

## Trends in Ambient Concentrations of Fine Particles in Dhaka City

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## Air Quality in Dhaka

### Scenario

- Rapid urbanization
- Increased economic activity
- High population density
- Increasing number of motor vehicles and brick kilns
- Traffic congestion



### Perception

- Bad air quality especially in dry seasons
- Particulate matter is the responsible pollutant
- Occurrence of haze in winter and reduced visibility
- Increased incident of respiratory diseases (asthma, bronchitis, lower respiratory tract infection, etc.)

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## ABATEMENT/CONTROL

- MONITORING
- SOURCE IDENTIFICATION
- STANDARDS: Laws & Regulations
- PRIORITIZATION : Effects & Costs
- MEASURES: Policy interventions
- ENFORCEMENTS: Legal & Technical
- PUBLIC AWARENESS

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## BAEC Activities

- PM monitoring using Gent sampler (PM<sub>2.2</sub> and PM<sub>2.2-10</sub>)
- Characterization of PM (Mass, Black Carbon, Elemental Concentration)
- Source apportionment
- Assessment of regional source contribution using PSCF modelling
- Collaboration with DoE

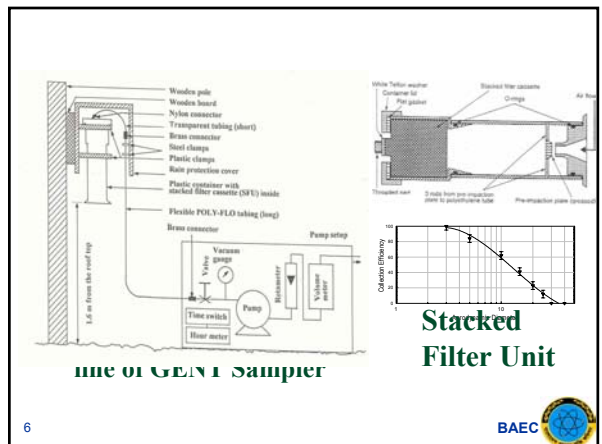
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## Analysis Technique

- Mass by gravimetric analysis
- Black Carbon by reflectance measurement
- Elemental analysis by Ion Beam Analysis (IBA) technique
- Source apportionment by receptor modeling

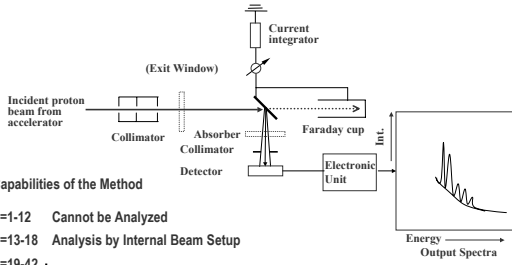
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## PIXE Analytical System



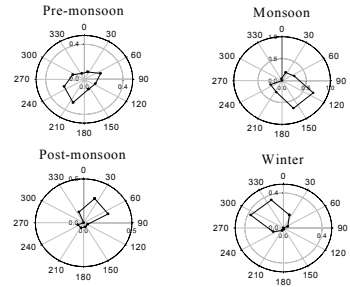
### Capabilities of the Method

- Z=1-12 Cannot be Analyzed
- Z=13-18 Analysis by Internal Beam Setup
- Z=19-42 Analysis by Internal or External Beam Setup
- Z=43-48 Analysis with reduced MDL

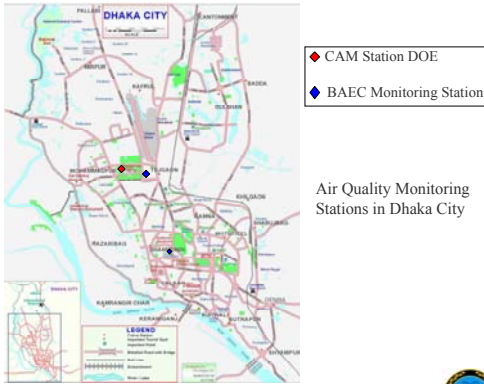
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## Meteorology



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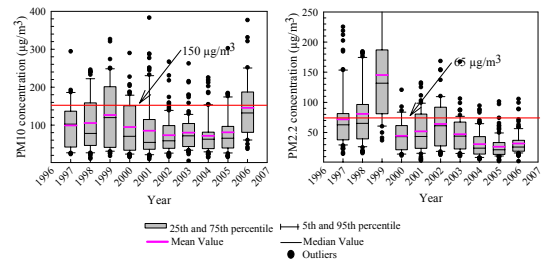


Air Quality Monitoring Stations in Dhaka City

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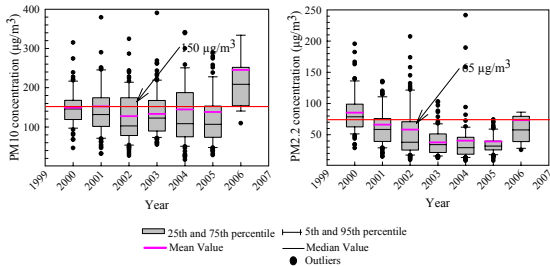
### PM Distribution at Semi-residential area in Dhaka



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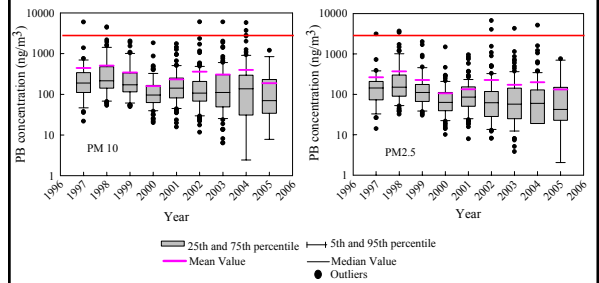
### PM Distribution at a hot spot area in Dhaka



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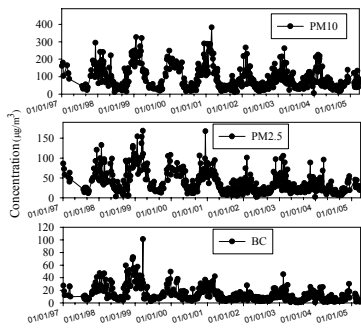
### Pb Distribution at Semi-residential area in Dhaka



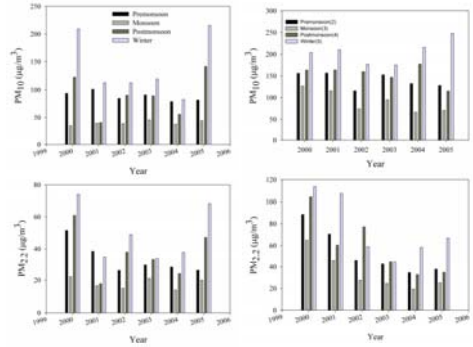
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### Time series pattern



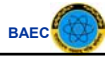
### Seasonal variation of PM at SR and HSD site



### Identification of Local Source

#### Receptor Modeling

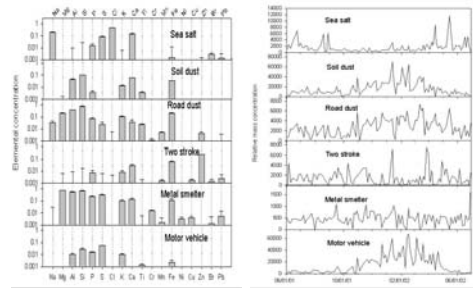
- Principal Component Analysis (PCA)
- Positive Matrix Factorization (PMF)



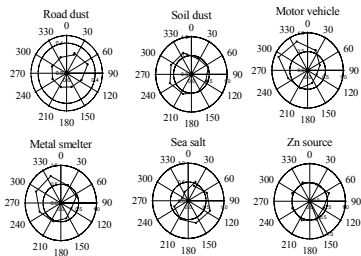
### Source Fingerprints Obtained from PMF method

Compositions for CPM at semi-residential area in Dhaka

Time variations for CPM at semi-residential area in Dhaka



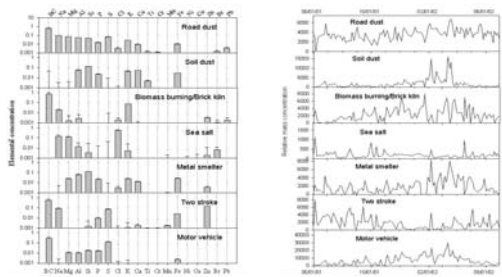
### Conditional probability function (CPF) Coarse PM



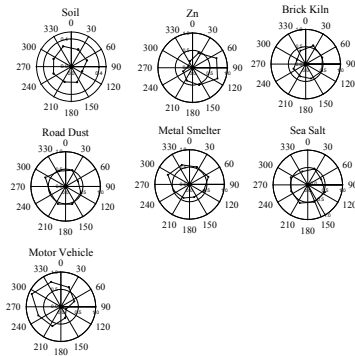
### Source Fingerprints Obtained from PMF method

Compositions for FPM at semi-residential area in Dhaka

Time variations for FPM at semi-residential area in Dhaka



### CPF for Fine PM



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### Average percent contribution of sources for two sites in the Dhaka (PMF modeling results)

Source profile	HSD (Dhaka)	SR (Dhaka)
<b>Coarse particles</b>		
Sea salt	9.41	4.45
Soil dusts	48.7	43.0
Road dusts	-	7.30
Two stroke engine	12.9	3.78
Metal smelter	-	1.21
Motor vehicle	23.4	40.2
Resuspended/Fugitive Pb	2.29	-
Civil construction	3.2	-
<b>Fine Particles</b>		
Road dusts	-	19.4
Soil dusts	1.00	10.2
Biomass burning/Brick kiln	37.5	11.9
Sea salt	-	1.00
Metal smelter	-	9.96
Two stroke engine	2.41	9.36
Motor Vehicle	43.0	38.2
Resuspended/Fugitive Pb	3.32	-
Others	12.7	-

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### Regional Source (PSCF Modeling)

To identify possible source locations of atmospheric aerosols by combining meteorology with measured chemical compositions  
The PSCF value for the cell is defined as

$$PSCF(i, j) = m(i, j) / n(i, j)$$

$n(i, j)$  = number of endpoints that fall in the cell

$M(i, j)$  = number of endpoints concentrations higher than an arbitrarily criterion value (e.g. average concentration)

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### PSCF Calculation

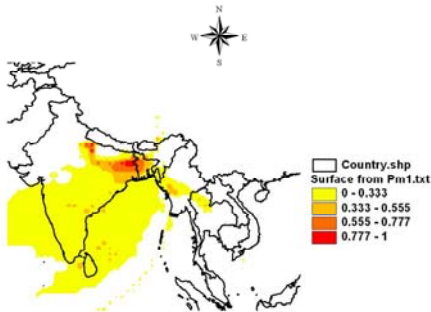
- Back Trajectory by HYSPLIT
- Vertically mixed model starting at 1,000m above ground level used
- Five-days trajectory 1 hour interval (120 endpoints)
- Sampling days: May 2001-March 2005
- Grid Size: 1° x 1° (2160 Cells)
- Over 25,000 trajectory endpoints terminates within the grid cell; average 12 endpoints per cell

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### PSCF: Fine PM (May 2001 to March 2005)

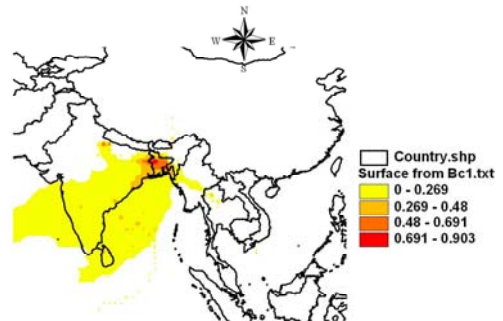


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### PSCF:BC (May 2001 to March 2005)

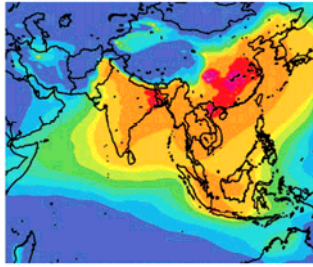


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The simulated annual mean optical depth of BC aerosols for 2004-2005 using the regional aerosol/chemical/transported model described by Ramanathan and Carmichael, *Nature GeoScience*, 1, 221-227 2007.

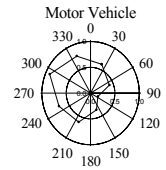
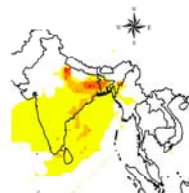


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## PSCF: MV

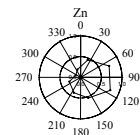
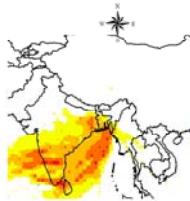


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## PSCF: Zn

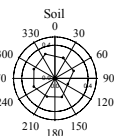
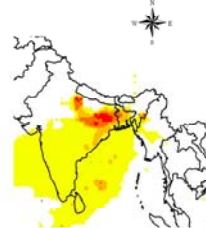


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## PSCF: Soil dust



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- Swapan K. Biswas, S.A. Tarafdar, A. Islam and M. Khaliq-zzaman, Investigation of Sources of Atmospheric Particulate Matter (APM) at an Urban area in Bangladesh, Technical Report, AECD/CH/55, 2001.
- Swapan K. Biswas, A. Islam, S.A. Tarafdar and M. Khaliqzzaman, Consequences of Introducing Unleaded Gasoline in Bangladesh, Proc. Int. Seminar on Air Pollution in Dhaka City, 30 October 2001.
- Swapan K. Biswas, Further studies and Action essential to reduce atmospheric lead in Dhaka The Daily Star, 25 October 2002.
- Swapan K. Biswas, S.A. Tarafdar, A. Islam, and M. Khaliqzzaman, H. Tervahattu, K. Kupiainen, Impact of Unleaded Gasoline Introduction on the Concentration of Lead in the Air of Dhaka, Bangladesh, *J. Air & Waste Manage. Assoc.* 2003, 53 1355-1362
- Swapan K. Biswas, Bilkis A. Begum, M. Khaliqzzaman, A. Islam and S.A. Tarafdar, Characterization of Air pollution at urban sites at Dhaka and Rajshahi in Bangladesh, Proceedings of the Silver Jubilee Conference, 2003, *Bangladesh Chemical Society*.
- Bilkis A. Begum, Eugene Kim, Swapan K. Biswas, and Philip K. Hopke, Investigation of sources of atmospheric aerosol urban and semi-urban areas in Bangladesh by positive matrix factorization, *Atmospheric Environment*, 2004, 38, 3025-3038.

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## List of Publications cont'd

- Bilkis A. Begum and Swapan K. Biswas, Characteristics of PM<sub>2.2</sub> and PM<sub>2.2-10</sub> in the Atmosphere of Dhaka City, *Nuclear Science and Applications*, 2004, 13, 9-19.
- Shahana Akhter, Md. Aminul Islam, A.K. Showkot Hossain, S.M. Abdul Quadir, Amir H. Khan, Bilkis A. Begum, M. Khaliqzzaman, Swapan K. Biswas, Air Quality Monitoring program in Bangladesh: Trends Analysis of Criteria Pollutants and source apportionment of particulate matter in Dhaka, Bangladesh, *CAI-Asia web site, baq2004.org*, 2004.
- Bilkis A. Begum, Swapan K. Biswas, Eugene Kim, Philip K. Hopke and M. Khaliqzzaman, "Investigation of sources of atmospheric aerosol at a hot spot area in Dhaka, Bangladesh", *J. Air and Waste Management Association*, 2005, 55, 227-240.
- Pentti Paatero, Philip K. Hopke, Bilkis A. Begum, Swapan K. Biswas, A graphical diagnostic method for assessing the rotation in factor analytical models of atmospheric pollution, *Atmospheric Environment*, 2005, 39, 193-201.
- Bilkis A. Begum and Swapan K. Biswas, Comparison of PM collection efficiency of Gent and Airmatrix MiniVol Portable Air Sampler, *Nuclear Science and Applications*, 2005, 14, 79-83.
- Bilkis A. Begum and Swapan K. Biswas, Receptor modeling for characterization of Air Particulate Matter, Technical Report, AECD/CH/59, 2005

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14. Bilkis A. Begum, Swapan K. Biswas, Hopke, P.K., Impact of Banning of Two-stroke Engines on Air Quality in Dhaka, Bangladesh, *J. Air and Waste Management Association*, **2006**, **56**, 85-89.
15. Bilkis A. Begum and Swapan K. Biswas, Ambient concentration of PM<sub>2.2</sub>, PM<sub>10</sub> and Black Carbon (BC) in Rajshahi City and comparison with Dhaka City of Bangladesh, *Nuclear Science and Applications*, **2006**, **1**, 14-22.
16. Bilkis A. Begum, Yeasmin N. Jolly, Swapan K. Biswas, Elemental analysis of air particulate matter and application to source fingerprinting, *Bangladesh Academy of Sciences*, **2006**, **30**, 85-93.
17. Bilkis A. Begum, Swapan K. Biswas, Philip K. Hopke and David D. Cohen, Multi-element analysis and characterization of atmospheric particulate pollution in Dhaka, *Aerosols and Air Quality Research*, **2006**, **6**, 334-359.
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19. Bilkis A. Begum, Samir K. Paul, M. Dildar Hossain, Swapan K. Biswas and Philip K. Hopke, Indoor Air Pollution from Particulate Matter Emissions in Different Households in Rural Areas of Bangladesh, *Building and Environment*, In press (2008).

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20. Philip K. Hopke, David D. Cohen, Bilkis A. Begum, Swapan K. Biswas, Bangfa Nid, Gauri Girish Pandite, Muhayaton Santoso, Yong-Sam Chung, Perry Davyh, Andreas Markwitz, Shahida Waheedi, Naila Siddiquei, Flora L. Santos, Preciosa Corazon B. Pabroaj, Manikkuwadura Consy Shirani Seneviratnek, Wanna Wimolwattanapuni, Supamatthree Bunrapob, Thu Bac Vuong, Pham Duy Hienn, Andrzej Markowicz, Urban air quality in the Asian region, *Science of the Total Env.* 404 (2008) 103-112
21. Bilkis A. Begum, Swapan K. Biswas, Md. Nasiruddin, A.M. Showkot Hossain and Philip K. Hopke, Source Identification of Chittagong Aerosol by Receptor Modeling, *Environmental Engineering Science*, (2008) In press

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# Thanks

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