Characterizing the Roadside Atmospheric Environment of an Urban Arterial

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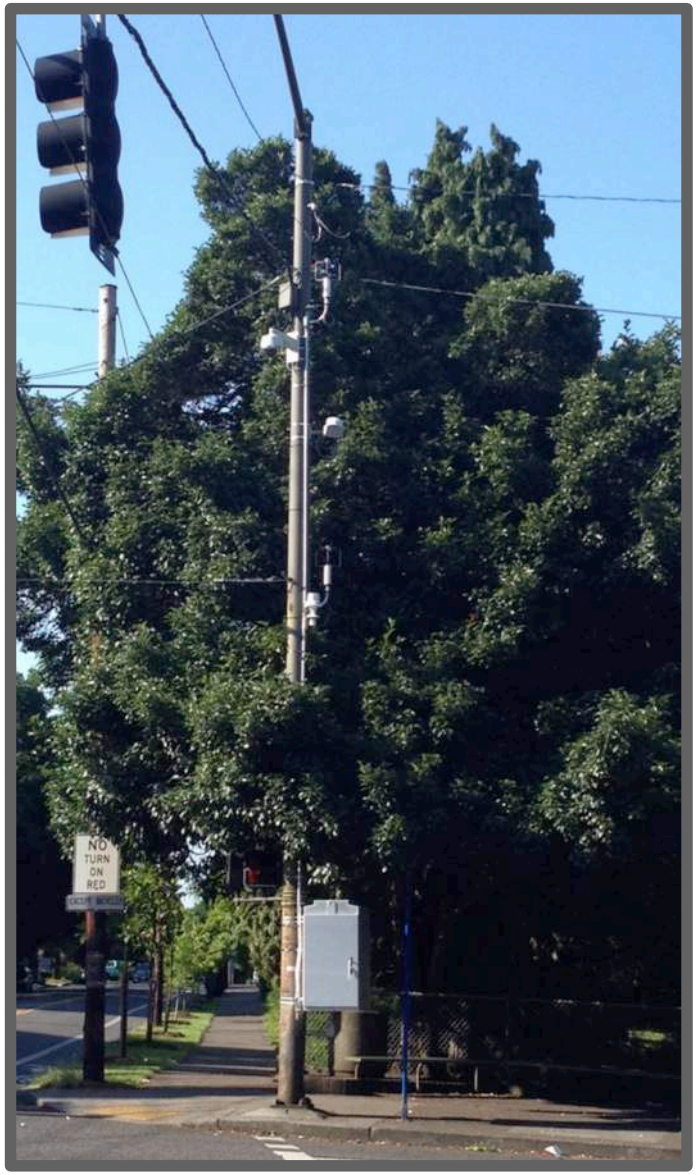
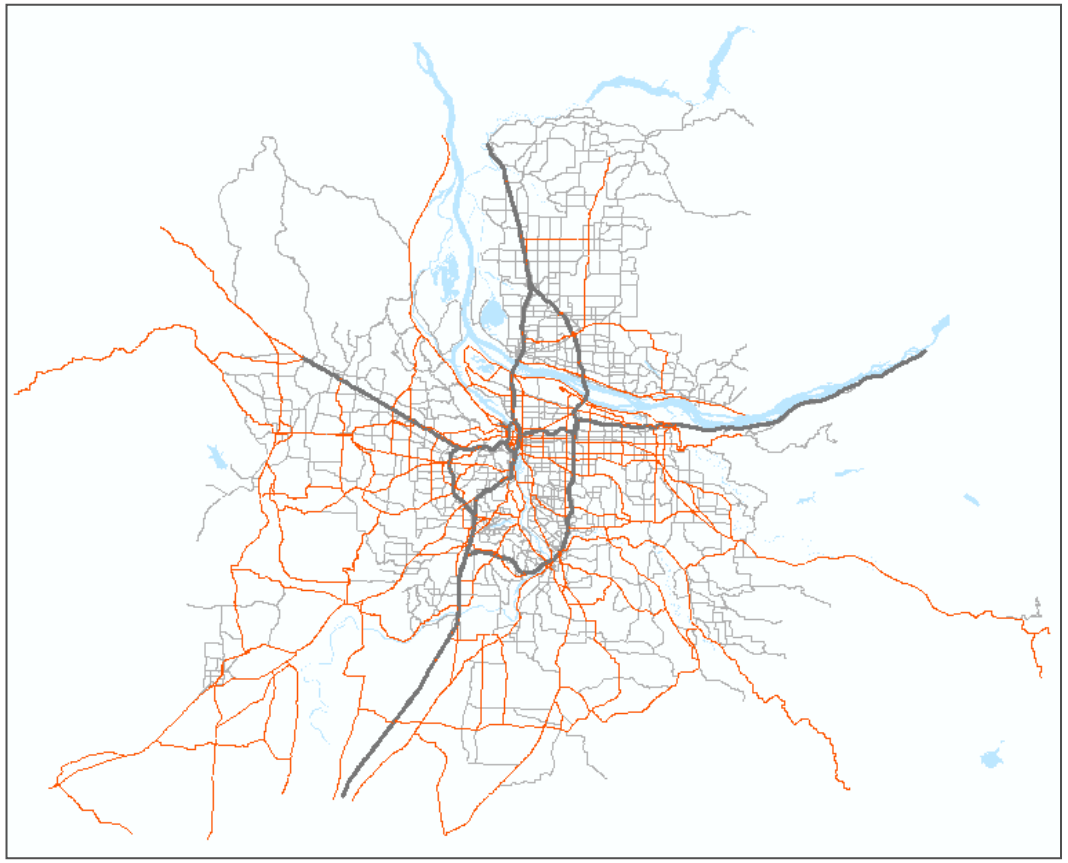


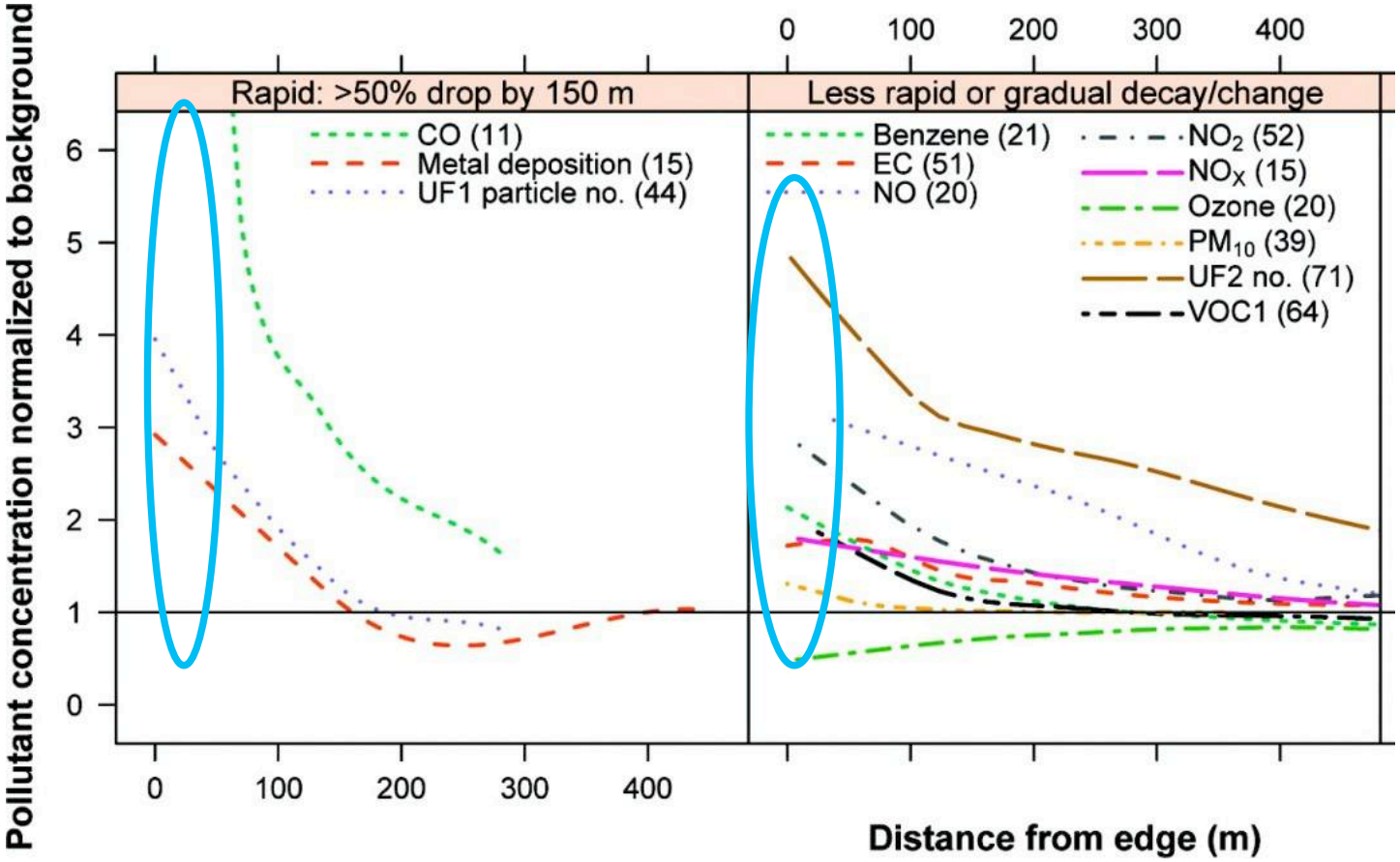
Motivation

- **Urbanization** is on the rise
- **Health impacts** are well established for those in closer proximity to traffic
- **Urban arterials** are key locations of increased exposures & under sampled
- **Mitigation opportunities** exist as arterials are seen as targets for adaptation



Portland RLIS Data

Research Objectives



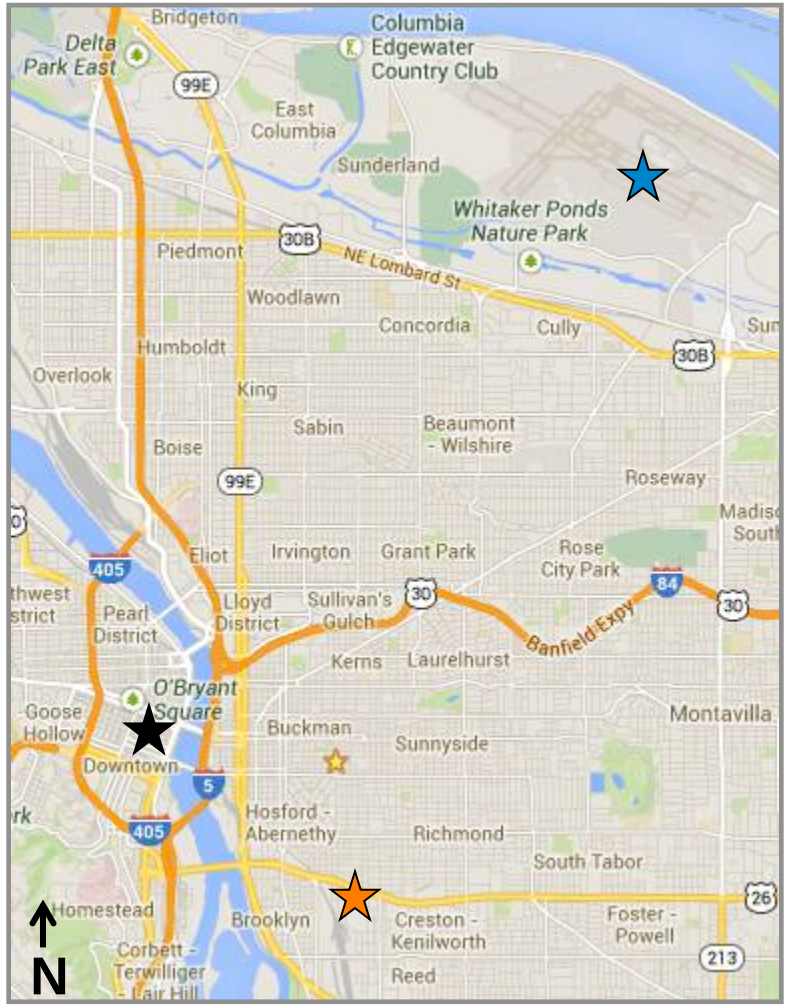
How well do traffic volumes perform as a proxy for roadside exposure concentrations?

Published in: Alex A. Karner; Douglas S. Eisinger; Deb A. Niemeier; *Environ. Sci. Technol.* **2010,** 44, 5334-5344.
DOI: 10.1021/es100008x

Research Objectives

- Traffic volumes frequently used as a proxy for exposure
- Epidemiology research moving beyond annual mean concentrations only for estimating exposure
- Promotion of active travel modes also increase the need for understanding exposure on shorter temporal scales

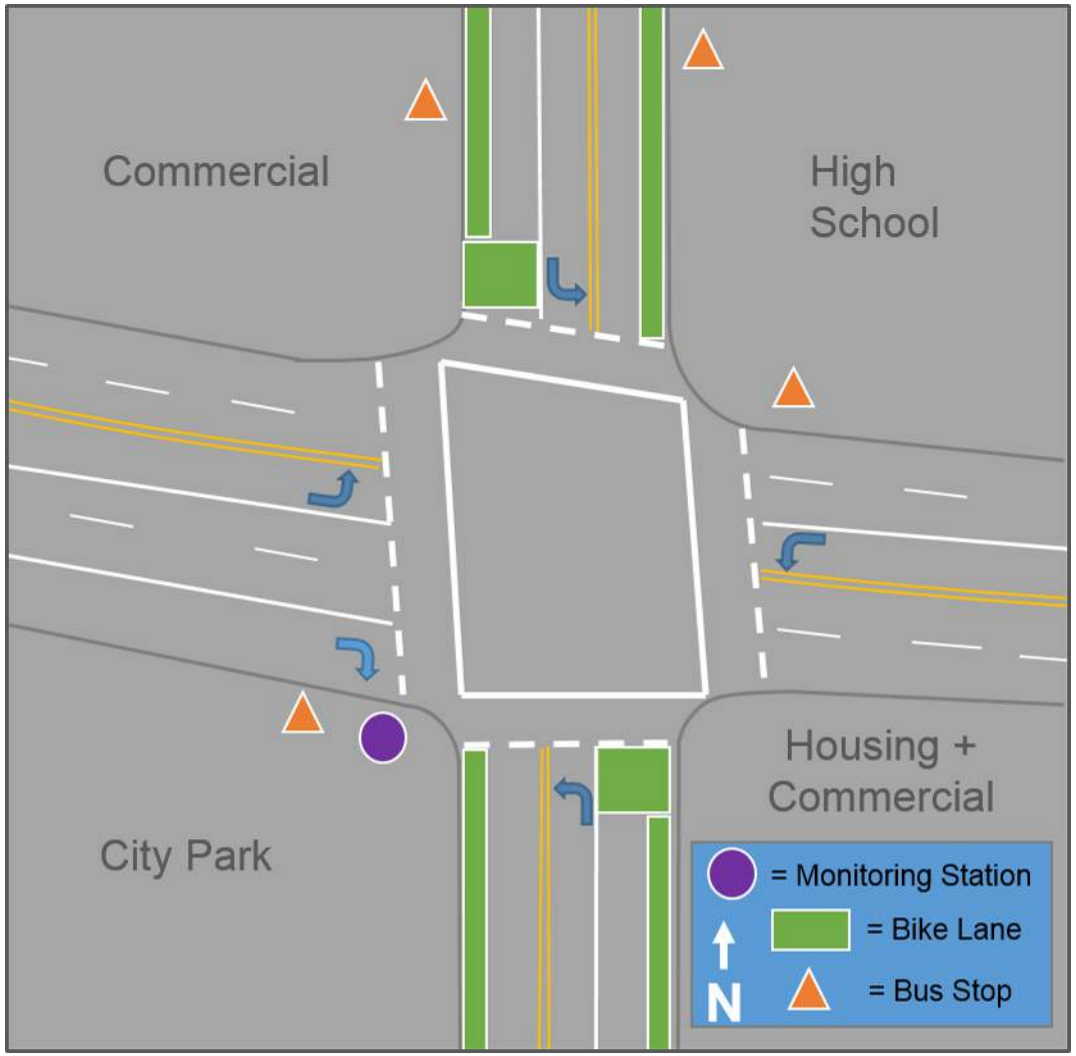
Roadside Station



Map data ©2013 Google

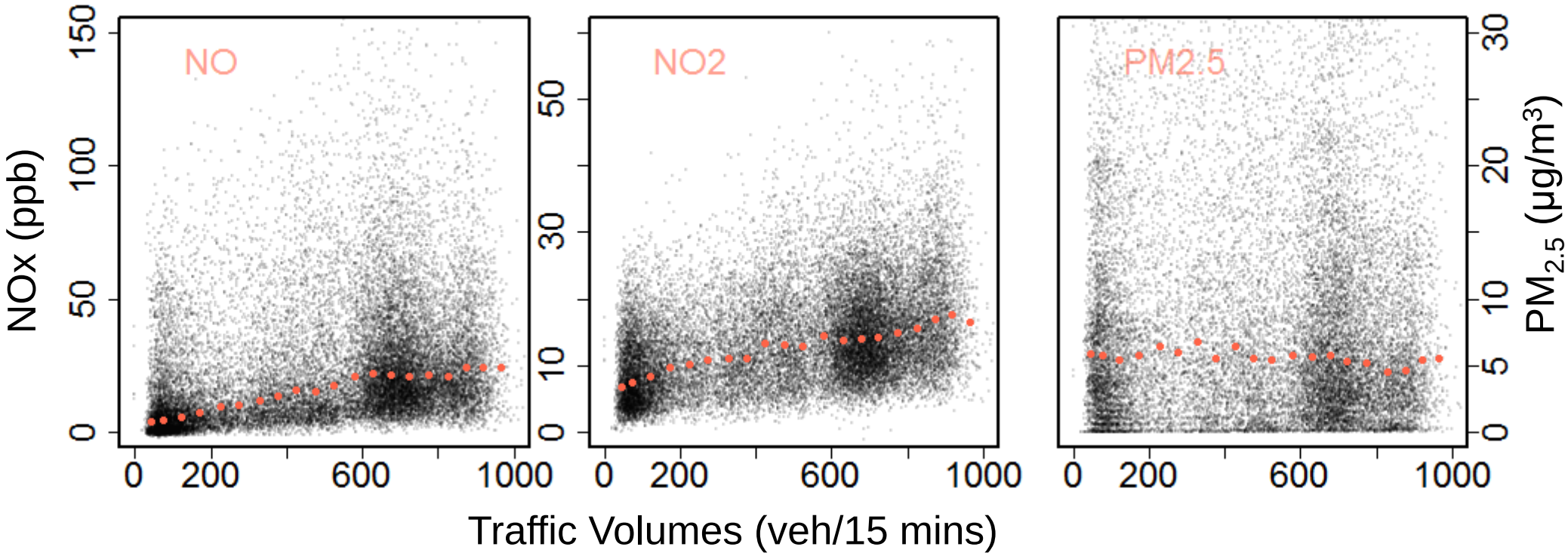
- Powell Boulevard
  - Major urban arterial and commuter corridor
  - AADT of 28,000 vehicles, 6% trucks on weekdays
  - Sydney Coordinated Adaptive Traffic Signal System (SCATS)
    - Traffic volumes, cycle lengths, degree of saturation, split and offset plans
- Intersection with SE 26th Ave
  - High compositional mix of road users

Roadside Station

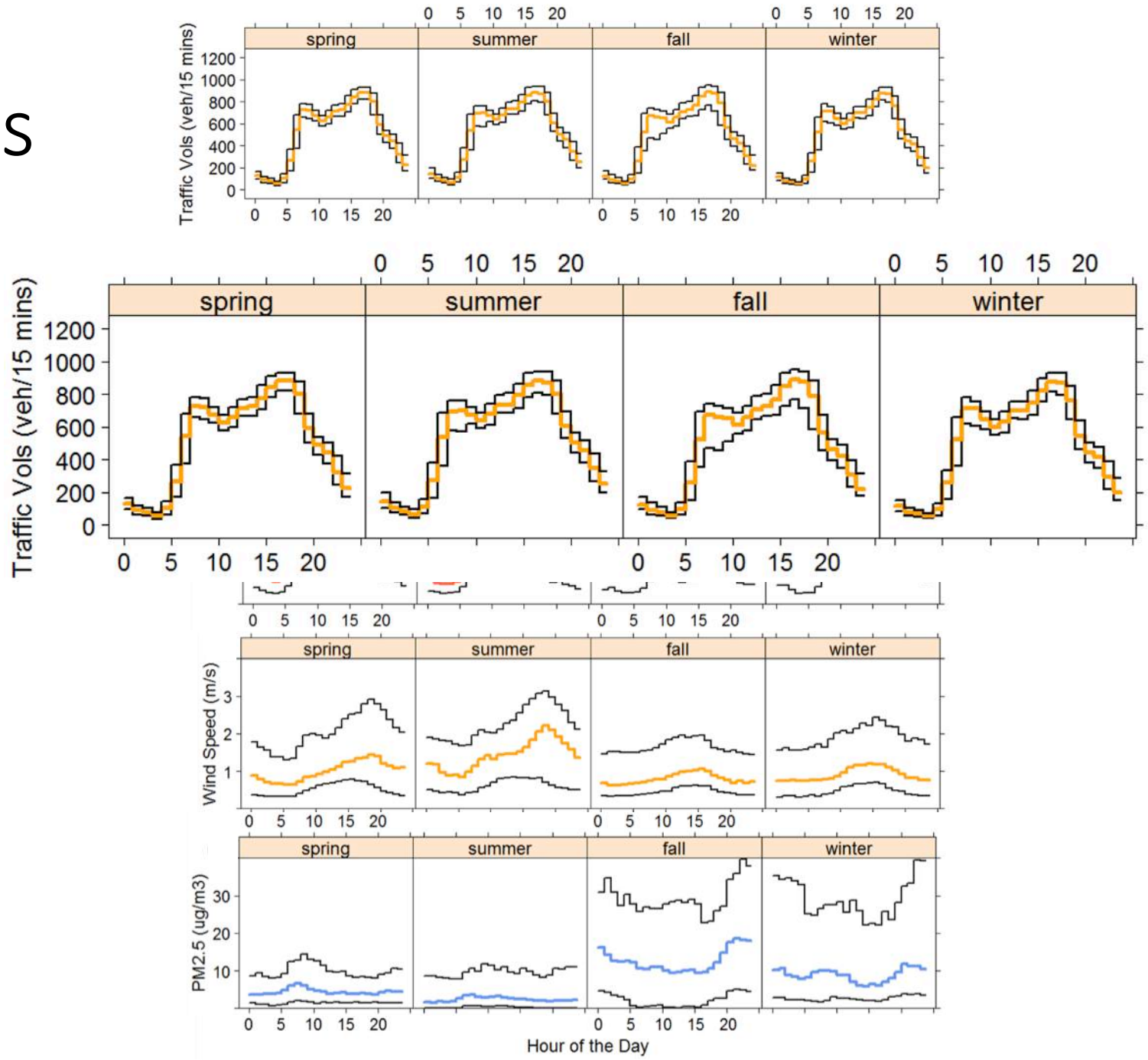


- Continuous monitoring:
  - NO,NO_2, NOx
  - $PM_{2.5}$
  - Wind speed & direction
  - Temp & relative humidity

Findings

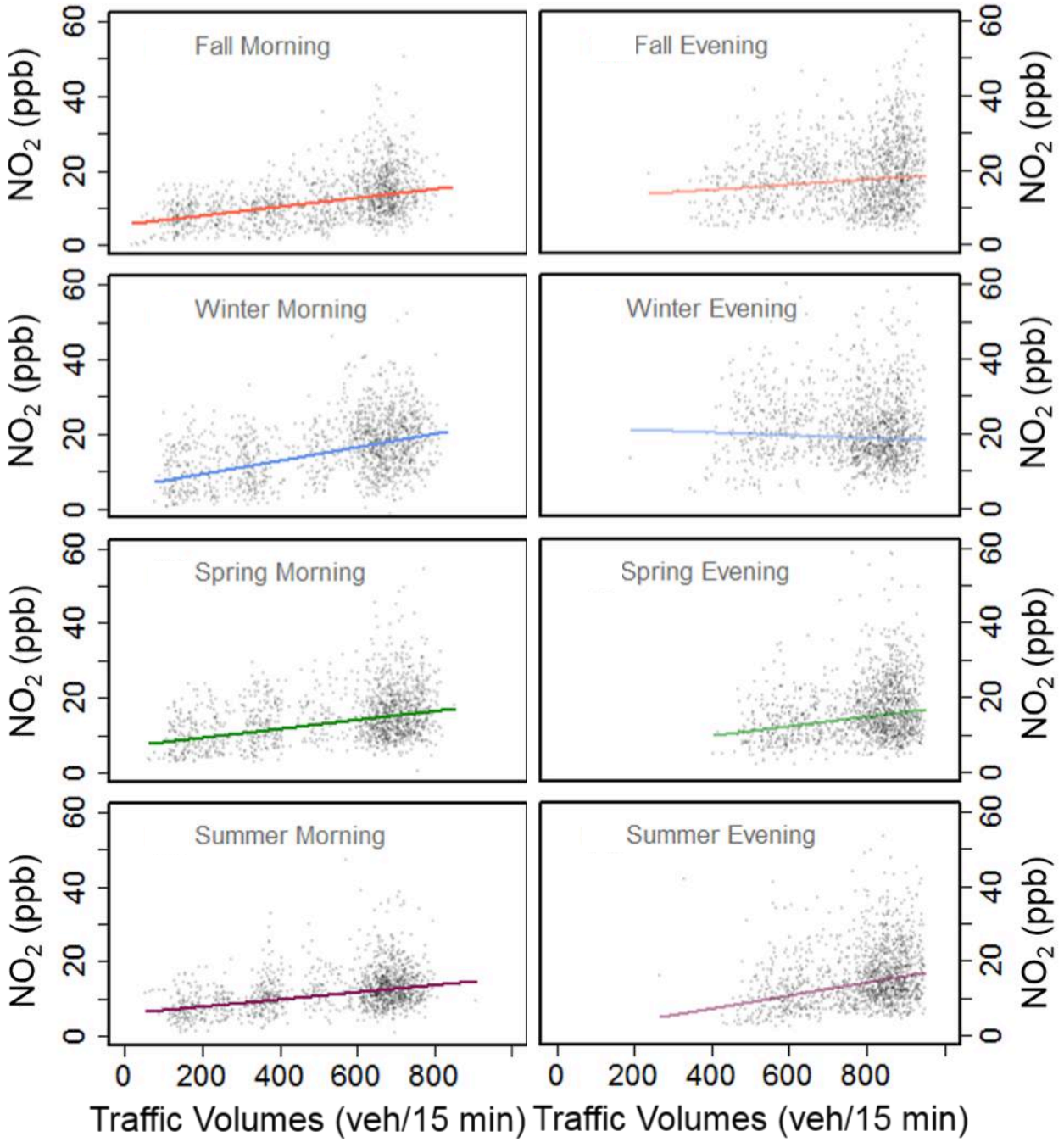

NO
NO2
PM2.5
NOx (ppb)
$PM_{2.5}$ (µg/m³)
Traffic Volumes (veh/15 mins)
0
50
100
150
10
30
5
20
200
600
1000

Findings

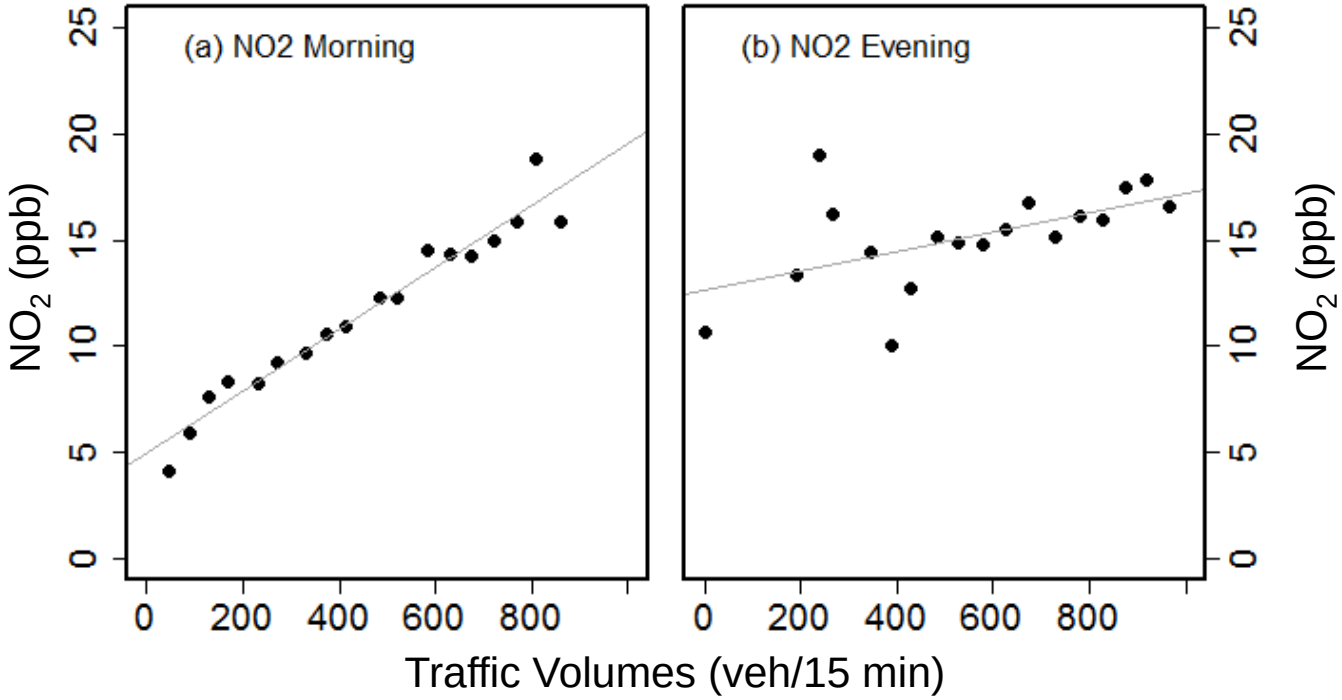

spring
summer
fall
winter
Traffic Vols (veh/15 mins)
Wind Speed (m/s)
PM2.5 (ug/m3)
Hour of the Day

Findings

- Morning periods across all seasons show significant linear relationship while evening periods do not
- However, variability is high
- Traffic volumes are not a good proxy at short-term time aggregations



Findings- Annual Scale



	Time Period	Coefficient NO per 100 vehicles	Adjusted r^2	Coefficient NO_2 per 100 vehicles	Adjusted r^2
Annual	Morning	3.8	0.83	1.5	0.94
Annual	Evening	0.1	-0.06	0.5	0.25

Implications of Findings

- Morning time periods are more consistent input throughout the year for modeling transportation and air quality impacts

- Other measures besides $PM_{2.5}$ mass may be needed at certain locations to capture the increased particulate exposure from traffic

- Short-term versus more coarse time aggregations for exposure estimates

Ongoing Work

Traffic Signal Effects

- Propensity score matching analysis to quantify the impacts of traffic signal interventions on roadside pollutant concentrations

Model Evaluation

- Uncertainty analysis of intersection variables for queue links in CALINE4 and queuing algorithm in CAL3QHC
- Model vs measurement comparisons for various meteorological & traffic conditions

Second Roadside Station

- Different arterial roadway- BC, NO, NO_2, NOx, $PM_{2.5}$

Thank you

- EPA Science To Achieve Results (STAR) Fellowship Program
- City of Portland, Portland Bureau of Transportation, Traffic Signals, Lighting and ITS Division
  - Willie Rotich, Lani Radtke
- National Institute for Transportation and Communities (NITC), Portland State University

Portland State UNIVERSITY

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PBOT PORTLAND BUREAU OF TRANSPORTATION

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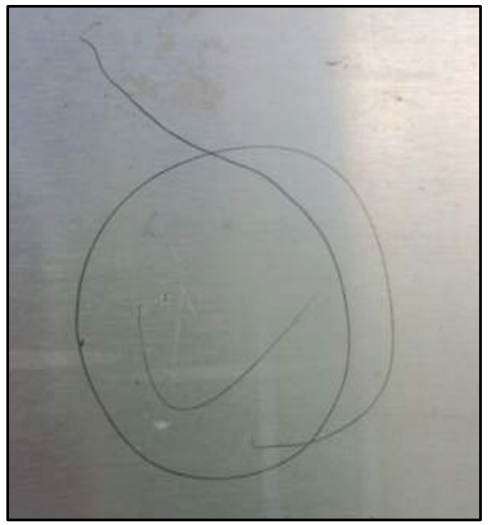
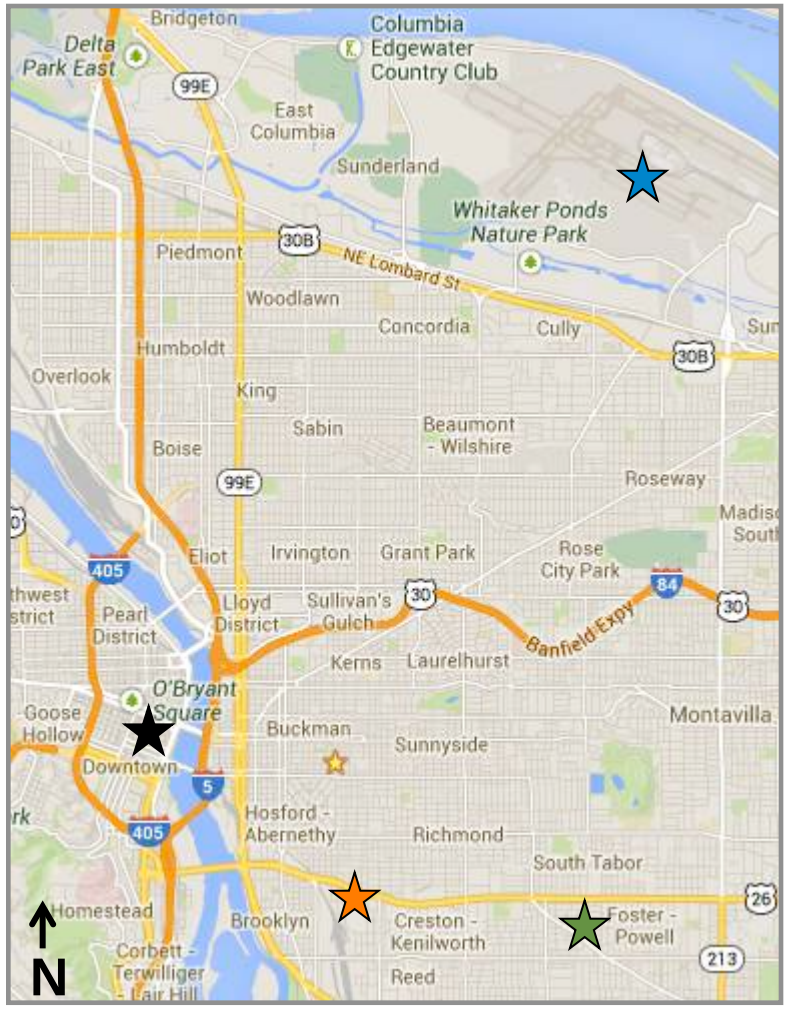


Urban Background



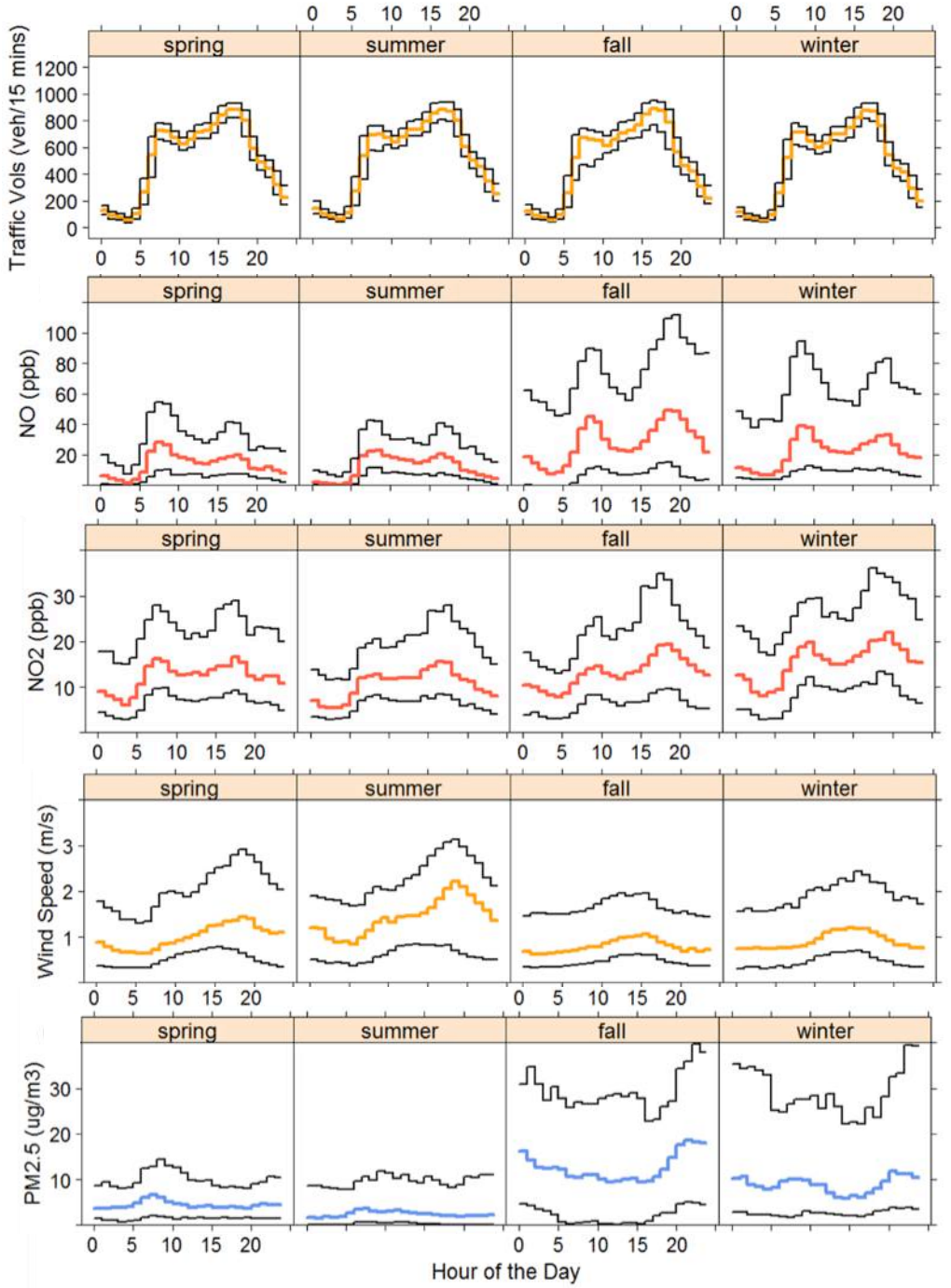
Map data ©2013 Google

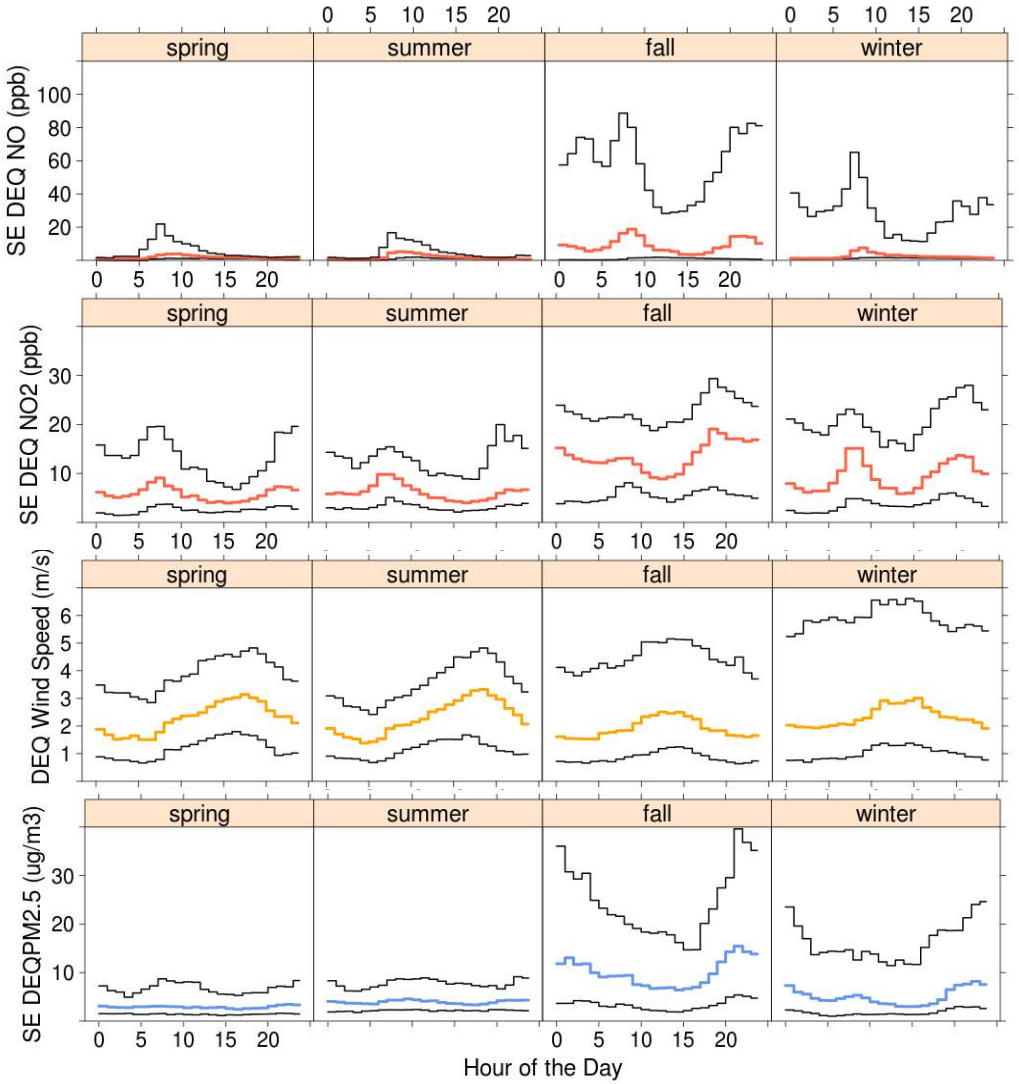
- DEQ Station- SE Lafayette & SE 58th
  - 3.4 km east of roadside station and 0.09km south of Powell Blvd

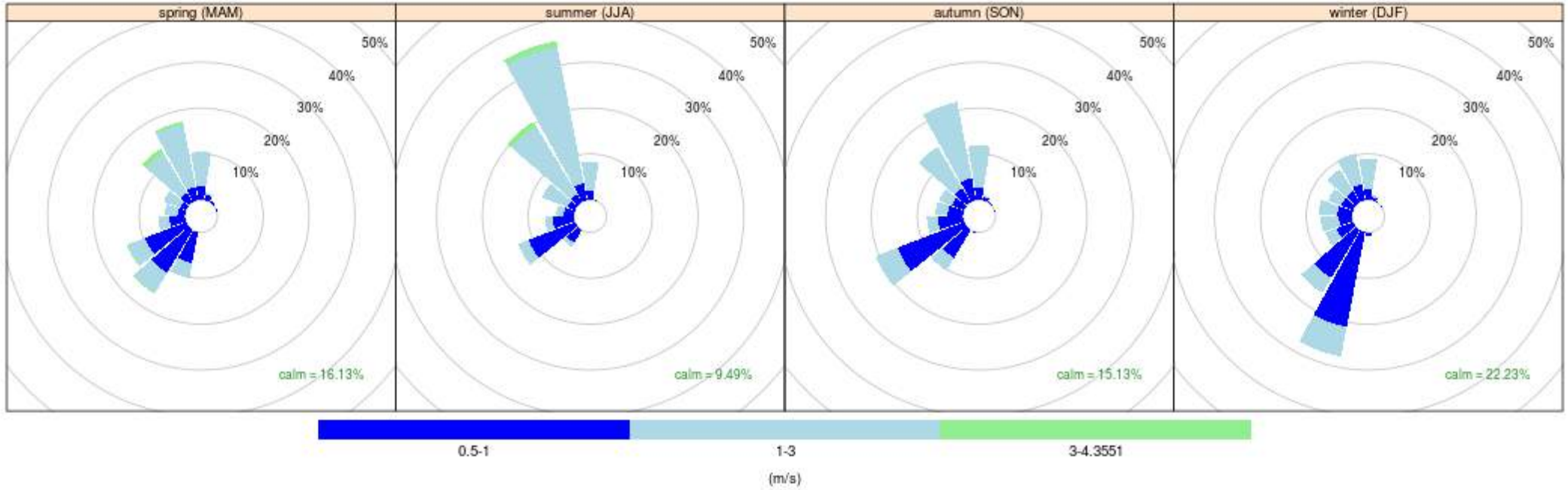
Comparison

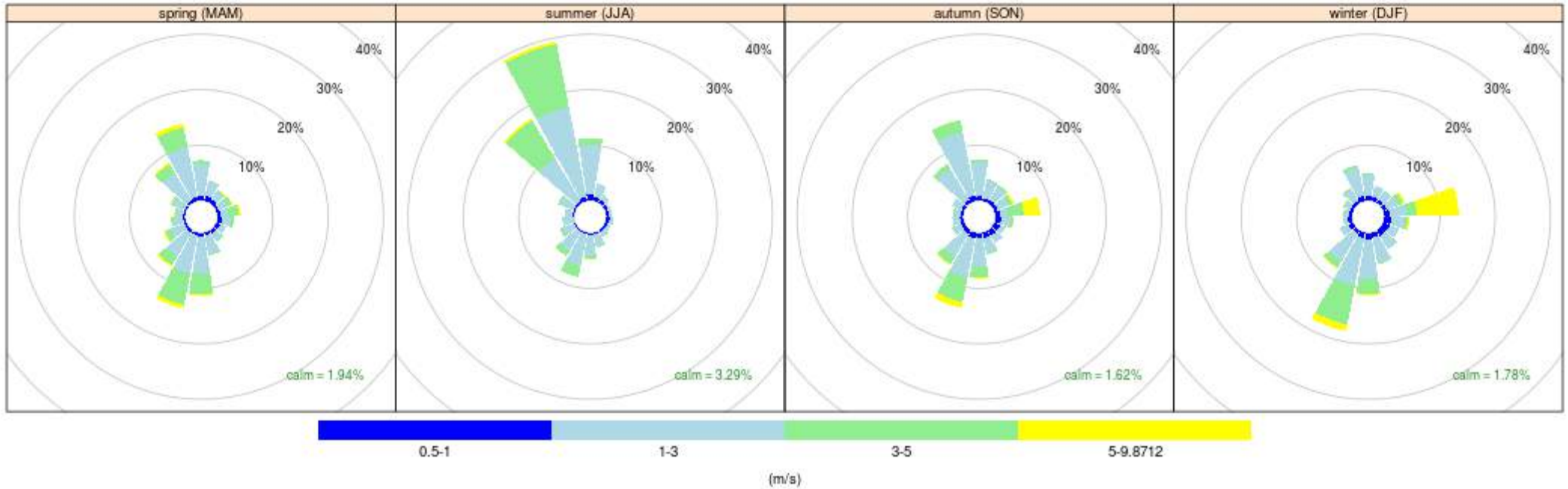
Pollutant	Weekdays		Weekends	
	Roadside Mean (5^{th}-95^{th} Percentiles)	**Urban Background** Mean (5^{th} – 95^{th} Percentiles)	**Roadside** Mean (5^{th}-95^{th} Percentiles)	**Urban Background** Mean (5^{th} – 95^{th} Percentiles)
NO (ppb)	24 (0.3-76)	9 (0.4 - 46)	14 (0 – 51)	7 (0.3- 36)
NO_2 (ppb)	14 (4 - 30)	10 (2 – 23)	10 (3 – 22)	8 (2 -20)
$PM_{2.5}$ (µg/m^3)	9 (0.2 – 28)	7 (1-21)	8 (0 – 27)	7 (1 – 21)
Traffic Volumes/ 15 mins	503 (64-887)		401 (73- 728)	

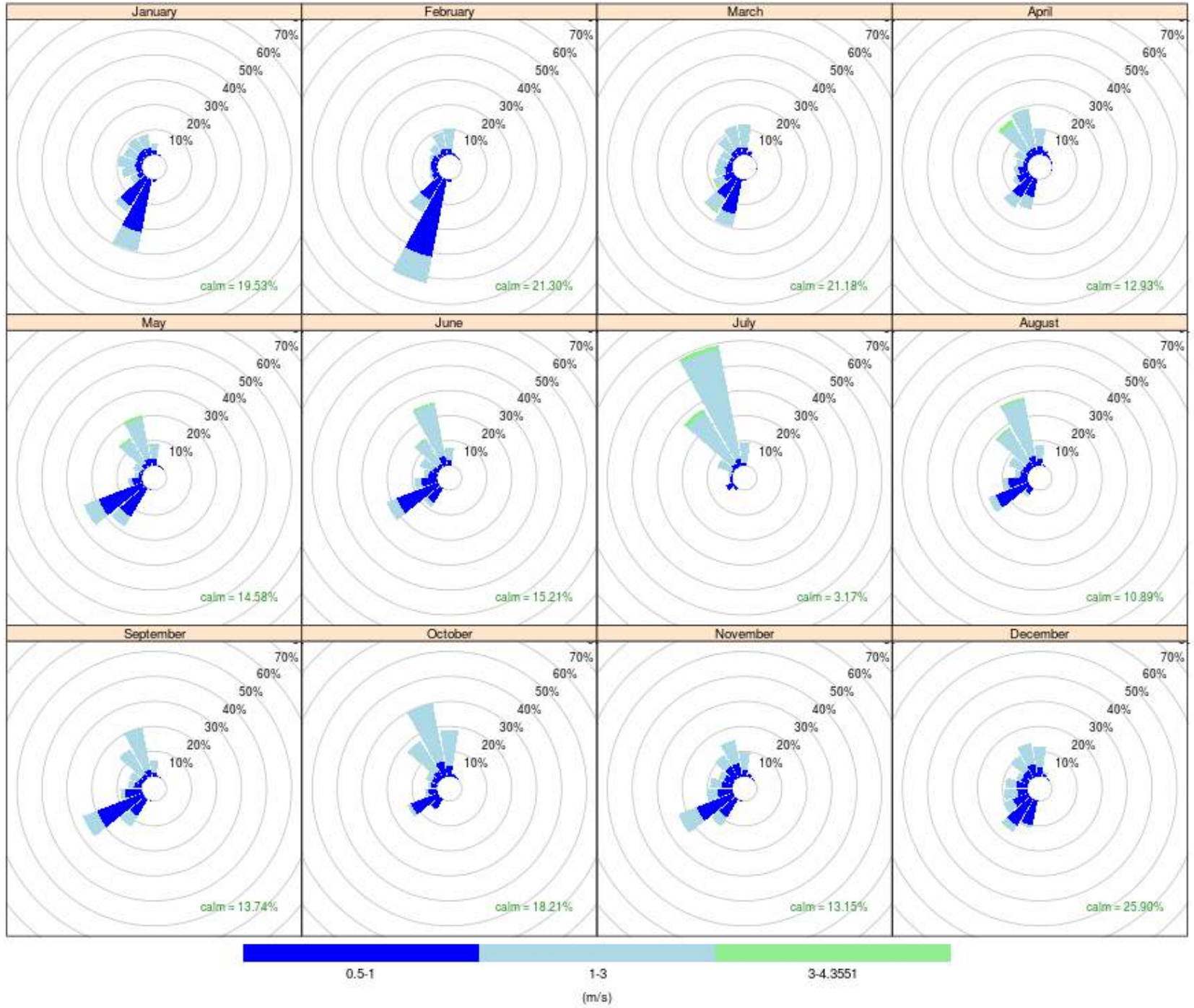
SE Lafayette DEQ

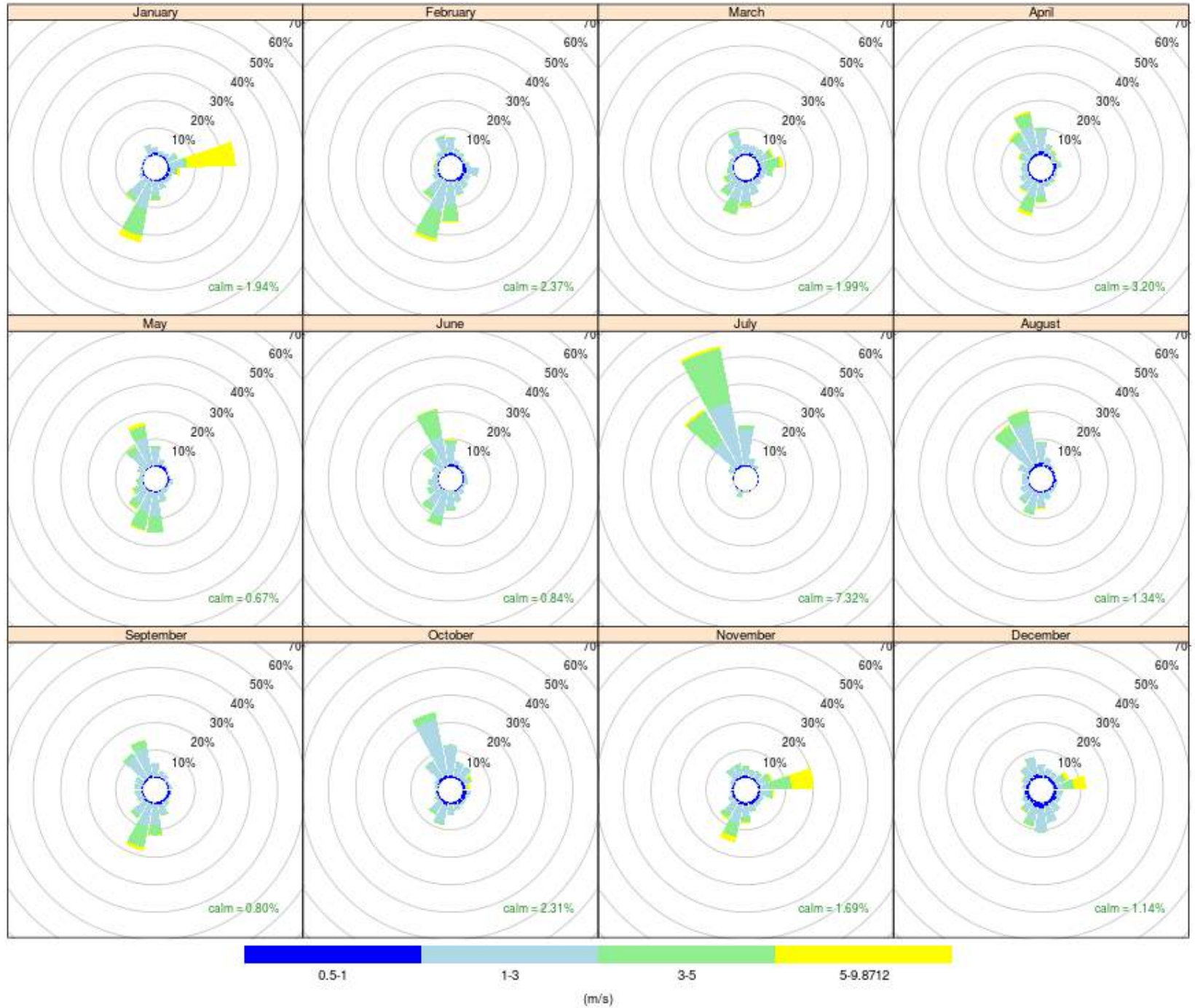





spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
50%
40%
30%
20%
10%
calm = 16.13%
calm = 9.49%
calm = 15.13%
calm = 22.23%
0.5-1
1-3
3-4.3551
(m/s)


spring (MAM)
summer (JJA)
autumn (SON)
winter (DJF)
40%
30%
20%
10%
calm = 1.94%
calm = 3.29%
calm = 1.62%
calm = 1.78%
0.5-1
1-3
3-5
5-9.8712
(m/s)


January
calm = 19.53%
February
calm = 21.30%
March
calm = 21.18%
April
calm = 12.93%
May
calm = 14.58%
June
calm = 15.21%
July
calm = 3.17%
August
calm = 10.89%
September
calm = 13.74%
October
calm = 18.21%
November
calm = 13.15%
December
calm = 25.90%
10%
20%
30%
40%
50%
60%
70%
0.5-1
1-3
3-4.3551
(m/s)


January
February
March
April
May
June
July
August
September
October
November
December
10%
20%
30%
40%
50%
60%
70
calm = 1.94%
calm = 2.37%
calm = 1.99%
calm = 3.20%
calm = 0.67%
calm = 0.84%
calm = 7.32%
calm = 1.34%
calm = 0.80%
calm = 2.31%
calm = 1.69%
calm = 1.14%
0.5-1
1-3
3-5
5-9.8712
(m/s)

Season	Time Period	Coefficient NO per 100 vehicles	Adjusted r^2	Coefficient NO_2 per 100 vehicles	Adjusted r^2
Fall	Morning	6	0.15	1.2	0.22
Winter	Morning	5	0.14	1.8	0.19
Spring	Morning	3.5	0.19	1.2	0.13
Summer	Morning	3.6	0.33	1	0.15
Fall	Evening	-0.2	0.0007	0.7	0.04
Winter	Evening	-0.6	0.002	-0.4	0.0003
Spring	Evening	3	0.09	1.3	0.06
Summer	Evening	3.7	0.11	1.7	0.07