

Using Top-down and Bottom-up Source Apportionment Studies to Evaluate Benefits and Co-Benefits

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Workshop on Vehicular Air Pollution and Its Impact on Human Health

Jointly Organized by MOEF / CPCB / EPCA / ICCT

New Delhi, India

September 2nd, 2011

Let's talk about..

- the sources of air pollution
- the source apportionment methods
- using results for evaluations and decisions

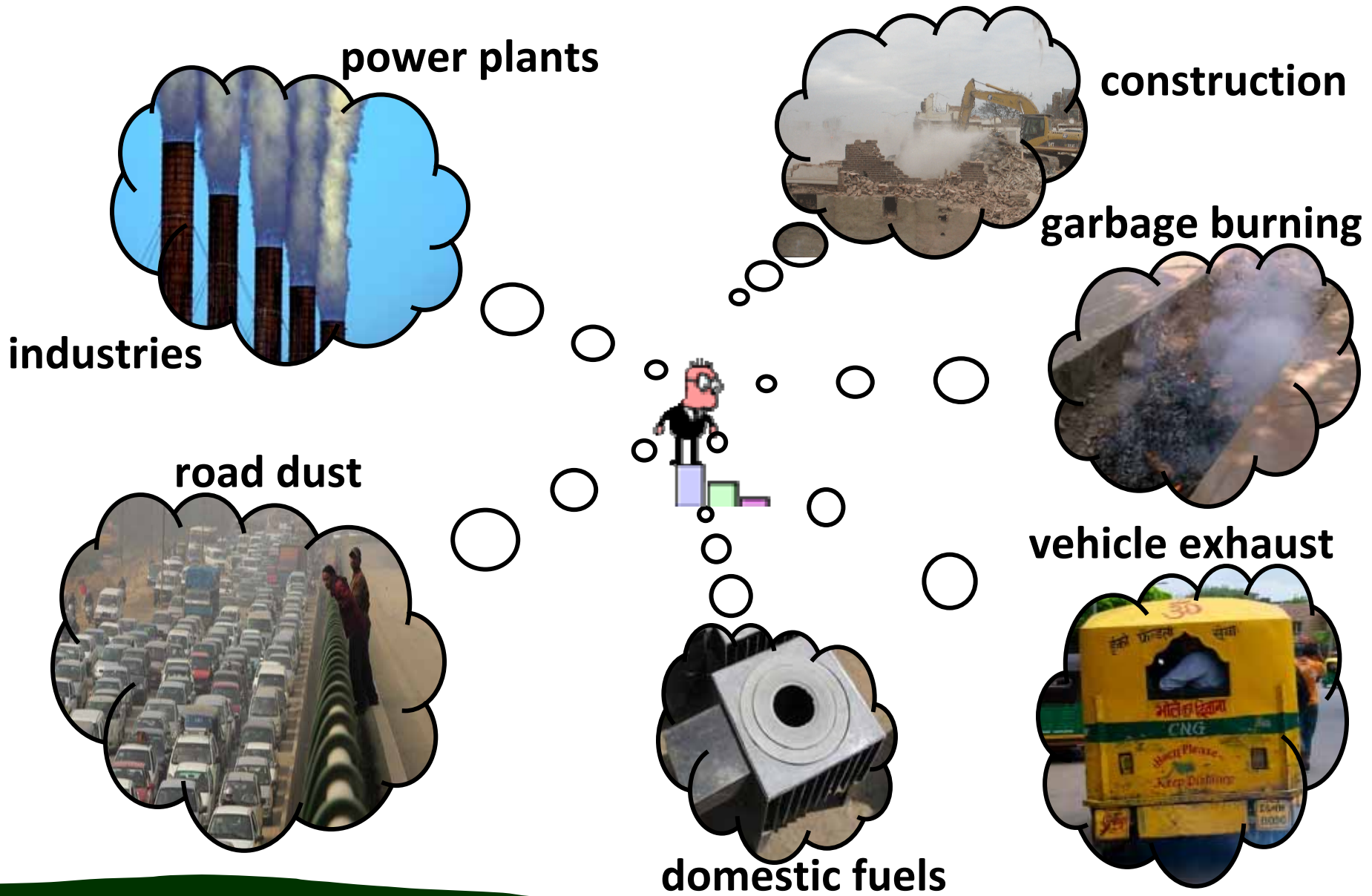
Sources

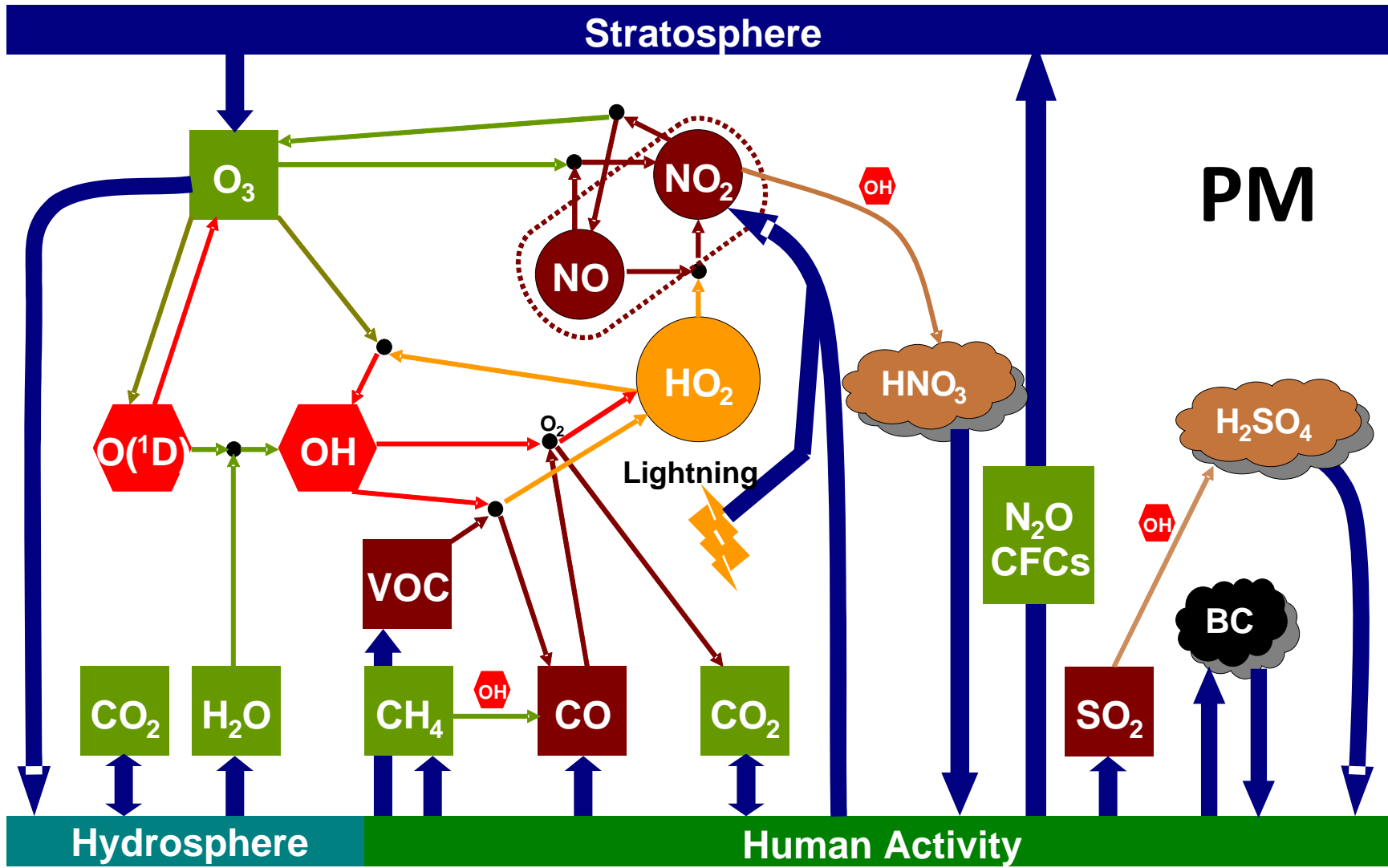


..... what we need to know for better evaluations and efficient decision making

Impacts

Sources and their Contributions





Greenhouse Gases
Primary Pollutants
Absorbing Aerosols (BC)

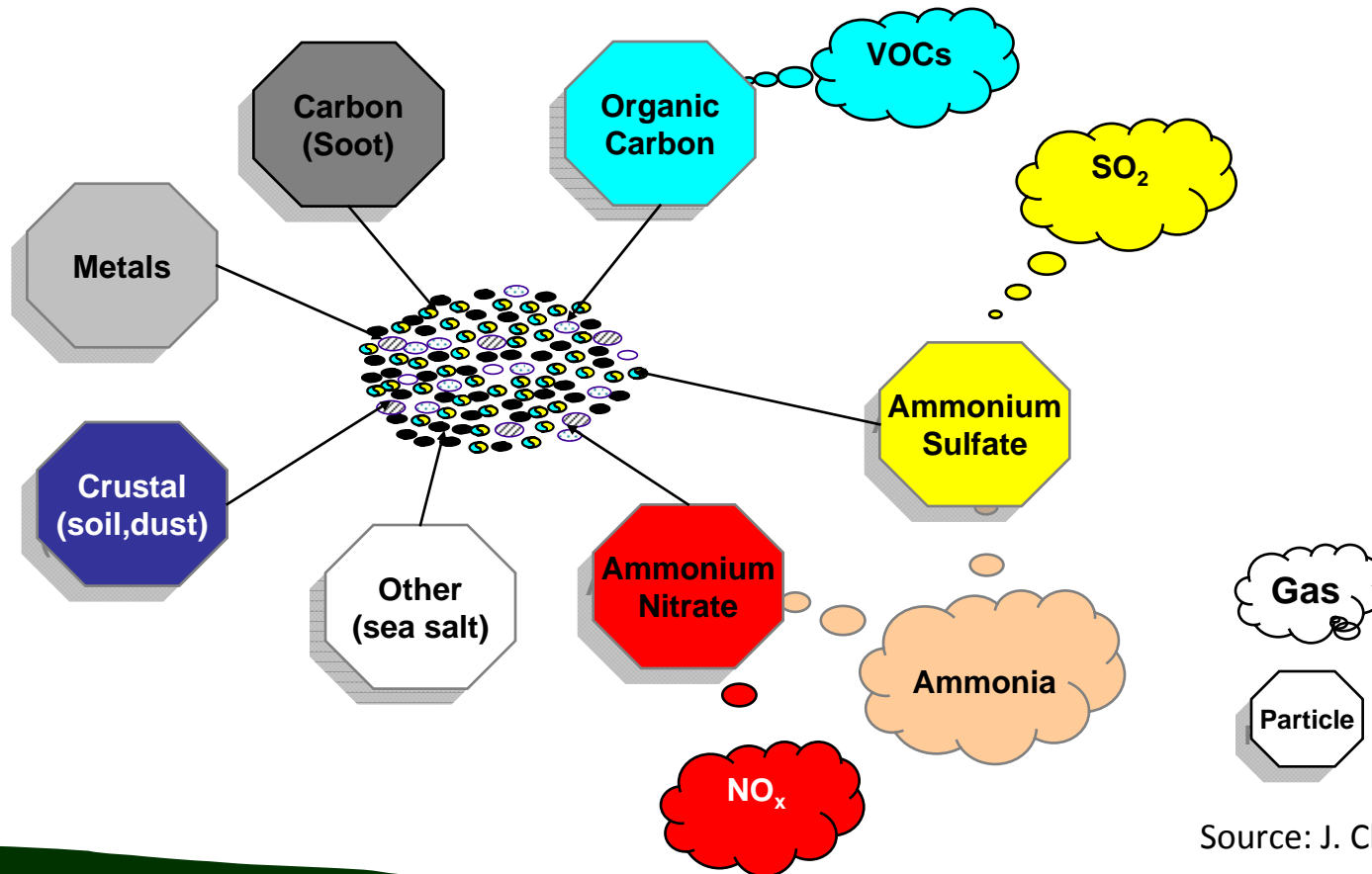
Reactive Free Radicals
Less Reactive Radicals
Reflective Aerosols

PM

Chemical composition gives an indication of the sources

Primary Particles
(directly emitted)

Secondary Particles
(from precursor gases)

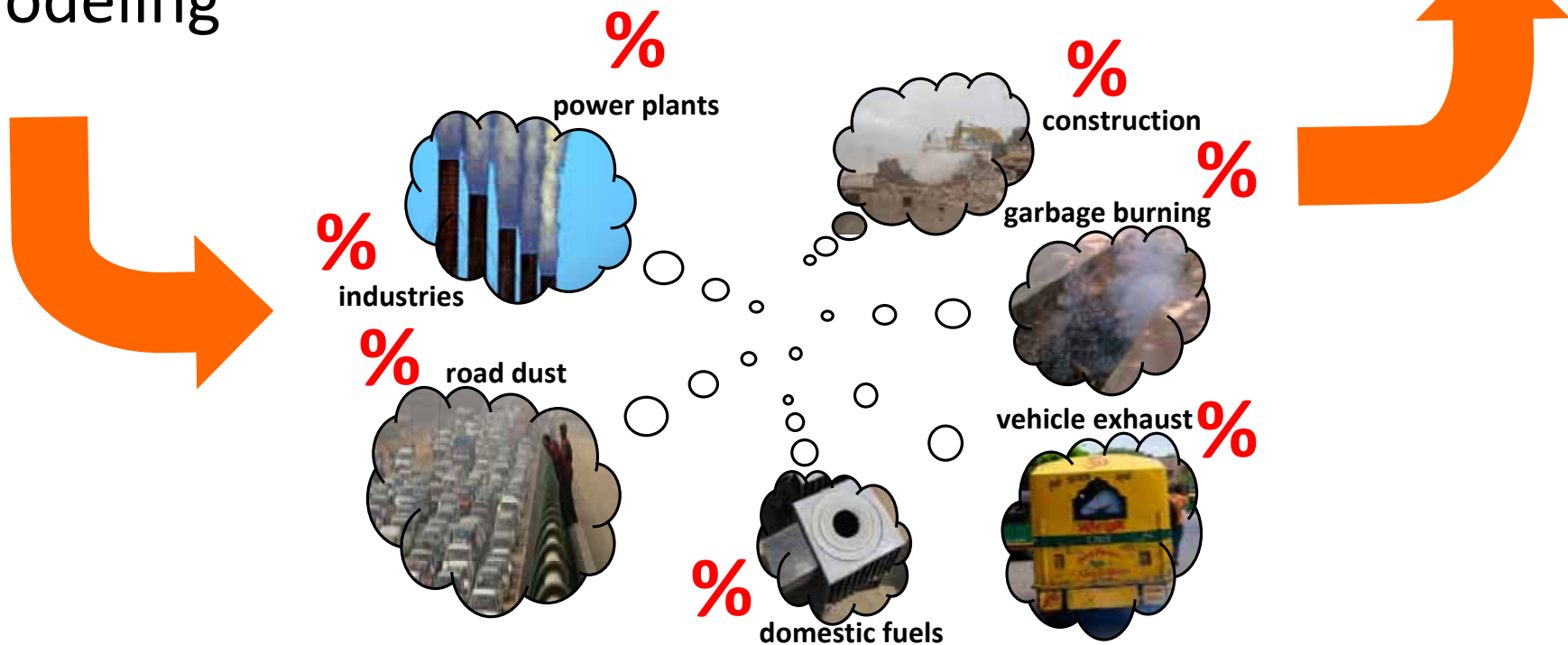


Source: J. Chow, DRI

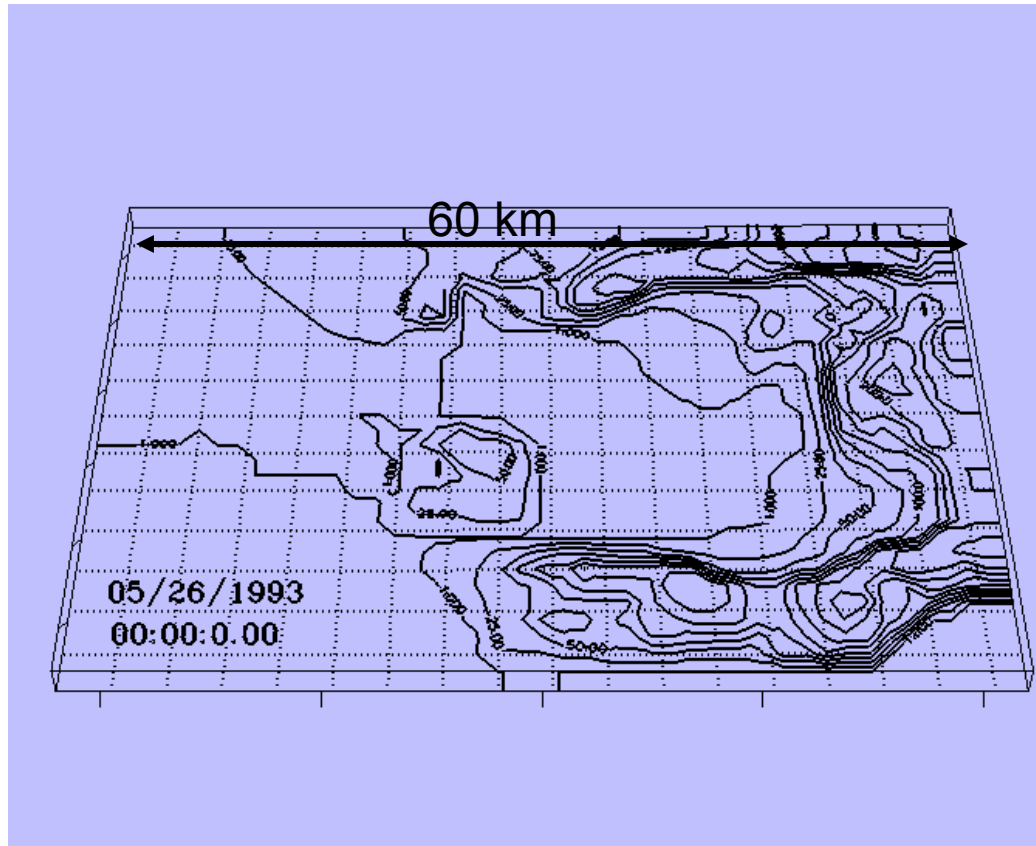
Results, using..

Monitoring data
Chemistry of the pollutants
Geographical knowledge
Meteorology
Modeling

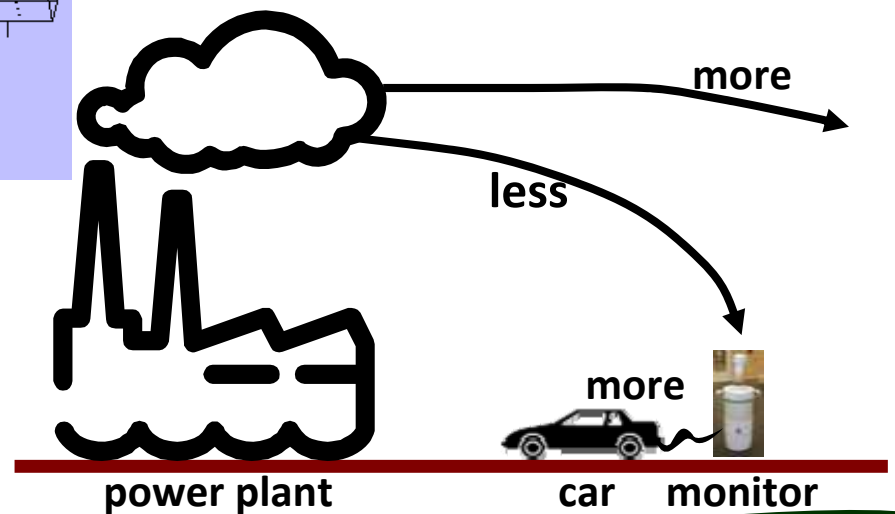
Consolidated decisions



% Emissions \neq % Ambient Pollution



A simulation of sulfur dioxide emissions from power plant stacks



Source Apportionment

- Top-down approach
- Bottom-up approach

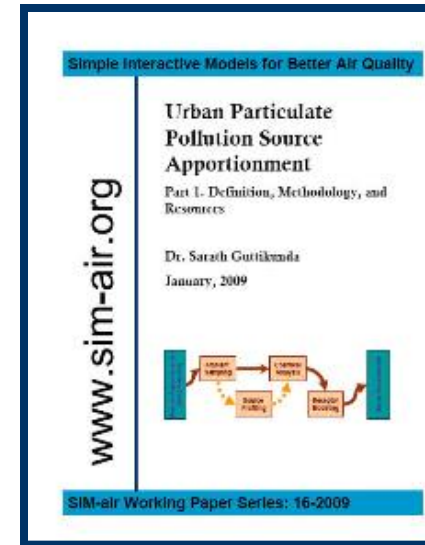
Reference:

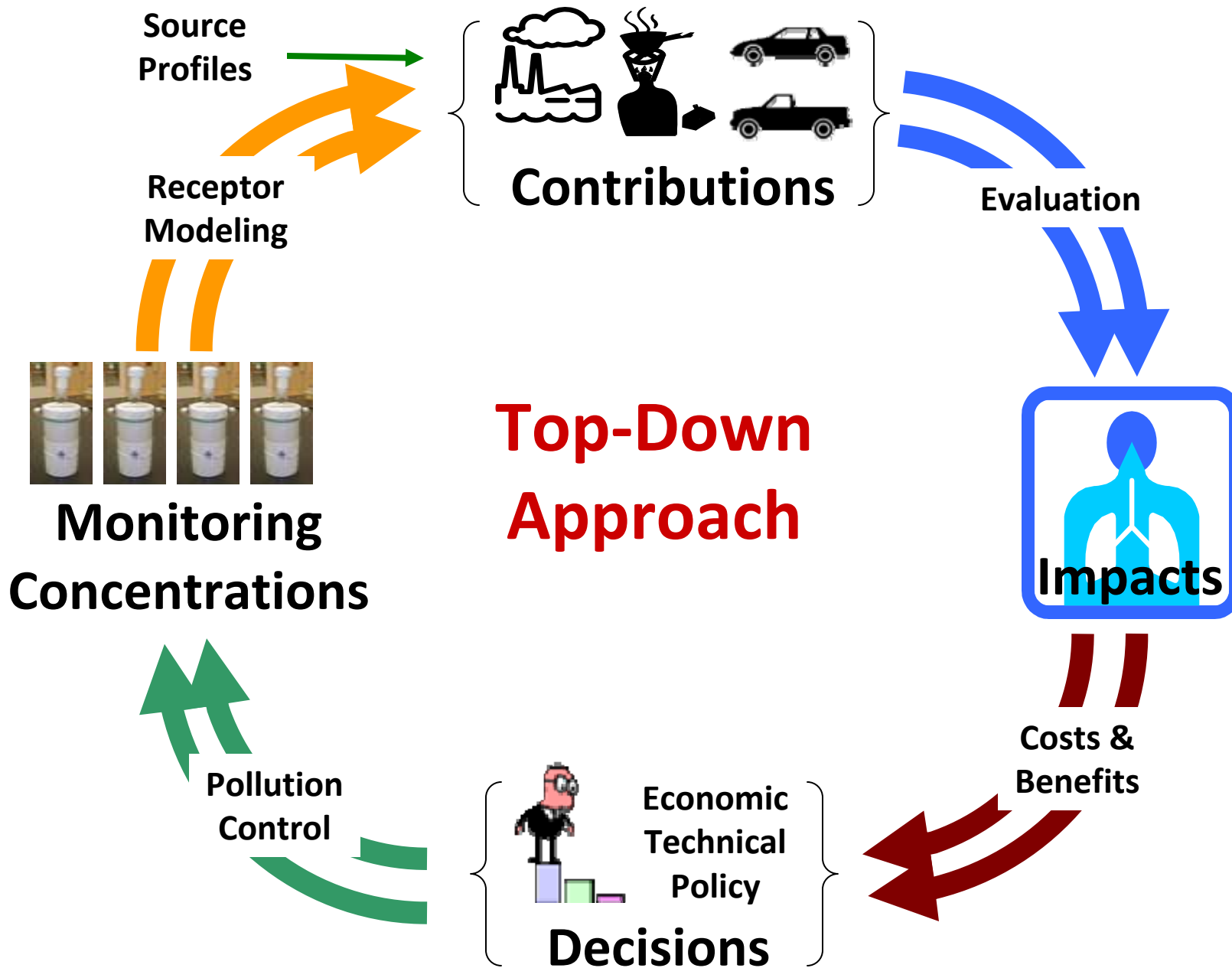
Johnson TM, Guttikunda SK, Wells G, Artaxo P, Bond T, Russell T, Watson J, and West J (2011)

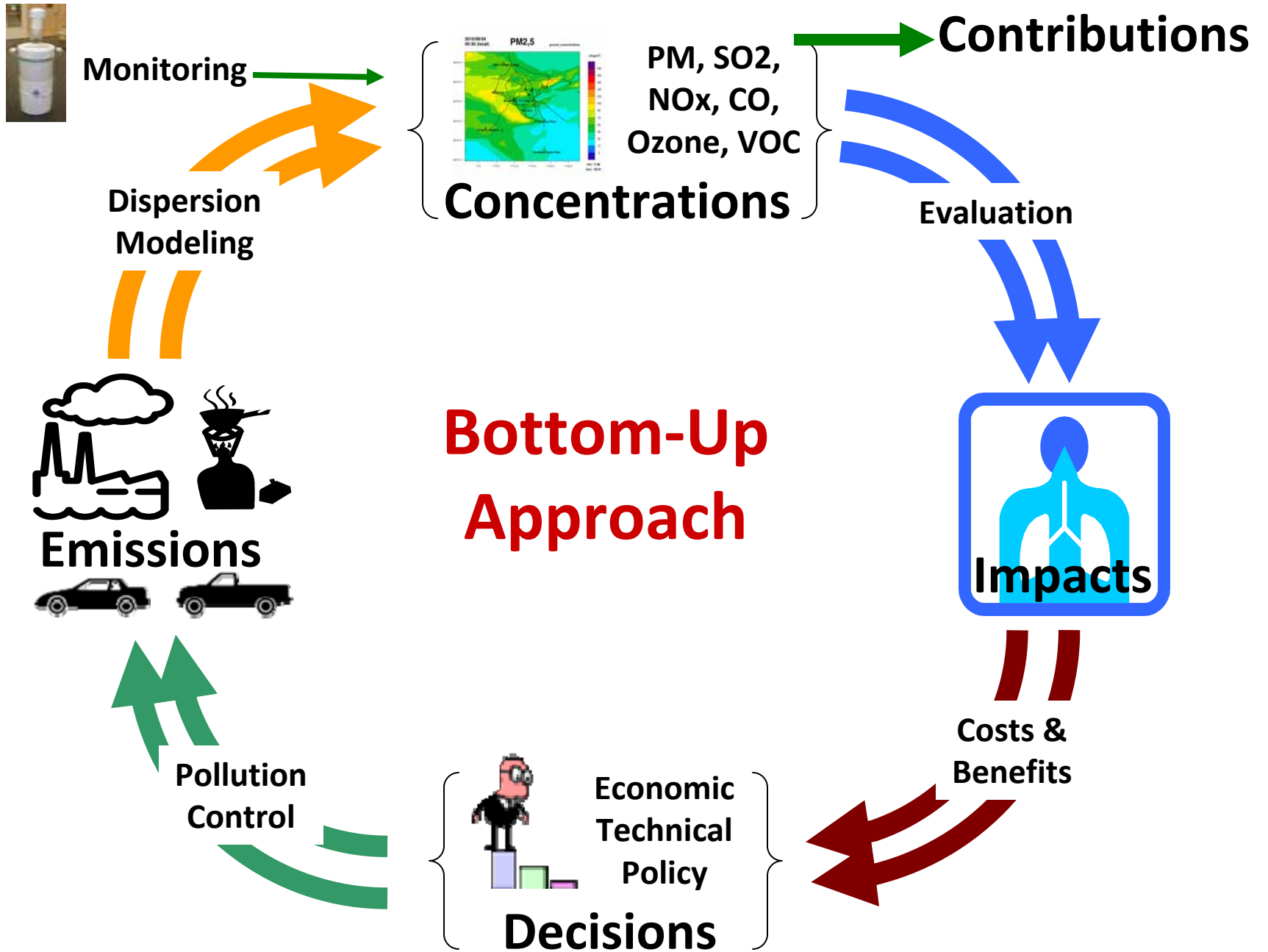
“Tools for Improving Air Quality Management – A Review of Top-Down Source Apportionment Techniques and their Applications in the Developing World”

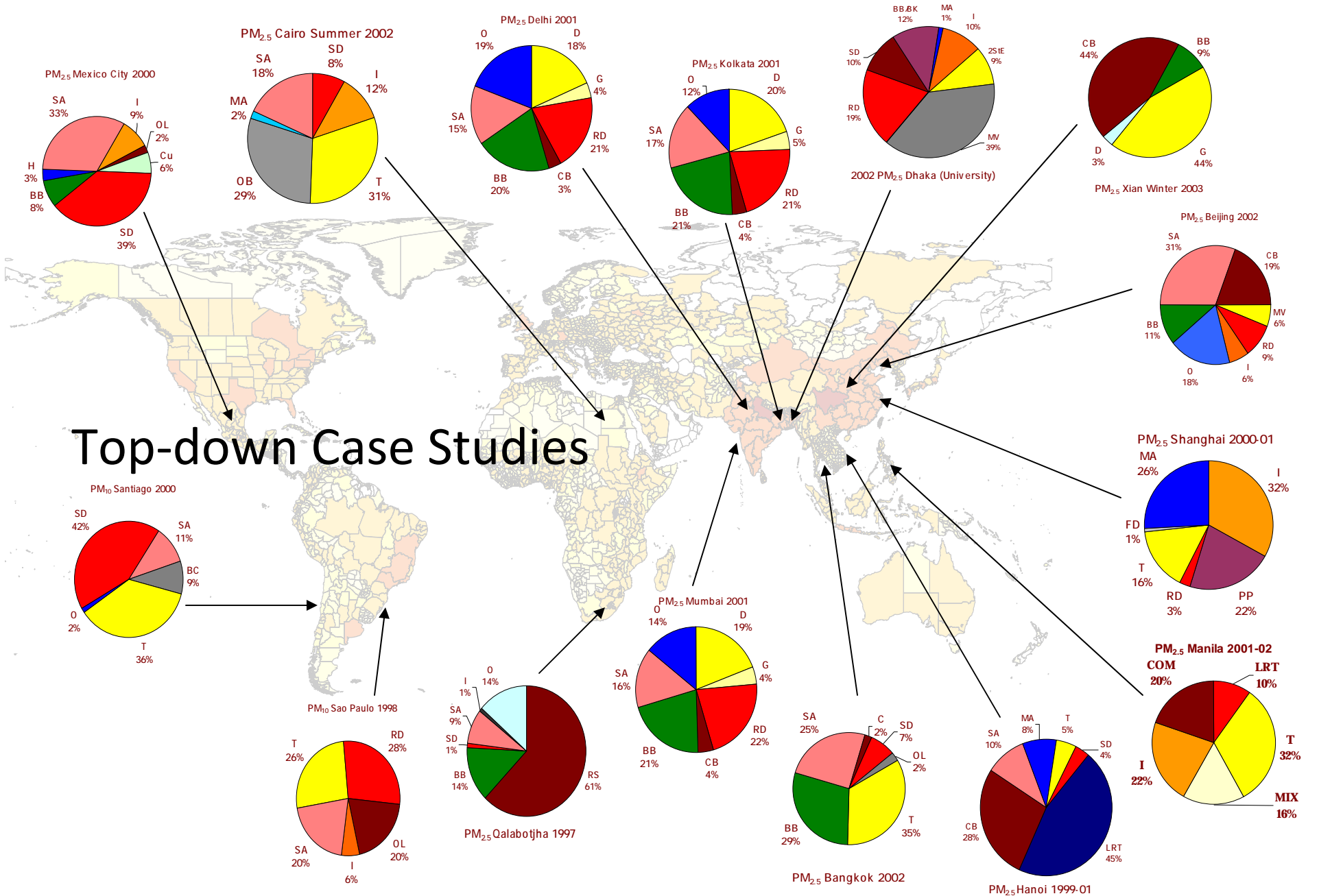
ESMAP publications, The World Bank, Washington DC, USA

<http://www.esmap.org/esmap/node/1159>

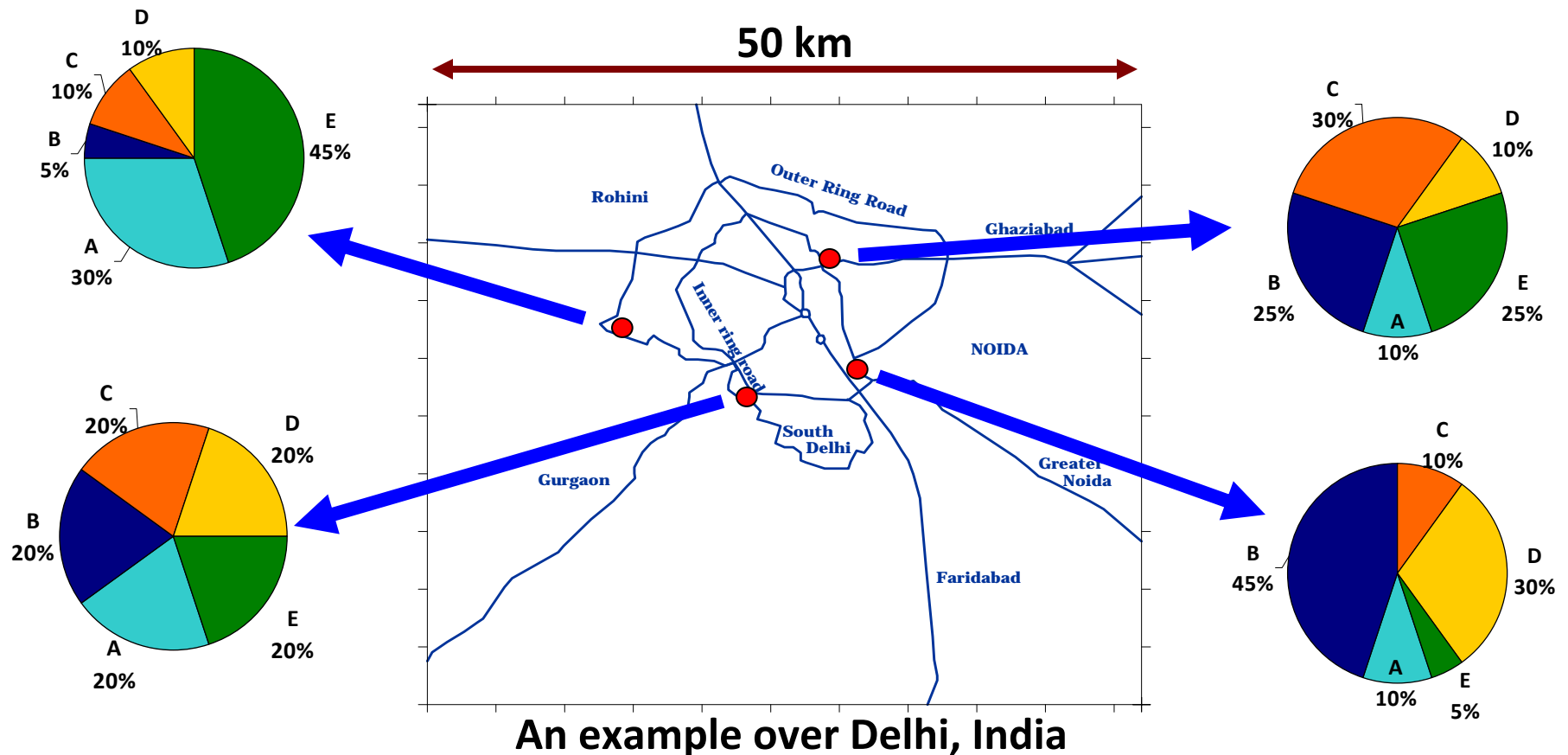






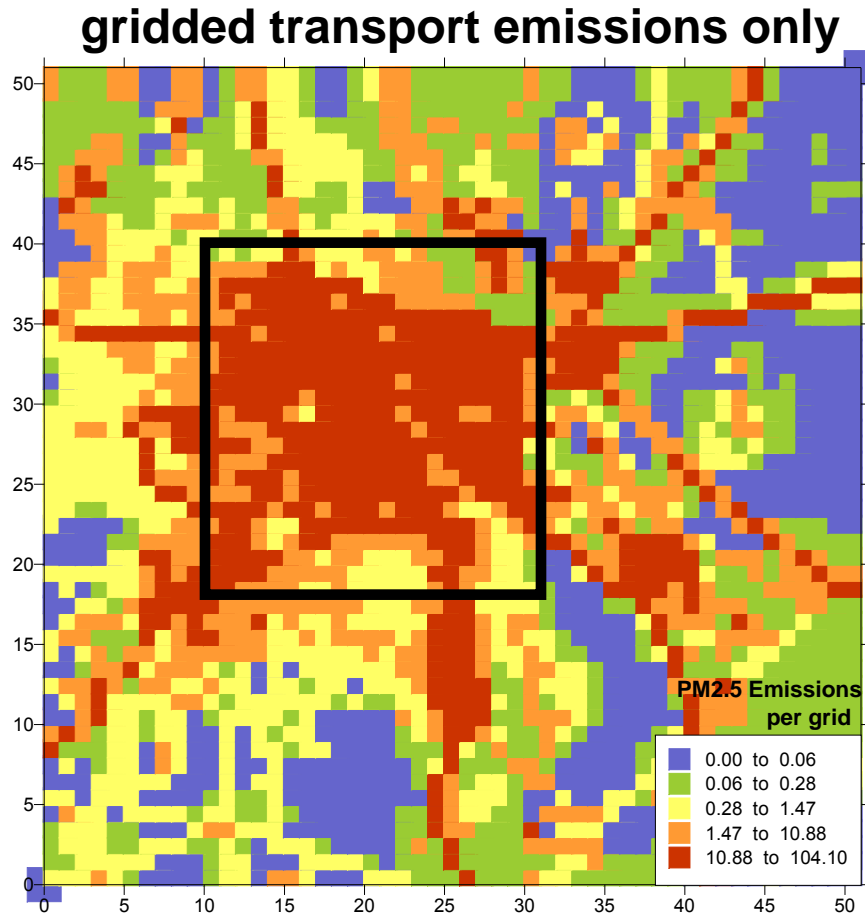


Top-down vs. Bottom-up

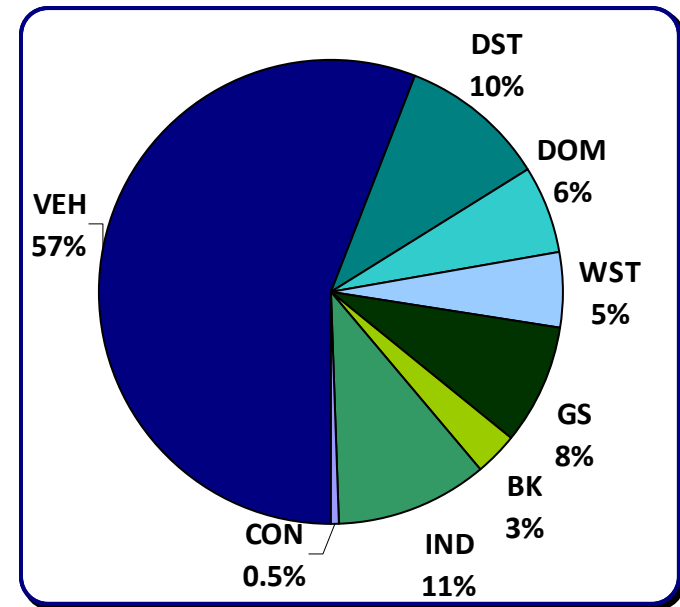


Top-down results are limited to sampling locations

Top-down vs. Bottom-up



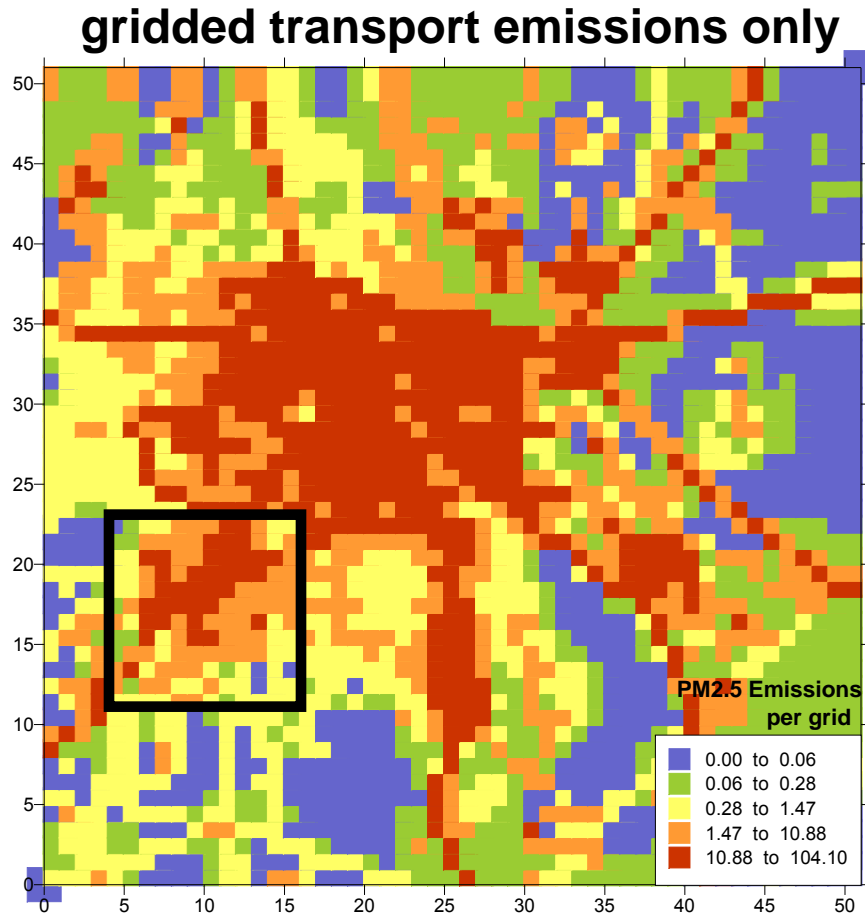
% PM_{2.5} ground emissions in the box



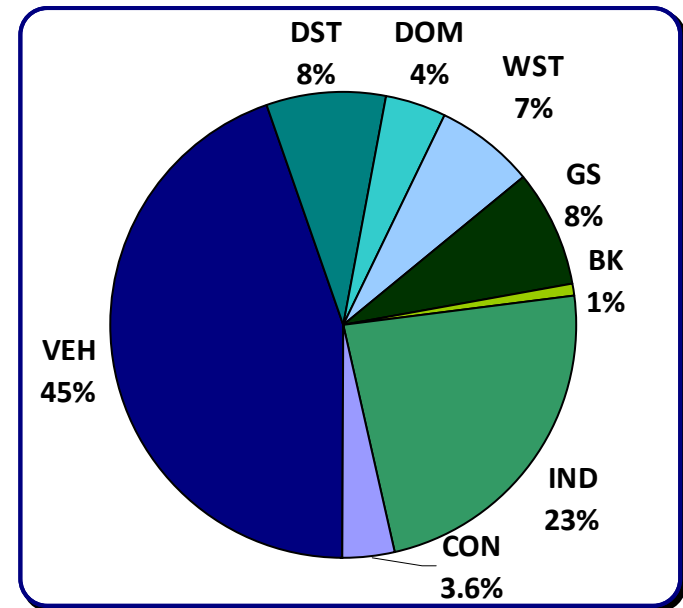
**Bottom-up results
for all areas**

*IND = industries; PP = power plants; DOM = domestic; VEH = transport; DST = road dust; WST = waste burning;
CON = construction activities; BK = brick kilns; GS = generator sets*

Top-down vs. Bottom-up



% PM_{2.5} ground emissions in the box

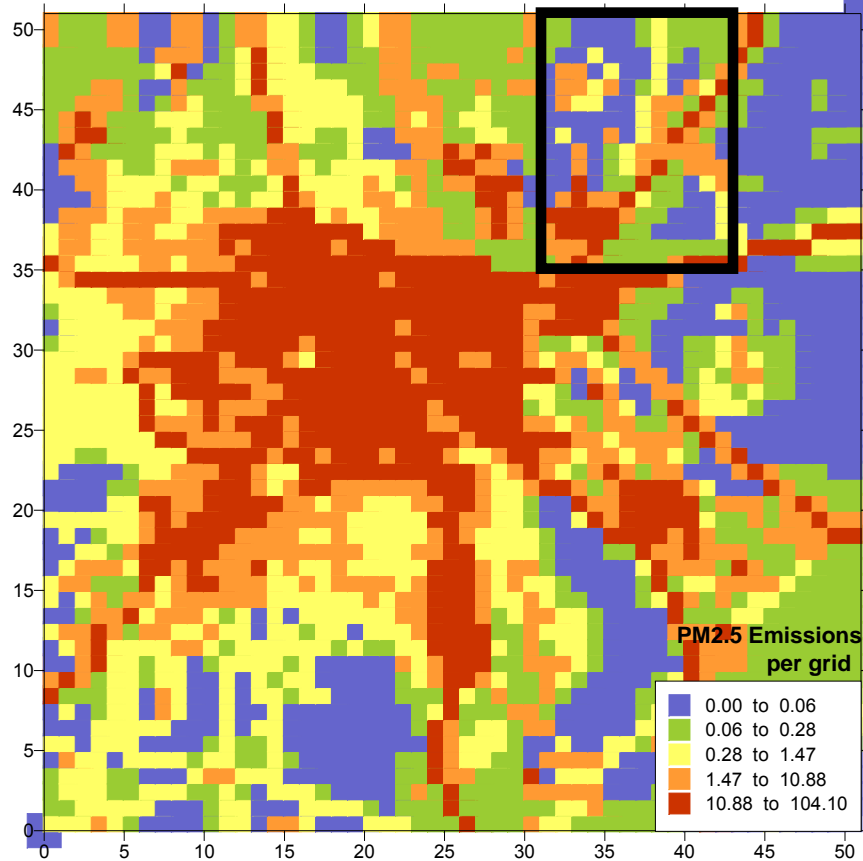


Bottom-up results for all areas

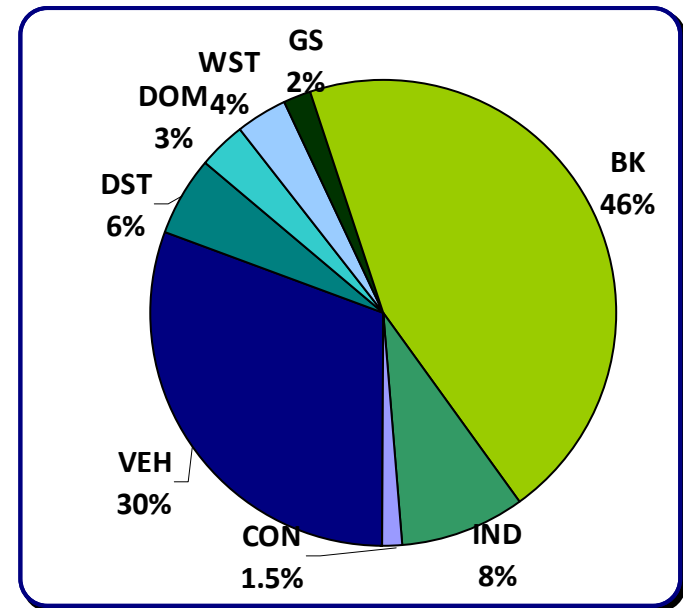
IND = industries; PP = power plants; DOM = domestic; VEH = transport; DST = road dust; WST = waste burning; CON = construction activities; BK = brick kilns; GS = generator sets

Top-down vs. Bottom-up

gridded transport emissions only



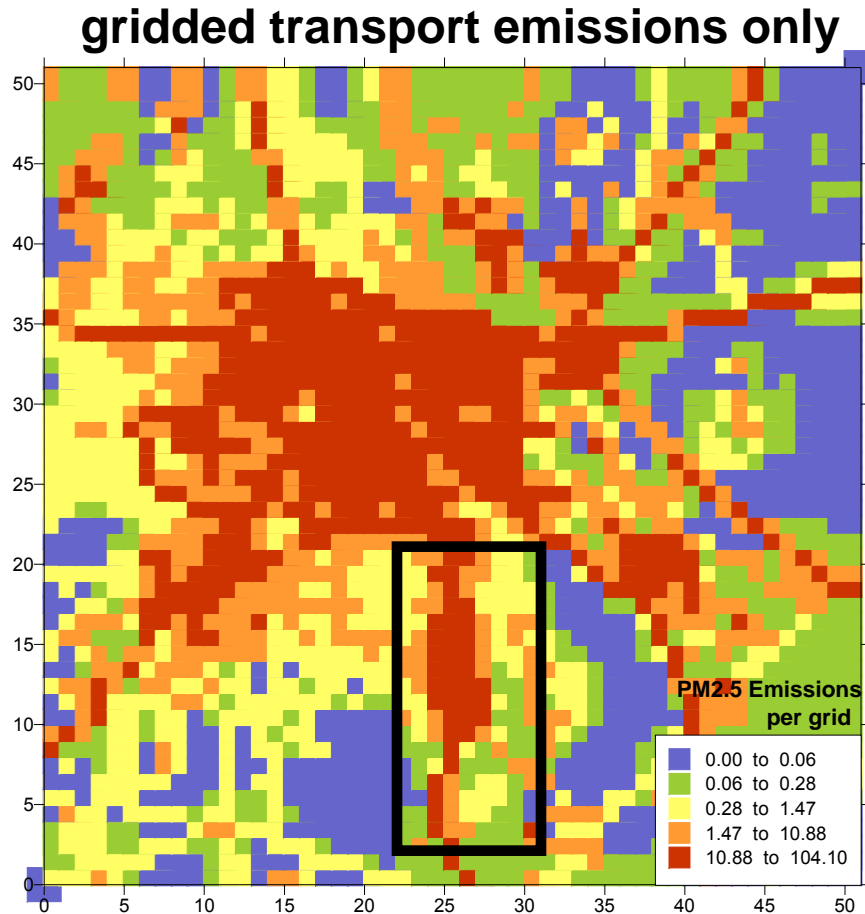
% PM_{2.5} ground emissions in the box



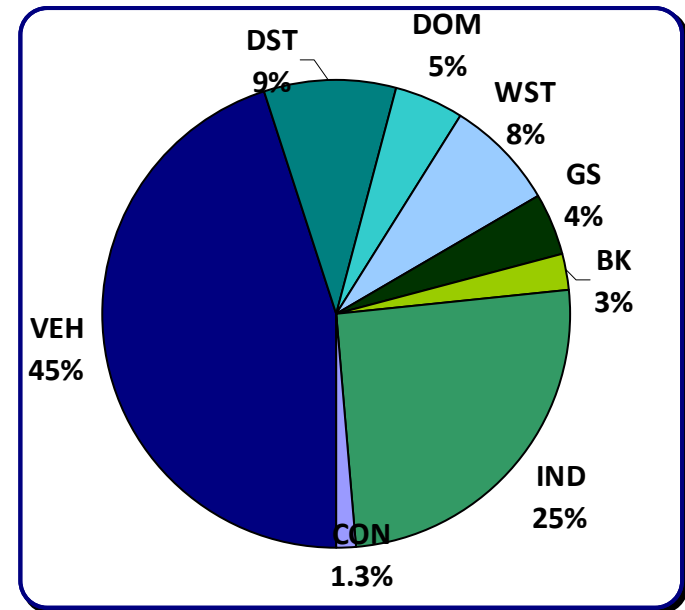
**Bottom-up results
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Top-down vs. Bottom-up

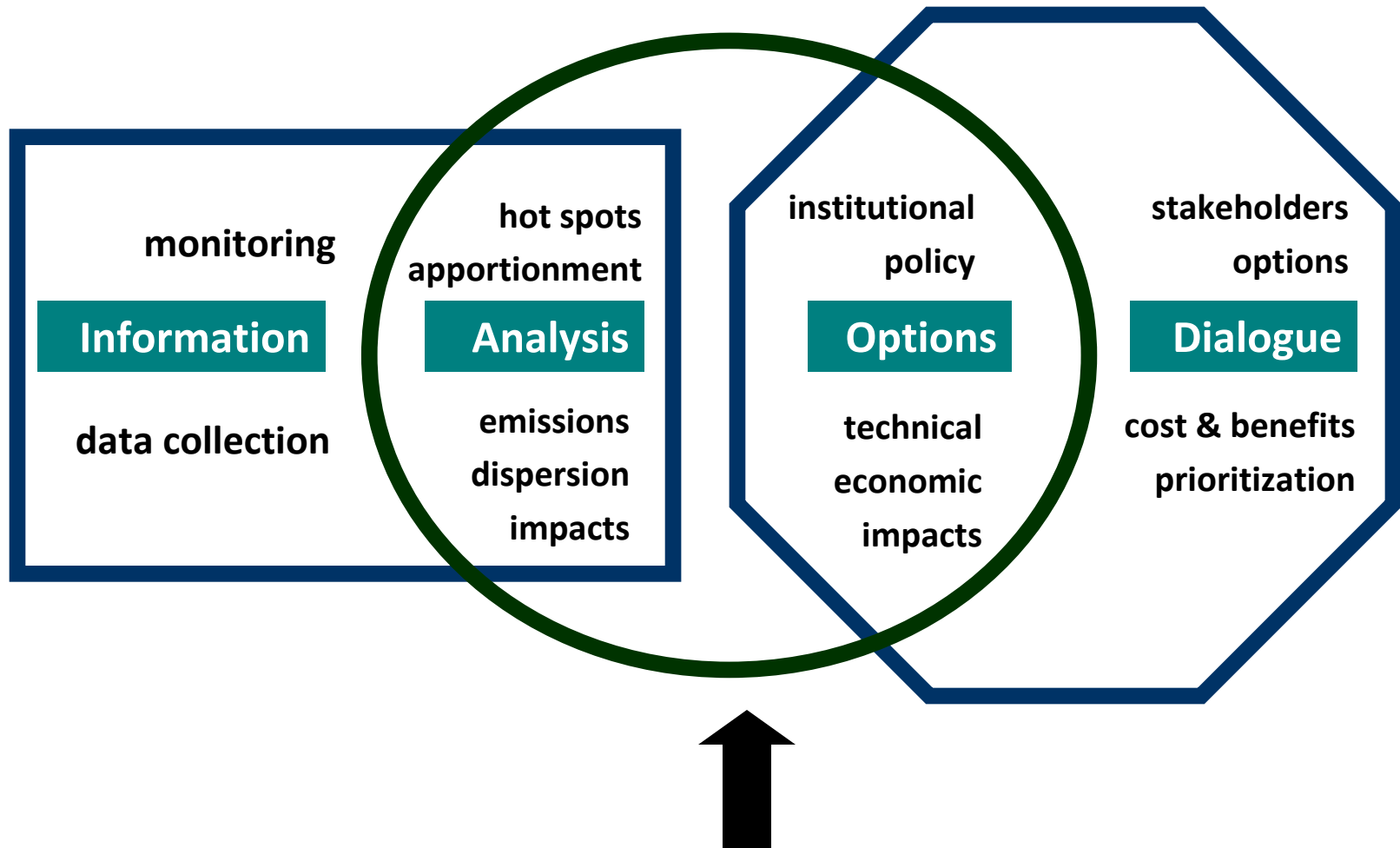


% PM_{2.5} ground emissions in the box



Bottom-up results for all areas

IND = industries; PP = power plants; DOM = domestic; VEH = transport; DST = road dust; WST = waste burning; CON = construction activities; BK = brick kilns; GS = generator sets



Evaluating Benefits & Co-Benefits

Beijing's Olympic Effort, 2008

August 31st 2008, API = 24



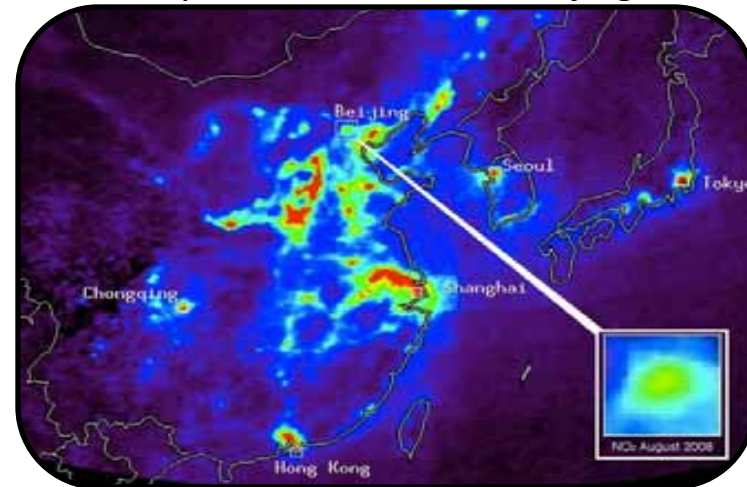
August 24th 2009, API = 97



August 13th 2010, API = 83

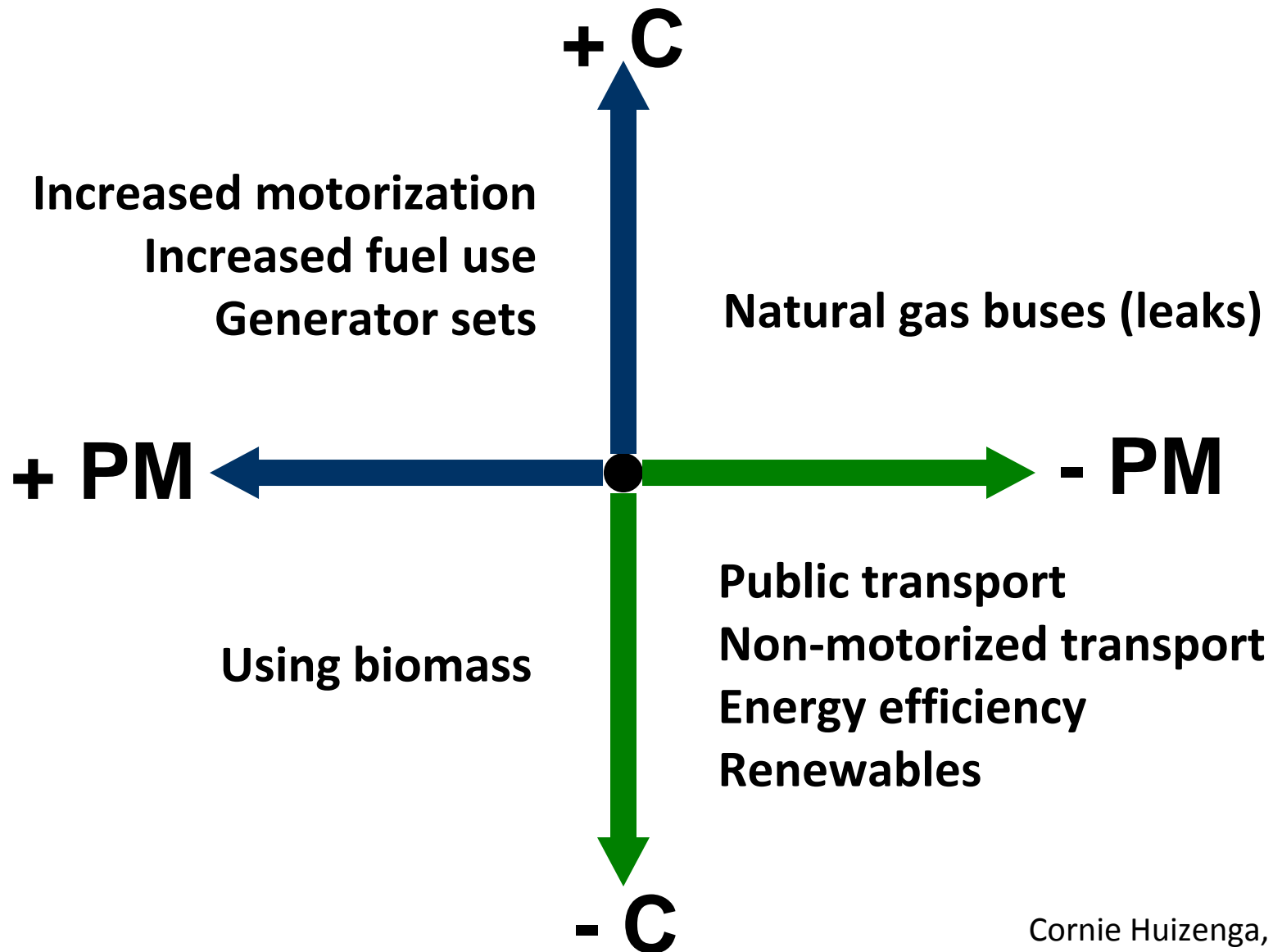


Photo Diary of Air Pollution in Beijing



50% drop in the NO_x concentrations, during the 2 months of Olympic interventions.

Co-benefits approach

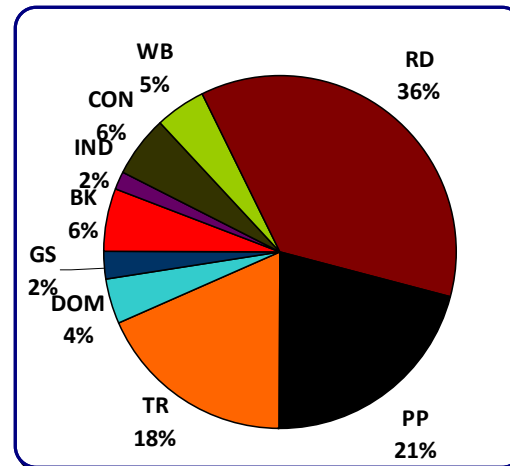


Cornie Huizenga, CAI-Asia

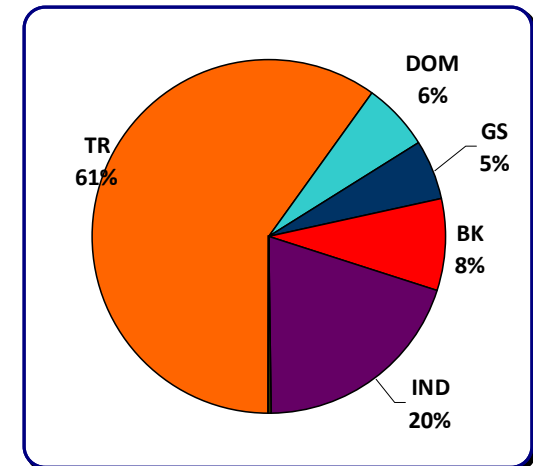
Chennai, India, 2010



Brick Kilns



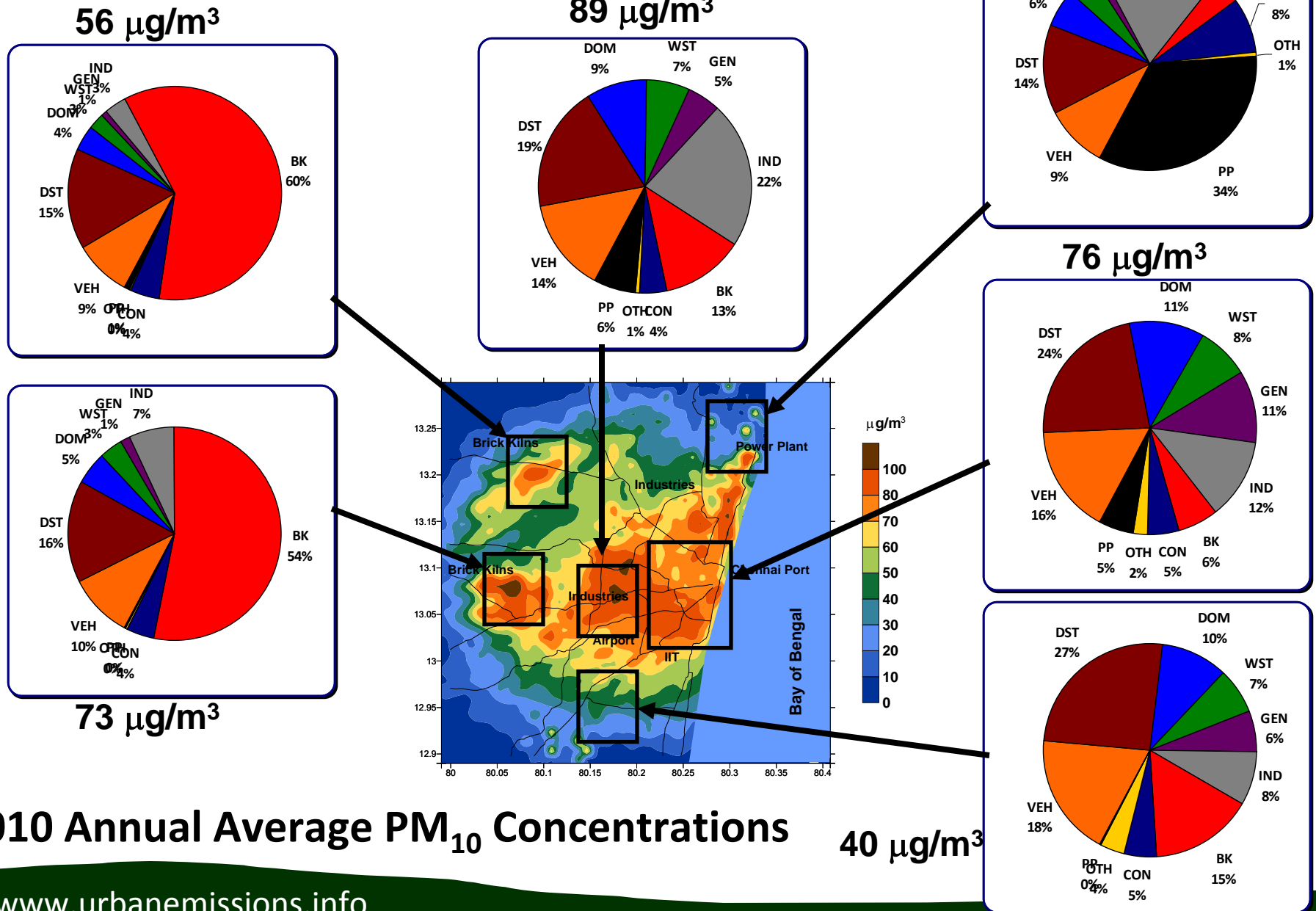
**2010 - PM₁₀
~56,000 tons/yr**



**2010 - CO₂
~25 mil tons/yr**



Chennai, India, 2010



2010 Annual Average PM₁₀ Concentrations

Health Impacts in 6 Cities

**Table 5.2: Estimated Mortality and Morbidity due to air pollution for 2010
(numbers rounded to nearest zero)**

Mortality & Morbidity	Pune	Chennai	Indore	Ahmedabad	Surat	Rajkot
Domain size (km x km)	32 x 32	44 x 44	32 x 32	44 x 44	44 x 44	24 x 24
Study Domain Population (million)	6.5	8.5	3.3	7.8	5.0	1.4
Land-Sea Breeze	NO	YES	NO	NO	YES	NO
2010 PM ₁₀ emissions (tons/yr)	36,600	56,400	18,100	35,100	19,900	14,000
Premature Deaths	3,600	3,950	1,800	4,950	1,250	300
Mortality per ton of PM10	0.1	0.07	0.1	0.14	0.06	0.02
Adult Chronic Bronchitis	10,800	11,800	5,400	14,800	3,750	950
Child Acute Bronchitis	79,250	86,600	39,300	108,300	27,400	6,800
Respiratory Hospital Admission	5,000	5,460	2,500	6,800	1,700	450
Cardiac Hospital Admission	1,350	1,480	670	1,850	470	120
Emergency Room Visit	97,800	106,900	48,500	133,700	33,800	8,400
Asthma Attacks (million)	1.2	1.3	0.6	1.7	0.4	0.1
Restricted Activity Days (million)	10.4	11.3	5.1	14.2	3.6	0.9
Respiratory Symptom Days (million)	49.7	54.1	24.5	67.6	17.1	4.2

Questions to ask?

- What is the role of domestic and construction sectors?
- What is the role of sustainable transport interventions?
- How can we improve monitoring?
- Where are the co-benefits?
 - Urban vs. Rural
 - Outdoor vs. Indoor
 - Sector by Sector
- How to raise public awareness?

Co-Benefits in 6 Cities

Table 6.14: Estimated combined benefits for emissions and health from the six interventions in 2020

Mortality & Morbidity	Pune	Chennai	Indore	Ahmedabad	Surat	Rajkot
Domain size (km x km)	32 x 32	44 x 44	32 x 32	44 x 44	44 x 44	24 x 24
Study Domain Population (million)	7.6	10.5	4.3	10.3	6.2	1.9
Land-Sea Breeze	NO	YES	NO	NO	YES	NO
2020 PM ₁₀ emissions (tons/yr)	38,000	55,100	21,000	31,800	23,200	18,500
Estimated PM10 emissions reduced (tons/yr)	13,900	17,400	6,200	8,800	8,200	7,900
% compared to 2020	37%	31%	30%	27%	35%	42%
Premature deaths saved	1,700	1,270	630	1,390	590	290
% compared to 2020	39%	21%	25%	18%	29%	42%
Estimated CO2 emissions reduced (million tons/yr)	3.0	5.7	1.8	2.5	2.4	1.4

Reconciling Approaches

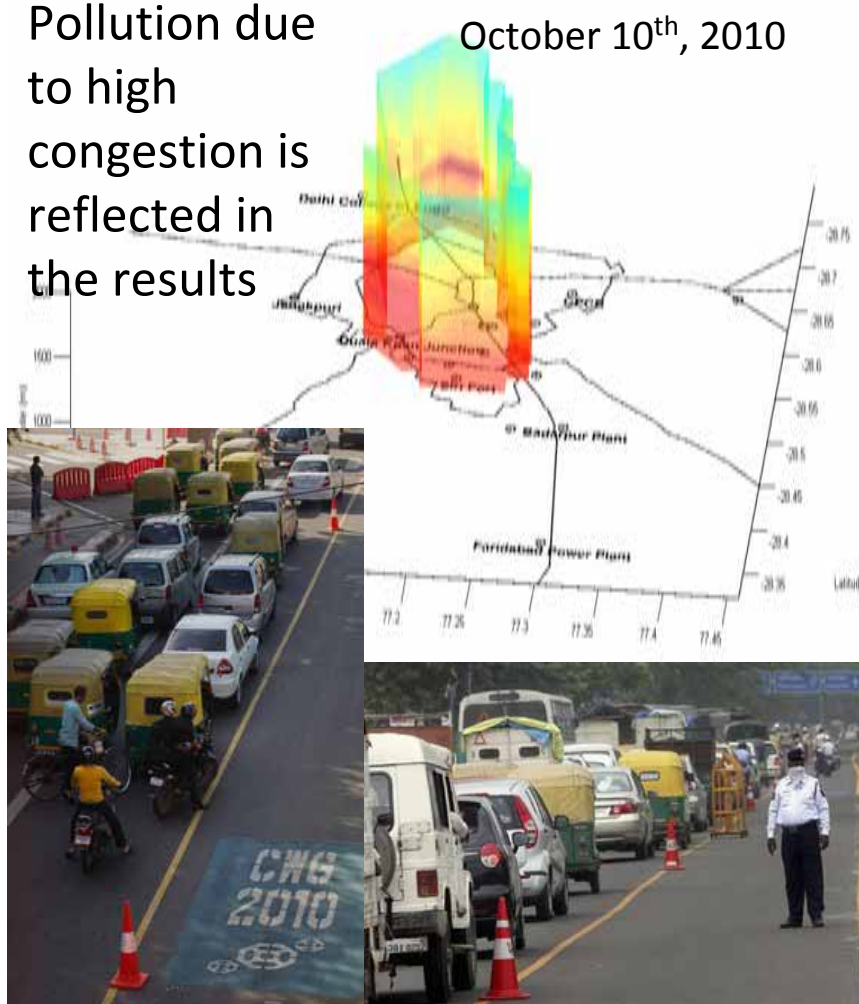
- Validating emission factors with measurements during source profiling
- Identifying missing sources using top-down results
- Identifying hot-spots for monitoring via dispersion modeling
- Using monitoring data for validating dispersion modeling results
- Establishing an pollution control strategy

Delhi, India, 2010

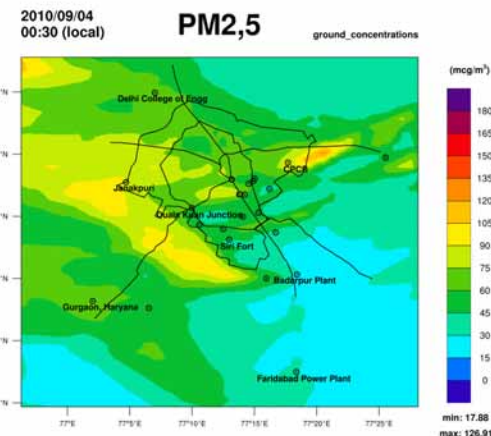
Mobile lidar monitoring provided spatial and temporal evolution of pollution during the games.



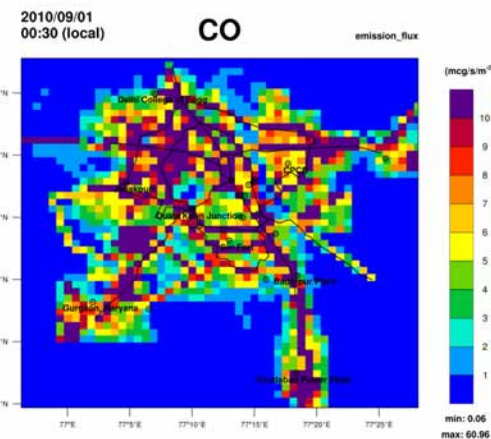
Pollution due to high congestion is reflected in the results



October 10th, 2010



Concentrations



Emissions

Thank you

Questions?

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September, 2011

