

Fine particulate emission sources identification in the atmosphere of São paulo

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Abstract

The contribution of this work was related to the evaluation of the emission sources profile for the fine particles concentration, mainly the role of vehicular emission in Sao Paulo atmosphere. During a year, starting in August 2007, daily 24 hours samples were collected. The particles were characterized for its mass concentration, elemental speciation by means of X-Ray fluorescence analysis, ionic composition and Black Carbon mass concentration. Receptor modeling was applied as the methodology for the identification of fine particles pollutants sources.

Resumo

O objetivo deste trabalho foi identificar a participação das fontes emissoras na concentração de partículas finas ($MP_{2,5}$) e principalmente verificar a contribuição das emissões veiculares para a atmosfera da cidade de São Paulo. As coletas de $MP_{2,5}$ (24 horas de amostragem) foram diárias por um ano (começando em agosto de 2007). Utilizaram-se métodos analíticos para caracterização de concentração de massa, especiação elementar, composição iônica e concentração em massa de Black Carbon (BC). Para a identificação das fontes foram aplicados modelos receptores baseados em métodos estatísticos multivariados.

Introduction

The Metropolitan Region of São Paulo (MRSP) holds a lot of polluter industries and a 7 million car's fleet. These features are responsible for strong air quality degradation and a complex mixture of aerosols and gases in the atmosphere. The aerosol consists in solid and liquid particles suspended in the atmosphere. The chemical composition (origin and

source) and size distribution (nanometers to micrometers) may vary according to emission and secondary process in the atmosphere.

The aerosol can be split in two different size modes: course particulates (diameter between 2.5 and 10 μm) and fine ones (diameter below 2.5 μm). The last one, although harmful to the health, is not regulated in Brazil by the national government environmental agency (Seinfeld e Pandis, 1998, CETESB, 2008).

Methodology

The samples were collected at the Medical School building, located at Dr. Arnaldo Avenue, using the fine particulate sampler, during 24 hours, between August 2007 and August 2008, totalizing one year data. The filters were submitted to a gravimetric analysis, (weighing) before and after the sampling period. The weighting's objective is to quantify the PM_{2.5}. The samples were submitted to analysis for the determination of: black-carbon, by means of reflectance analysis, elementary constitution with X-ray fluorescence analysis and cation-anion concentration, with chromatography analysis.

The sources identification was accomplished using multivariate models: principal component analysis (PCA) and absolute PCA. The objective is to reduce a dataset, with a large variables number (elements identified in the elementary analysis), to a small one, only with independent variables (sources indicated by this analysis).

Results

The figure 1 shows the dataset obtained by the gravimetric and reflectance analysis. The BC concentrations follow the MP_{2.5} variability. The higher concentrations ($75\mu\text{gm}^{-3}$ PM_{2.5} and $25\mu\text{gm}^{-3}$ BC) occurs during the winter (less precipitation period and with more stable atmosphere). In these months a wet removal process reduction are observed. The lower concentration occurs (in both cases) during the summer, a rainy and airy period. The Figure 2 presents the elementary concentrations obtained by the X-ray fluorescence analysis. The lower concentrations were identified in V, Cr and Ni, below than 1.6 ngm^{-3} and the higher concentrations were observed in S, K and Fe (important urban center markers). The higher Al, Si and Fe concentrations indicates soil dust re-suspension. The S concentrations were due to the gas-particle conversion, (mainly the SO₂ gas).

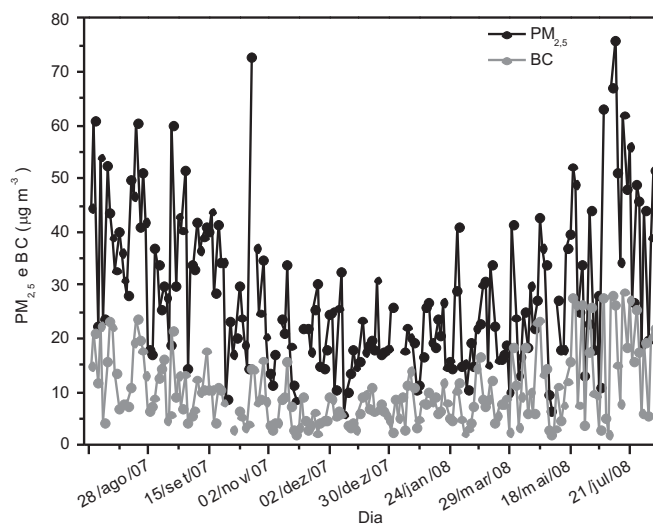


Figure 1. $PM_{2.5}$ e BC concentration variability.

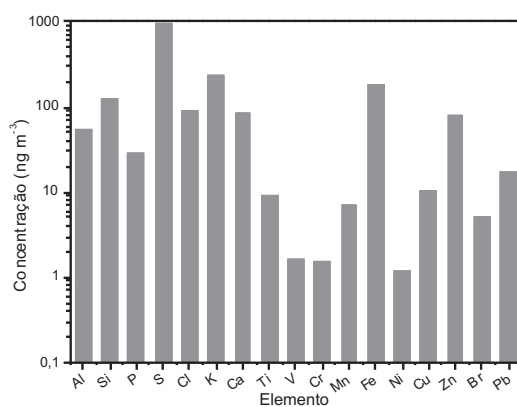


Figure 2. Mean trace-elements concentration.

The sources quantification was accomplished by $PM_{2.5}$ normalized regression calculation, applied to the FA absolute scores. These results can be visualized in the table 1. The identified sources were: light and heavy vehicles, industry and soil resuspension, a factor related to industries present mixture sources. The regression explained about 93.5% of the $PM_{2.5}$ possible sources. The heavy vehicles (diesel fuel) and industries distinguish of this total.

Table 1. Sources identification and participation.

Identified source	Participation (%)
Heavy vehicle	38,5
Light vehicle	13,7
Industry (and vehicles)	24,7
Soil	16,7
Total	93,5

Conclusions

The most significative $PM_{2,5}$ and BC concentrations occur during the winter with less precipitation and more stable atmosphere. The lower concentrations were observed during the summer. Four main sources were identified by the PCA technique (some uncertainty still remains because more than one source can contributes to same element emission). The most important emission was the vehicular one, contributing with more than 50%, mainly heavy vehicles (39%), due to the diesel burning.

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Bibliography

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