ENVIRONMENTAL AND ECONOMIC RESEARCH AND DEVELOPMENT PROGRAM

Contributions of Fossil Fuel-fired Electric Power Generation to PM2.5 Concentrations in Wisconsin

Executive Summary
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Executive Summary

The goal of the project was to incorporate state-of-the-art receptor and inverse transport models to quantify the contribution of fossil fuel-fired electric power generation to PM2.5 concentrations in Wisconsin. The project integrated four main components to achieve the overall project goal: 1) analysis of trends in the concentrations and components of historical PM2.5 measurements in Southeastern Wisconsin, 2) application of a multi-variant receptor model to existing PM2.5 monitoring data collected as part of the EPA Speciation Trends Network in Milwaukee (Site 550790026), Waukesha (Site 551330027), and Mayville (Site 550270007), 3) collection of targeted high time resolution PM2.5 chemical composition data used to understand the climatology that lead to speciated PM2.5 concentrations at rural and urban locations in Wisconsin, and 3) employ an inverse transport model and Concentrations Field Analysis (CFA) to identify the spatial distribution, including point, mobile, and area sources of speciated PM2.5 concentrations in Wisconsin.

A key conclusion of the project was that annual average concentrations of PM2.5 sulfate ion and PM2.5 nitrate ion at the Milwaukee and Waukesha sites were not statistically different from the concentrations observed in Mayville providing strong evidence that these PM2.5 components are largely transported into Southeast Wisconsin and are not greatly impacted by local emissions. The urban excess of PM2.5 for these sites is dominated by carbonaceous aerosols, which were found to be largely associated with local emissions of mobile sources and biomass burning. Given that ammonium sulfate and ammonium nitrate contribute approximately 50-60 percent of the annual average PM2.5 concentrations in Southeast Wisconsin and organic carbonaceous aerosol makes up another 25-35 percent, PM2.5 mitigation strategies need to address these PM2.5 components. Analysis of meteorological data demonstrates that days with high PM2.5 sulfate ion concentrations are associated with long range transport from the Ohio Valley, and high PM2.5 nitrate ions are associated with long range transport from the Ohio Valley and other regions of the Midwestern United States. The results demonstrate that although fossil fuel fired power generation is impacting the PM2.5 concentration and non-attainment periods; these impacting emissions are not local to Southeast Wisconsin and are emissions in other regions of the country. Reductions of PM2.5 mass concentrations in Southeast Wisconsin should be

directed at carbonaceous aerosol associated with mobile sources, biomass burning and emissions from stationary power generation in the Ohio Valley.

Local point sources in Southeastern Wisconsin, including stationary power generation, does impact local concentrations of trace components of particulate matter including trace metals, black carbon, and bromine. Although these are not major contributors to PM2.5 concentrations and reduction in emissions of these components are not likely to provide a significant impact in reducing PM2.5 concentrations, there may be potential air quality and human health benefits from reducing these emissions.

The details of the study are outlined in this report and are summarized in four manuscripts that have either been accepted for publication or will be submitted for consideration for publication in the near future. These publications are listed below.

Project Publications

1) J. E. McGinnis, J. Heo, M. R. Olson, A. P. Rutter, and J. J. Schauer. Understanding the Sources and Composition of the Urban Excess of Fine Particulate Matter. In preparation for submission for publication.

2) J. Heo, J. E. McGinnis, B. de Foy, and J. J. Schauer. Identification of Potential Source Areas for Elevated PM2.5, Nitrate and Sulfate Concentrations in the Southern-Wisconsin. In review for publication.

3) A. M. Smyth, S. L. Thompson, B. de Foy, M. R. Olson, N. Sager, J. J. Schauer, and Deborah S. Gross. Sources of Metals and Bromine-Containing Particles in Milwaukee. In review for publication.

3) B. de Foy, A. M. Smyth, S. L. Thompson, D. S. Gross, M. R. Olson, N. Sager, and J. J. Schauer. 2012. Sources of Nickel, Vanadium and Black Carbon in Aerosols in Milwaukee .*Atmospheric Environment.* 59, 294-301.

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ANOVA = ANalysis Of VAriance

AQS = Air Quality System

ATOFMS = Aerosol Time Of Flight Mass Spectrometer

BC = Black Carbon

CAMx = Comprehensive Air quality Model with eXtensions

CFA = Concentrations Field Analysis

EC = Elemental Carbon

EDAS = Eta Data Assimilation System

FIPS = Federal Information Processing Standard

HYSPLIT = Hybrid Single-Particle Lagrangian Integrated Trajectory

IC = Ion Chromatography

KENW = Climatic Data for Kenosha

KFLD = Climatic Data for Fond du Lac

KMKE = Climatic Data for Milwaukee, General Mitchell International Airport

KMSN = Climatic Data for Madison/Dane County Air port

KRAC = Climatic Data for Racine

LADCO = Lake Michigan Air Directors COnsortium

MANOVA = Multivariate ANalysis Of VAriance

MCMC = Markov Chain Monte Carlo

MDL = Method Detection Limit

NAAQS = National Ambient Air Quality Standard

NEI = National Emission Inventory

OC = Organic Carbon

PCA = Principal Component Analysis

PM2.5 = Particulate matter less than 2.5 micrometer in diameter

PMF = Positive Matrix Factorization

PSCF = Potential Source Contribution Function

QAQC = Quality Assurance/Quality Control

SER = South East Regional Headquarters

SOA = Secondary Organic Aerosol

STN = Speciation Trends Network

WDNR = Wisconsin Department of Natural Resources

WRF = Weather Research and Forecasting Model

XRF = X-Ray Fluorescence