13.2 DRY TO WET SEASON LBA CAMPAIGN IN THE AMAZON: RADIATION, CLOUDS AND CLIMATE INTERACTIONS

Maria A. Silva Dias[1] Tercio Ambrizzi[1], Gilberto Fisch[2], Luiz A. Machado[2], Antonio Manzi[3], Jose Marengo[3], Artemio Plana-Fattori[1], and Pedro Silva Dias[1]

[1]Universidade de São Paulo, São Paulo, Brazil
[2]Centro Tecnológico da Aeronáutica, São José dos Campos, Brazil
[3]Instituto Nacional de Pesquisas Espaciais, Cachoeira Paulista, Brazil

## 1. INTRODUCTION

During the transition from the dry to wet season in 2002 (September and October), an atmospheric intensive field campaign was carried in the southwestern region of the Amazon Basin within the framework of the Large Scale Biosphere Atmosphere Experiment in Amazonia – LBA. The specific objectives of the DRYTOWET/LBA campaign were to describe and analyze: the global and large scale controls of the beginning of the rainy season in the Amazon Region; the impact of convection in the Amazon region on the global and regional climate in the transition season; the transition season in terms of cloud pattern evolution and aerosol concentration; the weather systems and air mass evolution during the transition from the dry to wet season; the several convective features of the Amazon region in the transition season including life cycle, rainfall intensity, lightning, dynamics and thermodynamics; the relationship between CCN and convective patterns; the temperature inversion equilibrium in the presence of a mixed layer with aerosol and its evolution after the first major rains; the evolution of the PBL during the transition season as a function of soil moisture and of evapotranspiration; the surface and PBL radiative budget before, during and after the beginning of the rainy season, over forest and over pasture; the impact of land cover heterogeneity on PBL and surface layer turbulence during the transition season; the evolution of surface energy, momentum, water and $CO_2$ budgets in pasture and forest and its seasonal and interannual variability; the radiative transfer processes in the presence of aerosol and to what extent they modify the processes associated to water vapor seasonality; the microphysics processes with different aerosol concentration and to improve the ability to model the different processes in an integrated view of climate and regional weather.

*Corresponding author address:* Maria A. Silva Dias, Departmento de Ciências Atmosféricas, Universidade de São Paulo, Rua do Matão 1226, 05508-900 São Paulo – SP, Brazil. mafdsdia@usp br

The campaign involved four sites with frequent radiosonde launchings, 2 aircraft (one for air chemistry and the other for cloud microphysics), a 10 cm meteorological radar, a rain gage network, pasture and forest flux towers, a lightning network besides the operational meteorological network, plus a whole range of surface and airborne chemistry measurements, a network of sun photometers, microwave passive radiometers and spectral measurements of solar radiation.

The preliminary results of this campaign will be presented showing the atmospheric evolution from a very high concentration of aerosols due to biomass burning to a clean atmosphere.

## 2. DATA

The data collected during the DRYTOWET/LBA campaign may be seen in Table 1. More details in htpp://www.lba.iag.usp.br.

TABLE 1

| Instrument and or measurement | Description of operation |
|---|---|
| Radiosonde/atmospheric profiles of temperature, moisture and winds | 4-6 launches per day; locations as seen in Figure 1 |
| 10 cm Doppler Weather Radar/reflectivity and radial velocity | Volume scans every 10 minutes |
| Piranometers/atmospheric radiation | Continuous measurements at the pasture and forest sites |
| Micrometeorological towers/ turbulent fluxes of heat, moisture and $CO_2$ profiles | Continuous high frequency measurements at forest and pasture sites |
| Network of 25 automatic raingages/instantaneous rainfall | Continuous operation in 25 locations |
| Atmospheric chemistry/ concentrations of aerosol, CCN, CO, $CO_2$, $NO_x$, $O_3$, $NH_3$ | Surface measurements at the pasture site and with chemistry aircraft measurements during 100 flight hours |
| Cloud microphysics/ droplet spectra, liquid water, CCN | 72 flight hours with microphysics aircraft |

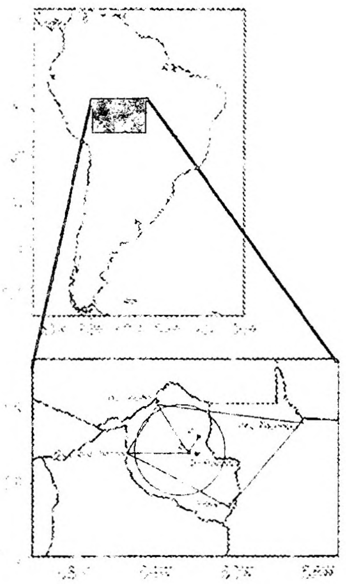

Figure 1 Study area in SW Amazon. P is a pasture site, F is a forest site. Radiosonde sites are R, F, Guajará Mirim, Porto Velho, Vilhena and Alta Floresta. The circle indicates the area covered by the S-band Doppler radar. The airplanes were based in Ji-Paraná and flew over the larger box, with one flight extending northwest to Cruzeiro do Sul (7°35'47"S, 72°46'7"W).

## 3. RESULTS

The global circulation during the DRYTOWET/LBA campaign was perturbed by an El Niño event with drier then normal precipitation in September and October over most of Central Brazil and Amazon basin. Fire activity was observed throughout the two months with aerosol optical thickness (AOT at 440 nm) reaching 3 (cf. http://aeronet.gsfc.nasa.gov) in the last week of September. More regular rainfall in October, lowered the AOT to about 1-2 reaching less than 1 only in the first week of November. Rainfall was observed during September but very sparse. A few severe storms were observed with gusty winds and graupel, Most of the time in October, deep convective cells were quite vertical and short lived, reaching 18-20 km with less than 1 hour live time. The surface forcing showed that in the deforested areas of central Rondônia (c.f. Silva Dias et al 2002 for a map) the sensible heat flux was almost 300 $W.m^{-2}$ in the beginning of September and lowering to about 150 $W.m^{-2}$ in October, responding to an increase in soil moisture. The mixed layer heights also evolved from very deep (2300 m) to values more typical of the wet season (1000 m) with significant day to day variability until a more stable rainfall regime was established in November.

The possible effects of aerosols from biomass burning include a modification of the thermodynamics by shifting a portion of the solar heating from the surface to the boundary layer and the modification of the microphysics process inside the convective cells. Silva Dias et al (2002) and Williams et al (2002, discuss the evolution of cloud condensation nuclei concentration, low level wind regimes and convective regime during the wet season in SW Amazon. The dry season presents an extreme case for that since CCN concentration reaches 3000-10000 $m^{-3}$ The CCN concentration as well as total particle concentration measured by the aircraft indicated a significant transport of aerosol from the mixed layer to a deeper layer by cumulus clouds A regional model of biomass burning transport run during the campaign (c.f. www.master.iag.usp.br/queimadas) captured quite well the effect of convective transports.

The droplet spectra in cumulus clouds indicated a double peaked distribution probably associated to large nuclei from the biomass burning material. The integrated effect of the aerosol on the radiation reaching the surface may reach more than 80 $W.m^{-2}$ for each unit of AOT (Schafer et al, 2002). The biomass burning material contains black carbon and can thus absorb part of the incoming solar radiation that is not reaching the ground thus heating the boundary layer. The combined effect of less radiation at the ground and more absorption in lower levels of the atmosphere reduces the convective instability during day time, thus inducing the development of less vigorous thermals which in turn support less vigorous updrafts. These aspects will the analyzed further with the data of the DRYTOWET/LBA campaign

## 4. REFERENCES

Silva Dias, M. A. F., S. Rutledge , P. Kabat, P L Silva Dias, C. Nobre, G. Fisch, A.J. Dolman, E. Zipser, M. Garstang, A. Manzi, J D. Fuentes, H. Rocha, J.Marengo, A Plana-Fattori, L. Sá. R. Alvalá, M. O Andreae, P. Artaxo, R. Gielow, L. Gatti. Clouds and rain processes in a biosphere atmosphere interaction context, *J. Geophys. Res.* 107, D20,pp 46.1 46.23, 2002..

Williams,E., D. Rosenfeld, N. Madden, J. Gerlach, N. Gears, L. Atkinson, N. Dunnemann, G. Frostrom, M. Antonio, B. Biazon, R. Camargo, H. França, A. Gomes, M. Lima, R. Machado, S. Manhaes, L. Nachtigall, H. Piva, W. Quintiliano, L. Machado, P. Artaxo, G. Roberts, N. Renno, R. Blakeslee, J. Bailey, D. Boccippio, A. Betts, D. Wolff, B. Roy, J. Halverson, T. Rickenbach, J. Fuentes, E. Avelino. Contrasting convective regimes over the Amazon; implications for cloud electrification *J. Geophys. Res.*,107, D20, 2002.

Schafer, J. S., B N Holben, T. F. Eck, M. A. Yamasoe, P. Artaxo, Atmospheric effects of insolation in the Brazilian Amazon: observed modification of solar radiation by clouds and smoke and derived single scattering albedo fof fire aerosols. *J. Geophys. Res.*,107, D20, pp. 41.1-41.15 2002.