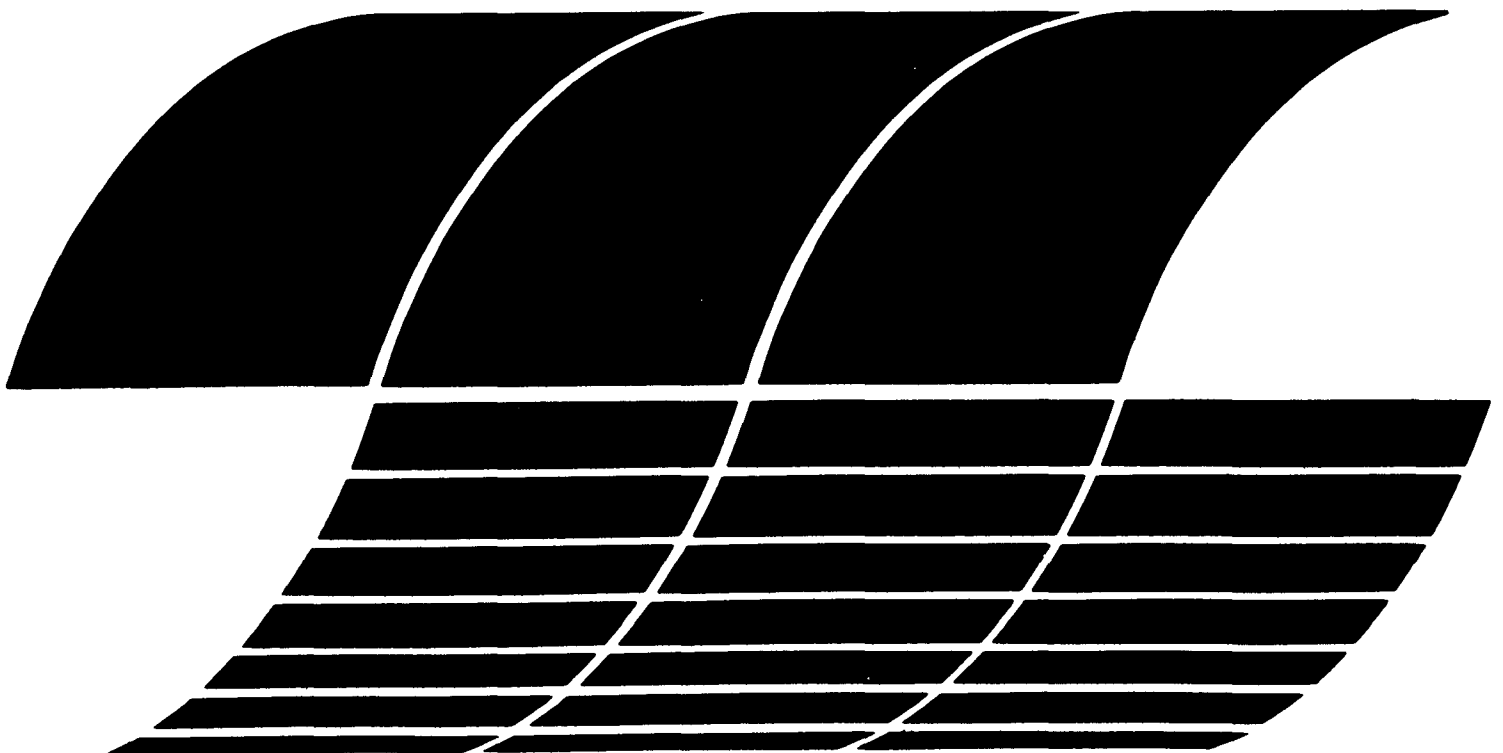


Research and Development



Intercomparison of Samplers Used in the Determination of Aerosol Composition

Interagency
Energy/Environment
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Report



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INTERCOMPARISON OF SAMPLERS USED IN THE
DETERMINATION OF AEROSOL COMPOSITION

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ABSTRACT

An intercomparison study was carried out to evaluate the performance of 11 different designs of aerosol samplers. The samplers were operated by participating scientific groups having recognized expertise in sampler development, operation, and the subsequent analysis of the samples they collected. The devices tested include hi-vol, TWO MASS, multiday, cyclone, CHAMP, streaker, stacked filter, and manual and automated dichotomous samplers. The samplers were operated simultaneously (on the roof of the Federal Building) in Charleston, West Virginia for eight consecutive days during May of 1977. The collection surfaces of each sampler were changed at least every 12 hours which enabled the intercomparison to be made for 16 sampling periods. Samples collected were analyzed by each participant for one or more of the pollutants for mass, nitrate, sulfur or sulfate, lead, and 8 other trace elements. The analysis methods used by the various participants included x-ray fluorescence, particle induced x-ray emission, atomic absorption, ion chromatography, colorimetry, beta gauge and gravimetric techniques.

Most of the samplers separated the aerosol into two fractions with 50 percent separation diameters ranging from 2.4 μm to 4.3 μm . The upper 50 percent cutoff diameter for the various samplers ranged from 14 μm to above 30 μm . Data were intercompared for the total, fine and coarse size fractions.

Best agreement among samplers was found for elements such as sulfur and lead that occurred primarily in the fine fraction.

The amount of total mass collected appeared to be strongly influenced by the upper 50 percent cutoff diameter of each sampler.

For the stacked filter samplers and the tandem filter samplers, the fine fraction appeared to be enriched with crustal elements such as Si, Ca, and Fe, which suggests that there are particle bounce errors.

Of all the samplers reporting results, the automated dichotomous sampler showed the greatest precision for the fine fraction species.

In the intercomparison study, total sulfur was measured by x-ray fluorescence, and sulfate was measured by ion chromatography and by wet chemical methods. The mean sulfur and sulfate concentrations were in agreement with the assumption that all of the sulfur is in the form of sulfate.

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Grateful appreciation is also extended to each of the intercomparison study participants who, through their creative criticisms, helped make this final report more comprehensive and complete.

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SECTION 1

INTRODUCTION

HISTORICAL PERSPECTIVE

One of the consequences that grew out of the environmental concerns of the 1960's was a demand for better air quality. For research scientists in this field this meant improving the measurement, characterization, and understanding of air pollutants both at their emission sources and in the ambient atmosphere. Consequently, more attention began to be focused on the performance of aerosol particulate samplers. Performance parameters examined more closely included sampler inlet designs, their flow rate capabilities, the particle size cutpoints employed, internal particle loss mechanisms, and types of collection substrates used, to name just a few. As a result of this attention, the development of both simple and sophisticated aerosol particulate samplers began to take place all across the country. Several conferences (1,2) helped focus on what had been accomplished as well as on what the needs were. By 1976 a great deal of air pollution information was being collected with the many different sampler designs, and results were being published in numerous journals. One of the questions that arose following the second conference (2) was how intercomparable are the results from different samplers? If the results did differ, was it by small percentages, by factors of 2, or did they differ by orders of magnitude? Were some pollutants easier to measure than others? Thus, it was suggested that a study be carried out which would begin to answer these and other questions.

OBJECTIVE

The objective of the study was to operate representative state-of-the-art aerosol particulate samplers simultaneously and side-by-side for an extended period and to compare the analytical results. This objective was achieved through a field study at which the samplers were operated by their developers or users in nearly the same manner as they are operated in typical air pollution research and/or monitoring programs. The samples collected were analyzed for selected pollutant concentrations by each participant using those analytical methods normally employed for the type of sample and pollutant collected.

SITE SELECTION

Several considerations entered into the selection of an appropriate site for the field study. Among the more important were that sufficient space, sufficient electrical power, and security for the samplers be provided. It was also desirable to conduct the study in an area where some pollutant information was available. The earlier results would give some indication of the

kind of pollutant concentrations to be expected. These considerations led to the selection of the Federal Building in downtown Charleston, West Virginia, as the site where the field study would be conducted.

This is a five story building through which there is access to a large, open roof area. It has the added bonus of a 24-hour security service. The earlier study (3) carried out in the Charleston area indicated that the month of May offered satisfactory weather conditions for the study. The field study was scheduled to begin at 8 am, Wednesday, May 11, 1977, and end at 8 am, Thursday, May 19, 1977. Sample collection was to be continuous throughout the study with collection substrates to be changed at least once every 12 hours. This 8-day duration led to sixteen 12-hour periods for which pollutant concentrations could be intercompared.

POLLUTANTS SPECIES SELECTED

There are a wide range of air pollutant species that could have been measured in such a study. Because the objective of the study was to intercompare results from as many different types of samplers as possible, the number of pollutant species selected was purposefully restricted.

Those pollutant results for which an intercomparison was believed to be meaningful were mass, nitrate, sulfur and sulfate, lead, and eight other trace elements to be selected after the field study was completed. Since the type of samplers brought to the study varied from simple to complex, the study was designed so that comparisons could be made for the total pollutant concentration reported; and also for fine and coarse fractions for samplers which collected particles according to aerodynamic size.

Following completion of the study eight trace elements were chosen. Three of these - silicon, calcium, and titanium - are representative of those elements found in the earth's crust. A fourth element, iron, is also found in this group, but may also be associated with local emission sources. These four elements tend to concentrate in the coarse or large particulate fraction, that is, in particles having aerodynamic sizes greater than 2.0 micrometers. Three other trace elements chosen were copper, zinc, and bromine. The last was chosen because of the well known bromine to lead ratio characteristic of automotive exhausts. The eighth trace element chosen was selenium, which usually occurs in very low concentrations. Its measurement becomes a challenging test of the various samplers and analytical methods used in the study.

PARTICIPANT SELECTION

Because of space restrictions atop the Federal Building in Charleston, only a limited number of samplers could be accommodated. This restriction plus the desirable option of replicate samplers limited the number of participants that could be invited to the study. Table 1 lists those participants invited to the field study and who brought samplers which were representative of those aerosol collection devices most widely used in research and monitoring programs.

TABLE 1. INTERCOMPARISON STUDY PARTICIPANTS

Mr. Robert Burton:	Health Effects Research Laboratory, Environmental Protection Agency, Research Triangle Park, NC 27711
Dr. Thomas Cahill:	Physics Department, University of California, Davis, CA 95616
Dr. R. Delumyea, and Dr. E. Macias:	Department of Chemistry, Washington University, St. Louis, MO 63130
Dr. Thomas Dzubay and R. K. Stevens:	Environmental Sciences Research Laboratory, Environmental Protection Agency, Research Triangle Park, NC 27711
Dr. Martin Hudson:	Physics Department, Florida State University, Tallahassee, FL 32306
Dr. Billy W. Loo:	Lawrence Berkeley Laboratory, Berkeley, CA 94720
Dr. Peter Mueller:	Environmental Research and Technology, Inc., West Lake Village, CA 91361
Dr. Charles Rodes:	Environmental Monitoring & Support Laboratory, Environmental Protection Agency, Research Triangle Park, NC 27711
Dr. Roger Tanner and Dr. Leonard Newman:	Atmospheric Sciences Division, Brookhaven National Laboratory, Upton, L.I., NY 11973

SAMPLER TYPES AND ARRANGEMENT

Table 2 lists those samplers brought to the study. Both a one page summary and detailed description of each type can be found in Appendix A. It is apparent that a number of duplicate samplers were brought. The well known high volume sampler was well represented at the study. Included were those with and without particle size inlet restrictions as used in the CHESS* study carried out in a number of communities by the Environmental Protection Agency (EPA). Of the 35 samplers brought to the study, 20 had the capability of collecting particles in two or more size fractions. Of these 15 reported size fraction results.

All of the samplers assembled on the roof of the Federal Building are shown in Figure 1. This view looks southeast toward downtown Charleston, WV.

* Community Health and Environmental Surveillance Studies

The lower part of Fig. 1 includes a sketch of each sampler type. A number is used to identify each sampler or group of samplers, while a capital letter is attached to only some of the samplers. This letter identification denotes those samplers reporting results which were intercompared and is useful in distinguishing between duplicate or triplicate samplers brought by the same participant. Sampler A is located approximately 9 meters from the eastern corner of the building while sample U is about 9 meters from the southern corner of the Federal Building. All of the samplers were located on a line approximately 1.5 meters from the southeast face of the building. All around the edge of the roof the side of the building continues upward 0.4 meter above the roof level.

Table 3 lists all of the samplers or groups assembled on the roof according to the numerical order shown on the sketch in Fig. 1. The last two columns list the sampler inlet height to the nearest centimeter, and the approximate spacing between sampler inlets. Inlet heights varied from a low of about 0.9 meters to a high of 1.75 meters. (This excludes the SO₂ sampler inlets at 2.4 m. Its results were not part of the intercomparison study).

Table 4 lists the more important operating characteristics for those samplers whose reported results were intercompared. The alphabetical identification of the various samplers is used throughout this report both in the graphical presentations and in the tabular intercomparisons. There are several important points to be noted in this table. First, an examination of the column listing the fine cut points reveals that they vary between 2.5 and 4.3 micrometers. The first two stages of Sampler G, the Sierra Multiday Sampler, were added together before comparing its results with other samplers. Similarly, the column listing the inlet cutoff also shows a range of large particle sizes accepted by each sampler. These variations in cut-point sizes must be kept in mind when examining the results of the fine and coarse particulate fractions. The column listing the frequency of filter changes shows that for some samplers, two to four sub-period totals had to be added together to obtain the desired 12-hour pollutant concentrations. Florida State University employs an analytical technique which is capable of analyzing their linear streaker filters to within ± 30 minutes.

The filter substrates used in the automated dichotomous samplers - C, L, and S - were changed automatically every 6 hours. These samplers also employed a flow control mechanism which shut the samplers down in the event the flow rate dropped below a prescribed tolerance. On several occasions at night the particulate loading was sufficiently heavy to cause shut down very near the end of the first 6 hour period. In these instances the following 6 hours of data were not obtained.

TABLE 2. SAMPLER TYPES BROUGHT TO THE STUDY

a) <u>Type of Sampler</u>		<u>Participant Inst.</u>	<u># Units at study</u>	<u>Results reported for</u>
Diffusion Battery Sampler	Tanner	BNL	1	(b)
High Volume Sampler:	Tanner	BNL	1	1
High Volume Samplers:	Rodes	EPA	2	1 ^{c)}
High Volume Sampler:	Burton	EPA	1	1
Champ (with size cuts)	Burton	EPA	2	2
Dichotomous Samplers - ERC.	Rodes	EPA	2	1 ^{c)}
Dichotomous Samplers - Manual	Dzubay	EPA	2	2
Dichotomous Samplers - Automated	Loo	LBL	4	3 ^{d)}
Linear Streaker	Hudson	FSU	4	2 ^{e)}
Batelle Impactors	Hudson	FSU	4	(e)
Tandem Filter Units	Dzubay	EPA	2	2
Stacked Filter Units	Cahill	UCD	2	2 ^{f)}
Sierra Multiday	Cahill	UCD	1	1
Cyclone (1 w & 1 w/o size cut)	Mueller	ERT	2	2
Two Mass	Delumyea	WU	4	1
Sulfur dioxide experiment	Loo	LBL	4	(g)

a) See Appendix A for a detailed description of each sampler type.

b) Results were reported but were not intercompared, and are not included in the tables of Appendix C.

c) Data were taken with both samplers for only half of the study.

d) The fourth sampler was included in case spare parts were needed for the other three.

e) All four operated throughout the study. Results available from FSU.

f) A third total filter unit was operated throughout the study with no sizing. Only one filter change was made after four days, hence its results could not be intercompared.

g) These samplers were not part of the intercomparison study.

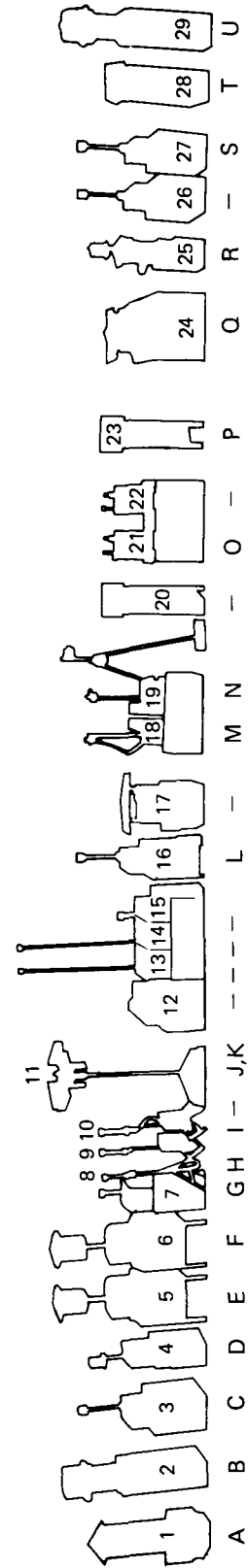


Figure 1. A photograph of the 39 different samplers assembled on the roof of the Federal Building by 9 invited participants. The profile sketch provides a key to sampler identification. The sampler numbering is from Table 3 and the alphabetical coding from Table 4.

TABLE 3. SAMPLER TYPES, INLET HEIGHTS AND SPACINGS

<u>Sampler Type</u>	<u>Investigator</u>	<u>Inlet Height(cm)</u>	<u>Spacing(cm)</u>
1. ^{a)} Hi-Vol and Diffusion	(Tanner-BNL)	135 & 114	86
2. Champ + Size Fractionator	(Burton-EPA)	160	91
3. Auto Dichotomous	(Loo-LBL)	160	69
4. Manual Dichotomous	(Dzubay-EPA)	132	81
5. Cyclone-total	(Muller-ERT)	175	71
6. Cyclone-fine	(Muller-ERT)	175	71
7. Sierra Multiday	(Cahill-UCD)	140	20
8. Total Filter Unit-1 stage	(Cahill-UCD)	137	30
9. Stacked Filter Unit-2 stages	(Cahill-UCD)	140	28
10. Stacked Filter Unit-3 stages	(Cahill-UCD)	140	~ 81
11. 4-Batelle Impactors 6 stages	(Hudson-FSU)	165	140
4-Linear Streakers	(Hudson-FSU)	185	
12. Sulfur Dioxide Analyzer	(Loo-LBL)	114	~ 0
13. ERC Sampler, w/o MgO	(Loo-LBL)	238	36
14. ERC Sampler, w MgO	(Loo-LBL)	238	36
15. ERC Sampler w/o MgO	(Loo-LBL)	107	76
16. Auto Dichotomous	(Loo-LBL)	160	71
17. 2-Two Mass Samplers	(Delumyea-WU)	89	84
18. Stacked Filter Unit	(Dzubay-EPA)	157	56
19. Stacked Filter Unit	(Dzubay-EPA)	157	124
20. Hi-Vol	(Rodes-EPA)	112	74
21. ERC Virtual Impactor	(Rodes-EPA)	124	56
22. ERC Virtual Impactor	(Rodes-EPA)	124	89
23. Hi-Vol	(Rodes-EPA)	112	132
24. Two Mass + Beta Gauge	(Delumyea-WU)	114	91
25. Manual Dichotomous	(Dzubay-EPA)	132	71
26. Auto Dichotomous	(not working)	157	58
27. Auto Dichotomous	(Loo-LBL)	157	79
28. Hi-Vol	(Burton-EPA)	112	64
29. Champ + Size Fractionator	(Burton-EPA)	157	

^{a)} These numbers are used in Figure 1 to identify the sampler groups.

TABLE 4. SAMPLER TYPE VS. OPERATING CHARACTERISTICS & POLLUTANTS REPORTED

Sampler Type	Investigator and Lab	Fine Cut ^{a)} Points μm	Inlet ^{a)} Cutoff μm	Flow ^{a)} Rate (ℓ/m)	Filter ^{a)} Change (hrs)	Pollutants Reported				
						M a s s	N O 3	S O 4	su fur a	L e e l e m e n t s
A Hi-Vol	Tanner BNL	-	large	700	12		N	S		
B Champ										
+ Size Cut	Burton EPA	3.5	~ 26	1130	12	M	N	S		
C Auto Dicho- tomous	Loo LBL	2.4	~ 25	50	6	M			s	L te
D Manual										
Dichotomous	Dzubay EPA	3.5	14	14	12	M		S	s	L te
E ERT - Total	Mueller ERT	-	~ 15	100	3	M	N	S		
F ERT - Fine	Mueller ERT	2.5	-	100	3	M	N	S		
G Sierra		0.78								
Multiday	Cahill UCD	4.3	< 20	24	12				s	L te
H Total Filter										
1 stage	Cahill UCD	-	< 20	24	12				s	L te
I Stacked Filter										
2 stages	Cahill UCD	2.6	< 20	5	12				s	L te
J Linear Streaker	Hudson FSU	-	~ 15	0.35	continuous				s	L te
K Linear Streaker	Hudson FSU	-	~ 15	0.50	continuous				s	L te
L Auto Dicho- tomous	Loo LBL	2.4	~ 25	50	6	M			s	L te
M Tandem Filter	Dzubay EPA	3.5	c)	7.2	12				s	L te
N Tandem Filter	Dzubay EPA	3.5	c)	5.9	12				s	L te
O ERC Dichotomous	Rodes EPA	3.5	~ 20	14	12	M		S		L
P Hi-Vol	Rodes EPA	-	large	1415	12	M		S		
Q Two-Mass	Delumyea WU	3.5	c)	16.7	3	M			s	
R Manual										
Dichotomous	Dzubay EPA	3.5	14	14	12	M	N	S	s	L te
S Auto Dicho- tomous	Loo EPA	2.4	~ 25	50	6	M			s	L te
T Hi-Vol	Burton EPA	-	large	1130	12	M	N	S		
U Champ										
+ Size Cut	Burton EPA	3.5	~ 26	1130	12	M	N	S		

a) See Appendix A for a more detailed discussion of these sampler types and their operating characteristics.

b) Trace element means that silicon, calcium, titanium, iron, copper, zinc, bromine, and selenium were usually reported when they could be detected.

c) Not measured

SECTION 2

CONCLUSIONS

An intercomparison study was carried out to evaluate the performance of 11 different designs of aerosol samplers. The devices tested include hi-vol, TWO MASS, cyclone, CHAMP, streaker, stacked filter, and manual and automated dichotomous samplers. The samplers were operated simultaneously on the roof of the Federal Building in Charleston, West Virginia for eight consecutive days during May of 1977. The collection surfaces of each sampler were changed at least every 12 hours which enabled the intercomparison to be made for 16 sampling periods. The collected samples were returned to the laboratory of each participant and analyzed for mass, nitrate, sulfur or sulfate, lead, and 8 other elements.

Most of the samplers separated the aerosol into two fractions with 50 percent separation diameters ranging from 2.4 μm to 4.3 μm . The upper 50 percent cutoff diameter for the various samplers ranged from 14 μm to above 30 μm . Results were intercompared for the total, fine and coarse size fractions. Elements found most abundantly in the fine fraction included S, Zn, Cu, Br, and Pb; elements found most abundantly in the coarse fraction included Si, Ca, Ti, and Fe. The total mass was equally distributed between both size fractions.

Best agreements among samplers was found for elements that occurred primarily in the fine fraction. For lead the standard deviation of the results from all of the samplers were 17% and 11% for the total and fine fractions respectively. The standard deviations for sulfur were 15% and 11% for the total and fine fractions respectively. In computing the standard deviation for sulfur, the results associated with the TWO MASS sampler were excluded. For that sampler the results were lower than the mean by a factor of about 3.

The amount of total mass collected appeared to be strongly influenced by the upper 50 percent cutoff diameter of each sampler. The amounts of Si, Ca, Ti, and Fe collected in the coarse fraction were similarly affected by the inlet. The hi-vol sampler, which had the largest upper cutoff diameter, collected about 50% more mass than the manual dichotomous sampler, which had the lowest upper diameter (14 μm).

For the stacked filter samplers and the tandem filter samplers, the fine fraction was enriched in crustal elements such as Si, Ca, and Fe. This indicates that there are particle bounce errors for such samplers.

Of all the samplers reporting results the automatic dichotomous sampler

showed the greatest precision for the fine fraction species. Three automated dichotomous samplers when compared pairwise yielded an average agreement of 1.8%, 1.8% and 3.3% for sulfur, lead, and mass in the fine fraction, respectively. For the total fraction, the agreement between pairs averaged 2%, 3%, 7% and 12% for sulfur, lead, mass and iron, respectively.

In the intercomparison study, total sulfur was measured by x-ray fluorescence, and sulfate was measured by ion chromatography and by wet chemical methods. The mean sulfur and sulfate concentrations were in agreement with the assumption that all of the sulfur is in the form of sulfate. The nitrate results showed the greatest differences among samplers, and no simple explanation for the differences was found.

SECTION 3

RECOMMENDATIONS

This sampler intercomparison study was the first side-by-side field test of a large number of representative state-of-the-art aerosol samplers. It was successful in that it demonstrated for those samplers brought to the study that particulate mass and selected pollutant concentrations can be determined with reasonable accuracy. In fact, for lead, sulfur, and zinc concentrations in the fine fraction, all reported results were within 10% of a mean value. On the other hand nitrate concentrations were not well determined in this study for reasons that remain unclear at this time.

Among those who participated in this study, it was unanimous that the field study was well worthwhile, and it was a general consensus that a similar study should be held again at some future date. With such a future study as a possibility and based on the experiences gained in the present study a number of recommendations can be advanced which may help insure that any future study will be even more successful.

The flow rate of all samples at any future study should be checked periodically (e.g., at least twice a day). More importantly all flow rates ought to be cross-checked with a single flow rate meter so that all sampler flow rates at the study are tied relatively to a single calibration device.

All samplers brought to a future study should have nearly the same inlet restrictions and preferably axially symmetric inlets. Similarly, the cut point used to define the fine particle fraction for all samplers at such a study should be very nearly the same.

Samplers used to evaluate the possibility of any inhomogeneity in the sampled air should be run side-by-side both prior to and following the study for periods approximately 1/4 the duration of the study (i.e., two days before and two days after in an 8-day study).

One or more separate studies should be held soon and devoted to a determination of those factors that influence the determination of nitrate concentrations.

Following completion of the study, analytical technique quality control samples should be mailed to all participants and all participants required to report concentrations in ng/cm^3 for at least three selected pollutants. The method of appealing to independent referee analysts for quality control was successful in this study.

All samplers deployed at any future study should guarantee that they do not exhaust any pollutant which can bias another samplers results. This may require additional filtration of the exhausts of some samplers.

The spacing between samplers at any future study should average 1 meter.

All participants should be required to field and report results for at least duplicate samplers. Also, no samplers should be allowed to take up space or electrical power which do not report results.

As was the case in this study, some form of security is desirable to prevent access to the samplers by the general public.

Multi-redundant fusing of the electrical power was well worth the planning and additional investment required. A number of samplers at this study blew fuses at various times, but none was responsible for the shut down of any other sampler.

Although no rain fell during this study, any future study should plan for this eventuality.

SECTION 4

FIELD STUDY CONDITIONS

AIR HOMOGENITY SAMPLERS AND QUALITY CONTROL SAMPLES

The aerosol samplers were assembled on the roof of the five story Federal Building in Charleston, WV along the southeast face of the building. Since the objective of the field study was to intercompare the pollutant concentrations obtained by samplers that were not located at the same point, it was necessary to test the possibility that the air sampled might not be homogeneous. Interaction between wind and the roof penthouse structures might create non-uniform wind streams. To monitor this possibility, three Lawrence Berkeley Laboratory (LBL) designed automated dichotomous samplers were operated near both ends and near the middle of the linear array of samplers. A detailed discussion of the results is presented in Section 6.

In general duplicate samplers brought by a single participant were not set up side by side. However, an attempt was made to "pair-up" samplers which were similar in operating or design principle. Two samplers might be operated side by side, but were brought to the study by different participants. Some types of samplers were more effectively operated in clusters.

In planning the study it was recognized that the concentrations reported by the various participants would be different. How much of any reported differences are due to sampler performances and how much to the different analytical methods used to analyze the samples, should be resolved if possible. The method chosen to resolve these two for this study was based, in part, on the fact that most of the participants would report trace element concentrations determined from an x-ray emission technique. The method chosen was as follows.

From one of the automated dichotomous samplers operated at the field study, a set of fine particulate fraction samples were selected. This set was analyzed by two referee analysts who were not participants in the study. Both referee analysts used energy dispersive x-ray fluorescence analysis to determine the trace element concentrations in ng/cm^2 of filter area. They sent their results to the study director and from the combined data, concentration values in ng/cm^2 were adopted for each trace element and sample in the set. Then, 3 samples were selected from the set and mailed to each of 8 participants (24 samples-total). X-ray fluorescence analysis carried out before and after extremely vigorous shake tests on the entire set of samples demonstrated that no particle losses would occur as a result of mailing. Each participant then determined selected trace element concentrations in ng/cm^2 for his three samples and reported these results to the study director. Their

results were compared with the adopted values from the referee analysts. Agreement between the two would suggest that the analytical method was not a source of any reported pollutant concentration differences. Results for each participants analytical quality control samples can be found in Section 6.

FIELD STUDY PRECAUTIONS AND PROCEDURES

The roof of the Federal Building was of a standard tar and gravel construction. Since the filter substrates used in most of the samplers required changing every 12 hours, a great deal of traffic would occur on this roof surface. To reduce the potential for creating large particles, certain precautions and procedures were adopted. A plywood walkway was laid down on the roof all along and in front (NW) of the samplers. A narrow walkway leading from the roof entrance/exit to the samplers was also laid down. Almost all participant traffic on the roof used these walkways. The roof also contained 3 rest rooms vent stacks and 2 water drains in the vicinity of the samplers. The presence of H_2S gas was clearly noted from these stacks (most serious in the former), hence they were vented away from the immediate sampling area using 6.1 m lengths of flexible plastic pipe. The 3 rest room stacks were vented at the top of the 1st level penthouse (3.35 m) and the water drains were vented at roof level 4 m NW of the sampler array.

Filter substrates were changed at least every 12 hours, at 8 am and 8 pm. Each participant was responsible for the operation of his own sampler, including the changing and storage of new or used filter substrates. At other times traffic on the roof was discouraged. Except for one TV news interview, there was no public traffic on the roof throughout the study. At the end of the study each participant was responsible for the disassembly and removal of his samplers.

Electrical power for all of the samplers was distributed via 12 circuits each with an individual 20 amp circuit breaker. Each of these circuits terminated in a 4-plex electrical outlet into which were plugged one or two individually fused (at 15 amps) 6-circuit multi-outlet modules. Individual sampler power cords were plugged into one of the six circuits which were also separately fused at an appropriate current rating for the particular sampler connected. In the event one sampler drew too much current, this multi-redundant fusing isolated and protected each sampler from all others.

METEOROLOGICAL CONDITIONS

Meteorological conditions were satisfactory during the entire study; however, no rain was recorded during any of the sixteen 12-hour periods. Fig. 2 shows the hourly temperature variations recorded at the Charleston Airport located approximately two miles northeast of the Federal Building. Morning temperatures varied from a low of 3°C (37°F) on the first day of the study to 17°C (63°F) on the last day of the study, while the daytime maximum readings varied from 20°C (68°F) to 31°C (87°F). Since these data were obtained above the valley floor, actual temperatures atop the Federal Building may have been several degrees higher.

The relative humidity as recorded hourly at the Charleston Airport

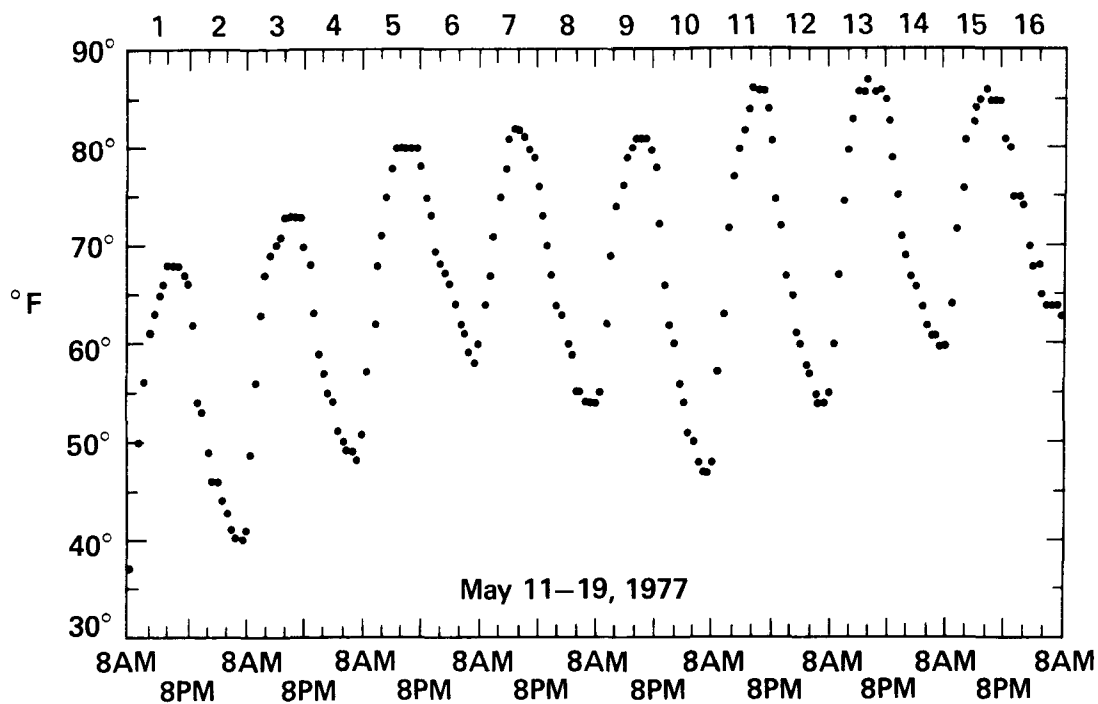


Figure 2. Hourly temperatures recorded at the U.S. Weather Station, Charleston Metropolitan Airport, throughout the intercomparison study.

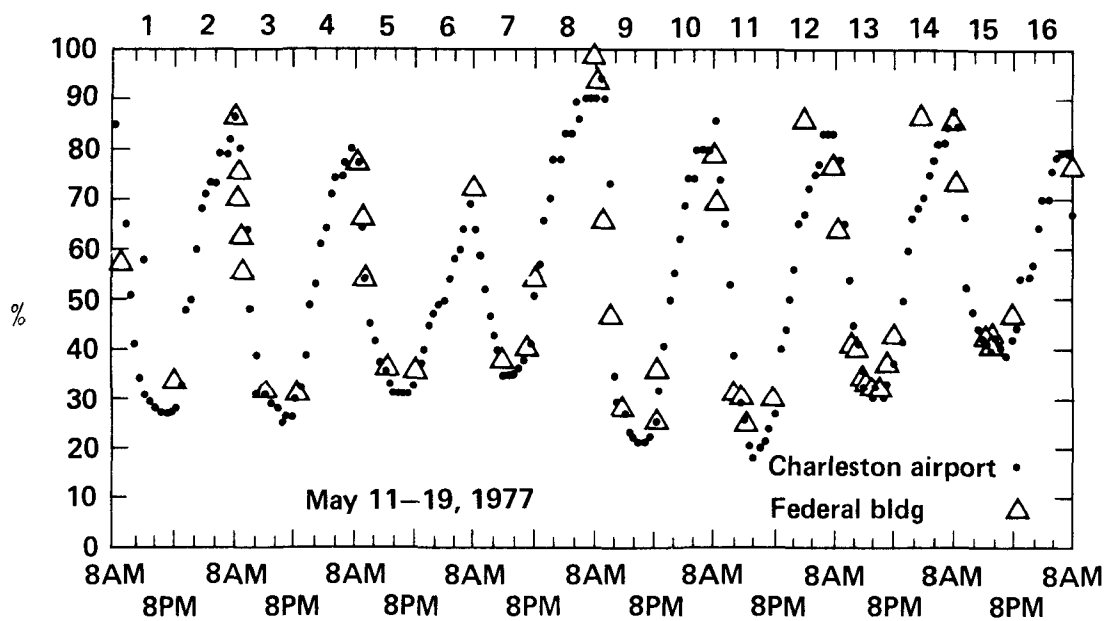


Figure 3. The relative humidity recorded hourly at the U.S. Weather Station, Charleston Airport, and occasionally on the roof of the Federal Building, downtown Charleston.

varied from 18 to 91%, while that recorded intermittently atop the Federal Building showed variations from 24 to 98%. Even though these ranges are different, it appears that the daily cycle of minimum humidity near 4 pm and maximum near 8 am are sufficiently well represented by the hourly Airport data. These data can be used to evaluate any humidity induced chemical effects that may have occurred in the filter substrates. The hourly readings are shown in Fig. 3.

The wind speed and direction (as recorded by an anemometer, wind vane, and strip chart recorders atop the Federal Building) showed a diurnal pattern. The daytime wind direction averaged about $300^{\circ} \pm 45^{\circ}$, while the nighttime wind direction was $120^{\circ} \pm 15^{\circ}$. During four of the study periods (2,4,14,16) the winds came nearly directly into the southeast face of the building. After the study, the wind vane strip chart recording was examined and wind directions were analyzed for every 15 minutes throughout the study. From this analysis, hourly directional averages were obtained and plotted. The results are shown in the top section of Fig. 4. Using the anemometer strip chart recording the approximate mean wind velocity sustained during each hour was estimated and also the maximum wind velocity recorded during each hour was noted. These data are plotted in the lower portion of Fig. 4. Wind rose patterns are shown in Fig. 5. The odd periods (daytime) are grouped together at the top, while the even periods (night) are grouped at the bottom. These wind rose data clearly show the diurnal wind pattern typical of the Kanawha Valley in the spring.

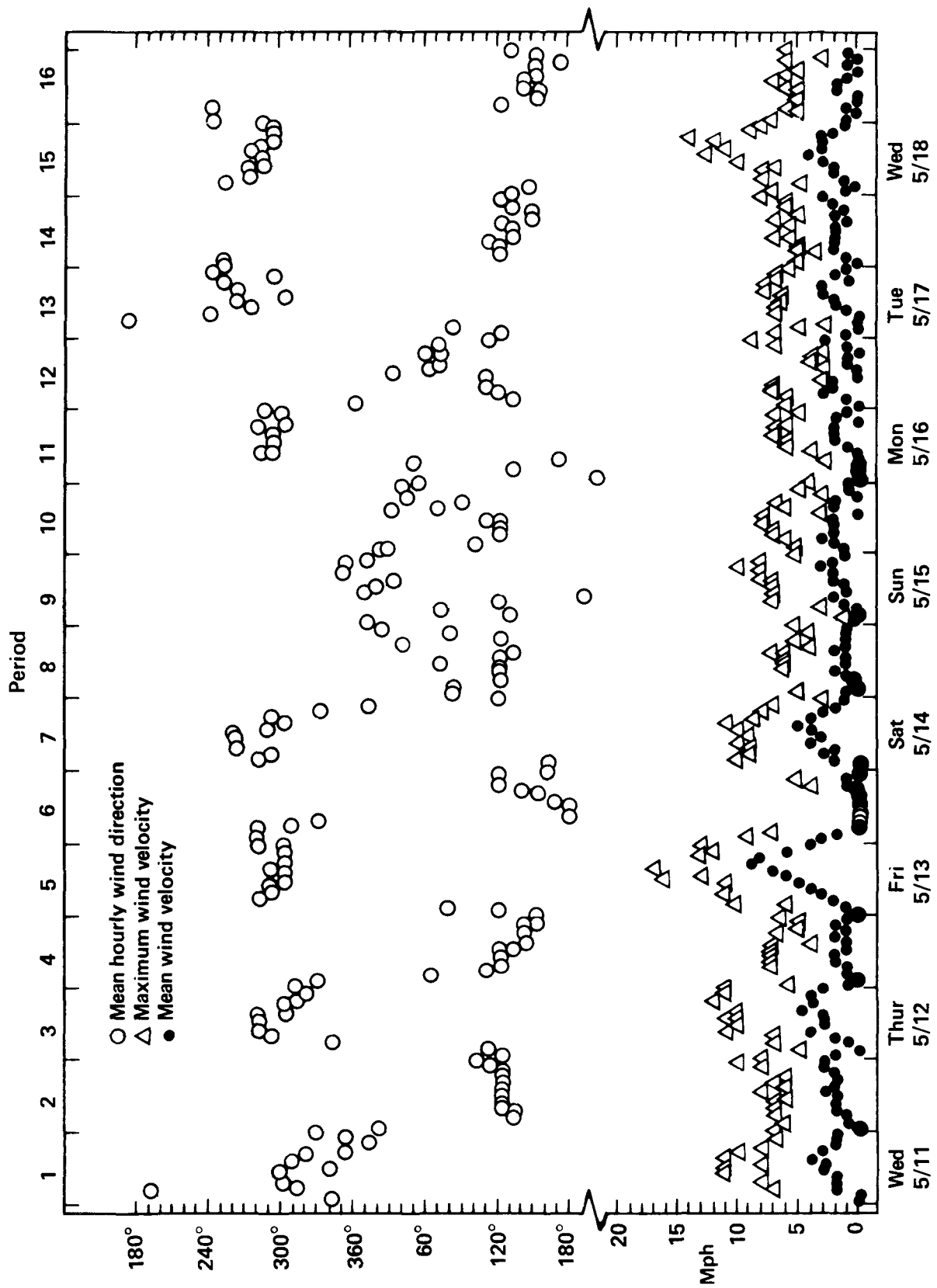
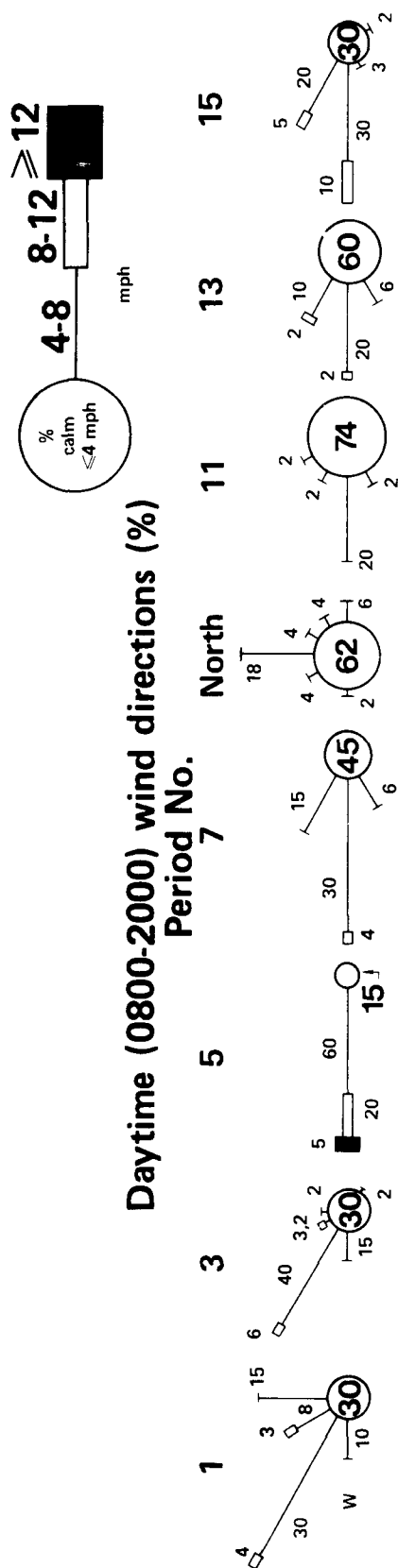
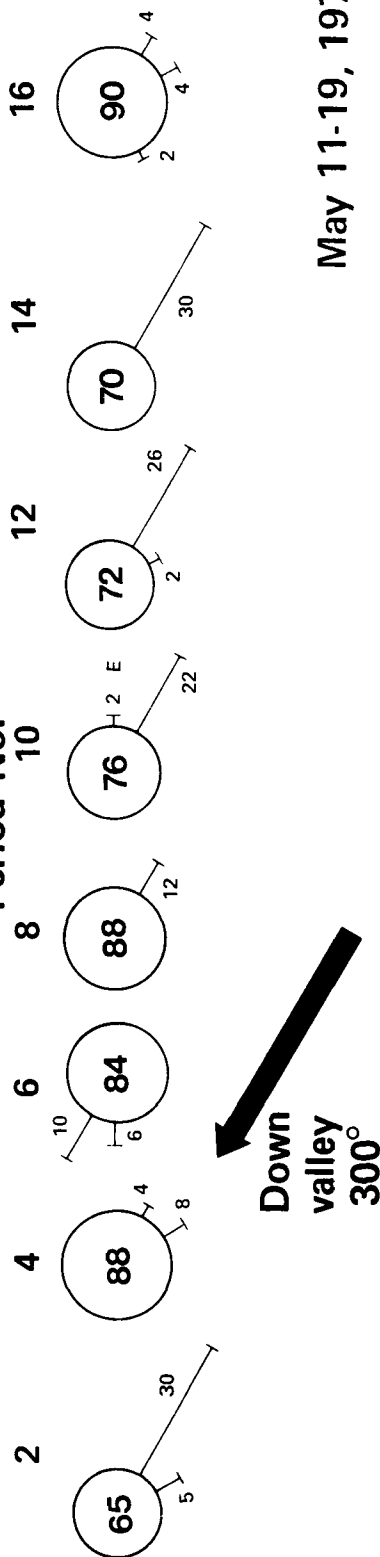


Figure 4. The mean hourly wind direction and velocity, and the maximum hourly wind velocity recorded atop the Federal Building during the sampler intercomparison study.



Nighttime (2000-0800) wind directions (%)

Period No. 8



May 11-19, 1977

Figure 5. The wind speed and direction results recorded atop the Federal Building shown as wind roses.

SECTION 5

MATHEMATICAL TREATMENT OF RESULTS

CALCULATION OF A MEAN CONCENTRATION

Table 4 listed 21 samplers that reported pollutant concentrations which could be intercompared. Concentrations were reported in micrograms per cubic meter for the mass fractions, and in nanograms per cubic meter for all other pollutants. Since no sampler brought to the study was to be regarded as the standard of comparison, the reported pollutant concentrations from all samplers were assigned equal weights. Thus, a mean concentration can be calculated for each of the 16 periods, for the 13 different pollutants, and for the total, fine, and coarse particulate fractions. Only one participant reported results for coarse nitrate, while thirteen participants reported total lead concentrations.

Since all samplers were accorded equal weight, the calculation of a mean concentration can be regarded as a "composite sampler" concentration. However, there are three effects which can bias the calculated mean concentrations.

First, any sampler can potentially malfunction with the result that less than 16 concentrations values are reported. The remaining values may or may not distort the composite sampler concentration and a priori there is no way to judge which samplers should be included or excluded. Another reason for unreported results might be that the pollutant could not be detected because of poor analytical sensitivity or insufficient amounts collected. Thus, not-detected is not synonymous with zero concentration.

Second, in any large data set there always exists the possibility of outliers. These values may appear "bad" because of sampling errors, analytical technique calibration errors, sampler malfunction, or errors in transcribing results. Also an actual measured value may be quite reasonable, but is identified as an outlier by any statistical tests, because all other values reported happen to be nearly identical. Thus, statistical tests for outlying values should not be applied indiscriminately, but can be used to identify unusual values in very large data sets.

Third, in calculating a composite concentration, the mean value may be biased by duplicate or triplicate samplers if the reported concentrations from these additional samplers all lie to one side of the mean. Thus, mean concentrations can be calculated from all samplers reporting results, or from only one sampler of each type. The influence of these three factors (1) fewer than 16 periods of results reported, (2) outlying values, and (3) multi-sampler

bias must be considered in calculating a mean. After defining the equations from which the mean composite concentration is derived, each of the three factors will be discussed.

The mean concentration for any period can be calculated from the simple expression

$$Z_j = \frac{1}{n} \sum_{i=1}^n C_{ij} \quad , \quad (1)$$

where C_{ij} is the concentration reported by the i^{th} sampler for the j^{th} period, n is the number of sampler result sets used, and j is the period number ($j = 1, 2, \dots, 16$). The standard deviation associated with Z_j is calculated from

$$S_{Zj} = \left[\frac{1}{n-1} \left(\sum_{i=1}^n C_{ij}^2 - n Z_j^2 \right) \right]^{\frac{1}{2}} \quad (2)$$

There will be 16 Z-mean concentrations for the 39 pollutant size fractions reported (13 pollutants x 3 size fractions).

Fewer Than 8 Results

Because of a number of reasons including sampler malfunction, non-detectable pollutant concentrations, and others, some participants reported fewer than the total of 16 periods expected. Since there is no way to decide a priori which results are "bad" or "good" or for what reasons, the decision was arbitrarily made to eliminate from the mean concentration calculation any result set containing fewer than 8 of the 16 period results for any given pollutant size fraction. Applying this criterion, there were only 4 result sets eliminated out of 139 reported for the total particulate fractions, 4 out of 111 for the small fraction, and 5 out of 100 for the large fraction. Seven of these were because of low to non-detectable pollutant concentrations, leaving only 6 of 350 (< 2%) result sets rejected because of fewer than 8 periods reported.

Outliers

Almost always in large data sets, values can be found which fall well outside the expected statistical spread in the mean. For whatever reasons these values appear "bad", two major decisions are required. First, should a statistical test for outliers be applied and if so which one? Second, if outliers are found, should they be eliminated from the mean indiscriminately, or should some subjective judgement be employed? This is not simply rhetoric since the definition of an outlying value depends on the breadth of the distribution deemed acceptable. If the probability for rejecting an observation is made sufficiently small enough, all values can be made to be acceptable.

Two different statistical tests were used to identify outliers. One is the well-known Dixon criterion (4); and the second, the Grubbs-criterion as developed by Tietjen and Moore (5) for the detection of multiple outliers. The latter is a multi-pass or cyclical test in which means are calculated,

outliers identified, the mean value recomputed, additional outliers sought, and etc. The number of cycles and the statistical breath to the mean distribution depend on the number of observations. Application of this statistical test resulted in many values being identified as "outliers" - too many it seemed. Although it appears to be a very sophisticated test, the number of observation sets (result sets) obtained in this study was too few for most of the pollutant species reported. The Dixon criterion when used in the single pass mode is much more conservative, i.e., fewer outliers identified. The Dixon criterion was used with α arbitrarily set equal to 4%. This is the probability assumed in rejecting an observation that really belongs in the group. Any values falling more than 2% high or 2% low will be rejected. The equations which define the Dixon criterion as applied to this study's results can be found in Appendix B.

The Dixon criterion was applied to all result sets submitted. Immediately, punch card errors and recording errors were spotted. Several participants submitted results for the wrong pollutant, or results in ng/cm^2 instead of ng/m^3 . These were quickly identified by the outlier criteria. Another participant had 9 of 16 results identified as outliers. Since only 7 of the 16 periods results remained, their results were eliminated from the mean composite calculation. This was the only data set eliminated by the outlier test.

Table 5 lists all those sampler-period results which were identified as outliers by the Dixon criterion. Most of these outlying values can be understood or explained. For example, the selenium concentrations lie near the threshold of detectability, hence wide fluctuations are expected. The zinc values occasionally clustered very tightly, allowing even a reasonable value to appear as an outlier. The copper excursions were due to local sources (copper from pump motors), and the excursions observed in certain crustal elements were probably real. The outlying small nitrate values also could be explained (see Section 6). In effect, then, except for the Q-sampler's small sulfur results, which were generally low by a factor of 3, all of the outliers identified were allowed to remain in the calculation of the mean.

Multiple Sampler Bias

There is a potential problem due to some participants having duplicate samplers and others having only a single sampler. If one or more sets of duplicate samplers lie well to one side of a calculated mean, the mean would be biased. To examine this possibility an alternative mean concentration can be calculated by averaging results from only one sampler of each type. Clearly, the latter mean is defined by a sub-set of the samplers defining the former mean. Statistically, one expects the difference between these two means to show a positive or negative bias if the additional duplicate samplers are high or low. Since the number of samplers contributing to the the subset mean is less than or equal to the full set, the standard deviation in the subset mean is usually greater. Defining the full set of sampler means as Z and the subset sampler means as X , the quantities $(Z-X)$ and $(S_X - S_Z)$ can be calculated and compared.

Table 6 shows the results of 592 mean comparisons. Almost as many mean pollutant concentrations decreased as increased when the duplicate samplers

were eliminated. As expected S_x is on the average, larger than S_z . Therefore, there is no strong evidence that including duplicate and triplicate sampler results biases the composite Z-means. In general, samplers N and R were lower than the composite mean by about the same amount that samplers C and S were higher, hence these four samplers offset each other and reduced the influence of other duplicate samplers.

TABLE 5. OUTLIERS ACCORDING TO DIXON CRITERION ($\alpha = 4\%$)

Total	Sampler-Period	Small	Sampler-Period	Large	Sampler-Period
SO ₄	P-13 a)	NO ₃	F-3,5,8,14	Mass	O-8,10 a)
S	K-7 b)	S	Q-4-7,9,12-15 c)	Ti	J-15 d)
Si	J-9 d)	Si	I-9,12 d)	Fe	N-8
Fe	N-8	Ti	M-12;I-8,12	Cu	D-2,9 e)
Cu	D-9 e)	Zn	N-8; S-3	Zn	R-13
Zn	N-8	Se	M-9,11,16; N-8 f)	Se	M-2 f)
Se	M-2,9,11,14 f)				
Pb	J-9; K-9 b)				

a) EPA (Rodes) Hi-Vol Sampler. Reason for high value unknown.

b) FSU Linear Streaker. Apparently an artifact of the averaging process.

c) These data were low because of an unresolved analytical error.

d) Crustal elements. Incorrect subtraction of blank values.

e) Occasional high values of copper due to local sources, see Section 6.

f) Because selenium concentrations were at the threshold of detectability, these values cannot be considered outliers.

RATIO TO MEANS

Once a composite mean has been defined for each pollutant specie and sampling period, it is very useful to normalize all reported concentrations to these composite sampler mean concentrations. This results in a table in which all of the entries are near 1.0. This has numerous advantages. Among them are

- (1) Deviations from the mean are more easily observed and can be quickly converted to approximate percentage differences.
- (2) Average ratios for all 16-periods for each sampler can be calculated independent of day to day changes in concentrations. A relative measure of a sampler's overall accuracy (how far from 1.0 which is equivalent to the mean concentration) is shown by this average; and

an indication of a sampler's precision may be shown by the standard deviation in the 16-period average ratio.

- (3) Appropriate graphs of these average ratios vs samplers reporting allow sampler to sampler comparisons.
- (4) Multiple graphs of the type described in (3) allow pollutant to pollutant comparisons independent of their actual aerosol concentration differences (which may be orders of magnitude).

These advantages will become evident upon a detailed examination of the results presented in Section 6.

TABLE 6. MEAN CONCENTRATION CHANGES VS NUMBER OF SAMPLERS AVERAGED

Quantity	Change			Totals ^{b)}
	+	0 ^{a)}	-	
(Z-X)	263	77	252	592
(S _x - S _z)	344	59	189	592

- a) No change is defined as less than a 1% change in the Z-mean or standard deviation, S_z, compared to the X-mean or S_x.
- b) A total of 624 period-pollutant-means can be calculated (16 pds x 13 pollutants x 3 size fractions). Since only one sampler reported results for large NO₃ and one sampler remained in the X-group for large sulfate, only 592 comparisons were made.

REGRESSION ANALYSIS

Regression analyses were performed between the results from every pair of samplers, and between each sampler and the composite Z-mean. If a linear mathematical relationship is assumed to exist between two variables (sampler concentrations), then we can write

$$y = a + bx \quad , \quad (3)$$

where y is the dependent variable, and x is the independent variable (the Z-mean, for example). Since in this study both x and y are pollutant concentrations in $\mu\text{g}/\text{m}^3$ or ng/m^3 , the intercept, a, will also be in these units. Standard equations exist for calculating e_a , the error in a. Similarly, the slope, b, and its error, e_b , can also be calculated. The equations for these calculations are given in Appendix B. The extent to which artifacts exist between any two pairs of samplers, will be indicated by the extent to which $a \pm e_a$ does not overlap 0, and any consistent bias between any two samplers by the extent to which $b \pm e_b$ does not overlap 1.0. A measure of one samplers precision relative to another is given by $100 e_b/b$ in percent. Another

form of this precision is given by the root mean square deviation concentration of the y-sampler from the regression fit $y = a + bx$. It is useful to see this value for all samplers compared to the composite sampler. Finally, it is useful to examine the extent to which the variables y and x are correlated. This is revealed by the correlation coefficient. In this study all samplers attempted to measure the same pollutant concentration, hence their correlation with the composite mean will usually be near 1.0. However, whenever sampler malfunctions occurred and/or few results were reported, the reported results will correlate poorly with the composite mean. The equations used to calculate all of these quantities are given in Appendix B.

SAMPLER RESULT TABLES

The complete set of results from the study is given in Appendix C. Concentration values were reported for 13 different pollutant species in 3 size fractions, the total, the small or fine, and the large or coarse particulate fraction (39 Tables). The sulfur concentration results were multiplied by 3 and combined with the sulfate results to give 3 additional tables. Figure 6 illustrates a portion of one of the 42 tables (small sulfur).

The top most grouping lists the reported concentrations in appropriate units as a function of period (1 through 16) of the study. The alphabetical sampler identification letter is that of Table 4. A dash means no value reported and a concentration value preceded by a minus sign indicates an outlier value according to the Dixon Criterion ($\alpha = 4\%$). The composite sampler concentration or Z-mean is listed next along with its standard deviation. Any sampler excluded is noted parenthetically, and as discussed above, all outlier values are included in the Z-mean (except for sampler Q, small sulfur). The X-mean and its standard deviation exclude selected duplicate samplers. Those included in this calculation are shown in parentheses.

The next grouping lists all sampler concentrations normalized to the composite Z-mean concentrations. Most of these entries generally lie near 1.0. To the far right, the 16 period average ratio, its standard deviation, and the coefficient of variation (percent error) are shown. An asterisk preceding any tabular values indicates that the participants reported error for that period allows his value to overlap the Z-mean (1.0). If a participant's value deviates far from 1.0 yet still has an asterisk, this indicates a rather large error; while values close to 1.0 without asterisks may suggest a small error. Below this grouping appears the mean ratios which by definition are always 1.0. However, its standard deviation reflects how tightly clustered all of the reported results are as a function of period. Note that the 16-period average standard deviation multiplied by the average pollutant concentration yields the error given to the far right of the top most grouping.

The lower grouping tabulates results of the regression analysis of each sampler vs the composite sampler (Z-mean). The quantities listed left to right are the intercept and its error in either μg or ng/m^3 , the slope and its error, the root mean square deviation in concentration units, and the correlation coefficient.

Appendix C of this report contains only the regression analysis results

INTERCOMPARISON STUDY C														PERIODS 1-16, MAY 11-18 1977.									
RESULTS				PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD	
D	EPA	DZUBAY	MDS-A		4562	2668	3737	2943	5142	4336	7912	-	8951	-	D								
M	EPA	DZUBAY	TF-M		5009	3572	3894	4182	6018	4695	7586	9298	8606	8687	M								
N	EPA	DZUBAY	TF-P		4951	3170	3443	3684	5521	4525	7764	-	8612	-	N								
R	EPA	DZUBAY	MDS-S		4297	3040	3707	3373	5741	4683	7362	-	9234	-	R								
C	LBL	LOO	DICOT		5336	-	-	4123	6572	5571	8475	9532	10125	9019	C								
L	LBL	LOO	DICOT		5308	3518	4309	3945	6430	5468	8617	9851	9998	8969	L								
S	LBL	LOO	DICOT		5244	3693	4274	-	6448	514	-	9577	10146	9094	S								
G	UCD	CAHILL	SMDAY		4310	2500	2940	3800	5570	74	-	-	-	-	G								
I	UCD	CAHILL	SFU		3769	2693	3491	3481	7557	724	3	6950	9314	7375	I								
Q	STL	DEL/ED	2MASS		1900	1210	1270	-970	-1430	-1154	-2090	-1390	-1920	3130	Q								
Z MEAN(WITHOUT Q)					4754	3107	3724	3691	6157	7650	7809	9514	9131	8320							5869	626	
STANDARD DEVIATION					548	458	451	416	670	603	591	226	959	1399									
X MEAN(D,M,L,G,I)					4592	2990	3674	3670	6225	7851	744	5	9488	8733									
STANDARD DEVIATION					601	512	507	479	829	423	451	315	1081	1735									
RATIO TO Z				PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD	CV
D	EPA	DZUBAY	MDS-A		*0.96	0.86	*1.00	0.80	0.90	-	*0.97	0	-	*0.98	-	D					0.92	0.08	9
M	EPA	DZUBAY	TF-M		*1.05	1.15	*1.05	1.13	*0.98	*1.03	*1.01	18	0.94	*1.04	M						1.02	0.06	6
N	EPA	DZUBAY	TF-P		*1.04	*1.02	0.92	*1.00	0.90	0.88	*0.98	0.9	-	0.94	-	N					0.95	0.05	5
R	EPA	DZUBAY	MDS-S		0.90	*0.98	*1.00	0.91	0.93	0.91	*0.96	0.91	*1.01	-	R						0.94	0.03	4
C	LBL	LOO	DICOT		1.12	-	-	1.12	*1.07	*1.08	*1.08	-	*1.11	*1.08	C						1.09	0.03	3
L	LBL	LOO	DICOT		1.12	1.13	1.16	*1.07	*1.04	*1.08	*1.08	-	*1.10	*1.08	L						1.09	0.03	3
S	LBL	LOO	DICOT		*1.10	1.19	1.15	-	*1.05	*1.03	*1.07	-	*1.11	*1.09	S						1.09	0.05	5
G	UCD	CAHILL	SMDAY		*0.91	0.81	0.79	*1.03	*0.90	*1.04	*0.92	1.31	*0.91	-	G						0.94	0.15	16
I	UCD	CAHILL	SFU		0.79	0.87	*0.94	*0.94	1.23	*0.95	*0.95	*1.11	*1.0	1	I						0.95	0.13	14
Q	STL	DEL/ED	2MASS		0.40	0.39	0.34	0.26	0.23	0.15	0.16	0.14	0.23	0.38	Q						0.29	0.14	47
MEAN(WITHOUT Q)					1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00							1.00		
STANDARD DEVIATION					0.12	0.15	0.12	0.11	0.11	0.08	0.06	0.22	0.08	0	0.17						0.11		
REGRESSION VS Z				INTERCEPT	ERROR				SLOPE		ERROR		RMS.DEV.		COR.COEF								
D	EPA	DZUBAY	MDS-A		-219.166	396.721				0.963		0.070		530.327		0.972							
M	EPA	DZUBAY	TF-M		387.016	195.029				0.944		0.031		284.104		0.993							
N	EPA	DZUBAY	TF-P		62.634	207.518				0.934		0.036		281.747		0.991							
R	EPA	DZUBAY	MDS-S		-95.827	167.455				0.962		0.029		227.354		0.995							
C	LBL	LOO	DICOT		266.537	189.194				1.040		0.029		240.356		0.996							
L	LBL	LOO	DICOT		195.124	114.091				1.051		0.018		166.201		0.998							
S	LBL	LOO	DICOT		325.002	196.595				1.023		0.031		270.438		0.995							
G	UCD	CAHILL	SMDAY		-1002.408	731.934				1.170		0.139		880.238		0.942							
I	UCD	CAHILL	SFU		449.415	610.244				0.866		0.097		890.555		0.923							
Q	STL	DEL/ED	2MASS		0.	0.				0.		0.		0.		0.							

Figure 6. A portion of one of the tables listing results for the pollutant small sulfur. Complete results for all pollutants can be found in Appendix C. See text for an explanation of the entries.

of each sampler with the composite sampler. Regression analysis results on all pairs of samplers are available from the study director, the EPA project officers, or any of the participants.

SECTION 6

SELECTED RESULTS AND DISCUSSION

PRECAUTIONS IN INTERPRETING RESULTS

The objective of the study was to evaluate sampler performance by inter-comparing the reported concentrations of selected pollutant species as measured by the samplers. The measured concentrations contain many factors which influence their magnitude. Before presenting the results, it is worthwhile examining some factors that can influence the concentration values obtained.

In Section 1, Table 4, the various sampler performance parameters were presented. Among the more prominent differences were sampler flow rates, inlet designs, particle size cut-points, and collection substrates. Those samplers which had cylindrically symmetric inlet designs should be insensitive to wind direction, but not necessarily wind speed. Samplers with such inlets will accept particles up to some limiting aerodynamic size. Others which do not have cylindrically symmetric inlets will be wind direction dependent. In comparing total pollutant specie concentrations, the maximum size particles accepted may influence the final concentrations obtained.

Some of the samplers brought to the study separated the incoming air particles into two or more size fractions. In comparing results from these samplers, the particle size distribution will influence the results obtained. A sampler having a fine particle cut-point of 2.5 micrometers cannot obtain the same concentration as one having a 3.5 micrometer cut-point, all other factors being equal. In comparing results for large particle sulfur, for example, a sampler having a cut-point of 2.5 micrometers may record significantly more large particle sulfur than one having a cutpoint of 4.3 micrometers particularly if very little sulfur is associated with particles having diameters greater than 3.0 micrometers. Also some filter substrate materials, particularly fiberglass, will allow the formation of stable SO_4 ions from SO_2 gas which passes through them. This adds some mass and causes an artificial increase in the SO_4 concentration.

Another important factor is the analytical technique, its sensitivity, accuracy, and precision. Supposedly all analytical techniques used are calibrated as carefully as possible. But different calibrations can result even for identical instruments if two different "standards" are used. Thus, even analytical technique calibrations can lead to differences as large as 5%, and possibly 10% depending on the technique.

Clearly, sampler flow rates, cut-points, and analytical techniques can lead to differences in reported concentrations. Other important parameters

that may cause differences are the extent of particle bounce-off from sampler walls, sticky vs non-sticky substrates, different methods employed in the initial calibration of a sampler flow rate and cut points, different methods of monitoring sampler flow rates at the field study, screened or unscreened inlets, and possible inhomogeneity in the air actually sampled. These are just a few of the sampler parameters which can lead to differences in the final results. Some of the differences may be explained and removed, other parameters will be unknown and the differences they cause in the results not removable. Therefore, the reader is urged to consider very carefully those factors which can contribute to observed differences, before drawing conclusions about a samplers relatively "good" or "bad" performance.

POLLUTANT CONCENTRATION VS PERIOD

Pollutant concentrations were reported for each 12 hour period in $\mu\text{g}/\text{m}^3$ for all mass fractions and in ng/m^3 for all other pollutants. Table 7 lists the 16 period pollutant concentration averages and standard deviations for all thirteen species measured. For the total fraction, maximum and minimum values and their standard deviations observed during the 16 periods are also given. For the small and large fractions, only the 16-period averages and standard deviations are tabulated. The sum of the latter two averages is not always equivalent to the total average because some sampler types measured the total fraction, but not either sub-fraction. An inspection of the results shows that large particulate crustal elements have the largest standard deviations. On the other hand, those elements typically found in the small particulate fraction are somewhat better measured even though their absolute concentration is less.

Not all of the various pollutant species measured behaved in the same manner throughout the study. Figure 7 shows several selected pollutant species composite sampler concentrations (the Z-means) as a function of half day periods for the total and small fractions. The error bars shown represent standard deviations. The slightly displaced squares indicate the small or fine fraction ($< 3.0 \pm 0.5 \mu\text{m}$) Z-mean concentrations. From Table 4 it was clear that there was a wide range in particle sizes selected by the sampler inlets (as well as the fine particle cut-points), hence part of the spread in the standard deviations is due to variable size particles accepted by the different sampler inlet designs and cutpoints. The standard deviations in the crustal elements, silicon, calcium, titanium, and iron, show the greatest variation; mass shows somewhat less variation. Pollutants typically concentrated in the fine fraction show the smallest standard deviations.

Throughout Figure 7 the odd periods represent daytime collections (0800 - 2000 hrs) while the even periods represent nighttime collections (2000 - 0800 hrs). Except for sulfur the lowest pollutant concentrations were recorded during period 9. Note that the silicon and iron concentrations track each other closely, and mass behaves similarly to the crustals, but is not identical. The zinc concentrations were approximately constant except for two large excursions during periods 2 and 4. Lead concentrations peaked Friday and Saturday nights, periods 6 and 8. Sulfur slowly increases as the study progressed except for the 24 hour dip beginning Sunday at 0800. Visibility was good during the beginning of the study, but deteriorated steadily ending in

TABLE 7. 16-PERIOD POLLUTANT CONCENTRATION AVERAGES FROM ALL
SAMPLERS REPORTING RESULTS FOR MAY 11-19, 1977

Pollutant	Total Fraction		Small Fraction	Large Fraction
	Avg	Max & Min Values Recorded	Avg	Avg
Mass ₃ g/m ³	104 ± 18*	146 ± 23 47 ± 6	55 ± 13	43 ± 15
Nitrate ₃ ng/m ³	1880 ± 1000	2860 ± 2400 860 ± 450	1020 ± 760	1090 ± 500
Sulfate ₃ ng/m ³	19350 ± 3000	30600 ± 3800 6420 ± 2360	18200 ± 3000	930 ± 400
Sulfur ₃ ng/m ³	6640 ± 1000	10800 ± 970 1935 ± 400	5870 ± 630	574 ± 240
Silicon ₃ ng/m ³	9950 ± 3650	17600 ± 7200 4000 ± 2100	1140 ± 520	7680 ± 3300
Calcium ₃ ng/m ³	2500 ± 900	4200 ± 1500 730 ± 350	300 ± 160	2230 ± 1000
Titanium ₃ ng/m ³	250 ± 90	400 ± 100 88 ± 46	44 ± 29	210 ± 100
Iron ₃ ng/m ³	1750 ± 500	2400 ± 670 730 ± 240	350 ± 150	1400 ± 600
Copper ₃ ng/m ³	88 ± 40	400 ± 70 24 ± 12	80 ± 30	17 ± 9
Zinc ₃ ng/m ³	116 ± 22	283 ± 41 62 ± 14	76 ± 13	40 ± 13
Selenium ₃ ng/m ³	10 ± 3	27 ± 4 3 ± 1	9 ± 3	1 ± 1
Bromine ₃ ng/m ³	236 ± 59	489 ± 126 65 ± 19	190 ± 48	64 ± 23
Lead ₃ ng/m ³	1070 ± 180	1660 ± 260 326 ± 93	820 ± 90	220 ± 90

* Standard deviations

an air stagnation alert (throughout the southeastern mountain states) that began 36 hours before the end of the study.

Typically, the small mass fraction constituted about half of the total mass collected; while small silicon and iron constitute only 11 and 20% of their totals, respectively. About 80% of the sulfur and lead are found in the small fraction, while zinc is almost equally distributed 60/40% in the small/large fraction. All of the results from which these plots were made can be found in the complete tabulation of the total, small and large fraction results in Appendix C.

AIR HOMOGENEITY

As mentioned in Section 1 all samplers were arranged in a linear array 1.5 meters from the southeast face of the building. Sampler A was located about 9 meters southwest of the eastern corner of the roof, and sampler U about 9 meters from the southern corner of the building. Two CHAMP samplers, B and U, were duplicates and collected both large and small fractions; samplers C, L and S were the automated dichotomous samplers (ADS); and samplers D and R were the manual dichotomous samplers (MDS). Note that samplers B, C, and D were adjacent while R, S, and U were nearly adjacent. The former group was toward the eastern end; the latter group toward the southern end. Sampler L was located nearly centrally. The three automated dichotomous samplers C, L, and S were brought to the study and used to evaluate the homogeneity of the air sampled on the roof (see Section 4, page 13).

One method of evaluating any possible inhomogeneity in the air sampled is to ratio concentration results from pairs of duplicate samplers. This can be done for selected pollutant species, say mass and the crustal elements in one group, and man-made elements in a second group. Table 8 lists the ratio of pollutant concentrations as obtained from 4 pairs of samplers for three size fractions and two pollutant groups. Ratios obtained from the two ADS pairs for the crustals pollutants in the total and large fraction suggest that about 20% more crustals are collected at the south end relative to the east end. However, the MDS and CHAMP sampler pairs do not observe this dispersion. For the small particulate fraction in either pollutant group there is no dispersion. The MDS samplers suggest a reverse dispersion for the fine particle crustal elements at the east end. For pollutant group B (anthropogenic trace elements) there really is no strong evidence for any south to east dispersion. In retrospect it would have been useful to have operated the ADS samplers side by side before or after the study to verify that they would yield identical results. However, such tests were not carried out.

Results obtained for wind velocity and direction, which were monitored atop the Federal Building, indicated a strong diurnal wind pattern. Winds were predominantly from $300^\circ \pm 45^\circ$ during the day, while at night they were from $120^\circ \pm 15^\circ$. If the south to east dispersion were caused by the roof penthouses one might expect it to disappear or reverse as the winds changed directions from night to day. Ratios similar to those in Table 8 were obtained for the same pairs of samplers, only grouped according to odd and even periods, and mean values obtained. There was no significant statistical evidence for any diurnal variation of the dispersion. That is, the ADS sampler

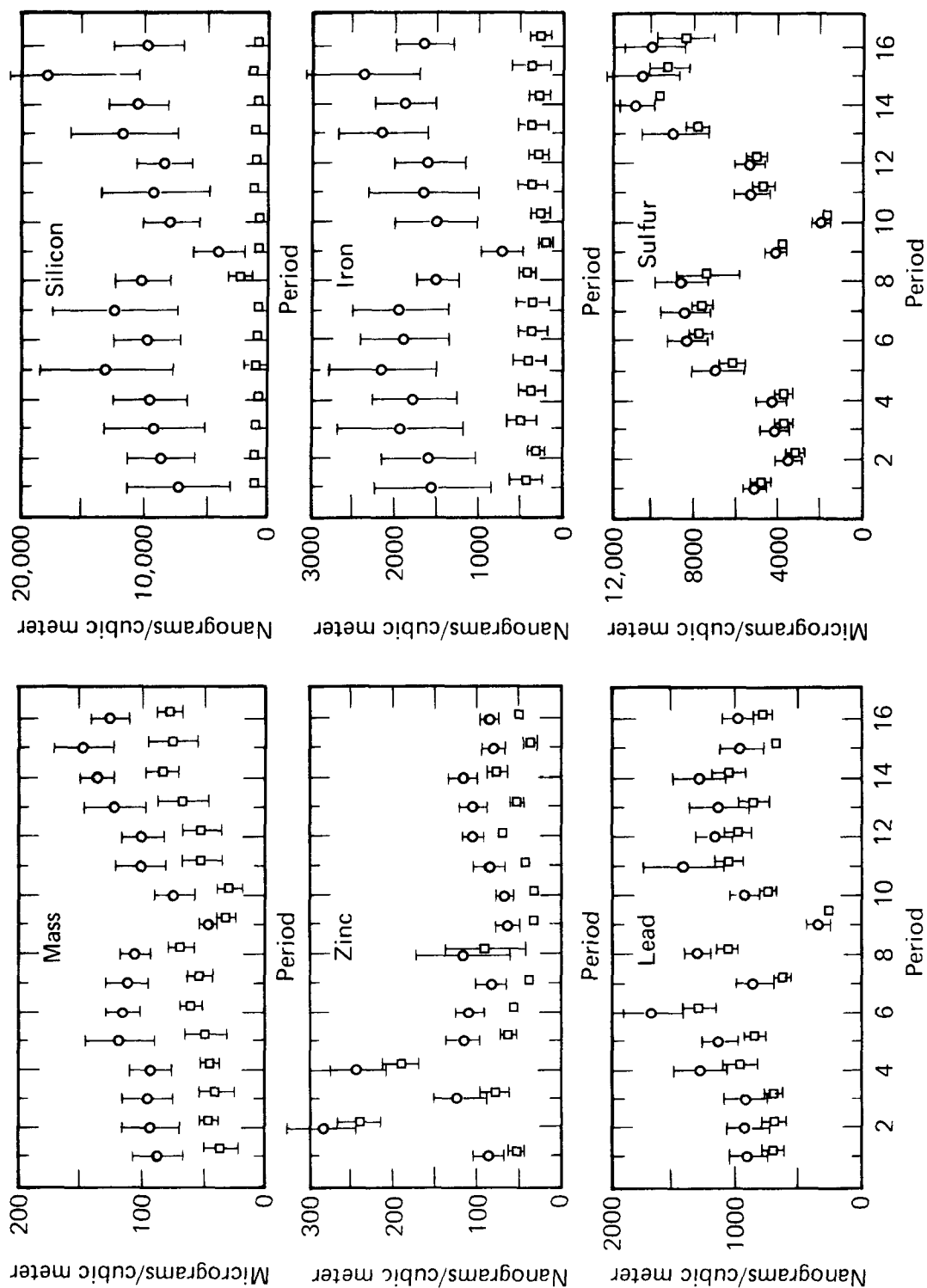


Figure 7. Sixteen 12-hour mean concentrations of all samplers reporting results for total (circles) and small (boxes) particle size fractions for the pollutants mass, Si, Zn, Fe, Pb, and S.

showed the south to east dispersion consistently for pollutant group A, total and large fractions, night or day; while the MDS did not. The observed dispersion, then, appears to be independent of any micrometeorological wind streams associated with the penthouses or roof.

TABLE 8. POSSIBLE SOUTH TO EAST DISPERSION IN THE AIR SAMPLED

Pollutant Group		Sampler Identification and Ratios			
		S/C ADS	S/L ADS	R/D MDS	U/B CHAMP
Total	A	1.19 \pm .05 ^{b)}	1.08 \pm .02	0.99 \pm .05	0.98 ^{c)}
Fraction	B	1.06 \pm .05	1.04 \pm .05	0.97 \pm .12	
Large	A	1.22 \pm .01	1.08 \pm .02	1.04 \pm .05	1.05 ^{c)}
Fraction	B	1.10 \pm .08	1.02 \pm .08	0.97 \pm .09 ^{d)}	
Small	A	1.00 \pm .05	0.98 \pm .04	0.74 \pm .06 ^{e)}	0.96 ^{c)}
Fraction	B	1.03 \pm .05	1.04 \pm .06	0.98 \pm .08	

a) Pollutant Group A contains mass, silicon, calcium, titanium, iron, i.e., the crustal elements. Pollutant Group B contains the anthropogenic elements sulfur, zinc, bromine, and lead.

b) Standard deviation.

c) Only mass was determined by the CHAMP samplers.

d) Excludes the large zinc fraction ratio (0.73).

e) Excludes the small mass ratio (1.04).

ANALYTICAL TECHNIQUE QUALITY CONTROL SAMPLES

From one of the automated dichotomous samplers operated by LBL, a set of 30 fine fraction samples was selected. These samples were analyzed by two referee analysts (Robert Giauque of LBL and Norman Bonner of LLL) for Ca, Ti, Fe, Cu, Zn, Se, Br, and Pb. Silicon was not determined because of significant particle size corrections that must be applied for the soft silicon x-ray. Agreement between the results from the two referee analysts was good. Regression analyses were performed on the two sets of data and the results are tabulated in Table 9. In two past intercomparison studies (6,7) in which these two referee analysts have participated the LLL values were also observed to be 5% or so lower than the LBL values. Thus, for this study adopted concentration results were used which were essentially mean values of the reported referee results.

TABLE 9. REGRESSION ANALYSIS FITS OF REFEREE ANALYSTS RESULTS

Element	LLL = (B ± ϵ_b)LBL + (A ± ϵ_A)		No. Values LLL/LBL
Ca	0.915 ± 0.071	66.2 ± 25.9	30/30
Ti	0.933 ± 0.114	8.2 ± 7.7	29/23
Fe	1.003 ± 0.026	-12.0 ± 15.0	30/30
Cu	0.986 ± 0.012	-4.6 ± 4.9	29/30
Zn	0.937 ± 0.007	9.2 ± 2.1	30/30
Se	0.887 ± 0.018	1.2 ± 0.7	28/28
Br	1.063 ± 0.020	-6.3 ± 9.2	30/30
Pb	0.935 ± 0.014	8.9 ± 36.2	30/30
Mean Slope	0.957 ± 0.056		

Sulfur was analyzed on all 30 samples by one of the participants (Loo) and on 6 samples by one of the referee analysts (Giauque). Before the sulfur measurements could be performed by the referee the six filter samples had to be cut down to 2.54 cm diameter circles. Since the sulfur analyses were performed after the samples were cut, there was a possibility that material may have been lost as a result of the cutting process in which case the sulfur data would be biased. Five of the six filter samples were analyzed for sulfur, and then reanalyzed at LLL for the 8 trace elements previously measured. The sixth sample was rendered unmeasurable in trying to cut it. Table 10 shows the results for the LLL reanalysis. Sample 80721 may have been contaminated somehow by a copper-zinc source because the values were unquestionably different afterwards. The selenium concentration on sample 80730 was very low (large error). Otherwise there is excellent agreement before and after cutting. There is evidence that the bromine concentration changed and additional evidence for its loss with time is discussed below. There was excellent agreement between Loo's 5-sulfur results and the LBL referee values, hence Loo's sulfur values were used as reference values for the remaining 24 samples.

TABLE 10. RATIO OF XRF RESULTS FOR CUT TO UNCUT FILTER SAMPLES

Cut Sample Concentrations (ng/cm ²) by XRFA									
Uncut Sample Mean Concentrations (ng/cm ²) by XRFA									
Sample Number	Ca	Ti	Fe	Cu	Zn	Se	Br	Pb	
80721	1.053 ±.167 ^{a)}	N.D.	0.959 ±.163	1.809 ±.177	1.368 ±.191	N.D.	0.814 ±.203	0.935 ±.142	
80724	0.966 ±.126	0.903 ±.169	0.897 ±.125	1.092 ±.201	0.879 ±.201	0.861 ±.150	0.819 ±.120	0.933 ±.142	
80725	1.062 ±.131	1.288 ±.264	1.125 ±.138	1.081 ±.159	1.023 ±.191	1.000 ±.264	0.912 ±.159	1.052 ±.141	
80730	1.000 ±.168	0.630 ±.226	1.126 ±.157	1.051 ±.150	1.026 ±.145	0.571 ±.566	0.945 ±.157	1.036 ±.141	
80734	0.993 ±.157	1.188 ±.223	0.943 ±.151	---	---	N.D.	---	0.896 ±.141	GRAND MEAN ±error/# samples
MEAN	1.015 ±.041	1.002 ±.297	1.010 ±.108	1.223 ±.394	1.074 ±.208	0.811 ±.219	0.873 ±.066	0.970 ±.069	1.003 ±.209/34
WITHOUT [] Entries				1.028 ±.068	0.976 ±.084	0.931 ±.098	0.979 ±.123/31		

a) Standard deviation

Eight sets of three samples each were mailed to the remaining participants. Some of the participants did not make trace element concentration measurements on their own samples, so were not required to measure them on the reference samples. The results for all elements except silicon are shown in Table 11. Except for the Washington University group these results eliminate the analytical technique as a source for any large (> 10%) differences in reported pollutant concentrations. The bromine values appear to be unstable with time and will be discussed more completely below.

TABLE 11. PARTICIPANT RESULTS FROM ANALYTICAL
TECHNIQUE QUALITY CONTROL SAMPLES

	S	Ca	Ti	Fe	Cu	Zn	Se	Br	Pb	Mean
Cahill ^{a)}	1.01	1.41 ^{b)}	1.04	1.01	0.90	1.14	0.93	0.91	0.92	0.98 ^{c)}
UCD (3)	± 0.07	± 0.26	± 0.43	± 0.06	± 0.01	± 0.05	± 0.06	± 0.05	± 0.03	± 0.08
Dzubay	0.93	0.89	1.14	0.96	1.04	0.95	0.96	0.92	0.93	0.97
EPA (3)	± 0.04	± 0.06	± 0.13	± 0.05	± 0.13	± 0.06	± 0.14	± 0.05	± 0.02	± 0.08
Loo (30) ^{d)}	0.98 ^{d)}	1.27	1.33	0.98	1.02	1.10	0.87	1.16 ^{e)}	1.03	1.08
LBL	± 0.04	± 0.13	± 0.19	± 0.05	± 0.07	± 0.06	± 0.14	± 0.06	± 0.02	± 0.15
Hudson	0.89	1.06	1.01	0.94	1.33	1.12	(f)	0.92	0.84	1.01
FSU (3)	± 0.05	± 0.16	± 0.05	± 0.04	± 0.44	± 0.20		± 0.07	± 0.05	± 0.16
Rodes	1.06	-	-	-	-	-	-	-	1.03	-
EPA (2)	± 0.16								± 0.02	
Tanner	0.84									
BNL (3)	± 0.12									
Delumyea	0.76									
WU (3)	± 0.15									

Burton (EPA) and Mueller (ERT) did not report trace element concentrations.

- a) The number of reference samples measured is given in parenthesis.
- b) The filters were temporarily exposed to a known source of calcium contamination (cement dust).
- c) Mean value calculated without including calcium.
- d) All 30 reference samples were originally from one of the automated dichotomous samplers. Only five could be compared with the referee results.
- e) These bromine values were obtained early, then divided by the referees' results which were obtained later after an apparent bromine loss. See the Bromine Loss discussion below.
- f) Selenium concentrations were too small to be accurately measured by PIXE.

AVERAGE SAMPLER RATIOS VS SAMPLER TYPE

Each sampler's 12-hour pollutant concentration was normalized to the Z-means to yield ratios near 1.0. These ratios can be averaged for all the periods to obtain an average sampler ratio for the duration of the study. For example, if the high volume sampler consistently collects more total mass than the composite sampler Z-mean, its mean ratio for the entire 16 periods would be greater than 1.0. Another sampler with a more restrictive inlet would have a ratio less than 1.0. An examination of these mean ratios can show systematic trends, illustrate consistent differences between sampler

types, and even give an indication of the accuracies and precisions for groups of samplers brought to the study by an individual participant.

Figure 8 shows results for a composite of four selected pollutant species. The 16-period average ratios are plotted as a function of sampler type. The abscissa lists the sampler identification number (see Table 4). The samplers are grouped by participants and arranged within each group in an east to south direction. The top two plots display those samplers reporting total and small mass. Some participants reported both. The two ordinary Hi-Vol samplers P and T report the highest relative mass, undoubtedly because of their ability to collect larger sized particles (unrestricted inlet size). These two samplers report 50% more total mass than the two manual dichotomous samplers, D and R. The CHAMP samplers, B and U, with inlet restrictions report 15% less mass than P and T. Sampler E, the cyclone unit, also reports relatively lower total mass. For small mass, all of the samplers excluding B and U report an average mean sampler ratio of 0.89 ± 0.03 vs 1.36 ± 0.03 for B and U, a factor of 1.56 times as much mass. This is a large difference and suggests that more than a single sampler performance parameter is responsible. Sampler O (Rodes manual dichotomous reports more variability than do samplers D or R (Dzubay manual dichotomous). Sampler O is an older model.

The middle set of plots display all of the sampler results for total silicon and iron. Note the much larger scatter in these two elements compared to total mass, the larger standard deviations, and the same patterns for groups of samplers for the two elements. Sampler H is anomalously high only for silicon, not for iron (or calcium or titanium). The systematic increase shown by samplers C, L and S - east to south is the same 20% air inhomogeneity discussed above, but it is not evidenced by the ratio of samplers R to D, or U to B (total and small mass). The two tandem filter samplers M and N also record more iron (and titanium and calcium) than silicon, relative to D and R. These two tandem filter samplers operate in a similar manner to the UCD stack filter sampler, I, but record relatively more iron than silicon.

The two lower plots display the behavior of the mean sampler ratios for total and small lead. The tight clustering of the small lead results and the generally smaller standard deviations for both is immediately apparent. Note the lack of statistically significant evidence in samplers C, L and S for the south to east air inhomogeneity. As discussed above the crustal elements exhibited such an inhomogeneity in these samplers, but the fine particles, e.g. sulfur, lead, and zinc, did not. Once again, the pattern of certain groups of samplers high, others low, is repeated. Thus, a given participant has reproducible results regardless of which kind or type of sampler he operates, but apparently there are real group to group calibration differences. For example, LBL (samplers C, L, and S) reported 10% more lead in the analytical technique control samplers (Table 11) than did EPA (Dzubay-samplers D, M, N, and R) or UCD (samplers G, H and I). If an appropriate correction is made to their small lead average ratios averages there is even better agreement in the overall results. However, how does one correct for the fact that the fine particle cut-points of samplers C, L, S, and I are about 2.5 micrometers, versus 3.5 micrometers or greater for samplers D, M, N, R and G? The former should record less small lead, not the same, unless there are yet other compensating

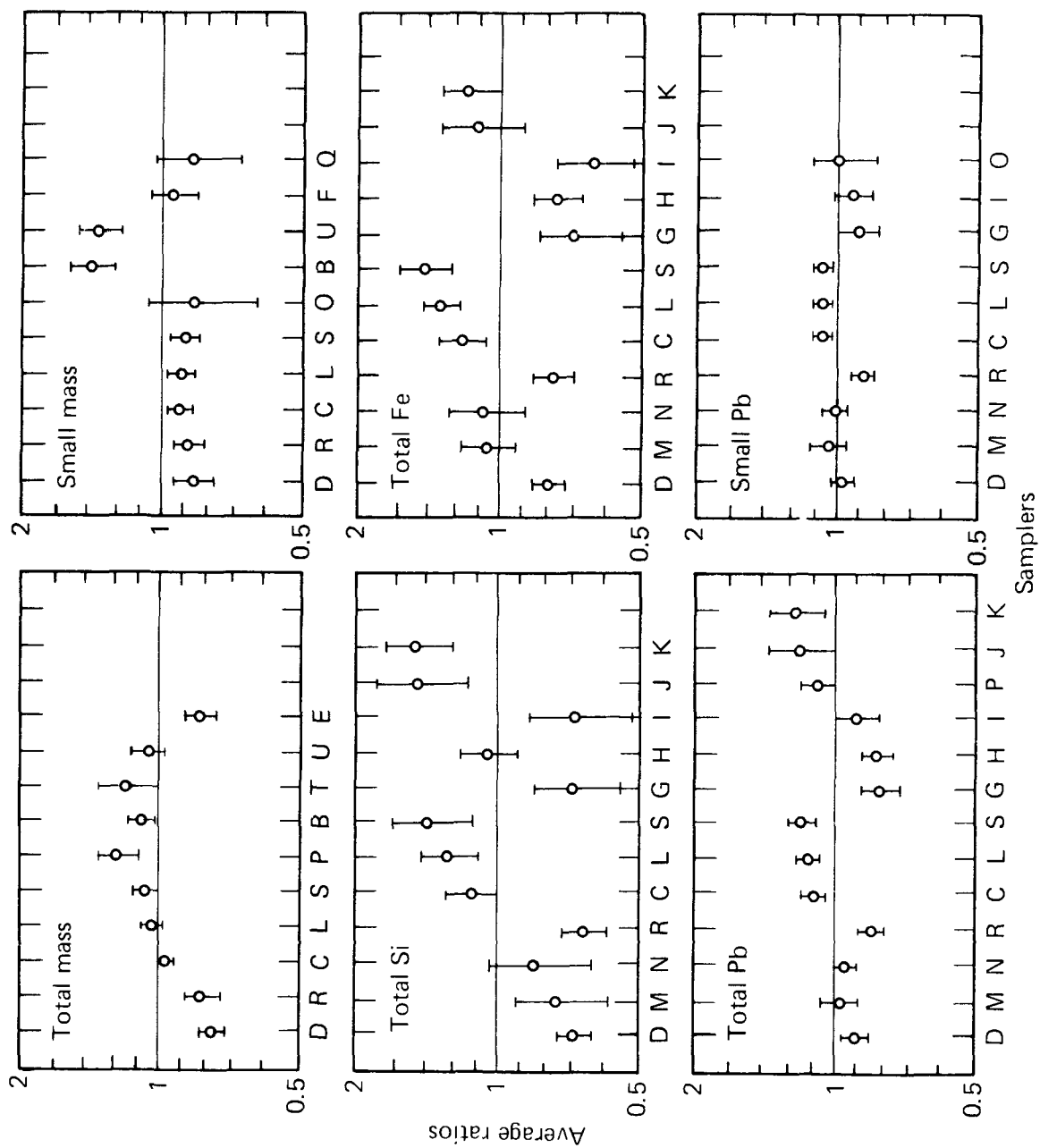


Figure 8. The average ratio vs sampler type. Each sampler reported concentration results for up to 16 periods. Each reported result was normalized to the Z-mean and averaged over the number of results reported to yield the ratios and standard deviations shown here.

factors. For total lead concentrations inlet particle size restriction differences may be invoked to explain any remaining differences. Sampler O, which operates on the same principle and has the same flow rate as D and R, is less precise. It also shows a larger variation for small mass than did D and R.

Figure 8 is an example of the kind of comparison that can be drawn for the pollutant species measured at the intercomparison study. The foregoing discussion points out some of the striking differences, and in several cases, advances possible explanations. Other comparisons of sampler average ratios will be discussed below.

PAIRWISE PRECISION OF SAMPLERS

There were 6 participants who brought two or more samplers of one type to the field study. Of these 4 reported results that could be intercompared. Since one participant brought triplicates and another, two different duplicates, 7 sets of samplers can be pairwise compared. One measure of the precision of one sampler versus another is contained in the error on the slope of the linear regression fit to the results from both samplers. Since a regression analysis was performed on all pairs of samplers, the data are available. In the expressions

$$y = a + bx \text{ or } x = c + dy \quad (4)$$

the percent error or precision, P, is given by

$$P = 100 \epsilon_b/b = 100 \epsilon_d/d \quad (5)$$

where ϵ is the error in the slope b or d. Note that, in general, $b \neq d$, nor does $\epsilon_b = \epsilon_d$, unless the correlation coefficient and both slopes are nearly exactly equal to 1.0.

Table 12 lists the precisions of the 7 pairs of samplers for selected pollutant species in the three size fractions. Of course, not all of the samplers were able to measure each of the size fractions hence the blank entries. For example, samplers J and K measured only the total fractions. The best precisions were obtained on fine sulfur and lead as was suggested by the standard deviations shown in Figs. 8 and 9. For these two pollutants, the automated dichotomous samplers obtained excellent precision or reproducibility (1.4 to 2.3%). When the good to excellent precision obtained by the manual and automated dichotomous samplers for the fine particulate fraction is compared to results for the large fraction, there is a suggestion that large particulates are not as easy or reproducible to collect. In addition, it appears that the automated dichotomous sampler, S, did not behave as uniformly as did C or L. Perhaps there are variable amounts of particle bounce off or other loss mechanisms associated with large particles in dichotomous samplers; or differences between sampler inlet designs.

Appendix C contains all of the reported results for all pollutants, participants, and periods. However, the only linear regression analysis results included are those for each sampler versus the composite sampler (Z-mean).

Detailed regression analysis results for all pairs of samplers can be obtained from the study director, one of the EPA project officers, on any of the participants.

TABLE 12. PAIRWISE INTERCOMPARISON OF SAMPLER PRECISIONS (%)

Fraction	Pollutant	Burton ^{a)} B vs U	Dzubay ^{b)} M vs N	Dzubay ^{c)} D vs R	Loo ^{d)} C vs L	Loo ^{d)} L vs S	Loo ^{d)} C vs S	Hudson ^{e)} J vs K
T O T A L	MASS	6.2		10.6	4.6	8.9	8.3	
	SULFUR		7.3	5.9	1.5	1.8	2.3	5.7
	IRON		14.3	8.2	9.0	15.6	11.8	12.6
	LEAD		5.7	5.1	1.7	2.7	2.8	11.2
S M A L L	MASS	4.8		7.0	2.5	3.4	4.1	
	SULFUR		5.0	6.1	1.5	1.9	1.9	
	LEAD		5.3	3.3	1.7	1.4	2.3	
L A R G E	MASS	15.2		18.5	8.0	13.1	11.0	
	IRON		13.1	9.3	9.2	17.8	11.8	
	ZINC		14.5		8.0	30.0	14.2	

- a) The CHAMP sampler with inlet size restrictions and one size cut.
- b) The tandem filter units; however, different substrates were used.
- c) The manual dichotomous samplers.
- d) The automated dichotomous samplers.
- e) The linear streaker samplers, one with 0.4 μ nucleopore, the other with 0.2 μ nucleopore substrate filters.

SULFUR-SULFATE COMPARISONS

Recently it has been shown (8) that sulfate concentrations can be obtained by determining the elemental sulfur concentration and multiplying by three. Figure 9 shows an intercomparison of the sulfur and sulfate concentrations as reported by the various participants. The sulfur concentrations were multiplied by three, combined with the sulfate results, and a combined Z-mean concentration determined. Then, the normalized ratios were calculated for each period, and regression analyses were performed on the combined result set. These results are included in Appendix C. The 16-period average sample

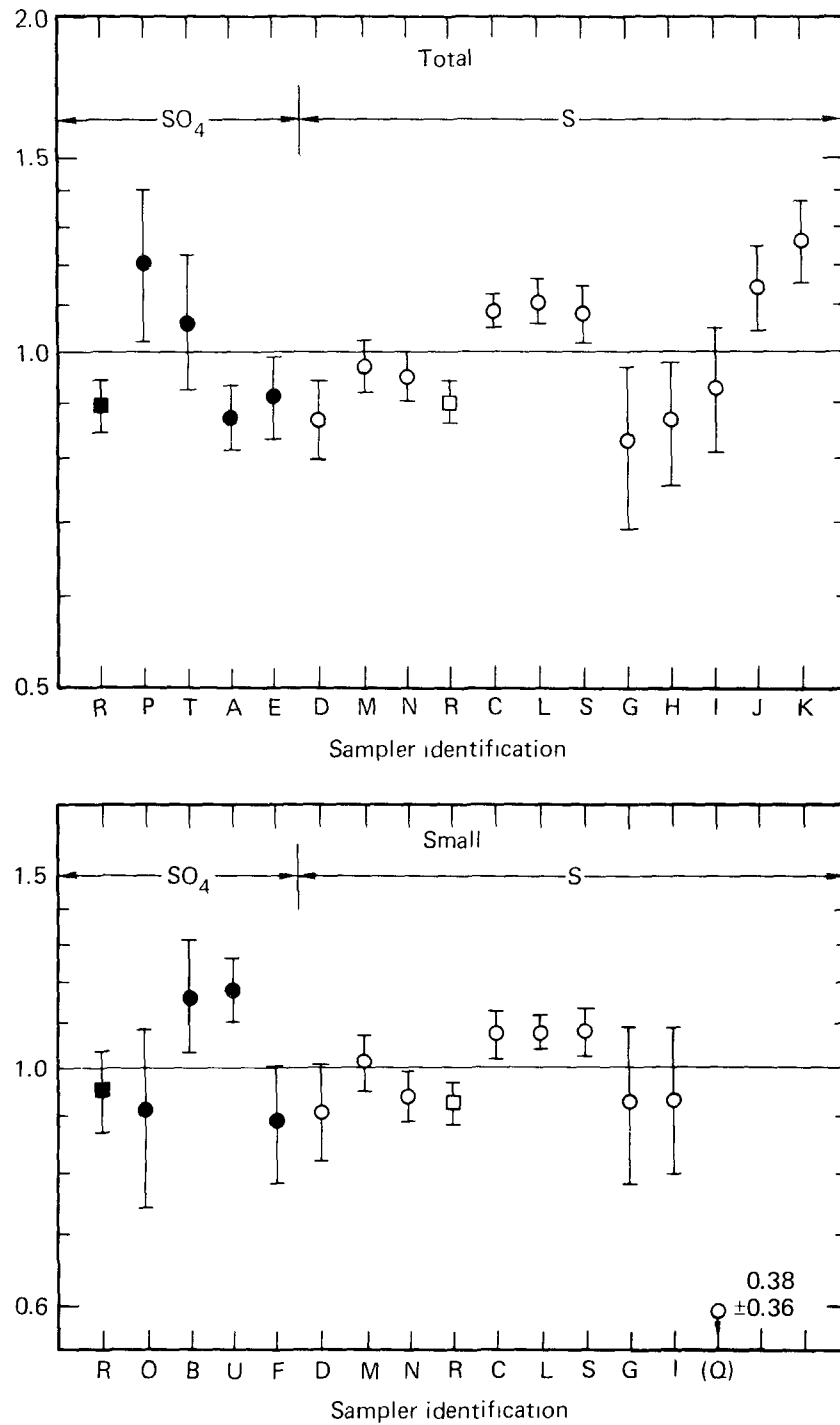


Figure 9. 16-Period average sampler ratios for sulfur and sulfate combined. It was assumed that the determined elemental sulfur concentration times 3 is equivalent to determined sulfate concentration. Only one sampler, R, reported both. Participant using sampler Q reported results which were low.

ratios are plotted vs sampler type for total and small sulfate-sulfur. Filled symbols represent sulfate, open symbols sulfur. Only one participant (Dzubay-EPA) measured both for the same sampler (R). It is assigned a square symbol versus circles for all other samplers.

Sulfur occurs predominantly in the small fraction; and comparison with the small lead results shown in Figure 8 reveals the same samplers are relatively high and low. Samplers C, L, and S suggest no south to east inhomogeneity for small sulfur. Dzubay's group (D, M, N, and R) and the UCD group (G, H, and I) report on an average 10% lower concentrations than the LBL group. However for sulfur, Table 11 indicates that there is not a 10% difference in the analytical technique quality control results for these three groups as there was for lead. Sampler G (the Sierra Multiday - UCD, fine cut point $\leq 4.3 \mu\text{m}$) reports only 5% as much sulfur as does sampler I (stacked filter unit, UCD, fine cut point $\leq 2.6 \mu\text{m}$) in the large (coarse) particles. Yet for total sulfur the former two groups are lower than the LBL values by about 18%. Therefore, from the total sulfur and lead results there appears to be at least a 10% difference between what samplers D, M, N, R, G, H, and I collect and what C, L, and S collect. Samplers J and K, the linear streakers, also report relatively more sulfur.

For the total sulfate results, the two EPA Hi-Volume samplers, P and T, are 28% higher than the average of the three remaining samplers R, A, and E. (Note that sampler A is a Hi-Volume sampler, which used phosphoric acid treated filters.) Similarly for small sulfate, the two samplers, B and U are 28% higher than the average of the three remaining samplers R, O, and F. This 28% increase in both the total and fine fraction results may be due to artifact formation (9) of SO_4 from SO_2 by the fiberglass filters used in samplers P, T, B, and U. The standard deviations in the sulfate determinations do not appear to be as good as those for total and small sulfur ($\pm 12\%$ for SO_4 vs $\pm 8\%$ for S). If the sulfate to sulfur ratio is calculated from the total and small concentration results instead of assuming it to be 3.0, the 16-period means are 3.03 ± 0.34 for total sulfate to sulfur, and 3.11 ± 0.23 for the small fraction. Thus the assumption of obtaining sulfate concentrations from elemental sulfur results multiplied by three, is supported by results obtained in this intercomparison study.

NITRATE RESULTS

An inspection of the reported results in Appendix C for total or small nitrate concentrations reveals a number of strange variations in reported concentrations. For total nitrate the sampler pairs R and T showed higher nitrate concentrations relative to themselves during the day (odd periods) than at night (even periods). The samplers A and E relative to themselves showed the opposite pattern, that is, higher nitrate concentrations at night.

Nitrate concentrations in the small fraction were measured by samplers R, B, U, and F; coarse nitrate was measured by only sampler R. Samplers E and F operate similarly except for fine particle cutpoint. No diurnal pattern similar to that recorded for the total fraction was evident for those samplers reporting small nitrate. Except for periods 1, 14, and 16, sampler R reported nitrate concentrations below their detectability limit of 50 ng/m^3 , compared

to concentrations of nearly 4000 ng/m³ reported by sampler F for periods 3 and 8.

There are two hypotheses which may explain the wide disparity of nitrate results. The results varied by a factor of 4 to 9 for total nitrate concentrations and up to two orders of magnitude for the fine fraction nitrate concentrations. Neither hypothesis invokes problems with nitrate determination after collection and extraction since all investigators determined nitrate by either a reduction-colorimetric technique or by ion chromatography. Cross-checks by both methods of the same extract from samples derived from sampler A yielded roughly equivalent results: mean (IC [NO₃⁻]/colorimetric [NO₃⁻]) = 1.03 ± 0.57.

One hypothesis is that the differences in nitrate levels reported are due to the presence of nitric acid vapor and/or NO₂ in the sampled air, which was collected with varying efficiency depending on the filter material used, and analyzed as nitrate. Based on the work of Spicer (10) on nitric acid collection efficiency one would predict total nitrate values for the reporting samplers (R, T, A, and E) which increased in the order R (Teflon) ≤ A (acid-treated quartz) < E (Teflon-coated glass) < T (glass fiber). The actual order was R < T < A < E and it is necessary to introduce other explanations for the observed nitrate concentration order.

A second explanation is that already-collected nitrate-containing particles may be impacted by acidic sulfate particles resulting in the topochemical reaction



releasing nitrate from those filter materials which, by reason of surface neutrality do not adsorb nitric acid vapor. This might explain why, for example, the total nitrate values of sampler A sometimes are close to those of sampler R (periods 7, 13; acidic sulfate present) while at other times sampler A values approximate those of sampler E (periods 4 and 6). But this hypothesis does not explain the relatively low results of sampler T. Thus, results from this study would suggest that further extensive laboratory and field studies are required before credible nitrate concentrations can be quoted for ambient aerosols.

PARTICLE BOUNCE

Recently, John et al (11) described tests on the filtration of solid particles by Nuclepore filters in which evidence for the phenomenon of particle bounce was presented for tandem or stacked filter units. The mechanism for this phenomenon is pictured as solid particles nominally in the coarse fraction rebounding from the filter surface, being re-entrained in the flow, penetrating the filter, and being collected as part of the fine fraction. By contrast liquid particles stick to the filter surface inhibiting the bounce phenomenon. Thus, the collection efficiency assumed for the coarse or fine fraction may become dependent on the physical state of the aerosol particles collected, and possibly on the substrate used.

Results were reported by two groups that used either Tandem Filters (TF) or Stacked Filter Units (SFU). These two samplers operate similarly; however, their fine cut points were different, $3.5\mu\text{m}$ for the TF and $2.6\mu\text{m}$ for the SFU. Nevertheless, some evidence for the bounce of coarse particles into the fine fraction can be found for these samplers if a comparison is drawn with other samplers having similar fine cut points. The manual dichotomous samplers had a $3.5\mu\text{m}$ fine cut point, while the automated dichotomous samplers had a $2.4\mu\text{m}$ fine cut point. By ratioing the results reported for one sampler to another for pollutants found predominantly in the fine fraction, e.g., Zn, Pb, and S; and then for those found primarily in the coarse fraction, e.g., Si, Ca, and Fe, a relative measure of bounce into the fine fraction can be obtained. Table 13 lists the ratios of 16-period averages from just the small fraction results for selected samplers. For example, samplers M and N obtained 16-period average ratios of 1.13 and 1.03 respectively for Zn (see results, page 132, Appendix C), while D and R obtained 0.99 and 0.88, respectively. Ratioing the sum of (M + N) to (D + R) yields the ratio of 1.16 shown for Zn.

TABLE 13. COARSE PARTICLE BOUNCE INTO THE FINE FRACTION

Selected Sampler Ratios of 16-Period Average Small Fraction Results									
% in Small Fraction ^{a)}	Element			Mean Fine	Element			Mean Coarse	Mean C Mean F
	Zn	Pb	S		Si	Ca	Fe		
	57	77	90		11	12	20		
M+N ^{b)} D+R	1.16	1.11	1.06	1.11 ±.05	1.45	2.53	2.10	2.03 ±.54	1.83
3(I) ^{c)} C+L+S	0.88	0.86	0.87	0.87 ±.01	2.54	1.70	1.44	1.89 ±.57	2.17
The coarse particle content in the fine fraction for the tandem or stacked filter samplers relative to the manual or automated dichotomous samplers appears to be about 2.									2.00 ±.17

a) From Table 14 (page 48).

b) M and N are the Tandem Filter Samplers (Dzubay) and D and R are the Manual Dichotomous Samplers (Dzubay). The 16-period average ratios for individual samplers and particular pollutants can be found in Appendix C.

c) I is the Stacked Filter Unit (Cahill) and C, L, and S are the Automated Dichotomous Samplers (Loo).

Column 5 in Table 13 gives the mean ratio for three of the elements characteristically found in the fine fraction, while column 9 gives the mean ratio for three elements characteristic of the crustal fraction. It appears that tandem filters M and N obtain 11% more fine pollutant concentration than D and R, the manual dichotomous samplers while the stacked filter unit obtains 13%

less than the automated dichotomous sampler. The small percentage differences for Zn, Pb, and S are not the focus of the particle bounce question. Continuing, column 9 shows that M and N record twice as much Si, Ca, and Fe as do samplers D and R, while sampler I records almost twice as much as samplers C, L, or S. Finally, if the mean coarse results are ratioed to the mean fine results (last column), any sampler bias or normalization differences are removed. The average mean ratio shown in the bottom section of Table 13 indicates that there is about twice as much coarse particle content in the fine fraction for the tandem and stacked filter units relative to the manual and automated dichotomous samplers. Once again, the very excellent agreement in pollutant concentrations obtained by all of the sampler types at the study for fine lead, sulfur, and zinc would indicate that the crustal particle increases in the fine fraction observed for the tandem and stacked filter units can be attributed to particle bounce from the coarse filter onto the fine filter.

There is also some evidence for particle bounce in another sampler that collects particles by inertial impaction. The CHAMP sampler uses a 26 μm cut-off inlet, a glass fiber filter covered impaction stage and backup filters designed to collect particles in the 0-3.5 μm and 3.5-26 μm ranges. Compared with other samplers the CHAMP sampler collected more mass in the fine fraction and relatively less mass in the coarse fraction. This is consistent with a particle bounce phenomenon that has been observed in previous field studies when dry surfaces were used as impaction plates (12). Because of the bounce problem, overestimation of the crustal materials in the fine fraction can occur depending on the sampler type, and any attempt to measure the acidity of the fine particle fraction would be compromised due to the presence of alkaline crustal elements.

LOCAL SOURCES OF COPPER

Thirty nine samplers were assembled on the roof of the Federal Building within approximately 18 meters. This is an average of one-half meter separation between samplers, much closer together than samplers would normally operate in monitoring programs. Precautions were taken to vent the exhaust of selected samplers over the edge of the roof if they were suspected of causing problems. Several participants claimed filtered exhausts. In spite of the precautions taken there appears to have been several localized sources of copper, probably from winding dust generated in several sampler pump motors.

Copper and zinc are neighboring elements in the periodic chart ($Z = 29$ and 30 , respectively) and their mean concentrations throughout the study were comparable (90 ± 40 and 120 ± 20 ng/m^3 - totals, and about 80 ng/m^3 each-small). Their respective K x-rays are not considered soft and are easy to excite via the several x-ray fluorescence analysis techniques used to obtain the concentrations from the collected particulate matter. Thus, they would appear to be excellent monitors of each other if one assumes their behavior as aerosols are similar. As has already been mentioned in the previous sections, the zinc pollutant levels were, along with sulfur and lead, among the most consistently and accurately measured. This is illustrated by the two graphs shown in the top half of Figure 10. These plots show the 16 period average ratios for total and small zinc obtained by all those samplers reporting trace elements. The standard deviations on the total fraction are

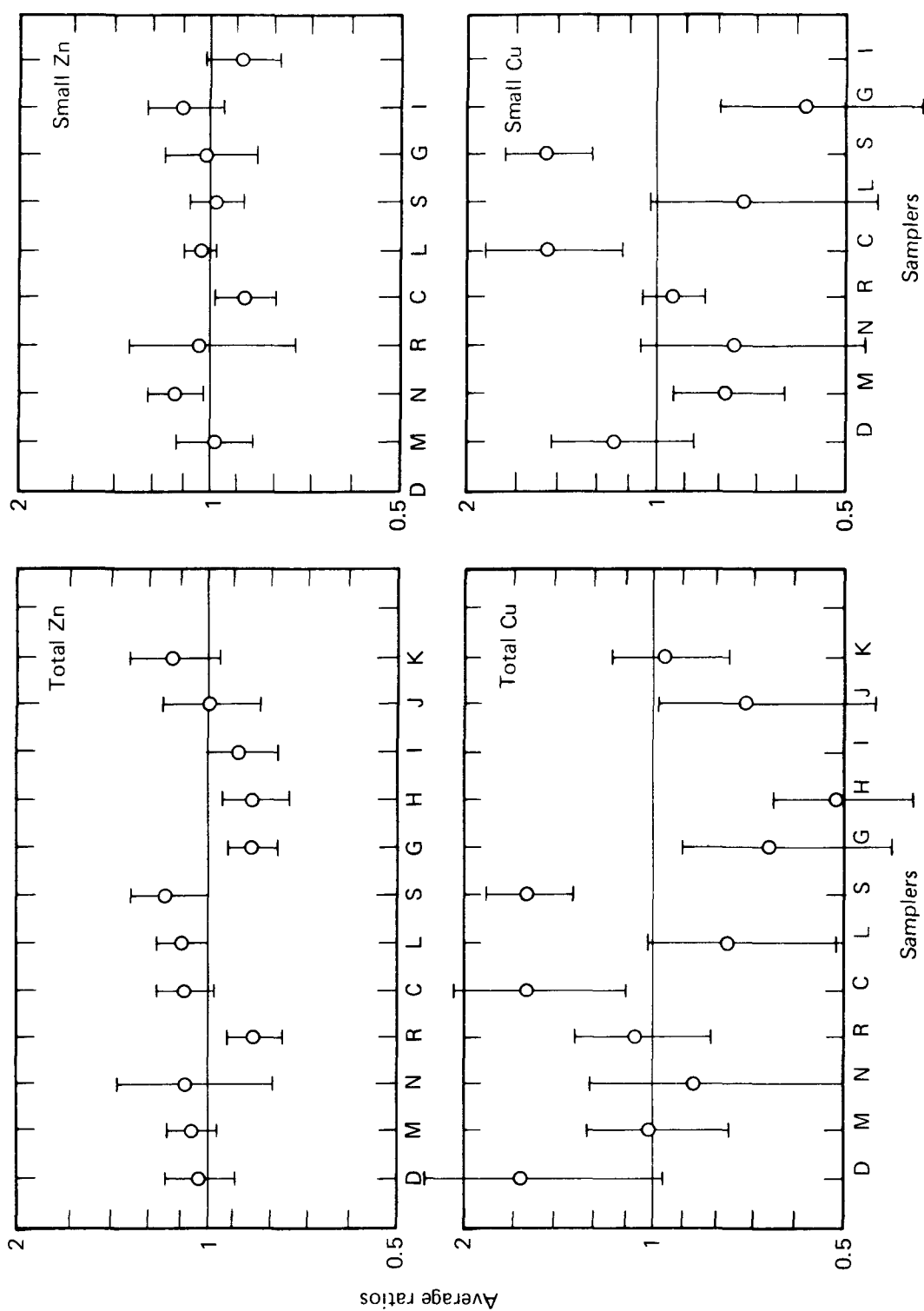


Figure 10. 16-Period average sampler ratios for zinc and copper. The zinc concentrations appear to be accurately determined; while copper concentrations show large fluctuations. This was probably due to nearby high-volume sampler pump motor exhausts which caused localized copper "hot" spots for samplers D, C, and S.

comparable to those for the small fraction (indicating that even the large zinc particles were well behaved).

These two graphs are to be compared to the lower half of Figure 10 which shows similar results for copper. Note that samplers M, N, and L report approximately equivalent concentrations for total and small, zinc and copper. These samplers are centrally located. Samplers C and S report twice as much small and large copper as L, while the nearly adjacent samplers D and R report less than twice as much as M and N. This decrease in recorded concentration towards the center suggests the outer samplers A and/or B, and T and/or U - all CHAMP or high volume samplers - may be responsible for the localized copper source. These samplers have the highest flow rates. Two additional high volume samplers were in permanent operation by the West Virginia Air Pollution Board about 2 meters to the southwest of sampler U. This makes a total of 3 high volume samplers to the southwest of sampler S, and only one to the northeast of sampler C, yet the concentrations recorded by S and C are nearly the same. This suggests a rapid decrease in localized concentrations levels with distance. Note also that sampler D was 0.7 m inwards and adjacent to C, while R was 1.3 m inwards and NOT adjacent to S (see Table 3). Since no trace element concentration levels were evaluated for any of the CHAMP or high volume filter samples, it is not known whether these samplers can induct their own emissions. This can probably happen, but will be dependent on meteorological conditions.

There also appeared to be a strong local source of copper and its concentrations were highest during some of the even periods (2000-0800 hrs). From the diurnal wind patterns this places the source southeast of the Federal Building. For periods 2, 4, 12, 14, and 16 mean copper concentrations varied from 80 to 400 ng/m³ and averaged 200 ng/m³. The other three even periods averaged 38 ± 6 ng/m³; while all odd periods except 13 and 15 averaged 28 ± 6 ng/m³ (13 and 15 averaged 54 ± 6 ng/m³). Eliminating all results from the five high concentration even periods, and calculating an average concentration value for samplers (D, C, and S) less samplers (M, N, R, L, G, H, J, and K) yields 32 ng/m³ additional total copper collected by samplers D, C, and S. Almost 95% of the total copper seen during periods 2, 4, 12, 14, and 16 was contained in the small fraction ($\leq 3.5 \mu\text{m}$); whereas only about 60% of the pump motor copper is contained in the small fraction.

BROMINE LOSS

Thirty fine particulate samples were selected from one of the automated dichotomous samples. These particulate samples were collected on teflon filter substrates having 1 μm pore sizes and were used as analytical technique quality control samples. Results obtained by the participants were presented above. It was mentioned that a possible bromine loss with time may have occurred on these substrates. This evidence comes from four measurements. First, the original measurement of bromine concentration on all 30 samples by Loo when normalized to the lead concentrations gave 1.19 ± 0.10 . Second, the LLL value obtained for Br to Pb one month later gave 1.14 ± 0.03 . Two months later 5 of the 30 samples when remeasured after cutting gave 1.02 ± 0.10 for the Br to Pb ratio. Finally, six months after Loo's original measurement, he remeasured 2 of the 24 samples that were mailed out and obtained 1.00 ± 0.03

for the relative bromine to lead concentration. In this last measurement Loo also observed a 12% loss of chlorine. Thus, it appears that fine fraction lead bromochloride deposited on teflon filter substrates may require two to six months to stabilize after deposition.

DIURNAL VARIATIONS IN POLLUTANT CONCENTRATIONS

Because of the regular and dramatic wind shifts of nearly 180° at approximately 9 am and 9 pm each day, it is worthwhile examining the reported pollutant concentrations for any day/night variations in the size fraction concentrations. These variations are easily obtained from the composite sampler concentrations or Z-means for the totals and two size fractions reported. Odd periods correspond to daylight hour collections (0800-2000 hrs); while even periods correspond to predominantly nighttime collections (2000-0800 hrs).

Table 14 lists the percentage of selected pollutants found in either the small or large fraction. The tabular entries are recorded in percent. The second column lists the 16-period average percent of pollutant concentration measured in the small fraction, exceptions as footnoted. The results under column three indicate that perhaps as much as 12% more small fraction mass is collected at night as during the day. The crustal elements are definitely concentrated in the large fraction, and only a suggestion of any diurnal variation is found. Note that the sum of the small and large fractions for the silicon and titanium percentages do not total to 100%. This bias is introduced by samplers which report only total trace elements. The local sources of copper were discussed earlier. Selenium is not entered in this table. Its concentrations were very low, were concentrated 88% in the small fraction, and showed no diurnal variation. During periods 13 and 11 selenium concentrations increased to 2 and 3-times the typical concentrations of 10ng/m³ observed. Zinc also showed three excursions above normal during periods 2, 4, and 8. Otherwise about 60% of it is found in the small fraction. Bromine and lead are two well known pollutants associated with the internal combustion engine. They show evidence of a diurnal variation. The recorded bromine concentration did increase to about twice the average observed concentrations during period 2, indicating a local non-automotive source. There appears to be 20% more bromine collected at night. One possible explanation is that the lack of sunlight allows more bromine to remain in particulate form, while during the day more of it is converted to a gaseous form.

Period 8 and 9 appear to yield anomalous Z-mean ratios for all of the crustal elements. These two periods were also the least normal in terms of the typical diurnal wind patterns (see Figures 4 and 5); and period 9 was unusual because the wind was nearly calm and shifted constantly (see Fig. 5).

TABLE 14. PERCENT OF POLLUTANT IN THE SMALL OR LARGE FRACTION

Pollutant	% in Small Fraction	% in Small or Large Fraction Day, Night, Fraction ^{a)}	Comments
Mass	51 \pm 7 ^{b)}	48 \pm 6, 54 \pm 8, small ^{b)}	Pd. 8/9 high, 67% small
S + SO ₄	90 \pm 3	No diurnal effect	Pd. 8/9 normal
Silicon	11 \pm 3 ^{b)}	76 \pm 5, 84 \pm 3, large ^{b)}	Pd. 8/9 low, 57%-large
Calcium	12 \pm 2 ^{b)}	87 \pm 2, 93 \pm 4, large ^{b)}	Pd. 9 low, 68%-large
Titanium	17 \pm 2 ^{b)}	86 \pm 6, 89 \pm 2, large ^{b)}	Pd. 8/9 low, 72%-large
Iron	20 \pm 3 ^{b)}	77 \pm 3, 84 \pm 3, large ^{b)}	Pd. 8/9 low, 68%-large
Copper	See discussion on local sources of copper, page 44		
Zinc	57 \pm 7 ^{c)}	55 \pm 7, 60 \pm 7, small	Pd. 8/9 normal
Bromine	79 \pm 9 ^{d)}	72 \pm 7, 86 \pm 3, small	20% more Br at night
Lead	77 \pm 4	74 \pm 2, 79 \pm 3, small	Pd. 8/9 normal
Br/Pb	20 \pm 4 ^{d)}	18 \pm 3, 23 \pm 3, small	

- a) The plus or minus value is the standard deviation. Small or Large refers to the percentage of either the small or large fraction (Z-mean) found relative to the total (Z-mean).
- b) Periods (Pd.) 8 and 9 were omitted from calculations because of anomalous percentages and unusual meteorology (see text).
- c) Periods 2, 4, and 8 were omitted from the calculation. During these periods 87, 79 and 79% respectively, of the total zinc was recorded in the small fraction. A local source of zinc probably caused the dramatic increase in zinc concentrations recorded during these periods.
- d) Periods 2 and 10 were omitted from the calculation. The bromine concentration increased dramatically during period 2. The bromine to lead ratios went to 61 and 33%, respectively, for periods 2 and 10.

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APPENDIX A

SAMPLER AND ANALYTICAL TECHNIQUE SUMMARIES

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SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Robert M. Burton

INSTITUTION: U.S. EPA, Health Effects Research Laboratory

SAMPLER TYPE: CHAMP Particulate Fractionator

OPERATING CHARACTERISTICS:

FLOW RATE: 1130 ℓ /m

PARTICLE SIZE CUTPOINTS: 26 μm (upper cut-off)
3.5 μm (lower cut-off)

COLLECTION SUBSTRATE: 12-inch diameter Glass Fiber,
Gelman Type A (3.5-26 μm)
8-inch by 10-inch Glass Fiber,
Gelman Type A (0-3.5 μm)

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

1. Sierra Calibration Orifice Model 330.
2. Sierra High Volume constant Flow Controller model 310, with measured stability of .03 cubic meters/minute.

ALL SPECIFIC POLLUTANT SPECIES MEASURED:

1. Mass (0-3.5 μm).
2. Mass (3.5-26 μm).
3. Suspended Nitrates (0-3.5 μm).
4. Suspended Sulfates (0-3.5 μm).

ANALYTICAL TECHNIQUE(S) USED:

1. Mass - (0-3.5 μm) and (3.5-26 μm) Mettler Digital Balance (.01 mg sensitivity).
2. Suspended Nitrates - (0-3.5 μm) Filter strip reflux with distilled water, copper-cadmium reduction, sulfanilamide reaction.
3. Suspended Sulfates - (0-3.5 μm) Filter strip reflux with distilled water, water soluble sulfate then measured by the methylthymol blue (MTB) method.

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Robert M. Burton

INSTITUTION: U.S. EPA, Health Effects Research Laboratory

SAMPLER TYPE: CHAMP Flow Controlled High Volume Sampler

OPERATING CHARACTERISTICS:

FLOW RATE: 1130 ℓ /m

PARTICLE SIZE CUTPOINTS: none

COLLECTION SUBSTRATE: 8-inch by 10-inch Glass Fiber,
Gelman Type A

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

1. Sierra Calibration Orifice, Model 330.
2. Sierra High Volume Constant Flow Controller Model 310, with measured stability of .03 cubic meters/minute.

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

1. Total Mass
2. Total Suspended Nitrates
3. Total Suspended Sulfates

ANALYTICAL TECHNIQUE(S) USED:

1. Mass - Mettler Digital Balance (.01 mg sensitivity).
2. Suspended Nitrates - Filter strip reflux with distilled water, copper-cadmium reduction, sulfanilamide reaction.
3. Suspended Sulfates - Filter strip reflux with distilled water, water soluble sulfate then measured by the methylthymol blue (MTB) method.

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Thomas A. Cahill, + Air Quality Group, Crocker Nuclear Lab.

INSTITUTION: University of California, Davis 95616

SAMPLER TYPE: Sierra Multiday Impactor

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 24 liters/min

PARTICLE SIZE CUTPOINTS: Stage 1 - 4.3 microns - less than 20 microns*
Stage 2 - 0.78 microns - 4.3 microns
Stage 3 - 0.01 microns - 0.78 microns

COLLECTION SUBSTRATE: Mylar type S, with about 60 micrograms/cm²
Apiezon L coatings; filter - 0.4 micron
Nuclepore

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Rotometer in instrument; orifice (0.5" H₂O) on intake, (interm.) cal. by 9 litre Collins Sprimeter

No flow control (early unit borrowed for test)

Mean change in flow - 5.7%; Estim. error, \pm 2%

ALL SPECIFIC POLLUTANT SPECIES MEASURED:

(including those not intercompared)

1. Routinely included in output: Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ge, Ga, As, Se, Br, Rb, Sr, Zr, Mo, Ba, Pt, Au, Hg, Pb
2. All other elements heavier than sodium - x-ray lines recorded, with energy and intensity, for manual reduction. Second analysis with higher gain to cover Ca - Rare earths.

ANALYTICAL TECHNIQUE(S) USED:

1. PIXE - 18 MeV alphas (2 detector gains)
2. XRF - secondary fluorescers and filters

*Intake calibrated for 20 micron cut point (approximate); 60 mesh stainless steel screen added since that time has reduced the cut point.

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Thomas A. Cahill, + Air Quality Group, Crocker Nuclear Lab.

INSTITUTION: University of California, Davis 95616

SAMPLER TYPE: Stacked Filter Unit

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 5 liters/min

PARTICLE SIZE CUTPOINTS: Coarse stage - 2.6 microns - less than 20
microns*

COLLECTION SUBSTRATE: Fine stage - 0.01 microns - 2.6 microns
Coarse stage - 8 micron Nuclepore Filter
Fine stage - 0.4 micron Nuclepore Filter

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Orifice meter intermittantly placed over
intake, calibrated by 9 litre Collins
Spirometer

Passive flow control through a 10:1 ballasting
orifice at pump.

Mean change in flow - 9%; Estim. error, $\pm 2\%$

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

1. Routinely included in output: Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ge, Ga, As, Se, Br, Rb, Sr, Zr, Mo, Ba, Pt, Au, Hg, Pb
2. All other elements heavier than sodium - x-ray lines recorded, with energy and intensity, for manual reduction. Second analysis done during this test for Ca through rare earths.
3. Mass, coarse and fine

ANALYTICAL TECHNIQUE(S) USED:

1. PIXE - 18 MeV alphas (2 detector gains)
2. XRF - secondary fluorescers and filters
3. Mettler balance

*Intake calibrated for 20 micron cut point (approximate); 60 mesh stainless steel screen added since that time has reduced the cut point.

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Thomas A. Cahill, + Air Quality Group, Crocker Nuclear Lab.

INSTITUTION: University of California, Davis 95616

SAMPLER TYPE: Total Filter Unit

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 24 liters/min

PARTICLE SIZE CUTPOINTS: None; intake, less than 20 microns*

COLLECTION SUBSTRATE: Gelman GA4 Filters (NOTE: Results obtained at Charleston low by 8% due to incorrect filter area used.)

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Orifice meter intermittantly placed over intake, directly calibrated by a 9 litre Collins Spirometer

Passive flow control through a 2:1 ballasting orifice at pump.

Mean change in flow - 1%; Estim. error, $\pm 1\%$

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

1. Routinely included in output: Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ge, Ga, As, Se, Br, Rb, Sr, Zr, Mo, Ba, Pt, Au, Hg, Pb
2. All other elements heavier than sodium - x-ray lines recorded, with energy and intensity, for manual reduction. Second analysis done during this test for Ca through rare earths.
3. Mass

ANALYTICAL TECHNIQUE(S) USED:

1. PIXE - 18 MeV alphas (2 detector gains)
2. XRF - secondary fluorescers and filters
3. Mettler balance

*Intake calibrated for 20 micron cut point (approximate); 60 mesh stainless steel screen added since that time has reduced the cut point.

SUMMARY OF SAMPLING AND ANALYSIS METHOD

PARTICIPANT: Richard Delumyea & Ed Macias

INSTITUTION: Washington University

SAMPLER TYPE: TWOMASS two stage sequential tape sampler

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 12 to 18 ℓ /m

PARTICLE SIZE CUTPOINTS: 3.5 μ m

COLLECTION SUBSTRATE: Glass fiber with cellulose backing

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

See long write-up, page 74

SPECIFIC POLLUTANT SPECIES MEASURED:

Mass, Sulfur

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: T. Dzuby, et al

INSTITUTION: US EPA

SAMPLER TYPE: Two manual Dichotomous, Samplers D and R

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 14 ℓ /m

PARTICLE SIZE CUTPOINTS: 3.5 μm (14 μm upper cut-off)

COLLECTION SUBSTRATE: Sampler D: asymmetric teflon (1-10 μm)
Sampler R: 1 μm (FALP) Fluoropore

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Sampler D: Differential pressure regulator on pump exhaust

Sampler R: Sierra Series 250 servo system

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

Sampler D: mass and all elements detected by XRF

Sampler R: mass, SO_4 , NO_3 , S, Pb, and other trace elements detected
by XRF

ANALYTICAL TECHNIQUE(S) USED:

Gravimetric, XRF, Ion chromatograph

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: T. Dzubay, et al

INSTITUTION: US EPA

SAMPLER TYPE: Two Tandem Filter Samplers, M and N

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 7.2 l/m

PARTICLE SIZE CUTPOINTS: 3.5 μ m

COLLECTION SUBSTRATE:	Sampler M:	9.6 μ m Nucleopore (coarse)/
		0.4 μ m Nucleopore (fine)
	Sampler N:	9.6 μ m Nucleopore (coarse)/
		Assymetric Teflon (fine)

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Sierra flow servo system

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

All elements detected by XRF

ANALYTICAL TECHNIQUE(S) USED:

XRF

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: G. Martin Hudson, Physics Department
Alistair C. D. Leslie, Oceanography Department

INSTITUTION: Florida State University

SAMPLER TYPE: Linear Streaker Samplers

OPERATING CHARACTERISTICS:

	Streaker #1	Streaker #2
FLOW RATE (in liters/m):	0.5 ℓ /m	0.35 ℓ /m
PARTICLE SIZE CUTPOINTS:	Total filter	Total filter
COLLECTION SUBSTRATE:	0.4 μ nuclepore	0.2 μ nuclepore

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Calibrated TYLAN model FC 260 Mass Flow Controllers. Field checks made with rotometers.

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

Particulate, elemental: Al, Si, S, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ge, As, Se, Br, Rb, Sr, Mo, Ag, Cd, Sn, Sb, I, Cs, Ce, Au, Hg, Pb, Bi

ANALYTICAL TECHNIQUE(S) USED:

PIXE (proton induce x-ray emission) calibrated to commercially prepared standards good to $\pm 5\%$.

SUMMARY OF SAMPLING AND ANALYSIS METHOD

PARTICIPANT: Billy W. Loo

INSTITUTION: Lawrence Berkeley Lab, Univ. of California

SAMPLER TYPE: 3 Automated Dichotomous Air Samplers: C, L, and S

OPERATING CHARACTERISTICS:

SAMPLING FLOW RATE: 50 ℓ /m

PARTICLE SIZE CUTOPOINTS: 2.4 μ m

COLLECTION SUBSTRATE: 0.1 μ m pore size teflon membrane filter
mounted on 5 x 5 cm plastic frames

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

The Dwyer RMC-103-SSV and Metheson #603 rotometers were used for field calibration. They were cross-checked with laboratory dry and wet test meters.

An automated flow controller consisting of pressure sensors and water driven micrometer valves maintains the flow to within 1% of present values.

SPECIFIC POLLUTANT SPECIES MEASURED:

Total mass, Si, S, Ca, Ti, Fe
Cu, Zn, Se, Br, and Pb

ANALYTICAL TECHNIQUE(S) USED:

Beta gauge, Energy dispersion x-ray fluorescence analysis, secondary excitors.

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Peter K. Mueller

INSTITUTION: Environmental Research & Technology, Inc.

SAMPLER TYPE: Sequential Filter Samplers: E and F

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 100 l/m

PARTICLE SIZE CUTPOINTS: Sampler E: About 15 m at inlet

Sampler F: 2.5 μm

COLLECTION SUBSTRATE: 47 mm dia. Teflon-coated glass fiber,
(Pallfelx TX40HI20)

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Calibrated orifice used for field calibration.

Flow monitored by continuous chart recording of vacuum upstream pump.

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

Total mass, SO_4 , NO_3

Small mass, SO_4 , NO_3

ANALYTICAL TECHNIQUE(S) USED:

Mass: Gravimetry

SO_4 , NO_3 : Ion chromatography

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Charles E. Rodes

INSTITUTION: EPA/EMSL

SAMPLER TYPE: EMSL Dichotomous

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 14 ℓ /min

PARTICLE SIZE CUTPOINTS: Inlet 20 μm , cutpoint 3.5 μm

COLLECTION SUBSTRATE: Fluropore 37 mm

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Flow Calibration using mass flow meters.

Flow maintained by restrictor valves.

ALL SPECIFIC POLLUTANT SPECIES MEASURED:
(including those not intercompared)

TSP, Pb, $\text{SO}_4^{=}$

ANALYTICAL TECHNIQUE(S) USED:

TSP gravimetric

Pb Atomic Absorption (flameless)

$\text{SO}_4^{=}$ Ion Chromatograph

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Charles E. Rodes

INSTITUTION: EPA/EMSL

SAMPLER TYPE: Hi-Vol

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 1415 ℓ /m

PARTICLE SIZE CUTPOINTS: "Total Suspended Particulates" (TSP)

COLLECTION SUBSTRATE: Glass Fiber 8 x 10 inch

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Flow Calibration using orifice meter.

Flow maintained by mass flow controller.

ALL SPECIFIC POLLUTANT SPECIES MEASURED:
(including those not intercompared)

TSP, Pb, $\text{SO}_4^{=}$

ANALYTICAL TECHNIQUE(S) USED:

TSP: gravimetric

Pb: Atomic Absorption

$\text{SO}_4^{=}$: Methyl Thymol Blue

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Roger L. Tanner, Leonard Newman

INSTITUTION: Brookhaven National Laboratory

SAMPLER TYPE: Diffusion Sampler

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): DB0: 10.6 ℓ /min; DB1: 16.8 ℓ /m
DB2: 13.8 ℓ /min.

PARTICLE SIZE CUTPOINTS: DB0: 0 to ca 5 μm ; DB1: 0.03 μm to ca 5 μm ;
DB2: 0.12 μm to ca 5 μm .

COLLECTION SUBSTRATE: Phosphoric acid-treated Pallflex GA0 tissue quartz.

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Flows were calibrated with open Matheson rotometer tubes in series with and upstream from the 47 mm filter holders. The flow variations in calibrations before and after the Intercomparison averaged 11% for the 3 sample sets.

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

1. Sulfate
2. Nitrate
3. Strong acid
4. Ammonium
5. Sulfuric acid

ANALYTICAL TECHNIQUE(S) USED:

1. Extraction into pH 4 aqueous solution and determination by ion chromatography.
2. Hydrazine reduction and colorimetry.
3. Gran titration with correction for pH 4 leach solution.
4. Indophenol colorimetry.
5. Benzaldehyde extraction and determination by flash volatilization-FPD or by ion chromatography.

SAMPLING AND ANALYSIS METHOD SUMMARY

PARTICIPANT: Roger L. Tanner, Leonard Newman

INSTITUTION: Brookhaven National Laboratory

SAMPLER TYPE: Staplex HiVol with 5-in circular filter pack in conventional HiVol enclosure.

OPERATING CHARACTERISTICS:

FLOW RATE (in liters/m): 700 ℓ /m

PARTICLE SIZE CUTPOINTS: 0 to ca 20 μ m

COLLECTION SUBSTRATE: Phosphoric acid-treated Pallflex GA0 tissue quartz for aerosol collection. K_2CO_3 , glycerol-impregnated cellulose (S & S 2W, 2 sheets) for SO_2 collection.

METHOD OF FLOW CALIBRATION AND MAINTENANCE:

Magnetohelic gauge measured with filter pack in place with unexposed filters; checked for repeatability with representative exposed filter packs after study. The average reduction in flow during sampling was 1.1 m^3/hr (3%) with average flow used for concentration calculations.

ALL SPECIFIC POLLUTANT SPECIES MEASURED: (including those not intercompared)

1. Sulfur dioxide
2. Sulfate
3. Nitrate
4. Strong acid
5. Ammonium
6. Sulfuric acid

ANALYTICAL TECHNIQUE(S) USED:

1. Filter pack, extraction into peroxide solution, determination as sulfate by turbidimetry or ion chromatography.
1. Extraction into pH 4 aqueous solution and determination by ion chromatography, or extraction into $10^{-2}N$ HCl with determination by Methylthymol Blue colorimetry.
2. Hydrazine reduction and colorimetry.
3. Gran titration with correction for pH 4 leach solution.
4. Indophenol colorimetry.
5. Benzaldehyde extraction and determination by flash volatilization-FPD or ion chromatography.

CHAMP AND HIGH VOLUME SAMPLERS

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EQUIPMENT DESCRIPTION

Two CHAMP RSP samplers and one flow-controlled high volume sampler were sent to Charleston, W. Va., to participate in an intercomparison study of particulate analyzers. The CHAMP RSP sampler divides the particulate matter into two collected groups, 3.5 - 26 microns and 0 - 3.5 microns.

Particles greater than 26 microns in diameter are excluded by the aerodynamic construction of the analyzer. Particulate matter in the 3.5 to 26 micron region is impacted on a 12-inch diameter filter utilizing a single stage Andersen impactor plate. Particles smaller than 3.5 microns are collected on a standard 8 X 10 inch hi volume filter. The Andersen impactor is adapted to fit between the after filter and the base section of the fractionator itself. All filter media are of glass fiber construction.

The third sampler was a standard hi volume sampler, which collects all particulate matter smaller than 100 microns. All samplers used Sierra Flow controllers operating on General Metal's Model 2000H motor assemblies to maintain a constant 1.13 m³/min (40 cfm) flow. The hi volume sampler is described in detail in Volume 36, No. 228 of the Federal Register.

SAMPLER CALIBRATION

All devices were calibrated using a standard sierra orifice calibrated at the factory and verified by our laboratory Rootsmeter. The calibration curve of the orifice is: $Q = 1.4054 (\Delta P)^{1/2}$ where ΔP is the pressure difference in inches of water as measured across the orifice. Q is then corrected using the following equation to 760 mm Hg and 25°C (298°K):

$$Q_s = (P_a/T_a)^{1/2} (3.156)Q$$

where Q_s is the standard flow,
 P_a is the barometric pressure in mm
HG, and
 T_a is the ambient temperature in
degrees Kelvin.

The orifice was placed on top of the Andersen head without the RSP top hat and a calibration curve was drawn using clean filters for the Andersen and hi volume heads which are assembled in series. Various flows were obtained by

changing the speed of the hi vol motor with a variac to simulate different loadings on the filters. A curve was obtained for each sampler. For field operations a small rotameter was attached to the bottom of each hi vol and calibrated simultaneously with the orifice. The rotameters facilitated taking field flow measurement, although both rotameter and orifice readings were recorded for this study. After the response equations were determined for each device the flow controllers were then set to obtain 1.13 m³/min (40 cfm) flow. The flow obtained during the study show little variation from this 1.13 setting, varying only from 1.17 to 1.11 m³/min. Keep in mind, however, that only stop and start flows were recorded during operation and actual flows during sampling may vary but should have been kept within the above tolerances with properly operating flow controllers.

ANALYSIS

The glass fiber filters were conditioned at 40% relative humidity and 25°C for 24 hours. They were then numbered and weighed to the nearest 0.1 mg. Upon return from the field they were again equilibrated at the previous conditions and weighed. Total suspended particulate (TSP) and respirable suspended particulate (RSP) were then determined for the appropriate samplers. The weight of the collected particulate matter was divided by the total volume of air sampled to obtain TSP and RSP concentrations in µg/m³. The sample volumes were calculated using the following equation:

$$V = \frac{Q_i + Q_f}{2} T$$

where Q_i = initial flow - m³/min
 Q_f = final flow - m³/min
 T = total sampling time - min
 V = air volume - m³

After the particulate concentrations were determined, the filters were then sent to Stewart Laboratories in Knoxville, Tenn. for SO₄⁼ and NO₃⁼ analysis. The SO₄⁼ analysis was performed using the methylthymol blue (MTB) method while the NO₃⁼ analysis utilized a copper-cadmium reduction column and NEDA dye. The concentrations were expressed as µg/m³ of each ion.

Our program does not routinely analyze for lead. For specific lead samples, Tom Dzubay would perform our lead analysis. Since his section also participated in this study, no lead analyses were performed on these filters.

Further detailed explanation of these methods can be found in EPA publication 600/1-76-011, Community Health Environmental Surveillance Studies Air Pollution Monitoring Handbook: Manual Methods.

SIERRA MULTIDAY AND STACKED FILTER UNITS

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The Davis Air Quality Group, working in conjunction with the California Air Resources Board, the Research Applied to the National Needs Division of the National Science Foundation, and the U.S. Energy Research and Development Agency, had developed and modified techniques for collecting and analyzing atmospheric particulates. Monitoring of aerosols in California (1) by size and elemental composition for the California Air Resources Board (CARB), began in January, 1973, using a Lundgren-type rotating drum impactor (2), modified for this program, and since marketed as the Environmental Research Corporation, and later, Sierra Instruments Corporation, Multiday Impactor. Quantitative operation of this device was achieved through use of quasi-monolayer depositions on coated surfaces in the two impaction stages, and non-hygroscopic, surface-deposition filter media for the backup filter. Normal integration period was 24 hours. Approximately 5000 station-days of data in three size fractions, 20 μm to 3.6 μm , 3.6 μm to 0.65 μm , and 0.65 to 0.01 μm , have been accumulated in this program. The major aims of the program are in characterization of aerosol components, the identification of aerosol sources, study of transport, transformations, and sinks, identification of sources of gaseous pollutants measured by the ARB monitoring network, and effects of aerosols and gases upon visibility.

Elemental analysis of samples collected in this program occurs after transport of samples to Davis, with contamination and loss effects summarized in the Table. Analysis occurs primarily via particle induced x-ray emission (PIXE) (3,4) with significant support through energy-dispersive x-ray fluorescence (XRF) and ion scattering analysis (ISA). Smaller numbers of analyses are done using a scanning electron microscope and an electron microprobe with wave-length-dispersive XRF capabilities. Total number of elemental values to date in the monitoring program exceed 500,000. The system has participated in numerous interlaboratory comparisons (5), in addition to a massive (6000 analyses/year) internal program of analytical validation.

The need to perform diurnal and spatial profiles that have some size information and full gravimetric and elemental analysis compatibility has led to development of low cost, portable stacked filter units (SFU's) (6) following a suggestion of K. R. Spurney et al.(7) These units are designed to deliver a quasi-respirable separation of aerosols, with a 50% cut point and shape as close as possible to that occurring between the nasal-pharyngeal and tracheo-pulmonary compartments of the human respiratory tract. Evaluations of this

device are given in the SFU table for a two stage device designed to operate at 5 ℓ /min.

In an attempt to upgrade the information delivered by the large number of Hi-Vol samplers operated by state and local agencies in California, the SFU has been evaluated as a continuous monitoring device. The SFU would operate on a 7 day integration period, avoiding the statistical problems inherent in a 1 day in 6 Hi-Vol mode, while delivering respirable and non-respirable size cuts in samples suitable for gravimetric and full elemental analysis. Lower flows are used, 2 ℓ /min, and on occasion, especially when visibility problems exist, a third stage is added to mimic the cut points of the multiday.

For the sampler intercomparison study, a Multiday impactor and a stacked filter unit will be used. The impactor will use 0.6 mg/cm² mylar, coated with 0.065 mg/cm² Apiezon type L grease, as impaction surfaces, and 0.4 micron Nuclepore filter for the afterfilter. The stacked filter unit will use 8 micron and 0.4 micron filters. Flow for both units will be set by a spirometer-calibrated orifice meter on the intake. Analysis will be by both PIXE and XRF, with elements aluminum and heavier quoted either as observed values or upper limits of elements not observed. Calibration of the analysis systems will be via gravimetric thin element standards, and total accuracy will be within $\pm 10\%$ absolute when statistical precision is adequate.

REFERENCES

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Summary of Sample Collection Evaluations

MULTIDAY IMPACTOR

- | | |
|--|---|
| 1. Large particle cut-off (50%)
(intake) | $D_p = 20 \mu\text{m}$, variable w. wind speed* |
| 2. First stage cut-off (50%) | $D_p = 4.3 \mu\text{m}$, $\pm 0.4 \mu\text{m}$ |
| 3. Second stage cut-off (50%) | $D_p = 0.78 \mu\text{m}$, $\pm 0.05 \mu\text{m}$ |
| 4. Impaction collection efficiency | (97 \pm 3)% |
| 5. Filter capture efficiency | |
| a) laboratory aerosols | (96 \pm 2)% |
| b) ambient aerosols | (99 \pm 3)% |
| 6. Sizing errors due to non-optimum collection | |
| a) coarse collected on filter (soils) | < 1% |
| b) fine collected on coarse (Pb, S aerosols) | < 1% |
| 7. Summary of sizing: | Stage 1 (coarse) < 20 μm to 4.3 μm
Stage 2 (intermediate) 4.3 μm to 0.78 μm
Stage 3 (fine) 0.78 μm to 0.01 μm |
| 8. Flow calibration | Rotometer - continuous
Orifice and meter on Intake (0 to 1" H_2O)
(Intermittent; Spirometer calibrated) |
| 9. Total unit efficiency (fine particles) | (93 \pm 3)% (4 X 5a)
[correction <u>not</u> applied to the Charleston data] |

Summary of Sample Transport and Handling Corrections

- | | |
|---------------------------------------|--|
| 1. Contamination in Handling | $\gtrsim 15 \text{ ng/m}^3$ Si,
$< 10 \text{ ng/m}^3$ Al, K; 6 ng/m^3 others
$< 2\%$ of Si value at most locations
less for other elements |
| 2. Loss of particles during transport | < 2% |
| 3. Loss of material during storage | $\ll 10\%$ |

*Addition of a 60 mesh screen has lowered this cut.

Summary of Sample Collection Evaluations

U.C. Davis Stacked Filter Unit at 5 l/min (2 stage)

- | | |
|--|--|
| 1. Large particle cut-off (50%)
(intake) | $D_p = 20 \mu\text{m}$, variable w. wind speed* |
| 2. Coarse stage cut-off (50%) | $D_p = 2.6 \mu\text{m} \pm 0.5 \mu\text{m}$, quasi-respirable shape |
| 3. Filter collection efficiency | |
| a) laboratory aerosols | (96 \pm 2)% |
| b) ambient aerosols | (99 \pm 3)% |
| 4. Sizing errors due to non-optimum collection | |
| a) coarse particulates on fine stage (soils) | < 6% |
| b) fine particulates on coarse stage (Pb, idling auto) | < 2.5% |
| 5. Summary of sizing: | Coarse < 20 μm to 2.6 μm
Fine 2.6 μm to 0.01 μm
Shape quasi-respirable, 20 l/min nasopharynx |
| 6. Flow calibration | Orifice and meter on Intake (0 to 1" H_2O)
(Intermittent; Spirometer calibrated) |
| 7. Total unit efficiency | (96 \pm 2)% (4a)
[correction <u>not</u> applied to the Charleston test] |

Summary of Sample Transport and Handling Corrections

- | | |
|---------------------------------------|---|
| 1. Contamination in Handling | $\gtrsim 15 \text{ ng/m}^3$ Si,
$< 10 \text{ ng/m}^3$ Al, K; $< 6 \text{ ng/m}^3$ others
$< 2\%$ of Si value at most locations
less for other elements |
| 2. Loss of particles during transport | < 2% |
| 3. Loss of material during storage | $\ll 10\%$ |

*Addition of a 60 mesh screen has lowered this cut.

Summary of Analytical Corrections and Uncertainties

1. Statistical uncertainty in peak counts - variable
2. Uncertainty in gravimetric standards - $\pm 5\%$
3. Integration of Ion beam - $\pm 2\%$
4. Ion beam attenuation - $< 5\%$
5. Electronic corrections, accuracy - $\pm 5\%$
6. Peak integration and background uncertainties - $\pm 7\%$, (variable)
- Thus, reproducibility - $\pm 5\%$
- system uncertainty - $\pm 10\%$
7. Loss of volatile elements (beam + vacuum) - $< 5\%$

8. Particle Size Corrections

	<u>Stage #1</u>	<u>Stage #2</u>	<u>Filter Stage</u>
Na	2.49	1.32	$< 10\%$
Mg	1.96	1.22	"
Al	1.68	1.16	"
Si	1.49	1.12	"
P	1.37	1.09	"
S	1.26	1.07	"
Cl	1.31	$< 10\%$	"
K	1.12	$< 10\%$	"
others	$< 10\%$	$< 10\%$	"

9. Loading Corrections (for $120 \mu\text{g}/\text{m}^3$ aerosol)

	<u>Stage #1</u>	<u>Stage #2</u>	<u>Filter Stage</u>
Na	$< 10\%$	1.70	1.22
Mg	"	1.39	1.11
Al	"	1.23	1.07
Si	"	1.14	1.04
others	"	$< 10\%$	$< 10\%$

Uncertainty in particle size and loading corrections are estimated at $\pm 20\%$ for most ambient aerosols, although, especially for the particle size corrections, worse cases are common. These corrections thus increase the total error for the four lightest elements.

REFERENCE (Sierra Multiday)

"Monitoring California's Aerosols by Size and Elemental Composition", R. G. Flocchini, T. A. Cahill, D. J. Shadoan, S. J. Lange, R. A. Eldred, P. J. Feeney, G. W. Wolfe, D. C. Simmeroth, and J. K. Suder, *Env. Sci. and Technology* 10, 76 (1976).

REFERENCE (Stacked Filter Units)

"Analysis of Respirable Fractions in Atmospheric Particulates via Sequential Filtration", T. A. Cahill, L. L. Ashbaugh, J. B. Barone, R. A. Eldred, P. J. Feeney, R. G. Flocchini, C. Goodart, D. J. Shadoan, and G. W. Wolfe, *J. Air Pollution Control Assoc.* 27, 675 (1977)

TWO MASS SAMPLER

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INTRODUCTION

As part of an EPA/DOE sponsored Sampler Intercomparison Field Study, TWOMASS tape samplers were installed on the roof of the Federal Building in downtown Charleston, West Virginia and run from May 11 through May 19, 1977. One TWOMASS sampler collected 6 hr samples at a nominal flow rate of 12 ℓ /pm and another collected 3 hr samples at a nominal flow rate of 18 ℓ /pm. The 3 hr sampler was equipped with a beta-attenuation mass monitor system which provided a continuous record of coarse ($>3.5 \mu\text{m}$) and fine ($<3.5 \mu\text{m}$) particle concentration.

The purpose of the study was to compare results obtained from various sampling and analytical procedures. The sulfur content of the samples was determined by flash vaporization followed by flame photometric detection (FV-FPD). The sampling system was designed for high time resolution (30-120 min). For this study three hour samples were collected. Since the reporting time for all intercomparison data was set at 12 hour intervals, four 3-hr samples were added to give the required information. In cases where one 3-hr sample was not available, the remaining three were averages. If more than one sample was missing during a twelve hour period, no results were reported.

ANALYTICAL METHODS AND PROCEDURES

Sampler

Atmospheric aerosol samples were collected in two size ranges with a TWOMASS automated two-stage sequential filter sampler. The flow system separated particles into two size fractions. Coarse particles ($\text{diam} > 3 \mu\text{m}$) were impacted on a glass fiber filter with cellulose backing. Fine particles were collected on the same type of high efficiency-low mass density filter. The flow rate through the TWO MASS was set at 12 or 18 ℓ /min using a GAST rotary vane pump.

Beta Attenuation Mass Monitor

Both the impaction and filtration heads of one TWOMASS were fitted with independent sources (Carbon-14) and detector systems (solid state ruggedized silicon surface-barrier type). After electronic amplification and filtration

the output signals were sent through counters to a programmable calculator. Mass was calculated using the equation

$$\Delta M = \frac{A}{\Delta t f \mu_m} \ln (I_0/I)$$

where ΔM is the mass concentration, A the spot area, f is the flow rate, μ_m the mass attenuation coefficient, t the time counting interval, I_0 the count rate of the previous interval and I the count rate of the current interval. The beta intensity transmitted through the filter paper was measured as the particulates were being deposited; mass concentrations were obtained at the end of each 10-min counting period. Tapes were automatically advanced at three hour intervals.

Particulate Sulfur Analysis

Water soluble particulate sulfur in the fine particle samples from the TWOMASS instrument was determined using a flash vaporization-flame photometric detection method. The sulfur analyzing system consisted of a flash vaporization vessel, flame photometric detector (Melo SA-160), electronic integrator, and a strip chart recorder. The sample vaporization was performed by capacitor discharge across a tungsten boat, resulting in resistance heating to 1100°C. Vaporized gaseous decomposition products of sulfur compounds were carried to the flame photometric detector by a stream of clean, charcoal filtered air at a flow rate of 2 cm³/sec. The linearized output was registered on the strip chart recorder and the peak area integrated by an electronic integrator.

To the filter deposits, 0.5 to 1 ml double distilled deionized water was added and ultrasonically disintegrated at 25°C for 10 minutes. Sample standard solutions were transferred with a 5 μ l microsyringe to the tungsten boat and heated at 60°C for 30 seconds until dry. The residue was then vaporized by capacitor discharge.

This technique was calibrated using solutions of sulfuric acid, ammonium sulfate and bisulfate, zinc- and zinc-ammonium sulfate in the range 0.16-34 μ g/ml of sulfur. [Husar et al, Anal. Chem., 47, 2062 (1975)]. A 5 μ l sample of distilled deionized water gave a signal equivalent to 0.3 ± 0.05 ng sulfur, corresponding to a solution concentration of 0.06 μ g/ml. This value was a factor of five lower than the measured sulfur content of filter blank extract.

MANUAL DICHOTOMOUS AND SERIES FILTER RESPIRABLE SAMPLERS

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AEROSOL SAMPLING DEVICES

For our participation in the sampler intercomparison conducted in Charleston, West Virginia between May 11 and May 19, 1977, four size fractionating aerosol samplers were used. Two were manual dichotomous samplers (1) (MDS-S and MDS-A), and two were tandem filter respirable samplers (2) (TF-M and TF-P). Table 1 summarizes the characteristics of each sampler and the filter media that were used.

The manual dichotomous samplers use a virtual impactor designed to separately collect fine and coarse particles with a 50% separation diameter occurring at 3.5 μm . The upper 50% cutoff occurs at 14 μm and is due partly to losses in the virtual impactor but is mainly due to the use of a sampling inlet designed to sample particles with an efficiency that is independent of wind speed and also to reject giant, nonrespirable particles.(3)

The tandem filter sampler consists of a large pore sized Nuclepore filter followed by a highly efficient filter. This sampler separately collects the coarse and fine particle fractions on the two filters.(2,4,5) For the flow rates and filters shown in Table 1, the cutpoint occurs at 3.5 μm for liquid particles.(2,4) Although there are no particle losses for this fractionator, the size separation is not quantitative because of tendency for dry, solid particles to bounce through the first filter.(6) The upper 50% cutoff of the inlet is estimated to occur at about 20 μm .

Flow rates were checked using a Sierra Model 541* portable mass flow meter at the beginning and end of each sampling interval. Such measurements were made while the samplers were running and required about one minute per

*Mention of commercial products or company names does not constitute endorsement by the U.S. Environmental Protection Agency.

sampler. The calibration of the portable flow meter was checked daily against a dry test meter at flow rates of 6 and 14 liters per minute. After the first 4 days of sampling the jets in the virtual impactor were inspected and cleaned.

CALCULATION OF CONCENTRATIONS

In determining the sampled volumes, the mean of the initial and final flow rates was used. Samples were rejected if the final flow rates differed by more than 15% from the nominal values indicated in Table 1. (See page 78.)

For each dichotomous sampler there is a small flow of air through the coarse particle filter, and a proportionally small amount of fine particle mass is collected on the coarse particle filter. To correct for this effect, particle concentrations in the two size ranges were determined from the equations:

$$C_f = M_f / (t F_f)$$

$$C_c = [M_c - (M_f F_c / F_f)] / [t (F_f + F_c)].$$

where C_f and C_c = the atmospheric concentrations of the fine and coarse particle fractions, respectively in $\mu\text{g}/\text{m}^3$
 M_f and M_c = the masses collected on the fine and coarse particle filters, respectively in μg
 F_f and F_c = the flow rates through the fine and coarse particle filters, respectively in m^3/min
 t = the sampling time in minutes.

MASS ANALYSIS

The masses of the aerosol deposits were determined gravimetrically using a Perkin Elmer Ad-2 electrobalance that was located in the laboratory at Research Triangle Park, N.C. The electrobalance was operated on the 100 mg scale, and the weighing precision was 10 μg . At the beginning of each daily series of weighings, the span of the electrobalance was adjusted for correct response to a standard 100 mg weight. The zero of the electrobalance was checked before the weighing of each filter and was adjusted whenever a nonzero reading occurred. To eliminate any electrostatic charges on the filters, they were held for a few seconds within 1 cm of a ^{210}Po radioactive source (500 μCi) before weighing. A second similar radioactive source was positioned inside the balance enclosure. The relative humidity in the balance room was between 35 and 45% for all weighings. To equilibrate the filters after sampling, the petri dishes containing the filters were stored in the balance room for a least 24 hours with the covers partly open.

ELEMENTAL ANALYSIS

Elemental analysis of samples by x-ray fluorescence spectroscopy was carried out with an energy dispersive unit.(7) The detector is a Si(Li) diode with a resolution of 208 eV for Mn-55 K x-rays. This spectrometer (a pulsed x-ray tube design) excites the sample by characteristic x-rays from a selected set of secondary fluorescers. Elements with atomic numbers 13 through 20 are

TABLE A.1. SAMPLER AND FILTER MEDIA DESCRIPTIONS USED IN THE INTERCOMPARISON STUDY.

Sampler Type	Description	Upper 50% cutoff dia.	Flow rate l/min.	Deposit Area cm ²	Filter Media
Dichotomous (MDS-S)	Two stage virtual impactor having 50% cut point at 3.5 μ m. The flow rates through the fine and coarse filters is 13.6 and 0.4 liters/min respectively and is maintained using a Sierra Series 250 mass flow sensor and pump servosystem.	14 μ m measured	14	6.7	Teflon membrane having 1 μ m pores bonded to a polyethylene net (FALP Fluoropore from Millipore Corp.)
Dichotomous (MDS-A)	Same as MDS-S except that the constant flow rate is maintained using a constant differential pressure controller on the pump exhaust.	14 μ m measured	14	6.7	Teflon membrane having assymetric pores (1 μ m/10 μ m) oriented so that particles are collected on the 1 μ m side (P137PL25 Ghia Corp.)
Tandem Filter (TF-M)	Two filters operated in series with a sampling velocity of 15 cm/sec. maintained using a Sierra (Kurtz) servo-system.	20 μ m estimated	7.2 : 8.0		Coarse: Nucleopore having 9.6 μ m dia. pores (N137PE2 Ghia Corp.) Fine: Nucleopore having 0.4 μ m dia. pores (N040 Poly 101 Ghia Corp.)
Tandem Filter (TF-P)	Same as TF-M	20 μ m estimated	5.9	6.7	Coarse: 9.6 μ m Nucleopore (N137-PE1, Ghia Corp.) Fine: Teflon, same as used for sampler MDS-A above.

analyzed using a titanium fluorescer; elements with atomic number between 22 and 38 plus Pb and Hg are analyzed using a molybdenum fluorescer; elements Cd, Sn, Sb and Ba are analyzed with a samarium fluorescer.

Spectral analysis was carried out with a linear least squares fitting program which uses a library of single element spectra as the fitting functions. These spectra were acquired by the spectrometer under analysis conditions. A blank filter spectrum is used for the background and is included in the library.(8) The spectrometer is calibrated for copper and sulfur using a well characterized thin copper film standard and thin laboratory generated deposits of 0.3 μm copper sulfate particles.(8) Evaporated metal film standards obtained from Micromatter Co. (Seattle, Washington) were used for lead and other elements.(8)

To correct for attenuation of sulfur x-rays in the fine particle fraction, a very slight correction (1 to 10%) was made in proportion to the amount of mass collected.(8) For the coarse particle fraction, the attenuation correction factors for Si, S, K, Ti, Fe, Cu, Zn, Se, Br, and Pb, used were 0.48, 0.78, 0.87, 0.94, 0.94, 0.95, 0.98, 0.99, and 1.00 respectively.(9) Descriptions of the analysis procedure are described in more detail by Stevens et al.(8)

ANALYSIS OF IONIC SPECIES

The samples from MDS-S were analyzed for sulfate and nitrate using ion exchange chromatography. Extraction, the initial step in the analysis was accomplished by placing each sample in a Nalgene polypropylene bottle (30 ml volume) containing 20 ml of $5 \times 10^{-5}\text{N}$ perchloric acid extraction solution. The extraction vessel was capped and put in a sonic bath for 20 minutes. A study using x-ray fluorescence techniques has shown this procedure extracts 99% of the sulfur from the fine fraction and 95% of the sulfur from the coarse fraction.

After extraction, sulfate and nitrate were determined using a Dionex Model 14 Ion Chromatograph (IC). The samples were spiked with a base ($.003\text{M NaHCO}_3 + 0.0005\text{M Na}_2\text{CO}_3$) so that the range 10^{-5}M to 10^{-3}M was spanned. Retention times and peak areas were obtained using standards (10^{-7} to 10^{-4}M of $(\text{NH}_4)_2\text{SO}_4$ and NaNO_3), and a calibration curve was drawn. Analysis of sulfate data showed that the minimum detectable level was 10^{-1} neq/ml and that sulfate concentrations were determined to within $\pm 10\%$.

The minimum detectable level for nitrate was $5 \times 10^{-2}\text{ neq/ml}$, and the concentrations were determined to within $\pm 15\%$. For the 12 hour samples collected with a 14 l/min flow rate, the detection limits expressed in units of atmospheric concentrations were $10^{-2}\text{ }\mu\text{g/m}^3$ and $7 \times 10^{-3}\text{ }\mu\text{g/m}^3$ for sulfate and nitrate, respectively. A more detailed description of the extraction and analysis procedures is given by Stevens et al.(8)

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LINEAR STREAKER SAMPLERS

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LINEAR STREAKER SAMPLERS

The Florida State Elemental Analysis Group working with the Environmental Protection Agency, the National Science Foundation, the Florida Sulfur Oxide Study Board, and numerous international groups in Europe, Asia, Africa, and South America has developed a complete air particulate monitoring system. The heart of this system is the linear streaker.(1)

During the Charleston study four streakers were deployed, but data were reported for only two of the samplers. These devices filter continuously collecting particulate over a small area of 2 mm x 5 mm. An orifice is moved by a synchronous motor-screw drive across the filter surface at a rate of 1 mm per hour to produce a 5 mm wide, 168 mm long strip sample in a time of one week. Analysis of the filter is limited to a width of 2 mm which yields pollutant data equivalent to 84 time averaged 2 hour samples. For the purpose of the intercomparison study 6 two hour samples were averaged to give the 12 hour samples reported. Polycarbonate nuclepore filters of 0.4 μ m and 0.2 μ m pore size were used depending on the flow rate desired. The Nuclepore filter itself may be used to limit the flow, or a flow control device may be connected in series. Flows of one liter per minute or less produce satisfactory loadings for PIXE analysis of elements $Z \geq 13$. Regularly measured are Al, Si, S, Cl, K, Ca, Fe, Zn, Br, and Pb; and less often Ti, V, Cu, Ni, Sn and As. The streaker samples are also well suited for PESA(2) (proton elastic scattering analysis) which gives trace element information in the range $1 \leq Z \leq 20$.

The streaker is a simple reliable, and flexible sampler, which is also highly portable and inexpensive. This has led to its reliable use in the Amazon basin, in the Namib desert, and in the Indian Ocean. Over 100,000 elemental data points have been generated in one year with a time resolution needed to compare with meteorological data. The linear streaker is a total filter device. Its main disadvantage is that it does not give two size fractions. This will be remedied by the circular streaker(3) which will soon be network tested. The linear streaker's intake is vertically upward, and electron microscope pictures of filters indicate an upper size limit of 15 μ m for particles collected. The Nuclepore filter is mounted on an aluminum frame which can be quickly inserted and removed from the streaker.

The streaker filters frames require no preparation before being placed in a specially designed vacuum chamber(3) where the filters are irradiated with 5 MeV protons from FSU's super-FN Tandem Van de Graaff. (A small vertical Van de Graaff dedicated to PIXE analysis is planned for operation in 1979 and will allow the production of 10^6 data points a year). The x-rays generated are detected using an energy dispersive Si(Li) detector purchased from Nuclear Semiconductor, which has a resolution of about 170 eV FWHM for the iron K x-ray (6.4 keV). The detector signals are processed using Nuclear Semiconductor electronics which include an amplifier, a pulse pile up rejector, a low level discriminator, and live time counter. Processed signals are fed into a Northern Scientific ADC which is Camac interfaced to an EMR 6130 on-line computer. At the end of each run the data is written on magnetic tape for off-line analysis. The PIXE technique is well understood(4) and the Elemental Analysis Group has taken part in numerous intercomparison studies.(5,6)

A sophisticated FORTRAN code REX(7) is used to fit the x-ray spectra. This code carefully models the spectra obtained. It contains information relevant to elemental x-ray line shapes, the Bremsstrahlung background, the silicon absorption edge, x-ray production cross sections, self absorption and attenuation, and other parameters. Absolute calibration is made from standards produced by Micro-Matter, Inc. and checked by PESA.(2)

During this experiment flow rates were maintained using a Mass Flow Controller TYLAN Model FC 260. The precision of this device was confirmed before and after the experiment using a spirometer and a factory calibrated variable area flowmeter (Matheson Model 601).

As a side experiment two other linear streakers were run. One was uncontrolled at 0.8 μm and one had a prefilter of 8 μm pore size. Modified Battelle cascade impactors were used as well with 4 hour sampling periods. These impactors have size cuts > 4 , 4-2, 1-0.5, 0.5-0.25 and < 0.25 μm , respectively. Mylar impaction surfaces and 0.4 μm Nuclepore afterfilters were employed. Petroleum jelly was used to coat the impaction surface except for the last impaction stage which was coated with parafin. Flow rates of the impactors were controlled by a critical flow orifice and were measured with a calibrated variable area flowmeter. Additional results from these samplers will be reported in a separate publication at a later date.

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AUTOMATED DICHOTOMOUS SAMPLERS

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QUALITY ASSURANCE MEASURES

Sampling

1. Flow calibrations performed in the field.
2. Automated flow controller in the sampler maintains the pre-set flow rate.
3. Fault sensors continuously check for filter loading, proper filter transport and vacuum seals.
4. Flow calibrations checked upon completion of study.

Analysis

1. Checked calibration and XRF spectrometer gain setting.
2. Checked helium level during XRF analysis.
3. Calibrate beta-gauge every hour.
4. Check and correct for long term beta-gauge response.
5. All samples measured twice for both total mass and elemental composition which checks for precision and any obvious error.

DETAILED ANALYTICAL METHODS AND PROCEDURES

Mass Measurement

A beta gauge consisting of a Pm^{147} source and a cooled Si detector was used. The areal mass of all filters was measured twice prior and subsequent to field sampling. The measured beta intensity I was related to the sample thickness X in $\mu\text{g}/\text{cm}^2$ by $I = I_0 e^{-\mu X}$ where I_0 and μ were constants derived from a leastsquare fit to five calibration standards. These standards were gravimetrically weighted polycarbonate films of thicknesses 1034.6, 1511.9, 1970.6, 2552.2 and 2931.0 $\mu\text{g}/\text{cm}^2$. The counting times used for calibration and routine measurement were 100 and 30 sec. respectively. About 4×10^6 counts were accumulated within 30 sec. for a sample of 1 mg/cm^2 . For a mean aerosol concentration of 107 $\mu\text{g}/\text{cm}^2$ the mean reproducibility was 4.7 $\mu\text{g}/\text{cm}^2$. A correction factor for long term systematic changes of 12.5 $\mu\text{g}/\text{cm}^2$ was determined from the remeasurement of 25 unexposed filters.

XRF Measurements

An XRF spectrometer including a pulsed x-ray source, cooled anti-coincidence guard-ring Si(Li) detector and fluorescent targets of Ti, Mo and Sm were used for elemental analysis. The x-ray calibration factors were determined using a series of thin-film standards which closely replicate the membrane filter samples. These standards are either uniform evaporation deposits of single element whose mass has been determined gravimetrically or multiple element standards in which the elemental concentration ratios are accurately known. For example the sulfur calibration was obtained by measuring specimens of $0.3\text{ }\mu\text{m}$ $\text{Cu SO}_4 \cdot 5\text{H}_2\text{O}$ aerosols deposited on the surface of $0.1\text{ }\mu\text{m}$ pore size nucleopore filters. In this case evaporated deposits were used as primary standards. This calibration was cross-checked with that determined from a series of relative standards, namely K_2SO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$ and Cu-Cr mixed aerosol standards. The agreement was within 1%.

The x-ray attenuations due to the size of the particles were corrected using the method described by Dzubay and Nelson (Adv. in X-ray Anal. 18, 619, 1975). The values employed are listed as follows:

Element	Fine Particles	Coarse Particles
Si	0.93 ± 0.07	0.48 ± 0.15
S	0.97 ± 0.03	0.64 ± 0.22
Ca	0.99 ± 0.01	0.81 ± 0.13
Ti		0.87 ± 0.10
Fe		0.94 ± 0.05
Cu		0.94 ± 0.06
Zn		0.95 ± 0.05

Due to the flow division within the virtual impactor, the reported values on size segregated samples have an implicit 5% interference of fine particle on the coarse particle fraction. This effect, of course, disperses when the two size fractions are summed. The only case where it may introduce any significant error is where the particles are found predominantly in fine particles and where the coarse particle size attenuation correction is large. This was the case with S and the attenuation corrections were applied after making the 5% fine particle interference correction.

CYCLONE SEQUENTIAL FILTER SAMPLERS

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The samplers used in the aerosol sampler intercomparison conducted in Charleston, West Virginia between May 11 and May 19, 1977, were RT Model 5200 Sequential Filter Samplers. The sampling head consists of a 5 cm I.D. by 50 cm long tube topped by a cylindrical shroud. The purpose of the shroud is to render the entry of large particles into the sampler relatively insensitive to changes in wind speed. The conical covering prevents entry of rain. Wire screens are located over the top and the bottom of the shroud to prevent entry of insects into the duct.

One of the samplers, F, was equipped with a cyclone preseparator located within the shroud. The Unico 240 cyclone used was calibrated for particle removal by Eisenbud and Kneip (1975). Based on their results, the 50 percent collection efficiency size for unit density spheres varied from 2.0 to 2.7 μm diameter as the flow rate varied over the range from 100 to 150 ℓpm . The sampler equipped with the cyclone collected only particles smaller than these sizes. The second sampler did not have a preseparator and collected particles smaller than approximately 15 μm diameter.

Sampled air passes through the inlet duct to the cylindrical chamber containing position for 13 filter holders. The circular arrangement of the filters subjects each to similar flow patterns. Air is never sampled through the thirteenth position; a filter is placed in this position to assess the effects of particle deposition when sampling is not occurring.

The filter holders are connected to a common pump through a system of solenoid valves. The valves are actuated by timers to allow sampling of the twelve filters in succession. The sampling times are programable for periods from 5 minutes to 24 hours by means of a 24-hour time switch. A sampling sequence can be programmed to start at any time within seven days after set-up. The deviation of the actual starting time from the programmed time is 30 minutes or less.

Flow rates are monitored continuously by means of a vacuum recorder connected upstream of the pump. The recorder is calibrated for flow rate.

The samplers accommodate open-face 47 mm diameter filter holders. The filter holders are equipped with quick-disconnect type fittings to allow easy installation and removal. Filters were shipped to and from the field in fil-

XRF Measurements

An XRF spectrometer including a pulsed x-ray source, cooled anti-coincidence guard-ring Si(Li) detector and fluorescent targets of Ti, Mo and Sm were used for elemental analysis. The x-ray calibration factors were determined using a series of thin-film standards which closely replicate the membrane filter samples. These standards are either uniform evaporation deposits of single element whose mass has been determined gravimetrically or multiple element standards in which the elemental concentration ratios are accurately known. For example the sulfur calibration was obtained by measuring specimens of $0.3\text{ }\mu\text{m}$ $\text{Cu SO}_4 \cdot 5\text{H}_2\text{O}$ aerosols deposited on the surface of $0.1\text{ }\mu\text{m}$ pore size nucleopore filters. In this case evaporated deposits were used as primary standards. This calibration was cross-checked with that determined from a series of relative standards, namely K_2SO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$ and Cu-Cr mixed aerosol standards. The agreement was within 1%.

The x-ray attenuations due to the size of the particles were corrected using the method described by Dzubay and Nelson (Adv. in X-ray Anal. 18, 619, 1975). The values employed are listed as follows:

Element	Fine Particles	Coarse Particles
Si	0.93 ± 0.07	0.48 ± 0.15
S	0.97 ± 0.03	0.64 ± 0.22
Ca	0.99 ± 0.01	0.81 ± 0.13
Ti		0.87 ± 0.10
Fe		0.94 ± 0.05
Cu		0.94 ± 0.06
Zn		0.95 ± 0.05

Due to the flow division within the virtual impactor, the reported values on size segregated samples have an implicit 5% interference of fine particle on the coarse particle fraction. This effect, of course, disperses when the two size fractions are summed. The only case where it may introduce any significant error is where the particles are found predominantly in fine particles and where the coarse particle size attenuation correction is large. This was the case with S and the attenuation corrections were applied after making the 5% fine particle interference correction.

CYCLONE SEQUENTIAL FILTER SAMPLERS

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The samplers used in the aerosol sampler intercomparison conducted in Charleston, West Virginia between May 11 and May 19, 1977, were ERT Model 5200 Sequential Filter Samplers. The sampling head consists of a 5 cm I.D. by 50 cm long tube topped by a cylindrical shroud. The purpose of the shroud is to render the entry of large particles into the sampler relatively insensitive to changes in wind speed. The conical covering prevents entry of rain. Wire screens are located over the top and the bottom of the shroud to prevent entry of insects into the duct.

One of the samplers, F, was equipped with a cyclone preseparator located within the shroud. The Unico 240 cyclone used was calibrated for particle removal by Eisenbud and Kneip (1975). Based on their results, the 50 percent collection efficiency size for unit density spheres varied from 2.0 to 2.7 μm diameter as the flow rate varied over the range from 100 to 150 ℓpm . The sampler equipped with the cyclone collected only particles smaller than these sizes. The second sampler did not have a preseparator and collected particles smaller than approximately 15 μm diameter.

Sampled air passes through the inlet duct to the cylindrical chamber containing position for 13 filter holders. The circular arrangement of the filters subjects each to similar flow patterns. Air is never sampled through the thirteenth position; a filter is placed in this position to assess the effects of particle deposition when sampling is not occurring.

The filter holders are connected to a common pump through a system of solenoid valves. The valves are actuated by timers to allow sampling of the twelve filters in succession. The sampling times are programable for periods from 5 minutes to 24 hours by means of a 24-hour time switch. A sampling sequence can be programmed to start at any time within seven days after set-up. The deviation of the actual starting time from the programmed time is 30 minutes or less.

Flow rates are monitored continuously by means of a vacuum recorder connected upstream of the pump. The recorder is calibrated for flow rate.

The samplers accommodate open-face 47 mm diameter filter holders. The filter holders are equipped with quick-disconnect type fittings to allow easy installation and removal. Filters were shipped to and from the field in fil-

ter holders to eliminate the need for filter handling at the sites. A protective plastic cap is placed over the filter holder during shipment and handling.

The vacuum recorders in the samplers were calibrated three times during the program: on 10, 15, and 19 May 1977. Calibrations were performed with dry test meter attached at the sampler inlet. The cyclone preseparator was removed from the RSP sampler and the dry gas meter was connected in its place. Various types and combinations of filters were installed in the sampler to produce various flow rates for the calibration. The calibration was performed by cycling the sampler through these filters and recording the readings of the dry gas meter and the vacuum recorder. In the case of the TSP sampler which did not have a cyclone, the cylindrical chamber from the RSP sampler was installed for the calibration.

The results of the first and second and the second and third calibrations for each sampler were taken together and linear least-squares fits to each set of two calibrations were made. The calibration curve from the first set was used for reducing the data from the 11-14 May sampling; that from the second set was used for the 15-19 May sampling data.

CALCULATIONS OF CONCENTRATIONS

To calculate the volume of air sampled during each 3-hour sampling interval, the initial and final flow rates were averaged and multiplied by the time elapsed during the interval.

The quantity of anionic material on each filter was determined as the product of the concentration of the anion in the extracted solution times any dilution factor times the reciprocal of the fraction of the filter which was extracted. These products, in nanograms, for four 3-hour intervals were added and the sum was divided by the sum of the volumes of air sampled during the four intervals to yield the average concentration of the anion in air, in ng m^{-3} , for each 12-hour reporting period.

FILTER MEDIUM

Particulate samples were collected on 47 mm diameter Teflon-impregnated glass fiber disks with the designation TX40HI20 manufactured by Pallflex Products Corp. to ERT specifications. This choice was based on the following considerations:

- The filter medium must retain particles efficiently while transmitting gases.
- Flow rates achievable using the filters in the Sequential Filter Samplers must be sufficient to allow collection of adequate material for analysis by the methods chosen.
- The filters must have sufficient mechanical strength for easy handling.

The first consideration, transmission of gases, eliminated ordinary glass fiber filters, because filters of this type have been shown to interact strongly with sulfur dioxide and other acid gases such as nitrogen oxides leading to erroneously high measurements of sulfates and nitrates. Membrane filters were

eliminated by the second consideration because of their high flow resistance. The remaining types of filters to be considered were quartz fiber filters and the Teflon-impregnated glass fiber filters. Evaluation of the quartz fiber filters indicated they were too fragile to handle without significant loss of filter material.

GRAVIMETRIC ANALYSIS

Weighings were performed with a Cahn Model 4700 Automatic Electro-balance. Static charges were removed from the balances and from filters with Po^{210} ionization units located inside the weighing chambers in the balances.

Filters were equilibrated for a minimum of 24 hours in the balance room prior to weighing. The room was maintained between 23 and 25°C and at a relative humidity below 50 percent. Unexposed filters were equilibrated in the containers with the lid open in which they were received from the manufacturer. Exposed filters remained in the shipping containers with the lid open and the protective caps in place during equilibration.

Filters were inspected visually for defects prior to weighing. Unexposed filters showing defects were discarded.

The balance was operated at a full-scale range of 2000 μg with a resolution of 10 μg . Calibration was performed with Class M weights.

ANION ANALYSIS

Nitrate and sulfate were determined from a single extract by the technique developed by Small and co-workers (1975). This technique is called ion chromatography (IC).

A quarter of the filter was placed in a numbered borosilicate culture tube which had been previously cleaned and conditioned with eluent buffer, and 10 ml of buffer were added by means of a Repipet liquid dispenser. The tube was then capped and shaken ultrasonically for minutes in a Branson 32 ultrasonic cleaner. Because standing waves may exist at some points in the cleaner, the tubes were moved continuously during the extraction process.

Stock solutions of standard were prepared by dissolving analytical grade reagents in distilled deionized water and storing them in the refrigerator. Standard mixtures of NO_3^- and SO_4^{2-} were prepared in eluent buffer daily. All solutions were allowed to equilibrate at the instrument room conditions before analysis.

A Model 10 ion chromatograph (Dionex Corp., Palo Alto, CA) was used for the analysis of the anions. For maximum resolution of the ions of interest, the instrument was operated at a pump speed of 2 ml/min. The eluent buffer was 0.001M Na_2CO_3 and 0.003M NaHCO_3 prepared in distilled deionized water having a conductivity of less than 0.1 $\mu\text{mho/cm}$. All samples were run at the 10 μmho full-scale setting.

A disposable syringe was used to load the solution into the sample loop.

Each sample was individually filtered in-line with a 0.2 μm pore size membrane filter during the sample-loading step in order to prevent contamination of the column with insoluble matter. Injections of the samples were spaced by fifteen minutes to allow complete elution of all anions.

For each ionic species, the peak height was measured from the defined baseline of initial to final inflection.

Calibration curves were prepared from a plot of peak height in inches versus concentration in $\mu\text{g/ml}$. The linear regression for each curve was used to reduce the data.

HIGH VOLUME AND DICHOTOMOUS SAMPLERS

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INTRODUCTION

The Environmental Monitoring and Support Laboratory (EMSL) of EPA will participate in the Aerosol Sampler Comparison Study by operating 2 high-volume (hi-vol) samplers and 2 EMSL dichotomous samplers. EMSL will be responsible for all aspects of our portion of the study including: (1) equipment and personnel transportation, (2) set-up and take-down, (3) operation during the 8 day period and (4) analysis for selected parameters.

SAMPLING DEVICES AND FILTER SUBSTRATES

The hi-vols used will conform to the standard Federal Register (1) requirements with the addition of constant mass flow controllers and Dixon flow recorders. The hi-vols will be operated at 1.42 sm³/min (50 SCFM) using acid washed 200 x 250 cm (8 x 10 in.) glass fiber filters.

The EMSL dichotomous samplers have the standard "Coarse" and "Fine" channels with a 3.5 μ m cutpoint and an inlet cut-off of $\sim 20 \mu$ m. These samplers also include a separate "Total" channel which collects aerosols $\lesssim 20 \mu$ m. Flow control is maintained by critical flow valves with rotameters on all 3 channels. The sampler utilizes 37 mm Fluoropore Teflon filters with a polyethylene backing. These filters are backed with a 37 mm cellulose pad and placed in circular holders which fit holders in the respective sampler channels.

QUALITY CONTROL

The samplers will be checked for flow calibration only. All samplers will be calibrated initially in RTP using a Rootsmeter® as the traceable standard. After the samplers are set up in the field, transfer flow standards will be used to audit check the flowrate initially and in the middle of the study. A standard audit orifice also calibrated using the Rootsmeter® is used to check the hi-vols. A 300 mm rotameter calibrated in the lab against a dray-test meter is used to audit check the "Total" and "Fine" dichotomous channels. The "Coarse" channel is checked with a calibrated mass flowmeter. At the conclusion of the study all samplers will be recalibrated with the audit flow devices.

During sample collection a change in flowrate from the beginning to the end of a sampling period (12 hrs) of $\pm 15\%$ is allowable. Flow changes greater than this would invalidate the respective sample.

In order to obtain reproducibility information 2 samplers of each type will be operated simultaneously for 8 sample periods (4 days). After these comparison tests the samplers will be operated alternately to obtain only one sample of each type per time period.

ANALYSES

The primary measurements will be gravimetric mass using a 5-place balance, with subsequent analyses for sulfate ($\text{SO}_4^{=}$) by the MTB method and lead (Pb) by atomic absorption. Mass measurements will be made on all filters. Two measurements - $\text{SO}_4^{=}$ and Pb - will be performed on all samples collected except the duplicate dichotomous samples. The wet chemistry and mass analyses will be performed by the Analytical Chemistry Branch of EMSL.

REFERENCES

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HIGH VOLUME AND DIFFUSION SAMPLER

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The samplers used in this study are a conventional Staplex High Volume sampler sampling at about $0.9 \text{ m}^3/\text{min}$ and a diffusion sampler sampling through three 47 mm filters at a total flow rate of about $2.5 \text{ m}^3/\text{hr}$. The Hi-Vol sampler samples all particles less than about $20 \mu\text{m}$ in diameter. All three diffusion-processed samples were taken through an entrance tube that excluded most particles larger than about $5 \mu\text{m}$ in diameter: Sample DB0 samples all remaining size ranges of particles; particles smaller than about $0.04 \mu\text{m}$ are removed by diffusion from sample DB1, particles smaller than about $0.1 \mu\text{m}$ are removed from sample DB2.

Samples from both the Staplex HiVol and the diffusion sampler were collected on phosphoric acid-treated quartz filters (1) (Pall Corp., Putnam, Conn., Type GA0). This filter material is prepared as follows: the filter as received is ignited overnight at 750°C to remove binder material; filter is then washed then treated with hot (80°C) phosphoric acid; following a rinse to remove excess H_3PO_4 , filter is reignited to 750°C . A post-ignition rinse in Ph 5 HCl removes excess P_2O_5 and following drying at 100°C , the filter is ready for use. The HiVol sampler was also used to collect an SO_2 sample during each period on two K_2CO_3 , glycerol-impregnated cellulose filters in series with the quartz prefilter.

The HiVol sampler was mounted in a conventional HiVol enclosure protected from precipitation and could be operated under any precipitation conditions. The diffusion-sampling pump was placed in a protective box but in the absence of an enclosed shed, no protection was used with the diffusion battery and filter holders; although no diffusion sampling during heavy rain conditions could be conducted, these conditions were not encountered during the study.

The HiVol sampler has been calibrated with the filter pack in place using a magnetohelic gauge. Decreases in flow during 12 hr sampling were checked out after the experiment and found to be less than 1 cfm, insignificantly low to require measurement for each sample. The diffusion sampler has been calibrated using unrestricted Matheson rotameter tubes in series upstream from the three 47 mm filter holders, (i.e., in line at ambient pressure). This calibration was assumed to hold constant for 47 mm quartz filters from the same batch of treated quartz. The calibration was checked after the experiment for constancy; changes of only a few % were observed

and the average of flows before and after the Intercomparison were used for sample volume calculations.

Each 4-in diameter, HiVol quartz particulate filter was quartered with one filter quarter sequentially extracted by benzaldehyde and isopropanol and the extract contents analyzed for H_2SO_4 and bisulfate, respectively, by the flash volatilization-FPD technique (3). A second quarter was extracted into pH 4 aqueous solution and soluble strong acid determined by Gran titration (1), ammonium and nitrate ions by Autoanalyzer colorimetric techniques (1), and soluble sulfate determined by ion chromatography (4) and also by Methylthymol Blue colorimetry (5). The remaining quarters were saved for replicate determinations as needed or for cross checks of sulfur content by the reduction-sliver-110 technique (2). The SO_2 was determined in the two K_2CO_3 , glycerol-impregnated cellulose backup filters by extraction into aqueous peroxide with determination as sulfate by ion chromatographic or turbidimetric Autoanalyzer techniques.

The diffusion-processed samples, collected on 47 mm treated quartz filters, were bisected. One half was analyzed for soluble strong H^+ , NH_4^+ , SO_4^{2-} and NO_3^- by the methods described above; the second half was sequentially extracted by benzaldehyde for determination of H_2SO_4 and also by the techniques described above.

REFERENCES

- (1) R. L. Tanner, R. Cederwall, R. Garber, D. Leahy, W. Marlow, R. Meyers, M. Phillips and L. Newman, "Separation and Analysis of Aerosol Sulfate Species at Ambient Concentrations", Atmos. Environ., 11, 955 (1977).
- (2) J. Forrest and L. Newman, "Application of ^{110}Ag Microgram Sulfate Analysis for the Short Time Resolution of Ambient Levels of Sulfur Aerosol", Anal. Chem., 49, 1579 (1977).
- (3) R. L. Tanner, R. W. Garber and L. Newman, "Speciation of Sulfate in Ambient Aerosols by Solvent Extraction with Flame Photometric Detection", 173rd National Meeting, American Chemical Society, New Orleans, LA, March 20-25, 1977.
- (4) W. E. Rich, "Analysis of Nitrate and Sulfate Collected on Air Filters", Application Note No. 2, Dionex Corp., Palo Alto, CA, January 23, 1976.
- (5) J. M. Adamski and S. P. Villard, "Application of the Methylthymol Blue Sulfate Method to Water and Wastewater Analysis", Anal. Chem., 47, 1191 (1975).

APPENDIX B

OUTLIER AND REGRESSION ANALYSIS EQUATIONS

OUTLIER TEST

The Dixon criterion is a statistical test applied to any set of n observations, where $n \geq 3$. Its objective is to identify an observation, which to within a chosen probability, does not belong to the other $(n-1)$ observations. These do not include observations where there is a known cause for its deviation. Otherwise when the deviation is larger than one can reasonably expect, this should serve as a stimulus to discover what happened. If it appears that nothing happened then the results in this intercomparison study were left as is; however, the outlying values were flagged for all to see.

Let n be defined as the number of real non-zero sampler concentrations reported for a given period of the intercomparison study. Four coefficients are defined by each period's result set; however, only one coefficient will apply. Its use and definition depend on the number of results for that period, and whether the suspected observation lies at the low or high end. If the observations are ordered from 1 to n , where the first value, X_1 , is the lowest concentration reported and X_n is the greatest, then the four coefficients are defined as follows depending on n .

$$r_1: 3 \leq n \leq 7 \quad (B-1)$$

$$r_2: 8 \leq n \leq 10 \quad (B-2)$$

$$r_3: 11 \leq n \leq 13 \quad (B-3)$$

$$r_4: 14 \leq n \leq 25 \quad (B-4)$$

If result X_n is suspect, then

$$r_1 = (X_n - X_{n-1}) / (X_n - X_1) \quad (B-5)$$

$$r_2 = (X_n - X_{n-1}) / (X_n - X_2) \quad (B-6)$$

$$r_3 = (X_n - X_{n-2}) / (X_n - X_2) \quad (B-7)$$

$$r_4 = (X_n - X_{n-2}) / (X_n - X_3) \quad (B-8)$$

If the result X_1 is suspect, then

$$r_1 = (X_2 - X_1) / (X_n - X_1) \quad (B-9)$$

$$r_2 = (X_2 - X_1) / (X_{n-1} - X_1) \quad (B-10)$$

$$r_3 = (X_3 - X_1) / (X_{n-1} - X_1) \quad (B-11)$$

$$r_4 = (X_3 - X_1) / (X_{n-2} - X_1) \quad (B-12)$$

The r_j coefficients are calculated and compared to tabulated coefficients $r(1-\alpha/2)$, where α is defined as the probability assumed in rejecting a re-

sult that really belongs in the group. For the intercomparison study α was defined as 4%, thus any value greater than 2% high or less than 2% low would be defined as an outlier.

The calculated r_j coefficients are compared to standard tables, a portion of which is given in Table B-1. Although α was chosen as 4%, if α is chosen smaller the coefficients will become larger and the likelihood of rejection decreases.

TABLE B-1. CRITERIA FOR REJECTION OF OUTLYING OBSERVATIONS

Coeffi- cient	# of Observ.	Upper Percentiles			Coeffi- cient	# of Observ.	Upper Percentiles		
		$\alpha=10$.95	$\alpha=4$.98	$\alpha=2$.99			$\alpha=10$ 0.95	$\alpha=4$ 0.98	$\alpha=2$ 0.99
r_1	3	.941	.976	.988	r_3	11	.576	.638	.679
	4	.765	.846	.889		12	.546	.605	.642
	5	.642	.729	.780		13	.521	.578	.615
	6	.560	.644	.698		14	.546	.602	.641
	7	.507	.586	.637		15	.525	.579	.616
r_2	8	.554	.631	.683	r_4	16	.507	.559	.595
	9	.512	.587	.635		17	.490	.542	.517
	10	.477	.551	.597		\vdots	\vdots	\vdots	\vdots
						\vdots	\vdots	\vdots	\vdots

More detailed information on the Dixon criterion can be found in Experimental Statistics, a National Bureau of Standards Handbook 91, Chapter 17, by M. G. Natrella, issued August 1, 1963, reprinted October 1966, with corrections.

REGRESSION ANALYSIS

Assume that the pollutant concentration results obtained for sampler Y are linearly correlated with those obtained for sampler X. Let j be the period number ($j = 1, 2, 3, \dots, 16$). Then for any sampler Y we can write

$$y = a + bx \quad (B-13)$$

The intercept, a , will be given by

$$a = \frac{1}{n} \left[\sum Y - \frac{\sum XY}{\sum X} \right] \quad (B-14)$$

and

$$b = \frac{\sum XY}{\sum X^2} = \frac{\sum XY - \frac{1}{n} \sum X \sum Y}{\sum X^2 - \frac{1}{n} (\sum X)^2} \quad (B-15)$$

and n is defined as the number of paired $X_j Y_j$ values (≤ 16). Note that when regression analysis is performed between any sampler and the composite Z -means there will always be 16 Z_j values, but not necessarily 16 paired $Y_j Z_j$ values.

Similarly, when regression analysis is performed between any two samplers $X_j Y_j$, the number of paired values will define n . The errors ϵ_a and ϵ_b can also be calculated using

$$\epsilon_a = \left\{ \frac{1}{n-2} \left[\sum Y^2 - \frac{1}{n} (\sum Y)^2 - \frac{(SXY)^2}{SXX} \right] \left[\frac{1}{n} + \frac{(\bar{X})^2}{SXX} \right] \right\}^{\frac{1}{2}} \quad (B-16)$$

where $\bar{X} = \frac{1}{n} \sum X_j$ and $\bar{Y} = \frac{1}{n} \sum Y_j$

$$\epsilon_b = \left\{ \frac{1}{n-2} \frac{1}{SXX} \left[\sum Y^2 - \frac{1}{n} (\sum y)^2 - \frac{SXY}{SXX} \right] \right\}^{\frac{1}{2}} \quad (B-17)$$

The root mean square residual, r , of the fit is one measure of how well the two samplers define a linear relationship. The results from two samplers may tightly define their mutual slope, b , in which case r is small. However, if two samplers report widely fluctuating values, then r will be large. If all samplers are compared to the composite sampler, then an intercomparison of their respective r 's is a measure of their relative precisions (assuming that b is approximately 1.0). The root mean square residual concentration for sampler Y relative to sampler X is defined by

$$r = \left[\frac{1}{m} \sum_{j=1}^m (Y_j - \hat{Y})^2 \right]^{\frac{1}{2}} \text{ in ng/m}^3 \text{ (or } \mu\text{g/m}^3 \text{)}, \quad (B-18)$$

where there are m concentration results for sampler Y_j and \hat{Y} is given by (B-13). Finally, it is useful to examine how well the two samplers X and Y are correlated, i.e., how linearly related their concentrations are. The correlation coefficient is given by

$$(b_{XY} \cdot b_{YX})^{\frac{1}{2}} = \left(\frac{SXY}{SXX} \frac{SYX}{SYY} \right)^{\frac{1}{2}} \quad (B-19)$$

SXY was given in (B-15) and SYX is obtained by interchanging X and Y in that expression.

The intercept and its error, the slope and its error, the root mean square deviation in μg or ng/m^3 , and the correlation coefficient are listed in Appendix C for each sampler that reported results for any pollutant fraction or total concentration.

More detailed information on linear regression analysis of two variables can be found in Experimental Statistics, a National Bureau of Standards Handbook 91, Chapter 5, by M. G. Natrella, issued August 1, 1963, reprinted October 1966, with corrections.

APPENDIX C

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Introduction, Definitions, and Comments	100
Pollutant	Total/Small/Large
Mass	101
Nitrate	104
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Silicon	116
Calcium	119
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Iron	125
Copper	128
Zinc	131
Selenium	133
Bromine	136
Lead	139

INTRODUCTION

DEFINITIONS

COMMENTS

POLLUTANT RESULTS ARE GROUPED TOTAL, SMALL, & LARGE WITH THE FOLLOWING ORDER:
MASS, NO₃, SO₄, S, S+SO₄, & TRACE ELEMENTS-SI, CA, TI, FE, CU, ZN, SE, BR, & PB.

TOTAL: REPORTED TOTAL CONCENTRATIONS OR SUM OF ALL FINE & COARSE FRACTION RESULTS

SMALL: USUALLY THE FINE FRACTION(S); CUT POINTS WILL VARY WITH SAMPLER TYPE:
SMALL MEANS ABOUT 3.0 + OR - 0.5 MICROMETERS AND SMALLER

LARGE: THE COARSE FRACTION; INLET RESTRICTIONS AND FINE CUT POINTS VARY ALSO.
LARGE MEANS ABOUT 3.0 + OR -0.5 MICROMETERS AND GREATER, UP TO THE INLET CUTOFF

MASS RESULTS & ERRORS (NOT SHOWN) ARE PUNCHED IN TENTHS OF MICROGRAMS/CUBIC METER
BUT ROUNDED OFF IN THE TABLES. ALL OTHER RESULTS ARE LISTED IN NANOGRAMS/CUBIC M

S A M P L E R

D E F I N I T I O N S

DICOT= AUTOMATED DICHOTOMOUS SAMPLERS (3-C, L, & S) FROM LBL-L00
DICOT= AN ERC DICHOTOMOUS SAMPLER (1 - O) FROM EPA-RODES
HIVOL= HIGH VOLUME SAMPLERS (3: A FROM BNL-TANNER & P/T FROM EPA-RODES/BURTON)
LS = LINEAR STREAKER SAMPLERS (2 - J & K) FROM FLA.ST.UNIV.- HUDSON
MDS = MANUAL DICHOTOMOUS SAMPLERS (2 - D & R) FROM EPA-DZUBAY
RSP = CHAMP SAMPLERS (2-B&U) FROM EPA-BURTON; CYCLONE SAMPLER (1-F) FROM MUELLER
SMDAY= SIERRA MULTIDAY SAMPLER (1 - G) 3-STAGES UNIV.CA.DAVIS-CAHILL
SFU = STACKED FILTER UNIT (1 - I) 2-STAGES FROM UNIV.CA.DAVIS-CAHILL
TTLF = TOTAL FILTER UNIT (1 - H) 1-STAGE FROM UNIV.CA.DAVIS-CAHILL
TSP = CYCLONE SAMPLER (1 - E) FROM ERT-MUELLER
ZMASS= TWO MASS SAMPLER (1 - Q) FROM WASH.UNIV.,ST.LOUIS-DELMUYEA/MACIAS

FOR EACH POLLUTANT, THE FIRST RESULT TABLE LISTS THE REPORTED CONCENTRATIONS AS
A FUNCTION OF PERIOD, EACH 12 HOURS LONG, AND LISTED FROM COLUMNS 1 THROUGH 16.

EACH SAMPLER IS ASSIGNED AN ALPHABETICAL INDEX ACCORDING TO ITS SPATIAL LOCATION
AT THE FIELD STUDY. SEE FIGURE 1 AND TABLE 4 IN THE TEXT FOR MORE INFORMATION.

A DASH - ENTERED IN THE TABLE INDICATES NO VALUE REPORTED FOR THAT SAMPLER & PD.
OUTLIER VALUES ARE DENOTED BY A -(NEG) SIGN BUT ARE INCLUDED IN MEAN CALCULATION

THE Z-MEAN INCLUDES ALL SAMPLER RESULTS & OUTLIERS EXCEPT THOSE IN PARENTHESIS.

THE X-MEAN INCLUDES ONLY THOSE SAMPLER RESULTS NOTED IN PARENTHESIS-NO DUPLICATE

THE SECOND TABLE LISTS RATIOS OF REPORTED RESULTS TO THE APPROPRIATE Z-MEANS.
THE LAST 3 COLUMNS LIST THE 16-PERIOD AVERAGE RATIOS, THEIR STANDARD DEVIATIONS,
AND THE PERCENT ERROR ASSOCIATED WITH THAT STD.DEV. (COEFFICIENT OF VARIATION)

AN ASTERISK BY ENTRIES IN THIS TABLE INDICATE THAT A PARTICIPANTS REPORTED ERROR
FOR THAT PERIOD ALLOWS HIS RESULT TO OVERLAP 1.0 OR THE Z-MEAN CONCENTRATION.

NOTE THAT THE STANDARD DEVIATIONS VS PD. IN THE MEAN RATIOS INDICATE THE DEGREE
OF SCATTER IN THE REPORTED CONCENTRATIONS FOR THAT PARTICULAR PERIOD & POLLUTANT

THE LAST TABLE LISTS THE RESULTS OF A LINEAR REGRESSION ANALYSIS OF EACH SAMPLER
WITH THE Z-MEAN. LEFT TO RIGHT ARE THE INTERCEPT, ITS ERROR; THE SLOPE, ITS ERROR;
THE ROOT MEAN SQUARE DEVIATION IN CONC. UNITS; AND THE CORRELATION COEFFICIENT.

1 INTERCOMPARISON STUDY OF TOTAL MASS; MICROGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A		70	69	68	71	93	-	84	90	-	48	69	75	90	-	114	103 D		
R EPA DZUBAY MDS-S		66	70	71	71	85	86	94	93	42	-	80	82	96	119	125	108 R		
C LBL LOO DICOT		-	-	-	96	108	117	110	-	47	63	98	97	116	126	133	120 C		
L LBL LOO DICOT		86	95	95	97	113	122	115	-	50	74	106	98	128	132	142	132 L		
S LBL LOO DICOT		99	96	109	-	124	118	127	-	48	77	-	-	-	137	139	126 S		
P EPA RODES HIVOL		114	138	123	116	159	129	134	113	51	89	126	112	158	137	183	127 P		
B EPA BURTON CHAMP		92	98	97	89	122	120	117	114	57	82	110	113	131	149	159	147 B		
T EPA BURTON HIVOL		119	114	117	115	161	124	132	120	50	95	124	122	150	156	177	138 T		
U EPA BURTON CHAMP		74	89	94	99	126	121	112	112	46	81	104	118	137	149	165	139 U		
E ERT MULLER TSP		63	74	79	82	85	99	91	97	34	52	86	80	94	113	125	114 E		
Q STL DEL'ED 2MASS		39	153	97	136	-	-	-	-	-	92	-	-	111	157	-	-	0	
Z MEAN(WITHOUT Q)		87	94	95	93	118	115	111	106	47	73	100	100	122	136	146	125	104	18
STANDARD DEVIATION		20	22	19	17	27	14	17	12	6	16	19	18	25	14	23	14		
X MEAN(D,L,P,T,U,E)		88	96	96	97	123	119	111	106	46	73	103	101	126	138	151	125		
STANDARD DEVIATION		23	26	21	18	32	12	21	13	7	19	22	20	28	15	28	14		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A		0.81	0.73	0.72	0.77	0.79	-	0.75	0.85	-	0.66	0.69	0.75	0.74	-	0.78	0.82 D	0.76	0.05 7
R EPA DZUBAY MDS-S		0.76	0.75	0.75	0.76	0.72	0.75	0.84	0.88	0.89	-	0.80	0.82	0.79	0.87	0.86	0.86 R	0.81	0.06 7
C LBL LOO DICOT		-	-	-	1.03	0.92	1.02	1.08	-	0.99	0.86	0.97	0.98	0.95	0.93	0.91	0.96 C	0.96	0.05 5
L LBL LOO DICOT		0.99	1.02	1.00	1.04	0.96	1.06	1.03	-	1.05	1.01	1.05	0.98	1.05	0.97	0.97	1.05 L	1.02	0.04 3
S LBL LOO DICOT		1.14	1.03	1.15	-	1.05	1.02	1.14	-	1.03	1.05	-	-	-	1.01	0.95	1.01 S	1.05	0.06 6
P EPA RODES HIVOL		1.31	1.47	1.30	1.25	1.35	1.12	1.20	1.07	1.09	1.22	1.27	1.13	1.29	1.01	1.25	1.02 P	1.21	0.13 11
B EPA BURTON CHAMP		1.06	1.05	1.02	0.95	1.04	1.05	1.05	1.08	1.20	1.11	1.09	1.13	1.08	1.10	1.08	1.17 B	1.08	0.06 5
T EPA BURTON HIVOL		1.37	1.22	1.24	1.24	1.37	1.08	1.18	1.14	1.07	1.29	1.23	1.23	1.22	1.15	1.21	1.10 T	1.21	0.09 7
U EPA BURTON CHAMP		0.86	0.95	1.00	1.06	1.07	1.05	1.00	1.07	0.96	1.11	1.03	1.18	1.12	1.10	1.13	1.11 U	1.05	0.08 8
E ERT MULLER TSP		0.72	0.80	0.84	0.89	0.72	0.86	0.81	0.91	0.72	0.70	0.85	0.81	0.77	0.87	0.85	0.91 E	0.81	0.07 8
Q STL DEL'ED 2MASS		0.45	1.64	1.03	1.47	-	-	-	-	-	1.25	-	-	0.91	1.15	-	-	0	1.13 0.39 34
MEAN(WITHOUT Q)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION		0.24	0.24	0.21	0.18	0.23	0.12	0.16	0.12	0.14	0.22	0.19	0.18	0.20	0.10	0.16	0.11	0.17	

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	-12.792	7.763	0.883	0.073	4.793	0.965
R EPA DZUBAY MDS-S	-7.218	7.574	0.875	0.070	6.127	0.961
C LBL LOO DICOT	4.581	5.906	0.914	0.054	4.826	0.983
L LBL LOO DICOT	4.120	4.584	0.974	0.043	4.009	0.988
S LBL LOO DICOT	11.766	8.002	0.933	0.074	6.743	0.973
P EPA RODES HIVOL	12.214	16.288	1.089	0.152	14.258	0.886
B EPA BURTON CHAMP	-0.725	6.356	1.083	0.060	5.564	0.980
T EPA BURTON HIVOL	6.565	10.501	1.144	0.098	9.192	0.952
U EPA BURTON CHAMP	-16.800	8.048	1.219	0.075	7.045	0.974
E ERT MULLER TSP	-11.956	7.314	0.937	0.068	6.403	0.965
Q STL DEL'ED 2MASS	0.	0.	0	0.	0.	0.

INTERCOMPARISON STUDY OF SMALL MASS: MICROGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	37	43	35	41	41	-	45	56	-	22	37	45	57	-	-	64	75 D		
R EPA DZUBAY MDS-S	36	42	34	41	42	54	46	64	25	-	41	48	58	79	64	73 R			
C LBL LOO DICOT	34	-	-	41	42	60	51	-	32	27	42	52	60	77	66	73 C			
L LBL LOO DICOT	34	41	38	40	44	61	51	-	30	24	43	50	52	80	68	76 L			
S LBL LOO DICOT	36	40	34	-	44	57	52	-	30	24	42	-	63	77	64	72 S			
O EPA RODES DICOT	21	52	20	46	27	58	46	73	38	35	46	28	49	73	70	67 O			
B EPA BURTON CHAMP	64	59	65	58	74	77	73	83	46	48	79	75	108	107	117	99 B			
U EPA BURTON CHAMP	52	52	66	59	79	76	71	82	42	44	78	73	103	104	112	97 U			
F ERT MULLER RSP	38	42	42	49	48	59	51	69	22	23	59	53	67	79	72	76 F			
Q STL DEL/ED 2MASS	17	55	37	46	-	51	-	57	-	33	-	-	53	72	58	69 Q			
Z MEAN(ALL SAMPLERS)	37	47	41	47	49	61	54	69	33	31	52	53	68	83	76	78	55	13	
STANDARD DEVIATION	14	7	15	7	17	9	11	11	8	10	16	15	20	13	21	11			
X MEAN(D,L,O,U,F,Q)	33	48	40	47	48	61	53	67	33	30	53	50	65	82	74	77			
STANDARD DEVIATION	13	6	15	7	19	9	11	11	9	9	16	16	20	13	19	11			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.01	0.92	0.85	0.89	0.83	-	0.83	0.82	-	0.70	0.72	0.85	0.84	-	-	0.85	0.97 D	0.85	0.09 10
R EPA DZUBAY MDS-S	0.98	0.90	0.82	0.87	0.86	0.87	0.85	0.92	0.75	-	0.79	0.91	0.86	0.95	0.85	0.94 R	0.88	0.06 7	
C LBL LOO DICOT	0.93	-	-	0.89	0.85	0.97	0.95	-	0.96	0.86	0.81	0.99	0.82	0.93	0.88	0.94 C	0.91	0.05 6	
L LBL LOO DICOT	0.93	0.87	0.92	0.85	0.90	0.99	0.95	-	0.90	0.77	0.82	0.94	0.91	0.96	0.90	0.97 L	0.91	0.06 7	
S LBL LOO DICOT	0.98	0.84	0.82	-	0.90	0.93	0.96	-	0.90	0.78	0.81	-	0.93	0.92	0.84	0.92 S	0.89	0.06 7	
O EPA RODES DICOT	0.56	1.10	0.48	0.97	0.54	0.94	0.85	1.05	1.15	1.14	0.89	0.52	0.71	0.88	0.93	0.87 O	0.85	0.22 26	
B EPA BURTON CHAMP	1.75	1.24	1.57	1.24	1.52	1.26	1.35	1.21	1.40	1.55	1.52	1.41	1.59	1.28	1.55	1.27 B	1.42	0.16 11	
U EPA BURTON CHAMP	1.41	1.10	1.60	1.27	1.61	1.24	1.31	1.19	1.26	1.42	1.50	1.38	1.51	1.25	1.49	1.25 U	1.36	0.15 11	
F ERT MULLER RSP	1.02	0.88	1.02	1.04	0.99	0.96	0.95	0.99	0.68	0.72	1.13	1.00	0.98	0.96	0.96	0.98 F	0.95	0.11 12	
Q STL DEL/ED 2MASS	0.45	1.16	0.91	0.99	-	0.84	-	0.82	-	1.07	-	-	0.79	0.87	0.76	0.89 Q	0.87	0.18 21	
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.37	0.15	0.37	0.16	0.34	0.15	0.19	0.16	0.25	0.32	0.31	0.29	0.30	0.15	0.28	0.14	0.25		
REGRESSION VS Z	INTERCEPT			ERROR	SLOPE		ERROR	RMS.DEV.	COR.COEFF.										
D EPA DZUBAY MDS-A	-3.069	4.658	0.910	0.084	0.957		4.228	0.957											
R EPA DZUBAY MDS-S	-5.460	2.818	0.978	0.048	0.985		2.767	0.985											
C LBL LOO DICOT	-0.986	2.939	0.929	0.051	0.984		2.961	0.984											
L LBL LOO DICOT	-5.364	2.398	1.013	0.043	0.989		2.589	0.989											
S LBL LOO DICOT	-2.708	2.852	0.942	0.050	0.985		3.006	0.985											
O EPA RODES DICOT	-4.244	9.670	0.928	0.169	0.826		10.569	0.826											
B EPA BURTON CHAMP	10.248	7.855	1.215	0.138	0.921		8.585	0.921											
U EPA BURTON CHAMP	6.089	7.678	1.244	0.135	0.927		8.392	0.927											
F ERT MULLER RSP	-4.533	3.859	1.047	0.068	0.972		4.218	0.972											
Q STL DEL/ED 2MASS	4.418	8.557	0.784	0.142	0.879		8.073	0.879											

1 INTERCOMPARISON STUDY OF LARGE MASS: MICROGRAMS/CUBIC METER: PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	33	25	33	30	30	52	-	39	33	8	27	32	30	33		50	28 D		
R EPA DZUBAY MDS-S	30	28	37	30	43	43	32	48	30	17	38	39	34	38	40	61	35 R		
C LBL LOO DICOT	-	-	-	54	66	58	58	58	-	15	37	56	45	56	52	67	47 C		
L LBL LOO DICOT	52	54	57	57	69	61	61	61	-	20	50	63	48	66	52	75	56 L		
S LBL LOO DICOT	63	57	75	-	80	61	61	75	-	19	52	-	-	-	61	76	54 S		
O EPA RODES DICOT	24	42	41	36	57	19	42	42	-46	29	-95	51	28	29	135	57	29 O		
B EPA BURTON CHAMP	27	39	32	31	48	43	43	44	30	11	34	30	38	24	42	42	48 B		
U EPA BURTON CHAMP	23	36	29	39	48	45	41	41	30	4	37	25	45	34	45	53	42 U		
Q STL DEL/ED 2MASS	23	98	60	90	-	-	-	-	-	-	59	-	-	57	84	-	- Q		
Z MEAN(WITHOUT Q)	36	40	43	40	58	46	46	51	34	15	46	42	38	40	60	60	42	43	14
STANDARD DEVIATION	15	12	17	12	13	16	13	13	7	8	22	14	8	15	33	12	11		
X MEAN(D,L,O,U)	33	39	40	41	56	42	42	46	37	15	52	43	38	40	77	59	39		
STANDARD DEVIATION	14	12	13	12	9	21	21	12	9	11	30	17	10	17	50	11	13		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.92	0.63	0.76	0.76	0.89	-	0.76	0.93	0.87	0.54	0.57	0.76	0.79	0.83	-	0.84	0.66 D	0.76	0.13 17
R EPA DZUBAY MDS-S	0.84	0.69	0.85	0.75	0.75	0.70	0.93	0.87	0.87	0.13	0.82	0.91	0.89	0.95	0.65	0.81	0.82 R	0.85	0.13 15
C LBL LOO DICOT	-	-	-	1.37	1.15	1.26	1.14	-	-	0.00	0.79	1.32	1.17	1.41	0.81	1.12	1.12 C	1.14	0.20 17
L LBL LOO DICOT	1.44	1.34	1.32	1.44	1.19	1.34	1.25	-	1.29	1.09	1.50	1.50	1.25	1.65	0.86	1.24	1.33 L	1.30	0.18 14
S LBL LOO DICOT	1.76	1.41	1.73	-	1.38	1.33	1.47	-	1.22	1.14	-	-	-	-	1.00	1.26	1.28 S	1.36	0.23 17
O EPA RODES DICOT	0.66	1.05	0.94	0.91	0.99	0.42	0.81	0.37	0.87	2.06	0.12	0.72	0.72	0.72	2.22	0.56	0.68 O	1.10	0.53 49
B EPA BURTON CHAMP	0.76	0.98	0.74	0.77	0.83	0.95	0.85	0.89	0.70	0.73	0.71	0.71	0.71	0.60	0.70	0.69	1.13 B	0.81	0.14 17
U EPA BURTON CHAMP	0.63	0.90	0.66	0.99	0.82	0.99	0.79	0.89	0.26	0.80	0.80	0.59	1.18	0.85	0.75	0.88	0.98 U	0.81	0.21 26
Q STL DEL/ED 2MASS	0.63	2.45	1.38	2.28	-	-	-	-	-	-	1.27	-	-	1.44	1.40	-	- Q	1.55	0.62 40
MEAN(WITHOUT Q)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.43	0.30	0.39	0.29	0.22	0.35	0.26	0.26	0.21	0.50	0.47	0.34	0.21	0.38	0.55	0.20	0.26	0.33	

REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR	COEFF
D EPA DZUBAY MDS-A	-3.987	5.397	0.869	0.125	4.874	0.895	0.895
R EPA DZUBAY MDS-S	4.583	5.584	0.728	0.125	5.384	0.841	0.841
C LBL LOO DICOT	10.610	10.497	0.892	0.226	9.220	0.780	0.780
L LBL LOO DICOT	17.942	8.793	0.873	0.195	8.145	0.780	0.780
S LBL LOO DICOT	12.541	12.021	1.072	0.256	10.440	0.813	0.813
O EPA RODES DICOT	-17.514	26.225	1.501	0.588	25.282	0.563	0.563
B EPA BURTON CHAMP	4.496	6.347	0.709	0.142	6.119	0.799	0.799
U EPA BURTON CHAMP	-3.302	7.006	0.906	0.157	6.754	0.839	0.839
Q STL DEL/ED 2MASS	0.	0.	0.	0.	0.	0	0

INTERCOMPARISON STUDY OF TOTAL NO3 ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.																			
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S		1270	850	1360	710	1810	1250	2180	1140	460	470	730	530	1070	1530	1750	2020	R	
T EPA BURTON HIVOL		2267	925	2187	1089	2365	1014	1550	593	777	1531	1030	839	753	604	634	685	T	
A BNL TANNER HIVOL		1610	2480	3120	3290	2740	4290	2130	4120	-	1270	1070	2430	980	3150	970	3570	A	
E ERT MULLER TSP		-	2240	-	3020	3340	4380	3600	5590	1350	970	1850	2040	2150	3190	2640	3990	E	
Z MEAN(ALL SAMPLERS)		1716	1624	2222	2027	2564	2734	2365	2861	862	1060	1170	1460	1238	2119	1499	2566	1880	973
STANDARD DEVIATION		507	856	881	1316	643	1852	872	2390	451	455	478	918	622	1272	893	1514		
X MEAN(T,A,E)		1939	1882	2654	2466	2815	3228	2427	3434	1064	1257	1317	1770	1294	2315	1415	2748		
STANDARD DEVIATION		465	837	660	1200	492	1918	1057	2568	405	281	462	829	750	1482	1074	1799		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
R EPA DZUBAY MDS-S		0.74	0.52	0.61	0.35	0.71	0.46	*0.92	0.40	0.53	0.44	0.62	0.36	0.86	0.72	1.17	0.79	R	0.64 0.23 35
T EPA BURTON HIVOL		1.32	0.57	*0.98	0.54	0.92	0.37	0.66	0.21	0.90	1.44	0.88	0.58	0.61	0.29	0.42	0.27	T	0.68 0.37 53
A BNL TANNER HIVOL		*0.94	1.53	1.40	1.62	*1.07	1.57	0.90	1.44	-	1.20	*0.91	1.67	0.79	1.49	0.65	1.39	A	1.24 0.33 27
E ERT MULLER TSP		-	1.38	-	1.49	1.30	1.60	1.52	1.95	1.57	*0.92	1.58	1.40	1.74	1.51	1.76	1.56	E	1.52 0.24 16
MEAN(ALL SAMPLERS)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00
STANDARD DEVIATION		0.30	0.53	0.40	0.65	0.25	0.68	0.37	0.84	0.52	0.43	0.41	0.63	0.50	0.60	0.60	0.59		0.52
REGRESSION VS Z	INTERCEPT			ERROR		SLOPE		ERROR	RMS.DEV.		COR.COEFF.								
R EPA DZUBAY MDS-S		141.429		349.713		0.561		0.177	436.355		0.647								
T EPA BURTON HIVOL		910.096		504.164		0.142		0.255	629.071		0.148								
A BNL TANNER HIVOL		-680.118		532.221		1.623		0.262	585.282		0.864								
E ERT MULLER TSP		-378.121		354.334		1.746		0.179	436.978		0.942								

1 INTERCOMPARISON STUDY OF SMALL NO3 ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	400	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	550	<50	760	R	
B EPA BURTON CHAMP	740	355	1184	273	862	315	277	369	699	700	671	545	442	441	405	356	B		
U EPA BURTON CHAMP	978	430	1162	538	849	501	360	355	556	796	418	435	429	611	315	357	U		
F ERT MULLER RSP	1960	2180	-3770	2180	-1750	2510	1440	-3900	900	770	1240	1380	970	-2220	1170	2660	F		
Z MEAN(WITHOUT R)	1226	988	2039	997	1154	1109	692	1541	718	755	776	787	614	1091	630	1124	1015	761	
STANDARD DEVIATION	647	1033	1499	1033	516	1217	649	2043	173	50	421	517	309	982	470	1330			
X MEAN(U,F)	1469	1305	2466	1359	1300	1506	900	2128	728	783	829	908	700	1416	743	1509			
STANDARD DEVIATION	694	1237	1844	1161	637	1421	764	2507	243	18	581	668	383	1138	605	1628			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
R EPA DZUBAY MDS-S	0.33	<0.05	<0.02	<0.05	<0.04	<0.05	<0.07	<0.03	<0.07	<0.07	<0.07	<0.06	<0.06	<0.08	0.50	<0.08	0.68	R	0.18 35
B EPA BURTON CHAMP	0.60	0.36	0.58	0.27	0.75	0.28	0.40	0.24	*0.97	0.93	0.86	0.69	0.72	0.40	0.64	0.32	B	0.56 43	
U EPA BURTON CHAMP	0.80	0.44	0.57	0.54	0.74	0.45	0.52	0.23	0.77	1.05	0.54	0.55	0.70	0.56	0.50	0.32	U	0.58 34	
F ERT MULLER RSP	1.60	2.21	1.85	2.19	1.52	2.26	2.08	2.53	*1.25	*1.02	1.60	1.75	1.58	2.04	1.86	2.37	F	1.86 42 22	
MEAN(WITHOUT R)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.53	1.05	0.74	1.04	0.45	1.10	0.94	1.33	0.24	0.07	0.54	0.66	0.50	0.90	0.75	1.18	0.75		
REGRESSION VS Z	INTERCEPT		ERROR		SLOPE		ERROR	RMS.DEV		COR. COEFF.									
R EPA DZUBAY MDS-S	0.		0.		0.		0.	0.		0.									
B EPA BURTON CHAMP	213.792	170.831		0.321	0.159	229.402		0.476											
U EPA BURTON CHAMP	165.610	154.894		0.397	0.144	208.002		0.593											
F ERT MULLER RSP	-379.402	307.818		2.282	0.286	413.356		0.906											

1 INTERCOMPARISON STUDY OF LARGE NO3 ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	870	850	1360	710	1810	1250	2180	1140	460	470	730	530	1070	980	1750	1260	R		
Z MEAN(ALL SAMPLERS)	870	850	1360	710	1810	1250	2180	1140	460	470	730	530	1070	980	1750	1260	1089	0	
STANDARD DEVIATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
X MEAN()	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
STANDARD DEVIATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	*1.00	R	0
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
REGRESSION VS Z	INTERCEPT	0.		ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.											
R EPA DZUBAY MDS-S				0.	1.000	0.	0.	0.	1.000										

1 INTERCOMPARISON STUDY OF TOTAL SO₄ ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY	MDS-S	12910	10230	11670	11100	17820	21440	22330	24000	11000	4470	14750	13500	24080	29100	28600	27930	R	
P EPA RODES	HIVOL	17600	19000	16400	15600	22100	27300	25200	27900	17700	9600	18700	17800	30900	33100	34900	30900	P	
T EPA BURTON	HIVOL	13650	15360	13080	15250	20540	25480	23330	25960	14890	8290	16500	18200	25200	34150	25700	28800	T	
A BNL TANNER	HIVOL	13500	11500	11300	12300	16400	21800	20200	-	-	5040	13000	14800	23600	25800	23900	26000	A	
E ERT MULLER	TSP	-	11000	-	13200	16700	23400	22800	-	9500	4700	14400	16600	25000	29300	28200	26900	E	
Z MEAN(ALL SAMPLERS)		14415	13418	13113	13490	18712	23884	22772	25953	13273	6420	15470	16180	25756	30290	28260	28106	Z	19344 3011
STANDARD DEVIATION		2147	3695	2322	1921	2500	2488	1804	1950	3724	2360	2194	1998	2950	3367	4176	1885		
X MEAN(P,T,A,E)		14917	14215	13593	14088	18935	24495	22883	26930	14030	6908	15650	16850	26175	30588	28175	28150	X	
STANDARD DEVIATION		2325	3738	2588	1594	2829	2401	2063	1372	4167	2417	2491	1526	3229	3811	4818	2173		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
R EPA DZUBAY	MDS-S	0.90	0.76	0.89	0.82	0.95	0.90	0.98	0.93	0.83	0.70	0.95	0.83	0.94	0.96	1.01	0.99	R	0.90 0.09 10
P EPA RODES	HIVOL	1.22	1.42	1.25	1.16	1.18	1.14	1.11	1.08	1.33	1.50	1.21	1.10	1.20	1.09	1.24	1.10	P	1.21 0.12 10
T EPA BURTON	HIVOL	0.95	1.15	1.00	1.13	1.10	1.07	1.02	1.00	1.12	1.29	1.07	1.13	0.98	1.13	0.91	1.03	T	1.07 0.09 9
A BNL TANNER	HIVOL	0.94	0.86	0.86	0.91	0.88	0.91	0.89	-	-	0.79	0.84	0.92	0.92	0.85	0.85	0.93	A	0.88 0.04 5
E ERT MULLER	TSP	-	0.82	-	0.98	0.89	0.98	1.00	-	0.72	0.73	0.93	1.03	0.97	0.97	1.00	0.96	E	0.92 0.10 11
MEAN(ALL SAMPLERS)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00
STANDARD DEVIATION		0.15	0.28	0.18	0.14	0.13	0.10	0.08	0.08	0.28	0.37	0.14	0.12	0.11	0.11	0.15	0.07		0.16
REGRESSION VS Z	INTERCEPT			ERROR	SLOPE	ERROR	RMS DEV	COR. COEFF.											
R EPA DZUBAY	MDS-S	-2876.984	651.527	1.069	0.032	872.124	0.994												
P EPA RODES	HIVOL	3072.122	1052.180	1.019	0.051	1408.431	0.983												
T EPA BURTON	HIVOL	1754.886	1128.762	0.957	0.055	1510.943	0.978												
A BNL TANNER	HIVOL	-152.720	587.006	0.893	0.029	743.091	0.994												
E ERT MULLER	TSP	-2362.810	904.203	1.064	0.043	1099.141	0.991												

1 INTERCOMPARISON STUDY OF SMALL SO₄ : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	12379	9773	10795	11478	17139	20915	21758	22975	10493	3799	13776	12686	23468	28599	27707	26868	R		
O EPA RODES DICOT	11600	11720	8250	4800	16330	21970	21170	23230	10710	4550	11600	15820	23200	-	25260	27730	O		
B EPA BURTON CHAMP	14985	14441	13649	13816	22256	26343	22933	26935	11977	7887	16442	14400	28000	32713	29437	28646	B		
U EPA BURTON CHAMP	14643	13500	12829	14815	22222	27159	27662	26899	13026	6787	15434	17081	28650	32438	29695	28998	U		
F ERT MULLER RSP	14600	9700	10100	10600	16700	24600	22800	13700	7800	4200	12000	13300	21600	25400	24800	25000	F		
Z MEAN(ALL SAMPLERS)	13641	11827	11125	11102	18929	24197	23265	22748	10801	5445	13850	14657	24984	29788	27380	27448	18199	2993	
STANDARD DEVIATION	1540	2144	2162	3913	3035	2705	2565	5406	1965	1791	2105	1804	3141	3476	2283	1600			
X MEAN(O,U,F)	13614	11640	10393	10072	18417	24576	23877	21276	10512	5179	13011	15400	24483	28919	26585	27243			
STANDARD DEVIATION	1745	1901	2304	5028	3300	2595	3377	6813	2619	1404	2108	1925	3696	4977	2703	2043			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
R EPA DZUBAY MDS-S	0.91	0.83	0.97	1.03	0.91	0.86	0.94	1.01	0.97	0.70	*0.99	0.87	0.94	0.96	1.01	0.98	R	0.93	0.09
O EPA RODES DICOT	0.85	*0.99	0.74	0.43	0.86	0.91	0.91	*1.02	*0.99	*0.84	*1.08	0.93	-	0.92	*1.01	0.89	O	0.89	0.15
B EPA BURTON CHAMP	1.10	1.22	1.23	1.24	1.18	1.09	*0.99	1.18	1.11	1.45	1.19	*0.98	1.12	1.10	1.08	1.04	B	1.14	0.11
U EPA BURTON CHAMP	1.07	1.14	1.15	1.33	1.17	1.12	1.19	1.18	1.21	1.25	1.11	1.17	1.15	1.09	1.08	1.06	U	1.16	0.07
F ERT MULLER RSP	1.07	0.82	0.91	*0.96	0.88	*1.02	*0.98	0.60	0.72	0.77	0.87	0.91	0.86	0.85	0.91	0.91	F	0.88	0.11
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.11	0.18	0.19	0.35	0.16	0.11	0.11	0.24	0.18	0.33	0.15	0.12	0.13	0.12	0.08	0.06		0.16	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.													
R EPA DZUBAY MDS-S	-929.696	721.269	0.994	0.037	1069.188	0.991													
O EPA RODES DICOT	-2112.424	1331.718	1.031	0.071	1882.892	0.970													
B EPA BURTON CHAMP	1956.156	849.885	1.008	0.043	1259.845	0.987													
U EPA BURTON CHAMP	1466.196	670.146	1.059	0.034	993.405	0.993													
F ERT MULLER RSP	-159.967	1504.520	0.891	0.077	2230.257	0.952													

1 INTERCOMPARISON STUDY OF LARGE SO₄ ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	532	453	875	629	682	527	571	1017	506	667	975	570	609	490	888	1060	R		
O EPA RODES DICOT	450	200	530	1350	1070	690	1670	1600	200	1840	1440	1310	1880	2320	1070	1030	O		
Z MEAN(ALL SAMPLERS)	491	327	703	990	876	609	1121	1309	353	1254	1208	940	1245	1405	979	1045		928	402
STANDARD DEVIATION	58	179	244	510	274	115	777	412	216	829	329	523	899	1294	129	21			
X MEAN(O)	450	200	530	1350	1070	690	1670	1600	200	1840	1440	1310	1880	2320	1070	1030			
STANDARD DEVIATION	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	1.08	1.39	1.25	0.64	0.78	0.87	0.51	0.78	1.43	0.53	0.81	0.61	0.49	0.35	0.91	*1.01	R	0.84	0.33
O EPA RODES DICOT	*0.92	*0.61	*0.75	*1.36	*1.22	*1.13	1.49	*1.22	*0.57	1.47	*1.19	*1.39	1.51	1.65	*1.09	*0.99	O	1.16	0.33
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.12	0.55	0.35	0.52	0.31	0.19	0.69	0.32	0.61	0.66	0.27	0.56	0.72	0.92	0.13	0.02		0.43	
REGRESSION VS Z	INTERCEPT			ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.											
R EPA DZUBAY MDS-S	463.515	142.678		0.245		0.145	191.696		0.412										
O EPA RODES DICOT	-463.515	142.678		1.755		0.145	191.696		0.956										

INTERCOMPARISON STUDY OF TOTAL S : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977																			
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY	MDS-A	4830	3060	-	3300	5870	-	7660	-	3680	-	-	4400	8220	-	9160	-	D	
M EPA DZUBAY	TF-M	5230	3930	4300	4550	6380	8370	7870	-	3840	1750	5240	5000	8040	10020	9040	9580	M	
N EPA DZUBAY	TF-P	5280	3730	3960	4260	6040	7120	7980	7950	3640	1860	4880	5070	8480	-	10270	-	N	
R EPA DZUBAY	MDS-S	4540	3350	4130	3690	6040	7330	7560	7380	3650	1820	4820	4880	7680	-	9610	-	R	
C LBL LOO	DICOT	-	-	-	4819	7313	9062	8954	-	4528	2158	6054	6102	9345	10587	11033	10097	C	
L LBL LOO	DICOT	5969	4283	5174	4685	7206	9072	8960	-	4540	2234	5957	6106	9538	10974	10987	10117	L	
S LBL LOO	DICOT	5869	4382	5145	-	7186	8592	8868	-	4348	2250	-	-	-	10620	11013	10109	S	
G UCD CAHILL	SDAY	-	2503	2966	3819	5577	7988	7009	9620	3474	1578	3584	-	-	-	-	-	G	
H UCD CAHILL	TTLF	5027	3120	4093	3847	5582	7193	7555	6919	3949	1055	4980	4654	7174	9513	9079	9307	H	
I UCD CAHILL	SFU	4579	2949	3724	3836	8086	7764	7814	8942	4088	1934	4882	5748	7644	10306	7851	7042	I	
J FSU HUDSON	LS 2	-	-	-	4620	8309	8699	9915	8874	4418	2502	5971	5418	11064	11933	13235	11709	J	
K FSU HUDSON	LS 4	-	-	-	6093	9725	10340	11209	10549	5133	2144	6791	6080	11960	12427	13707	11617	K	
Z MEAN(ALL SAMPLERS)		5166	3479	4187	4322	6943	8320	8438	8605	4107	1935	5316	5346	8915	10798	10453	9947	5642	1007
STANDARD DEVIATION		538	641	724	763	1279	977	1199	1276	493	395	901	636	1566	967	1798	1462		
X MEAN(0.M.L.G.I.K)		5152	3345	4041	4381	7141	8707	8420	9704	4126	1928	5291	5467	9080	10932	10149	9589		
STANDARD DEVIATION		607	736	932	983	1563	1039	1504	807	615	271	1202	745	1760	1074	2283	1904		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY	MDS-A	0.94	0.88	-	0.76	0.85	-	0.91	-	0.90	-	-	0.82	0.92	-	0.88	-	D	0.87 0.05 6
M EPA DZUBAY	TF-M	1.01	1.13	1.03	1.05	0.92	1.01	0.93	-	0.94	0.90	0.99	0.94	0.90	0.93	0.87	0.96	M	0.97 0.07 7
N EPA DZUBAY	TF-P	1.02	1.07	0.95	0.99	0.87	0.86	0.93	0.92	0.89	0.96	0.92	0.95	0.95	-	0.98	-	N	0.95 0.06 6
R EPA DZUBAY	MDS-S	0.88	0.96	0.99	0.85	0.87	0.88	0.90	0.86	0.89	0.96	0.94	0.91	0.86	-	0.92	-	R	0.90 0.04 4
C LBL LOO	DICOT	-	-	-	1.12	1.05	1.09	1.06	-	1.10	1.12	1.14	1.14	1.05	0.98	1.06	1.02	C	1.08 0.05 5
L LBL LOO	DICOT	1.16	1.23	1.24	1.08	1.04	1.09	1.06	-	1.11	1.15	1.12	1.14	1.07	1.02	1.05	1.02	L	1.11 0.07 6
S LBL LOO	DICOT	1.14	1.26	1.23	-	1.04	1.03	1.05	-	1.06	1.16	-	-	-	0.98	1.05	1.02	S	1.09 0.09 8
G UCD CAHILL	SDAY	-	0.72	0.71	0.88	0.80	0.96	0.83	1.12	0.85	0.82	0.67	-	-	-	-	-	G	0.84 0.13 16
H UCD CAHILL	TTLF	0.97	0.90	0.98	0.89	0.80	0.86	0.90	0.80	0.96	0.55	0.94	0.87	0.81	0.88	0.87	0.94	H	0.87 0.10 12
I UCD CAHILL	SFU	0.89	0.85	0.89	0.89	1.17	0.93	0.93	1.04	1.00	1.00	0.92	1.08	0.86	0.95	0.75	0.71	I	0.93 0.11 12
J FSU HUDSON	LS 2	-	-	-	1.07	1.20	1.05	1.18	1.03	1.08	1.29	1.12	1.01	1.24	1.11	1.27	1.18	J	1.14 0.09 8
K FSU HUDSON	LS 4	-	-	-	1.41	1.40	1.24	1.33	1.23	1.25	1.11	1.28	1.14	1.34	1.15	1.31	1.17	K	1.26 0.10 8
MEAN(ALL SAMPLERS)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00
STANDARD DEVIATION		0.10	0.18	0.17	0.18	0.18	0.12	0.14	0.15	0.12	0.20	0.17	0.12	0.18	0.09	0.17	0.15		0.15
REGRESSION VS Z	INTERCEPT																		
D EPA DZUBAY	MDS-A	-278.785	285.986																
M EPA DZUBAY	TF-M	516.563	232.792																
N EPA DZUBAY	TF-P	147.906	250.244																
R EPA DZUBAY	MDS-S	169.248	148.255																
C LBL LOO	DICOT	622.054	227.655																
L LBL LOO	DICOT	735.700	167.264																
S LBL LOO	DICOT	798.496	228.612																
G UCD CAHILL	SDAY	-1105.987	595.622																
H UCD CAHILL	TTLF	68.194	283.977																
I UCD CAHILL	SFU	636.936	614.587																
J FSU HUDSON	LS 2	-392.676	539.841																
K FSU HUDSON	LS 4	240.014	555.500																

1 INTERCOMPARISON STUDY OF SMALL S ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	4562	2668	3737	2943	5548	-	7367	5449	3541	1506	4542	4336	7912	-	8951	-	D		
M EPA DZUBAY TF-M	5009	3572	3894	4182	6019	7901	7661	-	3813	1642	4998	4695	7586	9298	8606	8687	M		
N EPA DZUBAY TF-P	4951	3170	3443	3684	5529	6709	7426	6804	3413	1495	4411	4525	7764	-	8612	-	N		
R EPA DZUBAY MDS-S	4297	3040	3707	3373	5743	6938	7284	6678	3499	1601	4368	4683	7362	-	9234	-	R		
C LBL LOO DICOT	5336	-	-	4123	6572	8287	8186	-	4131	1795	5225	5571	8475	9532	10125	9019	C		
L LBL LOO DICOT	5308	3518	4309	3945	6430	8270	8172	-	4100	1819	5150	5468	8617	9851	9998	8969	L		
S LBL LOO DICOT	5244	3693	4274	-	6448	7859	8119	-	3987	1825	5261	5514	-	-	-	-	S		
G UCD CAHILL SMDAY	4310	2500	2940	3800	5570	7970	7000	9600	3470	1580	3560	-	-	-	-	-	G		
I UCD CAHILL SFU	3769	2693	3491	3481	7557	7263	7225	8148	3801	1744	4473	5433	6950	9314	7375	5833	I		
Q STL DEL/ED 2MASS	1900	1210	1270	-970	-1430	-1150	-1250	1010	-860	1130	1610	-1500	-2090	-1390	-1920	3130	Q		
Z MEAN(WITHOUT Q)	4754	3107	3724	3691	6157	7650	7604	7336	3751	1667	4665	5028	7809	9514	9131	8320	Z	5869	626
STANDARD DEVIATION	548	458	451	416	670	603	451	1586	280	132	552	514	591	226	959	1399			
X MEAN(D,M,L,G,I)	4592	2990	3674	3670	6225	7851	7485	7732	3745	1658	4545	4983	7766	9488	8733	7830	X		
STANDARD DEVIATION	601	512	507	479	829	423	453	2106	251	125	622	560	694	315	1081	1735			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	0.96	0.86	1.00	0.80	0.90	-	0.97	0.74	0.94	0.90	0.97	0.86	1.01	-	0.98	-	D	0.92	0.08
M EPA DZUBAY TF-M	1.05	1.15	1.05	1.13	0.98	1.03	1.01	-	1.02	0.99	1.07	0.93	0.97	0.98	0.94	1.04	M	1.02	0.06
N EPA DZUBAY TF-P	1.04	1.02	1.02	1.00	0.90	0.88	0.98	0.93	0.91	0.90	0.95	0.90	0.99	-	0.94	-	N	0.95	0.05
R EPA DZUBAY MDS-S	0.90	0.98	1.00	0.91	0.93	0.91	0.96	0.91	0.93	0.96	0.94	0.93	0.94	-	1.01	-	R	0.94	0.03
C LBL LOO DICOT	1.12	-	-	1.12	1.07	1.08	1.08	-	1.10	1.08	1.12	1.11	1.09	1.00	1.11	1.08	C	1.09	0.03
L LBL LOO DICOT	1.12	1.13	1.16	1.07	1.04	1.08	1.08	-	1.09	1.09	1.10	1.09	1.10	1.04	1.10	1.08	L	1.09	0.03
S LBL LOO DICOT	1.10	1.19	1.15	-	1.05	1.03	1.07	-	1.06	1.09	1.13	1.10	-	1.01	1.11	1.09	S	1.09	0.05
G UCD CAHILL SMDAY	0.91	0.81	0.79	1.03	0.90	1.04	0.92	1.31	0.93	0.95	0.76	-	-	-	-	-	G	0.94	0.15
I UCD CAHILL SFU	0.79	0.87	0.94	0.94	1.23	0.95	0.95	1.11	1.01	1.05	0.96	1.08	0.89	0.98	0.81	0.70	I	0.95	0.13
Q STL DEL/ED 2MASS	0.40	0.39	0.34	0.26	0.23	0.15	0.16	0.14	0.23	0.68	0.35	0.30	0.27	0.15	0.21	0.38	Q	0.29	0.14
MEAN(WITHOUT Q)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.12	0.15	0.12	0.11	0.11	0.08	0.06	0.22	0.08	0.08	0.12	0.10	0.08	0.02	0.11	0.17		0.11	

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	-219.166	396.721	0.963	0.070	530.327	0.972
M EPA DZUBAY TF-M	387.016	195.029	0.944	0.031	284.104	0.993
N EPA DZUBAY TF-P	62.634	207.518	0.934	0.036	281.747	0.991
R EPA DZUBAY MDS-S	-95.827	167.455	0.962	0.029	227.354	0.995
C LBL LOO DICOT	266.537	189.194	1.040	0.029	240.356	0.996
L LBL LOO DICOT	195.124	114.091	1.051	0.018	166.201	0.998
S LBL LOO DICOT	325.002	196.595	1.023	0.031	270.438	0.995
G UCD CAHILL SMDAY	-1002.408	731.934	1.170	0.139	880.238	0.942
I UCD CAHILL SFU	449.415	610.244	0.866	0.097	890.555	0.923
Q STL DEL/ED 2MASS	0.	0.	0.	0.	0.	0.

INTERCOMPARISON STUDY OF LARGE S : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	267	391	-	356	327	-	290	-	139	-	-	-	257	307	-	212	424 D		
M EPA DZUBAY TF-M	222	360	393	367	362	470	212	-	26	113	240	299	450	716	438	896 M			
N EPA DZUBAY TF-P	329	559	518	601	507	637	447	1148	231	363	469	546	714	1000	1655	1072 N			
R EPA DZUBAY MDS-S	239	316	427	319	293	385	280	701	156	219	450	192	319	484	374	537 R			
C LBL LOO DICOT	-	-	-	696	741	775	768	-	797	363	799	531	870	1055	908	1078 C			
L LBL LOO DICOT	661	765	865	740	776	802	788	-	440	415	807	638	921	1123	989	1148 L			
S LBL LOO DICOT	625	689	871	-	738	733	749	-	361	425	-	-	-	1043	867	1015 S			
G UCD CAHILL SMDAY	-	-	23	26	4	18	-	8	-	-	23	-	-	-	-	-	G		
I UCD CAHILL SFU	810	256	233	355	529	501	589	794	287	190	409	315	694	992	476	1209 I			
Z MEAN(WITHOUT G)	450	477	551	491	534	615	515	881	255	298	529	397	611	916	740	922	574	237	
STANDARD DEVIATION	241	196	262	182	198	164	239	236	143	123	227	171	253	230	466	289			
X MEAN(D.M.L.I)	490	443	497	455	499	591	470	794	223	239	485	377	593	944	529	919			
STANDARD DEVIATION	291	222	329	190	205	183	267	0	180	157	291	176	271	208	328	357			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.59	0.82	-	0.73	0.61	-	0.56	-	0.55	-	-	-	0.65	0.50	-	0.29	0.46 D	0.58	0.15 25
M EPA DZUBAY TF-M	0.49	0.76	0.71	0.75	0.68	0.76	0.41	-	0.10	0.38	0.45	0.75	0.74	0.78	0.59	0.97 M	0.62	0.22 35	
N EPA DZUBAY TF-P	0.73	1.17	0.94	1.23	0.95	1.04	0.87	1.30	0.91	1.22	0.89	1.38	1.17	1.09	2.24	1.16 N	1.14	0.34 30	
R EPA DZUBAY MDS-S	0.53	0.66	0.78	0.65	0.55	0.63	0.54	0.80	0.61	0.73	0.85	0.48	0.52	0.53	0.51	0.58 R	0.62	0.11 18	
C LBL LOO DICOT	-	-	-	1.42	1.39	1.26	1.49	-	1.56	1.22	1.51	1.34	1.42	1.15	1.23	1.17 C	1.35	0.14 10	
L LBL LOO DICOT	1.47	1.61	1.57	1.51	1.45	1.31	1.53	-	1.73	1.39	1.53	1.61	1.51	1.23	1.34	1.24 L	1.47	0.14 10	
S LBL LOO DICOT	1.39	1.45	1.58	-	1.38	1.19	1.45	-	1.42	1.43	-	-	-	1.14	1.17	1.10 S	1.34	0.16 12	
G UCD CAHILL SMDAY	-	-	0.04	0.05	0.01	0.03	-	0.01	-	-	0.04	-	-	-	-	-	G	0.03	0.02 62
I UCD CAHILL SFU	1.80	0.54	0.42	0.72	0.99	0.82	1.14	0.90	1.13	0.64	0.77	0.79	1.14	1.08	0.64	1.31 I	0.93	0.34 37	
MEAN(WITHOUT G)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.54	0.41	0.48	0.37	0.37	0.27	0.46	0.27	0.56	0.41	0.43	0.43	0.41	0.25	0.63	0.31	0.41		
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.													
D EPA DZUBAY MDS-A	162.482	76.598	0.249	0.135	74.998	0.547													
M EPA DZUBAY TF-M	-222.130	65.619	1.072	0.112	80.428	0.935													
N EPA DZUBAY TF-P	-170.241	175.854	1.472	0.290	226.894	0.805													
R EPA DZUBAY MDS-S	9.778	56.473	0.603	0.093	72.863	0.866													
C LBL LOO DICOT	159.077	54.417	1.037	0.090	63.244	0.964													
L LBL LOO DICOT	206.966	43.445	1.057	0.074	53.250	0.969													
S LBL LOO DICOT	205.820	62.598	0.933	0.103	71.126	0.949													
G UCD CAHILL SMDAY	0.	0.	0.	0.	0.	0.													
I UCD CAHILL SFU	-113.287	145.254	1.138	0.240	187.413	0.786													

1 INTERCOMPARISON STUDY OF TOTAL S & SON. NANOGRAMS/CUBIC METER, PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD	
R EPA DZUBAY	MDS-S	12910	10230	11670	11100	17820	21440	22330	24000	11000	4470	14750	13500	24080	29100	28600	27930	R		
P EPA RODES	HIVOL	17600	19000	16400	19600	22100	27300	25200	27900	17700	9600	18700	17800	30900	33100	34900	30900	P		
T EPA BURTON	HIVOL	13650	15360	13080	15250	20540	25480	23330	25960	14890	8290	16500	18200	25200	34150	25700	28800	T		
A BNL TANNER	HIVOL	13500	11500	11300	12300	16400	21800	20200	-	-	5040	13000	14800	23600	25800	23900	26000	A		
E ERT MULLER	TSP	-	11000	-	13200	16700	23400	22800	-	9500	4700	14400	16600	25000	29300	28200	26900	E		
D' EPA DZUBAY	MDS-A	14490	9180	-	9900	17610	-	22980	-	11040	-	-	13200	24660	-	27480	-	D		
M' EPA DZUBAY	TF-M	15690	11790	12900	13650	19140	25110	23610	-	11520	5250	15720	15000	24120	30060	27120	28740	M		
N' EPA DZUBAY	TF-P	15840	11190	11880	12840	18120	21360	23840	23850	10920	5580	14640	15210	25440	-	30810	-	N		
R' EPA DZUBAY	MDS-S	13620	10050	12390	11070	18120	21990	22680	22140	10950	5460	14460	14640	23040	-	28830	-	R		
C' LBL LOO	DICOT	-	-	-	14457	21939	27186	26862	-	13584	6474	18162	18306	28035	31761	33099	30291	C		
L' LBL LOO	DICOT	17907	12849	15522	14055	21618	27216	26880	-	13620	6702	17871	18318	28614	32922	32961	30351	L		
S' LBL LOO	DICOT	17607	13146	15435	-	21558	25776	26604	-	13044	6750	-	-	-	31860	33039	30327	S		
G' UCD CAHILL	SMOAY	-	7509	8898	11457	16731	23964	21027	28860	10422	4734	10752	-	-	-	-	-	G		
H' UCD CAHILL	TTLF	15081	9360	12279	11541	16746	21549	22665	20757	1847	3165	14940	13962	21522	28539	27237	27921	H		
I' UCD CAHILL	SFU	13737	8847	11172	11508	24258	23292	23442	26826	12264	5802	14646	17244	22932	30918	23553	21126	I		
J' FSU HUDSON	LS 2	-	-	-	13860	24927	26097	29745	26622	13254	7506	17913	16254	33192	35799	39705	35127	J		
K' FSU HUDSON	LS 4	-	-	-	18279	29175	31020	33627	31647	15399	6432	20373	18240	35880	37281	41121	34851	K		
Z MEAN(ALL SAMPLERS)		15136	11501	12744	13129	20206	24624	24566	25856	12560	5997	15788	16085	26414	31584	30391	29174	19735	3095	
STANDARD DEVIATION		1788	2945	2133	2130	3560	2765	3336	3258	2136	1583	2475	1867	4112	3134	5124	3629			
X MEAN(PTEADMLGK)		15225	11893	12753	13520	20427	25398	24310	28239	12928	6283	15774	16600	26767	31691	29437	28459			
STANDARD DEVIATION		1882	3540	2600	2433	4066	2785	3773	2197	2675	1695	2973	1851	4262	3474	5796	4015			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD	
R EPA DZUBAY	MDS-S	0.85	0.89	0.92	0.85	0.88	0.87	0.91	0.93	0.88	0.75	0.93	0.84	0.91	0.92	0.94	0.96	R	0.89	0.05
P EPA RODES	HIVOL	1.16	1.65	1.29	1.19	1.09	1.11	1.03	1.08	1.41	1.60	1.18	1.11	1.17	1.05	1.15	1.06	P	1.21	0.19
T EPA BURTON	HIVOL	0.90	1.34	1.03	1.16	1.02	1.04	0.95	1.00	1.19	1.38	1.05	1.13	0.95	1.08	0.85	0.99	T	0.15	0.14
A BNL TANNER	HIVOL	0.89	1.00	0.89	0.94	0.81	0.89	0.82	-	-	0.84	0.82	0.92	0.89	0.82	0.79	0.89	A	0.07	0.06
E ERT MULLER	TSP	-	0.96	-	1.01	0.83	0.95	0.93	-	0.76	0.78	0.91	1.03	0.95	0.93	0.93	0.92	E	0.08	0.09
D' EPA DZUBAY	MDS-A	0.96	0.80	-	0.75	0.87	-	0.94	-	0.88	-	0.82	0.93	-	0.90	-	0.87	D	0.07	0.07
M' EPA DZUBAY	TF-M	1.04	0.81	0.93	1.01	0.95	1.02	0.96	-	0.92	0.88	1.00	0.93	0.91	0.95	0.89	0.99	M	0.07	0.05
N' EPA DZUBAY	TF-P	1.05	0.97	0.93	0.98	0.90	0.87	0.96	0.92	0.87	0.93	0.93	0.95	0.96	-	1.01	-	N	0.05	0.05
R' EPA DZUBAY	MDS-S	0.90	0.87	0.97	0.84	0.90	0.89	0.92	0.86	0.87	0.91	0.92	0.91	0.87	-	0.95	-	R	0.04	0.04
C' LBL LOO	DICOT	-	-	-	1.10	1.09	1.10	1.09	-	1.08	1.08	1.15	1.14	1.06	1.01	1.09	1.04	C	1.09	0.04
L' LBL LOO	DICOT	1.18	1.12	1.22	1.07	1.07	1.11	1.09	-	1.08	1.12	1.13	1.14	1.08	1.04	1.01	1.04	L	1.11	0.05
S' LBL LOO	DICOT	1.16	1.14	1.21	-	1.07	1.05	1.08	-	1.04	1.13	-	-	-	1.01	1.09	1.04	S	1.09	0.06
G' UCD CAHILL	SMOAY	-	0.65	0.70	0.87	0.83	0.97	0.86	1.12	0.83	0.79	0.68	-	-	-	-	-	G	0.83	0.17
H' UCD CAHILL	TTLF	1.00	0.81	0.96	0.88	0.83	0.88	0.92	0.80	0.94	0.53	0.95	0.87	0.82	0.90	0.90	0.96	H	0.87	0.11
I' UCD CAHILL	SFU	0.91	0.77	0.88	0.88	1.20	0.95	0.95	1.04	0.98	0.97	0.93	1.07	0.87	0.98	0.78	0.72	I	0.93	0.12
J' FSU HUDSON	LS 2	-	-	-	1.06	1.23	1.26	1.21	1.03	1.06	1.25	1.13	1.01	1.26	1.13	1.31	1.20	J	1.15	0.10
K' FSU HUDSON	LS 4	-	-	-	1.39	1.44	1.26	1.37	1.22	1.23	1.07	1.29	1.13	1.36	1.18	1.35	1.19	K	1.27	0.11
MEAN(ALL SAMPLERS)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION		0.12	0.26	0.17	0.16	0.18	0.11	0.14	0.13	0.17	0.26	0.16	0.12	0.16	0.10	0.17	0.12		0.16	

INTERCOMPARISON STUDY OF SMALL S & SON; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY	MDS-S	12379	9773	10795	11478	17139	20915	21758	22975	10493	3799	13776	12686	23468	28599	27707	26868	R	
O EPA RODES	DICOT	11600	11720	9250	4800	16330	21970	21170	23230	10710	4550	11600	15820	23200	-	25260	27730	O	
B EPA BURTON	CHAMP	14985	14441	13649	13816	22256	25343	22933	26335	11977	7887	16442	14400	28000	32713	29437	28646	B	
U EPA BURTON	CHAMP	14643	13500	12829	14815	22822	27159	27662	26899	13026	6787	15434	17081	28650	32438	29695	28998	U	
F EPA MULLER	RSP	14600	3700	10100	10600	16700	24600	22800	13700	7700	4200	12000	13300	21600	25400	24800	25000	F	
D' EPA DZUBAY	MDS-A	13686	8004	11211	8829	16644	-	22101	16347	10623	4518	13626	13008	23736	-	26853	-	D	
M' EPA DZUBAY	TF-M	15027	10716	11682	12546	18057	23703	22983	-	11439	4926	14994	14085	22758	27894	25818	26061	M	
N' EPA DZUBAY	TF-P	14853	9510	10329	11052	16587	20127	22278	20412	10239	4485	13233	13575	23292	-	25836	-	N	
R' EPA DZUBAY	MDS-S	12891	9120	11121	10119	17229	20814	21852	20034	10497	4803	13104	14049	22086	-	27702	-	R	
C' LBL L00	DICOT	16008	-	-	12369	19716	24861	24558	-	12393	5385	15675	16713	25425	28596	30375	27057	C	
L' LBL L00	DICOT	15924	10554	12927	11835	19290	24810	24516	-	12300	5457	15450	16404	25851	29553	29994	26907	L	
S' LBL L00	DICOT	15732	11079	12822	-	19344	23577	24357	-	11961	5475	15783	16542	-	28731	30438	27282	S	
G' UCD CAHILL	SMDAY	12930	7500	8820	11400	16710	23910	21000	28800	10410	4740	10680	-	-	-	-	-	G	
I' UCD CAHILL	SFU	11307	8079	10473	10443	22671	21789	21675	24444	11403	5232	13419	16299	20850	27942	22125	17499	I	
Q' STL DEL/ED	2MASS	5700	3630	3810	2910	4290	3450	3750	3030	2580	3390	4830	4500	6270	4170	5760	9390	Q	
Z MEAN(ALL SAMPLERS)		14640	10284	11154	11085	18635	23429	22975	22378	11091	5160	13944	14920	24076	29096	27388	26205	Z	
STANDARD DEVIATION		1577	2060	1620	2452	2318	2178	1790	4817	1294	1063	1749	1587	2438	2278	2563	3269		
X MEAN(OUTLIER)		13715	9972	10787	10659	18578	23992	22988	22237	10964	5051	13400	15142	23806	28645	26364	25366	X	
STANDARD DEVIATION		1653	2071	1716	2940	2581	1830	2203	5971	1556	809	1833	1644	2668	2588	2782	4091		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
R EPA DZUBAY	MDS-S	0.88	0.95	0.97	1.04	0.92	0.89	0.95	1.03	0.95	0.74	0.99	0.85	0.98	0.98	1.01	1.03	R	0.08
O EPA RODES	DICOT	0.83	1.14	0.74	0.43	0.88	0.94	0.92	1.04	0.97	0.88	0.83	1.06	0.96	-	0.92	1.06	O	0.17
B EPA BURTON	CHAMP	1.07	1.40	1.22	1.25	1.19	1.12	1.00	1.20	1.08	1.53	1.18	0.97	1.16	1.12	1.08	1.09	B	0.14
U EPA BURTON	CHAMP	1.04	1.31	1.15	1.34	1.19	1.16	1.20	1.19	1.32	1.11	1.15	1.15	1.11	1.12	1.08	1.11	U	0.08
F EPA MULLER	RSP	1.04	0.94	0.91	0.96	0.90	1.05	0.99	0.61	0.70	0.81	0.86	0.89	0.50	0.87	0.91	0.95	F	0.13
D' EPA DZUBAY	MDS-A	0.98	0.79	1.01	0.80	0.89	-	0.96	0.73	0.96	0.88	0.98	0.87	0.99	-	0.98	-	D	0.10
M' EPA DZUBAY	TF-M	1.07	1.04	1.05	1.13	0.97	1.01	1.00	-	1.03	0.95	1.08	0.94	0.95	0.96	0.94	0.99	M	0.06
N' EPA DZUBAY	TF-P	1.06	0.93	0.93	1.00	0.89	0.86	0.97	0.91	0.92	0.87	0.95	0.91	0.97	-	0.94	-	N	0.05
R' EPA DZUBAY	MDS-S	0.92	0.89	1.00	0.91	0.92	0.89	0.95	0.90	0.95	0.93	0.94	0.94	0.92	-	1.01	-	R	0.04
C' LBL L00	DICOT	1.14	-	-	1.12	1.06	1.06	1.07	-	1.11	1.06	1.11	1.10	1.07	1.02	1.10	1.03	C	0.04
L' LBL L00	DICOT	1.13	1.03	1.16	1.16	1.04	1.06	1.07	-	1.08	1.06	1.13	1.11	-	0.99	1.11	1.04	L	0.05
S' LBL L00	DICOT	1.12	1.08	1.15	-	1.04	1.01	1.06	-	1.08	1.06	1.13	1.11	-	0.99	1.11	1.04	S	0.05
G' UCD CAHILL	SMDAY	0.92	0.73	0.79	1.03	0.90	1.02	0.91	1.29	0.94	0.92	0.77	-	-	-	-	-	G	0.15
I' UCD CAHILL	SFU	0.81	0.79	0.94	0.94	1.22	0.93	0.94	1.09	1.03	1.01	0.96	1.09	0.87	0.96	0.81	0.67	I	0.14
Q' STL DEL/ED	2MASS	0.41	0.35	0.34	0.26	0.23	0.15	0.16	0.14	0.23	0.66	0.35	0.30	0.26	0.14	0.21	0.36	Q	0.28
MEAN(ALL SAMPLERS)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
STANDARD DEVIATION		0.11	0.20	0.15	0.22	0.12	0.09	0.08	0.22	0.12	0.21	0.13	0.11	0.10	0.08	0.09	0.13		
REGRESSION VS Z	INTERCEPT																		
R EPA DZUBAY	MDS-S	-1131.690	673.419															R	
O EPA RODES	DICOT	-2161.459	1484.731															O	
B EPA BURTON	CHAMP	1879.978	1024.562															B	
U EPA BURTON	CHAMP	1309.138	746.840															U	
F EPA MULLER	RSP	-308.132	1526.507															F	
D' EPA DZUBAY	MDS-A	-668.907	1249.297															D	
M' EPA DZUBAY	TF-M	1271.471	506.292															M	
N' EPA DZUBAY	TF-P	179.267	643.675															N	
R' EPA DZUBAY	MDS-S	-277.456	580.752															R	
C' LBL L00	DICOT	1248.835	677.192															C	
L' LBL L00	DICOT	768.559	458.787															L	
S' LBL L00	DICOT	1106.434	655.830															S	
G' UCD CAHILL	SMDAY	-3103.357	2156.711															G	
I' UCD CAHILL	SFU	1603.787	1903.345															I	
Q' STL DEL/ED	2MASS																	Q	

1 INTERCOMPARISON STUDY OF LARGE S & S04; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	532	453	875	629	682	527	571	1017	506	667	975	570	609	609	490	888	1060	R	
O EPA RODES DICOT	450	200	530	1350	1070	690	1670	1600	200	1840	1440	1310	1880	2320	1070	1030	0		
D' EPA DZUBAY MDS-A	801	1173	-	1068	981	-	870	-	417	-	-	771	921	-	636	1272	0		
M' EPA DZUBAY TF-M	666	1080	1179	1101	1086	1410	636	-	78	339	720	897	1350	2148	1314	2688	M		
N' EPA DZUBAY TF-P	987	1677	1554	1803	1521	1911	1341	3444	93	1089	1407	1638	2142	3000	4965	3216	N		
R' EPA DZUBAY MDS-S	717	948	1281	957	879	1155	840	2103	468	65	1350	576	957	1452	1122	1611	R		
C' LBL L00 DICOT	-	-	-	2088	2223	2325	2304	-	1191	1089	2397	1593	2610	3165	2724	3234	C		
L' LBL L00 DICOT	1983	2295	2595	2220	2328	2406	2364	-	1320	1245	2421	1914	2763	3369	2967	3444	L		
S' LBL L00 DICOT	1875	2067	2613	-	2214	2199	2247	-	1083	1275	-	-	-	-	3129	2601	3045	S	
G' UCD CAHILL SMDAY	-	-	69	78	12	54	-	24	-	69	-	-	-	-	-	-	6		
I' UCD CAHILL SFU	2430	768	699	1065	1587	1503	1767	2382	861	570	1227	945	2082	2976	1428	3627	I		
Z MEAN(WITHOUT G)	1160	1185	1416	1365	1457	1570	1461	2109	682	975	1492	1135	1702	2450	1972	2423	1534	755	
STANDARD DEVIATION	733	707	803	548	614	693	707	909	422	461	615	495	775	958	1339	1055			
X MEAN(ODMLG1)	1266	1103	1251	1361	1410	1502	1461	1991	575	999	1452	1167	1799	2703	1483	2412			
STANDARD DEVIATION	882	767	937	495	565	704	704	553	512	680	713	463	705	569	883	1207			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
R EPA DZUBAY MDS-S	0.46	0.38	0.62	0.46	0.47	0.34	0.39	0.48	0.74	0.68	0.65	0.50	0.36	0.20	0.45	0.44	R	0.48	0.14
O EPA RODES DICOT	0.39	0.17	0.37	0.99	0.73	0.44	1.14	0.76	0.29	1.89	0.97	1.15	1.11	0.95	0.54	0.43	O	0.77	0.44
D' EPA DZUBAY MDS-A	0.69	0.99	-	0.78	0.67	-	0.60	-	0.61	-	-	0.68	0.54	-	0.32	0.53	D	0.64	0.18
M' EPA DZUBAY TF-M	0.57	0.91	0.83	0.81	0.75	0.90	0.44	-	0.11	0.35	0.48	0.79	0.79	0.88	0.67	1.11	M	0.69	0.26
N' EPA DZUBAY TF-P	0.85	1.42	1.10	1.32	1.04	1.22	0.92	1.63	1.02	1.12	0.94	1.44	1.26	1.22	2.52	1.33	N	1.27	0.39
R' EPA DZUBAY MDS-S	0.62	0.80	0.91	0.70	0.60	0.74	0.58	1.00	0.69	0.67	0.91	0.51	0.56	0.59	0.57	0.67	R	0.69	0.14
C' LBL L00 DICOT	-	-	-	1.53	1.53	1.48	1.58	-	1.75	1.12	1.61	1.40	1.53	1.29	1.38	1.34	C	1.46	0.17
L' LBL L00 DICOT	1.71	1.94	1.83	1.63	1.60	1.53	1.62	-	1.94	1.28	1.62	1.69	1.62	1.38	1.51	1.42	L	1.62	0.19
S' LBL L00 DICOT	1.62	1.75	1.85	-	1.52	1.40	1.54	-	1.59	1.31	-	-	-	1.28	1.32	1.26	S	1.49	0.20
G' UCD CAHILL SMDAY	-	-	0.05	0.06	0.01	0.03	-	0.01	-	0.05	-	-	-	-	-	-	G	0.03	0.02
I' UCD CAHILL SFU	2.09	0.65	0.49	0.78	1.09	0.96	1.21	1.13	1.26	0.59	0.82	0.83	1.22	1.22	0.72	1.50	I	1.04	0.40
MEAN(WITHOUT G)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.63	0.60	0.57	0.40	0.42	0.44	0.48	0.43	0.62	0.47	0.41	0.44	0.46	0.39	0.68	0.44		0.49	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.	COEFF.												
R EPA DZUBAY MDS-S	380.904	153.040	0.202	0.095	182.991	0.493													
O EPA RODES DICOT	234.300	476.936	0.607	0.297	570.277	0.480													
D' EPA DZUBAY MDS-A	493.099	238.758	0.274	0.157	228.562	0.526													
M' EPA DZUBAY TF-M	-727.436	235.814	1.230	0.150	274.872	0.915													
N' EPA DZUBAY TF-P	-715.568	576.008	1.786	0.358	688.738	0.800													
R' EPA DZUBAY MDS-S	3.762	211.428	0.693	0.131	252.807	0.815													
C' LBL L00 DICOT	317.740	184.238	1.238	0.113	197.606	0.961													
L' LBL L00 DICOT	550.963	167.923	1.220	0.107	195.737	0.953													
S' LBL L00 DICOT	586.030	223.026	1.069	0.138	245.142	0.932													
G' UCD CAHILL SMDAY	0.	0.	0.	0.	0.	0.													
I' UCD CAHILL SFU	-523.314	466.181	1.397	0.290	557.417	0.790													

INTERCOMPARISON STUDY OF TOTAL SI . NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.																			
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY	MOS-A	5400	6460	-	6360	8480	-	7970	-	2450	-	-	6240	7330	-	12320	7060	D	
M EPA DZUBAY	TF-M	4170	8970	7590	9080	11040	8540	9280	-	1860	5930	4540	5620	8530	7830	-	5900	M	
N EPA DZUBAY	TF-P	3570	9430	8895	8730	-	9010	9890	9200	2220	8930	3730	7710	9520	9180	14220	8270	N	
R EPA DZUBAY	MOS-S	5290	5730	6940	5660	7090	6180	7610	6370	2330	6000	7250	5470	6750	6720	11670	6280	R	
C LBL L00	DICOT	-	-	-	11916	13869	11685	12696	-	3726	8148	12998	11148	13803	10803	18069	10845	C	
L LBL L00	DICOT	11878	12142	12037	12521	13896	12278	13934	-	4209	10799	13580	11215	14276	12044	18474	11927	L	
S LBL L00	DICOT	14171	13370	16454	-	16438	12614	15941	-	4720	11565	-	-	-	-	13107	19122	S	
H UCD CAHILL	SHDAY	-	6137	5376	8330	7076	6436	7465	9898	2962	4773	5243	-	-	-	-	-	H	
G UCD CAHILL	TTLF	10070	8817	12324	8810	13407	9116	12893	10341	4251	7911	8401	9774	13368	9331	17203	9110	G	
I UCD CAHILL	SFU	3645	6252	4155	5968	9115	6411	7589	9406	3248	4344	247	5967	7879	10200	6416	8376	I	
J FSU HUDSON	LS 2	-	-	-	12703	22554	13145	22850	13135	9250	10287	12816	9152	16780	12480	28144	13000	J	
K FSU HUDSON	LS 4	-	-	-	14930	21200	12580	19870	12675	6814	8180	16790	10313	19350	13750	29934	13570	K	
Z MEAN(ALL SAMPLERS)		7274	8590	9221	9548	13106	9818	12332	10146	4003	7897	9260	8361	11759	10545	17557	9686	Z	9944 3640
STANDARD DEVIATION		4150	2752	4111	3070	5304	2741	5101	2278	2148	2422	4470	2721	4361	2318	7198	2751		
X MEAN(0.M.L.G.I.K)		6273	7992	7290	9532	11801	9249	11018	10660	3591	6805	9480	8071	11473	10956	16786	9367	X	
STANDARD DEVIATION		3808	2598	3470	3535	5175	3031	4971	1763	1765	2683	5422	2490	5212	2539	10053	3261		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY	MOS-A	0.74	0.75	-	0.67	0.65	-	0.65	-	0.61	-	-	0.75	0.62	-	0.70	0.73	D	0.69 0.05 .8
M EPA DZUBAY	TF-M	0.57	1.04	0.82	0.95	0.84	0.87	0.75	-	0.46	0.75	0.49	0.79	0.73	0.74	-	0.61	M	0.75 0.17 .22
N EPA DZUBAY	TF-P	0.49	1.10	0.96	0.91	-	0.92	0.80	0.91	0.55	1.13	0.40	0.92	0.81	0.87	0.81	0.85	N	0.83 0.21 .25
R EPA DZUBAY	MOS-S	0.73	0.67	0.75	0.60	0.54	0.63	0.62	0.63	0.58	0.76	0.78	0.65	0.57	0.64	0.67	0.65	R	0.65 0.07 .11
C LBL L00	DICOT	-	-	-	1.25	1.06	1.19	1.03	-	0.93	1.03	1.40	1.33	1.17	1.02	1.03	1.12	C	1.13 0.14 .13
L LBL L00	DICOT	1.63	1.41	1.31	1.31	1.06	1.25	1.13	-	1.05	1.37	1.47	1.34	1.21	1.14	1.05	1.23	L	1.27 0.17 .13
S LBL L00	DICOT	1.95	1.56	1.78	-	1.25	1.29	1.29	-	1.18	1.46	-	-	-	-	-	1.26	S	1.40 0.27 .19
G UCD CAHILL	SHDAY	-	0.71	0.58	0.87	0.54	0.66	0.61	0.98	0.74	0.60	0.57	-	-	-	-	0.69	G	0.14 .21
H UCD CAHILL	TTLF	1.38	1.03	1.34	0.92	1.02	0.93	1.05	1.02	1.06	1.00	0.91	1.17	1.14	0.89	0.98	0.94	H	1.05 0.15 .14
I UCD CAHILL	SFU	0.50	0.73	0.45	0.63	0.70	0.65	0.62	0.93	0.81	0.55	0.78	0.71	0.67	0.97	0.37	0.87	I	0.68 0.17 .24
J FSU HUDSON	LS 2	-	-	-	1.33	1.72	1.34	1.85	1.29	2.31	1.30	1.38	1.09	1.43	1.18	1.60	1.34	J	1.48 0.33 .22
K FSU HUDSON	LS 4	-	-	-	1.56	1.62	1.28	1.61	1.25	1.70	1.04	1.81	1.23	1.65	1.30	1.71	1.40	K	1.47 0.24 .16
MEAN(ALL SAMPLERS)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00
STANDARD DEVIATION		0.57	0.32	0.45	0.32	0.41	0.28	0.41	0.22	0.54	0.31	0.48	0.27	0.37	0.22	0.41	0.28		0.37
REGRESSION VS Z	INTERCEPT																		
D EPA DZUBAY	MOS-A	238.955	497.652																
M EPA DZUBAY	TF-M	-1428.177	1602.926																
N EPA DZUBAY	TF-P	-76.524	1597.218																
R EPA DZUBAY	MOS-S	646.791	618.166																
C LBL L00	DICOT	1516.928	1278.370																
L LBL L00	DICOT	3688.059	1123.230																
S LBL L00	DICOT	4632.616	1993.842																
H UCD CAHILL	SHDAY	1246.805	1957.887																
G UCD CAHILL	TTLF	1206.161	1167.846																
I UCD CAHILL	SFU	2877.217	1661.787																
J FSU HUDSON	LS 2	-2307.378	2560.163																
K FSU HUDSON	LS 4	-3724.416	2092.543																

1 INTERCOMPARISON STUDY OF SMALL SI ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	1031	1271	1181	782	842	-	676	1622	782	756	1286	1001	1269	-	1320	1211	D		
M EPA DZUBAY TF-M	1359	1172	1405	893	1270	853	1397	-	539	616	1736	843	1215	720	2208	712	M		
N EPA DZUBAY TF-P	1879	1374	1309	1149	1749	1205	1517	1749	869	860	1603	1059	1758	1227	2088	1081	N		
R EPA DZUBAY MDS-S	748	1070	706	737	446	667	294	1539	496	448	917	828	699	743	733	723	R		
C LBL LOO DICOT	-	-	-	545	514	478	454	-	749	416	934	793	882	667	819	497	C		
L LBL LOO DICOT	925	1047	913	550	518	480	462	-	729	427	967	701	848	666	797	492	L		
S LBL LOO DICOT	839	1084	797	-	474	465	464	-	703	430	978	-	-	654	787	507	S		
G UCD CAHILL SMDAY	1750	1870	1250	1760	1490	2040	1240	3670	1220	1370	1270	-	-	-	-	-	G		
I UCD CAHILL SFU	1133	1110	1833	1455	3258	1479	1543	3360	-2169	1846	2309	-2037	1954	1143	2365	617	I		
Z MEAN(ALL SAMPLERS)	1208	1250	1174	984	1173	958	894	2388	917	797	1333	1037	1232	831	1390	730		1144	520
STANDARD DEVIATION	419	274	367	438	921	573	519	1037	513	501	473	457	475	245	716	275			
X MEAN(D.M.L.G.I)	1240	1294	1316	1088	1476	1213	1064	2884	1088	1003	1514	1146	1322	843	1673	758			
STANDARD DEVIATION	327	332	339	502	1065	688	470	1104	654	589	523	607	461	261	743	315			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	0.85	*1.02	*1.01	0.80	0.72	-	0.76	0.68	0.85	*0.95	*0.96	*0.97	*1.03	-	*0.95	1.66	D	0.94	0.24
M EPA DZUBAY TF-M	*1.13	*0.94	1.20	*0.91	*1.08	*0.89	1.56	-	0.59	0.77	1.30	0.81	*0.99	0.87	1.59	*0.98	M	1.04	0.28
N EPA DZUBAY TF-P	1.56	*1.10	*1.12	1.17	1.49	1.26	1.70	0.73	*0.95	*1.08	1.20	*1.02	1.43	1.48	1.50	1.48	N	1.27	0.26
R EPA DZUBAY MDS-S	0.62	0.86	0.60	0.75	0.38	0.70	0.33	0.64	0.54	0.56	0.69	0.80	0.57	*0.89	0.53	*0.99	R	0.65	0.18
C LBL LOO DICOT	-	-	-	0.55	0.44	0.50	0.51	-	0.82	0.52	0.70	0.76	0.72	0.80	0.59	0.68	C	0.63	0.13
L LBL LOO DICOT	0.77	0.84	0.78	0.56	0.44	0.50	0.52	-	0.80	0.54	0.73	0.68	0.69	0.80	0.57	0.67	L	0.66	0.13
S LBL LOO DICOT	0.69	0.87	0.68	-	0.40	0.49	0.52	-	0.77	0.54	0.73	-	-	0.79	0.57	0.69	S	0.65	0.14
G UCD CAHILL SMDAY	1.45	1.50	*1.06	1.79	*1.27	2.13	1.39	1.54	1.33	1.72	*0.95	-	-	-	-	-	G	1.47	0.33
I UCD CAHILL SFU	*0.94	*0.89	1.56	1.48	2.78	1.54	1.73	1.41	2.36	2.32	1.73	1.96	1.59	1.38	1.70	*0.85	I	1.64	0.53
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.35	0.22	0.31	0.45	0.78	0.60	0.58	0.43	0.56	0.63	0.35	0.44	0.39	0.29	0.52	0.38		0.46	

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	460.916	163.924	0.520	0.132	191.161	0.750
M EPA DZUBAY TF-M	-814.294	377.476	1.832	0.350	269.122	0.824
N EPA DZUBAY TF-P	749.156	246.987	0.573	0.205	307.438	0.598
R EPA DZUBAY MDS-S	60.839	142.480	0.591	0.118	177.353	0.800
C LBL LOO DICOT	27.643	199.756	0.604	0.191	135.986	0.706
L LBL LOO DICOT	-106.150	196.932	0.761	0.182	140.403	0.757
S LBL LOO DICOT	-59.102	231.569	0.703	0.215	160.356	0.718
G UCD CAHILL SMDAY	54.117	353.108	1.402	0.281	384.022	0.857
I UCD CAHILL SFU	389.221	465.077	1.278	0.386	578.906	0.662

1 INTERCOMPARISON STUDY OF LARGE SI ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	5267	5190	-	5576	7628	-	7292	-	1661	-	-	-	5137	6158	-	10999	5847	D	
M EPA DZUBAY TF-M	2806	7798	6185	8190	9767	7790	7877	-	1320	5309	2800	5772	7320	7110	-	-	5183	M	
N EPA DZUBAY TF-P	1694	8056	7586	7581	-	7808	8372	7453	1347	8066	2130	6651	7857	7955	12128	7191	N		
R EPA DZUBAY MDS-S	4539	4656	6232	4946	6641	5515	7319	4828	1837	5556	6332	4641	6048	5975	10934	5554	R		
C LBL LOO DICOT	-	-	-	11371	13355	11207	12242	-	2777	7732	12064	10356	12920	10136	17250	10348	C		
L LBL LOO DICOT	10953	11095	11124	11971	13378	11798	13322	-	3480	10373	12613	10514	13428	11378	17677	11435	L		
S LBL LOO DICOT	13332	12286	15657	-	15964	12149	15478	-	4017	11135	-	-	-	-	-	-	S		
G UCD CAHILL SMDAY	-	4264	4125	6570	5590	4393	6221	6225	1740	3408	3978	-	-	-	-	-	G		
I UCD CAHILL SFU	2512	5142	2322	4513	5857	4932	7230	6046	1079	2498	4938	3930	5925	9057	4051	7759	I		
Z MEAN(ALL SAMPLERS)	5872	7311	7604	7590	9773	8199	9484	6138	2162	6760	6408	6714	8522	9152	13053	8128	Z	7679 3283	
STANDARD DEVIATION	4505	3057	4493	2813	3989	3169	3303	1074	1056	3112	4279	2681	3260	2328	5123	2677			
X MEAN(D.M.L.G.I.)	5385	6698	5939	7364	8444	7228	8388	6136	1856	5397	6082	6338	8208	9182	10909	7556	X		
STANDARD DEVIATION	3912	2791	3800	2910	3225	3392	2822	127	946	3518	4441	2887	3533	2137	6813	2807			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	*0.90	0.71	-	0.74	*0.78	-	*0.77	-	*0.77	-	-	-	*0.77	0.72	-	*0.84	0.72	D	0.77 0.06 8
M EPA DZUBAY TF-M	0.48	*1.07	*0.81	*1.08	*1.00	*0.95	*0.83	-	0.61	*0.79	0.44	*0.86	*0.86	*0.78	-	-	0.64	M	0.80 0.20 25
N EPA DZUBAY TF-P	0.29	*1.10	*1.00	*1.00	-	*0.95	*0.88	*1.21	0.62	*1.19	0.33	*0.99	*0.92	*0.87	*0.93	*0.89	N	0.88 0.27 31	
R EPA DZUBAY MDS-S	*0.77	0.64	*0.82	0.65	0.68	0.67	*0.77	*0.79	*0.85	*0.82	*0.99	0.69	0.71	0.65	*0.84	0.68	R	0.75 0.10 13	
C LBL LOO DICOT	-	-	-	1.50	1.37	1.37	1.29	-	1.38	1.14	1.88	1.54	1.52	*1.11	1.32	1.27	C	1.39 0.21 15	
L LBL LOO DICOT	1.87	1.52	1.46	1.58	1.37	1.44	1.41	-	1.61	1.53	1.97	1.57	1.58	1.24	1.35	1.41	L	1.53 0.19 12	
S LBL LOO DICOT	2.27	1.68	2.06	-	1.63	1.48	1.63	-	1.86	1.65	-	-	-	-	1.36	1.40	S	1.68 0.28 17	
G UCD CAHILL SMDAY	-	0.58	0.54	*0.87	0.57	0.54	0.66	*1.01	*0.81	0.50	0.62	-	-	-	-	-	G	0.67 0.17 25	
I UCD CAHILL SFU	0.43	0.70	0.31	0.59	0.60	0.60	*0.76	*0.99	0.50	0.37	*0.77	0.59	0.70	*0.99	0.31	*0.95	I	0.63 0.22 35	
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.77	0.42	0.59	0.37	0.41	0.39	0.35	0.18	0.49	0.46	0.67	0.40	0.38	0.25	0.39	0.33		0.43	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	RMS.DEV.	COR.COEFF.														
D EPA DZUBAY MDS-A	-372.738	474.498	0.820	0.057	484.373	0.981													
M EPA DZUBAY TF-M	-1847.693	1476.522	1.072	0.194	1329.379	0.848													
N EPA DZUBAY TF-P	-1005.701	1532.234	1.034	0.195	1685.445	0.827													
R EPA DZUBAY MDS-S	15.335	667.713	0.743	0.084	744.509	0.922													
C LBL LOO DICOT	1355.206	1468.358	1.206	0.176	1494.811	0.908													
L LBL LOO DICOT	2765.691	1062.408	1.140	0.131	1149.926	0.924													
S LBL LOO DICOT	3326.841	1813.536	1.211	0.217	1853.463	0.881													
G UCD CAHILL SMDAY	1065.548	1322.193	0.502	0.178	1133.320	0.706													
I UCD CAHILL SFU	1307.372	1723.441	0.463	0.216	1921.661	0.498													

INTERCOMPARISON STUDY OF TOTAL CA : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977																			
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	1870	1490	-	1790	2970	-	3290	3570	-	460	-	-	1560	1990	-	2220	1610	D	
M EPA DZUBAY TF-M	2050	2650	3150	3250	4520	-	2960	3660	2440	585	2580	1510	2310	2860	2250	-	1940	M	
N EPA DZUBAY TF-P	1950	2510	3170	2900	-	1830	2470	1440	500	1540	2030	1460	1840	2180	2180	2180	2310	N	
R EPA DZUBAY MDS-S	1510	1320	2220	1670	2780	-	3924	5293	3480	4129	-	784	2337	3976	3189	3992	2766	3558	R
C LBL LOO DICOT	-	-	-	3924	5293	3480	4129	-	784	2337	3976	3189	3992	2766	3558	2652	3067	C	
L LBL LOO DICOT	3724	3243	4080	4115	5325	3960	4595	-	937	3144	4164	3240	4134	3282	3712	3067	3052	L	
S LBL LOO DICOT	4682	3638	5690	-	6453	4133	5398	-	1028	2601	-	-	-	3523	3570	3052	3052	S	
G UCD CAHILL SMDAY	-	1570	1426	2307	2194	1848	2151	2350	474	1150	1346	-	-	-	-	-	-	G	
H UCD CAHILL TTLF	1851	1423	2795	2074	2987	1531	2339	1121	459	1630	1421	1714	2017	1330	2199	2143	2143	H	
I UCD CAHILL SFU	1303	1369	1499	1492	2587	1809	2708	1779	450	1002	1638	1425	2061	2082	1555	1914	1914	I	
J FSU HUDSON LS 2	-	-	-	2542	5459	2463	4592	1746	1694	2100	2900	2022	3165	2054	3298	1901	1901	J	
K FSU HUDSON LS 4	-	-	-	3304	5383	2433	4247	1710	856	1541	3042	1949	3270	2027	3386	1752	1752	K	
Z MEAN(ALL SAMPLERS)	2318	2135	3004	2670	4177	2705	3536	1798	731	2006	2398	2108	2833	2327	2868	2162	2496	Z	885
STANDARD DEVIATION	1215	893	1406	901	1491	919	1074	468	355	666	1056	656	838	695	771	552	552		
X MEAN(10 M.L.G., I.K.)	2237	2064	2539	2710	3830	2668	3307	1946	628	1835	2428	2077	2863	2410	2718	2057	2057		
STANDARD DEVIATION	1041	835	1300	1011	1420	938	985	351	216	897	1163	721	893	589	1006	580	580		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.81	0.70	-	0.67	0.71	-	0.73	-	0.63	-	-	-	0.74	0.70	-	0.77	0.75	D	0.05
M EPA DZUBAY TF-M	0.88	1.24	1.05	1.22	1.08	1.22	1.01	-	0.81	1.17	0.81	1.05	1.01	0.97	-	0.90	0.90	M	0.15
N EPA DZUBAY TF-P	0.67	1.18	1.06	1.09	-	1.10	1.04	1.36	0.80	1.29	0.63	1.10	1.06	1.03	1.01	1.07	1.03	N	0.19
R EPA DZUBAY MDS-S	0.65	0.62	0.74	0.63	0.67	0.68	0.70	0.80	0.68	0.82	0.85	0.69	0.65	0.67	0.76	0.67	0.67	R	0.10
C LBL LOO DICOT	-	-	-	1.47	1.27	1.29	1.17	-	1.07	1.17	1.66	1.51	1.41	1.19	1.24	1.23	1.31	C	0.13
L LBL LOO DICOT	1.61	1.52	1.36	1.54	1.28	1.46	1.30	-	1.28	1.57	1.74	1.54	1.46	1.41	1.29	1.42	1.45	L	0.14
S LBL LOO DICOT	2.02	1.70	1.89	-	1.55	1.53	1.53	-	1.41	1.30	-	-	-	1.51	1.28	1.41	1.51	S	0.15
G UCD CAHILL SMDAY	-	0.74	0.48	0.86	0.53	0.68	0.61	1.31	0.65	0.57	0.56	-	-	-	-	0.70	0.70	G	0.35
H UCD CAHILL TTLF	0.80	0.67	0.93	0.78	0.72	0.57	0.66	0.62	0.63	0.81	0.59	0.81	0.71	0.57	0.77	0.99	0.73	H	0.17
I UCD CAHILL SFU	0.56	0.64	0.50	0.56	0.62	0.67	0.77	0.99	0.62	0.50	0.68	0.68	0.73	0.89	0.54	0.89	1.00	I	0.21
J FSU HUDSON LS 2	-	-	-	0.95	1.31	0.91	1.30	0.97	2.26	1.05	1.21	0.96	1.12	0.88	1.15	0.88	1.15	J	0.37
K FSU HUDSON LS 4	-	-	-	1.24	1.29	0.90	1.20	0.95	1.17	0.77	1.27	0.92	1.15	0.87	1.18	0.81	0.81	K	0.19
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
STANDARD DEVIATION	0.52	0.42	0.47	0.34	0.36	0.34	0.34	0.30	0.26	0.49	0.33	0.44	0.31	0.30	0.30	0.27	0.26		0.36

REGRESSION VS Z										RMS DEV		COR COEFF	
	INTERCEPT	ERROR	SLOPE	ERROR	RMS DEV	COR COEFF							
D EPA DZUBAY MDS-A	2 425	106.459	0.725	0.039	109.370	0.988							
M EPA DZUBAY TF-M	-180.531	299.928	1.115	0.114	326.977	0.942							
N EPA DZUBAY TF-P	78.375	444.531	1.001	0.181	434.339	0.837							
R EPA DZUBAY MDS-S	101.866	144.134	0.660	0.056	164.764	0.954							
C LBL LOO DICOT	149.787	389.230	1.254	0.146	408.867	0.939							
L LBL LOO DICOT	628.987	294.462	1.192	0.112	321.287	0.948							
S LBL LOO DICOT	-53.103	575.357	1.589	0.215	606.137	0.927							
G UCD CAHILL SMDAY	652.352	455.204	0.409	0.170	487.932	0.648							
H UCD CAHILL TTLF	15.989	272.546	0.724	0.105	311.556	0.879							
I UCD CAHILL SFU	212.194	297.095	0.585	0.115	339.618	0.807							
J FSU HUDSON LS 2	-308.817	467.321	1.235	0.179	517.651	0.901							
K FSU HUDSON LS 4	-822.984	375.897	1.411	0.144	416.382	0.947							

I INTERCOMPARISON STUDY OF SMALL CA : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	228	211	283	228	300	-	262	215	126	218	279	211	307	-	296	248 D			
M EPA DZUBAY TF-M	703	457	792	570	878	554	730	-	236	518	783	435	599	331	588	328 M			
N EPA DZUBAY TF-P	643	391	641	439	892	461	686	401	227	419	683	415	616	349	508	304 N			
R EPA DZUBAY MDS-S	162	143	214	167	220	195	207	177	98	162	178	172	170	124	188	123 R			
C LBL LOO DICOT	159	-	-	185	208	180	186	-	112	143	193	188	204	149	189	137 C			
L LBL LOO DICOT	169	205	246	197	202	197	200	-	107	146	193	166	203	155	149	146 L			
S LBL LOO DICOT	174	199	196	-	191	171	180	-	84	143	212	-	-	-	-	- G			
G UCD CAHILL SMDAY	325	406	360	497	545	571	452	494	244	344	313	-	-	-	-	- G			
I UCD CAHILL SFU	288	241	347	322	560	266	248	417	187	280	332	254	379	227	365	166 I			
Z MEAN(ALL SAMPLERS)	317	282	385	326	444	324	350	341	158	264	352	263	354	211	306	197	305	158	
STANDARD DEVIATION	211	118	216	157	288	174	219	137	65	137	224	115	187	94	168	84			
X MEAN(D,M,L,G,I)	343	304	406	363	497	397	378	375	180	301	380	267	372	238	350	222			
STANDARD DEVIATION	210	119	221	165	263	193	219	144	62	142	232	118	168	88	183	83			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.72	0.75	0.74	0.70	0.68	-	0.75	0.63	0.80	0.83	0.79	0.80	0.87	-	*0.97	1.26 D	0.81	0.16	19
M EPA DZUBAY TF-M	2.22	1.62	2.06	1.71	1.98	1.71	2.09	-	1.50	1.96	2.23	1.65	1.69	1.57	1.92	1.67 M	1.84	0.24	13
N EPA DZUBAY TF-P	2.03	1.39	1.67	1.35	2.01	1.42	1.96	1.18	1.44	1.59	1.94	1.58	1.74	1.65	1.66	1.54 N	1.63	0.25	15
R EPA DZUBAY MDS-S	0.51	0.51	0.56	0.51	0.50	0.60	0.59	0.52	0.62	0.61	0.51	0.65	0.48	0.59	0.62	0.63 R	0.56	0.06	10
C LBL LOO DICOT	0.50	-	-	0.57	0.47	0.56	0.53	-	0.71	0.54	0.55	0.72	0.58	0.71	0.62	0.70 C	0.60	0.09	14
L LBL LOO DICOT	0.53	0.73	0.64	0.61	0.46	0.61	0.57	-	0.68	0.55	0.55	0.63	0.57	0.73	0.49	0.74 L	0.61	0.09	14
S LBL LOO DICOT	0.55	0.71	0.51	-	0.43	0.53	0.51	-	0.53	0.54	0.60	-	-	0.69	0.53	0.63 S	0.56	0.08	14
G UCD CAHILL SMDAY	*1.03	1.44	*0.94	1.53	1.23	1.76	1.29	1.45	1.55	1.31	0.89	-	-	-	-	- G	1.31	0.27	21
I UCD CAHILL SFU	*0.91	0.86	*0.90	*0.99	1.26	0.82	0.71	1.22	1.18	*1.06	*0.94	*0.97	*1.07	*1.07	1.19	0.84 I	1.00	0.16	16
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.67	0.42	0.56	0.48	0.65	0.54	0.63	0.40	0.41	0.52	0.64	0.44	0.53	0.44	0.55	0.43	0.52		
REGRESSION VS Z	INTERCEPT		ERROR		SLOPE		ERROR		RMS.DEV.		COR.COEFF.								
D EPA DZUBAY MDS-A	91.035	40.290		0.493		0.127	33.822		0.747										
M EPA DZUBAY TF-M	-151.457	66.442		2.377		0.214	60.192		0.951										
N EPA DZUBAY TF-P	-135.349	90.926		2.102		0.291	82.577		0.888										
R EPA DZUBAY MDS-S	40.567	15.936		0.421		0.051	14.472		0.911										
C LBL LOO DICOT	73.316	16.330		0.331		0.053	14.266		0.882										
L LBL LOO DICOT	65.877	22.915		0.374		0.074	20.760		0.815										
S LBL LOO DICOT	53.932	23.483		0.372		0.076	20.705		0.840										
G UCD CAHILL SMDAY	136.120	128.214		0.862		0.389	89.523		0.594										
I UCD CAHILL SFU	-30.842	61.087		1.103		0.195	55.478		0.833										

1 INTERCOMPARISON STUDY OF LARGE CA : NANOGRAMS/CUBIC METER; PERIODS 1-16 MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	1644	1278	-	1563	2671	-	2306	-	331	-	-	-	1346	1682	-	1924	1358 D		
M EPA DZUBAY TF-M	1344	2197	2355	2677	3640	2735	2836	-	359	1821	1163	1776	2265	1922	-	-	1610 M		
N EPA DZUBAY TF-P	906	2119	2527	2459	-	2515	2974	2038	359	2058	828	1895	2386	2058	2396	2009 N			
R EPA DZUBAY MDS-S	1350	1175	2003	1503	2559	1634	2265	1262	398	1476	1854	1286	1671	1437	1990	1319 R			
C LBL LOO DICOT	-	-	-	3739	5085	3300	3943	-	572	2194	3783	3001	3788	2617	3369	2515 C			
L LBL LOO DICOT	3555	3038	3834	3918	5123	3763	4395	-	830	2998	3971	3674	3931	3127	3563	2921 L			
S LBL LOO DICOT	4508	3439	5494	-	6262	3962	5218	-	944	2458	-	-	-	-	-	-	-	-	-
G UCD CAHILL SMDAY	-	1164	1066	1810	1649	1277	1699	1856	330	806	1043	-	-	-	-	-	-	-	-
I UCD CAHILL SFU	1015	1128	1152	1170	2027	1543	2460	1362	263	722	1306	1171	1682	1855	1190	1748 I			
Z MEAN(ALL SAMPLERS)	2046	1942	2633	2355	3627	2591	3122	1630	498	1817	1993	2021	2496	2342	2563	2051	2232	993	
STANDARD DEVIATION	1405	913	1569	1037	1683	1037	1154	376	250	788	1326	956	983	716	930	660			
X MEAN(D, M, L, G, I)	1890	1761	2102	2228	3022	2330	2739	1609	423	1587	1871	1992	2390	2301	2226	1909			
STANDARD DEVIATION	1140	838	1296	1095	1396	1147	1012	349	230	1065	1404	1150	1063	716	1215	694			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.80	0.66	-	0.66	0.74	-	0.74	-	0.66	-	-	-	0.67	0.68	-	0.75	0.66 D	0.70	0.05 7
M EPA DZUBAY TF-M	0.66	*1.13	*0.89	*1.14	*1.00	*1.06	*0.91	-	0.72	*1.00	0.58	*0.88	*0.91	0.82	-	-	0.79 M	0.89	0.17 19
N EPA DZUBAY TF-P	0.44	*1.09	*0.96	*1.04	-	*0.97	*0.95	1.25	0.72	*1.13	0.42	*0.94	*0.96	*0.88	*0.94	*0.98 N	0.91	0.23 25	
R EPA DZUBAY MDS-S	0.66	0.61	0.76	0.64	0.71	0.63	0.73	0.77	0.80	0.81	*0.93	0.64	0.67	0.61	0.78	0.64 R	0.71	0.09 13	
C LBL LOO DICOT	-	-	-	1.59	1.40	1.27	1.26	-	1.35	1.21	1.90	1.49	1.52	1.12	1.31	1.23 C	1.39	0.21 15	
L LBL LOO DICOT	1.74	1.56	1.46	1.66	1.41	1.45	1.41	-	1.67	1.65	1.99	1.82	1.58	1.34	1.39	1.42 L	1.57	0.19 12	
S LBL LOO DICOT	2.20	1.77	2.09	-	1.73	1.53	1.67	-	1.89	1.35	-	-	-	-	1.44	1.37	1.43 S	1.68	0.29 17
G UCD CAHILL SMDAY	-	0.60	0.41	0.77	0.46	0.49	0.54	*1.14	0.66	0.44	0.52	-	-	-	-	-	-	0.60	0.22 36
I UCD CAHILL SFU	0.50	0.58	0.44	0.50	0.56	0.60	0.79	*0.84	0.53	0.40	0.66	0.58	0.68	0.79	0.46	*0.85 I	0.61	0.15 24	
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.69	0.47	0.60	0.44	0.46	0.40	0.37	0.23	0.50	0.43	0.67	0.47	0.40	0.31	0.36	0.32	0.45		
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.													
D EPA DZUBAY MDS-A	-107.809	107.871	0.756	0.045	111.030	0.986													
M EPA DZUBAY TF-M	-313.112	319.013	1.049	0.136	346.803	0.913													
N EPA DZUBAY TF-P	-97.891	451.644	0.966	0.204	453.533	0.796													
R EPA DZUBAY MDS-S	52.768	167.134	0.681	0.072	190.208	0.930													
C LBL LOO DICOT	141.423	455.011	1.322	0.189	477.125	0.911													
L LBL LOO DICOT	652.945	343.923	1.257	0.145	374.139	0.923													
S LBL LOO DICOT	-61.516	641.340	1.695	0.265	672.880	0.905													
G UCD CAHILL SMDAY	460.189	364.035	0.365	0.154	398.740	0.642													
I UCD CAHILL SFU	18.209	294.487	0.602	0.126	335.143	0.786													

1 INTERCOMPARISON STUDY OF TOTAL T1 : NANOGRAMS/CUBIC METER: PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	192	214	-	222	273	-	198	-	24	-	-	151	265	-	379	252	D		
M EPA DZUBAY TF-M	162	294	300	338	442	273	289	-	25	197	186	255	347	286	-	231	M		
N EPA DZUBAY TF-P	95	295	242	280	-	297	224	267	73	268	90	190	347	258	411	256	N		
R EPA DZUBAY MDS-S	172	186	254	192	213	171	212	166	73	192	241	155	222	220	388	193	R		
C LBL LOO DICOT	-	-	-	356	393	308	299	-	95	220	405	330	404	322	449	297	C		
L LBL LOO DICOT	319	376	381	385	379	333	352	-	102	309	441	322	431	381	482	339	L		
S LBL LOO DICOT	382	406	501	-	456	346	397	-	117	322	-	-	-	-	464	480	S		
G UCD CAHILL SHDAY	-	150	120	188	123	121	135	160	69	95	132	-	-	-	-	-	G		
H UCD CAHILL TTLF	149	156	214	182	213	148	145	128	74	121	153	170	214	163	251	120	H		
I UCD CAHILL SFU	153	135	148	121	122	182	303	187	-	189	160	240	191	181	197	128	I		
J FSU HUDSON LS .2	-	-	-	190	284	174	275	139	135	156	278	156	281	242	471	213	J		
K FSU HUDSON LS .4	-	-	-	333	350	271	331	217	183	219	350	218	369	325	505	245	K		
Z MEAN(ALL SAMPLERS)	203	246	270	253	295	239	263	181	88	208	244	219	307	284	401	237	Z	246	90
STANDARD DEVIATION	97	101	124	88	119	81	81	48	46	71	121	67	84	92	103	72			
X MEAN(0.1 M.L.G., 1.1 K)	207	234	237	265	282	236	268	188	81	202	254	237	321	293	391	239	X		
STANDARD DEVIATION	77	101	124	103	135	84	84	29	66	76	135	62	94	84	140	75			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	0.95	0.87	-	0.88	0.92	-	0.75	-	0.27	-	-	0.69	0.86	-	0.94	1.06	D	0.82	0.22
M EPA DZUBAY TF-M	0.80	1.20	1.11	1.33	1.50	1.14	1.10	-	0.28	0.95	0.76	1.17	1.13	1.01	-	0.98	M	1.03	0.29
N EPA DZUBAY TF-P	0.47	1.20	0.90	1.11	-	1.25	0.85	1.48	0.83	1.29	0.37	0.87	1.13	0.91	1.02	1.08	N	0.98	0.29
R EPA DZUBAY MDS-S	0.65	0.76	0.94	0.76	0.72	0.72	0.81	0.92	0.83	0.92	0.99	0.71	0.72	0.77	0.97	0.81	R	0.82	0.10
C LBL LOO DICOT	-	-	-	1.40	1.33	1.29	1.14	-	1.08	1.06	1.66	1.51	1.32	1.13	1.12	1.25	C	1.27	0.19
L LBL LOO DICOT	1.57	1.53	1.41	1.52	1.28	1.40	1.34	-	1.16	1.49	1.81	1.47	1.40	1.34	1.20	1.43	L	1.42	0.16
S LBL LOO DICOT	1.88	1.65	1.86	-	1.54	1.45	1.51	-	1.33	1.55	-	-	-	1.63	1.20	1.41	S	1.55	0.21
G UCD CAHILL SHDAY	-	0.61	0.44	0.74	0.42	0.51	0.51	0.89	0.78	0.46	0.54	-	-	-	-	0.59	G	0.16	0.27
H UCD CAHILL TTLF	0.73	0.64	0.79	0.72	0.72	0.62	0.55	0.71	0.84	0.98	0.63	0.78	0.70	0.57	0.63	0.51	H	0.67	0.09
I UCD CAHILL SFU	0.75	0.55	0.55	0.48	0.41	0.76	1.15	1.04	-	0.91	0.66	1.10	0.62	0.64	0.49	0.54	I	0.71	0.24
J FSU HUDSON LS .2	-	-	-	0.75	0.96	0.73	1.04	0.77	1.53	0.75	1.14	0.71	0.92	0.85	1.17	0.90	J	0.94	0.24
K FSU HUDSON LS .4	-	-	-	1.31	1.19	1.14	1.26	1.20	2.08	1.05	1.44	1.00	1.20	1.14	1.26	1.03	K	1.25	0.27
Z MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	Z	1.00	
STANDARD DEVIATION	0.48	0.41	0.46	0.35	0.40	0.34	0.31	0.27	0.52	0.34	0.50	0.31	0.27	0.33	0.26	0.30		0.37	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR. COEFF.													
D EPA DZUBAY MDS-A	-58.800	29.270	1.097	0.111	26.830	0.961													
M EPA DZUBAY TF-M	-137.890	57.785	1.695	0.236	45.387	0.897													
N EPA DZUBAY TF-P	-8.179	67.119	1.020	0.267	67.254	0.727													
R EPA DZUBAY MDS-S	-15.172	26.903	0.887	0.106	27.179	0.913													
C LBL LOO DICOT	31.590	50.197	1.151	0.191	46.297	0.885													
L LBL LOO DICOT	63.959	39.476	1.164	0.153	37.851	0.904													
S LBL LOO DICOT	78.020	61.196	1.223	0.236	56.517	0.865													
G UCD CAHILL SHDAY	64.015	40.440	0.285	0.172	30.276	0.507													
H UCD CAHILL TTLF	16.583	20.957	0.593	0.082	21.172	0.887													
I UCD CAHILL SFU	167.193	66.099	0.034	0.253	50.148	0.037													
J FSU HUDSON LS .2	-43.787	47.130	1.107	0.183	46.183	0.877													
K FSU HUDSON LS .4	28.463	37.725	1.101	0.147	36.966	0.915													

1 INTERCOMPARISON STUDY OF SMALL TI ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	50	53	80	24	56	-	5	11	0	36	48	33	65	-	51	82 D			
M EPA DZUBAY TF-M	72	57	76	76	92	70	90	-	0	52	91	-41	86	22	85	72 M			
N EPA DZUBAY TF-P	58	0	22	0	29	40	0	32	0	9	0	0	53	48	72	51 N			
R EPA DZUBAY MDS-S	29	14	45	36	31	21	28	40	10	37	26	32	24	37	54	36 R			
C LBL LOO DICOT	28	-	-	35	29	27	25	-	17	25	33	34	33	38	28	20 C			
L LBL LOO DICOT	29	45	51	38	29	29	31	-	13	18	36	32	41	41	32	29 L			
S LBL LOO DICOT	27	46	43	-	25	26	27	-	13	22	-	-	-	41	33	23 S			
G UCD CAHILL SMDAY	26	60	28	51	23	29	33	40	30	21	232	-	-	-	-	- G			
I UCD CAHILL SFU	40	40	93	91	35	52	160	-130	-	105	45	-141	53	40	112	50 I			
Z MEAN(ALL SAMPLERS)	40	39	55	44	39	37	44	51	10	36	64	45	51	38	58	45	44	29	
STANDARD DEVIATION	17	21	26	29	22	17	50	46	10	29	73	44	21	8	30	23			
X MEAN(D,M,L,G,I)	43	51	66	56	47	45	64	60	11	46	90	62	61	34	70	58			
STANDARD DEVIATION	19	8	26	27	28	20	62	62	14	35	82	53	19	11	36	24			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.25	1.35	1.46	0.55	1.44	-	0.11	0.22	0.	*1.00	0.75	0.74	1.28	-	*0.87	1.81	D	0.92	0.55 60
M EPA DZUBAY TF-M	1.81	*1.45	*1.39	1.73	2.37	1.91	2.03	-	*0.	*1.44	1.43	*0.92	1.70	*0.58	1.46	1.59	M	1.45	0.59 40
N EPA DZUBAY TF-P	*1.45	0.	0.40	0.	*0.75	*1.09	0.	*0.63	*0.	0.25	0.	0.	*1.05	*1.26	*1.23	*1.12	N	0.58	0.55 96
R EPA DZUBAY MDS-S	0.73	0.36	*0.82	*0.82	*0.80	0.57	0.63	0.79	*0.96	*1.02	0.41	0.72	0.47	*0.97	*0.93	0.79	R	0.74	0.20 27
C LBL LOO DICOT	0.70	-	-	0.80	0.75	0.74	0.56	-	1.64	0.69	0.52	0.76	0.65	*1.00	0.48	0.44	C	0.75	0.31 41
L LBL LOO DICOT	0.73	*1.14	*0.93	*0.87	0.75	0.79	0.70	-	*1.25	0.50	0.56	0.72	0.81	*1.08	0.55	0.64	L	0.80	0.22 28
S LBL LOO DICOT	0.68	1.17	0.79	-	0.65	0.71	0.61	-	*1.25	0.61	-	-	-	*1.08	0.57	0.51	S	0.78	0.26 33
G UCD CAHILL SMDAY	0.65	1.52	0.51	1.16	0.59	0.79	0.74	0.79	2.89	0.58	3.63	-	-	-	-	-	G	1.26	1.04 83
I UCD CAHILL SFU	*1.00	*1.02	1.70	2.07	*0.90	1.42	3.61	2.57	-	2.91	0.70	3.15	*1.05	*1.05	1.92	*1.10	I	1.74	0.93 53
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.42	0.54	0.47	0.66	0.57	0.45	1.13	0.91	1.01	0.80	1.14	0.99	0.41	0.21	0.51	0.50		0.67	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.													
D EPA DZUBAY MDS-A	0.618	24.043	0.942	0.523	23.752	0.462													
M EPA DZUBAY TF-M	-5.169	18.069	1.642	0.405	18.538	0.747													
N EPA DZUBAY TF-P	3.963	24.666	0.504	0.548	25.403	0.239													
R EPA DZUBAY MDS-S	7.268	8.958	0.551	0.199	9.226	0.595													
C LBL LOO DICOT	18.253	5.398	0.244	0.122	5.387	0.516													
L LBL LOO DICOT	11.608	7.694	0.496	0.172	7.894	0.623													
S LBL LOO DICOT	10.458	9.300	0.477	0.222	8.633	0.582													
G UCD CAHILL SMDAY	-54.261	54.394	2.550	1.247	53.002	0.563													
I UCD CAHILL SFU	35.849	53.916	0.947	1.377	43.086	0.187													

1 INTERCOMPARISON STUDY OF LARGE T1 ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A		142	161	-	198	217	-	193	-	24	-	-	118	200	-	328	170 D		
M EPA DZUBAY TF-M		90	237	224	262	350	203	199	-	25	145	95	214	261	264	-	159 M		
N EPA DZUBAY TF-P		37	295	220	283	-	257	224	235	73	259	89	192	294	210	339	205 N		
R EPA DZUBAY MDS-S		143	172	209	156	182	150	184	126	63	155	215	123	198	183	334	157 R		
C LBL LOO DICOT		-	-	-	321	364	281	274	-	78	195	372	296	371	284	421	277 C		
L LBL LOO DICOT		290	331	330	349	350	304	321	-	89	251	405	290	390	340	450	310 L		
S LBL LOO DICOT		355	360	458	-	431	320	370	-	104	300	-	-	-	363	447	310 S		
G UCD CAHILL SMDAY		-	90	92	137	100	92	102	120	39	74	81	-	-	-	-	-	6	
I UCD CAHILL SFU		113	95	55	30	87	130	143	57	-	83	115	99	138	141	-85	78 I		
Z MEAN(ALL SAMPLERS)		167	218	227	217	260	217	223	135	62	188	196	190	265	255	343	208	211	100
STANDARD DEVIATION		114	104	137	107	131	86	85	74	30	89	139	81	94	82	126	84		
X MEAN(O.M.L.G.I.)		159	183	175	195	221	182	192	89	44	148	174	180	247	248	288	179		
STANDARD DEVIATION		90	102	126	121	128	93	82	45	31	100	155	89	108	100	186	96		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A		0.85	0.74	-	*0.91	0.83	-	0.86	-	0.39	-	-	0.62	0.76	-	*0.96	0.82 D	0.77	0.17 21
M EPA DZUBAY TF-M		0.54	*1.09	*0.99	1.21	1.35	*0.94	*0.89	-	0.40	0.77	0.49	*1.12	*0.99	*1.04	-	0.76 M	0.90	0.28 31
N EPA DZUBAY TF-P		0.22	1.36	*0.97	1.30	-	*1.18	*1.00	1.75	*1.18	1.38	0.45	*1.01	*1.11	0.82	*0.99	*0.98 N	1.05	0.37 35
R EPA DZUBAY MDS-S		0.86	0.79	*0.92	0.72	0.70	0.69	0.82	*0.94	*1.02	0.83	*1.10	0.65	0.75	0.72	*0.97	0.75 R	0.83	0.13 16
C LBL LOO DICOT		-	-	-	1.48	1.40	1.29	1.23	-	1.26	*1.04	1.90	1.56	1.40	1.11	1.23	1.33 C	1.35	0.23 17
L LBL LOO DICOT		1.74	1.52	1.46	1.61	1.35	1.40	1.44	-	1.44	1.55	2.07	1.52	1.47	1.33	1.31	1.49 L	1.51	0.19 12
S LBL LOO DICOT		2.12	1.65	2.02	-	1.66	1.47	1.66	-	1.68	1.60	-	-	-	1.42	1.30	1.49 S	1.64	0.24 15
G UCD CAHILL SMDAY		-	0.41	0.41	0.63	0.38	0.42	0.46	*0.89	0.63	0.39	0.41	-	-	-	-	-	0.50	0.17 33
I UCD CAHILL SFU		0.68	0.44	0.24	0.14	0.33	0.60	0.64	0.42	-	0.44	0.59	0.52	0.52	0.55	0.25	0.37 I	0.45	0.16 35
MEAN(ALL SAMPLERS)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION		0.68	0.48	0.60	0.49	0.50	0.40	0.38	0.55	0.48	0.47	0.71	0.43	0.35	0.32	0.37	0.40	0.48	
REGRESSION VS Z	INTERCEPT			ERROR	SLOPE		ERROR	RMS.DEV.	COR.COEFF.										
D EPA DZUBAY MDS-A		-47.643	20.895	1.034	0.092	20.132	0.970												
M EPA DZUBAY TF-M		-105.557	53.451	1.451	0.252	45.637	0.857												
N EPA DZUBAY TF-P		19.409	61.959	0.939	0.207	66.626	0.672												
R EPA DZUBAY MDS-S		-0.335	26.108	0.817	0.119	28.348	0.878												
C LBL LOO DICOT		32.793	49.865	1.196	0.219	47.845	0.865												
L LBL LOO DICOT		68.482	36.882	1.178	0.165	37.028	0.893												
S LBL LOO DICOT		84.743	53.845	1.218	0.239	51.813	0.862												
G UCD CAHILL SMDAY		44.198	27.828	0.250	0.138	23.503	0.539												
I UCD CAHILL SFU		68.265	42.975	0.128	0.191	34.551	0.184												

INTERCOMPARISON STUDY OF TOTAL FE : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.																
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D EPA DZUBAY MDS-A	1380	1240	-	1410	1640	-	1520	-	490	-	-	-	1270	1530	-	2020
M EPA DZUBAY TF-M	1460	2060	2090	2190	2630	2290	2050	-	700	1690	1310	1700	2170	1850	-	1460 M
N EPA DZUBAY TF-P	1150	2030	2170	1980	-	2160	2170	-2010	620	2090	1050	1910	2340	2040	2550	1790 N
R EPA DZUBAY MDS-S	1200	1110	1610	1210	1520	1410	1500	1290	570	1300	1510	1080	1420	1400	1980	1250 R
C LBL L00 D1COT	-	-	-	-	2400	2532	2335	2155	-	770	1635	2480	2206	2685	2001	2637 1913 C
L LBL L00 D1COT	2360	2181	2469	2533	2536	2517	2426	-	891	2163	2617	2211	2800	2338	2755	2172 L
S LBL L00 D1COT	2908	2456	3356	-	3053	2604	2792	-	1024	2254	-	-	-	2500	2855	2178 S
G UCD CAHILL SMOAY	-	1091	1111	1519	1375	1225	1097	1549	525	901	1083	-	-	-	-	- G
H UCD CAHILL TTLF	1004	1159	1686	1515	1756	1389	1360	1316	490	1189	1003	1467	1881	1402	1758	1271 H
J UCD CAHILL SFU	1026	1024	950	1015	1275	1112	1205	1392	497	735	1073	943	1484	1539	1026	1321 J
I FSU HUDSON LS 2	-	-	-	1613	2699	1796	2501	1379	1237	1466	2089	1469	2401	1799	3059	1750 I
K FSU HUDSON LS 4	-	-	-	2244	2823	1943	2513	1557	897	1236	2483	1715	2814	1982	3141	1744 K
Z MEAN(ALL SAMPLERS)	1561	1595	1930	1784	2167	1889	1941	1499	726	1514	1670	1597	2153	1885	2378	1658
STANDARD DEVIATION	696	572	775	509	653	536	578	248	243	506	673	435	546	369	668	343
X MEAN(D.M.L.G.I.K)	1557	1519	1655	1819	2047	1817	1802	1499	667	1345	1713	1568	2160	1927	2236	1617
STANDARD DEVIATION	568	556	740	589	692	628	615	93	192	585	771	483	650	331	931	349
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
D EPA DZUBAY MDS-A	0.83	0.78	-	0.79	0.76	-	0.78	-	0.68	-	-	-	0.80	0.71	-	0.85
M EPA DZUBAY TF-M	0.94	1.29	1.08	1.23	1.21	1.21	1.06	-	0.96	1.12	0.78	1.06	1.01	0.98	-	0.88
N EPA DZUBAY TF-P	0.74	1.27	1.12	1.11	-	1.14	1.12	1.34	0.85	1.38	0.63	1.20	1.09	1.08	1.07	1.08
R EPA DZUBAY MDS-S	0.77	0.70	0.83	0.68	0.70	0.75	0.77	0.86	0.79	0.86	0.90	0.68	0.66	0.74	0.83	0.75
C LBL L00 D1COT	-	-	-	1.35	1.17	1.24	1.11	-	1.06	1.08	1.49	1.38	1.25	1.06	1.11	1.15
L LBL L00 D1COT	1.51	1.37	1.28	1.42	1.17	1.33	1.25	-	1.23	1.43	1.57	1.38	1.30	1.24	1.16	1.31
S LBL L00 D1COT	1.86	1.54	1.74	-	1.41	1.38	1.44	-	1.41	1.49	-	-	-	1.33	1.20	1.31
G UCD CAHILL SMOAY	-	0.68	0.58	0.85	0.63	0.65	0.57	1.03	0.72	0.60	0.65	-	-	-	-	-
H UCD CAHILL TTLF	0.64	0.73	0.87	0.85	0.81	0.74	0.70	0.86	0.68	0.79	0.60	0.92	0.87	0.74	0.74	0.77
I UCD CAHILL SFU	0.66	0.64	0.49	0.57	0.59	0.59	0.62	0.93	0.69	0.49	0.64	0.59	0.69	0.82	0.43	0.80
J FSU HUDSON LS 2	-	-	-	0.90	1.25	0.95	1.29	0.92	1.70	0.97	1.25	0.92	1.12	0.95	1.29	1.06
K FSU HUDSON LS 4	-	-	-	1.26	1.30	1.03	1.30	1.04	1.24	0.82	1.49	1.07	1.31	1.05	1.32	1.05
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
STANDARD DEVIATION	0.45	0.36	0.40	0.29	0.30	0.28	0.30	0.17	0.33	0.33	0.40	0.27	0.25	0.20	0.28	0.30
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR. COEFF.										
D EPA DZUBAY MDS-A	-34.674	138.113	0.811	0.076	105.438	0.966										
M EPA DZUBAY TF-M	-230.956	349.022	1.200	0.199	253.706	0.868										
N EPA DZUBAY TF-P	-73.757	415.166	1.131	0.237	327.271	0.799										
R EPA DZUBAY MDS-S	82.171	168.876	0.717	0.095	137.293	0.897										
C LBL L00 D1COT	107.011	317.160	1.145	0.174	241.887	0.902										
L LBL L00 D1COT	462.945	248.390	1.060	0.138	196.861	0.905										
S LBL L00 D1COT	453.633	465.109	1.195	0.258	351.838	0.838										
G UCD CAHILL SMOAY	298.432	345.368	0.508	0.202	238.547	0.665										
H UCD CAHILL TTLF	-108.297	194.166	0.837	0.109	157.854	0.899										
I UCD CAHILL SFU	358.638	275.969	0.425	0.155	224.359	0.592										
J FSU HUDSON LS 2	-78.979	412.605	1.150	0.229	324.642	0.834										
K FSU HUDSON LS 4	-473.240	383.619	1.454	0.213	301.835	0.900										

1 INTERCOMPARISON STUDY OF SMALL FE ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	366	294	454	306	315	-	289	354	175	238	310	282	361	-	356	350	D		
M EPA DZUBAY TF-M	810	511	866	606	740	652	722	-	372	486	740	465	625	481	787	474	M		
N EPA DZUBAY TF-P	751	441	712	521	732	532	698	537	321	416	621	431	674	459	704	415	N		
R EPA DZUBAY MDS-S	304	235	385	253	264	279	230	314	154	203	230	232	219	217	258	188	R		
C LBL LOO	DICOT	293	-	-	238	235	215	210	-	153	148	226	223	242	191	223	171	C	
L LBL LOO	DICOT	300	217	382	241	239	232	213	-	153	154	225	191	237	194	207	177	L	
S LBL LOO	DICOT	308	223	362	-	250	217	217	-	155	161	238	-	-	198	211	165	S	
G UCD CAHILL SMDAY	373	369	431	477	413	489	264	631	197	331	386	-	-	-	-	-	G		
I UCD CAHILL SFU	417	233	437	313	423	303	360	487	216	231	355	291	368	254	374	211	I		
Z MEAN(ALL SAMPLERS)	436	315	504	369	401	365	356	465	211	263	370	302	389	285	390	269	Z	356	158
STANDARD DEVIATION	200	113	184	144	203	169	206	131	81	122	188	106	188	128	229	125			
X MEAN(1,1,1,1,1)	453	325	514	389	426	419	370	491	223	288	403	307	398	310	431	303	X		
STANDARD DEVIATION	204	120	199	150	191	189	204	139	87	127	198	114	163	151	249	136			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	0.84	0.93	0.90	0.83	0.79	-	0.81	0.76	0.83	0.90	0.84	0.93	0.93	-	0.91	1.30	D	0.89	0.13
M EPA DZUBAY TF-M	1.86	1.62	1.72	1.64	1.84	1.79	2.03	-	1.77	1.85	2.00	1.54	1.61	1.69	2.02	1.76	M	1.78	0.15
N EPA DZUBAY TF-P	1.72	1.40	1.41	1.41	1.83	1.46	1.96	1.16	1.52	1.58	1.68	1.43	1.73	1.61	1.81	1.54	N	1.58	0.20
R EPA DZUBAY MDS-S	0.70	0.75	0.76	0.69	0.66	0.77	0.65	0.68	0.73	0.77	0.62	0.77	0.56	0.76	0.66	0.70	R	0.70	0.06
C LBL LOO	DICOT	0.67	-	-	0.64	0.59	0.59	0.59	-	0.73	0.56	0.61	0.74	0.62	0.67	0.57	C	0.63	0.06
L LBL LOO	DICOT	0.69	0.69	0.76	0.65	0.60	0.64	0.60	-	0.73	0.59	0.61	0.63	0.61	0.68	0.53	L	0.64	0.06
S LBL LOO	DICOT	0.71	0.71	0.72	-	0.62	0.60	0.61	-	0.74	0.61	0.64	-	-	0.70	0.54	S	0.65	0.06
G UCD CAHILL SMDAY	0.86	1.17	0.86	1.29	1.03	1.34	0.74	1.36	1.05	1.26	1.04	-	-	-	-	-	G	1.08	0.22
I UCD CAHILL SFU	0.96	0.74	0.87	0.85	1.05	0.83	1.01	1.05	1.03	0.88	0.96	0.96	0.95	0.89	0.96	0.79	I	0.92	0.09
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.46	0.36	0.36	0.39	0.51	0.46	0.58	0.28	0.39	0.46	0.51	0.35	0.48	0.45	0.59	0.46		0.44	
REGRESSION VS Z	INTERCEPT		ERROR		SLOPE		ERROR		RMS DEV.		COR. COEFF.								
D EPA DZUBAY MDS-A	73.931	46.597		0.678		0.126	37.154		0.840										
M EPA DZUBAY TF-M	-33.050	71.147		1.882		0.200	56.204		0.934										
N EPA DZUBAY TF-P	50.263	101.525		1.434		0.279	84.549		0.808										
R EPA DZUBAY MDS-S	20.101	27.507		0.640		0.076	22.908		0.915										
C LBL LOO	DICOT	28.560	25.714		0.544		17.112		0.910										
L LBL LOO	DICOT	-19.942	29.987		0.701		23.689		0.917										
S LBL LOO	DICOT	-11.449	29.936		0.683		22.995		0.932										
G UCD CAHILL SMDAY	51.944	125.318		0.935		0.332	89.171		0.684										
I UCD CAHILL SFU	-35.920	39.383		1.028		0.108	32.798		0.930										

1 INTERCOMPARISON STUDY OF LARGE FE : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	1012	948	-	1105	1323	-	1235	-	314	-	-	-	984	1170	-	1661	1044	D	
M EPA DZUBAY TF-M	653	1545	1228	1588	1891	1640	1334	-	319	1196	574	1237	1549	1374	-	-	985	M	
N EPA DZUBAY TF-P	395	1589	1454	1464	-	1623	1469	-1474	299	1669	432	1478	1663	1576	1849	1376	N		
R EPA DZUBAY MDS-S	891	877	1225	960	1256	1134	1269	974	413	1095	1281	849	1201	1182	1719	1059	R		
C LBL LOO DICOT	-	-	-	2162	2297	2120	1945	-	317	1487	2254	1983	2443	1810	2414	1742	C		
L LBL LOO DICOT	2060	1964	2087	2292	2297	2285	2213	-	738	2009	2392	2020	2563	2144	2548	1995	L		
S LBL LOO DICOT	2600	2233	2994	-	2803	2387	2575	-	869	2093	-	-	-	-	2302	2644	2013	S	
G UCD CAHILL SMDAY	-	722	680	1042	956	736	833	918	328	570	697	-	-	-	-	-	-	G	
I UCD CAHILL SFU	609	791	513	702	853	809	845	905	281	504	718	652	1116	1285	652	1110	I		
Z MEAN(ALL SAMPLERS)	1174	1334	1454	1414	1710	1592	1524	1068	464	1328	1193	1315	1672	1668	1927	1416	1331	601	
STANDARD DEVIATION	829	579	852	574	715	649	600	272	220	599	817	539	604	433	693	438			
X MEAN(D.M.L.G.I)	1084	1195	1127	1346	1464	1368	1292	912	396	1070	1095	1223	1600	1601	1620	1284			
STANDARD DEVIATION	676	540	709	616	618	736	562	9	192	700	867	583	671	472	949	477			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	0.86	0.71	-	0.78	0.77	-	0.81	-	0.68	-	-	-	0.75	0.70	-	0.86	0.74	D	0.06
M EPA DZUBAY TF-M	0.56	1.16	0.84	1.12	1.11	*1.03	0.88	-	0.69	0.90	0.48	*0.94	0.93	0.82	-	0.70	M	0.87	0.21
N EPA DZUBAY TF-P	0.34	1.19	*1.00	*1.04	-	*1.02	*0.96	1.38	0.64	1.26	0.36	1.12	*0.99	*0.95	*0.96	*0.97	N	0.95	0.29
R EPA DZUBAY MDS-S	0.76	0.66	0.84	0.68	0.74	0.71	0.83	0.91	0.89	0.82	*1.07	0.65	0.72	0.71	0.89	0.75	R	0.79	0.11
C LBL LOO DICOT	-	-	-	1.53	1.34	1.33	1.28	-	1.33	1.12	1.89	1.51	1.46	*1.09	1.25	1.23	C	1.36	0.22
L LBL LOO DICOT	1.75	1.47	1.44	1.62	1.34	1.44	1.45	-	1.59	1.51	2.01	1.54	1.53	1.29	1.32	1.41	L	1.51	0.18
S LBL LOO DICOT	2.21	1.67	2.06	-	1.64	1.50	1.69	-	1.87	1.58	-	-	-	-	1.38	1.37	S	1.67	0.28
G UCD CAHILL SMDAY	-	0.54	0.47	0.74	0.56	0.46	0.55	0.86	0.71	0.43	0.58	-	-	-	-	-	G	0.59	0.14
I UCD CAHILL SFU	0.52	0.59	0.35	0.50	0.50	0.51	0.55	0.85	0.61	0.38	0.60	0.50	0.67	0.77	0.34	0.78	I	0.56	0.15
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.71	0.43	0.59	0.41	0.42	0.41	0.39	0.26	0.47	0.45	0.69	0.41	0.36	0.26	0.36	0.31		0.43	

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	-89.030	110.273	0.838	0.076	90.374	0.968
M EPA DZUBAY TF-M	-416.830	324.095	1.192	0.230	259.880	0.831
N EPA DZUBAY TF-P	-230.279	388.208	1.133	0.276	344.794	0.751
R EPA DZUBAY MDS-S	100.328	168.438	0.709	0.118	152.454	0.849
C LBL LOO DICOT	300.208	354.726	1.142	0.240	292.824	0.833
L LBL LOO DICOT	540.858	250.927	1.109	0.173	216.263	0.871
S LBL LOO DICOT	629.590	439.063	1.192	0.300	359.384	0.798
G UCD CAHILL SMDAY	233.377	208.362	0.394	0.154	162.305	0.670
I UCD CAHILL SFU	196.469	244.331	0.414	0.171	221.144	0.543

INTERCOMPARISON STUDY OF TOTAL CU : NANOGRAMS/CUBIC METER, PERIODS 1-16, MAY 11-18 1977.																			
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	39	172	-	381	52	-	59	-	-98	-	-	-	184	111	-	62	125 D		
M EPA DZUBAY TF-M	32	124	20	444	62	45	36	-	21	26	29	129	57	215	-	-	65 M		
N EPA DZUBAY TF-P	26	112	20	372	-	32	29	53	11	13	7	138	59	226	87	64 N			
R EPA DZUBAY MDS-S	23	120	29	386	45	53	36	68	28	33	36	151	56	115	46	95 R			
C LBL LOO DICOT	-	-	-	469	42	102	45	-	44	68	61	223	76	305	60	121 C			
L LBL LOO	20	115	30	418	25	25	17	-	10	14	18	155	46	265	30	61 L			
S LBL LOO DICOT	46	150	45	-	57	83	56	-	39	52	-	-	-	-	311	65	138 S		
G UCD CAHILL SMOAY	-	85	14	359	14	19	11	35	17	22	28	-	-	-	-	-	G		
H UCD CAHILL T1LF	11	72	11	275	16	26	11	26	13	16	8	109	31	180	19	45 H			
I UCD CAHILL SFU	-	91	-	342	56	19	52	-	17	30	15	167	44	283	30	65 I			
J FSU HUDSON LS 2	-	-	-	340	16	12	11	39	17	30	25	198	63	291	30	65 J			
K FSU HUDSON LS 4	-	-	-	519	34	34	23	38	29	31	25	198	63	291	30	65 K			
Z MEAN(WITHOUT I)	28	119	24	396	36	43	30	43	30	31	25	162	60	243	48	84	88	40	
STANDARD DEVIATION	12	32	12	69	18	29	18	15	25	18	17	36	23	65	22	33			
X MEAN(D,M,L,G,K)	30	124	21	424	37	31	29	37	35	23	25	167	69	257	41	79			
STANDARD DEVIATION	10	36	8	62	20	11	19	2	36	7	5	31	29	39	18	31			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.39	1.45	-	*0.96	1.43	-	1.94	-	3.30	-	-	-	1.14	1.84	-	1.30	1.48 D	1.62	0.66 40
M EPA DZUBAY TF-M	*1.14	*1.04	0.83	1.12	1.71	*0.74	*0.96	1.23	0.37	0.43	0.28	0.85	*0.98	0.93	1.83	0.76 M	1.01	0.25 25	
N EPA DZUBAY TF-P	*0.92	*0.94	*0.83	0.94	-	0.74	*0.96	1.23	0.37	0.43	0.28	0.85	*0.98	0.93	1.83	0.76 N	1.01	0.25 25	
R EPA DZUBAY MDS-S	0.82	*1.01	1.20	*0.97	1.24	1.23	1.19	1.58	*0.94	*1.08	1.43	0.94	0.93	0.47	*0.97	1.13 R	1.07	0.25 24	
C LBL LOO	-	-	-	1.18	1.16	2.37	1.48	-	1.48	2.23	2.42	1.38	1.26	1.25	1.26	1.43 C	1.58	0.47 30	
L LBL LOO DICOT	0.71	*0.97	1.24	*1.06	0.69	0.58	0.56	-	0.34	0.46	0.71	*0.96	0.76	*1.09	0.63	0.72 L	0.77	0.25 33	
S LBL LOO DICOT	1.63	1.26	1.86	-	1.57	1.93	1.84	-	1.31	1.71	-	-	-	-	1.28	1.36	1.64 S	1.58	0.25 16
G UCD CAHILL SMOAY	-	0.72	0.58	*0.91	0.39	0.44	0.36	0.81	0.57	0.72	*1.11	-	-	-	-	-	G	0.66	0.24 36
H UCD CAHILL T1LF	0.39	0.61	0.46	0.69	0.44	0.60	0.36	0.60	0.44	0.52	0.32	0.68	0.51	0.74	0.40	0.53 H	0.52	0.13 24	
I UCD CAHILL SFU	-	0.77	-	*0.86	1.54	0.44	1.71	-	-	-	-	0.74	-	*0.87	-	-	I	0.99	0.46 46
J FSU HUDSON LS 2	-	-	-	0.86	0.44	0.28	0.36	*0.90	0.57	*0.98	0.60	*1.03	0.73	1.16	0.63	0.77 J	0.72	0.27 37	
K FSU HUDSON LS 4	-	-	-	1.31	*0.94	0.79	*0.76	*0.88	*0.98	*1.02	*0.99	1.23	*1.04	1.20	0.53	0.77 K	0.96	0.20 21	
MEAN(WITHOUT I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.42	0.27	0.48	0.18	0.49	0.67	0.58	0.35	0.85	0.57	0.66	0.22	0.38	0.27	0.47	0.39	0.45		

REGRESSION VS Z

REGRESSION VS Z		INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV	COR COEFF.
D	EPA DZUBAY MDS-A	40 931	9 362	0 879	0 064	21.733	0.979
M	EPA DZUBAY TF-M	4 880	7 363	1.047	0.053	20 544	0.985
N	EPA DZUBAY TF-P	-2 225	5 437	0.938	0.040	15 644	0.988
R	EPA DZUBAY MDS-S	9 848	10.113	0.828	0.077	30.258	0.945
C	LBL LOO DICOT	20 688	6 429	1.150	0.044	16 522	0.993
L	LBL LOO DICOT	16.667	3 147	1.102	0.023	9 086	0.997
S	LBL LOO DICOT	-15.330	4 547	1.219	0.050	10 467	0.992
G	UCD CAHILL SMOAY	-11 579	3 684	0.926	0.027	9.495	0.997
H	UCD CAHILL T1LF	-9.723	1 585	0 730	0 013	4.982	0.998
I	UCD CAHILL SFU	0	0	0	0	0	0
J	FSU HUDSON LS 2	-10 413	8 409	0 978	0 059	22.638	0.981
K	FSU HUDSON LS 4	-20 076	4 515	1 332	0 032	12.54	0.997

1 INTERCOMPARISON STUDY OF SMALL CU ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	24	129	21	357	23	-	28	68	42	29	24	154	53	-	29	86 D			
M EPA DZUBAY TF-M	14	106	12	394	24	28	20	-	9	17	19	115	37	200	33	51 M			
N EPA DZUBAY TF-P	26	94	14	339	18	26	12	42	11	12	5	122	31	206	52	53 N			
R EPA DZUBAY MDS-S	16	103	20	358	29	38	24	52	18	23	20	138	43	192	33	72 R			
C LBL LOO DICOT	24	-	-	445	30	82	34	-	35	55	46	200	62	287	47	101 C			
L LBL LOO DICOT	14	107	24	400	18	18	12	-	7	9	11	145	38	253	23	52 L			
S LBL LOO DICOT	26	135	32	-	41	63	41	-	28	39	44	183	79	289	50	113 S			
G UCD CAHILL SMDAY	8	78	7	359	14	17	5	27	17	16	16	-	-	-	-	- G			
I UCD CAHILL SFU	-	81	-	296	37	-	35	-	-	-	-	120	-	180	-	- I			
Z MEAN(WITHOUT I)	19	107	19	379	25	39	22	47	21	25	23	151	49	238	38	75	80	31	
STANDARD DEVIATION	7	20	8	36	9	25	12	17	13	16	15	31	17	44	11	25			
X MEAN(D,M,L,G)	15	105	16	378	20	21	16	48	19	18	18	138	43	227	28	63			
STANDARD DEVIATION	7	21	8	23	5	6	10	29	16	8	5	20	9	37	5	20			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.26	1.20	1.13	0.94	*0.93	-	1.27	1.44	2.01	1.16	*1.04	*1.02	1.08	-	0.76	1.14	D	1.17	0.29 25
M EPA DZUBAY TF-M	0.74	*0.99	0.65	*1.04	*0.97	0.72	*0.91	-	0.43	0.68	0.82	0.76	0.76	0.84	0.87	0.68	M	0.79	0.16 20
N EPA DZUBAY TF-P	1.37	0.88	0.75	0.90	0.73	0.67	0.55	0.89	0.53	0.48	0.22	0.81	0.63	0.87	1.36	0.70	N	0.77	0.29 38
R EPA DZUBAY MDS-S	0.84	*0.96	*1.08	0.95	1.18	*0.98	1.09	1.10	0.86	0.92	0.87	0.91	0.88	0.81	0.87	*0.95	R	0.95	0.11 11
C LBL LOO DICOT	1.26	-	-	1.17	1.22	2.11	1.55	-	1.68	2.20	1.99	1.32	1.27	1.21	1.23	1.34	C	1.50	0.37 25
L LBL LOO DICOT	0.74	*1.00	1.29	*1.06	0.73	0.46	0.55	-	0.34	0.36	0.48	*0.96	0.78	*1.06	0.60	0.69	L	0.74	0.29 39
S LBL LOO DICOT	1.37	1.26	1.72	-	1.67	1.62	1.86	-	1.34	1.56	1.90	1.21	1.61	1.22	1.31	1.50	S	1.51	0.23 15
G UCD CAHILL SMDAY	0.42	0.73	0.38	*0.95	0.57	0.44	0.23	0.57	0.81	0.64	0.69	-	-	-	-	-	G	0.58	0.21 36
I UCD CAHILL SFU	-	0.75	-	0.78	1.50	-	1.59	-	-	-	-	0.80	-	0.76	-	-	I	1.03	0.40 39
MEAN(WITHOUT I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.36	0.18	0.45	0.10	0.35	0.63	0.55	0.37	0.61	0.62	0.64	0.21	0.34	0.19	0.30	0.34		0.39	

REGRESSION VS Z

D	EPA	DZUBAY	MDS-A	9.382	3.507	0.935	0.030	10.412	0.994
M	EPA	DZUBAY	TF-M	-9.850	4.755	0.998	0.037	14.203	0.991
N	EPA	DZUBAY	TF-P	-5.088	2.969	0.896	0.024	9.155	0.995
R	EPA	DZUBAY	MDS-S	1.385	2.681	0.906	0.021	8.267	0.996
C	LBL	LOO	DICOT	13.702	4.044	1.151	0.030	11.337	0.996
L	LBL	LOO	DICOT	-14.179	2.816	1.093	0.022	8.413	0.997
S	LBL	LOO	DICOT	12.240	2.541	1.165	0.029	6.784	0.996
G	UCD	CAHILL	SMDAY	-12.751	2.620	0.971	0.022	7.296	0.998
I	UCD	CAHILL	SFU	0.	0.	0.	0.	0.	0.

INTERCEPT ERROR RMS.DEV. COR.COEFF.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	24	129	21	357	23	-	28	68	42	29	24	154	53	-	29	86 D			
M EPA DZUBAY TF-M	14	106	12	394	24	28	20	-	9	17	19	115	37	200	33	51 M			
N EPA DZUBAY TF-P	26	94	14	339	18	26	12	42	11	12	5	122	31	206	52	53 N			
R EPA DZUBAY MDS-S	16	103	20	358	29	38	24	52	18	23	20	138	43	192	33	72 R			
C LBL LOO DICOT	24	-	-	445	30	82	34	-	35	55	46	200	62	287	47	101 C			
L LBL LOO DICOT	14	107	24	400	18	18	12	-	7	9	11	145	38	253	23	52 L			
S LBL LOO DICOT	26	135	32	-	41	63	41	-	28	39	44	183	79	289	50	113 S			
G UCD CAHILL SMDAY	8	78	7	359	14	17	5	27	17	16	16	-	-	-	-	- G			
I UCD CAHILL SFU	-	81	-	296	37	-	35	-	-	-	-	120	-	180	-	- I			
Z MEAN(WITHOUT I)	19	107	19	379	25	39	22	47	21	25	23	151	49	238	38	75	80	31	
STANDARD DEVIATION	7	20	8	36	9	25	12	17	13	16	15	31	17	44	11	25			
X MEAN(D,M,L,G)	15	105	16	378	20	21	16	48	19	18	18	138	43	227	28	63			
STANDARD DEVIATION	7	21	8	23	5	6	10	29	16	8	5	20	9	37	5	20			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.26	1.20	1.13	0.94	*0.93	-	1.27	1.44	2.01	1.16	*1.04	*1.02	1.08	-	0.76	1.14	D	1.17	0.29 25
M EPA DZUBAY TF-M	0.74	*0.99	0.65	*1.04	*0.97	0.72	*0.91	-	0.43	0.68	0.82	0.76	0.76	0.84	0.87	0.68	M	0.79	0.16 20
N EPA DZUBAY TF-P	1.37	0.88	0.75	0.90	0.73	0.67	0.55	0.89	0.53	0.48	0.22	0.81	0.63	0.87	1.36	0.70	N	0.77	0.29 38
R EPA DZUBAY MDS-S	0.84	*0.96	*1.08	0.95	1.18	*0.98	1.09	1.10	0.86	0.92	0.87	0.91	0.88	0.81	0.87	*0.95	R	0.95	0.11 11
C LBL LOO DICOT	1.26	-	-	1.17	1.22	2.11	1.55	-	1.68	2.20	1.99	1.32	1.27	1.21	1.23	1.34	C	1.50	0.37 25
L LBL LOO DICOT	0.74	*1.00	1.29	*1.06	0.73	0.46	0.55	-	0.34	0.36	0.48	*0.96	0.78	*1.06	0.60	0.69	L	0.74	0.29 39
S LBL LOO DICOT	1.37	1.26	1.72	-	1.67	1.62	1.86	-	1.34	1.56	1.90	1.21	1.61	1.22	1.31	1.50	S	1.51	0.23 15
G UCD CAHILL SMDAY	0.42	0.73	0.38	*0.95	0.57	0.44	0.23	0.57	0.81	0.64	0.69	-	-	-	-	-	G	0.58	0.21 36
I UCD CAHILL SFU	-	0.75	-	0.78	1.50	-	1.59	-	-	-	-	0.80	-	0.76	-	-	I	1.03	0.40 39
MEAN(WITHOUT I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.36	0.18	0.45	0.10	0.35	0.63	0.55	0.37	0.61	0.62	0.64	0.21	0.34	0.19	0.30	0.34		0.39	

1 INTERCOMPARISON STUDY OF LARGE CU : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY	MDS-A	15	-43	-	24	29	-	31	-	-56	-	-	30	58	-	39	39 D		
M EPA DZUBAY	TF-M	18	18	8	50	38	17	16	-	12	9	10	14	20	15	-	14 M		
N EPA DZUBAY	TF-P	0	18	6	33	-	6	17	11	0	1	2	16	28	20	35	11 N		
R EPA DZUBAY	MDS-S	7	17	9	28	16	15	12	16	10	10	16	13	13	23	13	23 R		
C LBL LOO	DICOT	-	-	-	24	12	20	11	-	9	13	15	23	14	18	13	20 C		
L LBL LOO	DICOT	6	8	6	18	7	7	5	-	3	5	7	10	8	12	7	9 L		
S LBL LOO	DICOT	20	15	13	-	16	20	15	-	11	13	-	-	-	23	15	25 S		
G UCD CAHILL	SMDAY	-	7	7	-	-	-	6	-	-	6	12	-	-	-	-	- G		
I UCD CAHILL	SFU	-	-	-	46	19	19	17	-	-	-	-	-	-	31	-	- I		
Z MEAN(WITHOUT G,I)		11	20	8	30	20	14	15	14	14	9	10	18	24	19	20	20	17	9
STANDARD DEVIATION		8	12	3	11	12	6	8	4	19	5	6	7	18	4	13	10		
X MEAN(D,M,L)		13	23	7	31	25	12	17	-	24	7	9	18	29	14	23	21		
STANDARD DEVIATION		6	18	1	17	16	7	13	0	28	3	2	11	26	2	23	16		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY	MDS-A	1.36	2.17	-	0.81	1.47	-	2.03	-	3.88	-	-	1.70	2.47	-	1.92	1.94 D	1.98	0.81 41
M EPA DZUBAY	TF-M	1.64	*0.91	*0.95	1.70	1.93	*1.20	*1.05	-	*0.83	*1.06	*1.00	0.79	0.85	0.81	-	0.70 M	1.10	0.38 35
N EPA DZUBAY	TF-P	0.	*0.91	*0.71	*1.12	-	0.42	*1.11	*0.82	0.	0.12	0.20	*0.91	1.19	*1.08	1.72	0.55 N	0.72	0.50 69
R EPA DZUBAY	MDS-S	0.64	0.86	*1.07	*0.95	0.81	*1.06	0.79	1.19	0.69	*1.18	1.60	0.74	0.55	1.24	0.64	*1.14 R	0.95	0.28 30
C LBL LOO	DICOT	-	-	-	0.81	0.61	1.41	0.72	-	0.62	1.53	1.50	1.30	0.60	*0.97	0.64	*0.99 C	0.98	0.37 38
L LBL LOO	DICOT	0.55	0.40	0.71	0.61	0.36	0.49	0.33	-	0.21	0.59	0.70	0.57	0.34	0.65	0.34	0.45 L	0.49	0.15 32
S LBL LOO	DICOT	1.82	0.76	1.55	-	0.81	1.41	*0.98	-	0.76	1.53	-	-	-	1.24	0.74	1.24 S	1.17	0.38 33
G UCD CAHILL	SMDAY	-	0.35	*0.83	-	-	-	0.39	-	-	0.71	*1.20	-	-	-	-	- G	0.70	0.35 50
I UCD CAHILL	SFU	-	-	-	1.56	*0.97	*1.34	*1.11	-	-	-	-	-	-	1.68	-	- I	1.33	0.30 22
MEAN(WITHOUT G,I)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION		0.71	0.60	0.34	0.38	0.59	0.44	0.52	0.26	1.31	0.56	0.58	0.42	0.78	0.24	0.65	0.51	0.56	
REGRESSION VS Z	INTERCEPT			ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.											
D EPA DZUBAY	MDS-A	29.544	18.291	0.358	0.927	14.205	0.135												
M EPA DZUBAY	TF-M	-5.642	6.315	1.466	0.362	7.850	0.760												
N EPA DZUBAY	TF-P	-13.962	5.013	1.689	0.290	6.385	0.850												
R EPA DZUBAY	MDS-S	3.804	3.282	0.581	0.188	4.186	0.695												
C LBL LOO	DICOT	9.476	4.468	0.370	0.242	4.608	0.435												
L LBL LOO	DICOT	0.573	2.034	0.436	0.115	2.535	0.724												
S LBL LOO	DICOT	11.205	4.796	0.366	0.298	4.346	0.381												
G UCD CAHILL	SMDAY	0.	0.	0.	0.	0.	0.												
I UCD CAHILL	SFU	0.	0.	0.	0.	0.	0.												

INTERCOMPARISON STUDY OF TOTAL ZN ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	100	298	-	214	108	-	-	86	-	81	-	-	89	108	-	80	90 D		
M EPA DZUBAY TF-M	82	294	126	274	140	117	89	-	-	65	81	74	104	113	116	-	87 M		
N EPA DZUBAY TF-P	95	292	108	239	-	113	63	-238	-	61	70	65	110	105	119	104	96 N		
R EPA DZUBAY MDS-S	76	247	104	193	95	89	65	86	66	63	71	89	74	85	75	71 R	95 C		
C LBL LOO DICOT	-	-	-	282	129	133	81	-	-	52	67	99	125	108	130	79	93 L		
L LBL LOO DICOT	101	339	135	269	124	122	84	-	-	50	71	100	118	111	137	79	88 S		
S LBL LOO DICOT	107	344	187	-	134	122	96	-	-	57	73	-	-	-	137	80	- G		
G UCD CAHILL SMDAY	-	236	99	238	98	84	61	102	47	60	74	-	-	-	-	-	78 H		
H UCD CAHILL TTLF	69	241	110	231	91	86	68	84	40	56	60	107	83	102	71	52	76 I		
I UCD CAHILL SFU	63	254	95	222	90	92	77	102	62	82	64	106	95	112	98	81	68 J		
J FSU HUDSON LS 2	-	-	-	200	126	99	91	83	82	64	106	95	112	98	81	68 J	72 K		
K FSU HUDSON LS 4	-	-	-	304	140	117	127	113	80	65	103	98	122	115	88	72 K			
Z MEAN(ALL SAMPLERS)	87	283	121	242	116	107	82	115	62	65	85	104	103	116	79	83	116	22	
STANDARD DEVIATION	16	41	30	36	20	17	18	55	14	9	17	12	15	17	13	10			
X MEAN(10 M.L.G.I.K)	87	284	114	254	117	106	87	106	64	65	89	102	109	123	75	84			
STANDARD DEVIATION	18	40	20	35	21	17	22	6	14	12	14	11	11	10	16	9			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.15	1.05	-	0.88	0.93	-	-	1.04	-	1.31	-	-	0.86	1.05	-	1.01	1.08	0.104	0.13
M EPA DZUBAY TF-M	0.95	1.04	1.05	1.13	1.21	1.10	1.08	-	1.05	1.24	0.88	1.00	1.10	1.00	-	1.05	1.06	0.10	0.9
N EPA DZUBAY TF-P	1.10	1.03	0.90	0.99	-	1.06	0.77	2.06	0.99	1.07	0.77	1.06	1.02	1.02	1.32	1.15	1.09	0.30	0.28
R EPA DZUBAY MDS-S	0.88	0.87	0.86	0.80	0.82	0.83	0.79	0.75	1.07	0.96	0.84	0.86	0.72	0.73	0.95	0.85	0.85	0.09	0.11
C LBL LOO DICOT	-	-	-	1.16	1.11	1.25	0.98	-	0.84	1.03	1.17	1.20	1.05	1.12	1.00	1.14	1.09	0.11	0.10
L LBL LOO DICOT	1.17	1.20	1.12	1.11	1.07	1.14	1.02	-	0.81	1.09	1.18	1.14	1.08	1.18	1.00	1.12	1.09	0.10	0.9
S LBL LOO DICOT	1.24	1.22	1.55	-	1.16	1.14	1.17	-	0.92	1.12	-	-	-	-	1.18	1.01	1.06	0.16	0.14
G UCD CAHILL SMDAY	-	0.83	0.82	0.98	0.85	0.79	0.74	0.88	0.76	0.92	0.88	-	-	-	-	-	0.85	0.07	0.9
H UCD CAHILL TTLF	0.80	0.85	0.91	0.95	0.79	0.81	0.83	0.73	0.65	0.86	0.71	1.03	0.81	0.88	0.90	0.94	0.84	0.10	0.12
I UCD CAHILL SFU	0.73	0.90	0.79	0.92	0.78	0.86	0.94	0.88	1.00	0.75	1.10	0.99	0.90	1.06	0.66	0.94	1.08	0.12	0.14
J FSU HUDSON LS 2	-	-	-	0.83	1.09	0.93	1.11	0.72	1.32	0.98	1.25	0.92	1.09	0.84	1.03	0.82	0.99	0.18	0.18
K FSU HUDSON LS 4	-	-	-	1.25	1.21	1.10	1.54	0.98	1.29	0.99	1.22	0.94	1.19	0.99	1.12	0.86	1.13	0.18	0.16
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.19	0.15	0.25	0.15	0.17	0.16	0.22	0.48	0.22	0.13	0.21	0.11	0.15	0.15	0.17	0.12	0.15		
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS DEV	COR COEFF													
D EPA DZUBAY MDS-A	8.286	9.442	0.944	0.066	14.876	0.981													
M EPA DZUBAY TF-M	-2.456	5.719	1.085	0.043	9.930	0.991													
N EPA DZUBAY TF-P	8.851	19.260	1.007	0.148	34.653	0.884													
R EPA DZUBAY MDS-S	1.977	4.653	0.820	0.036	8.427	0.987													
C LBL LOO DICOT	-12.969	5.853	1.234	0.052	8.117	0.991													
L LBL LOO DICOT	-10.924	4.206	1.209	0.032	7.565	0.995													
S LBL LOO DICOT	-10.391	10.274	1.282	0.083	16.047	0.982													
G UCD CAHILL SMDAY	-7.695	7.250	0.920	0.050	11.110	0.989													
H UCD CAHILL TTLF	-8.150	5.595	0.923	0.043	10.134	0.985													
I UCD CAHILL SFU	-2.860	6.341	0.915	0.049	11.485	0.981													
J FSU HUDSON LS 2	27.372	10.184	0.698	0.090	14.137	0.920													
K FSU HUDSON LS 4	-13.712	12.645	1.267	0.112	17.553	0.960													

1 INTERCOMPARISON STUDY OF SMALL ZN : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	57	239	74	170	61	-	45	74	41	30	39	64	62	-	34	54	D		
M EPA DZUBAY TF-M	64	244	84	210	74	66	49	-	39	46	55	71	61	70	47	53	M		
N EPA DZUBAY TF-P	74	248	65	178	66	55	27	-177	31	24	37	67	51	77	52	53	N		
R EPA DZUBAY MDS-S	49	222	70	165	58	58	34	58	32	33	36	66	45	57	39	43	R		
C LBL LOO DICOT	54	-	-	210	65	61	39	-	31	34	42	76	57	88	38	53	C		
L LBL LOO DICOT	51	278	80	203	63	58	38	-	27	30	37	70	56	90	34	49	L		
S LBL LOO DICOT	46	285	-114	-	62	55	39	-	27	32	-	75	-	85	35	46	S		
G UCD CAHILL SMDAY	52	220	84	220	75	64	45	80	36	47	53	-	-	-	-	-	G		
I UCD CAHILL SFU	45	209	69	175	61	50	38	68	28	28	50	80	41	73	27	47	I		
Z MEAN(ALL SAMPLERS)	55	243	80	191	65	58	39	91	32	34	44	71	53	77	38	50	76	13	
STANDARD DEVIATION	9	27	15	22	6	5	7	49	5	8	8	6	8	12	8	4			
X MEAN(D.M.L.G.I.)	54	238	78	196	67	60	43	74	34	36	47	71	55	78	36	51			
STANDARD DEVIATION	7	26	7	22	7	7	5	6	6	9	8	7	10	11	8	3			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	*1.04	*0.98	0.93	0.89	0.94	-	1.14	0.81	1.26	0.89	0.89	0.90	1.16	-	0.89	1.09	D	0.99	0.13
M EPA DZUBAY TF-M	1.17	*1.00	*1.05	1.10	1.14	1.13	1.25	-	1.20	1.36	1.26	*1.00	1.15	0.91	1.23	*1.07	M	1.13	0.12
N EPA DZUBAY TF-P	1.35	*1.02	0.81	0.93	*1.02	*0.94	0.69	1.94	*0.96	0.71	0.85	*0.94	*0.96	*1.00	1.36	*1.07	N	1.03	0.30
R EPA DZUBAY MDS-S	0.90	0.91	0.88	0.86	0.89	*0.99	0.86	0.63	*0.99	*0.98	0.83	0.93	0.84	0.74	*1.02	0.86	R	0.88	0.10
C LBL LOO DICOT	*0.99	-	-	*1.10	*1.00	*1.05	*0.99	-	*0.96	*1.01	*0.96	*1.07	*1.07	1.14	*0.99	*1.07	C	1.03	0.06
L LBL LOO DICOT	*0.93	1.14	*1.00	*1.06	*0.97	*0.99	*0.97	-	0.83	0.89	0.85	*0.98	*1.05	1.17	0.89	*0.99	L	0.98	0.10
S LBL LOO DICOT	0.84	1.17	1.43	-	*0.95	*0.94	*0.99	-	0.83	*0.95	-	*1.05	-	*1.10	*0.92	*0.92	S	1.01	0.16
G UCD CAHILL SMDAY	*0.95	*0.91	*1.05	*1.15	*1.15	*1.10	*1.14	*0.88	*1.11	1.39	1.22	-	-	-	-	-	G	1.10	0.15
I UCD CAHILL SFU	0.82	0.86	0.86	*0.91	*0.94	0.86	*0.97	0.74	0.86	0.83	*1.15	*1.13	0.77	*0.95	0.71	*0.95	I	0.89	0.12
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.17	0.11	0.19	0.11	0.09	0.09	0.17	0.53	0.16	0.23	0.18	0.08	0.15	0.15	0.21	0.08		0.17	
REGRESSION VS Z	INTERCEPT			ERROR	SLOPE		ERROR	RMS.DEV.	COR.COEFF.										
D EPA DZUBAY MDS-A	2.681		3.391	0.926			0.035	7.774	0.992										
M EPA DZUBAY TF-M	7.056		2.652	0.996			0.028	6.277	0.995										
N EPA DZUBAY TF-P	2.585		10.314	1.015			0.109	24.532	0.928										
R EPA DZUBAY MDS-S	-0.847		3.196	0.882			0.034	7.602	0.990										
C LBL LOO DICOT	-4.888		1.287	1.128			0.017	2.495	0.999										
L LBL LOO DICOT	-9.819		2.001	1.159			0.021	4.737	0.998										
S LBL LOO DICOT	-11.507		4.950	1.233			0.051	9.657	0.991										
G UCD CAHILL SMDAY	8.313		6.663	0.948			0.062	13.541	0.981										
I UCD CAHILL SFU	1.417		3.188	0.872			0.034	7.582	0.990										

1 INTERCOMPARISON STUDY OF LARGE ZN ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	43	59	-	44	47	-	41	-	40	-	-	-	25	46	-	46	36 D		
M EPA DZUBAY TF-M	18	50	42	64	66	51	40	-	26	35	19	33	52	46	-	-	34 M		
N EPA DZUBAY TF-P	21	44	43	61	-	58	36	61	30	46	28	43	54	42	52	43 N			
R EPA DZUBAY MDS-S	27	25	34	28	37	31	31	28	34	30	35	23	-29	28	36	28 R			
C LBL LOO DIC	-	-	-	71	64	67	43	-	21	33	57	49	51	42	41	42 C			
L LBL LOO DICOT	50	61	55	66	61	64	46	-	22	40	63	48	55	47	45	44 L			
S LBL LOO DICOT	61	59	34	-	72	67	57	-	30	41	-	-	-	-	45	42 S			
G UCD CAHILL SMDAY	-	16	15	18	23	20	16	22	11	13	21	-	-	-	-	-	-	-	-
I UCD CAHILL SFU	18	45	26	47	29	42	39	34	34	21	43	23	51	50	25	31 I			
Z MEAN(ALL SAMPLERS)	34	45	36	50	50	50	39	36	28	32	38	35	48	44	41	38	40	13	
STANDARD DEVIATION	17	17	13	19	19	18	11	17	9	11	17	12	9	8	9	6			
X MEAN(D,M,L,G,I)	32	46	35	48	45	44	36	28	27	27	37	32	51	48	39	36			
STANDARD DEVIATION	17	18	18	19	19	19	12	8	11	12	21	11	4	2	12	6			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.27	1.32	-	0.88	0.94	-	1.06	-	1.45	-	-	0.72	0.95	-	1.11	0.96 D	1.07	0.22	21
M EPA DZUBAY TF-M	0.53	1.11	1.18	1.28	1.32	1.02	1.03	-	0.94	1.08	0.50	0.95	1.08	1.05	-	0.91 M	1.00	0.24	24
N EPA DZUBAY TF-P	0.62	0.98	1.21	1.22	-	1.16	0.93	1.68	1.09	1.42	0.74	1.23	1.12	0.96	1.26	1.15 N	1.12	0.26	23
R EPA DZUBAY MDS-S	0.79	0.56	0.96	0.56	0.74	0.62	0.80	0.77	1.23	0.93	0.92	0.66	0.60	0.64	0.87	0.75 R	0.78	0.18	23
C LBL LOO DICOT	-	-	-	1.42	1.28	1.34	1.11	-	0.76	1.02	1.50	1.41	1.06	0.96	0.99	1.12 C	1.16	0.23	19
L LBL LOO DICOT	1.47	1.36	1.55	1.32	1.22	1.28	1.19	-	0.80	1.24	1.66	1.38	1.14	1.07	1.09	1.17 L	1.26	0.21	17
S LBL LOO DICOT	1.79	1.32	0.96	-	1.44	1.34	1.47	-	1.09	1.27	-	-	-	1.19	1.09	1.12 S	1.28	0.23	18
G UCD CAHILL SMDAY	-	0.36	0.42	0.36	0.46	0.40	0.41	0.61	0.40	0.40	0.55	-	-	-	-	-	0.44	0.08	19
I UCD CAHILL SFU	0.53	1.00	0.73	0.94	0.58	0.84	1.01	0.94	1.23	0.65	1.13	0.66	1.06	1.14	0.60	0.83 I	0.87	0.22	26
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
STANDARD DEVIATION	0.51	0.37	0.36	0.38	0.37	0.35	0.29	0.48	0.31	0.34	0.45	0.34	0.19	0.18	0.21	0.16	0.33		

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	18.062	14.317	0.605	0.346	7.821	0.526
M EPA DZUBAY TF-M	-27.251	12.918	1.693	0.315	8.376	0.841
N EPA DZUBAY TF-P	0.928	15.710	1.092	0.392	9.799	0.612
R EPA DZUBAY MDS-S	29.441	6.303	0.020	0.155	4.164	0.035
C LBL LOO DICOT	-18.534	13.876	1.632	0.333	8.288	0.840
L LBL LOO DICOT	0.743	11.862	1.246	0.289	7.692	0.767
S LBL LOO DICOT	-8.510	15.555	1.500	0.387	8.763	0.791
G UCD CAHILL SMDAY	4.686	5.597	0.318	0.136	3.258	0.636
I UCD CAHILL SFU	-2.295	13.407	0.925	0.329	8.856	0.601

INTERCOMPARISON STUDY OF TOTAL SE : NANOGRAMS/CUBIC METER: PERIODS 1-16, MAY 11-18 1977.

INTERCOMPARISON STUDY OF TOTAL SE : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.																			
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	10	9	13	8	6	-	8	7	2	8	26	17	21	-	12	6 D			
M EPA DZUBAY TF-M	8	-22	19	11	13	8	10	-	-6	11	-36	21	23	-17	9	9 M			
N EPA DZUBAY TF-P	5	8	8	4	-	3	6	6	3	4	24	15	17	12	11	7 N			
R EPA DZUBAY MDS-S	10	9	15	7	8	7	7	8	3	10	27	8	18	12	12	5 R			
C LBL LOO DICOT	-	-	-	7	5	2	4	-	2	7	27	15	21	10	9	5 C			
L LBL LOO DICOT	7	8	14	6	5	4	4	-	3	8	27	13	21	12	9	5 L			
S LBL LOO DICOT	7	8	14	-	4	3	5	-	3	7	-	-	-	10	9	5 S			
G UCD CAHILL SHDAY	-	-	9	-	-	-	-	-	-	6	25	-	-	-	-	-	G		
H UCD CAHILL TFLF	7	7	11	-	-	-	-	6	-	-	24	14	16	11	8	7 H			
I UCD CAHILL SFU	-	-	22	-	-	-	-	-	-	-	27	27	23	-	-	-	I		
Z MEAN(WITHOUT G.1)	8	10	13	7	7	5	6	7	3	8	27	15	20	12	10	6	10	3	
STANDARD DEVIATION	2	5	3	2	3	2	2	1	1	2	4	4	3	2	2	1			
X MEAN(D.M.L.)	8	13	15	8	8	6	7	7	4	9	30	17	22	15	10	7			
STANDARD DEVIATION	2	8	3	3	4	3	3	0	2	2	6	4	1	4	2	2			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.30	0.89	0.97	1.12	0.88	-	1.28	1.00	0.63	1.02	0.95	1.16	1.07	-	1.22	0.98	0	1.03	0.18
M EPA DZUBAY TF-M	1.04	2.17	1.42	1.54	1.90	1.78	1.60	-	1.90	1.40	1.32	1.43	1.18	1.42	0.91	1.47	M	1.50	0.34
N EPA DZUBAY TF-P	0.65	0.79	0.60	0.56	-	0.67	0.96	0.86	-	0.51	0.88	1.02	0.87	1.00	1.11	1.14	N	0.83	0.21
R EPA DZUBAY MDS-S	1.30	0.89	1.12	0.98	1.17	1.56	1.12	1.14	0.95	1.27	0.99	0.54	0.92	1.00	1.22	0.82	R	1.06	0.23
C LBL LOO DICOT	-	-	-	0.98	0.73	0.44	0.64	-	0.63	0.89	0.99	1.02	1.07	0.83	0.91	0.82	C	0.83	0.19
L LBL LOO DICOT	0.91	0.79	1.04	0.84	0.73	0.89	0.64	-	0.95	1.02	0.99	0.88	1.07	1.00	0.91	0.82	L	0.90	0.12
S LBL LOO DICOT	0.91	0.79	1.04	-	0.59	0.67	0.80	-	0.95	0.89	-	-	-	0.83	0.91	0.82	S	0.84	0.13
G UCD CAHILL SHDAY	-	-	0.67	-	-	-	-	-	-	0.76	0.92	-	-	-	-	-	G	0.78	0.12
H UCD CAHILL TFLF	0.91	0.69	0.82	-	-	-	0.96	-	-	1.02	0.88	0.95	0.82	0.92	0.81	1.14	H	0.90	0.12
I UCD CAHILL SFU	-	-	1.64	-	-	-	-	-	-	-	0.99	1.84	1.18	-	-	-	I	1.41	0.39
MEAN(WITHOUT G.1)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.23	0.52	0.25	0.32	0.48	0.54	0.33	0.14	0.47	0.27	0.15	0.27	0.13	0.20	0.16	0.24		0.29	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.	COEFF.												
D EPA DZUBAY MDS-A	0.536	0.738	0.989	0.061	1.399	0.978													
M EPA DZUBAY TF-M	2.312	1.511	1.202	0.125	2.954	0.936													
N EPA DZUBAY TF-P	-0.729	1.087	0.912	0.087	1.948	0.950													
R EPA DZUBAY MDS-S	1.478	1.078	0.870	0.091	2.174	0.931													
C LBL LOO DICOT	-1.985	0.504	1.099	0.041	0.946	0.993													
L LBL LOO DICOT	-1.350	0.510	1.061	0.042	0.998	0.990													
S LBL LOO DICOT	-1.399	0.858	1.028	0.101	0.992	0.959													
G UCD CAHILL SHDAY	0	0.	0	0.	0.	0.													
H UCD CAHILL TFLF	0.630	0.735	0.830	0.054	1.088	0.982													
I UCD CAHILL SFU	0.	0.	0.	0	0.	0													

1 INTERCOMPARISON STUDY OF SMALL SE ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	8	7	13	7	5	-	6	7	1	8	26	15	19	-	-	10	5 D		
M EPA DZUBAY TF-M	8	11	15	11	10	7	8	-	-6	9	-36	18	22	15	9	8 M			
N EPA DZUBAY TF-P	5	5	8	2	1	3	3	-6	1	3	21	12	16	8	8	5 N			
R EPA DZUBAY MDS-S	8	8	13	6	6	6	5	7	2	9	24	6	16	12	10	5 R			
C LBL LOO DICOT	7	-	-	6	4	2	3	-	2	7	25	14	19	9	8	4 C			
L LBL LOO DICOT	6	7	12	5	4	3	3	-	3	7	24	12	19	10	8	4 L			
S LBL LOO DICOT	6	7	12	-	3	2	4	-	3	6	25	15	20	9	8	4 S			
G UCD CAHILL SMDAY	4	-	9	-	-	-	-	-	-	6	25	-	-	-	-	-	- G		
I UCD CAHILL SFU	-	-	22	-	-	-	-	-	-	-	27	27	23	-	-	-	- I		
Z MEAN(WITHOUT G.I.)	7	8	12	6	5	4	5	7	3	7	26	13	19	11	9	5	9	3	
STANDARD DEVIATION	1	2	2	3	3	2	2	1	2	2	5	4	2	3	1	1	1		
X MEAN(D,M,L)	7	8	13	8	6	5	6	7	3	8	29	15	20	13	9	6			
STANDARD DEVIATION	1	2	2	3	3	3	3	0	3	1	6	3	2	4	1	2			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.17	*0.93	*1.07	*1.14	*1.06	-	1.31	*1.05	0.39	1.14	*1.01	1.14	*1.02	-	1.15	*1.00	D	1.04	0.21
M EPA DZUBAY TF-M	1.17	1.47	1.23	1.78	2.12	1.83	1.75	-	2.33	1.29	1.39	1.37	1.18	1.43	*1.03	1.60	M	1.53	0.37
N EPA DZUBAY TF-P	*0.73	0.67	0.66	0.32	0.21	*0.78	*0.66	*0.90	0.39	0.43	0.81	*0.91	0.86	0.76	*0.92	*1.00	N	0.69	0.23
R EPA DZUBAY MDS-S	1.17	*1.07	*1.07	*0.97	1.27	1.57	*1.09	*1.05	*0.78	1.29	*0.93	0.46	0.86	1.14	1.15	*1.00	R	1.05	0.24
C LBL LOO DICOT	*1.02	-	-	*0.97	*0.85	0.52	0.66	-	*0.78	*1.00	*0.97	*1.07	*1.02	0.86	*0.92	0.80	C	0.88	0.16
L LBL LOO DICOT	*0.88	*0.93	*0.99	0.81	*0.85	*0.78	0.66	-	*1.17	*1.00	*0.93	0.91	*1.02	*0.95	*0.92	0.80	L	0.91	0.12
S LBL LOO DICOT	*0.88	*0.93	*0.99	-	0.64	0.52	*0.88	-	*1.17	0.86	*0.97	*1.14	*1.07	0.86	*0.92	0.80	S	0.90	0.18
G UCD CAHILL SMDAY	0.58	-	0.74	-	-	-	-	-	-	*0.86	*0.97	-	-	-	-	-	G	0.79	0.16
I UCD CAHILL SFU	-	-	1.81	-	-	-	-	-	-	-	*1.04	2.05	*1.23	-	-	-	I	1.53	0.48
MEAN(WITHOUT G.I.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.18	0.26	0.19	0.47	0.60	0.56	0.42	0.09	0.67	0.30	0.18	0.29	0.11	0.25	0.11	0.28	0.31		

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	0.368	0.439	1.017	0.040	0.905	0.991
M EPA DZUBAY TF-M	1.769	0.877	1.212	0.080	1.872	0.973
N EPA DZUBAY TF-P	-1.282	0.630	0.886	0.059	1.379	0.971
R EPA DZUBAY MDS-S	1.646	0.937	0.810	0.087	2.052	0.928
C LBL LOO DICOT	-0.884	0.381	1.033	0.034	0.795	0.994
L LBL LOO DICOT	-0.499	0.305	0.979	0.028	0.651	0.995
S LBL LOO DICOT	-1.048	0.504	1.057	0.045	1.041	0.989
G UCD CAHILL SMDAY	0.	0.	0.	0.	0.	0.
I UCD CAHILL SFU	0.	0.	0.	0.	0.	0.

1 INTERCOMPARISON STUDY OF LARGE SE : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	2	2	-	-	1	1	-	2	-	1	-	-	2	2	-	2	1	D	
M EPA DZUBAY TF-M	0	-11	4	0	3	1	1	2	-	0	2	0	3	1	2	-	1	M	
N EPA DZUBAY TF-P	0	3	0	2	-	0	0	3	0	0	1	3	3	1	4	3	2	N	
R EPA DZUBAY MDS-S	2	1	2	1	2	1	1	2	1	1	1	3	2	2	0	2	0	R	
C LBL LOO DICOT	-	-	-	-	1	1	0	1	-	0	0	2	1	2	1	1	1	C	
L LBL LOO DICOT	1	1	2	1	1	1	1	1	-	0	1	3	1	2	2	1	1	L	
S LBL LOO DICOT	1	1	2	-	1	1	1	1	-	0	1	-	-	-	1	1	1	S	
G UCD CAHILL SMDAY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	
I UCD CAHILL SFU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	
Z MEAN(WITHOUT G,1)	1	3	2	1	2	1	1	2	1	0	1	2	2	2	2	2	1	1	
STANDARD DEVIATION	1	4	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1		
X MEAN(D,M,L)	1	5	3	1	2	1	1	2	-	0	2	2	2	2	2	2	1		
STANDARD DEVIATION	1	6	1	1	1	0	1	1	0	1	1	2	1	1	0	1	0		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	2.00	0.63	-	*1.00	*0.67	-	*1.17	-	*3.50	-	-	-	*1.00	*1.20	-	*1.20	*1.00	D	1.34 0.85 63
M EPA DZUBAY TF-M	0.	3.47	2.00	0.	2.00	*1.50	*1.17	-	*0.	2.00	0.	-	1.50	*0.60	*1.20	-	*1.00	M	1.17 1.02 87
N EPA DZUBAY TF-P	0.	*0.95	0.	2.00	-	*0.	1.75	*0.	*0.	*1.00	*1.36	*1.36	1.50	*0.60	2.40	1.80	2.00	N	1.02 0.87 85
R EPA DZUBAY MDS-S	2.00	0.32	*1.00	*1.00	*1.33	*1.50	*1.17	*2.00	*3.50	*1.00	*1.00	*1.36	*1.00	*1.20	0.	*1.20	0.	R	1.22 0.84 68
C LBL LOO DICOT	-	-	-	*1.00	*0.67	*0.	*0.58	-	*0.	0.	0.	*0.91	0.50	*1.20	*0.60	*0.60	*1.00	C	0.59 0.41 70
L LBL LOO DICOT	*1.00	0.32	*1.00	*1.00	*0.67	*1.50	*0.58	-	*0.	*1.00	*1.36	0.50	*1.20	*1.20	*1.20	*0.60	*1.00	L	0.86 0.41 47
S LBL LOO DICOT	*1.00	0.32	*1.00	-	*0.67	*1.50	*0.58	-	*0.	*1.00	-	-	-	-	*0.60	*0.60	*1.00	S	0.75 0.41 54
G UCD CAHILL SMDAY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	G	- 0. - 0
I UCD CAHILL SFU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	I	- 0. - 0
MEAN(WITHOUT G,1)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
STANDARD DEVIATION	0.89	1.24	0.71	0.63	0.56	0.77	0.44	1.44	1.41	1.71	0.63	0.59	0.45	0.31	0.82	0.49	0.58		0.77

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REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	0.980	0.311	0.414	0.186	0.431	0.618
M EPA DZUBAY TF-M	-2.245	1.201	2.944	0.728	1.931	0.759
N EPA DZUBAY TF-P	-0.071	0.663	1.210	0.411	1.164	0.632
R EPA DZUBAY MDS-S	0.862	0.446	0.400	0.278	0.786	0.359
C LBL LOO DICOT	-0.337	0.339	0.919	0.231	0.436	0.783
L LBL LOO DICOT	0.536	0.395	0.487	0.239	0.636	0.491
S LBL LOO DICOT	0.592	0.268	0.286	0.167	0.409	0.495
G UCD CAHILL SMDAY	0.	0.	0.	0.	0.	0.
I UCD CAHILL SFU	0.	0.	0.	0.	0.	0.

INTERCOMPARISON STUDY OF TOTAL BR : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	159	484	-	279	181	-	114	-	45	-	-	-	246	123	-	138	207	D	
M EPA DZUBAY TF-M	176	690	218	387	278	489	226	-	93	314	314	274	209	263	-	275	M		
N EPA DZUBAY TF-P	172	527	191	310	-	421	164	300	51	308	250	240	160	235	242	222	N		
R EPA DZUBAY MDS-S	144	479	200	291	187	410	120	292	36	314	271	233	134	218	128	222	R		
C LBL LOO DICOT	-	-	-	346	253	422	139	-	53	329	310	343	180	344	185	352	C		
L LBL LOO DICOT	192	546	229	352	252	430	157	-	56	344	331	345	188	358	191	351	L		
S LBL LOO DICOT	210	597	284	-	289	486	175	-	63	377	-	-	-	413	199	350	S		
G UCD CAHILL SHDAY	-	260	116	150	145	253	125	208	63	201	197	-	-	-	-	-	G		
H UCD CAHILL TTLF	131	365	140	284	150	275	117	208	58	220	187	191	162	163	140	168	H		
I UCD CAHILL SFU	93	450	144	296	169	372	108	243	91	196	270	208	134	161	173	193	I		
J FSU HUDSON LS .2	-	-	-	150	139	222	120	140	81	310	281	197	225	174	183	194	J		
K FSU HUDSON LS .4	-	-	-	222	181	287	160	221	84	311	249	171	182	153	187	196	K		
Z MEAN(ALL SAMPLERS)	160	489	190	279	202	370	144	230	65	293	266	245	170	248	177	248	Z	236	59
STANDARD DEVIATION	37	126	55	77	55	95	34	55	19	60	47	60	33	94	34	71			
X MEAN(D.M.L.G.I.K)	155	486	177	281	201	366	148	224	72	273	272	249	167	234	172	244	X		
STANDARD DEVIATION	43	156	55	86	52	98	44	18	20	69	53	66	37	97	24	68			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	1.00	0.99	-	1.00	0.90	-	0.79	-	0.70	-	-	-	1.01	0.73	-	0.78	0.83	D	0.87
M EPA DZUBAY TF-M	1.10	1.41	1.15	1.39	1.38	1.32	1.57	-	1.44	1.07	1.18	1.12	1.23	1.06	-	1.11	M	1.25	0.16
N EPA DZUBAY TF-P	1.08	1.08	1.00	1.11	-	1.14	1.14	1.30	0.79	1.05	0.94	0.98	0.94	0.95	1.37	0.89	N	1.05	0.15
R EPA DZUBAY MDS-S	0.90	0.98	1.05	1.04	0.93	1.11	0.84	1.27	0.56	1.07	1.02	0.95	0.79	0.88	0.73	0.89	R	0.94	0.17
C LBL LOO DICOT	-	-	-	1.24	1.25	1.14	0.97	-	0.82	1.12	1.17	1.40	1.06	1.39	1.05	1.42	C	1.17	0.18
L LBL LOO DICOT	1.20	1.12	1.20	1.26	1.25	1.16	1.09	-	0.87	1.17	1.24	1.41	1.11	1.44	1.08	1.41	L	1.20	0.15
S LBL LOO DICOT	1.32	1.22	1.49	-	1.43	1.31	1.22	-	0.98	1.29	-	-	-	1.66	1.13	1.41	S	1.31	0.19
G UCD CAHILL SHDAY	-	0.53	0.61	0.54	0.72	0.68	0.87	0.90	0.98	0.69	0.74	-	-	-	-	-	G	0.73	0.15
H UCD CAHILL TTLF	0.82	0.75	0.74	1.02	0.74	0.74	0.81	0.90	0.90	0.75	0.70	0.78	0.95	0.66	0.79	0.68	H	0.80	0.10
I UCD CAHILL SFU	0.58	0.32	0.76	1.06	0.84	1.01	0.75	1.06	1.41	0.67	1.02	0.85	0.79	0.65	0.98	0.78	I	0.88	0.21
J FSU HUDSON LS .2	-	-	-	0.54	0.69	0.60	0.84	0.61	1.26	1.06	1.06	0.81	1.33	0.70	1.04	0.78	J	0.87	0.26
K FSU HUDSON LS .4	-	-	-	0.80	0.90	0.78	1.11	0.96	1.30	1.06	0.94	0.70	1.07	0.62	1.06	0.79	K	0.93	0.19
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.23	0.26	0.29	0.28	0.27	0.26	0.24	0.24	0.29	0.20	0.18	0.25	0.20	0.38	0.19	0.29		0.25	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.													
D EPA DZUBAY MDS-A	-33.103	13.028	1.060	0.054	18.230	0.990													
M EPA DZUBAY TF-M	-28.036	27.093	1.366	0.104	38.819	0.967													
N EPA DZUBAY TF-P	-7.243	20.711	1.092	0.081	30.322	0.966													
R EPA DZUBAY MDS-S	-34.406	18.668	1.121	0.073	27.782	0.971													
C LBL LOO DICOT	-24.582	29.734	1.312	0.125	33.028	0.958													
L LBL LOO DICOT	8.847	20.962	1.182	0.082	31.008	0.970													
S LBL LOO DICOT	14.322	27.043	1.271	0.104	38.339	0.971													
G UCD CAHILL SHDAY	49.831	21.562	0.483	0.078	27.687	0.910													
H UCD CAHILL TTLF	15.275	16.411	0.719	0.065	24.423	0.948													
I UCD CAHILL SFU	-18.581	25.419	0.953	0.100	37.828	0.931													
J FSU HUDSON LS .2	67.098	46.281	0.526	0.195	51.543	0.631													
K FSU HUDSON LS .4	52.984	30.185	0.652	0.127	33.617	0.840													

I INTERCOMPARISON STUDY OF SMALL BR ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	107	421	145	212	122	-	60	195	26	228	228	199	78	-	85	165 D			
M EPA DZUBAY TF-M	152	533	179	329	227	386	188	-	85	264	285	236	167	219	140	234 M			
N EPA DZUBAY TF-P	155	462	149	258	192	329	128	238	43	254	218	188	116	191	188	176 N			
R EPA DZUBAY MDS-S	105	429	151	239	128	317	71	231	22	266	203	198	80	172	75	174 R			
C LBL LOO DICOT	119	-	-	251	166	268	74	-	33	249	197	262	101	263	111	256 C			
L LBL LOO DICOT	125	452	156	254	164	267	79	-	35	256	216	261	104	269	112	258 L			
S LBL LOO DICOT	133	507	194	-	188	326	88	-	39	287	-	-	-	-	-	- G			
G UCD CAHILL SMDAY	103	249	97	150	101	232	105	208	63	189	169	-	-	-	-	-			
I UCD CAHILL SFU	72	347	120	242	133	274	61	164	55	146	179	138	92	103	135	148 I			
Z MEAN(ALL SAMPLERS)	119	425	149	242	158	300	95	207	45	238	212	212	105	219	120	208	191	47	
STANDARD DEVIATION	26	91	31	50	40	49	41	30	20	44	36	45	30	72	35	47			
X MEAN(O.M.L.G.I.)	112	400	139	237	149	290	99	189	53	217	215	209	110	197	118	201			
STANDARD DEVIATION	29	108	32	65	49	67	53	23	23	49	46	53	39	85	25	53			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.90	*0.99	*0.97	0.88	0.77	-	0.63	0.94	0.58	*0.96	1.08	0.94	0.74	-	0.71	0.79	D	0.85	0.15
M EPA DZUBAY TF-M	1.28	1.25	1.20	1.36	1.44	1.29	1.98	-	1.91	1.11	1.35	1.12	1.58	*1.00	1.16	1.12	M	1.34	0.28
N EPA DZUBAY TF-P	1.30	1.09	*1.00	1.07	1.22	1.10	1.35	1.15	*0.97	1.07	*1.03	0.89	1.10	0.87	1.56	0.85	N	1.10	0.19
R EPA DZUBAY MDS-S	0.88	*1.01	*1.01	*0.99	0.81	1.06	0.75	1.12	0.49	1.12	*0.96	0.94	0.76	0.78	0.62	0.84	R	0.88	0.18
C LBL LOO DICOT	*1.00	-	-	*1.04	*1.05	0.89	0.78	-	0.74	*1.05	*0.93	1.24	*0.96	1.20	*0.92	1.23	C	1.00	0.16
L LBL LOO DICOT	*1.05	*1.06	*1.05	*1.05	*1.04	0.89	0.83	-	0.79	*1.08	*1.02	1.23	*0.99	1.23	*0.93	1.24	L	1.03	0.14
S LBL LOO DICOT	1.12	1.19	1.30	-	1.19	*1.09	*0.93	-	0.88	1.21	-	-	-	-	-	-	- G	0.84	0.25
G UCD CAHILL SMDAY	0.87	0.59	0.65	0.62	0.64	0.77	*1.11	*1.00	1.41	0.80	0.80	-	-	-	-	-	-	0.84	0.25
I UCD CAHILL SFU	0.61	0.82	0.81	*1.00	*0.84	*0.91	0.64	0.79	*1.23	0.61	*0.85	0.65	*0.87	0.47	*1.12	0.71	I	0.81	0.20
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.22	0.21	0.21	0.21	0.26	0.16	0.43	0.14	0.45	0.19	0.17	0.21	0.29	0.33	0.29	0.22		0.25	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.													
D EPA DZUBAY MDS-A	-29.844	9.709	1.061	0.048	16.011	0.988													
M EPA DZUBAY TF-M	27.000	18.720	1.131	0.089	31.364	0.962													
N EPA DZUBAY TF-P	14.661	16.711	0.999	0.079	28.059	0.958													
R EPA DZUBAY MDS-S	-34.747	12.482	1.119	0.059	20.958	0.981													
C LBL LOO DICOT	-10.416	19.891	1.094	0.106	26.794	0.952													
L LBL LOO DICOT	-5.227	14.444	1.084	0.069	24.201	0.975													
S LBL LOO DICOT	-10.052	16.249	1.234	0.076	25.551	0.983													
G UCD CAHILL SMDAY	44.070	18.296	0.540	0.082	27.261	0.910													
I UCD CAHILL SFU	-1.398	19.392	0.796	0.092	32.559	0.918													

INTERCOMPARISON STUDY OF LARGE BR : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

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RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	52	63	-	-	67	59	-	54	-	19	-	-	47	45	-	53	42 D		
M EPA DZUBAY TF-M	24	58	39	58	51	103	38	38	-	8	50	29	38	42	44	-	41 M		
N EPA DZUBAY TF-P	17	65	42	52	-	92	36	62	62	8	54	32	52	44	44	54	46 N		
R EPA DZUBAY MDS-S	39	50	48	52	59	93	49	61	61	14	48	68	35	54	46	53	48 R		
C LBL LOO DICOT	-	-	-	95	87	154	65	-	-	20	80	113	81	79	82	74	96 C		
L LBL LOO DICOT	67	94	73	99	88	163	78	-	-	22	88	115	84	84	89	79	93 L		
S LBL LOO DICOT	77	90	90	-	101	170	87	-	-	24	90	-	-	-	95	82	96 S		
G UCD CAHILL SMDAY	-	11	19	-	-	44	21	20	-	-	13	28	-	-	-	-	- G		
I UCD CAHILL SFU	21	103	24	54	36	98	47	79	79	36	50	91	70	42	58	38	45 I		
Z MEAN(WITHOUT G)	42	75	53	68	69	125	57	67	67	19	66	75	58	56	65	62	63	64	23
STANDARD DEVIATION	24	21	24	20	24	36	18	18	10	9	19	38	20	18	23	17	26		
X MEAN(D,M,L,I)	41	80	45	70	59	121	54	79	79	21	63	78	60	53	64	57	55		
STANDARD DEVIATION	22	22	25	20	22	36	17	17	0	12	22	44	21	21	23	21	25		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	1.23	0.84	-	*0.98	0.86	-	*0.95	-	*1.01	-	-	-	0.81	0.81	-	0.86	0.66 D	0.90	0.15 17
M EPA DZUBAY TF-M	0.57	0.78	0.74	0.85	0.74	0.83	0.67	-	0.42	0.76	0.39	0.65	0.75	0.67	-	-	0.65 M	0.68	0.14 20
N EPA DZUBAY TF-P	0.40	0.87	0.80	0.76	-	0.74	0.63	0.92	0.42	0.82	0.43	0.89	0.79	0.67	0.87	0.73 N	0.72	0.17 24	
R EPA DZUBAY MDS-S	0.92	0.67	0.91	0.76	0.86	0.75	0.86	0.91	0.74	0.73	0.91	0.60	*0.97	0.70	0.86	0.76 R	0.81	0.11 13	
C LBL LOO DICOT	-	-	-	1.39	1.27	1.24	1.15	-	*1.06	1.22	1.51	1.39	1.42	1.25	1.20	1.52 C	1.30	0.14 11	
L LBL LOO DICOT	1.58	1.26	1.39	1.45	1.28	1.31	1.37	-	1.17	1.34	1.54	1.45	1.51	1.36	1.28	1.47 L	1.38	0.12 8	
S LBL LOO DICOT	1.82	1.20	1.71	-	1.47	1.36	1.53	-	1.27	1.37	-	-	-	1.45	1.33	1.52 S	1.46	0.18 13	
G UCD CAHILL SMDAY	-	0.15	0.36	-	0.64	0.17	0.35	-	-	0.20	0.38	-	-	-	-	-	- G	0.32	0.17 53
I UCD CAHILL SFU	0.50	*1.38	0.46	*0.79	0.52	*0.79	*0.83	*1.17	1.91	*0.76	*1.22	*1.20	*0.75	*0.89	0.61	0.71 I	0.91	0.38	42
MEAN(WITHOUT G)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
STANDARD DEVIATION	0.56	0.28	0.46	0.30	0.34	0.29	0.33	0.15	0.49	0.29	0.51	0.35	0.33	0.35	0.27	0.42	0.36		

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR. COEFF.
D EPA DZUBAY MDS-A	9.603	9.256	0.712	0.157	7.554	0.848
M EPA DZUBAY TF-M	-10.999	6.882	0.873	0.102	8.402	0.927
N EPA DZUBAY TF-P	-3.829	8.005	0.797	0.120	9.830	0.879
R EPA DZUBAY MDS-S	5.569	5.372	0.714	0.080	6.598	0.922
C LBL LOO DICOT	2.343	7.898	1.276	0.115	8.895	0.962
L LBL LOO DICOT	5.910	5.333	1.289	0.080	6.546	0.976
S LBL LOO DICOT	11.276	7.850	1.263	0.116	9.352	0.964
G UCD CAHILL SMDAY	0.	0.	0.	0.	0.	0.
I UCD CAHILL SFU	3.377	15.643	0.822	0.234	19.213	0.685

INTERCOMPARISON STUDY OF TOTAL PB : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.																			
RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	845	792	-	1153	995	-	-	781	-	325	812	1194	1051	886	-	789	856	D	
M EPA DZUBAY TF-H	955	987	919	1320	1160	1768	849	849	-	276	1001	1324	1021	1001	1128	788	919	M	
N EPA DZUBAY TF-P	878	902	878	1219	1081	1600	846	1358	274	940	1192	1056	1032	1177	882	913	N		
R EPA DZUBAY MDS-S	745	722	815	1031	958	1423	696	1187	240	808	1148	1000	847	980	783	810	R		
C LBL LOO DICOT	-	-	-	1473	1275	1891	895	-	-	318	1060	1597	1309	1207	1482	999	1094	C	
L LBL LOO DICOT	1093	1065	1127	1477	1258	1881	937	-	-	329	1078	1599	1299	1203	1538	1020	1117	L	
S LBL LOO DICOT	1131	1079	1203	-	1333	1909	991	-	-	331	1060	-	-	-	1534	1057	1122	S	
G UCD CAHILL SMDAY	-	665	689	1066	1010	1257	586	1227	263	751	1023	-	-	-	-	-	-	G	
H UCD CAHILL TLTF	753	770	835	1070	989	1312	638	1134	276	754	1010	972	828	899	691	830	H		
I UCD CAHILL SFU	686	749	763	1060	984	1345	780	1356	252	862	1333	1216	1044	1298	835	870	I		
P EPA RODES HIVOL	1000	1220	1070	1370	1230	1850	910	1370	310	1010	1540	1190	1310	1280	1080	1040	P		
J FSU HUDSON LS 2	-	-	-	1308	1145	1707	1062	1303	-545	997	1942	1320	1524	1408	1248	1030	J		
K FSU HUDSON LS 4	-	-	-	1698	1310	1946	1090	1422	-500	950	1890	1353	1509	1317	1243	981	K		
Z MEAN(ALL SAMPLERS)	898	895	922	1270	1133	1657	851	1295	326	929	1399	1162	1126	1276	951	965	1066	Z	
STANDARD DEVIATION	158	185	174	209	138	259	154	101	93	119	314	145	246	214	185	114			
X MEAN(0.M.L.G.I.P.K)	916	913	914	1306	1135	1675	848	1344	322	923	1415	1188	1159	1312	959	964			
STANDARD DEVIATION	156	213	189	234	137	296	157	83	84	118	287	132	228	147	186	102			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.94	0.89	-	0.91	0.88	-	0.92	-	*1.00	0.87	0.85	0.90	0.79	-	0.83	0.89	D	0.89	0.05
M EPA DZUBAY TF-H	1.06	1.10	*1.00	*1.04	*1.02	1.07	*1.00	-	0.85	1.08	0.95	0.88	0.89	0.88	0.83	0.95	M	0.97	0.09
N EPA DZUBAY TF-P	*0.98	*1.01	0.95	*0.96	*0.95	*0.97	*0.99	*1.05	0.84	*1.01	0.85	0.91	0.92	0.92	0.93	0.95	N	0.95	0.06
R EPA DZUBAY MDS-S	0.83	0.81	0.88	0.81	0.85	0.86	0.82	0.92	0.74	0.87	0.82	0.86	0.75	0.77	0.82	0.84	R	0.83	0.05
C LBL LOO DICOT	-	-	-	1.16	1.13	1.14	*1.05	-	*0.98	1.14	1.14	1.13	*1.07	1.16	*1.05	1.13	C	1.11	0.06
L LBL LOO DICOT	1.22	1.19	1.22	1.16	*1.11	1.14	*1.10	-	*1.01	1.16	1.14	1.12	*1.07	1.21	*1.07	1.16	L	1.14	0.06
S LBL LOO DICOT	1.26	1.21	1.30	-	1.18	1.15	1.17	-	*1.02	1.14	-	-	-	1.20	*1.11	1.16	S	1.17	0.08
G UCD CAHILL SMDAY	-	0.74	0.75	0.84	0.89	0.76	0.69	*0.95	0.81	0.81	0.73	-	-	-	-	-	G	0.80	0.08
H UCD CAHILL TLTF	0.84	0.86	*0.91	0.84	*0.87	0.79	0.75	*0.88	0.85	0.81	0.72	0.84	0.74	0.70	0.73	0.86	H	0.81	0.06
I UCD CAHILL SFU	0.76	0.84	0.83	0.83	0.87	0.81	*0.92	*1.05	0.77	*0.93	*0.95	*1.05	*0.93	*1.02	*0.88	*0.90	I	0.90	0.09
P EPA RODES HIVOL	1.11	1.36	1.16	1.08	1.09	1.02	1.07	1.06	*0.95	1.09	1.10	*1.02	1.16	*1.00	1.14	1.08	P	1.10	0.09
J FSU HUDSON LS 2	-	-	-	*1.03	*1.01	*1.03	1.25	*1.01	1.67	*1.07	1.39	1.14	1.35	1.10	1.31	*1.07	J	1.19	0.20
K FSU HUDSON LS 4	-	-	-	1.34	*1.16	1.17	1.28	*1.10	1.53	*1.02	1.35	1.16	1.34	*1.03	1.31	*1.02	K	1.22	0.16
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.18	0.21	0.19	0.16	0.12	0.16	0.18	0.08	0.28	0.13	0.22	0.13	0.22	0.17	0.19	0.12		0.17	
REGRESSION VS Z	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.													
D EPA DZUBAY MDS-A	60.151	50.577	0.819	0.049	44.073	0.982													
M EPA DZUBAY TF-H	-40.391	92.239	1.016	0.085	95.489	0.958													
N EPA DZUBAY TF-P	11.725	57.629	0.940	0.052	60.184	0.979													
R EPA DZUBAY MDS-S	-32.508	47.975	0.863	0.043	50.102	0.983													
C LBL LOO DICOT	-93.006	36.482	1.204	0.032	35.219	0.996													
L LBL LOO DICOT	-15.199	50.656	1.158	0.046	52.440	0.990													
S LBL LOO DICOT	-2.339	59.064	1.182	0.057	58.397	0.990													
G UCD CAHILL SMDAY	-19.288	100.046	0.818	0.089	98.419	0.956													
H UCD CAHILL TLTF	56.861	69.544	0.753	0.063	72.627	0.954													
I UCD CAHILL SFU	-57.364	97.227	0.959	0.088	101.538	0.946													
P EPA RODES HIVOL	34.563	78.906	1.068	0.071	82.404	0.970													
J FSU HUDSON LS 2	215.061	174.459	0.958	0.152	169.203	0.885													
K FSU HUDSON LS 4	52.681	155.912	1.152	0.136	151.215	0.931													

I INTERCOMPARISON STUDY OF SMALL PB ; NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	677	671	713	955	801	-	633	1045	249	663	975	899	755	-	637	722	D		
M EPA DZUBAY TF-M	812	761	769	1099	898	1435	685	-	229	819	1167	869	769	949	673	759	M		
N EPA DZUBAY TF-P	792	730	698	1013	884	1310	686	1122	224	741	1050	876	831	989	689	689	N		
R EPA DZUBAY MDS-S	615	617	660	887	769	1170	544	1012	199	656	914	828	670	837	606	660	R		
C LBL LOO DICOT	747	-	-	1132	899	1377	638	-	245	782	1134	1022	890	1177	721	821	C		
L LBL LOO DICOT	742	801	809	1115	884	1331	651	-	244	762	1127	995	878	1197	715	825	L		
S LBL LOO DICOT	733	800	798	-	893	1341	662	-	236	755	1160	1005	-	1193	735	816	S		
G UCD CAHILL SMDAY	588	552	619	946	829	1167	500	1105	218	676	898	-	-	-	-	-	G		
I UCD CAHILL SFU	582	596	597	853	867	1036	552	1112	207	697	1039	1016	819	1059	634	677	I		
O EPA RODES DICOT	730	710	650	670	660	1410	600	890	260	650	890	1190	1100	970	730	880	O		
Z MEAN(ALL SAMPLERS)	702	693	701	963	838	1286	615	1048	231	720	1035	967	839	1046	682	765	Z	89	
STANDARD DEVIATION	82	90	77	149	77	133	64	88	19	59	110	111	127	133	47	75			
X MEAN(D,M,L,G,I,O)	689	682	693	940	823	1276	604	1038	235	711	1016	994	864	1044	678	773	X		
STANDARD DEVIATION	91	96	85	165	88	170	68	103	20	66	116	126	140	113	44	81			
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	*0.97	*0.97	*1.02	*0.99	*0.96	-	*1.03	*1.00	1.08	0.92	0.94	0.93	0.90	-	0.93	0.94	D	0.97	0.05
M EPA DZUBAY TF-M	1.16	1.10	1.10	1.14	1.07	1.12	1.11	-	*0.99	1.14	1.13	0.90	0.92	0.91	*0.99	*0.99	M	1.05	0.09
N EPA DZUBAY TF-P	1.13	*1.05	*1.00	*1.05	*1.05	*1.02	1.12	1.07	*0.97	*1.03	*1.01	0.91	*0.99	0.95	*1.01	*0.95	N	1.02	0.06
R EPA DZUBAY MDS-S	0.88	0.89	0.94	0.92	0.92	0.91	0.88	*0.97	0.86	0.91	0.88	0.86	0.80	0.80	0.89	0.86	R	0.89	0.05
C LBL LOO DICOT	*1.06	-	-	1.18	*1.07	*1.07	*1.04	-	*1.06	*1.09	*1.10	*1.06	*1.06	1.13	*1.06	*1.07	C	1.08	0.04
L LBL LOO DICOT	*1.06	1.16	1.15	1.16	*1.05	*1.04	*1.06	-	*1.06	*1.06	*1.09	*1.03	*1.05	1.14	*1.05	*1.08	L	1.08	0.05
S LBL LOO DICOT	*1.04	1.15	1.14	-	*1.07	*1.04	*1.08	-	*1.02	*1.05	1.12	*1.04	-	1.14	*1.08	*1.07	S	1.08	0.04
G UCD CAHILL SMDAY	0.84	0.80	0.88	*0.98	*0.99	*0.91	0.81	*1.06	*0.94	*0.94	0.87	-	-	-	-	-	G	0.91	0.08
I UCD CAHILL SFU	0.83	0.86	0.85	*0.89	*1.03	0.81	*0.90	*1.06	*0.90	*0.97	*1.00	*1.05	*0.98	*1.01	*0.93	*0.88	I	0.93	0.08
O EPA RODES DICOT	*1.04	*1.02	*0.93	0.70	0.79	*1.10	*0.98	0.85	*1.13	*0.90	0.86	1.23	1.31	*0.93	*1.07	*1.15	O	1.00	0.16
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	
STANDARD DEVIATION	0.12	0.13	0.11	0.15	0.09	0.10	0.10	0.08	0.08	0.08	0.11	0.12	0.15	0.13	0.07	0.10		0.11	

REGRESSION VS Z INTERCEPT ERROR SLOPE ERROR RMS.DEV. COR.COEFF.

D EPA DZUBAY MDS-A	27.910	31.830	0.926	0.040	30.207	0.989
M EPA DZUBAY TF-M	2.939	79.233	1.047	0.094	85.506	0.951
N EPA DZUBAY TF-P	27.330	45.873	0.984	0.054	50.263	0.980
R EPA DZUBAY MDS-S	-9.111	39.453	0.898	0.046	43.229	0.982
C LBL LOO DICOT	-27.266	31.487	1.117	0.037	32.645	0.994
L LBL LOO DICOT	8.839	39.518	1.071	0.047	42.647	0.988
S LBL LOO DICOT	3.015	34.855	1.078	0.042	37.410	0.982
G UCD CAHILL SMDAY	-56.059	65.942	0.987	0.078	68.687	0.973
I UCD CAHILL SFU	-24.562	74.333	0.970	0.087	81.448	0.948
O EPA RODES DICOT	41.231	138.748	0.939	0.163	152.028	0.839

INTERCOMPARISON STUDY OF LARGE PB : NANOGRAMS/CUBIC METER; PERIODS 1-16, MAY 11-18 1977.

J

RESULTS	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD
D EPA DZUBAY MDS-A	158	121	-	198	194	-	333	164	-	76	149	219	151	131	-	152	134	D	
M EPA DZUBAY TF-M	143	226	150	221	262	333	164	-	-	47	182	157	152	232	179	115	160	M	
N EPA DZUBAY TF-P	35	172	180	216	197	290	160	236	50	199	142	180	201	188	193	185	185	N	
R EPA DZUBAY MDS-S	130	105	155	144	189	253	152	175	41	152	234	172	177	143	177	150	150	R	
C LBL LOO DICOT	-	-	-	341	376	514	257	-	73	278	463	287	317	305	278	273	273	C	
L LBL LOO DICOT	351	284	318	362	374	550	286	-	85	316	472	304	325	341	305	272	272	L	
S LBL LOO DICOT	338	279	405	-	440	568	329	-	95	305	-	-	-	341	322	306	306	S	
G UCD CAHILL SMDAY	-	113	70	120	181	90	86	122	45	75	125	-	-	-	-	-	-	G	
I UCD CAHILL SFU	104	153	166	207	117	309	228	244	45	165	294	200	225	239	201	193	193	I	
Z MEAN(ALL SAMPLERS)	137	179	206	226	259	363	201	194	62	202	263	207	230	248	218	209	217	Z	86
STANDARD DEVIATION	125	69	114	85	111	167	78	57	20	81	137	63	71	82	75	65	65		
X MEAN(D.M.L.G.I)	192	175	176	222	226	321	182	183	60	177	253	222	228	253	193	190	190	X	
STANDARD DEVIATION	110	67	104	88	98	188	77	86	19	88	138	72	79	82	82	60	60		
RATIO TO Z	PERIOD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	AVG	SD CV
D EPA DZUBAY MDS-A	0.95	0.68	-	0.88	0.75	-	0.74	-	1.23	0.74	0.83	0.73	0.57	-	0.70	0.64	0.78	D	0.17 21
M EPA DZUBAY TF-M	0.73	1.26	0.73	0.98	1.01	0.92	0.82	-	0.76	0.90	0.60	0.74	1.01	0.72	0.53	0.77	0.83	M	0.19 22
N EPA DZUBAY TF-P	0.43	0.96	0.87	0.96	0.76	0.80	0.80	1.22	0.81	0.98	0.54	0.87	0.88	0.76	0.89	0.89	0.84	N	0.18 21
R EPA DZUBAY MDS-S	0.56	0.59	0.75	0.64	0.73	0.70	0.76	0.90	0.66	0.75	0.89	0.83	0.77	0.58	0.81	0.72	0.73	R	0.10 13
C LBL LOO DICOT	-	-	-	1.51	1.45	1.41	1.28	-	1.18	1.37	1.76	1.39	1.38	1.23	1.28	1.31	1.38	C	0.15 11
L LBL LOO DICOT	1.78	1.47	1.54	1.60	1.45	1.51	1.42	-	1.37	1.56	1.79	1.47	1.42	1.38	1.40	1.30	1.50	L	0.14 9
S LBL LOO DICOT	2.02	1.56	1.96	-	1.70	1.56	1.64	-	1.54	1.51	-	-	-	-	1.38	1.46	1.52	S	0.20 13
G UCD CAHILL SMDAY	-	0.63	0.34	0.53	0.70	0.25	0.43	0.63	0.73	0.37	0.48	-	-	-	-	-	-	G	0.51 0.16 32
I UCD CAHILL SFU	0.53	0.85	0.81	0.92	0.45	0.85	1.13	1.26	0.73	0.82	1.12	0.97	0.98	0.96	0.92	0.92	0.92	I	0.89 0.21 23
MEAN(ALL SAMPLERS)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
STANDARD DEVIATION	0.63	0.39	0.56	0.38	0.43	0.46	0.39	0.29	0.33	0.40	0.52	0.31	0.31	0.33	0.35	0.31	0.31		0.40

REGRESSION VS Z

	INTERCEPT	ERROR	SLOPE	ERROR	RMS.DEV.	COR.COEFF.
D EPA DZUBAY MDS-A	24.628	26.890	0.630	0.129	21.699	0.841
M EPA DZUBAY TF-M	-8.439	40.698	0.871	0.180	41.515	0.802
N EPA DZUBAY TF-P	30.375	36.759	0.689	0.164	37.995	0.747
R EPA DZUBAY MDS-S	2.585	21.116	0.724	0.094	21.826	0.899
C LBL LOO DICOT	-32.492	36.527	1.544	0.157	35.238	0.952
L LBL LOO DICOT	-12.247	31.826	1.562	0.141	32.464	0.951
S LBL LOO DICOT	18.713	44.570	1.528	0.199	44.783	0.931
G UCD CAHILL SMDAY	53.937	35.883	0.226	0.158	35.977	0.452
I UCD CAHILL SFU	9.199	45.466	0.849	0.203	46.995	0.746

TECHNICAL REPORT DATA		
(Please read Instructions on the reverse before completing)		
1 REPORT NO EPA-600/7-78-118	2	3 RECIPIENT'S ACCESSION NO.
4 TITLE AND SUBTITLE INTERCOMPARISON OF SAMPLERS USED IN THE DETERMINATION OF AEROSOL COMPOSITION	5 REPORT DATE July 1978	6 PERFORMING ORGANIZATION CODE
7 AUTHOR(S) D.C. Camp, A.L. Van Lehn, and B.L. Loo	8 PERFORMING ORGANIZATION REPORT NO.	
9 PERFORMING ORGANIZATION NAME AND ADDRESS Lawrence Livermore Laboratory Livermore, CA 94550 Lawrence Berkeley Laboratory Berkeley, CA 94720	10 PROGRAM ELEMENT NO. 1NE625D EB-11 (FY-78)	11 CONTRACT GRANT NO. IAG-D6-0800 IAG-D7-F1108
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15. SUPPLEMENTARY NOTES		
16 ABSTRACT <p>An intercomparison study was carried out to evaluate the performance of 11 different designs of aerosol samplers. The samplers were operated by participating scientific groups having recognized expertise in sampler development and operation. The devices tested include hi-vol, TWO MASS, cyclone, CHAMP, streaker, stacked filter and manual and automated dichotomous samplers. The samplers were operated in Charleston WV for eight consecutive days during May of 1977. The collection surfaces of each sampler were changed at least every 12 hours which enabled the intercomparison to be made for 16 sampling periods. The collected samples were returned to the laboratory of each participant and analyzed for mass, nitrate, sulfur or sulfate, lead, and 9 other elements. Most of the samplers separated the aerosol into two fractions with 50% separation diameters ranging from 2.4 μm to 4.3 μm. The upper 50% cutoff diameter for the various samplers ranged from 14 μm to about 30 μm. Best agreement among samplers was found for elements such as sulfur and lead that occurred primarily in the fine fraction. The amount of total mass collected was strongly influenced by the upper 50% cutoff diameter of each sampler. For stacked filter samplers and the tandem filter samplers, the fine fraction appeared to be enriched with crustal elements such as Si, Ca, and Fe, which suggests that there are particle bounce errors. Of all the samplers tested, the automatic dichotomous sampler showed the greatest precision.</p>		
17. KEY WORDS AND DOCUMENT ANALYSIS		
a DESCRIPTORS	b IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
*Air pollution *Aerosols *Samplers *Comparison *Mass *Sulfur		13B 07D 14B 07B
18. DISTRIBUTION STATEMENT RELEASE TO PUBLIC	19 SECURITY CLASS (This Report) UNCLASSIFIED 20 SECURITY CLASS (This page) UNCLASSIFIED	21. NO. OF PAGES 151 22. PRICE

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