Long-term Variations of Particle Sources in Beijing, China

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Studies have shown that ultrafine particles (UFP, often expressed in particle number concentrations, PNC) have adverse health effects independently from particulate mass (Delfino *et al*., 2005). Beijing, the home of about 20 million people, is one of the most air polluted cities. To improve the air quality during the 2008 Summer Olympics, Beijing had strove to cut the emissions. As already reported, air quality during the Game period (Aug 8-24, 2008) was improved, e.g., levels of particulate mass, chemical composition and gaseous pollutants (Wang *et al*., 2010; Schleicher *et al*., 2012). However, it is still not clear whether the observed decrease was caused by the introduced measures or by meteorological conditions. The aims of this study are to evaluate the long-term variations in source contribution to particle levels in Beijing by means of Positive Matrix Factorization (US EPA PMF 3.0), and to study the reductions of PNC in summer 2008.

Particle number size distribution data (PNSD) covering the size range of 3 nm to 10 µm was obtained by a combination of Dual Mobility Particle Size Spectrometer (TROPOS-type TDMPS) and Aerodynamic Particle Size Spectrometer (TSI APS model 3321). The data was collected at an urban background monitoring site located on the campus of Peking University, Beijing between March 2004 and December 2008.

Seven factors were obtained from the source apportionment analysis and were associated with nucleation, growth of new particles, traffic emissions, combustion emissions, secondary aerosols, long range transported dust and coarse particles. Factor particle volume concentration (PVC) was calculated from PNC assuming spherical shape of particles.

Table 1 shows the factor PNC and PVC from 2005-2008. Figure 1 presents the factor contributions to PNC in four years. Highest PNC was found in 2005 (27317 cm^{-3}). The lowest PNC were observed in 2008 and 2006 (20057 and 21173 cm^{-3}, respectively), a decrease of ~23% compared with 2005. A consistent decrease in combustion factor from 2005 to 2008 was observed. The other factors, with their highest levels observed in 2005, didn't show consistent increasing or decreasing trends.

High particle volume concentrations were found in 2007 (131.0 $\mu m^3\ cm^{-3}$), followed by 2005 (124.5 $\mu m^3\ cm^{-3}$). Lower PVC were found in 2006 and 2008 (105.7 and 109.3 $\mu m^3\ cm^{-3}$, respectively), which was mainly due to low concentrations of combustion factor and secondary aerosols factor. Long-range dust factor showed an increasing trend from 2005 to 2008.

Table 1. Factor PNC and PVC in 2005-2008 (factors with marginal contributions to PNC/PVC are omitted).

PNC (cm^{-3})	2005	2006	2007*	2008
Nucleation	3079	1823	1714	2376
Growth of new particles	5578	4224	5006	4681
Traffic	11256	8528	10113	9124
Combustion	6463	5924	5918	4124
Sum	27317	21173	23761	21057
PVC ($\mu m^3\ cm^{-3}$)	2005	2006	2007	2008
Combustion	39.6	36.3	43.1	30.0
Secondary aerosols	38.7	25.8	39.2	27.9
Long-range dust	17.1	24.4	26.1	26.8
Coarse particles	23.4	14.9	16.8	19.3
Sum	124.5	105.7	131.0	109.3

*the year 2007 has data coverage of 34% only.

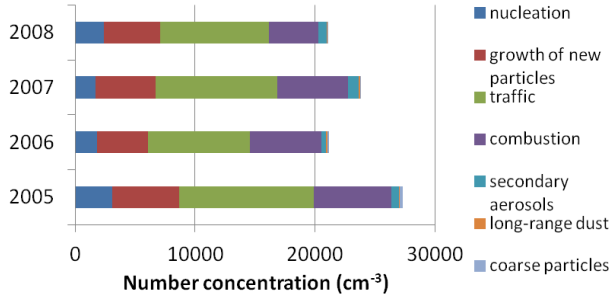

Figure 1. Factor contributions to PNC in 2005-2008.

Analysis on the summer 2008 to study if the meteorology further influenced the PSD factors during the Olympic Game period is already ongoing and will be presented at the conference.

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