

Enhanced Monitoring of Acetaldehyde in Linn County, Iowa



**Wanda Reiter Kintz, Ph.D., Kyle Lundberg, and
Shane Dodge**

**Linn County Public Health Department
Laboratory and Air Quality Divisions
Cedar Rapids, Iowa 52405**

Project Information

- The Linn County Public Health Department (LCPHD) was awarded a two-year grant from the Environmental Protection Agency (EPA) to monitor ambient acetaldehyde concentrations in Linn County.
- Linn County ranks fourth among all counties in the United States for acetaldehyde emissions (Toxics Release Inventory – 2002).

Sources of Acetaldehyde

- Combustion of fossil fuels
- Photochemical oxidation of ozone
- Product of fermentation processes/ethanol production

Monitoring Locations

- Site A – Residential Exposure Monitoring Site (Linn County Public Health)
- Site B – Industrial Point Source Monitoring Site (Source #1)
- Site C – Industrial Point Source Monitoring Site (Source #2)
- Site D – Background Monitoring Site (City of Coggon)



Site Information

- Industrial Site (Site B – Source #1)
 - Nutritional yeast product used as a feed additive for cattle
 - Three dryers are operational (two have no thermal oxidizers)
 - 2007 acetaldehyde emissions – 94.86 tons
 - 2008 acetaldehyde emissions – 92.95 tons
 - 2009 acetaldehyde emissions – 76.37 tons

Site Information

- Industrial Site (Site C – Source #2)
 - Ethanol production
 - Current alcohol production – permitted at 332 million gallons per year
 - 2007 acetaldehyde emissions – 78.95 tons
 - 2008 acetaldehyde emissions – 3.45 tons (RTO added)
 - 2009 acetaldehyde emissions – 4.30 tons
 - New dry mill became operational in summer 2010 and was permitted at an additional 420 million gallons per year
 - Dry mill has the potential to increase acetaldehyde emissions by 28.34 tons per year

Air Sampling

- Air sampling occurred from April to November (ozone season) – 2009 and 2010
- Site A (Linn County Public Health) was the only air monitoring site during non-ozone season
- Sampling frequency
 - One out of every six days for carbonyl compounds (TO-11)
 - One out of every twelve days for volatile organic compounds (TO-15)

Air Monitoring Program

Site	Location	Method	Frequency	Duration
Site A	Linn County Public Health	TO-11	1/6 days	1 @ 24 hrs.
		TO-15	1/12 days	1 @ 24 hrs.
Site B	Industrial Site #1	TO-11	1/6 days	2 @ 12 hrs.
Site C	Industrial Site #2	TO-11	1/6 days	2 @ 12 hrs.
		TO-15	1/12 days	1 @ 12 hrs.
Site D	City of Coggon	TO-11	1/6 days	1 @ 24 hrs.

Analysis of Samples

- The State Hygienic Laboratory at the University of Iowa (SHL) is the contract laboratory for analysis
- Carbonyl cartridges were analyzed by the TO-11 compendium method using HPLC
- Canisters were analyzed by the TO-15 compendium method using GC/MS

Data Completeness

- Goal = 75% for all sites
- Linn County Public Health (Residential Site)
88.9% (TO-11), 86.1% (TO-15)
- Industrial Site #1 (Site B)
99.3% (TO-11)
- Industrial Site #2 (Site C)
100% (TO-11), 91.7% (TO-15)
- City of Coggon (Background Site)
94.4% (TO-11)

**Results from the Two-Year
Sampling Period: April 2009 –
October 2010**

Acetaldehyde Monitoring

Acetaldehyde Concentrations Site D (Coggon - Background)

- Minimum = $0.47 \mu\text{g}/\text{m}^3$
- Maximum = $3.06 \mu\text{g}/\text{m}^3$
- Range = $2.59 \mu\text{g}/\text{m}^3$
- **Average = $1.13 \mu\text{g}/\text{m}^3$**

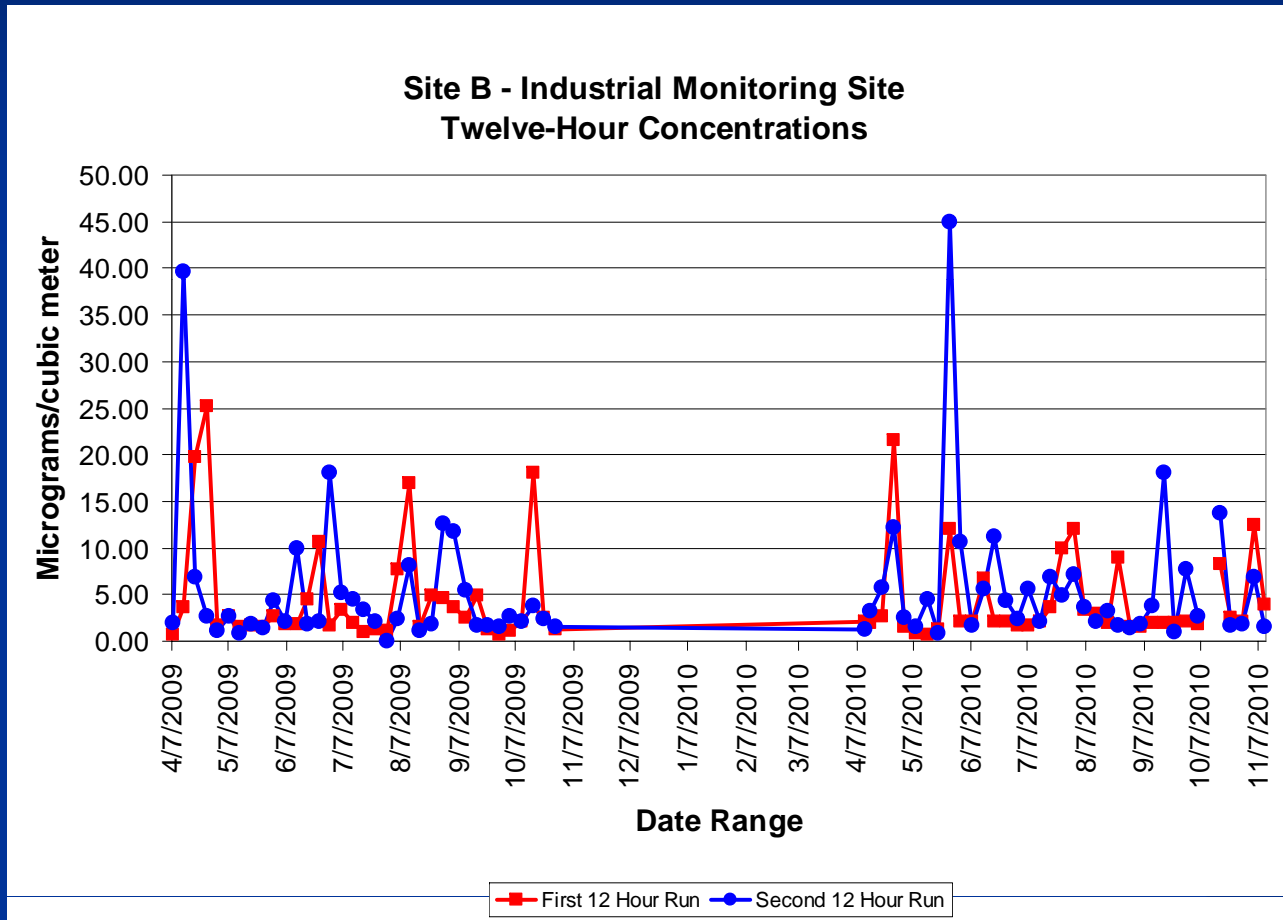
Acetaldehyde Concentrations Site A (Public Health)

- Minimum = $0.52 \mu\text{g}/\text{m}^3$
- Maximum = $4.50 \mu\text{g}/\text{m}^3$
- Range = $3.98 \mu\text{g}/\text{m}^3$
- Average = $1.70 \mu\text{g}/\text{m}^3$

Acetaldehyde Concentrations Site B (Industrial Location)

- Twenty-four hour averages
- Minimum = $1.07 \mu\text{g}/\text{m}^3$
- Maximum = $28.54 \mu\text{g}/\text{m}^3$
- Range = $27.47 \mu\text{g}/\text{m}^3$
- Average = $4.98 \mu\text{g}/\text{m}^3$

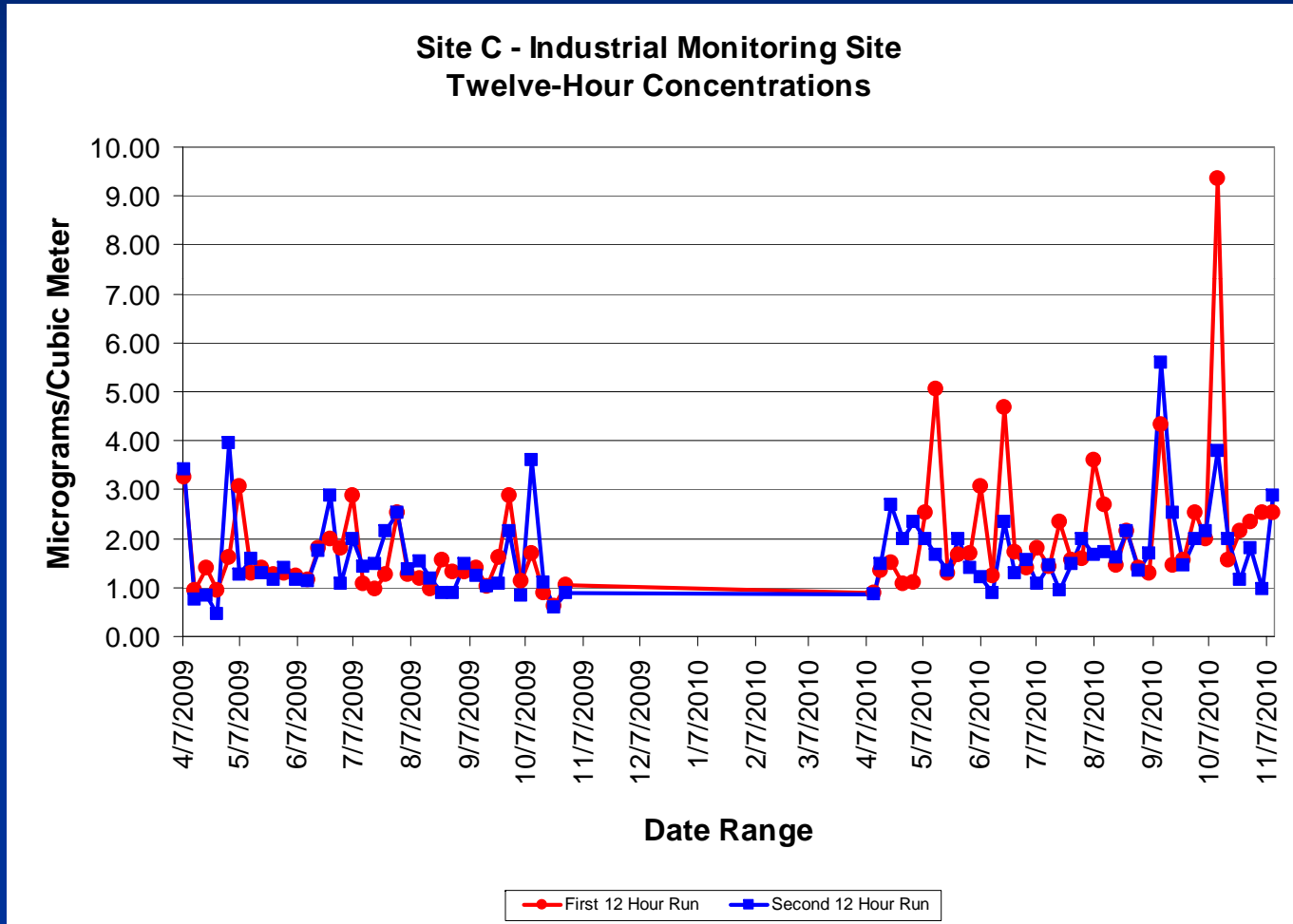
Acetaldehyde Concentration – Site B (Industrial Site #1)



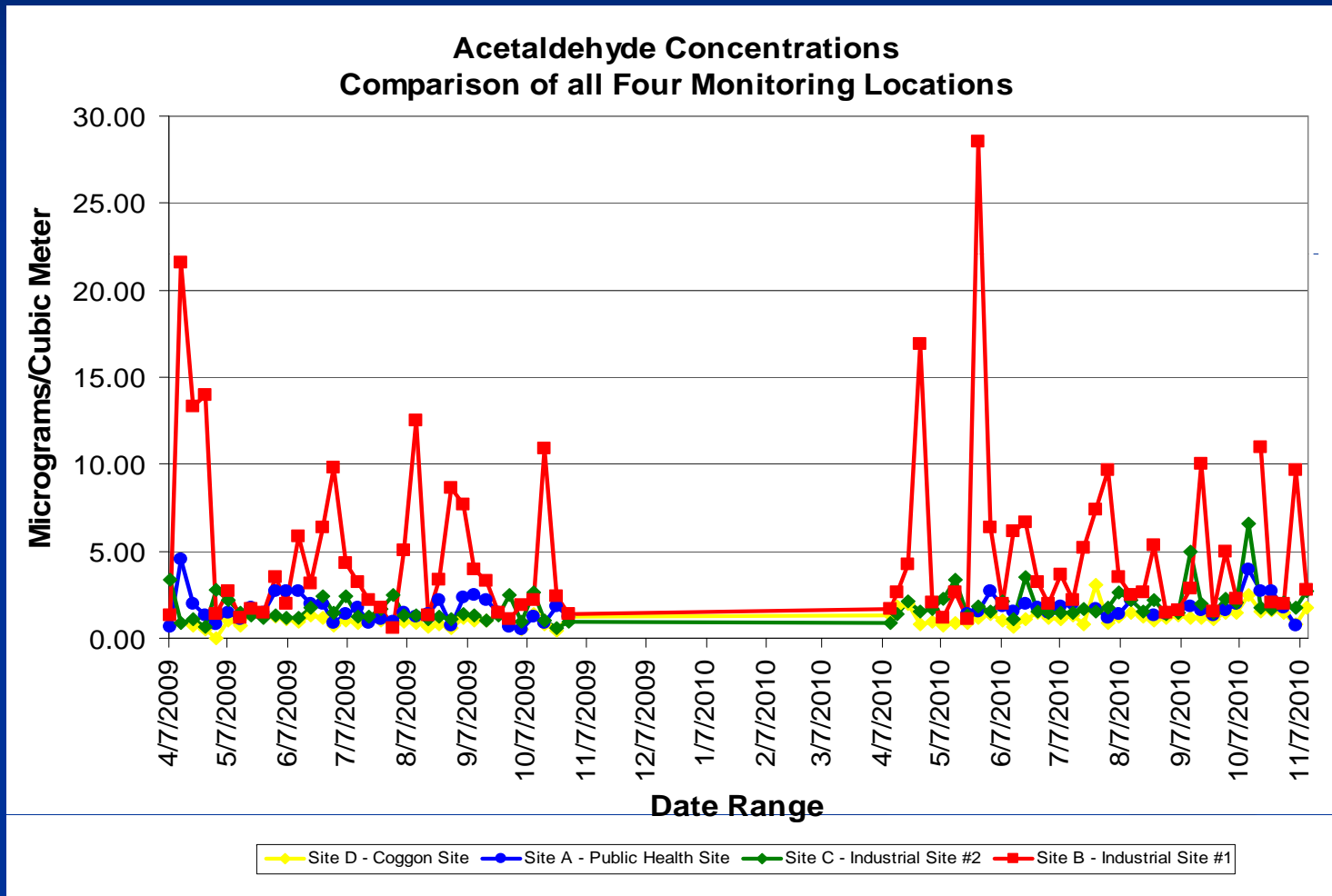
Acetaldehyde Concentrations Site C (Industrial Location)

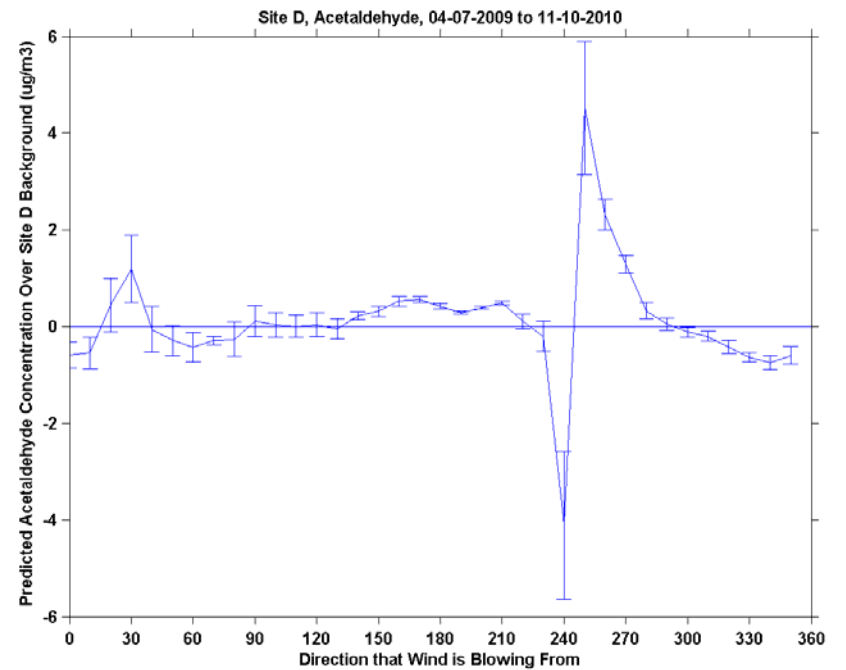
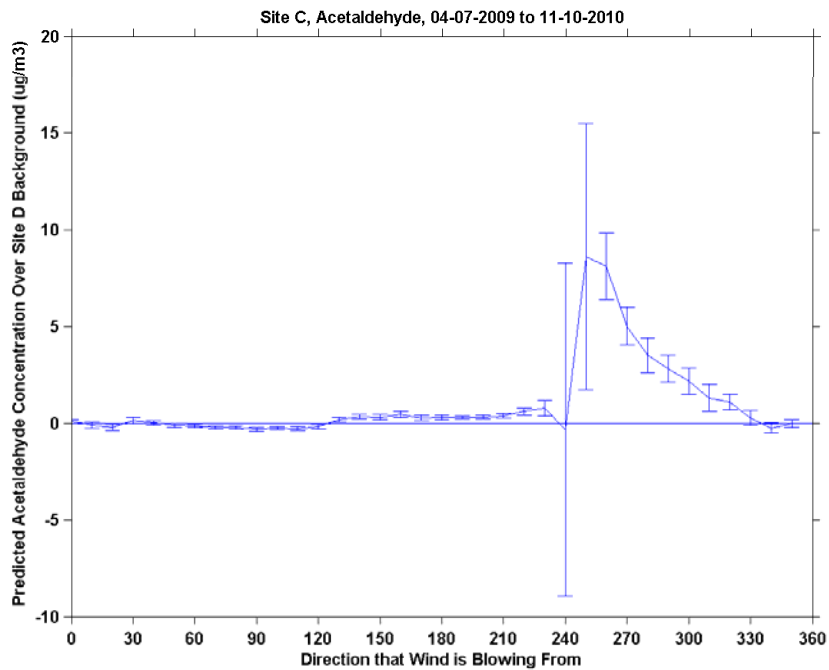
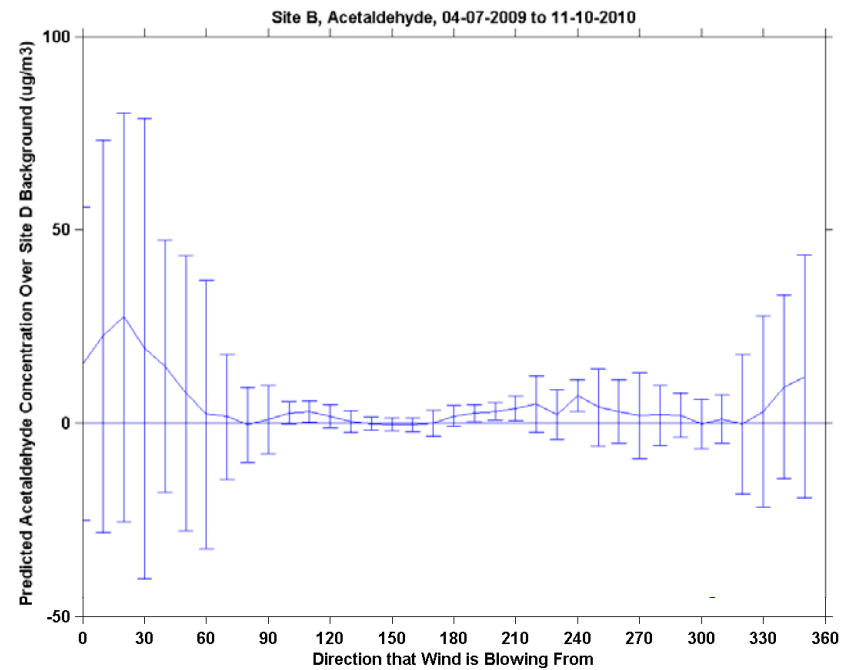
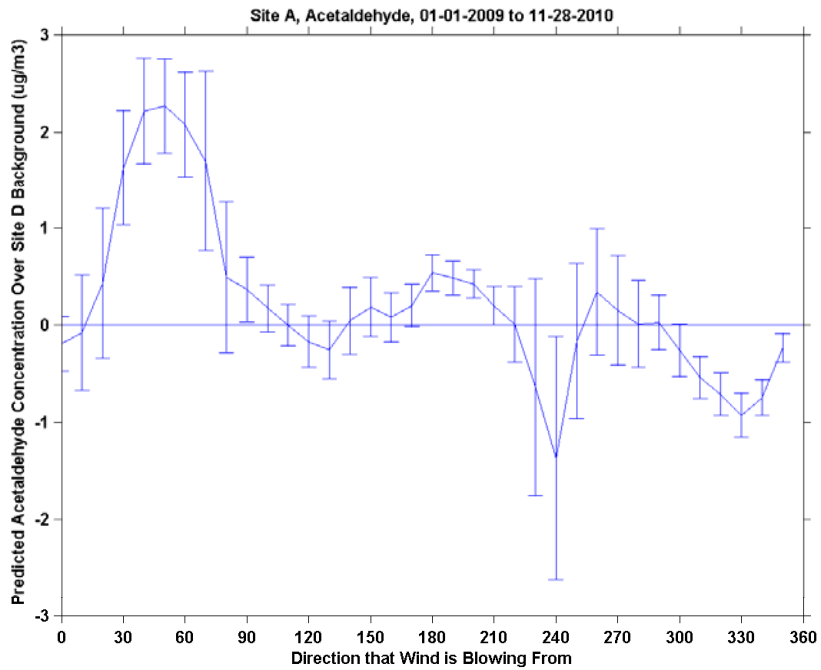
- Twenty-four hour averages
- Minimum = $0.60 \mu\text{g}/\text{m}^3$
- Maximum = $6.57 \mu\text{g}/\text{m}^3$
- Range = $5.97 \mu\text{g}/\text{m}^3$
- Average = $1.80 \mu\text{g}/\text{m}^3$

Acetaldehyde Concentration – Site C (Industrial Site #2)

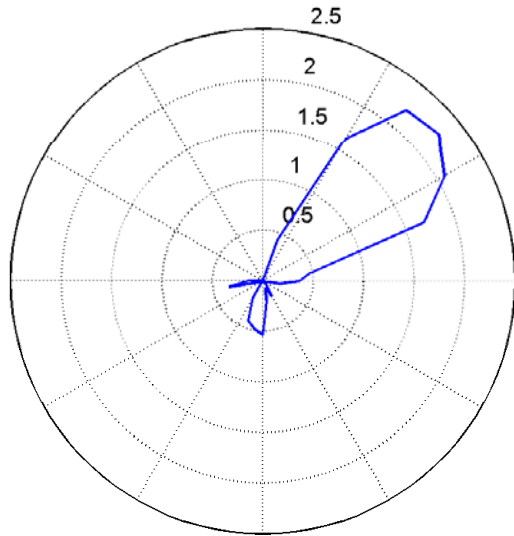


Comparison of Acetaldehyde Levels - Four Sites

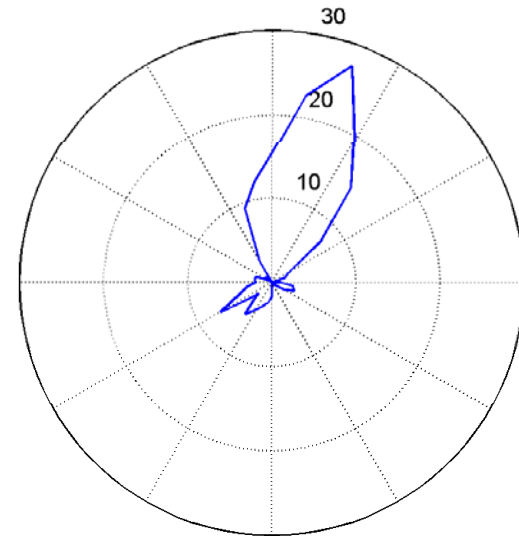




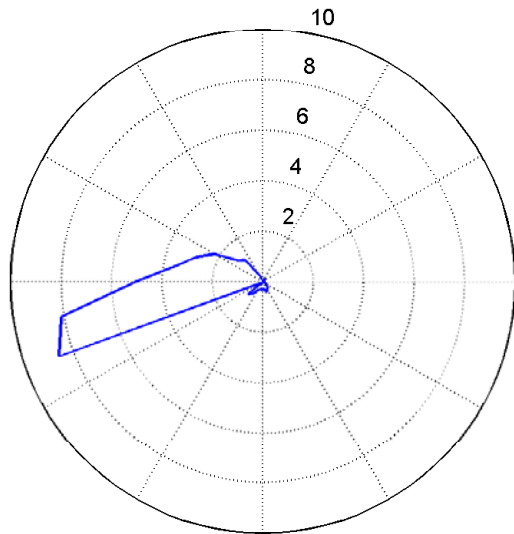
Directionality of Acetaldehyde at Site A, 01-01-2009 to 11-28-2010



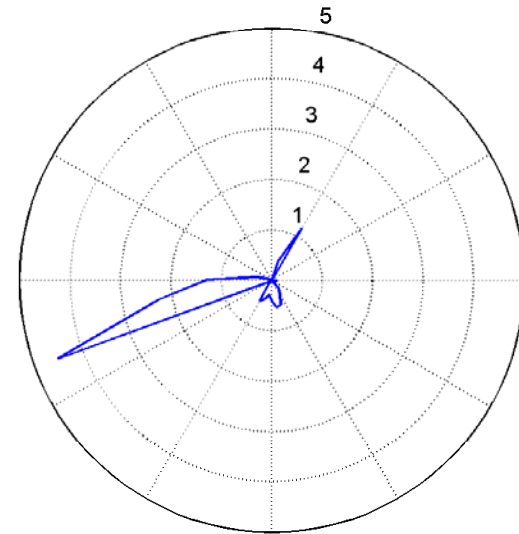
Directionality of Acetaldehyde at Site B, 04-07-2009 to 11-10-2010

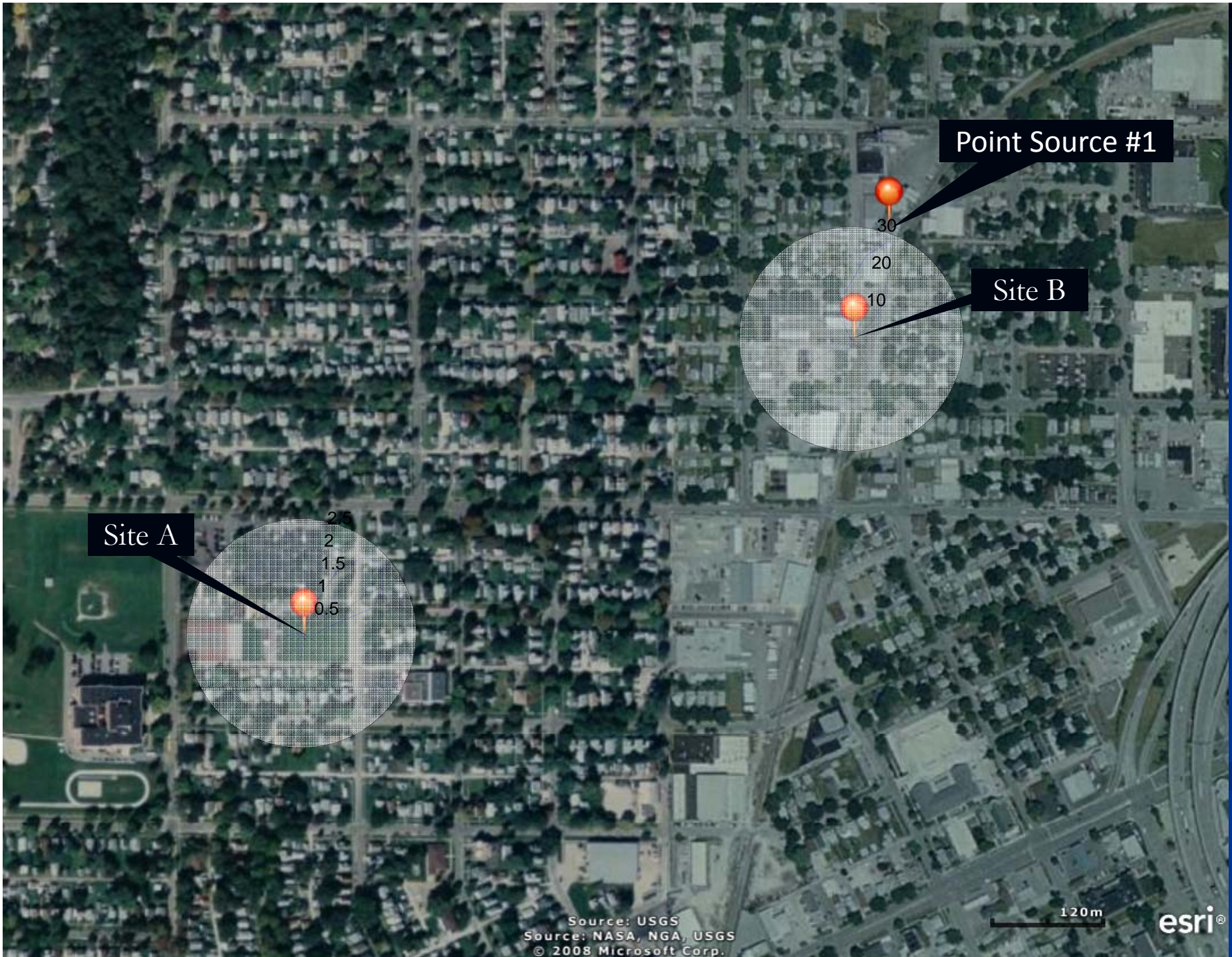


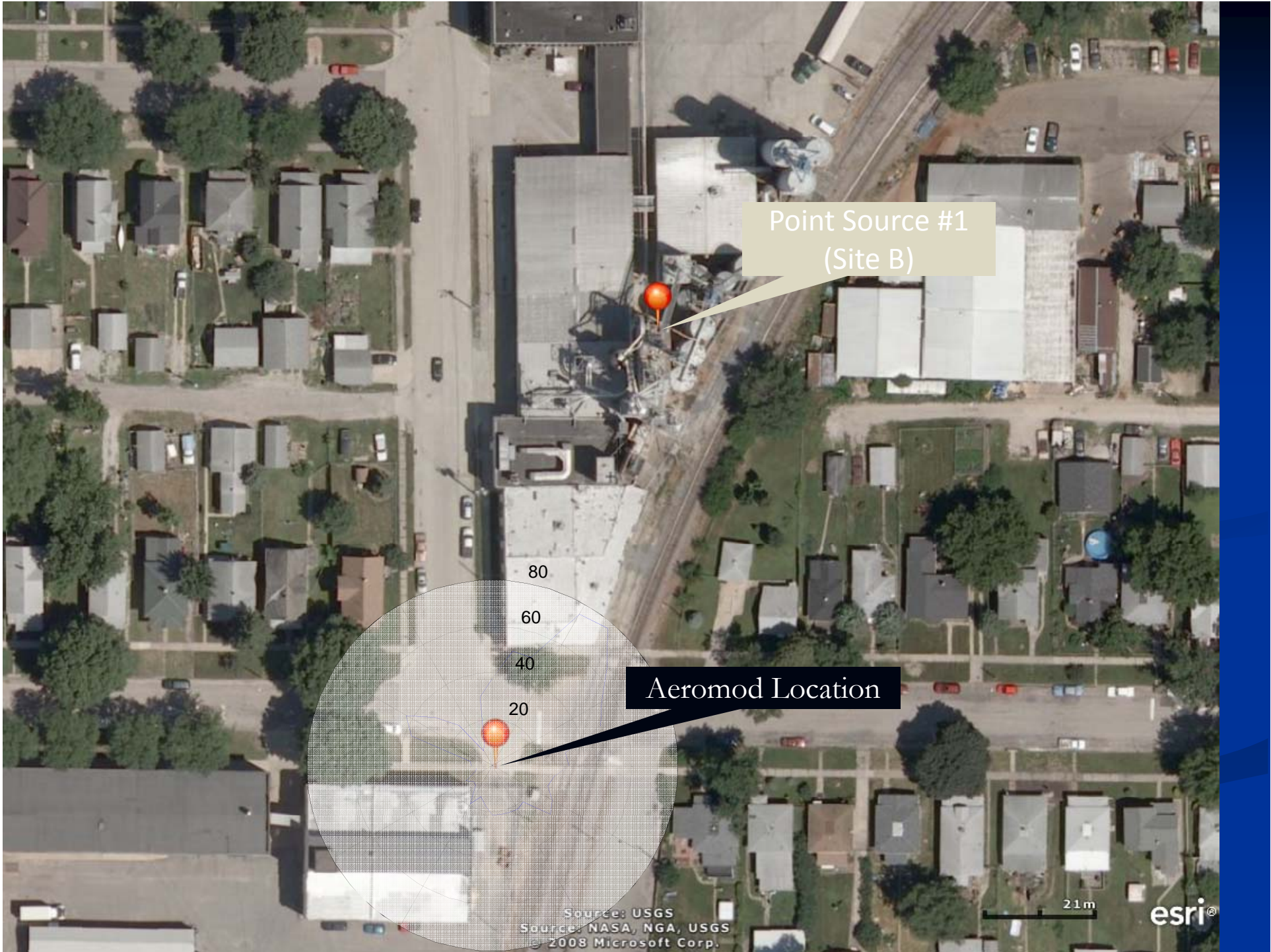
Directionality of Acetaldehyde at Site C, 04-07-2009 to 11-10-2010



Directionality of Acetaldehyde at Site D, 04-07-2009 to 11-10-2010







Point Source #1
(Site B)

Aeromod Location

Source: USGS
Source: NASA, NGA, USGS
© 2008 Microsoft Corp.

21m

esri®

Health Effects of Acetaldehyde Exposure

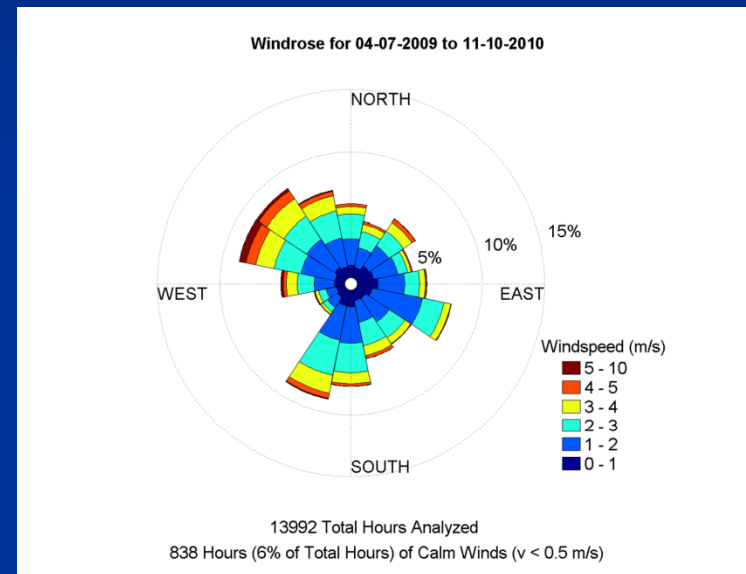
- Carcinogenic Risk (Inhalation Exposure)
 - 1 in 10,000 – 50 $\mu\text{g}/\text{m}^3$
 - 1 in 100,000 – 5 $\mu\text{g}/\text{m}^3$
 - 1 in 1,000,000 – 0.5 $\mu\text{g}/\text{m}^3$
- Source – EPA Integrated Risk Information System (IRIS)

Conclusions

- Preliminary results show elevated levels of acetaldehyde at the first industrial site (4.5 times higher than background levels)
- There is a strong correlation with acetaldehyde concentration and wind direction

Future Work

- Continued sampling at the industrial sites
 - Year-round monitoring
 - One in three day sampling during ozone season
 - Better placement of monitoring trailers based upon wind direction
- Emission reduction is currently being negotiated with Source #1 to decrease ambient levels of acetaldehyde concentrations within the impacted area



Acknowledgments

- Environmental Protection Agency
- Dr. Mark Young – University of Iowa Department of Chemistry
- Brian Meland (Graduate Student) – University of Iowa Department of Physics
- Dr. Charles Stanier – University of Iowa Department of Chemical and Biochemical Engineering
- Mr. Curtis Dickson, Director (LCPH)
- Tony Daugherty and Amy Drahos, Air Quality Division (LCPH)