Project 2 Abstract: Air Pollutant Mixtures in Eastern Massachusetts: Spatial Multi-resolution Analysis of Trends, Effects of Modifiable Factors, Climate, and Particle-induced Mortality

Air, Climate and Energy (ACE) Centers (EPA-G2014-STAR-J1)

Project Center Title: Regional Air Pollution Mixtures: The Past and Future Impacts of Emission Controls and Climate Change on Air Quality and Health

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Project Period and Location: July 1, 2015 – June 30, 2020, Boston, MA

Project Cost: $1,259,996

Project Summary: 1) Objective: To characterize historical air pollution in Eastern Massachusetts at a high spatial resolution and identify modifiable factors responsible for observed changes in PM$_{2.5}$ mass, emissions, elemental profiles, and ground air temperature. Project 2 will investigate within-region variability of pollutant mixtures (EPA ACE Center Research Question 1); examine the impact of modifiable factors on air quality (Research Question 2); and evaluate the effectiveness of source control policies (Research Question 4).

2) Experimental Approach: Objective 1: Use a novel, multi-resolution spatial analysis based on wavelet decomposition of high-resolution (1x1 km) remote sensing data on PM$_{2.5}$ mass and ground air temperature to identify daily regional, sub-regional (urban background) and locally-generated variation in these fields. Objective 2: Develop and apply spatiotemporal regression models to (a) quantify the impact of modifiable factors, including transportation, heating fuel use, energy, urban planning, PM$_{2.5}$ emissions, population statistics, and policy interventions, on (i) sub-regional and local variation in PM$_{2.5}$ mass and ground air temperature and (ii) high-resolution local estimates of PM$_{2.5}$ emissions; (b) identify locations in which these impacts are greatest; and (c) identify lag times between implementation of a given control strategy and decreases in PM$_{2.5}$ emissions and mass. Objective 3: Implement a novel multi-resolution correlation analysis to identify PM$_{2.5}$ elemental profiles that vary at regional, sub-regional, and local scales, and apply spatiotemporal regression models to these profiles to identify modifiable factors driving urban background and local variability in PM$_{2.5}$ composition. Objective 4: Use the spatial scale-specific (regional, sub-regional, and local) temporal variability in PM$_{2.5}$ mass and the PM$_{2.5}$ elemental profiles to identify source types (regional, urban background, or local) and the composition of their emissions driving pollution-induced mortality in Eastern Massachusetts. This project will rely on existing remote-sensing satellite data, ambient monitoring data collected from numerous sampling campaigns (including the HSPH Boston SuperSite daily samples collected since 1998 and samples from 600 locations), as well as new data collected from 2015-2018 in Eastern Massachusetts.

3) Expected Results: We will directly estimate the impact of source control policies, other changes in energy and transportation sectors, and community-level characteristics on PM$_{2.5}$ mass, emissions, and elemental profiles as well as ground air temperature in Eastern Massachusetts. We will describe how the effectiveness of control strategies vary across space and time and identify additional factors that potentially impact air quality. We will identify local actions at the state, city, or community level that may improve air quality, and develop and introduce accountability tools to assess the effectiveness of these local policies, which will be applicable in other areas.

Supplemental Keywords: climate change, regional pollution, multi-resolution spatial analysis, source emissions, local pollution control strategies, wavelet analysis