Aerosol size distribution of outdoor and indoor subway station depending on outdoor wind speed

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The concentration and properties of the particulate matter (PM) have attracted much public attention. Given that around eight million commuters use the subway each day, the indoor air quality (IAQ) of its stations has been studied intensively in our previous study (Kwon et al., 2015). This study was conducted to analyze the effect of outdoor wind speed on the indoor aerosols by particle size. We conducted a correlation analysis between the number concentration of PM sized 0.3 to 10 ㎛ ($PM_{0.3\text{-}10}$) dividing by 13 groups of sizes for different wind speeds, by using principal component analysis (PCA).

We have monitored a major transfer station (Jongno-3-station). The sampling of $PM_{0.3\text{-}10}$ was conducted 3 times which started at 9 am, 11 am and 6 pm in 7 October, 2015. $PM_{0.3\text{-}10}$ was monitored using an optical particle sizer (OPS: TSI model 3330) through the method of light-scattering. Monitoring points were selected from outdoor (A), entrance (B), downstairs (C) and concourse (D) for subway entrance gate with open type roof. The wind speed of outdoor was obtained from Korea Metrological Administration (KMA; http://web,kma.go.kr/eng/) situated 1.2 km away from the subway station.

Table 1. Main wind direction and mean speed of wind at outdoor

Time	morning (9:00)	afternoon (11:00)	evening (18:00)
Wind direction	ENE	NE	WNW
mean(m/s)	2.33	0.74	1.62
max(m/s)	2.80	1.20	2.10
min(m/s)	1.50	0.10	1.40

The high wind speed (HWS) was recorded as 2.33 m/s in the morning and the lowest wind speed (LWS) was 0.74 m/s.

We conducted PCA analysis using commercial software of SPSS (SPSS ver.22) to investigate any statistically significant relationship between $PM_{0.3\text{-}10}$ for different wind speed through the orthogonal transformation of raw datasets. The original variables consisted of 13 size bins of OPS data and they were orthogonally transformed to obtain a new set of variables which comprises a principal component (PC). PC loading matrixes were successfully estimated $PM_{0.3\text{-}10}$ for different wind speed datasets (Fig 1).

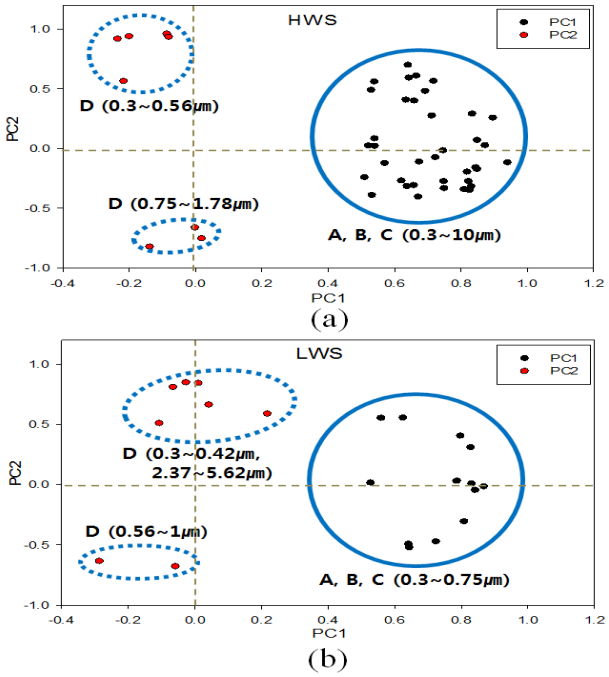

Fig 1. PCA biplots of $PM_{0.3\text{-}10}$ for each wind speed of outdoor; (a) high wind speed (HWS), (b) low wind speed (LWS).

The solid-line circles represent the size fraction from A, B and C sampling points and the dotted-line circles represent that from D point of the subway concourse. Regardless of wind speeds, A, B and C points are correlated each other whereas D point, deep inside of station, was found to be independent. For the case of HWS, all the size fractions (0.3~10 ㎛) were correlated each other, however only 0.3~0.75 ㎛ particles were correlated for LWS case. The dotted-line circles in HWS also represent a wider range of size fraction than LWS.

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