19th AIM International Workshop
13th – 14th December, 2013
NIES, Tsukuba, JAPAN

Air Pollution Model: Co-benefits on regional and local air quality.

Gakuji KURATA
Pichnaree Lalitaporn, Minna Guo, Ken Senoo, Naoya Kuramoto
Kyoto University

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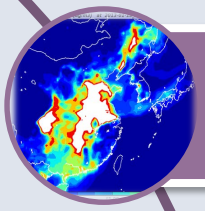
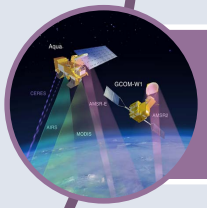


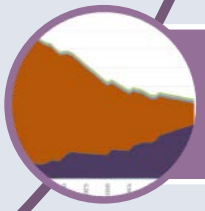
Model Simulation of $PM_{2.5}$ during January to March 2013 from China to Japan.

Observation and model simulation of severe haze event in June 2013

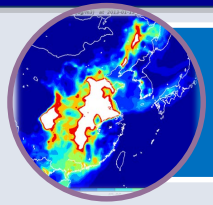
Development of personal exposure model to estimate the health impact



15years trend analysis of Satellite retrieval NO_2 and Aerosol Optical Depth (AOD) around Asian region.

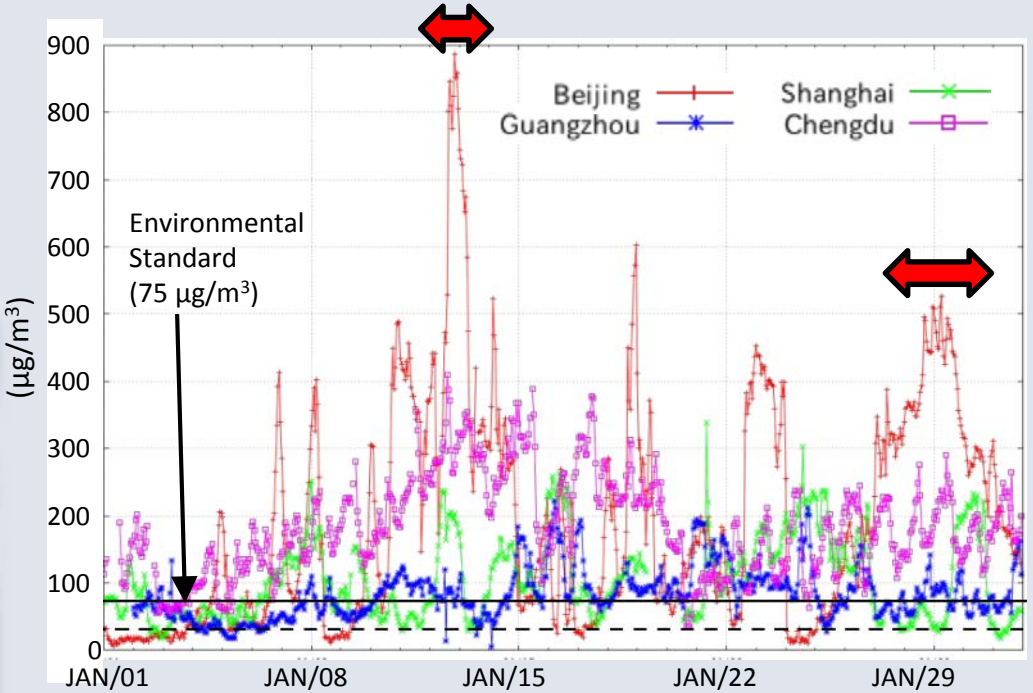


Design of framework to estimate co-benefits, especially for residential sector and urban activities.



Model Simulation of $PM_{2.5}$ during January to March 2013 from China to Japan.

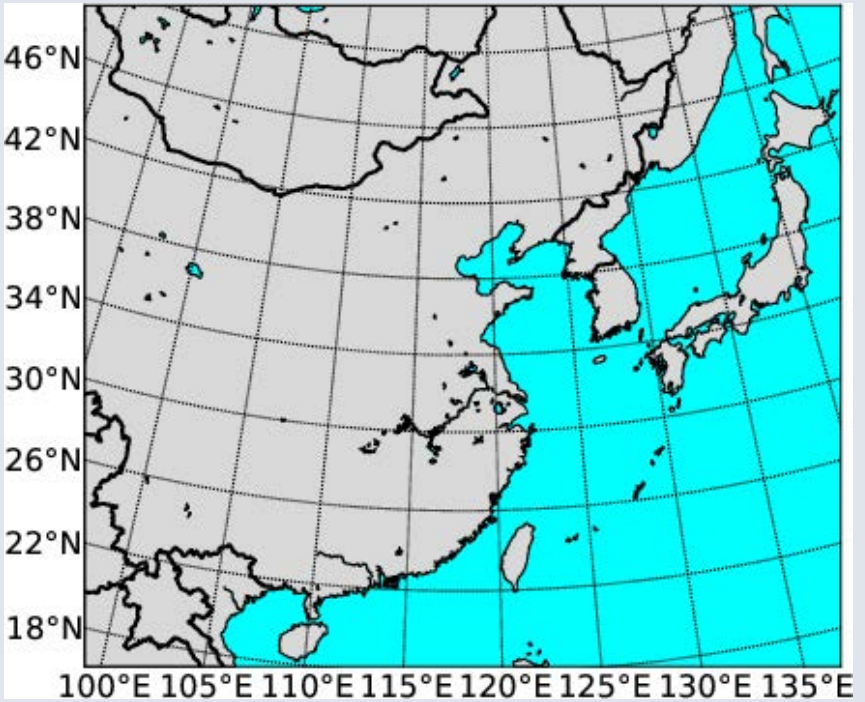
- From January to March 2013, US Embassy in Beijing recorded very high $PM_{2.5}$ concentration in Beijing. (over 800 μg/m^3).
- Also, $PM_{2.5}$ level at the major cities in China showed Hazardous level (over 250 μg/m^3)
- During this period, relatively high $PM_{2.5}$ concentration was observed in Japan, especially western part of Japan.



Source: US embassy at Beijing

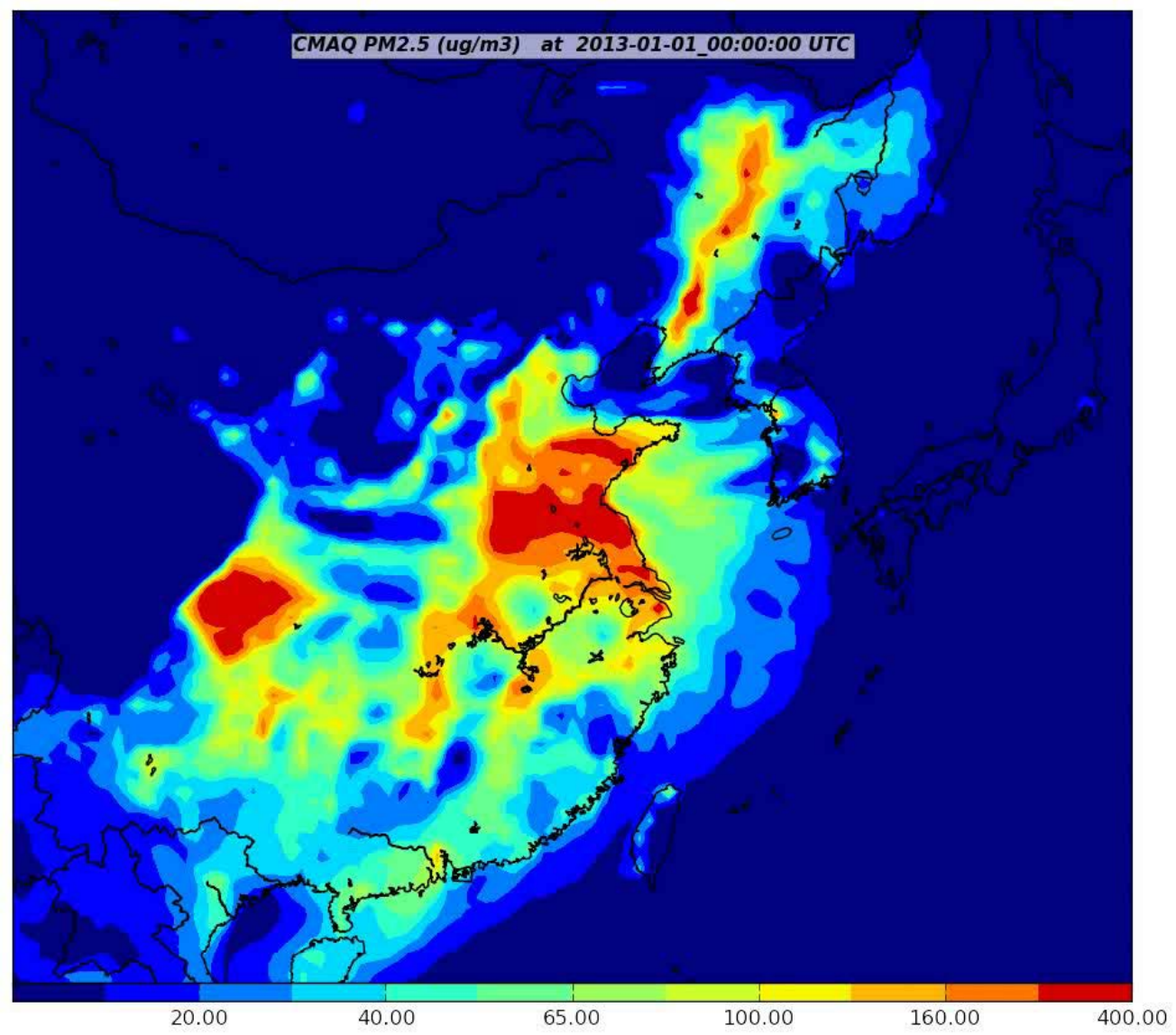
Model Simulation

Description of Simulation

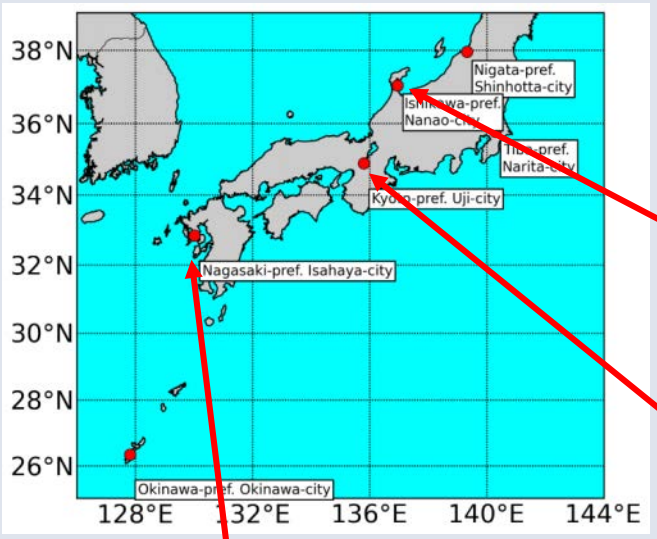


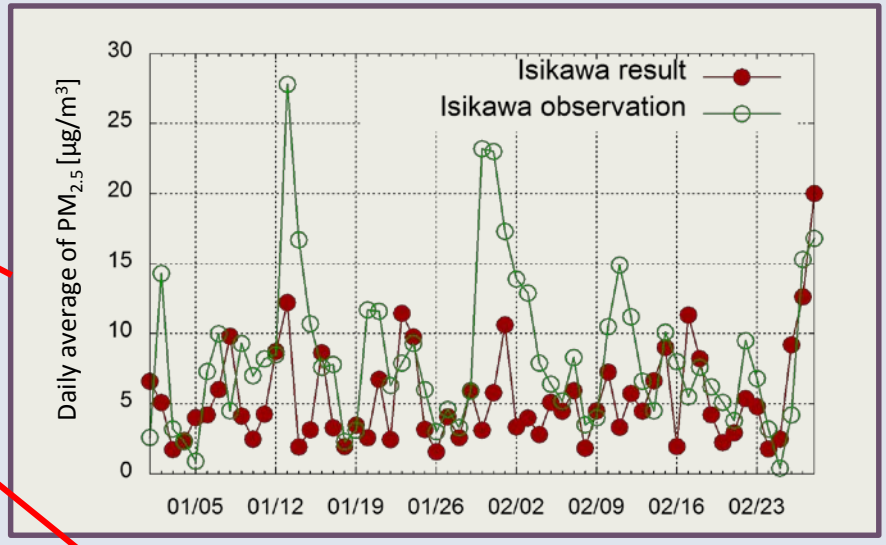
- Meteorological Model
  - WRF version 3.4
  - 36km x 36km
  - input Meteorological : NCEP FNL
- Chemical Transport Model
  - CMAQ version 5.0
  - Chemical Solver: CB5-Aero4
- Period
  - 20th December 2012 ～ 31st March 2013
- Emission Inventory
  - Combined Emission : EDGAR 4.2 , GEIA and REAS
  - Reference year of Emission: 2008 (apply no Adjustment)

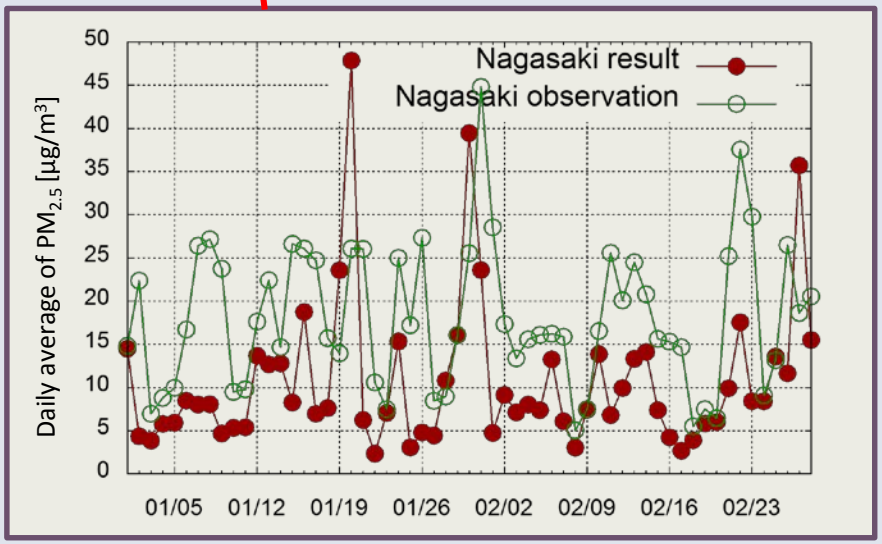
Simulation Result (Surface $PM_{2.5}$ Jan-Feb 2013)

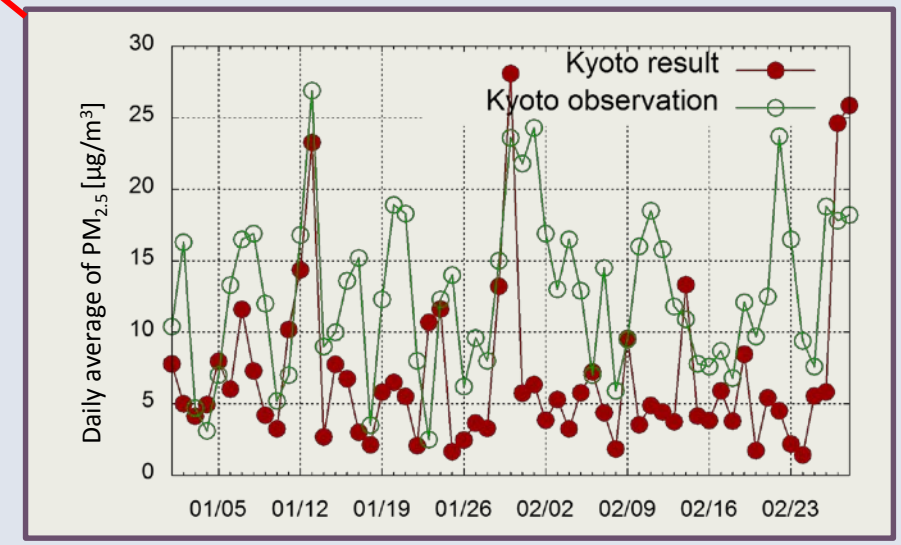


Comparison with observation







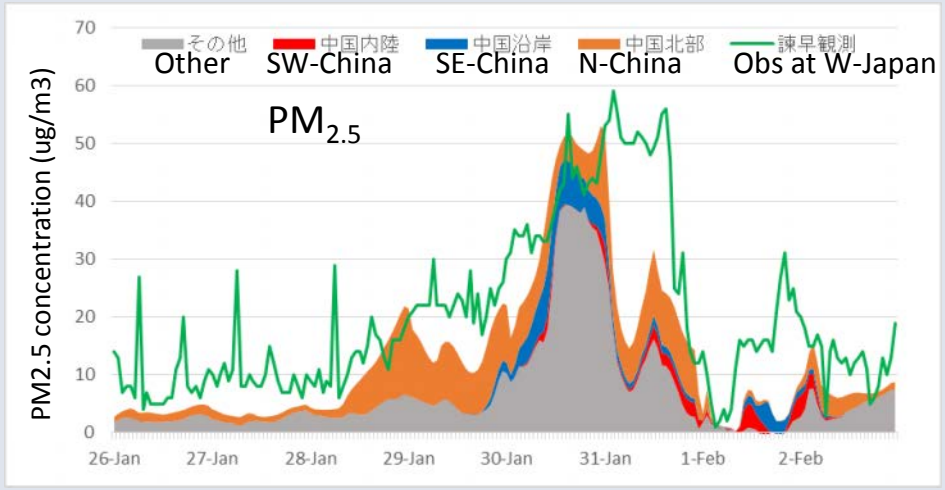


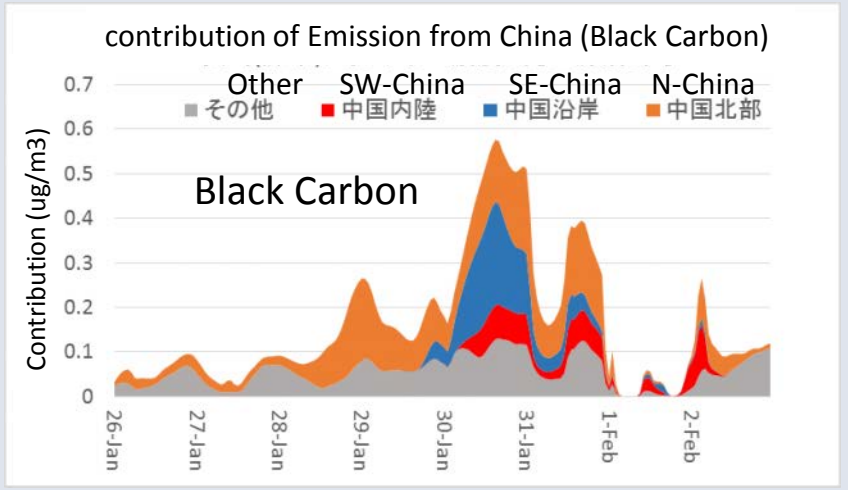
Source Contribution Analysis

1. Northern China
2. South-East China
3. South-West China
4. Other Asia

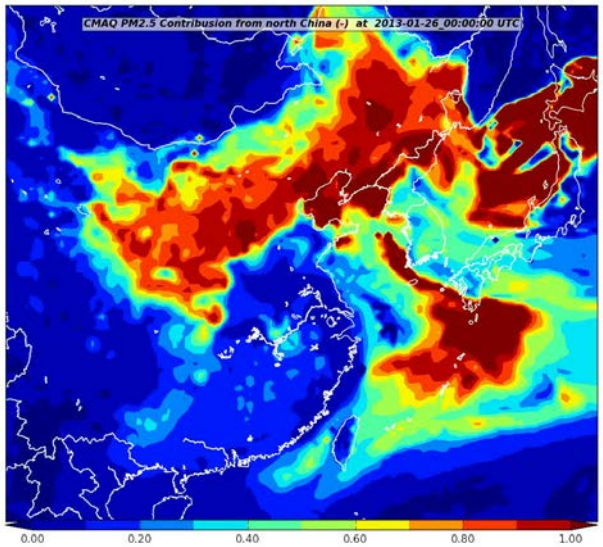
Contributions from above four area were calculated .

Period: 26th January 2013 - 4th February 2013

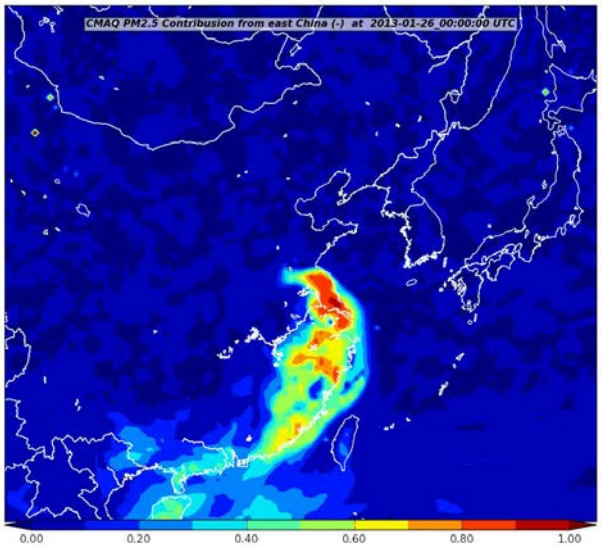




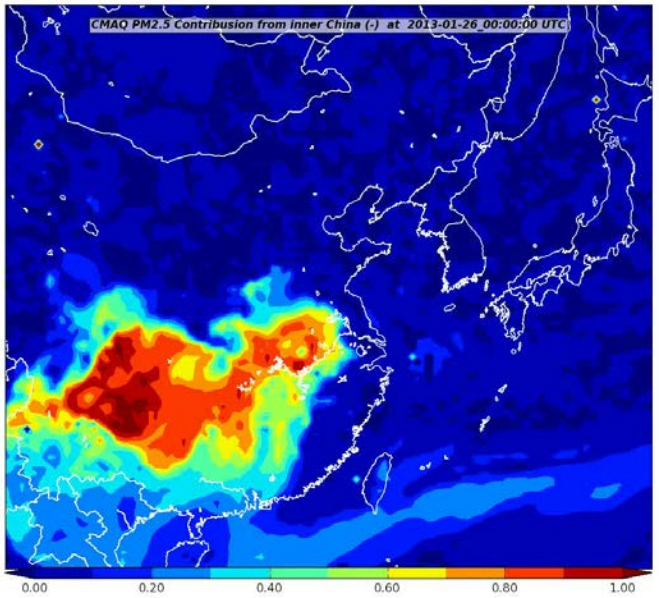
Contribution from each region



Northern China



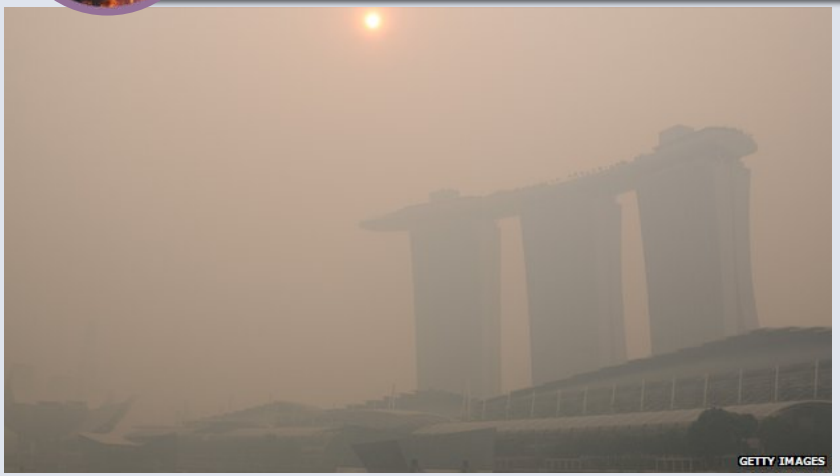
Coastal China



Southern inland China

- Contribution from Northern China is large for Korea and Japan.
- However, Contribution from Southen inland China reach to Japan, periodically.

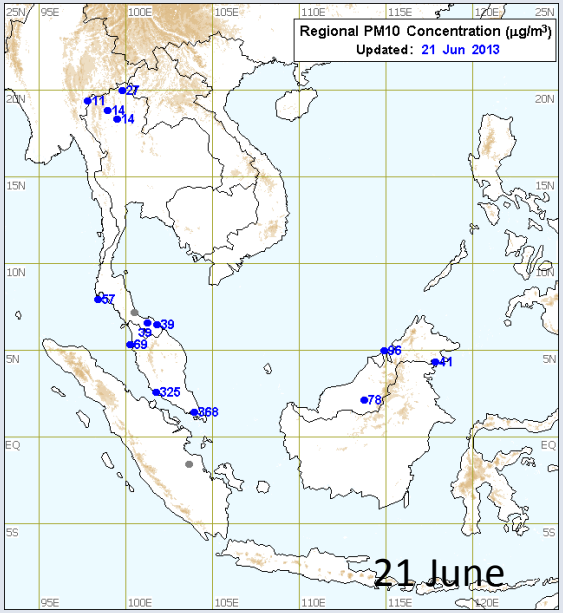
Observation and model simulation of severe haze event in June 2013

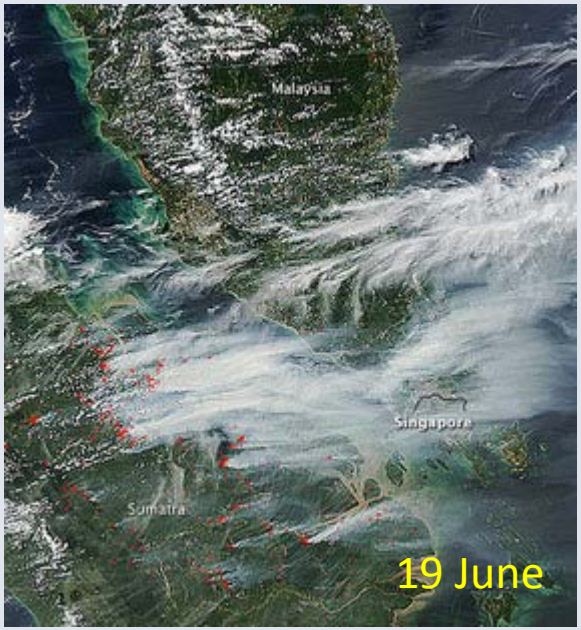


Marina Bay Hotel (Singapore)

(BBC news)

Causeway （Malaysia - Singapore） (Alter net)

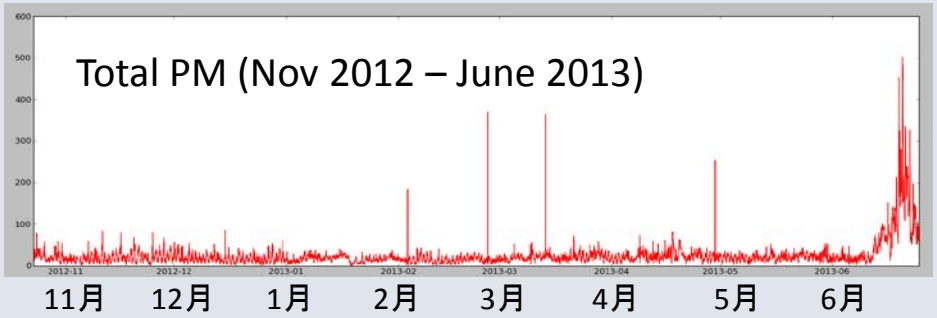


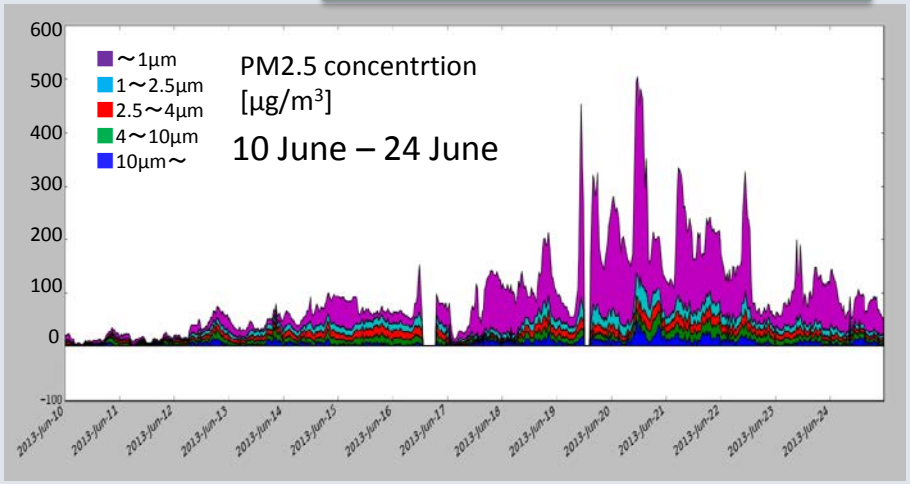


PM Monitoring at Johor, Malaysia (Universiti Technologi Malaysia)

GRIMM EDM164
PM : 0.25µm-34um , 31 ch.
1～2,000,000 particles/L
dust mass: 0.1～6,000µg/m^3
Time resolution : ～1 min.
Meteorology:
wind, temperature, precipitation, RH

Operating under SATREPS project



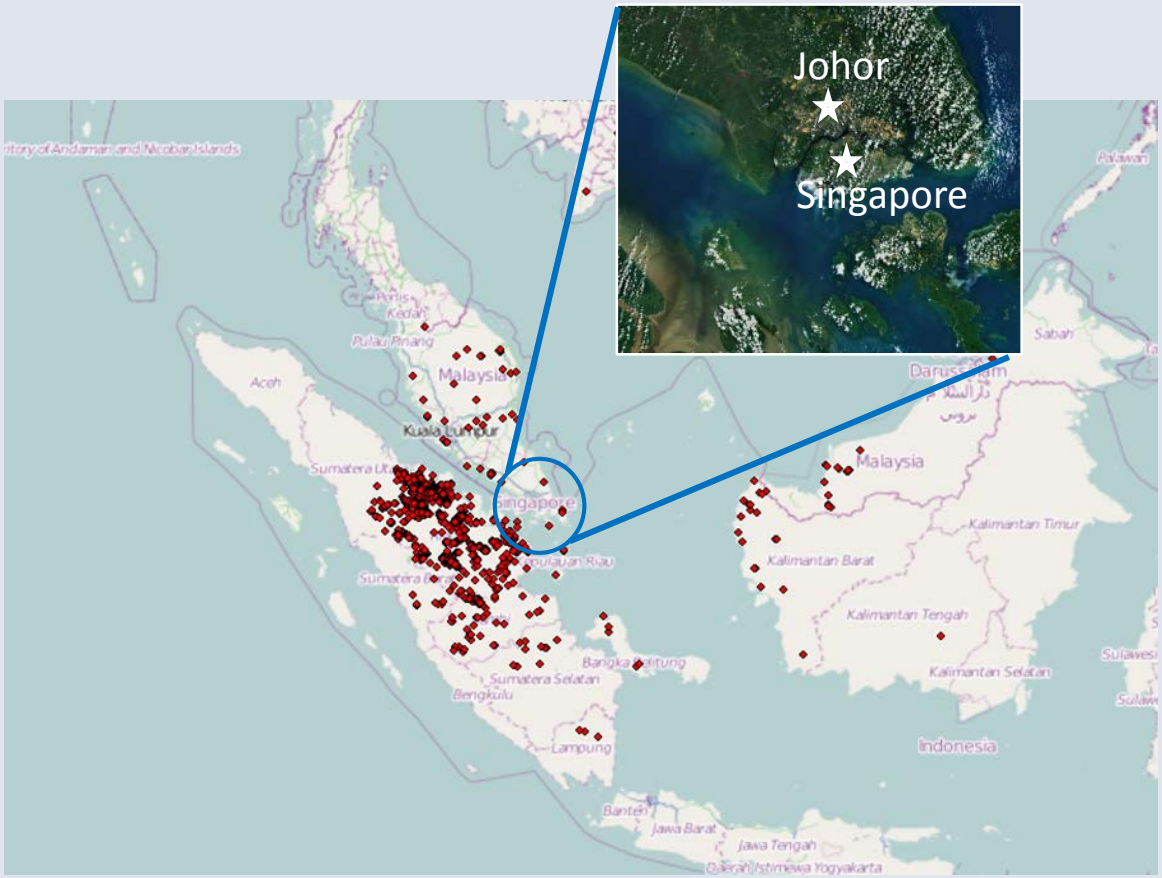


Development of Forest Fire Dataset

- NASA LANCE-FIRMS Database

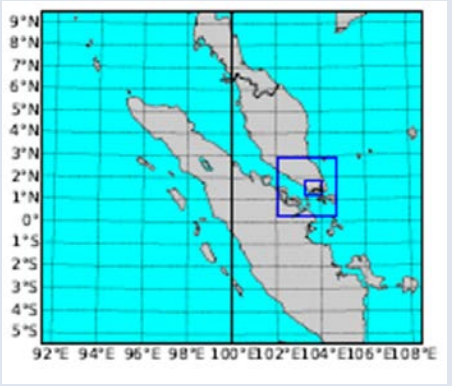
  Location of Forest Fire and estimated fire intensity (Based on Satellite Monitoring)　[semi-realtime dataset]

Fire location during
1 June 2013～ 10 July



フィールド	値
FID	218181
Shape	ポイント
LATITUDE	0.847
LONGITUDE	101.855
BRIGHTNESS	338.9
SCAN	1.4
TRACK	1.2
ACQ_DATE	2013/06/19
ACQ_TIME	1555
SATELLITE	T
CONFIDENCE	100
VERSION	5.0
BRIGHT_T31	299.6
FRP	75.5

Model Simulation for Haze event



Description of Simulation

WRF version 3.4 & CMAQ version 5.0

Grid size: 16km x 16km,

Period: June 1st - 30th June 2013

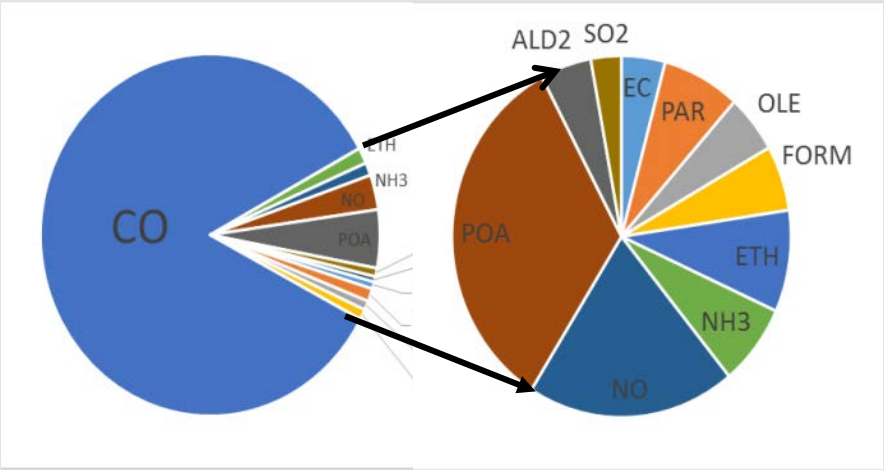
Emission Inventory

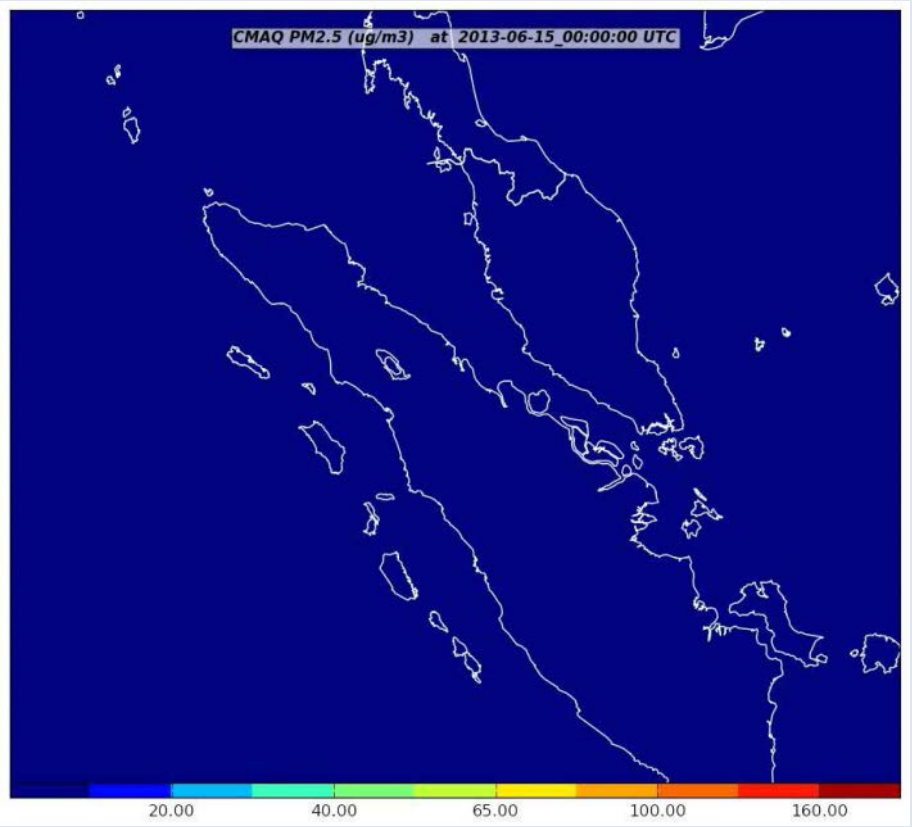
Anthropogenic and Biogenic

EDGAR 4.2 , GEIA and REAS

+ Forest Fire: NASA LANCE-FIRMS

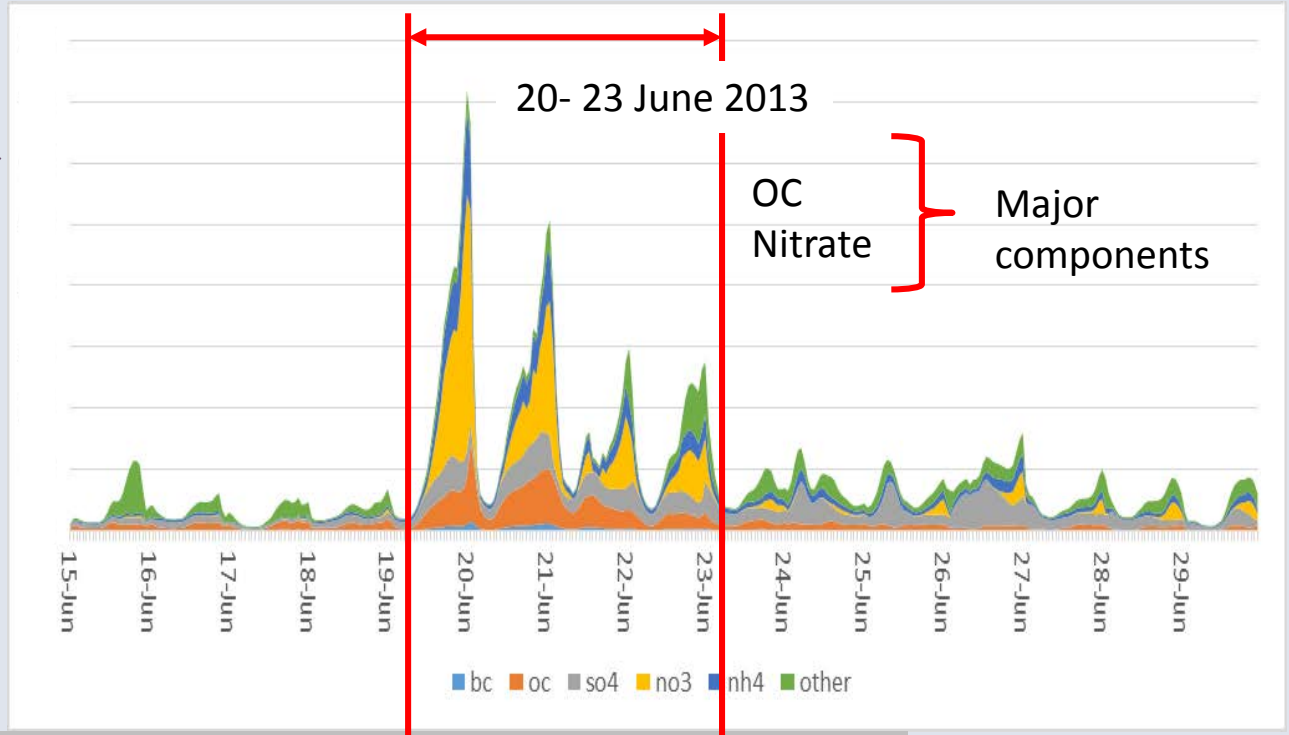
Chemical Component of
Biomass Burning at Indonesia



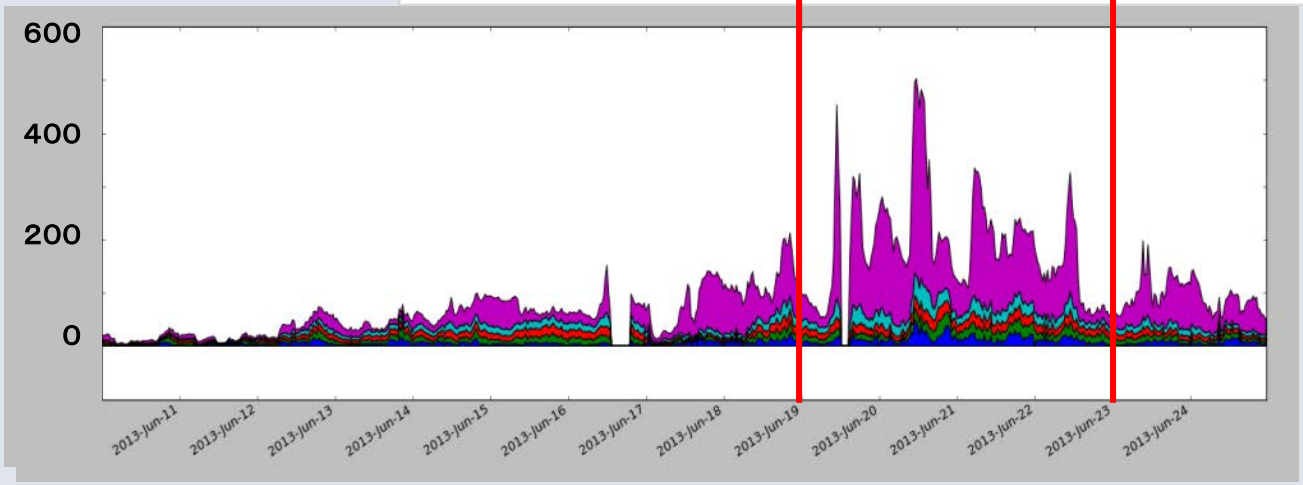


Simulation Result ($PM_{2.5}$)

Simulation Result
at UTM location

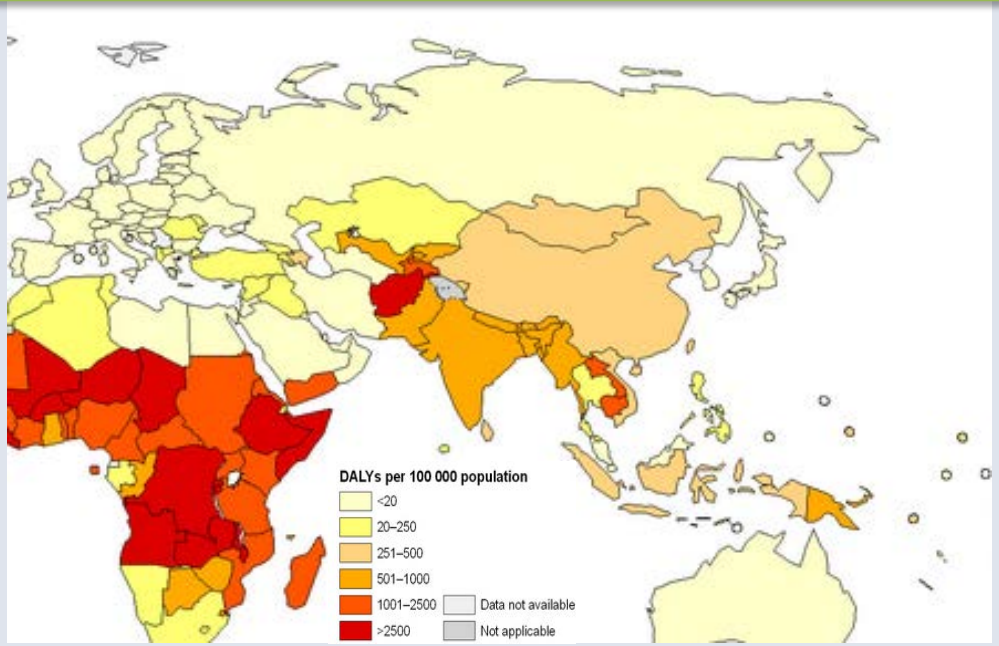


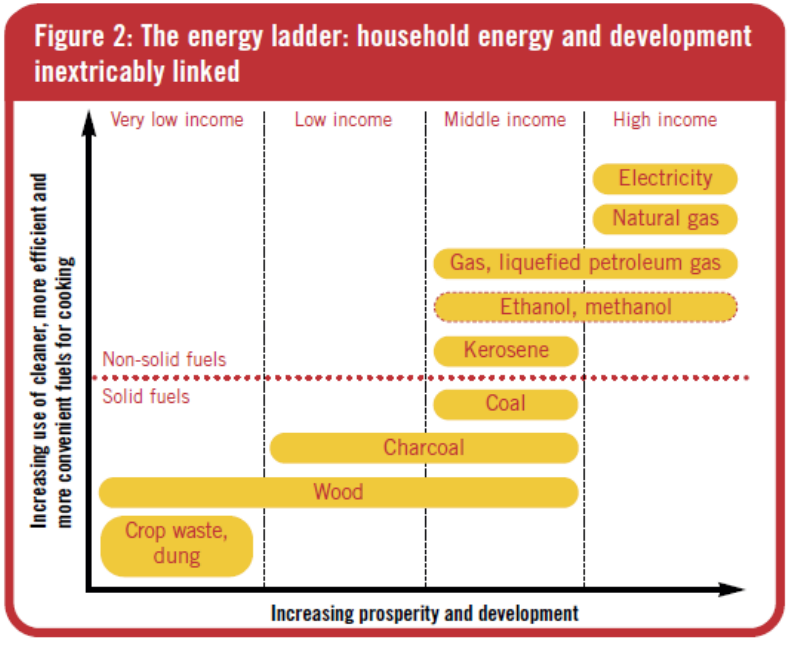
Observation
at UTM campus [μg/m³]



Development of personal exposure model to estimate the health impact

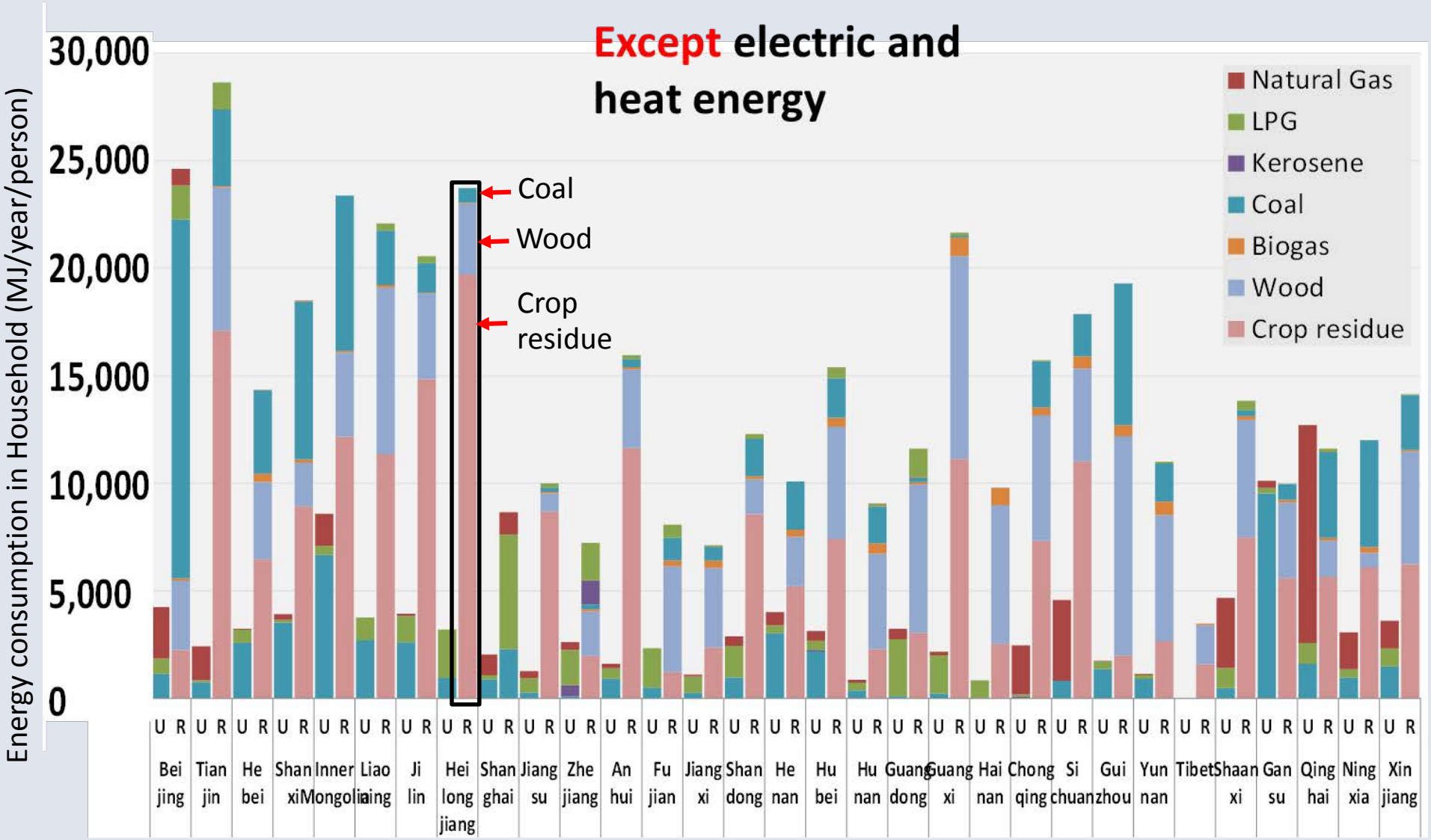
DALYs attributable to household air pollution





Source: WHO(2011)

Domestic fuel use in the Urban/Rural area in China



Micro-environment individual Exposure Model

Single-Compartment Mass Balance Model under steady-state assumption

$$C_m = \frac{1}{v + F_d}\left(F_p v C_o + \frac{Se}{V}\right)$$

◆Formulation to calculate the concentration.

➢**With Indoor emission ME A、B、C**

$$C_m = \frac{1}{(v + F_d)}(F_p v C_0 + \frac{S_e}{V})$$

➢**w/o indoor emission ME D**

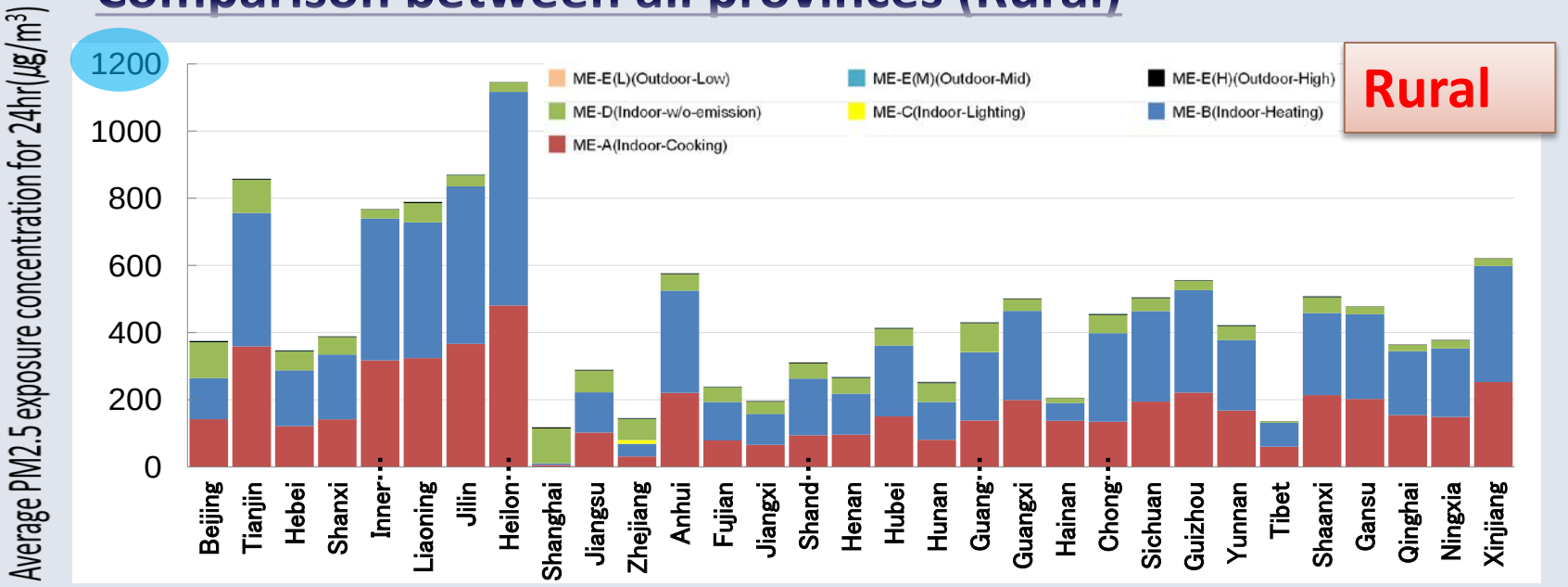
$$C_m = \frac{F_p v}{v + F_d} C_o$$

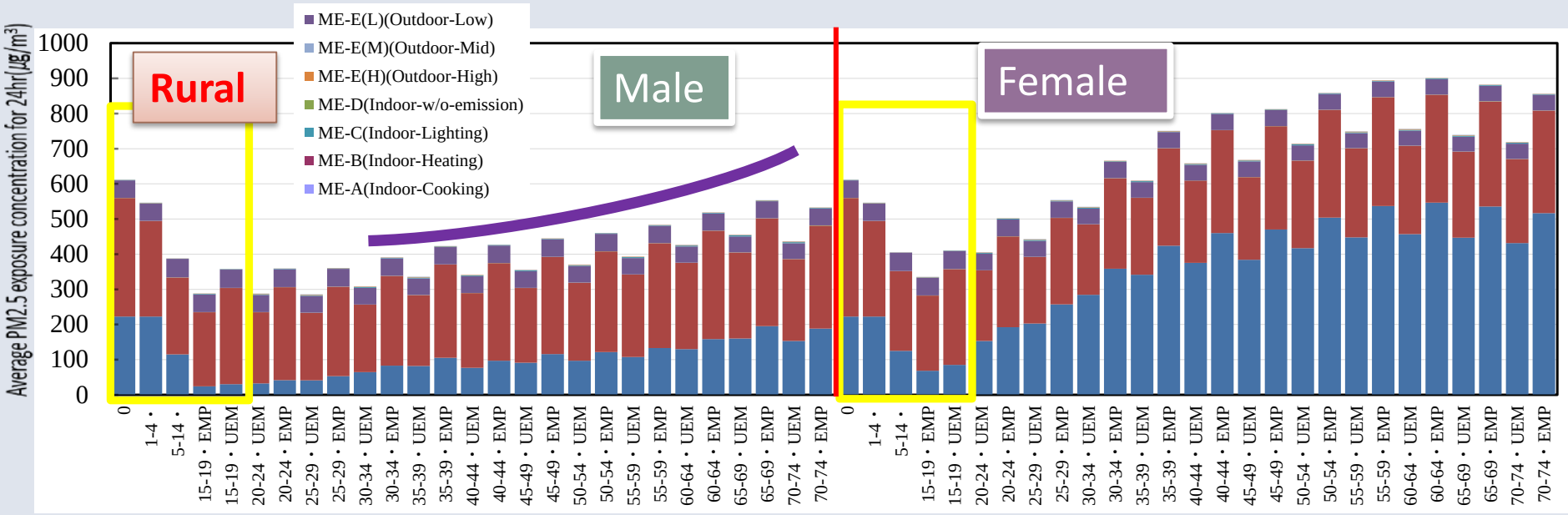
➢**Outdoor ME E**

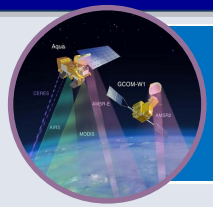
$$C_m = C_o$$

C_m	:	Pollutant concentration at micro environment (m) (μg/m³)
C_o	:	Pollutant concentration at Outdoor (μg/m³)
F_p	:	Penetration Factor (-)
v	:	Air Exchange Rate (1/hr)
F_d	:	Deposition rate (1/hr)
S	:	Energy consumption (KJ/hr)
e	:	Emission Factor (μg/KJ)
V	:	Volume of Micro Environment(m³)

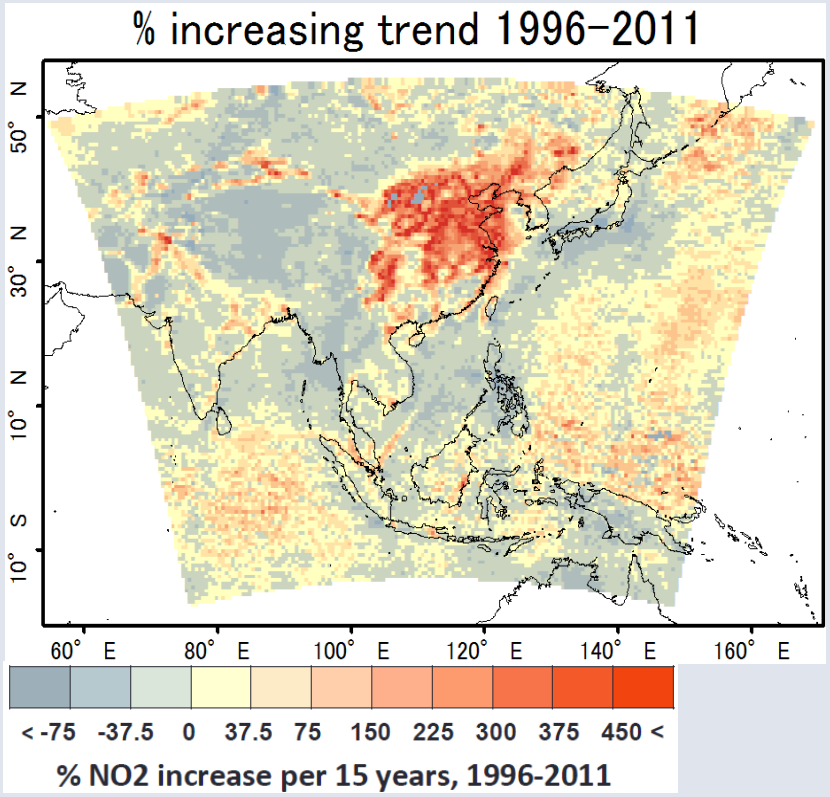
Comparison between all provinces (Rural)

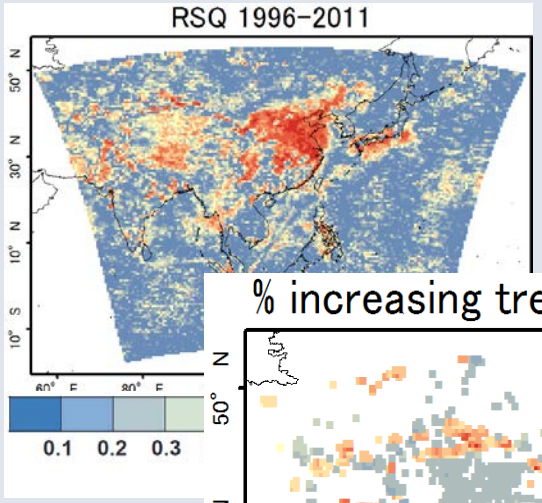


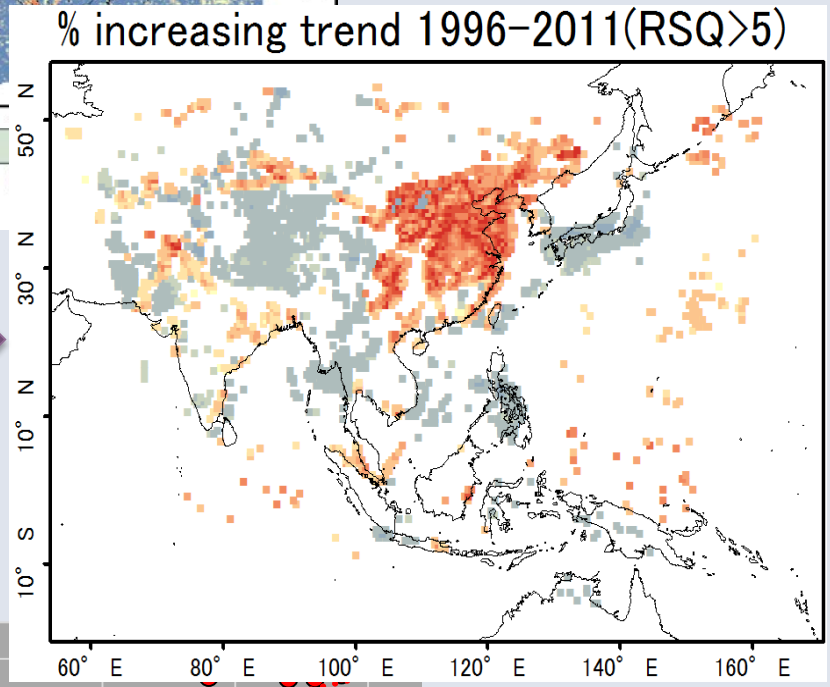




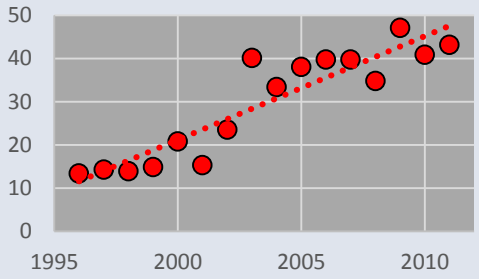
15years trend analysis of Satellite retrieval NO_2 and Aerosol Optical Depth (AOD) around Asian region.



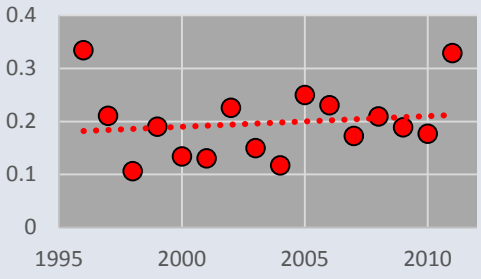


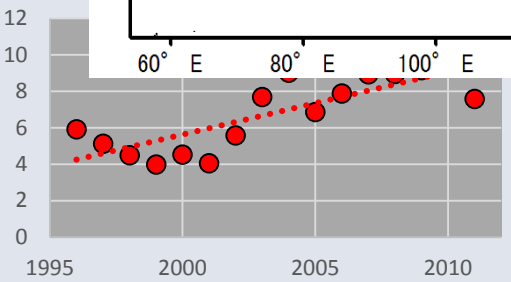


Trend at Beijing



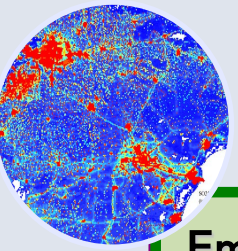
Trend at Remote area

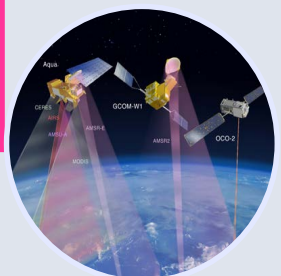




Design of framework to estimate co-benefits, especially for residential sector and urban activities.

To quantify the **co-benefit** of LCS countermeasure to reduction of health impact of air pollution





LCS policies

Emission inventory (Mesh data)

Downscaling

Time variation (Annual, Daily)

ArcGIS

Emission Inventory (Regional)

Emission Mesh data

Death Disease

Health Impact

Exposure

Indoor

Co-benefit Analysis

Micro Environment

Outdoor

Calculated Concentration

Impact Assessment

Boundary Condition

CMAQ

Chemical Transport Model

GCM Output

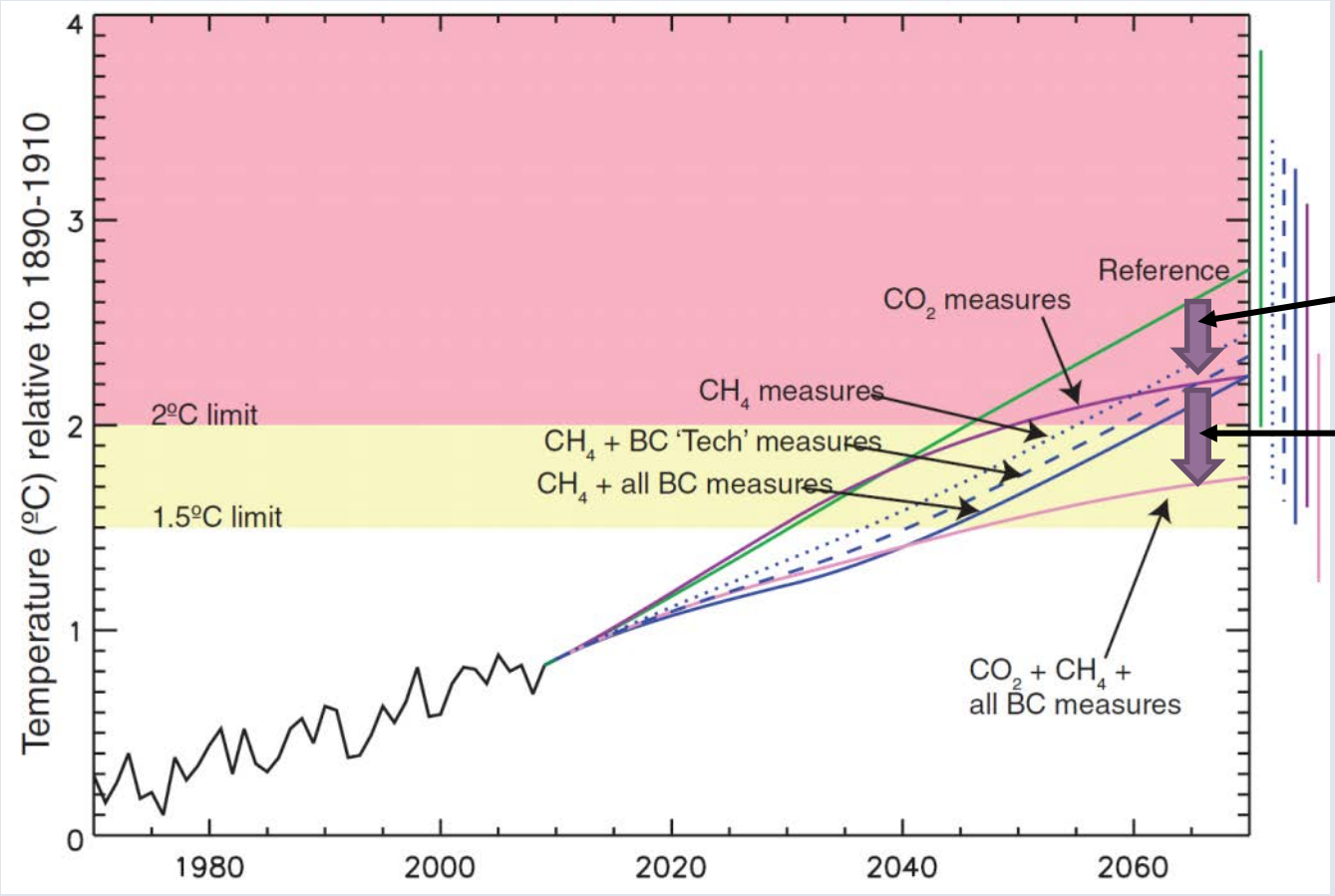
Landuse Terrain

WRF

Meteo. Field

Meteorological Model

Short-lived Climate Pollutants



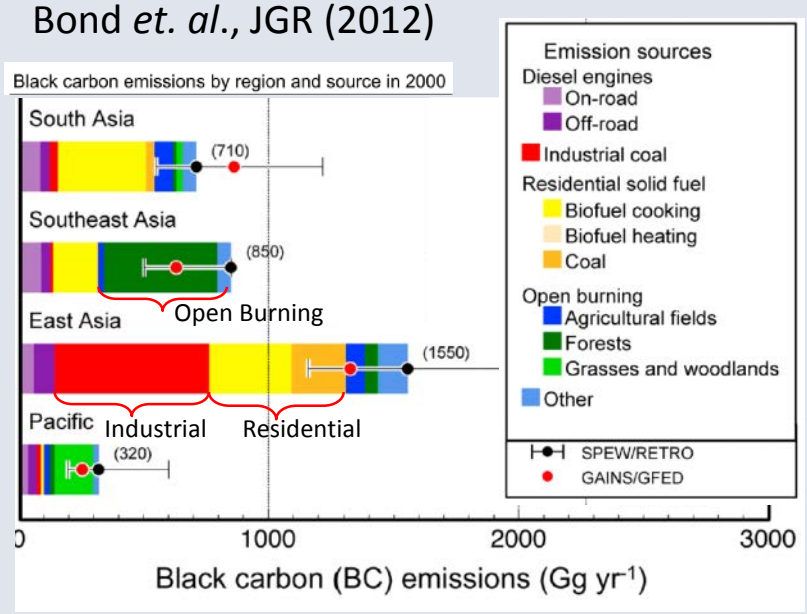
Shindell et al., (2012)

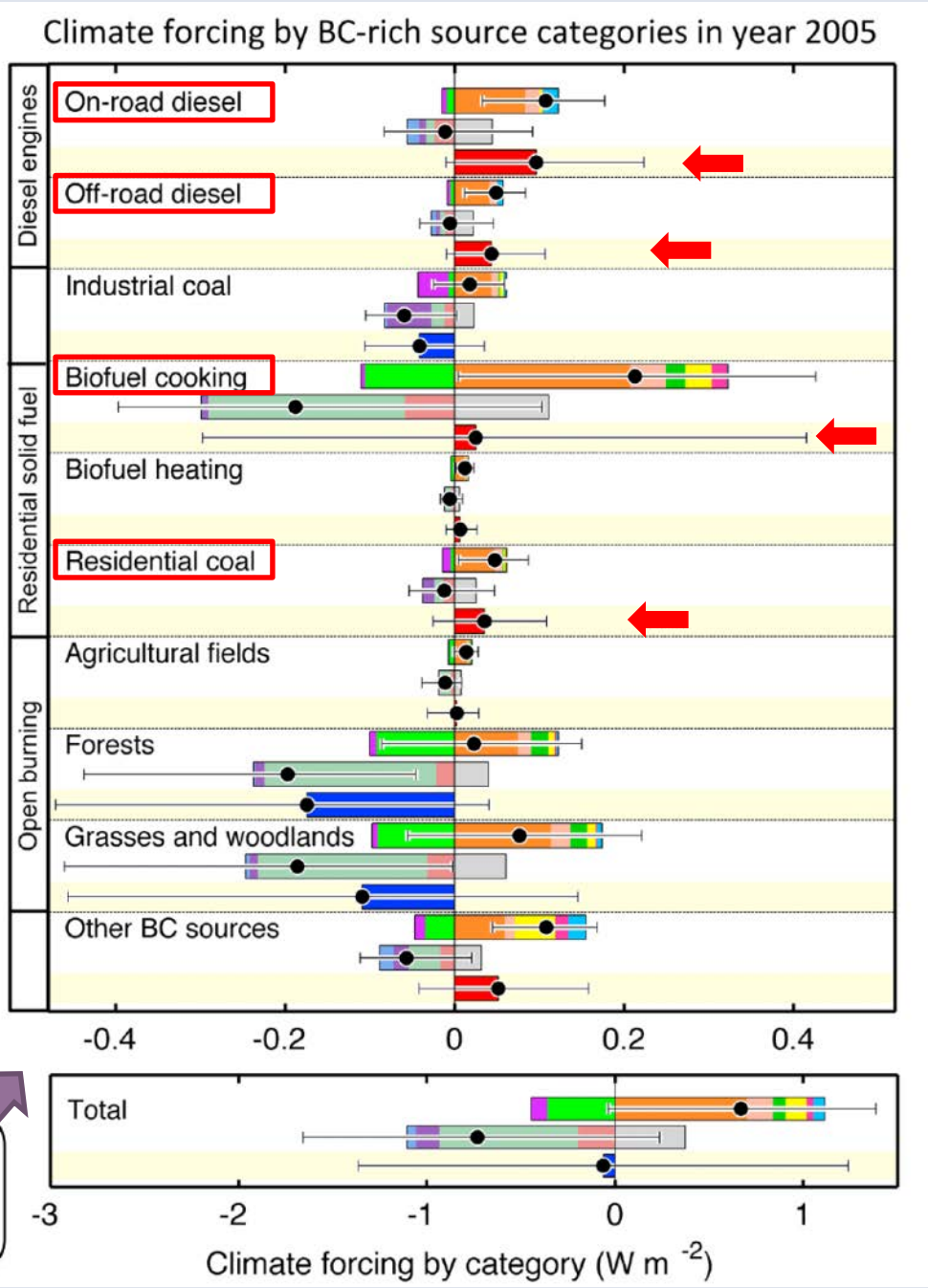
- Health Impact of SLCP(expecially $PM_{2.5}$ and Ozone) is very large.
- At the same time, SLCP contribute global radiative forcing.
- Recently, It is said that the rapid reduction of CH_4 and BC can reduce the temperature increase around 0.5 ℃ soon after the reduction.

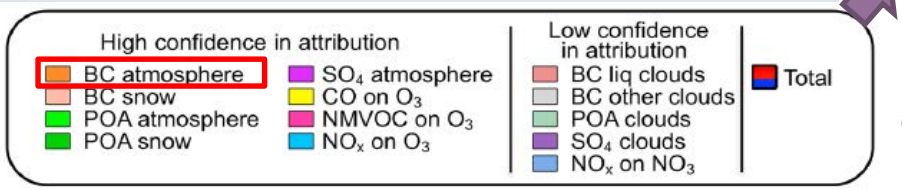
Black Carbon Emission source and net radiative forcing

- Most BC-rich source emit OC simultaneously. So, net radiative forcing by such source negative.
- Reduction of BC-rich source enhances global warming.

Bond *et. al.*, JGR (2012)







Plan for next year

- Further development of emission estimation method for residential sector. (Collect additional data for energy consumption and cooking and heating equipment)
- Development of urban pollution model which can manage roadside high concentration to improve personal exposure model.
- Future estimation under BaU case and LCS scenarios.
- Validation of the model and historical health impact.

Thank you for your attention.