Ionic content apportionment of airborne particulate by size from a biomass burning experiment.

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Abstract

Particulate Matter (PM) emitted from a combustion chamber experiment was collected in a multistage cascade impactor with particles nominal cut size ranging from 10.0 μm (inlet) to 0.010 μm (13th stage). PM mass and major cations and anions distribution was determined for each stage. The ionic content was determined in the aqueous extract of each filter. Ultrafine particle has the main mass.

Introduction

Knowledge of the composition of the different fractions of PM derived from biomass burning is important since the particles with small aerodynamic diameters can impact regions far from their sourced due to long distance transport. In addition, depending on their size, the impact on human health and on other living things can be more or less hazardous depending on the composition of that particular size mode, for example, particles with aerodynamic diameter less than 1 μm can cross the pulmonary alveoli and reach the blood. In this study, we evaluate the distribution of Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, Cl^-, NO_3^- and SO_4^{2-} in the aqueous extract of different size fractions PM emitted from a biomass burning experiment.

Results and Discussion

Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, Cl^-, NO_3^- and SO_4^{2-} was determined in the aqueous extract from 13 substrate (GF/F Whaterman filters) collected with a cascade impactor of 13 stages (Model 125 NanoMoudi-II, MSP Corporation) connected to a stack of combustion chamber. The size distribution among the 13 stages are: 10.0; 5.60; 3.20; 1.80; 1.00; 0.56; 0.32; 0.18; 0.10; 0.06; 0.03; 0.02 and 0.01 μm. The first two are the coarse mode, the second and third are the fine one and the remaining are the ultra-fine fraction.

For this experiment, 4.836 kg of litter (leaves, twigs and small branches) was burned from which 3.868 kg was burned during the flame phase (17 minutes) and 0.332 kg was burned during 10 minutes of smoldering phase. The chamber dimension was (2.5x2.5x2.5) m^3 inside of which the litter was burned on an inox plate of 1 m^2 placed atop of a scale. The litter was sampled in the Amazonian forest (Alta Floresta, MT) and air-dried. The mass of the collected material was determined gravimetrically (scale Mettler-XP6)and the ions were determined in a 30 ml aqueous extract of Type II purified water (18 MΩ) using a Metrohm 860 professional Liquid Ion chromatograph. The mass distribution by stage was [μm-mg]: [10.0-0.430]; [5.60-0.431]; [3.20-0.441]; [1.80-0.762] ;[1.00-1.153]; [0.56-0.947]; [0.32-0.922]; [0.18-0.610]; [0.056-0.435]; [0.032-0.384]; [0.018-0.346]; [0.010-0.401] where the coarse is 10.8%, fine 15.2% and ultrafine 74%. The ionic apportionment is shown in fig. 1.

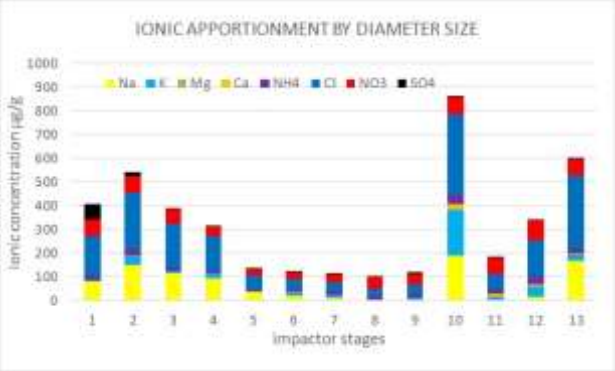

Figure 1. Ionic apportionment of the ions among the stage/particle aerodynamic diameter.

Discussion

The results show that the particles are emitted mainly as ultrafine (74%) mode that are the more hazardous mode. There is an important ionic fraction distributed among the coarse-fine spectrum that are generated as particle from the burning process. The last 4 stages concentrate most of the particle derived from gas-particle conversion. Data show that 63% of SO_4^{2-} is emitted as coarse particle while all the others are mainly in the ultrafine mode. These results indicates that the forest burning generates an important fraction of ultrafine particle that can easily be transported through long distance and should likely affect the health of individuals outside the main area of influence of forest fires.

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