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Atlanta Rail Yard Study: Evaluation of local-scale air pollution trends using stationary and mobile monitoring

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Purpose of this talk

- Provide an overview of research field measurements to evaluate multipollutant air pollution trends near a major rail yard in Atlanta, GA

Background

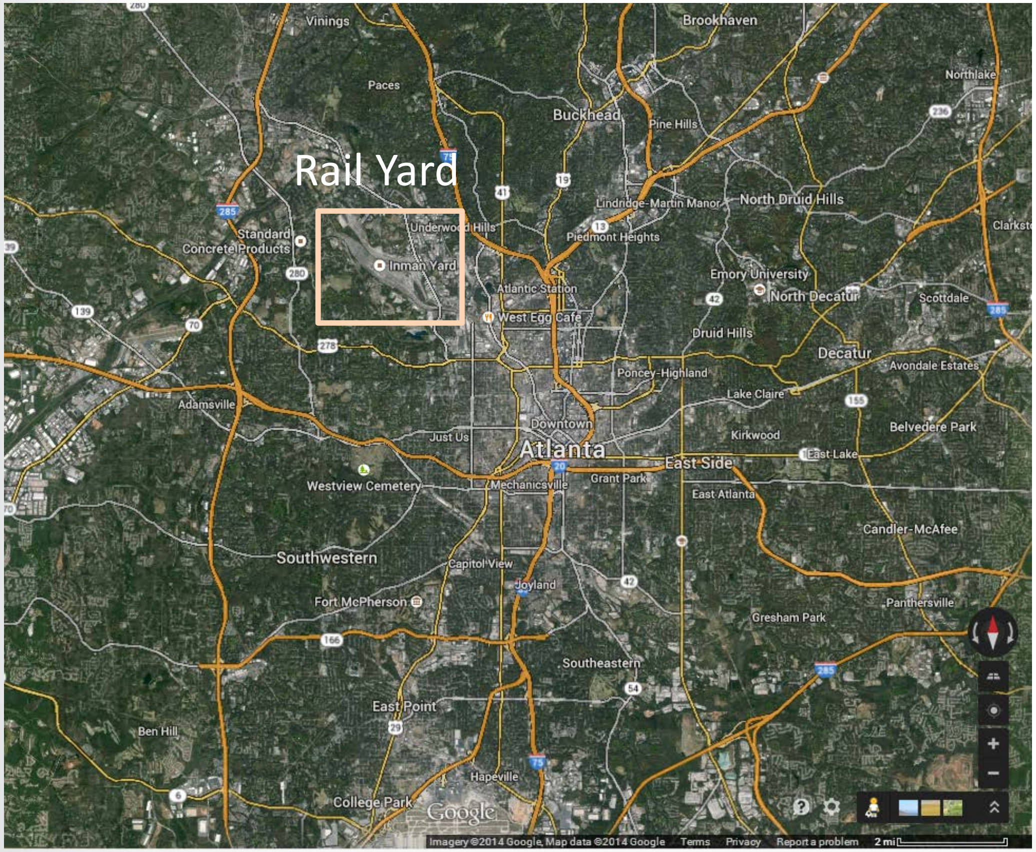
- Air pollution in close proximity to rail yards is not well understood and a challenging issue to study
  - Significant variety of rail yards - size, operations, surrounding environment, local meteorology
  - Emissions vary spatially and temporally, over large geographic area
  - Confounding sources often nearby – highways, manufacturing

- Some large rail yards are in very close proximity to residential areas; environmental justice concerns

- Several recent studies to note:
  - CSX Rougemere Rail Yard in Dearborn, MI – Turner, 2009
  - Davis Rail Yard in Roseville, CA – Cahill et al., 2011; Campbell, 2009
  - Cicero Rail Yard Study in Cicero, IL – Rizzo et al., 2014

Atlanta Rail Yard Study (ARYS)

- CSX and Norfolk Southern co-located rail yards, Tilford and Inman Yards, are in a non-attainment or maintenance area for $PM_{2.5}$



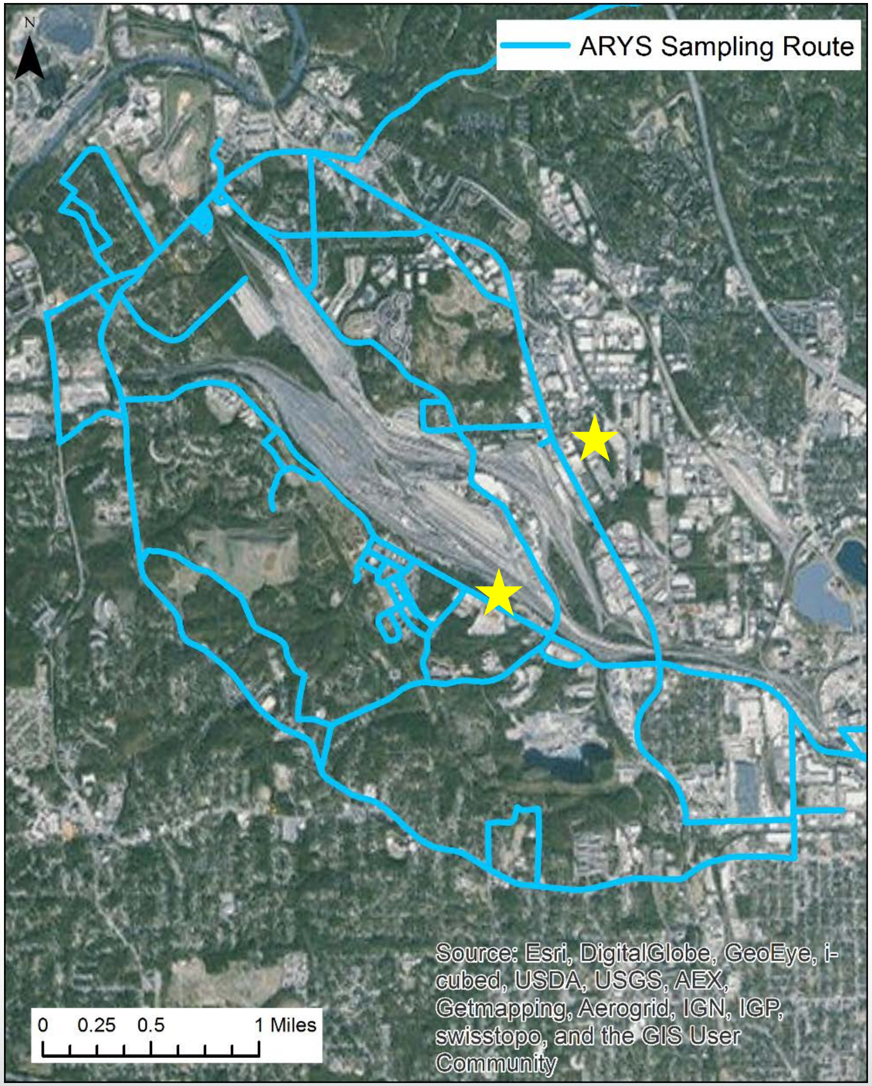
- State of GA received \$44.9M in CMAQ and HPP* funding to support low-emission switch-duty locomotives in Georgia (\$36M for Atlanta area rail yards, remainder for Macon and Rome)

- CMAQ funding also supported local monitoring upwind and downwind by Georgia Tech (Galvis, 2013)

*Middle Georgia Clean Air Coalition for Congestion Mitigation and Air Quality Improvement High Priority Projects (HPP)

Field study

- Monitoring near rail yard

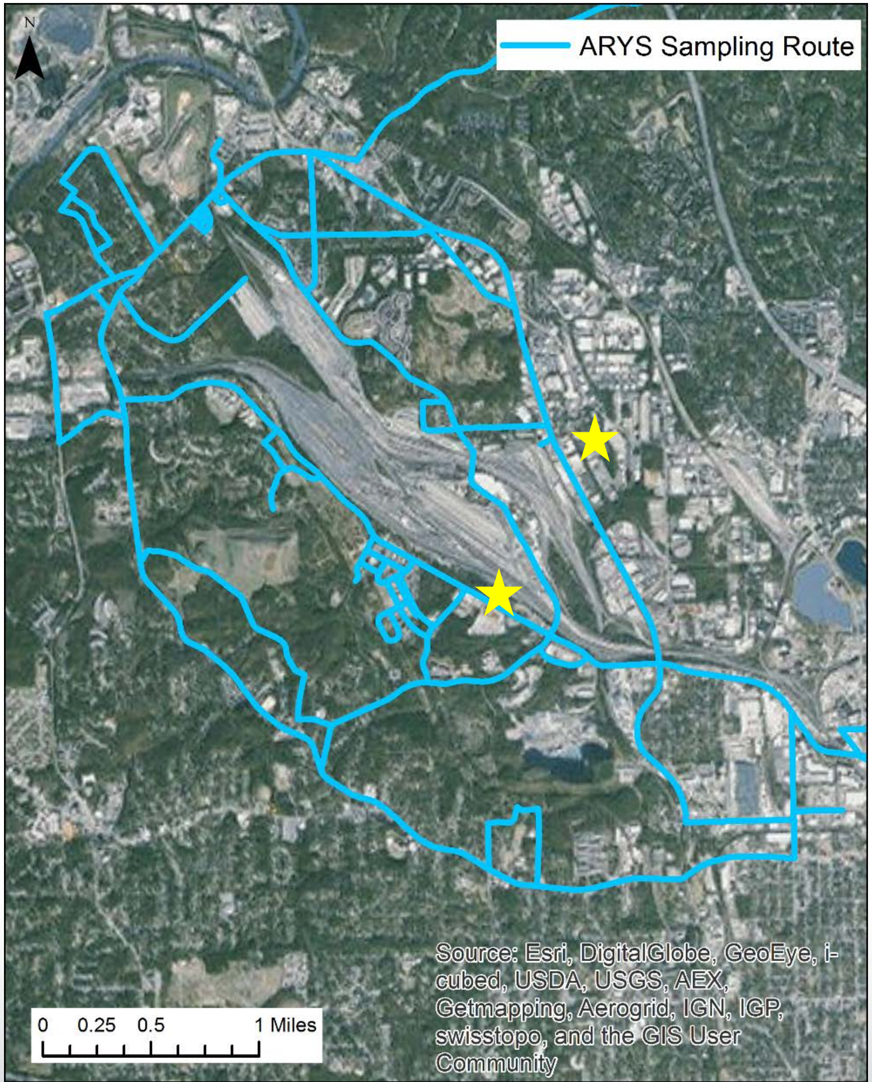


★ Georgia Tech sites (initiated in 2010): $PM_{2.5}$, BC, CO_2

Two independent monitoring studies (Georgia Tech, EPA) – developed official Memorandum of Understanding (MOU) to collaborate and share data.

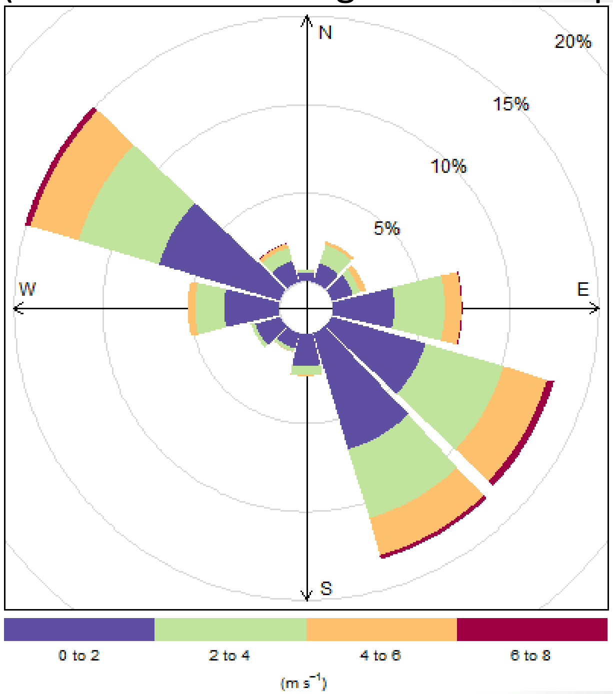
Mobile field study

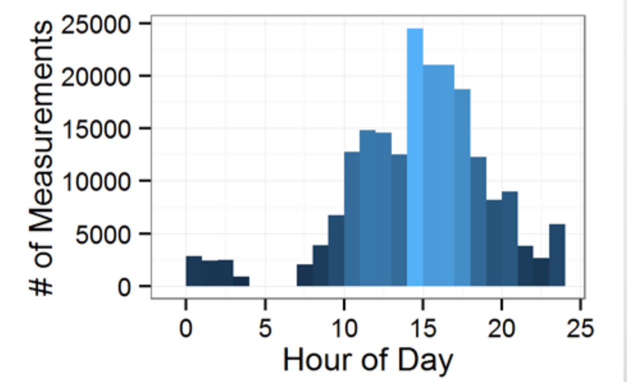
- 19 sampling runs conducted in May 2012



★ Georgia Tech sites (initiated in 2010): $PM_{2.5}$, BC, CO_2

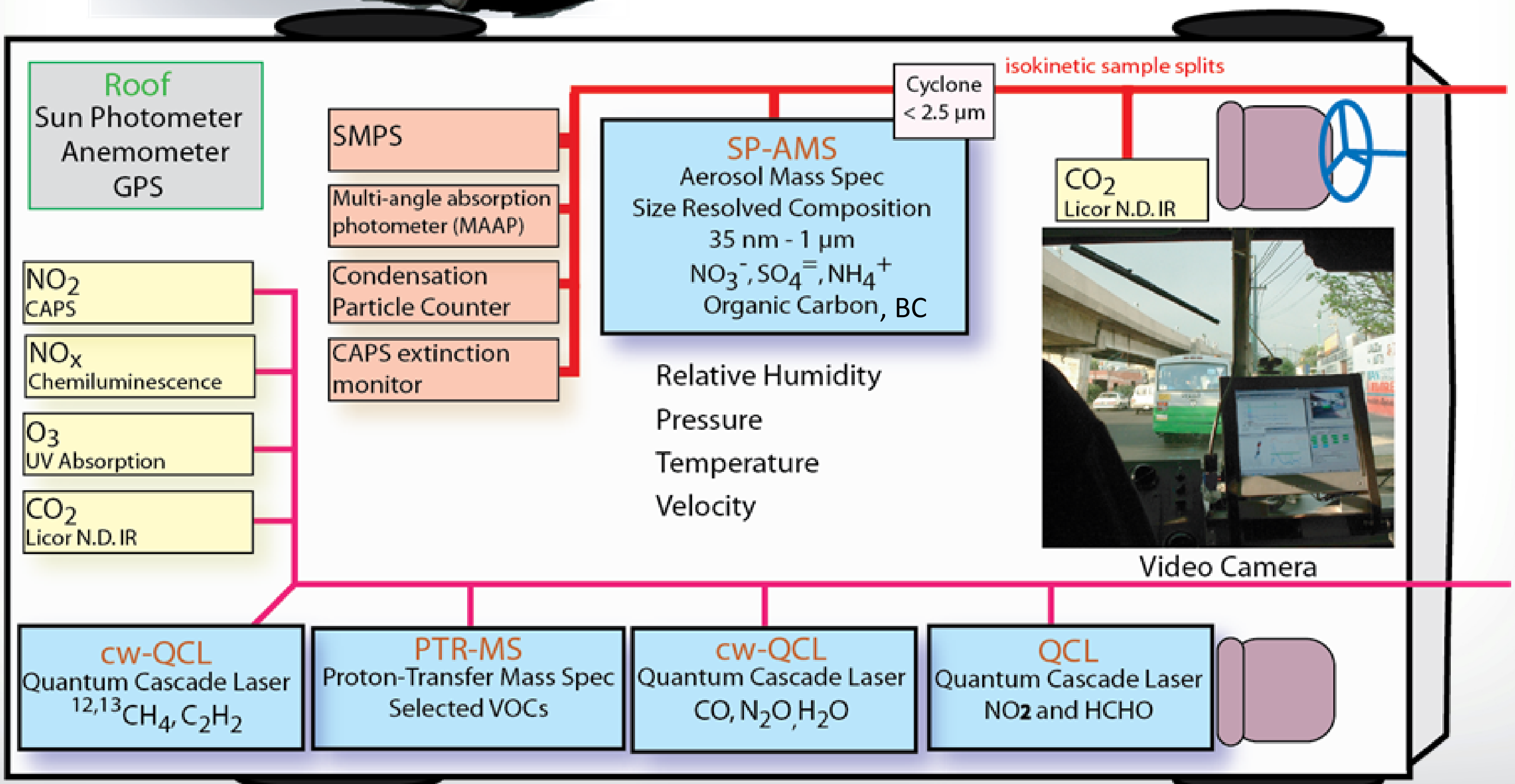
Wind conditions during sampling (measured on Georgia Tech rooftop)





Field study

Aerodyne Mobile Lab
ARYS 2012



Field study

Measurement	Rate	Instrument
Carbon Dioxide (CO_2)	0.9 s	Licor 6262 (2) and Licor 820
Carbon Monoxide (CO)	1 s	Quantum Cascade Laser System (2230 cm-1)
Nitric Oxide (NO)	1 s	Thermo 42i Chemiluminescence
Nitrogen Dioxide (NO_2)	1 s	Quantum Cascade Laser System (1600 cm-1)
Nitrogen Dioxide (NO_2)	5 s	Cavity Enhanced Phase Shift
Oxides of Nitrogen (NO_y)	1.4 s	Thermo 42i with external inlet-tip Mo Converter
Black Carbon PM (< 2.5 µm)	3 s	Multi-Angle Absorption Photometer
Black Carbon PM (70 nm -1.5 µm)	1 s (variable)	SP-AMS with laser-on mode
Non-refractory PM coating on Black Carbon (70 nm – 1.5 µm)	1 s (variable)	SP-AMS with laser-on mode;
Particle Extinction	3 s	Cavity Enhanced Phase Shift
Particle Number Density	1.8 s	Condensation Particle Counter
Number based Size Distribution	2 minutes	Differential Mobility Analyzer with Condensation Particle Counter
Various Aromatics and Oxygenates such as: Benzene, Toluene, Xylene, Acetone, Acetaldehyde	1.4 s	Proton Transfer Reaction Mass Spectrometer
Alkanes, Selected Alkenes and Aromatics	Hourly	Gas Chromatogram with Flame Ionization Detector

Example plume event

Nitrogen oxide

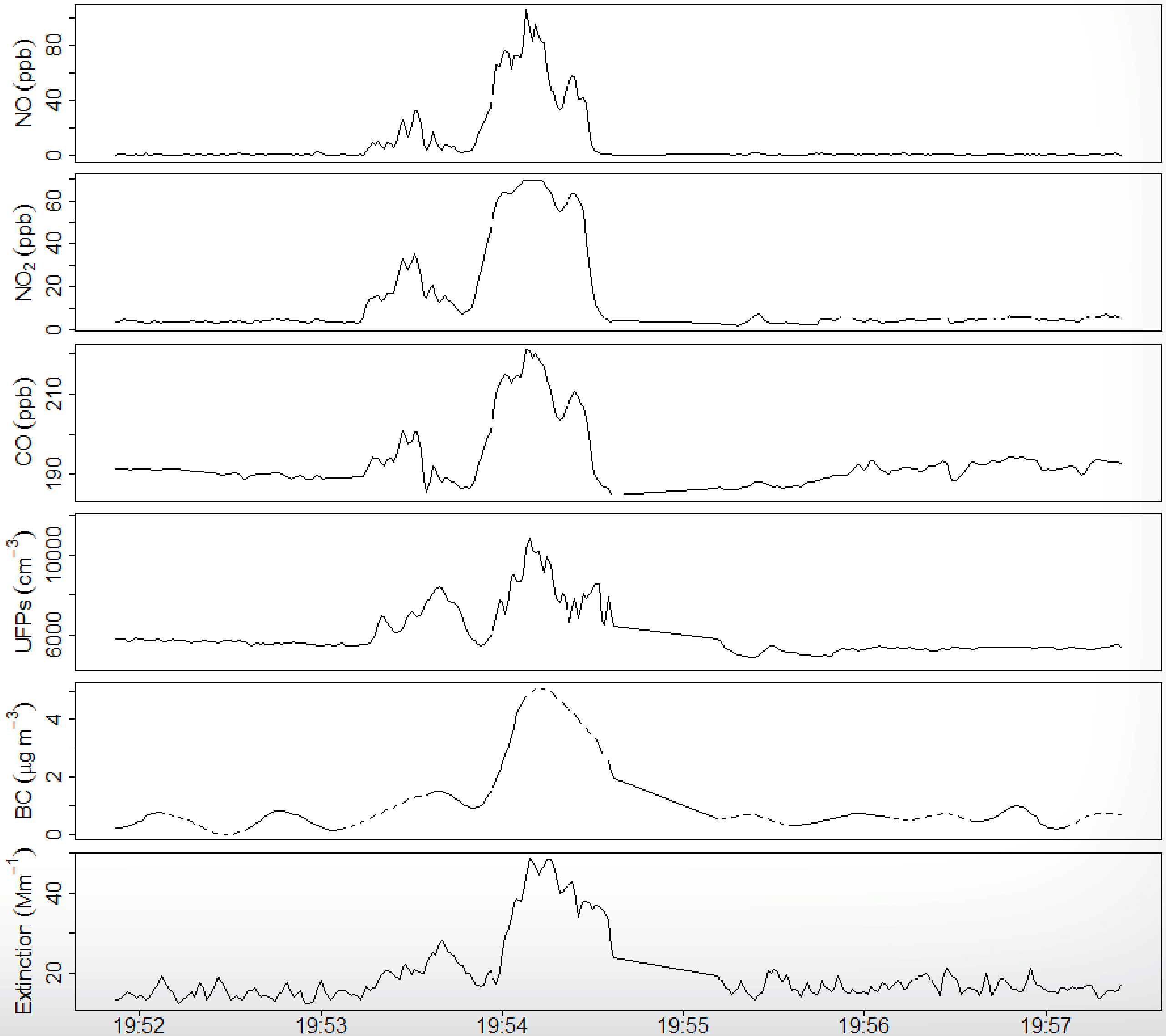
Nitrogen dioxide

Carbon monoxide

Ultrafine particles

Black carbon

Particle extinction

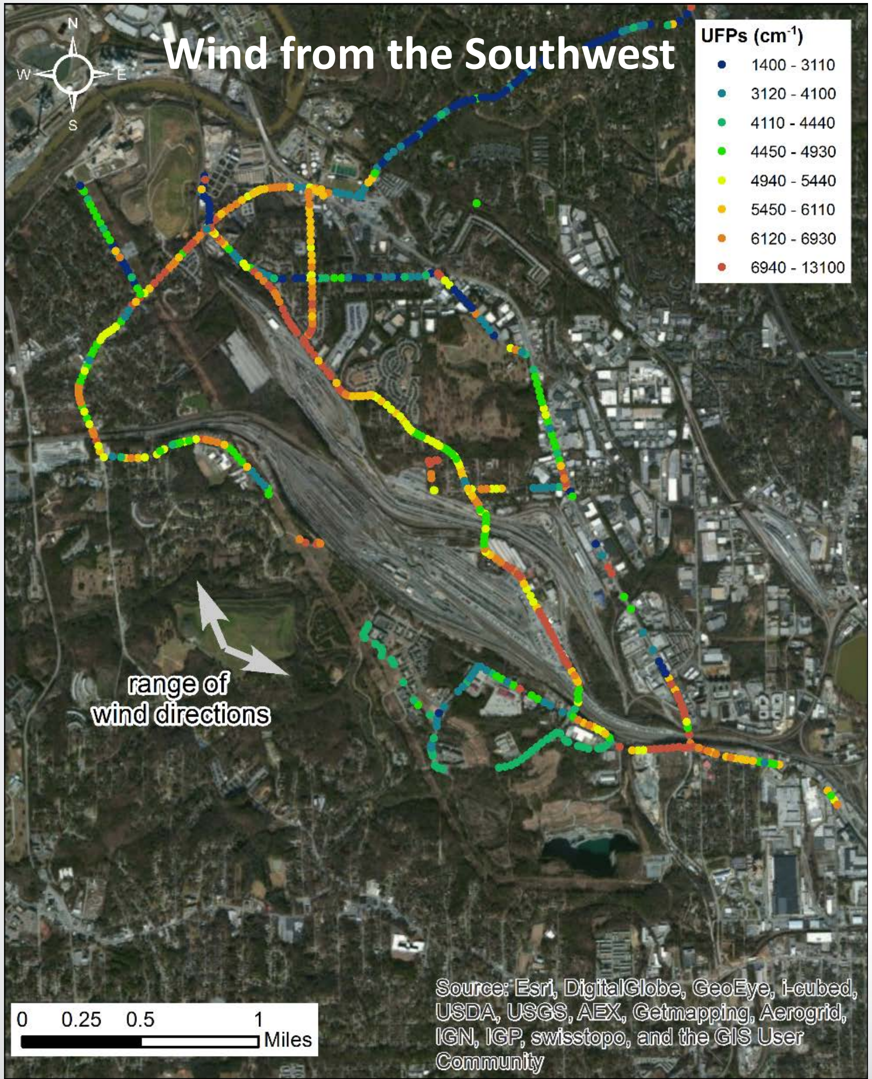


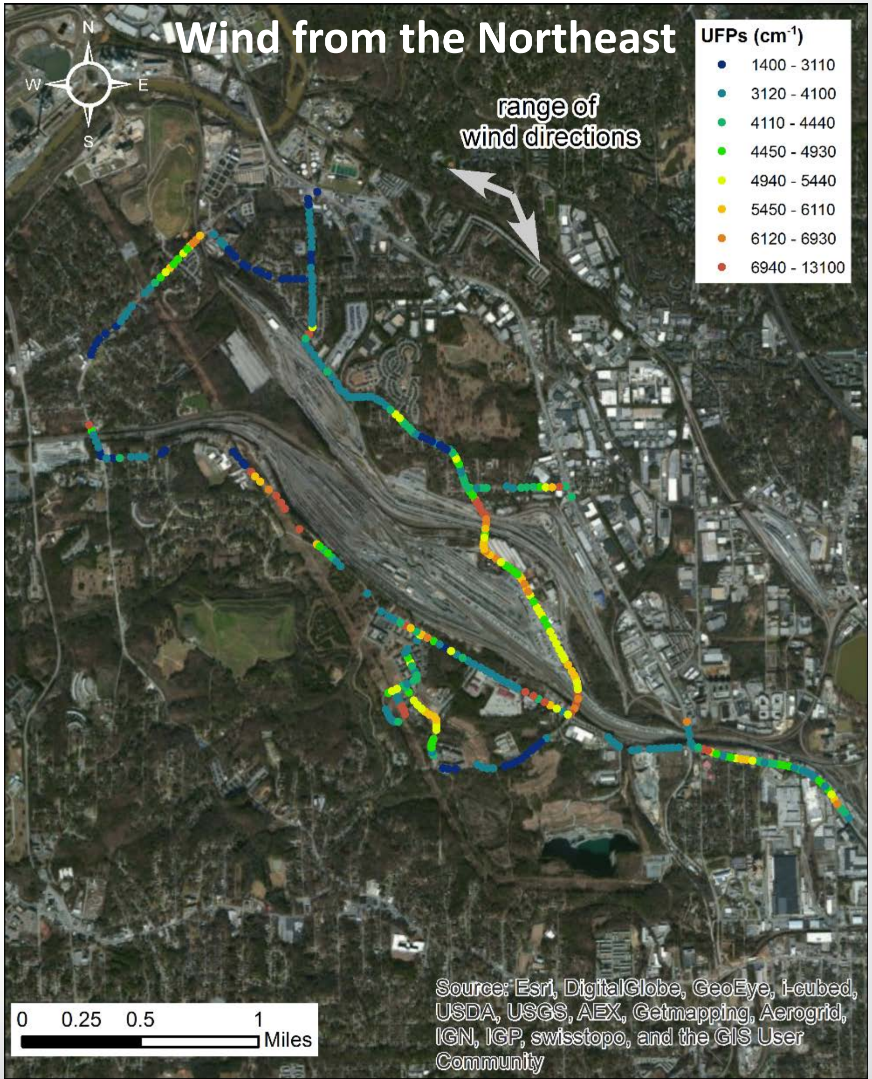
Research question #1

Are there statistically significant differences in air pollutant concentrations downwind of the rail yard relative to upwind air?

Results

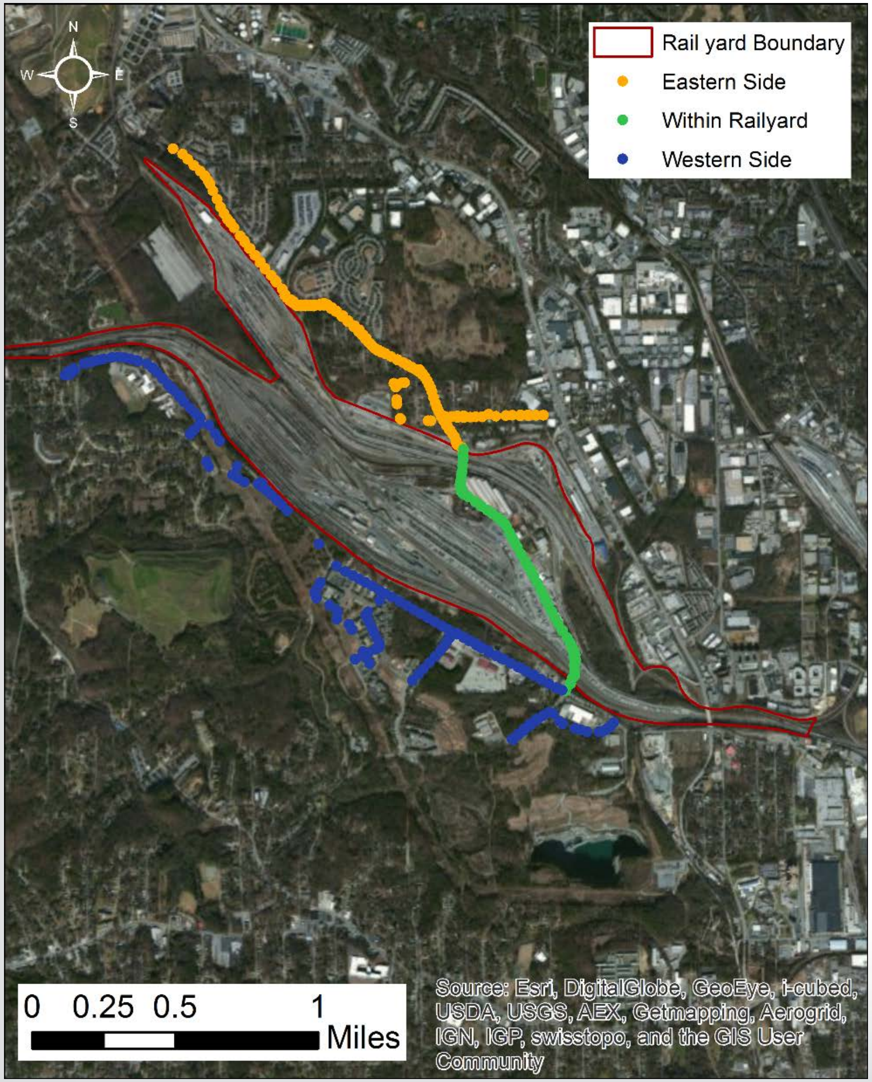
50 m median UFP concentrations by wind category (N > 5)

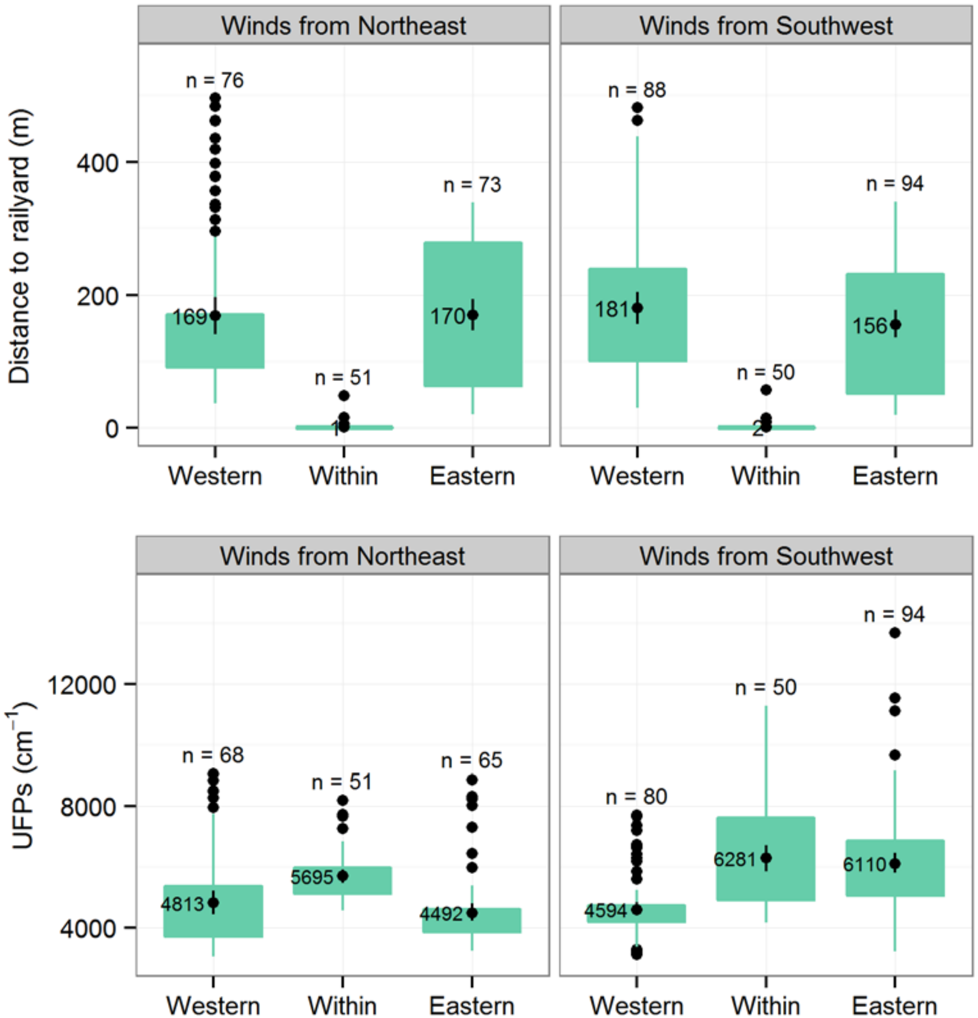




Results

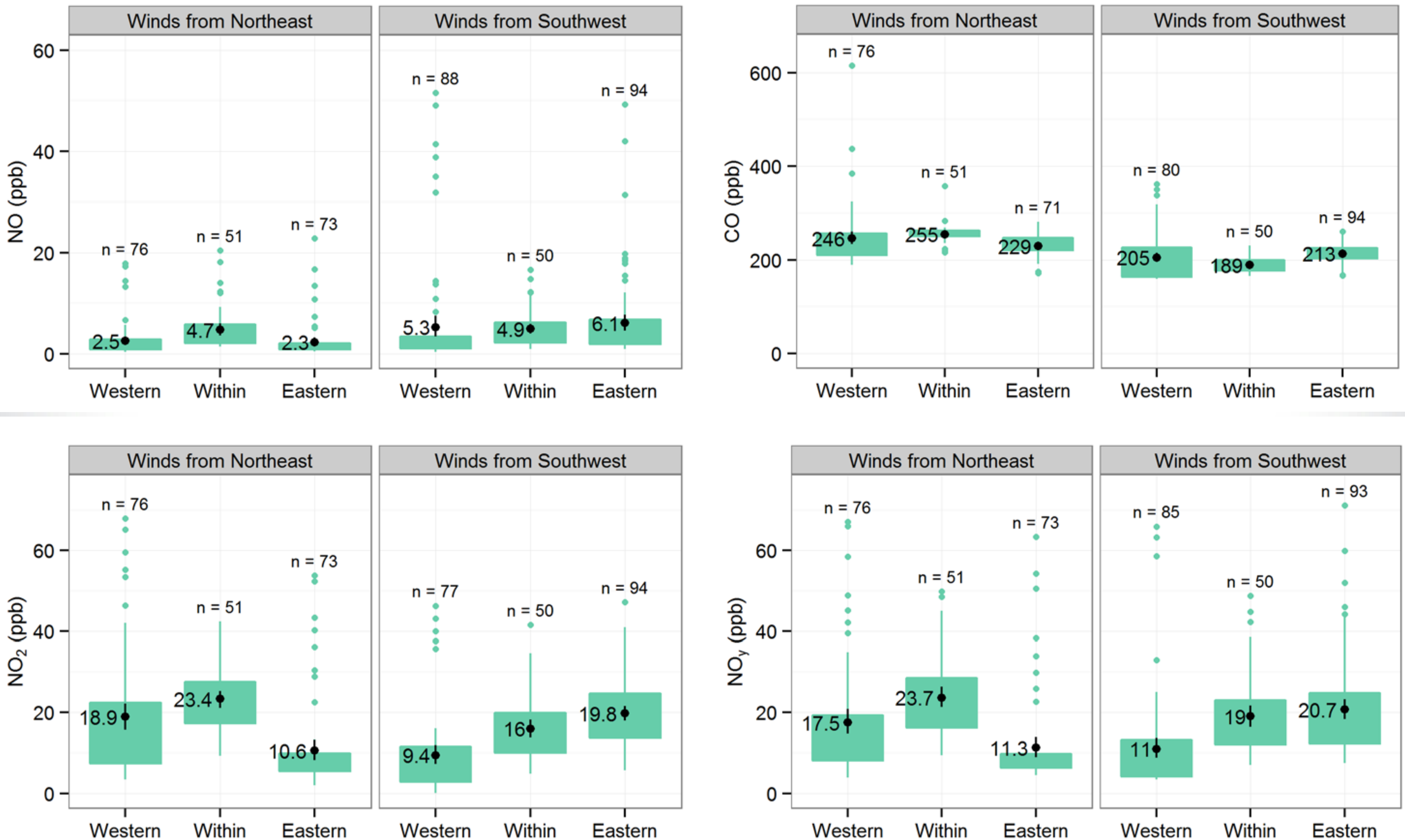
Median concentrations by 50 m segment and wind category





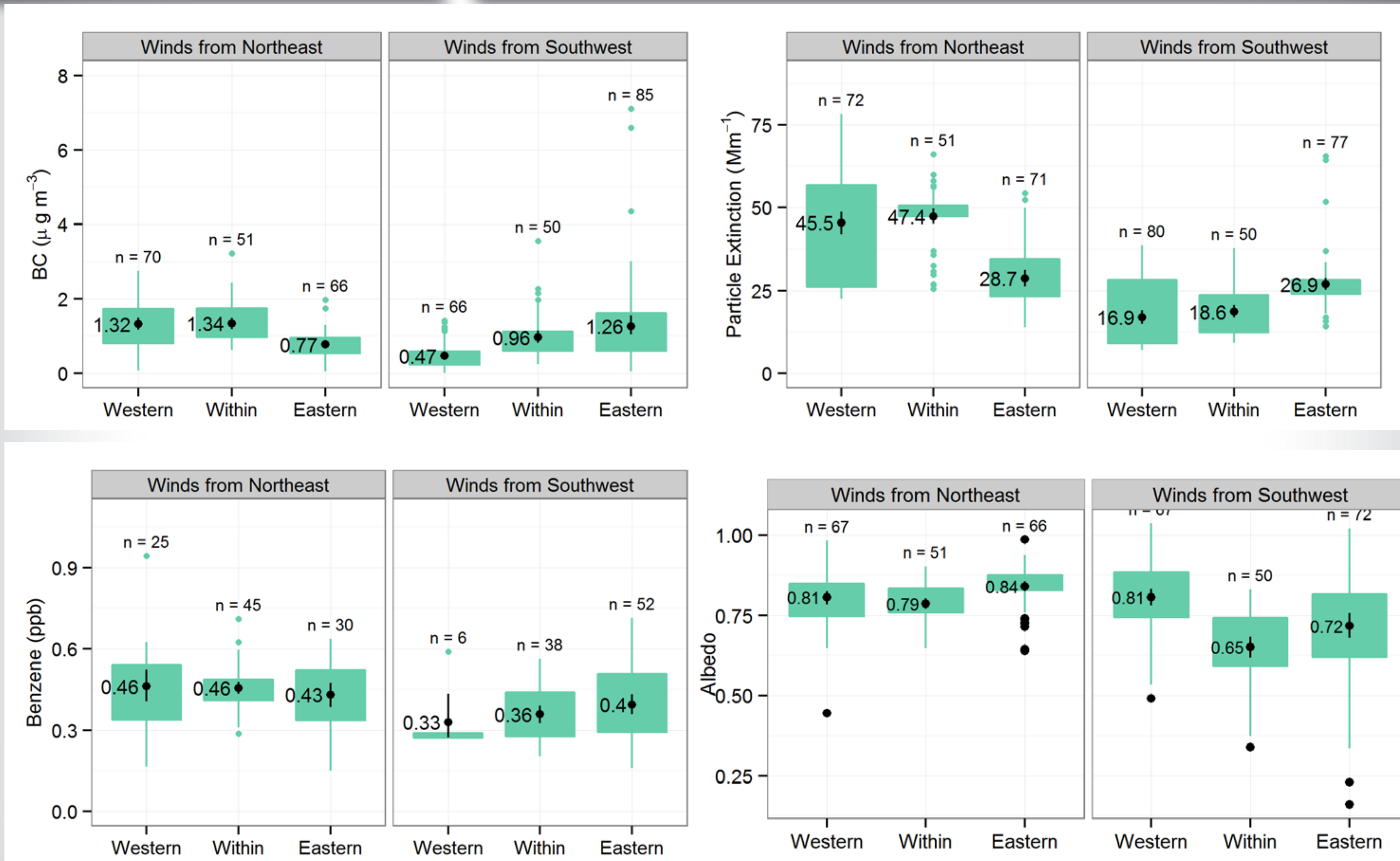
Points represent means and 95% CL

Results



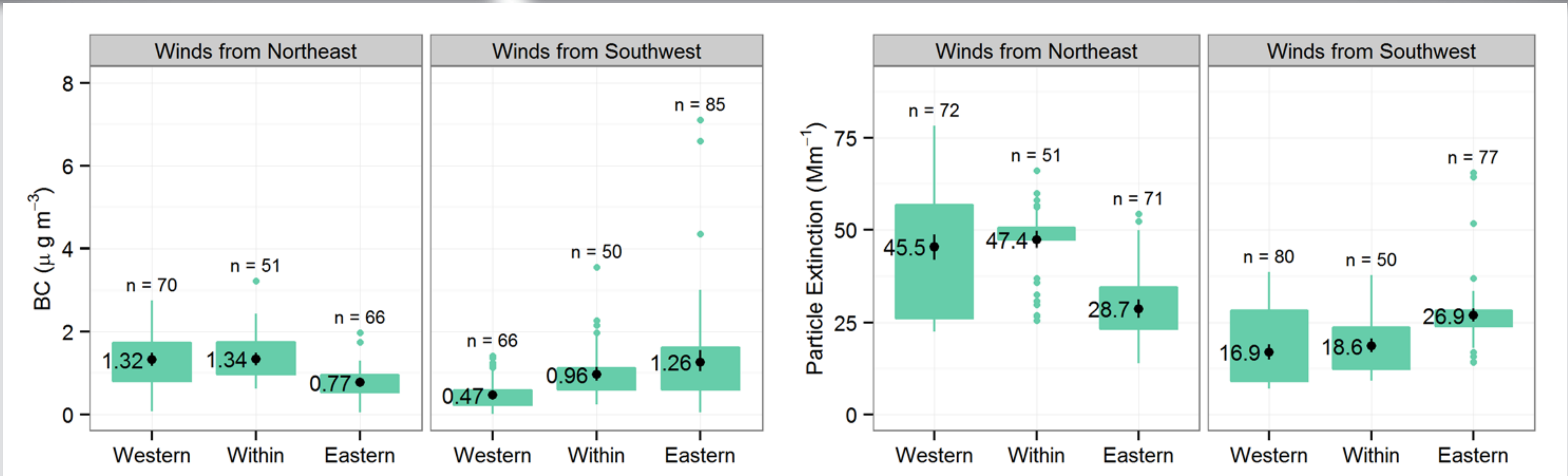
Winds from Northeast
Winds from Southwest
NO (ppb)
n = 76
n = 51
n = 73
n = 88
n = 50
n = 94
2.5
4.7
2.3
5.3
4.9
6.1
CO (ppb)
n = 76
n = 51
n = 71
n = 80
n = 50
n = 94
246
255
229
205
189
213
NO_2 (ppb)
n = 76
n = 51
n = 73
n = 77
n = 50
n = 94
18.9
23.4
10.6
9.4
16
19.8
NO_y (ppb)
n = 76
n = 51
n = 73
n = 85
n = 50
n = 93
17.5
23.7
11.3
11
19
20.7
Western
Within
Eastern

Results

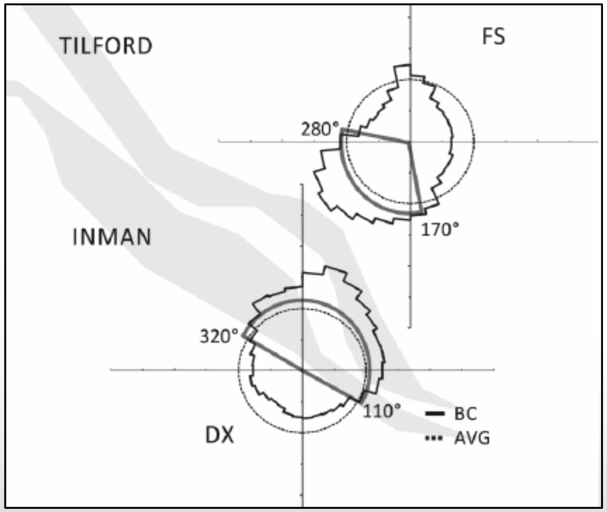


Winds from Northeast
Winds from Southwest
BC (μ g m^{-3})
8
6
4
2
0
n = 70
n = 51
n = 66
1.32
1.34
0.77
n = 66
n = 50
n = 85
0.47
0.96
1.26
Western
Within
Eastern
Winds from Northeast
Winds from Southwest
Particle Extinction (Mm^{-1})
75
50
25
0
n = 72
n = 51
n = 71
45.5
47.4
28.7
n = 80
n = 50
n = 77
16.9
18.6
26.9
Western
Within
Eastern
Winds from Northeast
Winds from Southwest
Benzene (ppb)
0.9
0.6
0.3
0.0
n = 25
n = 45
n = 30
0.46
0.46
0.43
n = 6
n = 38
n = 52
0.33
0.36
0.4
Western
Within
Eastern
Winds from Northeast
Winds from Southwest
Albedo
1.00
0.75
0.50
0.25
n = 67
n = 51
n = 66
0.81
0.79
0.84
n = 50
n = 72
0.81
0.65
0.72
Western
Within
Eastern

Results



Example BC stationary data:

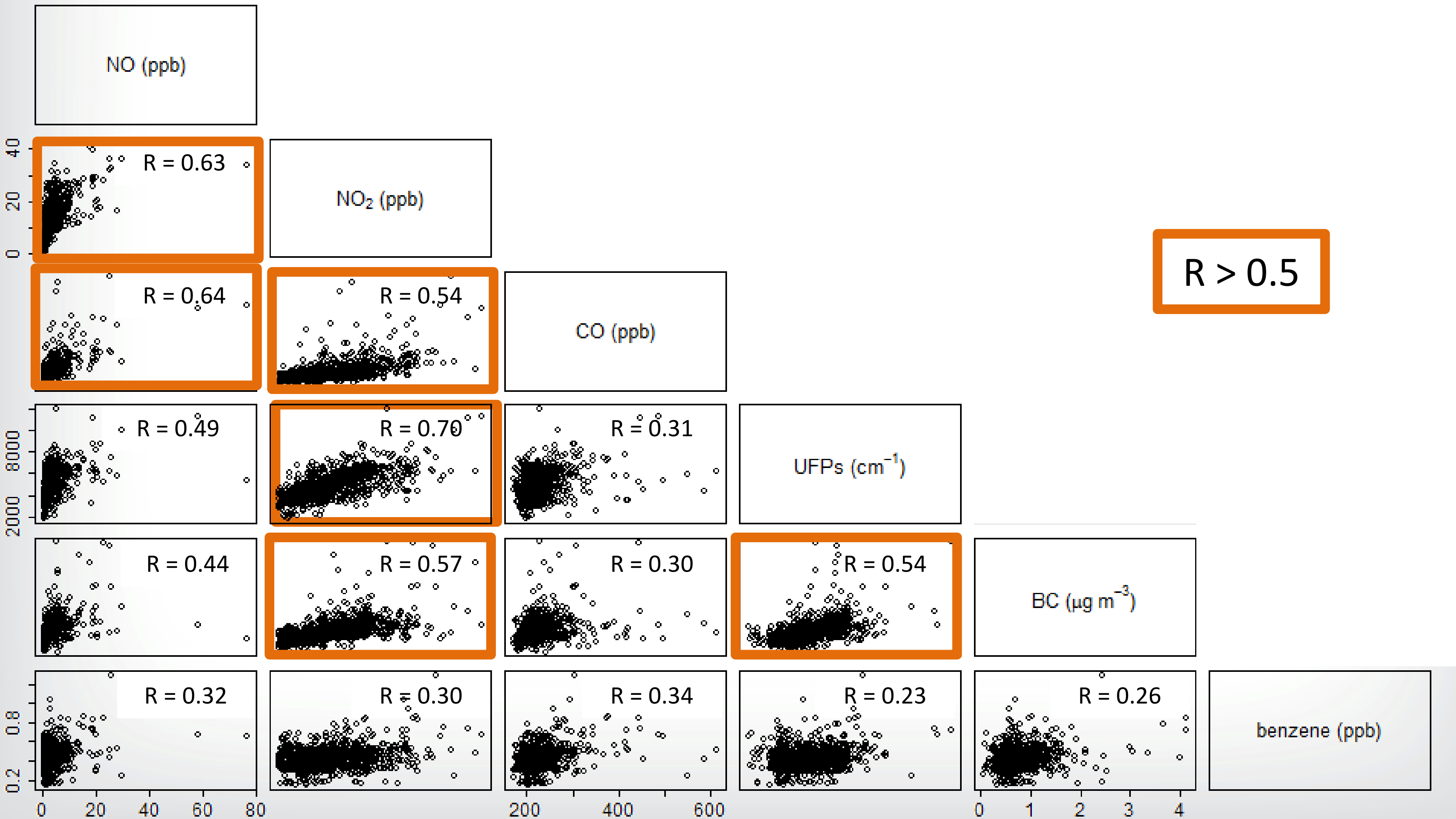


General agreement between mobile and stationary data indicating downwind excess BC / light-absorbing particles

Figure from Galvis et al., 2013. Fuel-based fine particulate and black carbon emission factors from a railyard area in Atlanta. *JAWMA*

Results

Correlation of 50m medians, all wind directions



Summary

- Detectable upwind/downwind shift in local air pollution levels in neighborhoods surrounding the yard.
  - Statistically significant increase in: UFPs, BC, particle extinction, NO_2, NOy
  - Albedo shift towards more light-absorbing particulate mixture in downwind areas

- Next steps
  - Compare in situ emission factors developed by Galvis et al. stationary data and mobile data sets for BC, $PM_{2.5}$

Acknowledgements

- EPA Office of Research and Development
- EPA Region 4
- Georgia Department of Natural Resources, Environmental Protection Department