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# Evaluation of Exposures to $PM_{2.5}$ Components and Health Effects: Conclusions from the 2019 Integrated Science Assessment for Particulate Matter

**Health Effects Institute Annual Meeting**

*April 29, 2020*

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# Disclaimer

*This presentation is based on information provided in the Final Integrated Science Assessment for Particulate Matter.*

# Evaluation of PM Sources and Components: PM ISA (2009)

- $PM_{2.5}$ Sources and Components
  - Evaluation of epidemiologic, toxicological, and controlled human exposure studies
  - Conclusion at that time:
    - "Many components of PM can be linked with differing health effects and the evidence is not yet sufficient to allow differentiation of those components or sources that are more closely related to specific health outcomes."
      - Subsequently detailed in:
        - *Stanek et al. (2011). Attributing health effects to apportioned components and sources of particulate matter: An evaluation of collective results. Atmospheric Environment. 45(32):5655-5663.*

# What is new since the 2009 PM ISA?

- Multiple methods being used to evaluate components – health effects relationship
  - *Mostofsky et al. (2012). Modeling the Association Between Particle Constituents of Air Pollution and Health Outcomes. Am. J. Epidemiol. 176(4):317-26.*
    1. Constituent Concentration
    2. Constituent Proportion
    3. Interaction between constituent concentration (or proportion) and $PM_{2.5}$ mass
    4. Constituent concentration adjusting for $PM_{2.5}$ mass
    5. Constituent residual
    6. $PM_{2.5}$ residual
- Since 2009 PM ISA, extensive amount of literature has examined PM components and health effects
  - HEI's National Particle Component Toxicity (NPACT) study
  - A number of single-city and multi-city epidemiologic studies
  - More limited number of experimental studies, primarily animal toxicological studies of cardiovascular endpoints

# Scope of PM ISA: Components and Sources

- Integrated Review Plan for the National Ambient Air Quality Standards (NAAQS) for Particulate Matter (Final – December 2016)
  - Details overall scope and policy-relevant questions for ISA
    - Are the current indicators (i.e., $PM_{2.5}$ for fine particles and $PM_{10}$ for thoracic coarse particles), averaging times (e.g., 24-hour average, annual average), and levels of the PM NAAQS appropriate?
      - Individual component or group of components in the context of a composite measure of PM (e.g., mass of $PM_{2.5}$ and/or $PM_{10-2.5}$, or in the case of ultrafine particles [UFP] mass, particle number, etc.)
      - For sources (e.g., diesel exhaust, gasoline exhaust, wood smoke), must apply some approach to assess the particle effect of the mixture (e.g., particle trap) for the study to be considered in the ISA

# $PM_{2.5}$ Component Concentrations and Trends

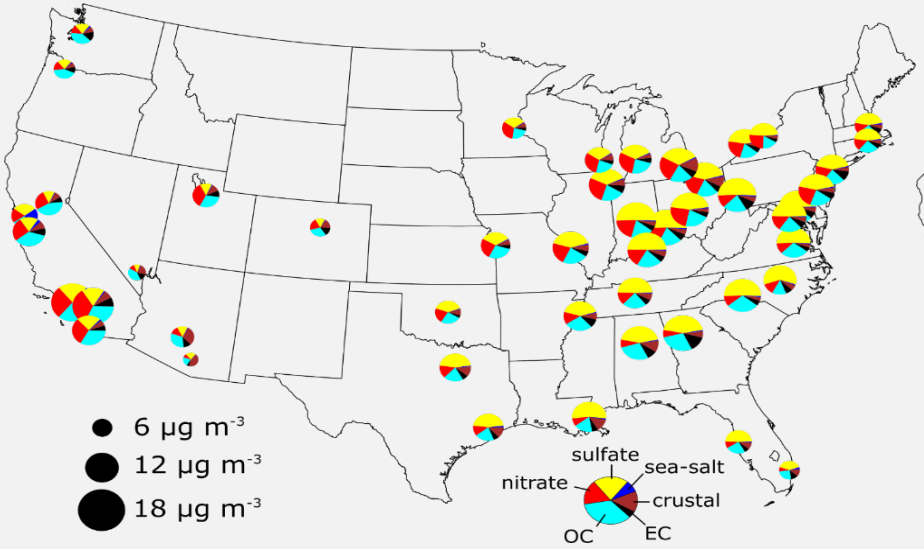



**Figure 2-25. 2003 – 2005 $PM_{2.5}$ Concentrations**

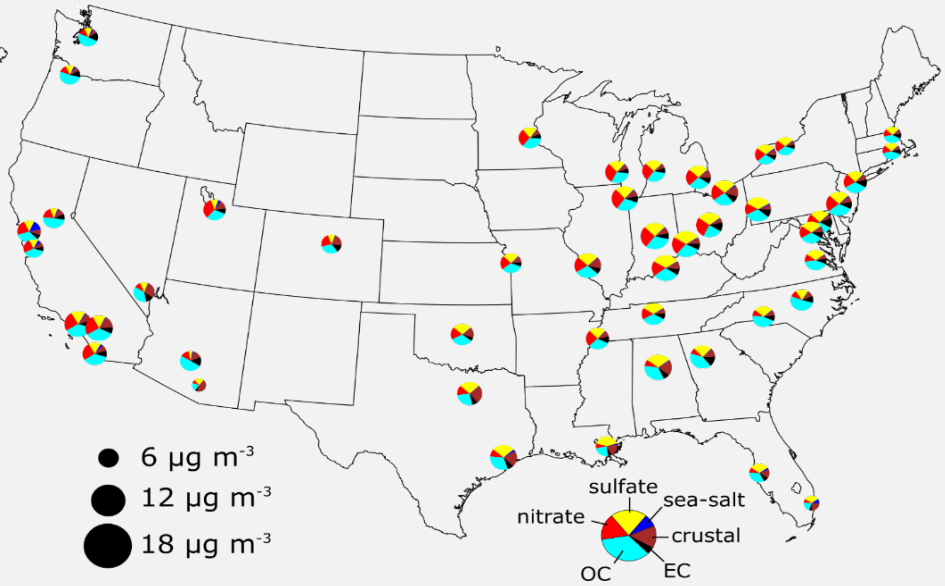
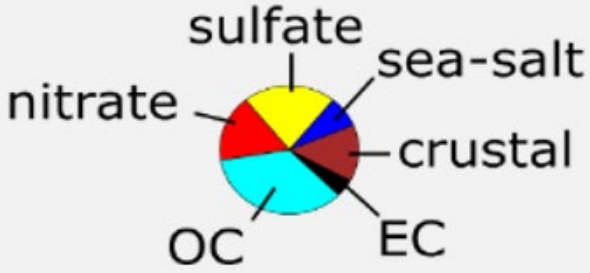



**Figure 2-26. 2013 – 2015 $PM_{2.5}$ Concentrations**




- 2003 - 2005: As % of total mass, sulfate higher in East; OC in West
- 2013 – 2015: Reduction in sulfate contribution in East; contributions similar to 2003 – 2005 in West
- Overall: Organic carbon has replaced sulfate as the most abundant component of $PM_{2.5}$ in many locations, specifically in the eastern U.S.
  - Resulting from ~65% reduction in $SO_2$ emissions

# Short-term $PM_{2.5}$ and $PM_{2.5}$ Components Exposure and Cardiovascular Effects: Hospital Admissions and Emergency Department (ED) visits – Heat Map

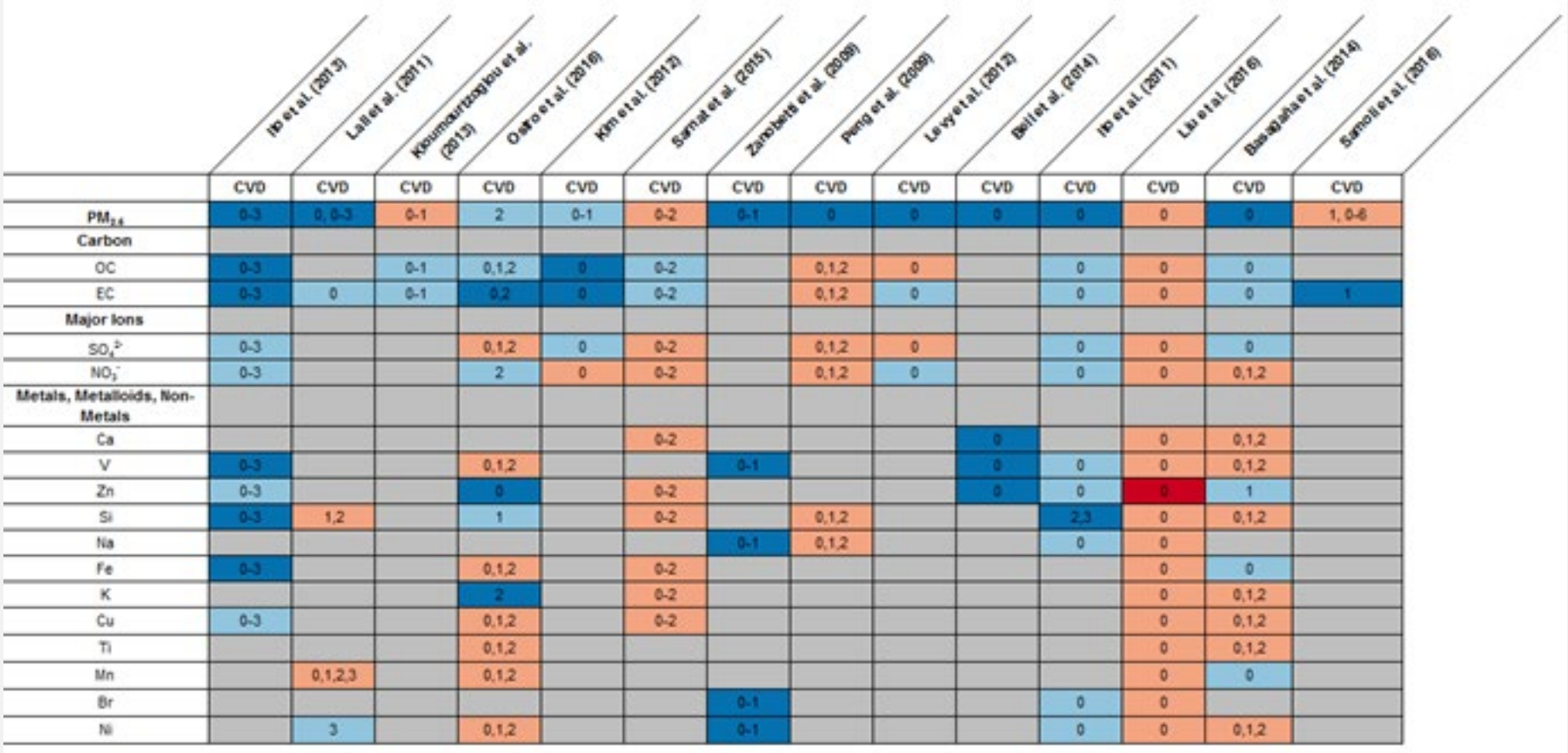



**Figure 6-14. Heat map of associations between short-term $PM_{2.5}$ and $PM_{2.5}$ component exposure and cardiovascular-related ED visits and hospital admissions.**

- Numbers represent lags for which associations observed.
- $PM_{2.5}$ mass or $PM_{2.5}$ components associations categorized by results that are statistically significant positive (dark blue), positive/null (light blue), null/negative (light orange), statistically significant negative (red), or not examined (gray).

# Short-term $PM_{2.5}$ and $PM_{2.5}$ Components Exposure and Cardiovascular Effects (cont.): Hospital Admissions and ED visits – Distribution of Risk Estimates

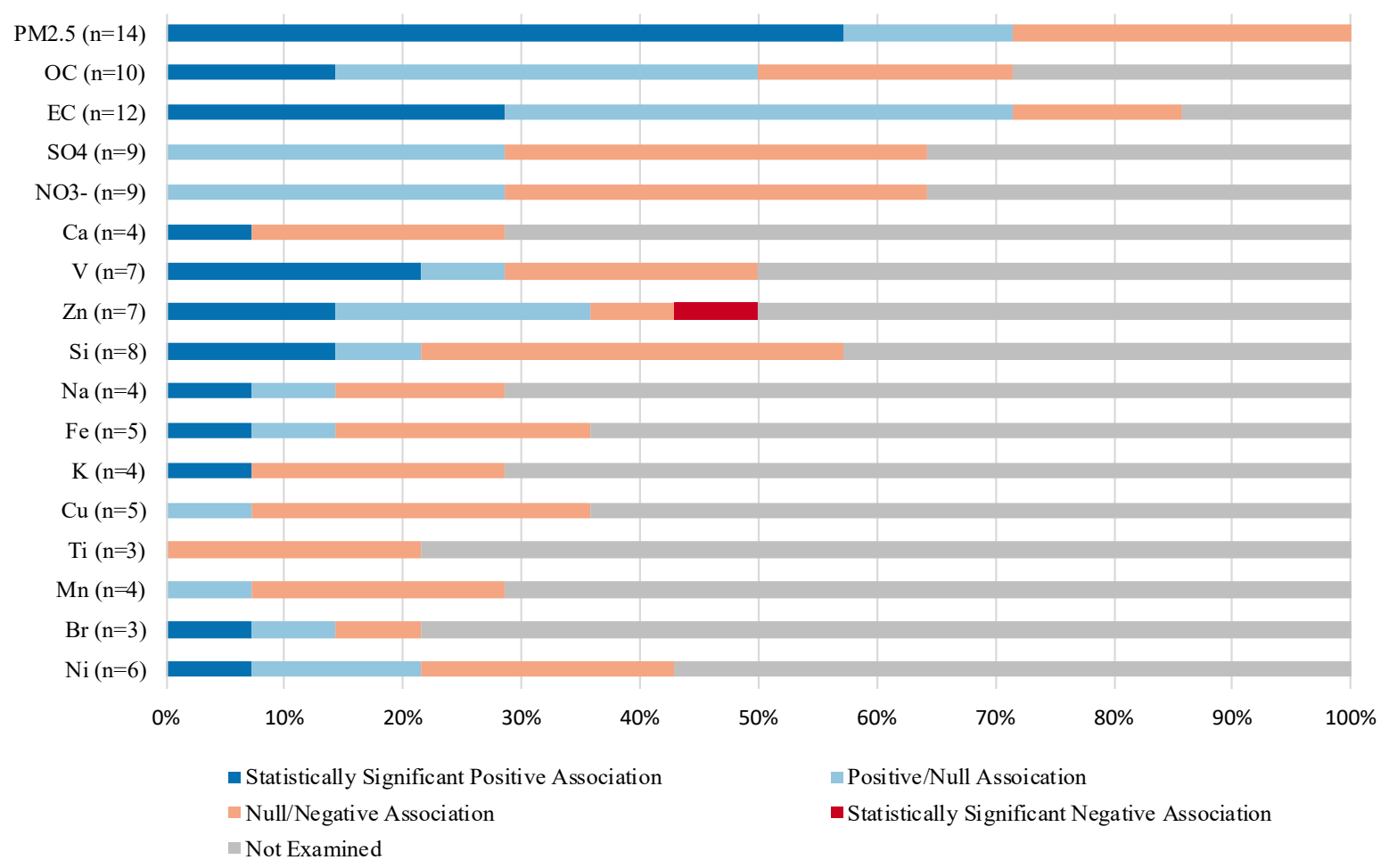



**Figure 6-15. Distribution of associations for short-term $PM_{2.5}$ and $PM_{2.5}$ component exposure and cardiovascular-related ED visits and hospital admissions.**

Bars represent the percent of associations across studies for $PM_{2.5}$ mass or $PM_{2.5}$ components that are statistically significant positive (dark blue), positive/null (light blue), null/negative (light orange), statistically significant negative (red), or not examined (gray). n = number of studies that provided an estimate for $PM_{2.5}$ mass and individual $PM_{2.5}$ components.

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# 2019 PM ISA Conclusion

- New studies build upon the evidence evaluated in the 2009 PM ISA

*"Many $PM_{2.5}$ components and sources are associated with many health effects, and the evidence does not indicate that any one source or component is more strongly related with health effects than $PM_{2.5}$ mass."*

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# Remaining Questions

- Compared to $PM_{2.5}$ mass, how has the more limited monitoring of PM components impacted our overall understanding of the relationship between PM components and health effects?
  - What are the advantages and disadvantages of the different statistical methods that have been used across epidemiologic studies to assess PM component effects?
- Should a priority be placed on PM components research or smaller size fractions beyond $PM_{2.5}$ mass?
- How have recent research efforts spanning experimental and epidemiologic studies informed our thought process on next steps for PM components?
  - Should we maintain course or is a shift in thinking needed to move away from the individual PM component assessment?
  - What currently available approaches could be used to examine combinations of $PM_{2.5}$ components? Or would new methods need to be developed?