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BLACK CARBON RESEARCH AND FUTURE STRATEGIES

Reducing emissions, improving human health and taking action on climate change

Introduction

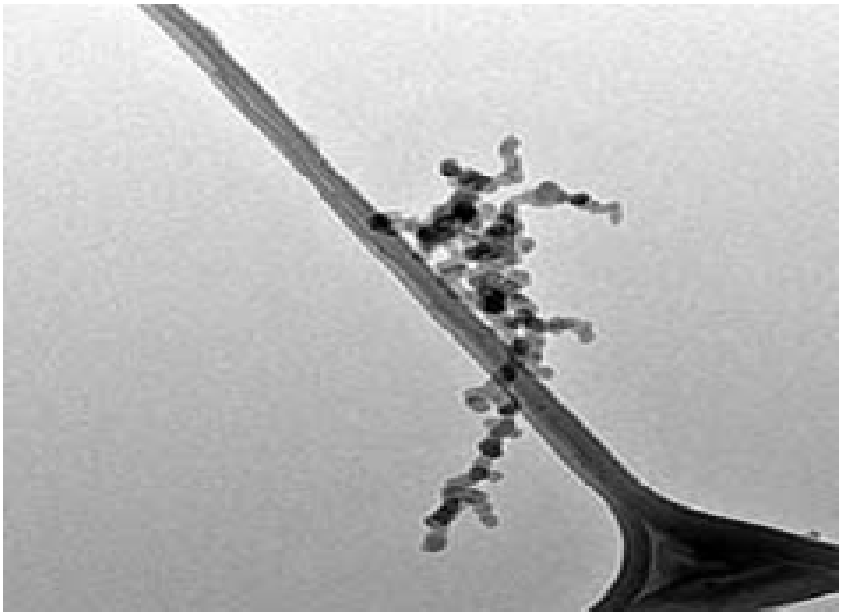
Black carbon is the sooty black material emitted from gas and diesel engines, coal-fired power plants, and other sources that burn fossil fuel. It comprises a significant portion of particulate matter or PM, which is an air pollutant.

Black carbon is a global environmental problem that has negative implications for both human health and our climate. Inhalation of black carbon is associated with health problems including respiratory and cardiovascular disease, cancer, and even birth defects. And because of its ability to absorb light as heat, it also contributes to climate change. For example, as black carbon warms the air, rapid changes in patterns of rain and clouds can occur.

This absorption quality also impacts polar ice. As black carbon deposits in the Arctic, the particles cover the snow and ice, decreasing the Earth's ability to reflect the warming rays of the sun, while absorbing heat and hastening melt.

This broad and complex role of airborne black carbon is now under intense study by the EPA. Scientists are conducting integrated and multidisciplinary research to improve our understanding and determine more clearly the role of black carbon in air pollution and climate change and how we might reduce its emissions and impacts.

The black carbon research initiative includes in-house research and research by grantees at universities.



Diesel exhaust black carbon particle (500 nm). Photo by NASA.

Nine EPA STAR Research grants, totaling more than $6.6 million, were announced in October 2011 to eight universities to research black carbon. The grantees will further research the pollutant's emission sources and its impacts on climate change and health.

Measurement Research

EPA scientists are working to improve ways to measure black carbon, learn more about its composition and compare its impacts relative to other airborne particles.

Researchers are:

- Studying how particles absorb and scatter different wavelengths of light
- Measuring black carbon's mass and if other particles adhere to black carbon
- Evaluating low-cost and palm-sized black carbon instruments that may give a wider range of measurements.

New black carbon measurement methods have been tested in laboratory and field studies using EPA's Geospatial Measurement of Air Pollution (GMAP) mobile sampling vehicle. GMAP evaluates air quality by measuring near roadway emissions.

Modeling Research

Models developed by EPA researchers simulate black carbon, as well as other particles, in the atmosphere and are used to examine

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possible scenarios of future air pollution.

One such model developed by EPA is called the Community Multiscale Air Quality (CMAQ) model. It uses fundamental emission data, including that of black carbon, and atmospheric chemistry reactions to describe air pollution within the continental U.S. It provides information similar to a weather forecast map.

Another model developed by EPA, called GLIMPSE, simulates every continent's air quality to study climate change. It enables scientists to look at ways to reduce air pollutants, including black carbon emissions, within each continent and across continental boundaries with the goal to minimize both climate change and public health impacts.

Health Effects Research

In the PM family, black carbon is a major contributor to the fine particle ($PM_{2.5}$) burden in the air. It is small enough to be easily inhaled into the lungs and has been associated with adverse health effects. Whether black carbon is itself toxic or functions as an indicator of other co-pollutants is currently under debate. But, clearly, black carbon is *associated* with asthma, and other respiratory problems, low birth rates, heart attacks and lung cancer. EPA scientists study the effects of particles including black carbon on human health through clinical and animal testing.

Using human and animal exposure data, researchers can estimate the amount of black carbon deposited into lungs under a variety of breathing conditions. When compared with lung tissue samples from coal miners, smokers and nonsmokers, correlations and predictions can be drawn between the exposure and potential risk of adverse lung outcomes. Such research has contributed to global awareness of black carbon's health effects.

Research to investigate children's asthma in Detroit, Michigan, is examining the impact of diesel exhaust from roadways. As part of this research effort, the Near-Road EXposures to Urban Air Pollutants Study (NEXUS) is evaluating the impact of vehicle emissions, including black carbon, on near-road exposures and asthma outcomes.

Similarly, controlled clinical studies in adults are being conducted to examine the health effects from exposure to different air quality scenarios: diesel exhaust, clean air, ozone, or a mixture of diesel exhaust and ozone.

Peat-burning wildfires, as occurred in a large wildfire in the summer of 2008 in rural eastern North Carolina, released enormous amounts of PM, especially black carbon, which were linked to increased risk of heart failure and respiratory hospital visits in the affected region.

EPA research will continue to evaluate the health effects wildfires, involving black carbon, have on disadvantaged groups.

Cook Stove Initiative

Almost 2 million deaths a year are caused by the use of indoor cook stoves worldwide, according to the World Health Organization. That's more deaths per year than malaria. Burning wood, dung or coal in cook stoves emits substantial amounts of black carbon.

A five-year cook stove research initiative by EPA will work to find efficient solutions to reduce exposures to black carbon and thus the resulting health effects. This research will include tests on different stove types and fuels to find better alternatives and guide future stove developments. It will also help inform international efforts to reduce black carbon emissions and human exposures.

Health effects and exposure from cook stoves will be studied through clinical, cell and animal studies. Such tests will be used to further define black carbon's role in disease and to improve risk assessments.

Research findings and technical support will be provided to other EPA offices, the Global Alliance for Clean Cookstoves (GACC), the Partnership for Clean Indoor Air (PCIA) and other partners to set global standards for cleaner stoves and fuels and improve current stove designs while taking socio-economic costs into account for those affected.

Black carbon research is being conducted on many fronts to improve understanding of this tiny carbon particle.

REFERENCES:

STAR GRANTS:
http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/recipients.display/rfa_id/533/records_per_page/all

COOK STOVE:
http://www.epa.gov/research/sciencematters/august2010/cook-stoves.htm

CONTACT: Dan Costa, Sc.D., Interim National Program Director, 919-541-2532 costa.dan@epa.gov

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