Long-range Transport of Polycyclic Aromatic Hydrocarbons from Asian Continent to Taiwan

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Introduction

Long-range transport of pollutants has been received increasing attention in recent years[1]. High levels of anthropogenic species such as sulfate and nitrate have been observed in the outflow from the Asian continent[2,3]. Taiwan locates in the outer rim of the Asian continent; thus, the impact of long-range transport of pollutants on Taiwan's air quality deserved extensive investigation. Due to rapid increase of energy consumption and economic activities in Asian countries, the pollutant levels in the continent outflow are expected to be increased in the future.

Currently, very few studies focus on the long-range transport of polycyclic aromatic hydrocarbons (PAHs) from Asian continent. Since PAHs are products of incomplete combustion and some of them have long half-lives such as 40 days, PAHs produced in Asian continent could be transported to Taiwan. Nevertheless, metropolitan areas such as Taipei city also have significant local PAH sources. In this work, the concentrations and profiles of seventeen PAH species of the gaseous and particulate phases under the influence of long-range transport and local pollution in Taipei were investigated.

Methods and Materials

Sampling activities were carried out during January-April, 2004, since air masses originated from Asian continent were passing through Taiwan during this period that may carry pollutants to Taiwan from time to time. Twelve-hour samples were taken in the center of Taipei city, about 20 meters above ground. Harvard Impactor mounted with 37mm Teflon filters with a size cut of 2.5µm and 10µm were used to collect particulate matters with aerodynamic diameters less than 2.5µm and 10µm, i.e. $PM_{2.5}$ and PM_{10}, respectively. Polyurethane foams (PUF, 22mm*75mm) inside a glass tube were used to obtain gaseous samples. NOAA (National Oceanic and Atmospheric Administration) HYSPLIT Model was used to plot the backward trajectories at 500, 1000, and 1500 meters to identify the origin of the air mass for each sample.

Filters and PUFs were extracted and analyzed[4] for 17 PAHs, which mostly are listed as priority pollutants[5]. They are acenaphthylene (Acy), acenaphthene (Acp), fluorene (Flu), phenanthrene (Phe), anthracene (Ant), fluoranthene (Fl), pyrene (Pyr), benz[a]anthracene (B[a]A), chrysene (Chry), benzo[b]fluoranthene (B[b]F), benzo[k]fluoranthene (B[k]F), benzo[e]pyrene (B[e]P), benzo[a]pyrene (B[a]P), perylene (Pery), indeno[1,2,3-c,d]pyrene (Ind), dibenz[a,h]anthracene (DBA), and benzo[g,h,i]perylene (B[ghi]P). PAH analysis was performed on a Varian CP-3800 Gas Chromatograph-Saturn 2200 Mass Spectrometry, equipped with a 60m× 0.25mm ID× 0.25µm VF-5MS capillary column.

Results and Discussion

The concentrations of the total PAHs of gaseous, $PM_{2.5}$, and PM_{10} samples were 19.5±9.9 (n=43), 3.8±2.5 (n=43), 4.4±2.8 (n=43) ng/m^3, respectively, during the sampling period. According to backward trajectories, samples were classified as influenced by long-range transport if the air mass was from Asian continent (e.g. Fig. 1); samples were viewed as dominated by local sources if the air mass was stagnant around Taiwan area (e.g. Fig. 2). There were quite a few mixed cases in which the three back trajectories of the same sample were from different origins.

Air masses of Feb. 15 and 16 were clearly from Asian continent (Fig. 1); while those of Feb. 18 and 19 were circulated around Taiwan (Fig. 2). These data were used as an example to illustrate the differences in the concentrations and profiles of PAH species under the influence of long-range transport and local PAH sources. The concentrations of the total PAHs of gaseous, $PM_{2.5}$, and PM_{10} samples on Feb. 15 and 16 were 12.8±3.4, 4.1±0.9, 5.7±0.7 ng/m^3, respectively. The corresponding concentrations on Feb. 18 and 19 were 29.6±10.6, 7.8±2.3, 10.0±2.9

ng/m^3, respectively. More importantly, the PAH profiles were quite different between these two periods (Fig. 3 & 4). PAH species with shorter half-life such as Acy accounted for less percentages during days influenced by Asian continental outflow.

Long-range transport of pollutants from Asian continent during January to April was associated with frontal passage. Although the strong wind speed would enhance the dispersion of PAHs from local sources, the contribution of PAHs originated from Asian continent was shown on the different profiles of PAH species. Even though the concentrations of total PAHs were higher in samples from local sources, the percentages of certain carcinogenic PAH species such as DBA were higher in samples from long-range transport. The influences of long-range transport on PAH concentrations and profiles are worth more attention.

Acknowledgement

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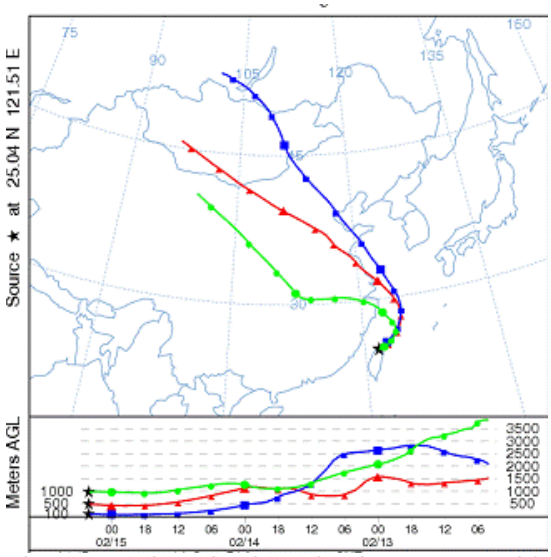

Figure 1 72-hour backward trajectory started from UTC (coordinated universal time) 0400 (local standard time 12pm) February 15, 2004.

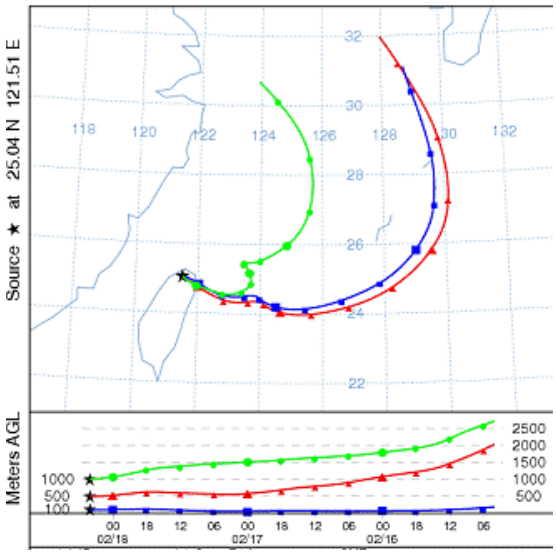

Figure 2 72-hour backward trajectory started from UTC (coordinated universal time) 0400 (local standard time 12pm)

February 18, 2004.

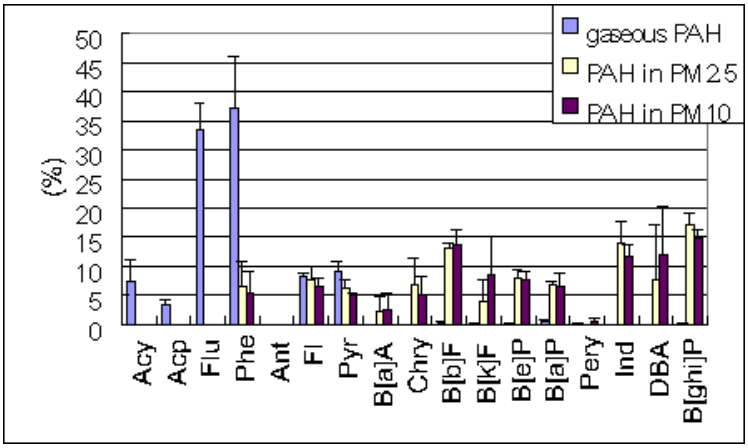

Figure 3 Profile of PAH species during days influenced by Asian Continental outflow

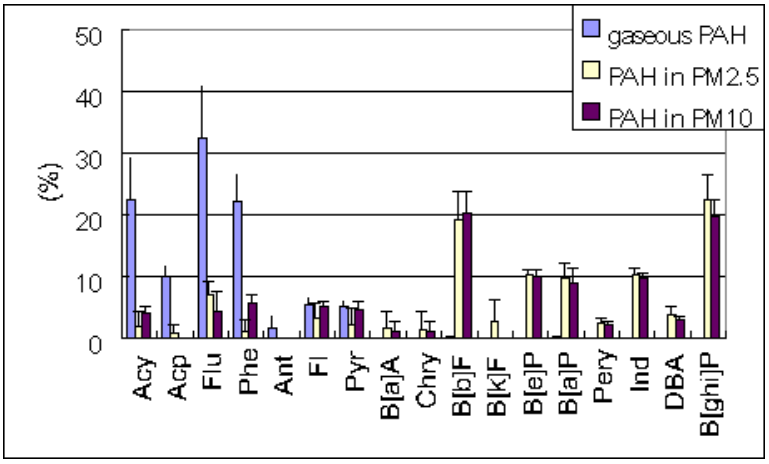

Figure 4 Profile of PAH species during days dominated by local pollution sources

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