In 2009, Congress asked the U.S. Environmental Protection Agency (EPA) to study black carbon (BC) to improve our understanding of the air pollutant. The agency’s report to Congress in 2012 summarized the extensive scientific review of BC, and highlighted areas where more research is needed.

Black Carbon Research at EPA

The station used to test blended biomass fuels and study combustion conditions at EPA’s Multipollutant Control Research Facility in RTP, NC.
Black carbon emissions are associated with adverse health and environmental effects, visibility impairment, and have been linked to a range of direct and indirect climate impacts. It is created by the incomplete combustion of fuels and is emitted in the form of fine particles.

EPA’s Office of Research and Development is addressing some of the scientific uncertainties through an interdisciplinary research program. The research group, led by researcher Mike Hayes at EPA's Multipollutant Control Research Facility in Research Triangle Park, NC, and field locations, is focused on identifying ways to better measure and characterize BC and exploring new control and removal technologies to reduce emissions.

Currently, BC is measured using a variety of techniques, which can generate a variety of results for the same air sample. One of the major difficulties of measuring BC stems from the fact that there are many different ways to measure the pollutant depending on what aspect is being studied, the combustion source, what measurement methods are being used, and what co-pollutants might be included in the sample.

To address this challenge, EPA researcher Amara Holder is measuring and characterizing emissions of fine particles from a variety of combustion sources, including gasoline vehicles, diesel generators, coal combustion, waste gasification, forest fires, and agricultural burning. She has been working with the National Institute of Standards & Technology and the International Bureau of Weights and Measurements to develop criteria for a BC standard that can be used to harmonize the many BC measurement methods.

Improved BC measurements could complement research being done on co-pollutants and other emissions. Researcher Mike Kosusko is head of the working group aiming to include BC data into the EPA inventory of air pollution source profiles, SPECIATE's v. 5.0. The database is designed to help provide a more complete picture of pollutant sources, and there is an opportunity to include BC optical properties into the system in the future.

In an effort to identify ways to mitigate emissions, EPA researchers are studying the combustion sources such as diesel engines. Diesel engines are regulated by EPA to reduce emissions of hazardous air pollutants and other air pollutants, including BC. Emissions from diesel engines were classified as a carcinogen by the World Health Organization in 2012.

EPA researcher Tiffany Yelverton is currently studying pre- and post-combustion control technologies for reducing BC emissions from stationary sources such as diesel generators. One pre-combustion approach is to use blended fuels (a combination of diesel fuel and alternative fuels such as dimethyl ether) in retrofitted engines developed to run on blended fuels. In this case, different combinations of fuels and controls are being tested to better understand the combustion process and how emissions change. This research will help determine if BC is present in emissions from different fuels, what instruments can measure pollutant emissions, and what control devices might be best suited for retro-fitting the engine.

Reducing the amount of BC and other pollutants being emitted could also occur at the combustion level. Co-investigators Bill Linak and C.W. Lee are using reactors and furnace technologies to study how pollutants form and are distributed during a process called oxy-fuel combustion, and investigating techniques to minimize their generation.

Oxy-fuel combustion is one promising technology to capture carbon from utility and industrial combustion systems (e.g., coal-burning power plants) for later use and storage. This type of combustion uses oxygen and recycled flue gas from earlier reactions to remove nitrogen, while controlling the temperature and heat transfer involved. By removing the nitrogen and using recycled gas, the resulting exhaust gases contain large amounts of carbon dioxide that are easier to capture.

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aviation. Researcher John Kinsey has led this effort, developing a test for the particulate matter emissions from airplanes, which is comprised mostly of BC. The final document from the project will be released in 2019.

EPA’s Science to Achieve Results (STAR) research program has funded 10 BC research projects that complemented the work being done at the Research Triangle Park facility. Grant recipients engaged in a variety of BC projects such as better accounting for emissions and uncertainty, tracking how BC “ages” or reacts in the atmosphere, and better representing its ability to impact cloud droplet formation.

The measurement and emissions research at EPA is advancing the science on BC and closing the gap in understanding of the uncertainties in BC emissions. Research results will be used to improve air quality and climate models and emissions inventories and ultimately can be used to make more informed decisions to protect public health and the environment.

Learn More

- BC research grants: https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/recipient.display/rfa_id/533
- About BC: (https://www3.epa.gov/airquality/blackcarbon/)

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