

# Traffic- Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects

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Combustion Generated Nanoparticles  
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# Goals of the Review

Summarize and synthesize relevant information on air pollution from traffic and its health effects linking

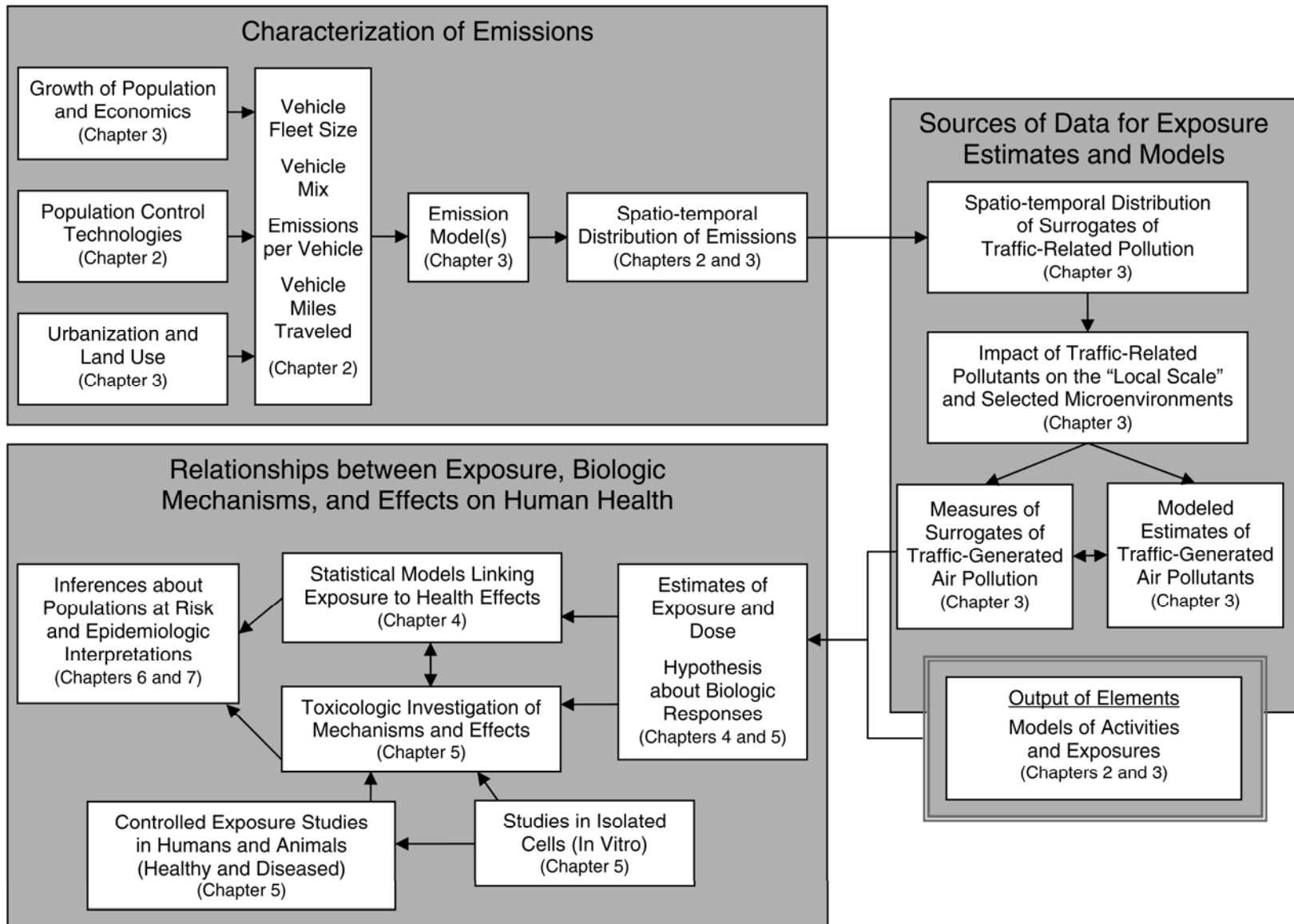
- Information on tailpipe emissions with human exposure
- Human exposure to air pollution from traffic with human health effects (epidemiology)
- Toxicological data with epidemiologic associations

A preprint of the report was released in May 2009

The formal Report will be published in the fall of 2009



# Scheme of Report Organization



# Organization of the Panel

- Emissions and Exposure Characterization
  - Kenneth Demerjian\* (chair), Michael Jerrett, Brian Leaderer \*, Fred Lurmann, Mike Walsh
- Epidemiology
  - Ira Tager (chair)\*, Nino Künzli, Thomas Lumley, Sylvia Richardson\*, John Samet
- Toxicology
  - Mark Frampton (chair), Frank Kelly, Lester Kobzik

\*Member of Research or Review Committee



# Emissions from Motor Vehicles

## The Current Context

Significant progress has been made in reduction of pollutant emissions from motor vehicles despite increases in number of vehicles and vehicle miles traveled

Increased urbanization and urban populations have:

- Increased dependence on motor vehicles and traffic congestion
- Changed land use patterns such that **more people are near traffic sources of pollution**



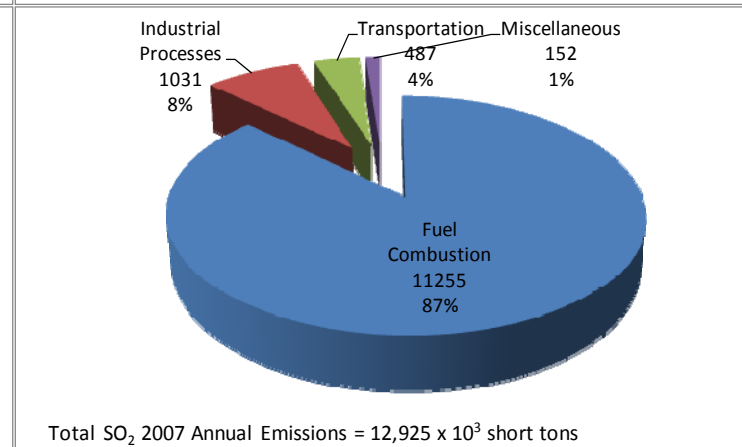
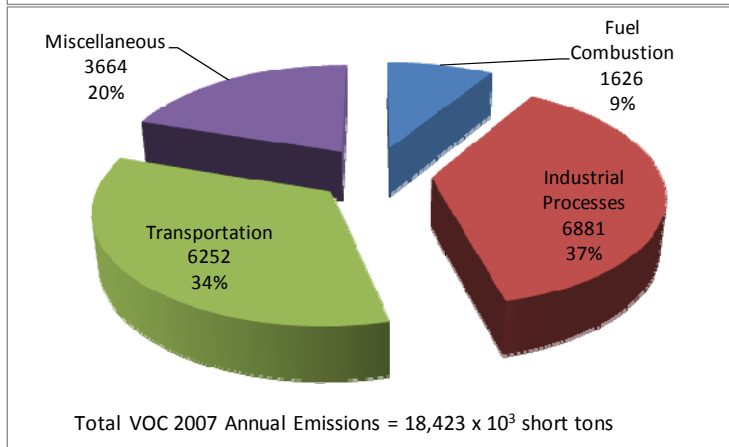
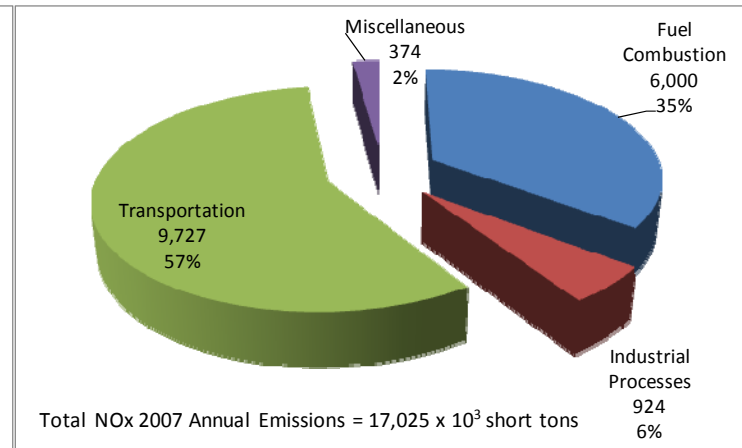
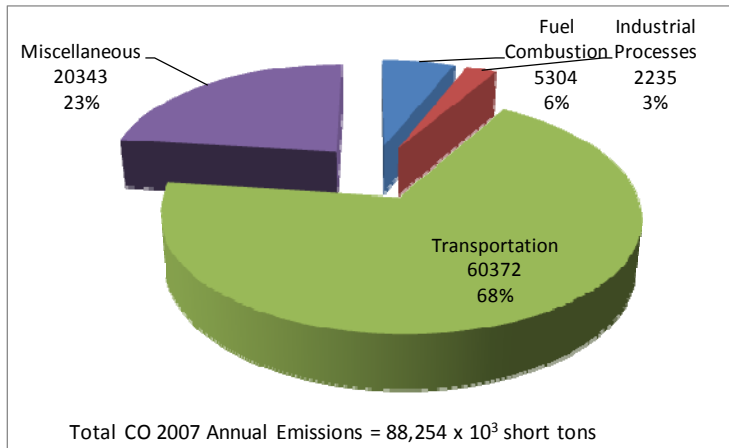
# Emissions from Motor Vehicles

*Premise: Emissions data are needed to:*

- Describe exposure
  - Trends in transportation emissions in the context of national inventories
    - Effects of control technologies, new fuels, etc
  - Emissions inventories and modeling
  - Physical and chemical transformations near roads
- *Understand the relative importance of traffic emissions to air pollution in total and at specific locations*
  - Contribution to PM, gases, VOC, NO<sub>x</sub>



# Annual 2007 CO, NO<sub>x</sub>, VOC, and SO<sub>2</sub> Emissions Distribution in the US

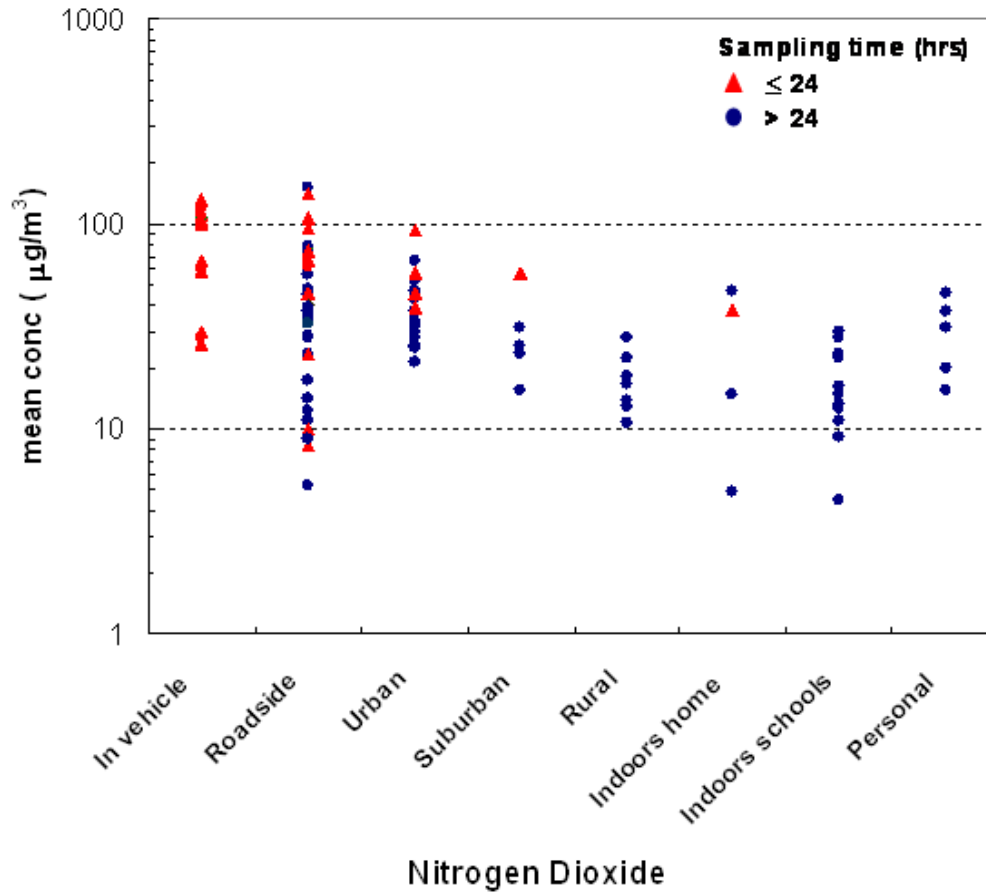


# Exposure to Primary Traffic-Generated Air Pollution (PTGP)

- **Exposure surrogates used in epidemiologic studies**
  - Pollutant surrogates for traffic exposures (e.g., NO<sub>2</sub>, EC/BS, CO, UFPM, benzene, etc.)
  - Distance from and/or length of roadways
  - Estimate of traffic density or intensity
  - Modeling of primary traffic-generated pollutant exposure

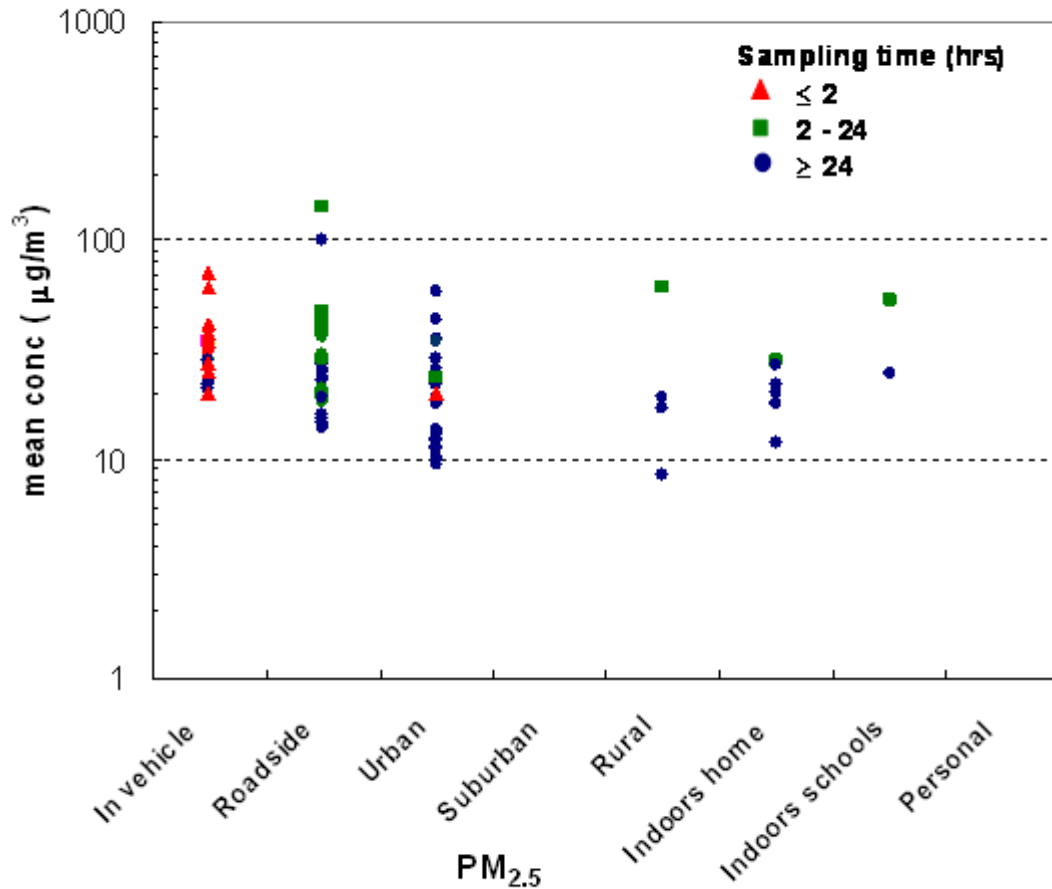


# NO<sub>2</sub> Measurements



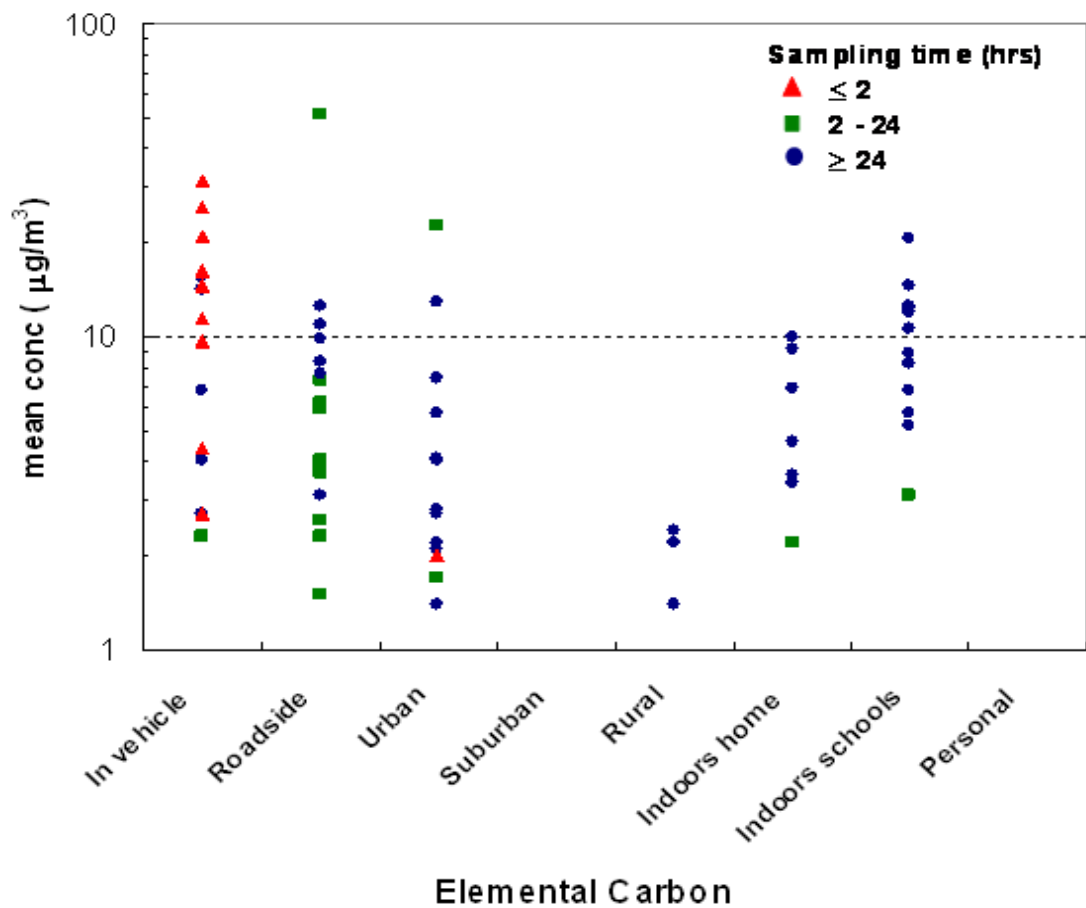
- There is substantial variability in average concentrations by locations.
- NO<sub>2</sub> is a potential surrogate for vehicle emissions if it is measured on a fine spatial resolution.

# PM<sub>2.5</sub> Measurements



- Use of PM<sub>2.5</sub> as a surrogate is of limited value because many sources contribute to urban PM<sub>2.5</sub> and PM<sub>2.5</sub> concentrations are well mixed within a region
- Current central monitors do not provide sufficient spatial resolution for assessing the contribution of traffic to ambient PM<sub>2.5</sub>

# Elemental Carbon Measurements



- Data suggest that EC is highly variable in ambient air.
- Its contribution from traffic needs to be evaluated against other anthropogenic emissions



# Exposure Models

## Models used

- Proximity models
- Geostatistical interpolation models
- Dispersion models
- Land-use regression models
- Hybrid models
  - Combine a model with time-activity data, or personal/microenvironmental monitoring



# Epidemiology

## Criteria for Causal Inference

4 categories used to infer causal association based on how well studies **controlled for confounding**, on the **consistency** of the findings with other studies, and on the **quality** of the method to estimate exposure to primary traffic-generated pollutants

- Sufficient evidence
- Suggestive but not sufficient
- Inadequate and insufficient evidence
- Suggestive of no association



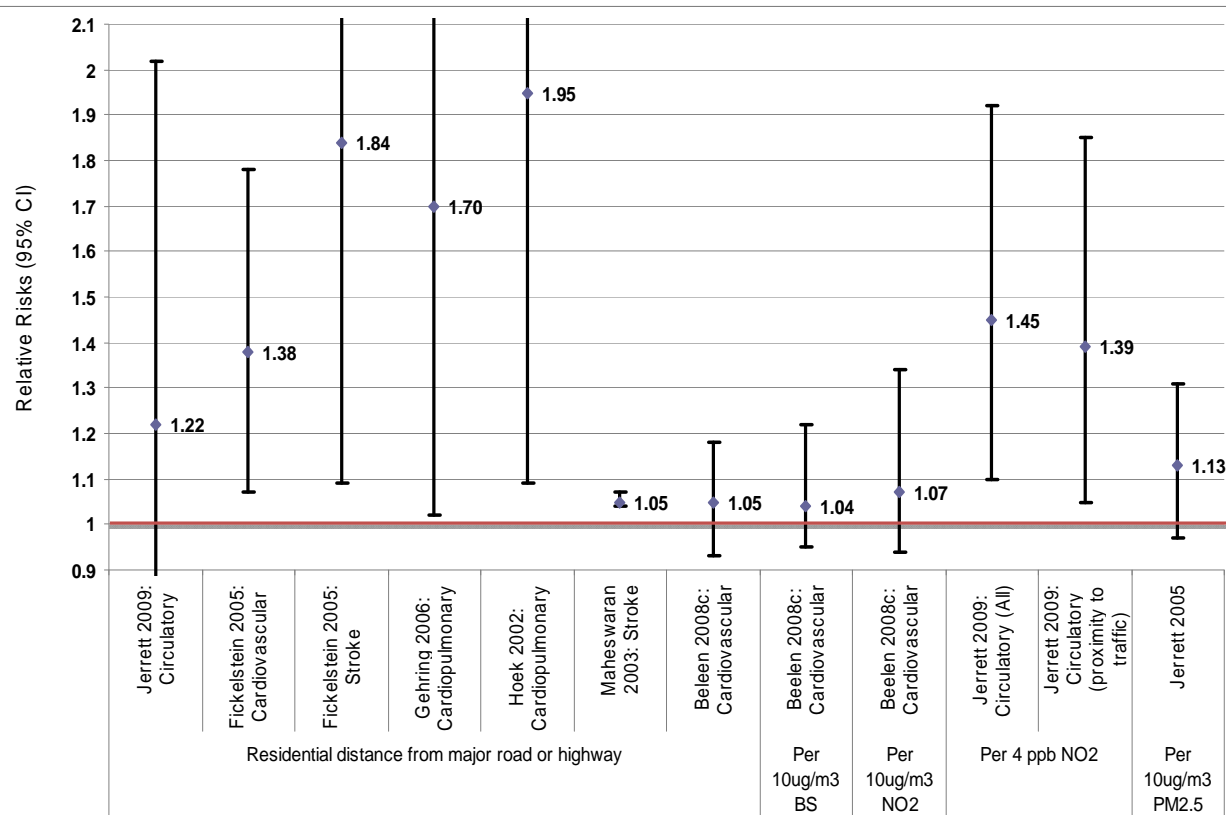
# Epidemiology

## Health Outcomes Evaluated

- Mortality (all cause, cardiopulmonary)
- Cardiovascular morbidity
- Respiratory disease
  - Asthma—childhood/adult
  - General respiratory symptoms
  - Lung function-childhood/adult/COPD
  - Health care utilization
- Non-asthmatic allergy
- Birth Outcomes
- Cancer



# Long-Term Traffic Exposure and Cardiopulmonary Mortality



**Proximity**

**BS NO<sub>2</sub> PM**

## Synthesis of Evidence

Suggestive but insufficient” to infer causal association

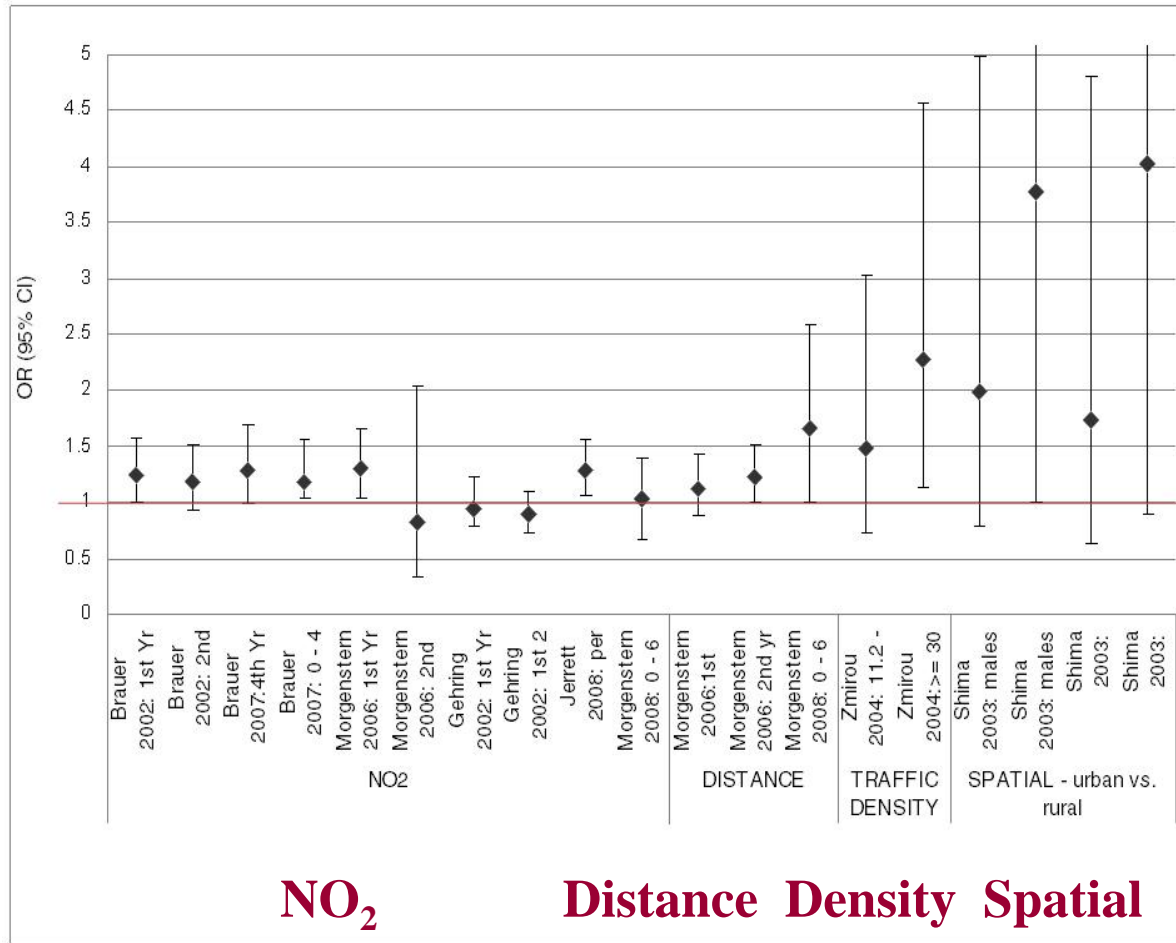
## Reasons

Too few studies

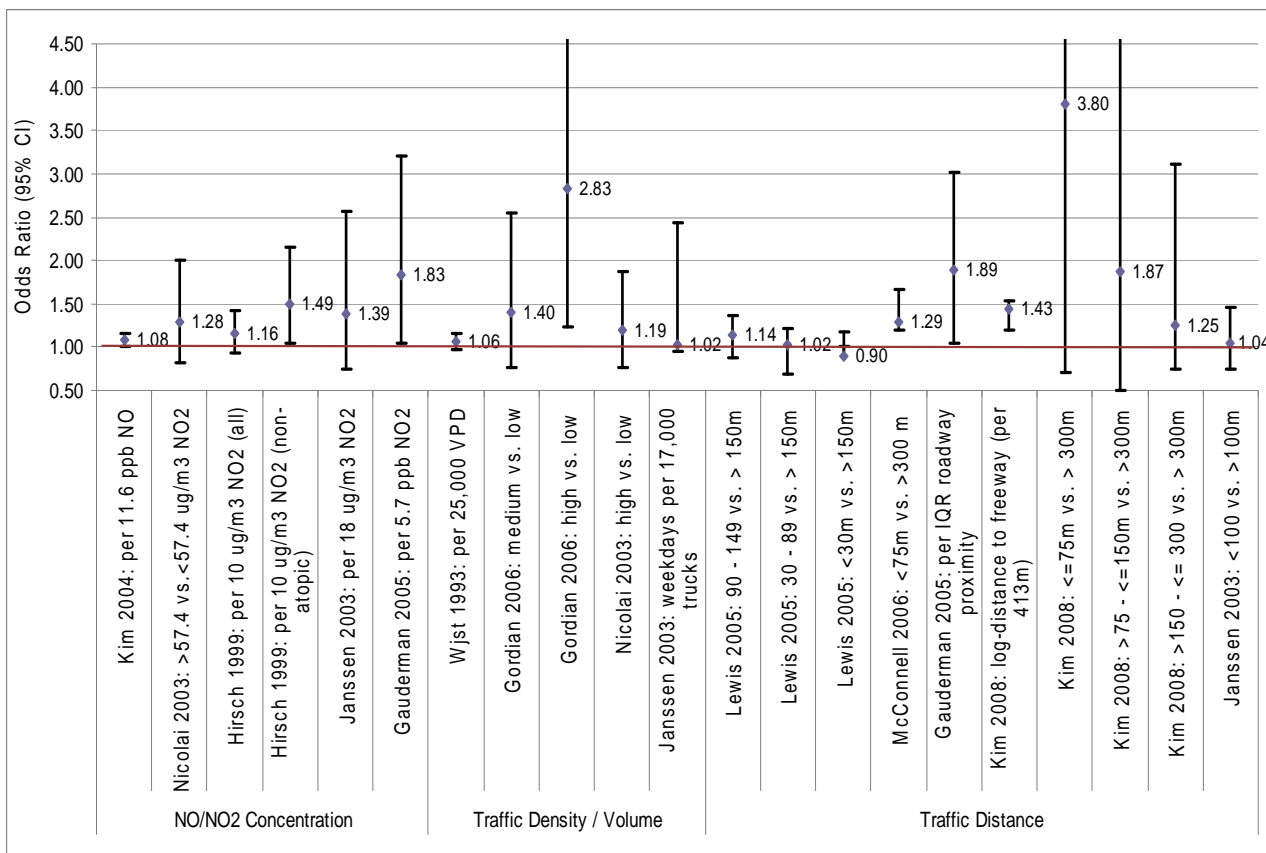
Relative imprecision of most estimates



# Traffic Exposure and Asthma Incidence



# Traffic Exposure and Asthma Prevalence



**Synthesis of Evidence**  
 “Sufficient” OR  
 “suggestive but insufficient”  
 to infer causal association  
**Reasons**  
 Studies that included both  
 traffic-specific pollutants  
 and density measures most  
 consistent

**NO<sub>2</sub>**

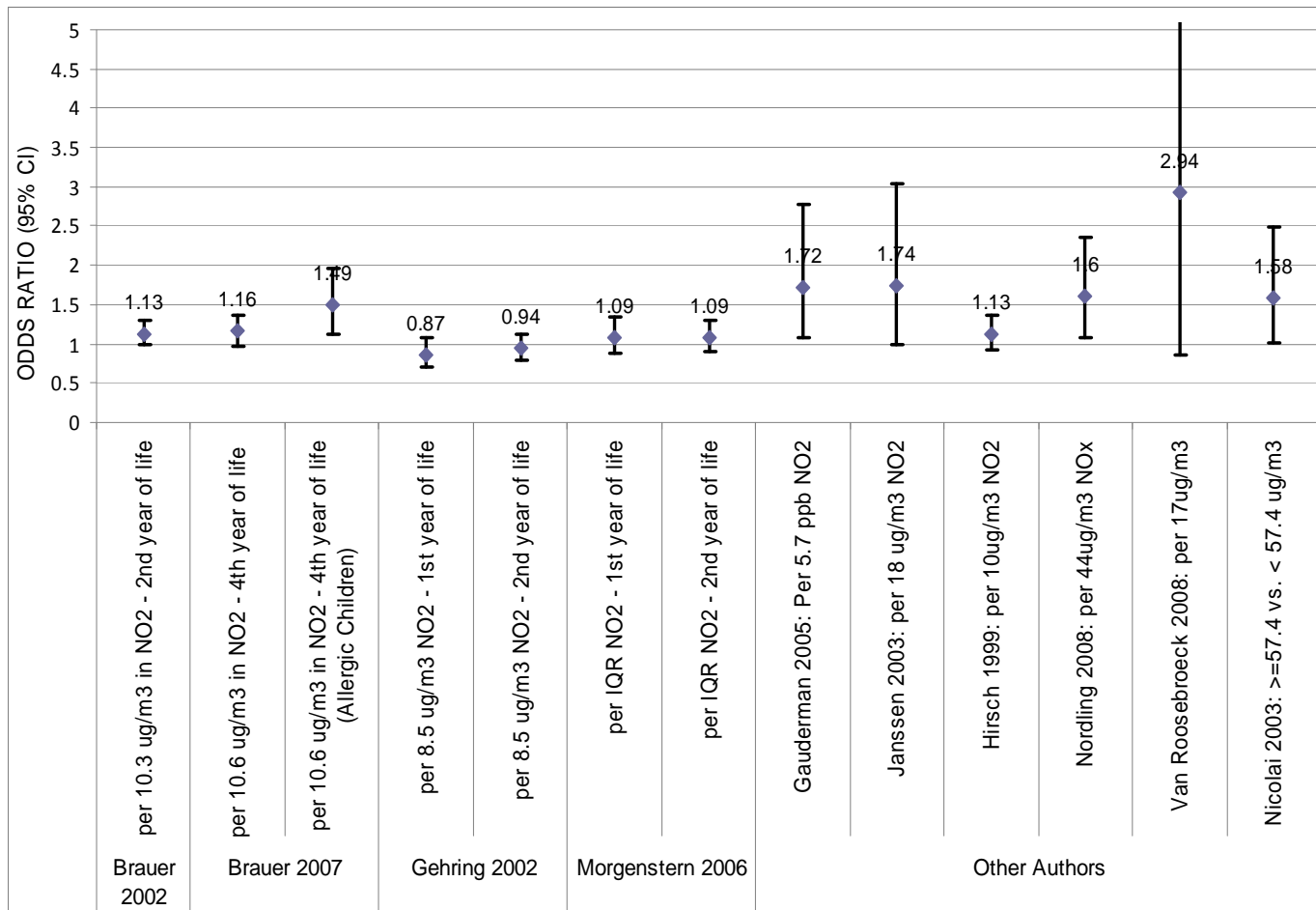
**Density/Volume**

**Distance**



# Exacerbation of Asthma Symptoms

## Increase in Wheeze Per Increment NO2



### Synthesis of Evidence

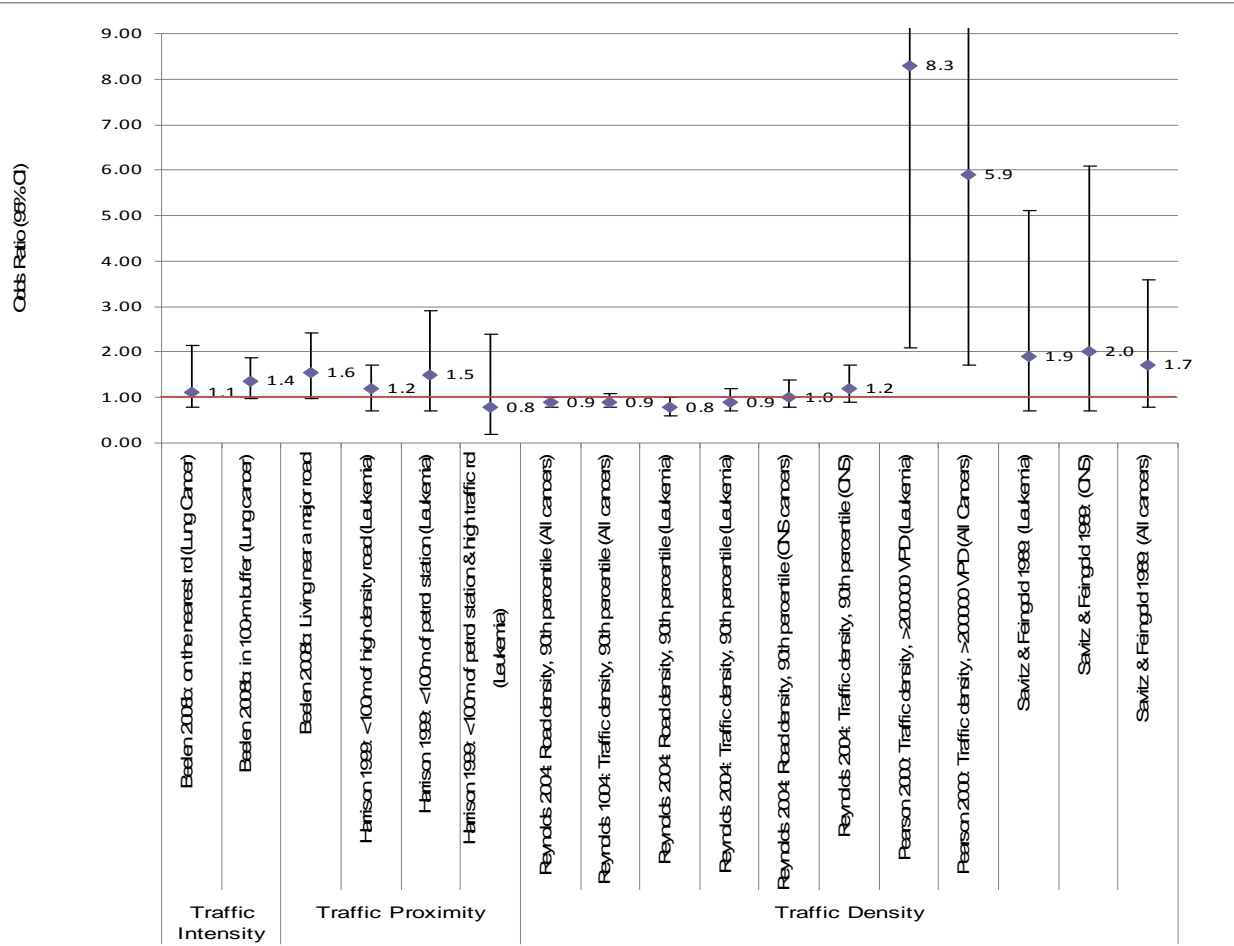
Exacerbations with asthma—”Sufficient” to infer causal association

### Reasons

Large number of studies with adequate control for confounding and mostly precise effect estimates



# Traffic Exposure and Cancer



## Synthesis of Evidence

“Insufficient” evidence to infer causal association

## Reasons

Too few studies of any one type of cancer



# Conclusions



# Exposure to Primary Traffic-Generated Air Pollution

- Traffic-related pollutants impact ambient air quality on a broad spatial scale ranging from roadside, to urban, to regional background
- Based on synthesis of evidence, 500 meters from major road was identified as the near-source area most impacted by traffic; variations exist depending on meteorology, background pollution, and local factors



# Issues for Exposure to Primary Traffic-Generated Air Pollution

- None of the pollutant surrogates considered met all criteria for an ideal surrogate
  - CO, benzene, and NO<sub>x</sub> [NO<sub>2</sub>] found in on-road vehicle emissions are major components of emissions from all sources
  - UFPM have not been used in epidemiologic studies so far. It is difficult to model them because there are no emission inventories
- Exposure models are important, but have various degrees of utility to health studies
  - The proximity model is the most error-prone
  - The hybrid model provides a feasible “best” estimate of exposure



# Conclusions From Epidemiologic Studies

- “Sufficient ” evidence to Infer causal associations
  - Exacerbations of asthma
  - *Asthma incidence and prevalence in children*
- “Suggestive but insufficient” evidence
  - Mortality (all-cause and cardiovascular)
  - Decreases in lung function
  - General respiratory symptoms
- “Inadequate and insufficient” evidence to Infer causal associations
  - Adult onset asthma
  - Health care utilization for childhood and adult respiratory diseases
  - COPD
  - Non-asthmatic allergy
  - Birth outcomes
  - Cancers



# Summary

Epidemiology studies are based on past estimates of exposure and they may not provide an accurate guide to estimating health associations in the future

Given the large number of people living within 300- 500 meters of a major road, the Panel concluded that exposures to primary traffic generated pollutants are likely to be of public health concern and deserve attention

For a preprint version visit [www.healtheffects.org](http://www.healtheffects.org)



