

Carbon in Southeastern Aerosol Particles

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Background

- Black carbon (BC) and Organic carbon (OC) are major ubiquitous components of $PM_{2.5}$, both in rural and urban environments.
- Sources include both primary emissions and secondary material produced from VOC oxidation in the atmosphere.
- Partitioning dependent on measurement method, and concentrations involve assumed OC adjustment for H and O.
- Southeast of particular interest because of apparent large sources of BC and OC.
 - --Biological or biogenic component may be large.

SEARCH Objectives

- Summarize the carbon characterization from SEARCH sites
- Note the potential sources of BC and OC in the SEARCH region
- Seek evidence for the secondary OC component of particulate carbon from the (24 hr. avg.) SEARCH data.

SEARCH Measurements

- Particle and Gas Observations taken at four paired urban-rural sites—Atlanta-Yorkville; Birmingham-Centreville; Urban Pensacola-Suburban Pensacola; Gulfport-Oak Grove.
- --Focus mainly on 1999 period.
- -- (Quartz) filter based measurements with VOC denuder and back-up filter adsorber.
- --Note positive and negative artifacts.
- --OC observations used without O-H multiplier.

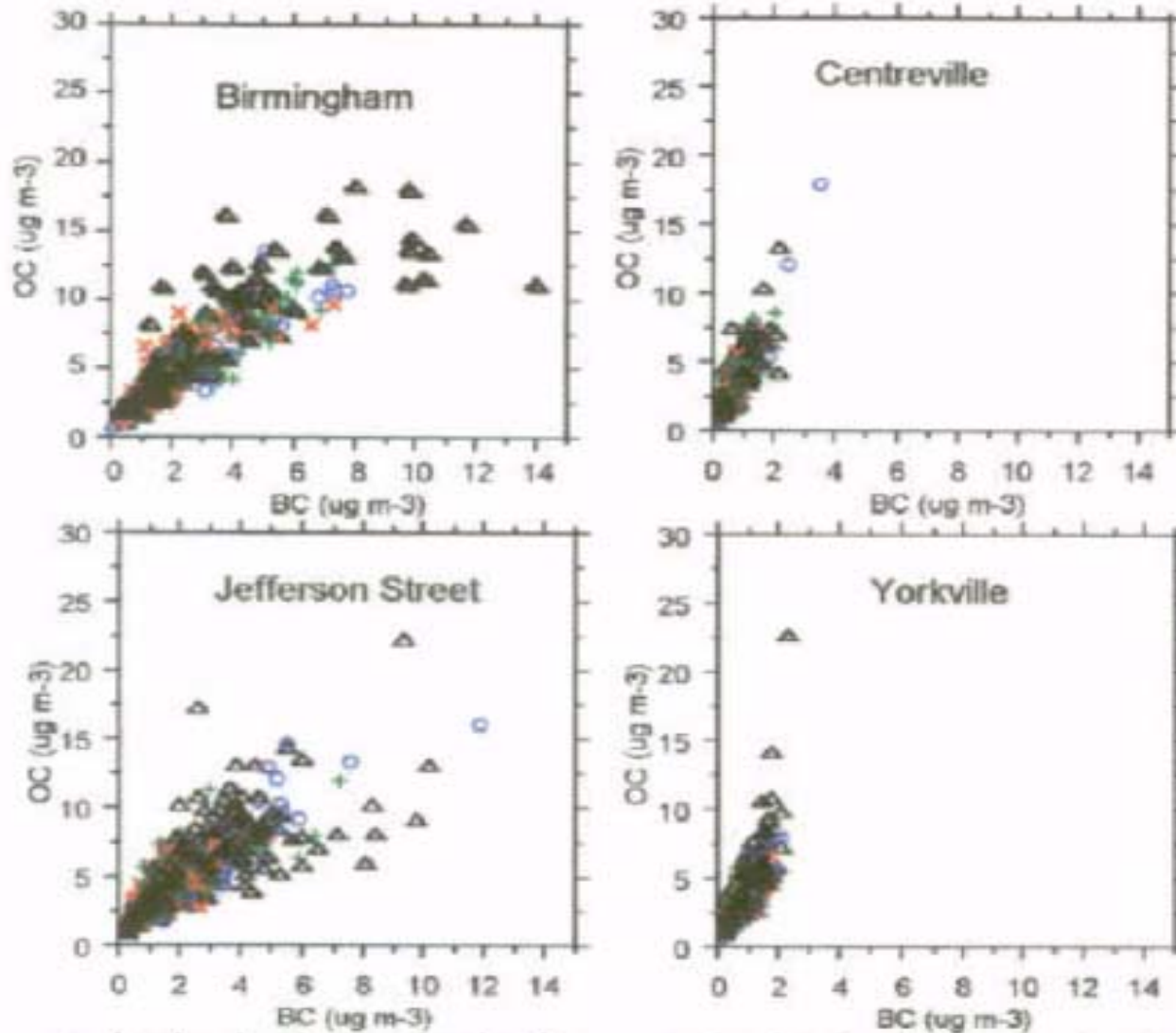
Summary of Annual Average Data for 1999-2000

Table 1. Annual average carbon and ammonium sulfate concentrations compared with fine mass concentration at the SEARCH sites, based on 1999-2000 data (units are $\mu\text{g m}^{-3}$ for all concentrations, and values in parentheses are percent of mass concentration).

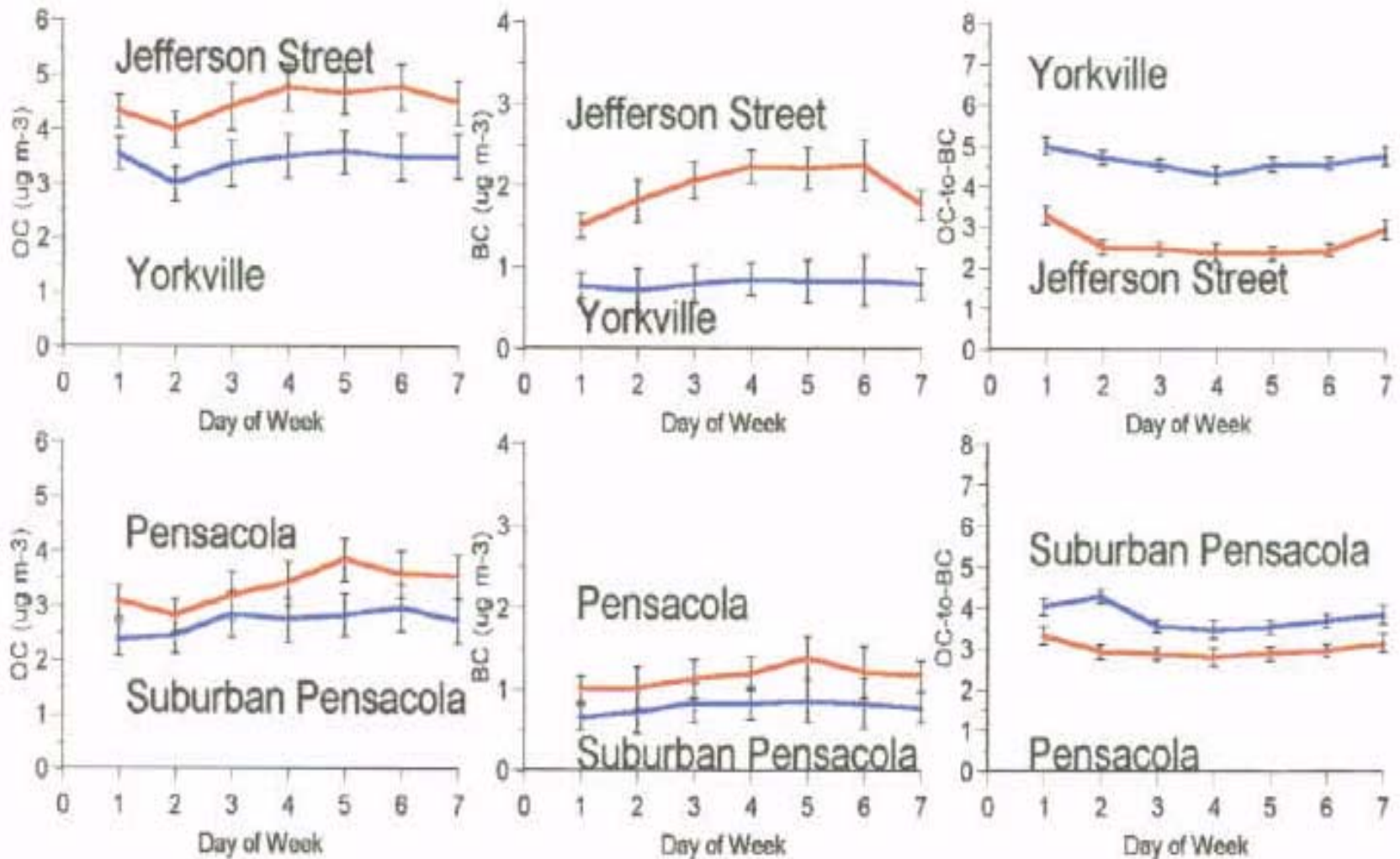
Species	Atlanta (Jeff St.)	York- ville	Birming- ham	Centre- ville	Gulfport	Oak Grove	Pensacola	OLF#8
Total C	6.25 (35.9)	4.19 (29.3)	7.70 (41.8)	3.86 (29.7)	3.75 (30.6)	3.88 (33.1)	4.48 (35.1)	3.46 (30.3)
BC	1.81 (10.4)	0.76 (5.3)	2.50 (13.6)	0.67 (5.1)	0.88 (7.2)	0.70 (6.0)	1.15 (9.0)	0.77 (6.8)
OC	4.44 (25.5)	3.43 (24.0)	5.20 (28.2)	3.20 (24.5)	2.87 (23.4)	3.18 (27.1)	3.33 (26.1)	2.69 (23.5)
Sulfate*	6.19 (35.5)	5.98 (41.7)	6.39 (34.7)	5.42 (41.6)	4.88 (39.8)	4.67 (39.8)	4.93 (38.6)	4.74 (41.5)
Mass	17.4	14.3	18.4	13.0	12.2	11.7	12.8	11.4

*As ammonium sulfate.

Relation Between BC and OC 1998-2000



The Weekday-Weekend Effect



Potential Sources in SEARCH Region

- o Anthropogenic

- Primary-Fuel combustion, including transportation and wood burning; food cooking

- Secondary-Oxidation and partitioning of VOC to condensed phase (role of aromatics??)

- o Natural

- Primary-vegetation fires and biological debris

- Secondary-Oxidation of biogenic VOC

Note: C isotope data suggests a major C fraction of modern C

What is the comparative role of secondary OC?

Carbon Source Estimates

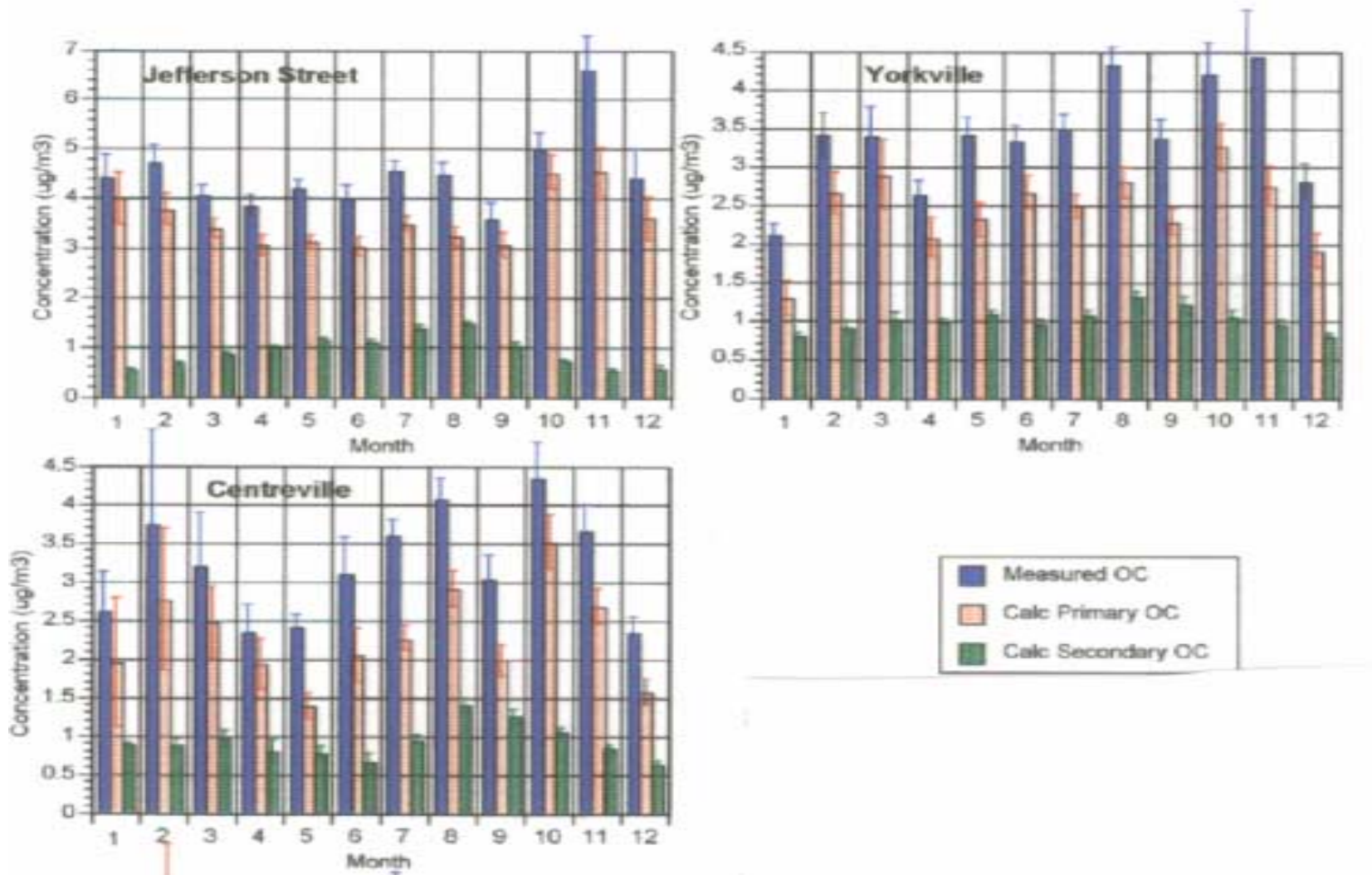
- Analysis of composite samples for different seasons suggest that primary carbon can account for most of OC except perhaps in summer-early fall.
- --Zheng et al (2001)
“Source apportionment of fine particle air pollutants in the Southeastern U.S. using solvent-extractable organic compounds as tracers.”

Can we obtain an independent estimate of primary and secondary OC using empirical gas-particle relationships?

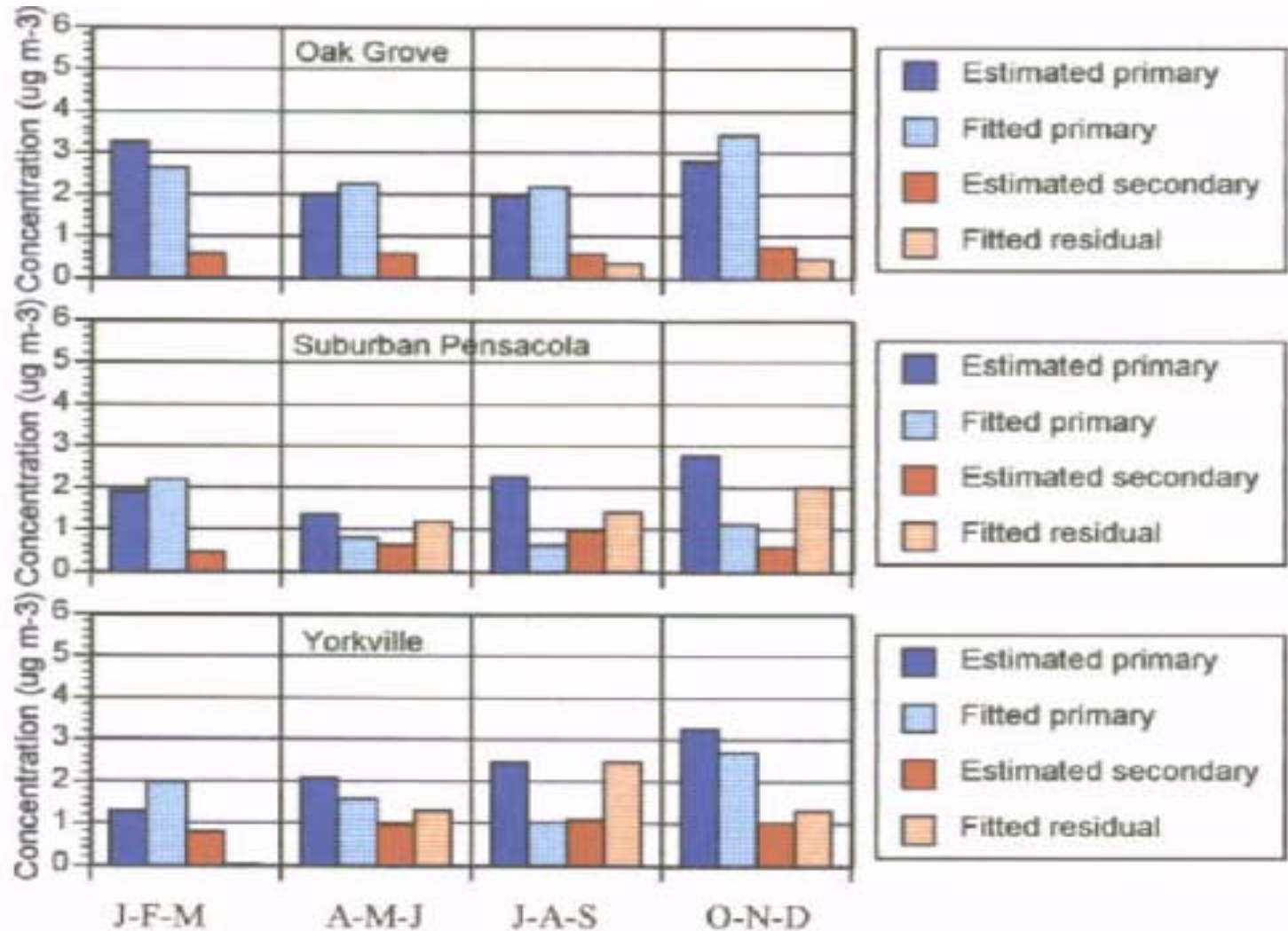
Empirical Relationships

- Use knowledge of relationships between primary and secondary OC and gas phase surrogates established, for example, by linear regression.
- --Predicted OC sum of primary and secondary
- --Primary OC = $a + b \times \text{BC} + c \times \text{CO} + \dots$
- --Secondary OC = $d \times \text{O}_3 = e \times (\text{HNO}_3 + \text{nitrate}) + \dots$
- Accounts for relation between BC and primary OC, and partially combusted fuel fn (CO), and for O₃ as a surrogate for VOC oxidation, and HNO₃ and nitrate as a measure of condensed nitrate from reactions.

Some Results

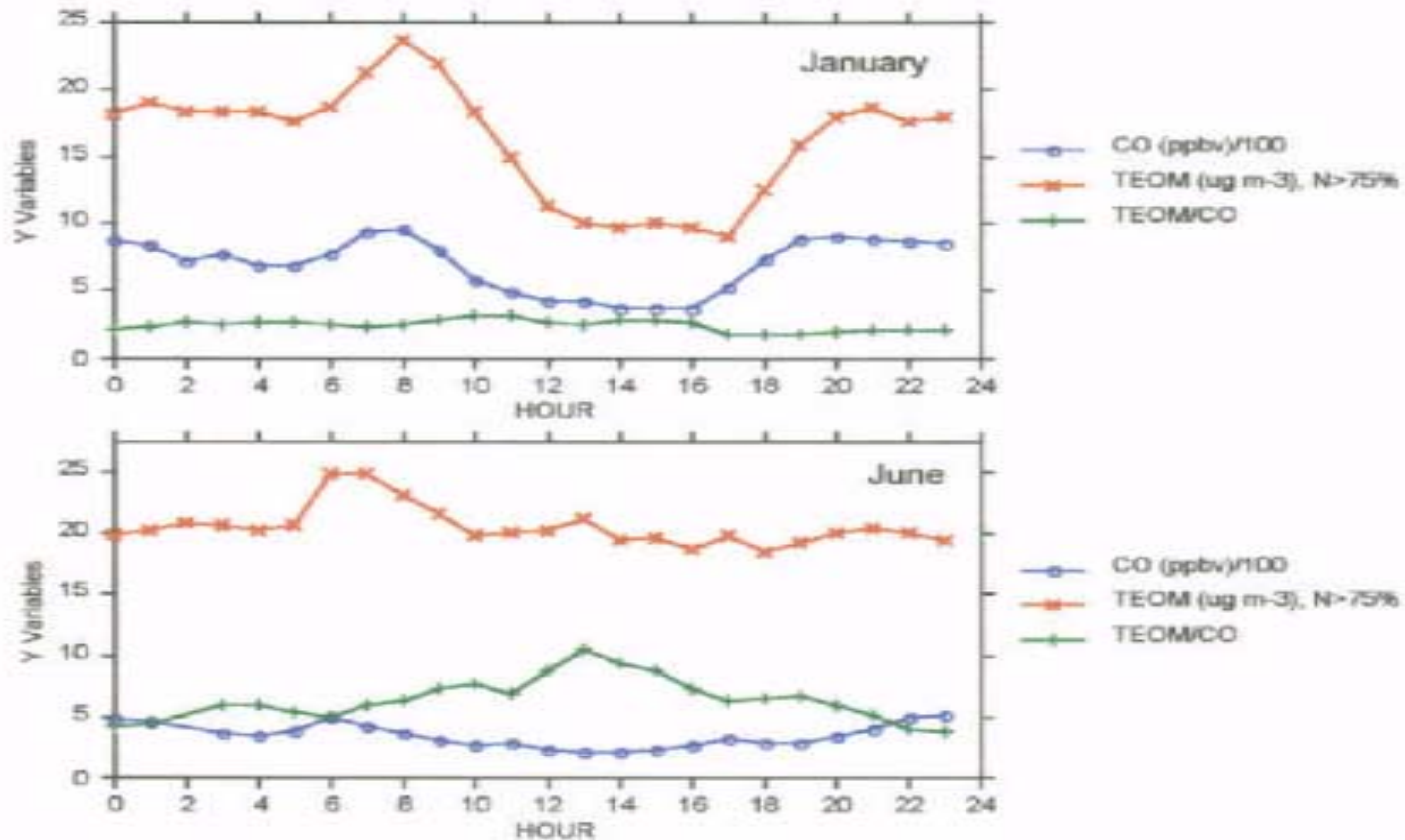


Comparison with Source Apportionment



Next Steps—Semi Continuous OC Data?

- Illustrate with TEOM and CO data by season (Atlanta)



SUMMARY AND CONCLUSIONS

- Black Carbon and Organic Carbon are an important component of urban and rural PM_{2.5} in the SEARCH Region.
- Source Apportionment suggests that primary OC is dominant except possibly in summer and early fall.
- Primary carbon component offers an important leverage on PM_{2.5} management.
- Empirical particle-gas relationships give insight about the significance of OC component for 24 hr. averages.
- --Can this be supported with analysis of semi-continuous C data?