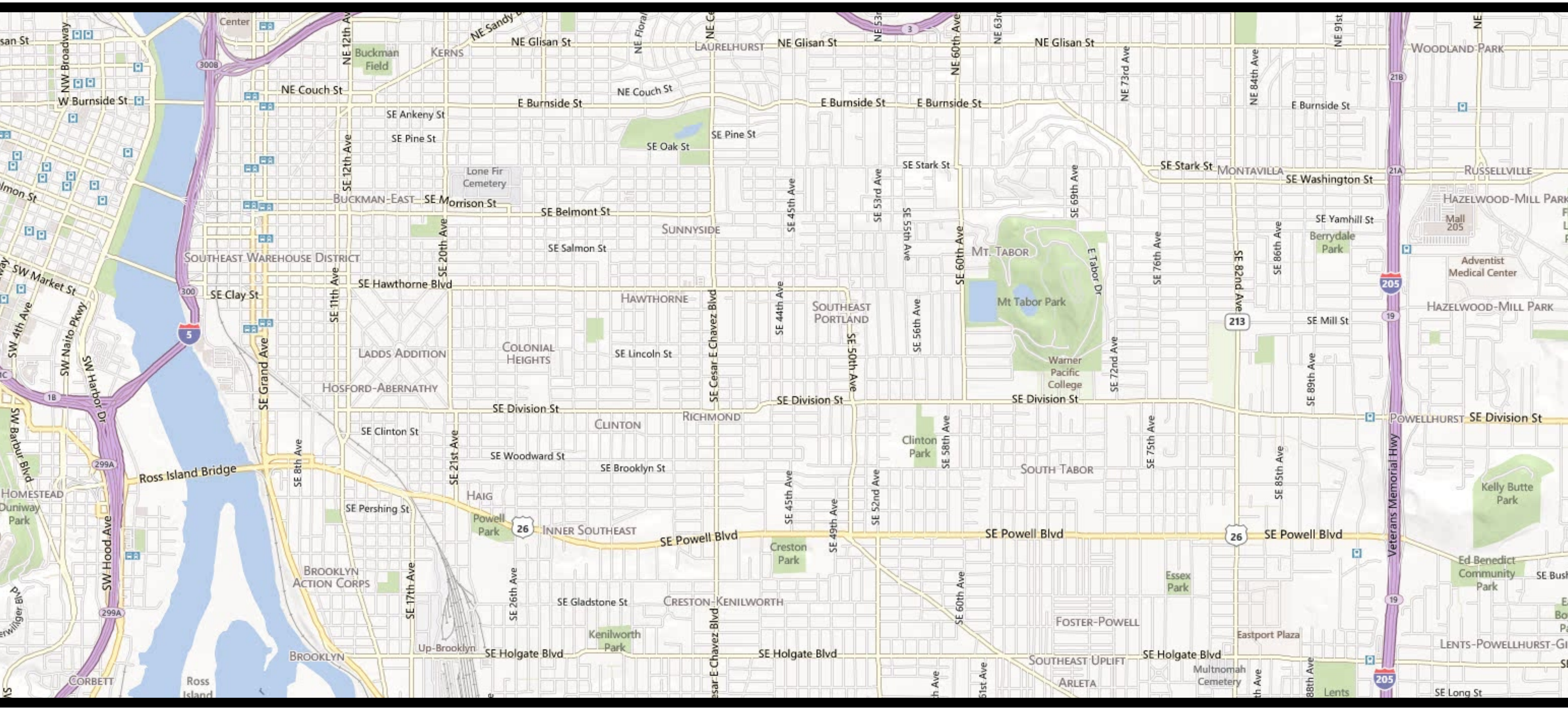
1-17-2014

Modeling the Impact of Traffic Conditions on the Variability of Mid-Block Roadside PM2.5 on an Urban Arterial

Adam Moore
Portland State University



Modeling the Impact of Traffic Conditions on the Variability of Mid-block Roadside $PM_{2.5}$ on an Urban Arterial

Adam Moore
Miguel Figliozzi
Alexander Bigazzi

Friday Transpo Seminar

17 January 2014

ITS
OTREC
Portland State University

INTRODUCTION

Portland State University has been studying the Powell Boulevard corridor in southeast Portland

- Busy arterial linking downtown to suburbs

- Investigating variations in PM levels
- Incorporating many data sources
  - Traffic, air quality, meteorology
- Utilizing statistical analyses to control for many factors

Background

Exposure to Air Pollution on Roadways

Vehicle

Public Transportation

Bicyclist/Pedestrian

What factors affect exposure to air pollution?

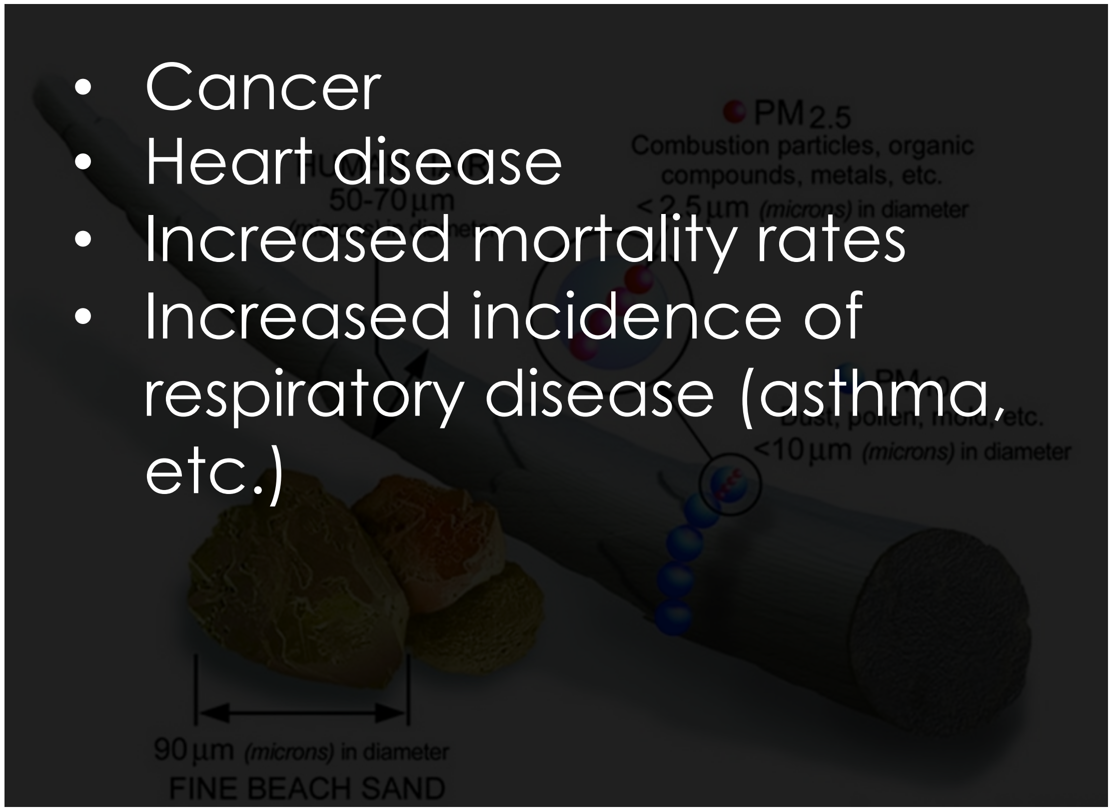
Built Environment

Vehicle Activity

Meteorological Conditions

Very High Resolution Data Collection

Fine Particulate Matter ($PM_{2.5}$)

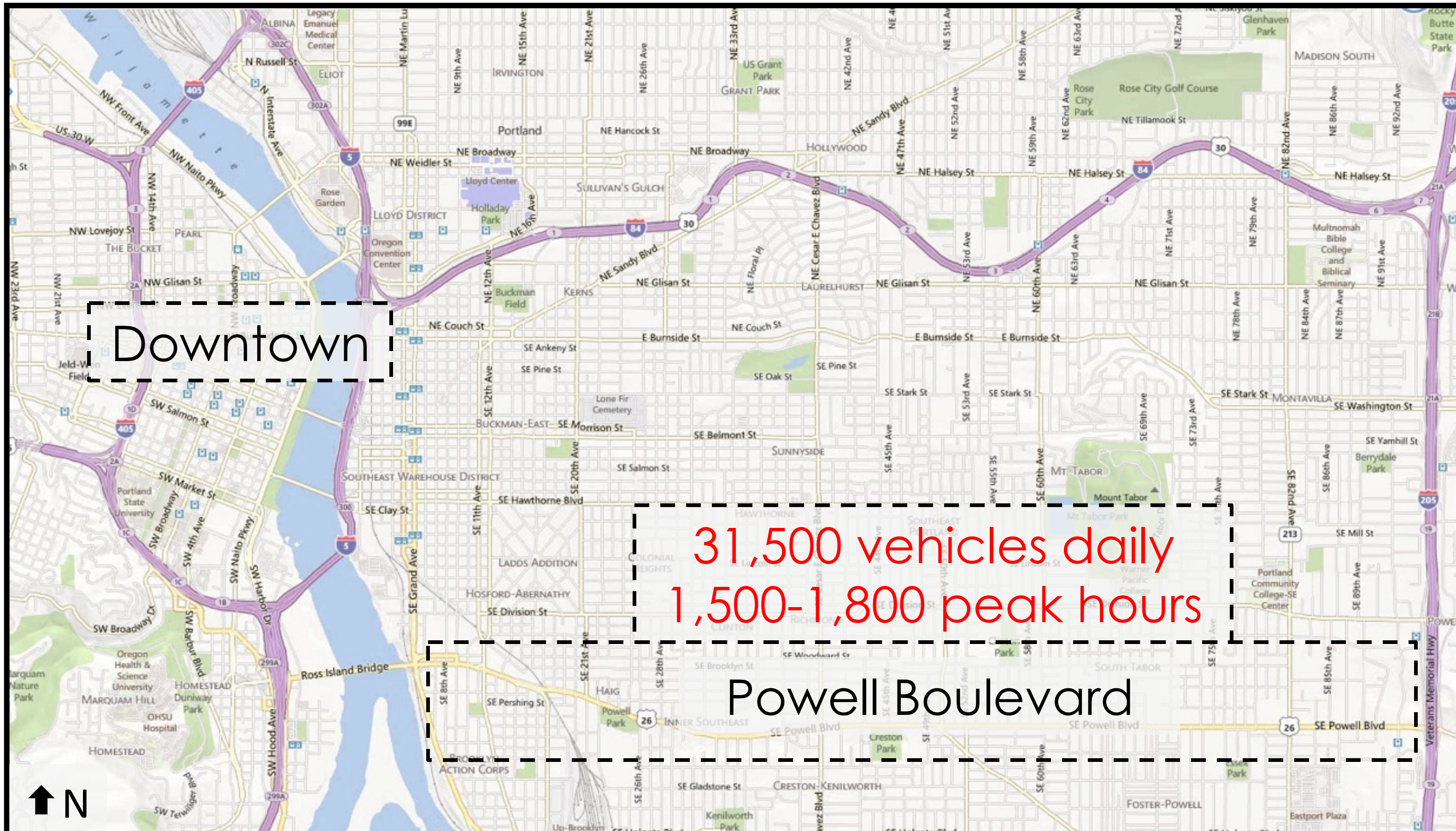


- Cancer
- Heart disease
- Increased mortality rates
- Increased incidence of respiratory disease (asthma, etc.)

Vehicle emissions, brake wear, tire wear

image: epa.gov

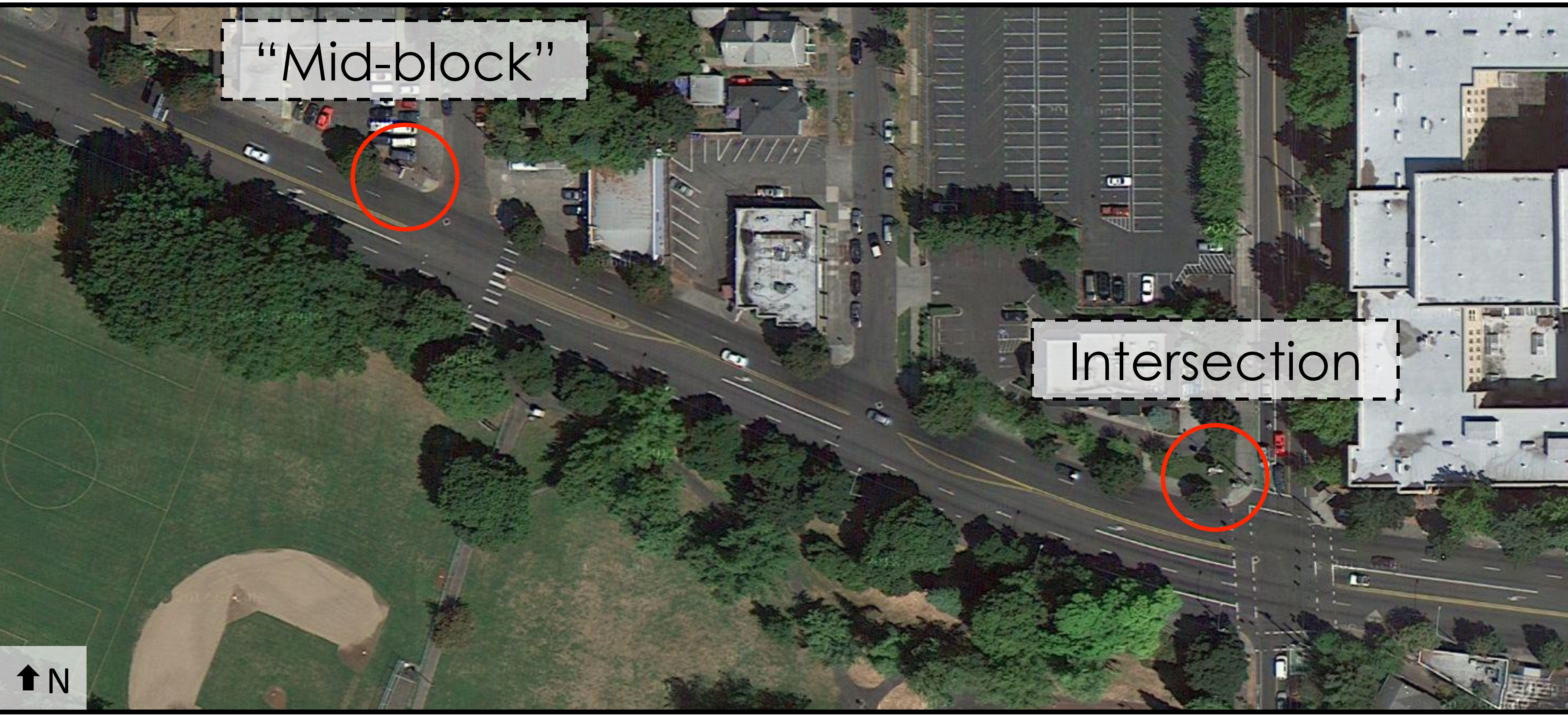
Study Location



map: bing.com/maps

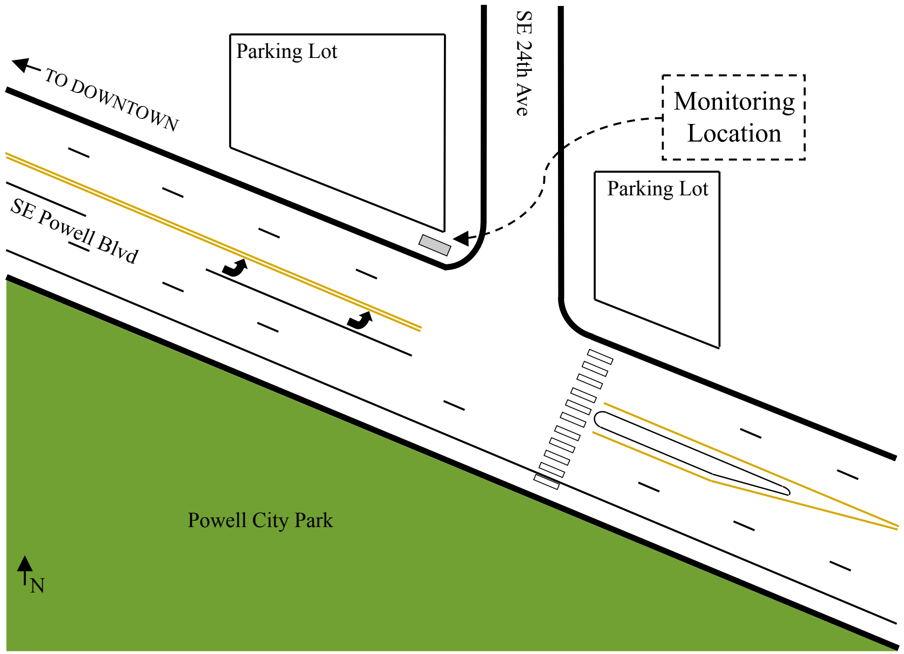
STUDY SITES

May 1, 2013 7:00-9:00am

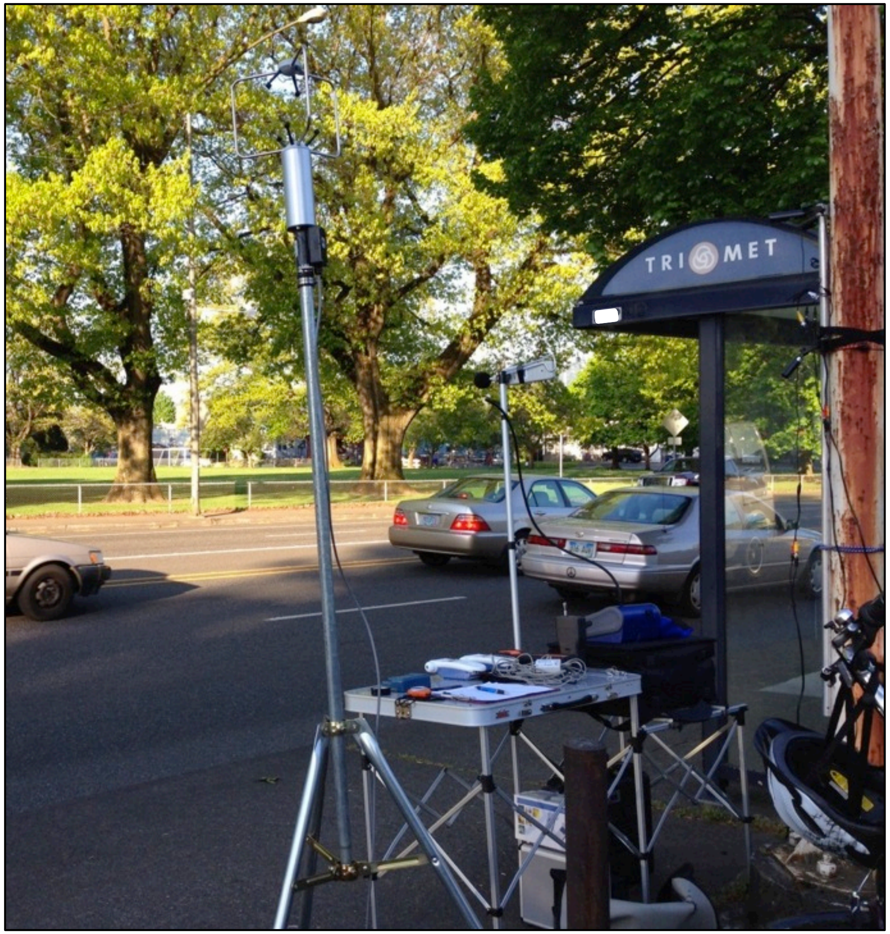


map: google.com/maps

MID-BLOCK STUDY SITE



Equipment



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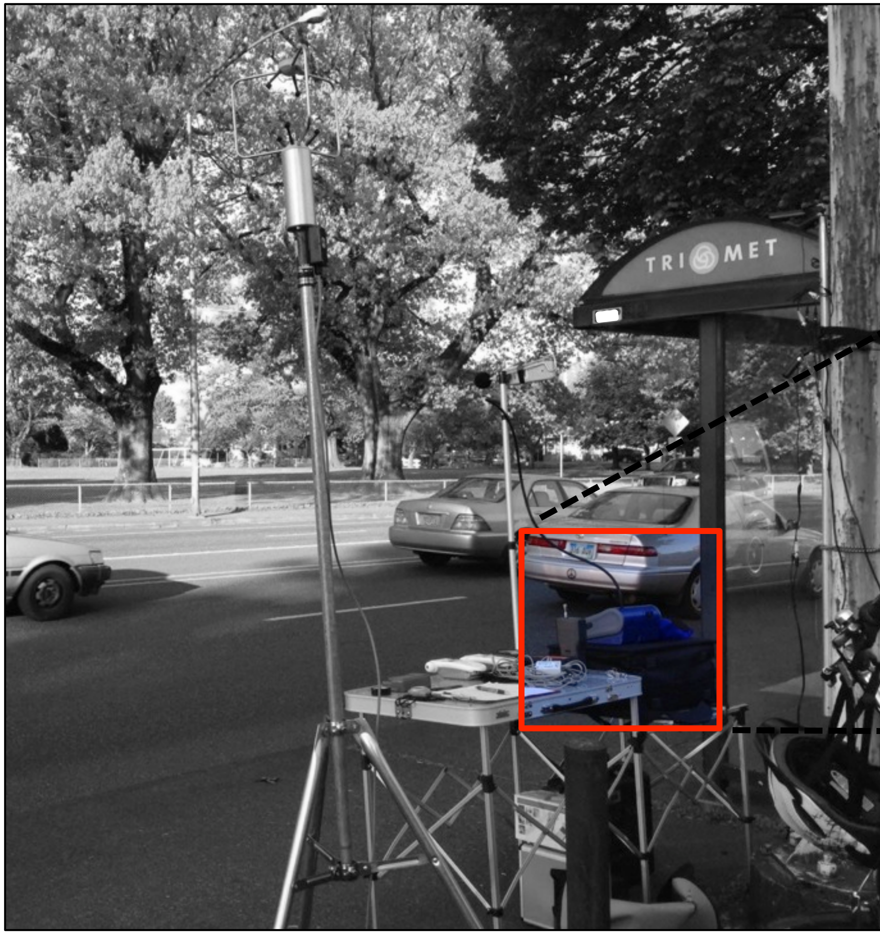


TSI DustTrak DRX 8533

Fine Particulate Matter ($PM_{2.5}$)

photo: www.tsi.com

EQUIPMENT

RM Young Ultrasonic Anemometer 81000

Wind Speed
Wind Direction

Onset HOBO U12

Temperature
Relative Humidity

photo: www.youngusa.com
photo: www.onsetcomp.com

EQUIPMENT

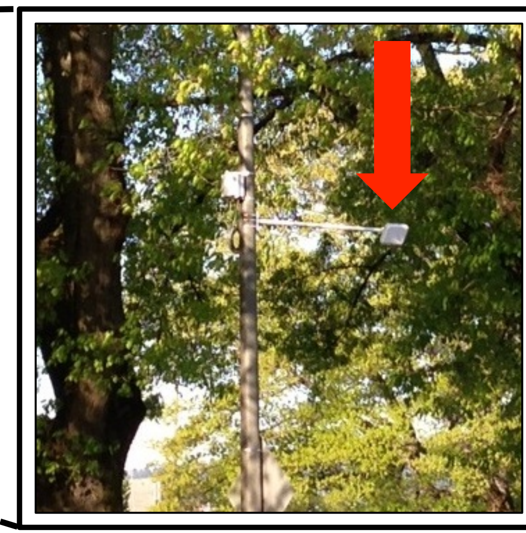
CountingCars
CountCam System

Video Reference

photo: www.countingcars.com

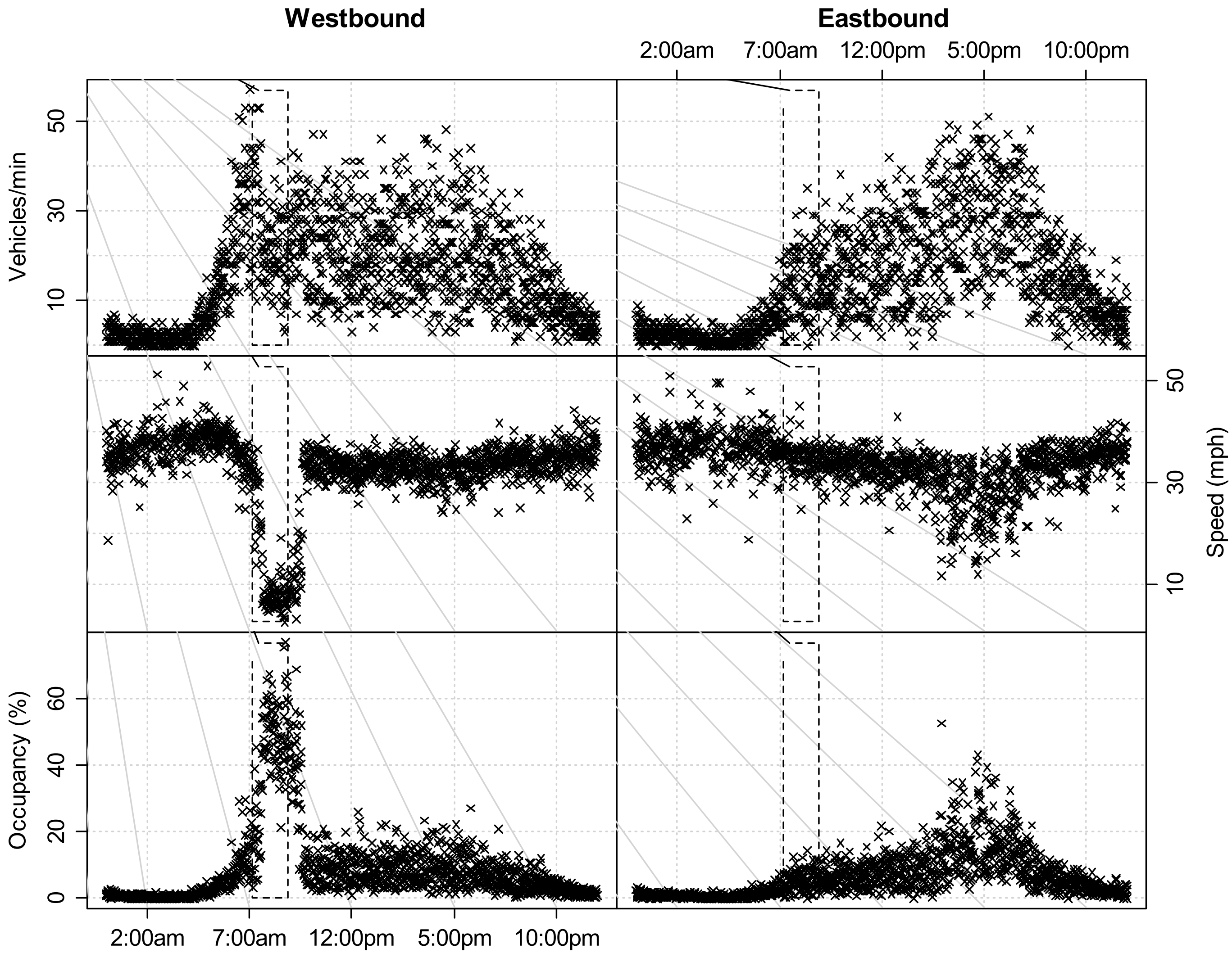
EQUIPMENT

Wavetronix
SmartSensor HD



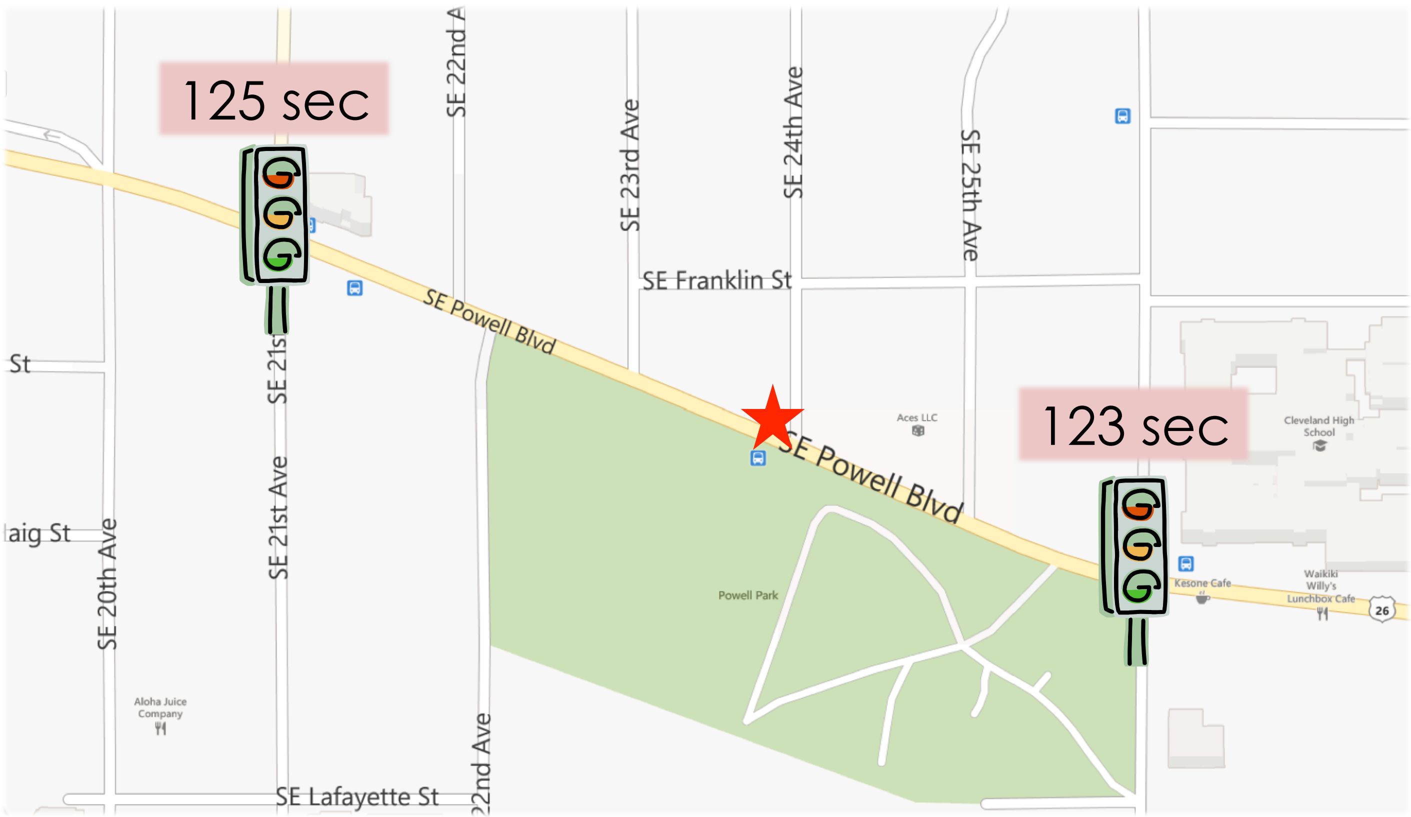
Vehicle Volume, Speed,
Classification,
Lane Occupancy

TRAFFIC ACTIVITY



Nearby Signals

Can we see vehicle platooning?

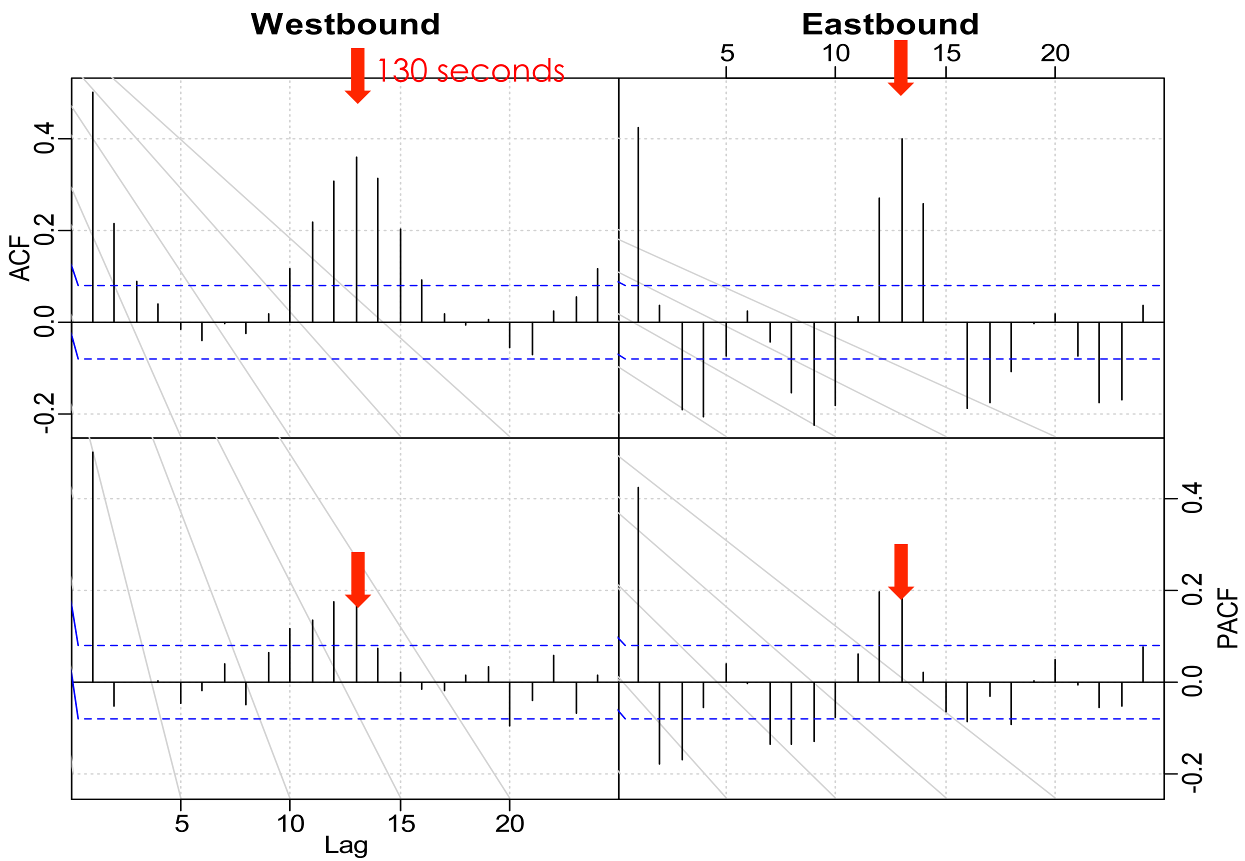


map: google.com/maps

Vehicle Platooning

Autocorrelation Function

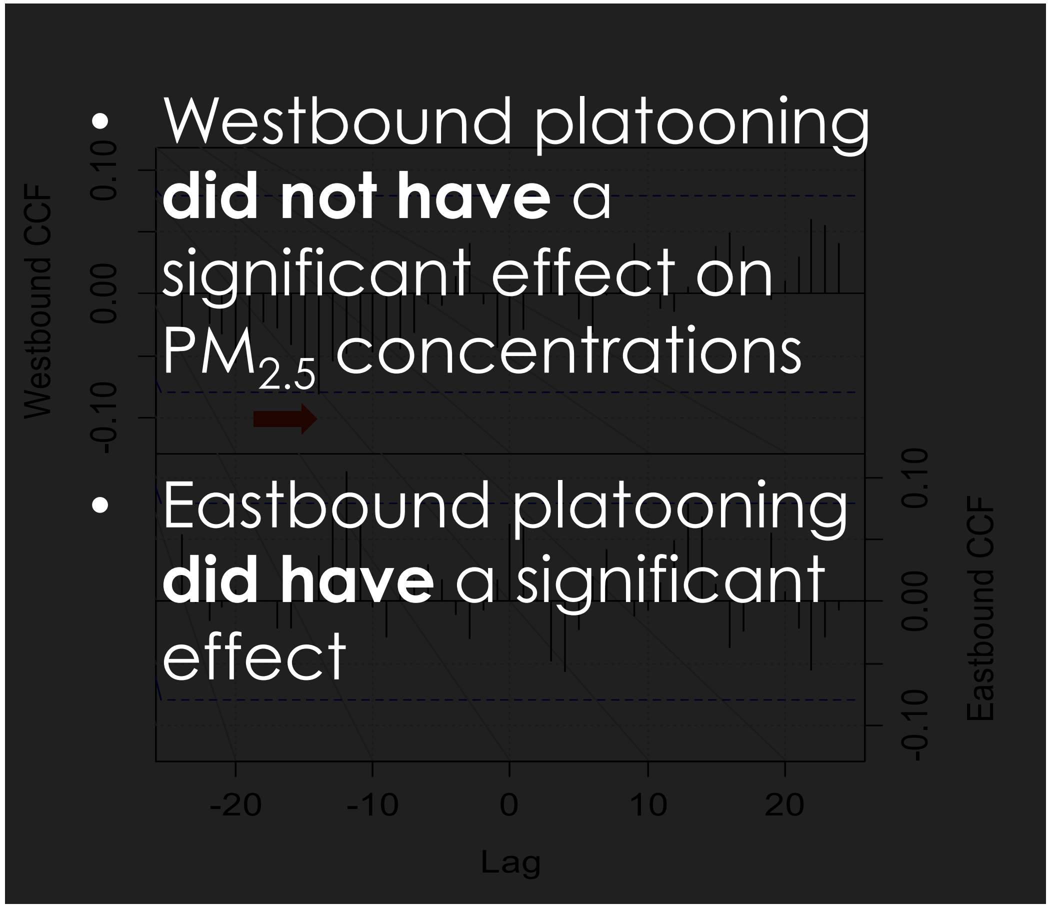
Partial Autocorrelation Function



One lag = 10 seconds

PLATOONING EFFECT ON $PM_{2.5}$

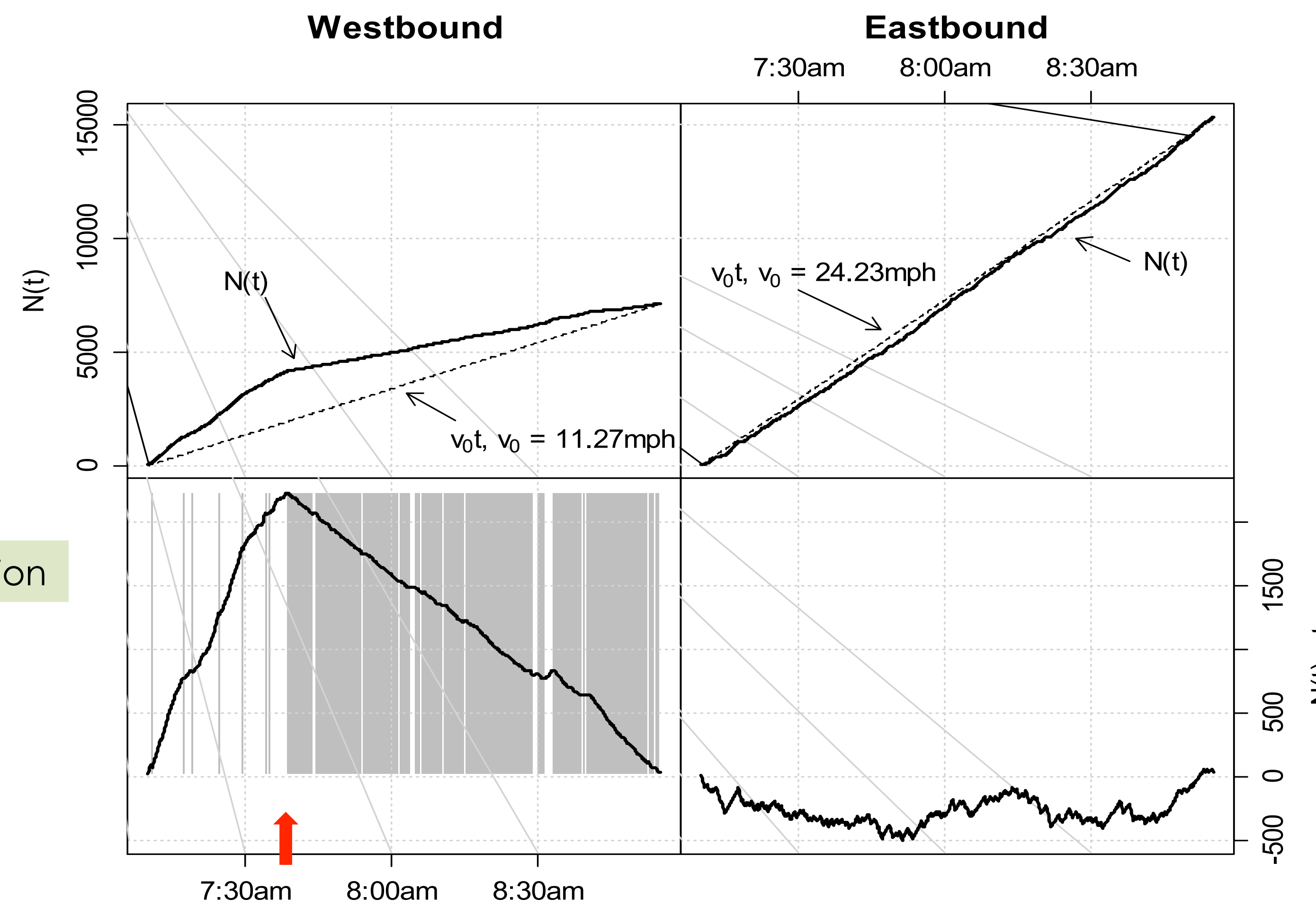
Cross-correlation Function

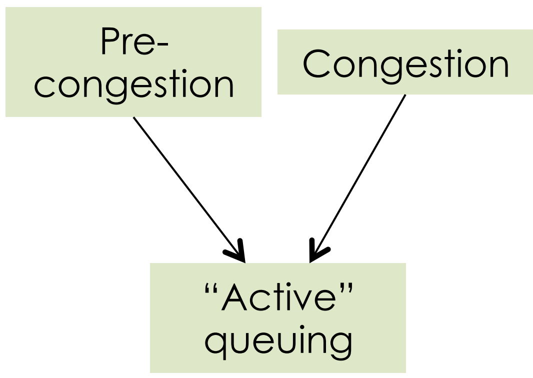


- Westbound platooning **did not have** a significant effect on $PM_{2.5}$ concentrations
- Eastbound platooning **did have** a significant effect

One lag = 10 seconds

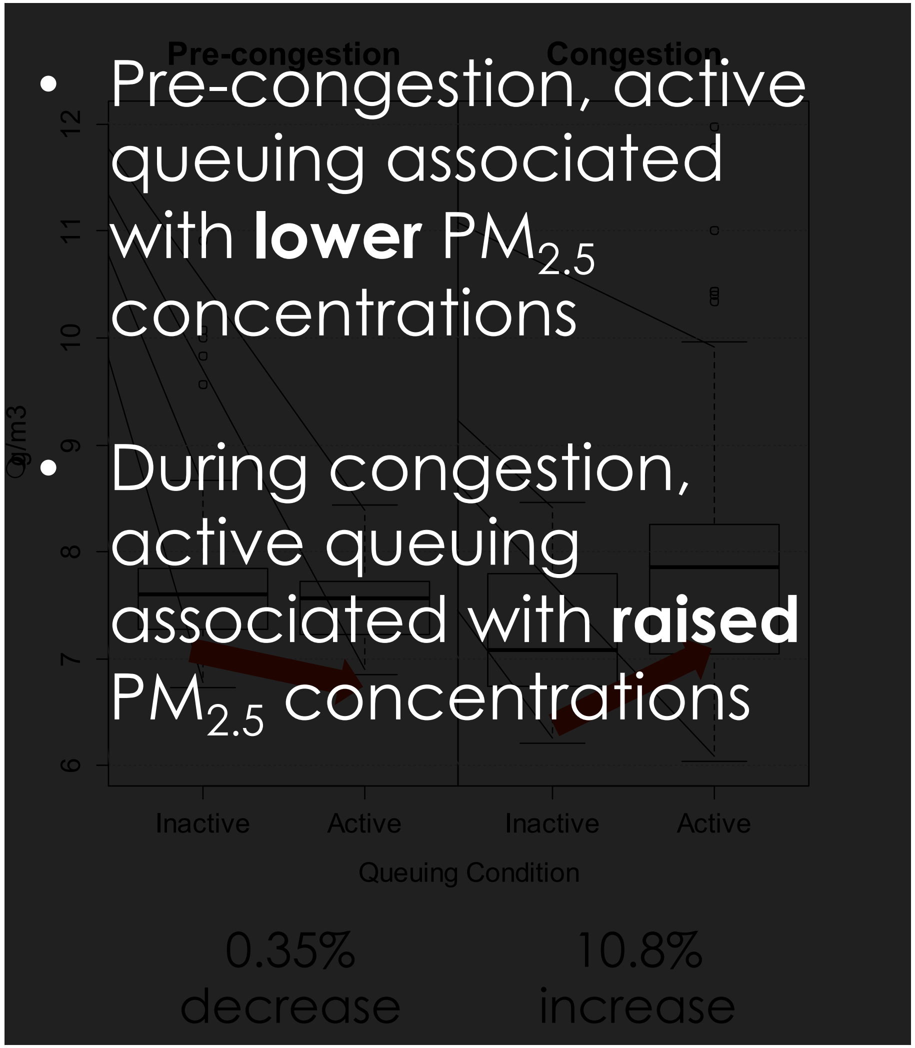
EXAMINING CONGESTION





Congestion Effect on $PM_{2.5}$

- Pre-congestion, active queuing associated with **lower** $PM_{2.5}$ concentrations
- During congestion, active queuing associated with **raised** $PM_{2.5}$ concentrations



Regression Findings

PM$_{2.5}$ concentrations

Vehicles passing when wind blows across roadway towards monitoring station

– Current and previous observations

Relative humidity increases

Congestion worsens

Wind blows from the background as vehicles pass

Wind speed increases

R^2 .6589

R_{adj}^2 .65

VEHICLE SEMI-ELASTICITIES

Variable…	…lagged…	…changed $PM_{2.5}$ by…	…per…
Occupancy	0 sec	.05%	% occupancy increase
When wind was blowing across roadway towards monitoring station:			
EB Passenger Vehicle	(80, 110, 200) sec	(.49%, .46%, .45%)	Additional vehicle
EB Heavy Vehicle	0 sec	2.45%	Additional vehicle
When wind was blowing from background neighborhoods:			
WB Passenger Vehicle	0 sec	-.40%	Additional vehicle

Conclusions

Exposure to Roadside Fine Particulate Matter

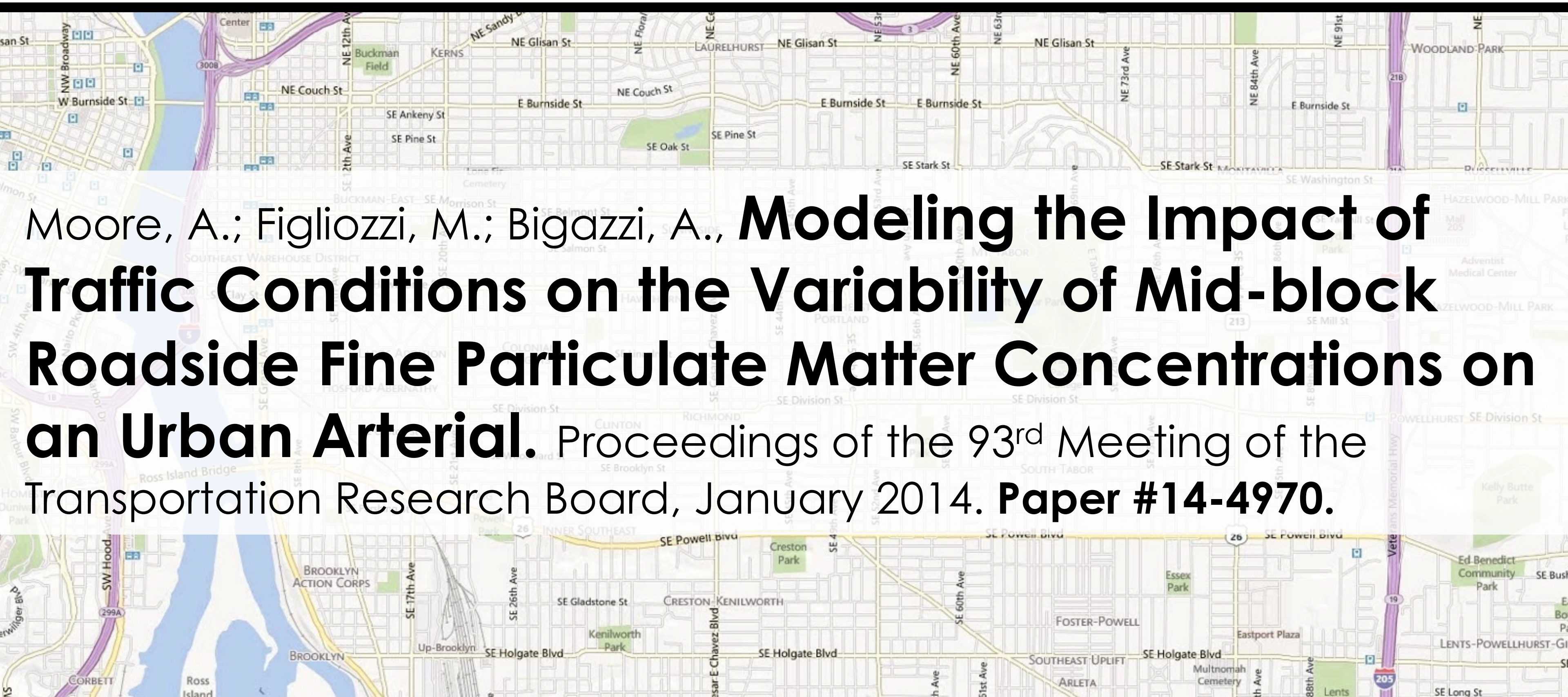
Data Availability

Platooning

Congestion

Model Calibration

Policy Implications to Minimize Exposure



Moore, A.; Figliozzi, M.; Bigazzi, A., **Modeling the Impact of Traffic Conditions on the Variability of Mid-block Roadside Fine Particulate Matter Concentrations on an Urban Arterial.** Proceedings of the 93rd Meeting of the Transportation Research Board, January 2014. **Paper #14-4970.**

Acknowledgements

OTREC
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Research and Innovative Technology Administration

QUESTIONS?

Portland State UNIVERSITY

ITS

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Alexander Bigazzi

Regression Model

Dependent variable: $\ln(PM_{2.5})$					
R^2 ($R^2_{adjusted}$)	.6589 (.6533)				
Residual standard error	.06138 on 600 degrees of freedom				
AIC[a]	–1663.29				
Variable	**Lag**	**Coefficient**	**SE**	**p**	**Unit increase effects on dependent variable (Semi-elasticity)**
Intercept	0	.63261	.05693	<.001	
$\ln(PM_{2.5})$	1	.63829	.03013	<.001	
Traffic Conditions					
WB Occupancy	0	.00046	.00013	<.001	Increase by .05% per percentage point occupancy increase
Meteorological Conditions					
Relative Humidity	0	.00138	.00020	<.001	Increase by .14% per percentage point RH increase
Wind Speed	1	–.01274	.00368	.001	Decrease by 1.27% per 1m/s increase
	2	.00917	.00368	.013	Increase by .92% per 1m/s increase
Vehicle Volume × Wind					
Wind towards monitoring station					
EB Passenger Veh	8	.00488	.00214	.023	Increase by .49% per additional vehicle
	11	.00455	.00215	.035	Increase by .46% per additional vehicle
	20	.00448	.00214	.037	Increase by .45% per additional vehicle
EB Heavy Veh	0	.02418	.01075	.025	Increase by 2.45% per additional vehicle
Wind away from monitoring station					
WB Passenger Veh	0	–.00400	.00144	.006	Decrease by .40% per additional vehicle

[a] Akaike Information Criterion