NC BREATHE CONFERENCE
April 8, 2016 Charlotte

Conference Report

Clean Air Carolina
Your advocates for healthy air

UNC CHARLOTTE

MAHA
Medical Advocates for Healthy Air

Environmental Health Scholars Program

Fred and Alice Stanback

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Executive Summary

The NC BREATHE conference provides an interactive forum for North Carolinians to share the latest research related to the impacts air pollution has on human health, the environment and the economy, and to discuss the critical role policy making plays in improving air quality. At the 2016 conference, nearly 200 participants from across the Carolinas and the Southeast gathered to discuss and consider specific air pollution issues and solutions. The plenary talks provided an overview of air pollution effects, while breakout sessions focused on major air pollution issues affecting Carolinians. The sessions touched on three themes: health and economics, air pollution trends and emissions and emerging research and technology.

The health and economic sessions encompassed heart health and the economics of clean air policy making. The heart health session provided evidence that fine particulate matter is a major and modifiable contributor to cardiovascular disease and that through clean air policy making, mortality rates from heart attack and stroke can be reduced. The US Environmental Protection Agency (EPA) has now prioritized educational programming related to air pollution and heart health. The economics of clean air policy making session highlighted how North Carolina takes into consideration the cost to industry to reduce emissions, but not the health care costs associated with pollution borne by the general public. Legislators need to understand and weigh the cost and benefits to consumers when considering environmental regulations.

The air pollution emissions sessions covered carbon emissions, confined animal feeding operations (CAFOs) and diesel exhaust. The carbon emissions session established that while some carbon emissions can have a greater impact than others, all of them are important and should be addressed in policy and decision making. The CAFO session concluded that passing appropriate legislation is necessary to protect the health of individuals living near the operations. The diesel exhaust session indicated that vehicle fleet turnover is the most effective way to reduce diesel emissions and more grant funding is needed to accelerate this turnover.

The emerging issues sessions looked at the state of air quality, citizen science, and research and educational initiatives. The state of air quality session noted that in 2015 North Carolina achieved compliance with federal air pollution standards and that small improvement in air quality can have a major impact on survival rate. The citizen science session demonstrated innovative ways to measure air pollution locally by involving the community and building social capital. The research and educational initiatives session described a variety of North Carolina-based projects from ozone research in the Great Smoky Mountains National Park to air awareness programs at the university level and in our cities.

The 2016 conference provided important key outcomes and insights on how to improve and understand air pollution, health, economics, and policy making by reforming the legislative process, utilizing emerging technologies and educating the public and policymakers about air pollution.

Plenary Sessions

Air Pollution and Health: Recent Findings and Next Steps, Antonella Zanobetti, Ph.D.

Ambient particulate matter (PM) is a serious health concern. In 2010, PM was responsible for 3.2 million excess deaths globally. There are three types of PM: coarse (particles between 10 and 2.5 microns, PM_{10}), fine (particles between 2.5 and 0.1 microns, $PM_{2.5}$) and ultrafine (particles less than 0.1 microns, $PM_{0.1}$). The association of particulate air pollution and mortality is well established. $PM_{2.5}$ has been shown to be the most harmful to human health, causing oxidative stress, systemic inflammation and cerebrovascular dysfunction. There is an increased interest in the effect of air pollution on the central nervous system and neurodegeneration. Primary sources of particles are directly emitted from fuel combustion, industrial activities, fires and during construction. Most particulate matter is derived from secondary sources formed by complicated reactions in the atmosphere stemming from chemical emissions from power plants, automobiles and industry activity. The challenge is identifying and quantifying the influence of these particles on human health. Moving forward, it is important to improve exposure assessments and estimate health effects to protect human health.

How Do We Measure the Benefits of Improving Air Quality?, Christopher Timmins, Ph.D.

Clean air represents a public good in the study of economics. Because clean air is non-excludable and non-rivalrous, it's true value to society can be difficult to determine. Cost-benefit analysis provides an important avenue through which economic theory and practice can influence environmental policy. Cost-benefit analysis monetizes and quantifies all benefits from a regulation for consistent comparison with costs and impact. Environmental regulations have not only led to improvements in environmental and human health, but have also been very economically beneficial. This is especially true with 1990 Clean Air Act Amendments, where costs of $65 billion have been exceeded by $2 trillion in benefits in reduction of mortality, asthma exacerbation, emergency room visits and improved productivity from reduction in lost work days. Adding up these diverse improvements suggest very large total benefits. Cost-benefit analyses are important tools, but understanding the underlying assumptions is also critical.

Connecting Air Pollution, Climate Change, Energy, and Health, Jason West, Ph.D.

Air pollution and its health impacts are changing globally and will change in ways interrelated with climate change. The global burden of air pollution accounts for 5.5 million deaths per year, roughly 10 percent of global morbidity. Air pollution from ambient particulate matter and ozone, combined with indoor sources from solid fuel burning, accounted for more deaths in 2013 than alcohol and drug use, obesity and unsafe water and sanitation. Technological advancements in air pollution science offer new possibilities: new measurement methods for monitoring chemical components, cost effective sensors that can be widely deployed by scientists with the help of citizen scientists, improvements to satellites and further advancement in big data driven computer models. Global abatement of greenhouse gas (GHG) emissions bring substantial air quality and human health co-benefits, indicating an average monetized co-benefits of $50-380 per ton of carbon dioxide. The direct co-benefits from air pollutant emission reductions exceed the cost of slowing climate change.

Breakout Sessions

Clean Air and Heart Health

While most people tend to associate air pollution with asthma and other respiratory conditions, research has long shown that exposure to particle pollution plays a key role in cardiovascular disease and stroke. Three national experts in the field of air pollution research and heart health shared their latest research on this topic, which has implications for physicians, patients and policy makers.

Key Outcomes

- Exposure to fine particle pollution ($PM_{2.5}$) contributes to cardiovascular and cerebrovascular morbidity and mortality through a number of mechanisms, including systemic inflammation and subsequent malfunction of blood vessel contraction and dilation.
- Research shows that North Carolina's landmark 2002 Clean Smokestacks Act resulted in significant pollution reductions from coal plants and saved over 7,500 lives of people 65 or older.
- Cardiovascular disease patients and those at high risk need to be educated about the health risks of air pollution and provided with recommendations for reducing exposure.

Presentations

Air Pollution and Cardiovascular Disease, Antonella Zanobetti, Ph.D.

Air pollution can cause acute and chronic adverse health effects, such as cardiovascular and respiratory mortality, and morbidity and neurodegeneration. People with diabetes, the elderly and people who have been hospitalized previously are at higher risk. The American Heart Association has deemed $PM_{2.5}$ exposure a modifiable factor that contributes to cardiovascular morbidity and mortality.

EPA's Healthy Heart Toolkit and Research, Wayne Cascio, M.D.

Exposure to air pollution is responsible for 60,000 premature deaths in U.S. per year and more than 100 million people live in areas where pollution exceeds the national standards. The EPA has created the Healthy Heart Toolkit to educate medical providers and the public about the risks of air pollution exposure and strategies for reducing exposure.

Improving Air Quality and Reducing Deaths in N.C., Kim Lyerly, M.D.

Generally death rates and hospitalizations are measured, but not the quality of health. Cardiovascular and cerebrovascular diseases, associated with air pollution exposure, are leading causes of death in North Carolina. Using statistical data, Lyerly and colleagues have been able to estimate that over 7,500 lives of people over age 65 were saved due to pollution reduction following the implementation of the 2002 Clean Smokestacks Act.

Economics of Clean Air Policy Making

This breakout session provided an overview of both the current Federal and State approaches to valuing public health and welfare in the air quality regulatory development; compared Federal and State processes; and discussed whether the state of North Carolina satisfactorily values the impacts and benefits of future air quality rules for both the regulated community and the public.

Estimates of the benefits and costs of air quality rules are typically derived by examining the differences in economic, human health and environmental outcomes under two alternative scenarios: a “control scenario” and a “no-control scenario.” Each of the two scenarios is evaluated through a sequence of analyses that consider economics, emissions estimates, air quality impacts, human health and welfare effects and uncertainty. The results of the analyses for the two scenarios are then considered by policy makers to help make informed choices regarding air quality regulations.

Key Outcomes

- The economics of human health should play a more pronounced role in state environmental legislation, policy and regulation. Quantification of health impacts is a prominent practice in federal air quality rulemaking.
- Public policy can be better informed by increasing i) staff’s access to scientific and health economics data, ii) the number of qualified economists to perform public health cost-benefit and fiscal analyses, and iii) guidance to policy decision-makers on weighing results of cost-benefit analyses.
- Achievable, effective air quality policy actions include i) suspending the mandate for readoption/repeal of air quality rules, ii) reducing the burden and complexity of the rulemaking process, and iii) reducing fine particulate matter emissions.

Presentations

Estimating the Benefits of EPA's Air Pollution Regulations, Amy Lamson, M.P.A., M.S.E.S.

Cost benefit analysis is required under two executive orders and the Clean Air Act encourages economic information when making decisions, but does not allow it to be considered for all decisions. The Benefit Mapping and Analysis Program (BENMAP) aids in analyzing the health benefits and impacts of pollution.

Benefits of Regulating Air Pollution in North Carolina, Mary McLean Asbill, J.D.

Recently many environmental regulations have been reduced or removed due to stipulations in the rulemaking process that requires economic factors to be considered. It is important to understand how to quantify environmental regulation benefits to demonstrate their value and need.

NC Experience with Regulating Air Pollution in N.C., Anca Grozav, M.P.P.

Regulatory impact analysis helps understand the realistic consequences of a set of permanent rules considered for adoption. The document is called a fiscal note and is used by the the Office of State Budget and Management (OSBM) to inform decision makers and the public. However, OSBM faces several challenges when preparing fiscal notes: insufficient staff, analysis is sometimes done after a decision is made, data is not easily accessible, disproportionate focus on cost because it is easy to quantify and few public comments are received.

Thumb on the Scales of Justice, Ryke Longest, J.D.

The policymaking process has become increasingly complex as more and more resistance to environmental policy has surfaced. In contrast, it has become easier to reduce and remove environmental regulations due to specific statutes and bureaucratic operations in the rulemaking process. It is important to understand the process in order to reform the policy making process and ensure legislators understand the benefits of environmental regulations.

Reducing Carbon Emissions

The panel discussed the ancillary benefits of reduced emissions of greenhouse gases as stipulated for individual states by the EPA's Clean Power Plan and currently under review by the US Supreme Court. This is the basis of the US commitments articulated at the United Nations COP-21 Conference in Paris. The benefits and costs of using forest biomass as a potentially carbon-neutral energy source to replace coal in North Carolina was discussed. An update on North Carolina's Climate Ready NC Program, part of a national public health effort to anticipate and prepare for human health effects related to global and local climate change, was presented.

Key Outcomes

- North Carolina health officials have highlighted fine particle pollution ($PM_{2.5}$) as an important factor in our state's ability to address health vulnerabilities associated with climate change.
- The EPA's Clean Power Plan relies on a federal-state partnership to reduce carbon pollution from the biggest sources – existing power plants.
- Biomass is an energy source growing in use, but more research is needed to determine its ability to reduce greenhouse gases.

Presentations

Climate Ready N.C. Program, Lauren Thie, M.S.P.H.

Climate Ready NC mapped North Carolina climate vulnerability through 2025, which indicated that efforts should focus on fine particulate matter ($PM_{2.5}$), air quality awareness and smoke dispersion. One of the focal efforts for Climate Ready NC is high temperatures since they are highly correlated with poor air quality and health (i.e., heat stroke) and environmental issues (i.e., wildfires). The NC Heat Health Vulnerability Tool is a new collaboration with EPA created to help monitor heat vulnerability.

EPA's Clean Power Plan, Terry Johnson

As part of the Clean Power Plan, EPA is acting and promoting a variety of actions to reduce greenhouse gases (GHGs). EPA is collecting various types of GHG emissions data and promoting consistencies in inventories; reducing GHG emissions by promoting a clean energy economy with public-private partnerships and regulatory initiatives; and engaging the private sector through voluntary climate programs. EPA is also striving to reduce its own footprint.

Biomass and Greenhouse Gas Reductions, Justin Baker, Ph.D.

Biomass is biogenic material, forestal material, and construction debris. Biomass is an important energy component that could help reduce GHG emissions. Biomass use for energy production has been increasing with the industrial sector consuming the most. Research on GHG emissions and biomass is a growing area. Future biomass demand will depend on policy and market forces.

Additional Policy Implications, Jason West, Ph.D.

Various sectors affect GHG emissions differently, so policies have to be targeted at specific sectors such as transportation. China is the world's biggest producer of carbon dioxide followed by the US, European Union, India, Russia and Japan. GHG emissions and climate change are local and global issues, so international policies and collaborations are important.

Concentrated Animal Feeding Operations

North Carolina is home to 9.7 million hogs and 2,310 permitted hog waste facilities (CAFOs). Many of these are located in Duplin, Sampson, Bladen and Wayne counties. Residents living in areas where facilities are located are impacted by emissions of ammonia, particulate matter, sulfur dioxide, and methane. Unfortunately, these facilities are exempt from many of the Clean Water Act, the Clean Air Act, Community Right to Know laws and animal cruelty regulations. Experts in this session shared the latest scientific and health research on the impact of hog waste on human health and the environment. The challenging policy environment was also presented with priorities for policy change.

Key Outcomes

- Increased health services and programs are needed for communities living near confined animal feeding operations to address illnesses associated with air emissions and soil and groundwater contamination.
- Although the Clean Air Act is designed to protect public health from air pollution emissions from stationary sources, regulatory agencies have failed to enforce the law against CAFOs. More advocacy is needed at the state level and through other federal laws to change current practices of hog waste disposal. Litigation, while costly, may be needed, and additional incentives are needed to help farmers reduce and control emissions.

Presentations

The Effects of Hog Waste on Human Health, Julia Kravchenko, M.D, Ph.D.

Hog waste has been shown to cause a variety of health issues. Studies show the odor correlates with depression, fatigue, decreased immune function, wheezing, decreased neurobehavioral function and higher blood pressure, while waste discharge may lead to infections and antimicrobial resistance. Emissions have been linked to upper respiratory diseases, such as tuberculosis, asthma and chronic bronchitis. Better medical resources, children's adverse health prevention programs, and other resources are need to improve health in communities near CAFOs.

The Effects of Hog Waste on the Environment, Viney Aneja, Ph.D.

The transportation involved with hog farming and the confinement of hogs leads to harmful chemicals such as ammonia, methane, pesticides, volatile organic compounds, eutrophying substances and carbon dioxide being emitted into the air. These chemicals can lead to decreased visibility, acidic precipitation, nitrogen deposition and nitrogen cycle perturbations, which can destroy soils and

watersheds leading to further negative consequences. It is important to learn to coexist with CAFOs by passing effective laws controlling hog waste emissions.

Policy Opportunities for Improving Health, Michelle Nowlin, J.D.

Respiratory health effects of CAFO emissions on neighboring communities are well-documented and understood. Recent studies raise additional concerns associated with antibiotic resistant bacteria and greenhouse gas emissions from waste management practices. Increased global meat consumption, land clearance and other activities exacerbate and add to these concerns. Laws such as the Clean Air Act are designed to protect those affected by CAFO emissions, but exemptions and a lack of enforcement have excluded many CAFOs from basic legal requirements, including reporting of emissions. It is important to regulate air pollution from CAFOs to improve the health of neighboring communities and to reduce that sector's GHG emissions. Litigation and incentives are important tools to enforce regulations and protect public health.

Cleaning Up Diesel

Diesel exhaust is a complex mixture of gases and particles that contain more than 40 toxic air contaminants, including many known or suspected cancer-causing substances, such as benzene, arsenic and formaldehyde. It also contains harmful pollutants such as nitrogen oxides which contribute to ground-level ozone. This session covered the latest research on maximizing reductions of diesel exhaust in on-road vehicles and practical resources for encouraging construction managers to improve air quality on their sites by reducing emissions from off-road vehicles and equipment.

Key Outcomes

- Studies have shown that advanced pollution controls (i.e., diesel particulate filters) reduce particle pollution between 88 and 99 percent.
- Funding programs targeting older diesel engines are effective in reducing nitrogen oxide (NOx) emissions, a major contributor to ground-level ozone pollution.
- Programs and policies aimed at turning over diesel fleets are the most effective way to reduce overall emissions from this sector.

Presentations

Mecklenburg County GRADE Program - Grants to Replace Aging Diesel Engines, Leslie Rhodes

Historically, Mecklenburg County has been the worst county in North Carolina and one of the worst in the Southeast for ozone pollution. Recently, the county met the federal ozone standards for the first

time. Mobile source emissions are the primary culprit in NOx production in the county, but the county cannot pass regulations and must rely on voluntary or incentive programs. GRADE is a rebate program to replace aging diesel engines started in 2007 with an initial infusion of $500,000 from the county. Since then, the program has received $332,000 in state funding and $4.3 million in federal grants. GRADE results include 283 completed projects, 434 tons of NOx emissions reduced and five million dollars in grants awarded.

Factors Related to Emissions Reductions in Diesel Vehicles, Chris Frey, Ph.D.

Advanced emission controls for diesel engines are relatively effective and real world emissions from diesel engines are decreasing in the US. Trucks today haul over 70 percent of freight in the US, however, rail is less fuel intensive per ton mile of freight, but not nearly as convenient as point-to-point trucking. Reduction in air pollution centers on newer technologies deployed as a function of fleet turnover.

Promoting Clean Construction Practices, David Wolfe, P.E., ENV SP

The City of Charlotte has implemented five principal strategies to reduce air pollution from construction projects: idle reduction, clean air zones, operator training, preventive maintenance, use of ultra-low sulphur diesel (ULSD) and engine retrofit and replacement. This is a recent implementation, but preliminary results are promising.

State of Air Quality in N.C.: Trends and Issues

North Carolina has a long history of establishing effective and innovative programs, policies, and partnerships that have resulted in cleaner air and better health for all the residents of the state. The North Carolina Clean Smokestacks Act, discussed at the 2015 NC BREATHE Conference, is one example among many. Now, confronted with a different legislative landscape that may adversely affect air quality, the state faces the challenge of how to progress toward cleaner air and better health across the state and region.

Key Outcomes

- In the summer of 2015, North Carolina met federal air quality standards for all pollutants for the first time since 1997.
- New stronger federal standards and a rapidly increasing population in Charlotte and Raleigh call for continued efforts to reduce emissions statewide, especially in the transportation sector
- Medical research links exposure to $PM_{2.5}$ to preterm birth, which can lead to lifelong health problems.

Presentations

Current State of Air Quality in North Carolina, Michael Pjetraj

While state emission levels are decreasing, so are regulatory standards. In 2015, North Carolina went from a nonattainment state to an attainment state for ground-level ozone. Currently, all monitors across the state are measuring in compliance, but final averages are due next year. Recently, EPA went to a one-hour standard from a 24-hour standard, which is more difficult to confirm compliance. The NC Division of Air Quality website contains information on regulations, monitors and how to provide public input.

Trends in Air Quality in Charlotte and Raleigh, Larry Raymond, M.D.

The World Health Organization notes that one in four deaths is due to air pollution and that most environment-related deaths are due to cardiovascular disease, including stroke and heart disease. Research shows that stronger air quality standards can yield major improvements in survival rates. Policies to control smokestack emissions and costs associated with improvements lead to cleaner air and improved health.

Citizen Science and Air Pollution

Citizen science is a fast growing field that is providing exciting new opportunities to monitor air quality. EPA, UNC Charlotte and the NC Museum of Natural Sciences have been testing and using sensors to monitor air quality in real-time that is local and relevant to affected communities. These organizations presented findings on specific projects, resources useful to citizen scientists and guidelines for organizing a successful project.

Key Outcomes

- Citizen science provides opportunities to improve science literacy, raise awareness of local air pollution issues and address environmental justice health outcomes.
- Air sensor technology continues to evolve and improve as public demand grows for real-time health information, but scientific oversight of citizen science projects is critical to ensure effective outcomes.

Presentations

Citizen Science 101, Caren Cooper, Ph.D.

The use of citizen science is occurring in all fields through a variety of venues. It encourages public engagement in science. In recent years, professional associations have been formed to study best practices, expand boundaries and improve awareness of citizen science. The Citizen Science

Association created the scientific journal, *Citizen Science: Theory and Practice*, to encourage peer-reviewed citizen science research publications. Social networks are forming through citizen science and increasing science literacy.

EPA's Air Sensor Toolbox for Citizen Scientists, Amanda Kaufman, M.S.P.H.

The EPA created the Air Sensor Toolbox for Citizen Scientists and the Air Sensor Guidebook to help build a platform of trust and collaboration for citizen scientists. The Toolbox and Guidebook offer information and resources about planning a citizen science project, choosing the appropriate air quality sensors, managing data sets, locating funding sources, and other important topics.

Designing a Citizen Science Monitoring Project, Ron Williams, Ph.D.

It is important to understand how to design and plan a citizen science project for useful results. Many new types of air monitoring equipment are rapidly becoming available and the price of this equipment is becoming more affordable. However, all equipment is not equal. Many have not been tested for data reliability and may lack clear operating manuals. The EPA is currently reviewing and evaluating many of these monitors and their evaluations are available on their Air Sensor Toolbox website. It is important when designing a citizen science project to think like a scientist because it's easy to become overwhelmed with too much data. Often it is helpful to develop a decision tree to help participants be consistent when dealing with data.

Citizen Science in Action, Brian Magi, Ph.D.

Keeping Watch on Air, a UNC Charlotte community air awareness project, includes a citizen science project using Dylos fine particulate matter ($PM_{2.5}$) monitors to measure air pollution levels in the Charlotte area. The project is a collaboration between UNC Charlotte and Charlotte-Mecklenburg Schools to help educate students while collecting data. The preliminary lessons learned and project outcomes include raised awareness of nearly invisible air pollution, field tested low-cost particle monitor, tested particle count and particle mass relationship and understanding the variability between air monitoring sites.

NC Research and Education Initiatives

This session provided an opportunity to learn about and discuss important research and innovative educational approaches in North Carolina. Attendees learned how Davidson College links undergraduate education to important science-based research, how UNC Charlotte brings together art and education to raise awareness of air quality issues, how Appalachian State University uses interdisciplinary research and teaching to explore atmospheric processes and how work from the EPA is being conducted locally. The session offered information about a diversity of approaches all targeting a common end – protecting the quality of the air.

Key Outcomes

- Art can be a powerful tool to help the public visualize nearly invisible air pollution and engage in community conversations about solutions.
- Local air monitoring projects in neighborhoods using portable sensors and innovative tools like the EPA's Village Green bench offer opportunities for real-time air pollution measurements and raising awareness about steps to take to reduce exposure to pollution.
- While ozone levels in the Great Smoky Mountain National Park have been steadily decreasing over the years due to strong clean air policies, efforts at the local, state and federal levels must continue in order to protect the park's vegetation and the health of visitors.

Presentations

KEEPING WATCH on AIR, Crista Cammaroto, M.F.A.

KEEPING WATCH is part of a multi-year art project of UNC Charlotte's College of Arts + Architecture to increase awareness of environmental issues. This year's project KEEPING WATCH on AIR, brings visual awareness to the nearly invisible problem of air pollution through the outdoor art exhibit Particle Falls, and other exhibits and community engagement activities. In previous years, KEEPING WATCH has focused on water and plastics.

Evaluation of Portable Monitors to Capture the Spatial Variability of Air Quality in Charlotte's Northwest Corridor, Cindy Hauser, Ph.D.

The AirKeepers project looked at how air quality may vary spatially throughout Charlotte using portable monitors. The monitors showed no variability between neighborhoods for particulate matter, ozone and nitrogen dioxide. However, significantly higher concentrations were found in different regional corridors, indicating that portable monitors can detect spatial variability. Importantly, the project found that not all portable monitors are the same and purchase and use decisions should be made depending on a project's need for accuracy, precision, reliability, size, ease-of-use and budget.

AMPS - A Natural Air Filter for Buildings, Jefferson Ellinger, A.I.A., N.C.A.R.B.

Just as trees can improve the air quality in our communities, plants can make the air in our homes and buildings cleaner. UNC Charlotte Associate Professor of Architecture Jefferson Ellinger and his partners at Fresh Air Building Systems have been working for years to develop the Active Modular Phytoremediation System (AMPS), a "probiotic" plant wall air filtration system. As air moves through the AMPS plants' root rhizosphere (the micro-ecosystem surrounding the root ball), microbes on the roots digest contaminants that are in the air.

Ozone's Impact on Plant Life in Great Smoky Mountains National Park, Howie Neufeld, Ph.D.

Ozone concentrations have been decreasing since the early 1990s thanks to various emission regulations such as the Clean Air Act, NC Clean Smokestacks Act and Clean Air Interstate Rules. Ozone reductions have improved visibility and plant health. However, some areas in the Appalachian Mountains still show concentrations above national standards. Studies have shown that high ozone

concentrations vary in this area and are detrimental to plant life. Further localized reductions are needed to preserve North Carolina's mountains.

Novel Applications of Sensor or Technology, Dan Costa, Ph.D.

Citizen science has been and will continue to be an important element in promoting environmental health and well-being. Sensor technologies are revolutionizing the way we can measure and monitor air pollution. The EPA has been engaging in citizen science and sensor evaluation and development with projects such as the Village Green, which is a community bench in multiple cities to monitor air quality and allow users to check real-time monitors online. The EPA also hosted a community air monitoring training and created the Air Sensor Toolbox for citizen scientists to help educate and train communities and citizen scientists. EPA is involved in several other citizen science projects and collaborations.

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