LBA- Ecology Regional Modeling Workshop
12 December 1999
San Francisco, CA

LBA-Ecology sponsored a workshop, open to all LBA researchers, focusing on data sets for use in large-scale ecosystem and hydrological models that describe the behavior of the Amazon environment and how it responds to natural and anthropogenic forcing.

The purposes of this workshop were to:

> (1) Determine the need for large-scale environmental data sets in LBA-Ecology;
> (2) Coordinate the development, documentation, and exchange of existing data sets (e.g., climate, soil texture, river discharge, vegetation cover);
> (3) Coordinate the development of new data sets (e.g., historical land use/land-cover change); and plan future model data comparisons.

A group of 27 scientists representing a variety of LBA-Ecology and LBA-Hydrometeorology projects participated in the workshop. The workshop took place at the San Francisco Marriott, San Francisco, CA, U.S.A. from 8:30 AM to 6:00 PM on Sunday, 12 December 1999. The principal organizer of the workshop was John Foley. Michael Keller, Chris Potter, and George Hurtt were co-organizers.

In the morning sessions, investigators currently working on modeling and analysis projects summarized ongoing activities. Presentations reviewed some of the capabilities of models being developed, identified data sets that are needed for the continued development and testing of these models, and described some of the relevant data sets that are being compiled. The afternoon sessions were conducted in a discussion format that identified potentially beneficial collaborations among research groups and resulted in a specific list of follow-up activities to be accomplished by participants.

Introduction

Jon Foley presented the day's agenda and the plans and goals for the meeting, and introduced the subsequent speakers. Michael Keller, LBA-Ecology Project Scientist, discussed strategies for integrating LBA-Ecology activities resulting from the meeting within LBA efforts.

MORNING SESSION
Overview of Modeling / Analysis Projects

- Aurelie Botta presented the ongoing evolution of IBIS (Integrated Biosphere Simulator), an integrated dynamic biosphere model being developed through

an LBA-Ecology collaboration between the University of Wisconsin and the University of Viçosa. She described problems in simulating the vegetation cover (especially savannas), and commented that more realistic definitions of savannas are possible when interannual climate variability and fires are included. She noted progress in vegetation dynamics modeling through using fire models; the group is incorporating natural disturbances, particularly fire, into IBIS. The disturbance rate has a very strong impact on predicted ecosystem structure and positions of biome boundaries. The group has data to share on the results of vegetation dynamics and fractional cover of the upper canopy, and is interested in biomass estimation satellite data.

Conclusion: Researchers need to have long-term data on interannual climate variability and fire disturbances for ecosystem processes. An intercomparison of fire models and data sets should be considered.

Data Topics: What climate data sets should be used for modeling Amazonia? What are researchers going to use for fire data sets?

- George Hurtt, representing the UNH/MBL/Princeton/CPTEC team, discussed TEM and ED models being developed for the LBA-Ecology study. His presentation focused on the ED model. ED predicts ecosystem structure and fluxes from climate and soil type inputs. ED is based on individual plant dynamics, but includes integrated sub-models of ecophysiology, natural disturbances including fire, organic matter decomposition, nitrogen cycling, and hydrology. The model uses statistical mechanics methods to scale-up to large spatial scales. Land use and land-use history are currently not included but are being added. The model is currently forced with ISLSCP I climate and soil type information. Validation data currently include Olson vegetation biomass, RADAM soil carbon, and Miami Model NPP across the region and detailed information from a set of individual sites. Data needs include additional climate data sets representing an expanded period of time, land use, land management and land use history data, stand structure information, biomass, soil carbon, flux-tower results (carbon, water), and data on disturbance rates (fire, logging).

Data Topics: Will we have good land use, land management, and land-use history information for the Amazon region? We can look forward to having high-resolution forest structure information for Amazonia from the upcoming VCL mission. What do we know about fires and fire history in Amazonia? What useful fire data sets exist now? What are in progress? What is the best available meteorology data from the region with which to drive ecosystem models?

- Chris Potter spoke on behalf of the NASA-CASA modeling team, which includes NASA-Ames in collaboration with EMBRAPA. He described their use of satellite (and climate) data to drive models. Their model simulates

ecosystem production and nutrient mineralization, as well as consequent biogenic trace gas fluxes. They are now developing a land-use change model by prescribing transition rates from satellite data and are working on a state-by-state level. Several data sets that could be useful for LBA-Ecology are now available, including a new precipitation data set (8 km) based on point data, with good error analysis and a 1982/1990 NDVI Pathfinder data set (cleaned up a bit more) at 8 km resolution. Some solar radiation data sets still need some work, and are limited, especially after 1990. These data sets can be identified through the *Beija-flor* system. More land cover types (Stone et al., 1992) will be needed over time for transition probabilities.

They are working with Dan Nepstad of Woods Hole Research Center (WHRC) and with Urbano Lopez of IPAM on the RisQue98 (risk of forest and agricultural fires in the Brazilian Amazon) project on fire risk data sets. Logging data are available from WHRC. High-resolution land cover data sets are available from Landsat, but they need to be evolved into land-use change data sets.

Data Topics: Dramatic improvements to climate data (especially solar radiation and precipitation) are needed. Land use/cover change data are needed -- how would this be done?

- Miles Logsdon represented Jeff Richey's group at the University of Washington, which collaborates with CENA and is currently working on several projects (CAMREX, EOS Amazon, LBA). They are using the NASA-CASA model as a starting point. This model is driven with satellite inputs (e.g., NDVI). River routing and hydrology are particular foci of this group, and they are producing a river biogeochemical model, linking terrestrial, aquatic and hydrological processes. They are also focusing on trying to produce a meaningful time series of long-term NDVI data sets.

Data Topics: What about the long-term AVHRR data sets? How do we correct for clouds, aerosols, etc.? Tucker is working on new NDVI data set activity too -- should this be coordinated?

- Roni Avissar represented the LBA-Hydrometeorology Science Team and provided an overview of their projects. Project topics and activities include:
  - Reanalysis of data sets;
  - Satellite radar altimetric data sets for the Amazon basin;
  - Coupled ocean-land-atmosphere on climatic variability in the Amazon;
  - Land cover change and climate on river basin hydrology within Rondônia;
  - Two-way interacting regional climate model simulations in the Amazon basin;
  - Surface radiation budgets (short-wave and PAR);
  - Sub-grid heterogeneity on remotely-sense estimates of Amazonian surface energy balance;

- High resolution (4 km), multi-spectral, automatic satellite rainfall estimate over Amazonia in real time (only heavy events);
- Water budget closure system;
- Influence of land surface processes/land cover changes in Amazonia on regional hydrometeorology; and
- Impacts of land use and land cover in Amazonia on hydrometeorological processes.

Avissar's own work focuses on deforestation and its tele-connections around the world.

Data Topic: Many meteorological data sets are model derived. What are the errors in these products? These errors need to be understood for applications using these products.

Overview of Existing Data Products

- Jon Foley presented a brief overview of ORNL activity to create a global/regional ecosystem modeling data collection. Veronica Fisher has created some regional data sets for Amazonia, which can be useful for LBA-related studies.

- Merilyn Gentry described the *Beija-flor* metadata catalog and searching system developed to support LBA activities, as well as the software tools being developed for use by investigators to register and share data. She also distributed information on the pre-LBA data sets available on CD-ROM.

- Chris Potter discussed what is available for off-the-shelf soils data sets, and presented a table of potential soils data sets. High-resolution data sets are created by several groups (texture, awc, C, N, pH), and most are based on the RADAM data set, which covers about 1000 soil pits around Brazil. RADAM, FAO, and ISRIC offer soils maps. There are at least 4-5 different maps made from the RADAM soil-pit data sets, but different interpolation techniques give different results! Important considerations are geographical domain, and how soil types translate to soil hydraulic properties. He raised questions of how to choose the characteristics of a source and how to translate them into parameters, and how geo-statistical methods can be evaluated and improved. Whendee Silver raised the question of how researchers can link what they learn at the site level into models, and how to recover information lost in scaling upward.

Data Topic: What data exist on soil characteristics outside of Brazil? What is the quality of these products?

- Jeff Cardille, of the University of Wisconsin, described land use/land-cover change data sets that are available for the Amazon area and Tocantins.

Their goal is to merge census data with satellite data to develop useful information about land management, and to integrate this data into IBIS. There are some limitations to what satellite data can indicate about cultivation and management. The data covers the entire basin and includes Brazil, Colombia, Ecuador, and Peru. Their approach is to examine agricultural census information for each region and tie it to maps to create a time series of land use for the basin. There is some correspondence with fire data and remote sensing of land cover. He raised questions of how land-use data could be projected before the satellite era/1960's, and crop and pasture data could be associated with satellite land cover data from UMD, MSU, and IGBP. Modelers would need to be careful because some systems are rotating between croplands and pastures, and farmers may be shifting cultivation and rotation.

Data Topic: It may be desirable to combine remote sensing information and census statistics to develop new spatially-resolved estimates of land-use.

- David Skole followed up on Jeff's presentation by commenting that there are good relationships between farm size and agricultural practices that could be used in models, e.g., more machinery and fertilizer use on larger farms. He gave an overview of the TRFIC Information Center at Michigan State University (an ESIP) and introduced its Web site. They have an archive of Landsat data at a progression of scales from basin to local. Individual scenes and pictures are available from MSU at a cost of $25 per scene, and cover forest, deforested areas, secondary growth, cerrado, water, and clouds. Availability includes the mid-1970's (sparse), 1986, the early 1990's, and 1996. The data is from various sensors: MSS, TM, and ETM+. Pan-Amazon data should eventually be integrated into MSU on-line system. 16 KM derived data sets are now on line, but research products not available yet. MSU also has some new "harmonized vegetation, above ground carbon, and soil carbon" data sets.

Data Topics: The details and logistics concerning Landsat-7 data need to be discussed. Information on carbon density above-ground and below-ground is needed.

- Scott Webber represented Charlie Vorosmarty's group and discussed the Regional HydroNET project at the University of New Hampshire. Their goals are to extend the existing HydroNET to higher resolution and to expand holdings for the LBA region, providing a GIS-based repository useful to the LBA community. The data includes river discharge, stage, wetland flooding, precipitation, atmospheric moisture convergence, temperature, radiation, wind, vegetation, and soils. There are various data levels, with some levels open to the public and some with password protection for the LBA community. They are planning a workshop on this data set in July 2000 at CPTEC, open to all LBA investigators.

AFTERNOON SESSION

Discussions identified potentially useful data sets and follow-up actions to promote collaborative activities. Michael Keller proposed compiling an initial list by data category, and Jon Foley called for volunteers to take on follow-up activities for each category.

Climate Data Sets

- RADIATION: Rachel Pinker's proposed data products include GOES derived shortwave/PAR/nIR products (TOA and surface), mostly for Amazonia or South America, probably on the order of 8 km resolution, with a 3 hour frequency, which still can be changed. The temporal domain is still open (~2 years); she is mainly interested in algorithm development.
- RADIATION: Eric Smith has a similar project (i.e., GOES-based radiation estimates) underway. Data start at April 1998 around 4 km resolution, at 3-hour intervals (3 hour snapshot, not 3 hour average), with detailed sub-setting in August/September (dry), and March/April (wet). Data may be available from the Web site. Most products are likely to be available within the year.
- RADIATION: ISLSCP products are available.
- RADIATION: LW and SW can be empirically derived from temperature, humidity, and cloud cover estimates (but need these other data).
- RADIATION: Various reanalysis products exist, e.g., NCEP, ECMWF, NASA/GSFC.

- PRECIPITATION: A Vicente/Costa project is producing data derived from satellite-based measurements, based on GOES and other measurements. Resolution is 4x4 km; the product covers the entire continent, with a product for Amazonia as well. The data requirements are huge, so storage is a problem; right now, the product is available on the Web for a short time, then deleted. The UNH ESIP may be able to take the lead on long-term storage/archive of these data. It is a good product, but limited to heavy precipitation events (maybe 50% of the total).
- PRECIPITATION: Various station measurements are available. NASA-AMES has produced a data set at 8 km from DNAEE station points for 1980s; UNH and the University of Washington have done this also. The NASA-AMES data set is available already. An EOS-Amazon data set is available -- raw station data are available, so these can be interpolated to whatever modelers want. The question was raised about what is available outside Brazil.
- PRECIPITATION: Global gridded climate data sets exist (e.g., Legates & Willmott, Cramer & Leemans, CRU05).
- PRECIPITATION: TRMM data needs follow-up and evaluation. Scott Webber will produce a summary of products.

- PRECIPITATION: Reanalysis data sets exist. Precipitation fields aren't very reliable from the first-generation reanalysis data sets.

- OTHER CLIMATE FIELDS: Global gridded climate data sets exist (e.g., Legates & Willmott, Cramer & Leemans, CRU05).
- OTHER CLIMATE FIELDS: Reanalysis data sets are available. Precipitation fields aren't very reliable from the first-generation reanalysis data sets; other fields may be much better.

- SURFACE HYDROLOGY: UNH and others have hydrological data sets (river discharge etc.).
- SURFACE HYDROLOGY: GSFC radar altimetry measurements of river/wetland/floodplain/lake height, and UCSB floodplain area are available.
- SURFACE HYDROLOGY: Alan Robock's global soil moisture measurements at Rutgers may contain a little bit of data for the Amazon. This is reputed to be the best soil moisture data holding in the world.

Next Steps:

- A follow-up on TRMM data is needed.
- There should be a special focus on precipitation data in the near future.
- Weather generators that scale from monthly data to daily/hourly time scales are needed.
- Soil moisture measurements are very important. Is there an LBA-Ecology observing strategy for this? Coordination of measurements is important (gravimetric, TDR, neutron probe).* There should be coordination between hydrographic and precipitation data. Charlie Vorosmarty and others are planning a meeting on this topic for July 2000.

*An evaluation of the merits and weaknesses of the available products is needed so that this information can be transferred to ecosystem modeling studies using this information.

Soils Data Sets

- RADAM/IGBE DERIVED SOILS MAPS: There are various incarnations of the RADAM data set (NASA-AMES, IPAM, CENA, UW); data are available on various data systems.

- ISRIC-WISE DATA SET: 0.5˚ resolution globally, based on FAO soil map and WISE soil profiles. This data set is available from the Dutch ISRIC group (Batjes et al.).

- FAO-WISE DERIVED SOILS MAPS: 5 minute (~10 km) resolution globally, based on the FAO soil maps and the WISE soil profiles. IGBP-DIS soils product (Scholes et al.)

Next Steps:

- Need to merge Brazilian and non-Brazilian data sets.
- Finer scale soils data sets are available in several regions; these should be made available and used.
- We need information on agricultural soils. RADAM does not include managed lands.
- Information on rooting depth is a lacking in many areas. Jackson and others have some measurements, but more information is needed.

Vegetation And Land Cover

- AVHRR-BASED DATA: Various 1 and 8 km land cover classifications exist (IGBP DISCOVER, UMD, etc.); all are generally available.
- CONTINUOUS VEGETATION COVER: Ruth DeFries 1 km fractional cover data. Skole's group is working on SPOT/VGT data (ongoing). There is also fPAR from AVHRR data (the University of Washington and GSFC have ongoing efforts to clean up the AVHRR record).
- HIGH RESOLUTION DATA: MSU has several data products (forest, cerrado, non-forest, regrowth). Synoptic data sets (1978, 1986, 1992) are available in a 16 km grid. A 1992 data set is available on a 30 m grid (on a scene by scene base, tile basis) for the entire Brazilian Amazon. Bolivia is available for 1986, resolution is 100 m; Peru is available as well.
- POTENTIAL VEGETATION: Various maps exist -- RADAM vegetation cover data (MSU), IGBE vegetation map (WHRC), Ramankutty/Foley (Wisconsin), Olson, Matthews, Wilson and Henderson-Sellers, etc.
- CROPLANDS: Historical data from statistical fusion of census data with satellite data (global data set published by Ramankutty & Foley, 1999); ongoing efforts at MSU and Wisconsin to improve census data and merge them with satellite data (through the 1970s, 1980s, and 1990s).

Next Steps:

- Ongoing efforts to evaluate existing land cover products need to be continued.
- More integration between land-cover products and many ecosystem models is needed.

Ecosystem Properties and Structure

- BIOMASS: Olson et al (1983) global 1-degree biomass product.
- BIOMASS: RADAM-derived products; timber volume estimates (above 40 cm dbh).
- BIOMASS: Various biomass estimates in the literature based on field surveys.

Next Steps:

- We should compile all existing biomass data, as well as LAI, vegetation height, composition, and other parameters from the literature.
- Analysis of existing information may identify additional field-surveys that are needed
- VCL may greatly improve the availability of data on vegetation structure and biomass in the near future.

Land Use and Management

Examples of land-use data include cropland area, types of crops, fertilizers, pasture area, pasture management, cattle head, farm size-class distribution, etc.

- CENSUS BASED DATA: Good agricultural census data from various countries are available. The University of Wisconsin and MSU are both working with these data, and some data sets will soon be available.
- SATELLITE-BASED DATA: NASA-AMES and MSU are generating products based on temporal land cover change detection with high-resolution satellite data. They are currently concentrating on several "super sites," not the whole basin. The products are still in development, but very promising. What about the PRODES project at INPE on increments of deforestation (year by year since ~1981)?
- SYNTHETIC CENSUS/SATELLITE DATA: Census-based and remote-sensing based data can be linked to produce products that have advantages of each source. An example of this is the global map of cropland area at 5 min. resolution by Ramankutty & Foley, 1998 (U. of Wisconsin).

Next Steps:

- A comprehensive compilation and synthesis of available census-based statistics on land use for the region is needed.
- An important activity is to link census and satellite data. More work is needed in this area. The University of Wisconsin, UNH, and MSU and are actively interested in this topic.
- Clarification of the definition of the LBA study region is needed.

Disturbance: Natural and Anthropogenic

- FIRE: Various satellite-based fire products exist (some from GOES at CPTEC and Wisconsin, some from AVHRR some in INPE, ISPRA).
- LOGGING: Nepstad et al. have sawmill data sets (i.e., *Nature* paper). MSU is working on a 1992 16 km resolution data set of areas affected by logging in the legal Amazon. Many disturbances are probably not reflected in the government statistics, because a large amount of the logging is illegal. Some work is going on in this area.
- INSECTS AND OTHER CREATURES HERBIVORY: This is a potentially important area, but no data seem to be available.

Next Steps:

- Are there burned area estimates from satellite-based data? Some groups are working on this; LBA scientists need to coordinate with these researchers.
- There seems to be a mismatch between atmospheric and terrestrial budgets of trace gas emissions from fire. This needs to be reconciled.
- A coordination and synthesis of logging data is needed.
- Herbivory estimates are needed.

Some Other Notes about Future Data Initiatives

ESIP FEDERATION

Annette Schloss reported on activities of the LBA partnership cluster within the ESIP Federation. The Type II ESIPs are commissioned to develop scientific products and provide data services, and to be responsive to the needs of the user community.

Outcomes from This Meeting

1. DEFINITION OF EXISTING DATA SETS

The group made an effort at this meeting to describe existing data sets; follow-up activities will expand and disseminate this information.

2. WAYS OF EXCHANGING DATA

- ORNL will continue to assist groups in archiving LBA metadata within the *Beija-flor* system
- GCMD will register all ESIP data

3. POSSIBLE LONG-TERM GROUP ACTIVITIES:

3.1. Synthesis of available information on ecosystem structure

The UNH/Princeton group will begin to gather and synthesize available information on ecosystem structure, but welcomes the involvement of other groups. The activity will move along two tracks: *in situ* and satellite-based estimates. A short-term data initiative to collect *in situ* data that exist now, involving Paul Moorcroft, Aurelie Botta, and others was proposed, with a goal of compiling these data by June 2000.

3.2. Synthesis and integration of land use and land cover change data

A short-term data initiative involving statistical comparison of census and satellite-based land use/land cover data will be led by David Skole, Jeff Cardille, and George Hurtt. A goal of this activity is to use these products together to obtain highly-resolved spatial estimates of land use. A preliminary report on this effort is expected by June 2000.

3.3. Planning for model intercomparison activities

How would a formal model -data comparison exercise be designed for the entire basin? Chris Potter, Annette Schloss, and others from the UNH group will work on this question with preliminary recommendations expected in June 2000.

3.4. Integration of satellite-based fire measurements, ecological implications (e.g., fire area burned), and the consequent emissions to the atmosphere

Data sets on fires and their consequences for ecosystems are needed for LBA modeling studies. LBA investigators will contact research groups that are creating remote-sensing based fire products using GOES and AVHRR data. This information needs to be integrated with field research to help determine risk factors and consequences of fires. Mark Cochrane, Robert Chatfield, and George Hurtt agreed to initiate this effort and report on it by June 2000.

Currently available precipitation data sets with spatial coverage of the LBA domain.*

Dataset	Reference/Metadata Source	Resolution	Type	Series Span	Data Source
Cramer & Leemans version 2.1	unpublished, see Leemans and Cramer, 1991	0.5º x 0.5º	Climatology	1930-1960	raingage
[1]Willmott & Matsuura version 1.01	climate.geog.udel.edu/~climate/	0.5º x 0.5º	Climatology	1920-1980	raingage
[2]Willmott & Webber version 1.02	climate.geog.udel.edu/~climate/	0.5º x 0.5º	Climatology	1960-1990	raingage
[3]Webber & Willmott version 1.02	climate.geog.udel.edu/~climate/	0.5º x 0.5º	Time Series	1960-1990	raingage
East Anglia Mean Monthly Climatology (CRU05)	New *et al.* , 1999	0.5º x 0.5º	Time Series	1901-1996	raingage
East Anglia Global Precipitation (GU23 & G55)	Hulme *et al.* , 1998	2.5º x 3.75º 5.0º x 5.0º	Time Series	1900-1998	raingage
EOS Amazon Project	www-eosdis.ornl.gov/hydrology/ amazon_river.html	0.2º x 0.2º	Time Series	1972-1992	raingage
Global Precipitation Climatology Centre	GPCC, 1992 & 1993; Rudolph, 1993 www.dwd.de/research/gpcc	2.5º x 2.5º	Time Series	1986-1999	raingage/infrared
Global Precipitation Climatology Project	WMO/ICSU, 1990; Janowiak and Arkin, 1991	2.5º x 2.5º	Time Series	7/1987-10/1999	raingage/infrared
SEISIP DAO 4D Assimilation Pentad Subset	Schubert et al., 1995	2.0º x 2.5º	Time Series	3/1980-11/1993	NWP model
NCEP/NCAR Reanalysis	Kalnay et al., 1996	1.9º x 1.9º	Time Series	1976-1996	NWP model
[4]NASA/NASDA Tropical Rainfall Measuring Mission	daac.gsfc.nasa.gov/CAMPAIGN_DOCS/ hydrology/hd_main.html	0.5º x 0.5º 0.1º x 0.1º	Time Series	8/1998-present	microwave radar/microwave
[5]GSFC GOES-8 IR Auto-Estimator	Vicente et al., 1998	4 Km x 4 Km	Time Series	4/1998-present	infrared

A summary of precipitation data sets that are currently available for the LBA domain is contained in the table.

Notes:

[*]While some DNAEE stations are included in EOS AP and Webber & Willmott, contemporary ANEEL data are not represented here.

[1]Willmott & Matsuura climatology is a regridding of the Legates & Willmott climatic station data using a modified version of SPHEREMAP (Shepard's algorithm). The regridded fields produces lower cross-validation errors than the Legates and Willmott grids.

[2]Willmott & Webber climatology is a merging of Legates & Willmott station climatologies with climatologies developed from the Webber & Willmott station time series data.

[3]Webber & Willmott time series grids are created from station data which are a merger of GHCN v1, a superset of the EOS Amazon Project data set, and data from Fred Wernstedt (Penn State). Webber & Willmott have the same station base as GHCN v2 because there was a collaboration between Webber & Willmott and Vose & Peterson in the data compilation stages. The two data sets differ in that Webber & Willmott is South America only and GHCN is global. Collocation and quality control procedures are different (but similar). NCDC does not produce gridded fields of GHCN.

[4]TRMM TMI (microwave) product is 0.5 degree, while the combined TMI+PR (radar) product is 0.1 degree resolution. I have not yet worked with the combined product.

[5]The GSFC GOES-8 IR data set is designed for convective P and does not capture lesser rain rates, but it should be useful generally if combined with other data.

Known Data Sets for Amazon Region Soil Properties

DATA TYPE	SOURCE	SITE HOLDING	RESOLUTION	EXTENT
Texture, paw, C, N, pH	RADAM	NASA-ARC (Potter et al.)	8-km	Brazil
Texture, paw	RADAM	IPAM (Nepstad et al.)	8-km	L. Amazon
C, N	RADAM	CENA (Moraes et al.)	polygons	L. Amazon
Type, texture	RADAM, ISRIC	UW (Richey et al.)	polygons	Amazon
C, N, depth, type	RADAM	UNH/WHRC	1200 profiles	Brazil
ISRIC-WISE	Global Pedon Database	ISRIC (Batjes et al..)	polygons, pedons	global
IGBP-DIS	FAO, ISRIC, etc.	CSIR (Scholes et al.)	polygons	global
SOTERLAC	FAO, WISE, etc.	ISRIC	polygons	global
Texture, depth, slope	FAO/UNESCO (1985)	UNH	0.5^{o}	global
Type, texture, slope	FAO/UNESCO (1995)	FAO (and NASA-ARC)	polygons, 8-km	global
Texture, units, slope	Zobler	ORNL	1.0^{o}	global
Organic C, N	Zinke	ORNL	3500 profiles	global

Some Issues for Development/Refinement of Amazon Region Soil Data Sets

- What soil properties are required for most regional modeling in LBA?
- How can geo-statistical methods be improved and evaluated to generate the required soil maps for regional modeling in LBA?
- How can LBA coordinate efforts to collect soil profile data sets from locations outside of Brazil?