

# **Carbonaceous Species in Atmospheric Aerosols: Sources and Temporal Variability**

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**By**

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## ***D E C L A R A T I O N***

I Mr. **Kirpa Ram**, S/o: Mr. **Ram Raj**, resident of **A-1, PRL residences, Navrangpura, Ahmedabad – 380 009**, hereby declare that the research work incorporated in the present thesis entitled “**Carbonaceous Species in Atmospheric Aerosols: Sources and Temporal Variability**” is my own work and is original. This work (in part or in full) has not been submitted to any University for the award of a Degree or a Diploma. I have properly acknowledged the material collected from secondary sources wherever required. I solely own the responsibility for the originality of the entire content.

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# ***C E R T I F I C A T E***

I feel great pleasure in certifying the thesis entitled “**Carbonaceous Species in Atmospheric Aerosols: Sources and Temporal Variability**” by Kirpa Ram under my guidance. He has completed the following requirements as per Ph.D. regulations of the University

- (a) Course work as per the university rules.
- (b) Residential requirements of the university
- (c) Regularly submitted six monthly progress report
- (d) Presented his work in the departmental committee
- (e) Published/accepted minimum of one research paper in a referred research journal.

I am satisfied with the analysis of data, interpretation of results and conclusions drawn.

I recommend the submission of thesis.

Date: 2010

Name and Designation of supervisor

*Countersigned by  
Head of the Department*

*To my Grand parents*  
*&*  
*Sister Anjani*

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## ABSTRACT

This thesis presents a comprehensive study of the chemical and optical properties of ambient aerosols (with emphasis on carbonaceous species) collected from high-altitude sites (Manora Peak and Mt Abu) and an urban location (Kanpur) in the Indo-Gangetic Plain (IGP). The mass concentrations of OC, EC and WSOC at an urban site are an order of magnitude higher than those at the high-altitude sites. The source variability, emission strength, secondary aerosol formation and boundary layer dynamics, all contribute significantly to the seasonal trend in the mass concentrations of carbonaceous species at Kanpur. Based on the chemical tracers ( $K^+$  concentration,  $K^+/OC$ :  $A_v = 0.06 \pm 0.03$  and  $OC/EC$  ratios:  $A_v = 7.8 \pm 3.4$ ), biomass burning emission (wood-fuels and agricultural waste) has been identified as a major source of carbonaceous aerosols. The  $WSOC/OC$  ratios vary within a narrow range ( $\sim 0.35$ – $0.40$ ) at Kanpur during wintertime; whereas the elevated ratios ( $\sim 0.55$ ) during summertime suggest significant contribution from secondary organic aerosols. The highly acidic environment ( $SO_4^{2-}$  and  $NO_3^-$  aerosols) over IGP, during the wintertime, may significantly alter the morphological features of EC. In addition, the secondary aerosol formation and their hygroscopic growth (through nucleation/coagulation) can enhance the scattering properties of aerosols, a process that can be invoked for the poor visibility over northern India during the wintertime.

A novel approach is also proposed for the determination of absorption coefficient ( $b_{abs}$ ) and mass absorption efficiency ( $\sigma_{abs}$ ) of EC using simultaneous measurements of optical-attenuation (at 678 nm) in the thermo-optical EC-OC analyzer. At Manora Peak and Mt Abu,  $b_{abs}$  is  $13.7 \pm 7.3$  and  $5.8 \pm 4.3 \text{ Mm}^{-1}$  respectively; and that at urban site (Kanpur) is  $42.7 \pm 17.9 \text{ Mm}^{-1}$ . The  $\sigma_{abs}$  varies from 4.3 to  $20.9 \text{ m}^2\text{g}^{-1}$ , unlike the constant conversion factor used in optical instruments for the determination of BC concentration. The *in-situ* measurements of optical properties along with the aerosol chemical composition (this study) are useful for the inter-comparison with other techniques/measurements.

**Keywords:** Elemental and organic carbon (EC, OC), water-soluble OC (WSOC), OC/EC and WSOC/OC ratios, secondary organic aerosols, aerosol absorption coefficient ( $b_{abs}$ ), mass absorption efficiency of EC ( $\sigma_{abs}$ ), Indo-Gangetic Plain (IGP)



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