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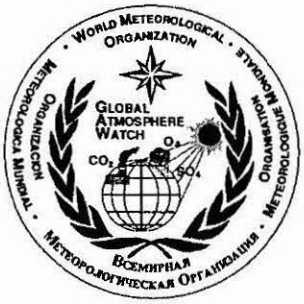

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Biomass Burning in Central Brazil and Impact on the Atmospheric Composition

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Introduction

Biomass burning has been systematically practiced during centuries, mainly in underdeveloped countries, with the main purpose to prepare soils for agriculture or to facilitate later timber exploitation. However, this practice was recently considered by scientists about its possible impact on soils and on the atmospheric composition, reducing visibility conditions during biomass burning time and mainly because its possible influence on climatic change due to the high injection to the atmosphere of matter produced by biomass burning.

In this work, still in progress, we collected rainwater samples (bulk and wet only) and total particulate matter (TPM) suspended in the air, at Campo Grande City, Mato grosso do Sul State, located in Brazil central upland. Sampling were done from August 1993 to September 1994, in order to cover the dry period which is biomass burning time (April to September) and the rain season (October to March). Pluviometry for these periods is 222 mm and 1421 mm respectively. The determination of the chemical composition of rain and particulate matter samples for the two periods permits to obtain by difference the increase of ionic species injected in the atmosphere from biomass burning, taking into account the fact that the region has no industries, being exclusively devoted to agriculture and stock rising. For this reason, the only sources of pollution are vehicle traffic (practically uniform all year long) and biomass burning.

We present here the results of the first year of this work, for only some of the ionic species studied (calcium, potassium, magnesium, sulfate, nitrate and ammonium) in rainwater and TPM. The results on other parameters studied will be published later on.

Methods

For rainwater samples, a wet only type collector developed at INPE was used. A fraction of the sample was taken to measure pH in loco, and the remaining was preserved with chloroform and sent airmail to the laboratory at INPE to performed chemical analysis.

Aerosol (TPM) samples were collected on Millipore HAWP-0.47 filters making use of a vacuum pump, flowmeter, manometers, thermometers and an inlet. The results were corrected for 25°C and 760 mmHg. The filters were weighed before and after sampling with a microbalance, measuring this way the total mass of collected particles (gravimetric method). The filters are then put inside a

polyethylene bottle containing 100 ml of deionized water and exposed during 0.5 hour to supersonic waves. The solution obtained is filtered and analyzed. The cation concentrations are determined by atomic absorption spectrometry (Ca, K and Mg) and the anion ones by liquid ionic chromatography (Dionex 2010i). NH_4^+ was determined by potentiometry. The precision on the calculated means is typically 10%. During this period 40 TPM and 55 rainwater samples were collected.

Results

Table 1 shows the mean yearly concentrations in rain and TPM of the species for the whole period studied. The mean value for rainwater samples was obtained weighting the ionic concentration of every element in every sample by the pluviometry of the corresponding event (volume weighted mean). For TPM, the mean value corresponds the arithmetic mean of the concentrations. The same procedure was used to obtain the mean values corresponding to the dry period and to the rainy period, independently.

It may be observed, in Table 1, that either for rain either for TPM the greatest mean concentrations are obtained for sulfate, nitrate and ammonium, greater than the values obtained by us (L.M. Moreira-Nordemann et al., 1991) in other more industrialized and more populated cities of Brazil. Among the other ions, calcium and potassium, for being predominant elements in biomass, present naturally greater concentrations than magnesium.

To estimate the impact of biomass burning on the concentration of every species, we divide the mean value for the dry period by the corresponding value for the rainy period, which leads to an "enrichment factor" (EF), that is to say how many times the dry period mean concentration is greater than the rainy period one. The same was done for the rainwater. These results are contained in Table 2.

We can observe that the mean concentrations of the species increase during the dry period in rainwater as well as in the TPM, principally in the TPM, except for K which presents the same EF in both cases. The greatest relative increase of concentration was observed for ammonium.

The EF values should be due to the low pluviometry of the dry season, on regard to the wet season, because of the low washout of the dry period. However, when calculating also the EF in rain, our purpose was exactly to consider the effect of the rain in this atmospheric washout phenomenon. In the same manner, we have to consider the different physical-chemical reactions which occur differently for the various species considered: greater or smaller solubility, different residence times, etc. But this does not explain at all why ammonium, sulfate and magnesium are more "enriched" in TPM than in rainwater, calcium only a little more and potassium and nitrate are equally "enriched" in the dry season, either in the TPM or in the rainwater, because most of these species are very soluble.

TPM total mass

The "enrichment" (that is to say the emission) of species in the atmosphere during biomass burning -mainly in the region we are studying, with no industries, which means no other anthropogenic pollution- is expected as well under gaseous form as solid. Recent studies in sugar cane plantation regions, also in Brazil (Marinho and Kirchhoff, 1991) have shown that during biomass burning period the ozone concentration increases almost 3 times and the carbon dioxide concentration up to 6 times in relation to the rainy period, during which no burning occurs.

In our case, we found a total mean mass of 34 micrograms per cubic meter in the rainy period and this value is multiplied by a factor 2.5 in the dry period; similar enrichments were found for nitrate, calcium, sulfate and magnesium in the TPM (Table 2). The TPM mass being an image of the composition of the total solid matter in suspension in the air, we can conclude after the data discussed in this work that the injection of "continental" matter in the local atmosphere during biomass burning, multiplies at least this value by a factor of 2 and is not so alarming as some estimations already affirm, but it is not at all negligible.

pH

The mean annual value is 4.95, being 4.74 in the dry period (minimum 3.09; maximum 5.90) and 5.07 in the rainy period (minimum 4.45; maximum 5.94). We believe rain should be more acid during the dry period, if it were not the ammonium EF, so much greater than those of the other ions, which lead to neutralize the nitrate and sulfate possible effect on acidification of rainwater.

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Table 1
Volume weighted means of the ionic species in rain water and arithmetic means in the total particulate matter (TPM) for one year.

	Rain Water		TPM
	mg/l	µeq/l	$\mu g/m^3$
Ca	0,103	5,14	0,303
K	0,079	2,02	0,270
Mg	0,024	1,93	0,058
SO_4^{-2}	0,350	7,28	1,176
NO_3^-	0,426	6,87	0,836
NH_4^+	0,287	15,91	0,367
Total		39,15	

Table 2
Enrichment factor (EF) of the species in the TPM and in raiwater. EF is the ratio between the mean concentration of the species during the dry and wet periods.

	TPM	Rainwater
Ca	2,5	1,7
K	3,4	3,5
Mg	2,3	1,2
SO_4^{-2}	2,3	1,4
NO_3^-	2,2	2,0
NH_4^+	5,4	2,0