**Ambient, Indoor, Personal, and Breath Concentrations of Volatile Organic Air Toxics among Populations in Industrial, Urban, and Suburban Neighborhoods**

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The overall goal of this project was to provide an objective basis for characterizing the distributions and determinants of air pollutant exposures of volatile organic compounds (VOCs) in representative urban populations. The research included the following: (1) measurements of adult population exposures to VOCs using a combination of ambient and indoor monitoring; (2) collection of housing, personal, location, and other information potentially related to VOC exposures and that might help explain the relationship between outdoor and indoor exposures; (3) collection of highly time-resolved VOC concentrations at selected ambient locations, including tracer gas measurements for air exchange and air flow determinations for a subset of a sample population; and (4) data analysis and modeling to characterize and compare VOC exposures for each population group/subgroup to identify sources of VOC exposure, to compare indoor and personal exposures to those at fixed monitoring sites, and for other purposes. State-of-the-art methods were used to collect integrated VOC samples (e.g., thermal desorption tube sampling with gas chromatography-mass spectrometry (GC-MS) analysis), continuous VOC monitoring (microanalytical system), and other data. Three communities along an urban/industrial gradient in metropolitan Detroit were selected as field study sites given the significance of existing exposures, the diversity of sources, the wealth of recent air toxics information, the strong partnerships with local community and governmental organizations, and the proximity to investigators. Project results enhance the understanding of VOC exposures and sources, the accuracy of risk assessments, and the effectiveness of air quality management efforts.

**Implications**: This body of work demonstrates the feasibility and high performance of passive thermally-desorbable adsorbent samplers for VOC measurements in indoor and outdoor settings; identifies key sources of VOCs in homes; suggests that concentrations of several VOCs in many homes exceed risk-based criteria; shows potential interferences of adsorbent based sampling with high ozone levels; demonstrates a new marker for quantitative assessment of tobacco smoke exposure; and highlights the importance of considering correlations and non-normal distributions in exposure assessments and mitigation measures.

**Start and end date:** August 2003 – December 2006

**Presentations:**

Batterman, S.A., Jia, C., and Godwin, C. (2004). Sources and significance of VOC exposures in microenvironments: Schools, offices, residences, outdoors and vehicles. Presention at the Air & Waste Management Association Meeting, Indianapolis, IN, June 22-25, 2004.

Jia, C., Batterman, S.A., and Godwin, C. (2004). Levels and sources of VOC exposures in microenvironments: A monte carlo analysis. Presentation at the International Society of Exposure Analysis Annual Meeting, Philadelphia, PA, October 17-21, 2004.

Batterman, S.A., Jia, C., and Godwin, C. (2005). Distributions of volatile organic compounds (VOCs) in indoor and outdoor air among industrial, urban and suburban neighborhoods. Presentation at IAQ 05, Beijing, China, October 4-9, 2005.

Jia, C., Batterman, S.A., and Godwin, C. (2005). Development of a sensitive thermal desorption GC-MS method using selective ion monitoring for a wide range of VOCs. Presentation at IAQ 05, Beijing, China, October 4-9 2005.

Batterman, S., Godwin, C., and Jia, C. (2006). Design and evaluation of a new breath monitoring system for volatile organic compounds. Presentation at the International Council of Chemical Association (ICCA) Biomonitoring Workshop, Minneapolis, MN, July 26-27, 2006. (Invited).

Batterman, S., Jia, C., Godwin, C., and Hatzivasilis, G. (2006). A dominant source of VOC exposure: Attached garages. Presentation at the International Conference on Environmental Epidemiology & Exposure, Paris, France, September 2-6, 2006.

Batterman, S., Jia, C., and Hatzivasilis, G. (2006). Simultaneous measurement of air exchange and VOC concentrations: Application in vehicles, houses and garages. Presentation at the Air & Waste Management Association 99th Annual Conference & Exhibition, New Orleans, LA, June 20-23, 2006.

Batterman, S., Jia, C., and Godwin, C. (2007). Determinants of VOC exposures and mixtures: Review of distributions of VOCs in indoor and outdoor air, factors affecting concentrations, and statistical analysis of high-concentration mixtures and their sources. Presentation at the International Society of Exposure Analysis 2007 Annual Meeting, Durham/Research Triangle Park, NC, October 14-18, 2007.

Batterman, S., Jia, C., and Godwin, C. (2008). Indoor and outdoor concentrations of VOCs and their determinants in industrial, urban and suburban neighborhoods. Presentation at Indoor Air 08, Copenhagen, Denmark, Aug. 17-22, 2008.

**Peer-reviewed publications:**

Batterman, S., Godwin, C., and Jia, C. (2005). Long duration tests of room air filters in cigarette smokers' homes. *Environmental Science & Technology* 39(18): 7260-7268.

Batterman, S., Hatzivasilis, G., and Jia, C. (2006). Concentrations and emissions of gasoline and other vapors from residential vehicle garages. *Atmospheric Environment* 40: 1828-1844.

Batterman, S., Jia, C., Hatzivasilis, G., and Godwin, C. (2006). Simultaneous measurement of ventilation using tracer gas techniques and VOC concentrations in homes, garages and vehicles. *Journal of Environmental Monitoring* 8: 249-256.

Jia, C., Batterman, S., and Chernyak, S. (2006). Development and comparison of methods using MS scan and selective ion monitoring modes for a wide range of airborne VOCs. *Journal of Environmental Monitoring* 8: 1029-1042.

Lee, J.H., Batterman, S., Jia, C., and Chernyak, S. (2006). Ozone artifacts and carbonyl measurements using Tenax GR, Tenax TA, Carbopack B and Carbopack X adsorbents. *Journal of Air and Waste Management Association* 56: 1503-1517.

Batterman, S., Jia, C., and Hatzivailis, G. (2007). Migration of volatile organic compounds from attached garages to residences: A major exposure source. *Environmental Research* 104(2): 224-240.

Jia, C., Batterman, S., and Godwin, C. (2007). Continuous, intermittent, and passive sampling of airborne VOCs. *Journal of Environmental Monitoring* 9(19): 1220-1230.

Jia, C., Batterman, S., and Godwin, C. (2008). VOCs in industrial, urban and suburban neighborhoods: Part 1: Indoor and outdoor concentrations, variation, and risk drivers. *Atmospheric Environment* 42: 2083-2100.

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