Introduction

The rapid economic development during the last three decades in China has led to a severe decrease in air quality, especially in densely populated regions such as Beijing, Shanghai, and the Pearl River Delta (Chen and Yao, 2008). Although during last years many governments have implemented policies to combat air pollution, it is still regarded to be one of the most serious environmental issues in China during the next decade. To better characterize the processes leading to the frequently observed high concentrations of air pollutants on a regional scale, the international field campaign “Campaigns of Air Quality Research in Beijing 2006” (CAREBEIJING2006) was conducted in summer 2006. Organized by the Peking University, project partners from Japan, Korea, Hong Kong, Germany, and China studied the various aspects of gaseous and particulate air pollution in a megacity environment. In this contribution, we present chemical data of size-resolved particles, obtained by a 5-stage Berner impactor during 3 weeks at an urban and a suburban site in the area of Beijing, China.

Sampling and Analysis

Samples were taken in August and September 2006 (Table 1) at two sites in parallel (Figure 1): an urban site was located on the campus of the Peking University in the urban north-west area of Beijing, which is surrounded by busy streets, commercial companies and stores, and residential apartments. The inlet was on the roof of a five-story building at approx. 20 m above ground. A second site was located near the suburb Yufa, approx. 50 km south of PKU, on top of the building of Shuangxi University (about 20 m above ground). The close vicinity there is dominated by mainly familial and residential areas of the urban Yufa suburb. Particle sampling was carried out using five-stage Berner cascade impactors (Hauck, Austria) with cut points of 0.05, 0.14, 0.42, 1.2, 3.5, and 10 nm aerodynamic particle diameter ($D_{ap}$). The sampling time of the impactors was about 4.5 hours.

The samples were analyzed by cationic ionic species (Cl, $SO_4^{2-}$, $NO_3^-$, $NH_4^+$, $Ca^{2+}$, $Mg^{2+}$, $Na^+$, $Mn^{2+}$) by ion chromatography and capillary electrophoresis, carbon and sulfur (C, S, EC, WSOC), a variety of organic compounds such as dicarboxylic acids (by capillary electrophoresis), $Ca$ to $C_6$ n-alkanes, and 18 different PAHs (by gas chromatography - mass spectrometry) and nitrosamines with molecular weight 295 (by liquid chromatography - mass spectrometry). Details on the applied analytical methods can be found elsewhere (van Pinxteren et al., 2009).

Information on the background layer (BLH) was derived from lidar measurements which took place approx. 10 km east of the PKU site (Takegawa et al., 2006). The mass of the sampled air masses were estimated by calculating 96-hours-backward trajectories using the HYSPLIT model (Draxler and Rolph, 2003).

Table 1: Mean concentrations during CAREBEIJING at PKU and Yufa

<table>
<thead>
<tr>
<th>Date</th>
<th>Particle Stage (min-max)</th>
<th>PM10 Yufa</th>
<th>PM10 Beijing</th>
<th>PM2.5 Yufa</th>
<th>PM2.5 Beijing</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/08/06 2:30</td>
<td>(1.2-3.5)</td>
<td>5.2</td>
<td>4.2</td>
<td>2.4</td>
<td>2.0</td>
</tr>
<tr>
<td>18/08/06 0:30</td>
<td>(1.2-3.5)</td>
<td>5.2</td>
<td>4.2</td>
<td>2.4</td>
<td>2.0</td>
</tr>
<tr>
<td>24/08/06 0:30</td>
<td>(1.2-3.5)</td>
<td>5.2</td>
<td>4.2</td>
<td>2.4</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 2: Mass concentrations during CAREBEIJING at PKU and Yufa

In Table 2, PM mass concentrations (sum of impactor stages) of PM mass, inorganic ions, carbon species, dicarboxylic acids, sum of determined alkanes and the sum of PAHs are presented. The mean concentrations during CAREBEIJING usually lie well within the range of previously reported concentration values for the highly urbanized Beijing metropolitan region. Regarding the differences between urban PKU and suburban Yufa, and between south and north of Beijing, most of the compounds showed different behavior. The mean concentrations were within 20%. The ratios, however, could not be directly compared due to the lack of authentic standards. High peak areas in the chromatograms were found for the night samples, indicating an influence of nocturnal chemistry and/or anthropogenic activities on the concentrations of such compounds.

Diurnal profiles

In Table 2, the PM mass concentrations are shown. The highest levels were observed during the evening and night hours (Table 2). In addition, the highest PM2.5 mass concentration was recorded during the night at Beijing PKU site. The highest PM2.5 concentration was recorded during the night at Beijing PKU site. A strong diurnal variation of particle sulfate concentration with increasing values from morning to afternoon was observed, which can be attributed to the increase in traffic during the studied period of intense photochemistry. Also some primary ions accumulate during the two-day intensive period due to the phase-coagulation in the atmosphere. Possible sources include coal combustion, waste incineration, domestic and field biomass burning, construction dust and crustal material. Elemental carbon, inorganic ions, and PAHs showed clear night time maximum, probably due to the increased particle loading on top of the already elevated regional level. During periods of stable atmospheric conditions, higher wind speed was observed in the north (East and North category) which lead to an additional pollutant loading on top of the already elevated level.

Characterization of a nucleation event

An intense nucleation event was observed at the Yufa site starting at 09:00 on 29 August 2006 and lasting into the afternoon of the following day. During this event three-stage Berner impactor masses, size fraction and growth event as it is depicted in Figure 4. A strong increase of the particle stages diameter as a function of time with color-coded number concentrations in particles cm$^{-3}$.

Acknowledgement

This work is part of CAREBEIJING2006 (Program of Atmospheric Research in Beijing and surrounding areas in 2006) was supported by Beijing Council of Science and Technology (20060804-04, 20060804-02).

Figure 1: Sampling locations during CAREBEIJING at PKU and Yufa

Figure 2: Diurnal profiles of BLH averaged PM10 concentrations of different particle concentrations during intensive period 24-25 August 2006.