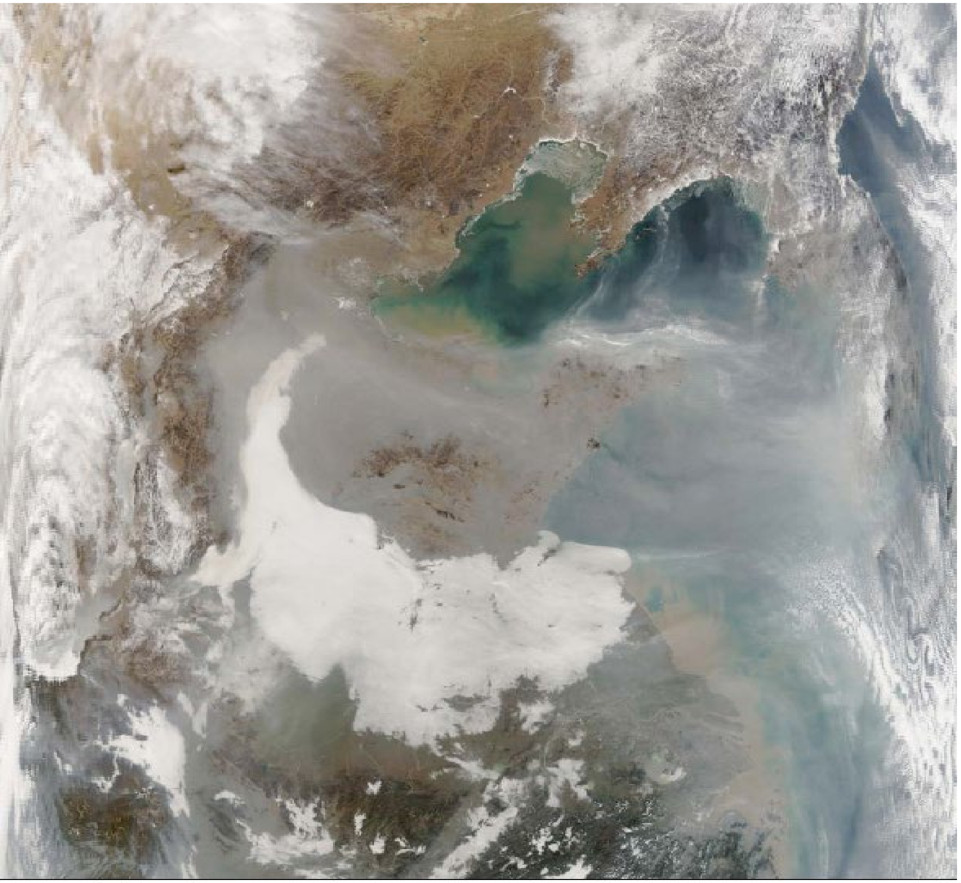
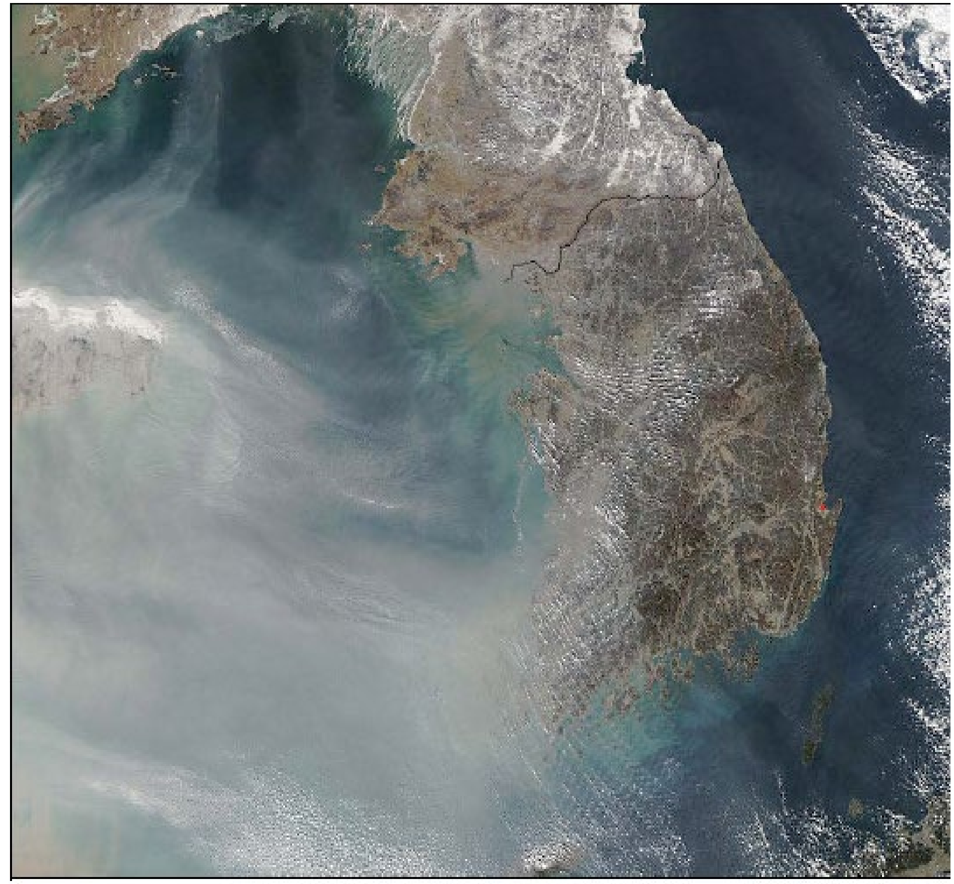
Scientific Assessment of Health Effects of Air Pollution in North-East Asia and the Related Transboundary Cooperation Mechanisms

Yun-Chul Hong
Seoul National University

Air pollution in East Asia

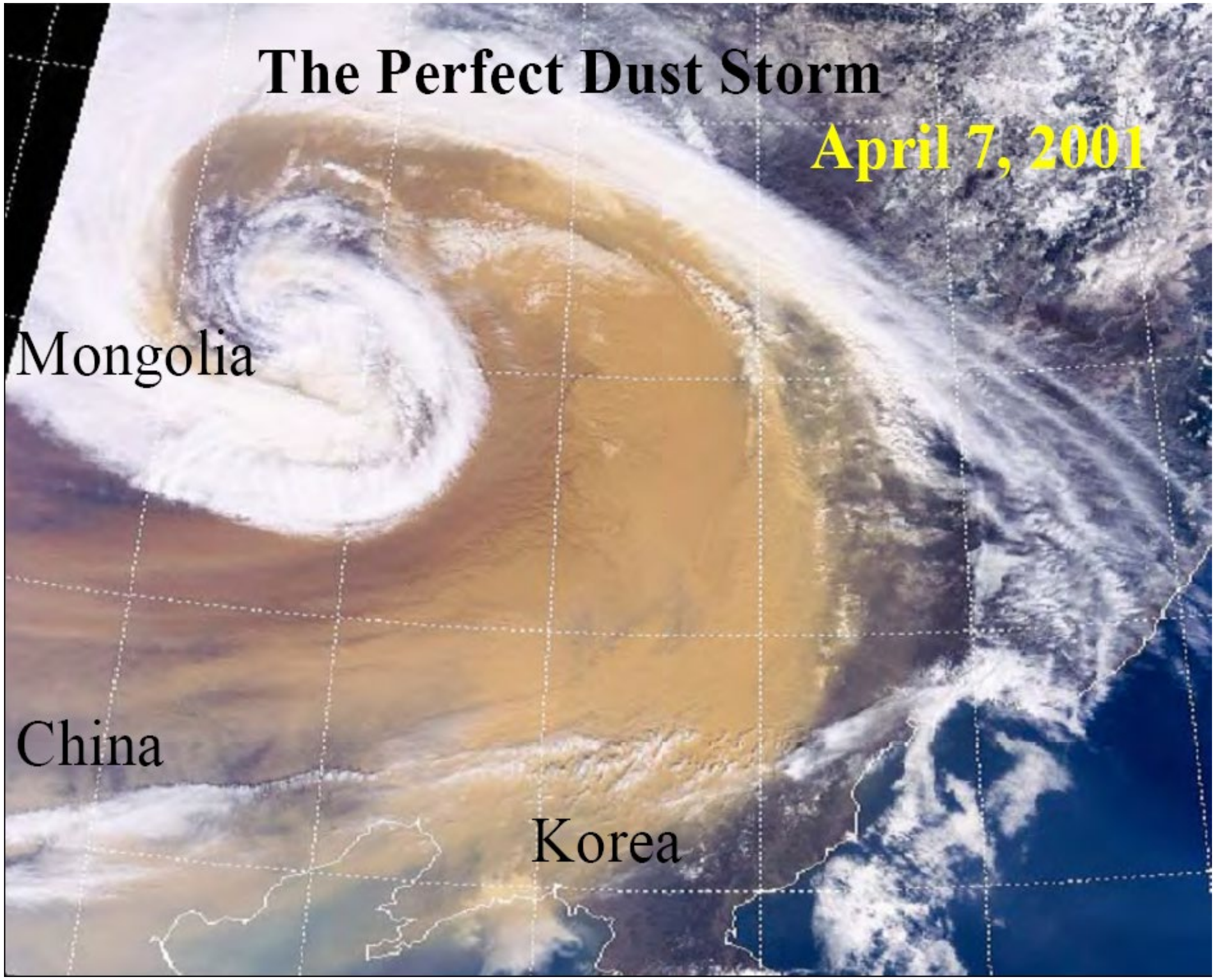


This **January 27, 2006**, MODIS/Terra Real-Time image shows the effects of prevailing west winds during the winter. Smog is being pushed by the winds across the eastern coastal plains of China, and over the Yellow Sea to the Korea Peninsula and Japan. Note the ground fog below the haze in the southern portion of the coastal plains. Fog forms when warm moist air flows over colder air near the ground. The fog, and the associated humidity, tend to concentrate air pollution near the ground.



Taken the same day as the previous image, this **January 27, 2006**, MODIS/Aqua image of the Korean Peninsula shows the dramatic influence t Chinese air pollution has on its neighbors to the east. The Japanese island of Kyushu can just be seen in the bottom right corner of the image, just across t Korean Strait from the South Korean city of Busan. China's Shandong Penins which is covered with thick smog, is just above center on the left edge of the image.

Asian Dust



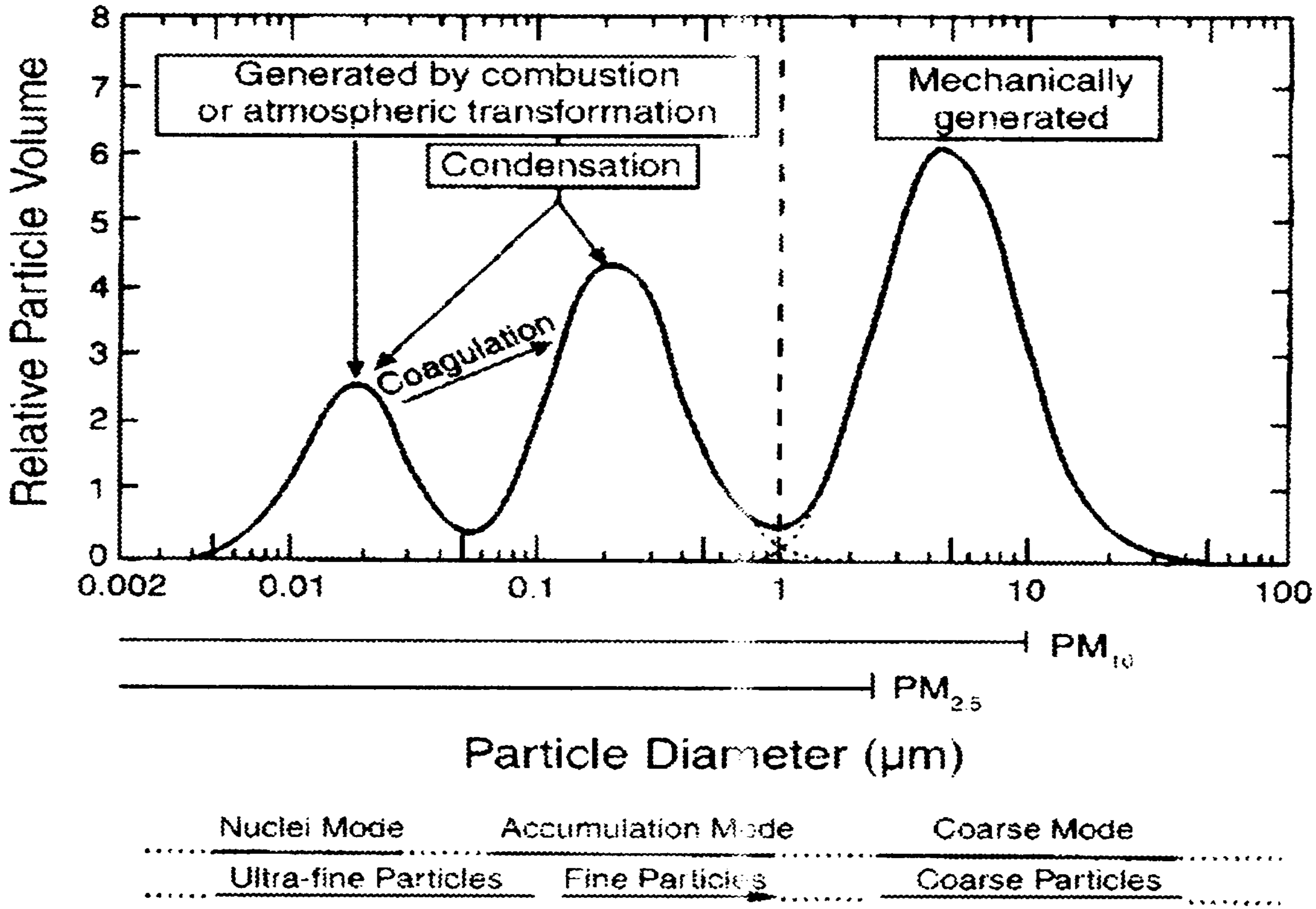


Figure 1. Typical distribution of three sizes or modes of particles in urban air and how different definitions of particle size relate to these modes (69).

Transboundary Pollutant - Particulate Matters

- PM is an air pollutant consisting of a mixture of solid and liquid particles suspended in the air.
- Primary PM can have anthropogenic and nonanthropogenic sources. PM can either be from dust wind from desert area or forest fire, and also attributed to urban air pollutant migrating to adjacent area.

Charateristics of long-range migrating particles

- 0.1 um and 1 um can stay in the atmosphere for days or weeks and thus can be transported over long distances (up to thousands of kilometers)
- The coarse particles are more easily deposited and typically travel less than 10 km from their place of generation. However, dust storms may transport even coarse mineral dust for over 1,000 km.

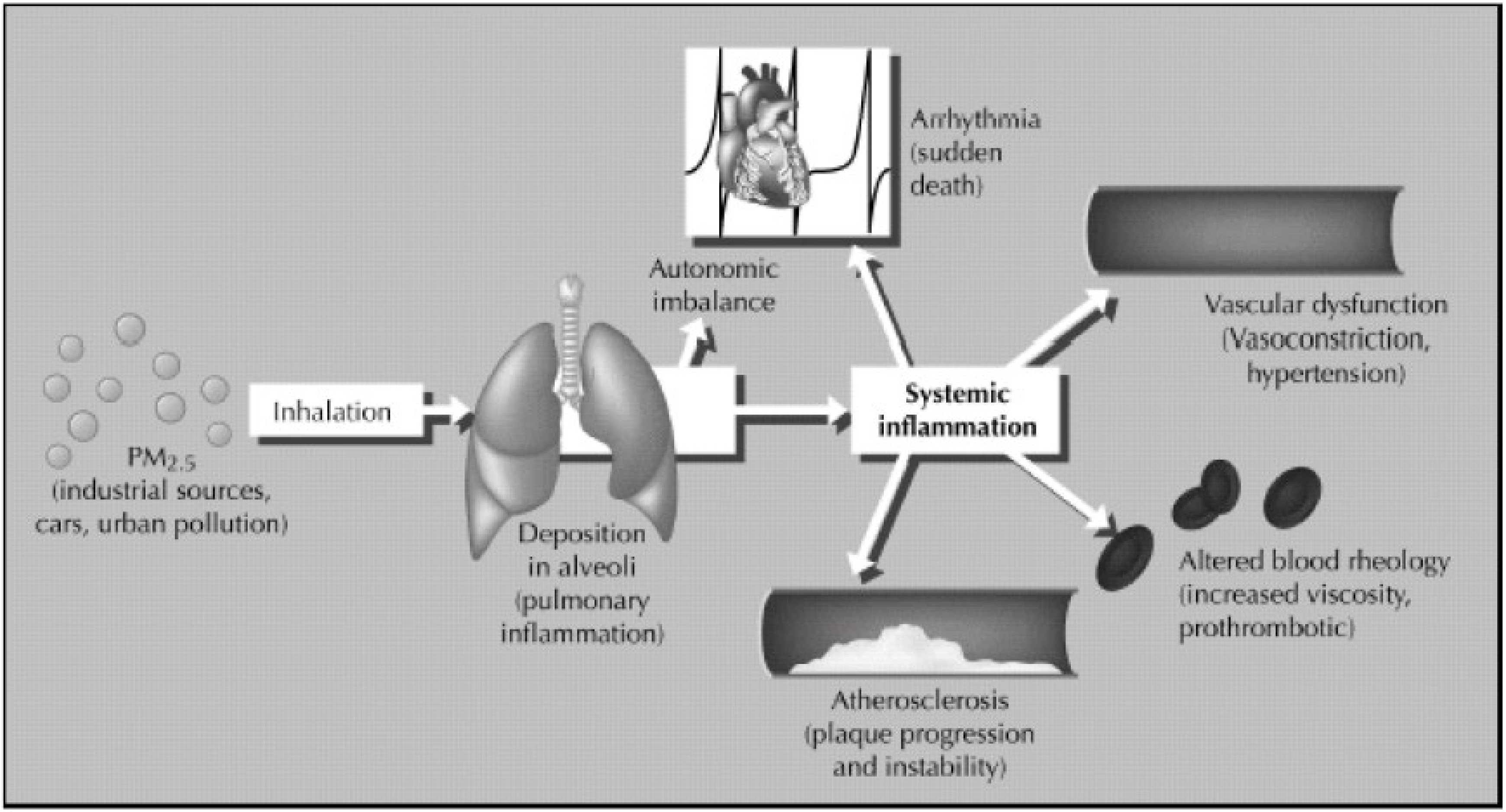
Health Outcomes

- Exposure to PM in ambient air has been linked to a number of different health outcomes:

  - modest transient changes in the respiratory tract and impaired pulmonary function

  - increased risk of symptoms requiring emergency room or hospital treatment

  - increased risk of death from cardiovascular and respiratory diseases or lung cancer.
- This evidence stems from studies of both acute and chronic exposure.
- Toxicological evidence supports the observations from epidemiological studies.


Arrhythmia (sudden death)
Autonomic imbalance
Vascular dysfunction (Vasoconstriction, hypertension)
Inhalation
Systemic inflammation
PM2.5 (industrial sources, cars, urban pollution)
Deposition in alveoli (pulmonary inflammation)
Altered blood rheology (increased viscosity, prothrombotic)
Atherosclerosis (plaque progression and instability)

Epidemiologic Studies of air pollution in Asia

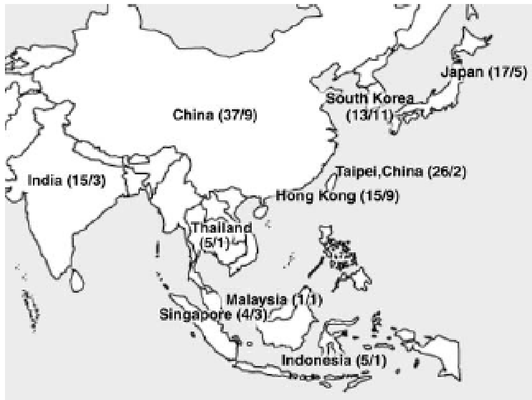


Figure 15. Epidemiologic studies of air pollution in Asia published from 1980 to June 2003. Numbers in parentheses are total studies/time-series studies conducted.

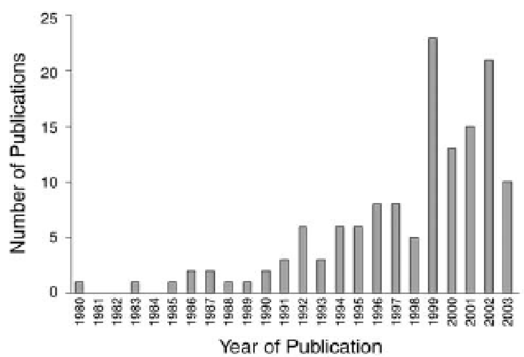


Figure 16. Number of publications of epidemiologic studies of air pollution in Asia by year. In 2003, published papers were collected only through June.

studies) comprised nearly 70% of the total.

We conducted a critical quantitative review of the time-series studies of daily morbidity and mortality only, not of

Table 11. Health Outcomes in Epidemiologic Studies of Outdoor Air Pollution in Asia 1980–2003

Health Outcome	Number of Studies
Mortality	26
Hospital admissions, visits, discharges	17
Respiratory diseases, symptoms, function, asthma	57
Biomarker	9
Pregnancy or birth outcomes	9
Lung cancer	10
Other	10
Total	138

Table 12. Designs Used in Epidemiologic Studies of Health Effects of Outdoor Air Pollution in Asia 1980–2003

Study Design	Number of Studies
Cross section	48
Time series[a]	45
Cohort	14
Case control	8
Panel	7
Ecologic	9
Case crossover	3
Impact assessment	4
Total	138

[a] Includes episode studies.

HEI, Special Report 15, 2004

PM10 and Mortality

Figure 18. PM_{10} and All-Cause Mortality

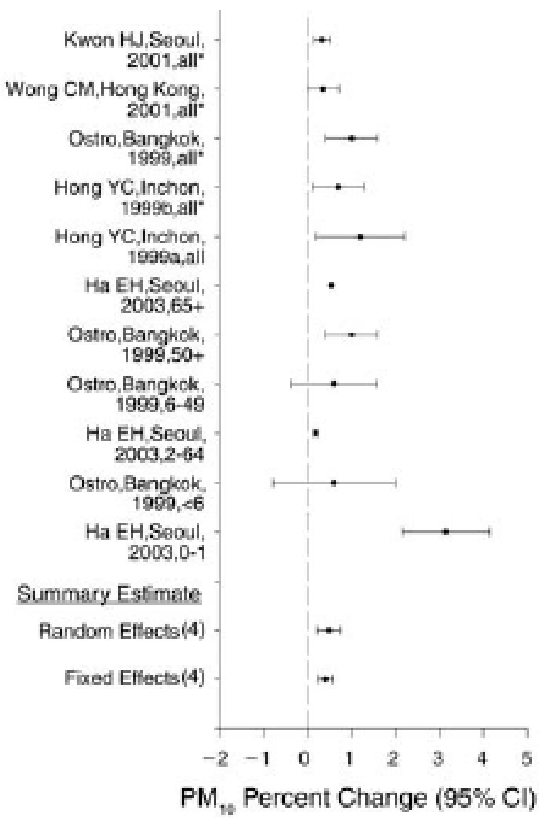


Figure 19. PM_{10} and Respiratory Mortality

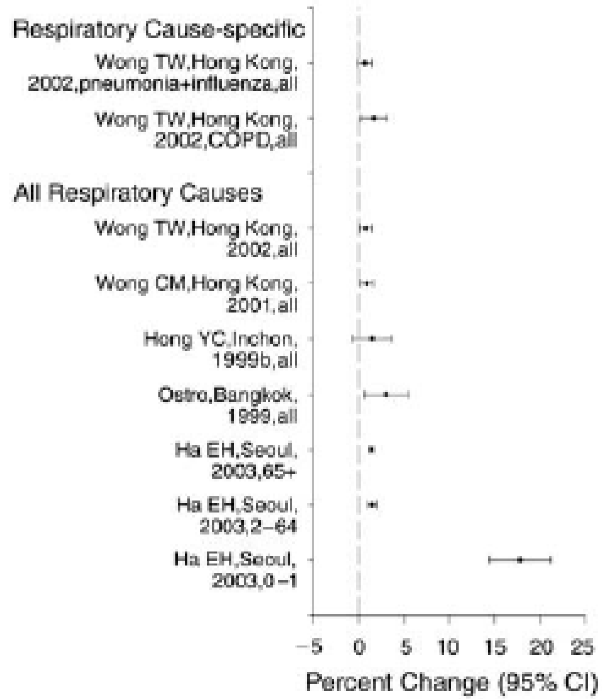
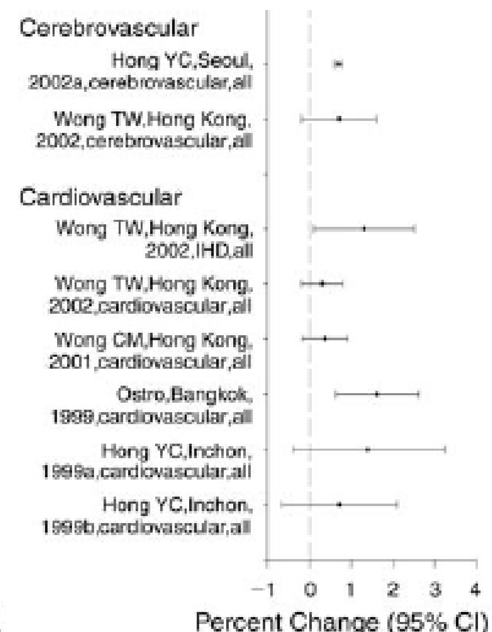


Figure 20. PM_{10} and Cardiovascular Mortality



PM10 and Hospital Admissions

Figure 21. PM_{10} and Respiratory Hospital Admissions

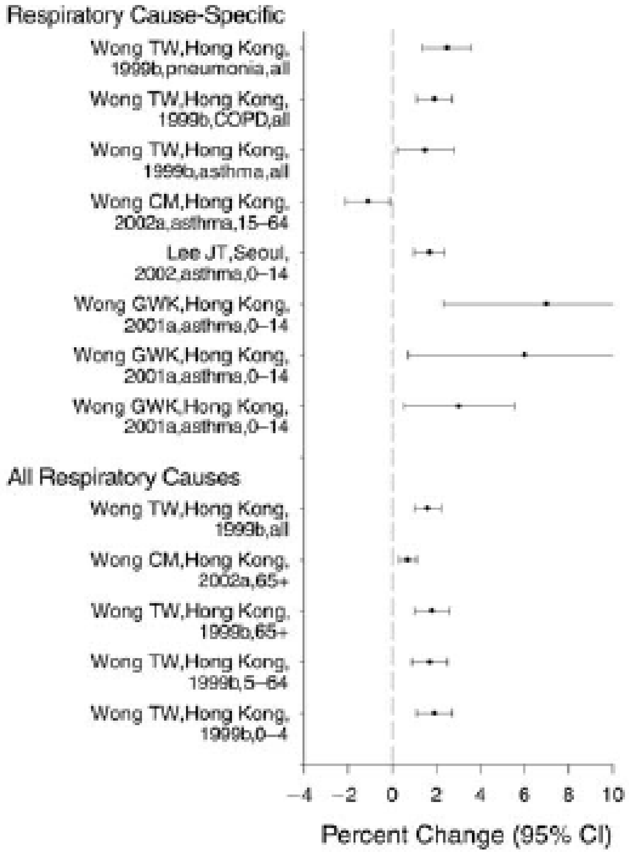
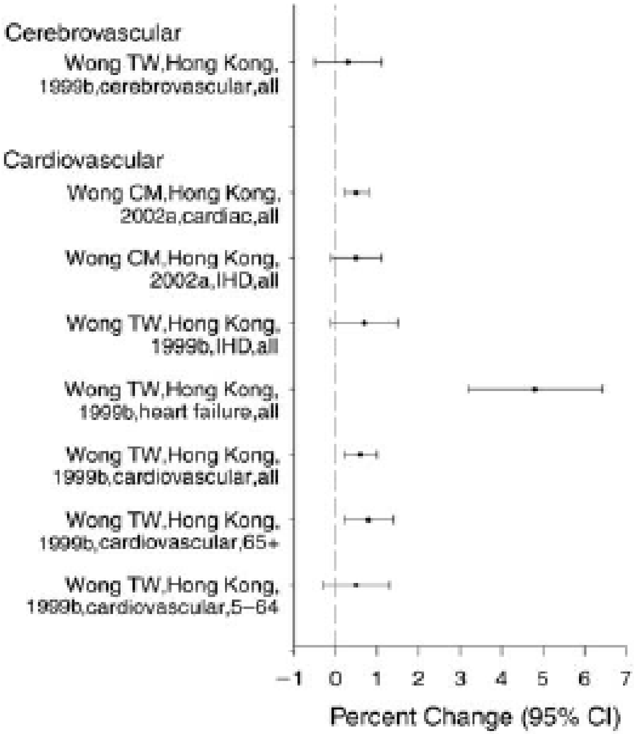


Figure 22. PM_{10} and Cardiovascular Hospital Admissions



Metals in Particulate Pollutants Affect Peak Expiratory Flow of Schoolchildren

Yun-Chul Hong,[1,2] Seung-Sik Hwang,[1] Jin Hee Kim,[1] Kyoung-Ho Lee,[1,2] Hyun-Jung Lee,[3] Kwan-Hee Lee,[4] Seung-Do Yu,[5] and Dae-Seon Kim[5]

[1]Department of Preventive Medicine, Seoul National University College of Medicine, Seoul, Republic of Korea; [2]Institute of Environmental Health, Seoul National University Medical Research Center, Seoul, Republic of Korea; [3]Department of Epidemiology and Biostatistics, Seoul National University School of Public Health, Seoul, Republic of Korea; [4]Department of Occupational and Environmental Medicine, Inha University Hospital, Incheon, Republic of Korea; [5]Division of Environmental Epidemiology, National Institute of Environmental Research, Incheon, Republic of Korea

BACKGROUND: The contribution of the metal components of particulate pollutants to acute respiratory effects has not been adequately evaluated. Moreover, little is known about the effects of genetic polymorphisms of xenobiotic metabolism on pulmonary function.

OBJECTIVES: This study was conducted to assess lung function decrement associated with metal components in particulate pollutants and genetic polymorphisms of glutathione *S*-transferase M1 and T1.

METHODS: We studied 43 schoolchildren who were in the 3rd to 6th grades. Each student measured peak expiratory flow rate three times a day for 42 days. Particulate air concentrations were monitored every day, and the concentrations of iron, manganese, lead, zinc, and aluminum in the particles were measured. Glutathione *S*-transferase M1 and T1 genetic polymorphisms were determined using DNA extracted from participant buccal washings. We used a mixed linear regression model to estimate the association between peak expiratory flow rate and particulate air pollutants.

RESULTS: We found significant reduction in the peak expiratory flow rate after the children's exposure to particulate pollutants. The effect was shown most significantly 1 day after exposure to the ambient particles. Manganese and lead in the particles also reduced the peak expiratory flow rate. Genetic polymorphisms of glutathione *S*-transferase M1 and T1 did not significantly affect peak expiratory flow rate.

CONCLUSIONS: This study demonstrated that particulate pollutants and metals such as manganese and lead in the particles are associated with a decrement of peak expiratory flow rate. These effects were robust even with consideration of genetic polymorphisms of glutathione *S*-transferase.

KEY WORDS: air pollution, genetic polymorphism, lung function, metals, particles. *Environ Health Perspect* 115:430–434 (2007). doi:10.1289/ehp.9531 available via *http://dx.doi.org/* [Online 11 December 2006]

polymorphisms of *GSTM1* and *GSTT1* were associated with PEFR in schoolchildren, we performed a panel study that included daily measures of the PEFR and PM concentrations. PEFR monitoring has been used for assessment of particulate air pollutant effects on airways because it is easy to perform and allows for a large number of measurements during the study period (Bellia et al. 2003). In a panel study with daily measurements of PEFR, each subject can be used as his or her own control, and only time-varying covariates for the subject need to be considered in the analysis. We hypothesized that elevations of PM or metal components in PM are associated with a decrease of PEFR in schoolchildren, and that genetic polymorphisms of *GSTM1* and *GSTT1* affect PEFR as well.

Materials and Methods

Study population. The study group consisted of children in a school on the Dukjeok Island near Incheon City, Korea. We invited all of the 46 students in the 3rd to 6th grades to

Table 4. Regression coefficients of morning and daily mean PEFR on $PM_{2.5}$, PM_{10}, and metal components of PM_{10} using linear mixed-effects regression.

	Morning PEFR				Mean PEFR			
	Crude		Adjusted[a]		Crude		Adjusted	
Variable	β	p-Value	β	p-Value	β	p-Value	β	p-Value
Lag1 ($PM_{2.5}$)	–0.14	0.12	–0.54	< 0.01	–0.15	0.02	–0.54	< 0.01
Lag1 (PM_{10})	–0.00	0.99	–0.04	0.37	0.00	0.93	–0.05	0.12
Lag1 (logFe)	–1.26	0.31	–3.24	0.13	–1.20	0.20	–2.37	0.15
Lag1 (logMn)	–4.40	< 0.01	–9.82	< 0.01	–4.05	< 0.01	–8.44	< 0.01
Lag1 (logPb)	–6.79	< 0.01	–6.83	< 0.01	–6.23	< 0.01	–6.37	< 0.01
Lag1 (logZn)	–0.55	0.71	–0.98	0.59	1.33	0.24	1.53	0.28
Lag1 (logAl)	–0.58	0.57	–2.22	0.25	–0.59	0.45	–1.48	0.32

[a]Adjusted by age, sex, height, weight, asthma history, environmental tobacco smoke exposure, temperature, relative humidity, atmospheric pressure, and day of the week.

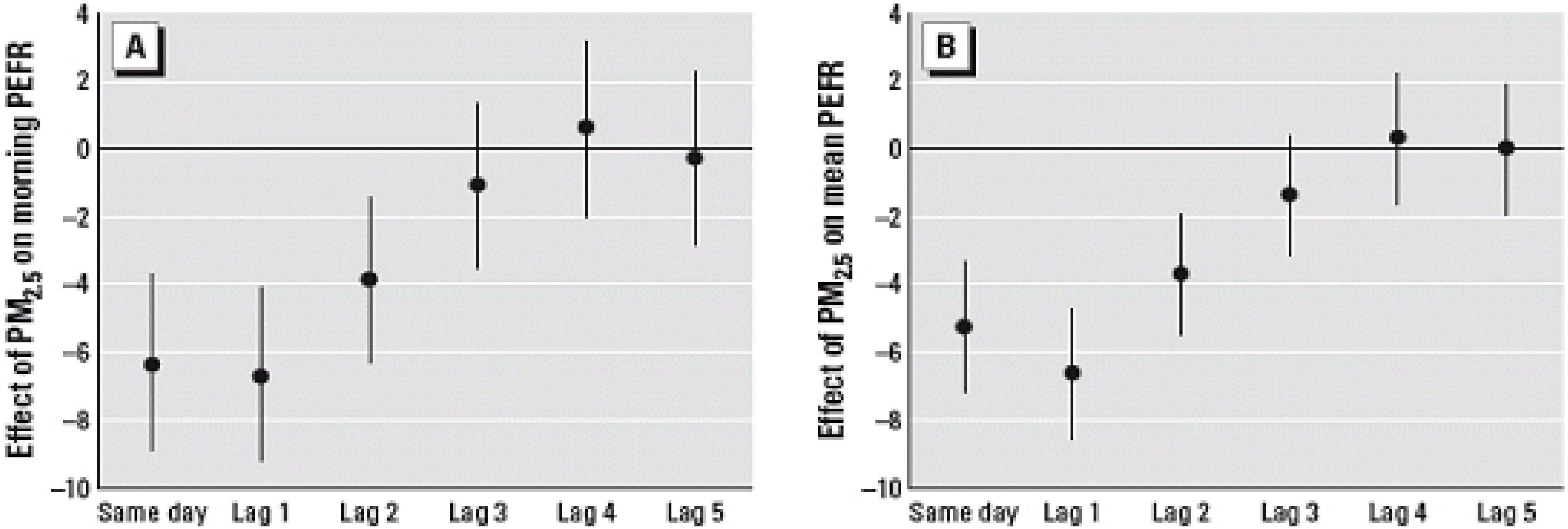


Figure 1. Lag distribution of morning PEFR (*A*) and daily mean PEFR (*B*) change by interquartile increase of $PM_{2.5}$. Estimated decrements of PEFR (dots) and 95% confidence intervals (error bars) controlling for age, sex, height, weight, asthma history, environmental tobacco smoke exposure, meteorologic variables, and day of the week are shown.

Environmental Health Prospective (Hong et al., 2007)

Study area

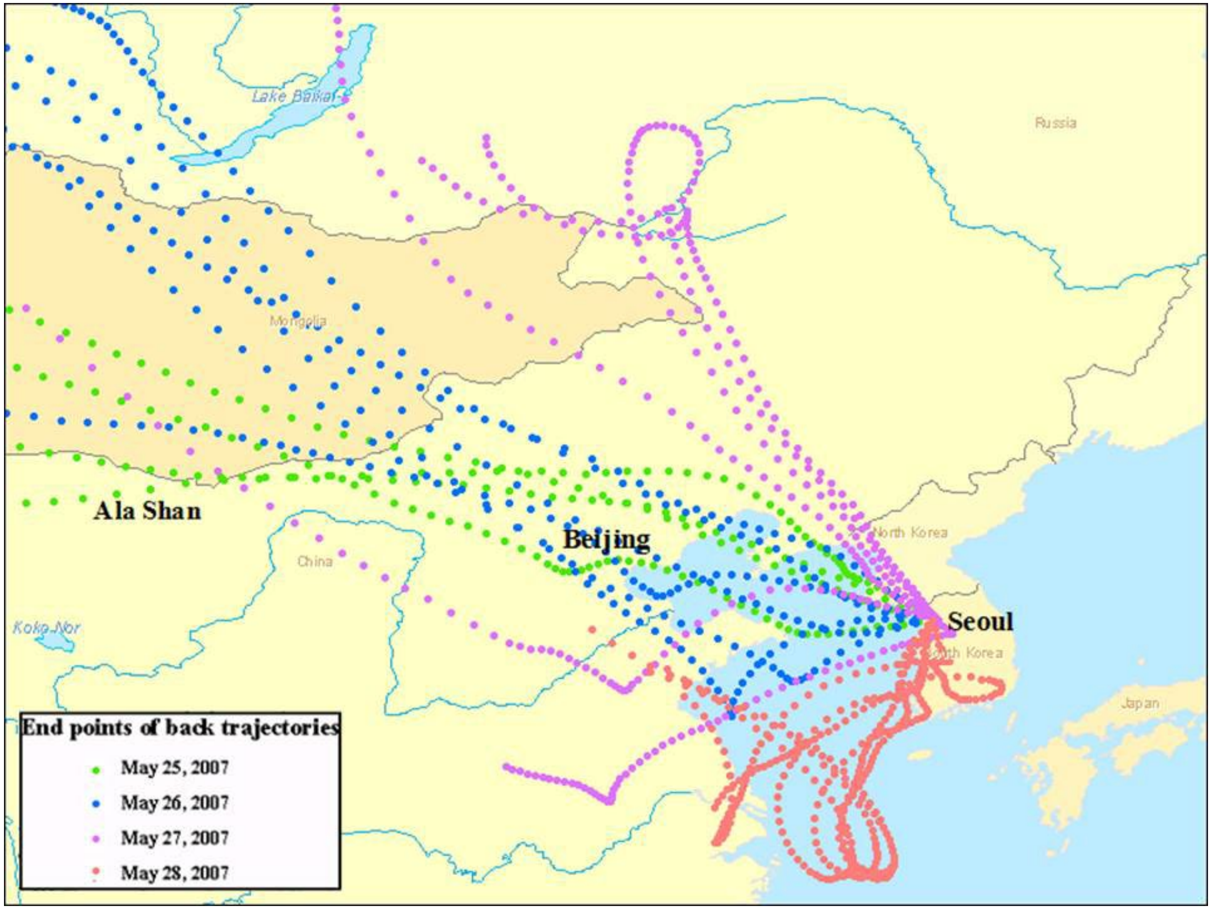


Figure 1. Three-day backward trajectories of ADS arriving at Seoul during the study periods.

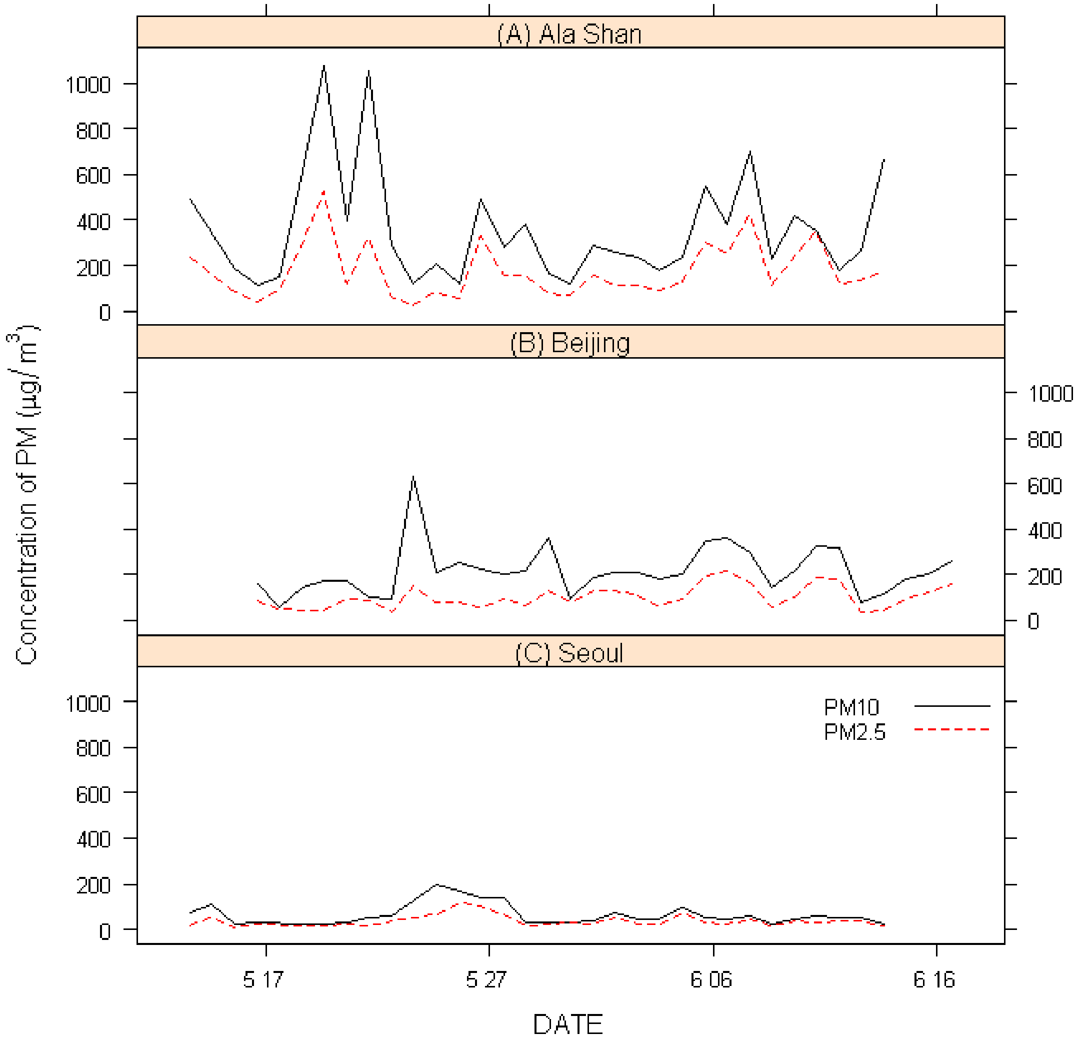


Figure 2. PM2.5 and PM10 levels in (A) Ala Shan, (B) Beijing, and (C) Seoul between 2007-5-14 and 2007-6-17.



Table 1 Study subjects and summary statistics (Mean(SD) or N(%))

	Ala Shan	Beijing	Seoul
Male/Female	61/55	61/48	56/54
Age (year)	10.8 (0.5)	10.1 (0.4)	9.3 (0.5)
Height (cm)	141.5 (5.7)	143.8 (6.4)	138.1 (6.0)
Weight (cm)	33.6 (5.8)	37.3 (8.7)	34.9 (6.4)
Asthma	0 (0.0)	6 (5.6)	18 (16.8)
Second-hand smoke exposure	67 (75.3)	42 (37.8)	20 (18.7)
PEFR (L/min)	311.4 (51.8)	340.8 (53.3)	267.6 (49.8)

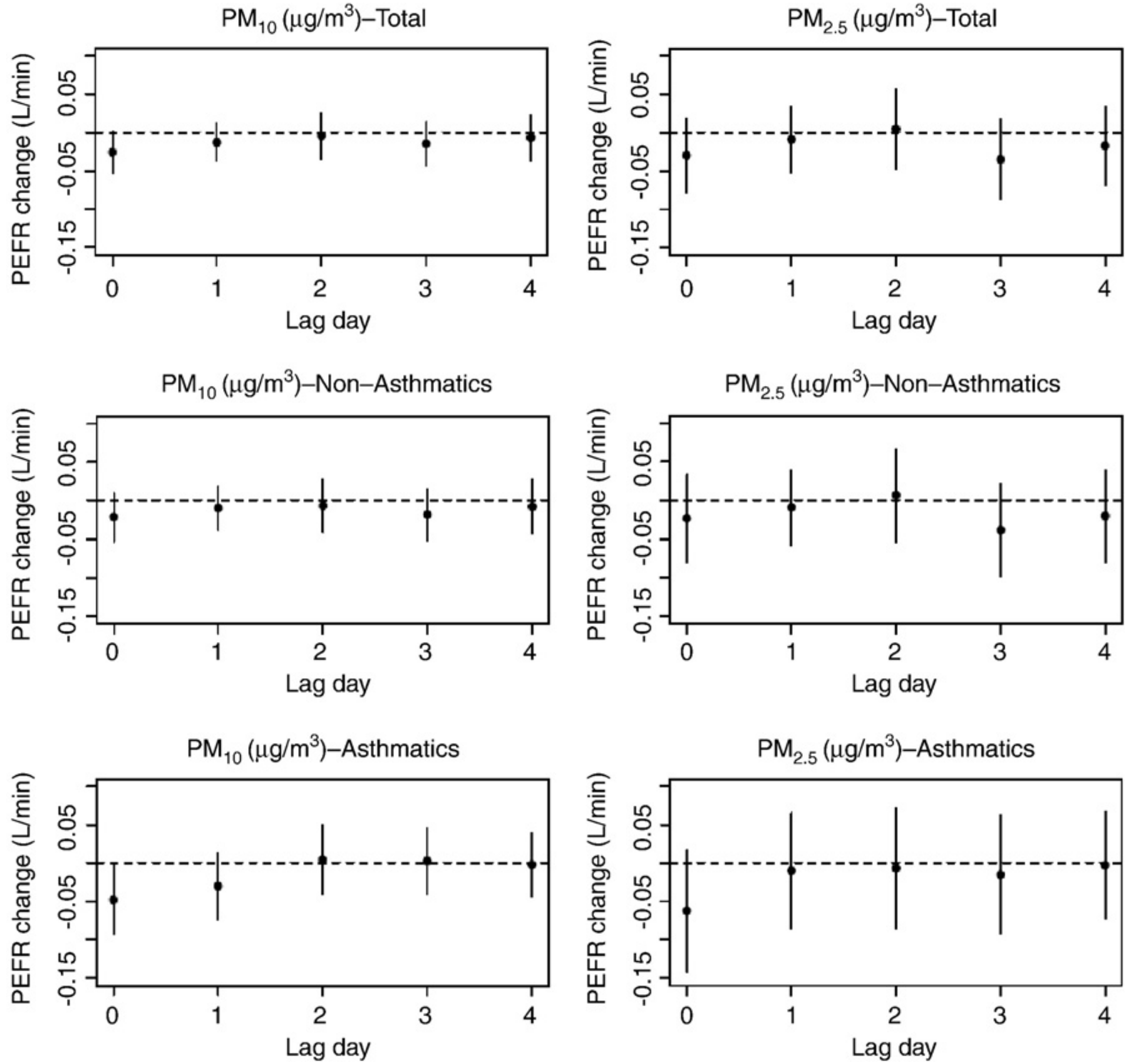


Fig. 2. PEFR change by 1μg/m^3 increase of $PM_{2.5}$ and PM_{10} for all subjects, non-asthmatics and asthmatics from the current day to the 4 previous days. Estimated decrements of PEFR (dots) and 95% confidence intervals (error bars) controlling for age, sex, height, weight, asthma history, and environmental tobacco exposure at home; meteorological variables such as daily mean temperature, mean relative humidity, and air pressure; and the linear time trend.

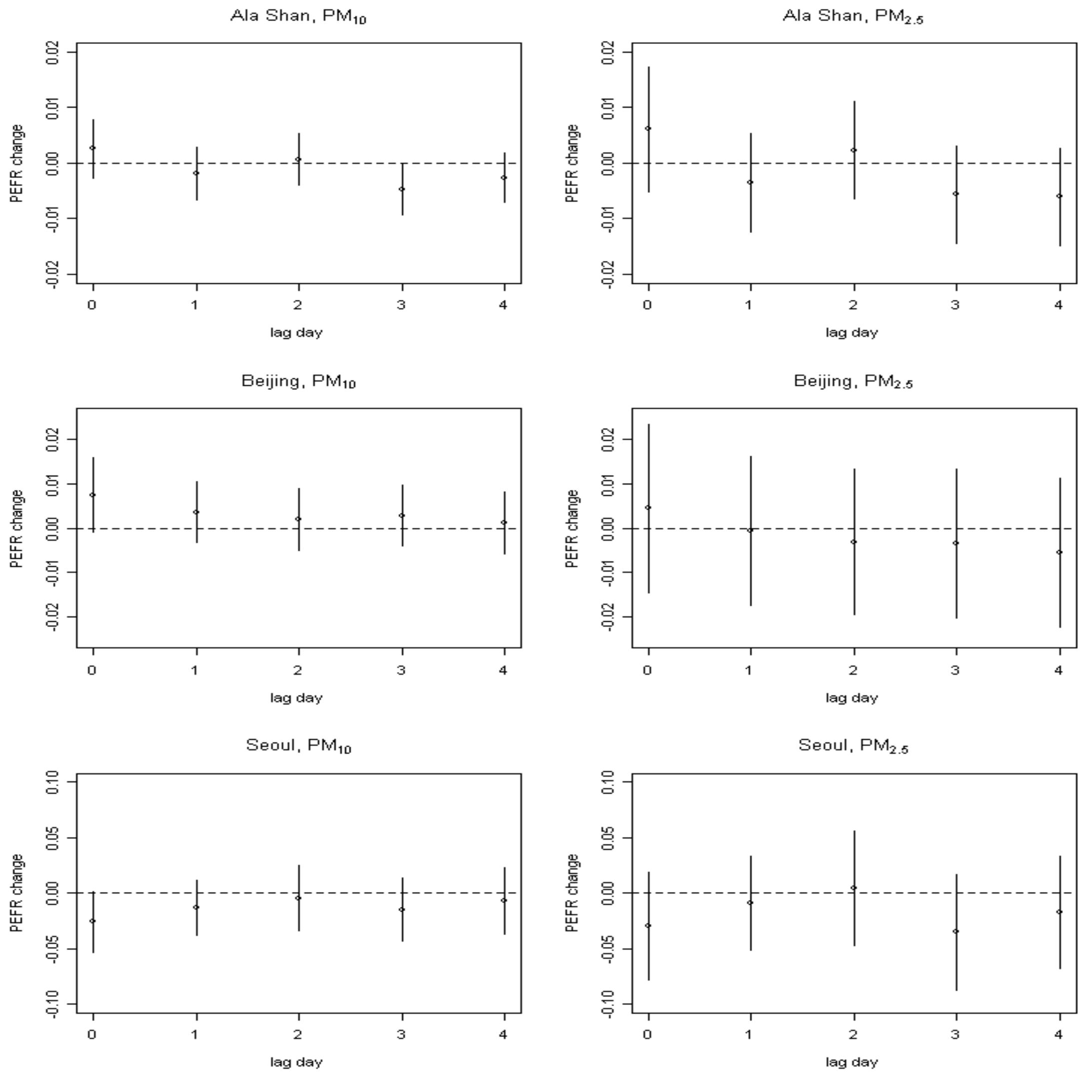


Figure 4. Lag distribution of daily mean PEFR change by unit increase of PM2.5 and PM10. Estimated decrements of PEFR (dots) and 95% confidence intervals (error bars) controlling for age, sex, height, weight, asthma history, and environmental tobacco exposure at home; meteorological variables such as daily mean temperature, mean relative humidity, and air pressure; and the linear time trend.

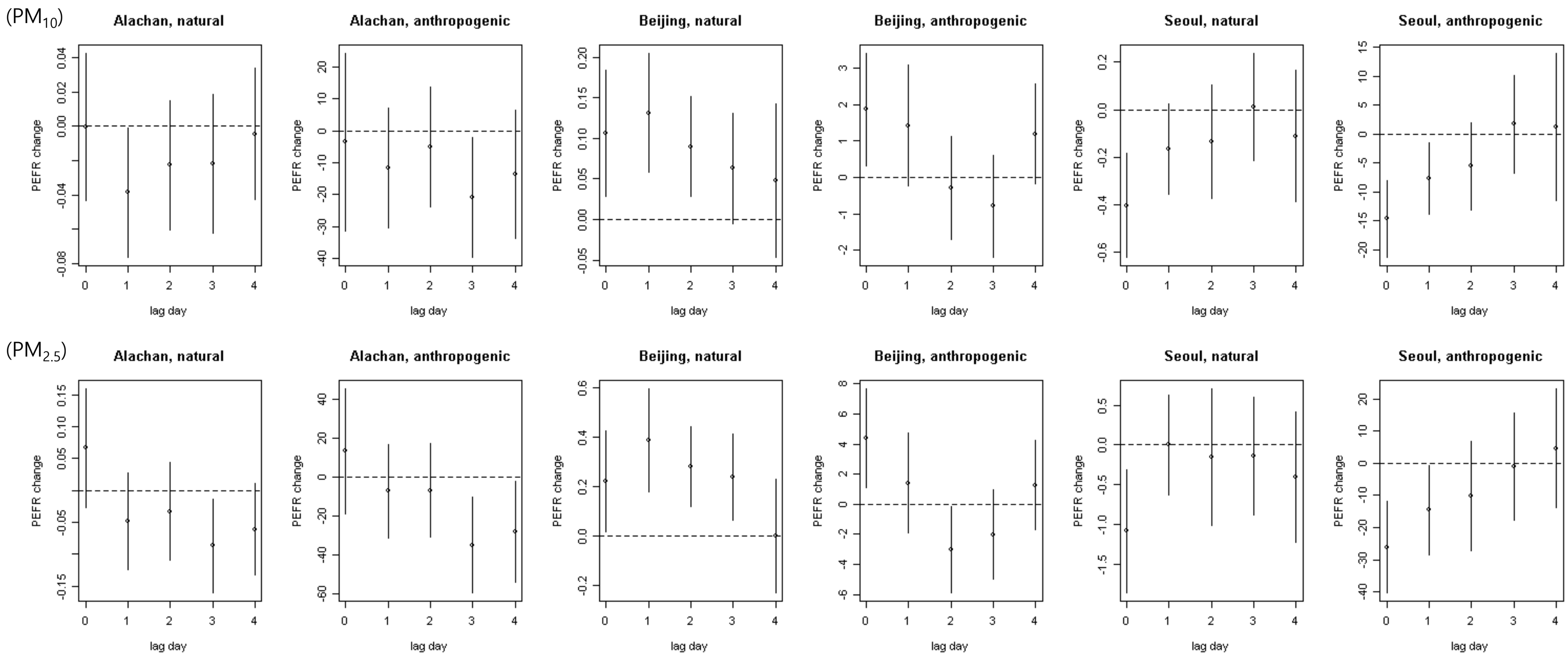
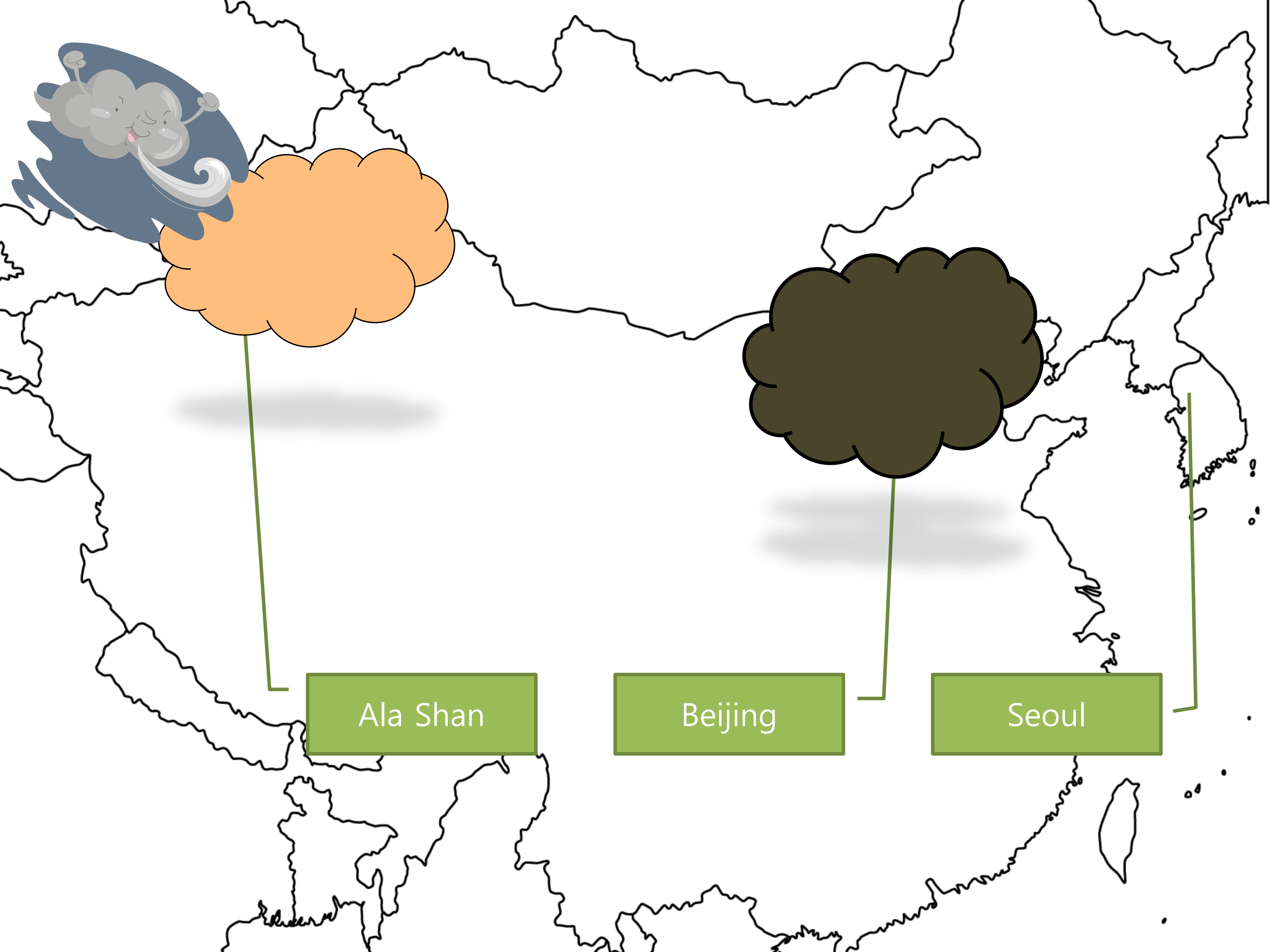


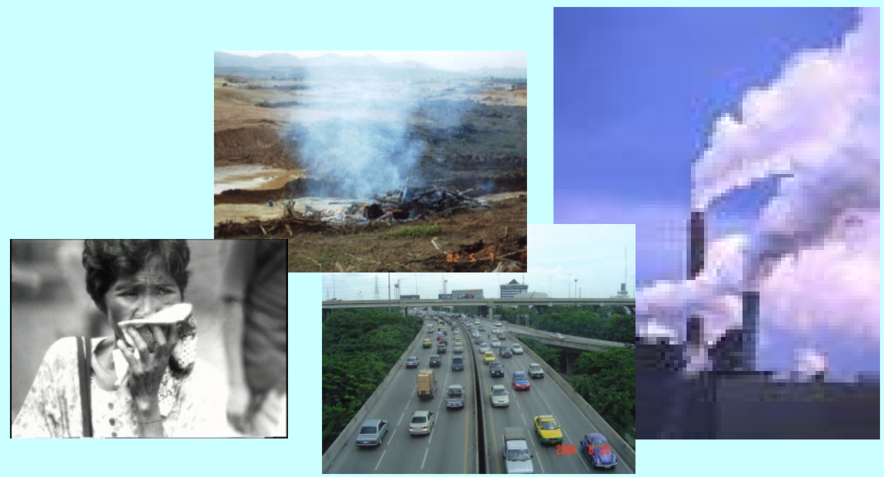
Figure 5. Lag distribution of daily mean PEFR change by unit increase of each sum of the five natural and anthropogenic metal components from the current day to the 4 previous days. Estimated decrements of PEFR (dots) and 95% confidence intervals (error bars) controlling for age, sex, height, weight, asthma history, and environmental tobacco exposure at home; meteorological variables such as daily mean temperature, mean relative humidity, and air pressure; and the linear time trend.


Ala Shan
Beijing
Seoul

Conclusion

1) Airborne particulates move from the desert areas through Beijing to Seoul, which influence on particulate concentrations in the cities.
2) The ADS affects pulmonary function in school children, and the health impact was different depending on the locations of the cities along the ADS paths.
3) This study suggests that the ADS contribute to displacement of urban air pollution and the health effect from eastern China to Korea.

Policy Brief and Regional Workplan
Air Quality Thematic Working Group



The Second Ministerial Forum on
Environment and Health in South-East and East Asian Countries

14-15 July 2010
Jeju, Republic of Korea

Thematic Working Group on Air Quality

Co-chairs:

- **Professor Yun-Chul Hong, College of Medicine, Seoul National University, Republic of Korea**
- **Dr.Wijarn Simachaya, Deputy Director General, Pollution Control Department, Thailand**

Objectives:

- **Reducing health burden imposed by deteriorating air quality;**
- **Strengthening the cooperation at national and regional levels;**
- **Building capacity of researchers and scientists focusing on air quality and health effects;**
- **Promoting public participation and public relations**;

Common issues in the region:

- **Urban air pollution**
- **Indoor air pollution**
- **Transboundary air pollution**

Summary of key activities/outputs

- **Overview of air quality standards**
- **Recommendations on air quality standards and monitoring protocols**
- **Policy guidance on integrating poverty in the design**
- **Implementation of air quality management policies**
- **Researches on air pollution and impacts to human health**
- **Documented methodology on studying the linkages between poverty, health, air quality and green house gases (GHGs) reduction;**
- **Training and courses for air quality professionals**
- **Developing guidelines and methodologies for monitoring air pollutants, especially PM & ozone.**

Pre-event of Better Air Quality (BAQ) 2008

November 11, 2008

Bangkok, Thailand

Organized by Co-Chairs Air Quality Thematic Working Group

- Member of Air Quality TWG exchanged knowledge and skills in the area of air quality and health in Asia;
- Professional resources and researcher discussed on research and management activities;

Symposium on Air Quality and Health in South-East and East Asia
August 30, 2010 in ISES-ISEE2010,
Seoul, Republic of Korea

Organized by Co-Chairs Air Quality Thematic Working Group

- Introduction of Regional Air Quality Workplan;
- Opportunity for professional resources and researcher to exchange idea and discuss on current research and future needed academia activities;

Thank you