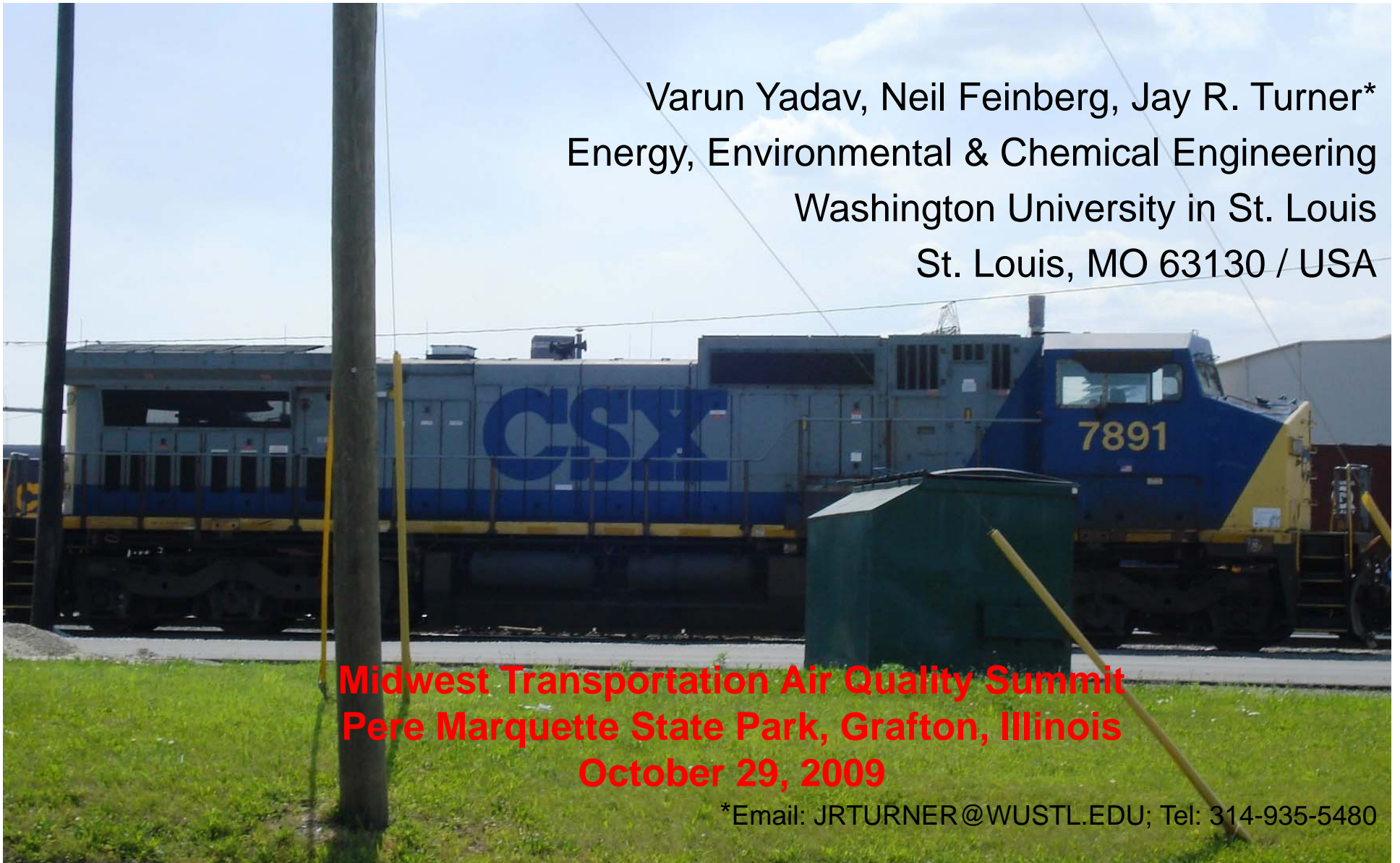


The Midwest Rail Study (Phase I)

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**Midwest Transportation Air Quality Summit
Pere Marquette State Park, Grafton, Illinois
October 29, 2009**

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Project Motivation and Objectives

- Large rail yards often located in vicinity of monitors violating particulate matter NAAQS
 - Characterize and quantify PM emissions from rail yard activities
- Funded as a USEPA Region V RARE project
 - LADCO project management
 - Michigan DEQ air quality monitoring (special study)
 - Sierra Research emission inventory development
 - Wash. Univ. data analysis and dispersion modeling

Project Overview and Timeline

- Focus on **CSX Rougemere Yard**, Dearborn, MI
- Field measurement campaign
 - September 2008 to January 2009
 - Semicontinuous measurement of PM carbon at three sites, September to December
 - Instrument collocation study, December to January
- Emission inventory – delivered by Sierra Research, June 2009
- Data analysis and dispersion modeling completed
 - **Draft final report submitted to LADCO, October 2009**

Emissions Inventory

- Developed by Sierra Research, Inc.
- CSX Rougemere Yard, Dearborn
- Period January 2007 to December 2008
- Emission estimates for THC, CO, NO_x, PM_{2.5}, SO_x
- Date-specific emission rates (lb/day)
 - Further temporal allocation by hour-of-day profiles
 - Spatial allocation by rail yard activities maps

Emission Categories

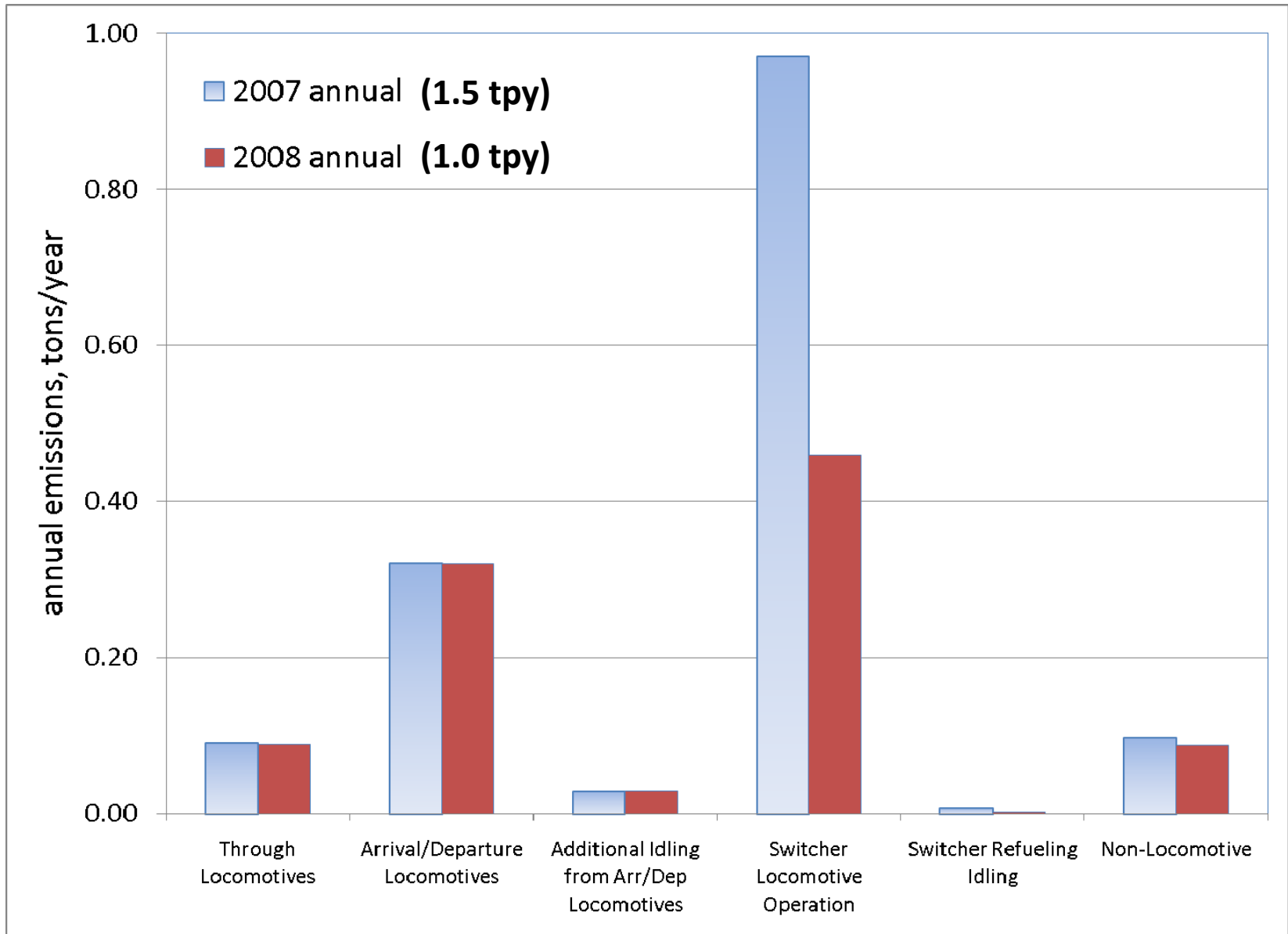
Locomotives

- Through Locomotives
- Arrival/Departure Locomotives
- Additional Idling from Arrival/Departure Locomotives
- Switcher Locomotive Operation
- Switcher Refueling Idling

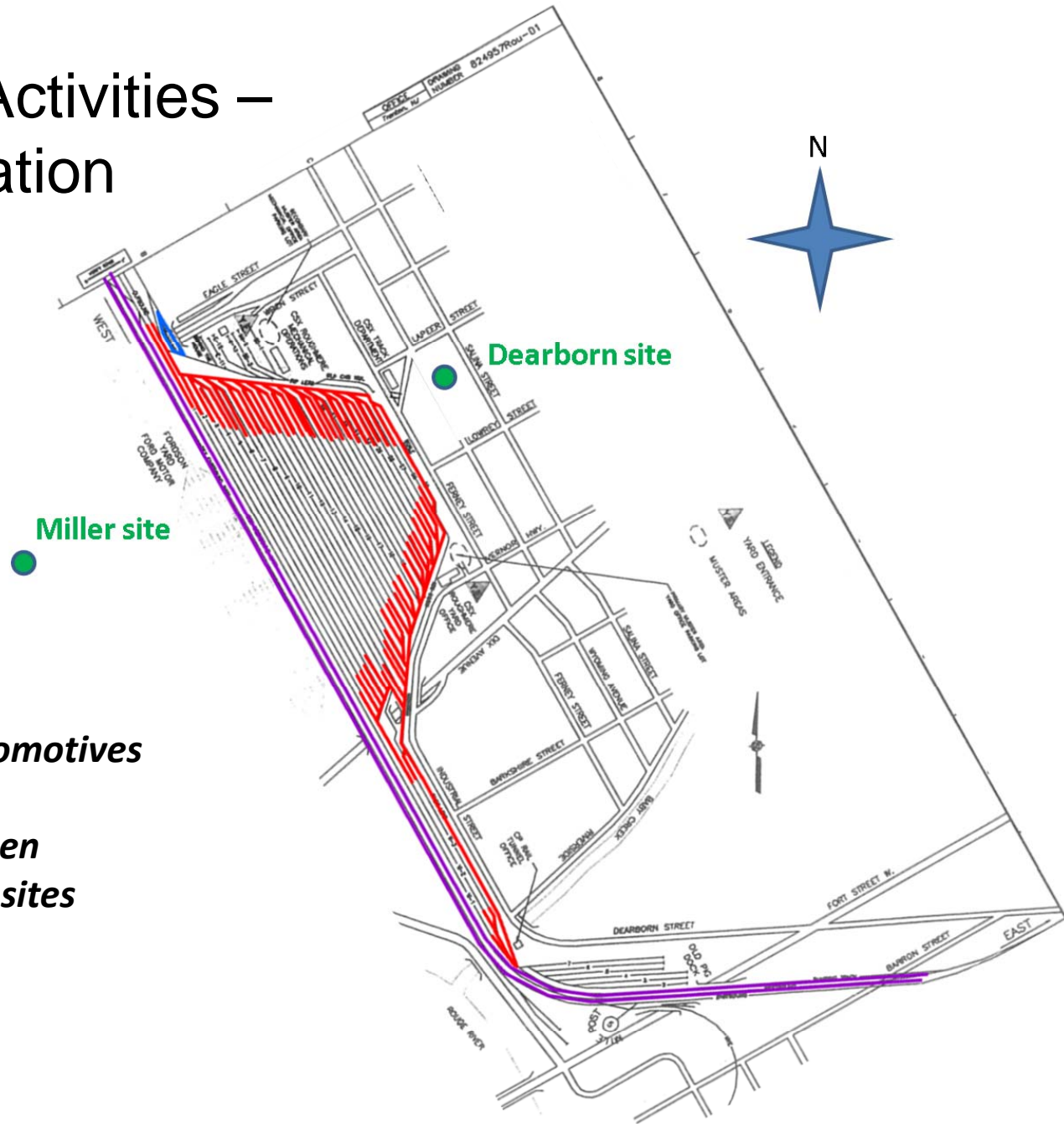
Non-Locomotives

- Worker Vehicle Exhaust
- Worker Vehicle Evaporative
- HDDT Delivery
- HDDT Delivery Idle
- Facility Truck Facility Truck Idle
- Space Heating
- Water Heating
- LPG - Welders/Cutters
- Diesel - Specialty Vehicle Carts
- Diesel - Rubber Tire Loaders
- Diesel - Forklifts
- Diesel - Other General Industrial Equipment
- Diesel - Snowblowers
- Aerosol Paints

PM_{2.5} Annual Emissions



Locomotive Activities – Spatial Allocation



Red = switchers

Purple = through locomotives

**Approx. 400m between
Dearborn and Miller sites**

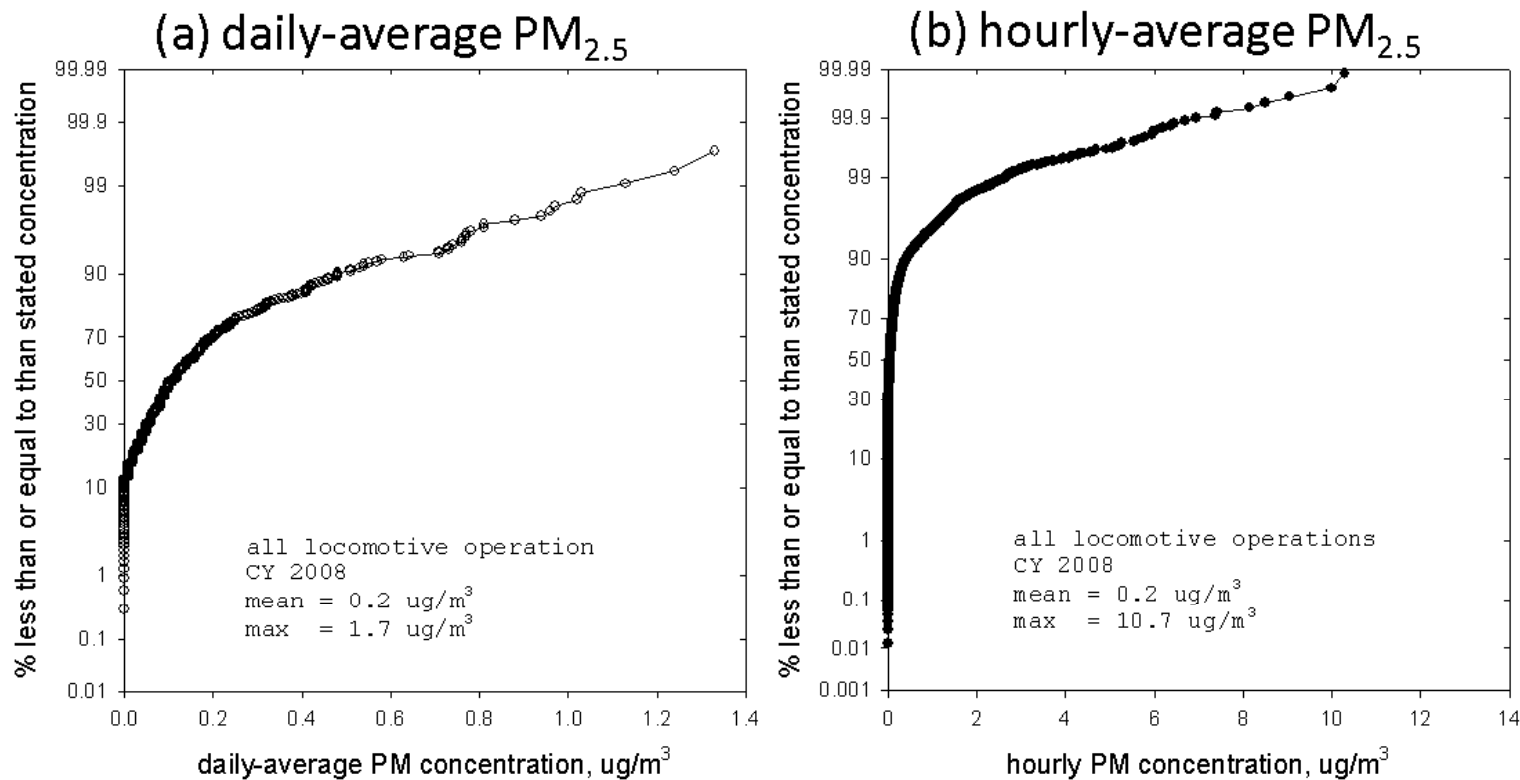
Dispersion Modeling

- AERMOD
- Model locomotive activities only
- Model each track segment as an area source
- Surface winds for DTW airport (Jim Haywood/MDEQ)
- Model each hour of the day from 1/1/2007 to 12/31/2008
- **BASE CASE**
 - Locomotive activity emissions homogeneously distributed over the activity zones defined by Sierra (previous map)
- Additional Scenarios...
 - Weight *Switcher Locomotives* to tracks where they tend to park between tasks
 - Weight *Arrival/Departure Locomotives* to area near Yard Office

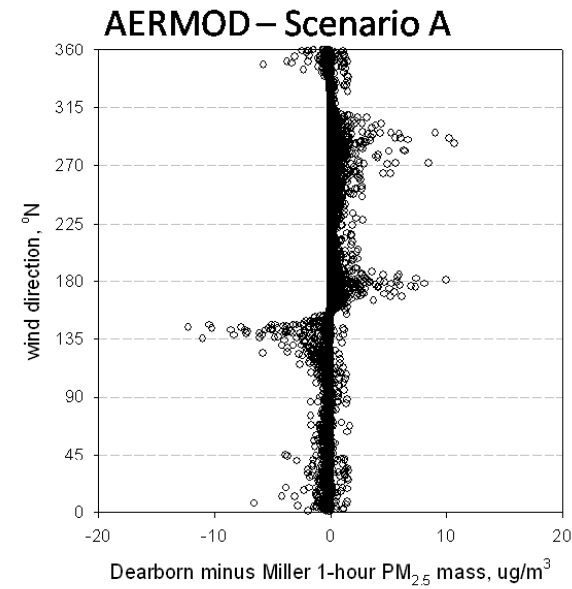
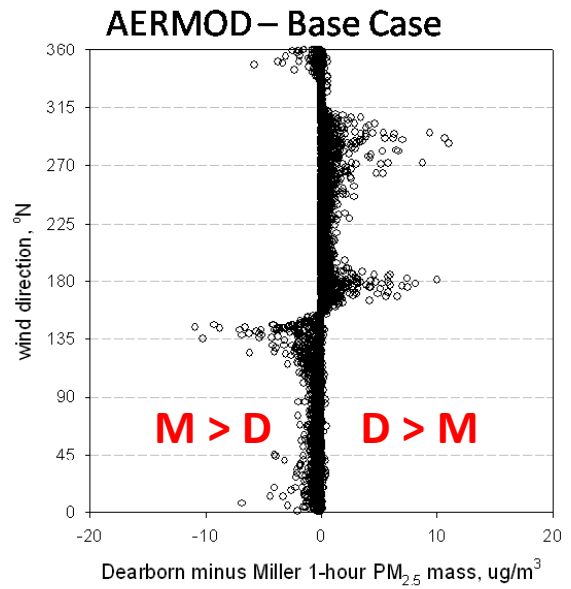
Dispersion Modeling Results

- Annual average PM_{2.5} mass @ Dearborn station:
 - 2007: 0.45 $\mu\text{g}/\text{m}^3$
 - **2008: 0.21 $\mu\text{g}/\text{m}^3$**
 - Excludes calm hours (11% in 2007, 9% in 2008)
 - Overwhelmingly from switcher locomotive operation

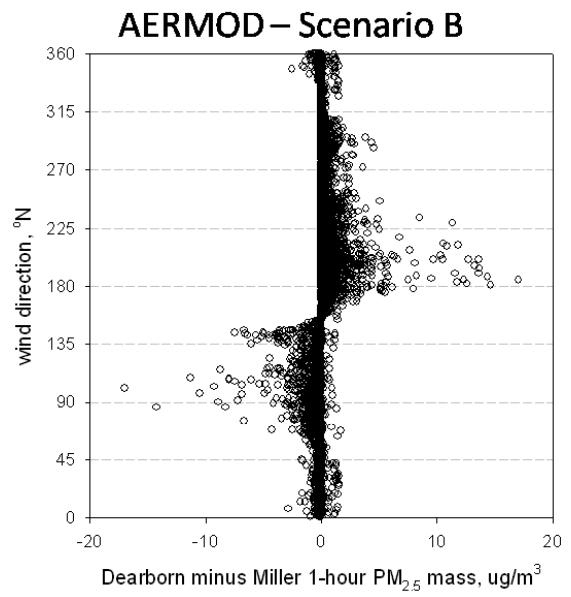
Year
2008



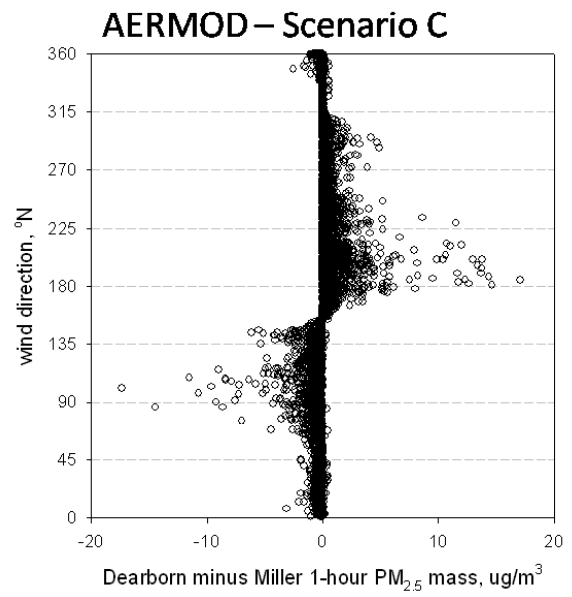
Year 2008 Hourly Impacts at Dearborn and Miller Stations



Arrival/departure locomotives weighted towards Yard Office



Switcher locomotives weighted towards outside (eastern) edge of track ladder

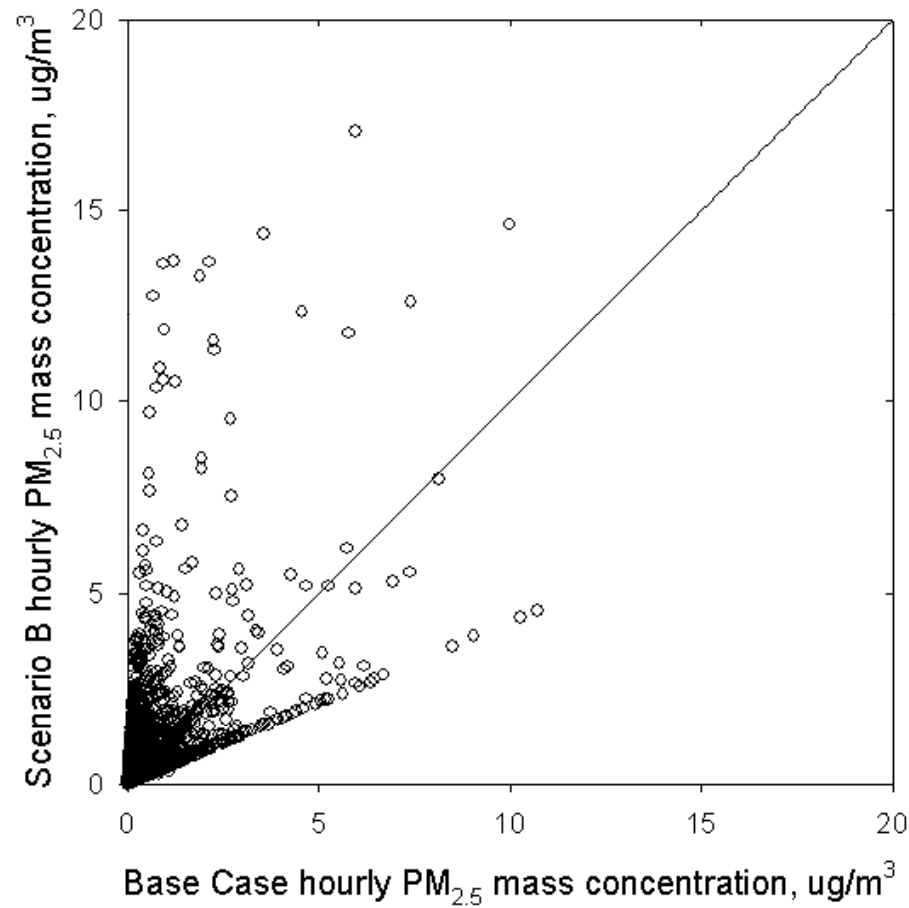


Arrival/departure locomotives weighted towards Yard Office

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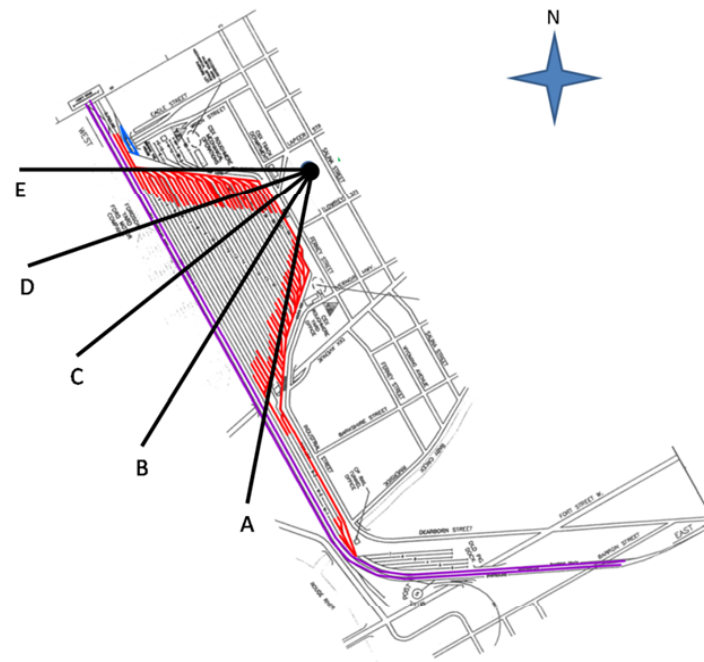
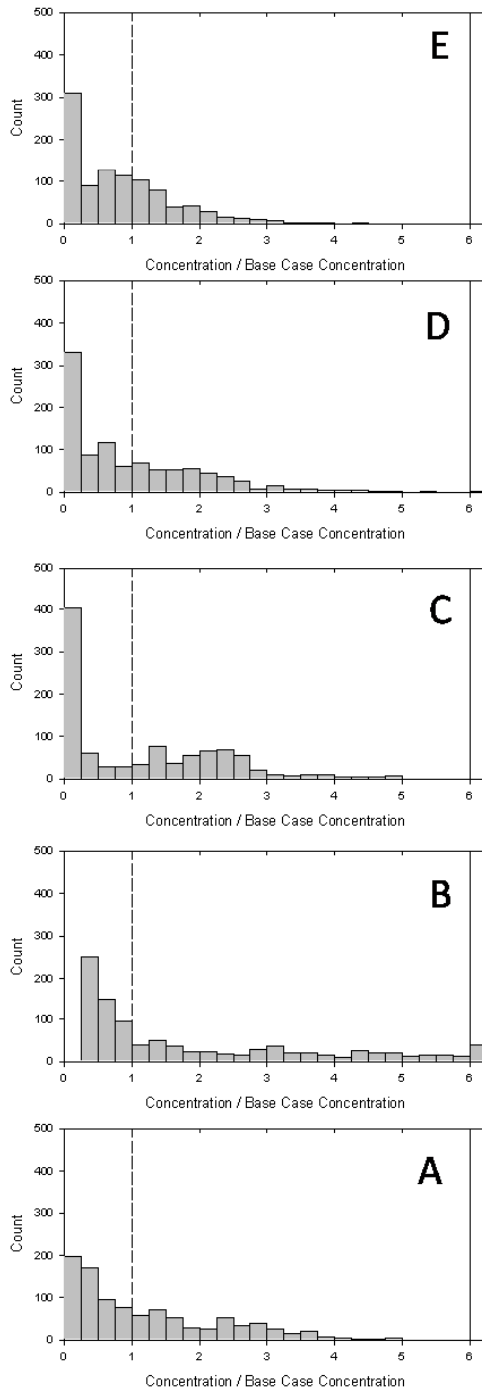
Year 2008 Modeled Hourly Impacts at Dearborn Station: Sensitivity to Spatial Allocation of Switcher Activities

Switcher locomotives
weighted towards
outside (eastern) edge
of track ladder



Switcher locomotives
uniformly distributed
across activity zones
defined by Sierra

Monte Carlo Simulations: Spatial Allocation of Switcher Activities



- random allocation of switcher activities to four locations within red zones
- calculate modeled concentration at Dearborn, repeat 100 times to get distribution of impacts
- examples shown for five hours with noted wind directions from southwest through west (1000 simulations in these cases)
- ***x axis*** is modeled concentration scaled to base case concentration; ***y axis*** is counts (# of hours)

Field Campaign

Hourly OC, EC and BC at three sites for three months

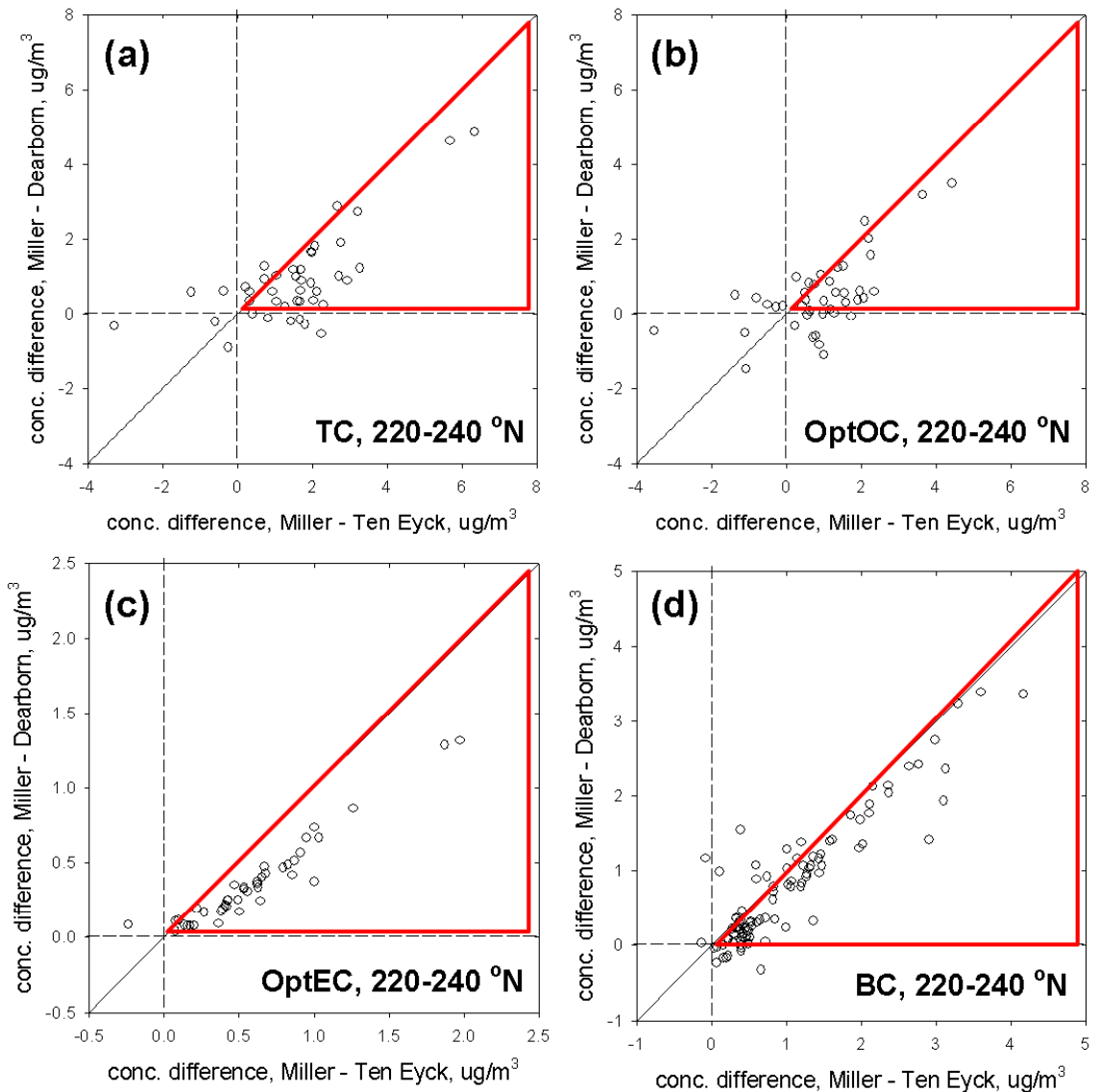


Upwind/Downwind Measurements Across the Rail Yard

Winds rarely from the
northeast during the study

For winds from southwest,
higher concentrations
upwind of the rail yard
than downwind of the rail
yard

Dearborn station winds



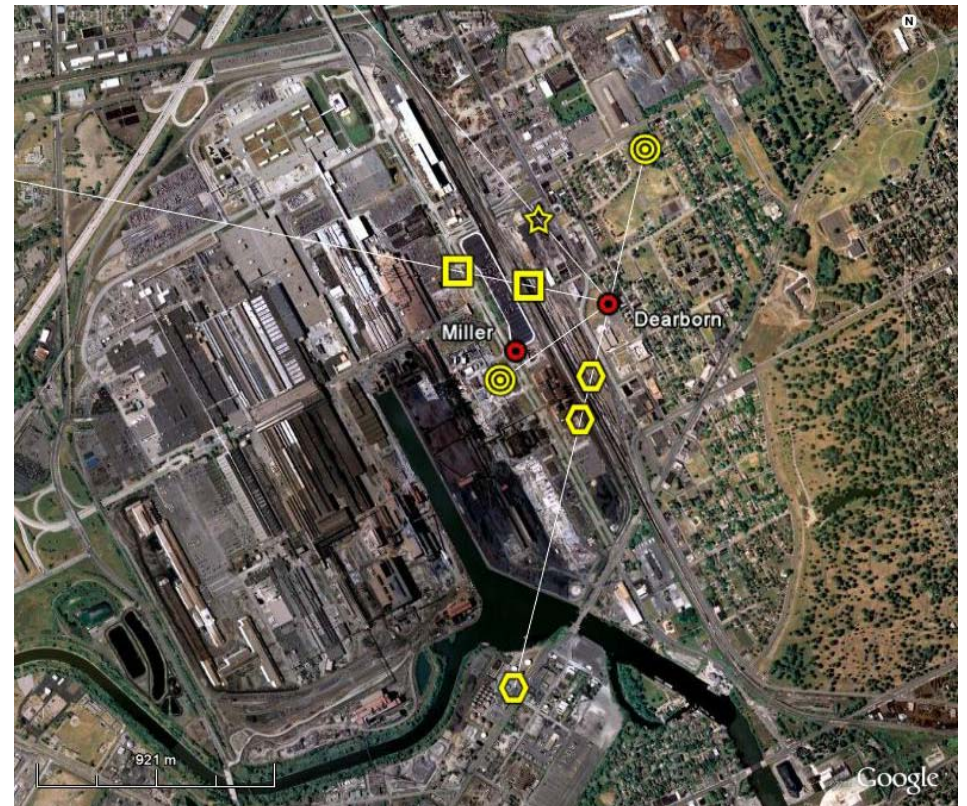
Triangulation of Pollution roses to Obtain Putative Emission Source Locations

(more sources located off the maps)



Organic Carbon (OC)

Elemental Carbon (EC)



Dispersion Modeling Summary and Status

CSX Rougemere rail yard PM_{2.5} emissions study

- Year 2008 modeled impact at Dearborn station is 0.2 $\mu\text{g}/\text{m}^3$
- Annual-average results are resistant to spatial allocation of locomotive activities
- Hourly-average results very sensitive to spatial allocation of locomotive activities
 - Complicates comparisons to field observations
- Numerous other local carbonaceous PM emission sources confounds measuring rail yard impacts

Future Work (beyond the project deliverable)

- This analysis used DTW winds; repeat using winds measured at Dearborn station and Severstal (nearby steelworks)
- Generating annual-average concentration field around rail yard

Acknowledgements

USEPA Region V

- Loretta Lehrman, Monica Paguia

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Amy Robinson

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- Jeremy Heiken, Jim Lyons