Air Quality Modeling of Traffic-related Air Pollutants for the NEXUS Study

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A major challenge in traffic-related air pollution exposure studies is the lack of information regarding pollutant exposure characterization. Air quality modeling can provide spatially and temporally varying exposure estimates for examining relationships between traffic-related air pollutants and adverse health outcomes. This paper presents a hybrid air quality modeling approach and its application in NEXUS in order to provide spatial and temporally varying exposure estimates and identification of the mobile source contribution to the total pollutant exposure. Model-based exposure metrics, associated with local variations of emissions and meteorology, were estimated using a combination of the AERMOD and RLINE dispersion models, local emission source information from the National Emissions Inventory, detailed road network locations and traffic activity, and meteorological data from the Detroit City Airport. The regional background contribution was estimated using a combination of the Community Multiscale Air Quality (CMAQ) model and the Space/Time Ordinary Kriging (STOK) model. To capture the near-road pollutant gradients, refined “mini-grids” of model receptors were placed around participant homes. Mini-grids gave anonymity to 50 or 100 m, a distance sufficient to protect participants' identity. Exposure metrics were calculated from mini-grids to produce an estimate at each home location (n=160). Exposure metrics for CO, NOx, PM2.5 and its components (EC and OC) were predicted for multiple time periods including daily (24h period) as well as AM and PM rush hours. The exposure metrics were evaluated in their ability to characterize the spatial and temporal variations of multiple ambient air pollutants compared to measurements across the study area. Preliminary results of the epidemiologic analyses using model-based exposure estimates indicate a potential to help discern relationships between air quality and health outcomes.