Trace Gases Measurements in the Amazon Basin During the Wet and Dry Seasons

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Introduction

Human activities are changing the face of Amazônia and the way this region functions as an integral system, in which the biota, the atmosphere, and the human population interact with one another. This change is expected to have far-reaching effects on the global carbon balance, the concentrations of greenhouse gases and aerosol particles, and on the oxidizing power of the global atmosphere. Present scientific knowledge is inadequate to assess these changes and their impacts on global change with the required degree of reliability. Therefore, to address the key questions — (a) how does Amazônia currently function as a regional entity? And (b) how will changes in land use and climate affect the biological, chemical and physical functions of Amazônia, including the sustainability of development in the region and the influence of Amazônia on global climate? — The international multidisciplinary research initiative Large Scale Biosphere-Atmosphere Experiment in Amazônia (LBA) is now taking place in Amazônia

Biogenic trace gases emitted by the vegetation are important in the regulation of the oxidizing power of the tropical and global atmosphere (Andreae and Crutzen, 1997). The Amazon region is a key tropical ecosystem that is suffering profound changes in land use (Artaxo, 2001). Although only about 11-14 % of the original forest area is now deforested, the vast area of the forest (5.5 million square kilometers) and the rapid land use change are responsible for the regional climatic effects that only recently are being noticed in Rondônia State and in the region south of Para State (Silva Dias et al., 2001, Williams et al., 2001).

The study of NO_2–NO–O_3–CO trace gas exchange over Amazonian landscapes, which have undergone extreme ecosystem modification, is fundamental to understanding how deforested environments affect regional trace gas budgets, and consequently global tropospheric chemistry (Kirkman at al, 2001).

Sampling sites description

Several intensive sampling campaigns were performed in 1999, 2000 and 2001, in different regions such as Rondônia, Pará and Amazônas (**Figure 2**). Concentrations of O_3, NO, NO_2 and CO were measured at three sites in Amazônia: Rondônia, Santarém and Balbina. From January to March 1999 a wet season experiment and a dry season experiment was run in September and October 1999 in Rondônia state (**Figures 3, 5 and 6**). The sampling site that was used as representative of a pasture environment is called "Fazenda Nossa Senhora Aparecida", located at 10º 45' 44" S, 62º 21' 27" W, and 315 m a.s.l. A wet season campaign in Pará state during February 2000, was measure in Primary forest site (**Figures 4 and 7**). The National Forest of Tapajós (Flona Tapajós) is an IBAMA reserve. The exact localization is Km 67 2º 51,42' S, 54º 57.54' W. The Fourth intensive campaign was accomplished during the wet season in Balbina (1º55,20 S; 59º28,07 W), located 180 Km North of Manaus, during June and July 2001 (**Figure 1**).

The wet season experiments extended from February to July and the dry season experiment measured atmospheric composition associated with biomass burning emissions (September - October).

Results

During the wet season, ozone, carbon monoxide and nitrogen oxides concentrations, shows similar values at the several sites: National Forest of Tapajós region, in Pará state,

Balbina in Amazônas states and in pasture region in Rondônia state.

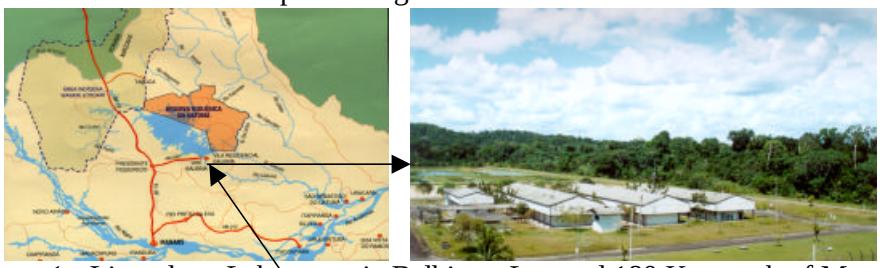

Figure 1 - Limnology Laboratory in Balbina - Located 180 Km north of Manaus

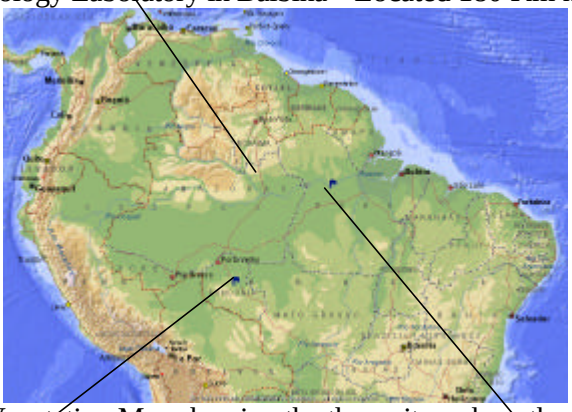

Figure 2- Amazon Vegetation Map showing the three sites where these studies were made

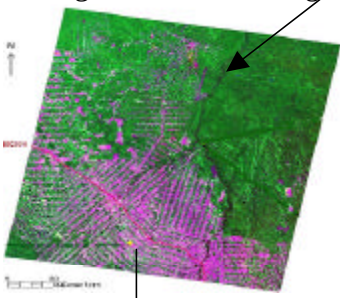

Figure 3 – Satellite Image of Rondonia Ouro Preto do Oeste -

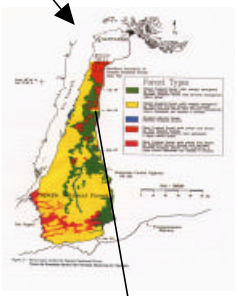

Figure 4- National Forest of Tapajós - Pará - 67 Km of BR 163

Figure 5- Fazenda Nossa Senhora Aparecida -Ouro Preto do Oeste – Rondônia - samples to 4 m height

Figure 6- Real time Monitors f O_3, NOx e CO of Thermo Enviromental Instruments.

Figure 7- Samples to 40 m height in 67Km of BR 163 road

The ozone peak concentrations, during the wet season, were similar at all sites at 12 to 15 ppb at mid-day. This is a rather low concentration, especially in Rondônia, were large changes in land use have modified the original forest. However, during the nighttime, the concentrations at the National Forest of Tapajós were larger than Rondônia and Balbina (9.0, 4.5 and 1.5 ppb respectively), Figure 8. This nighttime ozone enhancement occurs due to convective transport from higher Tropospheric levels air masses to the ground during the

night, associated with convective clo ud process and nocturnal jets. The nocturnal peaks occur during 85% of the sampling period. The tropical atmosphere is characterized by a decrease with height of equivalent potential Temperature, $?_E$, because the primary source of $?_E$ is from the daytime fluxes at the surface, and the primary sink is radioactive cooling of the troposphere. Studies have shown that O_3 concentrations increase with height in the rainy season over Amazônia, because the forest is predominantly a sink of O_3 at that time (Betts at al 2001).

During the dry season (Set – Oct 99), with high loadings of biomass burning emissions, the nighttime O_3 average concentrations were 15 ppb and in daytime it reached 41ppb. This result indicates an O_3 enhancement of 4 times compared to wet season values (Figure 8).

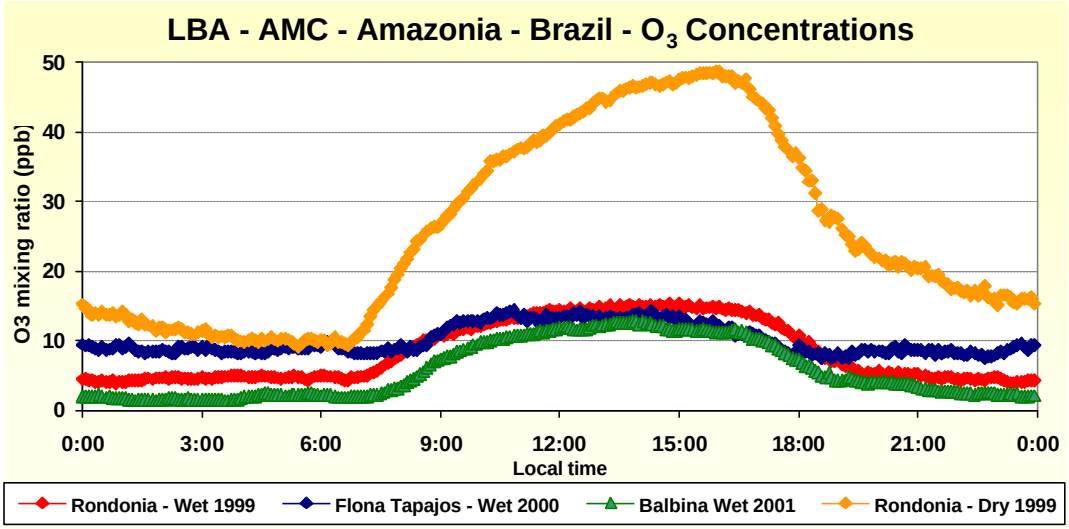

Figure 8 - Ozone measurements during wet seasons: Rondonia - pasture site 1999, Flona Tapajós - Pará in 2000 and Balbina 2001 and dry season: Rondonia - pasture site 1999

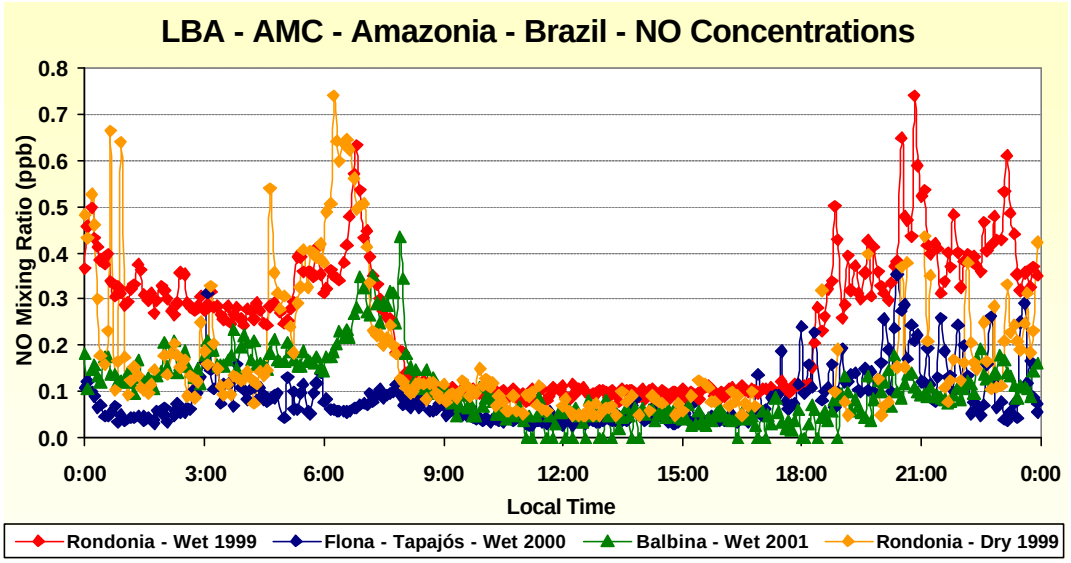

Figure 9 - NO measurements during wet seasons: Rondonia - pasture site 1999, Flona Tapajós - Pará in 2000 and Balbina 2001 and in Dry season: Rondonia - pasture site 1999

The concentrations of NO e NO_2 during the wet season campaigns (Figures 9 and 10 respectively) shows that in Rondônia, the effects of land use change can be observed. In the

wet season, it was expected a very clean atmospheric condition, but it was observed a strong effect of charcoal factory emissions. In Balbina it was possible to observe vehicles activies near the site. These anthropogenic activities enhance NO, NO_2 and CO concentrations. During the dry season, burning emissions enhances O_3 and CO concentrations (Figures 8 and 11). The conversion of NO to NO_2 is very efficient during the dry season due the oxidants compounds shows very high concentrations. In the dry season at Rondônia, NO_2 concentrations are 10 times higher and CO concentrations are 6 times higher than at the Flona Tapajós. This result shows the important impact in the atmospheric composition from biomass burning emissions.

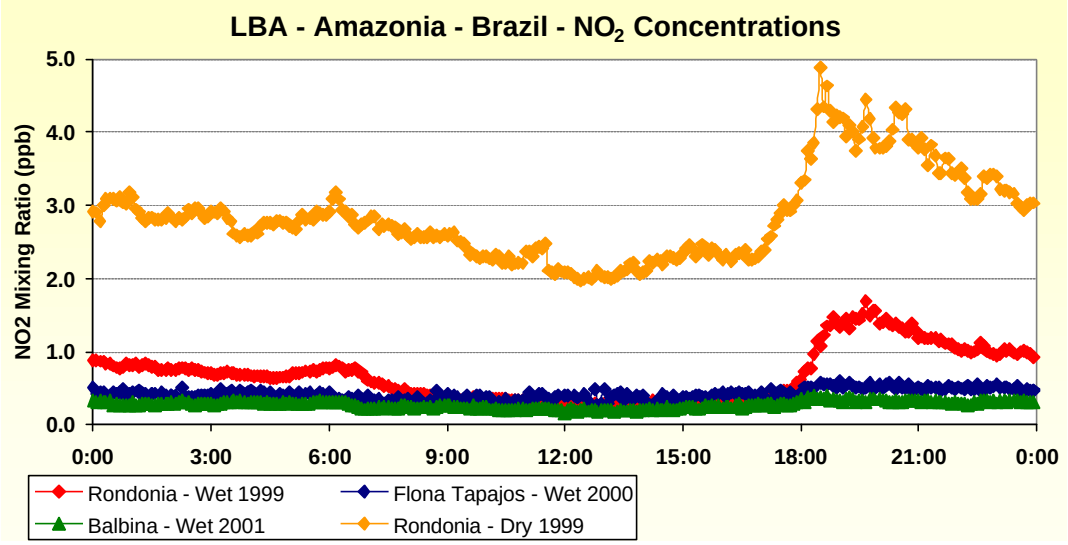

Figure 10 - NO_2 measurements during wet seasons: Rondônia - pasture site 1999, Flona Tapajós - Pará in 2000 and Balbina 2001 and in Dry season: Rondônia - pasture site 1999

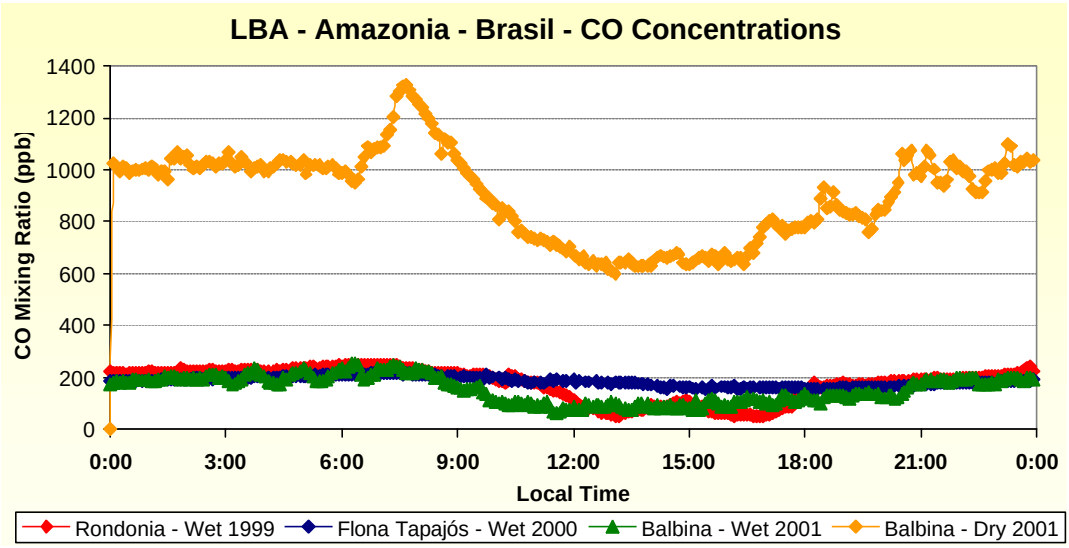

Figure 11 - CO measurements during wet seasons: Rondônia - pasture site 1999, Flona Tapajós - Pará in 2000 and Balbina 2001 and in Dry season: Rondonia - pasture site 1999

Conclusions

The results in Rondônia show that O_3 and NO_2 concentrations are significantly enhanced during the dry season in comparison with wet season due the biomass burning emissions. The NO_2 and O_3 concentrations, during the dry season, reached very high values, similar to urban levels concentrations. The CO and O_3 high concentrations affect the NO/NO_2 relationship. High concentrations of oxidants and high temperatures during the biomass burning season, enhances the production of HNO_3, PAN and others organic nitric compounds. This depletes NO concentrations, enhancing NO_2 concentrations during the dry season.
The clear correlation between CO, NO_2 and Black Carbon during the wet and dry season in Rondônia shows the antropic impact in this Amazon region.

The NO, NO_2 and CO concentrations during the wet seasons at the Flona Tapajós and Balbina are characteristic of natural background areas. This means that in this part of Amazon we can to study the natural atmosphere composition of Amazon forest. The Rondonia situation is different, where we can see the antropic effect include during the wet season.

The nocturnal O_3 concentrations during the wet season in Santarém show clearly the convective transport of O_3 from upper troposphere.

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