Instituto Brasileiro de Geografia e Estatística (RECOR/IBGE), in Brasília, DF. The native areas have been subjected to prescribed fires since 1992 every two years at the end of dry season (September) and the last fire was in 2002. Soils samples (0 - 5 cm) were taken from June/2002 to June/2003. Microbial biomass (fumigation-incubation method), soil moisture and pH were higher in unburned native areas than in burned native areas. Denaturing Gradient Gel Electrophoresis (DGGE) was used to analyze the diversity of the soil bacterial communities from native cerrado soils. Samples for DDGE analysis were collected from wet and dry season, transitions between seasons and after prescribed fires. There were no differences in DGGE profiles from unburned and burned soils from native areas after the prescribed fire. The seasonality was the main factor to differentiate bacterial communities.

### 13.30-P: FPAR estimada pelo produto do MODIS e por observações de campo em uma floresta de transição Amazônia Cerrado

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Entre os sensores orbitais com dados disponibilizados para a comunidade científica destaca-se o MODIS (Moderate Resolution Imaging Spectroradiometer), um dos principais sensores de mapeamento global a bordo do satélite Terra. Por meio dos produtos do MODIS (<http://modis.gsfc.nasa.gov>) pode-se fazer a análise da vegetação natural, realizada numa escala multitemporal, melhorando o entendimento deste bioma, quanto a sua estrutura, funcionamento e papel ecológico. Entre os produtos do MODIS está um produto de dado biofísico FPAR (Fração Absorvida da Radiação Ativa Fotossinteticamente) uma variável que pode ser usada para quantificar a presença da vegetação com uma ótima confiabilidade em uma escala global. Entretanto, incertezas estão associadas ao emprego dos dados de produtos e necessitam de uma validação por meio de estimativas realizadas com dados obtidos em campo. O objetivo deste trabalho foi analisar a FPAR estimada pelo produto do MODIS e estimativa por dados de campo baseados na refletância e transmitância do dossel pela equação de GOWER et al. (1999), em floresta de transição Amazônia Cerrado (11°24.75'S; 55°19.50'O) no período de 2001 a 2003. Para os anos de 2001, 2002 e 2003, a média ( $\pm$ DP) anual de FPAR estimada pelo produto do MODIS foi de  $0,836 \pm 0,042$ ,  $0,845 \pm 0,083$ ,  $0,844 \pm 0,032$ , e FPAR estimada por dados obtidos em campo foi de  $0,93 \pm 0,01$ ,  $0,922 \pm 0,042$ ,  $0,936 \pm 0,01$ , respectivamente. Não houve correlação significativa entre as estimativas mensais de FPAR, e os resultados encontrados mostraram que os valores da FPAR estimada por medições de campo foram aproximadamente 10,4% maiores que a estimada pelo produto MODIS.

### 13.31-P: New Hybrid Estimate of Tropical Deforestation Rates in the 1980s and 1990s

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Tropical land cover dynamics during the 1980s and 1990s are highly uncertain, with enormous implications for balancing the global carbon budget and understanding the impacts on ecosystem goods and services. Recent estimates of tropical deforestation vary by +/-40% due in part to differences in domain, forest baselines, methods, and definitions. The 8km AVHRR satellite record provides the only spatially-explicit data, with comprehensive global coverage, for both the 1980s and 1990s. However, sensor calibration and degradation issues combined with the coarse spatial resolution of AVHRR data mask more diffuse deforestation events and likely capture only net changes in forest cover, thereby underestimating both gross deforestation and forest regrowth. Higher resolution Landsat data can capture gross changes in forest cover but the processed data products are currently limited to particular regions or sampling schemes and “wall-to-wall” coverage is not available for the total tropics during the 1980s and 1990s. We are using ~600 manually classified Landsat scenes from the TREES project and the FAO’s Forest Resources Assessment to develop spatially-explicit regression models based on demographic, biophysical, and land-use predictor variables. We are using the regression models to create an improved spatially-explicit estimate of tropical deforestation rates and locations that incorporates the strengths of key regional and global-scale data sets.

### 13.32-P: Assessment of satellite-derived vegetation indices across the Amazon forest

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Different products derived from satellite remote sensing are available to study vegetation dynamics from several spatial, temporal and spectral resolution and algorithms have been developed to compute vegetation indices using blue, red and near-infrared imagery. The state of the art Enhanced Vegetation Index (EVI) product from the recently launched Terra Moderate Resolution Imaging Spectroradiometer (MODIS) has played a key role in detecting changes in the Amazonian vegetation phenology caused by drought stress. More recent investigations by Huete et al. (2006) and Xiao et al. (2006) built on this product over the Amazon region found an unexpected EVI peak in the late dry season, which was indicative of a more intense vegetation activity at the end of the dry season. In this study, we focus our investigations on the extent to which the Normalized Difference Vegetation Index (NDVI) has similar behavior to the EVI peak in the late dry season across the Amazon region using ten-day composites of NDVI and EVI data for the period 1998 and 1999 from the SPOT 4 satellite Végétation sensor. A simple comparison between the spatial and temporal patterns of the NDVI and EVI responses based on analyses of time series were determined in order to show agreement and discrepancies of the two indices in the late dry season. Our preliminary analysis confirmed the consistencies between this investigation and other investigations that spatial variations in the EVI across Amazon forests (i.e., the evergreen forests) exhibited the peak vegetation green up in the late dry season, whereas in areas converted to pasture the reverse was observed. In contrast, the NDVI differed significantly from the peak EVI in the late dry season for its minima in the late dry season. Although there was less NDVI variation observed in areas of evergreen forests relative to those in areas converted to pasture. But the later showed similar vegetation greenness minima in the late dry season and was much more impacted by drought stress. We believe the use of satellite-derived EVI observations as an index of canopy photosynthetic capacity holds great promise in evaluating changes in land vegetation at the tropical rainforest plant formations.

Science Theme: LC (Land Use and Land Cover Change)  
Session: 2B: The Changing Amazon Landscape  
Presentation Type: Oral

## ND (Nutrient Dynamics)

### 14.1-P: Turbidity Scalar Trend and Flood Pulse at the Curuai Lake Floodplain System

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It is well known that the Amazon flood pulse affects Curuai Lake Turbidity by delivering high concentrations of suspended inorganic particle during the flooding stage. However, it is not well known how strong this relationship is along the year and what are the spatial scales at which it holds. In this paper we investigate this relationship in two time scales: at a local scale and high frequency (1 hour) variability and regional scale (seasonally). We used data collected from 20/11/2004 to 26/04/2005 by a turbidity sensor integrated to an automatic data collection system deployed at Curuai Lake for carrying on the local/high frequency analyses. Wavelet Transform(WT) was applied for the time series analyses. The regional analyses was carried out by applying the Spectral Mixing Model (SMM) to MODIS images acquired at four flood pulse stage: rising (27/02/2004), high (02/05/2004), receding (29/09/2003) and low water level (09/12/2003). The WT results showed that the flood-pulse modulates the turbidity only at a seasonal time scale. At smaller time scales other forcing functions such as wind, water depth and nutrient distribution are more important. The MME results showed that the relationship between the flood pulse and turbidity varies from spatially throughout the hydrological cycle.

### 14.2-P: Channel Sensitivity Between Amazon River and Lake Curuai System

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The understanding of the water and sediments exchanges between the Amazon River and its floodplain is critically important to understand the C and Hydrological cycles. Those exchanges determine the distribution of riparian plants and regulate the complex habitat mosaic of the floodplain. A field campaign was carried out

during the high water period, between June 23 and 29, 2006, to measure water depth, flow velocity, and discharge along the inlet and outlet channels of Curuai Lake Floodplain system using a 1.5 MHz Acoustic Doppler Profiler (ADP). During this campaign, in situ radiometric and limnological data were collected and a Landsat/TM5 image was acquired over Lake Curuai. In this work a comparative analysis among ADP results (inlet and outlet discharges) and previous studies is presented. Essentially, we seek to determine channel sensitivity to changes within river-floodplain system by combining remote-sensing and GIS techniques with field-based ground-true methods. The approach to model changes in potential channel sensitivity and volumetric flux of sediment is essential to future sediment budget estimates. The LBA-ECO-LC07 team is aiming to identify these sediment transport issues to understand the spatial and temporal variability of cut-and-fill processes which are the driving physical forces sustaining the ecological health of the floodplain system.

#### 14.3-P: Caracterização Biogeoquímica do rio Urupá, Rondônia

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O estado de Rondônia possui hoje o 8º maior rebanho bovino do país. Essa característica o torna um estado essencialmente pecuarista, muito embora já se perceba um avanço na atividade agrícola extensiva. Em termos de impacto ambiental, a pecuária é extremamente agressiva, pois nas práticas de manejo do gado era comum a conversão direta da floresta em pastagem e consecutivas queimadas nos primeiros anos para a limpeza da biomassa remanescente da floresta. Este trabalho tem como objetivo a avaliação de possíveis alterações na composição química das águas do rio Urupá mediante áreas que conservam características naturais e áreas com elevado grau de perturbação. Para tal, a bacia foi dividida, com auxílio de técnicas de geoprocessamento, em unidades de drenagem para cada ponto coletado e determinado através destas, características como área de drenagem, percentual de pastagem e tipos de solos. Em cada unidade de drenagem foram analisadas as concentrações dos íons maiores ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{NH}_4^+$ ,  $\text{Cl}^-$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$  e  $\text{PO}_4^{3-}$ ), carbono orgânico e inorgânico dissolvidos (COD e CID) e a razão isotópica do CID ( $\delta^{13}\text{C}$ ). Em geral, os resultados mostraram que à medida que a área de drenagem aumenta (aumentando o percentual de pastagem), a concentração do CID e íons maiores dissolvidos aumentam consideravelmente, elevando o valor mediano em até seis vezes para  $\text{Ca}^{2+}$  e  $\text{Mg}^{2+}$  e em cinco vezes para o CID. No entanto, quanto à sazonalidade, os íons maiores e o CID tiveram concentrações maiores no período de seca. As análises de  $\delta^{13}\text{C}$  do CID revelaram também que as maiores proporções de  $\text{CO}_2$  dissolvido no período de cheia, podem ter origem na oxidação da matéria orgânica dissolvida. Os valores medianos detectados nos pontos à jusante se mantiveram mais próximos aos esperados para os de plantas C4 (pastagem) (-9,07%), enquanto que o ponto mais a montante, mantém valores baixos (-17,6%), característico de plantas C3.

#### 14.4-P: Dissolved organic and inorganic carbon in small streams in Eastern Amazonia

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We conducted this study in streams situated in Paragominas and Igarapé-açu counties, in Pará state, Eastern Amazonia during the year of 2005. The streams in Paragominas were: Cinquenta e Quatro (Cq), Sete (St) e Pajeú (Pj). In all three catchments, the dominant soil type is clay Oxisols. Remnant forests are common in the headwater areas and other land use (pastures, crops, and secondary vegetation) dominate downstream. The stream in Igarapé-açu was Cumaru, where the soils are sandy and small farms are the most important land use class, with areas of headwaters protected by secondary vegetation. The objective of this work was to evaluate the dynamics of dissolved organic and inorganic carbon (DOC and DIC) in these water bodies and its relationships with land use, identifying sources that contribute to the aquatic ecosystem and the seasonality of their concentrations. The maximum values in the Paragominas streams sampling stations were (Cq, St and Pj, respectively): pH (6.30; 4.66 and 4.82), conductivity (59.8; 32.7 and 75.8  $\mu\text{S cm}^{-1}$ ) and dissolved oxygen (DO) (6.32; 7.94 and 7.35  $\text{mg L}^{-1}$ ). The minimum values were: pH (4.23; 4.05 and 4.04), conductivity (25.5; 26.2 and 30.5  $\mu\text{S cm}^{-1}$ ) and DO (2.14; 4.10 and 1.83  $\text{mg L}^{-1}$ ). In these streams the concentrations of DOC varied between 0.24 and 9.84  $\text{mg L}^{-1}$ , and DIC ranged from 0.33 to 8.43  $\text{mg L}^{-1}$ . At Cumaru stream, in Igarapé-açu, the maximum and minimum values were: pH (6.22 and 3.62 - headwater; 6.11 and 3.85 - main channel), conductivity (62.0 and 3.7  $\mu\text{S cm}^{-1}$  - headwater; 39.7 and 7.7  $\mu\text{S cm}^{-1}$  - main channel) and DO (8.60 and 2.00  $\text{mg L}^{-1}$  - headwaters; 8.70 and 3.30  $\text{mg L}^{-1}$  - main channel). DOC varied between 0.01 and 15.13  $\text{mg L}^{-1}$  (headwaters) and 0.56 and 16.00  $\text{mg L}^{-1}$  (main channel). The highest DOC concentrations are related to higher discharges in both regions (Paragominas and Igarapé-açu). Higher DOC concentrations in Igarapé-açu compared with Paragominas data point to larger organic carbon leaching in sandy soils than in clay soils. Other conclusions can be reached after the finalization of the complementary studies that focus on the differences in land use, especially agriculture, the characteristics of the soils, leaching and overland flow processes.

#### 14.5-P: Análise Interanual da Produção, do Acúmulo e da Taxa de Decomposição da Serrapilheira na Floresta de Transição Amazônia-Cerrado

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A serrapilheira constitui uma fonte permanente de adição de matéria orgânica no solo e as dinâmicas dos processos de sua produção, seu acúmulo e sua decomposição podem estar igualmente relacionadas à do crescimento vegetal. Considerando essa hipótese, este trabalho teve como objetivo avaliar esses processos numa floresta de transição entre a Amazônia e o Cerrado, em Sinop, Mato Grosso. Verificou-se que a fração foliar da serrapilheira produzida (75,6%) se incrementa a partir do final das chuvas, em abril, só diminuindo no início do próximo período das chuvas, em setembro. As frações constituídas por flores e frutos (5,2 % e 5,4%, respectivamente) apresentam maior concentração no período chuvoso, especialmente entre setembro e dezembro, ao passo que a constituída por galhos (13,8%) tem distribuição errática. Entre maio de 2004 e abril de 2005, a produção de serrapilheira total teve seu pico em setembro de 2004 (119,10 g m<sup>-2</sup> para esse mês) para um total no período de 871,95 g m<sup>-2</sup>. Entre junho de 2005 e maio de 2006, o pico ocorreu em outubro de 2005, (160,0 g m<sup>-2</sup> para esse mês) para um total no período de 1123,10 g m<sup>-2</sup>. O valor médio do acúmulo de serrapilheira entre 2004 e 2005 foi de 515,07 g m<sup>-2</sup> e entre 2005 e 2006, de 537,07 g m<sup>-2</sup>. Estes valores revelam, para o período de



2005/2006, um incremento de 23,5% na taxa de renovação da serrapilheira em relação ao anterior (1,69 ano<sup>-1</sup>), provavelmente devido à redução de 21,2% na precipitação acumulada verificada nesse período.

#### **14.6-P: Biochemical characterization and nutritional quality of soil under secondary forest succession in central Amazonia**

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In central Amazonia, soil preparation for pastures and crops includes biomass burning after deforestation what adds ash to soil, changing its nutritional status, organic matter and physical properties. Those practices affect the introduced crop and following secondary vegetation after land abandonment. This study aims to evaluate nutritional quality of litter layer produced by secondary forests (named capoeiras) of different ages and origins, and determine their relation with soil nutrient availability.

This study, conducted nearby Manaus, Brazil, consisted on collection of the accumulated and superficial litter (0-10 cm) on 20 capoeira plots of several ages and land use history. No direct relation was detected between soil properties and litter quality. However the litter mass varied significantly ( $p > 0.001$ ) with age and use history of capoeiras. Soil pH (3.42 - 4.79) has not changed significantly with age, although was greater on those originated from abandoned pastures. Soil moisture (22.6 - 52.5 %) and field capacity have not shown significant differences between ages and land use history. On soil organic carbon there was only detected significant differences between capoeiras originated from pastures. The soil obtained from the younger capoeira (5 years) has greater ( $p > 0.001$ ) organic C content than older ones (8 - 14 years), still reflecting the greater turnover of grasses. The soil P and Mg content did not vary with age. However P was significantly greater on soils from harvested forests than others with other land use history while Mg was significantly greater on pasture originated soils.

The decrease of litter layer with capoeira age seems to reflect a decomposition process more efficient on older capoeiras that produce litter with better nutritional quality. The nutrient content is more related to past land use than abandonment time.

#### **14.7-P: APLICAÇÃO DA RAZÃO K/Si(OH)<sub>4</sub> PARA A SEPARAÇÃO DAS HIDRÓGRAFAS EM MICROBACIAS DO ESTADO DE RONDÔNIA.**

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Para estudos biogeoquímicos em bacias de ordem inferior, tanto de floresta como pastagem, é necessário reconhecer o deslocamento da água desde a atmosfera até a descarga nos canais. Esse reconhecimento pode ser obtido por meio de traçadores isotópicos como o <sup>18</sup>O. Porém, análises isotópicas são relativamente caras e demoradas. Portanto, pretende-se com este trabalho demonstrar a viabilidade do emprego da razão K/Si(OH)<sub>4</sub> como alternativa para a separação das hidrógrafas em comparação com os resultados da composição isotópica do oxigênio (<sup>18</sup>O), e verificar se existem mudanças entre as principais fontes durante os eventos de chuva em duas bacias (floresta e pastagem).

Neste estudo foram utilizadas amostras coletadas na Fazenda Rancho Grande no Estado de Rondônia no ano de 2004.

Os resultados mostraram que nos primeiros eventos de chuva na floresta há uma presença maior da precipitação interna no igarapé, ao passo que, após vários eventos, observa-se que a água subterrânea começa a influenciar a composição deste, com uma mistura entre esta fonte e a atmosférica. Por outro lado, na pastagem, observa-se predomínio de escoamento superficial e da precipitação no início e após alguns eventos de precipitação, sem influência da água subterrânea.

De uma forma geral, estes resultados mostram uma diferença entre as principais vias hidrológicas em cada evento de precipitação na contribuição do igarapé da floresta e da pastagem. Além disso, estes resultados indicam ser viável o emprego das razões entre os componentes químicos K/Si(OH)<sub>4</sub> para identificar fontes de água durante o escoamento superficial em bacias de drenagem.

#### **14.8-P: Pathways of nutrient flow in an eastern Amazonian watershed.**

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To investigate pathways of nutrient flow to streams we combine data from numerous flow paths in the 130 km<sup>2</sup> watershed of Stream Cinquenta e quatro in Fazenda Vitoria Paragominas, Brazil. Flow paths include rainwater, pasture and forest surface runoff, soil lateral flow waters, upland groundwater wells, near-stream groundwater wells, and a single riparian zone well. We are combining traditional geochemical mixing models and end-member mixing analysis (EMMA) to assess discharge fractions from specific flow paths. Using a graphical approach we found K and Ca to be well behaved conservative tracers. The volume-weighted mean concentrations of three end-members (pasture surface runoff, upland groundwater, and riparian groundwater) geometrically encompass >85% of the streamwater concentrations. Initial analysis with EMMA using seven solutes indicates, however, that as many as five end-members may be appropriate. Solution for the discharge fractions over two annual cycles of high and low flows demonstrate that during the low flow periods of the year riparian groundwater is predominate, contributing ~70% fractional discharge. As stream flow increases pasture runoff has increasing importance with fractional discharge increasing from 0 to ~20%. More interesting, perhaps, is the increasing importance of upland groundwater during these same periods with fractional discharge increasing from 20 to ~80%, on average. Kinematic pressure waves (i.e., a rapid forcing of groundwater to the stream from increased pressure of rainfall inputs) may be an important process in this watershed.

#### **14.9-P: Integration of biogeochemical and hydrological data in pasture and forest covered catchments in Eastern Amazonia**

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The changes in land use in Amazonia are altering the chemical environment of small streams. Studies have shown that the intensive use of soil by cattle graze and agricultural activities in Eastern Amazonia has degraded the water and soil quality in their small catchments. A biogeochemistry data set from water samples collected during our LBA phase II project has been compiled and treated for subsequent statistical analysis, integration with hydrological data set, and modeling purpose. Field work were done in Paragominas, state of Pará, Eastern Amazonia, from 1999 to 2003. In two catchments (pasture and forest covered) our research group collected water samples of rainfall, throughfall, overland flow, subsurface flow, stream water and groundwater, as well as measured hydrological paths flow rates. We expect that this work can contribute to the comprehension of how land use change in the Amazon region affects nutrients and carbon transfer processes from terrestrial to aquatic ecosystems.

#### **14.10-P: Hydrologic Processes Modeling and Watershed Management - developing tools for Amazonian region.**

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Due to increasing impact on water resources in Amazonian region, related to deforestation, agriculture and grazing expansion, infrastructural projects like highways and hydroelectric plants, it is urgent to consider watershed monitoring and management planning. This study aims to develop some management tools, like watershed models, through investment in human capabilities in Amazonian region and investigation of comprehensive models in order to: i) achieve understanding of fluxes mechanisms; ii) estimate erosion losses; iii) evaluate trends and estimates in biogeochemical cycle changes.

The proposal is highly supported by institutional interchange between Amazonian research centers, traditionally focused on Ecosystem studies, biogeochemical cycling and territory management, and others Brazilian scientific centers that develop numerical simulation of solute transport in porous media, a potential tool to evaluate aquifer pollution by contaminants.

The project has three components with particular approaches. The first refers to "Watershed Management Models" applied to different sub-regions in Eastern Amazonia, by three students. The study sites are located in: a) Paragominas/PA, where small catchments of Uraim River have been monitored for two years; b) Santarém county, on Mojú River watershed and c) counties of Canarana and Querência, Mato Grosso state, on Xingu River headwaters. These three regions have different histories of occupation and demographic fluxes, but all of them are under the impacts of recent agriculture expansion. In this initial phase of the project (six months), we should use GIS tools to present results from landscape analysis and aquifer vulnerability classification model GOD.

Erosion model studies are proposed in the second project component that should be applied initially to monitored small catchments in Paragominas region.

The third part of proposal, "Hydrogeochemistry Modeling", as a partnership between hydrobiogeochemistry researchers and those dedicated to numerical modeling of transport phenomena. We should use a numerical model to represent nutrient transfers in saturated porous media, and try to validate the model through its application on field data.

#### **14.11-P: Identificação dos fatores responsáveis pelas características biogeoquímicas de um lago meandrônico situado em uma planície de inundação na transição entre Cerrado e Floresta Amazônica.**

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A região da planície do Araguaia, próxima a Ilha do Bananal, destaca-se por sua exuberante paisagem resultante da interação de aspectos do bioma Cerrado e Amazônico e pela abundante presença de mananciais. Além dos corpos hídricos principais, verifica-se na região a ocorrência de inúmeros lagos meandrônicos, que sazonalmente conectam-se a mananciais lóticos, devido à expansão do leito dos mesmos durante os períodos de cheia. Tendo em vista a relevância destes lagos para o equilíbrio ecológico local, e que possíveis alterações antrópicas nas áreas circunvizinhas podem influenciar as características de suas águas, desenvolveu-se o presente estudo que buscou identificar os fatores responsáveis pela composição química das águas de um lago meandrônico característico da região (lago Chave), que durante o período de cheia interliga-se a um manancial lótico (rio Javaés). Observou-se que o lago Chave apresentou maiores concentrações iônicas durante o período chuvoso, comportamento este inverso ao observado no Rio Javaés. Quanto ao carbono orgânico dissolvido (COD), verificou-se um comportamento sazonal similar entre o lago e o manancial lótico (maiores concentrações no período chuvoso), entretanto as concentrações foram mais elevadas no lago durante todo o período estudado. As condições anteriormente mencionadas proporcionam a ocorrência de menores concentrações de oxigênio dissolvido e menores valores de pH no lago, quando comparado ao observado ao rio Javaés. Tendo em vista os resultados obtidos, pode-se considerar que o controle da composição química das águas do lago Chave deve-se somente a fenômenos naturais, sendo sua conectividade com o rio Javaés um dos fatores preponderantes nesta composição.

## TG (Trace Gases)

### 15.1-P: Emissão de Gases em Agroecossistema com Milho e Plantas de Cobertura no Cerrado

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EMIÇÃO DE GASES EM AGROECOSSISTEMA COM MILHO E PLANTAS DE COBERTURA NO CERRADO

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O objetivo deste trabalho foi avaliar emissões sazonais de NO, N<sub>2</sub>O e CO<sub>2</sub> em agroecossistema com milho em sucessão às plantas de cobertura (Crotalaria juncea L, Mucuna pruriens L.) e vegetação espontânea, em Latossolo sob plantio direto e convencional. Os fluxos de NO foram determinados com analisador de quimiluminescência e amostras de N<sub>2</sub>O coletadas com seringas e analisadas por meio de cromatografia gasosa. A concentração de CO<sub>2</sub> foi medida por analisador de gás infravermelho. Coletaram-se amostras de solo (0 a 5 cm) para determinar N-NO<sub>3</sub>, N-NH<sub>4</sub> e umidade. Os teores gravimétricos θ<sub>g</sub> (g g<sup>-1</sup>) foram convertidos em proporção de espaço dos poros preenchido pela água (%EPPA). A ocorrência de chuva depois da estação seca resultou em pulsos de NO e CO<sub>2</sub>. Os fluxos de N<sub>2</sub>O no início da estação chuvosa ficaram abaixo do limite de detecção, porém, foram elevados no início da seca no solo sob mucuna-cinza e vegetação espontânea, em plantio direto. Fertilizações de nitrogênio na presença de chuva proporcionaram altos fluxos de NO e CO<sub>2</sub>. As leguminosas resultaram em fluxos anuais mais elevados de CO<sub>2</sub> (22 Mg C-CO<sub>2</sub> ha<sup>-1</sup> ano<sup>-1</sup>) em plantio direto e de gases de nitrogênio (0,9 N kg ha<sup>-1</sup> ano<sup>-1</sup>) considerando os dois sistemas. %EPPA explicou 38% dos fluxos de NO, no solo sob crotalaria juncea em plantio direto e 64% de CO<sub>2</sub> sob mucuna-cinza em plantio direto. A concentração de N-NH<sub>4</sub><sup>+</sup> explicou 47%, 66% e 11% dos fluxos de CO<sub>2</sub> sob crotalaria juncea e mucuna-cinza, com incorporação e vegetação espontânea em plantio direto respectivamente.

### 15.2-P: Including the sub-grid scale plume rise of vegetation fires in low resolution atmospheric transport models.

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We adopt the super-parameterization concept to include the vertical transport of hot gases and particles emitted from biomass burning in low resolution atmospheric-chemistry transport models. This sub-grid transport mechanism is simulated by embedding a 1D cloud resolving model with appropriate lower boundary condition in each column of the 3D host model. Through assimilation of remote sensing fire product, we recognize which column has fires, using a land use dataset appropriate fire properties are selected. The host model provides the environmental condition and, finally, the plume rise is explicitly simulated. The final height of the plume is then used in the source emission field of the host model to determine the effective injection height, releasing the material emitted during the flaming phase at this height. Model results are compared with CO aircraft profiles from the SMOCC campaign and with MOPITT and AIRS CO data showing the huge impact that this mechanism has on model performance.

### 15.3-P: The Coupled Aerosol and Tracer Transport Model to the Brazilian developments on the Regional Atmospheric Modeling System: model validation using direct and remote sensing observations.

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The atmospheric transport of biomass burning emissions is studied through a numerical simulation of the air mass motions using the CATT-BRAMS (Coupled Aerosol and Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System). CATT-BRAMS is an on-line transport model fully consistent with the simulated atmospheric dynamics. The sources emission from biomass burning and technological activities for gases and aerosol may be defined from several published dataset and remote sensing. The mass concentration prognoses accounts also for convective transport by shallow and deep cumulus, wet and dry deposition and plume rise following the super-parameterization concept. Also, an additional radiation parameterization, which takes the interaction between aerosol particles and short and long wave radiation into account, was implemented. The model is applied to simulate carbon monoxide (CO) and particulate material PM<sub>2.5</sub> transport during the SMOCC/RACCI campaign during the 2002 dry season. The model validation is presented with comparison of model results with remote sensing products from MODIS, AIRS and MOPITT. Also comparison with surface and airborne measurements of particulate material (dp < 2.5 μm) and carbon monoxide obtained during the SMOCC/RACCI campaign in Amazonia will be discussed.

### 15.4-P: Determination of Soil Radon-222 Flux at Tree Area With Different Activity Related When use of the Soil in the Eastern Amazon

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Radon-222 is a radioactive noble gas, chemically inert with a half life of 3.8 days, emitted mostly from soil, behaving conservatively. As a result, Rn-222 has a strong potential to offer a reliable measurement of biosphere-atmosphere exchange rates of reactive trace gases. Rn-222 soil-air fluxes are a critical component of the Radon budgets used to study these processes. Three sites were included in this study: a Logged Forest (km 83) and Primary Forest (km 67) in the Tapajós National Forest, and an agricultural field (km 77) undergoing periodic crop rotation (rice and soybeans). Ground flux samples were collected three times a week using portable detectors placed on permanent PVC soil collars in areas around the LBA flux towers and record the “soil-air” flux during sequential periods of 60 minutes. These detectors consist of a 15-liter chamber and an electronic part that counts  $^{222}\text{Rn}$ . The results showed that the annual variation of the soil Rn-222 flux on period of 2001 did not present a significant statistic different between the site ( $P>0.05$ ). However, on period of 2002 was noticed a significant statistic different between them ( $P<0.05$ ). The results suggest that the site of the km 83 and km 67 are similar while the site of the km 77 is different.

#### **15.5-P: Isotopic composition of methane ( $\text{CH}_4$ ) sources in a tropical Amazon forest: A preliminary data set**

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The greatest sources of  $\text{CH}_4$  are fossil fuel burning and wetlands. As one of the biggest wetland areas in the world, the Amazon region has an important role in current scenario since recent estimations indicate the  $\text{CH}_4$  flux in the Amazon basin is approximately  $22 \text{ TgC yr}^{-1}$ . However, not only flooded areas but also upland forests in the Amazon could contribute as source of  $\text{CH}_4$ , with emissions ranging from 4 to  $38 \text{ TgCH}_4 \text{ yr}^{-1}$ . Here we present preliminary results of the stable isotopic composition of  $\text{CH}_4$  in tropical upland. This first campaign was done at Flona do Tapajós tower site (km67), in Santarém-Para, where a set of tubes were placed and inlets for sampling allowed us to pull atmospheric air samples in a vertical profile (0.2, 7, 22, 35, and 45m) in different times of the day (4, 16, 22, and 24h) during 3 days. The air samples were pulled through the tubes by a battery-operated pump and then stored into glass flasks. The  $\delta^{13}\text{CH}_4$  was determined in a Carlo Erba NA 1600 elemental analyzer equipped with a Finnigan MAT ConFlo interface. The mean  $\delta^{13}$  value found was equal to  $-47.04 \pm 0.07\%$ ; it is in the range for values found for atmospheric methane ( $-47.3\%$  to  $-46.2\%$ ). The  $\text{CH}_4$  produced during nighttime ours tends to be more depleted in  $^{13}\text{C}$  than during daytime hours indicating that microbial production of methane within the canopy should be an important source of this gas

#### **15.6-P: Preliminary measurements of $\text{N}_2\text{O}$ partial pressures in the Negro and Solimões Rivers, Amazon Basin, Brazil**

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The concentrations of nitrous oxide ( $\text{N}_2\text{O}$ ), an important component of the greenhouse effect and with long residence time in the atmosphere, have significantly increased in this century. The reasons for this atmospheric increase in  $\text{N}_2\text{O}$  are still partially unexplainable. This uncertainty is worse in relation to aquatic environments. In this article we report on preliminary measurements of  $\text{N}_2\text{O}$  partial pressures in the rivers of the Amazon basin. The studied area is located in the Brazilian Amazon, in the state of Amazonas. The rivers Solimões and Negro were sampled from September 2005 to April 2006. River water was collected with immersion pumps, lowered in the middle of the channel to 60% of total depth. To avoid contact with air, water was pumped into a 1 L graduated cylinder and a headspace methodology was used to equilibrate the dissolved  $\text{N}_2\text{O}$  with  $\text{N}_2$ . The resulting gas sample was stored in evacuated and sealed 25 mL vials. Atmospheric samples were taken from one meter above the water column and stored the same way.  $\text{N}_2\text{O}$  partial pressures were determined on a Shimadzu GC-14 "Green House Analyzer". Partial pressures of  $\text{N}_2\text{O}$  in Solimões and Negro river water showed little variations around an average of  $0.48 \pm 0.08 \mu\text{atm}$  ( $n=67$ ) and  $0.38 \pm 0.04 \mu\text{atm}$  ( $n=64$ ), respectively. The atmospheric averages were approximately  $0.32 \pm 0.03 \mu\text{atm}$  ( $n=134$ ) in both rivers. These preliminary results indicate that partial pressures of  $\text{N}_2\text{O}$  in the Amazon rivers, although probably not a major source of this gas to the atmosphere, may constitute an important part of the Nitrogen cycling in these systems.

#### **15.7-P: Variations in the Concentrations of Nitrous Oxide in the Soil Pore Space at the Tapajós National Forest**

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Over the course of two years, we made weekly measurements of the concentrations of nitrous oxide, carbon dioxide and methane in the soil pore space at depths from 0.05 to 2.00 m in three replicated profiles. Near the end of the first year of observations, two large trees fell in the vicinity of one of the three profiles (03) resulting in a notable change in nitrous oxide mixing ratios within this profile. The mixing ratios of nitrous oxide in profile 03 varied from 650 to 2060 ppb at 0.05 m depth and from 1130 to 5990 ppb at 2.00 m; these mixing ratios were significantly greater ( $p<0.05$ ) than the mixing ratios measured in profiles 01 and 02. Carbon dioxide concentrations also increased in profile 03 compared to profiles 01 and 02 although to a lesser extent. Results from previous studies in tropical forests have indicated that root mortality may result in increased soil-atmosphere emissions of nitrous oxide (Keller et al. 2000; Varner et al., 2003; Silver et al. 2005). Our observations

support the hypothesis that root mortality increases the pool of available organic matter and the consumption of oxygen within the soil leading to conditions favorable for nitrous oxide production.

#### **15.8-P: SF<sub>6</sub>, CO and H<sub>2</sub> mixing rate since 2000 in vertical profile over Central Amazon**

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Vertical Profiles of Hexafluoride Sulfur (SF<sub>6</sub>), Carbon Monoxide (CO) and Molecular Hydrogen (H<sub>2</sub>) mixing rates were studied over undisturbed forest and disturbed area in the Central Amazon at Floresta Nacional do Tapajós (Flona Tapajós), Pará, and at Reserva Biológica de Cuieiras (Cuieiras), Amazonas. Samples from 300 m to 4000 m were developed during Dry and Wet Season since December 2000 at Flona Tapajós, and since December 2004 at Reserva Biológica de Cuieiras.

SF<sub>6</sub> followed global trend during all studied periods. SF<sub>6</sub> vertical profiles were similar with Ascension, due it isn't produced naturally for the forest. The important observation was 8% higher concentration over Cuieiras than Flona Tapajos indicating different sources of air mass during the Wet Season. CO and H<sub>2</sub> presented same different behavior during Dry and Wet Season. At wet season, their values mixing rates were closed of background mixing rates (Ascension Inland), where CO mixing rates show in the average 40 ppb (60%) more than Ascension. During Dry Season their mixing rate were higher in 130ppb (200%) due biomass burning season in Flona Tapajos and 155ppb (215%) in Cuieiras. H<sub>2</sub> vertical profile presented tend of sink during the wet seasons and source during dry season, due biomass burning process.



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- 9.1 Projecting Future Amazonian Landscapes: An Econometric Approach (Robert Walker)
- 9.2 Pattern-Process Relationships in Coupled Human-Natural Systems: Modeling Land Use/Land Cover Dynamics in the Northern Ecuadorian Amazon (Stephen Walsh)
- 9.3 The economics of fire management in communities of the Tapajos National Forest (Maria Bowman)
- 9.4 A policy-sensitive, spatial-dynamic model of logging for the Brazilian Amazon (Britaldo Soares Filho)
- 9.5 An economic model of the Amazon timber industry (Frank Merry)
- 9.6 Econometric Estimation of Deforestation Impacts from Roads and Other Drivers (Alexander Pfaff)
- 10.5 Estimating Interannual Variability of Carbon Emissions from Land Use-Related Fires in the Southern Amazon (Ruth DeFries-Bajpai)
- 13.1-P Dynamics of the Water Table in Pasture Area and Transitional Forest Amazonia Cerrado in Brazil (Nara Luísa Reis de Andrade)
- 13.2-P Análise do Efeito do Fotoperíodo Sobre a Dinâmica do Índice de Área Foliar da Floresta de Transição Amazônia-Cerrado (Paulino Bambi)

- 13.3-P Scale-dependency of socio-demographic data in a colonization settlement area in Pará, Brazil (Alvaro D'Antona)
- 13.4-P Dinâmicas de Fronteira e Ecologia de Paisagem, uma Análise Multitemporal do Uso e Cobertura da Terra em Santarém e Belterra, Pará. (Williams Castro)
- 13.5-P Fire in the Brazilian Amazon: a household behaviour model and policy implications. (Larissa Chermont)
- 13.6-P A multi-platform technique to validate active fire detections from the GOES Imager (Ivan Csiszar)
- 13.7-P Analysis Of Land Cover Change in Eastern Para, Brazil Based On Four Dates Of Landsat Data From 1984 To 2002 (Eric Davidson)
- 13.8-P Gap Fraction for Detection and Mapping of Canopy Opening in Undisturbed and Selectively Logging Forests (Fernando Espírito-Santo)
- 13.9-P Efeito da Fertilização Nitrogenada Sobre a Emissão de  $\text{NO}$  e  $\text{N}_2\text{O}$  em Solos Cultivados com Milho na Região dos Cerrados de Goiás-Brasil (Erika Fernandes)
- 13.10-P Deforestation and Land Concentration in Brazilian Amazonian Forest (Nilson Ferreira)
- 13.11-P Data rejection and gap filling in micrometeorology measures of an Amazonian transitional forest (Camila Fraga)
- 13.12-P Using Wavelet Transform for MODIS Time-Series Analysis (Ramon Morais Freitas)
- 13.13-P Effects of seasonality and timing of image acquisition on remote observation of regenerating vegetation in the seasonally-dry tropical forests in Rondonia, Brazil (Stephen Hagen)
- 13.14-P Assessment of multi-scale optical and microwave imagery for mapping biodiversity surrogates at an Amazon floodplain site (Laura Hess)
- 13.15-P Proposal of a Protocol to Post-Process Micrometeorological Data (Hewlley Imbuzeiro)
- 13.16-P Use of the Mixture Model in the attainment of the training data futures to be employed in the integration method of Multi Resolutions Remote Sensing data, for the representation of the land covering (Marcelo Latorre)
- 13.17-P REAL CONSERVATION SCENARIOS FOR THE MATO GROSSO STATE Analysis of landscape structural indexes for the microregions of Alto Teles Pires and Aripuanã. (Andre Lima)
- 13.18-P Land-Cover Classification in the Brazilian Amazon with Satellite Images: Towards Increasing Accuracy (Dengsheng Lu)
- 13.19-P Analysis of the Transformed of Wavelet of Morlet in Signs of Temperature, Humidity and  $\text{CO}_2$  in the Experimental Site of Santarém (Cintya Martins)
- 13.20-P Socioeconomic development and forest fragmentation in the state of Mato Grosso, in the 1986-2000 period (Marcia Mello)
- 13.21-P Spatial patterns of nocturnal surface-to-atmosphere decoupling over the Amazon (Otávio Acevedo)
- 13.22-P The impact of scaling-up on biophysical variable estimation (Unknown)
- 13.23-P Ajuste de Polinômio para Dados do Índice de Área Foliar da Floresta de Transição Amazônia-Cerrado (Durval Rezende)

- 13.24-P A Multitemporal MOD13Q1 "Ready-to-Use" Databasis for the Brazilian Cerrado (Noely Ribeiro)
- 13.25-P Responses of Central Amazon Biodiversity and Carbon Storage to Altered Disturbance Regimes (Amanda Robertson)
- 13.26-P Monitoring the development of carbon uptake and turbulent fluxes changes over an Agricultural Field in Western Amazon. (Ricardo Sakai)
- 13.27-P Interação entre índice de área foliar e conteúdo de água no solo em uma floresta de transição Amazônia Cerrado (Luciana Sanches)
- 13.28-P Quantifying the impact of cloud obscuration on remote sensing of active fires in the Brazilian Amazon (Wilfrid Schroeder)
- 13.29-P Effects of prescribed fires on bacterial communities of savanna soils from Cerrado region (Maria Silva)
- 13.30-P FPAR estimada pelo produto do MODIS e por observações de campo em uma floresta de transição Amazônia Cerrado (Maricéia Vilani)
- 13.31-P New Hybrid Estimate of Tropical Deforestation Rates in the 1980s and 1990s (Holly Gibbs)
- 13.32-P Assessment of satellite-derived vegetation indices across the Amazon forest (Humberto Barbosa)

## **ND (Nutrient Dynamics)**

- 2.1 Effects of land use change on stream water chemistry in three meso-scale catchments in Eastern Amazonia (Ricardo Figueiredo)
- 2.2 Watershed Scale and the Importance of Riparian Zones in Modifying Solute Inputs from Land to Streams (Christopher Neill)
- 2.3 Nutrient dynamics in nested catchments at nested time scales: trends in hydrologic exports from 1st and 2nd order watersheds in the seasonally dry Southern Amazon (Mark Johnson)
- 2.4 Scaling changes in biogeochemistry of small streams to the landscape: Using <sup>15</sup>N to Trace N Transformations and Transport (Linda Deegan)
- 2.5 Atmospheric deposition (wet and dry) and nutrient cycles in Amazon Basin (Luciene Lara)
- 2.6 Organic Material Decomposition and Mineral Nutrient Dynamics in a Leguminous Tree-Enriched Mulch System in Amazon (José Cattanio)
- 5.3 The origin of stream flows in small Amazon forest and pasture watersheds: an end-member mixing analysis approach (Joaquin Chaves)
- 5.6 Water circulation dynamics in Amazon river/Curuai floodplain system: a remote sensing approach (Claudio Barbosa)
- 14.1-P Turbidity Scalar Trend and Flood Pulse at the Curuai Lake Floodplain System (Enner Alcântara)

- 14.2-P Channel Sensitivity Between Amazon River and Lake Curuai System (Claudio Barbosa)
- 14.3-P Caracterização Biogeoquímica do rio Urupá, Rondônia (Marcos Bolson)
- 14.4-P Dissolved organic and inorganic carbon in small streams in Eastern Amazonia (Fabiola Costa)
- 14.5-P Análise Interanual da Produção, do Acúmulo e da Taxa de Decomposição da Serrapilheira na Floresta de Transição Amazônia-Cerrado (Andrea Dalmolin)
- 14.6-P Biochemical characterization and nutritional quality of soil under secondary forest succession in central Amazonia (Fabiane Lima de Oliveira)
- 14.7-P APLICAÇÃO DA RAZÃO K/Si(OH)<sub>4</sub> PARA A SEPARAÇÃO DAS HIDRÓGRAFAS EM MICROBACIAS DO ESTADO DE RONDÔNIA. (Adriane Liberale)
- 14.8-P Pathways of nutrient flow in an eastern Amazonian watershed. (Daniel Markewitz)
- 14.9-P Integration of biogeochemical and hydrological data in pasture and forest covered catchments in Eastern Amazonia (Livia Vasconcelos)
- 14.10-P Hydrologic Processes Modeling and Watershed Management - developing tools for Amazonian region. (Marysol Schuler)
- 14.11-P Identificação dos fatores responsáveis pelas características biogeoquímicas de um lago meandrítico situado em uma planície de inundação na transição entre Cerrado e Floresta Amazônica. (Carlos Silva)

## **TG (Trace Gases)**

- 7.1 Amazon forest tree species composition influences soil fluxes of CO<sub>2</sub> and N<sub>2</sub>O (Joost van Haren)
- 7.2 An integrated assessment of soil and fire emissions of greenhouse gases from slash-and-burn and chop-and-mulch agriculture in the eastern Amazon (Eric Davidson)
- 7.3 Spatial and seasonal variations in the carbon isotopic composition of methane over a five-year period in stream sediments of eastern Amazonia (José Mauro Moura)
- 7.4 CO<sub>2</sub> Profiles Over Central Amazon (Luciana Gatti)
- 7.5 Nitrous oxide mixing ratio during dry and wet seasons in vertical profile over the central Amazon (Monica Tais Siqueira D'Amelio)
- 7.6 Aircraft measurements show strong enhancements of methane above central Amazonia. (John Miller)
- 7.7 Is size distribution or chemical composition the key parameter to aerosols act as CCN? (Theotonio Pauliquevis)
- 10.6 Synthesis Studies of Intensive Agriculture Impacts in the Amazon/Cerrado: Field Data, Remote Sensing, Modeling Approaches (Christopher Potter)
- 15.1-P Emissão de Gases em Agroecossistema com Milho e Plantas de Cobertura no Cerrado (Arminda Carvalho)

- 15.2-P Including the sub-grid scale plume rise of vegetation fires in low resolution atmospheric transport models. (Saulo Freitas)
- 15.3-P The Coupled Aerosol and Tracer Transport Model to the Brazilian developments on the Regional Atmospheric Modeling System: model validation using direct and remote sensing observations. (Saulo Freitas)
- 15.4-P Determination of Soil Radon-222 Flux at Tree Area With Different Activity Related When use of the Soil in the Eastern Amazon (Risonaldo Lima)
- 15.5-P Isotopic composition of methane ( $\text{CH}_4$ ) sources in a tropical Amazon forest: A preliminary data set (José Mauro Moura)
- 15.6-P Preliminary measurements of  $\text{N}_2\text{O}$  partial pressures in the Negro and Solimões Rivers, Amazon Basin, Brazil (Carolina de Oliveira)
- 15.7-P Variations in the Concentrations of Nitrous Oxide in the Soil Pore Space at the Tapajos National Forest (Raimundo Oliveira Jr.)
- 15.8-P  $\text{SF}_6$ , CO and  $\text{H}_2$  mixing rate since 2000 in vertical profile over Central Amazon (Monica Tais Siqueira D'Amelio)