Rutgers, The State University of New Jersey

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Improving Air Quality at Our Port and Airports

NJ CLEAN AIR COUNCIL PUBLIC HEARING

Prof. Monica Mazurek, Civil & Environmental Engineering Department

April 9, 2008

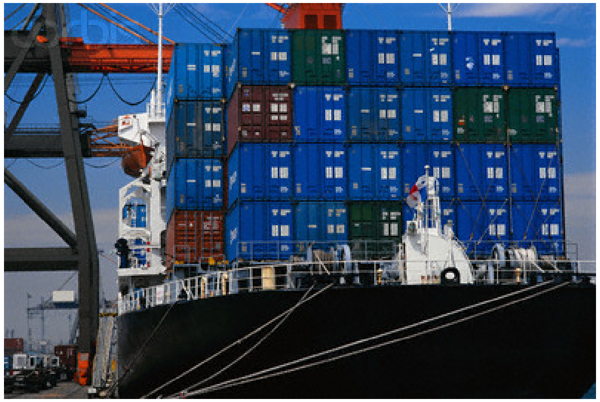
Improving Air Quality in Our Port and Airports Requires.....

Monitoring

Spatial and temporal gas and particle phase chemical constituents

Measurement

Emissions sources and operations



Modeling

Emissions and operations

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New tools for modeling emissions and quantifying operations in PNYNJ

Ongoing research at Rutgers Center for Advanced Infrastructure and Transportation (CAIT)

- Transportation models
  - -- microsimulation
  - -- regional scale
- Chemical emissions profiles

➔ Compare to existing inventories & ambient concentrations

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Freight and Maritime Program – Prof. Boile

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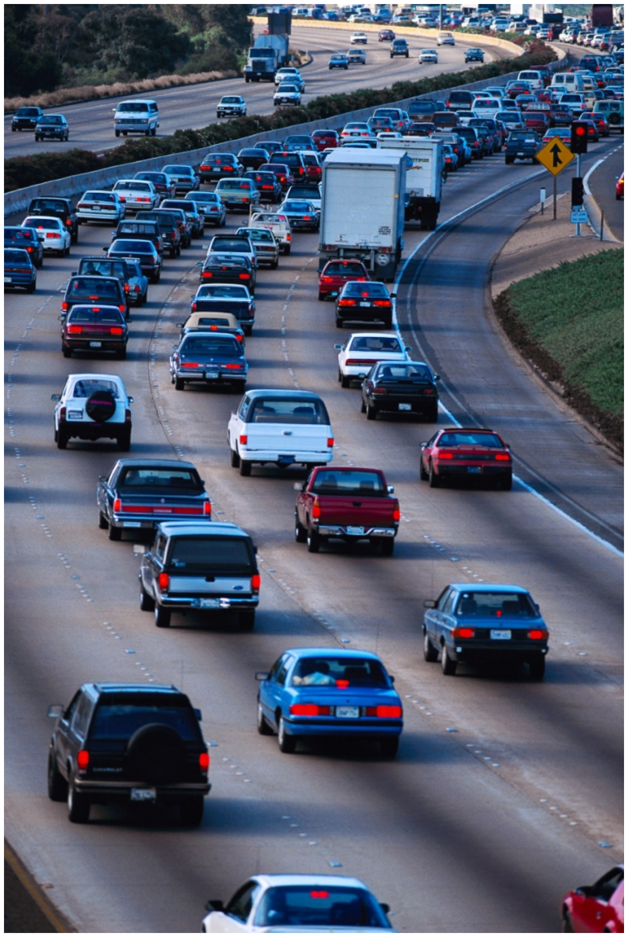
FMP's Large Scale Network Traffic Microsimulation Tool

- Most realistic representation of traffic conditions on large scale networks by time of the day
- Multiple vehicle classes (different types of autos and light, medium, heavy trucks) and type of movement (e.g. full/empty truck, full/empty container, bobtail, etc.)
- Traffic dynamics and time of day variations in traffic (individual vehicles traced every 6 seconds measuring speed, delays, idling in addition to travel time, VMTs, average speed)
- Internet based (accessible anytime, anywhere, from any machine, real time sharing of information among agencies)
- GIS based
- Data Warehouse (Stores all data: Network, Demand, Controls, Outputs, GIS Data) Query and manipulate data directly. Accessible from: Microsoft Excel, Access, any ODBC-enabled application

Air Pollution Modeling from Large-Scale Traffic Networks – Prof. Kaan Ozbay



- Microscopic simulation based estimation of the spatio-temporal change in air pollution levels
- Disaggregates spatial estimation & analysis of emissions (improves current aggregate system-wide estimations)
- Uses vehicle-based, calibrated microscopic simulation model of NJTPK network in PARAMICS (PARAlell Microsimulation software) to disaggregate emission estimation
- US EPA MOBILE 6.2 source emission model integrated in PARAMICS (simulation air pollution levels – CO, HC, NOx, PM10) calculated each vehicle type as function of speed

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Sources of fine particles in NYC area

- Monitoring PM2.5
- Measuring molecular markers
- Chemical Mass Balance (CMB-MM) model output

➔ Compare to emissions inventory

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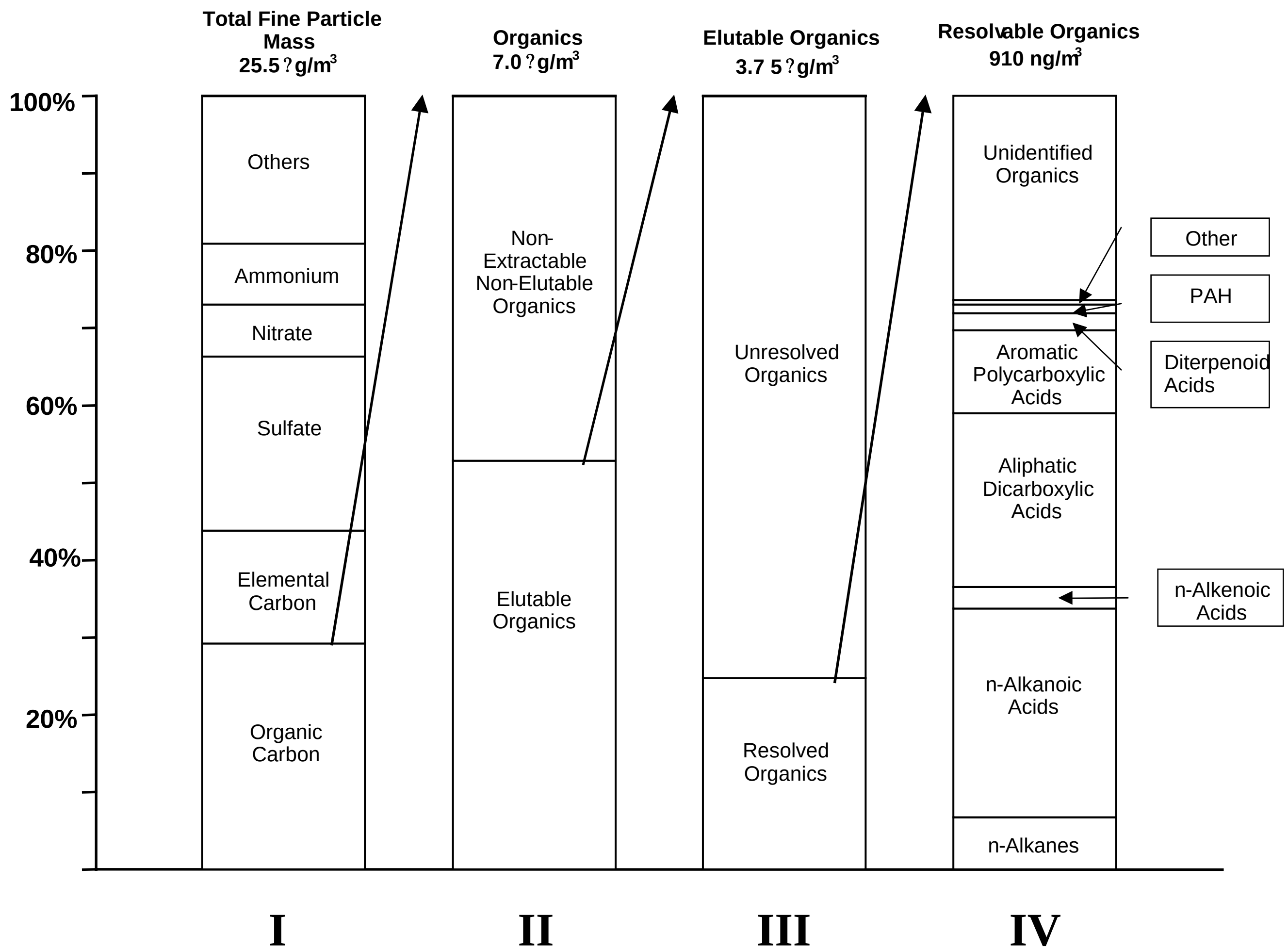
Receptor modeling and CMB-MM

Professor Glen Cass

Chemical species mass balance for ambient PM2.5

- Accounts for various forms of organic carbon
- Multiple analytical measurements
- Monitor variations in fine aerosol composition from bulk C to molecular organic C



Cass Group, eg., Rogge et al., *Atmos. Env.* 1993

Urban sources of fine carbonaceous particles

Los Angeles, CA fine particle emissions inventory

- Oil-fired boiler
- Autos (non- and catalyst-equipped)
- Heavy-duty diesel trucks
- Home heating furnace
- Home fireplace
- Roofing tar pots
- Road dust
- Tire dust
- Brake dust
- Cigarette smoke
- Meat cooking operations
- Vegetation (cultivated, native)

Mathematical Models Accounting for Individual Emission Contributions from Discrete Urban Sources

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Estimating source contribution

Total C (EC+OC) : Organic Matter (1.4 X OC) : Elutable Organic Matter : Molecular Tracer

Mass emission ratios

$$\frac{\text{hopane concentration ng/m}^3}{\text{OC concentration } \mu\text{g/ m}^3} = \text{ratio of source emission rates}$$

Rogge et al., 1993 vehicle exhaust = 2.7×10^{-3}

Relative Source Contribution to Modeled OC Compounds Ambient Concentrations

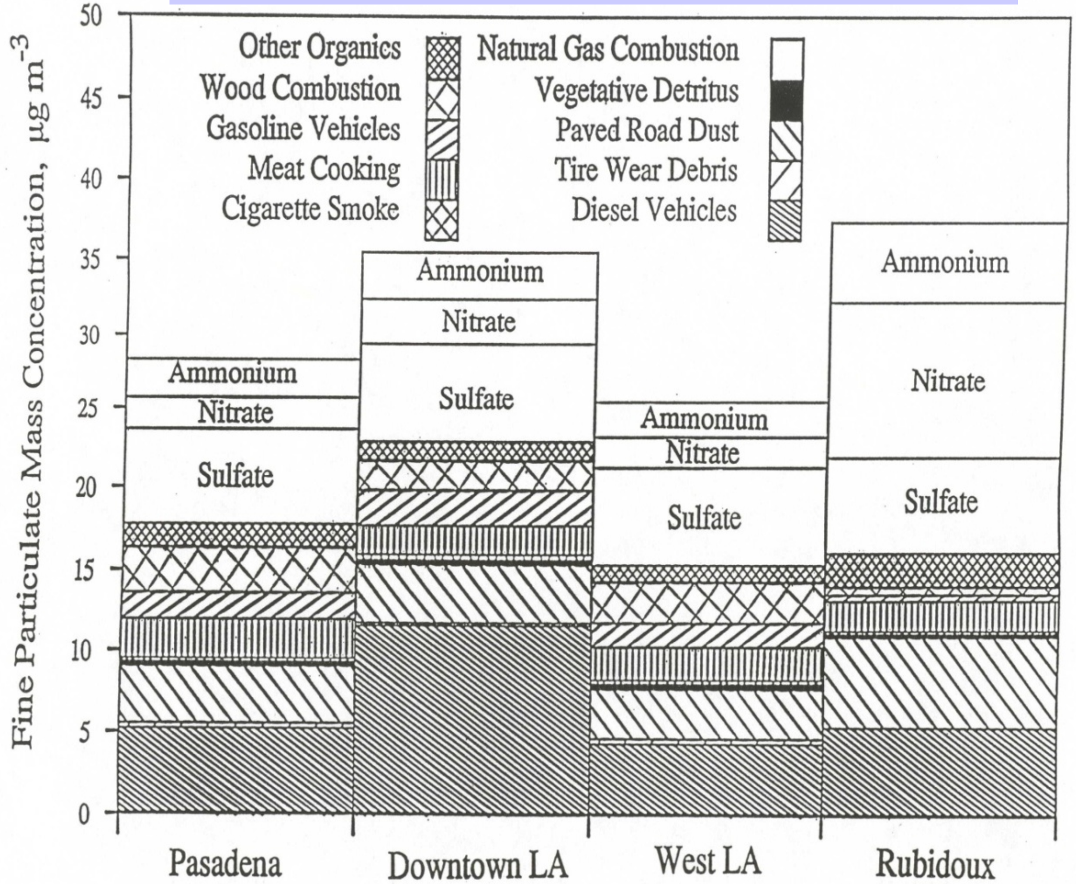
Diesel vehicles = 60% Gasoline Vehicles = 30%
Paved road dust = 10%

Schauer et al., 1996

Urban sources of PM2.5 mass

- Chemical Mass Balance – Molecular Markers (CMB-MM)
- Requires detailed chemical analysis
- Mathematical modeling tool
- Linear combinations of source types
- Emissions inventories for major sources $PM_{2.5}$

Metropolitan Los Angeles, CA



Mass balance for Downtown Los Angeles, 1982, annual average.
Schauer 1996

Speciation of Organics for Apportionment of PM2.5 in the NY City Area (SOAP) **SOAP 2002-2003**

What is the organic composition of PM 2.5?

What are its sources?

What components are directly emitted vs. secondary?

NY, NJ CT Fine Particulate Matter Study

Toll Plaza 13, NJ Turnpike
Elizabeth,NJ

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PM-2.5 Collection in Port and Airports Vicinity

SOAP 2002-2003 network field program

Queen's College NY Supersite

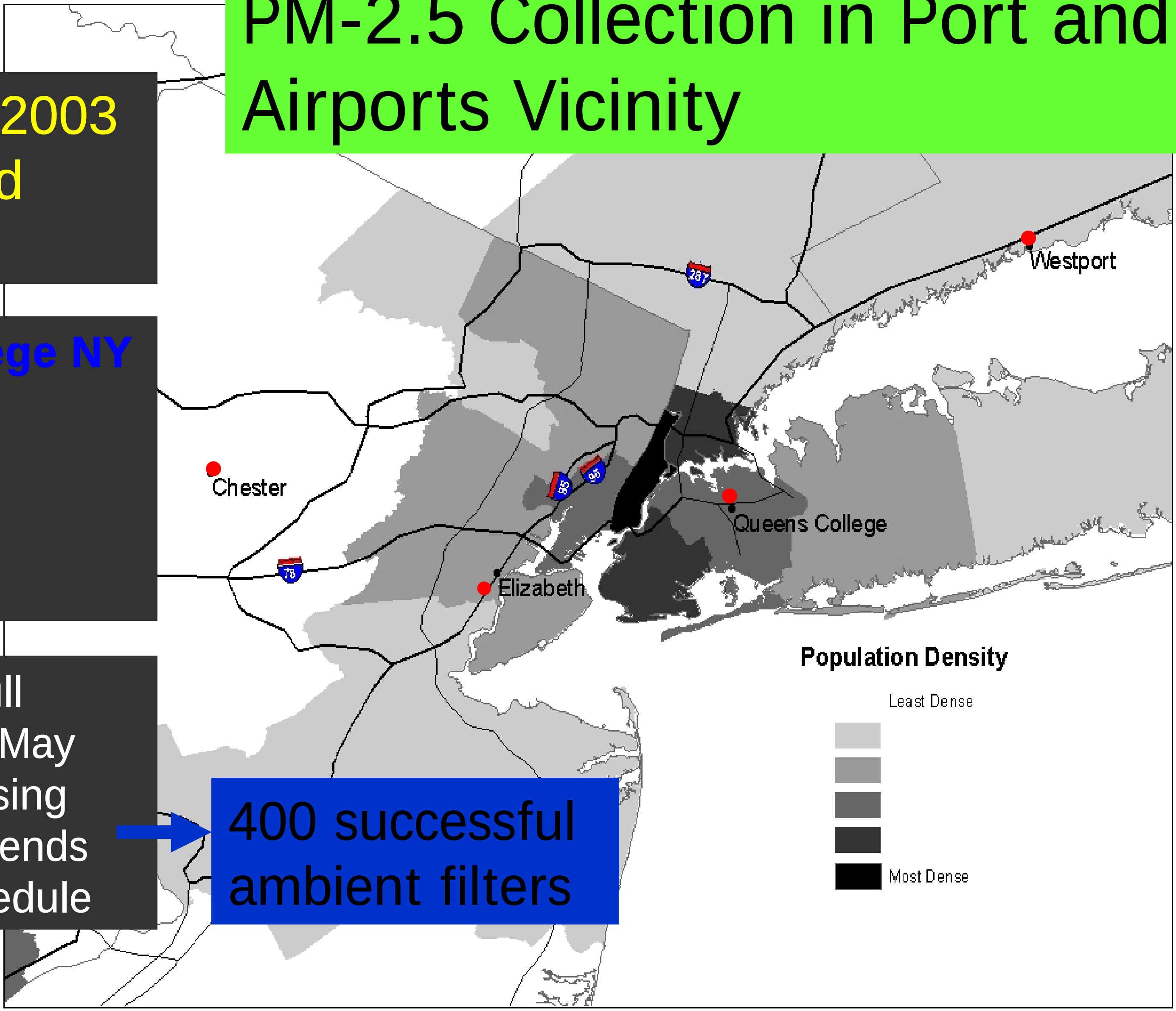
Elizabeth, NJ

Chester, NJ

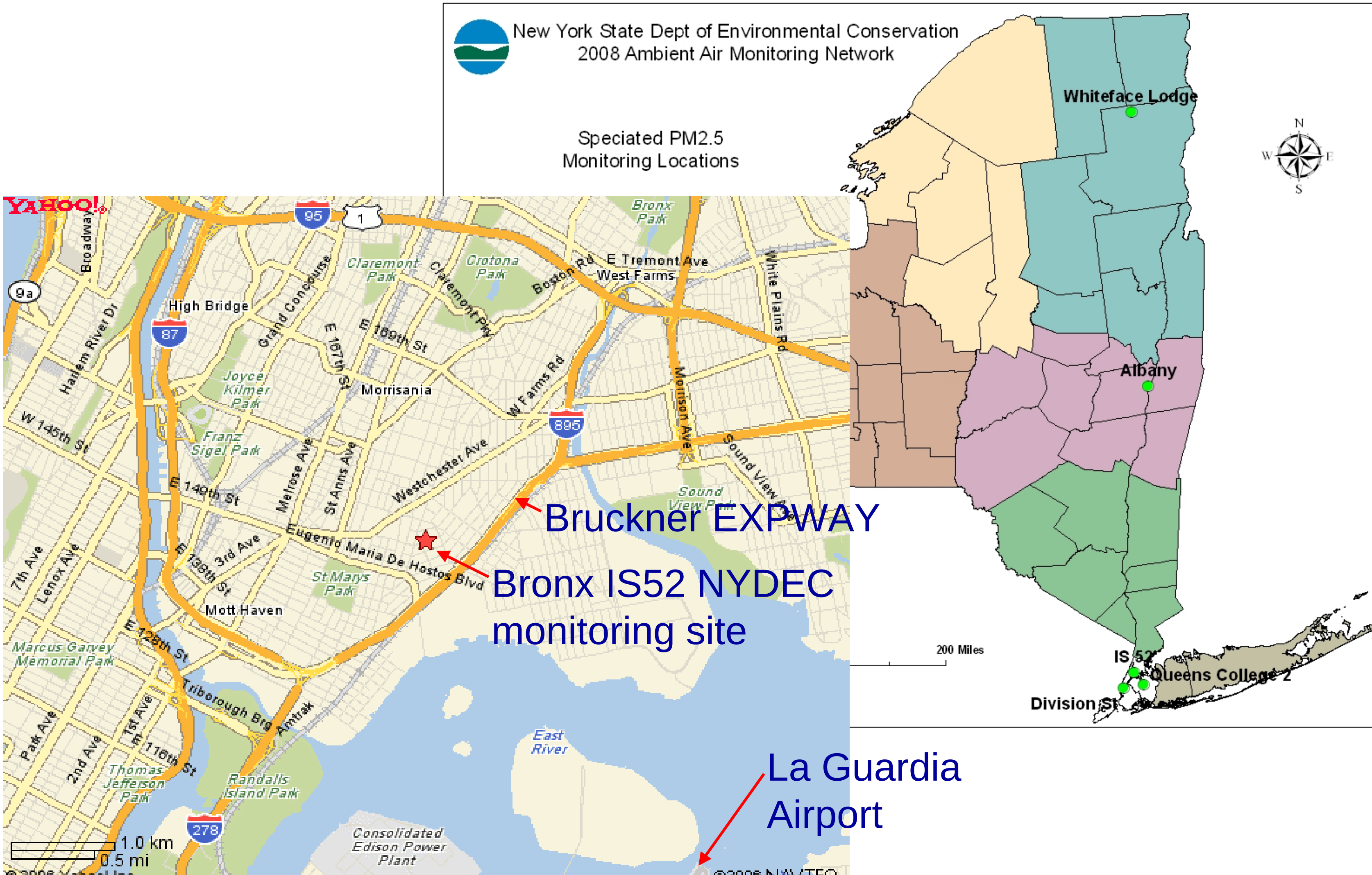
Westport, CT

Completed full annual cycle May 2002-2003 using Speciation Trends Network Schedule

400 successful ambient filters



Current State Monitoring Sites Do Not Capture PNYNY and Surroundings



Motor vehicle emissions profiles

- Collaborative research with NY State DEC Automotive Emissions Laboratory

Goals

- ➔ Updated emission profiles for light-duty diesel and gasoline-powered vehicles
- ➔ Mass balance relationships for vehicle molecular markers to EC and OC mass emission rates
- ➔ Identify molecular markers for CMB modeling

NYSDEC Automotive Emissions Lab

Light duty dynamometer

Vehicle selection
availability, engine characteristics, age/ mileage, type of service, repeatability

Species measured
HC, CO, CO_2, NO_x, PM2.5 (filter & real-time), EC, OC, gas & particle-phase PAHs, PM surface area

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Vehicles tested

Vehicle Make/Type	Model Year	No. of Cylinders	Engine Displacement (L)	Rated Power (hp)	Odometer (mi)	Test Wt. (lb)
Gasoline						
Ford Taurus	2005	6	3	155	36,362	3625
Honda Civic Hybrid	2004	4	1.2	85	27,800	3000
Chevrolet-Cavalier	2004	4	2.2	140	28,892	3375
Chevrolet Venture Minivan	2002	6	3.4	185	54,939	4000
Ford Windstar Minivan	2001	6	3.8	200	50,720	4500
Ford Crown-Victoria	2000	8	4.6	200	55,792	4250
Jeep Cherokee	1998	6	4	185	93,839	3875
Oldsmobile Achieva	1997	4	2.4	150	172,270	3250
Jeep Grand Cherokee	1995	8	5.2	230	171,033	4000
Chevrolet Astro Cargo Van	1994	6	4.3	190	105,274	4500
Jeep Cherokee	1992	6	4	185	229,196	3875
Dodge Ram Van	1990	8	5.2	140	154368	3750
CNG						
Chevrolet-Cavalier	2004	4	2.2	140	28,892	3375
Ford Crown Vic	1999	8	4.6	200	34015	4500
Diesel						
Volkswagon Jetta	2003	4	1.9	90	74391	3500
Volkswagon New Beetle	2001	4	1.9	90	64546	3250
Ford F350	1999	8	7.3	350	115115	4500
Dodge Ram	1999	10	8	300	101745	4500
Grease						
Ford F350	1999	8	7.3	350	115115	4500
Bio-diesel						
Ford F350	1999	8	7.3	350	115115	4500

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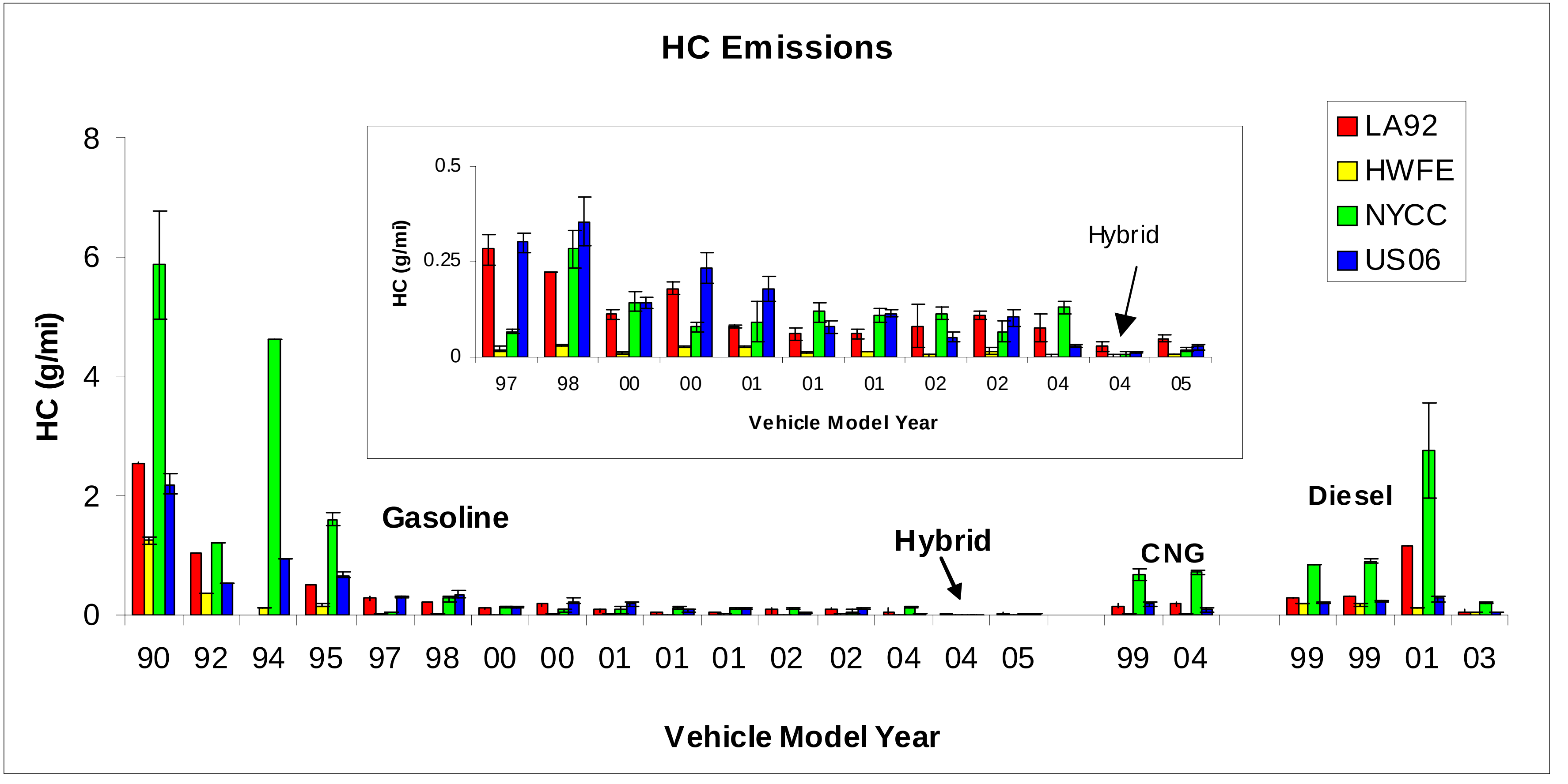
Emissions profiles of regulated pollutants highly variable for on-road vehicles tested



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Tang et al., 2008, *SAE*

Organic complex mixtures diesel & gasoline powered vehicles

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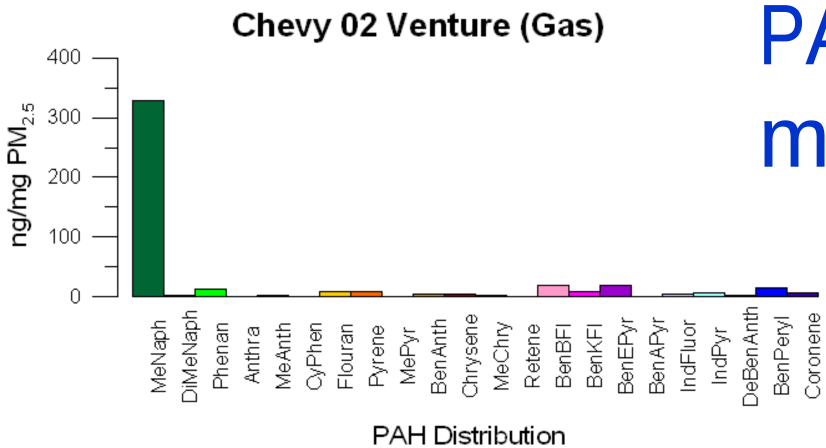
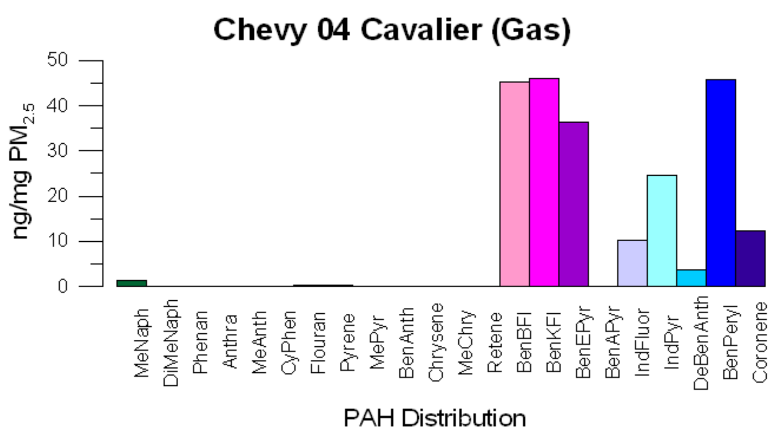
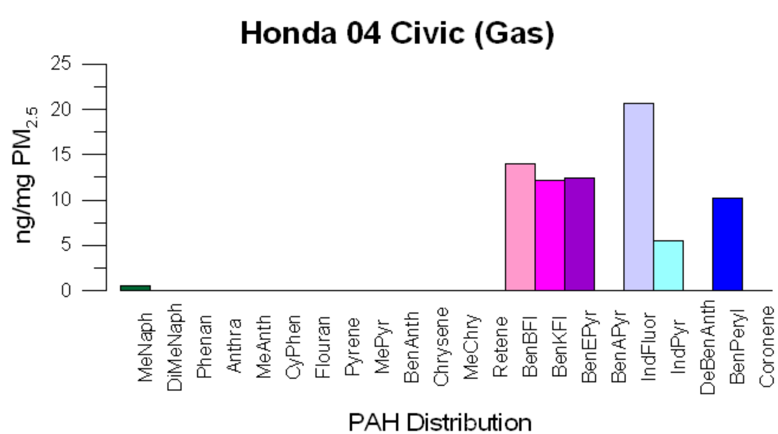
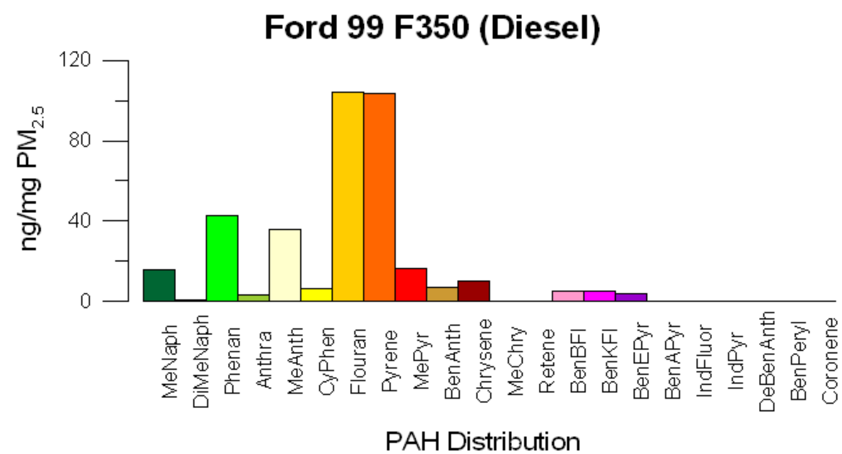
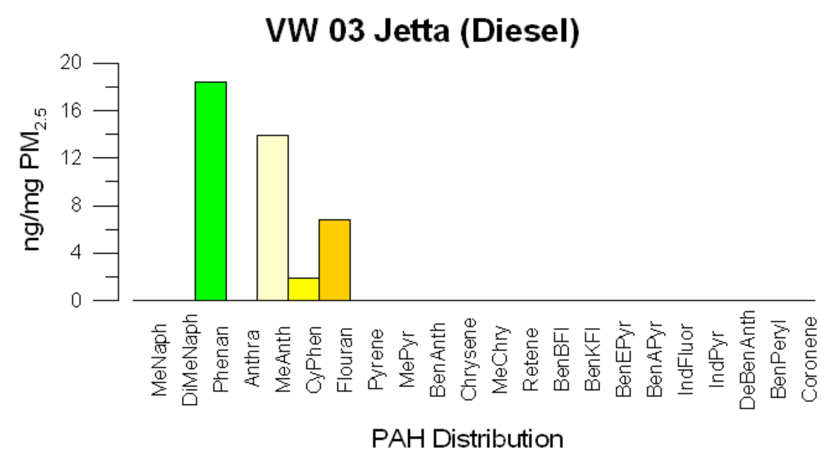
PAH mixtures in motor vehicle PM2.5











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Key points

- Extensive air quality monitoring provides long term pollutant concentrations in NYC area, but NOT adequate to assess improvements to PNYNJ
- Transportation models at micro and large-scale network levels under development with on-road emissions profiles based on NYDEC AEL tests (emissions function of vehicle speed)
- Distributions or chemical profiles distinct patterns for key molecular markers used in CMB modeling; source profiles of "INPORT" vehicles needed to enhance accuracy model output
- Vehicle chemical emission profiles important for NE U.S. state emissions inventories and SIPs – model output versus observed concentrations -- predict impact of motor vehicle emissions on urban airsheds from transportation systems

New York Air Quality Circa 1953

Control of gas phase pollutants (NO_X, SO_X, O_3) and PM has improved air quality in urban atmospheres

The Metro Section

The New York Times

Neal Boenzi/The New York Times

Manhattan, engulfed in smog in November 1966. Past pollution crises led to new clean-air standards and enforcement.

You Should Have Seen the Air in '53

After Sept. 11, Considering History's Lessons on Pollution

By KIRK JOHNSON

A dry, wheezing, watery-eyed cough became common. The number of emergency room visits climbed, and the theaters in Times Square went dark for lack of business. Smoke and haze drifted across the region.

Lower Manhattan after Sept. 11? No. It was November

how little science knew. Air researchers in those days were not even sure what to call the stuff that had descended on the city, let alone what health impact it had. (They tried the word "smaze," to describe the combination of smoke and haze, but it never caught on; smog had more punch.)

But within a generation of those first smog crises in New York and Los Angeles, the federal Clean Air Act had encoded

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End of Presentation

Thank you

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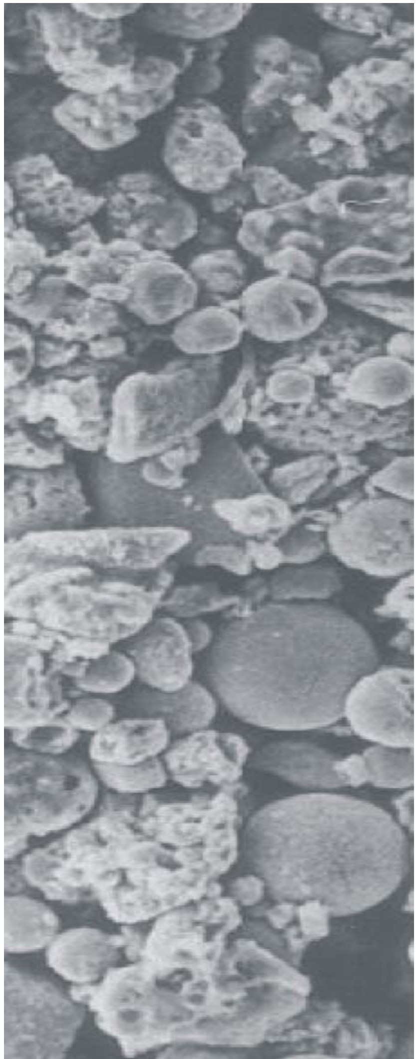

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