SEASONAL VARIABILITY OF $PM_{2.5}$ COMPOSITION AND ITS SOURCES OVER DELHI, INDIA

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Abstract: Seasonal variabilities of sources and processes involving fine particulate matter were studied at National Physical Laboratory, Delhi. $PM_{2.5}$ samples were collected from January 2013 to December 2016 and chemically analyzed to determine concentration of several species: Organic carbon, elemental carbon, metals (Al, Mg, S, Cl, K, Ca, Ti, Cu, Mn, Fe, Zn, Br, Cr, As, and Pb) and ions (Na^+, NH_4^+, K^+, Ca^{2+}, Mg^{2+}, F^-, Cl^-, NO_3^-, and SO_4^{2-}). To study the seasonal influence on different sources of $PM_{2.5}$, a year has been classified according to India Meteorological Department (IMD) into four different seasons i.e. Winter (January-February), Summer or Pre-Monsoon (March- May), Monsoon (June-September) and Post Monsoon (October-December). Data was processed through Positive Matrix Factorization (PMF) receptor model characterizing seasonal variabilities of eight source contributions. The annual average concentrations of $PM_{2.5}$ were 131.8 ± 79.3 μg/m^3 (range: 17.4 – 529.5 μg/m^3). PMF identified the main sources contributing to $PM_{2.5}$ emissions and reconfirmed that Vehicular Emissions, Secondary Aerosols, Biomass Burning, and soil/road dust were the dominant contributors in Delhi.

INTRODUCTION

Receptor models (RMs), a multivariate statistical method, have been accepted to quantitatively apportion and identify the sources of air pollutants. Moreover, on the basis of identification of signatory molecules, RMs establishes missing links between receptors and its sources. Receptor model i.e. PMF has been applied to recognize and establish the sources and contribution of each source of receptor concentrations.

METHODOLOGY

$PM_{2.5}$ samples were collected on quartz microfiber filters (QM-A) by using a fine particulate sampler at CSIR National Physical Laboratory, (an urban site) New Delhi, India, during January 2013 to December 2016. Major and trace elements of $PM_{2.5}$ were analyzed using WD-XRF (Rigaku ZSX Primus Wavelength Dispersive X-ray Fluorescence Spectrometer). Analysis of WSICs, OC and EC of $PM_{2.5}$ samples has been carried out by Ion Chromatograph and OC/EC carbon analyzer, respectively.

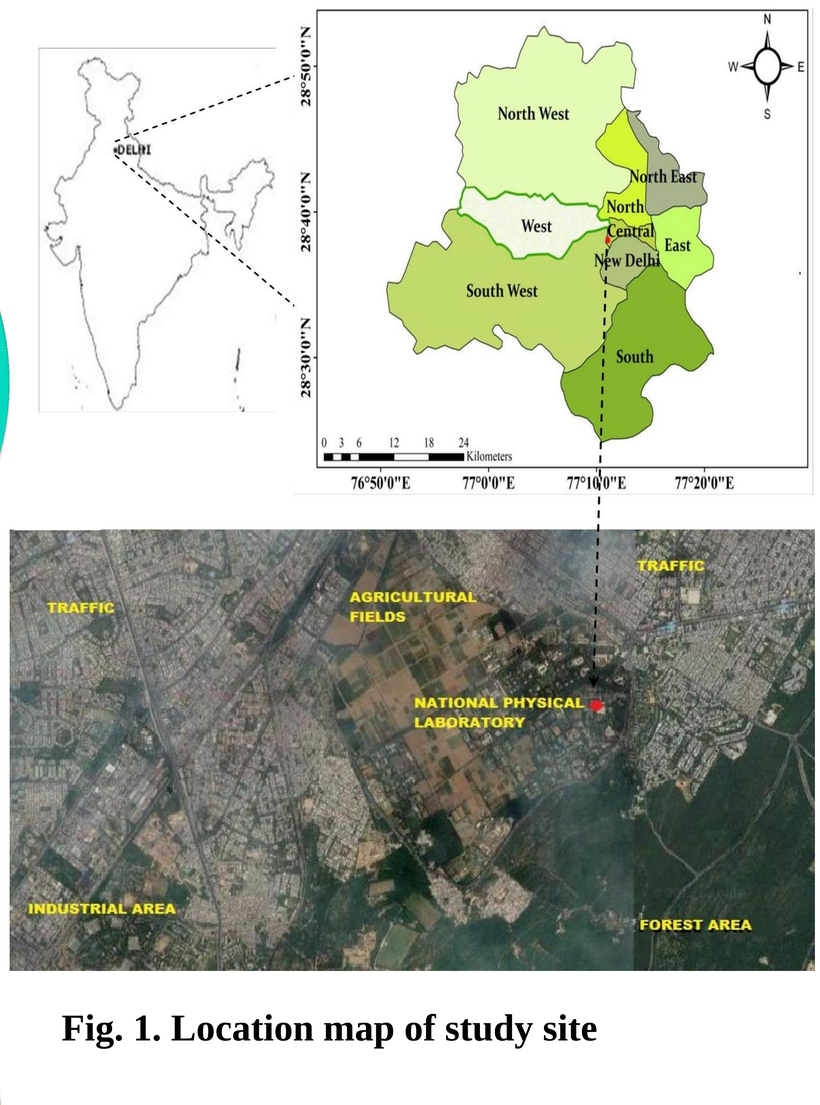


Fig. 1. Location map of study site

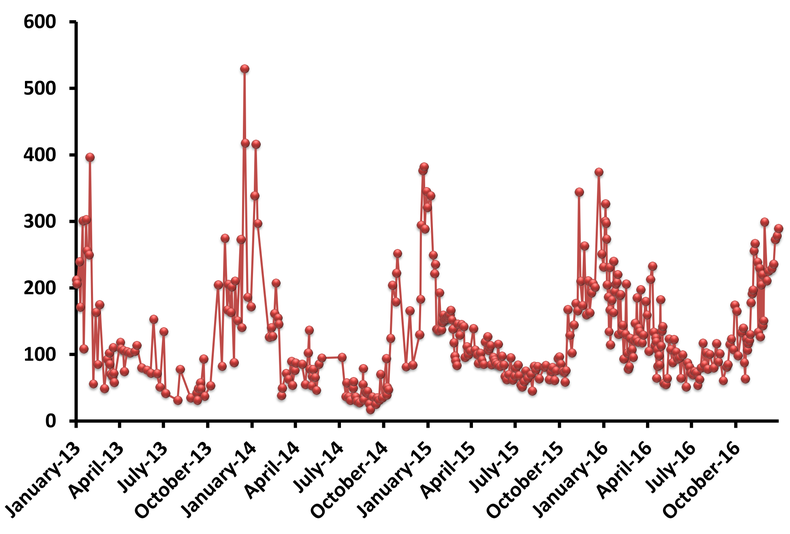


Fig 2. Monthly variation of $PM_{2.5}$ in Delhi

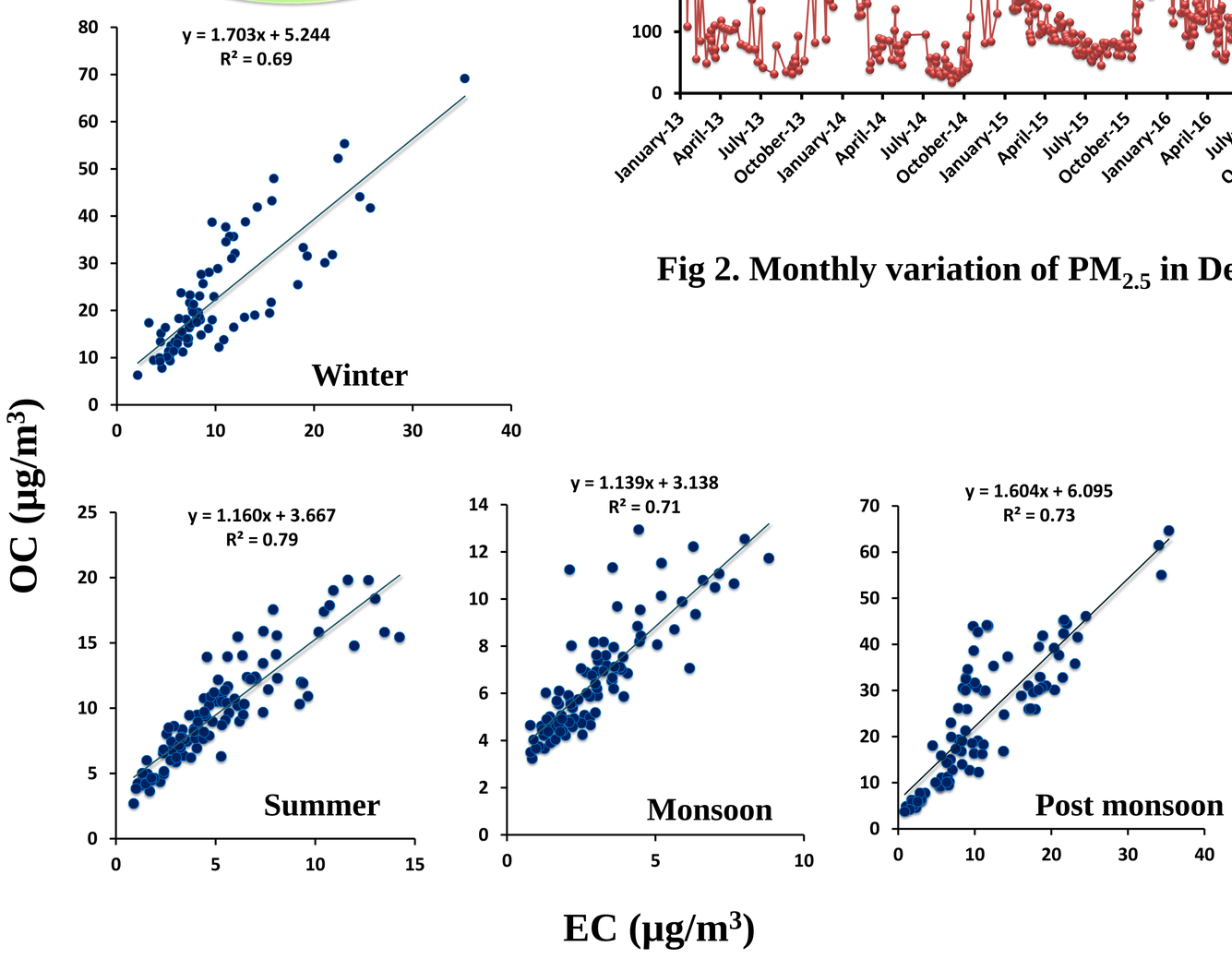
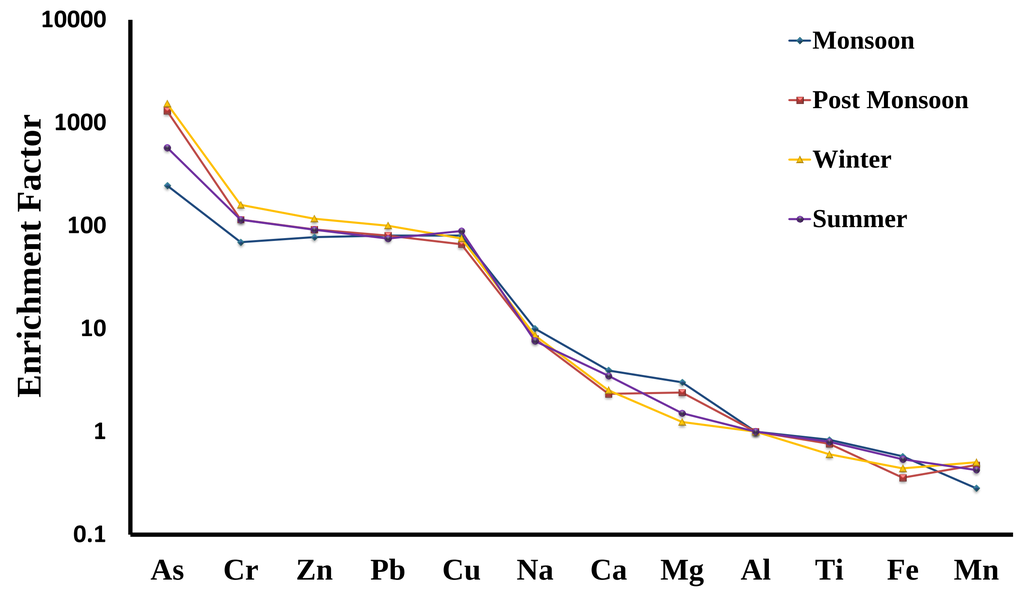
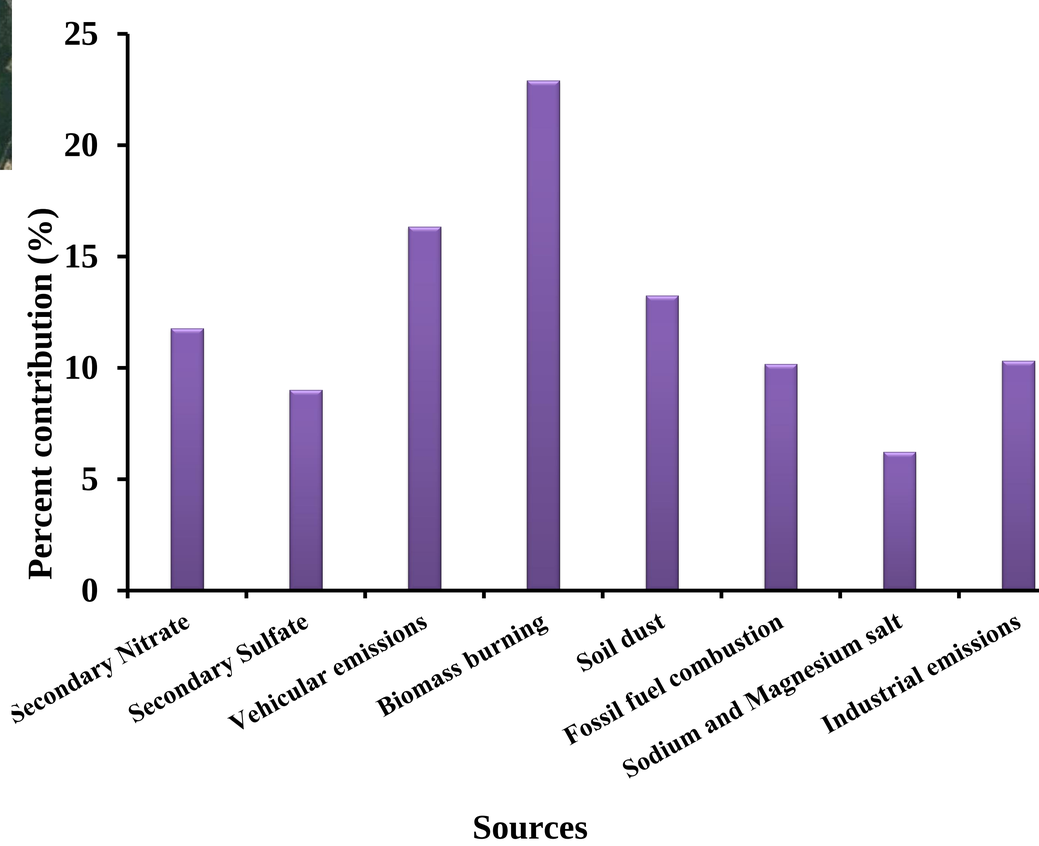


Fig. 3. Scatter plot of Organic carbon vs. Elemental carbon during different seasons

RESULTS AND DISCUSSIONS





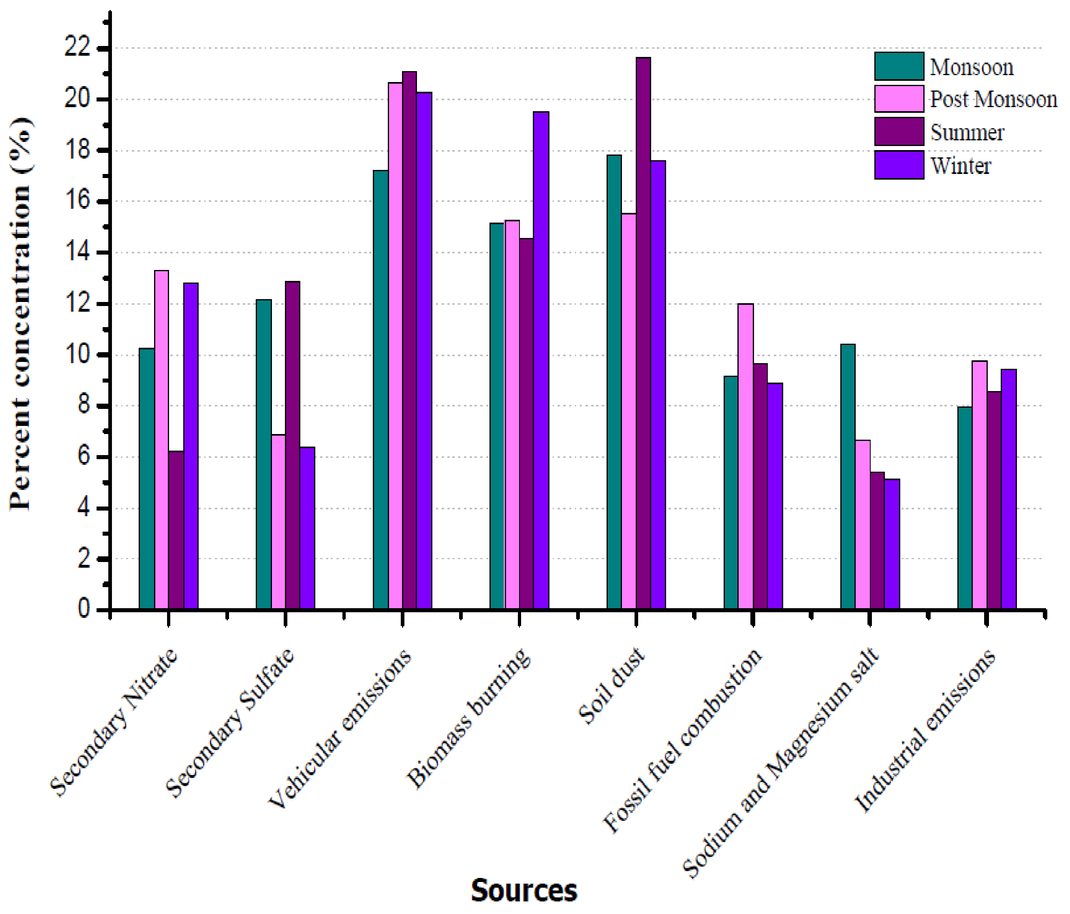


Fig 4. Source contributions using three different receptor models

CONCLUSION

Source apportionment of $PM_{2.5}$ has been carried out using Positive Matrix Factorization (PMF5) receptor model, characterizing the seasonal variabilities and resolved eight sources of $PM_{2.5}$ (secondary sulphate, secondary nitrate, biomass burning, coal combustion, vehicular emissions, industrial emissions, crustal/soil dust and marine/sea salt) in urban area of Delhi. The results show that secondary sulphate is higher during summer (13% of $PM_{2.5}$) while secondary nitrate is higher during post monsoon (13% of $PM_{2.5}$). The secondary nitrate is favored by low temperature while high temperature favors the formation of secondary sulfates. Biomass burning shows larger contribution during winter (20%) because of the influence of domestic heating, wood burning, however, this source is not negligible in summer (14%), likely because of the contributions of fires and agricultural practices. Contributions from vehicular emissions (21%) are higher during post monsoon attributed to stable atmosphere and lower boundary layer height. Crustal/soil dust contribution (22%) is observed to be higher during summers attributed to strong winds and dust storms that prevail during the season.

ACKNOWLEDGEMENT

The authors would like to thank Director, CSIR-NPL and Head, EBMD, CSIR-NPL, New Delhi for their constant support.