Estimating Exposure to Residential Woodsmoke in Rochester, NY

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OUTLINE

- Exposure Assessment
- Rochester Results
  - General Exposure
  - Local Exposure
- Summary/Conclusions

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Exposure Assessment

- Exposure is the amount of time people are in contact with specific concentrations of woodsmoke or other biomass burning particles.
- We want to separate the woodsmoke component from other sources of PM based on the measured chemical constituents.

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Receptor Models

- Receptor models use the different patterns of composition that different sources emit to separate the measured particle compositions into how much of the material comes from each source.

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Measurements in Rochester

- Fixed site measurements at NYS DEC site
  - Particle compositions every third day
  - Light absorption at 2 wavelengths (370 and 880 nm)

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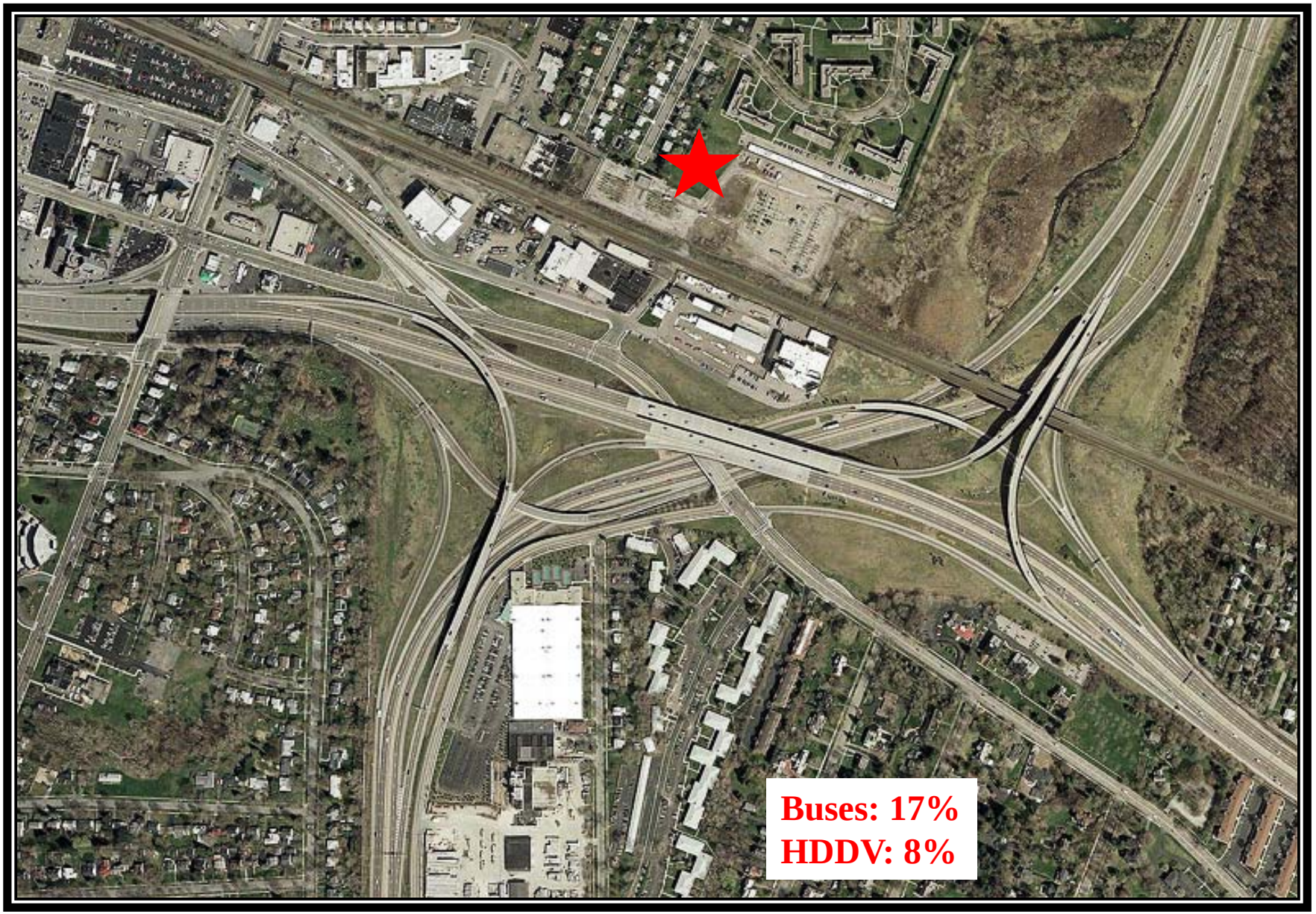
Rochester, New York



Black Carbon and Delta-C

- The two-wavelength aethalometer measures the optical absorption of PM at 880 nm (BC) and 370 nm (UVBC).
- Organic aerosol components of wood combustion PM enhance optical absorption at 370 nm relative to 880 nm.

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Black Carbon and Delta-C

- The difference in the amount of black carbon measured at 880 nm and 370 nm is defined to be Delta-C.
- Prior work has suggested that Delta-C provides a good indicator of biomass burning.

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Black Carbon and Delta-C

- A definitive indicator of biomass burning is levoglucosan, a sugar produced by the decomposition of cellulose.

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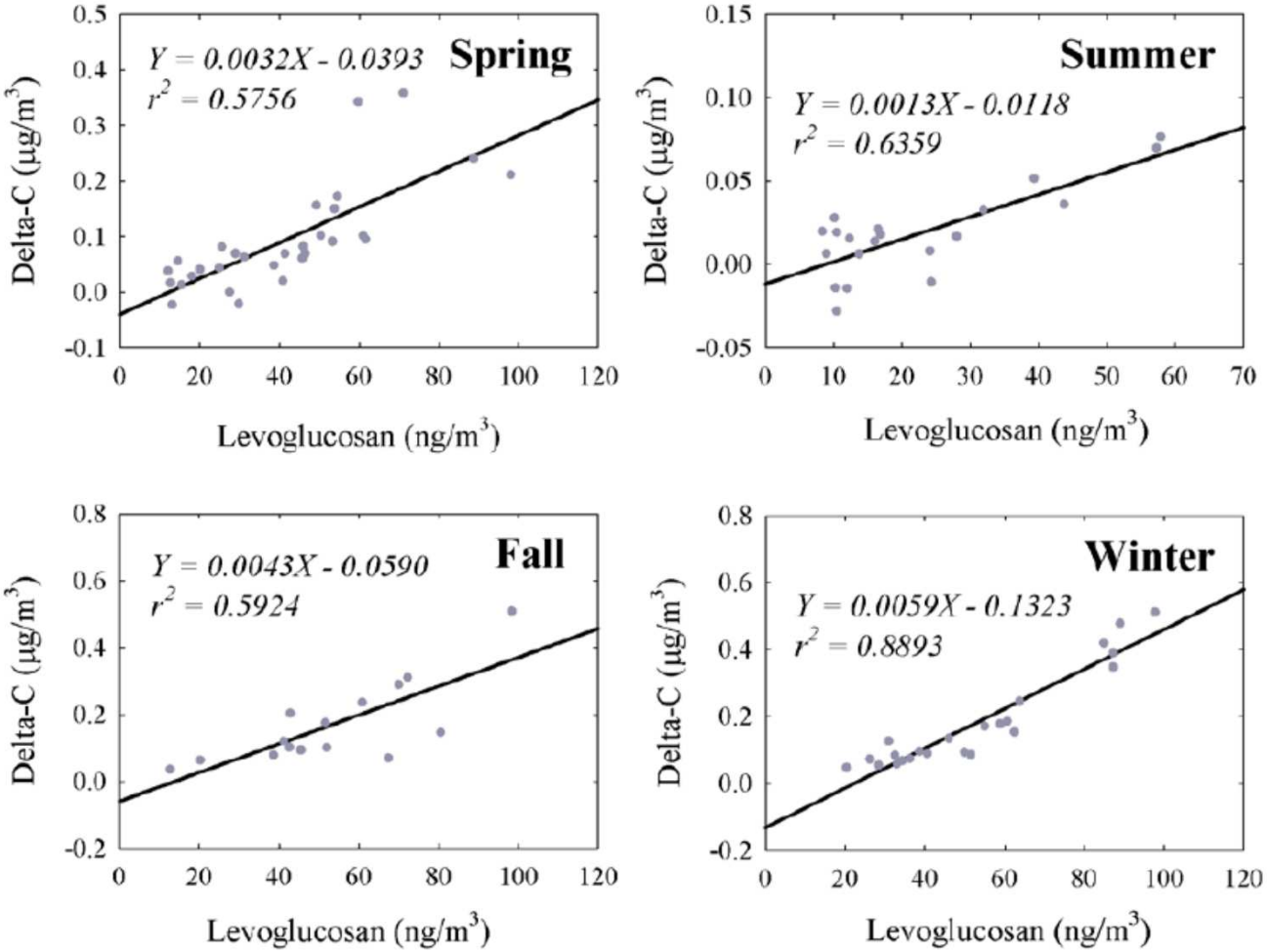
Delta-C and Levoglucosan



Linear regression analysis results between Delta-C and levoglucosan during spring, summer, fall, and winter.

Results

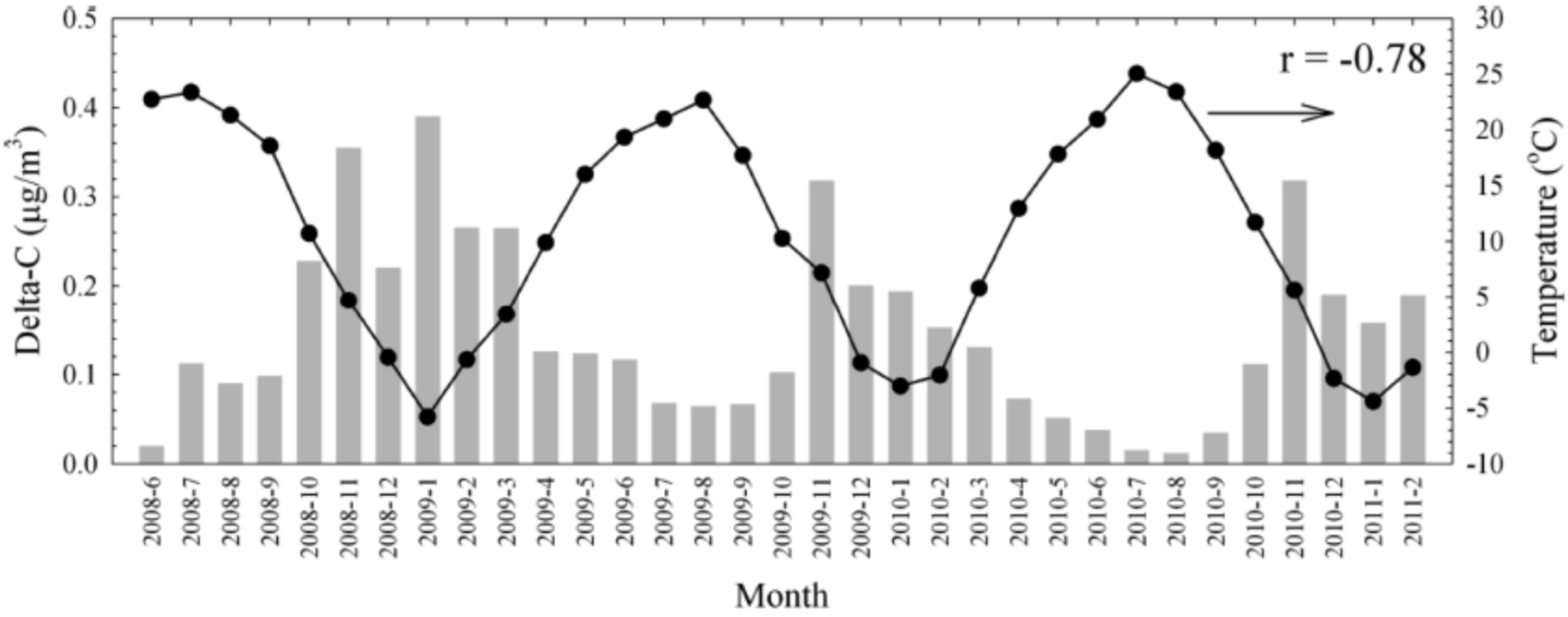


Figure 1. Time series plot of the monthly average Delta-C values (gray bars) and ambient temperature (solid circles). The correlation coefficient between the two variables is shown in the top-right corner.

Results (cont.)

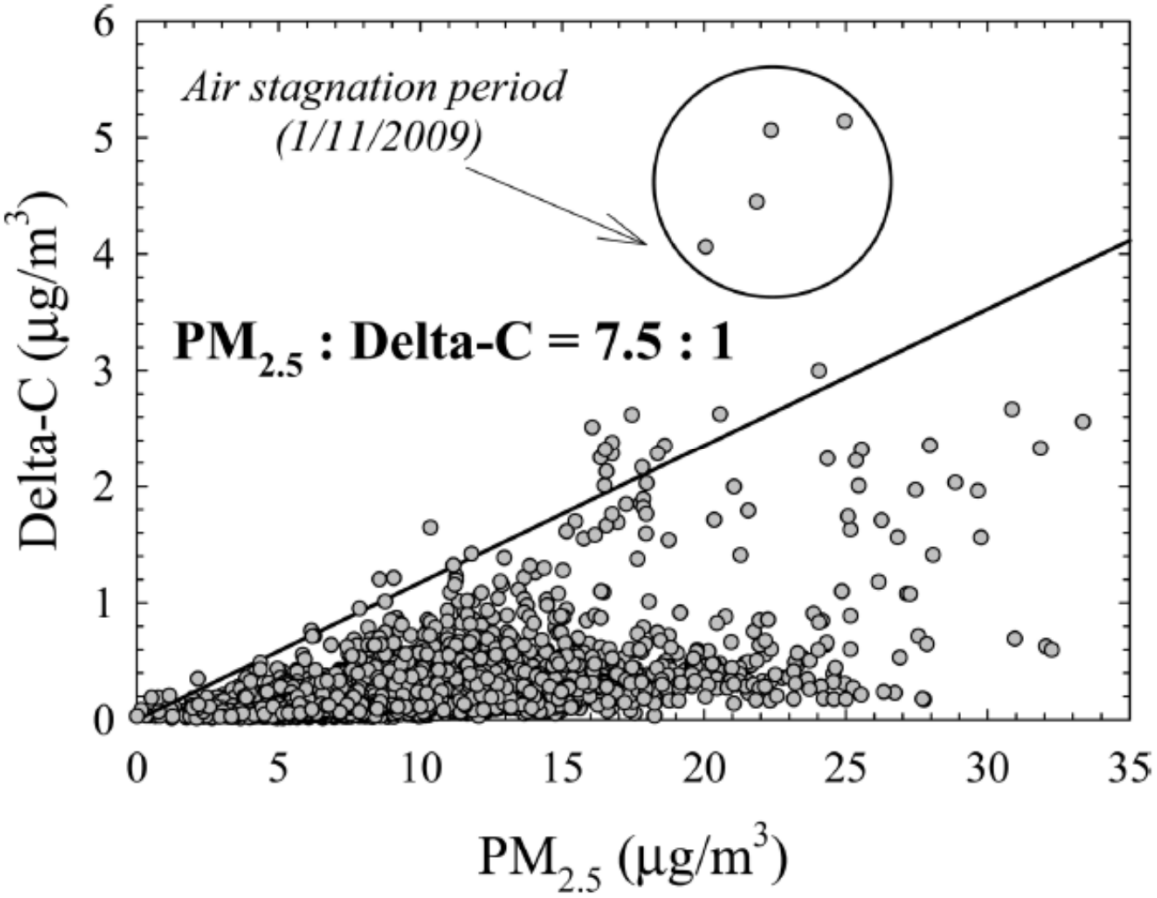


Figure 5. The scatter plot of hourly Delta-C versus $PM_{2.5}$ concentrations during winter. The edge is shown by the black solid line.

Source Apportionment in Rochester

- An edge with $PM_{2.5}$ to Delta-C ratio of 7.5 was observed. The Rochester RWC contribution to winter $PM_{2.5}$ can, therefore, be estimated to be 17%.
- Similar results were obtained from the composition data.

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Source Apportionment in Rochester

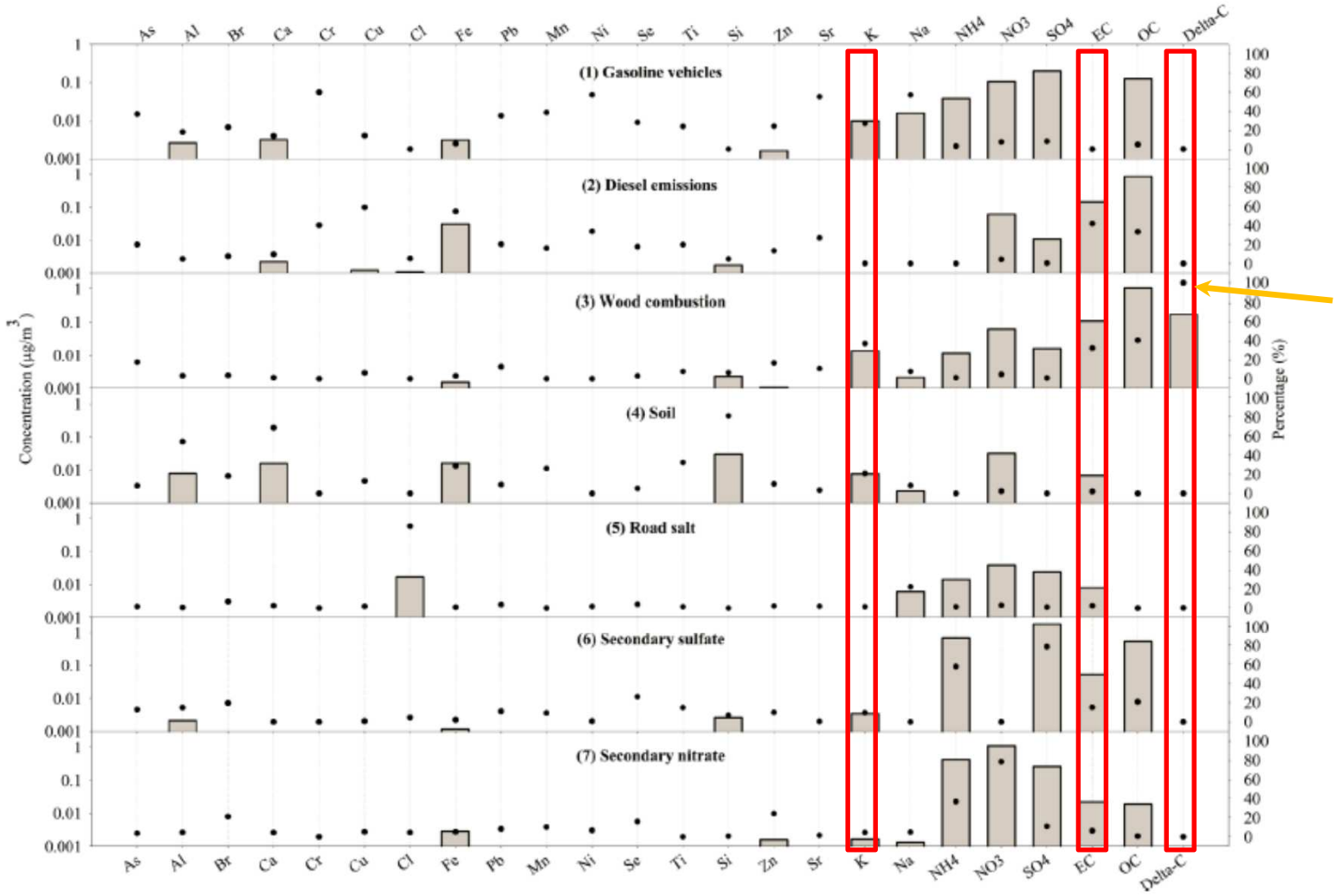

Figure 6. PMF source profiles. Gray bar and black dot indicate the concentration and percentage contribution of each species, respectively.

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Source Apportionment in Rochester

- The annual average contribution

Wang et al., Atm Env 2012		Wang et al., JAWMA 2012	
Soil	1.02	Soil	0.45
Wood combustion	0.72	Wood combustion	0.84
Diesel emissions	0.62	Diesel emissions	1.45
Gasoline vehicles	0.63	Gasoline vehicles	1.73
Secondary nitrate	0.50	Secondary nitrate	1.00
Secondary sulfate	3.62	Secondary sulfate	3.72
Isoprene SOA	0.55	Road salt	0.12
Other SOA	0.29		

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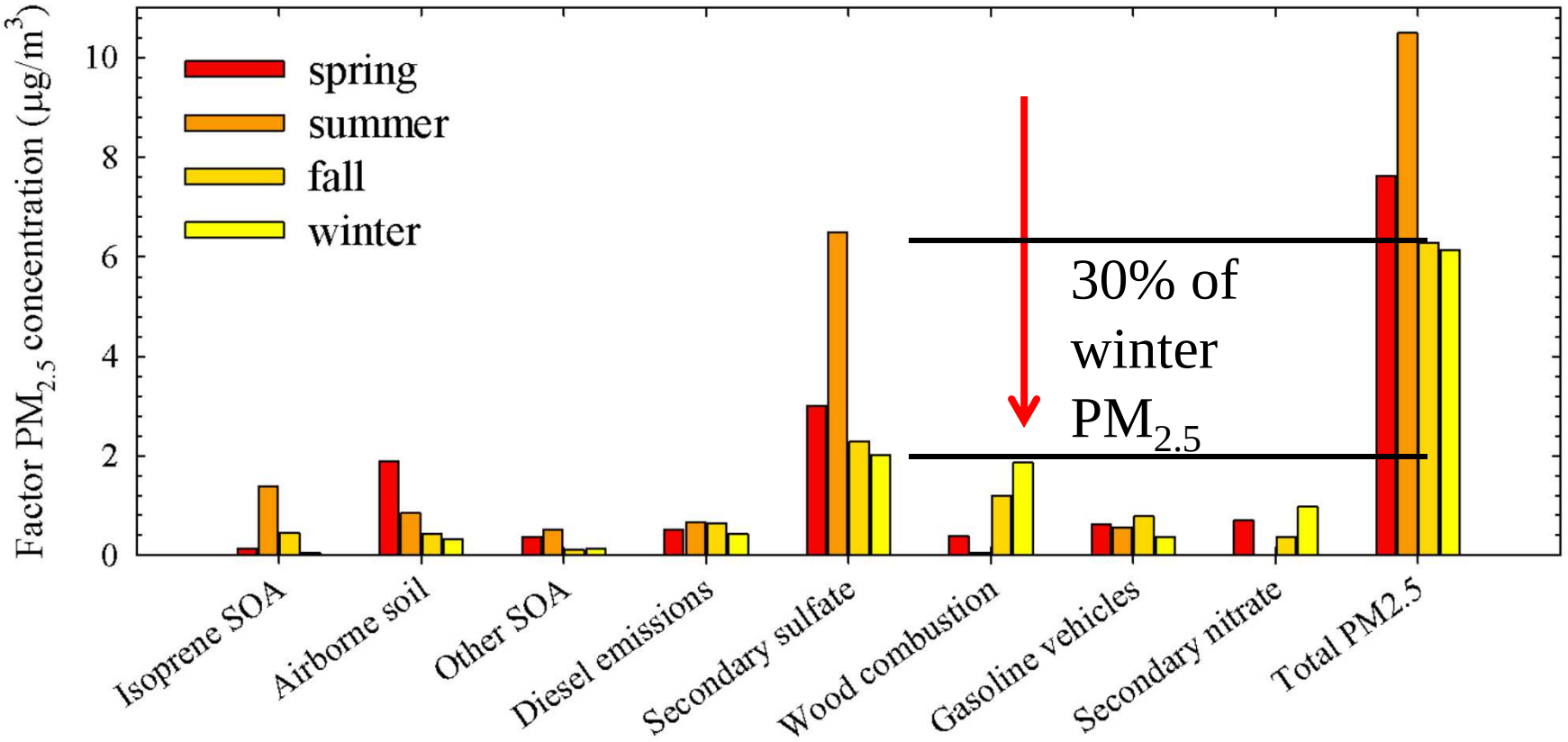
Source Apportionment in Rochester



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Mobile Measurements in Rochester

- Mobile measurements around the east side of Rochester
  - Particle size distributions
  - Light absorption at 2 wavelengths

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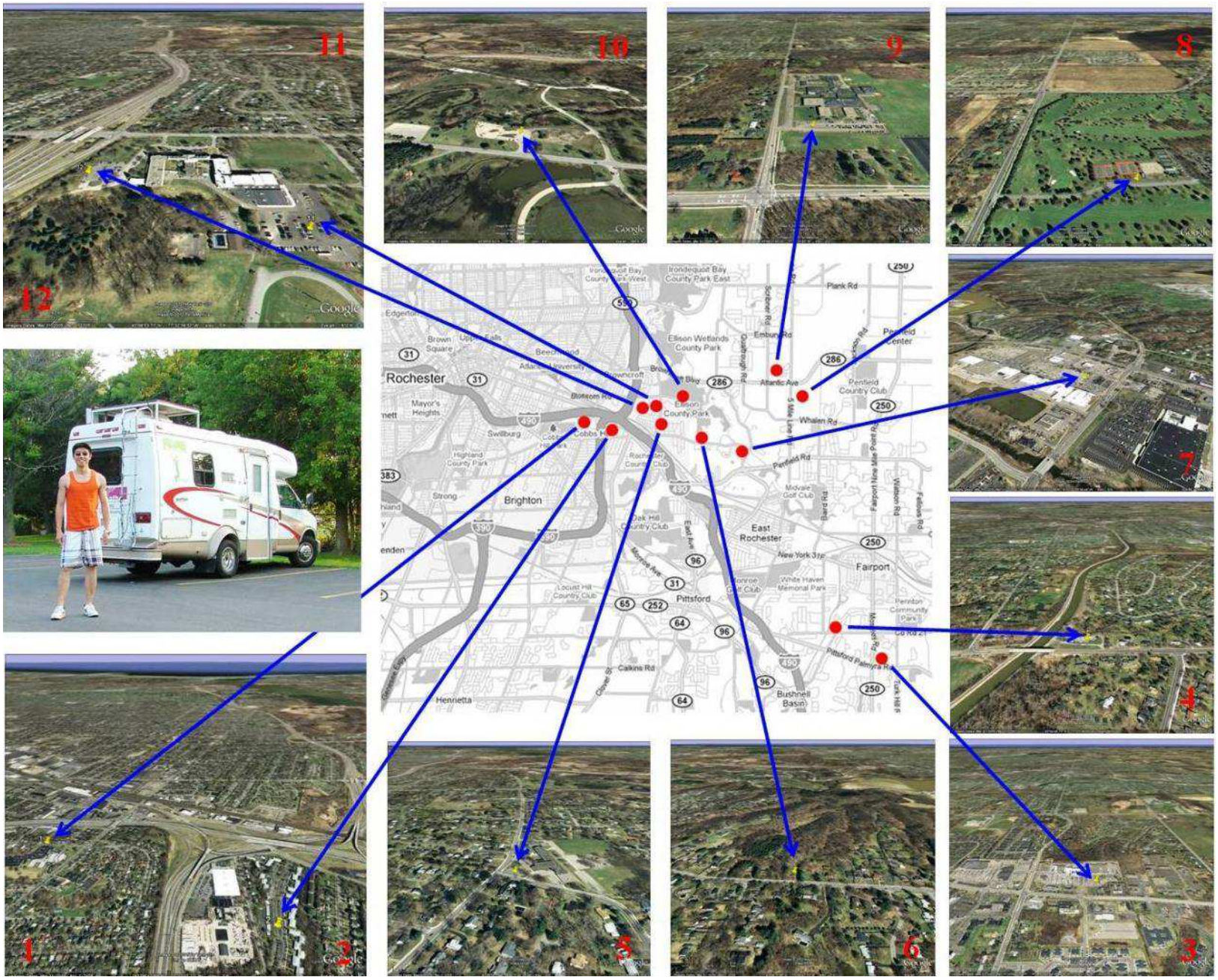
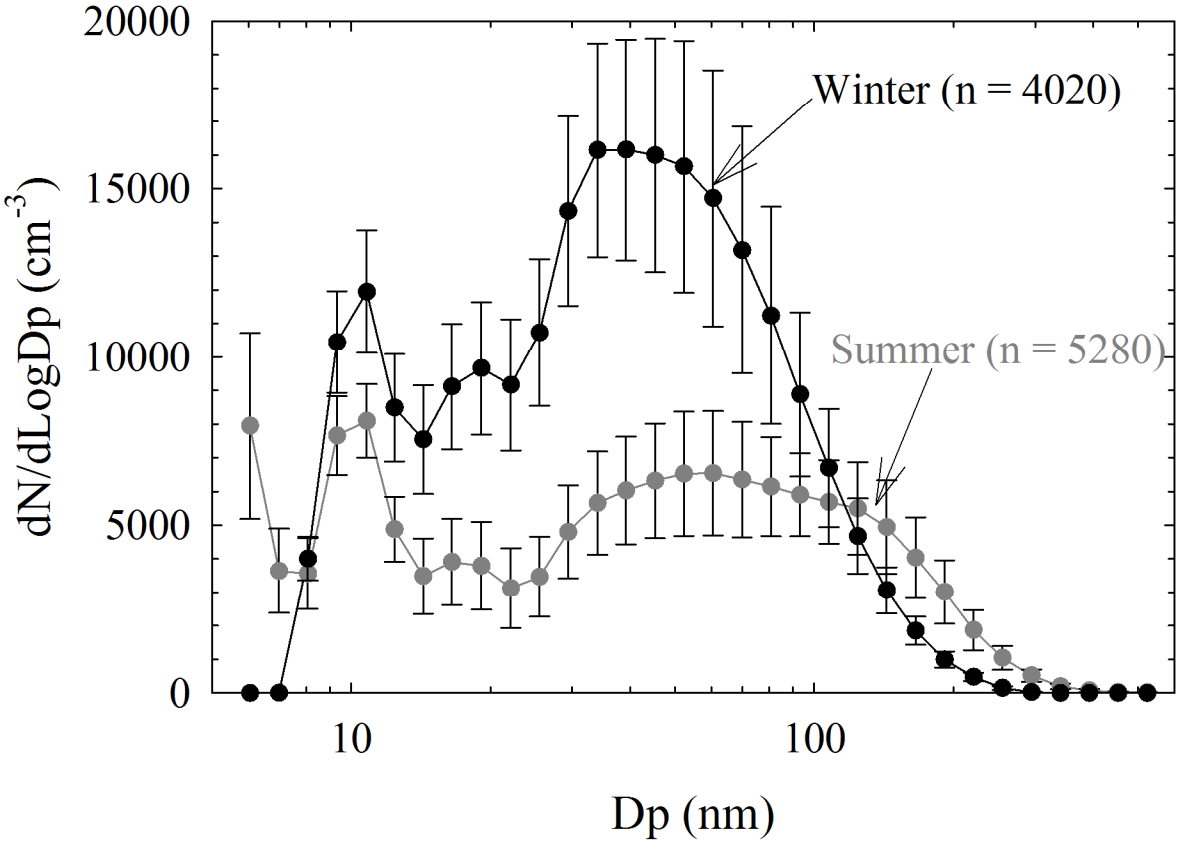
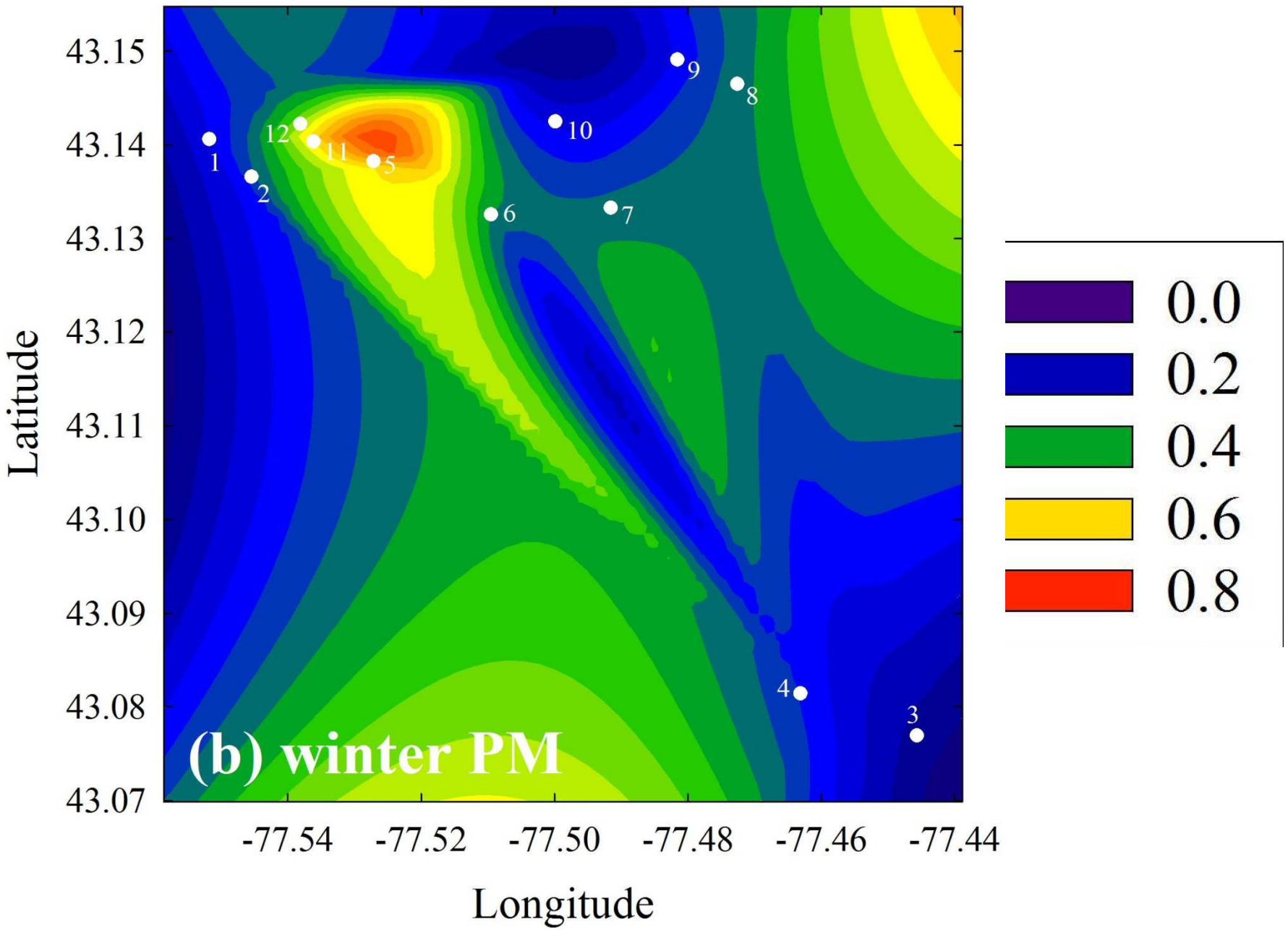

11
10
9
8
12
7
Rochester
Brighton
East Rochester
Fairport
Pittsford
Henrietta
Bushnell Basin
1
5
6
3
4
2

Particle size distributions at site 5 during summer and winter 2009




43.15
43.14
43.13
43.12
43.11
43.10
43.09
43.08
43.07
Latitude
-77.54
-77.52
-77.50
-77.48
-77.46
-77.44
Longitude
1
2
3
4
5
6
7
8
9
10
11
12
(b) winter PM
0.0
0.2
0.4
0.6
0.8

LOCAL SCALE EXPOSURES

- Peak PM concentrations of biomass smoke reached ~6 $\mu g/m^3$ in the vicinity of a source area.
- There is also an increase in particles in size ranges that are effectively deposited in the conducting airways.

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LOCAL SCALE EXPOSURES

- Thus, local exposure to biomass smoke such as would occur in the vicinity of a source area could be higher than that experienced by the general population.

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CONCLUSIONS

- Woodsmoke in winter represent a significant source of PM2.5 and ultrafine particles
- Local exposures can be significantly higher than those across the community.

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Thanks for your attention!

QUESTIONS?

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