Variations of Elemental Concentration in PM 10 and PM 2.5.

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Introduction

- Atomic Energy Authority (AEA) jointly with Central Environmental Authority (CEA) participates in the RCA sub project on "**IAEA/RCA Subproject on Improved Urban Air quality Management through Isotope and related Techniques (RAS/7/013) since 2000.**

National Objectives

- To measure the elemental composition of the coarse and fine air particulates using the nuclear analytical technique ED-XRF in the selective sites to monitor the long-term trends.

- Identifying the main Pollutant sources and qualifying the source contribution.

- Identifying the direction of local point sources and long term pollutant dispersion.

Sample Collection And Analysis

- Sampling Period: 2000 to up to date

- Sampling sites: 1. Air Quality Monitoring
                         Station
                 2. AEA Premises

- Air Samplers : Gent PM 10 Air Sampler

- Particulate Size: PM10-2.5 and PM2.5

- Elemental Analysis : ED-XRF

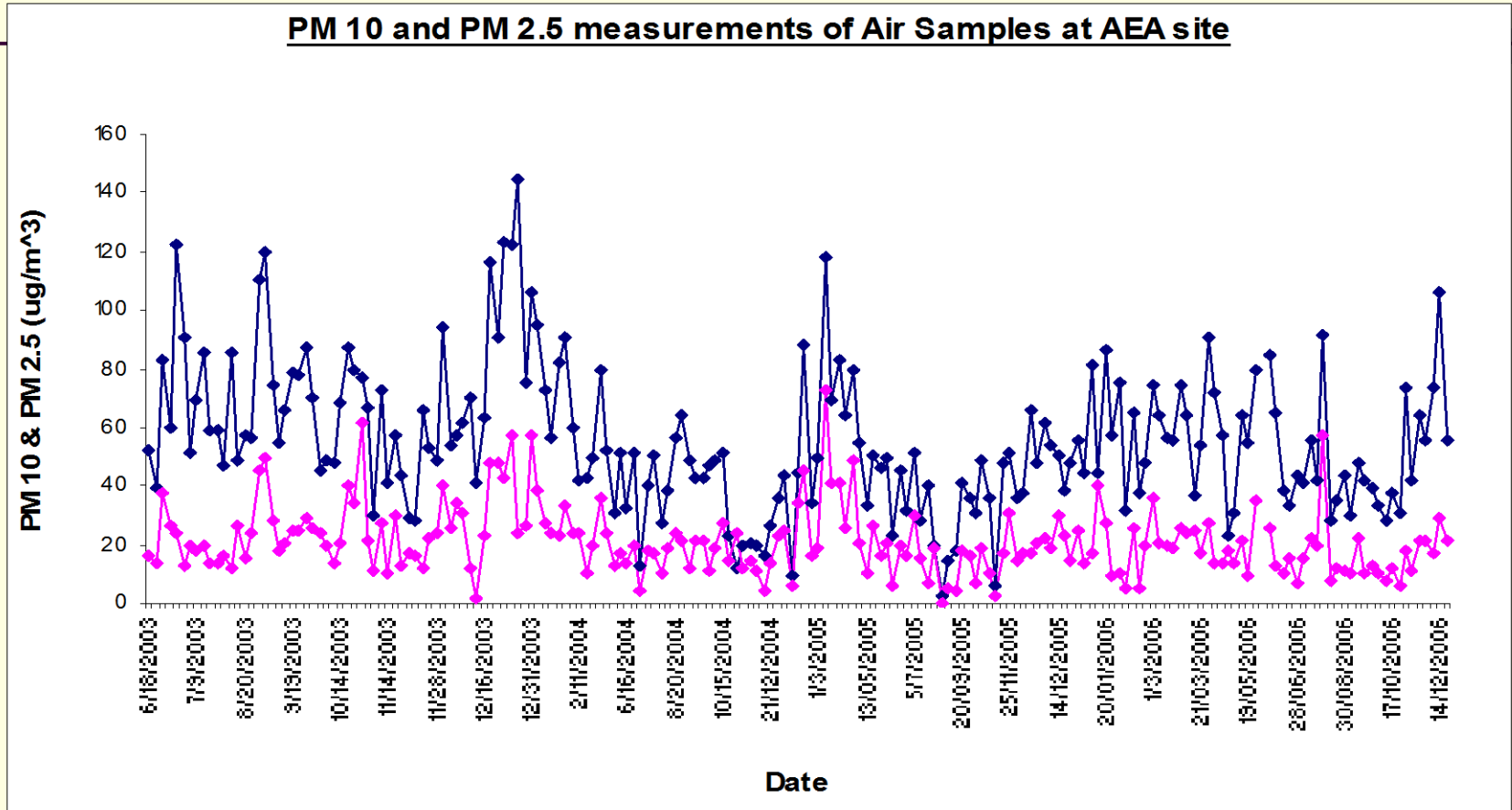- Black Carbon : Stain Smoke Reflectometer.

Gent PM 10 Air Sampler

X-RAY FLUORESCENCE ANALYSIS

- Well Established
- Fast
- Non destructive
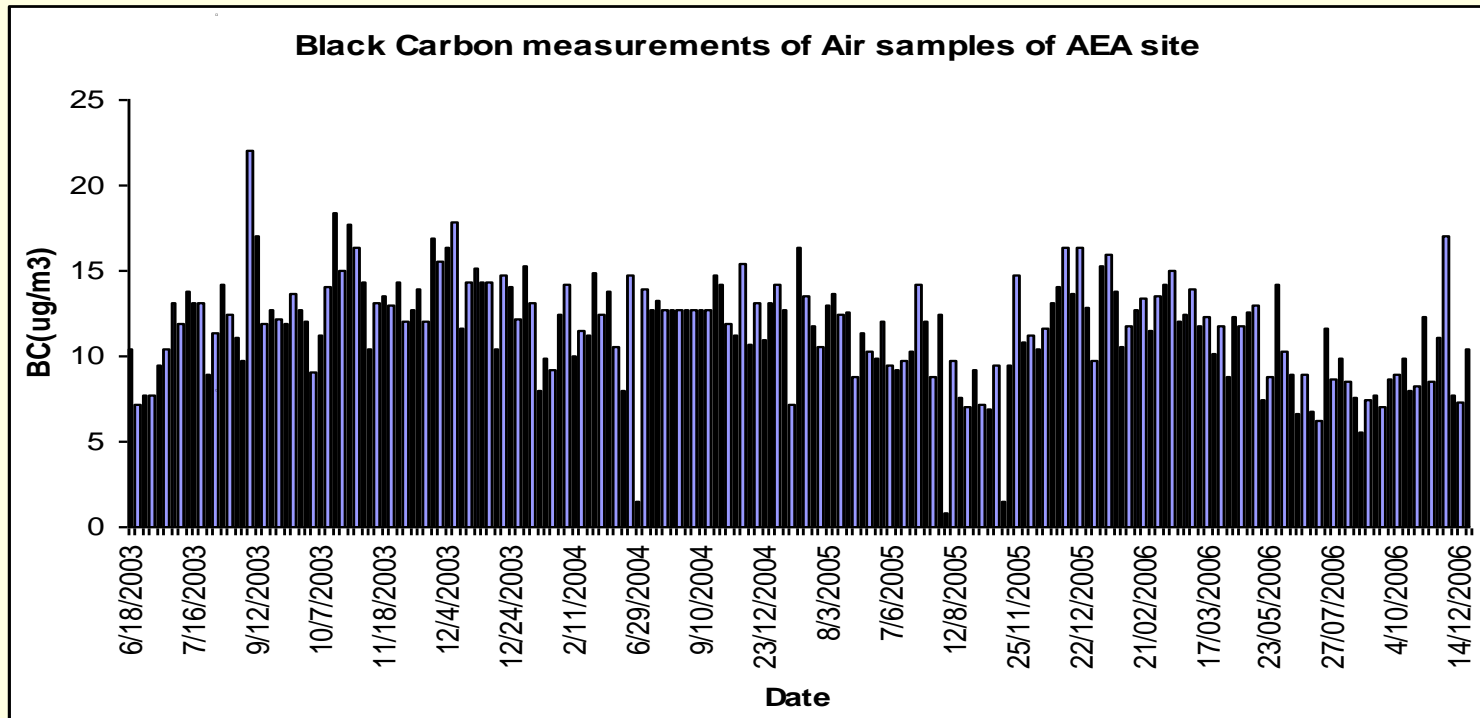- multi-Elemental analysis
- cost effective Method

Time Series-PM 2.5 &PM10 (AEA)

The average PM 2.5 and PM 10 values are 18μg/m3 and 54 μg/m3 which exceed the USEPA values.   The average PM 2.5 particulates component of PM 10 is 42% at the AEA station.

Time Series- Black Carbon (AEA)

Variation of the black carbon measurements in the fine filters collected at AEA site is shown in above. The Average of BC is 10 μg/m3.
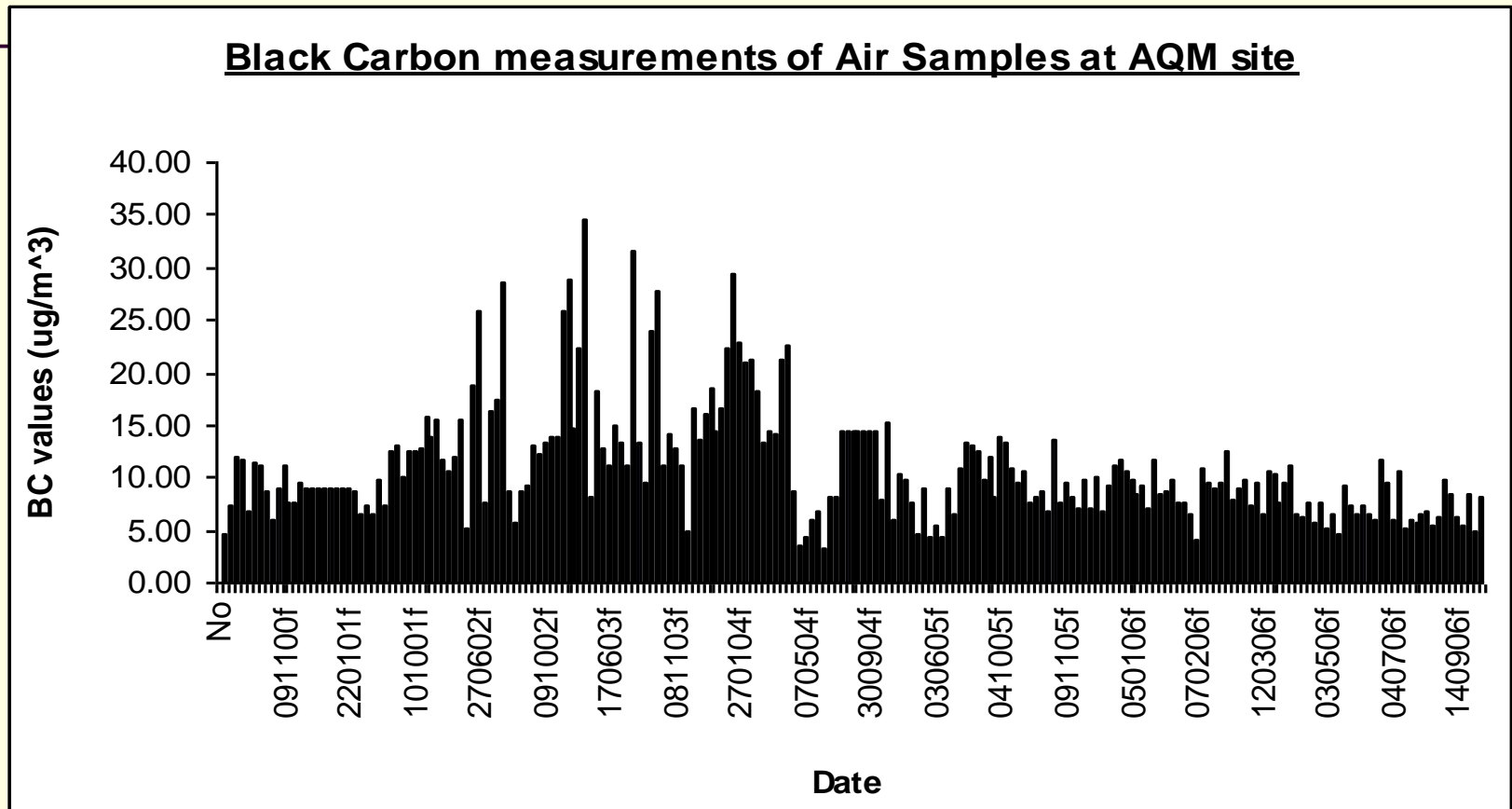
Time Series-PM 2.5 &PM10 (AQM)
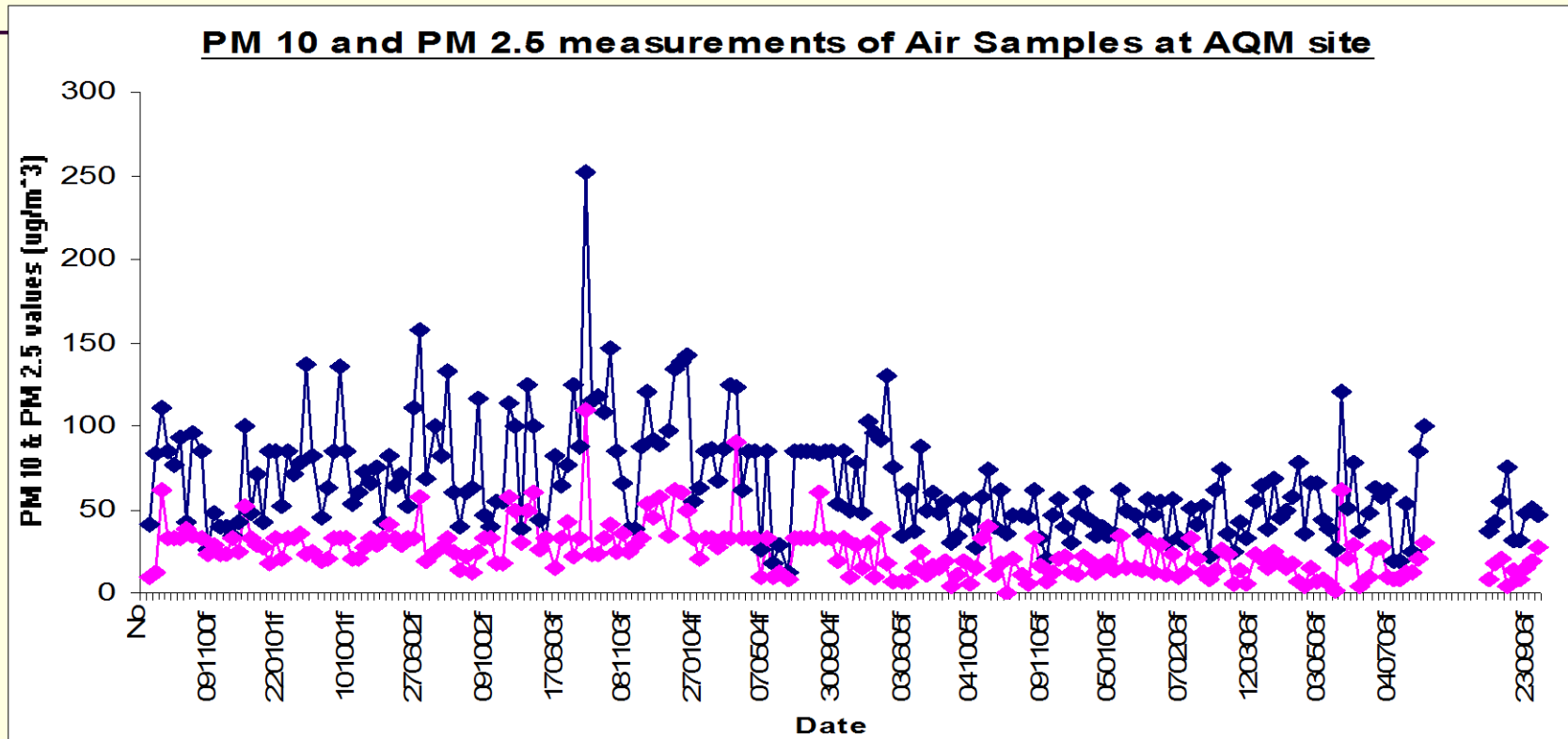
The annual averages of PM 10 and PM 2.5 were measured as 50μglm3 and 17 μg/m3 in 2006 respectively.

This Indicates about 38% of fine particulates are in PM 10 mass fraction.

Time Series-Black Carbon (AQM)

Black Carbon measurements of Air Samples at AQM site

The average concentration of BC is 8μg/m3 and it was nearly 1/2 of the total PM. 2.5 mass concentration. This indicates that the combustion source dominates in the fine fraction in this site.

Summary of PM 10, PM 2.5 and BC in two sites

PM 10, PM 2.5 and Black Carbon variations of Air Samples at AEA site

PM 10, pm 2.5 AND Black Carbon variations of Air Samples at AQM site
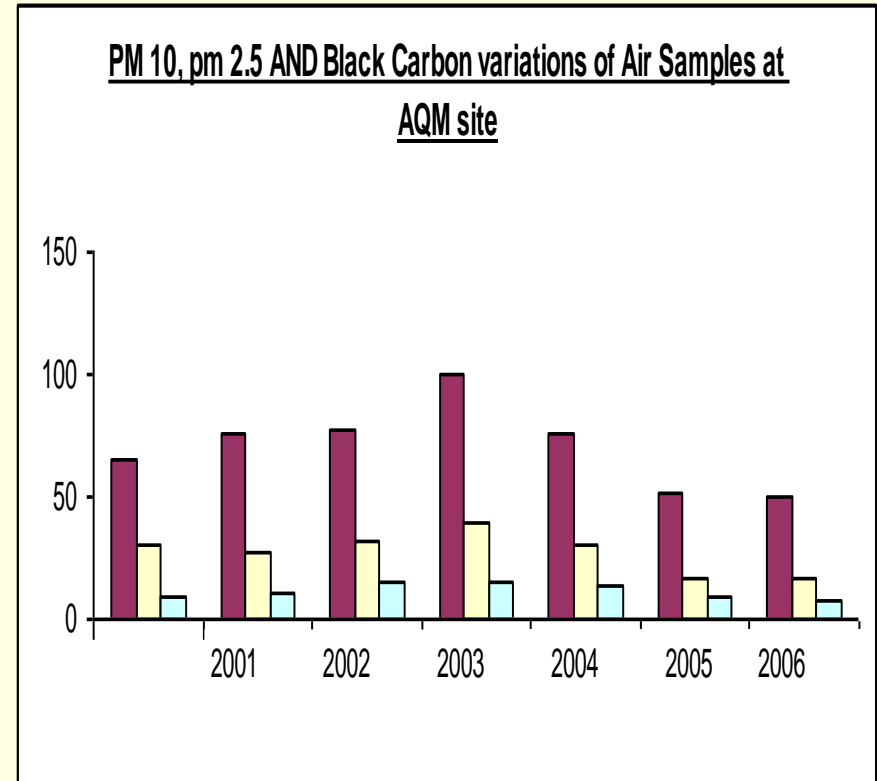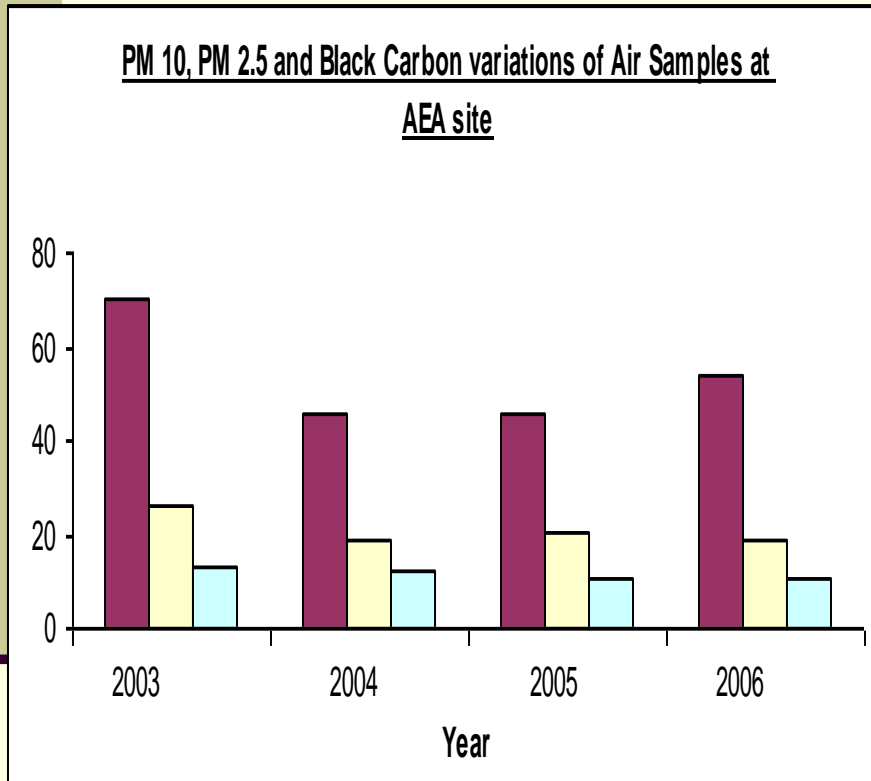
Comparison of Mass Concentration in two sites

■ Both size fractionated particle masses were lower in site 1 comparing the last few years.

■ The following factors can be stated for negative trends for particulates pollution.

∗ Better management practice for motor traffic control.

∗ Introducing the standards of vehicular emissions and on spot emission testing.

∗ Improving the Public transportation.

∗ Phasing out the old vehicles from the main roads with regards to quality of emissions.

Box plot for Elemental Concentration in Fine Filters (AEA)
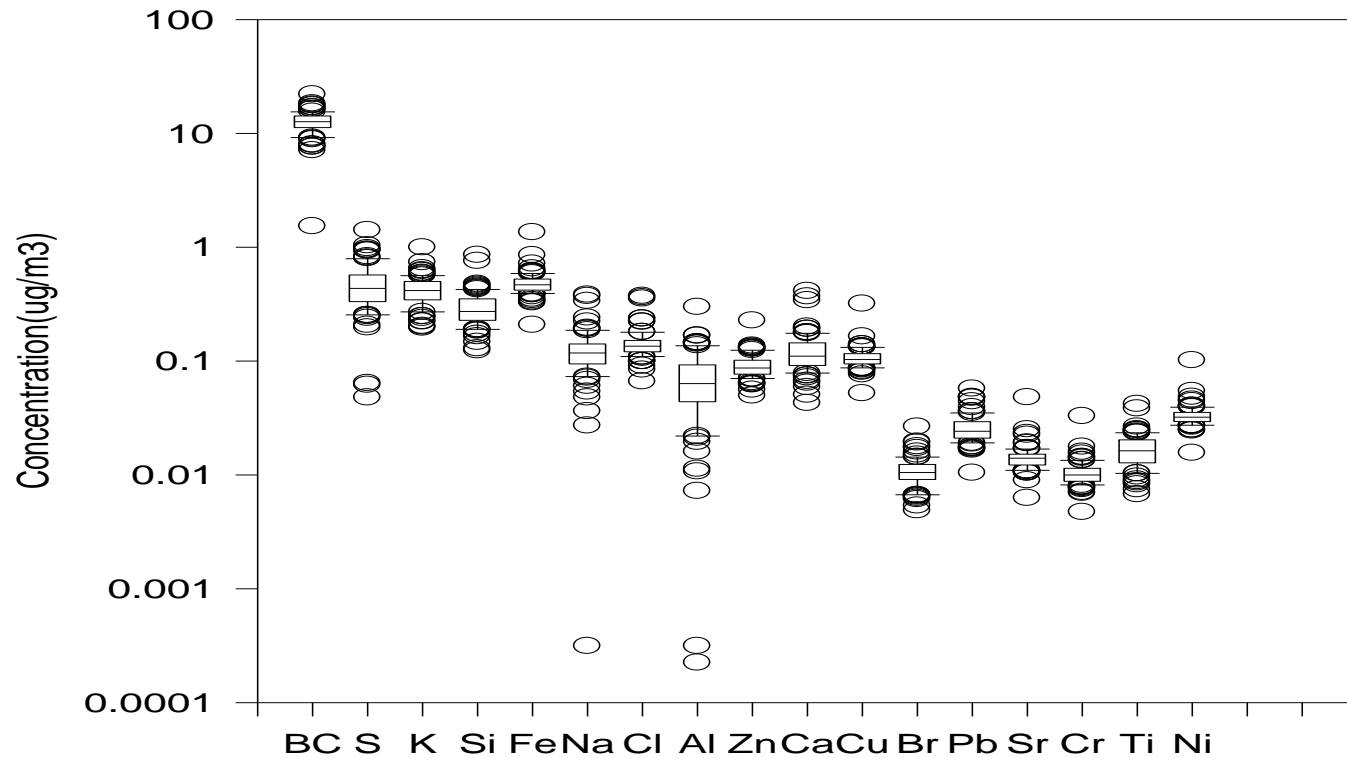
# Box plot for Elemental Concentration in Fine Filters (AQM)
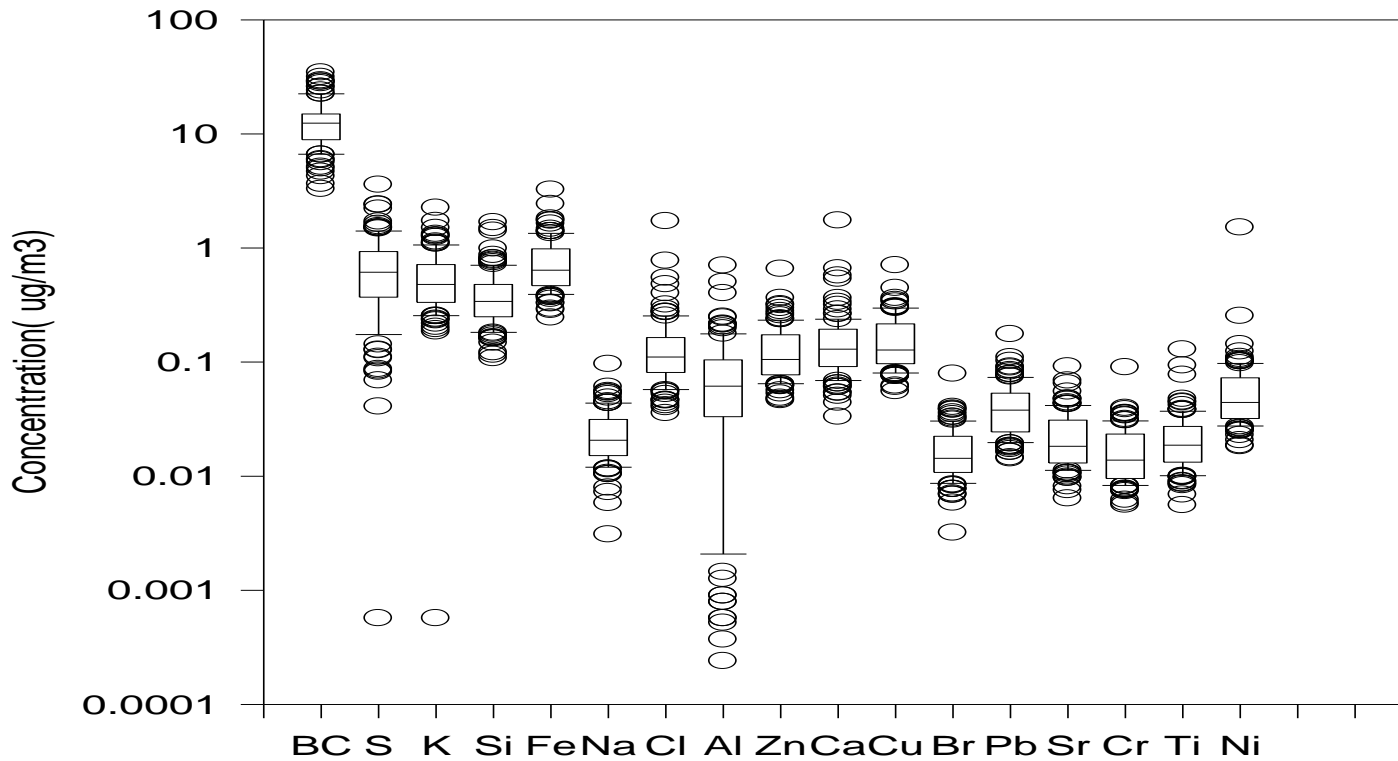
Summary of Elemental Concentration

- Sulphate and BC are dominant elements in the fine fraction collected from both sites.

- K and Zn are significant in the fine particles when compared with the other anthropogenic elements.

- Zn is released and is often observed as a white smoke coming from the two strokes engine exhausts.

- Pb is not significant in the fine fraction when compare with the other elements., (unleaded fuel was introduced in 2001 to improve the air quality.)

Source Apportionment of the Fine particulate matter collected from AEA Station

- The elemental Concentration measured on 100 fine filters from AQM Station were used for PMF Analysis.

  - 28 key elements analyzed by ED-XRF were selected for PMF.

  - Data Quality control using Box & whisker of Statgraphics.

Source Identification (PMF)

Sulfer

12%

Soil

40%

Sea
Salt+Vehi
cular

33%
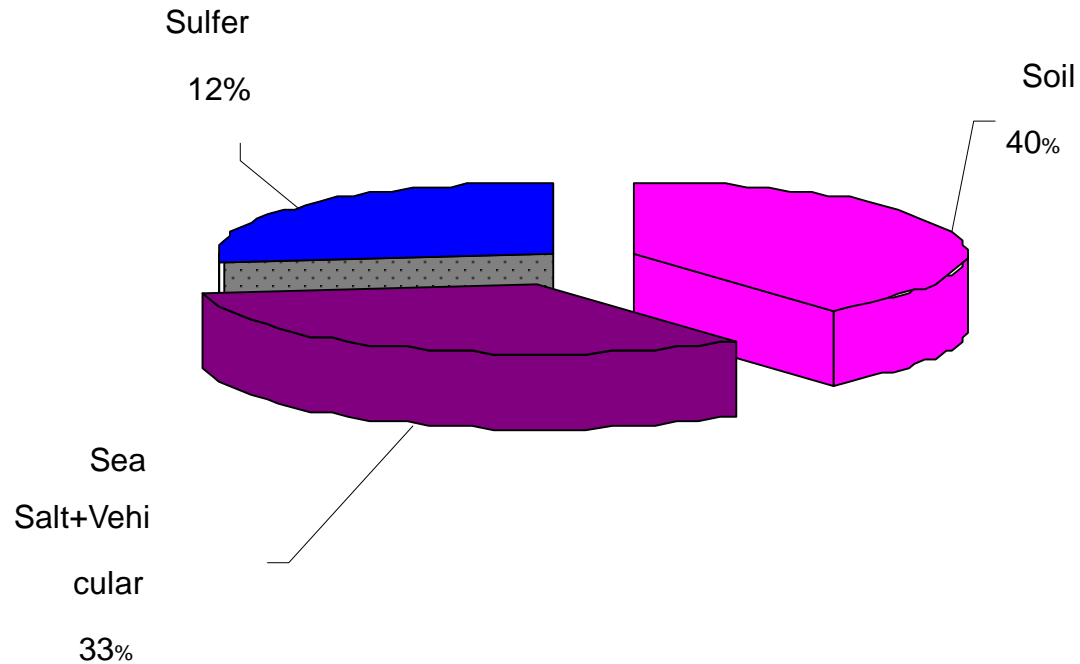
AEA –Fine Fraction
(Average RCM 26ug/m3)

Identified Sources and Finger Print Elements from PMF –AEA Site

PMF Factors	High loading	Mass contribution	Main sources	Potential source location
1	S, Mg, Al, Si, Ca, Sn, Ti	40%	Soil	Point source and long term dispersion are not identified.
2	V, Sc, K, S, P	27%	Sulphate /Smoke	
3	BC, Cl, K, Cr, Fe, Co, Ni, Cu, Zn, Br, Rb, Sr, Cd, Cs, Ba, La,Pb	33%	Vehicular Emission/R efineries	

Source Identification (PMF)
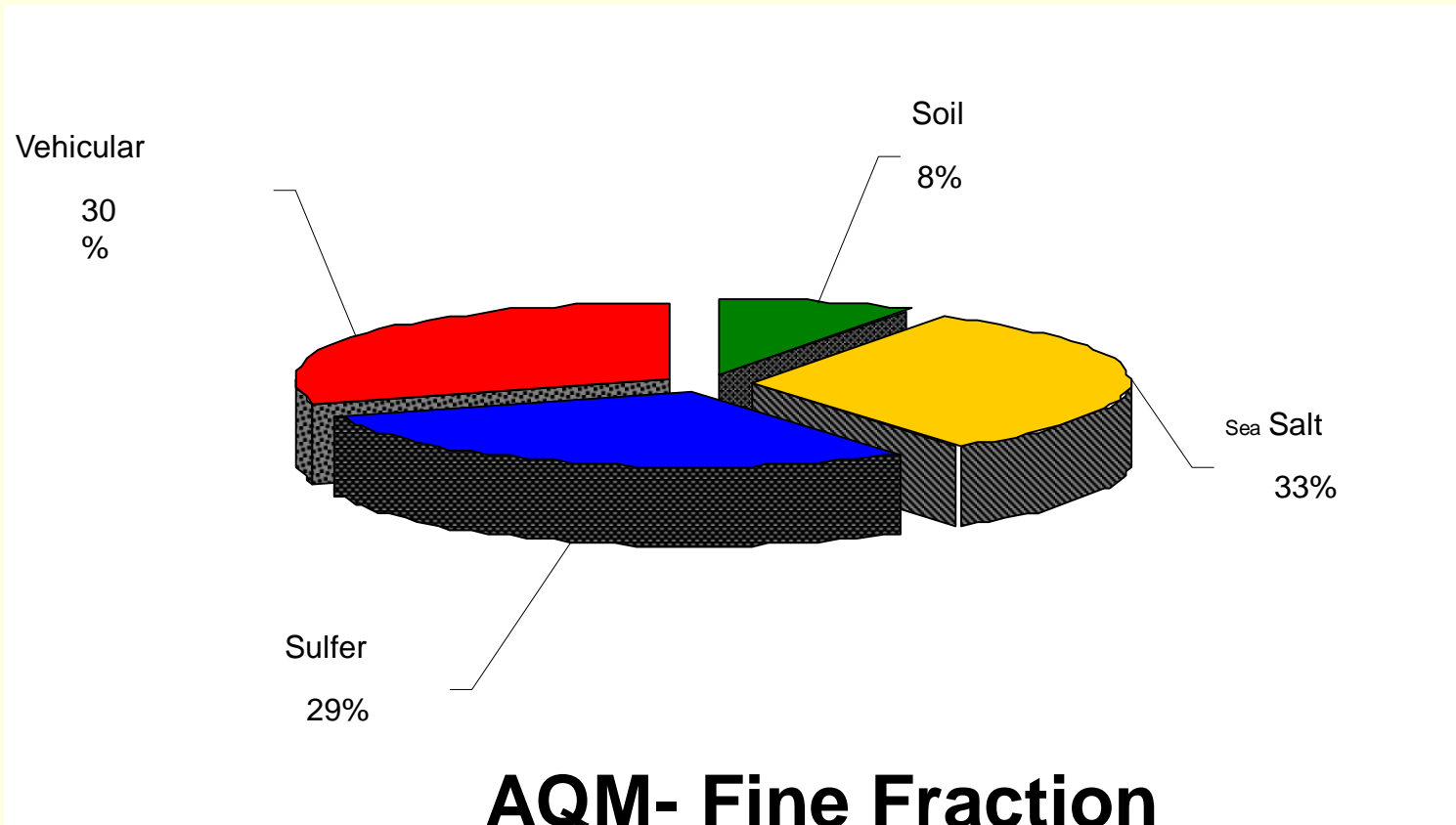
AQM- Fine Fraction

(Average RCM 29 ug/m3)

Identified Sources and Finger Print Elements from PMF –AQM Site

| PMF Factors	High loading	Mass contribution	Main sources	Potential source location
1	Al, Si, K, Ca, Sc, Ti, Fe	8%	Soil	Point source and long term dispersion are not identified.
2	Na, Mg, Cl	33%	Seaspray	
3	P, S, V	29%	Sulphate	
4	BC, Cr, Fe, Co, Ni, Cu, Zn, Br, Rb, Sr, Cd, Sn, Cs, Ba, La, Pb	30%	Vehicular Emission	

Air data with local meteorology

- The local meteorological information could be useful in interpreting source apportionment results.
- Multiple methods (CPF and NPR) are available to combine the compositional data with meteorological data to explore the directionality of possible sources or source areas that are contributing to the PM Concentrates observed at the sampling site.
- PM 2.5 and EC concentration were treated with meteorological data to identify the source direction.

# Comparison between CPF and NPR plots for the BC in AQM site
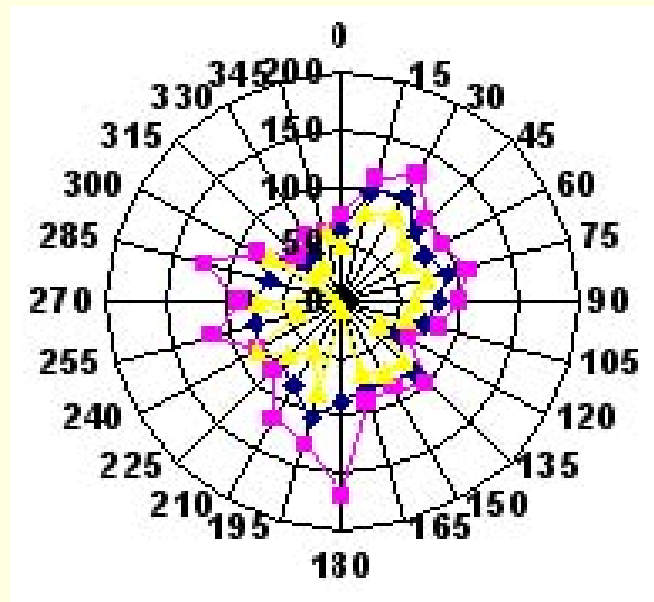
NPR
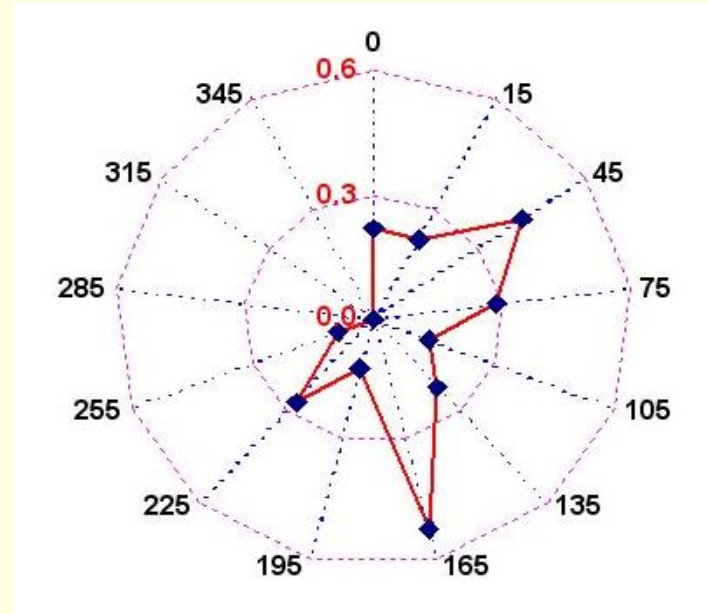
CPF

These plots indicate actual direction of a fuel burning electricity production plant and emissions from the direction of the central railway station in Colombo city.

Use of HYSPLIT-4 Back Trajectory Model.

■ Dispersion models describe the transport of the particles from a source to the sampling location and it can be used to examine the motion of the atmosphere forward or backward in time.

■ One of the uses for the trajectories is to examine the origins of observed spike in the time series of element or source species.

Time series plot of S at AEA site

NOAA HYSPLIT MODEL
Backward trajectories ending at 08 UTC 22 Oct 03
CDC1 Meteorological Data
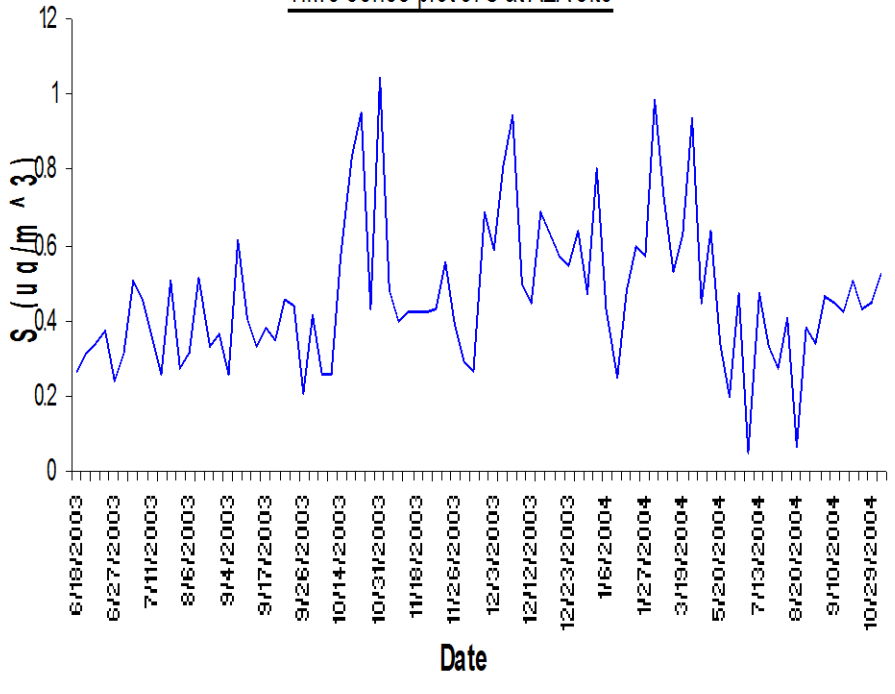
Time Series of S measured in AEA.
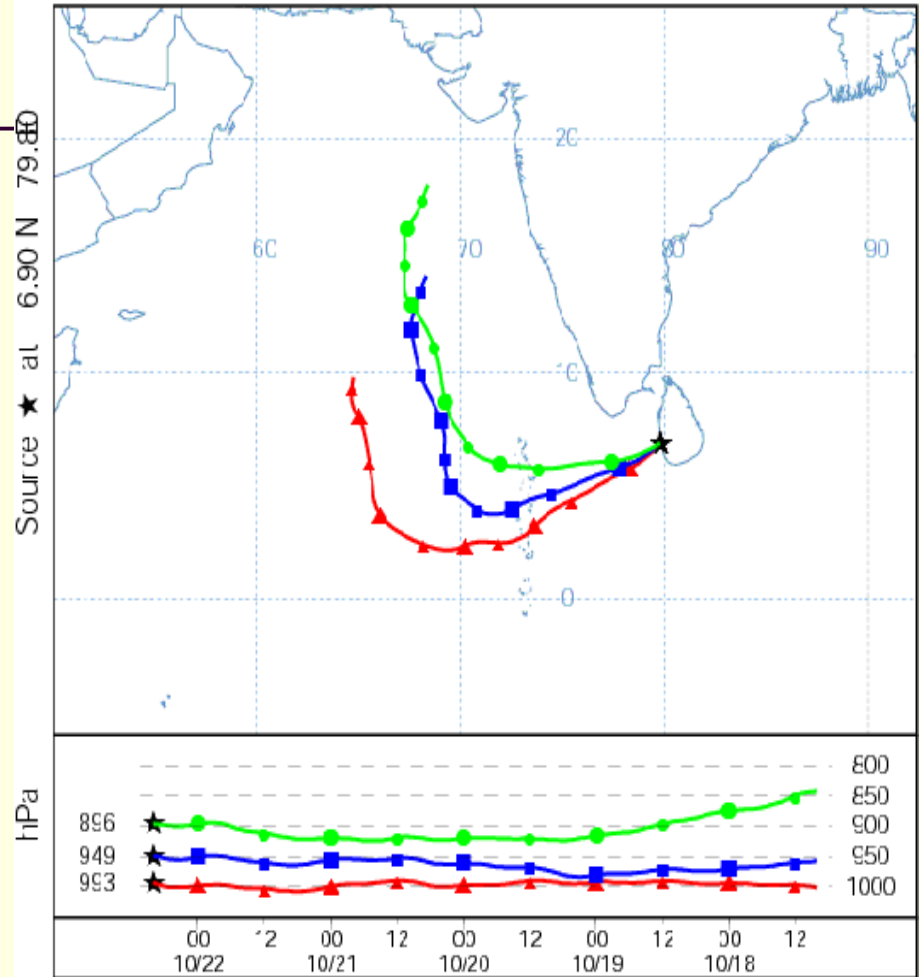
It can be suggested that both event are associated with ship's emissions from this major shipping route due to large ocean- going ships burning low grade residue oils which have influence on long term sulphate in PM 2.5

Conclusions

I This project continues positively in Sri Lanka for the last few years in Collaboration with the End-user Institution.

I Data of PM 10, PM 2.5 and elements and results of the Source Apportionment Technique can be utilized for:

* the identification of long-term trends of pollution

* contribution of major pollutants

* local and long term transport pathways of specific sources.

I The findings will be helpful to implement the air quality management strategies by the relevant Authorities..

I The participation of AEA in this project complements the on going national air quality monitoring programme effectively.

Acknowledgement

The Technical Assistance provided by IAEA and in kind contribution to analyze our samples by EDXRF at Prof. Hopke's laboratory are acknowledged.

Thank you