

A photograph of the St. Louis skyline featuring the Gateway Arch in the foreground. The arch is a large, white, parabolic structure. Behind it, several skyscrapers are visible, including the Old Courthouse with its green roof. The sky is overcast. In the foreground, there are trees and a road.

**High Time Resolution PM₁₀ Metals by the
CES Ambient Metals Monitor (Xact 620):
Field Performance Evaluation and Data Trends for St. Louis**

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Motivation

The St. Louis Community Air Project (CAP)

- identified six hazardous air pollutants of concern including arsenic, *however...*
- poor data quality for PM_{2.5} arsenic from speciation network data
- PM₁₀ air toxics metals routinely measured at only one site

Objectives

Community Air Toxics Grant from USEPA

- Phase I [Paper #370]
 - four site network of HiVol PM₁₀ samplers
 - one year at 1-in-3 days
 - hot acid extraction and analysis by ICP-MS
 - ~2x urban excess for arsenic
- Phase II [Paper #146]
 - high(er) time resolution measurements
 - six one-month deployments of CES Xact 620
 - Xact performance evaluation

Cooper Environmental Services (CES) Xact 620

- particle collection on a filter tape
- analysis by x-ray fluorescence (XRF)
- continuous data time series at user-defined intervals
- MDNR instrument optimized for As, Hg, and Pb at remote areas



ELEMENTS THE XACT CAN MEASURE (IN BLUE)

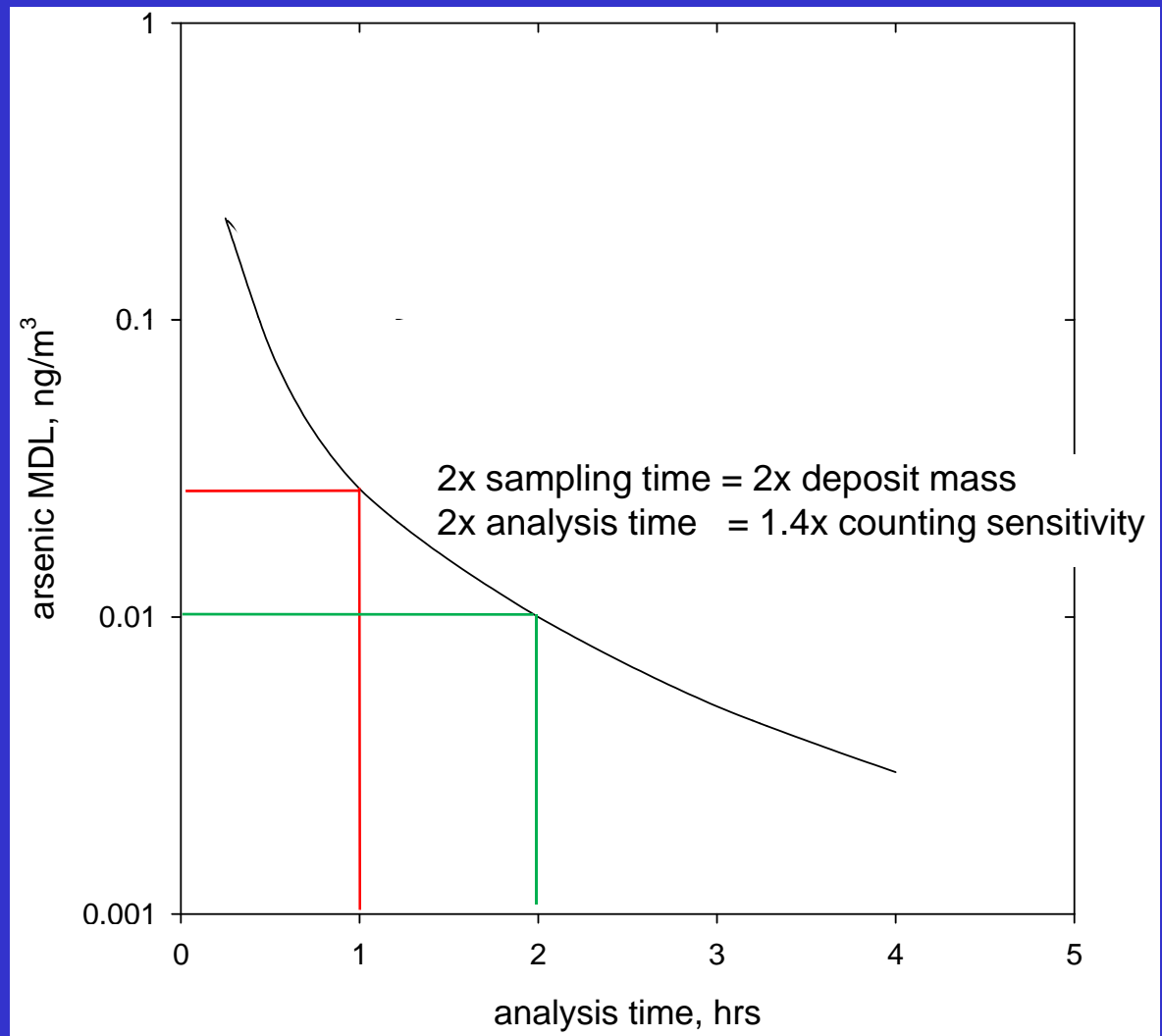
1	1																	18
	H																	He
	1.0079																	4.0026
2	3	4											5	6	7	8	9	10
	Li	Be											B	C	N	O	F	Ne
	6.941	9.0122											10.811	12.011	14.007	15.999	18.998	20.18
3	11	12										13	14	15	16	17	18	
	Na	Mg										Al	Si	P	S	Cl	Ar	
	22.99	24.305										26.982	28.086	30.974	32.066	35.453	39.948	
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
	39.098	40.078	44.956	47.88	50.942	51.996	54.938	55.847	58.933	58.693	63.546	65.39	69.723	72.61	74.922	78.96	79.904	83.8
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
	85.468	87.62	88.906	91.224	92.906	95.94	(97.91)	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.6	126.9	131.29
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
	132.91	137.33	138.91	178.49	180.95	183.84	186.21	190.23	192.22	195.08	196.97	200.59	204.38	207.2	208.98	(209)	(210)	(222)
7	87	88	89	104	105	106	107	108	109	110	111							
	Fr	Ra	Ac	Rf	Ha	Sg	Ns	Hs	Mt	Unn	Unu							
	(223)	(226)	(227)	(261.1)	(262.1)	(263.1)	(262.1)	(265.1)	(266.1)	(268)	(269)							

Lanthanide Series	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	140.12	140.91	144.24	(144.9)	150.36	151.97	157.25	158.93	162.5	164.93	167.26	168.93	173.04	174.97
Actinide Series	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	232.04	231.04	238.03	(237)	(244.1)	(243.1)	(247.1)	(247.1)	(251.1)	(252.1)	(257.1)	(258.1)	(259.1)	(262.1)

-  measured by Xact in this study
-  EPA Air Toxics PM metals

Optimizing the Sampling Time Interval

- depends on study objectives!
- trade-offs between time resolution and frequency above MDL
- Blair Street (STL)
 - 1-hour: 56% > MDL
 - 2-hour: 86% > MDL



Xact Performance Evaluation



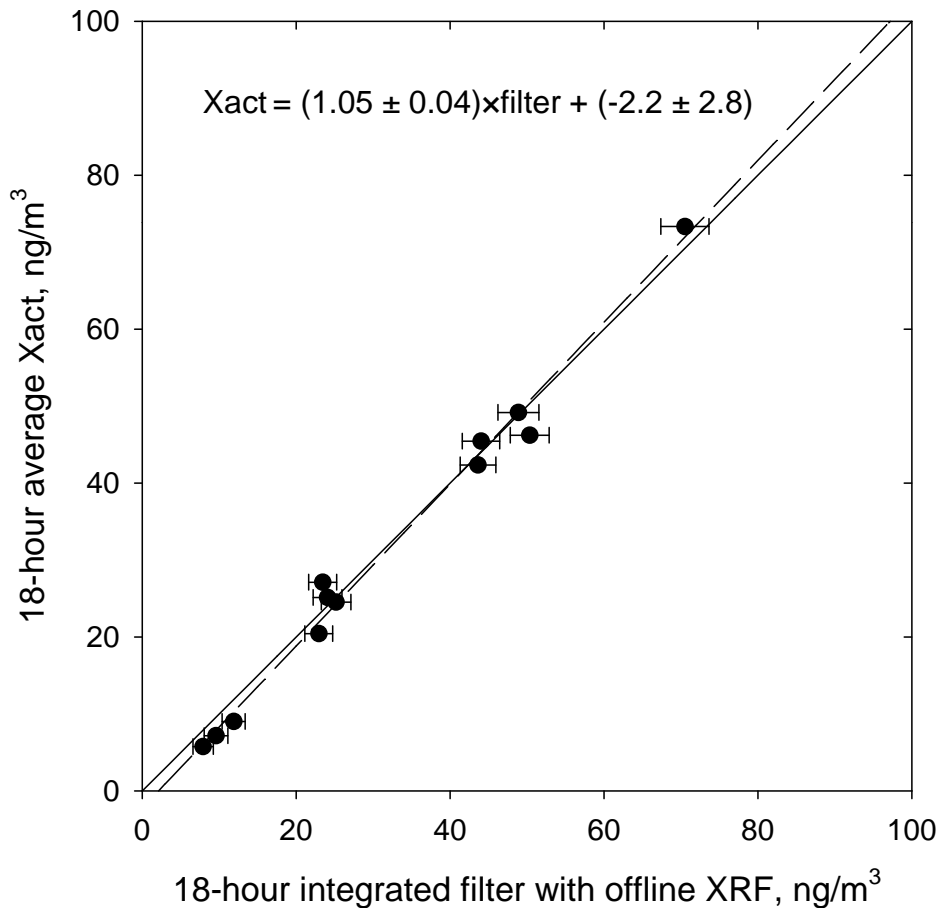
HiVol PM₁₀ / quartz filter,
NATTS digestion protocol
ICP-MS: As, Pb, Se...



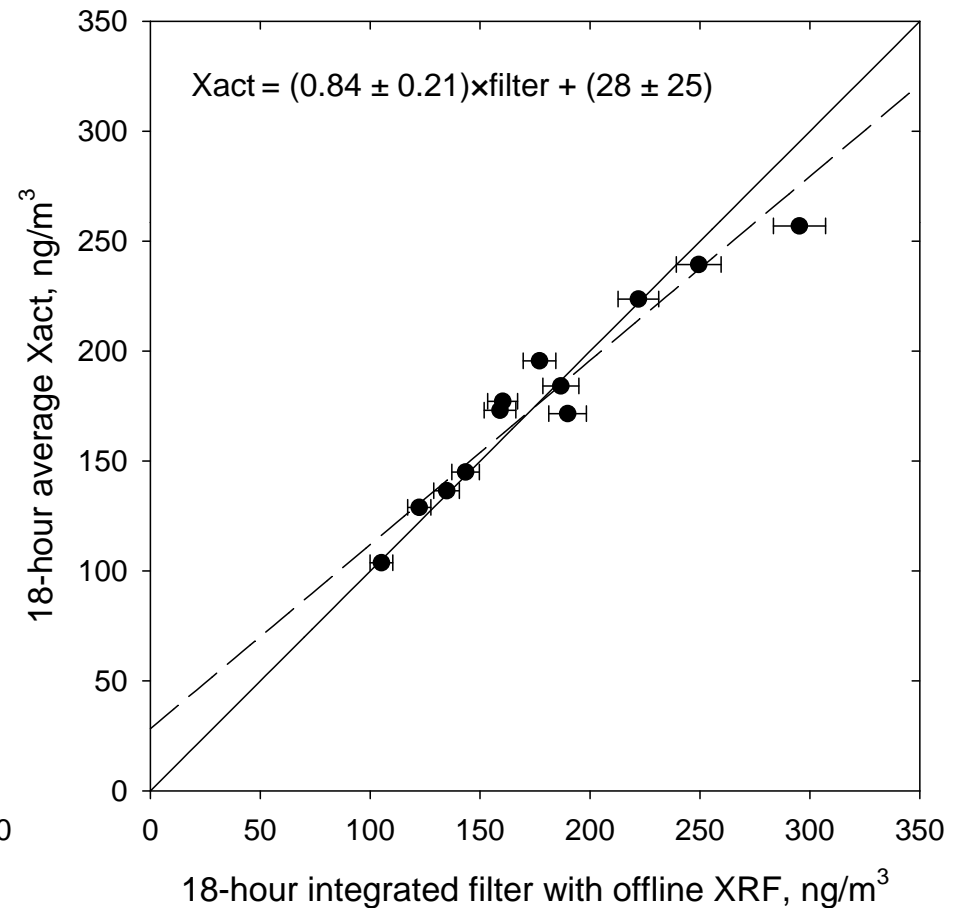
LowVol PM₁₀ (FRM) / Teflon filter
XRF: Ca, Fe, K, Mn, Pb, Ti...

Xact vs. LowVol PM₁₀ FRM / XRF

Titanium



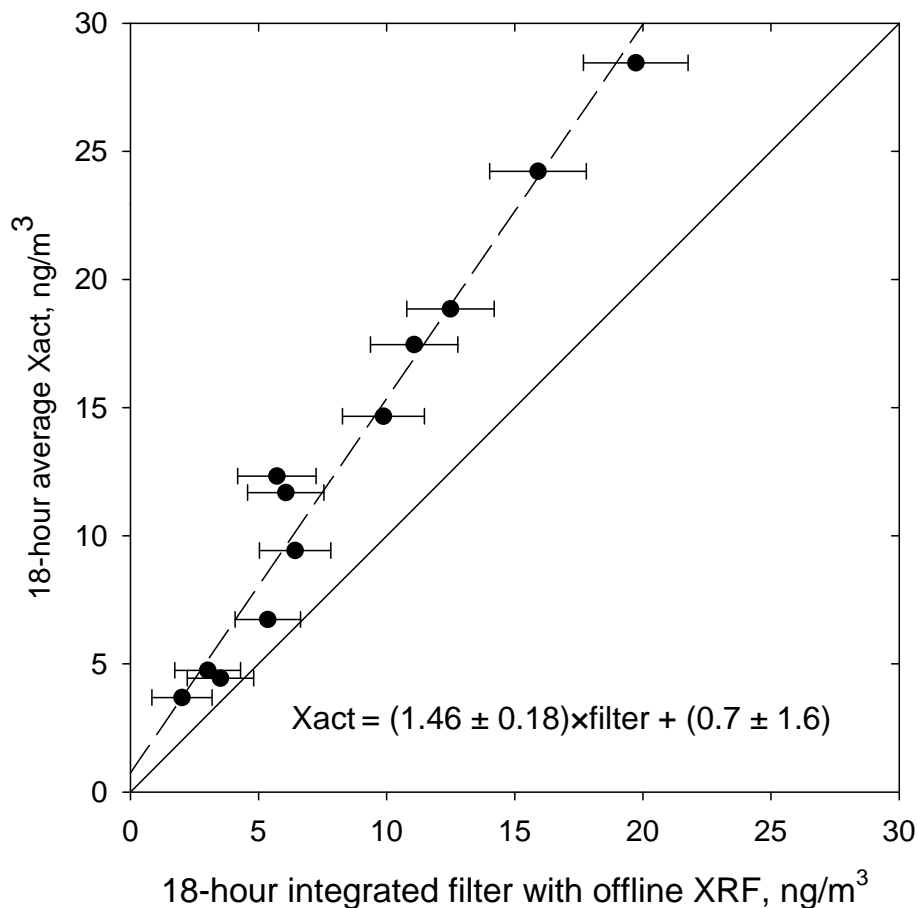
Potassium



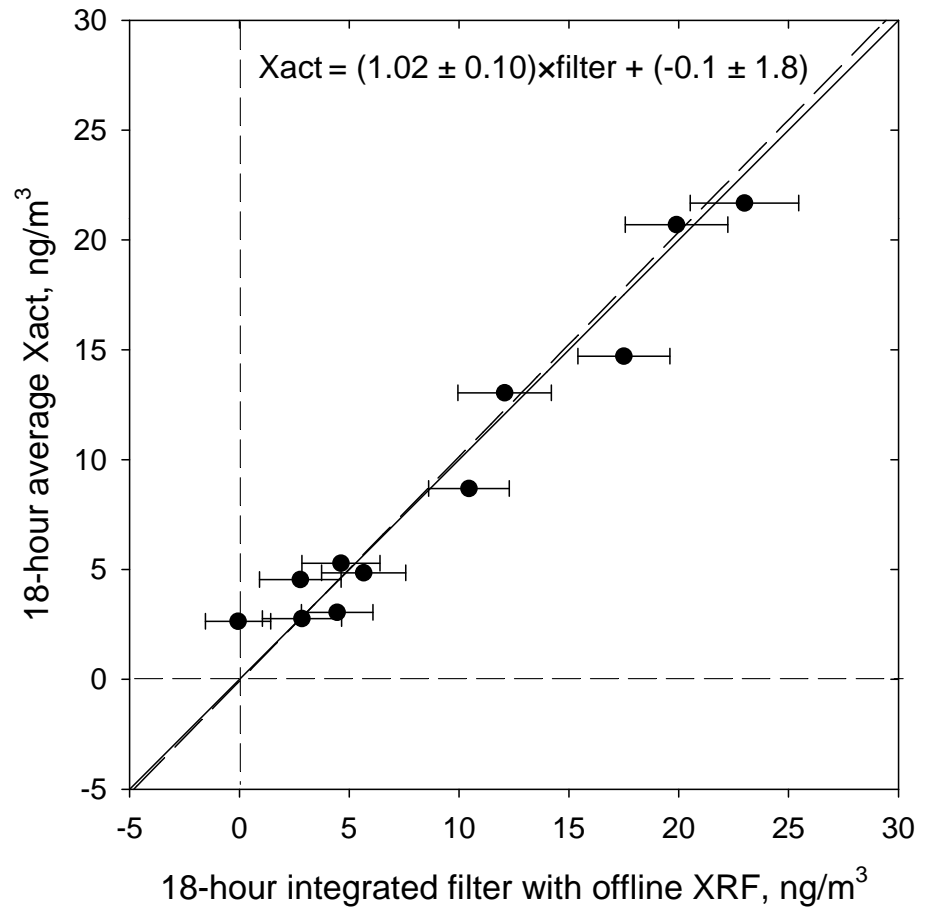
*K: narrow dynamic range,
regression misleading*

Xact vs. LowVol PM₁₀ FRM / XRF

Manganese



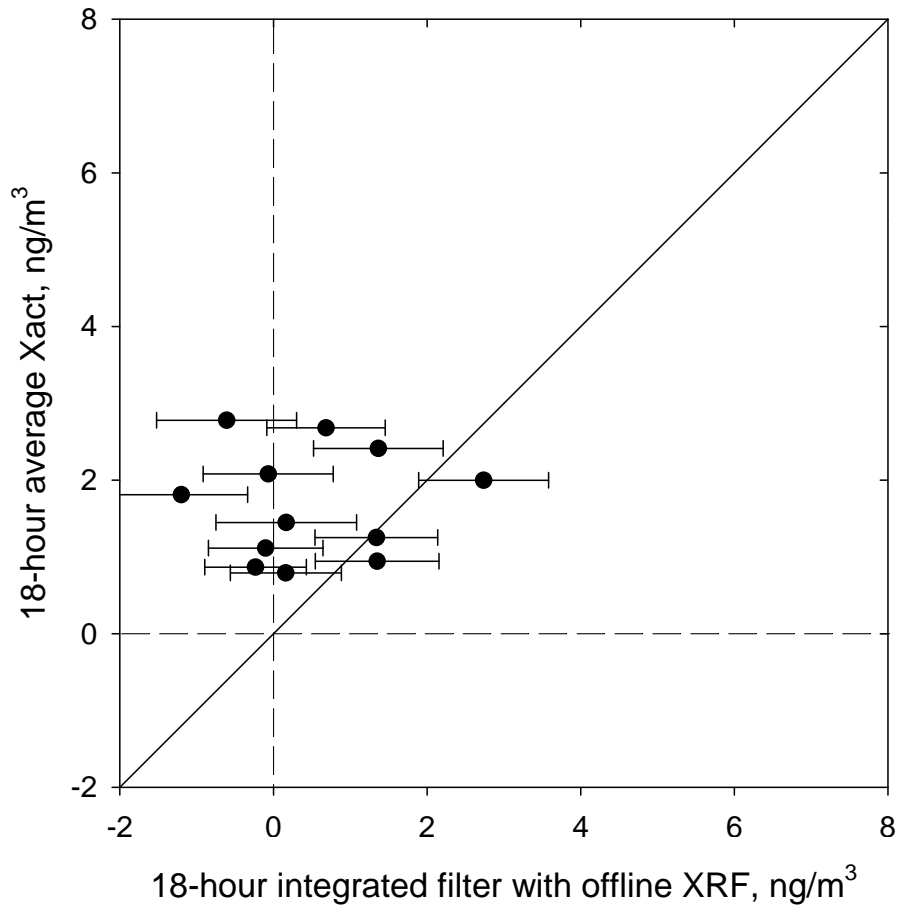
Lead



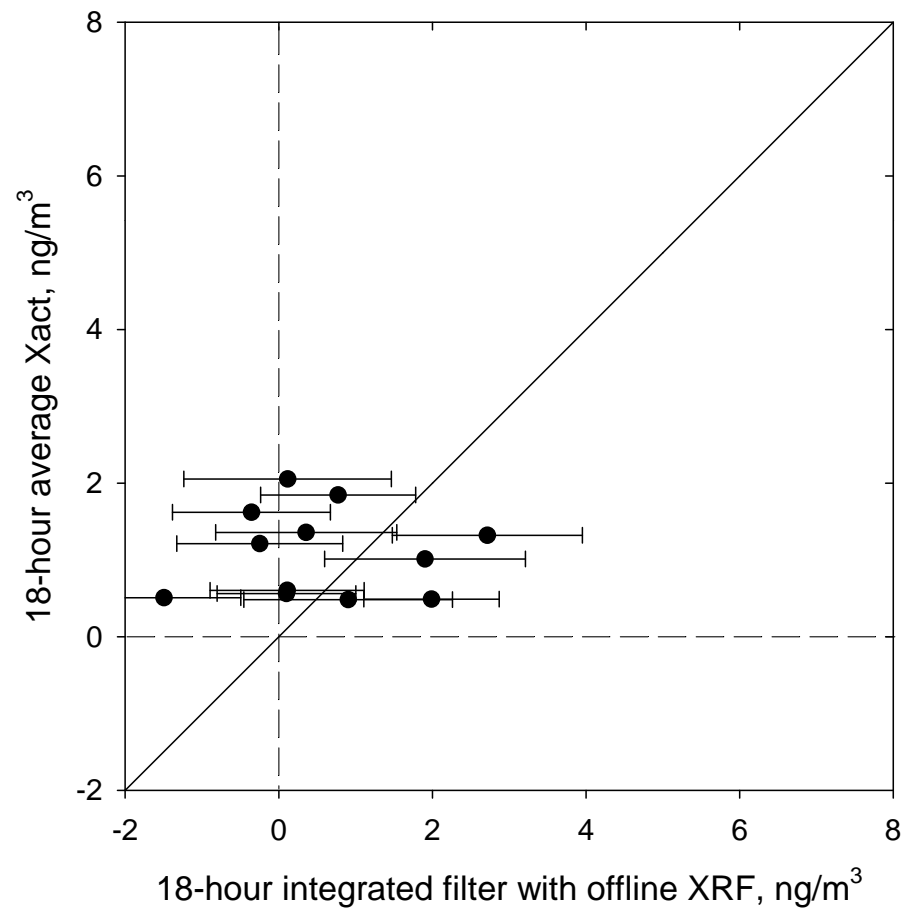
Mn: biased but highly correlated

Xact vs. LowVol PM₁₀ FRM / XRF

Selenium

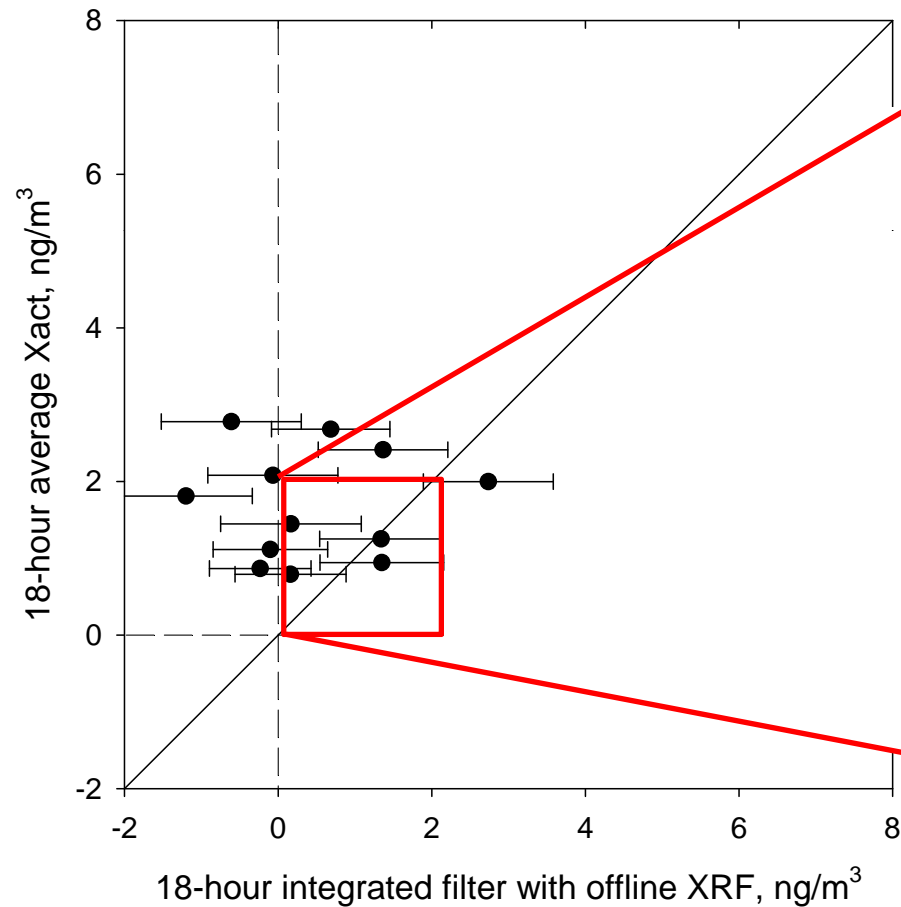


Arsenic

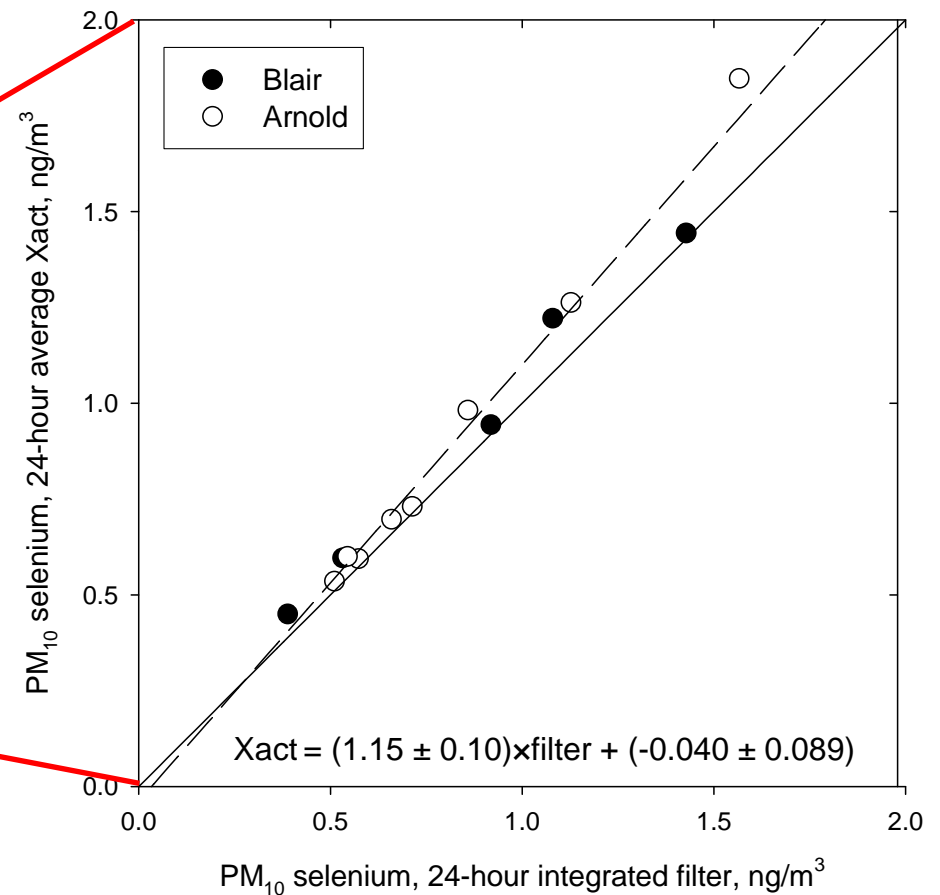


Selenium: Xact vs. Filter-Based Measurements

Xact vs. LowVol filter / lab XRF

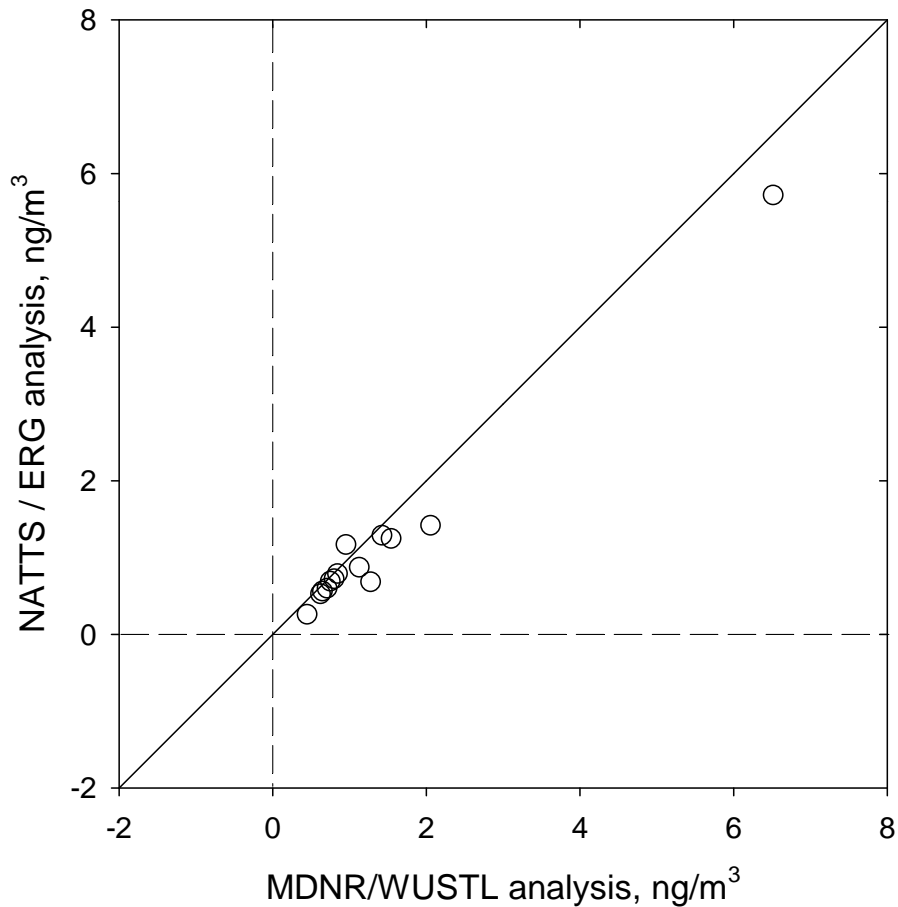


Xact vs. HiVol filter / lab ICP-MS

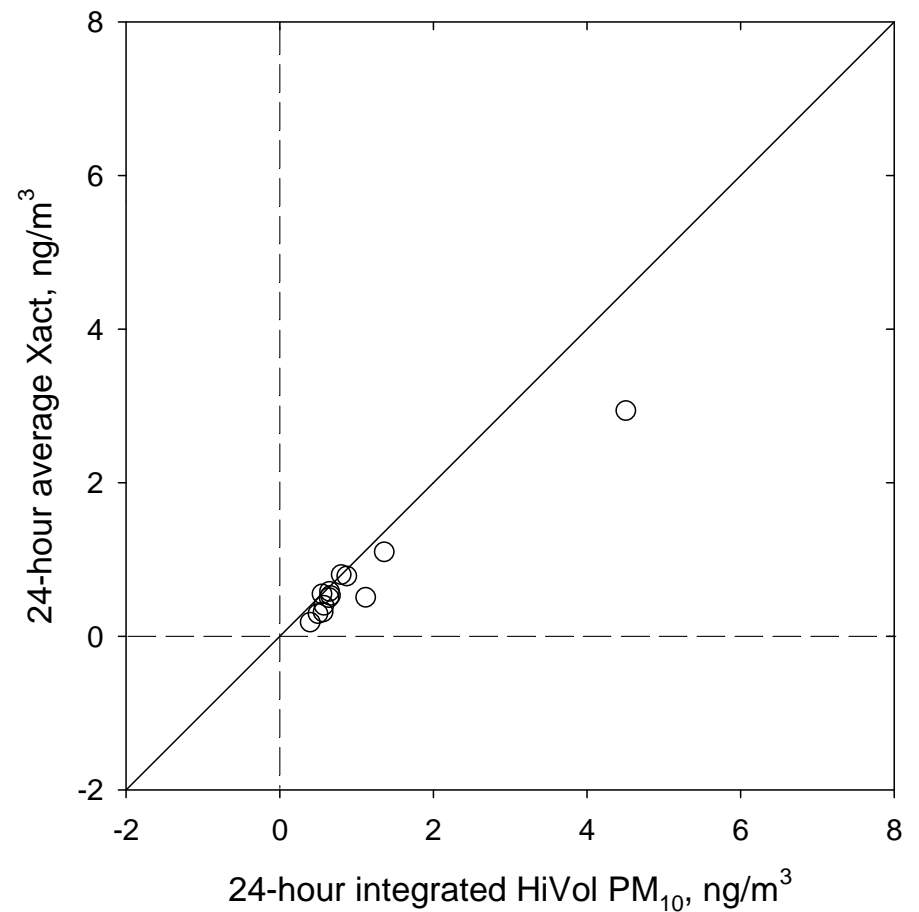


Arsenic – Methods Comparisons

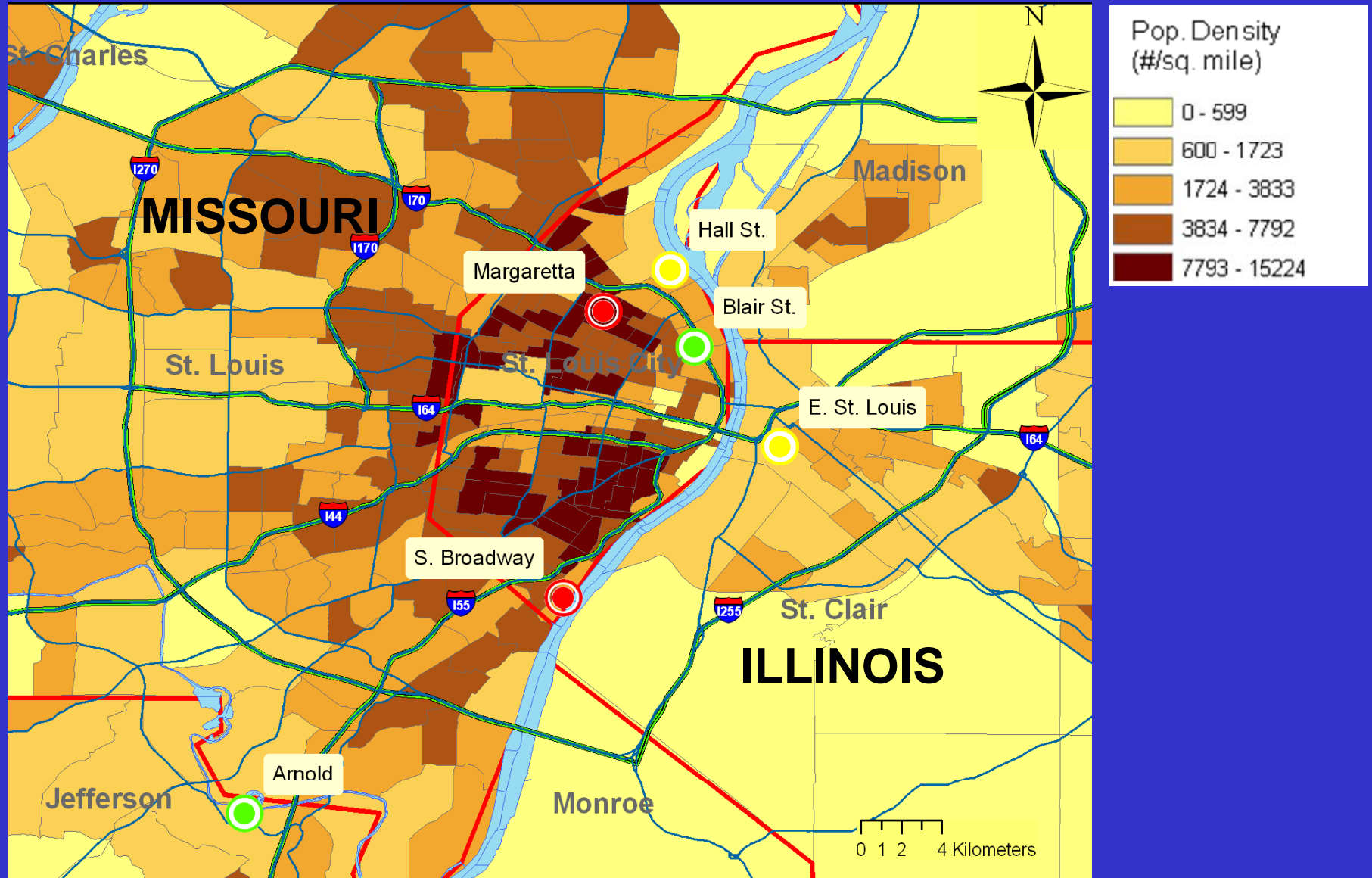
Collocated HiVol Samplers
Blair site, 4th Quarter 2008



Xact vs. WUSTL HiVol
Dec 2008 / Jan 2009

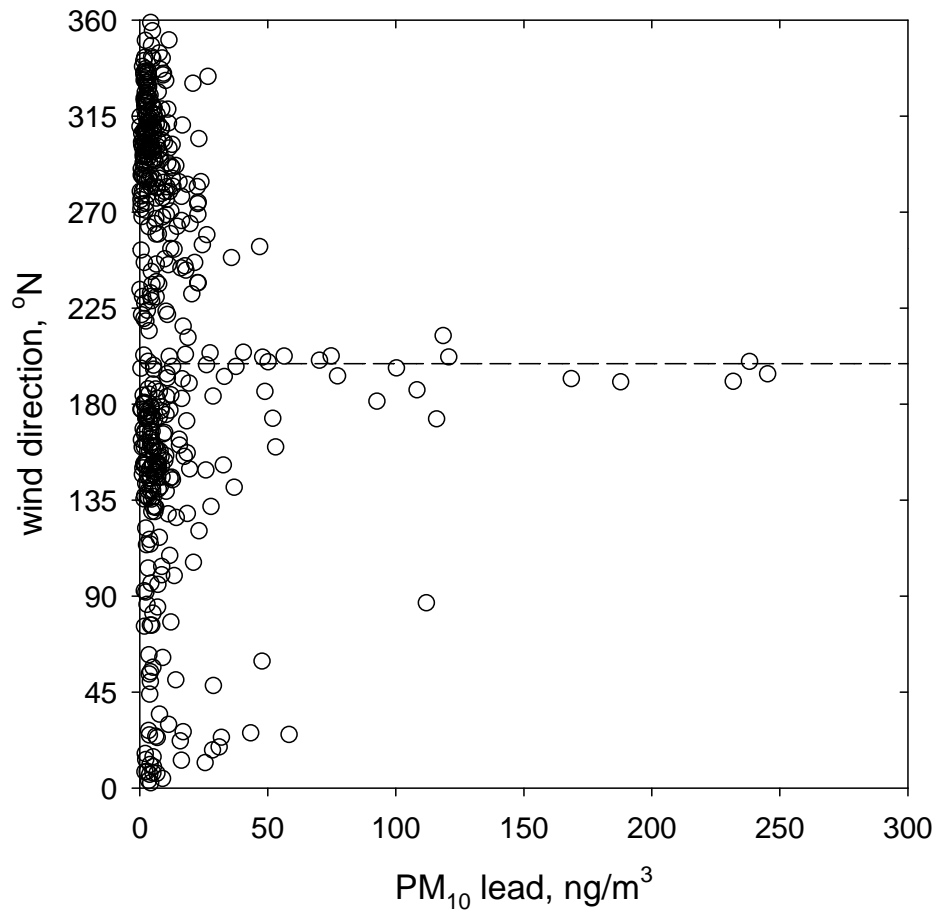


Xact Monitoring Sites

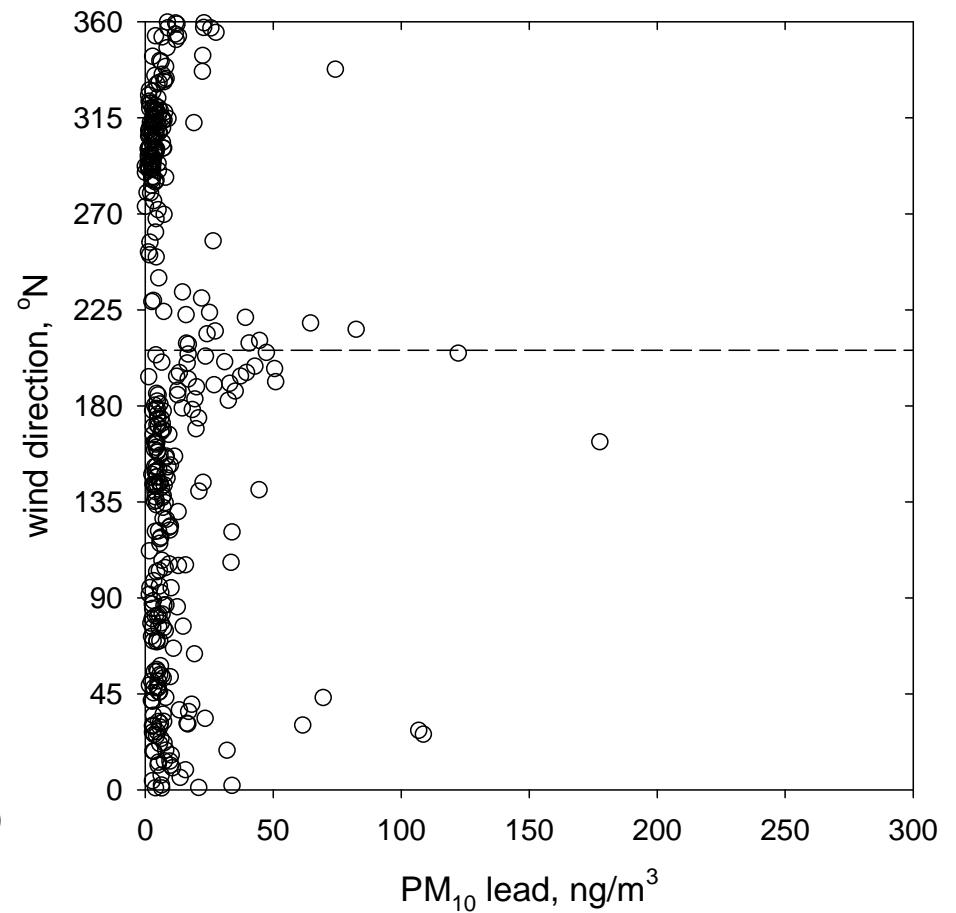


PM₁₀ Lead by Xact (2-hour resolution)

BLAIR



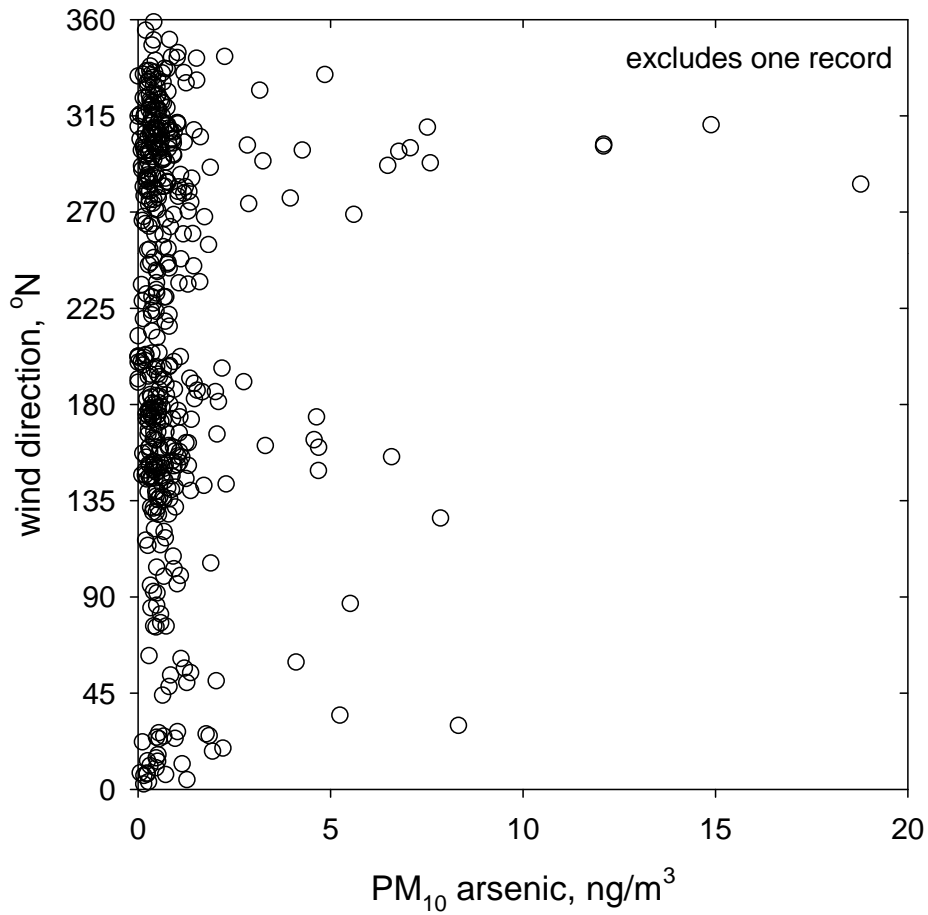
ARNOLD



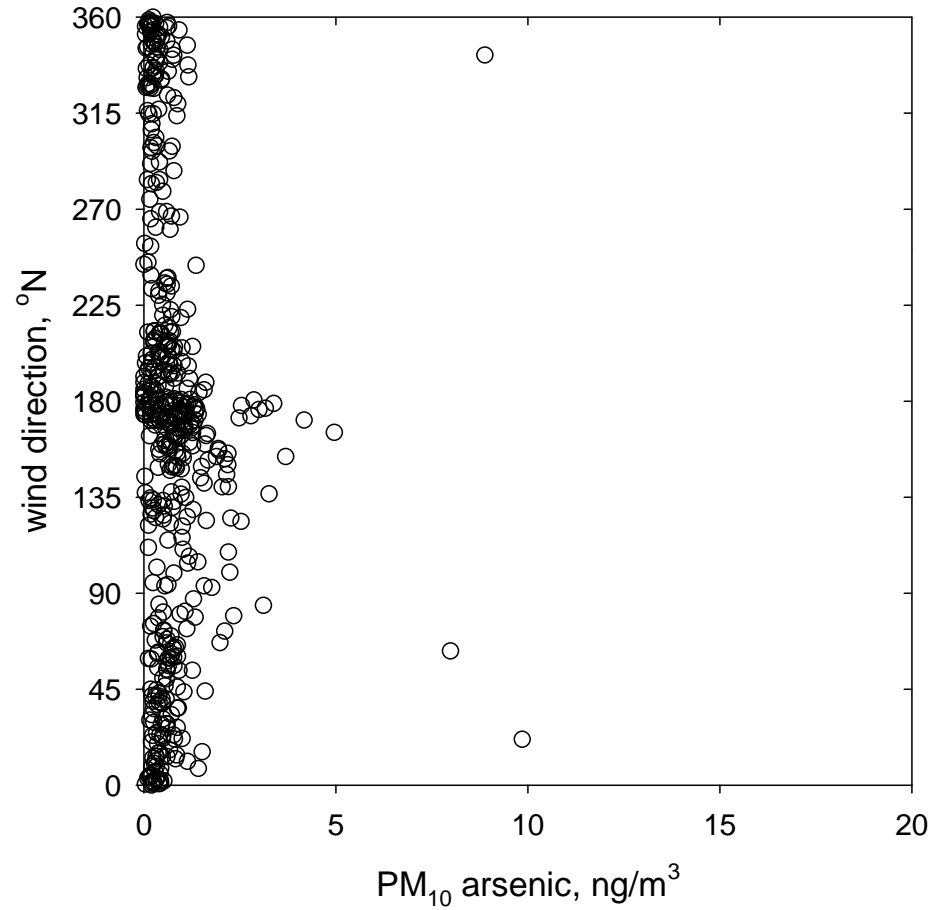
Dashed line is bearing of Doe Run – Herculaneum lead smelter

PM₁₀ Arsenic by Xact (2-hour resolution)

BLAIR

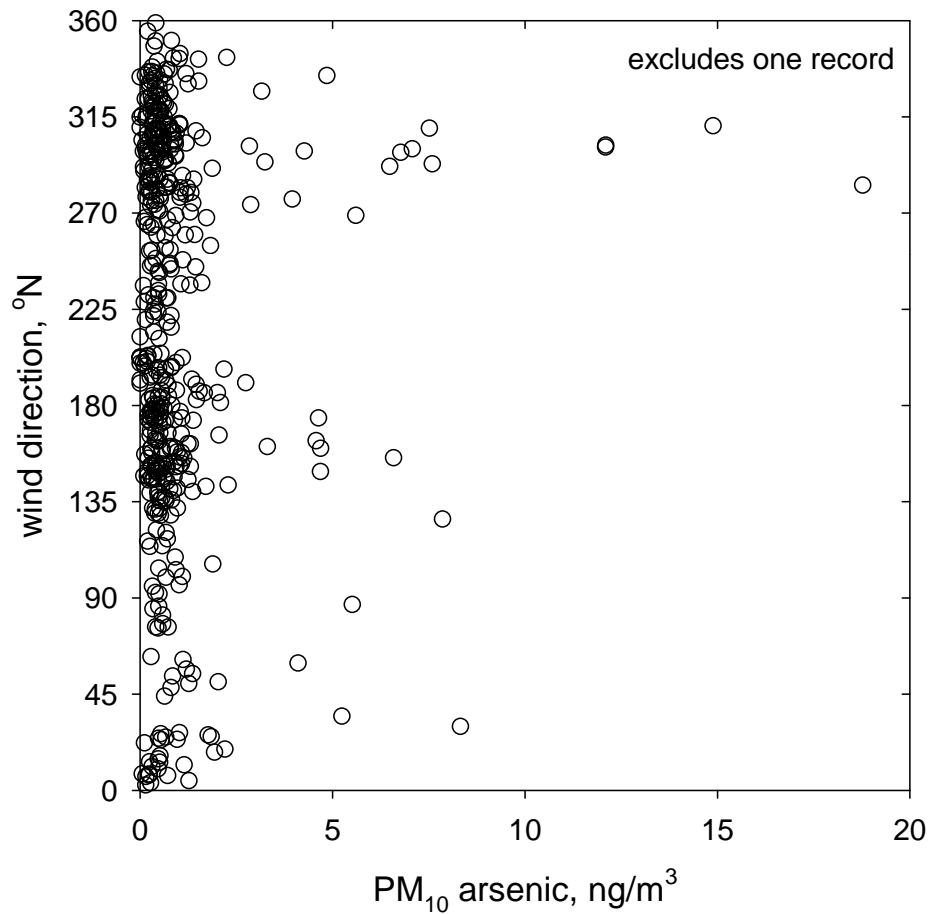


ARNOLD

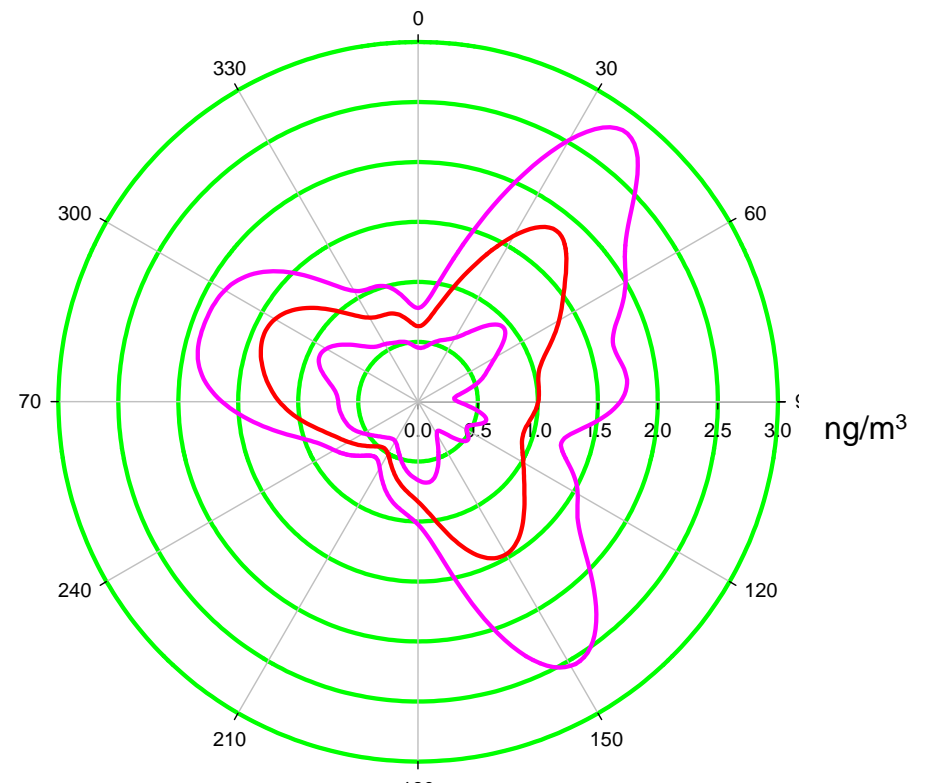


PM₁₀ Arsenic at Blair by Xact (2-hour resolution)

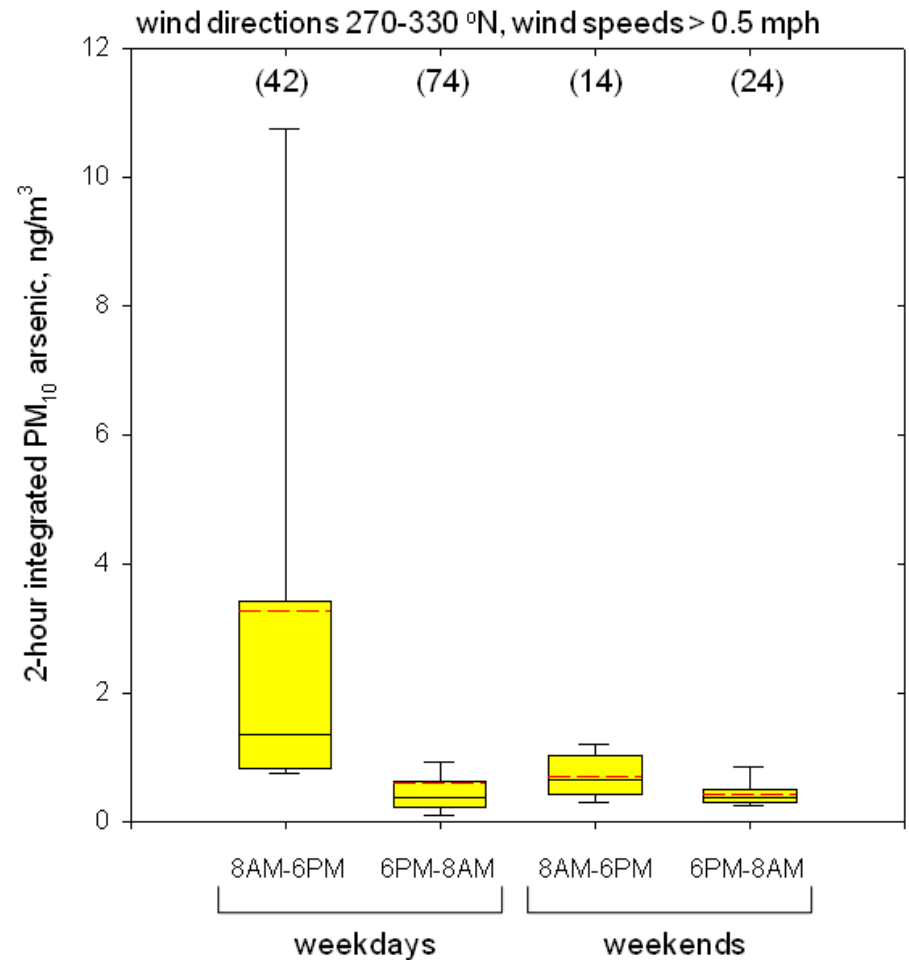
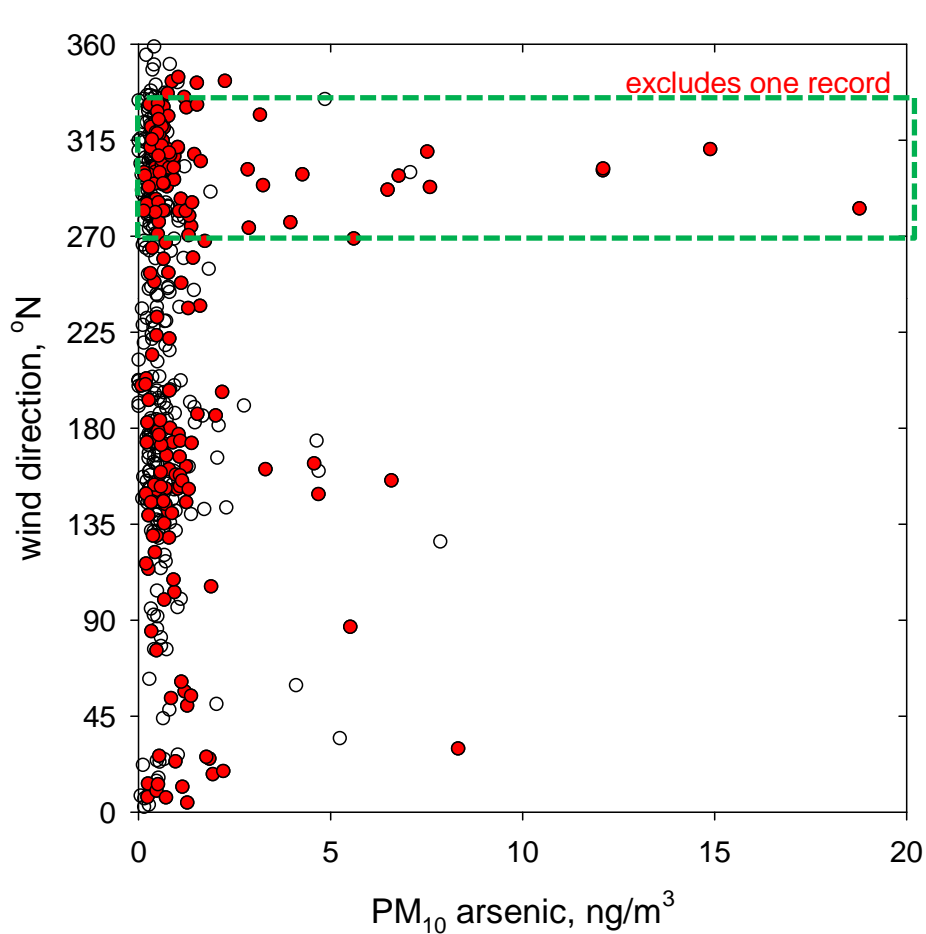
wind direction vs. concentration



nonparametric wind regression

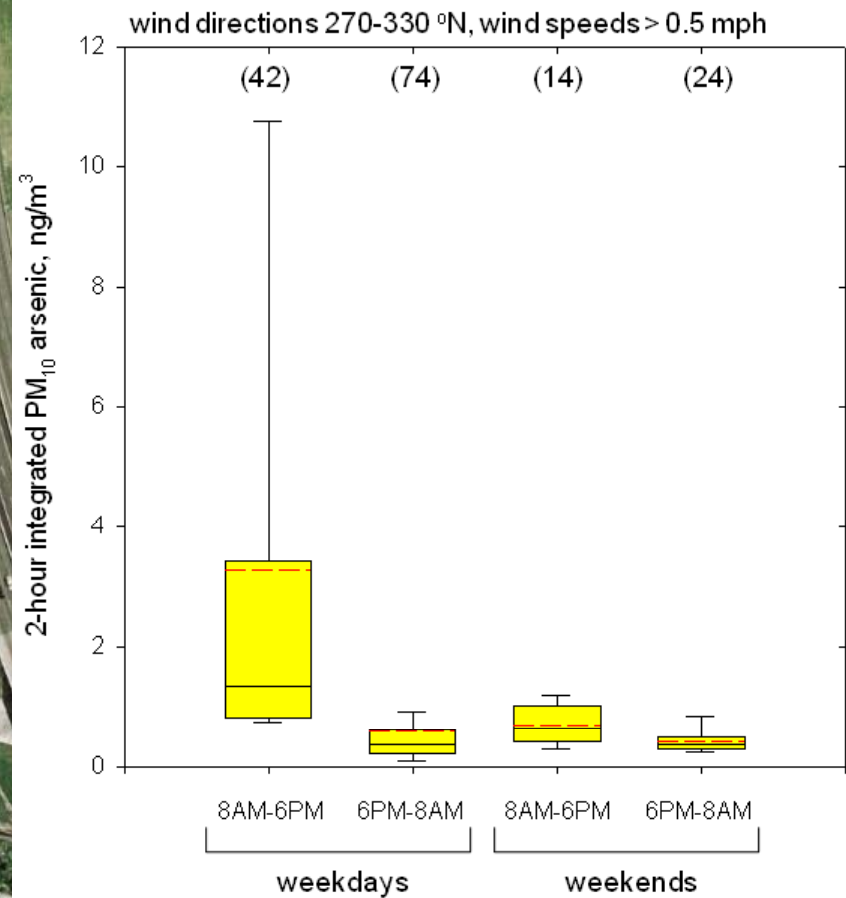
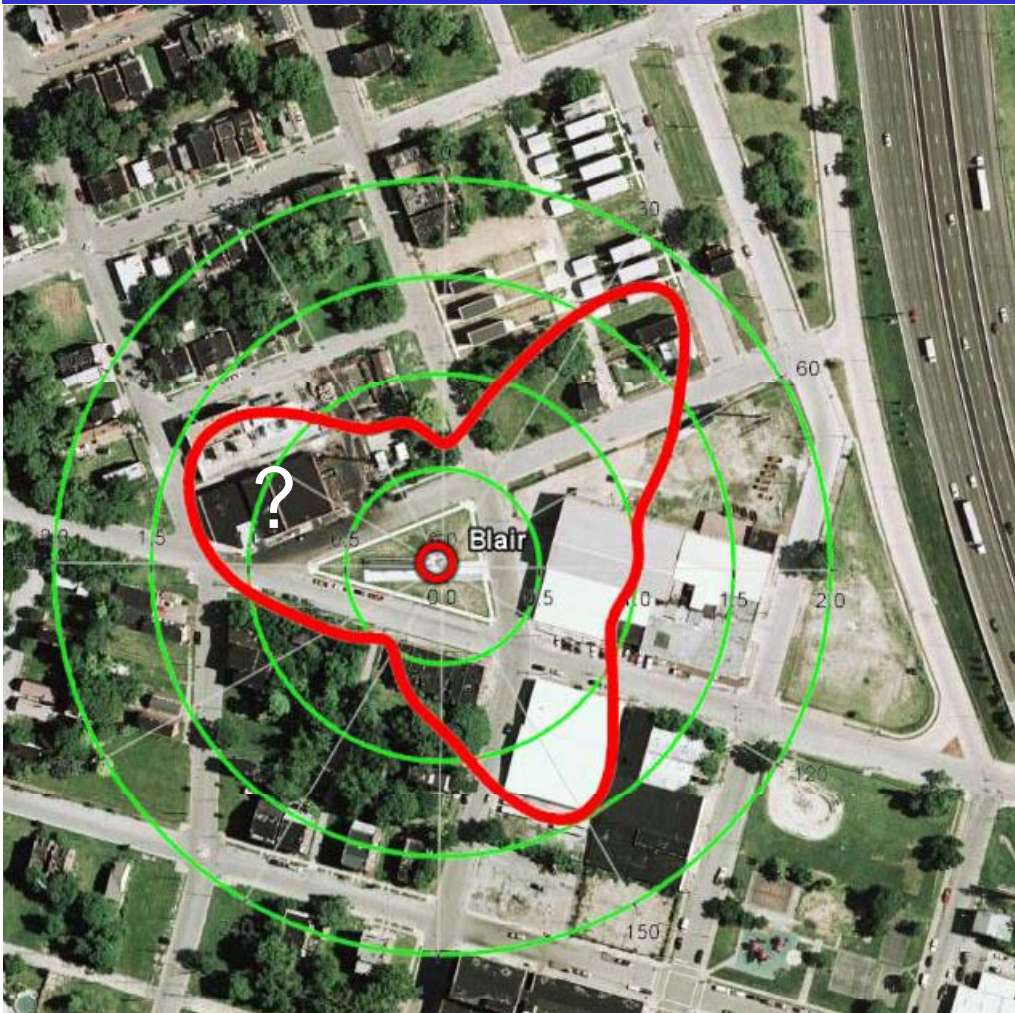


PM₁₀ Arsenic at Blair for Winds from Northwest



red markers = 8 AM – 6PM weekdays

PM₁₀ Arsenic at Blair for Winds from Northwest



*Emission source zone of influence?
Monitor zone of representation?*

The Next Steps

- Additional Xact deployments
 - currently on fifth of six deployments
- Expanded performance evaluation
 - additional low-volume PM₁₀ FRM samples, analysis by XRF and ICP-MS
- Collocated Xact measurements (MDNR and CES)
 - Herculaneum, August 2009
 - crucial data for receptor modeling
- Receptor modeling of the data sets

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- Washington University
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