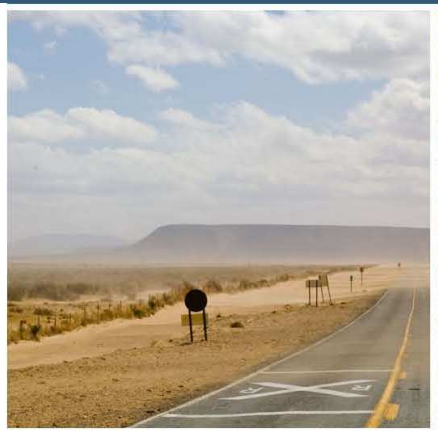
United States Environmental Protection Agency

Integrated Science Assessment for Particulate Matter (2nd External Review Draft)

Briefing for Clean Air Scientific Advisory Committee



Office of Research and Development
National Center for Environmental Assessment, Research Triangle Park, NC

5 October 2009

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Overview

2nd draft ISA revisions in response to CASAC and public comments on 1st draft PM ISA:

- Focus on $PM_{2.5}$, $PM_{10-2.5}$, ultrafine PM
  - PM_{10} studies as supportive for $PM_{2.5}$ or $PM_{10-2.5}$ causality determinations
- All causality determinations included in Chapter 2
  - Some determinations were revised
- Welfare determinations included in Chapter 2
- Restructuring of Susceptibility Chapter
- Other revisions to text and figures, addition of new sections

- Health and Environmental Research Online (HERO) system
  - PM citation hotlinks

PM ISA Organization

Chapter 1: Introduction
Chapter 2: Integrative Health and Welfare Effects Overview
Chapter 3: Source to Exposure
Chapter 4: Dosimetry
Chapter 5: Mode of Action
Chapter 6: Integrated Health Effects of Short-term PM Exposure
Chapter 7: Integrated Health Effects of Long-term PM Exposure
Chapter 8: Susceptible Subpopulations
Chapter 9: Welfare Effects

Annexes (more detailed summaries of evidence)
A: Atmospheric science and exposure
B: Dosimetry
C: Human clinical
D: Toxicology
E: Epidemiology
F: Source apportionment health studies

PM ISA Revisions
Chapters 1 and 2

- Chapter 1 (Introduction)
  - Further detail added on history of previous PM NAAQS review
  - Expanded section on study selection criteria
  - Revised to include more specific considerations for causality determinations on PM
- Chapter 2 (Integrative Overview)
  - Reorganized to focus on effects of $PM_{2.5}$, $PM_{10-2.5}$, and ultrafine particles
  - Included all health causality conclusions
  - Added integration sections by PM size fraction
  - Added figures that incorporate effect estimates and the concentrations at which they are observed
  - Added new section on policy-relevant considerations
  - Included welfare effects

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Causality Determinations for Exposures to $PM_{2.5}$

Health Category	Short-term Exposure	Long-term Exposure
Cardiovascular Effects	Causal	Causal
Respiratory Effects	Likely to be Causal	Likely to be Causal
Central Nervous System	Inadequate	------
Mortality	Likely to be Causal	Likely to be Causal
Reproductive and Developmental	-----	Suggestive
Cancer, Mutagenicity, Genotoxicity	-----	Suggestive

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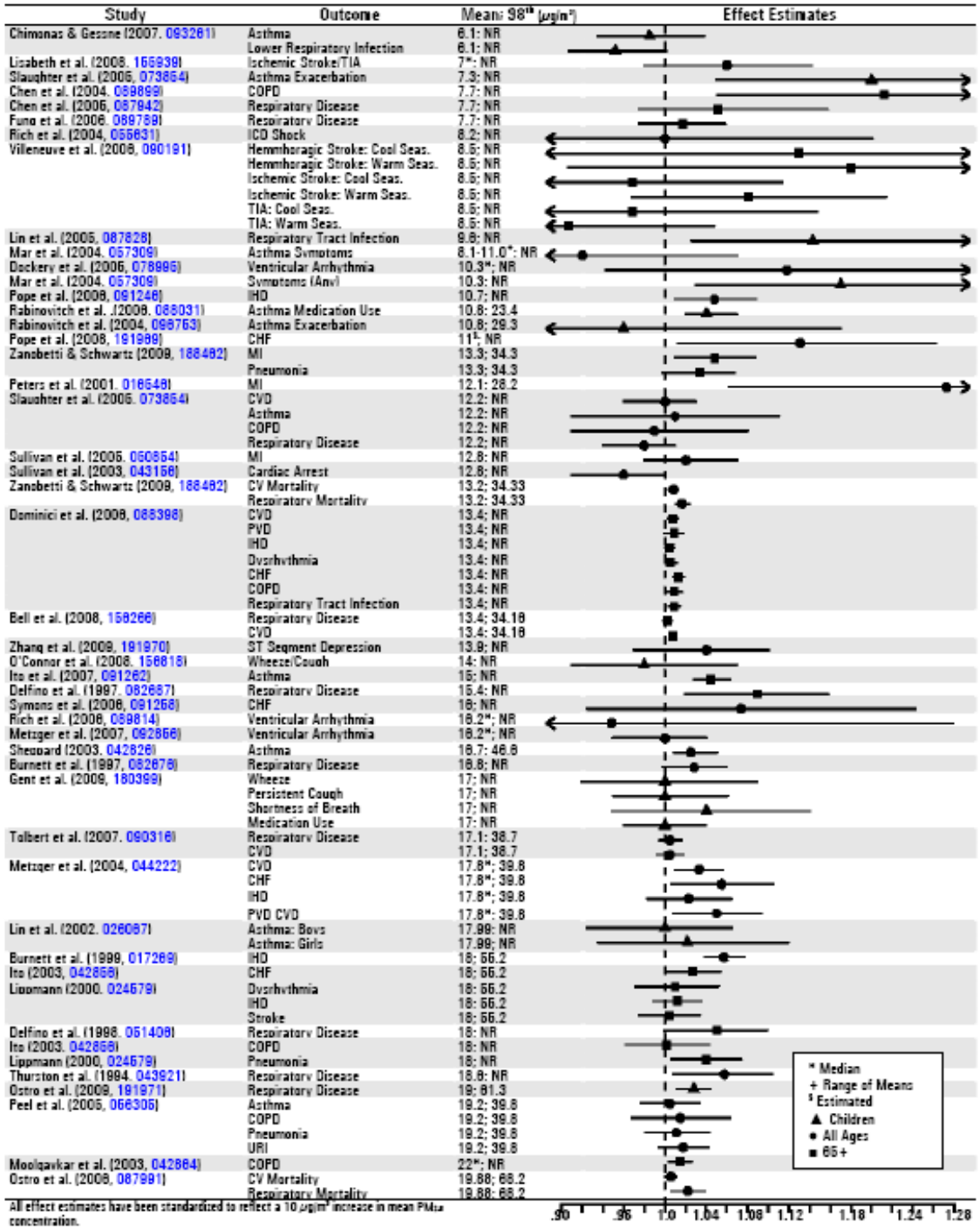
Epidemiologic Effect Estimates for Short-Term Exposures to $PM_{2.5}$

- Mean concentrations ranged from 6.1 to 22 $\mu g/m^3$
- Effects more precise and consistently positive with mean $PM_{2.5}$ concentrations $\geq 13\ \mu g/m^3$



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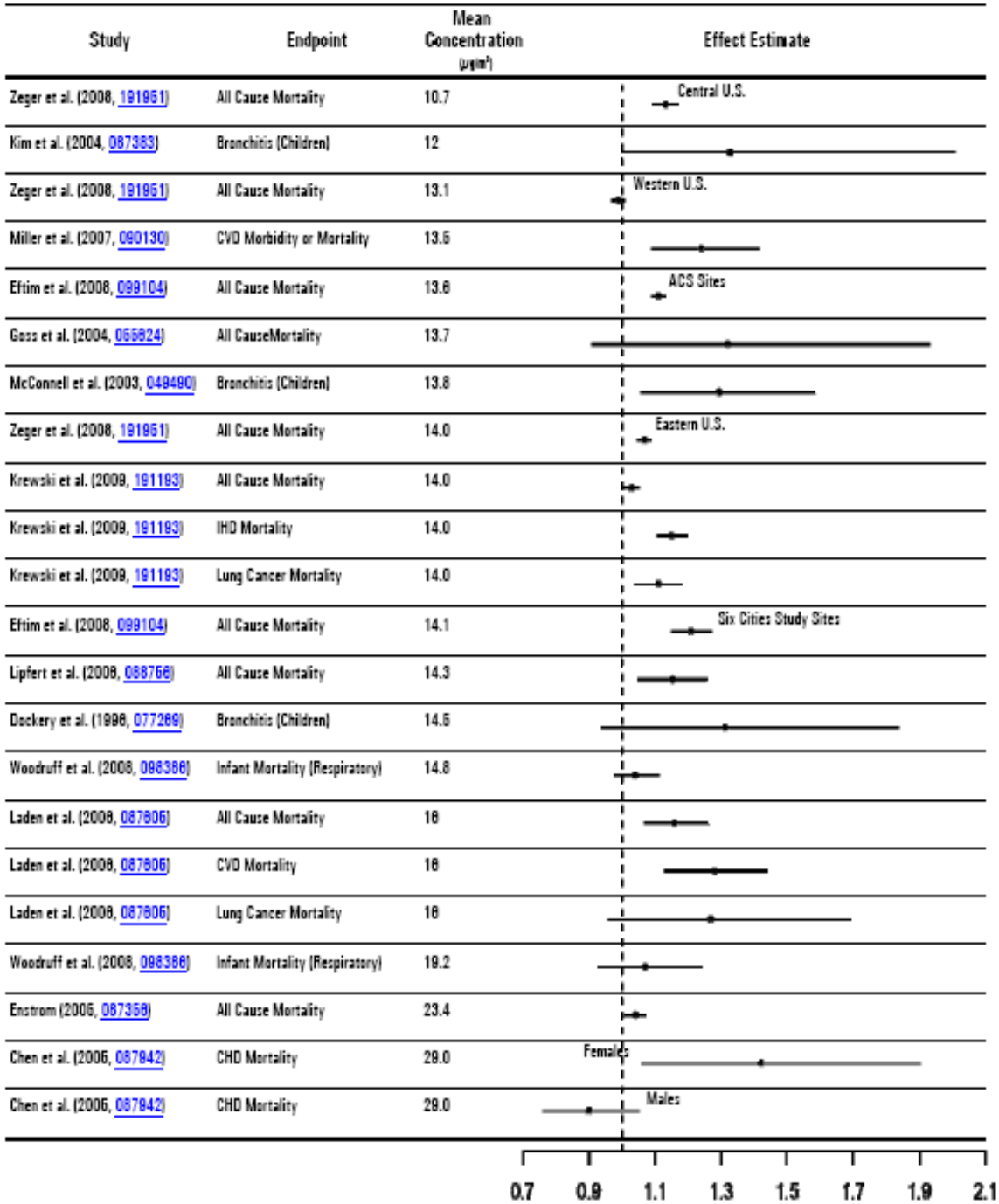
Epidemiologic Effect Estimates for Long-Term Exposures to $PM_{2.5}$

- Mean concentrations ranged from 10.7 to 29.0 $\mu g/m^3$
- Effects more precise and consistently positive with mean $PM_{2.5}$ concentrations $\geq 13.5\ \mu g/m^3$



Causality Determinations for Exposures to $PM_{10-2.5}$

Health Category	Short-term Exposure	Long-term Exposure
Cardiovascular Effects	Suggestive	Inadequate
Respiratory Effects	Suggestive	Inadequate
Central Nervous System	Inadequate	------
Mortality	Suggestive	Inadequate
Reproductive and Developmental	-----	Inadequate
Cancer, Mutagenicity, Genotoxicity	-----	Inadequate

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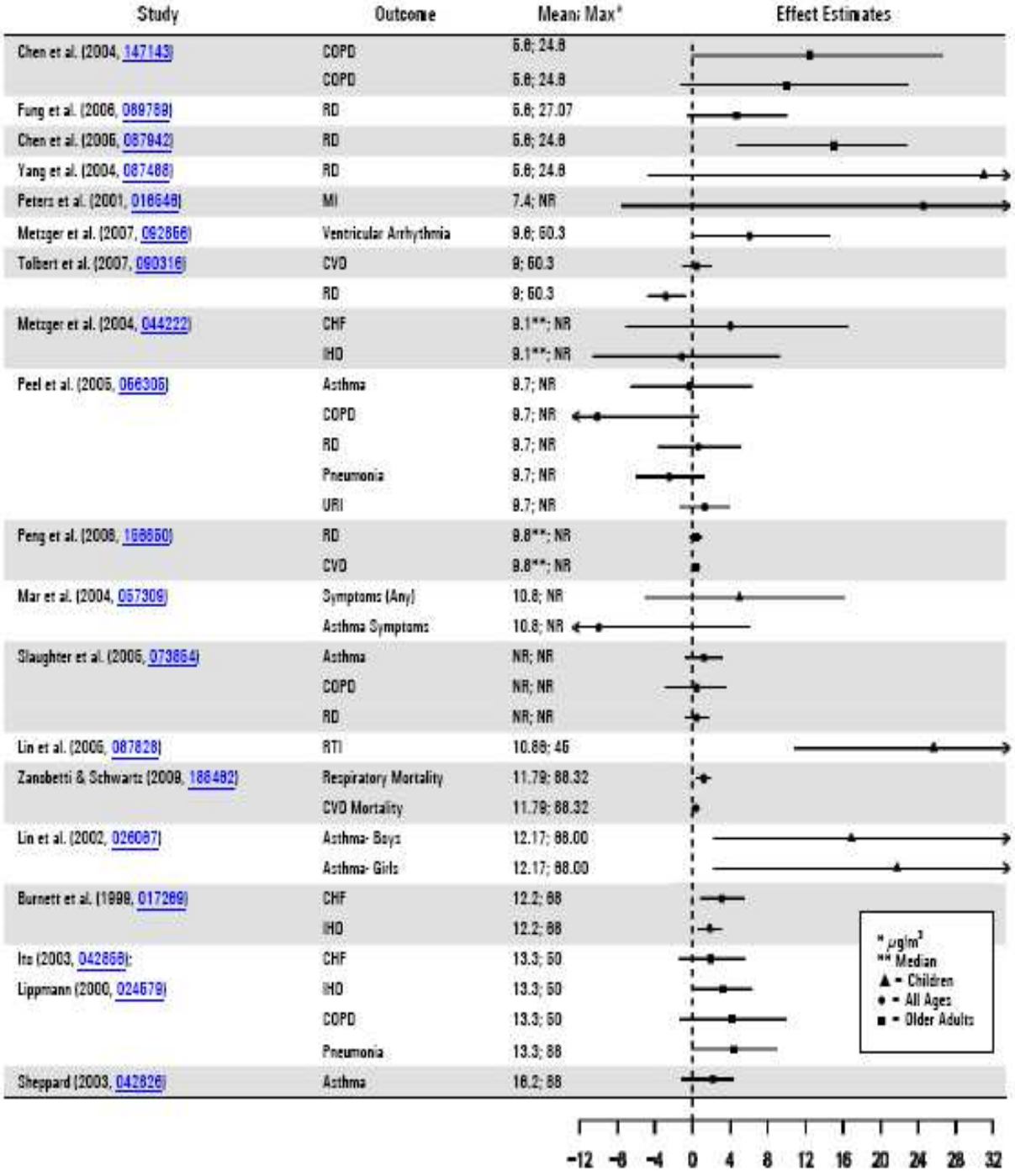
Epidemiologic Effect Estimates for Short-Term Exposures to $PM_{10-2.5}$

- Mean concentrations ranged from 5.6 to 13 μg/m³
- Of the maximum concentrations obtained, the range is 25-88 μg/m³



Causality Determinations for Exposures to Ultrafine PM

Health Category	Short-term Exposure	Long-term Exposure
Cardiovascular Effects	Suggestive	Inadequate
Respiratory Effects	Suggestive	Inadequate
Central Nervous System	Inadequate	------
Mortality	Inadequate	Inadequate
Reproductive and Developmental	-----	Inadequate
Cancer, Mutagenicity, Genotoxicity	-----	Inadequate

Causality Determinations for Welfare Effects of PM

Welfare Effect	Causality Determination
Effects on Visibility	Causal
Effects on Climate	Causal
Ecological Effects	Likely to be Causal
Effects on Materials	Causal

PM ISA Revisions
Chapter 3 (Source to Human Exposure)

- Included additional summaries of 2004 PM AQCD findings
- Reorganized size-specific sections: $PM_{2.5}$, $PM_{10-2.5}$, PM_{10}, ultrafine
- Added new elements to the discussions on PM morphology, deposition, diesel emissions, $PM_{10-2.5}$ measurement techniques and satellite measurements
- Enhanced discussion on monitoring networks and spatial scales
- Expanded discussion on ultrafine particle composition and spatial variability including near-road environments
- Added analysis of PM constituent trends and hourly variability
- Expanded modeling discussion and consolidated it into a new section
- Reorganized exposure section by spatial scale and provided additional discussion of $PM_{10-2.5}$, ultrafine PM, and multipollutant issues

PM ISA Revisions
Chapters 4 (Dosimetry) and 5 (MOA)

- Chapter 4 (Dosimetry)
  - Added section on modulation of deposition by physical activity
  - Updated section on tracheobronchial clearance
  - Added new discussion on effects of asthma, acute inflammation, and epithelial permeability to section on factors that modulate clearance
  - Added paragraph on leachable metals to clearance kinetics section

- Chapter 5 (Mode of Action)
  - Added paragraphs on ultrafine PM
  - Expanded discussions of:
    - neutrophilic inflammation
    - epithelial permeability
    - factors that affect resolution of inflammation/progression or exacerbation of disease
    - neural reflexes
    - translocation of PM or soluble PM components
    - additional gaps in knowledge
  - Added sections on epigenetics, lung development, atherosclerosis, and acute/chronic responses

PM ISA Revisions
Chapters 6 and 7 (Health Chapters)

- Refocused use of PM_{10} studies as supportive for $PM_{2.5}$ or $PM_{10\text{-}2.5}$ causality determinations
- Changed causality determinations for a few health categories
- Used morbidity and cause-specific mortality evidence for causality determinations for cardiovascular and respiratory effects
- Considered controlled human exposure and toxicological studies of fresh diesel and gasoline exhaust as part of ultrafine PM evidence, as well as $PM_{2.5}$ evidence
- Included lung cancer mortality studies and toxicological studies conducted using intratracheal instillation and dermal routes of exposure to better characterize PM cancer effects
- Added new sections on epidemiologic studies of allergic responses and host defense

PM ISA Revisions
Chapter 8 (Susceptible Subpopulations)

- Revised definition for susceptibility:
  - populations that have a greater likelihood of experiencing health effects related to PM exposure
- Reorganized discussion for each susceptibility factor to:
  - Clearly identify whether the evidence is from studies of short- or long-term exposure
  - Focus the evidence on studies that examined health effects of $PM_{2.5}$ and $PM_{10-2.5}$, while using PM_{10} studies as supporting evidence where applicable

Susceptible Subpopulations

Factor	Exposure	PM Size Fraction Evaluated
Children (< 18)[15]	Short-term	$PM_{2.5}$, $PM_{10-2.5}$, PM_{10}
Older Adults (≥ 65)	Short-term	$PM_{2.5}$, $PM_{10-2.5}$, PM_{10}
	Long-term	$PM_{2.5}$
Pregnancy and Developmental Effects	Long-term	$PM_{2.5}$
Gender	Short-term	$PM_{2.5}$, PM_{10}
	Long-term	$PM_{2.5}$, $PM_{10-2.5}$, PM_{10}
Race/Ethnicity	Short-term	$PM_{2.5}$, PM_{10}
Genetic polymorphisms	Short-term	$PM_{2.5}$
	Long-term	PM_{10}
Cardiovascular Diseases	Short-term	$PM_{2.5}$, PM_{10}
	Long-term	$PM_{2.5}$
Respiratory Illnesses	Short-term	$PM_{2.5}$, PM_{10}
	Long-term	PM_{10}
Respiratory Contributions to Cardiovascular Effects	Shot-term	$PM_{2.5}$, PM_{10}
Diabetes	Short-term	PM_{10}
Obesity	Short-term	$PM_{2.5}$
Health Status (e.g., Nutrition)	Short-term	$PM_{2.5}$
Socioeconomic Status (SES)	Short-term	$PM_{2.5}$, $PM_{10-2.5}$, PM_{10}
Educational Attainment	Short-term	$PM_{2.5}$, PM_{10}
	Long-term	$PM_{2.5}$
Residential Location	Short-term	PM_{10}

PM ISA Revisions
Chapter 9 (Welfare Effects)

9.2 Effects on Visibility

- Added new section on *Direct Optical Measurements*
- Added new section on *Value of Good Visual Air Quality*
- Several figures revised for clarity and consistency

9.3 Effects on Climate

- Expanded section on aerosol effects on climate with more details from the latest NOAA, NASA, and EPA and IPCC reports
- Described specific effects from specific size- and component-fractions in more detail
- Edited text for precision and flow
- Added more detail to climate section summary and carried through to summaries in Chapters 9 and 2

9.4 Ecological Effects

- Reorganized to focus on types of effects (i.e., direct vs. indirect) and effects of individual PM components (i.e., metals and organics)
- Added studies and revised causal determination

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HERO

Health & Environmental Research Online

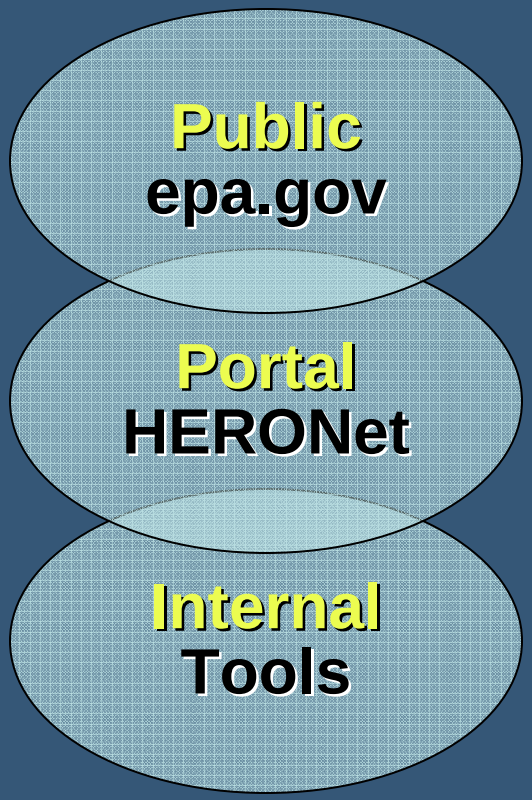
A comprehensive system to identify, compile, characterize, analyze, synthesize and prioritize scientific studies.

- Facilitates complete, sustainable and effective assessment development
- Houses citations and study data from scientific literature
- Includes studies in EPA's priority areas
- Efficient and intelligent information extraction and synthesis
- Assures the highest scientific integrity in data quality.
- Employs advanced searching and screening techniques using advanced algorithms
- Utilizes rapid and comprehensive information retrieval
- Provides transparency to stakeholders and the public

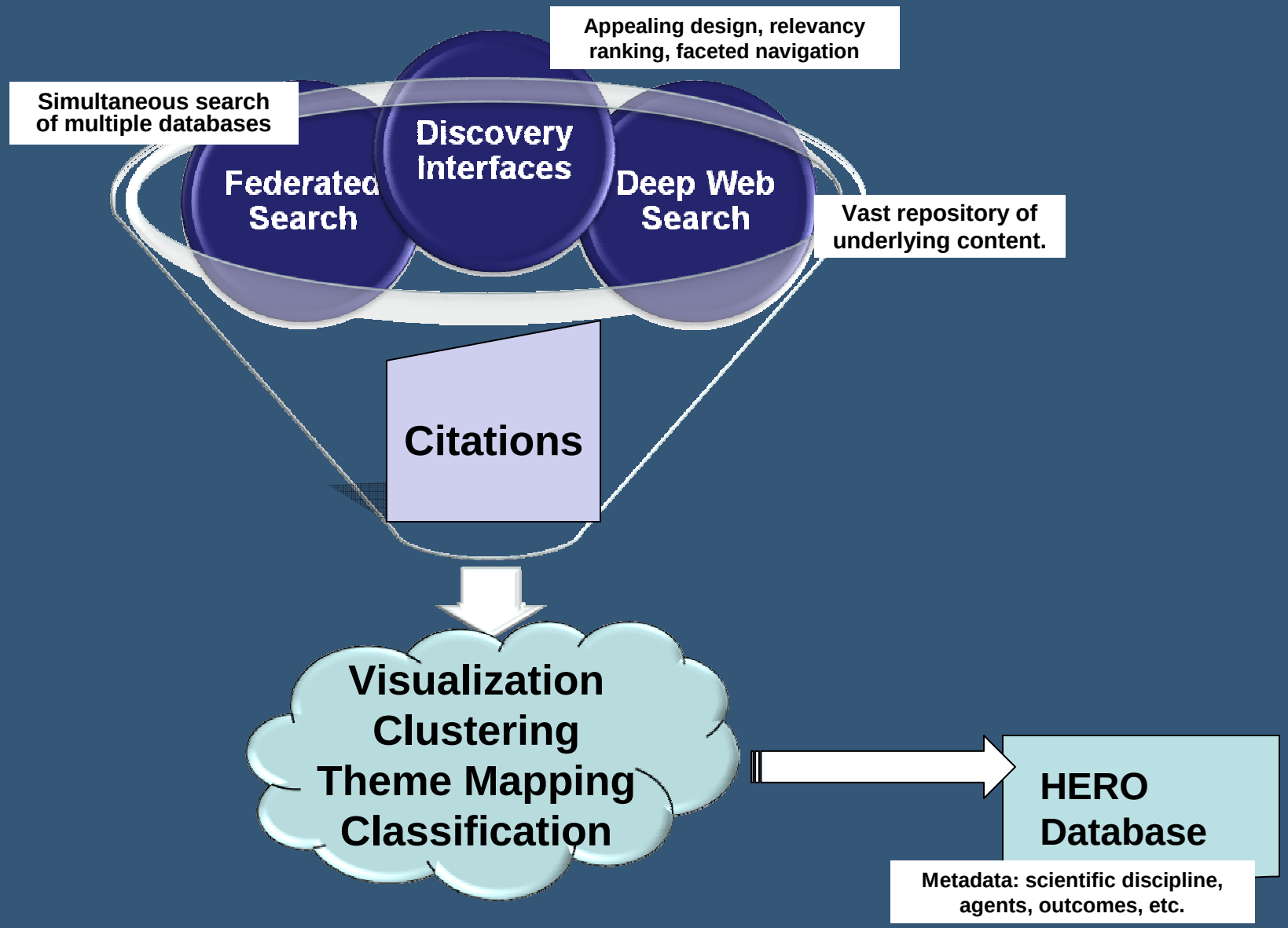
HERO Database System

Public Website

- Search references used in assessments – 105,000+
- View detailed data
- Data entry screens with QC/QA features incorporated – "LitExtractor"
- Document management for PLUS full-text PDFs
- Pre-defined reports to print or save
- Management dashboard for real-time reporting



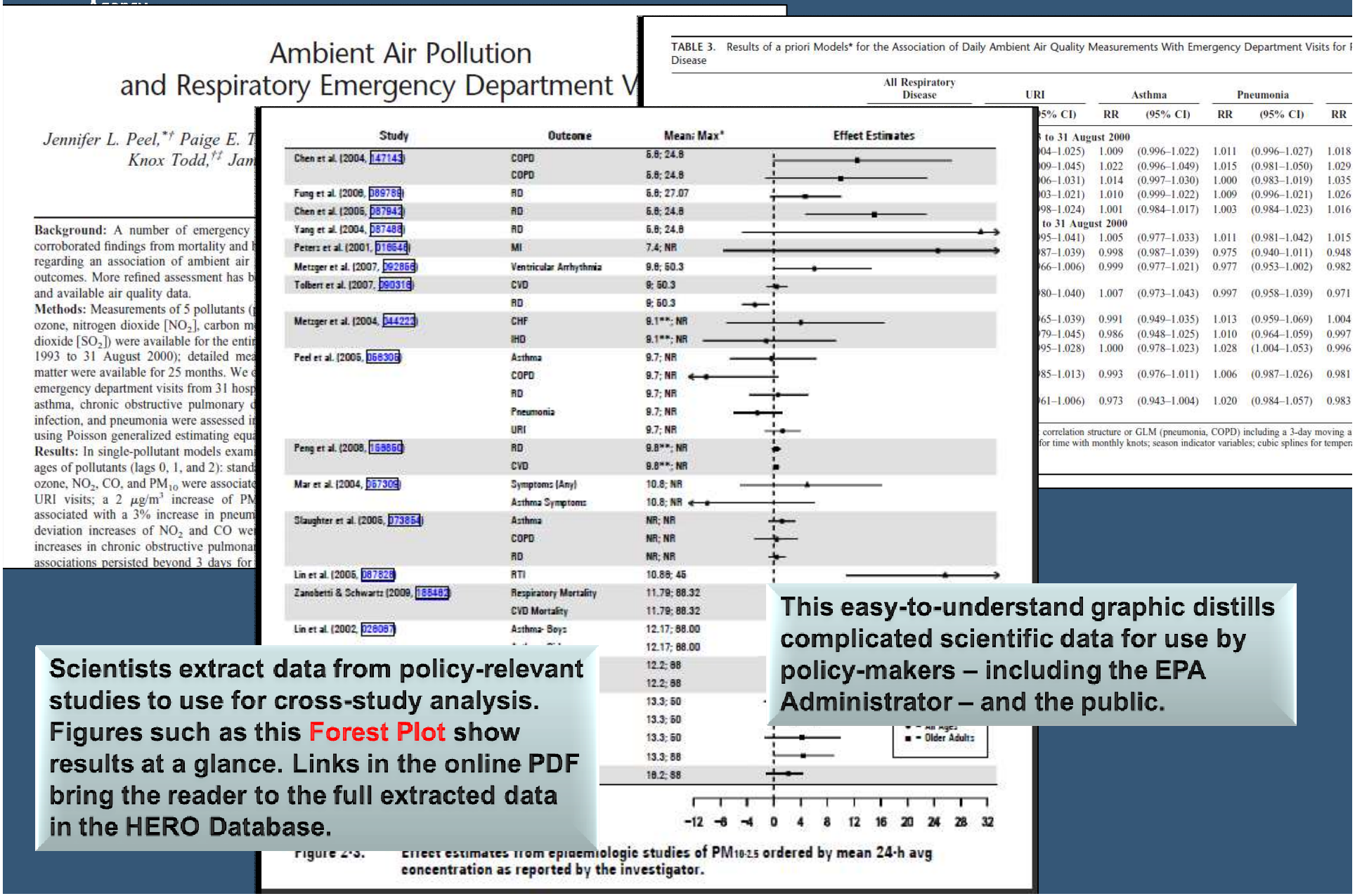
Literature Search & Screening



Details

HERO ID	156743
Author(s)	Mauad T; Rivero DH; de Oliveira RC; Lichtenfels AJ; Guimaraes ET; de Andre PA; Kasahara DI; Bueno HM; Saldiva PH
Year	2008
Title	Chronic exposure to ambient levels of urban particles affects mouse lung development
Reference Type	Journal Article
Journal	American Journal of Respiratory and Critical Care Medicine
Volume	178
Page(s)	721-728
Abstract	RATIONALE: Chronic exposure to air pollution has been associated with adverse effects on children's lung growth. OBJECTIVES: We analyzed the effects of chronic exposure to urban levels of particulate matter (PM) on selected phases of mouse lung development. METHODS: The exposure occurred in two open-top chambers (filtered and nonfiltered) placed 20 m from a street with heavy traffic in São Paulo, 24 hours/day for 8 months. There was a significant reduction of the levels of PM(2.5) inside the filtered chamber (filtered = 2.9 +/- 3.0 microg/m(3), nonfiltered = 16.8 +/- 8.3 microg/m(3); P = 0.001). At this exposure site, vehicular sources are the major components of PM(2.5) (PM
Cited In	PM 2009

Data Extraction & Analysis



Scientists extract data from policy-relevant studies to use for cross-study analysis. Figures such as this Forest Plot show results at a glance. Links in the online PDF bring the reader to the full extracted data in the HERO Database.

This easy-to-understand graphic distills complicated scientific data for use by policy-makers – including the EPA Administrator – and the public.

Agenda for PM ISA Review

9:30 am	Public Comments
10:30 am	Break
10:45 am	Charge questions 1-3
12:30 pm	Lunch
1:30 pm	Charge questions 4-6
3:00 pm	Break