APPENDIX AVAILABLE ON REQUEST

Research Report 160
Personal and Ambient Exposures to Air Toxics in Camden, New Jersey
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Appendix I. Detailed Comparisons of Modeling Results

[Note: Appendices Available on the Web appear in a different order than in the original Investigators' Report. HEI has not changed these documents. Appendices were relettered as follows:

Appendix I was originally Appendix VIII

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Although this document was produced with partial funding by the United States Environmental Protection Agency under Assistance Award CR–83234701 to the Health Effects Institute, it has not been subjected to the Agency's peer and administrative review and therefore may not necessarily reflect the views of the Agency, and no official endorsement by it should be inferred. The contents of this document also have not been reviewed by private party institutions, including those that support the Health Effects Institute; therefore, it may not reflect the views or policies of these parties, and no endorsement by them should be inferred.

This document was reviewed by the HEI Health Review Committee
but did not undergo the HEI scientific editing and production process.

Appendix VIII. Detailed Comparisons of Modeling Results

WFS vs. CDS

The ambient measurements and associated model predictions for WFS were compared to those for CDS to examine the spatial variations of the selected air toxics between the two stationary sites. Two types of plots were generated to facilitate the comparisons between measurements and model predictions: (1) the cumulative distribution functions (CDF) and (2) box-plots of the model-to-measurement ratios. The CDF plot would reveal the differences between measurements and model predictions for the whole distribution without pairing the values for the comparison. Further, the CDF plot also showed the general trend of differences between groups of measurements and corresponding model predictions stratified by their attributes such as location (i.e., WFS vs. CDS). The box-plots of the model-to-measurement ratios were used for more rigorous model performance evaluation by pairing them in space and time. The bottom of the box is the 25th percentile, the top of the box is the 75th percentile, and the horizontal line in the middle of the box is the median. If the model predictions consistently agreed with the measurement data for the pollutant, the box plots would be short, and centered at "1". Two horizontal lines of half and double model-to-measurement ratios were highlighted in each of the box plots to facilitate the visualization of the "within a factor of 2" agreement.

The CDF plots and box-plots of model-to-measurement ratios are shown in Figures VIII-1 to VIII-3 for benzene, toluene, and formaldehyde, respectively. For benzene, the agreement between the model predictions and the ambient measurements were generally within a factor of two as shown in the box-plots of model-to-measurement ratios (see Figure VIII-1). The cumulative distributions of both the WFS and CDS measurements appeared to overlap each other for the entire distribution (see Figure VIII-1). The corresponding model predictions also found little difference between the two stationary sites for the entire distribution. Further, the median levels of ISCST3 and AERMOD predictions were comparable to those measured at the corresponding WFS and CDS sites (see Figure VIII-1). However, both model predictions were under-estimated for the measurements above the 70^{th} percentile.

For toluene, the WFS measurements were consistently higher than the CDS measurements across the whole distribution, while the model predictions also revealed the similar trend between the two central sites (see Figure VIII-2). This is mainly due to the affect of local stationary sources close to the WFS site, while the CDS site is relatively far away from these sources. The median

levels of ISCST3 and AERMOD predictions were also comparable to those measured at the corresponding WFS and CDS sites as seen in the Benzene case. In general, the model predictions were in agreement with the measurements within a factor of two as revealed by the box-plots of model-to-measurement ratios (see Figure VIII-2). However, both model predictions were under-estimated for the measurements above the 75th percentile.

In the case of formaldehyde, the model predictions at both the WFS and CDS sites were significantly lower than the measurements collected at these two sites for the entire distribution (see Figure VIII-3). The boxes of model-to-measurement ratios were generally located in the zones of 0.04 to 0.15 for CDS and 0.07 to 0.20 for WFS, indicating that the model performance was slightly better in WFS than CDS. The severe under-estimation by the dispersion modeling completed for formaldehyde ambient concentrations appeared to be due to the following two reasons. *First, both of the dispersion models could not take into account the secondary formation of formaldehyde due to photochemistry. Second, the county-level mobile sources emissions of formaldehyde based on the NEI-2002 were significantly under-estimated for this "hot-spot" area in Camden, NJ with very heavy localized truck traffic reported by the NJDEP (2005).*

Weekday vs. Weekend

Temporal variation of ambient concentrations of the three air toxics were examined by comparing the cumulative distribution functions of measurements and model predictions on weekdays with those on weekends as well as the box-plots of model-to-measurement ratios. For benzene, very little difference was observed between the weekday and weekend measurements. The corresponding model predictions did not show the weekday/weekend differences either. For toluene, a trend of higher weekday measurements than those on weekends was observed. The model predictions also showed distinguishable weekday/weekend differences in the same direction as the measurements. For formaldehyde, the weekend measurements were consistently higher than those on weekday. The model predictions did not show the weekday/weekend differences for the whole distribution, and they were significantly under-estimated.

Summer vs. Winter

Seasonal variations of ambient concentrations of the three air toxics were characterized by comparing the cumulative distribution functions of measurements and model predictions for the summer with the winter. For benzene ambient measurements, there was no seasonal

difference except for the high-end percentiles (above 85%tile), where the summer concentrations were higher than those in winter. The model predictions showed relatively minor differences approximately above the 70th percentile with the predicted ambient concentrations of benzene being higher in winter than those in summer. This trend might be due to the fact that the mixing heights in winter were generally lower than those in summer, and resulted in better mixing of sources emissions in the winter. However, the opposite trend shown for the ambient measurements at the high-end percentiles collected at the two stationary sites might be due to a strong seasonal difference in local source emissions of benzene, which were not captured by the emissions estimates used for the dispersion calculations. By examining the model-to-measurement ratios, we found that the dispersion modeling predictions in winter have better agreement with ambient measurements than those in summer. This indicates that the discrepancy in characterizing local source emissions of benzene for dispersion modeling was greater in summer than winter. The faster photochemical removal rates in summer should result in lower ambient levels of benzene. However, this was not observed in the ambient measurements due to the strong impact of local source emissions. For toluene, the measurements did not show seasonal differences.. However, the model predictions showed a trend in seasonal differences similar to benzene due to the meteorological conditions mentioned above. For formaldehyde, the summer measurements were higher than those in winter. This trend might be due to photochemistry, since secondary formation of formaldehyde occurs in summer. However, the model predictions showed the differences approximately above the 70th percentile with the predicted ambient concentrations being higher in winter than those in summer. This was due to the lack of considering the secondary photochemical production in summer and also the fact that formaldehyde is treated as an inert species like benzene in dispersion modeling.

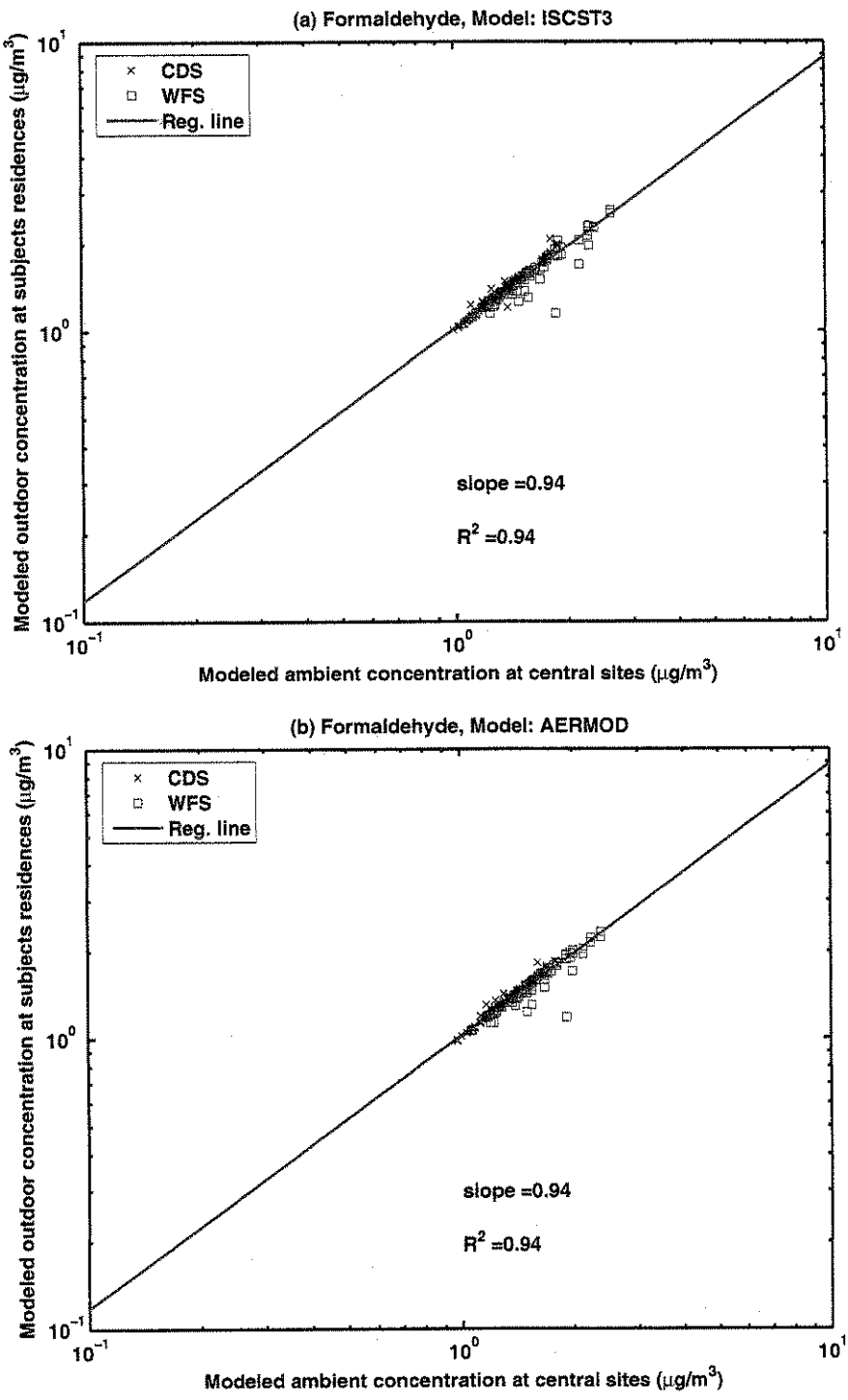

Figure VIII-1. Scatter plots of the modeled formaldehyde ambient concentrations at two stationary sites (CDS and WFS) versus the corresponding modeled outdoor concentrations at the subjects' residences for (a) ISCST3 and (b) AERMOD predictions.

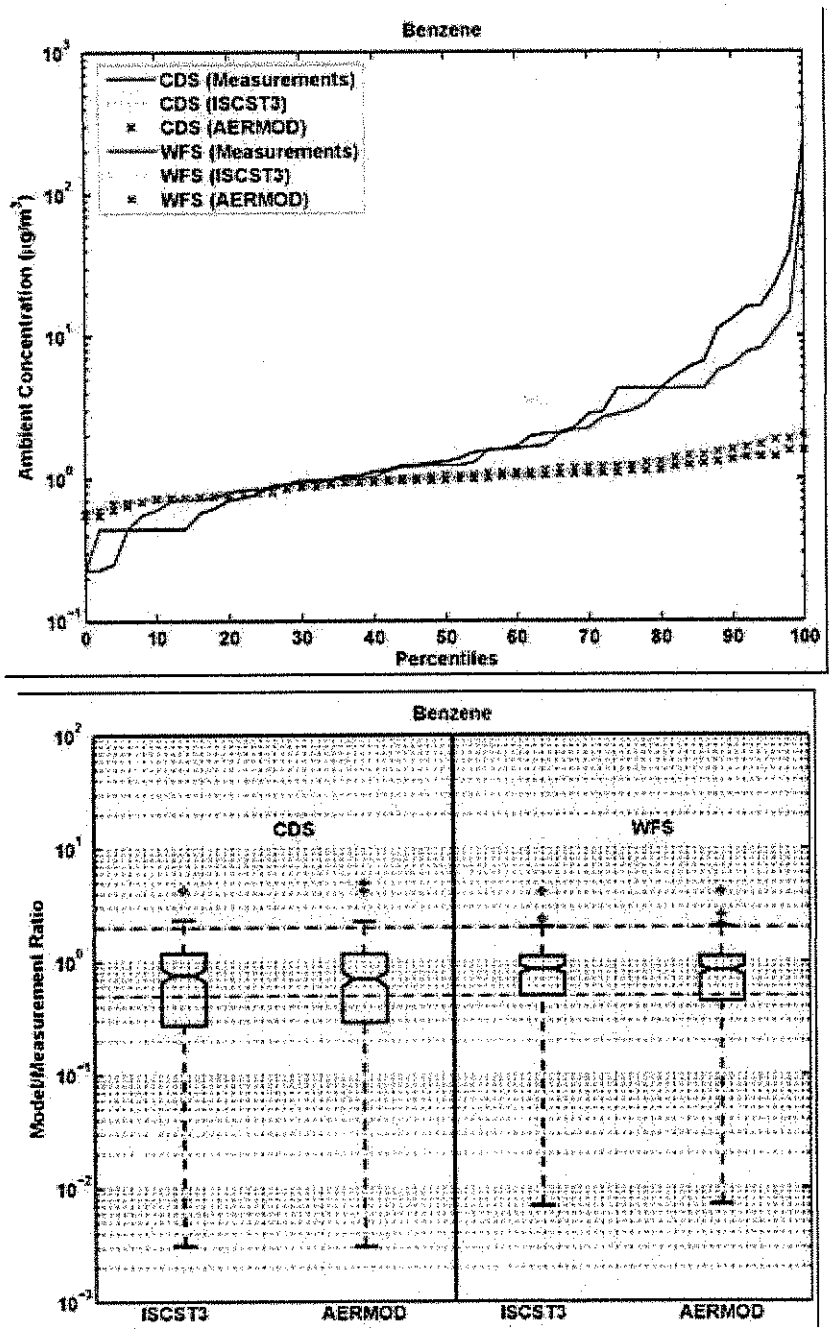

Figure VIII-2. Cumulative distribution functions of the benzene ambient concentrations measured at the two stationary sites (CDS vs. WFS) and the corresponding atmospheric dispersion (ISCST3 and AERMOD) modeling results (upper panel). Box-plots of the model-to-measurement ratios (lower panel) show the comparisons paired in space and time.

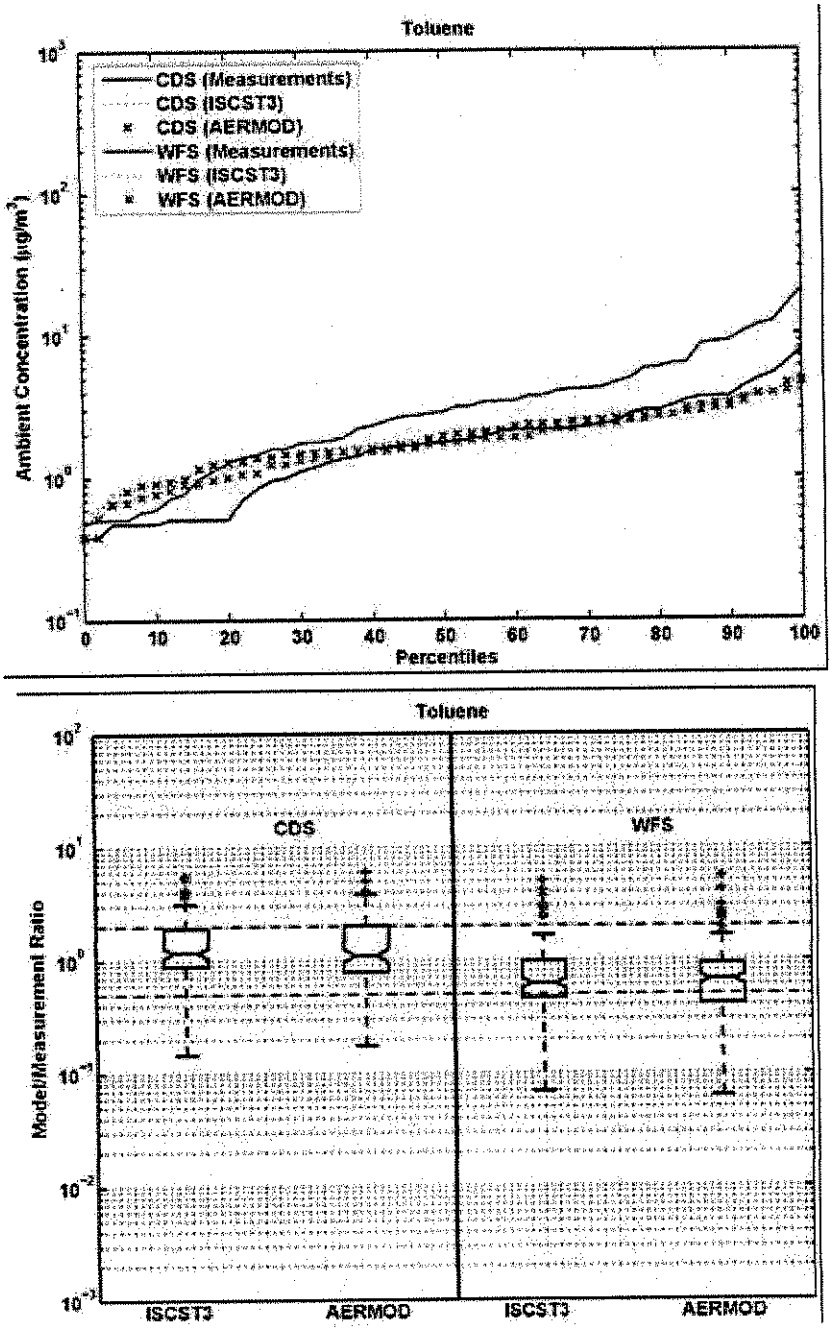

Figure VIII-3. Cumulative distribution functions of the toluene ambient concentrations measured at the two stationary sites (CDS vs. WFS) and the corresponding atmospheric dispersion (ISCST3 and AERMOD) modeling results (upper panel). Box-plots of the model-to-measurement ratios (lower panel) show the comparisons paired in space and time.