Measuring Asthma Indicators at New York City Public Schools

J. Richmond-Bryant[1], C.J. Saganich[1,2], R. Kalin[3], L. Bukiewicz[3], M.L. Valentine[3], A. Burgie[1], A. Sanders[3], L. Krahling[3]

[1]Urban Public Health Program, Hunter College, 425 East 25th Street, New York, NY 10010
[2]Weill Medical College of Cornell University, New York Presbyterian Hospital, 1509 York Avenue, New York, NY 10032
[3]Asthma Free School Zone, 273 Bowery St., New York, NY 10002

The Asthma Free School Zone Study: Objectives

- Characterize the traffic and air pollution in the vicinity of New York City schools during dismissals

- Evaluate the effectiveness of the *Asthma Free School Zone* program for reducing traffic-based air pollution around schools

Approach

- Monitor traffic and air quality at three school sites New York City boroughs
  - Three one-month tests per year
- For each school site, associate traffic and concentration of air pollution
  - Use minute-by-minute concentration and traffic count data to assess the immediate impact of traffic on air quality
  - Also log behavior of idlers to understand why idling takes place and how to address it
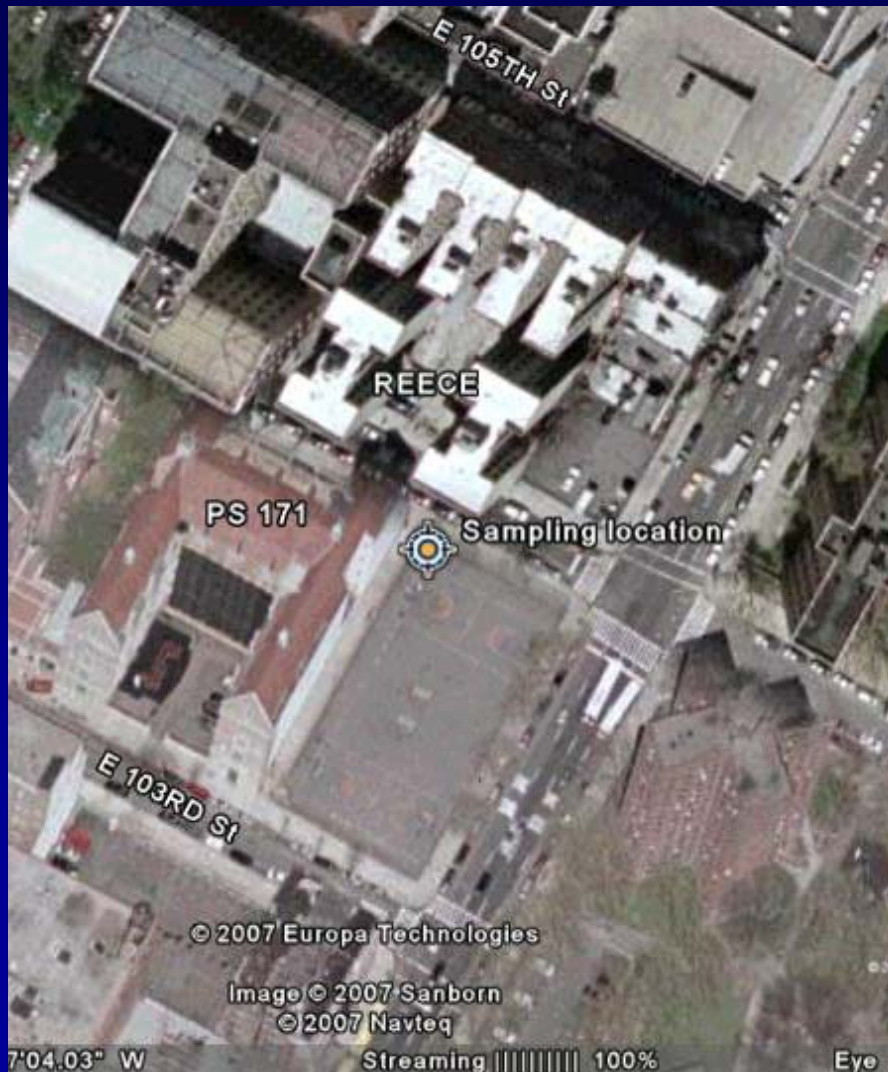
Approach

- Repeat monitoring of traffic and air quality at same schools during year 2
  - In the 11 months between sampling at each school site, AFSZ administers their program:
    - Removing sources of asthma in school
    - Reducing vehicular idling
- Compare relationship between traffic and air quality for each year
  - Have total concentrations reduced?
  - Has the contribution of idling and other traffic sources decreased?

Site Criteria

- **Distribute study over boroughs**
  - Building type and density varies across boroughs
- **Find areas with highest asthma hospitalization rates**
  - East Harlem (Manhattan)
  - Bedford-Stuyvesant and Bushwick areas (Brooklyn)
  - Bronx (most areas)

Asthma Hospitalization Rates by ZIP Code Area, Children Aged 0-14, New York City, 2000

Source: NYC DOHMH (2003).
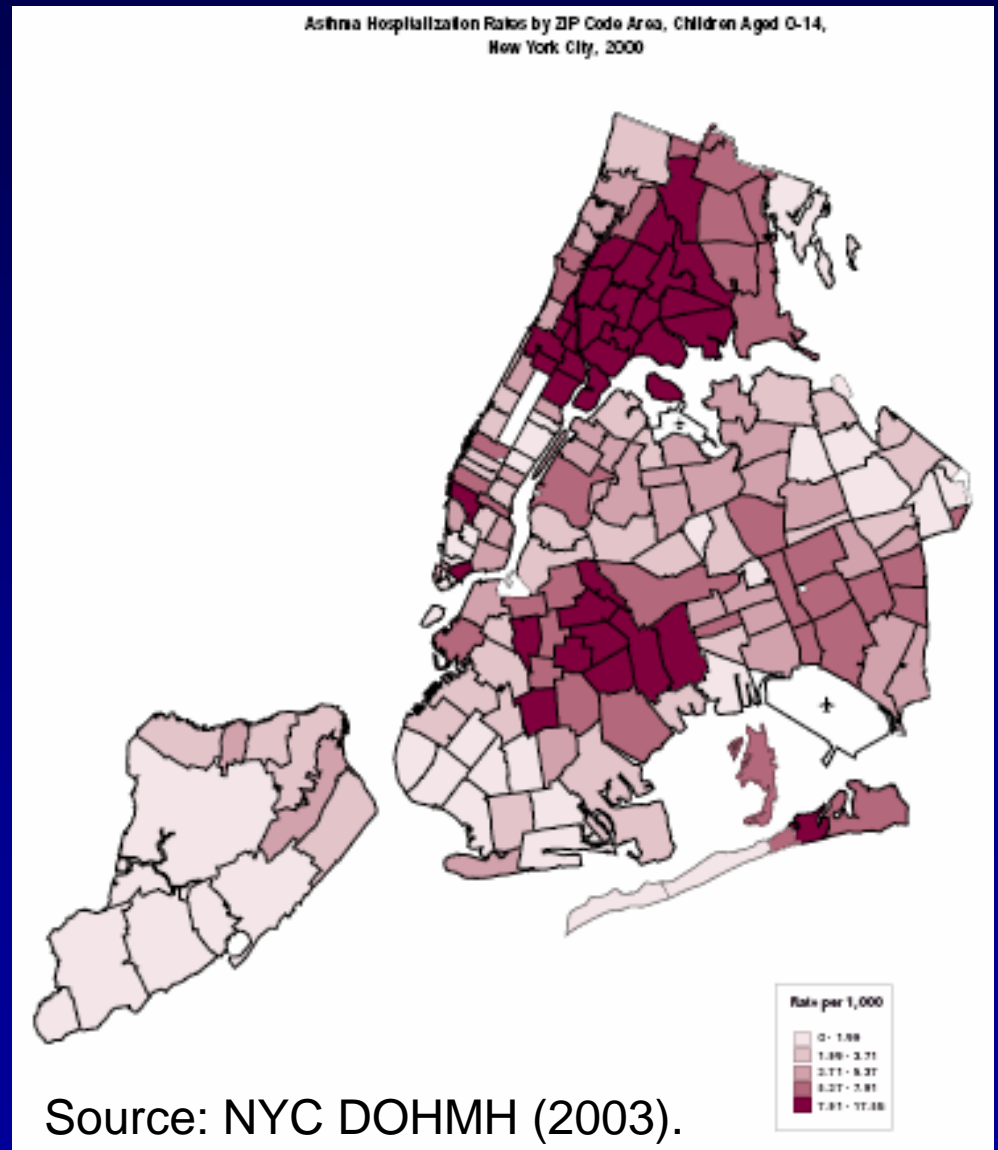
East Harlem School Cluster

- Cluster of four schools
  - Reece (special ed.)
  - PS 171 (PK-6)
  - CPE II (9-12)
  - Harbor School (PK-12)
- Dense street canyon
  - 3-4 story buildings lining street
- Madison Ave. AADT = 84,550 (at 135th)
  - From NYS DOT (2006)

East Harlem School Cluster

Methods:
Air Quality Measurements

- Measure mass conc. of two quantities
  - Demonstrated in epi. studies to cause and trigger asthma
- $PM_{2.5}$: TSI SidePak (Shoreview, MN)
- Black carbon (BC): Magee Scientific aethalometer (Berkeley, CA)
- Sampled for 1 hr. 45 minutes at 1-minute intervals

Methods:
Traffic Observations

- Each minute, count passing data:
  - Break down by bus, truck, or car
  - Break down by red light, green light, parking

- Record start and stop time of idling traffic
  - Break down by bus, truck, or car

- Construct a time series of idling and passing traffic from data, e.g.:
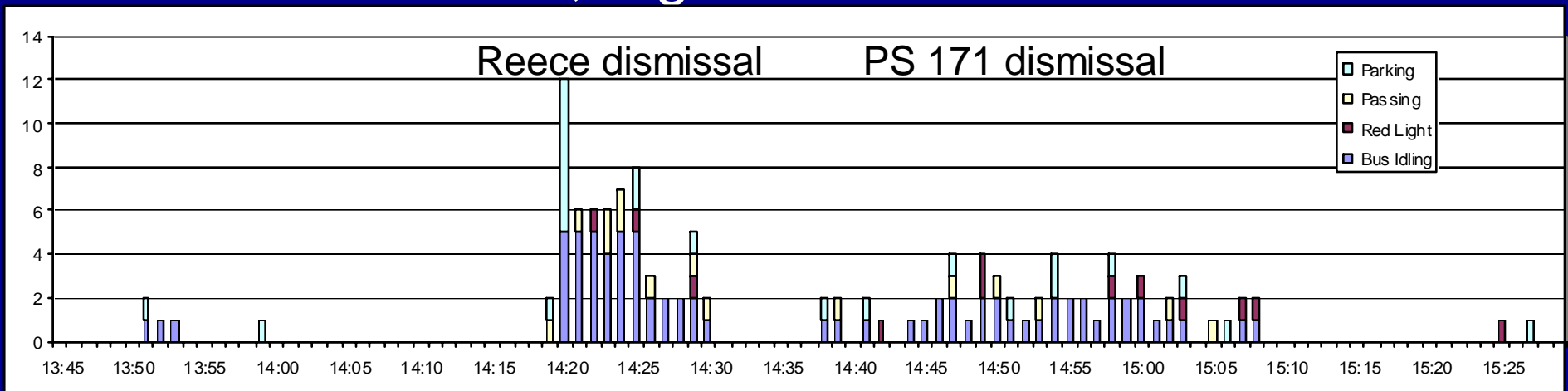
Test Variables

- Concentration of $PM_{2.5}$ in street ($C_{PM2.5}$)
- Concentration of black carbon in street (C_{BC})
- Bus and truck idling ($Idle_{BT}$)
- Bus and truck passing ($Pass_{BT}$)
- Car idling ($Idle_{Car}$)
- Car passing ($Pass_{Car}$)
- Background $PM_{2.5}$ ($Bckg_{PM2.5}$)*
- Temperature (Temp)*
- Wind speed (WS)*
- Wind direction (WD)*
- Relative humidity (RH)*
- Barometric pressure (BP)*

*From NYS DEC, averaged over all NYC sites.

Methods: Statistical Analysis

- Took 5-minute moving average over time series to smooth data
  - $C_{PM2.5}$, C_{BC}, $Idle_{BT}$, $Pass_{BT}$, $Idle_{Car}$, $Pass_{Car}$
- First pass: Applied generalized linear model to $C_{PM2.5}$ and C_{BC} as a function of all independent variables:

$$C = \beta_0 + \sum_i \beta_i X_i$$

- Second iteration: removed independent variables with non-significant regression coefficients and re-fit significant variables
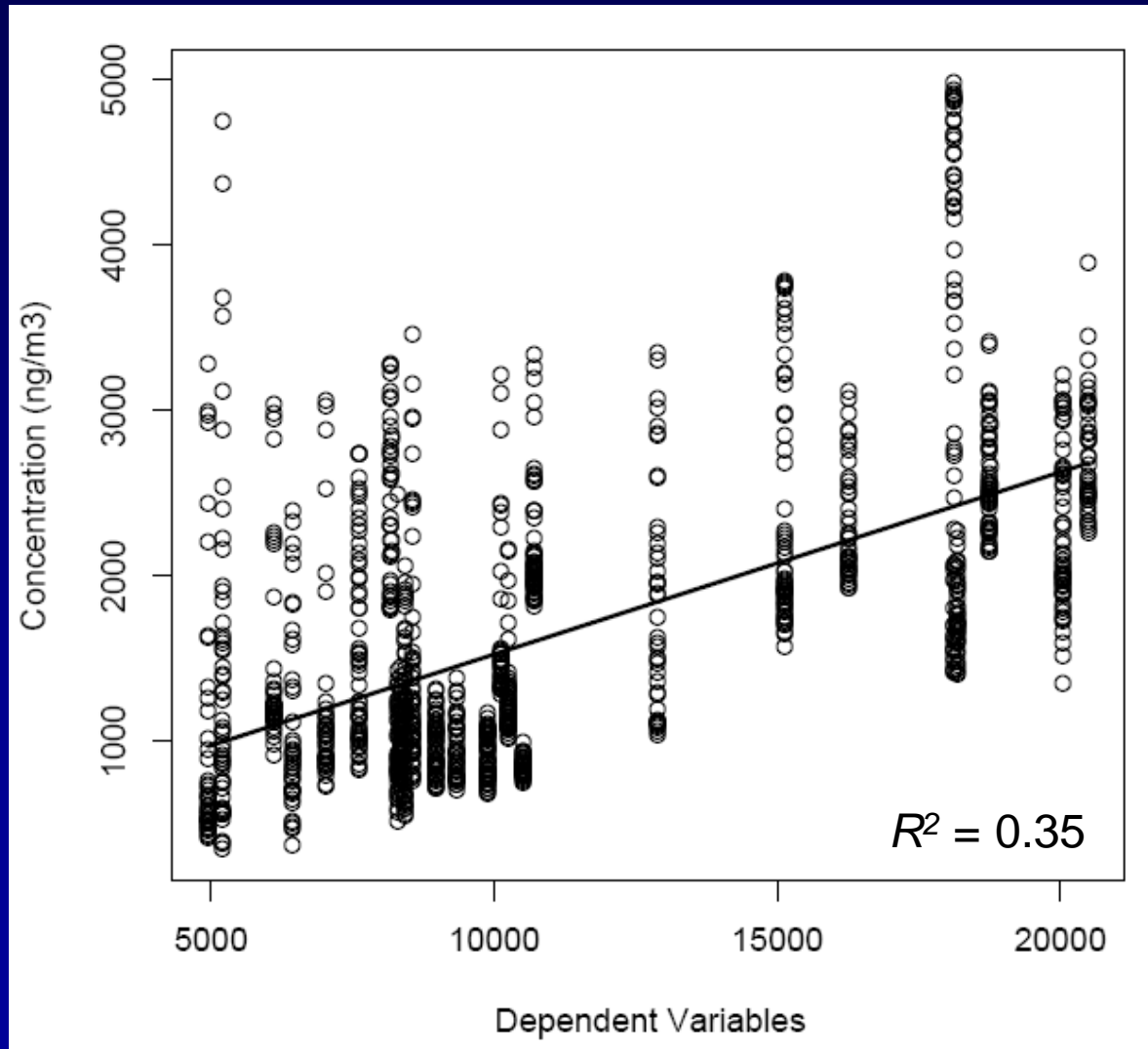
Results: PM$_{2.5}$ Concentration

$$C_{PM2.5} = 951{,}500 + 1{,}561*Idle_{BT} + 803.3*Pass_{Car} + 3.528*Bckg_{PM2.5}$$
$$- 558.6*Temp - 1{,}576*WS - 116.4*WD - 195.7*RH - 29{,}530*BP$$
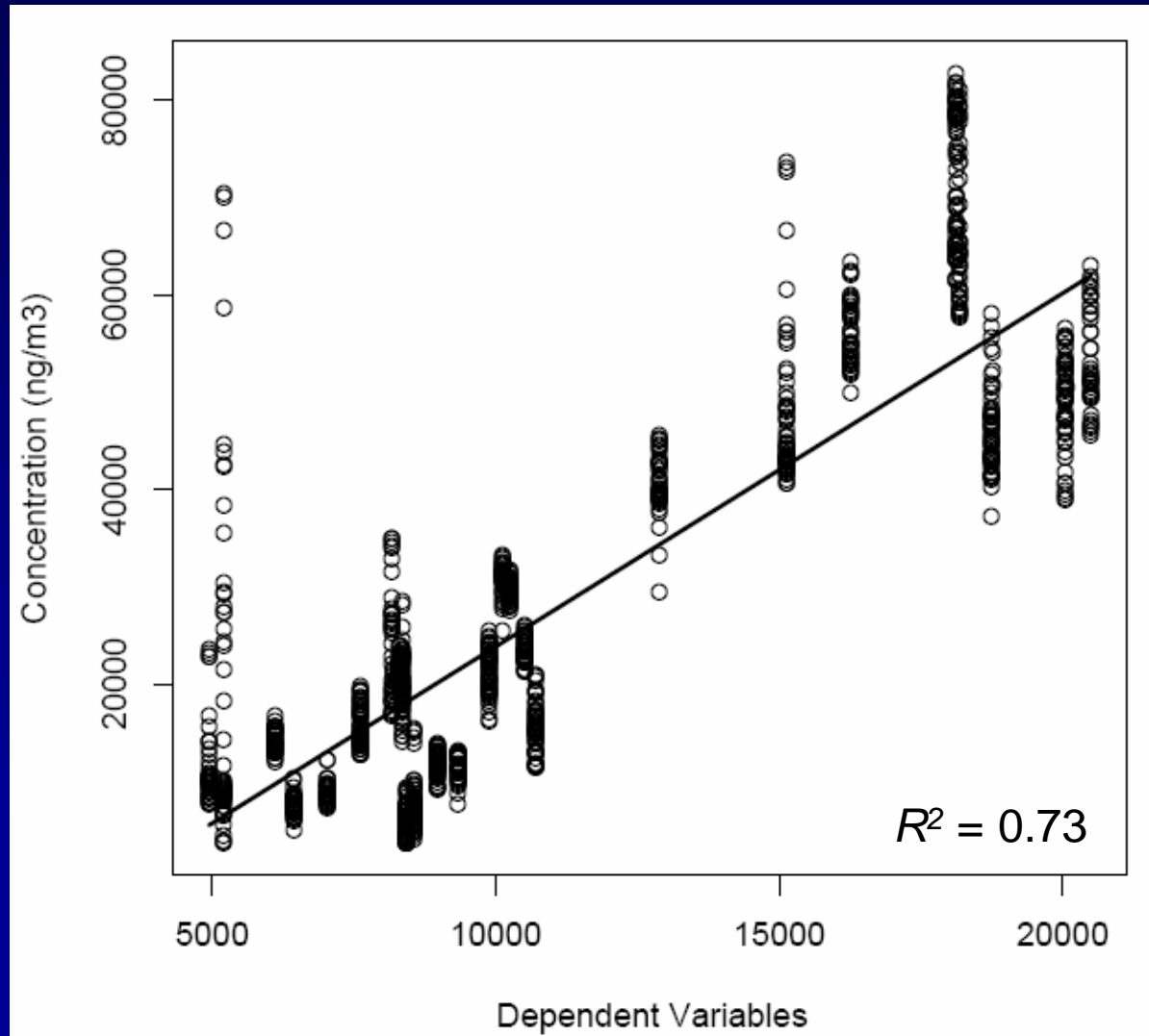
Results: BC Concentration

$$C_{BC} = 40{,}180 + 149.2*Idle_{BT} + 85.87*Pass_{BT} + 29.58*Idle_{Car}$$
$$+ 0.1223*Bckg_{PM2.5} - 14.88*Temp - 86.62*WS - 1{,}292*BP$$

Findings

- Significant traffic and meteorological variables produced good correlation:
  - 85% of $PM_{2.5}$ concentration
  - 59% of BC concentration
- Idling of diesel vehicles accounted for:
  - 67% of traffic-generated $PM_{2.5}$
  - 56% of traffic-generated BC
    - And, all vehicle idling accounted for 68% of traffic-generated BC
- On 13/15 sampling periods, street-level $PM_{2.5}$ concentration significantly higher than DEC background

Implications

- Documentation that idling and passing traffic are associated with elevated concentrations
  - Data-driven decisions can be made on how to improve the school environment

- Evidence that automobile passing is a significant contributor to concentrations suggests need for traffic mitigation

Implications

- AFSZ and other advocates can use information to work towards zero tolerance for all idling in school zones
  - Enforce new NYS and NYC laws
  - Detailed information is used directly to inform outreach and training efforts