Indian Journal of Air Pollution Control Vol. VIII No. I March 2008 pp 18-25

Findings on Particulate Matter**

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Abstract

Data generated by CPCB of ambient air quality in various cities and towns of India under National Air Quality Monitoring Programme (NAMP) have been analyzed. A decreasing trend has been observed in ambient sulphur dioxide levels in many cities like Delhi, Hyderabad, Kanpur, Lucknow, Mumbai etc. This may be due to various interventions like reduction of sulphur in diesel, use of CNG as the vehicular fuel in Delhi and Mumbai etc. No definite trend has been observed in ambient nitrogen dioxide and Respirable Suspended Particulate Matter, although various interventions have taken place to mitigate them. This may be due to the exponential increase in the number of vehicles in all the cities of India. Further, carbonaceous fraction observed in summer months was low, while during winter months it was comparatively higher. This may indicate that natural dust from hazy conditions constitutes a large fraction of RSPM in summer. Analysis of organic carbon and elemental carbon at a few locations in Delhi has also been done and is being undertaken for other locations, since this analysis is crucial to gain understanding of the sources that contribute to ambient RSPM levels. The analyzed data is of various uses such as public dissemination, and evaluating trends to determine effects of efficacy of implementation of action plans.

Keywords: Organic carbon, elemental carbon, characterization, air quality monitoring.

1.0 Introduction

Central Pollution Control Board is executing a nation-wide network of ambient air quality monitoring known as National Air Quality Monitoring Programme (N.A.M.P.). There are 341 operating stations under NAMP covering 126 cities/towns in 25 states and 4 union territories of the country.

1.1 Objectives

The objectives of the N.A.M.P. are as follows:

- To determine status and trends of ambient air quality;
- To ascertain whether the prescribed ambient air quality standards are violated,
- To Identify Non-attainment Cities
- To obtain the knowledge and understanding necessary for developing preventive and corrective measures;
- To understand the natural cleansing processes undergoing in the environment through pollution dilution, dispersion, wind based movement, dry deposition, precipitation and chemical transformation of pollutants generated.

1.2 Monitoring Locations and Parameters

Under N.A.M.P., four air pollutants *viz.*, Sulphur Dioxide (SO_2), Oxides of Nitrogen (NO_2), Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM/PM_{10}), have been identified for regular monitoring at all the locations. Monitoring of meteorological parameters such as wind speed and direction, relative humidity and temperature were also integrated with the monitoring of air quality. Monitoring is being carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have 104 observations in a year. Central Pollution Control Board carries out direct monitoring in Delhi, through State Pollution Control Boards in the respective States, through Pollution Control Committees in the Union Territories, and through National Environmental Engineering Research Institute (NEERI), Nagpur in 6 other metro cities of the country. CPCB co-ordinates with all the agencies to ensure uniformity and consistency of air quality data. It also provides technical and financial support to them for operating the monitoring stations. However, it is pertinent to mention that collected data may be considered more as indicative rather than absolute, since NAMP is being operated through various monitoring agencies, and a large number of personnel and equipments are involved in sampling, chemical analyses, data reporting etc., that increases the probability of personal biases being reflected in the data.

*** Paper presented in the workshop on Some Recent Advances in the Field of Air quality) Management held on 23.09.2007*

1.3 Data Dissemination

Data is available on daily basis in Environmental Data Bank software on CPCB website (http://cpcbedb.nic.in). Data of 3 continuous stations and 1 mobile van is also available on real time basis on CPCB website (http://www.cpcb.nic.in), and Reports on Status and Trends are published regularly.

1.4 Utilization of Data

Observed ambient air quality data is utilized by various organizations. Some of the ways in which data are being utilized are:

i) Non-attainment cities are identified and concerned SPCBs /PCCs formulate action plans to control air pollution.
ii) Review of National Ambient Air Quality Standards (NAAQS) is carried out.
iii) Epidemiological Studies are carried out.
iv) Policy Levels Decisions are made at Central and State Govt. level, and Parliament Questions are replied etc
v) Research Institutes like IITs use the data in their research work

2.0 Results

2.1 Trends in Annual Average Concentration of SO_2

Trends in Annual average concentration of SO_2 are depicted in Figures 1 and 2. A decreasing trend has been observed in ambient sulphur dioxide levels in many cities like Delhi, Hyderabad, Kanpur, Lucknow, Mumbai etc. Decreasing trend may be due to various interventions that have taken place in recent years such as reduction of sulphur in diesel, use of cleaner fuel such as CNG in Delhi and Mumbai etc. Other measures include implementation of Bharat Stage-III emission norms for new vehicles and commensurate fuel quality. Also there has been a change in domestic fuel used from coal to LPG which may have contributed to reduction in ambient levels of SO_2.

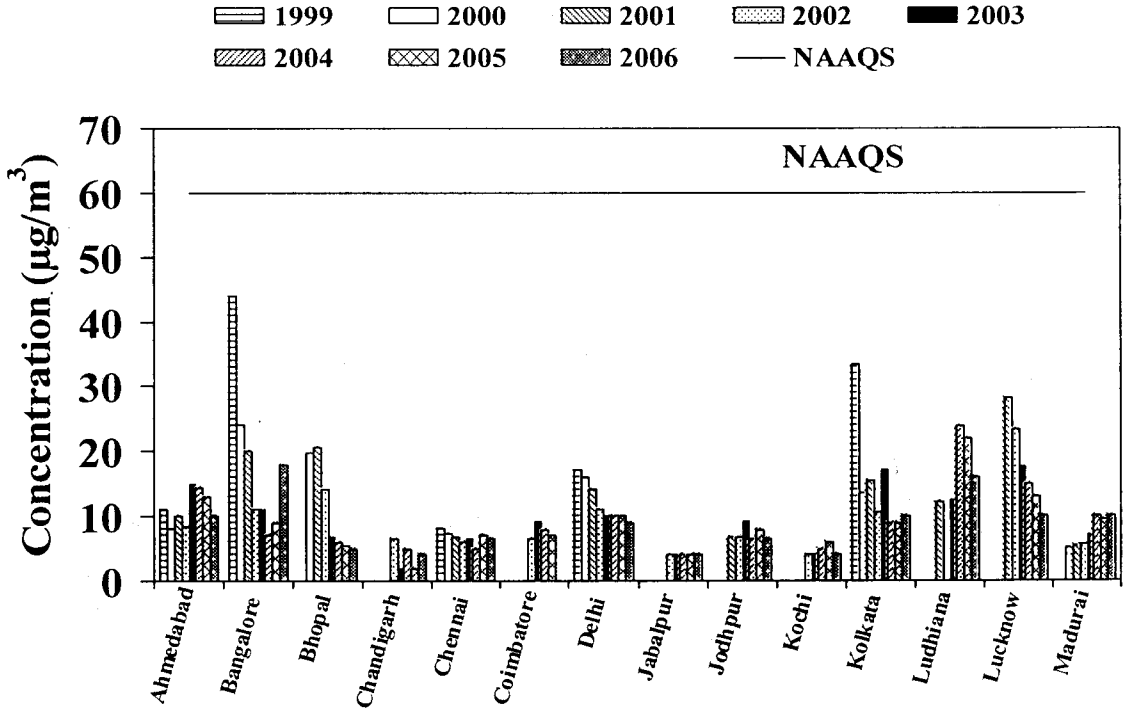

Fig 1: Trend in Annual Average Concentration of SO_2 (Res. Areas)

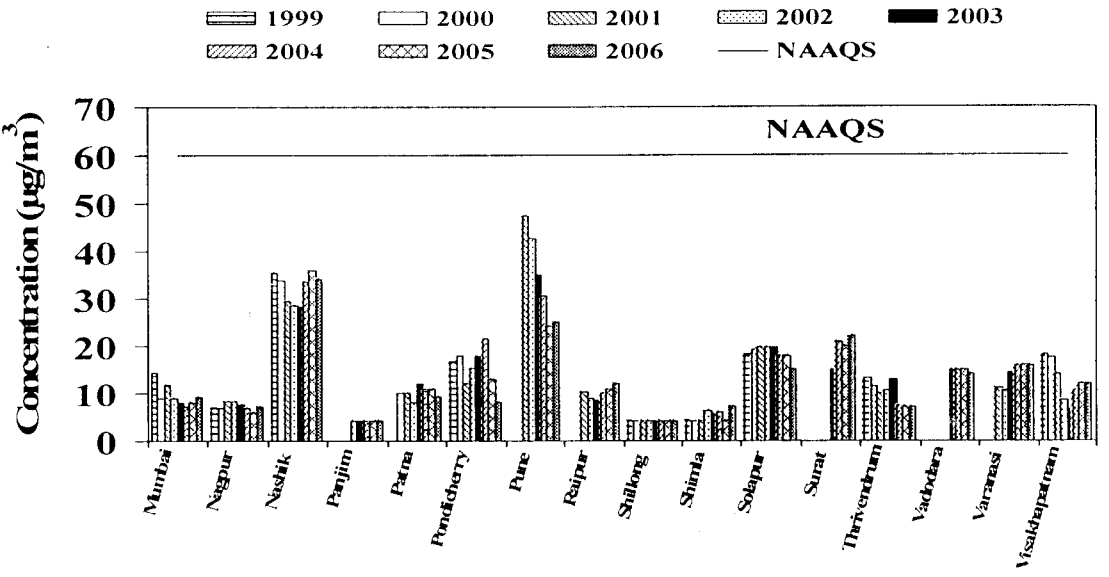

Fig 2: Trend in Annual Average Concentration of SO_2 (Res. Areas)

2.2 Trends in Annual Average Concentration of NO_2

Trends in Annual average concentration of NO_2 are depicted in Figures 3 and 4. Decreasing trends have been observed in some cities and fluctuating trends in some other cities. Vehicles are one of the major sources of NO_2 and their number is increasing exponentially. The reasons behind reduction in NO_2 may be introduction of improved vehicular technology in the form of Bharat Stage –III vehicles, banning of old vehicles in some cities, and improved traffic management etc.

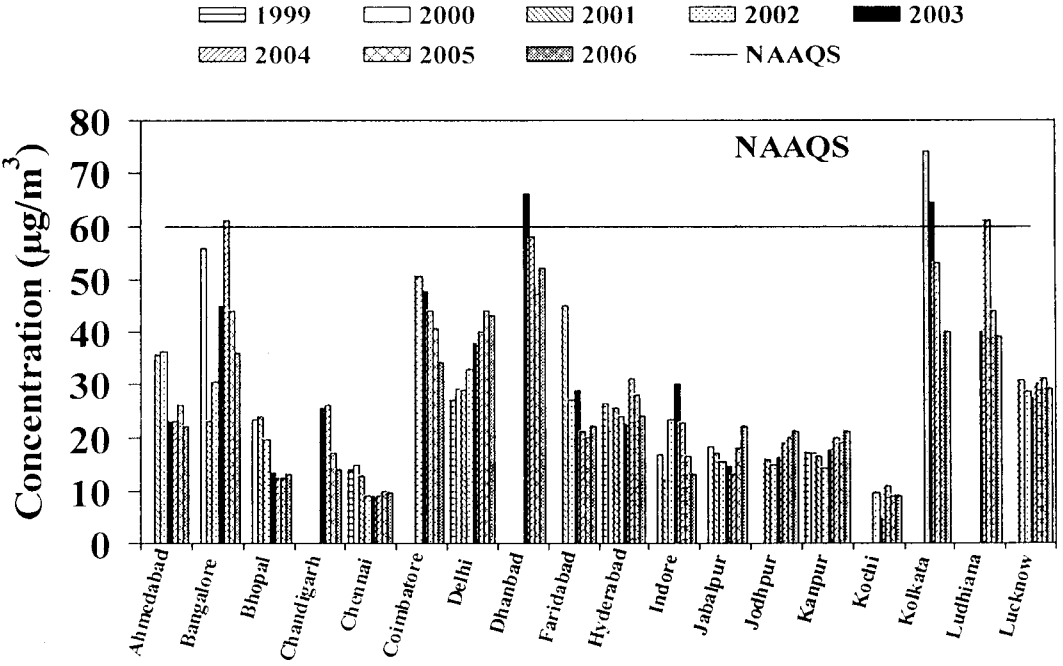

Fig 3: Trend in Annual Average Concentration of NO_2 (Res. Areas)

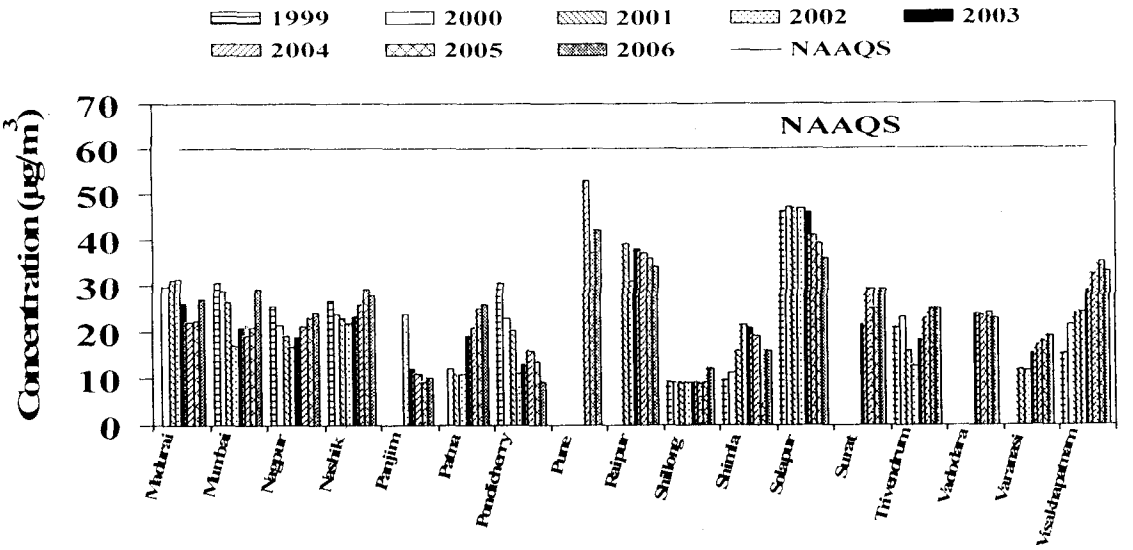

Fig 4: Trend in Annual Average Concentration of NO_2 (Res. Areas)

2.3 Trends in Annual Average Concentration of RSPM

Trends in Annual average concentration of RSPM are depicted in Figures 5 and 6. Decreasing trend has been observed in some cities and fluctuating trend was observed in some other cities. The reason for high particulate matter levels may be vehicles, gensets, small scale industries, biomass incineration, re-suspension of traffic dust, commercial and domestic use of fuels etc. Vehicles are one of the major sources of RSPM and their number is increasing exponentially.

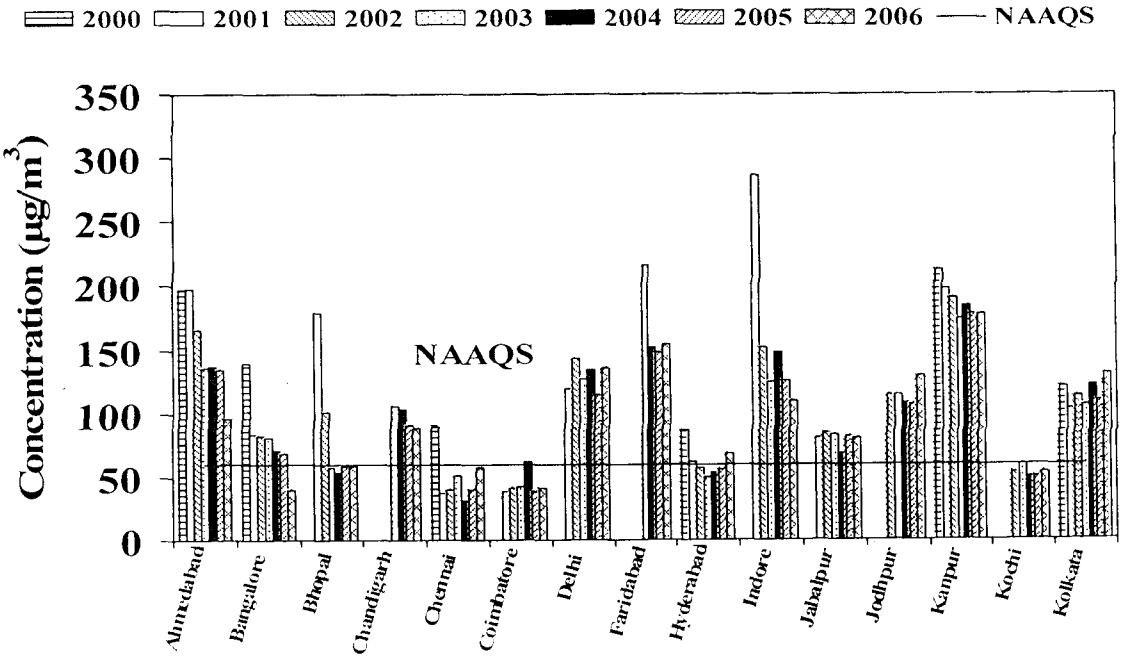

Fig 5: Trend in Annual Average Concentration of RSPM (Res. Areas)

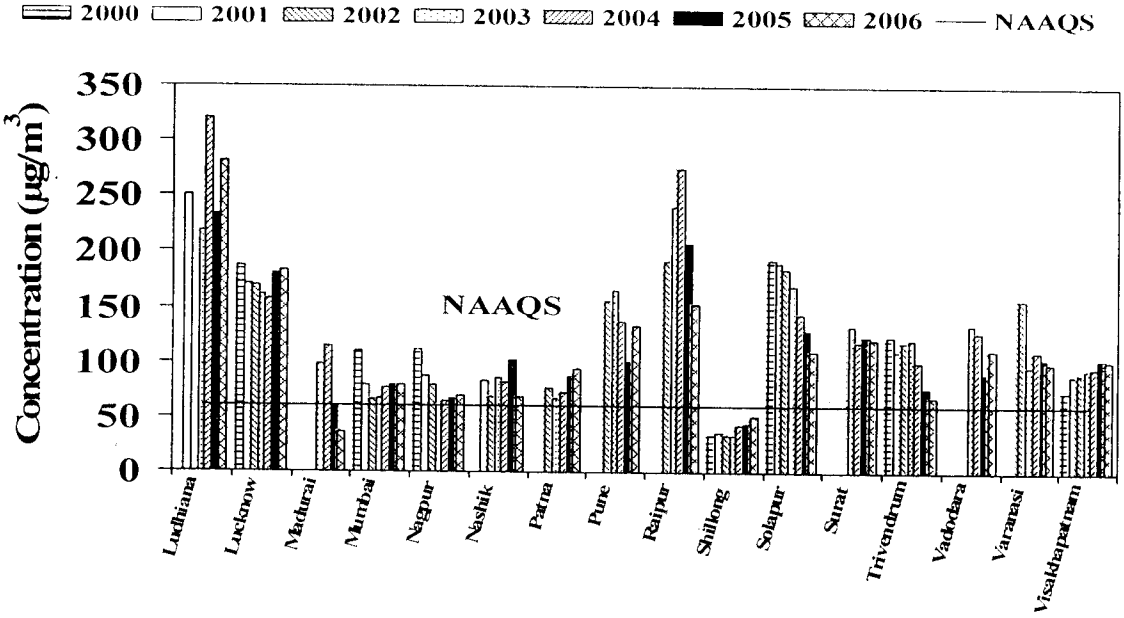

Fig 6: Trend in Annual Average Concentration of RSPM (Res. Areas)

2.4 Percentage of Cities with Low, Moderate, High and Critical Levels

Percentage of cities (Res. Areas) with low, moderate, high and critical levels of SO_2, NO_2, RSPM and SPM is depicted in Figure 7. It is observed from here that percentage of cities with low levels of SO_2 have increased over the years thus indicating that SO_2 pollution have reduced over the years. On the other hand NO_2, SPM and RSPM levels have hardly changed over the years and SPM and RSPM levels have not shown any low level existing at all over any of these cities.

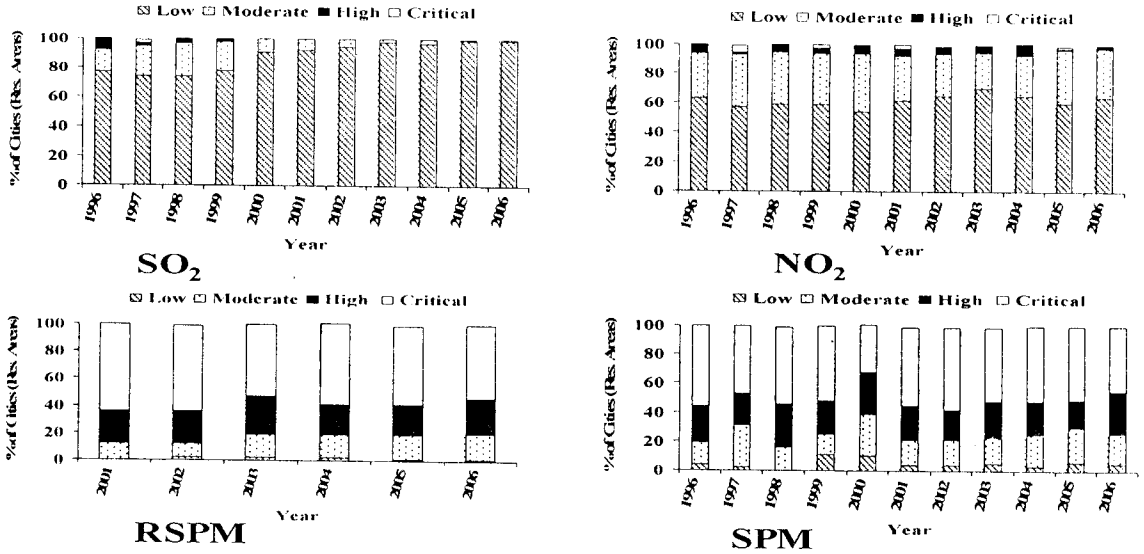

Fig 7: Percentage of Cities (Res. Areas) with Low, Moderate, High and Critical levels of SO_2, NO_2, RSPM and SPM.

2.5 National Mean Concentration

National mean concentration with 90th percentile and 10th percentile for SO_2, NO_2, RSPM and SPM is depicted in Figure 8. National mean SO_2 concentration has decreased over the years indicating that there has been a decline in SO_2 levels. National mean NO_2 and RSPM concentration has remained stable over the years despite increase in vehicle like sources. The reason for this may be various intervention measures such as improvement in vehicular technology and other vehicular pollution control measures like alternate fuel etc., that have been adopted over the years. National mean SPM concentration has been fluctuating over the years.

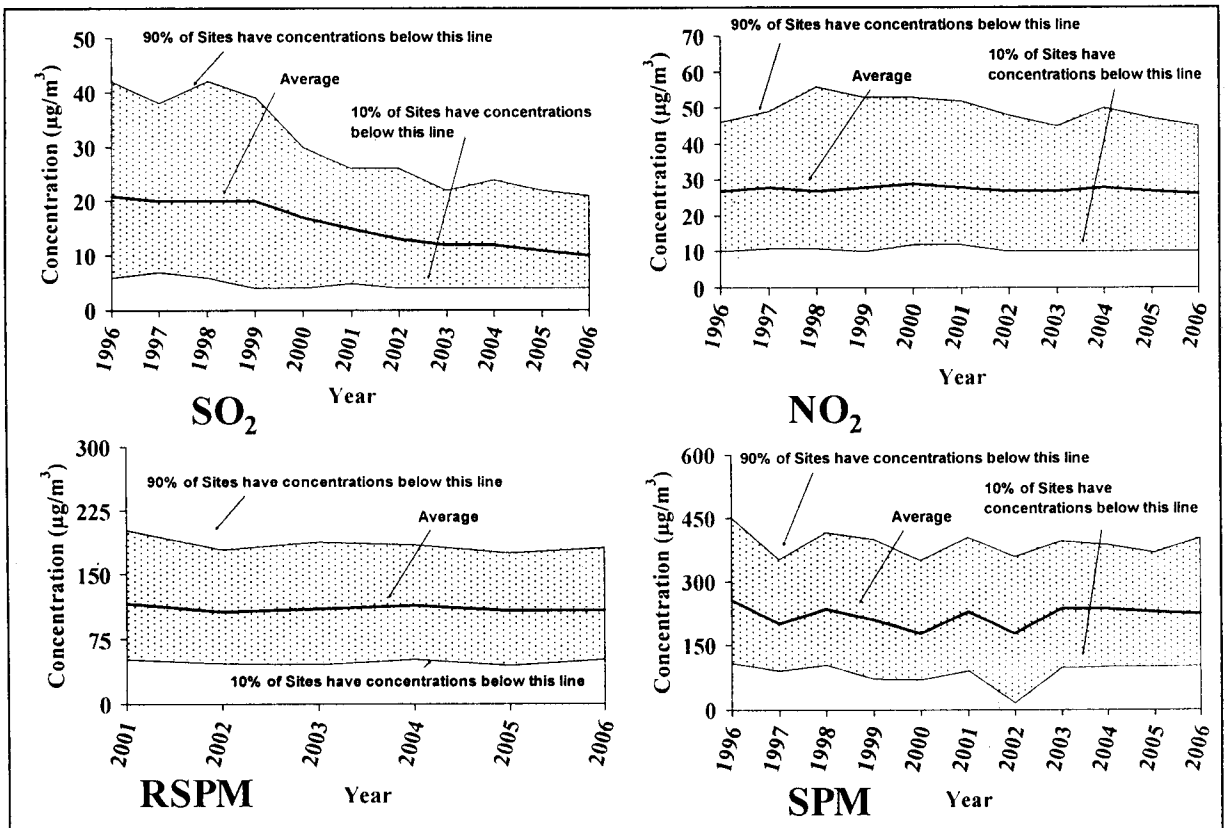

Fig 8: National Mean Concentration of SO_2, NO_2, RSPM and SPM

2.6 Organic Carbon and Elemental Carbon

Organic Carbon and Elemental carbon in RSPM were analyzed using OC/EC analyzers in CPCB lab. RSPM, Total carbon (TC), organic carbon (OC) and elemental carbon (EC) in Delhi during Oct., Jan is depicted in Figure 9, and during April it is depicted in Figure 10. Based on these data OC/EC ratios have been computed for various locations in Delhi and are shown in Table 1. It may be inferred from these data that the percentage of total carbon during summer months decreases as compared to other months indicating sources other than vehicles like natural dust n may contribute to ambient RSPM levels.

Table1: OC/EC ratios at various locations in Delhi.

S.no.	Location	OC/EC ratios
1	ITO	1.3
2	Shahdara	3.3
3	Ashok Vihar	2.8
4	Nizamuddin	2.2

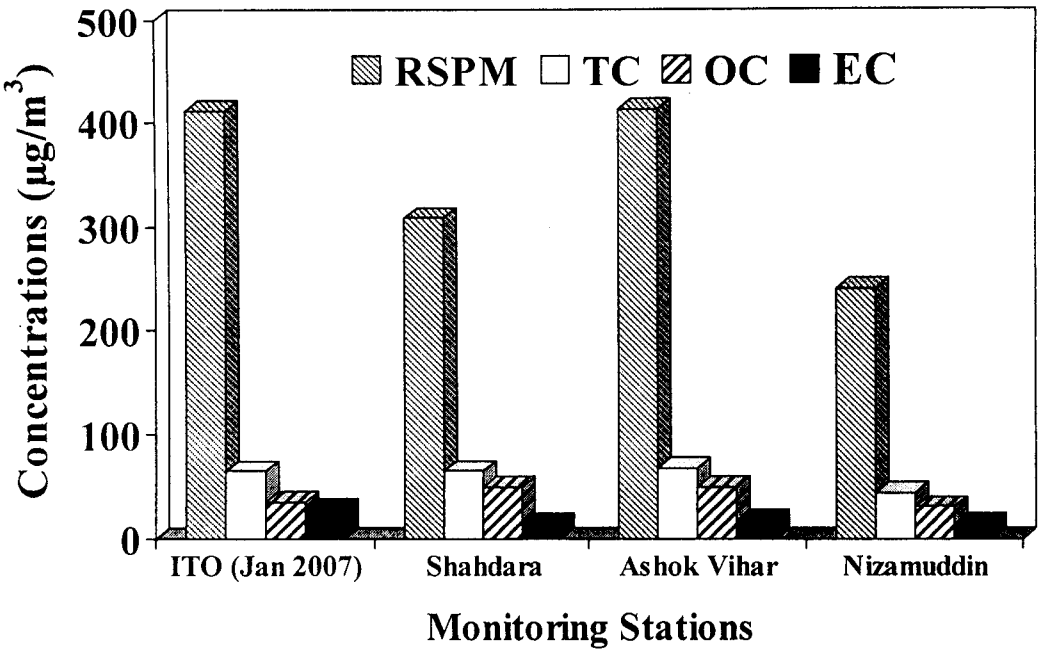

Figure 9: RSPM, Total Carbon (TC), Organic Carbon (OC) & Elemental Carbon (EC) in Delhi (during Oct., Jan).

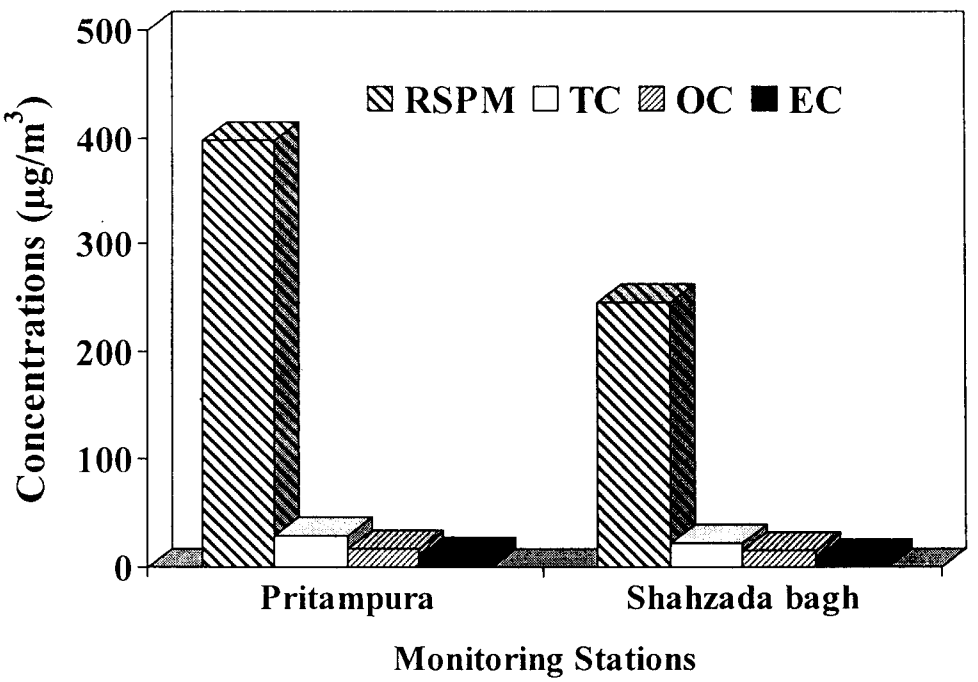

Figure 10: RSPM, Total Carbon (TC), Organic Carbon (OC) & Elemental Carbon (EC) in Delhi (during April).

3.0 Conclusions

A decreasing trend has been observed in ambient sulphur dioxide levels in many cities like Delhi, Hyderabad, Kanpur, Lucknow, Mumbai etc. The decreasing trend in ambient SO_2 levels is may be due to various interventions that have taken place such as reduction of sulphur in diesel, use of cleaner fuel such as CNG in Delhi and Mumbai etc. This finding is corroborated by decrease in National mean Concentration of sulphur dioxide and increase in percentage of cities with low levels of SO_2 over the years. No definite trend has been observed in ambient nitrogen dioxide and Respirable Suspended Particulate Matter. In some cities ambient NO_2 and RSPM levels are decreasing whereas in some other cities the trend is fluctuating. Although various interventions have been made to mitigate ambient NO_2 and RSPM levels but at the same time number of vehicles have increased exponentially. The vehicles are one of the major sources of NO_2 and RSPM.

Further, OC is higher than EC at all the locations. At BSZ Marg (ITO), OC/EC ratio was observed as 1.3. At Shahdara, Ashok Vihar and Nizamuddin, OC/EC ratios more than 2 were observed. Different OC/EC ratios were observed at traffic intersection and other monitoring stations. Low carbonaceous fraction was observed in summer months. Carbonaceous fraction during winter months was higher. This indicates that natural dust from hazy conditions may constitute larger fraction of RSPM in summer. Analysis of organic carbon and elemental carbon is crucial to gain understanding of the sources that contribute to ambient RSPM levels.

Acknowledgements

The authors wish to thank Sh. A.K. Sinha, Sc'C', Sh Gurnam Sungh, EE, Dr R.C. Srivastava Sc ' B', Sh D.C. Jakhwal, Sc 'B", Sh Y.N. Mishra, SSA, Sh R.D. Swami, DEO, Sh Suresh Sharma, DEO, Ms. Garima Dublish, JRF, Sh Ved Parkash, STS and all other monitoring staff of Air Lab of CPCB for generating, scrutinizing, and compiling the ambient air quality data.

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