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Source Estimation of Long-range Transport Aerosols at Background Sites in Korea

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A study of source types of pollutants and their quantitative contributions to particulate concentrations at two background sites in Korea were conducted. The background concentration sites of Deokjeok and Gosan were selected because they were deemed suitable for monitoring the impact of long-range transported air pollutants. Both sites are located along the west coast of Korea, close to the east coast of China. Deokjeok (37˚13‘N, 126˚9‘E) is located to the west of the Korean peninsula, and Gosan (33˚17‘N, 126˚10‘E) is situated on the west coast of Jeju Island off the southern tip of the Korean Peninsula. Both sites are located on islands and there are no large anthropogenic sources adjacent to the sites.

Episodic measurements of PM_{10} and its size distribution along with its ion and elemental components were performed from 2005 to 2007, and a comprehensive analysis of the results was conducted utilizing statistic analysis and a receptor model. The sampling was carried out over a total of 101 days divided into 9 periods as follows: October 15∼24 in 2005, January 5∼19, April 1∼15, June 6∼15, October 15∼25 in 2006, and January 11∼20, April 16∼25, July 16∼25, October 15∼24 in 2007. Teflon filter packs connected to cyclones (URG, 16.7 L/min) with cutoff diameters of 10 were used for measurement of PM_{10}. We used a MOUDI (Micro-Orifice Uniform Deposit Impactor; MSP, Model 100 with rotator-8 stage or with rotator-10 stage) for size distribution with 30L/min flow rate. The MOUDI is comprised of 8 stages with cut-off diameters of 18, 10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32, and 0.18 μm. Additional cut-off points at 0.1 and 0.056 μm are provided with the 10 stage model. The Teflon filters (Gelman Sciences, pore size 2.0, 47ø) were exchanged at 9 am every day. Size distribution sampling was carried out every 2∼4 days for two samples per sampling period. Mass, ionic and elemental concentrations were measured using Teflon filters. Mass concentration was measured using gravimetric analysis for PM_{10} and size distribution. Ionic components, such as NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, NO_3^- and Cl^-, of particles were analyzed by the Ion Chromatography method (Dionex, ICS-2000). Also,we used the ICP-AES (ThermoJarrell Ash, Model IRIS-DUO) for providing elemental components concentration such as Al, Fe, Ca, Na, K, Mg, Ti, Mn, Ba, Sr, Zn, V, Cr, Pb, Cu, Ni, Co, Mo, Cd, and S. The PMF (Positive Matrix Factorization) receptor model was intensively applied to estimate the relative quantitative contribution of various air pollution sources based on the chemical information. Through a case study of the PMF modeling for PM_{10}, a total of 7 factors were determined for both sites.

In the case of Deokjeok, we defined the 7 factors as secondary aerosol, S-related secondary aerosol, sea salt, biomass burning, crustal aerosol and combustion. In the other case, Gosan, the 7 factors were designated as secondary aerosol, secondary aerosol-$(NH_4)_2SO_4$, sea salt, biomass burning, crustal aerosol and unknown source. The contribution of secondary aerosol showed the highest value of about 50% at both sites. As for frequency of wind direction, it was quite apparent that the two sites are heavily influenced by air masses originating from the eastern

and northern regions of China. It takes approximately 2$\sim$4 days for most of the gaseous precursors to transform in the atmosphere to particulate SO_4^{2-}, NH_4^+, and NO_3^-, and it takes about 3 days for the transport of air masses from east China to both sites. Therefore, it is reasonable to think that much of the secondary aerosol originated from east China. We observed that crustal aerosol has the second-highest contribution of about 20% at both sites. However, for crustal aerosol, the Deokjeok case showed a higher contribution than Gosan. It seemed that Deokjeok was more strongly influenced by Asian Dust because Deokjeok is located closer to the source location than Gosan. Other sources contributed below 10%.