Abstract and Supporting Material Submitted to the NCS Research Day, August 24, 2011

Title: An Exposure Index estimation framework for the National Children's Study (NCS)

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Description of Research

Exposure Indices (EIs) are designed to capture and summarize, in a small set of numerical values/ranges, complex distributions of potential exposures to multiple contaminants. They are defined in relation to health risks associated with common health endpoints, and take into account location-specific contaminant information on multiple media and exposure pathways. The NCS-EI framework is designed to support formulation and testing of specific exposure-based hypotheses, to maximize the use of extant data in exposure estimation, and to rank different NCS locations in relation to potential for environmental exposures. This framework utilizes an Exposure Information System (EXIS) that has been developed by processing and integrating diverse extant databases of environmental, demographic, behavioral, biological, etc. attributes at the Federal, regional, State, and local level. Within the EXIS, these data are supplemented by estimates from numerical model simulations of environmental quality and population exposures. The EXIS has been designed to support and to take advantage of the MENTOR (Modeling ENvironment for TOtal Risk studies) and PRoTEGE (Prioritization/Ranking of Toxic Exposures with GIS Extension) systems. Initial EI applications have focused on inhalation exposures potentially relevant to pregnancy outcomes such as low birth weight and pre-term birth rates, and are demonstrated (a) for the set of all NCS counties, and (b) for NCS study segments for Queens County, NY. They highlight the feasibility of the EI analysis and also identify various challenges due to heterogeneities and gaps in data. Systematic analyses of these challenges will help prioritize future information collection efforts for specific NCS study components.

Proposed Figures and Graphs:

Methods:

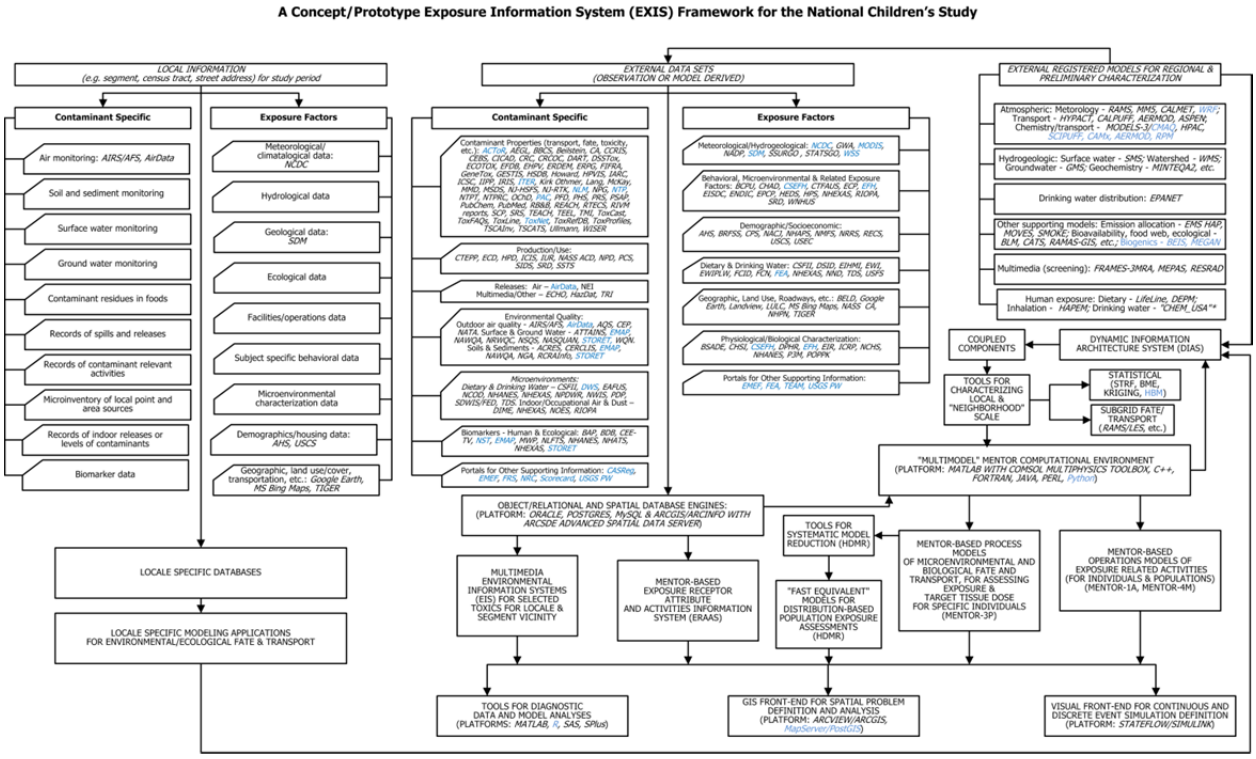
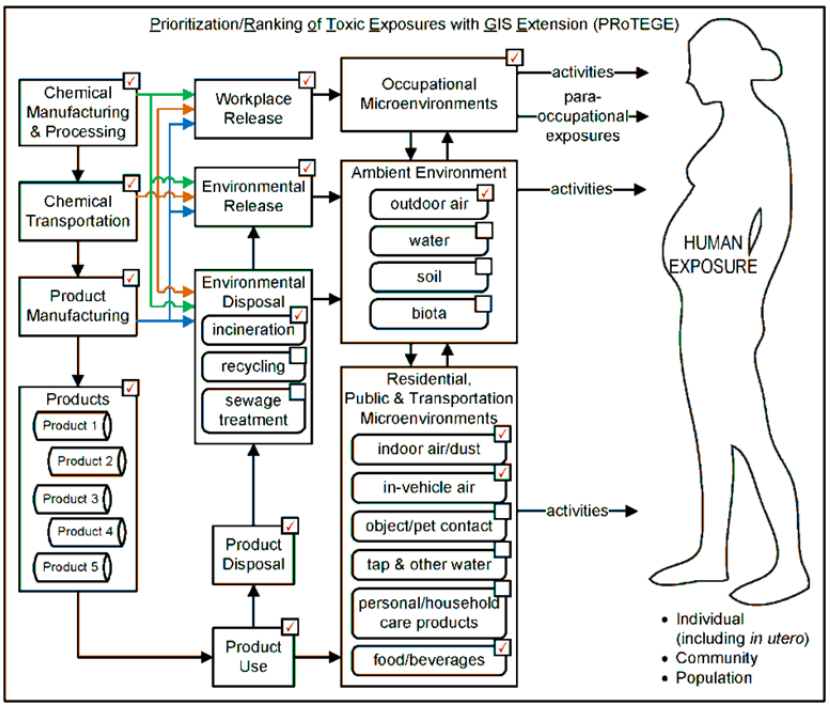
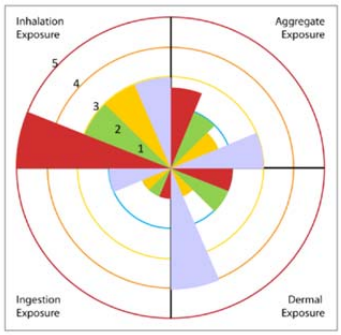


Figure 1: The Exposure Information System (EXIS) framework was constructed and is updated continually (since 1992) for the MENTOR system

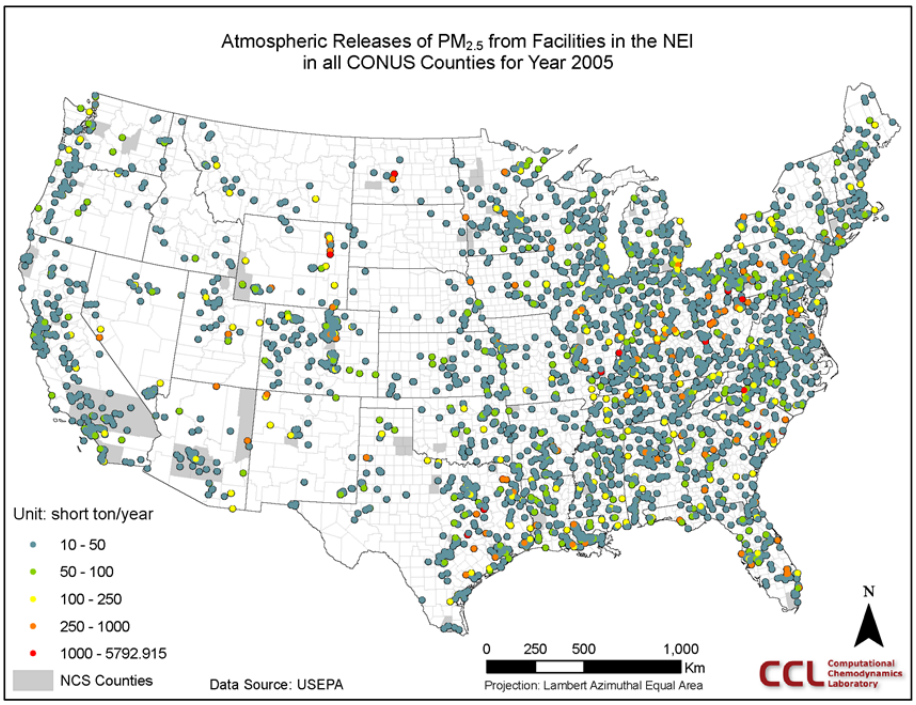




Formaldehyde Semi-Quantitative Exposure Ranking

	Pervasiveness	Persistence	Severity	Efficacy
Inhalation	5	3	3	3
Ingestion	1	1	1	2
Dermal	2	2	1	4
Aggregate	2.66	2	1.66	3

Figure 2: NCS EI development takes advantage of the PRoTEGE framework; protégé utilizes components of the comprehensive MENTOR system developed at EOHSI and provides a simplified modeling platform employing extant data and screening modules to examine human exposures associated with environmental toxics and will eventually include site-specific measurement data from NCS participants.



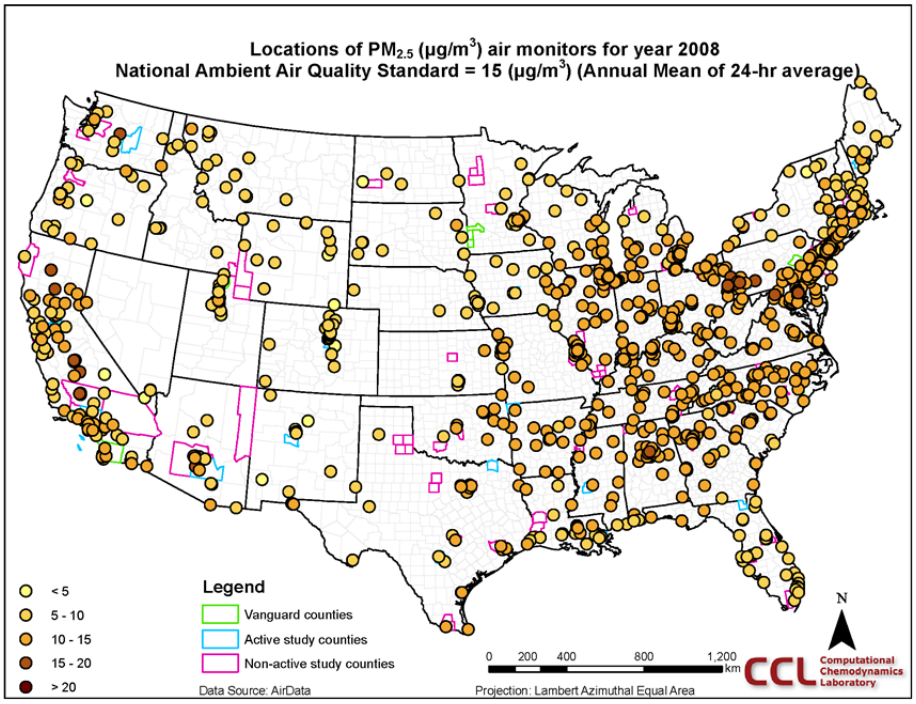
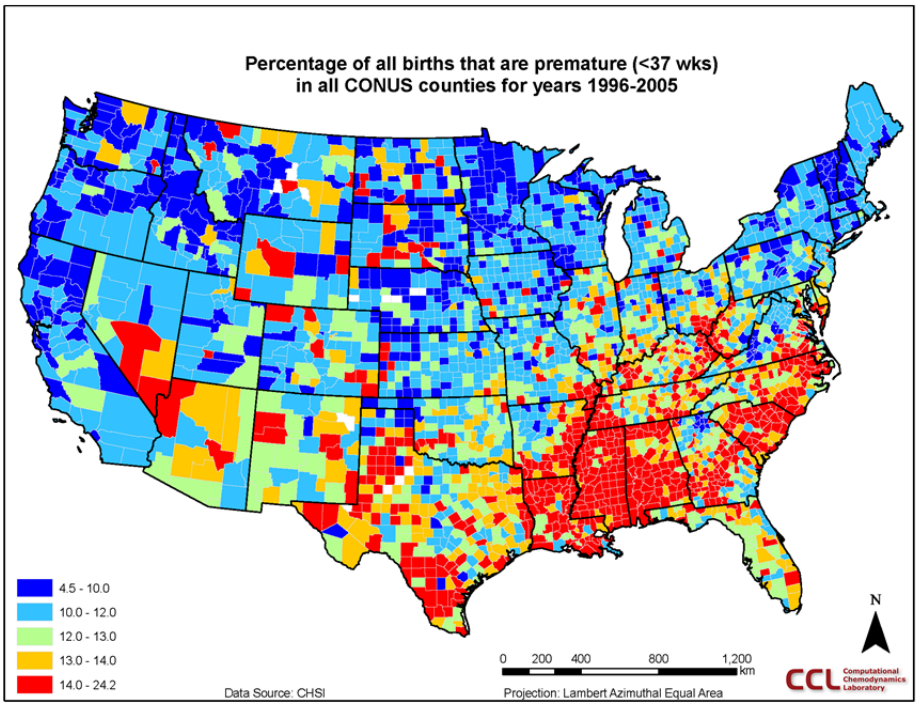


Figure 3: Representative examples of data sources in EXIS available for use in development of the EI: environmental releases (top); environmental and microenvironmental concentrations (bottom)



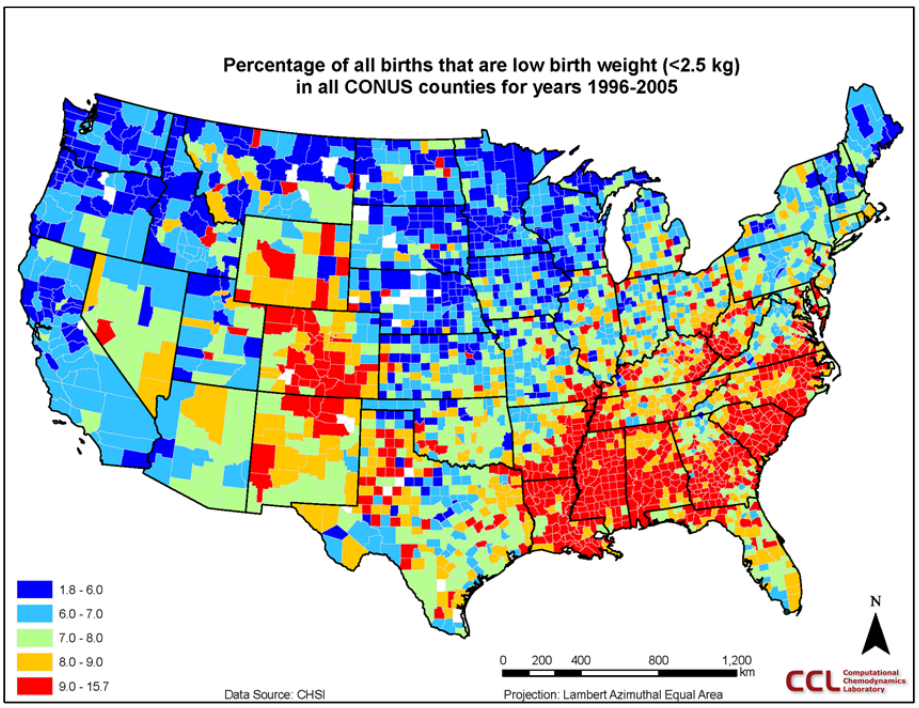


Figure 4: Distributions of the selected endpoints for the first set of NCS EIs: preterm birth rates and low birth weights

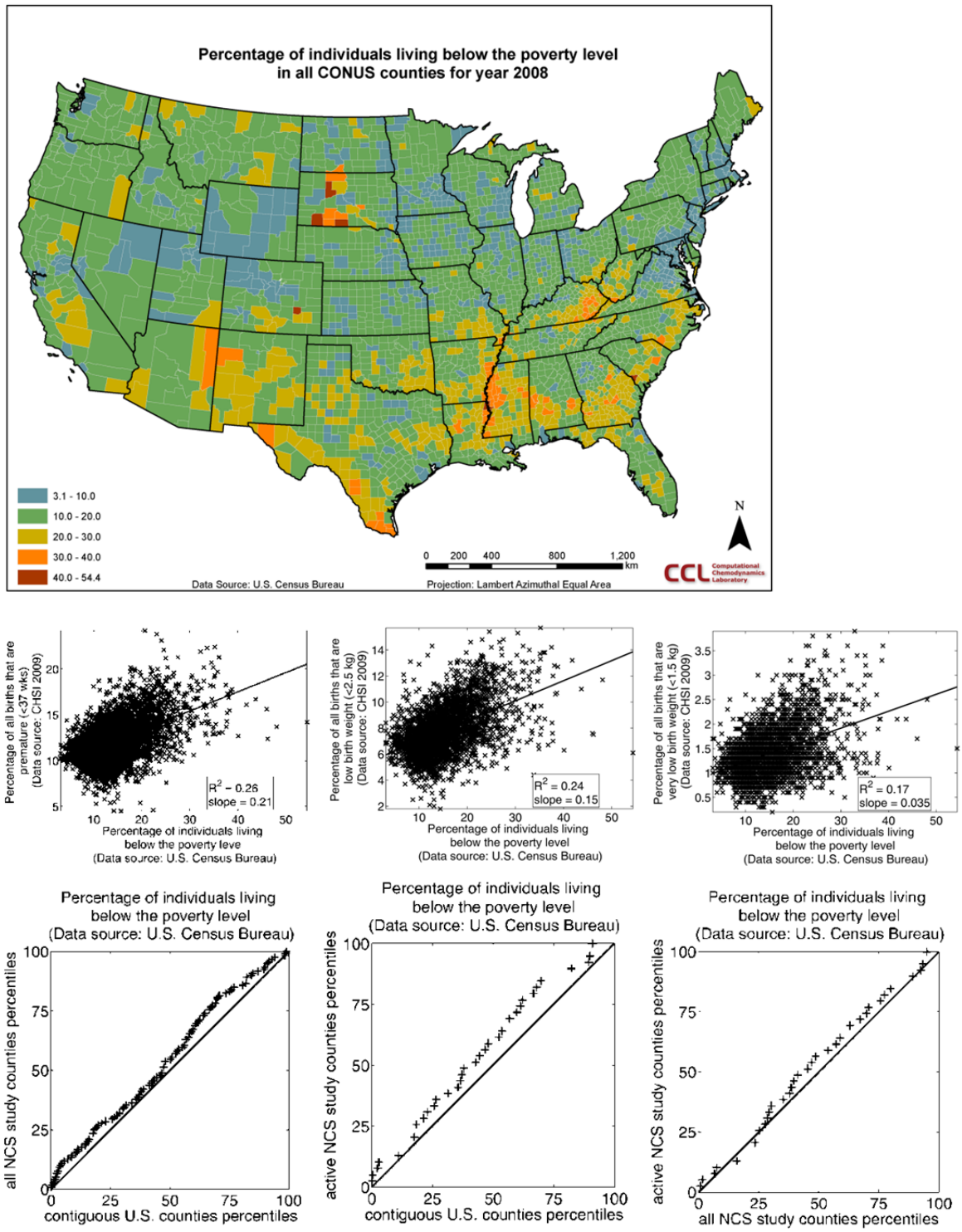


Figure 5: Example of exposure-relevant factors considered within the EI framework: Individuals living below the poverty level for 2008 in the U.S.

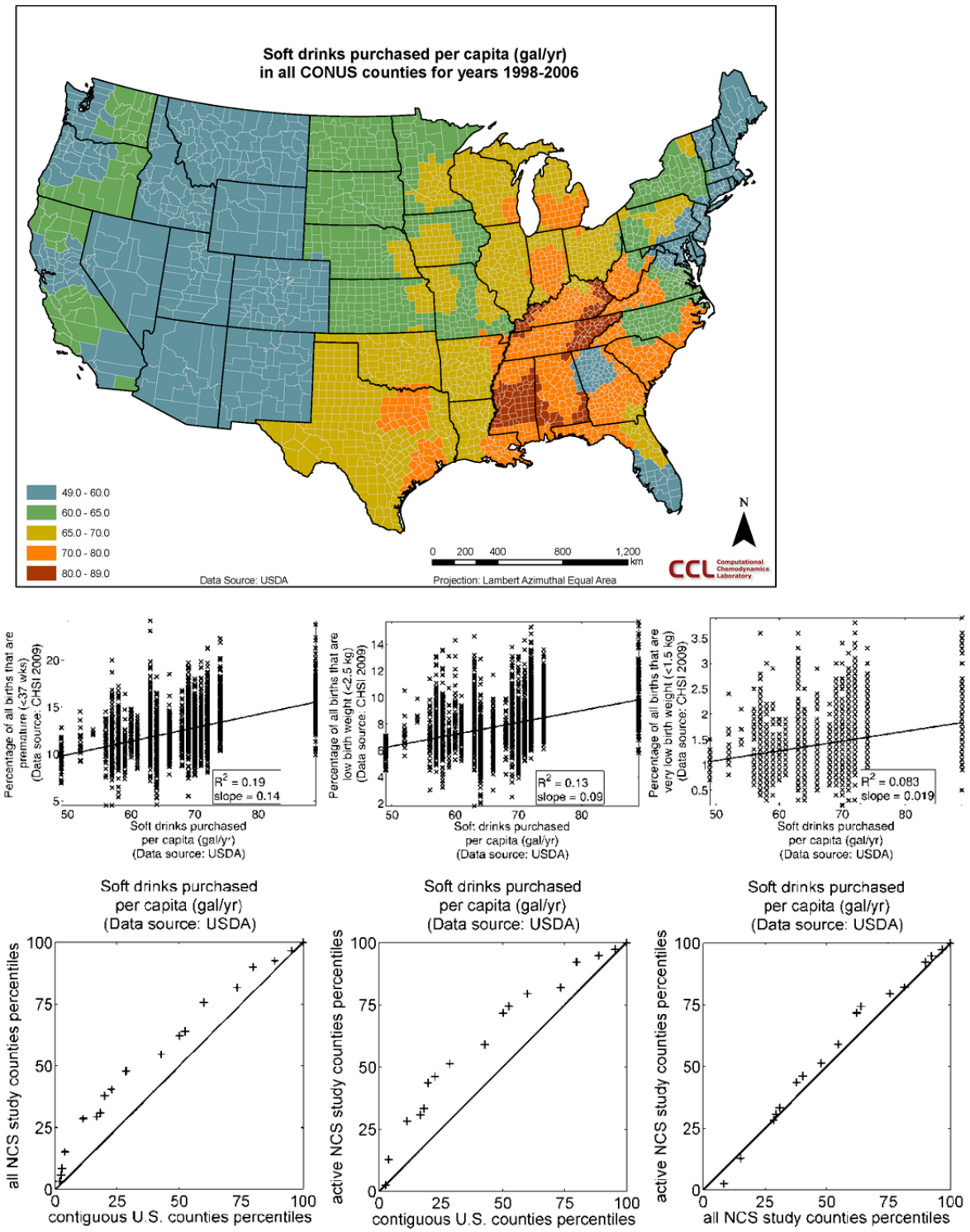


Figure 6: Example of exposure-relevant factors considered within the EI framework: Soft drinks purchased per capita

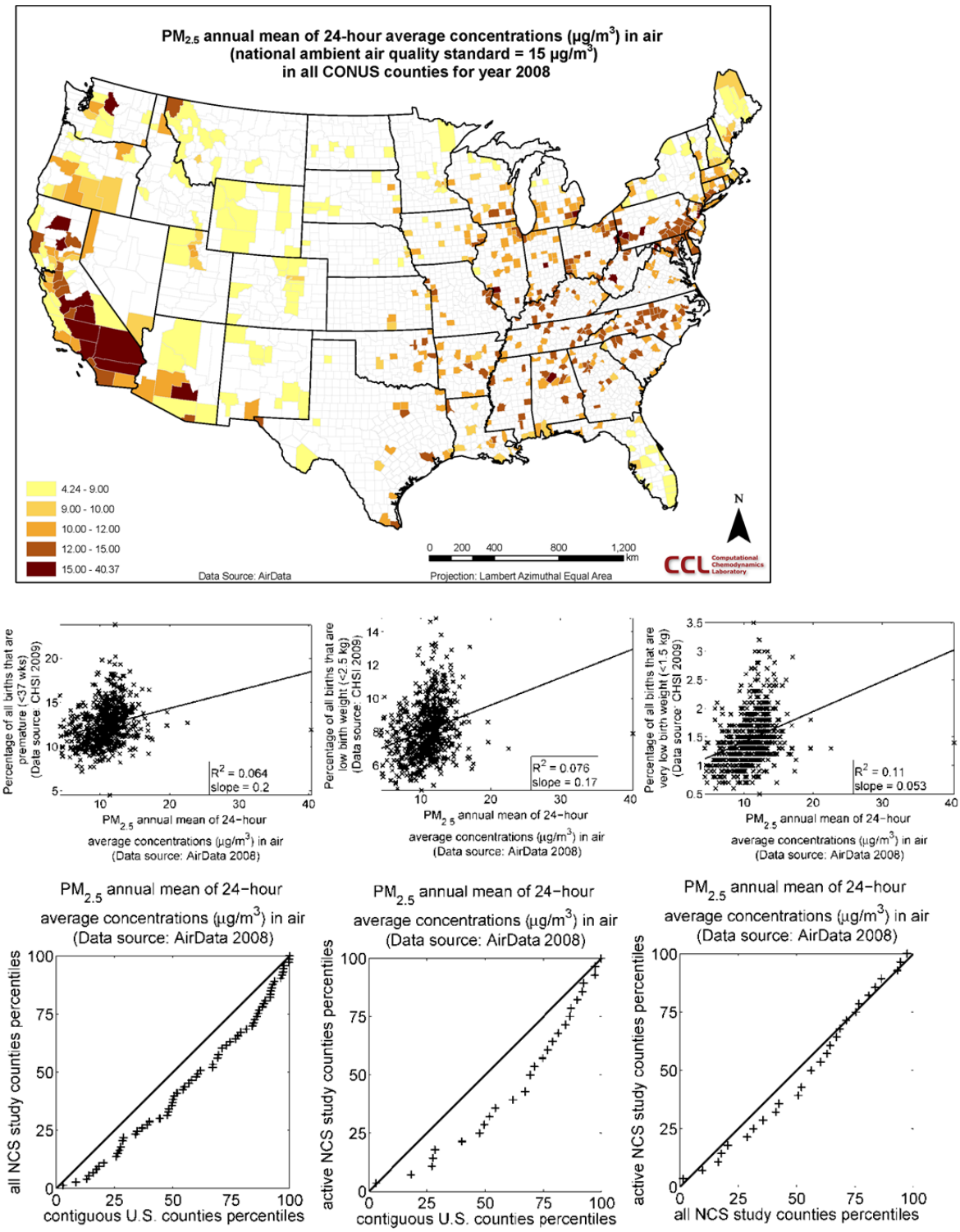


Figure 7: Example of exposure-relevant factors: ambient PM2.5 levels

Results:

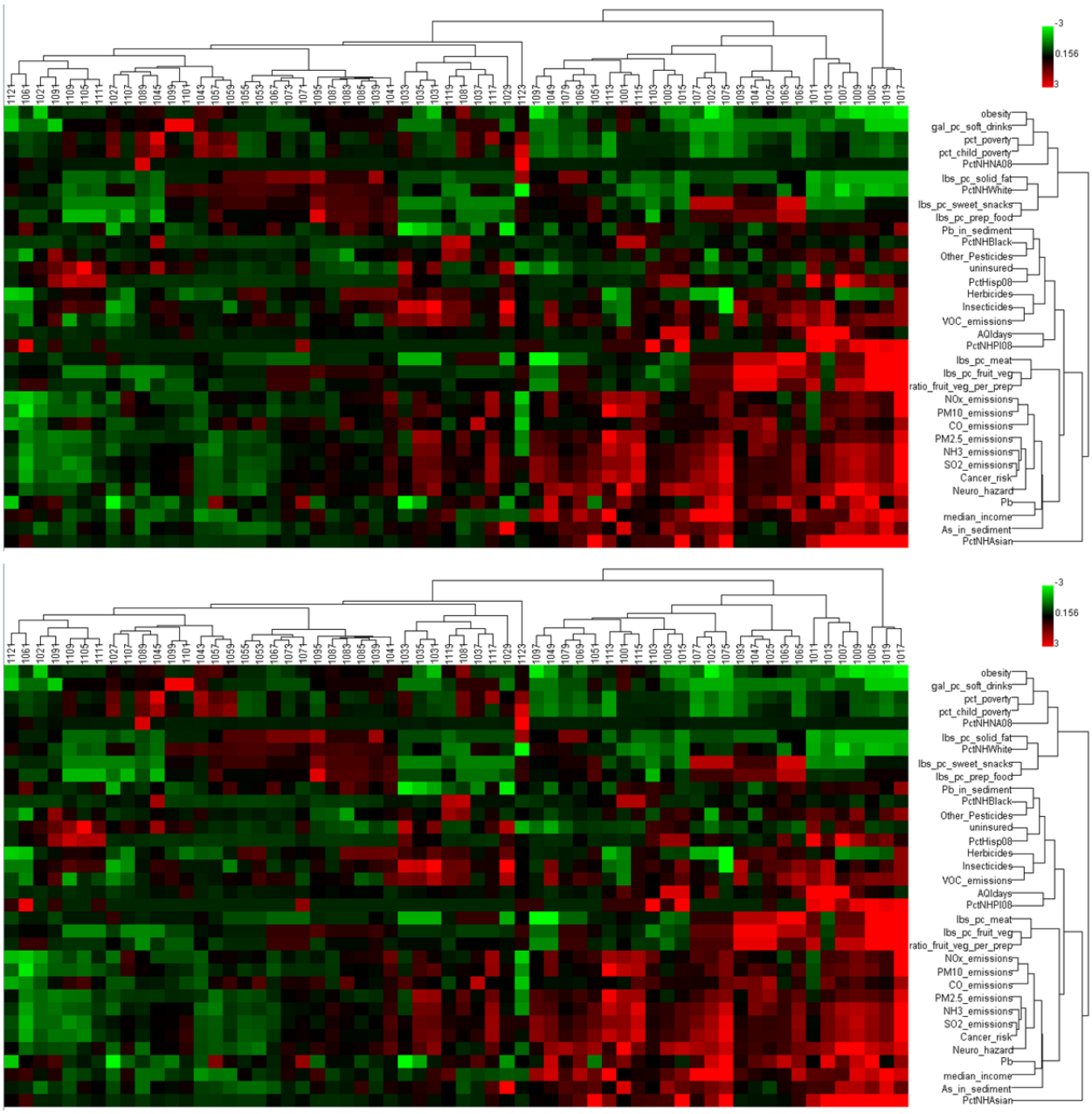


Figure 8: Bi-clustered heatmaps showing similarities between 48 selected exposure-relevant attributes; top shows 62 "central" counties of metro area with population >1 million, bottom shows 1,216 noncore counties with urban population of <2,500 - 49,999 adjacent or not adjacent to metro area.

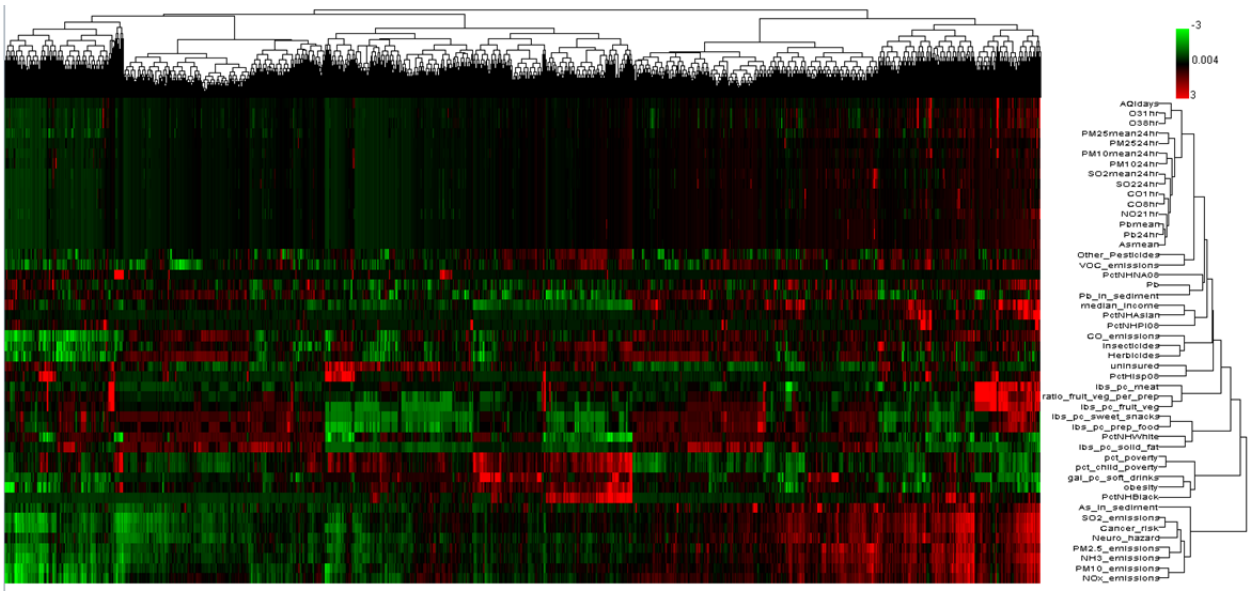
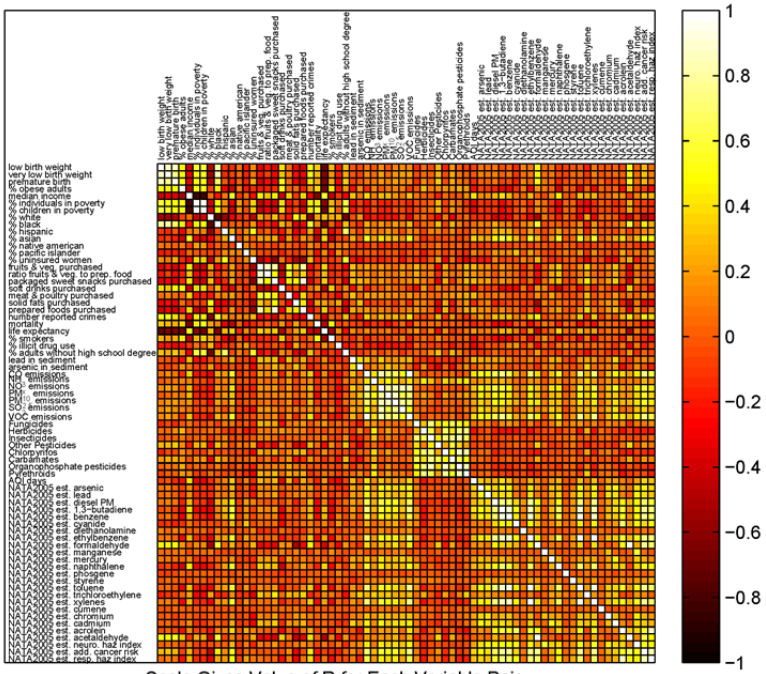


Figure 9: Bi-clustered heatmap showing similarities between 48 selected exposure-relevant attributes – all US counties



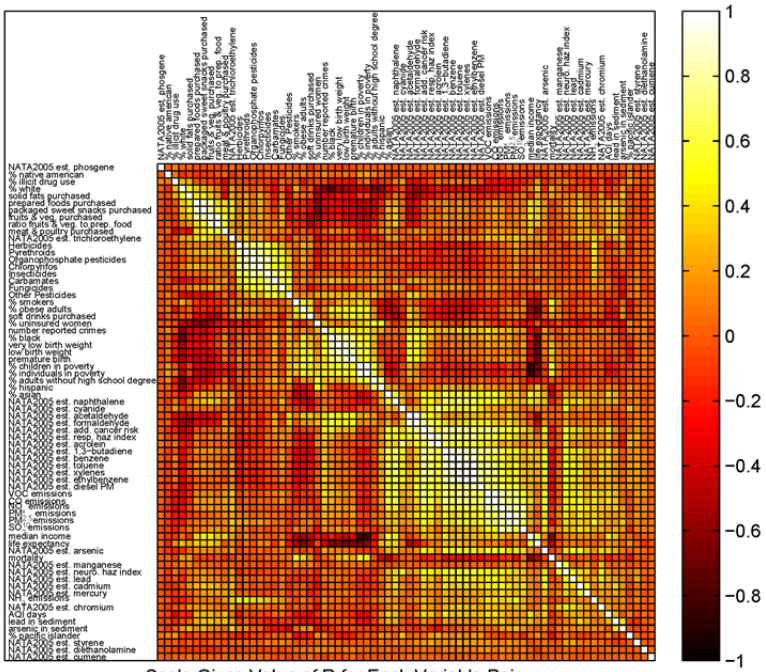


Figure 10: Exploratory multivariate analysis of exposure-relevant factors: the correlation map is a visual representation of the linear dependence between pairs of variables (top: variables are in original order; bottom: variables are grouped by similarity)

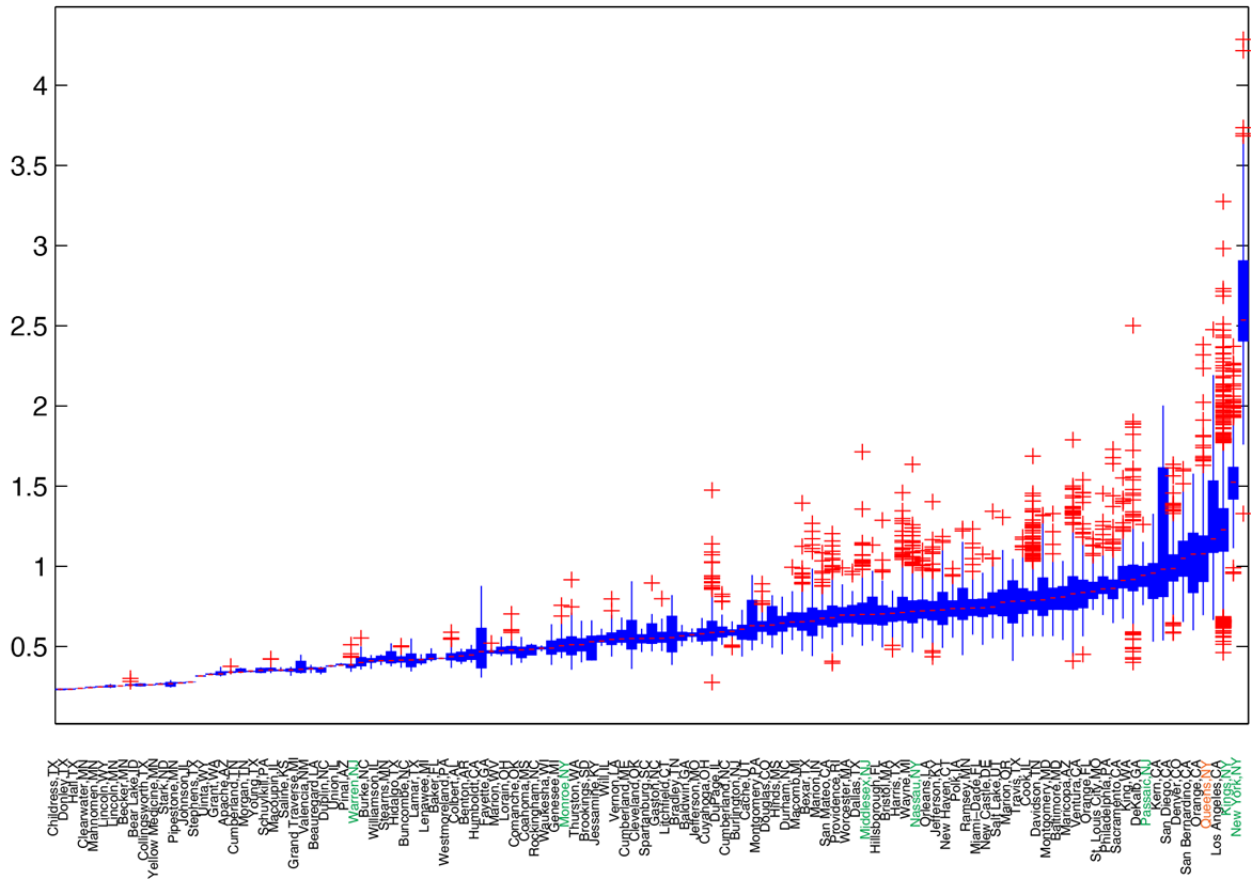


Figure 11: Preliminary estimates of ambient inhalation exposure index: all NCS counties

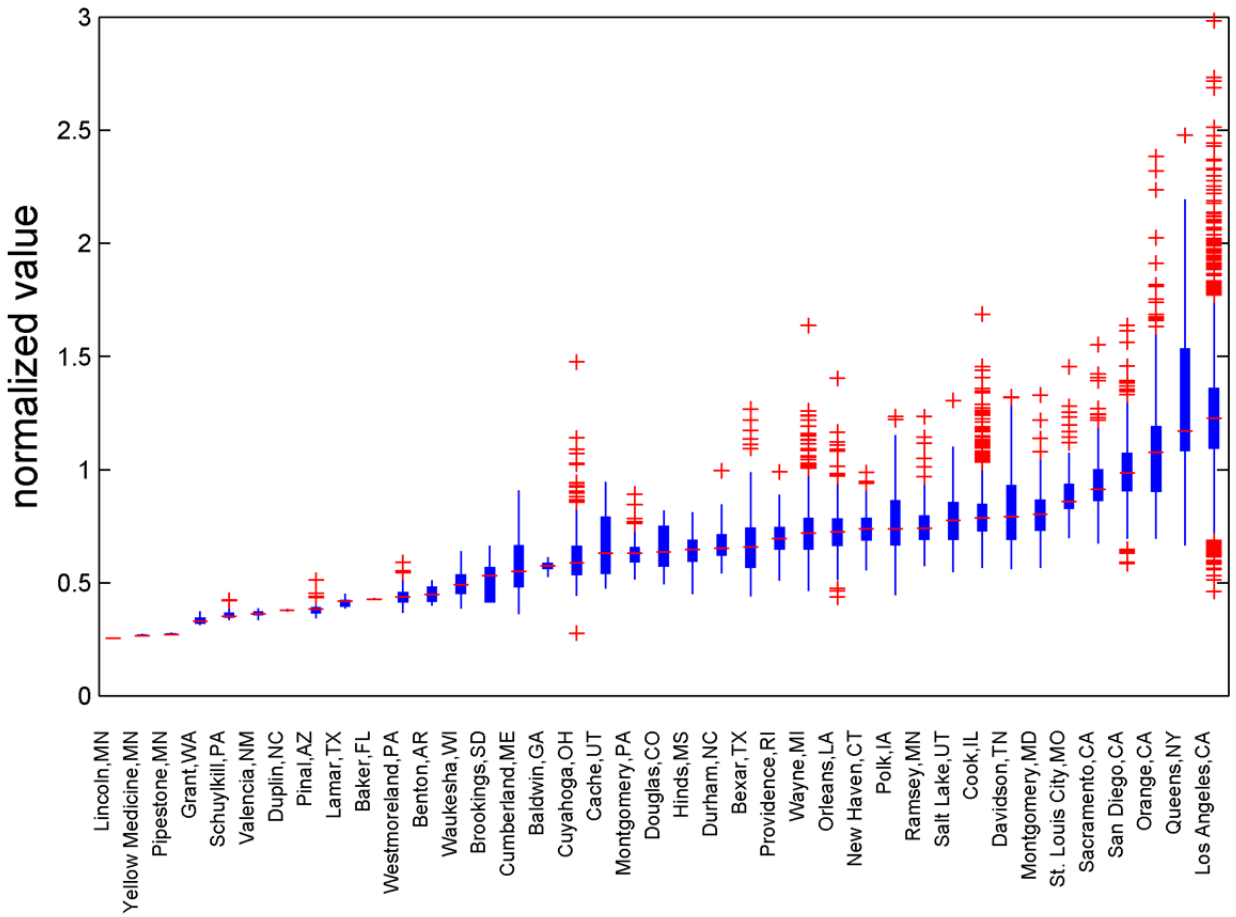


Figure 12: Preliminary estimates of ambient inhalation exposure index: 40 active NCS counties

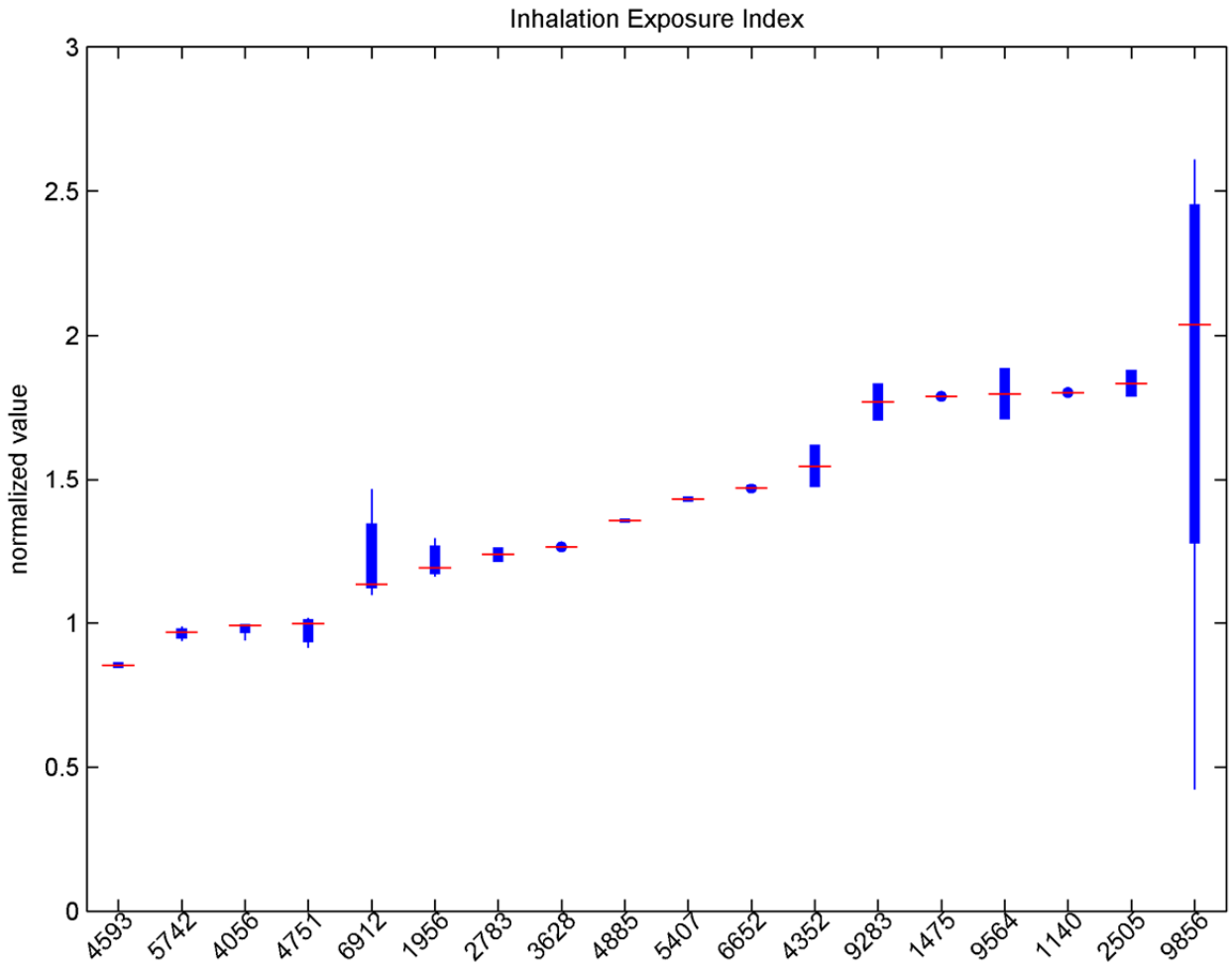


Figure 13: Ambient inhalation exposure index estimates for birth outcomes for segments in Queens County; arbitrary numbers replace actual segment numbers [as per Lioy et al., *Environmental Health Perspectives*, 2009; 117(10): 1494-1504].