Assessment of Carbonaceous $PM_{2.5}$ for New York State and the Region

John Graham

jgraham@nescaum.org

2007 NYSERDA EMEP CONFERENCE
ENVIRONMENTAL MONITORING, EVALUATION, AND PROTECTION IN NEW YORK: LINKING SCIENCE AND POLICY
Albany, New York
November 16, 2007

Project Goals

- Produce a policy-relevant assessment of scientific and technical understanding of behavior and control of carbonaceous $PM_{2.5}$ for the State of New York
  - Two equally important perspectives for assessment
    - Attainment of NAAQS for $PM_{2.5}$ (and ozone) for the New York Metro area (three-state area, NY, Conn., NJ) : urban focus
    - Public health and human exposure to $PM_{2.5}$ (across the state including rural areas) : human exposure focus
- Provide recommendations to decision makers on how to move forward (science, technology, controls, need for future work)
- Report written for broad audience

NESCAUM

Assessment Report

- Final product : A written assessment report
  - In two volumes
    - Volume I : Executive Summary (six pages) and a Synthesis Document (21 pages; includes recommendations); both written for broad audience
    - Volume II : Three-chapter comprehensive assessment report (chapters on atmospheric processes, human health effects, and control technologies and strategies), and six detailed appendices ($PM_{2.5}$ Emission Inventory, Diesel Engine Technologies, Cost-Effectiveness Analysis, New Vehicle and Engine Emission Standards, Airports and Aircrafts, and $PM_{2.5}$ Speciation profiles)

NESCAUM

Focus Questions (two of five)

- (1) Do carbonaceous aerosols contribute significantly to high levels of ambient $PM_{2.5}$ in the New York State ?

- (2) What proportion of carbonaceous $PM_{2.5}$ present in NY is derived from in-state sources?

Ambient data used to illustrate temporal (seasonal, daily, sub-daily) & spatial (regional, urban, community) variation of carbonaceous aerosol in New York State.

Combined with available emissions inventory information, provide answer to above questions.

NESCAUM

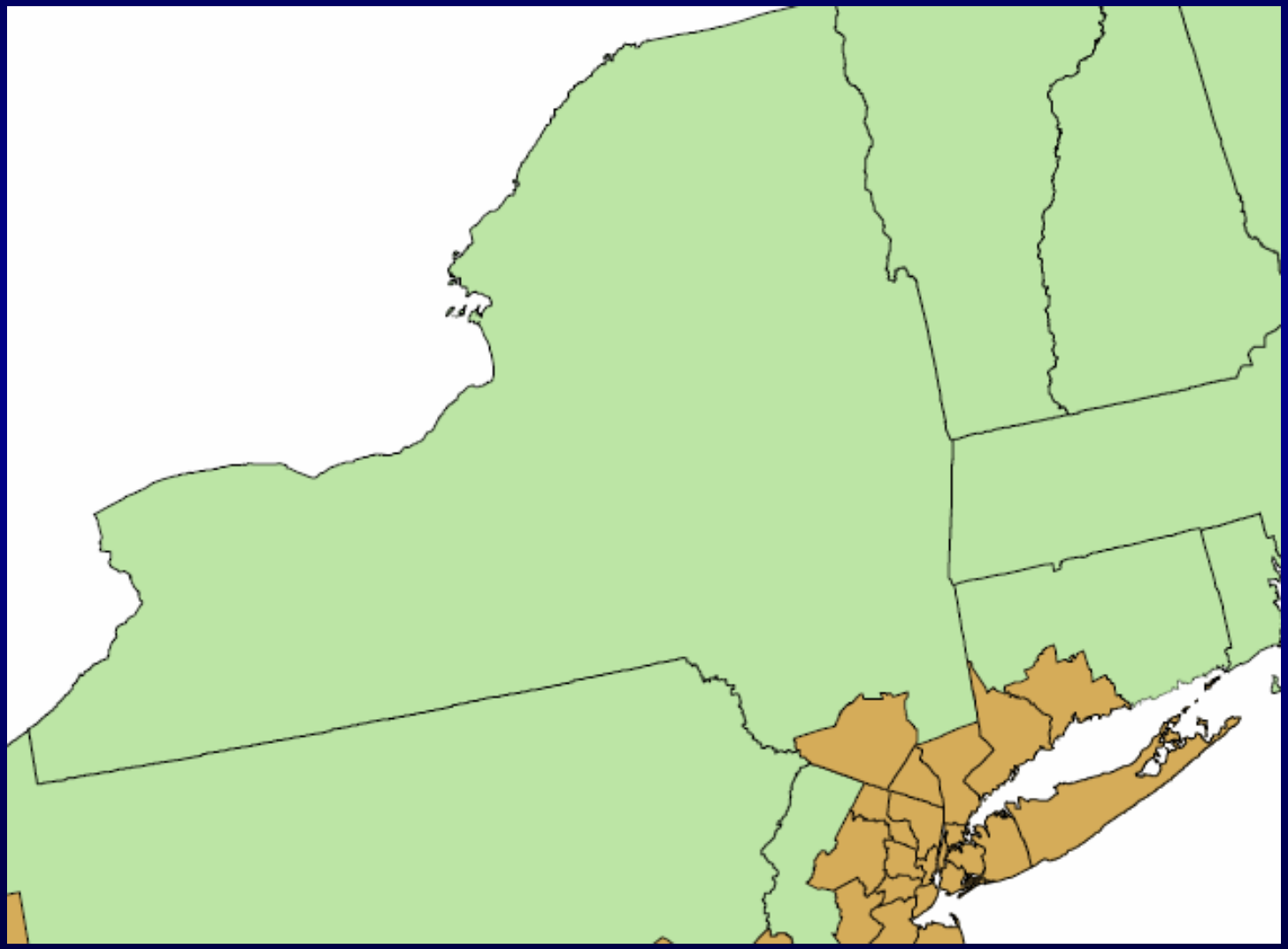
Emissions Inventory

- Information Sources: US EPA National Emissions Inventory and MANE-VU Inventory
- PM2.5 emissions speciated with US EPA profiles
- Seven emission areas emphasized, based on their contribution to EC and OC fraction of PM2.5 emissions:

  (1) commercial meat cooking, (2) residential fuel combustion, (3) light-duty vehicles, (4) heavy-duty trucks and buses, (5) nonroad engines, (6) airports, and (7) marine ports

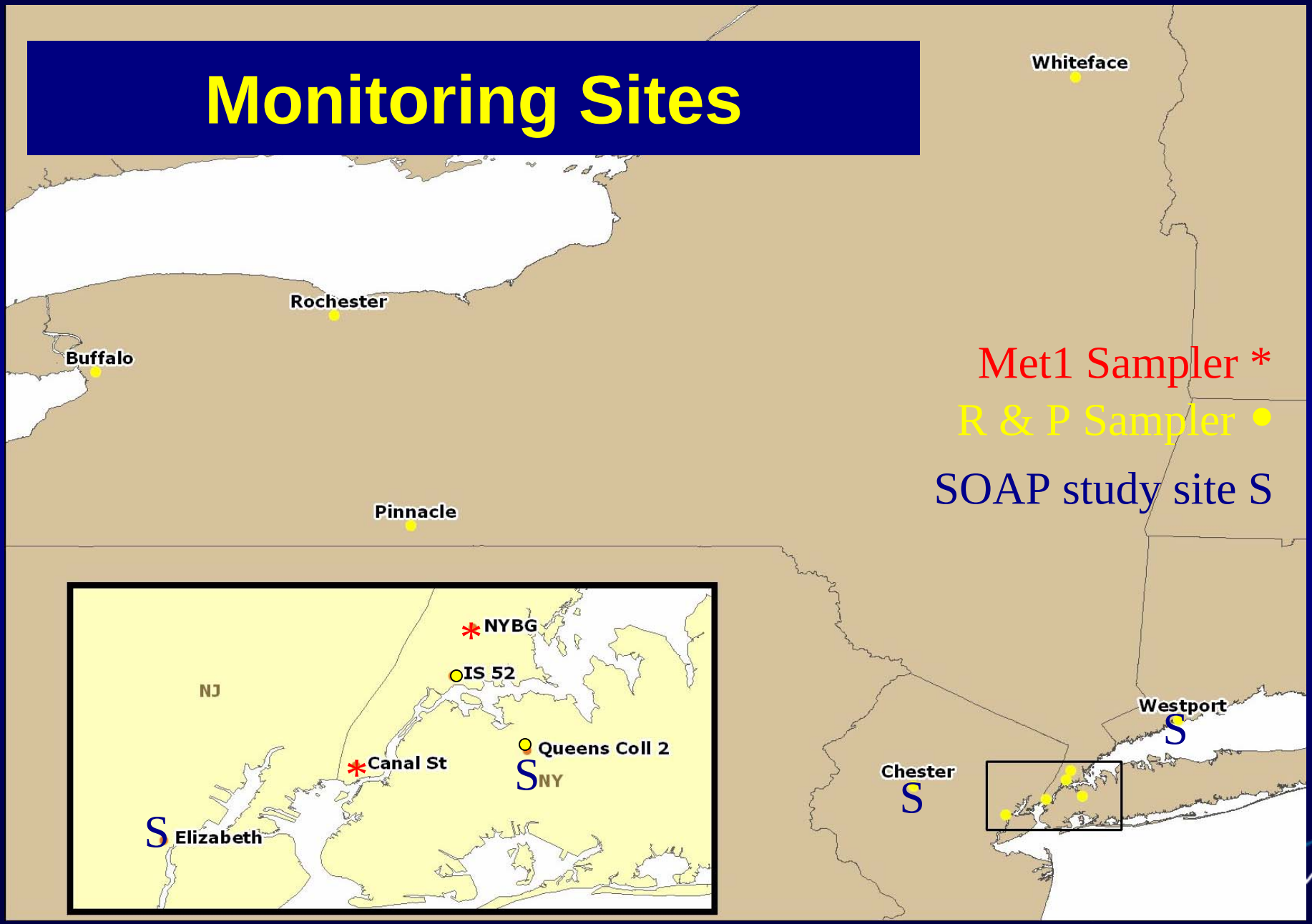
NESCAUM

$PM_{2.5}$ Nonattainment Area



NESCAUM

Monitoring Sites



Ambient Measurements and Data Analysis Findings

- Filter-based Measurements in New York State
  - Blank Correction & Organic Carbon Mass Adjustment Factor
  - Reconstructed Mass Data
  - Monthly Variation of Carbonaceous $PM_{2.5}$
  - EC Tracer Method
  - Weekday-weekend Analysis
  - Local versus Regional Analysis

NESCAUM

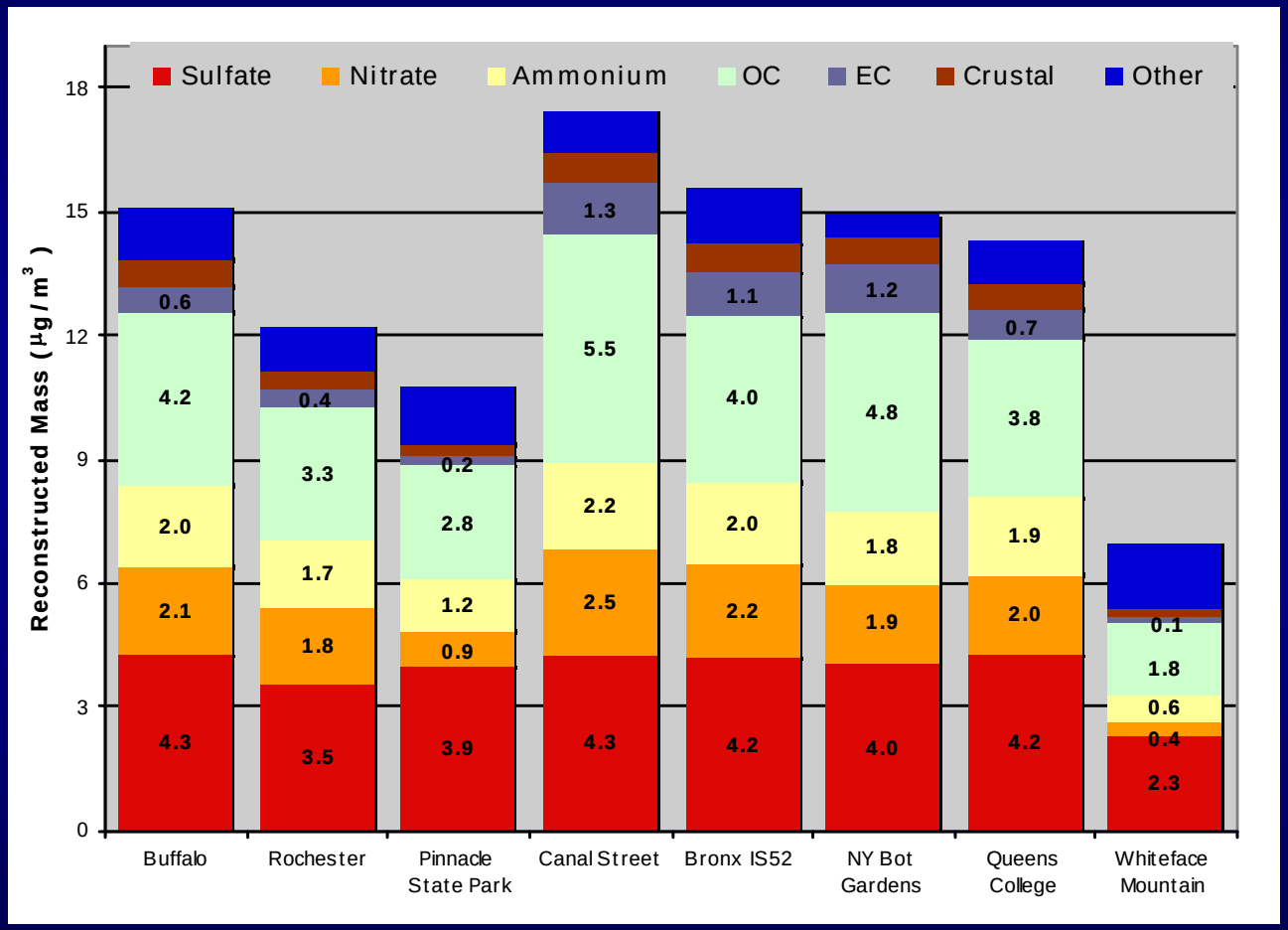
Ambient Measurements and Data Analysis Findings: Filter-based Measurements -Mass Adjustment Factor

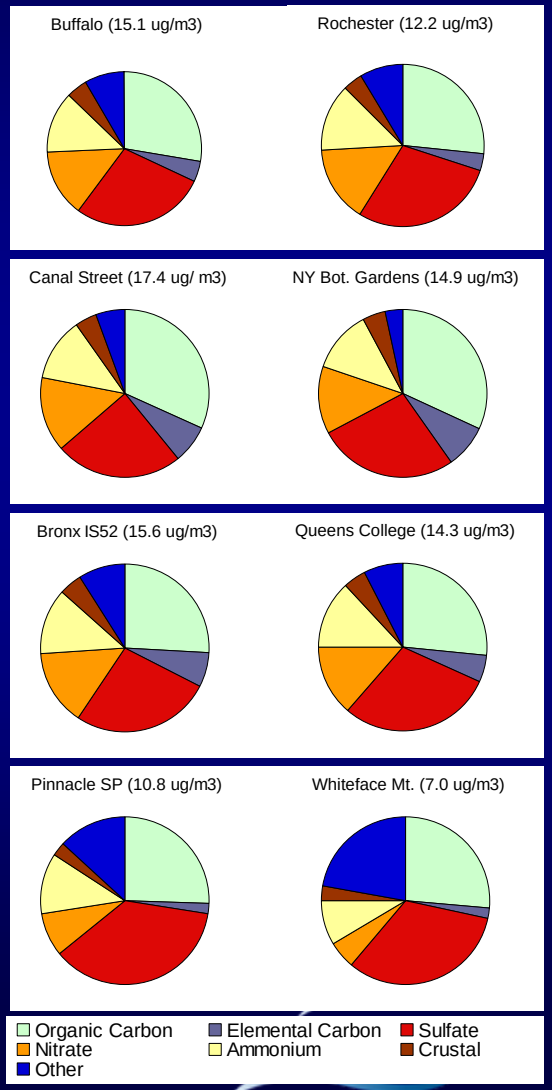
- This work employed a mass-balance approach based on Frank's (2006) SANDWICH approach
- Sample-specific OC adjustment factors calculated for blank corrected data
- Sulfate, Nitrate, Ammonium, EC and Crustal mass subtracted from total sample mass
- Adjustment made for particle-bound water and seasonally adjusted nitrate loss

Site Name	OC Factor		Site Name	OC Factor
Buffalo (BUFF)	1.5		Botanical Gardens (NYBG)	1.4
Whiteface (WHTE)	1.6		IS 52 (IS52)	1.4
Rochester (ROCH)	1.6		Queens College (QCII)	1.5
Pinnacle State Park (PINN)	1.6		Canal St (CANL)	1.3

NESCAUM

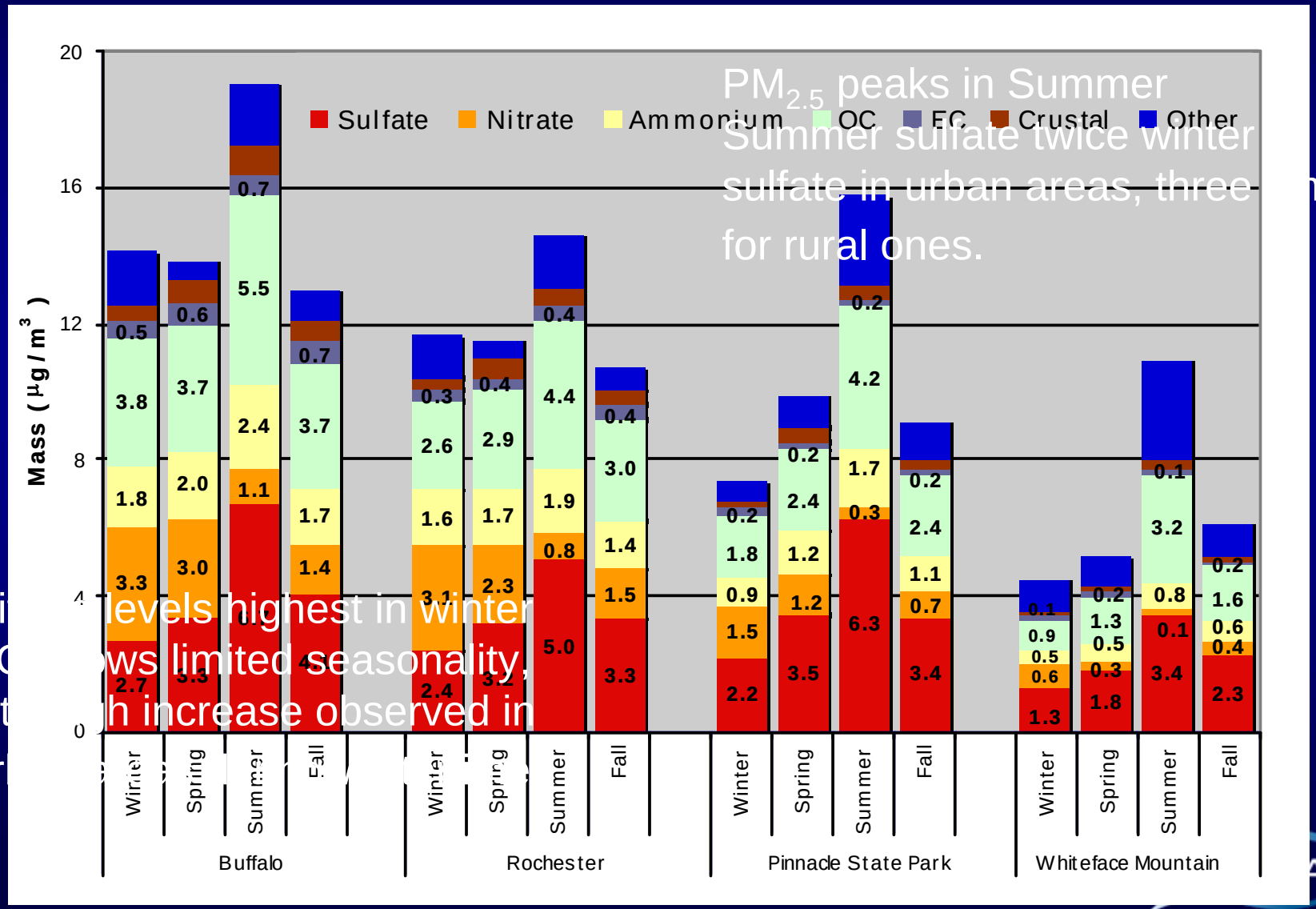
Ambient Measurements and Data Analysis Findings: Filter-based Measurements -Reconstructed Mass





Annual SO_4 mass constant across NYS, NO_3, OC and EC greater in urban areas than in rural ones; OC mass represents 1/4 -1/3 of total $PM_{2.5}$ mass.

Ambient Measurements and Data Analysis Findings: Filter-based Measurements -Reconstructed Mass



$PM_{2.5}$ peaks in Summer

Summer sulfate twice winter sulfate in urban areas, three [illegible]nes for rural ones.

Ni[illegible] levels highest in winter

EC[illegible]ws limited seasonality,

alt[illegible]h increase observed in

ur[illegible]

Ambient Measurements and Data Analysis Findings: Filter-based Measurements -EC Tracer Method

- EC used as tracer for primary emissions. Derived primary ratio based on dataset.
- Note: this approach assumed constant averaged primary source ratio of OC:EC

Estimated contribution of secondary organic aerosol to total OC

Site	Cooler Months	Warmer Months	Site	Cooler Months	Warmer Months
Buffalo	42%	47%	Pinnacle State Park	60%	78%
Canal St.	~0%	15%	Queens College	~0%	29%
IS52	~0%	27%	Rochester	51%	61%
NY Botanical Gardens	~0%	39%	Whiteface	50%	80%

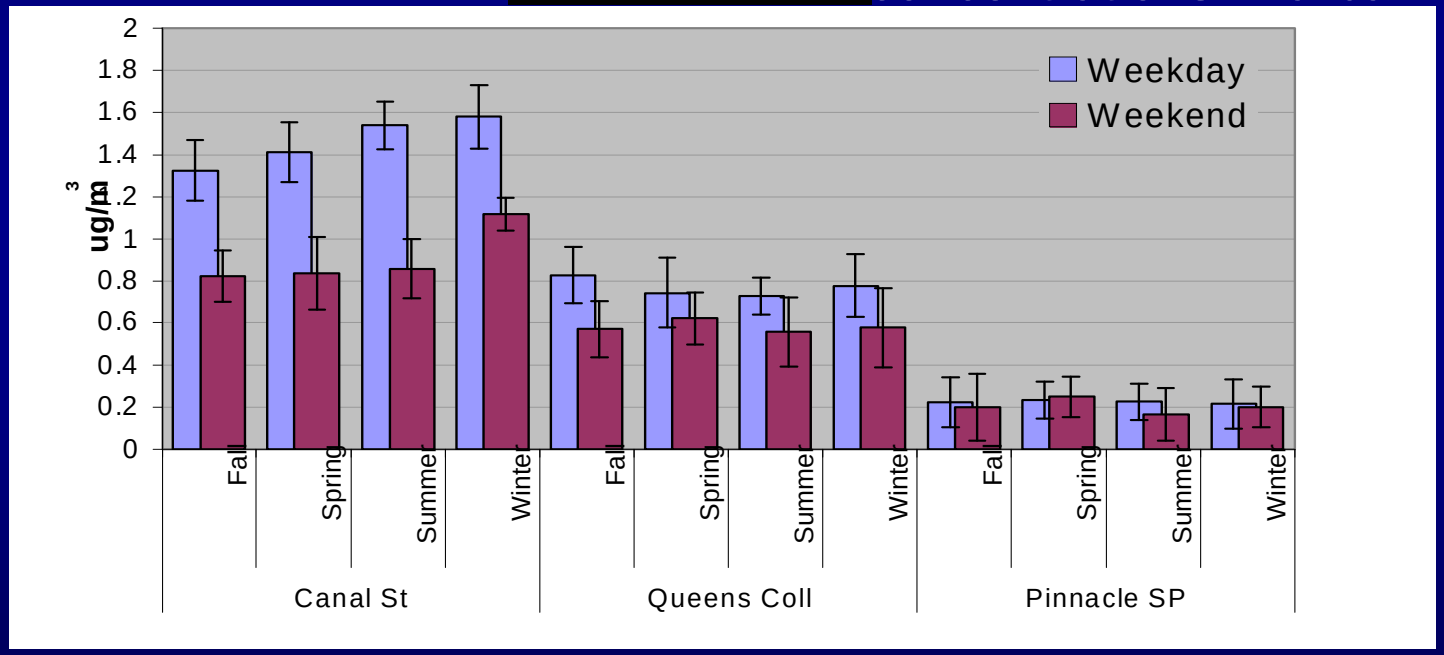
Warmer months = May to September

NESCAUM

Ambient Measurements and Data Analysis Findings: Filter-based Measurements -Weekday-weekend Analysis

Little difference seen between weekday-weekend OC levels. Differences apparent for EC concentrations in urban areas.

Seasonal EC



NESCAUM

Ambient Measurements and Data Analysis Findings: Filter-based Measurements -Local versus Regional

- NYC sites compared to Pinnacle State Park site
  - Pinnacle site assumed to represent regional background
  - Sample dates matched
- Intra-Urban [(max-min)/max)] comparison represents a lower bound for local source contribution (sampler specific comparison ~10% less than in table)
- Urban-rural [(urban-rural)/urban] estimate may or may not accurately portray local source contribution

Pollutant	Comparison	Winter	Spring	Summer	Fall	Annual
Sulfates	Intra-Urban	5%	15%	10%	5%	10%
	Urban-Rural	30-35%	10-25%	0-10%	-15 – (-5%)	5-15%
Nitrates	Intra-Urban	15%	35%	30%	25%	25%
	Urban-Rural	50-55%	50-65%	75-80%	55-65%	55-65%
Organic Carbon	Intra-Urban	35%	35%	30%	40%	35%
	Urban-Rural	40-65%	30-55%	10-35%	25-50%	25-50%
Elemental Carbon	Intra-Urban	50%	40%	50%	40%	45%
	Urban-Rural	70-85%	65-80%	70-85%	70-80%	70-85%

NESCAUM

Major Findings

- We still have a lot to learn about carbonaceous aerosols
- We know they contribute significantly to $PM_{2.5}$ levels in New York City and the rest of the State
- A substantial fraction of OC and most EC is likely of local in origin for New York City

NESCAUM

Special Thanks to:

- NYSERDA for supporting the project (Dr. Ellen Burkhard, Project Manager)
- Dr. Mort Lippmann and Dr. Ken Demerjian for invaluable expertise
- NESCAUM Staff : Praveen Amar, Michael Block, Coralie Cooper, Addison Faler, Phil Johnson, Iyad Kheirbek, Paul Miller, Lisa Rector, Emily Savelli, Eric Skelton, and Jung-Hun Woo
- MJB Associates for preparing substantial portions of many of the control technology chapters and appendices
- EPA ORD for speciation profiles; NACAA for background material on technologies

NESCAUM