Individual-Based Exposure Modeling to VOCs in Three Urban Areas of the United States

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Abstract

A source-to-exposure modeling study of exposures to HAPs was presented for the subjects of the three sample populations (Elizabeth, NJ; Houston, TX; Los Angeles, CA). The method included the Individual-Based Exposure Modeling (I REM) approach of the MITOR-1A computational framework. MENTOR-1A is a comprehensive modeling tool for evaluating algorithms and methods used in the state-of-the-science, step-by-step evaluation of source-to-exposure modeling sequences. MENTOR-1A includes a step-by-step sequence of sub-models that simulate the outdoor HAP exposure and personal exposure for the study participants. The objective of this study was to perform evaluation of algorithms and methods used in the state-of-the-science, source-to-exposure modeling sequence. Specifically, the data were:

- Characterization of background concentrations of contaminants through a combination of environmental model predictions and field data;
- Characterization of background concentrations of contaminants in various microenvironments;
- Calculation of personal exposure concentrations by combining activity data and the measured environmental concentrations.

Operational Model Evaluation

The source-to-exposure modeling results for all of the adult participants were compared with the corresponding RIOPA measurements (outdoor, indoor, and personal air) for each of the three RIOPA cities. Model-to-measurement ratios for the four VOCs are presented in the following box plots for the three RIOPA cities. The bottom of the box is the 25th percentile, the top is the 75th percentile, and the horizontal line in the middle is the median. The box plots demonstrate the variability of the model-to-measurement ratios and provide insights into the performance of the source-to-exposure modeling approach. The box plots are only based on local emission sources without the contribution from background concentrations. ISCST3 and AERMOD predictions are based on both the ambient air quality estimates from each atmospheric dispersion model and the outdoor measurement. The ambient air quality estimates from each atmospheric dispersion model (ISCST3 and AERMOD) and the outdoor measurement were subsequently used as inputs to the microenvironmental module of MENTOR-1A to estimate personal exposure concentrations for each study participant.

Conclusions

MENTOR-1A was applied to perform individual-based exposure modeling on the RIOPA study subjects, for the estimation of exposure assessment approaches. Specifically, step-by-step evaluation of the outdoor HAP exposure modeling results from MENTOR-1A was conducted by comparing modeling results with the corresponding RIOPA measurements. These results indicate that the source-to-exposure modeling approach is effective in estimating the personal exposure concentrations of the study participants. Further work will focus on the development of modules to account for contributions of indoor sources of VOCs.