Commuter Exposure to Vehicle Air Pollution in New Delhi

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Study and Measurements

- Motivation:
  - Pollution in traffic is generally much higher than ambient levels, but few data available for Indian cities
- Study design:
  - Measure pollution inside vehicles and in ambient air
  - Auto-rickshaws, non-AC cars, AC cars
  - Consistent sampling route (40 km)
  - 75 weekday trips: 200 hours in AM & PM commutes (Feb-May 2010)
- 3 pollutants measured:
  - Particulate matter: Fine, ultrafine and black carbon particles
  - Associated with respiratory, heart diseases and premature death

Results: In-vehicle vs. ambient levels

In-vehicle: auto-rickshaw

Ambient site 1: Lodhi Garden

Pollutant	In-vehicle		Ambient	Ratio
Fine particles ($PM_{2.5}$)	190	vs.	130 µg / m^3	1.5 ×
Black carbon	42	vs.	12 µg / m^3	3.6 ×
Ultrafine particles	280,000	vs.	35,000 # / cm^3	8.4 ×

Results: Comparison of vehicle types

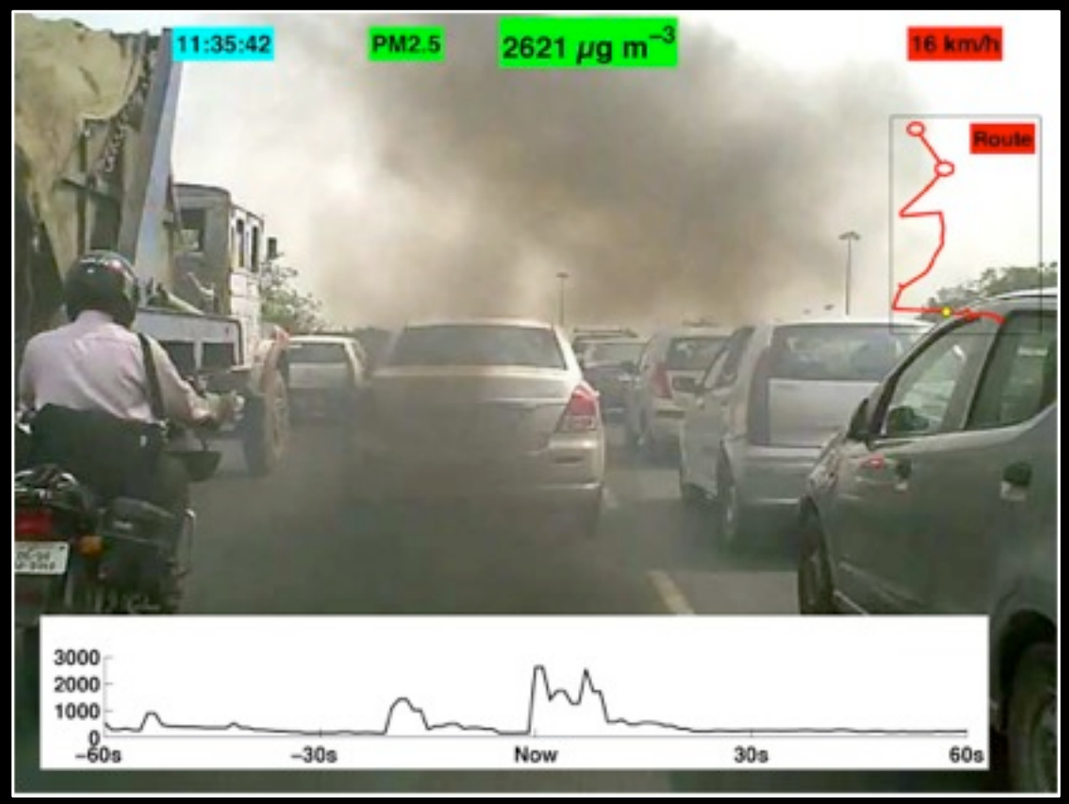
- Pollution especially high in unenclosed vehicles
  - Auto-rickshaws & open-window (non-AC) cars have similar levels
  - AC cars: pollution 35-55% less with windows closed

- **International Perspective:**
  Pollution in unenclosed vehicles is very high in Delhi!
  - Concentrations in Delhi auto-rickshaws are ~ 2-10 × higher than measured in other megacities around the world

Results: Extreme peaks

- Short-term peak concentrations in auto-rickshaws
  - 4 - 10 × higher than average in-vehicle levels
  - 6 - 50 × higher than ambient levels

- Videos show sources of extreme peaks



Lessons Learned

- Exposure in Delhi vehicles is not well represented by ambient air pollution monitors
- Very high concentrations inside "open" vehicles
- Watch out for the peaks!

Key step: reduce emissions of vehicle fleet

For further information:

- Journal article published in *Atmospheric Environment* last month
  - Apte JS, Kirchstetter TW, Reich AH, Deshpande SJ, Kaushik G, Chel A, Marshall JD, and Nazaroff WW. 2011. Concentrations of fine, ultrafine, and black carbon particles in auto-rickshaws in New Delhi, India. Atmospheric Environment. Vol. 45 (26), p. 4470-4480.
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