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ATMOSPHERIC CARBONACEOUS SPECIES (EC, OC): TEMPORAL VARIABILITY OVER A HIGH ALTITUDE SITE IN SEMI-ARID REGION OF WESTERN INDIA

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INTRODUCTION

In the present-day scenario of growing anthropogenic activities, carbonaceous species (EC, OC) are considered as the major pollutants in the atmosphere and contribute nearly 30 to 70% of the total suspended particulates (TSP). Both EC and OC are of primary origin; formed directly by fossil fuel combustion and biomass burning (known as primary organic aerosols, POA). Those formed by oxidation of gas-phase precursors in the atmosphere are referred as secondary organic aerosols (SOA). Particulate organic carbon (POC) consists of elemental carbon (EC) and organic carbon (OC). Depending on the analytical measurement technique, EC is also termed as black carbon (BC), and is formed by incomplete combustion via pyrolysis of hydrocarbons. It is one of the major absorbing species of solar radiation and, thus, contributes to positive atmospheric radiative forcing and global warming (Jacobson, 2001). On the other hand, OC represents a large variety of organic compounds such as aliphatic, aromatic compounds and acids, etc. These organic aerosols can act as cloud condensation nuclei (CCN) and, thus, have indirect climatic effects, through changes in cloud albedo and precipitation efficiency. It is, thus, essential to study temporal and spatial variability in the atmospheric abundances of carbonaceous species and OC/EC ratio. We present here results of a case study conducted from a high altitude site (Mt Abu,1700m asl) located in a semi-arid region of western India.

SAMPLING AND EXPERIMENTAL METHOD

Bulk-aerosol samples were collected from the experimental site on a weekly basis, beginning May 2005 to Feb 2006 using a high-volume air sampler. The sampler was operated for approximately 24 hours to filter about 1500 m^3 of air through quartz microfiber filter (20.3x25.4 cm) at a flow rate of 1.2 m^3 min^{-1}. The filter had a collection efficiency of 99.9% for particle size up to 0.3 µm. The total suspended particulates (TSP) were ascertained gravimetrically based on weighing of full filters, before and after the sampling. In the laboratory, aerosol samples were analyzed for elemental carbon and organic carbon on EC-OC analyzer using thermal-optical reflectance (TOR) protocol (as described in NIOSH-5040). The analytical procedure adopted had a detection limit of 0.2 µg C for OC and EC (Birch and Cary, 1996).

RESULT AND DISCUSSION

Total suspended particulates (TSP) ranged form 14 – 432 µg m^{-3} (Fig: 1), however except two values of 432 µg m^{-3} and 103 µg m^{-3} , all TSP concentrations were less than 100 µg m^{-3} . The relatively high TSP abundances were characteristics of May-June (Av: 56 µg m^{-3} , n=5, range: 24 to 83 µg m^{-3}) associated with high dust loading of the atmosphere. The low values occurring in monsoon period (Av: 42 µg m^{-3} , n=11, range: 14 to 84 µg m^{-3}) result due to efficient scavenging by rain. The abundance of OC varied from 0.9 to 12.3 µg m^{-3} (Fig: 1); whereas maximum concentration of EC was 2.3 µg m^{-3} during Dec'06

and less than 0.1 µg m^{-3} in May-Aug. Both, OC and EC, were relatively low during May-Sept (Pre-monsoon – monsoon) compared to their abundances in Oct- Feb (Post- monsoon and winter). Total Carbonaceous aerosol (TCA=1.6*OC+EC) contribute only 10% of the TSP during May- Sept and nearly 20% in Oct- Feb. This is attributed to decrease in source strength (emission products of biomass burning) and enhanced aerosol scavenging during May- Sept. The relatively high abundances of carbonaceous species during Oct- Feb (winter months) are associated with the increase in emission sources and processes associated with boundary layer dynamics. The highest OC and EC concentrations were observed on 21st Dec-2006; associated north-easterly winds; thus, implying long-range transport of pollutants from northern India.

The OC/EC ratios ranging from 3.0 to 11.5 have been computed for the period Sept'05 to Feb'06. The ratios for May-Aug are not considered to be relevant due to EC

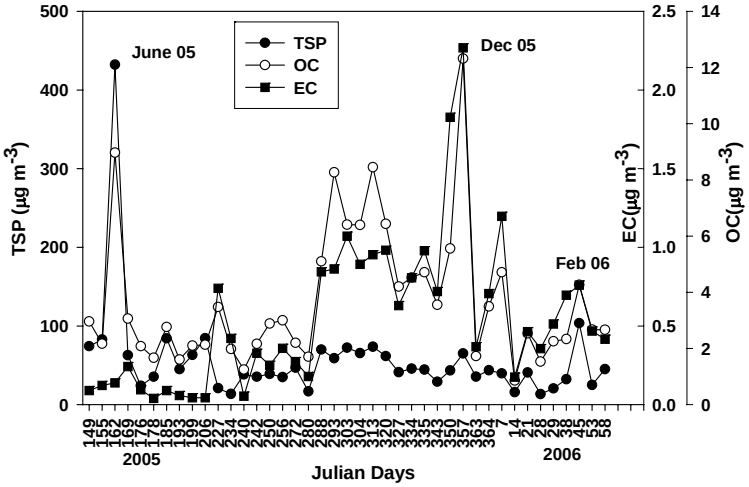

Fig 1. Temporal variation of TSP , EC and OC abundances in the ambient atmosphere over high altitude site (Mount Abu)

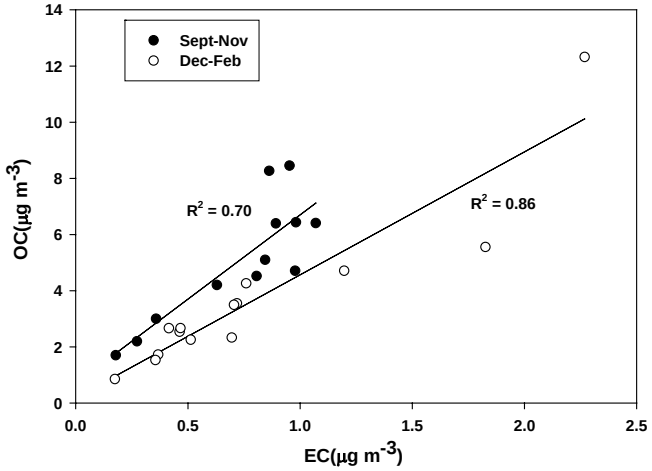

Fig 2: Scatter plot between OC and EC showing temporal trends.

concentrations less than 0.1 µg m^{-3} . The high OC/EC ratios (Av: 7.6, n =13) and significant co-relation (R^2 = 0.70) between OC and EC (Fig: 2) during Sept-Nov compared

to that in Dec-Feb (Av: 4.8, n =14) and (R^2 = 0.86); suggest relative dominance of OC (primary / secondary or both) following the monsoon period (Sept-Nov). Secondary organic carbon (SOC) contribution has been estimated using minimum OC/EC ratio method (Turpin and Huntzicker, 1995; Cabada et al, 2004) and accounts for about 35 % of OC for the data presented in Fig: 2. The lower OC/EC ratios, somewhat closer to urban scenario, during Dec- Feb imply increased contribution of EC from the long-range transport of vehicular emissions.

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