

CHARACTERIZATION OF CARBONACEOUS AEROSOLS AND WATER-SOLUBLE IONS DURING THE BIOMASS BURNING PERIOD IN THE BRAZILIAN AMAZON

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Introduction

Aerosol particles may influence the earth's radiative balance directly by scattering and absorbing solar radiation, or indirectly by altering cloud properties through their ability to act as cloud condensation nuclei (CCN) [Andreae & Crutzen, 1997]. It was suggested that more than 80% of the worldwide biomass burning emissions are originating from the tropics [Hao & Liu, 1994]. Organic aerosols may absorb and/or scatter solar radiation. Moreover, water-soluble organic compounds and water-soluble inorganic species may have a significant impact on indirect climate forcing. Due to the preponderance of the organic aerosol fraction in biomass burning aerosols, of which ~ 50 % may be water soluble [Mayol-Bracero et al., 2002] a detailed chemical characterization of these particles is required. Size-resolved chemical characterization was performed on aerosol samples collected in a pasture site in the Amazon Basin as part of the project *Smoke Aerosols, Clouds, Rainfall and*

Climate: Aerosols from Biomass Burning Perturb Global and Regional Climate (LBA-SMOCC), covering dry season (biomass burning), transition period, and wet season (clean conditions) from Sept. to Nov. 2002).



Figure 1. Sampling site Fazenda Nossa Senhora, in Ouro Preto D'Oeste, in the state of Rondonia, Brazil.

Sampling and Analysis



Figure 2. Fazenda Nossa Senhora, showing the DLPI sampling setup in the tower.

Size-resolved particles were collected on quartz filters or aluminum substrates using a Dekati Low Pressure Impactor (DLPI) with 13 stages. The DLPI classifies particles according to their diameter from 10 μm to 30 nm. The sampler was located in a tower at a height of 8 m from the ground (Figure 2). Simultaneous with the sampling, measurements were made of particle number concentration at a time resolution of 60 seconds and over a size range of $D_p = 7 \text{ nm} - 3 \mu\text{m}$, using a condensation particle counter (CPC, Model 3022A TSI). Analyses of the impactor filter-substrates were performed using: gravimetry, ion chromatography, inductively-coupled plasma, and evolved-gas analysis.

Particle Number Concentration

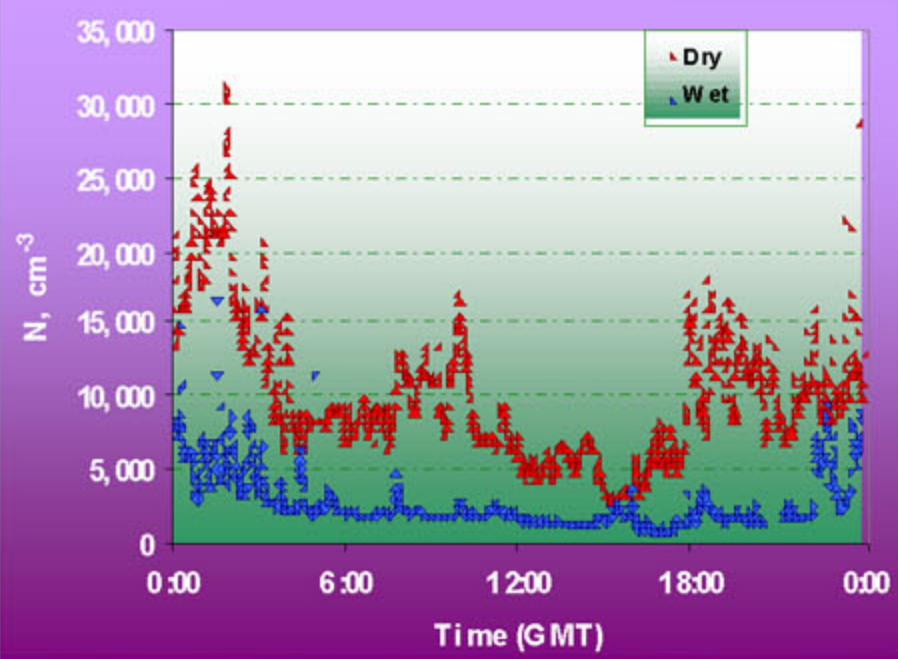


Figure 5. Particle number concentrations for typical days during dry (Oct 3, 2002) and wet (Nov 7, 2002) seasons measured by the CPC.

Mass Scattering Efficiency

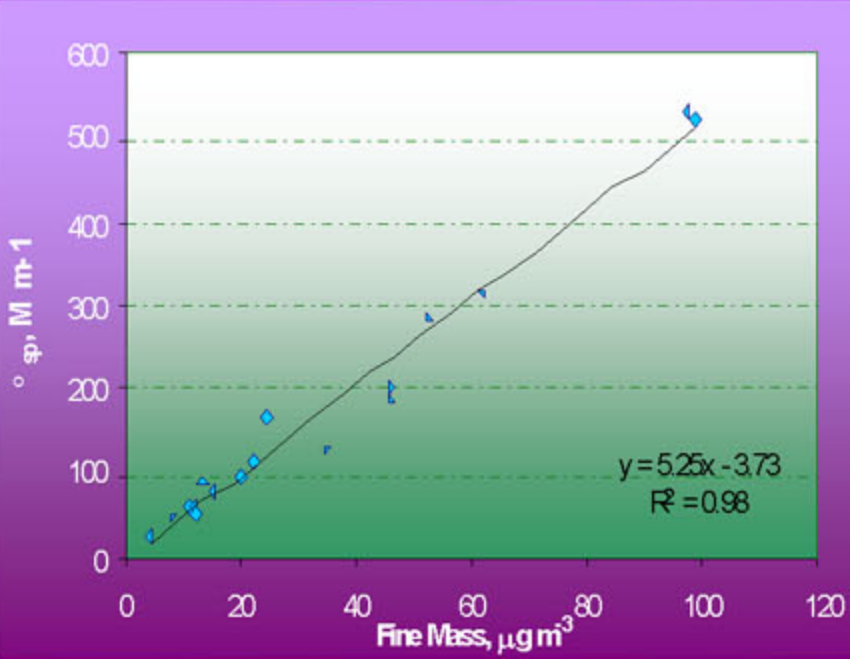


Figure 6. Mass scattering efficiency (α_{sp}) of the fine aerosol mass.

Size Distributions

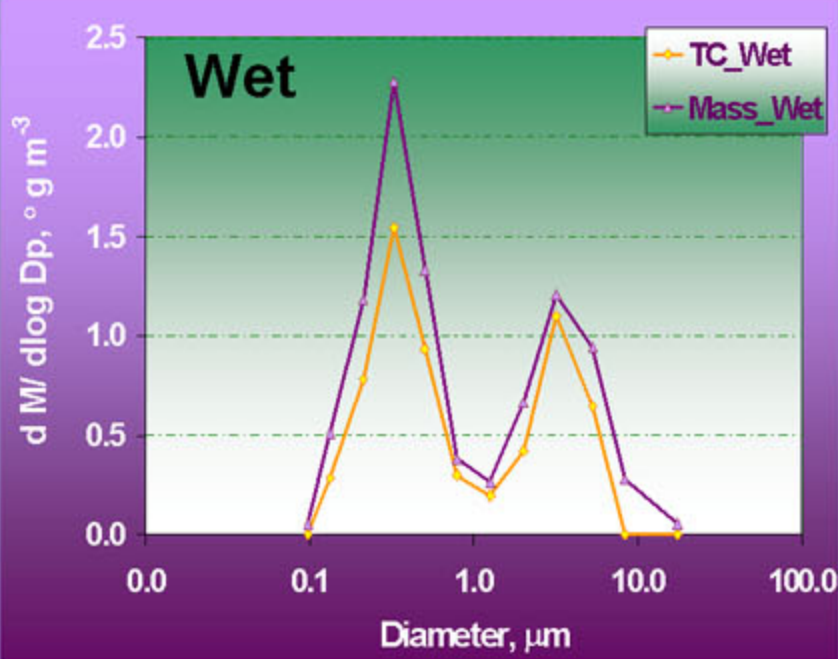
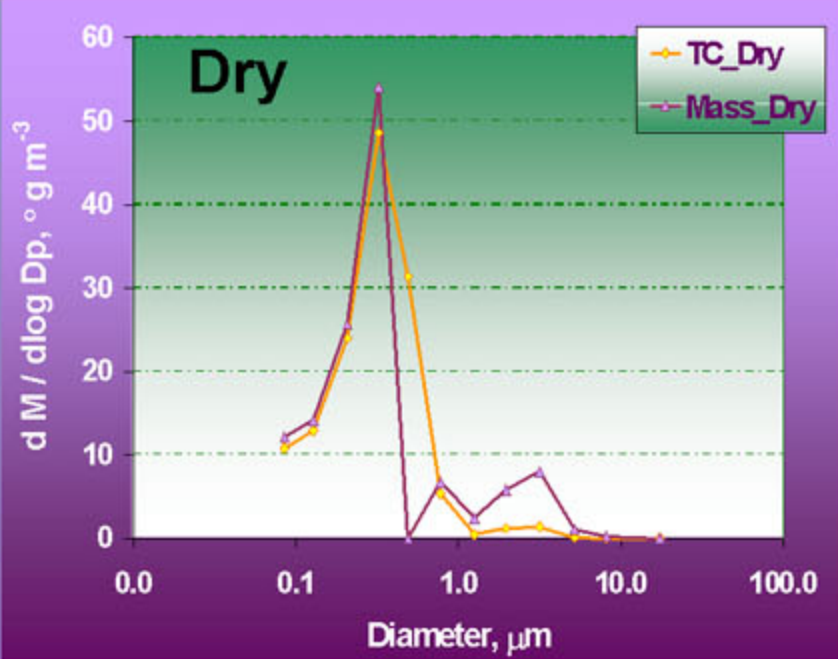


Figure 3. Typical size distributions for mass and total carbon (TC) concentrations during the dry and wet seasons.

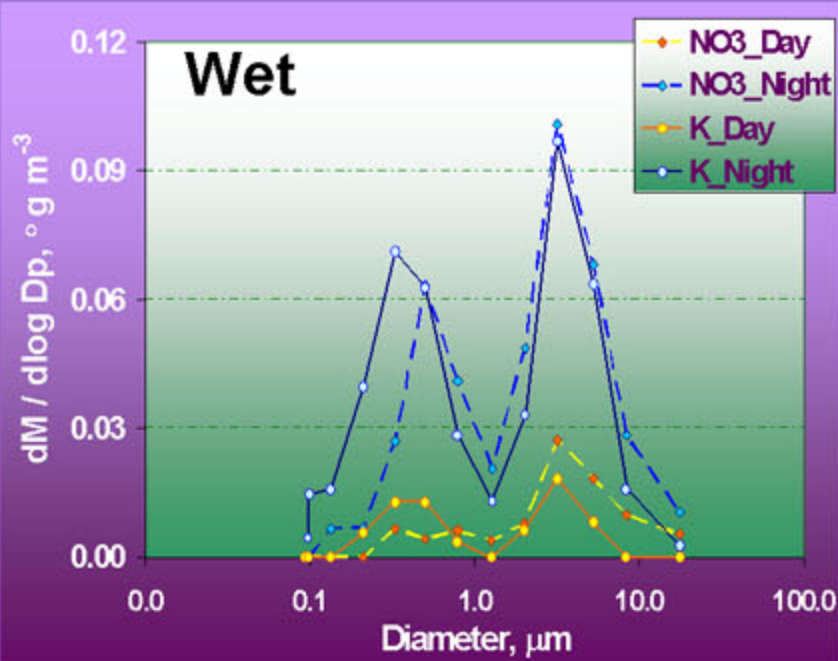
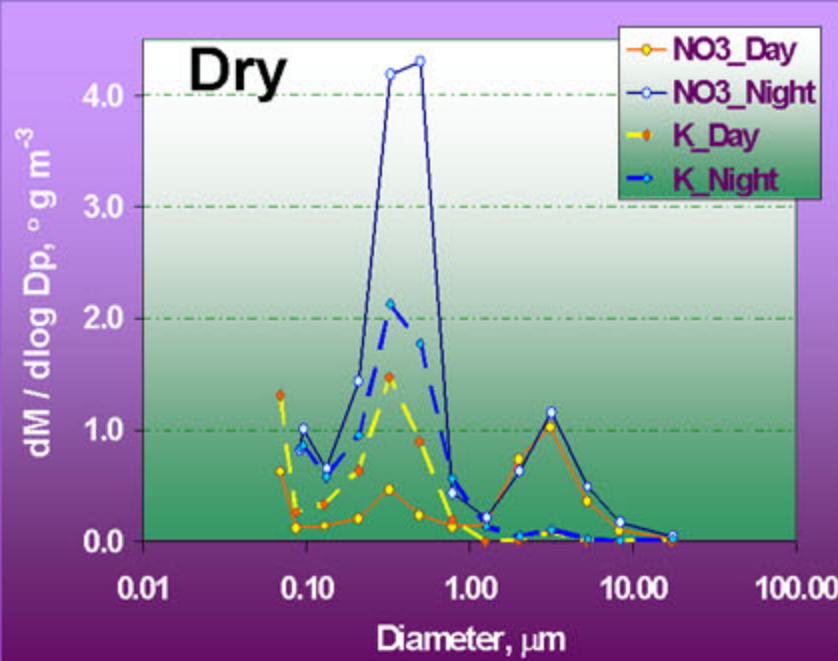


Figure 4. Typical size distributions for NO_3^- and K^+ during dry and wet seasons.

Size-Resolved Chemical Composition

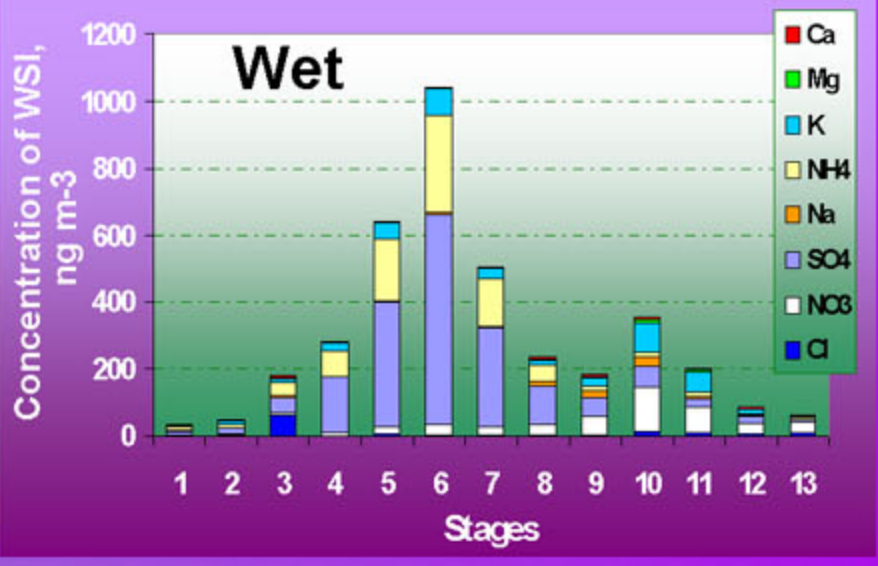
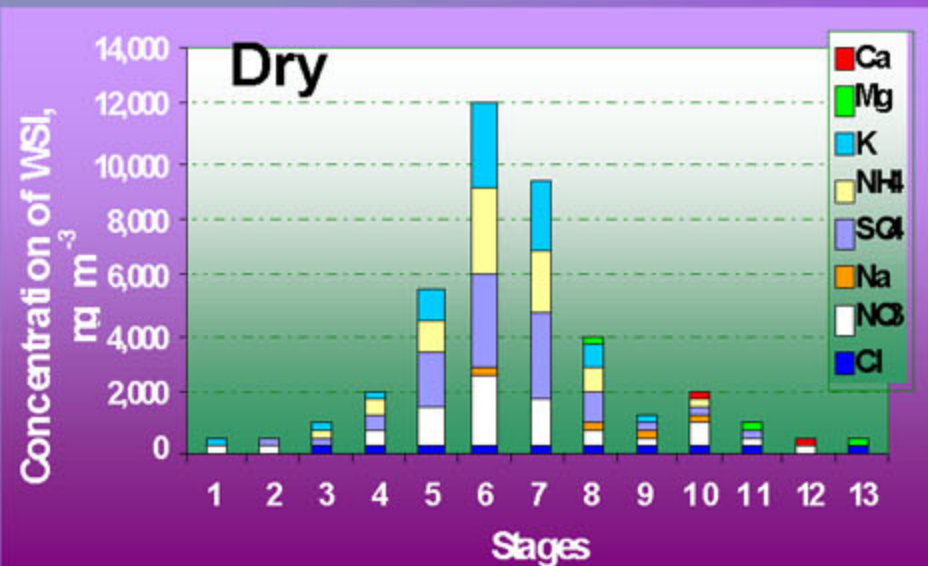


Figure 7. Averaged size-resolved chemical composition of water-soluble ions (WSI) during the dry and wet seasons. Sizes (μm) per Stage 1: 0.08, 2: 0.09, 3: 0.13, 4: 0.21, 5: 0.33, 6: 0.50, 7: 0.78, 8: 1.26, 9: 2.00, 10: 3.17, 11: 5.26, 12: 8.30 and 13: 17.50.

Results and Conclusions

Size distributions of mass and total carbon (TC) concentrations showed the predominance of fine particles during biomass burning (dry season, September-October period). In many cases, as the predominant species, TC represented up to ~90% of the total aerosol mass (Figure 3). Size distributions (Figure 4) showed that concentrations were usually higher during nighttime. This may have been due to (a) condensation of volatile compounds in the aerosol phase at predominantly high relative humidities, and (b) a stable thermal stratification of the nocturnal boundary layer. Aerosol NO_3^- dominated in the fine mode during nighttime. This may be attributable to fast condensation of HNO_3 vapor on fine mode particles at high relative humidities. K^+ was more abundant in the fine mode during the dry season since it was emitted mainly by biomass fires. The good correlation of this species with, for example, SO_4^{2-} and NH_4^+ suggests that biomass burning is the main source of the aerosol species identified during the dry season. This season was also characterized by high particle number concentrations (~10000 cm^{-3}) as shown in Figure 5, compared to the beginning of the wet season (November period) (~2600 cm^{-3}). On a mass basis, the major contributing species to fine mode aerosol were: $\text{SO}_4^{2-} > \text{NO}_3^- > \text{NH}_4^+ > \text{K}^+$ (D_p 0.3 to 2.0 μm) (Figure 7). During the wet season, these species $\text{NO}_3^- > \text{SO}_4^{2-} > \text{K}^+ > \text{NH}_4^+ > \text{Na}^+$ were found in significant amounts in the coarse mode (D_p 2 to 8 μm ; Figure 7) which may be attributable to biogenic sources. Preliminary results from mass scattering efficiency ($\alpha_{sp} \sim 5.3 \text{ m}^2 \text{ g}^{-1}$) demonstrate that scattering is dominated by the fine mode aerosols (Figure 6).

Future Outlook

- Inclusion of meteorological parameters such as relative humidity, temperature, etc., to assist in the interpretation of our results.
- Chemical apportionment of aerosol size-resolved species including carbonaceous species and water-soluble ions.
- Integration of our results with those from the rest of the SMOCC community in order to gain a better understanding of the chemical and physical properties of smoke aerosols and how these affect the CCN activity and precipitation patterns.

References

- Andreae & Crutzen, Science, 276 (5315), 1052-1058, 1997.
- Hao & Liu, Global Biogeochem. Cycles, 8 (4), 495-503, 1994.
- Mayol-Bracero et al., Journal of Geophysical Research, 107, 59: 1-15, 2002.

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