Synthesis Studies of Intensive Agriculture Impacts in the Amazon and Cerrado: Field Data, Remote Sensing, Modeling Approaches

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LBA-ECO III Team: TG-30
• **Validate ecosystem model predictions** by comparison to tower-based and small plot measurements of net ecosystem production (NEP), trace gas fluxes, and other field-based measurement data sets from intensive field plots.

• **Prioritize improvements to ecosystem models**, which will incorporate intensive agricultural development, to better constrain source/sink estimates for atmospheric CO$_2$ and other trace gases (N$_2$O, NO, CO, CH$_4$) of importance in LBA.

• **Use satellite observations MODIS EVI and FPAR** to make regional modeling assessments of trace gas exchange over the past six years.
FIELD SITE DATA SOURCES

Site Locations
Cerrado MODIS Mosaics

Image collection from 2001 to 2005
Data Screening Processing Flow

- MOD13Q1 Product
- Metadata Processing
- Cloud, Shadow and Aerosol Mask
- VI's and Reflectance Filtering
- Filtered Imagery
NASA-CASA MODEL
(Potter et al., 2001 and 2004)

(a) Soil Moisture Balance and Plant Functional Types
(b) Ecosystem Production Nutrient Mineralization
(c) Biogenic Trace Gas Flux

Soil Profile Layers

Grass/Crop
Shrub
Tree

PPT
PET

Heat & Water Flux

Soil Surface

Leaf Litter
Root Litter
Microbes
Soil Organic Matter

Biomass

NPP
NEP

CO₂

f(TEMP)
f(WFPS)
f(SOLAR)
f(Lit q)

Rh

CO₂ ↔ CH₄

N₂O
NO

Mineral N
Dados Meteorológicos para a América do Sul
(Source: CPTEC)
INITIAL CASA MODELING RESULTS

The NASA-CASA model was driven by EVI and NCEP climate inputs. Following conversion of Cerrado vegetation, three years of soybean cultivation were simulated (below), without the addition of fertilizer. Simulated conversion removed all standing live and dead biomass at the soil surface.

Ecosystem Carbon Balance

Nitrogen Trace Gas Emission from Soils

Cerrado | Soybean
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Cerrado | Soybean
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INPUTS:
LAI (EVI)
Crop Type
Fertilizer
Harvest Index

OUTPUTS:
TG (CO₂, NO, CO)
SOM (30 cm)

TG-30 Data Analysis Activities Underway

- Survey of crop rotation and fertilizer application practices.
- Evaluation of changes in soil properties, nutrient pathways, and moisture dynamics in transition systems.
- Characterization of MODIS EVI seasonal profiles with physiognomic functions for transition systems.
The multiple impacts of soybean expansion on biodiversity and other development considerations have several implications for policy:

- Protected areas need to be created in advance of soybean frontiers,
- Elimination of the many subsidies that speed soybean expansion beyond what would occur otherwise from market forces is to be encouraged,
- **Studies to assess the costs of social and environmental impacts associated with soybean expansion are urgently required,**
- The environmental-impact regulatory system requires strengthening, including mechanisms for commitments not to implant specific infrastructure projects that are judged to have excessive impacts.
Intensive Agriculture

**Benefits**
- Crop Products
- Employment
- Livestock Products

**Costs**
- Pollutants
- Sedimentation
- Trace Gases
- Landlessness
- Biodiversity