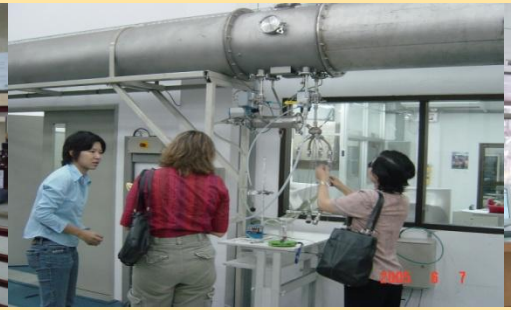



Know your Researcher @ Asian Institute of Technology






Edition January 2011 : Prof Nguyen Thi Kim Oanh

Air pollution and climate co-benefit research at EEM/SERD

Prof Nguyen Thi Kim Oanh

Highlights

1. Regional networks to establish a comprehensive air toxics database and climate forcers in Asian cities
2. Source emission characterization
3. Emission inventory of air pollution and climate forcers
4. Modeling air quality: receptor modeling, urban/regional dispersion modeling
5. Exposure assessment: biomass burning smoke, traffic emission, pesticides applied indoor
6. Development of air pollution control technologies
7. Air quality and climate interaction: air quality and climate modeling for quantification of co-benefits

1. Regional research networking

- AIRPET (Asian Air Pollution Research Network) is a component of Asian Regional Research Program on Environmental Technology (ARRPET)
- Sponsored by Sida, coordinated by AIT
  http://www.arrpet.ait.ac.th/
- Project duration:
  - Phase 1 (2001-2004)
  - Phase 2 (2005-2010)
- AIRPET is a regional network involving 6 countries
  http://www.serd.ait.ac.th/airpet

ARRPET network

AIRPET (2001-2010)

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AIT AIRPET

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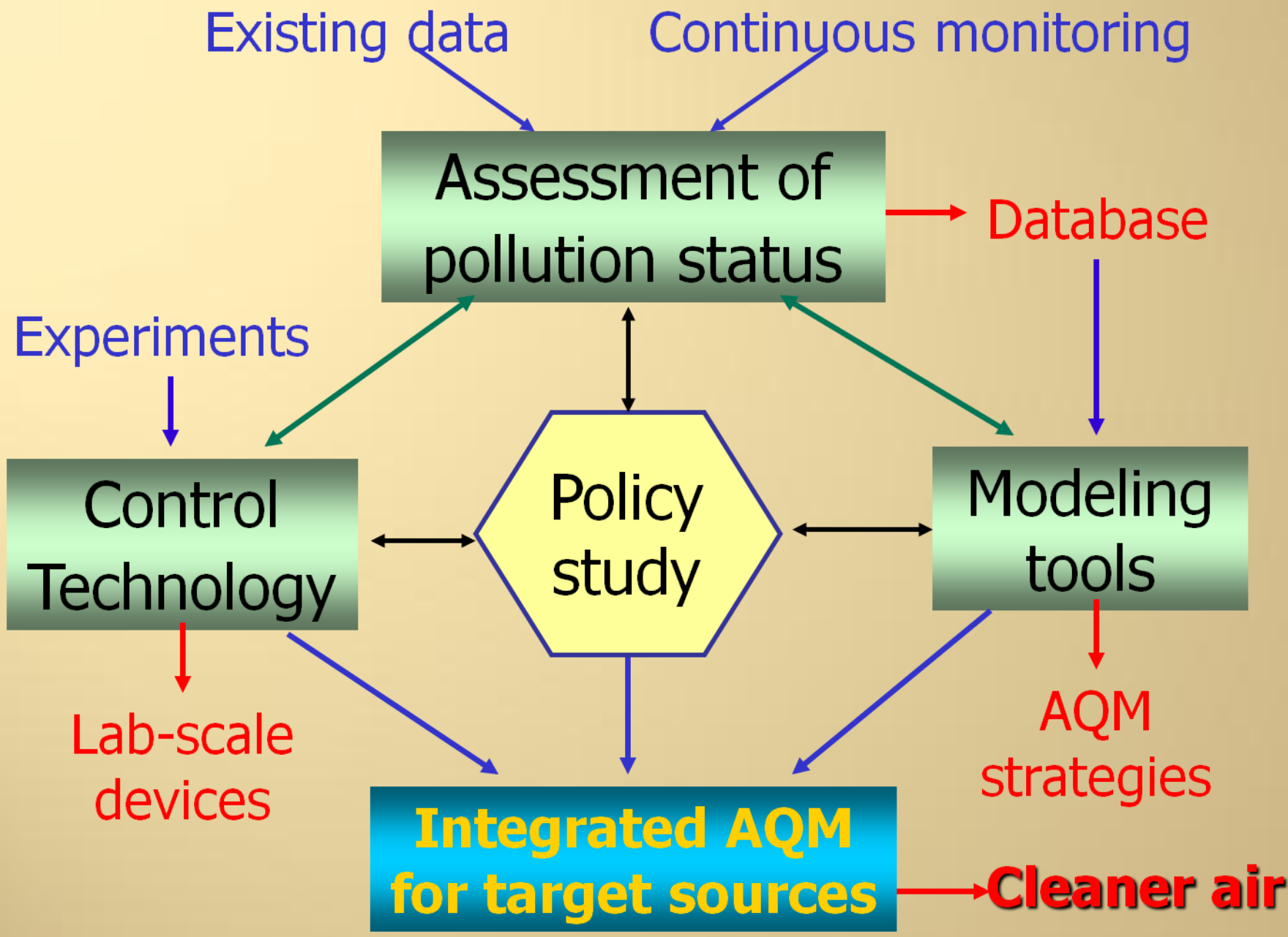
Asian Institute of Technology
Pathumthani 12120, Thailand

Project website http://www.serd.ait.ac.th/airpet/

Regional activities within AIRPET

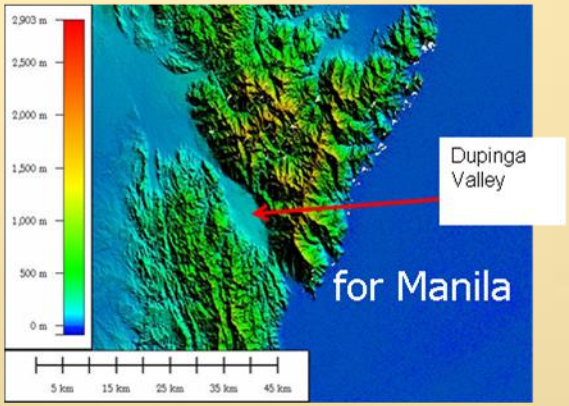


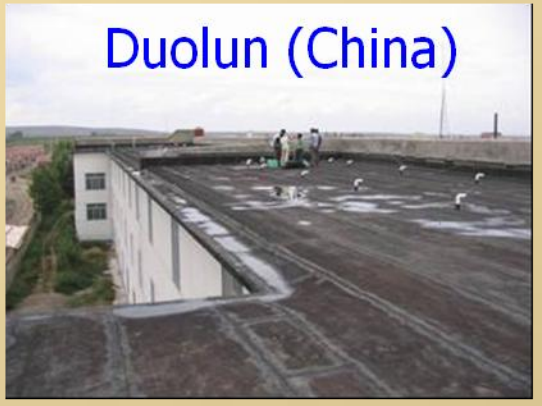
AIRPET ambient air quality monitoring

- AIRPET activities: Ambient Particulate Matter (PM2.5, PM10) mass and composition (black carbon, organic carbon, ions, elements), air toxics including benzene, toluene, ethybenzene, xylenes and semi-volatile organic compounds (PCB, Pesticides, PAHs) at urban areas, remote sites
- Over 8000 PM samples collected in 6 countries ➔ database of detail mass and composition with adequate QA/QC

AIRPET monitoring sites

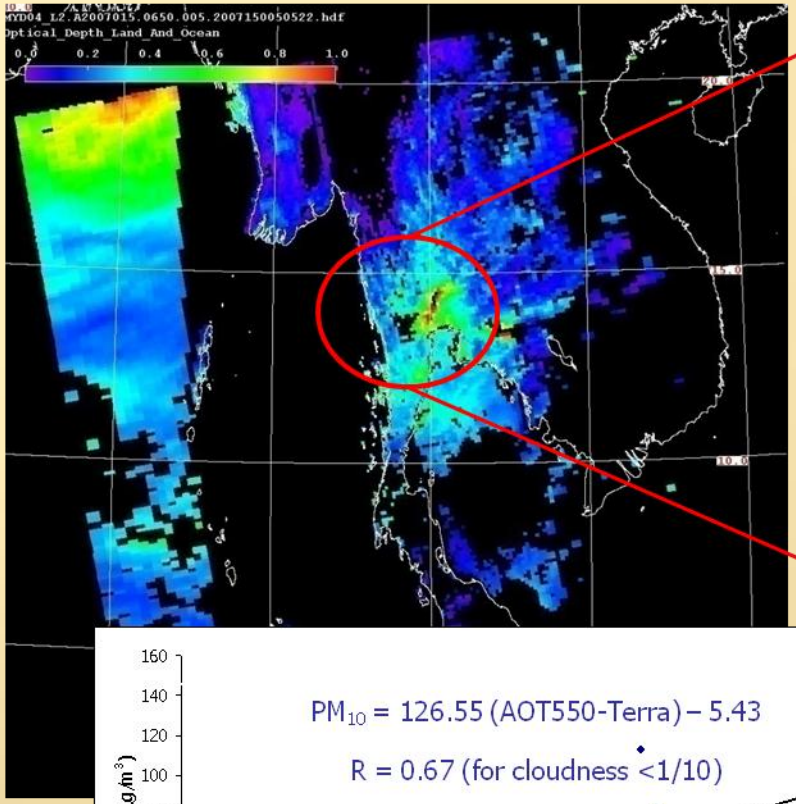
Remote sites

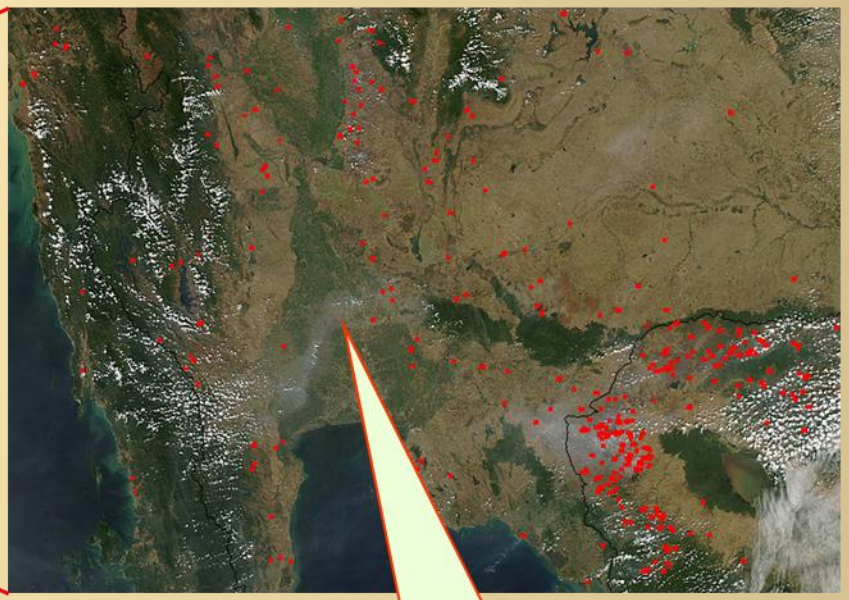


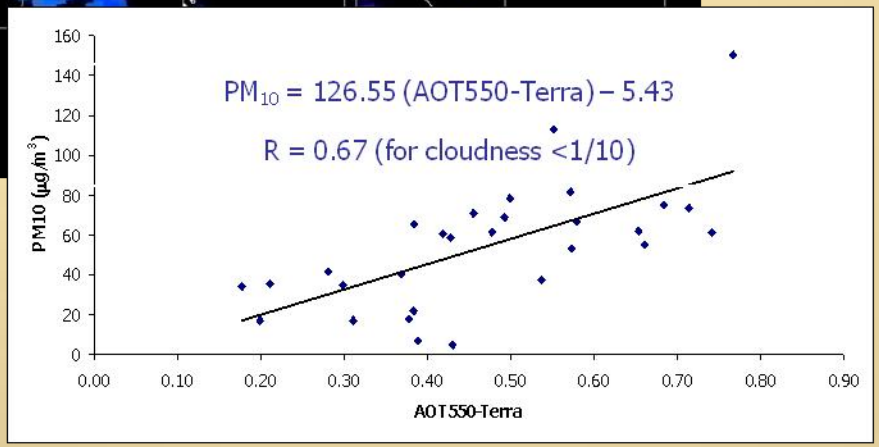


- Urban sites to capture different characteristics: traffic, commercial, suburban, residential, etc.
- Remote sites: far away from major man-made sources ➔ provide information on long-range and regional transport of air pollution

Large scale monitoring of air quality using satellite data





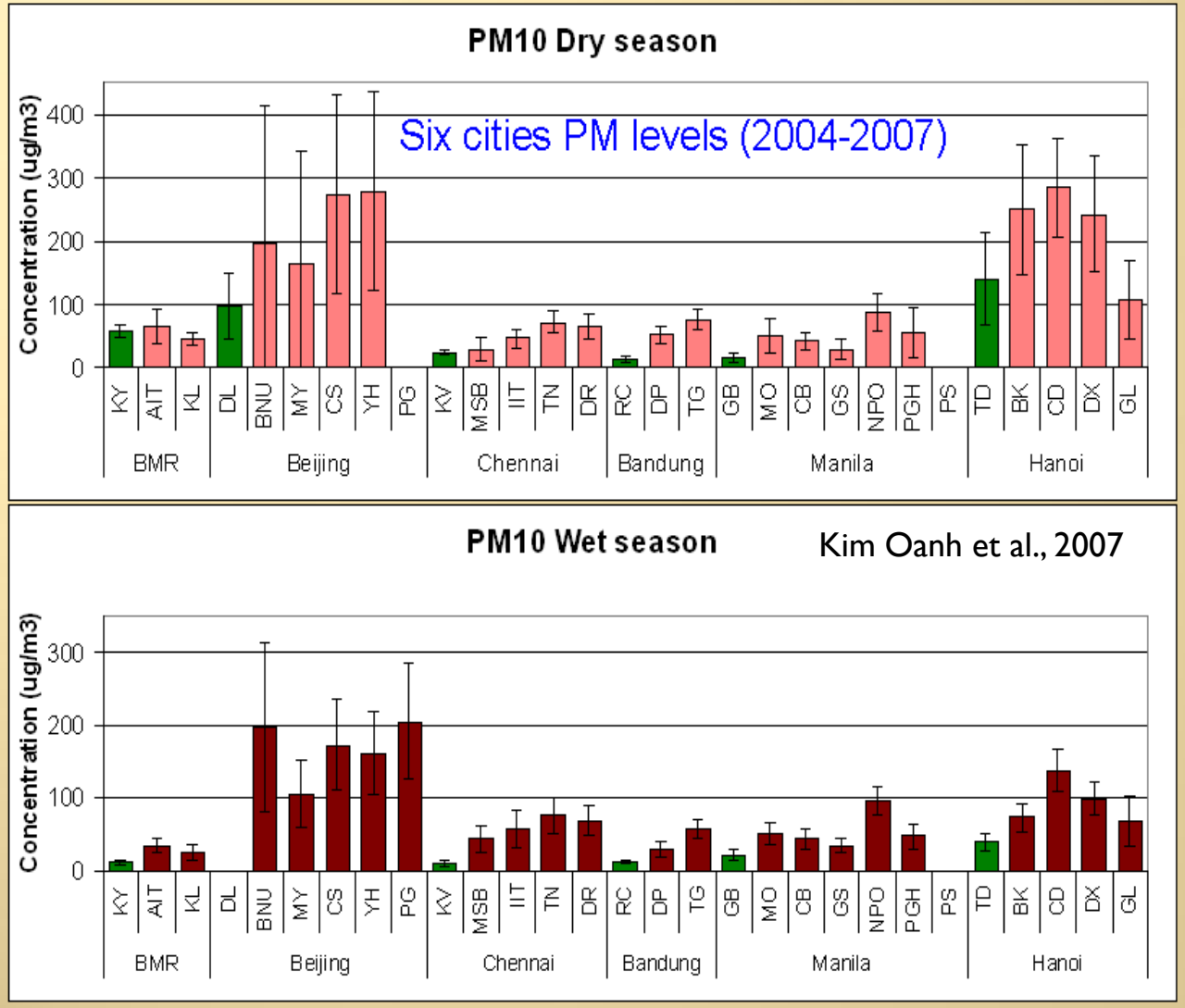


Jan 15, 2007
$PM_{2.5}$ = 71 µgm^{-3}
PM_{10} = 111 µgm^{-3}

MODIS-Aqua True Color showing hotspots (fires) and Aerosol optical thickness (AOT) over Bangkok Metropolitan Region (BMR), Jan 15, 2007

Thongchai and Kim Oanh, 2010

Particulate Matter PM10 levels in 6 countries



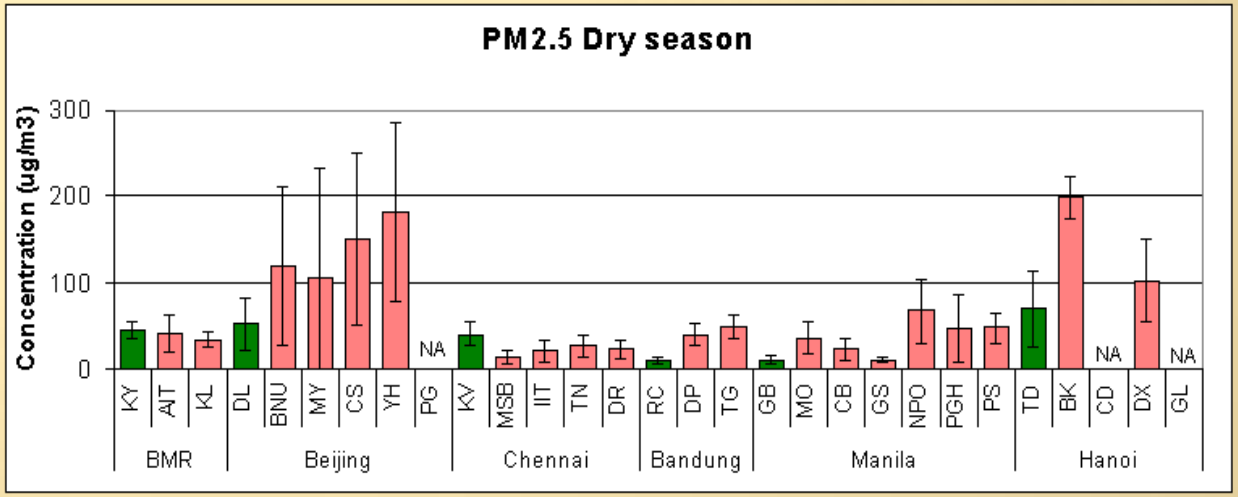
- Levels of PM10 were frequently exceeding the WHO 24-h guidelines of 50 $\mu g/m^3$
- Annual average levels were well above WHO guideline of 20 $\mu g/m^3$
- High levels were also observed at remote sites

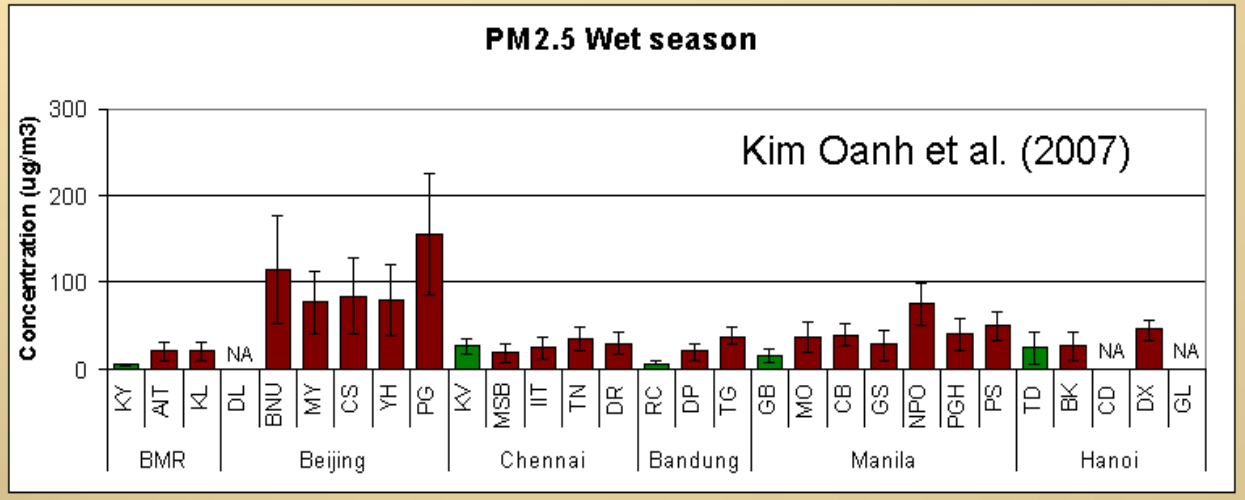
PM10: particles with size ≤10 μm and are respirable

Particulate Matter PM2.5 levels in 6 countries

AIRPET phase 2 data with remote sites

WHO guideline annual average 10 µg/m^3

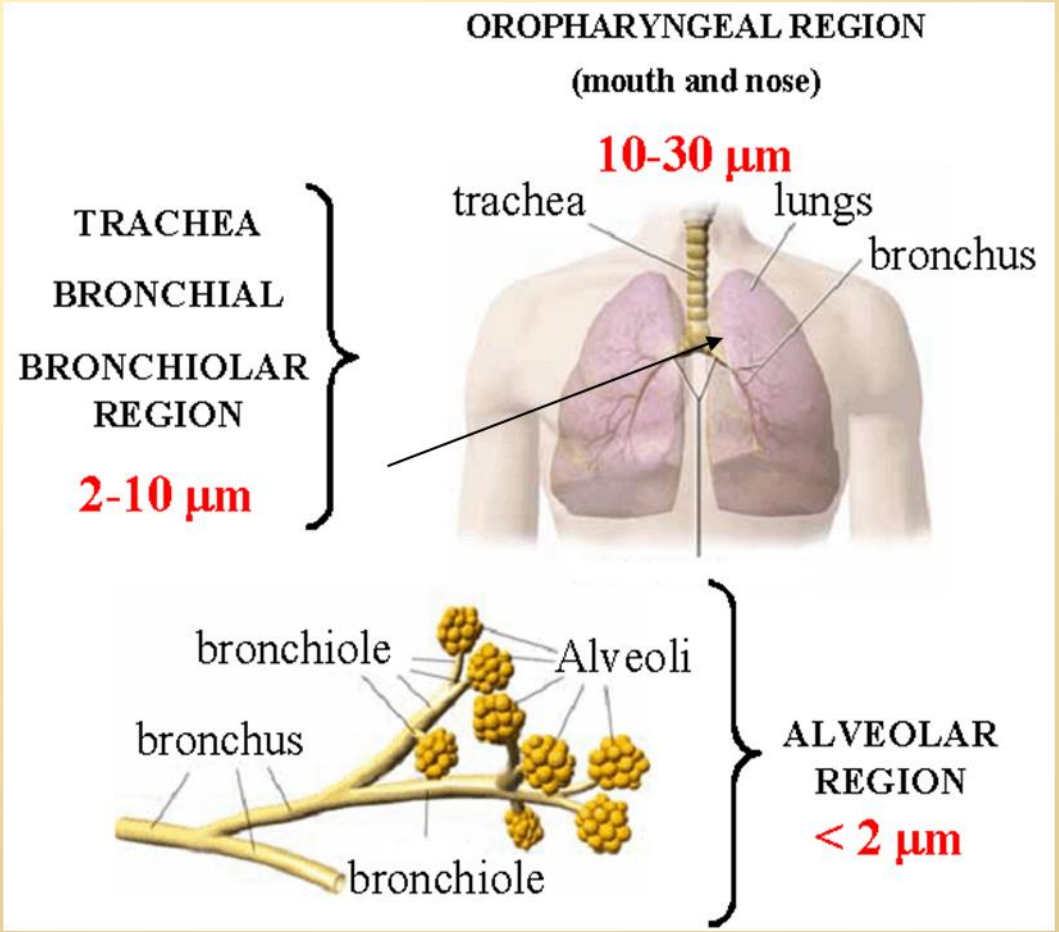


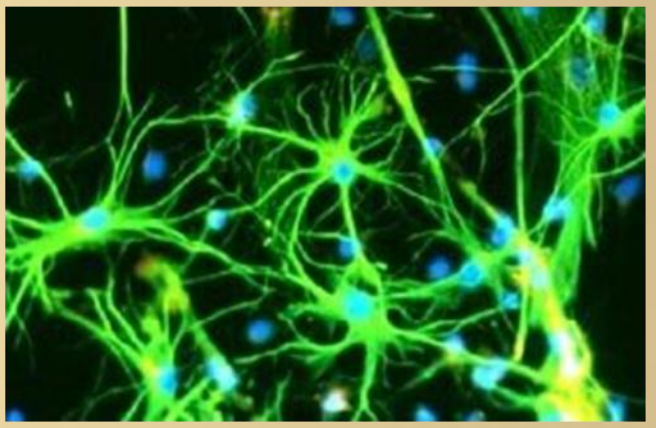


- Levels of PM2.5 were frequently above the WHO 24-h guidelines of 25 µg/m^3
- Annual average levels were well above WHO guideline of 10 µg/m^3
- High levels were also observed at remote sites

PM2.5: particles with size ≤2.5 µm can penetrate deep and deposit in alveoli

Effects of Airborne Particles: smaller particles are more toxic!





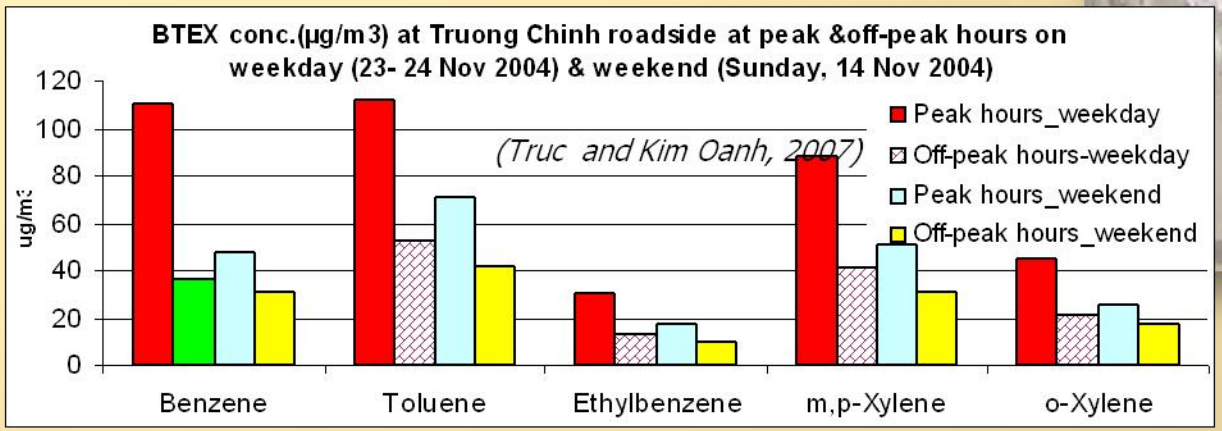
Nanoparticles are also found in the brain!

Nanoparticles

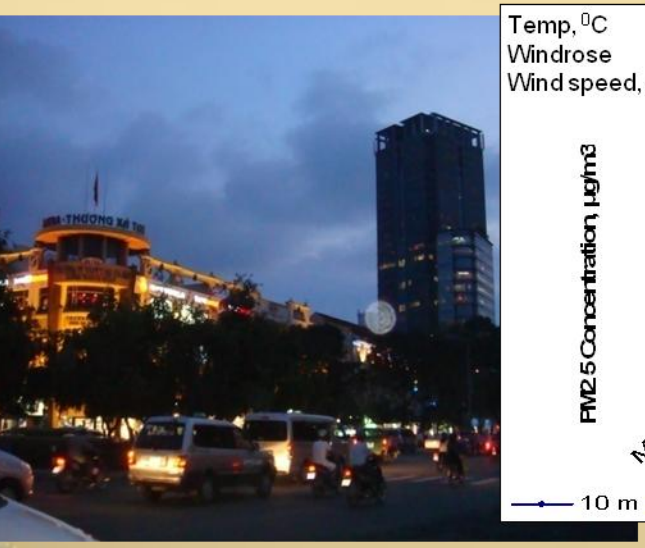
Source: adapted from UNEP, ABC training, 2006

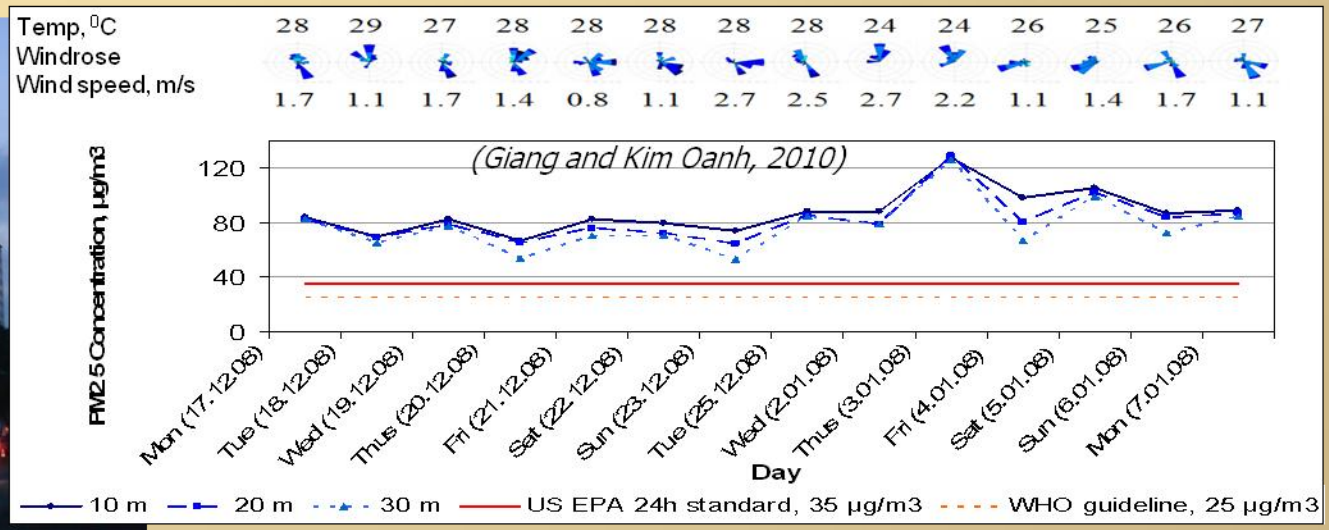
Air toxics levels at roadside

BTEX in Hanoi, Vietnam

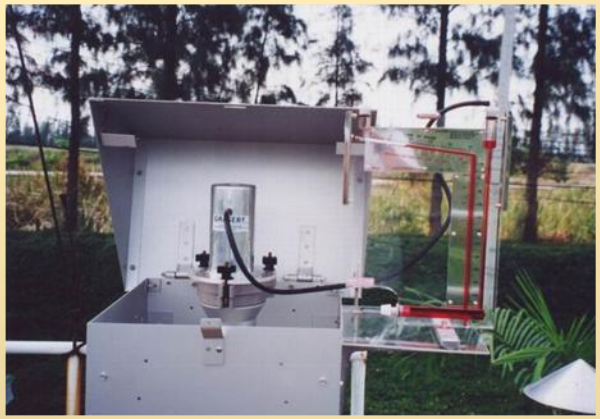


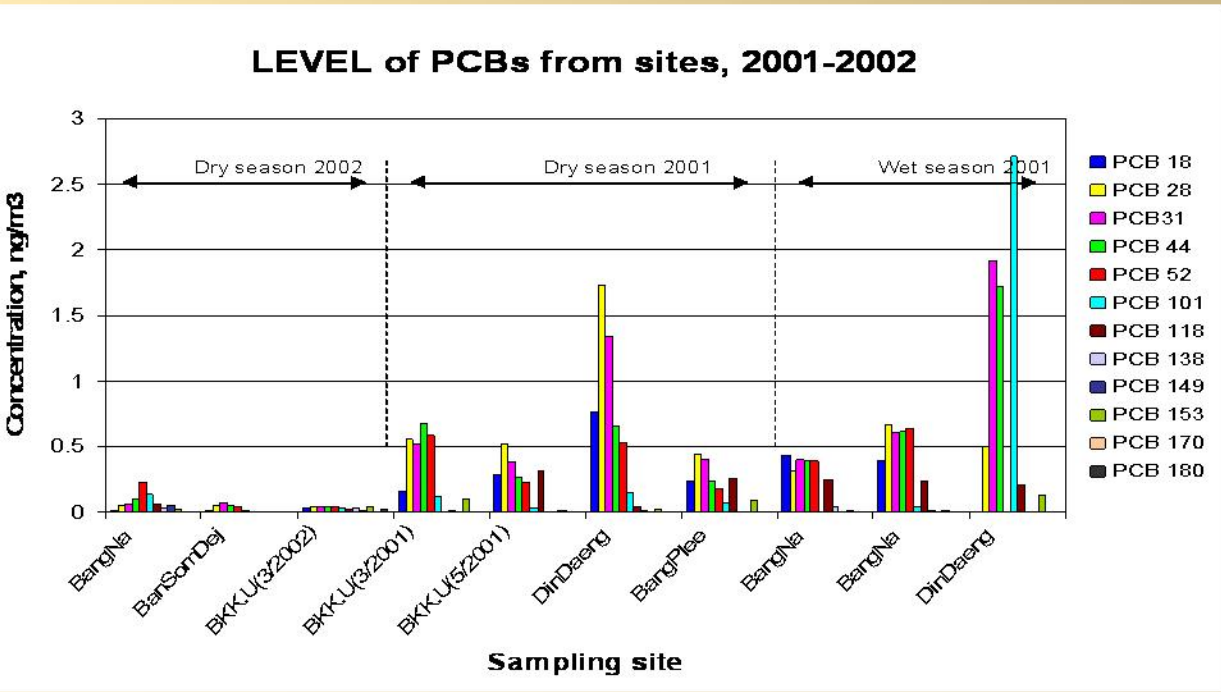
24h PM2.5 at roadside in Hochiminh City, Vietnam

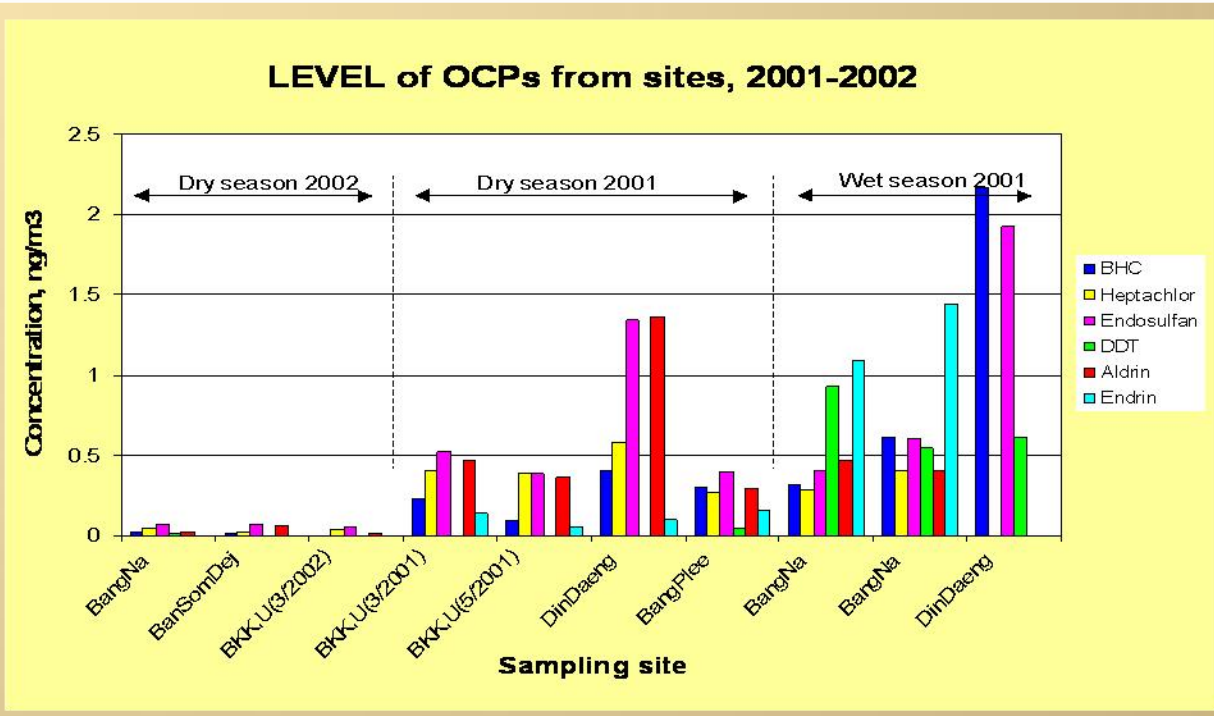




PCB and pesticides in air at different locations in Bangkok



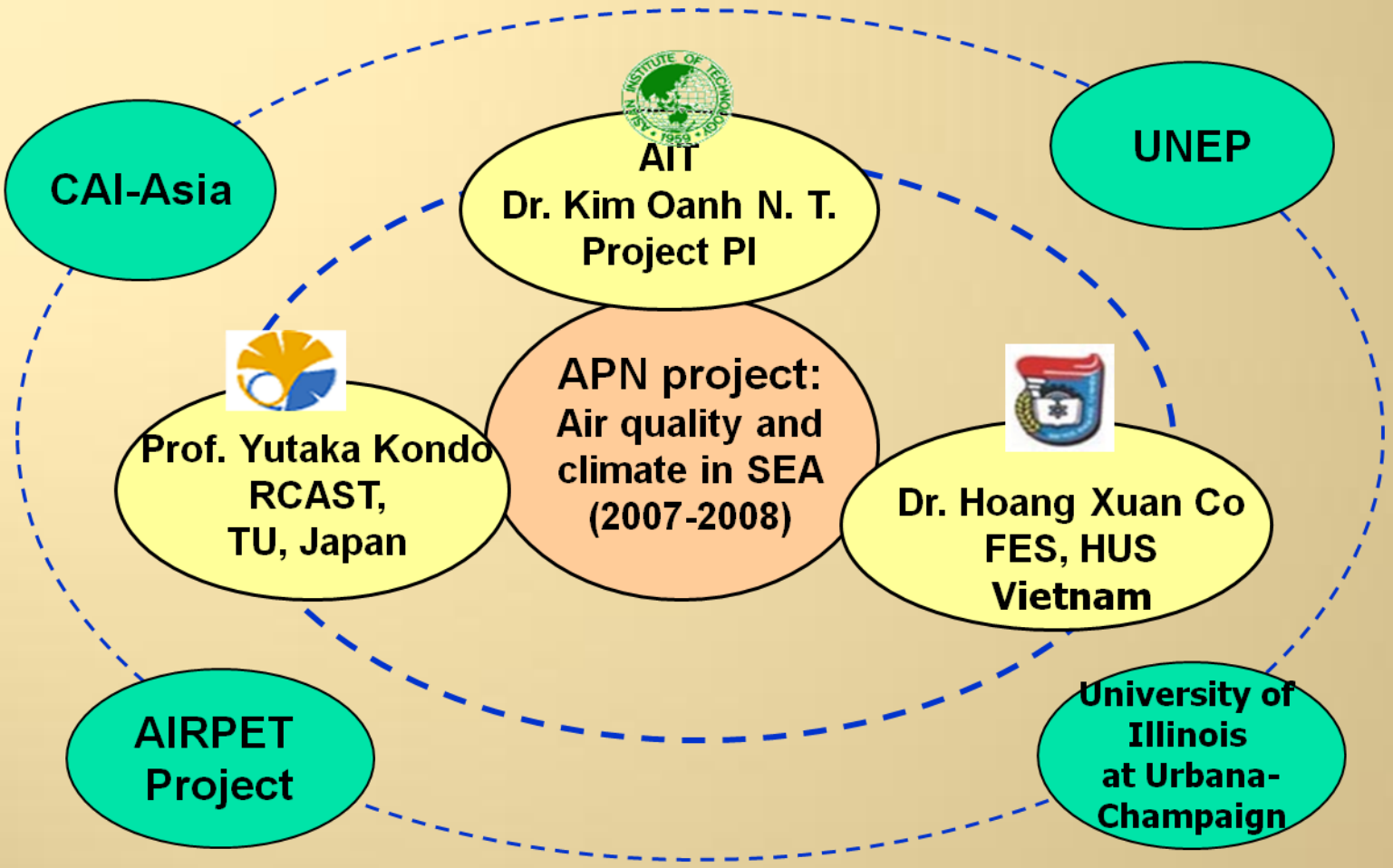




Dry deposition study using Noll plates in Pathumthani

Deposition fluxes of PM, ions and persistent organic pollutants at rural, urban and near water reservoir

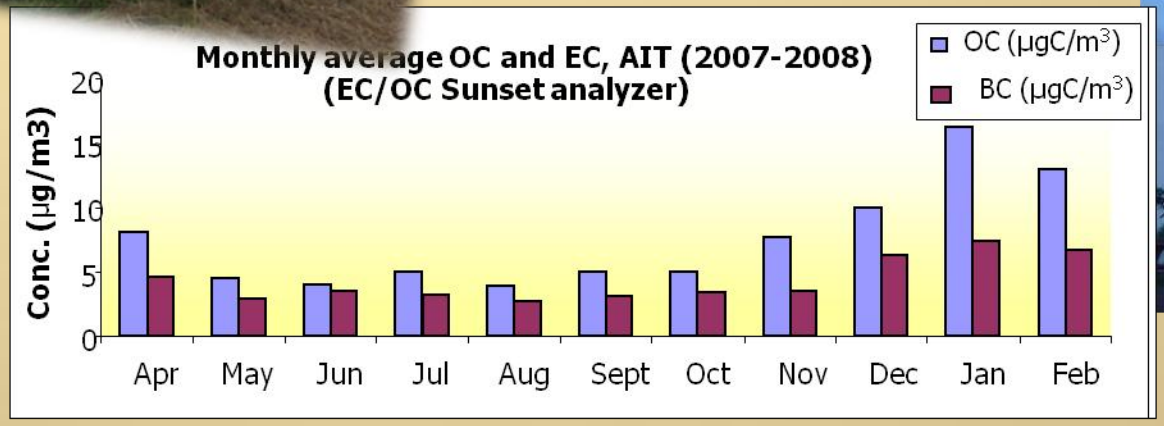
AIT-TU-HUS APN project:
"Investigation on the impacts of urban-rural air pollution on air quality and climate in Southeast Asia"



Asia-Pacific Network for Global Change Research

APN project: Black Carbon (BC) levels in air, AIT

BC is toxic air pollutant and climate warming agent



2. Monitoring for exposure assessment

- School children exposure to rice straw field burning smoke
- Near-road and on-road exposure to traffic pollution
- Exposure to pesticides applied indoor

Personal exposure monitoring for school children in Pathumthani and Khaoyai

PM2.5, Semi-VOC, SO_2, NO_2, VOCs

24h monitoring of personal exposure

Lung function test

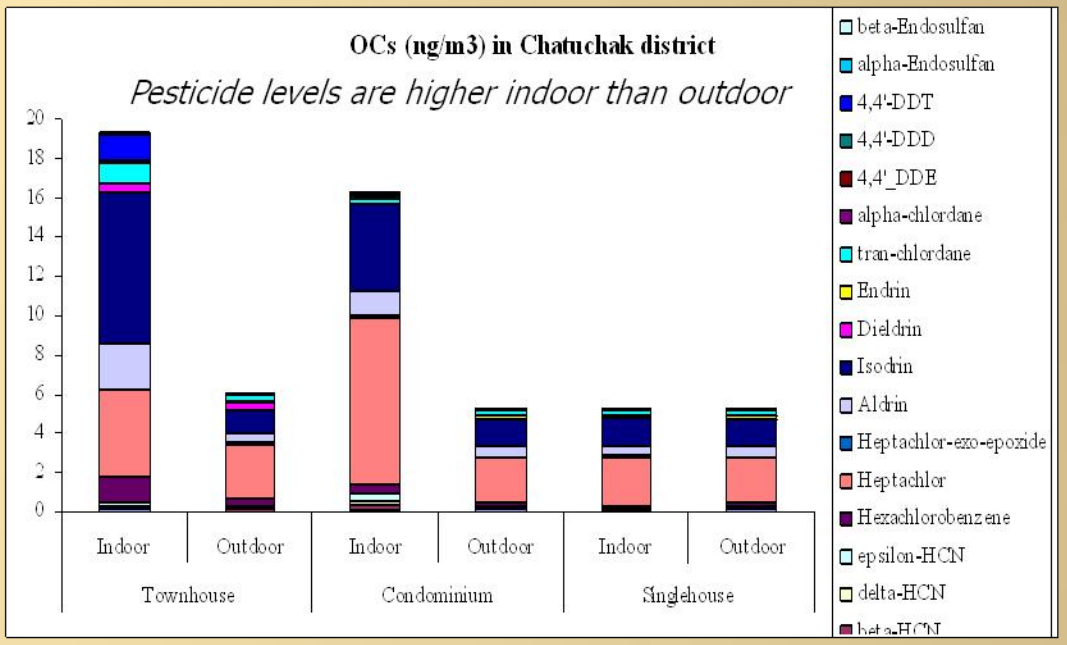
Comparative analysis of exposure during burning and non-burning season in burning and non-burning areas

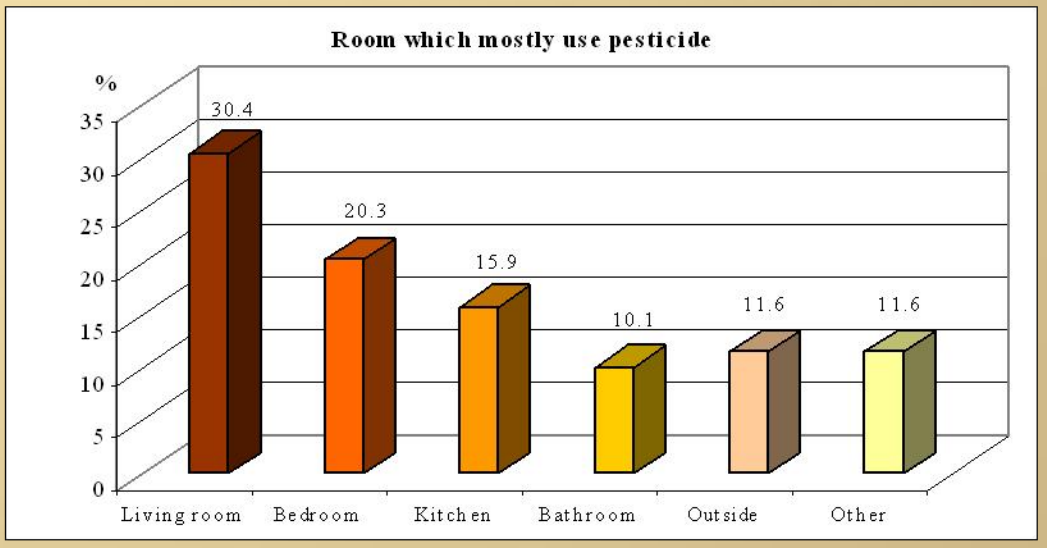
Aungsiri K. (2008)

Indoor pesticides use and exposure in Bangkok

Common pesticides used indoor

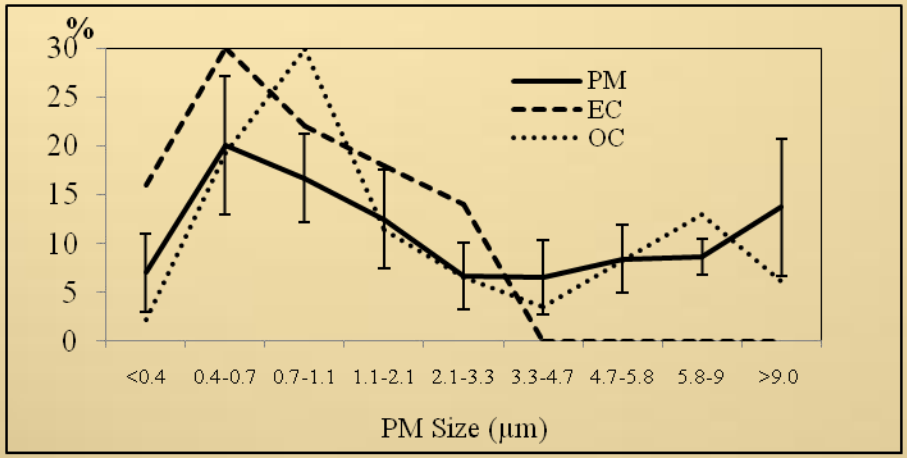
Sampling of pesticide deposit on floor

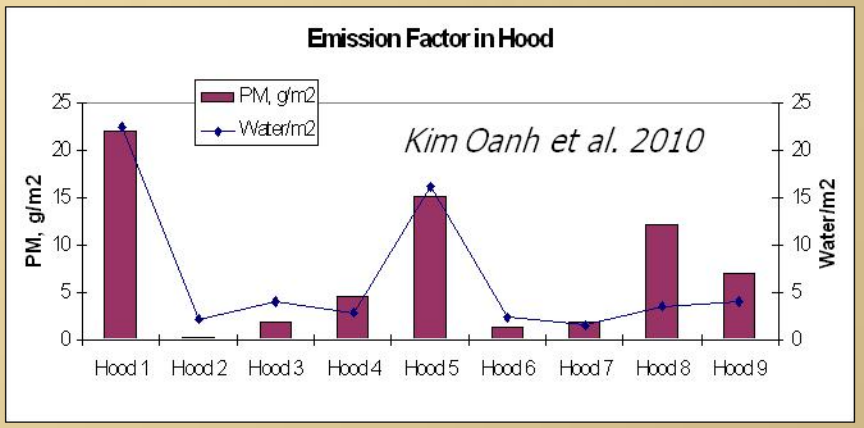




Pemtawa and Kim Oanh, 2009

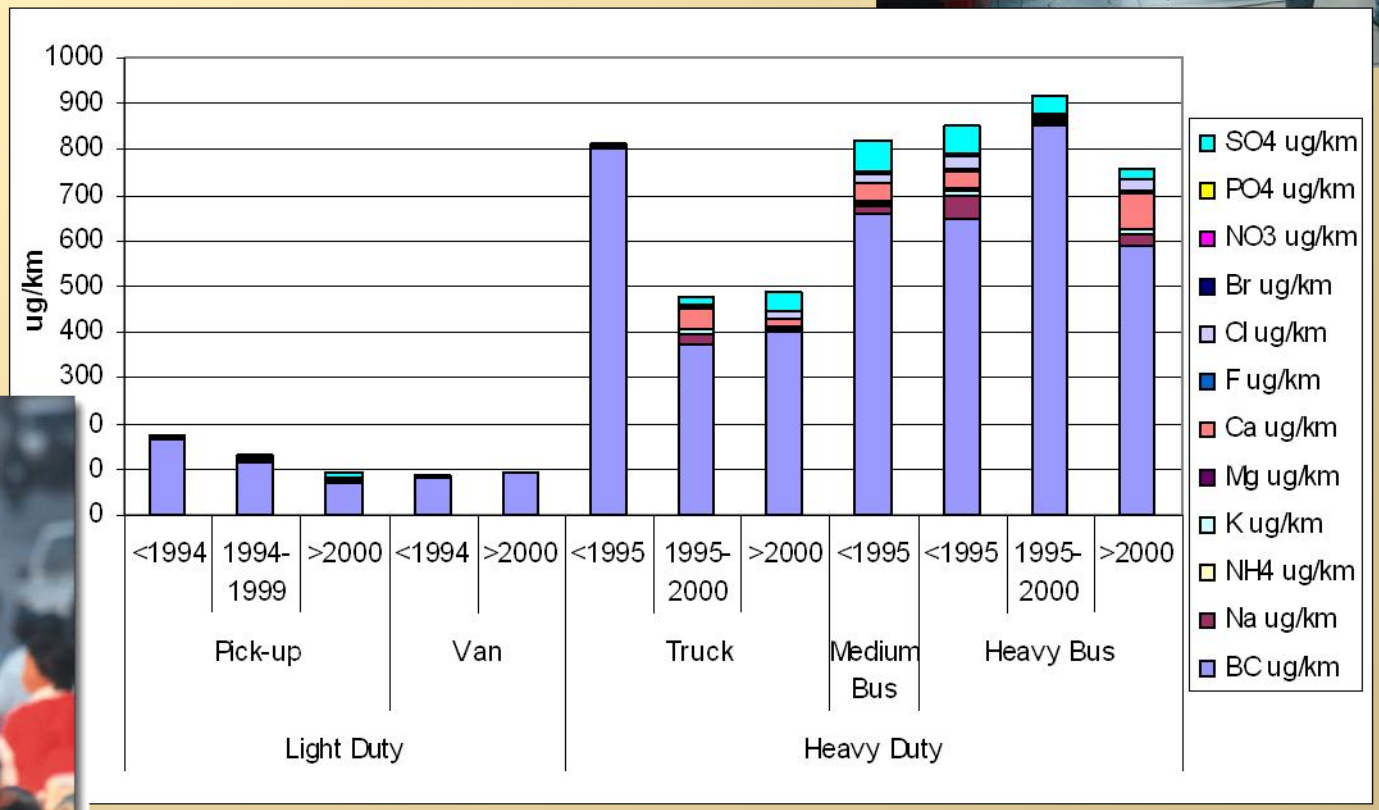
3. Source characterization: field burning





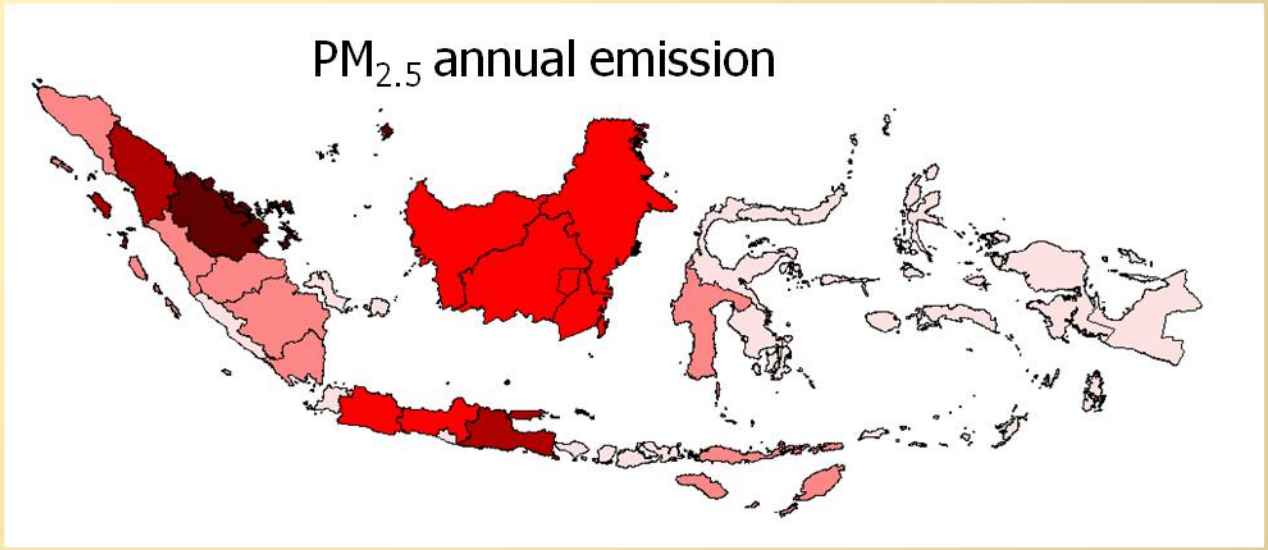
Sampling for agroresidue field burning: emission levels and profiles of particulate matter and air toxics

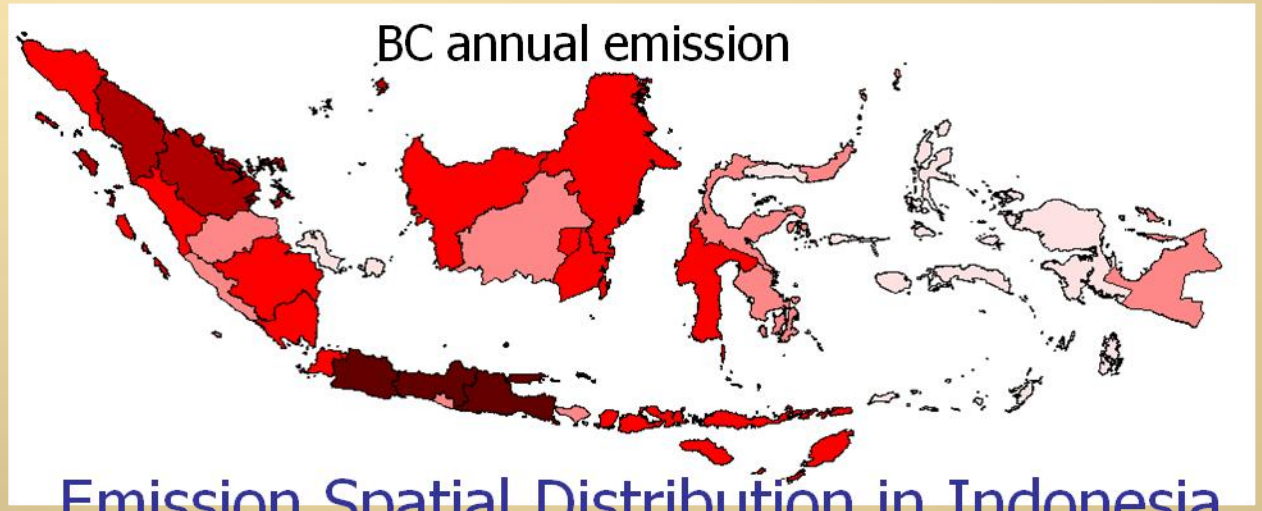
Source characterization: PM emission from diesel vehicles



4. Emission inventory: what pollutants, where and when

(AIT-UNEP ABC project, in collaboration with Prof. Shrestha of Energy, Dr. Shrestha of NRM, Dr. Rupakheti of UNEP)

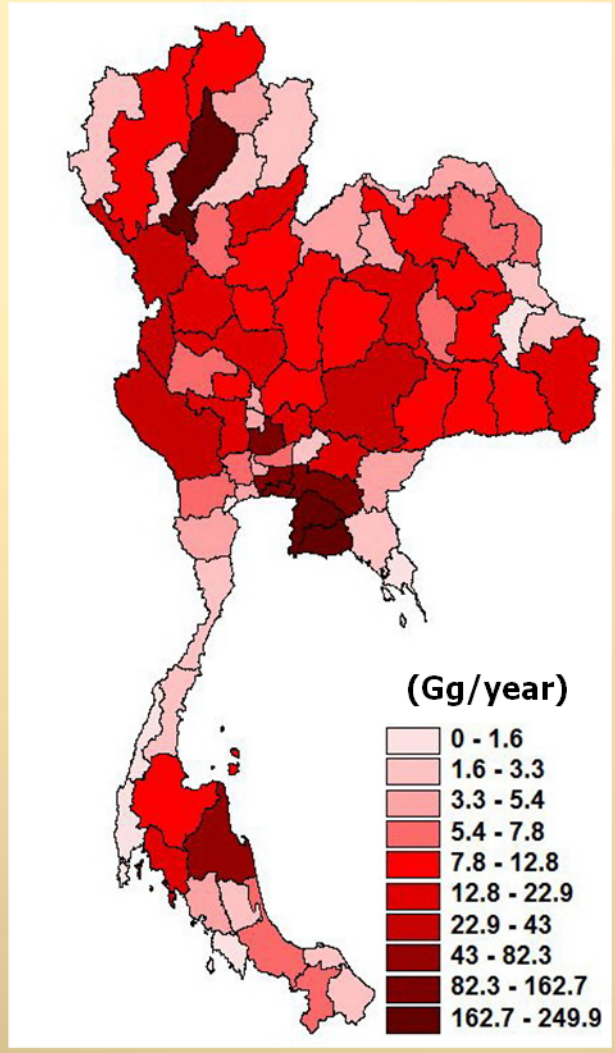




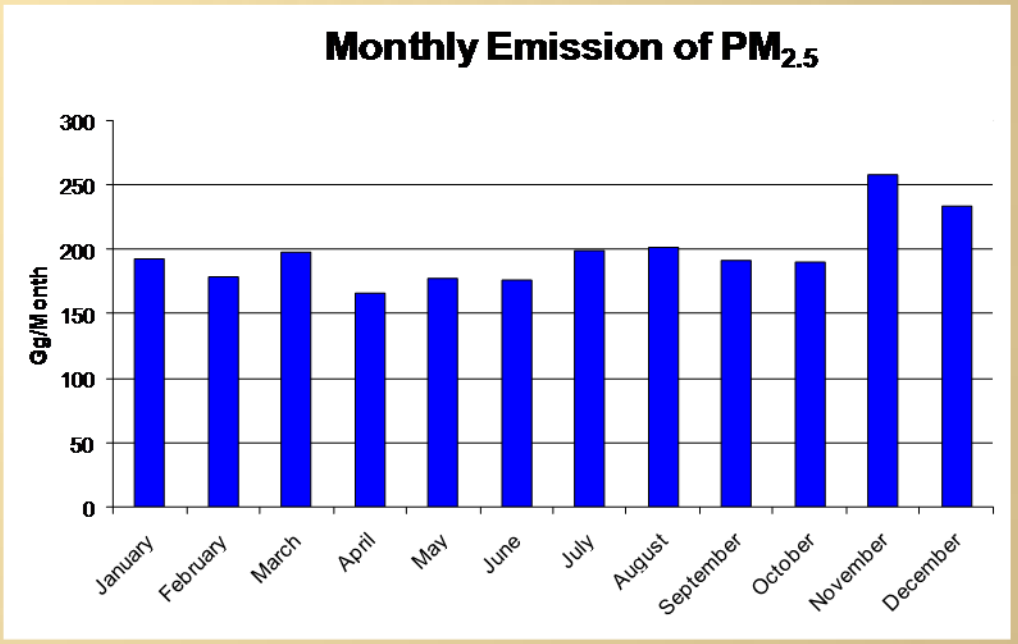
Emission Spatial Distribution in Indonesia, 2005

Agustian at al. (2010)

Spatial and temporal distribution of PM2.5 emissions in Thailand, 2005



$PM_{2.5}$ annual emission

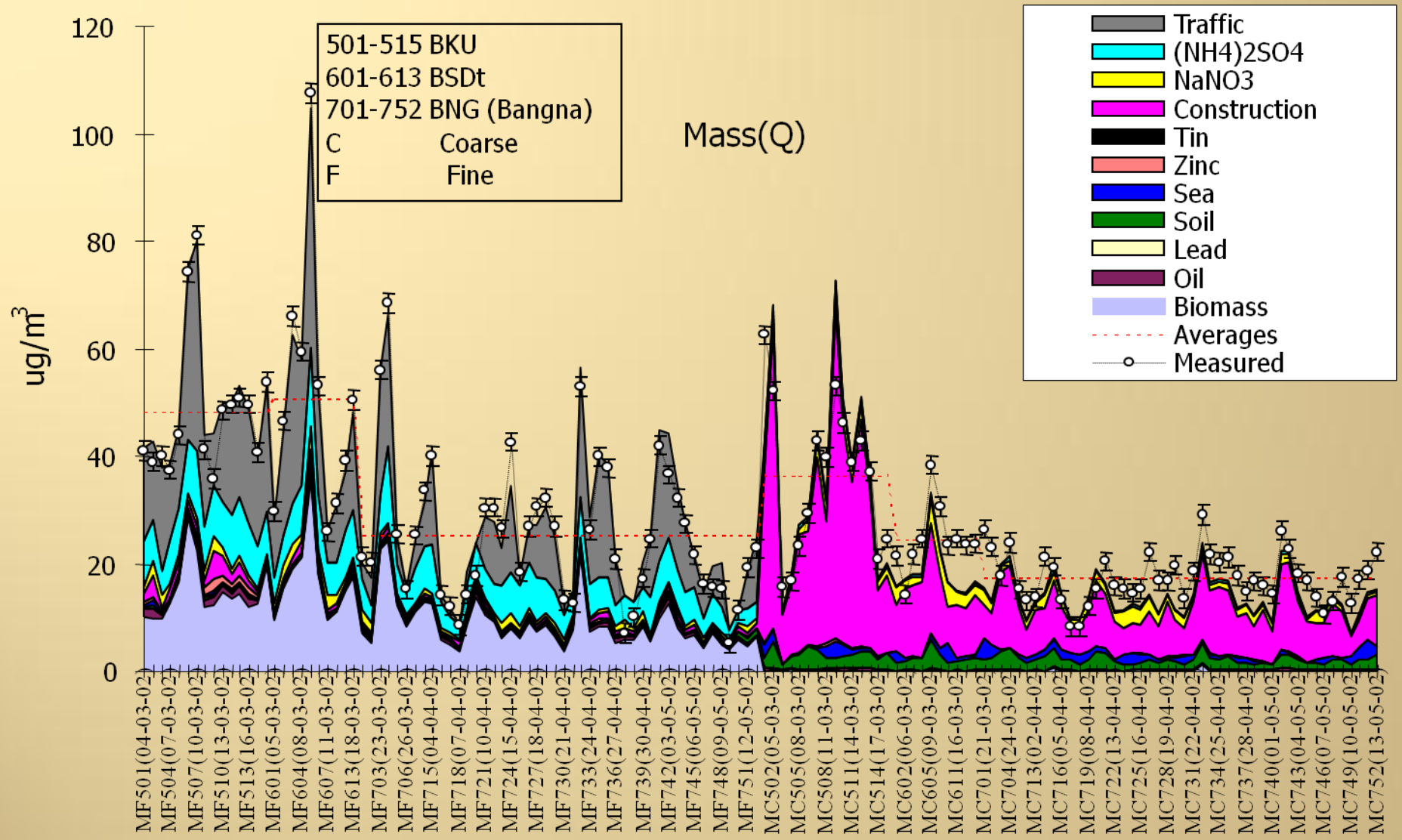


AIT-UNEP ABC project, case study

5. Modeling air quality at AIT

- Receptor modeling for source apportionment of PM
- Dispersion modeling:
  - Modeling for urban air quality in BMR, Hanoi, Jakarta (ozone) and Phnom Penh (CO)
  - Southeast Asia ozone air quality modeling for assessment of effects on crops
- Synoptic climatological modeling for episode warning

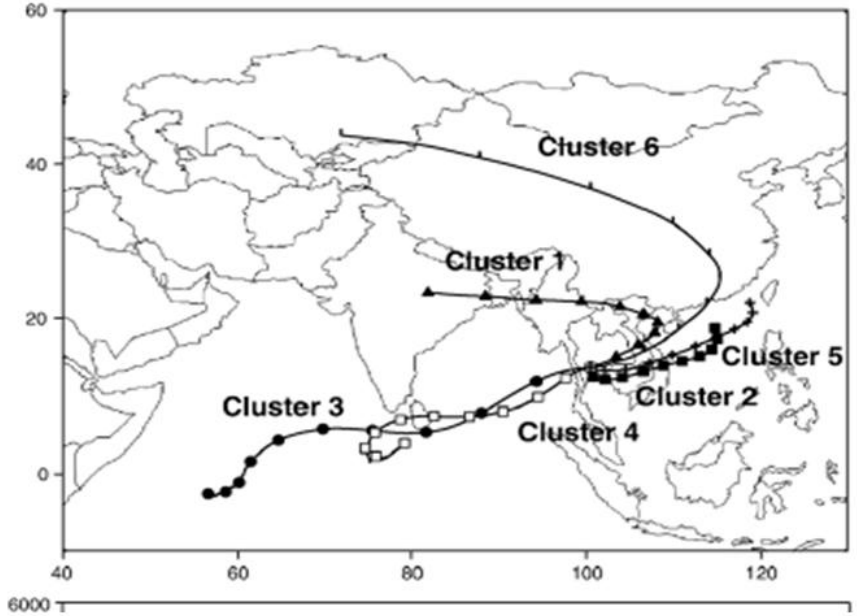
Source Apportionment by COPREM model for PM in dry season at different sites in Bangkok

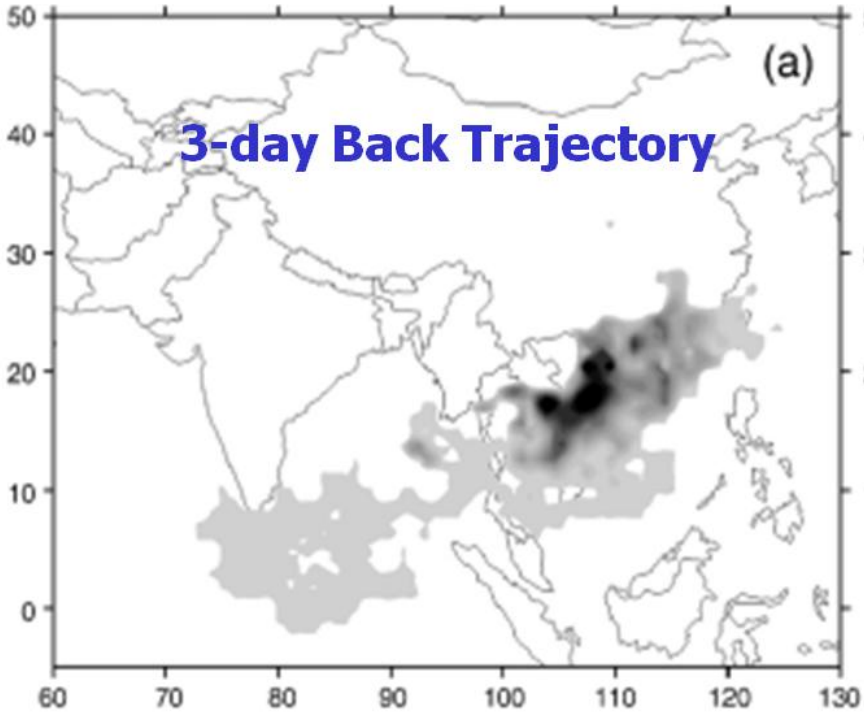


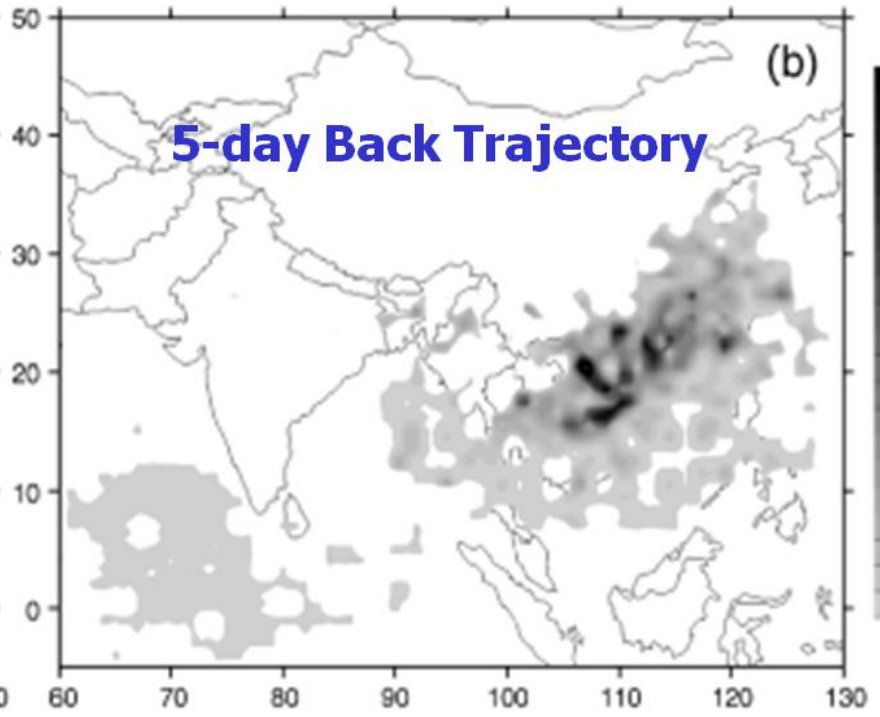
Source: Nabin U. (2003)

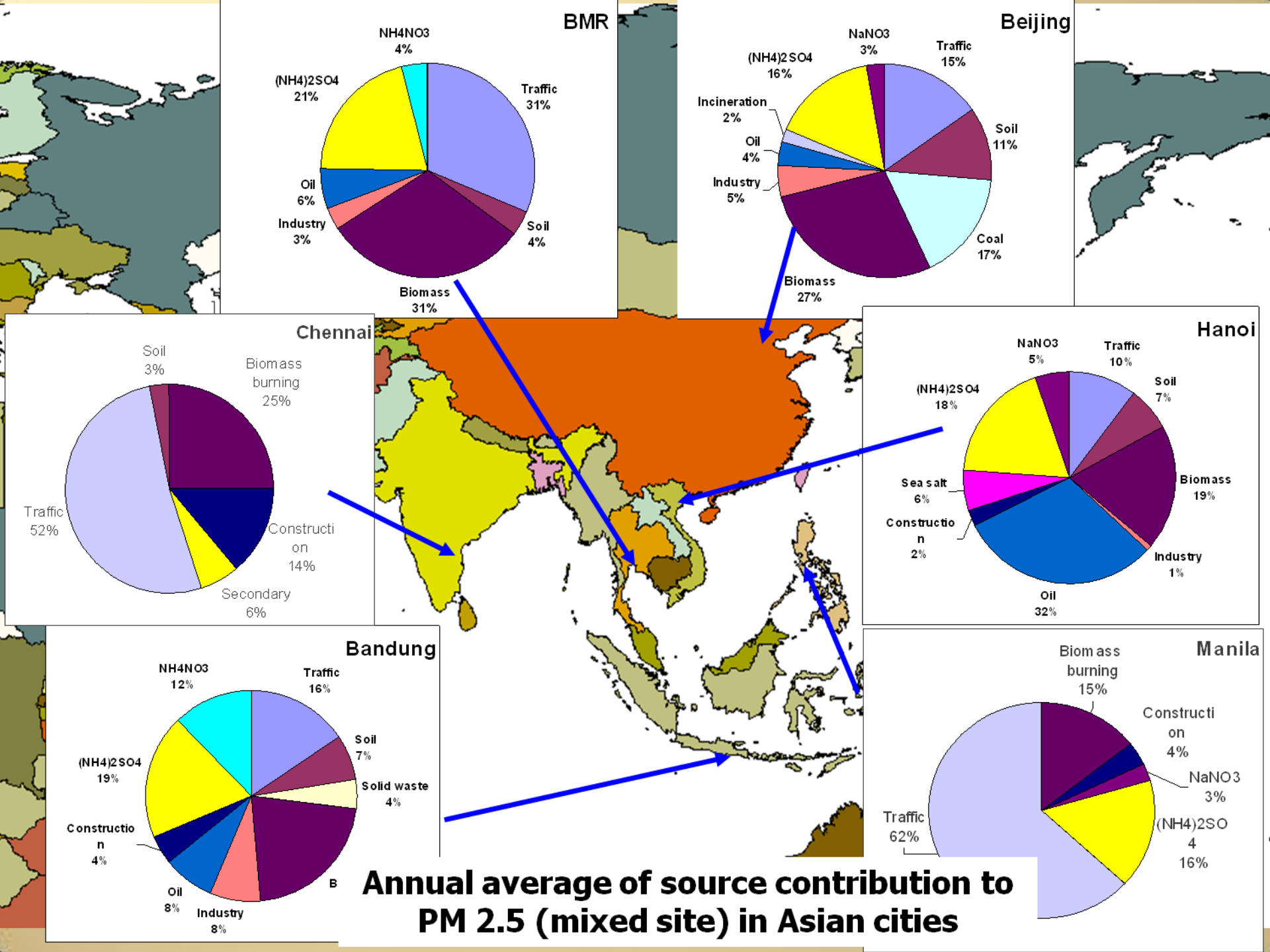
Potential regional transport of air pollution in BMR

Prapat and Kim Oanh (2007)







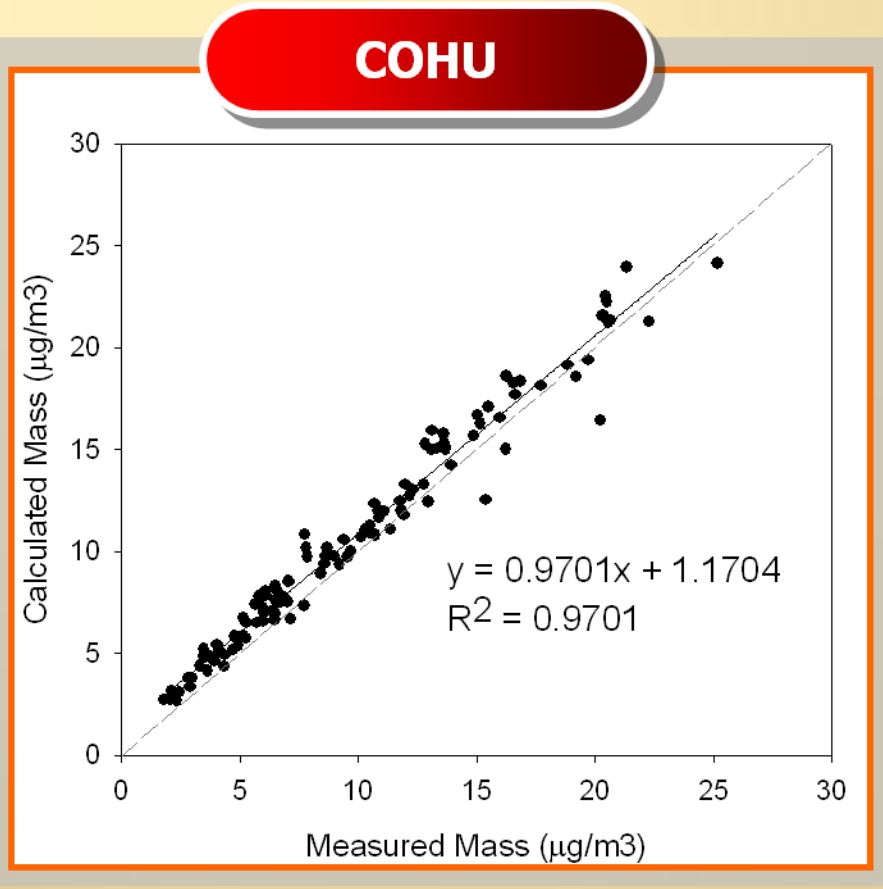


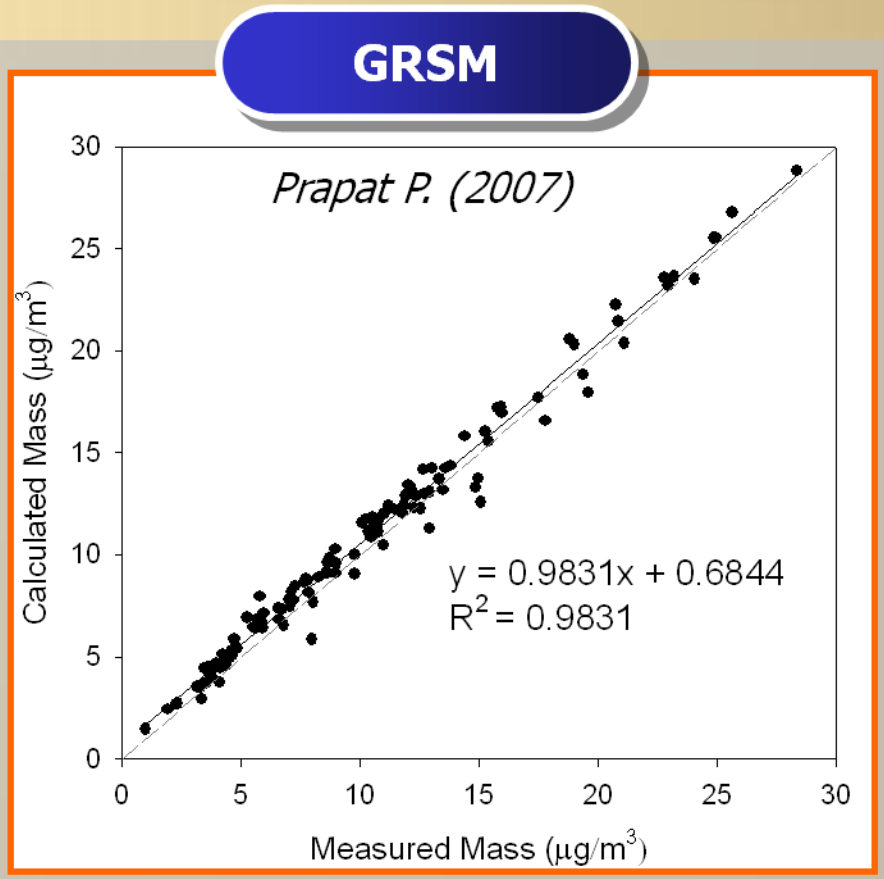
Annual average of source contribution to PM 2.5 (mixed site) in Asian cities

New model developed and tested: DUALM

Developed using expanded Multilinear Engine (ME-2)

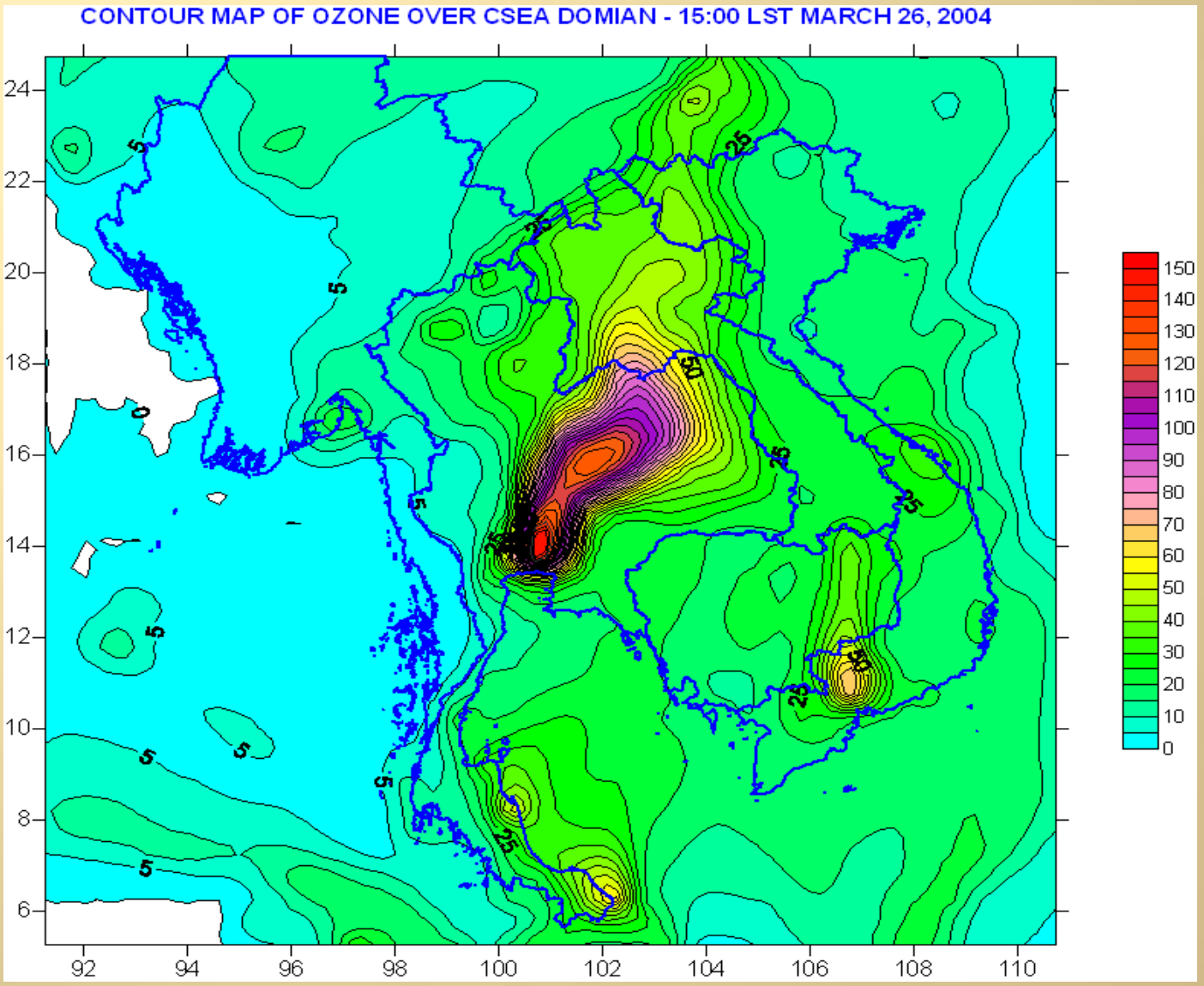
Applied to PM data collected at 2 sites simultaneously





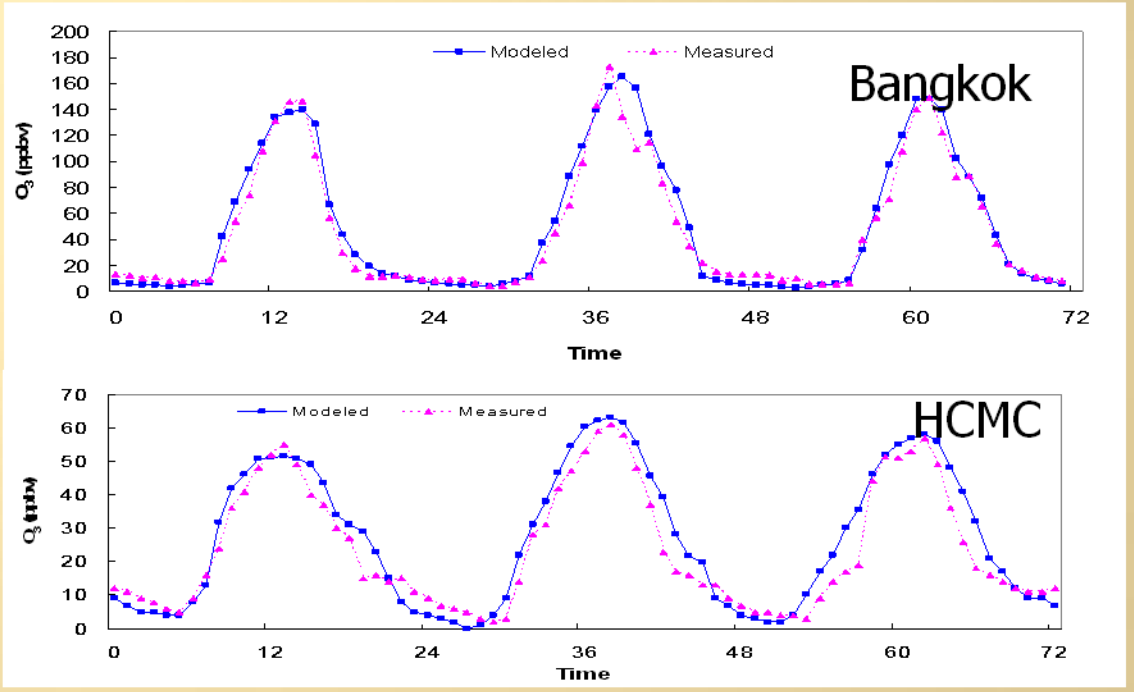
Comparison between measured and calculated masses by DUALM at 2 monitoring sites (US IMPROVE data)

Dispersion models: CMAQ-MM5 modeling for O_3 air quality over South East Asia,



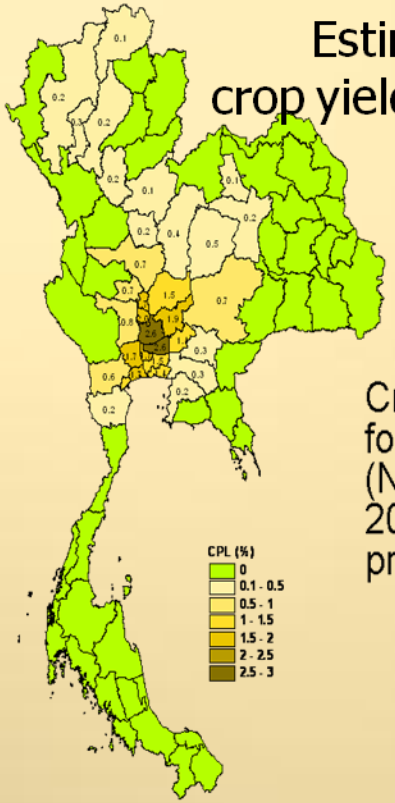
Nghiem and Kim Oanh, 2008

Simulated vs. measured ground level ozone in Bangkok, Ho Chi Minh city and Hanoi



Modeling approach to assess potential ozone effects on crops

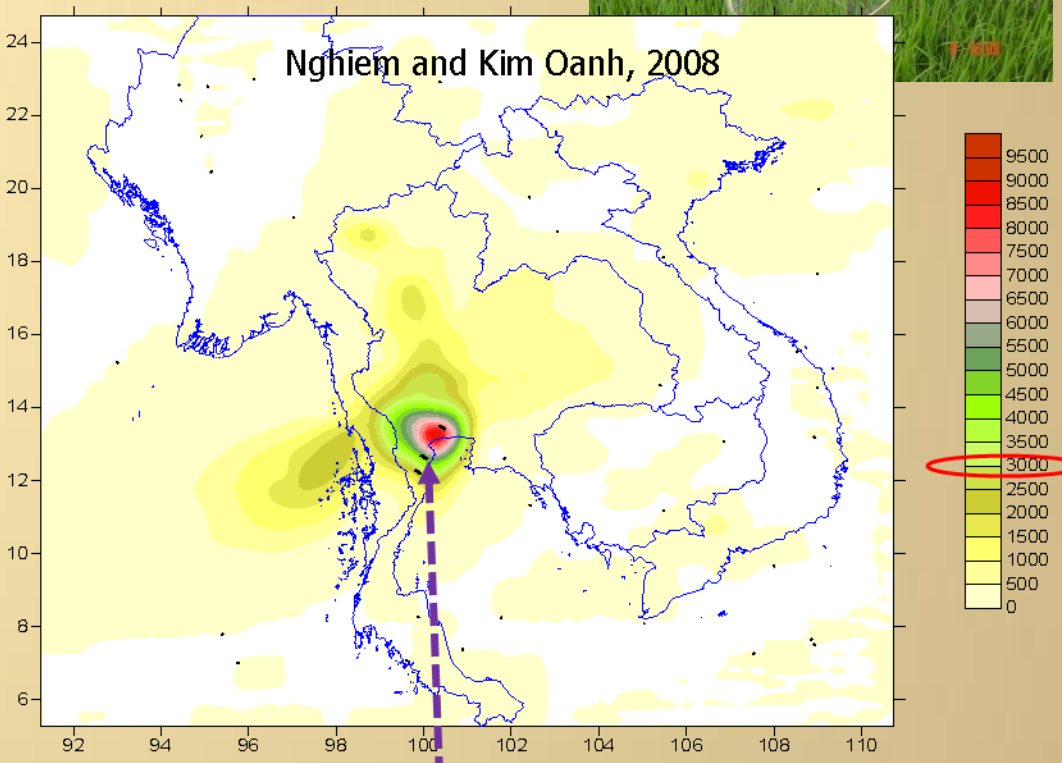
AOT40 Map over CSEA Domain for December 2003



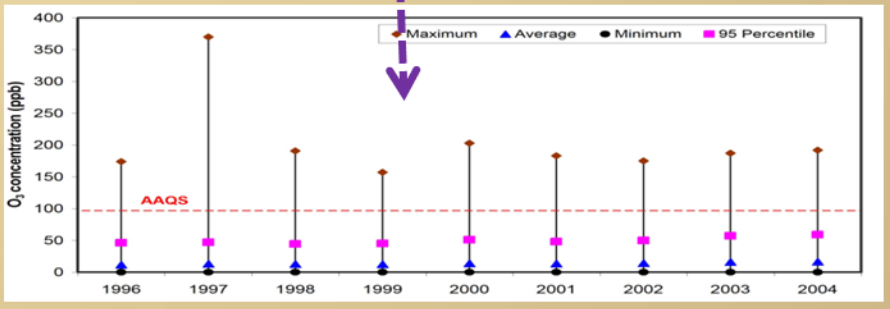
Estimation of rice crop yield reduction in Thailand

Crop production loss (%) for the second rice crop (November 2003 – April 2004) in different provinces of Thailand

Nghiem and Kim Oanh, 2008

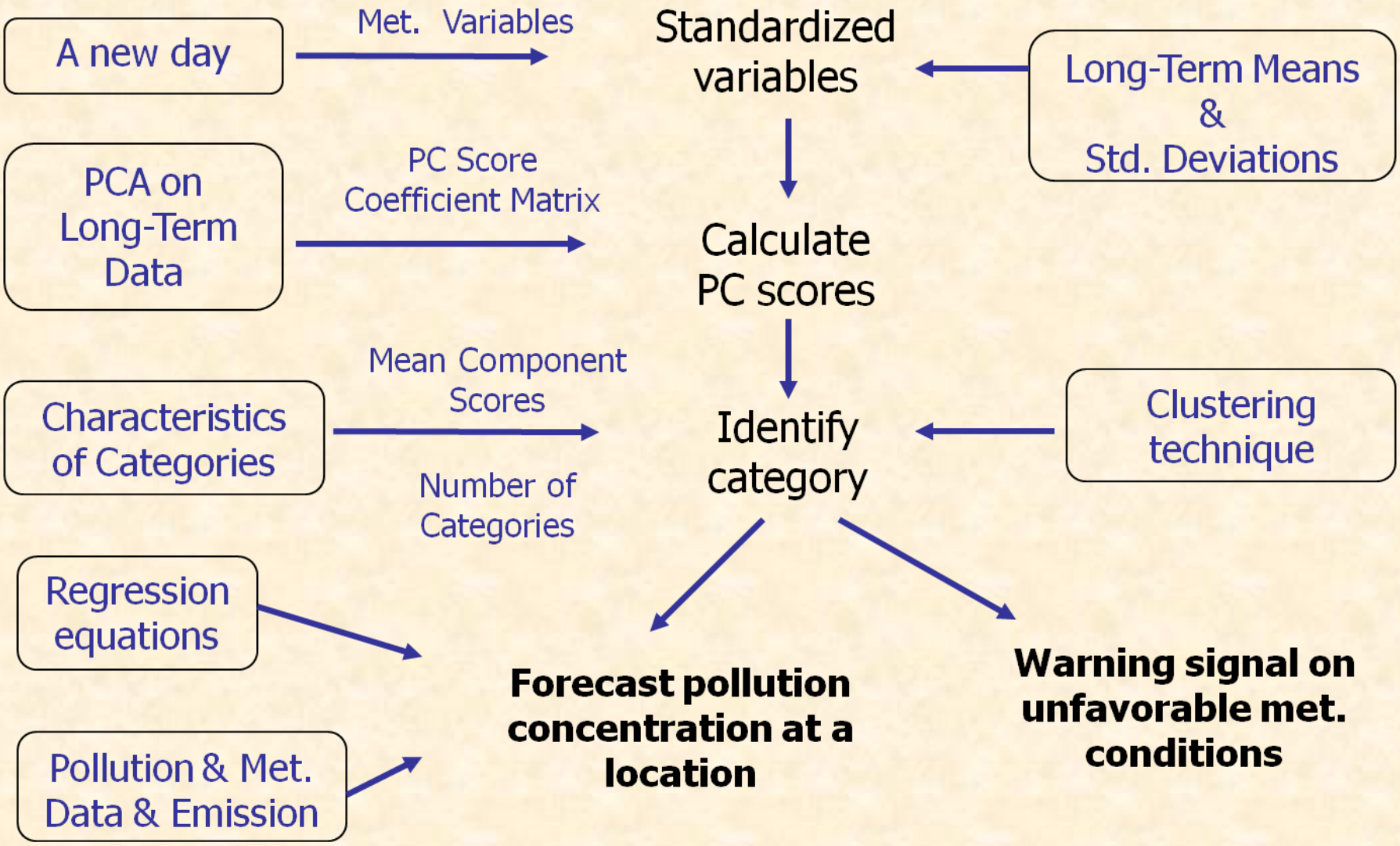


AOT for one month of Dec. 2003



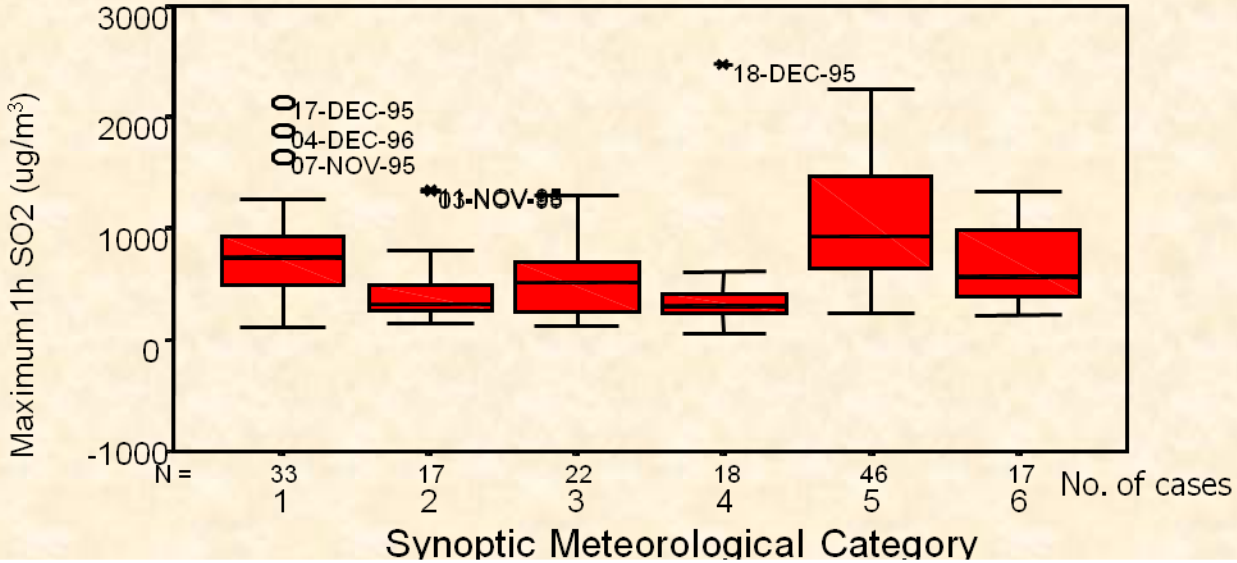
AOT values for one month were above WHO guideline for crop growth season of 3000ppb.h suggesting substantial yield reduction

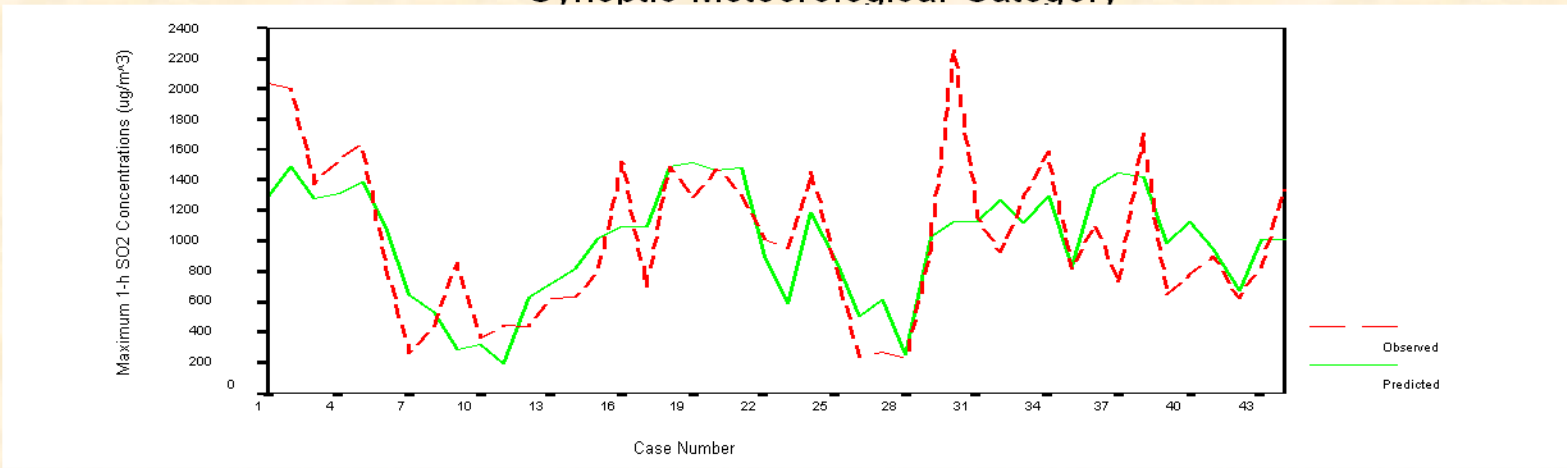
Synoptic climatological modeling: development of warning signals for air pollution episode



Kim Oanh, 2010

Synoptic climatological model application for SO_2 concentration in Mahmoh valley, Chiangmai (1995-1997)





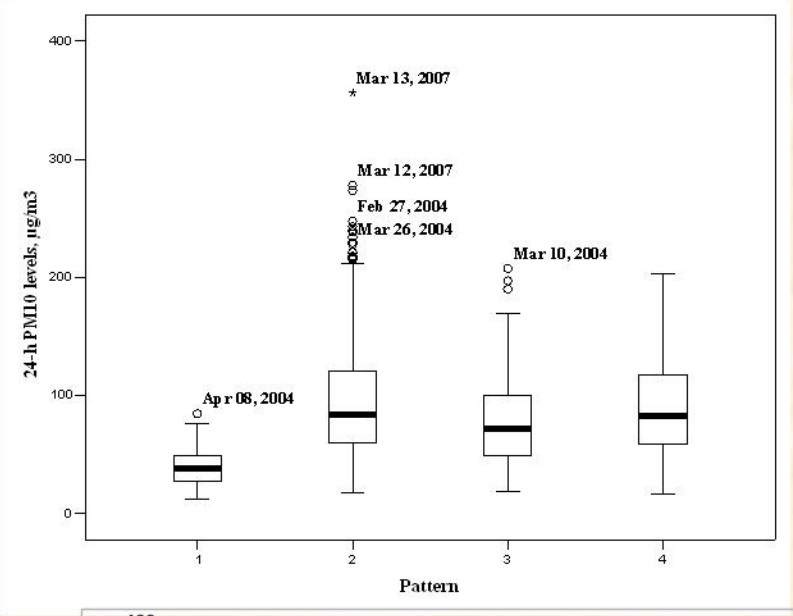
Model prediction of SO_2 concentration for met. pattern 5

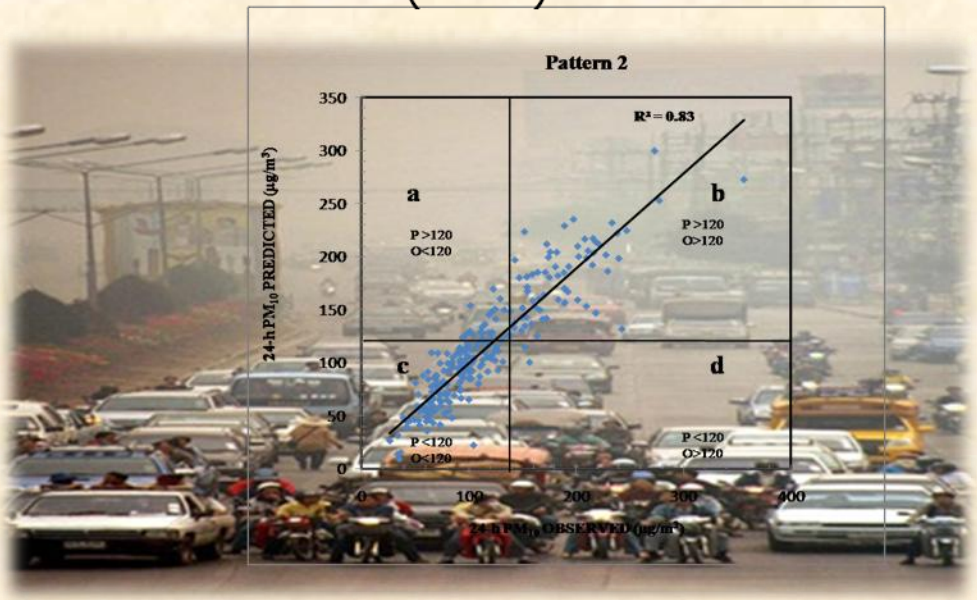
(R^2 = 61%, RMSE = 340 ug/m^3, Mean error = 33%)

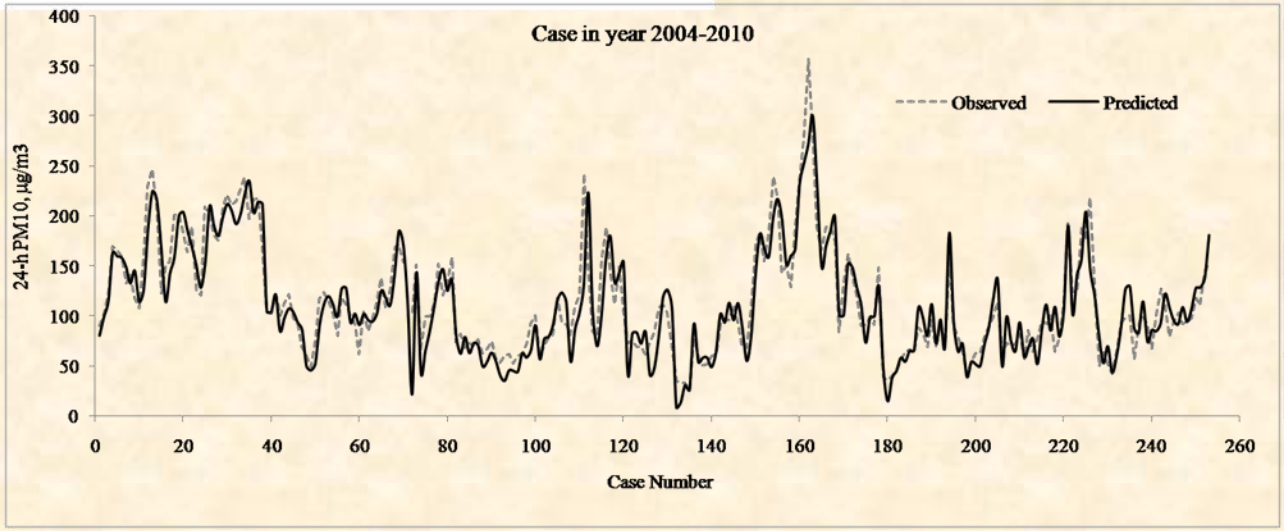
Kim Oanh et al. 2005

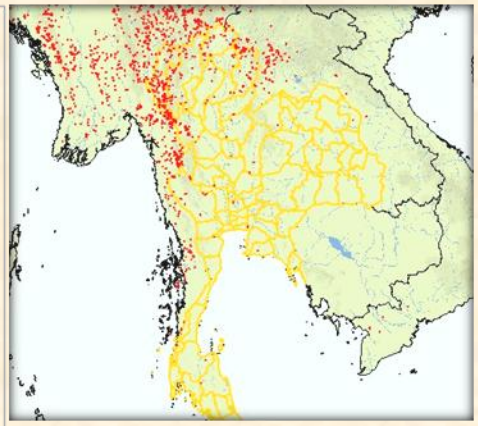
Modeling PM10 for haze prediction in Chiangmai

Leelasakultum & Kim Oanh (2010)





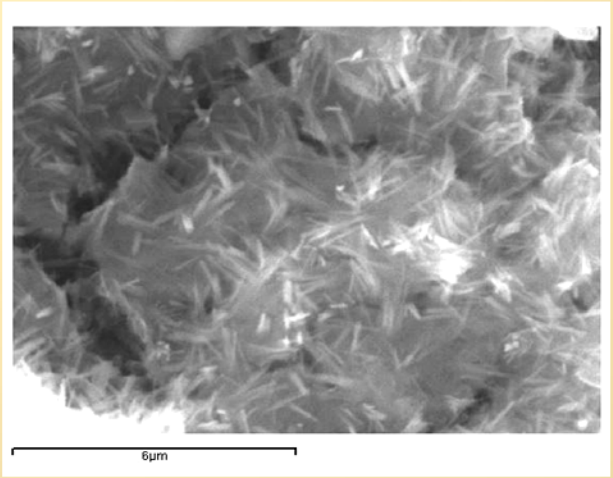


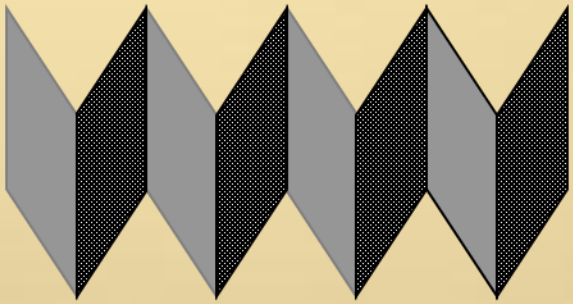


$$[PM_{10}] = -4044 + 0.568\ P\_PM_{10} - 0.008\ Vis - 1.948\ Hum + 4.258\ SLP$$

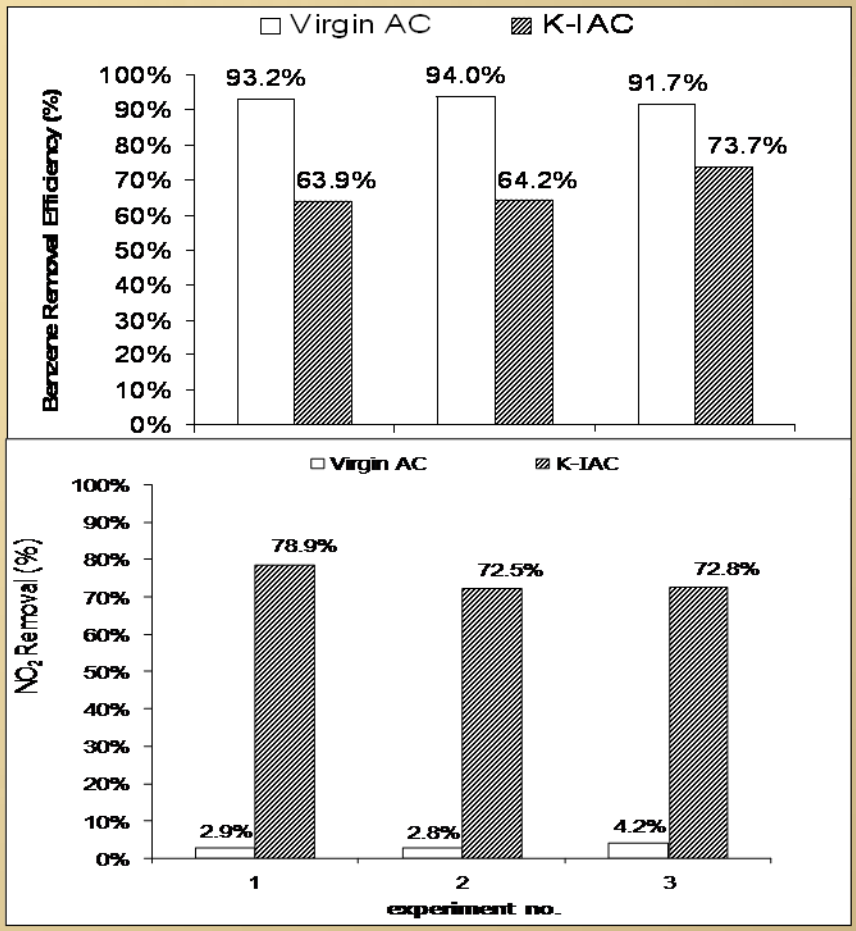
6. Emission control technologies (I)

VOC & NOx control using KOH impregnated activated carbon





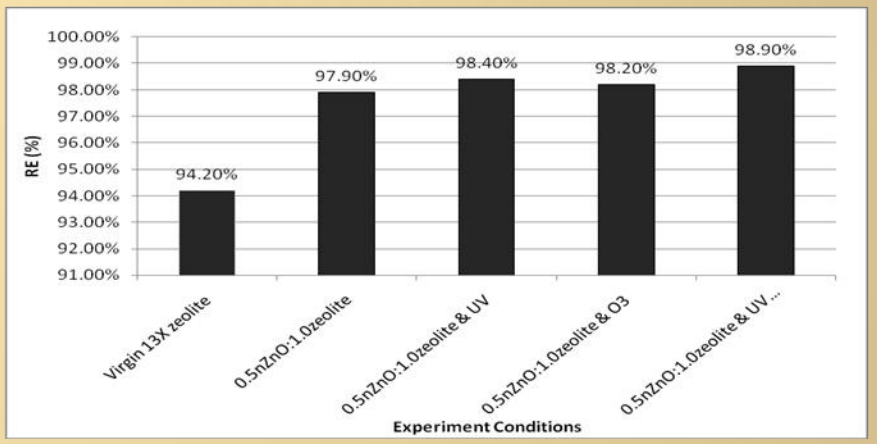
Alternate AC and K-IAC beds for simultaneous removal of NOx and VOC for indoor in car use

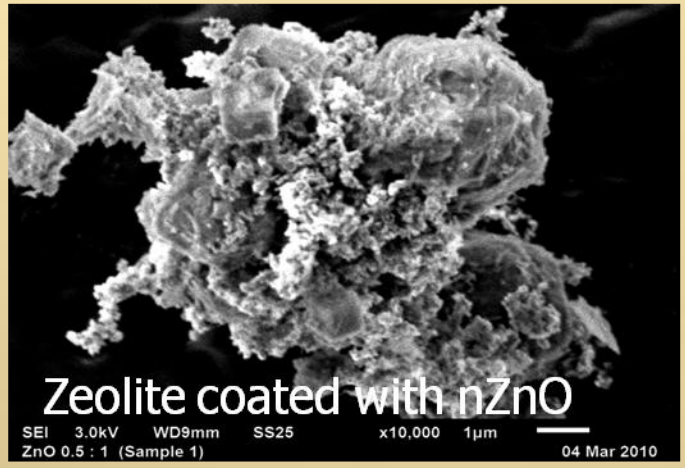


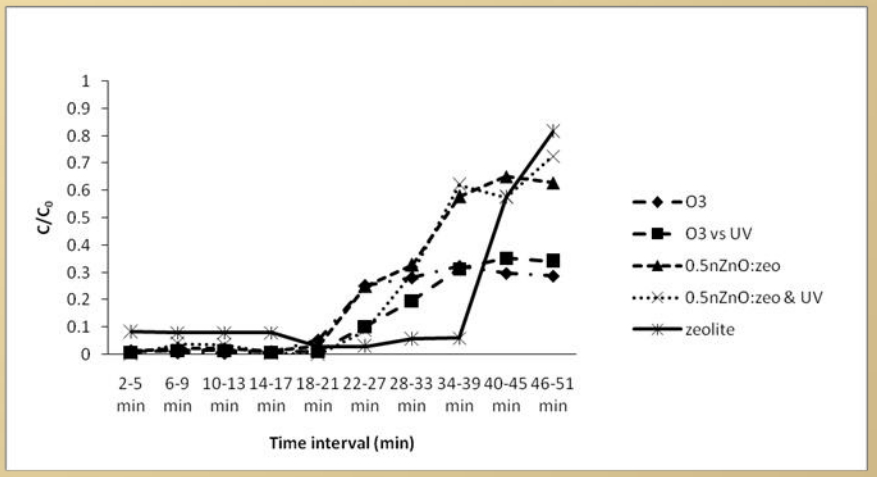
Kim Oanh et al. 2010

VOC control using nano-particles

Adsorbents coated with nano-particles improve VOC removal efficiency





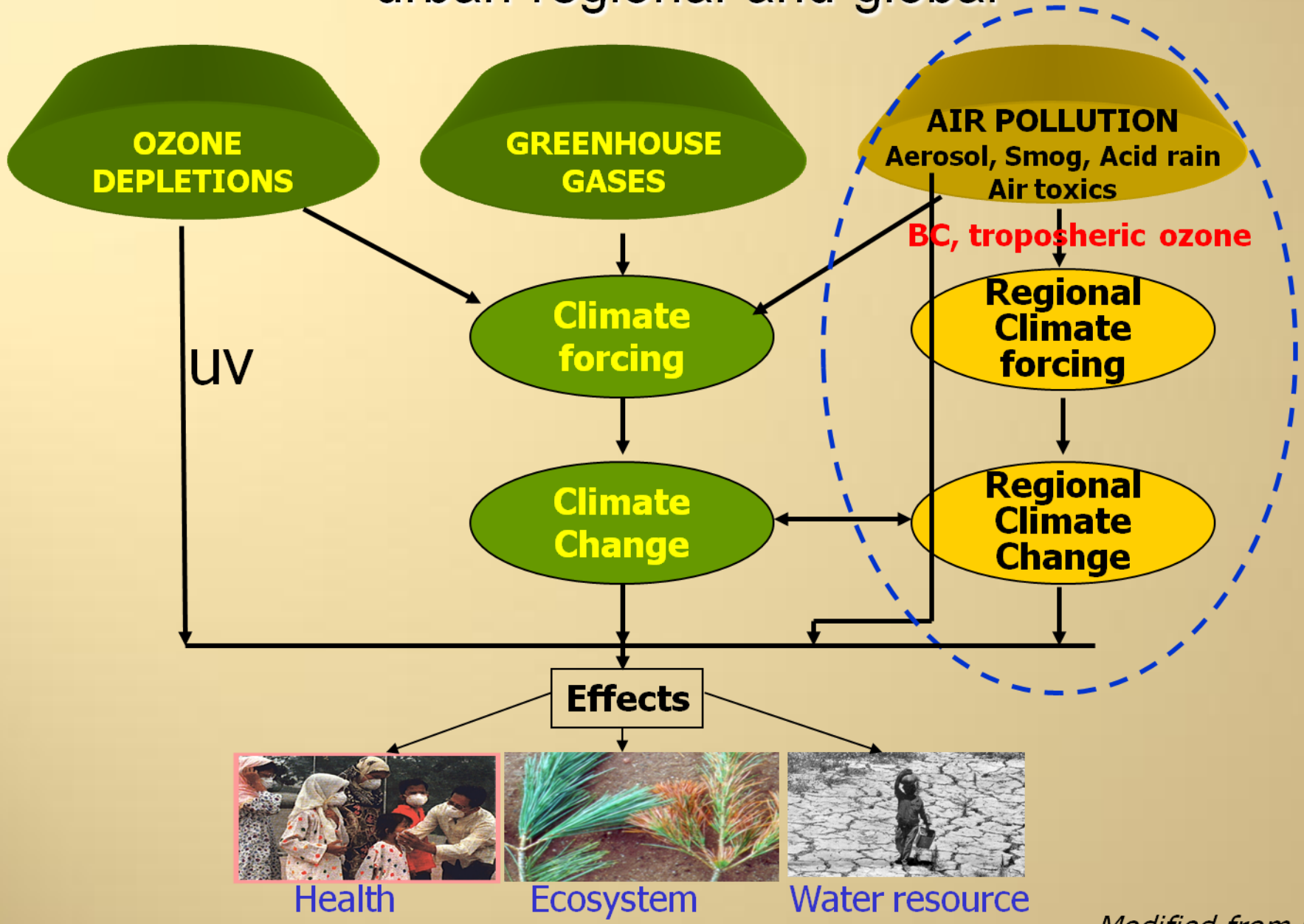


Amonporn and Kim Oanh, 2010

7. Air quality and climate interaction research

- Integrated assessment of air quality and climate co-benefits
- Quantification of co-benefits of emission control strategies using integrated air quality – climate modeling approach

Emerging Atmospheric Environmental Issues: urban-regional and global

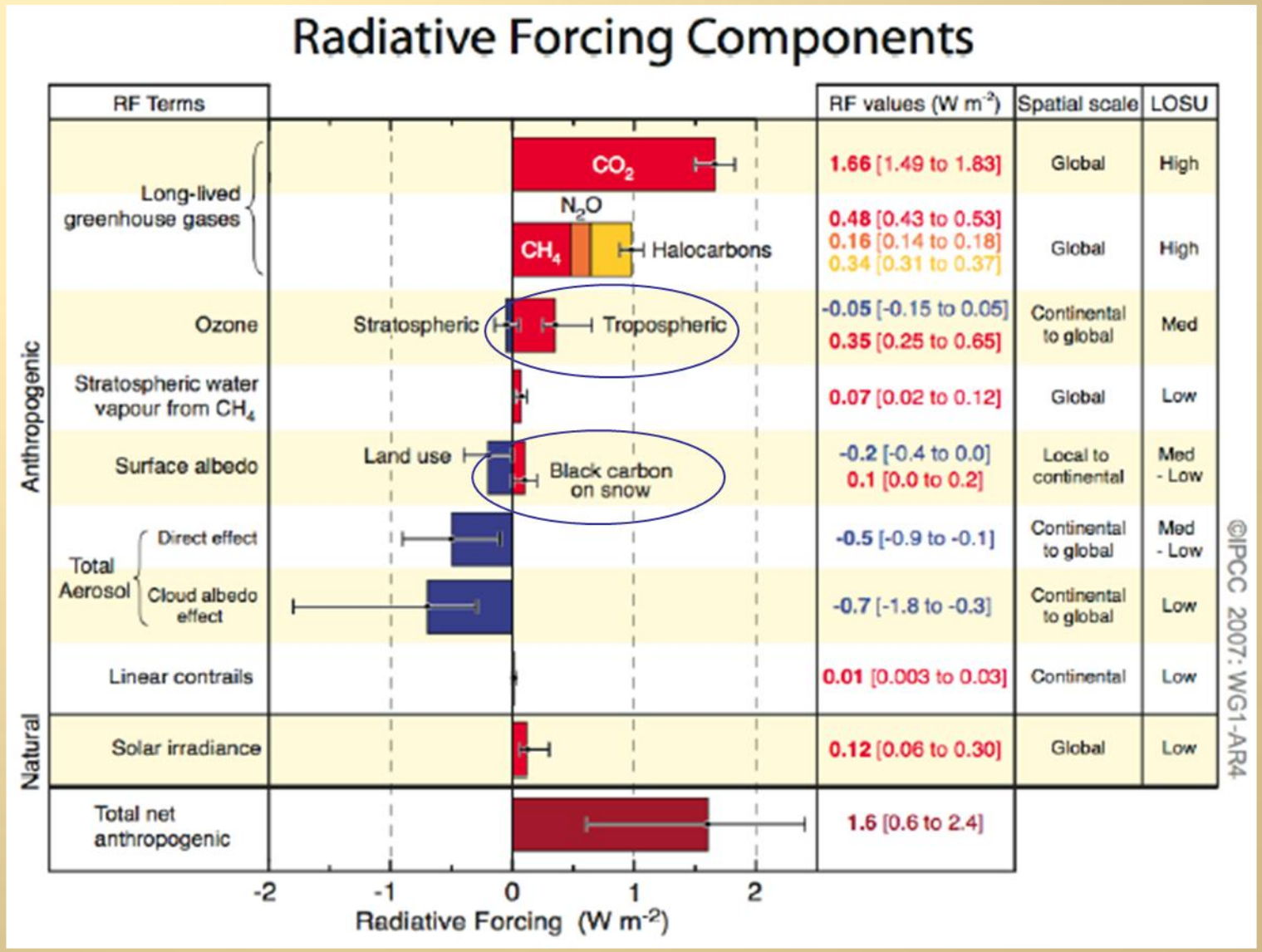


Modified from UNEP

Air pollution and climate change interaction

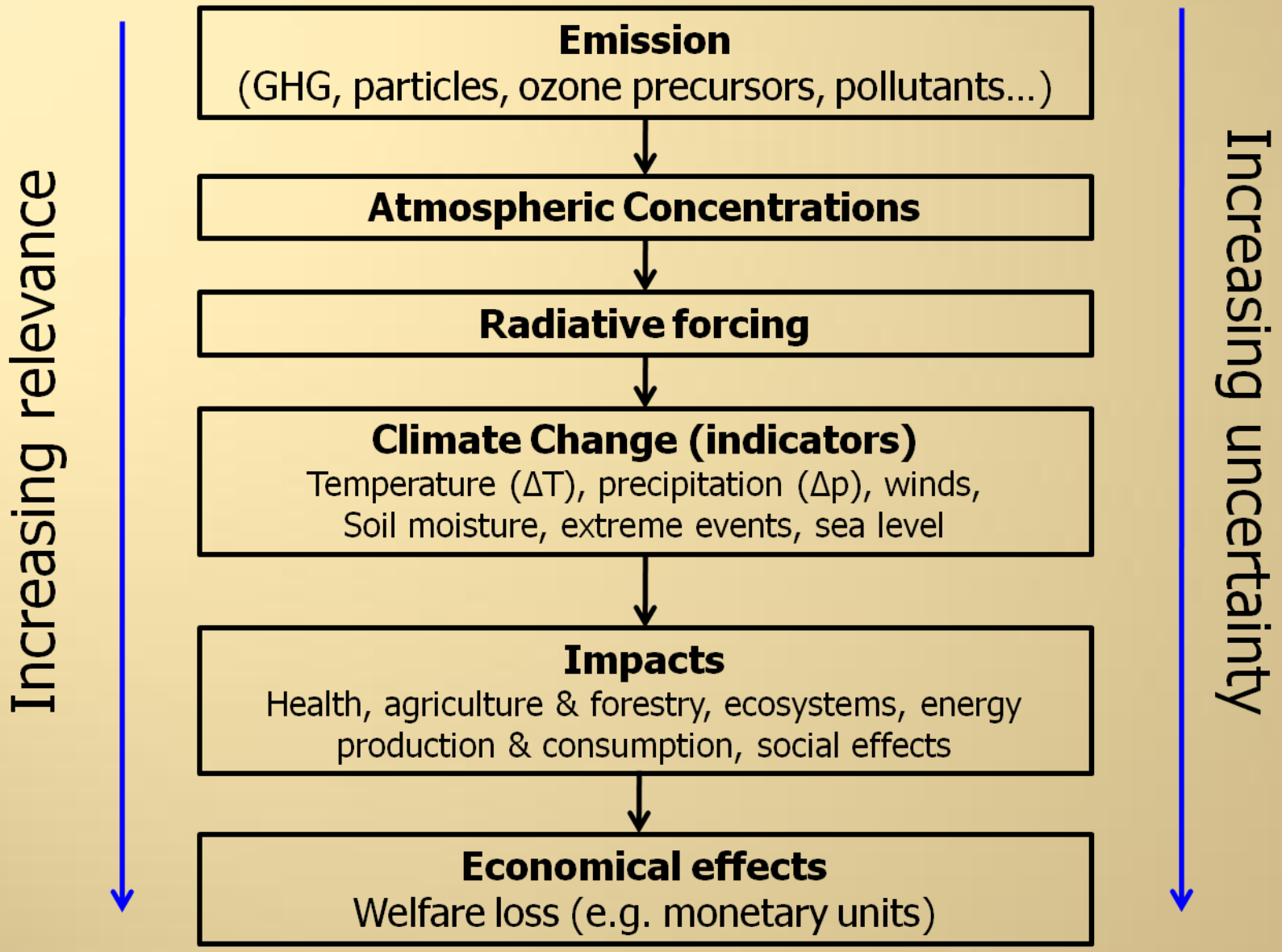
- Some traditional air pollutants (tropospheric ozone and particles) are short-lived forcers → important role in climate system
- Common sources: main air pollutants and CO_2 are emitted from the same sources (combustion) → air pollution abatement affects climate change
- Atmopsheric chemistry: some air pollutants affect the lifetimes of GHGs

BC and tropospheric ozone are toxic and also strong short-lived climate forcers



Cause – effect chain of potential climate change effects

Ref. Fuglestvedt et al. 2009

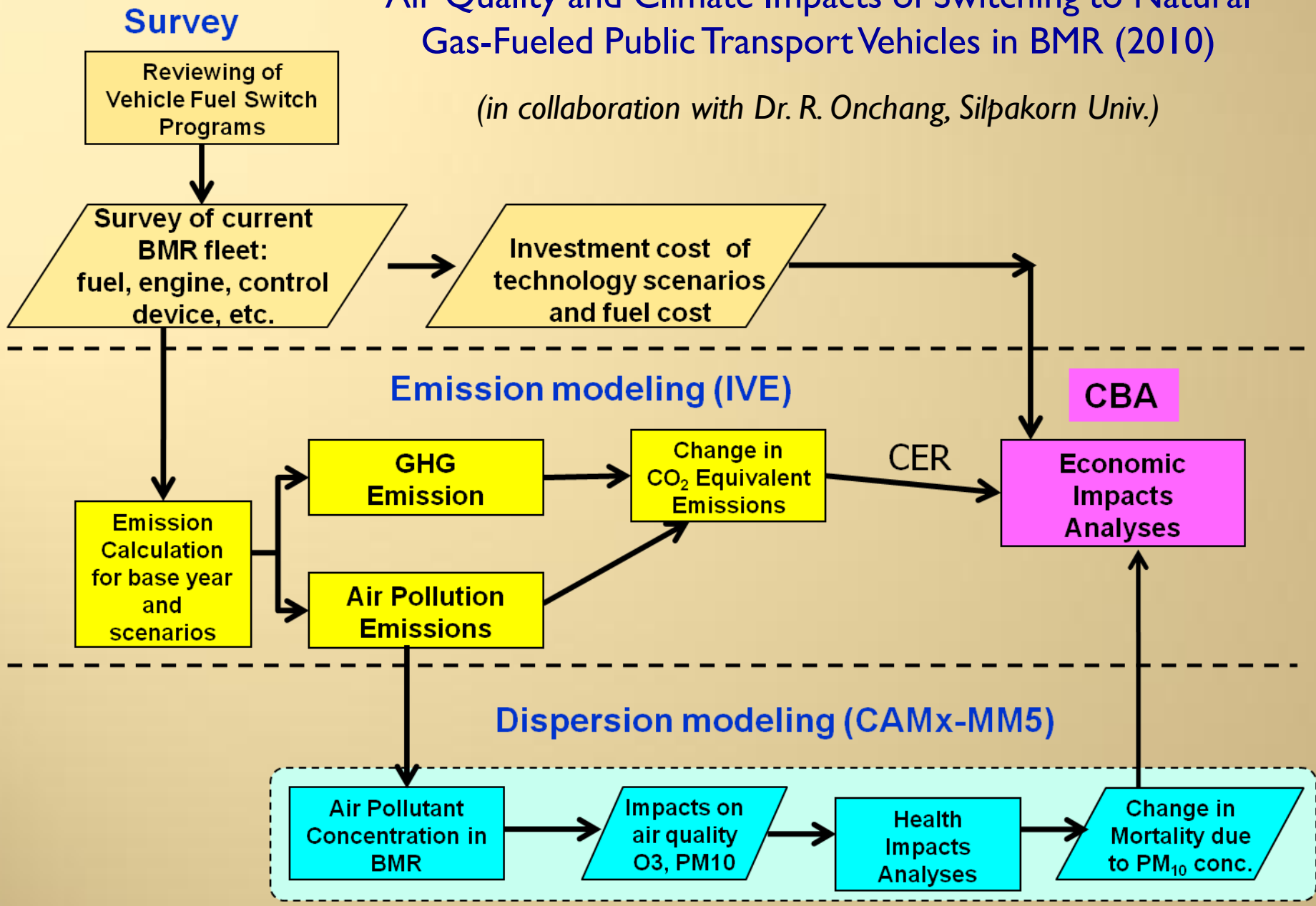


Kim Oanh, AIT

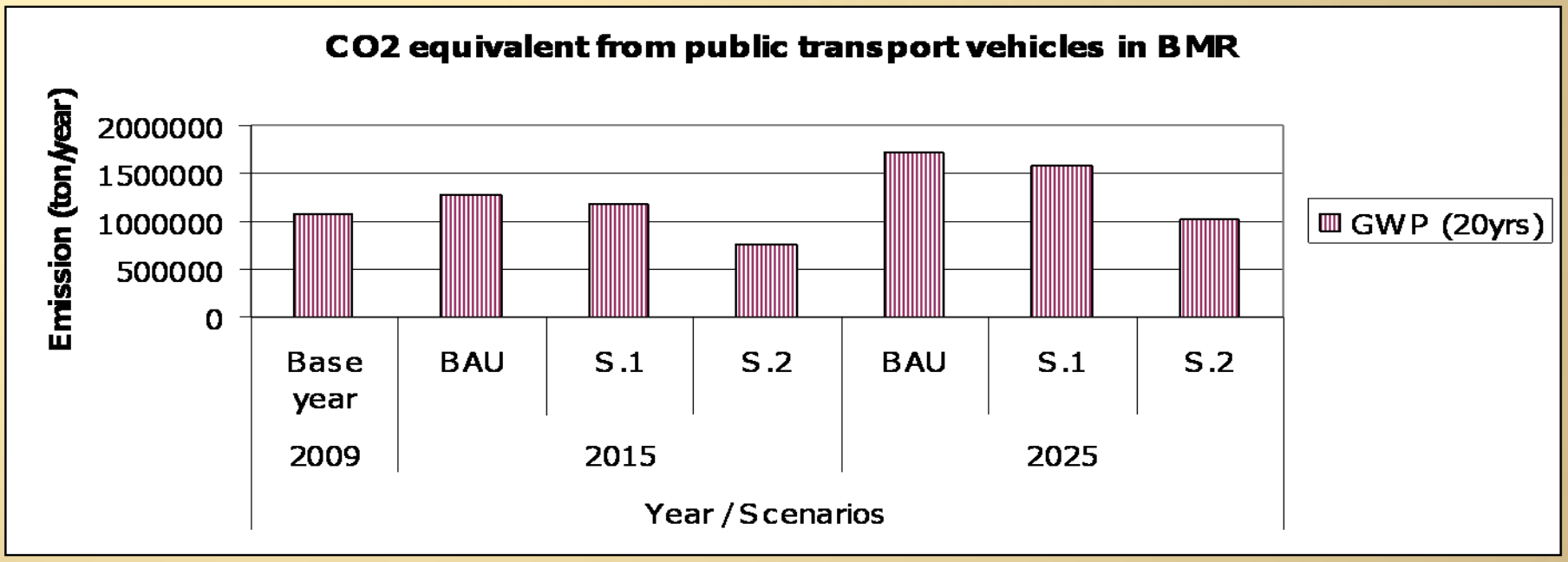
AIT-RTG Join Research Project:

Air Quality and Climate Impacts of Switching to Natural Gas-Fueled Public Transport Vehicles in BMR (2010)

(in collaboration with Dr. R. Onchang, Silpakorn Univ.)



Co-benefit of CNG use in public transport in BMR



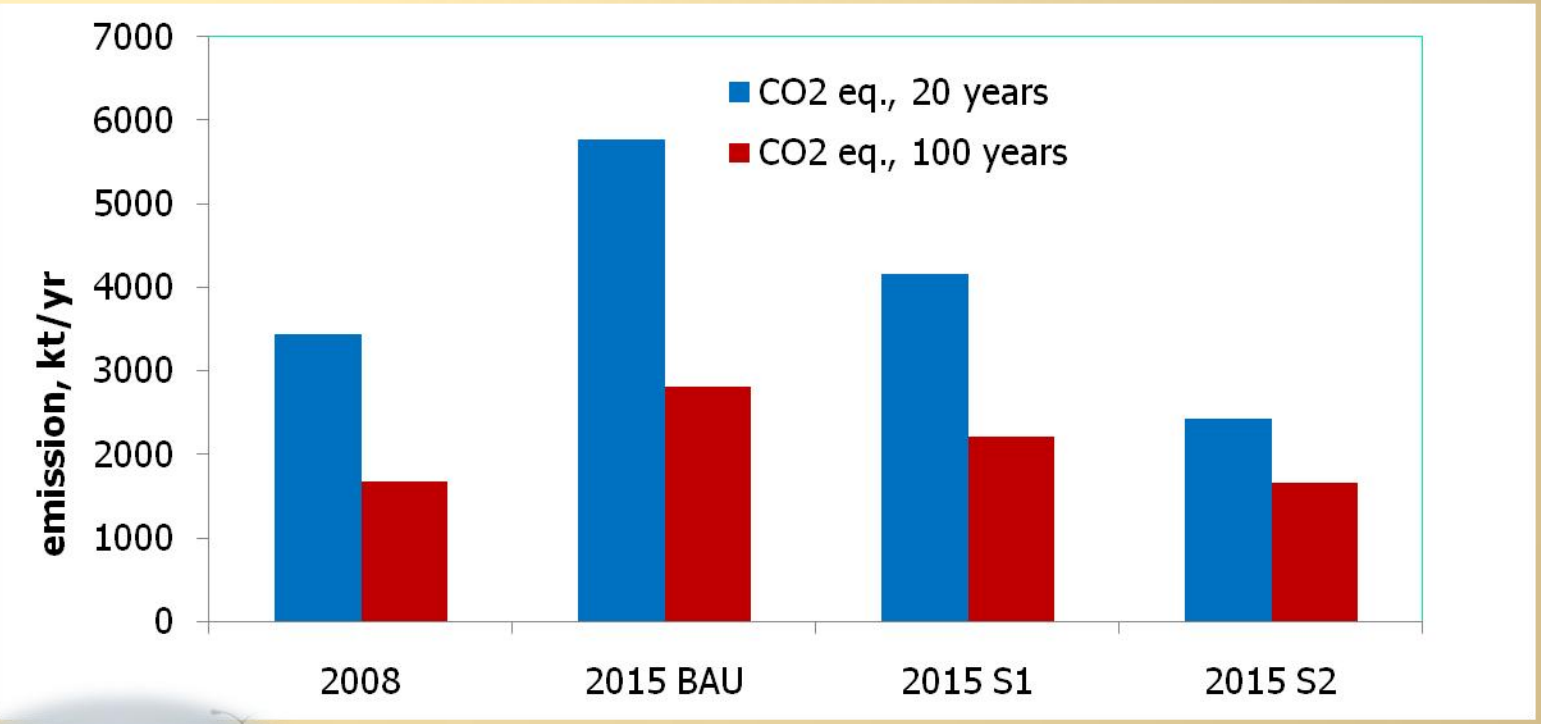
For 20 year horizon:

Emission reduction in 2015: S1: 7.3% S2: 41%

Emission reduction in 2025: S1: 8.2% S2: 41%

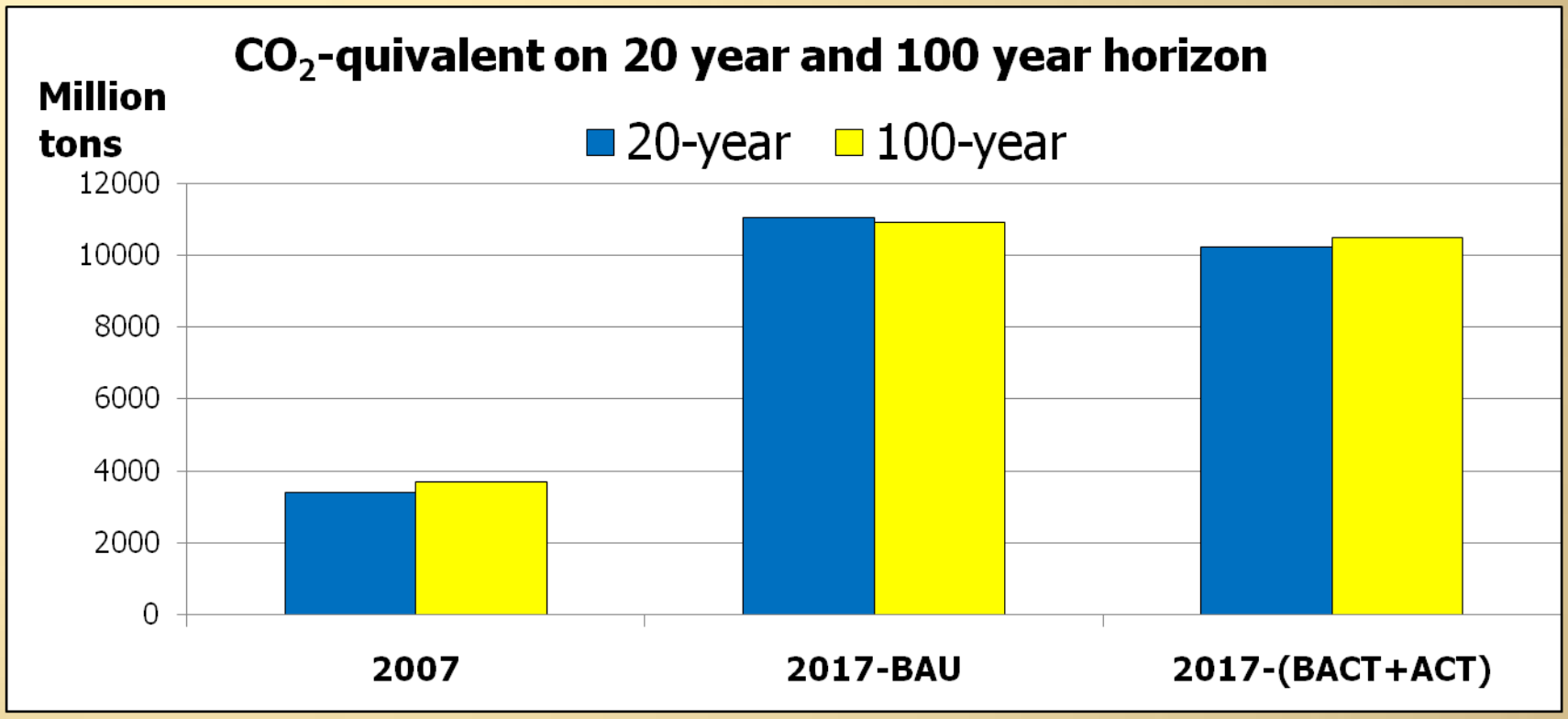
Aue-Enndu Vilaiphorn, AIT thesis

Co-benefit of motorcycle technology improvement in Hanoi



S1: gradual intrusion of Euro3 technology
S2: rapid intrusion of Euro3 technology

Co-benefit of Coal fired power plants, China

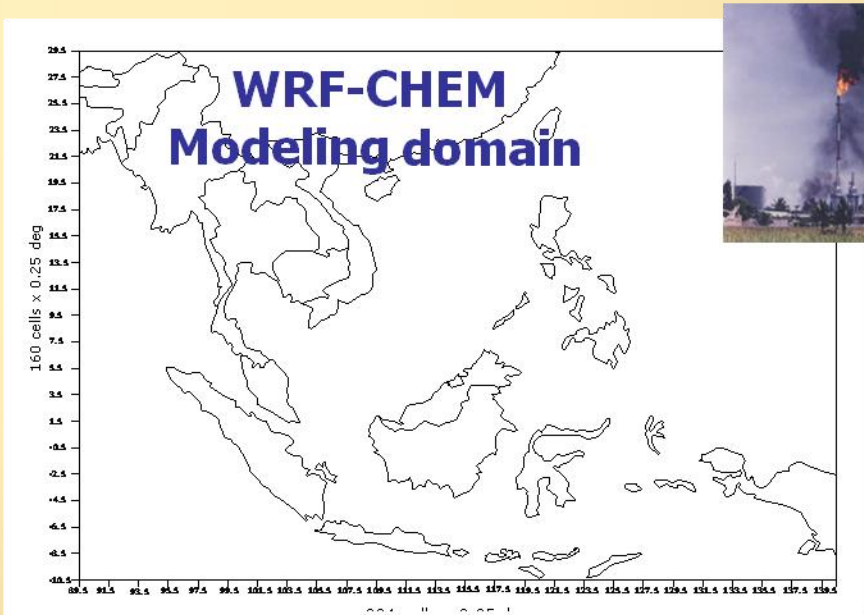


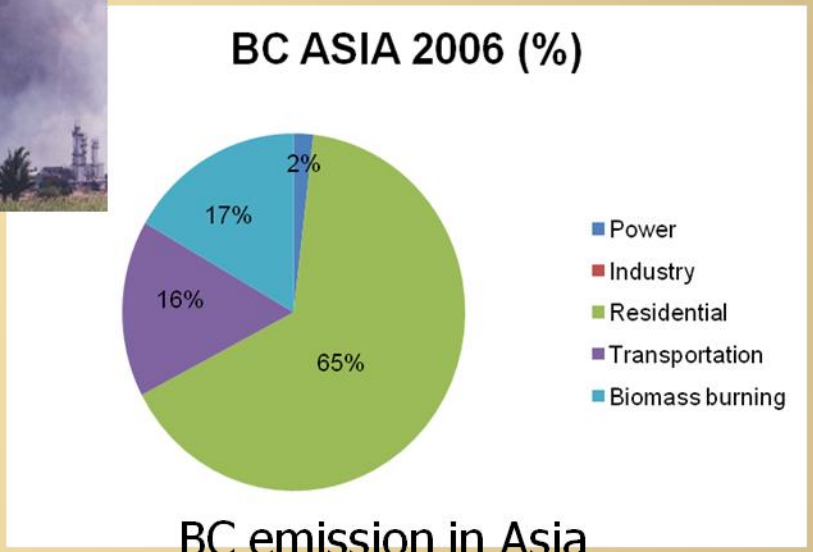
BACT: best available control technology
ACT: advanced combustion technology

CO2 eq reduction compared to 2017-BAU:
7% for 20-year, 4% for 100 year

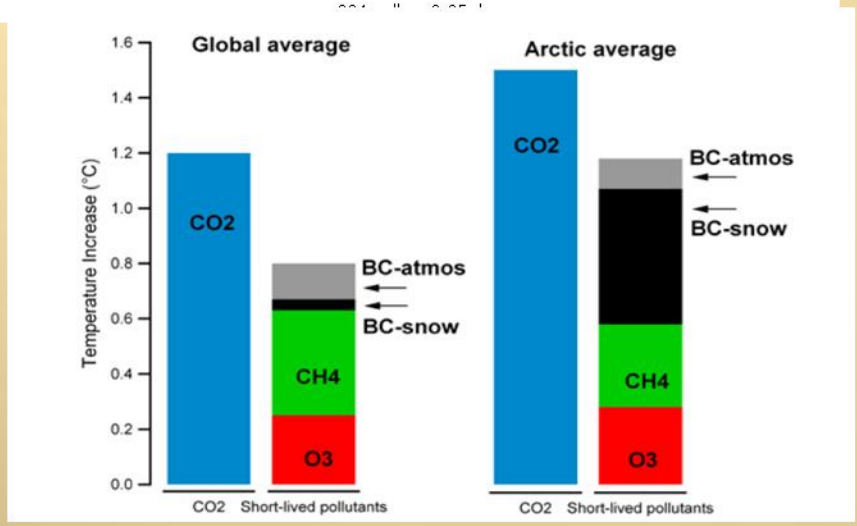
Chen and Kim Oanh, 2010

French-SDCC project: Assessment of BC emission reduction strategies on air quality and climate in SEA

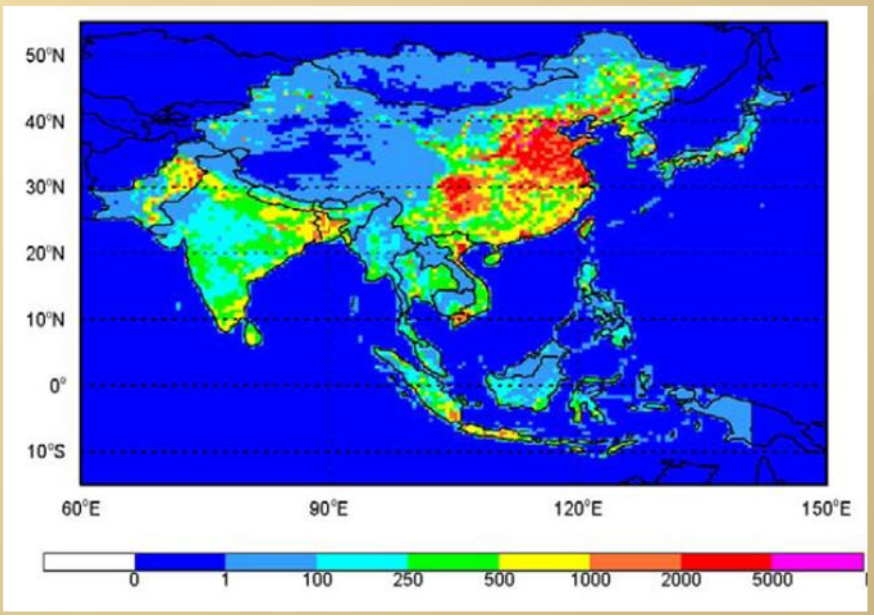




BC emission in Asia



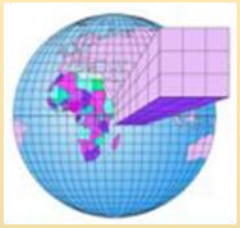
Temperature increase due to forcers



Climate change impact assessment: downscaling climate modeling to assess effects on air quality in Thailand

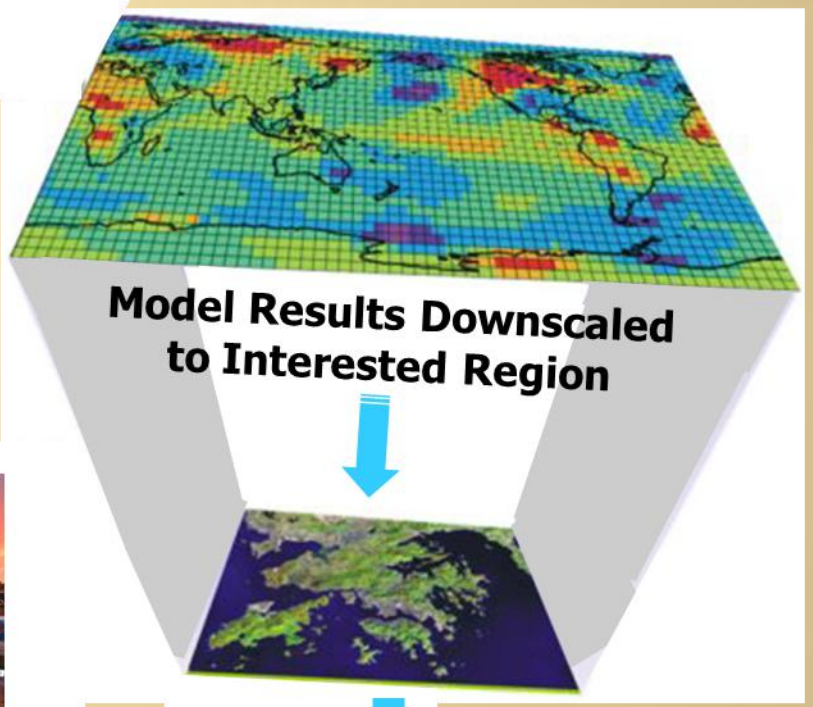
Supercomputer

Simulation of
Regional Climate Change



Global Climate Models

Emission Scenarios



Impact (e.g. Air Quality in Local Area)

Ongoing projects

- Near road and on-road exposure assessment, sponsored by KIST (Korea), started in June 2010
- Hazardous chemical management, 2006-2010 (phase 1); 2011-2013 (phase 2); sponsored by Norwegian MFA
  - Involving Vietnam and Thailand
  - High temperature incinerator of PCB and OCPs
  - Bio-nano technologies for treatment of VOC, POP (including dioxin)-contaminated soil

Air Quality Hero

Prof Kim Oanh has been awarded the plaque "Air Quality Hero" at the Better Air Quality (BAQ) Conference held at Singapore recently.

She was felicitated by the organizers for "consistent best presentation, most presentations and most number of abstracts submitted for BAQ over the years."

Thank You

If you would like to highlight your research activities do send in your inputs to

scpo@ait.ac.th