LBA-ECO
Experiment Plan

2003-2005

DRAFT
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Science Approach

Introduction: Context for LBA-ECO

The world's tropical forests are experiencing unprecedented rates of clearing and conversion of various forms of land use.[1] Altered cycles of water, energy, carbon and nutrients, resulting from the changes in Amazonian vegetation cover, are expected to have climatic and environmental consequences at local, regional, and global scales.


burned hillside, Santarém, November 1997

To understand these consequences, enhanced knowledge is needed of the natural forest systems as well as systems which have already been converted to various other forms of land use or secondary re-growth.

To this end, the Brazilian scientific community called for a new multidisciplinary research effort in the early nineties. A large number of South American, North American and European research programs, agencies and individual groups have contributed extensive efforts toward defining an integrated research program in Brazil. The Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) is an international research initiative led by Brazil. LBA is centered on two key questions:

- How does Amazonia currently function as a regional entity?
- How will changes in land use and climate affect the biological, chemical, and physical functions of Amazonia, including the sustainability of development in the region and the influence of Amazonia on Global climate?

The broad goal of the ecological research program is to improve our understanding of the effects of tropical forest conversion on ecosystem function and the sustainability of land use. The LBA-ECO science question that focuses this study is:

How do tropical forest conversion, re-growth, and selective logging influence carbon storage, nutrient dynamics, trace gas fluxes, and the prospect for sustainable land use in Amazonia?

The main science objectives that will be used in answering this question are as follows:

- To quantify, understand and model the physical, chemical and biological processes controlling the energy, water, carbon, trace gas, and nutrient cycles found within Amazonia and to determine how these link to the global atmosphere.

- To quantify, understand and model how the energy, water, carbon, trace gas and nutrient cycles respond to deforestation, agricultural practices and other land use changes, and how these responses are influenced by climate. As well as to predict the impacts of these responses both within and beyond

Amazonia under future scenarios of changes in land use and climate.

- To determine the exchanges of key greenhouse gases and species regulating the oxidizing potential between Amazonia and the atmosphere, and to understand the processes regulating these exchanges.

- To provide quantitative and qualitative information to support sustainable development and ecosystem protection policies in Amazonia, in the context of both its regional and global functionality.

In LBA, emphasis is given to observations and analyses that will enlarge the knowledge base for Amazonia in several general areas:

1. Physical Climate
2. Carbon Storage and Exchange
3. Atmospheric Chemistry
4. Land Surface Hydrology and Water Chemistry
5. Biogeochemistry
6. Land Use and Land Cover
7. Human Dimensions

The LBA-ECO Science Team is pursuing an integrated approach involving synthesis of past results and data sets, modeling, remote sensing, Geographic Information System (GIS)-based analyses, new field observations and process studies, training and education and synthesis and integration of new results in order to tackle the LBA-ECO science question.
The results produced by the LBA-ECO Science Team will provide a new understanding of environmental controls on flows of energy, water, carbon, nutrients, and trace gases between the atmosphere, hydrosphere, and biosphere of Amazonia. The results will also provide a scientific basis for the implementation of policies regarding the sustainable use of Amazonian natural resources.

[1]The LBA Science Planning Group. 1996. The Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA): Concise Experimental Plan. SC-DLO, Wageningen, Netherlands. 44 p.

LBA-ECO Science Themes

The LBA-ECO Science Team has pursued an integrated approach to answering the broad LBA-ECO science question:

How do tropical forest conversion, re-growth, and selective logging, influence carbon storage, nutrient dynamics, trace gas fluxes, and the prospect for sustainable land use in Amazônia?

To this end, the LBA-ECO science team has organized into four science themes, each with its own specific set of questions:

- Carbon Dynamics
- Nutrient Dynamics and Surface Water Chemistry
- Trace Gas and Aerosol Fluxes
- Land Cover and Land Use Change

Carbon Dynamics
Investigation Code: CD
The Carbon Dynamics theme studies involve the quantification of the carbon pools in vegetation and soils and the rates of carbon exchange among the atmosphere, vegetation, and soils, and the way in which these rates are altered by natural and human disturbances.

Nutrient Dynamics and Surface Water Chemistry
Investigation Code: ND
The Nutrient Dynamics and Surface Water Chemistry theme studies are focused on the quantification of nutrient pools and fluxes and relationships with land use and sustainability. Studies are quantifying the changes in surface water chemistry resulting from land cover and land use change. Nitrogen and phosphorus are the nutrients of major interest.

Trace Gas and Aerosol Fluxes
Investigation Code: TG
The Trace Gas and Aerosol Fluxes theme studies
focus on the quantification of the fluxes of trace gases between the surface and the atmosphere and the identification of the biological and physical factors that control these fluxes. Studies are comparing natural systems with managed land uses and systems recovering from human management.

Land Cover and Land Use Change
Investigation Code: LC
The Land Cover and Land Use Change theme studies focus on the documentation of past and current land cover and land use changes throughout Amazônia and development of a capability to predict the location and magnitude of future land cover and land use changes in the region.

LBA-ECO Science Questions

The LBA-ECO Science Team is organized into four science themes, each with its own specific set of questions listed below. Each LBA-ECO Investigation has proposed to answer a subset of these questions.

Carbon Dynamics Science Questions

CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux? This question can be approached through a number of subsidiary questions:
CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?
CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?
CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?
CD-Q3d - What portion of the Amazônia–wide carbon flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Land Cover and Land Use Change Science Questions

LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?
LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?
LC-Q4 - What are plausible scenarios for future land cover change in Amazônia?

Nutrient Dynamics and Surface Water Chemistry Science Questions

ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
ND-Q2 - Are nutrients major factors that control the rates of regrowth and carbon accumulation in abandoned pastures and regrowing secondary forests?
ND-Q3 - What are the processes and consequences of atmospheric horizontal transport of nutrients (wind) on the nutrient stocks and cycles of ecosystems within the Amazon basin at various spatial and temporal scales? For example, what are the effects of Saharan dust inputs, losses and re-distribution due to fire, and links between physical climate models and nutrient cycling?
ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?
ND-Q4b - Are there unique signatures that can be traced downstream?
ND-Q4c - To what extent do intact riparian zones buffer streams against changes due to anthropogenic activities in surrounding uplands?
ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

Trace Gas and Aerosol Flux Science Questions

TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?
TG-Q3 - Are losses and gains of carbon from Amazônian ecosystems in forms other than carbon dioxide (e.g. carbon monoxide, methane, volatile organic carbon, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance

LBA-ECO Investigation Profiles

CD-01 (Denning / Dias) Investigation Profile

Spatial Integration of Regional Carbon Balance in Amazonia

Principal Investigators:

Allan Scott Denning, Colorado State University (US-PI)
Pedro Leite da Silva Dias, IAG/USP (SA-PI)

Abstract 2003:

Under the new Cooperative Agreement, we will perform the following specific tasks in very active collaboration with our colleagues at USP.

1. Evaluate the new SiB3 model for a series of Amazon flux sites. This will entail producing or obtaining from collaborators filled micrometeorological timeseries data (no missing values in any "driver" variable) from the three Tapajos sites, and from as many other sites as possible. We will then run multiyear simulations of latent and sensible heat and net ecosystem exchange of CO2 at each site with SiB3 using local site meteorlogy and vegetation parameters. We will compare the simulated and observed seasonality in the three fluxes among sites near Santarem, Manaus, Rondonia, and possibly others. We will investigate the influence of seasonal drought on gross photosynthesis and respiration, and evaluate model simulation of the seasonality of net carbon flux along regional gradients of vegetation and of timing, severity, and duration of the dry season.

2. Analyze the two-way interaction between drought and physiological stress in Amazonian ecosystems and the implications for possible amplification and persistence of regional drought as simulated in the "Amazon catastrophe" experiment of Cox et al (2000). Coupled simulations with SiB2 in the CSU GCM can reproduce this phenomenon for current climate. We will investigate the cause of this phenomenon in the current model, and explore what must be done in fully coupled climate simulations to produce such a catastrophe, and what model changes are required to avoid it. This work will include local-scale simulations and comparison to drought stress observed in the field, as well as a range of fully coupled experiments with climate models.

3. Perform a detailed analysis and forward simulation of the Santarém mesoscale campaign of July-August 2001 using SiB3/RAMS5. We will compare simulated to observed meteorology and tower fluxes at the three Tapajos towers. We will focus on the diurnal cycle of sensible and latent heat fluxes and CO2 flux at the three towers, diurnal development of the planetary boundary layer, its interaction with the regional trade wind circulation, and on mesoscale circulations in the presence of topography and rivers. We will also compare the time-varying vertical structure of CO2 in and just above PBL, and river-land contrasts of mid-morning CO2 on the two days during which we collected these data.

4. Participate in a major campaign to be organized in the Tapajos region in 2003 or 2004 to investigate the Richey et al hypothesis of major fluxes of CO2 by evasion from inundated lands and open waters. We will provide modeling support using SiB3 and RAMS to simulate "background" fluxes from terre firme forests and pastures, and will also specify evasion fluxes from input obtained from collaborators. Our simulations will be used to interpret airborne and surface-based continuous measurements of CO2 and other tracers. This campaign will be coordinated with members of the Fitzjarrald, Saleska, Ehleringer, Bakwin, Melack, and Richey teams.

5. Perform regional inversion analyses of data collected by the COBRA-Brazil field campaigns, using SiB3-RAMS and the Lagrangian Particle Dispersion Model developed under the previous Cooperative Agreement. This will be carefully coordinated with other investigators, and is contingent on the approval of the field campaigns in 2003.

6. Produce improved estimates of monthly Basin-wide carbon balance using a global atmospheric inversion method similar to the TransCom experiments. This will be improved by the inclusion of d13C of CO2 and CO as additional tracers to distinguish among biomass burning, C3 photosynthesis from forests and C4 photosynthesis in pastures and cerrados. The new inversions will also make use of new data collected by airborne sampling (Bakwin/Artaxo team), continuous surface-based measurements of trace gases by the Saleska and Fitzjarrald teams, and isotopic measurements made by the Ehleringer/Ometto team.

Investigation Duration:

1998 - 2005

Participants:

Allan Scott Denning, US-PI, Colorado State University
Pedro Leite da Silva Dias, SA-PI, IAG/USP
Maria Assuncao Faus Silva Dias, Co-Investigator, USP
Rodrigo Gevaerd, Universidade de São Paulo
Elicia Eri Inazawa, Colorado State University
Marcos Longo, IAG - USP
Lixin Lu, Colorado State University
Jason Rist, Colorado State University
Connie Uliasz, Colorado State University
Marek Uliasz

Student Information:

Rodrigo Gevaerd, Universidade de São Paulo, Citizenship: BRAZIL, Masters student, Thesis: Study of the three-dimensional redistribution of forest fire gases and aerosols in Roraima State, Brazil, in 1998

Elicia Eri Inazawa, Colorado State University, Citizenship: BRAZIL, Ph.D. student, Thesis: Mesoscale variations of CO2 and water vapor over a tropical forest and adjacent pasture and rivers in Brazil

Marcos Longo, IAG - USP, Citizenship: BRAZIL, Postdoctoral Researcher, Thesis: High resolution numerical simulations/Convection dynamics/Local circulations

Jason Rist, Colorado State University, Citizenship: USA, Bachelors student

Proposed Research Sites:

Pará Western (Santarém)
km 67 Primary Forest Tower Site
km 67 Seca-Floresta Site
km 77 Pasture Tower Site
km 83 Logged Forest Tower Site

Proposed Training and Education:

Educational Materials

- A web-based course for students and teacher in remote areas to gain an understanding of numerical modeling, preparing them for further work in the subject. It is basic enough to be of use to advanced undergraduates, while remaining scientifically accurate, so that nothing will have to be unlearned as the student advances and the problems become more complex.
- Short articles on numerical modeling and climate change will be developed which will be suitable for the Earth Science Enterprise NASA Facts series of pamphlets.

Formal Training

- This group plans to continue providing educational support to Brazil's environmental and global change research community. Currently, a PhD level student from the University of São Paulo is working at Colorado University on Amazonian meteorology and numerical modeling - forward and inverse modelling of land-atmosphere exchanges of CO2. The student will receive her Ph.D. and return to Brazil. Collaborative work with professors Pedro Silva Dias and Maria Assunção Silva Dias (USP) will continue.

Short Courses / Seminars / Workshops

- A short course on numerical modeling will be developed to be made available on line for advanced undergraduate students and beginning graduates. The course consists of seven chapters: a) Introduction to numerical modelling b) Finite difference equations and time differencing schemes c) Dynamical systems and the

development of a mathematical model d) Time differencing schemes e) Constrained optimization f) Waves, Fourier transforms, and spectral space g) Transport.

Visits / Exchange Programs

- A ten-week visit for USP scientists to Colorado State University is planned and follow-up visits by CSU scientist to USP.

Beija-Flor Datasets: (as of 2003-06-16)

Coupled Simulations of Physical Climate and CO2 Exchange in Rondonia (Poster)

Simulations of Physical Climate and CO2 Exchange in Rondonia and Para (Poster)

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

CD-02 (Ehleringer / Martinelli) Investigation Profile

Carbon and Oxygen Isotope Ratio CO2 Flux Analyses at the Soil, Canopy, and Landscape Scales

Principal Investigators:

James Ehleringer, University of Utah (US-PI)
Luiz Antonio Martinelli, CENA/USP (SA-PI)

Abstract 2003:

We propose two areas of research emphasis to better understand and constrain estimates of carbon dynamics in Amazônia ecosystems, based on progress during Phase I of LBA-ECO. These are (1) field observations of stable isotope components of water and CO2 fluxes and (2) development of mechanistic leaf and canopy models to link with other projects evaluating ecosystem and regional carbon dynamics.

(1) Stable isotope analyses of atmospheric CO2 are one tool that scales processes from the soil and individual plant levels through to the troposphere. We will apply 13C18O16O analyses as tools for better understanding gas exchange processes within ecosystems and regionally across ecosystems (forest, pasture, and river) in Manaus and Santarém. These data will also directly contribute to regional and aircraft studies which rely on ground observations for their data interpretation.

(2) Mechanistic leaf, canopy and site-scale canopy-scale models including isotope exchange are tools for extrapolating from local scale measurements towards understanding carbon cycling on an ecosystem and a basin-scale. Parameterized with leaf gas exchange characteristics (functional response curves, N values, 13C18O16O

and, canopy structure) and driven by meteorological inputs, these models will be used to understand how climate influences carbon gain at the canopy-ecosystem scale and will be used to link with eddy covariance studies (NEE estimates), atmospheric sampling programs and regional carbon cycle modeling efforts as part of our science integration.

The proposed study will make several key LBA-Ecology measurements at two primary regions: Manaus and Santarém:

• leaf-scale parameters to parameterize canopy photosynthesis models

• canopy scale photosynthesis models driven by climate data

• d13C and d18O values of stocks in forest and pastures: leaves and soils

• d13C and d18O values of CO2 effluxing from soils and from the total ecosystem at forest and pasture sites

• d13C and d18O values of ecosystem photosynthetic discrimination in forests and pastures

• d13C and d18O values of landscape-level respiration (PBL)

Our studies will be conducted in close association with eddy covariance measurements, atmospheric CO2 sampling, and regional carbon modeling groups. The leaf and canopy-level models of carbon gain and of isotope fractionation will linked directly with regional scale models. The information gathered using our isotope studies will help in determining the role of the Amazon Basin as a net sink or source of CO2 to the atmosphere.

Investigation Duration:

1998 - 2005

Participants:

Paulo Artaxo, USP
Joseph A Berry, Co-Investigator, Carnegie Institution of Washington, Department of Global Ecology
Craig Cook, Co-Investigator, University of Utah
Haroldo Jackson Pereira da Silva
Alessandro Carioca de Araujo, INPA
Rafaela Delfini, Cena/USP
Tomas Ferreira Domingues, University of Utah
James Ehleringer, US-PI, University of Utah
Sylvia Englund
Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Luiz Antonio Martinelli, SA-PI, CENA/USP
Edmar A Mazzi
Gabriela Bielefeld Nardoto, Universidade de Sao Paulo
Antonio Donato Nobre, INPA
Jean Pierre H.B. Ometto, University of Utah
Shela Jane Patrickson, University of Utah
Adam West, University of Utah

Student Information:

Alessandro Carioca de Araujo, INPA, Citizenship: BRAZIL, Masters student

Tomas Ferreira Domingues, University of Utah, Citizenship: BRAZIL, Ph.D. student, Thesis: Photosynthetic characteristics used in modeling carbon gain

Sylvia Englund, Citizenship: USA, Ph.D. student

Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher

Gabriela Bielefeld Nardoto, Universidade de Sao Paulo, Citizenship: BRAZIL, Ph.D. student, Thesis: O papel das leguminosas em dois ecossistemas tropicais – Amazônia e Cerrado – utilizando-se a técnica isotópica

Jean Pierre H.B. Ometto, University of Utah, Citizenship: BRAZIL, Postdoctoral Researcher

Shela Patrickson, University of Utah, Citizenship: SOUTH AFRICA, Masters student, Technician, Thesis: Palynology/Ecology

Adam West, University of Utah, Citizenship: SOUTH AFRICA, Ph.D. student

Proposed Research Sites:

Amazonas (Manaus)
- ZF2 km 14
- ZF2 km 25 - INPA Forest Management Site
- ZF2 km 34

Pará Western (Santarém)
- Fazenda Sr. David (km 117)
- Jamaraqua - Santarém River Site
- km 67 Primary Forest Tower Site
- km 67 Seca-Floresta Site
- km 77 Pasture Tower Site
- km 83 Logged Forest Tower Site

Proposed Training and Education:

Formal Training

- Undergraduates will continue to be involved in both field collection and analysis efforts. Other undergraduate students will be identified from the Santarém isotope ecology courses involved in individual research projects on a variety of topics (terrestrial, aquatic, thophic studies, etc) with sample collection in Amazonia. Support for graduate students will also continue to be provided. Currently, Jean Pierre Ometto (CENA-USP) is developing his postdoctoral research on stable isotope analyses at UTAH and CENA-USP.Tomas Domingues was admitted to the University of Utah PhD graduate program and is developing his thesis research focusing on functional-response-curve gas exchange measurements and other key photosynthetic parameters needed for carbon-gain modelling at field sites in both Manaus and Santarém. Graduate training will also include Alesandro Araújo (thesis work in Manaus under Dr. A. Nobre supervision) and Erika de Miranda Vieira (thesis work in Santarém, under Dr. Niro Higuchi's supervision). There has been a strong interaction between the isotope ration labs at CENA and Utah. Standards and technological capabilities were exchanged. Air sampling capacities at CENA - high precision isotope ration and CO2 concentration capacities were also developed. This technology will be expanded and transferred with implementation of the automated high-precision measurement capacity for atmospheric gases. Institutions in this program are open student and technician training for any stable isotope project in the LBA-ECO program.

Short Courses / Seminars / Workshops

- Oportunities for Brazilian students will be offered for participating in the Annual International Stable Ecology at University of Utah. The bonding and interactions that develop during this course provide an unusual opportunity for students to get to know each other and each other's science, forster the notion of collaborative science, and expose students to a wide spectrum of scientific endeavors.

Visits / Exchange Programs

- Opportunities for Brazilian students (1-20) will be offered for participating in the Annual International Stable Isotope Ecology Course in Utah. Treinamento em amostragem de ar nos estudos e análises de concentração de CO2.
- Visitsof students and researchers to CENA-USP and the University of Utah for training on advanced technology are planned.

Beija-Flor Datasets: (as of 2003-06-16)

Carbon isotopes in the atmosphere

Ecophysiological characteristics related to gas-exchange in the Amazonian tropical rain forest (Poster)

Oxygen isotope ratio of CO2 in forest and pastures ecosystems in the Amazon Basin (Poster)

Photosynthesis Measurements in Manaus and Santarém

Stable Isotope Measurements in Manaus and Santarém

Publications:

Martinelli LA, Almeida S, Brown IF, Moreira MZ, Victoria RL, Filoso S, Ferreira CAC, Thomas WW. (2000) Variation in nutrient distribution and potential nutrient losses by selective logging in a humid tropical forest of Rondonia, Brazil. *Biotropica*, **32**, 597-613.

Magnusson WE, Lima AP, Faria AS, Victoria RL, Martinelli LA. (2001) Size and carbon acquisition in lizards from Amazonian savanna: Evidence from isotope analysis. *Ecology*, **82**, 1772-1780.

de Camargo PB, Trumbore SE, Martinelli LA, Davidson EA, Nepstad DC, Victoria RL. (1999) Soil carbon dynamics in regrowing forest of eastern Amazonia. *Global Change Biology*, **5**, 693-702.

Magnusson WE, de Araujo MC, Cintra R, Lima AP, Martinelli LA, Sanaiotti TM, Vasconcelos HL, Victoria RL. (1999) Contributions of C-3 and C-4 plants to higher trophic levels in an Amazonian savanna. *Oecologia*, **119**, 91-96.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

CD-03 (Fitzjarrald / Moraes) Investigation Profile

Periodic, Transient, and Spatially Inhomogeneous Influences on Carbon Exchange in Amazonia

Principal Investigators:

David R. Fitzjarrald, State University of New York, Albany (US-PI)
Osvaldo Luiz Leal de Moraes, Universidade Federal de Santa Maria (UFSM) (SA-PI)

Abstract 2003:

We propose observations and analyses to infer transports of CO2, water vapor, and energy from the natural and the disturbed regions of Amazonia. We ask support to continue ongoing direct surface climate and flux measurements at several sites in LBA-ECO. Fluxes will also be estimated using the boundary layer budget approach. A major focus will be to determine how carbon fluxes are influenced by natural and human-induced landscape inhomogeneities. Scales of inhomogeneities addressed range from the river-land contrast, the pasture-forest contrast, and the gap-closed canopy contrast inside the forest. Special attention will go to understanding how changes in agricultural practices in the Amazon alter carbon exchanges in cleared areas. One new initiative aims to improve understanding of the respiration rate in forests by studying subcanopy flows. A second new initiative to quantify canopy structure to relate this structure to the forest flux tower observations is proposed. This proposal addresses LBA-ECO Science Questions CD–Q1 CD–Q3b, and LC–Q1.

Our objectives are:

1) To observe local wind circulations (river and land breezes, drainage flows) and assess their influence on boundary layer development. To infer surface heat, water vapor, and CO2 fluxes from temporal changes in their canopy and boundary layer concentrations .

2) To relate light availability to the ecosystem to cloudiness, and to determine the resulting effect on net ecosystem carbon exchange (NEE).

3) To quantify how land use change from pasture to cultivation alters the carbon budget in one cleared area, and develop parameterizations of exchange processes for modeling.

4) To quantify the vertical and horizontal structure of the forest canopy near flux towers in the Tapajos National Forest.

5) To relate canopy structure n to turbulent canopy-atmosphere exchange in regions of closed-canopy primary forest, near natural gaps, and in the cut-over mosaic of a selectively logged site.

6) To reduce uncertainties in long-term tower flux observations of the respiration rate)through better understanding the effect of subcanopy drainage flows at two LBA-ECO Study Areas.

Investigation Duration:

1998 - 2005

Participants:

Otavio C Acevedo, Co-Investigator, Universidade Federal de Santa Maria (UFSM)
Vagner Anabor, Universidade Federal do Rio Grande do Sul
Matthew J Czikowsky, State University of New York at Albany
Rodrigo da Silva, Universidade Federal de Santa Maria
David R. Fitzjarrald, US-PI, State University of New York, Albany
Osvaldo Luiz Leal de Moraes, SA-PI, Universidade Federal de Santa Maria (UFSM)
Geoffrey Parker, Smithsonian Environmental Research Center
Ricardo Sakai, Co-Investigator, State University of New York
Irene Cibelle Gonçalves Sampaio, LBA-Ecologia
Valdelirio Miranda Silva, LBA-ECO and STFP
Ralf Manfred Staebler, Co-Investigator, Meteorological Service of Canada
Julio Tota da Silva, SUNY
Alexander E. Tsoyref

Student Information:

Otavio Acevedo, Universidade Federal de Santa Maria (UFSM), Citizenship: BRAZIL, Ph.D. student

Vagner Anabor, Universidade Federal do Rio Grande do Sul, Citizenship: BRAZIL, Masters student, Thesis: Análise descritiva dos sistemas convectivos de alpha mesoescala através das imagens de satélite GOES-8

Matthew J Czikowsky, State University of New York at Albany, Citizenship: USA, Ph.D. student, Thesis: Atmospheric Science

Rodrigo da Silva, Universidade Federal de Santa Maria, Citizenship: BRAZIL, Ph.D. student, Thesis: Estudo da Camada Limite Interna sobre a Floresta Amazonica e sua influência nos Fluxos Turbulentos de CO2, Calor e Momento.

Ricardo Sakai, State University of New York, Citizenship: BRAZIL, Postdoctoral Researcher

Irene Cibelle Gonçalves Sampaio, LBA-Ecologia, Citizenship: BRAZIL, Thesis: Regime de irradiancia solar dentro de uma floresta tropical primária na região de Santarém Pará

Valdelirio Miranda Silva, LBA-ECO and STFP, Citizenship: BRAZIL, Bachelors student, Technician, Thesis: Bacharelado em Turismo

Ralf Manfred Staebler, Meteorological Service of Canada, Citizenship: GERMANY, Ph.D. student

Julio Tota da Silva, SUNY, Citizenship: BRAZIL, Ph.D. student, Thesis: Eta-Sib2: Um modelo acoplado para simulacao de fluxo de CO2 na Amazonia

Proposed Research Sites:

Amazonas (Manaus)
ZF2 km 25 - INPA Forest Management Site

Pará Western (Santarém)
Belterra
Fazenda Sr. David (km 117)
Guaraná
Jamaraqua - Santarém River Site
km 67 Primary Forest Tower Site
km 77 Pasture Tower Site
km 83 Logged Forest Tower Site
Mojuí

Proposed Training and Education:

Formal Training

- The long collaboration work between Jungle Research Group from SUNY Albany and the Laboratório de Micrometeorologia from Universidade Federal de Santa Maria (UFSM) will continue to be developed. Rodrigo Silva, a doctoral student at UFMS is now at Albany where he will spend 18 months as part of his degree, expanding the data analysis he started in Santa Maria. Roberto Magnago, a Master student at UFMS is expected to work at the sites in Santarém in 2003 and in the later future, to spend some time at Albany. Three undergraduate students are being trained in collaboration with TG-04. Additional undergraduate students in Santarém will be supported.

Beija-Flor Datasets: (as of 2003-06-16)

Mesoscale Meteorological Station Network at Santarem (PA) region

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

CD-04 (Goulden / Rocha) Investigation Profile

Measuring the Effects of Logging on the CO2 and Energy Exchange of a Primary Forest in Tapajós National Forest

Principal Investigators:

Michael L. Goulden, University of California (US-PI)
Humberto Ribeiro da Rocha, DCA/IAG/USP (SA-PI)

Abstract 2003:

We propose to continue investigating the effects of selective logging on the exchanges of CO2 and energy by a primary forest in the Tapajos National Forest (TNF), Pará. Our study can be thought of as a large experimental manipulation, where we use a range of techniques, including eddy covariance, to monitor forest physiology before, during, and after selective logging.

We have been making eddy covariance measurements, and ground-based measurements of soil respiration, litterfall, wood increment, and coarse woody debris, at the Santarem km-83 site since 2000. As of March 2002 we had collected, and submitted to Beija-Flor, 20 months of nearly continuous tower-flux observations. The first 14 months of observations were made while the forest was relatively undisturbed. These data served as the basis for three submitted manuscripts that detail the exchanges of CO2 and energy by the intact forest. The remaining 6 months of observations were made after the forest was selectively logged in September 2001. The logging operation, which was conducted by a local firm using reduced impact procedures, covered ~400-ha of forest that extended ~2-km upwind of the tower. The loggers removed only ~6% of the biomass in large trees, but left another ~18% of the biomass in large trees as slash, and eliminated ~13% of the canopy on an area basis. Preliminary analysis of the tower observations indicate that canopy photosynthesis declined by ~15% following logging, and that ecosystem respiration increased in the subsequent wet season.

In this proposal we request support to complete our study by continuing these observations for three more years. Our goal is to use the combined tower and ground-based observations to quantify the forest's response to, and recovery from, logging. We will do this in collaboration with other researchers working in Santarem, and, in particular those making flux measurements at the km-67 tower (CD10, Wofsy PI; TG07, Keller and Crill PIs), which serves as an undisturbed control for the km-83 tower, and those making additional measurements at the km-83 tower (TG07, Keller and Crill PIs; CD03 Fitzjarrald PI, and TG04, Martens PI). Additionally, we will focus efforts on scientific integration within LBA, both among researchers working in Santarem, and among all tower groups within LBA. Finally, we will continue our educational activities by further involving Brazilian students in the research, both at UCI and USP, as well as in Santarem.

Investigation Duration:

1998 - 2005

Participants:

Christopher Eric Doughty, U. C. Irvine
Michela Figueira
Helber Freitas, USP
Michael L. Goulden, US-PI, University of California
Robinson Juarez, IAG-USP
Augusto Rodrigues Maia
Mary Catherine Menton, Projeto LBA -Ecologia
Scott Dennis Miller, Co-Investigator, University of California at Irvine
Edward Lloyd Read, University of California at Irvine
Humberto Ribeiro da Rocha, SA-PI, DCA/IAG/USP
Rafael Rosolem, CENA-USP
Cleilim Albert Dias de Sousa, Universidade Federal do Pará
Leandro Della Vedova Pinto, USP
Fabricio Berton Zanchi, IAG-USP

Student Information:

Adelaine Michela e Silva Figueira, Citizenship: BRAZIL

Helber Freitas, USP, Citizenship: BRAZIL, Masters student

Robinson Juarez, IAG-USP, Citizenship: PERU, Ph.D. student

Augusto Rodrigues Maia, Bachelors student

Rafael Rosolem, CENA-USP, Citizenship: BRAZIL, Masters student, Thesis: O Impacto do Desmatamento no Ciclo Hidrológico: Um Prognóstico para o Caso da Rodovia Cuiabá-Santarém

Cleilim Albert Dias de Sousa, Universidade Federal do Pará, Citizenship: BRAZIL, Bachelors student

Leandro Della Vedova Pinto, USP, Citizenship: BRAZIL, Masters student

Fabricio Berton Zanchi, IAG-USP, Citizenship: BRAZIL, Masters student, Postdoctoral Researcher, Thesis: Medição do Efluxo de CO2 do solo: Monitoramento com câmaras automáticas sobre floresta e pastagem em Rondônia.

Proposed Research Sites:

Pará Western (Santarém)
km 83 Logged Forest Tower Site

Proposed Training and Education:

Formal Training

- Three types of activities are planned: training in Santarém, at UCI and at USP. Local Brazilian students will continue receiving training. Currently, two students - Adelaine Michela Silva e Figueira e Cleilim Albert Dias de Sousa are working in the project with support from LBA fellowships. Michela has taken progressively larger role in the project and is now responsible for day-to-day operation of the project in Santarém. Michela and Albert were initially supervised by Mary Menton, a US-citizen who lived in Santarém from 3/00 to 08/01. In 2003 it is planned that these students visit UCI for one month to work on data analysis. Additional students will be involved in the project during Phase II. A Brazilian PhD, a Masters student or a Postdoctoral fellow will work on the project. Two students from USP and one from Santarém will spend some time at UCI working on data analysis. Currently, at USP, there are four students under Dr. Humberto Rocha's supervision: Helber Freitas, Leandro Vedova, Robinson Juarez and Rafael Rosolem. Helber and Leandro have played central roles in the project. Leandro took an important role in developing software and analyzing data. Helber took a lead role in the design, fabrication, installation, and maintenance of equipment. Robinson Juarez is a graduate student under the doctorate program at USP and has worked with estimates of leaf area index using hemispherical photographs. Rafael Rosolem is an undergraduate student and spent a month at TNF working on the gap instrumentation. It is expected that these students from USP will continue to play a central role in the project.

Visits / Exchange Programs

- A Brazilian PhD, Masters or Posdoctoral student will spend several months at University of California, Irvine working on data analysis.

Beija-Flor Datasets: (as of 2003-06-16)

Santarém - FLONA Tapajós Logged Forest Tower Site Leaf Area Index

Santarém - FLONA Tapajós Logged Forest Tower Site Leaf Level Photosynthesis/Respiration, and Soil Respiration Data

Santarém - FLONA Tapajós Logged Forest Tower Site March 2000 Biomass Survey

Santarém - FLONA Tapajós Logged Forest Tower Site Meteorological and Flux Data

Santarém - FLONA Tapajós Logged Forest Tower Site Post-Logging Damage Survey

Santarém - FLONA Tapajós Logged Forest Tower Site Soil Respiration Chamber Data

Santarém - FLONA Tapajós Logged Forest Tower Site Spring 2001 Coarse Woody Debris Data

Santarém - FLONA Tapajós Logged Forest Tower Site Woody Increment (Dendrometry) Data (Poster)

Tower- and Biometry-based Measurements of Tropical Forest Carbon Balance (Poster)

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

Land Cover and Land Use Change:

- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?

CD-05 (Nepstad / Klink / Moutinho) Investigation Profile

Amazon Scenarios: Modeling Interactions Among Land Use, Fire, and Climate

Principal Investigators:

Carlos Augusto Klink, University of Brasilia (SA-PI)
Paulo Roberto de Souza Moutinho, IPAM - Instituto de Pesquisa Ambiental da Amazonia (SA-PI)
Daniel Curtis Nepstad, WHRC (US-PI)

Abstract 2003:

Amazonia has entered an era of rapid change as new transportation corridors traverse the region, stimulating the expansion of logging and agricultural frontiers. This large experiment in infra-structure investments presents an important scientific challenge to the LBA community?to simulate the effects of transportation infra-structure on regional patterns of land-use change and carbon emission. In this second phase of our LBA grant we propose to develop and refine a process-based model of ecosystem productivity and fire probability and economic models of agriculture and forestry that begin to address this challenge. These models will be coupled within a Pan-Amazonian GIS, and will be responsive to plausible policy scenarios, as model inputs. Model outputs will include spatially-explicit simulations of future land uses, fire regime, and associated carbon emissions. The interaction between land cover and regional climate will be investigated using both a meso-scale climate model (RAMS) and a global circulation model (COLA/CPTEC).

We will help reduce the considerable uncertainty about areas of logging and understory fire in Amazonia by geo-referencing, through fieldwork, the perimeters of logging and forest fire scars in each of five ?reference landscapes?. Vegetation structure and biomass will be measured within a subsample of patches in each landscape. We will also establish a prescribed burn experiment in the Amazon-Cerrado transition forest of Mato Grosso. The proposed research will also be supported by datasets being collected at our ongoing rainfall exclusion experiments in Amazonia and the Cerrado (LC-14), and by measurements of sub-soil controls on the ecological dynamics of forest-savanna ecotones.

Investigation Duration:

1998 - 2005

Participants:

Sergio Viana de Andrade, Universidade de Brasilia
Irene Annamaria Angeletti
Javier Alberto Arce, Columbia University
Gregory Paul Asner, Co-Investigator, Carnegie Institution
Jennifer Kakareka Balch, Yale University
Barbara Bamberger
Elizabeth Leslie Belk, University of Georgia
Lace Medeiros Breyer, Universidade de Brasilia
Marina Thereza Campos
Gina Knust Cardinot, IPAM - Seca Floresta
Oswaldo de Carvalho Jr, IPAM
Larissa Steiner Chermont, Federal University of Para - UFPA
Avery Simon Cohn, Yale School of Forestry
Lisa M. Curran, Yale University
Wanderley Rocha da Silva, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Pedro Leite da Silva Dias, Co-Investigator, IAG/USP
Moacyr Bernardino Dias-Filho, Co-Investigator, Embrapa Amazonia Oriental / CPATU
Maria del Carmen Vera Diaz, IPAM
Juan Carlos Espinosa
Ricardo de Oliveira Figueiredo, Co-Investigator, Embrapa Amazônia Oriental
Margaret Rose Francis, Yale University School of Forestry and Environmental Studies
Jose Benito Guerrero, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Noel Michele Holbrook, Harvard University
Wendy Kingerlee, Co-Investigator, The Woods Hole Research Center
Carlos Augusto Klink, SA-PI, University of Brasilia
Paul A. Lefebvre, The Woods Hole Research Center
Eduardo Jorge Maklouf, Co-Investigator, Embrapa Amazonia Oriental
Daniel Markewitz, Co-Investigator, University of Georgia
Frank David Merry, University of Florida
Luciana Monacao
Douglas Christopher Morton, University of Maryland/NASA
Paulo Roberto de Souza Moutinho, SA-PI, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Daniel Curtis Nepstad, US-PI, WHRC
Rafael Silva Oliveira, University of California, Berkeley
Christian Tobler Palmer
Joanne Pawlowski
Charles Merideth Peters, New York Botanical Garden
Alexandra Gisela Ponette
Carlos Alberto Nobre Quesada, University of Brasilia
David Graham Ray, Woods Hole Research Center
Sergio Rivero, Núcleo de Altos Estudos Amazônicos/Universidade Federal do Pará.
Patricia Rodin, UnB
Fabio de Oliveira Romeu, Universidade de Brasília
Maria Rosenildes Guimaraes dos Santos
Alexandre Barbosa Santos, UnB
Karen R. Schwalbe, The Woods Hole Research Center
Elizabeth Naomi Shapiro, Yale University
Dulce Alves da Silva, Universidade de Brasilia
Liliane Bezerra Silva, Instituto de Pesquisa Ambiental da Amazônia
Marcos de Oliveira Soares, IPAM
Britaldo Silveira Soares-Filho, UFMG
Luis Anibal Solorzano Cardenas, The Woods Hole Research CenterHRC
Ingrid Marisa Tohver, IPAM
Javier Tomasella, CPTEC/INPE
Maria Teresa Vargas
Daniela Vizcaino

Student Information:

Sergio Viana de Andrade, Universidade de Brasilia, Citizenship: BRAZIL, Ph.D. student

Javier Alberto Arce, Columbia University, Citizenship: USA, Ph.D. student, Thesis: Effects of Forest Fires on Community Forest Management.

Jennifer Kakareka Balch, Yale University, Ph.D. student, Thesis: Plant community response to human disturbance

Barbara Bamberger, Citizenship: USA, Masters student, Thesis: Inhibition of deforestation by parks and indigenous reserves in Amazonia.

Elizabeth Leslie Belk, University of Georgia, Citizenship: USA, Masters student, Thesis: The effect of experimental throughfall exclusion on soil nutrient flows in Amazonia.

Lace Medeiros Breyer, Universidade de Brasilia, Citizenship: BRAZIL, Ph.D. student, Thesis: A comparison of gas exchange among cerrado vegetation and the atomosphere using eddy correlation.

Gina Cardinot, IPAM - Seca Floresta, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Effects of experimental throughfall exclusion on tree water relations.

Oswaldo de Carvalho Jr, IPAM, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Effects of understory fire and logging on forest biomass and large mammal populations in eastern Amazonia./ Impact of Forest Fire in Biomass Reduction

Larissa Steiner Chermont, Federal University of Para - UFPA, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Economic Aspects of Fire Use and Prevention: A household model for the Brazilian Amazon

Avery Simon Cohn, Yale School of Forestry, Citizenship: USA, Masters student, Thesis: Livelihoods, education and develolpment in Latin America

Maria del Carmen Vera Diaz, IPAM, Citizenship: COLOMBIA, Ph.D. student

Paul A. Lefebvre Jr., The Woods Hole Research Center, Citizenship: USA, Technician

Luciana Monacao, Citizenship: BRAZIL, Masters student, Thesis: experimental forest fire

Rafael Silva Oliveira, University of California, Berkeley, Citizenship: BRAZIL, Ph.D. student, Thesis: Drought-related strategies of different plant functional groups in contrasting water conditions in two Brazilian ecosystems.

Joanne Pawlowski, Citizenship: USA, Masters student, Thesis: property rights and poverty alleviation

Carlos Alberto Nobre Quesada, University of Brasilia, Citizenship: BRAZIL, Bachelors student

Sergio Rivero, Núcleo de Altos Estudos Amazônicos/Universidade Federal do Pará., Citizenship: BRAZIL, Ph.D. student, Thesis: The game of logging: a multi-agent model for simulating the Amazon timber industry.

Patricia Rodin, UnB, Masters student

Maria Rosenildes Guimaraes dos Santos, Masters student

Alexandre Jose Barbosa Santos, UnB, Citizenship: BRAZIL, Ph.D. student, Thesis: Effects of fire on surface carbon, energy and water vapour fluxes over campo sujo savanna in central Brazil

Dulce Alves da Silva, Universidade de Brasilia, Citizenship: BRAZIL, Ph.D. student, Thesis: The effect of CO2 concentration and water stress on the ecophysiology of wooody species of a Cerrado savanna

Liliane Bezerra Passos da Silva, Instituto de Pesquisa Ambiental da Amazônia, Citizenship: BRAZIL, Technician, Thesis: Plant water availability and evapotranspiration in a natural Cerrado savanna and a planted pasture

Luis Anibal Solorzano Cardenas, The Woods Hole Research CenterHRC, Citizenship: COLOMBIA, Postdoctoral Researcher

Ingrid Marisa Tohver, IPAM, Citizenship: BRAZIL, Bachelors student

Javier Tomasella, CPTEC/INPE, Citizenship: ARGENTINA

Proposed Research Sites:

Acre

Amazon Basin (large-scale studies)

Brasília
- Reserva Ecologica Aguas Emendadas
- Reserva Ecologica do Roncador IBGE

Mato Grosso
- Canarana
- Guaranta

Pará Eastern (Belém)
- Paragominas
- Santana do Araguaia

Pará Western (Santarém)
- Fazenda Treviso
- km 67 Seca-Floresta Site
- km 83 Logged Forest Tower Site
- Santarém-Cuiabá Road

Peru
- Assis-Puerto Maldonado Road

Proposed Training and Education:

Community / Government Outreach

- At least one seminar about Amazonian economic and ecological modeling will be presented for the Brazilian National Congress.

Formal Training

- Most of the planned training activities will involve Amazonian students (9 to 10 doctoral students). IPAM will continue supporting ongoing scholarships from Amazonian students. UFAC will continue hosting courses in collaboration with this team. Approximately ten undergraduates, twelve Brazilian doctoral students (9 from Amazonia) and eight MS students will receive training. Faculty from these institutions will have training responsibilities: VA Polytechnic Institute, Boston University, USP (University of So Paulo), IPAM, University of Brasilia and Federal University of Pará.

Short Courses / Seminars / Workshops

- Courses on community ecology and vegetaion science and a one 10-day field course per year on ecosystems, ecology and land use are planned. At least one seminar about Amazonian economic and ecological modeling will be presented for the Brazilian National Congress.

Beija-Flor Datasets: (as of 2003-06-16)

Fuel loads (volumes and weights) by size class for a number of sites and forest conditions in Amazonia, rainfall exclusion experiment, Tapajós National Forest (LBA)

Lateral Extension of Adult Tree Roots of Three Species: Erisma Uncinatum (Vochysiaceae), Lecythis Lurila (Lecythidaceae) and Manilkara Huberi (Sapotaceae), in the National Forest of Tapajos (Poster)

Modeling and Mapping of the Retention Capacity of Plant Available Water of Brazilian Amazon Soils (Poster)

Moisture content of fuel sticks located in the forest understory, rainfall exclusion experiment, Tapajós National Forest (LBA)

RisQue: A Forest Fire Risk Model for the Brazilian Amazon (Poster)

Seasonal variation in leaf water potential of species frequent in one area of a humid tropical forest in Amazonia (Poster)

Simulating El Nino: An Amazon Forest Rainfall Exclusion Experiment (Poster)

Solar radiation logged at half hour intervals (daily 8AM - 5PM), rainfall exclusion experiment, Tapajós National Forest (LBA)

Specific Leaf Area (SLA) of 32 Wood Species in Three Cerrado Plant Communities (Poster)

Temperature, relative humidity, and vapor pressure deficit estimates from sensors at various locations, rainfall exclusion experiment, Tapajós National Forest (LBA)

The economic aspects of ground fires in forests in Amazônia (Poster)

Publications:

Potter C, Davidson EA, Nepstad D, de Carvalho CR. (2001) Ecosystem modeling and dynamic effects of deforestation on trace gas fluxes in Amazon tropical forests. *Forest Ecology and Management*, **152**, 97-117.

Nepstad D, Carvalho G, Barros AC, Alencar A, Capobianco JP, Bishop J, Moutinho P, Lefebvre P, Silva UL, Prins E. (2001) Road paving, fire regime feedbacks, and the future of Amazon forests. *Forest Ecology and Management*, **154**, 395-407.

Uhl C, Nepstad D. Amazonia at the millennium. Interciencia **25**, 159-164. 2000.

Nepstad DC, Verissimo A, Alencar A, Nobre C, Lima E, Lefebvre P, Schlesinger P, Potter C, Moutinho P, Mendoza E, Cochrane M, Brooks V. (1999) Large-scale impoverishment of Amazonian forests by logging and fire. *Nature*, **398**, 505-508.

Carvalho G, Barros AC, Moutinho P, Nepstad D. (2001) Sensitive development could protect Amazonia instead of destroying it. *Nature*, **409**, 131-131.

Cochrane MA, Alencar A, Schulze MD, Souza CM, Nepstad DC, Lefebvre P, Davidson EA. (1999) Positive feedbacks in the fire dynamic of closed canopy tropical forests. *Science*, **284**, 1832-1835.

Nepstad D, McGrath D, Alencar A, Barros AC, Carvalho G, Santilli M, Diaz MDV. Environment - Frontier governance in Amazonia. Science **295**, 629-+. 2002.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?
- CD-Q3d - What portion of the Amazônia–wide carbon flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Land Cover and Land Use Change:

- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?
- LC-Q4 - What are plausible scenarios for future land cover change in Amazônia?

CD-06 (Richey / Victoria) Investigation Profile

Carbon and Moisture Fluxes along the LBA Transects: Data Assimilation and Modeling

Principal Investigators:

Jeffrey E. Richey, University of Washington (US-PI)
Reynaldo Luiz Victoria, CENA/USP (SA-PI)

Abstract 2003:

Our research addresses the overall role rivers and periodically inundated environments play in the biogeochemical cycles of the Amazon Basin. Recent evidence suggests that outgassing of CO2 is of comparable magnitude to the lower estimates of carbon sequestration by forests. We have two primary objectives:

Objective 1. Complete research on the question of landuse change and its consequences for water chemistry in the Ji-Paraná River Basin

Objective 2. Expand research on the fluxes of gases between wetlands and the atmosphere, by testing the working hypothesis that "CO2 evasion returns as much carbon to the atmosphere as is sequestered in upland forests on an interannual basis. Export of organic material from upland and riparian forests to fluvial environments is the primary source of carbon that is eventually respired in rivers and evaded as CO2."

We are addressing our objectives by (1) Conducting fieldwork in characteristic sub-basins to complete water chemistry and to obtain an extensive suite of pCO2 distribution measurements over the hydrologic regime, and to use proven geochemical techniques (gas flux measurements, isotopic tracers, remineralization rates) to quantify the rates of the lateral transfer and cycling of water and bioactive organic matter from the land, through riparian environments and to the river system. (2) Using a terrestrial source/river transport and reaction model to synthesize and extrapolate the site-specific CO2 evasion rate measurements to a basin-wide estimate of CO2 evasion rate. The work will be executed across a series of environments (primarily Manaus, Ji-Parana, Bananal, Acre, Caxiuana, Mato Grosso, and hopefully Tefe). This will be done by setting up specific student-based collaborations at each site, coordinated through CENA. The overall research here is relevant to a series of the LBA-ECO Science questions. The work considers explicitly the effects of changing land use, the relation of surface water chemistry to regional flow patterns, and the role of the extensive wetlands and temporarily inundated or saturated areas in Amazônia.

Investigation Duration:

1998 - 2005

Participants:

Simone Rebecca Alin, University of Washington
Anthony K. Aufdenkampe, Stroud Water Research Center
Maria Victoria Ramos Ballester, Co-Investigator, CENA/USP
Marcelo Correa Bernardes, Universidade Federal Fluminense
Marcos Alexandre Bolson, UNIR-JP
Michelle Cristine Cogo, CENA - USP
Allan H. Devol, Co-Investigator, University of Washington
Beatriz M. Gomes
Sergio Candido de Gouveia Neto, UNIR - JP
Lais de Carvalho Hanada, CENA/USP
Niro Higuchi, Co-Investigator, INPA
Alex V. Krusche, Co-Investigator, CENA-USP
Nei Kavaguichi Leite, CENA-USP
Miles Grant Logsdon, Co-Investigator, University of Washington
Gelson de Macedo, ULBRA-JP
Renata Marcondes, CENA-USP
Marcelo Zacharias Moreira, CENA/USP
Vania Neu, CENA - USP
Jean Pierre H.B. Ometto, University of Utah

Nicolau Priante Filho, Universidade Federal de Mato Grosso
Maria de Fátima Fernandes Lamy Rasera, CENa/USP
Sonya Marie Remington, University of Washington
Jeffrey E. Richey, US-PI, University of Washington
Cleber Ibraim Salimon, CENA/USP
Andre Marcondes Toledo, CENA-USP
Reynaldo Luiz Victoria, SA-PI, CENA/USP
Daniel de Castro Victoria, CENA-USP

Student Information:

Maria Victoria Ramos Ballester, CENA/USP, Citizenship: ARGENTINA, Postdoctoral Researcher, Thesis: From patterns to process: land use and land cover changes and its effects on the biogeochemistry of surface waters of tropical rivers in western Amazonia (Ji-Parana, Rondonia)

Marcelo Correa Bernardes, Universidade Federal Fluminense, Citizenship: BRAZIL, Postdoctoral Researcher, Thesis: Organic matter composition of rivers of the Ji-Parana basin

Marcos Alexandre Bolson, UNIR-JP, Citizenship: BRAZIL, Bachelors student, Technician, Thesis: Carbon dynamics in two rivers of Rondonia with different land use/cover

Sérgio Candido de Gouveia Neto, UNIR - JP, Citizenship: BRAZIL, Bachelors student, Technician, Thesis: Temporal variability of the water quality of two rivers of Rondonia with different land use/cover

Lais de Carvalho Hanada, CENA/USP, Citizenship: BRAZIL, Masters student, Thesis: Land use and land cover changes at the agricultural frontier in western Amazonia, the Ji-Parana River Basin, Rondonia

Alex V. Krusche, CENA-USP, Citizenship: BRAZIL, Postdoctoral Researcher

Nei Kavaguichi Leite, CENA-USP, Citizenship: BRAZIL, Masters student, Thesis: Land use/cover changes in the Ji-Parana basin and its effects on the river biogeochemistry

Gelson de Macedo, ULBRA-JP, Citizenship: BRAZIL, Ph.D. student, Thesis: Biogeochemical effects of land use/cover changes at the interface land-water in the Urupa river, Ji-Parana, RO

Renata Marcondes, CENA-USP, Citizenship: BRAZIL, Bachelors student, Thesis: Occupation and land use in the Ji-Parana River basin (Rondonia): socio-economic and agricultural survey

Jean Pierre H.B. Ometto, University of Utah, Citizenship: BRAZIL, Postdoctoral Researcher

Sonya Marie Remington, University of Washington, Citizenship: USA, Ph.D. student, Thesis: Carbon transport through soils of the lowland Amazon Basin

Cleber Salimon, CENA/USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Carbon dioxide soil fluxes due to differing land uses in eastern Acre

Andre Marcondes Toledo, CENA-USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Environmental diagnosis of the Ji-Parana river basin, Rondonia

Daniel de Castro Victoria, CENA-USP, Citizenship: BRAZIL, Bachelors student, Thesis: Using GIS and the Thornthwaite hydric balance to estimate the potential evapotranspiration in the Ji-Parana river basin (RO)

Proposed Research Sites:

Acre

Amazon Basin (large-scale studies)

Amazonas (Manaus)
- Rio Cuieras (lower)
- Rio Negro
- Rio Preta da Eva

ZF2 km 34

Brasília

Mato Grosso
Alta Floresta
Juruena
Sinop

Pará Eastern (Belém)
FLONA Caxiuanã

Peru
Pachitea

Rondonia
Rancho Grande
Rio Ji-Parana
Rio Madeira
Urupa River

Tocantins

Proposed Training and Education:

Educational Materials

- Production of texts for dissemination of LBA results for the general public.
- "Rivers Research Groups" is a web site (www. .....) maintained by this team which leads not only to frequent "hits" but has up-to-date information about the Amazon.

Formal Training

- This group will continue providing support for students not only at the University of Washington and CENA-USP but also from Amazonian institutions.

Short Courses / Seminars / Workshops

- Short courses on analytical environmental chemistry. A network of liquid chromatographs is being installed in the Amazon (INPA, Paragominas, possibly Belém, as well as Ji Paraná). These courses will be useful as joint endeavors with other investigations.
- A annual workshop on regional-scale integration of CO2 fluses will be sponsored.
- A short course on watershed analysis will be offered.

Beija-Flor Datasets: (as of 2003-06-16)

CAMREX Amazon River System

Publications:

McClain ME, Victoria RL, Richey JE. (2001) *The Biogeochemistry of the Amazon Basin*.

Aufdenkampe AK, Hedges JI, Richey JE, Krusche AV, Llerena CA. (2001) Sorptive fractionation of dissolved organic nitrogen and amino acids onto fine sediments within the Amazon Basin. *Limnology and Oceanography*, **46**, 1921-1935.

Richey JE, Melack JM, Aufdenkampe AK, Ballester VM, Hess LL. (2002) Outgassing from Amazonian rivers and wetlands as a large tropical source of atmospheric CO2. *Nature*, **416**, 617-620.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?
- ND-Q4b - Are there unique signatures that can be traced downstream?
- ND-Q4c - To what extent do intact riparian zones buffer streams against changes due to anthropogenic activities in surrounding uplands?
- ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

Trace Gas and Aerosol Flux:

- TG-Q3 - Are losses and gains of carbon from Amazônian ecosystems in forms other than carbon dioxide (e.g. carbon monoxide, methane, volatile organic carbon, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance?

CD-08 (Trumbore / Camargo) Investigation Profile

Carbon Dynamics in Vegetation and Soils Along the Eastern LBA Transect

Principal Investigators:

Plinio B. de Camargo, USP (SA-PI)
Susan E. Trumbore, University of California (US-PI)

Abstract 2003:

Our overall goals are to quantify the contributions of different components of the carbon cycle to overall ecosystem carbon balance in Amazonian tropical forests and to undertake process studies at a number of sites along the eastern LBA transect to understand how and why these fluxes vary with site, season, and year. We are dividing this work into a number of specific tasks: (1) determining the average rate (and variability) of tree growth over the past 3 decades; (2) determining age demographics of tree populations, using radiocarbon to determine tree age; (3) assessing the rate of production and decomposition of dead wood debris; (4) determining turnover rates for organic matter in soils and the mean age of C respired from soil using radiocarbon measurements; and (5) comparing our results with models and constructing models to predict the potential of tropical forests to function as sources or sinks of C.

The overall picture of tropical forest C dynamics emerging from our Phase I studies suggests that the fraction of gross primary production allocated to growth in these forests is only 25-30%, as opposed to the 50% assumed by many ecosystem models. Consequent slow tree growth rates mean greater mean tree age for a given diameter, as reflected in our measurements and models of tree age. Radiocarbon measurements in leaf and root litter suggest that carbon stays in living tree biomass for several years up to a decade before being added to soils, where decomposition is rapid. The time lags predicted from 14C, when coupled with climate variation on similar time scales, can lead to significant interannual variation in net ecosystem C exchange.

In Phase II we will continue our measurements to observe how forest C budgets can vary from year to year with climate. In addition to filling gaps in our stand-level C budgets, activities we will (1) expand our efforts in integration across sites through modeling, and (2) augment our existing measurements where needed to facilitate modeling (through availability of continuous temperature and moisture data), or to fill gaps in coverage of C cycle components, and (3) continue measurements begun in the past year to study differences in C dynamics between primary forest and other land cover types (flooded forest and cerrado). Some more detailed physiological measurements begun by Chambers, Higuchi, Santos, and Tribuzy at the INPA ZF2 forest and FLONA seca floresta project will continue in Year 1.

Investigation Duration:

1998 - 2005

Participants:

Plinio B. de Camargo, SA-PI, USP
Jeffrey Q. Chambers, Co-Investigator, University of California
Guaciara dos Santos
Niro Higuchi, INPA
Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Luciene L. S. Lara, CENA/USP
Luiz Antonio Martinelli, Co-Investigator, CENA/USP
Antonio Willian Flores de Melo, Laboratório de Ecologia Isotópica/CENA/USP
Erika Miranda, INPA
Marcelo Zacharias Moreira, CENA/USP
Tibisay Josefina Perez Acosta, Co-Investigator, University of California
Alberto C.M. Pinto, Inpa
Rosana Rocha, INPA
Joaquim dos Santos, INPE
Diogo Selhorst, UFAC/PZ/SETEM
Roseana P. da Silva, INPA
Vanessa P. Silveira, CENA/USP
Chieno Suemitzu, UFPA- Santarem
Liliane Martins Teixeira
Everaldo de Carvalho Conceicao Telles, Universidade de Brasília
Edgard Siza Tribuzy, ESALQ/INPA
Susan E. Trumbore, US-PI, University of California
Simone Aparecida Vieira, CENA/USP

Student Information:

Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher

Antonio Willian Flores de Melo, Laboratório de Ecologia Isotópica/CENA/USP, Citizenship: BRAZIL, Masters student, Thesis: Avaliação do Estoque e Composição Isotópica do Carbono do Solo no Acre

Erika Miranda, INPA, Citizenship: BRAZIL, Masters student, Thesis: Padrão de crescimento individual de espécies arbóreas da Amazonia Central

Tibisay J. Perez, University of California, Citizenship: VENEZUELA, Postdoctoral Researcher

Alberto C.M. Pinto, Inpa, Bachelors student

Rosana Rocha, INPA, Thesis: Dinãmica de floresta tropical primária da Amazônia Central na Bacia do Rio Cuieiras

Diogo Selhorst, UFAC/PZ/SETEM, Citizenship: BRAZIL, Masters student, Technician, Thesis: Datação radiocarbônica de Swietenia macrophylla King (mogno) e Dipterix Odorata (Aubl) Willd (cumaru) e implicações para o manejo.

Roseana P. da Silva, INPA, Citizenship: BRAZIL, Masters student, Thesis: Studies of growth ratesof several species using dendrometry bands.

Everaldo de Carvalho Conceicao Telles, Universidade de Brasília, Citizenship: BRAZIL, Postdoctoral Researcher, Thesis: Carbon and nutrients dynamics in tropical forest soils

Edgard Siza Tribuzy, ESALQ/INPA, Citizenship: BRAZIL, Ph.D. student, Thesis: AVALIAÇÃO DE ASPECTOS ECOFISIOLÓGICOS DA PRODUTIVIDADE DE ÁRVORES DO DOSSEL, EM ÁREAS FLORESTAIS DA AMAZÔNIA CENTRAL

Simone Aparecida Vieira, CENA/USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Mudanças Globais e taxa de crescimento arbóreo na Amazômia

Proposed Research Sites:

Acre
Catuaba Experimental Farm

Amazonas (Manaus)
ZF2 km 25 - INPA Forest Management Site
ZF2 km 34

Brasília
Reserva Ecologica do Roncador IBGE

Pará Eastern (Belém)
Paragominas

Pará Western (Santarém)
km 67 Primary Forest Tower Site
km 67 Seca-Floresta Site
km 83 Logged Forest Tower Site

Proposed Training and Education:

Formal Training

- Training of current students will continue and new Masters students will be added. Currently, twelve students are involved. The Brazilian student Enir Salazar da Costa thesis on the C dynamics of leaves and roots in primary tropical forest and the role of these as sources of soil respiration; in addition she is working explore howland management changes cycling of C and N near Santarém. Everaldo de cArvalho Conceição Telles, a Brazilian PhD student at CENA (funded by FAPESP) works on carbon and nitrogen stocks and isotopic signature in soils from Santarém and Manaus with focus on spatial variability, topography, and C dynamics in soils of different texture. The Brazilian PhD student at CENA-USP - Simone Aparecida Vieira (funded by FAPESP) is developing comparison of tree growth rates and forest age structure in Acre, Manaus and Santarém using permanent plot, dendrometer, and radiocarbon analyses. The CNPq funded MS student Roseana Pereira da Silva is developing studies at INPA on "Padrões de crescimento de árvores que ocorrem em diferentes toposseqüências na região de Manaus. She has been studying monthly changes in tree grow rates using dendrometer bands for trees in three size classes equally distributed among plateau, slope, and valley forests. Rosana de Miranda Rocha, a MS students at INPA has been developing a thesis titled "Taxas de recrutamento e mortalidade da floresta de terra-firme da bacia do Rio Cuieiras na região de Manaus. Rosana calculated recruitment, growth and mortality rates for two 20 x 2,500 m permanent inventory plots (5 ha each) from 1996 to 2000. She found that the trees were a net carbon sink of about 0.34 Mg C ha-1yr1over the four year period.

Short Courses / Seminars / Workshops

- A short course on the use of isotopes in the carbon cycle as part of the UCI/Keck AMS facility will be offered in June/July 2003. Investigators and PhD student will continue to participate in seminars and course offerings associated with LBA-ECO.

Visits / Exchange Programs

- Training of students from INPA and CENA at University of California, Irvine.

Beija-Flor Datasets: (as of 2003-06-16)

24-hour leaf respiration profiles for tower trees in forest near Manaus

Carbon and Carbon isotopes in soil organic matter in primary and secondary forests and pastures at Fazenda Vitoria in 1996

Carbon isotopes in roots separated from soils sampled from Santarem transect near km83 in 1999-2000

Carbon isotopes in roots separated from soils sampled from soil pits in Paragominas in 1996

Carbon isotopes in soil organic matter sampled from Manaus ZF2 transect in 1999-2000

Carbon isotopes in soil organic matter sampled from Santarem transect near km83 in 1999-2000

Coarse wood litter decompostion data from forest near Manaus

Coarse wood litter respiration data from forest near Manaus

Global change and growth rate of trees in Amazon forest

Isotopes in soil gases sampled in primary and secondary forests and pastures at Fazenda Vitoria 1992 to 1999

Monthly tree growth data for ten species by wood density from forest near Manaus

Monthly tree growth data for three species in forest near Manaus

Monthly tree growth data for trees from three size and topography classes for forest near Manaus

Poster presenting preliminary data on tree age and growth rates presented at the AGU and LBA_Ecology meeting in Atlanta

Presentation given at HJ Andrews on Net Primary Productivity in the Central Amazon (Poster)

Presentation given at LBA meeting in Belem (Poster)

Radiocarbon dates for large trees from forest near Manaus

Seasonal and spatial variability in soil respiration from forest near Manaus

Seasonal variability in tree stem wood respiration for forest near Manaus

Talk on soil carbon dynamics presented at the AGU and LBA-Ecology meeting in Atlanta (Poster)

Tree inventory data for a five hectare plot at Ducke Reserve near Manaus

Where are the oldest of the forest? Radiocarbon use to determine the age and growth rate of trees from the Brazilian Amazonian Forest (Poster)

Publications:

Chambers JQ, Schimel JP, Nobre AD. (2001) Respiration from coarse wood litter in central Amazon forests. *Biogeochemistry*, **52**, 115-131.

Chambers JQ, dos Santos J, Ribeiro RJ, Higuchi N. (2000) Tree damage, allometric relationships, and above-ground net primary production in central Amazon forest. *Forest Ecology and Management*, **5348**, 1-12.

de Camargo PB, Trumbore SE, Martinelli LA, Davidson EA, Nepstad DC, Victoria RL. (1999) Soil carbon dynamics in regrowing forest of eastern Amazonia. *Global Change Biology*, **5**, 693-702.

Chambers JQ, Higuchi N, Tribuzy ES, Trumbore SE. (2001) Carbon sink for a century. *Nature*, **410**, 429-429.

Chambers JQ, Higuchi N, Schimel JP, Ferreira LV, Melack JM. (2000) Decomposition and carbon cycling of dead trees in tropical forests of the central Amazon. *Oecologia*, **122**, 380-388.

Chambers JQ, Trumbore SE. An age-old problem. Trends in Plant Science **4**, 385-386. 1999.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

Trace Gas and Aerosol Flux:

- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?

CD-10 (Wofsy / Kirchhoff / Camargo / A. Nobre) Investigation Profile

Ecosystem Carbon Balance in a Primary Tropical Forest in Central Amazonia: Integrating Long-term Eddy Covariance with Comprehensive Ecological Methods

Principal Investigators:

Plinio B. de Camargo, USP (SA-PI)
Volker W. J. H. Kirchhoff, INPE (SA-PI)
Antonio Donato Nobre, INPA (SA-PI)
Steven C. Wofsy, Harvard University (US-PI)

Abstract 2003:

We have been making measurements of net ecosystem exchange (NEE) and concentrations of CO2 and H2O using eddy correlation methods, intended to continue for 3-5 years at a primary forest site located at km 67 on the Santarém-Cuiaba highway in the Tapajós National Forest in central Amazônia. Complementing these measurements is a comprehensive set of ecological observations, including tree speciation, stocks and growth, coarse woody debris stocks and dynamics, etc. We are also making measurements of CO2 and other greenhouse gases at a remote coastal site near Natal.

We are collaborating with Dr. V. Kirchhoff to help install and operate a long-term coastal site for observations of important trace gases, starting with CO2. We are collaborating with Plinio B. de Carmargo on the ecological measurements. Our work with Antonio Nobre involves advanced analysis and synthesis of eddy flux data from his Manaus site and comparison with the Santarém site.

The objectives of the measurements are:

1. Define the experimental protocols needed to measure accurately seasonal and annual net fluxes of CO2, H2O, and energy at a primary forest in the Tapajós region of Amazônia;

2. Define the net source or sink of CO2 from the undisturbed forest;

3. Determine the variations of net exchange of CO2 seasonally and inter-annually, and define the response of carbon sequestration in the system to climatic and other environmental variables;

4. Provide the experimental control for interpretation of the results obtained at a harvested site at km 83 by recording the CO2 exchange at a nearby undisturbed site;

5. Provide the flux and gradient measurements for CO2, sensible heat and momentum needed to define the flux of N2O, CH4, and mineral elements from sub-canopy concentration changes or from above-canopy gradient measurements of these species;

6. Determine CO2 boundary layer concentrations at mid-continent and coastal sites to test models.

Value to LBA

The proposed work focuses on defining the "undisturbed state" of the primary tropical forest, a requirement "to fill the most critical of gaps and/or to gain the most leverage on major scientific uncertainties" (NRA-97-MTPE-02). Studies of this type were specifically requested for LBA: ("Continuous observations of a core set of measurements (e.g., CO2 fluxes, trace gas fluxes, trace gas concentrations, micrometeorological conditions, radiation, aerosols) made at the primary field sites over a period of 3-5 years".

Approach

Fluxes of momentum, CO2, H2O, sensible heat, net radiation, and PAR, atmospheric and soil profiles of temperature, CO2 and H2O, and wind profiles are being measured continuously using automated instruments on a 60meter tower. Fluxes will be measured using eddy correlation, with an infrared gas analyzer (closed-path) for CO2 and H2O mounted on the tower near the sonic anemometer. The data are being analyzed to determine net exchange of CO2 and H2O on hourly, daily, seasonal, and annual time scales. Environmental regulation of variations in net uptake are being quantitatively elucidated by measuring the response of the system to climatic variations and by comparison between flux measurements and ecological observations.

Site

The measurements are being made from a 65 m tall, small-cross-section tower of the type used to support radio antennas (Rohn 55G, Peoria IL), selected to minimize wind distortion and possible heating artifacts, placing the sensor well above the tallest emergent trees. The data acquisition system and most instruments are housed in a climate controlled hut 15-30 meters west of the tower base, accessible by a dirt road. The CO2-H2O sensor will be placed close to the sonic anemometer near the top of the tower to keep tubing short.

The site is in a protected primary forest reserve at km 67 south of Santarém. This site is extremely flat, an extensive planalto that drops about 30m to the level of the Tapajos river 10-15 km to the west. Soils are uniform yellow oxisols similar to soils at the site recently harvested. The nearest secondary road is 5 km to the east and the nearest urban area is
60 km to the North (Santarém); otherwise the area is quite isolated.

Tower Measurements

Table 1 shows the measurements at the site in this and in collaborative studies. Eddy fluxes of sensible heat, latent heat, CO2, and momentum are measured at 60 m and independently at 47 m on the tower. The mixing ratios of CO2 and H2O are monitored by sampling 6 to 8 standard liter/min (slpm) from an inlet located directly behind the vertical axis of the anemometer into a CO2/H2O infrared gas analyzer (IRGA; Model 6262, LiCor, Lincoln NE). Errors due to separation of the inlet from the anemometer should be small (1 to 2%, Lee and Black 1994). Wind and temperature will be measured with a 3-axis sonic anemometer pointed into the dominant wind direction (east)

Table 1. Tapajos Forest Measurements

Sensor	inlet/instrument alt(s)	determined quantity (data rate)
Sonic Anemometers	60m and 47m (3-axis),	u,v,w,T Fmom, Fheat (10 Hz, 30-min avg.)
high-speed CO2-H2O (IR-Absorbance)	60m, 47m	CO2 and H2O fluxes (30-min avg.)
slow CO2-H2O (IR Absorbance)	8-10 levels	CO2, H2O vertical profiles (2 /hour)
Thermistors, thin-film capacitors	5-6 levels	T and R.H. profiles (5,60-min avg.)
Thermistors	2 cm (6 rep), 20cm, 50cm	soil temperatures (5,60-min avg.)
Photosynthetically Active Radiation	60,24,2 m	(5 min avg.)
Net radiometer	60m	radiant heat flux (5,60-min Avg.)

Relationship with Other Experiments

The experiment is closely coordinated with three other LBA projects, in addition to the Antonio Nobre measurements at Manaus noted above:

M. Keller, P. Crill: Our flux measurements will help extend the spatial (canopy) and temporal (years) scales, and provide a quantitative framework, for integrating biogeochemical measurements to the ecosystem function.

Crill, Silver,and Li and Goulden plan to work at a flux tower on a nearby primary forest that will be commercially harvested during the observations. Our measurements at an uncut site nearby will provide the control for this experiment, determining changes in carbon storage and ecological parameters in the absence of disturbance.

We plan to combine our data with observations of canopy/atmosphere interchange and energy balance by Fitzjarrald, Moore, to help define the tower footprint and to wring out systematic errors from the observations.

Collaboration is ongoing also with Martens (222Rn) and Trumbore and Crill. (13C/12C) isotopic ratios and turnover rates of soil organic matter and wood.

Investigation Duration:

1998 - 2005

Participants:

Paulo Artaxo, Co-Investigator, USP
Alfram V. H. Bright, Co-Investigator, Harvard University
John Walter Budney, Co-Investigator, Harvard University
Plinio B. de Camargo, SA-PI, USP
Victoria Ye Chow, co-investigator, Harvard University
Bruce C. Daube, Co-Investigator, NOAA
James W. Elkins
Christoph Gerbig, Harvard University
Alejandro Guarin, The Pennsylvania State University
Lucy Hutyra, Co-Investigator, Harvard University
Raimundo Sousa Lima Junior, Universidade Federal do Pará
Volker W. J. H. Kirchhoff, SA-PI, INPE
John Chun-Han Lin, Harvard University
Henry William Loescher, Oregon State University
Dulcyana Ferreira Marques, FIT/Santarem
Daniel Michael Matross, Harvard University
James William Munger, Co-Investigator, Harvard University
Antonio Donato Nobre, SA-PI, INPA
Kadson Oliveira, LBA
Mark John Potosnak, NCAR
Elizabeth Hammond Pyle, Co-Investigator, Harvard University
Scott Reid Saleska, Co-Investigator, Harvard University
Gregory Winn Santoni, Harvard University
Steven C. Wofsy, US-PI, Harvard University

Student Information:

Christoph Gerbig, Harvard University, Citizenship: GERMANY, Postdoctoral Researcher

Lucy Hutyra, Harvard University, Citizenship: USA, Ph.D. student

Raimundo Sousa Lima Junior, Universidade Federal do Pará, Citizenship: BRAZIL, Bachelors student

John Chun-Han Lin, Harvard University, Citizenship: TAIWAN, Ph.D. student

Dulcyana Ferreira Marques, FIT/Santarem, Citizenship: BRAZIL, Bachelors student, Thesis: Avaliação da quantidade e concentração de carbono e nitrogênio e seus isótopos, em amostras de serrapilheira coletadas em área de parcela permanente da Flona-Tapajós, Santarém

Kadson Oliveira, LBA, Citizenship: BRAZIL, Bachelors student

Scott Saleska, Harvard University, Citizenship: USA, Postdoctoral Researcher

Gregory Winn Santoni, Harvard University, Citizenship: USA, Masters student

Proposed Research Sites:

Amazonas (Manaus)
ZF2 km 14
ZF2 km 34

Pará Western (Santarém)
km 67 Primary Forest Tower Site
km 83 Logged Forest Tower Site

Proposed Training and Education:

Formal Training

- It is planned to continue the work being developed with current or recently graduated undergraduate students, graduate students and technicians at INPA by close collaboration with A. Nobre. Students will be focusing on understanding and analyzing eddy covariance data, and using Manaus and FLONA sites as a case study.

Visits / Exchange Programs

- A student currently developing a second year undergraduate majoring in Biology at the Faculdades Integradas do Tapajós in Santarém is expected to visit Harvard and New England forests for a 6-8 week period during the summer of 2003 to be trained on new analytical techniques and work closely with Harvard graduate students and researchers. Additional opportunities for advanced students will be offered for students from INPA and residents in the Amazon region. They participate in intensive training and working meetings at Harvard, focused on understanding and analyzing eddy covariance data, using Manaus and Santarém sites as a case study. It is planned that students from INPA will be long-term visitors as suitable for their needs and interests, participating in all aspects of the research group activities.

Beija-Flor Datasets: (as of 2003-06-16)

Belem 2000 Biometry Poster

Belem 2000 Instrument Poster

Coarse Woody Debris measurements for the km 67 tower site, Tapajos National Forest

Comparison of Aerosol Optical Thickness in the UV-B Band in Biomass Burning and Seashore Regions in Brazil (Poster)

Eddy-covariance measurements of CO2 and H2O at km 67 tower site, Tapajos National Forest

Forest litter measurements for km 67 tower site, Tapajos National Forest

Ground-based biometry measurements for km 67 tower site, Tapajos National Forest

June 2001 AGU talk (Poster)

Manaus 2002 Eddy Flux Poster

Manaus Carbon Dynamics Poster

Santarem km67 CO concentrations for 2001

Tree DBH measurements at the km 67 tower site, Tapajos National Forest

Variations in carbon monoxide concentrations at a Central Amazonian site (Poster)

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

CD-11 (Houghton / Alencar) Investigation Profile

Selective logging, fire, and biomass in Amazonia

Principal Investigators:

Ane A. C. Alencar, IPAM - Instituto de Pesquisa Ambiental da Amazonia (SA-PI)
Richard A. Houghton, Woods Hole Research Center (US-PI)

Abstract 2003:

For 2003 we are going to identify and measure biomass, canopy damage, fuel loads and regrowth and in different types of burned and logged forest in northern Mato Grosso (Guaranta), similar to what was done for Santarem/ Belterra site and started for Paragominas site in 2001 and 2002. The goal is to identify differences in forest structure and its response to disturbances by to fire and logging among different types of forest (dense forest intensive logged, dense forest moderate logging, and transitional forest intensive logging). More specifically, the field work will be done in private property areas and account for direct measurements of forest structure, informal field interviews to check and reconstruct the forest disturbance history and ground truth for remote sensing analysis. Logging and fire maps are already done for this area using remote sensing image classification and visual interpretation. The field measurements will be used to parameterize the remote sensing image and improve the classification done previously.

For 2004 and 2005, we will expand the study to open forests with intensive and moderate logging and to transitional forests with moderate logging. The existing grant ends in 2003, however, and the fieldwork for 2004 and 2005 will depend on obtaining renewed funding.

Investigation Duration:

1999 - 2003

Participants:

Ane A. C. Alencar, SA-PI, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Oswaldo de Carvalho Jr, IPAM
Richard A. Houghton, US-PI, Woods Hole Research Center
Neal A. Scott, Woods Hole Research Center
Thomas A. Stone, Co-Investigator, WHRC

Student Information:

Ane A. C. Alencar, IPAM - Instituto de Pesquisa Ambiental da Amazonia, Citizenship: BRAZIL, Masters student

Oswaldo de Carvalho Jr, IPAM, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Effects of understory fire and logging on forest biomass and large mammal populations in eastern Amazonia./ Impact of Forest Fire in Biomass Reduction

Proposed Research Sites:

Mato Grosso
Guaranta

Pará Eastern (Belém)
Paragominas

Pará Western (Santarém)
Belterra

Proposed Training and Education:

Currently none available.

Beija-Flor Datasets:

Currently none available.

Publications:

Houghton RA, Lawrence KT, Hackler JL, Brown S. (2001) The spatial distribution of forest biomass in the Brazilian Amazon: a comparison of estimates. *Global Change Biology*, **7**, 731-746.

Nepstad DC, Verissimo A, Alencar A, Nobre C, Lima E, Lefebvre P, Schlesinger P, Potter C, Moutinho P, Mendoza E, Cochrane M, Brooks V. (1999) Large-scale impoverishment of Amazonian forests by logging and fire. *Nature*, **398**, 505-508.

Houghton RA, Skole DL, Nobre CA, Hackler JL, Lawrence KT, Chomentowski WH. (2000) Annual fluxes or carbon from deforestation and regrowth in the Brazilian Amazon. *Nature*, **403**, 301-304.

Cochrane MA, Alencar A, Schulze MD, Souza CM, Nepstad DC, Lefebvre P, Davidson EA. (1999) Positive feedbacks in the fire dynamic of closed canopy tropical forests. *Science*, **284**, 1832-1835.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?
- CD-Q3d - What portion of the Amazônia–wide carbon flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Land Cover and Land Use Change:

- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?

CD-12 (Vourlitis / Priante) Investigation Profile

A Pilot Study for Assessing the Carbon and Energy Balance of a Transitional Tropical Forest in Southwest Amazonia

Principal Investigators:

Nicolau Priante Filho, Universidade Federal de Mato Grosso (SA-PI)
George L. Vourlitis, California State University (US-PI)

Abstract 2003:

This cooperative project between California State University-San Marcos (CSUSM) and the Universidade Federal de Mato Grosso (UFMT) is designed to quantify the seasonal and interannual variations in the mass (CO2 and H2O vapor) energy exchange of an Amazonian tropical transitional forest. Our study site is located near Sinop, Mato Grosso in a transitional (ecotonal) region that separates the tropical rain forest and savanna. Mass and energy exchange is measured using tower-based eddy covariance over a mature, undisturbed transitional tropical forest that is approximately 28-30 m tall. Additional field measurements include leaf photosynthesis, soil CO2 efflux, soil water content and water table depth, leaf area index, aboveground litter production, litter decomposition, and micrometerology; data that are required for interpreting the temporal variations forest mass and energy exchange. Our previous LBA research significantly helped build capacity in South American institutions by intensive training of UFMT undergraduate and graduate students and faculty and the development of a M.Sc. degree program in environmental physics that was recently approved by the Coordenacão de Aperfeicoamento de Pessoal de Nivel Superior (CAPES). Our group is also beginning a comparable research campaign in cattle pasture that is adjacent to the mature forest stand and a proposed tower in a selectively-logged stand near our Sinop site is pending approval from the USDA. With these additional projects, we hope to be able to develop a comprehensive picture of how land cover change and land use alter mass and energy exchange of transitional tropical systems in southern Amazonia, and ultimately, allow for collaborative assessments of how land cover change and climate alter the mass and energy exchange of the Amazon Basin.

Investigation Duration:

1999 - 2005

Participants:

Marcelo Sacardi Biudes, Universidade Federal de Mato Grosso
Jose Holanda Campelo, Co-Investigator, Universidade Federal de Mato Grosso
Eduardo Guimarães Couto, Co-Investigator, Universidade Federal de Mato Grosso
Carlo Ralph De Musis, Co-Investigator, Universidade Federal de Mato Grosso
Sergio Roberto de Paulo, Co-Investigator, Universidade Federal de Mato Grosso
Clovis Lasta Fritzen, Co-Investigator, Universidade Federal de Mato Grosso
Pierre Girard, Co-Investigator, Universidade Federal de Mato Grosso (UFMT)
Mauro Massao Shiota Hayashi, Co-Investigator, Universidade Federal de Mato Grosso
Moacir Lacerda, Co-Investigator, Universidade Federal de Mato Grosso
Jose Carlos Leite, UFMT
Eduardo Jacusiel Miranda, UFMT
Jose de Souza Nogueira, Co-Investigator, Universidade Federal de Mato Grosso
Luis Carlos Pereira, Co-Investigator, Universidade Federal de Mato Grosso
Pedro Correto Priante, UFMT
Nicolau Priante Filho, SA-PI, Universidade Federal de Mato Grosso
Fernando Raiter, Universidade Federal de Mato Grosso
Wander Roeger, Universidade Federal de Mato Grosso
Shozo Shiraiwa, Co-Investigator, Universidade Federal de Mato Grosso
George Sanches Suli, Co-Investigator, Universidade Federal de Mato Grosso
George L. Vourlitis, US-PI, California State University
Peter Zeilhofer, Co-Investigator, Universidade Federal de Mato Grosso

Student Information:

Marcelo Sacardi Biudes, Universidade Federal de Mato Grosso, Citizenship: BRAZIL, Bachelors student

Clovis Lasta Fritzen, Universidade Federal de Mato Grosso, Citizenship: BRAZIL

Mauro Massao Shiota Hayashi, Universidade Federal de Mato Grosso, Citizenship: BRAZIL, Bachelors student

Moacir Lacerda, Universidade Federal de Mato Grosso, Citizenship: BRAZIL

Eduardo Jacusiel Miranda, UFMT, Citizenship: BRAZIL, Bachelors student

Luis Carlos Pereira, Universidade Federal de Mato Grosso, Citizenship: BRAZIL, Bachelors student

Pedro Correto Priante, UFMT, Citizenship: BRAZIL, Bachelors student

Fernando Raiter, Universidade Federal de Mato Grosso, Citizenship: BRAZIL, Bachelors student

Wander Roeger, Universidade Federal de Mato Grosso, Citizenship: BRAZIL, Bachelors student

George Sanches Suli, Universidade Federal de Mato Grosso, Citizenship: BRAZIL, Masters student

Proposed Research Sites:

Mato Grosso
    Sinop

Proposed Training and Education:

Currently none available.

Beija-Flor Datasets: (as of 2003-06-16)

Estimate of the consumption of photosyntheticaly active radiation (PAR) for the forest and the leaf area index (LAI) from remote sensing, related with collected field data (Poster)

Litter decomposition rate estimation by mass balance model in a transitional tropical forest –savanna in Mato Grosso - Brazil (Poster)

Photosynthesis light curves of sun and shade plants of transitional tropical forest (cerradão) in Mato Grosso (Poster)

Relationship Between Litter Production and Reflected Photosynthetic Active Radiation by the Canopy of Transitional tropical forest (Poster)

Sinop Raw data; Excel worksheet reduced data; Posters; Reports; Pictures

Sinop Raw data; Excel worksheet reduced data; Posters; Reports; Pictures

The role of seasonal variations in meteorology on the net CO2 exchange of Brazilian Cerradão (Poster)

Using Eddy Covariance and Bowen Ratio Methods to Estimate Inter-Annual Variation in Evapotranspiration of a Transition Tropical Forest of Mato Grosso, Brazil (Poster)

Water Potential of Plants in Different Conditions of Light Intensity in a Tropical Rain Forest – Savanna Ecotone of Mato Grosso (Poster)

Publications:

Vourlitis GL, Priante N, Hayashi MMS, Nogueira JD, Caseiro FT, Campelo JH. (2001) Seasonal variations in the net ecosystem CO2 exchange of a mature Amazonian transitional tropical forest (cerradao). *Functional Ecology*, **15**, 388-395.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

CD-15 (Cohen / Costa) Investigation Profile

BigFoot II: In situ Measurements, Remote Sensing, and Models to Validate MODIS Products Related to the Terrestrial Carbon Cycle

Principal Investigators:

Warren B. Cohen, USDA Forest Service (US-PI)
Marcos Heil Costa, Federal University of Vicosa (UFV) (SA-PI)

Abstract 2003:

This proposal is for a continuation of our existing project, BigFoot. The overall goal of BigFoot and the proposed BigFoot II project is to provide validation of MODLand (MODIS Land Science Team) science products, including land cover, leaf area index (LAI), fraction absorbed photosynthetic active radiation (f_{APAR}), and net primary production (NPP). To do so, we use ground measurements, remote sensing data, and ecosystem process models at sites representing different biomes. BigFoot sites are 5 x 5 km in size and surround the relatively small footprint (.1 km^2) of CO_2 flux towers. At each site we make multi-year *in situ* measurements of ecosystem structure and functional characteristics that are related to the terrestrial carbon cycle. Our sampling design allows us to explicitly examine scales of fine-grained spatial pattern in these properties, and provides for a field-based ecological characterization of the flux tower footprint. Multi-year measurements ensure that inter-annual validity of MODLand products can be assessed.

In BigFoot II, for each measurement year we will derive land cover, f_{APAR}, and LAI surfaces by linking our *in situ* measurements to Landsat ETM+ data. These BigFoot surfaces will be developed using logic that preserves functionally important fine-grained information. Errors in these surfaces will be quantified and the surfaces summarized to provide a characterization of vegetation patterns in the greater flux tower footprint. Using these land cover and LAI surfaces and derived climate surfaces, we will model NPP over the 5 x 5 km BigFoot footprint. Two independent ecosystem process models will be used: Biome-BGC and IBIS. The ability of the models to capture environmental and ecological controls on water and carbon cycles will be assessed with the following comparisons: modeled NPP against *in situ* measurements of NPP, modeled GPP to tower-based calculations of GPP, and modeled daily water vapor and CO_2 fluxes to tower estimates. We will validate MODLand land cover, LAI, f_{APAR}, and NPP surfaces by comparing them to BigFoot surfaces derived using field measurement data. A series of exercises that isolate important scaling factors will be conducted, so that their effects on BigFoot and MODLand NPP model estimates can be better understood. This will involve rerunning the models after converting site-specific land cover classes into broad, globally applicable classes, successive coarsening of land cover and LAI surface grain size, and generalizing the light use efficiency factor (g) to coincide with the more generalized land cover classes.

The proposed BigFoot II study will be conducted at nine sites (several supported by separate funding) that span eight major biomes, from desert to tundra, to tropical forest. At these sites, in addition to validation of MODIS products, we will quantify carbon content and NPP, examine how these variables vary spatially and temporally, and how NPP is related to climatic variables. Collectively, the standardized NPP data from the contrasting biomes will elucidate biophysical controls on NPP, and their sensitivity to changing climate and land use. Our standardized data also allow for direct testing of whether light use efficiency (LUE) differs among plant functional types, or seasonally for a given type.

A global terrestrial observation system is needed to assist in the validation of global products such as land cover and NPP from MODIS and other sensor and modeling programs. A key component of such a system is the eddy flux tower network, FLUXNET; however, flux sensors measure net ecosystem productivity (NEP), not NPP. BigFoot is learning how NEP and NPP are related, and through modeling, how to integrate a wide range of carbon cycle observations. Another key component of an observing system is the use of remote sensing and models to scale tower fluxes and field measurements. Although this may be relatively common at a given site, no other project is doing so with standardized methods across so many biomes. As such, BigFoot is a pathfinding activity that will contribute to the development of useful scaling principles. The project can also serve as a nucleus for the global terrestrial observing system that is needed to validate global, generalized products used to monitor the health of the terrestrial biosphere.

Investigation Duration:

2001 - 2004

Participants:

Douglas Eric Ahl, University of Wisconsin-Madison
Ricardo Guimarães Andrade
John Walter Budney, Harvard University
Dulce Castleton, Science Department- Dept of State US Embassy
Warren B. Cohen, US-PI, USDA Forest Service
Marcos Heil Costa, SA-PI, Federal University of Vicosa (UFV)
Stith Tom Gower, Co-Investigator, University of Wisconsin
Robert E. Kennedy
Alan Kirschbaum, UW-Madison Forestry Department
Thomas Krueger Maiersperger
Dave Ritts
David Patrick Turner, Co-Investigator, Oregon State University
Mônica Carneiro Alves Xavier

Student Information:

Currently none available.

Proposed Research Sites:

Pará Western (Santarém)
    km 67 Primary Forest Tower Site

Proposed Training and Education:

Currently none available.

Beija-Flor Datasets:

Currently none available.

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?

CD-17 (Ducey / Alves) Investigation Profile

Validating, Scaling and Parameterizing a Forest Regrowth Model for the Amazon Region Using Aircraft and Spaceborne Sensors and GIS

Principal Investigators:

Diogenes Salas Alves, INPE/DPI (SA-PI)
Mark J Ducey, University of New Hampshire (US-PI)

Abstract 2001:

This proposal is in response to the NASA-Carbon Cycle Science and LBA-Ecology Program request for remote sensing research and the development of methods and datasets for exploring the response of ecosystems to disturbance at the regional scale. We propose a four-step, incremental approach directed toward the spatially explicit modeling and mapping of forest regrowth potential for the Amazon region. Each of the four steps will make a significant contribution to current understanding of the response of ecosystems to disturbance at the regional scale. Developing an ability to predict forest regrowth potential has considerable implications for our understanding of carbon dynamics in a future characterized by increased conversion of old-growth Amazonian forests and the subsequent abandonment of many areas originally cleared for agricultural activities. A central focus of our approach is the development of remote sensing approaches for quantifying vegetation recovery and changes in biomass following disturbance, determination of the optimal scale for these approaches, and testing of disturbance-specific parameters that may influence rates of forest regrowth in Amazonia.

Step 1 is the production of preliminary forest regrowth potential maps for the region using an empirical model of biomass accumulation in global secondary forests (Johnson et al.2000; see Appendix B). The maps are a spatially explicit application of model algorithms within a GIS framework constrained by readily available regional datasets on climate and soil texture. Step 1 products include maps illustrating potential biomass accumulation in Amazonian regrowth forests at 5-year intervals (Zarin et al. submitted; see Appendix C).

Step 2 is the definition of a set of normalized spectral indices of forest regrowth optimized for the Amazon region. These indices will be derived from MASTER and multi-temporal Landsat TM/ ETM+data and calibrated against field measurements of regrowth structure and estimates of canopy height and vertical distribution. The ideal resolution for these spectral indices will be quantified. Expected products from Step 2 include forest regrowth data bundles that will contain age and land use history for each stand, temporal sequences of regrowth indices, derived canopy height, canopy profiles and canopy structural properties for a subset of regrowth stands.

Step 3 is the testing of the reliability of the preliminary maps (Step 1 product) and the remote sensing indices of regrowth structure (Step 2 products). We will employ traditional validation methods to compare the spatially explicit model predictions with forest inventory data not included in the development of the model. Validation is used here in a strictly statistical sense. Using independent data, we will assess the bias and variance characteristics of the global model when used as a regional predictor, including partitioning the variance components into local (within-site) and regional (between-site) components. And although the model was developed with reference to regrowth biomass, we will also test its applicability to the prediction of regrowth structure as expressed by the spectral indices defined in Step 2. AIRSAR estimates of biomass will be tested and compared to assess between-site and seasonal differences in SAR based biomass retrievals. Expected products from Step 3 are spatially explicit accuracy assessment of regrowth maps for biomass and structure, based on both field and remotely-sensed data.

Step 4 is the refinement of the global model to enhance its regional applicability by including known disturbance-specific parameters shown to explain a significant amount of variance between measured and modeled regrowth biomass and structure. We will test parameters that describe disturbance type, size, perimeter:area ratio and land-use history, including the number of agricultural cycles and persistence of the various stages of vegetation cover. Remote sensing based observations are required to adequately test the importance of these disturbance-specific parameters with a sufficient number of observations. A subset of the forest inventory data will be used to calibrate this regional enhancement of the model. Model selection will employ cross-validation with reserved independent data, or resampling cross-validation techniques, to avoid overfitting and to assess expected prediction errors. The resulting spatial pattern of predictions will also be compared to the spatial pattern of the spectral indices defined in Step 2. The principal products of Step 4 will be a regionally refined and accuracy-assessed forest regrowth potential model and derivative maps that will provide our best predictions (and corresponding error estimates) for the regional responses of biomass and forest structure to current and future land-use patterns in Amazonia.

Investigation Duration:

2001 - 2004

Participants:

Diogenes Salas Alves, SA-PI, INPE/DPI
Carlos José Capela Bispo, Universidade Federal Rural da Amazônia
Mark J Ducey, US-PI, University of New Hampshire
Lucas Berio Fortini, University of Florida
Stephen Charles Hagen, University of New Hampshire
Alexandre Junqueira Homem de Mello, INPE
Monique Susanne LaPerriere, University of Florida
Joanna Marie Tucker, University of Florida
Daniel Jacob Zarin, Co-Investigator, University of Florida

Student Information:

Currently none available.

Proposed Research Sites:

Pará Eastern (Belém)
Bragantina

Rondonia
Ariquemes

Proposed Training and Education:

Currently none available.

Beija-Flor Datasets: (as of 2003-06-16)

Stem Recruitment and Mortality in an Eastern Amazonian Secondary Forest (Poster)

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?

CD-18 (Shuttleworth / Nobre) Investigation Profile

Modeling Amazonian Carbon Release with Calibrated SVAT Models

Principal Investigators:

John H. Gash, Centre for Ecology & Hydrology (EU-PI)
Carlos Afonso Nobre, INPE (SA-PI)
William James Shuttleworth, University of Arizona (US-PI)

Abstract 2003:

This proposal is motivated by the question "How do ecosystems respond to and affect global environmental change and the carbon cycle?" for the Amazônian forest ecosystem. Over the last decade, description of carbon exchange processes has been introduced into some of the more realistic and important Soil-Vegetation-Atmosphere Transfer (SVAT) models used in General Circulation Models (GCMs). Over the last decade, important progress has also been made in developing state-of-the-art multi-parameter estimation techniques that can provide values of preferred sets of the (often many) model parameters used in complex SVAT models by optimizing against the (often multiple) measurements collected in present-day field experiments. The LBA Experiment is providing a uniquely rich source of long-term field data for Amazon forest sites in different climatic conditions and for a range of soils and disturbance regimes. We propose to use these data to calibrate the description of the carbon and energy-water exchange processes represented in two advanced SVAT models (SiB2C and MOSES-TRIFFID) using advanced multi-parameter estimation techniques. Further, we will investigate whether and how the preferred sets of model parameters in the two SVAT models change with season, the nature of the underlying soil, and/or disturbance regimes, and explore relationships between the preferred parameters found at individual LBA sites and relevant remotely sensed (e.g., TERRA) data products. The National Centers for Environmental prediction (NCEP) and the European Centre for Medium-Range Weather Forecasting (ECMWF) are both currently preparing long (50-year and 40-year, respectively) time series of atmospheric variables (including near-surface atmospheric forcing variables) from historical atmospheric and remotely sensed observations using data assimilation techniques. These time series will become available for scientific use within the lifetime of this proposal. We propose to compare these new model-calculated re-analysis data with Amazônian climate records and with field data obtained during LBA and earlier studies to investigate their reliability within Amazônia. Assuming these data are reasonably realistic (or that simple corrections can be made to make them so), we then propose to use these historical data to force two-dimensional arrays of calibrated versions of SiB2C and MOSES-TRIFFID to investigate model-to-model differences and the spatial and temporal variability in carbon exchange of and within the Amazônian region. When doing so, we will exploit any relationships we have previously found between calibrated parameters and seasonal climate, forest disturbance, underlying soil type, and remotely sensed variables, as appropriate.

Investigation Duration:

2003 - 2005

Participants:

Luis Bastidas, Co-Investigator, Untah State University
Eleanor J. Burke, Co-Investigator, University of Arizona
John H. Gash, EU-PI, Centre for Ecology & Hydrology
Chris Huntingford, Co-Investigator, Government Research Laboratory
Antonio Ocimar Manzi, Co-Investigator, INPE
Carlos Afonso Nobre, SA-PI, INPE
Humberto Ribeiro da Rocha, Co-Investigator, DCA/IAG/USP
Rafael Rosolem, CENA-USP
William James Shuttleworth, US-PI, University of Arizona

Student Information:

Eleanor J. Burke, University of Arizona, Citizenship: UK, Postdoctoral Researcher

Rafael Rosolem, CENA-USP, Citizenship: BRAZIL, Masters student, Thesis: O Impacto do Desmatamento no Ciclo Hidrológico: Um Prognóstico para o Caso da Rodovia Cuiabá-Santarém

Proposed Research Sites:

Amazon Basin (large-scale studies)

Proposed Training and Education:

Formal Training

- Formal training of a Brazilian graduate student, preferably linked to CPTEC, for a Doctoral degree in Hydrometeorology in the Department of Hydrology and Water Resources at the University of Arizona. On-the-job training of Brazilian investigators through shared research carried out at the University of Arizona, CPTEC and CEH, facilitated by exchange visits. On-the-job training of Brazilian graduate students from USP and INPE. Additional Brazilian students will be added to this program who will receive training on the use of advanced systems engineering techniques such as multi-parameter optimization and the evaluation of model-calculated variables as observations.

Visits / Exchange Programs

- Regular one-two month exchange visits by researchers from partnering institutions – University of Arizona, CPTEC, and CEH –are planned for training on the use of advanced systems engineering techniques such as multi-parameter optimization and the evaluation of model-calculated variables as observations. Short visits by students from USP and INPE to the University of Arizona are also scheduled.

Beija-Flor Datasets:

Currently none available.

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

LC-01 (Walsh / Bilsborrow / Ruiz) Investigation Profile

Modeling the Scale Dependent Drivers of LCLU Dynamics in Northeastern Ecuador: Simulating Patterns of Landscape Change and Assessing their Cause and Consequence through Multi-Level Models and Cellular Automata

Principal Investigators:

Richard E. Bilsborrow, University of North Carolina (US-PI)
Alicia Ruiz, CEPAR (SA-PI)
Stephen J. Walsh, University of North Carolina (US-PI)

Abstract 2003:

Using longitudinal household survey data collected in 1990 and 1999, a 2000 community survey, a multi-resolution remote sensing time series, GIS coverage of resource potentials and endowments, and field verification and geodetic control data, we analyze the determinants of changes in LCLU at the plot, sector, and regional levels, and annual and decadal periods.

The fundamental research questions revolve around (a) the rates, and mechanisms of forest conversion to agricultural and urban uses, (b) the relative importance of exogenous and endogenous variables on these land uses, (c) the associated scale dependant drivers of LCLU dynamics and patterns operating across socio-economic and demographic, biophysical, and geographical domains; (d) rate and pattern of land conversion from forest to agricultural crops, pasture, secondary plant succession, and urbanization, as well as the rate and pattern of land abandonment at the farm level; and (e) plausible scenarios of future land cover change and their policy implications as assessed multi-level models that are responsive to multi-scale effects as well as spatial simulations of LCLU dynamics through a cellular automata approach.

The survey periods and the assembled satellite time-series images serve as our reference dates that are integrated to define relationships through (1) multivariate logit models of LCLU for 1990, 1999, and for changes between those two survey periods; (2) satellite image classifications and change-detections of LULC dynamics, space-time trajectories of pixel histories, and pattern metrics of landscape organization to define LCLU composition and spatial structure; (3) LCLU simulation through cellular automata, informed by the satellite and multivariate models of LCLU change, to create spatial simulations of LULC dynamics; and (4) multi-level models to integrate variables and effects from multiple scales into an integrated model of LCLU dynamics to assess the scale dependence of variable interactions on LCLU patterns.

The analysis will be framed within a dynamic systems approach that emphasizes non-linear relationships, feedback, mechanisms, and critical thresholds in population-environment interactions. Theoretical foundations include principles involving the interplay of political ecology, human ecology, landscape ecology, and complexity theory.

Investigation Duration:

1998 - 2005

Participants:

Francis Baquero, EcoCiencia, Quito, Ecuador
Alisson Flavio Barbieri, Department of City and Regional Planning and Carolina Population Center, University of North Carolina at Chapel Hill
Richard E. Bilsborrow, US-PI, University of North Carolina
Laura Patricia Boschini, Carolina Population Center
Jason Lee Bremner, University of North Carolina at Chapel Hill
Christine Erlien, Department of Geography, University of North Carolina
Brian G. Frizzelle, Carolina Population Center - UNC
Clark Gray
Carlos Mena, University of North Carolina at Chapel Hill
Joseph P. Messina, Center for Global Change and Earth Observations
William Pan, University of North Carolina
Alicia Ruiz, SA-PI, CEPAR
Stephen J. Walsh, US-PI, University of North Carolina

Student Information:

Francis Baquero, EcoCiencia, Quito, Ecuador, Citizenship: ECUADOR, Bachelors student

Alisson Flavio Barbieri, Department of City and Regional Planning and Carolina Population Center, University of North Carolina at Chapel Hill, Citizenship: BRAZIL, Ph.D. student, Thesis: Population Redistribution and Land Use in the Ecuadorian Amazon

Laura Patricia Boschini, Carolina Population Center, Citizenship: USA, Masters student

Jason Lee Bremner, University of North Carolina at Chapel Hill, Citizenship: USA, Ph.D. student

Christine Erlien, Department of Geography, University of North Carolina, Citizenship: USA, Ph.D. student, Thesis: socioeconomic, geographic, and demographic factors involved in land use and land cover change in the Ecuadorian Amazon

Carlos Mena, University of North Carolina at Chapel Hill, Citizenship: ECUADOR, Ph.D. student, Thesis: Land Use Land Cover Change in the Northern Ecuadorian Amazon

William Pan, University of North Carolina, Citizenship: USA, Ph.D. student, Thesis: A multilevel statistical and spatial analysis to examine the relationship between population and environment: A case study of the Ecuadorian Amazon

Proposed Research Sites:

Ecuador
Northern Ecuadorian Amazon

Proposed Training and Education:

Community / Government Outreach

- Two dissemination workshops on project results and new agricultural technologies will be organized. They will be held for farmers, local community and NGO leaders in the Amazon region in Lago Agrio and Coca. A major conference for scholars and government officials in Quito will be held to disseminate analytical results and present and discuss policy simulations toward the end of the proposed project. Presentations to disseminate interim findings will also be given to smaller groups of high officials.

Formal Training

- Training of six PhD students admitted at University of North Carolina under LBA Funds - three from the US, two from Brazil and one from Peru - will continue. Many other students from Ecuador have received and will continue to receive training.

Short Courses / Seminars / Workshops

- Two dissemination workshops on project results and new agricultural technologies will be organized. They will be held for farmers, local community and NGO leaders in the Amazon region in Lago Agrio and Coca. A major conference for scholars and government officials in Quito will be held to disseminate analytical results and present and discuss policy simulations toward the end of the proposed project. Presentations to disseminate interim findings will also be given to smaller groups of high officials.

Beija-Flor Datasets: (as of 2003-06-16)

1999 Household Survey in the Northern Ecuadorian Amazon

2.5D Morphogenesis: Modeling Landuse and Landcover Dynamics in the Ecuadorian Amazon

Boundary for the North ISA in Ecuador

Boundary of the Cuyabeno Wildlife Reserve

Boundary of the East ISA in Ecuador

Boundary of the South ISA in Ecuador

Boundary of the Southwest ISA in Ecuador

Boundary of the Yasuni National Park

Community locations in the Northern Ecuadorian Amazon

Detailed Plot Data for Fincas (farms) from the Northern Ecuadorian Amazon 1999 Household Survey

Digital Elevation Model for Ecuadorian Eastern Intensive Study Area

Digital Elevation Model for Ecuadorian Northern Intensive Study Area

Digital Elevation Model for Ecuadorian Southern Intensive Study Area

Eastern Intensive Study Area Terrain Aspect

Eastern Intensive Study Area Terrain Slope

Ecuador National Boundary

Ecuador Provincial Boundaries

Elevation Contour Vectors for the East Intensive Study Area in Ecuador

Elevation Contour Vectors for the North Intensive Study Area in Ecuador

Elevation Contour Vectors for the South Intensive Study Area in Ecuador

Elevation Points for the North Intensive Study Area in Ecuador

Elevation Points for the South Intensive Study Area in Ecuador

Household and Finca GPS Data from the 1999 Northern Ecuadorian Amazon Household Survey

Land Use Land Cover Classification (1986) for the East Intensive Study Area in the Northern Ecuadorian Amazon

Land Use Land Cover Classification (1996) for the East Intensive Study Area in the Northern Ecuadorian Amazon

Land Use Land Cover Classification (1996) for the Southwest Intensive Study Area in the Northern Ecuadorian Amazon

Land Use Land Cover Classification (1999) for the East Intensive Study Area in the Northern Ecuadorian Amazon

Land Use Land Cover Classification (1999) for the Southwest Intensive Study Area in the Northern Ecuadorian Amazon

Major Cities in the Northern Ecuadorian Amazon

Northern Ecuadorian Amazon Aerial Photographs (1979 and 1990)

Northern Ecuadorian Amazon Hydrography (1:250,000 - PROFORS)

Northern Ecuadorian Amazon Landsat MSS Imagery (1973 - 1987)

Northern Ecuadorian Amazon Landsat TM Imagery (1984 - 2002)

Northern Ecuadorian Amazon Morphology and Edaphology

Northern Intensive Study Area 1986 LULC Classification (General)

Northern Intensive Study Area 1989 LULC Classification (General)

Northern Intensive Study Area 1996 LULC Classification (General)

Northern Intensive Study Area 1999 LULC Classification (General)

Northern Intensive Study Area Terrain Aspect

Northern Intensive Study Area Terrain Slope

Point Elevations for Ecuadorian Eastern Intensive Study Area

Road network for Northern Ecuadorian Amazon

Sample Fincas (farms) from the Northern Ecuadorian Amazon 1999 Household Survey

Southern Intensive Study Area 1986 LULC Classification (General)

Southern Intensive Study Area 1996 LULC Classification (General)

Southern Intensive Study Area 1999 LULC Classification (General)

Southern Intensive Study Area Terrain Aspect

Southern Intensive Study Area Terrain Slope

Publications:

Messina JP, Walsh SJ. (2001) 2.5D Morphogenesis: modeling landuse and landcover dynamics in the Ecuadorian Amazon. *Plant Ecology*, **156**, 75-88.

Science Questions Addressed by this Investigation:

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?
- LC-Q4 - What are plausible scenarios for future land cover change in Amazônia?

LC-02 (Brown / Silveira / Esteves) Investigation Profile

Land-Cover/Land-Use Change and Carbon Dynamics in an Expanding Frontier in Western Amazonia: Acre, Brazil

Principal Investigators:

Irving Foster Brown, WHRC-UFAC (US-PI)
Benedita Gomes Esteves, Federal University of Acre (SA-PI)
Marcos Silveira, UFAC (SA-PI)

Abstract 2003:

Southwestern Amazonia of Brazil, Bolivia, and Peru, an area of about 1.5 million km2, has shifted from being the hinterland to the forefront of development in the Amazon Basin. Major highways will soon traverse this region, linking it to Pacific Rim economies. Madre de Dios Department, Peru, eastern Acre State, Brazil, and Pando Department, Bolivia—the MAP region of about 200,000 km2—constitute the heart of southwestern Amazonia and the research site for this proposal. Recent public policy decisions have the potential of dramatically changing land

use and land cover in the region. Existing data, however, are inadequate to decipher such change. We propose to conduct calibration and accuracy assessments of several factors associated with such changes: 1) Validation of fire pixel data from GOES/AVHRR/MODIS imagery. This comparison will serve not only for Acre, but will also provide a calibrated GOES half-hourly fire data set for the period of 1998 to 2005 for all of Amazonia; 2) Deforestation estimates of PRODES/INPE, of other state and federal agencies, and of LBA research for the MAP region. Such comparisons at validation sites will permit accuracy assessments of current and past deforestation data for Amazonia; 3) Estimates of the rapidly growing logging activity in the MAP region. This will include extensive fieldwork and permit comparison with remote-sensing-based estimates of forest canopy opened by logging; 4) Demographic and economic data in the tri-frontier municipalities. We will conduct sensitivity analysis of these data coupled with high-resolution imagery of growing urban centers along the frontier for validation; 5) Preliminary analysis of energy resources in southwestern Amazonia; and 6) Participatory Scenario Planning that will provide new information as to the aspirations of local and regional societies.

The above information will also provide data for a case study of Pan-Amazon modeling of plausible scenarios for land use in the region. We have collaborators from all three countries and a history of developing the regional scientific community on land use and land cover change. We will continue to expand collaboration with state and municipal governments in Acre State and to develop complementary activities with Bolivian and Peruvian universities and institutions on land use and global change. Our program will strengthen the only graduate program on natural resource management in lowland southwestern Amazonia and advance our goal to help educate Amazonian researchers in land use. We intend to integrate LBA results into regional education systems so that the results of LBA will help Amazonian societies decide how they wish to develop the region.

Investigation Duration:

1998 - 2005

Participants:

Andrea Silva Alechandre, Federal University of Acre
Eufran do Amaral, CPAF/EMBRAPA, Federal University of Viçosa
Paulo Artaxo, Co-Investigator, USP
Silvia Helena Costa Brilhante, Co-Investigator, Federal University of Acre
Irving Foster Brown, US-PI, WHRC-UFAC
Plinio B. de Camargo, USP
Ramene Hevea dos Santos, Federal University of Acre
Alejandro Antonio Fonseca Duarte, Co-Investigator, UFAC
Benedita Gomes Esteves, SA-PI, Federal University of Acre
Roberto Feres, Universidade Federal do Acre
Carlos Augusto Klink, University of Brasilia
Monica De los Rios Maldonado, Federal University of Acre (UFAC)
Antonio Willian Flores de Melo, Laboratório de Ecologia Isotópica/CENA/USP
Elsa Renee Huaman Mendoza, Co-Investigator, Federal University of Acre
Daniel Curtis Nepstad, Co-Investigator, WHRC
Nara Vidal Pantoja, Federal University of Acre
Jorcinei Widson Pereira, UFAC/PZ/SETEM
Jose Augusto Rocha, UFAC
Cleber Ibraim Salimon, CENA/USP
Peter Schlesinger, Woods Hole Research Center
Diogo Selhorst, UFAC/PZ/SETEM
Rodrigo Perea Serrano, UFAC
Alberto Setzer, INPE
Yosio Edemir Shimabukuro, INPE
Marcos Silveira, SA-PI, UFAC
Adelia Maria Oliveira Sousa, Universidade de Évora
Francisco Kennedy Souza, Co-Investigator, Federal University of Acre (UFAC)
Thomas A. Stone, WHRC
Susan E. Trumbore, University of California
Sumaia Saldanha de Vaconcelos, Federal University of Acre
Judson Valentin, CPAF/EMBRAPA
Simone Aparecida Vieira, CENA/USP

Student Information:

Andrea Silva Alechandre, Federal University of Acre, Citizenship: BRAZIL, Masters student, Thesis: Trail transects as a rapid and inexpensive means of evaluating forest resources.

Eufran do Amaral, CPAF/EMBRAPA, Federal University of Viçosa, Citizenship: BRAZIL, Masters student, Thesis: The implications of soil types on land use in Acre

Silvia Helena Costa Brilhante, Federal University of Acre, Citizenship: BRAZIL, Technician, Thesis: Logging Activity in Acre State

Alejandro Antonio Fonseca Duarte, UFAC, Citizenship: BRAZIL, Postdoctoral Researcher

Antonio Willian Flores de Melo, Laboratório de Ecologia Isotópica/CENA/USP, Citizenship: BRAZIL, Masters student, Thesis: Avaliação do Estoque e Composição Isotópica do Carbono do Solo no Acre

Elsa Renee Huaman Mendoza, Federal University of Acre, Citizenship: PERU, Postdoctoral Researcher, Thesis: Susceptibility of forests to the fire during the phenomena El Niño: A case study in Southwestern Amazonian

Nara Vidal Pantoja, Federal University of Acre, Bachelors student, Thesis: Forestry

Jorcinei Widson Pereira, UFAC/PZ/SETEM, Citizenship: BRAZIL

Jose Augusto Rocha, UFAC, Citizenship: BRAZIL, Bachelors student

Cleber Salimon, CENA/USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Carbon dioxide soil fluxes due to differing land uses in eastern Acre

Diogo Selhorst, UFAC/PZ/SETEM, Citizenship: BRAZIL, Masters student, Technician, Thesis: Datação radiocarbônica de Swietenia macrophylla King (mogno) e Dipterix Odorata (Aubl) Willd (cumaru) e implicações para o manejo.

Rodrigo Perea Serrano, UFAC, Citizenship: BRAZIL

Marcos Silveira, UFAC, Citizenship: BRAZIL, Ph.D. student, Thesis: A floresta aberta com bambu no sudoeste da Amazônia: padrões e processos em múltiplas escalas

Adelia Maria Oliveira Sousa, Universidade de Évora, Citizenship: PORTUGAL, Ph.D. student, Thesis: Estimates of burned asreas using orbital remote sensing

Francisco Kennedy Araújo de Souza, Federal University of Acre (UFAC), Citizenship: BRAZIL, Masters student, Postdoctoral Researcher, Thesis: Alternatives for Sustainable Development in the Tri-frontier Area: A Regional Development Scenario for Rural Communities in Madre de Dios (Peru), Acre (Brazil) and Pando (Bolívia)

Simone Aparecida Vieira, CENA/USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Mudanças Globais e taxa de crescimento arbóreo na Amazômia

Proposed Research Sites:

Acre

Proposed Training and Education:

Community / Government Outreach

- Curriculum development planning for the state of Acre is planned in collaboration with the Acre Forum on Education. Short seminars for regional decision-makers are also planned. The on-going collaboration with the State Institute of Environment (IMAC) and the State Executive Secretariat of Forests and Extractivism (SEFE) in Acre will continue. Work in collaboration with Assis Brasil and Inapari municipal government, representatives of civil society and state government representatives will continue to be developed and serve as a conduit for LBA results to municipal and state decision makers. The Education Department of the State of Acre solicited this group's recommendations on how to put global change in the classroom. As a result, a proposal for a curriculum development is being elaborated. Publication for the general public will continue to be developed oriented toward scenarios of land use in the MAP region.

Educational Materials

- Production of articles and booklets addressed to the general public and remote communities focusing on the sustainable use of land.

Formal Training

- Five students of UFAC, who did an internship at SETEM-LBA/Acre), plan to initiate their Masters degree. A total of 12 graduate students associated with SETEM (Sector of Land Use and Global Change Studies) will likely be in a graduate school during the next three years. University of Florida graduate students from units ranging from forestry to geography to civil engineering to law have recently formed a working group focused on the impacts of roads on ecosystems and social systems. The "Roadies" working group can serve as a valuable resource to MAP-origin students and for the development of new theoretical models and methods to better anticipate the impacts of new roads on social and ecological systems. As such, it provides a forum for interdisciplinary discussion and intensive collaboration in the TCD tradition, with a focus on the MAP region and issues key to near-future changes under way there.

Short Courses / Seminars / Workshops

- A 3-5 day course entitled "Introduction to LBA Science" is planned for scientists and professors of universities and research institutions in Acre to help incorporate the scientific results in the regional scientific community. A 3-5-day course for 25 participants in Acre in collaboration with 7 other LBA PIs and short seminars for regional decision-makers are planned to be organized.

Beija-Flor Datasets: (as of 2003-06-16)

A Comparison of Satellite Fire Products and In Situ Observations in Southwestern Amazonia: A Case Study in Acre, Brazil (Poster)

Black Carbon Comparative Aspects for Climate Characterization of Rio Branco - AC, Brazil (Poster)

Carbon as an economic strategy to reduce deforestation in southwestern Amazonia: opportunities and limits for rural populations in Acre State, Brazil (Poster)

Challenges in the democratization of knowledge generated by LBA for Amazonian societies (Poster)

Committed carbon emissions from deforestation in three municipalities of Acre State, Brazil: a first approximation for public policy decision-making (Poster)

Daily Meteorological Station Data in Rio Branco/AC, Brazil, 1970 -

flutuação do lençol freático na Faz. Experimental Catuaba/UFAC

Forest susceptibility to fire during a one year El Niño period (1998-99); a case study Western Amazon (Poster)

In situ monitoring of smoke, radiation, and aerosol concentrations in southwestern Amazonia

Inventory of 1023 trees in a 10 hectare transect: Catuaba Experimental Farm

queimadas georeferenciadas e descritas no Estado do Acre em 2002

Reliability of low-cost GPS data for ecological and land use studies in Amazonia (Poster)

Rio Branco-Acre monthly rainfall 1984-1999

Rio Branco-Acre rainfall 1984-1999

Spatial analysis of heat areas: a confront with vegetation (Poster)

Susceptabilidade da floresta ao fogo durante o fenômeno El Niño. Estudo de caso na Amazônia Sul Ocidental

The broader impacts of LBA science: Examples from Acre, Brazil (Poster)

The impact of accidental fires in southwestern Amazonian agroecosystems and forests. A case study in Acre State, Brazil. (Poster)

Publications:

Brown IF, Kainer K, do Amaral E. (2001) Extractive Reserves and Participatory Research as Factors in the Biogeochemistry of the Amazon Basin.

Martinelli LA, Almeida S, Brown IF, Moreira MZ, Victoria RL, Filoso S, Ferreira CAC, Thomas WW. (2000) Variation in nutrient distribution and potential nutrient losses by selective logging in a humid tropical forest of Rondonia, Brazil. *Biotropica*, **32**, 597-613.

Salimon CI, Brown IF. (2000) Secondary forests in western Amazonia: Significant sinks for carbon released from deforestation?. *Interciencia*, **25**, 198-202.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3d - What portion of the Amazônia–wide carbon flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?
- LC-Q4 - What are plausible scenarios for future land cover change in Amazônia?

LC-04 (Foley / Costa) Investigation Profile

Exploring Interactions Among the Ecological, Hydrological and Climate Systems of Amazonia

Principal Investigators:

Marcos Heil Costa, Federal University of Vicosa (UFV) (SA-PI)
Jonathan A. Foley, University of Wisconsin-Madison (US-PI)

Abstract 2003:

This proposal describes a research project that focuses on the large-scale, integrated behavior of environmental systems in the Amazon basin. We aim to address several broad research questions:

· How do the terrestrial ecosystems across the Amazon behave? How do they interact with the freshwater and climate systems of the region?

· How do the terrestrial ecosystems, freshwater systems and atmosphere of the Amazon operate as a single, integrated system?

· How does this integrated regional environmental system respond to human activity and global environmental change? How do changes in the environmental systems of the Amazon affect the rest of the Earth system?

In order to address these questions, our research team is actively building state-of-the-art coupled models of terrestrial ecosystems, hydrological systems, and the atmosphere. These integrated modeling tools will be used to explore the complex behavior of regional environmental systems, and examine how they may respond to human activity and global environmental change. By considering the coupled behavior of the atmosphere, terrestrial ecosystems, and freshwater systems, we will explore the rich dynamics of this regional environmental system – including complex responses that could not be anticipated by considering each system in isolation.

Our project has three major objectives:

Objective 1. Understand the Dynamics of Terrestrial Ecosystems – Variability, Disturbance, and Long-Term Change. We will use a regional-scale terrestrial ecosystem model (IBIS) to explore the behavior of terrestrial ecosystems across the Amazon basin. First, we will continue to test the components of the model against a hierarchy of measurements being made in LBA, including tower flux data, in situ biomass and canopy measurements, isotope samples, stream-flow data, and satellite measures. Next, we will examine how terrestrial ecosystems across the basin respond to climatic variability, disturbances, and land use / land cover change. In particular, we will use the IBIS modeling system to examine changes in ecosystem functioning (including terrestrial carbon cycling, water balance, nutrient cycling), as well as changes in ecosystem structure (including leaf area, biomass, and vegetation composition).

Objective 2. Investigate the Interactions between Terrestrial Ecosystems and Freshwater Systems – Hydrological and Biogeochemical Linkages. First, we will examine the hydrological connections between terrestrial ecosystems and the rivers, streams, floodplains and wetlands of the basin. We will use our terrestrial ecosystem model (IBIS) to examine how the surface water balance responds to climate variability and land use / land cover change. We will also use our large-scale hydrological transport model (HYDRA) to examine the effects of changing water balance on river discharge, as well as the extent of wetlands and flooding. Next we will consider the biogeochemical linkages between terrestrial ecosystems and the freshwater systems in Amazonia. In particular, we will consider the transport of carbon from terrestrial ecosystems into freshwater systems, and the biological processing of carbon within aquatic ecosystems. The transport of carbon from terrestrial ecosystems to the rivers and wetlands of Amazonia is particularly relevant to the goals of LBA-ECO, as it may represent a significant fraction of the basin's carbon balance.

Objective 3. Explore the Interactions between Terrestrial Ecosystems and the Atmosphere – Physical and Biogeochemical Linkages. We will use a fully coupled climate – ecosystem model (CCM3-IBIS) to investigate how the climate and ecosystems of Amazonia will change in response to different scenarios of land use, rising CO2 (considering both the ecological and climatic effects of CO2), as well as different patterns of sea surface temperatures in the tropical Atlantic. We will use the modeling studies to evaluate the biogeophysical feedbacks of changing land cover conditions (either directly from land use practices, or indirectly through climate changes) on the regional climate, as well as the biogeochemical feedbacks of changing terrestrial carbon balance on atmospheric CO2 concentrations and the global climate.

Investigation Duration:

1998 - 2005

Participants:

Aurelie Botta, Co-Investigator, University of Wisconsin
Michael T Coe, Co-Investigator, SAGE
Marcos Heil Costa, SA-PI, Federal University of Vicosa (UFV)
Jonathan A. Foley, US-PI, University of Wisconsin-Madison
Erica Akiko Howard, University of Wisconsin - Madison
Silvia N. Monteiro Santos, Universidade Federal de Viçosa

Student Information:

Erica Akiko Howard, University of Wisconsin - Madison, Citizenship: USA, Ph.D. student, Thesis: Aquatic losses of carbon from terrestrial ecosystems of the Amazon Basin

Silvia N. Monteiro Santos, Universidade Federal de Viçosa, Citizenship: BRAZIL, Ph.D. student

Proposed Research Sites:

Amazon Basin (large-scale studies)

Proposed Training and Education:

Community / Government Outreach

- This team is committed to writing about LBA science discoveries in a form that is accessible to the general public, either through tradicional magazine publications or through new internet-based publication venues. See an article about LBA research in the Brazilian magazine Ação Ambiental (http://www.ufv.br/acao/edicoes.html), 10 th edition. This team is also committed to giving public lectures on environmental topics related to LBA. Professors Foley and Costa routinely give talks on environmental issues to groups in Brazil and the United STates. Electronic presentation materials - shared between Wisconsin and Viçosa - that will facilitate giving lectures to a variety of audience, in both Portuguese and English, will be created.

Educational Materials

- Students will produce 5-10 short papers each semester, as well as orally present results of the research they are involved. It is intended to be an integrative course for advanced undergraduate and beginning graduate students.
- "Building a Portable Classroom: Teaching in the Amazon": In order to teach and train on an Amazonian setting, this team plan to build "a portable computer classroom" to overcome basic infrastructure problems. It is planned to be used by this team to teach classes across Brazil.
- Articles for dissemination of LBA science findings will be written for publications in Brazilian, American and European magazines/oulets or to be posted on internet-based venues.
- The Interactive Atlas of the Global Environment (http://atlas2.sage.wis.edu) is an innovative online resource where students, educators, business leaders, and invironmental organizations can access and download state-of-the-art scientific data, images, and maps pertaining to human activities and the global environment. A new Atlas of Amazoniaweb site (with Portuguese, Spanish and English versions), highlighting environmental information is being produced by this team.

Formal Training

- Formal training is planned for graduate (3-4) and several undergraduates at the Federal University of Viçosa. Current Post-Doc students will continue training at the Wisconsin University.

Short Courses / Seminars / Workshops

- Courses in Environmental System Dynamics and Modeling. This course will focus on the principles of system dynamics and mathematical modeling. Students will develop computer models to solve problems coering a range of topics, including climatology, hydrology, forest ecology, carbon cyclin and biocheochemistry. The course will also emphasize communication skills. The course will have six major components.

Visits / Exchange Programs

- Visiting internships at partner institutions for training of students in a range of interdisciplinary research.

Beija-Flor Datasets: (as of 2003-06-16)

A New Five-Minute Land Use Data Set for Amazonia Produced from Satellite-Based and Agricultural Census-Based Data

A set of macrohydrological data for the Amazon basin (Poster)

Agricultural Density in the mid-1990s in the Amazon and Tocantins Basins

Amazon and Tocantins River Basins Border

Cropland Density in the mid-1990s in the Amazon and Tocantins Basins

HYDRA model simulations of inundation area for the Amazon/Tocantins River basins: 1939-1998

HYDRA model simulations of river discharge for the Amazon/Tocantins River basins: 1939-1998

HYDRA model simulations of river height for the Amazon/Tocantins River basins: 1939-1998

IBIS model simulation of annual CO2 fluxes for the Amazon and Tocantins basin: 1935-1998

IBIS model simulation of annual NPP for the Amazon and Tocantins basins: 1935-1998

IBIS model simulation of monthly CO2 fluxes for the Amazon and Tocantins basins: 1935-1998

IBIS model simulation of monthly NPP for the Amazon and Tocantins basins: 1935-1998

IBIS model simulation of the annual percentage of burned area for the Amazon and Tocantins basins: 1935-1998

Macrohydrological dataset for the Amazon basin

Natural Pasture Density in the mid-1990s in the Amazon and Tocantins Basins

Planted Pasture Density in the mid-1990s in the Amazon and Tocantins Basins

Publications:

Foley JA, Levis S, Costa MH, Cramer W, Pollard D. (2000) Incorporating dynamic vegetation cover within global climate models. *Ecological Applications*, **10**, 1620-1632.

Costa MH, Foley JA. (1998) A comparison of precipitation datasets for the Amazon basin. *Geophysical Research Letters*, **25**, 155-158.

Botta A, Ramankutty N, Foley JA. (2002) Long-term variations of climate and carbon fluxes over the Amazon basin. *Geophysical Research Letters*, **29**, art-1319.

Cardille JA, Foley JA, Costa MH. (2002) Characterizing patterns of agricultural land use in Amazonia by merging satellite classifications and census data. *Global Biogeochemical Cycles*, **16**, art-1045.

Costa MH, Foley JA. (2000) Combined effects of deforestation and doubled atmospheric CO2 concentrations on the climate of Amazonia. *Journal of Climate*, **13**, 18-34.

Costa MH, Foley JA. (1999) Trends in the hydrologic cycle of the Amazon basin. *Journal of Geophysical Research-Atmospheres*, **104**, 14189-14198.

Delire C, Foley JA. (1999) Evaluating the performance of a land Surface/ecosystem model with biophysical measurements from contrasting environments. *Journal of Geophysical Research-Atmospheres*, **104**, 16895-16909.

Costa MH, Oliveira CHC, Andrade RG, Bustamante TR, Silva FA, Coe MT. (2002) A macroscale hydrological data set of river flow routing parameters for the Amazon Basin. *Journal of Geophysical Research-Atmospheres*, **107**, art-8039.

Coe MT, Costa MH, Botta A, Birkett C. (2002) Long-term simulations of discharge and floods in the Amazon Basin. *Journal of Geophysical Research-Atmospheres*, **107**, art-8044.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
- ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

LC-05 (Laurance / Mesquita) Investigation Profile

Anthropogenic Land-use Change and the Dynamics of Amazon Forest Biomass

Principal Investigators:

William F. Laurance, Smithsonian Tropical Research Institute (US-PI)
Rita Guimaraes Mesquita, BDFFP/INPA (SA-PI)

Abstract 2003:

This investigation seeks to understand the impacts of prevalent land-use changes such as habitat fragmentation and forest regeneration on the dynamics of biomass and carbon storage in Brazilian Amazonia. Further goals include assessing the effects of anthropogenic climate change and El Niño-related droughts on fragmented and intact forests. This project is also playing a vital role in providing advanced training for Amazonian graduate and undergraduate students, postdoctoral researchers, and government decision-makers.

A key strategy of this investigation is to extrapolate upward from intensive studies at local and landscape scales to much larger regional and basin-wide scales. This is accomplished by various modeling approaches that link long-term studies of forest dynamics and biomass in fragmented and regenerating forests in central Amazonia with remote-sensing data, including Landsat TM and AVHRR at regional scales, and higher-resolution techniques at landscape and local scales.

This study incorporates one of the world's most important datasets on tropical forest dynamics. Within the 1000-km2 study area of the Biological Dynamics of Forest Fragments Project (BDFFP) near Manaus, a long-term (>23 year) investigation of forest biomass, carbon-cycle dynamics, and plant diversity and community composition is being conducted using 69 1-ha plots in fragmented and intact forests. Within these plots, >60,000 large (>10 cm diameter) trees of ca. 1,200 species have been continuously monitored since 1980. In addition, virtually all other components of aboveground biomass (small trees, saplings, seedlings, palms, lianas, snags, fine and coarse wood debris, litter standing stock) are being quantified, providing insights of unparalleled detail into the striking ecological impacts of forest fragmentation on carbon storage and cycling and plant-community dynamics.

In addition, long-term biomass studies are being undertaken to help determine whether intact Amazonian forests are functioning as a significant carbon sink (possibly in response to increasing CO2 fertilization). Carefully selected plot chronosequences are being used to study the dynamics of carbon sequestration and floristic change in forests regenerating on abandoned lands, and are revealing the critical role of disturbance history in forest regeneration.

Investigation Duration:

1998 - 2005

Participants:

Ana Cristina Segalin de Andrade, INPA/PDBFF
Juliana Stropp Carneiro, INPA
Carlos Da Costa, BDFFP/INPA
Rosely Cavalcante Hepólito, PDBFF
William F. Laurance, US-PI, Smithsonian Tropical Research Institute
Flavio Jesus Luizao, Co-Investigator, INPA
Rita Guimaraes Mesquita, SA-PI, BDFFP/INPA
Marcelo Paustein Moreira, Projeto Dinâmica Biológica de Fragmentos Florestais
Henrique Eduardo Nascimento, Co-Investigator
Heraldo L. Vasconcelos, Co-Investigator, BDFFP/INPA
Eduardo Martins Venticinque, INPA/BDFFP
Susan Gai Warriner Laurance, Co-Investigator, Smithsonian Tropical Research Institute
G. Bruce Williamson, Co-Investigator, INPA

Student Information:

Ana Cristina Segalin de Andrade, INPA/PDBFF, Citizenship: BRAZIL, Bachelors student

Marcelo Paustein Moreira, Projeto Dinâmica Biológica de Fragmentos Florestais, Citizenship: BRAZIL, Masters student, Technician, Thesis: Uso de sensoriamento remoto para avaliar a dinâmica de sucessão secundária da Amazônia Central

Henrique Eduardo Nascimento, Citizenship: BRAZIL, Ph.D. student, Thesis: Ecological effects of forest fragmentation on aboveground biomass and carbon cycling in central Amazonia

Eduardo Martins Venticinque, INPA/BDFFP, Citizenship: BRAZIL, Postdoctoral Researcher

Proposed Research Sites:

Amazon Basin (large-scale studies)

Amazonas (Manaus)
Mil Madeira Itacoatiara
ZF3 Biological Dynamics of Forest Fragments Project (BDFFP)
ZF3 Fazenda Dimona

Proposed Training and Education:

Community / Government Outreach

- Communication about research findings with the Brazilian and international public has been recognized as a key priority in this project, and is one of the main resong this team was awarded the prestigious Ford-Conservation International Award for Conservation in 2000. Public-outreach activities are being achieved by (1) many popular and semi-technical publications in Portuguese (e.g. Laurance and Delamonica, 1998); Mesquita 1999; Williamson et al. 1999b; Laurence and Vasconcelos 1000; Delamonica et al. 2001; Laurence 2001c; Fernside at al., in press; Laurence et al., in press Monaco et al., in press). (2) Public seminars and guest lectures at many venues in Brazil; (3) frequent inerviews with Brazilian and international newspapers, radio, and TV news programs. ; and (4) invited testimony before the Brazilian Congress and state political bodies on the conservation and management of amazonian forest.

Educational Materials

- Communication about research findings with the Brazilian and international public will continue to be a key priority in this project.Popular and semi-technical publications for education and dissemination of rainforest ecology will be produced by students an investigators.
- A series of booklets about rainforest ecology and sustainable use of tropical forests is being developed in collaboration with educators of elementary and middle schools in the Manaus region envolving students under the supervision of the principal investigators of this team.

Formal Training

- Training and education activities will play a key role in determining the capacity of Brazilian researchers, resource managers, decision-makers, and the general public to make well-informed decisions about the future of Amazonian forests. For this reason, training and educational activities, in their broadest sense, are an integral part of this proposal. Advanced training will be provided for 6-8 Brazilian postgraduate students (including three students from Phase 1; these students will be involved in field studies of carbon storage and ecosystem processes in fragmented, logged, and regenerating forests; (2) GIS-based spatial analyses of carbon storage and emissions in anthropogenic landscapes; (3) spatial analyses designed to identify the key proximate drivers of Amazonian deforestation; and (4) policy-related analyses of Amazonian development trends. Numerous current Brazilian undergraduate students will continue to receive training in rainforest ecology, database management, GIS application, remote sensing, and field biology.

Beija-Flor Datasets: (as of 2003-06-16)

Amazon Deforestation and Human and Physical Factors

Anthropogenic Landscape Changes and the Dynamics of Amazon Forest Biomass

Publications:

Mesquita RCG, Delamonica P, Laurance WF. (1999) Effect of surrounding vegetation on edge-related tree mortality in Amazonian forest fragments. *Biological Conservation*, **91**, 129-134.

Williamson GB, Costa F. (2000) Dispersal of amazonian trees: Hydrochory in Pentaclethra macroloba. *Biotropica*, **32**, 548-552.

Williamson GB, Laurance WF, Oliveira AA, Delamonica P, Gascon C, Lovejoy TE, Pohl L. (2000) Amazonian tree mortality during the 1997 El Nino drought. *Conservation Biology*, **14**, 1538-1542.

Laurance WF. (2001) Tropical logging and human invasions. *Conservation Biology*, **15**, 4-5.

Laurance WF, Lovejoy TE, Vasconcelos HL, Bruna EM, Didham RK, Stouffer PC, Gascon C, Bierregaard RO, Laurance SG, Sampaio E. (2002) Ecosystem decay of Amazonian forest fragments: A 22-year investigation. *Conservation Biology*, **16**, 605-618.

Phillips OL, Malhi Y, Vinceti B, Baker T, Lewis SL, Higuchi N, Laurance WF, Vargas PN, Martinez RV, Laurance S, Ferreira LV, Stern M, Brown S, Grace J. (2002) Changes in growth of tropical forests: Evaluating potential biases. *Ecological Applications*, **12**, 576-587.

Laurance WF, Perez-Salicrup D, Delamonica P, Fearnside PM, D'Angelo S, Jerozolinski A, Pohl L, Lovejoy TE. (2001) Rain forest fragmentation and the structure of Amazonian liana communities. *Ecology*, **82**, 105-116.

Laurance WF, Albernaz AKM, Da Costa C. Is deforestation accelerating in the Brazilian Amazon?. Environmental Conservation **28**, 305-311. 2001.

Laurance WF. (2000) Mega-development trends in the Amazon: Implications for global change. *Environmental Monitoring and Assessment*, **61**, 113-122.

Nelson BW, Mesquita R, Pereira JLG, de Souza SGA, Batista GT, Couto LB. (1999) Allometric regressions for improved estimate of secondary forest biomass in the central Amazon. *Forest Ecology and Management*, **117**, 149-167.

Laurance WF, Albernaz AKM, Schroth G, Fearnside PM, Bergen S, Venticinque EM, Da Costa C. (2002) Predictors of deforestation in the Brazilian Amazon. *Journal of Biogeography*, **29**, 737-748.

Mesquita RCG, Ickes K, Ganade G, Williamson GB. (2001) Alternative successional pathways in the Amazon Basin. *Journal of Ecology*, **89**, 528-537.

Laurance WF, Delamonica P, Laurance SG, Vasconcelos HL, Lovejoy TE. Conservation - Rainforest fragmentation kills big trees. Nature **404**, 836-836. 2000.

Laurance WF, Vasconcelos HL, Lovejoy TE. (2000) Forest loss and fragmentation in the Amazon: implications for wildlife conservation. *Oryx*, **34**, 39-45.

Gascon C, Williamson GB, da Fonseca GAB. (2000) Ecology - Receding forest edges and vanishing reserves. *Science*, **288**, 1356-1358.

Laurance WF. The future of the Brazilian Amazon (vol 291, pg 438, 2001). Science **291**, 988-988. 2001.

Laurance WF, Fearnside PM, Cochrane MA, D'Angelo S, Bergen S, Delamonica P. Development of the Brazilian Amazon - Response. Science **292**, 1652-1654. 2001.

Laurance WF, Fearnside PM. Amazon burning. Trends in Ecology & Evolution **14**, 457-457. 1999.

Laurance WF. Cut and run: the dramatic rise of transnational logging in the tropics. Trends in Ecology & Evolution **15**, 433-434. 2000.

Laurance WF. Edge effects and ecological processes: are they on the same scale? Reply. Trends in Ecology & Evolution **15**, 373-373. 2000.

Laurance WF. Do edge effects occur over large spatial scales?. Trends in Ecology & Evolution **15**, 134-135. 2000.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?

LC-07 (Melack / Novo / Forsberg) Investigation Profile

Multi-Scale Analysis of Inundation with Microwave and Optical Remote Sensing in the Amazon Basin: Applications to Biogeochemical Measurements and Modeling

Principal Investigators:

Bruce R Forsberg, INPA (SA-PI)
John M. Melack, University of California, Santa Barbara (US-PI)
Evlyn Marcia Leao de Moraes Novo, INPE/DSR (SA-PI)

Abstract 1998:

We propose to conduct a multi-temporal, multi-scale, multi-sensor analysis of inundation and wetland vegetation in the Amazon basin that will be linked to biogeochemical measurement and modeling activities of LBA.

Our proposed remote sensing analyses will include optical (Landsat, AVHRR and EOS sensors), passive microwave (SMMR/SSMI) and active microwave (SIRC, JERS, ERS, and Radarsat) data to determine the

temporally varying extent of inundation and associated vegetation. We will (1) provide synoptic, seasonal mapping of inundation and wetland vegetation structure for the Amazon basin; (2) incorporate the inundation and vegetation data into a GIS-based database; and (3) apply results from our analyses of wetland vegetation and inundation to related LBA studies of hydrological, ecological, and biogeochemical processes.

The expected time periods for recording an image useable for inundation analysis with the different remote sensing instruments we propose to employ varies from days to months. Based on an analysis of the spatial and temporal resolutions of the satellite sensors, we have determined that data fusion amongst the instruments will be critical to insure sufficient temporal coverage at the appropriate spatial scales. We anticipate that there will be an inundation-mapping limit for typical rivers with contributing drainage basins on the order of 1000-10,000 km2 when the flood conditions occur only for a week to a month. Individual sites may be mappable above and below this limit, depending on the local geomorphology and inundation hydrology.

We anticipate results of our analyses to be important for LBA activities associated with (1) methane and other trace gas emissions, (2) carbon dynamics of flooded forests, (3) land use on flood plains, (4) regional hydrologic modeling, and (6) detection of seasonal and inter-annual climate variability.

Implementation

Implementation of our activities will be done as follows:

Optical sensing - The most effective technique for tracking the zone of river-water influence, in contrast to local-water influence, on wetland inundation is through the use of optical data of sufficiently fine resolution. We will modify our current method for suspended sediment analysis to incorporate data from the optical instruments expected during LBA, i.e., Landsat 7, MODIS, and AVHRR. The optical image analysis will be limited by access to sufficiently cloud and smoke-free data.

Active microwave sensors - We plan to use a multi-stage, hierarchical, rules-based approach to delineate floodplain inundation and vegetation using a decision-tree model which constructs a binary classification tree by recursively partitioning the training data into increasingly homogeneous subsets. Inundation mapping at a fine scale (12.5 m to 100 m pixel spacing) will be carried out using a combination of JERS (LHH), Radarsat (CHH), and ERS-2 (CVV) data. All these data will offer multi-temporal coverage of selected regions; only Radarsat's ScanSAR is expected to provide multi-temporal coverage of the whole Amazon basin during LBA.

Passive microwave sensors - Low-resolution sensors, such as the Scanning Multi-channel Microwave Radiometer (SMMR) and the Special Sensor Microwave Imager (SSMI), afford a synoptic view of the Amazon basin that complements finer-resolution SAR and optical data. We have developed linear mixing models that incorporate the observed microwave signature's major end members to estimate fractional inundation area. Data will be obtained as 0.25° x 0.25° grid cells, and modal values for each 2-week period will be used to determine inundation area

Field studies - Field surveys will be required at key LBA sites and selected wetlands to validate our classifications and maps. These surveys will entail low altitude videography and surface inspections from land and water. Geo-location of flight lines and surface sites will be done with portable GPS units. Further, we will use information obtained from the many hours of low altitude videography and field observations that we have collected previously, as well as from published literature and from personal contacts. To improve correlation between water levels and inundation extent in wetlands distant from major rivers or gauging stations on rivers, we will install automatic water level recorders.

Projected Schedule

During the first year, we will emphasize extension and validation of our microwave and optical classification algorithms and assembly of mutli-temporal data sets from ERS, Radarsat, JERS, Landsat and SSMI acquisitions. During the second and third years, we will emphasize production and distribution of inundation and wetland vegetation maps to relevant LBA projects and for our own complementary analyses.

Investigation Duration:

1998 - 2003

Participants:

Doug Alsdorf, UCLA
Claudio Barbosa, INPE
Lauren Belger, INPA

Joao Carlos Carvalho, Instituto Nacional de Pesquisas Espaciais
Sueli Pissarra Castellari, INPE
Maycira Costa, Co-Investigator, INPE, University of Victoria
Bruce R Forsberg, SA-PI, INPA
Andreia Maria Silva França, INPE
Ramon Morais de Freitas
Mary Gastil, University of California, Santa Barbara
Laura Lorraine Hess, Co-Investigator, University of California, Santa Barbara
Dayson José Jardim-Lima, Instituto Nacional de Pesquisas da Amazônia - INPA
Alexandre Kemenes, INPA
Ivan Bergier Tavares de Lima, INPE
Bruce Gavin Marshall
John M. Melack, US-PI, University of California, Santa Barbara
Leal Mertes, Co-Investigator, University of California
Evlyn Marcia Leao de Moraes Novo, SA-PI, INPE/DSR
Willian Palha, INPE
Yosio Edemir Shimabukuro, INPE
Claudio Roberto Silva
Thiago Sanna Freire Silva, National Institute for Space Research - INPE - Brazil
Cintia Honorio Vasconcelos, INPE

Student Information:

Claudio Barbosa, INPE, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Spatial and temporal distributions of Amazon waters derived from remote sensing and measurements

Lauren Belger, INPA, Citizenship: BRAZIL, Ph.D. student, Thesis: Fatores que influienciam na emissão de CO2 e CH4 em áreas algáveis interfluviais do médio Rio Negro

Joao Carlos Carvalho, Instituto Nacional de Pesquisas Espaciais, Citizenship: BRAZIL, Postdoctoral Researcher

Alexandre Kemenes, INPA, Citizenship: BRAZIL, Ph.D. student, Thesis: Estimativa de Emissões de Gases de Efeito Estufa pelo Reservatório de Balbina, AM

Ivan Bergier Tavares de Lima, INPE, Citizenship: BRAZIL, Postdoctoral Researcher

Bruce Gavin Marshall, Citizenship: CANADA, Masters student

Willian Palha, INPE, Citizenship: BRAZIL, Masters student, Thesis: A multi-sensor, multi-scale analysis of aquatic vegetation in the Amazon basin

Thiago Sanna Freire Silva, National Institute for Space Research - INPE - Brazil, Citizenship: BRAZIL, Masters student, Postdoctoral Researcher, Thesis: Research aimed to model the relationship between Amazon water level, vegetation fraction derived from MODIS Reflectance Products and methane emission at Obidos -Monte Alegre reach.

Cintia Honorio Vasconcelos, INPE, Citizenship: BRAZIL, Ph.D. student, Thesis: Integracao de dados de Sensoriamento Remoto na Identificacao de Habitats favoraveis a incidencia de Malaria em regioes sujeitas a construcao de Barragens Hidreletricas / Using remote sensing to correlate deforestation and increase of malaria in Amazon region

Proposed Research Sites:

Amazon Basin (large-scale studies)

Amazonas (Manaus)
- Balbina
- Cabaliana
- Cuiuni
- Demini
- Mamiraua
- Marchantaria
- Zamula

Pará Eastern (Belém)

FLONA Caxiuanã
Marajó

Pará Western (Santarém)
Lago Curuai
Lago Grande de Monte Alegre

Roraima
Boa Vista

Tocantins
Ilha do Bananal

Proposed Training and Education:

Educational Materials

- A series of lectures, available on this team website http://www/icess.ucsb.edu/LBA/training.html and on the CD-ROM titled "Microwave and optical remote sensing of Amazonian wetlands: a multi-scale, multi-sensor approach to understanding wetland hydrology and ecology", will be used in tutorials and in a course to be taught at INPA.

Formal Training

- Three Brazilian students - one PhD, two Masters and also a technician - will be developing fieldwork at INPA and at the Canguçú Research Center (near the field sites) and receive training on field validation, analysis of remote sensing data for the region, digital videography data and passive and active microwave data.

Short Courses / Seminars / Workshops

- Course on Remote Sensing organized in collaboration with INPE, to be offered at INPE.

Visits / Exchange Programs

- Opportunities to spend time at UCSB for training on specific aspects of research will be offered for the Brazilian students. Support will be given for students to participate in national and international symposia in order to present results of their research.

Beija-Flor Datasets: (as of 2003-06-16)

Briefing slides for NASA HQ, October 2001

Central Amazon Wetlands Mask, 100 m, version 0

Hess, L., Presentation at the SIVAM Technology Transfer Seminar VI, 12-15 Feb 2001

Interferometric SAR

Multi-scale analysis of inundation and wetland vegetation in the Amazon Basin (Poster)

Multitemporal Radarsat-1

Passive Microwave Measurement of Inundated Area

Slides presentation at LBA2002 Symposium

Publications:

Engle D, Melack JM. (2000) Methane emissions from an Amazon floodplain lake: Enhanced release during episodic mixing and during falling water. *Biogeochemistry*, **51**, 71-90.

Alsdorf D, Birkett C, Dunne T, Melack J, Hess L. (2001) Water level changes in a large Amazon lake measured with spaceborne radar interferometry and altimetry. *Geophysical Research Letters*, **28**, 2671-2674.

Siqueira P, Hensley S, Shaffer S, Hess L, McGarragh G, Chapman B, Freeman A. (2000) A continental-scale mosaic of the Amazon Basin using JERS-1 SAR. *Ieee Transactions on Geoscience and Remote Sensing*, **38**, 2638-2644.

Alsdorf DE, Smith LC, Melack JM. (2001) Amazon floodplain water level changes measured with interferometric SIR-C radar. *Ieee Transactions on Geoscience and Remote Sensing*, **39**, 423-431.

Elvidge CD, Hobson VR, Baugh KE, Dietz JB, Shimabukuro YE, Krug T, Novo EMLM, Echavarria FR. (2001) DMSP-OLS estimation of tropical forest area impacted by surface fires in Roraima, Brazil: 1995 versus 1998. *International Journal of Remote Sensing*, **22**, 2661-2673.

Hess LL, Novo EMLM, Slaymaker DM, Holt J, Steffen C, Valeriano DM, Mertes LAK, Krug T, Melack JM, Gastil M, Holmes C, Hayward C. (2002) Geocoded digital videography for validation of land cover mapping in the Amazon basin. *International Journal of Remote Sensing*, **23**, 1527-1555.

Shimabukuro YE, Novo EM, Mertes LK. (2002) Amazon river mainstem flooodplain landsat TM digital mosaic. *International Journal of Remote Sensing*, **23**, 57-69.

Birkett CM, Mertes LAK, Dunne T, Costa MH, Jasinski MJ. (2002) Surface water dynamics in the Amazon Basin: Application of satellite radar altimetry. *Journal of Geophysical Research-Atmospheres*, **107**, art-8059.

Hamilton SK, Sippel SJ, Melack JM. (2002) Comparison of inundation patterns among major South American floodplains. *Journal of Geophysical Research-Atmospheres*, **107**, art-8038.

Alsdorf DE, Melack JM, Dunne T, Mertes LAK, Hess LL, Smith LC. (2000) Interferometric radar measurements of water level changes on the Amazon flood plain. *Nature*, **404**, 174-177.

Richey JE, Melack JM, Aufdenkampe AK, Ballester VM, Hess LL. (2002) Outgassing from Amazonian rivers and wetlands as a large tropical source of atmospheric CO2. *Nature*, **416**, 617-620.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
- ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?
- TG-Q3 - Are losses and gains of carbon from Amazônian ecosystems in forms other than carbon dioxide (e.g. carbon monoxide, methane, volatile organic carbon, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance?

LC-09 (Moran / Batistella) Investigation Profile

Human and Physical Dimensions of Land Use/Cover Change in Amazonia: Towards a Multiscale Synthesis

Principal Investigators:

Mateus Batistella, Embrapa Satellite Monitoring (SA-PI)
Emilio Federico Moran, Indiana University (US-PI)

Abstract 2003:

Building on 30 years of research experience in the Amazon, this study will advance our understanding of land use and land cover change through integrative science activities and by collaboration with 11 other LBA projects. This project builds on a seven-region study, along the LBA transects, supported for six years by NSF and NIGEC, and then for the past three years by LBA funds. We have used a nested-georeferenced approach that collected soil analyses, vegetation stand structure and composition (100+ sites), land use histories, institutional analyses, demography of 600+ households, and land cover classification using Landsat MSS and TM multitemporal data to understand land use and land cover change (LCLUC) trajectories. The seven regions in our study, represent a soil fertility gradient across Amazonia from most (i.e. alfisols) to least (i.e. spodosols) fertile and include a wide array of land uses and land cover types along an east-to-west transect extending from the Amazon estuary and Bragantina region east of Belém, all the way to Rondônia in the west.

We propose in phase II of this NASA/LBA project to extend this work by:

1. Developing a multi-scale synthesis of land use and land cover change dynamics integrating our seven study areas, in order to understand the role of demographic, economic, institutional and biophysical variables on LCLUC trajectories during the past 25 years.

2. Developing a multi-sensor analysis of the capabilities and limitations of different platforms (IKONOS-TM & ETM+-MODIS) for land cover discrimination using the full capabilities of artificial neural networks for classification and modeling.

3. Developing an integrated study of land use, land cover, and land-water interactions by using a watershed approach encompassing at least two of our most intensive research sites (i.e. the Santarém-Altamira region), thereby addressing fundamental questions of the landscape-level controls on nutrient-carbon interactions within, and sustainability of forests in the Amazon Basin.

4. Developing a comprehensive scientific collaboration strategy within LBA projects to contribute to modeling and synthesis efforts by formal collaboration with 11 LBA projects, hands-on training, and dissemination of a data management CD for the benefit of all of LBA.

Investigation Duration:

1998 - 2005

Participants:

Ryan Thomas Adams, Anthropological Center for Training and Research on Global Environmental Change
Mateus Batistella, SA-PI, Embrapa Satellite Monitoring
Bruce William Boucek, Anthropological Center for Training and Research on Global Environmental Change
Eduardo S. Brondizio, Co-Investigator, Indiana University
Kristin Rooke Demming
Stefano Fiorini, Indiana University
Scott S. Hetrick, Indiana University
Ryan R. Jensen, Co-Investigator, Indiana State University
Thomas Ludewigs, ACT - Indiana University
Paul Mausel, Co-Investigator, Indiana State University
Megan McGroddy, Princeton University

John Iral Menzies, Indiana State University
Emilio Federico Moran, US-PI, Indiana University
Flavio Jorge Ponzoni, Co-Investigator, INPE
J.C. Randolph, Co-Investigator, Indiana University
Hans Peter E. Schmid, Indiana University
Andrea Dalledone Siqueira, ACT, Indiana University
Maria Angelica Toniolo, Indiana University - CIPEC
Dalton De Morisson Valeriano, Co-Investigator, INPE
Leah VanWey, Co-Investigator, Indiana University
Genong Yu, Indiana State University

Student Information:

Ryan Thomas Adams, Anthropological Center for Training and Research on Global Environmental Change, Citizenship: USA, Ph.D. student

Bruce William Boucek, Anthropological Center for Training and Research on Global Environmental Change, Citizenship: USA, Ph.D. student, Thesis: Dynamics of Land Cover Change in an Amazonian Per-urban Region

Stefano Fiorini, Indiana University, Citizenship: ITALY, Ph.D. student, Thesis: Population Dynamics and Economic Change in Two Amazonian Regions

Scott S. Hetrick, Indiana University, Citizenship: USA, Technician, Thesis: ENVIRONMENTAL SCIENCE/SPATIAL INFORMATION PROCESSING

Thomas Ludewigs, ACT - Indiana University, Citizenship: BRAZIL, Ph.D. student, Thesis: Persistance of Settlers in a Government-Sponsored Colonization Project in the Western Amazon

Megan McGroddy, Princeton University, Citizenship: USA, Postdoctoral Researcher, Thesis: Fate of Phosphorus in a seasonal lowland Amazonian ecosystem: geochemical sequestration versus biological cycling

Andrea Dalledone Siqueira, ACT, Indiana University, Citizenship: BRAZIL, Ph.D. student

Ms. Maria Angelica Toniolo, Indiana University - CIPEC, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Papel dos Regimes de Propriedade na Ocorrência de Fogos Acidentais na Região Amazônica: Estudos de Caso da Região de Santarém.

Genong Yu, Indiana State University, Citizenship: CHINA, Ph.D. student

Proposed Research Sites:

Pará Eastern (Belém)
- Bragantina
- Igarapé Açu
- Marajó
- Ponta de Pedras
- Tomé Açu

Pará Western (Santarém)
- Altamira
- Belterra
- Curua Una
- Mojuí
- Santarém-Cuiabá Road

Rondonia
- Machadinho D'Oeste

Proposed Training and Education:

Educational Materials

- A book including LBA results will be produced in Portuguese.
- Production of CD ROMs for training and education on remote sensing for distribution in universities.

Formal Training

- A full-time graduate assistant will be working on the project. Seven PhD Students will be added, including periodic visiting students of varying academic levels.

Short Courses / Seminars / Workshops

- A course on Human Dimensions addressing the needs of Amazonian institutions in Bolivia, Peru and Brazil in the tri-country region is under discussion with the team led by I.Foster- Brown.

Visits / Exchange Programs

- It is planned to develop exchange programs offering the resources of ACT, INPE, EMBRAPA, ISU/ISURSL to a number of Amazonian institutions (EMBRAPA/CPATU, EMBRAPA /Satellite Monitoring, UFAC, INPA, Museu Goeldi, UFPA for doctoral and masters level students. Also, it is planned to provide support for exchange programs for two, one-month, individualized training for Amazonian students to ACT for intensive work on land use/land cover change methods. Support for several Amazonian and INPE's students will be provided for participation in the annual Summer Institute course taught by CIPEC.

Beija-Flor Datasets: (as of 2003-06-16)

Human Dimensions and Metrics of Landscape Change in Rondonia, Brazilian Amazon (Poster)

Vegetation inventories and soil sampling summary

Publications:

Kesselmeier J, Kuhn U, Wolf A, Andreae MO, Ciccioli P, Brancaleoni E, Frattoni M, Guenther A, Greenberg J, Vasconcellos PD, de Oliva T, Tavares T, Artaxo P. (2000) Atmospheric volatile organic compounds (VOC) at a remote tropical forest site in central Amazonia. *Atmospheric Environment*, **34**, 4063-4072.

Evans TP, Manire A, de Castro F, Brondizio E, McCracken S. (2001) A dynamic model of household decision-making and parcel level landcover change in the eastern Amazon. *Ecological Modelling*, **143**, 95-113.

Moran EF, Brondizio ES, Tucker JM, Silva-Forsberg MC, McCracken S, Falesi I. (2000) Effects of soil fertility and land-use on forest succession in Amazonia. *Forest Ecology and Management*, **139**, 93-108.

Lu D, Moran E, Mausel P. (2002) Linking amazonian secondary succession forest growth to soil properties. *Land Degradation & Development*, **13**, 331-343.

McCracken SD, Brondizio ES, Nelson D, Moran EF, Siqueira AD, Rodriguez-Pedraza C. (1999) Remote sensing and GIS at farm property level: Demography and deforestation in the Brazilian Amazon. *Photogrammetric Engineering and Remote Sensing*, **65**, 1311-1320.

Science Questions Addressed by this Investigation:

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?
- LC-Q4 - What are plausible scenarios for future land cover change in Amazônia?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q2 - Are nutrients major factors that control the rates of regrowth and carbon accumulation in abandoned pastures and regrowing secondary forests?
- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?

LC-13 (Asner / Silva / Pereira) Investigation Profile

Low-Cost Evaluation of EO-1 Hyperion and ALI for Detection and Biophysical Characterization of Forest Logging in Amazonia

Principal Investigators:

Gregory Paul Asner, Carnegie Institution (US-PI)
Rodrigo Antonio Pereira, Fundacao Floresta Tropical (SA-PI)
Jose Natalino Macedo Silva, EMBRAPA AMAZONIA ORIENTAL (SA-PI)

Abstract 2000:

Major uncertainties exist regarding the rate and intensity of logging in tropical forests worldwide: these uncertainties severely limit economic, ecological, and biogeochemical analyses of these regions. Recent sawmill surveys in the Amazon region of Brazil show that the area logged is nearly equal to total area deforested annually, but conversion of survey data to forest area, forest structural damage, and biomass estimates requires multiple assumptions about logging practices. Remote sensing could provide an independent means to monitor logging activity and to estimate the biophysical consequences of this land use. Previous studies have demonstrated that the detection of logging in Amazon forests is difficult and no studies have developed either the quantitative physical basis or remote sensing approaches needed to estimate the effects of various logging regimes on forest structure. A major reason for these limitations has been a lack of sufficient, well-calibrated optical satellite data, which in turn, has impeded the development and use of physically-based, quantitative approaches for detection and structural characterization of forest logging regimes.

We propose to use data from the EO-1 Hyperion imaging spectrometer to greatly increase our ability to estimate the presence and structural attributes of selective logging in the Amazon Basin. Our approach is based on four "biogeophysical indicators" not yet derived simultaneously from any satellite sensor: 1) green canopy leaf area index; 2) degree of shadowing; 3) presence of exposed soil and; 4) non-photosynthetic vegetation material. Airborne, field and modeling studies have shown that the optical reflectance continuum (400-2500 nm) contains sufficient information to derive estimates of each of these indicators. Our ongoing studies in the eastern Amazon basin also suggest that these four indicators are sensitive to logging intensity. Satellite-based estimates of these indicators should provide a means to quantify both the presence and degree of structural disturbance caused by various logging regimes.

Our quantitative assessment of Hyperion hyperspectral and ALI multi-spectral data for the detection and structural characterization of selective logging in Amazonia will benefit from data collected through an ongoing project run by the Tropical Forest Foundation, within which we have developed a study of the canopy and landscape biophysics of conventional and reduced-impact logging. We will add to our base of forest structural information in concert with an EO-1 overpass. Using a photon transport model inversion technique that accounts for non-linear mixing of the four biogeophysical indicators, we will estimate these parameters across a gradient of selective logging intensity provided by conventional and reduced impact logging sites. We will also compare our physically-based approach to both conventional (e.g., NDVI) and novel (e.g., SWIR-channel) vegetation indices as well as to linear mixture modeling methods. We will cross-compare these approaches using Hyperion and ALI imagers to determine the strengths and limitations of these two sensors for applications of forest biophysics. This effort will yield the first physically-based, quantitative analysis of the detection and intensity of selective logging in Amazonia, comparing hyperspectral and improved multi-spectral approaches as well as inverse modeling, linear mixture modeling, and vegetation index techniques. The study sites of this investigation include the Fazenda Cauaxi in the municipality of Uliolandia and the Tapajos National Forest in Santarem, Para (Tab.1).

Objectives

There are two primary objectives of this project:

1. Test the efficacy of EO-1 Hyperion imaging spectrometer and ALI multi-spectral data for detection and quantification of forest structural damage resulting from selective logging in the eastern Amazon Basin.

2. Test the strength of traditional and novel spectral indices, linear mixture modeling, and photon transport inverse modeling in delivering reliable estimates of biogeophysical variation across a site matrix of logging intensity and time since harvesting.

Table 1. Physical and logistical characteristics of logging research sites. Completed field and remote sensing data collections.

	Fazenda Cauaxi	FLONA-Tapajos / Fazenda Fortaleza
Central Lat./Long.	3°43'S, 48°17'W	3°3'S, 54°58'W
Dry season	July - December	
Logging treatments	Conventional and Reduced-impact Logging	
Treatment Years	1995-1999	1996-1999 / 1991-1999
Preliminary Field Measurements	Stand density; tree heights; crown dimensions; LAI; fPAR; location and extent of roads, skids, logdecks; GPS; field spectrometry (400-2500nm): tissue optical properties and soil reflectance; vegetation cover	Species identification and mapping; trunk diameters (dbh); GPS; field spectrometry (400-2500nm): tissue optical properties and soil reflectance; LAI
Recent Remote Sensing	Landsat 5 TM; SPOT tasked; Airborne LIDAR; Airborne digital videography	Landsat 5 TM; SPOT; JERS-1 radar; Airborne LIDAR; Airborne digital videography

Investigation Duration:

2000 - 2003

Participants:

Gregory Paul Asner, US-PI, Carnegie Institution
Briana Christine Constance, University of Colorado
Amanda Naslund Cooper, Carnegie Institute of Washington
Anna Quinn Hare
Albert Thomas Harris III, Carnegie Institution of Washington Department of Global Ecology
Michael Keller, Co-Investigator, University of New Hampshire
David E. Knapp, INPA
Lydia Pauline Olander, Carnegie Institute of Washington
Michael William Palace, Complex Systems Research Center
Rodrigo Antonio Pereira, SA-PI, Fundacao Floresta Tropical
Jose Natalino Macedo Silva, SA-PI, EMBRAPA AMAZONIA ORIENTAL
Amanda Susan Warner

Student Information:

Amanda Naslund Cooper, Carnegie Institute of Washington, Citizenship: USA, Technician

Lydia Pauline Olander, Carnegie Institute of Washington, Citizenship: USA, Postdoctoral Researcher

Michael William Palace, Complex Systems Research Center, Citizenship: USA, Ph.D. student, Thesis: The Role of Coarse Woody Debris in the Carbon Budget of a Tropical Moist Forest

Proposed Research Sites:

Mato Grosso
    Sinop

Pará Eastern (Belém)
    Fazenda Cauaxi
    Tailândia

Pará Western (Santarém)
    Belterra
    km 67 Primary Forest Tower Site
    km 67 Seca-Floresta Site
    km 83 Logged Forest Tower Site

Proposed Training and Education:

Currently none available.

Beija-Flor Datasets: (as of 2003-06-16)

GIS Coverages of Forest Areas Selectively Logged in 1996 and 1998

Publications:

Asner GP, Palace M, Keller M, Pereira R, Silva JNM, Zweede JC. (2002) Estimating canopy structure in an Amazon Forest from laser range finder and IKONOS satellite observations. *Biotropica*, **34**, 483-492.

Asner GP. (2001) Cloud cover in Landsat Observations of the Brazilian Amazon. *International Journal of Remote Sensing*, **22**, 3855-3862.

Asner GP, Keller M, Pereira R, Zweede JC. (2002) Remote sensing of selective logging in Amazonia - Assessing limitations based on detailed field observations, Landsat ETM+, and textural analysis. *Remote Sensing of Environment*, **80**, 483-496.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?
- CD-Q3d - What portion of the Amazônia–wide carbon flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Land Cover and Land Use Change:

- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?

LC-14 (Nepstad / Moutinho) Investigation Profile

The Effects of Partial Throughfall Exclusion on Forest Flammability, Productivity, Metabolism and Nutrient Cycling in an Amazon Forest

Principal Investigators:

Paulo Roberto de Souza Moutinho, IPAM - Instituto de Pesquisa Ambiental da Amazonia (SA-PI)
Daniel Curtis Nepstad, WHRC (US-PI)

Abstract 2003:

Drought is changing moist tropical forests in Amazonia and elsewhere. Drought severity has increased in these regions in association with El Niño events and may increase further through global warming and land use change. The consequences of this trend include potentially large effects on greenhouse gas emissions, tree mortality, reproductive biology, biogeochemistry, and forest flammability. During the 1998 El Niño episode, for example, approximately one third of Amazon forests experienced depleted soil moisture and may have become susceptible to fire. An integrated understanding of the responses of moist tropical forests to severe drought has eluded the scientific community in part because intensive field studies of episodic natural drought "experiments" are extremely difficult.

In this research, we continue a large-scale throughfall reduction experiment in an Amazon forest. Predicted responses to a total of 5 years of experimentally-induced drought and 2 years of release from drought stress will be tested. The study exploits the research infrastructure previously established with NSF funding, including one-hectare control and treatment study plots with canopy towers (8), catwalks (200 m), 12-m soil shafts (10) and perimeter trenches (800 m). The plots were compared during a one-year calibration period prior to treatment initiation. Measurements include stem and root sapflow, photosynthesis, leaf water potential, xylem cavitation, fine root dynamics, soil water, canopy phenology, stem growth, stem respiration, nutrient fluxes through the forest canopy, floor and soil, and soil fluxes of CO2, CH4, N2O and NO. Beginning in 2000, throughfall has been partially excluded from the treatment plot with 5,660 plastic panels that are installed in the understory during the rainy season and removed during the dry season.

Forests growing on deep, clay soils throughout much of Amazonia are buffered against the effects of moderate droughts by the large amount of water stored in the rooting profile. But even mild drought elicits important forest responses. After excluding 890 mm of throughfall in 2000 and 680 mm in 2001 from the one-hectare treatment plot, several unanticipated forest responses were documented that would have been very difficult to detect without a throughfall manipulation of this magnitude.

A reduction in soil methane emissions relative to the control plot appeared within days of installation of the exclusion panels. Surprisingly, a reduction in the growth of small tree stems (<20 cm diameter) and a reduction in sap flow were the next major treatment responses, appearing during the dry season of the first treatment year. This decline in stemwood production of nearly 1 Mg ha-1 yr-1 is sufficient to offset the net carbon sink that has been reported for Amazon forests. The anticipated reduction of leaf area index (LAI)

appeared only during a second phase of drought in which deep soil moisture depletion began, accompanied by declines in leaf water potential. Most of the LAI reduction was caused by decreases in new leaf production instead of through increased leaf shedding. Hence the stomatal closure provoked by mild drought stress was manifested as slower stemwood growth; leaf production declined only as deep soil moisture supplies were depleted. Estimates of NPP allocation to belowground production are awaiting further analyses, but soil respiration measurements indicate little total change.

During the next three years of throughfall reduction, a third phase of drought responses is predicted in which further soil moisture depletion provokes xylem embolism and the death of trees and tree branches. Tree- and branchfall gaps will open the forest understory to sunlight, but soil moisture deficits will limit the recovery processes that gap formation usually triggers. Soil trace gas emissions will respond both to changes in soil aeration and to changes in substrate availability caused by root mortality. Movement of solutions through the soil profile will depend upon root distributions, water content, and hydraulic conductivity. Forest floor accumulation combined with drought-induced reduction in leaf area index will greatly increase forest flammability. After cessation of the throughfall reduction treatment, persistent xylem damage in surviving large trees may restrict the supply of water to canopy foliage and suppress photosynthesis for years, while gaps are quickly filled by saplings and vegetative sprouts.

These complex forest responses to drought, and the cessation of drought, will be tested and modeled. Field measurements will be used to test and refine canopy metabolism and forest models, improving our ability to simulate the responses of moist tropical forests to severe drought, and the cessation of drought. This experiment is the focus of 6 PhD dissertations, 2 MS theses, 5 undergraduate theses, and numerous field ecology courses, and has been widely disseminated in the popular media.

Investigation Duration:

1998 - 2005

Participants:

Sergio Viana de Andrade, Universidade de Brasilia
Javier Alberto Arce, Columbia University
Gregory Paul Asner, Co-Investigator, Carnegie Institution
Elizabeth Leslie Belk, University of Georgia
Paulo Monteiro Brando, USP
Lace Medeiros Breyer, Universidade de Brasilia
Gina Knust Cardinot, IPAM - Seca Floresta
Oswaldo de Carvalho Jr, IPAM
Luciana Miranda Costa, IPAM
Wanderley Rocha da Silva, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Moacyr Bernardino Dias-Filho, Co-Investigator, Embrapa Amazonia Oriental / CPATU
Ricardo de Oliveira Figueiredo, Co-Investigator, Embrapa Amazônia Oriental
Jose Benito Guerrero, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Noel Michele Holbrook, Harvard University
Wendy Kingerlee, The Woods Hole Research Center
Carlos Augusto Klink, Co-Investigator, University of Brasilia
Wanja Janayna Miranda Lameira, Instituto de Pesquisa Ambiental da Amazônia - IPAM
Paul A. Lefebvre, The Woods Hole Research Center
Eduardo Jorge Maklouf, Co-Investigator, Embrapa Amazonia Oriental
Daniel Markewitz, Co-Investigator, University of Georgia
Heloisa S. Miranda, Co-Investigator, UnB
Luciana Magalhaes Monaco, IPAM
Douglas Christopher Morton, University of Maryland/NASA
Paulo Roberto de Souza Moutinho, SA-PI, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Daniel Curtis Nepstad, US-PI, WHRC
Rafael Silva Oliveira, University of California, Berkeley
Charles Merideth Peters, New York Botanical Garden
Flavia dos Santos Pinto, IPAM - Instituto de Pesquisa Ambiental da Amazonia
David Graham Ray, Woods Hole Research Center
Alexandre Barbosa Santos, UnB
Karen R. Schwalbe, The Woods Hole Research Center
Dulce Alves da Silva, Universidade de Brasilia
Luis Anibal Solorzano Cardenas, The Woods Hole Research CenterHRC
Leonel Sternberg, Co-Investigator, University of Miami
Corrina Dawn Steward, Yale University School of Forestry and Environmental Studies

Student Information:

Sergio Viana de Andrade, Universidade de Brasilia, Citizenship: BRAZIL, Ph.D. student

Javier Alberto Arce, Columbia University, Citizenship: USA, Ph.D. student, Thesis: Effects of Forest Fires on Community Forest Management.

Elizabeth Leslie Belk, University of Georgia, Citizenship: USA, Masters student, Thesis: The effect of experimental throughfall exclusion on soil nutrient flows in Amazonia.

Lace Medeiros Breyer, Universidade de Brasilia, Citizenship: BRAZIL, Ph.D. student, Thesis: A comparison of gas exchange among cerrado vegetation and the atomosphere using eddy correlation.

Gina Cardinot, IPAM - Seca Floresta, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Effects of experimental throughfall exclusion on tree water relations.

Oswaldo de Carvalho Jr, IPAM, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher, Thesis: Effects of understory fire and logging on forest biomass and large mammal populations in eastern Amazonia./ Impact of Forest Fire in Biomass Reduction

Wanja Janayna Miranda Lameira, Instituto de Pesquisa Ambiental da Amazônia - IPAM, Citizenship: BRAZIL, Bachelors student, Technician, Thesis: Geografia - Sensoriamento Remoto

Paul A. Lefebvre Jr., The Woods Hole Research Center, Citizenship: USA, Technician

Luciana Magalhaes Monaco, IPAM, Citizenship: BRAZIL, Masters student, Thesis: Effects of fire on regeneration of pioneer plant species in central Amazonia

Rafael Silva Oliveira, University of California, Berkeley, Citizenship: BRAZIL, Ph.D. student, Thesis: Drought-related strategies of different plant functional groups in contrasting water conditions in two Brazilian ecosystems.

Alexandre Jose Barbosa Santos, UnB, Citizenship: BRAZIL, Ph.D. student, Thesis: Effects of fire on surface carbon, energy and water vapour fluxes over campo sujo savanna in central Brazil

Dulce Alves da Silva, Universidade de Brasilia, Citizenship: BRAZIL, Ph.D. student, Thesis: The effect of CO2 concentration and water stress on the ecophysiology of wooody species of a Cerrado savanna

Luis Anibal Solorzano Cardenas, The Woods Hole Research CenterHRC, Citizenship: COLOMBIA, Postdoctoral Researcher

Corrina Dawn Steward, Yale University School of Forestry and Environmental Studies, Masters student, Thesis: Soybean Production and the Brazilian Amazon: Mapping the socio-economic and ecological factors of the soybean frontier

Proposed Research Sites:

Brasília
    Reserva Ecologica Aguas Emendadas
    Reserva Ecologica do Roncador IBGE

Pará Western (Santarém)
    km 67 Seca-Floresta Site

Proposed Training and Education:

Formal Training

    - It is planned that 9-10 undergraduate students and approximately eight Masters students will receive training. Faculty from VA Polytechnic Institute, Boston University, USP (University of So Paulo), IPAM, University of Brasilia and Federal University of Pará will have training responsibilities.

Beija-Flor Datasets: (as of 2003-06-16)

Bi-weekly estimates of canopy density measured with a spherical densiometer, rainfall exclusion experiment, Tapajós National Forest (LBA)

Bi-weekly estimates of coarse litter production (stems and twigs>1cm diameter), rainfall exclusion experiment, Tapajós National Forest (LBA)

Bi-weekly estimates of fine litter production (foliage and reproductive structures), rainfall exclusion experiment, Tapajós National Forest (LBA)

Daily precipitation estimates from two locations in close proximity to the study site, rainfall exclusion experiment, Tapajós National Forest (LBA)

Fine root (0-2mm diameter) biomass to 6-m depth, rainfall exclusion experiment, Tapajós National Forest (LBA)

Inventory and spatial location data for all stems >2 m tall, rainfall exclusion experiment, Tapajós National Forest (LBA)

Leaf Area Index measurements taken before and after treatment, rainfall exclusion experiment, Tapajós National Forest (LBA)

Mapeando a inflamabilidade florestal na Floresta Nacional do Tapajós (Poster)

Monthly estimates of stem increment for trees and lianas > 10 cm Dbh, rainfall exclusion experiment, Tapajós National Forest (LBA)

Monthly estimates of volumetric soil water at the soil surface (0-50cm) measured using time domain reflectometry, rainfall exclusion experiment, Tapajós National Forest (LBA)

Root phenology measured with rhizotrons to 2 meters depth, rainfall exclusion experiment, Tapajós National Forest (LBA)

Sap flow measurements from heated probes for stems in the control and treatment plots, rainfall exclusion experiment, Tapajós National Forest (LBA)

Specific leaf areas for 86 species in the control and treatment plots, rainfall exclusion experiment, Tapajós National Forest (LBA)

Surface root biomass, rainfall exclusion experiment, Tapajós National Forest (LBA)

Publications:

Potter C, Davidson EA, Nepstad D, de Carvalho CR. (2001) Ecosystem modeling and dynamic effects of deforestation on trace gas fluxes in Amazon tropical forests. *Forest Ecology and Management*, **152**, 97-117.

Nepstad D, Carvalho G, Barros AC, Alencar A, Capobianco JP, Bishop J, Moutinho P, Lefebvre P, Silva UL, Prins E. (2001) Road paving, fire regime feedbacks, and the future of Amazon forests. *Forest Ecology and Management*, **154**, 395-407.

Uhl C, Nepstad D. Amazonia at the millennium. Interciencia **25**, 159-164. 2000.

Asner GP. (2001) Cloud cover in Landsat Observations of the Brazilian Amazon. *International Journal of Remote Sensing*, **22**, 3855-3862.

Carvalho G, Barros AC, Moutinho P, Nepstad D. (2001) Sensitive development could protect Amazonia instead of destroying it. *Nature*, **409**, 131-131.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

LC-16 (Davidson / Klink) Investigation Profile

The Effects of Rainfall Exclusion on Canopy Phenology, Water Dynamics, Carbon, Nutrients, and Survival of Plants of the Cerrado Projeto Seca-Cerrado

Principal Investigators:

Eric A. Davidson, WHRC (US-PI)
Carlos Augusto Klink, University of Brasilia (SA-PI)

Abstract 1998:

In recent years severe droughts have become common in tropical regions and may become more frequent in the future. Recent images of large, extensive fires in the Amazonian and Cerrado regions remain fresh in our memories. Although characterized as a biome with vegetation that explores deep soil to obtain nutrients and water, the cerrado has suffered from land use change over a large geographic area which has brought changes in the structure and function of this ecosystem. Models that predict climate change show that substitution of native vegetation by monocultures of pasture plants can change precipitation patterns and the frequency dry periods in central Brazil. These climatic changes can alter the balance between woody plants with deep roots and herbaceous and grass species with shallow roots. The increase of global temperatures and a concomitant decrease in precipitation may increase the dominance of grasses to the detriment of deep-rooted woody vegetation in the cerrado. The cerrado vegetation has the capacity to extract water and nutrients from deep soil layers during the long dry season, which permits the foliage to continue to transpire. Recharge of soil water after a long drought is necessary for maintenance of the ecosystem. During periods of prolonged drought, such as the last El Nino event of 1997/1998, this recharge of soil water did not occur, resulting in pronounced hydrologic stress. The vertical distribution of carbon inputs by roots, and hence the stocks of soil carbon, could be substantially affected. In this research project, we propose to test these predictions in the cerrado by provoking an experimental reduction in rainfall in an area of natural cerrado in the Reserva Ecológica do IBGE (protected from fire for more than 20 years) using a constructed cover over the vegetation with a removable top. To understand the effects of rainfall exclusion on the structure and function of the vegetation, we are studying canopy phenology, growth and mortality of woody plants, production and quality of litter, nitrogen mineralization, microbial biomass, retranslocation of nutrients by woody species, production and distribution of roots, and soil respiration. These measurements will be correlated with measures of soil water, using the same methodology that we have used to study soil water in deep soil shafts. We will compare results from the experimental plot with an adjacent control plot.

Investigation Duration:

1998 - 2005

Participants:

Roberto Engel Aduan, Universidade de Brasilia
Eric A. Davidson, US-PI, WHRC
Eddie Lenza de Oliveira, UnB
Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia

Carlos Augusto Klink, SA-PI, University of Brasilia
Rafael Silva Oliveira, University of California, Berkeley
Liliane Bezerra Silva, Instituto de Pesquisa Ambiental da Amazônia

Student Information:

Roberto Engel Aduan, Universidade de Brasilia, Citizenship: BRAZIL, Ph.D. student, Thesis: Ciclagem de carbono em áreas nativas e pastagens no Cerrado Brasileiro

Eddie Lenza de Oliveira, UnB, Citizenship: BRAZIL, Ph.D. student, Thesis: The effects of rainfall exclusion on woody plant phenology of a Cerrado savanna.

Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher

Rafael Silva Oliveira, University of California, Berkeley, Citizenship: BRAZIL, Ph.D. student, Thesis: Drought-related strategies of different plant functional groups in contrasting water conditions in two Brazilian ecosystems.

Liliane Bezerra Passos da Silva, Instituto de Pesquisa Ambiental da Amazônia, Citizenship: BRAZIL, Technician, Thesis: Plant water availability and evapotranspiration in a natural Cerrado savanna and a planted pasture

Proposed Research Sites:

Brasília
Reserva Ecologica do Roncador IBGE

Proposed Training and Education:

Formal Training

- It is planned to continue providing support for technicians employed by IPAM. Two of them have moved to graduate degree programs and a third is now applying. New technicians are planned to be hired and will be encouraged to move on to further graduate training. Links with the Millenium Project through EMBRAPA/CPATU collaborators will offer opportunities to include students from UFPA and FCAP. Co-PI Figueiredo has lectured on classes at the UFPa program at Santarém regarding LBA science and has recruited students from this program to apply for CNq-LBA bolsas. This effort will continue to be developed in Phase II. Six bolsistas (probably Brazilian undergraduates) will receive individual mentoring and field experiences. It is also expected to provide research experience to some technicians.

Beija-Flor Datasets:

Currently none available.

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?

Trace Gas and Aerosol Flux:

- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?

LC-21 (Asner / Bustamante / Silva) Investigation Profile

Regional Effects of Selective Logging on Canopy Damage and Nutrient Dynamics in Amazonia: Linking Landsat ETM+ and Field Biogeochemical Studies

Principal Investigators:

Gregory Paul Asner, Carnegie Institution (US-PI)
Mercedes M.C. Bustamante, UnB (SA-PI)
Jose Natalino Macedo Silva, EMBRAPA AMAZONIA ORIENTAL (SA-PI)

Abstract 2003:

Selective logging is a dominant form of land use in the Brazilian Amazon. Several LBA studies are quantifying the effects of logging on carbon dynamics, including the role of fire as an agent of continued change following timber harvest. Despite ongoing efforts, surprisingly little is known about the extent, intensity or biogeochemical effects of logging in Amazon forests. At the scale of the entire Basin, the extent of logging is hotly contested, with current estimates ranging from 2,000-15,000 km2 yr-1. Even less is known about the intensity of logging, where intensity is defined here as canopy structural damage caused by the harvest operation. Moreover, there exists almost no information on changes in nutrient stocks and dynamics in selectively logged forests. The fate of nutrients could be central to determining rates of regrowth and the long-term sustainability of timber harvesting in Amazonia.

During the past two years, we have tested a method to quantify both the extent and intensity of selective logging using Landsat ETM+ data with a Monte Carlo spectral mixture model. The method produces coverages of fractional canopy, bare soil and surface necromass (slash) cover, along with statistical uncertainty maps for each cover fraction. The canopy fractional cover results have proven highly correlated with field-measured forest gap fraction, which in turn, is spatially correlated with the volume (and biomass) of wood removed from the forest and the coarse woody debris remaining in the harvest sites. This approach opens the door to regional-scale studies of logging extent and intensity as well as the resulting changes in carbon and nutrient stocks. Before considering the method viable for basin-wide logging studies, additional testing is needed across a wider range of forest structural types, logging regimes and in areas subjected to fire following harvest. Additional studies are also needed to determine the functional, quantitative linkages between satellite-observed changes in forest canopy cover and exposed surface slash, carbon stock changes in vegetation and soils, and nutrient cycling.

We propose to extend our remote sensing approach to a much larger region of the Amazon, and to further develop linkages between our satellite analyses and measured carbon and nutrient changes. The satellite studies will take place primarily in Para and Mato Grosso states, and will cover the period 1999-2004. We will use the fractional cover maps to direct field studies and continued canopy gap fraction validation efforts across a range of forest types. The field sites will include low- and high-damage logging blocks with and without fire, and additional areas containing forest structural variation under study by groups led by Dan Nepstad, Foster Brown, Emilio Moran, and other LBA collaborators. At a subset of sites within the imagery, we will quantify changes in vegetation and soil nitrogen, phosphorus, and base cation stocks. Using established logging chronosequences, we will measure changes in nutrient pools, mineralization rates and other key nutrient cycling processes to determine the short-term and the potential long-term effects of harvest on nutrient availability. We will use the canopy damage information derived from Landsat ETM+ to spatially integrate nutrient and carbon data, and to predict regional-scale changes in nutrient stocks and their partitioning in vegetation and soils. Our results will be compared to studies of intact forest underway by other LBA teams. We will also use the Landsat analyses of logging extent and intensity to assess linkages between logging practices and the spatial and temporal patterns of fire occurrence over large regions of the eastern Amazon. Fire occurrence data have been and will be provided by the Tropical Rainfall Mapping Mission (TRMM) satellite, and will be validated during our (and Nepstad's) proposed field studies.

The project will produce a set of tangible products to be freely shared by LBA investigators and Brazilian agencies such as EMBRAPA and INPE. These include: (1) regional maps of selective logging extent and canopy damage for

1999-2004; (2) nutrient stock and flux data partitioned by forest and soil types, and by landscape units such as logging decks, roads, skid trails, and tree-falls; (3) spatially integrated nutrient budgets showing how nutrients are altered by logging; and (4) regional maps of canopy damage from logging in relation to fire occurrence from field and TRMM satellite data. This project will have a strong educational component, including: (a) training a Brazilian and an American post-doc, including exchange between the co-PIs labs; (b) training students from the Universidade de Brasilia in remote sensing studies and field methods; (c) training of EMBRAPA personnel in the use and validation of the satellite results; and (d) outreach to Brazilian land managers interested in the use of satellite data for logging operations (technology transfer).

The project will directly address LBA questions LC-Q3, CD-Q3b, CD-Q3c, and ND-Q1. In doing so, we will contribute to answering the overall LBA question: "How do tropical forest conversion, re-growth and selective logging influence carbon storage, nutrient dynamics, trace gas fluxes, and the prospect for sustainable land use in Amazonia?"

Investigation Duration:

2003 - 2005

Participants:

Gregory Paul Asner, US-PI, Carnegie Institution
Mercedes M.C. Bustamante, SA-PI, UnB
Anna Quinn Hare
Albert Thomas Harris III, Carnegie Institution of Washington Department of Global Ecology
Jose Natalino Macedo Silva, SA-PI, EMBRAPA AMAZONIA ORIENTAL
Everaldo de Carvalho Conceicao Telles, Universidade de Brasília

Student Information:

Everaldo de Carvalho Conceicao Telles, Universidade de Brasília, Citizenship: BRAZIL, Postdoctoral Researcher, Thesis: Carbon and nutrients dynamics in tropical forest soils

Proposed Research Sites:

Mato Grosso
    Sinop

Pará Eastern (Belém)
    Fazenda Cauaxi
    Tailândia

Pará Western (Santarém)
    Belterra
    km 67 Primary Forest Tower Site
    km 67 Seca-Floresta Site
    km 83 Logged Forest Tower Site

Proposed Training and Education:

Educational Materials

- Educational training materials on remote sensing and biogeochemical research including documentation on the theories and methods in each subject area, figures and sample data sets will be produced and made available on line: http:/asnerlab.stanford.edu.

Formal Training

- It is planned to greatly increase T & E program in a variety of activities. Two post-doctoral trainees will be included (one Brazilian and one American). They will receive in-depth training in three areas: nutrients dynamics, remote sensing and biogeochemical modeling. They will work closely together and with the PI's in the field and they will exchange long visits in Asner's and Bustamante's laboratories.

Short Courses / Seminars / Workshops

- A one-week seminar, involving classroom and field training on remote sensing, will be developed by Asner and co-instructed by Bustamante and Post-Docs at UnB. The same seminar will be taught at the Federal University of Pará (UFPA) and at EMBRAPA in Belém. Topics covered will include. remote sensing theory, spaceborne instrumentation, analytical methods, and field measurements. Training materials developed for remote sensing and biogeochemical research, including theories and methods in each area, will be available for students and seminar participants.
- A one-week seminar on nutrients and measurements will be developed by two post-docs and taught at UnB. It will cover topics such as rock-derived nutrient stocks and fluxes in forest ecosystems, field and laboratory measurements, and techniques for constructing a nutrient budget at the ecosystem level.

Visits / Exchange Programs

- A short -term visit by two graduate students from UnB to Asner's lab will be provided. A visit by Asner's and his staff to Belém will be made to provide technology transfer to EMBRAPA personnel working on remote sensing and land-use issues. A visit by Asner's and his staff to Belém will be made to provide technology transfer to EMBRAPA personnel working on remote sensing and land-use issues. PI's will continue the on-going work on training on the use of GPS, forestry survey methods and canopy damage assessment instruments in collaboration with the Tropical Forest Foundation.

Beija-Flor Datasets:

Currently none available.

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

Land Cover and Land Use Change:

- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
- ND-Q2 - Are nutrients major factors that control the rates of regrowth and carbon accumulation in abandoned pastures and regrowing secondary forests?
- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?

LC-22 (DeFries / Shimabukuro) Investigation Profile

Integrating Coarse and Fine Resolution Satellite Data to Monitor Land Cover Change throughout Amazônia

Principal Investigators:

Ruth DeFries, University of Maryland (US-PI)
Yosio Edemir Shimabukuro, INPE (SA-PI)

Abstract 2003:

This proposal addresses a key need to accurately monitor land cover change at repeated intervals throughout Amazônia. Spatially-explicit data on land cover dynamics in response to land use change are essential to extrapolate process-level understanding of carbon, nutrient, and trace gas fluxes over the larger region. Currently, monitoring efforts to quantify land cover change based on analysis of Landsat data are time-consuming, laborious, and data-intensive. Estimates from different analyses often yield conflicting results, highlighting differences in land cover definitions and methodologies applied by various researchers.

We propose to collaborate with colleagues from the Brazilian National Institute for Space Research (INPE) to develop efficient, accurate, and repeatable methods for monitoring land cover dynamics throughout the region. The emphasis will be on integrating data from different sensors at multiple resolutions to apply methods that are as automated and practicable as possible. Specifically, we propose to:

1) develop and test a nested approach using coarse resolution (250-500m) MODIS data to identify locations undergoing land cover change and Landsat data for more detailed characterization and analysis of those identified locations. Very high resolution (1-4m) IKONOS data and *in situ* observations will be used to validate the results. Through a nested approach, we aim to reduce the amount of high resolution data requiring time consuming analysis without sacrificing wall-to-wall coverage of the entire region.

2) examine an alternative approach to describe land cover dynamics in terms of subpixel percentage tree cover to circumvent the definitional differences in terms such as "forest", "nonforest", "degraded forest", "deforestation", and "regrowth." Through such an approach, we aim to improve the ability to identify subpixel changes in tree cover and provide estimates of forest area and change that are consistent in space and time.

3) Establish collaborative relationships and exchanges of methods and data between INPE, the University of Maryland, and the LBA-ECO team.

4) Provide subsets of 250m and 500m MODIS data and improved estimates of land cover dynamics throughout the region to the LBA community through the University of Maryland Global Land Cover Facility (already linked to the LBA data distribution system).

Investigation Duration:

2003 - 2005

Participants:

Liana Oighenstein Anderson
Ruth DeFries, US-PI, University of Maryland
Matthew C. Hansen, University of Maryland
Ellen W. Jasinski, NASA/GSFC
Marcelo Lopes Latorre
Douglas Christopher Morton, University of Maryland/NASA
Yosio Edemir Shimabukuro, SA-PI, INPE

Student Information:

Ellen W. Jasinski, NASA/GSFC, Citizenship: USA, Masters student

Proposed Research Sites:

Amazon Basin (large-scale studies)

Mato Grosso
    Sinop

Pará Western (Santarém)

Altamira
km 77 Pasture Tower Site
km 83 Logged Forest Tower Site

Rondonia
Fazenda Nova Vida

Proposed Training and Education:

Formal Training

- A graduate program will be provided for a Brazilian graduate student at the University of Maryland and INPE.

Short Courses / Seminars / Workshops

- A workshop during the third year of Phase II is planned to be held at INPE. The objective is to discuss results and possibilities for implementation with a broader number of scientists.

Beija-Flor Datasets: (as of 2003-06-16)

MODIS 500m Vegetation Continuous Fields percent tree cover product

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?

LC-23 (Morisette / Schroeder / Pereira) Investigation Profile

Quantifying the Accuracy of MODIS Fire Products and Establishing Their Relationship with Land Cover Dynamics

Principal Investigators:

Jeffrey Thomas Morisette, NASA (US-PI)
Joao Antonio Raposo Pereira, MMA-IBAMA (SA-PI)
Wilfrid Schroeder, IBAMA (SA-PI)

Abstract 2003:

Why is it important to monitor fires in the Amazon? The role of fires in tropical ecosystems has been established (Goldammer, 1990). Throughout the 80s and early 90s, constantly increasing human forcing and climate anomalies made forest fires in the Amazon Basin a major environmental issue. Federal efforts have been directed at early detection and management of uncontrolled wildfires (Pereira et al., 1999) and fires play a role in the regional carbon cycle (Potter et al., 2001). However, not all fires are equal. Some fires result in a major *conversion* of the landscape. While in other locations, fires are necessary to *maintain* the landscape (Eva and

Lambin, 2000). As land management and carbon science efforts continue to expand, it will be important to "filter" fire maps to differentiate between conversion and maintenance fires. To develop such a filter, research is needed on the relationship between land cover and fire data. Due to the large extent of the LBA region and the current use of remote sensing for regional fire monitoring (Pereira et al., 1999), this research needs to be based on land cover and fire products derived from satellite data available throughout the region.

Existing work on fire and land cover maps indicates there is a relationship between fire occurrence and land cover dynamics, but the *form* of that relationship depends on the initial and subsequent land cover. However, there were areas for improvement in the data quality cited in that work (Eva and Lambin, 2000). To address these shortfalls we propose to investigate the relationship between land cover and fire maps within the context of validation of new MODIS fire products. This will allow us to leverage off existing equipment and infrastructure within the region and take advantage of the new capabilities offered by MODIS. With this, we focus on two separate, complementary, components:

1- Quantifying the uncertainly in satellite derived fire and burn scar products, concentrating primarily on new MODIS fire products and

2- Establish techniques to distinguish between fires that cause land-cover change and fires that maintain a state of equilibrium

The first component will provide validated products to quantify the extent and timing of burning in the Amazon. NASA has an interest in having its latest tools and data products utilized to the furthest extent possible. By teaming with the IBAMA, the Brazilian agency responsible for national fire monitoring, the proposed effort will help integrate new MODIS fire products into the region and help establish the use of these products into the operational fire monitoring and managemnent of IBAMA. The geolocation accuracy (~50m) and multiple overpasses (4 per day with Aqua and Terra) imply fire products from MODIS offer enhanced locational accuracy and the ability to capture diurnal characteristics. However, before these products are put into operational use, they will need to be validated in a rigorous way; where uncertainties in the product are quantified. The first component of our effort will meet this need.

The second component will address the management and carbon cycle question on the interaction between fire and land cover dynamics. Using the validated products from the first component, we will build on the integrative nature of the LBA program by coupling IBAMA's fire products with existing and forthcoming land cover maps developed by the LBA program. By coupling the best available regional fire products with the latest land cover maps the second component will determine fire's influence in answering the questions posed in the LBA solicitation.

▪····· How are global ecosystems changing? (V3)

▪····· What changes are occurring in global land cover and land use, and what are their causes? (F2)

▪····· What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity? (C2)

Overall scientific and technical expertise will be realized by the collaboration between IBAMA and the MODIS fire product team. IBAMA is responsible for operational fire monitoring in Brazil. To date IBAMA has used AVHRR and GOES data and is now interested in using MODIS data. The investigators on this proposal have extensive experience with MODIS data and the validation of MODIS products. We are also involved with international fire monitoring efforts that will help place this work within the context of the Global Observation of Forest Cover (GOFC) program and the Committee on Earth Observing Satellites (CEOS) Land Product Validation (LPV) subgroup.

The proposed plan includes unique and innovative methods by coupling coincident MODIS and ASTER data with airborne campaigns. The soundness, logic, and practicality of the proposed techniques have been demonstrated through pilot work in Southern Africa (Justice et al., in press) and existing research (Eva and Lambin, 2000). Leveraging off existing IBAMA, the MODIS-Fire team, GOFC, and CEOS creates a high likelihood of achieving the objectives. The proposal utilizes existing equipment, infrastructure, data sets, and analytical tools. The proposed work will integrate with the LBA program by providing validated fire and burn scar maps to the LBA team. We will look to existing and proposed work to provide high-resolution land cover products (namely, work of Skole et al, LBA team "LC-10"); which will augment the land cover maps available from MODIS.

The training and education component includes annual workshops in Brazil on the use of remote sensing for fire and burnt area monitoring and management. In addition, the proposal requests funding for in-region graduate student (or students).

Investigation Duration:

2003 - 2005

Participants:

Ivan Andras Csiszar, Co-Investigator, University of Maryland
Jeffrey Thomas Morisette, US-PI, NASA
Douglas Christopher Morton, Co-Investigator, University of Maryland/NASA
John Martin Owens, Co-Investigator
Joao Antonio Raposo Pereira, SA-PI, MMA-IBAMA
Wilfrid Schroeder, SA-PI, IBAMA

Student Information:

Currently none available.

Proposed Research Sites:

Acre
- Assis Brasil
- Cachoeira
- Epitaciolandia
- Humaita Forest Reserve

Pará Eastern (Belém)
- Carajás
- Marabá
- Santana do Araguaia

Roraima

Proposed Training and Education:

Formal Training

- At least one graduate student at INPE or Brazilian University or post-doc or recent Brazilian PhD/MS will be involved. The priority is to fund a graduate student (or students) at INPE or a Brazilian university (with some time at IBAMA) who will assist with fieldwork and attend meetings and/or spend sometime at GSFC.

Short Courses / Seminars / Workshops

- In order to help establish capacity within the region and promote wider use of the MODIS fire products, an annual workshop on the access and use of the satellite-derived fire products will be held adjacent to, or in conjunction with INPE's Brazilian Remote Sensing Symposium. It will be a 3-5 day workshop and will include: data access, overview of products, software tools and a mini-project to use the product.

Beija-Flor Datasets:

Currently none available.

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3d - What portion of the Amazônia–wide carbon flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?
- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?
- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?

LC-24 (Walker / Reis) Investigation Profile

A Basin-Scale Econometric Model for Projecting Future Amazonian Landscapes

Principal Investigators:

Eustáquio J Reis, IPEA/DIMAC (SA-PI)
Robert T. Walker, Michigan State University (US-PI)

Abstract 2003:

The proposed project seeks to develop a basin-scale econometric model for use in predicting land cover change scenarios in the Amazon basin. It will combine the region-scale of the GIS-based approach, with the behavioral rigor of the micro-level studies, in constructing a model that can predict land cover change over large areas with theoretical grounding, and empirical testing.

Three key issues will be addressed in the research in order to improve upon existing aggregate models for the Amazon. First, the model will not only incorporate economic theory for individual decisions, but also theory related to macro-level effects on land cover, as generated by state policies. Second, the model will account for spatial heterogeneity in the determinants of land use across the region by drawing on empirical research from multiple sites with contrasting settlement histories. And third, in both estimation of the effects of land-cover drivers and landscape projections, "endogenous" road construction following initial deforestation along major roads will be accounted for. These three innovations will allow an improved econometric model from which coefficients used in projections are based on observed historical deforestation in the basin. This empirical approach also facilitates the evaluation of confidence intervals for coefficients and comparison of model predictions with out-of-sample new data.

The proposed research thus addresses the LBA-ECO theme "land cover and land use change."

By focusing on construction of an econometric statistical model of deforestation for the entire Amazon basin, this analysis seeks to help answer the second-tier NASA research question (F2):

"What changes are occurring in the global land cover and land use, and what are their causes?"

It also seeks to address the related question (LC-Q1): "What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?" In addressing such questions, the proposed project will provide projections of land use, with error bounds, contributing to understanding of future land-use and vegetative-cover scenarios for the Amazon basin. That could also prove of value for second-tier issues such as (P5) regarding the "reliability of models predicting future atmospheric concentrations of carbon dioxide and methane." The research will involve key informant interviews at several field sites to address the issue of road endogeneity, satellite image interpretation to provide data for dependent variables that will be used in statistical modeling, and specification and estimation of an econometric model. In addition, an explicitly spatial model will be developed for implementation in the Santarém/Tapajos sub-region.

Investigation Duration:

2003 - 2005

Participants:

Eugenio Arima, Michigan State University
Claudio Belmonte de Athayde Bohrer, Universidade Fedral Fluminense
Marcellus Marques Caldas, Michigan State University
Carlos Moreira de Souza, IMAZON
Stephen G Perz, Co-Investigator, University of Florida
Alexander Pfaff, Co-Investigator, Columbia University
Jiaguo Qi, Co-Investigator, Michigan State University
Eustáquio J Reis, SA-PI, IPEA/DIMAC
Robert T. Walker, US-PI, Michigan State University

Student Information:

Eugenio Arima, Michigan State University, Citizenship: BRAZIL, Ph.D. student

Carlos Moreira de Souza, IMAZON, Citizenship: BRAZIL, Ph.D. student, Thesis: Biophysical and spatialtemporal characterization of degraded forests in the Brazilian Amazon through remote sensing

Proposed Research Sites:

Mato Grosso
    Sinop

Pará Western (Santarém)
    Altamira
    Uruará

Rondonia
    Ariquemes

Proposed Training and Education:

Educational Materials

- As part of the teaching module initiative, project members will also develop a web page tutorial for broad outreach. It will be made available for general distribution to secondary schools, or other venues of interest.

Formal Training

- The primary focus in education and training will be in the support of graduate education. Here, the proposed project will support graduate students at three US institutions, and will also provide valuable training to individuals associated with a Brazilian institution (IPEA). A significant educational aspect of this project relates to its integrative nature, which unites disciplines and technologies to construct a basin-wide projection model. Through involvement on the project, the students at all participating institutions will become conversant with issues in behavioral theory, geography, economics, sociology, spatial modeling, and remote sensing technologies. They will emerge from their programs of study with a powerful interdisciplinary imprint, from the perspective of the social sciences. Thus, they will be very well equipped to continue with research on environmental change in Brazil that, as in every other part of the world, is the outcome of complex social processes, at least in the short to mid-run.

Beija-Flor Datasets:

Currently none available.

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?

ND-01 (Roberts / Barreto / Soares) Investigation Profile

Land Cover Conversion in Amazonia, the Role of Environment and Substrate Composition in Modifying Soil Nutrient Cycling and Forest Regeneration

Principal Investigators:

Paulo Barreto, (SA-PI)
Dar A. Roberts, University of California (US-PI)
Joao Vianei Soares, INPE (SA-PI)

Abstract 2003:

We propose an integrated remote sensing and field-based examination of the causes and biogeochemical consequences of regional land-cover change within the Arc of Deforestation in the southern Amazon Basin. Research components include field observations, regional synthesis, and multiresolution studies, with a major focus on remote sensing. We will refine the standardized methods we developed during LBA-ECO Phase I for consistent mapping of regional land-cover conversion through time. The techniques will be expanded to include diverse environmental variation, and new methods will be developed to map forest degraded by logging, fire, and fragmentation. These remote sensing products will be combined with ancillary data sets and field measurements to evaluate the relative importance of environmental and human controls on patterns of land-cover change, and the consequences of land-cover change for vegetation growth and succession and for soil and stream biogeochemistry. Our previous research in Rondônia shows that variations in topography and rock type generate significant gradients in natural soil fertility and stream nutrient concentrations across the state. Roads and urban networks, superimposed on this natural variation, constrain or accelerate land-cover conversion and have important consequences for human impacts on stream biogeochemistry.

Our questions represent diverse academic disciplines, but all aim to combine remote sensing with field measurements to develop an integrated understanding of regional patterns in land-cover change and its biogeochemical consequences. In addition to producing a variety of remote sensing products to monitor land-cover change, we will address the following questions: How can remote sensing methods be combined with field measurements to better quantify changes in vegetation community structure due to selective logging, and how extensive are those changes? What are the topographic and geologic determinants of soil mineralogy and fertility across the state of Rondônia, and how does this natural variation in soil type constrain or promote land-cover conversion? Finally, how do vegetation conversion and the evolving human settlement system affect terrestrial and aquatic biogeochemistry and over what scales do these drivers operate?

Our research approach can be divided into three intersecting phases: 1) mapping and monitoring a suite of land-cover changes; 2) evaluation of the natural and human drivers of forest conversion; and 3) measurement of the impacts of those changes on forest structure in selectively logged areas and on soil and stream biogeochemistry in areas converted to pasture. The research will be conducted in the Brazilian states of Rondônia and Mato Grosso, which show significant intra- and interstate variations in deforestation rates, selective logging intensity, urban development, and environmental gradients. An important aspect of the project is a dedication to exchange research methods and techniques in the LBA/Amazon research community, most intensively among Imazon, INPE, and UCSB. Institutional exchanges will provide an opportunity for intensive training, data sharing and research collaboration among U.S. and Brazilian participants.

Investigation Duration:

1998 - 2005

Participants:

Paulo Barreto, SA-PI
Trent W Biggs, University of California, Santa Barbara

Oliver A. Chadwick, Co-Investigator, University of California
Carlos Moreira de Souza, IMAZON
Karen W. Holmes, University of California
Andre L. Monteiro, IMAZON
Izaya Numata, University of California
Rebecca Lynn Powell, University of California, Santa Barbara
Dar A. Roberts, US-PI, University of California
Joao Vianei Soares, SA-PI, INPE

Student Information:

Trent W Biggs, University of California, Santa Barbara, Citizenship: USA, Ph.D. student, Thesis: The regional biogeochemistry of land use change in the Brazilian Amazon

Carlos Moreira de Souza, IMAZON, Citizenship: BRAZIL, Ph.D. student, Thesis: Biophysical and spatialtemporal characterization of degraded forests in the Brazilian Amazon through remote sensing

Karen W. Holmes, University of California, Citizenship: USA, Ph.D. student, Thesis: Controls on field-to-regional scale soil variability in the tropics

Izaya Numata, University of California, Citizenship: JAPAN, Ph.D. student

Rebecca Lynn Powell, University of California, Santa Barbara, Citizenship: USA, Ph.D. student, Thesis: Long-term Monitoring of Urbanization in the Brazilian Amazon Using Remote Sensing

Proposed Research Sites:

Mato Grosso
    Sinop

Pará Eastern (Belém)
    Paragominas

Pará Western (Santarém)
    Santarém-Cuiabá Road

Rondonia
    Ariquemes
    Fazenda Nossa Senhora
    Fazenda Nova Vida
    Ouro Preto do Oeste

Proposed Training and Education:

Educational Materials

- A tutorial of advanced remote sensing course will be developed in cooperation with Imazon. This tutorial will be considered of public domain and will be available to all LBA community. From the Airborne mission in 2003, which will provide AVIRIS spectra at 4 meter resolution, a spectral library will be developed for Brazil.

Formal Training

- Five PhD students will be supported and enrolled at UCSB, including two Brazilian students, from IMAZON, who entered the PhD Program at UCSB.

Short Courses / Seminars / Workshops

- A workshop on Hyperspectral Remote Sensing is planned to be organized at INPE.

Visits / Exchange Programs

- Two Brazilian researchers will visit UCSB for a six-month training in image processing techniques designed to provide reflectance retrievals, spectral mixture analysis with reference end member selection, land-cover mapping and decision tree classifiers.

Beija-Flor Datasets: (as of 2003-06-16)

Ariquemes Age Since Cut: 1975-2000

Ariquemes Classified: 1975-1999

Ariquemes Registered MSS: 1975

Ariquemes Registered TM: 1984-2000

Ariquemes Spectral Mixture Models: 1984-2000

Controls on soil pH distribution in Rondonia, Brazil (Poster)

Jiparana age since cut: 1978-2000

Jiparana classified: 1978-1999

JiParana Registered MSS: 1978

JiParana Registered TM: 1986-1999

Jiparana Spectral Mixture Models, 1986-1999.

Luiza Classified Map: 1986-1999

Luiza primary forest reclassified to non-forest class: age since cut map

Luiza Registered TM: 1986-1999

Luiza Spectral Mixture Models: 1986-1999

Portovelho Registered TM: 1986-2000

Probability of deforestation predicted using geographic variables (Poster)

Rondonia stream chemistry

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?

- LC-Q2 - At what rate are converted lands abandoned to secondary forests; what is the fate of these converted lands, and what are the overall dynamic patterns of land conversion and abandonment?
- LC-Q3 - What is the area of forest that is affected by selective logging each year? How does the intensity of selective logging influence forest ecosystem function, thus altering forest regrowth and flammability?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
- ND-Q2 - Are nutrients major factors that control the rates of regrowth and carbon accumulation in abandoned pastures and regrowing secondary forests?
- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?
- ND-Q4b - Are there unique signatures that can be traced downstream?

ND-02 (Davidson / Carvalho / Sa / Vieira / Moutinho / Figueiredo) Investigation Profile

Dynamics of Biogeochemical Cycles in Secondary Vegetation of Amazonia

Principal Investigators:

Claudio Jose Reis de Carvalho, EMBRAPA/CPATU (SA-PI)
Eric A. Davidson, WHRC (US-PI)
Ricardo de Oliveira Figueiredo, Embrapa Amazônia Oriental (SA-PI)
Paulo Roberto de Souza Moutinho, IPAM - Instituto de Pesquisa Ambiental da Amazonia (SA-PI)
Tatiana Deane De Abreu Sa, EMBRAPA/CPATU (SA-PI)
Ima Celia G. Vieira, Museu Paraense Emilio Goeldi (SA-PI)

Abstract 2003:

Most deforested land in the Amazon Basin has passed through stages of secondary forest succession following agricultural abandonment. Nutrients lost through logging, fire, and runoff have immediate effects on air and water quality, and then have longer lasting effects on plant productivity and stream quality during ecosystem recovery. Inadequate understanding of nutrient cycles during tropical forest secondary succession, however, precludes confidence in predictions of spatial and temporal variation of carbon sequestration, trace gas production, and nutrient losses to stream water and ground water in the secondary vegetation of the Amazon Basin. Hence, this proposal is motivated by three questions concerning secondary vegetation:

1. Do nutrients limit rates of forest regrowth in deforested lands of Amazonia?

We propose to continue addressing this question experimentally in a long-term, replicated, and controlled forest fertilization study in eastern Pará. In addition, a forest chronosequence study that we completed on sandy soils will be repeated in a nearby area dominated by clayey soils, thus providing estimates of rates of recuperation of biogeochemical cycles during succession. These results will be integrated into a modeling framework designed to be generally applicable to the successional dynamics of aboveground and belowground pools of plant-available nutrients that affect C sequestration and trace gas emissions in disturbed Amazonian forest ecosystems.

2. How well can stages of secondary forest succession be detected in satellite imagery?

Confidence in spatial extrapolation of C and nutrient stocks and fluxes in secondary forests depend largely on identification of these ecosystems in remotely sensed imagery. Three or four stages of forest succession usually can be distinguished in Landsat imagery, but the stand ages represented by each stage vary by region, soil type,

and land use history. Advanced regeneration can require 30-70 years, depending on these factors. Rather than forest age, we propose that stages of succession (early, intermediate, advanced, and mature) identified from stand characteristics and spectral properties will offer the most regionally consistent approach for characterizing successional processes and attendant changes in biomass and trace gas fluxes. We will evaluate the feasibility and accuracy of supervised classification at several scales by nesting ground-based measurements within high-resolution IKONOS images of our study sites, which will then be nested within Landsat imagery, which will finally be nested within MODIS imagery. In addition, we will collaborate with studies of AVIRIS to estimate canopy N and LVIS to estimate stand height and structure to aid identification of successional forest stages.

3. How does land-use affect the exchange of nutrients between terrestrial and aquatic habitats?

Forest cutting and subsequent regeneration alter both the hydrology and biogeochemistry of the landscape. In both mature forests and altered landscapes the source of many elements to stream waters is not well understood because links between stream chemistry and upland nutrient status are unclear and because riparian zone and in-stream processes are also important. We propose to measure changes in stream chemistry along three first-order streams from their headwaters in remnant mature forests, through pastures, secondary forests, and large fertilized fields of rice and corn in a region of highly weathered deep Oxisols of the eastern Amazon Basin. Soils and groundwater in riparian zones will be studied in each land use. Collaborations with studies in other regions will provide an opportunity to address interactions among soil substrates and land-use patterns as they affect stream chemistry across the basin.

Investigation Duration:

1998 - 2005

Participants:

Arlete Silva de Almeida, Museu Paraense Emilio Goeldi
Claudio Jose Reis de Carvalho, SA-PI, EMBRAPA/CPATU
Ewerton da Silva Cunha
Wanderley Rocha da Silva, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Luciana Pimentel da Silva, IPAM
Eric A. Davidson, US-PI, WHRC
Ricardo de Oliveira Figueiredo, SA-PI, Embrapa Amazônia Oriental
Georgia Silva Freire, EMBRAPA
Liane S. Guild, NASA Ames Research Center
Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Wendy Kingerlee, The Woods Hole Research Center
Eliane Constantinov Leal
Letícia Campos Lopes
Daniel Markewitz, University of Georgia
Paulo Roberto de Souza Moutinho, SA-PI, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Karina de Fatima Rodrigues Pantoja, Museu Paraense Emilio Goeldi
Tatiana Deane De Abreu Sa, SA-PI, EMBRAPA/CPATU
Renata Tuma Saba, CNPQ
Cleber Ibraim Salimon, CENA/USP
Elisana Batista Santos
Maria Tereza Primo dos Santos, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Luis Anibal Solorzano Cardenas, The Woods Hole Research CenterHRC
Thomas A. Stone, Co-Investigator, WHRC
Ima Celia G. Vieira, SA-PI, Museu Paraense Emilio Goeldi

Student Information:

Arlete Silva de Almeida, Museu Paraense Emilio Goeldi, Citizenship: BRAZIL, Bachelors student

Luciana Pimentel da Silva, IPAM, Citizenship: BRAZIL, Bachelors student

Georgia Silva Freire, EMBRAPA, Citizenship: BRAZIL, Masters student

Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher

Eliane Constantinov Leal

Karina de Fatima Rodrigues Pantoja, Museu Paraense Emilio Goeldi, Citizenship: BRAZIL, Masters student

Renata Tuma Saba, CNPQ, Citizenship: BRAZIL, Ph.D. student

Cleber Salimon, CENA/USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Carbon dioxide soil fluxes due to differing land uses in eastern Acre

Luis Anibal Solorzano Cardenas, The Woods Hole Research CenterHRC, Citizenship: COLOMBIA, Postdoctoral Researcher

Proposed Research Sites:

Pará Eastern (Belém)
- Capitao Poco
- Igarapé Açu
- Paragominas
- Paragominas
- Sao Francisco do Para

Pará Western (Santarém)
- km 67 Seca-Floresta Site

Proposed Training and Education:

Formal Training

- The objective of this project is to provide meaningful research experiences for young Brazilian scientists and students, from undergraduate to post-doctoral levels. Training will focus on hands-on experience in all phases of research, from idea development, to field and laboratory work, to writing of manuscripts for publication. It is planned to continue providing support for technicians employed by IPAM. Two of them have moved to graduate degree programs and a third is now applying. New technicians are planned to be hired and will be encouraged to move on to further graduate training. Links with the Millenium Project through EMBRAPA-CPATU collaborators will offer opportunities to include students from UFPA and FCAP. Co-PI Figueiredo has lectured on classes at the UFPa program at Santarém regarding LBA science and has recruited students from this program to apply for CNq-LBA bolsas. This effort will continue to be developed in Phase II. Six Brazilian undergraduate students from FCAP in Belém and Federal University of Pará/EMBRAPA will receive individual mentoring and field experiences.

Visits / Exchange Programs

- Technicians, students and bolsistas will continue to be invited for exchange programs under a cooperative agreement enacted between the University of Georgia and FCAP.A 6-8 week training program at Woods Hole will be provided for technicians, students, and bolsistas. Undergraduate exchanges are planned between UGa in the U.S. and FCAP in Belém.

Beija-Flor Datasets: (as of 2003-06-16)

Autotrophic X Heterotrophic respiration in pastures in Western Amazonia, Acre-Brazil (Poster)

Biogeochemical cycles in a secondary forest, Igarape Acu, eastern Para, Brazil

Biogeochemical Cycles in a secondary forest, Paragominas, eastern Para, Brazil

Biogeochemical cycles of a primary forest, FLONA-Tapajós, western Pará, Brazil

CO2 flux from soils in forests and pastures in western Amazonia

Emissions of trace gases from enriched fallows of northeast Para - Brazil (Poster)

Landscape Dynamics In Areas Of Slash And Burn Agriculture In Eastern Amazonia Based On Multi-Temporal Analysis Of Landsat Data (Poster)

Mechanisms of conservation and cycling of N and P in a chronosequence of secondary vegetation in Eastern Amazonia (Poster)

Nutrient Manipulation Experiment in a Secondary Forest of Eastern Amazonia (Poster)

Paragominas secondary forest tree heights and diameters

The Effects of Rainfall Exclusion on Biogeochemical Cycles in Tapajos National Forest, Eastern Amazonia (Poster)

Throughfall exclusion in a moist tropical forest: Impacts on solution nutrient fluxes (Poster)

Publications:

Davidson EA, Verchot LV, Cattanio JH, Ackerman IL, Carvalho JEM. (2000) Effects of soil water content on soil respiration in forests and cattle pastures of eastern Amazonia. *Biogeochemistry*, **48**, 53-69.

Verchot LV, Davidson EA, Cattanio JH, Ackerman IL. (2000) Land-use change and biogeochemical controls of methane fluxes in soils of eastern Amazonia. *Ecosystems*, **3**, 41-56.

Potter C, Davidson EA, Nepstad D, de Carvalho CR. (2001) Ecosystem modeling and dynamic effects of deforestation on trace gas fluxes in Amazon tropical forests. *Forest Ecology and Management*, **152**, 97-117.

Verchot LV, Davidson EA, Cattanio JH, Ackerman IL, Erickson HE, Keller M. (1999) Land use change and biogeochemical controls of nitrogen oxide emissions from soils in eastern Amazonia. *Global Biogeochemical Cycles*, **13**, 31-46.

Perez T, Trumbore SE, Tyler SC, Davidson EA, Keller M, de Camargo PB. (2000) Isotopic variability of N2O emissions from tropical forest soils. *Global Biogeochemical Cycles*, **14**, 525-535.

de Camargo PB, Trumbore SE, Martinelli LA, Davidson EA, Nepstad DC, Victoria RL. (1999) Soil carbon dynamics in regrowing forest of eastern Amazonia. *Global Change Biology*, **5**, 693-702.

Markewitz D, Davidson EA, Figueiredo RDO, Victoria RL, Krusche AV. (2001) Control of cation concentrations in stream waters by surface soil processes in an Amazonian watershed. *Nature*, **410**, 802-805.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q2 - How do biological processes such as mortality and recruitment or succession following land use change influence the net annual carbon balance for different land cover and land use types?
- CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
- ND-Q2 - Are nutrients major factors that control the rates of regrowth and carbon accumulation in abandoned pastures and regrowing secondary forests?
- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?
- ND-Q4c - To what extent do intact riparian zones buffer streams against changes due to anthropogenic activities in surrounding uplands?

- ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?

ND-03 (Deegan / Victoria / Krusche / Ballester) Investigation Profile

Key Connections in Amazonian Stream Corridors

Principal Investigators:

Maria Victoria Ramos Ballester, CENA/USP (SA-PI)
Linda A. Deegan, Marine Biological Laboratory (US-PI)
Alex V. Krusche, CENA-USP (SA-PI)
Reynaldo Luiz Victoria, CENA/USP (SA-PI)

Abstract 2003:

Deforestation in the Amazon has the potential to alter the biogeochemistry of carbon and major nutrients over large regions and to alter the movements of these materials among adjoining ecosystems. Small streams dominate the total length of stream channels in the landscape. They receive material from adjacent uplands and contribute material to larger rivers. Because of their position, small streams and their associated riparian zones thus play a key role in the landscape as links and regulators of material fluxes between terrestrial ecosystems and larger rivers of the Amazon Basin.

Our goal is to develop an understanding of how C and nutrients are transformed as water moves from uplands through small streams to larger rivers in forested and deforested landscapes of the Amazon. We will do this by: 1) focusing on carbon and nutrient transformations in riparian zones and small stream channels--key points in the landscape where these transformations are potentially of major importance but very poorly known in tropical landscapes; 2) comparing these transformations in drainage basins with forest and pasture land use and in streams of different sizes, and; 3) coupling our process level work with information on land use and riparian zone structure derived from remote sensing and models of stream channel processing to predict transfers of organic matter and nutrients to larger rivers in stream networks. The work will be focused in central Rondônia.

In riparian zones, we will determine the spatial variability of water entering and leaving the riparian zones of forest and pasture streams of different sizes using surveys of ground water characteristics. We will use 15N, nutrient and conservative tracer additions to identify key processes and rates of transformation in the groundwater of forest and pasture riparian zones.

In stream channels, we will use 15N tracer additions in forest and pasture streams to determine key processes and rates of transformation, and production and consumption of dissolved organic carbon and dissolved inorganic carbon. We will use the isotopes of 13C in dissolved organic carbon and dissolved inorganic carbon and different particulate and dissolved constituents to trace the sources of C to streams. We will extend this work to a regional basis with surveys of nutrients and organic matter in 2-5th order streams in forest and pasture land use on different soil types within the region.

At the regional scale, satellite images will be used to classify areas to land use type, riparian zone type and extent and length of stream channels of different stream orders in forest and pasture. A multi-compartment stream biogeochemistry model will be used to predict the transformations of C and N and their downstream transport in streams of different sizes and land uses. We will integrate watershed land use area and stream channel length in different land use types to estimate regional impacts of land use change on biogeochemical cycles in small streams and transport from small streams to larger rivers.

This project will bring together studies of land and water biogeochemistry and link them together with an understanding of changes in processes that occur in key points in the landscape. It will provide new information on how these processes change when forest is replaced by pasture and it will put this information in a framework to predict the effects of forest-to-pasture conversion on stream water quality and C and nutrient transport to larger rivers.

Investigation Duration:

1998 - 2005

Participants:

Maria Victoria Ramos Ballester, SA-PI, CENA/USP
Marcos Alexandre Bolson, UNIR-JP
Nilton Bonelle
Adriana Bonilla
Luiz Fernando Charbel, CENA-USP
Linda A. Deegan, US-PI, Marine Biological Laboratory
Helmut Elsenbeer, University of Potsdam, Institute of Geoecology
Alaide Fonseca Gessner, Co-Investigator, USP- São Carlos.
Sergio Candido de Gouveia Neto, UNIR - JP
Christie Lynn Haupert, Marine Biological Laboratory
Juan Carlos Huamani, SENAMHI - Regional Direction of San Martin
Alex V. Krusche, SA-PI, CENA-USP
Samantha Morris Lampert
Luiz Antonio Martinelli, Co-Investigator, CENA/USP
Rodrigo Menuzzo, CENA-USP
Jorge Marcos de Moraes, CENA-University of Sao Paulo
Christopher Neill, Co-Investigator, Marine Biological Laboratory
Ana Christina Belarmino de Oliveira
Jean Pierre H.B. Ometto, Co-Investigator, University of Utah
Kathia Sonoda, CENA-USP
Suzanne Michelle Thomas, Co-Investigator, Marine Biological Laboratory
Daniel de Castro Victoria, CENA-USP
Reynaldo Luiz Victoria, SA-PI, CENA/USP

Student Information:

Maria Victoria Ramos Ballester, CENA/USP, Citizenship: ARGENTINA, Postdoctoral Researcher, Thesis: From patterns to process: land use and land cover changes and its effects on the biogeochemistry of surface waters of tropical rivers in western Amazonia (Ji-Parana, Rondonia)

Marcos Alexandre Bolson, UNIR-JP, Citizenship: BRAZIL, Bachelors student, Technician, Thesis: Carbon dynamics in two rivers of Rondonia with different land use/cover

Nilton Bonelle, Ph.D. student

Luiz Fernando Charbel, CENA-USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Change in of carbon dinamic as function of land use change, in two small catchments at Fazenda Nova Vida-Rondonia

Sérgio Candido de Gouveia Neto, UNIR - JP, Citizenship: BRAZIL, Bachelors student, Technician, Thesis: Temporal variability of the water quality of two rivers of Rondonia with different land use/cover

Alex V. Krusche, CENA-USP, Citizenship: BRAZIL, Postdoctoral Researcher

Rodrigo Menuzzo, CENA-USP, Citizenship: BRAZIL, Bachelors student

Ana Christina Belarmino de Oliveira, Citizenship: BRAZIL, Ph.D. student

Jean Pierre H.B. Ometto, University of Utah, Citizenship: BRAZIL, Postdoctoral Researcher

Kathia Sonoda, CENA-USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Stream insect biodiversity in Sao Paulo State

Daniel de Castro Victoria, CENA-USP, Citizenship: BRAZIL, Bachelors student, Thesis: Using GIS and the Thornthwaite hydric balance to estimate the potential evapotranspiration in the Ji-Parana river basin (RO)

Proposed Research Sites:

Rondonia
- Ariquemes
- Fazenda Nova Vida
- Ouro Preto do Oeste
- Rancho Grande
- Urupa River

Proposed Training and Education:

Formal Training

- Training and education will include post-doctoral training (2 post-docs), graduate (4 students) and undergraduate students (at least 2). This project will contribute to the development of Brazilian scientists by training a combination of post-docs and students at CENA and at two universities in Rondônia, Universidade Federal de Rondônia (UNIR- Ji-Paraná) and the Universidade Luterana do Brasil – Ji-Paraná (ULBRA). Our present LBA award supports a core group of two post-doctoral scholars and one Ph.D. student at CENA in Piracicaba, São Paulo. In the next phase, we plan to mentor two post-doctoral scholars: one will be Brazilian with a PhD from a Brazilian university and one will be from the US. These two post-docs will have leadership roles in the 15N additions in the field and are expected to spend up to 6 months per year in Rondônia. Our hope is that by pairing two post-docs at similar stages in their careers in unified field experiments, they will develop a working relationship that will continue beyond LBA. Dr. Gessner (USP- São Carlos) will continue to participate in the 15N additions to streams under funding from FAPESP. Because of collaborations developed during the first phase of LBA, we are now in a position to shift our emphasis towards students resident in Rondônia. Our presentation at a workshop in Ji-Parana, entitled, "Seminário UNIR/LBA, Perspectiva de Cooperação Científica em Rondônia," stimulated much interest among students and faculty from the Federal University of Rondônia - Ji-Paraná and the Lutheran University of Rondônia in our project. We have identified a student who will develop a thesis project related to in-stream processing and identification of sources of DOC and DI13C. We also intend to include MS or Ph D graduate students from CENA. We will encourage students to participate in experiment planning, fieldwork, sample and data analysis and writing papers for journal publication.

Short Courses / Seminars / Workshops

- A two-week short course for graduate students will be offered at USP-CENA on "Stable Isotope Tracer Additions to Ecosystems". Lectures will be given by Drs. Linda Deegan, Christopher Neill, Reynaldo Victoria and Luiz Antonio Martinelli.
- Curso de 2 semanas no CENA com foco em "15 N Additions" e uso de LINX em estudos de modelagem.

Visits / Exchange Programs

- Brazilian students and post-docs are planned to travel to the US (MBL) each year for a 3-month trip for education and training on analytical techniques relevant to biogeochemistry, plant ecology, soils, environmental chemistry, animal ecology, marine biology, and oceanography. Students will also have access to other researchers communities such as the Woods Hole Oceanographic Institution, Boston University Program and the United States Geological Survey.

Beija-Flor Datasets: (as of 2003-06-16)

Effects of land use changes in stream DOC dynamics in southern Amazon (Fazenda Nova Vida, Rondonia) (Poster)

Fazenda Nova Vida Streamwater Chemistry Dataset

Fazenda Nova Vida Streamwater Temperatures

How does Deforestation Affect Small Stream Chemistry? (Poster)

Land use change alters the biogeochemistry and downstream movement of nitrogen in small drainage basins (Poster)

Links between soil biogeochemistry and water chemistry following deforestation for pasture in small watersheds in Rondônia (POSTER)

Nova Vida, RO Lysimeter Data

Publications:

Neill C, Deegan LA, Thomas SM, Cerri CC. (2001) Deforestation for pasture alters nitrogen and phosphorus in small Amazonian Streams. *Ecological Applications*, **11**, 1817-1828.

Science Questions Addressed by this Investigation:

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?
- ND-Q4b - Are there unique signatures that can be traced downstream?
- ND-Q4c - To what extent do intact riparian zones buffer streams against changes due to anthropogenic activities in surrounding uplands?
- ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

ND-07 (Zepp / Bustamante) Investigation Profile

Effects of Land Use Changes on the Functioning of Soils and Watersheds of Central Brazil Savannas: Impacts on Nutrient and Carbon Cycles and Trace Gas Exchange

Principal Investigators:

Mercedes M.C. Bustamante, UnB (SA-PI)
Richard G. Zepp, US EPA (US-PI)

Abstract 2003:

We propose to assess the effects of land use on: 1) the stocks and cycling rates of carbon and nutrient cycling and related ancillary data (microbial biomass; soil temperature, soil moisture, etc.); 2) soil-atmosphere fluxes of trace carbon and nitrogen gases (CO2, CH4, CO, N2O, and NO); and 3) the composition and quantity of nutrients and organic matter entering small streams via gallery forests.

We will quantify rates of carbon and nutrient cycling and characterize soil organic matter (SOM) and litter quality at both native and converted sites. We plan to study the influence of fertilization and management practices (tillage, no-tillage, cover crops, irrigation) on the carbon balance in pastures and cropland. These experiments will include measurements of soil-atmosphere fluxes of trace carbon and nitrogen gases (CO2, CH4, CO, N2O, NO), different SOM fractions, litter quality, N cycling, and P fractions. To provide data and relationships needed for regional trace gas and nutrient dynamics models we will measure relevant ancillary data, including changes in soil temperature, moisture, incident solar radiation, and the size and diversity of the soil microbial community. To assess land use changes on gallery forests and aquatic systems, streams that drain watersheds dominated by natural vegetation, agriculture, and urban lands, will be selected. Chemical analyses of water collected from surface runoff collectors, soil lysimeters, and groundwater piezometer located within the gallery forest, and directly from the stream, will be used to evaluate nutrient cycling within the forest buffers and the stream. The

goal will be to develop predictive models that relate the landscape metrics, determined by analysis of spatial land cover databases, to the various chemical and physical parameters.

Research Team Responsibilities

●Roger Burke – Watershed runoff; stream nutrient chemistry; gas fluxes

●Mercedes Bustamante – Soil-air trace gas fluxes; nutrient pools and fluxes

●Alexandre Nunes Cardoso –soil carbon pools and fluxes; SOM fractionation

●Daniel Markewitz – watershed runoff; stream nutrient chemistry

●Marirosa Molina – Nutrient pools and fluxes; microbial biomass/diversity

●Alexandre Rosado – Nutrient pools and fluxes; microbial biomass/diversity

●Richard Zepp – Soil-air trace gas fluxes; litter quality & decomposition

Research sites

Our native study sites will continue to include native cerrado stricto sensu and campo sujo and will expand to include gallery forests. Added converted Cerrado sites will include croplands and recently converted pastures. Sites include the research and ecological reserve operated by the Instituto Brasileiro de Geografia e Estatística (IBGE) (http://www.recor.ibge.br/) and located 35 km south of Brasília D.F (15o 56' S, 47o 51' W) and pasture sites located at the Fazenda Rio de Janeiro (15° 14' S, 47° 42' W) northwest of Brasilia.

● Soil trace gas exchange and related ancillary data (ambient and soil temperatures, gravimetric and volumetric soil water content, solar irradiance, microbial biomass) for the same sites and frequency included in nutrient research

● SOM and litter characterization at the six sites

● Nutrient pools/flux characterization and microbial biomass for six sites (six chambers per site), two native cerrado, two crop sites, two pasture sites with 2 intense data sets (4 measurement sets on weekly basis) per year and monthly measurements in intervening months.

● Stream chemistry from a single location in six watersheds and along two transects of samplers moving from the stream to three different adjacent land use classes

Investigation Duration:

1998 - 2005

Participants:

Flávia Aparecida de Alcântara, Universidade de Brasília
Joana Dias Bresolin, University of Brasília - UnB
Roger A. Burke, Co-Investigator, US Environmental Protection Agency
Mercedes M.C. Bustamante, SA-PI, UnB
Alexandre Cardoso, Co-Investigator
Cesar Coelho, União Pioneira de Integração Social - Brasília
Diana Cecilia Garcia-Montiel, WHRC
Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia
Keith Kisselle, Co-Investigator, Austin College
Daniel Markewitz, Co-Investigator, University of Georgia
Marirosa Molina, Co-Investigator, US EPA
Alexandre de Siqueira Pinto, University of Brasilia - UnB
Alexandre Rosado, Co-Investigator
Maria Regina Satori da Silva, University of Brasilia-UnB
Lucilia Parron Vargas, University of Brasilia - UnB
Richard G. Zepp, US-PI, US EPA

Student Information:

Flávia Aparecida de Alcântara, Universidade de Brasília, Citizenship: BRAZIL, Postdoctoral Researcher

Joana Dias Bresolin, University of Brasília - UnB, Citizenship: BRAZIL, Bachelors student

Cesar Coelho, União Pioneira de Integração Social - Brasília, Citizenship: BRAZIL, Bachelors student

Francoise Yoko Ishida, IPAM - Instituto de Pesquisa Ambiental da Amazonia, Citizenship: BRAZIL, Ph.D. student, Postdoctoral Researcher

Alexandre de Siqueira Pinto, University of Brasilia - UnB, Citizenship: BRAZIL, Ph.D. student, Thesis: Contribution of the Cerrado to emissions of N2O, NO, CO and CO2 B effects of seasonality and burning.

Lucilia Parron Vargas, University of Brasilia - UnB, Citizenship: BRAZIL, Ph.D. student, Thesis: Biogeochemical cycling in the Pitoco gallery forest, Brasília-DF.

Proposed Research Sites:

Brasília
- EMBRAPA Cerrados Pasture
- Fazenda Dom Bosco
- Fazenda Rio de Janeiro
- Reserva Ecologica do Roncador IBGE

Proposed Training and Education:

Educational Materials

- Educational materials in Portuguese based on short-term courses taught by this team will be developed and made available.

Formal Training

- Students will receive training through multi-disciplinary activities on ecological research in different scales. Three Post-docs, one Master Student, one Research Assistant and at least two undergraduate students will be trained. The performance of students involved will be evaluated periodically by the group through seminars and technical reports. Presentation of results by the students in scientific meeting will be encouraged.

Short Courses / Seminars / Workshops

- Cursos sobre estudos ecológicos, com foco na dinâmica de nutrientes.
- Undergraduate and graduate students will be trained through seminars, short courses and practices in the laboratories of the Department of Ecology in the University of Brasilia. Performance of the students will be evaluated periodically through seminars and technical reports. Participation of students in scientific meetings will be encouraged.

Beija-Flor Datasets: (as of 2003-06-16)

Impacts of Land Use Change on Soil Biogeochemistry and Trace Gas Exchange in Brazilian Savannas

Soil emissions of trace gases in Brazilian Cerrado, Brasilia-DF (Poster)

Publications:

Asner GP, Townsend AR, Bustamante MMC. (1999) Spectrometry of pasture condition and biogeochemistry in the Central Amazon. *Geophysical Research Letters*, **26**, 2769-2772.

Kisselle KW, Zepp RG, Burke RA, Pinto AD, Bustamante MMC, Opsahl S, Varella RF, Viana LT. (2002) Seasonal soil fluxes of carbon monoxide in burned and unburned Brazilian savannas. *Journal of Geophysical Research-Atmospheres*, **107**, art-8051.

Pinto AD, Bustamante MMC, Kisselle K, Burke R, Zepp R, Viana LT, Varella RF, Molina M. (2002) Soil emissions of N2O, NO, and CO2 in Brazilian Savannas: Effects of vegetation type, seasonality, and prescribed fires. *Journal of Geophysical Research-Atmospheres*, **107**, art-8089.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?
- ND-Q4c - To what extent do intact riparian zones buffer streams against changes due to anthropogenic activities in surrounding uplands?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?
- TG-Q3 - Are losses and gains of carbon from Amazônian ecosystems in forms other than carbon dioxide (e.g. carbon monoxide, methane, volatile organic carbon, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance?

ND-11 (Fernandes / Passos / Couto) Investigation Profile

Carbon and Nutrient Stocks and Regrowth in Reduced Impact and Conventionally Logged Forests and Settlements in NW Mato Grosso, Brazil

Principal Investigators:

Eduardo Guimarães Couto, Universidade Federal de Mato Grosso (SA-PI)
Erick C.M. Fernandes, World Bank (US-PI)
Carlos Passos, (SA-PI)

Abstract 2003:

Research Approach

Our major focus will be on the questions "What are the impacts of conventional and reduced impact logging on above and belowground carbon and nutrient stocks and water and nutrient fluxes and how do these impacts

change over time following the logging?" Answering these carbon and nutrient dynamics science questions will require ground-based biogeochemical studies and the enhancement and use of currently available GIS techniques.

The specific goals of our project are to: (1) Measure existing forest biomass (carbon) and nutrient stocks and validate available models for estimating forest biomass. (2) Quantify the impact of soil texture and fertility gradients on above and belowground C and nutrient stocks in local forests, and (3) Measure the impact of conventional (CL) versus reduced impact logging (RIL) on C dynamics. If time and funds permit, we will also obtain measurements on the quantity and composition of sediment, nutrients, water and organic matter entering first order streams.

We will estimate aboveground live biomass in primary forest using four alternative allometric equations that were calculated for moist tropical forest trees and fine-tune these estimates with destructive sampling and direct measurements of trees in similar forests and soils at settlement sites adjacent to primary forest on our site. Because settlers completely clear the forest for agriculture on 20-30% of their land, we will be able to use destructive harvests for all DBH size classes and then estimate the biomass contribution of bole extensions belowground. We will also use the plots on settlements to directly measure vine and epiphyte biomass and relate this to aboveground tree biomass.

We propose to quantify the impact of soil texture and fertility gradients on above and belowground C and nutrient stocks in local forests. We will use an empirical and a modeling approach to examine the relationship of soil texture, especially clay content, to patterns in above and belowground C and nutrient pools. Our site is characterized by an Oxisol-Ultisol-Entisol association that is commonly found across the Amazon basin. To examine the role of texture in greater detail, and to test mechanisms by which texture influences the biogeochemistry of moist lowland tropical forests, we will use the Century model to simulate the forest on the different soil textural classes at our site. Our data will contribute significantly to the robustness and reliability of existing allometric equations for forest biomass across the Amazon.

In addition, our site has a 10 year chronosequence of selective, conventional (CL) and reduced impact logging (RIL). We propose to evaluate the We will use the data from the studies mentioned above to measure the impact of CL and RIL on above and belowground C and nutrient dynamics. The removal of trees inevitably leads to nutrient export from the forest ecosystem. It is unclear to what extent nutrients are distributed among topsoil, subsoil, litter layer, standing biomass and streams by selective logging. We will collaborate with Richey et al. (CD-06) to link our measurements of C and nutrient flows to first order streams with local rivers. We are collaborating with Asner et al (LC-13) to evaluate canopy damage and the hyperspectral signatures of various stages in the selective logging chronosequence – from primary forest to the logging event to regrowth. Our links with work in CD-06 and LC 13 will contribute to the assessments of the impacts of selective logging on carbon management at the basin scale.

Investigation Duration:

2003 - 2005

Participants:

Pericles de Aquino Botelho
Eduardo Guimarães Couto, SA-PI, Universidade Federal de Mato Grosso
Ted R. Feldpausch, Cornell University
Erick C.M. Fernandes, US-PI, World Bank
Elenara Gandini
Stefan Jirka, Cornell University
Mark Stephen Johnson, Cornell University
Johannes Lehmann, Co-Investigator, Cornell University
Regina C. C. Luizao, INPA
Flavio Jesus Luizao, INPA
Maria Jose Miranda de Souza Noquelli
João Paulo Novaes Filho, UFMT
Carlos Passos, SA-PI
Daniela Pauletto
Susan J. Riha, Co-Investigator, Cornell University
Luiz Carlos Mattos Rodrigues, UFMT PGAT
Evandro Carlos Selva, UFMT
Rubenildo Silva
Michely Tomazi, UFMT
Hannah K. Wittman, Cornell University

Student Information:

Ted R. Feldpausch, Cornell University, Citizenship: USA, Ph.D. student, Thesis: Secondary forest resource capture and biogeochemistry, selective logging, and sustainable land-use of Brazilian Amazônia

Stefan Jirka, Cornell University, Citizenship: USA, Masters student, Thesis: Biomass estimation of lianas and epiphytes in Juruena, MT

Mark S. Johnson, Cornell University, Citizenship: USA, Ph.D. student, Thesis: Soil water repellency of Amazonian pastures and forest soils

João Paulo Novaes Filho, UFMT, Citizenship: BRAZIL, Masters student

Luiz Carlos Mattos Rodrigues, UFMT PGAT, Citizenship: BRAZIL, Masters student, Thesis: Dinâmica do Nitrato no fluxo da água em quatro micro bacias sob floresta em Juruena , MT.

Evandro Carlos Selva, UFMT, Citizenship: BRAZIL, Masters student, Thesis: Exportação de carbono via folhas de quatro micro-bacias em Juruena-MT

Hannah K. Wittman, Cornell University, Citizenship: USA, Ph.D. student, Thesis: Natural Resource Management and Farm Stability in Agrarian Reform Settlements in Mato Grosso

Proposed Research Sites:

Amazonas (Manaus)
EMBRAPA DAS Experiment - km 54 (CPAA)

Mato Grosso
Cuiaba
Juruena

Proposed Training and Education:

Formal Training

- It is planned to support one postdoctoral student and five PhD. Links with INPA will continue; students from INPA will be selected to undertake graduate research at the site in Jurena, MT.

Short Courses / Seminars / Workshops

- Ecologia Florestal e treinamento em medições no campo.

Visits / Exchange Programs

- Ecologia Florestal e estudos do solo.
- Visitas de 3 meses a cada ano, ao laboratório da equipe da Cornell University Laboratório.

Beija-Flor Datasets:

Currently none available.

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
- ND-Q2 - Are nutrients major factors that control the rates of regrowth and carbon accumulation in abandoned pastures and regrowing secondary forests?
- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?

TG-03 (Holben / Artaxo / Duarte / Setzer) Investigation Profile

Characterization of Aerosol Optical Properties and Solar Flux for LBA-ECO

Principal Investigators:

Paulo Artaxo, USP (SA-PI)
Alejandro Antonio Fonseca Duarte, UFAC (SA-PI)
Brent Norman Holben, NASA/GSFC (US-PI)
Alberto Setzer, INPE (SA-PI)

Abstract 2003:

We propose to continue monitoring aerosol optical properties, water vapor, and surface irradiance within our existing network. Our highly successful network currently includes eight established sites, with seven located in the Amazon basin, that have provided regular measurements at some locations since the early phase of the LBA project dating back to January 1999. Further observations will enhance the multi-year dataset already acquired, and allow for a comprehensive study of inter-annual variability of aerosol optical properties (biomass-burning and background aerosols) both seasonally and spatially.

We plan to continue our studies of the attenuation of broadband irradiance by biomass burning aerosols across the region. These studies have produced two LBA related journals papers to date. At least two funded LBA investigators are producing surface irradiance products from satellite data, and they will be relying on our flux measurements for validation of their products and on our AOD data for smoke attenuation analyses.

Our previous studies have presented fractional reductions in expected flux due to smoke, and we now plan to also assess the radiative effects of clouds at all our network sites. MODIS cloud products (fractional coverage and optical thickness parameters) will be used with the observed local irradiance reductions to develop algorithms for estimating cloud attenuation of surface flux. The large spatial aspect of MODIS data will allow us to scale our point source observations to a basin-wide quantification of cloud effect. The characterization of diurnal trends in cloud attenuation, which varies greatly with month, will provide time-of-day corrections that can be applied to MODIS observations. The accuracy of MODIS measurements, necessarily limited to a short duration, can thus be improved for application to non-overpass periods of the day.

Collection of additional aerosol properties data sets from our LBA network will enable us to study the regional aerosol optical properties in detail and to investigate seasonal trends. We plan to investigate possible differences in aerosol single scattering albedo and size distribution between sites in central Amazonia versus in the southern arc of deforestation, that may result due to differences in the severity of the dry season and thus differences in fuel moisture content. Additionally, seasonal trends in aerosol absorption at each site will be studied, which may result from differences in transport and aging of aerosols and in the fuel moisture as the dry season transitions to the wet season.

In addition to our permanent installations, a number of additional CIMEL sunphotometer and flux sensors will be deployed in support of intensive field campaigns planned for the next two years (SMOCC, Dry-to-Wet Season Field Campaign (August-November 2002)) with Brazilian and European collaborators. A micro-pulse lidar (providing details of vertical aerosol distribution), 4-5 additional CIMEL sun-sky radiometers, and a temporary network of 20-30 hand-held sunphotometers will be operated in Rondônia during select experiments.

Investigation Duration:

1998 - 2005

Participants:

Hellen Kelma Araujo, Federal University of Acre
Paulo Artaxo, SA-PI, USP
Alejandro Antonio Fonseca Duarte, SA-PI, UFAC
Thomas F. Eck, Co-Investigator, NASA/GSFC
Brent Norman Holben, US-PI, NASA/GSFC
Gilberto K. Nishioka, IFUSP - Intituto de física da USP
Aline Sarmento Procopio, GEPA - Instituto de Fisica, USP
Alcides Camargo Ribeiro, IFUSP - Intituto de física da USP
Joel S. Schafer, Co-Investigator, NASA/GSFC
Alberto Setzer, SA-PI, INPE

Student Information:

Hellen Kelma Araujo, Federal University of Acre, Citizenship: BRAZIL, Bachelors student

Alejandro Antonio Fonseca Duarte, UFAC, Citizenship: BRAZIL, Postdoctoral Researcher

Aline Sarmento Procopio, GEPA - Instituto de Fisica, USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Estudo das forçantes radiativas dos aerossóis na região Amazônica

Proposed Research Sites:

Acre
    Parque Zoobotanico

Amazonas (Manaus)
    Balbina

Mato Grosso
    Alta Floresta
    Cuiaba

Pará Western (Santarém)
    Belterra

Rondonia
    Fazenda Nossa Senhora

Proposed Training and Education:

Formal Training

    - Training will be provided in joint planned activities with the LBA Millenium Institute on carbon cycling and modeling of physical climate. Support for current student will continue - for a Brazilian student at the University of Rondônia at Ji Paraná, who is now graduate student at University of São Paulo and for two undergraduate interns at UFAC.

Short Courses / Seminars / Workshops

    - Short courses on environmental sciences will be taught for local students at the Institute of Physics, University of Cuiabá. They will be coordinated by Paulo Artaxo, Nicolau Priante and A;ejandro Duarte. Courses on aerosols and radiation will be taught at Federal University of Acre, coordinated by Paulo Artaxo, Nicolau Priante

and Alejandro Duarte will also be offered.

- Short courses on aerosols and radiation will be taught at the Federal University of Acre, coordinated by Paulo Artaxo, Nicolau Priante and Alejandro Duarte.

Visits / Exchange Programs

- A 6-month course for a student from Federal University of Acre and a-3-6-month internship on remote sensing measurements and AERONET validation for the Brazilian sites will be provided at NASA/Goddard.

Beija-Flor Datasets: (as of 2003-06-16)

AERONET Aerosol Optical Thickness Data: Abracos Hill, Rondônia, Brazil, 1999

AERONET Aerosol Optical Thickness Data: Abracos Hill, Rondônia, Brazil, 2000

AERONET Aerosol Optical Thickness Data: Abracos Hill, Rondônia, Brazil, 2001

AERONET Aerosol Optical Thickness Data: Abracos Hill, Rondônia, Brazil, 2002

AERONET Aerosol Optical Thickness Data: Aguas Emendadas, Brazil, 2000

AERONET Aerosol Optical Thickness Data: Alta Floresta, Mato Grosso, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Alta Floresta, Mato Grosso, Brazil, 1994

AERONET Aerosol Optical Thickness Data: Alta Floresta, Mato Grosso, Brazil, 1995

AERONET Aerosol Optical Thickness Data: Alta Floresta, Mato Grosso, Brazil, 1999

AERONET Aerosol Optical Thickness Data: Alta Floresta, Mato Grosso, Brazil, 2000

AERONET Aerosol Optical Thickness Data: Alta Floresta, Mato Grosso, Brazil, 2001

AERONET Aerosol Optical Thickness Data: Alta Floresta, Mato Grosso, Brazil, 2002

AERONET Aerosol Optical Thickness Data: Arica, Chile, 1998

AERONET Aerosol Optical Thickness Data: Ariquiums, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Balbina, Amazonas, Brazil, 1999

AERONET Aerosol Optical Thickness Data: Balbina, Amazonas, Brazil, 2000

AERONET Aerosol Optical Thickness Data: Balbina, Amazonas, Brazil, 2001

AERONET Aerosol Optical Thickness Data: Balbina, Amazonas, Brazil, 2002

AERONET Aerosol Optical Thickness Data: Belterra, Santarém, Brazil, 1999

AERONET Aerosol Optical Thickness Data: Belterra, Santarém, Brazil, 2000

AERONET Aerosol Optical Thickness Data: Belterra, Santarém, Brazil, 2001

AERONET Aerosol Optical Thickness Data: Belterra, Santarém, Brazil, 2002

AERONET Aerosol Optical Thickness Data: Brasilia, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Brasilia, Brazil, 1994

AERONET Aerosol Optical Thickness Data: Brasilia, Brazil, 1995

AERONET Aerosol Optical Thickness Data: Concepcion, Bolivia 1998

AERONET Aerosol Optical Thickness Data: Cuiaba, Mato Grosso, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Cuiaba, Mato Grosso, Brazil, 1994

AERONET Aerosol Optical Thickness Data: Cuiaba, Mato Grosso, Brazil, 1995

AERONET Aerosol Optical Thickness Data: Cuiaba, Mato Grosso, Brazil, 2001

AERONET Aerosol Optical Thickness Data: Jamari, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Ji-Parana, Brazil, 1994

AERONET Aerosol Optical Thickness Data: Ji-Parana, Brazil, 1995

AERONET Aerosol Optical Thickness Data: Los Fieros 98, Bolivia, 1998

AERONET Aerosol Optical Thickness Data: Los Fieros, Bolivia, 1996

AERONET Aerosol Optical Thickness Data: Porto Nacional, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Potosi Mine, Brazil, 1995

AERONET Aerosol Optical Thickness Data: Rio Branco, Acre, Brazil, 2000

AERONET Aerosol Optical Thickness Data: Rio Branco, Acre, Brazil, 2001

AERONET Aerosol Optical Thickness Data: Rio Branco, Acre, Brazil, 2002

AERONET Aerosol Optical Thickness Data: Santarem, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Santarem, Brazil, 1995

AERONET Aerosol Optical Thickness Data: Surinam, 1998

AERONET Aerosol Optical Thickness Data: Tukurui, Brazil, 1993

AERONET Aerosol Optical Thickness Data: Tukurui, Brazil, 1994

AERONET Aerosol Optical Thickness Data: Tukurui, Brazil, 1995

AERONET Aerosol Optical Thickness Data: Uberlandia, Brazil, 1995

AERONET Broadband Surface Irradiance Data: Abracos Hill, Rondônia, Brazil, 1999

AERONET Broadband Surface Irradiance Data: Abracos Hill, Rondônia, Brazil, 2000

AERONET Broadband Surface Irradiance Data: Abracos Hill, Rondônia, Brazil, 2001

AERONET Broadband Surface Irradiance Data: Abracos Hill, Rondônia, Brazil, 2002

AERONET Broadband Surface Irradiance Data: Alta Floresta, Mato Grosso, Brazil, 1999

AERONET Broadband Surface Irradiance Data: Alta Floresta, Mato Grosso, Brazil, 2000

AERONET Broadband Surface Irradiance Data: Alta Floresta, Mato Grosso, Brazil, 2001

AERONET Broadband Surface Irradiance Data: Alta Floresta, Mato Grosso, Brazil, 2002

AERONET Broadband Surface Irradiance Data: Balbina, Amazonas, Brazil, 1999

AERONET Broadband Surface Irradiance Data: Balbina, Amazonas, Brazil, 2000

AERONET Broadband Surface Irradiance Data: Balbina, Amazonas, Brazil, 2001

AERONET Broadband Surface Irradiance Data: Balbina, Amazonas, Brazil, 2002

AERONET Broadband Surface Irradiance Data: Belterra, Santarém, Brazil, 1999

AERONET Broadband Surface Irradiance Data: Belterra, Santarém, Brazil, 2000

AERONET Broadband Surface Irradiance Data: Belterra, Santarém, Brazil, 2001

AERONET Broadband Surface Irradiance Data: Belterra, Santarém, Brazil, 2002

AERONET Broadband Surface Irradiance Data: Cuiaba, Mato Grosso, Brazil, 2001

AERONET Broadband Surface Irradiance Data: Rio Branco, Acre, Brazil, 2000

AERONET Broadband Surface Irradiance Data: Rio Branco, Acre, Brazil, 2001

AERONET Broadband Surface Irradiance Data: Rio Branco, Acre, Brazil, 2002

AERONET Photosynthetically Active Radiation Data: Abracos Hill, Rondônia, Brazil, 1999

AERONET Photosynthetically Active Radiation Data: Alta Floresta, Mato Grosso, Brazil, 1999

Effect of smoke aerosol particles from biomass burning on the PAR absorbed by a primary forest in the Amazon (Poster)

Observed changes in Aerosols Properties at the Amazon Basin caused by a friagem phenomena during the LBA-CLAIRE 2001 experiment (Poster)

Publications:

Schafer JS, Eck TF, Holben BN, Artaxo P, Yamasoe MA, Procopio AS. (2002) Observed reductions of total solar irradiance by biomass- burning aerosols in the Brazilian Amazon and Zambian Savanna. *Geophysical Research Letters*, **29**, art-1823.

Schafer JS, Holben BN, Eck TF, Yamasoe MA, Artaxo P. (2002) Atmospheric effects on insolation in the Brazilian Amazon: Observed modification of solar radiation by clouds and smoke and derived single scattering albedo of fire aerosols. *Journal of Geophysical Research-Atmospheres*, **107**, art-8074.

Science Questions Addressed by this Investigation:

Trace Gas and Aerosol Flux:

- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?

TG-04 (Martens / Moraes / Victoria / Moreira) Investigation Profile

Radon-222 and Stable Carbon Isotope Tracing of Carbon Exchange and Trace Gas Fluxes in Old Growth and Selectively Logged Amazonian Forests

Principal Investigators:

Christopher S. Martens, University of North Carolina (US-PI)
Osvaldo Luiz Leal de Moraes, Universidade Federal de Santa Maria (UFSM) (SA-PI)
Marcelo Zacharias Moreira, CENA/USP (SA-PI)
Reynaldo Luiz Victoria, CENA/USP (SA-PI)

Abstract 2003:

We propose to continue studies of the rates and mechanisms of processes controlling carbon dioxide and trace gas fluxes at old growth forest and selectively-logged forest sites in the Tapajos National Forest and at pasture sites south of Santarém, Pará, Brazil using a unique suite of state-of-the-art radon and stable isotope measurements. The continuing work is fully integrated with LBA-ECO tower eddy covariance flux, forest canopy gas inventory and soil gas flux studies led by Keller et al. (TG-07), Goulden and Rocha (CD-04), and Wofsy et al. (CD-10). In addition, we propose to make tower and portable field radon measurements that will contribute to larger scale studies of gas transport processes associated with the development of nocturnal and convective boundary layers led by Fitzjarrald and Moraes (CD-03) and other LBA-ECO Science Team members. Brazilian collaborators and students lead or are involved in many aspects of the proposed project. All of the proposed radon-222 and stable isotope measurements will be made in Brazil except for limited laboratory intercalibration studies that are essential for achieving maximum analytical accuracy. The proposed research will quantitatively address two theme areas in LBA-ECO: Carbon Dynamics and Trace Gas and Aerosol Fluxes. The proposed work is focused on four primary objectives:

1. Quantification of net CO2 and trace gas exchange rates between the atmosphere and old growth and selectively logged forests and pastures utilizing tower and soil flux radon-222 measurements. Direct comparison of exchange rates from radon versus eddy covariance rates using the same canopy gas inventory measurements.
2. Radon tracing of periodic and spatially inhomogeneous vertical and horizontal gas transport on a regional scale up to the top of the convective boundary layer (CBL) including quantification of nocturnal and CBL vertical scales and inhomogeneity and initial investigations of horizontal air drainage from the FLONA Tapajos.
3. Quantification of CO2 and trace gas soil fluxes and production/consumption rates versus height within the forest canopy using measured radon-222 flux divergence. Direct comparison of these rates with results from auto-chamber soil flux and canopy respiration rate measurements.
4. Utilization of methane canopy inventory, soil flux and d13C-CH4 measurements to distinguish the sources, canopy height source distribution, and net flux of methane from soils and dispersed forest sources to the atmosphere.

Investigation Duration:

1998 - 2005

Participants:

Daniel Bruce Albert, Co-Investigator, University of North Carolina
Patrick Michael Crill, Co-Investigator, University of New Hampshire
Laura Lee Lapham, UNC-Chapel Hill
Risonaldo Leal Lima, FIT (Santarem)
Christopher S. Martens, US-PI, University of North Carolina
Howard P. Mendlovitz, Co-Investigator, University of North Carolina
Osvaldo Luiz Leal de Moraes, SA-PI, Universidade Federal de Santa Maria (UFSM)
Marcelo Zacharias Moreira, SA-PI, CENA/USP
José Mauro Sousa de Moura, LBA
Gilson Rego, LBA-ECO / FIT / UFPA
Reynaldo Luiz Victoria, SA-PI, CENA/USP
W. Stephen Woodward, University of North Carolina

Student Information:

Laura Lee Lapham, UNC-Chapel Hill, Citizenship: USA

Risonaldo Leal Lima, FIT (Santarem), Citizenship: BRAZIL, Technician

José Mauro Sousa de Moura, LBA, Citizenship: BRAZIL, Masters student, Technician, Thesis: Radon-222 flux from soils of the FLONA Tapajos

Proposed Research Sites:

Pará Western (Santarém)
Igarapé Maica
Jamaraqua - Santarém River Site
km 67 Primary Forest Tower Site
km 77 Pasture Tower Site
km 83 Logged Forest Tower Site

Proposed Training and Education:

Formal Training

- US graduate student from UNC-Chapel Hill will continue developing research activities with students at UFPa and other Amazonian university students. One of the students is expected to start a Master Program at CENA-USP in 2002. Current students will continue developing fieldwork in Santarém. One graduate student is planned to work on dispersed methane source problem, and another graduate student from UFSM to work on use of radon in gas exchange/concentration observations. Focus for Phase II will be mainly on encouraging the education of the individual students involved in the project, from undergraduate toward and through graduate study. All graduate students involved are expected to present results at LBA meetings and to contribute to papers.

Short Courses / Seminars / Workshops

- Seminars will be given at Federal University of Santa Maria and the local institutions in Santarém, as in Phase I. English courses will also be provided for the students in Santarém.

Visits / Exchange Programs

- Support will continue for formal exchange programs among Brazilian institutions and UNC-Chapel Hill for training in radon studies.
- This team will continue its formal exchange programs for Brazilian undergraduates.

Beija-Flor Datasets: (as of 2003-06-16)

Radon-222 Determination of Forest Canopy-Atmosphere gas exchange rates: New Methods and Inital Results (Poster)

Radon-222 Soil Fluxes at Two Tower Sites in the Tapajos National Forest, Para, Brazil (Poster)

Raw radon data from 67km

Raw radon data from 77km

Raw radon data from 83km

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
- TG-Q3 - Are losses and gains of carbon from Amazônian ecosystems in forms other than carbon dioxide (e.g. carbon monoxide, methane, volatile organic carbon, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance?

TG-05 (Potter / Carvalho / Oliveira / Schenato) Investigation Profile

Modeling the Effects of Land Use Change and Surface Hydrology on Carbon and Trace Gas Fluxes for the Amazon Region

Principal Investigators:

Claudio Jose Reis de Carvalho, EMBRAPA/CPATU (SA-PI)
Raimundo Cosme de Oliveira, EMBRAPA Amazônia Oriental (SA-PI)
Christopher S. Potter, NASA/ARC (US-PI)
Carlos Schenato, (SA-PI)

Abstract 2003:

The Amazon region includes the largest remaining tropical forest ecosystem on Earth. Despite the Amazon's potential importance for climate regulation, the precise pattern of a terrestrial sources and sinks for CO2 and other "greenhouse gas" compounds like methane remain uncertain for the region. These large gaps in our knowledge still exist to a great degree because many impacts of land cover change and geochemical controls related to surface hydrology have not been understood in adequate detail to determine precise regional fluxes for biogenic trace gases. Therefore, the fundamental approach we propose for LBA-ECO II research involves integrated studies and predictive modeling for Amazon carbon, water, and nutrient cycles using a regional ecosystem model called NASA-CASA (Carnegie-Ames Stanford Approach), which has been uniquely developed and applied using satellite data drivers as a component of the NASA LBA-ECO I program. Our proposed work thereby builds upon over four years of coordinated data assimilation and model development, as part of the LBA Science Team. The research plan we now propose is designed to extend the value of new LBA site (tower and small plot flux) data and remote sensing products by up-scaling with NASA-CASA to the regional level using a variety of different land cover products available for the Amazon region. In this manner, we propose to make new linkages in LBA-ECO project science between site-based investigation and regional scale modeling and remote sensing.

A unique aspect of our study approach is to treat land cover inputs to our ecosystem carbon modeling as variable according to time, spatial scale, and spatial resolution. In the proposed research plan, the NASA-CASA ecosystem model will make a series of simulation runs using multiple sequences of land cover change for the entire Amazon regional extent. The simulations will include the following land cover/land use class settings -- moist primary forest, dry primary forest, drought-deciduous forest, savanna, disturbed (burned), secondary forest, pasture, and annual crop. Nominal spatial resolution for hydro-meteorologic inputs to our LBA regional simulations will be 8x8 km pixel size. The percentage cover-weighted results from these individual model runs for land cover change sequences will be aggregated to reconstruct a history of regional heterogeneity in Amazon ecosystem dynamics. Trace gas fluxes (e.g., CO2, N2O) will be weighted by land cover change frequency distributions derived from the highest spatial resolution data available (e.g., from MODIS and Landsat sensors)

for the entire region and for selected smaller areas around intensive LBA studies. High resolution (< 1-km) land cover images for 'footprint' areas of LBA tower sites will be used to define the proportions of each land cover class with which to weight ecosystem model estimates and validate against measured tower fluxes of carbon and water exchange. Particular emphasis will be placed on Tapajós National Forest (TNF) tower sites, where our Brazilian co-investigators are actively making field measurements of energy, water, and carbon exchange, which are vital to ecosystem model evaluation.

A second integrative aspect of this study will be to extend NASA-CASA model predictions of carbon and trace gas fluxes to (seasonally) inundated areas of the region. Through close collaboration with other LBA investigator teams whose studies have developed or used radar remote sensing products or surface water models, we will adapt our CASA model to include Amazon mainstem and floodplain dynamics, with focus on up-scaling wetland ecosystem methane and CO2 emission fluxes. At the smaller scale of the TNF watershed, we will complete the development of a new parameterization scheme within the NASA-CASA model for coupling a surface water routing model called HYDRA (Univ. Wisconsin), and validating simulations of surface water flow against measured flow and dissolved carbon chemistry of the Rio Moju discharge network from the TNF.

Investigation Duration:

1998 - 2005

Participants:

Susan Alexander, Co-Investigator, California State University Monterey Bay
Claudio Jose Reis de Carvalho, SA-PI, EMBRAPA/CPATU
Vanessa Brooks Genovese
Steven A. Klooster, Co-Investigator, NASA/ARC
Marc Gerald Kramer, NASA
Raimundo Cosme de Oliveira, SA-PI, EMBRAPA Amazônia Oriental
Christopher S. Potter, US-PI, NASA/ARC
Carlos Schenato, SA-PI

Student Information:

Currently none available.

Proposed Research Sites:

Amazon Basin (large-scale studies)

Pará Western (Santarém)
km 67 Seca-Floresta Site

Proposed Training and Education:

Formal Training

- This team will continue to support two full annual student stipends at ULBRA in Santarém and EMBRAPA. The two students will participate in the development of surface hydrologic and biogeochemical transport studies in watersheds of the Rio Moju near the Tapajós National Forest.

Short Courses / Seminars / Workshops

- Annual training meetings with students and faculties in Santarém are planned in order to provide instruction and updates on simulation modeling techniques used in LBA-ECO studies.

Beija-Flor Datasets: (as of 2003-06-16)

8km Legal Amazon Mask

Detection of Deforestation and Land Conversion and Estimation of Atmospheric Emissions and Elemental Pool Losses from Biomass Burning in Rondonia, Brazil (Poster)

Effects of Interannual Climate Variability in Capoeira and Crops Under Traditional and Alternative Shifting Cultivation (Poster)

Global teleconnections of climate to regional model estimates of Amazon ecosystem carbon fluxes (Poster)

NASA Ames CASA 8-km Regional Mapping Data Sets of Brazil

Publications:

Potter C, Genovese VB, Klooster S, Bobo M, Torregrosa A. (2001) Biomass burning losses of carbon estimated from ecosystem modeling and satellite data analysis for the Brazilian Amazon region. *Atmospheric Environment*, **35**, 1773-1781.

Potter C, Davidson EA, Nepstad D, de Carvalho CR. (2001) Ecosystem modeling and dynamic effects of deforestation on trace gas fluxes in Amazon tropical forests. *Forest Ecology and Management*, **152**, 97-117.

Potter C, Klooster S, de Carvalho CR, Genovese VB, Torregrosa A, Dungan J, Bobo M, Coughlan J. (2001) Modeling seasonal and interannual variability in ecosystem carbon cycling for the Brazilian Amazon region. *Journal of Geophysical Research-Atmospheres*, **106**, 10423-10446.

Nepstad DC, Verissimo A, Alencar A, Nobre C, Lima E, Lefebvre P, Schlesinger P, Potter C, Moutinho P, Mendoza E, Cochrane M, Brooks V. (1999) Large-scale impoverishment of Amazonian forests by logging and fire. *Nature*, **398**, 505-508.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?
- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?
- CD-Q3c - What factors (biologically mediated, land use history, soil properties, etc.) control the rate of carbon sequestration in biomass and soils of regrowing forest?
- CD-Q3d - What portion of the Amazônia–wide carbon flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Land Cover and Land Use Change:

- LC-Q1 - What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?
- ND-Q2 - Are nutrients major factors that control the rates of regrowth and carbon accumulation in abandoned pastures and regrowing secondary forests?
- ND-Q4 - How do changes in land use and climate alter the stocks, processes and fluxes of dissolved and particulate organic matter, nutrients, and trace gases from the uplands across the riparian zones and floodplains and down the channels of river corridors?
- ND-Q4a - How will the composition and quantity of nutrients and organic matter entering and being processed within streams be altered under different land-use change scenarios?
- ND-Q4b - Are there unique signatures that can be traced downstream?
- ND-Q5 - What is the importance of periodically "wet" environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, carbon dioxide, trace gases, and water and energy on multiple scales?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?
- TG-Q3 - Are losses and gains of carbon from Amazônian ecosystems in forms other than carbon dioxide (e.g. carbon monoxide, methane, volatile organic carbon, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance?

TG-06 (Bakwin / Artaxo / Gatti / Martinelli) Investigation Profile

Vertical Profiles of Carbon Dioxide and Other Trace Gas Species Over the Amazon Basin Using Small Aircraft

Principal Investigators:

Paulo Artaxo, USP (SA-PI)
Peter S. Bakwin, NOAA/CMDL (US-PI)
Luciana Vanni Gatti, IPEN - Instituto de Pesquisas Energeticas e Nucleares (SA-PI)
Luiz Antonio Martinelli, CENA/USP (SA-PI)

Abstract 2003:

We propose to continue measurements, as part of LBA-ECO, of the vertical profiles of several atmospheric trace gas species and isotope ratios, and to develop a capability in Brazil for long-term measurements of trace gases and CO2 isotopes that does not currently exist. On flights using small charter aircraft over the Santarém Tapajos tower site, and over the Atlantic Ocean off the coast of Fortaleza, we will measure the mixing ratios of CO2, CO, CH4, N2O, H2 and SF6, the 13C/12C and 18O/16O isotopic ratios in CO2, and the 13C/12C ratio in CH4 in flask samples collected automatically up to an altitude of about 4 km. As they are available, we will use NASA, INPE or other research aircraft to obtain samples at higher altitudes and other locations. Flask samples collected over the Atlantic Ocean and over the forest in the central Amazon basin will enable us to quantify the change in trace gas mixing ratios and isotopic composition during the transit of air across the basin. Other areas will be sampled on a campaign basis, in coordination with other LBA and Brazilian studies, primarily to examine the isotopic signature of CO2 exchange in other ecosystem types.

Initially the flasks will be analyzed in our laboratories in Boulder using existing equipment. In the first year of this renewal we will develop the capacity to carry out the trace gas analyses in the Brazilian laboratories at IPEN, and in the second year we will upgrade existing equipment at CENA (Universidade de São Paulo) for measurements of 13C/12C and 18O/16O in CO2 in the flask samples. Doing the analyses in Brazil will alleviate very serious problems we have had so far with shipping into and out of Brazil, particularly with Brazilian Customs, and will lead to long-term cost savings. Also, this will provide the expertise for long-term observations in Brazil that can be integrated into the global observing network for these trace gases and isotopes, and can be used in other measurement campaigns. All species mixing ratios and isotopic ratios will be firmly tied to internationally accepted calibration scales. The observations will constitute the first multi-year time series of CO2, CH4 and N2O mixing ratios, and CO2 isotopic composition, over the Amazon region. Measurements of SF6 will give a sensitive indicator for penetration of northern hemisphere air into the study area. The data will provide an important constraint for regional and global models of these trace gases, and an independent estimate of regional exchange for validation of scaling of observations from the flux towers to the whole LBA study area. In addition, the payload requirements for our equipment are modest, approximately 60 kg, and our aircraft flights could be a useful resource for other investigators in LBA.

Our work includes a Training and Education component that is focused on establishing infrastructure so that all trace gas and isotope analyses will be done by Brazilian laboratories. For long-term (beyond LBA) monitoring in Brazil this is clearly needed for both logistical and political reasons. It is very important that we develop solid calibrations for the measurements made in Brazil and maintain on-going intercomparison and data exchange between the US and Brazilian laboratories.

Investigation Duration:

1998 - 2005

Participants:

Paulo Artaxo, SA-PI, USP
Peter S. Bakwin, US-PI, NOAA/CMDL
Williams Martins Castro, Universidade Federal do Pará-UFPA
Andrew Michael Crotwell, NOAA / CMDL
Luciana Vanni Gatti, SA-PI, IPEN - Instituto de Pesquisas Energeticas e Nucleares
Doug Guenther, Co-Investigator, NOAA/CMDL
Michael Paul Hahn, National Oceanic and Atmospheric Administration
Luiz Antonio Martinelli, SA-PI, CENA/USP
John Bharat Miller, Co-Investigator, University of Colorado
Aline Sarmento Procopio, GEPA - Instituto de Fisica, USP
Luciana Varanda Rizzo, USP
Pieter P. Tans, Co-Investigator, NOAA/CMDL
Kirk Thoning, NOAA / CMDL
Kirk Thoning, NOAA / CMDL

Student Information:

Williams Martins Castro, Universidade Federal do Pará-UFPA, Citizenship: BRAZIL, Bachelors student

Aline Sarmento Procopio, GEPA - Instituto de Fisica, USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Estudo das forçantes radiativas dos aerossóis na região Amazônica

Luciana Varanda Rizzo, USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Secondary Organic Aerosol Production in the Amazon

Proposed Research Sites:

Ceará
    Fortaleza

Pará Western (Santarém)

Proposed Training and Education:

Formal Training

- Support for the current Brazilian PhD student working under Gatti's supervision will continue to be provided.

Short Courses / Seminars / Workshops

- Short courses on stable isotopes in ecology and atmospheric trace gases will be given for undergraduate and graduate students from Universidade Federal do Pará (UFPa-Santarém).

Visits / Exchange Programs

- The Brazilian PhD Student participating in this team is scheduled to visit Boulder to work under the direction of the CMDL staff. A Brazilian scientist from CENA will also visit CMDL and CU/INSTAAR. A scientist from Stable Isotope Laboratory at CU/INSTAAR will travel to Brazil to help upgrade equipment at CENA. Additional training will be provided by CMDL staff. Students from Santarém and Fortaleza areas will be engaged in this project. Continual visits from US personnel to Brazil are planned.

Beija-Flor Datasets: (as of 2003-06-16)

Vertical profiles of carbon dioxide and other trace gas species over the Amazon Basin using small aircraft

Publications:

Artaxo P, de Campos RC, Fernandes ET, Martins JV, Xiao ZF, Lindqvist O, Fernandez-Jimenez MT, Maenhaut W. (2000) Large scale mercury and trace element measurements in the Amazon basin. *Atmospheric Environment*, **34**, 4085-4096.

Yamasoe MA, Artaxo P, Miguel AH, Allen AG. (2000) Chemical composition of aerosol particles from direct emissions of vegetation fires in the Amazon Basin: water-soluble species and trace elements. *Atmospheric Environment*, **34**, 1641-1653.

Kesselmeier J, Kuhn U, Wolf A, Andreae MO, Ciccioli P, Brancaleoni E, Frattoni M, Guenther A, Greenberg J, Vasconcellos PD, de Oliva T, Tavares T, Artaxo P. (2000) Atmospheric volatile organic compounds (VOC) at a remote tropical forest site in central Amazonia. *Atmospheric Environment*, **34**, 4063-4072.

Rinne HJI, Guenther AB, Greenberg JP, Harley PC. (2002) Isoprene and monoterpene fluxes measured above Amazonian rainforest and their dependence on light and temperature. *Atmospheric Environment*, **36**, 2421-2426.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q1 - What is the (climatically driven) seasonal and interannual variability of the carbon dioxide flux between the atmosphere and different land cover/use types?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?

TG-07 (Keller / de Mello) Investigation Profile

Soil Biogeochemistry of Carbon, Nutrients, and Trace Gases in the Amazon Region of Brazil: Field and Model Studies of Natural and Managed Conditions

Principal Investigators:

Michael Keller, University of New Hampshire (US-PI)
William Zamboni de Mello, Universidade Federal Fluminense (UFF) (SA-PI)

Abstract 2003:

We propose to address two theme areas of LBA-Ecology, carbon storage and exchange and trace gas fluxes. We plan to estimate ecosystem respiration and trace gas fluxes for the undisturbed and logged forest sites at the Tapajos National Forest (TNF). Our proposed work is summarized in two objectives:

1) Quantification of the soil-atmosphere exchange of carbon dioxide (CO2), nitrous oxide (N2O), nitric oxide (NO) and methane (CH4) in logged and undisturbed upland forests on contrasting soil types over a range of spatial (~m2 to ~km2) and temporal scales (hours to years) at several LBA forested sites in the Amazon region.

2) Quantification of ecosystem respiration components (including soil, bole and coarse necromass) in mature upland forests and in logged forests.

We propose measurements of trace gases using manually deployed and continously operated automated chambers and profiles of trace gas mixing ratios from towers at the TNF. We will extend our measurements to

other LBA tower sites using a portable system for measurement of soil-atmosphere CO2 flux and profiles of CO2, N2O and CH4.

Investigation Duration:

1998 - 2005

Participants:

Flavia Araujo
Lorena Cordeiro Brewster, University of New Hampshire
Plinio B. de Camargo, USP
Janaina Braga do Carmo, CENA/ESALQ
Patrick Michael Crill, University of New Hampshire
Jadson Dizencourt Dias, Universidade Federal do Para - Campus de Santarem
Michael Keller, US-PI, University of New Hampshire
Changsheng Li, Co-Investigator, University of New Hampshire
Evilene Lopes, University of New Hampshire
William Zamboni de Mello, SA-PI, Universidade Federal Fluminense (UFF)
Andrew H Mosedale, University of New Hampshire
Kadson Oliveira, LBA
Raimundo Cosme de Oliveira, Co-Investigator, EMBRAPA Amazônia Oriental
Michael William Palace, Complex Systems Research Center
Rodrigo Antonio Pereira, Fundacao Floresta Tropical
Cleuton Pereira
Maria Milagros Rivera Costa, USDA Forest Service
Hudson C.P. Silva, Universidade Federal do Para - Campus de Santarem
Kêmeson Oliveira da Silva
Eraclito Rodrigues de Sousa Neto, Universidade Federal do Para - Campus de Santarem
Ruth Varner, University of New Hampshire
Johan Cornelis Zweede, Fundacao Floresta Tropical (FFT)

Student Information:

Flavia Araujo, Citizenship: BRAZIL, Bachelors student

Janaina Braga do Carmo, CENA/ESALQ, Citizenship: BRAZIL, Ph.D. student, Thesis: Nitrogen Dynamics and Phosphorus Available in Pasture Restoration System in Rondônia

Jadson Dizencourt Dias, Universidade Federal do Para - Campus de Santarem, Citizenship: BRAZIL, Bachelors student

Evilene Lopes, University of New Hampshire, Citizenship: BRAZIL, Ph.D. student, Thesis: Stem respiration in tropical forests

Kadson Oliveira, LBA, Citizenship: BRAZIL, Bachelors student

Michael William Palace, Complex Systems Research Center, Citizenship: USA, Ph.D. student, Thesis: The Role of Coarse Woody Debris in the Carbon Budget of a Tropical Moist Forest

Cleuton Pereira, Citizenship: BRAZIL, Technician

Hudson C.P. Silva, Universidade Federal do Para - Campus de Santarem, Citizenship: BRAZIL

Eraclito Rodrigues de Sousa Neto, Universidade Federal do Para - Campus de Santarem, Citizenship: BRAZIL, Bachelors student, Technician, Thesis: Effects of soil texture and seasonality on litter productivity in the Tapajos National Forest

Proposed Research Sites:

Amazonas (Manaus)
- ZF2 km 14
- ZF2 km 34

Brasília
Reserva Ecologica Aguas Emendadas
Reserva Ecologica do Roncador IBGE

Mato Grosso
Alta Floresta
Juruena
Sinop

Pará Eastern (Belém)
Fazenda Cauaxi
FLONA Caxiuanã

Pará Western (Santarém)
km 67 Primary Forest Tower Site
km 83 Logged Forest Tower Site

Rondonia
Jaru Biological Reserve Tower A
Jaru Biological Reserve Tower B

Tocantins
Cangacu Research Center

Proposed Training and Education:

Formal Training

- Support for training of students in Phase I will continue. Evilene Lopes is currently enrolled in her second year in the Ph.D. program in Natural Resources at the University of New Hampshire under the supervision of Patrick Crill; and Marcel Franz is currently in his final year in the Ph.D. program in Geochemistry of the Universidade Federal Fluminense under the supervision of William de Mello. Cleyton Pereira and Kadson Oliveira are two recent graduates of the Agricultural Technician program from the Agricultural Technical School in Castanhal, Pará. They are working with us full time in the field and in the laboratory. We expect Evilene Lopes to complete her Ph.D. work by the close of LBA Phase 2. Hudson Silva will join us at UNH for a M.Sc. degree in Phase-2. We will continue to employ a biologist and a technician in Santarem and we expect to seek a post-doctoral level Brazilian scientist to join our group there. In addition to these students, it is planned to add one more student, Jadson Dias who should attend CENA-USP for his M.S. beginning in August 2003. He will be replaced in Santarem by another technician.

Short Courses / Seminars / Workshops

- Short courses coordinated with Brazilian partner institutions will continue to be offered involving students and technicians. Dates to be announced.

Visits / Exchange Programs

- Two students from CTA will spend one month each at UNH to work on data analysis and publications during 2004.

Beija-Flor Datasets: (as of 2003-06-16)

Biomass in the Tapajos National Forest: Examination of Sampling and Allometric Uncertainties (Poster)

Calibration of the Campbell CS-615 Water Content Reflectometer in High Clay Content Yellow Latasol in the Flona Tapajos (Poster)

CO2, CH4, NO and N2O fluxes from a root mortality experiment

Coarse Woody Debris in Logged and Undisturbed Forests: Determination of Stocks Using a New Methodology for Wood Density and Void Estimation (Poster)

Fate of Phosphorus in a Lowland Amazonian Rainforest

FFT Tree Census in 4 Logging Blocks at Tapajos National Forest, (km 83) Belterra, Para, Brazil

Seasonality of Stem Respiration at the Tapajos National Forest (Poster)

Soil-Atmosphere Flux of Carbon Dioxide in Undisturbed forest at the Flona Tapajos, Brazil (Poster)

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

Trace gas fluxes from undisturbed and logged forest sites at Tapajos National Forest, Km 83

Publications:

Silver WL, Neff J, McGroddy M, Veldkamp E, Keller M, Cosme R. (2000) Effects of soil texture on belowground carbon and nutrient storage in a lowland Amazonian forest ecosystem. *Ecosystems*, **3**, 193-209.

Keller M, Palace M, Hurtt G. (2001) Biomass estimation in the Tapajos National Forest, Brazil - Examination of sampling and allometric uncertainties. *Forest Ecology and Management*, **154**, 371-382.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3 - What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazônia-wide flux?
- CD-Q3b - How does selective logging change the storage and cycling of carbon in forests?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?
- TG-Q2 - What is the (climatically driven) seasonal and inter-annual variability of trace gas and aerosol fluxes between the atmosphere and different land use and land cover types?
- TG-Q3 - Are losses and gains of carbon from Amazônian ecosystems in forms other than carbon dioxide (e.g. carbon monoxide, methane, volatile organic carbon, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance?

TG-08 (Melillo / Cerri) Investigation Profile

Biogeochemical Consequences of Agricultural Intensification in the Amazon Basin

Principal Investigators:

Carlos Clemente Cerri, CENA/USP (SA-PI)
Jerry M. Melillo, Marine Biological Laboratory (US-PI)

Abstract 2003:

Intensification of agriculture is emerging as a major issue in the Amazon Basin because it is likely to have broad-scale biological and biogeochemical effects. We propose to study the biogeochemical effects of the intensification of pasture agriculture and the conversion of pasture to soybean monoculture. To do this we have established a series of large (40m x 40m) experimental plots on a ranch in Rondônia where we have studied pasture biogeochemistry for the past decade. Through a range of experimental treatments and a regional survey, we are developing a process-level understanding of how biogeochemical phenomena such as soil carbon balance, trace gas emissions and leaching losses of plant nutrients are affected by changes in agricultural land use. We will collaborate with other LBA investigators to scale site-specific data to the whole Basin.

Investigation Duration:

1998 - 2003

Participants:

Cristiano Alberto de Andrade, Escola Superior de Agricultura
Karine Cristian Augusti, Centro de Energia Nuclear na Agricultura (CENA- USP)
Janaina Braga do Carmo, CENA/ESALQ
Marcelo Elias Cassiolato, CENA/ESALQ/USP
Carlos Eduardo Pellegrino Cerri, CENA/USP
Carlos Clemente Cerri, SA-PI, CENA/USP
Diana Cecilia Garcia-Montiel, WHRC
Jerry M. Melillo, US-PI, Marine Biological Laboratory
Christopher Neill, Co-Investigator, Marine Biological Laboratory
Norberto Cornejo Noronha
Caio Cesar Passianoto, CENA-USP
Marisa de Cassia Piccolo, CENA-USP
Paul A. Steudler, Co-Investigator, MBL

Student Information:

Cristiano Alberto de Andrade, Escola Superior de Agricultura, Citizenship: BRAZIL, Ph.D. student, Thesis: Dinâmica da matéria orgânica do solo em cronossequência de pastagens e em pastagem degradada submetida a estratégias para recuperação

Karine Cristian Augusti, Centro de Energia Nuclear na Agricultura (CENA- USP), Citizenship: BRAZIL, Masters student, Thesis: Biomassa microbiana e suas relações com fontes de matéria orgânica do solo em sistemas de recuperação de pastagens em Rondônia.

Janaina Braga do Carmo, CENA/ESALQ, Citizenship: BRAZIL, Ph.D. student, Thesis: Nitrogen Dynamics and Phosphorus Available in Pasture Restoration System in Rondônia

Marcelo Elias Cassiolato, CENA/ESALQ/USP, Citizenship: BRAZIL, Masters student, Thesis: Chemical composition of soil solution and water runoff in pasture restoration and forest systems in Rondônia

Carlos Clemente Cerri, CENA/USP, Citizenship: BRAZIL, Ph.D. student

Carlos Eduardo Pellegrino Cerri, CENA/USP, Citizenship: BRAZIL, Ph.D. student, Thesis: VARIABILIDADE ESPACIAL E TEMPORAL DO CARBONO DO SOLO NA CONVERSÃO DE FLORESTA EM PASTAGENS NA AMAZÔNIA OCIDENTAL (RONDÔNIA)

Norberto Cornejo Noronha, Citizenship: BRAZIL, Ph.D. student

Caio Cesar Passianoto, CENA-USP, Citizenship: BRAZIL, Ph.D. student, Thesis: Soil trace gas emission influenced by different managements

Proposed Research Sites:

Rondonia
    Fazenda Nova Vida

Proposed Training and Education:

Formal Training

    - Currently there are seven Brazilian students working in this team - five doctoral students and two Masters students. They are developing research on soil nitrogen dynamics and trace gas fluxes. Support for current students will continue to be provided.

Beija-Flor Datasets: (as of 2003-06-16)

Changes to Inorganic Nitrogen in Soil and Soil Solution Following Forest Clearing for Pasture in Rondonia (Poster)

Chemical Composition of Soil Solution and Water Runoff in Pasture and Forest Systems in Rondonia (Poster)

Soil carbon stocks influenced by litter and roots quality on pasture chronosequence in Rondônia (Poster)

Soil trace gas emissions influenced by pasture reformation systems in Rondônia, Brazil (Poster)

Spatial variation of soil properties in a 63 ha low productivity Amazon pasture (Poster)

Spatial variation of soil properties in a 63 ha low productivity Amazon pasture (Poster)

Variability of Soil Microbial Biomass Carbon in Different Pasture Restoration Systems in Rondônia, Brazil (Poster)

Publications:

Currently none available.

Science Questions Addressed by this Investigation:

Carbon Dynamics:

- CD-Q3a - How do pools and fluxes of carbon and nutrients (in soils) of pasture/cropland change over time and what factors determine carbon gain or loss?

Nutrient Dynamics and Surface Water Chemistry:

- ND-Q1 - How do stocks, cycling rates and budgets of carbon and important elements nitrogen, phosphorus, potassium, calcium, magnesium, and aluminum change under different land covers and land uses?

Trace Gas and Aerosol Flux:

- TG-Q1 - How are fluxes of trace gases and aerosols between ecosystems (both upland and wetland) and the atmosphere of Amazônia affected by land cover and land use change?

Sites

Acre

Description

Acre is located in the western Amazon, bordering Bolivia and Peru. The capital of Acre, Rio Branco, is located about 85 km from the Bolivian border with Brazil. The state of Acre has large–scale colonization projects, logging activities, extensive cattle ranching, and a population growing at one of the highest rates in Amazonia, 3% each year (Instituto Brasileiro de Geografica e Estatística, 1997). In addition, the region has unique characteristics for comparative studies of degradation because of its extensive areas of eutrophic soils intermingled with nutrient–poor oxisols and ultisols. The area also has some of the most innovative alternative land uses in Amazonia; 1.4 million ha of extractive reserves (e.g., Chico Mendes Extractive Reserve) have been established, which serve to maintain forest ecosystems and to provide income to forest residents. Acre also has about half of the 18 million hectares of bamboo–dominated forests of western Amazonia. A logging boom has begun in Acre, with companies migrating from Pará to Acre to extract mahogany and other hardwoods. Rates of land–cover and land–use change are intensifying, and examples of many land–cover changes occur within a 70–km radius of the city of Rio Branco. Acre receives 1950 mm of annual precipitation. Within this region, collaborating institutions (Federal University of Acre–UFAC and Federal Agricultural Research Company–EMBRAPA/AC) have over 3,000 ha in experimental areas. In addition to other sites, two UFAC study sites within 30 km of Rio Branco are used.

LBA-ECO Researchers Proposing to Work in *Acre*

CD-05 (Nepstad / Klink / Moutinho)
CD-06 (Richey / Victoria)
CD-08 (Trumbore / Camargo)
LC-02 (Brown / Silveira / Esteves)
LC-23 (Morisette / Schroeder / Pereira)
TG-03 (Holben / Artaxo / Duarte / Setzer)

Acre - Assis Brasil

Field Site - The eastern part has the Santa Quiteria extractive settlement, the central part has small ranches. The southeastern area is an Indian reserve in Bolivia and the southwestern area has logging in Peru. Water supplies for Assis Brasil, Brasil and Inapari, Peru are being affected by land use changes.

Coordinates: NLat: 0.00, SLat: 0.00, ELong: -69.54900, WLong: -69.54900

Acre - Cachoeira

Field Site - The northern part is in the Chico Mendes Extractive Reserves with scattered clearings. The central part has large ranches, the southern part has the densely populated Cachoeira extractive settlement. The only certified wood extraction in the Brazilian Amazon is occurring in Cachoeira.

Coordinates: NLat: -10.5800, SLat: -10.5800, ELong: -68.2700, WLong: -68.2700

Acre - Catuaba Experimental Farm

Field Site - Located just outside Rio Branco near the intersection of BR 317 and BR 364, the Catuaba Experimental Farm (800 ha) is on dystrophic Oxisols and Ultisols. The vegetation cover types within this study site are primary forest, bamboo forest, secondary forest, and pasture.

Coordinates: NLat: -10.07300, SLat: -10.07300, ELong: -67.62900, WLong: -67.62900

Acre - Epitaciolandia

Field Site - The northern part has small ranches, the eastern part extractivists, the southern part is in Bolivia where burning is concentrated along the road. Bolivia is planning on opening up this region for cattle ranching.

The northern region also has implications for water supply for the local urban centers

Coordinates: NLat: 0.00, SLat: 0.00, ELong: -68.61200, WLong: -68.61200

Acre - Humaita Forest Reserve

Field Site - The Humaita Forest Reserve (1,300 ha) includes some agricultural lands and is underlain by a mosaic of eutrophic and dystrophic Ultisols. The vegetation cover types within this study site are primary forest, bamboo forest, secondary forest, and pasture.

Coordinates: NLat: -7.00, SLat: -7.00, ELong: -67.00, WLong: -67.00

Acre - Mapinguari Antimari

No description available.

Acre - Parque Zoobotanico

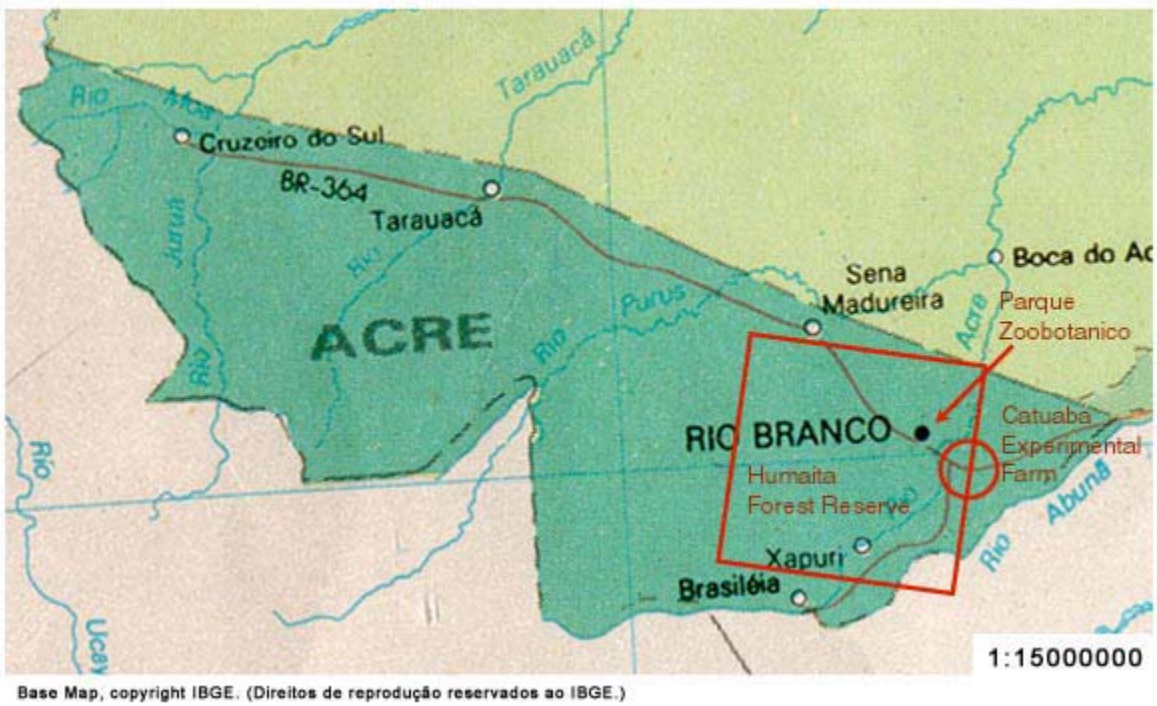
Field Site - The Parque Zoobotânico is located at the Universidade Federal do Acre in Rio Branco.

Coordinates: NLat: -9.9500, SLat: -9.9500, ELong: -67.8700, WLong: -67.8700

Acre - Ponteio Capixaba

No description available.

Maps for Acre



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Main Regional Map for Acre for Acre

Amazonas (Manaus)

Description

The capital city of the state of Amazonas is Manaus, located near the confluence of the Negro and Solimões Rivers. This area of the central Amazon is relatively undisturbed compared to the eastern Amazon or the Andean Piedmont, but it is currently the focus of increasing deforestation pressure for pasture establishment and selective logging. The recent (1996) completion of the asphalt road (BR 174) linking Manaus with Boa Vista and Venezuela is already significantly increasing deforestation along the highway. The majority of the study sites in Amazonas are near Manaus. These sites are located within 100 km of the city in evergreen secondary and primary forest, pastures derived from primary forest conversion, logged forest, agrosilvopastoral areas, and inundated areas. Many of these sites are located in preexisting research areas. The Manaus area has an annual precipitation that averages 2186 mm and a mean annual temperature of 27°C. The wettest months are March and April (c. 300 mm rainfall per month), and July, August, and September are the driest (<100 mm rainfall per month).

LBA-ECO Researchers Proposing to Work in *Amazonas (Manaus)*

CD-02 (Ehleringer / Martinelli)
CD-03 (Fitzjarrald / Moraes)
CD-06 (Richey / Victoria)
CD-08 (Trumbore / Camargo)
CD-10 (Wofsy / Kirchhoff / Camargo / A. Nobre)
LC-05 (Laurance / Mesquita)
LC-07 (Melack / Novo / Forsberg)
LC-09 (Moran / Batistella)
ND-04 (Fernandes / Wandelli)
ND-09 (Richey / Victoria)
ND-11 (Fernandes / Passos / Couto)
TG-03 (Holben / Artaxo / Duarte / Setzer)
TG-07 (Keller / de Mello)

Amazonas (Manaus) - Balbina

No description available.

Amazonas (Manaus) - Cabaliana

Field Site - Cabaliana also includes Calado

Coordinates: NLat: -3.14235, SLat: -3.81735, ELong: -60.49131, WLong: -61.59964

Amazonas (Manaus) - Cuiuni

Field Site - upper Negro site

Coordinates: NLat: -0.47570, SLat: -1.14236, ELong: -63.09964, WLong: -64.10797

Amazonas (Manaus) - Demini

Field Site - upper Negro site

Coordinates: NLat: 0.65918, SLat: -0.37415, ELong: -62.04255, WLong: -62.86755

Amazonas (Manaus) - EMBRAPA DAS Experiment - km 52

Field Site - The Embrapa DAS Experiment site is located 52 km north of Manaus on the highway BR 174 Manaus-Boa Vista.

Amazonas (Manaus) - EMBRAPA DAS Experiment - km 54 (CPAA)

Field Site - The Embrapa DAS Experiment site (Embrapa–CPAA pasture research station) is located 54 km north of Manaus on the highway BR 174 Manaus-Boa Vista at 60 m elevation. This station is only a few kilometers away from the INPA tower and forest management areas. The site is characterized by a rolling topography with plateaus and small valleys, and the dominant vegetation at the site is evergreen forest. The soil type is a Xanthic Hapludox, which is the major soil type in the central Amazon. There is good access to both old and newly established pastures in conditions representative of those faced by small farmers. Approximately 200 hectares of a forest were cleared and burned in the 1980's, and Brachiaria humidicola pastures were established. Secondary succession of the pastures began soon after pasture establishment. Studies on vegetation characterization at the site have resulted in the identification of 39 species representing 34 genera and 23 families. The most abundant tree species were Laetia procera, Vismia amazonica, V. lateriflora, and V. cayennensis. The most frequently encountered herbaceous species were the competitive forbs Borreria verticillata and Rolandra fruticosa. The species and genera detected at this site have also been reported in species inventories of abandoned pastures at other locations in Amazonia.

Coordinates: NLat: -2.51800, SLat: -2.51800, ELong: -60.0300, WLong: -60.0300

Amazonas (Manaus) - Mamiraua

No description available.

Amazonas (Manaus) - Marchantaria

Field Site - Marchantaria also includes Ariau, Barroso, and Careiro

Coordinates: NLat: -3.00902, SLat: -3.53402, ELong: -59.50798, WLong: -60.49965

Amazonas (Manaus) - Mil Madeira Itacoatiara

Field Site - The Mil Madeira Itacoatiara is located 227 km east of Manaus and 40 km west of Itacoatiara between the coordinates 20 43' S and 30 04' S and 580 31' W and 580 57' W. Mil Madeira is a part of a commercial logging operation in Itacoatiara, Am, Brazil.

Coordinates: NLat: -20.71667, SLat: -30.06667, ELong: -58.51667, WLong: -58.9500

Amazonas (Manaus) - Pico Da Neblina National Park

Field Site - Pico de Neblina National Park is located near São Gabriel da Cachoeira in the northwestern corner of Amazonas, along the banks of the Negro River. Pico da Neblina National Park is a mature, undisturbed evergreen forest. This site is in one of the wettest parts of Amazônia, with an annual precipitation of 4000 mm.

Coordinates: NLat: 0.48300, SLat: 0.48300, ELong: -66.500, WLong: -66.500

Amazonas (Manaus) - Reserva Ducke

Field Site - Reserva Ducke is an area of protected primary forest, 25 km north-east of Manaus at 80 m above mean sea level. The experimental site was also the site of the Amazon Regional Micrometeorological Experiment in the early 1980s (see Shuttleworth et al. (1991) for a summary), but was re-established for ABRACOS in late 1990. The mean forest canopy is 35 m high, but some trees reach up to 40 m. The forest in Reserva Ducke, in common with the other two forest sites studied, is made up of a large variety of tree species. The tallest species in the area around the tower are Piptadenia suaveolens Miq., Licania micrantha Miq., Bocoa viridiflora (Ducke) Cowan, Naucleopsis glabra Spruce ex Baill and Enterolobium schomburgkii Benth. The site is surrounded by undisturbed forest for at least 5 km.

Coordinates: NLat: -2.9500, SLat: -2.9500, ELong: -59.9500, WLong: -59.9500

Amazonas (Manaus) - Rio Cuieras (lower)

No description available.

Amazonas (Manaus) - Rio Negro

No description available.

Amazonas (Manaus) - Rio Preta da Eva

No description available.

Amazonas (Manaus) - Zamula

Field Site - upper Negro site

Coordinates: NLat: -0.41737, SLat: -1.07570, ELong: -62.21631, WLong: -62.94130

Amazonas (Manaus) - ZF2 km 14

Flux Tower Site - The National Institute of Amazon Research (INPA) forest management area and tower site are located in undisturbed primary forest.

Coordinates: NLat: -2.58900, SLat: -2.58900, ELong: -60.11520, WLong: -60.11520
Towers at ZF2 km 14:

- Flux Tower - 43 m walk-up flux tower

Amazonas (Manaus) - ZF2 km 25 - INPA Forest Management Site

Field Site - The National Institute of Amazon Research (INPA) forest management area and tower site are located in undisturbed primary forest.

Coordinates: NLat: -2.00, SLat: -2.00, ELong: -61.00, WLong: -61.00

Amazonas (Manaus) - ZF2 km 34

Flux Tower Site - The National Institute of Amazon Research (INPA) forest management area and tower site are located in undisturbed primary forest.

Coordinates: NLat: -2.500, SLat: -2.60900, ELong: -60.00, WLong: -60.20910
Towers at ZF2 km 34:

- Flux Tower - 54 m walk-up flux tower

Amazonas (Manaus) - ZF3 Biological Dynamics of Forest Fragments Project (BDFFP)

Field Site - The Biological Dynamics of Forest Fragments Project (BDFFP) is located 70–90 km north of Manaus near Km. 64 of BR 174 Manaus-Boa Vista Highway. It is in the Distrito Agropecuario, an area of approximately 500,000 ha of relatively undisturbed upland forest under development by the Manaus Free Trade Zone Authority (SUFRAMA). The project was initiated in 1979 as a joint Brazilian (INPA) and U.S. (World Wildlife Fund) project,

with the original research goal of identifying the minimum size of tropical forest habitat that would maintain most of the biotic diversity of an intact ecosystem (Lovejoy et al., 1986). This site is currently managed by INPA and the Smithsonian Institute, and has an elevation range from 80–110 meters. The predominant vegetation is non-flooded (terra firme) lowland tropical moist forest, far from large rivers and associated riverine habitats. Soils are nutrient–poor clay yellow Latosols (Xanthic Ferralsols). Forests are 30–37 m in height with emergents to 45–55 m. Based on a sample of 31 ha over a roughly 40–km transect the four most abundant tree families were Burseraceae, Sapotaceae, Leguminoseae, and Lecythidaceae. The most species rich were Sapotaceae (est. 72 species), Chrysobalanaceae (est. 58–80 species), Annonaceae, and Lecythidaceae (39 species). The research landscape of the BDFFP is composed of large cattle ranches cleared of forest in the early 1980s. These areas now include primary forest patches of varying sizes, extensive areas of mature continuous forest, and a matrix of cattle pastures and abandoned areas that are in different stages of forest regeneration. Information on the BDFFP research site was gathered from the BDFFP web page.

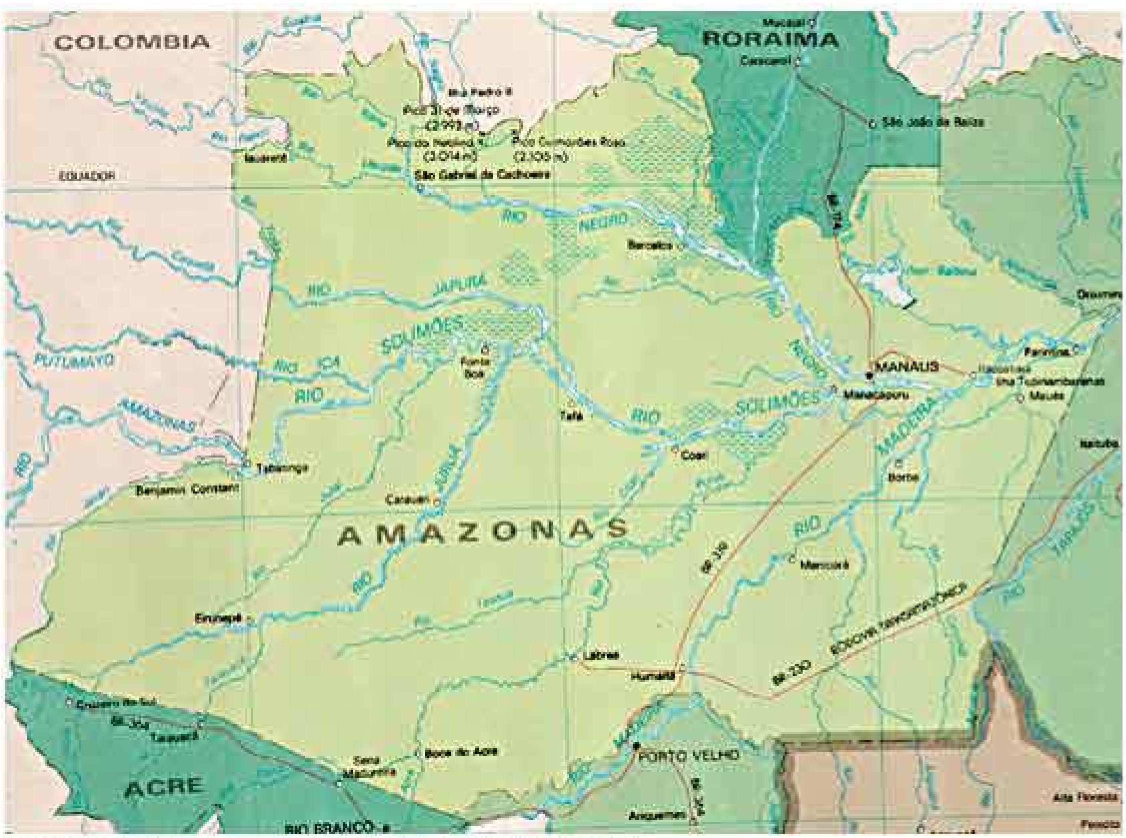
Coordinates: NLat: -2.33300, SLat: -2.33300, ELong: -60.06400, WLong: -60.06400

Amazonas (Manaus) - ZF3 Fazenda Dimona

Field Site - This is an experimental study area directly to the west of the main study area of the Biological Dynamics of Forest Fragments Project, about 80 km north of Manaus, Brazil. The study area is about 10 X 10 km in area, and is comprised by three forest fragments (1-10 ha in area), cattle pastures, regrowth forest,and intact forest. The Fazenda Dimona study area is accessible from the BR-174 Highway, about 2 hours north of Manaus. There are no towers located at this site. A small field camp with an electrical generator and basic kitchen and sleeping facilities is maintained on the site.

Coordinates: NLat: -2.00, SLat: -2.00, ELong: -59.00, WLong: -59.00

Maps for Amazonas (Manaus)



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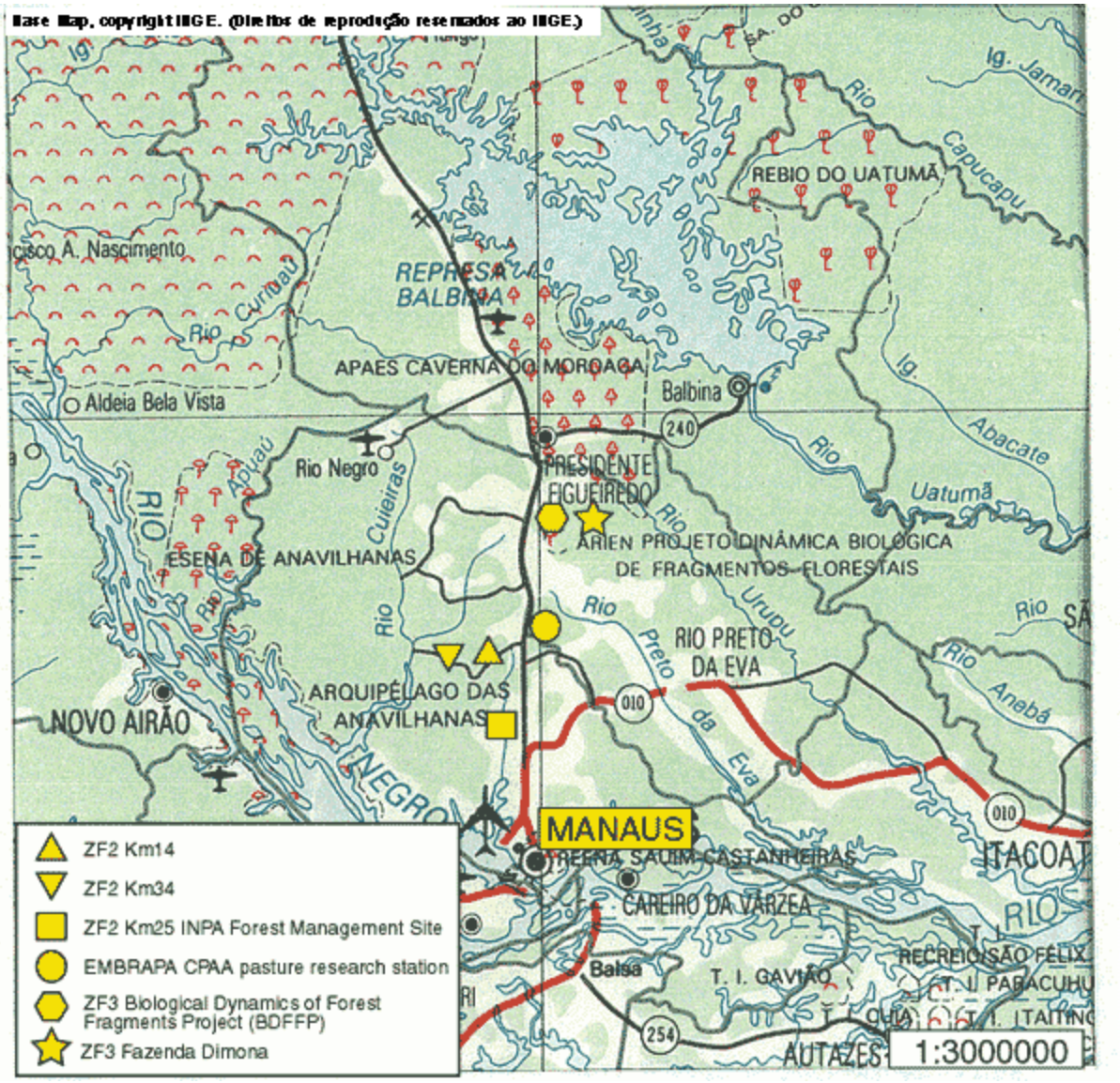
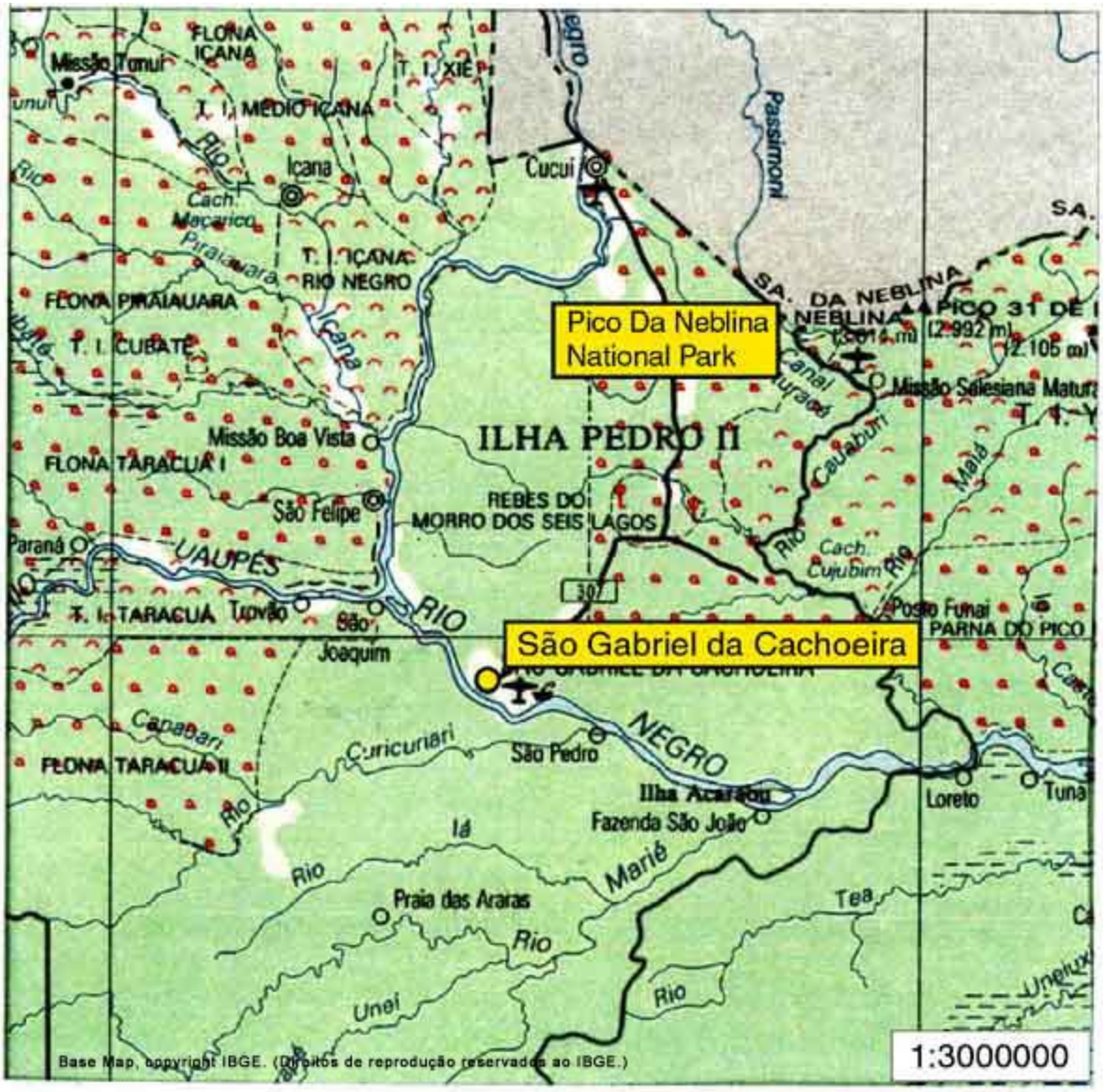
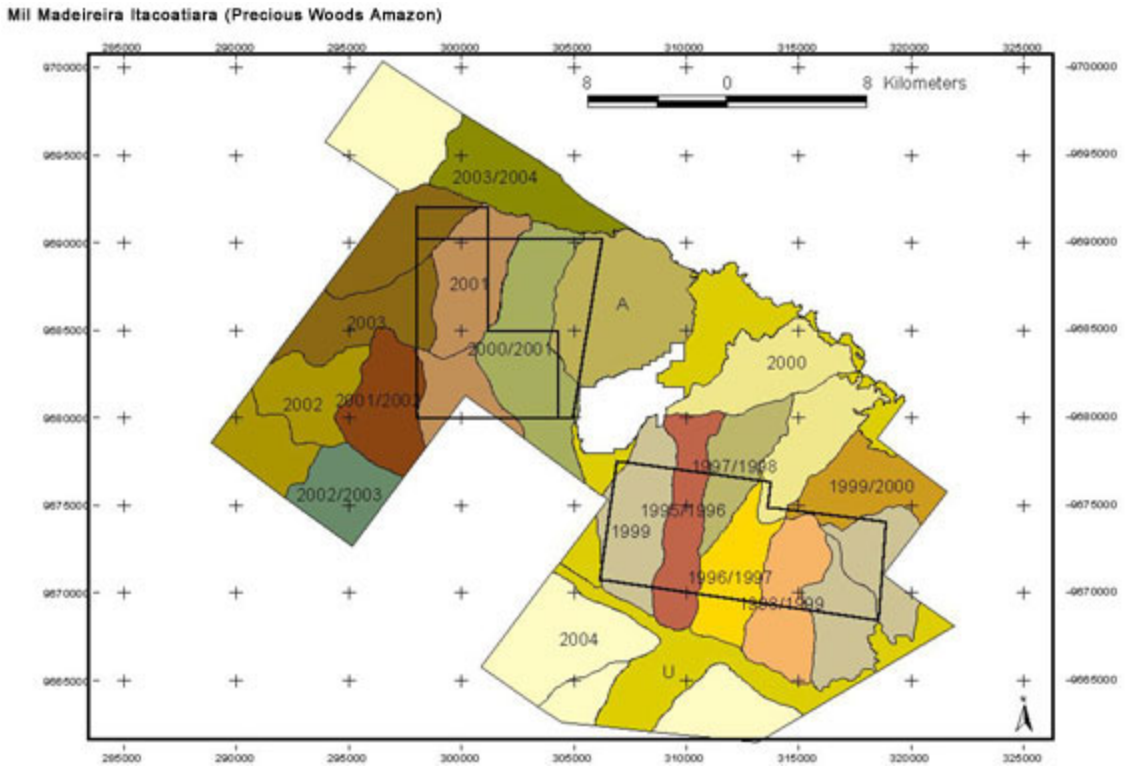
Main Regional Map for Amazonas (Manaus) for Amazonas (Manaus)



Main Site Map for Amazonas (Manaus) - Embrapa DAS Experiment - km 54 (CPAA) for Amazonas (Manaus)



Main Site Map for Amazonas (Manaus) - Pico Da Neblina National Park for Amazonas (Manaus)



Main Site Map for Amazonas (Manaus) - Mil Madeira Itacoatiara for Amazonas (Manaus)

Brasília

Description

Brasília, Federal District, is Brazil's capital, located in the Brazilian Central Plateau, locally known as the Cerrado region. The city is expanding very rapidly over the 5,814 km2 of the Federal District. Brasília was planned in the 1950s to be in the center of the country, strategically located in order to promote Brazil's inland development. Many of the governmental and urban facilities were built in the early sixties. The Cerrado is the second largest biome of Brazil, after the Amazon rain forest, representing 22 % of the country, or approximately 2 million km2. It is a tropical seasonal savanna, with a continuous layer of herbaceous species (mainly C4 grasses) at the peak of the vegetation growth, scattered with shrubs and trees that sometimes form a continuous canopy. It has a characteristic flora, which distinguishes it from other Brazilian biomes, such as the Amazonian and coastal rain forests or the Northeastern Caatinga. The Cerrado savanna is criss-crossed with corridors of mesophytic evergreen forest that occur along the rivers (gallery forest). Other types of vegetation occur infrequently such as hyperseasonal savannas (veredas), and dry savannas (campo rupestre). Four physiognomic types of savanna are commonly recognized in the Cerrado: campo limpo (grassland), campo sujo (shrub savanna), cerrado sensu strictu (savanna) and cerradão (woodland), which differ from each other by the relative abundance of woody and herbaceous (mainly grasses) species. The annual average rainfall is around 1,500 mm. Approximately 86 % of the Cerrado receives between 1,000 and 2,000 mm of precipitation annually, putting the region into an intermediary climatic position between the rainy Amazonian and the arid Caatinga. About 90% of total precipitation falls between October and March, resulting in two distinct climatic seasons (wet and dry). During the rainy season grasses are active and produce a large amount of green biomass that dries out during the dry season. The accumulation of dead material facilitates the occurrence of fire, especially at the end of the dry season. Cerrado has the richest flora among tropical savannas and is one of the world's environmental 'hot-spots'. Over 10,400 species of vascular plants are found, fifty of which are endemic. Fauna diversity is very high also with 180 species of reptiles, 113 of amphibians, 837 of birds and 195 of mammals. The Cerrado has a high diversity of soil types, geology, geomorphology, and climate. Most Cerrado soils are very deep and well drained, on gentle slopes (commonly less than 3 %), high in clay and iron oxides, and a mix of clay and secondary minerals. However, some soils are acidic; contain a low amount of organic matter; have a low concentration of calcium, magnesium, phosphorus and potassium; have a high concentration of iron and aluminum, and have a low cation exchange capacity. The high aluminum concentration in the soils is a matter of concern and argument. While high aluminum saturation in the cation exchange capacity of the soil can decrease crop productivity, some native trees are able to accumulate large amounts of aluminum in their leaves. The Cerrado is mostly composed of five topsoils: Latisols, or oxisols (cover 46% of the Cerrado); Cambisols and Litholic Neosols (occupy 10% of the Cerrado); Quartzarenic Neosols and Argisols (cover 15% each). The remaining 14% of the Cerrado is covered with various other soil types. The Federal District is located in the Brazilian Central plateau on the South

American tectonic plate. Rocks are mostly from the Pre-Cambrian period, covered with laterite from the Cenozoic period.

LBA-ECO Researchers Proposing to Work in *Brasília*

CD-05 (Nepstad / Klink / Moutinho)
CD-06 (Richey / Victoria)
CD-08 (Trumbore / Camargo)
LC-14 (Nepstad / Moutinho)
LC-16 (Davidson / Klink)
LC-21 (Asner / Bustamante / Silva)
LC-22 (DeFries / Shimabukuro)
ND-07 (Zepp / Bustamante)
TG-07 (Keller / de Mello)

Brasília - Brasília National Park

Field Site - The Brasília National Park, comprising an area of approximately 30,000 ha, is located in the northern Federal District of Brazil, between 15°35' S and 15°45' S latitude and 47°53' W and 48°05' longitude. It is the world's largest area of natural vegetation within an urban domain. The Brasília National Park encompasses the major true savanna formations encountered in the cerrado biome, which depicts the transitions from the dominant herbaceous stratum (savanna grassland, shrub grassland, and the savanna grassland or shrub savanna with termiters) to the more complex, wooded dominated stratum (wooded savanna and the savanna woodland). Other important land cover classes in the Park are the Santa Maria Lake in the central portion, and the anthropogenic and reforested areas, both located in the eastern part of the Park. The Brasília National Park serves as a test site for EOS MODIS evaluation along with other sites in Brasília, Santarém, and Ji-Paraná.

Coordinates: NLat: -15.58333, SLat: -15.7500, ELong: -47.88333, WLong: -48.08333

Brasília - Campo Sujo Bienal Tardia

Flux Tower Site - IBGE is located on identical, deeply weathered clay soils as those found at Águas Emendadas. The site has an annual precipitation of 1500–1550 mm and has a history of fires. IBGE has two cerrado study sites: one burned in 1977 and another burned in 1996. The reserve is an active research site utilized by scientists from many organizations, including the University of Brasília.

Coordinates: NLat: -15.95260, SLat: -15.95260, ELong: -47.86950, WLong: -47.86950
Towers at Campo Sujo Bienal Tardia:

- Flux Tower - 3 m

Brasília - Campo Sujo Quadrienal

Flux Tower Site - IBGE is located on identical, deeply weathered clay soils as those found at Águas Emendadas. The site has an annual precipitation of 1500–1550 mm and has a history of fires. IBGE has two cerrado study sites: one burned in 1977 and another burned in 1996. The reserve is an active research site utilized by scientists from many organizations, including the University of Brasília.

Coordinates: NLat: -15.95120, SLat: -15.95120, ELong: -47.86760, WLong: -47.86760
Towers at Campo Sujo Quadrienal:

- Flux Tower - 3 m

Brasília - EMBRAPA Cerrados Pasture

Field Site - Sites located at EMBRAPA (Brazilian Agricultural Research Center): selected pasture, crop and watershed sites.

Coordinates: NLat: -15.58333, SLat: -15.58333, ELong: -47.700, WLong: -47.700

Brasília - Fazenda Dom Bosco

Field Site - Fazenda Dom Bosco is a private farm where some crop sites will be studied: beans (under irrigation) and corn.

Coordinates: NLat: -16.300, SLat: -16.300, ELong: -47.500, WLong: -47.500

Brasília - Fazenda Rio de Janeiro

Field Site - Fazenda Rio de Janeiro is a private farm where some crop sites will be studied (North of Brasília).

Coordinates: NLat: -15.23333, SLat: -15.23333, ELong: -47.700, WLong: -47.700

Brasília - Reserva Ecologica Aguas Emendadas

Flux Tower Site - Águas Emendadas is located on deeply weathered clay soils and has an annual precipitation of 1500–1550 mm. Águas Emendadas has a history of fires. Two cerrado study sites at the reserve were burned: one in 1989 and another in 1995. The reserve is an active research sites utilized by scientists from many organizations, including the University of Brasília

Coordinates: NLat: -15.5500, SLat: -15.5500, ELong: -47.600, WLong: -47.600
Towers at Reserva Ecologica Aguas Emendadas:

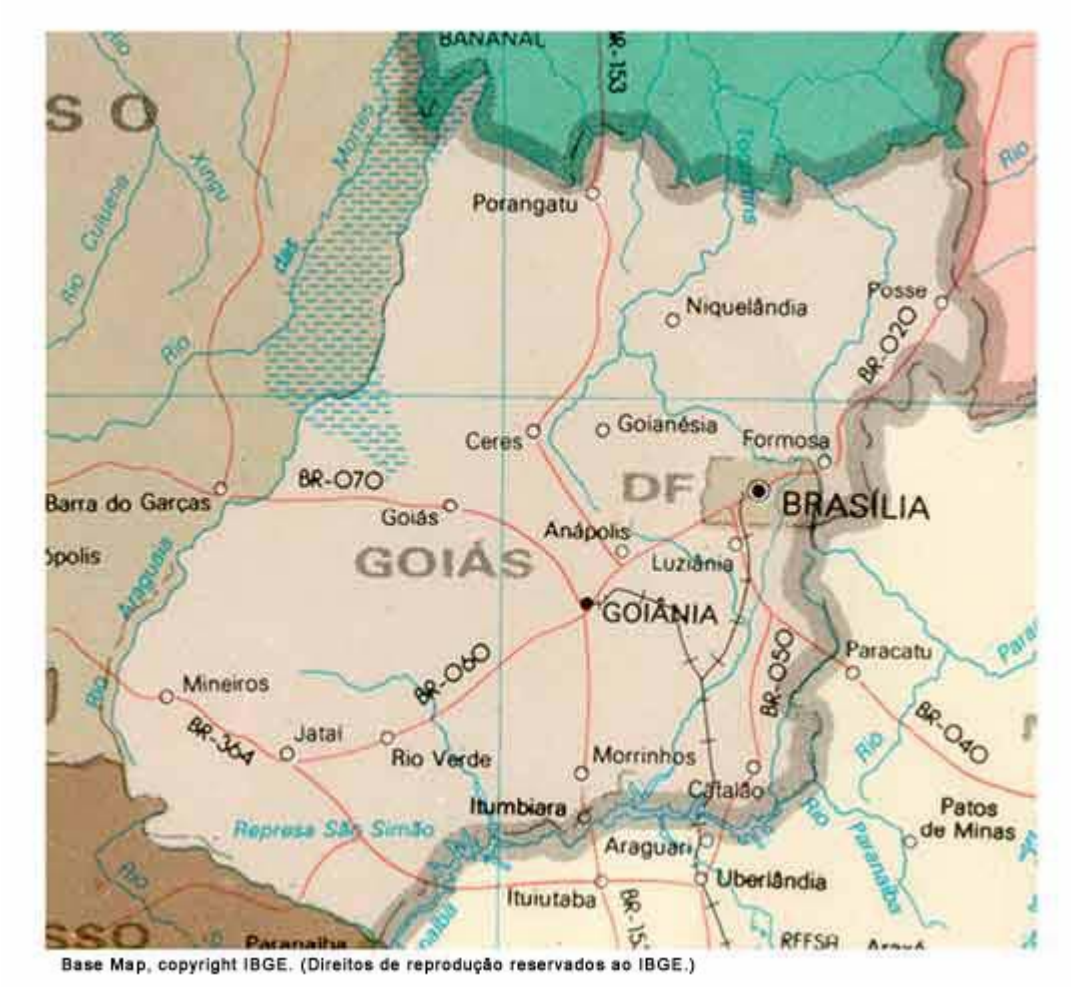
- Flux Tower - 2-15 m walk-up flux towers
- Met Tower - 15 m walk-up

Brasília - Reserva Ecologica do Roncador IBGE

Field Site - IBGE is located on identical, deeply weathered clay soils as those found at Águas Emendadas. The site has an annual precipitation of 1500 – 1550 mm and has a history of fires. IBGE has two cerrado study sites: one burned in 1977 and another burned in 1996. The reserve is an active research site utilized by scientists from many organizations, including the University of Brasília.

Coordinates: NLat: -15.93280, SLat: -15.93280, ELong: -47.85060, WLong: -47.85060

Maps for Brasília



Main Regional Map for Brasília for Brasília

Main Site Map for Brasília - Brasília National Park for Brasília

Ceará

Description

Ceará is located in the Northeast of Brazil. The state lies on the northern coast with the Atlantic Ocean. The area surrounding the capital city of Ceará, Fortaleza, is the site for aircraft flux measurements of vertical profiles of carbon dioxide and trace gases.

LBA-ECO Researchers Proposing to Work in *Ceará*

TG-06 (Bakwin / Artaxo / Gatti / Martinelli)

Ceará - Fortaleza

Field Site - Fortaleza is currently used only for aircraft flux measurements of vertical profiles of carbon dioxide and other trace gas species. The actual sampling area is approximately 50 km NE of Fortaleza over the Atlantic Ocean.

Coordinates: NLat: -2.500, SLat: -4.500, ELong: -37.00, WLong: -41.500

Maps for Ceará

Main Regional Map for Ceará for Ceará

Main Site Map for Ceará - Fortaleza for Ceará

Colombia

Description

Much of the Southeastern region of Columbia is part of western Amazonia. The Vaupes region, located in the area near the Northwest region of the Brazilian state of Amazonas, is an LBA-ECO study area. The vegetation includes dense upland forest and large patches of Amazon caatinga (found on the Spodosols). The soil contains large patches of nutrient-poor Spodosols intermixed with stretches of Oxisols. Previously collected field data from upland forest and swidden agricultural areas will be used for modeling purposes.

LBA-ECO Researchers Proposing to Work in *Colombia*

There are no investigators proposing to work in this region.

Colombia - Yapu

Field Site - Yapu, located in the Colombian Vaupes, is composed of large patches of nutrient–poor Spodosols intermixed with stretches of Oxisols covered by a dense upland forest and large patches of Amazon caatinga

(found on the Spodosols). The Vaupes site is populated by indigenous Amazonians who practice traditional long–fallow swidden cultivation based on bitter manioc at very low population densities.

Coordinates: NLat: -1.500, SLat: 2.500, ELong: -69.00, WLong: -72.00

Maps for Colombia

Main Regional Map for Colombia for Colombia

Ecuador

Description

Northeastern Ecuador borders the Andes and lies at headwaters of the Amazon River (Figure 6.12). This region of high biological diversity possesses major centers of endemism as well as identified biodiversity "hot spots" (FAO 1995; Myers, 1988). Among the Amazon Basin countries, forest is disappearing fastest in Ecuador. Oil exploration, road construction, and land settlement threaten major conservation areas contiguous to colonization zones. This lowland forest region differs significantly in soil, settlement, and farming characteristics from the Brazilian Amazon. First, settlement has been almost entirely spontaneous rather than government-sponsored. Second, although detailed soil maps for the region do not exist, available maps indicate that moderately infertile, fragile Ferralsols dominate, with pockets of fertile volcanic soil due to the proximity to the Andes (FAO–UNESCO, 1971). While soil quality and type vary, on average, soils are more fertile in western Amazonia than in Brazil. Third, average annual precipitation (2,800 mm/year) is high; the lack of a distinct dry season precludes burning, and a "slash–and–mulch" system (Bromley, 1981) has evolved, in contrast to the slash–and–burn used elsewhere in Amazonia. For these reasons, the environment, in general, may allow a more ecologically sustainable agriculture and be more conducive to agricultural intensification than in the Brazilian Amazon (Bilsborrow/Walsh Proposal).

LBA-ECO Researchers Proposing to Work in *Ecuador*

LC-01 (Walsh / Bilsborrow / Ruiz)

Ecuador - Northern Ecuadorian Amazon

Field Site - Northeastern Ecuador borders the Andes and lies at headwaters of the Amazon River (Figure 6.12). This region of high biological diversity possesses major centers of endemism as well as identified biodiversity "hot spots" (FAO 1995; Myers, 1988). Among the Amazon Basin countries, forest is disappearing fastest in Ecuador. Oil exploration, road construction, and land settlement threaten major conservation areas contiguous to colonization zones. This lowland forest region differs significantly in soil, settlement, and farming characteristics from the Brazilian Amazon. First, settlement has been almost entirely spontaneous rather than government-sponsored. Second, although detailed soil maps for the region do not exist, available maps indicate that moderately infertile, fragile Ferralsols dominate, with pockets of fertile volcanic soil due to the proximity to the Andes (FAO–UNESCO, 1971). While soil quality and type vary, on average, soils are more fertile in western Amazonia than in Brazil. Third, average annual precipitation (2,800 mm/year) is high; the lack of a distinct dry season precludes burning, and a "slash–and–mulch" system (Bromley, 1981) has evolved, in contrast to the slash–and–burn used elsewhere in Amazonia. For these reasons, the environment, in general, may allow a more ecologically sustainable agriculture and be more conducive to agricultural intensification than in the Brazilian Amazon (Bilsborrow/Walsh Proposal).

Coordinates: NLat: -0.500, SLat: -0.500, ELong: -77.00, WLong: -77.00

Maps for Ecuador

Main Regional Map for Ecuador for Ecuador

Mato Grosso

Description

Mato Grosso is Brazil's third largest state (906,806 km2). Northern Mato Grosso is part of western Amazonia, while the southern portion of the state is part of the Pantanal. The border of Mato Grosso and Tocantins is the

location of wetlands of the Ilha do Bananal. Mato Grosso's land types include primary forest, agriculture, cerrado, and wetlands.

LBA-ECO Researchers Proposing to Work in *Mato Grosso*

CD-05 (Nepstad / Klink / Moutinho)
CD-06 (Richey / Victoria)
CD-11 (Houghton / Alencar)
CD-12 (Vourlitis / Priante)
LC-13 (Asner / Silva / Pereira)
LC-21 (Asner / Bustamante / Silva)
LC-22 (DeFries / Shimabukuro)
LC-24 (Walker / Reis)
ND-01 (Roberts / Barreto / Soares)
ND-11 (Fernandes / Passos / Couto)
TG-03 (Holben / Artaxo / Duarte / Setzer)
TG-07 (Keller / de Mello)

Mato Grosso - Alta Floresta

No description available.

Mato Grosso - Canarana

Field Site - The Canarana area is located Southeast of Parque Indigena do Zingu

Mato Grosso - Cuiaba

No description available.

Mato Grosso - Guaranta

Field Site - Guaranta do Norte is the first city in Mato Grosso heading south from Para along BR-163.

Mato Grosso - Juruena

No description available.

Mato Grosso - Sinop

Flux Tower Site - Sinop is located in NW Mato Grosso, approximately 500 km north of Cuiabá along BR 163.

Coordinates: NLat: -11.41230, SLat: -11.41230, ELong: -55.32470, WLong: -55.32470

Maps for Mato Grosso

Main Regional Map for Mato Grosso for Mato Grosso

Pará Eastern (Belém)

Description

The Eastern region of Pará is made up of the area in the state Pará east of the Xingú River. This area lies in eastern Amazonia. The capital city of Pará, Belém, is contained within this region. Belém is a major port city near the mouth of the Amazon River.

LBA-ECO Researchers Proposing to Work in *Pará Eastern (Belém)*

CD-05 (Nepstad / Klink / Moutinho)
CD-06 (Richey / Victoria)
CD-08 (Trumbore / Camargo)
CD-11 (Houghton / Alencar)
CD-17 (Ducey / Alves)
LC-07 (Melack / Novo / Forsberg)
LC-09 (Moran / Batistella)
LC-13 (Asner / Silva / Pereira)
LC-21 (Asner / Bustamante / Silva)
LC-23 (Morisette / Schroeder / Pereira)
ND-01 (Roberts / Barreto / Soares)
ND-02 (Davidson / Carvalho / Sa / Vieira / Moutinho / Figueiredo)
TG-07 (Keller / de Mello)

Pará Eastern (Belém) - Bragantina

Field Site - Land use in the Bragantina region dates back at least 100 years and has gone through several phases. Today the dominant form is short–fallow swidden cultivation, given the proximity of the Belém market and the high population density; however, logging has also been a land use in the upland and igapo (bottomland) forests. Cultivation of secondary growth areas has been common for decades, and islands of mature forest are rare. These soils are nutrient–poor Spodosols and Oxisols. The soils are sandy and classified in the Brazilian system as Latossolo Vermelho–Amarelo. Annual precipitation is 2000–3000 mm, and the dry season is only about

3 months long, as compared to the 5–6 months at Paragominas.

Coordinates: NLat: -1.00, SLat: -1.400, ELong: -53.5200, WLong: -53.800

Pará Eastern (Belém) - Capitao Poco

No description available.

Pará Eastern (Belém) - Carajás

No description available.

Pará Eastern (Belém) - Fazenda Cauaxi

Field Site - Fazenda Cauaxí is in the Ulianópolis Municipality of Pará. The Tropical Forest Foundation maintains a logging camp and school for demonstration of forest management techniques at this site. Training courses, demonstration and research activities have been conducted there since 1995 with the collaboration of property owners. Prior to current logging operations, there is no historical record of land use or collection of non-timber forest products although there are indicators of indigenous activity. Ranchers and loggers first entered the area in 1976 through the Rio Capim and the Rio Surubiju. There were no roads in the area until the 1980's. The climate at Fazenda Cauaxi is humid tropical. Total annual precipitation averages about 2200 mm. A dry season extends from July through November (generally <50 mm/month) although June and December are also frequently dry enough for logging operations. Soils in the area are classified mainly as dystrophic yellow latosols according to the Brazilian system. The topography is mainly flat to mildly undulating. The forest at Fazenda Cauaxi is classified as tropical dense moist forest. The most common timber species that were harvested during five years of forest operations are Licania sp., Manilkara huberii, Astronium lecointei, Eschweilera odorata, and Parkia spp. Stand basal area is approximately 57 m2 ha-1 for trees greater than 10 cm diameter at breast height.

Coordinates: NLat: -3.73130, SLat: -3.73130, ELong: -48.29060, WLong: -48.29060

Pará Eastern (Belém) - FLONA Caxiuanã

Flux Tower Site - The FLONA Caxiuanã is an undisturbed and protected national forest near the mouth of the Amazon River in the state of Pará. It is located 350 km west of Belém on the Pará River and just east of the Xingu River. A 33,000 ha ecological research station lies within the national forest (200,000 ha). This reserve encompasses upland (terra firme) and seasonally flooded forest (varzea) amidst a network of rivers and lakes. Other vegetation types in the area include wetlands, savanna, and bottomland forest (igapo).

Coordinates: NLat: -1.74830, SLat: -1.74830, ELong: -51.45360, WLong: -51.45360

Pará Eastern (Belém) - Igarapé Açu

Field Site - Igarapé–Açu, in the Bragantina region of northeastern Pará, is located about 100 km east of Belém. This area of slash–and–burn agriculture on small land holdings has been the site of intensive studies by the Studies on Human Impact on Forests and Floodplains in the Tropics (SHIFT) project, which is a collaborative effort involving German and Brazilian scientists, including Embrapa scientists involved in LBA. Nutrient stocks and fluxes, rates of biomass accumulation, and rates of evapotranspiration have been studied by SHIFT researchers with different experimental treatments and using secondary growth of age ranging from two to ten years old (Hölscher et al., 1997a,b).

Coordinates: NLat: -1.100, SLat: -1.100, ELong: -47.600, WLong: -47.600

Pará Eastern (Belém) - Jari Celulose

Field Site - The Jarí Celulose Forestry Project is headquartered in the town of Monte Dourado, Pará. Jari Celulose is a private company that grows eucalyptus for fiber production as well as other plantation species (e.g., Gmelina arborea and Pinus caribaea). The project is surrounded by and immediately adjacent to primary forest that has no recent history of human intervention, with the possible exception of extractive practices such as Brazil nut gathering, hunting, and other low-impact activities. Because the property is privately owned, there is well–

established land tenure, which facilitates long–term research project stability. Auburn University has signed a research agreement with Jarí Celulose and has worked collaboratively with the company in the past. The Jarí property is located on both sides of the Jarí River, the first major tributary flowing south into the Amazon River, at approximately 1°S and 52°W. Rainfall averages 2,115 mm annually, varying from 290 mm in May to 41 mm in October, with a brief but distinct dry season from September to November. The average annual temperature is 26.4°C, varying less than 2° monthly. Natural vegetative cover may be classified as semi–evergreen forest with layered tree canopy, high floristic diversity, and few herbaceous species. Forest inventories have shown at least 507 woody plant species on the property with representation of common tropical botanical families: Sapotaceae, Leguminaceae, Lecythidaceae, Meliaceae, Bignoniaceae, and Myristicaceae. Jarí has mapped soils found on the property into 25 categories based on extensive field observations and laboratory analysis (Corrê et al., 1989). These fall into one of five general soil types: yellow and red–yellow Latosols (74% of the property), Podzols (16%), Cambisols (7%), Plinthosols (2%), and alluvial soils (1%).

Coordinates: NLat: -0.8600, SLat: -0.8600, ELong: -52.5500, WLong: -52.5500

Pará Eastern (Belém) - Marabá

Field Site - Marabá is on the eastern edge of the state of Pará on a bend of the Tocantíns River. The city of Marabá is about 190 km south of the hydroelectric plant at Tucuruí and about 40 km west of the intersection of the states of Pará, Maranhão, and Tocantins.

Coordinates: NLat: -4.7500, SLat: -6.00, ELong: -48.7500, WLong: -49.500

Pará Eastern (Belém) - Marajó

No description available.

Pará Eastern (Belém) - Paragominas

Field Site - Fazenda Vitoria is a ranch in Paragominas that has been the site of numerous biogeochemical studies in primary and secondary forests, and in degraded and managed cattle pastures (Camargo et al., 1999; Davidson and Trumbore, 1995; Nepstad et al., 1994; Trumbore et al., 1995; Uhl et al., 1988). The soils are clay–rich, Latossolos Vermelho–Amarelo in the Brazilian classification system (Haplustox). The mean annual precipitation is 1800 mm and is highly seasonal. An asset of this site is the previous research on the effects of land–use change on soil C, N, and other nutrients, which provides a data history for current and future work.

Coordinates: NLat: -2.98300, SLat: -2.98300, ELong: -47.51600, WLong: -47.51600

Pará Eastern (Belém) - Peixe Boi

Field Site - This area of slash–and–burn agriculture located about 150 km east of Belém shares many characteristics in common with the Igarapé–Açu site, including the soils and climate. It has undergone eight to ten cycles of slash–and–burn and, therefore, provides an excellent opportunity to test the effects of this long–term land use on biogeochemical cycles. This site also has a 200 ha remnant of upland primary forest that has been used for comparison to the secondary forest and agricultural sites. This area was the site of intensive ground truthing for a remote sensing study of chronosequences that included 5–, 10–, 20– and 40–year–old secondary forests (Vieira et al., 1996).

Coordinates: NLat: -1.1600, SLat: -1.1600, ELong: -47.300, WLong: -47.300

Pará Eastern (Belém) - Ponta de Pedras

Field Site - Ponta de Pedras, on the Marajó Island of Pará, represents a transitional environment composed of upland Oxisols and floodplain alluvial soils. There is a wide range of vegetative cover at this site, including upland floodplain forests, palm–dominated forests, flooded forests, açai palm agroforestry, and different types of savannas. The land uses in the area are swidden and mechanized agriculture, logging, and agroforestry. This site has been historically occupied by Caboclo (non–native American indigenous Amazonian populations, or traditional populations that live on the island of Marajó and elsewhere) populations devoted to agroforestry activities in the floodplain and swidden agriculture in the uplands. Previously collected field data from this site are being used in a Land–Cover Land–Use Change model and no ground measurements are planned at this time. Studies here will focus on three areas occupied by Caboclo populations where household–level socioeconomic and demographic

assessments have already been completed. Each of these three areas characterizes a particular land use system: long–fallow swidden agriculture, agroforestry, or mechanized agriculture (Murrieta et al., 1989; Brondizio et al., 1994; Brondizio, 1996).

Coordinates: NLat: -1.3600, SLat: -1.3600, ELong: -48.8600, WLong: -48.8600

Pará Eastern (Belém) - Santana do Araguaia

Field Site - Santana do Araguaia is in the southeast corner of Pará, 30 km west of the Araguaia River. This is a non-LBA research site; however, data from secondary forests in the area are used in modeling.

Coordinates: NLat: -8.00, SLat: -10.00, ELong: -49.00, WLong: -51.00

Pará Eastern (Belém) - Sao Francisco do Para

No description available.

Pará Eastern (Belém) - Tailândia

Field Site - Tailândia, Pará is located about 190 km south of Belém and 175 km west of Paragominas on the BR 475 highway.

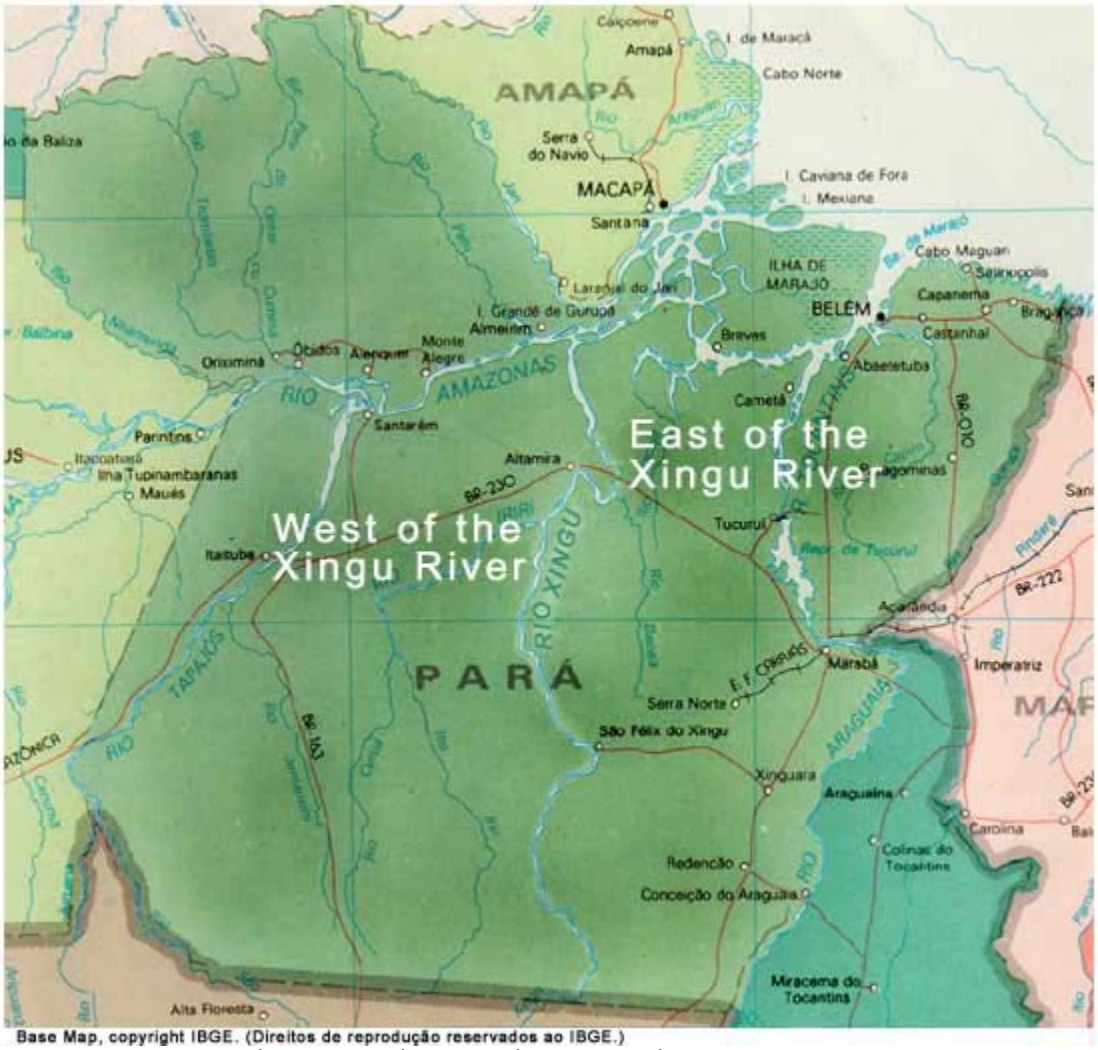
Coordinates: NLat: -2.9500, SLat: -2.9500, ELong: -48.9400, WLong: -48.9400

Pará Eastern (Belém) - Tomé Açu

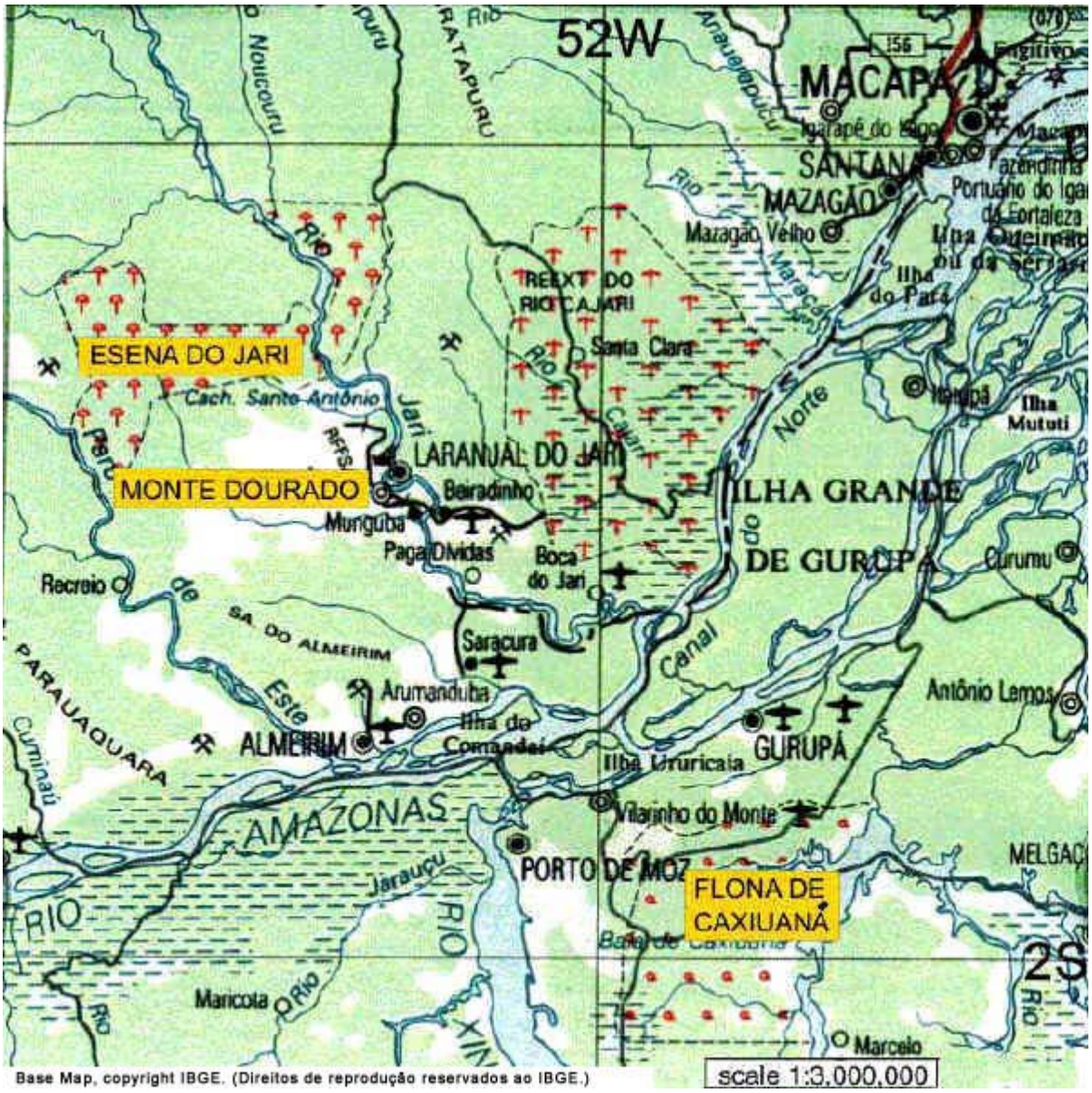
Field Site - Tomé–Açu is about 110 km directly south of Belém in northeastern Pará. This area represents a mosaic of Oxisol and Ultisol soils covered by dense, moist forest intermixed with secondary succession and agroforestry. This site has had intensive agricultural activities and is associated with past monoculture followed by agroforestry development during the past two decades.

Coordinates: NLat: -2.400, SLat: -2.400, ELong: -48.1800, WLong: -48.1800

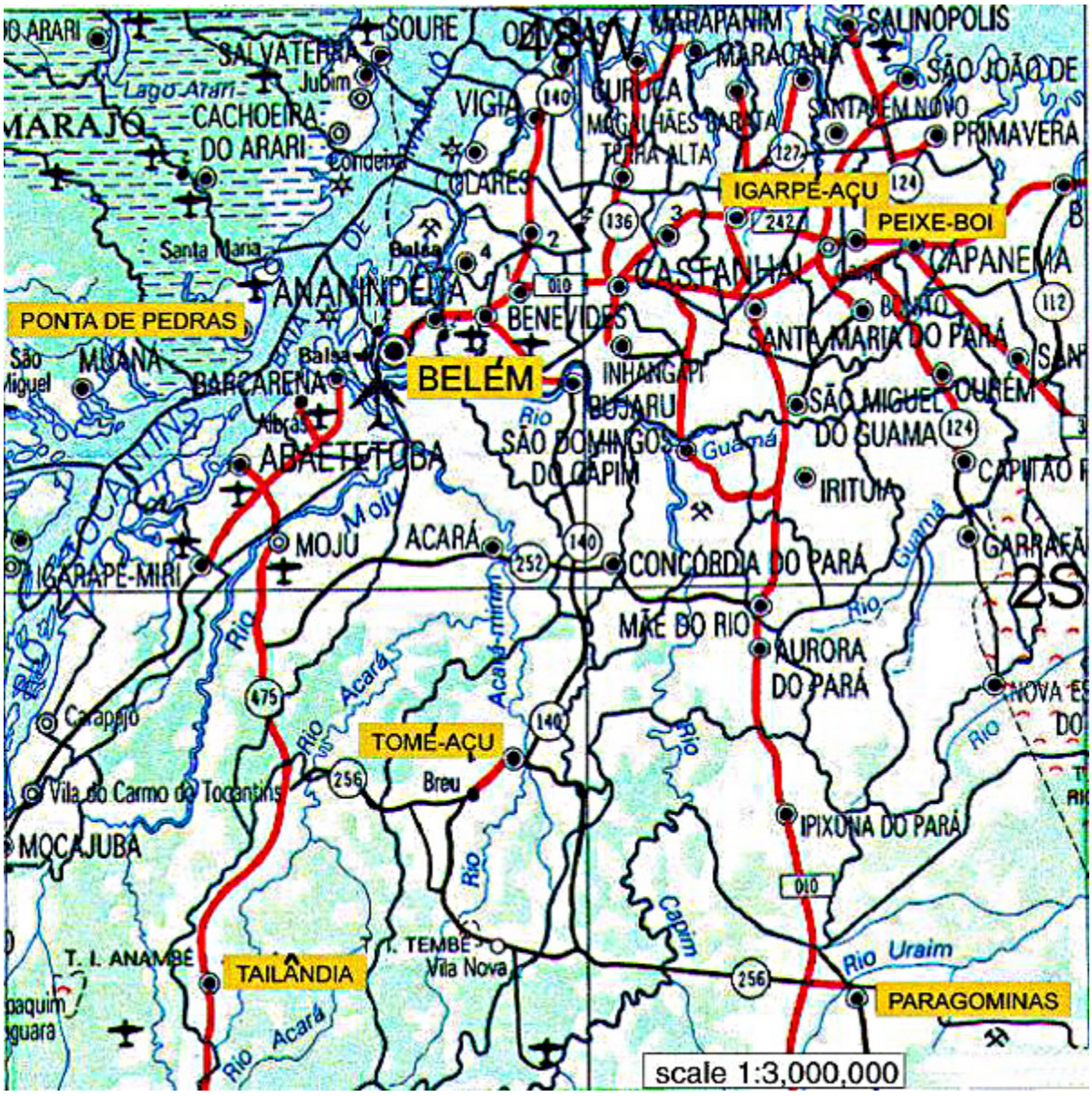
Maps for Pará Eastern (Belém)



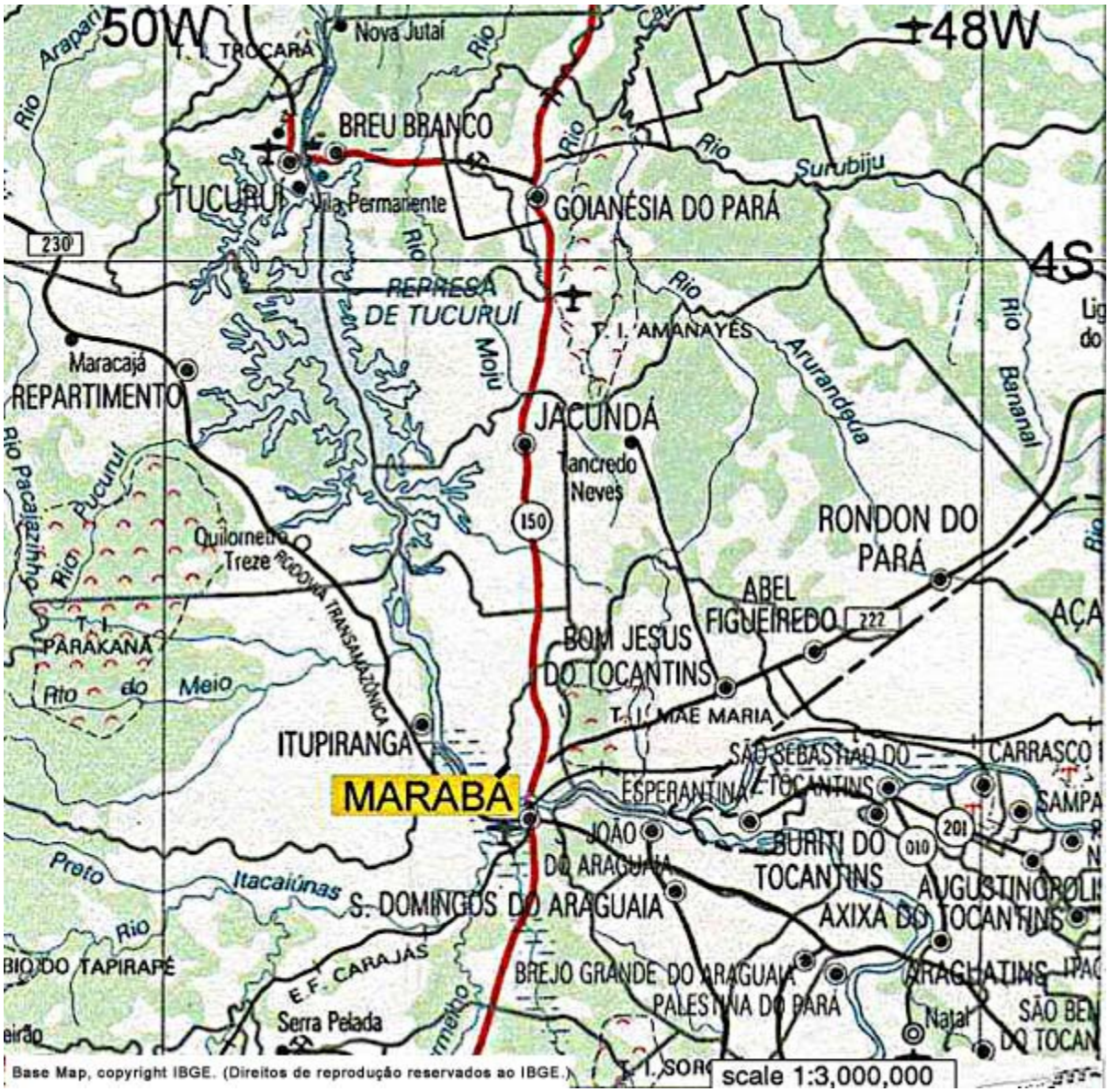
Main Regional Map for Pará Eastern (Belém) for Pará Eastern (Belém)



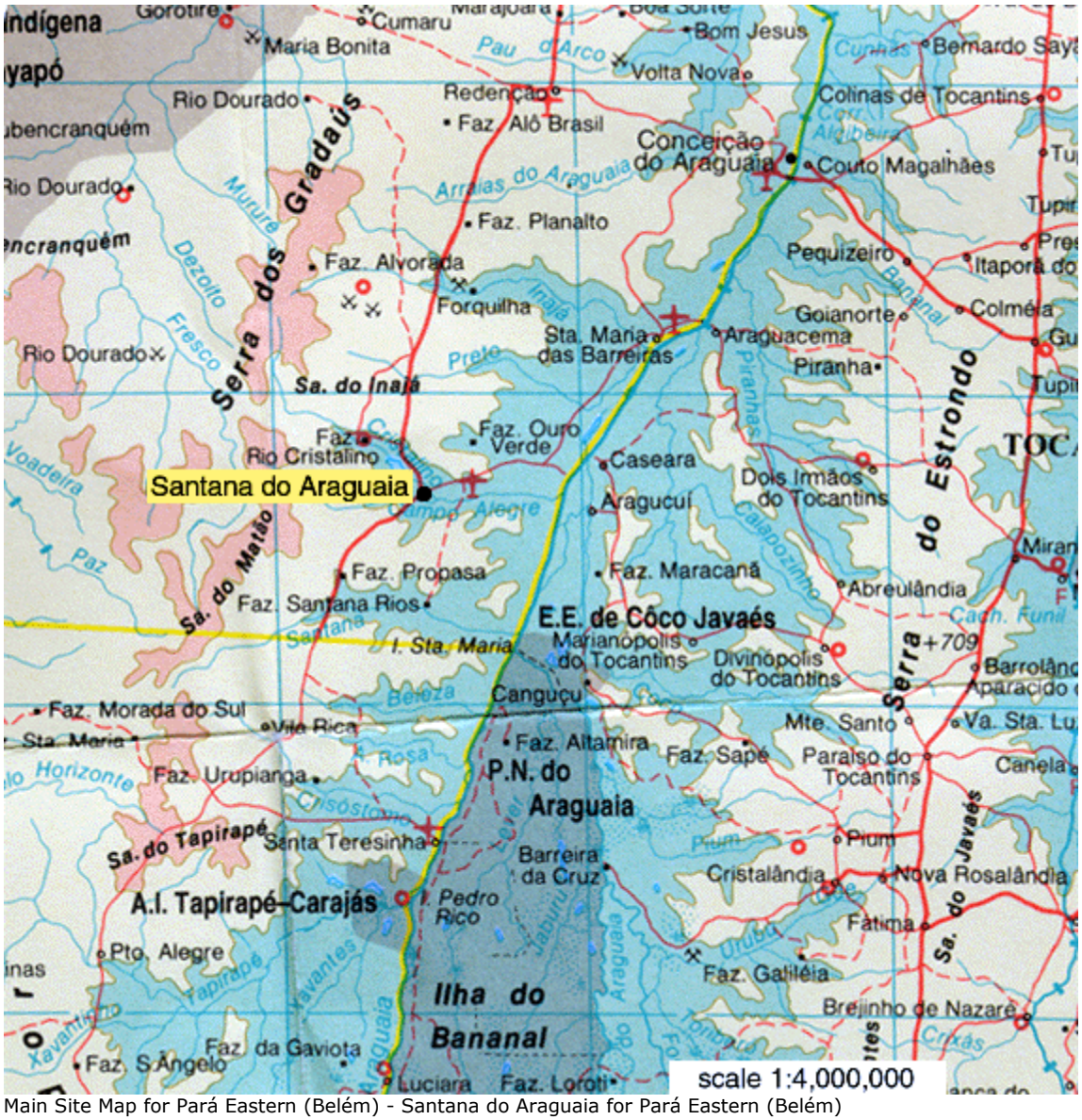
Main Site Map for Pará Eastern (Belém) - Bragantina for Pará Eastern (Belém)



Main Site Map for Pará Eastern (Belém) - Fazenda Cauaxi for Pará Eastern (Belém)



Main Site Map for Pará Eastern (Belém) - Marabá for Pará Eastern (Belém)



Main Site Map for Pará Eastern (Belém) - Santana do Araguaia for Pará Eastern (Belém)

Pará Western (Santarém)

Description

The focus of LBA-ECO research in western Pará is located in Santarém, a port city of 250,000 people at the confluence of the Tapajós and Amazon Rivers. Many of the LBA-ECO intensive study sites are in or near the Tapajós National Forest (Flona Tapajós), which contains nearly 600,000 ha of protected old?growth evergreen forest and is located 50 km south of Santarém. This national forest is bordered on the west by the Tapajós River and on the east by the highway BR 163, which intersects the Transamazon Highway about 180 km to the south of Santarém. The region receives about 2 m of rain each year with a seasonal pattern typical of much of eastern and southern Amazonia. The monthly rainfall extremes are March (375 mm) and October (50 mm; SUDAM, 1984). The Flona Tapajós has a variety of landforms and soils, which provide notable ecological contrasts for research.

LBA-ECO Researchers Proposing to Work in *Pará Western (Santarém)*

CD-01 (Denning / Dias)
CD-02 (Ehleringer / Martinelli)
CD-03 (Fitzjarrald / Moraes)

CD-04 (Goulden / Rocha)
CD-05 (Nepstad / Klink / Moutinho)
CD-06 (Richey / Victoria)
CD-08 (Trumbore / Camargo)
CD-10 (Wofsy / Kirchhoff / Camargo / A. Nobre)
CD-11 (Houghton / Alencar)
CD-15 (Cohen / Costa)
CD-17 (Ducey / Alves)
LC-07 (Melack / Novo / Forsberg)
LC-09 (Moran / Batistella)
LC-13 (Asner / Silva / Pereira)
LC-14 (Nepstad / Moutinho)
LC-21 (Asner / Bustamante / Silva)
LC-22 (DeFries / Shimabukuro)
LC-23 (Morisette / Schroeder / Pereira)
LC-24 (Walker / Reis)
ND-01 (Roberts / Barreto / Soares)
ND-02 (Davidson / Carvalho / Sa / Vieira / Moutinho / Figueiredo)
TG-03 (Holben / Artaxo / Duarte / Setzer)
TG-04 (Martens / Moraes / Victoria / Moreira)
TG-05 (Potter / Carvalho / Oliveira / Schenato)
TG-06 (Bakwin / Artaxo / Gatti / Martinelli)
TG-07 (Keller / de Mello)

Pará Western (Santarém) - Altamira

Field Site - Located on the Transamazon highway in the state of Pará, Altamira was colonized in 1971 and has experienced high rates of deforestation and secondary succession with implementation of agropastoral projects (Moran, 1981, 1993; Mausel et al., 1993; Moran et al., 1994). Altamira municipality is within the Xingu river basin and contains patches of nutrient–rich Alfisols and less fertile Ultisols covered by dense forest and liana–dominated upland forest. Secondary succession, liana forest, upland forest, and pasture are several of the land cover types; some of the land uses in the area are pasture, swidden agriculture, and logging.

Coordinates: NLat: -2.500, SLat: -4.00, ELong: -51.00, WLong: -54.00

Pará Western (Santarém) - Belterra

Met Tower Station - Belterra is a municipality located approximately 30 km southwest of Santarém. The Tapajós River borders Belterra to the west and BR163 borders the city to the east.

Coordinates: NLat: -2.64300, SLat: -2.64300, ELong: -54.94400, WLong: -54.94400
Towers at Belterra:

- Met Tower - 9m guyed flux tower (S -2.64631 , W -54.94361)

Pará Western (Santarém) - Cacoal Grande

No description available.
Towers at Cacoal Grande:

- 4m Met Tower (S -2.38944 , W -54.32861)

Pará Western (Santarém) - Curua Una

No description available.
Towers at Curua Una:

- 4m Met Tower (S -2.54417 , W -54.09083)

Pará Western (Santarém) - Fazenda Sr. David (km 117)

Met Tower Station - Fazenda Sr. David is located near km 117 of BR 163.

Coordinates: NLat: -1.00, SLat: -1.00, ELong: -56.00, WLong: -56.00
Towers at Fazenda Sr. David (km 117):

- Met Tower - 9m guyed flux tower

Pará Western (Santarém) - Fazenda Treviso

Field Site - The Fazenda Treviso site is located just to the east of km 101 on the Santarém-Cuiabá(BR-163) highway. Fazenda Treviso is across the road from Floresta Nacional do Tapajós.

Pará Western (Santarém) - Guaraná

No description available.
Towers at Guaraná:

- 9m Met Tower (S -2.67694 , W -54.32472)

Pará Western (Santarém) - Igarapé Maica

No description available.

Pará Western (Santarém) - Jamaraqua - Santarém River Site

River Site - Located on the Tapajós River near Santarém.

Coordinates: NLat: -1.00, SLat: -1.00, ELong: -55.00, WLong: -55.00
Towers at Jamaraqua - Santarém River Site:

- 9m Met Tower (S -2.80639 , W -55.03639)

Pará Western (Santarém) - km 100 Pasture Site

No description available.

Pará Western (Santarém) - km 67 Primary Forest Tower Site

Flux Tower Site - Flux towers have been built at primary forest, logged, and pasture sites in or near the Flona Tapajós. The primary forest tower site is located near the Embrapa/IBAMA camp approximately seven kilometers into the Flona Tapajós from km 67 of BR 163.

Coordinates: NLat: -2.85700, SLat: -2.85700, ELong: -54.95900, WLong: -54.95900

Towers at km 67 Primary Forest Tower Site:

- Flux Tower - 65m Rohn guyed triangular tower (S -2.85500 , W -55.03639)
- Walk-up Canopy Access Tower - 45m guyed metal platform tower (S -2.85611 , W -54.95806)

Pará Western (Santarém) - km 67 Seca-Floresta Site

Field Site - The Seca Floresta site is located in the Flona Tapajós approximately 8 km from km 67 of BR 163.

Coordinates: NLat: -2.7500, SLat: -2.7500, ELong: -55.00, WLong: -55.00
Towers at km 67 Seca-Floresta Site:

- 4 Walk-up Canopy Access Towers - 25m guyed wooden walk up towers w/canopy boardwalks (S -2.89833 , W -54.95583)

Pará Western (Santarém) - km 77 Pasture Tower Site

Flux Tower Site - The pasture/soybean field site tower is located east of the Flona Tapajós and BR 163 near km 77. This site is on private pastureland that was recently converted to a soybean field.

Coordinates: NLat: -3.02020, SLat: -3.02020, ELong: -54.88850, WLong: -54.88850
Towers at km 77 Pasture Tower Site:

- Flux Tower - 28m Rohn guyed triangular tower (S -3.16917 , W -54.89361)

Pará Western (Santarém) - km 83 Logged Forest Tower Site

Flux Tower Site - The logged forest site is located in the Flona Tapajós near km 83 of BR 163.

Coordinates: NLat: -3.01700, SLat: -3.01700, ELong: -54.97070, WLong: -54.97070
Towers at km 83 Logged Forest Tower Site:

- Walk-up Canopy Access Tower - km 83 platform - 30m guyed metal platform tower (S -3.01806 , W -54.96889)
- Flux Tower - New km 83 gap logged - 65m Rohn guyed triangular tower (S -3.01639 , W -54.95083)
- Flux Tower - km 83 logged - 65m Rohn guyed triangular tower (S -3.01750 , W -54.97083)

Pará Western (Santarém) - Lago Curuai

Field Site - Lago Curuai is a varzea lake located upstream from Santarém on the Tapajós River at 50 to 55? W and 01 to 03? S.

Coordinates: NLat: -1.82056, SLat: -2.33889, ELong: -50.02083, WLong: -55.83472

Pará Western (Santarém) - Lago Grande de Monte Alegre

No description available.

Pará Western (Santarém) - Mojuí

No description available.
Towers at Mojuí:

- 9m Met Tower (S -2.76667 , W -54.57917)

Pará Western (Santarém) - Santarém-Cuiabá Road

Field Site - The Santarém-Cuiabá Road (BR-163) connects Santarém and Cuiabá and is located east of the Tapajos National Forest.

Pará Western (Santarém) - Uruará

Field Site - Uruará is located on the Transamazon highway in the state of Pará between Altamira and Rurópolis. Uruará is a midpoint of the transect from Altamira, through Uruará, to Santarém. The transect passes through various vegetation types and is used for remote sensing purposes as well as for field surveys of local farmers.

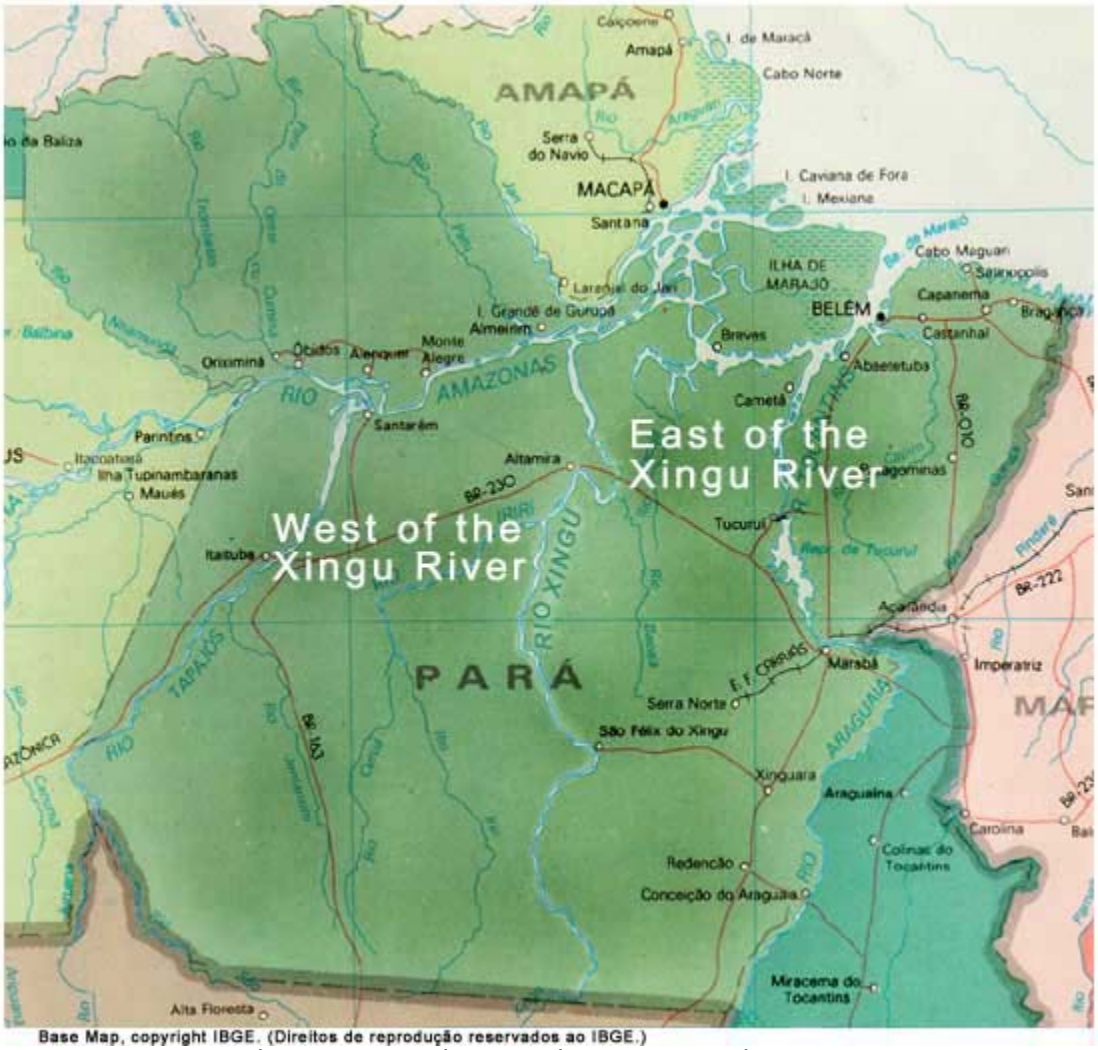
Coordinates: NLat: -3.70500, SLat: -3.70500, ELong: -54.100, WLong: -54.100

Pará Western (Santarém) - Vila Franca

No description available.
Towers at Vila Franca:

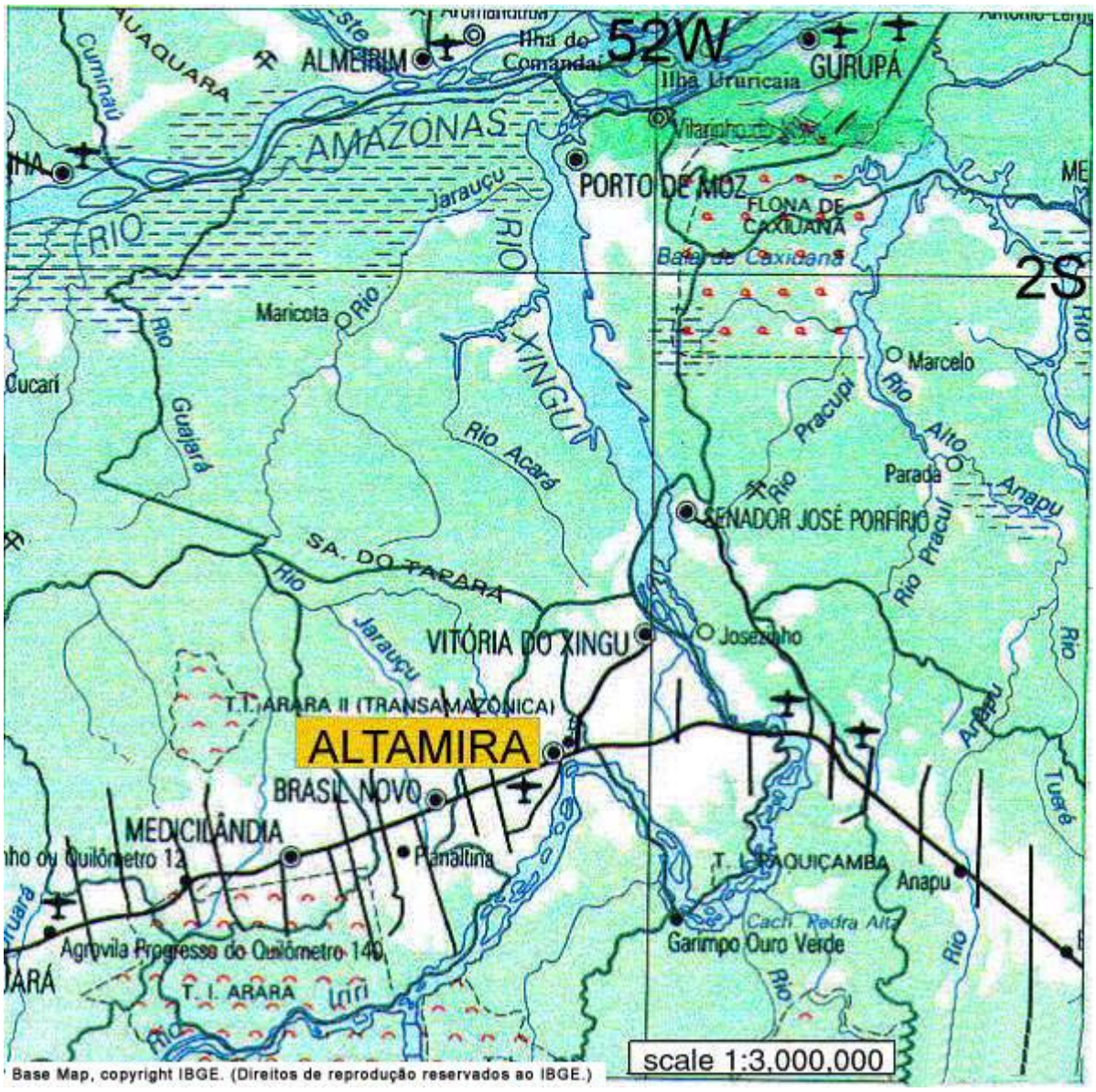
- 4m Met Tower (S -2.34861 , W -55.02889)

Maps for Pará Western (Santarém)

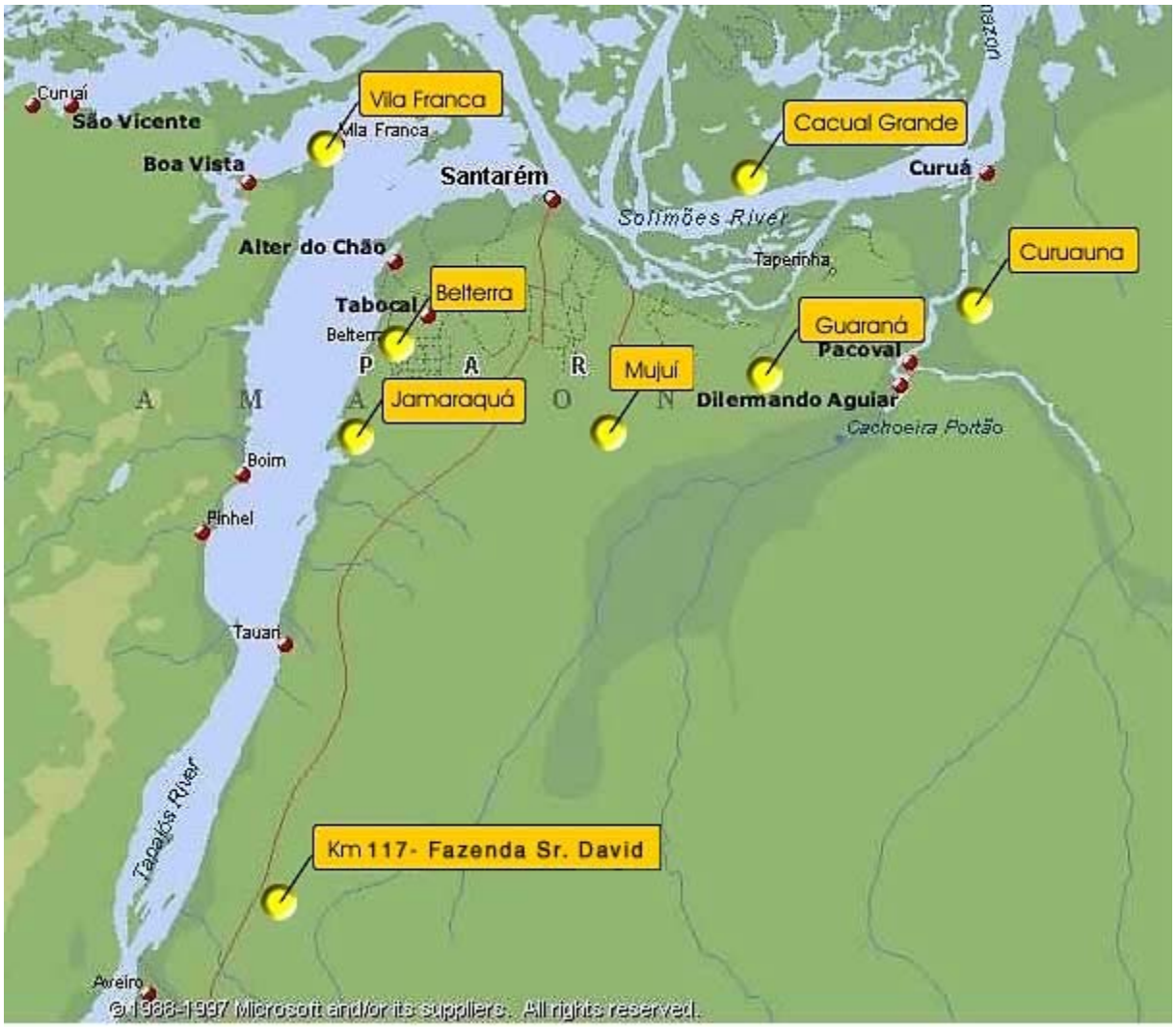


Base Map, copyright IBGE. (Direitos de reprodução reservados ao IBGE.)

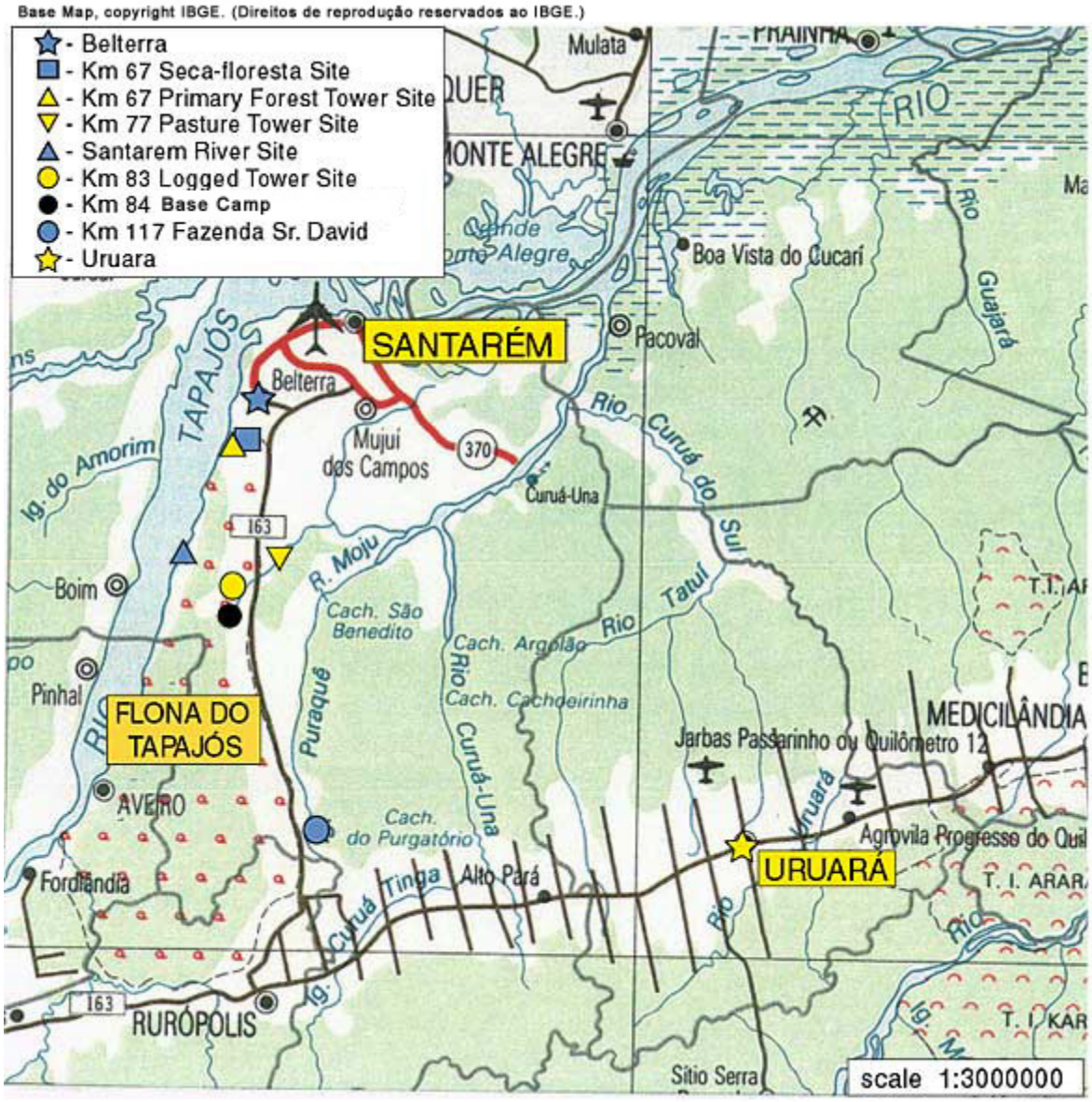
Main Regional Map for Pará Western (Santarém) for Pará Western (Santarém)



Main Site Map for Pará Western (Santarém) - Altamira for Pará Western (Santarém)



Main Site Map for Pará Western (Santarém) - Belterra for Pará Western (Santarém)



Main Site Map for Pará Western (Santarém) - km 67 Primary Forest Tower Site for Pará Western (Santarém)

Peru

Description

No description available.

LBA-ECO Researchers Proposing to Work in *Peru*

CD-05 (Nepstad / Klink / Moutinho)
CD-06 (Richey / Victoria)

Peru - Assis-Puerto Maldonado Road

No description available.

Peru - Pachitea

No description available.

Rio Grande do Norte

Description

Rio Grande do Norte is located in the Northeast region of Brazil. This region is not part of Amazonia; however, data collected at the Natal Weather Station is utilized in LBA-ECO studies.

LBA-ECO Researchers Proposing to Work in *Rio Grande do Norte*

There are no investigators proposing to work in this region.

Rio Grande do Norte - Natal Weather Station

Met Tower Station - Natal is a coastal city in the state of Rio Grande do Norte.

Coordinates: NLat: -5.800, SLat: -5.800, ELong: -35.200, WLong: -35.200

Maps for Rio Grande do Norte

Main Regional Map for Rio Grande do Norte for Rio Grande do Norte

Main Site Map for Rio Grande do Norte - Natal Weather Station for Rio Grande do Norte

Rondonia

Description

Rondônia is located in the western part of the Amazon, between 7° 58' and 13° 43' South latitude and 59° 50' and 66° 48' West longitude. Rondônia is bordered by the state of Amazonas to the North, the state of Mato Grosso to the East, Bolivia to the South, and the state of Acre to the West. It covers 243,044 km2 of area, about 6.79% of Brazil's North Region, and contains 52 municipalities and 1.3 million inhabitants. (www.ibge.gov.br) The state's climate is predominantly equatorial, with a tropical transition. It is hot and humid throughout the year, with a large yearly temperature range. The daily temperature ranges are also notable, especially during the winter. Throughout the summer, convective activity caused by greater incidence of solar radiation is high. The winter season is characterized by fluvial winds and increased rains influenced by ecosystems in the Intertropical Convergence Zone and the Bolivian Highlands. The rainiest period in the region is between November and March (winter). The driest period (with less convective activity) is between May and September (summer). The region's annual rainfall is approximately 1800. (www.rondomia.ro.gov.br) The greatest amount of deforestation in the Amazon region has taken place in Rondônia. Most of deforestation is a result of the intense colonization of the state that has occurred since the mid 1970s. The total area that has been deforested is approximately 276,315 hectares, about 1.2% of the state's area. (www.ibama.gov.br) The region contains five main geomorphological

environments which include areas of regional surface leveling domain divided into levels I, II and III; mountain chains composed of old sedimentary rock in the form of tabular surfaces; areas of tertiary sedimentary rock; slopes and hills associated with the presence of erosion resistant rock that highlight the regional leveling surface and the Madeira river system, including the Mamoré, Guaporé, Ji-Paraná and Roosevelt subsystems. The soils in Rondônia are predominantly Latosols, Argisols, Neosols, Gleisols and Combisols. Approximately 58% of the state is Latosols; of which 26% are Red-Yellow Latosols and 16% are Red-Yellow and Red Latosols. The flora of the region is made up of a large biodiversity of species because the region is in a transition area between the Cerrado, Pantanal, and Amazon regions. There is historical satellite data assembled and analyzed and a large body of process level soils and vegetation data already in existence for the state.

LBA-ECO Researchers Proposing to Work in *Rondonia*

CD-05 (Nepstad / Klink / Moutinho)
CD-06 (Richey / Victoria)
CD-17 (Ducey / Alves)
LC-09 (Moran / Batistella)
LC-22 (DeFries / Shimabukuro)
LC-24 (Walker / Reis)
ND-01 (Roberts / Barreto / Soares)
ND-03 (Deegan / Victoria / Krusche / Ballester)
ND-09 (Richey / Victoria)
TG-03 (Holben / Artaxo / Duarte / Setzer)
TG-07 (Keller / de Mello)
TG-08 (Melillo / Cerri)

Rondonia - Alto Paraiso

No description available.

Rondonia - Ariquemes

Field Site - Ariquemes lies on the BR 364 highway, between Porto Velho and Ji–Paraná, in the state of Rondônia. As a contribution to LBA, the EOS Amazon Project has initiated a mesoscale study of the effects of regional–scale land–use change on the hydrologic response and biogeochemistry of rivers with drainage areas of order 1,000–10,000 km2 in Rondônia. The study is being conducted in a group of river basins that drain northward through the state, and have differing amounts of deforestation, ranging from nearly zero to approximately 50% of basin area, gauged by the Brazilian National Department of Water and Electrical Energy (DNAEE). The Jaci–Paraná, Candeias, Jamari, and Ji–Paraná drainage basins are gauged in nested series with areas ranging from approximately 3,000 to 31,000 km2. The aim of the LBA/EOS Amazon investigation is to document and explain the loading of runoff, sediment and bioactive chemicals into the rivers of the region, both under original forest cover and under conditions disturbed by land use.

Coordinates: NLat: -9.9700, SLat: -9.9700, ELong: -63.0500, WLong: -63.0500

Rondonia - Fazenda Itapirama

Field Site - Itapirama Farm is situated at 10o55,6’ S and 62o01,266’ W, 162 meters of altitude and 15 kilometers from Ji-Paraná. It is divided by Urupá River (that comes from Ji-Paraná River). In the farm there is a primary forest area that is located 350 meters from the Urupá River, it has 500 meters in wide and 650 meters in length and the medium height of the trees is 30 meters. There is 40 meters of secondary forest between the primary forest and the pasture at the farm. The soil at the farm is classified as podzol red-yellow with medium texture, the granulometry is predominate sandy varying from 60 to 80%, with clay and silte growing in accord to the depth. The climatology is compared to that find in Ji-Paraná in accord to meteorological data collect during a decade by Comissão Executiva da Lavoura de Cacau (CEPLAC), located in Ouro Preto D’Oeste – 40 kilometers from Itapirama Farm.

Coordinates: NLat: -10.92667, SLat: -10.92667, ELong: -62.02111, WLong: -62.02111

Rondonia - Fazenda Jamaica

Field Site - Pasture site in Fazenda Jamaica.

Coordinates: NLat: -11.20692, SLat: -11.25780, ELong: -61.94665, WLong: -62.02699

Rondonia - Fazenda Nossa Senhora

Flux Tower Site - Fazenda Nossa Senhora (10° 45' 44" S, 62° 21' 27" W) is located approximately 15 km northwest of Ouro Preto d'Oeste and sits 230m above sea level. This experimental site is in a planal area, surrounded by a series of colinies within 4 to 10km from the site. The site was deforested in 1977 and burned during the height of the dry season (August to October). Several food crops have been cultivated in the area (e.g. rice, beans, corn), but when the production of the plantations declined in the following years grass (Brachiaria brizanth) was planted. The current flora consists of brachiaria brizanth, with small areas of Panicum maximum, palms, and shrubs. The CD-207 group built a 10m tower at this site in March of 1999. Meteorological, as well as solar and terrestrial radiation, data are monitored at this site since its construction. A eddy covariance system has been installed next to the tower atop a 4m post, measuring the energy and CO2 flux between the ground and the atmosphere.

Coordinates: NLat: -10.76180, SLat: -10.76180, ELong: -62.35720, WLong: -62.35720
Towers at Fazenda Nossa Senhora:

- Flux Tower - 20 m flux tower

Rondonia - Fazenda Nova Vida

Field Site - The ND–03 Deegan/Victoria team is measuring soil processes and stream chemistry in two pairs of drainage basins in Rondônia. The study area is southeast of the town of Ariquemes (6.1.3.1) in an area called Fazenda Nova Vida, which is 220 km2 in area and the site of ongoing MBL–CENA cooperative research on soil biochemistry and trace gas fluxes. The paired basins are approximately 10 km2 and are on the Nova Vida property. The rivers formed by the confluence of the paired basins, Rio Quatro Cachoeiras and Rio Andirá, also serve as sampling sites. One drainage basin in each pair has had land use exclusively of native forest; the other exclusively cattle pasture. These basins contain permanently flowing second–order streams closely matched in area and discharge. Second–order forest streams in the region are typically one to four meters wide, with clear water and sandy bottoms, and have a pH of 5.5 to 6.8. The forested basins contain moist terra upland forest, and pastures surround two of the drainage basins that were created in 1989. Forest vegetation consists of open perennially evergreen broadleaf trees with a high number of palms (Pires and Prance, 1986), and pastures have been planted with the widely used grass Brachiaria brizantha. All of the basins occupy a gently rolling topography with soils that are typical of large areas of the western Amazon Basin. Soils are well drained Kandiudults and Paleudults (red–yellow podzolic Latosols in the Brazilian classification). Clay content in these Ultisols generally ranges from 10 to 40% (Moraes et al., 1996). Mean annual temperature is about 27° C and varies by less than 4° C between warmest and coldest months (Bastos and Diniz, 1982). The elevation is 200–500 m in the region, which is generally underlain by Pre–Cambrian granitic rock (Projeto Radambrasil, 1978). Central Rondônia gets 2.2 m of rainfall annually and has a 5–month dry season.

Coordinates: NLat: -10.15600, SLat: -10.15600, ELong: -62.81100, WLong: -62.81100

Rondonia - Fazenda Santana

Field Site - Pasture site in Fazenda Santana

Coordinates: NLat: -9.84151, SLat: -9.87707, ELong: -62.64438, WLong: -62.68105

Rondonia - Jaru Biological Reserve Tower A

Flux Tower Site - The Jarú Biological Reserve covers 729,368 hectares in Northeast Rondônia. The Reserve is accessible by dirt roads 132 km from Ji-Paraná by boat on the Ji-Paraná River, 115km from Ji-Paraná. The Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) manages the reserve. IBAMA runs a base camp that may be used by LBA researchers doing research and data collection at the two towers located within the Reserve. Prior authorization from IBAMA in Ji-Paraná must be obtained before visiting the

reserve or using the base camp.

Coordinates: NLat: -10.08320, SLat: -10.08320, ELong: -61.93090, WLong: -61.93090
Towers at Jaru Biological Reserve Tower A:

- Flux Tower - 64m platform walk-up, extending 30m above the canopy. (S -10.07830 , W -61.93360)

Rondonia - Jaru Biological Reserve Tower B

Flux Tower Site - The Jarú Biological Reserve covers 729,368 hectares in Northeast Rondônia. The Reserve is accessible by dirt roads 132 km from Ji-Paraná by boat on the Ji-Paraná River, 115km from Ji-Paraná. The Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) manages the reserve. IBAMA runs a base camp that may be used by LBA researchers doing research and data collection at the two towers located within the Reserve. Prior authorization from IBAMA in Ji-Paraná must be obtained before visiting the reserve or using the base camp.

Coordinates: NLat: -10.07800, SLat: -10.07800, ELong: -61.93310, WLong: -61.93310
Towers at Jaru Biological Reserve Tower B:

- Flux Tower - 54m platform walk-up tower (currently not functional and is being relocated to another site in the Jaru Biological Reserve)

Rondonia - Machadinho D'Oeste

Field Site - Machadinho D'Oeste is a city in Rondônia about 130 km to the northeast of Ariquemes near the Machadinho River.

Coordinates: NLat: -9.5400, SLat: -9.5400, ELong: -62.0300, WLong: -62.0300

Rondonia - Ouro Preto do Oeste

Field Site - Ouro Preto do Oeste, Rondônia is a city on the BR 364 highway, about 40 km to the northwest of Ji-Paraná. This site is the endpoint of a study transect from Ouro Preto do Oeste to the town of Ariquemes that lies 120 km to the northwest. This transect passes through various vegetation types and will be for remote sensing/modeling purposes as well as for field surveys of decision making by local farmers.

Coordinates: NLat: -10.7500, SLat: -10.7500, ELong: -62.2600, WLong: -62.2600

Rondonia - Porto Velho EMBRAPA

Field Site - Experimental field in Porto Velho Embrapa

Coordinates: NLat: -8.79095, SLat: -8.80345, ELong: -63.84105, WLong: -63.85355

Rondonia - Rancho Grande

No description available.

Rondonia - Rio Ji-Parana

No description available.

Rondonia - Rio Madeira

River Site - Rio Madeira at Porto Vehlo

Rondonia - Urupa River

No description available.

Rondonia - Vilhena EMBRAPA

Field Site - Experimental field in Vilhena Embrapa

Coordinates: NLat: -12.76792, SLat: -12.77653, ELong: -60.08771, WLong: -60.09743
Towers at Vilhena EMBRAPA:

- Met Tower - 9m guyed flux tower

Maps for Rondonia

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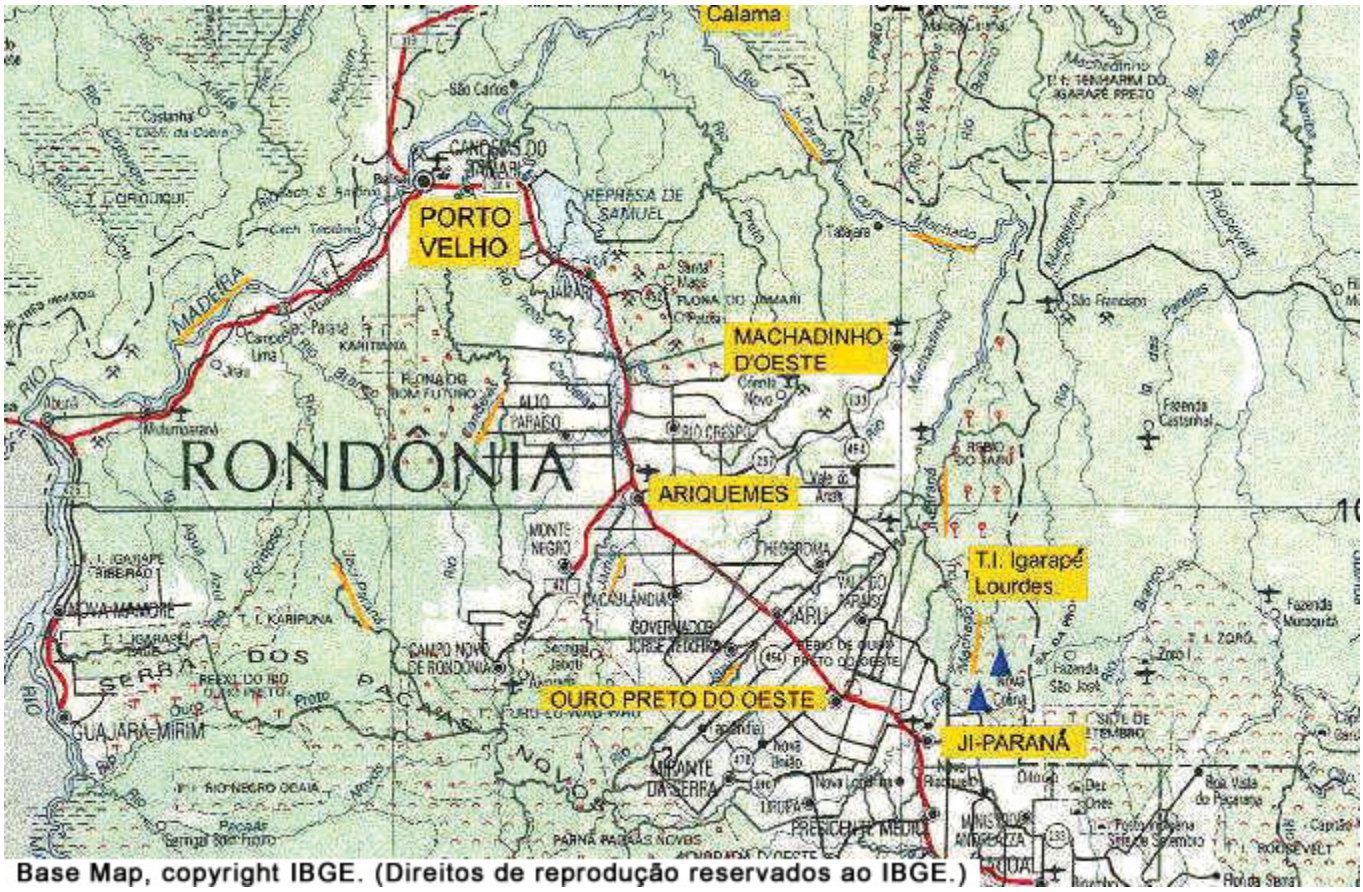
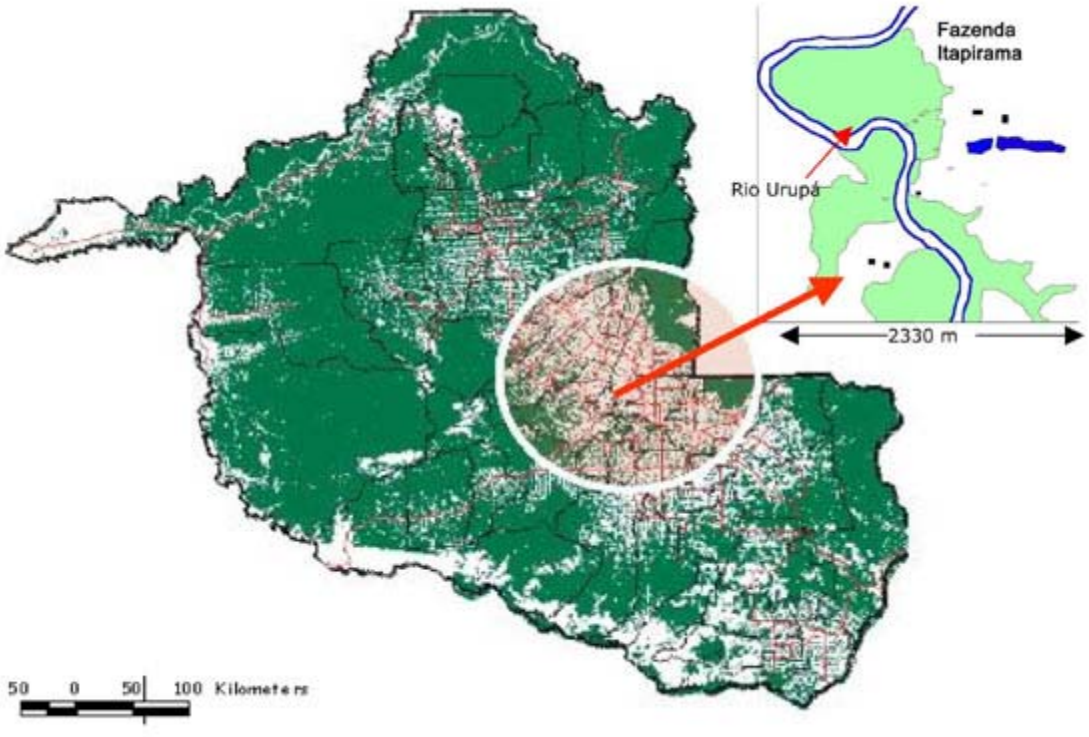
Main Regional Map for Rondonia for Rondonia



Main Site Map for Rondonia - Ariquemes for Rondonia



Main Site Map for Rondonia - Fazenda Itapirama for Rondonia

Roraima

Description

No description available.

LBA-ECO Researchers Proposing to Work in *Roraima*

LC-07 (Melack / Novo / Forsberg)
LC-23 (Morisette / Schroeder / Pereira)

Roraima - Boa Vista

Field Site - Floodplain near Boa Vista

Coordinates: NLat: 3.60917, SLat: 2.75918, ELong: -60.12589, WLong: -61.08422

Maps for Roraima

Main Regional Map for Roraima for Roraima

Tocantins

Description

No description available.

LBA-ECO Researchers Proposing to Work in *Tocantins*

CD-06 (Richey / Victoria)
LC-07 (Melack / Novo / Forsberg)
TG-07 (Keller / de Mello)

Tocantins - Cangacu Research Center

No description available.

Tocantins - Fazenda Javaes

No description available.

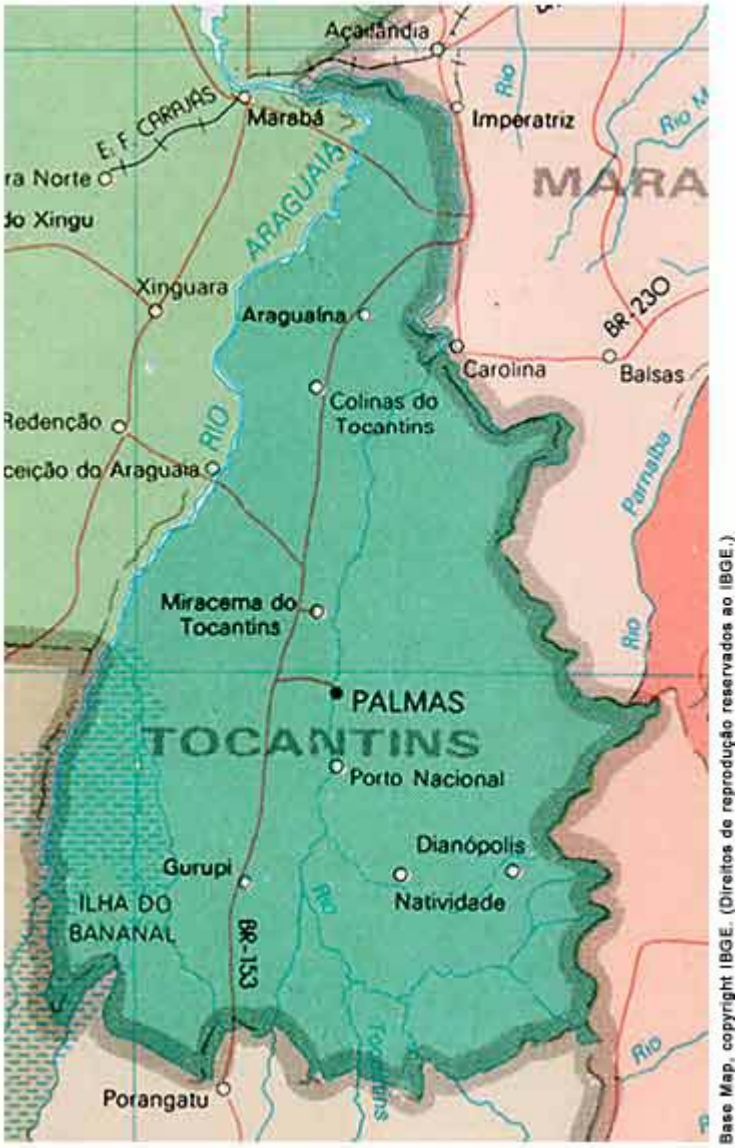
Tocantins - Ilha do Bananal

No description available.

Tocantins - Palmas

No description available.

Maps for Tocantins



Main Regional Map for Tocantins for Tocantins

Field Support

Acre

Acre Site Resources Coordination Group

Irving Foster Brown	Site Resource Coordinator
Antonio Willian Flores de Melo	LBA-ECO Science Team Representative
Elsa Renee Huaman Mendoza	LBA-ECO Science Team Representative

Vehicles:

Rio Branco Toyota 4x4 Truck

Housing:

There is no housing support for this region.

Amazonas (Manaus)

Field Office(s)

LBA Central Office (Manaus)
Flavio de Jesus Luizao / Ruth da Silva
LBA - Escritório Regional de Manaus, INPA
Av. André Araújo, 2939 - Petrópolis Alojamento 20
Manaus, AM, Brasil 69083-000
55 (92) 643-3238

Amazonas Site Resources Coordination Group

Jeffrey Q. Chambers	LBA-ECO Science Team Representative
Erick C.M. Fernandes	LBA-ECO Science Team Representative
Flavio Jesus Luizao	INPA Point of Contact; Site Resource Coordinator
Ana Cláudia Mendes Malhado	LBA Science Assistant
Ari de Oliveira Marques Filho	Alternate INPA Point of Contact
Luiz Antonio Martinelli	LBA-ECO Science Team Representative
Rita Guimaraes Mesquita	LBA-ECO Science Team Representative
Ruth Araujo da Silva	Logistics Support
Elisa Vieira Wandelli	LBA-ECO Science Team Representative

Vehicles:

Manaus Toyota 4x4 Jeep (3 available)
Manaus Toyota 4x4 Truck (3 available)
Manaus Volkswagen Quantum Station Wagon

Housing:

Manaus INPA Smithsonian Forest Fragments
Manaus km 54 EMBRAPA Camp
Manaus ZF2 INPA tower camp

Brasília

Field Office(s)

LBA-ECO Brasilia Support Office
Jair Maia
Universidade de Brasilia
SQS 413 Bl. S Apto. 202 Asa Sul
Brasília, DF, Brasil 70296-190
55 (61) 307-2326

Brasília Site Resources Coordination Group

Mercedes M.C. Bustamante	LBA-ECO Science Team Representative
Jair Max Furtunato Maia	Site Resource Coordinator

Vehicles:

Brasilia Toyota 4x4 Jeep
Brasilia Volkswagen Quantum Station Wagon

Housing:

Brasilia Aguas Emendadas
Brasilia IBGE

Ceará

No site resource coordination yet available.

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Colombia

Colombia Site Resources Coordination Group

Emilio Federico Moran	LBA-ECO Science Team Representative

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Ecuador

Ecuador Site Resources Coordination Group

Richard E. Bilsborrow LBA-ECO Science Team Representative

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Mato Grosso

Mato Grosso Site Resources Coordination Group

Daniel Curtis Nepstad	Site Resource Coordinator
George L. Vourlitis	LBA-ECO Science Team Representative

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Pará Eastern (Belém)

Field Office(s)

LBA Belém Regional Office
Claudio Jose Reis de Carvalho
Embrapa Amazonia Oriental
Tv. Eneas Pinheiro, s/n, casa 509 - Marco
Belem, PA, Brasil 66095-100
55 (91) 299-4611 x21

Pará (Eastern) - Belém Site Resources Coordination Group

Claudio Jose Reis de Carvalho	Site Resource Coordinator, Embrapa Point of Contact
Carlos Eiras	Vehicle Scheduler
Ricardo de Oliveira Figueiredo	LBA-ECO Science Team Representative
Edvaldo Givone	LBA-ECO Science Team Representative

Vehicles:

Belém Toyota 4x4 Truck

Housing:

There is no housing support for this region.

Pará Western (Santarém)

Field Office(s)

LBA Santarém Regional Office
Rosilene Santana / Bethany Reed
Rua 24 de Outubro, 3707
Santarém, PA, Brasil 68040-010
55 (91) 523-4138

LBA Santarém Office Annex (O Escritório-Anexo de Apoio do LBA em Santarém)
José Araújo Júnior / Ivani Pereira
Tv. Barjonas de Miranda, 434
(between Av. Mendonça Furtado and Av. São Sebastião)
Santarém, Para, Brazil CEP 68040-520
Tel: +55 93 523-1596 Fax: +55 93 523-1584

EMBRAPA Computer Lab

Pará (Western) - Santarém Site Resources Coordination Group

José Araújo Júnior	Office Annex Assistant
Claudio Carvalho	Logistics Support
Paulo Coutinho	LBA Santarem Regional Office Manager
David R. Fitzjarrald	LBA-ECO Science Team Representative; km 77 Tower Captain
Michael L. Goulden	LBA-ECO Science Team Representative; km 83 Tower Captain
Gladys Martinez	EMBRAPA-Santarém Liaison
James William Munger	LBA-ECO Science Team Representative; km 67 Tower Captain
Ivani Pereira	Outreach and Education Specialist
Bethany A Reed	Infrastructure and Logistics Manager
Iomar (Bill) Vidal da Silva	Logistics Support

Vehicles:

Santarém Ford Ranger 4x4 Truck-1
Santarém Ford Ranger 4x4 Truck-2
Santarém Sprinter Mercedes Van w/a 12pngr

Santarém Toyota 4x4 Jeep-1
Santarém Toyota 4x4 Jeep-2
Santarém Toyota 4x4 Truck-1
Santarém Toyota 4x4 Truck-2
Santarém Toyota 4x4 Truck-3

Housing:

Santarém km 67
Santarém km 84 Basecamp

Peru

No site resource coordination yet available.

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Rio Grande do Norte

Rio Grande do Norte Site Resources Coordination Group

Steven C. Wofsy LBA-ECO Science Team Representative

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Rondonia

Field Office(s)

LBA Rondonia Regional Office
Fernando Cardoso / Keila Aires
Avenida Rio Amazonas, 351, Jardim dos Migrantes
Bloco 08, Sala 01
CEP: 78961-970 Ji-Parana - RO
55 (69) 421-0242

Rondonia Site Resources Coordination Group

Keila Souza Aires	Site Resource Coordinator
Fernando Luiz Cardoso	LBA Regional Office Manager
Oliver A. Chadwick	LBA-ECO Science Team Representative
Marcos A. Pedlowski	LBA-ECO Science Team Representative

Vehicles:

Ji Paraná Toyota 4x4 Jeep
Ji Paraná Toyota 4x4 Truck
Ji Paraná Volkswagen Quantum Station Wagon

Housing:

Fazenda Nova Vida
Ji Paraná Field Office
Rebio Jaru

Roraima

No site resource coordination yet available.

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Tocantins

No site resource coordination yet available.

Vehicles:

There is no vehicle support for this region.

Housing:

There is no housing support for this region.

Data

LBA Data and Publication Policy

Approved by the LBA Science Steering Committee, May 13, 1998 Piracicaba, SP, Brazil

INTRODUCTION

LBA data polices are guided by the fundamental principle that cooperation and synergism should be maximized in all LBA activities. To ensure that all LBA participants have access to data in a timely manner and that appropriate credit is given to the Investigators, there is a strong need for a definition of data policies that will be adopted by the entire LBA.
LBA data policies will guide data sharing, citation of data from other, investigators access to restricted data and promote the exchange of quality controlled / quality assured data. All LBA researchers must follow the national laws concerning export of all data gathered by foreign researchers of the various Amazonian countries, notably Brazil. The LBA home page and the project offices in Brazil can provide this information.

LBA DATA AND PUBLICATION POLICIES

1. Data generated by LBA will become public domain and will be permanently archived in Brazil. The LBA Data Information System (DIS) will provide tools for documenting, storing, searching and distributing these data.
2. All LBA data should be available to all LBA researchers. Exceptions may be made in the case of raw or preliminary data, for which distribution can be restricted for a limited period of time.
3. There will be no periods of exclusive rights to publish LBA results. Exceptions are possible for students where graduation requirements prohibit publication of results prior to acceptance of a Thesis.
4. Individual investigators may make their own data more widely available at any time. Outside investigators may be given access to this data as soon as the data have been submitted to the LBA DIS, with some prudent time period for quality control.
5. Each LBA module is responsible for establishing a time schedule for data exchange within the projects and data delivery to LBA DIS. The time limit for data delivery to LBA-DIS will be no more than one year.
6. Data should be analyzed cooperatively by all scientists involved in obtaining them. Especially cooperation across disciplines and among South American, European and North American researchers should be encouraged. Publications resulting from work under LBA should be co-authored by all scientists who have participated substantially in the work, unless some participants choose not to be on the authors' list. The same applies to presentations at meetings. Special effort by each non-South American researcher should be put into integration of South American researchers in their work and in the publication of the results.
7. Where data are used for modeling or integrating studies, the scientist collecting the data will be credited appropriately, either by co-authorship or by citation. Investigators using data provided by another investigator as a substantial component of a paper should offer the originating investigator co-authorship. In cases where data from other investigators are a minor contribution to a paper, the data should be referenced by a citation. Users of the data will always have to state the source of the data.
8. Specific constraints for certain data sources (e.g. satellite products, global meteorological analysis, etc) may be subject to copyright restrictions which are more limiting than this LBA data policy. It is up to the LBA-OIC to take the first steps in making contacts with officials and institutions in order to prepare specific agreements that will allow LBA scientists to use the data.
9. If conflicts do occur, they should be resolved at the level of the LBA modules.

LBA Data and Information System (LBA-DIS)

from section IV-E of the NRA-01-OES-06 RESEARCH ANNOUNCEMENT

A data and information management system located at INPE/CPTEC – the LBA Data and Information System (LBA-DIS) – has been developed by INPE, with NASA's participation. The LBA-DIS holds, manages, and distributes LBA data and information. INPE is the repository for all LBA-DIS data and information, and NASA will have at its disposal copies of the system and of the data and information. The core of LBA-DIS is the archival and distribution system at INPE/CPTEC, and managed by the LBA Central Office, which has full responsibility for LBA data archival and distribution for decades to come. This LBA-DIS central node has mirror sites and supporting nodes in the U.S. and Europe. LBA-DIS activities, including those at other nodes are coordinated by the LBA-DIS Working group led by Mr. Luiz Horta, the LBA-DIS Officer.

As required by Brazilian law, the original data collected in Brazil must remain in Brazil (copies may be retained by foreign investigators). Additionally, NASA has agreed to ensure that copies of scientific data and results from LBA-ECO will be provided to INPE/CPTEC. Deliveries of data and results to INPE/CPTEC to fulfill this NASA obligation should be detailed in the Data Plan section of LBA-ECO proposals.

The NASA-designated long-term archive for ecological and biogeochemical data from field campaigns is the Distributed Active Archive Center (DAAC) at the Oak Ridge National Laboratory (ORNL). Thus, data collected through LBA-ECO will be archived and distributed at the ORNL DAAC as well as in Brazil.

An Internet-based approach for data and information management has been created for sharing scientific data within LBA. This aspect of LBA-DIS is distributed, consisting of LBA investigator web sites, LBA project and module web sites, the data archives at INPE/CPTEC and at the ORNL DAAC, and the Beija-flor system. The data sharing approach involves two major data and information management tools: Beija-flor and the LBA Metadata Editor (LME). By using World Wide Web, or simply "Web" technology, the combined capabilities of Beija-flor and the LME allow data and documentation to be stored on, and accessed from, the networked computers of individual scientists located around the world. In the case of large data sets, data need not be immediately available through web access to be part of the LBA-DIS. However, metadata must be present, and access should be provided through other mechanisms.

Currently, the LME facilitates the entry, editing, and storage of metadata in standard formats for use by Beija-flor. Metadata is the information that describes the characteristics (e.g., geographic locations, parameter names, dates) of the various data sets. Data set documentation capabilities are integrated with the LME. Beija-flor provides the needed metadata search and sharing functionality by harvesting and organizing metadata that are then accessed and reviewed by the users. Data providers and scientists use the LME to provide metadata to Beija-flor by saving the files of information in specified locations on their own or other web-accessible computer systems and marking the file as "searchable." During its regular harvesting cycle (currently nightly), Beija-flor collects metadata from only the files that are marked as searchable. Each Beija-flor system node (currently ORNL and the INPE/CPTEC) harvests metadata and builds a database of the harvested information. Harvested information is shared across the nodes so that users are able to search and review available metadata by accessing the web-based Beija-flor and LME interfaces at any of the nodes with their web-browser software.

For more information, see the Beija-flor search page: http://beija-flor.ornl.gov/lba/
and the LBA Metadata Editor: http://daacl.esd.ornl.gov/cgi-bin/MDEDIT/access.pl

LBA Data Checklist

1. Read LBA Data Policy
2. Collect data
3. Leave raw data collected in Brazil with Brazilian Counterpart
4. Register your data sets in LBA Metadata Editor (LME)
5. Transfer preliminary data sets to CPTEC
6. Update metadata files in LME
7. Make data publicly available one year from collection
8. Quality assure (QA) your metadata and data set documentation
9. Submit updates of interim data to CPTEC for archive
10. Submit your final, QA'd, documented data sets to CPTEC for permanent archive

Frequently Asked Questions

LBA is based on the concept of integrated science. LBA tools are in place to gather, standardize and distribute information about LBA data. The Beija-flor search engine will provide you with on-line access to LBA data products, data set descriptions, papers and posters. Participation in the LBA data process is required for all Investigators.

I have collected data, now what do I do?

Raw - Original raw data collected in Brazil must remain in Brazil with the Brazilian Counterpart.
Preliminary Year 1 - LBA Data Policy requires that your data be publicly available one year from collection. Submit Year-1 data to CPTEC and create or update its corresponding metadata file via the LBA Metadata Editor (LME).
Preliminary Years 2+ - Continue to update your metadata files and submit copies of your interim data sets to CPTEC.
Final - Submit final QA'd and documented data sets to CPTEC and update corresponding metadata files.

Register/Update Metadata

What is meant by "Register/Update Metadata"?
Use the LBA Metadata Editor (LME) to create metadata files describing your data; these metadata files will then be searchable by Beija-flor, the LBA Search Engine.
At what point should I register my metadata?
Registration (the creation of a metadata file) may take place before, during or shortly after data collection and should be updated as your data matures.
Do I need a user account to register metadata?
LME can be accessed by anyone as a guest, but to create a file that can be searched by Beija-flor, you must have a user account and password.
When I register my metadata, am I automatically making my data accessible?
No. Unless you also put your data on-line and place the data access URL in your metadata, Beija-flor users will only have access to your metadata, not your data.
What if I am still processing my data after one year?
It is recognized that some types of data require longer processing times than others. However, all data must be submitted to CPTEC for archive at one year, regardless of data maturity status. We recommend that you note in your metadata when you expect the data to be released.

My data are proprietary or copyrighted. Do I have to make this data public? Contact the LBA DIS manager for waiver approval. All data, however, must have registered metadata regardless of accessibility restrictions.

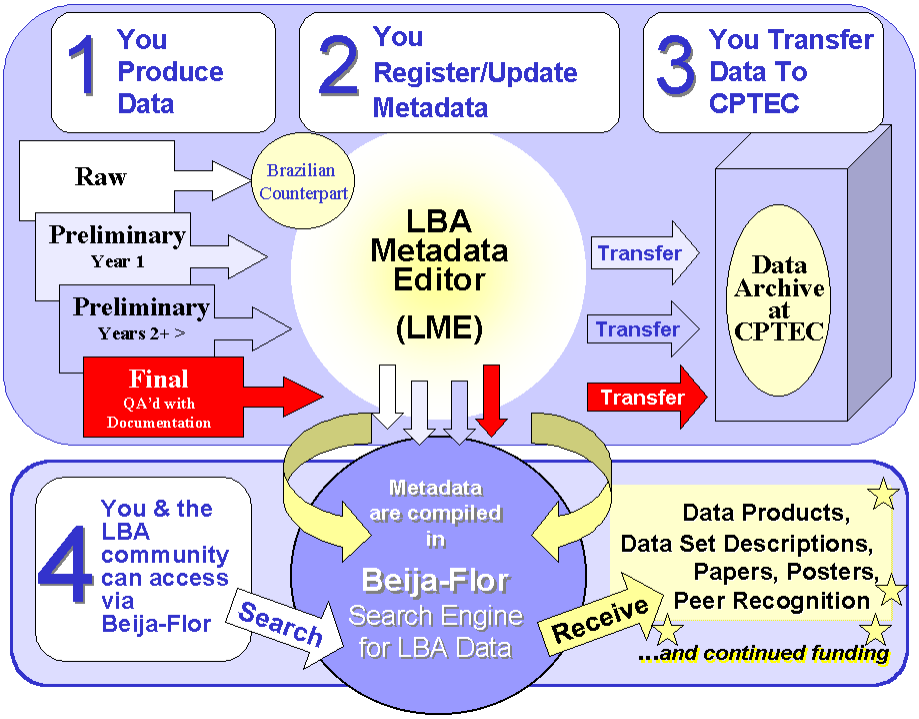
Transfer Data to CPTEC

If I submit data to CPTEC, will it automatically be visible to the public?
No, you instruct LBA DIS to archive it in a publicly accessible area.
How do I submit my data to CPTEC?
Data should be directed to the LBA DIS Manager via FTP, CD, email, or surface mail. Include data description; science team code; contact information; related metadata file, if applicable; and an indication whether the data are to be publicly accessible or restricted.
I've submitted preliminary data to CPTEC. May I continue to distribute the data from my home institution?
Yes, it is understood that while your data are still being processed and QA'd, your copy will be the most current version, and the data access URL in the metadata may continue to point to your copy.
When do I need to submit final data sets?
At this point, there is not a deadline associated with final data set submission.

Access Data

How can I find LBA data?
Use the Beija-Flor search engine to query data.
Do I need an account to use Beija-flor?
No, Beija-flor and the metadata contained in the Beija-flor database are open to the public. The actual data cannot be accessed unless the URL links are provided in the metadata.

Data Flow Chart



Web Sites

LBA Home Page:
http://lba.cptec.inpe.br/lba/

LBA-ECO Project Office:
http://www.lbaeco.org

Beija-flor
Brazil: http://lba.cptec.inpe.br/beija-flor/
US: http://beija-flor.ornl.gov/lba/

LBA Metadata Editor (LME)
Brazil: http://lba.cptec.inpe.br/cgi-bin/LME/access.pl
US: http://daac.ornl.gov/cgi-bin/MDEDIT/access.pl

LBA Data Policy and Data Management Guidelines
http://lba.cptec.inpe.br/lba/lbadis/info/

Data Submission

Luiz M. Horta
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INPE/CPTEC
Rodovia Presidente Dutra, km 39
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Questions?

Brazil: Luiz M. Horta horta@cptec.inpe.br
Europe: Holger F. Hoff hhoff@pik-potsdam.de
U.S: Merilyn J. Gentry mgentry2@utk.edu

Training and Education

Introduction

LBA-ECO has established two goals for training and education:

- increase the number of qualified participants in LBA research through assistance in developing technical and scientific skills and expertise;
- expand and strengthen the environmental and global change research community in Amazonia.

To improve Amazonian capacity, NASA strongly encourages each group to support training of students with ties to Amazonian institutions. Principal Investigators working in Brazil are required by Brazilian law to collaborate with a Brazilian institution. Therefore, capacity enhancement and training is key to the involvement of Amazonian scientists and to the recruitment of students and technicians from the region.
These goals are being met by formal and informal educational programs for Undergraduate, Master's, Doctoral and Post-Doctoral students, in a variety of internships, exchange programs, and technical instruction.
Members of the LBA-ECO staff have been working in close collaboration with the LBA Training and Education Committee, currently under the coordination of Dr. Regina Luizão, at INPA.

Proposed Training and Education Activities

The following tables include proposed training and education plans for the individual LBA-ECO investigations. These activities are organized in the following categories:

- Community / Government Outreach
- Educational Materials
- Formal Training
- Short Courses / Seminars / Workshops
- Visits / Exchange Programs

Community / Government Outreach

Team	Activity Description
CD-05 (Nepstad / Klink / Moutinho)	At least one seminar about Amazonian economic and ecological modeling will be presented for the Brazilian National Congress.
LC-01 (Walsh / Bilsborrow / Ruiz)	Two dissemination workshops on project results and new agricultural technologies will be organized. They will be held for farmers, local community and NGO leaders in the Amazon region in Lago Agrio and Coca. A major conference for scholars and government officials in Quito will be held to disseminate analytical results and present and discuss policy simulations toward the end of the proposed project. Presentations to disseminate interim findings will also be given to smaller groups of high officials.
LC-02 (Brown / Silveira / Esteves)	Curriculum development planning for the state of Acre is planned in collaboration with the Acre Forum on Education. Short seminars for regional decision-makers are also planned. The on-going collaboration with the State Institute of Environment (IMAC) and the State Executive Secretariat of Forests and Extractivism (SEFE) in Acre will continue. Work in collaboration with Assis Brasil and Inapari municipal government, representatives of civil society and state government representatives will continue to be developed and serve as a conduit for LBA results to municipal and state decision makers. The Education Department of the State of Acre solicited this group's recommendations on how to put global change in the classroom. As a result, a proposal for a curriculum development is being elaborated. Publication for the general public will continue to be developed oriented toward scenarios of land use in the MAP region.
LC-04 (Foley / Costa)	This team is committed to writing about LBA science discoveries in a form that is accessible to the general public, either through tradicional magazine publications or through new internet-based publication venues. See an article about LBA research in the Brazilian magazine Ação Ambiental (http://www.ufv.br/acao/edicoes.html), 10 th edition. This team is also committed to giving public lectures on environmental topics related to LBA. Professors Foley and Costa routinely give talks on

	environmental issues to groups in Brazil and the United STates. Electronic presentation materials - shared between Wisconsin and Viçosa - that will facilitate giving lectures to a variety of audience, in both Portuguese and English, will be created.
LC-05 (Laurance / Mesquita)	Communication about research findings with the Brazilian and international public has been recognized as a key priority in this project, and is one of the main resong this team was awarded the prestigious Ford-Conservation International Award for Conservation in 2000. Public-outreach activities are being achieved by (1) many popular and semi-technical publications in Portuguese (e.g. Laurance and Delamonica, 1998); Mesquita 1999; Williamson et al. 1999b; Laurence and Vasconcelos 1000; Delamonica et al. 2001; Laurence 2001c; Fernside at al., in press; Laurence et al., in press Monaco et al., in press). (2) Public seminars and guest lectures at many venues in Brazil; (3) frequent inerviews with Brazilian and international newspapers, radio, and TV news programs. ; and (4) invited testimony before the Brazilian Congress and state political bodies on the conservation and management of amazonian forest.

Educational Materials

Team	**Activity Description**
CD-01 (Denning / Dias)	A web-based course for students and teacher in remote areas to gain an understanding of numerical modeling, preparing them for further work in the subject. It is basic enough to be of use to advanced undergraduates, while remaining scientifically accurate, so that nothing will have to be unlearned as the student advances and the problems become more complex. Short articles on numerical modeling and climate change will be developed which will be suitable for the Earth Science Enterprise NASA Facts series of pamphlets.
CD-06 (Richey / Victoria)	"Rivers Research Groups" is a web site (www. .....) maintained by this team which leads not only to frequent "hits" but has up-to-date information about the Amazon. Production of texts for dissemination of LBA results for the general public.
LC-02 (Brown / Silveira / Esteves)	Production of articles and booklets addressed to the general public and remote communities focusing on the sustainable use of land.
LC-04 (Foley / Costa)	"Building a Portable Classroom: Teaching in the Amazon": In order to teach and train on an Amazonian setting, this team plan to build "a portable computer classroom" to overcome basic infrastructure problems. It is planned to be used by this team to teach classes across Brazil. Articles for dissemination of LBA science findings will be written for publications in Brazilian, American and European magazines/oulets or to be posted on internet-based venues. Students will produce 5-10 short papers each semester, as well as orally present results of the research they are involved. It is intended to be an integrative course for advanced undergraduate and beginning graduate students. The Interactive Atlas of the Global Environment (http://atlas2.sage.wis.edu) is an innovative online resource where students, educators, business leaders, and invironmental organizations can access and download state-of-the-art scientific data, images, and maps pertaining to human activities and the global environment. A new Atlas of Amazoniaweb site (with Portuguese, Spanish and English versions), highlighting environmental information is being produced by this team.
LC-05 (Laurance / Mesquita)	A series of booklets about rainforest ecology and sustainable use of tropical forests is being developed in collaboration with educators of elementary and middle schools in the Manaus region envolving students under the supervision of the principal investigators of this team. Communication about research findings with the Brazilian and international public will continue to be a key priority in this project.Popular and semi-technical

	publications for education and dissemination of rainforest ecology will be produced by students an investigators.
LC-07 (Melack / Novo / Forsberg)	A series of lectures, available on this team website http://www/icess.ucsb.edu/LBA/training.html and on the CD-ROM titled "Microwave and optical remote sensing of Amazonian wetlands: a multi-scale, multi-sensor approach to understanding wetland hydrology and ecology", will be used in tutorials and in a course to be taught at INPA.
LC-09 (Moran / Batistella)	A book including LBA results will be produced in Portuguese. Production of CD ROMs for training and education on remote sensing for distribution in universities.
LC-21 (Asner / Bustamante / Silva)	Educational training materials on remote sensing and biogeochemical research including documentation on the theories and methods in each subject area, figures and sample data sets will be produced and made available on line: http:/asnerlab.stanford.edu.
LC-24 (Walker / Reis)	As part of the teaching module initiative, project members will also develop a web page tutorial for broad outreach. It will be made available for general distribution to secondary schools, or other venues of interest.
ND-01 (Roberts / Barreto / Soares)	A tutorial of advanced remote sensing course will be developed in cooperation with Imazon. This tutorial will be considered of public domain and will be available to all LBA community. From the Airborne mission in 2003, which will provide AVIRIS spectra at 4 meter resolution, a spectral library will be developed for Brazil.
ND-07 (Zepp / Bustamante)	Educational materials in Portuguese based on short-term courses taught by this team will be developed and made available.

Formal Training

Team	**Activity Description**
CD-01 (Denning / Dias)	This group plans to continue providing educational support to Brazil's environmental and global change research community. Currently, a PhD level student from the University of São Paulo is working at Colorado University on Amazonian meteorology and numerical modeling - forward and inverse modelling of land-atmosphere exchanges of CO2. The student will receive her Ph.D. and return to Brazil. Collaborative work with professors Pedro Silva Dias and Maria Assunção Silva Dias (USP) will continue.
CD-02 (Ehleringer / Martinelli)	Undergraduates will continue to be involved in both field collection and analysis efforts. Other undergraduate students will be identified from the Santarém isotope ecology courses involved in individual research projects on a variety of topics (terrestrial, aquatic, thophic studies, etc) with sample collection in Amazonia. Support for graduate students will also continue to be provided. Currently, Jean Pierre Ometto (CENA-USP) is developing his postdoctoral research on stable isotope analyses at UTAH and CENA-USP.Tomas Domingues was admitted to the University of Utah PhD graduate program and is developing his thesis research focusing on functional-response-curve gas exchange measurements and other key photosynthetic parameters needed for carbon-gain modelling at field sites in both Manaus and Santarém. Graduate training will also include Alesandro Araújo (thesis work in Manaus under Dr. A. Nobre supervision) and Erika de Miranda Vieira (thesis work in Santarém, under Dr. Niro Higuchi's supervision). There has been a strong interaction between the isotope ration labs at CENA and Utah. Standards and technological capabilities were exchanged. Air sampling capacities at CENA - high precision isotope ration and CO2 concentration capacities were also developed. This technology will be expanded and transferred with implementation of the automated high-precision measurement capacity for atmospheric gases. Institutions in this program are open student and technician training for any stable isotope project in the LBA-ECO program.
CD-03 (Fitzjarrald / Moraes)	The long collaboration work between Jungle Research Group from SUNY Albany and the Laboratório de Micrometeorologia from Universidade Federal de Santa Maria (UFSM) will continue to be developed. Rodrigo Silva, a doctoral student at UFMS is now at Albany where he will spend 18 months as part of his degree, expanding the data analysis he started in Santa Maria. Roberto Magnago, a Master student at UFMS is expected to work at the sites in Santarém in 2003 and in the later future, to

	spend some time at Albany. Three undergraduate students are being trained in collaboration with TG-04. Additional undergraduate students in Santarém will be supported.
CD-04 (Goulden / Rocha)	Three types of activities are planned: training in Santarém, at UCI and at USP. Local Brazilian students will continue receiving training. Currently, two students - Adelaine Michela Silva e Figueira e Cleilim Albert Dias de Sousa are working in the project with support from LBA fellowships. Michela has taken progressively larger role in the project and is now responsible for day-to-day operation of the project in Santarém. Michela and Albert were initially supervised by Mary Menton, a US-citizen who lived in Santarém from 3/00 to 08/01. In 2003 it is planned that these students visit UCI for one month to work on data analysis. Additional students will be involved in the project during Phase II. A Brazilian PhD, a Masters student or a Postdoctoral fellow will work on the project. Two students from USP and one from Santarém will spend some time at UCI working on data analysis. Currently, at USP, there are four students under Dr. Humberto Rocha's supervision: Helber Freitas, Leandro Vedova, Robinson Juarez and Rafael Rosolem. Helber and Leandro have played central roles in the project. Leandro took an important role in developing software and analyzing data. Helber took a lead role in the design, fabrication, installation, and maintenance of equipment. Robinson Juarez is a graduate student under the doctorate program at USP and has worked with estimates of leaf area index using hemispherical photographs. Rafael Rosolem is an undergraduate student and spent a month at TNF working on the gap instrumentation. It is expected that these students from USP will continue to play a central role in the project.
CD-05 (Nepstad / Klink / Moutinho)	Most of the planned training activities will involve Amazonian students (9 to 10 doctoral students). IPAM will continue supporting ongoing scholarships from Amazonian students. UFAC will continue hosting courses in collaboration with this team. Approximately ten undergraduates, twelve Brazilian doctoral students (9 from Amazonia) and eight MS students will receive training. Faculty from these institutions will have training responsibilities: VA Polytechnic Institute, Boston University, USP (University of So Paulo), IPAM, University of Brasilia and Federal University of Pará.
CD-06 (Richey / Victoria)	This group will continue providing support for students not only at the University of Washington and CENA-USP but also from Amazonian institutions.
CD-08 (Trumbore / Camargo)	Training of current students will continue and new Masters students will be added. Currently, twelve students are involved. The Brazilian student Enir Salazar da Costa thesis on the C dynamics of leaves and roots in primary tropical forest and the role of these as sources of soil respiration; in addition she is working explore howland management changes cycling of C and N near Santarém. Everaldo de cArvalho Conceição Telles, a Brazilian PhD student at CENA (funded by FAPESP) works on carbon and nitrogen stocks and isotopic signature in soils from Santarém and Manaus with focus on spatial variability, topography, and C dynamics in soils of different texture. The Brazilian PhD student at CENA-USP - Simone Aparecida Vieira (funded by FAPESP) is developing comparison of tree growth rates and forest age structure in Acre, Manaus and Santarém using permanent plot, dendrometer, and radiocarbon analyses. The CNPq funded MS student Roseana Pereira da Silva is developing studies at INPA on "Padrões de crescimento de árvores que ocorrem em diferentes toposseqüências na região de Manaus. She has been studying monthly changes in tree grow rates using dendrometer bands for trees in three size classes equally distributed among plateau, slope, and valley forests. Rosana de Miranda Rocha, a MS students at INPA has been developing a thesis titled "Taxas de recrutamento e mortalidade da floresta de terra-firme da bacia do Rio Cuieiras na região de Manaus. Rosana calculated recruitment, growth and mortality rates for two 20 x 2,500 m permanent inventory plots (5 ha each) from 1996 to 2000. She found that the trees were a net carbon sink of about 0.34 Mg C ha-1yr1over the four year period.
CD-10 (Wofsy / Kirchhoff / Camargo / A. Nobre)	It is planned to continue the work being developed with current or recently graduated undergraduate students, graduate students and technicians at INPA by close collaboration with A. Nobre. Students will be focusing on understanding and analyzing eddy covariance data, and using Manaus and FLONA sites as a case study.
CD-18 (Shuttleworth / Nobre)	Formal training of a Brazilian graduate student, preferably linked to CPTEC, for a Doctoral degree in Hydrometeorology in the Department of Hydrology and Water Resources at the University of Arizona. On-the-job training of Brazilian investigators through shared research carried out at the University of Arizona, CPTEC and CEH, facilitated by exchange visits. On-the-job training of Brazilian graduate students from USP and INPE. Additional Brazilian students will be added to this program who will receive training on the use of advanced systems engineering techniques such as multi-parameter optimization and the evaluation of model-calculated variables as

	observations.
LC-01 (Walsh / Bilsborrow / Ruiz)	Training of six PhD students admitted at University of North Carolina under LBA Funds - three from the US, two from Brazil and one from Peru - will continue. Many other students from Ecuador have received and will continue to receive training.
LC-02 (Brown / Silveira / Esteves)	Five students of UFAC, who did an internship at SETEM-LBA/Acre), plan to initiate their Masters degree. A total of 12 graduate students associated with SETEM (Sector of Land Use and Global Change Studies) will likely be in a graduate school during the next three years. University of Florida graduate students from units ranging from forestry to geography to civil engineering to law have recently formed a working group focused on the impacts of roads on ecosystems and social systems. The "Roadies" working group can serve as a valuable resource to MAP-origin students and for the development of new theoretical models and methods to better anticipate the impacts of new roads on social and ecological systems. As such, it provides a forum for interdisciplinary discussion and intensive collaboration in the TCD tradition, with a focus on the MAP region and issues key to near-future changes under way there.
LC-04 (Foley / Costa)	Formal training is planned for graduate (3-4) and several undergraduates at the Federal University of Viçosa. Current Post-Doc students will continue training at the Wisconsin University.
LC-05 (Laurance / Mesquita)	Training and education activities will play a key role in determining the capacity of Brazilian researchers, resource managers, decision-makers, and the general public to make well-informed decisions about the future of Amazonian forests. For this reason, training and educational activities, in their broadest sense, are an integral part of this proposal. Advanced training will be provided for 6-8 Brazilian postgraduate students (including three students from Phase 1; these students will be involved in field studies of carbon storage and ecosystem processes in fragmented, logged, and regenerating forests; (2) GIS-based spatial analyses of carbon storage and emissions in anthropogenic landscapes; (3) spatial analyses designed to identify the key proximate drivers of Amazonian deforestation; and (4) policy-related analyses of Amazonian development trends. Numerous current Brazilian undergraduate students will continue to receive training in rainforest ecology, database management, GIS application, remote sensing, and field biology.
LC-07 (Melack / Novo / Forsberg)	Three Brazilian students - one PhD, two Masters and also a technician - will be developing fieldwork at INPA and at the Canguçú Research Center (near the field sites) and receive training on field validation, analysis of remote sensing data for the region, digital videography data and passive and active microwave data.
LC-09 (Moran / Batistella)	A full-time graduate assistant will be working on the project. Seven PhD Students will be added, including periodic visiting students of varying academic levels.
LC-14 (Nepstad / Moutinho)	It is planned that 9-10 undergraduate students and approximately eight Masters students will receive training. Faculty from VA Polytechnic Institute, Boston University, USP (University of So Paulo), IPAM, University of Brasilia and Federal University of Pará will have training responsibilities.
LC-16 (Davidson / Klink)	It is planned to continue providing support for technicians employed by IPAM. Two of them have moved to graduate degree programs and a third is now applying. New technicians are planned to be hired and will be encouraged to move on to further graduate training. Links with the Millenium Project through EMBRAPA/CPATU collaborators will offer opportunities to include students from UFPA and FCAP. Co-PI Figueiredo has lectured on classes at the UFPa program at Santarém regarding LBA science and has recruited students from this program to apply for CNq-LBA bolsas. This effort will continue to be developed in Phase II. Six bolsistas (probably Brazilian undergraduates) will receive individual mentoring and field experiences. It is also expected to provide research experience to some technicians.
LC-21 (Asner / Bustamante / Silva)	It is planned to greatly increase T & E program in a variety of activities. Two post-doctoral trainees will be included (one Brazilian and one American). They will receive in-depth training in three areas: nutrients dynamics, remote sensing and biogeochemical modeling. They will work closely together and with the PI's in the field and they will exchange long visits in Asner's and Bustamante's laboratories.
LC-22 (DeFries / Shimabukuro)	A graduate program will be provided for a Brazilian graduate student at the University of Maryland and INPE.
LC-23 (Morisette / Schroeder / Pereira)	At least one graduate student at INPE or Brazilian University or post-doc or recent Brazilian PhD/MS will be involved. The priority is to fund a graduate student (or students) at INPE or a Brazilian university (with some time at IBAMA) who will assist with fieldwork and attend meetings and/or spend sometime at GSFC.

LC-24 (Walker / Reis)	The primary focus in education and training will be in the support of graduate education. Here, the proposed project will support graduate students at three US institutions, and will also provide valuable training to individuals associated with a Brazilian institution (IPEA). A significant educational aspect of this project relates to its integrative nature, which unites disciplines and technologies to construct a basin-wide projection model. Through involvement on the project, the students at all participating institutions will become conversant with issues in behavioral theory, geography, economics, sociology, spatial modeling, and remote sensing technologies. They will emerge from their programs of study with a powerful interdisciplinary imprint, from the perspective of the social sciences. Thus, they will be very well equipped to continue with research on environmental change in Brazil that, as in every other part of the world, is the outcome of complex social processes, at least in the short to mid-run.
ND-01 (Roberts / Barreto / Soares)	Five PhD students will be supported and enrolled at UCSB, including two Brazilian students, from IMAZON, who entered the PhD Program at UCSB.
ND-02 (Davidson / Carvalho / Sa / Vieira / Moutinho / Figueiredo)	The objective of this project is to provide meaningful research experiences for young Brazilian scientists and students, from undergraduate to post-doctoral levels. Training will focus on hands-on experience in all phases of research, from idea development, to field and laboratory work, to writing of manuscripts for publication. It is planned to continue providing support for technicians employed by IPAM. Two of them have moved to graduate degree programs and a third is now applying. New technicians are planned to be hired and will be encouraged to move on to further graduate training. Links with the Millenium Project through EMBRAPA-CPATU collaborators will offer opportunities to include students from UFPA and FCAP. Co-PI Figueiredo has lectured on classes at the UFPa program at Santarém regarding LBA science and has recruited students from this program to apply for CNq-LBA bolsas. This effort will continue to be developed in Phase II. Six Brazilian undergraduate students from FCAP in Belém and Federal University of Pará/EMBRAPA will receive individual mentoring and field experiences.
ND-03 (Deegan / Victoria / Krusche / Ballester)	Training and education will include post-doctoral training (2 post-docs), graduate (4 students) and undergraduate students (at least 2). This project will contribute to the development of Brazilian scientists by training a combination of post-docs and students at CENA and at two universities in Rondônia, Universidade Federal de Rondônia (UNIR- Ji-Paraná) and the Universidade Luterana do Brasil – Ji-Paraná (ULBRA). Our present LBA award supports a core group of two post-doctoral scholars and one Ph.D. student at CENA in Piracicaba, São Paulo. In the next phase, we plan to mentor two post-doctoral scholars: one will be Brazilian with a PhD from a Brazilian university and one will be from the US. These two post-docs will have leadership roles in the 15N additions in the field and are expected to spend up to 6 months per year in Rondônia. Our hope is that by pairing two post-docs at similar stages in their careers in unified field experiments, they will develop a working relationship that will continue beyond LBA. Dr. Gessner (USP- São Carlos) will continue to participate in the 15N additions to streams under funding from FAPESP. Because of collaborations developed during the first phase of LBA, we are now in a position to shift our emphasis towards students resident in Rondônia. Our presentation at a workshop in Ji-Parana, entitled, "Seminário UNIR/LBA, Perspectiva de Cooperação Científica em Rondônia," stimulated much interest among students and faculty from the Federal University of Rondônia - Ji-Paraná and the Lutheran University of Rondônia in our project. We have identified a student who will develop a thesis project related to in-stream processing and identification of sources of DOC and DI13C. We also intend to include MS or Ph D graduate students from CENA. We will encourage students to participate in experiment planning, fieldwork, sample and data analysis and writing papers for journal publication.
ND-07 (Zepp / Bustamante)	Students will receive training through multi-disciplinary activities on ecological research in different scales. Three Post-docs, one Master Student, one Research Assistant and at least two undergraduate students will be trained. The performance of students involved will be evaluated periodically by the group through seminars and technical reports. Presentation of results by the students in scientific meeting will be encouraged.
ND-11 (Fernandes / Passos / Couto)	It is planned to support one postdoctoral student and five PhD. Links with INPA will continue; students from INPA will be selected to undertake graduate research at the site in Jurena, MT.
TG-03 (Holben / Artaxo / Duarte / Setzer)	Training will be provided in joint planned activities with the LBA Millenium Institute on carbon cycling and modeling of physical climate. Support for current student will continue - for a Brazilian student at the University of Rondônia at Ji Paraná, who is now graduate student at University of São Paulo and for two undergraduate interns at UFAC.

TG-04 (Martens / Moraes / Victoria / Moreira)	US graduate student from UNC-Chapel Hill will continue developing research activities with students at UFPa and other Amazonian university students. One of the students is expected to start a Master Program at CENA-USP in 2002. Current students will continue developing fieldwork in Santarém. One graduate student is planned to work on dispersed methane source problem, and another graduate student from UFSM to work on use of radon in gas exchange/concentration observations. Focus for Phase II will be mainly on encouraging the education of the individual students involved in the project, from undergraduate toward and through graduate study. All graduate students involved are expected to present results at LBA meetings and to contribute to papers.
TG-05 (Potter / Carvalho / Oliveira / Schenato)	This team will continue to support two full annual student stipends at ULBRA in Santarém and EMBRAPA. The two students will participate in the development of surface hydrologic and biogeochemical transport studies in watersheds of the Rio Moju near the Tapajós National Forest.
TG-06 (Bakwin / Artaxo / Gatti / Martinelli)	Support for the current Brazilian PhD student working under Gatti's supervision will continue to be provided.
TG-07 (Keller / de Mello)	Support for training of students in Phase I will continue. Evilene Lopes is currently enrolled in her second year in the Ph.D. program in Natural Resources at the University of New Hampshire under the supervision of Patrick Crill; and Marcel Franz is currently in his final year in the Ph.D. program in Geochemistry of the Universidade Federal Fluminense under the supervision of William de Mello. Cleyton Pereira and Kadson Oliveira are two recent graduates of the Agricultural Technician program from the Agricultural Technical School in Castanhal, Pará. They are working with us full time in the field and in the laboratory. We expect Evilene Lopes to complete her Ph.D. work by the close of LBA Phase 2. Hudson Silva will join us at UNH for a M.Sc. degree in Phase-2. We will continue to employ a biologist and a technician in Santarem and we expect to seek a post-doctoral level Brazilian scientist to join our group there. In addition to these students, it is planned to add one more student, Jadson Dias who should attend CENA-USP for his M.S. beginning in August 2003. He will be replaced in Santarem by another technician.
TG-08 (Melillo / Cerri)	Currently there are seven Brazilian students working in this team - five doctoral students and two Masters students. They are developing research on soil nitrogen dynamics and trace gas fluxes. Support for current students will continue to be provided.

Short Courses / Seminars / Workshops

Team	**Activity Description**
CD-01 (Denning / Dias)	A short course on numerical modeling will be developed to be made available on line for advanced undergraduate students and beginning graduates. The course consists of seven chapters: a) Introduction to numerical modelling b) Finite difference equations and time differencing schemes c) Dynamical systems and the development of a mathematical model d) Time differencing schemes e) Constrained optimization f) Waves, Fourier transforms, and spectral space g) Transport.
CD-02 (Ehleringer / Martinelli)	Oportunities for Brazilian students will be offered for participating in the Annual International Stable Ecology at University of Utah. The bonding and interactions that develop during this course provide an unusual opportunity for students to get to know each other and each other's science, forster the notion of collaborative science, and expose students to a wide spectrum of scientific endeavors.
CD-05 (Nepstad / Klink / Moutinho)	Courses on community ecology and vegetaion science and a one 10-day field course per year on ecosystems, ecology and land use are planned. At least one seminar about Amazonian economic and ecological modeling will be presented for the Brazilian National Congress.
CD-06 (Richey / Victoria)	A annual workshop on regional-scale integration of CO2 fluses will be sponsored. A short course on watershed analysis will be offered. Short courses on analytical environmental chemistry. A network of liquid chromatographs is being installed in the Amazon (INPA, Paragominas, possibly Belém, as well as Ji Paraná). These courses will be useful as joint endeavors with other investigations.

CD-08 (Trumbore / Camargo)	A short course on the use of isotopes in the carbon cycle as part of the UCI/Keck AMS facility will be offered in June/July 2003. Investigators and PhD student will continue to participate in seminars and course offerings associated with LBA-ECO.
LC-01 (Walsh / Bilsborrow / Ruiz)	Two dissemination workshops on project results and new agricultural technologies will be organized. They will be held for farmers, local community and NGO leaders in the Amazon region in Lago Agrio and Coca. A major conference for scholars and government officials in Quito will be held to disseminate analytical results and present and discuss policy simulations toward the end of the proposed project. Presentations to disseminate interim findings will also be given to smaller groups of high officials.
LC-02 (Brown / Silveira / Esteves)	A 3-5 day course entitled "Introduction to LBA Science" is planned for scientists and professors of universities and research institutions in Acre to help incorporate the scientific results in the regional scientific community. A 3-5-day course for 25 participants in Acre in collaboration with 7 other LBA PIs and short seminars for regional decision-makers are planned to be organized.
LC-04 (Foley / Costa)	Courses in Environmental System Dynamics and Modeling. This course will focus on the principles of system dynamics and mathematical modeling. Students will develop computer models to solve problems coering a range of topics, including climatology, hydrology, forest ecology, carbon cyclin and biocheochemistry. The course will also emphasize communication skills. The course will have six major components.
LC-07 (Melack / Novo / Forsberg)	Course on Remote Sensing organized in collaboration with INPE, to be offered at INPE.
LC-09 (Moran / Batistella)	A course on Human Dimensions addressing the needs of Amazonian institutions in Bolivia, Peru and Brazil in the tri-country region is under discussion with the team led by I.Foster- Brown.
LC-21 (Asner / Bustamante / Silva)	A one-week seminar on nutrients and measurements will be developed by two post-docs and taught at UnB. It will cover topics such as rock-derived nutrient stocks and fluxes in forest ecosystems, field and laboratory measurements, and techniques for constructing a nutrient budget at the ecosystem level. A one-week seminar, involving classroom and field training on remote sensing, will be developed by Asner and co-instructed by Bustamante and Post-Docs at UnB. The same seminar will be taught at the Federal University of Pará (UFPA) and at EMBRAPA in Belém. Topics covered will include. remote sensing theory, spaceborne instrumentation, analytical methods, and field measurements. Training materials developed for remote sensing and biogeochemical research, including theories and methods in each area, will be available for students and seminar participants.
LC-22 (DeFries / Shimabukuro)	A workshop during the third year of Phase II is planned to be held at INPE. The objective is to discuss results and possibilities for implementation with a broader number of scientists.
LC-23 (Morisette / Schroeder / Pereira)	In order to help establish capacity within the region and promote wider use of the MODIS fire products, an annual workshop on the access and use of the satellite-derived fire products will be held adjacent to, or in conjunction with INPE's Brazilian Remote Sensing Symposium. It will be a 3-5 day workshop and will include: data access, overview of products, software tools and a mini-project to use the product.
ND-01 (Roberts / Barreto / Soares)	A workshop on Hyperspectral Remote Sensing is planned to be organized at INPE.
ND-03 (Deegan / Victoria / Krusche / Ballester)	A two-week short course for graduate students will be offered at USP-CENA on "Stable Isotope Tracer Additions to Ecosystems". Lectures will be given by Drs. Linda Deegan, Christopher Neill, Reynaldo Victoria and Luiz Antonio Martinelli. Curso de 2 semanas no CENA com foco em "15 N Additions" e uso de LINX em estudos de modelagem.
ND-07 (Zepp / Bustamante)	Cursos sobre estudos ecológicos, com foco na dinâmica de nutrientes. Undergraduate and graduate students will be trained through seminars, short courses and practices in the laboratories of the Department of Ecology in the University of Brasilia. Performance of the students will be evaluated periodically through seminars and technical reports. Participation of students in scientific meetings will be encouraged.
ND-11 (Fernandes /	Ecologia Florestal e treinamento em medições no campo.

Passos / Couto)	
TG-03 (Holben / Artaxo / Duarte / Setzer)	Short courses on aerosols and radiation will be taught at the Federal University of Acre, coordinated by Paulo Artaxo, Nicolau Priante and Alejandro Duarte. Short courses on environmental sciences will be taught for local students at the Institute of Physics, University of Cuiabá. They will be coordinated by Paulo Artaxo, Nicolau Priante and A;ejandro Duarte. Courses on aerosols and radiation will be taught at Federal University of Acre, coordinated by Paulo Artaxo, Nicolau Priante and Alejandro Duarte will also be offered.
TG-04 (Martens / Moraes / Victoria / Moreira)	Seminars will be given at Federal University of Santa Maria and the local institutions in Santarém, as in Phase I. English courses will also be provided for the students in Santarém.
TG-05 (Potter / Carvalho / Oliveira / Schenato)	Annual training meetings with students and faculties in Santarém are planned in order to provide instruction and updates on simulation modeling techniques used in LBA-ECO studies.
TG-06 (Bakwin / Artaxo / Gatti / Martinelli)	Short courses on stable isotopes in ecology and atmospheric trace gases will be given for undergraduate and graduate students from Universidade Federal do Pará (UFPa-Santarém).
TG-07 (Keller / de Mello)	Short courses coordinated with Brazilian partner institutions will continue to be offered involving students and technicians. Dates to be announced.
TG-09 (Trumbore / Perez / Camargo)	A short course on the use of isotopes in the carbon cycle as part of the UCI/Keck AMS facility will be offered in June/July 2003.

Visits / Exchange Programs

Team	**Activity Description**
CD-01 (Denning / Dias)	A ten-week visit for USP scientists to Colorado State University is planned and follow-up visits by CSU scientist to USP.
CD-02 (Ehleringer / Martinelli)	Opportunities for Brazilian students (1-20) will be offered for participating in the Annual International Stable Isotope Ecology Course in Utah. Treinamento em amostragem de ar nos estudos e análises de concentração de CO2. Visitsof students and researchers to CENA-USP and the University of Utah for training on advanced technology are planned.
CD-04 (Goulden / Rocha)	A Brazilian PhD, Masters or Posdoctoral student will spend several months at University of California, Irvine working on data analysis.
CD-08 (Trumbore / Camargo)	Training of students from INPA and CENA at University of California, Irvine.
CD-10 (Wofsy / Kirchhoff / Camargo / A. Nobre)	A student currently developing a second year undergraduate majoring in Biology at the Faculdades Integradas do Tapajós in Santarém is expected to visit Harvard and New England forests for a 6-8 week period during the summer of 2003 to be trained on new analytical techniques and work closely with Harvard graduate students and researchers. Additional opportunities for advanced students will be offered for students from INPA and residents in the Amazon region. They participate in intensive training and working meetings at Harvard, focused on understanding and analyzing eddy covariance data, using Manaus and Santarém sites as a case study. It is planned that students from INPA will be long-term visitors as suitable for their needs and interests, participating in all aspects of the research group activities.
CD-18 (Shuttleworth / Nobre)	Regular one-two month exchange visits by researchers from partnering institutions – University of Arizona, CPTEC, and CEH –are planned for training on the use of advanced systems engineering techniques such as multi-parameter optimization and the evaluation of model-calculated variables as observations. Short visits by students from USP and INPE to the University of Arizona are also scheduled.
LC-04 (Foley / Costa)	Visiting internships at partner institutions for training of students in a range of interdisciplinary research.
LC-07 (Melack / Novo / Forsberg)	Opportunities to spend time at UCSB for training on specific aspects of research will be offered for the Brazilian students. Support will be given for students to

	participate in national and international symposia in order to present results of their research.
LC-09 (Moran / Batistella)	It is planned to develop exchange programs offering the resources of ACT, INPE, EMBRAPA, ISU/ISURSL to a number of Amazonian institutions (EMBRAPA/CPATU, EMBRAPA /Satellite Monitoring, UFAC, INPA, Museu Goeldi, UFPA for doctoral and masters level students. Also, it is planned to provide support for exchange programs for two, one-month, individualized training for Amazonian students to ACT for intensive work on land use/land cover change methods. Support for several Amazonian and INPE's students will be provided for participation in the annual Summer Institute course taught by CIPEC.
LC-21 (Asner / Bustamante / Silva)	A short -term visit by two graduate students from UnB to Asner's lab will be provided. A visit by Asner's and his staff to Belém will be made to provide technology transfer to EMBRAPA personnel working on remote sensing and land-use issues. A visit by Asner's and his staff to Belém will be made to provide technology transfer to EMBRAPA personnel working on remote sensing and land-use issues. PI's will continue the on-going work on training on the use of GPS, forestry survey methods and canopy damage assessment instruments in collaboration with the Tropical Forest Foundation.
ND-01 (Roberts / Barreto / Soares)	Two Brazilian researchers will visit UCSB for a six-month training in image processing techniques designed to provide reflectance retrievals, spectral mixture analysis with reference end member selection, land-cover mapping and decision tree classifiers.
ND-02 (Davidson / Carvalho / Sa / Vieira / Moutinho / Figueiredo)	Technicians, students and bolsistas will continue to be invited for exchange programs under a cooperative agreement enacted between the University of Georgia and FCAP.A 6-8 week training program at Woods Hole will be provided for technicians, students, and bolsistas. Undergraduate exchanges are planned between UGa in the U.S. and FCAP in Belém.
ND-03 (Deegan / Victoria / Krusche / Ballester)	Brazilian students and post-docs are planned to travel to the US (MBL) each year for a 3-month trip for education and training on analytical techniques relevant to biogeochemistry, plant ecology, soils, environmental chemistry, animal ecology, marine biology, and oceanography. Students will also have access to other researchers communities such as the Woods Hole Oceanographic Institution, Boston University Program and the United States Geological Survey.
ND-11 (Fernandes / Passos / Couto)	Ecologia Florestal e estudos do solo. Ecologia Florestal e estudos do solo. Visitas de 3 meses a cada ano, ao laboratório da equipe da Cornell University Laboratório.
TG-03 (Holben / Artaxo / Duarte / Setzer)	A 6-month course for a student from Federal University of Acre and a-3-6-month internship on remote sensing measurements and AERONET validation for the Brazilian sites will be provided at NASA/Goddard. A 6-month course for a student from Federal University of Acre and a-3-6-month internship on remote sensing measurements and AERONET validation for the Brazilian sites will be provided at NASA/Goddard.
TG-04 (Martens / Moraes / Victoria / Moreira)	Support will continue for formal exchange programs among Brazilian institutions and UNC-Chapel Hill for training in radon studies. This team will continue its formal exchange programs for Brazilian undergraduates.
TG-06 (Bakwin / Artaxo / Gatti / Martinelli)	The Brazilian PhD Student participating in this team is scheduled to visit Boulder to work under the direction of the CMDL staff. A Brazilian scientist from CENA will also visit CMDL and CU/INSTAAR. A scientist from Stable Isotope Laboratory at CU/INSTAAR will travel to Brazil to help upgrade equipment at CENA. Additional training will be provided by CMDL staff. Students from Santarém and Fortaleza areas will be engaged in this project. Continual visits from US personnel to Brazil are planned.
TG-07 (Keller / de Mello)	Two students from CTA will spend one month each at UNH to work on data analysis and publications during 2004.

Statistics for LBA-ECO Students by Team and Degree

The following table represents the student participation for each of the 2003-2005 LBA-ECO Investigations based on the current degree program in which each student is presently enrolled.

Investigation	Bachelors	Masters	Ph.D.	Postdoctoral	Technician	Unknown
CD-01 (Denning / Dias)	1	1	1	1	0	0
CD-02 (Ehleringer / Martinelli)	0	2	5	2	1	0
CD-03 (Fitzjarrald / Moraes)	1	1	5	1	1	1
CD-04 (Goulden / Rocha)	2	4	1	1	0	1
CD-05 (Nepstad / Klink / Moutinho)	2	7	12	4	2	1
CD-06 (Richey / Victoria)	4	3	4	5	2	0
CD-08 (Trumbore / Camargo)	1	4	3	3	1	1
CD-10 (Wofsy / Kirchhoff / Camargo / A. Nobre)	3	1	2	2	0	0
CD-11 (Houghton / Alencar)	0	1	1	1	0	0
CD-12 (Vourlitis / Priante)	7	1	0	0	0	2
CD-14 (Wofsy / Dias)	0	2	2	4	0	0
CD-15 (Cohen / Costa)	0	0	0	0	0	0
CD-17 (Ducey / Alves)	0	0	0	0	0	0
CD-18 (Shuttleworth / Nobre)	0	1	0	1	0	0
LC-01 (Walsh / Bilsborrow / Ruiz)	1	1	5	0	0	0
LC-02 (Brown / Silveira / Esteves)	2	5	4	3	2	2
LC-04 (Foley / Costa)	0	0	2	0	0	0
LC-05 (Laurance / Mesquita)	1	1	1	1	1	0
LC-07 (Melack / Novo / Forsberg)	0	4	4	4	0	1
LC-09 (Moran / Batistella)	0	0	7	2	1	0
LC-13 (Asner / Silva / Pereira)	0	0	1	1	1	0
LC-14 (Nepstad / Moutinho)	1	3	8	3	2	0
LC-16 (Davidson / Klink)	0	0	4	1	1	0
LC-21 (Asner / Bustamante / Silva)	0	0	0	1	0	0
LC-22 (DeFries / Shimabukuro)	0	1	0	0	0	0
LC-23 (Morisette / Schroeder / Pereira)	0	0	0	0	0	0
LC-24 (Walker / Reis)	0	0	2	0	0	0
ND-01 (Roberts / Barreto / Soares)	0	0	5	0	0	0
ND-02 (Davidson / Carvalho / Sa / Vieira / Moutinho / Figueiredo)	2	2	3	2	0	1
ND-03 (Deegan / Victoria / Krusche / Ballester)	4	0	4	3	2	0
ND-07 (Zepp / Bustamante)	2	0	3	2	0	0
ND-11 (Fernandes / Passos / Couto)	2	5	3	0	0	0
TG-03 (Holben / Artaxo / Duarte / Setzer)	1	0	1	1	0	0
TG-04 (Martens / Moraes / Victoria / Moreira)	0	1	0	0	2	1
TG-05 (Potter / Carvalho / Oliveira / Schenato)	0	0	0	0	0	0
TG-06 (Bakwin / Artaxo / Gatti / Martinelli)	1	0	2	0	0	0
TG-07 (Keller / de Mello)	4	0	3	0	2	1
TG-08 (Melillo / Cerri)	0	2	6	0	0	0

Appendix 1: LBA-ECO Project Office

Name	Location	Project Position
Project Management		
Dr. Diane Wickland	NASA HQ	Program Manager
Dr. Garik Gutman	NASA HQ	Program Manager
Dr. Jared Entin	NASA HQ	Program Manager
Dr. Darrel Williams	NASA/GSFC	Project Manager
Dr. Michael Keller	University of New Hampshire	Project Scientist
Science Support		
Dr. Peter Griffith	NASA/GSFC	Project Support Manager
Ellen White	NASA/GSFC	Administrative Officer
Sheila Humke	NASA/GSFC	Administrative Officer
Dr. Ivani Pereira	NASA/GSFC	Education & Outreach Officer
Joanne Santiago	NASA/GSFC	Grants & Contracts
Gary Shelton	NASA/DFRC	Aircraft Coordinator
Mike Palace	University of New Hampshire	Assistant to Project Scientist
Lorena Brewster	University of New Hampshire	Program Assistant
Field Operations		
Dan Hodkinson	NASA/GSFC	Field Operations Manager
Dave Knapp	LBA Central Office - INPA	Brazil Liaison/ Remote Sensing
Bethany Reed	Santarém, Pará, Brasil	Logistics and Infrastructure Manager
Ann Steele	NASA/GSFC	Infrastructure Engineer
Janel Cassard	NASA/GSFC	Administrative Officer
GSFC-Based DIS		
Amy Morrell	NASA/GSFC	Web Team Lead
Merilyn Gentry	University of Tennessee	LBA-ECO Data Coordinator
Maura Tokay	NASA/GSFC	Programmer/Analyst
Lisa Wilcox	NASA/GSFC	Programmer/Analyst
Beth Nelson	NASA/GSFC	Web Curator
Keith Rice	NASA/GSFC	Systems Administrator
Rishi Narain	NASA/GSFC	Systems Support
ORNL-Based DIS		
Tim Rhyne	Oak Ridge National Lab	Systems Engineer
Stan Attenberger	Oak Ridge National Lab	Systems Analyst
Chris Lindsley	Oak Ridge National Lab	Programmer/Analyst

Appendix 2: Site Resource Coordination

LBA Regional Site Coordination

- Responsible for facilitating the interactions among LBA modules to enable coordination of infrastructure and logistical resources.
- Receive regular communications regarding LBA-ECO activities.

LBA Central Office in Manaus

Jose Laurindo Campos Dos Santos	Participant
Glória Alegria Coelho	Participant
Flavio Jesus Luizao	Project Coordinator - INPA and SSC Chair
Ana Cláudia Mendes Malhado	Scientific Assistant
Antonio Ocimar Manzi	Manager of Implementation and Logistics
Fábio Júlio do Nascimento	Mechanic
Sulamita Santos Pinheiro	Administrate Assistant
Shirley Soares Santos Pinheiro	LBA Secretary
Ricardo Rios	System Analyst
Erika Laura Schloemp	T&E Comittee Assistant and SSC Secretary
Ruth Araujo da Silva	Administrative Auxiliary

Belem Regional Office

Claudio Jose Reis de Carvalho	LBA Regional Office Manager / EMBRAPA Point of Contact
Tatiana Deane De Abreu Sa	Alternate EMBRAPA Point of Contact
Marzane Pinto de Souza	Administrative Assistant

Rondonia Regional Office

Keila Souza Aires	Logistics Support
Fernando Luiz Cardoso	LBA Regional Office Manager

Santarém Regional Office

Paulo Coutinho	LBA Santarem Regional Office Manager
Bethany A Reed	Infrastructure and Logistics Manager

Site Resources Coordination

- Responsible for the local coordination of resources, through coordination with Regional Offices and the Science Teams.
- Receive site-specific automated e-mails concerning LBA-ECO activities.
- Regional Office Managers and Site Resource Coordinators are the primary points of contact for resource coordination.
- Science Team Representatives are advisors and alternates to the Site Resource Coordinators.

Acre Site Resources Coordination (lbaeco-acre-sc@mail.lbaeco.org)

Irving Foster Brown	Site Resource Coordinator
Antonio Willian Flores de Melo	LBA-ECO Science Team Representative
Elsa Renee Huaman Mendoza	LBA-ECO Science Team Representative

Amazonas Site Resources Coordination * (lbaeco-manaus-sc@mail.lbaeco.org)

Jeffrey Q. Chambers	LBA-ECO Science Team Representative
Erick C.M. Fernandes	LBA-ECO Science Team Representative
Flavio Jesus Luizao	INPA Point of Contact; Site Resource Coordinator
Ana Cláudia Mendes Malhado	LBA Science Assistant
Ari de Oliveira Marques Filho	Alternate INPA Point of Contact
Luiz Antonio Martinelli	LBA-ECO Science Team Representative
Rita Guimaraes Mesquita	LBA-ECO Science Team Representative
Ruth Araujo da Silva	Logistics Support
Elisa Vieira Wandelli	LBA-ECO Science Team Representative

Brasília Site Resources Coordination * (lbaeco-brasilia-sc@mail.lbaeco.org)

Mercedes M.C. Bustamante	LBA-ECO Science Team Representative
Jair Max Furtunato Maia	Site Resource Coordinator

Ceará - No site resource coordination yet available.

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Ecuador Site Resources Coordination (lbaeco-ecuador-sc@mail.lbaeco.org)

Richard E. Bilsborrow	LBA-ECO Science Team Representative

Mato Grosso Site Resources Coordination (lbaeco-matogrosso-sc@mail.lbaeco.org)

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George L. Vourlitis	LBA-ECO Science Team Representative

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Carlos Eiras	Vehicle Scheduler
Ricardo de Oliveira Figueiredo	LBA-ECO Science Team Representative
Edvaldo Givone	LBA-ECO Science Team Representative

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Michael L. Goulden	LBA-ECO Science Team Representative; km 83 Tower Captain
Gladys Martinez	EMBRAPA-Santarém Liaison
James William Munger	LBA-ECO Science Team Representative; km 67 Tower Captain
Ivani Pereira	Outreach and Education Specialist
Bethany A Reed	Infrastructure and Logistics Manager
Iomar (Bill) Vidal da Silva	Logistics Support

Peru - No site resource coordination yet available.

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Steven C. Wofsy	LBA-ECO Science Team Representative

Rondonia Site Resources Coordination * (lbaeco-rondonia-sc@mail.lbaeco.org)

Keila Souza Aires	Site Resource Coordinator
Fernando Luiz Cardoso	LBA Regional Office Manager
Oliver A. Chadwick	LBA-ECO Science Team Representative
Marcos A. Pedlowski	LBA-ECO Science Team Representative

Roraima - No site resource coordination yet available.

Tocantins - No site resource coordination yet available.

* Field office and logistics support available.

Appendix 3: Santarém Schematics

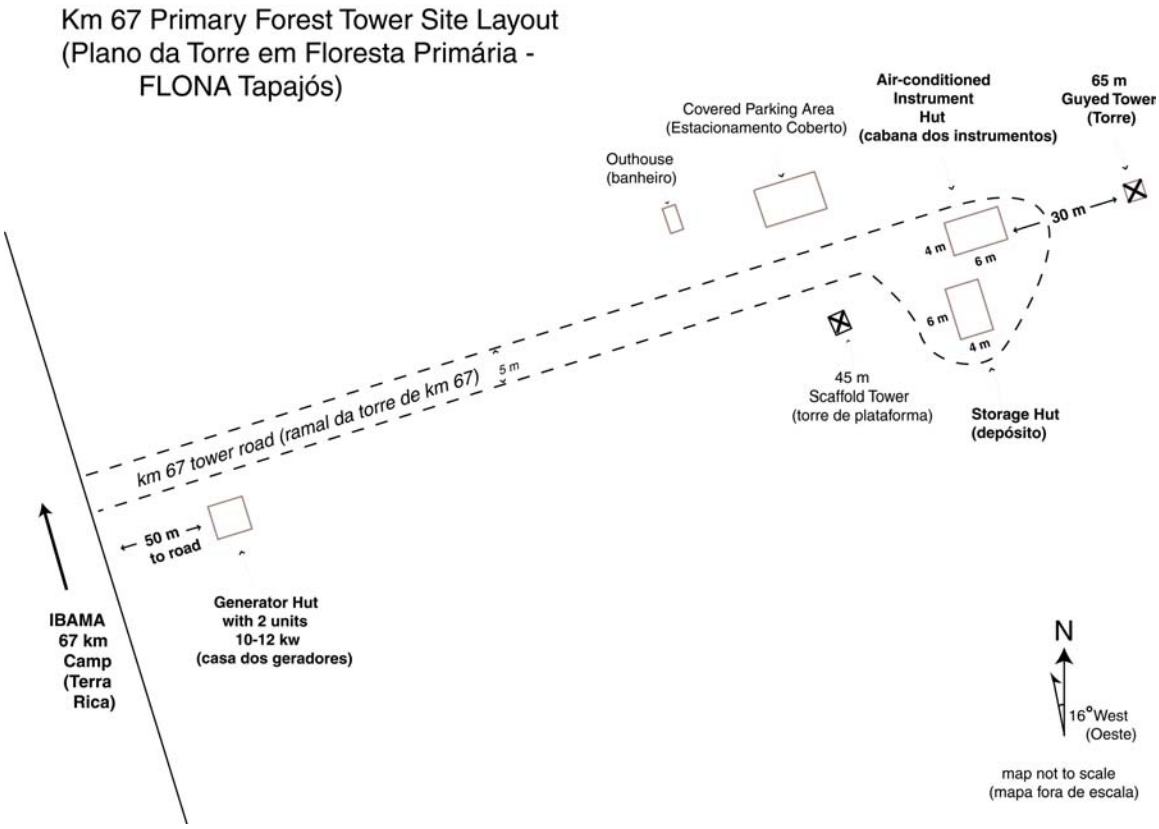


Figure 1. Santarém Km 67 Primary Forest Tower Site

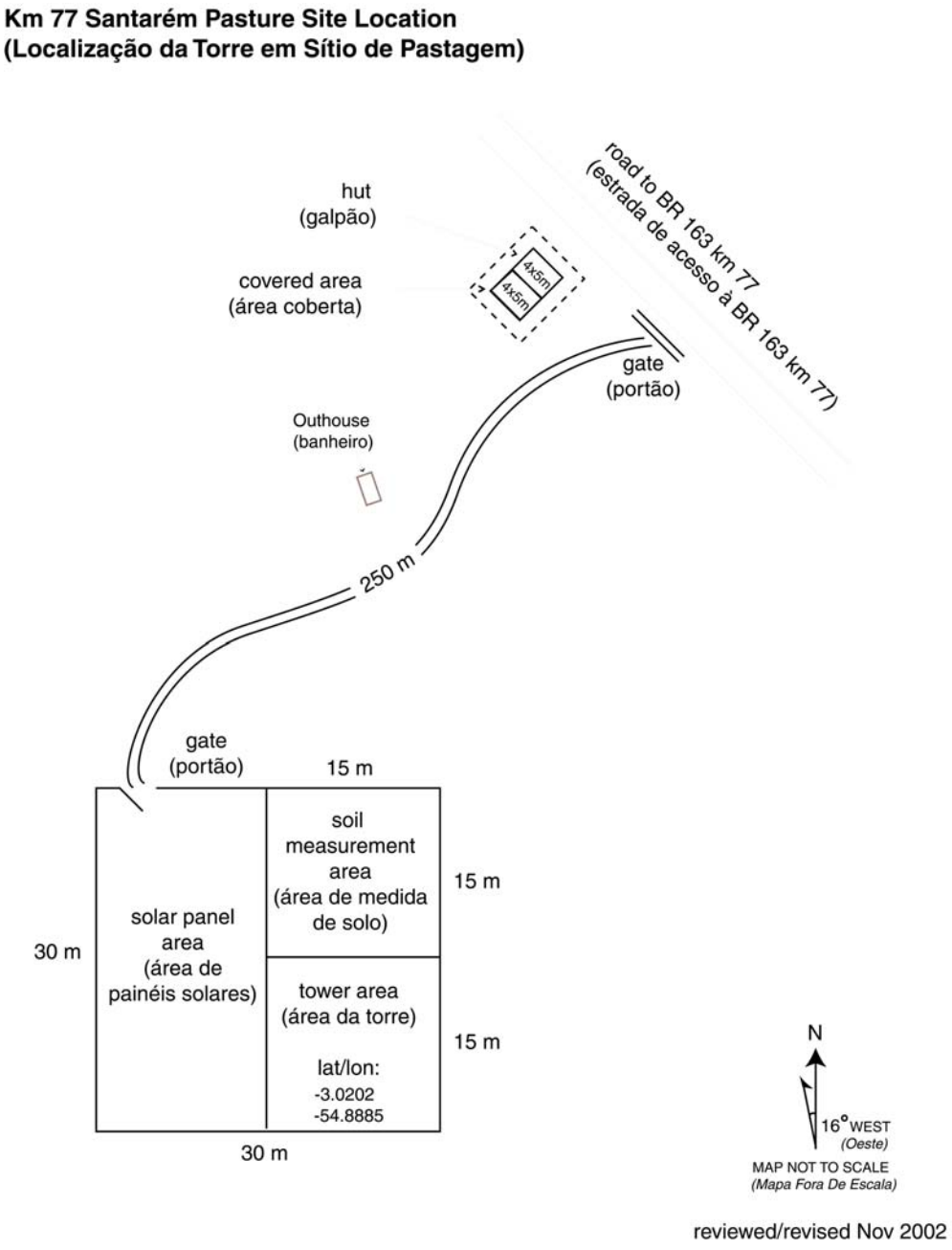


Figure 2. Santarém Km 77 Pasture Tower Site

Km 83 Logged Forest Tower Site Location
(Localização da Torre na Clareira - FLONA Tapajós)

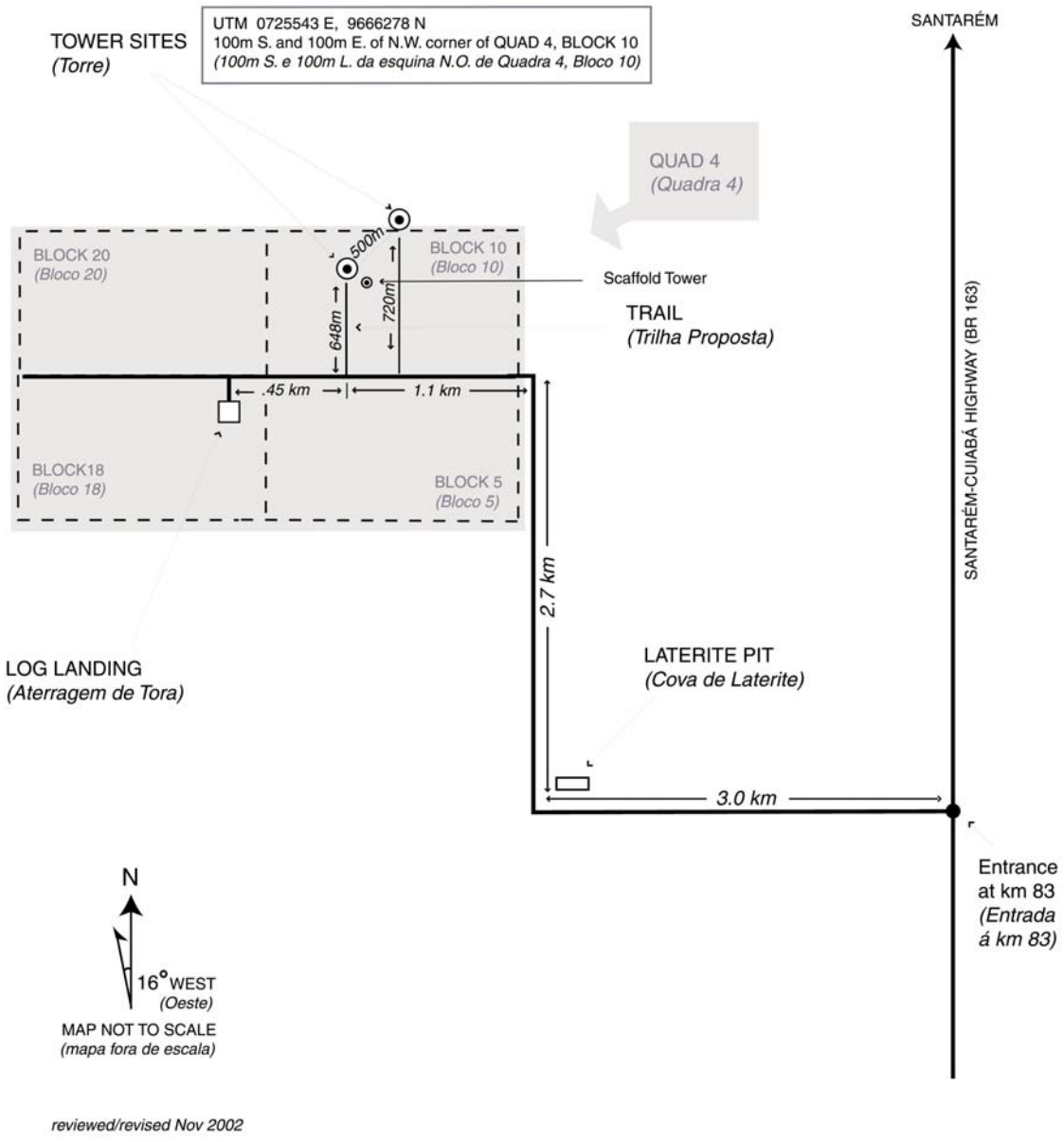


Figure 3. Santarém Km 83 Logged Forest Tower Site

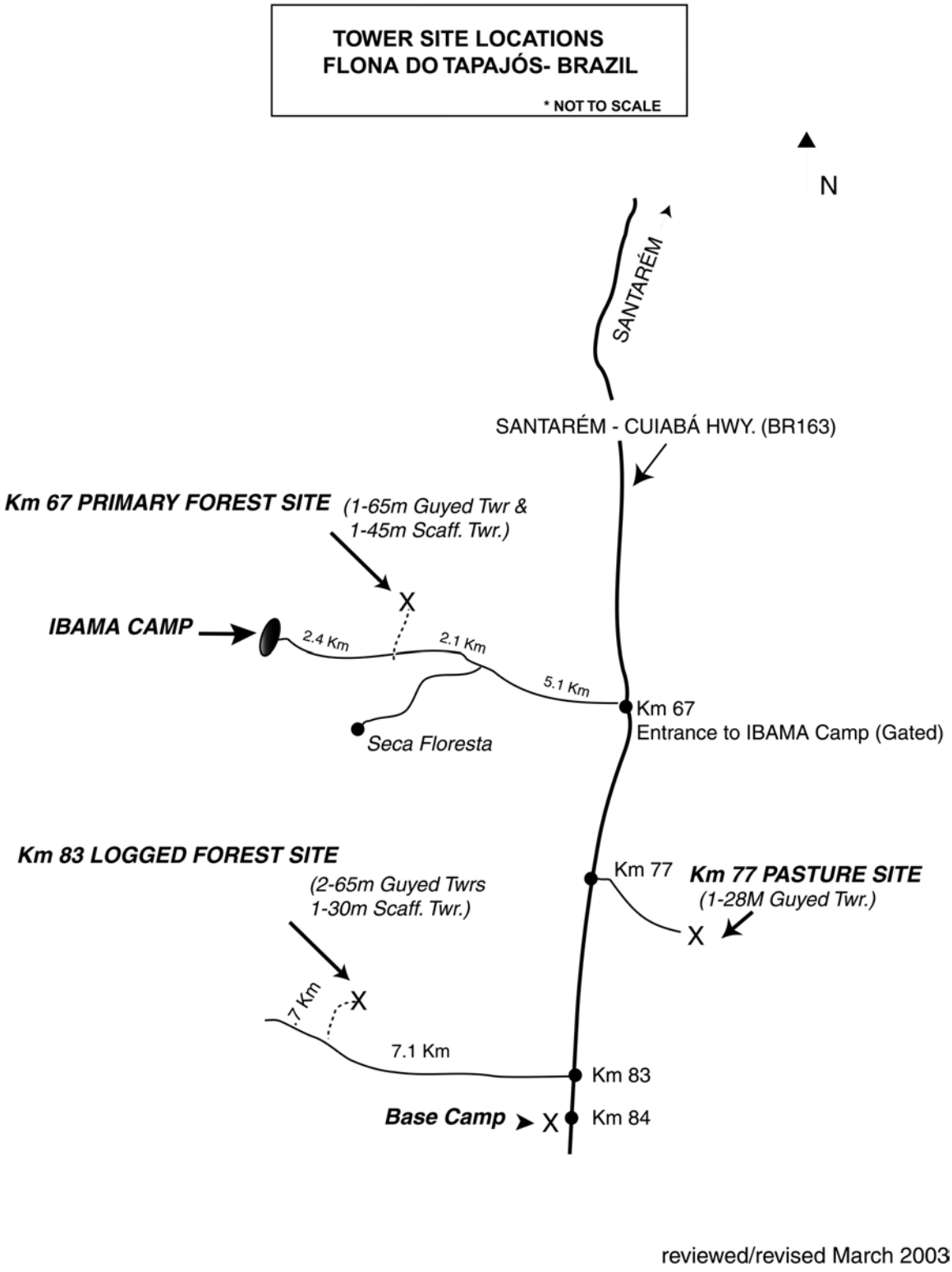


Figure 4. Santarém Tower Site locations

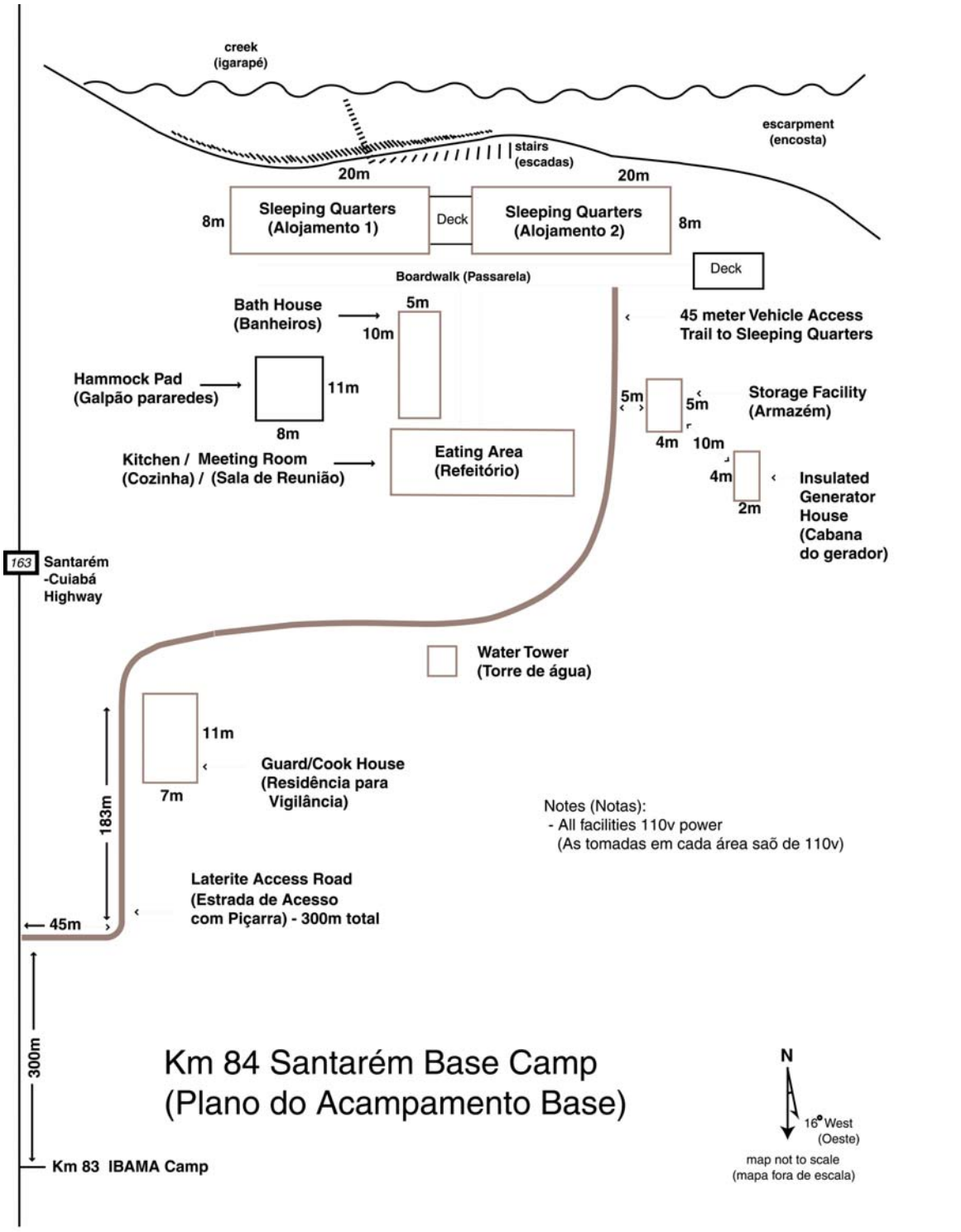


Figure 5. Santarém Km 84 Base Camp

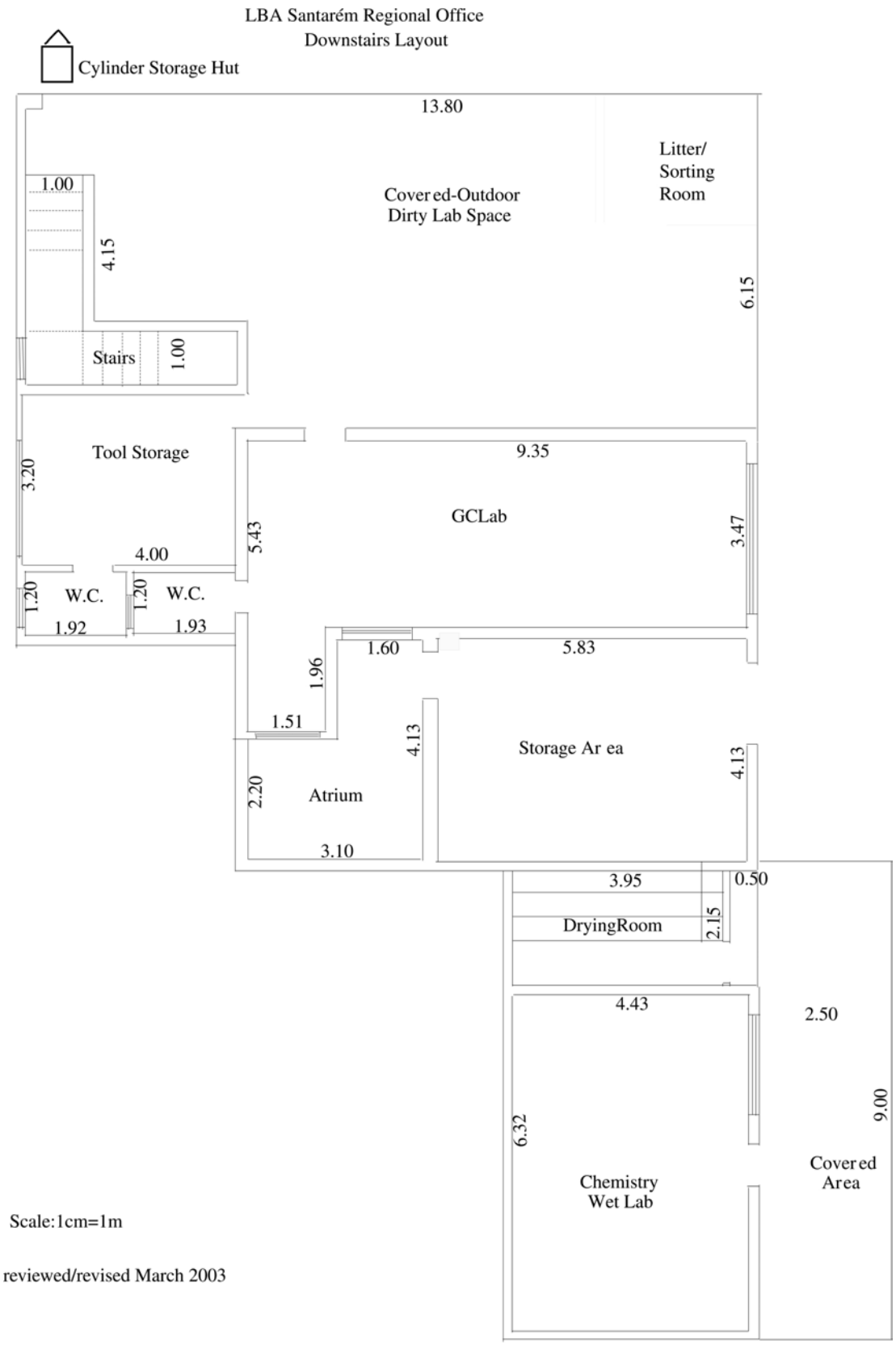
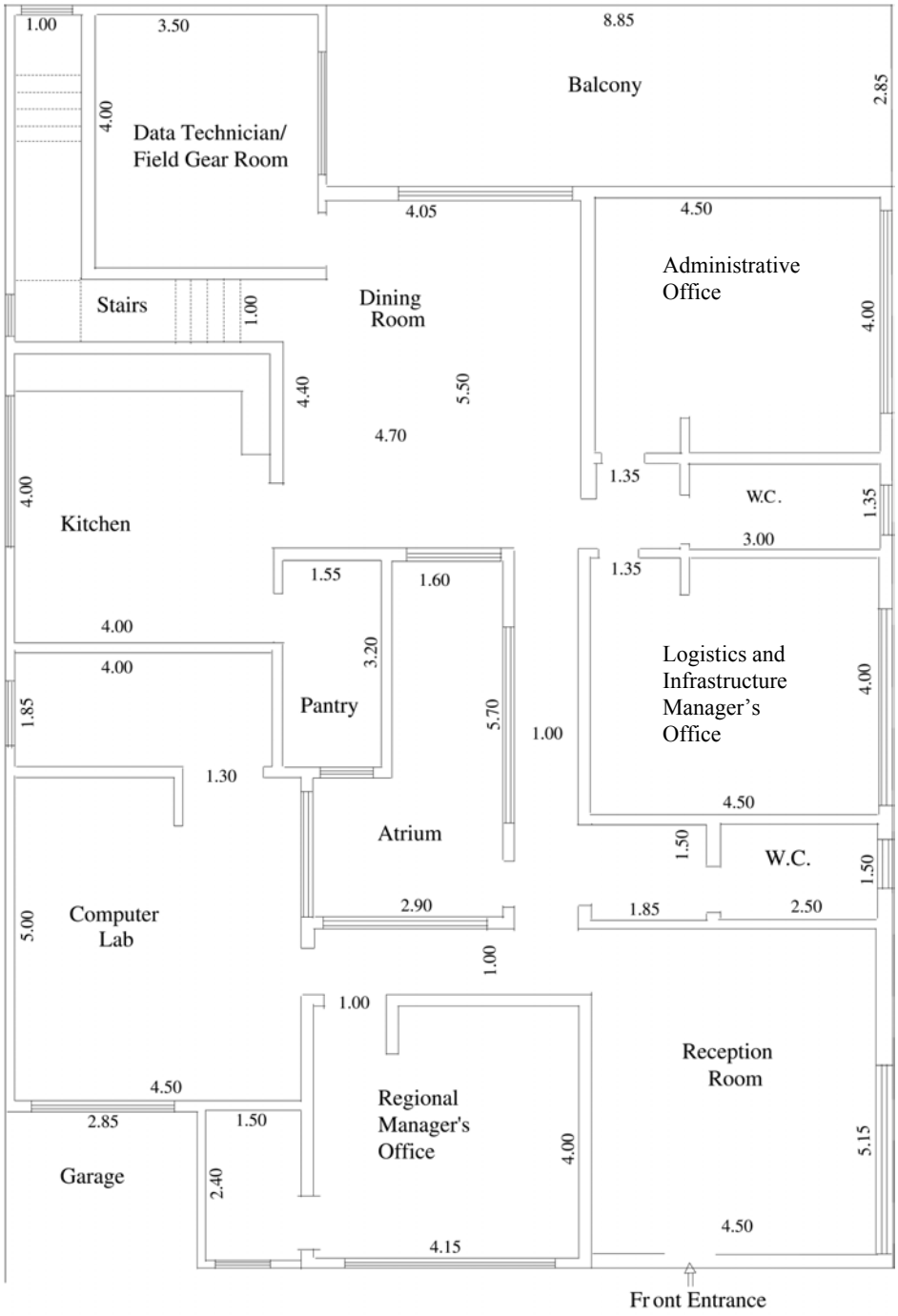


Figure 6. LBA Santarém Regional Office Downstairs Layout

LBA Santarém Regional Office

Upstairs Layout



Scale:1cm=1m

Revised September 2003

Figure 7. LBA Santarém Regional Office Upstairs Layout

LBA Santarém Regional Office GC Lab

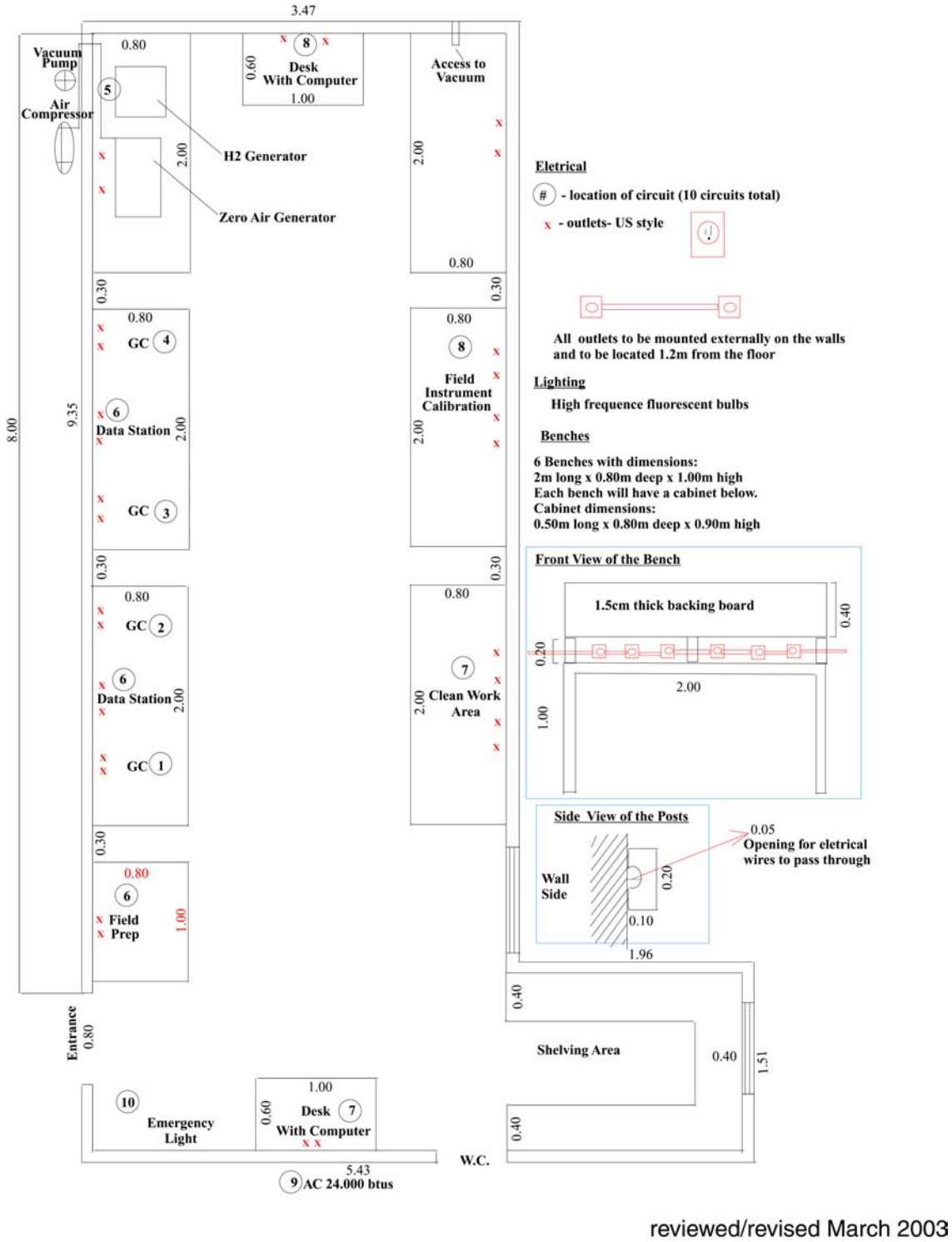


Figure 8. LBA Santarém Regional Office Gas Chromatograph Lab

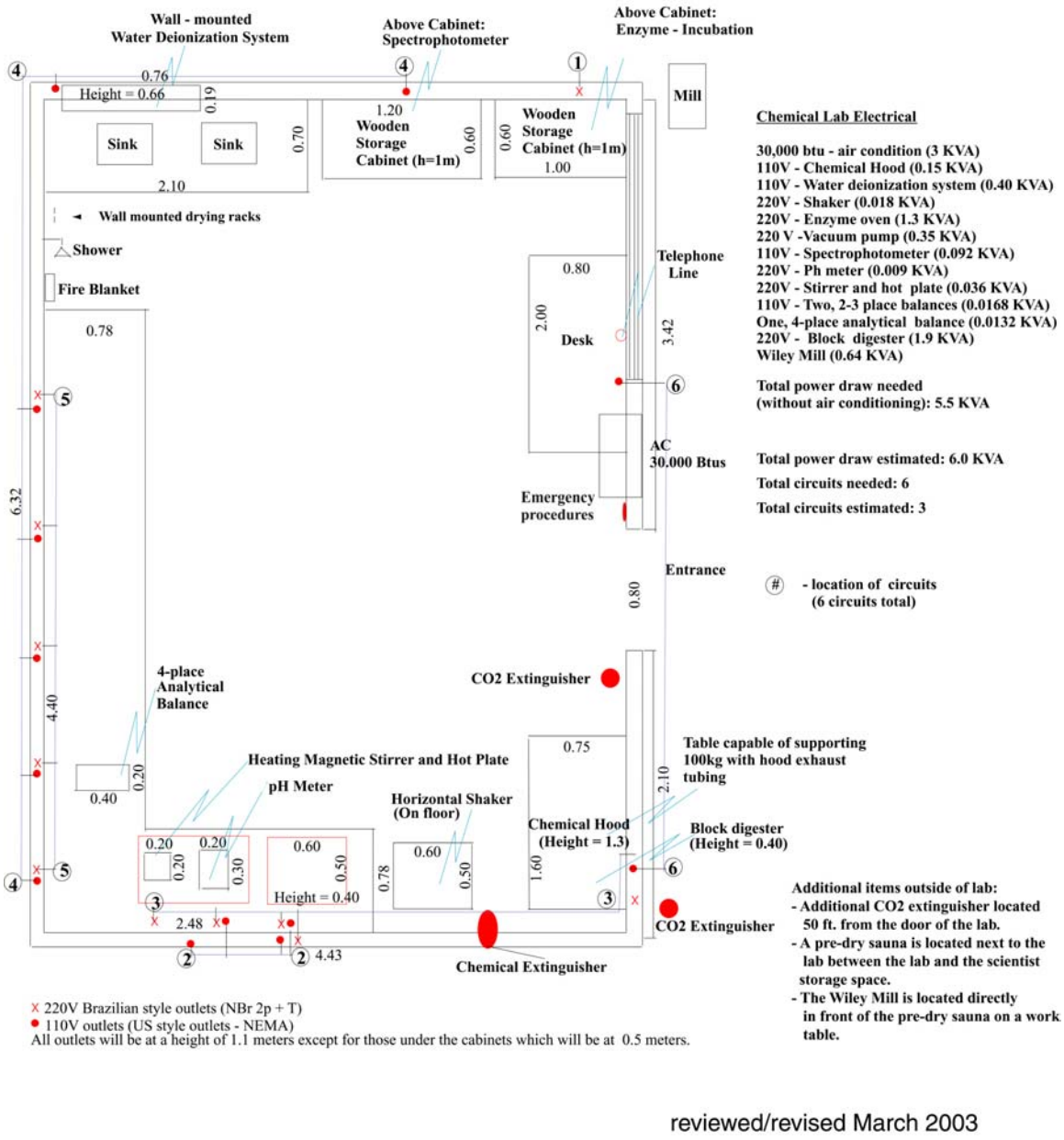


Figure 9. LBA Santarém Regional Office Wet Chemistry Lab

Appendix 4: LBA-ECO Science Questions Addressed by Investigation Team

(Information available for LBA-ECO Investigations continuing into 2003)

	CD							LC				ND								TG		
Team	CD-	CD-	CD-	CD-	CD-	CD-	CD-	LC-	LC-	LC-	LC-	ND-	ND-	ND-	ND-	ND-	ND-	ND-	ND-	TG-	TG-	TG-
CD-01	*																		*			
CD-02	*	*	*		*																	
CD-03	*		*	*	*	*																
CD-04	*	*	*		*					*												
CD-05	*	*	*		*		*			*	*											
CD-06			*													*	*	*	*			*
CD-08	*	*		*	*																*	
CD-10 (Wofsy	*	*	*		*	*																
CD-11			*		*	*	*			*												
CD-12	*	*		*	*																	
CD-15 (Cohen	*																					
CD-17 (Ducey		*				*		*	*													
CD-18	*	*				*																
LC-01 (Walsh								*	*		*											
LC-02							*	*		*	*											
	CD							LC				ND								TG		

	CD							LC				ND								TG		
Team (click on team to view profile)	CD-Q1	CD-Q2	CD-Q3	CD-Q3a	CD-Q3b	CD-Q3c	CD-Q3d	LC-Q1	LC-Q2	LC-Q3	LC-Q4	ND-Q1	ND-Q2	ND-Q3	ND-Q4	ND-Q4a	ND-Q4b	ND-Q4c	ND-Q5	TG-Q1	TG-Q2	Q3
LC-04 (Foley / Costa)	*	*	*					*	*						*				*			
LC-05 (Laurance / Mesquita)	*	*	*			*		*	*													
LC-07 (Melack / Novo / Forsberg)	*		*												*				*	*	*	*
LC-09 (Moran / Batistella)								*	*		*		*			*						
LC-13 (Asner / Silva / Pereira)		*	*		*	*	*			*												
LC-14 (Nepstad / Moutinho)	*	*	*			*																
LC-16 (Davidson / Klink)	*											*									*	
LC-21 (Asner / Bustamante / Silva)					*					*		*	*		*							
LC-22 (DeFries / Shimabukuro)								*	*													
LC-23 (Morisette / Schroeder / Pereira)							*	*	*	*												
LC-24 (Walker / Reis)								*														
ND-01 (Roberts / Barreto / Soares)					*			*	*	*		*	*		*	*	*					
ND-02 (Davidson / Carvalho / Sa / Vieira / Moutinho / Figueiredo)		*		*		*						*	*		*	*		*	*	*	*	
ND-03 (Deegan / Victoria / Krusche / Ballester)												*			*		*	*	*			
ND-07 (Zepp / Bustamante)				*								*			*	*		*		*	*	*

	CD							LC				ND								TG		
Team (click on team to view profile)	CD-Q1	CD-Q2	CD-Q3	CD-Q3a	CD-Q3b	CD-Q3c	CD-Q3d	LC-Q1	LC-Q2	LC-Q3	LC-Q4	ND-Q1	ND-Q2	ND-Q3	ND-Q4	ND-Q4a	ND-Q4b	ND-Q4c	ND-Q5	TG-Q1	TG-Q2	Q3
ND-11 (Fernandes / Passos / Couto)					*	*						*	*			*						
TG-03 (Holben / Artaxo / Duarte / Setzer)																					*	
TG-04 (Martens / Moraes / Victoria / Moreira)	*		*		*															*		*
TG-05 (Potter / Carvalho / Oliveira / Schenato)	*		*	*		*	*	*				*	*		*	*	*		*	*	*	*
TG-06 (Bakwin / Artaxo / Gatti / Martinelli)	*																			*	*	
TG-07 (Keller / de Mello)			*		*															*	*	*
TG-08 (Melillo / Cerri)				*								*								*		

Appendix 5: LBA-ECO Contact Information

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