

SEARCH

Latest Findings

John J. Jansen
Southern Company

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Tucson AZ
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Web Address: www.atmospheric-research.com

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**SOUTHERN
COMPANY**
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SouthEastern Aerosol Research and CHaracterization Study

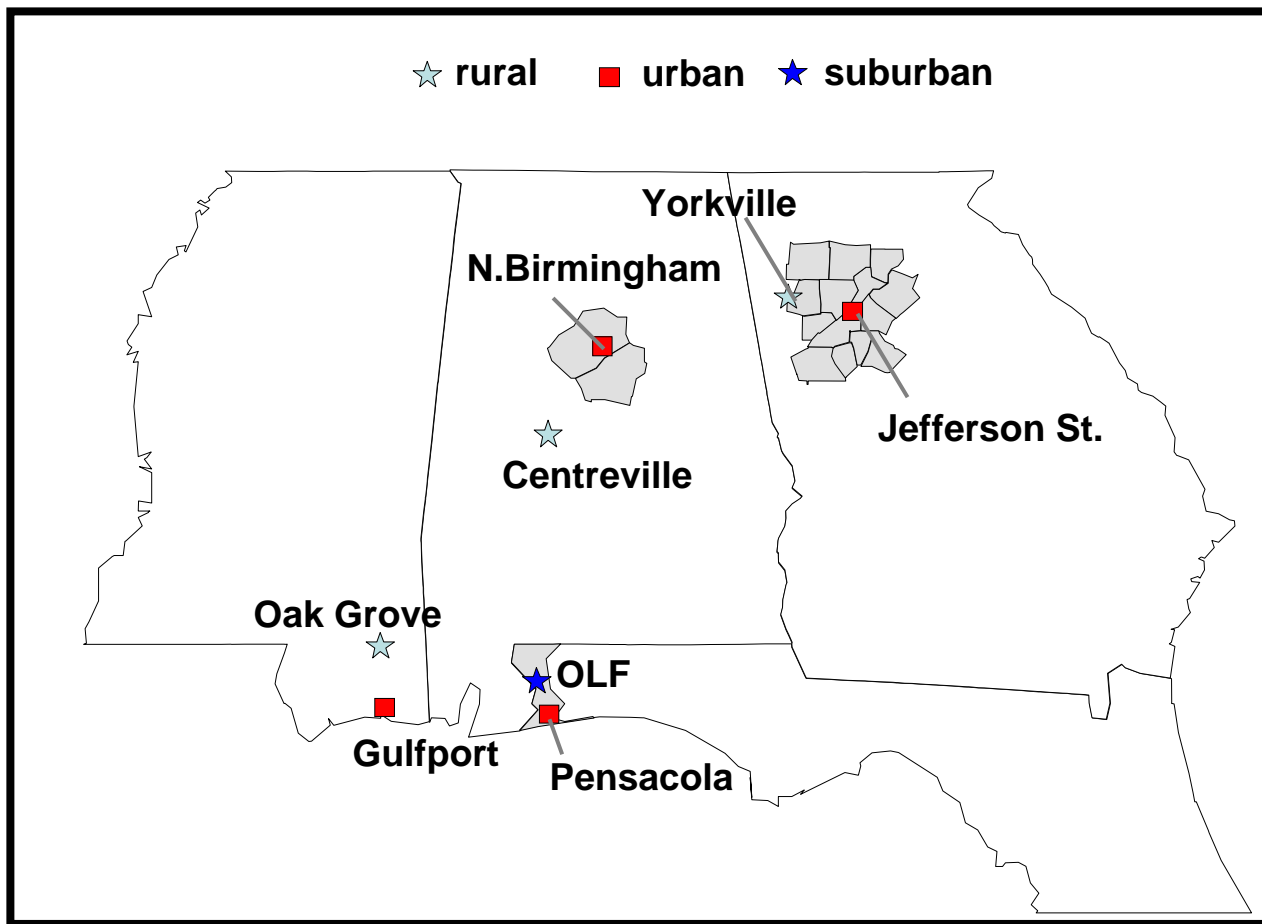


Yorkville Site (YRK)
Yorkville, GA

SEARCH Objectives

- ◆ Develop a PM_{2.5} Climatology for 8 Sites **(5+ years & growing)**
- ◆ Understand Composition and its Variability
 - Year to Year, Season to Season (1999-2005)
 - Rural vs. Urban
 - Coastal vs. Inland
- ◆ Estimate Source Contributions
- ◆ Test and Improve Methods
- ◆ Collaborate with States and Others

SEARCH Enhanced PM_{2.5} Network



SEARCH Measurements

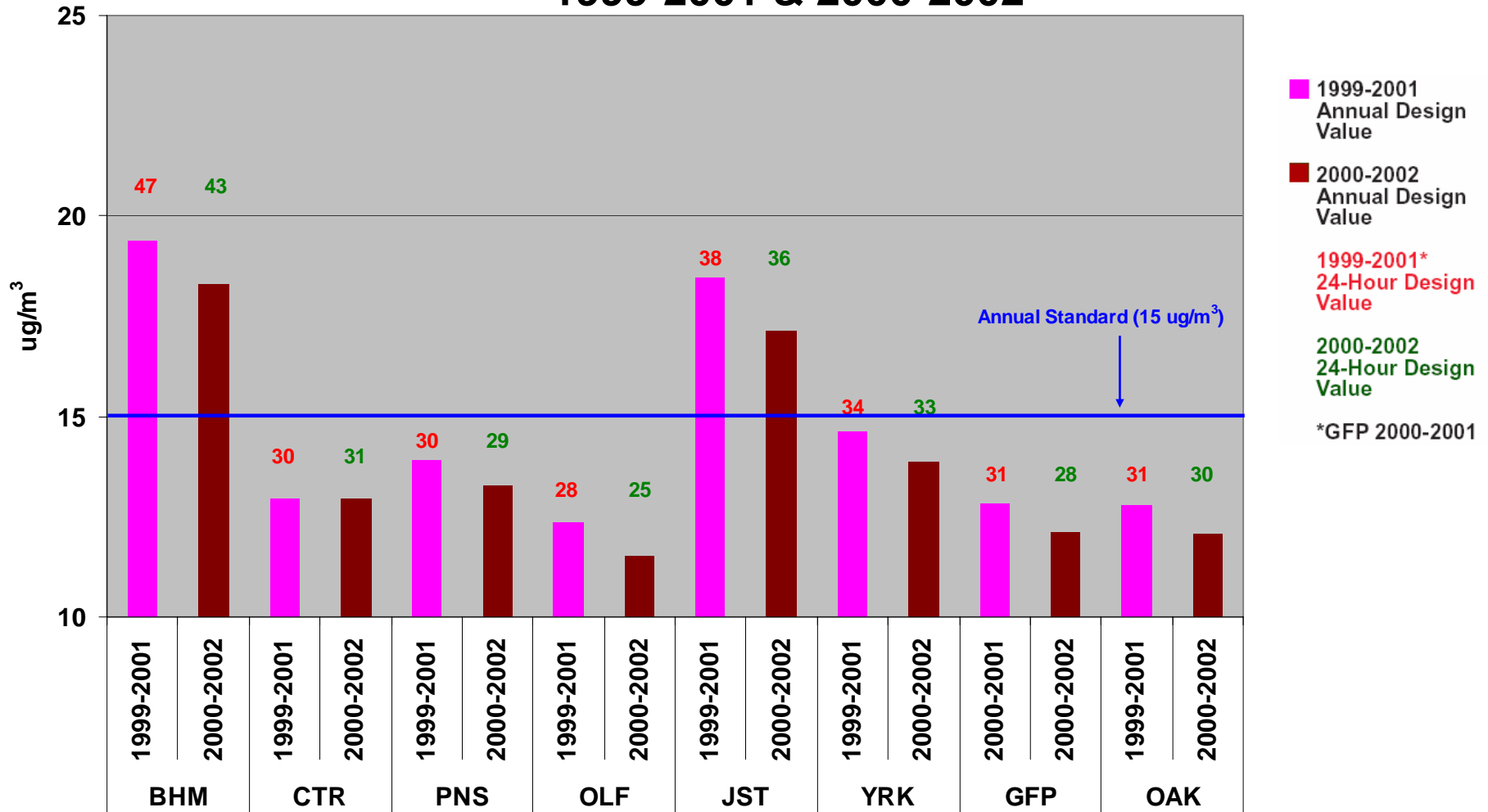
- ◆ Discrete Particles and Gases (24-hour)
 - FRM: PM_{2.5}
 - PCM and Dichot: PM_{2.5}, PM₁₀ and Speciation
 - NH₃
- ◆ Continuous Particles (1-min to 1-hr)
 - TEOM: mass
 - R&P 5400: OC/EC/TC
 - Aethelometer: BC
 - SEARCH/ARA: Ammonium/Nitrate
 - Modified HSPH: Sulfate
- ◆ Trace Gases (1-min)
 - O₃, NO, NO₂, NO_y, HNO₃, SO₂, CO, CO₂, NH₃ (2 sites)
- ◆ Meteorology (1-min)
 - WS, WD, T, RH, BP, SR, rainfall
- ◆ Visibility (1-min)
 - Dry Extinction, Absorption

Recent Deployments

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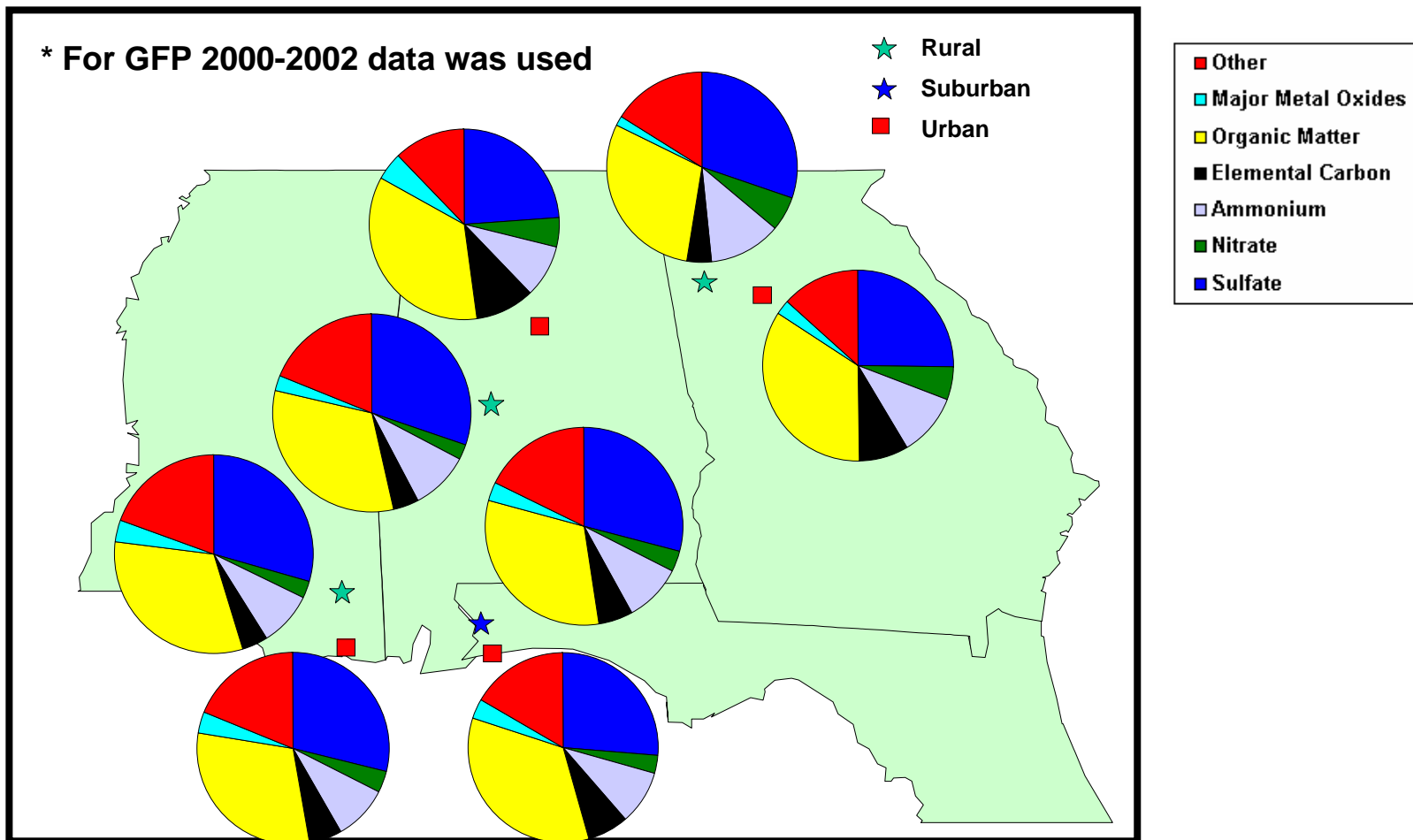
Summary of 1999 to 2002 Mass and Speciation Data

PM_{2.5} Annual and 24 Hour Standard Design Values for SEARCH sites 1999-2001 & 2000-2002



The PM_{2.5} annual and daily standard design values have declined from 1999-2001 to 2000-2002 and no site violates the daily standard. Only the Atlanta (JST) and Birmingham (BHM) urban areas (not the nearby rural areas) violate the annual standard.

Best Estimate PM_{2.5} Composition at SEARCH Sites (ug/m³) 1999-2002*



Organic matter (OC * 1.4) and sulfate are the major components of PM_{2.5}.
For Best Estimate: Organic matter is the larger component at all sites
except YRK.

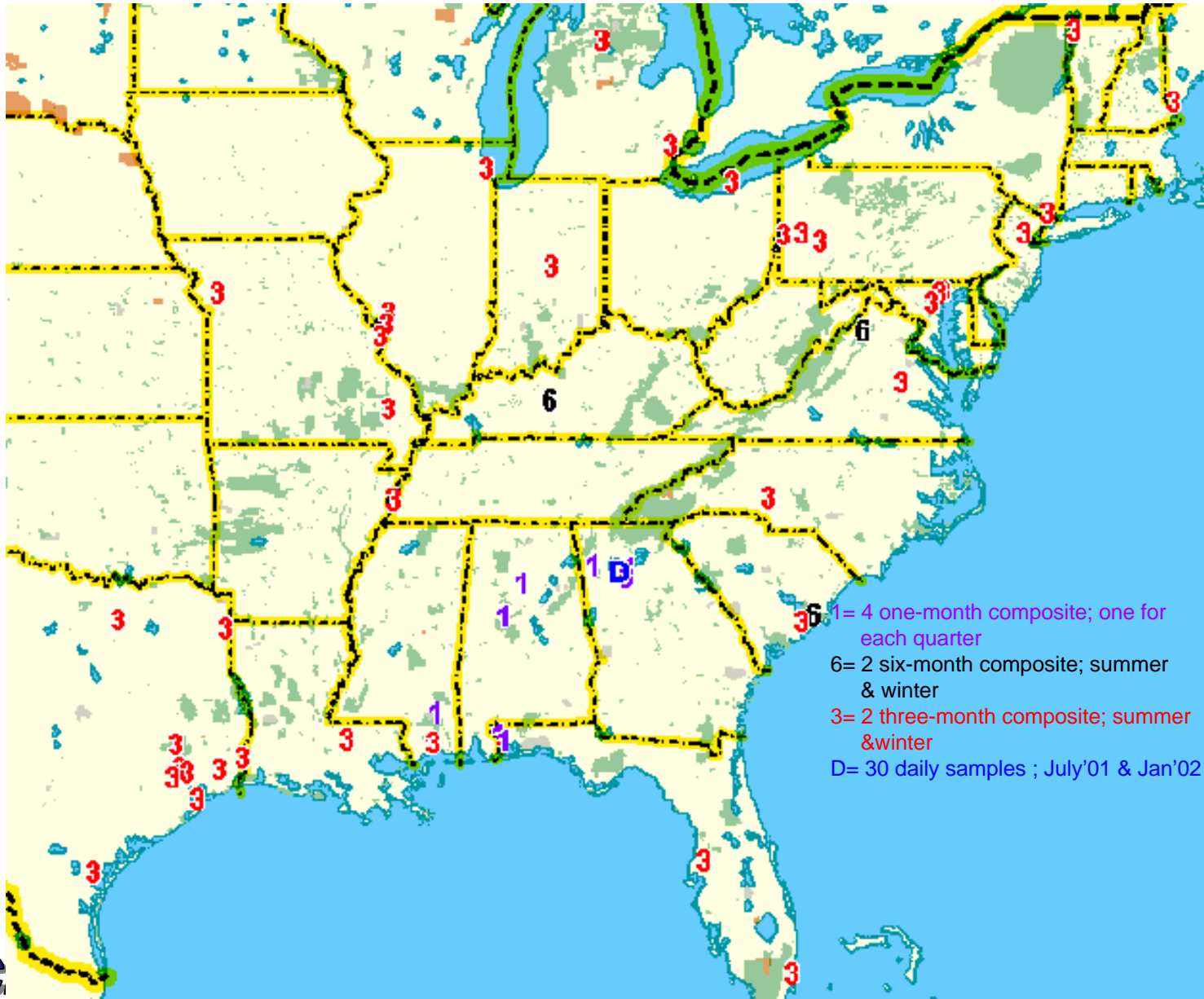
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**PM_{2.5} Organic Carbon Source
Identification**

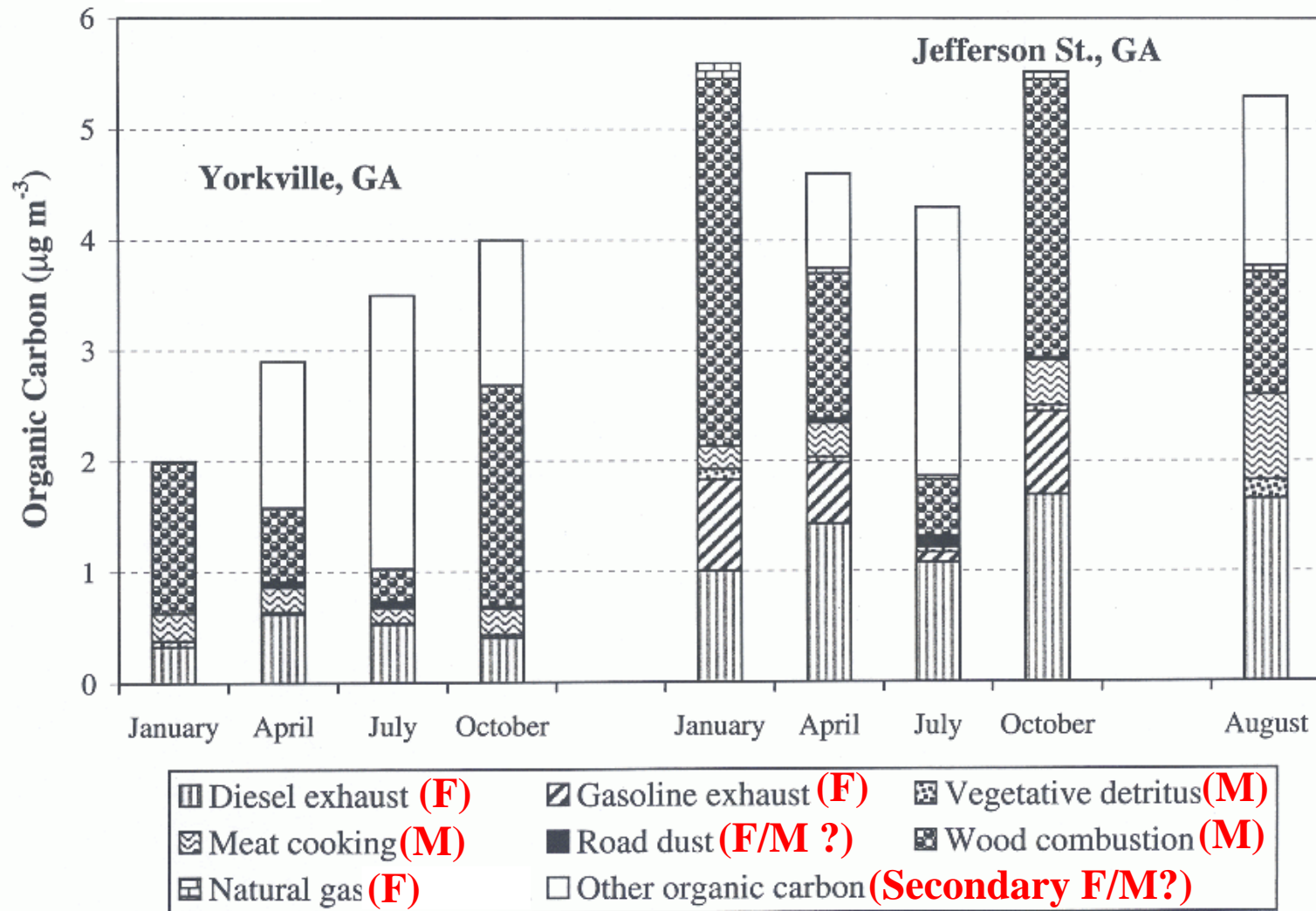
SEARCH-VISTAS Collaboration on Carbonaceous Aerosol

- ◆ Historical Samples (**SEARCH**/Improve/STN)
 - Composite Monthly or Seasonal Quartz Filters
 - Detailed Speciation (GC/MS)
 - CMB analysis for major sources
 - Some daily testing at JST
- ◆ Planned Samples (**SEARCH** 4 sites / VISTAS 5 sites)
 - Collect hi-vol samples
 - Detailed Speciation/CMB and ^{14}C for Selected Events

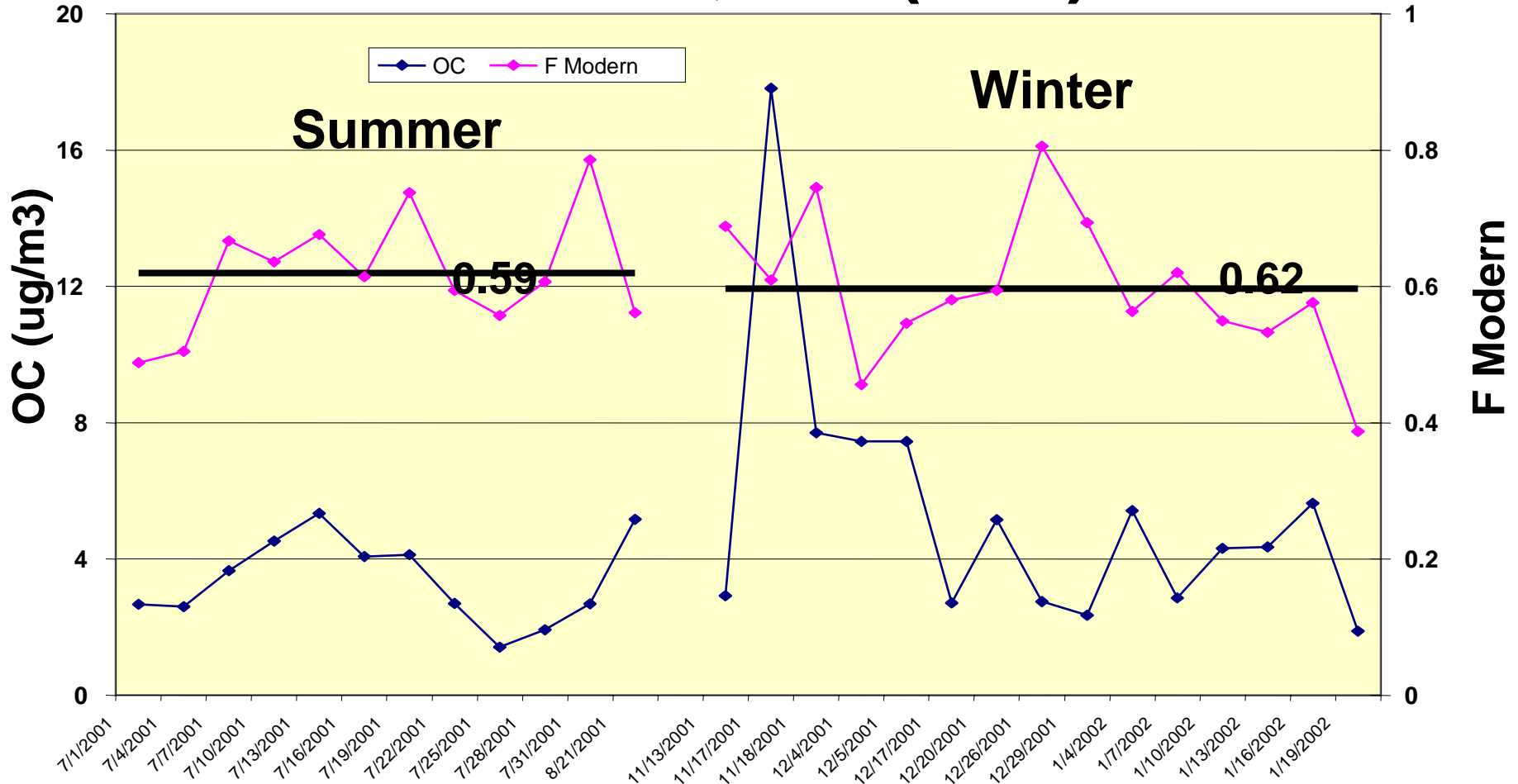
Primary Carbon Source Attribution Sample Matrix January -December 2002



Sources of Primary OC in PM_{2.5}

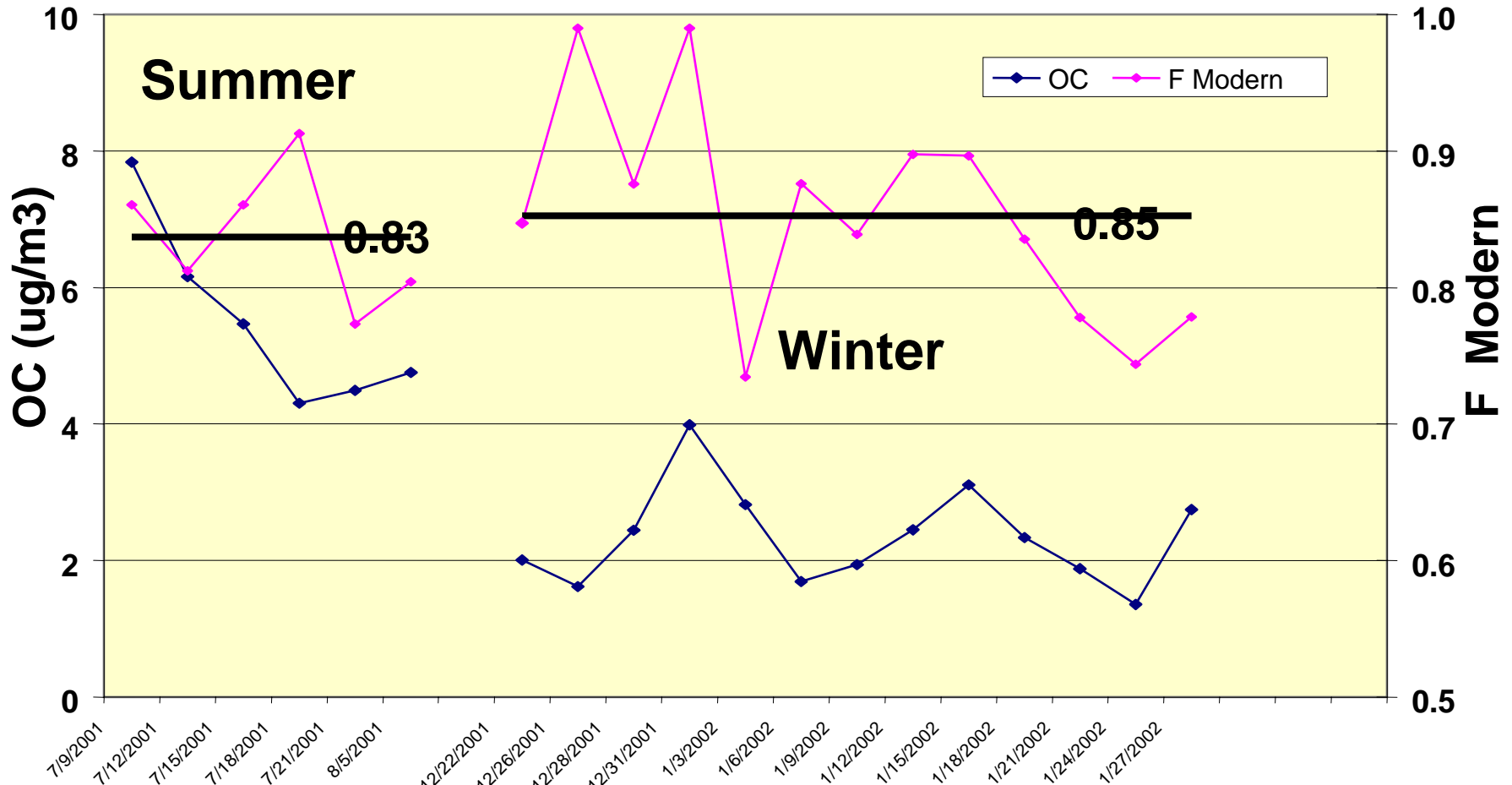


Carbon-14 and OC Data Atlanta, GA (JST)



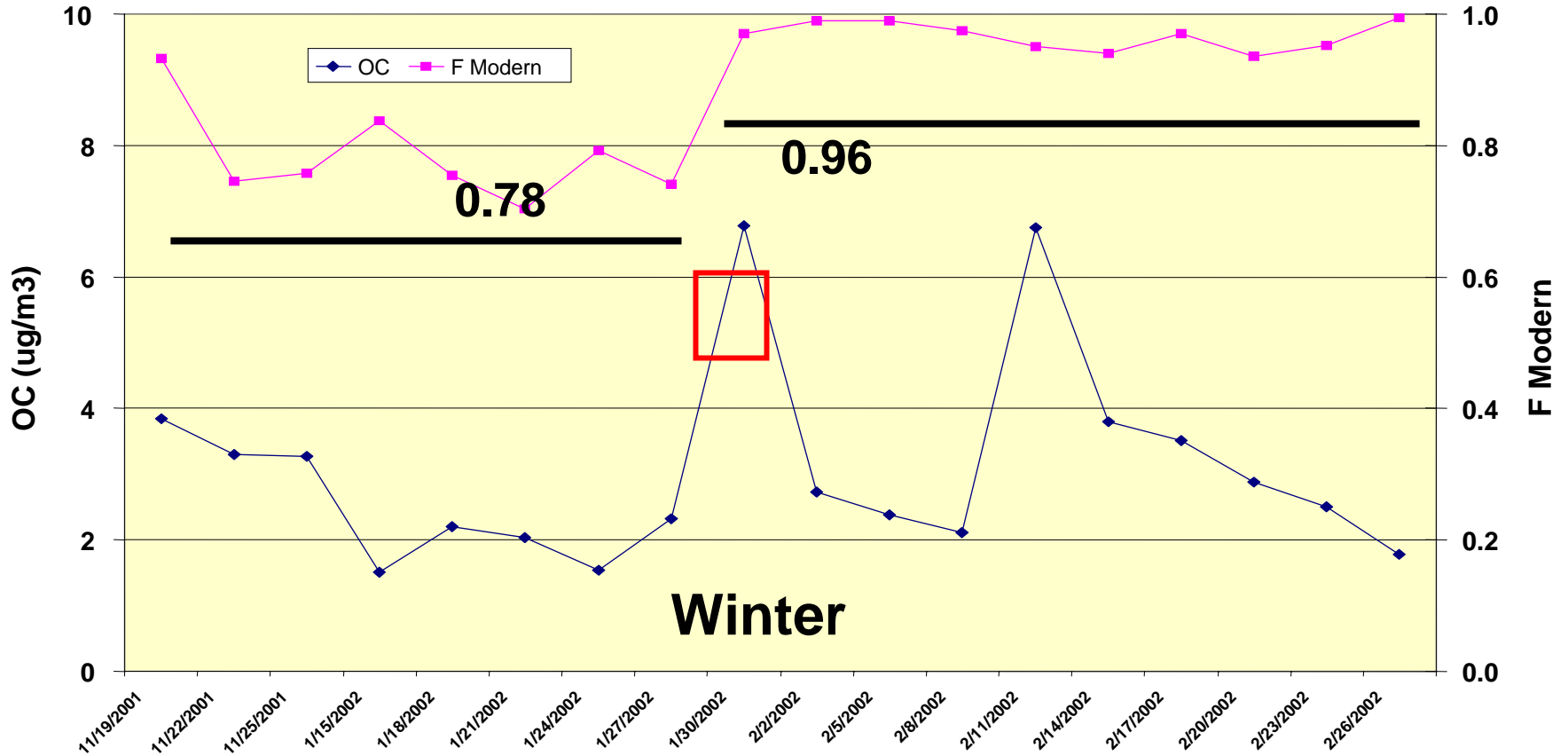
Modern or biogenic carbon (i.e., wood combustion, vegetative detritus, or secondary formation) represent about 60% of the observed OC.

Carbon-14 and OC Data Yorkville, GA



Modern or biogenic carbon (i.e., wood combustion, vegetative detritus, or secondary formation) represent about 85% of the observed OC.

Carbon-14 and OC Data Oak Grove, MS



Modern or biogenic carbon (i.e., wood combustion, vegetative detritus, or secondary formation) represent 80 – 95% of the observed OC.

Simplified Organic Carbon Source Matrix

	Primary	Secondary	Total
Modern	Speciation/CMB	Speciation, Models, Difference	^{14}C
Fossil	Speciation/CMB	Speciation, Models, Difference	^{14}C

Combination of CMB and C-14 data allows calculation of secondary OC by difference.

OC Source Matrix

Atlanta, GA – January

	Primary*	Secondary	Total#
Modern	64	<5	61 +/-5
Fossil	36	<5	39 +/-5

* 2000 Data: Zheng et al., ES&T, 2002.

from ¹⁴Cdata

OC Source Matrix

Atlanta, GA – July 2001

	Primary*	Secondary	Total[#]
Modern	<5	>50	59 +/-5
Fossil	40*	<5	41 +/-5

* Zheng et al. Source Apportionment of Fine Particles at Atlanta, GA, AAAR 2002

from ¹⁴C data

Comparison of ERs with Literature Values

FUEL	ER (g/kg CO)				
	NOy (as NO)	SO2	PM2.5	TC*	BC*
Savannah/Grassland	60	5.4	83	57	3.1
Trop. Forest	15	5.5	88	64	6.4
non-Trop. Forest	28	9	121	78	5.2
Biofuels	27	3.5	92	51	7.6
Ag. Residues	27	4.3	42	36	7.5
This Study (Fires)	28 +/- 14	5.0 +/- 2/7	195 +/- 54	63 +/- 14	15 +/- 6.1
This Study (Urban)#	147 +/- 10	n.d.	33 +/- 8	9.6 +/- 2.1	n.d.

Andreae and Merlet. Global Geochem Cyclec 15(4):955-966. 2001. (A&M)

* A&M TC and BC based on TSP

Based on Jefferson Street, Atlanta, GA SEARCH data

Summary & Conclusions

On Source of OC

- ◆ Zheng/Cass **primary** carbon work shows almost **all** OC primary in **winter**, **30-70 %** primary in **summer**
- ◆ Also show **wood smoke** makes up **>50% OC** in winter (detectable all seasons)
- ◆ ^{14}C data show OC is predominantly **modern** for all sites and all seasons.
- ◆ Urban site exhibits more fossil OC than rural sites (40% vs. <20%).
- ◆ **No evidence of strong seasonality in modern/fossil OC**, but an interesting step function observed at Oak Grove, MS during January 2002 (biomass burning?).
- ◆ **Combination of techniques shows convergence and permits semi-quantitative completion of source matrix.**
- ◆ Results suggest that secondary carbon is much more important in summer than winter and that the majority of secondary carbon (rural or urban) is of modern origin.
- ◆ **Fires in SE appear to produce more PM_{2.5} and EC than fires elsewhere.**

Effect of NOx Emissions Reductions in Context of Large SO2 Emissions Reductions

◆ Methods

- Used **observed** data (circa 1999-2000) of sulfate, nitrate, ammonium, ammonia, nitric acid, and meteorological data from **ARIES/SEARCH**
- The data were used in the thermodynamic equilibrium model **SCAPE2**
- To estimate changes in fine particulate nitrate resulting from changes in nitric acid, ammonia, and sulfate.

Effect of NOx Emissions Reductions in Context of Large SO2 Emissions Reductions

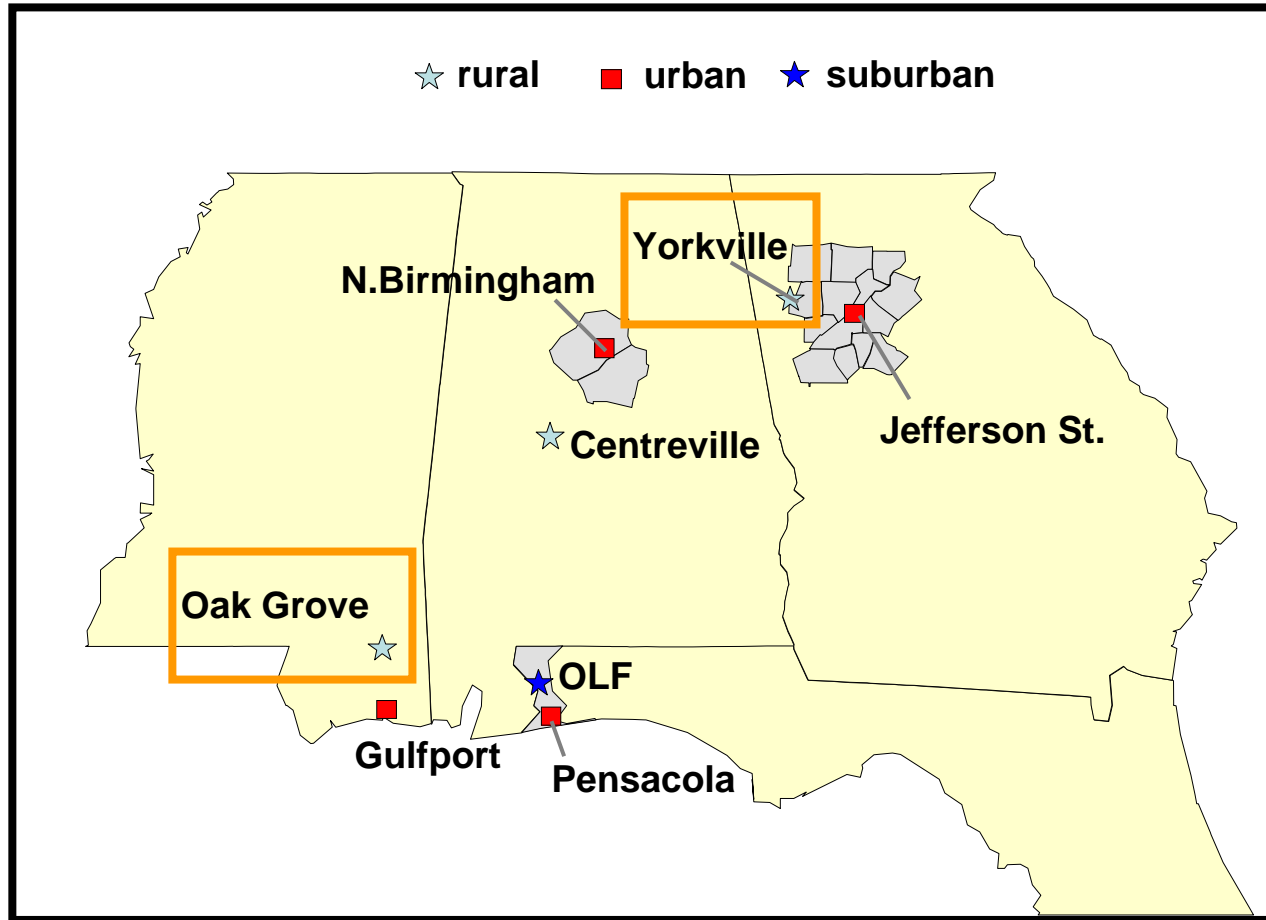
Site	Mean FRM mass ^a	Mean Sulfate ^a	Mean predicted FRM mass after CSF2 ^b				
			No NO _x change ^c	Utility NO _x ^d	35% HNO ₃ ^e	45% HNO ₃ ^e	55% HNO ₃ ^f
ATL	21.1	4.77	17.9	17.4	17.0	16.8	16.5
BHM	19.0	4.89	15.1	14.8	14.4	14.3	14.1
CTR	12.0	4.56	10.2	10.1	10.0	10.0	9.9
OAK	13.3	4.03	11.4	11.3	11.3	11.2	11.2
OLF	11.9	3.29	9.5	9.4	9.3	9.3	9.2
YRK	16.6	5.79	13.3	12.9	12.6	12.3	12.1

45% Column approximately represents CSI Phase 2 levels of SO2 reduction plus expected reductions of NOx from mobile sources

55% Column approximately represents all of above plus CSI Phase 2 levels of NOx reduction

CSI Phase 2 NOx reductions provide little, if any, additional benefit

SEARCH NH₃ Measurements

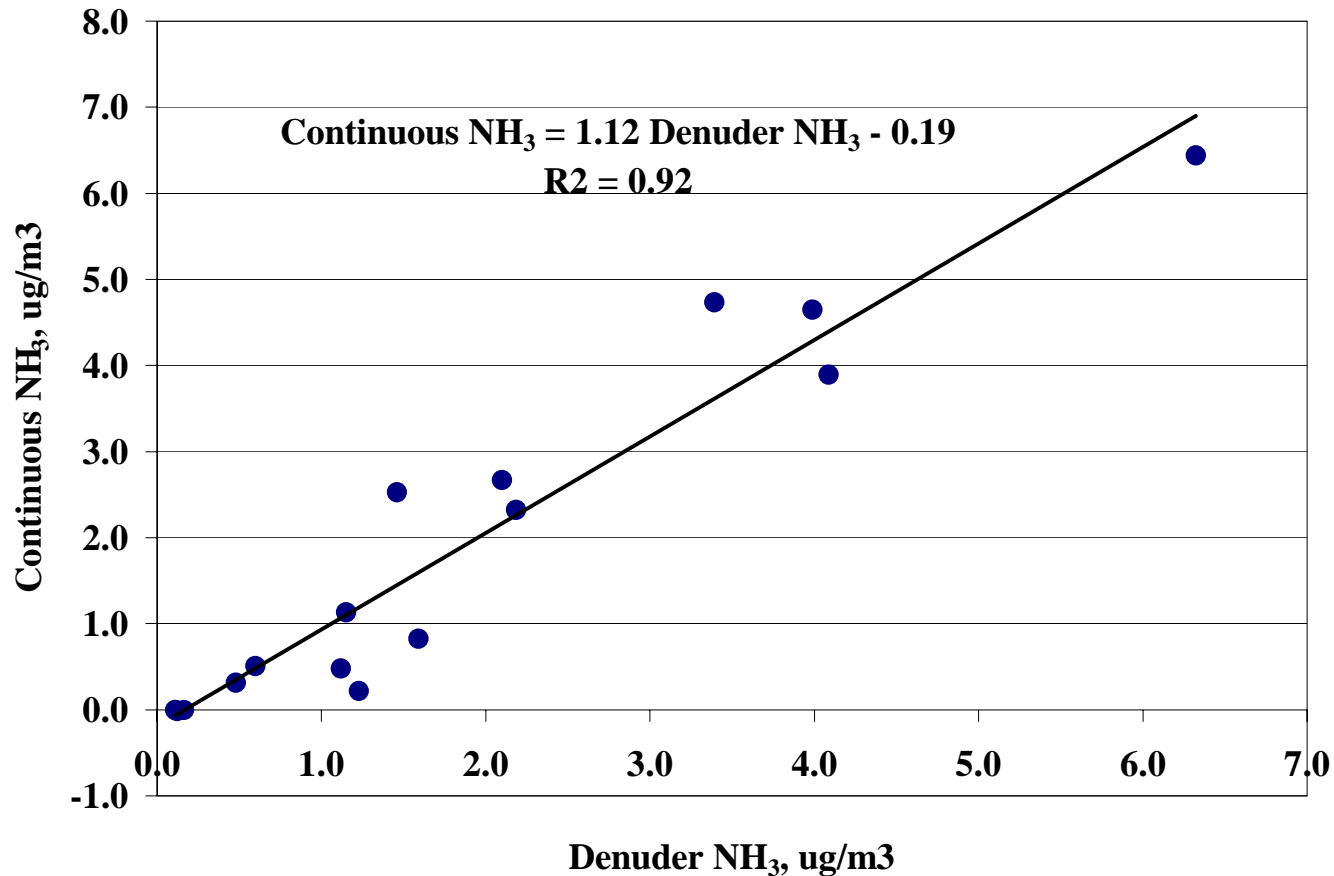


24-hour denuder
(1/3 day) all sites

Continuous at
Yorkville (9/15/03)
and Oak Grove
(1/15/04)

Continuous NH₃ vs Denuder NH₃

24 Hour Samples

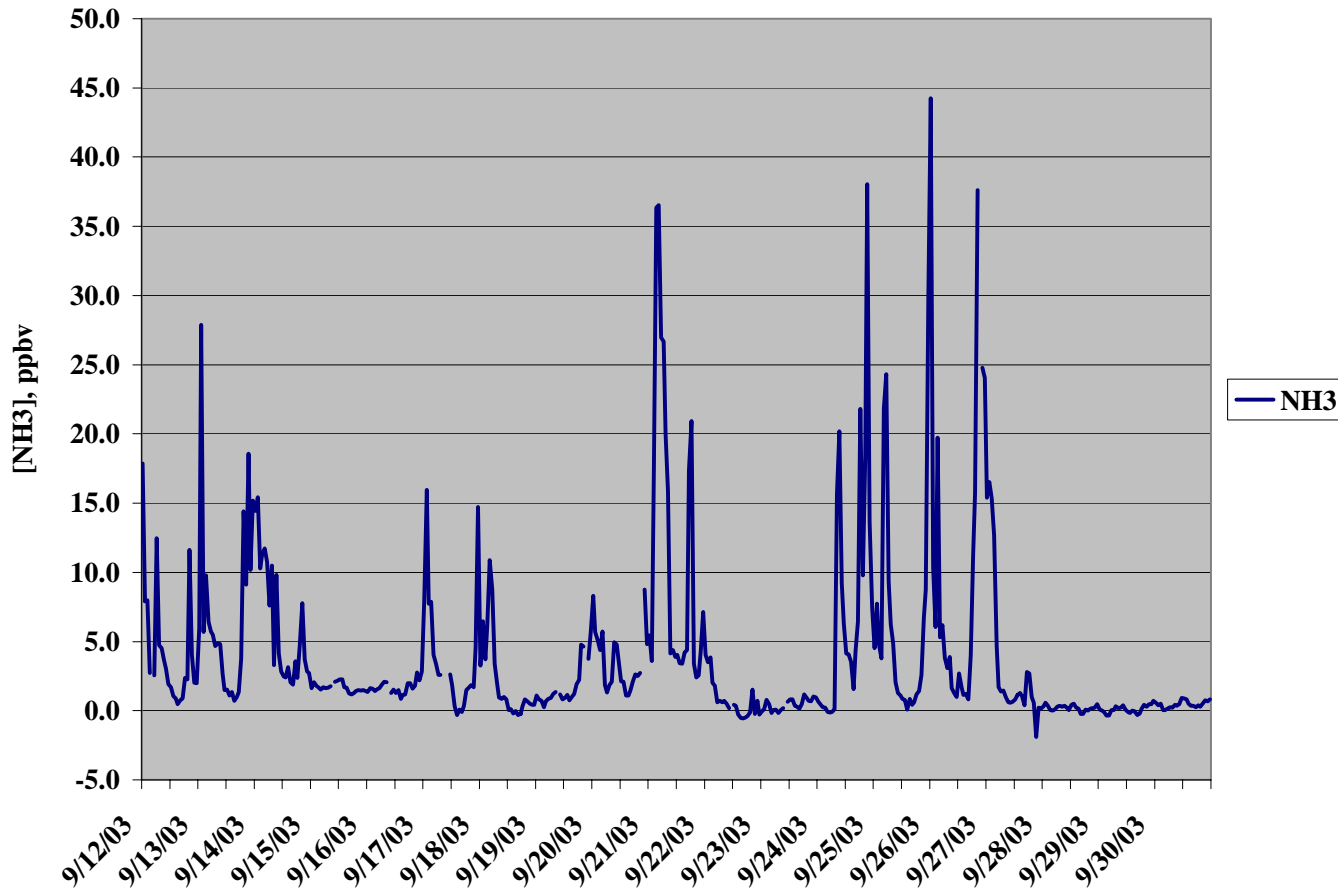


Gaseous NH₃ is deduced by subtracting particulate NH₄ from NH_x

NH₃ Time-Series

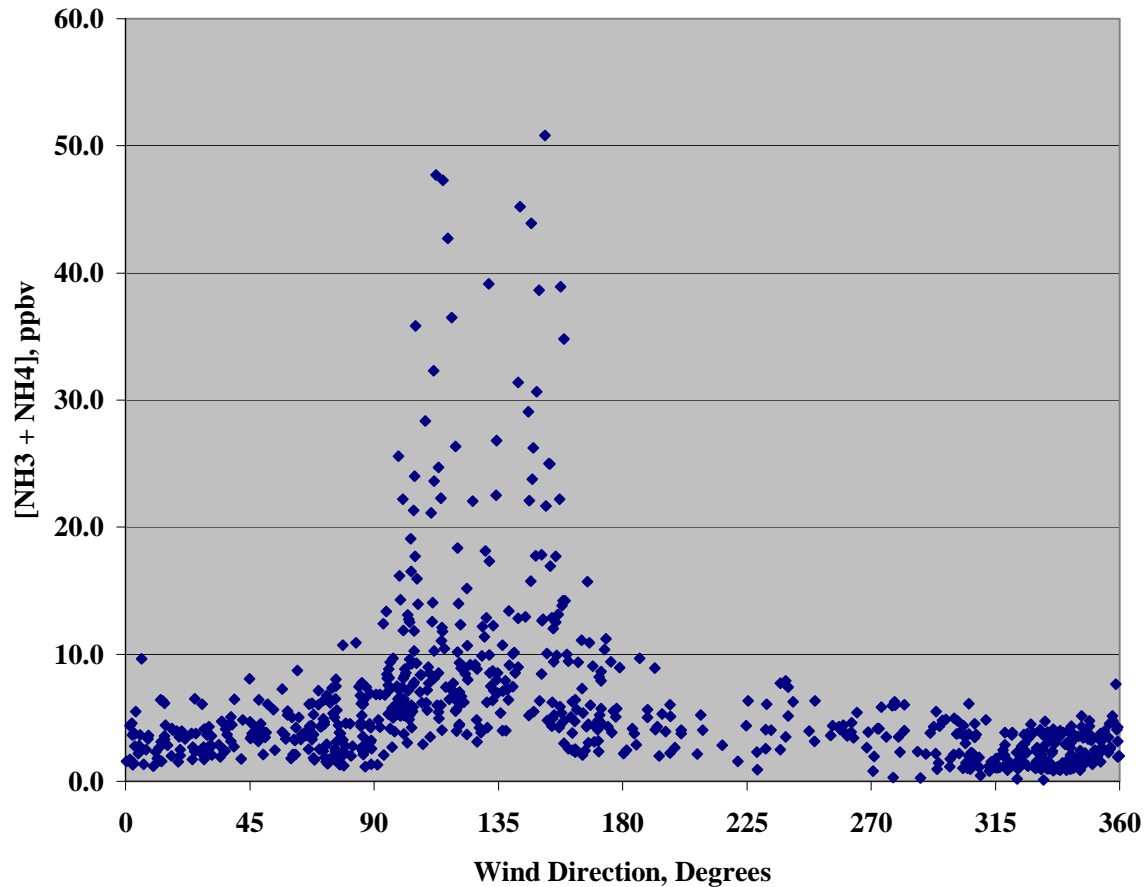
9/12/03 – 9/30/03

Yorkville, GA **SEARCH** Site



Gaseous NH₃ is deduced by subtracting
particulate NH₄ from TRN

1-hour NH_x vs. Wind Direction



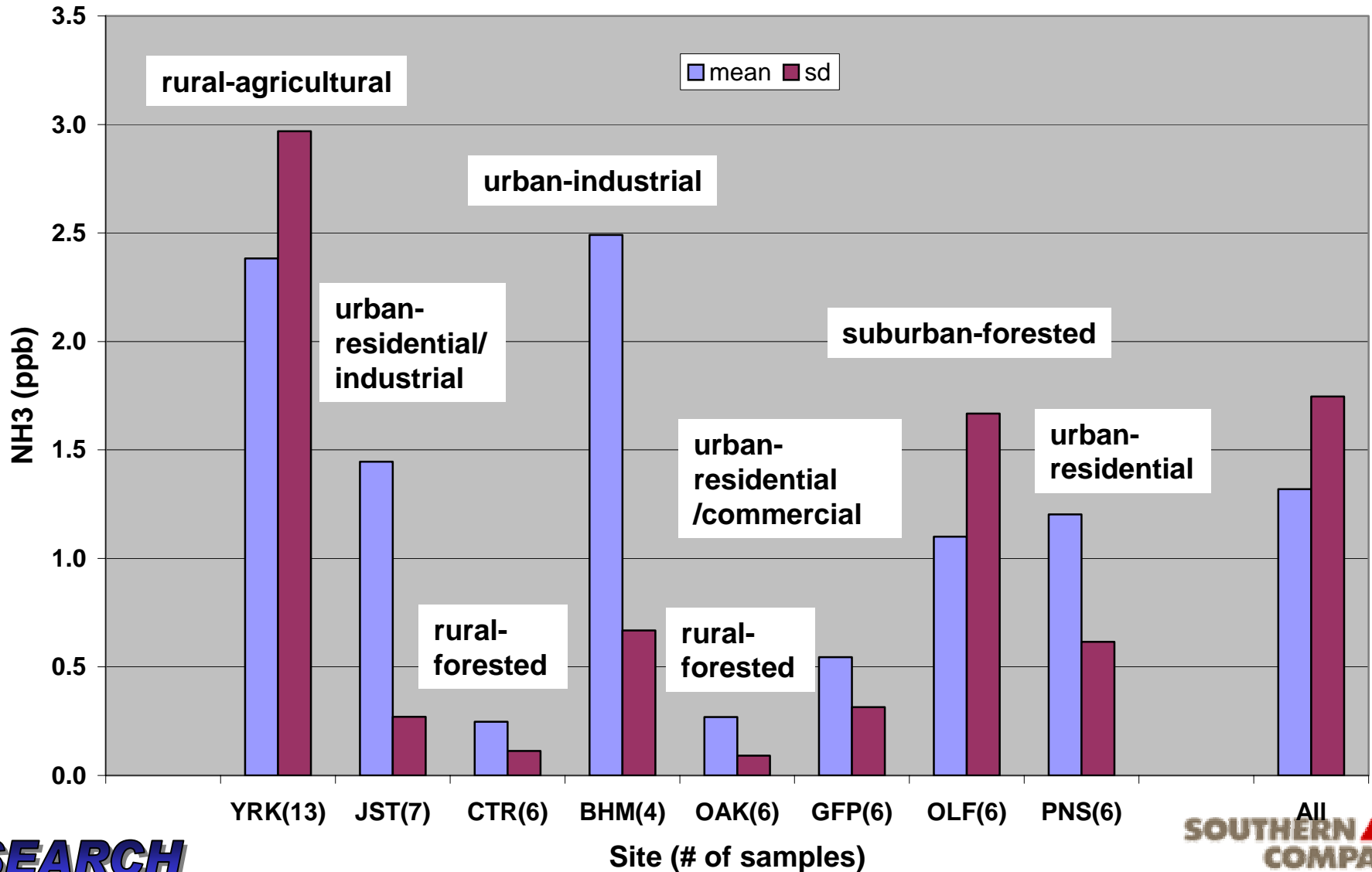
The Smoking Chicken



Poultry operations within several km of Yorkville (crosshair) line up exactly with NH_3 spikes.

SEARCH NH3 Data

24-hr Denuder Samples October 1-18, 2003



Summary

- ◆ There has been a declining trend in PM2.5
- ◆ **SEARCH** and other studies are beginning to bound the sources of carbon
- ◆ Power Plant NOx reductions proposed for CSI are not effective in reducing PM2.5 at **SEARCH** sites
- ◆ Initial look at ammonia show variability and confirmation of known sources
- ◆ With 5+ years of data, can now begin trends analyses