NC BREATHE Conference

April 8, 2016

Clean Air Carolina
Your advocates for healthy air

UNC CHARLOTTE
College of Arts + Architecture

Environmental Health Scholars Program

MAHA
Medical Advocates for Healthy Air

Fred and Alice Stanback

UNC Charlotte Center City

NC BREATHE

Bridging **R**esearch on **E**conomics and
Air Quality for **T**he **H**ealth of **E**veryone

MISSION STATEMENT

To provide 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.

4.8.2016
UNC Charlotte Center City
ncbreatheconference.org

WiFi: NinerWiFi-Guest (no password needed)
Facebook: facebook.com/cleanaircarolina/
Twitter: @cleanairNC #NCBREATHE

SPONSORS

Clean Air Carolina is a nonprofit organization based in Charlotte with a satellite office in the Triangle. Its mission is to ensure cleaner air quality for all North Carolinians through education and advocacy and by working with partners to reduce sources of pollution. Current programs include Medical Advocates for Healthy Air, Clear the Air for Kids!, Climate and Energy, and Diesel and Transportation. www.cleanaircarolina.org

UNC Charlotte is North Carolina's urban research university. It leverages its location in the state's largest city to offer internationally competitive programs of research and creative activity, exemplary undergraduate, graduate, and professional programs, and a focused set of community engagement initiatives. UNC Charlotte maintains a particular commitment to addressing the cultural, economic, educational, environmental, health, and social needs of the greater Charlotte region.

Medical Advocates for Healthy Air (MAHA), an initiative of Clean Air Carolina, is a statewide network of medical and health professionals leading the call for cleaner, healthier air. MAHA members educate colleagues, patients and policymakers about the health impacts of air pollution. MAHA also offers a clean air advocacy training to pediatric residents at medical schools across the state. www.medicaladvocatesforhealthyair.org

The Environmental Health Scholars Program supports faculty investigators and students to become involved in basic, translational and population research arenas to better understand the health impact of environmental changes in North Carolina. The Program is headed by Dr. H. Kim Lyerly, George Barth Geller Professor in Cancer Research and Professor of Surgery at Duke University.

Program Committee

Christina Baghdikian, MPH
Environmental Health Scientist
US Environmental Protection Agency

June Blotnick, MEd
Executive Director
Clean Air Carolina

Marion Deerhake, MSPH
Senior Research Environmental Scientist
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Director
Mecklenburg County Air Quality

William Ross, Jr., JD
Of Counsel
Brooks Pierce

William Schlesinger, PhD
Dean of the Nicholas School of the Environment, Emeritus
Duke University

Gary Silverman, PhD
Professor
School of Public Health Sciences
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Conference Agenda

MORNING SESSION	
8:00 – 9:00	Registration, Breakfast, and Poster Review
	PLENARY SESSIONS
9:00 – 9:15	**Welcome and Introductions** William Schlesinger, PhD June Blotnick, MEd Meg Whalen, MM
9:15 – 10:00	Plenary Session I ***Air Pollution and Health: Recent Findings and Next Steps*** Antonella Zanobetti, PhD
10:00 – 10:50	Plenary Session II ***How Do We Measure the Benefit of Improving Air Quality?*** Chris Timmins, PhD
10:50 – 11:20	**BREAK & POSTER REVIEW**
11:20 – 12:10	Plenary Session III ***Connecting Air Pollution, Climate Change, Energy, and Health*** Jason West, PhD
12:10 – 12:40	**LUNCH & POSTER REVIEW**
	Enjoy your lunch outside at First Ward Park and don't forget to stop in the Projective Eye Gallery!
	NC BREATHE CONFERENCE

Conference Agenda

AFTERNOON SESSION	
12:45 – 1:05	**Presentation of Airkeeper Award & Special Remarks** NC Attorney General Roy Cooper
1:15 – 3:00	**BREAKOUT GROUPS**
	I. Concentrated Animal Feeding Operations II. Citizen Science and Air Pollution III. Clean Air and Heart Health IV. Cleaning Up Diesel V. Economics of Clean Air Policymaking VI. State of Air Quality in NC: Trends and Issues VII. Reducing Carbon Emissions VIII. NC Research and Education Initiatives
3:00 – 3:30	**BREAK & POSTER REVIEW**
3:30 – 4:15	**Breakout Summaries** Bill Schlesinger and Breakout Group Moderators
4:15 – 4:30	**Student Poster Award** Gary Silverman, PhD
4:30 – 4:45	**Advocacy Opportunities** June Blotnick, MEd Stephen Keener, MD
4:45 – 5:00	**Closing Remarks** H. Kim Lyerly, MD
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Plenary Speakers

Antonella Zanobetti, PhD

Antonella Zanobetti is the Principal Researcher in the Department of Environmental Health at the Harvard T.H. Chan School of Public Health. She received her PhD in Statistics in 1999 at the University of Florence in Italy. Her research interest focuses on the health consequences of exposure to air pollutants and climate change, which is shaped by her background and training in both epidemiology and statistics, by developing and applying statistical methods for epidemiological investigations. Her work has contributed substantially to our understanding of air pollution and climate change-mediated health impacts. Recently, Dr. Zanobetti was included on Thomson Reuter's 2015 list of the most highly cited researchers in science and social sciences. With only approximately 3,000 researchers worldwide earning this distinction she is now ranked in the top 1% of scientists cited in her field.

Chris Timmins, Ph.D.

Christopher D. Timmins is a Professor in the Department of Economics at Duke University, with a secondary appointment in Duke's Nicholas School of the Environment specializing in natural resource and environmental economics, but he also has interests in industrial organization, development, public and regional economics. He works on developing new methods for non-market valuation of local public goods and amenities, with a particular focus on hedonic techniques and models of residential sorting. His recent research has focused on measuring the costs associated with exposure to poor air quality, the benefits associated with remediating brownfields and toxic waste under the Superfund program, the valuation of non-marginal changes in disamenities, and the causes and consequences of "environmental injustice". He has also recently begun a new research project on the social costs of hydraulic fracturing for the extraction of natural gas. Along with publishing his research findings and ideas, Professor Timmins has presented his work at conferences and seminars throughout the nation and the world.

Plenary Speakers

Jason West, Ph.D.

Dr. Jason West is an Associate Professor in the Department of Environmental Sciences and Engineering at the University of North Carolina at Chapel Hill, where he performs interdisciplinary research addressing air pollution and climate change, by using models of atmospheric chemistry and transport, and tools for quantitative policy analysis. Dr. West is interested broadly in the relationships between air pollution and climate change, and their relevance for environmental science and policy. Using computer models, Dr. West is currently exploring the effects of changes in emissions on global air quality (focusing on ozone and particulate matter), the international transport of air pollutants, the health effects of air pollution, the effects of climate change on air quality, and the radiative forcing of climate. Recently, Dr. West led the first study of the co-benefits of greenhouse gas (GHG) mitigation for air quality and human health to use global atmospheric models and future scenarios; results showed that the monetized co-benefits exceeded previous co-benefits estimates and exceeded the global costs of GHG mitigation in 2030 and 2050.

Conference Faculty

Rep. Kelly M. Alexander, Jr., MPA
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Mecklenburg County

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RTI International

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Antonella Zanobetti, PhD
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Harvard T.H. Chan School of Public Health
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Exhibitors

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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MECKLENBURG COUNTY
AIR QUALITY

MAHA
Medical Advocates for Healthy Air

MCAC
Mecklenburg County
Asthma Coalition

Concentrated Animal Feeding Operations (CAFOs)

Moderator:

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Michelle Nowlin
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Description:

North Carolina is home to 9.7 million hogs and 2,310 permitted hog waste facilities. 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 the Clean Water Act, the Clean Air Act, Community Right to Know laws and animal cruelty regulations. Experts in this session will share the latest scientific and health research on the impact of hog waste on human health and the environment. The challenging policy environment will also be presented with priorities for policy change identified. A grassroots movement is growing in Eastern North Carolina to address this issue and we'll hear the latest on what local residents are doing to protect themselves.

Agenda:

1:15	Opening Remarks and Introductions	Steve Wall
1:30	The Effects of Hog Waste on Human Health	Julia Kravchenko
1:50	The Effects of Hog Waste on The Environment	Viney Aneja
2:10	Policy Opportunities for Improving Health	Michelle Nowlin
2:30	Open Discussion	

Citizen Science & Air Pollution

Moderator:

Rachel McIntosh-Kastrinsky
Science Communications Editor [C]
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Panelists:

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Ron Williams
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Description:

Citizen science is a fast growing field that is providing exciting new opportunities to monitor our air quality. The Environmental Protection Agency, UNC Charlotte and the NC Museum of Natural Sciences have been testing and using sensors to monitor our air in real-time that is local and relevant to affected communities. In February 2017, the NC Museum of Natural Sciences in partnership with NC State University will host the Citizen Science Association Conference. Please join our panel as they discuss and answer questions about their experience with citizen science and air quality.

Agenda:

1:15	Opening Remarks and Introductions	Rachel McIntosh-Kastrinsky
1:25	Citizen Science 101	Caren Cooper
1:45	EPA's Air Sensor Toolbox for Citizen Scientists	Amanda Kaufman
2:05	Designing a Citizen Science Monitoring Project	Ron Williams
2:25	Citizen Science in Action	Brian Magi
2:45	Open Discussion	

Clean Air and Heart Health

Moderator:

Stephen Keener
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Panelists:

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Antonella Zanobetti
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Description:

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 share their latest research on this topic which has implications for physicians, patients and policy makers.

Agenda:

1:15	Opening Remarks and Introductions	Stephen Keener
1:25	Air Pollution and Cardiovascular Disease	Antonella Zanobetti
1:45	EPA's Healthy Heart Toolkit and Research	Wayne Cascio
2:05	Improving Air Quality and Reducing Deaths in NC	Kim Lyerly
2:25	Open Discussion	

Cleaning Up Diesel

Moderator:

June Blotnick
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Panelists:

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Description:

Diesel exhaust is a complex mixture of gases and fine 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 will cover 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.

Agenda:

1:15	Opening Remarks and Introductions	June Blotnick
1:25	Factors Related to Emissions Reduction in Diesel Vehicles	Chris Frey
1:45	Promoting Clean Construction Practices	David Wolfe
2:00	NC Mobile Source Emission Reduction Grant Program	Phyllis Jones
2:15	Mecklenburg County GRADE Program - Grants to Replace Aging Diesel Engines	Leslie Rhodes
2:30	Open Discussion	

Economics of Clean Air Policy Making

Moderator:

Marion Elliott Deerhake
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Panelists:

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Mary Maclean Asbill
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Description:

This breakout session is intended to provide an overview of both the current Federal and State approaches to valuing public health and welfare in air quality regulatory development; compare Federal and State processes; and discuss whether North Carolina's process 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 control and no-control scenarios are then weighed by policymakers as they make informed choices regarding air quality regulations.

Agenda:

1:15	Opening Remarks and Introductions	Marion Deerhake
1:25	Estimating the Benefits of EPA's Air Pollution Regulations	Amy Lamson
1:40	NC Experience with Regulatory Impact Analyses	Anca Grozav
1:55	Benefits of Regulating Air Pollution in NC	Mary Maclean Asbill
2:10	Thumb on the Scales of Justice	Ryke Longest
2:25	Open Discussion	

State of Air Quality in NC: Trends and Issues

Moderator:

Bill Ross
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Panelists:

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Rep. Kelly Alexander
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Rep. Charles Jeter
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Description:

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 people of our state. The North Carolina Clean Smokestacks Act, discussed at last year's NC BREATHE Conference, is one example among many. Now, confronted with many different kinds of change that may adversely affect our good air quality, our state faces the challenge of how to continue the crucial trend lines toward cleaner air and better health across the state and region.

Agenda:

1:15	Opening Remarks and Introductions	Bill Ross
1:25	Current State of Air Quality in NC	Michael Pjetraj
1:45	Trends in Air Quality in Charlotte and Raleigh	Larry Raymond
2:05	Air Quality in the Legislative Environment	Rep. Kelly Alexander Rep. Charles Jeter
2:30	Open Discussion	

Reducing Carbon Emissions

Moderator:

William H. Schlesinger
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Jason West
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Description:

The panel will discuss 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 U.S. Supreme Court. This is the basis of the U.S. commitments articulated at COP-21 in Paris. The benefits and costs of using forest biomass as a potentially carbon-neutral energy source to replace coal will be discussed as they apply to North Carolina. We'll also hear about 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.

Agenda:

1:15	Opening Remarks and Introductions	Bill Schlesinger
1:25	Climate Ready NC Program	Lauren Thie
1:40	EPA'S Clean Power Plan	Ken Mitchell
2:00	Biomass and GHG Reductions	Justin Baker
2:15	Additional Policy Implications	Jason West
2:30	Open Discussion	

NC Research and Education Initiatives

Moderator:

Gary Silverman
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Panel:

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Description:

This session provides an opportunity to learn about and discuss important research and innovative educational approaches originating from North Carolina. Attendees will learn about results from a local private college linking undergraduate education to science-based research, efforts at UNC Charlotte bringing together art and education to raise awareness of air quality issues, Appalachian State University's inter-disciplinary research and teaching program for exploring atmospheric processes, and work from the US EPA being conducted locally.

Agenda:

1:15	Opening Remarks and Introductions	Gary Silverman
1:20	KEEPING WATCH on AIR	Crista Cammaroto
1:35	Evaluation of Portable Monitors to Capture the Spatial Variability of Air Quality in Charlotte's Northwest Corridor	Cindy Hauser
1:50	AMPS - A Natural Air Filter for Buildings	Jefferson Ellinger
2:05	Ozone's Impact on Plant Life in Great Smoky Mountains National Park	Howie Neufeld
2:20	Novel Applications of Sensor or Technology	Dan Costa
2:35	Open Discussion	

POSTER ABSTRACTS

Nalyn Siripanichgon & Dr. Cindy DeForest Hauser, Davidson College

The Effects of Urbanization on School Playground Air Quality

The incidence of asthma has increased worldwide, and has been attributed to poor air quality. As urbanization at various locations increase, namely the presence of interstates and roads, so does the traffic density and volume. People, especially children, are susceptible to poor air quality as it can lead to various respiratory conditions, cardiovascular diseases, and allergies. Respiratory tract infections are one of the leading causes of death for children under five years old around the world. To measure the effects of distance to major roadways, traffic density, and presence of built environments, passive samplers were placed in front of and behind three different schools in the town of Davidson, NC: Davidson Elementary School (DES), Community School of Davidson (CSD), and Davidson Day School (DDS). This was conducted over three sampling periods with each period lasting four weeks – two while school was in session and one while school was out of session. Passive samplers were used to determine the concentrations of NO, NO_2, NO_x, and O_3. Real time measurements of NO_2 and O_3 were also collected using the Aeroqual handheld sampler.

NO concentrations in front of CSD while school was in session had a significantly higher concentration compared to all other locations with a mean value of 10.9 PPB. Schools located closer to I-77 (CSD and DDS) also had higher concentrations of NO_2 and NO_x compared to schools farther away (DES). Aeroqual data showed a dependence on traffic density with a higher concentration during school dismissal times compared to regular, non-dismissal hours. Nitrogen oxide concentrations also demonstrated a dependence on the presence of the built environment with concentration in front of the school building higher than behind.

We can conclude that a) decreasing the distance to major roadways (I-77) increases the pollutant concentration, b) areas with higher traffic density have higher pollutant concentrations, and c) the built environment played a role in acting as a physical barrier to air pollution.

Holly Dieu, East Carolina University

Characterization of Asthma-related Emergency Room Visits across North Carolina from 2008-2014

Asthma is a chronic lung disease characterized by inflammation and constriction of the airways. Although it affects individuals of all ages, races, sex and socioeconomic status, it is especially prevalent in the pediatric population. Periodically assessing the burden of asthma is important for monitoring overall trends in illness and hospitalizations. This study will calculate age-adjusted rates for asthma-related emergency room visits in the pediatric population, which have not yet been calculated in the literature. Additionally, this study will look at the geographic distribution of asthma-related emergency room visits and coal fired power plants across North

Carolina.

Data from North Carolina Disease Event Tracking and Epidemiology Collection Tool (NC DETECT) database were used in this secondary data analysis to examine the geographical distribution of patients with asthma-related emergency department visits between 2008 and 2014 for all counties in North Carolina. Patients with a primary or secondary diagnosis (ICD-493.0) of asthma were included in the study and were compared with state and national asthma rates. Geographic Information Systems was used to demonstrate the geographical distribution and patterns of age-adjusted asthma rates and coal fired power plants throughout North Carolina. We will provide maps and tables of age-adjusted rates in NC for the years 2008-2014.

Asthma continues to be one of the most common chronic diseases in the United States. Characterization of trends in illness and hospitalization over time is important for monitoring burden of disease and can be achieved through use of existing state databases. Mapping coal fired power plants with asthma-related emergency room visits can identify possible clusters, patterns or trends in the distribution of asthma across the state. Clinicians and public health officials can use this data to gain a better understanding of the distribution of asthma and to identify areas for improvement in the health care system. This information will be of use when planning and allocating resources across the state.

Linda Wei, and Dr. Greg Kearney, East Carolina University

Characterization of Mercury Emissions in Coal-Fired Power Plants in North Carolina (2010-2013)

Mercury emissions produced as a waste product of power plant operations must be taken into account when considering impacts of the environment on health in the state of North Carolina. These emissions can leach into local waterways and accumulate in fish and shellfish in the form of methylmercury, which can then make its way up the food chain into the human food supply. In this study, we sought to characterize temporal mercury vapor and mercury compound emission levels of coal-fired power plants (Title V facilities) throughout NC.

The NC Division of Air Quality (NCDAQ) databases CY2010 Reported and Assumed Emissions Inventory through CY2013 Reported and Assumed Emissions Inventory were used to evaluate the geographic distribution of mercury pollution across the state.

We found a general trend of decreasing mercury emissions from the years 2010 through 2013, with greater total emissions in the piedmont region compared to western and eastern regions of the state; an amount we consider largely due to the greater number of power plants located in that region.

Public health officials and policy makers can use this data to make more informed decisions about regional distributions of mercury as concerning health implications for susceptible populations such as pregnant women, young children, and subsistence.

Sara Duncan, Ronald Lauck
Rutgers University
Kenneth Sexton, Barbara Turpin
University of North Carolina, Chapel Hill

Water-soluble organic gases collected inside homes in New Jersey and North Carolina

Many volatile organic compounds (VOCs) have been identified and measured in indoor spaces. These compounds include alkanes, alkenes, aromatic rings, polycyclic aromatic hydrocarbons, aldehydes, and alcohols. Although these compounds span many compound classes, most measurements are of non-polar gases. This is mainly because non-polar VOCs are easier to measure. We hypothesize that there are many more compounds in indoor air that are polar, oxidized, and water-soluble. These compounds may be directly emitted from sources (such as cleaning products and cooking) or formed when VOCs react with oxidants such as ozone (~25ppb) in indoor air.

To identify and study the fate of water-soluble organic gases in indoor air, samples were collected inside and directly outside 13 homes in central New Jersey and the Triangle region of North Carolina using four mist-chamber devices sampling in parallel (two sampling indoors and two sampling outdoors). These devices scrub water-soluble gases out of the air into water with a flow rate of 25 liters per minute and a collection volume of 25 milli-liters of water each for two hours, twice consecutively. Total organic carbon (TOC) concentrations in indoor samples ranged from 542 to 1,387 micro-molar carbon; outdoor TOC concentrations ranged from 28 to 107 micro-molar carbon. On average, at least 86% of water-soluble organic carbon collected indoors originated from indoor sources and indoor formation rather than from outdoor-to-indoor transport (This lower-bound estimate assumes outdoor-to-indoor transport was 100% efficient).

Although the compounds collected by the mist chambers have yet to be identified, these results demonstrate a need to characterize water-soluble gases indoors. People, who spend on average upwards of 90% of their time indoors (Klepies et al. 2001), will be exposed to these compounds through dermal and inhalation routes. Given that these compounds are water-soluble, they can partition into liquid water on skin and in the respiratory tract and react further. These compounds may also partition into liquid water in other locations in homes, especially in homes that are considered "damp," such as in water films on walls and other surfaces and in wet particles. There, they may undergo additional chemistry which may change the indoor air chemical makeup and thereby affect exposure and potentially health.

Shih Ying Chang, Saravanan Arunachalam,
William Vizuete and Marc Serre, UNC Chapel Hill
Vlad Isakov, Environmental Protection Agency

Fine-scale characterization of premature deaths associated with exposure to $PM_{2.5}$ from on road sources in Central North Carolina

Emission from on road vehicles is a major contributor of air pollution-related premature death. Previous studies have estimated that on road emissions in the U.S.

cause 29,000 to 53,000 ozone and $PM_{2.5}$-related premature deaths. In these studies, grid-based air quality chemical transport models (CTM) were used to provide ambient concentration estimates. Because these models were usually run at a relatively coarse spatial resolution (i.e. 36 km × 36 km or 12 km × 12 km), they fail to fully characterize the concentration hotspots at the proximity of emission sources and thus fail to capture high-risk areas.

Several studies have shown that people living close to major roads have higher risk to develop respiratory diseases than those living several hundred meters away. To capture this sharp gradient and to improve characterization of the exposure and risk from traffic-related air pollutants, fine-resolution modeling is required. Fine-resolution modeling with CTM, however, is resource intensive because of the increased grid number and is not viable for large-scale applications.

In this study, we used a line source dispersion model, R-LINE, to provide primary $PM_{2.5}$ concentration estimates in the North Carolina Piedmont region at a Census block level. Secondary $PM_{2.5}$ due to on-road emission was estimated with a two-step approach combining CMAQ outputs and space-time ordinary kriging (STOK) of observations. In the first step, brute-force CMAQ simulations was performed with and without on road emissions to estimate the fraction of secondary $PM_{2.5}$ from on-road source to total $PM_{2.5}$ at a coarse resolution.

In the second step, the estimated fraction from Step 1 was applied to the observed $PM_{2.5}$ from surrounding monitoring sites to generate the "soft data" for STOK to estimate Census block-level secondary $PM_{2.5}$ from on road source. Concentration-response functions from literatures were used to estimate premature death based on predicted ambient concentration.

Preliminary results show that the fine-resolution modeling output estimated 4.33 times more premature mortality due to primary $PM_{2.5}$ from on-road source than the traditional CTM approach (225 vs. 52) in the NC Piedmont region. Further, 72% of the premature mortality due to on-road emission is within 1000 meters from roadways where 50% of the population in this region resides. This level of detail cannot be captured using traditional applications of CTMs alone.

Results from this study imply that there is a potential for underestimating premature mortality associated with on-road emissions using the traditional CTM approach, and shows the value of our hybrid modeling approach in improved characterization of health risk due to on road air pollution.

Mary Allen and Elizabeth Hammond, Appalachian State University

Ozone trends in the Great Smoky Mountain National Park and Shenandoah National Park

In 2003, the Environmental Protection Agency implemented stricter emission standards for nitrogen oxides under the NOx State Implementation Plans (SIP) Call. The impact of the NOx SIP Call on ozone (O3) mixing ratios was investigated in two National Parks: Great Smoky Mountains National Park (GSMNP) and Shenandoah National Park (SNP). The goal of this study is to continue the work of Neufeld et al.

(unpublished), observing O3 trends in GSMNP and comparing those trends to those observed in SNP. We calculated the N60, N80, and N100 indices, which are the number of hours at or above 60, 80 and 100 ppbv O3, respectively, as well as the W126 exposure index, which preferentially weights the higher O3 concentrations to estimate the impact of O3 on plant life. For GSMNP, we found a slight increase in W126 values of 31% between 2013 and 2014, but values are still below those found prior to 2002. For SNP, the W126 index was highest in 1998 and has steadily declined until the present. In GSMNP the N60 values increased by 65% from 2013 to 2014, a trend more apparent at higher elevation sites. For those same two years in SNP, the N60 index increased by 113% from 2013 to 2014. Despite the recent increase in the N60 the SIP call has resulted in reduced O3 pollution in eastern National Parks like GSMNP and SNP. These results are not only beneficial to the health of visitors to the Parks, but to the natural ecosystems and plants as well.

Natalie Smith, Appalachian State University

An Investigation of the Chemical and Optical Properties of Aerosols in the Southeastern U.S.

Aerosols are solid or liquid particles suspended in the Earth's atmosphere. These particles cause millions of deaths throughout the globe each year and significantly impacts the Earth's climate, making it an increasingly important area of research.

Currently, viable methods for simultaneous characterization of the chemical and optical properties of aerosols are not available. This research employs a new method to characterize chemical properties of aerosols collected on quartz fiber filters from a low-volume sampler connected to a particle soot absorption photometer (PSAP) located at the Appalachian Atmospheric Interdisciplinary Research (AppalAIR) facility in Boone, NC.

The chemical characterization of the aerosols involves the direct thermal desorption of quartz fiber filters by GC-MS. The standards used to analyze the PM on the filter include anthracene, fluoranthene, fluorene, levoglucosan, cis-pinonic acid, and methacrylic acid. These standards are markers for both anthropogenic and biogenic sources including biomass burning, combustion of fossil fuels, and secondary organic aerosols from vegetation.

The implications of this study will help improve climate models and identify the optical properties of particulate matter based on specific chemical signatures.

Andrea M. Patawaran-Hickman, UNC Charlotte

Wildlife Breathes

All too often, wildlife is either overly generalized or underrepresented in discussions on how pollution affects wildlife; yet, wildlife breathes just as we do. Generally, the public connects climate change with species that are far removed from their home. It is common to associate climate change with the plight of Polar Bears. The need to stabilize the sea ice habitats became apparent when they were listed in 2008 as a threatened species under the Endangered Species Act. However, it is not as common

for the masses to think about climate change and how it affects species in their own state or even in their own backyard. Undeniably, carbon pollution and greenhouse gases are changing the conditions of many wildlife habitats. Unfortunately, the state of North Carolina has not been an exception. Further habitat loss could cripple species that are already under state and federal protection and add new ones to the lists.

On behalf of an internship with the NC Wildlife Federation and as a graduate student of Professional and Technical Writing at UNC Charlotte, I would like to present the effects of climate change on wildlife across the state of North Carolina using visual representations. The infograph, Wildlife Breathes, aims to identify species in North Carolina that are struggling as the result of carbon emissions by answering questions such as: Which wildlife is most affected by climate change in our state? How does climate change adversely affects wildlife habitats? How does it contribute to habitat loss? What can we do to help?

The infograph will divide wildlife into regional zones and present a variety of species from the coast to the mountains to demonstrate real needs for clean energy resources in North Carolina today. The infograph will also provide a narrative for wildlife in North Carolina and give a voice to species that are listed as endangered, threatened, or of concern.

For example, in the coastal region, sea turtles and alligators are currently suffering from habitat loss. Further loss will weaken the biodiversity of the coast. Loggerheads are the most common and are known to nest annually on our coastline. Warmer temperatures could have an irreversible effect on the gender of hatchlings. Warmer ground temperatures are known to produce more female than male hatchlings. If that trend were to continue, then mating could become very problematic and adversely affect not only the species, but also the progress of the federal National Recovery Plan and unravel the work of many groups who fight to monitor and protect sea turtles each year. However, the greatest threat to sea turtles is additional habitat loss. If the sea levels continue to rise, then these turtles will no longer have a place to nests on our coast. Loggerheads are just one species affected by pollution in our state. The infograph is a survey of various species that appear disconnected from our everyday life, yet in reality, wildlife activities greatly strengthen the quality of the air and water in which we need to survive. By protecting wildlife, we are protecting ourselves and creating a better future for tomorrow.

Dr. Kyle Bunds, Dr. Jonathan Casper, and Dr. Chris Frey, NC State University

Major Event Air Pollution Monitoring

Large spectator events serve as a microclimate where there is the potential for high dosage air pollution exposure. The purpose of this projects was to 1) determine the best methodology to measure air pollution associated with large scale spectator events and 2) determine sources and levels of pollutant exposure associated with such events. This study examined the stadium and surrounding parking lots at NC State University over three football games in Fall 2015.

Stationary and mobile air collection methods were used to isolate the pollution effect specific to the sport event. The stationary collection used Dylos Air Monitors that were placed on light poles in five areas around the perimeter of the parking lot and

stadiums area. Data was collected four hours prior to kick-off, during the game, and three hours after the conclusion of the game. A “backpack” was used to quantify spatial variability based on “transects” through the stadium parking lots and measured Ozone, CO, PM, temperature, and relative humidity during pre-game tailgating and inside the stadium during the game. Preliminary results indicating 10 hour exposure levels and areas of high exposure related to air pollutants for the three games will be displayed.

Raquel A. Silva, Lauren Thie, and Sara J. Smith, NC Department of Health and Human Services, Raleigh, NC
Ana G. Rappold, Environmental Protection Agency
Margaret M. Sugg, Appalachian State University

Mapping health-related vulnerability to climate change in North Carolina

Multi-model simulations of future climate in North Carolina project an increase in average annual temperature, in frequency and duration of heat waves, and in frequency and intensity of precipitation. Additionally, changes in climate may lead to increased drought, intensity of tropical cyclones, and sea-level inundation. These changes in climate may negatively impact human health directly (e.g., heat-related illnesses, respiratory and cardiovascular health, mental health, increased risk of injury), and indirectly, due to adverse impacts on ecology, agriculture and infrastructure (e.g., water and foodborne diseases, vector-borne diseases, etc.). Adaptation efforts should take into account the spatial distribution and extent of those impacts throughout the state, so that the most vulnerable communities are identified and the most effective adaptation interventions are planned.

The North Carolina Climate and Health Profile identified the climate-related health impacts of greatest concern in North Carolina, using the Hanlon Method for Prioritizing Health Problems, which takes into account disease burden, urgency of action, vulnerability, and strength of evidence. Considering the overall scores, priority for more in-depth vulnerability assessment and adaptation planning in North Carolina has been given to: air quality and respiratory diseases; heat-related illness; extreme weather-related injuries; waterborne diseases. Under the Building Resilience Against Climate Effects (BRACE) cooperative agreement, funded by a CDC grant, the North Carolina Department of Health and Human Services is building on existing studies and data collection to improve vulnerability mapping in North Carolina. The objective of this work is to identify the most vulnerable communities in North Carolina to better plan adaptation interventions to minimize the potential adverse health effects of climate change at the community level.

Among the priority areas, our work focuses on: a) vulnerability to heat-related illness; b) vulnerability to smoke from wildfires due to adverse effects on respiratory and cardiovascular health. We started by identifying current research on vulnerability mapping in North Carolina targeting our focal areas. In parallel, we performed a literature review on climate change adaptation interventions at the community level. Vulnerability to heat-related illness takes into account the association between several area-level risk factors (e.g. low educational attainment, poverty, elderly population,

citizenship, number of mobile homes, labor-intensity of agriculture) and emergency department visits. Vulnerability to smoke from wildfires considers the level and duration of exposure to fine particulate matter, population susceptibility (prevalence of pre-existing conditions, elderly population, poverty, unemployment rate) and population awareness of air pollution hazards.

Having identified the most vulnerable counties for each priority area using state-wide county-level maps, we will meet with planning officials and community leaders in those counties to ground-truth existing maps and to discuss options regarding adaptation interventions. Then, we will improve the maps as needed and we will prepare a summary of results and recommendations for community-level adaptation to climate change in North Carolina.

Raquel A. Silva & J. Jason West, UNC Chapel Hill

Global mortality impacts of present and future ozone and $PM_{2.5}$ ambient air pollution

Anthropogenic ambient air pollution has increased substantially since the industrial revolution. Changes in ambient concentrations of air pollutants are driven by changes in emissions and by climate change. Due to their widespread negative impact, ground-level ozone and fine particulate matter (PM2.5) are two air pollutants of great concern from a global public health perspective. Exposure to ozone and PM2.5 has been associated with cardiopulmonary morbidity and mortality. We use modeled concentrations of anthropogenic ozone and PM2.5 to quantify: 1) the present-day burden of ambient air pollution on premature mortality and the impact of past climate change given its effect on air quality; 2) future premature mortality associated with exposure to ambient air pollution and the contribution of future climate change to overall mortality (due to emissions and climate change); 3) the impact of removing emissions from specific emission sectors (Energy, Industry, Residential & Commercial, Land Transportation, and All Transportation = Land Transportation + Shipping & Aviation) on the global mortality burden of anthropogenic air pollution.

Using output from an ensemble of 14 global chemistry climate models, we estimate present-day global average mortality to be 470,000 (95% CI, 140,000 to 900,000) ozone-related premature deaths/year and 2.1 (1.3 to 3.0) million PM2.5 deaths/year. Over two-thirds of ozone and of PM2.5 global mortality occur in East Asia and India. Considering multi-model future concentrations for four Representative Concentration Pathways (RCP) scenarios, and projected future population and baseline mortality, global PM2.5 mortality generally decreases in the future, but ozone mortality increases in some scenarios/periods (e.g. RCP8.5/2100: 316,000 [-187,000 to 1.38 million deaths/year]). While past climate change is estimated to have little effect on present-day air pollution mortality, RCP8.5 climate change in 2100 is likely to be strongly detrimental: 215,000 (-76,100 to 595,000) PM2.5 deaths/year and 127,000 (-193,000 to 1.07 million) ozone deaths/year.

Using new simulations with a global chemical transport model at fine horizontal resolution, we estimate present-day global premature mortality to be 493,000 (122,000-989,000) ozone deaths/year and 2.2 (1.0 - 3.3) million PM2.5 deaths /year. Globally, the Land Transportation and Residential & Commercial sectors have the

most impact on ozone mortality (16%) and PM2.5 mortality (30%), respectively. However, relative sectoral impacts vary among world regions and within each region.

Air pollution is likely the most important environmental exposure for global human health at present. Future reductions in mortality simulated here will be compromised if better air pollution control assumed in the future, for all RCPs, is delayed.

Jim Zhang, Duke University & Tsinghua University, Beijing

Ozone and $PM_{2.5}$ in Pollution Mixture Differentially Impact Cardiopulmonary Pathophysiologic Mechanisms

The relative contributions of ozone (O_3) and $PM_{2.5}$ in air pollution mixtures to cardiopulmonary outcomes remain poorly understood. This study examines whether and how O_3 and $PM_{2.5}$ may differentially impact mechanisms of cardiopulmonary pathophysiology using a novel filtration-based method.

Exposures to each pollutant were manipulated for 86 office workers living together on a work campus in China with various combinations of an O_3-generating electrostatic precipitator (ESP) and a high efficiency particulate air (HEPA) filter. Subjects were measured for biomarkers of cardiopulmonary pathophysiology at four time points each separated by 2-3 week intervals.

Mean 24-hour exposure concentrations during the study were 37 ± 1.5 μg/m^3 for $PM_{2.5}$ and 6.4 ± 0.2 ppb for O_3, and they were significantly negatively correlated. Contrary to previous literature showing these biomarkers all being associated with $PM_{2.5}$ exposure, this study shows that lung inflammation (fractional exhaled nitric oxide and exhaled breath condensate (EBC) nitrite and nitrate), systolic and diastolic blood pressure, and platelet activation (soluble P-selectin (sP-sel)) were tightly associated with short-term and chronic O_3 exposure. In contrast, pulmonary oxidative stress (EBC malondialdehyde), arterial stiffness (augmentation index), and endothelial cell dysfunction (von Willebrand factor (VWF)) were significantly associated with chronic $PM_{2.5}$ exposure. For example, an interquartile range (IQR) increase in 24-hour O_3 exposure concentration (4.1 ppb) and 2-week mean ambient O_3 (11.0 ppb) was significantly associated with a 12.5% and 27.4% increase in sP-sel, respectively. An IQR increase in 2-week mean ambient $PM_{2.5}$ (41.4 μg/m^3) was associated with a significant 11.2% increase in VWF.

These findings have provided insights into biological mechanisms by which O_3 and $PM_{2.5}$ can differentially enhance cardiopulmonary disease risk. The novel associations observed in this study will support air quality standards for $PM_{2.5}$ and O_3.

Mingquan Li, Duke University

Dual effects of productivity change on aggregate carbon dioxide emissions

The relationship between productivity change and carbon dioxide emissions is complex. Existing research has focused on productivity change in reducing carbon emission intensity but has ignored the impact of productivity change on economic growth, which leads to changes in carbon dioxide emissions.

We argue that productivity has relatively independent economic and environmental attributes. To provide evidence for this, we developed a method to distinguish the scale effect of productivity change and its influence on economic scale from the intensity effect of productivity change and its influence on carbon emission intensity. We applied this method to study the impact of productivity change on carbon dioxide emissions in 95 countries between 1996 and 2007.

We found that productivity change reduced aggregate carbon dioxide emissions, but the scale and intensity effects of productivity change separately expressed positive and negative values. As a consequence, previous studies that only consider the intensity effect overestimate the impact of productivity change on carbon dioxide emissions. Our findings yield important considerations for carbon dioxide emissions control in policy making.

Elizabeth A. W. Chan, Adam Benson, Aisha Dickerson
ORISE at the Environmental Protection Agency
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Concentrations of Individual Fine Particulate Matter Components in the United States around the 4th of July

Fireworks emit particulate matter (PM) air pollution. Laboratory and epidemiologic studies have linked exposure to PM with cardiovascular and respiratory effects. Although it was recently reported that the mass of PM with a nominal mean aerodynamic diameter less than or equal to 2.5 μm (PM2.5) is elevated on July 4th and 5th, no studies to date have used national, multi-year air quality monitoring data to determine which individual PM2.5 components increase due to July 4th fireworks. To evaluate this, we compiled and analyzed daily average PM2.5 air quality data collected by Environmental Protection Agency's Chemical Speciation Network monitors positioned at 379 urban sites across the United States (US) over the years 2000 to 2014. By combining all individual daily mean PM2.5 concentrations recorded and viewing the arithmetic mean concentrations over time, we observed sharp and statistically significant increases in the concentrations of the firework-related chemicals barium (Ba), copper (Cu), chlorine (Cl), magnesium (Mg), potassium (K), and strontium (Sr) on July 4th, which persisted through July 5th. There were also small, but statistically significant, increases of the firework-related components aluminum (Al), arsenic (As), antimony (Sb), chromium (Cr), phosphorous (P), sulfur (S), titanium (Ti), and zinc (Zn), but not of elemental or organic carbon (EC or OC), calcium (Ca), cesium (Cs), iron (Fe), nickel (Ni), or sodium (Na) on July 4th.

Megan Green, Mecklenburg County Air Quality

GRADE Uses Partnerships and Innovative Incentives to Reduce Air Pollution in the Charlotte Region

Grants to Replace Aging Diesel Engines (GRADE) is an innovative grant program providing funds to repower or replace old diesel engines with new, cleaner engines. Initiated in 2007 by Mecklenburg County Air Quality (MCAQ), GRADE is an example of a successful, voluntary emission reduction program implemented at the local level. GRADE has been funded by federal, state, and local grant money bringing over six million dollars in grants to the Charlotte region. This program has been used to fund repowers or replacements of equipment used for construction, industry, agriculture, freight, public works, transportation, and airport sectors in to the 13 county region surrounding Mecklenburg County. As a voluntary incentive program, GRADE encourages actions by local companies and municipalities that go above and beyond compliance with regulations. GRADE helps businesses accelerate fleet turnover; cost-effectively taking old equipment out of the fleet and replacing with cleaner running pieces.

By partnering with local organizations and businesses, GRADE has efficiently reduced emissions from on road and non-road mobile sources operating in the Charlotte non-attainment region. The US EPA has established health-based National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, including ground-level ozone. The Charlotte region has historically been in non-attainment for the ozone NAAQS. Unlike the other criteria pollutants, ozone is not directly emitted, instead it is formed by a chemical reaction between oxides of nitrogen (NOx) and volatile organic compounds (VOCs) in the presence of sunlight. Ozone is a primary constituent of smog and breathing in ozone can negatively impact lung function. In the Charlotte region, mobile sources produce nearly 90% of all NOx emissions. GRADE is focused on reducing mobile source NOx emissions.

MCAQ has collaborated with 44 different local businesses and municipalities to help them to successfully complete equipment repower or replacement projects in order to reduce NOx emissions. As of August 2015, GRADE has funded a combined 283 on-road and off-road projects, estimated to reduce NOx by more than 1,300 tons region-wide. GRADE is one of many innovative tools helping MCAQ to achieve its goal to improve ambient air quality. Through the use of GRADE and other programs, the Charlotte region reached compliance with the 2008 Ozone NAAQS of 75 ppb for the first time in 2014.

Rich Green, Citizen's Climate Lobby, Charlotte, NC

Economic Solution for Global Warming
Citizen's Climate Lobby Proposal, Carbon Fee and Dividend

While there are many specific proposals to help slow down Global Warming, what is needed is a comprehensive plan that will achieve carbon dioxide reduction across the board. The proposal for a carbon fee and dividend by the Citizen's Climate Lobby will solve the whole problem without governmental regulations that are being challenged in court.

The proposal changes the price of carbon to reflect the true cost to society, the external costs are internalized. In the first year a fee of $15 per ton of CO_2 is paid by fossil fuel producers and importers and placed into a trust fund. The fee rises by $10 per year. Each month, the funds are distributed completely and equally to every consumer. This way the economy is sustained even though many prices rise. The elegance of this proposal is that the decisions for the transition away from fossil fuels into clean energy is made by everyone in the market, not by interest groups or imperfect regulators.

The price of non-fossil fuel energy does not rise, so renewable energy will be favored. A REMI model showed that over 20 years, compared to the base case: global warming is solved, 260,000 lives are saved due to reduced pollution, GDP is increased by $1.4 trillion, and 2.8 million jobs are created.

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