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"Real & Simulated Particle Concentrations: Problems & Prospects for Public-Private Sector Collaboration 1998-2002"

Real & Simulated Particle Concentrations

Problems & Prospects for Public-Private Sector Collaboration 1998-2002

A Briefing to the

U.S. Department of Energy
Federal Energy Technology Center

by

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Palo Alto, California

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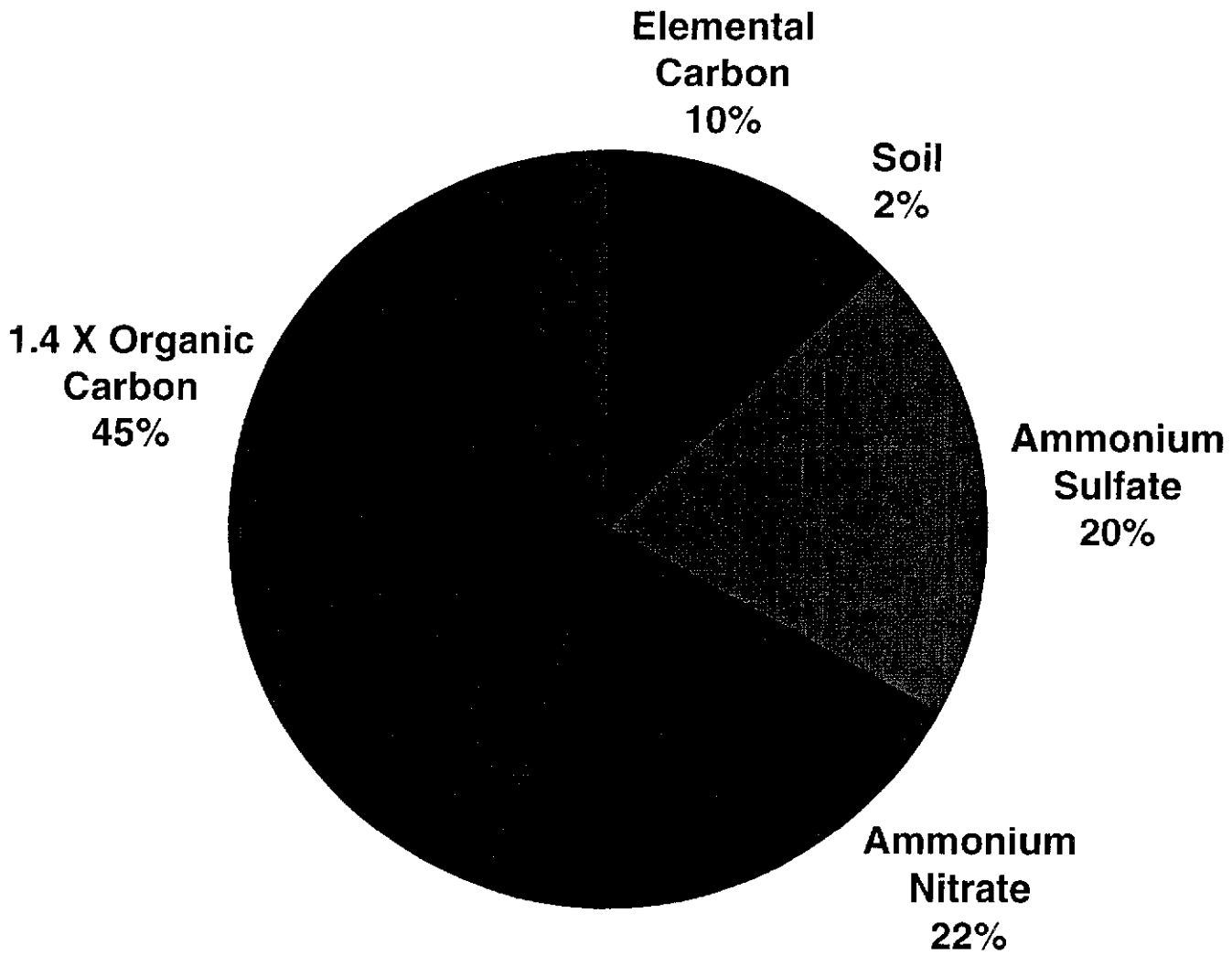
Application & Relevant End Points

Application	End Point
Human health (O_3, FPM)	Human airway or point of inhalation or residential indoor or urban outdoor (~ lower 10m of the atmosphere)
Visibility & global radiation balance (FPM)	Cities & National Parks (boundary layer); continental & marine " background" (entire troposphere)
Plant Health (O_3)	Agricultural & forested areas (~ lower 10m of the atmosphere)

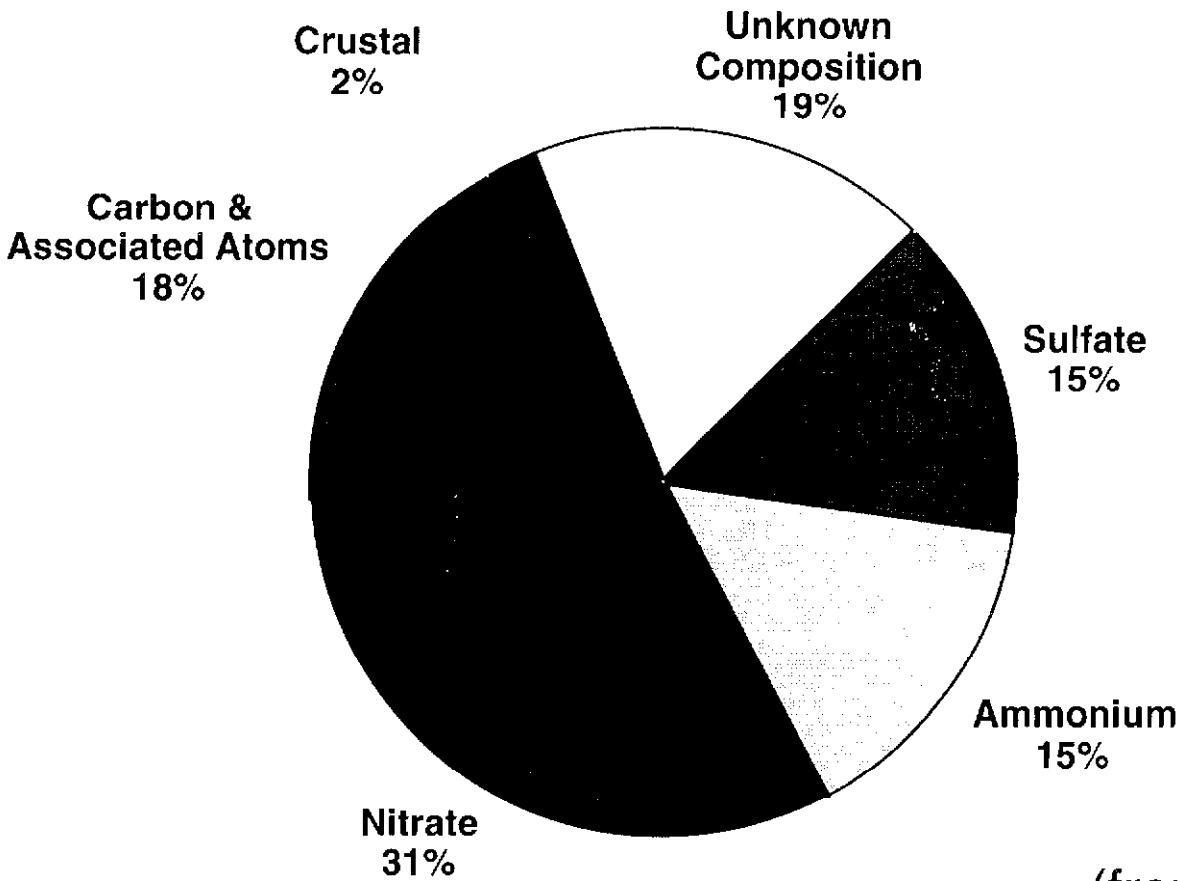
Dallas 1994-1995 Winter Haze Days
Fine PM Average Composition



Average sum of chemical components = 22 ug/m3. Average gravimetric fine mass = 16 ug/m3.

What are Fine Particles ($PM_{2.5}$)?

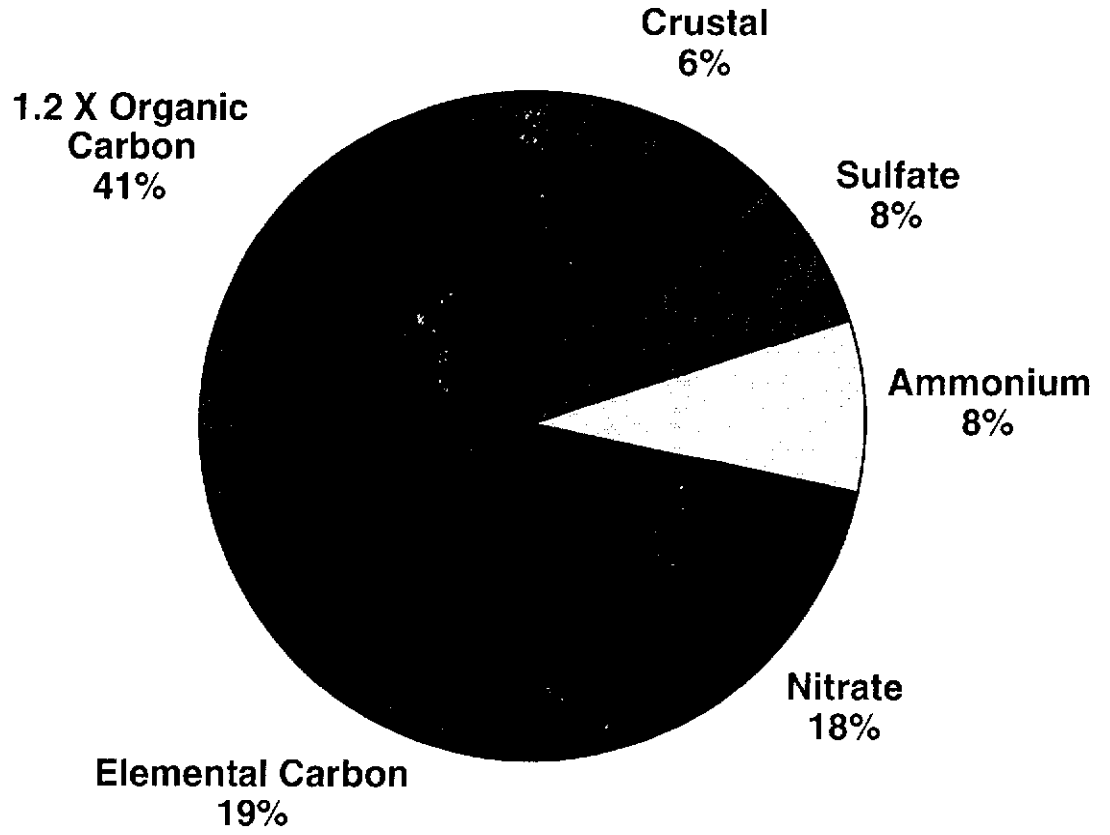
Average Fine Particle ($PM_{2.5}$) Composition
Summer 1987, Riverside, CA



(from Meng et al., 1995)

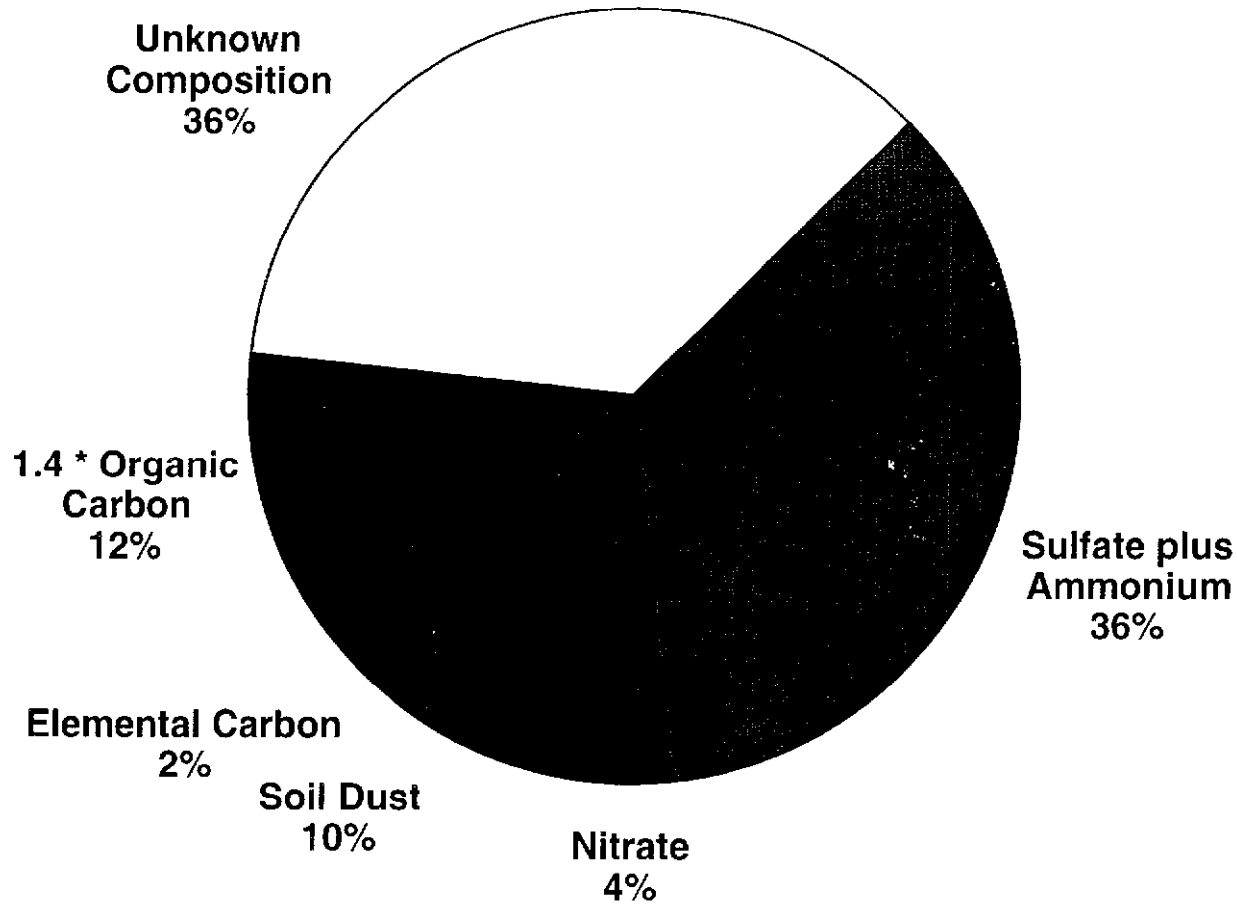
What are Fine Particles (PM2.5)?

Average Fine Particle Composition
1987-1988, Denver, CO

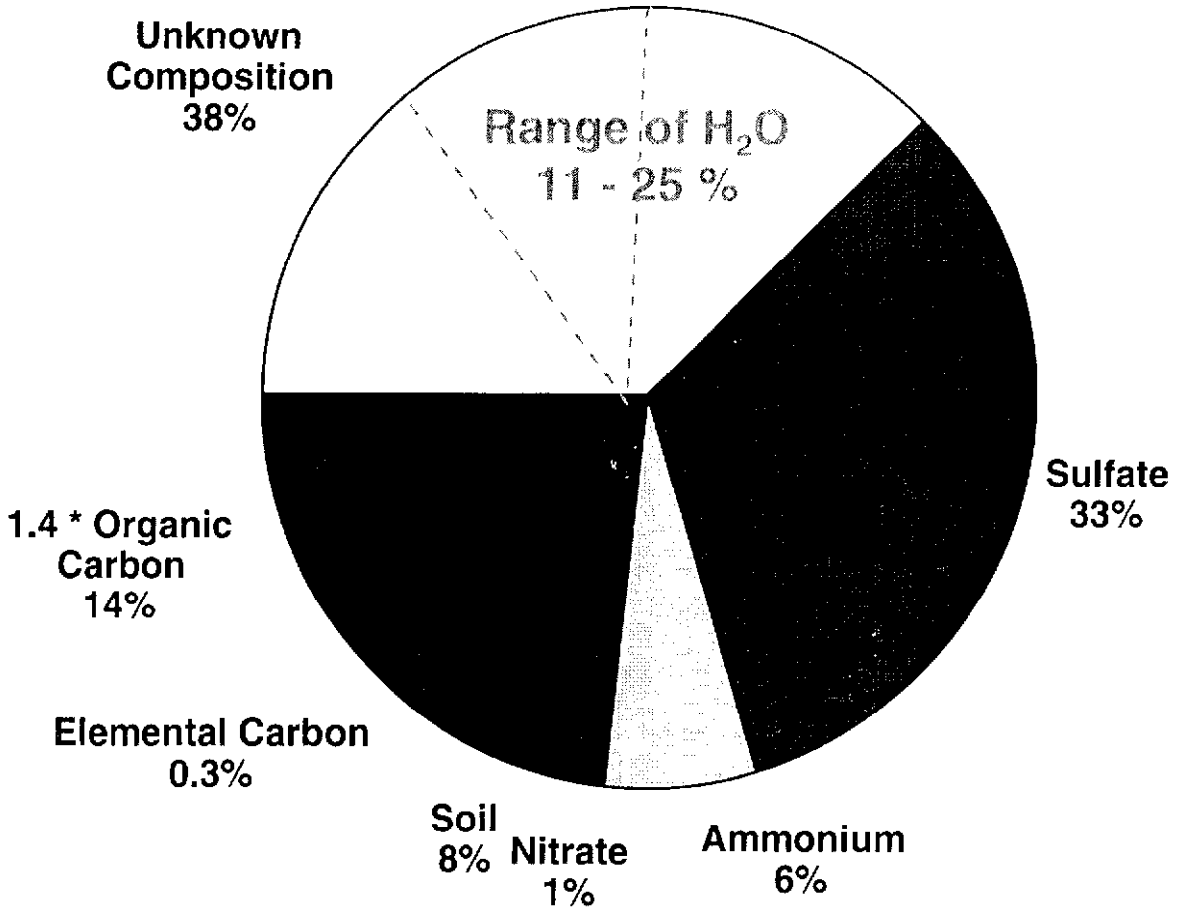


(from Watson, et al., 1988)

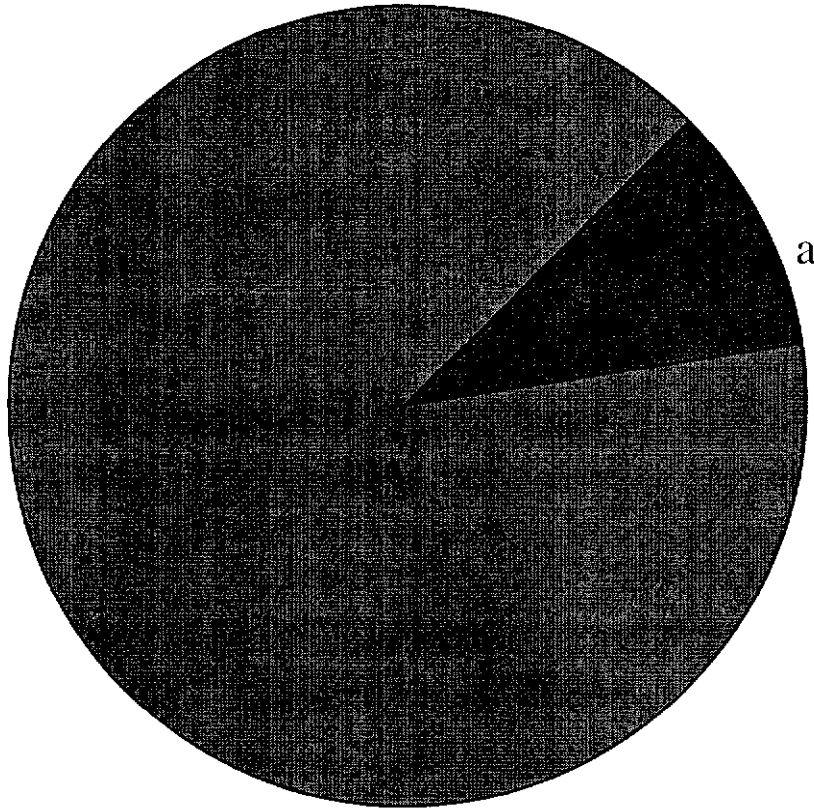
Meadview, AZ (near Grand Canyon)
Average Fine Particle Composition
Summer 1992 (June - Aug.)
(from Turpin, et al., 1997)



Average Fine Particle ($PM_{2.5}$) Composition Summer 1995, Look Rock, TN (SEAVS)



COMPOSITION OF AIRBORNE ORGANIC PM*

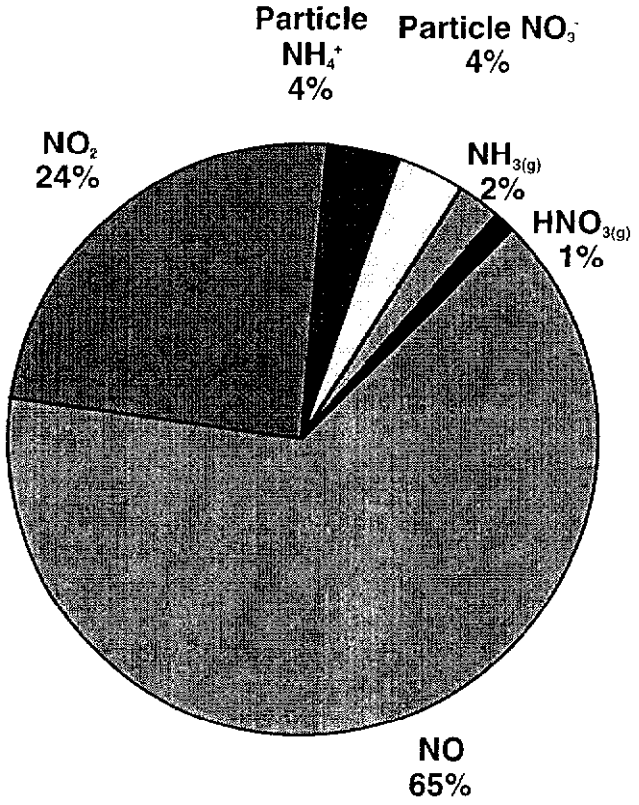


Unknown
90%

Approx. 10%
C_2-C_6 dicarboxylic acids
C_{23}-C_{34} alkanes
C_9-C_{30} monoacids & esters
aromatic polycarboxylic acids

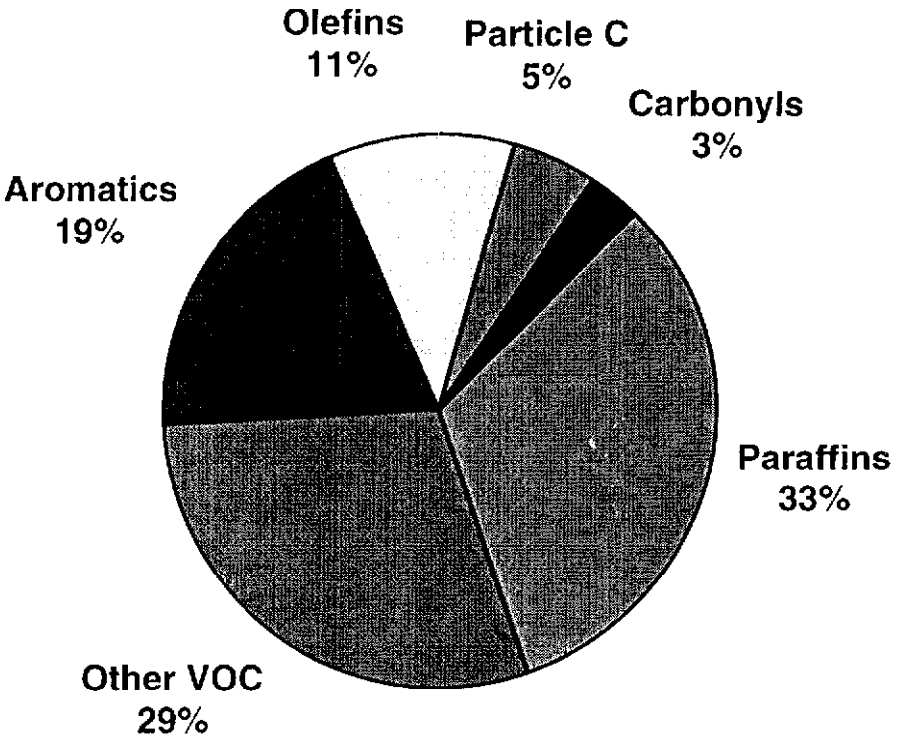
*Los Angeles (1982)
(Rogge et al., 1993)

Nitrogen Balance for Central Los Angeles
6-10 AM on September 9, 1993



Total of 200 µg N/m^3

Carbon Balance for Central Los Angeles
6-10 AM on September 9, 1993

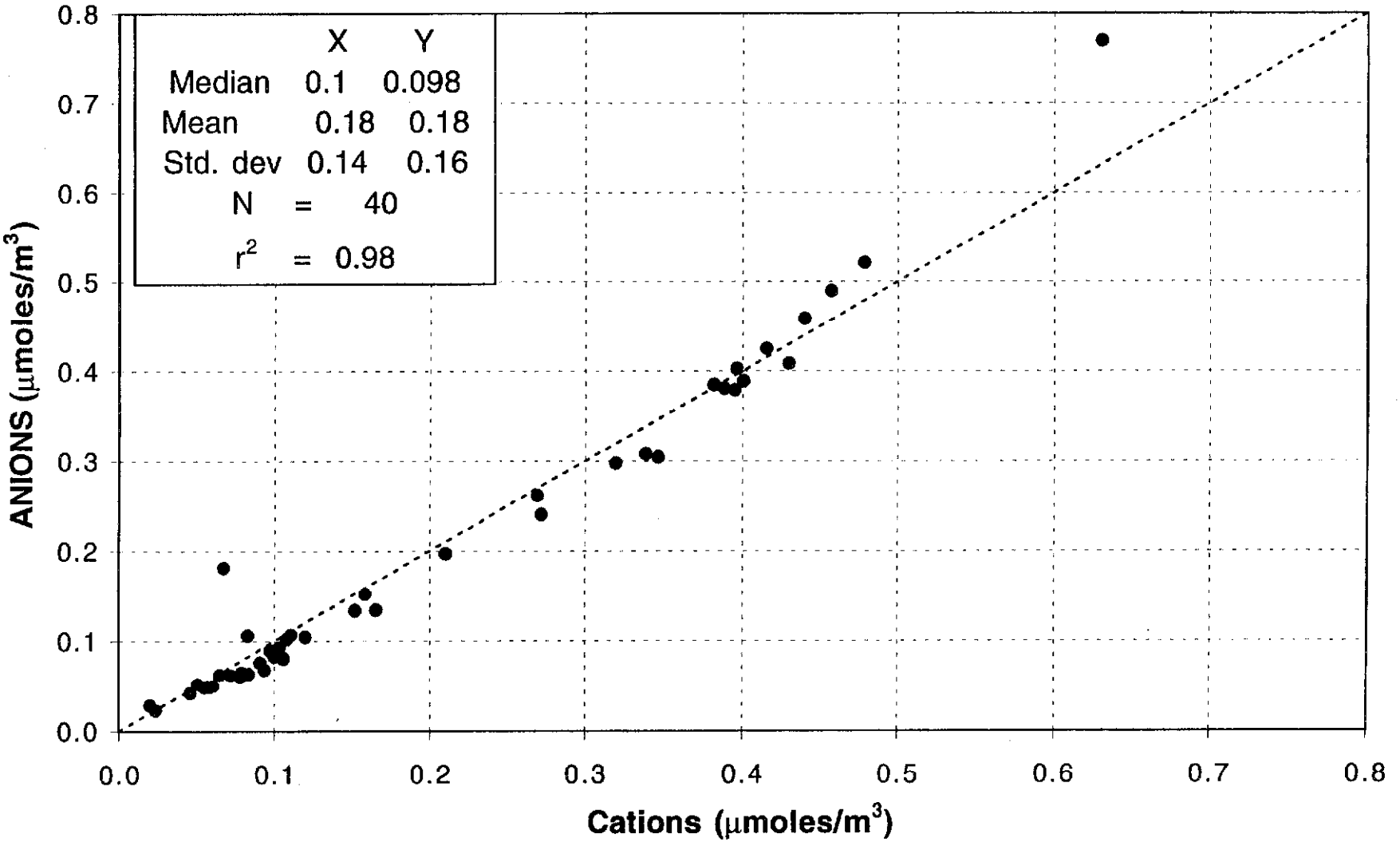


Total of 1200 µg C/m^3

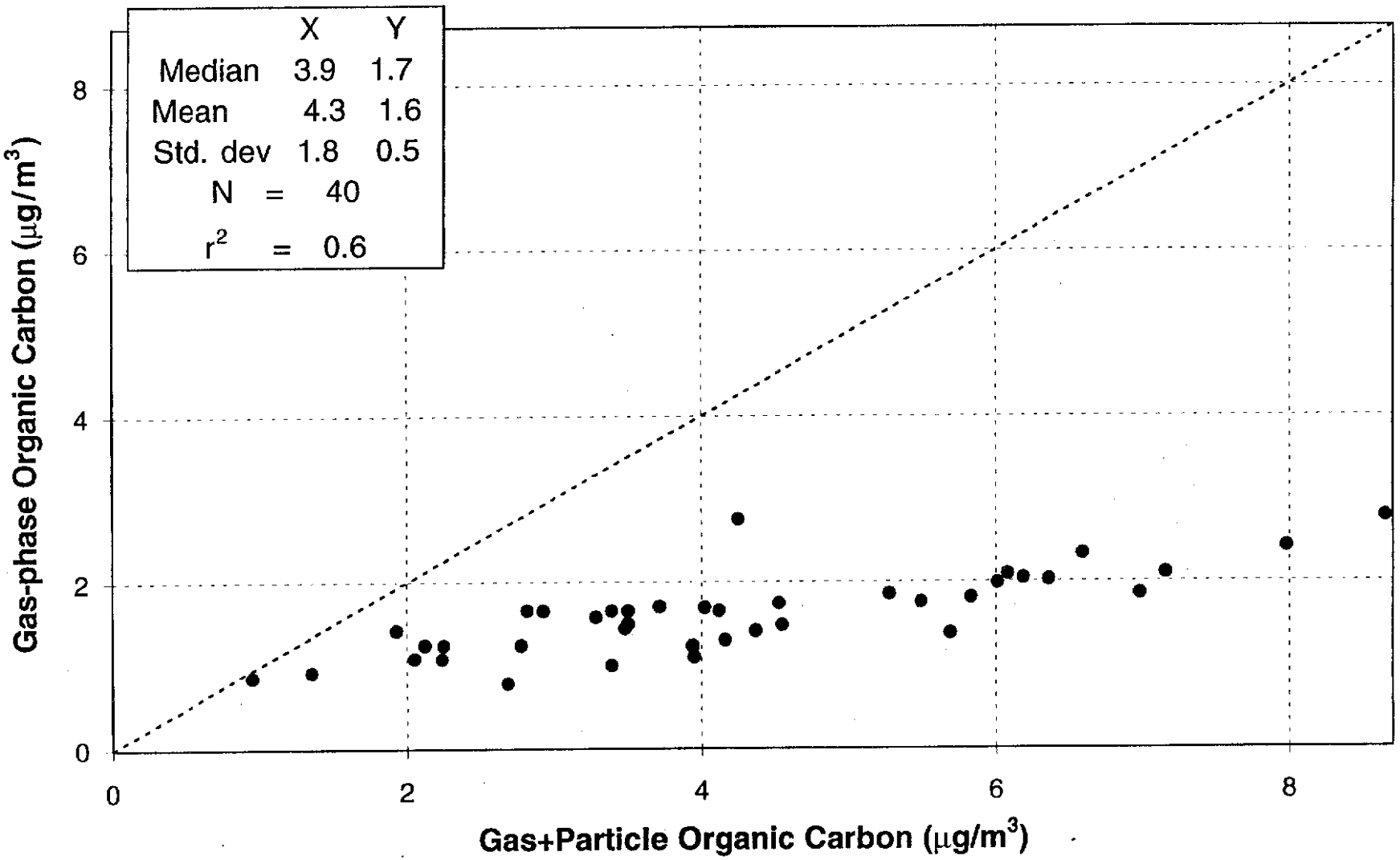
Fraser, et al., 1996

Message: Measure Total Aerosol

Fine PM Ions: Closure of Components
Summer 1995, Look Rock, TN (SEAVS)

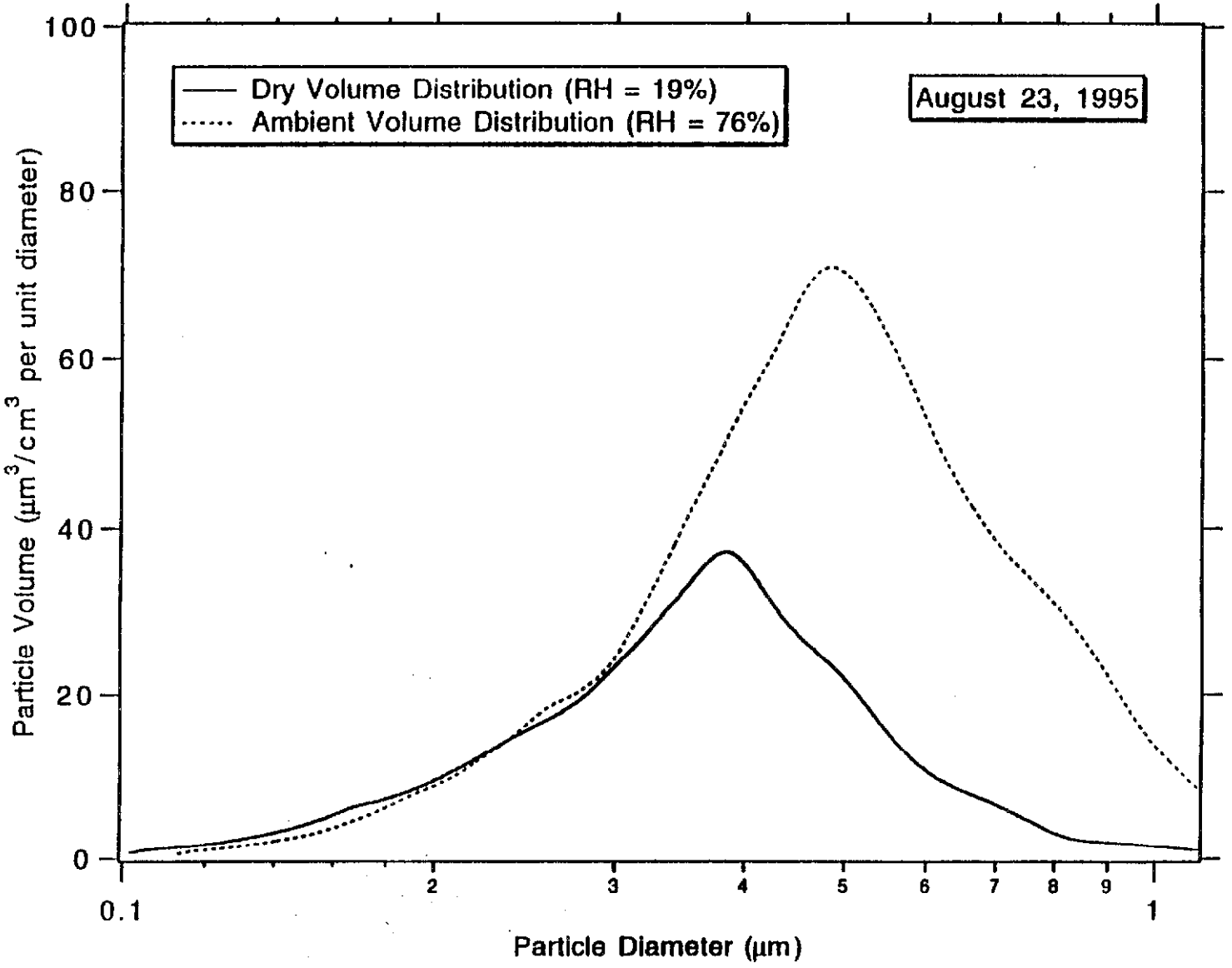


Organic Carbon: Signal vs. Noise
Summer 1995, Look Rock, TN (SEAVS)



Summer 1995, Look Rock, TN (SEAVS)

Particle Volume Distribution on High PM Day



Ozone & FPM

Compounds Relevant to Characterization, Simulation, Source Attribution, Epidemiology, or Optics

	Short-term ($\leq$ 3-hr) Measurements feasible?	Ozone	FPM	
			Health	Visibility
CO	Yes	X	X	X
VOC comp.	Depends	X	X	X
NO, NO_2, PAN	Yes	X	X	
O_3	Yes	X	X	X
H_2O_2	Yes		X	X
SO_2	Yes	X	X	X
HNO_3 & nitrate	Maybe	X	X	X
FPM mass	Maybe		X	X
Sulfate	Yes		X	X
NH_3 & Ammonium	Maybe		X	X
Particle carbon	Maybe		X	X

Ozone & FPM

Compounds Relevant to Characterization, Simulation, Source Attribution, Epidemiology, or Optics

	Short-term (< 3-hr) Measurements feasible?	Ozone	FPM	
			Health	Visibility
Organic FPM Composition	No		X	X
Particle acidity	Maybe		X	X
H_2O-soluble Transition metals	Maybe		X	
Particle H_2O	Maybe		X	X
Trace elements	Maybe		X	X
HCl and chloride	?		X	X

Global Radiation Balance Studies (ACE, TARFOX, INDOEX)

Experiment Design

- Total aerosol composition & physical properties (gases, particles, clouds, radiation)
- Lagrangian process studies (constant density balloons tracked by aircraft)
- Air column experiments
- Intensive 3-D, short-term experiments ☺
- Closure among chemical & physical properties ☺

Findings

- Aerosol & dust transported in distinct layers over the Atlantic up to 300km
- Cumulus clouds scrub "old" particles and inject "new" particles into the boundary layer
- Contribution of carbon to FPM higher aloft than near the surface

EPRI Short-Term Ongoing PM Experiments (late 1996-early 1997)

Objective

- Quantify the amount and composition of flabile FPM lost from single filter-based methods for a broad range of locations and seasons

Approach

- Birmingham, Riverside, Boston, Chicago, Dallas, Phoenix
- ~ 40 days/observatory
- Suite of measurements include undenuded single-filter fine mass, ammonium and nitrate; in situ fine mass; denuded inorganic composition (NH_3, HNO_3, SO_2, NH_4^+, NO_3^-, H^+, SO_4^{2-}; elemental composition, denuded and undenuded EC and OC; babs, bscat; continuous nitrate; other
- Parallel laboratory experiments with specific compounds

EPRI Long-Term Planned PM Experiments (late 1997-2000+)

- Starting with 7 sites in the Southeast
  (3 urban + 3 rural + 1 coastal)
- Continuous (5-60 minute): O_3, NO, NO_2, NO_y, HNO_3 and nitrate, CO, SO2, Mass, OC and EC, NH_4^+, SO_4^{2-} , meteorology, bscat, babs
- Integrated (24-Hr, daily or 1/3 days): single-filter mass, elemental composition, SO_4^{2-} , NO_3^-, NH_4^+, denuded EC and OC, PM10 mass
- Integrated (24-Hr, every 6 to 12 days, monthly aggregates): PM10 elemental composition; PM10 NO_3^-, SO_4^{2-} , NH_4^+, water-souble metals; VOC and FPM organic speciation
- Gradually phase-out integrated measurements; add other observables e.g. FPM H_2O)
- Pararell method development & comparison

Proposed Agenda for Collaborative Research

- Engineer & deploy "non-Ph.D." in situ particle sampling methods
- Measure and simulate organic FPM mass and composition
- Deal with the issue of data comparability up front (shootouts; benchmarking new methods against reference aerosol; laboratory certification)
- Create recommendations for a "standard suite of measurements for ozone and PM studies"
- Create a cookbook for data quality assessment & data interpretation

Agenda for Collaborative Research (concluded)

- Synchronize prospective O_3 and FPM experiments towards concurrent multi-station, multi year, 3-D measurements of "total aerosol," meteorology and radiation over the continent (EPA, DOE, NSF, NOAA, NASA, EPRI, CRC, private sector).
- Coordinate model development and testing efforts towards the production of a community tropospheric model, which is accessible to all, testable by all, and which benefits from the resources of the entire investigating and funding communities.

Motivation For Collaboration

- Problem:
  - There is always enough time to do it wrong several times but never enough to do it right once.
- Solution:
  - Start with ideas, not resource constraints.
  - Pool resources through collaboration.