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# CHARACTERISTICS OF $PM_{2.5}$ AND $PM_{10}$ AEROSOLS AT AN URBAN SITE DURING WINTERTIME

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## Introduction

The atmospheric concentrations of carbonaceous aerosols, produced by incomplete combustion of fossil and biomass fuels, are comparable to that of sulphate - the major inorganic aerosol species. The sulphate aerosols influence climate through their light-scattering properties whereas carbonaceous aerosols are composed of both light-absorbing elemental carbon (EC) and light-scattering organic carbon (OC). Efforts to characterize the atmospheric aerosols in South Asia and adjacent oceanic regions have been intensified after the Indian Ocean Experiment (INDOEX). In this context, studies on size-resolved aerosol chemical composition in a semi-arid Asian region revealing the extent of temporal variability and chemical transformation processes are rather limited (Tare et al., 2006). The time-series measurements on the chemical composition of aerosols at a semi-arid, urban site (Ahmedabad) conducted during the wintertime is reported here.

## Sampling And Experimental Method

The aerosol samples (both $PM_{10}$ and $PM_{2.5}$) were collected on a daily basis during December 2006 at Ahmedabad (23.1 ºN 72.6 ºE) using pre-combusted quartz filters and high-volume air samplers. The mass concentrations in both fine and course fractions were ascertained gravimetrically along with the chemical composition: water-soluble organic carbon (WSOC), ionic species ($NH_4^+$, $K^+$, $Na^+$, $Ca^{2+}$, $Mg^{2+}$, $Cl^-$, $NO_3^-$, $SO_4^{2-}$), EC and OC by using analytical procedures described in our earlier study (Rengarajan et al., 2007).

## Results And Discussion

Fig. 1 shows the daily variation of $PM_{2.5}$ and $PM_{10}$ aerosol mass along with the measured major constituents, viz. $SO_4^{2-}$, EC and OC. The average $PM_{10}$ concentration is 171 ± 41 μg $m^{-3}$ (range: 121 - 327 μg $m^{-3}$) whereas that of $PM_{2.5}$ is 57 ± 17 μg $m^{-3}$ (range: 32.0 - 106 μg $m^{-3}$). On average, $PM_{2.5}$ constitutes ~33 % of $PM_{10}$ mass (range: 23 - 44 %)

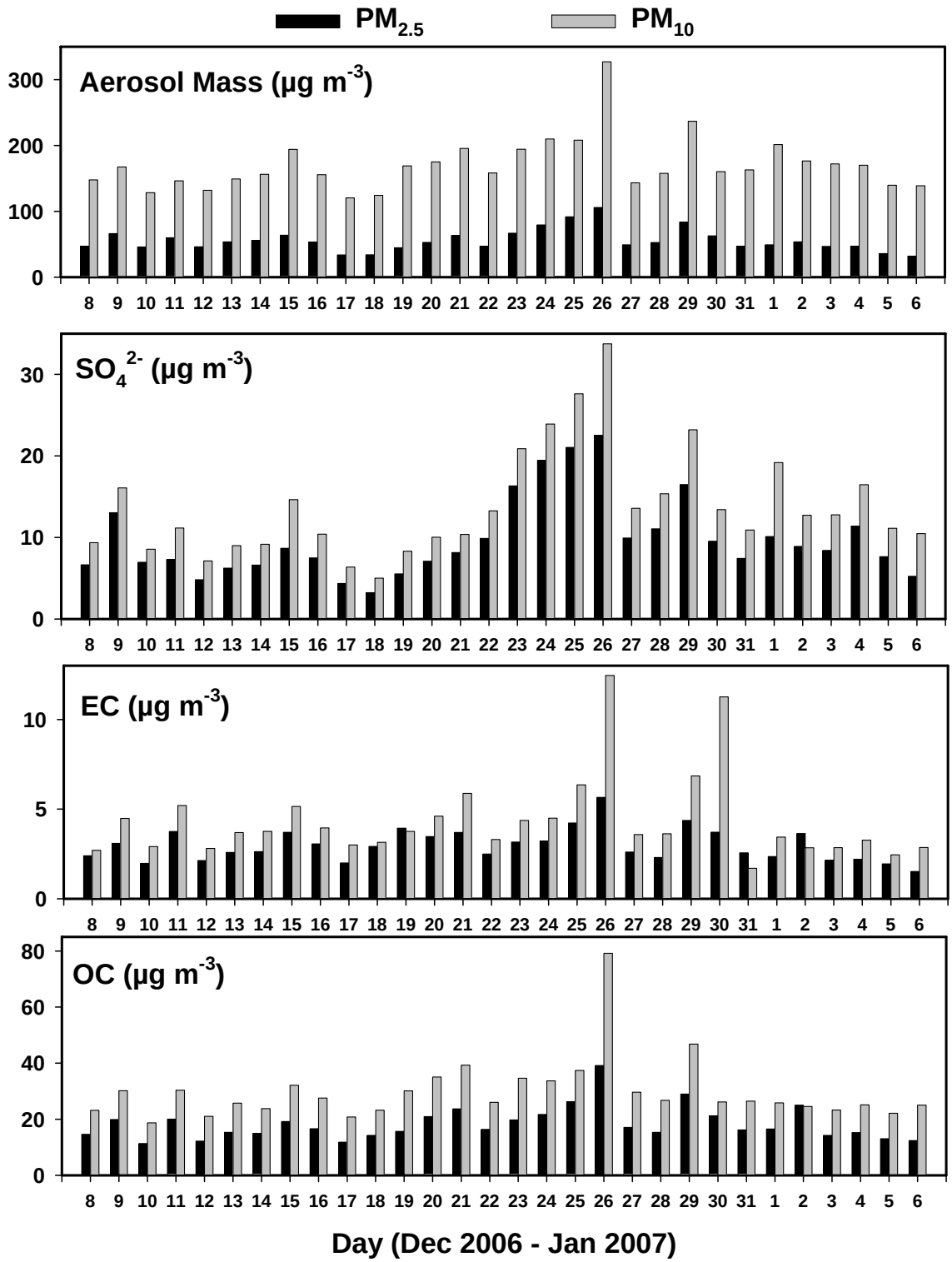


Fig. 1. Daily variation in the concentrations of aerosol mass, $SO_4^{2-}$, EC and OC in $PM_{2.5}$ and $PM_{10}$ size ranges during wintertime over an urban site (Ahmedabad).

demonstrating the dominance of coarse mode aerosols in an urban atmosphere during wintertime. The air mass back trajectories indicate air parcel originating from northern regions of sampling location during most of the sampling period. However, during December 26 – 30, 2006, the air mass back trajectory analysis shows the sampled air originated and transported from the eastern regions of the sampling location, mainly from central India. A significant increase in the mass concentration is observed when the winds were easterlies and the air mass originated from the central India. The concentrations of $NO_3^-$ and $SO_4^{2-}$ in fine mode vary from 0.4 to 2.1 g $m^{-3}$ (Av: 1.2 ± 0.4 g $m^{-3}$) and 3.2 to 22.5 g $m^{-3}$ (Av: 9.7 ± 4.9 g $m^{-3}$) respectively. The abundance of $SO_4^{2-}$ exhibits a significant correlation ($r^2$ = 0.88), with $NH_4^+$ with a slope of 0.95 and near-zero intercept, indicating that $SO_4^{2-}$ is neutralized with $NH_4^+$ almost quantitatively. The contribution of Ca and Mg to the total soluble fraction in $PM_{2.5}$ aerosol is very low implying insignificant contribution of mineral dust in $PM_{2.5}$. The WSOC in the fine aerosol ranges from 8.8 to 16 g $m^{-3}$, representing a major water-soluble fraction. It shows a very significant correlation with $K^+$ (range: 0.6 - 1.3 µg $m^{-3}$), indicating biomass burning is the most probable source in fine mode (Andreae, 1983).

The mean concentrations of EC and OC in $PM_{2.5}$ are 3.0±0.9 µg $m^{-3}$ (range: 1.5 - 2.7 g $m^{-3}$) and 18.3 ± 5.9 µg $m^{-3}$ (range: 11.3 - 39.1 g $m^{-3}$); and those in and $PM_{10}$ are 4.4 ± 2.4 µg $m^{-3}$ (range: 1.7 - 12.5 g $m^{-3}$) and 29.8 ± 11.2 µg $m^{-3}$ (range: 18.7 - 79.2 g $m^{-3}$), respectively. In both $PM_{2.5}$ and $PM_{10}$ samples, EC and OC show an excellent correlation ($r^2$ = 0.90 and 0.92 respectively), indicating the primary nature of OC. A representative OC/EC ratio in the primary carbonaceous aerosols for $PM_{2.5}$ and $PM_{10}$ of 6.3 and 5.5 respectively can be ascertained from the slope of the EC-OC regression line. Assuming that the secondary organic aerosol formation is minor during the winter period, as indicated by the small intercept; the observed OC/EC ratio suggests their contribution from both fossil fuel combustion and biomass burning. Based on the EC/TC ratio=0.11 for biomass burning and that for fossil fuels as 0.5, (Andreae and Merlet, 2001; Gillies et al., 2001), it is inferred that fossil fuel consumption alone contributes ~60 % to the carbonaceous aerosols in contrast to the results obtained from INDOEX. These results have major implications to the regional and long-range transport of carbonaceous aerosols in the South Asian region.

**References**


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