Comparative Evaluation of Ambient Fine Particulate Matter ($PM_{2.5}$) Data Obtained from Urban & Rural Monitoring Sites Along the Upper Ohio River Valley

Presented at:

The $PM_{2.5}$ and Electric Power Generation: Recent Findings and Implications

NETL-Sponsored Conference

Omni William Penn Hotel, Pittsburgh, PA

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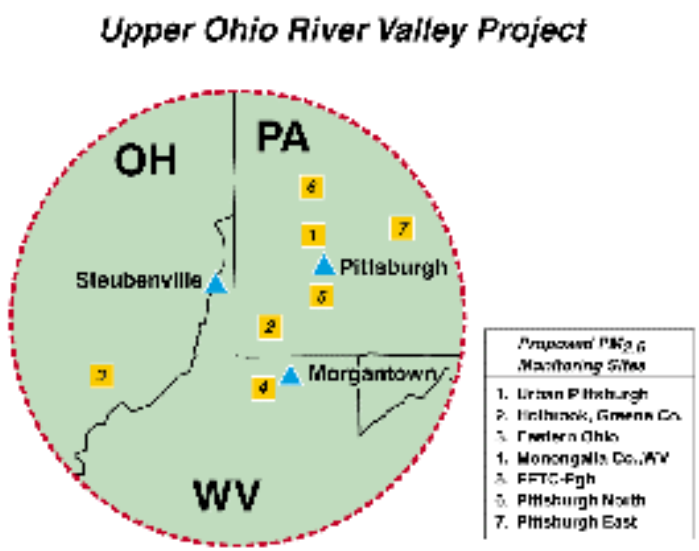
UPPER OHIO RIVER VALLEY OVERALL PROJECT GOAL

Obtain and provide reliable data that can be applied for the following:

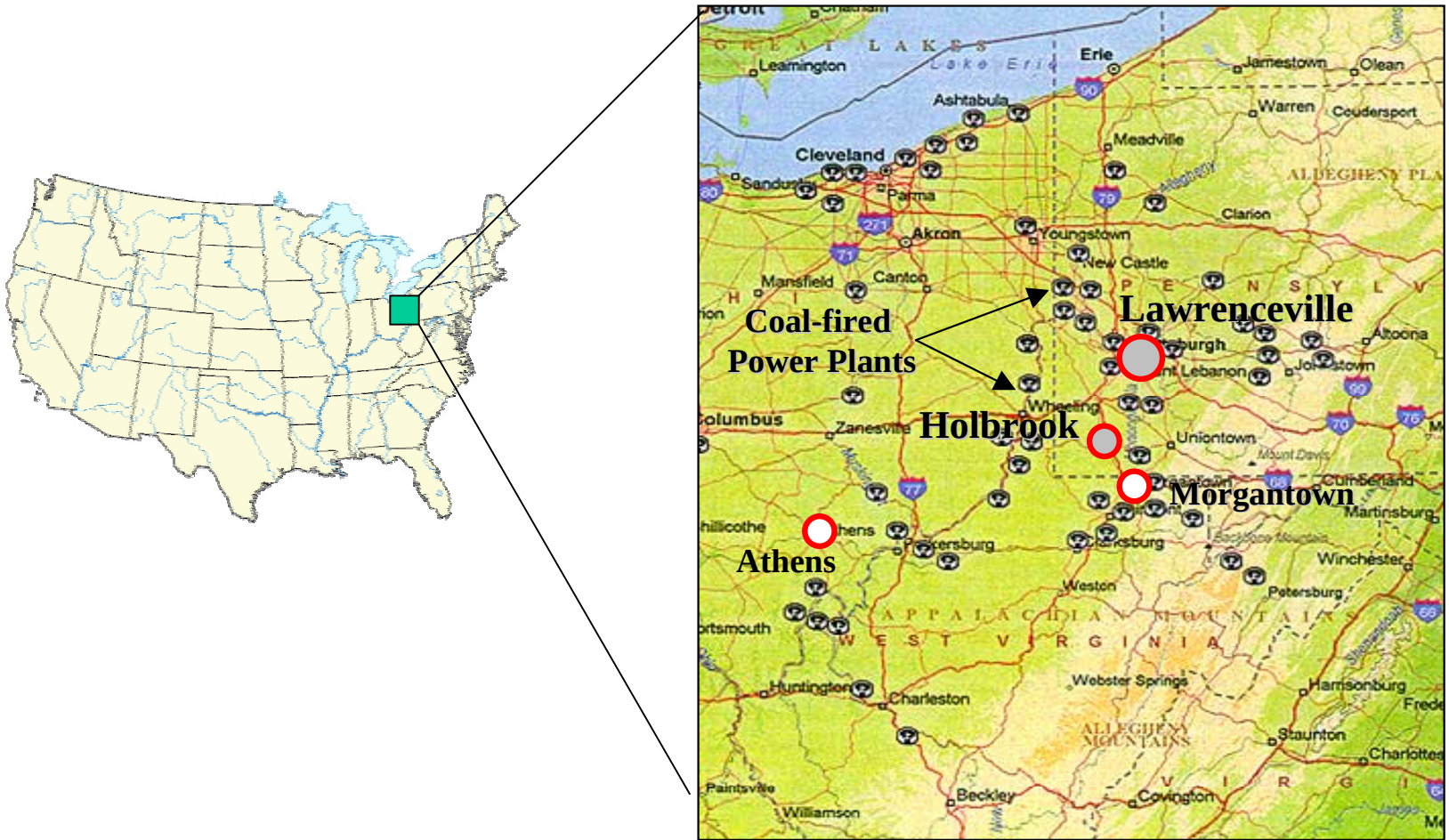
- Source apportionment (i.e., source-receptor) modeling
- Emissions trend analyses
- Management strategy (e.g., SIP) development
- FRM performance evaluation
- Human-exposure/health related studies



Candidate UORVP $PM_{2.5}$ monitoring sites

MAJOR SCIENCE QUESTIONS/ HYPOTHESES

- Are sulfates a major/minor component of eastern $PM_{2.5}$ mass?
- Is there a correlation between O_3 and $PM_{2.5}$ levels?
- Is there a (significant) variation in $PM_{2.5}$ composition/concentration between urban and rural sites impacted by similar regional emission sources?
- Does FRM performance provide an accurate/realistic measurement of $PM_{2.5}$ mass? (Influence of artifacts on measurement?)


Coal-fired
Power Plants
Lawrenceville
Holbrook
Morgantown
Athens
Erie
Cleveland
Akron
Youngstown
Canton
Mansfield
Meadville
Warren
Clarion
New Castle
Wheeling
Uniontown
Zanesville
Columbus
Weston
Webster Springs
Charleston
Huntington
Beckley
Covington
Staunton
Harrisonburg
Winchester
Martinsburg
Petersburg
Altoona
Jamestown
Olean
Leamington
Ashtabula
Sandusky
Parma
Paintsville
Williamson
Chillicothe
Portsmouth
Lake Erie
GREAT LAKES
APPALACHIAN MOUNTAINS
WEST VIRGINIA
ALLEGHENY MOUNTAINS

$PM_{2.5}$ SAMPLING AND ANALYSIS						
SAMPLER	**DENUDER**	**CHANNEL NO.**	**FILTER MATERIALS**		**ANALYSIS**	
			Front	**Back**	**Front**	**Back**
SFS-$PM_{2.5}$	(none)	1	Teflon®	Quartz	Mass (Gravimetry), Elements (XRF)	Carbon (TOR)
		2	Quartz	Cellulose/ NaCl	Carbon (TOR); Cl^-, NO_3^-, SO_4^{2-} (IC); NH_4^+ (AC); Na^+, K^+ (AA)	NO_3^- (IC)
SFS-PM_{10}	(none)	1	Teflon®	Quartz	Mass (Gravimetry), Elements (XRF)	Carbon (TOR)
		2	Quartz	Cellulose/ NaCl	Carbon (TOR); Cl^-, NO_3^-, SO_4^{2-} (IC); NH_4^+ (AC); Na^+, K^+ (AA)	NO_3^- (IC)
SGS-TP	Nitric Acid	1	Quartz	Cellulose/ NaCl	NO_3^- (IC)	NO_3^- (IC)
	(none)	2	Quartz	Cellulose/ NaCl	NO_3^- (IC)	NO_3^- (IC)
SGS-$PM_{2.5}$	Ammonia	1	Quartz	Cellulose/ Citric Acid	NH_4^+ (AC)	NH_4^+ (AC)
	(none)	2	Quartz	Cellulose/ Citric Acid	NH_4^+ (AC)	NH_4^+ (AC)
FRM (R&P) -a	(none)	1	Teflon®	(none)	Mass (Gravimetry), Elements (XRF)	-
FRM (R&P) -b	(none)	1	Quartz	(none)	Carbon (TOR); Cl^-, NO_3^-, SO_4^{2-} (IC); NH_4^+ (AC); Na^+, K^+ (AA)	-
Portable $PM_{2.5}$	(none)	1	Polycarbonate	(none)	CCSEM	-

XRF = X-Ray Fluorescence, TOR = Thermal/Optical Reflectance, IC = Ion Chromatography, AC = Automated Colorimetry, AA = Atomic Absorption, CCSEM = Computer Controlled Scanning Electron Microscopy

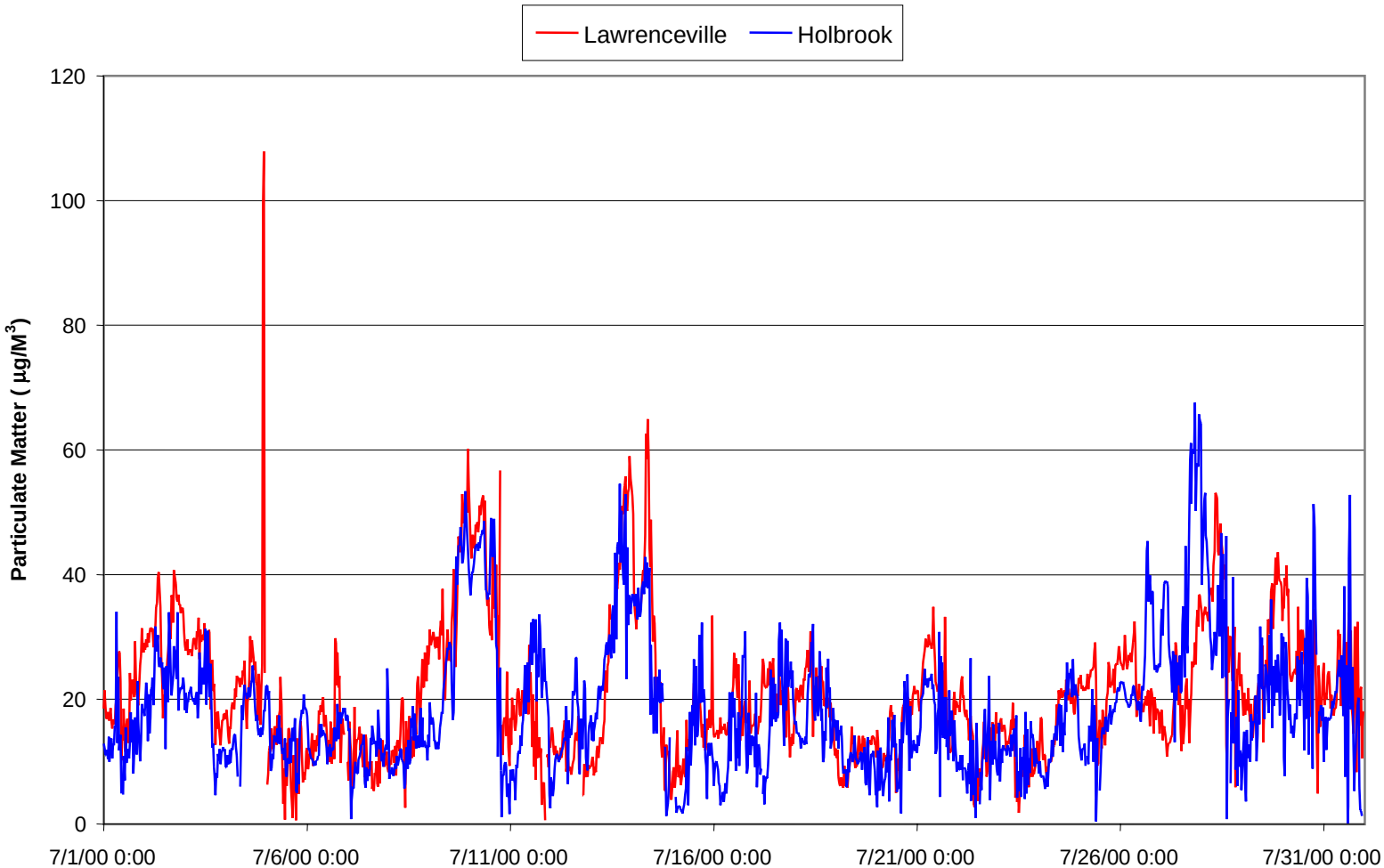
Lawrenceville Site

Holbrook Site

Table 3: Sample Collection Summary
February 1999 - October 2001

Sample Type	Parameter	Inlet Size	Total No. Collected
Discrete Filter Samples	Particulate (SFS)	PM2.5	1360
	Particulate (SASS)	PM2.5	162
	Particulate (SFS)	PM10	1201
	Ammonia (SGS)	PM2.5	1201
	Nitric Acid (SGS)	TSP	1201
	SEM (MiniVol)	PM2.5	1201
	Particulate (FRM-TEF)	PM2.5	332
	Particulate (FRM-QRTZ)	PM2.5	249
	TOTAL		6907
Continuous Filter Samples	Parameter		Collection Period
(TEOMs)	$PM_{2.5}$ Particulate		June 1999 - Present
	PM_{10} Particulate		June 1999 - Present
Precursor Gases	NOx		June 1999 - Present
	SO_2		June 1999 - Present
	O_3		June 1999 - Present
	CO		June 1999 - Present
Meteorological Data	Wind Speed		June 1999 - Present
	Wind Direction		June 1999 - Present
	Temperature		June 1999 - Present
	Relative Humidity		June 1999 - Present
	Solar Radiation		June 1999 - Present
	Precipitation		June 1999 - Present
	Barometric Pressure		June 1999 - Present

FIGURE 1:
Lawrenceville & Holbrook PM $_{2.5}$ TEOMs
July 2000



ATS Summer 1999 Intensive Sampling Program
Lawrenceville August TEOM Data

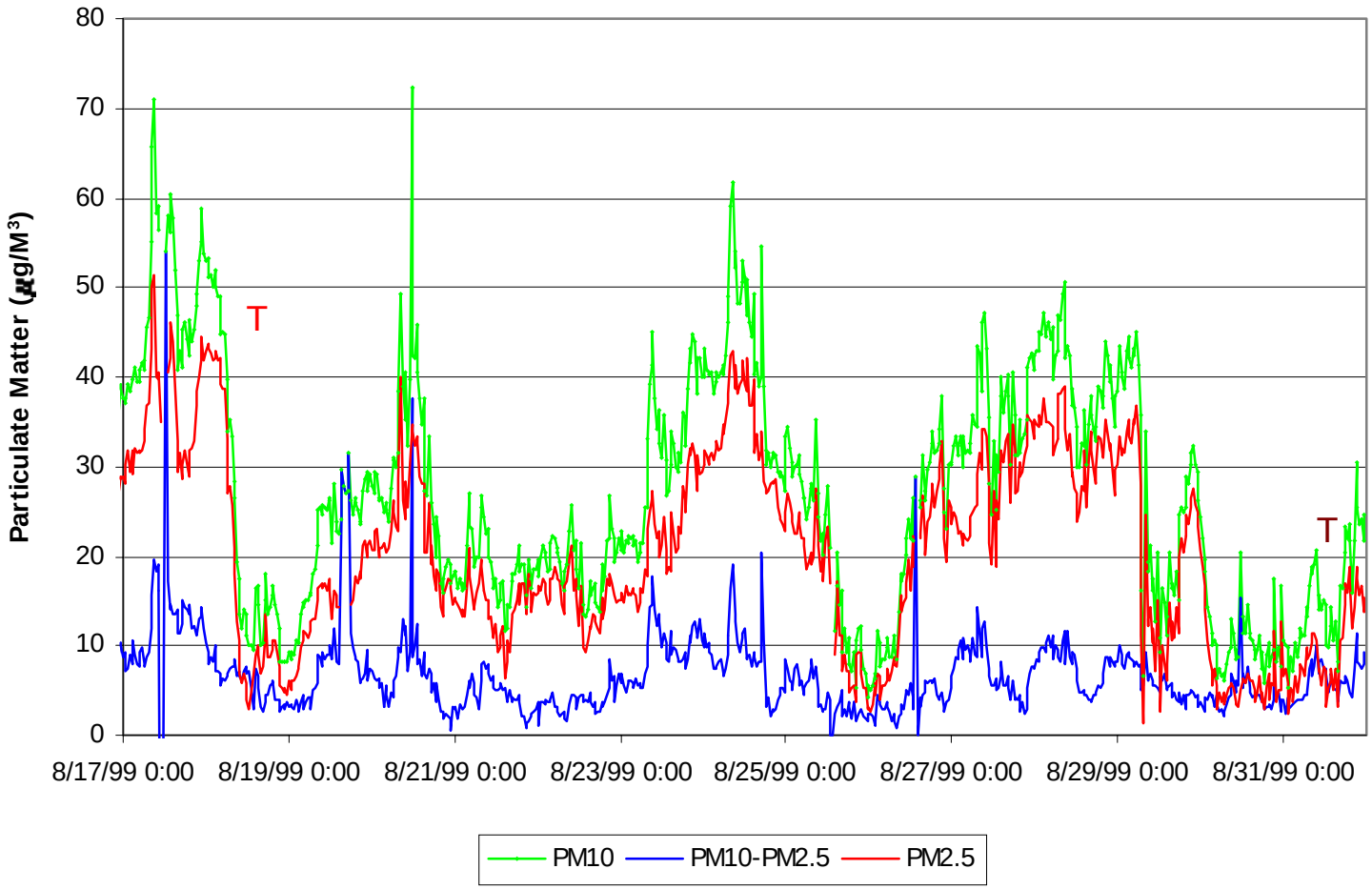


FIGURE 2c:
June 1999-May 2001
Holbrook ($PM_{2.5}$) TEOM Data Distribution

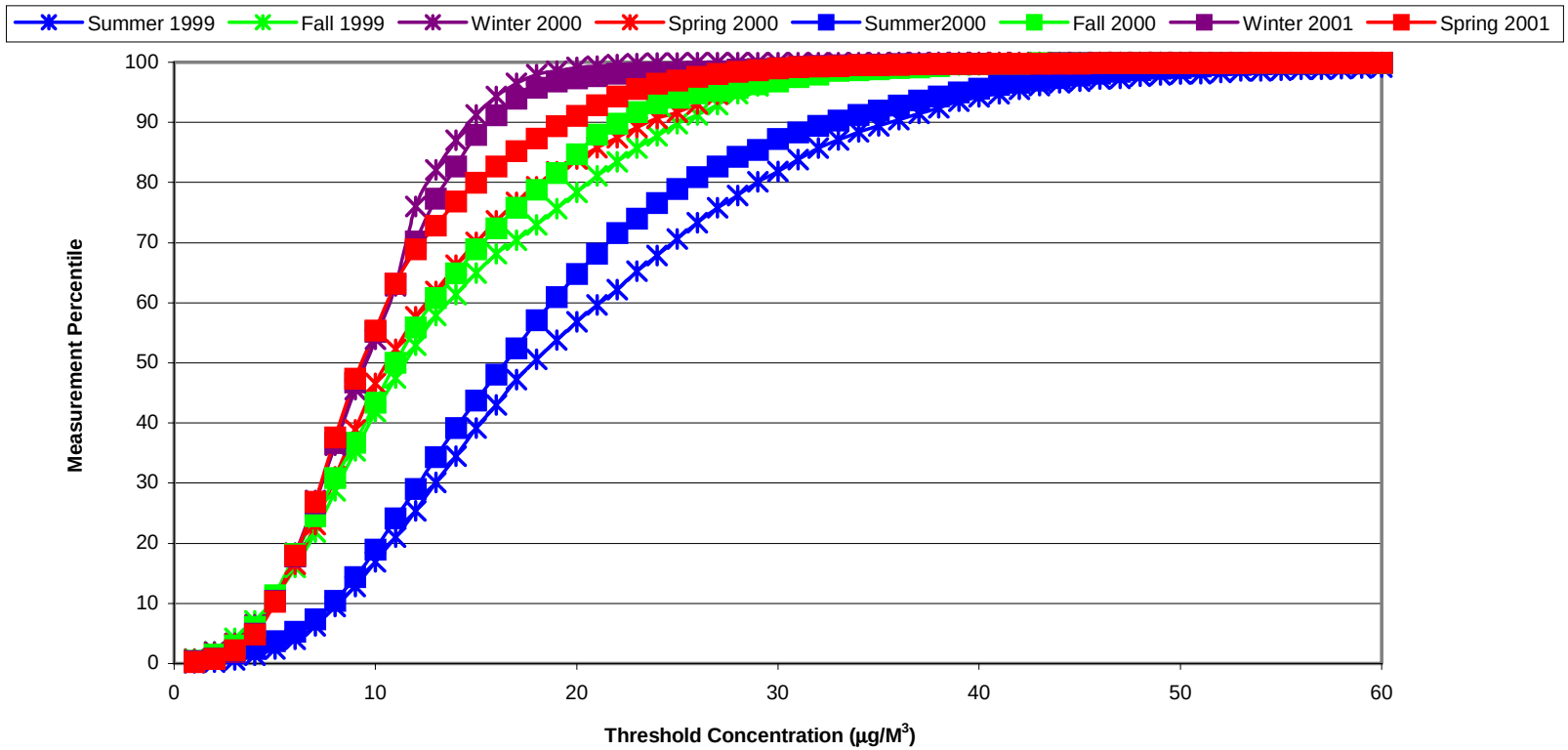
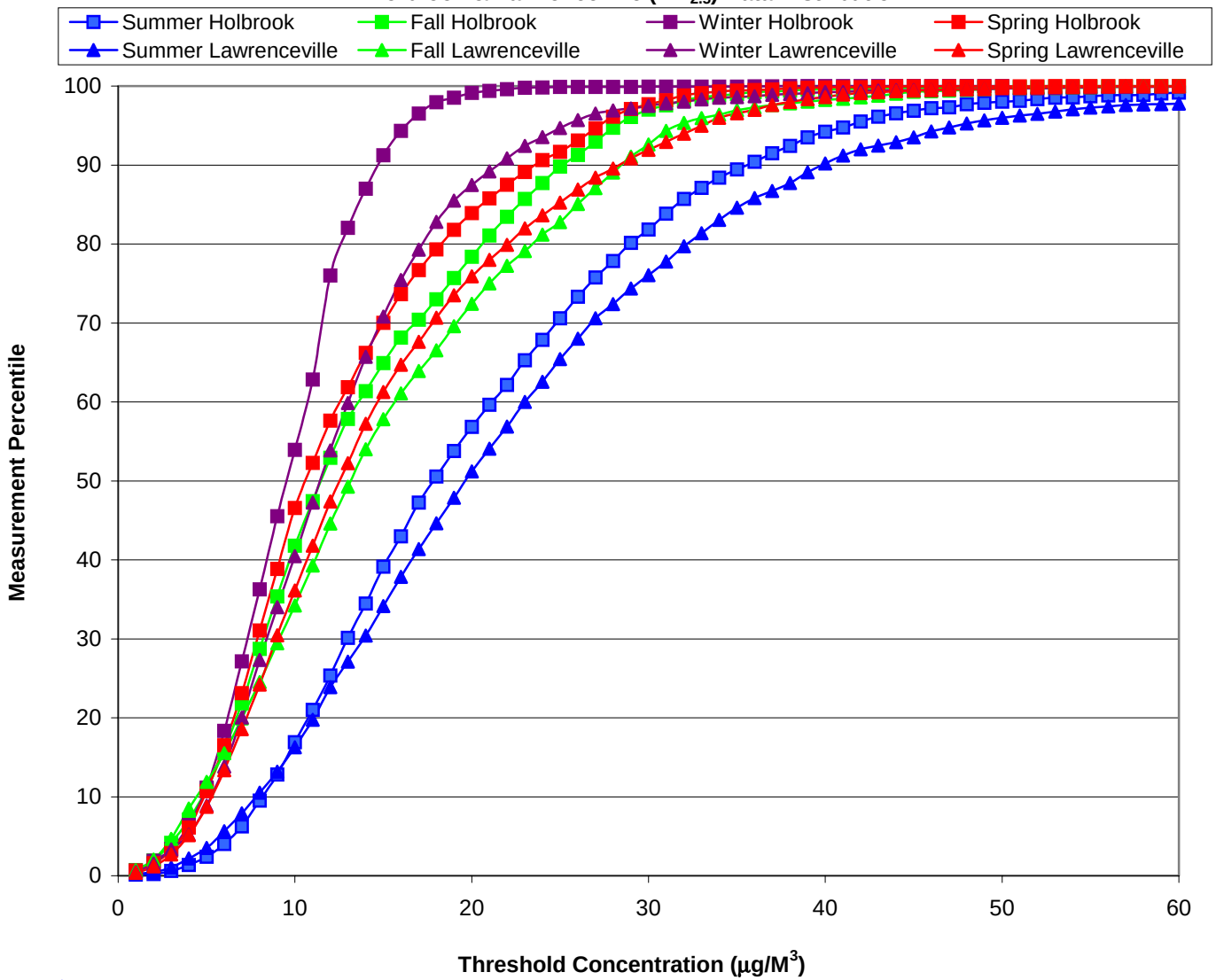
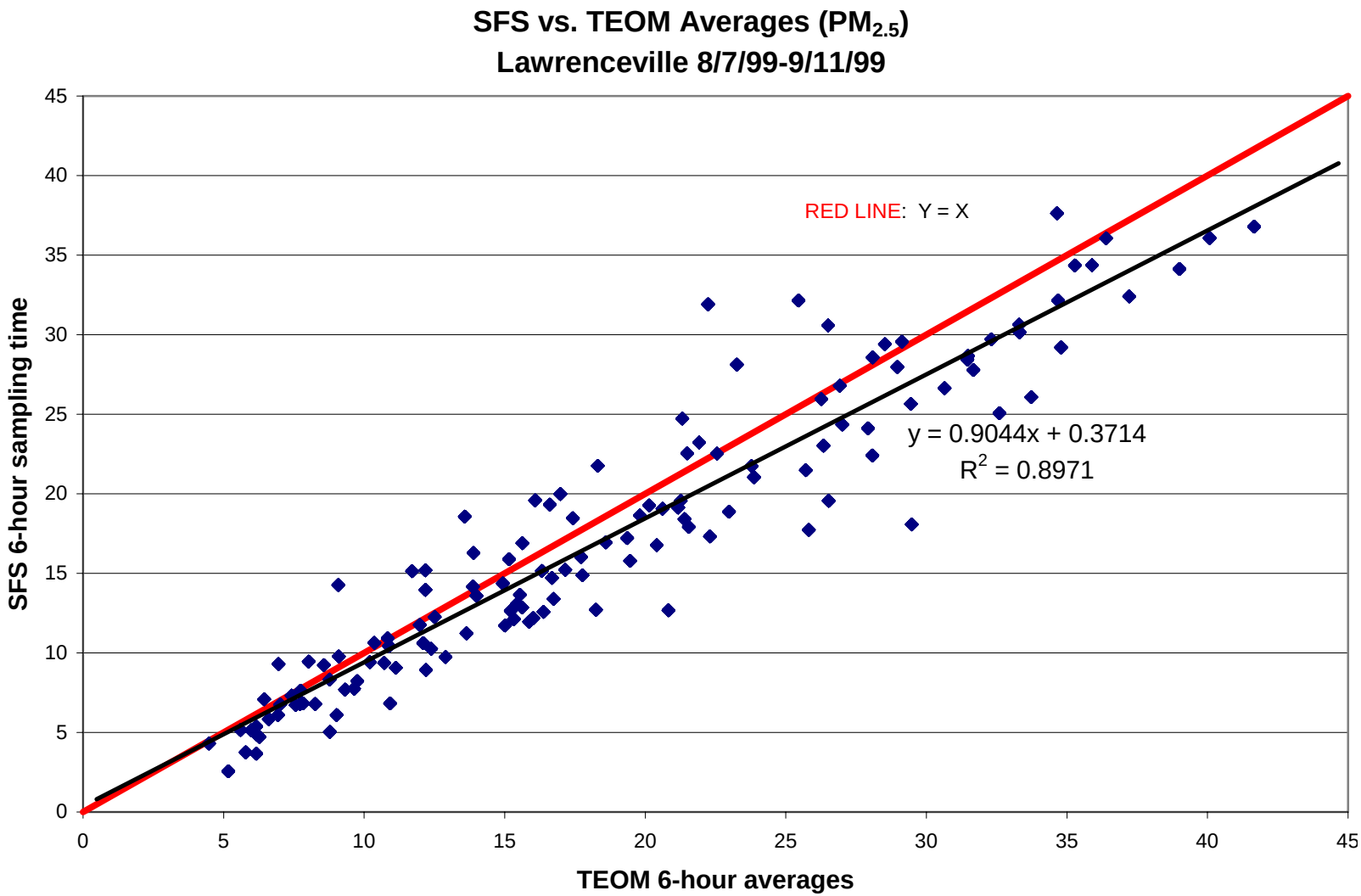


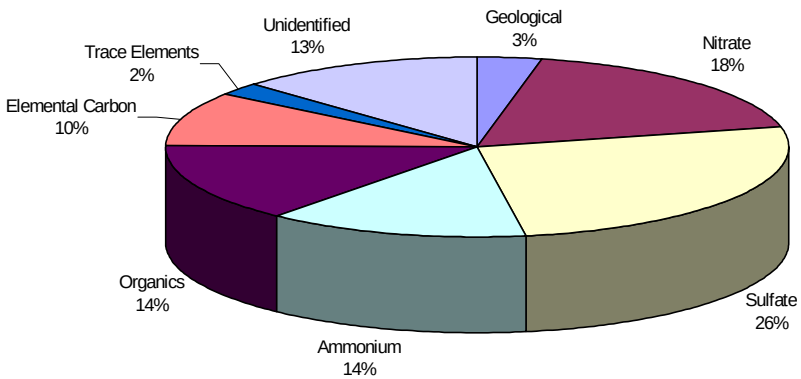
FIGURE 3:
June 1999-May 2000
Holbrook & Lawrenceville ($PM_{2.5}$) Data Distribution




SFS vs. TEOM Averages ($PM_{2.5}$)
Lawrenceville 8/7/99-9/11/99
RED LINE: Y = X
y = 0.9044x + 0.3714
R^2 = 0.8971
SFS 6-hour sampling time
TEOM 6-hour averages
0
5
10
15
20
25
30
35
40
45

Winter 1999
Lawrenceville
$PM_{2.5}$ Intensive Sampling Program
(36 6-Hour Samples)

FIGURE 7a: LAWRENCEVILLE/HOLBROOK WINTER COMPARISON



Winter 1999
Holbrook
$PM_{2.5}$ Intensive Sampling Program
(9 24-Hour Samples)

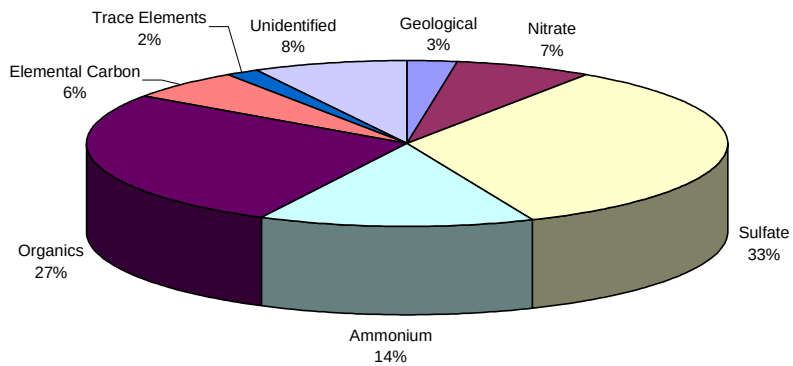
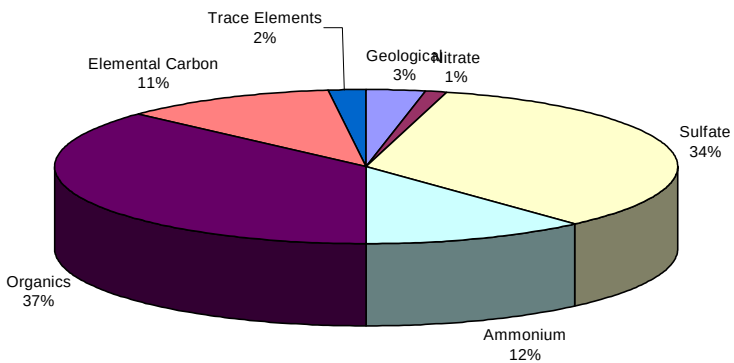
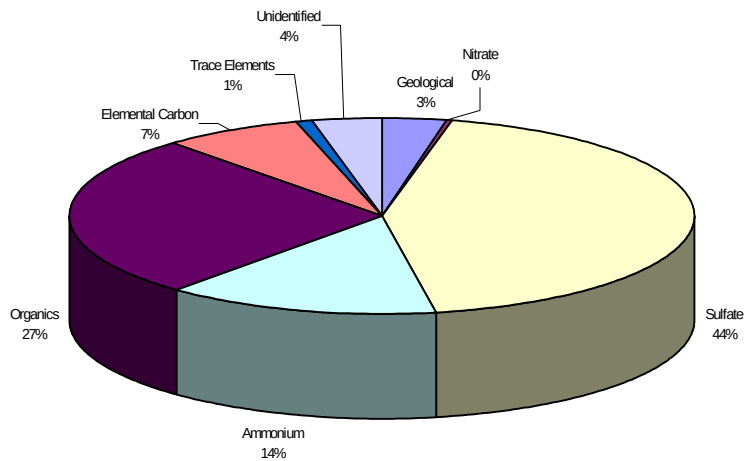


FIGURE 7b: LAWRENCEVILLE/HOLBROOK SUMMER COMPARISON

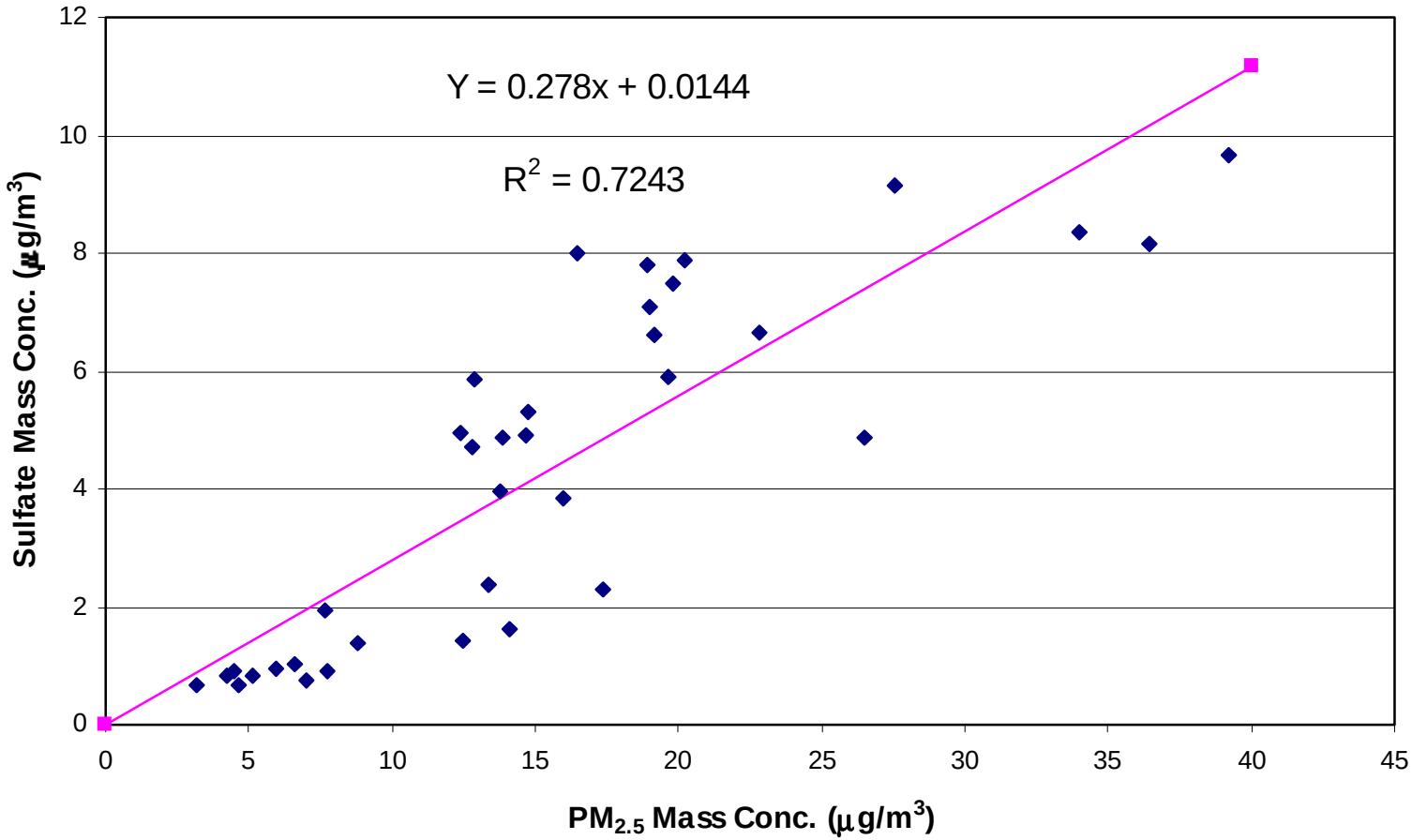
Summer 1999
Lawrenceville
$PM_{2.5}$ Intensive Sampling Program
(39 6-Hour Samples)



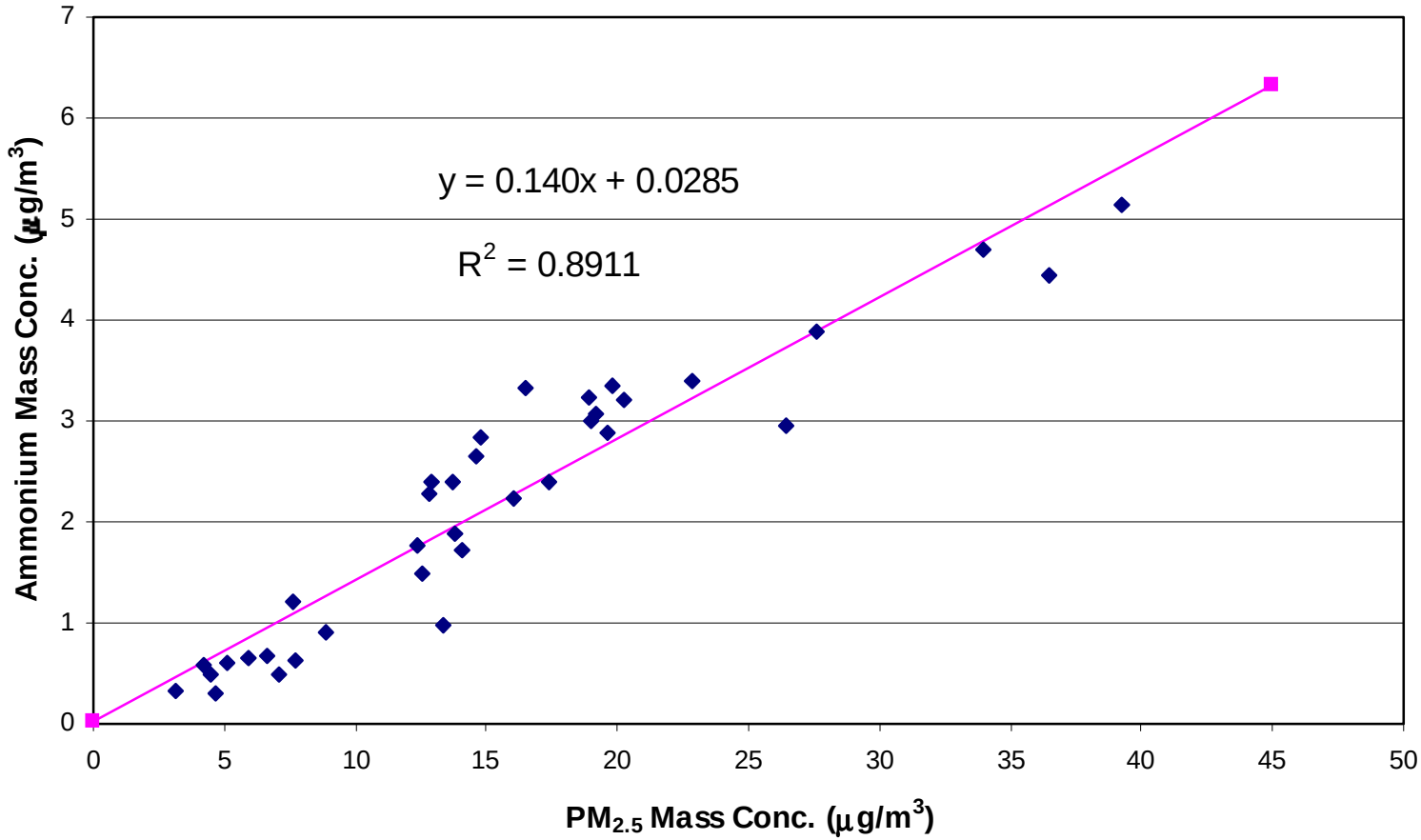
Summer 1999
Holbrook
$PM_{2.5}$ Intensive Sampling Program
(10 24-Hour Samples)



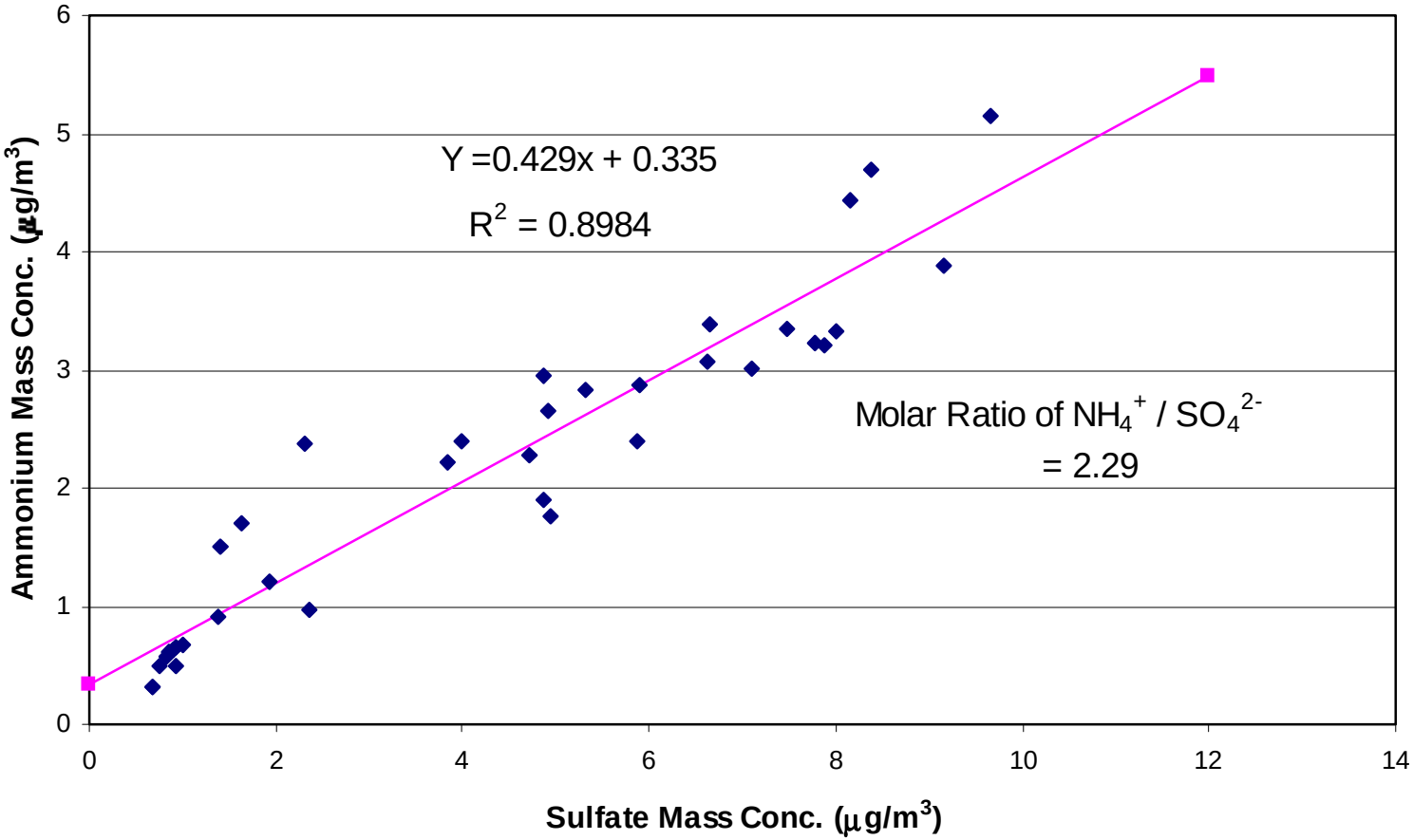
ATS Winter 1999 Intensive Sampling Program
Lawrenceville - SFS Data



ATS Winter 1999 Intensive Sampling Program
Lawrenceville - SFS Data



ATS Winter 1999 Intensive Sampling Program
Lawrenceville - SFS Data



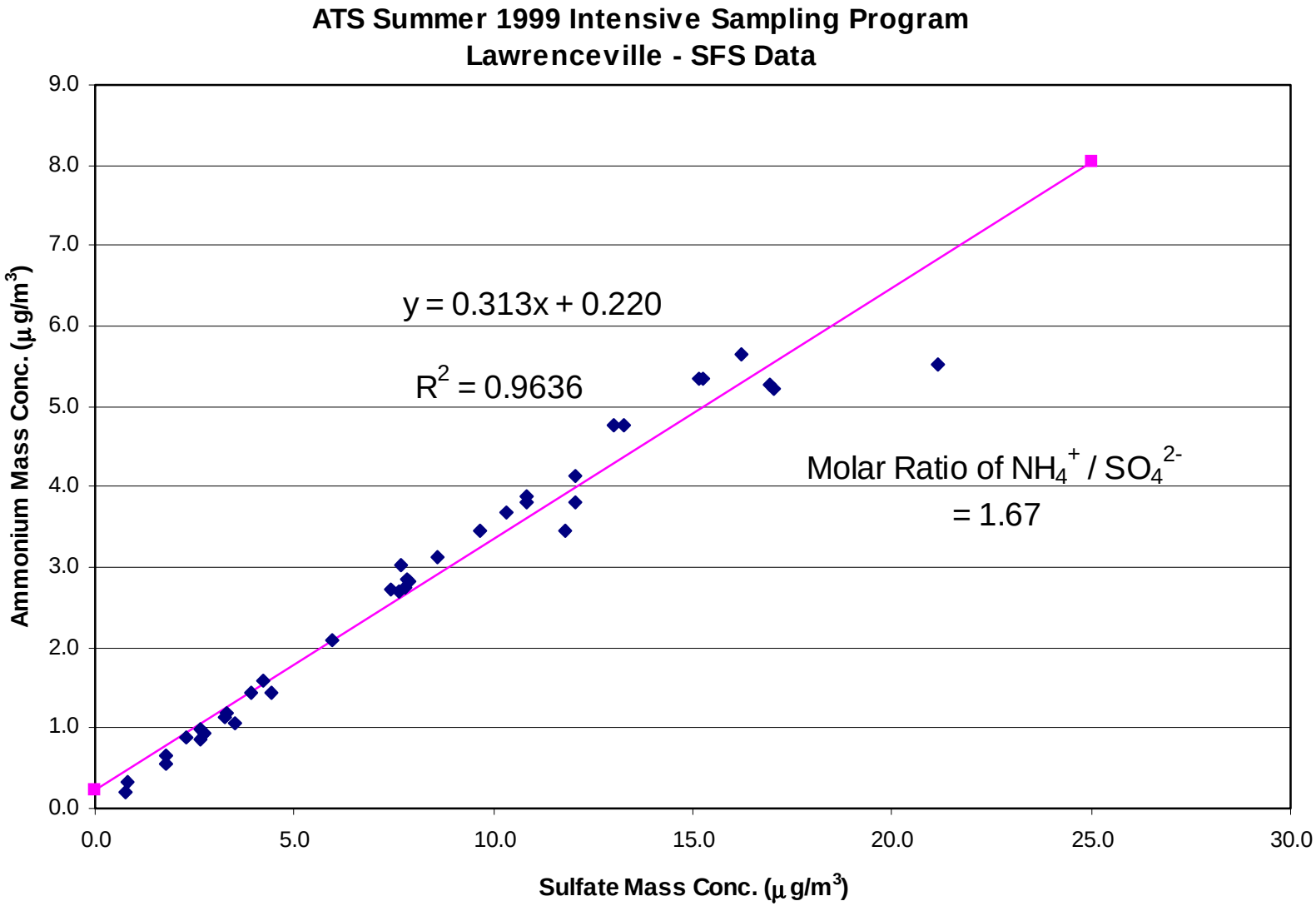

ATS Summer 1999 Intensive Sampling Program
Lawrenceville - SFS Data
y = 0.313x + 0.220
R2 = 0.9636
Molar Ratio of NH4+ / SO42-
= 1.67
Ammonium Mass Conc. (µg/m3)
Sulfate Mass Conc. (µg/m3)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0

FIGURE 9a:
***ATS* Winter 1999 Intensive Sampling Program**
Holbrook - SFS Data

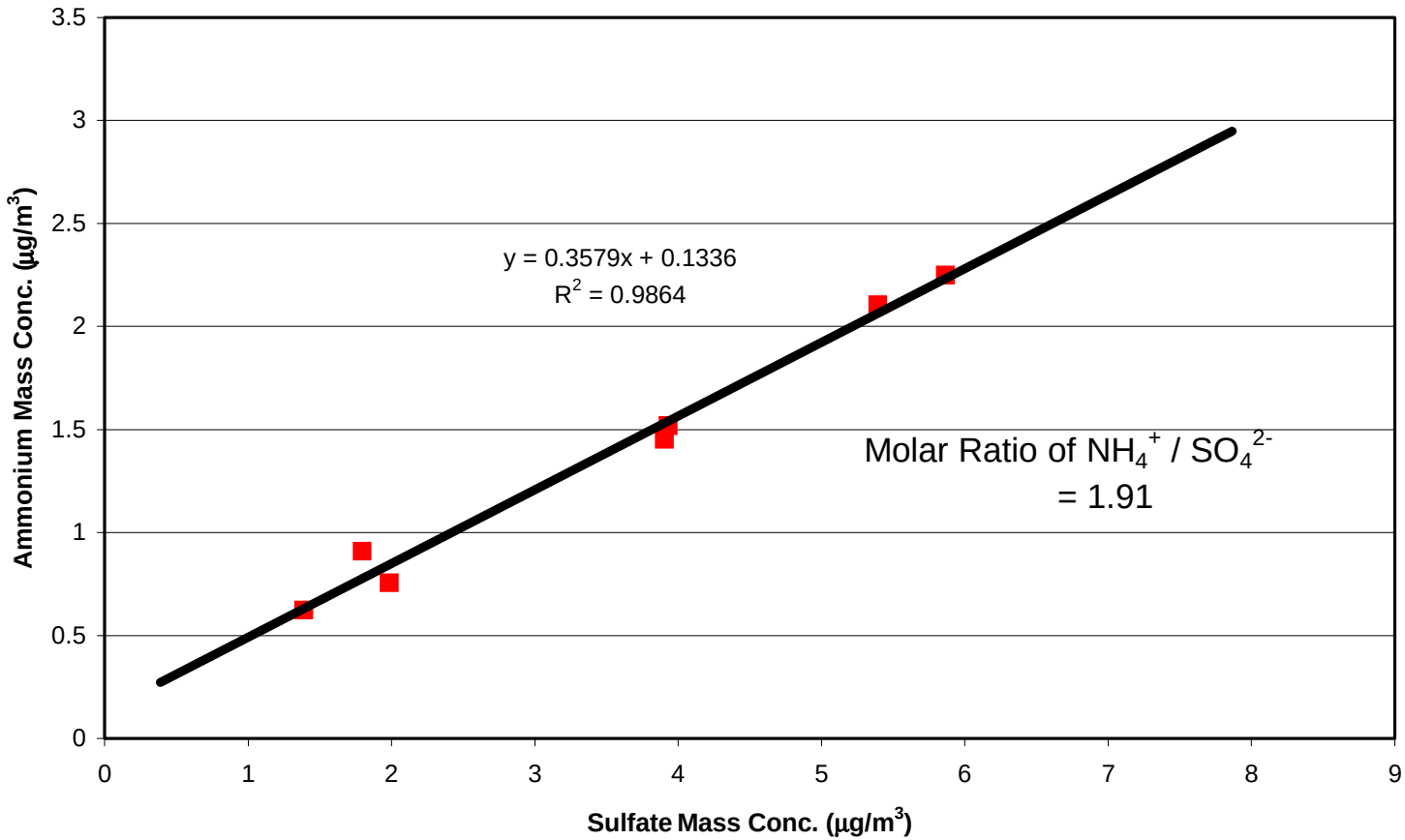
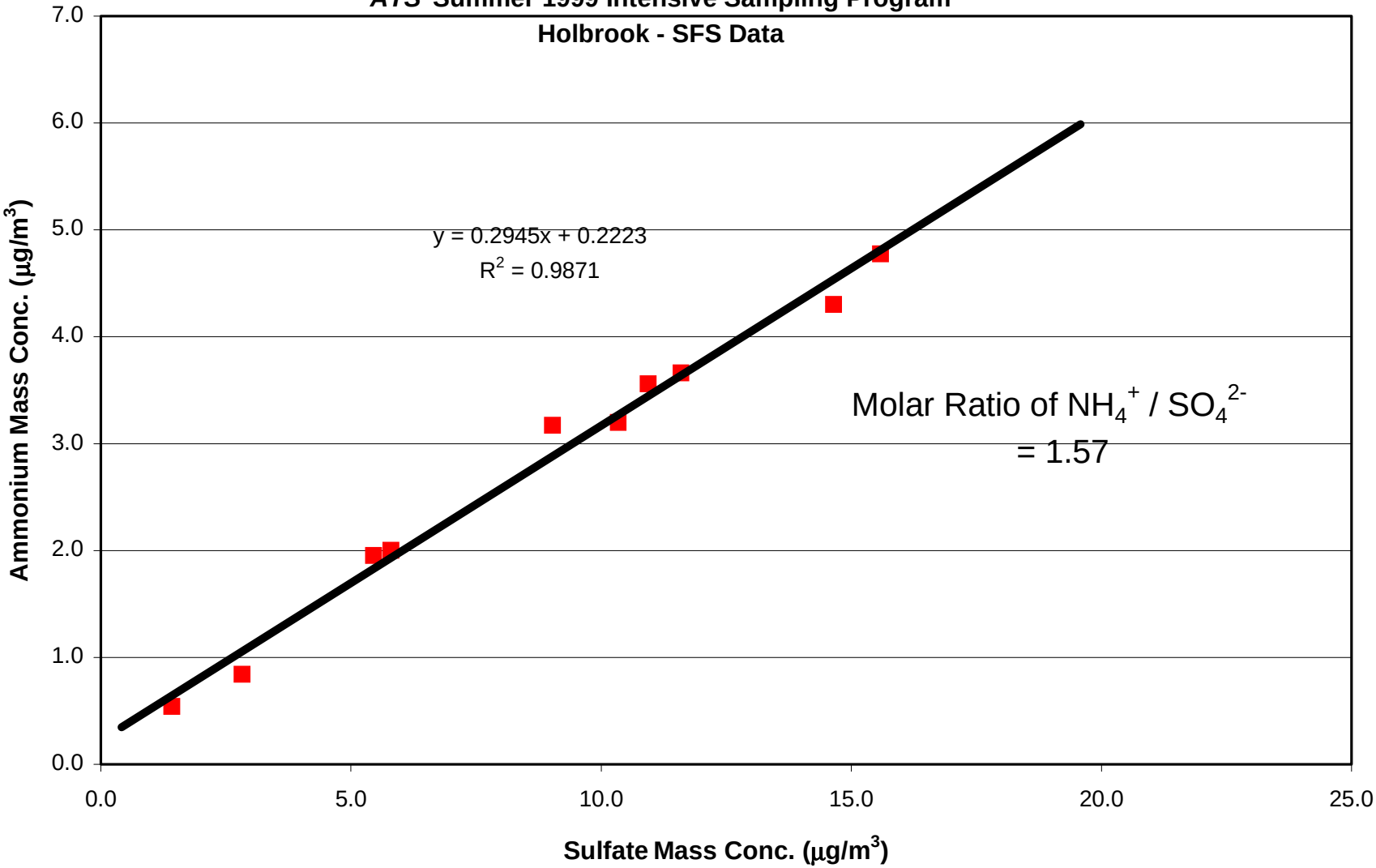


FIGURE 11a:
***ATS* Summer 1999 Intensive Sampling Program**



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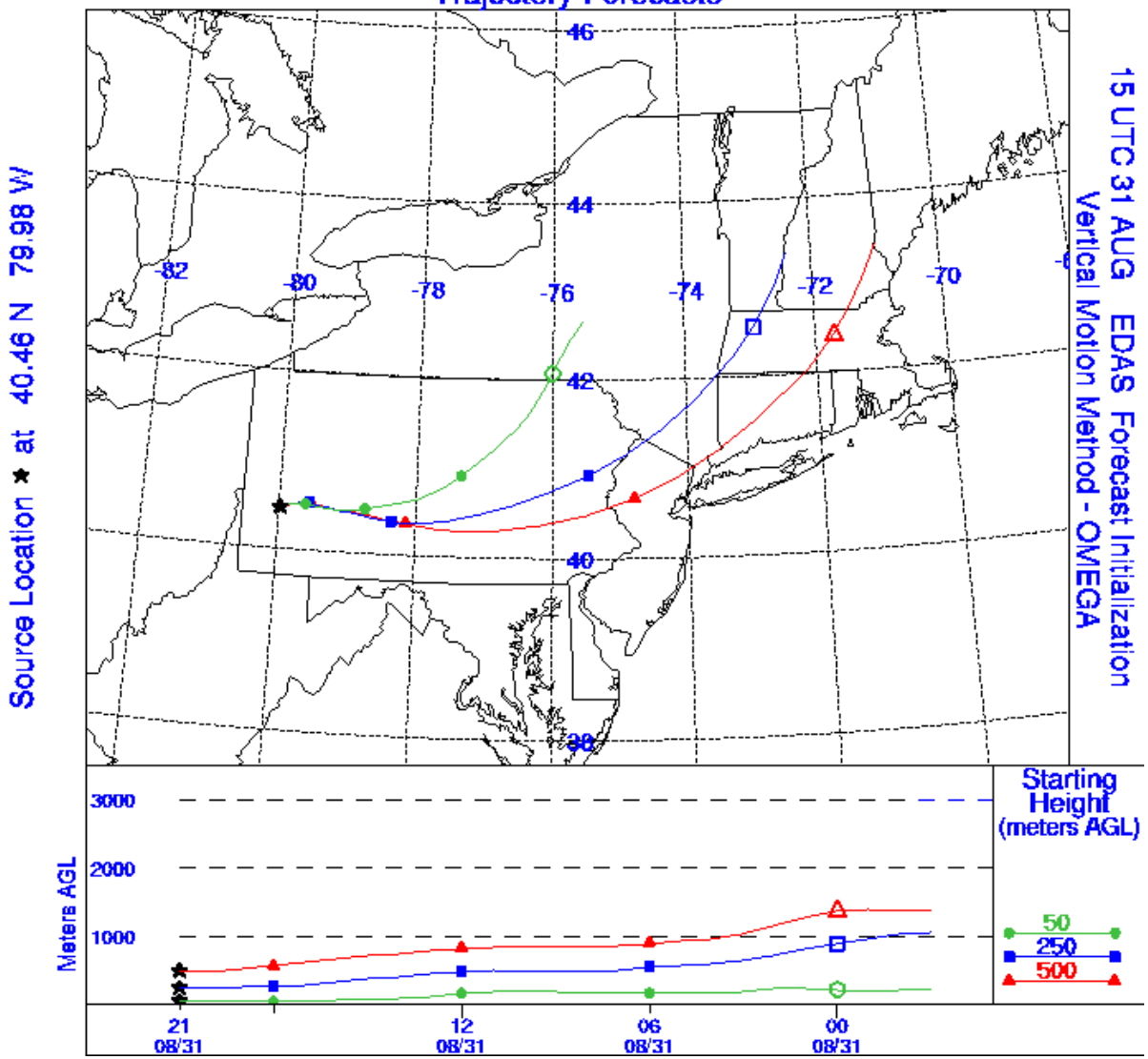
Backward Trajectories Ending- 21 UTC 31 AUG 99

Trajectory Forecasts



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Backward Trajectories Ending- 19 UTC 17 AUG 99

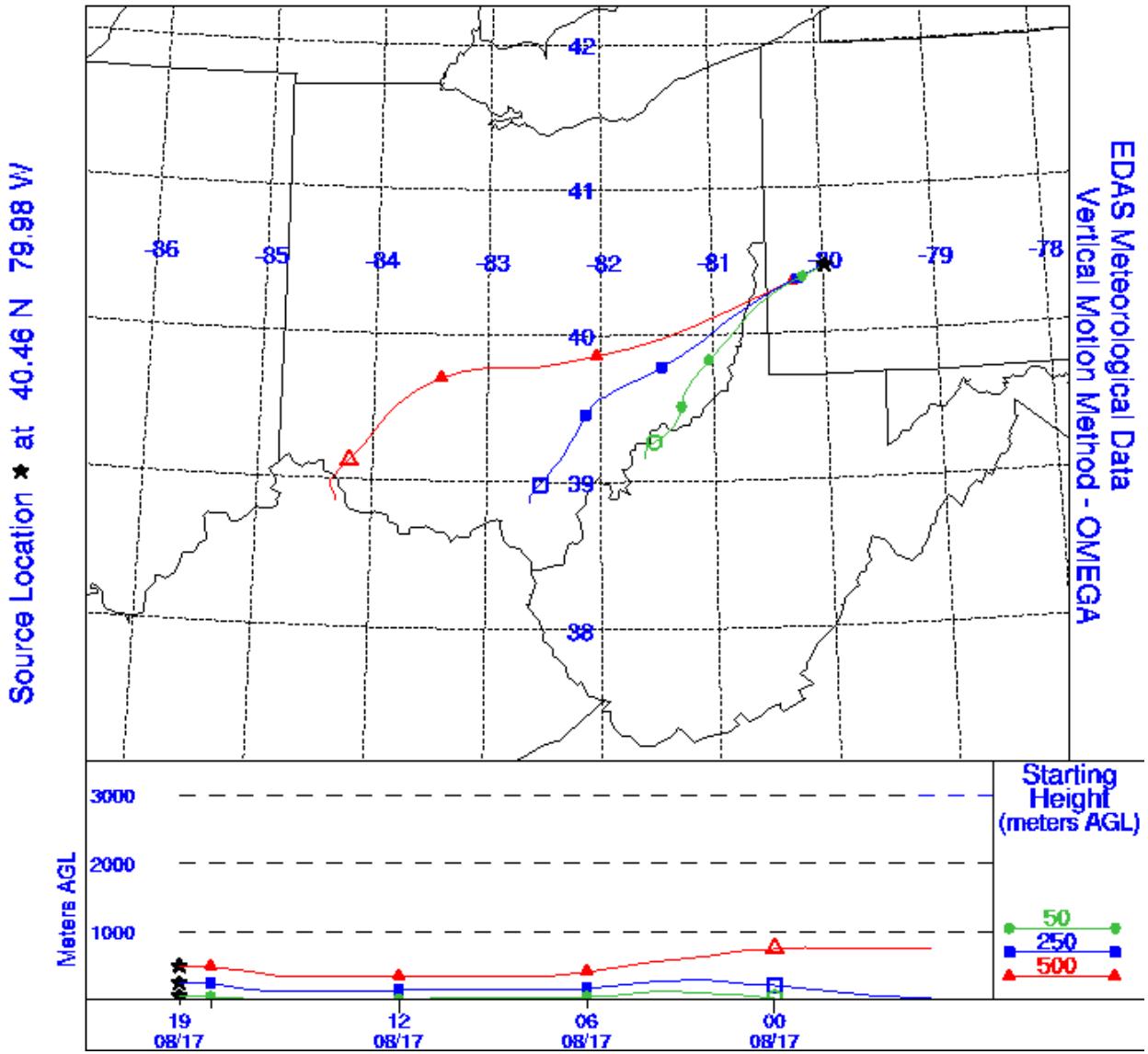

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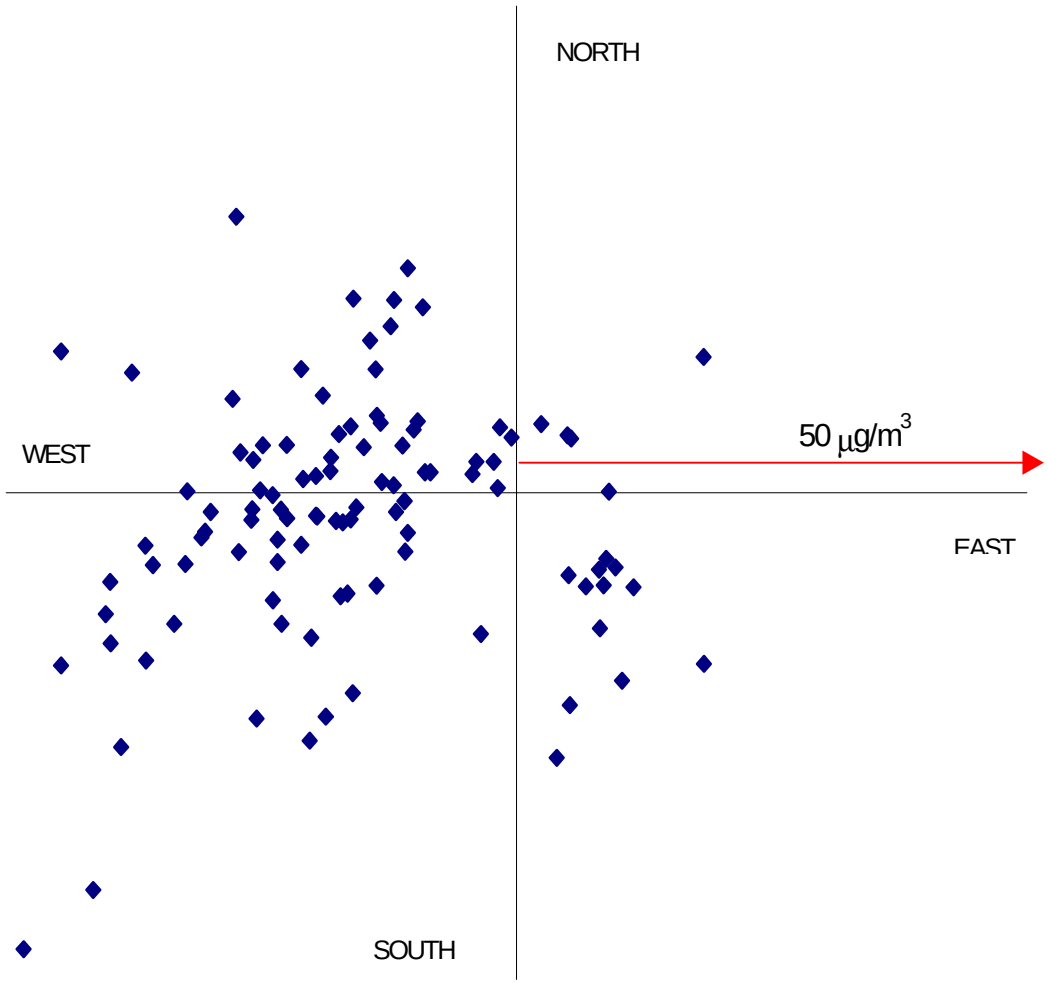
FIGURE 13a:
$PM_{2.5}$ Lawrenceville - July 1999
Polar Coordinate Plot
TEOM Conc. (r) vs. Wind Direction (θ)



SUMMARY OF RESULTS

- **$PM_{2.5}$ Mass:**
  - Urban site slightly higher than rural site
  - Higher levels and wider variations observed in summer
  - Higher at urban site when winds are from W, SW, NW
- **Sulfate is dominant component of $PM_{2.5}$ mass**
  - Higher nitrate at urban site vs rural site
  - Higher nitrate at urban site in winter
  - Higher OC at rural site
- **TEOMs and filter samplers give similar masses**
  - Less semi-volatile PM (more $SO_4^{=}$) than in other regions

ACKNOWLEDGEMENTS

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