Pattern and Process in Complex Urban Environments
Opportunities for Expanding NADP into Cities

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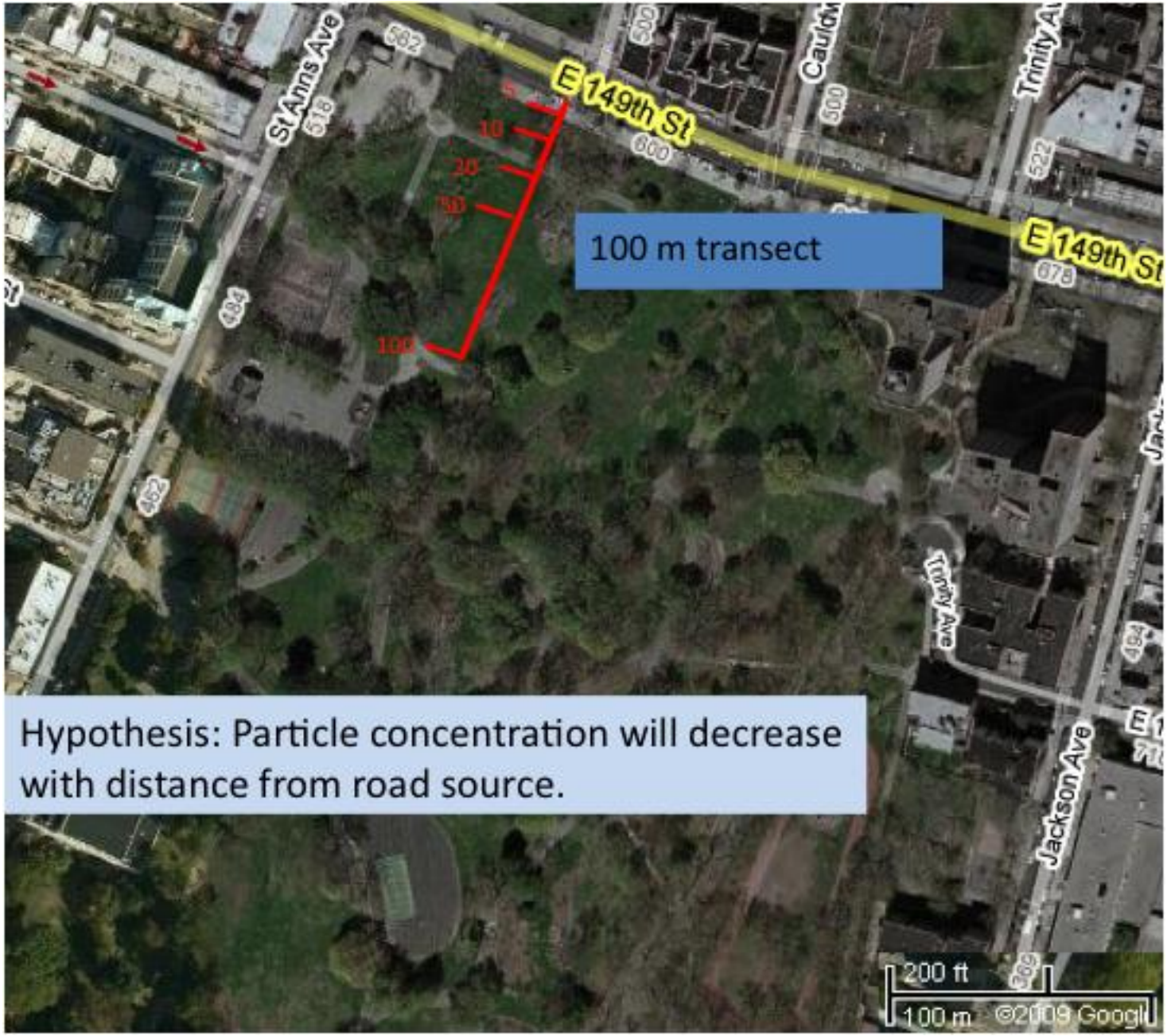
3 Sources of Atmospheric Input:
Long distance transport: Continental + Regional

Regional, proximate sources

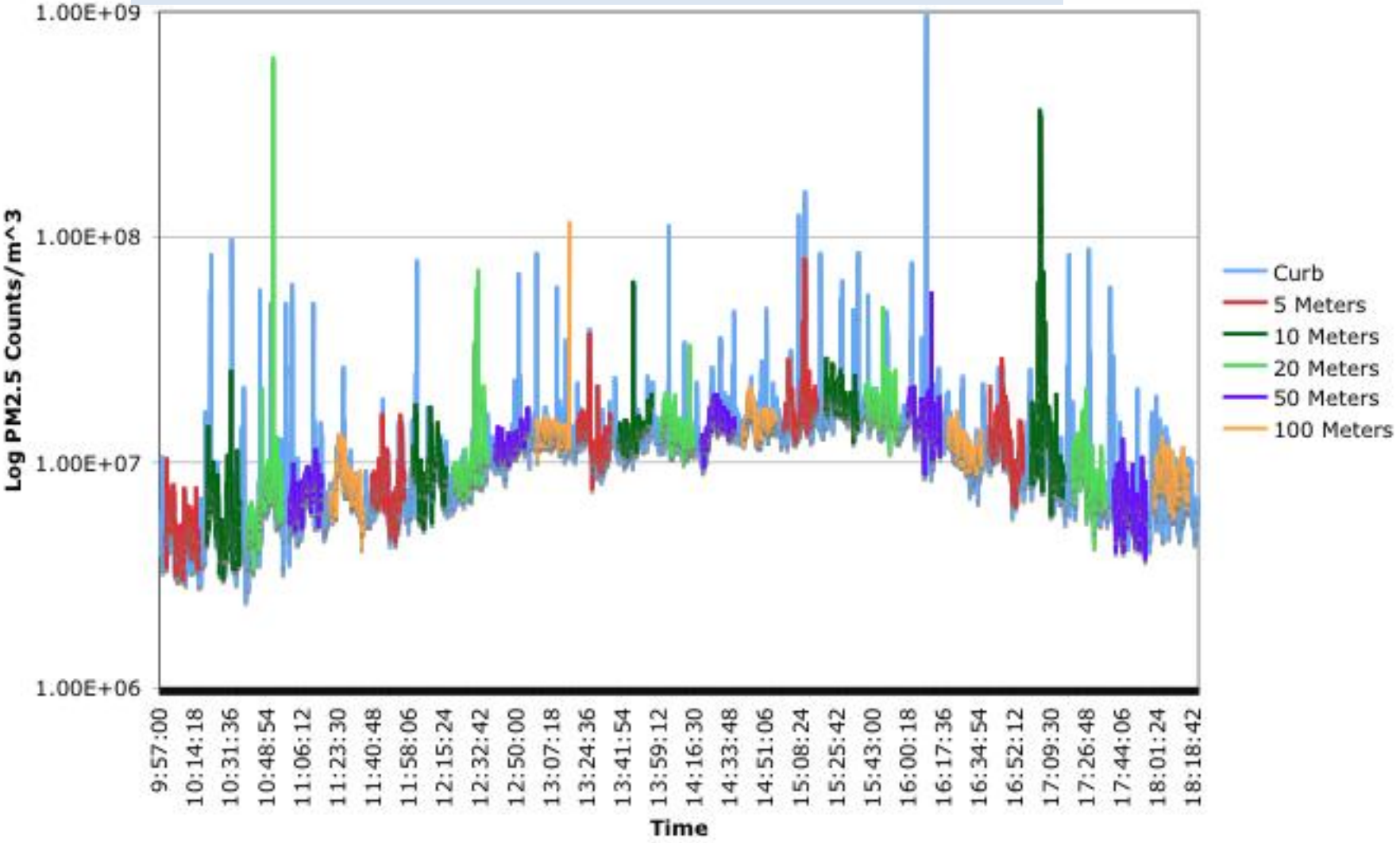

Local, mobile
QM2
BAY TERRACE
BELL BL
3001
ISUZU


Local, mobile
QM2
BAY TERRACE
BELL BL
3001
ISUZU
Inputs are stochastic, intense and near the ground
Disproportionate impact on local deposition

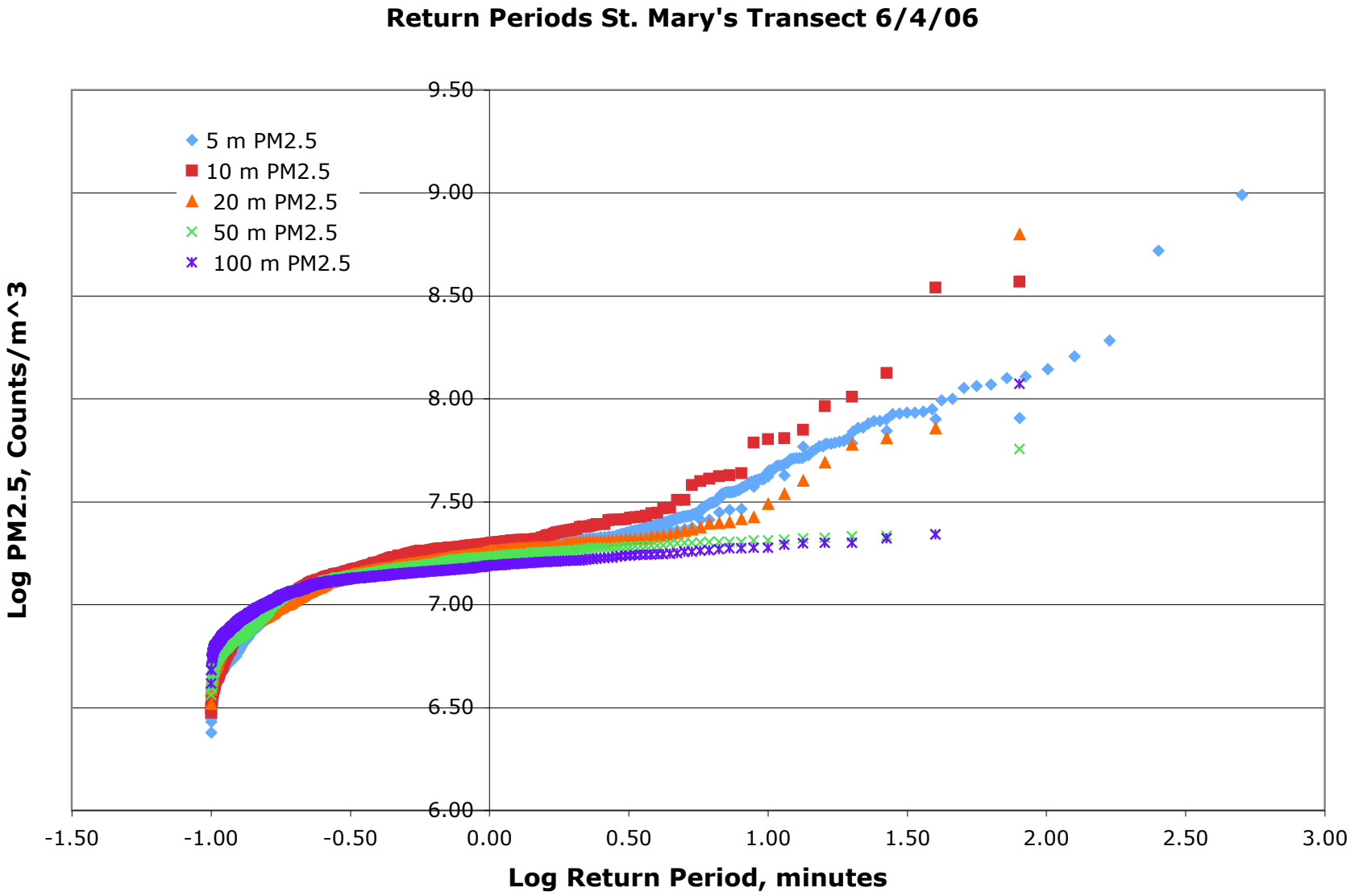

Field sampling: What do we observe in the city?
St. Mary's Park


E 149th St
St Anns Ave
Trinity Ave
Jackson Ave
5
10
20
50
100
100 m transect
Hypothesis: Particle concentration will decrease with distance from road source.
200 ft
100 m
©2009 Google

A koniograph: like a hydrograph, a spikey, stochastic mess!



We can make sense out of random variation through *extreme event analysis*
Analogous to the return period of floods and storms; “the 100 year event”



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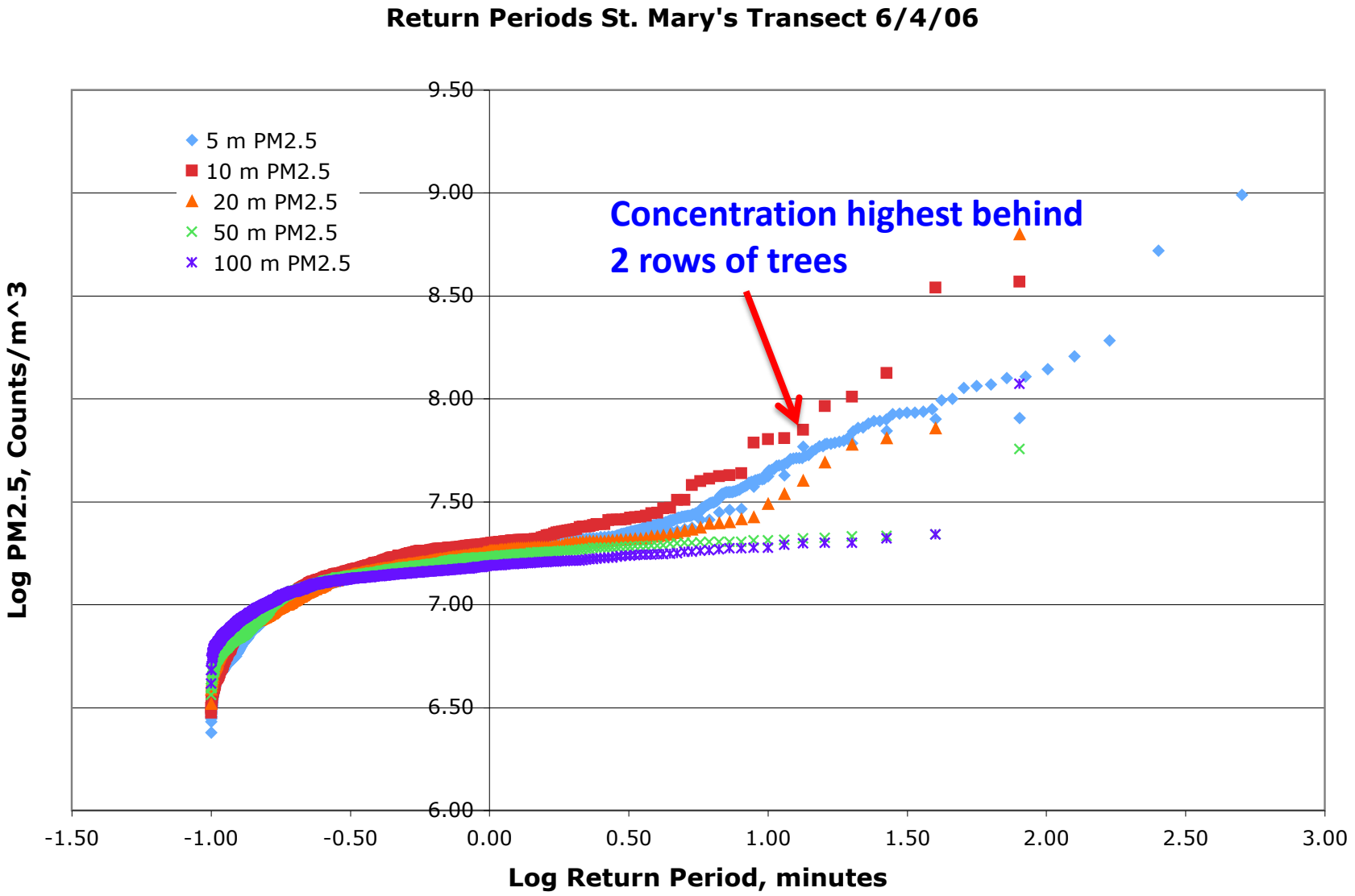
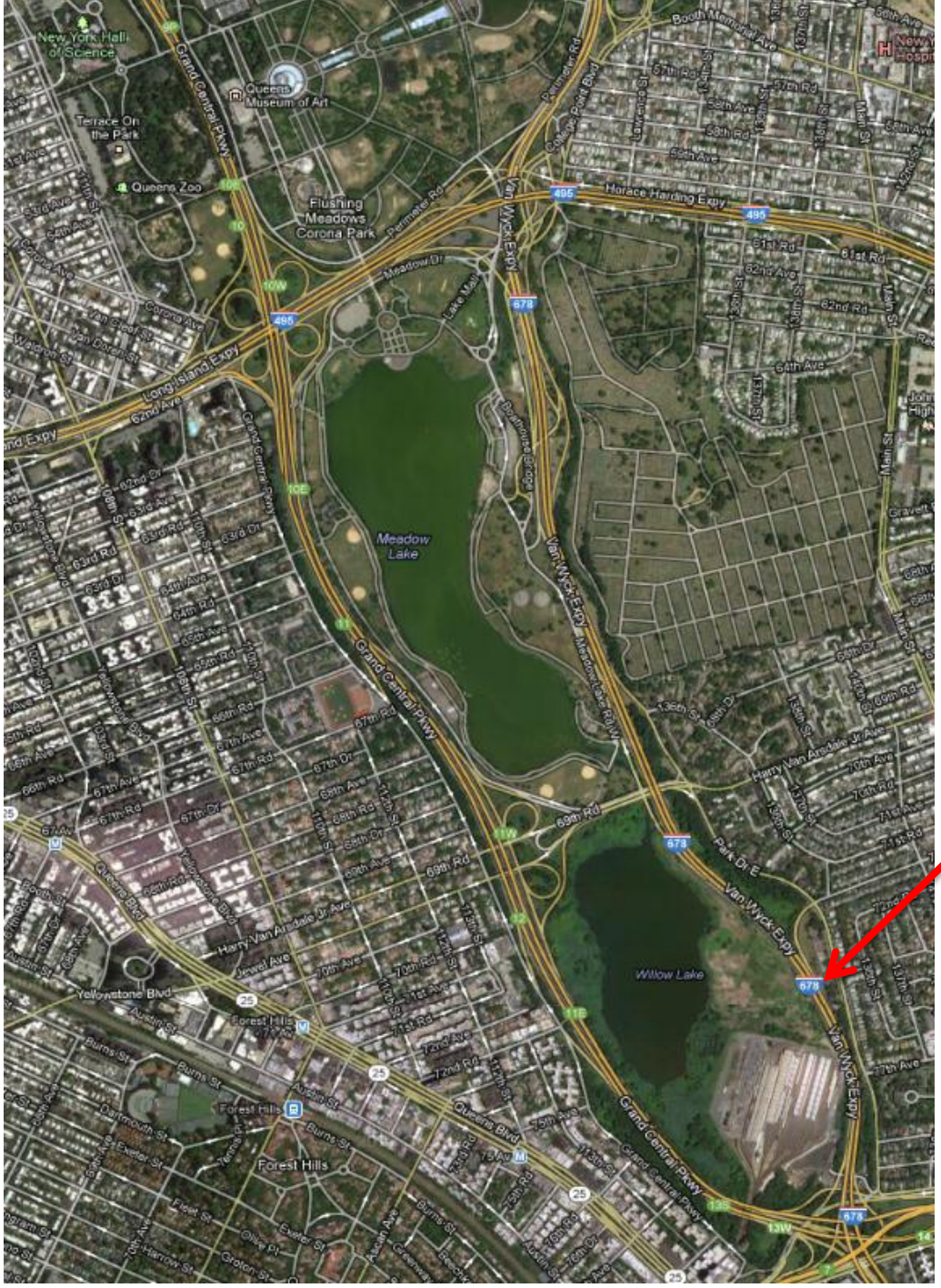


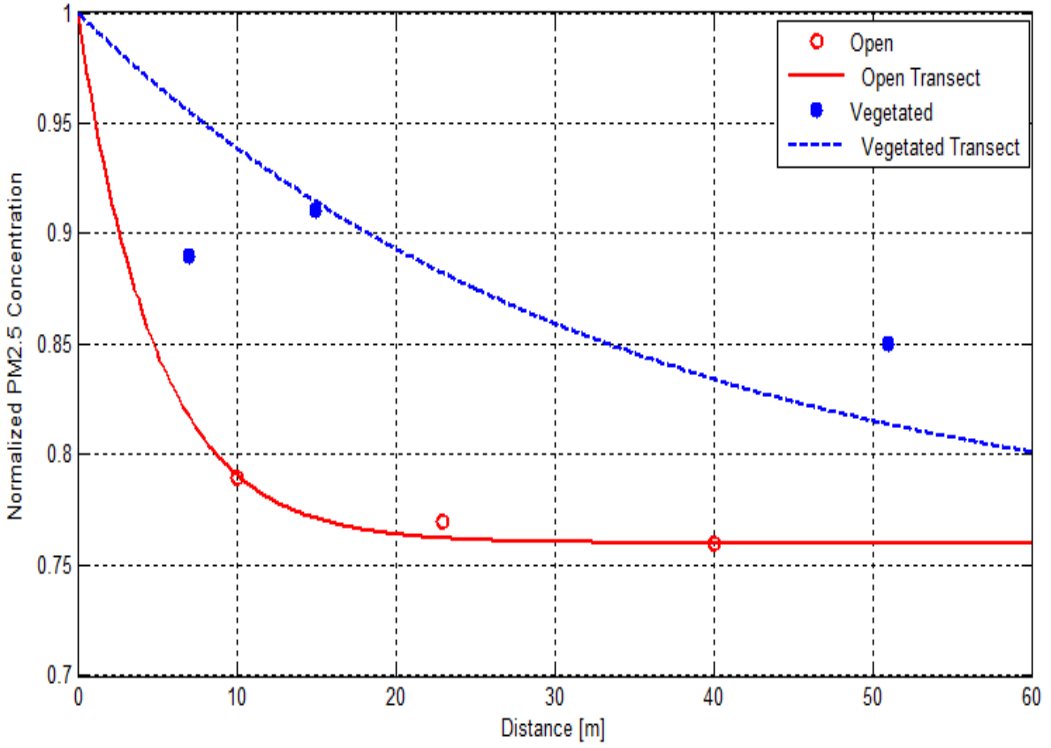


Flushing Meadows/Meadow Lake/
Willow Lake
Queens, NY

Van Wyck Expressway

Van Wyck Expressway
Transects with and without vegetation

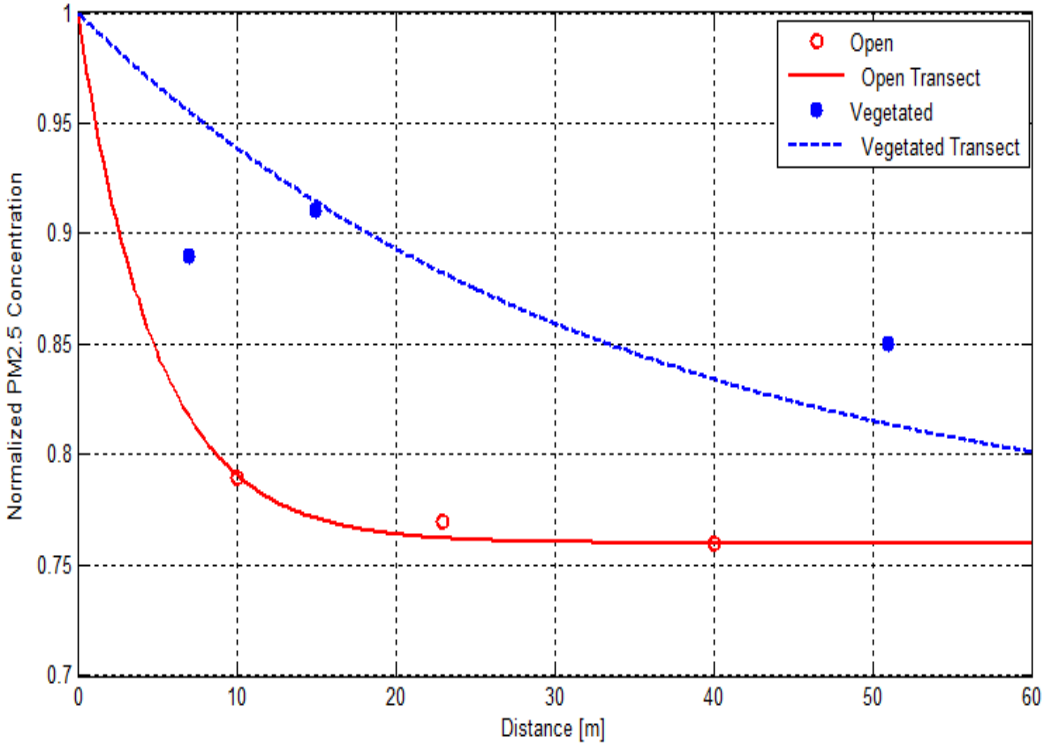
If trees are filtering PM, decay will be steeper along the vegetated transect.



Van Wyck Expressway
Transects with and without vegetation

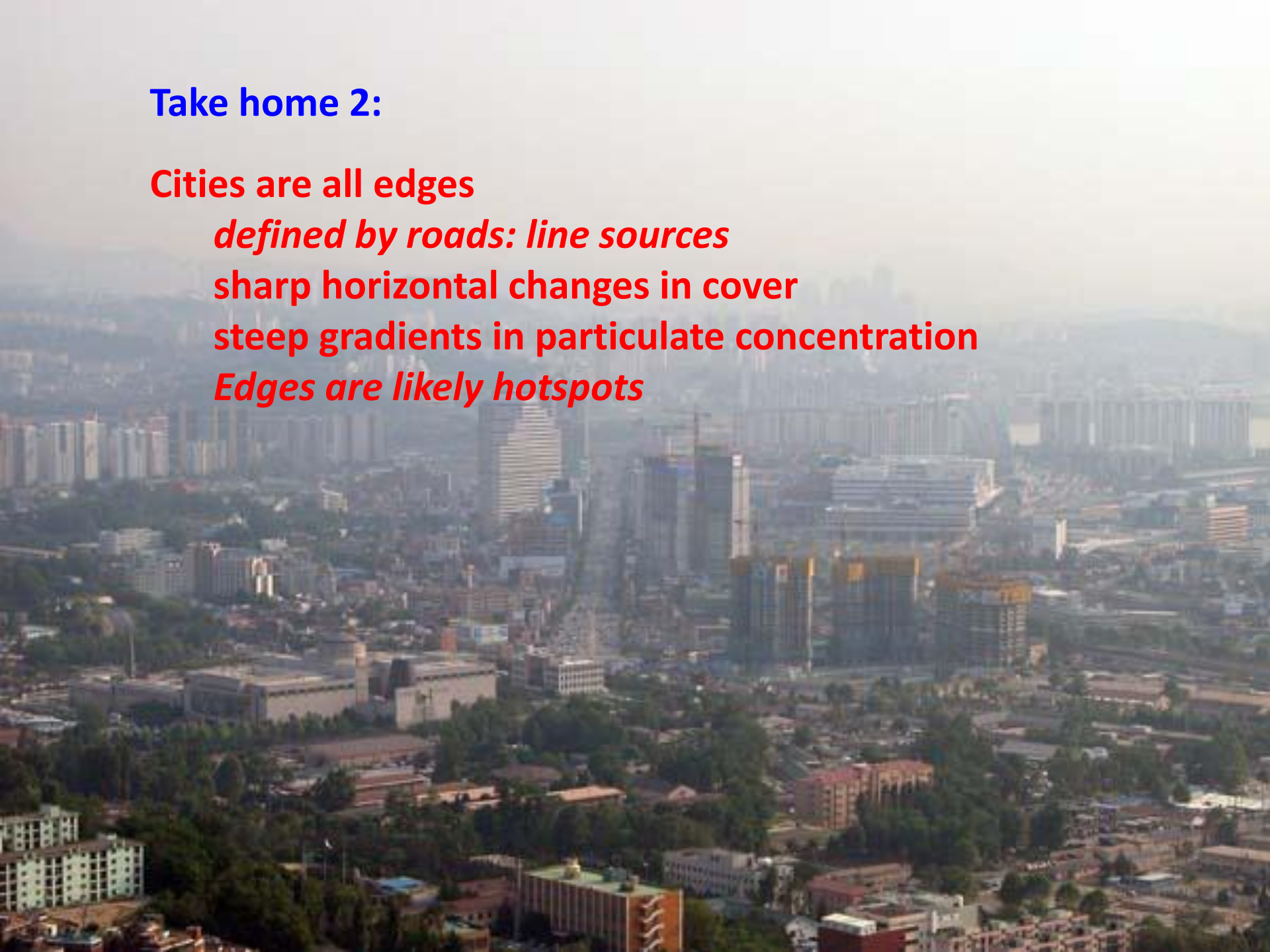
Trees act like a capacitor
Impose a time delay
Retard flushing

If trees are filtering PM, decay will be steeper along the vegetated transect.



Take home 1:

Re-circulating eddies form downwind of objects like trees, causing localized increases in concentration. These are ***depositional hotspots***



Take home 2:

Cities are all edges

- ***defined by roads: line sources***
- **sharp horizontal changes in cover**
- **steep gradients in particulate concentration**
- ***Edges are likely hotspots***


What about the vertical dimension?

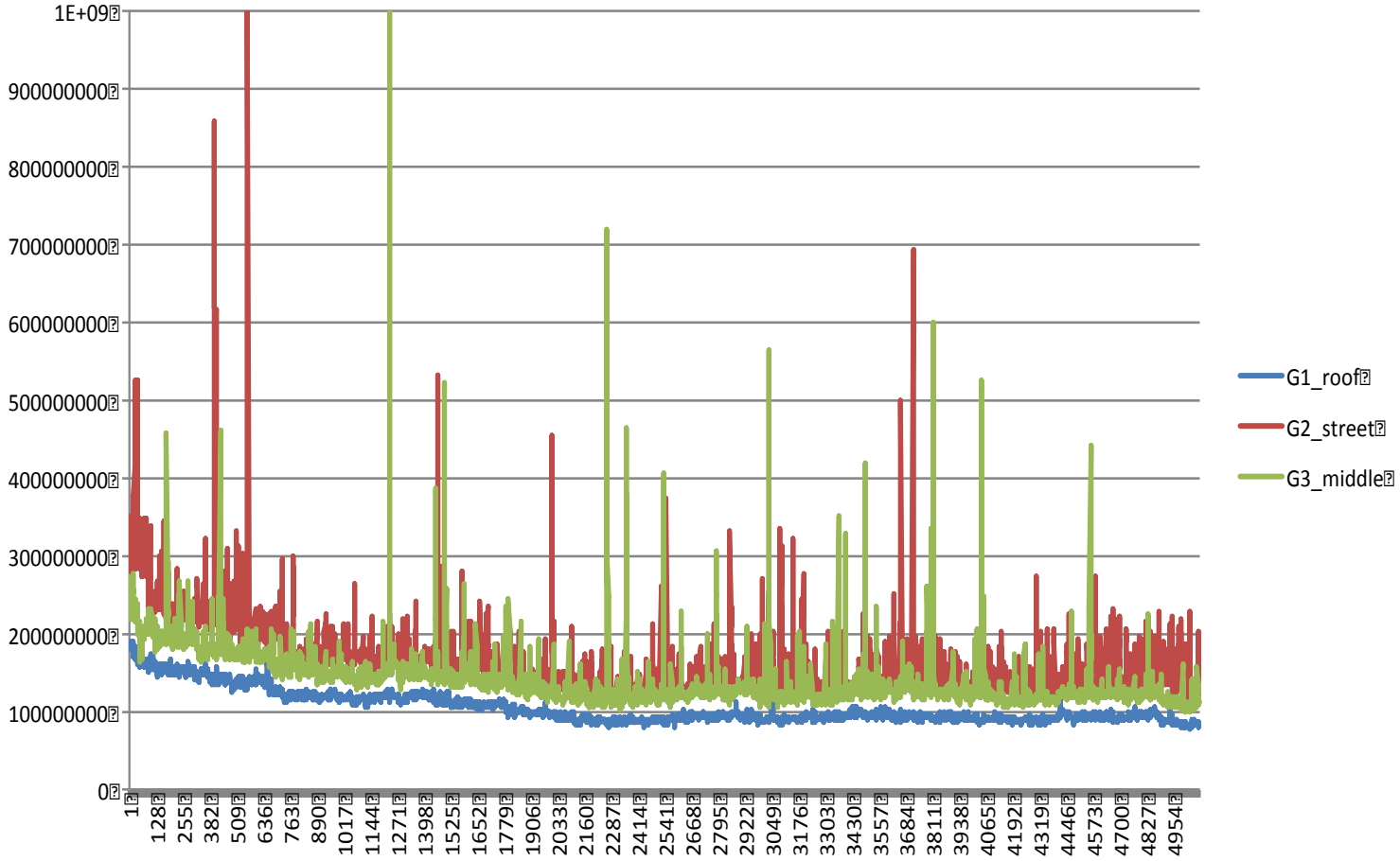
The Brooklyn Grange
Largest rooftop farm in the US

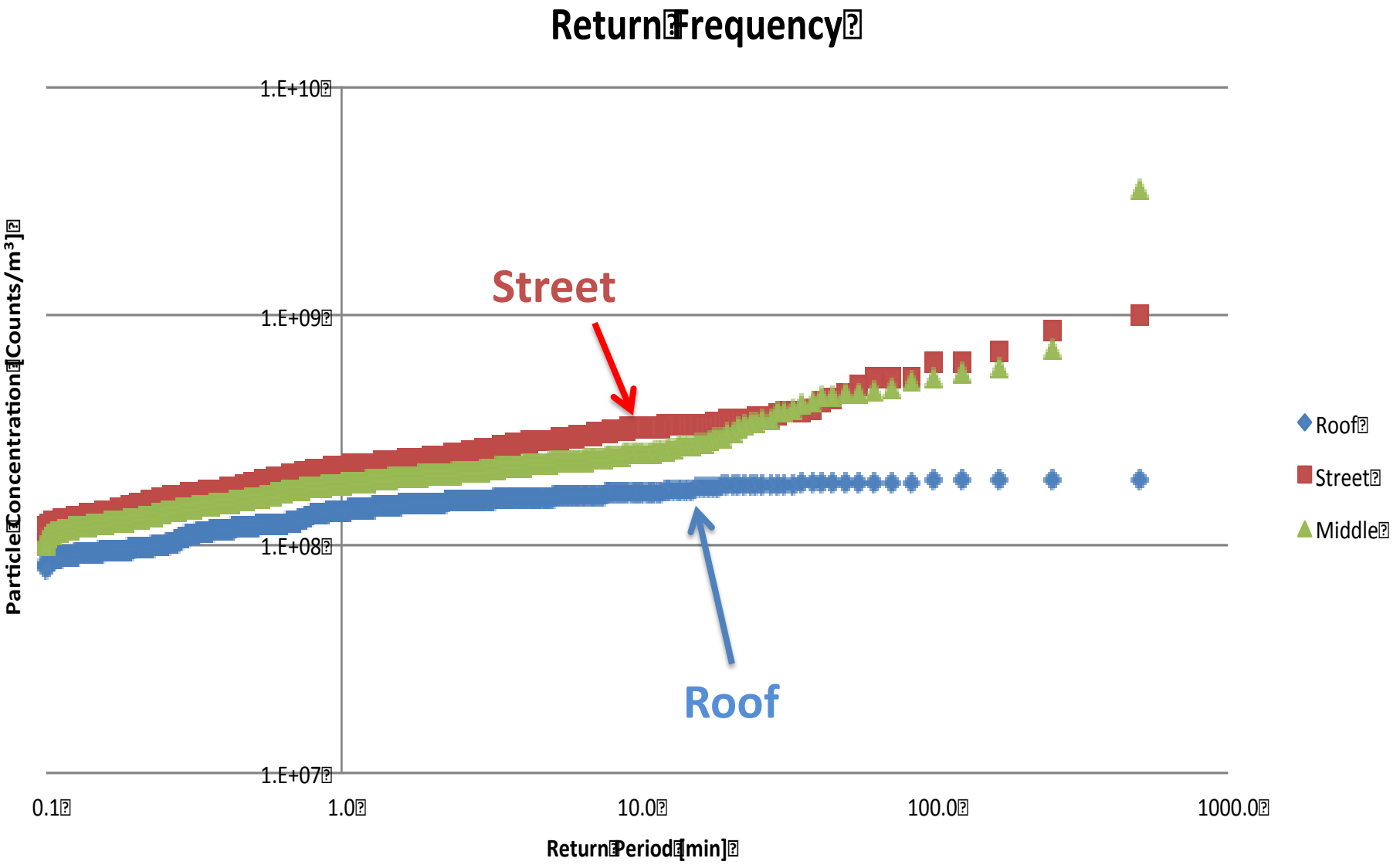
Street level


Between floors
3 & 4


Rooftop, 6 stories up
100 CAR INDOOR PRE-OWNED SHOWROOM

6.20


1E+09
900000000
800000000
700000000
600000000
500000000
400000000
300000000
200000000
100000000
0
1
128
255
382
509
636
763
890
1017
1144
1271
1398
1525
1652
1779
1906
2033
2160
2287
2414
2541
2668
2795
2922
3049
3176
3303
3430
3557
3684
3811
3938
4065
4192
4319
4446
4573
4700
4827
4954
G1_roof
G2_street
G3_middle

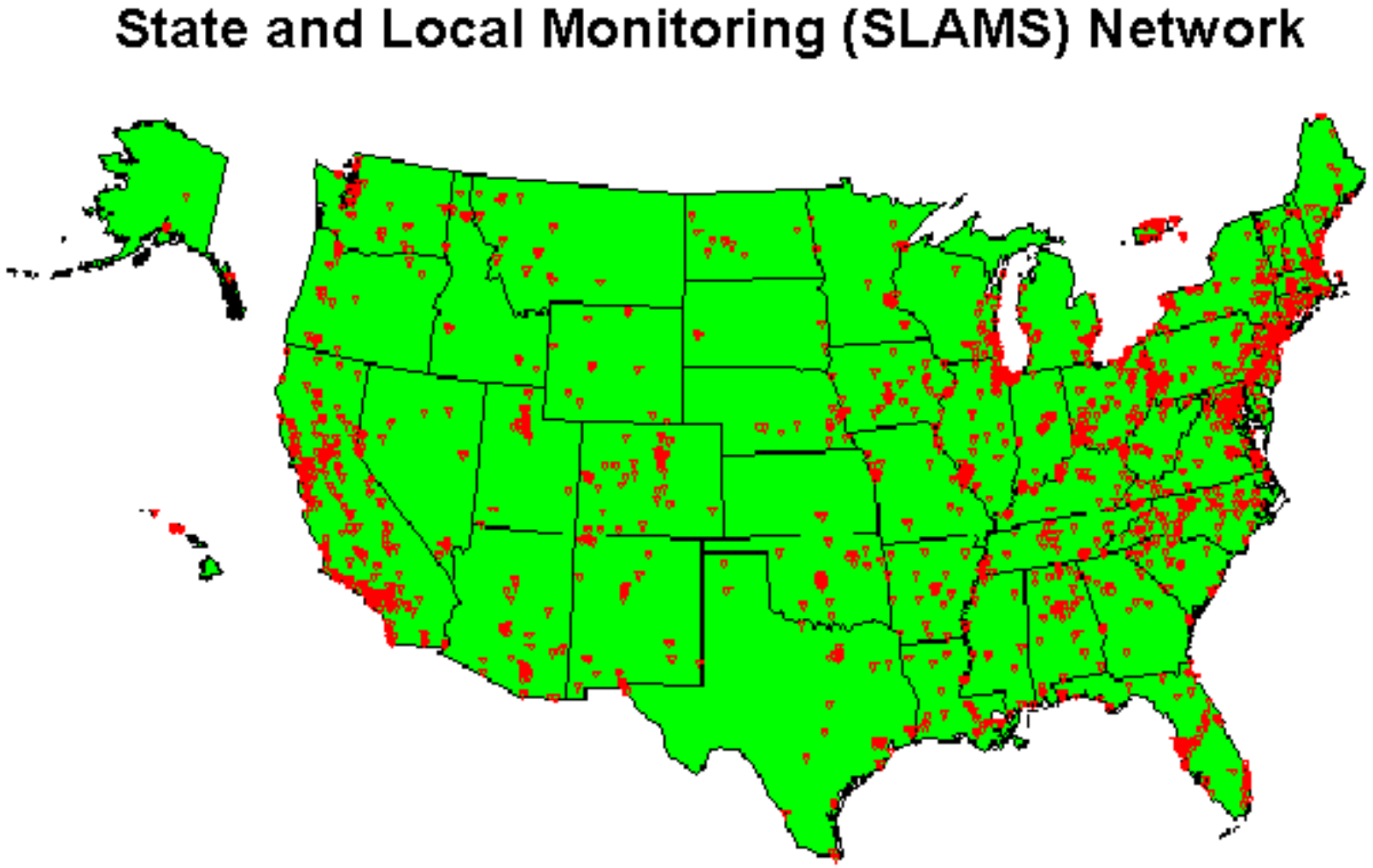

Return Frequency
1.E+10
1.E+09
1.E+08
1.E+07
Particle Concentration [Counts/m³]
Street
Roof
0.1
1.0
10.0
100.0
1000.0
Return Period [min]
Roof
Street
Middle

Take home 3

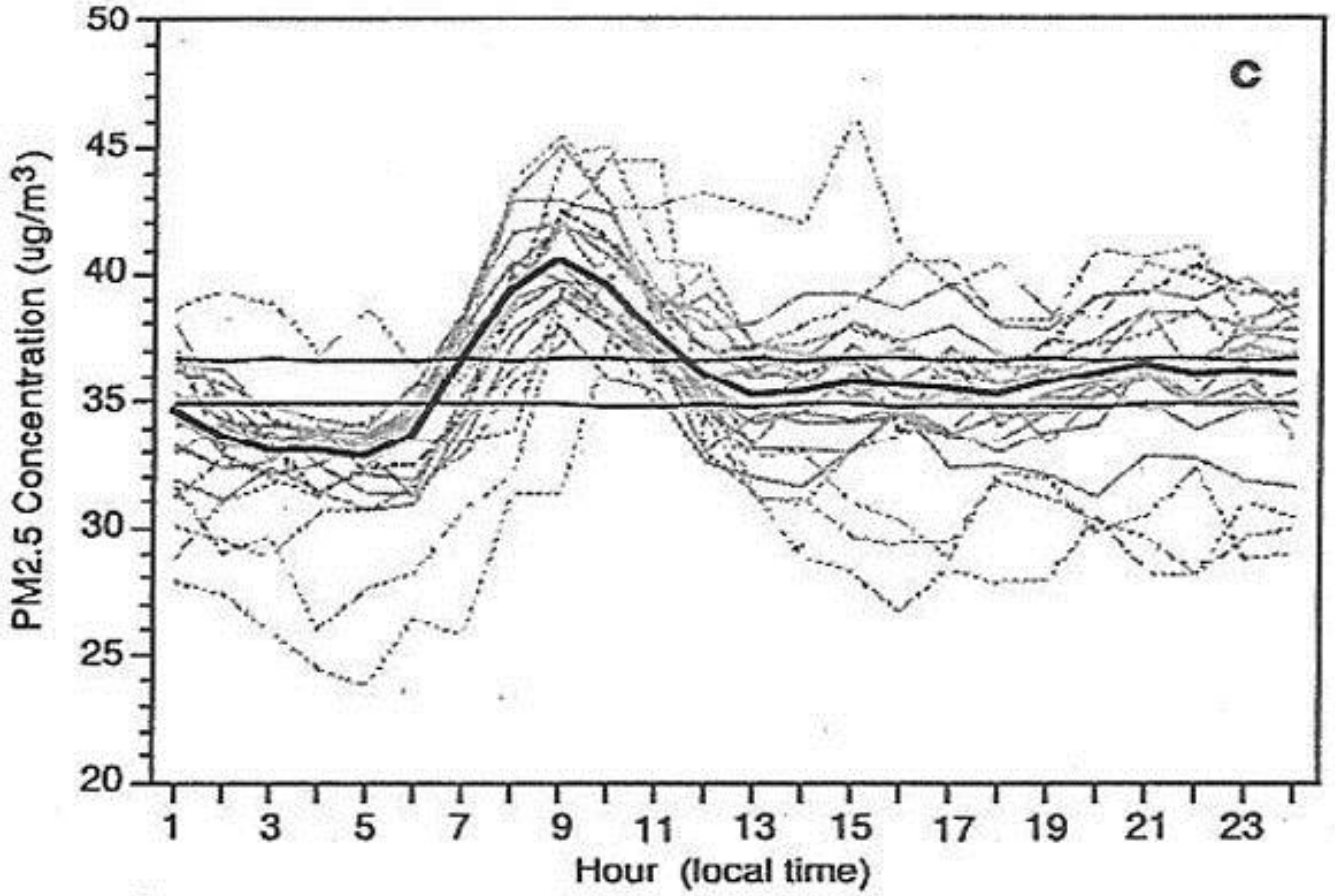
Rooftop sampling underestimates ground level concentration

Thereby leading to overestimates of deposition velocity

How can we begin to characterize such heterogeneous spaces?



NYC alone has 13 PM monitors (TEOM)



And monitors are deployed in every major city


1000’s of TEOM Filters
collected bi-weekly
Discarded!!
XRF?
EM microprobe?

EPA + FHWA + State Hwy = Natural Synergy

2010 EPA Rulemaking for near-road NO_2 monitoring

EPA United States Environmental Protection Agency

Near-Road NO_2 Monitoring Technical Assistance Document

June 2012

Physical Site Component	Impact on Site Selection	Desirable Attributes	Least Desirable Attributes	Potential Information Sources
Roadway design or configuration	Feasibility of monitor placements; affects pollutant transport and dispersion.	At-grade or nearly at-grade with immediate surrounding terrain.	Deep cut-sections/significantly below grade; significantly above grade (fill or bridge); above grade (bridge).	Field reconnaissance; satellite imagery.
Roadside Structures	Feasibility of monitor placement; affects pollutant transport and dispersion.	No barriers present other than low (<2 m in height) vegetation or safety features such as guardrails.	Presence of sound walls, mature (high and thick) vegetation, obstructive buildings.	Field reconnaissance; satellite imagery.
Terrain	Affects pollutant dispersion, local atmospheric stability.	Flat or gentle terrain, within a valley, or along a road grade.	Along mountain ridges or peaks, hillsides, or other naturally windswept areas.	Field reconnaissance; digital elevation models and vegetation files; satellite imagery.
Meteorology	Affects pollutant transport and dispersion.	Relative downwind locations; winds from road to monitor.	Strongly predominant upwind positions.	Local data; National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS); EPA's Air Quality System (AQS).

Road Weather Information Systems
The *RWIS* Observation Network

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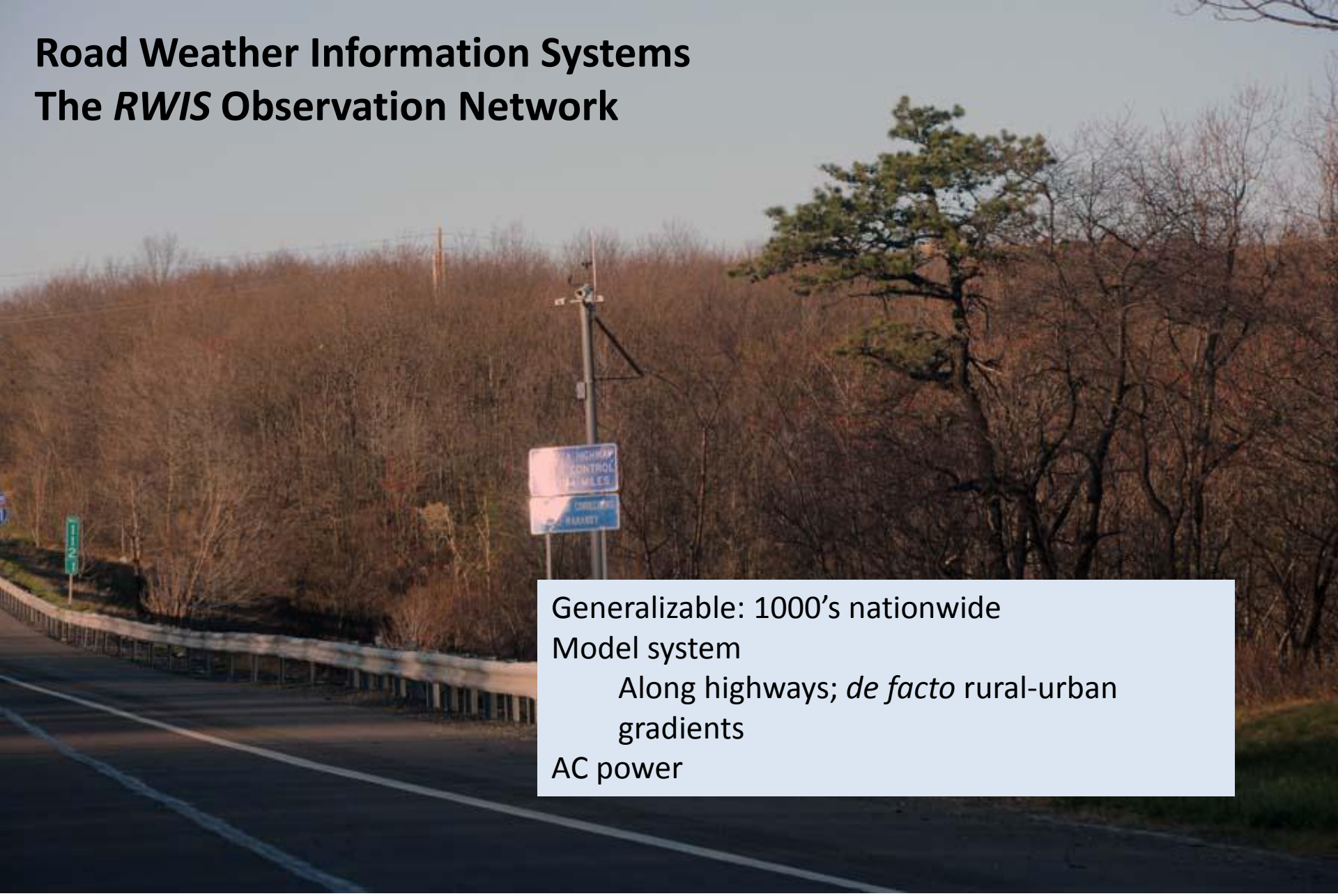


Generalizable: 1000's nationwide

Model system

- Along highways; *de facto* rural-urban gradients

AC power


The heavy lifting has been done for us!
AIR QUALITY
ACTION DAY
TODAY
Manhattan Bridge
LOWER RDWY
Canal St WEST
ALL TRUCKS
5AM - 10AM
MON - FRI
UPPER RDWY
Canal St EAST
HOV 2+ & BUSES
6AM-10AM MON-FRI
OTHER TIMES ALL TRAFFIC
MALIBU

We have access to an embarrassment of riches!

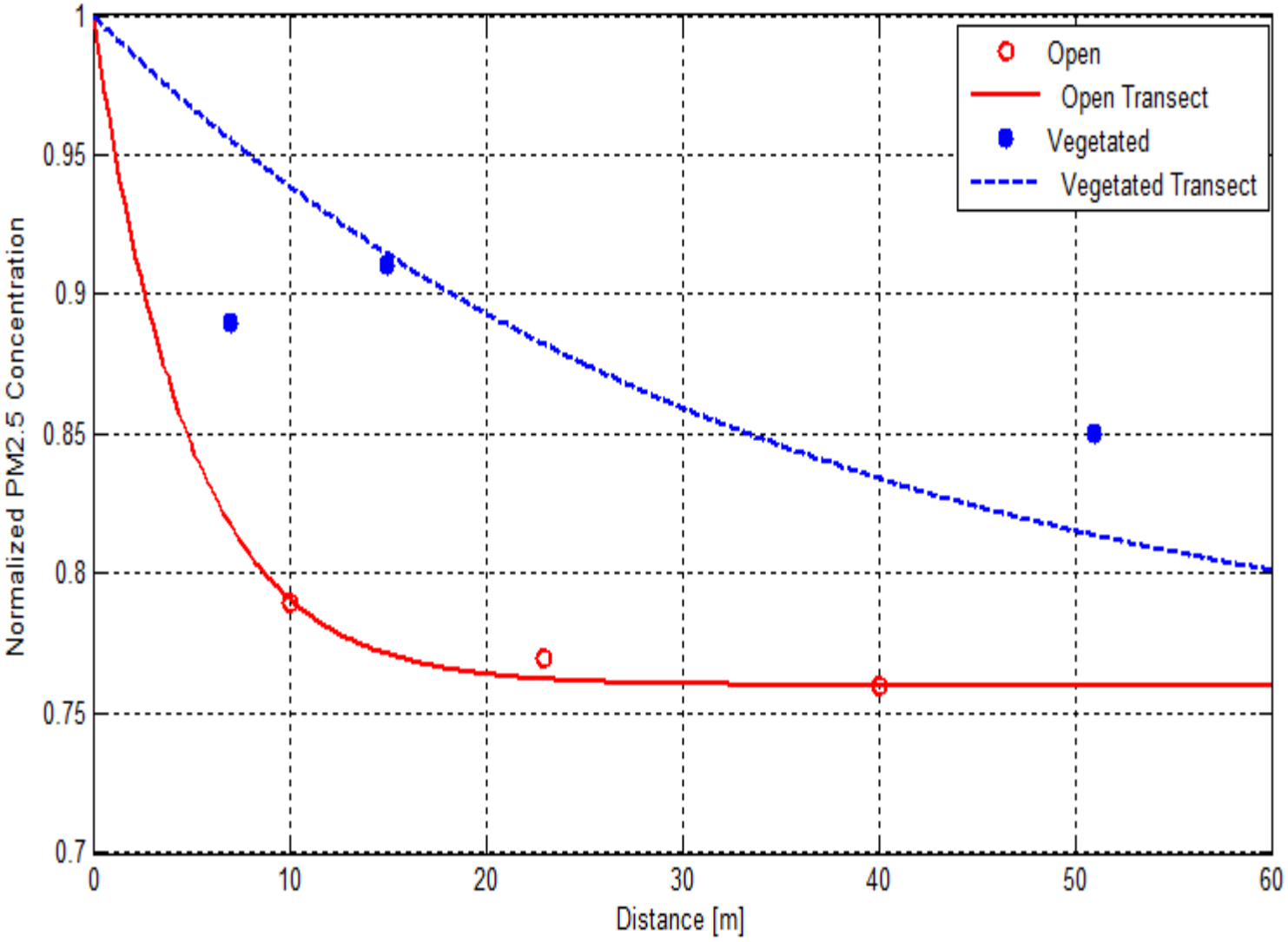
Select test bed cities

BES and CAP

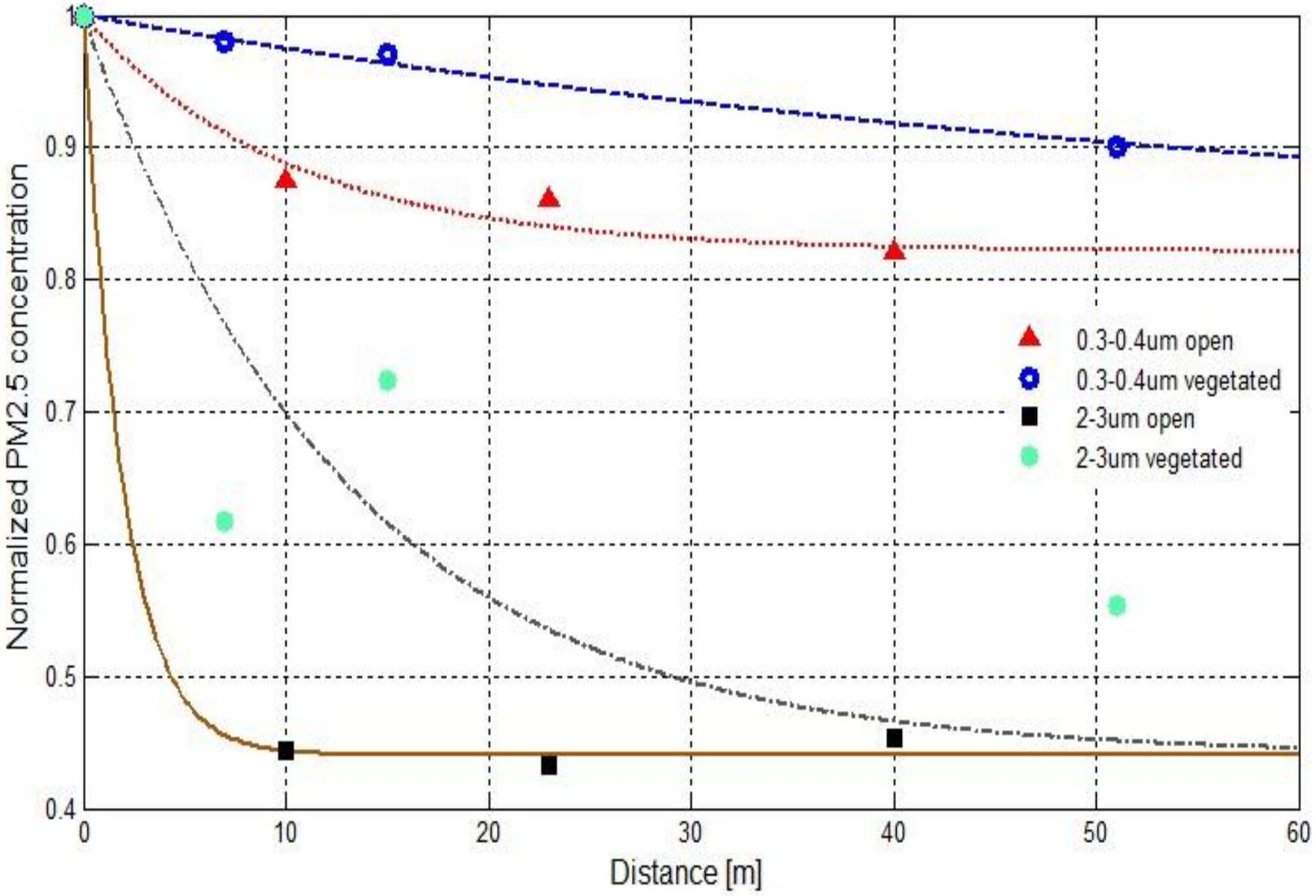
UltraEx


A&L CESSPOOL
718-729-9018

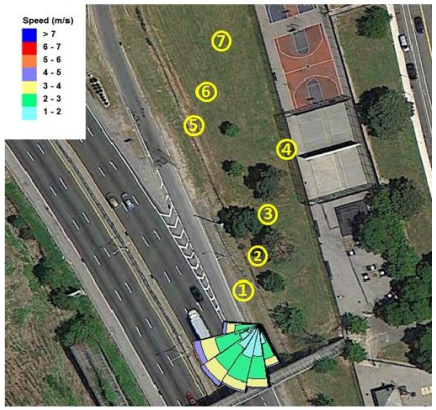
Van Wyck


Open
Open Transect
Vegetated
Vegetated Transect
Normalized PM2.5 Concentration
Distance [m]
1
0.95
0.9
0.85
0.8
0.75
0.7
0
10
20
30
40
50
60

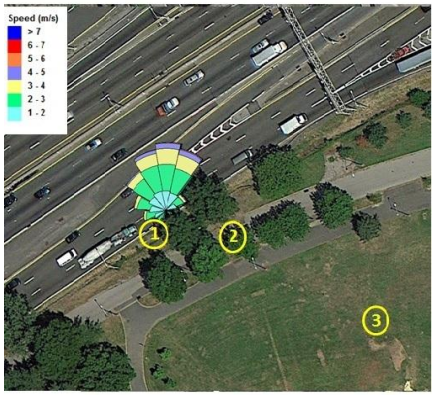
Van Wyck East



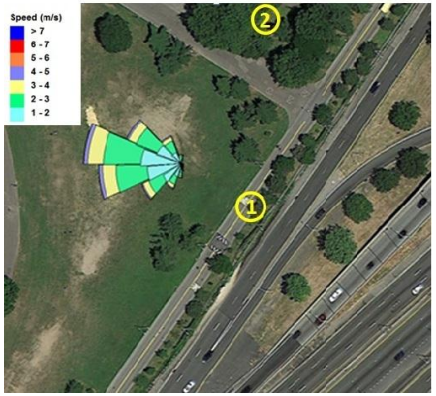
Van Wyck East **a**

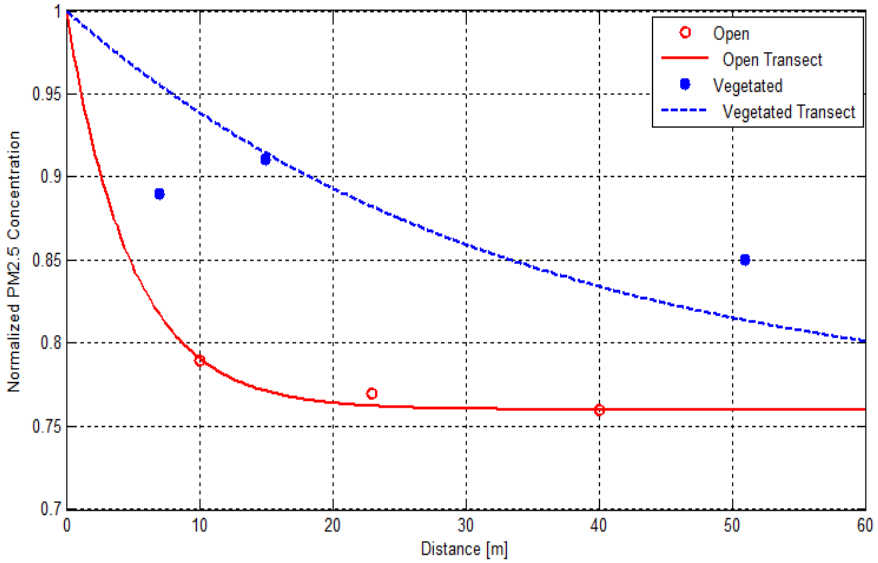


LIE South **b**



LIE North **c**



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LIE South 7/14/11