EPA
United States
Environmental Protection
Agency

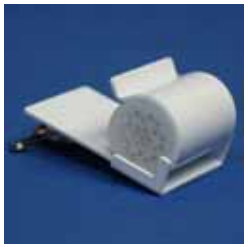
DEARS Exposure Relationships VOCs, EC and NO2

Alan Vette, Sheng-Wei Wang, BJ George, Don Whitaker,Karen Oliver, Herb Jacumin, Jonathan Thornburg, Charles Rodes and Ronald Williams

Office of Research and Development
National Exposure Research Laboratory

November 3, 2008

Passive Samplers



- Diffusive samplers - 25 VOCs + NO_2
- Aromatics/HCs (9)
- Halogenated HCs (16)
- Detection limits
  - VOCs ~ 50 pptv
  - NO_2 ~ 5 ppbv

VOCs Measured in DEARS

Aromatics/HCs

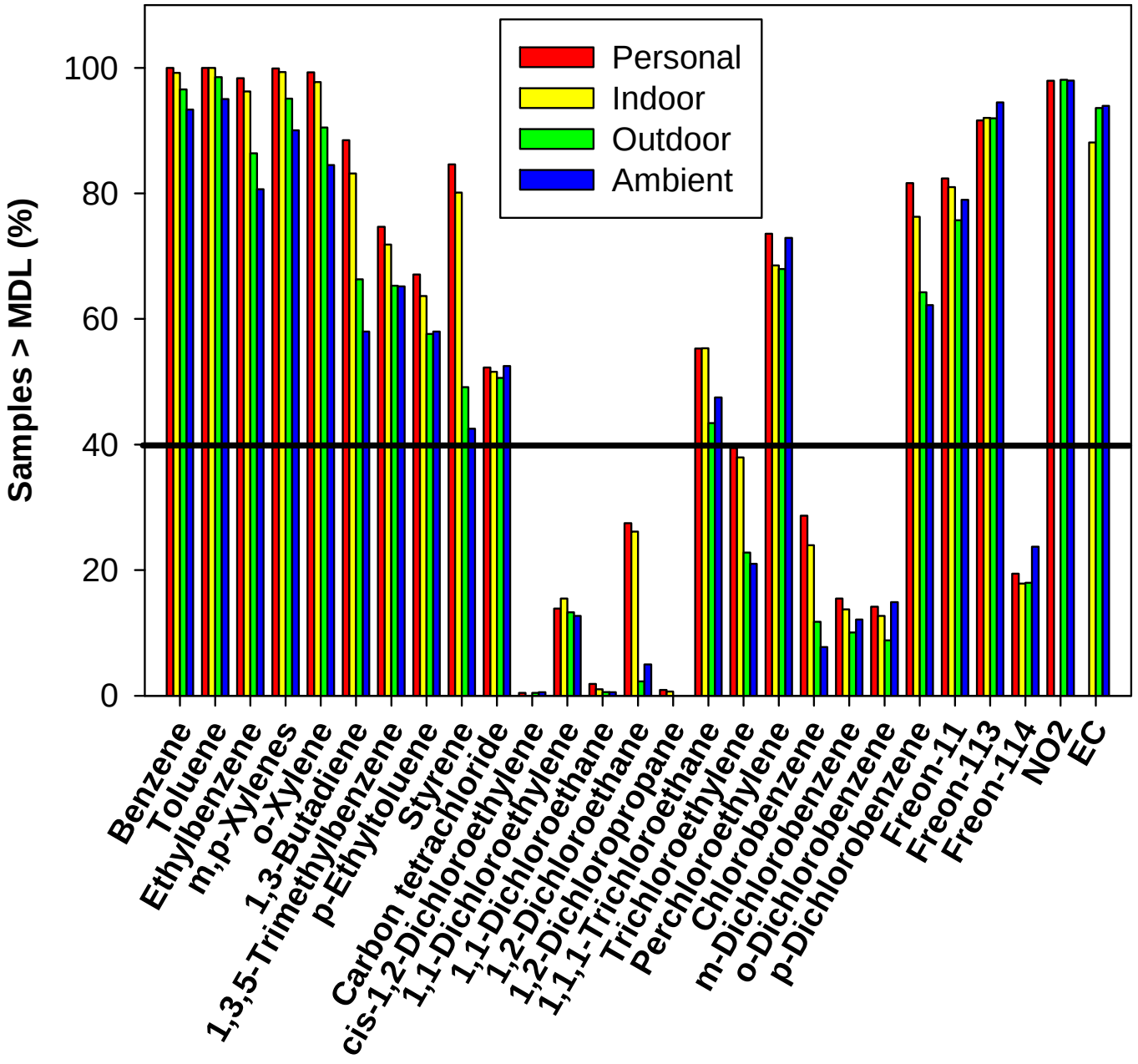
Benzene
Toluene
Ethylbenzene
m,p-Xylene
o-Xylene
1,3-Butadiene
4-Ethyltoluene
1,3,5-Trimethylbenzene
Styrene

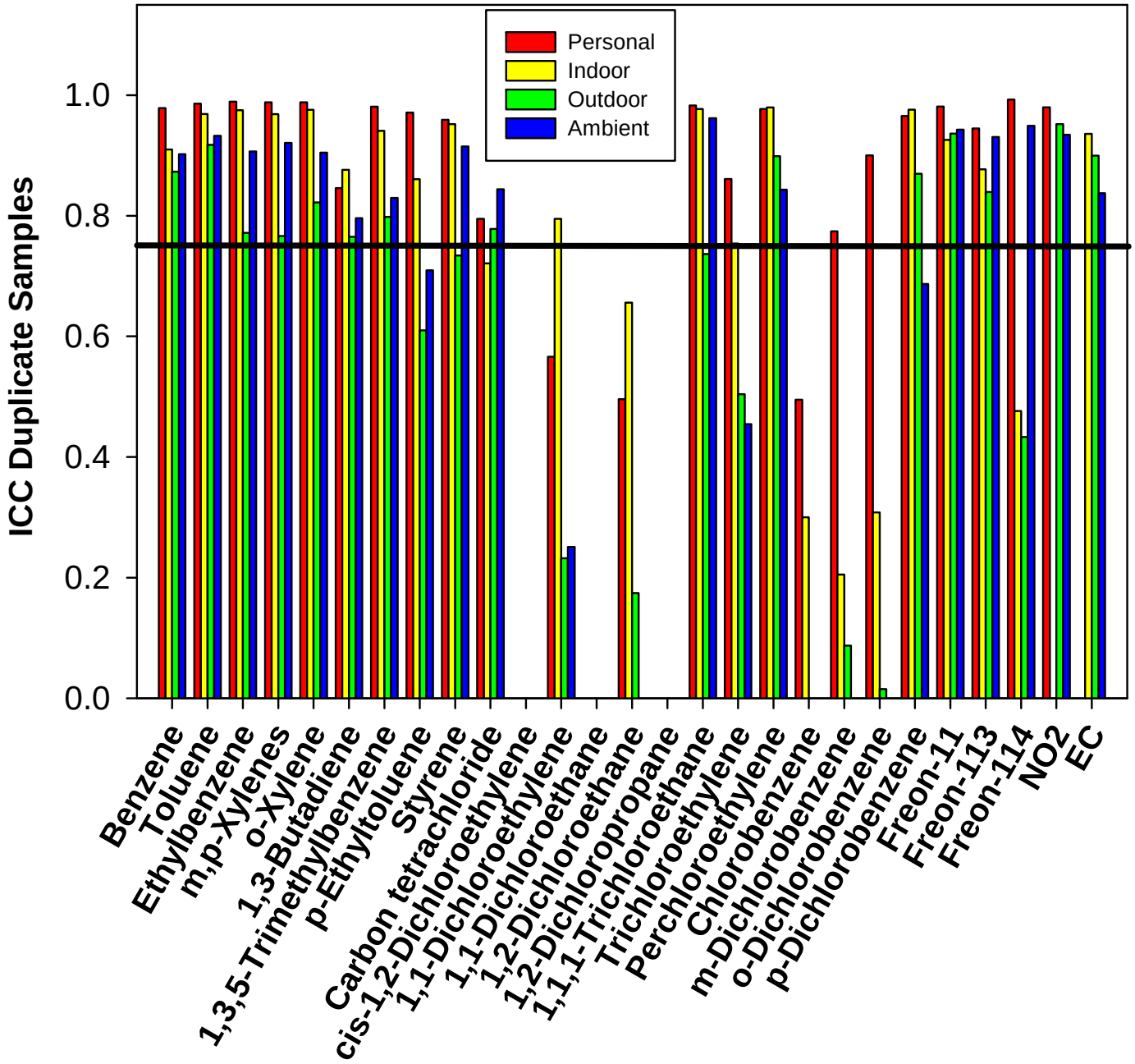
Chlorinated Aromatics/HCs

Carbon tetrachloride
1,1-Dichloroethane
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1-Dichloroethylene
cis-1,2-Dichloroethylene
Trichloroethylene
Perchloroethylene
1,2-Dichloropropane
Chlorobenzene
m-Dichlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene

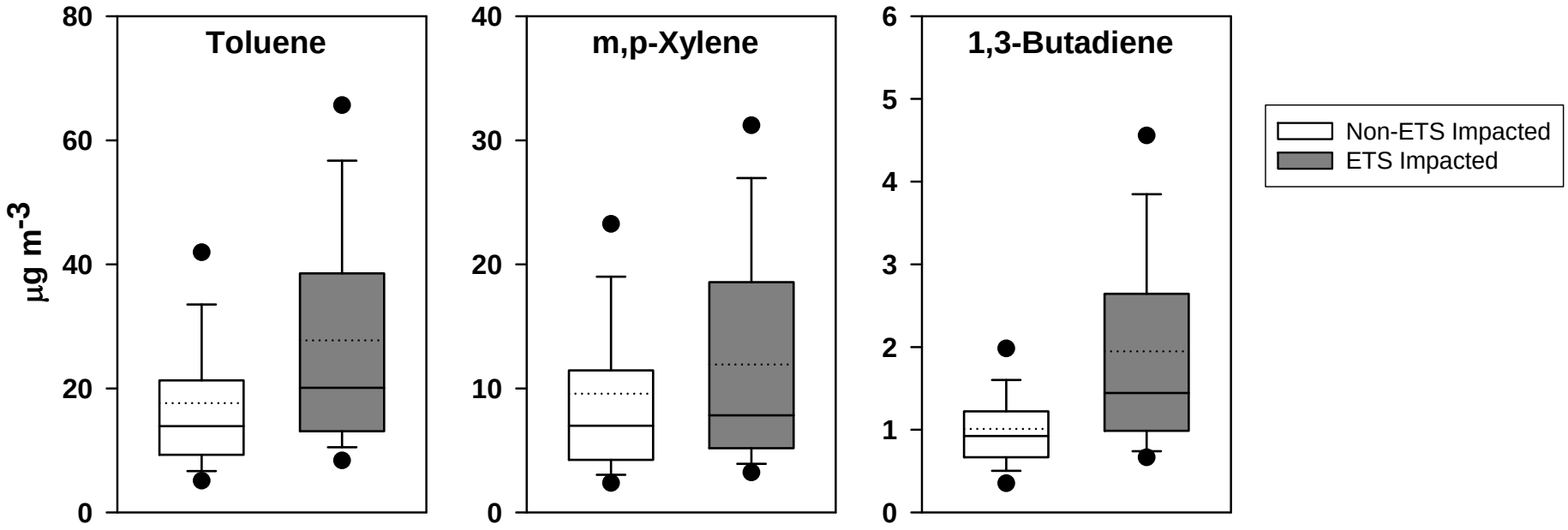
Freon

Trichlorofluoromethane (11)
1,1,2-Trichloro-1,2,2-trifluoroethane (113)
1,2-Dichloro-1,1,2,2-tetrafluoroethane (114)


Personal
Indoor
Outdoor
Ambient
Samples > MDL (%)
0
20
40
60
80
100
Benzene
Toluene
Ethylbenzene
m,p-Xylenes
o-Xylene
1,3-Butadiene
1,3,5-Trimethylbenzene
p-Ethyltoluene
Styrene
Carbon tetrachloride
cis-1,2-Dichloroethylene
1,1-Dichloroethylene
1,2-Dichloroethane
1,2-Dichloropropane
1,1,1-Trichloroethane
Trichloroethylene
Perchloroethylene
Chlorobenzene
m-Dichlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene
Freon-11
Freon-113
Freon-114
NO2
EC


Personal
Indoor
Outdoor
Ambient
ICC Duplicate Samples
1.0
0.8
0.6
0.4
0.2
0.0
Benzene
Toluene
Ethylbenzene
m,p-Xylenes
o-Xylene
1,3-Butadiene
1,3,5-Trimethylbenzene
p-Ethyltoluene
Styrene
Carbon tetrachloride
cis-1,2-Dichloroethylene
1,1-Dichloroethylene
1,2-Dichloroethane
1,2-Dichloropropane
1,1,1-Trichloroethane
Trichloroethylene
Perchloroethylene
Chlorobenzene
m-Dichlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene
Freon-11
Freon-113
Freon-114
NO2
EC

Impact of Environmental Tobacco Smoke



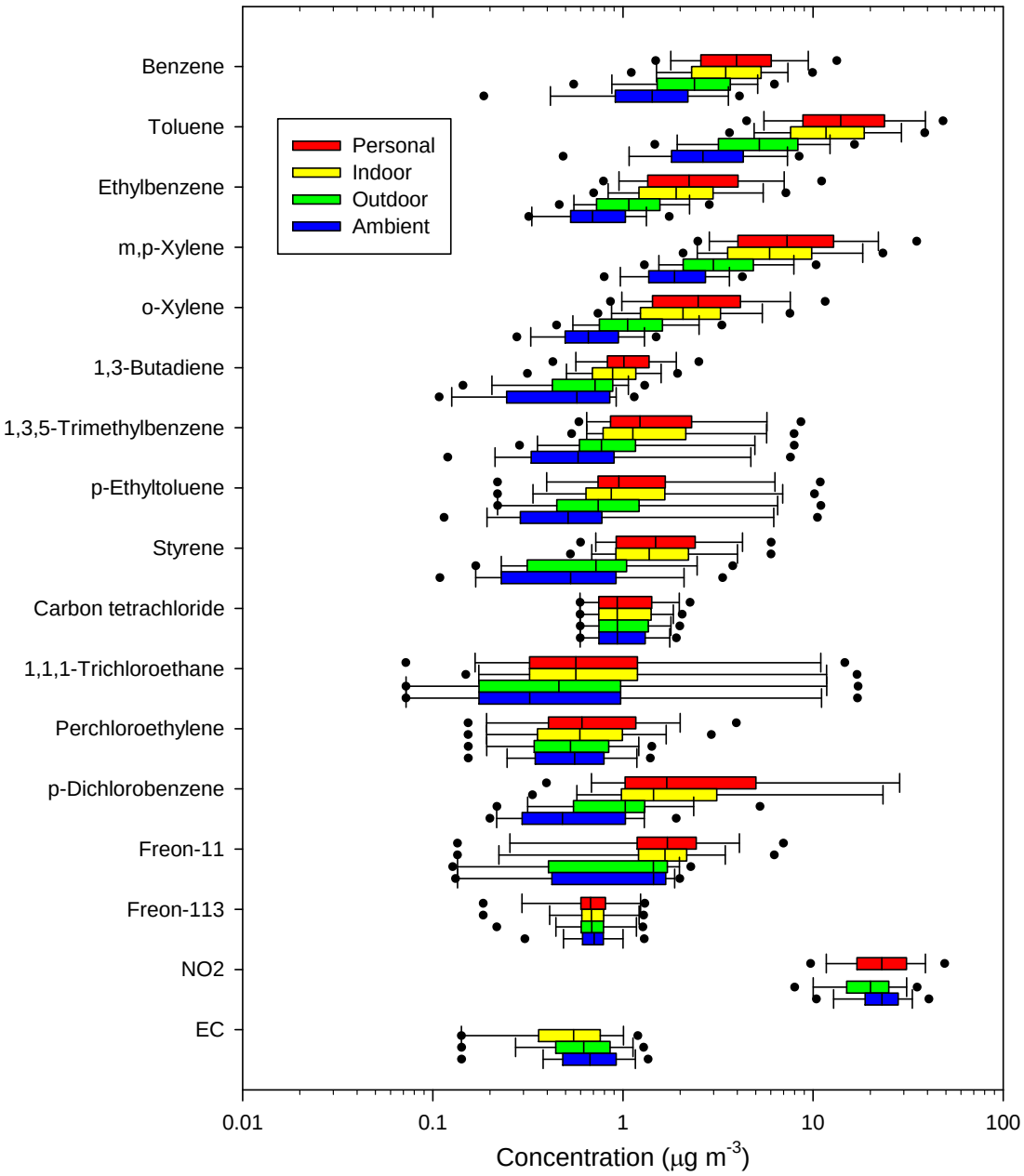
- Indoor levels of VOCs associated with tobacco smoke
- ETS was measured using an optical technique on filter samples
- Samples were considered impacted by ETS when ETS levels exceeded 1.5 µg m^{-3}
- 34% of personal and 21% of indoor samples contained ETS > 1.5 µg m^{-3}

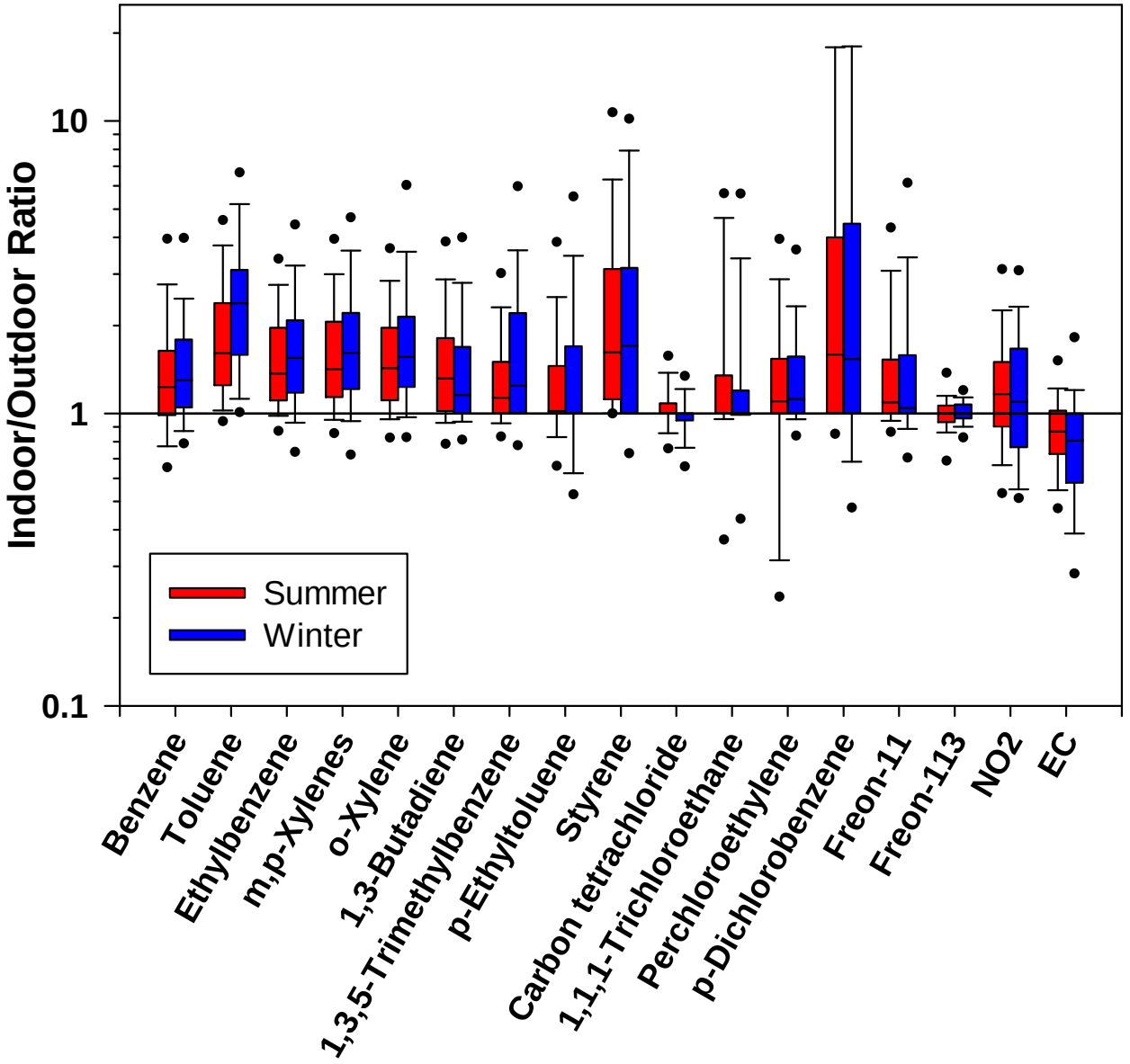
Effect of Residential Characteristics

Pollutant	Location	Attached Garage	Painting (7 d prior)	Carpet (6 mo. Prior)	Construction (6 mo. Prior)	Linoleum (6 mo. Prior)	Gas Stove
Benzene	Indoor	46	44	6		17	
	Personal	115	45				
Toluene	Indoor	48	51	37	14	66	
	Personal		38	36			
Ethylbenzene	Indoor	38	56	90	32	52	
	Personal		15	58	54		
m,p-Xylenes	Indoor	52	58	95	33	50	
	Personal	46	28	76	26		
Perchloroethylene	Indoor						
	Personal						
NO_2	Personal						34
EC	Indoor						

Effect of Personal Activities

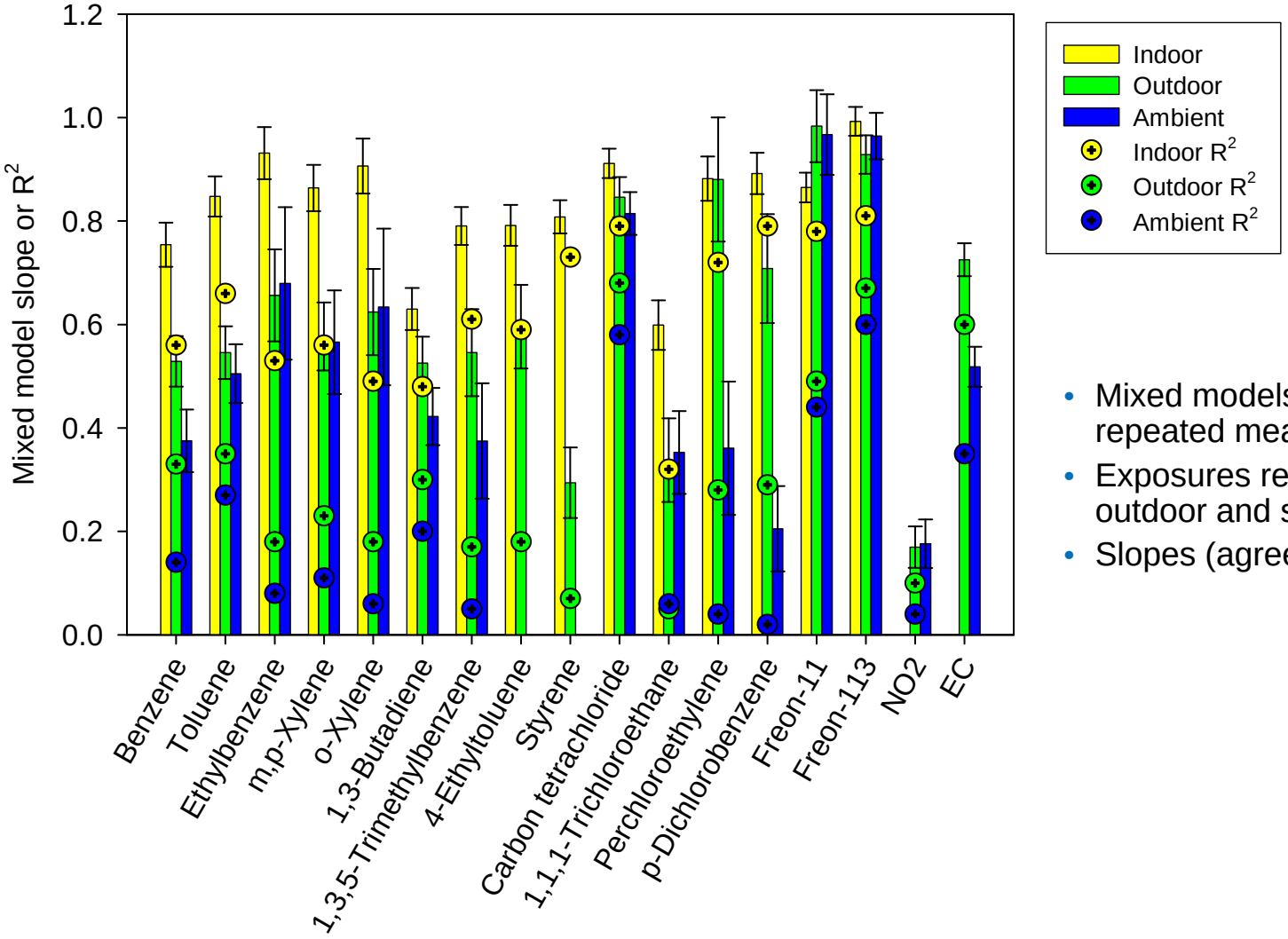
Pollutant	Location	Gas space heater	Solvent usage	Candles or incense	Dryclean (7 d. prior)
Benzene	Indoor			-27	
	Personal			-36	
Toluene	Indoor		38	-30	
	Personal			-38	
Ethylbenzene	Indoor		64	-30	
	Personal		118	-32	
m,p-Xylenes	Indoor		65		
	Personal		10		
Perchloroethylene	Indoor				376
	Personal				645
NO_2	Personal	114			
EC	Indoor			121	


Benzene
Toluene
Ethylbenzene
m,p-Xylene
o-Xylene
1,3-Butadiene
1,3,5-Trimethylbenzene
p-Ethyltoluene
Styrene
Carbon tetrachloride
1,1,1-Trichloroethane
Perchloroethylene
p-Dichlorobenzene
Freon-11
Freon-113
NO2
EC
Personal
Indoor
Outdoor
Ambient
0.01
0.1
1
10
100
Concentration (μg m-3)


Indoor/Outdoor Ratio
10
1
0.1
Summer
Winter
Benzene
Toluene
Ethylbenzene
m,p-Xylenes
o-Xylene
1,3-Butadiene
1,3,5-Trimethylbenzene
p-Ethyltoluene
Styrene
Carbon tetrachloride
1,1,1-Trichloroethane
Perchloroethylene
p-Dichlorobenzene
Freon-11
Freon-113
NO2
EC

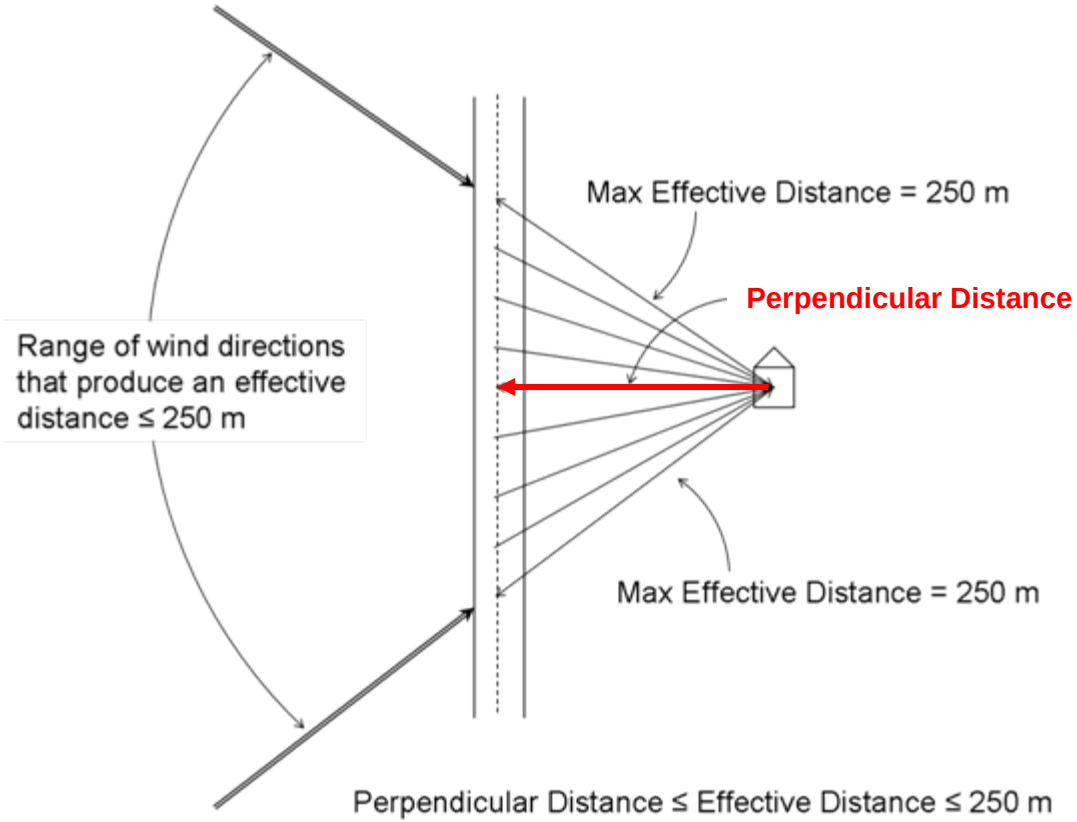
Personal Exposure Relationships

Log Transformed Data

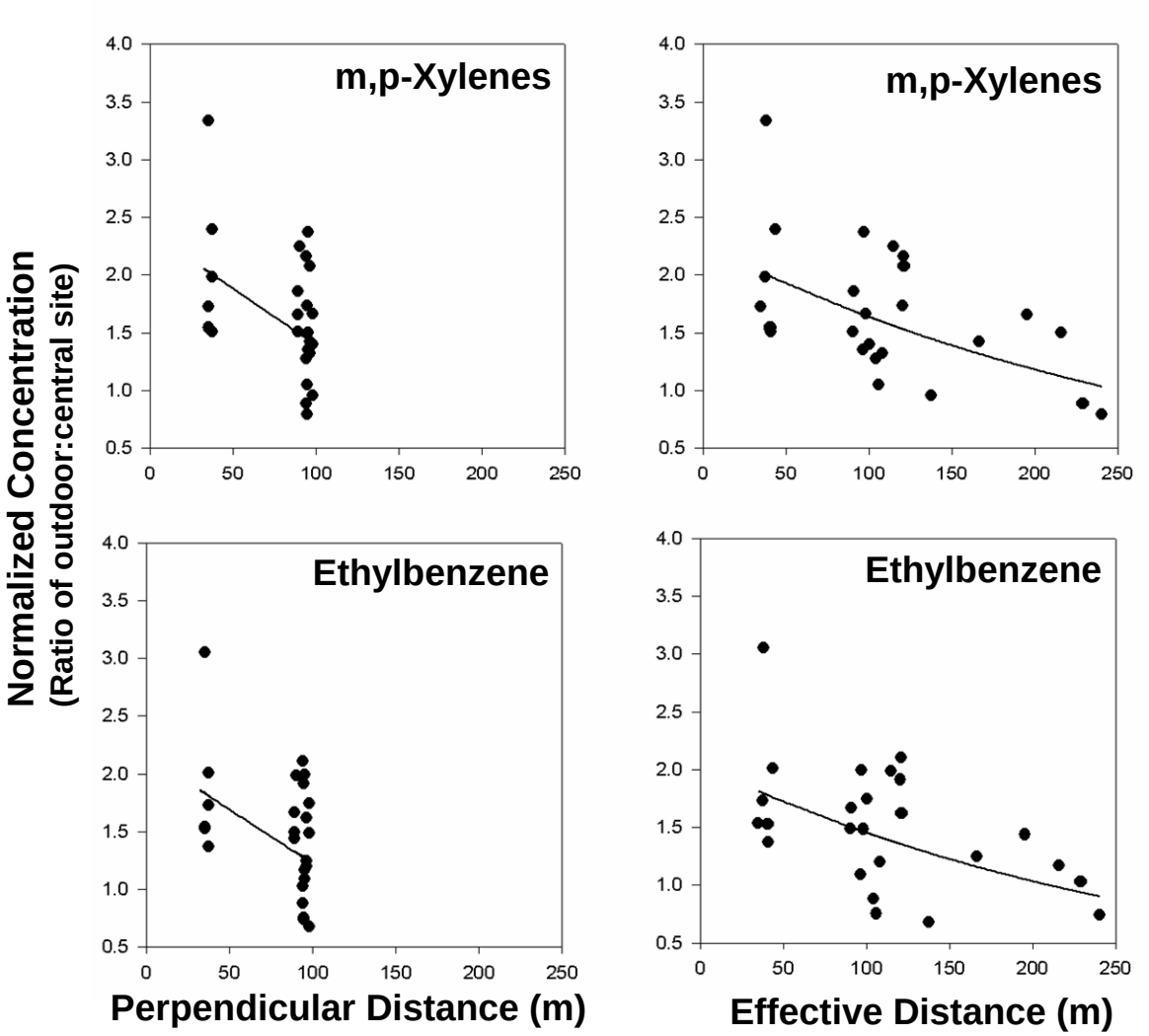


- Mixed models – account for repeated measures
- Exposures related to indoor, outdoor and sometimes ambient
- Slopes (agreement): I > O > A

Effective Distance from Roadway



Effective Distance from Roadway



Conclusions

- Carbopack-X passive tubes – robust and reliable method to measure VOCs
- ETS found in 21% of indoor air and 34% of personal exposure samples
- Residential characteristics and personal activities affect indoor and personal exposures
- Significant spatial and temporal variability in MSATs
  - Impact of sources (EMA) and locations (I, O, A)
- Personal exposures to MSATs
  - Indoor > Outdoor > Ambient

United States Environmental Protection Agency

Disclaimer

Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

The U.S. Environmental Protection Agency through its Office of Research and Development funded and conducted the research described here through contract 68-D-00-012 with RTI International, EP-D-04-068 to Battelle Columbus Laboratory, 68-D-00-206 and EP-05-D-065 to Alion Science and Technology.