Report of the Fourth LBA-Ecology Science Team Meeting
Belem, Para, Brazil
June 29-30, 2000

Prepared by Michael Keller and Lorena Brewster
September 5, 2000

Contributors: I. Foster Brown, Willian de Melo, Elsa Mendoza, Marcos Costa, George Hurtt, Alfredo Huete, Heloisa Miranda, Erick Fernandes, Rita Mesquita, Linda Deegan, Marcos Pedlowski, William Z. de Mello, Steve Wofsy, Scott Saleska, Humberto Rocha, Susan Trumbore, Eduardo Brondizio, João Vianei Soares, Eric Davidson, Reynaldo Victoria, Luciana Gatti, Alex Guenther, Plinio Camargo, Chris Martens, Luiz Martinelli, Dar Roberts, Tatiana Sá, Vicky Ballester, Stefan Sandmeier

1.0 Introduction: Purpose of the Meeting

The fourth Science Team Business meeting for the NASA LBA-Ecology Project was held at the Hilton Hotel in Belem, Para, Brazil from June 29-30, 2000. This meeting which was open to all LBA participants and the public was held during $1^1/_2$ days immediately following the First LBA Scientific Conference. The LBA-Ecology meeting had three goals: (1) discussion of preliminary results; (2) a mid-course re-evaluation of the science planning; and (3) planning for future LBA-Ecology activities. The first goal was largely accomplished through the First LBA Scientific Conference.

After introductory remarks by NASA Program and Project Management, the meeting focused primarily on the second goal. We evaluated both scientific and implementation progress during two sets of parallel sessions. The first set of parallel sessions considered the project from the perspective of research sites while the second set of sessions reviewed the progress of the four science themes. Finally, in two additional parallel discussions, we considered two implementation issues of primary importance that cross all sites and themes: education and training; and data and information systems.

This report presents the results of the meeting in a narrative fashion that follows the chronological order of the meeting. The meeting agenda can be found in Appendix 1. A list of persons attending the meeting is found in Appendix 2.

1.1 Introductory Remarks. The Project Scientist, Dr. Michael Keller, opened the meeting with a brief discussion of the goals and agenda of the meeting. Dr. Diane Wickland, NASA Program Manager for Terrestrial Ecology, reviewed a letter that she, Dr. Garik Gutman and Dr. Donald Deering sent to the LBA-Ecology Principal Investigators regarding an opportunity to extend LBA-Ecology awards for up to six months. This extension is meant to compensate for delays that have been experienced in securing permissions and the import of needed equipment, and to ensure that everyone who is making field observations will be able to collect, at a minimum, a full year's worth of data before their original award ends. A new NASA Research

Announcement (NRA) for LBA-Ecology Phase II activities should be released in February, 2001, with an anticipated selection in October, 2001, and award start dates of January 1, 2002. The expected duration of Phase II awards is three years. Dr. Wickland discussed an upcoming opportunity for airborne remote sensing research in LBA-Ecology to be released as part of the Carbon Cycle NRA in about two months. Dr. Wickland also noted that the Terrestrial Ecology Program and the Land Use and Land Cover change program need information on research accomplishments from the Science Team. Following Dr. Wickland's presentation Dr. Gutman, NASA Program Manager for the Land Cover and Land Use Change (LCLUC) Program introduced himself to the Science Team and related key elements of the Program. He indicated that the LCLUC Program would continue to support through the second LBA-Ecology project period. Support from the LCLUC Program to LBA-Ecology would probably decrease somewhat during the second phase of the LBA-Ecology Project compared to the first phase. Dr. Deering, Project Manager, provided an update on LBA-Ecology implementation. He noted that a new version of the Experiment Plan (Version 1.1) would be released in August. This version would include seven new investigations that have been included in LBA-Ecology since the Version 1.0 plan was published. Additionally, the infrastructure and logistics support capabilities as well as the data and information system have matured in the last 18 months. These sections are updated substantially.

2.0 Research Sites

Separate sessions were held for the main LBA-Ecology field sites and for the Amazon region as a site for studies at the continental scale. The primary purpose of these sessions was to coordinate research within each site. Site based groups addressed the following questions:

1) Are studies at the site coordinated both scientifically and logistically?
2) Are we taking advantage of the scientific opportunities that multiple groups present? Is the whole site activity generating results that are greater than the sum of the parts?
3) Are we sharing facilities and data sets?
4) Is the current coordination structure working? If not, please suggest a new mode of organization.
5) What, if any, obstacles exist to greater collaboration and how can these obstacles be overcome?
6) Are there any logistical obstacles that need to be brought to the attention of the project office?

The regional group addressed studies at the continental scale with a parallel set of questions:

1) Are regional studies coordinated both scientifically and logistically? In this case, logistics include the sharing of data and needed products among the groups.
2) Are we taking advantage of the scientific opportunities that multiple groups present? Is the whole regional activity generating results that are greater than the sum of the parts?
3) Are the region-wide studies linked to site scale studies where this is appropriate?
4) Are we sharing data sets and other products?

5) Is the current coordination structure working? If not, please suggest a new mode of organization.
6) What, if any, obstacles exist to greater collaboration and how can these obstacles be overcome?
7) Are there any practical obstacles that need to be brought to the attention of the project office?

2.1 Acre. The Acre group agreed that their scientific work was not coordinated optimally. They suggested the following ways to improve coordination: (i) specific meetings for discussion and exchange of results and data; (ii) maps of activities; (iii) a central calendar; (iv) Web-page and E-mail lists for information exchange; (v) abstracts of all research activities being done in Acre and other sites in Southwestern Amazonia. The LBA-Ecology office and the Acre coordinators can work together to improve the use of existing tools (e.g., STI) to meet some of the perceived needs. Specific facilities such as a telephone line, E-mail/Internet access, and database storage in a dedicated computer would improve data sharing and communications. Needs not covered by LBA-Ecology Office activities such as a map of activities should be managed locally.

The group also felt that they could take advantage of more scientific opportunities chiefly by increasing scientific exchange and training opportunities. A number of steps in this direction would include: (i) lectures beginning 3 July 2000 on sun photometers; (ii) courses including "Human Dimensions and Global Change taught by E. Moran and E. Brondizio for the triangle Brazil-Bolivia-Peru; and "Instrumentation applied to Ecophysiology", at the Universidade do Mato Grosso (July 2000); and a course on statistical design of experiments.

Sharing of facilities is working well in Acre but sharing of data sets is not working thus far. The obstacles for further coordination of research include: (i) lack of communication among researchers in the triangle (Brazil, Peru and Bolivia) group; and (ii) a lack of financing for projects outside of Brazil. A regional network focused on burning, deforestation, and logging activities was suggested as a means to focus coordination in the triangle – particularly for near real time data exchange during the burning season. The following researchers will help to coordinate the regional network for detection and verification of fires: (i) Acre - Elsa Mendoza and Alejandro Duarte; (ii) Peru - Paty Huerta and Juana Silva; and (iii) Bolivia - Eduardo and Julio Rojas. And a second group will be formed for the identification of logging activities and deforestation: (i) Acre - Hiromi Sassagawa and Diogo Selhorst; (ii) Peru - INRENA; (iii) Bolivia - UAP

The group also reported on upcoming research in the near future. Table 1 lists new activities.

Southwestern Amazonia will shortly be linked via an all-weather road network to the Pacific. This network and other development activities will have major impacts on land use and land cover, hydrology, and carbon stocks in the region. The Acre group recommends expanded research on the interaction of these impacts with regional-scale ecosystem dynamics.

Table 1. New research initiatives in Acre

Activity	Dates	Responsible Scientists
Sun photometer and "Black carbon"	July 2000	Alejandro Duarte, Foster Brown, Marcia Yamasoe, Joel Shafer, Paulo Artaxo and Brent Holben.
CO_2 Flux- Pasture, Secondary and Primary Forest Soil carbon stock; aerial and microbial biomass in eutrophic dystrophic soils		Cleber Salimon, Willian de Melo, Eric Davidson, Foster Brown, Reynaldo Victoria
Atmosphere Chemistry in Bamboo Forests	February to April 2001	Oscar Bustillos, Jim Greenberg, Alex Guenther

2.2 Amazon-Region. First the group endorsed the December 1999 report from the LBA-Ecology Regional Modeling Workshop. See the following URL for additional information: <http://lba-ecology.gsfc.nasa.gov/lbaeco/Investigator_Info/Reports/reg_mod_1299.pdf>. The group suggested that all activities identified in that report ought to be continued.

Thereafter, the discussion turned to the status of current and future data sets on topography, soils, land use, fire and other disturbances. The group recommended a request for internal reports at regular intervals from the LBA-DIS for variables identified by modelers. However, in discussion in plenary session, it was recognized that the LBA-DIS does not currently have personnel resources to fulfill this need. Increasing DIS capacity to fill this and similar needs would require a trade-off with other budget items and could possibly reduce science budgets. It might be more cost-effective for scientists to keep one another informed of data availability. In this vein, the Amazon Region group encouraged expanded support for the synthesis of field data and other measurements on an ongoing basis. Possibly, future funding should be directed toward data synthesis. While this was called for in the first NRA, there was only a limited response to the call for data synthesis efforts.

Historical data for the Amazon Region are relatively scarce and inaccessible particularly for times before the satellite era. In order to understand the lasting effects of past disturbance, the group recommended that new proposals for research on disturbance history should be considered in the next NRA.

Communication and interaction between teams has been good to date. Future interactions should be expanded and should be directed to finer levels of detail. Focused workshops on specific topics (e.g., LAI, soil carbon, biomass, land use, fires, etc.) in the future would be beneficial. These could be held at the next LBA meeting, during other meetings (AGU, etc.), and in planned sessions at facilities such as NCEAS.

In the latter part of the session, the Amazon Regional group met together with LBA-Hydrometeorology participants. Roni Avissar, Project Scientist for LBA-Hydrometeorology served as co-chair of the session. The assembled groups pointed out important inter-dependencies. LBA-Ecology may be able to provide information on land cover, LAI, and rooting-depth to LBA-Hydrometeorolgy while LBA-Hydrometeorology could provide information in return on precipitation, PAR, and temperature. The two groups agreed to continue to meet jointly to facilitate and expand their interaction.

2.3 Brasilia. Scientists operating from Brasilia found that their work was well coordinated scientifically but they felt that there was room for improvement in logistics. Specifically, they found that communication between the LBA Central office and the site coordinator was inadequate. In particular, the site coordinator needs copies of all project descriptions and permits required to conduct research. The group meets to share data and to enhance the training and education component of their work. Tentative plans were made to hold a meeting in Brasilia for everyone involved in *cerrado* science. While facilities are considered adequate, the group was concerned about emergency communications to the remote sites. The Project Office has ordered both cellular and satellite telephones in order to improve emergency communications.

2.4 Manaus. Although there is some coordination among some of the study sites, there is minimal (Manaus) Site level coordination at the moment. The group proposed to improve the coordination structure by clearly identifying roles and responsibilities. In particular, they found that staff responsibilities were not clearly defined even for the site coordinator. Office facilities are inadequate to meet the needs of the LBA Regional Office and Science Teams. The group felt that action regarding space for a Manaus Regional Office was a top priority. In order to improve the current management situation, the group plans the following actions: (i) hold a July meeting with INPA's new director to resolve office space issues; (ii) clarify staff responsibilities and reporting requirements; (iii) hold regular meetings for a local committee composed of research and logistics representative.

The group hoped to improve the climate for interaction by hosting seminars and other gatherings including local workshops (e.g., secondary vegetation dynamics, laboratory methods) and a seminar series to be held at INPA and the University of Amazonas. In order to coordinate activities more effectively the group also recommended the development of a Science/Activities newsletter for circulation via the Manaus list server along with a calendar for activities and information dissemination.

The group agreed that equipment is being shared generally while data has been shared among some of the teams. For all teams new data is now being generated so they expected to be able to share it via *Beija Flor*. Planned seminars should help to disseminate information about available data.

2.5 Rondonia. Eight of the 14 Rondonia projects were present at the meeting. This represented eight of ten projects with on-the-ground logistics needs. The group felt that logistic coordination was working well, although scientific integration was not fully developed. This meeting itself provided a significant opportunity for cross-project cooperation and coordination. The group thought that scientific collaboration would most probably occur through student projects. It was the unanimous opinion of those present that Keila was doing a great job. The

group considered that the current site coordination committee (Alex Krusche, Marcos Pedlowski, Oliver Chadwick) should remain in place. Alex was congratulated on doing a terrific job as chair and taking on most of the responsibility for making this committee work.

Four major obstacles to scientific collaboration were identified:

1) Knowledge of local experts. The group asked Keila to work with Beatriz Gomes (UNIR) to develop a list of potential Rondonia-based experts. This list would be circulated to the Rondonia E-mail list and then posted on the Web site.

2) The need to obtain existing local data. PLANAFLORA is a very detailed data set developed by the State of Rondonia that absolutely needs to be connected to LBA. This data set includes land use, soils, river networks, fauna and floral characteristics, etc. The group requested that the LBA office work to bring this data set into the LBA DIS. [The LBA Central Office through the NASA liaison, Dave Knapp, began this task in July.] This had been identified as a very high priority at the last LBA meeting but the goal has not been achieved. The group felt it was critical that this data be obtained quickly, since the PLANAFLORA team in Rondonia would be moving on to other work and would soon not be available to provide the data.

3) Students. Finding students has been a continuing issue. Identifying students at local institutions as well as the larger institutions is important. The group felt that the Brazilian collaborators were key to finding new students.

4) Communication. People needed to communicate both with the site office and with each other. An E-mail list for Rondônia exists and should be used.

The group identified three logistical issues that needed to be considered:

1) Research in Rondonia is moving from mostly campaign style (four- to six-week intensive campaigns, two times per year) to a mixture of campaign and more continuous measurements (one day per week). This has caused some tensions between groups that need a truck one day per week and those that need a truck for three weeks continuously. This will require much more careful and fine-scale cooperation and coordination. The group suggested that this is best handled by investigators within the Rondonia community planning as far ahead as possible, being generous to their fellow scientists, and being as flexible as possible.

2) When resolving logistical issues, the LBA office should communicate with all three of the coordinators because of the many different perspectives of the groups working in Rondônia.

3) Scientists need to register with the site office whenever they are in Rondonia, even if they do not need any assistance from the site office. They may register by phone, by fax, or in person.

2.6 Santarem. The Santarem group wished to update the detailed view of the activities at the sites obtained in the previous science team meeting, in order to understand the activities actually being undertaken. The group recommended use of a grid giving sites and measurement

information. A grid was prepared at the Third Science Team Meeting. This can be found at the following URL

<http://lba-ecology.gsfc.nasa.gov/lbaeco/Investigator_Info/Reports/SM3/SM3finalreport2a.PDF>

The grid needs to be kept up to date. Researchers should identify gaps in data collection. Researchers should communicate through the E-mail list (see the LBA-Ecology Web page). The group is large, so updates and communications are needed more frequently than the annual LBA-Ecology meetings.

The group called for closer scrutiny of eddy correlation results including many measurements and checks already planned. Proper instrument calibration within the Santarem cluster and throughout LBA is a key requirement. Working standards must be traceable to primary calibration standards. The question of inter-site comparison of instrumentation throughout LBA was raised. One suggestion was a movable eddy flux instrument used in AmeriFlux, to take to all Amazon towers. There was some discussion that Ameriflux inter-calibration efforts do not show large inter-instrument variations, however there are some exceptions (up to 40% differences with the traveling standard) and the inter-comparison of basic measurements is one prerequisite for understanding anomalous results discussed at the LBA First Scientific Conference. Nonetheless, short-term comparisons are inherently limited because they focus on a small range of meteorological conditions. Understanding the limitations of nocturnal measurements and ecosystem respiration remains a priority as reflected in ongoing research efforts. This would require exchange of raw and processed data, among other steps. These exchanges were informally agreed upon at the meeting and it was suggested that the Project Scientist, Dr. Michael Keller, undertake to ensure that appropriate exchanges take place.

Logistically, the main obstacle to coordination is the lack of maps showing where studies are located at the principal sites. The group recommended creation of maps at Harvard. These would be updated frequently and made available to the LBA-Ecology field office in Santarem. The features to be identified on maps were project ID, name, basic activity, plot location and area including buffer zone and special restrictions of other uses in the plot area. Site leaders for the tower sites (Primary forest: Munger/Harvard; logged forest: Goulden/UCI; pasture: Fitzjarrald/SUNY) were to be notified of activities at their particular sites. The Project Office will implement this function in STI. The group asked researchers to note team ID's on all flags and to remove flags when they are no longer needed.

Groups with unattended instrumentation will provide simple instructions to allow other visiting scientists to help them avoid disasters. The Santarem Data-Technician will coordinate data disaster prevention efforts.

3.0 Science Themes

Brief sessions were organized around the main science themes within LBA-Ecology. The primary purpose of these sessions was to examine the progress of the scientific program thus far and to begin to look ahead to the future of LBA-Ecology. The groups addressed the following questions:

1) Are the original LBA-Ecology science questions still a good guide for the current research effort?
2) Which, if any, questions are already answered?
3) Are any of the questions unanswerable or irrelevant?
4) Should we modify any of the questions? Please suggest modifications
5) Should we add any new questions now or in the context of a future NASA Research Announcement (NRA)?

3.1 Carbon. The carbon group saw no reason to refine or change existing science questions. However, they identified some subjects where the existing science activities may be insufficient to answer some questions. The key areas of uncertainty highlighted at the LBA First Scientific Conference were (i) above- and below-ground biomass estimates, particularly for basin-wide extrapolation; (ii) the role of coarse woody debris; (iii) monitoring of fire including the area burned, the type of burn, and the amount and timing of carbon loss; (iv) site history of disturbance.

An immediate response to item (i) would be to install more permanent plots along LBA transects. Additionally, it may be possible to take advantage of the logging at the FLONA Tapajos to check some aspects of allometry (e.g., LAI, excavation of roots).

For the future, the group recommended an increased focus on the top down constraints on regional C balance. These constraints would include both measurements of atmospheric CO_2 distribution and remote sensing of vegetation properties (e.g., biomass, canopy structure). An aircraft measurement campaign was recommended for regional analysis of CO_2 distribution in atmosphere. An ad-hoc group led by Steve Wofsy and Daniel Jacob has been planning an LBA Atmospheric Regional Study (LARS) that would add significant "top-down" constraints to budgets of CO_2 and other trace gases. The group also called for space-borne sensors (e.g., VCL) that could provide new data for determination of basin wide biomass and recovery from disturbance.

The group raised two additional questions that may be important for fine-tuning carbon budgets. First, do we have adequate accounting of the carbon budgets and areas for expanding land uses such as intensive agriculture and agro-forestry? Second, do we know the fate of wood products?

3.2 Land Cover and Land Use Change. The LCLUC groups accepted the present science questions but acknowledged that there is an imbalance in the degree to which these questions are being answered. There is ample opportunity for validation, integration, comparison, and synthesis of results.

LC-1. What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of land uses?

LC- 2. 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?

In the case of the first two LCLUC questions, the group recognized a number of obstacles to overcome. First, classification of land use is still inconsistent. There are multiple classification systems and often these cannot be directly mapped to one another. It was suggested that a modified and improved version of the IBGE system might be usable by all LBA investigations. Possibly, LBA-Ecology could develop its own land cover catalog using available materials such as videography from recent campaigns, aerial and ground photography, vegetation profiles, as well as species composition and structural descriptions. The group endorsed data sharing through *Beija-Flor* to help meet these goals.

For the second question, the group concluded that still more information was needed on the crops that farmers plant after deforestation. The data on annual and perennial crops, types of pasture, etc. are quite limited and not spatially resolved in part because of remote sensor limitations. However, details related to land use following deforestation have important implications for data analysis and for understanding of process, and policy. While they had a great deal of information about secondary succession, the LCLUC group strongly recommended that they were now ready for a regional synthesis on that subject.

In general, the LCLUC area needs to concentrate on a full regional representation and understanding of "driving forces." Local studies were still uneven and did not represent the full range of land use scenarios. In particular, in upland areas agro-forestry systems and fruit plantations have been under-represented. All floodplain and savanna areas are under-studied in LBA, compared to the upland forest areas. Some driving forces that have been under-represented in LBA-Ecology studies are the influences of price changes, national policies and diseases in influencing the pace and direction of agricultural land use. In general, it was recognized that the group had not developed or incorporated adequate economic models for agriculture and land use. At the process level, the group saw opportunities for advances in the study of interactions between different agents and the spatial configuration of different land use systems. Infrastructure, land tenure, and other social and biophysical factors affect the pattern of forest fragmentation.

LCLUC question LC-3 asks:

LC-3. 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 re-growth and flammability?

Currently, there is a debate regarding the total area affected by logging. Differences in area estimates can be partially attributed the way individual questions were developed. In order to validate different estimates, it would be necessary to select a range of representative sites (a gradient of logging types) across the various studies (INPE, MSU, IPAM-WHRC, IMAZON). It may be possible to validate some surveys using 1999 videography and other data. The group also recommended focusing not only on conventional logging sites but also on successful initiatives of reduced impact logging (e.g., LC-13 sites), as this may represent an important land use alternative in the future.

The fourth LCLUC question concerns the future of land use in the Amazon region:

LC-4. What are plausible scenarios for future land-cover change in Amazonia?

The group recognized a need to stratify the region to avoid generalization and to fine tune with local socioeconomic, demographic, and political dynamics. They felt it was important to combine different approaches to this question such as GIS projections, theoretical models, agent-based models. They also recognized the need for and educational benefit of simplified future scenarios. It would also be useful to incorporate study of the economic-ecological zoning plans in scenario development. The group asked how zoning plans had an impact land use and how their data could contribute to future plans.

While the LCLUC group endorsed the existing questions, they strongly emphasized the need to look ahead to support new questions on the connection between LCLUC and biodiversity, health, water supply, and urbanization. Another important future challenge is the role of the changing political economy of land use in Amazonia – in particular the role of emerging external markets and new connection routes (Pacific, Caribbean, Mercosul). Greater attention should be paid to the spatial patterns of interaction of land use systems, agents, and institutions. Finally, they suggested improving connections between LBA and other regional initiatives such as PPG7 and SIVAM.

3.3 Nutrient Cycling and Surface Water Chemistry. This group focused its discussion around the science questions. They accepted the previous questions 1-2.

ND-1. How do stocks, cycling rates, and budgets of carbon and important elements N, P, K, Ca, Mg, and Al change under different land covers and land uses?

ND-2. Are nutrients major factors that control the rates of re-growth and carbon accumulation in abandoned pastures and re-growing secondary forests?

In the case of question 1, the group focused on the future and proposed considering the question, "What are the most likely land covers and land uses in the future where these studies should be located?"

The original question, ND-3 (How does the capability of native vegetation to extract nutrients from soil differ from capabilities of exotic pasture grasses?) was considered too specific in relation to the other questions. This question can be subsumed under question ND-2 and it could be dropped from the list in the future.

The group offered a potential new question:

ND-X. What are the processes and consequences of atmospheric horizontal transport of nutrients on the nutrient stocks and nutrient cycles of ecosystems within the Amazon basin at various spatial and temporal scales?

Examples of horizontal transport issues include Saharan dust inputs, losses and redistribution due to fire, and links between physical climate models and nutrient cycling.

The group suggested replacing the original questions related to surface water chemistry (see Appendix 3) with a condensed question and a new question:

ND-4. (Condensed) 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?

- 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?

- Are there unique signatures that can be traced downstream?

- To what extent do intact riparian zones buffer streams against changes due to anthropogenic activities in surrounding uplands?

ND-5. (New). What is the importance of periodically wet environments (from moist soils to standing and flowing waters) for the land and atmospheric balances of nutrients, CO_2, trace gases, and water and energy on multiple scales?

3.4 Trace Gases and Aerosols. This group considered the original questions a good guide to current research work and found that none of the original questions could be considered either answered or unanswerable. While they did not manage to rewrite the questions they did offer general suggestions. They considered the first trace gas question:

TG–1. What is the magnitude of the annual flux of CH_4, N_2O, NO_x, CO, and VOC from Amazonia?

They suggested the inclusion of deposition fluxes (e.g., ozone, NO_2), sulfur compounds, and seasonal and spatial distributions. This question requires both top-down and bottom-up approaches. Top down constraints on trace gas emissions could be provided by the LBA Atmospheric Regional Study (LARS) which has been developed by an ad hoc planning group led by Steve Wofsy and Daniel Jacob.

The second through fourth trace gas questions focus on primary forest, secondary forest, selectively logged forest and pasture systems:

TG–2 How do the temporal and spatial patterns and controls of soil–atmosphere trace–gas fluxes resulting from conversion of forest to pasture vary across soils and climate in Amazonia?

TG–3 How does the magnitude of trace gas and aerosol flux in pastures vary through succession and with management practices?

TG–4 Do selective logging and related practices have a significant effect on soil–atmosphere exchange of trace gases, and how do these fluxes change as forest sites recover from logging impacts?

The group suggested the inclusion of other management practices.

Once again in the fifth trace gas question:

TG–5 What is the magnitude of CH_4 emissions from inundated areas, and what are the physical and ecosystem level controls? How do emissions of CO_2, N_2O, and CH_4 vary along a transect from uplands to the riparian zone and stream?

the group considered that we may wish to expand the scope of investigations to consider characterization of variations along savanna to forest gradient.

The group had no comment on the sixth or eighth trace gas questions but suggested once again to expand the seventh:

TG–7 What is the impact of aerosols on radiation (PAR, UV) fluxes and nutrient cycling, and what is the magnitude and composition of aerosol flux from different land use types in Amazonia?

The group felt that a complete investigation should include the impact of trace gas fluxes on chemical composition of the atmosphere, CCN and radiative forcing of the atmosphere. They would also include investigations of the potential feedback couplings between the biosphere and the atmosphere. While the group felt no need to add new questions, they suggested an expansion of the content of nearly all the other questions. Clearly there is an ambition among this group to expand the size of trace gas studies within LBA-Ecology.

4.0 Implementation Themes

4.1 Data and Information Systems. This session focused mainly on use of the *Beija-flor* search engine, the LBA Metadata Editor (LME), and the Science Team Information (STI) tools. The discussion began with general issues regarding *Beija-flor* usage. The Science Team would like to know at least in summary who is searching for and accessing data.

On a more specific level, the group raised a number of concerns regarding the parameter lists in *Beija-flor*. The general consensus was that the current parameter lists were not specific enough. Without question, inconsistencies develop when researchers enter new parameters, so the science team should help to develop lists of synonyms that will aid searching. Generally, it was agreed that the current smart pick-lists need to be smarter.

Continued improvement in *Beija-flor* will depend upon close collaboration between the Science Team and the Project Office. The Project Office needs contributions to lists of specific

parameters relevant to LBA. Some should come directly from the Science Team. Others can be gleaned from tables contained in the Report of the Third Science Team Meeting

<http://lba-ecology.gsfc.nasa.gov/lbaeco/Investigator_Info/Reports/SM3/SM3finalreport2a.PDF>.

Researchers at the meeting requested advice regarding the packaging of their data for distribution. A brief addition to the LME documentation may help investigators inexperienced in data exchange. Frequently the nature of the data itself helps to organize simple files by sites, time ranges, and variables.

Overall, the Science Team Information (STI) has had strong usage. It does present problems for those who have slow Internet connections. There are two potential ways to work around this difficulty. In cases where the Internet is inaccessible, Science Team members should work through logistics aids at the field sites. For those cases where the Internet access is merely slow, a text-only version of STI may solve the problem.

The group also requested the following additions and improvements to STI. First, it would be useful to have a tutorial or "dry run" opportunity to use the system where data would not be added permanently to the database. Second, researchers requested tracking of satellite data orders that coincide with data collection. Third, it was suggested that STI could also place a greater emphasis on tracking training and education events.

4.2 Training and Education. All agreed that the LBA-Ecology Science Team had made admirable progress in training and education. As of the Science Team meeting, our count suggests that we have involved 85 Brazilian students in long-term educational opportunities from undergraduate through post-doctoral levels. The group divided their discussion into two categories: (i) Undergraduate, Graduate and Post-Doctoral Education and; (ii) Short Courses and Other Educational Initiatives.

The basic question driving the discussion of Undergraduate, Graduate and Post-Doctoral Education was "What is the optimal approach?" Secondarily, the group asked whether the initial success in training and education by the LBA-Ecology project could be sustained. One possible shortcoming of the present program is that opportunities are not visible to all potential candidates. The group questioned whether the LBA Training and Education Committee was able to deal with the full range of projects? A major concern was that the Committee does not have sufficient administrative support to deal with outreach and inquiry. The group concluded that the role of graduate training was well recognized and supported within the project. They questioned whether sufficient opportunities and recognition were available for short-term visitor students versus students who studied for several years.

The group recognized that one major barrier to training undergraduates was the shortage of local faculty advisors at some of the field locations. Inexperienced students need daily mentoring in many cases. Although language skills among the LBA-Ecology Science Team members were improving, there were still a deficiencies in both Portuguese and English language skills. The group suggested a number of approaches to deal with these challenges:

1) On-site daily guidance especially for undergraduates and graduates in training prior to PhD studies;
2) On- site point of contact person identified for each group's T&E component;
3) A balance of post-docs/advanced students versus undergraduates and graduates in training is critical for bringing in and adequately developing the skills of less experienced people from local areas;
4) Language training opportunities are viewed as critical and projects can support this training financially;
5) Short-term opportunities should be advertised on an electronic bulletin board
6) Increase opportunities for informal collaborations and experiences for students with busy schedules;
7) Researchers should supply research papers written in Portuguese (also in PDF format), to be available at each research site and/or Web site for interested students.

Discussions of short-courses and other educational initiatives were organized by three questions:

What has been done?

How well did it work?

What should we do next?

The group agreed that every scientist visiting a field site should give a talk. Certainly, a large number of talks have been given. The best example is Acre, where visitors are requested to provide a title for a talk upon arrival. A common problem is that visitors may be willing to give a talk, but are not invited to do so, so no talk is given. Clearly, an invitation mechanism is needed. One potential mechanism is to include titles of talks as part of scheduling activities on the STI. Clearly, visiting researchers also must express their willingness to give a talk when contacting their counterparts at field sites.

A number of successful workshops and mini-courses have been implemented. Examples were provided for workshops in Manaus, Brasilia, Acre, Belem and Sao Jose Dos Campos. The general sense was that these have worked fairly well. Workshops were considered in two categories, A and B. In a type A workshop, students and instructors are transported from a large geographic area to a single facility. In order to keep costs down and to improve the quality of this sort of workshop, it helps to have a small number of faculty dedicate their time for the full length of the course rather than expend a great amount of money on airfare for a large number of faculty members who each visit the course for a short time. Type A workshops have the potential to integrate students and expertise from a wide diversity of backgrounds, but are expensive to implement. In a type B workshop, one to three instructors travel to a region and teach a short course to local students. Type B workshops are generally quite economical.

New topics and ideas and a new pool of instructors are needed. A suggestion was made that some courses could be taught a second time. Another possibility would be a shift to a more regional focus (Type B workshops). Groups of instructors should consider organizing

regional/cross-disciplinary workshops where a selection of scientists within a region could teach a short course. For example, several Rondonia teams could organize a workshop within Rondonia that involved a range of studies.

The possibility of providing teaching materials for a short course could also be investigated. For example, educational CD-ROMs (or overheads) could be supplied to instructors to provide a uniform, high-quality set of teaching materials. This could be extended to hybridize Type A and Type B workshops. For example, teachers could be invited to a facility (such as INPE) for a remote sensing short course and could receive an Educational CD-ROM or Web page. They could then return to their home areas and use the materials in their own courses, thus multiplying the effect.

One example of an educational CD-ROM is currently under development at University of California, Santa Barbara (UCSB; Dar Roberts). The UCSB product will focus on applications of remote sensing in Amazonia. Investigators at Indiana State University (Paul Mausel) and Michigan State University (David Skole) have developed similar products. CD-ROM's could be developed for other areas besides remote sensing. It may also be valuable to develop videos that show researchers working in the field.

5.0 Concluding Remarks

The investigators attending the meeting were satisfied with the current relatively loose organization of the Science Team. There were no recommendations for major reorganizations. The Science Team was impressed by the quality of support offered by the Project Office. While there were certainly many suggestions for minor adjustments to our logistics and operations, the Project Office is already actively dealing with most of those requests.

Almost unanimously, the scientists attending the meeting found that there was room for greater scientific coordination. Better communication was called for in nearly all the groups and the call to exchange data was heard throughout the meetings. Many tools (e.g., the LBA-Ecology Web site, STI, *Beija-flor*, E-mail lists) are available to the Science Team. It is up to the team to use the tools, to exchange data, and to communicate with one another (and throughout LBA) more frequently and more profoundly.

We are facing serious challenges related to data products and data sharing. Only a few of the investigations have focused on synthesizing new regional data sets. Generally, modeling groups have taken on these synthesis tasks and, in a few of those cases, they have made new products available to the community. We need more efforts of that type. The modeling groups have called on measurement specialists to synthesize available data in their areas of expertise. This call is sensible, but only in rare cases have the measurement oriented groups planned to synthesize regional scale data products. There is a gap in our project between site-based investigation and regional scale models that needs to be filled.

From a scientific perspective, the Science Team did not find that any of our original science questions have been solved or have become irrelevant. While the Carbon Theme group found that the current set of questions required no changes, the other three Theme groups

recommended some modifications. In some cases these changes in questions imply a considerable expansion in scope for the LBA-Ecology Project. Given that budget projections are for stable or shrinking funding levels into the second Phase of LBA-Ecology, the Science Team will either have to work more efficiently, establish partnerships outside of the team for the additional work, recruit funds from other sources, or look for trade-offs to accommodate new objectives.

The LCLUC Theme group raised a bothersome (perhaps minor) issue that deserves to be highlighted. Classification of land use is still inconsistent across LBA. The group suggested that a modified version of the IBGE system could be used by all LBA investigators. It is time to take this suggestion to all LBA investigators and to develop a classification that everyone can use. This classification system could be tied to a catalog of field examples.

Both the Carbon and Trace Gas theme groups expressed a strong desire for improvements in the top down constraints of regional budgets. As envisioned early in LBA planning, a regional aircraft chemistry campaign appears to be the best means to this end. Currently, one proposal for such a campaign, the LBA Atmospheric Regional Study (LARS) has been developed by an ad hoc planning group led by Steve Wofsy and Daniel Jacob. Based on the history of LBA planning and the results of this Science Team meeting, it is clear that this proposal and similar efforts deserve serious consideration.

Acknowledgement**:** We are grateful to Laura McShane for her editorial assistance and for help compiling the attendance list.

Appendix 1. Meeting Agenda

LBA-Ecology
Business Meeting
29 - 30 June 2000
Agenda

Thursday, 29 June

8:00 AM Welcome - *M. Keller*
Terrestrial Ecology Program - *D. Wickland*
LCLUC Program - *G. Gutman*
LBA-Ecology Project Office - *D. Deering*

10:00 AM Coffee Break

10:30 AM Breakout Groups - Sites
Acre - *I. Foster Brown, Willian de Melo, Elsa Mendoza*
Amazon Region - *Marcos Costa, George Hurtt*
Brasília - *Alfredo Huete, Heloisa Miranda*
Manaus - *Erick Fernandes, Rita Mesquita*
Rondônia - *Linda Deegan, Marcos Pedlowski*
Santarém - *William Z. de Mello, J. William Munger*

12:30 PM Lunch

2:00 PM Continuation of Site Breakout Groups

3:30 PM Coffee Break

4:00 PM Breakout Groups - Science Themes
Carbon - *Humberto Rocha, Susan Trumbore*
LCLUC - *Eduardo Brondizio, João Vianei Soares*
Nutrients and Water - *Eric Davidson, Reynaldo Victoria*
Trace Gas - *Luciana Gatti, Alex Guenther*

5:30 PM Plenary Session
Reports from Site Groups
Charge for Friday's Sessions

Appendix 1. Meeting Agenda (Continued)

Friday, 30 June

8:00 AM Plenary Session

8:15 AM Breakout Groups - Business Themes
Undergraduate, Graduate, and Post-Doctoral Education - *Plinio Camargo, Chris Martens*
Short Courses and Other Educational Approaches - *Luiz Martinelli, Dar Roberts*
CNPq Fellowships (Bolsas) - *Tatiana Sá*
Data and Information Systems - *Vicky Ballester, Stefan Sandmeier*

10:00 AM Coffee Break

10:30 AM Plenary Session
Reports from Science Theme Groups
Reports from Business Theme Groups
Discussion

12:00 Noon Adjournment

Appendix 2. Meeting Attendance.

(Based on signed attendance sheets for break-out groups)

LAST NAME	FIRST NAME	PROJECT
Aquino	Carlos Augusto Bauer	LC-06
Artaxo	Paulo	TG-06
Ballester	Maria Victoria R	ND-09
Batista	Getulio	LC-06
Belk	Elizabeth	ND-02
Botta	Auréélie	LC-04
Brondizio	Eduardo	LC-09
Brown	Foster	LC-02
Burke	Roger	ND-07
Bustamante	Mercedes	ND-07
Bustillos	Oscar Vega	TG-02
Camargo	Plinio	TG-09
Cochrane	Mark	LC-10
Costa	Marcos Heil	LC-04
Davidson	Eric	ND-02
de Melo	Willian	LC-02
Deegan	Linda	ND-03
Domingues	Tomas	CD-02
Ehleringer	Jim	CD-02
Fernandes	Erick	ND-04
Ferreira	Laerte	LC-06
Figueiredo	Ricardo	LC-14
Fiorini	Stefano	LC-09
Fitzjarrald	David	CD-03
Fleming	Justin	LC-09
Gatti	Luciana Vanni	TG-02
Greenberg	Jim	TG-02
Gu	Jiujing	CD-07
Guenther	Alex	TG-02
Harley	Peter	TG-02
Herbert	Darrell	CD-09
Holmes	Karen	ND-01
Houghton	R.A.	CD-11
Huete	Alfredo	LC-06
Keller	Michael	TG-07
Klink	Carlos A.	CD-05
Klooster	Steve	TG-05
Luizãão	Flavio	ND-04
MacGregor	Ian	TG-04
Martens	Chris	TG-04
Martinelli	Luiz A.	CD-02
Matricardi	Eraldo	LC-10
Melack	John	LC-07

LAST NAME	FIRST NAME	PROJECT
Mendlovitz	Howard	TG-04
Mendoza	Elsa	LC-02
Menton	Mary	TG-04
Mesquita	Rita	LC-05
Miranda	Heloisa	CD-05
Moran	Emilio	LC-09
Neill	Chris	ND-03
Nogueira	Joséé de Souza	CD-12
Pedlowski	Marcos	LC-10
Pinto	Alexandre de Siqueira	ND-07
Ray	David	CD-05
Richey	Jeffrey	CD-06
Riha	Susan	ND-04
Rinne	Janne	TG-02
Roberts	Dar	ND-01
Rocha	Humberto	CD-04
Rondóón	Marco	ND-04
Sáá	Tatiana Deane de Abreu	ND-02
Salas	William	LC-10
Saleska	Scott	CD-10
Salimon	Cleber	LC-02
Sassagawa	Hiromi S.Y.	LC-02
Shimabukuro	Yosio E.	CD-09
Silveira	Marcos	LC-02
Skole	David L.	LC-10
Steudler	Paul	TG-08
Stone	Tom	CD-11
Trumbore	Susan	CD-08
Vega	Oscar	TG-02
Williams	Mathew	CD-09
Wofsy	Steve	CD-10
Xiao	Xiangming	LC-08

Appendix 3. The Original LBA-Ecology Science Questions.

Land Use and Cover Change Science Questions

LC–1 What are the rates and mechanisms of forest conversion to agricultural land uses, and what is the relative importance of these land uses?

LC–2 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–3 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–4 What are plausible scenarios for future land–cover change in Amazonia?

Carbon Dynamics Science Questions

CD–1 What is the (climatically driven) seasonal and interannual variability of the CO_2 flux between the atmosphere and different land cover/use types?

CD–2 How do biological processes such as mortality and recruitment or succession following land use change influence the net annual C balance for different land–cover/land use types?

CD–3 What are the relative contributions of fluxes from natural and disturbed ecosystems to the net Amazonia–wide flux? This question can be approached through a number of subsidiary questions:

CD–3a How do pools and fluxes of C and nutrients (in soils) of pasture/cropland change over time and what factors determine C gain or loss?

CD–3b How does selective logging change the storage and cycling of C in forests?

CD–3c What factors (biologically mediated, land–use history, soil properties, etc.) control the rate of C sequestration in biomass and soils of regrowing forest?

CD–3d What portion of the Amazonia–wide C flux is from fire? How do ecosystems recover from fire? What are the relations between land management and fire occurrence/frequency?

Nutrient Dynamics and Surface Water Chemistry Science Questions

ND–1 How do stocks, cycling rates and budgets of carbon and important elements N, P, K, Ca, Mg, and Al change under different land covers and land uses?

ND–2 Are nutrients major factors that control the rates of re–growth and carbon accumulation in abandoned pastures and re–growing secondary forests?

ND–3 How does the capability of native vegetation to extract nutrients from soil differ from capabilities of exotic pasture grasses?

ND–4 What are the changes in the inputs, pathways and fluxes of dissolved organic matter, nutrients, and associated elements through river corridors?

ND–5 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? Are there unique signatures that can be traced downstream?

ND–6 To what extent do intact riparian zones buffer streams against changes due to anthropogenic activities in surrounding uplands?

Trace Gas and Aerosol Flux Science Questions

TG–1 What is the magnitude of the annual flux of CH_4, N_2O, NO_x, CO, and VOC from Amazonia?

TG–2 How do the temporal and spatial patterns and controls of soil–atmosphere trace–gas fluxes resulting from conversion of forest to pasture vary across soils and climate in Amazonia?

TG–3 How does the magnitude of trace gas and aerosol flux in pastures vary through succession and with management practices?

TG–4 Do selective logging and related practices have a significant effect on soil–atmosphere exchange of trace gases, and how do these fluxes change as forest sites recover from logging impacts?

TG–5 What is the magnitude of CH_4 emissions from inundated areas, and what are the physical and ecosystem level controls? How do emissions of CO_2, N_2O, and CH_4 vary along a transect from uplands to the riparian zone and stream?

TG–6 What are the major controls on CO and VOC production and emissions? Can different VOC emission capacities be associated with specific land use types?

TG–7 What is the impact of aerosols on radiation (PAR, UV) fluxes and nutrient cycling, and what is the magnitude and composition of aerosol flux from different land use types in Amazonia?

TG–8 Are losses of carbon from forested systems in forms other that CO_2 (CO, CH_4, VOC, organic aerosol) of sufficient magnitude to influence ecosystem carbon balance estimates obtained from eddy covariance techniques?