



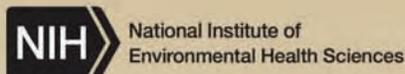
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# Extreme Weather, Climate, and Health: Putting Science into Practice

**The Hubert H. Humphrey Building**

Washington, D.C.

January 30-31, 2013



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## **Welcome to the U.S. Department of Health and Human Services in Washington, D.C.!**

**W**e are pleased you have joined us at the Extreme Weather, Climate, and Health: Putting Science into Practice meeting. The development of this meeting has been a collaborative effort between the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), the American Public Health Association (APHA), the Association of State and Territorial Health Officials (ASTHO), and the National Association of County and City Health Officials (NACCHO). Key to protecting public health in the face of climate change is building a community of researchers and public health practitioners who can analyze the complex data related to climate and health, translate the research findings for decision makers, and apply the information to improve public health outcomes. This momentous occasion marks the first time NIH and CDC have formally brought together our grantees working on climate change and human health to share accomplishments and discuss strategies for linking science to practice.

The National Institute of Environmental Health Sciences (NIEHS) and Fogarty International Center (FIC) have taken a lead role in coordinating and expanding NIH support of research on the human health impacts of climate change. In 2010, NIH launched its first targeted trans-NIH research program designed to examine the risk factors of populations that lead to increased vulnerability to climate change. Currently, these grantees are studying why some elderly populations are more at risk for negative health effects from climate change and are examining the association between air pollutants and pediatric asthma. Other grantees are using methodological approaches to analyze models that predict health vulnerabilities to climate change and are developing models to quantify the possible health impacts of exposure to higher levels of air pollution coming from power plant emissions as hotter summers increase electricity demand. The ultimate goal of the NIH program is to produce the scientific basis for informing climate change adaptation and public health interventions to reduce current and future adverse health effects of climate change. This joint meeting of our research community with members of the public health practitioner community is an excellent opportunity to inform each other, create a stronger coordinated effort, and ensure we are on track in reaching this goal.

As the nation's public health agency, CDC is using its prevention expertise to help state and city health departments investigate, prepare for, and respond to the health effects that climate change may have on people. CDC's National Center for Environmental Health is home to the Climate and Health Program (CHP) which has led the nation's work in climate adaptation for public health since its inception in 2009. CHP is helping state and city health departments through its Climate Ready States and Cities Initiative (CRSCI). Through the CRSCI, CDC provides health departments with funding and technical support to promote the systematic use of climate projections in public health adaptation efforts. The CRSCI fund 16 states and two cities to employ advanced methods that include applying and interpreting climate models and their likely effects on health exposures; predicting short, mid, and long range health impacts; and studying the effectiveness of public health interventions and adaptations. Through CRSCI, the CDC has the goal of creating best practices and tried and tested methods for health departments to address the health effects of climate change that can be duplicated across the nation and internationally. With greater engagement with the research community we look forward to creating a stronger evidence base that supports more effective responses to climate change at the local level.

Our hope is that over the next two days, we will provide meeting participants with opportunities to listen, engage, and network. We encourage you to contribute to panel discussions and use breaks and lunches for informal interactions. Let's catch-up with old friends, build new relationships, and plant the seeds for future collaborations toward solving one of the most critical public health issues facing our world.

### **APPRECIATION**

*NIH and CDC would like to extend a special thanks to the American Public Health Association (APHA), National Association of County and City Health Officials (NACCHO), and Association of State and Territorial Health Officials (ASTHO) for their role in helping to organize this meeting.*

***Planning meetings of this nature requires a great deal of hard work and commitment from a core group of individuals. Please extend a special thanks to planning committee members for this event:*** John Balbus, NIEHS; Jacques Colon, NACCHO; Caroline Dilworth, NIEHS; Angela Dyjack, APHA; Christine Jessup, FIC; Tracy Kolian, APHA; Abraham Kulungara, ASTHO; George Luber, CDC; Stephen Marcus, NIGMS; Gino Marinucci, CDC; Joshua Rosenthal, FIC; Kimberly Thigpen Tart, NIEHS.

***Special thanks also to those working behind the scenes to make this meeting a success:*** Kerri Moran, MDB; Carol Kelly, MDB; and the HHS conference, security, IT, and cafeteria staff.

## Agenda

### DAY 1: January 30, 2013

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7:45-8:30 a.m. **Registration**

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8:30-8:55 a.m. **Welcome**

*Judy Qualters, CDC/NCEH*

*John Balbus, NIH/NIEHS*

*Howard Koh, Assistant Secretary for Health, HHS*

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8:55-9:15 a.m. **Overview**

*Christopher Portier, Director, NCEH*

*Linda Birnbaum, Director, NIEHS*

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9:15-9:30 a.m. **CDC current programs and direction**

*George Luber, CDC/NCEH*

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9:30-9:45 a.m. **NIH current programs and direction**

*Caroline Dilworth, NIH/NIEHS*

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9:45-10:00 a.m. **Break**

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10:00-11:45 a.m. **Panel 1 – Latest research advances**

This session will focus on the latest scientific advances emerging from NIH and CDC research grantees, with an emphasis on how scientific efforts have been and could be better directed toward the most pressing public health practice community needs.

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10:00-10:15 **Health Impacts of Weather Extremes and Long-term Weather Variability on Vulnerable Populations**

*Joel Schwartz, Harvard University*

10:15-10:30 **Extreme Weather, Birth Defects, and Lyme Disease: Translating Research Findings into Public Health Practice**

*Shao Lin, New York State Department of Health*

10:30-10:45 **Ciguatera and Climate Change: New Evidence for Blunting of Effect by Population Changes**

*Lynn Grattan, University of Maryland*

10:45-11:00 **Climate Change Impacts on Energy Demand and Health**

*Jonathan Patz, University of Wisconsin*

11:00-11:45 **Discussion**

**Moderator:** *Gwen Collman, NIEHS*

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11:45 a.m. –1:00 p.m. **Lunch**

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1:00-2:45 p.m. **Panel 2 – How science can best aid public health planning and response**

This session will highlight ongoing planning and response projects from CDC practice grantees with an emphasis on how science has been and could be better integrated into projects moving forward.

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1:00-1:15 **Preparing for Extreme Heat Events in Maine? You've Got to be Kidding!**

*Andrew Smith, Maine Center for Disease Control and Prevention*

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1:15-1:30 **Oregon's Climate and Health Program: Raising Capacity to Address Climate Risk at the Local Level**

*Jae Douglas, Oregon Center for Health Protection*

1:30-1:45 **New York City Climate and Health: Responding Today, Adapting for Tomorrow**

*Nathan Graber, New York City Department of Health and Mental Hygiene*

1:45-2:00 **Local Climate Adaptation: Research and Practice in Michigan**

*Lorraine L. (Lorri) Cameron, Michigan Department of Community Health*

2:00-2:45 **Discussion**

*Moderator: Gino Marinucci, CDC*

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2:45-3:00 p.m. **Break**

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3:00-4:30 p.m. **Panel 3 – Surveillance data and indicators for public health solutions**

This session will highlight data needs and challenges for both the research and public health practice community. Speakers will discuss how they are approaching data availability and integration as well as identify current gaps in data sources and methodology.

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3:00-3:15 **Climate Information for Public Health Action: From Data to Development**

*Madeleine Thomson, Columbia University*

3:15-3:30 **Indicators for Extreme Weather and Health: What is Needed for Better Surveillance**

*Paul English, California Department of Public Health*

3:30-3:45 **Statistical Issues Arising from Integrating National Databases**

*Roger Peng, Johns Hopkins University*

3:45-4:30 **Discussion**

*Moderator: John Balbus, NIEHS*

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4:30-5:00 p.m. **Metadata Access Tool for Climate and Health (MATCH)**

This interactive session will include a live demonstration of this new online research tool developed by the Interagency Climate Change and Human Health Working Group's Data Integration team of the U.S. Global Change Research Program. MATCH is a geoportal repository for climate science and public health metadata of monitoring, surveillance, early warning systems, and other related research sets.

*Moderator: Juli Trtanj, NOAA*

## **DAY 2: January 31, 2013**

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8:30-9:15 a.m. **Day 2 keynote address: The National Climate Assessment**

*Kim Knowlton, Natural Resources Defense Council*

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9:15-10:45 a.m. **Panel 4 – Addressing vulnerable populations**

This session will highlight approaches to identifying vulnerable populations and associated planning and response. The panel will also discuss how research can inform adaptation, with a special emphasis on addressing health disparities and vulnerable populations. The session will begin with short presentations from three speakers followed by an open Q and A and discussion.

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9:15-9:30 **Community-Engaged Research in Urban and Rural Settings to Identify Health Risks from Extreme Heat Events**

*Julia Gohlke, University of Alabama at Birmingham*

9:30-9:45 **Building Resilience from Within: The Intersection of Research, Practice and Partnerships in a Changing Climate**

*Jalonne White-Newsome, WE ACT for Environmental Justice*

9:45-10:00 **Supplementing Extreme Heat Vulnerability Modeling with Remotely Sensed Data**

*Daniel Johnson, Indiana University – Purdue University Indianapolis*

10:00-10:45 **Discussion**

*Moderator: Sandra Howard, HHS*

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10:45–11:00 a.m. **Break**

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11:00 a.m.–12:30 p.m. **Panel 5 – Critical partnerships and consortia**

This session will highlight successful models for researchers and practitioners working together, as well as examples of community involvement in research and/or public health adaptation efforts. The session will begin with short presentations from three speakers followed by an open Q and A and discussion.

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11:00-11:15 **Stakeholder Perspectives Related to Health Department Priorities for Climate Change**

*Kathleen Clancy, New York State Health Department*

11:15-11:30 **International Partnerships to Understand, Anticipate, and Manage the Impacts of Climate**

*Simon Mason, International Research Institute*

11:30-11:45 **Developing International Hubs for Global Environmental and Occupational Health Research (GEOHealth)**

*Christine Jessup, Fogarty International Center*

11:45-12:30 **Discussion**

*Moderator: Joshua Rosenthal, Fogarty International Center*

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12:30–1:30 p.m. **Lunch**

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1:30–3:00 p.m. **Panel 6 – Translating science and practice for decision makers**

This session will focus on best practices for translating and communicating research and practice to reach decision makers, including key message development, case studies, and communication tools.

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1:30-1:45 **The New Communication Climate**

*Andrew Revkin, The New York Times/Pace University*

1:45-2:00 **Making the Case with Congress**

*Donald Hoppert, APHA*

2:00-2:15 **Why Climate Science Needs Social Science**

*Susan Bales, Frameworks Institute*

2:15-3:00 **Discussion**

*Moderator: Kimberly Thigpen Tart, NIEHS*

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3:00–3:30 p.m. **Closing remarks and group reflections**

*Claudia Thompson, NIEHS, and George Luber, NCEH*

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3.30 p.m. **End of symposium**

## Speaker Biosketches

**John Balbus, MD, MPH**

NIEHS



**DR. JOHN M. BALBUS**, M.D., M.P.H., serves as a senior advisor to the NIEHS Director on public health issues and as NIEHS liaison to its external constituencies, stakeholders, and advocacy groups. He also leads NIEHS efforts on [climate change](#) and human health. In this capacity he serves as HHS principal to the U.S. Global Change Research Program, for which he also co-chairs the Interagency Cross-Cutting Group on Climate Change and Human Health. Dr. Balbus' background combines training and experience in clinical medicine with expertise in epidemiology, toxicology, and risk sciences. He has authored studies and lectures on global climate change and health, transportation-related air pollution, the toxic effects of chemicals, and regulatory approaches to protecting susceptible subpopulations.

Before joining the NIEHS, Dr. Balbus was Chief Health Scientist for the non-governmental organization Environmental Defense Fund. He served on the faculty of The George Washington University, where he was founding Director of the Center for Risk Science and Public Health, founding co-Director of the Mid-Atlantic Center for Children's Health and the Environment, and Acting Chairman of the Department of Environmental and Occupational Health. He maintains an adjunct faculty appointment at the Johns Hopkins Bloomberg School of Public Health.

Dr. Balbus received his A.B. degree in Biochemistry from Harvard University, his M.D. from the University of Pennsylvania, and his M.P.H. from the Johns Hopkins School of Public Health. In addition to current membership on the Institute of Medicine Roundtable on Environmental Health Sciences, Research and Medicine, Dr. Balbus has also served as a member of the EPA Science Advisory Board, the National Research Council's Board on Environmental Studies and Toxicology and the EPA Children's Health Protection Advisory Committee. He is a member of the American College of Physicians, the American Public Health Association, and the Society of Toxicology.

**Susan N. Bales, MA**

The FrameWorks Institute



**SUSAN NALL BALES** is founder and president of the FrameWorks Institute, an independent nonprofit research organization founded in 1999 to advance the nonprofit sector's communications capacity for framing the public discourse about social problems. It has become known for its development of Strategic Frame Analysis™, which roots communications practice in the cognitive and social sciences. FrameWorks designs, conducts, manages and publishes multi-method, multi-disciplinary communications research to prepare nonprofit organizations to expand their constituency base, to build public will, and to further public understanding of specific social issues.

Ms. Bales is a senior fellow at the Center on the Developing Child at Harvard University. She has served as a visiting scientist in the department of society, human development, and health at the Harvard School of Public Health and a visiting scholar in education at the Harvard Graduate School of Education. She was awarded the Rural Sociological Society's 2004 award for excellence in translating research findings to policy.

A veteran communications strategist and issues campaigner, she has more than 30 years of experience researching, designing and implementing campaigns on social issues. Before founding FrameWorks in 1999, Bales served for six years as director of strategic communications and children's issues at the Benton Foundation, where she founded [www.connectforkids.org](http://www.connectforkids.org) (now

sparkaction.org), an award-winning Web gateway for news and research on children's issues. Bales served for four years as vice president for communications at the National Association of Children's Hospitals, where she helped create the popular "Who's for Kids and Who's Just Kidding?" public advocacy campaign and founded the Coalition for America's Children, with more than 350 organizational members. For eight years she served as president of Public Affairs Research & Communications, where she designed and managed communications campaigns nationwide.

A graduate of UCLA, she received her M.A. from Middlebury College.

## Linda Birnbaum, PhD, MS

NIEHS



**LINDA S. BIRNBAUM**, Ph.D., is Director of the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health (NIH), and [National Toxicology Program](#) (NTP). As NIEHS and NTP director, Birnbaum oversees a budget of \$780 million that funds biomedical research to discover how the environment influences human health and disease. The Institute also supports training, education, technology transfer, and community outreach. NIEHS currently funds more than 1,000 research grants.

A board certified toxicologist, Birnbaum has served as a federal scientist for nearly 32 years. Prior to her appointment as NIEHS and NTP Director in 2009, she spent 19 years at the Environmental Protection Agency (EPA) where she directed the largest division focusing on environmental health research. Birnbaum started her federal career with 10 years at NIEHS, first as a senior staff fellow at the National Toxicology Program, then as a principal investigator and research microbiologist, and finally as a group leader for the Institute's Chemical Disposition Group.

Birnbaum has received many awards and recognitions. In October 2010, she was elected to the Institute of Medicine of the National Academies, one of the highest honors in the fields of medicine and health. She was elected to the Collegium Ramazzini, received an honorary Doctor of Science from the University of Rochester, and a Distinguished Alumna Award from the University of Illinois. Her awards include the Women in Toxicology Elsevier Mentoring Award, the Society of Toxicology Public Communications Award, EPA's Health Science Achievement Award and Diversity Leadership Award, and 12 Science and Technology Achievement Awards, which reflect the recommendations of EPA's external Science Advisory Board, for specific publications.

Birnbaum is also an active member of the scientific community. She was vice president of the International Union of Toxicology, the umbrella organization for toxicology societies in more than 50 countries; former president of the Society of Toxicology, the largest professional organization of toxicologists in the world; former chair of the Division of Toxicology at the American Society of Pharmacology and Therapeutics; and former vice president of the American Aging Association. She is the author of more than 700 peer-reviewed publications, book chapters, abstracts, and reports. Birnbaum's own research focuses on the pharmacokinetic behavior of environmental chemicals; mechanisms of actions of toxicants, including endocrine disruption; and linking of real-world exposures to health effects. She is also an adjunct professor in the Gillings School of Global Public Health, the Curriculum in Toxicology, and the Department of Environmental Sciences and Engineering at the University of North Carolina at Chapel Hill, as well as in the Integrated Toxicology Program at Duke University.

A native of New Jersey, Dr. Birnbaum received her M.S. and Ph.D. in microbiology from the University of Illinois at Urbana-Champaign.

## Lorraine (Lorri) Cameron, PhD, MPH

Michigan Department of Community Health



**LORRI CAMERON** is an Environmental Epidemiologist Manager at the Michigan Department of Community Health (MDCH), supervising work at the state health department in environmental and occupational health, substance abuse and injury. Since 2010, she has been the principal investigator of grants from ASTHO and the CDC through the Climate Ready States and Cities Initiative and led the development of the Michigan Climate and Health Adaptation Plan, MiCHAP. Prior to her work on Climate Change, Dr. Cameron was the principal investigator of the Michigan Long-Term PBB Study, one of the longest running cohort studies of environmental contamination in the US.

Dr. Cameron holds an MPH in Epidemiology from the University of Michigan and a PhD in Environmental Epidemiology from Johns Hopkins. She was an EIS Officer assigned to the National Institute for Occupational Safety and Health, subsequently serving ten years there as a research scientist specializing in survey research. She is also Adjunct Assistant Professor of Epidemiology at Michigan State University.

## Kathleen Clancy, MPH

New York State Department of Health (NYSDOH)



**KATHLEEN CLANCY** is the Project Coordinator for the New York State Department of Health's CDC Climate-Ready States and Cities Initiative. She has a Master of Public Health degree with a concentration in Social Behavior and Community Health from the University of Albany School of Public Health. She is also credentialed as a Certified Health Education Specialist (CHES) and is Certified in Public Health (CPH). Prior to her public health career, Ms. Clancy had 10 years of experience in health care advertising and marketing. This included product launch strategic plan development, team management, market research, and creation of health education materials with messages tailored to diverse populations and audiences. Ms. Clancy's marketing and strategic planning methodology combined with her MPH training influence her approach to climate change adaptation planning and communication.

## Gwen Collman, PhD

NIEHS



**GWEN COLLMAN** is director of the NIEHS Division of Extramural Research and Training where she leads approximately 60 professional staff in areas of scientific program administration, peer review, and the management and administration of about 1,500 active grants each year. She directs scientific activities across the field of environmental health sciences including basic sciences (i.e., DNA repair, epigenetics, environmental genomics), organ-specific toxicology (i.e., reproductive, neurotoxicology, respiratory), public health related programs (i.e., environmental epidemiology, environmental public health), and training and career development. She also oversees the implementation of the Superfund Research Program and the Worker Education and Training Program.

Prior to her current role, Collman served in program development and management, beginning in 1992 as a member, then as Chief of the Susceptibility and Population Health Branch. During this time, she directed research on the role of genetic and environmental factors on the development of human disease, from animal models of genetic susceptibility to population studies focusing on etiology and intervention. She was responsible for building the NIEHS grant portfolio in environmental and molecular epidemiology, and developed several complex multidisciplinary research programs. These include the NIEHS Breast Cancer and the Environment Research Centers

Program, the NIEHS/EPA Centers for Children's Environmental Health and Disease Prevention, and the Genes, Environment and Health Initiative. Also, under her guidance, a team created a vision for the Partnerships for Environmental Public Health programs for the next decade.

In recognition of her achievements, she is the recipient of numerous NIEHS Merit Awards, two NIH Director's Awards, and the DHHS Secretary's Award for Distinguished Service. Collman received a Ph.D. in Environmental Epidemiology from the University of North Carolina School of Public Health where she was awarded the 2009 H.A. Tyroler Distinguished Alumni Award.

## Caroline Dilworth, PhD, MSPH

NIEHS

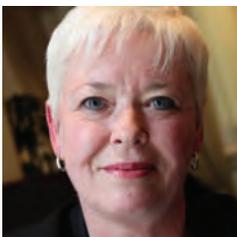


**CAROLINE DILWORTH**, Ph.D., is a health scientist administrator in the Division of Extramural Research and Training, where she co-directs the extramural environmental epidemiology program. She is responsible for developing a portfolio of grants focused on the impact of environmental exposures on human health, including male and female reproduction, pubertal maturation, cancer, adult cardiovascular and respiratory health, and general statistical methods development and exposure assessment for population-based studies. She leads the NIEHS Human Health Impacts of Climate Change program and is the lead program administrator for the puberty studies of the NIEHS and NCI-funded Breast Cancer and the Environment Research Program.

Prior to joining NIEHS in 2008, Caroline completed a postdoctoral fellowship at the University of North Carolina (UNC), where her research focused primarily on the adverse effects of exposure to drinking water disinfection by-products on pregnancy health. She received a joint MSPH in epidemiology and environmental and occupational health from Emory University and a Ph.D. in epidemiology from UNC.

## Jae Douglas, PhD

Oregon Health Authority



**JAE P. DOUGLAS** is a social and environmental scientist, serving as the senior administrative and technical resource for state and federally-funded environmental and occupational health programs in the Oregon Health Authority's Center for Health Protection.

Dr. Douglas has worked in the field of public health for 25 years, and has extensive knowledge, experience and expertise in working with communities addressing serious public health issues, most recently in the field of environmental and occupational health. She joined the Oregon Health Authority in 2004 and has led Environmental and Occupational Public Health since 2007.

Jae and her staff serve many audiences and stakeholders, including the legislature, local health departments, other state agencies, private industry partners, community based organizations, the media and the general public. They identify, assess and report on threats to human health from exposure to environmental and occupational hazards, and advise the people and communities of Oregon both on those hazards and ways to both reduce their risks and on ways to increase resiliency and to design environments and workplaces that promote healthy people, families, and communities.

Oregon was among the first states to be funded under the Climate Ready States Initiative. Jae and her team bring the same high level of creativity and focus on innovation to climate and health efforts that they are known for in other areas of environmental health. Oregon's climate and health program has focused primarily on increasing knowledge, skill and readiness at the local level to

address public health risks from climate change. The team and their local partners have developed important knowledge and insight into what local health professionals need in order to effectively address climate threats in communities around Oregon. Many of these lessons and insights are applicable to communities across the nation.

## **Paul English, PhD, MPH** Environmental Health Investigations Branch- California Department of Public Health

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**PAUL ENGLISH**, PhD, MPH, is currently State Environmental Epidemiologist and Science Advisor for the Environmental Health Investigations Branch at the California Department of Public Health. He was a World Health Organization advisor contributing to a systematic review of health indicators of climate change, was a consultant on heat preparedness for the Public Health Foundation of India, and serves on the Environment and Health Board for the American Meteorological Society. Dr. English received his Masters in public health and doctorate degree in Epidemiology from the University of California, Berkeley. He has over 16 years of experience working in environmental public health for the California Department of Public Health and has published extensively in the peer-reviewed literature.

## **Julia Gohlke, PhD** University of Alabama at Birmingham School of Public Health

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**JULIA GOHLKE** is an Assistant Professor in the Department of Environmental Health Sciences at the University of Alabama at Birmingham. Dr. Gohlke has a background in risk assessment, mechanisms of neurodevelopment, and bioinformatics and computational approaches for analyzing large datasets acquired through her graduate studies at University of Washington and postdoctoral fellowship at the National Institutes of Environmental Health Sciences. She has recently conducted analyses of health effects associated with different fuel sources for electricity production and evaluated seafood safety after the Deepwater Horizon oil spill. Currently, she is examining the health effects of exposure to high ambient temperatures in rural and urban populations in Alabama and initiating community-engaged research to develop effective adaptation strategies in both of these settings.

## **Nathan Graber, MD** New York City Department of Health and Mental Hygiene

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**DR. NATHAN GRABER** is the Medical Director for the Bureau of Environmental Disease Prevention at the New York City Department of Health and Mental Hygiene (NYC DOHMH). He is a fellow of the American Academy of Pediatrics, continues to care for patients in the Pediatric Emergency Department of St. Barnabas Hospital in the Bronx, and maintains an adjunct appointment at the Mount Sinai School of Medicine. He is primarily active on issues related to the prevention of illness and injury related to environmental exposures and occupational hazards. Most recently, he has lead a comprehensive surveillance project to understand drowning incidents in NYC, prevention efforts to reduce morbidity and mortality related to heat waves, and contributed to NYC's efforts to reduce the misuse of prescription opioids. Prior to working at DOHMH, he completed a fellowship in Pediatric Environmental Health at the Mount Sinai Medical School of Medicine along with earning his MPH. He started out his career in public health while in fellowship by drafting guidelines for the identification and management of pregnant women with elevated blood lead levels in NYC and contributed to the effort to create national guidance with CDC. He received his MD from the Sackler School of Medicine at Tel Aviv University and completed his residency in Pediatrics at Jacobi Medical Center in the Bronx.

## Lynn Grattan, PhD

University of Maryland School of Medicine



**LYNN GRATTAN** has a broad background in psychology and neuropsychology with specialized training and research experience in brain-behavior relationships; public health problems in coastal environments; and community mental health. She is the Director of the Neuropsychological Diagnostic and Research Laboratory at the University Of Maryland School Of Medicine and holds faculty appointments in Neurology, Psychiatry, Epidemiology and Public Health.

Dr. Grattan has been studying the impacts of climate on ciguatera poisoning in the U.S. Virgin Islands for more than 5 years, most recently serving as co-investigator on the CDC funded project, *Climate Change-Environmental Impact on Human Health*. In this project, her primary role was to identify risk factors for acute and chronic Ciguatera fish poisoning through emergency room based studies, these investigations expanded to include risk perceptions studies and island wide surveys to examine the impacts of climate change on incidence of ciguatera.

Dr. Grattan is also currently the Principal Investigator of two NIEHS funded studies: The CoASTAL cohort study of Domoic Acid Neurotoxicity in Native Americans in the Pacific Northwest and the Psychological Impacts of the Deepwater Horizon Oil Spill in NE Gulf Coast Communities.

In addition to her peer reviewed research, Dr. Grattan has authored numerous chapters in the diagnosis and intervention of people with neuropsychological deficits; dietary exposure to marine biotoxins as well as the behavioral predictors and sequelae of marine toxin exposures. She participates on numerous regional and national committees that plan, direct or fund coastal environmental health research.

## Donald Hoppert

American Public Health Association



**DON HOPPERT** is the Director of Government Relations at the American Public Health Association (APHA), the oldest public health association in the country. In this role, he leads the association's government relations and legislative advocacy activities on a variety of legislative issues including health reform, environmental health, funding for the Centers for Disease Control and Prevention, injury control and prevention and physical activity, nutrition and obesity. He also served as Director of Federal and Congressional Affairs at APHA from 1998 through 2004.

From 2004-2006, Don was a public policy and public affairs consultant in San Francisco, CA where he worked for both corporate and nonprofit clients on a variety of public policy issues, including prescription drug access, tobacco control, and emergency health services.

Don served as a Congressional aide to U.S. Representative Sherrod Brown from 1994 through 1998. He advised Representative Brown on several legislative issues including the environment, financial services, education and crime and judicial matters.

He received a BA in Environmental Policy and Analysis from Bowling Green State University.

## Sandra Howard

HHS



**SANDRA N. HOWARD** is the Senior Environmental Health Advisor in the Office of the Assistant Secretary for Health (OASH), U.S. Department of Health and Human Services (HHS). She co-chairs the HHS Environmental Justice Working Group and represents HHS on the Environmental Justice Federal Interagency Working Group. She also co-chairs the Senior Staff Steering Committee of the President's Task Force on Environmental Health Risks and Safety Risks to Children.

Ms. Howard has 29 years of experience in the development and coordination of Federal science policy. Prior to joining OASH, she served for twenty years as a senior policy analyst in HHS's Office of Science and Data Policy. She was the lead analyst for policy issues related to biomedical research and environmental health. She began her career at the National Institutes of Health (NIH), holding positions in budget, legislation and other policy and administrative areas. From there, she went to work for the Appropriations Committee of the U.S. House of Representatives. She later returned to NIH to help establish the Office of Minority Programs (now the National Institute on Minority Health and Health Disparities).

Ms. Howard is a graduate of Yale College. Her academic background is in medical anthropology and public health.

## Christine Jessup, PhD

Fogarty International Center, NIH



**CHRISTINE JESSUP** is a Program Officer in the Division of International Training and Research of the Fogarty International Center (FIC) of the National Institutes of Health (NIH), where she directs the health and environment grants portfolio and the global health career development program. Dr. Jessup received her PhD in Ecology and Evolutionary Biology from Stanford University. Following postdoctoral research on virus ecology and evolution at the Smithsonian National Zoological Park, Dr. Jessup received two AAAS Science and Technology Policy Fellowships: one leading strategic planning for climate and health activities in NOAA's Climate Program Office, and the other conducting research on infectious disease epidemiology and coordinating climate and health activities in FIC's Division of International Epidemiology and Population Studies. In addition to managing a portfolio of research and training grants, she co-founded the Trans-NIH Working Group for Climate and Health and serves on the U.S. Global Change Research Program's climate and health group. Dr. Jessup has authored a wide range of scientific and policy publications, including research reports, research reviews, commentaries, and book reviews on subjects including microbiology, ecology, biodiversity, and climate change and health.

## Daniel Johnson, PhD, MS

Indiana University – Purdue University Indianapolis



**DANIEL JOHNSON**, Ph.D. has extensive experience modeling vulnerability to extreme heat events in numerous cities nationwide. Dr. Johnson has worked with NASA and CDC to advance vulnerability models utilizing remotely sensed assets. He has developed a significant research agenda at Indiana University that models vulnerability using geospatial and data fusion techniques utilizing environmental and socioeconomic data.

## Kim Knowlton, DrPH, MS

Natural Resources Defense Council



**KIM KNOWLTON**, DrPH, is Senior Scientist in the Health and Environment program at the Natural Resources Defense Council (NRDC) in New York City and Co-Deputy Director of NRDC's Science Center. She is also Assistant Clinical Professor of Environmental Health Sciences at the Mailman School of Public Health, Columbia University; Adjunct Professor at the Bard Center for Environmental Policy; Co-Convening Lead Author for the Human Health chapter of the 2013 National Climate Assessment; and past Chair of the Global Climate Change and Health Topic Committee of the American Public Health Association's Environment Section. Kim was among the researchers who participated in the Intergovernmental Panel on Climate Change's 2007 Fourth Assessment Report. Her

work focuses on the health effects of climate change; advocating for strategies to prepare for and prevent these impacts, especially for our most vulnerable communities; and making health a more central feature of national, state and local climate change preparedness plans. She has researched heat- and ozone-related mortality and illnesses; connections between climate change, pollen, allergies and asthma, as well as infectious diseases like dengue fever; the health costs of climate change; and domestic and international climate-health adaptation strategies. Knowlton holds a Master's degree in Environmental and Occupational Health Sciences from Hunter College, and received her Doctorate in Public Health from the Mailman School of Public Health at Columbia University.

## Howard Koh, MD

Assistant Secretary for Health- HHS



**DR. HOWARD K. KOH** serves as the 14th Assistant Secretary for Health for the U.S. Department of Health and Human Services (HHS), after being nominated by President Barack Obama and confirmed by the U.S. Senate in 2009. Dr. Koh oversees 14 core public health offices, including the Office of the Surgeon General and the U.S. Public Health Service Commissioned Corps, 10 Regional Health Offices across the nation, and 10 Presidential and Secretarial advisory committees. He also serves as senior public health advisor to the Secretary. The Office of Assistant Secretary for Health implements an array of interdisciplinary programs relating to disease prevention, health promotion, the reduction of health disparities, women's and minority health, adolescent health, HIV/AIDS and chronic infectious diseases, vaccine programs, fitness, sports and nutrition, bioethics, population affairs, blood supply, research integrity and human research protections. As the Assistant Secretary for Health, Dr. Koh is dedicated to the mission of creating better public health systems for prevention and care so that all people can reach their highest attainable standard of health.

Dr. Koh previously served as the Harvey V. Fineberg Professor of the Practice of Public Health and Associate Dean for Public Health Practice at the Harvard School of Public Health. He was also Director of the Harvard School of Public Health Center for Public Health Preparedness. He has published more than 200 articles in the medical and public health literature in areas such as disparities, cancer control, melanoma and skin oncology, tobacco control, public health preparedness, disease prevention and health promotion, and public health leadership.

Dr. Koh served as Commissioner of Public Health for the Commonwealth of Massachusetts (1997-2003) after being appointed by Governor William Weld. Dr. Koh graduated from Yale College, where he was President of the Yale Glee Club, and the Yale University School of Medicine. He completed postgraduate training at Boston City Hospital and Massachusetts General Hospital, serving as chief resident in both hospitals. He has earned board certification in four medical fields: internal medicine, hematology, medical oncology, and dermatology, as well as a Master of Public Health degree from Boston University. At Boston University Schools of Medicine and Public Health, he was Professor of Dermatology, Medicine and Public Health, as well as Director of Cancer Prevention and Control.

## George Lubber, PhD

CDC



**GEORGE LUBER, PHD**, is an epidemiologist and the Associate Director for Climate Change in the Division of Environmental Hazards and Health Effects at the National Center for Environmental Health, Centers for Disease Control and Prevention.

Since receiving his PhD in Medical Anthropology from the University of Georgia, and joining CDC in 2002, Dr. Lubber has served as an Epidemic Intelligence Service (EIS) Officer and staff epidemiologist at the National Center for Environmental Health. His research interests in Environmental Health are broad and include the health impacts of environmental change and biodiversity loss, harmful

algal blooms, and the health effects of climate change. Most recently, his work has focused on the epidemiology and prevention of heat-related illness and death, the application of remote sensing techniques to modeling vulnerability to heat stress in urban environments, and Climate Change adaptation planning.

In addition to managing the Climate Change Program at CDC, Dr. Luber is a Co-Chair of the Climate Change and Human Health Interagency Workgroup at the US Global Change Research Program, a Convening Lead Author and member of the Federal Advisory Committee (ex-officio) for the US National Climate Assessment, a member of the American Anthropological Association's Presidential Task Force on Climate Change, and a lead author for the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report.

## Gino Marinucci, MPH

CDC



**GINO MARINUCCI** is the Strategy and Policy Advisor for the Climate and Health Program at the U.S. Centers for Disease Control and Prevention. In addition to climate change strategy and policy responsibilities, he currently works with state and local health departments in the US, to build their capabilities to address climate change. Mr. Marinucci's work history spans public health action in environmental health, communicable diseases, immunization and chronic disease prevention in Australia, the United Kingdom and the United States. His experience includes working in state and federal government, non-government organizations and as an advisor to the Western Australian Minister for the Environment. Prior to joining CDC in July, 2010, Mr. Marinucci spent four years as Senior Director for Environmental Health Policy and Programs at the Association of State and Territorial Health Officials in Washington D.C. He is a graduate of CDC's Environmental Public Health Leadership Institute and holds a Master of Public Health Degree from the University of Western Australia, a Post Graduate Diploma in Ecological Public Health Policy from Murdoch University, and a Bachelor of Science Degree in Environmental Health from Curtin University.

## Simon Mason

The International Research Institute for Climate and Society - Columbia University

**SIMON MASON** is Chief Climate Scientist at the International Research Institute for Climate and Society (IRI), part of the Earth Institute at Columbia University. He is leader of the IRI's disaster work, a key component of which is the [\*Partnership to Save Lives\*](#) with the [\*International Federation of Red Cross and Red Crescent Societies \(IFRC\)\*](#). Mason has worked extensively with the World Meteorological Organization, including most recently as a member of the drafting team for the [\*High-Level Task Force on the Global Framework for Climate Services \(GFCS\)\*](#), and as a lead author for the GFCS Implementation Plan. He has been heavily involved in capacity development activities in developing countries, primarily in Africa, with the aim of helping to develop national climate service capabilities. As part of these activities he has lead the development and support of the [\*Climate Predictability Tool \(CPT\)\*](#), a software package designed to produce climate forecasts. Mason's main areas of research include evaluation of the quality of forecasts, and development and use of climate information for humanitarian action. He was a contributing author to the recently published *IPCC Special Report: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*.

He has degrees from the University of the Witwatersrand, South Africa, and the University of Oxford, England.

## Jonathon Patz, MD, MPH

University of Wisconsin



**DR. JONATHON PATZ**, MD, MPH, is Professor & Director of the Global Health Institute at the University of Wisconsin in Madison. For the past 15 years, Dr. Patz served as a lead author for the United Nations Intergovernmental Panel on Climate Change (or IPCC) – the organization that shared the 2007 Nobel Peace Prize with Al Gore. He also Co-chaired the health expert panel of the US National Assessment on Climate Change, a report mandated by the US Congress.

Dr. Patz has written over 90 peer-reviewed scientific papers, a textbook addressing the health effects of global environmental change, and most recently, a co-edited five-volume Encyclopedia of Environmental Health (2011). He has been invited to brief both houses of Congress and has served on several scientific committees of the National Academy of Sciences. Dr. Patz served as Founding President of the International Association for Ecology and Health.

In addition to directing the university-wide Global Health Institute, Professor Patz has faculty appointments in the Nelson Institute, Center for Sustainability & the Global Environment (SAGE) and the Department of Population Health Sciences. He also directs the NSF-sponsored Certificate on Humans and the Global Environment (CHANGE).

Dr. Patz is double board-certified, earning medical boards in both Occupational/Environmental Medicine and Family Medicine and received his medical degree from Case Western Reserve University (1987) and his Master of Public Health degree (1992) from Johns Hopkins University.

## Roger Peng, PhD

Johns Hopkins Bloomberg School of Public Health



**ROGER D. PENG** is an Associate Professor of Biostatistics at the Johns Hopkins Bloomberg School of Public Health. He received his PhD in Statistics from the University of California, Los Angeles. He is a prominent researcher in the areas of air pollution, climate change, and health risk assessment and statistical methods for spatial and temporal data. He is a national leader in the area of methods and standards for reproducible research, and is the Reproducible Research editor for the journal Biostatistics. He has developed novel approaches to integrating complex national databases for assessing population health effects of environmental exposures and has developed software for efficiently distributing data over the Web for disseminating reproducible research. Dr. Peng's research is highly interdisciplinary and his work has been published in major substantive and statistical journals, including the *Journal of the American Medical Association*, *Journal of the American Statistical Association*, *Journal of the Royal Statistical Society*, and *American Journal of Epidemiology*. Dr. Peng is the author of over a dozen software packages implementing statistical methods for environmental studies, methods for reproducible research, and data distribution tools.

## Christopher Portier, PhD, MS

CDC



**CHRISTOPHER J. PORTIER**, PhD, joined CDC in 2010 as the Director of the National Center for Environmental Health and Agency for Toxic Substances and Disease Registry. Dr. Portier has worked for over 30 years to identify the impacts of our environment on our health and find ways to better protect people from environmental hazards. Prior to 2010, Dr. Portier was with the National Institute of Environmental Health Sciences (NIEHS), where he was a Principal Investigator in systems biology. He also served in many leadership roles at NIEHS including Senior Advisor to the Director, Associate Director, Director of the Environmental Toxicology Program, and Associate Director of the National Toxicology Program (NTP).

Dr. Portier is an internationally recognized expert in the design, analysis, and interpretation of environmental health data. His research efforts and interests include such diverse topics as cancer biology, risk assessment, climate change, bioinformatics, immunology, neurodevelopment, genetically modified foods, and genomics. As Associate Director of the NTP he developed a strategic initiative that is internationally recognized for its innovation. He has contributed to the development of cancer risk assessment guidelines for national and international agencies and has either directed or contributed significantly to numerous national and multinational risk assessments. He led the U.S. evaluation of electromagnetic fields by national and international scientists, which was the first comprehensive review in this field. Dr. Portier directed efforts of the U.S. government to develop a collaborative research agenda with Vietnam on the health effects of Agent Orange. He directed a multiagency review of research needs for the health effects of climate change for the entire U.S. government. He has served as an advisor to the Finnish Academy of Sciences, as a member of World Health Organization/International Agency for Research on Cancer scientific committees, and as a reviewer for grants for the United States, the European Union, and many other grant-sponsoring organizations.

Dr. Portier graduated from Nicholls State University with a BSc in mathematics and received both his MS and PhD degrees in biostatistics from the University of North Carolina in Chapel Hill. He has authored more than 180 peer-reviewed publications, 30 book chapters, and 40 technical reports. In the past 5 years, he has given more than 70 invited lectures, many of them at international meetings.

## Judith Qualters, PhD, MPH

CDC



**JUDITH QUALTERS** is a Distinguished Consultant at the Centers for Disease Control and Prevention (CDC) and serves as Director, Division of Environmental Hazards and Health Effects of the National Center for Environmental Health. Health issues investigated by Dr. Qualters' Division include, among others, carbon monoxide poisoning, asthma, drinking water contamination, air pollution, radiation exposures, environmental health tracking, cancer clusters, climate and health, and morbidity and mortality related to heat waves and extreme weather events. Prior to becoming the Division Director, Dr. Qualters managed the Environmental Health Tracking Branch since its inception in 2002. She has been a scientist at CDC since 1989 where she has investigated cancer among Vietnam Veterans as part of the Agent Orange Projects, analyzed cancer and non-cancer health risks among communities exposed to contaminants from nuclear weapons production and testing, and worked on the conceptualization and implementation of two large national programs: CDC's Breast and Cervical Cancer Early Detection Program and the National Program of Cancer Registries. Dr. Qualters received her M.P.H. in Epidemiology from the University of Michigan in 1982. She was awarded her Ph.D. in Epidemiology from the University of North Carolina at Chapel Hill in 1992.

## Andrew Revkin

Pace Academy for Applied Environmental Studies



**ANDREW REVKIN** is the senior fellow for environmental understanding at Pace University's Academy for Applied Environmental Studies and writes the award-winning Dot Earth blog for the Op-Ed section of The New York Times. He has spent nearly three decades covering subjects ranging from the assault on the Amazon rain forest to the changing conditions around the Arctic, from the troubled relationship of climate science and politics to the environmental impacts of rising human populations and resource appetites.

From 1995 through 2009, he covered the environment for The Times as a staff reporter. His quarter century of coverage of global warming has earned most of the major awards for science journal-

ism along with the John Chancellor Award for sustained journalistic excellence from Columbia University. Revkin has been a pioneer in multimedia communication, blogging and shooting still and video imagery in far-flung places. Dot Earth was created under a John Guggenheim Foundation Fellowship. Revkin has also carried his journalism to a new generation in *The North Pole Was Here: Puzzles and Perils at the Top of the World*, the first book on Arctic climate change written for the whole family. His other books are *The Burning Season*, which was the basis for a much-lauded HBO film, and *Global Warming: Understanding the Forecast*, which accompanied the first museum exhibition on climate change, at the American Museum of Natural History, in 1992. At Pace, he teaches courses on blogging, environmental-science communication and documentary video with a focus on sustainable development. He has written three book chapters on communication and the environment and speaks to varied audiences around the world about the power of the Web to foster progress on a finite planet. Revkin lives in the Hudson River Valley with his wife and two sons. In spare moments, he is a performing songwriter who occasionally backs up Pete Seeger and plays in a twangy roots jam band, [Breakneck Ridge](#).

## Joshua Rosenthal, PhD

Fogarty International Center, NIH



**JOSHUA ROSENTHAL** directs the Division of Research and Research Training grants for the Fogarty International Center (FIC) of the National Institutes of Health. He is an ecologist with a longstanding interest in the integration of public health, environment, and international development. Before coming to the NIH, Dr. Rosenthal completed his Ph.D. and post-doctoral research at the University of California, Berkeley. He came to the Fogarty Center as a AAAS Science and Diplomacy Fellowship to work on drug discovery and biodiversity conservation and subsequently directed the health and environment grants portfolio of FIC for over 15 years, including the International Cooperative Biodiversity Groups, Ecology of Infectious Diseases, Zoonotic Influenza, International Training in Environmental and Occupational Health, and Climate and Health programs. In 2011, Dr. Rosenthal was a Senior Fulbright Fellow at the University of Buenos Aires, Argentina where he taught a graduate course in Global Environmental Change and Human Health, and in 2012 he served as the Deputy Director of the Fogarty International Center. He has authored a wide variety of technical, policy and popular publications, including research reports, research topic reviews, global health program analyses, editorials, magazine articles and one edited book on Biodiversity and Human Health. Dr. Rosenthal serves and has served on advisory panels and policy working groups for a variety of NIH, U.S. Government, United Nations and World Health Organization programs on zoonotic diseases, biodiversity, climate and health, household air pollution, informatics, genetic resources and biomedicine.

## Joel Schwartz, PhD

Harvard School of Public Health



**JOEL SCHWARTZ** is a Professor of Environmental Epidemiology at the Harvard School of Public Health. His research is divided in three main areas: epidemiology looking at the health consequences of exposure to pollutants; methodological questions regarding the modeling of continuous covariates in epidemiologic studies, both for better covariate control and to more accurately assess the relationship between exposure and response; and the effects of antioxidants on respiratory health. An area of interest is in the use of cost benefit analysis to make environmental decisions. Schwartz has developed benefit methodologies for assessing the benefits of lead control, and applied those methodologies to the decision to remove lead from gasoline, and recently, in collaboration with colleagues at the Centers for Disease Control, to a decision to revise their screening recommendations for children. He is also involved in cost benefit analysis of air pollution control.

## Andrew E. Smith, SM, ScD

Maine Center for Disease Control and Prevention



Andrew Smith is the State Toxicologist and Director of the Environmental and Occupational Health Programs within the Maine Center for Disease Control and Prevention, Maine Department of Health and Human Services. Dr. Smith leads a team of scientists including toxicologists, epidemiologists, a public health physician, public health nurse, and information technology specialists that work on a range of topics including carbon monoxide poisoning, childhood and adult lead poisoning, fish consumption advisories, extreme heat events, private well water safety, and toxic chemicals in children's products. He is the Principal Investigator on three U.S. CDC Cooperative Agreements: Environmental Public Health Tracking, Healthy Homes and Lead Poisoning Prevention; and Climate Change Adaptations. Dr. Smith obtained his master's and doctorate of science degrees in environmental health from the Harvard School of Public Health. He has published in the fields of oceanography, toxicology, epidemiology and environmental health. Dr. Smith has served on USEPA external scientific advisory panels on mercury toxicology and arsenic exposure, is a member of the External Advisory Board for Dartmouth College's Children's Environmental Health Center, and is an Adjunct Associate Research Professor at the University of Southern Maine.

## Kimberly Thigpen Tart, JD

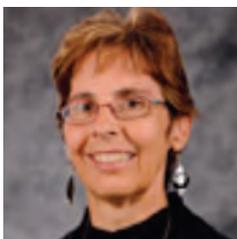
NIEHS



**KIMBERLY THIGPEN TART** is a Program Analyst in the Office of Program, Planning and Evaluation at the National Institute of Environmental Health Sciences focusing on issues of climate change and human health, global environmental health policy, and research translation. In 2009 she served as Coordinating Editor of the interagency report: *A Human Health Perspective on Climate Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change*. She currently serves on the Communications and Education Steering Committee for the U.S. Global Change Research Program and as a member of the program's Climate Change and Human Health Group. She received her B.A. with Honors in journalism and her J.D. from the University of North Carolina at Chapel Hill, where she is currently pursuing a Masters in Public Health Leadership.

## Claudia Thompson, PhD, MSc

NIEHS



**CLAUDIA THOMPSON**, Ph.D., is the branch chief for the Susceptibility and Population Health Branch (SPHB). She joined the Division of Extramural Research and Training in 1994 as a program administrator for the Superfund Research Program (SRP) and was also responsible for building the grant portfolio in the scientific areas of biomarker (exposure, effect, and susceptibility) development, metabolic toxicology, chemical mixtures research and molecular mechanisms of metal toxicity and carcinogenicity. In addition to her branch chief responsibilities, Thompson is a senior advisor to the SRP and is providing leadership to the Deepwater Horizon Disaster Academic-Community Research Consortium.

Thompson received her B.S. in biology from Bradley University in Peoria, Ill., and her Ph.D. in biochemistry and nutrition from the University of North Carolina at Chapel Hill. Prior to joining DERT in 1994, Claudia was a research scientist for 10 years in the Laboratory of Biochemical Risk Analysis in the Division of Intramural Research at NIEHS.

## Madeleine Thomson, PhD

International Research Institute for Climate and Society, Columbia University



**MADELEINE THOMSON** is based at Columbia University, New York where she is a Senior Research Scientist at the International Research Institute for Climate and Society (IRI), a Senior Research Scholar at the Mailman School of Public Health and the Director of the IRI-PAHO-World Health Organization Collaborating Centre for malaria early warning and other climate sensitive diseases.

Trained originally as a field entomologist (Ph.D. Liverpool University, M.Sc. Imperial College, London, BSc Sheffield University), with six years field experience in living in West Africa (Sierra Leone and The Gambia while working for the UK Medical Research Council), she has spent much of her career engaged in operational research in support of large-scale health interventions, primarily in Africa. Her research focuses on climate-sensitive health outcomes and includes vector, water and air-borne diseases. It is centered on the role that environment (especially climate variability and change) plays in driving changes in spatial and temporal risk. Her work draws on a wide range of disciplines including entomology, epidemiology, geography, climate science, remote sensing, spatio-temporal modeling, risk analysis, policy analytics etc. and focuses on relevance of this knowledge (and associated data methodology and tools) to public health planning, surveillance and response.

## Juli Trtanj, MS

NOAA



**JULI TRTANJ** is responsible for developing and implementing the National Oceanic and Atmospheric Administration (NOAA) Health Strategy across NOAA and with other federal, state, local and international Agencies, academic and private sector partners. She is the NOAA Lead for the Memorandum of Understanding between NOAA and the Centers for Disease Control (CDC), and coordinates a burgeoning NOAA One Health Working Group and related Ecological Forecasting efforts on pathogens. Ms. Trtanj co-chairs the US Global Change Research Program, Climate Change and Human Health Group (CCHHG); the United States/European Union Task Force on Biotechnology, Marine Genomics Working Group; and the CDC- supported Environment and Public Health Tracking Network, Climate Change Content Working Group. She is the Water-Related Illness Component Lead for the Group on Earth Observations (GEO) and is directly involved with European, South African, Asian partners and the World Health Organization (WHO) in the development of the Early Warning Systems, specifically for cholera and other vibrios. Ms. Trtanj is also an active collaborator in the NSF-funded Research Collaboration Network on Marine Emerging Diseases and is on the American Meteorological Society Board on Health and the Environment. From 1996 to present she has developed and directed multidisciplinary and multi-partner programs on Oceans and Human Health, and Climate Variability and Human Health. She has contributed to, reviewed, or edited sections of several IPCC and US National Climate Assessment reports and authored several book chapters and journal articles. She earned her Master in Environmental Science from Yale School of Forestry and Environmental Studies in 1994, and her Bachelors in 1986 from the University of California Santa Barbara.

**Jalonne White-Newsome, PhD, MS**

WE ACT



**JALONNE L. WHITE-NEWSOME** is a Federal Policy Analyst for WE ACT for Environmental Justice, based in the Washington, DC office. In this capacity, she engages in advocacy and education on Capitol Hill, to ensure an environmental justice perspective is included in policy and legislative conversations on clean air, toxic chemicals, clean energy, climate change and adaptation. Jalonne provides coordination for a national coalition, the Environmental Justice Leadership Forum on Climate Change (EJLFCC), whose mission is to engage with scientists and advocates to reduce carbon emissions. Prior to joining WE ACT, Jalonne was the inaugural Kendall Science Fellow in climate change and public health with the Union of Concerned Scientists (UCS) in DC, where she continues to engage in independent research on climate change adaptation, health and the costs of adaptation. While matriculating through the Environmental Health Sciences Department at the University Of Michigan School Of Public Health, her dissertation research focused on understanding the public health impacts of extreme heat events, specifically related to indoor heat exposure and how the urban-dwelling elderly adapt to hot weather. She spent a lot of her time translating her research into action through community outreach and engaging local policy makers and leaders on related issues. Before her time in academia, she spent over 10 years working in various manufacturing facilities, predominantly as an environmental manager, which also entailed assuming the role of emergency coordinator and voluntarily, liaising with the surrounding communities. She is also an adjunct professor at Kettering University in Flint, Michigan, and a Professorial Lecturer at The George Washington University. A native Detroiter, Jalonne also holds a bachelor's degree in chemical engineering from Northwestern University and a master's degree in Environmental Engineering from Southern Methodist University.

## Program Updates

### Building Resilience Against Climate Effects in State, Territorial and Tribal Health Departments



Anderson

#### **PRINCIPAL INVESTIGATOR:**

- *Dr. Henry Anderson, Wisconsin Department of Health Services*

#### **OTHER PARTNERS & KEY PERSONNEL:**

- *University of Wisconsin-Madison*
- *Department of Population Health Sciences, Center for Climatic Research*
- *Medical College of Wisconsin*
- *U.S. Geological Survey*
- *University of Wisconsin-Milwaukee*
- *Wisconsin Department of Natural Resources*
- *Wisconsin Department of Agriculture, Trade, and Consumer Protection*
- *Wisconsin Emergency Management*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

#### **BRIEF DESCRIPTION:**

The CDC Building Resilience Against Climate Effects (BRACE) grant will strengthen the ability of the Wisconsin Department of Health Services (DHS) to assist Wisconsin communities in planning for, responding to, and recovering from adverse weather events. This grant will leverage the knowledge and experience of DHS environmental health emergency response staff who address the public health implications of natural disasters and have expertise with health outcome and demographic data. It will also incorporate the analyses of weather data and downscaled models from the State Climatology Office, U.S. Geological Survey (USGS) studies, and research already conducted by Wisconsin's academic community to identify the weather events and localities most vulnerable to past and future public health impacts. DHS will establish an expert science advisory group of public health partners already involved in climate and health.

DHS will also prepare a Wisconsin Climate and Health Profile that describes the anticipated key risk factors and health impacts associated with climate in Wisconsin. Once the data and analyses are compiled, DHS will then work with local health departments, local emergency managers and others to develop adaptation plans that minimize the potential for future adverse health impacts.

#### **KEY SUCCESS & OUTCOMES:**

We are just beginning the BRACE grant, so staff recruitment and program start-up are underway.

## Developing a State-Level Health Impact Assessment of Climate Change in Wisconsin



Anderson

### PRINCIPAL INVESTIGATOR:

- *Dr. Henry Anderson, Wisconsin Department of Health Services*

### OTHER PARTNERS & KEY PERSONNEL:

- *University of Wisconsin-Madison*
- *Department of Population Health Sciences, Center for Climatic Research*
- *Medical College of Wisconsin*
- *U.S. Geological Survey*
- *University of Wisconsin-Milwaukee*

**FUNDING SOURCE:** CDC Climate Change Research and Development Grantee

### BRIEF DESCRIPTION:

The overall goal of this research project was to develop predictive models of climate change-related precipitation variability that pose environmental health risks at a statewide scale. The downscaled climate models analyzed by our project will be used to identify the magnitude and frequency of heavy precipitation in Wisconsin resulting from climate change, as well as areas within Wisconsin that will most likely be impacted by extreme weather-related events. The main climate-health interaction that we analyzed was the relationship between rainfall and gastrointestinal illness.

### KEY SUCCESS & OUTCOMES:

Targeted stakeholder engagement has occurred through PI, co-investigator, and other grant staff involvement on the scientific board and various work groups of the Wisconsin Initiative on Climate Change Impacts (WI CCI). Downscaled climate models have been generated and results indicate that heavy rainfall and total precipitation will increase across the entire state of Wisconsin as a result of climate change. We explored the relationship over time between rainfall and acute gastrointestinal illness (AGI) across the state. Statewide data did not show an association between rainfall and AGI amongst adults. This is different than what was found for children where a significant relationship was found between rainfall and pediatric ED visits for AGI in Wauwatosa, Wisconsin (Drayna et al. 2010). Our findings of no association between rainfall and AGI may be real (i.e. there is no association) or we don't have the right data at this point. Researchers believe that emergency department visits do not provide a strong enough "signal" to really represent that burden of disease across the state, so the information available is limited. Electronic medical record patient encounter data may be the best opportunity to advance understanding of climate-health interactions. More research using detailed data sources is needed (e.g. targeted long-term epidemiologic surveys, use of clinic/office visit data, or potential use of alternative health data resources such as pharmacy sales data to study issues of AGI and rainfall).

We plan to look at hazards forecasting specifically for children using data from previous studies. We also are collaborating with the Center for Water Policy at the School of Freshwater Sciences, UW-Milwaukee to craft messages from the research and to organize workshops to disseminate the findings.

**PROJECT OUTPUTS:**

- Drayna et al. "Association between rainfall and pediatric Emergency department visits for acute gastrointestinal illness." *Environ Health Perspect* 2010; 118(10):1439-1443.  
<http://dx.doi.org/10.1289/ehp.0901671>
- Gorelick et al. "Water use and acute diarrhoeal illness in children in a United States metropolitan area." *Epidemiology and Infection* 2011; 139(2): 295-301.  
<http://dx.doi.org/10.1017/S0950268810000828>
- Holman and Vavrus. "Understanding simulated extreme precipitation events In Madison, Wisconsin, and the role of Moisture Flux Convergence during the Late Twentieth and Twenty-First Centuries." *J Hydrometeor* 2012; 13: 877-894.  
<http://dx.doi.org/10.1175/JHM-D-11-052.1>
- Kucharik et al. "Patterns of climate change across Wisconsin from 1950 to 2006." *Physical Geography* 2010; 31(1): 1-28.  
<http://dx.doi.org/10.2747/0272-3646.31.1.1>
- Newton et al. "Lachnospiraceae and Bacteroidales Alternative Fecal Indicators Reveal Chronic Human Sewage Contamination in an Urban Harbor." *Appl Environ Microbiol* 2011; 77(19): 6972-6981.  
<http://dx.doi.org/10.1128/AEM.05480-11>

## Climate Change and Health: Assessing the Risk of Preterm Delivery



Avalos

### PRINCIPAL INVESTIGATORS:

- *Lyndsay Ammon Avalos, PhD, MPH, Kaiser Permanente Northern California, Division of Research, Oakland, CA*
- *Rupa Basu, PhD, Office of Environmental Health Hazard Assessment, Oakland, CA*

### OTHER PARTNERS & KEY PERSONNEL:

- *De-Kun Li, MD, PhD, Co-Investigator, Kaiser Permanente Northern California, Division of Research, Oakland, CA*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235



Basu

### BRIEF DESCRIPTION:

The proposed study examines an innovative hypothesis and a previously unknown risk factor for preterm delivery (PTD) that has newly emerged from the literature. Specifically, the objective of the proposed study is to examine the impact of climate change on the risk of PTD, and will be among the first such studies designed to address this association in a clinical setting. To achieve the proposed aims, we will conduct a case-crossover study utilizing members of Kaiser Permanente Northern California (KPNC), an integrated health care delivery system with more than 33, 000 deliveries each year. The case-crossover is a study design uniquely suited for examining the association between short-term high ambient temperature and the risk of PTD, as it has the advantage of eliminating potential measured and unmeasured confounders inherently by study design. The proposed study will use data on deliveries that occurred between January 1995 and December 2009 from KPNC's electronic medical records (EMR), which includes information on residence at the time of deliveries. Data on maternal residential apparent temperature, a measure of both temperature and relative humidity combined, will be provided by the California Irrigation and Management System and the US Environmental Protection Agency. A cohort of approximately half a million births will be identified through KPNC's EMR, and approximately ten percent of these births are expected to be preterm. The analyses will be stratified by season, and also by maternal race/ethnic group, maternal age, and socioeconomic status. Findings from this study will contribute to the nascent understanding of this relationship. Once the relationship between increased risk of PTD and apparent temperature has been established, public health interventions can be implemented to reduce the impact of increasing heat exposure on pregnant women, while targeting those who are at greatest risk. Precautions may include drinking more fluids and electrolytes, staying indoors in air conditioned environments, and being with others during the warm season, especially during heat waves.

### KEY SUCCESS & OUTCOMES:

We are in the process of ascertaining and merging all data birth data from Kaiser Permanente Northern California's electronic medical records and the temperature and pollution data from the Office of Environmental Health Hazard Assessment.

## Impact of Climate Change on Mosquito-Borne Arbovirus Transmission

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### PRINCIPAL INVESTIGATOR:

- *Chris M. Barker, University of California, Davis*

### OTHER PARTNERS & KEY PERSONNEL:

- *William K. Reisen, Co-PI [original grant awardee], University of California, Davis*

**FUNDING SOURCE:** NIH R01 Persistence of WNV In California

CDC Climate Change: Environmental Impact on Human Health (U01)

Fogarty RAPIDD Fellow Vectorborne Diseases

### BRIEF DESCRIPTION:

Our overall research seeks to understand the role of climate and landscape on the persistence, ecology and epidemiology of mosquito-borne arboviruses, using California with its large human population and diverse ecology as a model system. Our program partners with surveillance activities by the California Department of Public Health and 65 mosquito control districts and ranges from basic studies on virus and mosquito genetics, avian pathogenesis, mosquito biology and virus ecology and epidemiology to translational studies related to intervention. Recently in collaboration with Georgetown University, we have applied a modelling approach to utilize our extensive field data to investigate factors leading to outbreaks and develop useful metrics of transmission that can be tracked over time and space and projected into the future.

### KEY SUCCESS & OUTCOMES:

Our improved laboratory diagnostics and data management have been coalesced into a risk assessment scheme to direct state-wide health policy and intervention for West Nile virus through mosquito control in California. This scheme is being refined and extended to include models to understand the potential impact of anthropogenic and climate change on the distribution and intensity of transmission in time and space.

### PROJECT OUTPUTS:

- Hartley DM, Barker CM, Le Menach A, Niu T, Gaff HD, Reisen WK. 2012. "Effects of temperature on emergence and seasonality of West Nile virus in California." *Am J Trop Med Hyg*, 86(5): 884-94.  
<http://www.ajtmh.org/content/86/5/884.long>
- Wheeler SS, Langevin SA, Brault AC, Woods L, Carroll BD, Reisen WK. 2012. "Detection of persistent west nile virus RNA in experimentally and naturally infected avian hosts." *Am J Trop Med Hyg*, 87(3): 559-64.  
<http://www.ajtmh.org/content/87/3/559.full>
- Thiemann TC, Reisen WK. 2012. "Evaluating sampling method bias in *Culex tarsalis* and *Culex quinquefasciatus* (Diptera: Culicidae) bloodmeal identification studies." *J Med Entomol*, 49(1): 143-9.  
<http://www.bioone.org/doi/abs/10.1603/ME11134>

- Wheeler SS, Vineyard MP, Barker CM, Reisen WK. 2012. "Importance of recrudescence of avian infection in West Nile virus overwintering: incomplete antibody neutralization of virus allows infrequent vector infection." *J Med Entomol*, 49(4): 895-902.

<http://www.bioone.org/doi/abs/10.1603/ME11286>

- Thiemann TC, Lemenager DA, Kluh S, Carroll BD, Lothrop HD, Reisen WK. 2012. "Spatial variation in host feeding patterns of *Culex tarsalis* and the *Culex pipiens* complex (Diptera: Culicidae) in California." *J Med Entomol*, 49(4): 903-16.

<http://www.bioone.org/doi/full/10.1603/ME11272>

## Vulnerability to Health Effects of Wildfires under a Changing Climate in the Western United States



Bell

### **PRINCIPAL INVESTIGATOR:**

- *Michelle L. Bell, Yale University, School of Forestry & Environmental Studies*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Francesca Dominici, Harvard University, School of Public Health, Dept. of Biostatistics*
- *Loretta Mickley, Harvard University, School of Engineering and Applied Science*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### **BRIEF DESCRIPTION:**

The IPCC concluded that climate change will likely cause forest fires to burn more intensely and spread more rapidly. NIH identified climate change and forest fires as a critical research need. According to the U.S. Forest Service, fire risk has already increased. Several studies suggest that forest fires affect health; however, the true health burden is unknown as no large-scale studies have been conducted. Current research is limited in scope and methods to estimate exposure to fire smoke. Scientific literature on ambient air pollutants indicates that some populations are more vulnerable than others. We hypothesize that some populations are more vulnerable to health impacts of forest fires under a changing climate. To estimate this vulnerability, new data and methods are needed. We propose to develop the necessary databases and methods so we can investigate the vulnerability to hospital admissions from forest fires in the western U.S. In Aim 1 (exposure estimation), we will develop a new approach to integrate a chemical transport model, GEOS-Chem, with state-of-the-science forest fire emission inventories to estimate the contribution of forest fires to airborne particulate matter (PM). Our method generates daily, gridded estimates of PM<sub>2.5</sub> from forest fire smoke and PM<sub>2.5</sub> from other pollutant sources. In Aim 2 (risk estimation) we will develop a data set linking weather conditions, individual-level data on hospital admissions and co-morbidities, and community factors (e.g., unemployment) at the zip-code level with PM<sub>2.5</sub> from forest fires. We will develop statistical models for estimating associations between forest fire smoke and hospitalizations for persons >65. In this aim, we identify which populations are most vulnerable with respect to individual factors (age, race, sex, pre-existing conditions), region, community factors (e.g., unemployment) and environmental factors (e.g., weather). In Aim 3 (exposure and risk prediction through 2050), we use approaches developed in Aim 1 and climate model projections to predict future area burned and forest fire emissions through 2050. These estimates will be used with chemical transport modeling to estimate future forest fire exposures. We will then use approaches from Aim 2 to predict changes hospitalization risk, by vulnerability, under changing climate.

### **KEY SUCCESS & OUTCOMES:**

- Assembly and format of national health database for Medicare hospital admissions (by cause of admissions, sex, and age) for each day at the county-level, and ongoing assembly of information for the zip-code level.
- Improvement of our fire prediction schemes for Southern California through (1) use of smaller eco-regions than in our previous study and (2) consideration of the Santa Anas on fire activity.
- Calculation of area burned in a future atmosphere in Southern California.
- Training of a postdoctoral fellow on climate and atmospheric chemical modeling.

- Review of scientific literature on the health impacts of forest fires (manuscript in preparation).
- Training of graduate students on biostatistical modeling to be used for forest fire and health.

**PROJECT OUTPUTS:**

- Manuscript submitted: “Ensemble projections of wildfire activity and carbonaceous aerosol concentrations over the western U.S.”
- Manuscript submitted: “Accountability assessment: an emerging opportunity for causal inference in air pollution epidemiology”
- Manuscript submitted: “Evidence on vulnerability and susceptibility to adverse health effects associated with short-term exposure to O<sub>3</sub> and PM”
- Manuscript submitted: “Are we becoming less vulnerable to heat? A national analysis of temporal changes in heat-related mortality in the US”
- Manuscript submitted: “Heat related respiratory hospitalizations and costs in the Medicare population”

***Copies available upon publication of Project Outputs.***

## Developing Public Health Capacity and Adaptations to Reduce Human Health Effects of Climate Change

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### **PRINCIPAL INVESTIGATOR:**

- *Guthrie S. Birkhead, MD, MPH, New York State Department of Health/Health Research, Inc.*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Millicent Eidson, MA, DVM, Co-Principal Investigator, New York State Dept of Health/Health Research, Inc.*
- *Robert Chinery, MS, PE, Co-Principal Investigator, New York State Dept of Health/Health Research, Inc.*
- *Kathleen Clancy, MPH, Project Coordinator, New York State Dept of Health/Health Research, Inc.*

**FUNDING SOURCE:** CDC Climate-Ready States and Cities Initiative

### **BRIEF DESCRIPTION:**

Project Goals:

1. Inform planning for the public health impacts of climate change across multiple NYSDOH program areas.
2. Enlist executive level support for climate change policies that will produce immediate and long-term health benefits for individuals who would be disproportionately affected by climate change.
3. Strengthen the collaboration of public and private partners to improve the effectiveness, reach and impact of actions within NYS to control public health effects of climate change.
4. Raise institutional awareness of climate change issues and considerations at senior leadership levels, address gaps, and enhance climate change risk communication.
5. Assess existing health and disease surveillance systems and available climate-health indicators for usefulness in meeting the long-term goals of monitoring public health impacts of climate change, informing policy makers and partners, and assessing the effectiveness of climate change adaptation planning.
6. Facilitate information sharing among key climate change collaborators on the federal, state, and local levels.

### **KEY SUCCESS & OUTCOMES:**

We have successfully partnered with programs within our State Health Department, with our local health departments, and with stakeholder organizations to provide educational information and to conduct needs assessments. Our needs assessment tools, based on the NYS Climate Action Plan (<http://www.dec.ny.gov/energy/80930.html>), have served as models for other states. We have established a strong intranet site with climate change and health content, and have provided presentations and newsletter articles within our public health community and to the Council of State and Territorial Epidemiologists (CSTE). We developed a table-top educational display.

Our surveillance data sets have been enumerated and their potential value for monitoring health effects from climate change has been explored. We partnered with CSTE in providing feedback on national surveillance indicators. We have begun BRACE analyses focusing on enteric diseases. We partnered with CDC and Emory University on a presentation at the Sept., 2012 Science Symposium on Climate and Health titled "Evidence based public health adaptation to climate change: considerations and best practices."

Our Department adaptation plan is under development based on the needs assessments and available surveillance. We have incorporated climate change and health into our Department's Extreme Weather Planning and Response Guide.

**PROJECT OUTPUTS:**

- NYS Department of Health Extreme Weather Planning and Response Guide
- 3 Needs Assessment Tools based on NYSCAP for State, Local Health, & Stakeholders
- NYS Association of County Health Officials presentation
- Climate Change and Zoonoses (presentation at the University at Albany)
- Evaluating State Health Surveillance Systems for Monitoring Climate & Health Impacts (poster)

***Copies available upon publication of Project Outputs.***

## Michigan Climate and Health Adaptation Program (MICHAP)



Cameron

### PRINCIPAL INVESTIGATOR:

- *Lorraine L. (Lorri) Cameron, MPH, PhD, Michigan Department of Community Health*

### OTHER PARTNERS & KEY PERSONNEL:

- *University of Michigan School of Public Health*
- *Michigan State University*
- *Michigan Dept. of Environmental Quality*
- *Michigan Association of Planners*
- *Local Public Health Officers and Environmental Health Directors*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

### BRIEF DESCRIPTION:

The MICHAP program is implementing the Michigan Climate and Health strategic adaptation plan, developed through needs assessment and consensus with state and local public health, academic, and nonprofit partners. The main focus of the plan is the integration of climate into public health practice, and specifically the development of capacity, tools and resources for local public health and communities to adapt to current and future climate impacts; with extreme heat events and vulnerable populations the first priority. To develop statewide capacity for using the Health Impact Assessment (HIA) tool in climate adaptation, we sponsored trainings for state and local health personnel and community planners, and supported demonstration projects. We aided local health departments with surveys and outreach to heat vulnerable populations. We collaborated with academic researchers in the development and piloting of heat adaptation planning tools and in the construction of vulnerability mapping and climate downscaling materials to be used at the local level. Plans were developed for ongoing surveillance for extreme weather and climate-related health effects, with trainings and response materials provided for local health staff, communities, and the public.

### KEY SUCCESS & OUTCOMES:

Three climate-related HIAs were successfully conducted in Grand Rapids, East Lansing and Ann Arbor, and there is continuing interest in this use of the HIA by planners and HIA practitioners in Michigan and nationally. Surveys of low-income populations in Washtenaw County and Lansing indicated the lack of awareness of heat health risk, increased vulnerability and lack of adaptive capacity in these communities. Piloting of the I-Heat geospatial planning tool and the Mid-Michigan Heat Model (a systems model incorporating heat risk survey results) with local health officers and community planners provided valuable information to researchers on ways to improve their utility for local adaptation planning, and further research questions to be explored. A natural disasters annex has been put in place for emergency response to extreme heat and other weather events, with trainings, check lists, and response materials. Syndromic surveillance is in place for detecting increases in heat-related emergency room visits; state-level public health indicators for climate change effects have been calculated. We are working with medical geographers and climatologists to finalize population vulnerability and climate projections on a local/regional scale for use by Michigan community planners and local public health staff. Community group collaborations include the Detroit Climate Justice Task Force, a group of composed of academic, community, government, nonprofits and volunteers who launched a mass education campaign targeting vulnerable populations to help minimize heat-related illness during the summer months. MICHAP leads the

public health workgroup for the Detroit Climate Action Collaborative, convened to develop Detroit's first climate action plan.

**PROJECT OUTPUTS:**

- Michigan Climate & Health Program Webpage (has links to many products)  
<http://www.michigan.gov/climateandhealth>
- Internet-based Heat Evaluation and Assessment Tool (I-HEAT)  
<http://www.biomedware.com/?module=Page&SID=i-heat>
- Project Brief: The Mid-Michigan Heat Model  
[http://www.glisa.umich.edu/docs/projectbriefs/GLISA Reports 2011 Mid-Michigan Heat Model.pdf](http://www.glisa.umich.edu/docs/projectbriefs/GLISA_Reports_2011_Mid-Michigan_Heat_Model.pdf)

## NYC Department of Health and Mental Hygiene Climate Change and Public Health Program



Grabner

### **PRINCIPAL INVESTIGATORS:**

- Nancy Clark, NYC Department of Health and Mental Hygiene
- Nathan Grabner, NYC Department of Health and Mental Hygiene

### **OTHER PARTNERS & KEY PERSONNEL:**

- Kizzy Charles-Guzman, Project Director, NYC Department of Health and Mental Hygiene
- Kathryn Lane, Epidemiologist, NYC Department of Health and Mental Hygiene
- Thomas Matte, Assistant Commissioner, NYC Department of Health and Mental Hygiene

### **FUNDING SOURCE:** CDC

### **BRIEF DESCRIPTION:**

The New York City Department of Health and Mental Hygiene's Climate Change project works to assess climate-related public health impacts, identify vulnerable populations, work with other city agencies and relevant stakeholders to develop and implement needed public health adaptation strategies and to improve the ability of our communities to cope with climate hazards and extreme weather events. Using local-level climate projections from the NYC Panel on Climate Change along with local data on factors associated with increased risk for adverse health outcomes we are identifying and analyzing health impacts, conducting neighborhood level vulnerability assessments, and identifying relevant adaptation strategies for the following key priority areas: heat/ozone, coastal storms/flooding, and power outages. To assist in the development of recommendations for public health adaptation strategies to improve our capacity to address climate-related health outcomes we organized a workgroup of public health experts from city agencies, academic institutions, and non-governmental organizations. We are working to strengthen collaborations between the programs within and outside of our Agency's Division of Environmental Health to prevent and respond to climate-related public health issues.

### **KEY SUCCESS & OUTCOMES:**

The team conducted health risk assessments of key climate-related environmental hazards and drafted reports for all priority areas. We solicited and incorporated feedback on the draft assessments from our advisory workgroup and other partners and have incorporated key lessons learned and information from our experience following Superstorm Sandy.

To improve our understanding of interventions to prevent heat-related illness we conducted a citywide survey and conducted focus groups of New Yorkers. The survey was to assess the air conditioner usage, awareness of heat alerts, current prevention practices, and barriers to prevention. Likewise, the focus group addressed these same issues but also provided an opportunity to evaluate the effectiveness of DOHMH's educational materials. The results of our heat assessment, survey and focus groups led to the revision of our educational materials and informed our media outreach; and were used to assist the National Weather Service on improved messaging related to heat advisories, warnings and alerts. Our materials were distributed to senior centers and weatherization assistance programs/organizations throughout NYC. We also conducted presentations for our Agency's Division of Mental Health, DOHMH housing providers and NYC Department for the Aging and the NYC Housing Authority on possible heat health protection measures for those receiving case management and/or housing assistance. Finally, we

issued alerts through our Health Alert Network on preventing heat illness and availability of free air conditioners several times over the course of the summer.

The team is developing a “Toolkit for Adaptation Planning” to assist organizations that provide services to climate-sensitive populations to i) evaluate current capacity; ii) project how demand for their services could change under different climate change scenarios; and iii) develop adaptation strategies to prepare for threats posed by climate change.

We play an active role in new policy and planning efforts related to increasing the City’s climate resiliency to coastal storms such as Hurricane Sandy. For example, we have been appointed to Mayor Michael R. Bloomberg’s NYC Building Resiliency Task Force, which aims to review current building codes and operational practices, and to make recommendations on how they could be amended to improve building resiliency and to facilitate recovery in light of climate hazards. In addition, we are providing input to ongoing work by the City to review of storm impacts and community rebuilding needs and develop a long-term plan for the City that responds to and prepares for the threat of climate change. We also supported the enactment of citywide legislation that institutionalized the NYC Panel on Climate Change in order to ensure periodic scientific review and updates to local climate projections and related impacts.

A key success of this program has been in cementing the role of the NYC DOHMH in citywide climate and health adaptation planning. We continue to coordinate with agencies and programs that play an important role in researching climate impacts, responding to environmental emergencies, and accessing and servicing vulnerable populations so that we may align our analytical frameworks, develop appropriate interventions and messaging tools, and develop health-related climate impact products that are useful for stakeholders and vulnerable communities.

## **PROJECT OUTPUTS:**

- “Planning to Beat the Heat: Heat Health and Climate Adaptation in New York City” --NACCHO Exchange: Climate Change and Public Health (Summer 2012) (PDF)
- Climate Change Adaptation: Addressing Heat-Related Morbidity and Mortality among Seniors in New York City  
<http://apha-environment.org/pdf/nathangraberpresentation.pdf>
- Heat-related mortality, public awareness and behaviors: implications for messaging and prevention  
<https://ams.confex.com/ams/93Annual/webprogram/Paper223422.html>
- “Keep Cool” Educational Materials (in English, Spanish, Chinese, Russian, Haitian Creole)

## Pediatric Asthma, Photochemical Oxidant Air Pollutants, and Climate Change Vulnerability



Delfino

### PRINCIPAL INVESTIGATOR:

- *Ralph J. Delfino, MD, PhD, Department of Epidemiology, University of California, Irvine, School of Medicine*

### OTHER PARTNERS & KEY PERSONNEL:

- *Scott Bartell, PhD, Department of Epidemiology and Program in Public Health, UC Irvine*
- *Jun Wu, PhD, Department of Epidemiology and Program in Public Health, UC Irvine*
- *Michael J. Kleeman, PhD, Department of Civil and Environmental Engineering, UC Davis*
- *Daniel L. Gillen, PhD, Department of Statistics, UC Irvine*
- *Michael J. Prather, PhD, Department of Earth System Science and the UCI Environment Institute, UC Irvine*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### BRIEF DESCRIPTION:

Photochemical oxidant air pollutants such as ozone (O<sub>3</sub>) are anticipated to increase with climate change and could have major impacts on the health of children with asthma. Photochemical oxidant pollutants in secondary organic aerosols (SOA) are also likely to increase, but there is much less information about health risks. Research will utilize data in children and adolescents ages 0-19 years in California who have been seen for asthma in an emergency department or admitted to hospital for asthma and other lower respiratory illnesses (trend control outcomes) from 2000-2008. We hypothesize that daily asthma morbidity will be associated with both increased local exposures to photochemical oxidant air pollutants and primary combustion-related air pollutants. Furthermore, we hypothesize that these associations will be stronger in subjects living in regions with lower socioeconomic status and in warmer regions with more photochemical air pollution. We will assess the potential future risk of pediatric asthma morbidity from the effects of climate change on photochemical pollutant levels, stratified by hypothesized population vulnerabilities. The study will utilize available data on air pollution and hospital admissions and emergency department visits in California from 2000-2008. The research also combines a state-of-the-science reactive chemical transport model with the latest SOA formation theories and applies them to estimate population exposures for this period and to determine if SOA concentrations will experience significant changes in the future due to climate modification. Knowing this is critical to fully assessing the impact of climate change on specific populations vulnerable to the health effects of photochemical oxidant air pollution.

### KEY SUCCESS & OUTCOMES:

The total number of respiratory hospital records processed was 1,398,499. We then identified urbanized regions of California to subset the data based on ongoing regional air pollution modeling at UC Davis. The regions of California to be modeled were selected based on estimated PM<sub>2.5</sub> elemental carbon and they captured all of the major populated regions. Zip code polygons were created that intersected the nested model region. The resulting number of asthma hospital encounters (key outcome) was 125,900 hospital admissions and 306,361 ED visits. Just over half of the subjects seen in hospital had no private insurance and instead had government sponsored plans or were uninsured. Around a quarter of subjects are Hispanic, a fifth are African American, a quarter are white non-Hispanic, and the rest are other races. Epidemiologic analyses are awaiting

final estimates of photochemical and primary air pollutant exposures. A statistical analysis has been carried out on 1000 days of air quality in the current and future climate downscaled from ~100 km resolution to ~4 km resolution in preparation for exposure analysis. The results indicate that 10-year average air quality conditions in any climate period can be represented by 40 randomly selected months simulated within that time period. Global climate model predictions from the Community Earth System Model under a modern scenario from the Intergovernmental Panel on Climate Change are being downscaled during 40 such months to prepare exposure fields for airborne particulate matter concentrations.

## Climate Change Capacity Building Through Health Impact and Hazard Vulnerability Assessment



Douglas

### **PRINCIPAL INVESTIGATOR:**

- *Jae P. Douglas, Oregon Public Health Division, Oregon Health Authority*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Julie Early-Alberts, Program Manager, Oregon Health Authority*
- *Andrea Hamberg, Program Coordinator, Oregon Health Authority*
- *Mandy Green, Epidemiologist, Oregon Health Authority*
- *Benton County, Crook County, Jackson County, Multnomah County, North-Central Health District*
- *The Resource Innovation Group*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

### **BRIEF DESCRIPTION:**

In fall 2010, the Oregon Health Authority (OHA) Public Health Division established a climate change program through the Developing Public Health Capacity and Adaptations to Reduce Human Health Effects of Climate Change (CDC-RFA-EH-0-1006) cooperative agreement. This was the first federal funding the division received to work on climate change.

Through this cooperative agreement, the division has been working to build local and state climate change capacity and increase awareness about climate change, the public health implications, and the mitigation and adaptation strategies that can improve public health. Because climate change is a vast topic that requires the expertise of different disciplines and there are a numerous ways to accomplish our climate change-related goals, the division has been developing collaborative partnerships with organizations like the Climate Leadership Initiative (CLI) and the Multnomah County Health Department (MCHD). Because climate impacts will be felt primarily at the local level, we are working closely with local health jurisdictions to understand their climate risks and vulnerabilities and work to adapt to them through the BRACE Framework.

### **KEY SUCCESS & OUTCOMES:**

1. Ready for Change Workshops trained 68 people, representing 92% of Oregon's population through county participation
2. Five local health jurisdictions funded through minigrants to participate as cohort to go through BRACE Framework in their counties. Five public health climate change adaptation plans will be completed by August 2013.
3. The five local adaptation plans will inform the creation of a state public health adaptation plan after the end of the project period.
4. OHA conducted an assessment of heat-related illness and mortality a study to assess whether regional variations in heat-related health outcomes were sufficient to support region-specific heat wave definitions that differ from current definitions, and to assess the burden of illness and death due to heat statewide. OHA is now collaborating with the National Weather Service to adjust local heat advisories to be more protective of health.

5. Worked with local nonprofit Upstream Public Health to develop a curriculum and give a training on using Health Impact Assessment to assess the potential health impacts of climate change policy.
6. We are partnering with Oregon Public Health Preparedness to develop heat and flooding toolkits for local health jurisdictions, and to develop methodology to incorporate climate change health risks into required Hazard Vulnerability Assessments.

**PROJECT OUTPUTS:**

- Climate Change and Public Health  
[www.healthoregon.org/climatechange](http://www.healthoregon.org/climatechange)
- Heat Wave Analysis  
***Publication pending. Contact PI for information.***

## Developing Public Health Capacity to Reduce the Human Health Effects of Climate Change

### **PRINCIPAL INVESTIGATOR:**

- *Diane Eckles, Arizona Department of Health Services*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Jennifer Botsford, Program Manager, AZ Dept of Health Services*
- *Matthew Roach, Environmental Epidemiologist, AZ Dept of Health Services*
- *Amber Asbury, Program Planning & Evaluation, AZ Dept of Health Services*

**FUNDING SOURCE:** CDC Climate Change Research and Development Grantee

### **BRIEF DESCRIPTION:**

The Arizona Department of Health Services (ADHS) is now into the 3rd year of its cooperative agreement. ADHS is working to develop adaptation strategies to climate and health effects by focusing on policy, surveillance, and health promotion. Heat has been identified as the number one cause of weather-related deaths. In addition to focussing initial activities on heat-related illnesses and deaths, Arizona is now building capacity for other climate and health effects, such as vector-borne illnesses and wildfires.

### **KEY SUCCESS & OUTCOMES:**

ADHS has successfully analyzed descriptive epidemiology on heat-related morbidity and mortality and identified vulnerable populations through the data and maps. ADHS has created partnerships with local universities, state agencies, local health departments, research groups, non-profits, schools, and federal agencies, including the National Weather Service (NWS) Forecast Offices in Arizona. ADHS participated in opportunities with CSTE and ASTHO to build partnerships and capacity, for example, CSTE's Climate Change Indicators pilot project.

ADHS implemented heat safety toolkits targeted toward specific at-risk populations by successfully collaborating with key stakeholders. Stakeholder involvement and feedback were essential to ADHS in guiding the development of the population-specific health messaging and dissemination strategies.

ADHS created an extreme weather and public health website which provides links to the toolkits, sign-up for heat alerts, and other materials produced by the program on climate and health effects. ADHS developed a communication plan to define the agency's role in disseminating health-related warnings to public health professionals and the public. ADHS coordinates heat alerts with the NWS Forecast Offices and relays the alerts with heat safety prevention tips through every [azdhs.gov](http://azdhs.gov) web page, social media, e-mail campaign, and press releases. The alerts are sent by e-mail to schools, the general public, and state-licensed facilities. The communication plan was well received by the Public Information Office and is now used as a template for other program's in the agency that require releasing time-sensitive information.

With assistance from the New York State Department of Health, ADHS adapted their pilot-tested organizational needs assessment and administered it to ADHS staff. There were over 70 respondents, and ADHS is currently analyzing results to determine ADHS' capacity to adapt to climate change. The needs assessment will be used to direct resources and future adaptation activities.

ADHS is currently exploring the use of syndromic surveillance regarding climate and health effects and is coordinating with the Minnesota Department of Health to develop a working group with other state health departments. ADHS has access BioSense 2.0 which is a collaborative data exchange system allowing users to track health issues as they evolve.

## **PROJECT OUTPUTS:**

- ADHS' Extreme Weather & Public Health Program Website  
[www.azdhs.gov/phs/oeh/heat](http://www.azdhs.gov/phs/oeh/heat)
- Surveillance Data  
**Contact PI for information.**
- Heat Safety Toolkits (Schools, Older Adults, Outdoor Workers)  
[www.azdhs.gov/phs/oeh/heat](http://www.azdhs.gov/phs/oeh/heat)
- Vulnerability Indicators and Social Vulnerability Index  
[www.azdhs.gov/phs/oeh/heat/maps.htm](http://www.azdhs.gov/phs/oeh/heat/maps.htm)
- Agency Needs Assessment  
**Contact PI for information.**

## Confronting the Health Risks of Climate Change



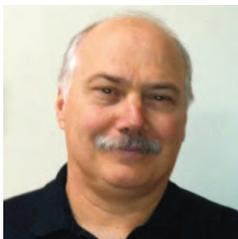
Fenske

### PRINCIPAL INVESTIGATOR:

- *Richard A. Fenske, University of Washington*

### OTHER PARTNERS & KEY PERSONNEL:

- *Susan Allan, Co-Principal Investigator, University of Washington*
- *Michael Yost, Co-Investigator, University of Washington*
- *Tania Busch Isaksen, Elizabeth Hom, Shirley Ren, Hil Lyons, Paul Sampson, Charles Treser, Cole Fitzpatrick, University of Washington*



Yost

**FUNDING SOURCE:** CDC RFA-EH-09-001, Climate Change: Environmental Impact on Human Health

### BRIEF DESCRIPTION:

Our research-to-practice project:

1. Quantified the historical relationship between humidex as a continuous heat exposure variable and non-traumatic health outcomes in three Washington State counties (King, Clark, and Spokane);
2. Combined this historical temperature-outcome relationship with population and climate projections to estimate future non-traumatic heat-related mortality and hospitalization for 2025 and 2045; and
3. Worked with local health jurisdictions to translate, interpret and use the study's findings.

### KEY SUCCESS & OUTCOMES:

In general, our study found an upward trend in historical regional temperatures, as well as an observed significant increase in death and hospitalizations with increasing temperatures, especially for the elderly. Climate projections indicate that local extreme heat events are likely to increase in frequency and intensity, and that there will be significant increases in heat-related deaths and hospitalizations, especially for the elderly. Aside from age, no other vulnerable populations were observed to be at an increased risk of death or hospitalization.

Public Health Seattle King County – The Seattle-King County project team's initial goal was to focus on climate change mitigation and build collaborations with other county departments that were positioned to develop mitigation policies and programs (e.g., Department of Transportation, Department of Natural Resources and Parks). Presentation and discussion of findings with staff from other county departments articulated why public health should be involved in climate change discussions; demonstrated the potential power of health consequences in climate change messaging; and laid some groundwork for future cross-department collaborations. The PHSKC team also worked with other PHSKC officials to build support for climate action and to incorporate the research findings into preparedness planning. In discussions with preparedness leaders, the team identified additional sources of data and research activities to undertake.

Clark county Public Health – From the outset, Clark County partners were interested in how our research findings could be used to support their efforts to integrate health into the next county comprehensive plan. Working within a fairly conservative county government, and knowing that the public favored healthy community development, the Clark County team focused on mobilizing

the community to back their efforts to integrate health into comprehensive planning. We supported the team by providing additional data as requested and by simplifying presentation of findings for use in communicating with the general public. Some of our findings were included in the health chapter of the “Growing Healthier Report” (Clark County Public Health Advisory Council and Clark County Public Health 2012). With broad community support and scientific evidence backing their recommendations, the team was able to get approval of this report from the Public Health Advisory Council, the County Board of Health, and the County Board of Commissioners. Their feedback to us was that the county-specific findings provided a way for Public Health to talk about local impacts and to lead on the issue of climate change.

Spokane Regional Health District – The Spokane team initially expressed interest in using our research findings to develop health promotion messaging (how to be physically active while protecting oneself from heat) and to integrate heat hazards into their All Hazards Plan. From the beginning, the team characterized climate change as a politically controversial topic in their county, and they wanted to take a low profile, under-the-radar approach to climate change activities. For example, without mentioning climate change, they might provide the public with practical information on how to prepare for an annual summer walk/run event and how to avoid heat exhaustion. While concerns about political obstacles and repercussions hampered the team’s progress, they were able to make some headway. The research findings focused their attention on developing a situational awareness system for heat impacts, and on working with agencies that serve the most vulnerable population segment – the elderly.

## PROJECT OUTPUTS:

- King County Master PowerPoint Stand-Alone Slide Deck  
**Contact PI for information.**
- Hazard Identification and Vulnerability Assessment Template (King County example)  
**Contact PI for information.**
- Hom EK, Busch Isaksen, Ren Y, Fenske RA, Lyons H, Sampson PD, Fitzpatrick C, Yost MG. “Historical and projected non-traumatic mortality associated with extreme heat exposure in three Washington State Counties.” Manuscript submitted  
**Contact PI for information, when accepted for publication.**
- Hom EK, Busch Isaksen T, Ren Y, Fenske RA, Lyons H, Sampson PD, Fitzpatrick C, Yost MG. “Impact of heat on hospitalization in three counties in Washington State and projected annual excess mortality and excess costs due to heat.” Manuscript to be submitted  
**Contact PI for information, when accepted for publication.**
- Busch Isaksen T, Schulman BA, Treser CD, Allan S. “Evaluation of a Research to Practice Climate Change Project.” Manuscript is being prepared for submission to Public Health Reports  
**Contact PI for information, when accepted for publication.**

## Respiratory Health Impacts of Wildfire Particulate Emissions Under Climate Change Scenarios



French

### PRINCIPAL INVESTIGATOR:

- Nancy H.F. French, PhD, Michigan Tech Research Institute

### OTHER PARTNERS & KEY PERSONNEL:

- Dr. Michele Ginsberg, San Diego County Health & Human Services Agency
- Dr. Jeffrey Johnson, San Diego County Health & Human Services Agency
- Dr. Tatiana Loboda, University of Maryland
- Dr. Brian Thelen, Michigan Tech Research Institute
- Dr. Benjamin Koziol, Michigan Tech Research Institute
- Dr. Mike Billmire, Michigan Tech Research Institute
- Dr. Shilian Wu, Michigan Technological University

**FUNDING SOURCE:** NIH ARRA Challenge Grant 1RC1 E8018812

### BRIEF DESCRIPTION:

This project (a) measures and statistically models a relationship between particulate emissions from wildland fires and respiratory illness and then (b) assesses the impact of future climatic conditions as manifest in respiratory health outcomes. The integrated modeling activity included 1) modeling spatially-defined fire emissions, taking into account vegetation fuels and weather, 2) accurately estimating particulate concentrations for downwind regions using transport/dispersion modeling, and 3) combining the smoke emissions, electronic health monitoring, and other parameters in a statistical model to relate the distribution of particulates to respiratory symptoms.

### KEY SUCCESS & OUTCOMES:

Results: Final model results (~75% deviance explained) show that at peak fire particulate concentrations the odds of a person seeking emergency care is increased by approximately 50% compared to non-fire conditions.

Our interdisciplinary research team developed a coupled statistical and process-based model system that:

- Demonstrates an end-to-end methodology for generating reasonable estimates of wildland fire particulate matter concentrations and effects on respiratory health,
- Is applicable at resolutions compatible with syndromic surveillance health information,
- Is flexible: model coefficients and functional estimates are specific to San Diego County, but the method has applicability to other regions and syndromic responses.

Applying climate change projections to the model: Since the final model included air temperature and relative humidity as variables, we transformed our base data for these parameters using IPCC's regional predictions to generate projections of the impact of wildfire particulates on health resulting from climate change. Results show a 6% increase in 1-day and 5-day maximum emergency department visits for the 2050 scenario and a ~11% increase for the 2100 scenario (base year=2007).

In a proposed additional grant activity, we hope to work more closely with public health agencies and first responders to better define the value of applying our model and how products we could generate from this study can be improved for their use.

**PROJECT OUTPUTS:**

- Official Project Website (Public)  
<http://www.mtri.org/firehealth.html>
- Thelen, B. et al. “Modeling acute respiratory illness during the 2007 San Diego wildland fires”. To be submitted 2013.  
**Contact PI for information.**
- French et al. “Wildfire Particulate Emissions & Respiratory Health under Climate Change Scenarios”, NEHA 2012 oral presentation  
[http://www.mtri.org/Documents/firehealth/NEHA\\_presentation\\_6-25-12.pdf](http://www.mtri.org/Documents/firehealth/NEHA_presentation_6-25-12.pdf)

## Extreme Heat Events: Evolving Risk Patterns in Urban and Rural Communities



Gohlke

### PRINCIPAL INVESTIGATOR:

- *Julia Gohlke, University of Alabama at Birmingham*

### OTHER PARTNERS & KEY PERSONNEL:

- *Benjamin Zaitchik, Johns Hopkins University*
- *Tiffany Smith, Johns Hopkins University*
- *Sheila Tyson, Friends of West End*
- *Sheryl Threadgill and Ethel Johnson, West Central Alabama Community Health Improvement League*
- *Molly Bernhard, University of Alabama at Birmingham*
- *Mary Evans, University of Alabama at Birmingham*
- *Shia Kent, University of Alabama at Birmingham*
- *Leslie McClure, University of Alabama at Birmingham*
- *Elizabeth Maples, University of Alabama at Birmingham*
- *Steven Becker, Old Dominion University*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### BRIEF DESCRIPTION:

We hypothesize that significant differences in vulnerability to heat-related health risks exist between urban and rural communities. To test this hypothesis we are 1) Examining spatial patterns and temporal trends across different heat wave definitions, 2) Defining relationships between mortality and adverse birth outcomes and heat waves in urban versus rural communities in Alabama, and 3) In collaboration with local community organizations working with particularly underserved urban and rural communities, prioritizing environmental health issues and developing a community-engaged intervention strategy. We are also examining other vulnerability factors in urban versus rural settings including occupations and demographic characteristics. Spatially explicit vulnerability maps that apply our findings will help to inform planning to decrease risk of heat related mortality and morbidity. The proposed investigation will contribute to climate change adaptation research by identifying whether there are specific public health needs in urban versus rural communities.

### KEY SUCCESS & OUTCOMES:

- An examination of 15 previously published heat wave indices suggests the Southeast region saw the highest number of heat wave days and increases in the number of heat waves days were the greatest in the Southeast and Great Plains between 1979-2011 (Smith et al. 2012). The relationship between mortality or premature birth and heat waves differs based on the heat wave definition applied (Kent et al. in preparation).
- When compared to high poverty African American populations in rural areas, high poverty African American populations in urban areas have heightened rates of adverse birth outcomes (Kent et al. Area and Individual-Level Risk Factors and Birth Outcome Trends in Urban and Rural Alabama. Under review)
- Community-level focus groups in Birmingham and West Central Alabama have established environmental health priorities in disadvantaged African-American urban and rural communities (Bernhard et al. Identifying environmental health priorities in underserved populations: a study of rural versus urban communities. Submitted).

- Granted funding from UAB Nutrition and Obesity Research Center (NIH-funded) and Center for the Study of Community Health (CDC-funded) to initiate ancillary community-based study to pilot a personal temperature/sunlight monitor for estimating heat exposure and time spent outdoors in rural and urban communities.

**PROJECT OUTPUTS:**

- Smith TT, BF Zaitchik, and JM Gohlke. 2012. "Heat Waves in the United States: definitions, patterns and trends." Climatic Change

<http://dx.doi.org/10.1007/s10584-012-0659-2>

## Effects of Climate Change on Cholera Dynamics and Prediction



Islam

### PRINCIPAL INVESTIGATOR:

- *Shafiqul Islam, Tufts University*
- *Ali S. Akanda, Tufts University*

### OTHER PARTNERS & KEY PERSONNEL:

- *Rita R. Colwell and A. Huq, University of Maryland*
- *Antarpreet S. Jutla, West Virginia University*
- *Partners from Bangladesh: (a) Institute of Water Modeling, and (b) International Center for Diarrhoeal Disease Research, Bangladesh (ICDDR, B).*

**FUNDING SOURCE:** NIH ARRA Challenge Grant 1RC1TW008587

### BRIEF DESCRIPTION:

This project focused on identifying the effects of climate change on cholera dynamics based on a two-pronged approach: diagnostic and predictive. We emphasize that the effects of possible climate warming on cholera transmission dynamics will be most directly felt through the alteration of underlying hydro-climatic and environmental drivers. Due to a highly seasonal and asymmetric nature of regional hydrology of the focus area, the Bengal Delta region in South Asia, the impacts are likely to be distinctly different in dry and wet seasons in both space and time. Also, sea-level rise and warming in Bay of Bengal will likely impact local environmental and pathogen growth conditions along coastal ecosystems.

### KEY SUCCESS & OUTCOMES:

We have developed a spatially explicit and seasonally varying cholera prevalence model with distributed macro-scale hydroclimatic and environmental forcings. This model combines the detailed understanding of our previous findings of distinct dry and wet season coastal and terrestrial drivers of cholera dynamics in the Bengal Delta that is calibrated and validated to simulate cholera prevalence in four distinct locations. We have also developed a preliminary prediction model of potential cholera incidences in South Asia using environmental determinants, we show that two seasonal cholera outbreaks in the Bengal Delta can be predicted two to three months in advance with prediction accuracy over 75% by using combinations of satellite-derived chlorophyll and air temperature. Such high accuracy is achievable because the two seasonal peaks of cholera are predicted using two separate models with distinct environmental processes.

Our ongoing research focuses on future climate scenarios for the period between 2010 and 2100 over the Ganges and Brahmaputra river basins in South Asia and will explore effects of climate projections for cholera with relation to the increasing (or decreasing) levels of hydro-climatic extremes in the region.

### PROJECT OUTPUTS:

- Akanda, AS, et. Al. "Hydroclimatic Influences on Seasonal and Spatial Cholera Transmission Cycles." *Water Resources Research* 2011; 47(3).

<http://dx.doi.org/10.1029/2010WR009914>

- Jutla, AS, AS Akanda, S Islam. "Tracking Cholera in Coastal Regions using Satellite Observations." J Am Water Resource Association 2010; 46(4): 651-662.  
<http://dx.doi.org/10.1111/j.1752-1688.2010.00448.x>
- Jutla, AS, et.al. "Warming oceans, phytoplankton, and river discharge: Implications for cholera outbreaks." Am J Trop Med Hyg 2011; 85(2): 303-308.  
<http://dx.doi.org/10.4269/ajtmh.2011.11-0181>
- Jutla, AS, AS Akanda, S Islam. "Satellite Remote Sensing of Space-Time Plankton Variability in the Bay of Bengal." Remote Sens Environ 2012; 123: 196-206.  
<http://dx.doi.org/10.1016/j.rse.2012.03.005>
- Akanda AS, et.al. "Reinforcing Cholera Intervention through Prediction aided Prevention." Bulletin of the World Health Organization 2012; 90: 243-244.  
<http://dx.doi.org/10.2471/BLT.11.092189>

## Planning a Regional China GEO Health Hub

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**Kreuzer**

### **PRINCIPAL INVESTIGATOR:**

- *Richard Kreuzer, MD, California Department of Public Health*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *John Petterson, Sequoia Foundation PO*
- *Fan Wu, Shanghai CDC PI*
- *Michael Bates, UC Berkeley SPH Senior Scientist*
- *Ying Tian, Jiaotong University Senior Scientist*
- *Lap Ah Tse, Chinese U. Hong Kong Senior Scientist*
- *Guowei Yu, NW U. for Nationalities-Lanzhou Senior Scientist*
- *Yongli Zhoushan Zhang, COC Senior Scientist*
- *Daniel Iacofano, MIG, Inc. Consultant*
- *Carol Woltring, Sequoia Foundation Consultant*

**FUNDING SOURCE:** NIH Fogarty International Center

### **BRIEF DESCRIPTION:**

The Hub will build capacity for environmental and occupation health research, training and policy development associated with climate change, food contamination and water quality. It will play a leadership role in a global network of hubs devoted to increasing knowledge broadly of environmental and occupational health. The focus on climate change will increase opportunities to expand Chinese research on climate change health impacts and will open opportunities for insertion of public health into the climate change policy arena of China.

### **KEY SUCCESS & OUTCOMES:**

The project is in the first year of a two year planning period.

## Climate Variability / Change and the Risks for a Spectrum of Diseases



### **PRINCIPAL INVESTIGATOR:**

- *Shao Lin, MD, PhD, New York Department of Health/Health Research, Inc.*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Edward Fitzgerald, PhD, University at Albany*
- *Gregory DiRienzo, PhD, University at Albany*
- *Marilyn Wurth, NYS Dept. of Environmental Conservation*
- *Patrick L. Kinney, Sc.D., Columbia University*
- *Scott Sheridan, PhD, Kent State University*
- *Valerie Garcia, PhD, US Environmental Protection Agency*

**FUNDING SOURCE:** CDC Climate Change Research and Development Grantee

### **BRIEF DESCRIPTION:**

The aim of this project is to first evaluate both the independent and joint effects of various meteorological factors reflecting climate change on a spectrum of diseases and then to develop a climate-health tracking and preparedness system by incorporating our local, specific research findings in New York State (NYS).

In addition to some common endpoints such as respiratory, cardiovascular diseases and heat-related conditions, this project also studied some biologically plausible, but under-studied health outcomes including vector-borne diseases, water/food-borne diseases, adverse birth outcomes, renal and cold-related diseases. The effects of individual weather factors such as extreme weather conditions, climate variability, special weather events, and season-modifying effect were examined in relation to the health outcomes. Air Mass, a composite weather index derived from multiple meteorological variables, was also used to assess the impact of joint effects on these outcomes.

We also identified vulnerable groups and geographic areas which have increased health risks to climate change and estimated public health burden related to climate change. Finally, we provided our findings to NYS Dept. of Health (DOH) and NYS Dept. of Environmental Conservation (DEC) to develop public communication and education. We identified vulnerable population to target our public health efforts, incorporated weather/health data into the NYS Environmental Public Health Tracking (EPHT) system, and displayed maps and key findings on the EPHT public portal.

### **KEY SUCCESS & OUTCOMES:**

During the 3-year project period, we published 8 papers, gave 21 presentations in international/national conferences, developed two indicators for the CSTE, and participated in 2 national white-papers writing. We also submitted 3 papers and are working on 7 other papers. We had met/exceeded all planned efforts.

Key outcomes: 1) For the effects of independent meteorological factors on various health outcomes, we found an overall 9% increase in odds of hospitalization for acute renal failure (ARF) per 5°F increase in summer (1-day lag). The findings also suggest increased susceptibility to ARF hospitalization for blacks, Hispanic, people aged 25–44 years, and those in the lowest income quartile. In another case-control study, we found that congenital cataracts were significantly associated with all extreme heat indicators (heat wave, number of heat waves, and number of days above the 90th percentile) in summer in NYS; 2) We also investigated the effects of special

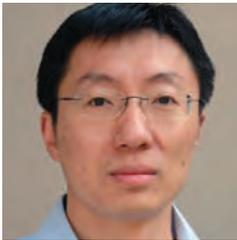
weather events, Blackout and temperature variability. We examined the impacts of 2003 Northeast Blackout on mortality and morbidity, and found that power outages had increased mortality and morbidity due to respiratory hospitalization, even stronger than the effects of heat alone. In contrast to the patterns observed for heat-health effects, higher socioeconomic groups were more likely to be hospitalized during the blackout. In terms of temperature variability, each 1°C increase in daily minimum temperature increase above 6-day average and in weekly variation were significantly associated with 0.52% and 0.40% higher risk of respiratory morbidity respectively in a different study; 3) By assessing temporal trends of climate change in the past 100 years in NYS, we found that weather has become warmer and wetter in NYS in general and specific regions may be more vulnerable to this climate change. Based on temporal trends, we estimated that excess respiratory admissions in NYS due to excessive heat would be 2 to 6 times higher in 2080–2099 than in 1991–2004; 4) Utilizing the Spatial Synoptic Classification, a cold and dry weather type (WT) in autumn corresponds to increased asthma admissions and spike days in admissions in New York City for the school-aged population, while hot and dry WTs in summer correspond to spike days in asthma admissions in all age groups.

Public health actions: The evidence-based findings from this project have been continuously provided to NYSDOH and NYSDEC to inform and assist policy makers in developing public health communications and education strategies. According to our findings, we have identified vulnerable subpopulations and are developing NYS climate vulnerability maps for targeting high-risk areas and populations for potential intervention. The key messages from the findings displayed by factsheets, maps, tables, and charts were put on the EPHT public portal. We also incorporated both climate and health data into the ongoing NYS EPHT program and plan to establish a new climate-health tracking and preparedness system for long-term surveillance and public response.

## **PROJECT OUTPUTS:**

- Three Publications Studying Extreme Heat on Renal, Respiratory Admissions and Birth Defects  
<http://aje.oxfordjournals.org/content/175/9/907.full.pdf+html>
- Three Publications Examining Blackout, Temperature Variation and Air Mass on Health  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3072860/pdf/phr126000384.pdf>
- Two Publications Regarding Climate Change Trend in NYS and Future Projection  
<http://ehp.niehs.nih.gov/wp-content/uploads/2012/10/ehp.1104728.pdf>
- Gave 21 Presentations in National/International Conferences and Helped CSTE Develop Climate Indicators  
<http://www.cste.org/group/ClimateChange>
- Work with NYSDOH and NYSDEC to Display Findings on the EPHT Public Portal  
[http://www.health.ny.gov/environmental/public\\_health\\_tracking/](http://www.health.ny.gov/environmental/public_health_tracking/)

## Uncertainties in Modeling Spatially-Resolved Climate Change Health Impact



Liu

### **PRINCIPAL INVESTIGATOR:**

- *Yang Liu, PhD, Emory University*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Ying Zhou, ScD, CDC*
- *Brent Johnson, PhD, Emory University*
- *Cheng Huang, PhD, George Washington University*
- *Justin Remais, PhD, Emory University*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

CDC Climate Change Research and Development Grantee

### **BRIEF DESCRIPTION:**

Decisions about climate policy must be made within the context of layers of uncertainty in the modeling process. Our project seeks to improve the characterization of the spatial distribution of health impacts by studying the uncertainty in the health impacts estimates through each stage of health risk modeling. Our study will make significant contributions in assessing population vulnerability to climate change. We use dynamically downscaled air pollution and weather projections data during the decades of 2000 and 2050 under two IPCC 5th assessment reports (AR5) Greenhouse Gas (GHG) emissions scenarios. The simulations are based on the Community Earth System Model (CESM), coupled with the Community Multiscale Air Quality model (CMAQ) and the Weather Research and Forecasting model (WRF). The fine resolution of 12 km and national coverage will allow us to study the spatial heterogeneity in the uncertainties of health impacts and population vulnerability estimates, which will be particularly important to facilitating targeted, locally informed preparedness efforts.

We will study the magnitude of uncertainties introduced by each analytical step of climate change health impacts modeling, such as greenhouse gas emission scenarios, climate, meteorological and air quality modeling, exposure-response characterization, future population distribution projections including the age structure, and background mortality rate. The end products of our proposed work will be a spatially explicit representation of the uncertainty of health impacts projections, including the relative importance of various error components. Our work will allow for improved precision of projections of health outcomes on a very fine spatial scale, facilitating planning for targeted preparedness for vulnerable populations. These outcomes will be useful in identifying gaps in theory and data, helping to prioritize future research, and increasing the validity of model projections so that they are more reliable for making decisions about public health.

### **KEY SUCCESS & OUTCOMES:**

1. We have processed 4 km WRF simulations of temperature and relative humidity in eastern U.S. for the baseline period (2001 - 2004) and the future (2057 - 2059) under both RCPs. Downscaling of CESM model with WRF was performed at University of Tennessee / Oak Ridge National Lab supported by CDC funding.
2. Dr. Zhou processed county-level baseline mortality and population data for 2001 - 2009 using CDC data.

3. Dr. Huang developed four population growth projections (high, medium, low growth, and business as usual) at county level for continental U.S.
4. Dr. Johnson developed a flexible search radius approach to calibrate baseline temperature data against NOAA MADIS observations. As a result, calibration ratios were derived to adjust future temperature projections to reduce model error.
5. We have aggregated high resolution data to county level and calibrated the temperature data with our calculated calibration ratios. We have coupled weather data with population data, baseline mortality, and temperature-mortality dose-response relationships found in the literature to calculate heat wave excess mortality under various conditions (different RCPs, search radii for data calibration and matching, dose-response functions, population growth patterns, etc.)
6. We have processed 12 km resolution nationwide ozone and PM2.5 projections provided by UT and model calibration as well as data integration are underway.
7. Our collaborator at UT has published their first paper to document the CESM-WRF simulations.
8. We have submitted (1) one manuscript on the heat wave excess mortality, (2) one manuscript on landscape determinants of vector-borne disease.
9. Multiple manuscripts are in preparation.

**PROJECT OUTPUTS:**

- Y. Gao, J. Fu, J. Drake, Y. Liu and J. Lamarque, “Climate downscaling and extreme events studies in eastern United States”

<http://iopscience.iop.org/1748-9326/7/4/044025>

## Building Resilience Against Climate Effects (BRACE), California (CalBRACE)

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### PRINCIPAL INVESTIGATOR:

- *Neil Maizlish, PhD, California Department of Public Health*

### OTHER PARTNERS & KEY PERSONNEL:

- *Paul English, PhD, Tracking Program, CDPH*
- *Kathy Dervin, MPH, Office of Health Equity, CDPH*
- *University of California, Davis*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

### BRIEF DESCRIPTION:

CDPH will assess the scope of potential direct and indirect effects of climate change on priority health conditions, vulnerable populations, and the burden of disease based on state-commissioned modeling of geographically down-scaled projections of temperature, sea level rise and coastal flooding, and wildfire risks.

To provide geographically relevant information for local adaptation planning, CDPH will carry out detailed assessments of vulnerabilities and the additional burden of disease due to climate change from a 2000 baseline to 2099 for one county in each of California's 10 climatic zones in consultation with local, regional, and statewide stakeholders. Short- and long-term interventions and their effectiveness will be identified from literature reviews and current climate adaptation planning documents. Data products, education, outreach, and communications strategies within the public health sector and for non-health sectors will be disseminated to enhance adaptation planning (including that of CDPH, local health departments, and other agencies), and to increase the awareness of effective interventions and the public health dimensions of climate change adaptation. Qualitative and quantitative methods will be used to assess the project impact and process.

### KEY SUCCESS & OUTCOMES:

The project deliverables will include:

- Report summarizing climate forecasts and health impacts
- Vulnerability assessment report, technical documentation, and atlas of maps; data for local health departments; lay guide on how to use information
- Burden of disease report and data for local health departments
- Report on adaptation interventions and their evidence basis
- Inventory of climate change adaptation plans and gap analysis
- Multi-year, evidence-based CDPH climate adaptation strategy report
- Communications strategy, educational materials, webinar content
- Project evaluation report

## Projected Heat Wave Magnitudes and Public Health Impacts



Margolis

### PRINCIPAL INVESTIGATOR:

- *Helene G. Margolis, PhD, University of California, Davis, School of Medicine*

### OTHER PARTNERS & KEY PERSONNEL:

- *Paul English, PhD, CA Dept. of Public Health*
- *Eric Roberts, MD, PhD, Gala King, MPH, Michelle Wong, MPH, CDC Env. Health Tracking Program*
- *Alexander Gershunov, PhD, Kristen Giurguis, PhD, UC San Diego, Scripps Institution of Oceanography*
- *D. Reynolds and D. Keeton, National Weather Service*
- *Kris Ebi, PhD, Consultant*

**FUNDING SOURCE:** NIH ARRA Challenge Grant

### BRIEF DESCRIPTION:

Overall Purpose/Goal: Extreme heat events (EHE) remain the leading cause of weather-related morbidity and mortality in the United States. Goal: To develop for the State of California an analytic framework to: (1) advance knowledge of the relations between ambient heat and morbidity and mortality, in particular EHE with different meteorologically-defined profiles, and the underlying determinants of risk (e.g., health status/co-morbidities, demographics, social/behavioral factors, and land surface and built environment characteristics) at multiple geographic scales; and (2) to translate that information into public health policy guidelines that reflect current climatological conditions, and conditions that are projected to exist under different climate models and scenarios. Expected Outcomes: Progress towards a significantly enhanced understanding of past and future climatological influences on heat-related morbidity and mortality (HRMM) is being achieved via a series of quantitative evaluations conducted at different geographical/spatial scales using measured and modeled meteorological data, and readily available secondary morbidity/mortality data (emergency department visits, hospitalizations, and vital statistics death certificate data) and risk factor data. Projected HRMM risks will be based on analyses of relevant parameters from a carefully selected subset of General Circulation Models (GCM) and scenarios available in the Intergovernmental Panel on Climate Change (IPCC) database. A Multi-Determinant Model of HRMM has been developed. Working with key stakeholders, information derived from this framework will be translated to enhance heat warning systems and develop strategies to reduce community, population and individual vulnerability with relevance to millions of California residents, and potentially many other U.S. populations. The framework can also be used to assess efficacy of heat warning systems and interventions and other adaptation strategies, and of climate change mitigation strategies as they evolve over time.

### KEY SUCCESS & OUTCOMES:

The aim of one set of analyses using emergency department (ED) data was to develop a simple, empirically-based EHE definition. An array of 21 candidate definitions were defined as Bayesian random effects models predicting ED visits due to electrolyte imbalance. Our results showed Tmax exceeding local seasonal mean by 6°C in a five-day distributed lag model (relative risk 1.04, 95%-credible interval 1.03-1.05) was the best EHE definition by this criterion. A key conclusion to be drawn from the relatively low threshold at which effects were observed across the State is that there are substantial public health impacts occurring at temperatures better described as 'elevated'

rather than 'extreme' levels commonly used to define a 'heat wave' and the triggering of extreme heat alerts and emergency response protocols. A manuscript reporting these results has been submitted (Roberts E. et al, 2012). We are working closely with colleagues at the National Weather Service (NWS), and other stakeholders to translate these observations to policies and heat alert products to enhance public health protection across the full range of temperatures that pose a risk to health; to that end on April 3, 2012 the project hosted a meeting with the NWS and California emergency response organizations to discuss the results and identify strategies and/or next steps including requisite research.

To systematically assess multiple determinants of vulnerability, we applied a conceptual framework previously developed by the PI (Margolis). The probability of an ED visit due to heat-related illness (HRI) was estimated using hierarchical generalized linear models with a logic link; this allowed the modeling of a binary outcome (whether a subject had a HRI or not), while accounting for nested sources of variability (subjects/controls within Zip Codes; Zip Codes within a higher order geographic unit), and allowed us to account for covariates that have a significant effect on HRI risk. The model has been applied to projected climatological data (for 2040-2050) to characterize risk of heat related illness in the future and develop recommendations for State and local-scale adaptation strategies. Manuscript in preparation (Margolis et al.)

## Building Resilience Against Climate Effects in State Health Departments

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### **PRINCIPAL INVESTIGATOR:**

- *Dr. Jose Montero, Director, New Hampshire Division of Public Health Services*

### **OTHER PARTNERS & KEY PERSONNEL:**

The project is in the start-up stages, including hiring of a Project Manager, as well as completing contract work for activities described in the application. The project will be placed in the DPHS Bureau of Public Health Protection (BPHP), which includes other environmental public health programs such as lead poisoning prevention, asthma management, radiological health and emergency response (related to two nuclear power plants), food safety, and health officers. Start-up stage is being managed by the BPHP Bureau Chief, Michael Dumond.

**FUNDING SOURCE:** CDC Environmental Public Health and Emergency Response

### **BRIEF DESCRIPTION:**

The major objectives of this program will be to:

- Re-convene the NH Climate Change and Public Health Taskforce (the Taskforce was created as part of the ASTHO capacity building grant, and consists of representatives from state and local government, non-profit organizations and the business community from across the State that are involved in public health).
- Working with the Taskforce, prepare a Climate and Health Profile that outlines the anticipated health impacts and key risk factors associated with climate change across New Hampshire.
- Work with climatologists and climate change scientists at the University of New Hampshire, Institute for the Study of Earth, Oceans, and Space (EOS) as well as the US Geological Survey (USGS) to assist in developing tools to model and geographically map specific climate-related impacts anticipated in the near and long term in NH. Contracts are in process.
- Develop a Vulnerability Assessment that identifies the range of climate impacts, the associated potential health outcomes, the vulnerable population groups (working with EPHT), and the communities and systems most at risk across the State.
- Develop an Evaluation Plan that includes performance indicators that evaluate both program Process Measures as well as Outcome Measures.
- Develop a Climate and Health Risk Assessment that will assess, project and quantify the health outcome(s) and disease burden(s) attributable to predicted climate impacts and identified specific vulnerabilities.
- Develop a Climate and Health Intervention Assessment that lists and prioritizes the most appropriate health interventions to address the identified vulnerabilities and health impacts for each region of the State.
- Using the results of these Assessments, prepare and implement a Climate Change and Public Health Adaptation Plan for the State. The Adaptation Plan will serve as the principal climate and health preparedness guideline for the State and local public health agencies.
- Assist six local public health regions within the State to develop and implement local plans focused on geographically specific health threats and vulnerable population groups.

- Work with national, state and local public health partners to disseminate information, share lessons learned, and develop skills to detect, track, respond, and develop interventions to reduce the human health effects of climate change.

**KEY SUCCESS & OUTCOMES:**

The project is in the start-up stage.

Key Factors for Success:

- Defining measurable climate related health impact objectives
- Collaboration and using existing capacities is key!
- Work with national, state and local public health partners to disseminate information, share lessons learned
- Borrow from other successful projects
- Utilize current science and literature
- Build out from current capacity of DPHS and State programs

## Climate Change and Health: Residential Energy-Efficiency for Comfort and Equity

### **PRINCIPAL INVESTIGATORS:**

- *Marie O’Neill, University of Michigan*
- *Larissa Larsen, Co-PI, University of Michigan*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Richard Rood, Veronica Berrocal, Nick Rajkovich, Kathryn Conlon, University of Michigan*
- *Jalonne White-Newsome, Empowering a Green Environment and Economy, LLC*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### **BRIEF DESCRIPTION:**

As the number and severity of extreme weather events increase with the advancement of global climate change, understanding the public health implications and prioritizing adaptation strategies for retrofitting urban infrastructure assumes greater urgency. Architects and urban planners in cold and temperate climates have long recognized the value of weatherizing residential structures to improve wintertime interior comfort and reduce utility costs. However, less understood is the contribution of weatherization efforts to additionally reduce the negative health effects of hot weather extremes and how these efforts might be targeted to lessen health disparities in urban environments. Our broad objective is to reduce temperature-related health disparities in U.S. communities. Using a trans-disciplinary approach, we propose to create new knowledge that will help guide health-enhancing residential energy conservation measures. This model will use data from three case-study communities— Detroit, Michigan, Cleveland, Ohio, and Washington, DC— where important social disparities in temperature-related health outcomes have been documented. Specifically, we propose 1) to update and expand existing maps of vulnerability to extreme temperatures, based on a finer-scale neighborhood level analysis using structural, environmental, socio-economic, and demographic data, and evaluate potential for home weatherization to reduce these vulnerabilities; 2) to model how future climate scenarios and changes in neighborhood conditions might impact the distribution of vulnerability and the interior comfort conditions that residents will experience in these communities; and 3) to share and discuss research results with key stakeholders (e.g. installers, public health officials, community leaders, city officials) to inform urban planning, public health preparedness, community improvement and weatherization programming decisions relevant to vulnerable populations.

### **KEY SUCCESS & OUTCOMES:**

The proposed study will combine existing data in a novel way to increase scientific understanding of the health benefits of residential weatherization now and in future climates. This research will provide a broadly applicable methodology for guiding local planning for built environment and neighborhood improvements, and climate change adaptation and mitigation programs. We will create maps and models for use by public health practitioners, weatherization program managers, city officials, urban planners and architects to reduce population health vulnerability to extreme temperatures.

## Washington State Environmental Health Tracking Program

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### **PRINCIPAL INVESTIGATOR:**

- *Glen Patrick, Washington State Department of Health*

### **OTHER PARTNERS & KEY PERSONNEL:**

- *Tina Echeverria (attendee), Washington State Department of Health*

**FUNDING SOURCE:** CDC Environmental Public Health Tracking Network

### **BRIEF DESCRIPTION:**

Building a climate impacts topic page for our public EHTP portal that will address threats to groundwater, infrastructure and hazardous waste sites.

Constructing a built environments topic page for our public EHTP portal that will address environmental exposure issues and livability.

A major emphasis in WA is ocean acidification. A Governor's panel has responded to the issue which threatens food security and the shellfish industry. Legislation to mitigate this trend is being developed. Ocean acidification will impact the growth of shells and have far reaching impacts to the marine ecosystem and humans that rely on those resources for food and livelihood. Near-term health issues include illnesses from *Vibrio* spp. and paralytic shellfish poisoning.

### **KEY SUCCESS & OUTCOMES:**

Extreme weather issues for WA include 1- heat stress for western WA, 2- reduced air quality, 3- increase in vector-borne diseases, 4- population influx.

The extreme event in 2012 was 4 weeks of forest fires in eastern WA. An increase in forest fires are predicted to be a response to climate change when conditions benefit bark beetle infestations and summer low precipitation make the forests tinder. September fires were lightning ignited and resulted in poor air quality (off the PM2.5 chart). Schools were closed (3400 excess absences), emergency room visits were up by 400 for respiratory distress. Team members worked with local health jurisdictions and advised on school closures, distribution of masks, establishment of clean air shelters. Plan to build on this experience with increasing outreach and education targeting at-risk populations for future events.

Tracking interacted directly with concerned citizens and provided access to near real-time air quality monitor data for their city. This information allowed those people to manage their activity levels in order to reduce environmental stresses to their health.

## Climate Change Impacts on Power Plant Emissions, Air Quality and Health in the US



Patz

### PRINCIPAL INVESTIGATOR:

- *Jonathan Patz, University of Wisconsin-Madison*

### OTHER PARTNERS & KEY PERSONNEL:

- *Tracey Holloway, University of Wisconsin-Madison*
- *Paul Meier, University of Wisconsin-Madison*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### BRIEF DESCRIPTION:

Our project quantifies the mid-century health impacts of climate-related air pollution (fine particulate matter and ozone) increases in the eastern US, especially with respect to increased summer electricity demand triggered by higher temperatures. Our overarching goal is to utilize a coupled approach integrating climate, energy, air quality, and health models to determine populations most exposed to air pollution-related health risks from climate change.

### KEY SUCCESS & OUTCOMES:

For future summers, we leveraged the breadth of model simulations archived through the North American Climate Change Assessment Program. The summer of 2069 was the warmest future summer simulated by the Community Climate System Model, with an average temperature of 27.7° C, and there were no temperatures in the study region below 22.5° C in 2069.

Modeling energy load demand for cooling of buildings during summer, under future climate change scenarios, we found peak demand increased by 29% from 146 to 188 GW for the East North Central region of the US.

### PROJECT OUTPUTS:

- Harkey, M.K. and T. Holloway. "Constrained Dynamical Downscaling for Assessment of Climate Impacts." Submitted to Journal of Geophysical Research-Atmospheres.

## Extreme Heat and Human Health: Characterizing Vulnerability in a Changing Climate



Peng

### PRINCIPAL INVESTIGATOR:

- *Roger D. Peng, Johns Hopkins Bloomberg School of Public Health*

### OTHER PARTNERS & KEY PERSONNEL:

- *Francesca Dominici, Harvard University*
- *Michelle L. Bell, Yale University*
- *Claudia Tebaldi, Climate Central*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### BRIEF DESCRIPTION:

Evidence of human-caused climate change over the past 50 years has been well documented. Global surface temperature has increased approximately 0.70° C over the past 50 years and much of that increase can be attributed to anthropogenic sources. Climate change is anticipated to affect human health largely by changing the distribution of known risk factors such as extreme heat episodes, floods, droughts, air pollution and aero-allergens, and vector- and rodent-borne diseases. In particular, an expected increase in the frequency, intensity, and severity of extreme heat episodes, will likely have a profound impact on the public's health. Changes in the levels of air pollutants such as particulate matter and ozone can potentially exacerbate the already severe effects of heat. Designing interventions and mitigation strategies to protect the public's health will require first developing a clear understanding of how extreme heat episodes affect mortality and morbidity and identifying populations that are most vulnerable. This project will be an applied study focused on the effects of climate change-induced extreme heat on cardiovascular morbidity and mortality in the US elderly population (age > 65 years). Our goals are to (1) conduct a national study of the cardiovascular mortality and morbidity effects of extreme heat episodes in a vulnerable population (the elderly); (2) evaluate the extent to which biological, socio-economic, and environmental factors modify vulnerability to extreme heat; and (3) estimate the impact on cardiovascular mortality and morbidity of future extreme heat episodes using temperature projections from the most up-to-date global climate model simulations for the 2020-2100 time period under a range of assumptions about pollutant emissions, population health, population age structure, climate adaptation, and climate modeling approaches. This project brings together a multi-disciplinary team with expertise in biostatistics, environmental epidemiology, atmospheric science, engineering, large database management, and climatology.

### KEY SUCCESS & OUTCOMES:

We have conducted a number of studies examining the effects of heat on mortality and morbidity in the United States. We highlight three key studies here: (1) In a national analysis of heat and mortality in 105 US cities over the time period 1987-2005, we found that the number of deaths (per 1000 deaths) attributable to each 10 degree increase in the same day's temperature decreased from 51 deaths in 1987 to 19 deaths in 2005. This decline was largest in northern regions of the US, in cities with cooler climates, and among the elderly (> 75 years of age). The increasing prevalence of central air conditioning has been cited as a key factor for reducing heat-related mortality, we found that it could not solely account for the observed decline in risk over time. (2) In a national analysis of heat and respiratory hospitalizations in about 12 million Medicare enrollees, we found that on average, a 10 degree increase in temperature was associated with a 4.3% increase in same-day

hospitalization and that counties with cooler average summer temperatures had significantly higher relative risks of hospitalization. (3) We have developed a new modeling approach to estimating the short-term health effects of temperature. These flexible distributed lag models use Gaussian random processes to model the distributed lag effect of temperature on health and simultaneously allow for making inference about the maximum lag effect. This modeling approach was applied to mortality and temperature data from four US cities where we found that the shape of the distributed lag function varied substantially by age group and by location.

## **PROJECT OUTPUTS:**

- Heaton, MJ and RD Peng. 2012. “Flexible distributed lag models using random functions with applications to estimating mortality displacement from heat-related deaths.” J of Agricultural, Biological and Environmental Statistics 17(3): 313-331.  
<http://dx.doi.org/10.1007/s13253-012-0097-7>
- Anderson, GB and ML Bell. 2012. “Lights out: impact of the August 2003 power outage on mortality in New York, NY.” Epidemiology 23(2): 189-193.  
<http://dx.doi.org/10.1097/EDE.0b013e318245c61c>
- Reduced Bayesian hierarchical models: Estimating health effects of simultaneous exposure to multiple pollutants  
**Contact PI for information.**
- Heat-related emergency hospitalizations for respiratory diseases in the Medicare population
- “Have risks of heat-related mortality changed over time? Adaptation to heat in the U.S., 1987–2005

## Minnesota Climate & Health Program | Developing Public Health Capacity and Adaptations to Reduce Human Health Effects of Climate Change

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### PRINCIPAL INVESTIGATOR:

- *Kristin K Raab, MPH, MLA, Minnesota Department of Health*

### OTHER PARTNERS & KEY PERSONNEL:

- *Dan Symonik, Supervisor, MN Dept of Health*
- *Kelly Muellman, Planner, MN Dept of Health*
- *Katie Muehe, Communications Coordinator, MN Dept of Health*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

### BRIEF DESCRIPTION:

The overall mission of the MN Climate & Health Program is to protect, maintain and improve the health of all Minnesotans through preparing for and adapting to climate change. The program achieves its mission through developing planning tools to assist local public health in their efforts, assessing the health impacts of climate change and vulnerable populations, educating public health professionals and the public, and developing policies that help mitigate or adapt to the public health impacts of climate change.

### KEY SUCCESS & OUTCOMES:

- Facilitated a State Community Health Services Advisory Committee (SCHSAC) Climate Change Adaptation Workgroup that developed state- and local-level recommendations for public health planning for climate change.
- Developed the MN Extreme Heat Toolkit that contains almost everything a public health professional or emergency manager needs to prepare for extreme heat events (including risk factors, strategies, draft heat response plan, sample media release, etc.).
- Mapped key heat risk factors for state; worked with three counties and four cities to develop maps of vulnerable populations to extreme heat.
- Developed website (<http://www.health.state.mn.us/divs/climatechange/>). Extreme heat website page has had over 2,600 “hits” since its release in April 2012, and created Listserv with over 300 subscribers.
- Developed four PowerPoint trainings on climate change and public health: Climate Change 101; Water Quality and Quantity; Air Quality; and Extreme Heat Events.
- Completed report on incorporating health impact assessment (HIA), climate change and public health into the Environmental Assessment Worksheet, part of the environmental review process in MN.
- Developed a training and “how to guide” for city/regional planners on incorporating health and climate change into comprehensive planning.

**PROJECT OUTPUTS:**

- SCHSAC Climate Change Adaptation Workgroup Final Report  
<http://www.health.state.mn.us/divs/cfh/ophp/system/schsac/workgroups/2011/climatechange.html>
- MN Extreme Heat Toolkit  
<http://www.health.state.mn.us/divs/climatechange/extremeheat.html>
- State Vulnerability Maps  
<http://www.health.state.mn.us/divs/climatechange/extremeheat.html#populations>
- Educational Training Modules on Health and Climate Change  
<http://www.health.state.mn.us/divs/climatechange/index.html>
- Comprehensive Planning Training & How-to Guide  
<http://www.health.state.mn.us/topics/places/index.html>

## Individual and Community Factors Conveying Vulnerability to Weather Extremes



Schwartz

### **PRINCIPAL INVESTIGATOR:**

- *Joel Schwartz, Harvard School of Public Health*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### **BRIEF DESCRIPTION:**

This grant proposes to identify medical and other individual characteristics of persons aged over 64 years that put them at increased risk of dying due to weather, to identify interactions with air pollution that contribute to that risk, and to identify profiles of patterns of pollutants and weather parameters that are particularly associated with elevated risk. Further, we will identify characteristics of community, such as socio-economic status, percent of impermeable surface, of green space, of water, climate zone, variability of weather, air conditioning prevalence, behavioral risk, baseline disease rates, etc which modify the risk of dying, and finally, interactions between the community level and individual characteristics. Importantly, these community level characteristics will be defined on the zip code level, not the city level, allowing us to capture the impact of true local land use. In addition, examining a less explored weather parameter, we will examine the association of rainfall with hospital admissions for gastrointestinal illness in the elderly. Finally, we will conduct a pilot risk assessment using projections, again on a fine scale, of the distribution of weather and pollution in 2030 compared to today, as well as community level projects of changes in risk modifiers. The results of this analysis will aid NIH by identifying disease states that convey risk, and more broadly aid the task of identifying interventions that can improve public health by reducing risk, and where, geographically, those interventions will be most efficacious. The methods used will be case-crossover and case-only analyses to identify risk and risk modifiers, and k-clustering to group weather and air pollution parameters.

## Physiologic Response to Weather Changes and Extremes in Elderly Cohort



Schwartz

### PRINCIPAL INVESTIGATOR:

- *Joel Schwartz, Harvard School of Public Health*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### BRIEF DESCRIPTION:

Global warming will produce increased extreme weather events as well as higher temperatures, and these have been associated with increased morbidity and mortality. The mechanisms and the sources of susceptibility are not clear, and understanding them may lead to more focused interventions, and improved risk assessment. The proposed project will examine the association between a number of weather-related exposures (temperature, humidity, barometric pressure) and multiple clinical outcomes, each related to one of four overarching biological pathways - cardiac autonomic function, inflammation, hemodynamics and lung function. This project will make use of access to an existing cohort of 1,597 elderly men who have been longitudinally followed for decades. Subjects in this cohort receive a clinical examination every 3 to 5 years, at which demographic, psychosocial, and other epidemiologic data are collected. Additionally, biomarker measurements, such as blood pressure, inflammatory blood markers, pulmonary function, and autonomic function measurements are collected at each visit. In this study, exposure will be characterized through the use of an existing stationary weather monitor and predicted temperature at each subject's residence, available from a spatio-temporal land use regression model that has previously been developed for this cohort. Each subject in this cohort has also been well characterized for their daily exposure to air pollutants. To account for the repeated measurements on each subject, the project will employ multivariate mixed regression models to examine the relationship between weather parameters and each of the observed biological outcomes, while adjusting for relevant potential confounders, such as air pollution exposure. Interaction terms will be used to test for effect modification and determine if any of the following confer susceptibility to the health effects of weather - air pollution, age, cognitive function, psychosocial stress, and co-morbid conditions. Finally, unique statistical methods, such as structural equation models and temporal clustering analysis, will enable avoidance of multiple comparisons, understanding of potential intermediates (e.g. DNA methylation) in the relationship between weather and morbidity, and more comprehensive examination of interactions between multiple weather and air pollution parameters. This project has the potential to address a number of gaps and limitations seen in previous studies, including more accurate exposure assessment, the ability to look at relevant biological intermediate outcomes to understand mechanisms affecting morbidity and mortality, and the evaluation of whether certain characteristics and conditions make some populations uniquely susceptible to the health effects of weather.

## Environmental Health Assessment of Vulnerability to Heat Waves and Air Quality



Comerford Scully

### PRINCIPAL INVESTIGATOR:

- *Cynthia Comerford Scully, San Francisco Department of Public Health (SFDPH)*

### OTHER PARTNERS & KEY PERSONNEL:

- *San Francisco Department of Emergency Management*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

### BRIEF DESCRIPTION:

The focus of our grant is on preventing heat stress morbidity and mortality from extreme heat events and associated air quality impacts, which are expected to increase in frequency and duration with climate change. SFDPH has created an environmental health assessment methodology to map community determinants of heat vulnerability, intra-urban land surface temperatures and attributes of the built environment to assess the spatial distribution of determinants of heat wave vulnerability. Environmental Health and Public Health Emergency Preparedness & Response in collaboration with the San Francisco Department of Emergency Management Services (SFDEM) is convening and co-chairing an inter-agency task force to conduct strategic planning that has provided guidance in the development of a City and County of San Francisco heat wave disaster response plan, appropriate surveillance and health education/outreach activities to protect San Franciscans. Through this process we have produced a gap analysis of public health capacity and adaptations to reduce human health effects of climate change by utilizing national performance standards and the environmental health assessment and are also engaging community partners in review of a draft strategic plan and the design of a heat wave public education and outreach plan, with special attention to vulnerable populations, including those populations with known health disparities.

### KEY SUCCESS & OUTCOMES:

1. Developed an environmental health assessment methodology to map determinants of heat vulnerability to assess the spatial distribution of extreme heat and associated air quality impact vulnerability.
2. Developed Heat Wave Disaster Response Plan which will be an annex to San Francisco's new Emergency Operation Plan.
3. Developed a draft heat emergency educational curriculum.
4. Developed Environmental Health Indicators for Climate Change.
5. Assessed the Health Co-benefits of San Francisco's Climate Action Plan.
6. Produced a gap analysis of San Francisco's public health capacity and adaptations to reduce human health effects of climate change by utilizing national performance standards and the environmental health.
7. Disseminated research, plans and information on climate health in 2012 by presenting at the following:
  - The State of California's Climate Action Team Public Health Workgroup
  - Bay Area Regional Energy and Climate Resilience - Public Health Sector Discussion

- San Francisco's City agency meeting about climate adaptation in San Francisco
  - The 139th Annual American Public Health Conference in San Francisco
  - The 2nd CDC/NOAA Climate Science Symposium in Atlanta.
  - The Annual NAACHO Conference in LA.
8. As a result of our work, SFDPH Heat Vulnerability Index was asked to be included in the State of California's Climate Adaptation Strategy heat as an example of local public health leadership in Adaptation Planning. The Heat Vulnerability Index is also being included in San Francisco Climate Action Plan and was part of the San Francisco Planning Department Urban Forest Plan.

## Children's Health and Vulnerability to Heat and Ozone in New York City



Sheffield



Clougherty

### PRINCIPAL INVESTIGATOR:

- *Perry Sheffield, Mount Sinai School of Medicine*
- *Jane Clougherty, University of Pittsburgh*

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### BRIEF DESCRIPTION:

To better understand effects of climate change on children's health, we are (1) developing high-resolution spatial and temporal models that enable us to estimate neighborhood-specific ground-level ozone and surface temperature levels, and (2) linking these estimated exposures to population-based data on childhood asthma hospitalizations and pediatric emergency department visits geo-coded to residential address. We propose to overcome previous studies' lack of high-resolution data by constructing spatially and temporally resolved estimates of surface temperature, heat index, and air pollution at the neighborhood level using datasets collected through atmospheric monitoring networks in New York City (NYC Community Air Survey, NYCCAS). Projected future spatial variation in exposures will be explored by integrating this information with local climate models. This study builds upon the unique data and analytic infrastructure of NYCCAS and existing models, to predict future temperature increases and potential city-wide variation in the health effects of climate change. Further, we employ a previously-compiled dataset of city-wide susceptibility indicators to understand community-level vulnerability to climate change by chronic stressors.

### KEY SUCCESS & OUTCOMES:

Results of this research will be shared with city agencies to inform both near-term climate adaptation, and longer-term planning efforts to incorporate climate risk information into decision-making on land use, infrastructure, and other climate change adaptation measures.

## Building Capacity to Implement Climate Change Programs and Adaptations in Maine



Smith

### PRINCIPAL INVESTIGATOR:

- *Andrew Smith, SM, ScD, Environmental Health, Maine Center for Disease Control, Department of Health and Human Services*

### OTHER PARTNERS & KEY PERSONNEL:

- *ME-CDC Division of Environmental Health*
- *ME-CDC Division of Infectious Disease*
- *Maine Medical Center Research Institute*
- *University of Maine Climate Change Institute*
- *Maine Indoor Air Quality Council*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

### BRIEF DESCRIPTION:

Our public health climate change programs and adaptations are focused on responding to extreme heat events and vector-borne disease. To prepare for an extreme heat event we are: 1) measuring historical and current burden of heat-related illness in Maine; 2) developing and testing a real-time early warning system to detect increases in heat illness; 3) identifying populations vulnerable to extreme heat events; 4) developing a coordinated Heat Response Plan in collaboration with the ME-CDC Office of Public Health Preparedness and in coordination with the Maine Emergency Management Agency and the National Weather Service. To develop actionable strategies to reduce the health effects associated with Lyme disease, Maine's 3rd most commonly reported infectious disease, we are: 1) evaluating and enhancing our human Lyme disease and tick surveillance systems; 2) describing the spread of deer ticks, including environmental and climate influences; 3) identifying populations with high risk of Lyme disease; and 4) developing interventions to help reduce the healthcare costs and health effects of Lyme disease in Maine.

### KEY SUCCESS & OUTCOMES:

Selected successes/outcomes for work in extreme heat event preparedness:

- Added a heat syndrome to Maine's existing syndromic surveillance system, and have tested the early warning system over the past two summers, as well as assessed its positive predictive value and sensitivity in relation to emergency department visits for heat illness
- Documented morbidity associated with past Maine heat events
- Obtained new data through surveys to assess prevalence of air conditioning in Maine homes and long-term care facilities to support efforts to better identify vulnerable populations
- Identified the need for indoor temperature policies due to low prevalence of air conditioning in public buildings such as schools and have initiated collaborative efforts to develop new policies
- Obtained projections for increase in Maine heat events in 2055-2060 through collaboration with the University of Maine Climate Change Institute.
- Developed collaborative working relationships with National Weather Service stations in Maine, ME-CDC Office of Public Health Preparedness, and Maine Emergency Management Agency on developing response plans and materials for use during extreme heat events.

**PROJECT OUTPUTS:**

- New Program Website for Heat Illness

<http://www.maine.gov/dhhs/mecdc/environmental-health/heat/>

## Impact of Climate-Responsive Design on Heat-Related Morbidity and Mortality in Large U.S. Cities: 2010–2050



Stone

### PRINCIPAL INVESTIGATOR:

- *Brian Stone, Georgia Institute of Technology*
- *Ted Russell, Georgia Institute of Technology*

### OTHER PARTNERS & KEY PERSONNEL:

- *Anthony DeLucia, East Tennessee State University*

**FUNDING SOURCE:** CDC Climate Change Research and Development Grantee

### BRIEF DESCRIPTION:

The intent of this project is to assess the potential for climate-responsive design strategies to mitigate the heat-related health impacts of climate change in large U.S. cities over a multi-decadal planning horizon. Specifically, this project will model the influence of alternative land development scenarios on temperature change in three major metropolitan areas of the United States between 2010 and 2050 and quantify the effects of each scenario on public health outcomes related to two classes of heat-related exposure: high levels of ambient heat and intensified concentrations of air pollution.

### KEY SUCCESS & OUTCOMES:

Preliminary findings include the following:

1. The amount of land converted to impervious surfaces per new suburban or rural resident in the Atlanta, Philadelphia, and Phoenix metropolitan regions is greater than that added per new urban resident by a factor of two or more;
2. Higher spatial resolution (1km) modeling of urban scale meteorology exhibits stronger associations between land use change and climate than lower spatial resolution (4km) modeling;
3. Land cover changes at the suburban fringe of the Atlanta metropolitan region in the form of increased tree cover or increased impervious cover measurably and significantly influence temperatures in the urban core, independent of any land cover change in the urban core itself;
4. A transition to a fully impervious suburban ring outside of the Atlanta metropolitan region would increase heat island intensity (measured between the urban core and rural areas) but as much as 20%, independent of land cover changes within the urban core itself.

### PROJECT OUTPUTS:

- Peng, Liu, Tsimpidi, Alexandra, Hu, Youngtao, Stone, Brian, Russell, Armistead, Nenes, Athanasios. 2012. "Differences Between Downscaling with Spectral and Grid Nudging Using WRF." *Atmospheric Chemistry and Physics Discussions*, 12: 1191-1213.

<http://atmos-chem-phys.net/12/3601/2012/acp-12-3601-2012.pdf>

- Vargo, Jason, Habeeb, Dana & Stone, Brian.2012. “The Importance of Land Cover Change Across Urban Rural Typologies for Climate Modeling.” *Journal of Environmental Management*, 114: 243-252.  
<http://www.sciencedirect.com/science/article/pii/S0301479712005117>
- Stone, B., Vargo, J.,Peng, L., Hu, Y., Russell, T. “Climate Change Adaptation through Urban Heat Management in Atlanta, GA.” *Environmental Science and Technology*, in review.

## Michigan Climate and Health Adaptation Program (MICHAP)

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Thie

### PRINCIPAL INVESTIGATOR:

- *Lauren Thie, North Carolina Department of Health and Human Services*

### OTHER PARTNERS & KEY PERSONNEL:

- *Michelle Ralston, Masters Student*
- *CDC Climate and Health Program Partners*
- *Southeast Regional Climate Center*
- *Interagency Leadership Team*
- *Our academic partners, especially the University of North Carolina at Chapel Hill School of Public Health*
- *Carolina Integrated Sciences Assessment (our regional RISA)*

**FUNDING SOURCE:** CDC Climate Ready States and Cities Initiative (BRACE)

### BRIEF DESCRIPTION:

We have developed a strategic plan to address the health impacts of climate change and are now focusing on heat-related illness, extreme weather-related injuries, air pollution, and water-borne disease.

### KEY SUCCESS & OUTCOMES:

We are currently collaborating on two main BRACE projects: pollen and allergic disease in Wake County (Raleigh), and ozone and respiratory and cardiovascular disease in Mecklenburg County (Charlotte).

We have created a health-specific adaptation plan, and have also contributed to a multi-sector state adaptation plan.

We have collected a wide range of indicator data on our focus areas, and further, on our original application areas which also include vector-borne disease and food-borne disease.

### PROJECT OUTPUTS:

- NC Climate and Health Workshop Summary  
<http://www.sercc.com/NCClimateHealth/>
- NC Climate Change Adaptation Strategy  
[www.ncilt.org](http://www.ncilt.org)
- NC Climate Change and Health Adaptation Plan  
**Test site; not yet public. Contact PI for information.**

## Climate Change and Cardiac Vulnerability in Humans



Zanobetti

### PRINCIPAL INVESTIGATOR:

- Antonella Zanobetti, Harvard School of Public Health
- Diane Gold, Harvard School of Public Health

### OTHER PARTNERS & KEY PERSONNEL:

- Joel Schwartz, Brent Coull, Harvard School of Public Health
- Loretta Mickley, School of Engineering & Applied Sciences Harvard University
- Murray A. Mittleman, Beth Israel Deaconess Medical Center

**FUNDING SOURCE:** NIH Climate Change and Human Health PAR-10-235

### BRIEF DESCRIPTION:

Taking advantage of our P01's precisely collected data on multiple pollutant exposures, and cardiovascular (blood pressure, paroxysmal atrial fibrillation, ventricular tachycardia) and cerebrovascular outcomes (stroke) in Eastern Massachusetts, we proposed an innovative study to integrate our understanding of current and projected climatic conditions with our understanding of pollution exposures, to define the conditions resulting in "high risk days" when cardiovascular and cerebrovascular health have been most at risk in vulnerable populations, and to forecast the magnitude of risk over the next 30 years, depending on projected climatic and pollution conditions.

### KEY SUCCESS & OUTCOMES:

In our diabetic panel of 70 subjects with type 2 diabetes mellitus with 355 repeated measures, we examined whether short-term exposures to air pollution (fine particles, ozone) and heat resulted in perturbation of arterial blood pressure (BP). In this published study we found that while increases in particle pollution increase blood pressure, higher temperatures were associated with a marginal decrease in blood pressure. This is the first study to report evidence of independent and diametrically opposed effects of ambient PM pollution, ozone, and climate (temperature) on persons with diabetes. Patients with diabetes tend to have depressed heart rate variability and autonomic dysfunction; particularly if their glucose levels are not well controlled, they also may become fluid depleted and hypo-volemic during periods of concurrent high temperature and high ozone concentrations. Therefore these effects may be clinically important in patients with already compromised autoregulatory function.

In the same panel of diabetic subjects, we investigated how changes in weather conditions and air pollution influenced brachial artery diameter. In 64 patients (279 repeated measures) we measured brachial artery diameter (BAD), and flow- and nitroglycerin-mediated dilation (FMD, NMD) at each visit. Our exposure variables were average daily temperature and water vapor pressure, which is a measure of the actual quantity of moisture in the air; and air pollution as fine particulate mass, black carbon (BC), and organic carbon. We found that higher temperature and water vapor pressure averaged over a one-to-two day period were associated with larger baseline brachial artery diameter. These weather-related responses may have significance for cardiovascular risk in this population. Particle pollution and temperature have opposing effects on the diameter of medium-sized conduit arteries. In diabetic patients with limited autoregulatory control and underlying endothelial dysfunction, vasoconstrictive or vasodilatory responses to these exposures may have adverse clinical consequences.



Gold

In a completed clinical trial that randomized 100 patients with stable heart failure and impaired systolic function to receive either 12 weeks of tai chi classes or time-matched education control, B-natriuretic peptide (BNP), C-reactive protein (CRP) and tumor necrosis factor were measured at baseline, 6 and 12 weeks. BNP and CRP reflect interrelated mechanisms known to be associated with heart failure prognosis and symptom severity.

CRP is an indicator of systemic inflammation and is associated with risk of heart failure decompensation, while BNP is more specifically a marker of increasing hemodynamic load used in diagnosis and risk stratification among patients with congestive heart failure. They observed significantly higher BNP and CRP with three to four day moving averages of apparent temperature. These findings suggest that changes in temperature and meteorology may alter underlying physiologic responses in this vulnerable population. Because of their compromised hemodynamic response, individuals with heart failure may have increased stress in the ventricles, as reflected by a rapid increase in circulating BNP levels, which may be accompanied or perhaps followed by elevation in systemic inflammatory responses, as indicated by CRP.

In our study of patients with dual chamber implanted defibrillators, a doctoral student in her thesis examined the effect of outdoor ambient temperature, estimated indoor temperature, and outdoor absolute humidity in association with triggering of atrial fibrillation (AF) episodes, and temperature and absolute humidity in association with arrhythmia risk. Among 47 patients followed an average of 1.9 years who experienced 230 AF episodes, she found that acute exposure to drier air was associated with increased risk of AF among patients with ICDs, while outdoor temperature and indoor temperature were not independently associated with AF onset. Among 84 patients who experienced 787 ventricular arrhythmias, cooler indoor temperatures and drier air in the days prior to ventricular arrhythmia onset were associated with increased risk. These findings support the hypothesis that the seasonality of ventricular arrhythmias is partly attributable to the weather.

We also developed a temporal clustering approach for estimating the effects of climate mixture. We grouped days based upon their multi weather profiles using temporal clustering. We determined 5 clusters; the weather parameters that we included in the clusters are: maximum daily temperature (to reflect the heat effect), standard deviation of daily temperature (to take into account fluctuations/variability in weather), water vapor pressure (a measure of the actual quantity of moisture in the air), barometric pressure and wind speed. We plan to estimate the health risks associated with days within a given cluster.

We will develop forecasting models to predict changes in our cardiovascular and cerebrovascular outcomes due to forecasted climate. We will use the Intergovernmental Panel on Climate Change (IPCC) archive of future climate to get expected changes in meteorological variables in 30 years. We will project pollution levels assuming past pollution levels vs change (worsening or improvement) in pollution levels. These projections will be used to estimate changes in the number of “high risk days” between 2000 and 2030, and the subsequent change in the level or number of adverse cardiovascular and cerebrovascular outcomes.

## PROJECT OUTPUTS:

- Hoffmann B, et al. “Opposing Effects of Particle Pollution, Ozone and Ambient Temperature on Arterial Blood Pressure.” *Environ Health Perspect*, 2012; 120(2):241-6  
<http://dx.doi.org/10.1289/ehp.1103647>

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- Nguyen, J. (2012). "Weather as a trigger of cardiac arrhythmias." Unpublished doctoral dissertation, Harvard School of Public Health, Boston, Massachusetts, USA.
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- Zanobetti A, et al. "Effects of air pollution and temperature on vascular function in people with diabetes." Abstracts of the 23rd Annual Conference of the International Society of Environmental Epidemiology (ISEE). September 13 - 16, 2011, Barcelona, Spain.

## Participant List

---

### Brooke Anderson

Johns Hopkins  
geanders@jhsph.edu

---

### Henry Anderson

Wisconsin Division of Public Health  
henry.anderson@dhs.wisconsin.gov

---

### Kenneth Archer

Centers for Disease Control (CDC)  
kaa1@cdc.gov

---

### Lyndsay Avalos

Kaiser Permanente Northern California  
Lyndsay.A.Avalos@kp.org

---

### Dee Ann Bagwell

Los Angeles County Department of  
Public Health  
dbagwell@ph.lacounty.gov

---

### Gerrit Bakker

Association of State and Territorial  
Health Officials  
gbakker@astho.org

---

### John Balbus

National Institute for Environmental  
Health Sciences (NIEHS)  
balbusjm@niehs.nih.gov

---

### Susan Bales

FrameWorks Institute  
susanb@frameworksinstitute.org

---

### Rupa Basu

Cal EPA/OEHHA  
rupa.basu@oehha.ca.gov

---

### Michelle Bell

Yale University  
michelle.bell@yale.edu

---

---

### Vjollca Berisha

Maricopa County Department of Public  
Health  
vjollcaberisha@mail.maricopa.gov

---

### Molly Bernhard

University of Alabama at Birmingham  
School of Public Health  
mbernar@uab.edu

---

### Linda Birnbaum

National Institute for Environmental  
Health Sciences (NIEHS)  
birnbaum@niehs.nih.gov

---

### Priscilla Boston

Texas Department of State Health  
Services  
priscilla.boston@dshs.state.tx.us

---

### Jennifer Botsford

Arizona Department of Health Services  
jennifer.botsford@azdhs.gov

---

### Jack Brondum

Hennepin County Public Health  
Jack.Brondum@co.hennepin.mn.us

---

### Christine Brooks

Marion County Public Health  
Department  
cbrooks@hhcorp.org

---

### Regina Bures

Eunice Kennedy Shriver National  
Institute of Child Health and Human  
Development  
regina.bures@nih.gov

---

### Lorri Cameron

Michigan Department of Community  
Health  
CameronL@Michigan.gov

---

---

### Carl Caneva

Northeastern Illinois  
ccaneva@cityofevanston.org

---

### Kizzy Charles-Guzman

New York City Department of Health  
and Mental Hygiene  
kcharlesguzman@health.nyc.gov

---

### Kathleen Clancy

New York State Department of Health  
Kxs25@health.state.ny.us

---

### Jane Clougherty

University of Pittsburgh  
jcloughe@pitt.edu

---

### Carla Coley

Georgia Department of Public Health  
cdcoley@dhr.state.ga.us

---

### Gwen Collman

National Institute for Environmental  
Health Sciences (NIEHS)  
collman@niehs.nih.gov

---

### Jacques Colon

National Association of County and City  
Health Officials (NACCHO)  
jcolon@naccho.org

---

### Julian Cyr

Massachusetts Department of Public  
Health  
julian.cyr@state.ma.us

---

### Steven Davis

Centers for Disease Control (CDC)  
sjd1@cdc.gov

---

### Caroline Dilworth

National Institute for Environmental  
Health Sciences (NIEHS)  
dilworthch@niehs.nih.gov

---

---

**Kathy Dolan**

Association of State and Territorial  
Health Officials  
kdolan@astho.org

---

**Sam Dorevitch**

U of Illinois at Chicago School of Public  
Health  
sdorevit@uic.edu

---

**Jae Douglas**

Oregon Health Authority, Center for  
Health Protection  
jae.p.douglas@state.or.us

---

**Chris DuClos**

Florida Department of Health  
chris\_duclos@doh.state.fl.us

---

**Michael Dumond**

New Hampshire Division of Public  
Health Services  
mdumond@dhhs.state.nh.us

---

**Angela Dyjack**

American Public Health Association  
(APHA)  
angela.dyjack@apha.org

---

**Tina Echeverria**

Washington State Department of Health  
tina.echeverria@doh.wa.gov

---

**Steve Englander**

Cincinnati Health Department  
Steven.englender@cincinnati-oh.gov

---

**Paul English**

California Department of Public Health  
paul.english@cdph.ca.gov

---

**Richard Fenske**

University of Washington  
rfenske@uw.edu

---

**Larry Figgs**

Douglas County Health Department  
larry.figgs@douglascounty-ne.gov

---

**Kathy Fowler**

Kentucky Department for Public Health  
kathyl.fowler@ky.gov

---

**Chris Frantsvog**

Polk County Health Department (Iowa)  
chris.frantsvog@polkcountyiowa.gov

---

**Nancy French**

Michigan Technological University  
nancy.french@mtu.edu

---

**Heidi Friedman**

NIH Center for Scientific Review  
heidi.friedman@nih.hhs.gov

---

**Chris Fuhrmann**

Southeast Regional Climate Center  
fuhrmann@unc.edu

---

**Gregg Furie**

US Environmental Protection Agency  
(EPA)  
furie.gregg@epamail.epa.gov

---

**Roger Glass**

NIH Fogarty International Center  
glassr@mail.nih.gov

---

**Julia Gohlke**

University of Alabama at Birmingham  
(UAB)  
jgohlke@uab.edu

---

**Diane Gold**

Harvard School of Public Health  
diane.gold@channing.harvard.edu

---

**Nathan Graber**

New York City Department of Health  
and Mental Hygiene  
ngraber1@health.nyc.gov

---

**David Grass**

Vermont State Department of Health  
David.Grass@state.vt.us

---

**Lynn Grattan**

University of Maryland School of  
Medicine  
LGrattan@som.umaryland.edu

---

**Dan Greenberg**

American Public Health Association  
(APHA)  
Daniel.Greenberg@apha.org

---

**Robert Hall**

National Institute of Allergy and  
Infectious Diseases (NIAID)  
robert.hall@nih.gov

---

**Jack Herrmann**

National Association of County and City  
Health Officials (NACCHO)  
jherrmann@naccho.org

---

**Jeremy Hess**

Centers for Disease Control (CDC)  
aso1@cdc.gov

---

**Richard Hicks**

Columbus Public Health  
rickh@columbus.gov

---

**Donald Hoppert**

American Public Health Association  
(APHA)  
donald.hoppert@apha.org

---

**Sandra Howard**

Department of Health and Human  
Services  
sandra.howard@hhs.gov

---

**Wan-Hsiang Hsu**

New York State Department of Health  
(NYSDOH)  
wxh06@health.state.ny.us

---

**Shafiqul Islam**

Tufts University  
Shafiqul.Islam@tufts.edu

---

**Christine Jessup**

NIH Fogarty International Center  
christine.jessup@nih.gov

---

**James Joerke**

Govt. of Johnson County, Kansas  
james.joerke@jocogov.org

---

**Daniel Johnson**

Indiana University – Purdue University  
at Indianapolis  
dpjohnso@iupui.edu

---

**Mary Grace Keating**

Connecticut Department of Public  
Health  
mary.keating@ct.gov

---

**Carol Kelly**

NIEHS Contractor: MDB, Inc.  
ckelly@michaeldbaker.com

---

**Mike Kleeman**

University of California, Davis  
mjkleeman@ucdavis.edu

---

**Kim Knowlton**

NRDC; Mailman SPH, Columbia  
University  
kknowlton@nrdc.org

---

**Howard Koh**

U.S. Department of Health and Human  
Services  
Howard.Koh@hhs.gov

---

**Richard Kreutzer**

California Department of Public Health  
Rick.Kreutzer@cdph.ca.gov

---

**Abraham Kulungara**

Association of State and Territorial  
Health Officials  
akulungara@astho.org

---

---

**Jennifer Li**

National Association of County and City  
Health Officials (NACCHO)  
jli@naccho.org

---

**Vijay Limaye**

University of Wisconsin-Madison  
vlimaye@wisc.edu

---

**Shao Lin**

New York State Department of Health  
sxl05@health.state.ny.us

---

**Yang Liu**

Emory University  
yang.liu@emory.edu

---

**George Luber**

Centers for Disease Control (CDC)  
gcl4@cdc.gov

---

**Neil Maizlish**

California Department of Public Health  
Neil.Maizlish@cdph.ca.gov

---

**Lucien Manga**

World Health Organization  
mangal@afro.who.int

---

**Stephen Marcus**

National Institute of General Medical  
Sciences (NIGMS)  
marcusst@mail.nih.gov

---

**Helene Margolis**

University of California, Davis  
helene.margolis@ucdmc.ucdavis.edu

---

**Gino Marinucci**

US Centers for Disease Control and  
Prevention (CDC)  
ipx1@cdc.gov

---

**Edward Marugg**

Utah State University  
emarugg@phd2.idaho.gov

---

---

**Simon Mason**

The Earth Institute of Columbia  
University  
simon@iri.columbia.edu

---

**Mike Mettler**

Indiana State Department of Health  
mmettler@isdh.in.gov

---

**Clifford Mitchell**

Maryland Department of Health &  
Mental Hygiene  
cliff.mitchell@maryland.gov

---

**Joe Mitchell**

Illinois Department of Public Health  
Joe.Mitchell@illinois.gov

---

**Kerri Moran**

NIEHS Contractor: MDB, Inc.  
kerri.moran@nih.gov

---

**Marie O'Neill**

University of Michigan  
marieo@umich.edu

---

**Jonathan Patz**

University of Wisconsin-Madison  
patz@wisc.edu

---

**Roger Peng**

Johns Hopkins Bloomberg School of  
Public Health  
rpeng@jhsph.edu

---

**Elizabeth Perera**

Sierra Club  
liz.perera@sierraclub.org

---

**Christopher Portier**

US Centers for Disease Control and  
Prevention (CDC)  
cportier@cdc.gov

---

**Judy Qualters**

US Centers for Disease Control and  
Prevention (CDC)  
jqualters@cdc.gov

---

---

**Kristin Raab**

Minnesota Department of Health  
kristin.raab@state.mn.us

---

**Jack Rayburn**

Trust for America's Health  
jrayburn@tfah.org

---

**William Reisen**

University of California, Davis  
wkreisen@ucdavis.edu

---

**Andrew Revkin**

Pace Academy for Applied  
Environmental Studies  
Revkin@gmail.com

---

**Joshua Rosenthal**

NIH Fogarty International Center  
Joshua.Rosenthal@nih.gov

---

**Joel Schwartz**

Harvard School of Public Health  
joel@hsph.harvard.edu

---

**Cynthia Scully**

San Francisco Department of Public  
Health  
cyndy.comerford@sfdph.org

---

**Bono Sen**

National Institute for Environmental  
Health Sciences (NIEHS)  
senb@niehs.nih.gov

---

**Gabrielle Serra**

Public Health Institute  
gabrielle.serra@phi.org

---

**Perry Sheffield**

Mount Sinai School of Medicine  
perry.sheffield@mssm.edu

---

**John Simkovich**

South Carolina Dept. of Health and  
Environmental Control Region 7  
simkovch@dhec.sc.gov

---

**Andrew Smith**

Maine Center for Disease Control and  
Prevention  
andy.e.smith@maine.gov

---

**Theresa Smith**

White House  
Theresa\_L\_Smith@nss.eop.gov

---

**Tiffany Smith**

Johns Hopkins University  
ttownse5@jhu.edu

---

**Kyle Steenland**

Rollins School of Public Health, Emory  
University  
nsteenl@emory.edu

---

**Brian Stone**

Georgia Institute of Technology  
stone@gatech.edu

---

**Lauren Thie**

North Carolina Department of Health  
and Human Services (NC DHHS)  
lauren.thie@dhhs.nc.gov

---

**Kimberly Thigpen Tart**

National Institute for Environmental  
Health Sciences (NIEHS)  
thigpenk@niehs.nih.gov

---

**Claudia Thompson**

National Institute for Environmental  
Health Sciences (NIEHS)  
thomps14@niehs.nih.gov

---

**Madeleine Thomson**

Columbia University  
mthomson@iri.columbia.edu

---

**Juli Trtanj**

National Oceanic and Atmospheric  
Administration (NOAA)  
juli.trtanj@noaa.gov

---

**Robert Vanderslice**

Rhode Island Department of Health  
Robert.Vanderslice@health.ri.gov

---

**Julie West**

Public Health - Seattle & King County  
julie.west@kingcounty.gov

---

**Jalonne White-Newsome**

WE ACT for Environmental Justice  
jalonne@weact.org

---

**Brian Woods**

New Mexico Department of Health  
brian.woods@state.nm.us

---

**Michael Yost**

University of Washington  
airion@uw.edu

---

**Antonella Zanutti**

Harvard School of Public Health  
azanobet@hsph.harvard.edu

---

**Jiang Zhou**

University of Pittsburgh  
jz603@nyu.edu