

# **SOURCE APPORTIONMENT OF PM<sub>2.5</sub> AEROSOL MASS AT GWANGJU, KOREA DURING ASIAN DUST AND BIOMASS BURNING EPISODIC PERIODS IN 2001**

HanLim Lee, Kyung W. Kim, Young J. Kim\*

*ADvanced Environmental Monitoring Research Center (ADEMRC),  
Department of Environmental Science & Engineering, Gwangju Institute of  
Science & Technology (GIST)  
1 Oryong-dong, Bukgu, Gwangju 500-712, Republic of Korea  
Email: yjkim@gist.ac.kr*

## **ABSTRACT**

Source apportionment of PM<sub>2.5</sub> has been estimated using the CMB (Chemical Mass Balance) receptor model for the aerosol samples collected from Mar 2001 through Feb 2002 at Gwangju, Korea. In order to investigate the effect of seasonal episodic events, comparison was made between the annual average source contribution and those during the Asian Dust and biomass burning events. Increased contributions by marine (2.5%) and continental dust (11.7%) were estimated during the Asian Dust periods, compared to the annual average contributions of these two sources; An increase of 34.2% in the biomass burning contribution was observed during the local biomass burning periods, compared to the annual average contribution of biomass burning of 8.2%. Diesel vehicle shows lower percentage contributions during both Asian Dust and biomass burning periods, which was about half of their annual averages.

## **1. INTRODUCTION**

The measurement of PM<sub>2.5</sub> (fine particulate matter, aerodynamic diameter of

which is less than  $2.5\ \mu\text{m}$ ) had been performed by the Advanced Environmental Monitoring Research Center at GIST from March 2001 through February 2002 in Gwangju, South Korea. Heavy fossil fuel combustions occur in and near Gwangju through diesel vehicles, gasoline vehicles, meat cooking, coal fired power plants, and etc. In addition to these ordinary fossil fuel combustions, there are frequent events such as local biomass burning (BB) and Asian Dust (AD) from China, which results in a large increase in the total PM<sub>2.5</sub> mass and a consequent decrease of visibility and serious respiratory problems. Therefore as the first step for building up the PM<sub>2.5</sub> control strategy, the quantification of PM<sub>2.5</sub> source contribution during the biomass burning and Asian Dust periods were conducted.

## **2. PM<sub>2.5</sub> MONITORING AND CHEMICAL ANALYSIS**

PM<sub>2.5</sub> measurement has been performed in Gwangju from Mar 2001 through Feb 2002. Two 12-hr samplings beginning from 6:00 and 18:00 were conducted each sampling day including biomass burning (BB) periods, 3<sup>rd</sup> and 9<sup>th</sup> of June and 21<sup>st</sup> of Nov and Asian Dust (AD) periods, 12<sup>th</sup>, 13<sup>th</sup> and 25<sup>th</sup> of April. An URG versatile air pollutant sampler (VAPS), a R&P sequential WINS sampler, and a micro orifice uniform deposit impactor (MOUDI) sampler were used to collect PM<sub>2.5</sub> particles for determination of gravimetric mass, chemical composition and ionic concentration of acidic aerosols [1]. Two channels of the URG-VAPS collect both PM<sub>2.5</sub> on a nylon and a quartz filter and PM<sub>10</sub> (coarse particulate matter, aerodynamic diameter of which is up to  $10\ \mu\text{m}$ ) on a polycarbonate (nuclepore) filter. The WINS sampler employs a Teflon filter to collect PM<sub>2.5</sub> samples. Teflon and polycarbonate nuclepore filters were used to measure gravimetric mass and trace element concentration. Inductivity Coupled Plasma (ICP)-Atomic Emission Spectrometry (AES) and ICP-Mass Spectrometry (MS) were used to analyze metallic species collected on the Teflon filters. Nylon filters at the

site were analyzed using Ion Chromatography (IC) to determine the concentrations of ionic species solubilized from nylon filters. The samples collected on the quartz filters for determination of OC (Organic Carbon) and EC (Elemental Carbon) were analyzed by the Thermal Manganese dioxide Oxidation (TMO) method.

### **3. CMB ANALYSIS**

The estimates of source contribution were conducted by using the U.S Environmental Protection Agency (EPA) & Desert Research Institute (DRI) Chemical Mass Balance (CMB) model. Source contributions to the airborne particle concentrations are determined by calculating the linear sum of products of source profiles using the CMB receptor model. Source profiles used in each CMB modeling are the mass fraction of chemical properties in the emissions from various sources. Source profiles are needed to be created based on the measurement of the source emissions considering times and places that represent emission compositions in order to optimize the regression between data at a receptor site and source emission data in a specific region. In this study, however, source profiles for coal fired power plant and dusts were obtained from Watson et al., 2001 [2]. The source profiles for gasoline vehicle, diesel vehicle, meat cooking, and biomass burning were obtained from Hildmann et al., 1991 [3]. Sources selected as an input profile in the CMB model included continental dust, coal fired power plant, secondary nitrate, secondary sulfate, secondary organic carbon, biomass burning, gasoline vehicle, diesel vehicle, automobile lead, steel production, and marine. Though there are possibilities of high cooking contribution to PM<sub>2.5</sub> due to the surrounding residential areas, vegetative detritus and cooking were not included in source selections to avoid conflict with the biomass burning profile, that eventually turned out to be a higher contributor than cooking, because vegetative detritus or cooking and biomass

burning have strong co-linearity in most cases of CMB modeling [4].

#### 4. RESULTS AND DISCUSSION

Diesel contributions during the Asian dust (AD) and biomass burning (BB) sampling periods were 12.2% and 15.5%, showing a decrease of 12.6% and 9.4%, respectively, compared to the annual average contributions.

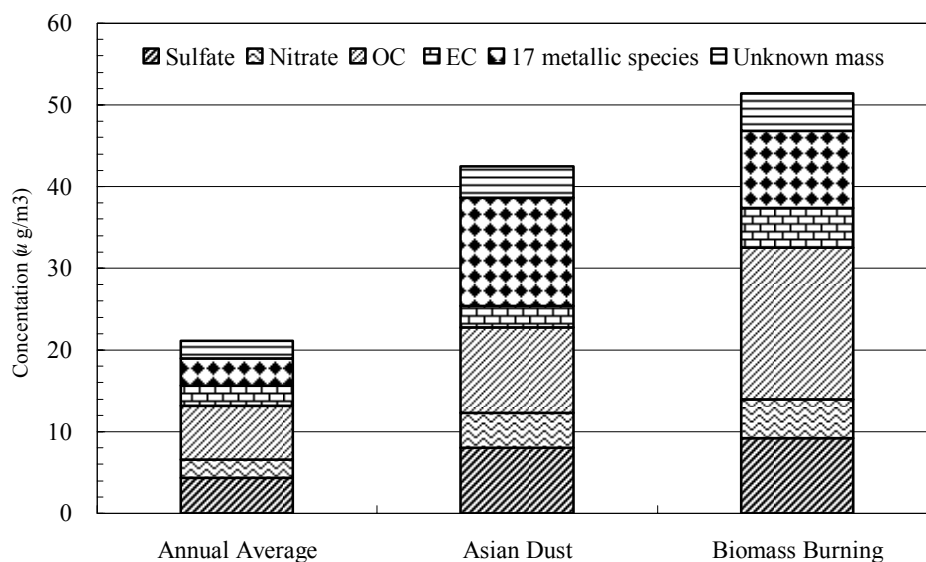


Figure 1. PM2.5 species concentrations ( $\mu\text{g}/\text{m}^3$ ) in annual average and during the Asian Dust and biomass burning periods.

Given the fact that diesel vehicle is a constant major source of fine particulates in Gwangju, it was not a surprise to find the similar mass contributions of diesel vehicle,  $4.6 \mu\text{g}/\text{m}^3$ ,  $7.0 \mu\text{g}/\text{m}^3$ , and  $5.3 \mu\text{g}/\text{m}^3$  during the Asian Dust, biomass burning, and non episodic periods (annual average), respectively.

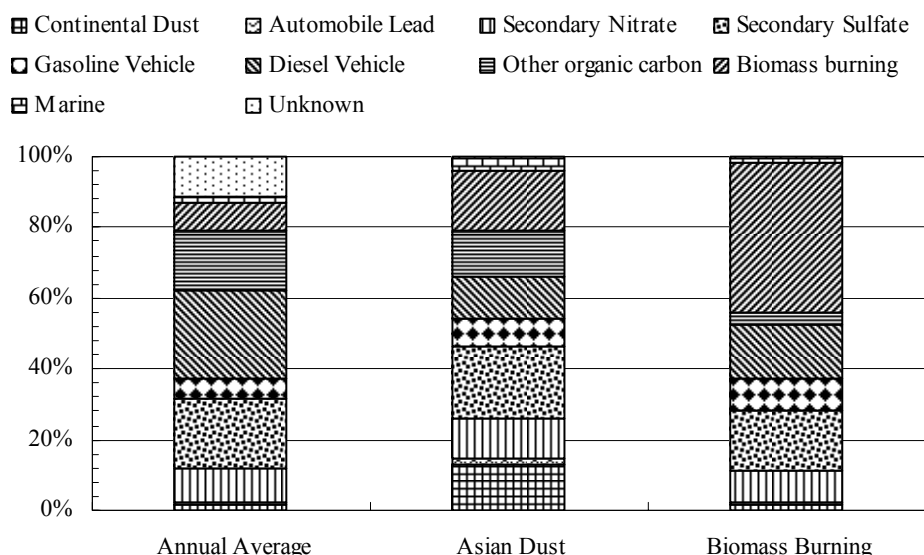


Figure 2. Source contributions (%) of PM<sub>2.5</sub> in annual average and during the Asian Dust and biomass burning periods.

The contributions of secondary sulfate during the Asian Dust and biomass burning periods were 20.6 and 17.2% which are similar to the annual average contribution, 19.7% while there was an increase of  $3.6 \mu\text{g}/\text{m}^3$  and  $3.6 \mu\text{g}/\text{m}^3$  in mass contribution from Asian Dust and biomass burning, respectively as shown in Figure 2. A distinctive increase, 33.9% in biomass burning contribution was observed during the biomass burning periods compared to that of the annual average as shown in Figure 2. Secondary nitrate contributed 10.1, 11.4, and 8.6% to fine particulates during non episodic days, Asian Dust, and biomass burning periods, respectively. In terms of other organic carbon, the contribution during the biomass burning periods was found to be 3.4% which is the lowest contribution among three categories in Figure 2. An increase of  $9.9 \mu\text{g}/\text{m}^3$  in metal species during the Asian Dust

periods in Figure 1 can be used to approximate the contribution, 23.2% from Asian Dust without considering the linear correlation between each fine particulate species. However, the contribution of continental dust during the Asian Dust was 13.2%, which shows an increase of 11.8% compared to that of the annual average, 1.4%, which must have resulted from the absence of the source profile for Asian Dust.

## **ACKNOWLEDGEMENT**

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