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Physicochemical and temporal characteristics of individual atmospheric aerosol particles in urban Seoul during KORUS-AQ campaign: insights from single-particle analysis

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Figure S1. Google map of the sampling site. (Map Copyright © Google Earth)

S.1. Classification of individual particle types

The chemical species of individual aerosol particles were determined based on their characteristic morphology and elemental compositions, as detailed in Table S1 and supported by our previous studies (Geng et al., 2011a; 2014). The method for classifying the chemical species of individual aerosol particles is as follows: firstly, particles with an atomic fraction of a chemical species above 90% were considered as a single chemical species. Secondly, reacted and internally mixed particles were identified based on all chemical species and morphology. Thirdly, elements with a concentration of less than 1% were disregarded for the classification, except for N and S (0.5%) which indicate the presence of nitrate and sulfate, respectively. More detailed description of particle type classification based on elemental compositions, morphology, and possible sources can be found in Table S1. In total, 8004 individual particles from 52 samples collected during 5/23-6/5, 2016 (excluding 5/24 due to rain) were classified into seven major types: genuine and reacted mineral dust; reacted sea-spray aerosols (SSAs) and a mixture of SSA and others; secondary aerosol particles (including secondary organic aerosols (SOAs) and secondary organic and inorganic aerosols (SOIAs)); Fe-rich particles; heavy metal-containing particles; particles from combustion events such as soot, tar balls, fly ash, and char particles; and biogenic and humic-like substances (HULIS) particles.

Table S1. Characteristic morphologies and chemical compositions and possible sources of individual particle types

Particle types		Characteristic morphologies and chemical compositions	Possible sources
Genuine mineral dust		Irregular-shaped and bright on their secondary electron image (SEI), including aluminosilicates (mainly containing Al, Si, and O), SiO_2, $CaCO_3$, $CaMgCO_3$, TiO_2, etc.	Soil, mining, and construction sites
Reacted mineral dust		Irregular-shaped particles often surrounded by liquid droplet shade Mineral dust particles with N or S (>0.5%).	Reactions of mineral dust with airborne NO_x/SO_2 and/or $(NH_4)_2SO_4$/NH_4NO_3
Reacted sea-spray aerosols (SSAs)		Liquid droplets or/with irregular shape solids containing N or S along with Na, Mg, and Cl.	Reactions of SSAs with NO_x/SO_2 and/or $(NH_4)_2SO_4$/ NH_4NO_3
Secondary aerosols	Secondary organic aerosols (SOAs)	Dark liquid droplets, in which the sum of C and O is more than 90% and the contents of C and O are comparable.	Accumulation and condensation of semi-volatile organic compounds.
	Secondary organic and inorganic aerosols (SOIAs)	Liquid droplets or solid particles in bright angular shape, mostly containing C, O, S and sometimes with N	Mixing of $(NH_4)_2SO_4$/NH_4NO_3 with organic carbons
Fe-rich particles		Bright irregular particles with Fe content of more than 20%	Metallurgical industries, mining, etc.
Heavy metal-containing particles		Particles containing heavy metal elements, i.e., Zn, Ba, Cu, Mn, Pb, Co, V, etc., of elemental concentrations greater than 1%.	Vehicle emissions, tire and brake pad, metallurgical industries, etc.
Particles from combustion events	Soot aggregates	Fractal-like structure on SEI, with more than 90% of C and O	Soot: Combustions Tar ball: smoldering combustion, such as biomass burning Fly ash: Thermal power and industrial plants Char particles: coal combustions
	Tar balls	Bright and round spherules with high contents of C and O	
	Fly ash	Bright and round spherules with high contents of Al, Si, and O	
	Char particles	Bright and irregular morphology with more than 90% of C and O (C is 3 times higher than O in atomic concentration)	
Biogenic and HULIS	Humic-like substances (HULIS)	Mainly containing comparable C and O, sometimes with S. Bright and irregular on SEI	from soil humic organics
	Biogenic	Unique morphology containing typically N and/or P	from ocean or forest emission or plant debris

Figure S2. Morphology, X-ray spectra, and elemental compositions of biogenic particles: (a) fungal spore, (b) microorganism, and (c) trichome or leaf fragment.

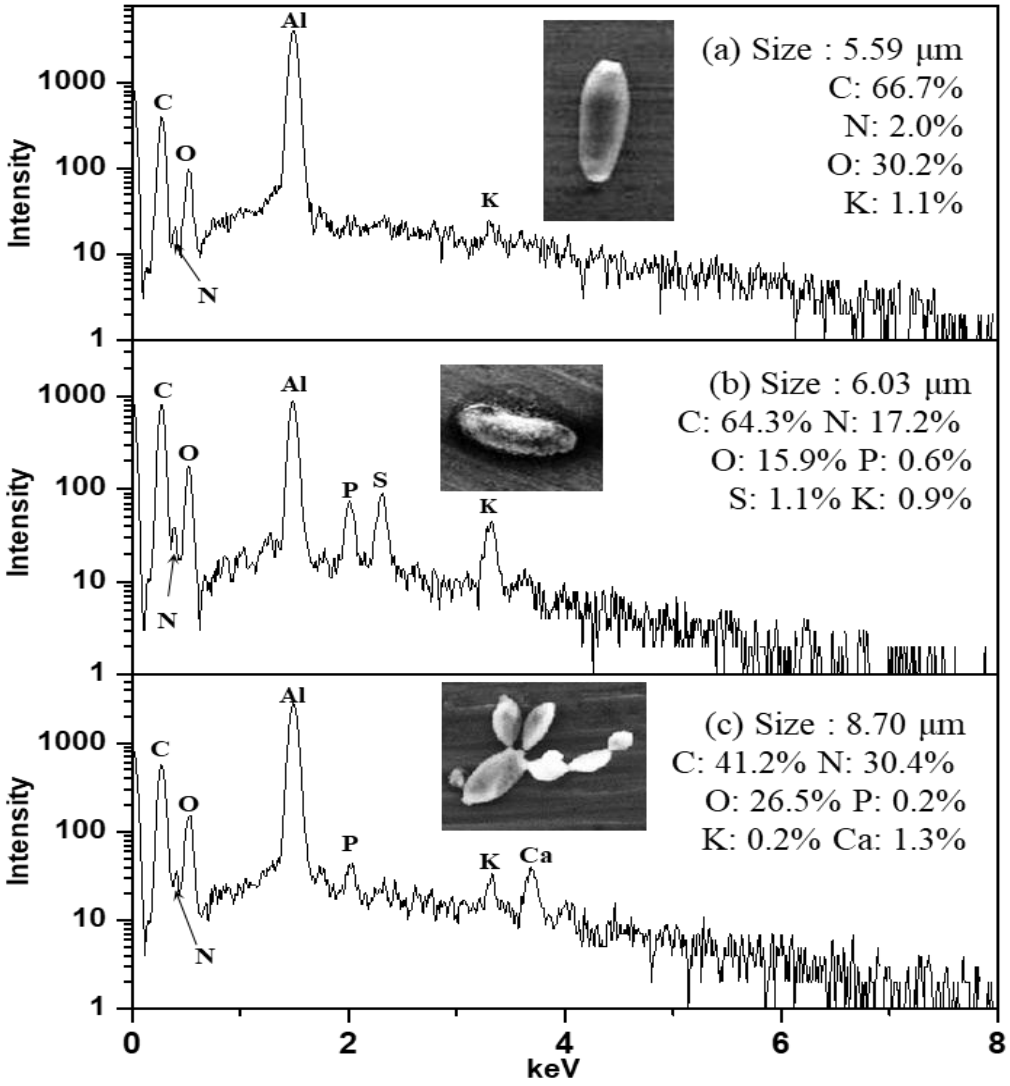

Figure S3. Hourly values of PM_{10} and $PM_{2.5}$ concentrations recorded in Olympic Park, Seoul, during 5/23-6/5, 2016. The blue dots are the sampling times for single-particle EPMA analysis. Black line: PM_{10}; red line: $PM_{2.5}$.

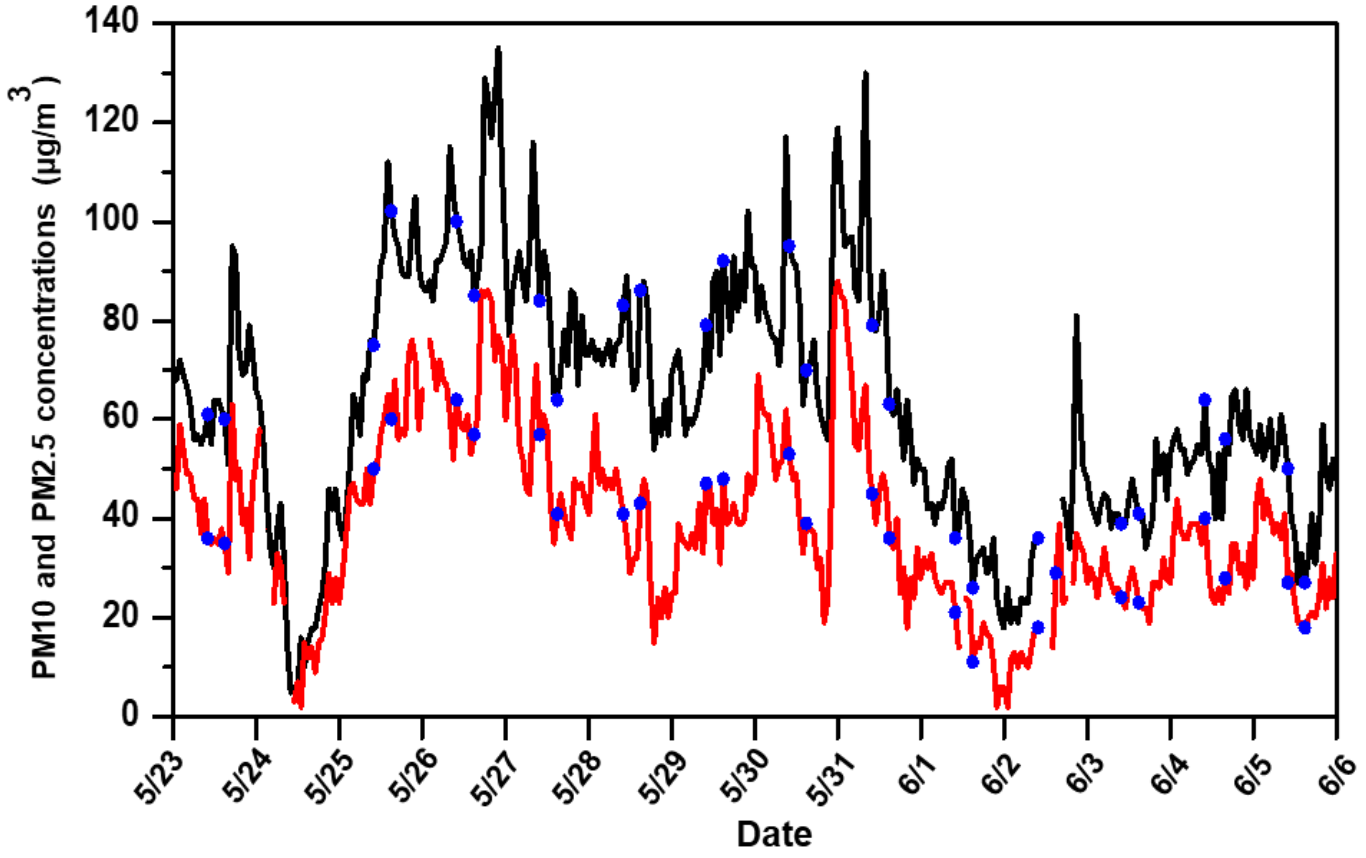

Figure S4. Typical 72-h backward trajectories at 3 different receptor heights (250, 500, and 1000 m above ground level) for (a) 5/23, (b) 5/25, (c) 5/29, (d) 5/30, (e) 6/1, and (f) 6/4.