Reducing Exposure to Airborne Chemical Toxics (REACT): Community-Scale Air Monitoring in Memphis

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Outline

- Project overview
- Project objectives
- Methods
  - Study design
  - Field sampling and laboratory analysis
- Preliminary results
- Community outreach
- Future work

Overview of "REACT"

- REACT:

  Reducing Exposure to Airborne Chemical Toxics

  - Funded by U.S. Environmental Protection Agency (EPA)
  - Total project budget: $574,404
- Study team:
  - Leader: The Shelby County Health Department's Pollution Control Section.
  - Collaborators:
    - University of Memphis School of Public Health
    - Middle Tennessee State University (MTSU) Department of Chemistry.
- The only air toxics study in TN in 2014.

Timeline of "REACT"

- May 2011, Shelby County Health Department, U of M, and MTSU collaborated to develop a proposal for US EPA's community-scale air toxics program.
- Aug 2011, The proposal was selected for award.
- Sep 2011 – mid 2013, Preliminary work
- Nov 2013, QAPP approved
- Jan-Dec 2014, Field monitoring and lab analysis
- Jan 2015 – current, Data analysis
- Aug 2011 – current, Community engagement
- Dec 2015, draft final report
- Mar 31, 2016, End of the project
- April 01, 2016, Start of "Memphis PAHs Study"

Objectives of the study

1. To measure ambient concentrations of air toxics in the metropolitan Memphis which include varying degrees of urbanization and industrialization.
2. To identify possible areas of high concentrations and major contributors of air toxic pollutants.
3. To evaluate health risks from exposures to air toxics, and
4. To explore if the spatial distribution of air toxics is associated with socioeconomic status and/or ethnicity.

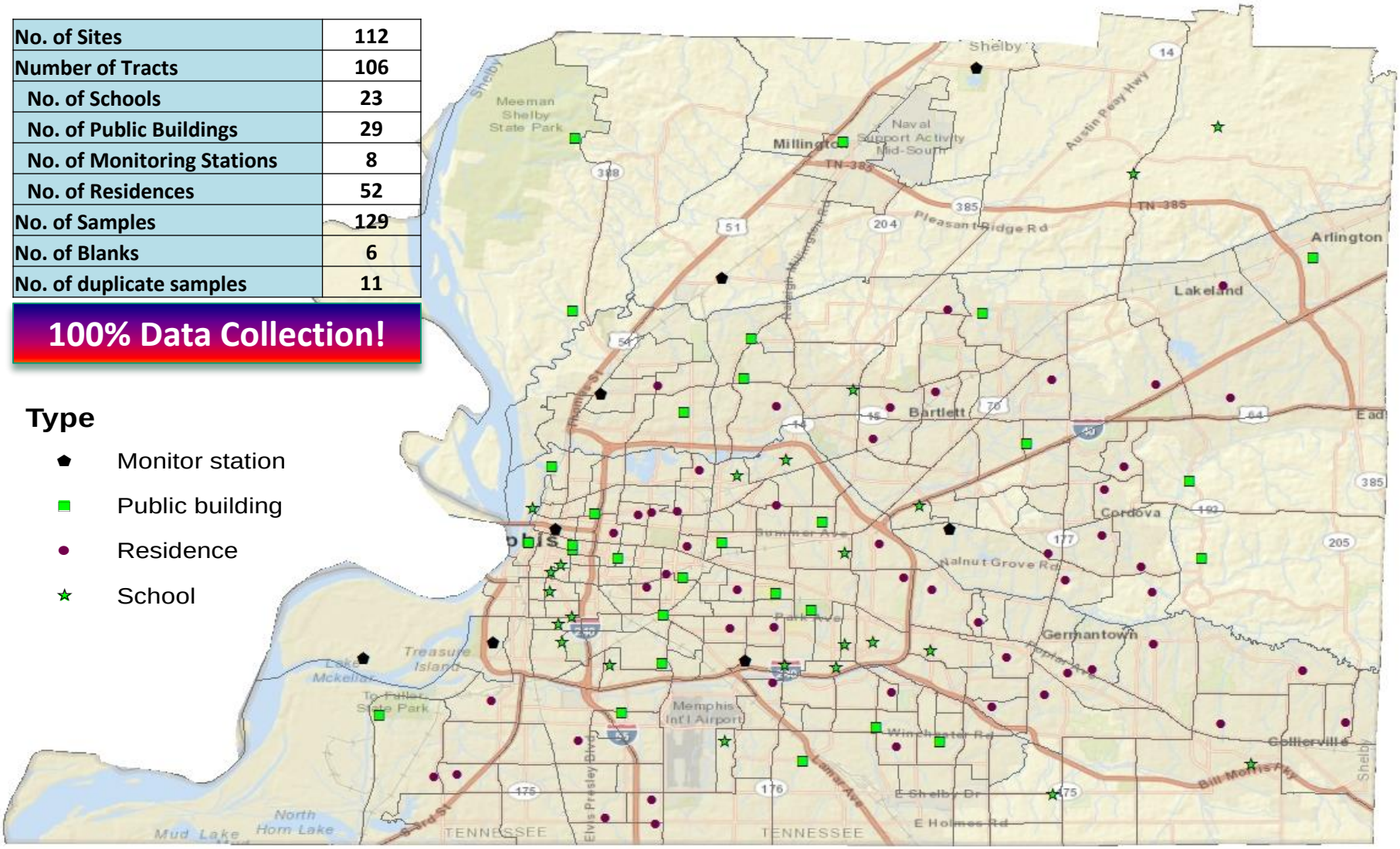
Study design

- Ambient air toxics concentrations were measured at 100 census tracts in Shelby County, TN.
- Monitoring sites in census tracts were selected based upon presence of industries (past and present), proximity to neighborhoods, and accessibility.
- Sampling will occur during each of the 4 seasons.
- 24-hour samples were collected in pre-cleaned and pre-evacuated canisters.
- Samples were analyzed for 70 target compounds.
  - They have high toxicity
  - They have been frequently detected in previous studies
  - They are suitable for the canister sampling and GC/MS analysis method.

Sampling sites

No. of Sites	112
Number of Tracts	106
No. of Schools	23
No. of Public Buildings	29
No. of Monitoring Stations	8
No. of Residences	52
No. of Samples	129
No. of Blanks	6
No. of duplicate samples	11

100% Data Collection!



Field sampling – Pilot, Aug 2013

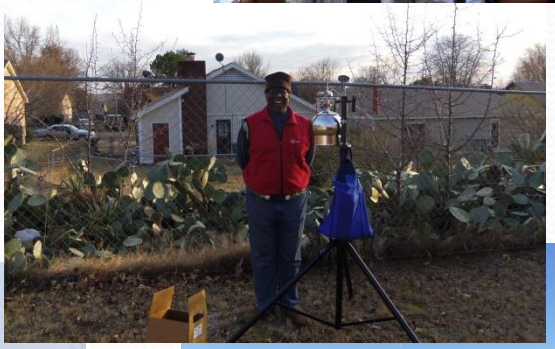
Riverview Elementary School

Edmund Orgill Park

Fite Road Monitoring Station

Alabama Monitoring Station

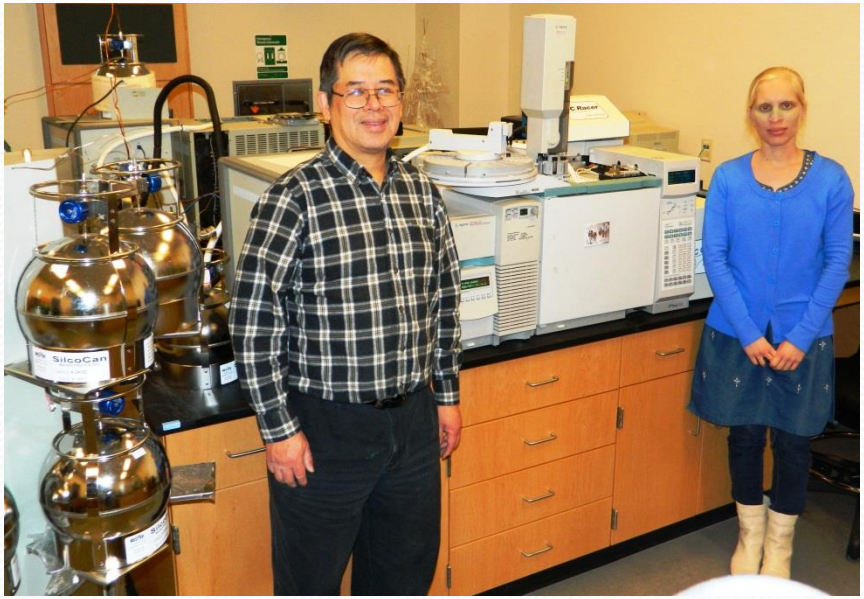
Field sampling, Jan-Dec, 2014



Laboratory analysis

- The analytical methods used for this study is EPA Method TO-15.
- Compounds are concentrated in cryogenic traps and then analyzed on a GC/MS system.
- After analysis, canisters are cleaned and vacuumed for the next use.

Laboratory analysis



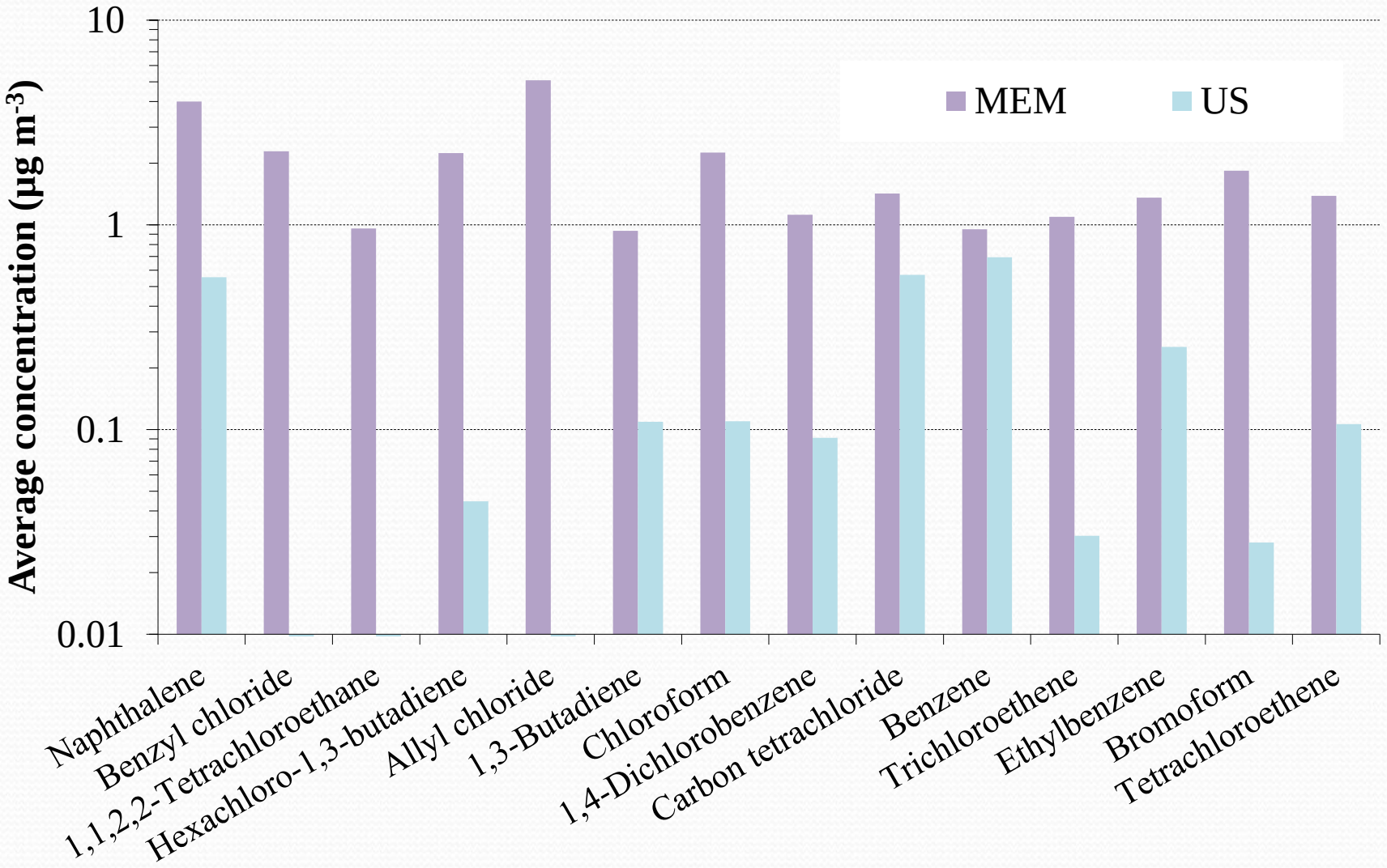
Results

Air Toxics	Descriptive Statistics						Non Cancer	Cancer Risk	Risk Contrib
	DF[a]	Mean	SD	Med	Max	RfC	Cancer	Risk	Contrib
	(%)	(µg/m^3)				(µg/m^3)	HQ[b]	×10^{-6}	(%)
Naphthalene	32	4.01	1.61	2.05	12.6	3	1.3	136.2	23.3
Benzyl chloride	27	2.29	0.78	3.03	19.9			112.1	19.2
1,1,2,2-Tetrachloroethane	2	0.96	0.63	0.15	1.69			55.7	9.5
Hexachloro-1,3-butadiene	27	2.24	1.21	2.01	14.2	90	0.0	49.3	8.4
Allyl chloride	37	5.08	0.67	29.4	309	1	5.1	30.5	5.2
1,3-Butadiene	9	0.94	0.48	0.23	1.70	2	0.5	28.1	4.8
Chloroform	11	2.25	0.66	4.04	34.8	98	0.0	23.0	3.9
1,4-Dichlorobenzene	3	1.12	0.74	0.32	2.25	800	0.0	12.3	2.1
Carbon tetrachloride	10	1.42	0.82	0.21	2.93	100	0.0	8.5	1.5
Benzene	31	0.95	0.66	0.29	3.08	30	0.0	7.4	1.3
Trichloroethene	3	1.09	0.68	0.11	1.83	2	0.5	4.5	0.8
Ethylbenzene	23	1.36	0.94	0.17	1.72	1000	0.0	3.4	0.6
Bromoform	1	1.84	1.11	0.22	2.97			2.0	0.3
Tetrachloroethene	3	1.39	0.82	0.14	2.37	40	0.0	0.4	0.1
HI[c]/Cumulative Risk							**7.6**	**585.06**	

Air toxics levels and risks

- A total of 53 out of 71 target compounds were detected.
- The concentration of total air toxics averaged 134 $\mu g/m^3$, and the maximum was 934 $\mu g/m^3$.
- Ethanol and acetone had the highest levels (15.1 and 11.0 $\mu g/m^3$, respectively), and other compounds were below 10 $\mu g/m^3$.
- Most air toxics had concentrations below their corresponding RfCs.
- Allyl chloride and naphthalene had mean concentrations exceeding the corresponding RfCs by 5.1 and 1.3 times, respectively.

Comparison with national levels



Cancer risks

- We detected 22 chemicals that have cancer potentials.
- The total cancer risk from 22 carcinogenic chemicals was 5.85×10^{-4}.
- The major contributors were naphthalene (23%), benzyl chloride (19%), 1,1,2,2-tetrachloroethane (10%), and hexachloro-1,3-butadiene (8%).
- The cancer risks associated with naphthalene and benzyl chloride were 1.4 and 1.1×10^{-4}, respectively, exceeding EPA's acceptable risk range.

Source identification – Summer 14

Air Toxics	F1	F2	F3	F4	F5
Ethyl benzene	0.85	0.11	0.30	0.23	0.02
m,p-Xylene	0.82	0.26	0.32	0.21	0.02
Styrene	0.63	0.31	-0.10	0.27	-0.14
o-Xylene	0.87	0.19	0.26	0.15	0.02
4-Ethyl toluene	0.80	0.06	-0.12	0.13	0.05
1,2,4-Trimethyl benzene	0.85	0.15	-0.11	0.04	0.02
2,2,4-Trimethyl pentane	0.65	-0.06	0.46	0.54	0.00
Toluene	0.55	0.76	0.02	0.10	0.00
Ethanol	0.08	0.81	0.00	0.08	-0.02
Acetone	0.05	0.92	0.11	-0.11	0.04
Iso propyl alcohol	0.13	0.65	-0.19	0.26	0.17
Ethyl methyl ketone	0.25	0.92	0.05	0.01	-0.04
Propene	0.03	0.09	0.85	0.05	0.01
Freon 112	0.03	-0.19	0.86	0.17	0.16
Benzene	0.33	0.12	0.57	0.29	0.32
n-Hexane	0.43	0.27	0.38	0.71	-0.03
Heptane	0.32	0.04	0.15	0.89	0.09
Chloromethane	-0.04	0.00	0.39	0.07	0.90
Allyl chloride	0.02	0.07	-0.04	0.00	0.97

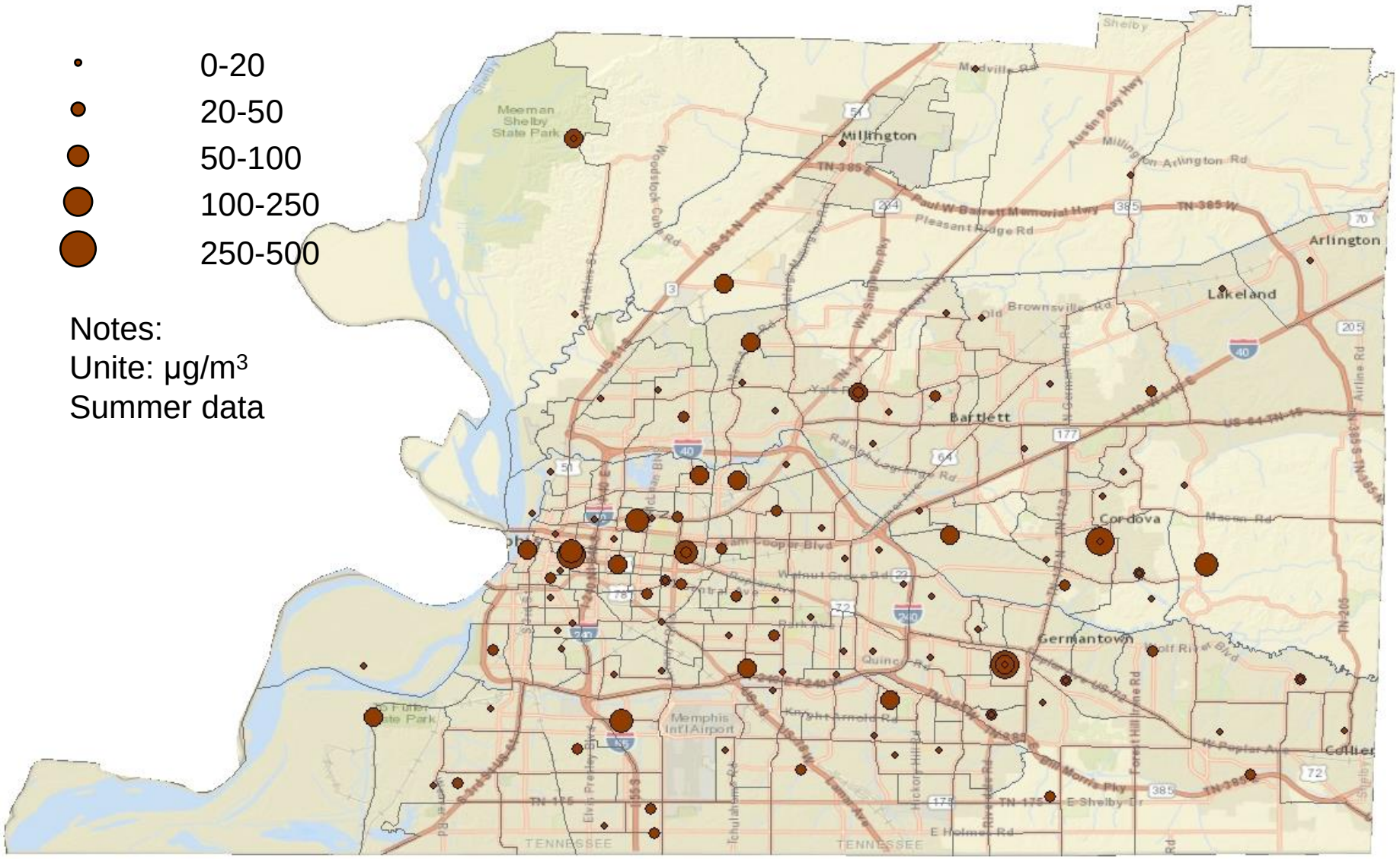
The numbers indicate the correlation between the compound and the factor (source)

F1: Vehicular exhaust
F2: Gasoline additives and solvents
F3: Ubiquitous/persistent chemicals
F4: Gasoline evaporation
F5: Industrial solvents

Spatial distribution of TVOC

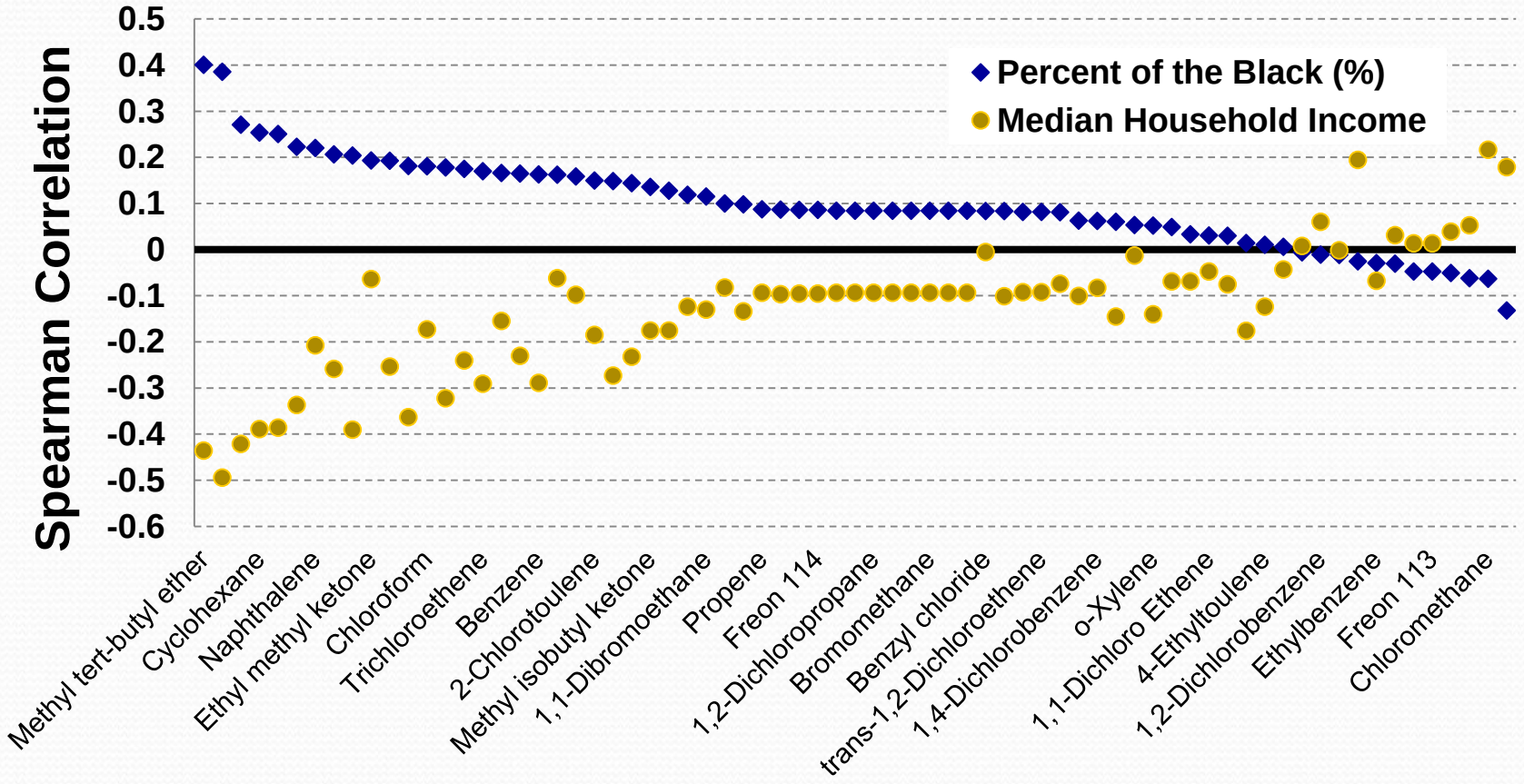
- 0-20
- 20-50
- 50-100
- 100-250
- 250-500

Notes:
Unite: μg/m^3
Summer data



Environmental justice

- At the census tract level, concentrations of the majority of compounds had positive correlations with percent of the black, and negative correlations with median household income.
- The associations are not statistically significant for most compounds.



Community outreach

- This community stakeholders group was established, which included representation from the local Sierra Club. The group has provided critical input into the selection of 100 sampling sites and developing public outreach.

Stakeholders Meetings:
9-21-12, 4-3-13, and
10-31-14

Stakeholders requested a website for study:
http://www.shelbycountytn.gov/REACT

Participating communities

- The project team has reached out and obtained support from many local nonprofit organizations, communities, schools, and individuals, e.g.,

- Sierra Club
- Memphis & Shelby County Office of Sustainability
- Shelby County Schools
- Westwood Neighborhood Association
- Engineers' Club of Memphis
- White House Council on Strong Cities, Strong Communities
- Chucalissa Museum
- Bridges
- Memphis Police Department
- Memphis Fire Department
- Shelby County Sherriff's Department
- and more…

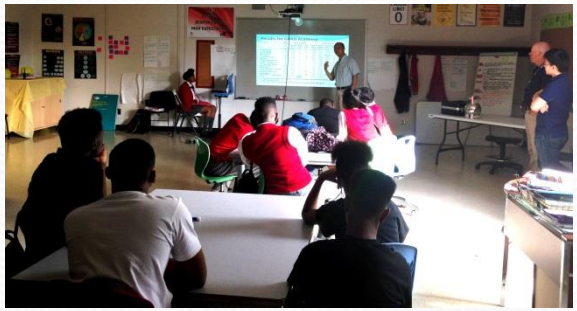
EPA site visits

2013

2014

August 23, 2013: Tabletop discussion with Region IV EPA, City of Memphis & Shelby County Governments, and White House Council representatives. Discussions focused on Environmental Justice, Sustainability, and Environmental Epidemiology.

Other community outreach



Presentation in Grad Academy May 15, 2015

Sierra Club library channel television show. This show was filmed on November 5, 2013. Shown are Judith Rutschman, Sierra Club (interviewer) and Jim Holt, Project Manager and Dr. Chunrong Jia, University of Memphis, Project Investigator.

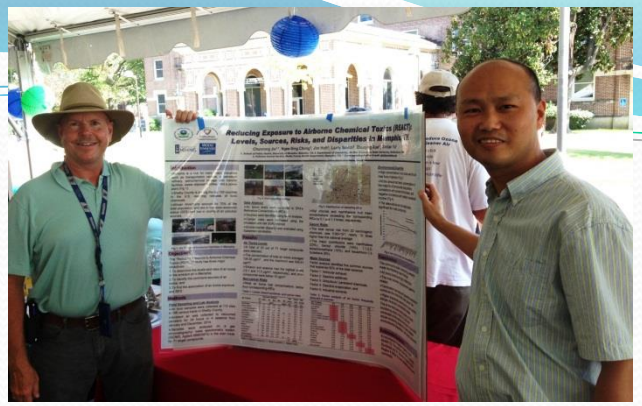
Sierra Club Environmental Justice Workshop on November 9, 2013 and November 1, 2014

Dr. Chunrong Jia and Jim Holt speaking on the REACT Study.

Harvard Env Health Fellowship

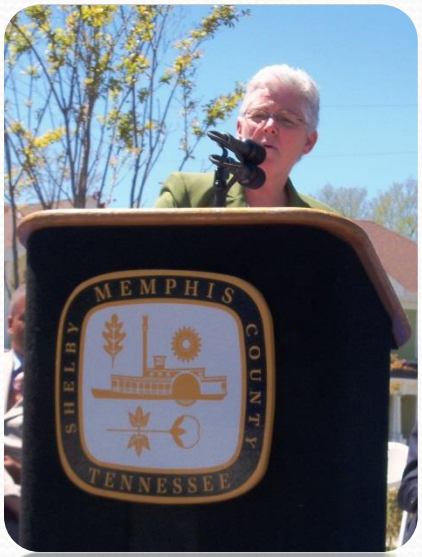
- Dr. Chunrong Jia, co-investigator of this project, has conducted a series of studies on air toxics in Memphis.
- He was recently selected to become a JPB Environmental Health Fellow at Harvard University.
  - The Harvard EH Fellowship Program aims to create a cadre of research leaders committed to finding solutions to complex environmental health problems.
  - Highly competitive – only 9 academic fellows were selected nationwide.
  - The program director, Dr. John Spengler, visited Memphis in mid-March.
  - This fellowship will help the county receive technical support from and establish collaborations with the Harvard University.

Events



Tiger Blue Goes Green
University of Memphis
2013, 2014, and 2015.

Earth Day at Shelby Farms
April 19, 2014



Earth Day Week: Administrator McCarthy promoting President Obama's Climate Action Plan refers to the REACT study in our County.

Future work

- Complete the final report
- Community outreach and information dissemination
  - Non-profit community organizations
  - Schools
  - Individual mails
- Memphis PAHs Study
  - PAHs: Polycyclic aromatic hydrocarbons
  - Overall objective: Delineate the concentrations and distributions of PAHs in ambient air in Memphis Tri-state Area, identify major sources and characterize near-source PAH profiles, and assess non-carcinogenic and carcinogenic risks.

Now its time to leave the world of air toxics behind and ride off into the sunset!
Thank you!!!!!