Linking Local-Scale and Regional-Scale Models for Exposure Assessments (3.1)

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Population-based human exposure models predict the distribution of personal exposures to pollutants of outdoor origin using a variety of inputs, including air pollution concentrations; human activity patterns, such as the amount of time spent outdoors versus indoors, commuting, walking, and indoors at home; microenvironmental infiltration rates; and pollutant removal rates in indoor environments. Typically, exposure models rely upon ambient air concentration inputs from a sparse network of monitoring stations.

We have developed a new method to enhance air quality and exposure modeling tools so that they can address finer-scale air toxics concentrations and exposures. The hybrid modeling approach combines the results from two types of regional- and local-scale air quality models (the CMAQ chemistry-transport model and the AERMOD dispersion model). The resulting hourly concentrations are used as inputs to population exposure models (the Hazardous Air Pollutant Exposure Model [HAPEM] and the Stochastic Human Exposure and Dose Simulation [SHEDS] model) to enhance estimates of urban air pollution exposures that vary temporally (annual and seasonal) and spatially (at census block group resolution). Thus, the new method establishes a linkage between air quality and exposure modeling and will improve health assessments that include near-source impacts of multiple ambient air pollutants.

We demonstrate how this linked air quality/exposure modeling approach may be used in future community-level environmental health studies by providing exposure estimates that reflect residences near large industrial facilities or major roadways. This research is an important component of an EPA feasibility study being conducted in New Haven, CT, that is examining the cumulative impact of various air pollution reduction activities (at local, state, and national levels) on changes in air quality concentrations, human exposures, and potential health outcomes in the community. In conjunction with local data on emission sources, demographic and socioeconomic characteristics, and indicators of exposure and health, the methodology presented here can serve as a prototype for providing high-resolution exposure data in future community air pollution health studies. For example, the methodology can be used to provide the baseline air quality assessments of impacts due to regional- or local-scale air pollution control measures. It can also be applied to estimate the likely impact of future projected air pollution control measures or urban/industrial growth on human exposures and health in the community.

The extent of variability in spatial and temporal concentration gradients associated with large point sources and roadways shown in this research is especially important, given the growing body of literature on the potential adverse health effects associated with elevated concentrations near such sources.