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Climate footprint of selected Indian emission sectors

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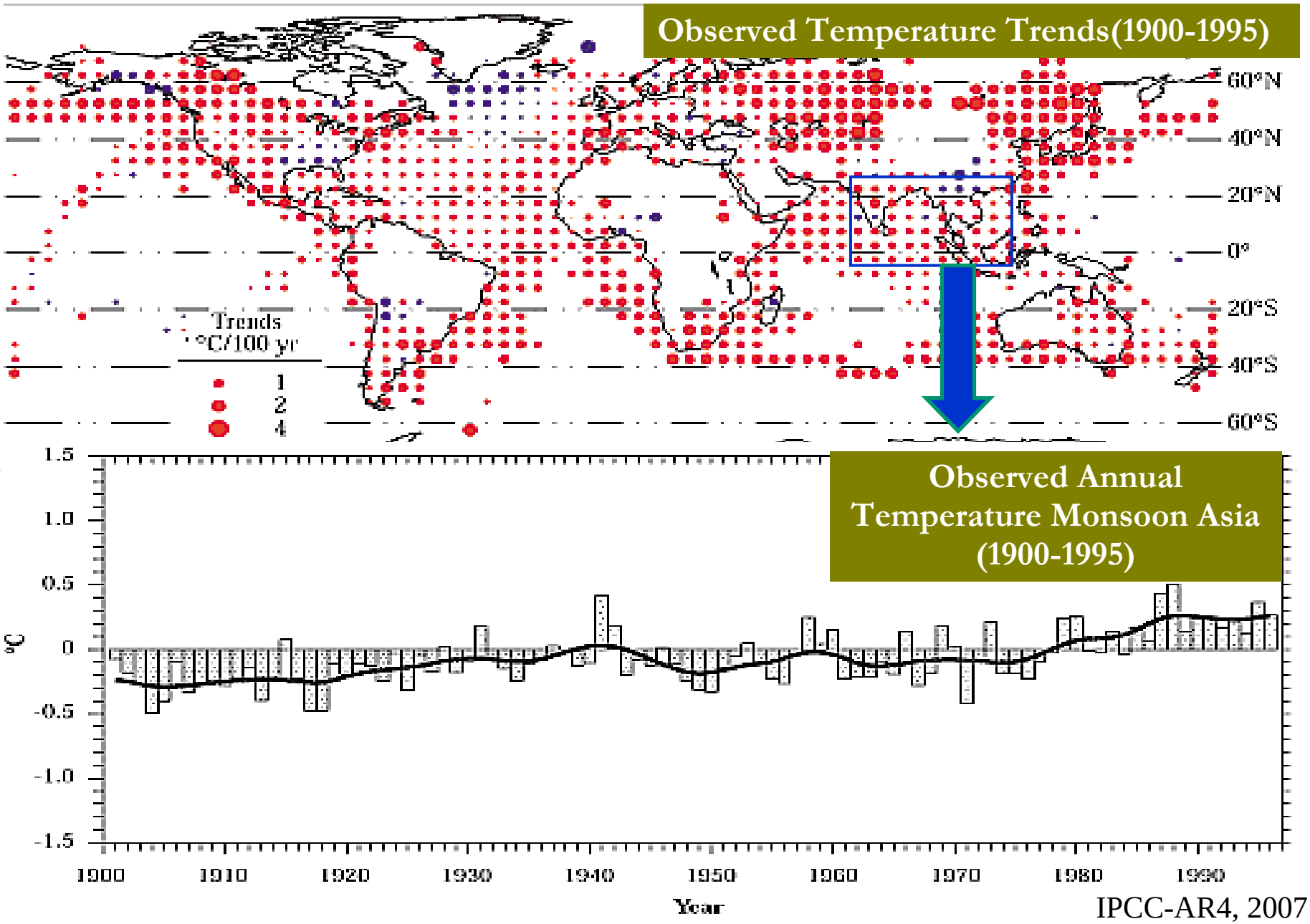
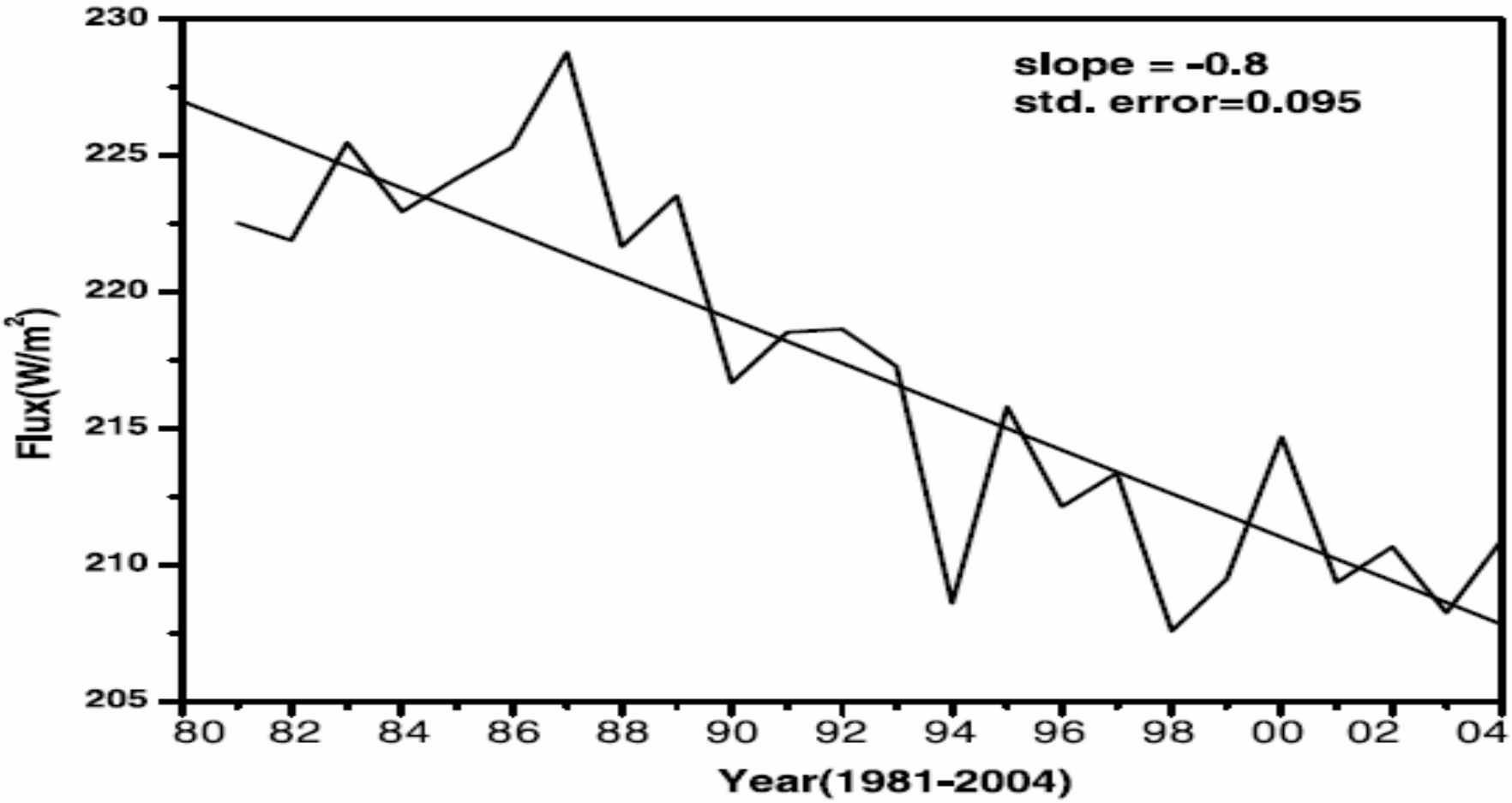
Climate change effects have a regional character



IPCC-AR4, 2007

Surface solar dimming is increasing



From 1981–2006, the rate of clear-sky dimming over India, attributed to aerosols, is 6 W/m^2-decade.(*Kumari et al.*, 2009, GRL) .

Aerosol mediated fog events in winter

Northern Grid Trips, Flights Hit At Delhi Airport

Fog blinds north India, 10 killed in train collisions

The Times Of India Kolkata; Date: Jan 3, 2010

The Times Of India Kolkata; Date: Jan 28, 2010

Over 50 flights cancelled as fog blankets Capital

The Times Of India Delhi; Date: Jan 28, 2010

Record at fog-hit IGI: 54 flights cancelled

Dense Fog Conditions Force Airport To Implement Low Visibility Procedures For 16 Hours

Three die, 17 hurt in train mishap due to fog in UP

Mumbai Mirror ; Date: Jan 17, 2010

Outline

- What do we know about S. Asian aerosol sources?
- How good is this understanding?
- Frameworks for mitigation.

Region specific sources

Brick kilns

Agricultural residue burning

Emissions from Cook stoves

Unregulated vehicular emissions

Emission Inventory

$$E_P = \sum_i Activity_i \times Emission\ Factor_{i,P}$$

Fuel consumption/Production

Emissions per unit fuel consumption/Production

Default Emission Factors
(IPCC 2006, EMEP 2009)

TIER 1
- Average emission factors for a broad source category
- Default fuel characteristics

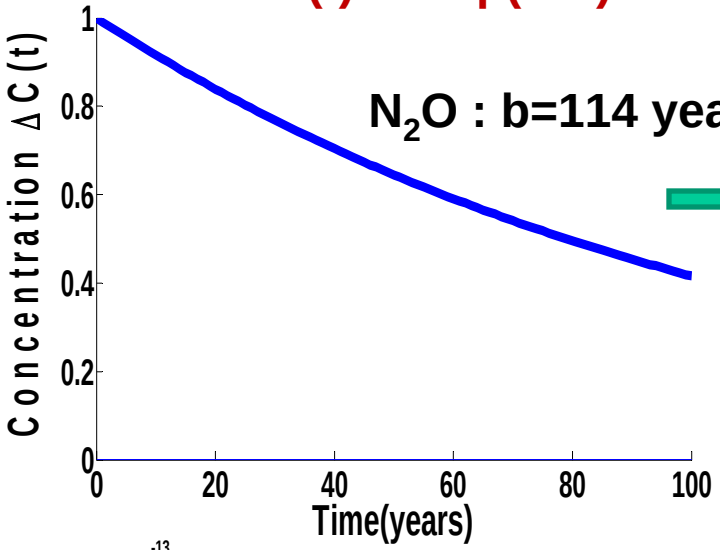
TIER 2
- Country specific details
- Fuel characteristics (like carbon content or ash content)
- Technological details

TIER 3
- Combustion technology
- Operating parameters
- Age of the equipment
- Pollution control equipment employed

Metrics of Climate Change

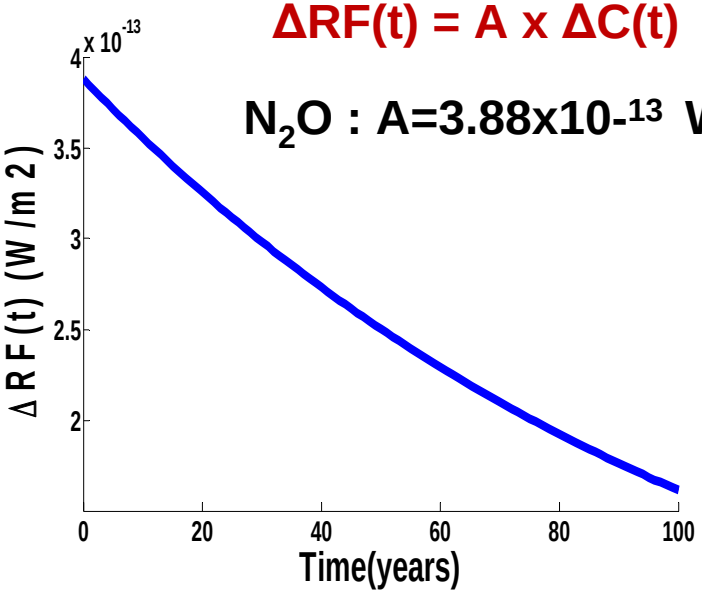
$\Delta C(t) = \exp(-t/b)$

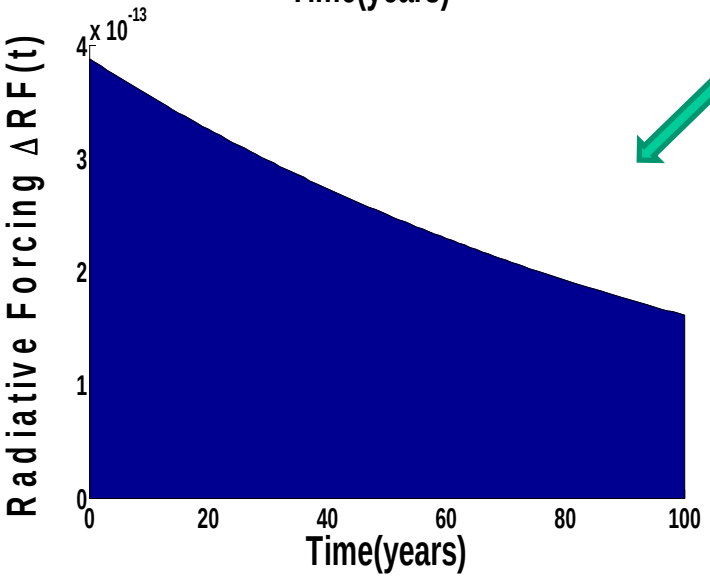
N_2O : b=114 years



$\Delta RF(t) = A \times \Delta C(t)$

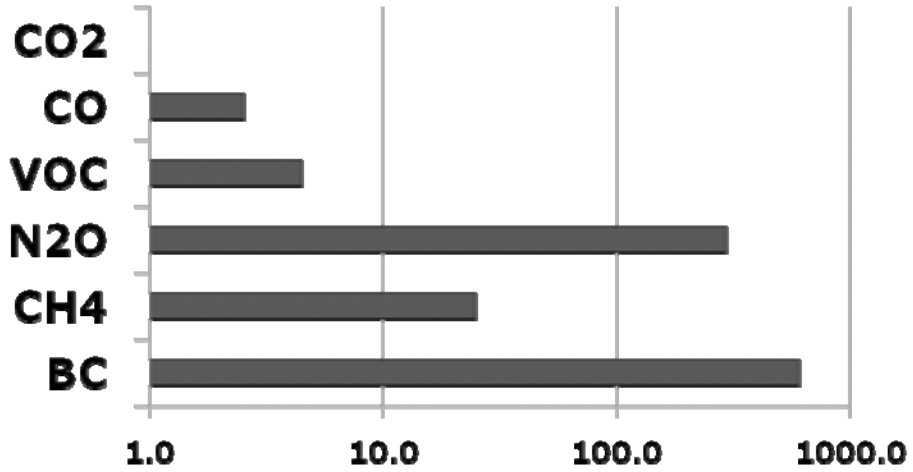
N_2O : $A=3.88\times10^{-13}$ $Wm^{-2}kg^{-1}$



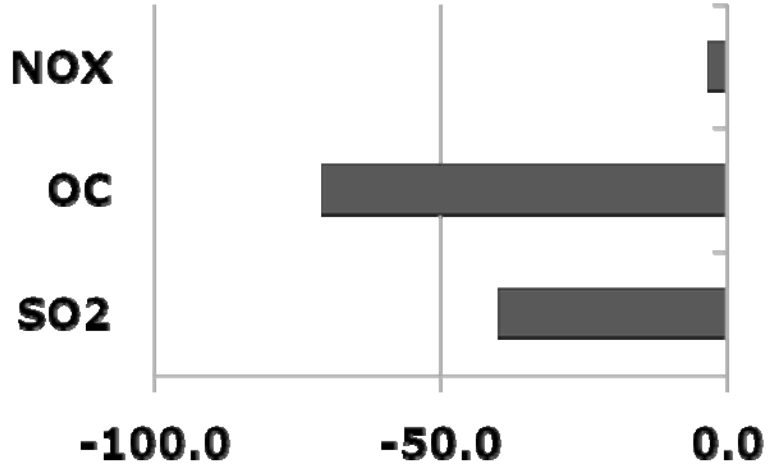


Absolute global warming potential (AGWP) (IPCC 1990)

GWP values used



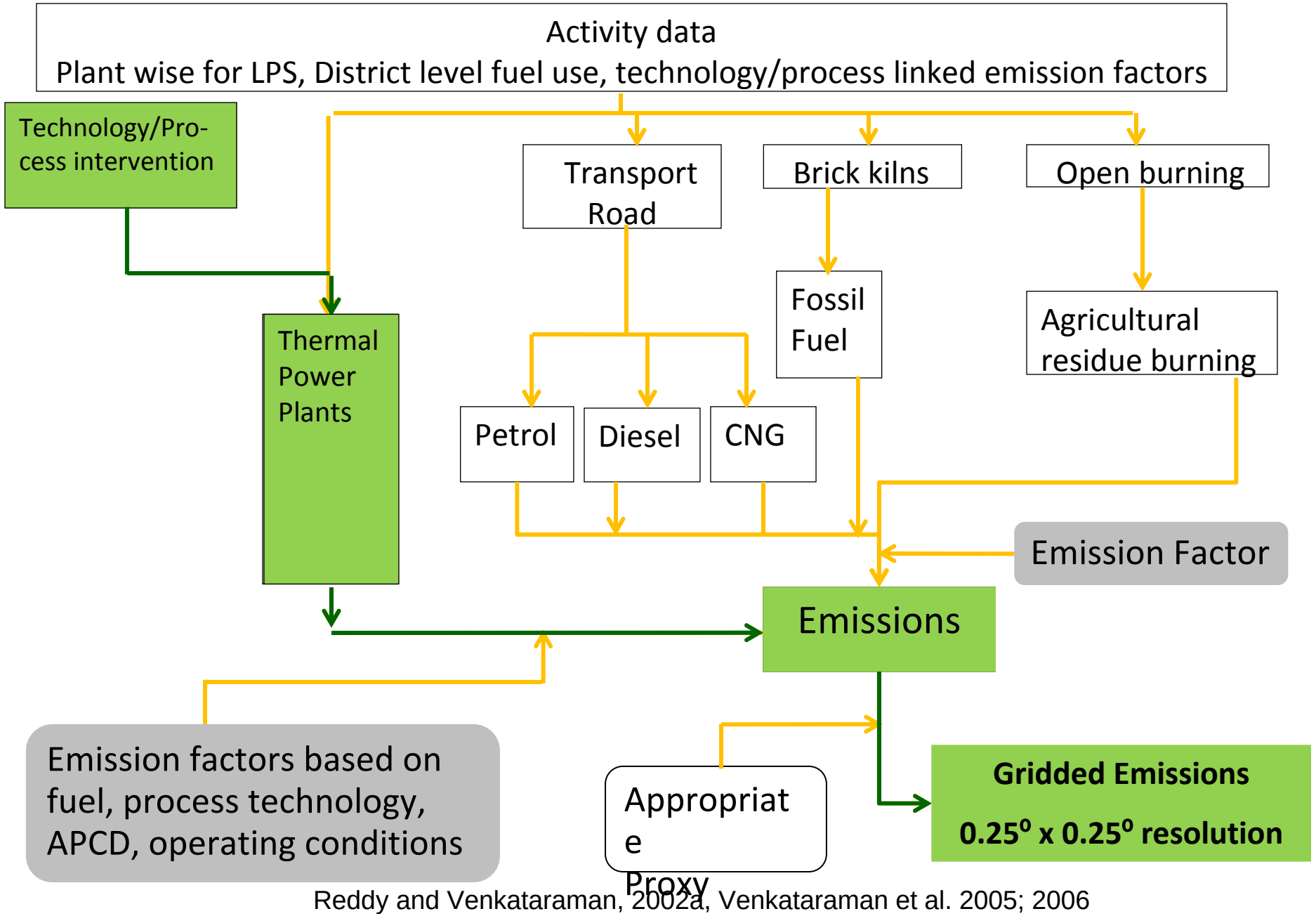
	BC	CH4	N2O	VOC	CO	CO2
GWP	608.	25.0	298.	4.5	2.5	1.0



	SO2	OC	NOX
GWP	-40.0	-70.8	-3.3

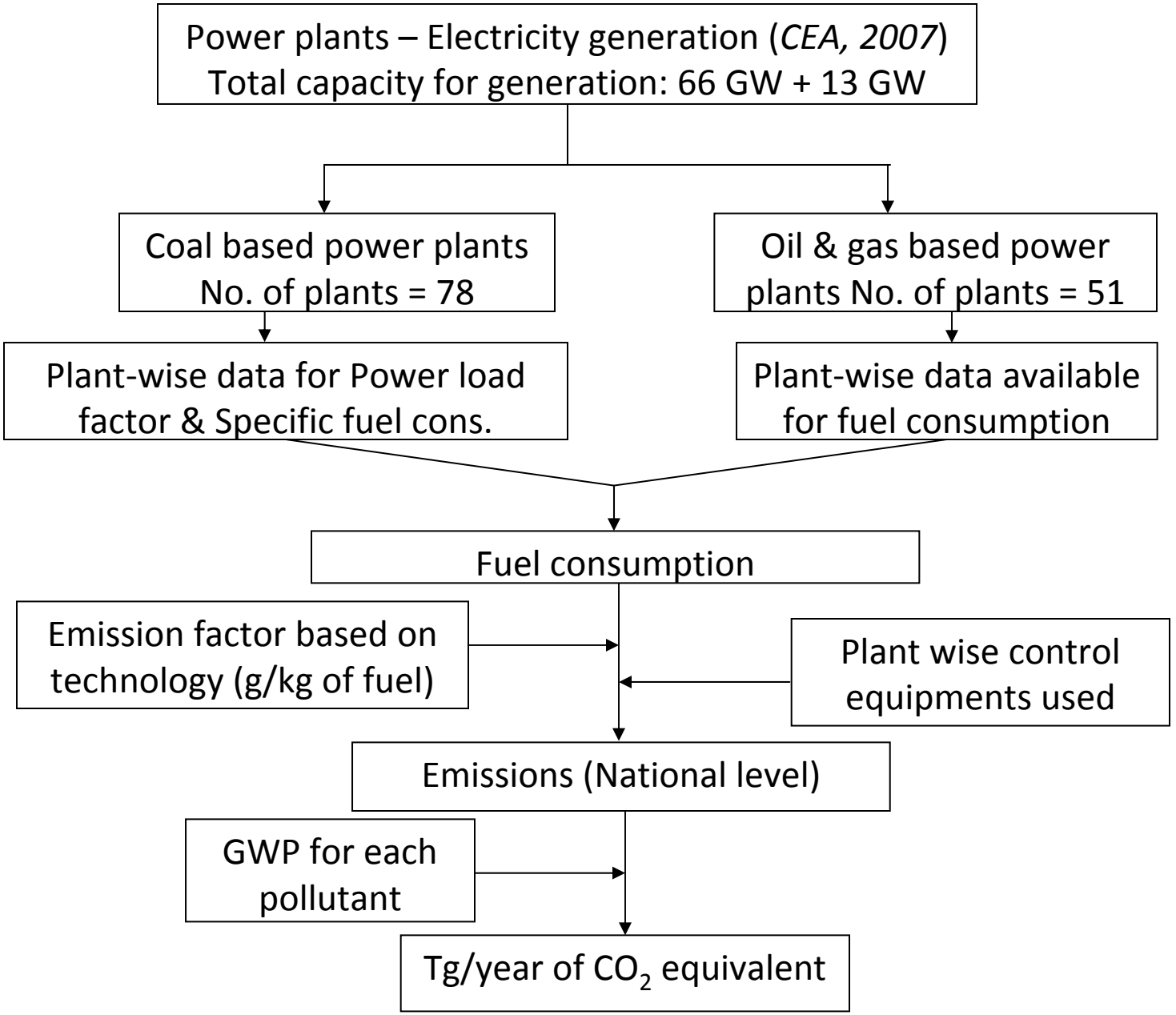
Metrics calculated using parameters from literature(Fuglestvedt et al. 2007 , Bond and Sun 2005)

Creating an emissions inventory ~Tier 3 detail

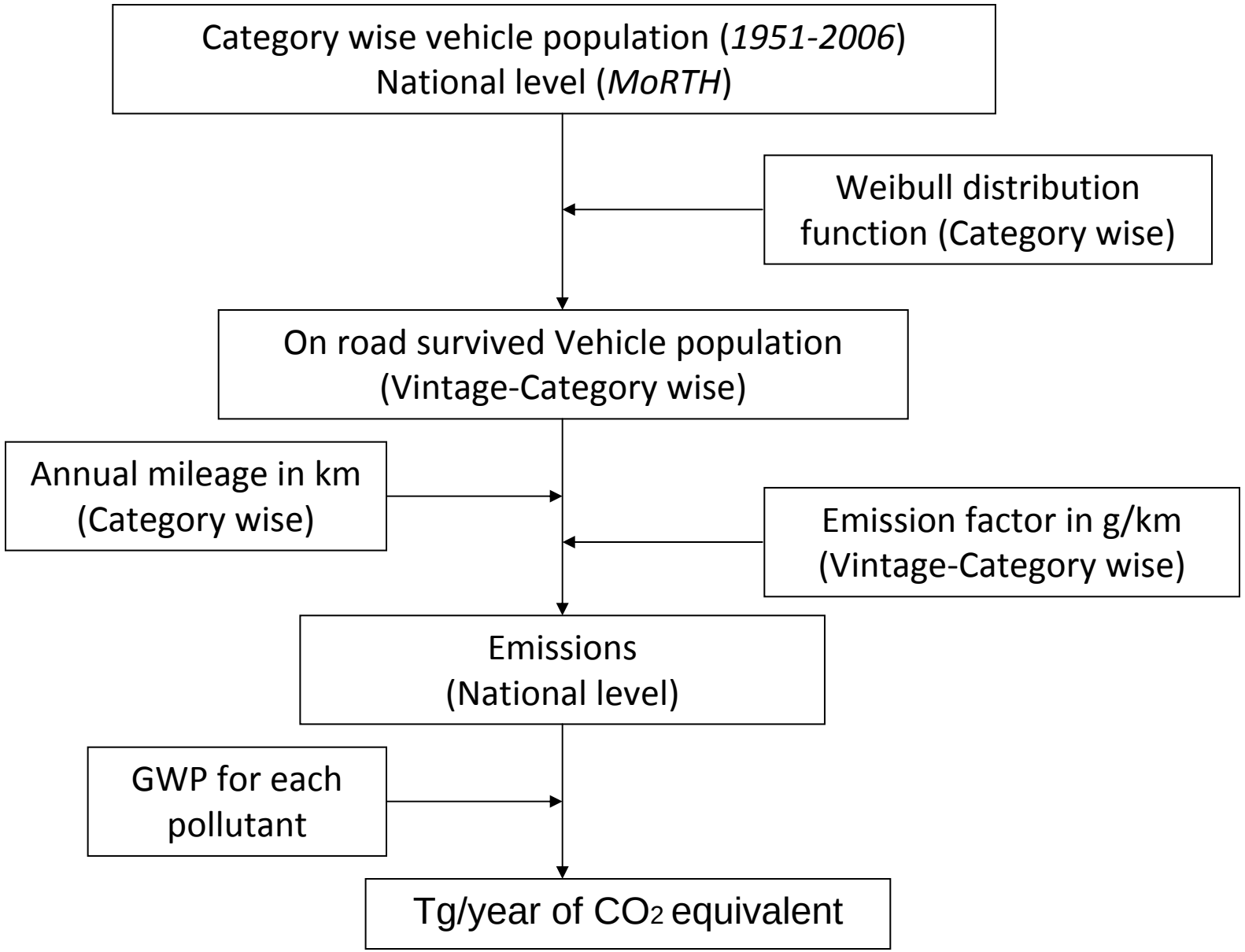


Reddy and Venkataraman, 2002a, Venkataraman et al. 2005; 2006

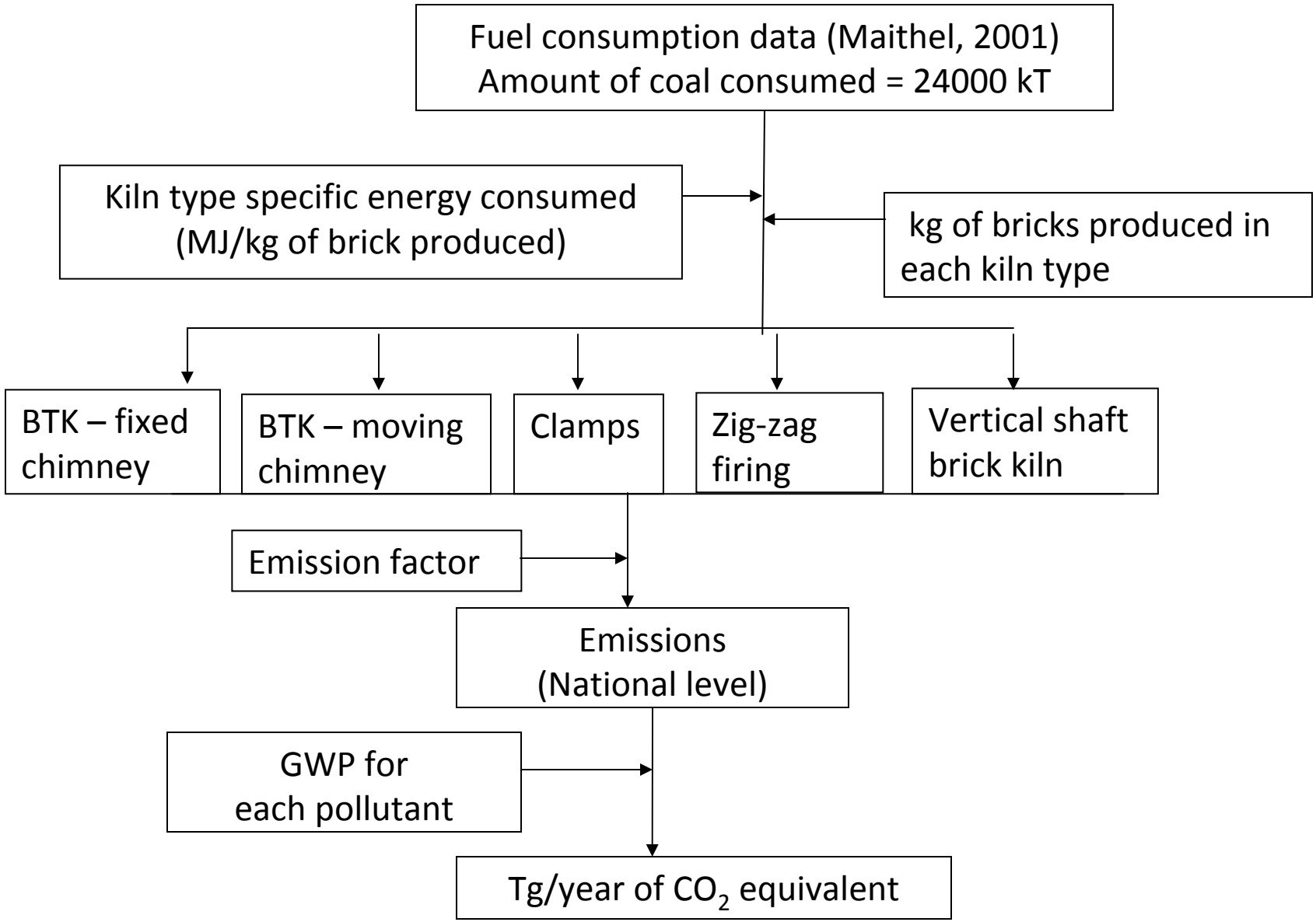
Thermal power plants



Transport sector - roadways

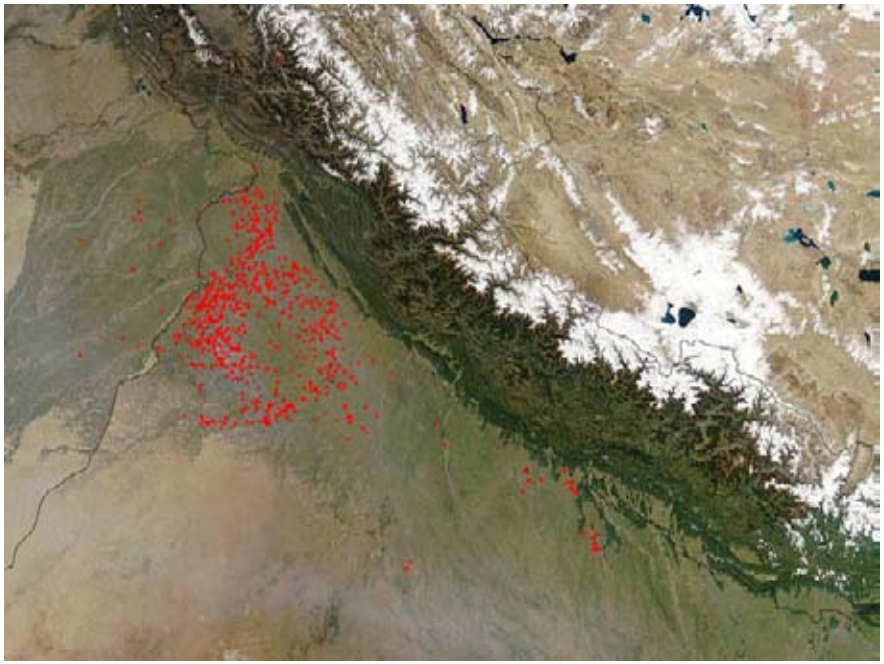


Brick production

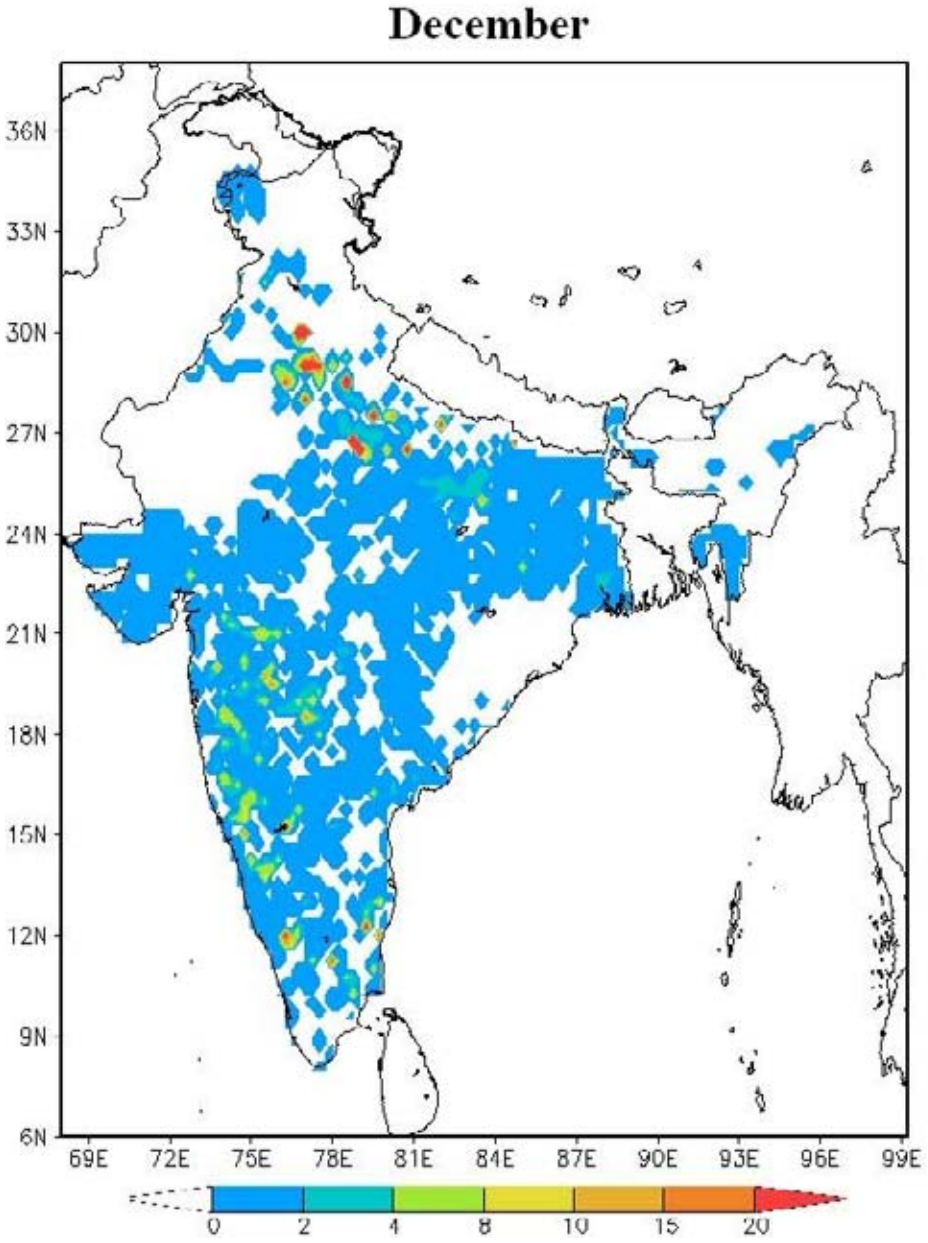


Discontinuous sources: agricultural residue burning

MODIS fire map: Oct 23, 2009



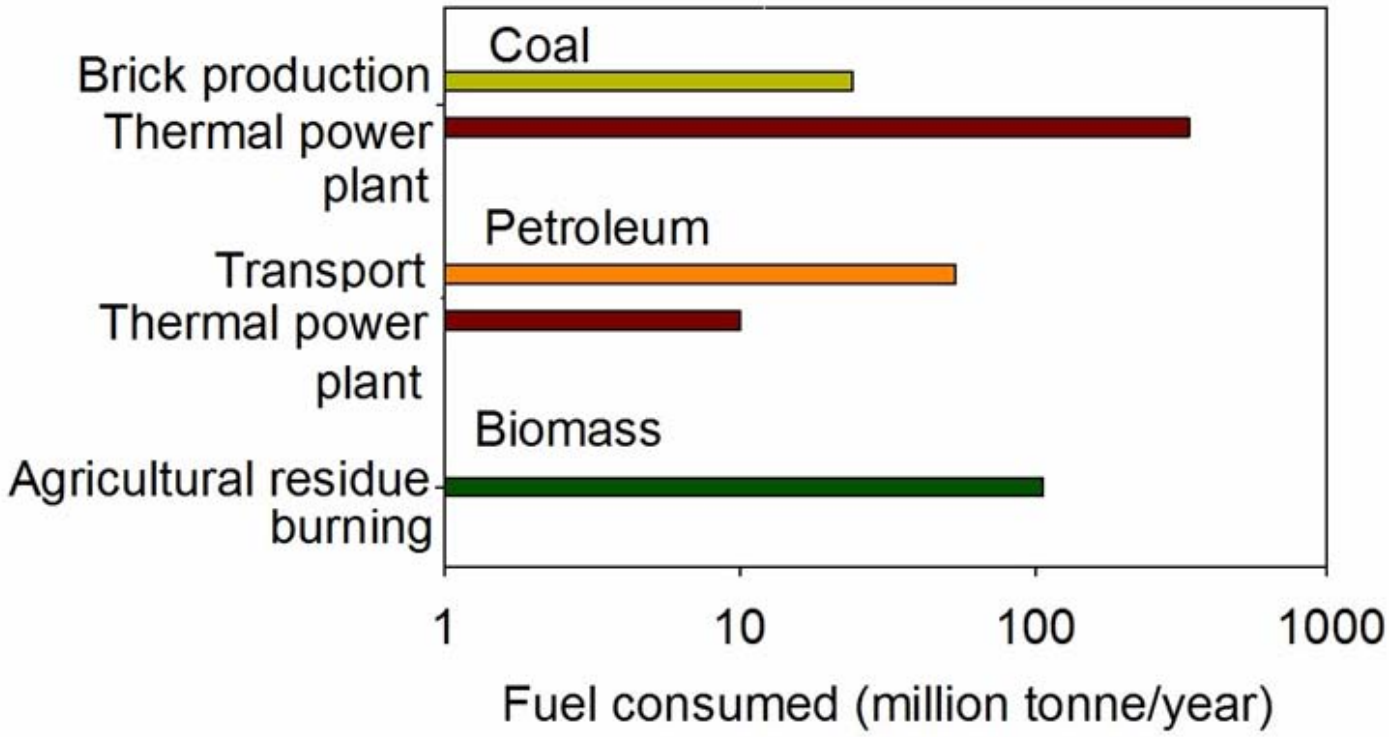
Field burning not well represented in global inventories.



Unit: kg/km^2 -mon

Estimated fuel consumption

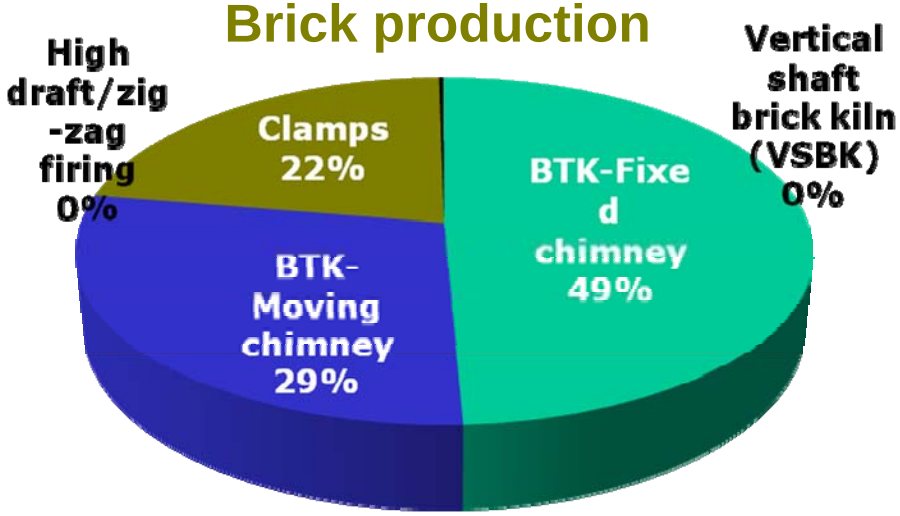
Fuel consumed in selected four sectors for year 2005



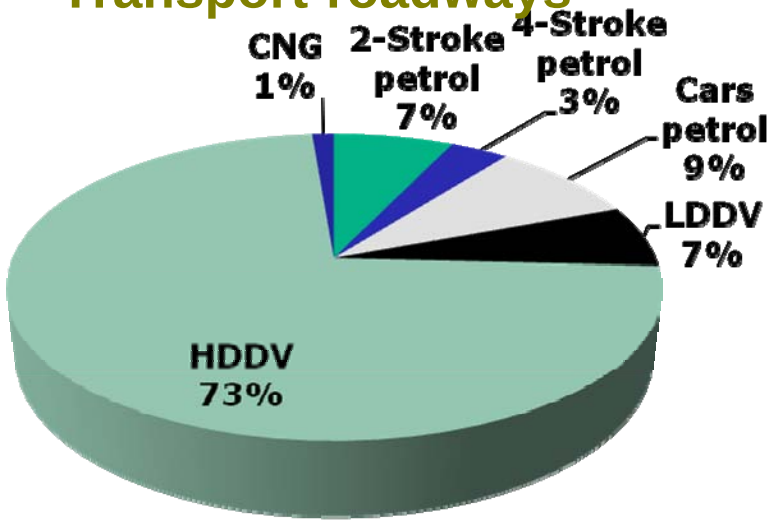
Coal consumption – Thermal power plant (330 million tonne/yr)
Petroleum consumption – Road transport (53 million tonne/yr)
Biomass consumption – Agricultural residue burning (101 million tonne/yr)

Technology-linked fuel consumption

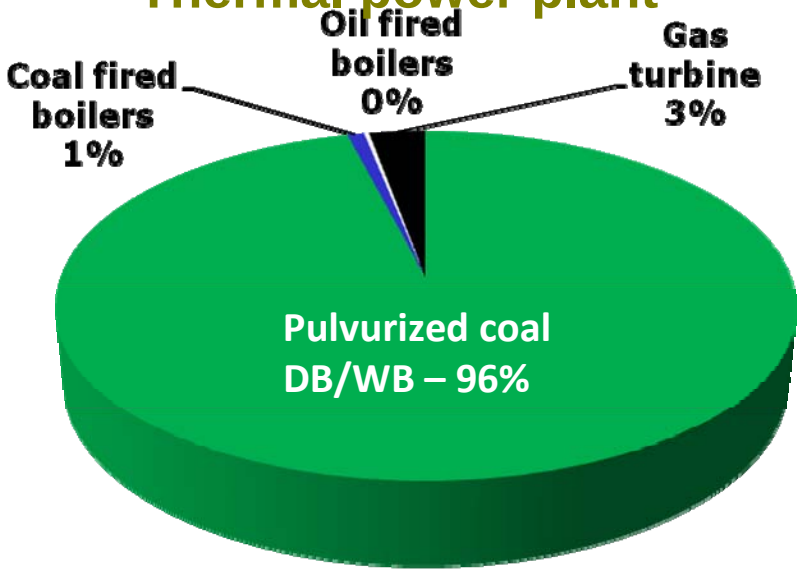
Brick production



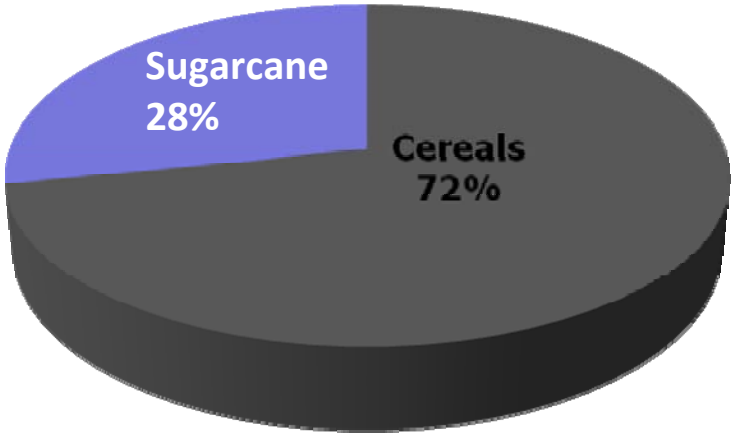
Transport-roadways



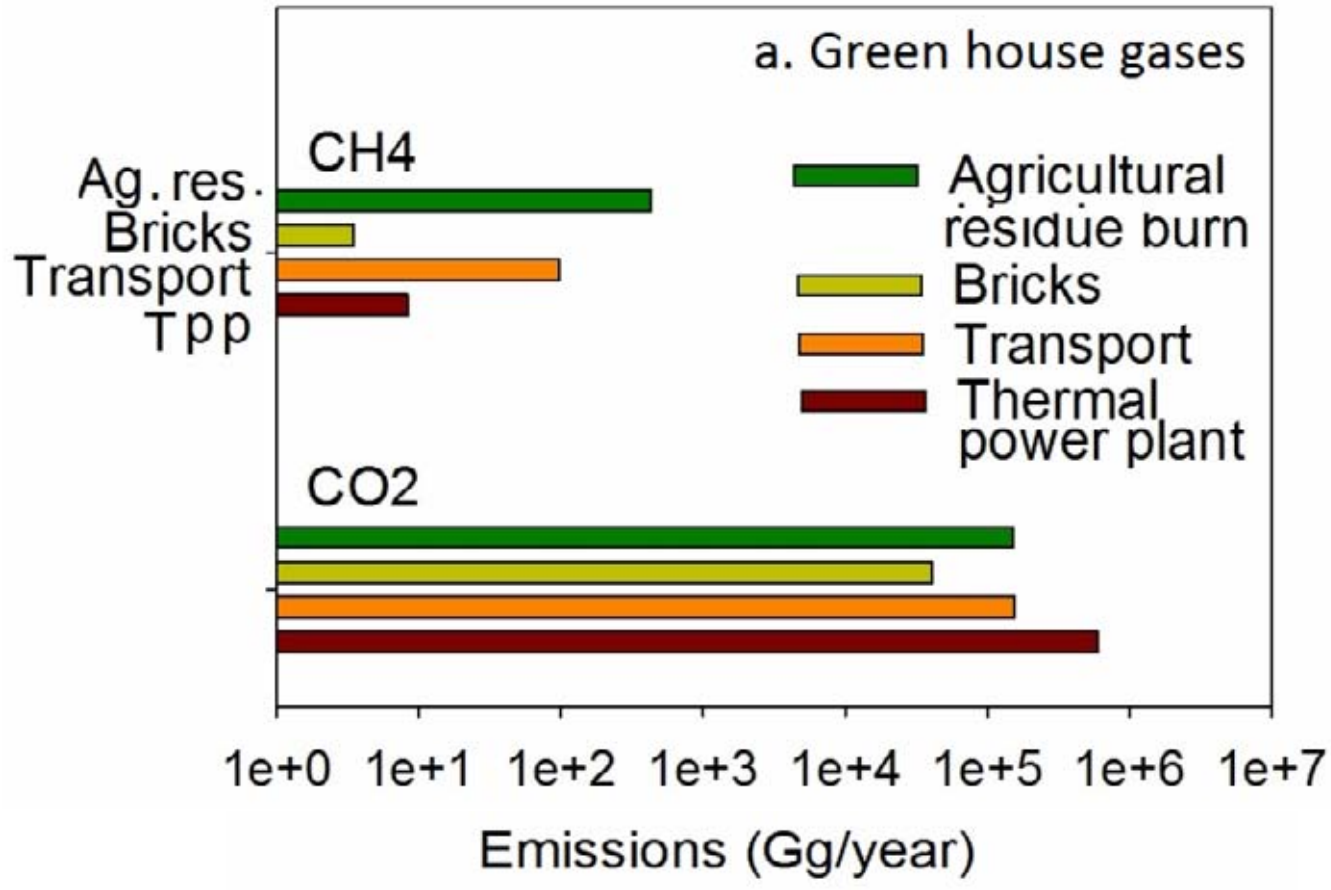
Thermal power plant



Agricultural residue burning

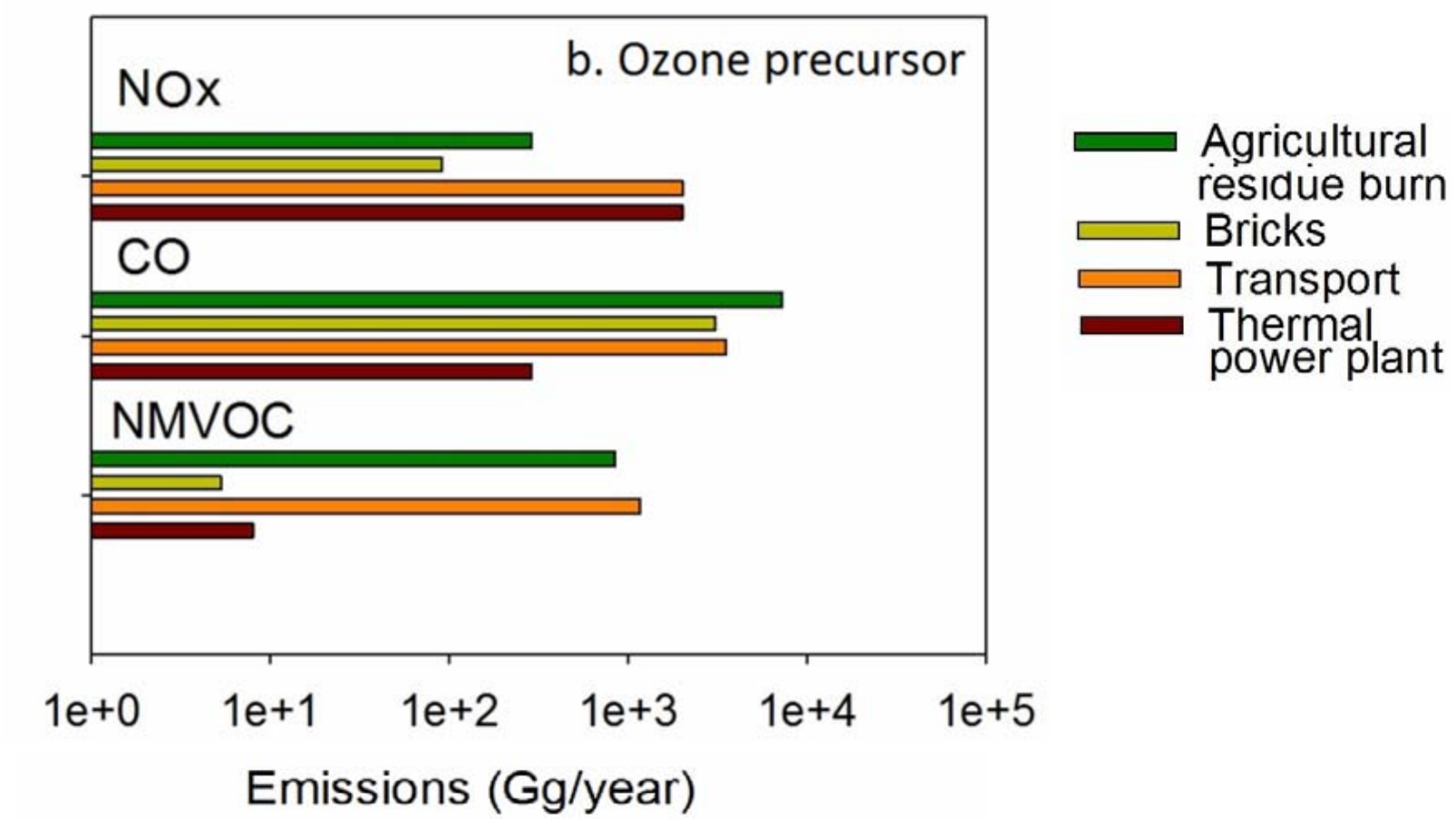


Sectoral emissions: Green house gases



Ag. Residue burn – Mainly responsible for methane emissions
Thermal Power Plant – Major source of CO_2 due to massive consumption of fossil fuel especially coal

Sectoral emissions: Ozone precursor



NOx emissions were emitted from burning of fossil fuels on large scale, i.e. transport and thermal power plants

Uncontrolled and incomplete combustions from agricultural residue burning caused higher **CO** emissions

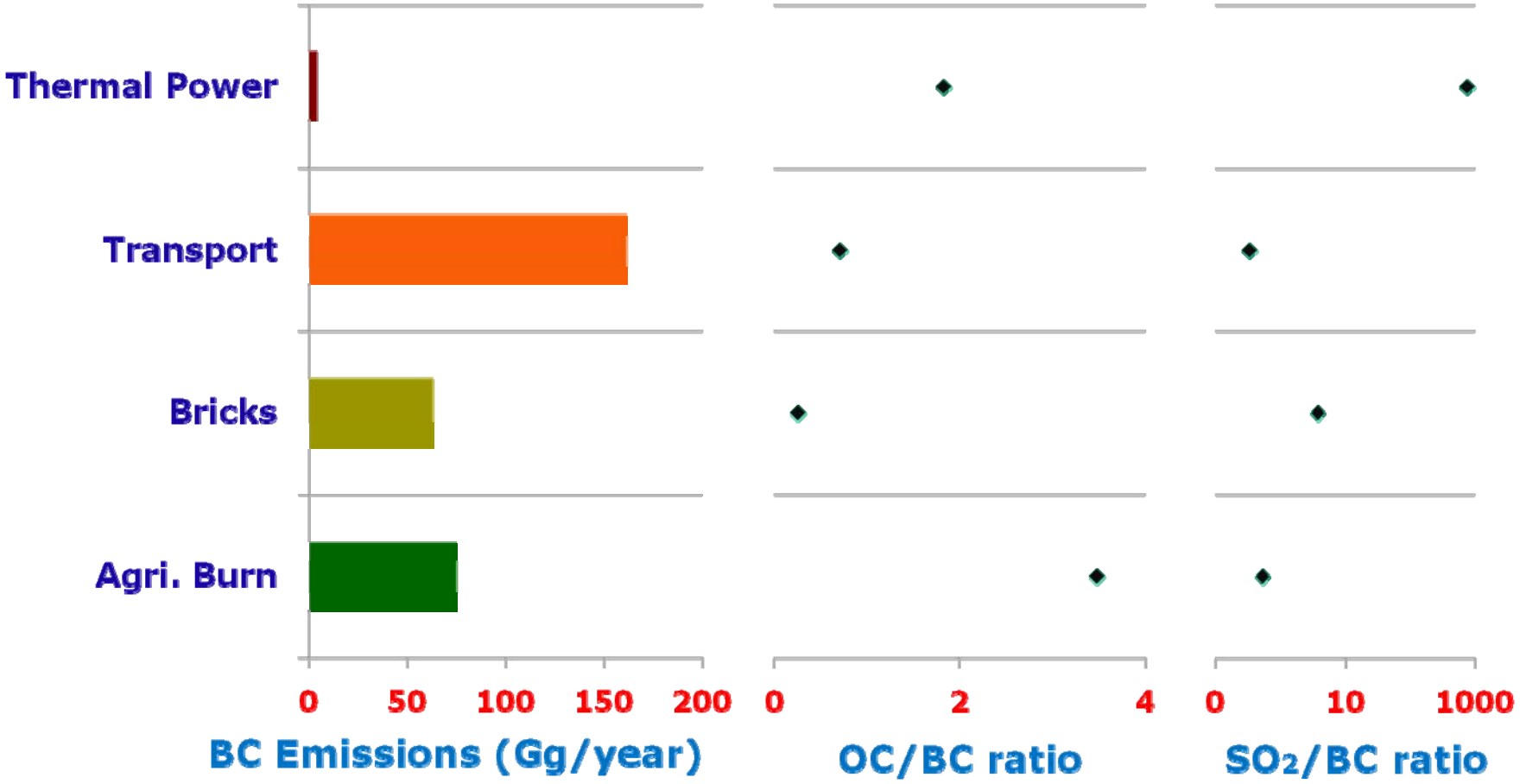
Sectoral emissions: Short lived forcers

Black carbon, was highly emitted from transport sector which made the use of super-emitter vehicles fraction.

SO_2 emissions were largely emitted from thermal power plant which consumed coal about 330 million tonnes

Organic carbon was found to be high from agricultural residue burnings

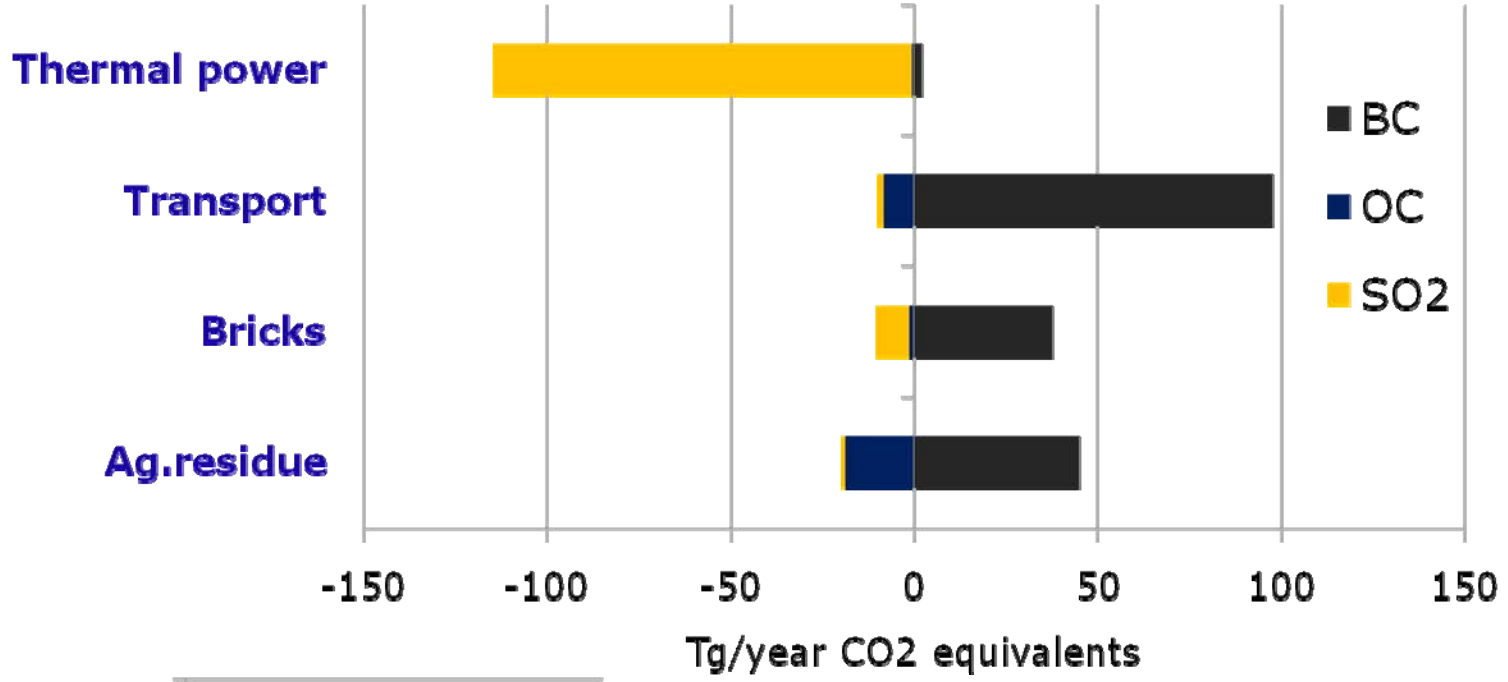
Emissions summary – Black carbon

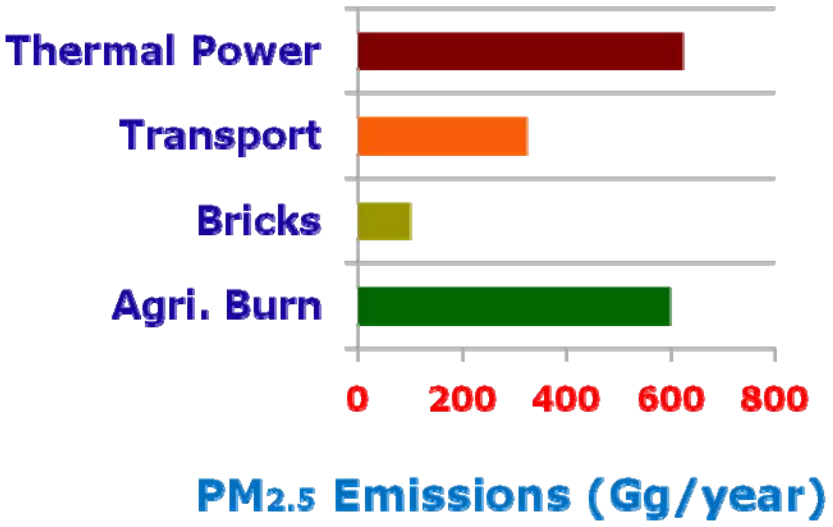


Emissions (Gg/year)

BC	302
OC	397

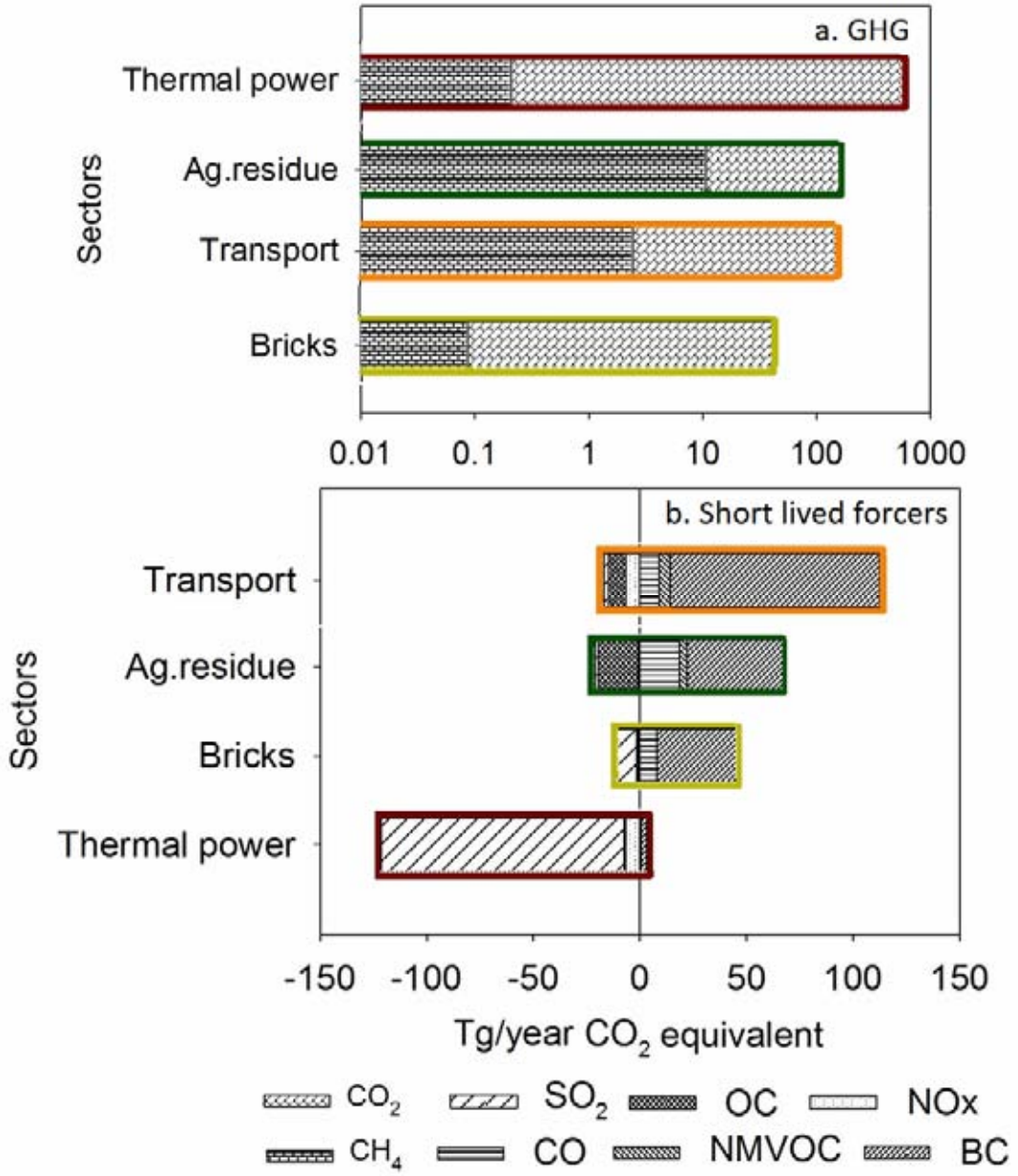
Frameworks for mitigation

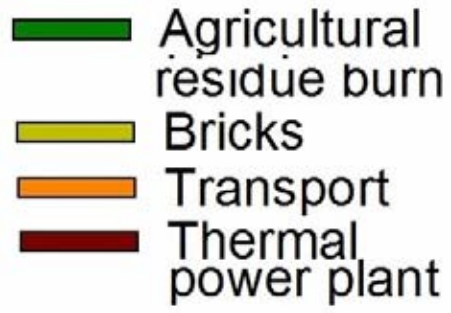




GWP		
BC	OC	SO4
608	-70.8	-40

Climate footprint of emission sectors





Among long-lived GHG, CO2 from thermal power plant was the highest

Among short-lived forcers BC was the dominant species warming the atmosphere mainly from transport. While OC from ag. residue burn and SO2 from power plant showed negative effect

Conclusions

- Sectoral methodologies are developed for energy use and emissions estimation.
- Technology-linked emissions estimation is needed for accurate magnitudes of total and sectors emissions.
- Short-lived forcers offer two important benefits: air-quality and health mitigation, immediate reduction in atmospheric warming (in the near term).
- Among sectors considered, diesel transport, agricultural residue burning and brick production offer mitigation potential based on short-lived forcers.
- Frameworks based on multiple criteria allow mitigation strategies which offer simultaneous benefits for air quality and climate.

THANK YOU