High Time Resolution PM_{10} Metals by the CES Ambient Metals Monitor (Xact 620): Field Performance Evaluation and Data Trends for St. Louis

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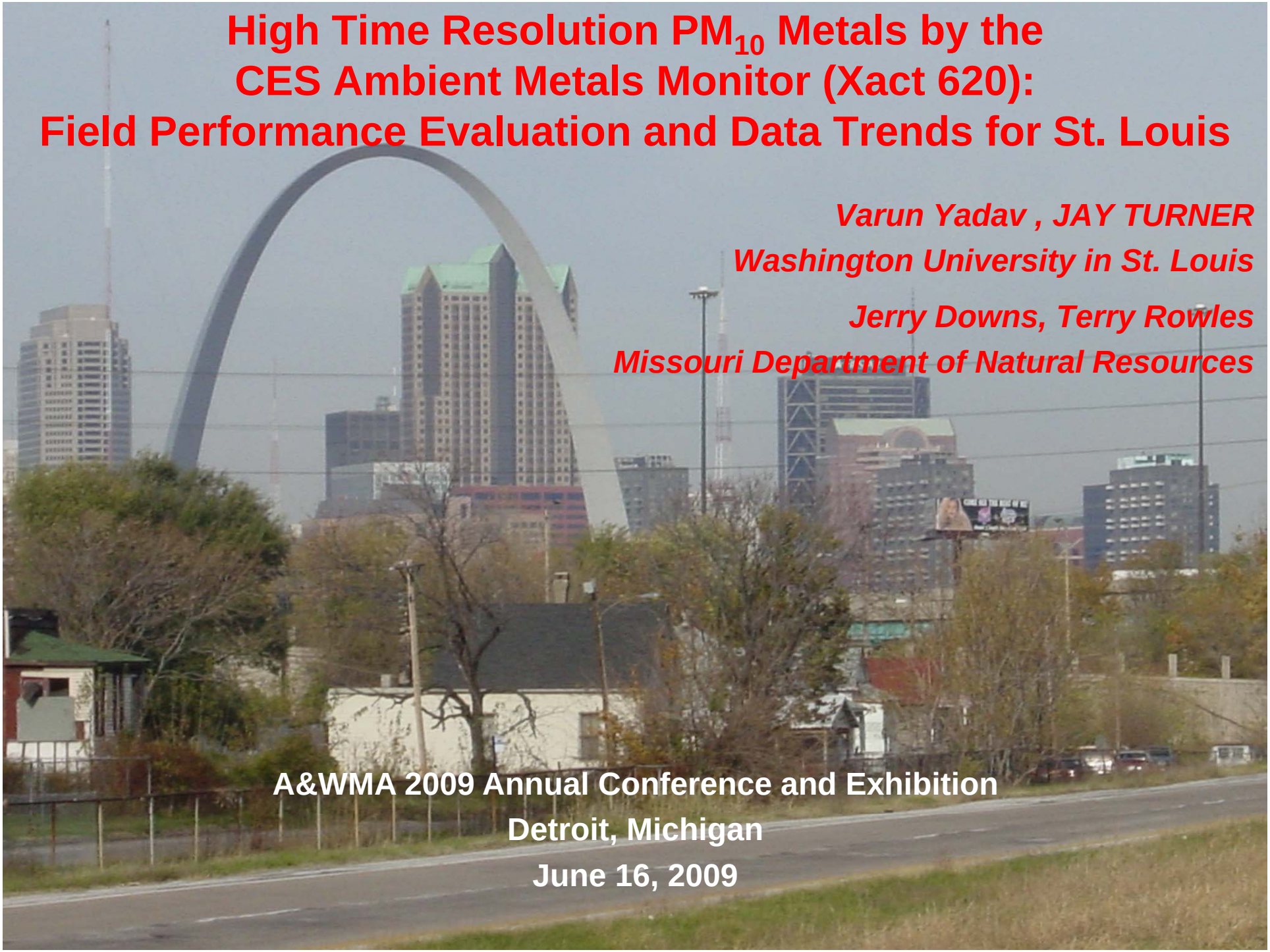

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Motivation

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
- PM_{10} air toxics metals routinely measured at only one site

Objectives

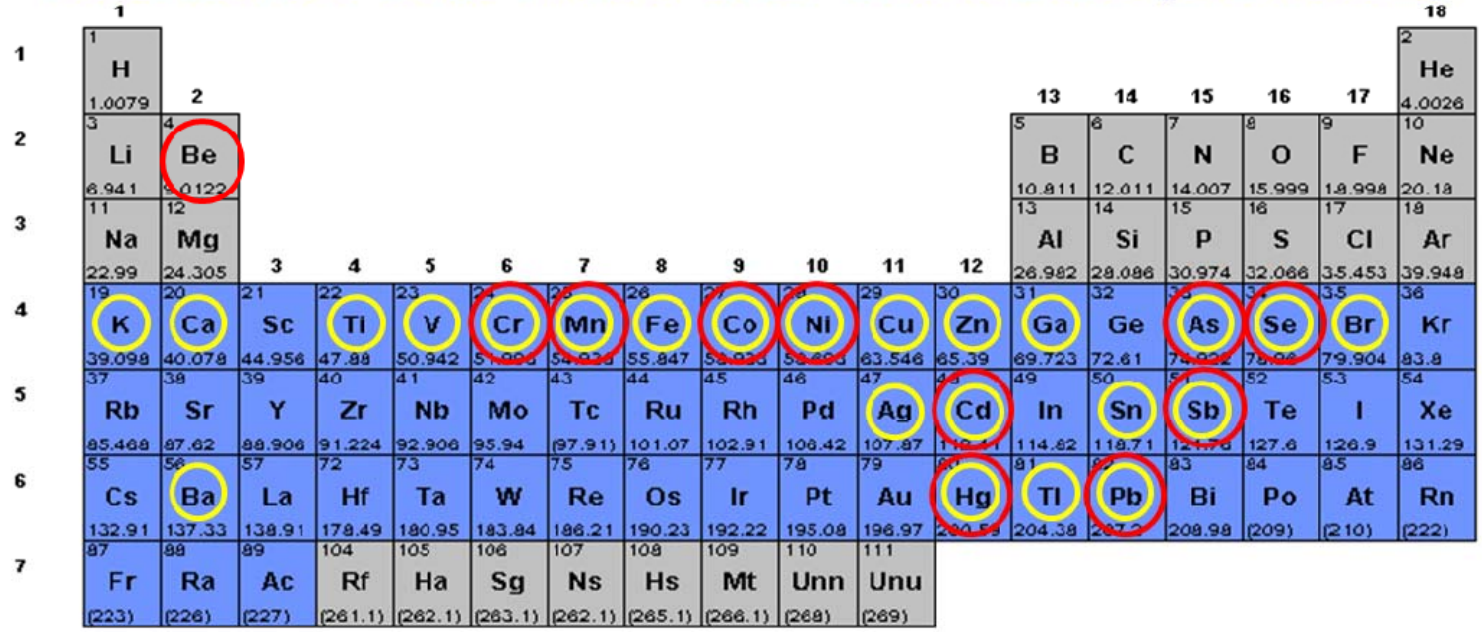
Community Air Toxics Grant from USEPA

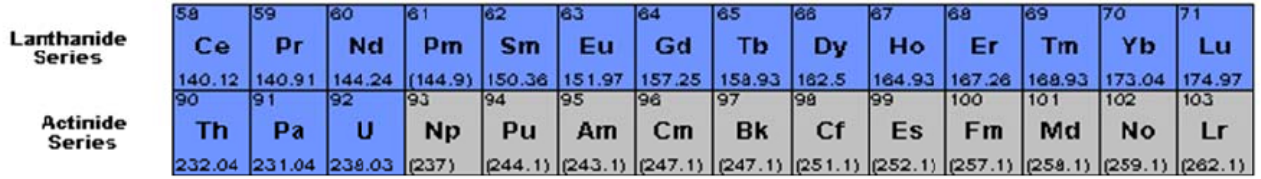
- Phase I [Paper #370]
  - four site network of HiVol PM_{10} samplers
  - one year at 1-in-3 days
  - hot acid extraction and analysis by ICP-MS
  - ~2x urban excess for arsenic
- Phase II [Paper #146]
  - high(er) time resolution measurements
  - six one-month deployments of CES Xact 620
  - Xact performance 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)



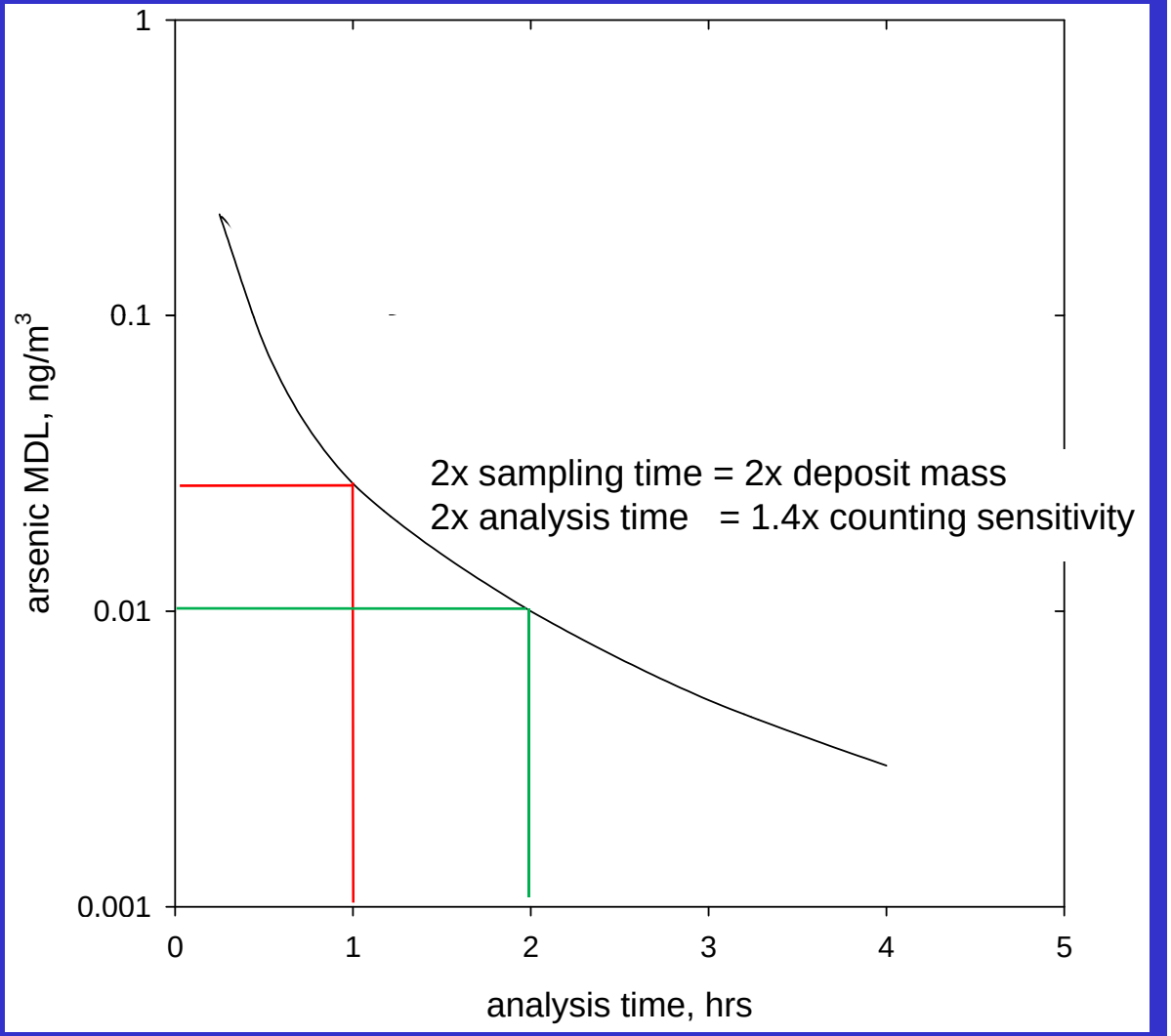


measured by Xact in this study

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 PM_{10} / quartz filter,
NATTS digestion protocol

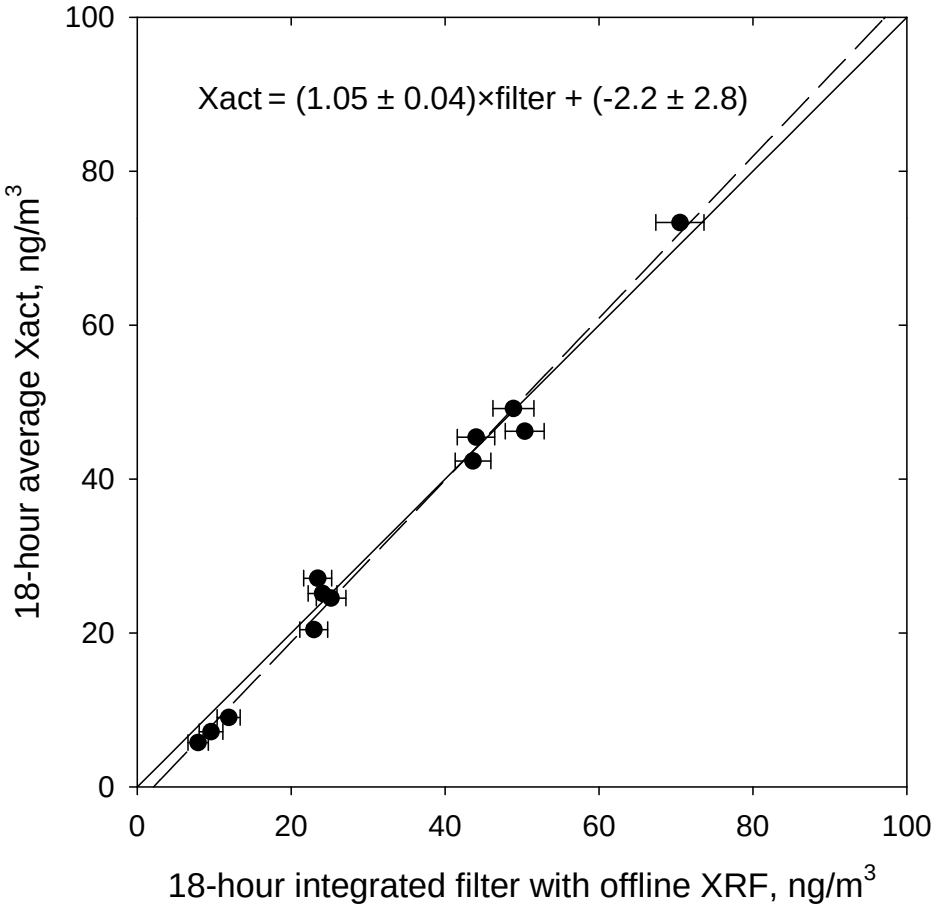
ICP-MS: As, Pb, Se…

LowVol PM_{10} (FRM) / Teflon filter

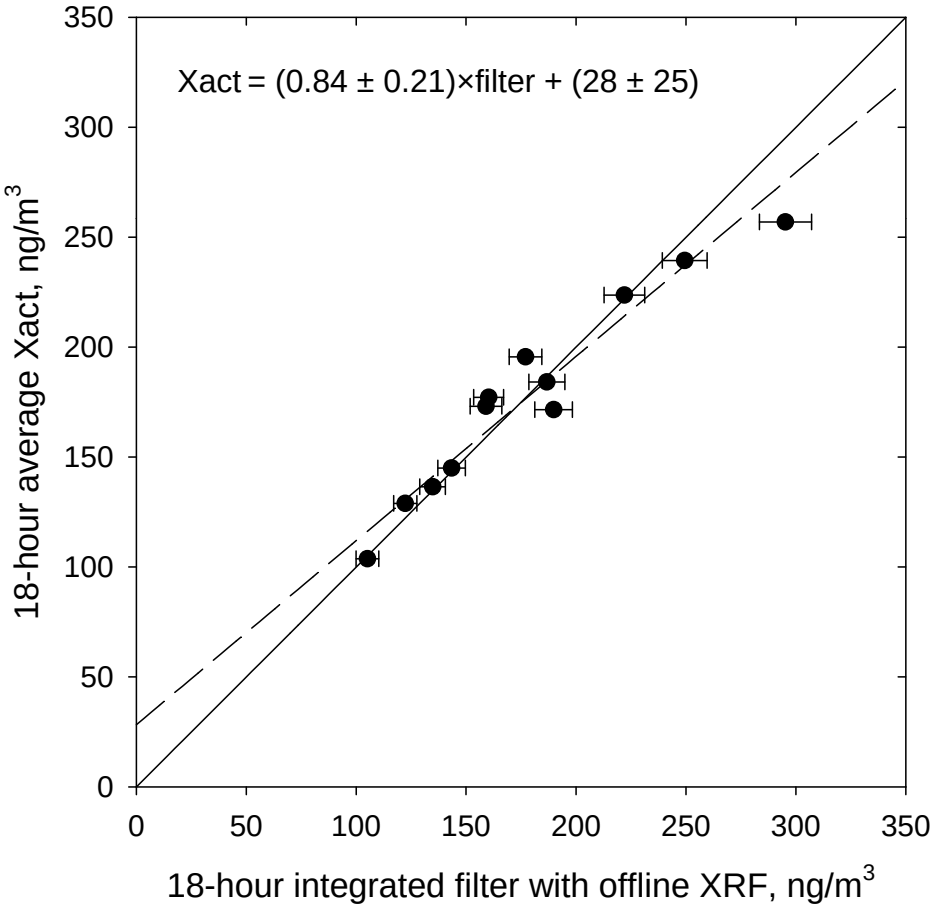
XRF: Ca, Fe, K, Mn, Pb, Ti…

Xact vs. LowVol PM_{10} FRM / XRF

Titanium



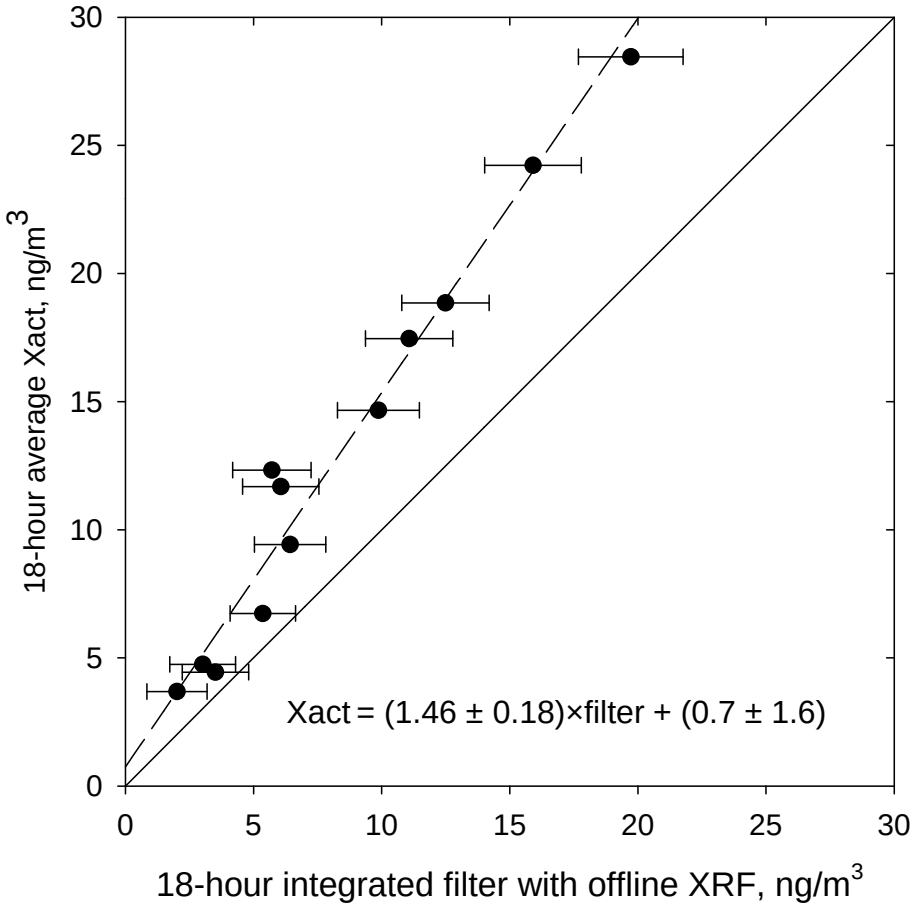
Potassium



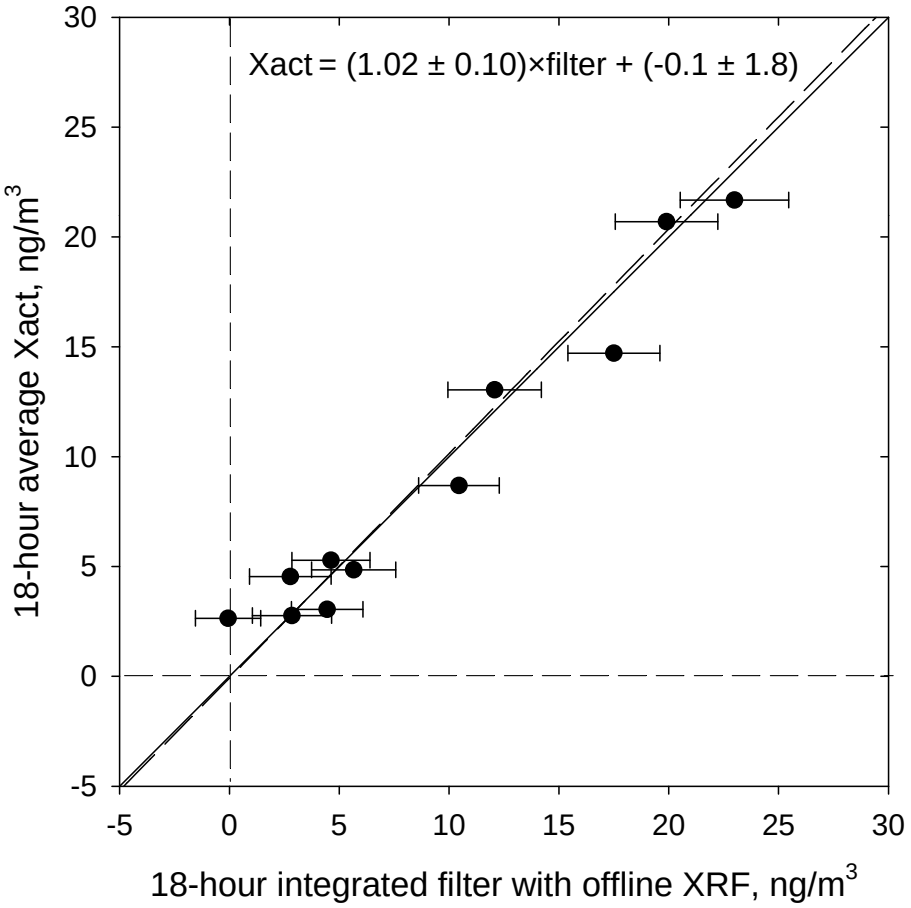
K: narrow dynamic range, regression misleading

Xact vs. LowVol PM_{10} FRM / XRF

Manganese



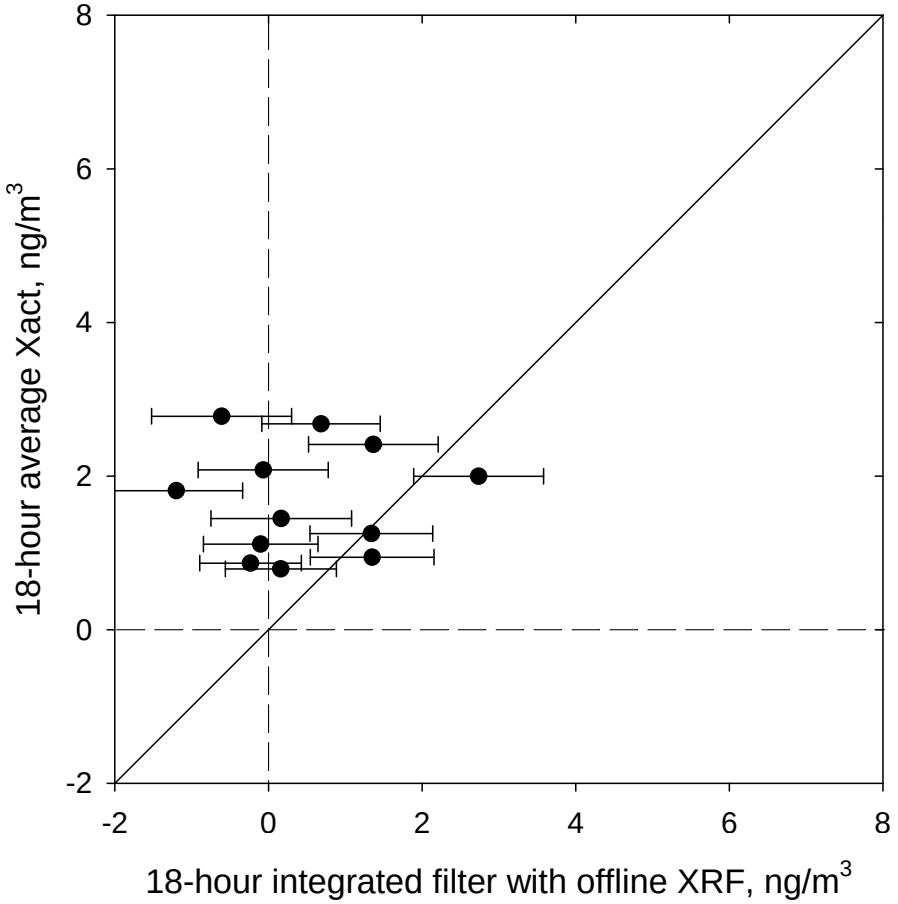
Lead



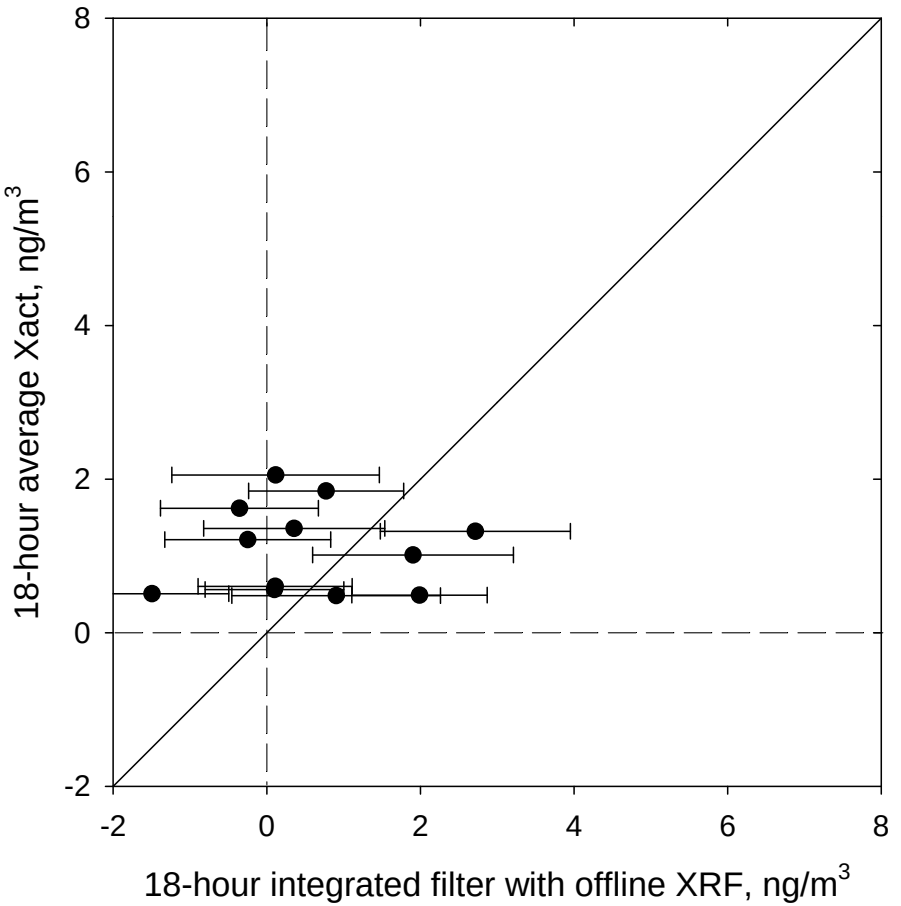
Mn: biased but highly correlated

Xact vs. LowVol PM_{10} FRM / XRF

Selenium

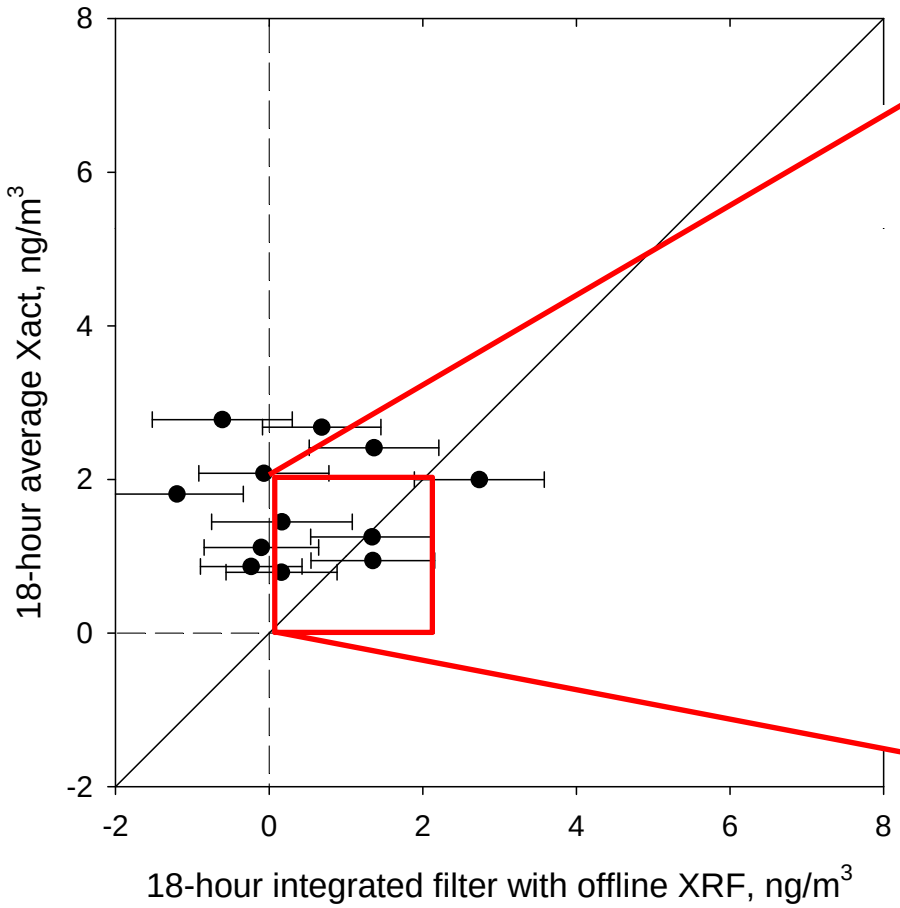


Arsenic

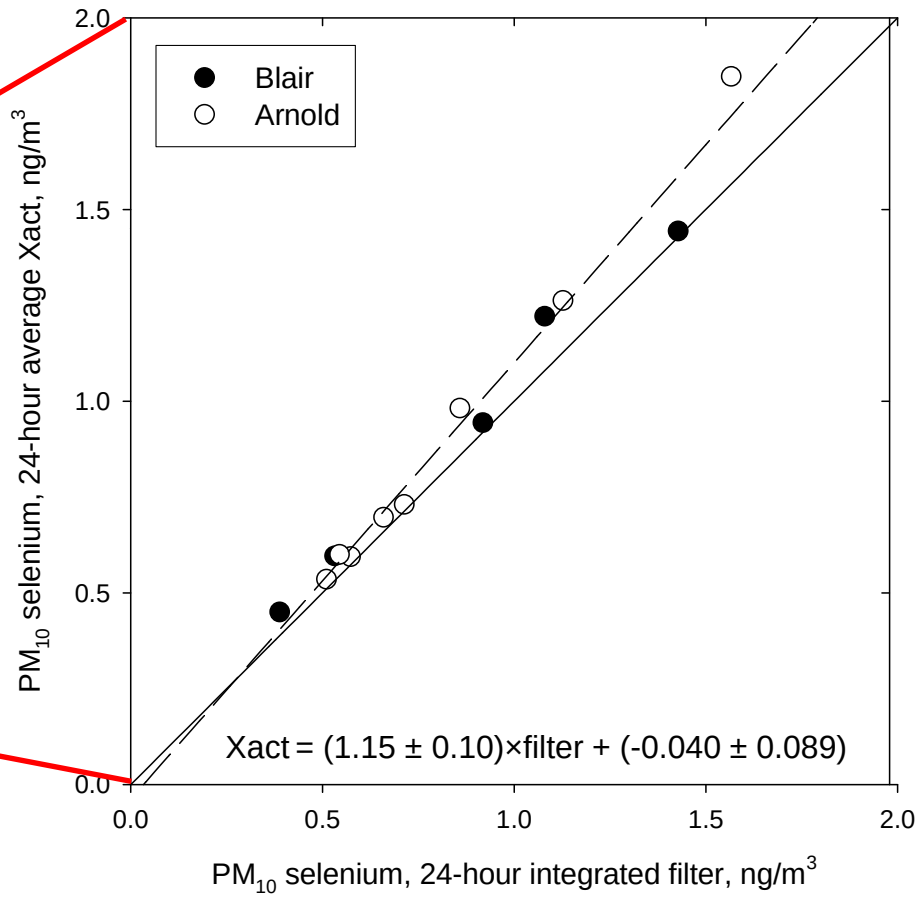


Selenium: Xact vs. Filter-Based Measurements

Xact vs. LowVol filter / lab XRF



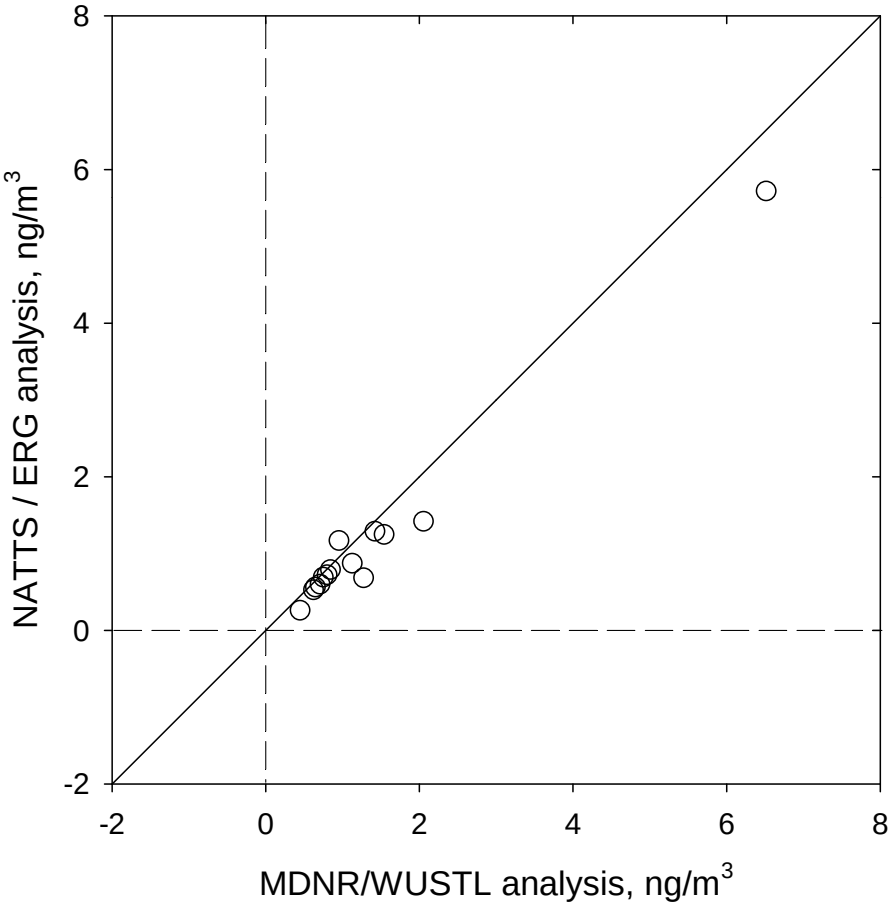
Xact vs. HiVol filter / lab ICP-MS



Arsenic – Methods Comparisons

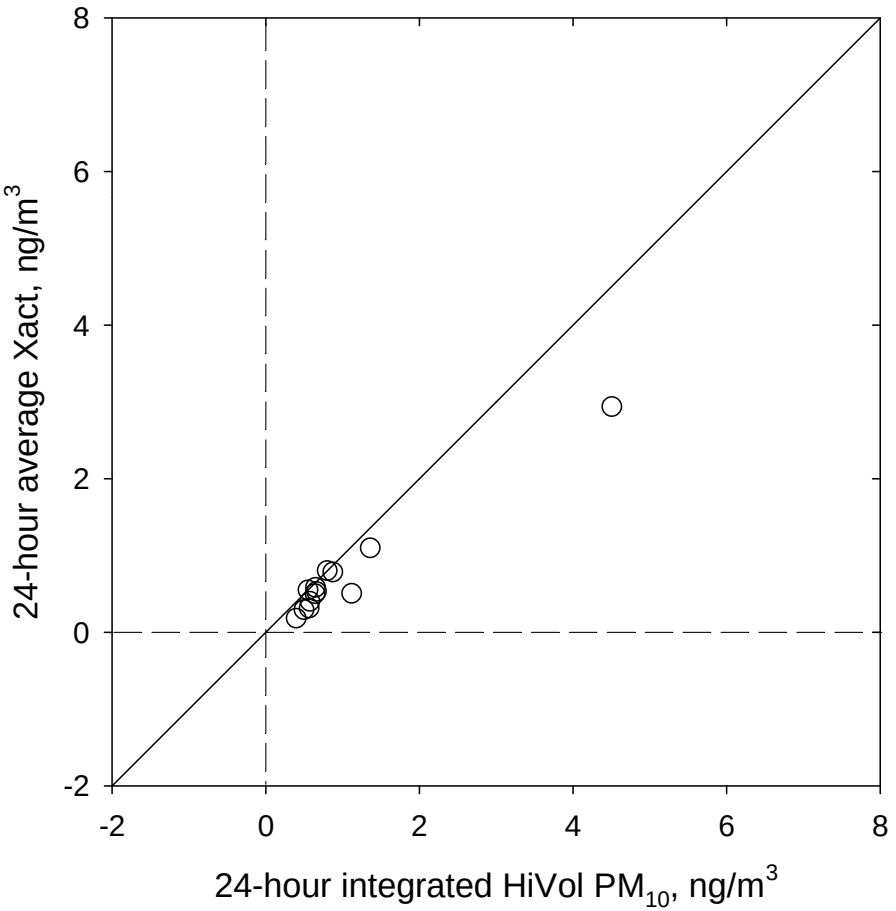
Collocated HiVol Samplers

Blair site, 4th Quarter 2008

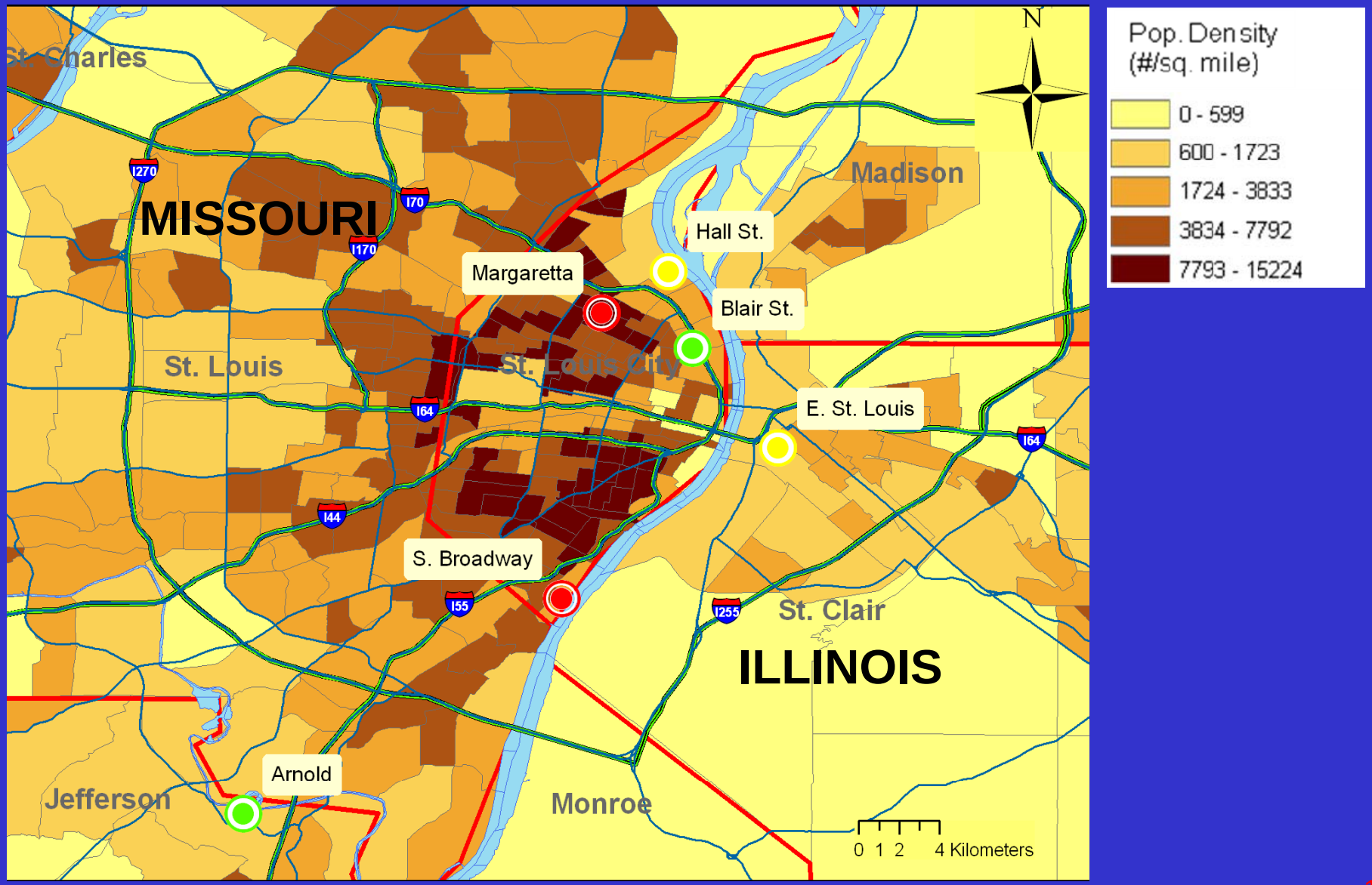


Xact vs. WUSTL HiVol

Dec 2008 / Jan 2009

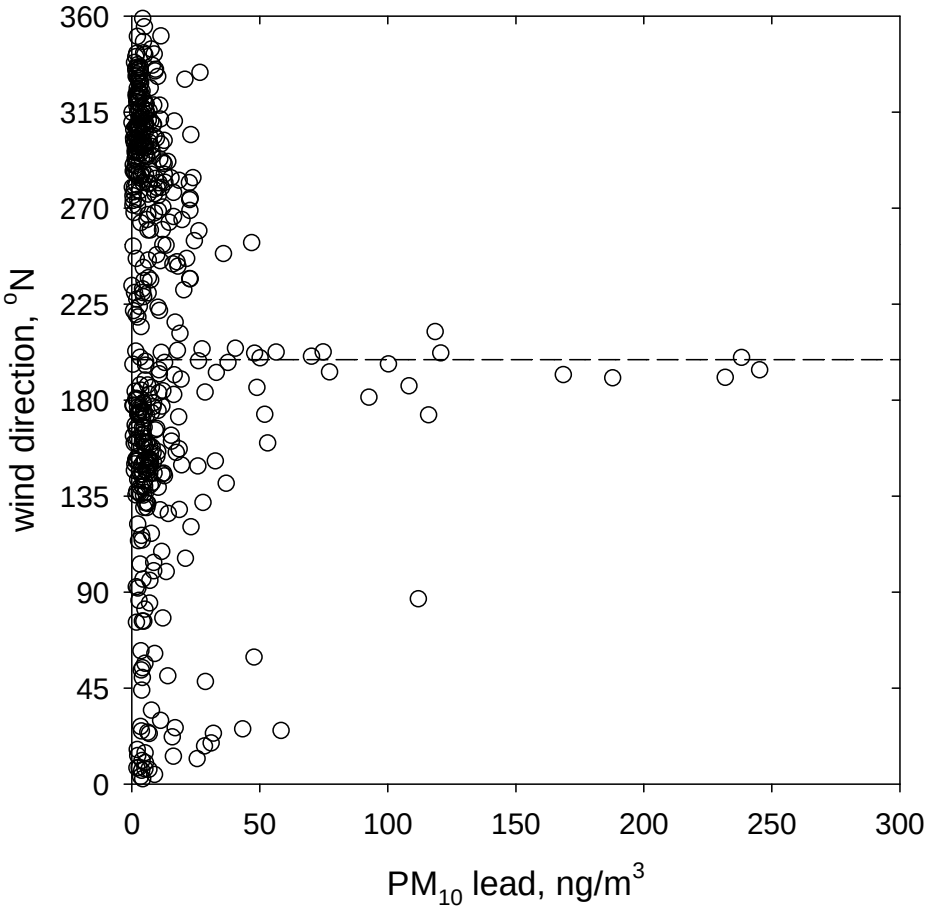


Xact Monitoring Sites

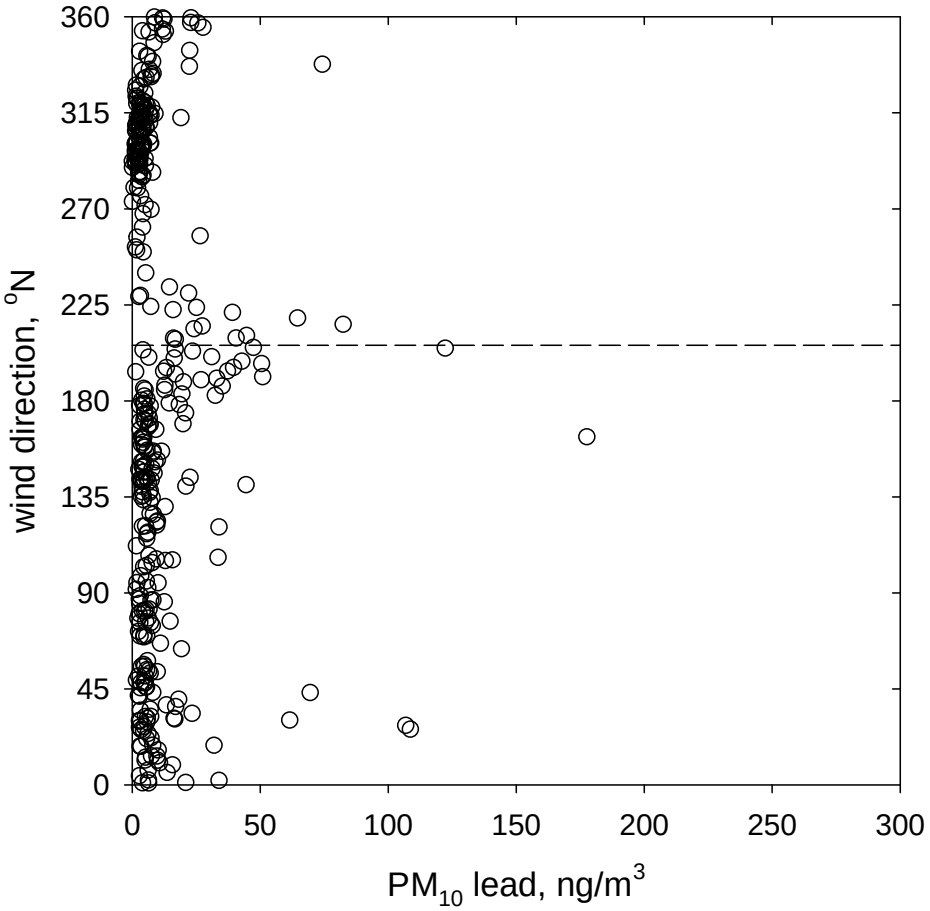


PM_{10} Lead by Xact (2-hour resolution)

BLAIR

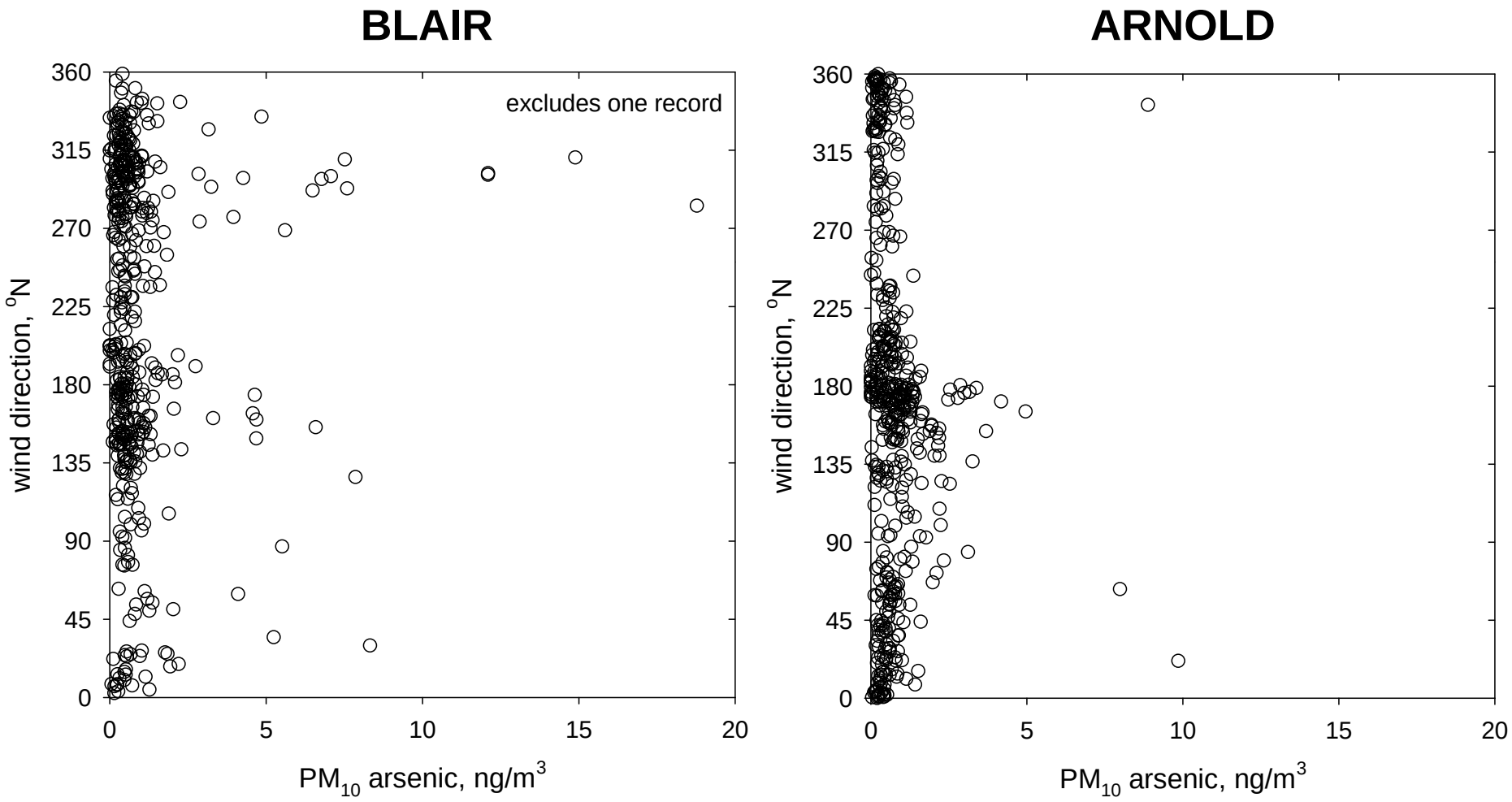


ARNOLD



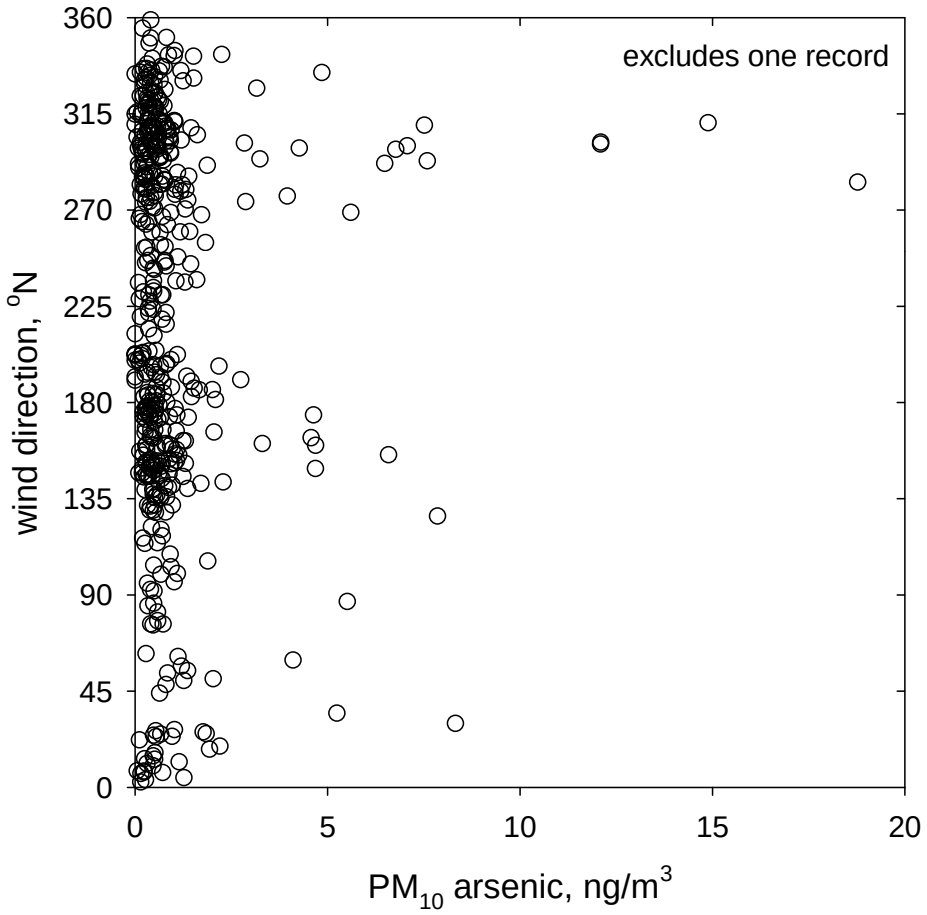
Dashed line is bearing of Doe Run – Herculaneum lead smelter

PM_{10} Arsenic by Xact (2-hour resolution)

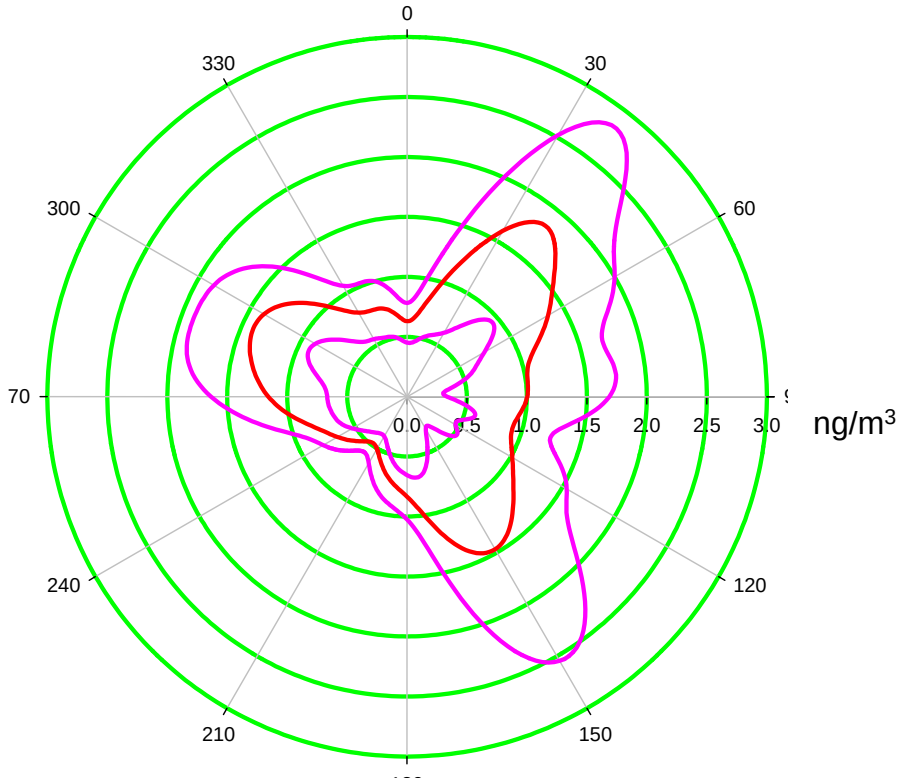


PM_{10} Arsenic at Blair by Xact (2-hour resolution)

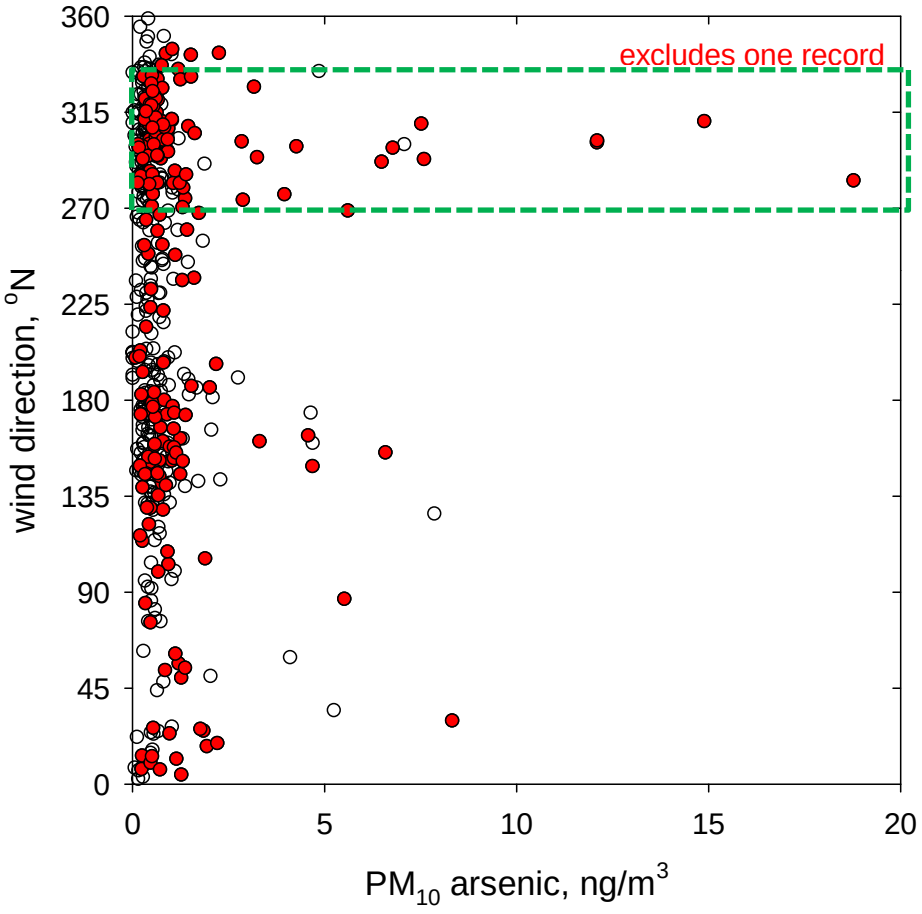
wind direction vs. concentration

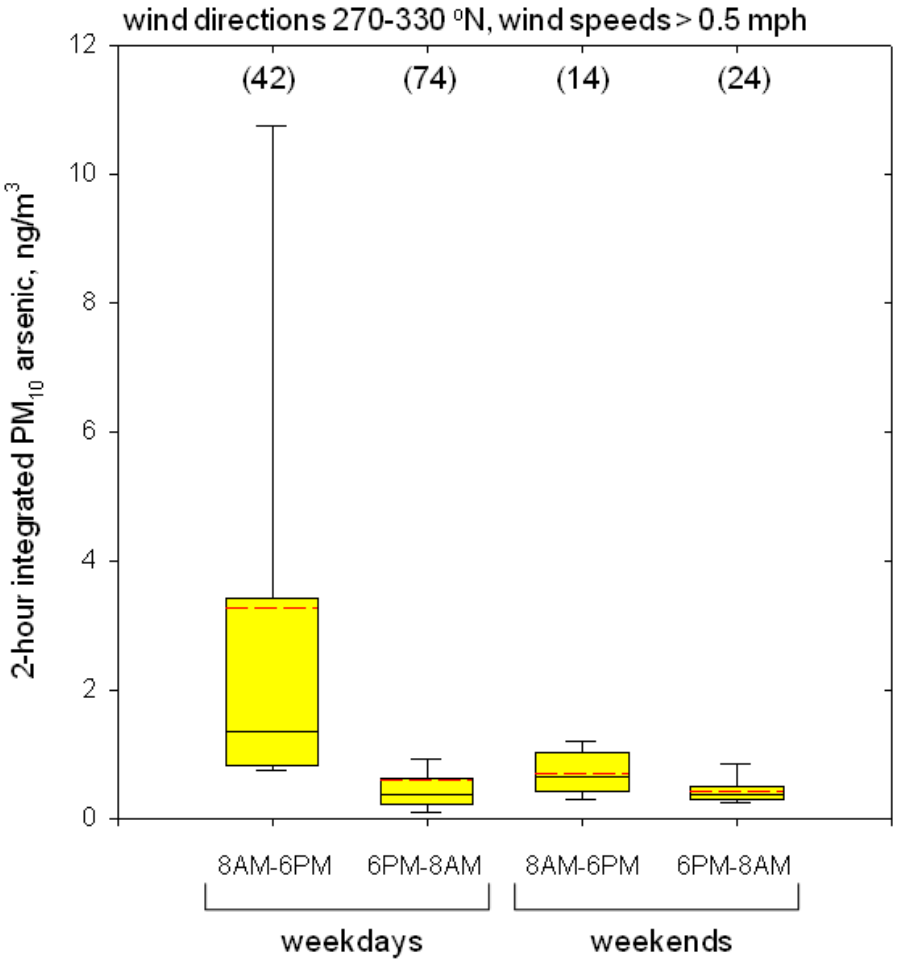


nonparametric wind regression



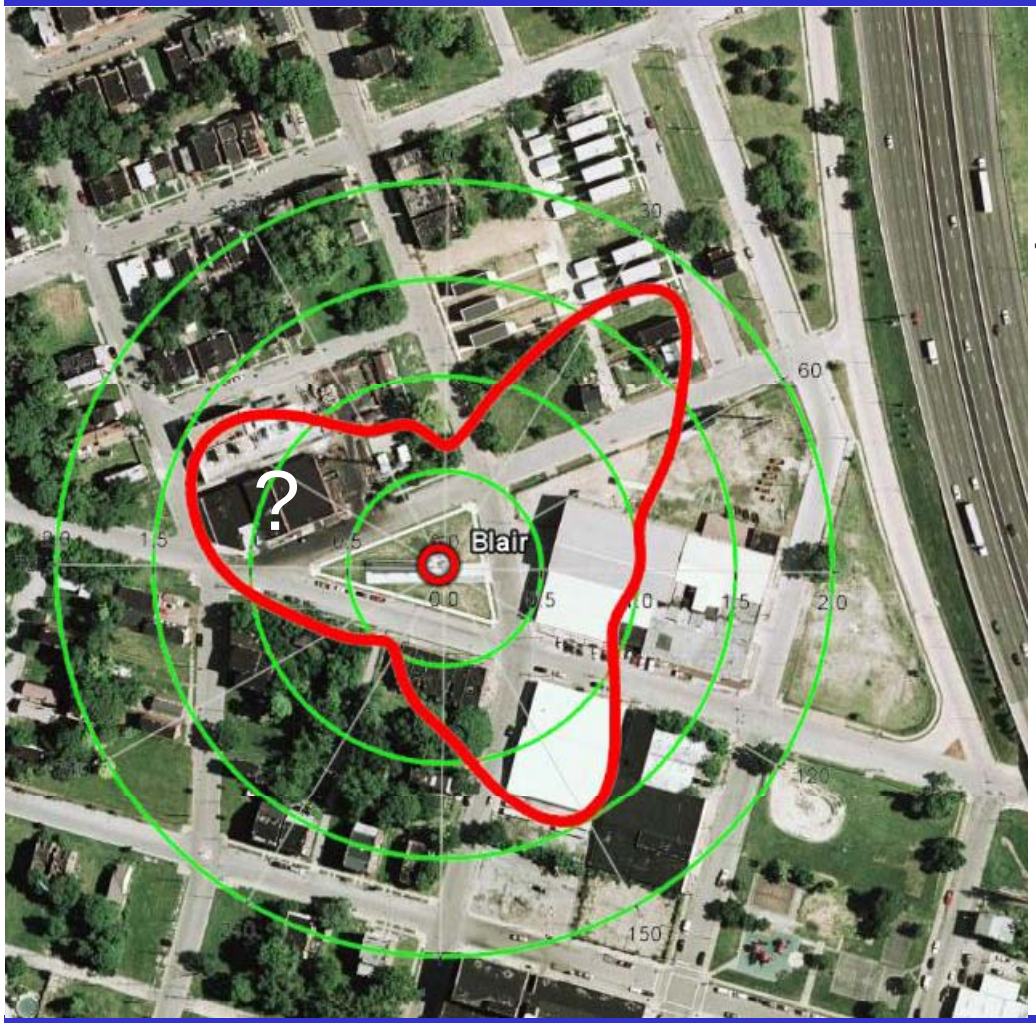
PM_{10} Arsenic at Blair for Winds from Northwest

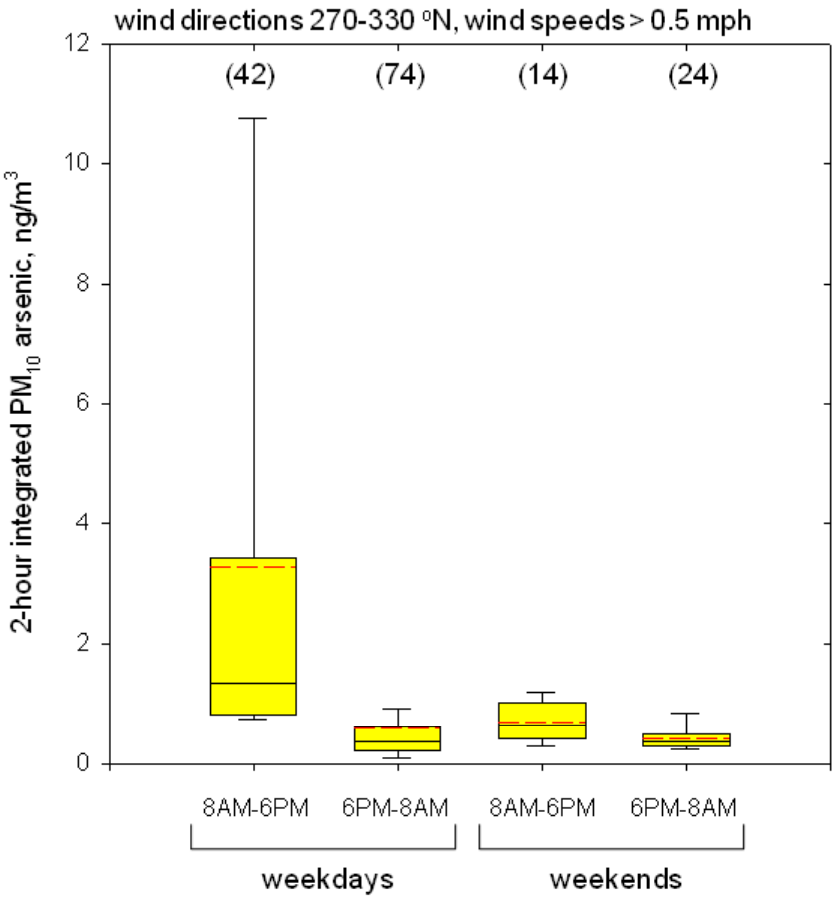




red markers = 8 AM – 6PM weekdays

PM_{10} 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 PM_{10} 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

Acknowledgements

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  - John Cooper, Krag Petterson
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