PA70) Seasonal Variation of Carbonaceous Aerosol and Their Optical Properties based on Filter Measurement in Ulaanbaatar, Mongolia

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1. Introduction

Mongolia is experiencing rapid rates of urbanization similar to other Asian countries, resulting in air pollution problems by the growing number of automobiles, and industrialization. Ulaanbaatar is also inherently vulnerable to air pollution because of its topography and climate. Carbonaceous aerosol is an abundant component of atmospheric particulate matter in Ulaanbaatar. There has been lack of measurements of carbonaceous aerosol. The objective of this study is to determine the level of carbonaceous aerosols, organic carbon (OC) and elemental carbon (EC), at an urban site in the centre of Ulaanbaatar, Mongolia from November 2007 to May 2008.

2. Methods

Samplers were installed at the rooftop of the National Agency for Meteorology, Hydrology and Environmental Monitoring (NAMHEM) of Mongolia at 10m above the ground. The sampling was done 24-hour interval from December 15, 2007 to January 7, 2008, & February 16, to May 2, 2008 and 12-hour interval from January 7 to February 16, 2008 due to high aerosol loading. The sampling was carried out based on the USA EPA procedure. $PM_{2.5}$ sampling was conducted using low volume particulate samplers (URG-1018, and 286). Flow rates were maintained at 16.0L min^{-1}. Teflon filter was used to analyze the mass concentration, water soluble ion, and heavy metals as well as prebaked quartz-fiber filter for carbon analysis. The backup quartz filter was located behind the Teflon filter in the $PM_{2.5}$ component to assess the magnitude of the organic artifact. Water soluble ions and carbonaceous particles were analyzed by ion chromatography (Dionex, DX-120) and sunset OC/EC analyzer (Sunset lab., RT3015), respectively. Elemental species (Al, As, Ca, Cd, Cr, Cu, Fe, K, Mn, Ni, Pb, Se, Si, Sr, Ti, V, and Zn) were also analyzed by ICP-MS (Elan6100/Perkin Elmer, USA) and ICP/OES (Optima 5300 DV). Extinction coefficient (b_{ext}) of dry fine particles was calculated by the IMPROVE method.

3. Results and Discussion

As shown in Figure 1, clear seasonal patterns in carbonaceous species were observed at urban site of Mongolia. OC concentration was much higher in winter season than those in spring season. The overall average OC concentrations were defined to be 18.1±8.5μg m^{-3}, 28.9±13.6μg m^{-3}, and 10.5±5.8μg m^{-3}, while EC concentration 2.9±1.2μg m^{-3}, 4.0±1.6μg m^{-3}, and 1.2±0.6μg m^{-3} for fall, winter, and spring seasons, respectively. The ratios of OC/EC in spring, fall and winter seasons were found to be 3.2, 3.8, and 4.1 respectively (Figure 2), and indicate that such emissions have seasonal behavior owing to increasing the coal burning for heating. On average, carbonaceous species accounted for 22,6%, 31.9%, and 23.1% of the $PM_{2.5}$ during fall, winter, and spring seasons, respectively. Ulaanbaatar has very high

OC and EC level during winter season compared to other major cities in Asia. The mean positive artifacts of the organic carbon in fall, winter, and spring were estimated to be 17%, 13% and 33% respectively, by measuring organic carbon concentrations on the backup quartz filter behind a front Teflon filter.

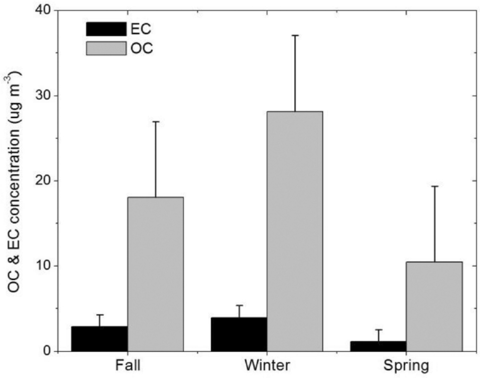

Fig. 1. Seasonal average concentration of OC and EC in Ulaanbaatar.

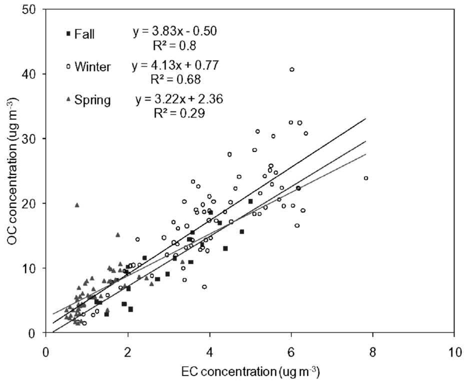

Fig. 2. Seasonal correlations of OC and EC concentration in Ulaanbaatar.

On average extinction coefficients (b_{ext}) of dry fine particles in fall, winter, and sprimg seasons were determined to be 136.7±56.4Mm^{-1}, 199.2±92.2Mm^{-1}, and 77.5±30.4Mm^{-1}, respectively.

The air pollution level was classified into three categories based on the daily average fine particulate mass concentration: Best20% (daily average values for the 20% least polluted days), Worst20% (daily average v alues for the 20% most polluted days) and Avg. (daily average values during the entire sampling periods). Carbonaceous aerosol concentration in $PM_{2.5}$ particles during the Worst20% condition was 1.3, 2.1 and 2.3 times higher than that during the Best20% condition in spring, winter, and fall seasons respectively. Optical properties of $PM_{2.5}$ particles during haze events will be further investigated.

References

Malm, W.C. and J.L. Hand (2007) An examination of the physical and optical properties of aerosols collected in the IMPROVE program, Atmos. Environ., 41, 3407-3427.