

## BIOSPHERE-ATMOSPHERE INTERACTION (PHASE 2) : CERRADO AND LAND USE CHANGES

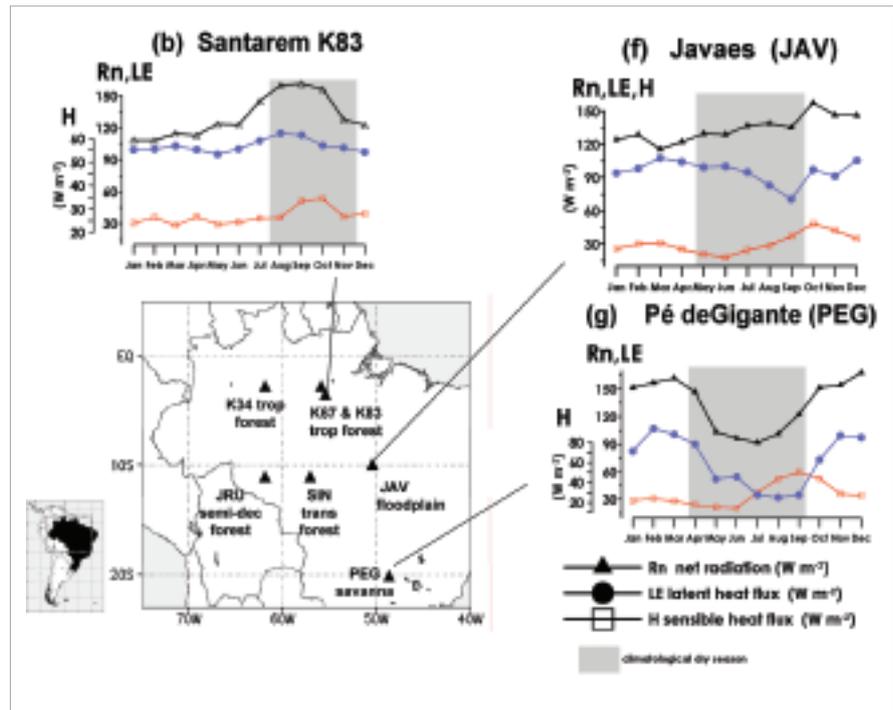
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The project aims in investigating the functional relationships of energy, water and carbon fluxes over tropical forests, Cerrado (savanna) and agricultural ecosystems (sugar cane and eucalyptus), that includes the control of climate and environment. It is a cross-disciplinary perspective of eco-climatology and hydrology, plant physiology and geochemistry, scheduled from 2005 to 2008.

The project has a close connection with the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA), and the team has three fronts of investigation: i) climate (climatology and land surface fluxes); ii) hydrology (hydrogeology, surface hydrology and biogeochemistry); and iii) ecology (plant physiology and ecological studies), that is coordinated to achieve the following tasks:

- 1) To monitor five experimental field sites:
  - Cerrado *sensu stricto*;
  - Ecotone (seasonally flooded savanna);
  - Tropical rain forest;
  - Agro system Sugar Cane;
  - Agro system Eucalyptus.
- 2) To measure leaf photosynthesis and water potential, according to key species and seasonality.
- 3) To measure the long term surface-atmosphere fluxes of water, energy and CO<sub>2</sub> over the field sites, using flux towers and weather stations.
- 4) To estimate the water balance for each



Source: Rocha et al. 2008, unpublished.

ecosystem on the watershed scale, using hydrogeological surveys and by measuring precipitation, evaporation and stream flow.

- 5) To characterize ecosystem functional relationships dependent on the climate and water availability, using remote sensing and field measurements.
- 6) To estimate the dynamics of C stocks in each ecosystem, and C balances in the long term by characterizing C sink or source.
- 7) To investigate how the climate variability (seasonal, intraseasonal, interannual and century-scale) controls the length and patterns of wet and dry season in the region of study.
- 8) To deploy mathematical numerical models (biosphere-hydrology-atmosphere) and field observations, to compare the productivity and water availability across the different ecosystems.

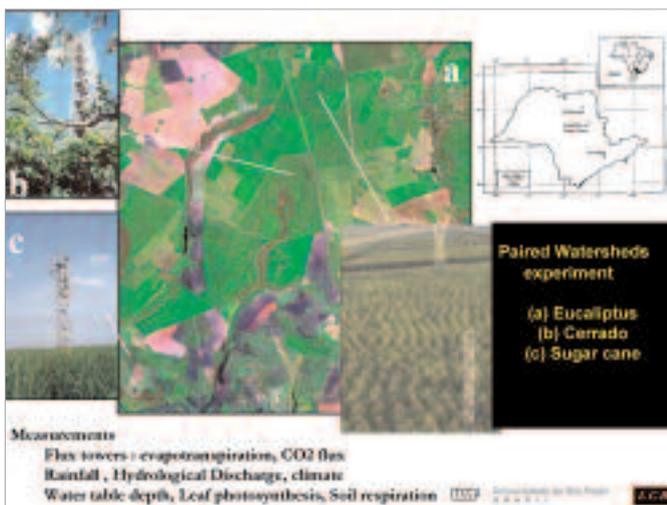
## SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

Four field sites with flux towers and stream gages are ran, three of them in northern Sao Paulo state (Cerrado and paired sites of sugar cane and eucalyptus), and the floodplain (savanna) site in Tocantins state. A species inventory and a set of 6 parcels were defined in the Cerrado site, where leaf photosynthesis and litter fall were measured.

*Anadenanthera falcata* Speng was a dominant species, with larger photosynthetic potentials. Photosynthetic rates show different patterns of the species, although the seasonality is similar and well defined between them.

In the forest-savanna transition in Brazil, the mean annual sensible heat flux at all sites varied from 20 to 38 Wm<sup>-2</sup> and was generally lower in the wet season and higher in the late dry season, consistent with seasonal variations of net radiation and soil moisture. At the sites where the dry season length does not exceed 4 months and annual precipitation is above 1900 mm, the monthly net radiation progressively increased along the dry season and was positively correlated with evaporation, that increased to as much as 4 mm d<sup>-1</sup> (Manaus, Santarem and Rondonia). In contrast, those ecosystems with less precipitation, below 1700 mm, and longer dry season, as in Mato Grosso, Tocantins and Sao Paulo, showed clear evidence of reduced evaporation in the dry season, to 2,5 mm d<sup>-1</sup> in the transitional forests and to 1 mm d<sup>-1</sup> in the Cerrado. The later sites showed characteristics of savanna, where the reduction of evaporation is more pronounced associated with longer dry season lengths and larger annual amplitude of air temperature. The patterns of seasonal evaporation and energy partitioning we have discussed is key to identifying two functionally different type of sites, that help to explain the complexity of functioning of tropical forests, savannas, and the transitional ecosystems that exist in between them.

Using the EVI (Enhanced Vegetation Index), photosynthesis increased during the late 2005 drought, which suggests that the resilience of the ecosystem might be higher than expected.



## MAIN PUBLICATIONS

Bitencourt, Marisa D, Mesquita Jr HN, Kuntzschik G, Rocha HR, Furley PA. 2008. A Cerrado vegetation study using optical and radar remote sensing: two brazilian case studies. *Canadian Journal of Remote Sensing*, in press.

Bombardi RJ, Carvalho LMV. 2008. Variabilidade do regime de monções sobre a região do cerrado: o clima presente e projeções para um cenário com 2xCO<sub>2</sub> usando o modelo MIROC. *Revista Brasileira de Meteorologia*, submitted.

Carvalho LMV, Tsonis AA, Jones C, Rocha HR, Polito PS. 2007. Anti-persistence in the global temperatura anomaly field. *Nonlinear Processes in Geophysics*, in press.

Bruno RD, Rocha H, Freitas HC, Goulden ML, Miller S. 2006. Soil moisture dynamics in an eastern amazonian tropical forest. *Hydrological Processes*. **20**:2477-2489.

da Silva DML, Ometto JPHB, Lobo GA, Lima WP, Scaranello MA, Mazzi E, Rocha HR. 2007. Can land use changes alter carbon, nitrogen and major ions transport in subtropical brazilian streams. *Scientia Agricola*. **64**:4.

Miller SD, Goulden ML, Rocha H. 2007. The effect of canopy gaps on subcanopy ventilation and scalar fluxes in a tropical forest. *Agricultural and Forest Meteorology*. **142**:25-34.

Rocha H, Manzi A, Cabral O, Miller S, Saleska S, Goulden M, Borma L, Wofsy S, Cardoso F, Nobre A, et al. 2008. Overview of surface water and heat fluxes across savanna – forest ecosystems in Brazil. *Journal of Geophysical Research, Biogeosciences* (accepted).

Saleska SR, Didan K, Huete AR, da Rocha HR. 2007. Amazon forests green-up during 2005 drought. *Science*. **318**: 612. DOI: 10.1126/science.1146663.

Silva AE, Carvalho LMV. 2007. Large-Scale Index for South America Monsoon (LISAM). *Atmospheric Science Letters*. **8**: 51–57, DOI: 10.1002/asl.150.

Della CL, Ribeiro CSL, Nardoto GB, da Rocha HR, Aidar MPM, Ometto JPHB. 2007. Utilização de isótopos estáveis do carbono e nitrogênio em estudos ecofisiológicos em área de cerrado *senso stricto* no Estado de São Paulo. *Scientia Agricola* (submitted).

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