Climate Variability, Air Quality and Human Health:
Measuring Regional Vulnerability for Improved Decision-Making

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Air pollution and heat stress are two important current public health stressors in many urban areas across the US, and both are strongly affected by climate variability. However, existing methods for assessing the influence of climate variability on levels, and corresponding public health risks, of air pollution and weather remain constrained by limitations in our knowledge of the interplay between climate, extreme heat, air quality and health at geographic scales fine enough to be relevant to urban decision makers.

We propose to develop and apply new methods for analyzing the potential link between climate variability, air quality, and health in NY State. The specific aims of the project are to: (1) develop fine-scale gridded maps of hourly surface weather, ozone, and particulate matter (PM) over NY State over the 15-year period 1988 to 2002 using station observations integrated with the MM5/CMAQ modeling system, (2) analyze the relationship between climate variability and episodes of extreme PM, ozone, and heat, (3) measure the independent and joint effects of air quality and weather on acute mortality and hospitalization risks at the county level across NY State from 1988-2002, and examine whether: vulnerability varies across the region; and/or concentration-response relationships have attenuated over the 15 year period, and (4) work with regional stakeholders to incorporate our findings into decision making related to heat stress and air quality.

The proposed research will assess the degree to which weather and air quality act independently and/or jointly in contributing to health effects, and develop and analyze highly resolved exposure and health maps over the state of New York. The exposure maps will be developed using a rich data base of observations augmented by regional-scale weather and air quality models. Results from the proposed research will advance the tools available for decision-makers to assess the health impacts of climate variability mediated by heat stress and air quality, and build upon and strengthen collaboration between health and climate researchers to improve understanding of these relationships.

WORK PLAN:

This project will build upon and strengthen an ongoing collaboration between health and climate researchers to improve our understanding of the relationships among climate variability, weather, air quality, and human health vulnerability, with a special emphasis on assessing the degree to which weather and air quality act independently and/or jointly in contributing to health effects. We will accomplish this by developing and analyzing highly resolved exposure and health maps over the state of New York. The exposure maps will be developed using a rich data base of observations augmented by regional-scale weather and air quality models, yielding highly

resolved space-time data fields for use both in analyzing the relationships between climate, weather and air quality, and in an epidemiologic analysis of acute effects on mortality and hospitalizations. Results from the research will advance the tools available for decision makers to use in assessing health impacts of climate variability mediated by heat stress and air quality.

The specific aims of the project are to:

- Develop fine-scale gridded maps of hourly surface weather, ozone, and particulate matter (PM) over NY State from 1988 to 2002 using station observations integrated with the MM5/CMAQ modeling system,

- Analyze the relationship between climate variability and episodes of extreme PM, ozone, and heat,

- Measure the independent and joint effects of air quality and weather on acute mortality and hospitalization risks at the county level across NY State from 1988-2002, and examine whether: vulnerability varies across the region; and/or concentration-response relationships have attenuated over the 15 year period,

- Work with regional stakeholders to incorporate our findings into decision making related to heat stress and air quality.

We will carry out a 15-year retrospective analysis of the potential link between climate variability, air quality, and health in NY State. This analysis will use winter and summer concentrations (observations augmented by CMAQ modeling results) of ozone and PM10/$PM_{2.5}$ for 1988-2002. The daily gridded estimates of weather, ozone, and PM will be matched with daily mortality and hospital admissions data at the county level, enabling robust estimation of exposure-response relationships. The results of this analysis will be a set of county-specific risk coefficients for the joint impacts of weather and air quality for all of New York State. To examine overall effects, the set of location-specific risk coefficients will be combined using a meta analysis approach, with weighting by the inverse variances of the individual estimates. This will be done for the entire state, for five geographic regions, and for an urban/suburban/rural stratification. In a sensitivity analysis, we will compare the risk estimates obtained using the space/time exposure maps developed here to those obtained in a traditional analysis that relies only on monitoring site data for exposure assessment. This will enable us to test whether more precise estimates of health risks are obtained using our new method (e.g., by examining relative effect sizes and 95 percent confidence intervals).

The methods and results we propose to develop will provide improved tools for public health policy and decision making. In particular, we will develop a methodology for assessing impacts of climate variability on air pollution and human health at fine geographic scales that are relevant to urban decision makers. This work will provide public health policy decision-makers with better tools to identify communities that are likely to be more impacted by climate and air quality effects. This in turn may help them to develop more targeted strategies for adaptation to or mitigation of those effects, and provide social benefits in the public health sector among those communities.