SOURCE APPORTIONMENT OF PM_{10} IN BOGOTÁ, COLOMBIA

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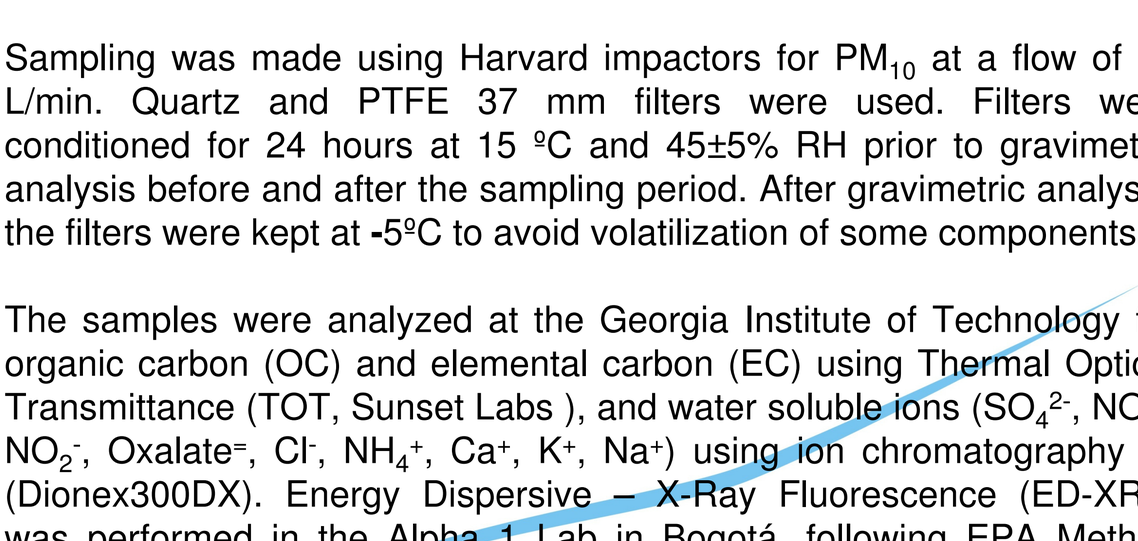
Palabras Clave: source apportionment, PMF, PM10, Bogotá.

Introduction

Bogota is Colombia's capital and largest city, with 7 million inhabitants, (17% of the total population), and 23% of the national Gross Domestic Product (GDP). As a result of its economic growth, Bogota's air is among the most polluted in Latin America. Monitoring network data show that PM_{10} is the contaminant of most concern in the city, with values near 55 µg/m^3 annual average, and some areas experiencing higher values[1; 2]. This study aimed to determine the source apportionment of PM_{10} at two residential sites, in order to better understand the origin of this pollutant.

Methodology

A total of 110 daily samples were collected at two residential sites, 55 at the area of Suba, in the North of the city, and 55 at Carvajal, in the Southwest. Suba is mostly a residential area, while Carvajal has not only houses but also medium-size low-technology industries nearby. Sampling site selection addressed neighborhood-scale EPA criteria.



Sampling was made using Harvard impactors for PM_{10} at a flow of 10 L/min. Quartz and PTFE 37 mm filters were used. Filters were conditioned for 24 hours at 15 ºC and 45±5% RH prior to gravimetric analysis before and after the sampling period. After gravimetric analysis, the filters were kept at -5ºC to avoid volatilization of some components.

The samples were analyzed at the Georgia Institute of Technology for organic carbon (OC) and elemental carbon (EC) using Thermal Optical Transmittance (TOT, Sunset Labs), and water soluble ions (SO_4^{2-}, NO_3^-, NO_2^-, Oxalate$^=$, Cl^-, NH_4^+, Ca^+, K^+, Na^+) using ion chromatography IC (Dionex300DX). Energy Dispersive – X-Ray Fluorescence (ED-XRF) was performed in the Alpha 1 Lab in Bogotá, following EPA Method IO3.3.

Ion balance and mass closure were performed. Based on chemical characterization, EPA's Positive Matrix Factorization (PMF) software was used to determine source contribution to PM_{10}. Uncertainties were calculated for every characterization method and species. A number of 3 to 7 factors were tested until the best adjustment to data results was achieved.

Results

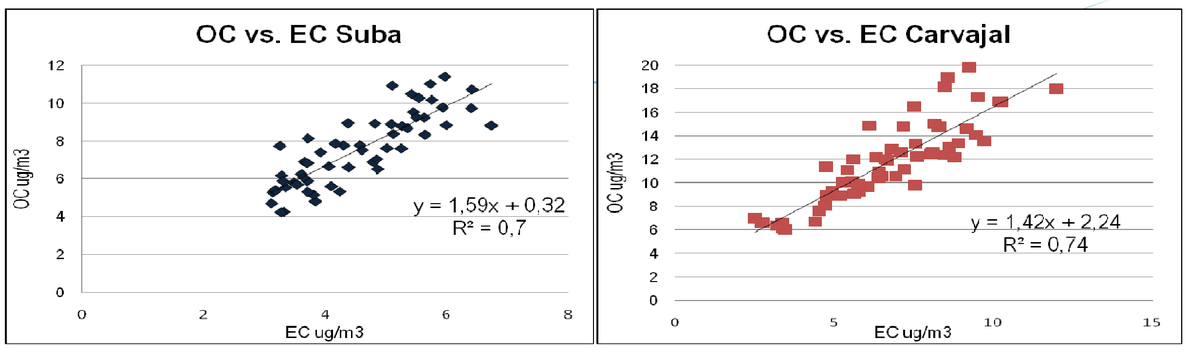


Fig. 1. Elemental Carbon vs. Organic Carbon

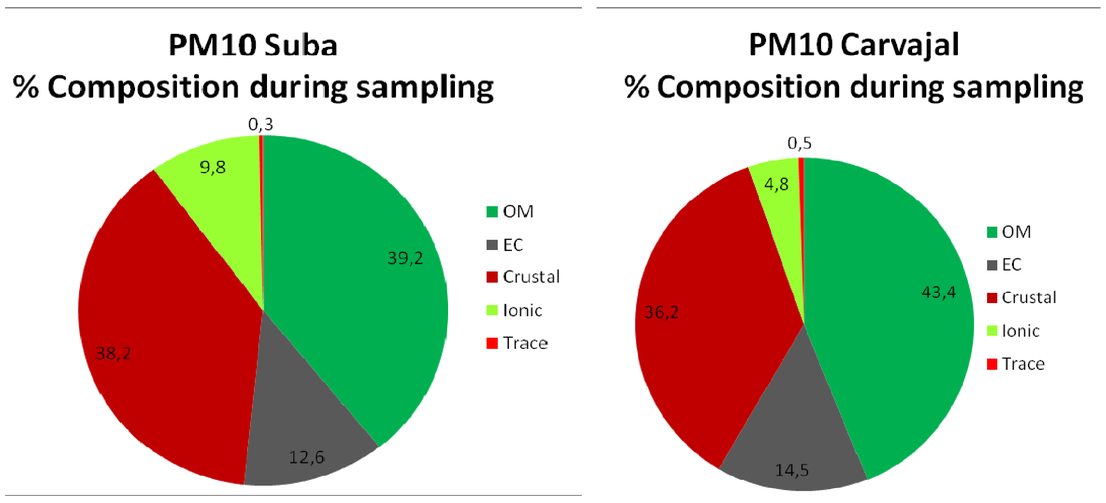
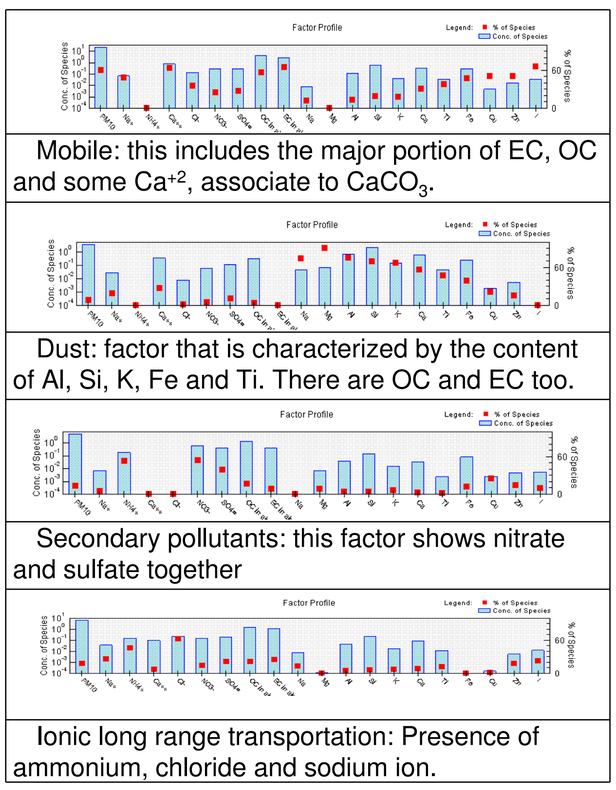


Fig. 2. Mass closure

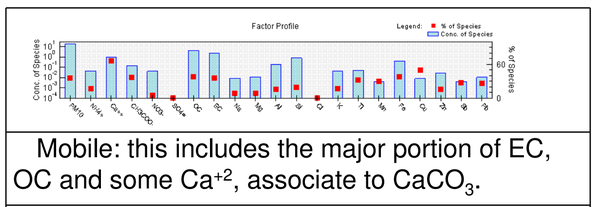


Mobile: this includes the major portion of EC, OC and some Ca^{+2}, associate to $CaCO_3$.

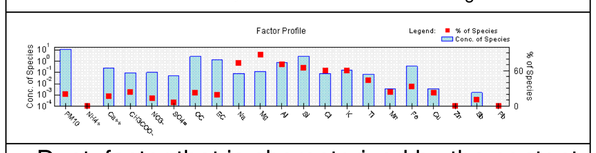
Dust: factor that is characterized by the content of Al, Si, K, Fe and Ti. There are OC and EC too.

Secondary pollutants: this factor shows nitrate and sulfate together

Ionic long range transportation: Presence of ammonium, chloride and sodium ion.

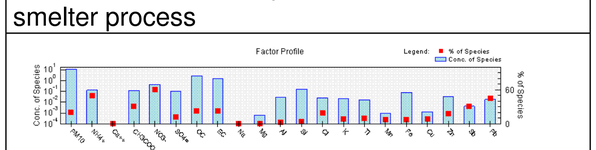


Mobile: this includes the major portion of EC, OC and some Ca^{+2}, associate to $CaCO_3$.

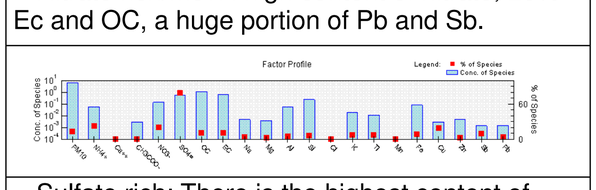


Dust: factor that is characterized by the content of Al, Si, K, Fe and Ti. There are OC and EC too.

Smelting non ferrous: this factor has Zn, Pb and Mn. Near the receptor site there is and smelter process



Nitrate rich/movil: high content of nitrate, 20% Ec and OC, a huge portion of Pb and Sb.



Sulfate rich: There is the highest content of sulfate.

Conclusions

More than 50% of PM_{10} at both sites was associated to carbonaceous fractions, which are mainly produced by combustion process. The crustal fractions, associated to resuspended matter and fugitive dust, are a great part of PM_{10}, between 36% and 38%. The ionic fraction is between 5 and 8%.

Composition and levels of PM_{10} in Bogotá varied between the selected sites. Systematic sampling and characterization of PM_{10} and $PM_{2.5}$ is needed to increase the number of samples and improve PMF results. Further work is needed for $PM_{2.5}$ composition and source apportionment. Additional monitoring should be conducted at other sites in the city to better understand the spatial variability in PM composition.

Acknowledgments

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