Atmospheric particulate mercury in the megacity Beijing – spatio-temporal variations, sources, and efficiency of mitigation measures

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Air quality remains one of the major challenges for the megacity Beijing. Mercury is known as a global pollutant, which is highly mobile in the environment and toxic to humans as well as to wildlife at extremely low levels (Carpy, 1997). However, unlike other heavy metals, only few studies investigated total particulate Hg (HgT_P) concentrations in atmospheric particles in Asian megacities. Sources for HgT_P are abundant in a city like Beijing. Coal combustion for industrial and residential use as well as coal-fired power plants constitutes a major source. Other potential sources are non-ferrous metal smelting, cement production, Hg mining, biofuel and biomass combustion, or waste incineration (Fu *et al.* 2012).

Within this study, weekly $PM_{2.5}$ (particles ≤ 2.5 µm, separately for day- and night-time) and total suspended particles (TSP) were investigated continuously for the whole year 2006 at one central sampling site in Beijing. Additionally, three months (Jan, Feb, Mar) within this period were selected for comparing HgT_P concentrations at four different sampling sites within the city. This approach aimed at (i) assessing the major HgT_P sources in Beijing and (ii) investigating the spatio-temporal variations in detail.

Furthermore, the period of the Olympic Summer Games in August 2008 with its strictly enforced mitigation measures (including traffic reductions and industry closures) provided the unique opportunity to investigate the efficiency of these comprehensive actions taken to reduce air pollution. The data set presented here includes TSP samples of each August from 2006 to 2010 in order to gain knowledge about HgT_P concentrations before, during, and after the Olympic Games period.

All samples were collected actively on quartz fibre filters (Mini-VS, 200 L/h, for $PM_{2.5}$ and TSP sampler, 1 m^3/h for TSP, Leckel, Germany). Mass concentrations were determined gravimetrically. Total particulate Hg was analyzed from circular filter punches by cold vapor atomic absorption spectrometry after calcination in an O_2 stream and amalgamation on an Au trap using a Direct Mercury Analyzer (DMA-80, Milestone, Italy).

Results show strong seasonal differences in HgT_P concentrations (Fig. 1). Lowest HgT_P concentrations occurred during summer months, while winter concentrations were up to 15-times higher. Both, meteorological conditions and seasonal sources were responsible for these high variations over the annual course. Usually, day-time HgT_P concentrations were higher compared to those during night. However, during the summer months (Jun, Jul, Aug, and also Sep), night-time concentrations were higher (Fig. 1).

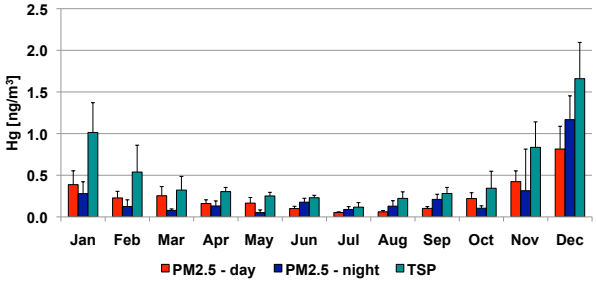

Figure 1. Average monthly HgT_P concentrations in ng/m^3 for $PM_{2.5}$ and TSP samples in 2006.

In Aug-08, the mitigation measures reduced not only overall mass and metal concentrations in Beijing (Schleicher *et al.* 2012) but also HgT_P (Fig. 2). On average, HgT_P in Aug-08 was reduced by about 60% compared to the previous two years. However, after the Olympic Games, HgT_P increased again to pre-Olympic levels. Generally, HgT_P concentrations in Beijing are comparably high and sustainable urban planning needs to include comprehensive reduction measures for Hg.

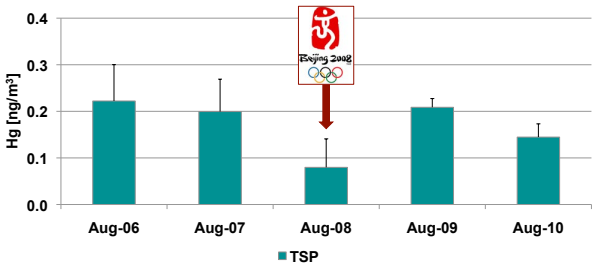

Figure 2. Average HgT_P concentrations in ng/m^3 for each August from 2006 to 2010.

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