

Characterizing the Spatial Variation of Air Quality near Roadways (3.2)

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Recent studies have identified increased adverse health effects in the large percentage of the population that lives, works, and attends school near major roadways. EPA's Clear Air Research multiyear plan therefore emphasizes air research to better understand the linkages between traffic-pollutant sources and health outcomes. The effort described here is to further understand the atmospheric transport and dispersion of emissions within the first few hundred meters of the roadway, a region often characterized by complex flow (e.g., sound barriers, road cuts, buildings, vegetation) and where steep gradients of concentration have been observed. Work within AMAD has focused on developing and improving various numerical modeling tools necessary for assessing potential human exposure in near-road environments.

Regarding modeling tools for simulating near-road concentration gradients, over the past decade the Division has played a central role in developing the AERMOD near-field dispersion model, adopted by EPA as the preferred tool for urban-scale (or smaller) analyses. While the model can simulate simple roadway-type scenarios, it does not specifically account for many complexities commonly found near roads. However, after a thorough review of publicly available modeling tools, AERMOD was selected as the preferred platform upon which improvements could be made for local-scale dispersion simulations of near-road applications and for inclusion in hybrid modeling (with CMAQ) for urban-scale exposure assessments. After initial wind tunnel studies, algorithms for estimating the concentration gradients downwind of roadways in the presence of noise barriers and depressed roadways have been developed and show much promise. Additional wind tunnel studies with variations in wind direction, barrier height, and surrounding surface characteristics are in progress. Computational fluid dynamics modeling of these and other scenarios is in progress and is expected to yield a significant database from which further improved parameterizations will result. Ongoing and future field campaigns and tracer studies will provide excellent development and evaluation databases.

Once improved and evaluated, the new near-road dispersion model will be used in the Air Quality Modeling Study in Atlanta as a part of a Cooperative Research Agreement between EPA/NERL and Emory University. In this project, air quality estimates will be correlated with a ten-year history of emergency room data and with the experiences of over 800 patients with Implanted Cardiac Defibrillators. Air quality estimates will be based on the hybrid approach using combined regional (CMAQ) and local-scale (AERMOD) modeling. Various source configuration options will be tested in a sensitivity study to estimate the impact of noise barriers on air quality and exposure near roadways. Similar hybrid modeling activities will be conducted for Baltimore as a part of another Cooperative Agreement with the University of Washington.

Finally, related urban research in AMAD prior to the near-roadway program involved focus on homeland security. Between 2002 and 2005, the Division's Fluid Modeling Facility (FMF) examined flow and dispersion in three actual urban settings. Using the meteorological wind tunnel, AMAD provided critical modeling information for EPA's response to the tragic events in Manhattan in late 2001. As part of the Pentagon Shield Program, FMF scientists examined the flow and potential exposure to hazardous releases around the Pentagon building. In collaboration with EPA's National Homeland Security Research Center, wind tunnel measurements were conducted for an examination of street canyon flows in an urban neighborhood in Brooklyn, NY.