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BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

CLEAN AIR RESEARCH PROGRAM

STUDIES EXAMINE ROLE OF COMPOSITION IN PARTICULATE MATTER (PM) HEALTH EFFECTS

Issue:

The U.S. Environmental Protection Agency currently regulates particulate matter (PM) on the basis of mass in specific size ranges. However, PM not only exists in different sizes, but each size range varies in chemical composition.

Scientists and policymakers want to know how particles vary in toxicity, depending on both size and composition, especially from sources that emit combustion by-products into the air. Are there specific chemical profiles responsible for PM-related cardiovascular and respiratory problems and possibly other adverse effects?

Science Objective:

The Clean Air Research Program in EPA's Office of Research and Development has contributed significantly to the understanding of health effects of PM and findings have been used to establish the Agency's regulations for PM.

As part of the program's comprehensive and multidisciplinary approach to studying PM, researchers are characterizing both outdoor (ambient) particles in various sizes and particles derived from varied sources. The research objectives are to identify which particles are most toxic, what attribute(s) of the particles confer toxicity, and what are the associated health outcomes.

Health scientists use a variety of research approaches including the use of samples obtained from various EPA studies. Samples are used to systematically address health questions based on cell assays, and/or laboratory and clinical studies.

The specific scientific questions with this effort include:

- What health effects are associated with PM of differing composition?
- What new biomarkers that indicate health impacts can be linked to specific PM components and associated gases that coexist with PM?
- What is the comparative toxicity of PM from different locations, and varied seasonal and climate conditions?
- What is the comparative toxicity of PM from defined sources (e.g., diesel exhaust, automotive traffic, coal emissions, ship-stack emissions, incinerators, wood smoke, etc)?
- What PM components and associated gases are responsible for differing toxicity of complex combustion emissions and how can they be used to

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link sources and processes to health effects?

Application and Impact:

EPA research provides crucial information on the toxicity of various types of PM, based on their components and sources. The studies also elucidate the mechanisms by which PM components may be linked to specific adverse health effects.

Taken together, this information improves the ongoing assessment of the current mass-based standards ($PM_{2.5}$ and PM_{10}) aids deliberations regarding the utility of component- or source-based PM regulations and control strategies.

Research has demonstrated that:

- PM toxicity varies by size and composition with both bioavailable metals and organic chemicals playing a role in the health outcomes.
- Diesel particulates obtained from different engines can have diverse chemical signatures which can affect particle toxicity, mutagenicity and allergic potentials.
- Particle-associated metals exert their toxicity in part due to their bioavailability and pro-oxidant potential.
- Size fractionated ambient (outdoor) particulate samples obtained from various cities across the United States have different chemical makeup and accompanying toxicity profiles.
- Ultrafine particles collected in Los Angeles were significantly higher in organic and elemental carbon than fine or coarse particles, and were also more potent in inducing oxidative stress in in vitro tests using mouse and human cell lines.
- Analysis of Medicare hospitalization data indicates that East-West coast differences in PM composition appear to be associated with rates of hospitalization for cardiovascular and respiratory causes.
- Analysis of data from 25 U.S. communities found an increase in mortality associated with fine PM, and the association was increased when the PM contained higher proportions of certain species, such as aluminum, arsenic, sulfate, silicon and nickel.

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