PROFILES AND CONCENTRATIONS OF PARTICULATE POLYCYCLIC AROMATIC HYDROCARBONS SPECIES FROM DIFFERENT SOURCE REGIONS SURROUNDING TAIWAN

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Introduction

Taiwan, surrounded by oceans, locates in the outer rim of the Asian continent, making it an ideal location to assess the pollutant levels in the continental outflow. The seasonal change of prevailing wind direction offers opportunities to assess influences of different surrounding source regions on local air quality. In recent years, long-range transport of pollutants has been received increasing attention[1]. High levels of anthropogenic species such as sulfate and nitrate have been observed in the outflow from the Asian continent[2]. 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. This work assessed the concentrations and profiles of seventeen PAH species of the particulate phase from different source regions.

Methods and Materials

Sampling activities were carried out during January-December, 2004, 3-7 days each month. 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. 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 were extracted and analyzed[3] for 17 PAHs, which mostly are listed as priority pollutants[4]. 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 $PM_{2.5}$ and PM_{10} samples were 3.4±2.8 (n=130) and 3.6±3.28 (n=130) ng/m^3, respectively, during the sampling period. According to backward trajectories, samples were classified as from six source regions: (a) inner Asian continent; (b) local re-circulation (under influence of high pressure system); (c) coast area of Asian continent; (d) Japan-Korea region; (e) south-western ocean; and (f) eastern ocean (Fig. 1). There were quite a few mixed cases in which the three back trajectories of the same sample were from different origins, which were excluded in the following data analysis.

The PAH concentrations of $PM_{2.5}$ were the highest from local re-circulation (7.8±2.3ng/m^3), followed by Asian coast areas (4.5±3.8ng/m^3), inner Asia (4.1 ±0.9ng/m^3), Japan-Korea region (2.8±2.4ng/m^3), south-western ocean (2.6±0.7ng/m^3), and eastern ocean (1.3±0.4ng/m^3), while those of PM_{10} were the highest from local re-circulation (10.0±2.9ng/m^3), followed by inner Asia (5.7 ±0.7ng/m^3), Asian coast areas (4.3±2.8ng/m^3), Japan-Korea region (2.9±2.8ng/m^3), south-western ocean (2.9±1.1ng/m^3), and eastern ocean (1.3±0.5ng/m^3). The profiles of PAH species were also different among six different source regions (Fig. 2). Using B[a]P/B[e]P as an aging indicator, it was shown that the most aged PAH species were from inner Asian continent, followed by local re-circulation, south-western ocean, eastern ocean, coast areas of Asian continent, and Japan-Korea region. However, several more volatile PAH species such as Acy, Acp, and Flu were shown in the samples of local re-circulation, indicating that the air masses of local re-circulation were mixed with aged PAHs as well as freshly generated ones.

It was shown that cleaner air was from eastern and south-western oceans; air masses from inner and coast areas of Asian continent carried 2 to 3 times higher PAHs than those from oceans. Local re-circulation had the highest PAH levels; however, the percentages of certain carcinogenic PAH species such as Ind, DBA, and B[ghi]P were higher in samples from other source regions. Thus, the influences of surrounding source regions on local air quality and human health are worth more attention.

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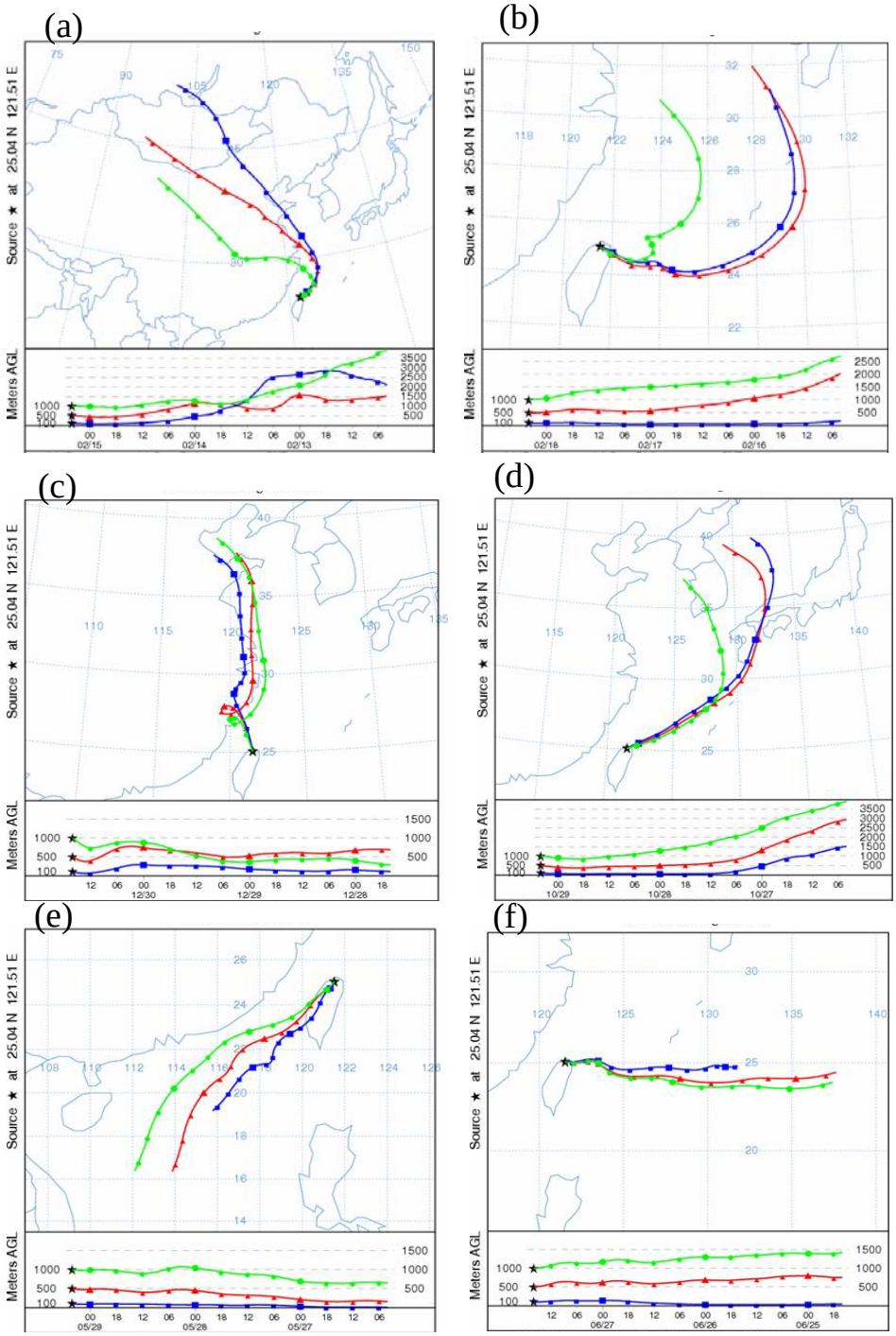

Figure 1 Six different source regions of air masses classified according to 72-hour NOAA HYSPLIT backward trajectories: (a) inner Asian continent; (b) local re-circulation (under influence of high pressure systems); (c) coast area of Asian continent; (d) Japan-Korea region; (e) south-western ocean; and (f) eastern ocean.

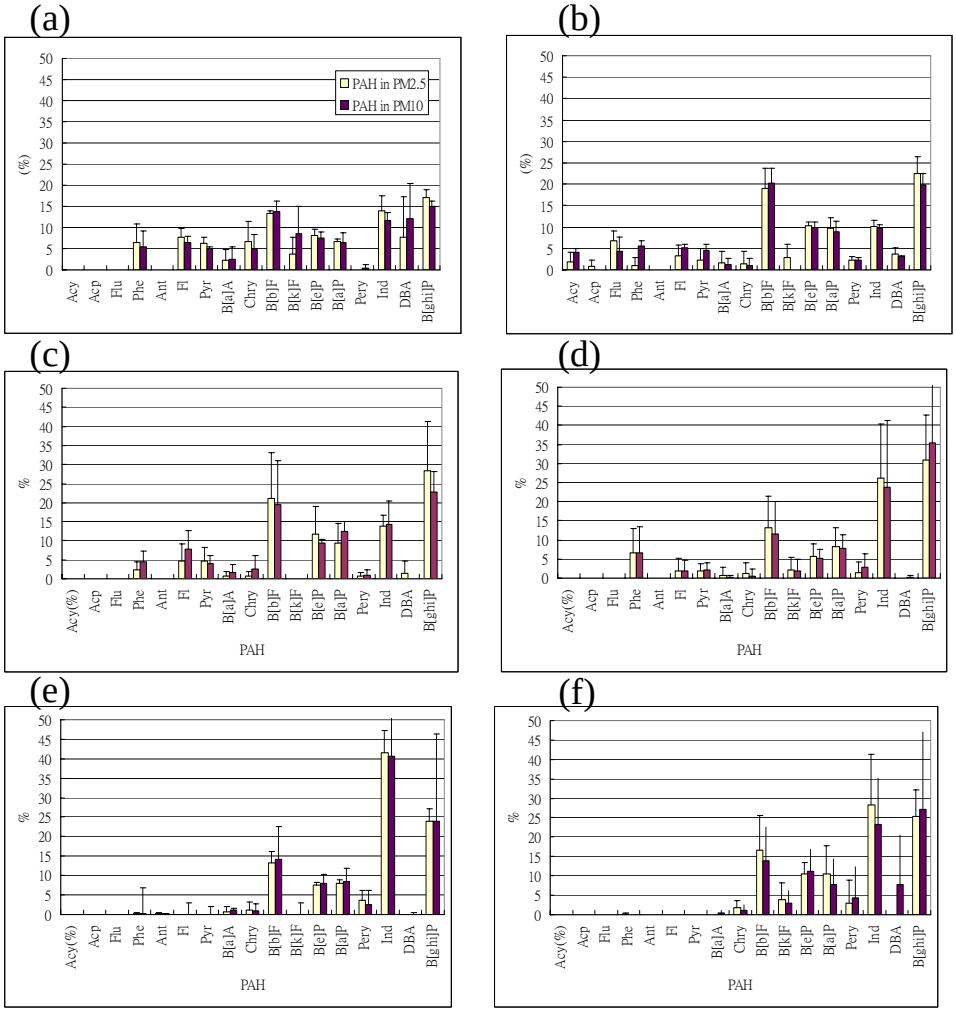

Figure 2 Profiles of PAH species from six different source regions: (a) inner Asian continent; (b) local re-circulation (under influence of high pressure system); (c) coast area of Asian continent; (d) Japan-Korea region; (e) south-western ocean; and (f) eastern ocean.

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