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Size - Time - Compostitional Analyses of Aerosols During SCAQS

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Size - Time - Compositional Analyses of Aerosols During SCAQS

Final Report

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ABSTRACT

This report describes the work done by the Air Quality Group of Crocker Nuclear Laboratory in the 1987 Southern California Air Quality Study. The main objective of the study was to form a comprehensive data base of aerosol and meteorological measurements in the South Coast Air Basin for further air quality and meteorological studies. Our participation in SCAQS consisted of monitoring four sites in the Los Angeles basin with high size-time-compositional resolution, emphasizing the fine aerosols that impact visibility. The subsequent analyses from two sampling methods (9-stage impactors for high size-resolution and cyclone samplers with teflon filters for high compositional sensitivity) led to a relatively complete elemental characterization of fine aerosols with their size distribution. Sampling and analysis methods are described along with their results and quality assurance.

Eighty to ninety percent of the fine aerosol mass was accounted for by the elements from H to Pb, while hydrogen had surprisingly high correlations with mass (R-squares from 0.88 to 0.99). The size-resolved elemental data showed that sulfur had complicated size and time patterns across the Los Angeles Basin with two important patterns emerging in the optically important size region for sulfur from 0.34 to 2.12μm. There can be a growth in total sulfur concentration with a constant size profile or there can be a change to a coarser size fraction, generally but not always with increasing concentration. This suggests there are two different formation modes for sulfur.

DISCLAIMER

The statements and conclusions in this report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such products.

ACKNOWLEDGMENTS

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PROJECT SUMMARY

To extend information on aerosol size and composition during the 1987 Southern California Air Quality Study (SCAQS), the Air Quality Group of Crocker Nuclear Lab monitored fine aerosols with size distribution and performed full elemental analyses for primary A and B SCAQS sites: Long Beach-Summer and Fall, Claremont-Summer, Rubidoux-Summer, and Los Angeles-Fall.

In SCAQS, our primary objective was to help form a comprehensive air quality data base for the South Coast Air Basin to be used for various types of air quality simulation modeling. To assist the SCAQS program, we utilized our sampling and analysis capabilities to characterize fine aerosols by size and composition which emphasize their effects upon visibility (e.g. size-resolved sulfur). This entailed providing elemental data to help resolve particulate mass into its chemical components, an important goal of any air quality study. By providing our fine aerosol data, we also made possible many quality assurance and data validation comparisons to other data; this is important in achieving a sound data base. We in turn would also benefit from elemental to chemical comparisons done in the SCAQS database.

The following list highlights what our work provided:

1. Size-resolution of aerosols.
2. An enhanced SCAQS data base with the light elements (H, C, O, N) that compose approximately 2/3 of fine particulate mass and are not available from normal x-ray methods.
3. Quality assurance comparisons between elemental and chemical measurements and redundant measurements.
4. Identification of trace elements for source attribution.
5. Constraints on indirect techniques such as Chemical Mass Balance.

A secondary objective was our interest in the effects of fine aerosols upon visibility in the Los Angeles basin. Specifically, we were interested to see whether sulfur (sulfate in the optically important size region from 0.34 to 2.5μm) had similar causal effects upon the degradation of visibility as we saw in a previous study near Glendora, the 1986 Carbon Species Methods Comparison Study.

Monitoring of aerosols was done with eight stage (plus afterfilter) Davis Rotating-drum Unit for Monitoring (DRUM) impactors continuously operated with a four hour time resolution. Elemental analysis of the 4 hour samples was done by Particle Induced X-ray Emission (PIXE) for the elements sodium and heavier. With five of the nine cutpoints below 2.5 microns, the fine aerosols most important to visibility degradation were segregated into five different size ranges. In conjunction with DRUM samplers, fine aerosols (PM2.5) were also monitored with high compositional sensitvity by Interagency Monitoring of PROtected Visual Environments (IMPROVE) cyclone samplers using teflon filters and standard SCAQS sampling schedules. This allowed analysis of mass, optical absorption, the elements Na to Pb by PIXE, and the light elements H to F by Forward Alpha Scattering Techniques to all be done on the same filters. The combination of the two elemental techniques called total elemental analysis, analyzed for the elements from hydrogen to lead making direct comparisons of

total elemental (H to Pb) to gravimetric mass concentrations possible. Combining the results from the IMPROVE filters and the DRUM gave a relatively complete size and total elemental characterization of SCAQS fine aerosols.

Results from the filter samples achieved good to very good resolution of gravimetric mass into elemental constituents. Combining PIXE and FAST analyses, over 80% of gravimetric mass was accounted for by the elements from H to Pb. The remaining unrecovered elemental mass was attributed to the loss of volatiles (e.g. water, volatile nitrogen) during analysis under vacuum. While the results from total elemental analysis should correlate with mass, a surprise was how well hydrogen correlated with mass at all sites and times, R^2 = 0.88 to 0.99.

Using the size-resolved elemental data from the DRUM samplers, the behavior of sulfur (sulfate), very important in visibility degradation, was found to be most interesting. Size-resolved sulfur showed complicated patterns by size and composition across the basin. It was clear that there were two different patterns (in the Los Angeles basin) that lead to growth of sulfur particles in the optically important size region from 0.34 to 2.12μm. There were not only increases in sulfur concentration with constant size but also increases in sulfur with a simultaneous shift out of the accumulation mode to a coarser mode > 0.56μm. The latter should have a disproportionately greater effect upon visibility. The two patterns suggest there are two formation modes of sulfur in the optically important size ranges.

Air Quality Group Participation in SCAQS:

I. SCAQS Sites and Intensive Sampling Days

A. Summer SCAQS - 11 Intensive Days

Long Beach	June 19,24,25
Claremont	July 13,14,15
Rubidoux	August 27,28,29
	September 2,3

B. Fall SCAQS - 6 Intensive Days

Long Beach	November 11,12,13
Downtown Los Angeles	December 3,10,11

II. Samplers

A. IMPROVE Fine particle sampler (21.7 liters per minute)
IMPROVE samples were collected on 25mm stretched teflon filters using a cyclone (PM2.5)

B. DRUM (8 stage) impactor with afterfilter (1.1 lpm)
DRUM samples were collected on Mylar strips coated with Apiezon-L grease and teflon afterfilters in the following size ranges:

Stage 1	15.0 - 8.54μm diameter*
Stage 2	8.54 - 4.26μm
Stage 3	4.26 - 2.12μm
Stage 4	2.12 - 1.15μm
Stage 5	1.15 - 0.56μm
Stage 6	0.56 - 0.34μm
Stage 7	0.34 - 0.24μm
Stage 8	0.24 - 0.069μm
afterfilter	0.069 - 0.00μm diameter

*Effective Cut-off Aerodynamic Equivalent Diameter

III. Analysis

A. IMPROVE Teflon Filters - 224 analyzed filters

1. Mass (gravimetric, Cahn 25 electrobalance with NPS/EPA protocols)
2. Optical Absorption (Laser Integrating Plate Method, LIPM, calibrated to an integrating sphere)
3. Elements Na to Pb (Particle Induced X-ray Emission, PIXE, using two X-ray detectors)
4. Light elements hydrogen, carbon, nitrogen, and oxygen (Forward Alpha Scattering Techniques, FAST)

B. DRUM impactor - over 2,750 four hour samples were analyzed for over 15,000 non zero values

1. Elements S, Cl, K, Ca, Fe, and Zn (Particle Induced X-ray Emission, PIXE)

RECOMMENDATIONS

All of our SCAQS data has been reported to the SCAQS data manager (ENSR) and entered into the SCAQS data base. Our quality assurance comparisons have shown the data to be in good quality and we shall await the results from further comparisons and validations.

Besides providing elemental data for various types of quality assurance, our data should also be a vital part of the various air quality models that will use the SCAQS data base. As shown by the complicated sulfur patterns across the Los Angeles basin during SCAQS, any attempt to model visibility would need size-resolved sulfur.

The 4 analysis techniques for the IMPROVE filters provided enough information to resolve fine aerosols into their chemical components with just one sampling method and various non-destructive analysis techniques. Additionally the filters provided trace elements for source apportionment and the light elements (H, C, O, N) not normally measured. In a large study such as SCAQS there were various types of methods to characterize aerosols by composition and size, but in smaller studies our combination of two sampling methods (DRUM and IMPROVE filters) and analysis techniques are an efficient and effective alternative for a relatively complete size-time-composition characterization of aerosols.

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INTRODUCTION

The U.C. Davis Air Quality Group's (AQG) participation in the 1987 Southern California Air Quality Study (SCAQS) was centered around two sets of aerosol measurements. Each of them were taken for specific and to a degree, unrelated purposes. However, combined together they give a relatively complete size and elemental characterization of aerosols in the South Coast Air Basin.

The first set of measurements focused on mass and the high sensitivity elemental analysis of fine aerosols (PM2.5) needed to reconstruct mass. Samples were collected on 25mm teflon filters using Interagency Monitoring of PROtected Visual Environments (IMPROVE) cyclone samplers at the following sites: Long Beach, Claremont, and Rubidoux in the summer; Long Beach and Los Angeles in the fall (Figure 1). The sampling protocol matched the standard SCAQS protocol in time and duration. The teflon filters were then analyzed for mass, optical absorption, and all elements H through Pb, most to a detectable limit of a few ng/m^3. The analysis of the elements from H to Pb which we call total elemental analysis, accounted for most of the aerosol mass (about 80%) and was measured by two separate methods. The first, Particle Induced X-ray Emission (PIXE), was done for the elements from Na to Pb. The second, Forward Alpha Scattering Techniques (FAST), is a nuclear scattering method which was used for the analysis of light elements, H to F, that can not be measured with normal x-ray techniques. These data were put into the SCAQS data base for use in modeling and allow detailed study into the nature of the aerosols, identification of tracer elements for source apportionment, as well as setting strict constraints on indirect but powerful techniques such as Chemical Mass Balance (CMB). Secondary goals were established to assist SCAQS by providing quality assurance comparisons and backing up the SCAQS sampler. In turn, we will benefit by comparing our results to the extensive chemical data collected in SCAQS.

The second set of measurements revolved around highly size-resolved aerosol samples taken in 9 size ranges at the same SCAQS sites and periods. The size-resolved aerosol collection was done with eight stage (plus afterfilter) Davis Rotating-drum Unit for Monitoring (DRUM) impactors. The DRUM sampler was especially designed for visibility studies and continuously operated with a time resolution of 4 hours. With five different cutpoints below 2.12 microns (μm), the fine aerosols most important to visibility degradation were segregated into 5 different sizes. Elemental analysis of the 4 hour samples was done with PIXE for the elements from Na to Pb. The size-resolved elemental data was also entered into the SCAQS data for use in modeling and studies (especially those involving visibility) as well as for comparison and quality assurance purposes.

Tying the two sets of measurements together are their uses in the study of visibility. Our approach of obtaining data to characterize visibility comprised of high resolution size-time particulate sampling with as much mass and elemental information as possible in the optically important size region below $2.5\mu m$. This provides information to explain the causal effects of aerosols on visibility without requiring size-resolved measurements of every optically significant component of the atmosphere (unlike SCAQS, this usually can not be done in small studies). In SCAQS, size-resolved analysis of key elements collected by the DRUM impactors were combined with a relatively complete analysis of the fine mode aerosols collected on teflon filters by

IMPROVE cyclone samplers. This combination of sampling and analysis techniques gives a relatively complete size-time-compositional characterization of fine aerosols important to an evaluation of visibility in the Los Angeles Basin.

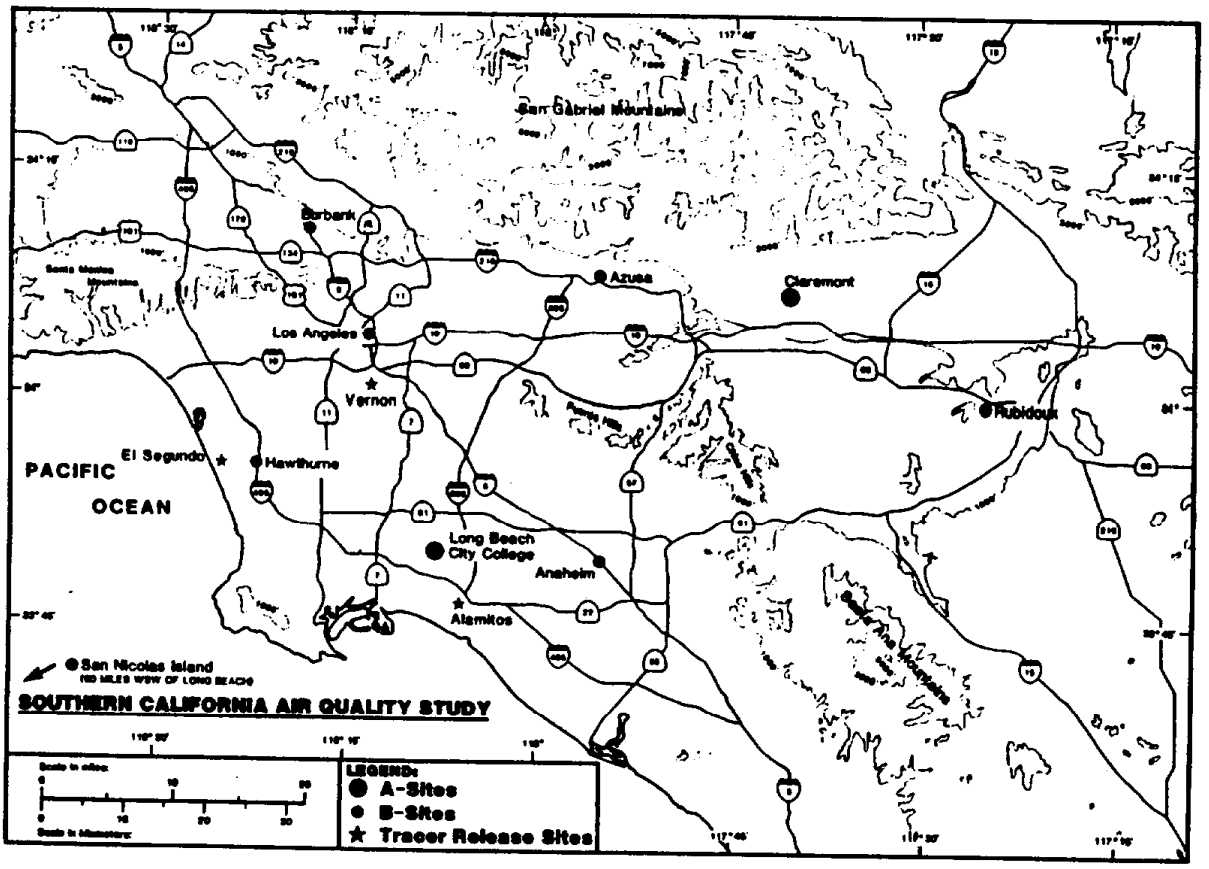


Figure 1. SCAQS Study sites.

IMPROVE FILTERS IN SCAQS

Interagency Monitoring of PROtected Visual Environments (IMPROVE) fine aerosol samplers (Eldred et al., 1988) measured PM2.5 aerosols during SCAQS. These modular samplers are used in a nationwide network designed to measure the concentration and composition of fine particles which impair visibility. Sites include Class I parks, monuments, and wilderness areas operated by the National Park Service (NPS), Environmental Protection Agency (EPA), United States Forestry Service (USFS), Bureau of Land Management (BLM), and United States Fisheries and Wildlife Service (USFWS). One configuration of the fine particulate module (Figure 2) of the IMPROVE sampler operated at four different SCAQS sites using a cyclone (Walter John design) to remove particles larger than 2.5μm. A programmable clock (4 channel, 7 day with battery backup) in a separate controller module directed airflow to up to 4 different filters by turning their corresponding solenoid valves on and off so filter exposures matched the SCAQS sampling schedules. Stretched teflon filters (25mm) collected particles allowing two separate elemental analyses, FAST (light elements, H to F) and PIXE (Na to Pb), in addition to mass and optical absorption measurements. During June and July, the filters were masked down according to U.C. Davis protocols, but incipient clogging problems caused the masks to be removed at certain sites for the remainder of the study. This saved the integrity of the sample collection and resulted in only a slight loss in sensitivity for the elemental analyses.

Flowrates and Volume

The 21.7 liter per minute (lpm) flowrate required by the cyclone for the 2.5μm cutpoint, was regulated by a critical orifice and measured by two different methods. The first method measured the pressure drop across the cyclone with a calibrated magnehelic gauge. Flowrate was calculated using the logarithmic relationship between flow and the measured pressure drop. The second method measured the pressure drop across the filter and cyclone with a vacuum gauge and used the linear relationship between the pressure drop and flow for flowrate calculations. Both methods are dependent on temperature and ambient pressure, but for SCAQS both had negligible effects. The vacuum gauge serves a dual purpose of also checking for leaks in the sampling system and for pump failure.

On-site flow calibrations were done by U.C. Davis personnel using magnehelic orifice meters calibrated to a spirometer. Flow audits, conducted by a third party auditor (mass flow meter), across the IMPROVE network have been within +/- 3% of U.C. Davis measurements. A sample's flowrate was determined from the average flowrate before and after sample collection. Sample volume was then calculated by multiplying the average flowrate by sample duration, as measured by elapsed time meters.

Heavy mass loadings during the summer brought about incipient clogging of filters. Calculations of volume using the average of beginning and ending flowrates for a sample assume that the flow stays relatively constant and decreases linearly with time. However, at the onset of filter clogging, flow drops slowly and then rapidly decreases. With only the beginning and ending flowrates, not enough information is known about the flowrate in time to accurately determine the volume of a clogging filter sample. If flowrate for

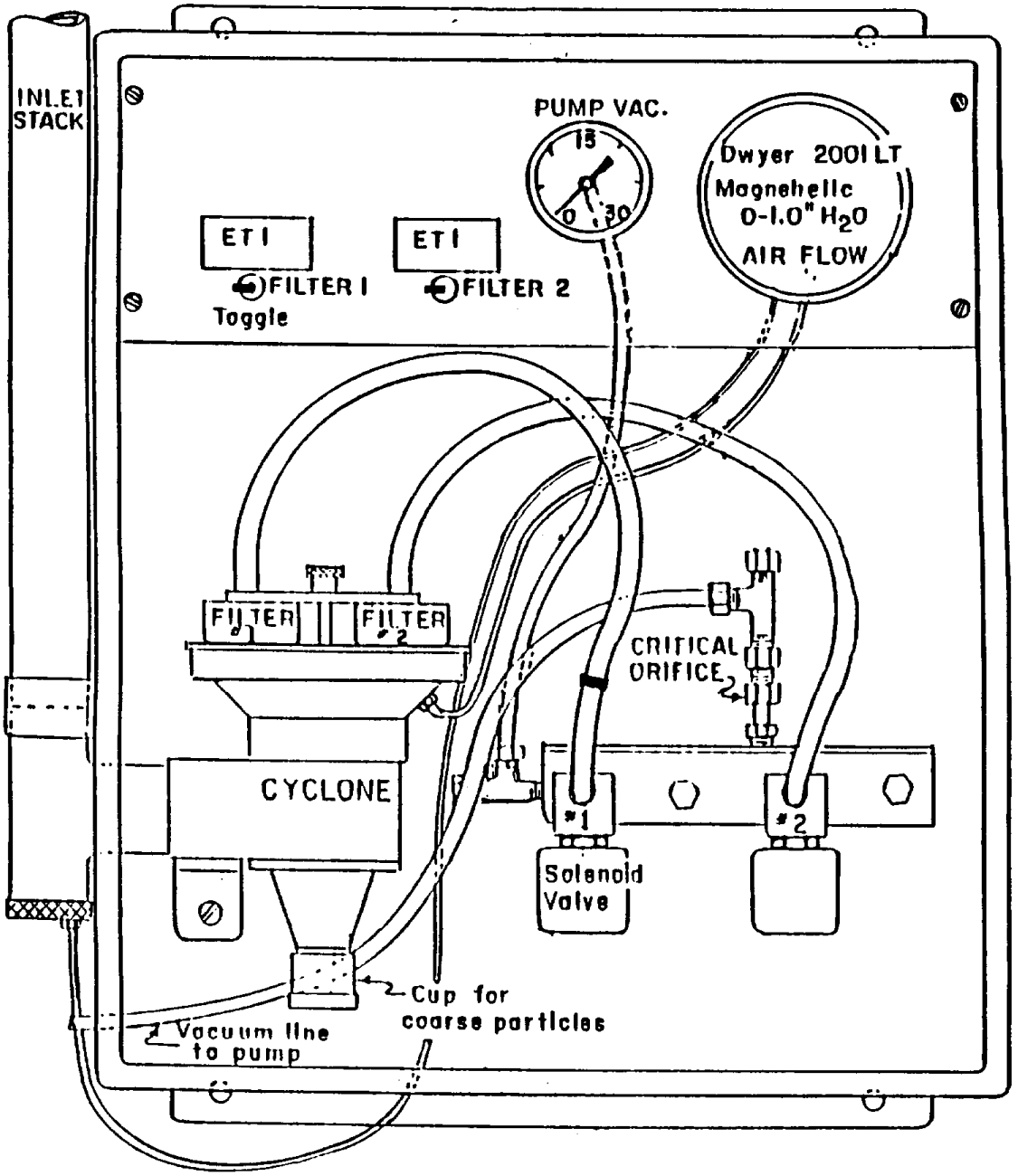


Figure 2. Layout of IMPROVE fine filter module.

a filter sample does not drop by more than 15% from start to end, flow is relatively constant and linear so the sample volume can be accurately calculated. In SCAQS, if the measured flowrate of a filter sample decreased by 15% or more, the sample's volume and all its subsequent analyses were considered invalid.

Teflon Filters

The 25mm stretched teflon (3μm pore size) filters were transported to and from SCAQS sites by car or plane in petri dishes. All filter handling and on-site sample changes were done by trained U.C. Davis personnel. Under ambient room conditions, pre-weighed and pre-lasered filters were loaded into Gelman, 25mm filter cassettes, while exposed filters were unloaded from their cassettes and put back into their respective petri dishes. During June, July, and August, the deposit area of the teflon filters was reduced from 3.8cm^2 to 1.1cm^2 by placing a mask behind the filters. This decreased the area of deposit on the filter which in turn increased the sensitivity of the elemental analyses by increasing the loading upon the analyzed deposit area. Unfortunately, incipient filter clogging at the Claremont and Rubidoux sites eliminated filter masking in September and in all fall sampling periods.

Sample Changes

On SCAQS intensive sampling days, on-site filter changes were performed once or twice a day. Clean filters (in cassettes) were installed onto IMPROVE cyclones with an electronic clock controller switching flow to the next filter (using solenoid valves). Ending and beginning flowrate readings (magnehelic and vacuum gauges) were recorded for filters being removed and for filters being inserted into IMPROVE modules during each sample change. Flow readings were taken by manually opening flow through a filter (usually about 5 seconds).

Field Blanks

Ten percent of the IMPROVE teflon filter samples were field blanks. Field blanks underwent the same protocols as actual samples with the exception that there was no flow through the field blanks. For mass, field blank averages and uncertainties were calulated with site and season taken into consideration. Average field blank masses were subtracted from all SCAQS masses. Field blanks were also analyzed by PIXE with no significant elemental concentrations found.

DRUM SAMPLES IN SCAQS

The Davis Rotating-drum Unit Monitoring (DRUM) sampler (Cahill et al., 1987e) is the product of combining two well-tested techniques (the single orifice multi-stage impactor of the Battele design and the rotating drum collection concept of the Lundgren design) into a single, well-engineered package. The unit, shown in Figure 3, consists of 8 sequential orifices impacting on 8 slowly rotating drums, plus an afterfilter. The unit impacts aerosols onto Mylar strips (lightly coated with Apiezen-L grease to eliminate bounce-off) mounted on rotating drums. After sampling, this results in 8 mylar strips with linear streaks of size-resolved aerosol deposits that are analyzed by PIXE.

For SCAQS, the drums with their grease-coated Mylar strips rotated continuously at the rate of 2mm every 4 hours for up to 2 weeks. At the end of 2 weeks of sampling, the drums were changed and the process repeated. The DRUM samplers ran at 1.1 lpm using GAST diaphragm pumps. The units included battery back-ups on their motor drives so that the drums rotated at all times, even during power failures. This was essential in keeping track of the times that sampling occurred. Nine DRUM units exist, all fully tested and equivalent, four of which operated at 4 different sites during SCAQS.

The DRUM has been exhaustively tested at Davis in laboratory and field conditions (Raabe, 1983; Cahill, 1984e), as well as at the Desert Research Institute (Reno, Nevada) and at the Carbon Species Methods Comparison Study (CSMCS), 1986 (Cahill et al., 1988a). The DRUM is especially designed for visibility studies with 5 cut points below 2.5μm. Table 1 contains the calculated and measured logarithmic size cuts for the DRUM. Bounce-off is less than 1 part in 5,000 (by mass for stages 2 to 6), despite particulate loadings that severly violated our monolayer criterion. Laboratory experiment results for all stages and particles down to 0.0669μm, are shown in Figure 4. Figure 5 shows side by side tests at Davis in severe conditions (T = 42°C, RH = 16%) which illustrate the size distribution for each chemical species. Note the double potassium peaks for smoke at 0.3μm and soils at > 8μm. The error flags represent the standard deviation of all 4 units, including sampling and elemental analysis variability. To our knowledge, such a test has never been done and published for any other multistage sampler.

From the DRUM, size segregated sampling and elemental analysis, major increases in our understanding of atmospheric aerosols and visibility have resulted. Most importantly, the strong association of visibility degradation with increased sulfur concentrations in the optically important size region from 0.34 to 2.12μm.

Flowrates and Volume

Flowrates for the DRUMs were set at 1.1 liters per minute and the flowrates, vacuums, and drum rotations were checked daily. Flow was measured using two independent methods. A minihelic pressure gauge measured the pressure drop at the 6th stage of the DRUM, while vacuum at the 8th stage was checked for critical flow. Both measurements allowed calculations of flow based upon their logarithmic relationships with flow.

Figure 3. Schematic illustration of the Davis Rotating-drum Unit for Monitoring (DRUM) impactor.

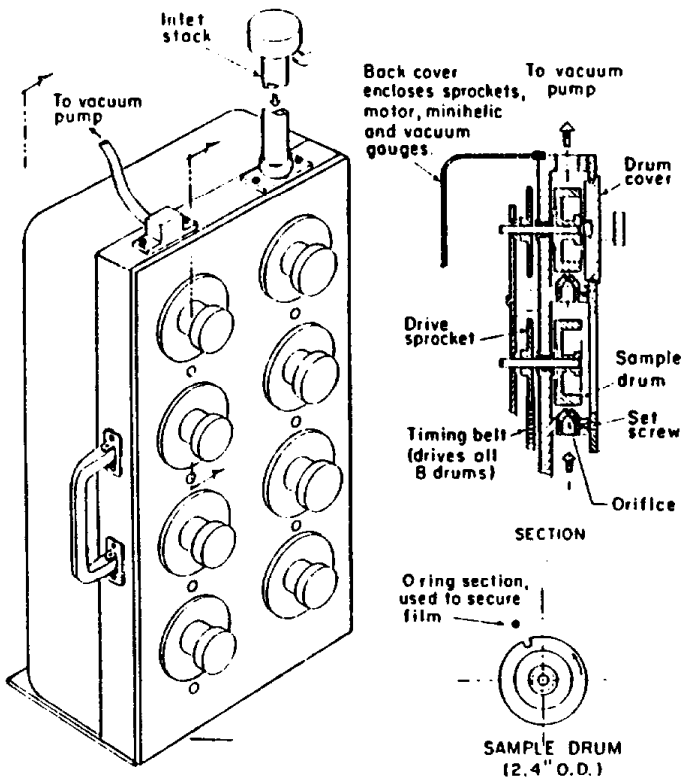


Table 1. DRUM impactor design criteria.

Impactor Stage No.	Jet W (cm)	S/W	T/W	Inlet pressure (kPa)	Outlet Re	Outlet u_o (m s^{-1})	Mach No.	Cut-off diam. ECD_{ar} (μm)	Cut-off diam. ECD_{ae} (μm)
1	0.373	0.5	2.0	101.3	407	1.7	0.00	8.62	8.54
2	0.236	1.0	1.1	101.3	642	4.2	0.01	4.34	4.26
3	0.150	1.0	1.4	101.3	1010	10.4	0.03	2.20	2.12
4	0.102	2.0	1.9	101.2	1500	22.6	0.07	1.23	1.15
5	0.066	3.0	2.5	100.7	2310	54.7	0.16	0.63	0.56
6	0.051	3.0	2.6	97.9	3050	97.8	0.29	0.41	0.34
7	0.046	3.0	2.8	90.1	3490	139.0	0.41	0.33	0.24
8	0.041	3.0	3.0	74.3	4510	315.0	1.00	0.19	0.069
9	Filter			< 39.2				0	0

Sampling rate = 18.3 cm^3 s^{-1}; conditions: 101.3 kPa at 23 C.

ECD_{ae} Effective cut-off aerodynamic equivalent diameter for impaction stage
ECD_{ar} Effective cut-off aerodynamic resistance diameter for impaction stage
Re Air flow Reynold's number at impactor orifice outlet ($\rho wu/\eta$)
S Distance from impactor orifice outlet to collection surface
T Impactor orifice throat length
W Diameter of circular orifice of an impactor stage

Figure 4. Summary of experimental results from DRUM impactor showing data values and curve approximating the nondimensionalized collection as a function of the square root of particle Stokes number (STK) for the corresonding impactor stages.

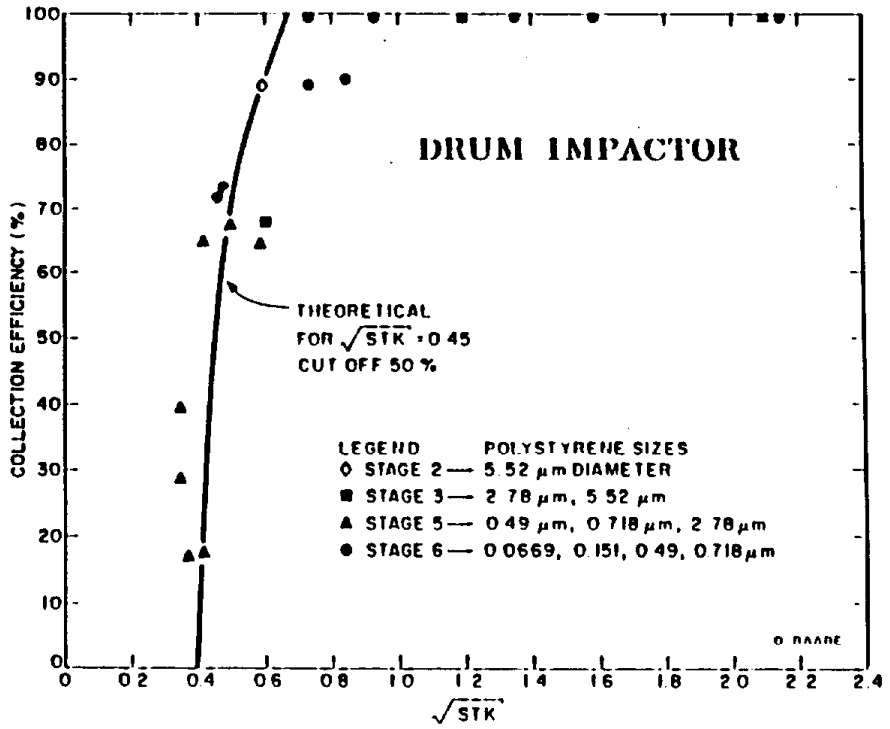
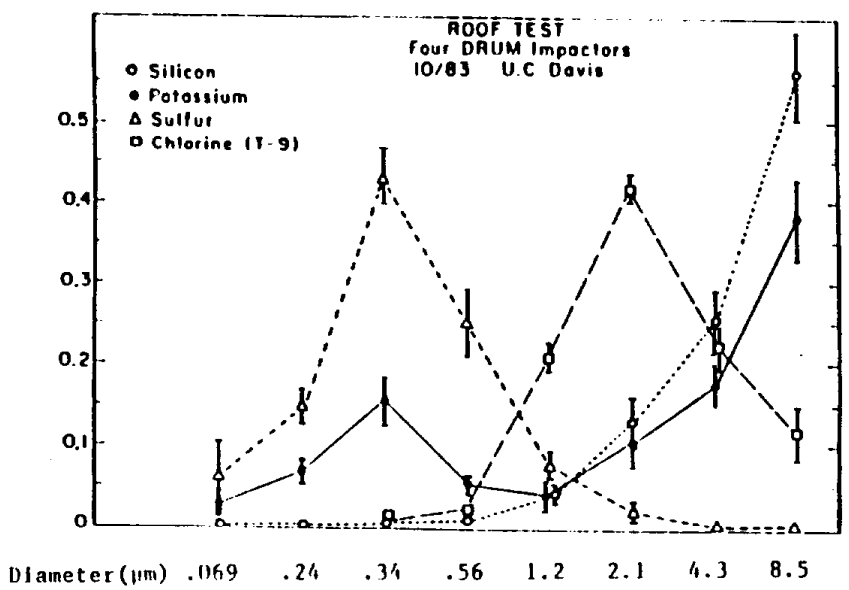


Figure 5. Comparison test of four DRUM samplers; the uncertainties represent the standard deviations of the four units for the relative amount seen on each stage for each element.



Flow calibration was done by U.C. Davis personnel with a calibrated magnehelic gauge (calibrated to a spirometer in Davis). SCAQS flow audits of the DRUM samplers were in good agreement with U.C. Davis measurements (within +/-5%). Flow is extremely consistent for the DRUM samplers and readings rarely differed from their original flow settings. Volume for each 4 hour DRUM sample was calculated by multiplying the exposure time of 4 hours by the average of the daily flowrates of a DRUM over a Mylar strip's entire exposure time (i.e. 2 weeks).

Mylar Strips

Clean Mylar strips were prepared at U.C. Davis using 1/8 mil Mylar ($432\mu g/cm^2$). The strips were coated with Apiezon-L grease to minimize bounce-off of particles (1 in 5000 by mass). Light even-coating was accomplished by dipping the Mylar strips (mounted on drums) into a 2% solution of grease dissolved in toluene. Drums rotated 2mm every 4 hours and a set of eight drums (grease-coated strips) were replaced every 2 weeks of exposure for each DRUM sampler. To assure that the drums rotated at all times, even during power failures, battery backup units were used in SCAQS; this ensured that all sample periods on a strip could be identified. After sampling, the drums were brought back to Davis. Upon removal from the drums, the Mylar strips were mounted onto identical plastic frames with the use of a scale. From the beginning and ending times of exposure, 4 hour sample periods were matched to their corresponding 2mm streak of aerosol deposit left on the exposed Mylar strip. The strips were carefully mounted so that the positioning of the sample deposits correctly matched the known sampling periods and durations.

Afterfilters

DRUM afterfilters collected the ultra-fine aerosols (below $0.069\mu m$) that have not impacted onto any of the eight DRUM stages and have negligible mass and optical absorptions which were not measured. Afterfilters had 12 hour sample durations and consisted of 25mm stretched teflon filters which were loaded into filter cassettes under room conditions at SCAQS. The filter cassettes held two filters, the afterfilter plus a second filter which protected the afterfilter from backflow and contamination. Daily, two afterfilter cassettes were installed onto the DRUMs. After 12 hours of exposure, a clock timer and solenoid valve switched flow from one afterfilter to another. Upon removal, afterfilters were put into petri dishes and transported back to Davis for elemental analysis by PIXE. Protocols for PIXE analysis of the afterfilters were the same as for the teflon filters used by the IMPROVE samplers.

Field Blanks

For SCAQS, no specially prepared Mylar strip field blanks were required because there are already blank areas at the ends of Mylar strips even after 2 weeks of exposure. These blank areas were analyzed by PIXE and showed no significant elemental concentrations. In fact, they were clean enough to use for blank subtraction in PIXE.

Afterfilter field blanks accounted for 5% of all DRUM afterfilters. The field blanks were transported, handled, and exposed just as the other afterfilters, except there was no actual flow through the field blanks. Just as with our

other types of field blanks, PIXE analysis showed no significant elemental concentrations.

ANALYSIS TECHNIQUES OF FILTERS

One of the most important goals for air quality studies involving atmospheric aerosols is the resolution of particulate matter into its chemical constituents. In this regard, SCAQS was no exception. However, unlike the majority of air quality studies, SCAQS included a very wide variety of elemental and chemical measurements. Measurements were based upon a variety of sample collection methodologies designed to directly establish the chemical constituents of the complex Southern California aerosol. Most studies can not mount such an intensive effort and must rely upon less intensive sample collection and analytical procedures, particularly if measurements are scheduled over an extended period of time at multiple sampling sites.

At U.C. Davis, we have been developing techniques designed to achieve reasonably complete resolution of atmospheric aerosols into their constituents based upon repeated non-destructive analyses of single teflon filters. These techniques include:

1. Gravimetric Mass (Engelbrecht et al., 1980; Cahill et al., 1984a)

2. Optical absorption measured by a Laser Integrating Plate/Integrating Sphere Method (LIPM) (Cahill et al., 1984a; Campbell et al., 1989)

3. Proton Induced X-ray Emission (PIXE) (Cahill et al., 1984a) for the elements sodium through lead (Na to Pb)

4. Forward Alpha Scattering Techniques (FAST) (Kusko et al., 1988) for the very light elements, hydrogen through fluorine

5. Proton Elastic Scattering Analysis (PESA) (Cahill et al., 1989a; Cahill et al., 1987a) which measures hydrogen

By the analysis of all elements from hydrogen through lead (total elemental analysis), the sum of the elements can then be directly compared to total gravimetric mass. Clearly, total elemental analysis (plus mass and optical absorption) on a single filter reduces the cost and effort of sample collection. It can also reduce analytical costs if one is attempting a complete resolution of particulate mass into major, minor, and trace constituents. But there are other advantages that should be useful even to a program as complete and intensive as SCAQS. First, all measurements are made from the same filter, avoiding a number of sampling problems and offering a very direct way to find the components of mass from the same filter which was measured gravimetrically . Second, the filter chosen is a relatively artifact-free stretched teflon filter, with a very low internal surface area. Both of these factors tend to minimize diffusion-based gas-to-particle conversion in the filter. Third, since the measurements are non-destructive, we can do as many or as few of the analyses as the program demands, allowing us to perform "ex-post-facto" experiments months or years in the future as interest warrants.

The disadvantages of the approach are also numerous. Measurements are made in vacuum, so that some volatiles are lost before analysis can take place. The measurements give only the elements involved, so that the chemical form must be "guessed" within the constraints of the elemental mass balance. Finally, the last measurement, FAST, tends to damage the delicate stretched teflon fibers, making them brittle. However, repeated measurements can and have been done on teflon filters after FAST analyses without statistically significant changes in results.

For SCAQS, analysis of IMPROVE filters were performed by a variety of techniques designed to obtain as much compositional information from a single teflon filter as possible. Descriptions of these techniques follow:

Gravimetric Mass

All gravimetric analyses of teflon filters were done at U.C. Davis using a Cahn 31 micro-electrobalance under laboratory conditions. For SCAQS, typical IMPROVE network protocols were used with small variations (e.g. transport) and were followed for maximum accuracy of lightly loaded samples. Filters were pre- and post-weighed (before and after sampling) with mass concentrations determined from a filter's mass difference (uncorrected sample mass) and appropriate field blank corrections. Following formal U.C. Davis protocols (Engelbrect et al., 1980; Cahill et al., 1984a), the gravimetric analysis of IMPROVE teflon filters yielded mass precisions of better than +/- 1 $\mu g/m^3$ under SCAQS conditions.

Field blank corrections for mass were made by site and season. Field blank corrections and their uncertainties were as follows:

Long Beach and Rubidoux - Summer	:	FB = 20 +/- 5μg
Claremont - Summer	:	FB = 5 +/- 6μg
Long Beach and Los Angeles - Fall	:	FB = 5 +/- 6μg

Mass uncertainties were based on uncertainties of the gravimetric analysis, field blank corrections and sample volume:

$$\text{mass uncertainty}^2 = (\sigma^2_{grav} + \sigma^2_{blank})/\text{sample mass}^2 + (\sigma^2_{vol}/\text{volume}^2)$$

σ_{grav} = 1 standard deviation of gravimetric analysis, +/- 5μg
σ_{blank} = 1 standard deviation of field blank mass, +/- 5 or 6μg
σ_{vol} = 1 standard deviation of volume, 3% of volume

Minimum detectable limits (MDLs) for mass for were based upon the minimum mass that was considered detectable (10μg) by the electrobalance. The MDLs for mass were averaged for SCAQS and were reported as 2.00$\mu g/m^3$ for all IMPROVE filters.

Optical Absorption

Optical absorption was determined for all filters using the laser integrating plate method (LIPM) (Cahill et al., 1984a; Campbell et al., 1989). The LIPM system has been calibrated to a 4-pi radiometer using NBS traceable reflection standards (Cahill, private communication) which verified that decreases in the

LIPM measurements are due only to light absorption by particles. By this technique, instrumental factors in the measurement can be ascertained and highly precise results, generally better than +/- 1% are obtained.

A series of standards are run at the beginning of each set of measurements to monitor the system calibration. At U.C. Davis, the LIPM system uses a 633 nm wavelength He(Ne) laser. The light is diffused and collimated to produce a uniform beam that is about 0.60 cm^2 at the sample. LIPM measures the ratio of transmittance through teflon filters before and after sampling (I_o and I respectively). The measured coefficient of optical absorption is:

$$b_{abs}(\text{measured}) = (\text{area of deposit/volume of sample}) * \ln(I/I_o)$$

Particle loading effects are somewhat troublesome since the monolayer criterion desirable for the optical measurements conflicts with the loading criterion for best compositional sensitivity. Aerosol loadings were adjusted after the June/July SCAQS episodes allowing optical absorption corrections as validated against the results of the 1986 Carbon Species Methods Comparison Study in Glendora, Ca. (Cahill et al., 1987b). The need to correct the optical absorption meaurements arises because densely-packed multiple layers of absorbing particles deposited on the filters are believed to shadow one another reducing the effective absorption coefficient (i.e. 2 filters having identical samples, mass and composition, but with different deposit areal densities, will have different measured absorption coefficients). No way of measuring the relationship between absorption and density of aerosol samples exists. This relationship is dependent on aerosol composition so a semi-empirical relationship formula was used to correct the LIPM measurements (Campbell et al., 1989):

$$b_{abs}(\text{true}) = b_{abs}(\text{measured})/[ke^{\rho t/A} + (1-k)e^{-\rho t/B}]$$

where k = 0.36, A = .22, B = 415 and ρt is the mass per unit area
this equation was based on past filter measurements taken
at Davis, Ca., 1989 and CSMCS, 1986

Uncertainties in optical absorption were calculated (summed quadratically) using the uncertainties from the LIPM measurement, the optical absorption correction formula, and the sample volume (3%):

$$\sigma^2_{LIPM} = (4/\ln(I_o/I))^2 * (1/I_o^2 + 1/I^2)$$

$$\sigma_{correction} = 0.1 * ((1-RAT)/RAT)$$
$$\text{where } RAT = [ke^{\rho t/A} + (1-k)e^{-\rho t/B}]$$

For SCAQS, absorption coefficients were all much greater than minimum detectable limits (MDLs) so an average MDL of 100 x 10^{-8} inverse meters was reported for all SCAQS IMPROVE filters. Optical absorption MDLs are based upon the assumption that the post-collection LIPM measurement must be one standard deviation less than the pre-collection measurement. The minimum coefficient of absorption used was:

$$b_{min} = (\text{area/volume}) * (0.01*I_o)$$

where 0.01 is the standard deviation in the intensity
and I_o is the intensity before sampling.

Since carbon soot usually dominates absorption, the LIPM measurement is also referred to as a measure of carbon soot. The actual relationship between soot mass and optical absorption can vary by as much as a factor of 4 depending on the soot (Cahill et al., 1984a). For SCAQS, our optical absorption measurements were in units of inverse meters which can be converted to carbon soot using a typical soot absorption efficiency of $10m^2/g$.

Hydrogen

Hydrogen was measured by two separate techniques. The first, Proton Elastic Scattering Analysis (PESA) (Cahill et al., 1989a; Cahill et al., 1987a) was simultaneously performed with Proton Induced X-ray Emission (PIXE). Hydrogen was also measured during the Forward Alpha Scattering Techniques (FAST) (Kusko et al., 1988) analyses for very light elements, giving two separate and independent measurements of hydrogen. Unfortunately, quality assurance comparisons with FAST measurements showed that the PESA system was not working correctly during the analysis of SCAQS IMPROVE filters (PESA protocols are not described in this report). No valid hydrogen values were available from PESA but fortunately there were hydrogen values from FAST. With hydrogen from either FAST or PESA, it is hard to overemphasize the quality assurance benefits from the analysis of hydrogen in SCAQS because of the extremely high correlations between hydrogen and gravimetric mass.

Particle Induced X-ray Emission (PIXE)

The U.C. Davis PIXE system measured the elements sodium through lead with a recently modified setup (Figure 6) resulting in better sensitivities through the addition of a second x-ray detector (Cahill et al., 1987c). The first detector, PIXE 1, detects the x-rays from elements sodium through manganese, as well as some heavier elements at lower sensitivities. The second detector, PIXE 2, is more heavily filtered to detect elements from about iron through lead at high sensitivity. Iron, seen well by both detectors, is routinely used for quality assurance purposes. PIXE and its protocols are described in section ELEMENTAL ANALYSIS: PIXE.

Forward Alpha Scattering Techniques (FAST)

The light elements from H to F were determined by FAST (Kusko et al., 1988) measurements based on the scattering of 30 MeV alpha particles into two detectors: a low angle detector at 62 degrees and a high angle detector at 74 degrees (Figure 6). Both measure carbon, but only the low angle detector sees hydrogen while the high angle detector has the better sensitivity for nitrogen and oxygen. Protocols and decriptions of FAST are described in section LIGHT ELEMENT ANALYSIS OF FILTERS: FAST.

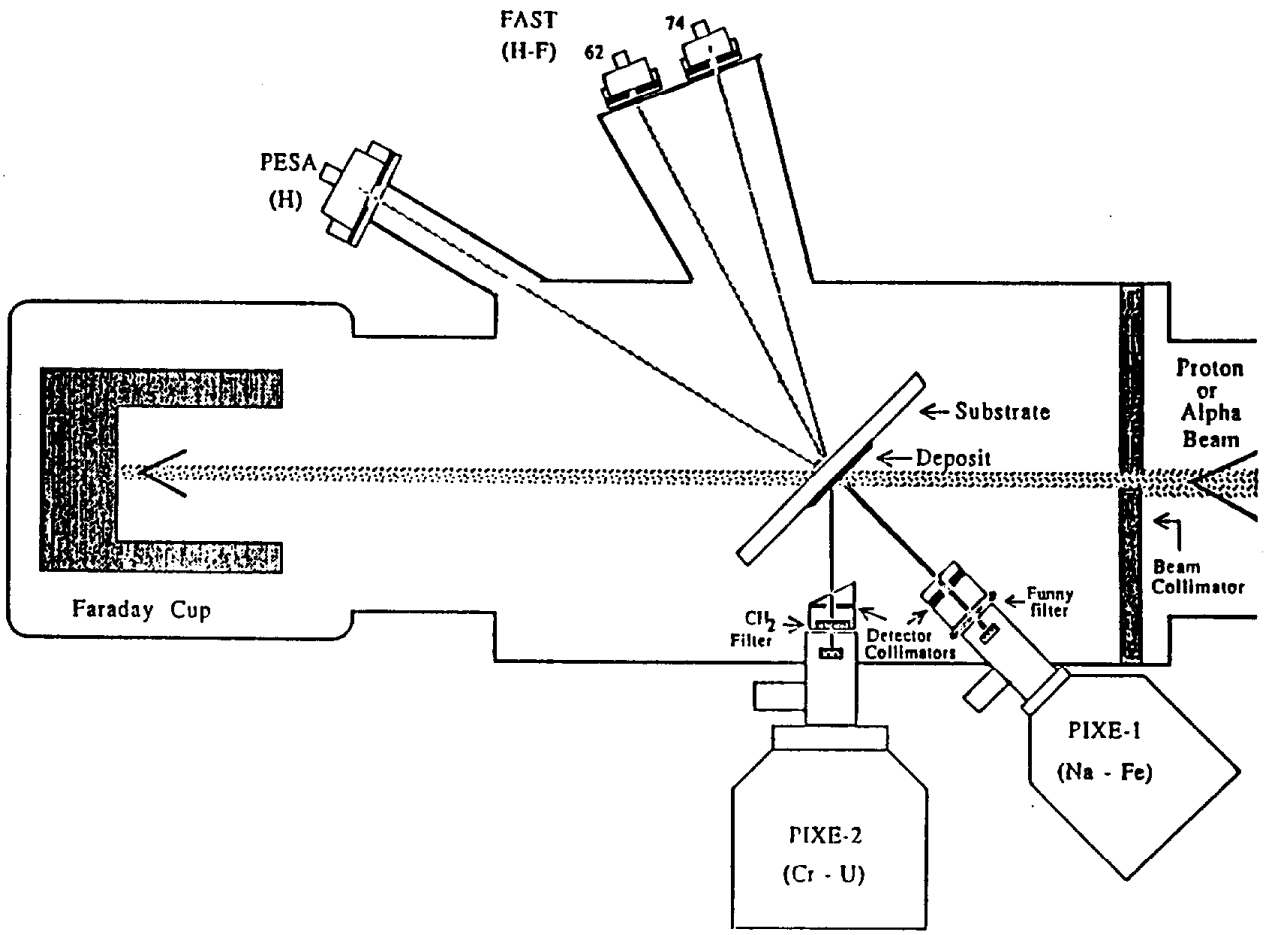


Figure 6. Beam line and target chamber showing detector placement for PIXE, PESA, and FAST.

ELEMENTAL ANALYSIS: PIXE

Particle Induced X-ray Emission (PIXE) (Cahill et al., 1984a; Cahill et al., 1987c) analysis of IMPROVE filters and DRUM samples (afterfilters and Mylar strips) measured the elements from sodium to lead for all SCAQS samples. This x-ray spectroscopy method uses a 4.5 MeV proton beam from the cyclotron at Crocker Nuclear Lab, U.C. Davis. Aerosol samples excited by the beam produce x-rays, whose energies are dependent upon the elements in the sample. The x-rays are measured using a multiple detector system. The first detector is optimized for the lighter elements from Na and heavier, while the other more heavily filtered detector measures elements from Fe and heavier. Thus, the detectors overlap near Fe in the elements they analyze and allow quality assurance comparisons between the two detectors. The data from both Si (Li) detectors is acquired and processed using a ND65 channel analyzer and a PDP 11/44 computer. The x-ray spectra are analyzed for elemental concentrations by an automated program specially designed for aerosol samples. PIXE is a rapid, non-destructive analysis that allows samples to be further analyzed and allows a concurrent hydrogen measurement by PESA (Proton Elastic Scattering Analysis).

Calibration

System calibration consists of around 30 elemental foils supplied by a commercial vendor that are used to calculate the system's x-ray production cross sections. Then, at the beginning of every analytical session, the system calibration of each detector is checked with a smaller series (about 20) of elemental foils. A renormalization of the system calibration is then calculated based upon these foils and is used for the remainder of the analysis session. The renormalization is due to differences in the proton beam, physical setup, etc. and is usually fairly small. The consistency between analysis sessions is checked by reanalyzing samples from previous sessions. At the end of a session, a few elemental foils are again used to check the calibration of the current analytical session.

Background Determination

Background of the spectral peaks arises from the 4.5 MeV proton beam interacting with the sample substrate (teflon filters or Mylar strips) and also the sample itself. The resulting smooth spectrum of background x-rays is produced from either the deceleration of electrons (bremsstrahlung) or from gamma rays. Background subtraction is done by an automated program in two parts. Initially, the background is estimated using the spectrum from a clean blank which removes most of the background. The remaining background is then mathematically removed.

Matrix Corrections

Matrix corrections are made to compensate for the absorption of x-rays by the material in the sample deposit. Absorption depends upon the composition of the deposit, the path length through the deposit, and the x-ray energies. Particle size corrections for given x-rays are used and depend on the size of

the particle from which the x-ray is emitted (e.g. PM2.5, PM10). A loading correction is also used to compensate for absorption by a particle lying over another particle containing an atom emitting an x-ray.

Minimum Detectable Limits

The calculated minimum detectable limits (MDLs) assume that a minimum number of x-ray counts is required for detection. This minimum number equals 3.29 times the square root of the background counts under the elemental peak being detected. Minimum detectable limits for all analyses are calculated in ng/m^3 and monitored.

Uncertainties

The uncertainties in PIXE analyses come from statistical and non-statistical sources which are summed together. The statistical uncertainty is based on the number of counts in a spectral peak:

Fractional uncertainty = 1 / (number of counts in peak)**0.5

The nonstatistical 5% uncertainty is due to calibration uncertainties of the analysis system (calibration standards, beam monitoring, etc.) and volume uncertainties from sample collection.

PIXE Analysis of IMPROVE Filters and DRUM Afterfilters

All of the SCAQS IMPROVE filters and DRUM afterfilters were analyzed during the same analysis session. Calibration protocols, as described previously, were followed with elemental foils analyzed at the beginning and end of the analysis session, as well as actual samples from previous sessions. For background subtraction, a clean 25mm teflon filter was used to estimate the background due to the teflon substrate in actual samples. The samples were irradiated for 100 seconds and analyzed for the elements from Na to Pb, most with minimum detectable limits of a few ng/m^3. For the relatively clean afterfilters, the elements reported to the SCAQS data base consisted of 6 elements (S, Cl, K, Ca, Fe, Zn) while 17 PIXE elements were reported for the IMPROVE filters (Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Pb, Se, and Br). Typical, not necessarily the best, minimum detectable limits of the reported elements for IMPROVE filters in SCAQS are shown in Figure 7.

PIXE Analysis of DRUM Samples

Prior to PIXE analysis, exposed Mylar strips with their narrow, linear streaks of aerosol deposits are mounted onto plastic frames for analysis. This is done using a scale in order that the streak of aerosol deposit on each strip be centered crosswise on the frame and so that each 2mm of deposit and its 4 hour sample period is accurately known by its lengthwise or lateral position in the frame. For PIXE, positioning of the strip relative to the proton beam is crucial for accurate time resolution of each 2mm streak of sample deposit. The beam is collimated laterally to a width of 2mm to match the deposit area from 4 hours of sampling by the DRUMs. The height of the beam is 3mm giving 4.2mm across the strip (strip is at 45 degrees) which covers all of the 2mm

Figure 7. Typical mimimum detectable limits (MDLs) for IMPROVE filters in SCAQS.

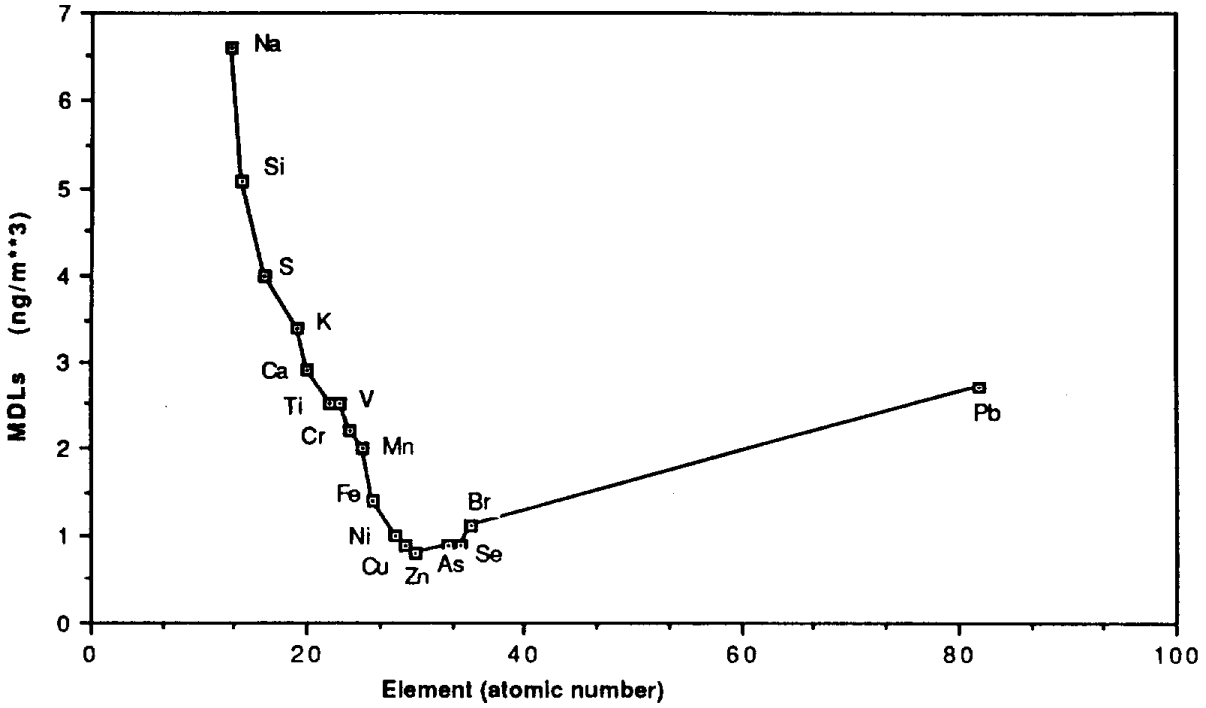
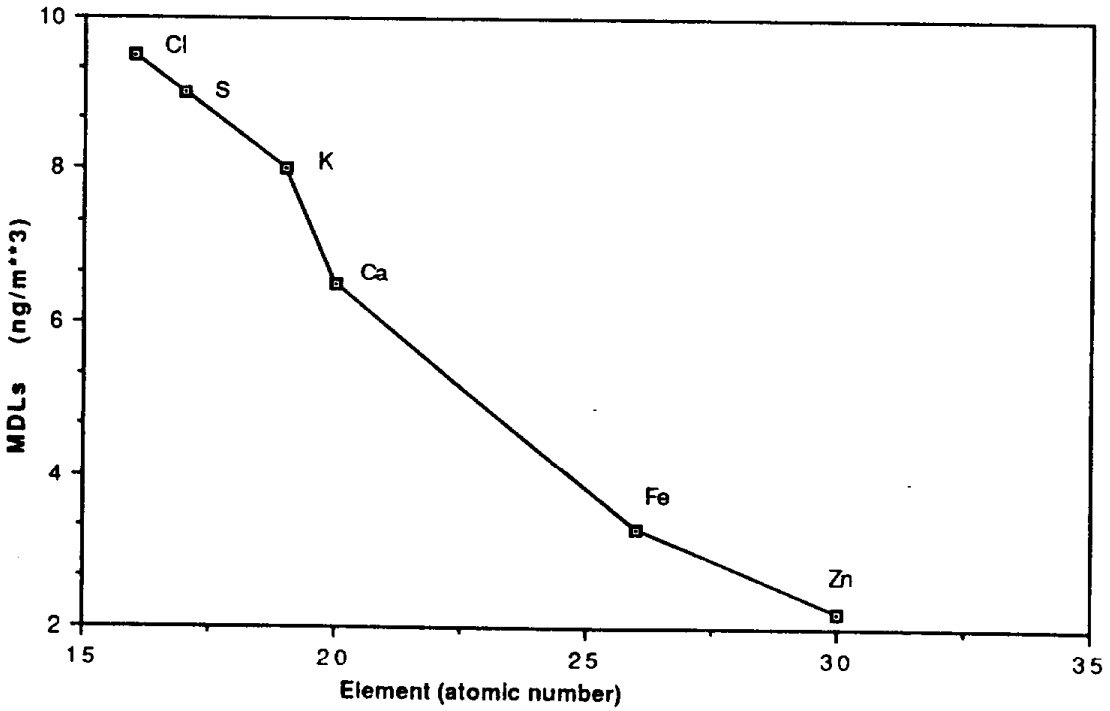


Figure 8. Typical mimimum detectable limits (MDLs) for DRUM samples in SCAQS.



wide deposit area (Cahill et al., 1984e). A stepping gear moves the strip frame laterally across the beamline in 2mm increments. The following system checks are done prior to the analysis of actual DRUM samples:

A. At the beginning of each DRUM sample analysis session, various positions along the Mylar strip and its frame are calibrated. This is done using blue "burn" paper with 84 marked 2mm positions corresponding with those of the scale used to mount the Mylar strips onto their plastic frames. The blue paper, mounted onto a regular plastic frame, is placed into the beamline. The beam "burns" a yellow spot onto the paper so the position of the frame and strip relative to the beam is known. Lateral beam positioning adjustments are made as necessary by adjusting the location of a 2mm wide beam collimator. This process is repeated until the 2mm wide beam area is centered onto the correct 2mm positions of the burn paper and Mylar strips.

B. Analyses of a copper wire check that both detectors are "seeing" the same position. The copper wire is mounted in a frame (sometimes intenionally off-center and only partially in the beamline). As the beam sweeps across the wire in 2mm increments, the copper analyses from both detectors should have a constant ratio along the wire if they are correctly "seeing" (detecting) x-rays from the same 2mm wide analysis area.

C. Calibration is done with elemental foils cut into 4mm or 6mm strips and positioned into a regular frame. This allows additional beam alignment checks as well as checking the system calibration. As the strip standards are incremented across the beam, the analyses are compared to their known elemental quantities and positions. Renormalization of the system calibration and beam alignment adjustments are done as necessary. Just as for the filters, a sample (strip) from a previous analytical session is reanalyzed to check for consistency between analysis sessions. The elemental foils are again analyzed at the end of each session to recheck calibration and beam alignment.

The above procedures were done for each of the 3 analysis sessions in which all SCAQS DRUM samples were analyzed. One SCAQS strip was analyzed during all 3 analysis sessions to check the precision among the 3 sessions. The strips from stages 1 to 3 of the DRUM were irradiated for 30 seconds while the strips from stages 4 to 8 were irradiated for 60 or 80 seconds for better sensitivities. Field blank areas of exposed Mylar strips from actual DRUM samples were clean enough to use for background subtraction of the Mylar substrate in PIXE. For DRUM samples in SCAQS, the elements S, Cl, K, Ca, Fe and Zn were reported to the SCAQS database. Typical minimum detectable limits for the DRUM samples in SCAQS are shown in Figure 8.

LIGHT ELEMENT ANALYSIS OF FILTERS: FAST

The analysis of IMPROVE teflon filters for the very light elements (hydrogen, carbon, oxygen, and nitrogen) was done using Forward Alpha Scattering Techniques (FAST) (Kusko et al., 1988; Cahill et al., 1984a). FAST measures the light elements that are very difficult to measure using PIXE and X-Ray Fluorescence (XRF) methods. With these two x-ray methods, the low energy x-rays emitted by the light elements are attenuated before they can be measured. Instead of using x-rays, FAST measures alpha particles elastically scattered forward by the target sample, as well as energies emitted from inelastic collisions. The measured energies of the scattered alpha particles are dependent upon the mass of the recoil target nucleus that scattered the alpha particles. The energies of the elastic peaks from the resulting cross section identify the light elements in the sample, while the number of particle counts in the peaks are proportional to the elemental amounts. FAST analysis also contains inelastic peaks due to energies given off when target nuclei are put into excited states. These inelastic peaks identify and measure light elements just as the elastic peaks do. Proton-proton scattering in FAST also allows a measurement of hydrogen. The hydrogen peak in FAST is due to the recoiled target nucleus rather than the scattered incident particle.

For FAST, two solid-state particle detectors are used at different angles for the selected cross sections (Figures 9 and 10). The 62 degree detector measures hydrogen and carbon (elastic) while the 74 degree detector measures oxygen (elastic), nitrogen (elastic), and carbon twice (elastic and inelastic). The total of three separate measurements for carbon are averaged into one carbon value.

FAST analysis of SCAQS IMPROVE filters was done using 30 MeV alpha particles produced by the Crocker Nuclear Lab cyclotron at U.C. Davis. Five minute analyses were done with a similar setup as for PIXE except the two FAST detectors were placed at different predetermined forward angles (Figure 6). Data acquisition was similar to PIXE and a specially designed program for FAST was used to calculate elemental concentrations. From FAST, we were able to account for most of the elemental aerosol mass (over 2/3) that is not normally found by x-ray methods. Besides enhancing the SCAQS data base with light elements (H, C, O, N), FAST provided:

1. An alternative method of measuring carbon without artifact problems (e.g. quartz filters)
2. Two direct comparisons to mass for quality assurance comparisons
   a. Mass vs hydrogen (hydrogen in SCAQS had a very high correlation with mass)
   b. Mass vs total elemental analysis (sum of H to Pb from FAST and PIXE)

Blank Subtraction

The problem with FAST is that one must see the substrate upon which the sample is deposited. Generally, the substrate chosen for sample collection should not contain any material that the sample will be analyzed for. For FAST, the selection of the substrate teflon (CF_2), composed of the light elements carbon

Figure 9. Spectrum from FAST 62 degree detector of a typical aerosol sample.

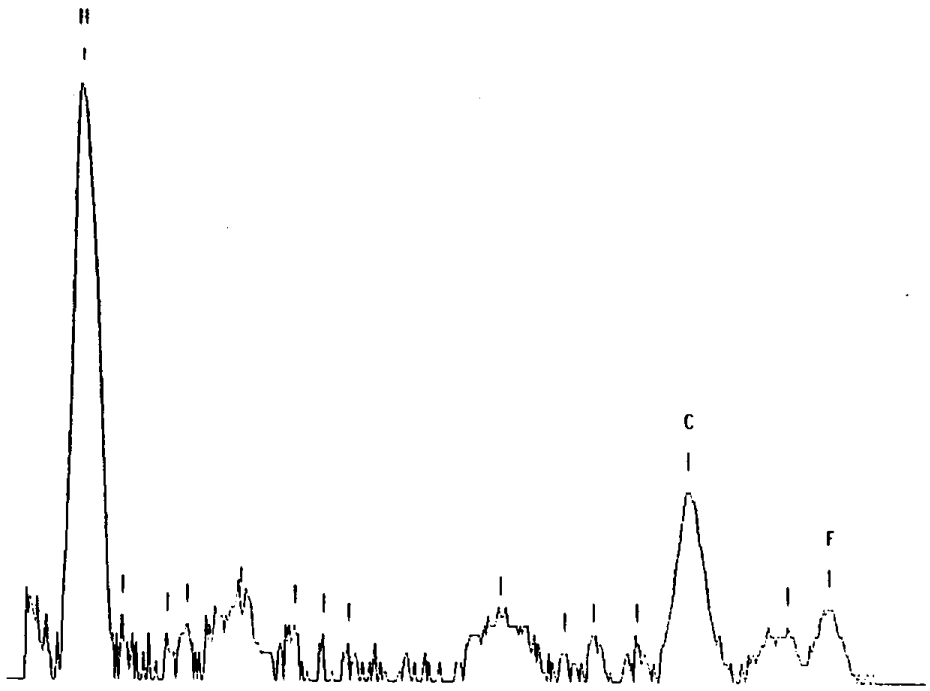
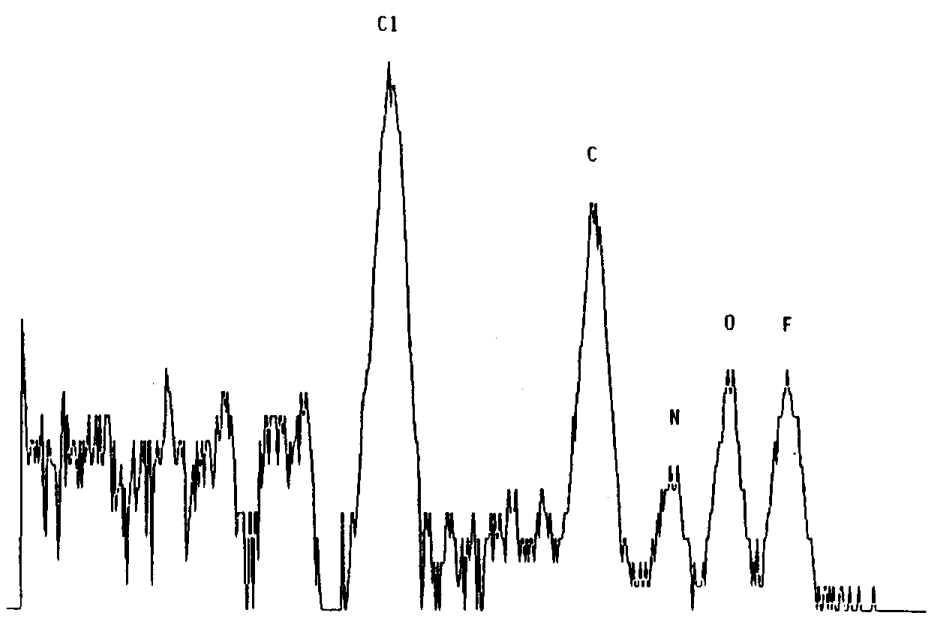


Figure 10. Spectrum from FAST 74 degree detector of a typical aerosol sample.



and fluorine, is actually beneficial to the analysis. The two detectors are suitable placed to optimize analysis capabilities with a teflon substrate in mind.

By using teflon (CF_2) and assuming that fluorine is far less prevalent in aerosols than carbon, one can use the teflon C/F stochiometric ratio to subtract the carbon of the teflon substrate from the analyzed sample. By this we mean, the elastic fluorine peak (labeled "F" in Figures 9 and 10) from an aerosol sample is assumed to be from the teflon substrate only. In each carbon peak, the amount of carbon due from teflon is then estimated by multiplying the fluorine in the elastic peaks by the carbon to fluorine ratios of teflon (calculated from the analysis of teflon blanks). The carbon due from teflon is then subtracted leaving only carbon from the sample. This subtraction is done for each of three carbon measurements which are then averaged into one carbon value. These subtractions are the reason that carbon is the least precise and accurate element. However, there was sufficient carbon in SCAQS aerosols on most days for good sensitivities.

With many interfering peaks due to the inelastic states of fluorine (from teflon filters), the forward angles of the detectors were selected so that the two inelastic fluorine peaks of the 74 degree detector overlapped the elastic peaks for oxygen and nitrogen (F^{II} with N and F^{I} with O). This gives well defined peaks for oxygen and nitrogen which can be easily detected. Blank subtraction for the peaks use the very stable inelastic to elastic fluorine ratios of teflon (F^{II}/F and F^{I}/F calculated from analysis of clean teflon blanks) to determine how much of each peak is due to fluorine in the teflon substrate. This enables reliable nitrogen and oxygen values after blank subtraction.

For the FAST analysis of SCAQS IMPROVE filters, clean teflon blanks were analyzed to establish the average carbon to fluorine ratios for blank subtraction in the 3 carbon measurements. Inelastic to elastic fluorine ratios of teflon were also calculated for the nitrogen and oxygen measurements. All calculated ratios were consistent (+/- 10%) using clean teflon filters that varied in thickness.

Calibration

At the beginning of every FAST analysis session, the system is calibrated with a set of standards of known areal density and elemental composition. Mylar ($C_{10}H_8O_4$) and Kapton ($C_{22}H_{10}N_2O_4$) are used as elemental standards in varying thicknesses (1/16, 1/8, 1/4 mil) and densities. Samples of Mylar plus teflon are also analyzed to check the system calibration and blank subtraction. These samples simulate the analysis of an actual sample deposit on a teflon substrate, with known elemental quantities of C, H, and O. For the SCAQS analysis session, results were within an acceptable percentage of the known amounts.

After the original SCAQS analysis session, it was found that the calibration for nitrogen was done incorrectly. Calibration for nitrogen was therefore partially based upon reanalysis of about 15% of SCAQS IMPROVE filters. Without the proper calibration and also the loss of volatile nitrogen in vacuum during analysis, all nitrogen values were reported as suspect.

Minimum Detectable Limits

Minimum detectable limits (MDLs) from FAST are based upon the requirement of a minimum number of counts. In order for a light element to be considered statistically significant or detectable, the target sample (teflon + aerosol deposit) must have more counts than those due to the teflon substrate only. The difference must be an amount greater than the probable uncertainty in estimating both the substrate and also the deposit itself. The minimum number of counts is then converted to an elemental concentration for a sample's minimum detectable limit.

minimum number of counts = counts from substrate only * (1 + [(uncertainty in substrate)^2 + (uncertainty in sample)^2]**0.5)

Typical minimum detectable limits for SCAQS were as follows:

Element	Scattering Angle	MDL
H	62' elastic-recoil proton	0.05μg/m^3
N	74' elastic (subtraction)	0.30μg/m^3
O	74' elastic (subtraction)	0.30μg/m^3
C	62' elastic	
C	74' elastic	3.0μg/m^3
C	74' inelastic	average of 3 carbon peaks

Uncertainties

Elemental uncertainties include factors from sampling as well as FAST analysis. Analysis uncertainties are caused by factors such as accuracy of standards, system calibration, subtraction of the teflon substrate, peak integration, beam monitoring, current integration, etc. The largest sources of error from FAST are from the following: sample volume, statistical counting in analysis, blank subtraction and system calibration. For SCAQS, these uncertainties were summed together appropriately (analysis errors were added quadratically) and used for the uncertainty calculations of hydrogen, carbon, oxygen and nitrogen.

For SCAQS, carbon was measured three different ways for one averaged carbon value per filter, but its uncertainty was calculated in two different ways. The first used the standard error between the 3 carbon measurements while the second method averaged the uncertainties from each carbon measurement. The lower of the two methods was reported to the SCAQS data base as the uncertainty in the carbon measurements.

RESULTS FROM FINE AEROSOLS IN SCAQS

SCAQS fine (PM2.5) aerosol samples, collected on IMPROVE teflon filters, were separated by site and season into five data sets:

1. Long Beach - Summer
2. Rubidoux - Summer
3. Claremont - Summer
4. Long Beach - Fall
5. Los Angeles - Fall.

The data sets (listed in Appendix A, p.58) are made up of gravimetric mass, optical absorption, and the elements from total elemental analysis (PIXE and FAST), H to Pb.

PIXE

Seventeen elements (Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Pb, Se, and Br) were reported to the SCAQS data set. Some elements from PIXE often found in aerosols were later eliminated from the reported data because of difficulties with analysis (e.g. Na and Mg had background subtraction problems in PIXE) or sampling (e.g. Cl was not found during the summer in most samples). Averages, maximums, ratios, and correlations of the SCAQS PIXE aerosol data were calculated and are discussed.

Figure 11 shows an ordered array of average elemental concentrations for Claremont. Concentrations spanned six orders of magnitude from 2280 ng/m^3 for sulfur to 0.04 ng/m^3 for selenium. Log-transformations of average and maximum elemental concentrations for each site and season were plotted (Figures 12-16) to provide improved definition of elements at low concentrations, some of which are toxic (e.g. arsenic). The relationship between average and maximum concentrations decreases as concentrations decrease, with differences being about a half order of magnitude for high concentrations (e.g. sulfur) and an order of magnitude for low concentrations (e.g. selenium).

Table 2 shows the average elemental concentrations for each site and season. They are ordered from high to low based upon Los Angeles-Fall concentrations. The maximums for each element are underlined and the results are summarized below:

Highest Average Elemental Concentrations of Reported Data

Long Beach - Summer :	S, Ni, Na (not reported)
Claremont - Summer :	
Rubidoux - Summer :	Al, Si, Ca, As, Se
Long Beach - Fall :	K, Ti, V, Mn, Zn, Pb, Br
Los Angeles - Fall :	gravimetric mass, Cr, Fe, Cu

Crustal elements Al, Si, and Ca were highest at Rubidoux-Summer. Elements Ni and V, associated with fuel oil combustion, were highest at Long Beach for the summer and fall sampling periods. Pb and Br, signatures for vehicular traffic, were highest at Long Beach-Fall. Zn, a signature for automobile tire dust, was also highest at Long Beach-Fall. Los Angeles-Fall was second highest for Pb, Br and Zn. Claremont-Summer, which experiences high ozone

concentrations during the summer, was only second highest in S. Cr and Cu, associated with industrial processes, were highest in Los Angeles-Fall.

Table 3 contains the same ordered array of elements as Table 2 and shows the percent contribution of each element to its PIXE sum-of-elements value (Na to Pb). Sulfur contribution to PIXE mass was highest at Long Beach-Summer and lowest at Long Beach-Fall. Na percentage (a signature for marine aerosol) was highest at Long Beach-Summer. The contributions made by the crustal elements Al, Si, and Ca were highest at Rubidoux-Summer and lowest at Long Beach-Summer. Pb, Br and Zn percentages (signatures for vehicular traffic and tire dust) were highest at Long Beach-Fall, followed closely by Los Angeles-Fall.

Figure 17 shows log-transformations of summer and fall maximum elemental concentrations for Long Beach. Summer concentrations were higher for S, Na, Cr, and As while fall concentrations were higher for Fe, Si, Pb, Al, K, Zn, Ca, Br, Mn, Ti, Cu, V, and Se.

Ordered arrays of correlation values between element pairs were prepared for the five sets of sites and seasons (Table 4). The number of element pairs with correlation coefficients > 0.60 was small at Los Angeles-Fall and large at Long Beach-Fall and Rubidoux-Summer. The correlations between Fe and Si, two elements with high concentrations in soil, were 0.98 at Rubidoux, 0.93 at Claremont, 0.83 at Long Beach-Fall, 0.78 at Long Beach-Summer and 0.53 at Los Angeles-Fall. The higher correlations between crustal elements at inland sites of Claremont and Rubidoux and the lower correlations between crustal elements at Los Angeles-Fall (downtown on a roof) should be expected.

Table 5 shows ratios of each element to Fe in soil and ambient air for the 5 sets of sites and seasons. Combining these data can be helpful in estimating the contribution of soil to fine aerosols. The ratio of each element to iron in soil was estimated from a composite soil (Bowen, 1979) and we assumed that the only significant source of Fe was soil. Using these rough estimates and our assumption, Table 5 indicates that the Pb/Fe, Br/Fe, S/Fe, Cu/Fe and Zn/Fe ratios at each site were significantly larger than the ratio in soil. This indicates non-soil sources of Pb, Br, S, Cu, and Zn which we expect. Other ratios of note are Ca/Fe and K/Fe. The Ca/Fe ratios at Los Angeles-Fall and Long Beach-Fall were similar to the soil ratio, yet the Ca/Fe ratio was significantly higher than the soil ratio at Long Beach-Summer, Claremont-Summer and Rubidoux-Summer. The K/Fe ratio at Los Angeles-Fall was similar to the soil ratio while the K/Fe ratio at other locations is higher than the soil ratio indicating non-soil potassium. Information such as this may be helpful in evaluating the contribution of soil elements to ambient aerosol concentrations or to its corollary, the emission of elements into ambient air by non-soil sources.

Figure 11. Average Elemental Values, Claremont-Summer (units in ng/m^3).

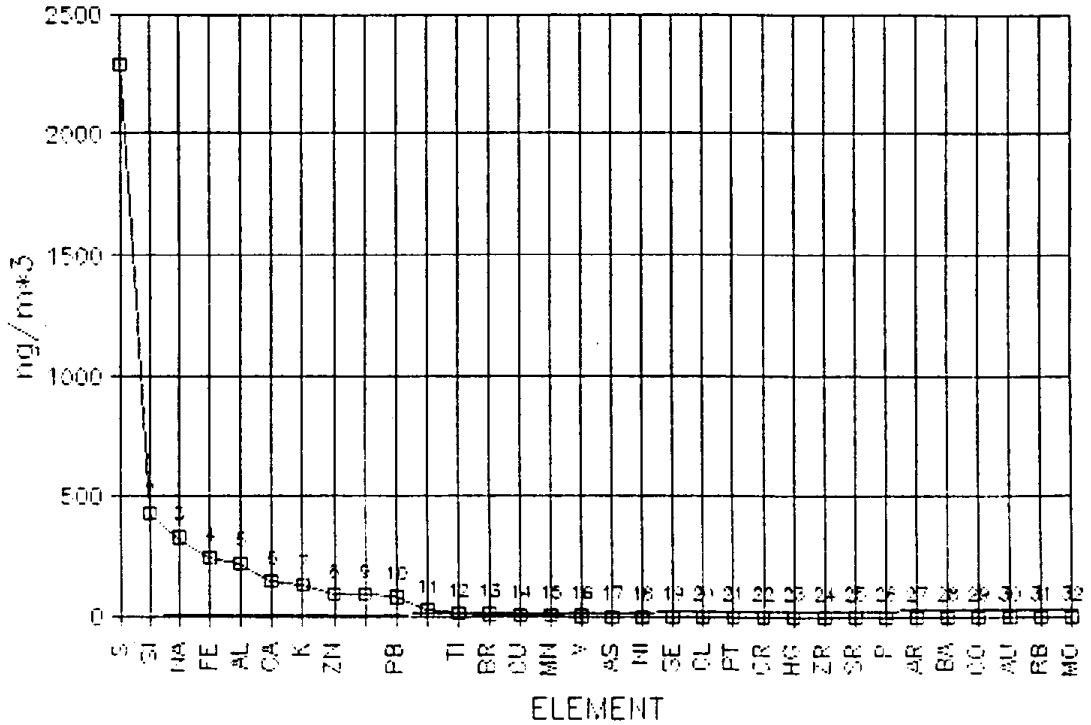


Figure 12. Log-transformations of maximum and average elemental values, Long Beach-Summer.

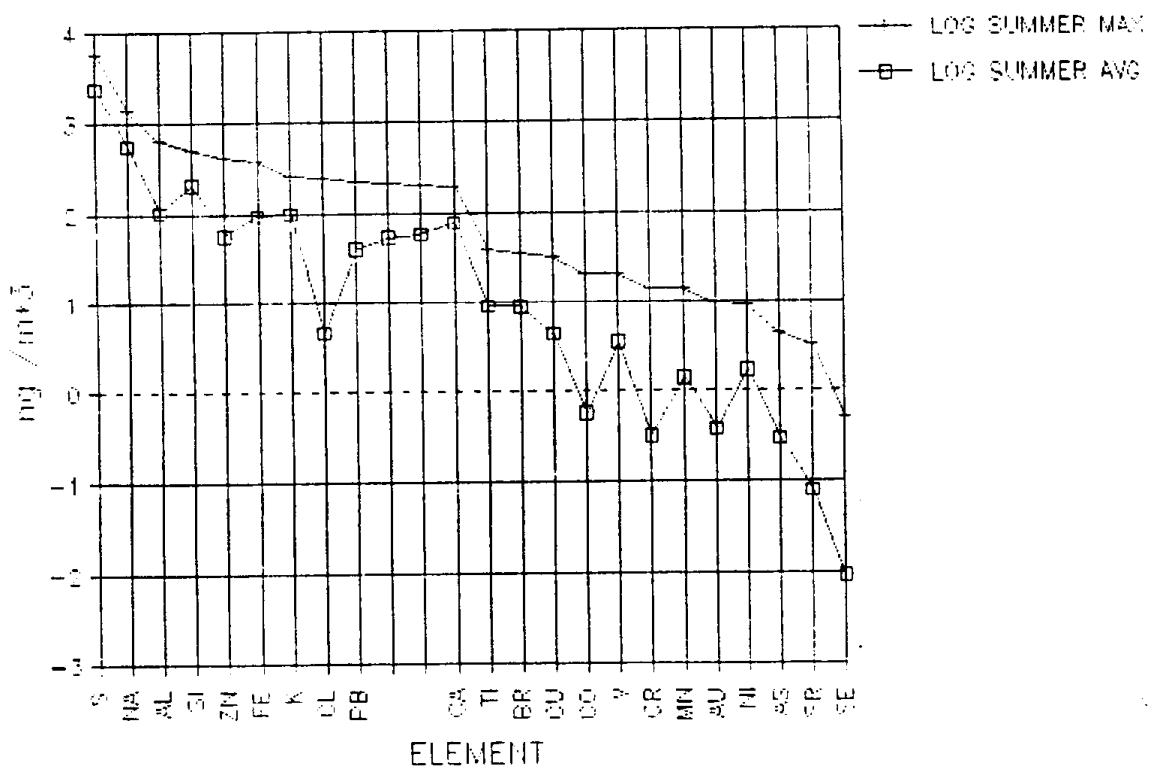


Figure 13. Log-transformations of maximum and average elemental values, Claremont-Summer

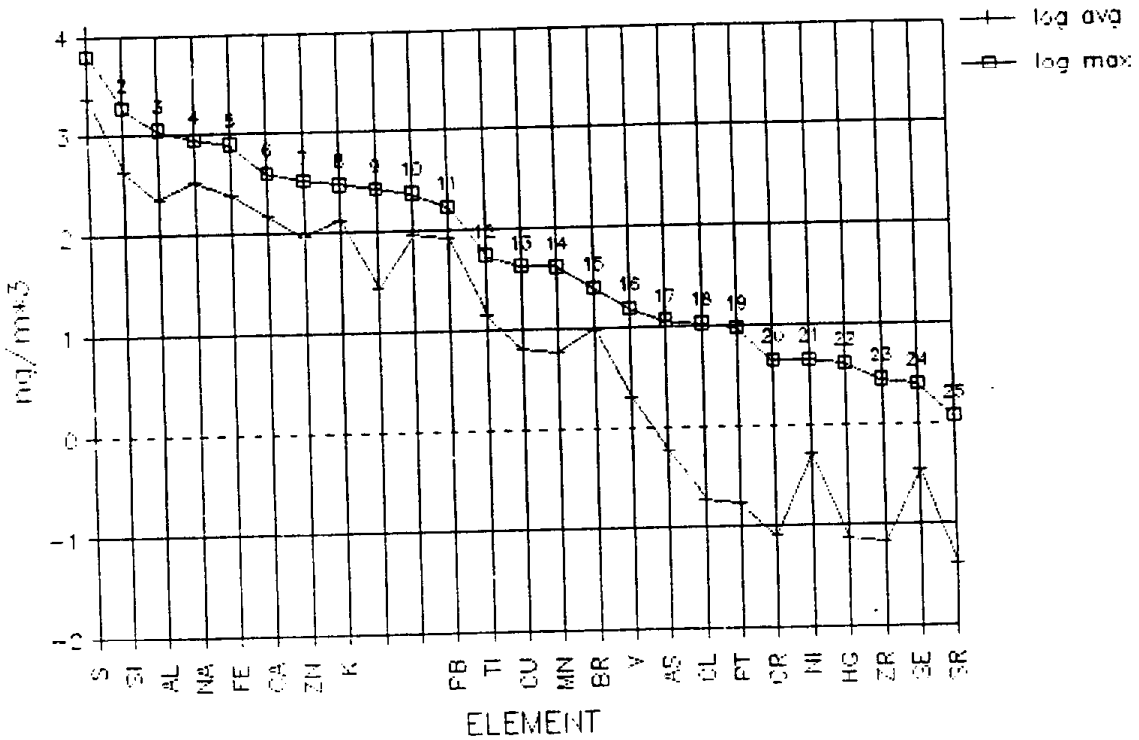


Figure 14. Log-transformations of maximum and average elemental values, Rubidoux-Summer

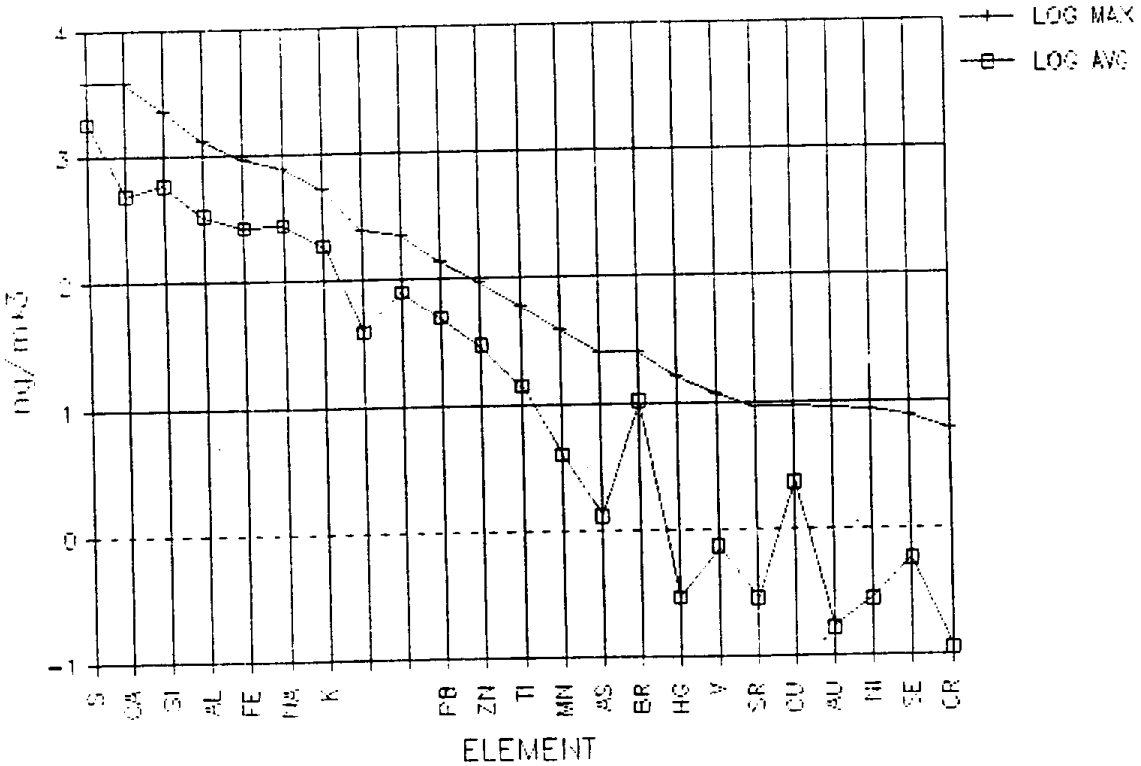


Figure 15. Log-transformations of maximum and average elemental values, Long Beach-Fall.

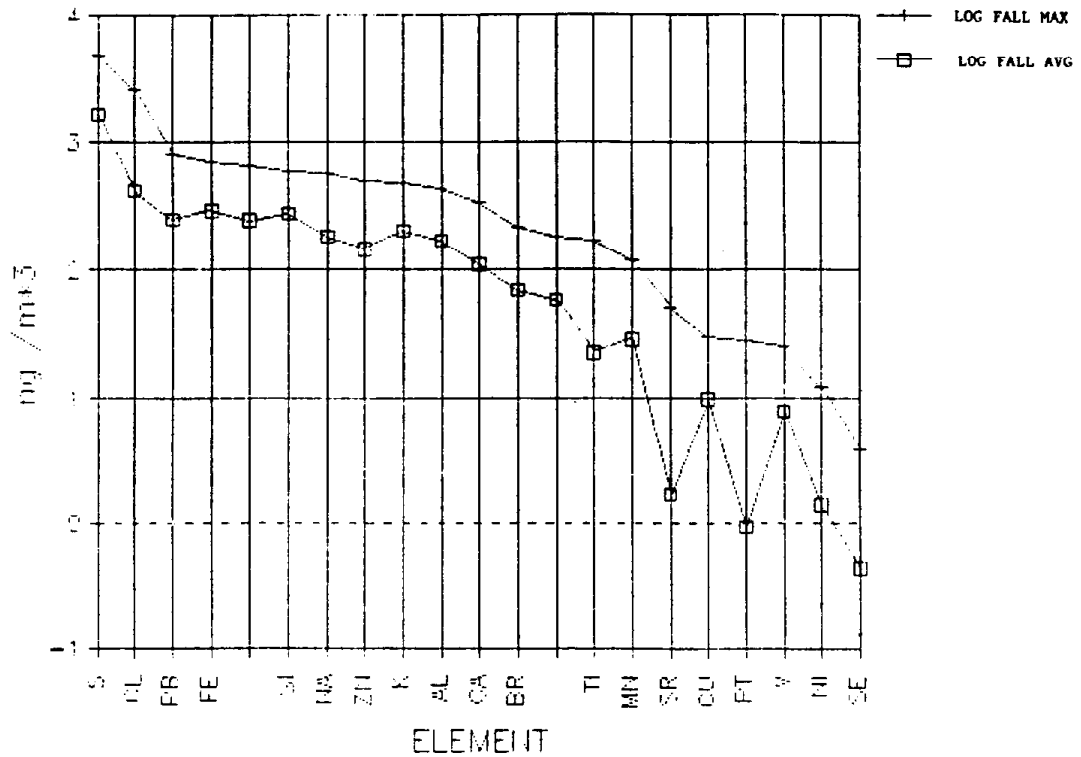


Figure 16. Log-transformations of maximum and average elemental values, Los Angeles-Fall.

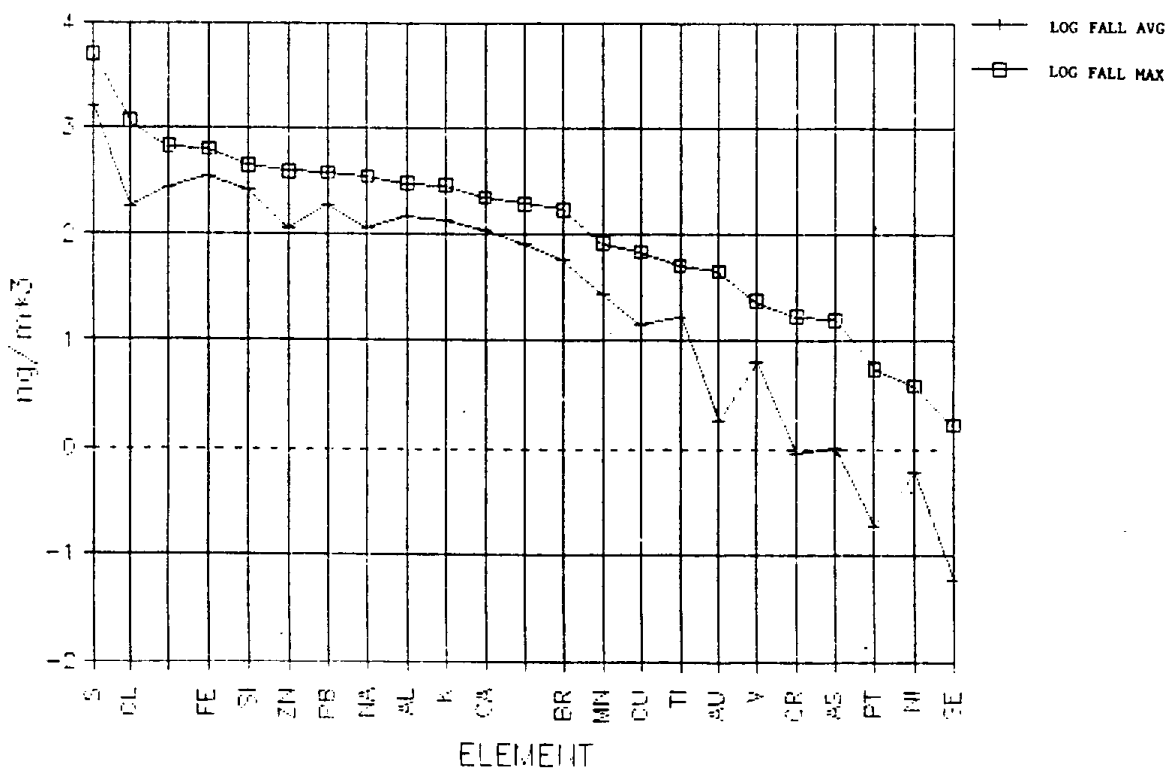


Figure 17. Log transformations of summer and fall maximum elemental values, Long Beach.

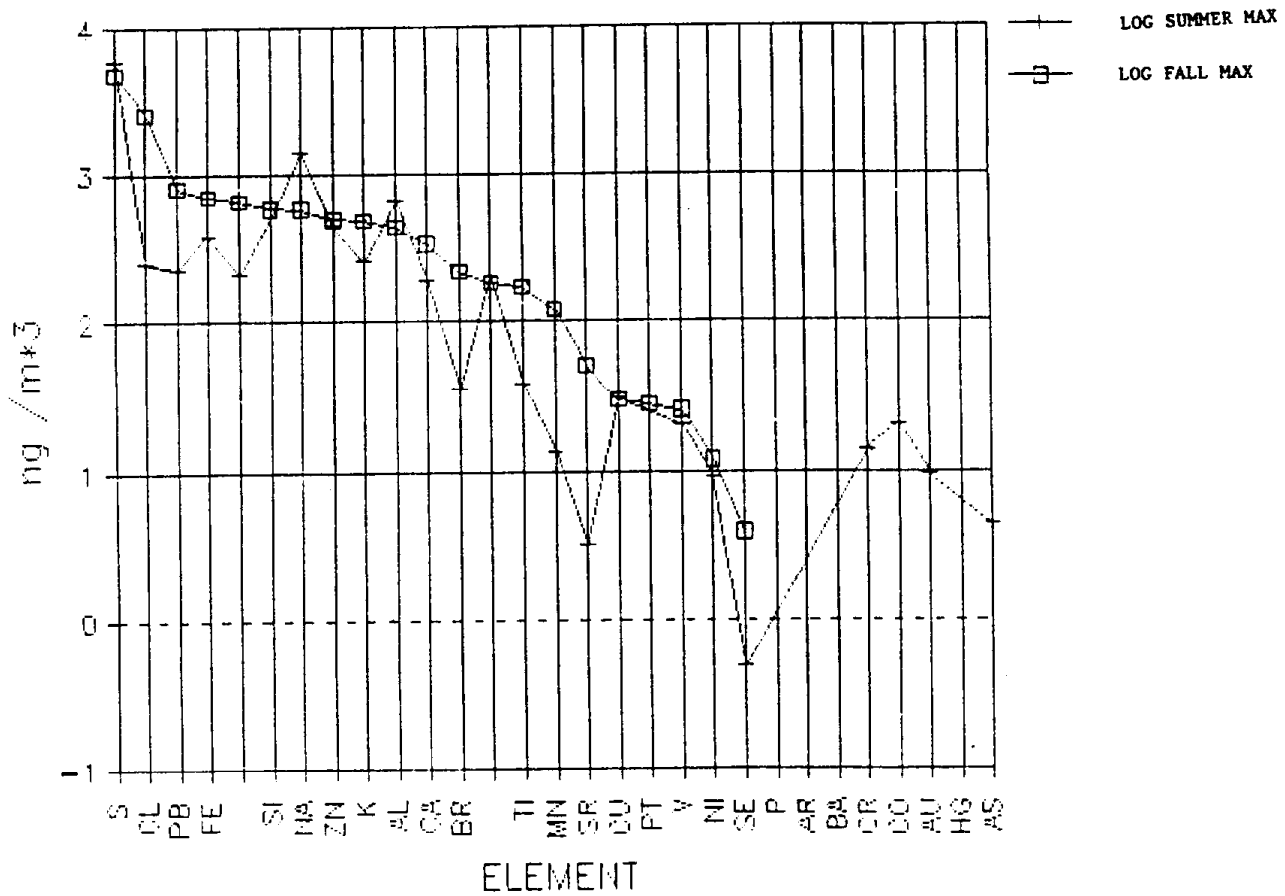


Table 2. Average elemental concentrations (ng/m^3) by site and season. Site and season maximums are underlined.

Element	Long Beach Summer	Claremont Summer	Rubidoux Summer	Long Beach Fall	Los Angeles Fall
Mass	26,400	45,800	54,500	75,700	79,700
Sum of Na to Pb	3,830	4,120	4,200	4,150	3,700
S	2459.1	2284.6	1821.2	1642.9	1603.8
Fe	93.6	243.4	269.5	293.3	350.0
Si	208.1	426.9	587.1	279.9	264.7
Pb	39.6	83.6	48.7	250.2	186.8
Al	101.5	222.3	334.3	171.4	146.4
K	96.9	133.0	188.9	202.6	137.2
Na	559.0	328.8	275.9	183.9	114.9
Zn	56.2	93.5	29.4	147.0	113.4
Ca	76.1	147.9	492.5	110.6	110.7
Br	8.8	9.6	10.3	69.4	58.7
Mn	1.4	5.7	4.0	28.4	27.6
Ti	9.1	14.0	13.9	22.4	17.0
Cu	4.4	6.5	2.3	9.7	14.2
V	3.4	2.0	0.7	7.7	6.4
As	0.3	0.6	1.3	0.0	1.0
Cr	0.3	0.1	0.1	0.0	0.9
Ni	1.7	0.5	0.3	1.4	0.6
Se	0.0	0.4	0.6	0.4	0.1

Table 3. Percent contribution of elements to sum of elements (PIXE, Na to Pb) by site and season

Element	Long Beach Summer	Claremont Summer	Rubidoux Summer	Long Beach Fall	Los Angeles Fall
S	64.1%	55.4%	43.4%	39.6%	43.4%
Fe	2.4	5.9	6.4	7.1	9.5
Si	5.4	10.4	14.0	6.7	7.2
Pb	1.0	2.0	1.2	6.0	5.1
Al	2.6	5.4	8.0	4.1	4.0
K	2.5	3.2	4.5	4.9	3.7
Na	14.6	8.0	6.6	4.4	3.1
Zn	1.5	2.3	0.7	3.5	3.1
Ca	2.0	3.6	11.7	2.7	3.0
Br	0.2	0.2	0.2	1.7	1.6
Mn	0.0	0.1	0.1	0.7	0.7
Ti	0.2	0.3	0.3	0.5	0.5
Cu	0.1	0.2	0.1	0.2	0.4
V	0.1	0.0	0.0	0.2	0.2
As	0.0	0.0	0.0	0.0	0.0
Cr	0.0	0.0	0.0	0.0	0.0
Ni	0.0	0.0	0.0	0.0	0.0
Se	0.0	0.0	0.0	0.0	0.0

Table 4. Correlation of elements with R > 0.60.

Element Pairs	Long Beach Summer	Claremont Summer	Rubidoux Summer	Long Beach Fall	Los Angeles Fall
Al, Ca		0.82	0.83	0.80	
Al, Fe		0.92	0.97	0.89	
Al, K		0.85	0.91		
Al, Mn				0.60	
Al, Pb			0.68	0.68	
Al, Si	0.71	0.98	0.98	0.88	0.65
Al, Ti		0.84	0.96	0.96	
Al, Zn				0.74	
Br, Ca	0.69				
Br, Cl				0.72	
Br, K	0.76			0.84	
Br, Mn				0.62	
Br, Pb	0.79			0.73	0.78
Br, S		0.65			
Ca, Fe	0.68	0.93	0.84	0.84	0.61
Ca, K	0.79	0.88	0.84		
Ca, Mn				0.62	
Ca, Na	0.63				
Ca, Pb			0.61	0.68	
Ca, Si	0.73	0.85	0.86	0.91	0.65
Ca, Ti		0.70	0.73		0.65
Ca, Zn				0.68	
Cr, Ti					0.64
Cu, Fe				0.68	
Cu, K				0.80	
Cu, Pb	0.69			0.83	
Cu, Zn	0.68				
Fe, K		0.91	0.94		
Fe, Mn		0.61		0.78	0.79
Fe, Pb			0.72	0.86	0.72
Fe, Si	0.78	0.93	0.98	0.83	
Fe, Ti		0.77	0.93		
Fe, Zn				0.82	
K, Mn				0.62	
K, Pb	0.68		0.74	0.71	
K, Si	0.63	0.88	0.92		
K, Ti		0.80	0.84		
Mn, Pb				0.92	0.78
Mn, Zn				0.71	0.70
Pb, Si			0.65		
Pb, Zn	0.87	0.67		0.76	
Si, Ti		0.84	0.95		
Si, Zn				0.65	0.63

Table 5. Ratios of elements to iron in soil and fine aerosols in SCAQS

Ratio	soil	Long Beach Summer	Claremont Summer	Rubidoux Summer	Long Beach Fall	Los Angeles Fall
Si/Fe	8.25	2.22	1.75	2.18	0.95	0.76
Al/Fe	1.78	1.08	0.91	1.24	0.58	0.42
Fe/Fe	1.00	1.00	1.00	1.00	1.00	1.00
Ca/Fe	0.38	0.81	0.61	1.83	0.38	0.32
K/Fe	0.35	1.04	0.55	0.70	0.69	0.39
Ti/Fe	0.13	0.10	0.06	0.05	0.08	0.05
Mg/Fe	0.13	0.65	0.11	0.14	0.20	0.23
Mn/Fe	0.10	0.02	0.02	0.02	0.10	0.08
S/Fe	0.02	26.3	9.39	6.76	5.60	4.58
V/Fe	0.00	0.04	0.00	0.00	0.03	0.02
Zn/Fe	0.00	0.60	0.38	0.11	0.38	0.32
Cr/Fe	0.00	0.00	0.00	0.00	0.00	0.00
Ni/Fe	0.00	0.02	0.00	0.00	0.00	0.00
Pb/Fe	0.00	0.42	0.34	0.18	0.34	0.53
Cu/Fe	0.00	0.05	0.03	0.01	0.03	0.04
Br/Fe	0.00	0.09	0.04	0.04	0.38	0.17
As/Fe	0.00	0.00	0.00	0.01	0.00	0.00

Gravimetric Mass and Total Elemental Analysis

The elements measured by FAST included hydrogen, carbon, nitrogen, and oxygen. These light elements make up the majority (approximately 2/3) of aerosol mass, as was seen in SCAQS. Sulfur, from PIXE, was also a major elemental component. These elements, which are the major contributors to aerosol mass, have been compared to the gravimetric mass from each filter in order to obtain a better understanding of the elemental composition of fine aerosols in SCAQS. Percentages and correlations of these major elements to mass are presented in the following two tables: Table 6 lists the average elemental composition of SCAQS fine aerosols by percentage of mass for each site and season; Table 7 shows a summary of results from linear regressions between gravimetric mass and total elemental analysis - the regressions compare the largest elemental contributors (C, O, N, H, S) and mass plus the sum of total elements (H to Pb) and mass; Figures of these linear regressions are shown in Appendix B, p.93.

Total elemental analysis, the combination of FAST and PIXE on the same filter, for the elements from H to Pb recovered over 80% of the mass on SCAQS IMPROVE filters (Table 6). The remaining elemental mass that was not recovered (less than 20%) is attributed to the loss of volatiles (mostly water and also volatile nitrogen) during analysis under vacuum. The sum of total elements from H to Pb had very high correlations (R-squares > 0.89) with gravimetric mass, as they should. The slopes and intercepts of total elements to mass give further information to resolve how the elemental mass was recovered. For example, the slope (1.00) and intercept for Los Angeles-Fall (Table 7) indicate that an average of $12\mu g/m^3$ per filter was not recovered by total elemental analysis. This means that there was an average offset between the elemental and gravimetric measurements that was probably from the loss of volatiles (after the mass measurements) due to the vacuum required by the elemental analyses. Conversely, the 0.90 slope for Rubidoux-Summer with its

almost zero intercept agrees closely with the 88% of mass accounted for by the sum of the total elements (Table 6). This shows that the gravimetric and elemental techniques differed by a constant factor of about 0.1.

Average masses for the summer sites increased inland from Long Beach to Claremont to Rubidoux. Long Beach, which is within 10 miles of the coast, had about half the mass as Claremont and Rubidoux. During the fall intensives, the average mass at Long Beach was three times greater than for summer and was also very close to the average mass at Los Angeles. For the fall, average PM2.5 masses were greater than those of the summer with mass concentrations exceeding $100\mu g/m^3$ on three separate days.

Interestingly, sulfur seemed to follow the opposite trends of mass as also previously illustrated in Tables 2 and 3 (p.30). Sulfur and its percentage of mass were highest at Long Beach-Summer where average mass was lowest, while sulfur amounts were lowest during the fall when average masses were highest. Sulfur, was the fourth largest elemental component of mass. It varied from 2 to 10% of mass with its percent contributions decreasing as mass increased for the five sets of sites and seasons. As seen by its relatively low R-squares (Table 7), sulfur did not correlate with aerosol mass as well as the other major elements.

The only element which stayed at a fixed ratio to mass for all sites and periods was hydrogen. An example of this is shown in Figure 18. Hydrogen was a constant 4 to 5% of mass with only a 1% standard deviation (Table 6). It was somewhat surprising that hydrogen had such very high R-squares with mass (0.88 to 0.99) (Table 7) which explains its fixed ratio to aerosol mass. The near-zero intercepts give slopes that agree with the percentages of hydrogen in fine aerosol mass from Table 6. Such high correlations between mass and hydrogen proved to be very helpful in quality assurance procedures.

Carbon and oxygen were the two largest elemental components of mass during SCAQS. Oxygen was present in larger percentages in the summer, while carbon was the largest elemental component in the fall. Oxygen also had high R-squares with gravimetric mass (except for Long Beach-Summer) with almost all R-squares above 0.91. Unlike hydrogen, oxygen did not stay at the same percentage of mass for each site and season.

Nitrogen was the third largest elemental component of fine aerosols, ranging from 8 to 17% of aerosol mass. The lowest percentages of nitrogen were at Long Beach-Summer and Claremont-Summer. Carbon, nitrogen, and sulfur all had R-squares of less than 0.70 to mass (except nitrogen during for fall).

The remainder of elements not listed in Tables 6 or 7 were not present in significant amounts relative to mass for all sites and seasons. They included soil elements (Si, Al, Ca, K, Ti, Fe), trace elements (Cu, Zn, Pb, Ni, Br, etc.), and marine influences (Na, Cl) which were discussed in the previous section RESULTS FROM FINE AEROSOLS IN SCAQS, PIXE.

The results from fine aerosols in SCAQS, collected on teflon filters, show that total elemental analysis accounted for most (over 80%) of the aerosol mass. The high correlations between the sum of the total elements (H to Pb) and mass show good agreement between very different and independent measurements of fine aerosols, gravimetric mass and total elemental analysis.

Mass measurements from the summer sampling periods showed that aerosol concentrations increased inland from the coast, as one would expect with inland sources of pollutants. As seen from the PIXE results, soil concentrations, correlations, and contributions to aerosol mass increased from Long Beach to Claremont and Rubidoux. The fall sampling periods were also found to be dirtier than the summer periods, by a factor of 3 in mass at Long Beach. In the fall, the light elements, soil elements, and trace elements were all at increased concentrations than from summer levels. The exception was sulfur which seemed to follow trends opposite to mass, meaning the summer intensive periods for SCAQS were relatively sulfur rich when compared to the fall.

In SCAQS, carbon and oxygen were found to be the largest elemental contributors to mass. Carbon was slightly higher for the fall intensives while oxygen was higher during the summer. Nitrogen, sulfur, and then hydrogen were found to be the next largest elemental contributors to mass. The most interesting result from total elemental analysis of IMPROVE filters in SCAQS was the high correlation between hydrogen and mass in the Los Angeles basin. Hydrogen exists in organics, and to a lesser degree in sulfates and nitrates, in about the same percentages (about 5%) as it did in mass during SCAQS. Since these chemical components make up the majority of aerosol mass, it is understandable that hydrogen stayed at a fixed ratio to mass. The extremely high correlations between hydrogen and mass were also found to be very helpful in quality assurance, identifying suspect samples or analyses when hydrogen to mass ratios differed from the consistent "fixed" ratio of 4 to 5%.

Table 6. Elemental composition of fine aerosols by percentage of mass.

	Long Beach Summer	Claremont Summer	Rubidoux Summer	Long Beach Fall	Los Angeles Fall
Average Mass($\mu g/m^3$)	26.4 +/- 11.0	45.8 +/- 18.7	54.5 +/- 24.3	75.7 +/- 48.1	79.7 +/- 48.2
% Total Elements (H to Pb)	81 +/- 11	82 +/- 11	88 +/- 11	80 +/- 9	82 +/- 11
% Carbon	22 +/- 7	29 +/- 8	27 +/- 8	33 +/- 11	33 +/- 14
% Oxygen	29 +/- 7	31 +/- 4	34 +/- 5	21 +/- 9	24 +/- 10
% Nitrogen	10 +/- 5	8 +/- 4	17 +/- 9	13 +/- 8	16 +/- 9
% Sulfur	10 +/- 3	5 +/- 1	4 +/- 1	3 +/- 1	2 +/- 1
% Hydrogen	5 +/- 1	5 +/- 1	4 +/- 1	5 +/- 1	5 +/- 1

Note: Filters with significant elemental percentages that were below minimum detectable limits (i.e. low mass concentrations) or suspect values were eliminated from this data set.

Table 7. Summary of linear regressions between total elemental analysis and gravimetric mass.

Site	Period	Element	R-squared	Slope	Intercept
Long Beach	Summer	Total Elements	.935	.942	- 3.26
Claremont	Summer	Total Elements	.926	.863	- 1.72
Rubidoux	Summer	Total Elements	.889	.897	- 0.54
Long Beach	Fall	Total Elements	.978	.932	- 8.23
Los Angeles	Fall	Total Elements (sum of H to Pb)	.982	1.00	-12.05
Long Beach	Summer	Carbon	.674	.341	- 2.94
Claremont	Summer	Carbon	.668	.300	- 0.27
Rubidoux	Summer	Carbon	.543	.196	+ 3.73
Long Beach	Fall	Carbon	.674	.224	+ 7.95
Los Angeles	Fall	Carbon	.537	.182	+10.58
Long Beach	Summer	Oxygen	.747	.302	- 0.28
Claremont	Summer	Oxygen	.923	.348	- 1.39
Rubidoux	Summer	Oxygen	.916	.386	- 1.96
Long Beach	Fall	Oxygen	.927	.351	- 7.53
Los Angeles	Fall	Oxygen	.956	.413	-11.31
Long Beach	Summer	Nitrogen	.668	.157	- 1.10
Claremont	Summer	Nitrogen	.390	.080	+ 0.01
Rubidoux	Summer	Nitrogen	.662	.301	- 6.65
Long Beach	Fall	Nitrogen	.831	.264	- 7.52
Los Angeles	Fall	Nitrogen	.905	.322	-10.97
Long Beach	Summer	Sulfur	.502	.069	+ 0.645
Claremont	Summer	Sulfur	.632	.054	- 0.167
Rubidoux	Summer	Sulfur	.512	.022	+ 0.648
Long Beach	Fall	Sulfur	.546	.015	+ 0.518
Los Angeles	Fall	Sulfur	.401	.018	+ 0.179
Long Beach	Summer	Hydrogen	.882	.051	- .009
Claremont	Summer	Hydrogen	.886	.048	- .003
Rubidoux	Summer	Hydrogen	.899	.041	+ .098
Long Beach	Fall	Hydrogen	.983	.047	+ .334
Los Angeles	Fall	Hydrogen	.991	.049	+ .285

Units for Intercept values are in micrograms per cubic meter.

Note: Values below minimum detectable limits or suspect values were eliminated from this data set.

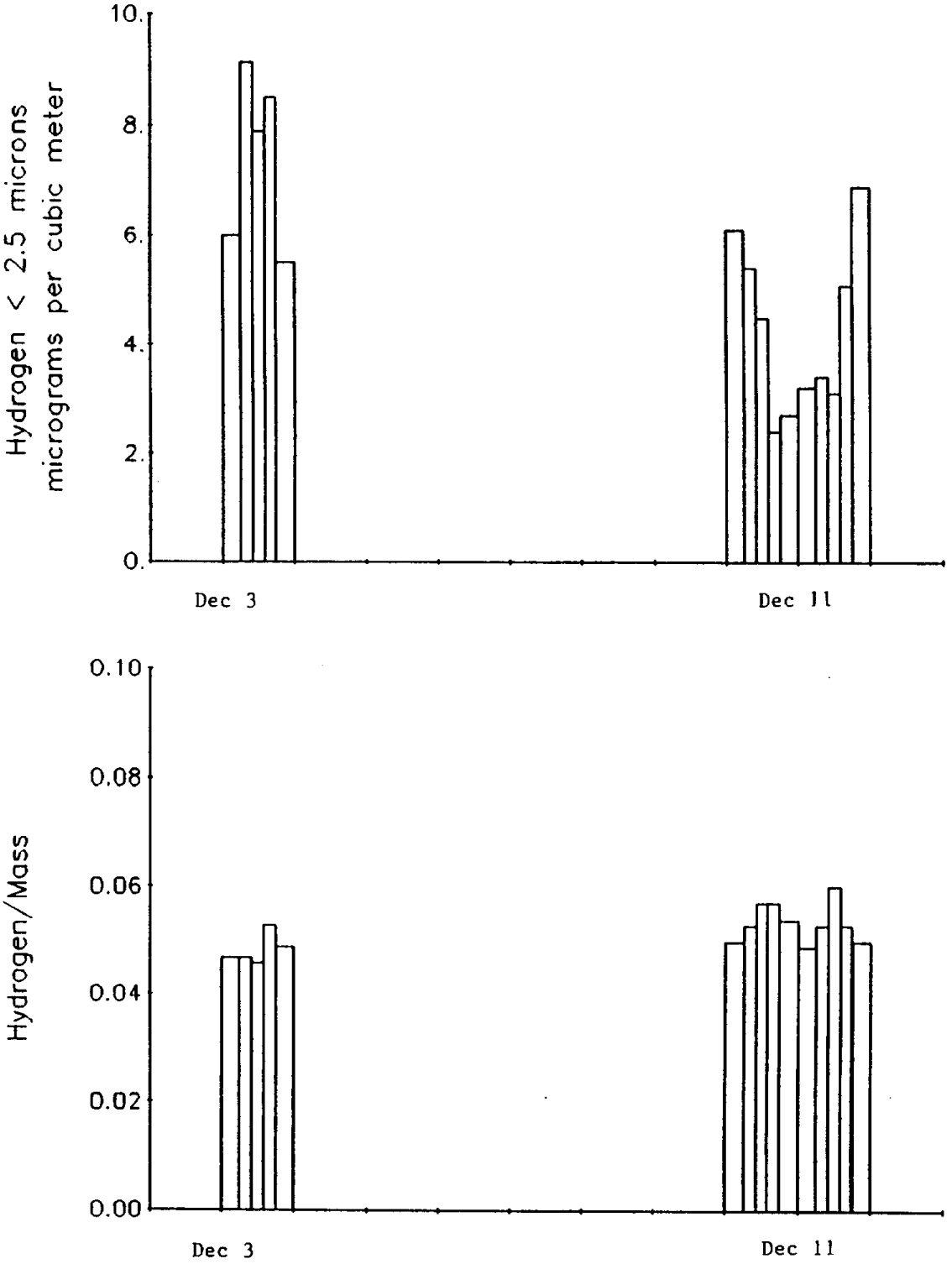


Figure 18. Hydrogen ($\mu g/m^3$)and its ratio to mass, Long Beach, December 2-13.

RESULTS FROM SIZE-RESOLVED AEROSOLS IN SCAQS

Nine-stage DRUM samplers operated at 3 SCAQS sites in the summer and at 2 sites in the fall. They operated continuously in the summer and only during intensive periods in the fall with each sampler generating 50 samples per day. Elemental analysis by PIXE of the DRUM aerosol samples, collected on Mylar strips and stretched teflon afterfilters, was done for all 17 SCAQS intensive sampling days. Additionally the non-intensive days June 18, 20, 23, and 26 were analyzed to help put the intensive days into context. Over 2,750 four hour DRUM samples were analyzed for the elements Na to Pb by PIXE. From these elements S, Cl, K, Ca, Fe, and Zn were reported to the SCAQS data base.

The size-resolved aerosol data was broken down by site and month as listed:

1. Long Beach - June
2. Claremont - June
3. Rubidoux - June
4. Long Beach - July
5. Claremont - July
6. Rubidoux - July
7. Long Beach - August, September
8. Claremont - August, September
9. Rubidoux - August, September
10. Long Beach - November
11. Los Angeles - November
12. Long Beach - December
13. Los Angeles - December

In this section, we present only size-resolved sulfur data since it is the single most important aerosol component obtained by PIXE analysis of DRUM samples. In the past, sulfur has been shown to be deeply implicated with visibility degradation (Barone et al., 1978; Cahill et al., 1987d; Cahill et all, 1988a; Macias et al., 1988; Ouimette et al., 1982; White et al.,, 1977). Not only is sulfur's mass important to visibility, but its size distribution is equally important. To have a dramatic effect upon visibility, sulfur must be in the optical size region that effectively scatters light. This makes high size and time resolution of sulfur so very important.

One of the purposes of the DRUM study in SCAQS, besides providing aerosol data by size for the SCAQS data base and modeling, was to examine sulfur size distributions across the Los Angeles basin under various atmospheric conditions. An important goal to us, was to ascertain if the behavior of sulfur and visibility as seen in the 1986 Carbon Species Method Comparison Study (CSMCS) near Glendora (Cahill et al., 1988a) was typical of the Los Angeles basin under summer conditions. During the 9 day CSMCS study, a large (factor of 2) change in visibility was observed on day 6. This change was most strongly correlated with a sharp (factor of 10) change of sulfur in the 0.56 to 1.15μm size range. Visibility degradation had the strongest associations with increased sulfur concentrations matched by a size shift out of the accumulation mode into the size region from 0.56 to 2.12μm.

In SCAQS, to gain a better understanding of sulfur in the optically important size regions, we have plotted DRUM sulfur > 0.56μm and its percentage of total DRUM sulfur (0 to 15μm) for each site and month. Sulfur from the coarsest 3 stages of the DRUM (2.12 to 4.26μm, 4.26 to 8.54μm, and 8.54 to 15μm) are in size ranges too large to have significant effects upon visibility but were in insignificant quantities and also included in sulfur > 0.56μm and its percentages of total DRUM sulfur. To help examine the sulfur distributions across the basin, we have put the plots from all sites of the same sampling periods next to one another.

Figure 19 shows sulfur > 0.56μm and its percentage to total DRUM sulfur for June 17-28 at Long Beach, Claremont, and Rubidoux. First, there were clear similarities among all three sites during this period. This shows that the size distribution of sulfur was regional for the 3 sites, as one might expect from a secondary aerosol. Local photochemistry also had an effect as the percentage of sulfur > 0.56μm increased (west to east) from Long Beach to Claremont and Rubidoux. One can immediately notice the differences between the June 17-20 and the June 23-28 periods with the establishment of a strong diurnal pattern in sulfur and an increase in the fraction of sulfur > 0.56μm. The increasing size correlated well with the increasing coarse size mode sulfur (> 0.56μm) compounding the effect of sulfur upon visibility. The diurnal pattern was not nearly as strong for the CSMCS during the "poor visibility" episode, and was completely absent during the "fair visibility" period.

The period July 13-17 is displayed in Figure 20. Again, while there are similarities, there are also striking differences. Note that on July 14, the amount of sulfur > 0.56μm at Long Beach was actually anticorrelated with the results at Claremont. However, Rubidoux benefitted from a smaller amount of sulfur > 0.56μm and again, correlated only moderately with Claremont.

The differences among the three sites, so similar in June and less correlated in July, were amplified in August and September (Figure 21). At that time, Long Beach was very different in sulfur size distribution and behavior in time from Claremont. Claremont and Rubidoux were similar on the average, but the strong episode of coarse sulfur (> 0.56μm) on August 29 was missing at Rubidoux and the diurnal pattern at Rubidoux in September was completely absent at Claremont. The striking change in sulfur mass > 0.56μm at Claremont in September should be repeated in the visibility data.

Dramatic changes in both the mass of sulfur and the fraction of sulfur > 0.56μm occurred in November at Long Beach and Los Angeles (Figure 22). However, in December there were major changes in the mass of sulfur > 0.56μm at Long Beach (Figure 23) that were not reflected in the fraction of sulfur > 0.56μm. At Los Angeles, the changes were correlated. For comparison, Figure 23a plots the same period in December for sulfur > 0.34μm (below 0.34μm, sulfur has little effect upon visibility). These figures suggest there are 2 different patterns of sulfur formation modes. One with the mass and fraction of sulfur > 0.56μm correlated and the other in which they are not. Both Mie thory calculations and the 1986 CSMCS study show a disproportionate influence of sulfur mass > 0.56μm upon visibility reduction. However, how growth in this size region occurs is unclear since sulfur formation modes that change mass but not size fraction may have different mechanisms than those that change both mass and size fraction.

Soils (K, Ca, Fe), the other major aerosol component besides sulfur (sulfate) from PIXE analysis of DRUM samples, remained in the coarser DRUM stages and changed very little in size, as expected. They maintained a fixed size fraction and did not show a rapid size shift into the optically efficient size range important to visiblity; an exception is potassium, which is present both in smoke and soil. Other PIXE elements (e.g. trace elements: Pb, Br, Cu etc.) were not present in large enough concentrations to affect visibility or to provide reliable results since aerosols below 2.12μm were separated into 6 different stages of the DRUM sampler. The PIXE analysis of IMPROVE filters were used to measure such elements with better sensitivity. Also, no size-resolved measurements were made on the DRUM for elements lighter than sodium (although fine carbon and nitrogen were measured with IMPROVE filters). Thus, we could not determine how size-resolved nitrogen or carbon correlated with sulfur.

Further timeplots of size-resolved sulfur are shown by size (stages 4 to 8 plus afterfilter) in Appendix C, p.114. These timeplots also show total DRUM (0.0 to 2.12μm, the sum of stages 4 to 8 plus afterfilter) and IMPROVE filter sulfur (PM2.5). Note in these figures that most sulfur is in the two size ranges 0.56 to 1.15μm (stage 5) and 0.34 to 0.56μm (stage 6). Total DRUM sulfur agreed fairly well with IMPROVE filter sulfur considering that 5 stages of the DRUM plus an afterfilter had to summed together. Most of the figures in Appendix C show good agreement between total DRUM sulfur and fine sulfur from IMPROVE filters, although exceptions for different sites and time periods were noted. Comparisons between DRUM and IMPROVE filter sulfur are discussed in section QUALITY ASSURANCE AND DATA VALIDATION, SULFUR COMPARISON BETWEEN DRUM SAMPLES AND IMPROVE FILTERS.

DRUM samplers have proven to be a reliable instrument, easy to use in field situations, generating tens of thousands of elemental data as a function of size. The most interesting results from the size-resolved data in SCAQS were obtained from sulfur. The size-resolved sulfur analyses showed a degree of variation in particulate size and concentration versus site, time, and season that was clearly large enough to indicate that any attempt to model visibility without such data would be highly suspect. The SCAQS data showed complicated sulfur patterns by size and composition across the basin while in the optically important size region from 0.34 to 2.12μm, two patterns emerged. For the first case, there were increases in sulfur mass with constant size, whereas in the other case, the mass increased simultaneously with a size shift to a usually coarser mode (> 0.56μm). This second case is especially important to visibility, as the shift to an optically important coarser mode increases sulfur concentrations in the size ranges that have a disproportionatly heavy influence upon visibility degradation, most importantly sulfur in the size range 0.56 to 1.15μm. One can hypothesize very different formation mechanisms for the two cases, but the resolution of the patterns must undergo further interpretation.

Figure 19. DRUM Sulfur (ng/m^3) > 0.56μm and the percentage of total DRUM sulfur > 0.56μm for June 17-28, all summer sites.

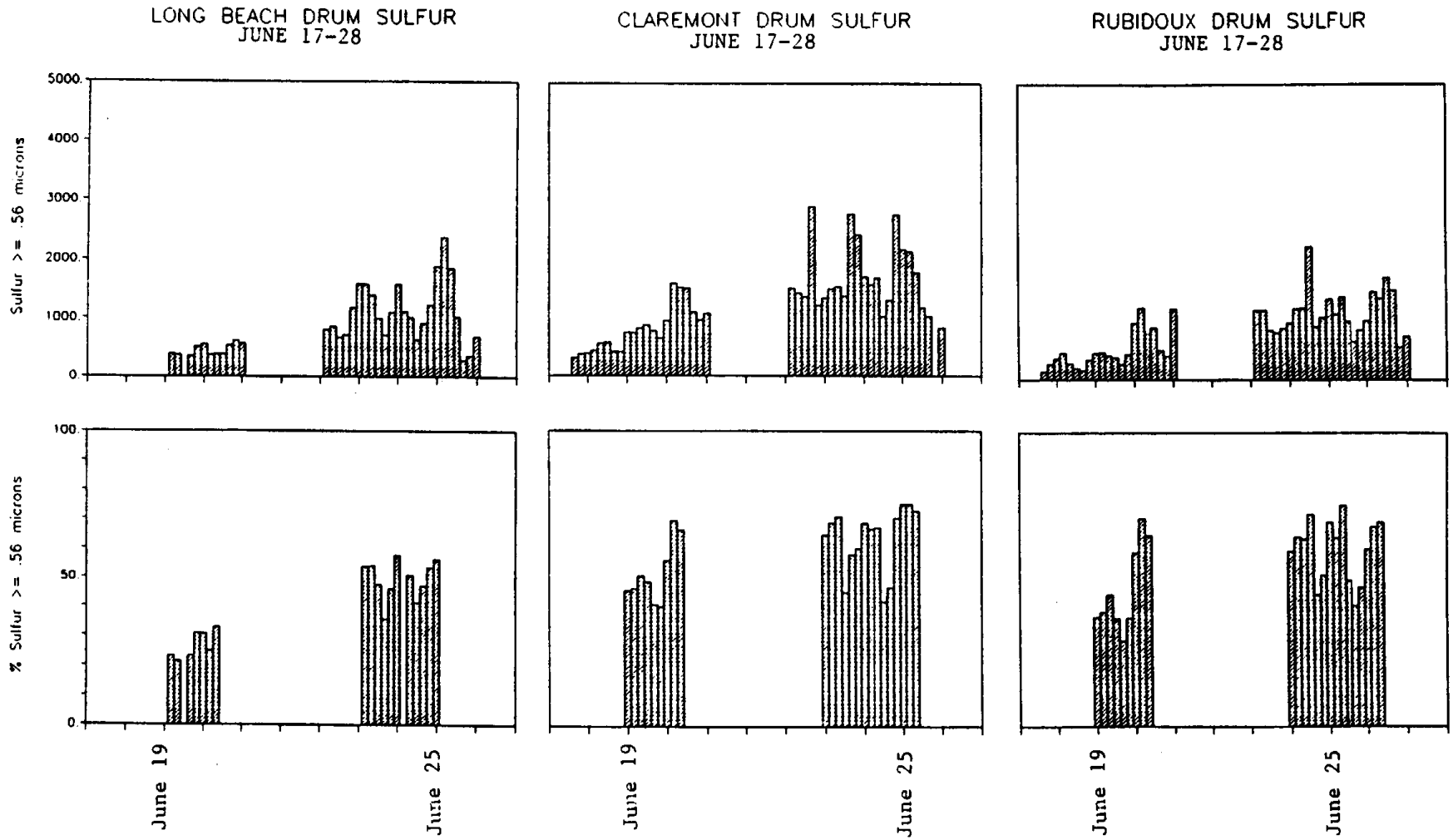


Figure 20. DRUM Sulfur (ng/m^3) > 0.56μm and the percentage of total DRUM sulfur > 0.56μm for July 13-17, all summer sites.

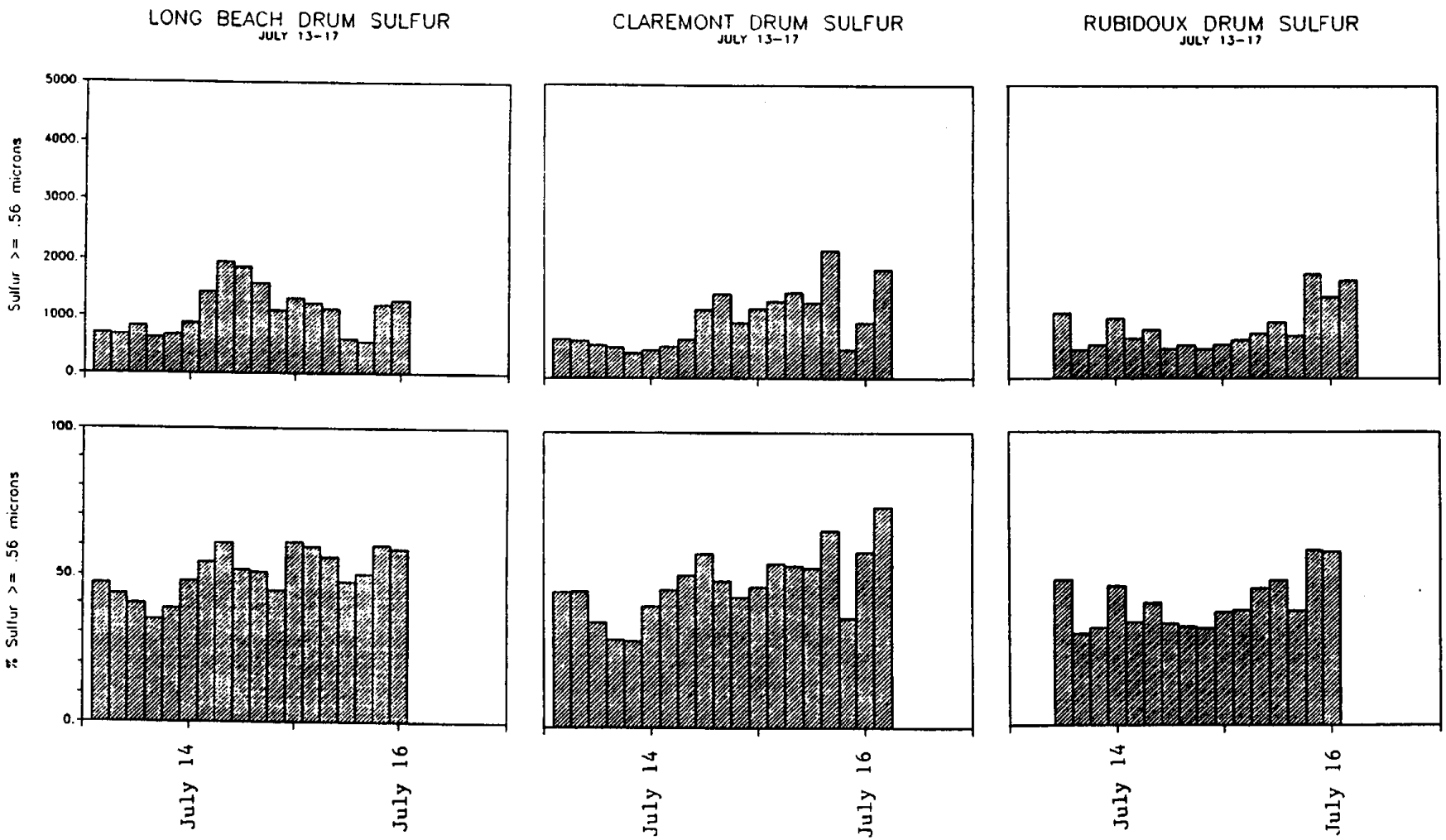


Figure 21. DRUM Sulfur (ng/m^3) > 0.56μm and the percentage of total DRUM sulfur > 0.56μm for August 26-31 and September 1-5, all summer sites.

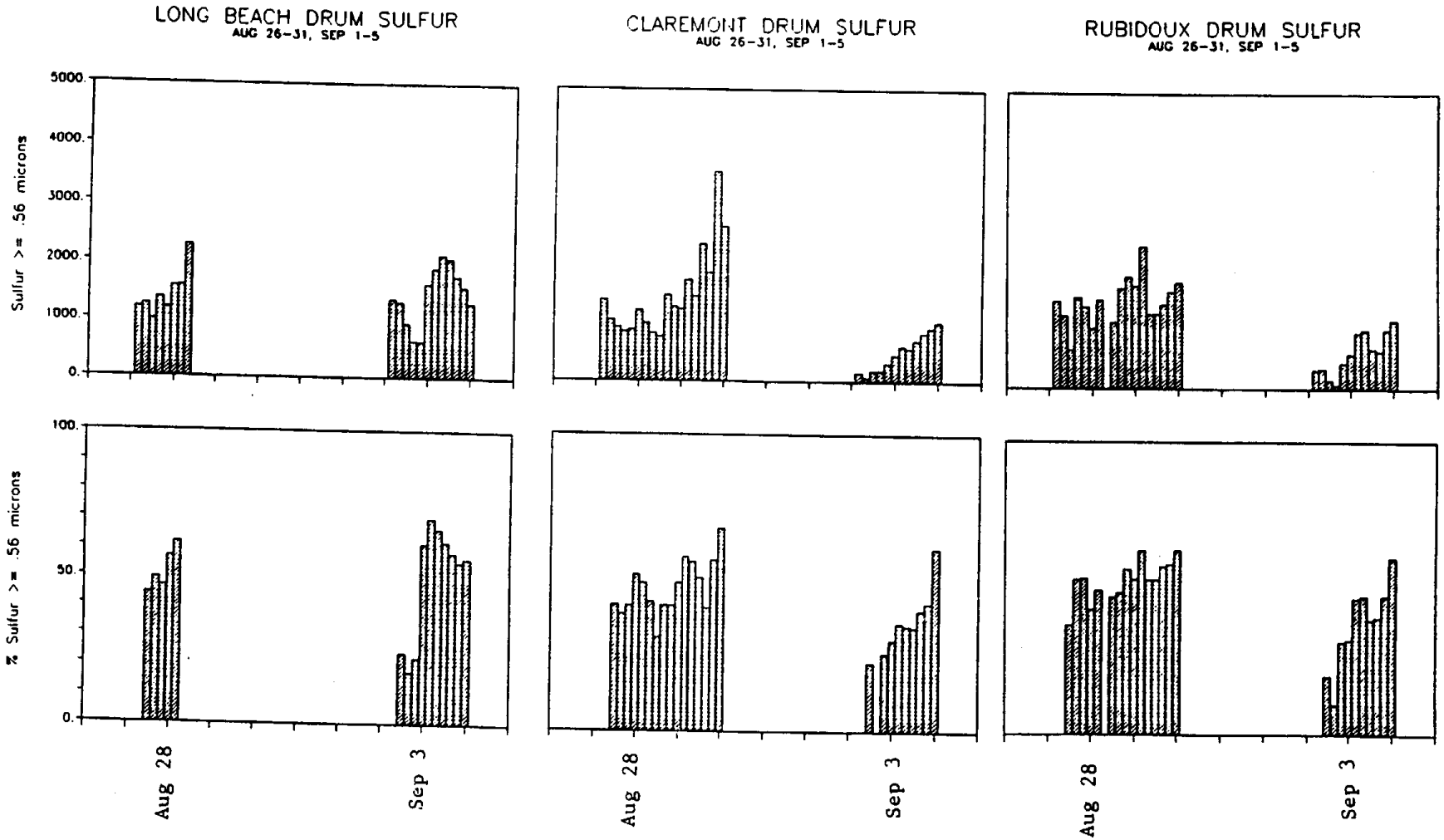


Figure 22. DRUM Sulfur (ng/m^3) > 0.56μm and the percentage of total DRUM sulfur > 0.56μm for November 10-15, all fall sites.

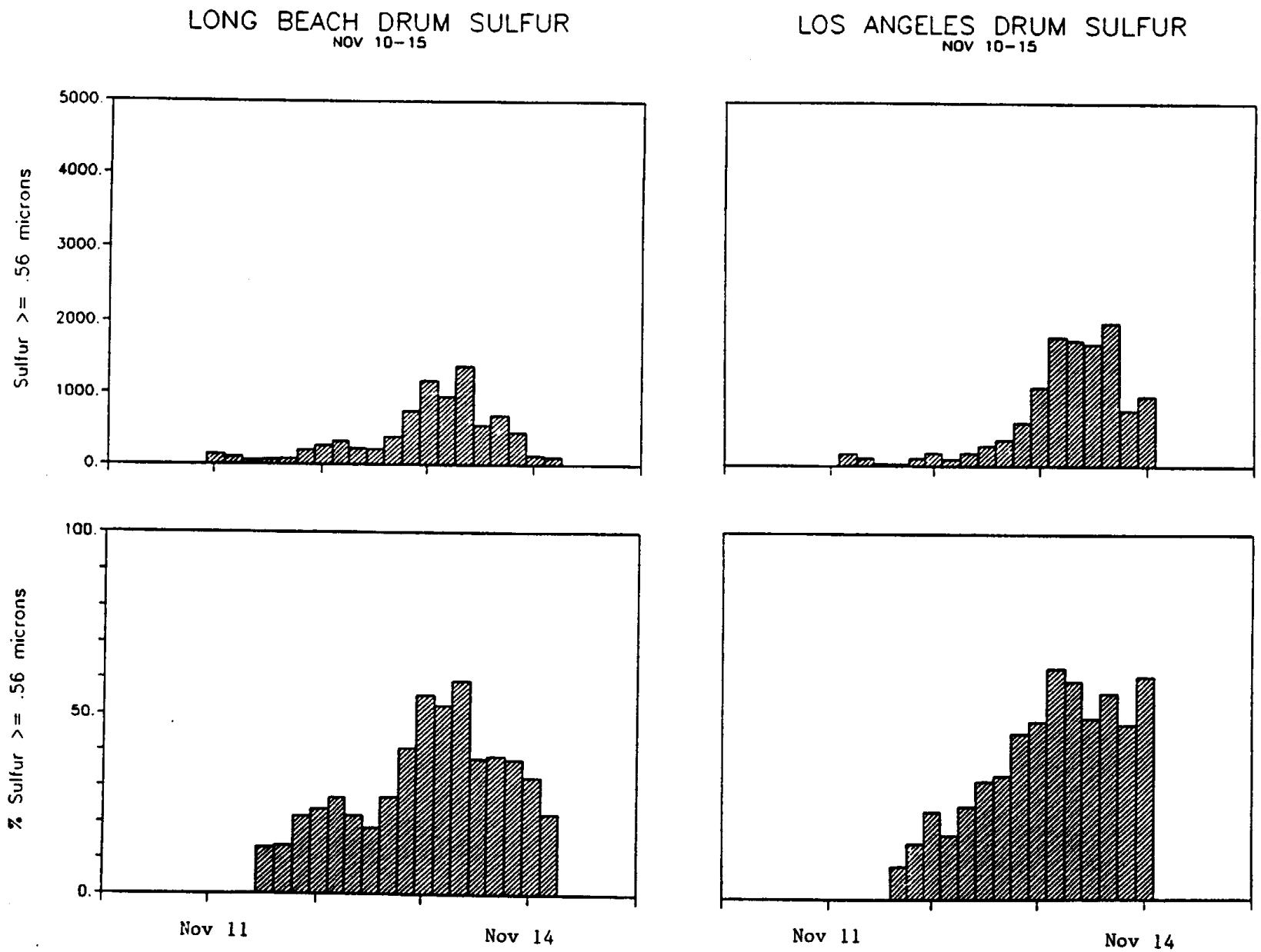


Figure 23. DRUM Sulfur (ng/m^3) > 0.56μm and the percentage of total DRUM sulfur > 0.56μm for December 2-13, all fall sites.

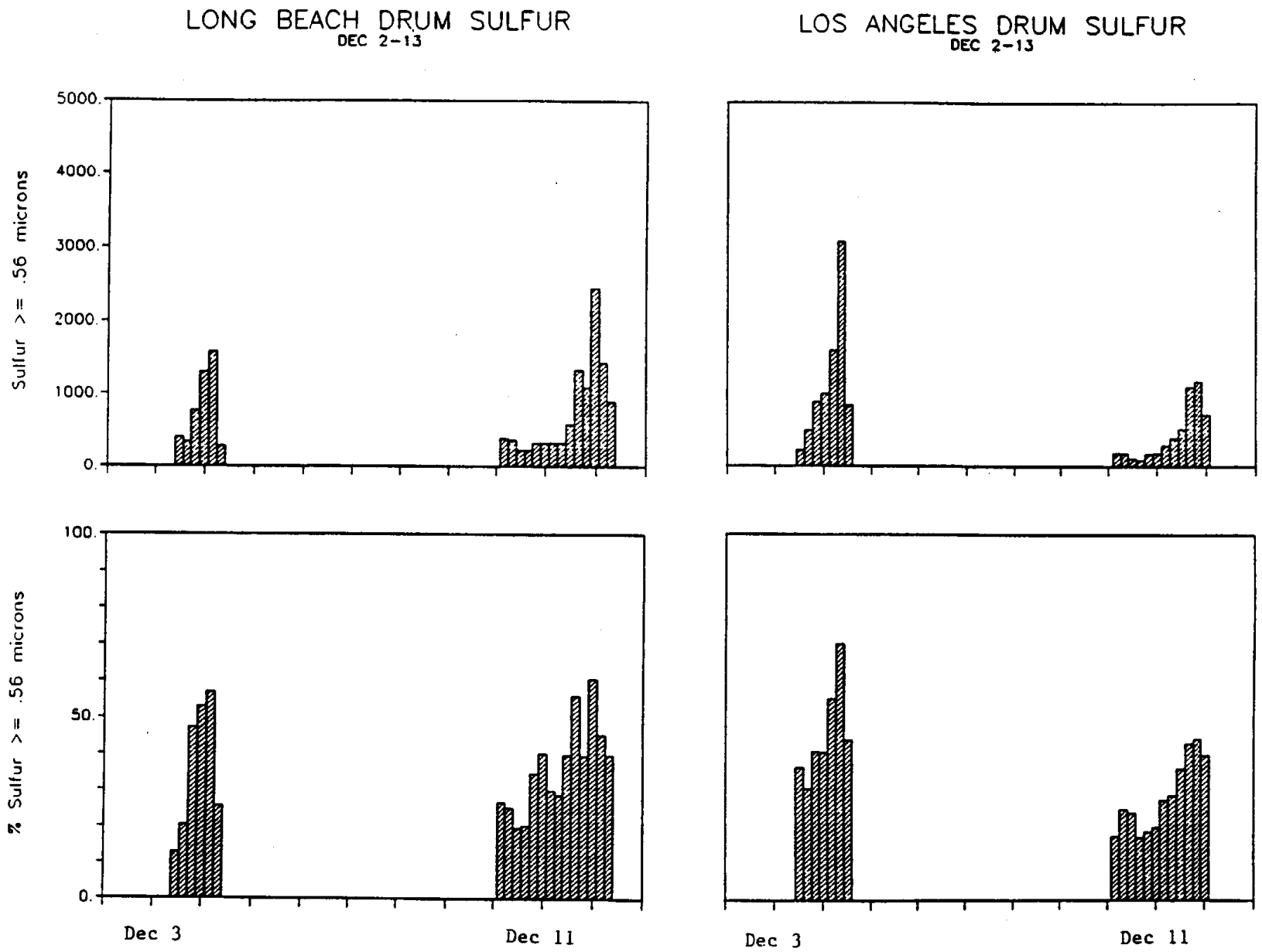
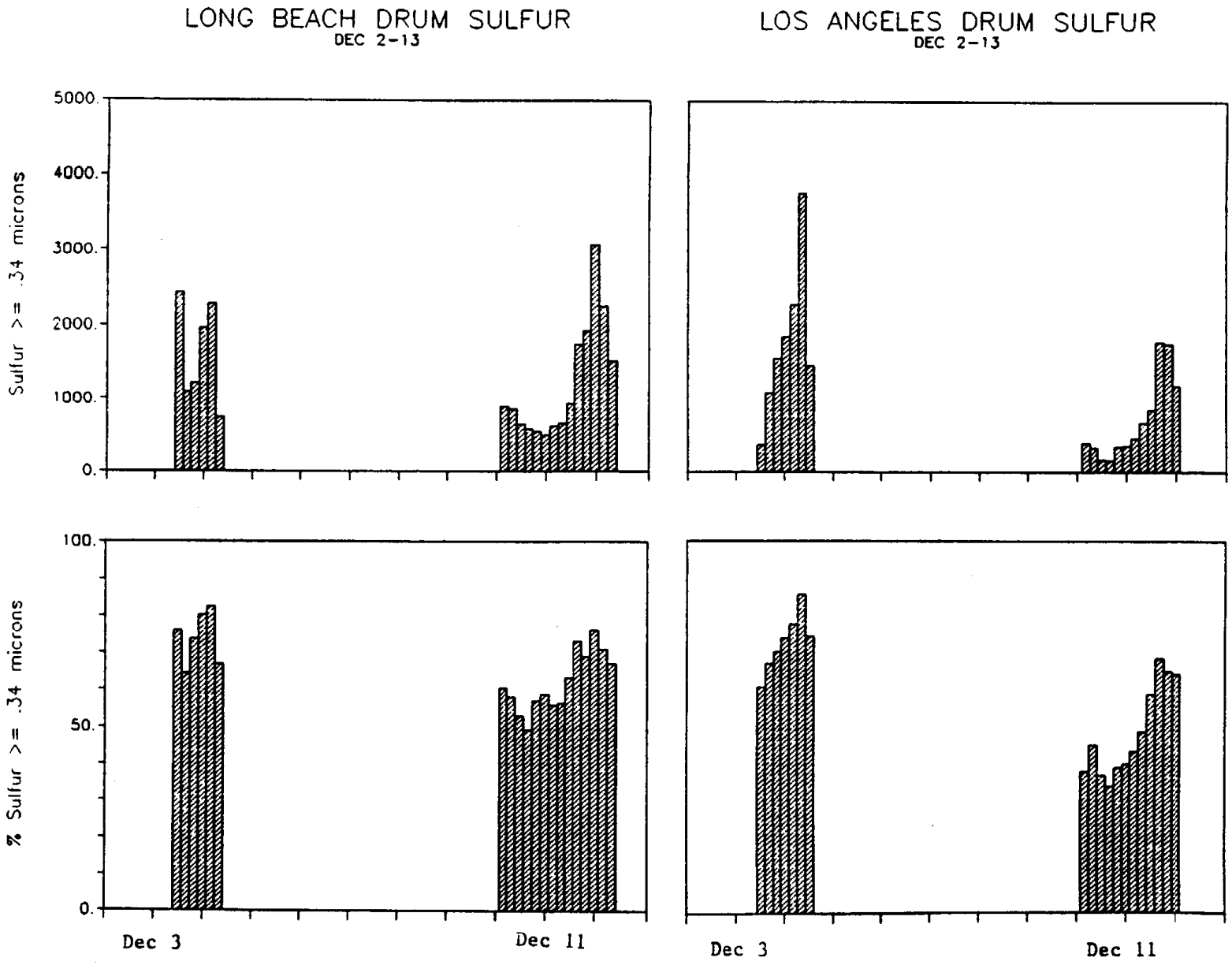


Figure 23a. DRUM Sulfur (ng/m^3) > 0.34μm and the percentage of total DRUM sulfur > 0.34μm for December 2-13, all fall sites.



QUALITY ASSURANCE AND DATA VALIDATION

Besides performing Level 1 data validations (Croes et all, 1989) that all SCAQS participants performed upon their own measurements (e.g. idenifying suspect samples and analyses), we also performed some of our own level 2 data validations. To assure that the DRUM and IMPROVE filter data entered into the SCAQS data base was of good quality (in both accuracy and precision), we made various checks upon the data. Our measurements of fine aerosols from IMPROVE filters included 4 separate analysis techniques whose results were compared among one another when possible. Additionally, our size-resolved measurements were compared to those of our IMPROVE filters. The following four sections (listed below) present our most important data validations used to ensure good quality assurance. We discuss the results of our data validations for analytical and physical consistencies, as well as pointing out anomolies in the data.

I. Iron Comparisons from Multiple Detector PIXE Analysis: Compares the PIXE (Fe) analysis between two separate detectors from the same irradiated sample.

   A. PIXE 1 vs PIXE 2 detectors
      1. IMPROVE filters
      2. DRUM samples

II. Reanalyses and Precisions: Checks the consistency and precision between analysis sessions using the same samples from one analysis session to another.

   A. PIXE
      1. IMPROVE filters
      2. DRUM samples

   B. FAST
      1. IMPROVE Filters

III. Comparison between Total Elemental Analysis and Gravimetric Mass: Checks the consistency and accuracy between the combination of two elemental analyses to a separate, independent analysis of the same sample.

   A. IMPROVE Filters
      1. FAST (H, C, O, N) + PIXE (Na to Pb)
      2. Gravimetric Mass

IV. Sulfur Comparison between DRUM Samples and IMPROVE Filters: Checks for consistency and accuracy between two different sampling methods and their elemental analysis.

   A. Sampling and PIXE
      1. DRUM samples
      2. IMPROVE filters

IRON COMPARISONS FROM MULTIPLE DETECTOR PIXE ANALYSIS

The multiple detector PIXE analysis system at U.C. Davis allows two simultaneous measurements of iron for all PIXE analyses. The setup of the PIXE 1 detector was designed for better sensitivity of the lower energy x-rays and is used for the lighter elements, Na to Pb. The second detector, PIXE 2, is more heavily-filtered and is used for the heavier elements from Ca to elements past Pb. The two detectors overlap in some of the elements that they analyze, allowing two measurements of these elements. However, the elemental values from the detector with the better sensitivities are always used, so PIXE 1 values are used for Na to Mn while PIXE 2 values are always given for the elements from iron and heavier.

The overlapping element which is usually found in aerosol samples as well as being analyzed well by both detectors is iron. The benefit from an iron comparison between the two detectors is that two analyses of the same irradiated sample can be checked against another. Ideally the iron values should almost match, verifying that the calibrations for both detectors and their analyses are most likely accurate. Comparisons of iron between the two detectors for all IMPROVE filter and DRUM analyses are shown in the following plots.

IMPROVE Filters

For the analysis of all IMPROVE filters, iron agreement was good with an average difference between PIXE 1 and PIXE 2 iron values of 10%. The largest percentage differences between the two detectors occurred when there were light loadings of iron. Figure 24 shows the iron values from PIXE 1 and PIXE 2 for all IMPROVE filters analyzed for SCAQS.

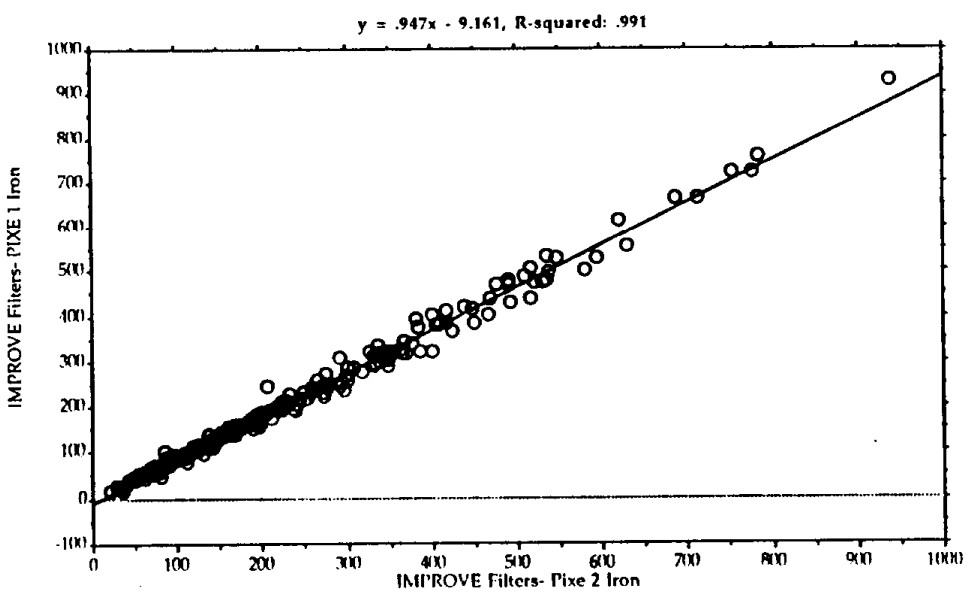


Figure 24. Linear regression between PIXE 1 and PIXE 2 iron values, IMPROVE filters (units in ng/m^3).

DRUM Samples

Examples of comparisons between DRUM iron values in SCAQS are shown in the linear regression plots of Figures 25 and 26. Agreement between PIXE 1 and PIXE 2 detectors was good for all SCAQS DRUM analyses (e.g. Figure 25) except for the DRUM data from June (e.g. Figure 26) in which iron values showed about a 30% difference. During one of the 3 separate PIXE analysis sessions of the DRUM samples, the PIXE 2 measurements in which the June DRUM data were analyzed were determined to be incorrectly calibrated. Using the fact that we have a multiple detector PIXE analysis system, we were able to easily recover the PIXE 2 elemental values. We simply used only the elemental values from the PIXE 1 detector for the June DRUM data which resulted in only a slight loss of sensitvity for iron and zinc.

Figure 25. Linear regression between PIXE 1 and PIXE 2 iron values, DRUM samples (units in ng/m^3); Rubidoux, August and September.

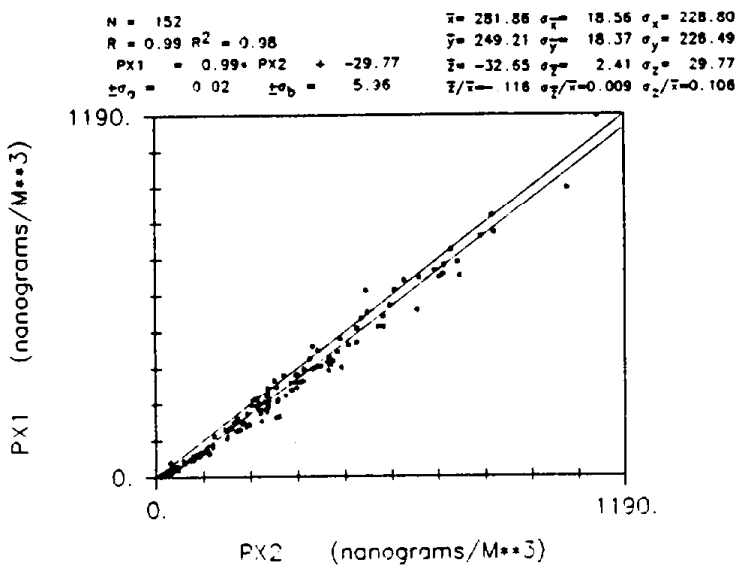
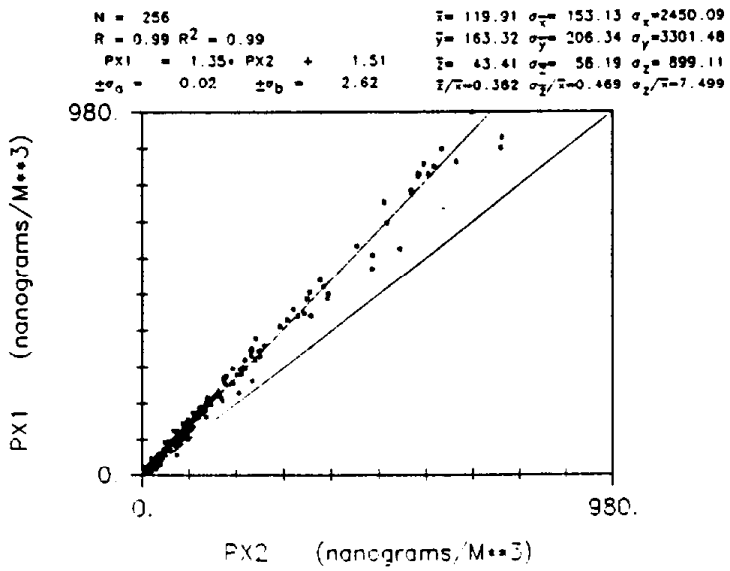


Figure 26. Linear regression between PIXE 1 and PIXE 2 iron values, DRUM samples (units in ng/m^3); Claremont, June.



REANALYSES AND PRECISIONS

PIXE: IMPROVE Filters

About 5% of the IMPROVE teflon filters were reanalyzed by PIXE during a separate analysis session. Reanalysis results were generally within 15% of the original analyses. Precison, defined as the ratio of the standard deviation to the average of the analyses, was within 15% for the elements seen in the largest concentrations (e.g. S, K, Ca, Fe, Zn, Pb). Correlations between the original and reanalysis elemental values were excellent with R-squares greater than 0.91.

FAST: IMPROVE Filters

Over 15% of the filters were reanalyzed by FAST to check the original measurements and to examine the consistency and precision between the two FAST analysis sessions. Precisions for carbon, the most difficult element, were 22%. Oxygen values were within 20% while hydrogen, the element with best sensitivity, had a precision of 10%. Nitrogen, having volatilization and calibration difficulties (all nitrogen values were reported as suspect), was the least precise of the four light elements with a 30% precision.

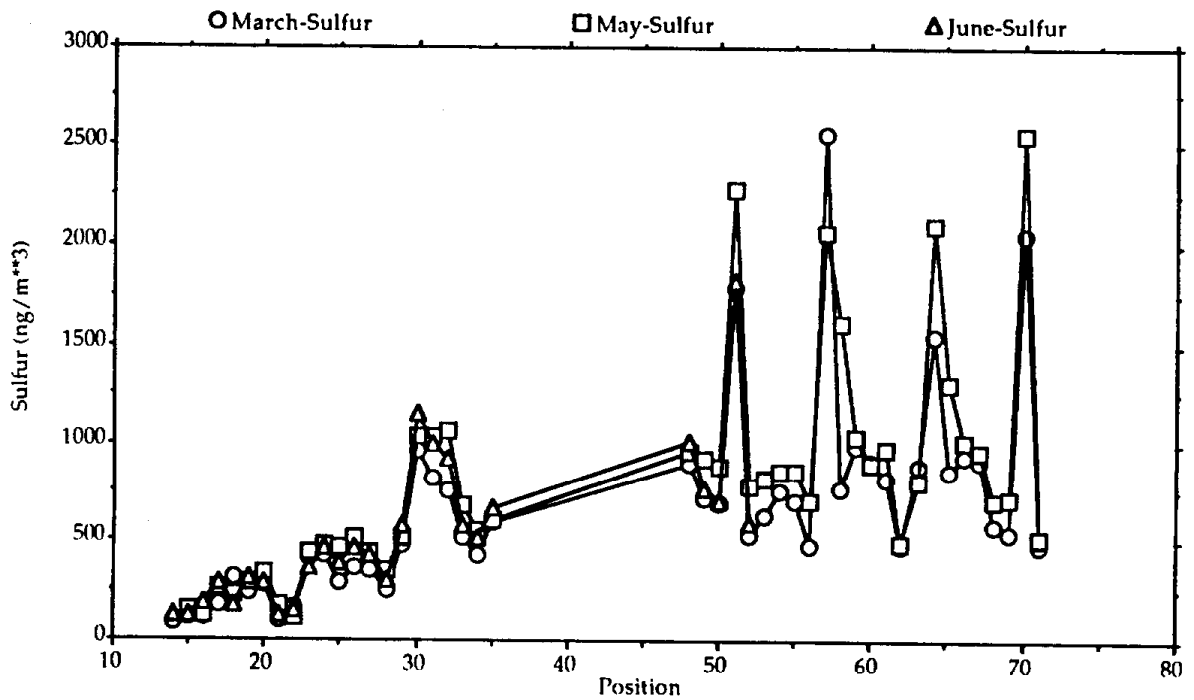
PIXE: DRUM Samples

Because of the enormous number of hours required to analyze all SCAQS DRUM strips, they were analyzed in three separate PIXE analysis sessions (each lasting 2 or 3 days). During each analysis session, one SCAQS DRUM strip was designated as the standard strip for all SCAQS DRUM analyses. It was analyzed at the beginning of every session to check the calibrations and the precisions (i.e. PIXE analysis and beam positioning for accurate time resolution of the 4 hour, 2mm wide samples) between analysis sessions. The selected strip was stage 5 (0.56 to 1.15μm) from Claremont which sampled during a two week period in June, 1987. The SCAQS standard strip was heavily loaded with sulfur and very lightly loaded with soil and trace elements.

Sulfur values of the SCAQS standard strip for all three analysis sessions are shown in Figure 27. All analysis sessions were in good agreement with the largest differences in sulfur occurring as sulfur changed dramatically in time (or across the strip). This illustrates the importance in the positioning of the strip relative to the beam area during analysis. The positioning of the analysis beam (2mm wide) relative to each deposit area from a 4 hour sample is crucial to the accuracy of each 4 hour sample's true elemental concentrations. This becomes increasingly important when there are sharp changes of aerosol concentrations in time, as a very small difference in analysis positioning may result in a significant difference in elemental concentrations.

Correlations between all three analysis sessions were good with R-squares greater than 0.95, except between the March and May sessions which included days where sulfur values changed sharply (R-squared of 0.87, but R-squared of 0.97 with two points thrown out). On the average for the 3 analysis sessions, sulfur values of the SCAQS standard strip were within +/- 15% of one another.

Figure 27. SCAQS standard strip - sulfur from three analysis sessions (units in ng/m^3).



COMPARISON BETWEEN TOTAL ELEMENTAL ANALYSIS AND GRAVIMETRIC MASS

Total elemental analysis, the combination of FAST and PIXE for the elements H to Pb, of IMPROVE filters from SCAQS was directly compared against a separate, independent measurement - gravimetric mass. To check the consistency between the elemental and gravimetric techniques, each filter's sum of total elements (H to Pb in $\mu g/m^3$) was directly compared to the filter's gravimetric mass. The mass measurements set stict upper limits for total elemental analysis and they agreed quite well with the sum of the elements. Comparisons between mass and total elemental analysis were good with R-squares > 0.89. Approximately 80 +/- 11% of the elemental composition by mass was recovered by total elemental analysis. A summary of the results from the comparisons between total elemental analysis and gravimetric mass are shown in Tables 6 (p.34) and 7 (p.35) of RESULTS FROM FINE AEROSOLS IN SCAQS, Gravimetric Mass and Total Elemental Analysis while Appendix B (p.93) contains figures from linear regressions between gravmetric mass and total elemental analysis (sum of total elements, H to Pb).

Appendix B also contains figures of linear regressions between gravimetric mass and the elements in the largest concentrations (C, O, N, S, H) for SCAQS fine aerosols. These elements usually account for most of the airborne particulate matter since they compose the major chemical components of aerosols (e.g. organics, sulfates, nitrates, soil oxides, carbon soot). Although they are the largest elemental components of aerosols, they do not necessarily have to follow the aerosol mass trends. We compared C, O, N, S, and H (optical absorption was also included) to gravimetric mass to find any grossly outlying, suspect values. The comparisons also provided some interesting results as discussed in section RESULTS FROM FINE AEROSOLS IN SCAQS, Gravimetric Mass and Total Elemental Analysis. Correlations of the light elements and sulfur to gravimetric mass were fair for carbon, sulfur and nitrogen, good for oxygen, and excellent for hydrogen. The very high correlation between hydrogen and mass in SCAQS allowed us to immediately identify any suspect samples that did not have the expected ratios between the two measurements.

SULFUR COMPARISON BETWEEN DRUM SAMPLES AND IMPROVE FILTERS

To check the consistency between our 2 sets of aerosol measurements, size-resolved aerosols from the DRUM and total elemental analysis of fine aerosols from IMPROVE filters, we compared their sulfur measurements. To do this, we summed sulfur from stages 4 to 8 plus the afterfilter for total DRUM sulfur (0.0 to 2.12μm). This was compared to fine sulfur (PM2.5) from the IMPROVE filters. A summary of the results is in Table 8 while Appendix D (p.128) contains figures of the linear regressions between total DRUM sulfur (0.0 to 2.12μm) and fine sulfur (PM2.5) from IMPROVE teflon filter samples. The data was separated by site and DRUM sample periods (up 2 weeks of exposure on a set of eight drums). Agreement was good considering there were two different sampling methods and that five stages were summed together for the DRUM; however there were exceptions which we will discuss.

To make direct comparisons between the sulfur measurements, the SCAQS sampling periods of the 2 samplers were matched together by their beginning and ending sampling times. For each sampling day, three 4 hour sample periods matched while the other 12 hours of a day (1800 to 0600 of the next day if it was also an intensive sampling day) were averaged together for one additional match per day. DRUM afterfilters (0.0 to 0.069μm) were 12 hour samples and their sulfur values were added to each corresonding 4 hour DRUM period during which the afterfilter sampled.

	Summer IMPROVE Sampling Schedule	Summer DRUM Sampling Schedule
Period 1	0100 - 0600 PDT 5 hours	0200 - 0600 PDT 4 hours
Period 2	0600 - 0930 PDT 3.5 hours	0600 - 1000 PDT 4 hours
Period 3	1000 - 1400 PDT 4 hours	1000 - 1400 PDT 4 hours
Period 4	1400 - 1800 PDT 4 hours	1400 - 1800 PDT 4 hours
Period 5	1800 - 0100 PDT 7 hours	1800 - 2200 PDT 4 hours
		2200 - 0200 PDT 4 hours

	Fall IMPROVE Sampling Schedule	Fall DRUM Sampling Schedule
Period 1	0000 - 0600 PST 6 hours	0200 - 0600 PST 4 hours
Period 2	0600 - 0930 PST 3.5 hours	0600 - 1000 PST 4 hours
Period 3	1000 - 1400 PST 4 hours	1000 - 1400 PST 4 hours
Period 4	1400 - 1800 PST 4 hours	1400 - 1800 PST 4 hours
Period 5	1800 - 0000 PST 6 hours	1800 - 2200 PST 4 hours
		2200 - 0200 PST 4 hours

Summer and Fall
DRUM Afterfilter Sampling Schedule
1000 - 2200 PDT, PST 12 hours
2000 - 0930 PDT, PST 12 hours

From the original set of matching sulfur data, total DRUM to IMPROVE filter sulfur ratios for all SCAQS values were calculated. The average ratio was almost 1:1 as it should be (0.95 +/- 0.27), with total DRUM sulfur slightly lower than IMPROVE filter sulfur. The particle size range of the samplers for this comparison was close, 0 to 2.12μm for the DRUM and PM2.5 for the filters. The sulfur ratio was not significantly affected by the slightly lower 2.12μm sizecut for total DRUM sulfur because adding the coarsest 3 stages of the DRUM

(2.12 to 15μm) had a negligible effect upon total DRUM sulfur - there was little sulfur in that size region.

Although the average ratio between total DRUM sulfur and IMPROVE filter sulfur differed by only 5%, the standard deviation was slightly high (+/- 0.27) and the R-squared was only 0.587. After plotting the data, we saw 8 anomolous data points. We eliminated those data which had a ratio of DRUM to IMPROVE sulfur that was +/- 2 standard deviations away from the average ratio. After eliminating the 8 points, the average ratio was not affected, but the standard deviation dropped to +/- 0.20 and the R-squared improved to a reasonable 0.759.

Table 8. Ratios and Correlations between total DRUM (0 to 2.12μm) and IMPROVE filter sulfur.

Site	Period	DRUM/IMPROVE	R-Squared	Slope	Intercept
All SCAQS		0.95 +/- 0.27	0.587	0.628	560.2
		(0.95 +/- 0.20	0.759	0.699	416.0)
Long Beach	June	0.81 +/- 0.17	0.725	0.377	922.6
Claremont	June	1.02 +/- 0.16	0.603	0.753	523.0
		(0.97 +/- 0.07	0.997	0.786	340.7)
Rubidoux	June	0.75 +/- 0.12	0.734	0.624	217.9
Long Beach	July	0.93 +/- 0.09	0.964	0.773	333.3
Claremont	July	0.87 +/- 0.21	0.600	0.585	612.0
Rubidoux	July	0.91 +/- 0.37	0.418	-.283	2301.3
		(1.11 +/- 0.32	0.682	0.862	242.7)
Long Beach	Aug./Sept.	1.00 +/- 0.20	0.349	0.342	1643.8
		(1.05 +/- 0.16	0.647	0.507	1293.6)
Claremont	Aug./Sept.	1.09 +/- 0.22	0.610	0.841	385.7
Rubidoux	Aug./Sept.	1.09 +/- 0.52	0.262	0.408	1084.9
		(0.98 +/- 0.11	0.961	0.801	250.0)
Long Beach	Fall	0.93 +/- 0.23	0.379	0.518	635.9
		(0.96 +/- 0.21	0.631	0.902	79.6)
Los Angeles	Fall	0.98 +/- 0.22	0.958	0.666	228.5
		(0.91 +/- 0.20	0.974	0.657	278.8)

Units of intercept values are in nanograms per cubic meter.

Values in parenthesis ( ) contain data in which points have been thrown out if the ratios of DRUM to IMPROVE filter sulfur were not within +/- 2 standard deviations of the mean for All SCAQS.

Each of the 8 eliminated data points was then examined to find possible causes for differences between DRUM and IMPROVE filter sulfur. Possible problems could have arisen from either sampling or analysis (PIXE) methods and are listed below. One of the 8 points was attributed to total DRUM sulfur changing by a factor of two among the three 4 hour sample periods which skewed the 12-hour-averaged DRUM sulfur value. Another point was due to a slight positioning offset in the PIXE analysis of a DRUM sample. The other 6

anomolous points could not be attributed to any one particular problem, but were possibly a combination of the problems listed below. The most likely problem being the positioning of PIXE analysis as sulfur changed by a significant factor within a time span not accurately resolved by the analysis.

1. Positioning of the PIXE analysis: As discussed in section REANALYSES AND PRECISIONS, PIXE: DRUM Samples, the position of the 2mm wide area representing each 4-hour time period relative to the analysis beam area becomes even more critical as sulfur changes become greater in time. The analysis position being off by 0.5 mm is equivalent to 30 minutes in time. This could have possibly led to significant errors when sulfur changed dramatically in a time span that was not correctly resolved by the PIXE analysis.

2. 12 hour sulfur averages: For an additional match of sulfur per day, the samples from 1800 to 0600 were averaged together for 12 hour sulfur values so both sampling methods had matching beginning and ending sample times. Two sulfur values were averaged for the filters (6 + 6 hours for summer and 7 + 5 hours for fall) while three 4 hour periods (4 + 4 + 4 hours) were averaged for the DRUM. The error resulting from averaging these analyses into 12 hour values also increased with changes in ambient sulfur concentrations in time.

3. Sampling Protocol of the DRUM: During the daily afterfilter changes and flow readings, airflow to the DRUM samplers was stopped for 30 minutes. This occurred in period 2, 0930 to 1000 for most DRUM samples to put identifiable gaps in the streak of deposit left by the aerosols. Its purpose was to aid in the mounting and correct positioning of Mylar strips into their plastic frames for PIXE analysis. The 30 minute gap was only 1/8 of a 4 hour sample period so the sample was still treated as a 4 hour sample. This artificially lowered the elemental concentrations for the 0600 - 1000 sample periods for the DRUM. The gap also could have affected the next 4 hour analysis if the positioning of the analysis was slightly off.

4. Filter clogging or particle bounce-off: Any IMPROVE filter with evidence of clogging was eliminated from the data set. For the DRUM, particle bounce-off was not significant because the Mylar strips were grease-coated and the SCAQS aerosols were probably somewhat sticky. Tests of the DRUM showed that bounce-off effects are 1 in 5000 by mass (Cahill et al., 1984e) under dry conditions.

5. IMPROVE Filter or DRUM sample mishandling: This was not likely with the filters since they underwent several analyses that crosschecked one another (e.g. H to mass correlations). It was slightly more likely with the DRUM samples since 6 different stages were used to calculate total DRUM sulfur (0 to 2.12μm).

GLOSSARY OF TERMS, ABBREVIATIONS, AND SYMBOLS

Analytical Techniques

FAST - Forward Alpha Scattering Techniques (H to F)
LIPM - Laser Integrating Plate Method (C soot)
PIXE - Particle Induced X-ray Emission (Na to U)
XRF - X-Ray Fluorescence (Ca to U)
PESA - Proton Elastic Scattering Analysis (H)

Sampler Systems

DRUM - Davis Rotating-drum Unit for Monitoring sampler
IMPROVE - Interagency Monitoring of PROtected Visual Environments cyclone sampler

Other

AQG - Air Quality Group
ARB - Air Resources Board
CARB - California Air Resources Board
CMB - Chemical Mass Balance
CNL - Crocker Nuclear Laboratory
CSMCS - Carbon Species Methods Comparison Study, 1986
ENSR - ENSR Consulting and Engineering
MDL - Minimum Detectable Limit
MeV - Mega Electron Volts
μg - micrograms
μm - microns
PM2.5 - Particulate Matter 2.5μm
PM10 - Particulate Matter 10μm
SCAQS - Southern California Air Quality Study, 1987
SOCAB - South Coast Air Basin
U.C. Davis - University of California, Davis

LIST OF PUBLICATIONS

1. Cahill, T.A., R.T. Matsumura, B.P. Perley, R.A. Eldred, L.K. Wilkinson and B. Kusko. 1989. Total elemental analysis of filters in SCAQS. Presented at the 82nd Annual AWMA Meeting and Exhibition, Anaheim, CA., June 25-30, 1989.

2. Cahill, T.A., R.T. Matsumura, P.H. Wakabayashi, and M. Surovik. 1989. Size-resolved aerosols and visibility during the Southern California Air Quality Study. Presented at the 82nd Annual AWMA Meeting and Exhibition, Anaheim, CA., June 25-30, 1989.

3. Cahill, T.A. and R.T. Matsumura. 1989. Particulate matter by size and composition during SCAQS. American Association for Aerosol Research. In preparation.

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10. Cahill, T.A., P.J. Feeney, R.A. Eldred and W.C. Malm. 1987d. Size/time/composition data at Grand Canyon National Park and the role of ultrafine sulfur particles. Visibility Protection: Research and Policy Aspects, ed. by P.S. Bhardwaja, APCA, Pittsburg, PA. :657.

11. Cahill, T.A., P.J. Feeney, R.A. Eldred. 1987e. Size-time profile of aerosols using the DRUM sampler. Nuclear Instruments and Method in Physics Research, B22(1987)344-348.

12. Cahill, T.A., M. Surovik, R.A. Eldred, P.J. Feeney, N. Motallebi. 1988a. Visibility and particle size at the 1986 Carbon Shoot-Out and 1987 WHITEX programs. Presented at the APCA 81st Annual Meeting, Dallas, Texas, June 20-24, 1988.

13. Croes, B.E., J.F. Collins. 1989. Data management for the Southern California Air Quality Study. Presented at the 82nd Annual Meeting of the Air and Waste Management Association, Anaheim, Ca., June 25-30, 1989. Paper 89-138.6.

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17. Kusko, B.H., T.A. Cahill and R.A. Eldred. 1988. Non-destructive light element analysis by Forward Ion Scattering Techniques. Presented at APCA 81st Annual Meeting, Dallas, TX., June, 1988. Paper 88-53.4.

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Appendix A

IMPROVE Filter Data: Mass, Optical Absorption, FAST, and PIXE

Gravimetric mass (Cahn 31 electrobalance), optical absorption (LIPM), and elemental measurements (FAST and PIXE) of all analyzed SCAQS IMPROVE teflon filters are listed by site in Appendix A. If a measurement was below minimum detectable limits, the MDL is given and denoted by negative sign. The data also includes filters which were not reported to the SCAQS data set due to sampling or analysis problems (i.e. filter's status is nonblank). The reported light elements from FAST analyses include hydrogen, carbon, oxygen, and nitrogen in micrograms per cubic meter. All nitrogen values were reported as suspect because of calibration difficulties as well as possible loss of volatile nitrogen under vacuum during analysis. Reported PIXE elements include Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Pb, Se, and Br in nanograms per cubic meter.

Site: Long Beach
Project: SCAQS 1987, Summer and Fall
Organization: U.C. Davis
Sampler: IMPROVE Cyclone - Teflon Filters
Particulate Size: < 2.5µm
Analysis: Gravimetric Mass, Optical Absorption, FAST, PIXE
Units: micrograms per cubic meter for Mass and FAST: H to O
: 10**(-6) meters for Optical Absorption
: nanograms per cubic meter for PIXE : Na to Br
# of Samples : 85
Column Header: ID = Identification # of sample for each row
: Description : Start Day, Month, Time(military time, PDT for Summ and PST for Fall)
: Status = CG - clogged filter, uncertain volume
= PP - Sample duration is >> SCAQS schedule
= OY - overlap of volume between 2 filters, uncertain volum
= PX - unacceptable PIXE Analysis
= XX - did not sample
: ET = Sample Durations(decimal hours)
: Ma = Gravimetric Mass - µg/m**3
: OA = Optical Absorption - 10**(-6) meters
: Elemental Concentrations (eg. Fe=iron) and uncertainties
If element is below minimum detectable limits(MDL), the MDL is given(marked by a negative sign).

ID	Description	Status	ET(hrs.)	Ma	OA (10**6 inverse meters)
1	19JUN 0100		4.70	15.55 +/- 1.37	15.78 +/- 0.59
2	19JUN 0600		3.49	17.08 +/- 1.83	18.08 +/- 0.72
3	19JUN 1000		3.70	23.55 +/- 1.95	22.03 +/- 0.82
4	19JUN 1400		3.49	22.21 +/- 1.91	25.16 +/- 0.93
5	19JUN 1800		6.70	20.39 +/- 1.11	16.59 +/- 0.52
6	24JUN 0100		4.76	31.65 +/- 1.61	19.24 +/- 0.58
7	24JUN 0600		3.50	40.26 +/- 2.24	29.32 +/- 0.93
8	24JUN 1000		3.75	25.18 +/- 1.80	26.93 +/- 0.94
9	24JUN 1400		3.51	24.21 +/- 1.91	26.64 +/- 0.96
10	24JUN 1800		6.75	24.79 +/- 1.23	16.96 +/- 0.50
11	25JUN 0100		4.76	28.45 +/- 1.56	17.80 +/- 0.56
12	25JUN 0600		3.50	25.12 +/- 1.94	23.50 +/- 0.84
13	25JUN 1000		3.71	18.41 +/- 1.76	23.37 +/- 0.89
14	25JUN 1400		3.49	20.98 +/- 1.91	24.19 +/- 0.91
15	25JUN 1800		6.50	25.18 +/- 1.26	23.28 +/- 0.69
16	13JUL 0100		4.74	13.08 +/- 1.34	14.39 +/- 0.56
17	13JUL 0600		3.50	26.61 +/- 1.93	38.59 +/- 1.35
18	13JUL 1000		3.75	25.82 +/- 1.88	33.57 +/- 1.18
19	13JUL 1400		3.49	20.03 +/- 1.88	26.26 +/- 1.00
20	13JUL 1800		6.70	14.41 +/- 1.03	12.47 +/- 0.44

(units in micrograms/m**3)

ID	Description	Status	ET(hrs.)	Me	OA (10**6 inverse meters)
21	14JUL 0100		4.76	19.48 +/- 1.44	12.68 +/- 0.46
22	14JUL 0600		3.49	25.16 +/- 1.99	21.27 +/- 0.78
23	14JUL 1000		3.75	33.32 +/- 2.03	34.61 +/- 1.14
24	14JUL 1400		3.48	26.58 +/- 1.97	31.27 +/- 1.10
25	14JUL 1800		6.80	17.40 +/- 1.06	15.07 +/- 0.50
26	15JUL 0100		4.77	14.70 +/- 1.41	10.38 +/- 0.41
27	15JUL 0600		3.50	17.00 +/- 1.91	18.96 +/- 0.76
28	15JUL 1000		3.62	12.10 +/- 1.82	14.85 +/- 0.65
29	15JUL 1400	PX	3.48	7.21 +/- 1.83	15.59 +/- 0.76
30	15JUL 1800		6.70	16.10 +/- 1.11	10.38 +/- 0.37
31	27AUG 0100		4.75	24.29 +/- 1.49	19.62 +/- 0.64
32	27AUG 0600		3.48	33.16 +/- 2.03	47.49 +/- 1.56
33	27AUG 1000		3.75	28.19 +/- 1.86	36.16 +/- 1.22
34	27AUG 1400		3.48	27.73 +/- 1.99	31.36 +/- 1.10
35	27AUG 1800		6.73	26.15 +/- 1.19	22.81 +/- 0.63
36	28AUG 0100		4.70	27.09 +/- 1.54	20.58 +/- 0.65
37	28AUG 0600		3.49	50.73 +/- 2.33	57.64 +/- 1.61
38	28AUG 1000		3.74	59.17 +/- 2.48	61.69 +/- 1.59
39	28AUG 1400		3.48	36.90 +/- 2.21	36.01 +/- 1.17
40	28AUG 1800		6.72	28.19 +/- 1.26	20.37 +/- 0.56
41	29AUG 0100		4.75	43.92 +/- 1.94	26.47 +/- 0.72
42	29AUG 0600		3.48	37.23 +/- 2.11	27.73 +/- 0.88
43	29AUG 1000		3.75	37.94 +/- 2.01	23.84 +/- 0.73
44	29AUG 1400		3.49	33.94 +/- 2.05	25.63 +/- 0.84
45	29AUG 1800		6.73	18.67 +/- 1.08	14.10 +/- 0.45
46	02SEP 0100		4.70	23.97 +/- 1.41	39.40 +/- 1.91
47	02SEP 0600		3.48	40.16 +/- 2.04	102.44 +/- 4.58
48	02SEP 1000		3.70	65.57 +/- 2.51	112.28 +/- 4.29
49	02SEP 1400		3.48	24.18 +/- 1.80	44.28 +/- 2.34
50	02SEP 1800		6.73	18.57 +/- 1.00	22.42 +/- 1.05
51	03SEP 0100		4.70	24.06 +/- 1.40	18.77 +/- 1.00
52	03SEP 0600		3.49	29.42 +/- 1.85	33.25 +/- 1.69
53	03SEP 1000		3.70	26.23 +/- 1.74	39.86 +/- 2.03
54	03SEP 1400		3.49	19.29 +/- 1.74	24.91 +/- 1.51
55	03SEP 1800		6.74	14.59 +/- 0.95	16.78 +/- 0.87
56	11NOV 0000		6.00	29.51 +/- 1.36	94.93 +/- 4.17
57	11NOV 0600		3.60	32.04 +/- 1.98	107.38 +/- 5.40
58	11NOV 1000	PP	10.56	48.49 +/- 1.56	117.98 +/- 3.76
59	11NOV 1400		4.00	23.47 +/- 1.64	47.07 +/- 2.52
60	11NOV 1800	PP	8.30	39.77 +/- 1.39	104.66 +/- 3.81
61	12NOV 0000		6.00	38.90 +/- 1.52	108.47 +/- 4.31
62	12NOV 0600		3.80	92.06 +/- 3.16	272.39 +/- 9.95
63	12NOV 1011		3.86	45.55 +/- 2.10	68.09 +/- 2.98
64	12NOV 1400		4.00	75.69 +/- 2.71	113.27 +/- 4.20
65	12NOV 1800		6.00	34.13 +/- 1.43	52.43 +/- 2.16
66	13NOV 0000		6.05	73.18 +/- 2.40	75.31 +/- 2.45

(units in micrograms/m**3)

Long Beach - IMPROVE Filter Data

ID	Description	Status	ET	Me	OA (10**6 inverse meters)
67	13NOV 0600		3.84	79.82 +/- 2.84	81.70 +/- 3.00
68	13NOV 1000		4.00	25.50 +/- 1.67	33.46 +/- 1.81
69	13NOV 1400		4.00	20.94 +/- 1.61	29.74 +/- 1.74
70	13NOV 1800		6.00	19.67 +/- 1.15	22.78 +/- 1.17
71	03DEC 0000		6.00	129.81 +/- 4.03	224.74 +/- 5.87
72	03DEC 0600		3.87	192.64 +/- 6.00	303.38 +/- 8.11
73	03DEC 1000		4.00	172.87 +/- 5.44	187.00 +/- 5.10
74	03DEC 1400		4.00	162.82 +/- 5.12	142.36 +/- 4.00
75	03DEC 1800		6.00	115.05 +/- 3.60	138.71 +/- 3.77
76	10DEC 0000		6.00	123.19 +/- 3.83	259.95 +/- 7.09
77	10DEC 0600		3.73	102.94 +/- 3.48	220.71 +/- 7.69
78	10DEC 1000		4.00	79.25 +/- 2.81	109.05 +/- 3.99
79	10DEC 1400		4.00	42.04 +/- 1.96	75.85 +/- 3.36
80	10DEC 1800		6.00	49.88 +/- 1.80	139.42 +/- 5.33
81	11DEC 0000		6.00	65.36 +/- 2.20	133.63 +/- 4.59
82	11DEC 0600		3.77	65.32 +/- 2.51	151.76 +/- 5.97
83	11DEC 1000		4.00	52.83 +/- 2.18	88.35 +/- 3.64
84	11DEC 1400		4.00	97.04 +/- 3.27	123.52 +/- 4.22
85	11DEC 1800		6.00	139.85 +/- 4.32	223.78 +/- 5.59

(units in micrograms/m**3)

Long Beach - IMPROVE Filter Data

ID	Description	Status	H	C	N	O
1	19JUN 0100		0.55 +/- 0.03	-2.12 +/- 0.00	0.46 +/- 0.19	5.24 +/- 0.50
2	19JUN 0600		0.66 +/- 0.03	-2.94 +/- 0.00	0.76 +/- 0.22	5.58 +/- 0.53
3	19JUN 1000		0.95 +/- 0.05	5.70 +/- 1.14	1.30 +/- 0.26	6.40 +/- 0.60
4	19JUN 1400		0.85 +/- 0.04	6.47 +/- 0.92	1.53 +/- 0.27	6.68 +/- 0.63
5	19JUN 1800		0.66 +/- 0.03		1.48 +/- 0.25	6.18 +/- 0.58
6	24JUN 0100		1.49 +/- 0.07	5.78 +/- 0.83	4.61 +/- 0.62	11.56 +/- 1.06
7	24JUN 0600		1.88 +/- 0.09	8.84 +/- 1.25	3.89 +/- 0.54	13.33 +/- 1.22
8	24JUN 1000		1.23 +/- 0.06	5.35 +/- 1.07	2.19 +/- 0.34	8.40 +/- 0.78
9	24JUN 1400		1.15 +/- 0.06	7.79 +/- 0.91	2.74 +/- 0.40	8.32 +/- 0.77
10	24JUN 1800		1.14 +/- 0.06	4.42 +/- 0.88	2.90 +/- 0.41	8.53 +/- 0.78
11	25JUN 0100		1.34 +/- 0.07		3.31 +/- 0.46	9.59 +/- 0.88
12	25JUN 0600		1.29 +/- 0.06	-3.85 +/- 0.00	2.82 +/- 0.41	8.48 +/- 0.78
13	25JUN 1000		0.97 +/- 0.05	4.48 +/- 0.63	0.68 +/- 0.21	5.39 +/- 0.51
14	25JUN 1400		1.13 +/- 0.06	4.09 +/- 0.40	1.55 +/- 0.28	6.03 +/- 0.57
15	25JUN 1800		1.14 +/- 0.06	5.14 +/- 0.49	2.33 +/- 0.34	7.06 +/- 0.65
16	13JUL 0100		0.58 +/- 0.03	3.68 +/- 0.74	0.67 +/- 0.19	2.62 +/- 0.27
17	13JUL 0600		1.01 +/- 0.05	6.68 +/- 0.63	1.17 +/- 0.24	3.96 +/- 0.39
18	13JUL 1000		1.44 +/- 0.07	6.65 +/- 1.27	2.45 +/- 0.37	7.33 +/- 0.68
19	13JUL 1400		1.20 +/- 0.06	5.69 +/- 0.82	1.13 +/- 0.24	5.81 +/- 0.55
20	13JUL 1800		0.66 +/- 0.03	-2.15 +/- 0.00	0.96 +/- 0.20	3.97 +/- 0.38
21	14JUL 0100		1.08 +/- 0.05	-3.21 +/- 0.00	1.61 +/- 0.27	6.44 +/- 0.60
22	14JUL 0600		1.57 +/- 0.08	4.92 +/- 0.91	4.16 +/- 0.57	8.65 +/- 0.80
23	14JUL 1000		1.82 +/- 0.09	8.61 +/- 0.62	4.25 +/- 0.58	10.97 +/- 1.00
24	14JUL 1400		1.63 +/- 0.08	6.37 +/- 0.80	5.20 +/- 0.70	10.66 +/- 0.98
25	14JUL 1800		0.92 +/- 0.05		2.07 +/- 0.31	5.75 +/- 0.54
26	15JUL 0100		0.87 +/- 0.04	-2.64 +/- 0.00	1.99 +/- 0.31	4.75 +/- 0.45
27	15JUL 0600		1.00 +/- 0.05	4.13 +/- 0.83	2.34 +/- 0.36	4.88 +/- 0.47
28	15JUL 1000		0.76 +/- 0.04	-3.57 +/- 0.00	0.46 +/- 0.00	2.52 +/- 0.26
29	15JUL 1400	PX		-3.26 +/- 0.00	-0.41 +/- 0.00	0.87 +/- 0.14
30	15JUL 1800		0.90 +/- 0.05	2.74 +/- 0.55	1.98 +/- 0.30	4.84 +/- 0.46
31	27AUG 0100		0.97 +/- 0.05	4.69 +/- 0.49	3.17 +/- 0.45	6.55 +/- 0.61
32	27AUG 0600		1.40 +/- 0.07	8.21 +/- 1.64	3.58 +/- 0.50	7.69 +/- 0.71
33	27AUG 1000		1.38 +/- 0.07	9.61 +/- 0.80	3.35 +/- 0.47	9.54 +/- 0.88
34	27AUG 1400		1.50 +/- 0.07	7.50 +/- 0.65	2.17 +/- 0.34	9.59 +/- 0.88
35	27AUG 1800		1.07 +/- 0.05	4.47 +/- 0.89	3.31 +/- 0.45	8.00 +/- 0.74
36	28AUG 0100		1.17 +/- 0.06	4.50 +/- 0.90	3.22 +/- 0.45	7.54 +/- 0.70
37	28AUG 0600		2.18 +/- 0.11	12.31 +/- 0.41	7.27 +/- 0.95	14.36 +/- 1.31
38	28AUG 1000		2.96 +/- 0.15	12.21 +/- 0.81	7.66 +/- 0.99	19.11 +/- 1.73
39	28AUG 1400		1.97 +/- 0.10	8.41 +/- 1.50	4.96 +/- 0.67	12.24 +/- 1.12
40	28AUG 1800		1.25 +/- 0.06	4.97 +/- 0.29	3.94 +/- 0.53	9.00 +/- 0.83
41	29AUG 0100		2.29 +/- 0.11	8.11 +/- 1.62	10.25 +/- 1.31	15.37 +/- 1.40
42	29AUG 0600		1.74 +/- 0.09	7.79 +/- 0.65	6.05 +/- 0.80	11.33 +/- 1.04
43	29AUG 1000		2.31 +/- 0.12	6.34 +/- 0.86	7.31 +/- 0.95	15.67 +/- 1.43
44	29AUG 1400		1.83 +/- 0.09	6.29 +/- 0.74	5.68 +/- 0.75	12.17 +/- 1.11
45	29AUG 1800		0.86 +/- 0.04	2.63 +/- 0.53	2.62 +/- 0.37	5.94 +/- 0.55
46	02SEP 0100		1.36 +/- 0.07	-8.67 +/- 0.00	-1.13 +/- 0.00	3.01 +/- 0.32

(units in micrograms/m**3)

Long Beach - IMPROVE Filter Data

ID	Description	Status	H	C	N	O
47	02SEP 0600		2.11 +/- 0.11	16.81 +/- 3.36	-1.22 +/- 0.00	6.17 +/- 0.60
48	02SEP 1000		3.55 +/- 0.18	29.48 +/- 3.69	6.22 +/- 0.85	15.86 +/- 1.45
49	02SEP 1400		1.54 +/- 0.08	-8.40 +/- 0.00	1.92 +/- 0.38	3.61 +/- 0.38
50	02SEP 1800		0.90 +/- 0.04		1.54 +/- 0.30	4.24 +/- 0.42
51	03SEP 0100		1.28 +/- 0.06	-8.47 +/- 0.00	1.91 +/- 0.36	3.84 +/- 0.39
52	03SEP 0600		1.81 +/- 0.09		1.58 +/- 0.35	6.96 +/- 0.67
53	03SEP 1000		1.82 +/- 0.09	-9.28 +/- 0.00	3.96 +/- 0.59	6.36 +/- 0.61
54	03SEP 1400		1.58 +/- 0.08	-12.14 +/- 0.00	2.98 +/- 0.49	2.20 +/- 0.27
55	03SEP 1800		0.95 +/- 0.05	-4.69 +/- 0.00	1.61 +/- 0.31	4.28 +/- 0.42
56	11NOV 0000		1.51 +/- 0.08	14.08 +/- 0.58	1.22 +/- 0.29	2.65 +/- 0.28
57	11NOV 0600		2.04 +/- 0.10	13.04 +/- 2.61	-1.50 +/- 0.00	2.26 +/- 0.25
58	11NOV 1000	PP	2.04 +/- 0.10	20.26 +/- 0.98	4.28 +/- 0.60	8.63 +/- 0.80
59	11NOV 1400		1.48 +/- 0.07	10.64 +/- 1.51	2.24 +/- 0.40	2.25 +/- 0.25
60	11NOV 1800	PP	1.84 +/- 0.09	15.06 +/- 2.81	2.90 +/- 0.44	6.03 +/- 0.57
61	12NOV 0000		2.06 +/- 0.10	17.19 +/- 0.83	4.84 +/- 0.67	6.21 +/- 0.59
62	12NOV 0600		4.67 +/- 0.23	45.49 +/- 1.90	4.83 +/- 0.70	13.34 +/- 1.23
63	12NOV 1011		2.67 +/- 0.13	19.57 +/- 3.82	3.38 +/- 0.52	8.40 +/- 0.78
64	12NOV 1400		3.34 +/- 0.17	16.02 +/- 3.20	6.66 +/- 0.90	13.42 +/- 1.23
65	12NOV 1800		1.89 +/- 0.09	6.76 +/- 0.65	6.28 +/- 0.85	7.41 +/- 0.70
66	13NOV 0000		3.38 +/- 0.17	14.86 +/- 2.97	14.06 +/- 1.80	20.41 +/- 1.85
67	13NOV 0600		3.91 +/- 0.20	-8.94 +/- 0.00	20.39 +/- 2.59	24.18 +/- 2.20
68	13NOV 1000		1.78 +/- 0.09	-9.02 +/- 0.00	-1.60 +/- 0.00	3.34 +/- 0.33
69	13NOV 1400		1.43 +/- 0.07	-8.48 +/- 0.00	1.57 +/- 0.34	2.31 +/- 0.24
70	13NOV 1800		1.11 +/- 0.06	-5.55 +/- 0.00	-0.99 +/- 0.00	1.92 +/- 0.21
71	03DEC 0000		6.09 +/- 0.30	45.26 +/- 4.09	17.02 +/- 2.16	28.71 +/- 2.60
72	03DEC 0600		9.12 +/- 0.46	50.08 +/- 6.37	37.37 +/- 4.70	57.27 +/- 5.17
73	03DEC 1000		7.95 +/- 0.40	39.38 +/- 4.96	53.02 +/- 6.65	53.60 +/- 4.84
74	03DEC 1400		8.59 +/- 0.43	32.95 +/- 6.59	42.32 +/- 5.32	64.68 +/- 5.83
75	03DEC 1800		5.59 +/- 0.28	27.87 +/- 4.03	23.86 +/- 3.01	35.73 +/- 3.23
76	10DEC 0000		6.14 +/- 0.31	50.72 +/- 2.26	16.65 +/- 2.12	31.27 +/- 2.83
77	10DEC 0600		5.45 +/- 0.27	38.92 +/- 1.80	16.70 +/- 2.13	26.96 +/- 2.44
78	10DEC 1000		4.54 +/- 0.23	25.47 +/- 3.52	12.37 +/- 1.60	23.47 +/- 2.13
79	10DEC 1400		2.42 +/- 0.12		4.97 +/- 0.70	6.03 +/- 0.57
80	10DEC 1800		2.72 +/- 0.14	26.20 +/- 1.87	1.64 +/- 0.32	7.08 +/- 0.66
81	11DEC 0000		3.23 +/- 0.16	26.78 +/- 0.86	5.03 +/- 0.69	12.85 +/- 1.18
82	11DEC 0600		3.47 +/- 0.17	25.30 +/- 3.41	10.10 +/- 1.32	12.96 +/- 1.19
83	11DEC 1000		3.15 +/- 0.16		6.33 +/- 0.86	12.71 +/- 1.17
84	11DEC 1400			19.65 +/- 3.77	22.84 +/- 2.89	33.67 +/- 3.05
85	11DEC 1800		6.93 +/- 0.35	43.33 +/- 4.20	32.46 +/- 4.08	41.57 +/- 3.75

(units in micrograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	AL			SI			S		
1	19JUN 0100	35.6	+/-	4.1	103.9	+/-	6.4	722.3	+/-	38.2
2	19JUN 0600	-6.3	+/-	0.0	99.1	+/-	7.6	1438.4	+/-	76.8
3	19JUN 1000	72.5	+/-	9.0	209.8	+/-	12.8	1823.7	+/-	92.4
4	19JUN 1400	82.0	+/-	9.9	239.5	+/-	15.3	1592.9	+/-	81.9
5	19JUN 1800	92.6	+/-	7.3	177.5	+/-	10.2	1303.4	+/-	66.1
6	24JUN 0100	-7.8	+/-	0.0	159.7	+/-	10.6	3291.6	+/-	166.3
7	24JUN 0600	136.5	+/-	12.3	240.4	+/-	16.1	3646.0	+/-	183.6
8	24JUN 1000	70.8	+/-	7.8	174.7	+/-	11.3	2682.0	+/-	135.4
9	24JUN 1400	84.7	+/-	9.8	234.1	+/-	14.1	2262.3	+/-	114.6
10	24JUN 1800	59.0	+/-	6.3	163.4	+/-	9.5	2000.5	+/-	100.7
11	25JUN 0100	41.5	+/-	5.0	156.3	+/-	10.1	2961.4	+/-	148.9
12	25JUN 0600	-7.9	+/-	0.0	165.8	+/-	12.7	2882.7	+/-	146.1
13	25JUN 1000	48.7	+/-	5.7	158.7	+/-	9.9	1860.0	+/-	95.1
14	25JUN 1400	53.4	+/-	6.1	218.3	+/-	12.8	2188.1	+/-	110.3
15	25JUN 1810	70.1	+/-	6.5	147.2	+/-	8.5	1662.6	+/-	83.7
16	13JUL 0100	17.3	+/-	3.0	67.3	+/-	5.0	889.1	+/-	45.1
17	13JUL 0600	44.4	+/-	5.0	140.1	+/-	9.1	1333.1	+/-	68.0
18	13JUL 1000	131.5	+/-	10.9	272.2	+/-	15.8	2201.6	+/-	111.0
19	13JUL 1400	240.2	+/-	16.0	341.1	+/-	19.2	1775.2	+/-	89.7
20	13JUL 1800	67.5	+/-	6.4	139.0	+/-	8.4	1438.9	+/-	72.8
21	14JUL 0100	79.8	+/-	8.5	137.5	+/-	9.9	2600.8	+/-	131.9
22	14JUL 0600	58.8	+/-	8.0	166.4	+/-	12.5	3464.2	+/-	174.8
23	14JUL 1000	123.9	+/-	11.5	278.5	+/-	16.2	3791.9	+/-	190.6
24	14JUL 1400	254.4	+/-	17.5	411.5	+/-	22.6	3403.1	+/-	171.2
25	14JUL 1800	132.8	+/-	9.8	192.5	+/-	11.2	1922.0	+/-	96.7
26	15JUL 0100	5.5	+/-	1.9	51.5	+/-	4.2	1902.7	+/-	96.4
27	15JUL 0600	57.3	+/-	9.1	121.7	+/-	8.9	2152.1	+/-	108.6
28	15JUL 1000	51.4	+/-	9.6	106.6	+/-	9.3	1351.3	+/-	69.6
29	15JUL 1400	-31.7	+/-	0.0	-24.1	+/-	0.0	1026.5	+/-	68.6
30	15JUL 1800	26.2	+/-	4.5	98.8	+/-	7.2	1741.3	+/-	87.6
31	27AUG 0100	44.5	+/-	5.2	98.9	+/-	6.5	1586.5	+/-	79.9
32	27AUG 0600	47.3	+/-	6.1	154.5	+/-	9.7	1761.6	+/-	89.8
33	27AUG 1000	161.3	+/-	11.3	304.7	+/-	16.9	2178.1	+/-	110.1
34	27AUG 1400	345.0	+/-	22.8	474.6	+/-	26.6	2333.5	+/-	117.6
35	27AUG 1800	120.8	+/-	8.6	195.3	+/-	11.1	1836.7	+/-	92.4
36	28AUG 0100	-6.4	+/-	0.0	169.1	+/-	10.0	1991.2	+/-	100.2
37	28AUG 0600	93.1	+/-	8.1	240.9	+/-	14.2	3277.0	+/-	165.1
38	28AUG 1000	151.2	+/-	15.9	437.6	+/-	26.4	5939.5	+/-	298.2
39	28AUG 1400	187.2	+/-	16.9	356.3	+/-	21.9	3849.1	+/-	194.6
40	28AUG 1800	98.6	+/-	8.4	187.4	+/-	10.9	2340.6	+/-	117.7
41	29AUG 0100	69.3	+/-	7.0	215.1	+/-	13.4	3765.8	+/-	189.4
42	29AUG 0600	95.2	+/-	21.3	149.2	+/-	12.8	3677.4	+/-	185.1
43	29AUG 1000	655.3	+/-	35.6	285.1	+/-	17.9	5489.2	+/-	275.7
44	29AUG 1400	186.3	+/-	13.1	291.3	+/-	17.0	4231.7	+/-	212.9
45	29AUG 1800	59.8	+/-	5.7	137.9	+/-	8.2	2064.8	+/-	103.9
46	02SEP 0100	116.2	+/-	13.1	211.5	+/-	15.9	2143.1	+/-	110.0
47	02SEP 0600	165.5	+/-	25.0	321.5	+/-	27.4	2303.1	+/-	122.5
48	02SEP 1000	246.1	+/-	21.5	502.5	+/-	29.5	3418.8	+/-	173.5
49	02SEP 1400	320.5	+/-	27.5	518.7	+/-	31.4	2081.8	+/-	106.8
50	02SEP 1800	65.3	+/-	7.3	170.3	+/-	10.5	1610.9	+/-	81.6
51	03SEP 0100	-14.3	+/-	0.0	132.7	+/-	12.5	2432.9	+/-	125.6
52	03SEP 0600	75.7	+/-	12.3	187.3	+/-	15.3	3570.7	+/-	181.2
53	03SEP 1000	60.3	+/-	9.8	220.3	+/-	15.6	3406.2	+/-	172.6
54	03SEP 1400	58.0	+/-	13.0	209.2	+/-	17.5	2582.2	+/-	132.4
55	03SEP 1800	21.6	+/-	4.1	99.2	+/-	7.4	2068.4	+/-	104.7

(units in nanograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	AL			SI			S		
56	11NOV 0000	218.8	+/-	15.6	434.3	+/-	24.1	605.2	+/-	32.0
57	11NOV 0600	321.8	+/-	40.6	470.1	+/-	35.4	612.1	+/-	37.5
58	11NOV 1030	165.5	+/-	11.0	290.6	+/-	16.1	665.9	+/-	37.5
59	11NOV 1400	228.8	+/-	17.7	360.9	+/-	21.5	699.9	+/-	37.0
60	11NOV 1800	145.0	+/-	13.9	214.2	+/-	14.3	700.7	+/-	41.7
61	12NOV 0000	143.4	+/-	11.0	248.6	+/-	14.6	660.1	+/-	37.0
62	12NOV 0600	435.4	+/-	33.3	588.0	+/-	36.3	1332.2	+/-	104.6
63	12NOV 1011	155.4	+/-	15.8	373.8	+/-	23.7	1325.1	+/-	69.4
64	12NOV 1400	204.7	+/-	20.9	292.7	+/-	21.5	2092.1	+/-	108.0
65	12NOV 1800	115.5	+/-	13.8	211.5	+/-	14.5	1150.2	+/-	59.6
66	13NOV 0000	89.9	+/-	10.4	167.7	+/-	12.7	2241.1	+/-	114.0
67	13NOV 0600	69.3	+/-	14.0	155.7	+/-	15.4	1939.0	+/-	99.3
68	13NOV 1000	-17.0	+/-	0.0	170.1	+/-	14.3	1744.0	+/-	89.4
69	13NOV 1400	51.1	+/-	9.4	171.5	+/-	14.9	1450.5	+/-	74.9
70	13NOV 1800	-15.8	+/-	0.0	99.4	+/-	10.7	1102.4	+/-	57.9
71	03DEC 0000	147.8	+/-	15.7	148.1	+/-	12.4	1866.2	+/-	98.8
72	03DEC 0600	297.9	+/-	30.2	385.8	+/-	28.2	3007.2	+/-	157.1
73	03DEC 1000	280.4	+/-	25.5	418.6	+/-	26.9	2328.3	+/-	119.5
74	03DEC 1400	232.1	+/-	25.3	347.2	+/-	25.1	3566.0	+/-	182.0
75	03DEC 1800	68.6	+/-	11.1	161.9	+/-	13.1	2226.1	+/-	113.5
76	10DEC 0000	198.5	+/-	17.8	295.2	+/-	19.7	1474.8	+/-	81.9
77	10DEC 0600	262.9	+/-	23.3	469.3	+/-	28.9	1418.3	+/-	76.8
78	10DEC 1000	340.4	+/-	30.9	529.6	+/-	34.4	1651.7	+/-	87.0
79	10DEC 1400	246.3	+/-	20.7	293.7	+/-	19.8	935.5	+/-	49.9
80	10DEC 1800	110.5	+/-	12.2	151.8	+/-	11.8	547.3	+/-	32.2
81	11DEC 0000	106.1	+/-	10.0	132.8	+/-	10.2	1110.1	+/-	58.6
82	11DEC 0600	108.1	+/-	13.9	141.0	+/-	12.7	1427.8	+/-	74.1
83	11DEC 1000	-16.3	+/-	0.0	214.8	+/-	17.7	1799.3	+/-	94.3
84	11DEC 1400	166.7	+/-	26.8	245.8	+/-	18.6	2799.5	+/-	144.5
85	11DEC 1800	232.9	+/-	25.6	210.9	+/-	19.0	4808.5	+/-	245.6

(units in nanograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	K		CA		TI		V		CR	
1	19JUN 0100	82.2 +/-	5.6	77.0 +/-	5.1	2.9 +/-	0.9	4.5 +/-	1.2	-1.6 +/-	0.0
2	19JUN 0600	101.1 +/-	10.9	92.1 +/-	11.9	-2.3 +/-	0.0	3.7 +/-	1.2	-2.1 +/-	0.0
3	19JUN 1000	146.6 +/-	9.0	119.1 +/-	8.1	4.9 +/-	1.4	4.1 +/-	2.5	-3.3 +/-	0.0
4	19JUN 1400	131.6 +/-	9.1	123.0 +/-	9.0	7.4 +/-	2.6	-4.8 +/-	0.0	2.4 +/-	1.6
5	19JUN 1800	102.0 +/-	6.1	81.0 +/-	5.5	7.6 +/-	1.3	2.6 +/-	1.2	-2.0 +/-	0.0
6	24JUN 0100	75.8 +/-	5.4	84.2 +/-	8.8	8.6 +/-	1.7	-2.5 +/-	0.0	-2.3 +/-	0.0
7	24JUN 0600	91.6 +/-	6.4	79.7 +/-	6.0	4.5 +/-	2.0	-3.8 +/-	0.0	-3.4 +/-	0.0
8	24JUN 1000	95.0 +/-	6.5	88.2 +/-	6.3	4.2 +/-	1.3	-3.5 +/-	0.0	-3.2 +/-	0.0
9	24JUN 1400	97.5 +/-	6.7	141.3 +/-	9.1	10.0 +/-	2.0	7.7 +/-	2.1	-3.4 +/-	0.0
10	24JUN 1800	71.0 +/-	4.3	80.2 +/-	5.1	36.4 +/-	2.5	-2.1 +/-	0.0	-1.9 +/-	0.0
11	25JUN 0100	64.3 +/-	4.3	51.1 +/-	3.8	5.8 +/-	1.2	-2.5 +/-	0.0	-2.3 +/-	0.0
12	25JUN 0600	117.4 +/-	8.8	79.6 +/-	7.7	-2.8 +/-	0.0	4.4 +/-	1.5	-2.5 +/-	0.0
13	25JUN 1000	110.1 +/-	8.3	96.8 +/-	7.5	-3.0 +/-	0.0	-2.9 +/-	0.0	-2.6 +/-	0.0
14	25JUN 1400	83.1 +/-	5.4	68.6 +/-	4.9	5.2 +/-	1.6	3.7 +/-	1.3	-2.6 +/-	0.0
15	25JUN 1810	52.2 +/-	3.4	45.9 +/-	3.4	5.5 +/-	1.1	2.9 +/-	1.0	-1.7 +/-	0.0
16	13JUL 0100	46.4 +/-	3.3	32.2 +/-	2.6	0.9 +/-	0.7	8.5 +/-	1.2	-1.8 +/-	0.0
17	13JUL 0600	77.4 +/-	5.1	57.0 +/-	4.7	-2.8 +/-	0.0	6.3 +/-	1.4	-2.5 +/-	0.0
18	13JUL 1000	79.8 +/-	5.3	94.5 +/-	6.2	11.5 +/-	1.7	8.3 +/-	1.6	-2.6 +/-	0.0
19	13JUL 1400	86.4 +/-	6.0	76.6 +/-	5.6	28.8 +/-	2.5	4.2 +/-	1.7	-2.8 +/-	0.0
20	13JUL 1800	41.8 +/-	3.2	40.0 +/-	3.3	17.9 +/-	1.9	3.9 +/-	1.4	1.2 +/-	0.8
21	14JUL 0100	46.8 +/-	5.6	40.8 +/-	5.4	-4.2 +/-	0.0	6.0 +/-	2.2	-3.7 +/-	0.0
22	14JUL 0600	56.0 +/-	5.2	49.4 +/-	4.6	3.7 +/-	1.7	-4.0 +/-	0.0	-3.7 +/-	0.0
23	14JUL 1000	84.8 +/-	5.7	91.6 +/-	6.1	10.3 +/-	1.7	-3.2 +/-	0.0	-2.9 +/-	0.0
24	14JUL 1400	97.3 +/-	6.3	98.6 +/-	6.7	18.9 +/-	2.1	-3.1 +/-	0.0	-2.8 +/-	0.0
25	14JUL 1800	70.4 +/-	4.4	39.8 +/-	3.0	13.3 +/-	1.4	2.2 +/-	1.5	-1.7 +/-	0.0
26	15JUL 0100	33.5 +/-	2.9	18.9 +/-	2.1	2.8 +/-	1.1	3.7 +/-	1.2	-1.7 +/-	0.0
27	15JUL 0600	39.2 +/-	3.5	24.2 +/-	2.8	2.9 +/-	1.4	-3.1 +/-	0.0	-2.8 +/-	0.0
28	15JUL 1000	47.5 +/-	5.2	42.9 +/-	5.1	-3.0 +/-	0.0	4.7 +/-	1.2	-2.6 +/-	0.0
29	15JUL 1400	39.5 +/-	11.7	45.4 +/-	10.8	-13.4 +/-	0.0	-12.8 +/-	0.0	-11.6 +/-	0.0
30	15JUL 1800	19.9 +/-	2.1	19.7 +/-	1.8	20.8 +/-	1.6	-1.7 +/-	0.0	-1.6 +/-	0.0
31	27AUG 0100	68.2 +/-	4.1	41.4 +/-	3.2	1.0 +/-	0.7	2.0 +/-	0.8	-1.7 +/-	0.0
32	27AUG 0600	103.6 +/-	6.8	66.0 +/-	4.9	6.5 +/-	1.3	-2.7 +/-	0.0	-2.5 +/-	0.0
33	27AUG 1000	123.2 +/-	7.4	87.4 +/-	6.2	14.7 +/-	2.0	3.2 +/-	1.2	-2.8 +/-	0.0
34	27AUG 1400	137.2 +/-	8.1	128.6 +/-	8.1	17.4 +/-	2.0	-3.0 +/-	0.0	-2.7 +/-	0.0
35	27AUG 1800	76.7 +/-	4.6	42.6 +/-	3.2	11.8 +/-	1.1	2.7 +/-	1.0	-1.5 +/-	0.0
36	28AUG 0100	74.6 +/-	4.6	50.7 +/-	3.7	6.1 +/-	1.2	11.5 +/-	1.5	-2.0 +/-	0.0
37	28AUG 0600	146.2 +/-	8.4	67.5 +/-	5.3	8.6 +/-	1.6	4.5 +/-	1.5	-2.9 +/-	0.0
38	28AUG 1000	132.2 +/-	8.4	118.6 +/-	7.9	22.6 +/-	2.6	-3.8 +/-	0.0	-3.4 +/-	0.0
39	28AUG 1400	151.0 +/-	10.1	133.6 +/-	9.8	14.0 +/-	2.7	7.3 +/-	3.1	-4.6 +/-	0.0
40	28AUG 1800	90.8 +/-	5.2	56.1 +/-	4.0	6.0 +/-	1.1	-1.9 +/-	0.0	-1.7 +/-	0.0
41	29AUG 0100	121.4 +/-	7.6	51.9 +/-	4.5	5.3 +/-	1.5	-3.1 +/-	0.0	-2.8 +/-	0.0
42	29AUG 0600	128.2 +/-	7.9	44.6 +/-	4.7	-3.5 +/-	0.0	2.6 +/-	1.3	-3.1 +/-	0.0
43	29AUG 1000	98.3 +/-	6.5	47.0 +/-	4.6	6.9 +/-	1.9	-3.5 +/-	0.0	-3.2 +/-	0.0
44	29AUG 1400	80.6 +/-	5.8	59.5 +/-	5.2	20.2 +/-	3.4	5.7 +/-	1.8	-3.4 +/-	0.0
45	29AUG 1800	86.6 +/-	5.1	46.1 +/-	3.6	1.5 +/-	1.1	6.8 +/-	1.4	-1.7 +/-	0.0
46	02SEP 0100	237.9 +/-	15.4	117.1 +/-	10.5	6.1 +/-	3.0	12.8 +/-	7.3	-7.4 +/-	0.0
47	02SEP 0600	249.0 +/-	20.0	183.1 +/-	17.3	-14.6 +/-	0.0	-14.1 +/-	0.0	-12.8 +/-	0.0
48	02SEP 1000	254.6 +/-	16.1	190.8 +/-	13.8	23.6 +/-	4.2	15.2 +/-	4.2	-6.9 +/-	0.0
49	02SEP 1400	96.0 +/-	8.8	149.0 +/-	11.6	16.7 +/-	4.2	-8.1 +/-	0.0	-7.3 +/-	0.0
50	02SEP 1800	101.9 +/-	6.4	81.7 +/-	5.9	11.0 +/-	2.0	7.7 +/-	1.7	-3.0 +/-	0.0
51	03SEP 0100	79.1 +/-	8.7	40.2 +/-	5.4	-5.8 +/-	0.0	6.0 +/-	2.2	-5.1 +/-	0.0
52	03SEP 0600	101.1 +/-	8.6	69.2 +/-	7.4	8.3 +/-	2.8	-7.4 +/-	0.0	-6.7 +/-	0.0
53	03SEP 1000	118.4 +/-	9.4	79.6 +/-	7.6	8.2 +/-	2.7	-7.3 +/-	0.0	-6.6 +/-	0.0
54	03SEP 1400	107.2 +/-	10.3	99.6 +/-	10.7	9.8 +/-	4.3	20.1 +/-	4.7	14.0 +/-	5.7
55	03SEP 1800	76.5 +/-	5.8	53.1 +/-	5.0	38.5 +/-	3.4	-4.0 +/-	0.0	-3.6 +/-	0.0

(units in nanograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	K			CA			TI			V			CR		
56	11NOV 0000	169.1	+/-	10.7	216.4	+/-	13.5	38.7	+/-	4.3	-5.3	+/-	0.0	-4.8	+/-	0.0
57	11NOV 0600	112.9	+/-	11.5	214.9	+/-	15.7	-10.1	+/-	0.0	-9.8	+/-	0.0	-8.9	+/-	0.0
58	11NOV 1030	181.8	+/-	10.2	156.7	+/-	9.9	18.4	+/-	2.0	-3.1	+/-	0.0	-2.8	+/-	0.0
59	11NOV 1400	51.6	+/-	5.9	106.0	+/-	8.1	21.5	+/-	3.8	-6.4	+/-	0.0	-5.8	+/-	0.0
60	11NOV 1800	91.0	+/-	6.9	97.0	+/-	7.4	17.5	+/-	2.9	11.9	+/-	2.8	-4.2	+/-	0.0
61	12NOV 0000	161.0	+/-	9.7	144.0	+/-	9.5	12.1	+/-	2.4	-4.2	+/-	0.0	-3.8	+/-	0.0
62	12NOV 0600	385.9	+/-	24.6	336.5	+/-	29.0	67.2	+/-	7.0	12.7	+/-	4.0	-6.4	+/-	0.0
63	12NOV 1011	110.9	+/-	10.1	114.5	+/-	10.0	6.0	+/-	3.2	18.4	+/-	8.6	-7.9	+/-	0.0
64	12NOV 1400	373.6	+/-	22.6	80.1	+/-	10.3	-9.7	+/-	0.0	10.6	+/-	3.9	-8.5	+/-	0.0
65	12NOV 1800	113.5	+/-	9.6	60.7	+/-	6.2	4.8	+/-	2.4	13.8	+/-	3.0	-5.1	+/-	0.0
66	13NOV 0000	145.4	+/-	10.2	74.0	+/-	8.0	7.5	+/-	3.0	14.4	+/-	3.4	-5.9	+/-	0.0
67	13NOV 0600	98.0	+/-	9.1	39.7	+/-	6.2	-7.5	+/-	0.0	6.8	+/-	2.6	-6.6	+/-	0.0
68	13NOV 1000	84.4	+/-	7.7	48.7	+/-	6.1	7.2	+/-	2.6	12.2	+/-	4.4	-6.0	+/-	0.0
69	13NOV 1400	80.5	+/-	7.5	65.2	+/-	7.5	4.2	+/-	2.9	-7.0	+/-	0.0	-6.3	+/-	0.0
70	13NOV 1800	93.7	+/-	8.1	34.7	+/-	5.7	27.1	+/-	4.0	15.6	+/-	3.6	-5.8	+/-	0.0
71	03DEC 0000	481.7	+/-	26.1	67.8	+/-	9.5	28.5	+/-	3.7	-6.3	+/-	0.0	-5.8	+/-	0.0
72	03DEC 0600	400.4	+/-	27.6	135.3	+/-	13.6	33.2	+/-	5.5	12.6	+/-	4.8	-7.8	+/-	0.0
73	03DEC 1000	178.9	+/-	13.7	137.4	+/-	12.6	32.3	+/-	5.2	-9.8	+/-	0.0	-8.9	+/-	0.0
74	03DEC 1400	206.5	+/-	14.4	89.5	+/-	10.3	-10.1	+/-	0.0	4.7	+/-	3.3	-8.9	+/-	0.0
75	03DEC 1800	347.5	+/-	20.0	39.0	+/-	7.5	2.8	+/-	2.3	-6.6	+/-	0.0	-6.0	+/-	0.0
76	10DEC 0000	378.0	+/-	21.6	128.4	+/-	11.6	42.4	+/-	4.7	-7.6	+/-	0.0	-6.9	+/-	0.0
77	10DEC 0600	292.6	+/-	18.2	232.8	+/-	17.9	21.2	+/-	4.7	-9.4	+/-	0.0	-8.5	+/-	0.0
78	10DEC 1000	185.2	+/-	15.1	218.5	+/-	16.5	171.0	+/-	12.5	23.8	+/-	7.6	-10.0	+/-	0.0
79	10DEC 1400	101.7	+/-	9.7	98.1	+/-	9.2	22.5	+/-	5.0	12.1	+/-	4.0	-7.9	+/-	0.0
80	10DEC 1800	364.4	+/-	20.7	53.9	+/-	8.0	6.7	+/-	2.4	7.1	+/-	3.3	-5.7	+/-	0.0
81	11DEC 0000	271.8	+/-	17.0	49.4	+/-	8.3	13.1	+/-	2.9	12.7	+/-	2.9	-3.6	+/-	0.0
82	11DEC 0600	144.8	+/-	10.3	51.2	+/-	7.0	17.3	+/-	5.8	-7.2	+/-	0.0	-6.5	+/-	0.0
83	11DEC 1000	109.7	+/-	10.7	74.8	+/-	8.4	14.8	+/-	4.9	25.6	+/-	5.6	-5.7	+/-	0.0
84	11DEC 1400	126.0	+/-	11.6	84.8	+/-	9.4	14.7	+/-	3.8	16.1	+/-	4.4	-5.6	+/-	0.0
85	11DEC 1800	236.7	+/-	14.9	69.2	+/-	8.1	18.9	+/-	3.3	-7.7	+/-	0.0	-7.0	+/-	0.0

(units in nanograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	MN		FE		NI		CU		ZN	
1	19JUN 0100	-1.4 +/-	0.0	47.3 +/-	2.6	0.6 +/-	0.3	10.2 +/-	0.7	23.9 +/-	1.4
2	19JUN 0600	-1.9 +/-	0.0	40.3 +/-	2.5	-1.5 +/-	0.0	2.3 +/-	0.5	4.2 +/-	0.6
3	19JUN 1000	-3.0 +/-	0.0	86.2 +/-	4.7	-1.6 +/-	0.0	1.9 +/-	0.5	6.4 +/-	0.7
4	19JUN 1400	-4.0 +/-	0.0	96.0 +/-	5.5	-2.2 +/-	0.0	2.6 +/-	0.6	26.6 +/-	2.1
5	19JUN 1800	1.9 +/-	0.7	86.3 +/-	4.6	0.9 +/-	0.3	1.6 +/-	0.3	37.9 +/-	2.1
6	24JUN 0100	-2.1 +/-	0.0	55.1 +/-	3.1	-1.3 +/-	0.0	3.4 +/-	0.6	13.6 +/-	1.0
7	24JUN 0600	-3.1 +/-	0.0	82.3 +/-	4.5	-1.6 +/-	0.0	3.7 +/-	0.6	26.5 +/-	1.7
8	24JUN 1000	-2.9 +/-	0.0	47.5 +/-	3.8	-1.6 +/-	0.0	2.1 +/-	0.7	9.9 +/-	0.9
9	24JUN 1400	2.1 +/-	1.2	108.0 +/-	5.8	-1.7 +/-	0.0	1.3 +/-	0.5	16.8 +/-	1.3
10	24JUN 1800	-1.7 +/-	0.0	73.5 +/-	3.9	1.4 +/-	0.3	1.4 +/-	0.3	13.6 +/-	0.9
11	25JUN 0100	-2.1 +/-	0.0	47.5 +/-	2.6	-1.1 +/-	0.0	6.8 +/-	0.6	13.3 +/-	0.9
12	25JUN 0600	1.4 +/-	0.8	61.6 +/-	3.5	1.3 +/-	0.4	4.8 +/-	0.7	5.6 +/-	0.6
13	25JUN 1000	1.0 +/-	0.9	74.5 +/-	4.1	-1.5 +/-	0.0	1.3 +/-	0.4	6.0 +/-	0.8
14	25JUN 1400	1.1 +/-	0.8	79.3 +/-	4.3	-1.3 +/-	0.0	1.2 +/-	0.3	7.6 +/-	0.7
15	25JUN 1810	2.9 +/-	0.7	80.3 +/-	4.4	1.7 +/-	0.7	2.8 +/-	0.4	16.5 +/-	1.0
16	13JUL 0100	1.6 +/-	0.6	27.3 +/-	1.6	3.3 +/-	0.4	4.3 +/-	0.5	212.4 +/-	10.8
17	13JUL 0600	6.9 +/-	1.7	88.0 +/-	4.7	0.8 +/-	0.4	9.5 +/-	0.9	304.2 +/-	15.4
18	13JUL 1000	2.9 +/-	0.9	125.0 +/-	6.5	3.1 +/-	0.6	1.8 +/-	0.5	145.3 +/-	7.5
19	13JUL 1400	8.5 +/-	1.3	380.4 +/-	19.3	-1.5 +/-	0.0	1.4 +/-	0.4	70.2 +/-	3.8
20	13JUL 1800	-2.0 +/-	0.0	46.9 +/-	2.6	1.3 +/-	0.5	2.4 +/-	0.4	43.0 +/-	2.4
21	14JUL 0100	-3.3 +/-	0.0	31.7 +/-	2.2	-1.8 +/-	0.0	6.0 +/-	1.0	23.1 +/-	1.7
22	14JUL 0600	-3.3 +/-	0.0	46.9 +/-	2.9	-1.8 +/-	0.0	9.5 +/-	1.0	22.6 +/-	1.6
23	14JUL 1000	-2.6 +/-	0.0	120.4 +/-	6.3	2.6 +/-	0.8	1.9 +/-	0.4	22.2 +/-	1.4
24	14JUL 1400	5.1 +/-	1.4	162.3 +/-	8.4	1.1 +/-	0.4	2.3 +/-	0.4	96.8 +/-	5.1
25	14JUL 1800	-1.5 +/-	0.0	58.2 +/-	3.1	1.0 +/-	0.2	1.4 +/-	0.3	35.7 +/-	1.9
26	15JUL 0100	1.5 +/-	0.6	22.1 +/-	1.4	-1.0 +/-	0.0	6.0 +/-	0.6	3.8 +/-	0.4
27	15JUL 0600	-2.5 +/-	0.0	42.9 +/-	2.6	-1.5 +/-	0.0	2.5 +/-	0.5	7.0 +/-	0.8
28	15JUL 1000	2.2 +/-	1.0	56.8 +/-	3.3	-1.6 +/-	0.0	3.3 +/-	0.6	11.2 +/-	1.1
29	15JUL 1400	-10.8 +/-	0.0	80.6 +/-	12.5	-8.0 +/-	0.0	-6.6 +/-	0.0	-6.4 +/-	0.0
30	15JUL 1800	-1.4 +/-	0.0	30.9 +/-	1.8	1.2 +/-	0.3	2.2 +/-	0.3	4.3 +/-	0.4
31	27AUG 0100	-1.5 +/-	0.0	42.7 +/-	2.3	2.7 +/-	0.4	1.0 +/-	0.2	21.0 +/-	1.2
32	27AUG 0600	6.7 +/-	1.3	138.4 +/-	7.2	-1.2 +/-	0.0	12.7 +/-	0.9	245.4 +/-	12.5
33	27AUG 1000	2.7 +/-	1.0	183.9 +/-	9.4	-1.3 +/-	0.0	0.9 +/-	0.4	67.3 +/-	3.6
34	27AUG 1400	-2.5 +/-	0.0	185.5 +/-	9.5	-1.3 +/-	0.0	1.4 +/-	0.4	104.3 +/-	5.4
35	27AUG 1800	1.6 +/-	0.5	68.4 +/-	3.5	-0.7 +/-	0.0	1.7 +/-	0.3	95.7 +/-	4.9
36	28AUG 0100	2.4 +/-	0.7	43.4 +/-	2.4	3.6 +/-	0.5	1.5 +/-	0.3	7.0 +/-	0.6
37	28AUG 0600	4.3 +/-	1.3	117.3 +/-	6.2	1.2 +/-	0.4	3.0 +/-	0.5	94.8 +/-	4.9
38	28AUG 1000	-3.1 +/-	0.0	144.8 +/-	7.5	2.0 +/-	0.5	0.4 +/-	0.4	73.7 +/-	4.0
39	28AUG 1400	-4.2 +/-	0.0	157.8 +/-	8.5	-2.2 +/-	0.0	2.4 +/-	0.7	51.1 +/-	3.1
40	28AUG 1800	-1.6 +/-	0.0	62.2 +/-	3.3	0.6 +/-	0.2	3.7 +/-	0.4	31.0 +/-	1.7
41	29AUG 0100	1.2 +/-	1.2	68.9 +/-	3.7	1.4 +/-	0.4	4.5 +/-	0.6	22.7 +/-	1.5
42	29AUG 0600	-2.8 +/-	0.0	59.5 +/-	3.4	-1.4 +/-	0.0	1.2 +/-	0.5	13.8 +/-	1.1
43	29AUG 1000	-2.9 +/-	0.0	67.2 +/-	3.7	7.1 +/-	0.8	1.8 +/-	0.5	10.4 +/-	0.8
44	29AUG 1400	-3.0 +/-	0.0	73.5 +/-	4.1	8.0 +/-	0.9	1.7 +/-	0.4	12.2 +/-	1.1
45	29AUG 1800	3.2 +/-	1.4	54.9 +/-	2.9	4.0 +/-	0.4	1.9 +/-	0.3	7.3 +/-	0.6
46	02SEP 0100	-6.7 +/-	0.0	98.8 +/-	6.1	4.3 +/-	1.3	18.4 +/-	2.0	163.2 +/-	9.1
47	02SEP 0600	-11.6 +/-	0.0	260.9 +/-	15.3	4.9 +/-	2.0	31.2 +/-	3.7	430.3 +/-	24.0
48	02SEP 1000	13.6 +/-	3.5	327.3 +/-	17.1	5.2 +/-	1.2	8.9 +/-	1.6	261.4 +/-	13.7
49	02SEP 1400	-6.7 +/-	0.0	220.9 +/-	12.0	-3.8 +/-	0.0	3.7 +/-	1.2	87.1 +/-	5.3
50	02SEP 1800	1.6 +/-	0.9	75.8 +/-	4.1	8.1 +/-	0.9	5.1 +/-	0.7	21.3 +/-	1.4
51	03SEP 0100	-4.6 +/-	0.0	35.9 +/-	3.8	4.7 +/-	1.5	11.9 +/-	1.4	10.8 +/-	2.0
52	03SEP 0600	-6.1 +/-	0.0	70.8 +/-	4.8	5.1 +/-	1.5	5.4 +/-	1.1	7.3 +/-	1.3
53	03SEP 1000	-6.0 +/-	0.0	90.1 +/-	5.8	-3.4 +/-	0.0	5.6 +/-	1.3	13.6 +/-	1.9
54	03SEP 1400	-7.6 +/-	0.0	60.9 +/-	5.3	9.1 +/-	3.3	4.7 +/-	1.3	4.3 +/-	2.1
55	03SEP 1800	-3.3 +/-	0.0	33.2 +/-	2.3	-1.9 +/-	0.0	3.5 +/-	0.7	2.5 +/-	0.7

(units in nanograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	MN		FE		NI		CU		ZN	
56	11NOV 0000	25.7 +/-	3.5	367.9 +/-	19.1	-2.4 +/-	0.0	7.9 +/-	1.0	163.6 +/-	8.6
57	11NOV 0600	18.3 +/-	4.4	400.6 +/-	21.5	-4.9 +/-	0.0	9.5 +/-	2.3	219.6 +/-	12.5
58	11NOV 1030	33.2 +/-	3.1	343.1 +/-	17.4	-1.3 +/-	0.0	8.4 +/-	0.8	128.9 +/-	6.8
59	11NOV 1400	19.4 +/-	5.0	263.5 +/-	14.0	-3.1 +/-	0.0	10.3 +/-	1.4	133.8 +/-	7.5
60	11NOV 1800	47.2 +/-	4.5	274.7 +/-	14.0	2.2 +/-	0.5	6.6 +/-	0.7	150.3 +/-	7.8
61	12NOV 0000	31.4 +/-	3.5	301.1 +/-	15.6	-1.9 +/-	0.0	7.1 +/-	0.8	97.5 +/-	5.3
62	12NOV 0600	119.8 +/-	15.1	712.3 +/-	36.2	-3.6 +/-	0.0	23.8 +/-	2.2	364.4 +/-	19.1
63	12NOV 1011	-7.2 +/-	0.0	272.3 +/-	14.7	-4.2 +/-	0.0	9.8 +/-	2.0	81.5 +/-	5.0
64	12NOV 1400	27.9 +/-	5.8	270.8 +/-	15.0	6.7 +/-	2.2	17.4 +/-	2.4	67.2 +/-	4.6
65	12NOV 1800	5.5 +/-	1.8	143.7 +/-	7.8	5.7 +/-	1.1	2.0 +/-	0.7	59.8 +/-	3.6
66	13NOV 0000	-5.4 +/-	0.0	147.7 +/-	8.0	-2.9 +/-	0.0	4.5 +/-	1.1	97.5 +/-	5.4
67	13NOV 0600	5.4 +/-	2.5	111.4 +/-	6.6	-3.5 +/-	0.0	3.3 +/-	1.1	42.1 +/-	2.8
68	13NOV 1000	4.7 +/-	2.0	77.3 +/-	5.0	-3.3 +/-	0.0	2.6 +/-	0.9	18.1 +/-	1.9
69	13NOV 1400	3.9 +/-	2.1	74.5 +/-	4.9	4.3 +/-	1.5	5.0 +/-	1.4	15.7 +/-	1.8
70	13NOV 1800	-5.2 +/-	0.0	50.7 +/-	3.8	5.5 +/-	1.1	-2.6 +/-	0.0	7.4 +/-	1.4
71	03DEC 0000	36.5 +/-	3.8	299.2 +/-	15.4	-2.7 +/-	0.0	21.1 +/-	1.8	179.1 +/-	9.6
72	03DEC 0600	44.3 +/-	5.7	516.3 +/-	27.1	-4.3 +/-	0.0	19.2 +/-	2.1	250.8 +/-	13.3
73	03DEC 1000	29.0 +/-	5.1	491.9 +/-	25.4	12.0 +/-	1.8	4.1 +/-	1.6	113.5 +/-	6.6
74	03DEC 1400	10.2 +/-	3.3	292.2 +/-	15.8	-4.3 +/-	0.0	10.6 +/-	1.7	190.1 +/-	10.6
75	03DEC 1800	18.1 +/-	3.9	200.0 +/-	10.6	2.1 +/-	0.9	5.2 +/-	1.0	67.3 +/-	4.1
76	10DEC 0000	64.9 +/-	6.8	475.5 +/-	24.9	-3.1 +/-	0.0	30.2 +/-	2.3	502.0 +/-	25.8
77	10DEC 0600	62.3 +/-	8.0	491.3 +/-	25.9	-4.1 +/-	0.0	18.3 +/-	2.0	381.0 +/-	20.0
78	10DEC 1000	32.2 +/-	6.2	535.7 +/-	28.2	-4.8 +/-	0.0	10.1 +/-	1.9	319.5 +/-	17.0
79	10DEC 1400	12.4 +/-	3.2	205.2 +/-	12.4	-4.2 +/-	0.0	-3.6 +/-	0.0	168.1 +/-	9.7
80	10DEC 1800	33.9 +/-	4.7	275.2 +/-	14.8	-2.9 +/-	0.0	14.4 +/-	1.5	78.1 +/-	4.6
81	11DEC 0000	48.5 +/-	10.9	187.7 +/-	10.1	-2.2 +/-	0.0	9.8 +/-	1.1	50.9 +/-	3.0
82	11DEC 0600	29.3 +/-	5.8	210.7 +/-	11.6	-3.4 +/-	0.0	7.9 +/-	1.4	59.8 +/-	3.7
83	11DEC 1000	18.5 +/-	4.1	182.6 +/-	10.1	-3.5 +/-	0.0	5.1 +/-	1.4	38.3 +/-	2.7
84	11DEC 1400	13.5 +/-	3.2	259.0 +/-	13.8	2.6 +/-	1.1	2.8 +/-	0.9	109.5 +/-	6.1
85	11DEC 1800	57.0 +/-	6.9	365.4 +/-	18.8	-3.2 +/-	0.0	12.8 +/-	1.6	255.6 +/-	13.6

(units in nanograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	AS		PB		SE		BR	
1	19JUN 0100	-0.8 +/-	0.0	101.5 +/-	4.7	-0.8 +/-	0.0	5.6 +/-	0.7
2	19JUN 0600	-1.3 +/-	0.0	11.3 +/-	1.9	-1.3 +/-	0.0	2.2 +/-	0.6
3	19JUN 1000	-1.4 +/-	0.0	21.9 +/-	2.6	-1.5 +/-	0.0	6.9 +/-	1.1
4	19JUN 1400	-1.9 +/-	0.0	27.4 +/-	5.0	-2.0 +/-	0.0	10.6 +/-	2.2
5	19JUN 1800	-0.9 +/-	0.0	26.3 +/-	2.1	-0.9 +/-	0.0	5.8 +/-	1.1
6	24JUN 0100	1.9 +/-	0.8	12.5 +/-	2.8	-1.1 +/-	0.0	6.8 +/-	0.9
7	24JUN 0600	-1.4 +/-	0.0	39.7 +/-	4.7	-1.5 +/-	0.0	9.0 +/-	1.1
8	24JUN 1000	4.4 +/-	1.2	15.3 +/-	3.1	-1.5 +/-	0.0	9.5 +/-	1.2
9	24JUN 1400	-1.5 +/-	0.0	26.5 +/-	2.9	-1.6 +/-	0.0	11.5 +/-	1.5
10	24JUN 1800	-0.7 +/-	0.0	17.0 +/-	1.5	-0.8 +/-	0.0	6.0 +/-	0.7
11	25JUN 0100	-0.9 +/-	0.0	24.6 +/-	2.4	-1.0 +/-	0.0	8.2 +/-	0.9
12	25JUN 0600	2.7 +/-	1.0	19.0 +/-	3.2	-1.3 +/-	0.0	9.5 +/-	1.1
13	25JUN 1000	-1.3 +/-	0.0	17.7 +/-	2.0	-1.4 +/-	0.0	9.3 +/-	1.3
14	25JUN 1400	-1.1 +/-	0.0	26.6 +/-	4.3	0.5 +/-	0.5	9.2 +/-	1.0
15	25JUN 1810	-0.7 +/-	0.0	32.3 +/-	2.1	-0.7 +/-	0.0	5.1 +/-	0.6
16	13JUL 0100	-0.8 +/-	0.0	46.4 +/-	2.7	-0.9 +/-	0.0	-1.0 +/-	0.0
17	13JUL 0600	-1.1 +/-	0.0	116.4 +/-	5.7	-1.1 +/-	0.0	14.1 +/-	1.5
18	13JUL 1000	-1.1 +/-	0.0	57.8 +/-	3.6	-1.1 +/-	0.0	10.8 +/-	1.3
19	13JUL 1400	-1.2 +/-	0.0	35.5 +/-	3.1	-1.3 +/-	0.0	3.9 +/-	0.8
20	13JUL 1800	-0.9 +/-	0.0	20.9 +/-	2.1	-1.0 +/-	0.0	2.6 +/-	0.6
21	14JUL 0100	-1.6 +/-	0.0	6.6 +/-	2.1	-1.7 +/-	0.0	-2.0 +/-	0.0
22	14JUL 0600	-1.6 +/-	0.0	16.2 +/-	2.3	-1.6 +/-	0.0	4.9 +/-	1.0
23	14JUL 1000	-1.1 +/-	0.0	22.0 +/-	2.0	-1.2 +/-	0.0	7.3 +/-	0.9
24	14JUL 1400	-1.1 +/-	0.0	29.2 +/-	2.3	-1.1 +/-	0.0	7.1 +/-	0.9
25	14JUL 1800	2.2 +/-	0.7	14.3 +/-	1.8	-0.7 +/-	0.0	2.5 +/-	0.5
26	15JUL 0100	-0.9 +/-	0.0	6.7 +/-	1.7	-0.9 +/-	0.0	2.2 +/-	0.5
27	15JUL 0600	-1.3 +/-	0.0	8.4 +/-	2.3	-1.3 +/-	0.0	2.6 +/-	0.7
28	15JUL 1000	-1.4 +/-	0.0	11.2 +/-	4.9	-1.5 +/-	0.0	-1.8 +/-	0.0
29	15JUL 1400	-6.4 +/-	0.0	-19.5 +/-	0.0	-7.2 +/-	0.0	-7.8 +/-	0.0
30	15JUL 1800	1.3 +/-	0.8	7.7 +/-	1.6	-0.7 +/-	0.0	1.4 +/-	0.3
31	27AUG 0100	-0.7 +/-	0.0	31.1 +/-	2.3	-0.7 +/-	0.0	7.1 +/-	0.8
32	27AUG 0600	-1.1 +/-	0.0	129.0 +/-	6.4	-1.1 +/-	0.0	16.0 +/-	1.4
33	27AUG 1000	-1.1 +/-	0.0	40.3 +/-	3.0	-1.2 +/-	0.0	10.2 +/-	1.4
34	27AUG 1400	-1.1 +/-	0.0	37.5 +/-	2.7	-1.1 +/-	0.0	10.8 +/-	1.1
35	27AUG 1800	-0.6 +/-	0.0	37.1 +/-	2.0	-0.6 +/-	0.0	9.4 +/-	1.2
36	28AUG 0100	-0.8 +/-	0.0	18.2 +/-	1.4	-0.8 +/-	0.0	8.0 +/-	0.8
37	28AUG 0600	-1.2 +/-	0.0	82.6 +/-	4.5	-1.2 +/-	0.0	8.4 +/-	1.7
38	28AUG 1000	-1.2 +/-	0.0	70.3 +/-	3.9	-1.3 +/-	0.0	20.4 +/-	1.7
39	28AUG 1400	-1.9 +/-	0.0	41.2 +/-	4.6	-2.0 +/-	0.0	15.5 +/-	2.1
40	28AUG 1800	-0.6 +/-	0.0	22.6 +/-	1.5	-0.7 +/-	0.0	9.2 +/-	0.8
41	29AUG 0100	3.7 +/-	1.0	22.2 +/-	3.2	-1.1 +/-	0.0	18.2 +/-	1.7
42	29AUG 0600	-1.2 +/-	0.0	47.6 +/-	3.5	-1.3 +/-	0.0	18.9 +/-	1.8
43	29AUG 1000	-1.1 +/-	0.0	29.9 +/-	2.4	-1.2 +/-	0.0	4.1 +/-	1.1
44	29AUG 1400	-1.4 +/-	0.0	28.5 +/-	3.0	-1.4 +/-	0.0	12.5 +/-	1.5
45	29AUG 1800	-0.7 +/-	0.0	28.7 +/-	2.0	-0.7 +/-	0.0	7.2 +/-	0.8
46	02SEP 0100	-3.4 +/-	0.0	73.0 +/-	6.7	-3.5 +/-	0.0	8.4 +/-	2.1
47	02SEP 0600	-5.6 +/-	0.0	228.8 +/-	16.5	-5.8 +/-	0.0	35.2 +/-	6.2
48	02SEP 1000	-2.9 +/-	0.0	188.9 +/-	11.0	-3.1 +/-	0.0	35.4 +/-	3.5
49	02SEP 1400	-3.2 +/-	0.0	54.4 +/-	8.0	-3.3 +/-	0.0	14.0 +/-	3.1
50	02SEP 1800	-1.4 +/-	0.0	21.0 +/-	2.1	-1.4 +/-	0.0	2.4 +/-	0.8
51	03SEP 0100	-2.7 +/-	0.0	-8.2 +/-	0.0	-2.8 +/-	0.0	-3.4 +/-	0.0
52	03SEP 0600	-3.0 +/-	0.0	37.0 +/-	5.8	-3.2 +/-	0.0	8.4 +/-	2.0
53	03SEP 1000	-2.9 +/-	0.0	50.3 +/-	6.4	-3.0 +/-	0.0	14.2 +/-	2.2
54	03SEP 1400	-3.8 +/-	0.0	25.2 +/-	4.8	-4.0 +/-	0.0	11.0 +/-	2.2
55	03SEP 1800	-1.7 +/-	0.0	12.9 +/-	2.5	-1.8 +/-	0.0	5.5 +/-	1.1

(units in nanograms/m**3)

Long Beach - IMPROVE Filter Data

ID	DESCRIPTION	AS		PB		SE		BR	
56	11NOV 0000	-2.0 +/-	0.0	233.9 +/-	12.4	2.0 +/-	0.9	50.3 +/-	3.8
57	11NOV 0600	-4.3 +/-	0.0	336.5 +/-	20.0	-4.5 +/-	0.0	54.4 +/-	5.9
58	11NOV 1030	-1.2 +/-	0.0	321.7 +/-	13.2	1.0 +/-	0.4	38.2 +/-	5.1
59	11NOV 1400	-2.7 +/-	0.0	111.3 +/-	7.9	-2.8 +/-	0.0	23.4 +/-	2.8
60	11NOV 1800	-1.4 +/-	0.0	308.7 +/-	13.0	-1.4 +/-	0.0	40.1 +/-	4.9
61	12NOV 0000	-1.6 +/-	0.0	293.4 +/-	12.8	-1.7 +/-	0.0	57.4 +/-	4.1
62	12NOV 0600	-3.1 +/-	0.0	820.1 +/-	33.9	-3.3 +/-	0.0	97.0 +/-	12.7
63	12NOV 1011	-3.5 +/-	0.0	134.8 +/-	8.7	3.9 +/-	1.5	32.2 +/-	3.5
64	12NOV 1400	-4.2 +/-	0.0	272.1 +/-	16.4	-4.5 +/-	0.0	107.0 +/-	8.8
65	12NOV 1800	-2.3 +/-	0.0	79.3 +/-	6.0	-2.4 +/-	0.0	12.4 +/-	2.7
66	13NOV 0000	-2.6 +/-	0.0	133.9 +/-	9.0	-2.7 +/-	0.0	57.9 +/-	5.6
67	13NOV 0600	-3.0 +/-	0.0	82.3 +/-	8.1	3.9 +/-	1.4	24.2 +/-	2.8
68	13NOV 1000	-2.9 +/-	0.0	38.6 +/-	8.4	-3.0 +/-	0.0	13.7 +/-	2.3
69	13NOV 1400	-2.9 +/-	0.0	45.4 +/-	5.9	-3.0 +/-	0.0	-3.7 +/-	0.0
70	13NOV 1800	-2.6 +/-	0.0	22.5 +/-	4.0	-2.8 +/-	0.0	8.8 +/-	1.8
71	03DEC 0000	-2.3 +/-	0.0	372.7 +/-	16.2	-2.4 +/-	0.0	144.2 +/-	11.6
72	03DEC 0600	-3.6 +/-	0.0	517.5 +/-	24.6	2.2 +/-	1.2	218.9 +/-	13.5
73	03DEC 1000	-3.7 +/-	0.0	247.4 +/-	13.2	-3.9 +/-	0.0	38.0 +/-	6.4
74	03DEC 1400	-3.7 +/-	0.0	186.4 +/-	15.0	-3.9 +/-	0.0	48.9 +/-	4.5
75	03DEC 1800	-2.5 +/-	0.0	215.2 +/-	11.3	-2.6 +/-	0.0	73.1 +/-	6.9
76	10DEC 0000	-2.7 +/-	0.0	521.5 +/-	22.9	-2.8 +/-	0.0	194.1 +/-	11.8
77	10DEC 0600	-3.6 +/-	0.0	452.3 +/-	21.8	-3.7 +/-	0.0	146.3 +/-	10.1
78	10DEC 1000	-4.1 +/-	0.0	250.0 +/-	15.6	-4.3 +/-	0.0	41.8 +/-	4.6
79	10DEC 1400	-3.7 +/-	0.0	92.2 +/-	7.5	-3.9 +/-	0.0	18.7 +/-	3.0
80	10DEC 1800	-2.5 +/-	0.0	286.6 +/-	14.3	-2.6 +/-	0.0	131.4 +/-	8.7
81	11DEC 0000	-1.9 +/-	0.0	231.9 +/-	11.4	-2.0 +/-	0.0	111.9 +/-	7.0
82	11DEC 0600	-2.9 +/-	0.0	276.9 +/-	15.5	-3.1 +/-	0.0	110.7 +/-	8.0
83	11DEC 1000	-3.0 +/-	0.0	117.4 +/-	8.1	-3.1 +/-	0.0	15.6 +/-	3.3
84	11DEC 1400	-2.9 +/-	0.0	147.9 +/-	8.6	-3.0 +/-	0.0	36.8 +/-	3.7
85	11DEC 1800	-2.7 +/-	0.0	355.7 +/-	16.3	-2.9 +/-	0.0	136.0 +/-	11.5

(units in nanograms/m**3)

Site: Claremont
Project: SCAQS 1987, Summer
Organization: U.C. Davis
Sampler: IMPROVE Cyclone - Teflon Filters
Particulate Size: < 2.5µm
Analysis: Gravimetric Mass, Optical Absorption, FAST, PIXE
Units: micrograms per cubic meter for Mass and FAST: H to O
: 10**(-6) meters for Optical Absorption
: nanograms per cubic meter for PIXE : Na to Br
# of Samples : 55
Column Header: ID = Identification # of sample for each row
: Description : Start Day, Month, Time(military time, PDT)
: Status = CG - clogged filter, uncertain volume
= PP - Sample duration is >> SCAQS schedule
= OV - overlap of volume between 2 filters, uncertain volume
= PX - unacceptable PIXE Analysis
= XX - did not sample
: ET = Sample Durations(decimal hours)
: Ma = Gravimetric Mass - µg/m**3
: OA = Optical Absorption - 10**(-6) meters
: Elemental Concentrations (eg. Fe=iron) and uncertainties.
If element is below minimum detectable limits(MDL),
the MDL is given(marked by a negative sign)

ID	Description	Status	ET(hrs.)	Ma	OA
1	19JUN 0100		5.00	34.23 +/-1.62	33.60 +/-0.99
2	19JUN 0600		3.50	48.83 +/-2.33	57.55 +/-1.70
3	19JUN 1010		3.85	32.75 +/-1.93	38.85 +/-1.29
4	19JUN 1400		3.70	36.59 +/-2.13	40.45 +/-1.34
5	19JUN 1800		7.00	33.17 +/-1.34	30.90 +/-0.79
6	24JUN 0100		5.00	45.95 +/-1.87	30.10 +/-0.78
7	24JUN 0600		3.53	107.29 +/-3.71	77.08 +/-1.46
8	24JUN 1000	CG	4.00	75.40 +/-2.89	73.64 +/-1.75
9	24JUN 1400	CG	3.50	92.80 +/-3.55	98.38 +/-2.34
10	24JUN 1800		7.00	40.76 +/-1.54	36.51 +/-0.85
11	25JUN 0100		5.00	47.09 +/-1.90	37.50 +/-0.95
12	25JUN 0600		3.50	86.57 +/-3.26	121.98 +/-2.83
13	25JUN 1011		3.82	83.21 +/-3.21	92.62 +/-2.23
14	25JUN 1400	CG	3.51	53.68 +/-2.50	58.58 +/-1.70
15	25JUN 1800		7.01	38.32 +/-1.46	37.29 +/-0.88
16	13JUL 0100		5.00	21.16 +/-1.42	25.21 +/-0.89
17	13JUL 0600		3.50	45.21 +/-2.33	71.79 +/-2.24
18	13JUL 1000	CG	4.00	33.45 +/-1.98	46.39 +/-1.55
19	13JUL 1400	CG	3.50	50.72 +/-2.47	56.76 +/-1.71
20	13JUL 1800		7.00	18.14 +/-1.06	24.13 +/-0.80

(units in micrograms/m**3)

Claremont - IMPROVE Filter Data

ID	Description	Status	ET(hrs.)	Me	OA (10**6 inverse meters)
21	14JUL 0100		5.00	19.37 +/-1.40	24.92 +/-0.90
22	14JUL 0600		3.50	36.72 +/-2.14	47.86 +/-1.59
23	14JUL 1000		4.00	42.61 +/-2.08	57.24 +/-1.72
24	14JUL 1400	CG	3.50	71.37 +/-2.96	84.80 +/-2.23
25	14JUL 1800		7.00	31.38 +/-1.32	28.67 +/-0.76
26	15JUL 0100		5.00	39.71 +/-1.75	36.78 +/-0.75
27	15JUL 0600		3.50	52.72 +/-2.43	36.94 +/-1.07
28	15JUL 1000		4.00	41.66 +/-2.16	48.23 +/-1.51
29	15JUL 1400		3.50	45.66 +/-2.29	56.23 +/-1.72
30	15JUL 1800		7.00	30.58 +/-1.31	31.06 +/-0.84
31	27AUG 0100		5.00	37.54 +/-1.67	30.78 +/-0.87
32	27AUG 0600		3.50	60.80 +/-2.48	79.21 +/-2.06
33	27AUG 1003	CG	3.95	62.86 +/-2.71	75.07 +/-2.05
34	27AUG 1400	CG	3.48	55.11 +/-2.49	57.88 +/-1.65
35	27AUG 1810		6.85	31.46 +/-1.35	38.04 +/-1.04
36	28AUG 0100		5.00	39.51 +/-1.77	40.25 +/-1.14
37	28AUG 0600		3.47	56.58 +/-2.60	82.46 +/-2.40
38	28AUG 1010	CG	3.85	22.58 +/-1.96	47.37 +/-1.84
39	28AUG 1400	CG	3.49	72.75 +/-3.07	57.61 +/-1.55
40	28AUG 1820		6.67	37.75 +/-1.42	38.18 +/-0.88
41	29AUG 0100		5.00	51.95 +/-1.97	51.36 +/-1.21
42	29AUG 0600		3.49	64.68 +/-2.55	63.03 +/-1.56
43	29AUG 1003	CG	3.96	81.20 +/-3.04	68.81 +/-1.58
44	29AUG 1400	CG	3.48	74.03 +/-2.91	67.21 +/-1.66
45	29AUG 1800		7.00	47.05 +/-1.64	46.46 +/-0.90
46	02SEP 0100		5.00	10.90 +/-1.21	19.49 +/-1.32
47	02SEP 0600		3.29	29.30 +/-1.99	62.50 +/-3.31
48	02SEP 1110		2.83	18.36 +/-2.15	32.48 +/-2.26
49	02SEP 1400		3.50	31.01 +/-1.91	44.53 +/-2.29
50	02SEP 1830		6.53	26.39 +/-1.21	45.20 +/-2.00
51	03SEP 0100		5.05	29.75 +/-1.48	49.05 +/-2.25
52	03SEP 0600		3.48	48.78 +/-2.24	103.22 +/-4.52
53	03SEP 1000		4.01	44.07 +/-1.99	85.19 +/-3.69
54	03SEP 1400		3.49	31.68 +/-1.95	50.05 +/-2.57
55	03SEP 1805		6.93	22.89 +/-1.10	24.51 +/-1.13

(units in micrograms/m**3)

Claremont - IMPROVE Filter Data

ID	Description	Status	H	C	N	O
1	19JUN 0100		1.23 +/- 0.06	8.25 +/- 1.18	2.07 +/- 0.31	9.15 +/- 0.84
2	19JUN 0600		1.63 +/- 0.08	13.19 +/- 2.41	2.82 +/- 0.41	12.71 +/- 1.16
3	19JUN 1010		1.49 +/- 0.07	9.40 +/- 0.19	1.54 +/- 0.26	10.36 +/- 0.95
4	19JUN 1400		1.61 +/- 0.08	11.40 +/- 1.34	2.06 +/- 0.32	11.23 +/- 1.03
5	19JUN 1800		1.12 +/- 0.06	7.57 +/- 0.98	2.39 +/- 0.34	8.71 +/- 0.80
6	24JUN 0100		1.93 +/- 0.10	6.18 +/- 1.24	6.68 +/- 0.87	14.17 +/- 1.29
7	24JUN 0600		2.66 +/- 0.13	4.38 +/- 0.88	8.48 +/- 1.09	20.58 +/- 1.87
8	24JUN 1000	CG	3.54 +/- 0.18	19.67 +/- 3.93	5.00 +/- 0.67	24.18 +/- 2.19
9	24JUN 1400	CG	4.66 +/- 0.23	30.15 +/- 6.03	5.69 +/- 0.75	31.24 +/- 2.82
10	24JUN 1800		1.83 +/- 0.09	8.71 +/- 1.74	5.98 +/- 0.77	14.03 +/- 1.28
11	25JUN 0100		2.12 +/- 0.11	7.49 +/- 1.50	8.25 +/- 1.06	17.26 +/- 1.57
12	25JUN 0600		3.55 +/- 0.18	19.88 +/- 3.98	13.94 +/- 1.77	26.20 +/- 2.37
13	25JUN 1011		4.08 +/- 0.20	24.43 +/- 2.32	7.08 +/- 0.93	28.04 +/- 2.54
14	25JUN 1400	CG	2.50 +/- 0.12	16.51 +/- 3.30	3.13 +/- 0.45	15.70 +/- 1.43
15	25JUN 1800		1.73 +/- 0.09	8.19 +/- 1.64	4.06 +/- 0.56	12.35 +/- 1.13
16	13JUL 0100		1.05 +/- 0.05	6.70 +/- 1.34	1.47 +/- 0.26	5.98 +/- 0.56
17	13JUL 0600		1.79 +/- 0.09	14.68 +/- 2.72	2.47 +/- 0.37	10.31 +/- 0.95
18	13JUL 1000	CG	1.76 +/- 0.09	13.37 +/- 1.59	2.33 +/- 0.36	9.97 +/- 0.92
19	13JUL 1400	CG	2.73 +/- 0.14	18.41 +/- 2.28	2.77 +/- 0.41	16.23 +/- 1.48
20	13JUL 1800		0.85 +/- 0.04	5.52 +/- 1.10	1.17 +/- 0.22	4.88 +/- 0.47
21	14JUL 0100		0.92 +/- 0.05	4.38 +/- 0.88	0.93 +/- 0.20	4.87 +/- 0.47
22	14JUL 0600		1.42 +/- 0.07	8.34 +/- 1.67	1.76 +/- 0.29	8.48 +/- 0.79
23	14JUL 1000		2.25 +/- 0.11	13.30 +/- 1.90	3.74 +/- 0.51	14.54 +/- 1.32
24	14JUL 1400	CG	3.78 +/- 0.19	22.20 +/- 2.36	5.73 +/- 0.76	24.05 +/- 2.18
25	14JUL 1800		1.43 +/- 0.07	6.05 +/- 1.21	3.39 +/- 0.46	10.14 +/- 0.93
26	15JUL 0100		1.86 +/- 0.09	6.34 +/- 1.27	5.51 +/- 0.72	13.22 +/- 1.21
27	15JUL 0600		2.54 +/- 0.13	7.01 +/- 1.40	6.80 +/- 0.89	19.96 +/- 1.81
28	15JUL 1000		2.23 +/- 0.11	10.69 +/- 1.73	4.21 +/- 0.57	13.80 +/- 1.26
29	15JUL 1400		2.49 +/- 0.12	17.81 +/- 2.34	4.31 +/- 0.59	15.70 +/- 1.43
30	15JUL 1800		1.55 +/- 0.08	9.12 +/- 0.89	4.14 +/- 0.55	10.64 +/- 0.97
31	27AUG 0100		1.85 +/- 0.09	10.48 +/- 2.10	5.33 +/- 0.70	12.95 +/- 1.18
32	27AUG 0600		2.46 +/- 0.12	18.35 +/- 3.40	8.14 +/- 1.05	16.54 +/- 1.51
33	27AUG 1003	CG	2.85 +/- 0.14	20.69 +/- 2.00	4.73 +/- 0.64	20.36 +/- 1.85
34	27AUG 1400	CG	3.04 +/- 0.15	24.32 +/- 3.63	2.50 +/- 0.38	18.36 +/- 1.67
35	27AUG 1810		1.44 +/- 0.07	10.67 +/- 1.22	1.83 +/- 0.28	10.41 +/- 0.95
36	28AUG 0100		1.92 +/- 0.10	13.36 +/- 2.67	3.55 +/- 0.49	13.63 +/- 1.24
37	28AUG 0600		2.11 +/- 0.11	14.22 +/- 2.84	2.31 +/- 0.35	12.26 +/- 1.12
38	28AUG 1010	CG	2.40 +/- 0.12		2.26 +/- 0.35	13.99 +/- 1.28
39	28AUG 1400	CG	4.13 +/- 0.21	32.98 +/- 3.60	4.67 +/- 0.63	25.74 +/- 2.33
40	28AUG 1820		1.68 +/- 0.08	13.23 +/- 2.65	2.01 +/- 0.30	11.29 +/- 1.03
41	29AUG 0100		2.55 +/- 0.13	18.38 +/- 1.81	2.99 +/- 0.42	15.62 +/- 1.42
42	29AUG 0600		3.20 +/- 0.16	14.68 +/- 1.82	2.73 +/- 0.40	22.89 +/- 2.07
43	29AUG 1003	CG	4.00 +/- 0.20	22.68 +/- 4.54	2.96 +/- 0.43	28.82 +/- 2.61
44	29AUG 1400	CG	4.25 +/- 0.21	20.59 +/- 4.12	6.70 +/- 0.88	28.61 +/- 2.59
45	29AUG 1800		2.38 +/- 0.12	11.57 +/- 2.31	2.14 +/- 0.31	17.13 +/- 1.55
46	02SEP 0100		1.04 +/- 0.11	-6.29 +/- 0.00	0.92 +/- 0.26	3.37 +/- 0.36

(units in micrograms/m**3)

Claremont - IMPROVE Filter Data

ID	Description	Status	H	C	N	O
47	02SEP 0600		1.48 +/- 0.12	12.50 +/- 2.50	2.12 +/- 0.39	10.62 +/- 0.99
48	02SEP 1110		1.70 +/- 0.08	15.71 +/- 3.14	-1.46 +/- 0.00	6.97 +/- 0.68
49	02SEP 1400		1.92 +/- 0.10	-9.01 +/- 0.00	-1.16 +/- 0.00	8.23 +/- 0.78
50	02SEP 1830		1.77 +/- 0.09	10.08 +/- 2.02	1.37 +/- 0.28	7.93 +/- 0.75
51	03SEP 0100		1.61 +/- 0.08	-6.70 +/- 0.00	-0.87 +/- 0.00	7.81 +/- 0.74
52	03SEP 0600		2.58 +/- 0.13	19.57 +/- 3.91	2.74 +/- 0.45	13.14 +/- 1.22
53	03SEP 1000		2.60 +/- 0.13	20.66 +/- 4.13	1.53 +/- 0.31	12.94 +/- 1.20
54	03SEP 1400		2.10 +/- 0.10	-9.70 +/- 0.00	2.61 +/- 0.44	12.27 +/- 1.14
55	03SEP 1805		1.14 +/- 0.06	6.23 +/- 1.25	1.98 +/- 0.35	6.62 +/- 0.64

(units in micrograms/m**3)

Claremont - IMPROVE Filter Data

ID	DESCRIPTION	AL		SI		S	
1	19JUN 0100	75.0	+/- 7.4	165.7	+/- 10.0	1193.2	+/- 60.5
2	19JUN 0600	497.0	+/- 30.0	715.5	+/- 37.9	1349.7	+/- 68.4
3	19JUN 1010	112.6	+/- 8.9	282.7	+/- 15.6	1669.5	+/- 84.7
4	19JUN 1400	113.4	+/- 8.9	283.2	+/- 15.6	1752.0	+/- 88.6
5	19JUN 1800	69.2	+/- 6.1	168.3	+/- 9.4	1231.5	+/- 62.3
6	24JUN 0100	68.4	+/- 6.9	187.6	+/- 11.3	1789.3	+/- 90.5
7	24JUN 0600	139.8	+/- 16.0	254.7	+/- 16.4	2176.6	+/- 110.3
8	24JUN 1000	346.2	+/- 33.1	499.5	+/- 31.5	4641.7	+/- 234.2
9	24JUN 1400	354.0	+/- 27.8	692.8	+/- 39.6	5848.0	+/- 295.3
10	24JUN 1800	105.7	+/- 8.6	210.0	+/- 12.1	1867.1	+/- 94.2
11	25JUN 0100	72.0	+/- 8.2	172.8	+/- 10.8	2058.0	+/- 104.0
12	25JUN 0600	717.4	+/- 44.2	1156.4	+/- 61.6	2430.0	+/- 123.4
13	25JUN 1011	356.9	+/- 31.3	685.4	+/- 39.5	5126.6	+/- 258.7
14	25JUN 1400	229.7	+/- 19.9	371.5	+/- 21.9	2845.4	+/- 143.5
15	25JUN 1800	100.0	+/- 10.5	194.9	+/- 12.4	1864.5	+/- 93.9
16	13JUL 0100	90.2	+/- 7.7	198.4	+/- 11.0	1025.5	+/- 51.9
17	13JUL 0600	265.4	+/- 17.5	459.8	+/- 25.2	1461.4	+/- 74.3
18	13JUL 1000	150.1	+/- 10.9	303.0	+/- 16.8	1674.7	+/- 84.6
19	13JUL 1400	173.5	+/- 14.2	325.1	+/- 19.2	2502.2	+/- 126.6
20	13JUL 1800	80.1	+/- 6.6	150.5	+/- 8.7	1028.4	+/- 52.1
21	14JUL 0100	54.7	+/- 5.0	148.4	+/- 8.6	1103.8	+/- 55.9
22	14JUL 0600	150.8	+/- 10.6	326.8	+/- 17.9	1749.4	+/- 89.6
23	14JUL 1000	187.6	+/- 14.4	379.7	+/- 21.0	3175.0	+/- 160.3
24	14JUL 1400	273.9	+/- 25.8	512.9	+/- 31.5	4931.5	+/- 248.1
25	14JUL 1800	66.0	+/- 7.6	184.0	+/- 10.7	1785.6	+/- 90.0
26	15JUL 0100	42.2	+/- 5.2	160.4	+/- 10.0	2262.2	+/- 114.1
27	15JUL 0600	82.2	+/- 9.1	220.1	+/- 15.4	3017.7	+/- 152.0
28	15JUL 1000	119.4	+/- 11.4	347.8	+/- 20.3	3403.2	+/- 171.5
29	15JUL 1400	137.7	+/- 12.1	295.9	+/- 17.1	3140.3	+/- 158.1
30	15JUL 1800	71.8	+/- 6.7	159.4	+/- 9.6	1739.7	+/- 87.8
31	27AUG 0100	94.8	+/- 8.5	218.3	+/- 13.0	1548.3	+/- 78.5
32	27AUG 0600	586.6	+/- 35.8	1101.3	+/- 57.8	1689.9	+/- 86.0
33	27AUG 1003	410.9	+/- 25.7	854.2	+/- 45.2	2197.2	+/- 112.2
34	27AUG 1400	232.7	+/- 18.5	470.6	+/- 26.8	2450.8	+/- 124.0
35	27AUG 1810	110.0	+/- 8.7	261.8	+/- 14.3	1770.3	+/- 89.6
36	28AUG 0100	143.9	+/- 12.9	287.1	+/- 16.9	1754.4	+/- 89.0
37	28AUG 0600	446.3	+/- 28.2	773.0	+/- 41.4	1674.2	+/- 85.1
38	28AUG 1010	300.5	+/- 24.5	514.1	+/- 29.8	2241.0	+/- 114.0
39	28AUG 1400	366.4	+/- 28.6	644.1	+/- 36.7	3828.0	+/- 193.6
40	28AUG 1820	102.3	+/- 8.6	216.1	+/- 12.5	1808.0	+/- 91.4
41	29AUG 0100	155.7	+/- 14.7	288.8	+/- 17.5	1881.1	+/- 95.4
42	29AUG 0600	117.7	+/- 12.6	218.9	+/- 14.0	2175.9	+/- 110.1
43	29AUG 1003	254.9	+/- 20.0	531.2	+/- 31.1	4462.8	+/- 224.7
44	29AUG 1400	239.7	+/- 19.2	548.0	+/- 32.3	6373.8	+/- 320.4
45	29AUG 1800	229.9	+/- 17.3	344.5	+/- 20.4	2677.6	+/- 135.0
46	02SEP 0100	277.3	+/- 27.2	473.3	+/- 29.7	1811.0	+/- 93.2
47	02SEP 0600	226.8	+/- 25.6	445.9	+/- 29.0	2300.3	+/- 118.7
48	02SEP 1110	445.3	+/- 41.1	932.8	+/- 52.9	2259.5	+/- 117.2
49	02SEP 1400	241.9	+/- 23.6	507.8	+/- 31.2	2225.8	+/- 114.5
50	02SEP 1830	163.9	+/- 13.7	287.1	+/- 17.1	581.3	+/- 30.4
51	03SEP 0100	1110.7	+/- 61.2	1852.2	+/- 95.3	494.2	+/- 27.1
52	03SEP 0600	206.5	+/- 19.8	483.2	+/- 28.0	463.6	+/- 26.1
53	03SEP 1000	242.5	+/- 21.2	465.7	+/- 28.0	1197.4	+/- 61.9
54	03SEP 1400	139.5	+/- 13.8	347.2	+/- 21.3	2319.7	+/- 118.3
55	03SEP 1805	79.3	+/- 10.3	198.9	+/- 13.2	1625.6	+/- 82.8

(units in nanograms/m**3)

Claremont - IMPROVE Filter Data

ID	DESCRIPTION	K		CA		TI		V		CR	
1	19JUN 0100	109.3 +/-	6.2	90.7 +/-	5.9	6.2 +/-	1.0	-1.7 +/-	0.0	-1.6 +/-	0.0
2	19JUN 0600	194.7 +/-	10.6	192.4 +/-	11.6	33.3 +/-	2.8	-2.8 +/-	0.0	-2.6 +/-	0.0
3	19JUN 1010	122.1 +/-	7.2	107.1 +/-	6.9	6.0 +/-	1.1	-2.3 +/-	0.0	-2.1 +/-	0.0
4	19JUN 1400	130.9 +/-	7.7	114.4 +/-	7.4	6.5 +/-	1.3	-2.4 +/-	0.0	-2.2 +/-	0.0
5	19JUN 1800	102.6 +/-	5.8	78.5 +/-	5.1	6.1 +/-	0.9	-1.6 +/-	0.0	-1.4 +/-	0.0
6	24JUN 0100	65.1 +/-	4.5	50.1 +/-	3.8	4.7 +/-	1.1	-2.6 +/-	0.0	-2.3 +/-	0.0
7	24JUN 0600	91.5 +/-	6.7	102.7 +/-	7.3	11.6 +/-	2.6	4.9 +/-	2.0	-3.9 +/-	0.0
8	24JUN 1000	189.9 +/-	11.8	175.3 +/-	11.5	22.2 +/-	3.0	-4.7 +/-	0.0	-4.3 +/-	0.0
9	24JUN 1400	205.6 +/-	13.3	225.1 +/-	14.8	47.3 +/-	5.4	-6.6 +/-	0.0	-6.0 +/-	0.0
10	24JUN 1800	71.0 +/-	4.3	89.8 +/-	5.5	9.4 +/-	1.3	3.5 +/-	1.0	-1.9 +/-	0.0
11	25JUN 0100	64.2 +/-	4.8	72.6 +/-	5.0	5.4 +/-	1.2	3.6 +/-	1.5	-2.4 +/-	0.0
12	25JUN 0600	241.9 +/-	14.4	320.4 +/-	19.1	28.3 +/-	3.6	-5.6 +/-	0.0	-5.1 +/-	0.0
13	25JUN 1011	224.3 +/-	13.1	225.4 +/-	14.0	25.3 +/-	2.9	-4.7 +/-	0.0	-4.3 +/-	0.0
14	25JUN 1400	132.2 +/-	8.1	152.6 +/-	9.7	14.7 +/-	2.4	-3.8 +/-	0.0	-3.5 +/-	0.0
15	25JUN 1800	68.0 +/-	4.3	64.0 +/-	4.9	7.2 +/-	1.1	-2.0 +/-	0.0	-1.8 +/-	0.0
16	13JUL 0100	66.8 +/-	4.2	133.2 +/-	7.6	2.3 +/-	1.2	-2.0 +/-	0.0	-1.8 +/-	0.0
17	13JUL 0600	166.5 +/-	9.8	312.3 +/-	17.6	5.9 +/-	1.7	-3.6 +/-	0.0	-3.2 +/-	0.0
18	13JUL 1000	114.2 +/-	7.1	100.9 +/-	6.9	8.7 +/-	1.5	-2.8 +/-	0.0	-2.6 +/-	0.0
19	13JUL 1400	88.6 +/-	5.9	96.2 +/-	6.5	13.1 +/-	1.9	-3.3 +/-	0.0	-3.0 +/-	0.0
20	13JUL 1800	79.4 +/-	4.6	55.8 +/-	3.7	3.4 +/-	0.7	-1.4 +/-	0.0	-1.3 +/-	0.0
21	14JUL 0100	76.3 +/-	4.5	70.5 +/-	4.6	3.7 +/-	0.8	2.2 +/-	0.9	-1.8 +/-	0.0
22	14JUL 0600	85.1 +/-	5.8	96.2 +/-	6.4	8.1 +/-	2.0	-3.2 +/-	0.0	-2.9 +/-	0.0
23	14JUL 1000	99.2 +/-	6.3	99.4 +/-	6.5	14.4 +/-	1.9	-3.1 +/-	0.0	-2.8 +/-	0.0
24	14JUL 1400	127.6 +/-	8.3	150.4 +/-	10.0	20.1 +/-	2.6	-4.6 +/-	0.0	-4.2 +/-	0.0
25	14JUL 1800	52.3 +/-	3.4	48.1 +/-	3.2	4.1 +/-	0.8	-1.7 +/-	0.0	-1.6 +/-	0.0
26	15JUL 0100	49.3 +/-	3.6	52.4 +/-	3.8	3.1 +/-	1.1	-2.4 +/-	0.0	-2.2 +/-	0.0
27	15JUL 0600	131.6 +/-	7.9	52.0 +/-	4.7	8.4 +/-	1.9	-3.3 +/-	0.0	-3.0 +/-	0.0
28	15JUL 1000	93.0 +/-	6.9	91.7 +/-	6.3	6.3 +/-	1.5	-3.2 +/-	0.0	-2.9 +/-	0.0
29	15JUL 1400	81.0 +/-	5.4	77.4 +/-	5.3	7.9 +/-	1.5	-2.9 +/-	0.0	-2.7 +/-	0.0
30	15JUL 1800	42.9 +/-	2.9	42.1 +/-	3.0	9.6 +/-	1.2	-1.7 +/-	0.0	-1.5 +/-	0.0
31	27AUG 0100	72.3 +/-	4.9	82.4 +/-	5.5	8.2 +/-	1.3	2.8 +/-	1.0	-2.3 +/-	0.0
32	27AUG 0600	253.0 +/-	14.5	288.5 +/-	17.3	27.9 +/-	2.9	5.1 +/-	2.4	-3.8 +/-	0.0
33	27AUG 1003	246.0 +/-	14.0	291.6 +/-	17.4	25.5 +/-	3.0	-4.4 +/-	0.0	-4.0 +/-	0.0
34	27AUG 1400	156.5 +/-	10.0	153.9 +/-	10.2	31.4 +/-	3.7	-4.5 +/-	0.0	-4.1 +/-	0.0
35	27AUG 1810	111.3 +/-	6.4	125.3 +/-	7.8	8.3 +/-	1.3	-2.3 +/-	0.0	-2.1 +/-	0.0
36	28AUG 0100	113.2 +/-	7.2	151.9 +/-	9.3	13.6 +/-	2.1	3.9 +/-	1.5	-2.7 +/-	0.0
37	28AUG 0600	230.0 +/-	13.4	274.8 +/-	16.7	24.1 +/-	3.0	4.8 +/-	1.9	-4.1 +/-	0.0
38	28AUG 1010	200.1 +/-	11.6	166.4 +/-	10.8	24.3 +/-	2.9	-4.1 +/-	0.0	-3.7 +/-	0.0
39	28AUG 1400	169.3 +/-	10.8	209.9 +/-	13.1	33.4 +/-	3.5	-4.9 +/-	0.0	-4.4 +/-	0.0
40	28AUG 1820	90.6 +/-	5.4	80.4 +/-	5.2	7.2 +/-	1.3	-2.0 +/-	0.0	-1.8 +/-	0.0
41	29AUG 0100	144.0 +/-	8.7	202.4 +/-	12.0	8.0 +/-	1.7	3.5 +/-	1.7	-2.8 +/-	0.0
42	29AUG 0600	111.5 +/-	7.3	137.9 +/-	8.7	7.0 +/-	1.8	-3.9 +/-	0.0	-3.5 +/-	0.0
43	29AUG 1003	160.7 +/-	10.5	152.3 +/-	10.3	14.0 +/-	2.4	-4.7 +/-	0.0	-4.3 +/-	0.0
44	29AUG 1400	136.8 +/-	9.2	106.4 +/-	8.1	14.3 +/-	3.0	-4.9 +/-	0.0	-4.4 +/-	0.0
45	29AUG 1800	74.7 +/-	4.7	69.9 +/-	4.9	11.0 +/-	1.5	2.7 +/-	1.1	-2.1 +/-	0.0
46	02SEP 0100	172.7 +/-	13.1	167.3 +/-	12.5	14.2 +/-	4.2	15.2 +/-	3.7	-7.3 +/-	0.0
47	02SEP 0600	152.0 +/-	13.1	164.8 +/-	13.7	10.5 +/-	4.9	11.9 +/-	5.2	-9.8 +/-	0.0
48	02SEP 1110	268.4 +/-	19.8	346.6 +/-	23.0	19.3 +/-	5.8	15.5 +/-	6.5	-11.1 +/-	0.0
49	02SEP 1400	227.3 +/-	15.9	166.5 +/-	13.0	24.2 +/-	5.0	-9.4 +/-	0.0	-8.6 +/-	0.0
50	02SEP 1830	101.3 +/-	8.1	161.8 +/-	9.9	11.4 +/-	2.6	-3.7 +/-	0.0	4.5 +/-	2.2
51	03SEP 0100	300.3 +/-	17.1	400.2 +/-	23.6	55.8 +/-	5.4	6.9 +/-	3.7	-5.5 +/-	0.0
52	03SEP 0600	152.4 +/-	11.1	331.4 +/-	19.8	19.1 +/-	4.2	8.9 +/-	3.2	-6.9 +/-	0.0
53	03SEP 1000	106.1 +/-	8.4	150.7 +/-	10.5	6.4 +/-	2.7	7.1 +/-	2.7	-6.2 +/-	0.0
54	03SEP 1400	109.7 +/-	9.3	115.1 +/-	9.5	-8.0 +/-	0.0	7.3 +/-	2.7	-7.1 +/-	0.0
55	03SEP 1805	85.3 +/-	6.7	93.5 +/-	7.2	-4.7 +/-	0.0	-4.6 +/-	0.0	-4.1 +/-	0.0

(units in nanograms/m**3)

Claremont - IMPROVE Filter Data

ID	DESCRIPTION	MN		FE		NI		CU		ZN	
1	19JUN 0100	-1.4 +/-	0.0	109.3 +/-	5.6	-0.7 +/-	0.0	2.7 +/-	0.3	58.6 +/-	3.1
2	19JUN 0600	13.4 +/-	1.6	450.4 +/-	22.8	-1.2 +/-	0.0	3.7 +/-	0.5	106.3 +/-	5.6
3	19JUN 1010	-1.9 +/-	0.0	143.2 +/-	7.4	-1.0 +/-	0.0	4.0 +/-	0.4	58.6 +/-	3.2
4	19JUN 1400	3.3 +/-	0.9	153.8 +/-	7.9	-1.1 +/-	0.0	1.7 +/-	0.4	35.0 +/-	2.0
5	19JUN 1800	3.1 +/-	0.7	95.7 +/-	4.9	-0.7 +/-	0.0	4.4 +/-	0.4	26.3 +/-	1.5
6	24JUN 0100	2.0 +/-	0.8	83.7 +/-	4.5	0.8 +/-	0.3	1.9 +/-	0.5	53.7 +/-	2.9
7	24JUN 0600	5.4 +/-	1.5	200.0 +/-	10.6	2.0 +/-	0.7	8.3 +/-	0.9	137.5 +/-	7.4
8	24JUN 1000	-3.9 +/-	0.0	253.9 +/-	13.2	-2.0 +/-	0.0	9.2 +/-	0.9	165.2 +/-	8.7
9	24JUN 1400	4.0 +/-	3.4	344.1 +/-	17.9	-2.8 +/-	0.0	6.8 +/-	1.3	149.0 +/-	8.2
10	24JUN 1800	3.0 +/-	0.8	122.3 +/-	6.4	1.2 +/-	0.3	2.3 +/-	0.4	43.6 +/-	2.4
11	25JUN 0100	3.6 +/-	0.9	94.1 +/-	5.0	0.8 +/-	0.4	4.4 +/-	0.5	76.5 +/-	4.1
12	25JUN 0600	34.9 +/-	4.4	776.4 +/-	39.4	-2.4 +/-	0.0	6.7 +/-	1.0	58.4 +/-	3.5
13	25JUN 1011	7.6 +/-	2.0	369.2 +/-	18.9	-1.9 +/-	0.0	10.9 +/-	1.0	144.3 +/-	7.7
14	25JUN 1400	5.2 +/-	1.4	223.2 +/-	11.5	-1.6 +/-	0.0	3.7 +/-	0.6	48.2 +/-	2.8
15	25JUN 1800	3.1 +/-	0.7	107.7 +/-	5.6	1.2 +/-	0.4	2.7 +/-	0.4	41.6 +/-	2.2
16	13JUL 0100	1.3 +/-	0.6	93.5 +/-	4.8	-0.9 +/-	0.0	2.9 +/-	0.3	42.2 +/-	2.3
17	13JUL 0600	41.4 +/-	4.4	490.6 +/-	25.1	-1.6 +/-	0.0	8.0 +/-	0.8	293.1 +/-	15.0
18	13JUL 1000	3.2 +/-	1.1	175.5 +/-	9.1	-1.2 +/-	0.0	6.0 +/-	0.6	101.7 +/-	5.4
19	13JUL 1400	7.2 +/-	1.8	195.3 +/-	10.1	-1.5 +/-	0.0	5.5 +/-	0.6	143.6 +/-	7.5
20	13JUL 1800	3.0 +/-	0.7	97.3 +/-	5.0	-0.6 +/-	0.0	2.7 +/-	0.3	23.9 +/-	1.3
21	14JUL 0100	3.2 +/-	0.7	82.8 +/-	4.4	1.3 +/-	0.4	1.6 +/-	0.3	63.9 +/-	3.4
22	14JUL 0600	5.4 +/-	1.2	192.6 +/-	10.0	-1.4 +/-	0.0	9.7 +/-	0.8	330.3 +/-	16.9
23	14JUL 1000	3.4 +/-	1.2	194.7 +/-	10.0	-1.3 +/-	0.0	9.6 +/-	0.8	232.0 +/-	11.9
24	14JUL 1400	9.1 +/-	1.9	277.0 +/-	14.3	-1.9 +/-	0.0	8.5 +/-	0.9	151.4 +/-	8.0
25	14JUL 1800	3.3 +/-	1.3	94.6 +/-	4.9	-0.7 +/-	0.0	2.2 +/-	0.3	28.6 +/-	1.6
26	15JUL 0100	1.6 +/-	0.8	68.6 +/-	3.7	-1.0 +/-	0.0	2.1 +/-	0.3	105.4 +/-	5.5
27	15JUL 0600	-2.7 +/-	0.0	86.7 +/-	4.7	0.9 +/-	0.4	4.7 +/-	0.6	147.9 +/-	7.7
28	15JUL 1000	2.0 +/-	1.0	152.5 +/-	7.9	0.9 +/-	0.4	5.5 +/-	0.7	75.7 +/-	4.1
29	15JUL 1400	4.4 +/-	1.0	164.3 +/-	8.6	-1.2 +/-	0.0	3.4 +/-	0.5	64.7 +/-	3.5
30	15JUL 1800	2.6 +/-	0.6	99.3 +/-	5.1	-0.7 +/-	0.0	2.4 +/-	0.3	40.7 +/-	2.2
31	27AUG 0100	-2.1 +/-	0.0	85.8 +/-	4.8	-1.1 +/-	0.0	10.5 +/-	0.8	30.0 +/-	1.7
32	27AUG 0600	12.6 +/-	2.2	537.1 +/-	27.3	-1.9 +/-	0.0	6.7 +/-	0.8	118.9 +/-	6.4
33	27AUG 1003	25.0 +/-	4.4	620.1 +/-	31.5	-1.9 +/-	0.0	14.7 +/-	1.2	268.6 +/-	13.9
34	27AUG 1400	13.3 +/-	2.5	308.9 +/-	16.0	-2.0 +/-	0.0	8.7 +/-	0.9	77.2 +/-	4.4
35	27AUG 1810	4.7 +/-	1.0	146.5 +/-	7.6	1.0 +/-	0.5	3.2 +/-	0.4	45.2 +/-	2.4
36	28AUG 0100	4.1 +/-	1.2	175.0 +/-	9.0	-1.3 +/-	0.0	9.0 +/-	0.8	85.2 +/-	4.6
37	28AUG 0600	18.4 +/-	2.9	517.1 +/-	26.5	-2.0 +/-	0.0	7.4 +/-	0.9	38.9 +/-	2.4
38	28AUG 1010	7.1 +/-	1.7	318.3 +/-	16.3	-1.8 +/-	0.0	8.3 +/-	0.8	107.7 +/-	5.8
39	28AUG 1400	11.9 +/-	2.6	355.2 +/-	18.3	-2.1 +/-	0.0	4.0 +/-	0.7	112.1 +/-	6.1
40	28AUG 1820	2.7 +/-	0.7	117.9 +/-	6.1	0.8 +/-	0.3	4.0 +/-	0.4	26.2 +/-	1.5
41	29AUG 0100	7.5 +/-	1.5	243.1 +/-	12.4	-1.4 +/-	0.0	42.7 +/-	2.4	68.3 +/-	3.8
42	29AUG 0600	7.3 +/-	2.3	198.5 +/-	10.3	-1.7 +/-	0.0	3.2 +/-	0.6	59.4 +/-	3.3
43	29AUG 1003	-3.9 +/-	0.0	249.5 +/-	12.9	-2.0 +/-	0.0	4.3 +/-	0.7	154.9 +/-	8.2
44	29AUG 1400	3.1 +/-	1.5	197.6 +/-	10.4	2.1 +/-	0.8	2.8 +/-	0.6	88.5 +/-	4.8
45	29AUG 1800	2.6 +/-	0.7	113.1 +/-	5.9	4.4 +/-	0.5	2.3 +/-	0.4	50.6 +/-	2.7
46	02SEP 0100	-6.7 +/-	0.0	259.7 +/-	14.1	-3.9 +/-	0.0	8.1 +/-	1.6	92.9 +/-	5.7
47	02SEP 0600	-8.9 +/-	0.0	252.7 +/-	13.8	4.5 +/-	1.9	7.5 +/-	1.8	175.2 +/-	10.1
48	02SEP 1110	-10.1 +/-	0.0	594.7 +/-	31.0	-5.8 +/-	0.0	27.3 +/-	3.2	159.5 +/-	9.4
49	02SEP 1400	-7.8 +/-	0.0	334.7 +/-	17.8	-4.4 +/-	0.0	7.4 +/-	1.5	127.2 +/-	7.6
50	02SEP 1830	-3.1 +/-	0.0	136.6 +/-	7.2	-1.8 +/-	0.0	8.0 +/-	0.9	56.4 +/-	3.3
51	03SEP 0100	-4.9 +/-	0.0	784.1 +/-	39.8	-2.8 +/-	0.0	4.8 +/-	1.0	26.0 +/-	1.9
52	03SEP 0600	10.5 +/-	3.6	351.2 +/-	18.5	-3.7 +/-	0.0	2.3 +/-	1.0	32.4 +/-	2.6
53	03SEP 1000	-5.6 +/-	0.0	225.7 +/-	12.1	-3.3 +/-	0.0	4.4 +/-	1.1	34.7 +/-	3.0
54	03SEP 1400	4.1 +/-	2.3	163.7 +/-	9.0	4.1 +/-	1.2	4.0 +/-	1.0	28.8 +/-	2.4
55	03SEP 1805	-3.8 +/-	0.0	107.9 +/-	6.1	3.1 +/-	1.0	2.8 +/-	0.6	26.9 +/-	1.8

(units in nanograms/m**3)

Claremont - IMPROVE Filter Data

ID	DESCRIPTION	AS		PB		SE		BK	
1	19JUN 0100	-0.6 +/-	0.0	60.5 +/-	3.0	1.9 +/-	0.3	4.2 +/-	1.0
2	19JUN 0600	-1.0 +/-	0.0	74.1 +/-	4.0	-1.0 +/-	0.0	5.0 +/-	1.3
3	19JUN 1010	-0.8 +/-	0.0	116.2 +/-	5.8	-0.9 +/-	0.0	-1.1 +/-	0.0
4	19JUN 1400	-0.9 +/-	0.0	46.0 +/-	3.1	-0.9 +/-	0.0	12.7 +/-	1.5
5	19JUN 1800	-0.6 +/-	0.0	49.6 +/-	2.7	1.4 +/-	0.3	6.0 +/-	0.9
6	24JUN 0100	3.3 +/-	1.2	33.4 +/-	3.7	-1.0 +/-	0.0	9.0 +/-	1.1
7	24JUN 0600	-1.7 +/-	0.0	87.1 +/-	5.8	-1.7 +/-	0.0	5.6 +/-	1.9
8	24JUN 1000	-1.7 +/-	0.0	119.4 +/-	6.6	-1.8 +/-	0.0	16.0 +/-	3.0
9	24JUN 1400	-2.3 +/-	0.0	117.8 +/-	7.6	-2.4 +/-	0.0	24.5 +/-	3.6
10	24JUN 1800	-0.8 +/-	0.0	53.5 +/-	3.0	0.8 +/-	0.3	9.1 +/-	1.4
11	25JUN 0100	-1.0 +/-	0.0	62.1 +/-	3.6	-1.0 +/-	0.0	2.5 +/-	1.1
12	25JUN 0600	-2.0 +/-	0.0	129.5 +/-	7.3	-2.1 +/-	0.0	15.5 +/-	2.9
13	25JUN 1011	-1.6 +/-	0.0	172.6 +/-	8.3	-1.6 +/-	0.0	14.8 +/-	3.1
14	25JUN 1400	-1.4 +/-	0.0	73.9 +/-	4.4	-1.4 +/-	0.0	19.7 +/-	2.5
15	25JUN 1800	-0.7 +/-	0.0	57.1 +/-	2.9	0.5 +/-	0.3	7.2 +/-	1.3
16	13JUL 0100	-0.8 +/-	0.0	32.3 +/-	2.1	-0.8 +/-	0.0	4.8 +/-	0.9
17	13JUL 0600	-1.3 +/-	0.0	122.4 +/-	6.3	0.8 +/-	0.4	6.3 +/-	2.1
18	13JUL 1000	-1.0 +/-	0.0	91.9 +/-	4.9	1.9 +/-	0.5	8.9 +/-	1.8
19	13JUL 1400	-1.2 +/-	0.0	82.0 +/-	4.7	-1.3 +/-	0.0	16.5 +/-	2.1
20	13JUL 1800	-0.5 +/-	0.0	51.9 +/-	2.6	1.6 +/-	0.3	3.0 +/-	0.9
21	14JUL 0100	-0.8 +/-	0.0	57.8 +/-	3.9	2.5 +/-	0.4	2.2 +/-	1.0
22	14JUL 0600	-1.2 +/-	0.0	152.1 +/-	7.2	1.5 +/-	0.7	-1.5 +/-	0.0
23	14JUL 1000	-1.1 +/-	0.0	97.7 +/-	4.7	0.7 +/-	0.4	6.6 +/-	1.7
24	14JUL 1400	-1.5 +/-	0.0	116.6 +/-	6.8	1.8 +/-	0.6	19.4 +/-	2.9
25	14JUL 1800	-0.6 +/-	0.0	44.1 +/-	2.4	-0.6 +/-	0.0	3.7 +/-	0.8
26	15JUL 0100	-0.9 +/-	0.0	50.4 +/-	3.1	1.1 +/-	0.4	3.4 +/-	1.2
27	15JUL 0600	-1.2 +/-	0.0	84.2 +/-	5.0	-1.2 +/-	0.0	-1.5 +/-	0.0
28	15JUL 1000	-1.1 +/-	0.0	73.3 +/-	4.4	-1.2 +/-	0.0	6.0 +/-	1.4
29	15JUL 1400	-1.0 +/-	0.0	84.7 +/-	4.8	-1.0 +/-	0.0	11.2 +/-	1.8
30	15JUL 1800	-0.6 +/-	0.0	69.4 +/-	3.4	-0.6 +/-	0.0	-0.7 +/-	0.0
31	27AUG 0100	2.2 +/-	0.9	26.5 +/-	3.2	-1.0 +/-	0.0	9.8 +/-	1.1
32	27AUG 0600	-1.6 +/-	0.0	92.4 +/-	6.0	-1.7 +/-	0.0	6.3 +/-	2.0
33	27AUG 1003	-1.6 +/-	0.0	154.5 +/-	7.8	-1.7 +/-	0.0	9.0 +/-	2.5
34	27AUG 1400	-1.7 +/-	0.0	123.3 +/-	6.7	-1.7 +/-	0.0	18.0 +/-	2.8
35	27AUG 1810	-0.8 +/-	0.0	74.3 +/-	3.9	-0.9 +/-	0.0	7.9 +/-	1.4
36	28AUG 0100	-1.1 +/-	0.0	79.2 +/-	4.3	1.1 +/-	0.4	10.1 +/-	1.7
37	28AUG 0600	-1.7 +/-	0.0	113.9 +/-	6.3	-1.8 +/-	0.0	14.2 +/-	2.6
38	28AUG 1010	-1.5 +/-	0.0	145.2 +/-	8.4	-1.6 +/-	0.0	10.7 +/-	2.4
39	28AUG 1400	-1.8 +/-	0.0	133.6 +/-	7.2	-1.8 +/-	0.0	21.3 +/-	3.2
40	28AUG 1820	-0.7 +/-	0.0	73.7 +/-	3.8	0.6 +/-	0.2	10.4 +/-	1.4
41	29AUG 0100	-1.1 +/-	0.0	103.8 +/-	5.5	-1.2 +/-	0.0	13.3 +/-	2.0
42	29AUG 0600	-1.4 +/-	0.0	89.8 +/-	5.0	-1.5 +/-	0.0	14.3 +/-	2.3
43	29AUG 1003	-1.6 +/-	0.0	138.6 +/-	7.2	1.1 +/-	0.7	18.1 +/-	2.9
44	29AUG 1400	-1.6 +/-	0.0	89.1 +/-	5.5	-1.6 +/-	0.0	22.5 +/-	2.7
45	29AUG 1800	-0.7 +/-	0.0	78.0 +/-	4.7	-0.8 +/-	0.0	12.7 +/-	1.7
46	02SEP 0100	6.8 +/-	2.9	67.0 +/-	10.7	-3.4 +/-	0.0	15.4 +/-	2.8
47	02SEP 0600	11.5 +/-	3.8	79.9 +/-	12.3	-4.5 +/-	0.0	9.3 +/-	3.4
48	02SEP 1110	-5.0 +/-	0.0	169.2 +/-	16.0	-5.1 +/-	0.0	-6.3 +/-	0.0
49	02SEP 1400	-3.7 +/-	0.0	118.8 +/-	10.8	-3.9 +/-	0.0	25.1 +/-	5.6
50	02SEP 1830	4.3 +/-	1.1	13.6 +/-	3.6	-1.6 +/-	0.0	-2.0 +/-	0.0
51	03SEP 0100	-2.4 +/-	0.0	34.5 +/-	4.3	-2.5 +/-	0.0	-3.0 +/-	0.0
52	03SEP 0600	-3.2 +/-	0.0	44.9 +/-	7.2	-3.4 +/-	0.0	5.5 +/-	1.4
53	03SEP 1000	-2.8 +/-	0.0	32.1 +/-	5.1	-3.0 +/-	0.0	9.2 +/-	1.8
54	03SEP 1400	4.9 +/-	2.3	23.1 +/-	6.0	-3.3 +/-	0.0	12.8 +/-	2.7
55	03SEP 1805	-1.8 +/-	0.0	36.1 +/-	4.2	-1.9 +/-	0.0	5.8 +/-	1.5

(units in nanograms/m**3)

Site: Rubidoux
Project: SCAQS 1987, Summer
Organization: U.C. Davis
Sampler: IMPROVE Cyclone - Teflon Filters
Particulate Size: < 2.5µm
Analysis: Gravimetric Mass, Optical Absorption, FAST, PIXE
Units: micrograms per cubic meter for Mass and FAST: H to O
: 10**(-6) meters for Optical Absorption
: nanograms per cubic meter for PIXE : Na to Br
# of Samples : 54
Column Header: ID = Identification # of sample for each row
: Description : Start Day, Month, Time(military time, PDT)
: Status = CG - clogged filter, uncertain volume
= PP - Sample duration is >> SCAQS schedule
= OV - overlap of volume between 2 filters, uncertain volume
= PX - unacceptable PIXE Analysis
= XX - did not sample
: ET = Sample Durations(decimal hours)
: Ma = Gravimetric Mass - µg/m**3
: OA = Optical Absorption - 10**(-6) meters
: Elemental Concentrations (eg. Fe=iron) and uncertainties.
If element is below minimum detectable limits(MDL),
the MDL is given(marked by a negative sign).

ID	Description	Status	ET(hrs.)	Ma	OA (10**6 inverse meters)
1	19JUN 0100		5.00	35.51 +/- 1.60	30.72 +/- 0.90
2	19JUN 0600		3.50	47.47 +/- 2.40	42.85 +/- 1.28
3	19JUN 1000	CG	4.00	46.65 +/- 2.26	30.93 +/- 0.90
4	19JUN 1400		3.50	29.18 +/- 2.02	28.23 +/- 0.97
5	19JUN 1800		7.00	35.35 +/- 1.42	24.38 +/- 0.60
6	24JUN 0100	CG	5.00	43.73 +/- 1.84	34.83 +/- 0.90
7	24JUN 0600		3.50	86.51 +/- 3.18	64.15 +/- 1.38
8	24JUN 1000	CG	4.00	98.06 +/- 3.66	51.19 +/- 1.13
9	24JUN 1400	CG	4.00	53.18 +/- 2.30	43.00 +/- 1.15
10	24JUN 1800	OV	7.37	36.61 +/- 1.40	33.28 +/- 0.77
11	25JUN 0100	OV	5.01	40.70 +/- 1.77	32.10 +/- 0.86
12	25JUN 0600		3.14	89.17 +/- 3.34	78.61 +/- 1.75
13	25JUN 1000		4.00	70.13 +/- 2.63	73.59 +/- 0.98
14	25JUN 1400		4.00	34.24 +/- 1.92	35.43 +/- 1.12
15	25JUN 1800	OV	8.92	33.83 +/- 1.25	31.90 +/- 0.69
16	13JUL 0100		5.01	42.84 +/- 1.80	41.57 +/- 1.07
17	13JUL 0600	CG	3.51	50.28 +/- 2.41	79.83 +/- 2.31
18	13JUL 1008		3.88	33.06 +/- 1.92	29.66 +/- 0.95
19	13JUL 1400		3.50	36.32 +/- 2.10	38.07 +/- 1.21
20	13JUL 1800	XX	0.00		

(units in micrograms/m**3)

ID	Description	Status	ET(hrs.)	Me	OA (10**6 inverse meters)
21	14JUL 0100		5.00	27.21 +/- 1.49	34.12 +/- 1.06
22	14JUL 0600		3.50	31.58 +/- 2.05	44.49 +/- 1.49
23	14JUL 1008	CG	3.88	54.90 +/- 2.51	45.09 +/- 1.26
24	14JUL 1400		3.50	46.82 +/- 2.31	47.79 +/- 1.40
25	14JUL 1800		7.00	34.81 +/- 1.38	27.75 +/- 0.67
26	15JUL 0100		5.00	41.94 +/- 1.79	24.22 +/- 0.64
27	15JUL 0600		3.50	72.16 +/- 2.82	42.10 +/- 1.00
28	15JUL 1000	CG	4.00	78.81 +/- 3.24	54.46 +/- 1.38
29	15JUL 1400		3.50	45.85 +/- 2.36	38.10 +/- 1.15
30	15JUL 1800		7.00	30.18 +/- 1.29	27.24 +/- 0.72
31	27AUG 0100		5.00	66.46 +/- 2.36	46.23 +/- 0.92
32	27AUG 0600		3.50	100.71 +/- 3.58	122.44 +/- 2.44
33	27AUG 1000	CG	4.00	90.74 +/- 3.39	73.81 +/- 1.64
34	27AUG 1400	CG	3.50	60.01 +/- 2.57	57.57 +/- 1.52
35	27AUG 1800		7.00	45.92 +/- 1.64	41.75 +/- 0.84
36	28AUG 0100	CG	5.00	56.48 +/- 2.15	53.11 +/- 1.21
37	28AUG 0600	CG	3.50	94.10 +/- 3.38	110.43 +/- 2.27
38	28AUG 1000	CG	3.86	98.79 +/- 3.69	85.76 +/- 1.90
39	28AUG 1400	CG	3.50	70.41 +/- 2.89	58.51 +/- 1.48
40	28AUG 1800		7.00	60.24 +/- 2.07	57.36 +/- 1.03
41	29AUG 0100		5.00	54.37 +/- 2.06	53.63 +/- 1.22
42	29AUG 0600		3.51	110.12 +/- 3.76	95.32 +/- 1.67
43	29AUG 1000		4.01	110.99 +/- 3.61	68.58 +/- 2.17
44	29AUG 1400		3.50	37.90 +/- 1.94	41.84 +/- 1.91
45	29AUG 1800		7.00	40.88 +/- 1.53	30.71 +/- 0.68
46	02SEP 0100	CG	5.01	51.06 +/- 2.15	121.93 +/- 3.28
47	02SEP 0600	CG	3.50	56.11 +/- 2.59	139.37 +/- 4.05
48	02SEP 1000		4.00	15.33 +/- 1.47	23.14 +/- 1.43
49	02SEP 1400		4.00	12.80 +/- 1.44	26.19 +/- 1.70
50	02SEP 1800		7.00	71.56 +/- 2.29	65.84 +/- 1.99
51	03SEP 0100		5.01	41.42 +/- 1.66	53.21 +/- 2.13
52	03SEP 0600		3.50	64.55 +/- 2.50	111.81 +/- 4.37
53	03SEP 1000		4.00	41.59 +/- 1.88	51.03 +/- 2.22
54	03SEP 1400		4.00	25.94 +/- 1.61	37.30 +/- 1.89
55	03SEP 1800		7.01	30.23 +/- 1.21	25.67 +/- 1.05

(units in micrograms/m**3)

Rubidoux - IMPROVE Filter Data

ID	Description	Status	H	C	N	O
1	19JUN 0100		0.96 +/- 0.05	8.36 +/- 1.67	3.25 +/- 0.46	8.21 +/- 0.76
2	19JUN 0600		1.53 +/- 0.08	9.39 +/- 1.88	5.50 +/- 0.74	14.31 +/- 1.31
3	19JUN 1000	CG	1.84 +/- 0.09	10.77 +/- 2.15	6.93 +/- 0.91	15.97 +/- 1.46
4	19JUN 1400		1.07 +/- 0.05	5.91 +/- 1.18	1.34 +/- 0.27	8.83 +/- 0.82
5	19JUN 1800		1.13 +/- 0.06	5.74 +/- 1.15	4.15 +/- 0.56	11.33 +/- 1.04
6	24JUN 0100	CG	1.59 +/- 0.08	10.49 +/- 2.03	9.45 +/- 1.21	13.63 +/- 1.25
7	24JUN 0600		3.66 +/- 0.18	10.44 +/- 2.09	27.95 +/- 3.52	35.61 +/- 3.22
8	24JUN 1000	CG	4.10 +/- 0.20	18.75 +/- 2.60	25.06 +/- 3.15	38.25 +/- 3.45
9	24JUN 1400	CG	2.46 +/- 0.12	15.93 +/- 3.19	7.17 +/- 0.93	20.80 +/- 1.89
10	24JUN 1800	OY	1.75 +/- 0.09	8.41 +/- 1.68	7.42 +/- 0.96	16.12 +/- 1.46
11	25JUN 0100	OY	1.74 +/- 0.09	8.70 +/- 1.37	11.23 +/- 1.43	14.73 +/- 1.34
12	25JUN 0600		3.75 +/- 0.19	21.55 +/- 4.13		32.18 +/- 2.91
13	25JUN 1000		2.76 +/- 0.14	15.52 +/- 3.10	12.14 +/- 1.55	25.91 +/- 2.35
14	25JUN 1400		1.65 +/- 0.08	12.66 +/- 2.53	2.74 +/- 0.40	12.94 +/- 1.18
15	25JUN 1800	OY	1.27 +/- 0.06	8.69 +/- 0.34	-0.12 +/- 0.00	10.17 +/- 0.93
16	13JUL 0100		2.02 +/- 0.10	10.21 +/- 1.98	7.86 +/- 1.01	17.13 +/- 1.56
17	13JUL 0600	CG	2.18 +/- 0.11	17.73 +/- 2.75	6.01 +/- 0.79	17.44 +/- 1.59
18	13JUL 1008		1.65 +/- 0.08	9.39 +/- 1.88	3.72 +/- 0.52	11.84 +/- 1.08
19	13JUL 1400		1.86 +/- 0.09	15.44 +/- 1.35	3.35 +/- 0.47	11.83 +/- 1.08
20	13JUL 1800	XX				
21	14JUL 0100		1.15 +/- 0.06	7.62 +/- 1.52	2.90 +/- 0.42	7.88 +/- 0.73
22	14JUL 0600		1.41 +/- 0.07	10.00 +/- 1.39	3.84 +/- 0.54	10.16 +/- 0.94
23	14JUL 1008	CG	2.24 +/- 0.11	13.02 +/- 2.60	7.12 +/- 0.93	18.53 +/- 1.68
24	14JUL 1400		2.46 +/- 0.12	17.81 +/- 1.40	6.21 +/- 0.82	17.29 +/- 1.57
25	14JUL 1800		1.69 +/- 0.08	7.87 +/- 1.57	7.84 +/- 1.01	14.92 +/- 1.36
26	15JUL 0100		1.67 +/- 0.08	5.72 +/- 1.14	10.46 +/- 1.33	15.25 +/- 1.39
27	15JUL 0600		3.33 +/- 0.17	10.62 +/- 2.12	18.35 +/- 2.32	30.11 +/- 2.72
28	15JUL 1000	CG	3.78 +/- 0.19	18.96 +/- 3.79	24.23 +/- 3.05	33.66 +/- 3.04
29	15JUL 1400		2.41 +/- 0.12	14.17 +/- 2.83	8.31 +/- 1.07	18.52 +/- 1.68
30	15JUL 1800		1.46 +/- 0.07	7.35 +/- 1.47	5.45 +/- 0.71	12.95 +/- 1.18
31	27AUG 0100		2.69 +/- 0.13	13.95 +/- 0.62	16.90 +/- 2.13	23.82 +/- 2.16
32	27AUG 0600		3.60 +/- 0.18	21.44 +/- 3.75	15.17 +/- 1.92	30.58 +/- 2.77
33	27AUG 1000	CG	3.40 +/- 0.17	21.46 +/- 4.25	13.41 +/- 1.71	28.96 +/- 2.62
34	27AUG 1400	CG	2.56 +/- 0.13	22.99 +/- 0.82	5.33 +/- 0.71	18.56 +/- 1.69
35	27AUG 1800		1.87 +/- 0.09	12.56 +/- 1.72	11.09 +/- 1.41	14.58 +/- 1.33
36	28AUG 0100	CG	2.13 +/- 0.11	13.51 +/- 2.11	10.70 +/- 1.36	17.08 +/- 1.55
37	28AUG 0600	CG	3.58 +/- 0.18	23.98 +/- 4.80	-0.43 +/- 0.00	29.86 +/- 2.70
38	28AUG 1000	CG	4.00 +/- 0.20	29.82 +/- 5.96	-0.50 +/- 0.00	32.56 +/- 2.94
39	28AUG 1400	CG	3.46 +/- 0.17	25.86 +/- 3.05	7.98 +/- 1.04	25.74 +/- 2.33
40	28AUG 1800		2.51 +/- 0.13	15.78 +/- 2.58	18.82 +/- 2.37	19.53 +/- 1.77
41	29AUG 0100		2.35 +/- 0.12	14.38 +/- 1.04	11.13 +/- 1.42	20.39 +/- 1.85
42	29AUG 0600		4.91 +/- 0.25	20.52 +/- 4.10	41.35 +/- 5.19	45.73 +/- 4.13
43	29AUG 1000		5.54 +/- 0.28	25.29 +/- 5.06	23.97 +/- 3.03	47.55 +/- 4.30
44	29AUG 1400		2.33 +/- 0.12	15.23 +/- 3.05	3.71 +/- 0.56	13.28 +/- 1.23
45	29AUG 1800		1.76 +/- 0.09	9.05 +/- 1.65	-0.13 +/- 0.00	15.12 +/- 1.37
46	02SEP 0100	CG	1.55 +/- 0.08	20.86 +/- 1.98	2.03 +/- 0.32	14.89 +/- 1.36

(units in micrograms/m**3)

Rubidoux - IMPROVE Filter Data

ID	Description	Status	H	C	N	O
47	02SEP 0600	CG	1.88 +/- 0.09	22.24 +/- 2.92	1.38 +/- 0.27	14.71 +/- 1.34
48	02SEP 1000		1.06 +/- 0.05		-0.95 +/- 0.00	5.43 +/- 0.54
49	02SEP 1400		1.04 +/- 0.05	-9.05 +/- 0.00	-1.12 +/- 0.00	2.92 +/- 0.33
50	02SEP 1800		3.00 +/- 0.15	19.80 +/- 3.33	8.43 +/- 1.10	23.09 +/- 2.10
51	03SEP 0100		1.80 +/- 0.09		3.54 +/- 0.53	11.55 +/- 1.07
52	03SEP 0600		2.53 +/- 0.13	26.16 +/- 4.67	5.63 +/- 0.78	17.22 +/- 1.58
53	03SEP 1000		2.31 +/- 0.12	18.02 +/- 3.60	3.38 +/- 0.52	11.83 +/- 1.10
54	03SEP 1400		1.90 +/- 0.10	14.02 +/- 2.80	1.73 +/- 0.35	10.05 +/- 0.94
55	03SEP 1800		1.29 +/- 0.06	8.00 +/- 1.60	3.23 +/- 0.48	8.70 +/- 0.81

(units in micrograms/m**3)

Rubidoux - IMPROVE Filter Data

ID	DESCRIPTION	AL			SI			S		
1	19JUN 0100	102.2	+/-	7.9	194.9	+/-	11.0	1025.1	+/-	51.9
2	19JUN 0600	207.7	+/-	15.6	442.7	+/-	24.1	1399.3	+/-	71.1
3	19JUN 1000	250.5	+/-	17.4	420.0	+/-	23.1	1318.2	+/-	66.8
4	19JUN 1400	208.7	+/-	15.5	438.8	+/-	23.5	1097.9	+/-	55.9
5	19JUN 1800	147.7	+/-	11.6	296.6	+/-	16.3	965.0	+/-	48.9
6	24JUN 0100	136.1	+/-	9.3	274.8	+/-	14.9	989.9	+/-	50.2
7	24JUN 0600	227.6	+/-	21.2	371.8	+/-	22.6	2608.0	+/-	131.8
8	24JUN 1000	432.7	+/-	28.2	849.1	+/-	45.5	2896.2	+/-	146.4
9	24JUN 1400	242.1	+/-	19.8	533.3	+/-	29.0	2427.3	+/-	122.6
10	24JUN 1800	192.1	+/-	13.0	356.7	+/-	19.3	978.5	+/-	49.6
11	25JUN 0100	107.9	+/-	10.5	231.2	+/-	14.5	1103.0	+/-	57.5
12	25JUN 0600	236.5	+/-	21.9	562.0	+/-	31.2	2402.5	+/-	121.7
13	25JUN 1000	560.6	+/-	38.9	775.7	+/-	43.0	2166.5	+/-	109.6
14	25JUN 1400	370.3	+/-	25.3	589.0	+/-	32.1	1833.9	+/-	92.7
15	25JUN 1800	211.0	+/-	12.8	385.1	+/-	20.2	948.6	+/-	47.9
16	13JUL 0100	196.0	+/-	13.1	363.1	+/-	19.9	1643.4	+/-	83.2
17	13JUL 0600	611.0	+/-	38.0	903.1	+/-	48.2	1836.7	+/-	93.8
18	13JUL 1008	211.2	+/-	14.0	373.0	+/-	20.4	1465.0	+/-	74.3
19	13JUL 1400	227.2	+/-	16.3	389.6	+/-	21.7	1914.8	+/-	96.7
21	14JUL 0100	161.4	+/-	13.1	317.4	+/-	17.7	1439.7	+/-	72.9
22	14JUL 0600	209.4	+/-	14.0	385.5	+/-	21.1	1486.9	+/-	75.4
23	14JUL 1008	263.5	+/-	19.4	619.1	+/-	33.0	2008.7	+/-	101.5
24	14JUL 1400	256.1	+/-	19.5	446.1	+/-	25.4	2807.0	+/-	141.4
25	14JUL 1800	176.0	+/-	12.2	337.0	+/-	18.2	1585.3	+/-	79.8
26	15JUL 0100	93.0	+/-	12.1	175.1	+/-	11.5	1993.3	+/-	100.4
27	15JUL 0600	109.6	+/-	10.3	267.2	+/-	16.4	3064.7	+/-	154.4
28	15JUL 1000	522.7	+/-	41.4	791.3	+/-	45.8	3147.7	+/-	159.1
29	15JUL 1400	226.3	+/-	23.4	372.2	+/-	23.5	2018.1	+/-	102.1
30	15JUL 1800	173.6	+/-	35.0	199.1	+/-	18.0	1007.2	+/-	54.1
31	27AUG 0100	91.6	+/-	9.3	244.2	+/-	14.0	1631.3	+/-	82.5
32	27AUG 0600	717.2	+/-	47.6	1155.8	+/-	62.6	2440.4	+/-	123.6
33	27AUG 1000	659.8	+/-	47.4	1029.9	+/-	56.8	2592.7	+/-	131.4
34	27AUG 1400	541.0	+/-	34.1	940.1	+/-	50.0	2258.3	+/-	114.9
35	27AUG 1800	312.0	+/-	24.5	456.2	+/-	26.0	1330.7	+/-	68.1
36	28AUG 0100	249.8	+/-	18.2	450.0	+/-	25.4	1719.3	+/-	87.9
37	28AUG 0600	604.9	+/-	40.9	890.9	+/-	48.6	2295.9	+/-	116.5
38	28AUG 1009	852.0	+/-	53.0	1497.6	+/-	79.2	2519.6	+/-	128.3
39	28AUG 1400	547.6	+/-	38.2	895.3	+/-	48.9	3340.3	+/-	168.8
40	28AUG 1800	327.0	+/-	21.1	525.3	+/-	28.5	1483.0	+/-	75.2
41	29AUG 0100	242.5	+/-	16.5	407.4	+/-	22.3	1228.0	+/-	62.4
42	29AUG 0600	268.8	+/-	25.4	483.4	+/-	29.2	2523.7	+/-	127.6
43	29AUG 1000	260.2	+/-	25.8	493.3	+/-	31.7	3961.9	+/-	201.8
44	29AUG 1400	185.9	+/-	18.1	402.7	+/-	25.1	2714.5	+/-	138.2
45	29AUG 1800	257.4	+/-	16.7	390.7	+/-	21.1	1264.0	+/-	63.9
46	02SEP 0100	1056.2	+/-	81.2	1757.7	+/-	100.0	1027.1	+/-	59.7
47	02SEP 0600	1311.5	+/-	77.2	2351.1	+/-	121.3	927.8	+/-	49.3
48	02SEP 1000	605.6	+/-	42.0	1038.7	+/-	57.0	682.8	+/-	38.5
49	02SEP 1400	203.3	+/-	16.9	467.0	+/-	27.9	651.7	+/-	35.9
50	02SEP 1800	406.3	+/-	27.8	667.7	+/-	37.0	1744.4	+/-	89.0
51	03SEP 0100	194.2	+/-	16.9	377.5	+/-	22.2	1595.9	+/-	81.5
52	03SEP 0600	642.8	+/-	36.3	923.0	+/-	52.6	1855.2	+/-	96.3
53	03SEP 1000	275.4	+/-	22.9	470.2	+/-	28.5	1781.9	+/-	92.3
54	03SEP 1400	240.8	+/-	21.9	491.8	+/-	29.2	1741.0	+/-	89.1
55	03SEP 1800	126.3	+/-	12.9	236.5	+/-	14.3	1457.4	+/-	74.1

(units in nanograms/m**3)

Rubidoux - IMPROVE Filter Data

ID	DESCRIPTION	K		CA		TI		V		CR	
1	19JUN 0100	125.2 +/-	7.1	174.3 +/-	10.0	3.1 +/-	0.9	-2.1 +/-	0.0	-1.9 +/-	0.0
2	19JUN 0600	210.1 +/-	12.0	367.3 +/-	20.5	8.1 +/-	2.1	-3.4 +/-	0.0	-3.1 +/-	0.0
3	19JUN 1000	168.1 +/-	9.8	250.3 +/-	14.5	8.4 +/-	1.5	-3.1 +/-	0.0	-2.8 +/-	0.0
4	19JUN 1400	183.1 +/-	10.6	223.8 +/-	13.3	10.6 +/-	1.9	-3.0 +/-	0.0	-2.7 +/-	0.0
5	19JUN 1800	172.0 +/-	9.2	185.6 +/-	11.0	6.3 +/-	1.3	-2.0 +/-	0.0	-1.8 +/-	0.0
6	24JUN 0100	76.9 +/-	4.9	137.0 +/-	8.0	7.3 +/-	1.3	-2.2 +/-	0.0	-2.0 +/-	0.0
7	24JUN 0600	142.2 +/-	9.1	226.9 +/-	13.4	6.1 +/-	2.1	-4.4 +/-	0.0	-4.0 +/-	0.0
8	24JUN 1000	233.8 +/-	13.7	475.2 +/-	26.8	21.8 +/-	2.9	-4.7 +/-	0.0	-4.3 +/-	0.0
9	24JUN 1400	174.3 +/-	10.3	259.8 +/-	15.1	14.9 +/-	2.1	-3.7 +/-	0.0	-3.4 +/-	0.0
10	24JUN 1800	103.7 +/-	6.2	219.1 +/-	12.1	11.3 +/-	1.4	-2.1 +/-	0.0	-1.9 +/-	0.0
11	25JUN 0100	64.9 +/-	5.8	126.2 +/-	8.8	-4.7 +/-	0.0	-4.6 +/-	0.0	-4.1 +/-	0.0
12	25JUN 0600	257.4 +/-	17.3	755.5 +/-	40.6	8.1 +/-	2.5	6.2 +/-	2.2	-4.2 +/-	0.0
13	25JUN 1000	255.5 +/-	14.7	419.3 +/-	23.5	21.1 +/-	2.4	-3.7 +/-	0.0	-3.4 +/-	0.0
14	25JUN 1400	194.0 +/-	11.0	279.3 +/-	16.0	9.3 +/-	1.7	-3.2 +/-	0.0	-2.9 +/-	0.0
15	25JUN 1800	105.3 +/-	5.9	217.1 +/-	11.9	9.9 +/-	1.0	-1.5 +/-	0.0	-1.4 +/-	0.0
16	13JUL 0100	134.6 +/-	7.7	210.5 +/-	12.0	6.0 +/-	1.2	-2.5 +/-	0.0	-2.3 +/-	0.0
17	13JUL 0600	259.6 +/-	15.5	992.0 +/-	52.4	23.0 +/-	2.8	4.0 +/-	1.8	-3.4 +/-	0.0
18	13JUL 1000	113.5 +/-	7.1	240.8 +/-	13.6	8.9 +/-	1.6	-2.8 +/-	0.0	-2.5 +/-	0.0
19	13JUL 1400	111.9 +/-	7.0	187.4 +/-	10.9	7.5 +/-	1.5	-2.9 +/-	0.0	-2.6 +/-	0.0
21	14JUL 0100	127.3 +/-	7.5	197.6 +/-	11.4	6.7 +/-	1.2	-2.3 +/-	0.0	-2.1 +/-	0.0
22	14JUL 0600	146.9 +/-	8.7	379.2 +/-	20.6	6.6 +/-	1.5	-3.0 +/-	0.0	-2.7 +/-	0.0
23	14JUL 1000	159.2 +/-	9.6	338.4 +/-	18.9	15.2 +/-	2.0	-3.3 +/-	0.0	-3.0 +/-	0.0
24	14JUL 1400	109.5 +/-	7.0	190.1 +/-	11.0	12.1 +/-	1.7	-3.1 +/-	0.0	-2.8 +/-	0.0
25	14JUL 1800	86.5 +/-	5.0	135.4 +/-	7.7	6.1 +/-	0.9	-1.7 +/-	0.0	-1.6 +/-	0.0
26	15JUL 0100	68.9 +/-	5.1	102.8 +/-	6.2	1.5 +/-	0.9	-2.1 +/-	0.0	-1.9 +/-	0.0
27	15JUL 0600	104.7 +/-	7.1	174.7 +/-	10.3	5.2 +/-	1.6	-3.3 +/-	0.0	-3.0 +/-	0.0
28	15JUL 1000	220.2 +/-	13.2	394.3 +/-	22.8	29.9 +/-	4.2	-4.9 +/-	0.0	-4.4 +/-	0.0
29	15JUL 1400	102.3 +/-	6.8	191.7 +/-	11.2	9.7 +/-	2.0	-3.7 +/-	0.0	-3.4 +/-	0.0
30	15JUL 1800	92.3 +/-	11.1	154.5 +/-	14.2	9.6 +/-	2.2	-3.2 +/-	0.0	-3.0 +/-	0.0
31	27AUG 0100	96.6 +/-	6.7	165.4 +/-	9.8	4.8 +/-	1.4	6.9 +/-	1.4	-2.6 +/-	0.0
32	27AUG 0600	471.2 +/-	30.0	1459.0 +/-	77.3	27.1 +/-	3.5	-4.7 +/-	0.0	-4.3 +/-	0.0
33	27AUG 1000	298.9 +/-	17.4	626.6 +/-	34.8	31.5 +/-	3.6	-5.1 +/-	0.0	-4.6 +/-	0.0
34	27AUG 1400	207.9 +/-	12.9	347.0 +/-	20.3	28.4 +/-	3.3	-4.9 +/-	0.0	-4.5 +/-	0.0
35	27AUG 1800	152.2 +/-	10.5	251.9 +/-	15.2	18.9 +/-	1.9	3.8 +/-	1.1	-1.8 +/-	0.0
36	28AUG 0100	167.6 +/-	13.5	617.5 +/-	34.0	6.5 +/-	1.4	-2.9 +/-	0.0	-2.6 +/-	0.0
37	28AUG 0600	355.6 +/-	22.2	1025.7 +/-	54.8	21.1 +/-	3.0	-4.9 +/-	0.0	-4.5 +/-	0.0
38	28AUG 1000	492.7 +/-	27.7	959.7 +/-	52.9	40.4 +/-	4.6	-6.4 +/-	0.0	-5.8 +/-	0.0
39	28AUG 1400	250.9 +/-	14.3	361.4 +/-	20.8	25.1 +/-	3.3	-4.4 +/-	0.0	-4.0 +/-	0.0
40	28AUG 1800	139.4 +/-	8.1	250.0 +/-	14.1	12.8 +/-	1.8	-2.8 +/-	0.0	-2.5 +/-	0.0
41	29AUG 0100	110.2 +/-	7.0	155.0 +/-	9.2	10.2 +/-	1.5	-2.4 +/-	0.0	-2.2 +/-	0.0
42	29AUG 0600	200.0 +/-	11.4	319.8 +/-	18.5	6.3 +/-	2.1	-4.0 +/-	0.0	-3.6 +/-	0.0
43	29AUG 1000	195.2 +/-	15.9	213.7 +/-	15.8	8.1 +/-	4.2	-10.1 +/-	0.0	-9.2 +/-	0.0
44	29AUG 1400	157.7 +/-	11.6	130.2 +/-	10.2	13.0 +/-	4.8	-7.0 +/-	0.0	-6.3 +/-	0.0
45	29AUG 1800	117.7 +/-	6.8	157.1 +/-	9.1	8.9 +/-	1.3	-1.7 +/-	0.0	-1.6 +/-	0.0
46	02SEP 0100	502.6 +/-	45.3	3930.4 +/-	212.5	39.5 +/-	5.7	-3.9 +/-	0.0	-3.6 +/-	0.0
47	02SEP 0600	538.7 +/-	33.3	3261.5 +/-	170.3	59.5 +/-	5.8	7.0 +/-	3.1	-4.3 +/-	0.0
48	02SEP 1000	190.0 +/-	14.5	666.6 +/-	37.4	25.3 +/-	5.9	11.8 +/-	3.9	-8.6 +/-	0.0
49	02SEP 1400	126.3 +/-	18.5	217.5 +/-	14.6	10.5 +/-	3.8	-8.3 +/-	0.0	6.1 +/-	2.7
50	02SEP 1800	203.2 +/-	12.9	586.6 +/-	32.2	15.5 +/-	2.9	-5.4 +/-	0.0	-4.9 +/-	0.0
51	03SEP 0100	139.4 +/-	9.5	358.7 +/-	20.2	4.7 +/-	2.2	-5.6 +/-	0.0	-5.0 +/-	0.0
52	03SEP 0600	343.1 +/-	23.9	1728.5 +/-	91.1	15.6 +/-	6.0	-10.0 +/-	0.0	-9.1 +/-	0.0
53	03SEP 1000	170.7 +/-	13.0	298.3 +/-	19.1	15.4 +/-	3.7	-8.9 +/-	0.0	-8.1 +/-	0.0
54	03SEP 1400	151.1 +/-	10.3	161.4 +/-	11.3	6.6 +/-	2.4	-6.7 +/-	0.0	-6.1 +/-	0.0
55	03SEP 1800	118.2 +/-	7.3	140.9 +/-	8.8	-3.9 +/-	0.0	-3.7 +/-	0.0	-3.4 +/-	0.0

(units in nanograms/m**3)

Rubidoux - IMPROVE Filter Data

ID	DESCRIPTION	MN		FE		NI		CU		ZN	
1	19JUN 0100	3.5 +/-	1.1	116.3 +/-	6.0	-0.9 +/-	0.0	2.1 +/-	0.3	16.2 +/-	1.0
2	19JUN 0600	7.6 +/-	1.7	249.4 +/-	12.8	-1.5 +/-	0.0	2.8 +/-	0.5	31.7 +/-	1.9
3	19JUN 1000	-2.5 +/-	0.0	220.5 +/-	11.3	-1.3 +/-	0.0	2.5 +/-	0.4	38.8 +/-	2.3
4	19JUN 1400	-2.5 +/-	0.0	206.4 +/-	10.6	-1.3 +/-	0.0	0.9 +/-	0.3	13.6 +/-	1.0
5	19JUN 1800	1.5 +/-	0.6	137.4 +/-	7.0	0.4 +/-	0.2	0.7 +/-	0.2	12.6 +/-	0.9
6	24JUN 0100	2.0 +/-	0.7	136.1 +/-	7.0	-0.9 +/-	0.0	1.3 +/-	0.3	7.1 +/-	0.6
7	24JUN 0600	3.2 +/-	1.3	189.8 +/-	9.9	-1.8 +/-	0.0	-1.5 +/-	0.0	24.3 +/-	1.6
8	24JUN 1000	4.8 +/-	1.5	377.9 +/-	19.3	-1.9 +/-	0.0	2.8 +/-	0.7	33.5 +/-	2.1
9	24JUN 1400	4.0 +/-	1.2	97.8 +/-	6.7	-1.4 +/-	0.0	9.1 +/-	0.8	7.6 +/-	0.8
10	24JUN 1800	-1.8 +/-	0.0	172.9 +/-	8.8	-0.9 +/-	0.0	1.0 +/-	0.3	16.5 +/-	1.1
11	25JUN 0100	-3.8 +/-	0.0	57.4 +/-	3.8	8.5 +/-	1.2	-1.8 +/-	0.0	-1.6 +/-	0.0
12	25JUN 0600	-3.8 +/-	0.0	280.6 +/-	14.5	1.1 +/-	0.6	2.8 +/-	0.6	29.2 +/-	1.9
13	25JUN 1000	-3.1 +/-	0.0	345.8 +/-	17.6	-1.5 +/-	0.0	1.9 +/-	0.5	28.5 +/-	1.8
14	25JUN 1400	3.5 +/-	1.1	259.7 +/-	13.3	-1.3 +/-	0.0	4.5 +/-	0.5	16.5 +/-	1.2
15	25JUN 1800	-1.3 +/-	0.0	172.8 +/-	8.8	-0.6 +/-	0.0	1.0 +/-	0.2	16.5 +/-	0.9
16	13JUL 0100	3.7 +/-	1.0	186.6 +/-	9.6	-1.0 +/-	0.0	1.2 +/-	0.3	15.7 +/-	1.0
17	13JUL 0600	12.4 +/-	2.1	407.3 +/-	20.7	-1.6 +/-	0.0	3.9 +/-	0.6	37.5 +/-	2.3
18	13JUL 1000	2.4 +/-	0.9	170.5 +/-	8.8	-1.2 +/-	0.0	1.7 +/-	0.4	25.0 +/-	1.5
19	13JUL 1400	-2.4 +/-	0.0	196.8 +/-	10.1	-1.2 +/-	0.0	1.3 +/-	0.4	62.3 +/-	3.3
21	14JUL 0100	3.4 +/-	0.9	153.0 +/-	7.9	-1.0 +/-	0.0	1.2 +/-	0.3	18.8 +/-	1.2
22	14JUL 0600	5.1 +/-	1.3	207.6 +/-	10.7	-1.3 +/-	0.0	1.9 +/-	0.4	45.0 +/-	2.5
23	14JUL 1000	5.2 +/-	1.1	259.4 +/-	13.3	-1.4 +/-	0.0	2.0 +/-	0.4	49.1 +/-	2.8
24	14JUL 1400	4.0 +/-	1.4	203.4 +/-	10.4	-1.3 +/-	0.0	2.6 +/-	0.5	44.3 +/-	2.5
25	14JUL 1800	1.7 +/-	0.9	146.6 +/-	7.5	0.5 +/-	0.2	1.1 +/-	0.2	24.4 +/-	1.4
26	15JUL 0100	-1.7 +/-	0.0	78.7 +/-	4.1	-0.8 +/-	0.0	0.8 +/-	0.3	21.5 +/-	1.3
27	15JUL 0600	1.9 +/-	1.0	134.6 +/-	7.0	-1.3 +/-	0.0	2.4 +/-	0.5	42.7 +/-	2.4
28	15JUL 1000	6.9 +/-	1.9	339.1 +/-	17.4	0.7 +/-	0.6	2.0 +/-	0.6	39.1 +/-	2.4
29	15JUL 1400	1.9 +/-	1.2	189.8 +/-	9.8	-1.6 +/-	0.0	1.3 +/-	0.5	24.8 +/-	1.7
30	15JUL 1800	-2.7 +/-	0.0	122.6 +/-	6.7	-1.7 +/-	0.0	1.6 +/-	0.5	19.3 +/-	1.5
31	27AUG 0100	3.3 +/-	0.9	139.7 +/-	7.3	-1.2 +/-	0.0	1.2 +/-	0.3	14.1 +/-	1.0
32	27AUG 0600	38.5 +/-	11.9	530.1 +/-	26.9	-1.8 +/-	0.0	1.5 +/-	0.5	37.1 +/-	2.3
33	27AUG 1000	11.9 +/-	2.7	546.3 +/-	27.8	-2.1 +/-	0.0	3.5 +/-	0.7	56.6 +/-	3.3
34	27AUG 1400	-4.1 +/-	0.0	438.6 +/-	22.4	-2.0 +/-	0.0	3.2 +/-	0.7	54.2 +/-	3.2
35	27AUG 1800	7.6 +/-	1.2	222.9 +/-	11.4	-0.9 +/-	0.0	1.7 +/-	0.3	27.0 +/-	1.5
36	28AUG 0100	2.7 +/-	1.1	266.0 +/-	13.6	-1.4 +/-	0.0	3.2 +/-	0.5	20.3 +/-	1.3
37	28AUG 0600	-4.1 +/-	0.0	468.5 +/-	23.9	-2.0 +/-	0.0	2.8 +/-	0.6	36.8 +/-	2.2
38	28AUG 1000	6.7 +/-	2.2	686.3 +/-	34.9	-2.6 +/-	0.0	3.3 +/-	0.7	93.0 +/-	5.3
39	28AUG 1400	-3.6 +/-	0.0	406.0 +/-	20.7	0.7 +/-	0.5	1.9 +/-	0.5	84.1 +/-	4.5
40	28AUG 1800	5.5 +/-	1.2	248.4 +/-	12.7	-1.1 +/-	0.0	1.3 +/-	0.3	26.4 +/-	1.5
41	29AUG 0100	4.2 +/-	1.0	218.4 +/-	11.1	-1.0 +/-	0.0	1.2 +/-	0.3	16.8 +/-	1.1
42	29AUG 0600	7.6 +/-	1.5	240.8 +/-	12.4	-1.6 +/-	0.0	2.3 +/-	0.5	25.6 +/-	1.6
43	29AUG 1000	-8.3 +/-	0.0	239.7 +/-	13.4	-4.5 +/-	0.0	6.1 +/-	1.5	39.0 +/-	3.3
44	29AUG 1400	3.9 +/-	2.1	158.0 +/-	8.9	-3.1 +/-	0.0	2.0 +/-	1.0	19.1 +/-	1.8
45	29AUG 1800	-1.4 +/-	0.0	167.6 +/-	8.5	0.9 +/-	0.2	0.7 +/-	0.2	11.6 +/-	0.8
46	02SEP 0100	17.3 +/-	2.8	752.8 +/-	38.3	-2.0 +/-	0.0	4.3 +/-	0.8	50.4 +/-	3.2
47	02SEP 0600	-3.9 +/-	0.0	939.4 +/-	47.7	-2.1 +/-	0.0	5.5 +/-	0.9	41.7 +/-	2.7
48	02SEP 1000	-7.8 +/-	0.0	383.5 +/-	20.3	-4.5 +/-	0.0	5.0 +/-	1.4	13.1 +/-	2.1
49	02SEP 1400	-6.8 +/-	0.0	158.5 +/-	9.2	-4.0 +/-	0.0	-3.4 +/-	0.0	4.6 +/-	1.8
50	02SEP 1800	7.6 +/-	1.9	337.3 +/-	17.4	-2.4 +/-	0.0	3.9 +/-	0.7	45.7 +/-	2.8
51	03SEP 0100	4.6 +/-	1.7	189.9 +/-	10.0	2.2 +/-	0.8	2.8 +/-	0.7	16.2 +/-	1.4
52	03SEP 0600	13.2 +/-	3.9	466.0 +/-	24.3	-4.5 +/-	0.0	5.1 +/-	1.4	43.4 +/-	3.6
53	03SEP 1000	-7.3 +/-	0.0	236.6 +/-	13.0	-4.3 +/-	0.0	2.4 +/-	1.2	26.9 +/-	2.3
54	03SEP 1400	2.3 +/-	1.9	184.2 +/-	10.0	-3.1 +/-	0.0	-2.6 +/-	0.0	13.7 +/-	1.5
55	03SEP 1800	-3.1 +/-	0.0	108.1 +/-	5.8	-1.7 +/-	0.0	2.4 +/-	0.6	7.9 +/-	0.8

(units in nanograms/m**3)

Rubidoux - IMPROVE Filter Data

ID	DESCRIPTION	AS			PB			SE			BR		
1	19JUN 0100	-0.8	+/-	0.0	38.7	+/-	2.4	-0.8	+/-	0.0	6.8	+/-	1.3
2	19JUN 0600	-1.2	+/-	0.0	72.1	+/-	4.8	1.5	+/-	0.5	7.7	+/-	1.6
3	19JUN 1000	-1.1	+/-	0.0	46.6	+/-	3.7	0.9	+/-	0.4	9.6	+/-	1.5
4	19JUN 1400	-1.1	+/-	0.0	23.0	+/-	2.3	-1.2	+/-	0.0	7.5	+/-	1.1
5	19JUN 1800	2.0	+/-	0.7	16.0	+/-	2.0	-0.7	+/-	0.0	7.6	+/-	0.8
6	24JUN 0100	2.3	+/-	0.9	27.8	+/-	2.8	-0.8	+/-	0.0	7.7	+/-	0.9
7	24JUN 0600	4.7	+/-	1.7	45.3	+/-	5.2	-1.6	+/-	0.0	19.0	+/-	2.1
8	24JUN 1000	-1.6	+/-	0.0	42.1	+/-	3.4	-1.7	+/-	0.0	10.2	+/-	1.7
9	24JUN 1400	-1.3	+/-	0.0	12.2	+/-	1.8	7.8	+/-	1.0	9.5	+/-	1.6
10	24JUN 1800	-0.8	+/-	0.0	28.2	+/-	1.9	-0.8	+/-	0.0	8.5	+/-	1.1
11	25JUN 0100	-1.8	+/-	0.0	11.7	+/-	3.0	-1.8	+/-	0.0	5.8	+/-	1.3
12	25JUN 0600	6.9	+/-	1.8	42.5	+/-	4.9	-1.7	+/-	0.0	21.1	+/-	2.3
13	25JUN 1000	2.9	+/-	1.1	22.1	+/-	3.3	-1.3	+/-	0.0	12.6	+/-	1.5
14	25JUN 1400	-1.1	+/-	0.0	36.1	+/-	3.0	-1.1	+/-	0.0	13.6	+/-	1.7
15	25JUN 1800	-0.5	+/-	0.0	37.2	+/-	2.0	-0.5	+/-	0.0	5.0	+/-	0.8
16	13JUL 0100	-0.8	+/-	0.0	66.3	+/-	3.7	1.3	+/-	0.4	8.0	+/-	1.4
17	13JUL 0600	-1.3	+/-	0.0	110.7	+/-	6.0	4.6	+/-	0.8	10.0	+/-	2.2
18	13JUL 1008	-1.0	+/-	0.0	32.4	+/-	2.4	-1.0	+/-	0.0	8.0	+/-	1.1
19	13JUL 1400	-1.0	+/-	0.0	38.5	+/-	2.8	-1.1	+/-	0.0	10.2	+/-	1.3
21	14JUL 0100	-0.9	+/-	0.0	44.9	+/-	2.8	-0.9	+/-	0.0	-1.1	+/-	0.0
22	14JUL 0600	13.5	+/-	1.6	23.0	+/-	10.9	2.4	+/-	0.6	-1.4	+/-	0.0
23	14JUL 1008	-1.1	+/-	0.0	39.1	+/-	2.7	1.6	+/-	0.5	6.4	+/-	1.2
24	14JUL 1400	-1.1	+/-	0.0	40.1	+/-	2.8	-1.2	+/-	0.0	15.1	+/-	1.4
25	14JUL 1800	-0.5	+/-	0.0	26.6	+/-	2.0	-0.6	+/-	0.0	4.9	+/-	0.7
26	15JUL 0100	-0.7	+/-	0.0	16.2	+/-	1.3	0.8	+/-	0.3	5.6	+/-	0.7
27	15JUL 0600	2.5	+/-	0.9	23.1	+/-	3.3	1.3	+/-	0.5	11.1	+/-	1.1
28	15JUL 1000	-1.8	+/-	0.0	30.1	+/-	3.4	-1.9	+/-	0.0	11.4	+/-	1.4
29	15JUL 1400	3.1	+/-	1.0	21.5	+/-	3.8	-1.4	+/-	0.0	8.4	+/-	1.2
30	15JUL 1800	-1.4	+/-	0.0	37.4	+/-	4.2	-1.4	+/-	0.0	-1.8	+/-	0.0
31	27AUG 0100	-1.0	+/-	0.0	36.6	+/-	2.4	-1.1	+/-	0.0	15.1	+/-	1.3
32	27AUG 0600	-1.5	+/-	0.0	138.0	+/-	6.9	-1.6	+/-	0.0	23.9	+/-	3.0
33	27AUG 1000	-1.8	+/-	0.0	58.8	+/-	4.4	-1.8	+/-	0.0	24.9	+/-	2.3
34	27AUG 1400	-1.7	+/-	0.0	58.7	+/-	4.2	-1.8	+/-	0.0	14.6	+/-	2.2
35	27AUG 1800	-0.8	+/-	0.0	50.1	+/-	2.7	-0.8	+/-	0.0	14.7	+/-	1.1
36	28AUG 0100	-1.1	+/-	0.0	52.3	+/-	3.2	0.5	+/-	0.4	9.9	+/-	1.5
37	28AUG 0600	-1.7	+/-	0.0	109.7	+/-	6.2	-1.8	+/-	0.0	23.1	+/-	3.0
38	28AUG 1009	-2.2	+/-	0.0	87.3	+/-	5.7	-2.2	+/-	0.0	22.0	+/-	3.9
39	28AUG 1400	-1.5	+/-	0.0	114.1	+/-	7.9	-1.6	+/-	0.0	13.7	+/-	2.4
40	28AUG 1800	-0.9	+/-	0.0	51.3	+/-	3.0	-0.9	+/-	0.0	6.5	+/-	1.2
41	29AUG 0100	-0.8	+/-	0.0	64.0	+/-	3.1	-0.8	+/-	0.0	8.2	+/-	1.4
42	29AUG 0600	-1.3	+/-	0.0	92.7	+/-	5.0	0.7	+/-	0.4	21.2	+/-	2.5
43	29AUG 1000	-3.8	+/-	0.0	79.8	+/-	10.6	2.5	+/-	1.3	24.5	+/-	3.8
44	29AUG 1400	-2.7	+/-	0.0	49.1	+/-	8.7	1.3	+/-	0.9	-3.5	+/-	0.0
45	29AUG 1800	-0.5	+/-	0.0	40.5	+/-	2.1	-0.6	+/-	0.0	7.4	+/-	1.0
46	02SEP 0100	-1.6	+/-	0.0	102.2	+/-	6.9	-1.7	+/-	0.0	10.6	+/-	2.3
47	02SEP 0600	-1.7	+/-	0.0	116.4	+/-	6.6	-1.7	+/-	0.0	10.5	+/-	2.6
48	02SEP 1000	-3.9	+/-	0.0	24.9	+/-	7.8	-4.0	+/-	0.0	-4.9	+/-	0.0
49	02SEP 1400	-3.5	+/-	0.0	8.1	+/-	3.8	-3.6	+/-	0.0	4.5	+/-	1.7
50	02SEP 1800	6.3	+/-	2.0	47.4	+/-	6.7	-2.1	+/-	0.0	-2.6	+/-	0.0
51	03SEP 0100	-2.2	+/-	0.0	42.0	+/-	4.3	2.0	+/-	1.6	8.3	+/-	1.9
52	03SEP 0600	25.4	+/-	4.5	66.7	+/-	37.5	-4.0	+/-	0.0	-4.9	+/-	0.0
53	03SEP 1000	-3.7	+/-	0.0	42.4	+/-	6.0	-3.9	+/-	0.0	22.3	+/-	3.2
54	03SEP 1400	-2.7	+/-	0.0	24.6	+/-	3.9	1.8	+/-	0.9	12.4	+/-	1.9
55	03SEP 1800	-1.5	+/-	0.0	20.7	+/-	2.2	-1.6	+/-	0.0	5.5	+/-	1.0

(units in nanograms/m**3)

Site: Downtown Los Angeles
Project: SCAQS 1987, Fall
Organization: U.C. Davis
Sampler: IMPROVE Cyclone - Teflon Filters
Particulate Size: < 2.5µm
Analysis: Gravimetric Mass, Optical Absorption, FAST, PIXE
Units: micrograms per cubic meter for Mass and FAST: H to O
: 10**(-6) meters for Optical Absorption
: nanograms per cubic meter for PIXE : Na to Br
# of Samples : 30
Column Header: ID = Identification # of sample for each row
: Description : Start Day, Month, Time(military time, PST)
: Status = CG - clogged filter, uncertain volume
= PP - Sample duration is >> SCAQS schedule
= OV - overlap of volume between 2 filters, uncertain volume
= PX - unacceptable PIXE Analysis
= XX - did not sample
: ET = Sample Durations(decimal hours)
: Ma = Gravimetric Mass - µg/m**3
: OA = Optical Absorption - 10**(-6) meters
: Elemental Concentrations (eg. Fe=iron) and uncertainties.
If element is below minimum detectable limits(MDL),
the MDL is given(marked by a negative sign).

ID	Description	Status	ET(hrs.)	Ma	OA (10**6 inverse meters)
56	11NOV 0000		6.01	31.47 +/- 1.29	138.64 +/- 5.95
57	11NOV 0600		4.00	25.99 +/- 1.53	108.23 +/- 5.36
58	11NOV 1000		4.00	12.93 +/- 1.48	31.79 +/- 2.10
59	11NOV 1400		4.02	21.68 +/- 1.60	48.15 +/- 2.64
60	11NOV 1800	PP	13.80	34.35 +/- 1.12	125.84 +/- 4.97
61	12NOV 0000		6.00	29.03 +/- 1.34	106.25 +/- 4.67
62	12NOV 0600		4.00	36.57 +/- 1.88	151.28 +/- 7.06
63	12NOV 1000	PP	5.79	44.48 +/- 1.72	86.49 +/- 3.42
64	12NOV 1400		4.01	71.42 +/- 2.64	91.50 +/- 3.49
65	12NOV 1800		6.00	64.12 +/- 2.18	135.92 +/- 4.74
66	13NOV 0000		6.00	97.46 +/- 3.10	117.69 +/- 3.48
67	13NOV 0600		4.00	121.79 +/- 3.96	132.63 +/- 4.21
68	13NOV 1000		3.71	146.27 +/- 4.70	148.64 +/- 4.53
69	13NOV 1400		3.99	62.50 +/- 2.43	68.98 +/- 2.74
70	13NOV 1800		6.00	38.93 +/- 1.56	50.68 +/- 2.06
71	03DEC 0000		6.01	170.22 +/- 5.21	190.08 +/- 4.18
72	03DEC 0600		4.00	132.06 +/- 4.23	171.43 +/- 5.25
73	03DEC 1000		3.80	81.36 +/- 2.90	86.46 +/- 3.18
74	03DEC 1400		4.00	115.65 +/- 3.77	106.40 +/- 3.41
75	03DEC 1800		6.00	135.80 +/- 4.19	213.80 +/- 5.34

(units in micrograms/m**3)

Downtown Los Angeles - IMPROVE Filter Data

ID	Description	Status	ET (hrs.)	Ma	OA (10**6 inverse meters)
76	10DEC 0000		6.00	65.95 +/- 2.20	185.32 +/- 6.56
77	10DEC 0600		4.00	49.83 +/- 2.09	180.49 +/- 7.67
78	10DEC 1000		3.80	35.69 +/- 1.88	73.95 +/- 3.49
79	10DEC 1400		4.00	55.56 +/- 2.21	85.32 +/- 3.43
80	10DEC 1800		6.00	94.77 +/- 3.01	192.06 +/- 5.77
81	11DEC 0000		6.00	87.11 +/- 2.79	207.84 +/- 6.57
82	11DEC 0600		4.00	95.65 +/- 3.21	298.16 +/- 10.89
83	11DEC 1000		3.95	120.82 +/- 3.92	141.78 +/- 4.47
84	11DEC 1400		4.00	153.68 +/- 4.83	206.60 +/- 5.83
85	11DEC 1800		6.00	162.17 +/- 4.97	310.02 +/- 7.07

(units in micrograms/m**3)

Downtown Los Angeles - IMPROVE Filter Data

ID	Description	Status	H	C	N	O
56	11NOV 0000		1.75 +/- 0.09	20.37 +/- 1.56	0.88 +/- 0.26	3.07 +/- 0.31
57	11NOV 0600		1.66 +/- 0.08	9.50 +/- 0.26	-1.17 +/- 0.00	-1.08 +/- 0.00
58	11NOV 1000			-6.70 +/- 0.00	-1.17 +/- 0.00	-1.08 +/- 0.00
59	11NOV 1400		1.33 +/- 0.07	-7.21 +/- 0.00	-1.28 +/- 0.91	-1.19 +/- 0.00
60	11NOV 1800	PP	1.86 +/- 0.09	19.14 +/- 0.58	1.17 +/- 0.24	4.69 +/- 0.45
61	12NOV 0000		1.75 +/- 0.09	13.62 +/- 2.72	1.76 +/- 0.33	2.45 +/- 0.27
62	12NOV 0600		2.29 +/- 0.11	21.13 +/- 4.23	-1.31 +/- 0.00	1.83 +/- 0.21
63	12NOV 1000	PP	2.41 +/- 0.12	12.74 +/- 2.55	2.40 +/- 0.40	8.36 +/- 0.78
64	12NOV 1400		3.59 +/- 0.18	17.09 +/- 1.20	11.36 +/- 1.47	17.16 +/- 1.57
65	12NOV 1800		3.40 +/- 0.17	23.89 +/- 4.00	8.87 +/- 1.16	16.39 +/- 1.50
66	13NOV 0000		4.58 +/- 0.23	22.42 +/- 2.68	20.35 +/- 2.58	28.25 +/- 2.56
67	13NOV 0600		5.93 +/- 0.30	23.00 +/- 4.60	30.72 +/- 3.87	41.65 +/- 3.76
68	13NOV 1000		7.14 +/- 0.36	28.64 +/- 3.10	36.39 +/- 4.58	51.72 +/- 4.67
69	13NOV 1400		3.61 +/- 0.18	-8.82 +/- 0.00	13.00 +/- 1.68	17.57 +/- 1.60
70	13NOV 1800		1.95 +/- 0.10	-6.25 +/- 0.00	3.55 +/- 0.52	7.54 +/- 0.70
71	03DEC 0000		8.78 +/- 0.44	47.68 +/- 7.26		56.77 +/- 5.12
72	03DEC 0600		7.20 +/- 0.36	34.46 +/- 4.24	43.59 +/- 5.47	42.03 +/- 3.80
73	03DEC 1000		4.21 +/- 0.21	17.94 +/- 2.63	12.77 +/- 1.65	24.37 +/- 2.21
74	03DEC 1400		5.93 +/- 0.30	25.97 +/- 5.19	22.19 +/- 2.81	38.82 +/- 3.51
75	03DEC 1800		6.85 +/- 0.34	38.49 +/- 4.65	27.76 +/- 3.50	46.80 +/- 4.22
76	10DEC 0000		3.53 +/- 0.18	33.89 +/- 0.89	6.25 +/- 0.84	11.51 +/- 1.06
77	10DEC 0600		2.81 +/- 0.14	23.37 +/- 1.05	-1.49 +/- 0.00	4.05 +/- 0.40
78	10DEC 1000		2.33 +/- 0.12	14.05 +/- 2.81	3.34 +/- 0.52	5.67 +/- 0.54
79	10DEC 1400		2.78 +/- 0.14	11.80 +/- 2.36	7.88 +/- 1.05	13.05 +/- 1.20
80	10DEC 1800		4.77 +/- 0.24	32.03 +/- 3.87	16.39 +/- 2.08	23.29 +/- 2.11
81	11DEC 0000		4.57 +/- 0.23	46.02 +/- 9.20	12.16 +/- 1.57	20.79 +/- 1.89
82	11DEC 0600		5.30 +/- 0.27	42.97 +/- 0.78	9.08 +/- 1.20	16.43 +/- 1.50
83	11DEC 1000		6.51 +/- 0.33	29.19 +/- 5.84	28.40 +/- 3.58	43.52 +/- 3.93
84	11DEC 1400		7.73 +/- 0.39	29.93 +/- 3.02	43.23 +/- 5.43	58.20 +/- 5.25
85	11DEC 1800		8.16 +/- 0.41	47.03 +/- 6.08	40.96 +/- 5.14	50.79 +/- 4.58

(units in micrograms/m**3)

Downtown Los Angeles - IMPROVE Filter Data

ID	DESCRIPTION	AL		SI		S		CL	
56	11NOV 0000	96.5 +/-	9.5	176.4 +/-	11.4	668.5 +/-	35.9	165.3 +/-	13.0
57	11NOV 0600	126.6 +/-	14.6	158.8 +/-	11.9	453.5 +/-	25.6	-8.7 +/-	0.0
58	11NOV 1000	78.2 +/-	13.7	175.9 +/-	14.0	337.1 +/-	20.3	75.7 +/-	11.0
59	11NOV 1400	183.6 +/-	19.4	247.0 +/-	17.0	454.5 +/-	25.8	-7.9 +/-	0.0
60	11NOV 1800	119.8 +/-	10.0	243.5 +/-	14.2	628.1 +/-	36.0	-4.7 +/-	0.0
61	12NOV 0000	133.1 +/-	15.1	291.3 +/-	20.9	695.9 +/-	39.5	-8.7 +/-	0.0
62	12NOV 0600	130.4 +/-	17.0	335.0 +/-	23.1	681.1 +/-	39.4	-16.3 +/-	0.0
63	12NOV 1000	227.5 +/-	19.6	436.2 +/-	26.0	673.6 +/-	37.9	-12.2 +/-	0.0
64	12NOV 1400	193.9 +/-	19.1	316.3 +/-	21.8	1300.3 +/-	69.6	171.0 +/-	18.8
65	12NOV 1800	125.6 +/-	18.8	194.9 +/-	14.5	1313.1 +/-	69.5	215.9 +/-	15.7
66	13NOV 0000	148.0 +/-	18.3	287.7 +/-	21.6	4104.8 +/-	209.7	1158.8 +/-	67.4
67	13NOV 0600	233.1 +/-	29.1	293.1 +/-	24.2	4026.4 +/-	205.4	-14.2 +/-	0.0
68	13NOV 1000	141.3 +/-	21.1	418.3 +/-	27.7	5019.2 +/-	255.9	426.9 +/-	35.2
69	13NOV 1400	90.6 +/-	14.6	237.8 +/-	18.3	4308.3 +/-	218.1	-13.7 +/-	0.0
70	13NOV 1800	34.7 +/-	6.1	118.9 +/-	9.6	1585.9 +/-	81.4	-9.4 +/-	0.0
71	03DEC 0000	118.4 +/-	16.2	331.6 +/-	26.4	2320.8 +/-	119.8	322.8 +/-	24.4
72	03DEC 0600	236.9 +/-	49.9	337.3 +/-	39.1	1818.0 +/-	95.6	232.1 +/-	15.7
73	03DEC 1000	198.8 +/-	25.1	353.3 +/-	24.3	1325.1 +/-	68.9	-11.6 +/-	0.0
74	03DEC 1400	105.5 +/-	15.9	251.3 +/-	19.8	2212.6 +/-	114.6	443.4 +/-	35.4
75	03DEC 1800	196.8 +/-	37.8	143.9 +/-	16.0	2311.3 +/-	122.0	1066.4 +/-	60.4
76	10DEC 0000	116.6 +/-	12.0	179.2 +/-	12.5	810.7 +/-	43.7	217.1 +/-	14.4
77	10DEC 0600	104.8 +/-	14.3	231.2 +/-	15.7	554.1 +/-	32.1	107.6 +/-	12.0
78	10DEC 1000	120.0 +/-	25.8	253.1 +/-	19.3	467.6 +/-	27.7	147.0 +/-	12.2
79	10DEC 1400	-14.5 +/-	0.0	197.1 +/-	14.8	572.6 +/-	32.9	-9.2 +/-	0.0
80	10DEC 1800	124.4 +/-	12.3	173.0 +/-	12.0	690.6 +/-	37.5	92.0 +/-	7.9
81	11DEC 0000	131.4 +/-	17.4	245.9 +/-	16.9	929.5 +/-	49.9	163.0 +/-	11.1
82	11DEC 0600	195.8 +/-	19.5	298.2 +/-	21.4	1074.6 +/-	57.7	-12.3 +/-	0.0
83	11DEC 1000	303.6 +/-	32.1	449.8 +/-	31.7	1631.0 +/-	89.9	-11.1 +/-	0.0
84	11DEC 1400	194.3 +/-	25.2	268.6 +/-	22.9	3200.8 +/-	162.7	-12.8 +/-	0.0
85	11DEC 1800	182.0 +/-	19.6	295.7 +/-	24.8	1945.3 +/-	103.4	356.4 +/-	21.2

ID	DESCRIPTION	K		CA		TI		V		CR	
56	11NOV 0000	92.2 +/-	6.7	82.2 +/-	6.3	6.8 +/-	2.2	-4.5 +/-	0.0	-4.0 +/-	0.0
57	11NOV 0600	46.6 +/-	5.1	98.1 +/-	7.3	5.2 +/-	2.4	-5.6 +/-	0.0	-5.1 +/-	0.0
58	11NOV 1000	54.9 +/-	6.5	96.2 +/-	10.6	13.5 +/-	3.5	6.4 +/-	2.3	-5.4 +/-	0.0
59	11NOV 1400	73.8 +/-	8.0	104.3 +/-	11.2	22.5 +/-	8.0	6.4 +/-	2.6	5.8 +/-	2.6
60	11NOV 1800	103.8 +/-	8.3	126.2 +/-	9.2	21.5 +/-	2.7	-2.9 +/-	0.0	-2.7 +/-	0.0
61	12NOV 0000	98.6 +/-	12.8	124.6 +/-	11.1	19.5 +/-	3.7	-5.5 +/-	0.0	4.7 +/-	2.3
62	12NOV 0600	99.3 +/-	10.9	144.5 +/-	12.6	17.0 +/-	5.1	-10.6 +/-	0.0	-9.6 +/-	0.0
63	12NOV 1000	159.8 +/-	11.9	203.1 +/-	14.0	31.6 +/-	4.9	-7.9 +/-	0.0	-7.2 +/-	0.0
64	12NOV 1400	111.8 +/-	11.8	95.2 +/-	10.6	14.6 +/-	5.1	-10.5 +/-	0.0	-9.5 +/-	0.0
65	12NOV 1800	151.0 +/-	10.3	107.1 +/-	9.1	9.4 +/-	3.0	8.1 +/-	3.8	-5.5 +/-	0.0
66	13NOV 0000	160.3 +/-	13.8	81.4 +/-	8.5	29.3 +/-	4.2	23.8 +/-	5.7	-5.3 +/-	0.0
67	13NOV 0600	148.2 +/-	11.7	95.7 +/-	9.5	31.6 +/-	5.4	21.7 +/-	4.9	-7.9 +/-	0.0
68	13NOV 1000	146.8 +/-	11.7	122.9 +/-	10.9	27.9 +/-	4.9	-9.4 +/-	0.0	-8.5 +/-	0.0
69	13NOV 1400	84.1 +/-	8.6	60.8 +/-	7.4	-8.9 +/-	0.0	15.0 +/-	4.5	-7.8 +/-	0.0
70	13NOV 1800	97.7 +/-	7.8	54.9 +/-	5.7	-6.2 +/-	0.0	-6.0 +/-	0.0	-5.4 +/-	0.0
71	03DEC 0000	291.7 +/-	17.1	82.6 +/-	8.6	12.5 +/-	3.7	10.6 +/-	4.8	-6.0 +/-	0.0
72	03DEC 0600	194.3 +/-	13.1	95.8 +/-	9.8	15.8 +/-	4.0	-7.9 +/-	0.0	-7.2 +/-	0.0
73	03DEC 1000	219.9 +/-	13.8	122.4 +/-	10.7	20.0 +/-	4.4	-7.3 +/-	0.0	-6.6 +/-	0.0
74	03DEC 1400	145.0 +/-	13.1	59.3 +/-	8.0	14.2 +/-	3.7	6.8 +/-	3.1	-5.9 +/-	0.0
75	03DEC 1800	216.1 +/-	15.0	54.9 +/-	6.5	14.1 +/-	2.7	18.2 +/-	6.0	-4.6 +/-	0.0
76	10DEC 0000	180.8 +/-	11.3	105.5 +/-	8.3	5.9 +/-	2.6	-5.4 +/-	0.0	-4.9 +/-	0.0
77	10DEC 0600	73.7 +/-	7.4	94.5 +/-	8.1	15.7 +/-	3.8	-7.3 +/-	0.0	-6.6 +/-	0.0
78	10DEC 1000	111.1 +/-	10.0	118.4 +/-	11.3	17.9 +/-	4.0	10.0 +/-	3.8	-6.2 +/-	0.0
79	10DEC 1400	177.4 +/-	14.6	142.2 +/-	12.8	13.2 +/-	3.9	23.5 +/-	6.1	-5.3 +/-	0.0
80	10DEC 1800	113.2 +/-	8.2	94.6 +/-	7.2	15.4 +/-	3.2	6.7 +/-	2.3	-4.4 +/-	0.0
81	11DEC 0000	134.4 +/-	9.0	126.5 +/-	9.0	16.4 +/-	2.9	6.6 +/-	2.4	-4.8 +/-	0.0
82	11DEC 0600	111.7 +/-	9.3	169.2 +/-	12.2	13.0 +/-	3.0	-7.8 +/-	0.0	-7.1 +/-	0.0
83	11DEC 1000	209.7 +/-	16.3	225.5 +/-	18.1	51.7 +/-	6.1	19.6 +/-	5.9	17.0 +/-	4.2
84	11DEC 1400	161.4 +/-	11.2	122.0 +/-	11.3	14.2 +/-	3.1	-7.9 +/-	0.0	-7.2 +/-	0.0
85	11DEC 1800	146.3 +/-	10.2	109.8 +/-	8.4	20.8 +/-	3.3	8.4 +/-	2.9	-5.3 +/-	0.0

(units in nanograms/m**3)

Downtown Los Angeles - IMPROVE Filter Data

ID	DESCRIPTION	MN		FE		NI		CU		ZN	
56	11NOV 0000	15.7 +/-	3.8	231.9 +/-	12.1	-2.0 +/-	0.0	26.4 +/-	1.9	99.1 +/-	5.5
57	11NOV 0600	16.6 +/-	2.9	227.4 +/-	12.1	-2.6 +/-	0.0	40.2 +/-	2.2	43.9 +/-	2.9
58	11NOV 1000	6.8 +/-	2.1	130.8 +/-	7.4	-3.0 +/-	0.0	7.3 +/-	1.2	100.0 +/-	5.6
59	11NOV 1400	6.7 +/-	2.5	229.2 +/-	12.1	-3.0 +/-	0.0	8.3 +/-	1.4	32.4 +/-	2.4
60	11NOV 1800	36.0 +/-	3.9	336.4 +/-	17.4	-1.6 +/-	0.0	14.7 +/-	1.1	48.7 +/-	2.9
61	12NOV 0000	20.5 +/-	4.1	290.3 +/-	15.4	-3.1 +/-	0.0	8.7 +/-	1.5	38.1 +/-	2.8
62	12NOV 0600	40.3 +/-	6.6	416.4 +/-	22.2	-4.8 +/-	0.0	17.2 +/-	2.2	161.2 +/-	9.2
63	12NOV 1000	26.8 +/-	4.5	447.1 +/-	23.3	-3.7 +/-	0.0	12.5 +/-	1.6	151.5 +/-	8.3
64	12NOV 1400	20.4 +/-	4.2	510.4 +/-	26.8	3.3 +/-	1.5	15.2 +/-	2.1	154.7 +/-	8.9
65	12NOV 1800	29.7 +/-	4.3	362.1 +/-	18.9	2.2 +/-	0.9	11.6 +/-	1.3	62.8 +/-	3.8
66	13NOV 0000	11.9 +/-	2.6	293.9 +/-	15.3	3.3 +/-	0.9	2.0 +/-	0.8	86.3 +/-	4.9
67	13NOV 0600	-7.1 +/-	0.0	233.3 +/-	12.7	-4.2 +/-	0.0	18.6 +/-	2.1	132.1 +/-	7.6
68	13NOV 1000	24.8 +/-	4.4	425.3 +/-	22.3	-4.1 +/-	0.0	19.9 +/-	2.1	395.0 +/-	20.7
69	13NOV 1400	5.7 +/-	2.6	167.5 +/-	9.4	-4.1 +/-	0.0	2.9 +/-	1.1	65.0 +/-	4.1
70	13NOV 1800	2.6 +/-	1.8	83.6 +/-	5.1	3.9 +/-	1.2	4.5 +/-	1.1	52.2 +/-	3.2
71	03DEC 0000	30.6 +/-	4.1	301.4 +/-	15.9	-2.9 +/-	0.0	7.9 +/-	1.1	74.2 +/-	4.3
72	03DEC 0600	42.9 +/-	5.3	347.2 +/-	18.5	-3.8 +/-	0.0	69.3 +/-	4.2	98.4 +/-	5.9
73	03DEC 1000	-6.0 +/-	0.0	272.1 +/-	14.4	-3.6 +/-	0.0	15.5 +/-	1.7	87.5 +/-	5.1
74	03DEC 1400	-5.3 +/-	0.0	295.2 +/-	15.8	2.6 +/-	1.1	5.8 +/-	1.1	88.2 +/-	5.3
75	03DEC 1800	35.6 +/-	4.3	386.1 +/-	20.1	-2.6 +/-	0.0	12.7 +/-	1.3	78.2 +/-	4.5
76	10DEC 0000	15.9 +/-	2.9	332.3 +/-	17.3	-2.5 +/-	0.0	7.9 +/-	1.0	71.4 +/-	4.0
77	10DEC 0600	26.4 +/-	3.9	401.3 +/-	21.0	-3.6 +/-	0.0	5.3 +/-	1.2	58.0 +/-	3.6
78	10DEC 1000	26.9 +/-	4.0	349.5 +/-	18.5	-3.9 +/-	0.0	7.0 +/-	1.3	194.2 +/-	10.7
79	10DEC 1400	24.2 +/-	3.7	332.7 +/-	17.5	2.3 +/-	1.4	6.3 +/-	1.1	91.4 +/-	5.2
80	10DEC 1800	66.9 +/-	8.6	417.3 +/-	21.5	-2.3 +/-	0.0	10.9 +/-	1.1	85.1 +/-	4.8
81	11DEC 0000	48.8 +/-	7.7	410.3 +/-	21.2	-2.6 +/-	0.0	9.6 +/-	1.1	131.4 +/-	7.0
82	11DEC 0600	56.8 +/-	6.1	521.4 +/-	27.1	-3.6 +/-	0.0	14.6 +/-	1.6	159.2 +/-	8.6
83	11DEC 1000	66.2 +/-	12.5	630.6 +/-	32.4	-3.8 +/-	0.0	14.9 +/-	1.7	250.8 +/-	13.3
84	11DEC 1400	37.2 +/-	4.6	535.9 +/-	27.7	-3.5 +/-	0.0	9.9 +/-	1.3	167.0 +/-	8.9
85	11DEC 1800	83.7 +/-	8.1	580.5 +/-	29.8	-2.6 +/-	0.0	18.1 +/-	1.5	142.5 +/-	7.7

ID	DESCRIPTION	AS		PB		SE		BR	
56	11NOV 0000	-1.7 +/-	0.0	139.5 +/-	8.7	-1.8 +/-	0.0	48.4 +/-	3.5
57	11NOV 0600	-2.2 +/-	0.0	160.3 +/-	10.0	-2.3 +/-	0.0	32.4 +/-	3.2
58	11NOV 1000	-2.6 +/-	0.0	55.4 +/-	5.8	-2.7 +/-	0.0	7.4 +/-	2.4
59	11NOV 1400	-2.5 +/-	0.0	81.8 +/-	7.1	-2.7 +/-	0.0	10.1 +/-	1.8
60	11NOV 1800	-1.3 +/-	0.0	191.5 +/-	9.0	-1.4 +/-	0.0	49.5 +/-	3.5
61	12NOV 0000	-2.7 +/-	0.0	116.9 +/-	8.2	-2.8 +/-	0.0	36.0 +/-	3.8
62	12NOV 0600	-4.1 +/-	0.0	232.4 +/-	14.7	-4.3 +/-	0.0	53.7 +/-	5.6
63	12NOV 1000	-3.2 +/-	0.0	177.6 +/-	12.2	-3.3 +/-	0.0	25.0 +/-	3.4
64	12NOV 1400	14.9 +/-	6.4	135.4 +/-	15.1	-4.4 +/-	0.0	34.4 +/-	4.6
65	12NOV 1800	-2.4 +/-	0.0	233.4 +/-	11.9	-2.6 +/-	0.0	80.3 +/-	5.8
66	13NOV 0000	-2.6 +/-	0.0	185.1 +/-	10.5	-2.7 +/-	0.0	84.8 +/-	6.6
67	13NOV 0600	15.9 +/-	5.0	146.1 +/-	13.7	-3.8 +/-	0.0	66.1 +/-	5.9
68	13NOV 1000	-3.5 +/-	0.0	349.8 +/-	17.3	-3.6 +/-	0.0	44.0 +/-	4.3
69	13NOV 1400	-3.6 +/-	0.0	64.1 +/-	7.3	-3.7 +/-	0.0	18.6 +/-	2.7
70	13NOV 1800	-2.4 +/-	0.0	44.8 +/-	4.5	-2.5 +/-	0.0	16.0 +/-	2.1
71	03DEC 0000	-2.5 +/-	0.0	167.9 +/-	9.8	-2.6 +/-	0.0	79.0 +/-	5.5
72	03DEC 0600	-3.1 +/-	0.0	322.1 +/-	18.7	-3.3 +/-	0.0	56.2 +/-	4.6
73	03DEC 1000	-3.1 +/-	0.0	116.4 +/-	10.5	1.7 +/-	1.0	24.4 +/-	3.2
74	03DEC 1400	-3.1 +/-	0.0	109.9 +/-	9.0	-3.2 +/-	0.0	36.1 +/-	3.6
75	03DEC 1800	-2.2 +/-	0.0	291.2 +/-	13.4	-2.3 +/-	0.0	118.5 +/-	7.3
76	10DEC 0000	-2.1 +/-	0.0	188.4 +/-	9.4	-2.2 +/-	0.0	88.6 +/-	6.3
77	10DEC 0600	-3.1 +/-	0.0	200.8 +/-	11.7	-3.2 +/-	0.0	74.1 +/-	6.0
78	10DEC 1000	-3.4 +/-	0.0	126.8 +/-	10.0	-3.5 +/-	0.0	22.9 +/-	2.8
79	10DEC 1400	-2.7 +/-	0.0	100.1 +/-	8.0	-2.9 +/-	0.0	19.7 +/-	2.7
80	10DEC 1800	-1.9 +/-	0.0	265.5 +/-	12.6	-2.0 +/-	0.0	110.7 +/-	7.9
81	11DEC 0000	-2.2 +/-	0.0	217.7 +/-	10.9	-2.3 +/-	0.0	98.7 +/-	6.4
82	11DEC 0600	-3.1 +/-	0.0	355.8 +/-	17.6	-3.3 +/-	0.0	145.7 +/-	9.8
83	11DEC 1000	-3.2 +/-	0.0	246.3 +/-	13.3	-3.3 +/-	0.0	49.5 +/-	4.2
84	11DEC 1400	-2.9 +/-	0.0	193.7 +/-	10.5	-3.1 +/-	0.0	59.0 +/-	4.9
85	11DEC 1800	-2.2 +/-	0.0	388.1 +/-	17.2	-2.3 +/-	0.0	171.5 +/-	10.0

(units in nanograms/m**3)

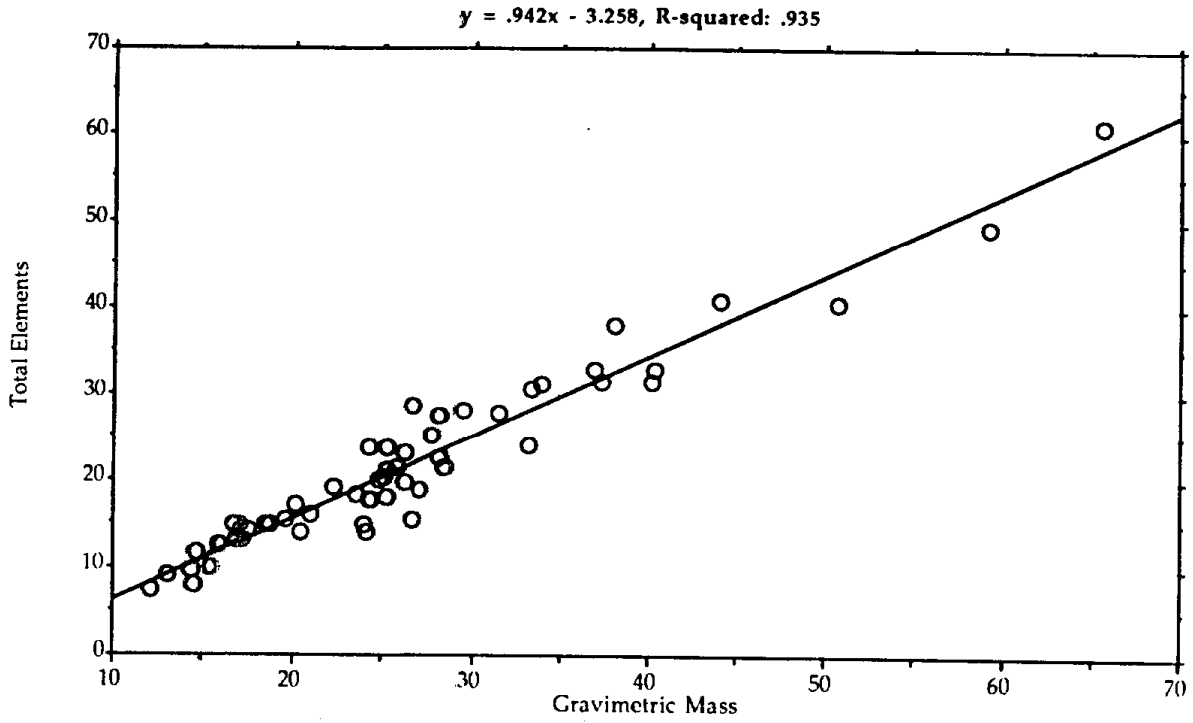
Appendix B

Linear Regressions Between Gravimetric Mass and Total Elemental Analysis

Appendix B contains figures of linear regressions between gravimetric mass and the sum of elements (H to Pb) from total elemental analysis. The elements (C, O, N, S, H) composing the largest amounts of fine aerosols were also compared to gravimetric mass. Additionally, linear regressions between optical absorption measurements (LIPM) and mass are also shown. Figures of all the regressions are divided by site and season. Units are in micograms per cubic meter, except for the optical absorption measurements which are in 10^{-6} inverse meters.

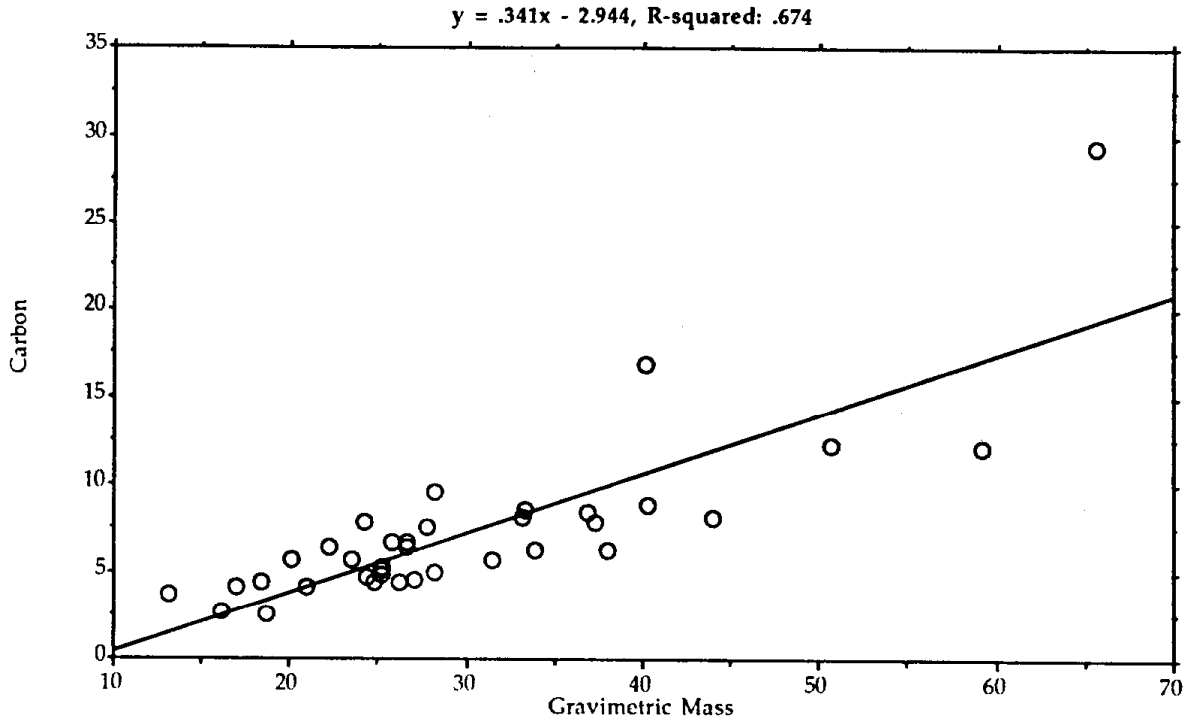
Long Beach - Summer

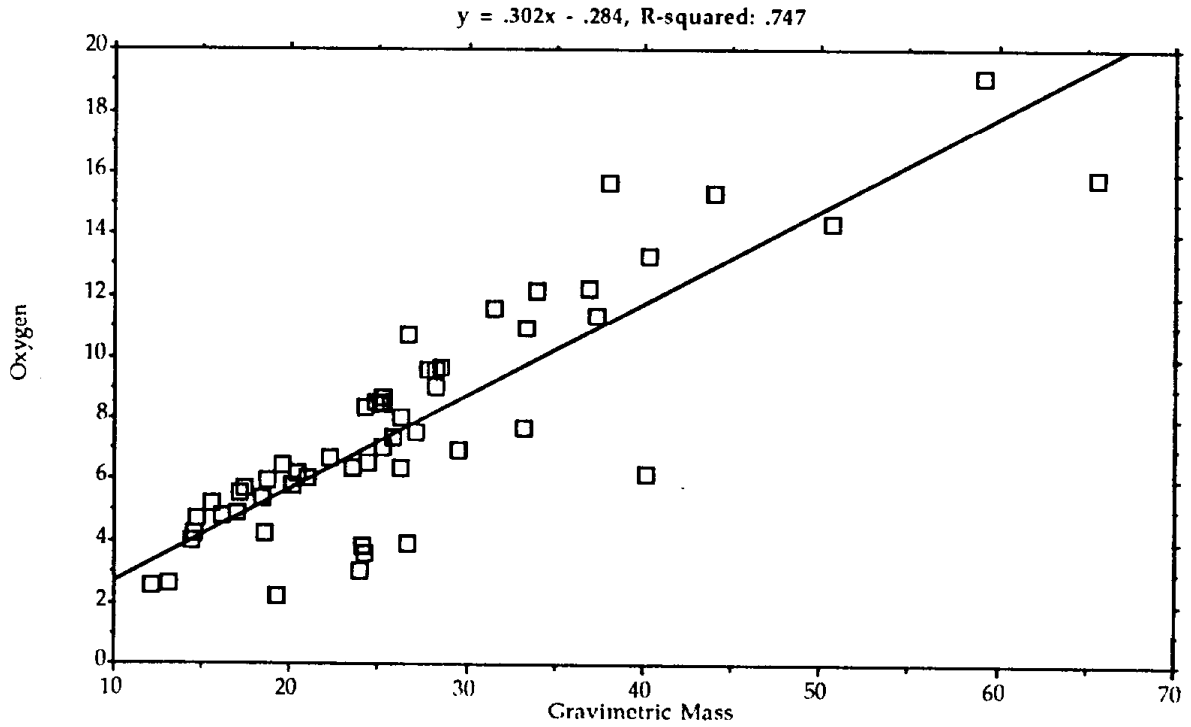
(units in micrograms/m**3)



Long Beach - Summer

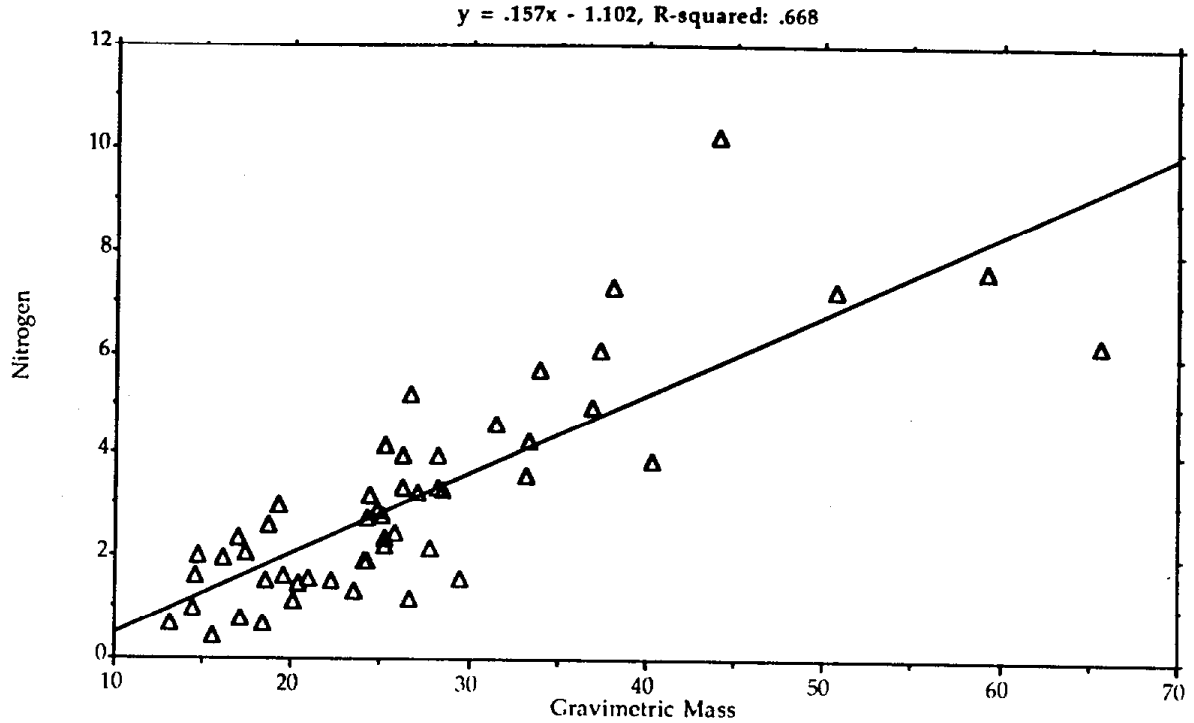
(units in micrograms/m**3)

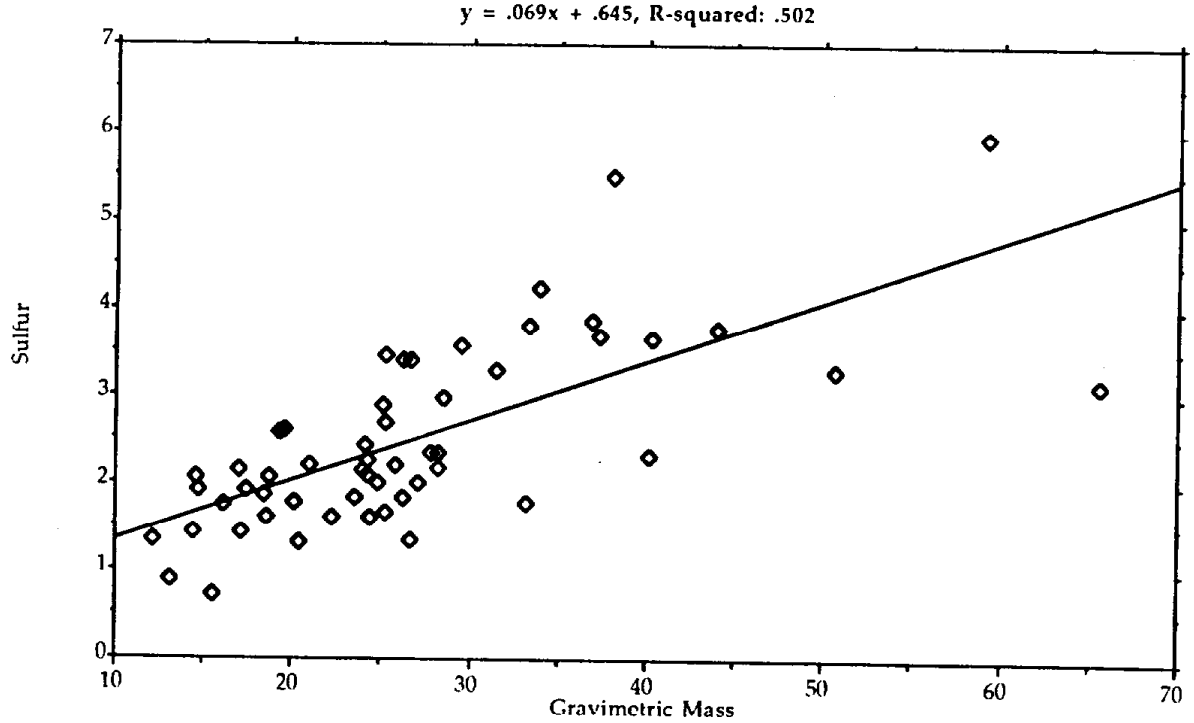




Long Beach - Summer

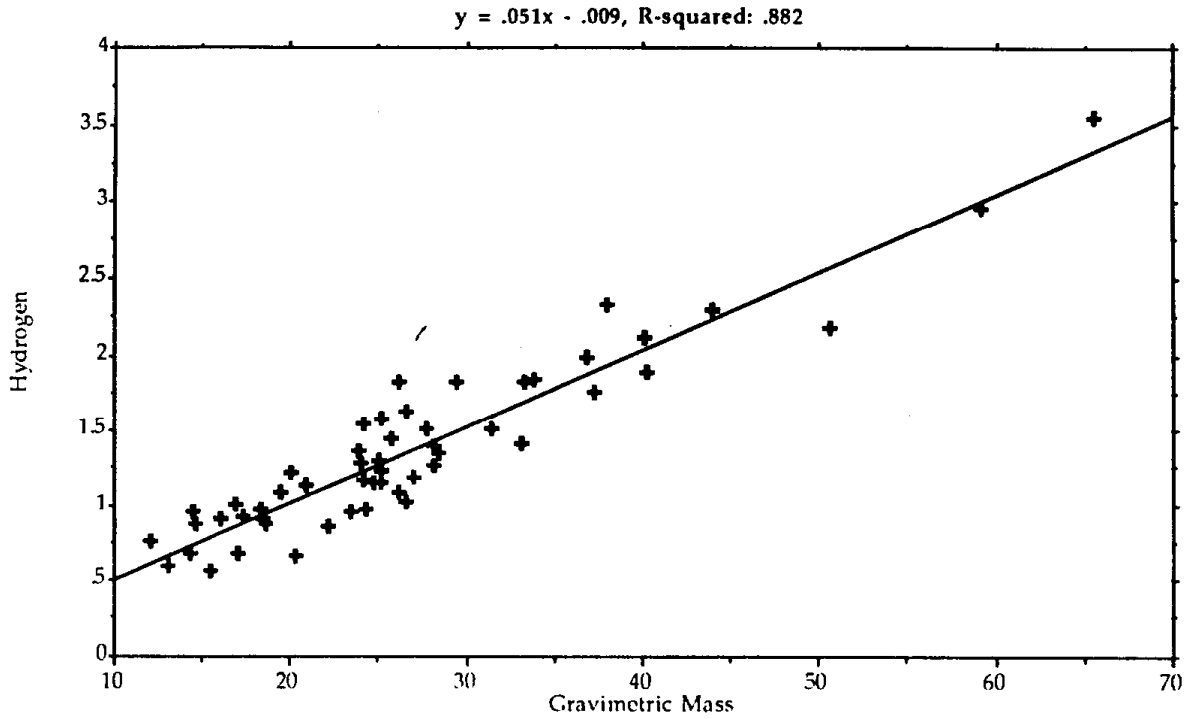
(units in micrograms/m**3)

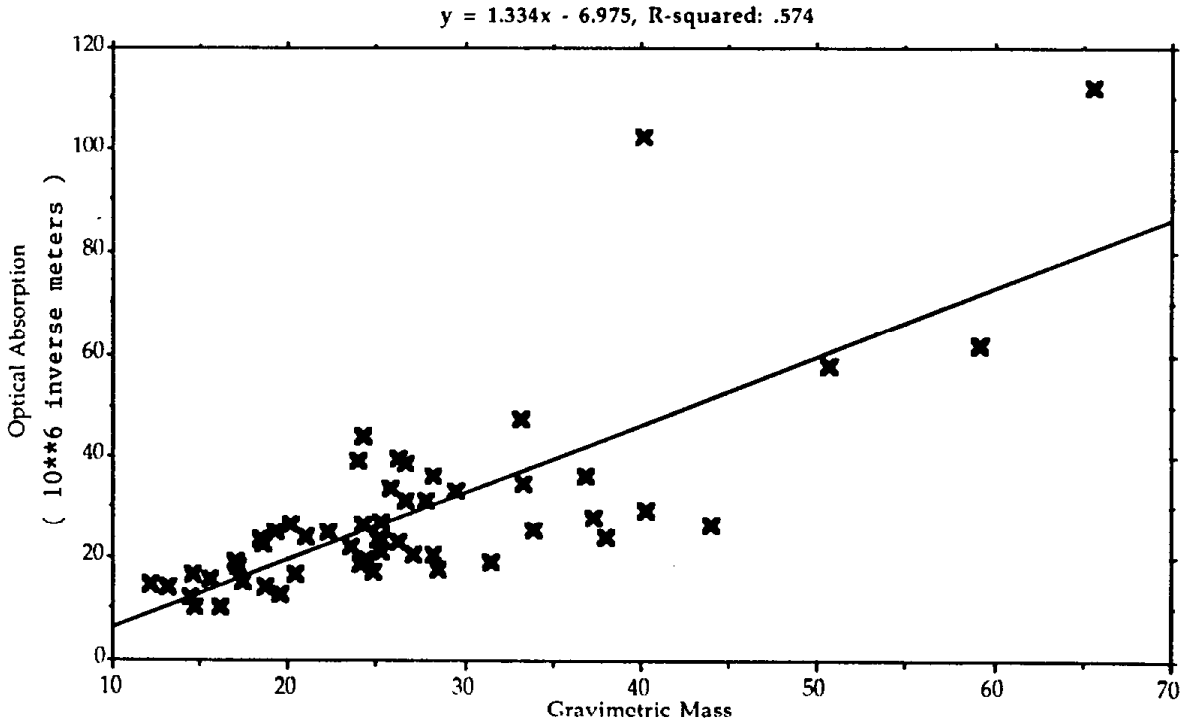




Long Beach - Summer

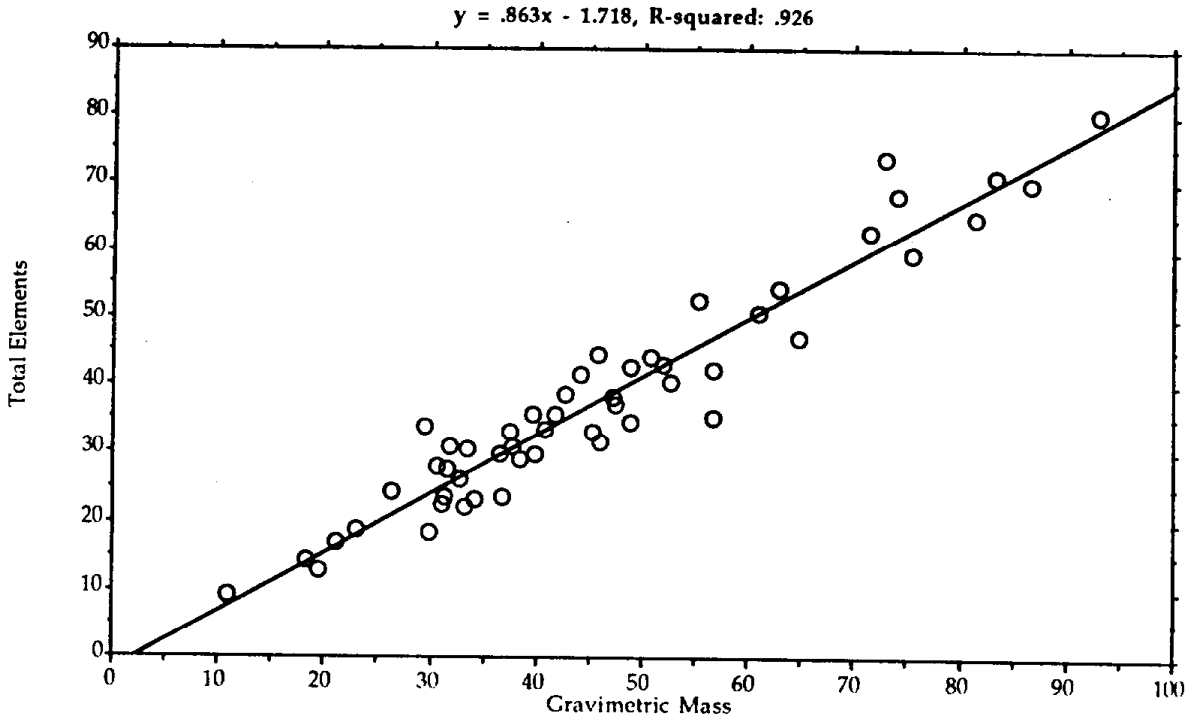
(units in micrograms/m**3)





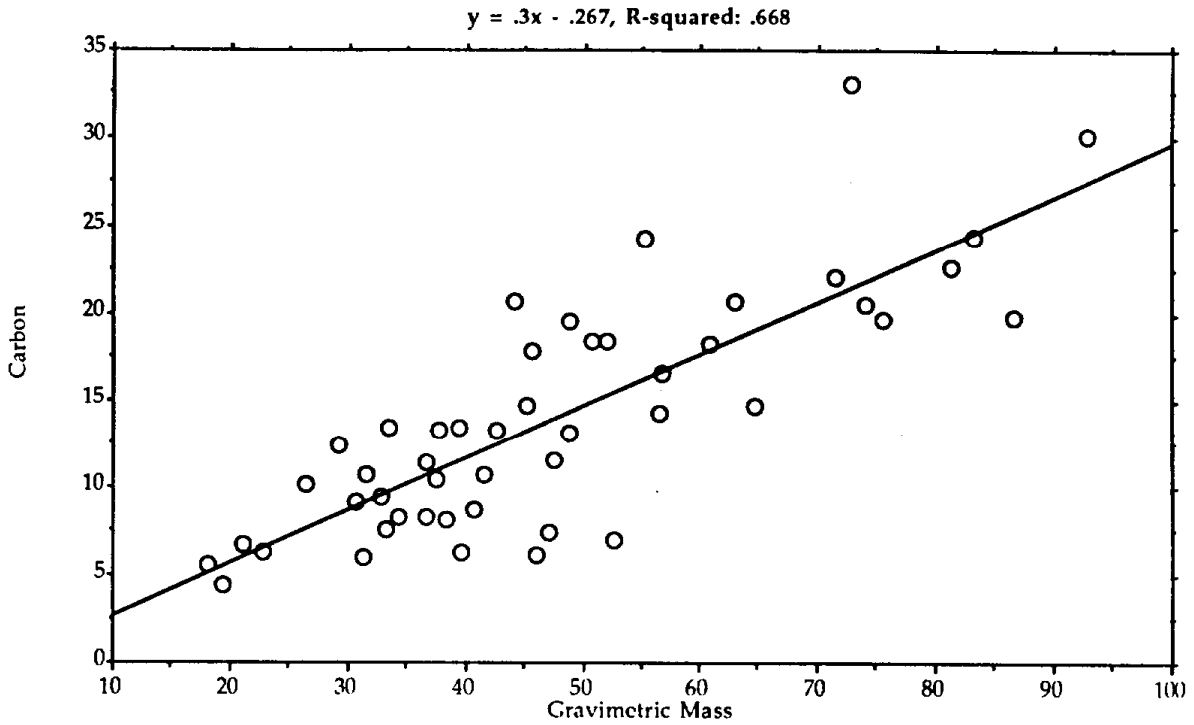
Claremont - Summer

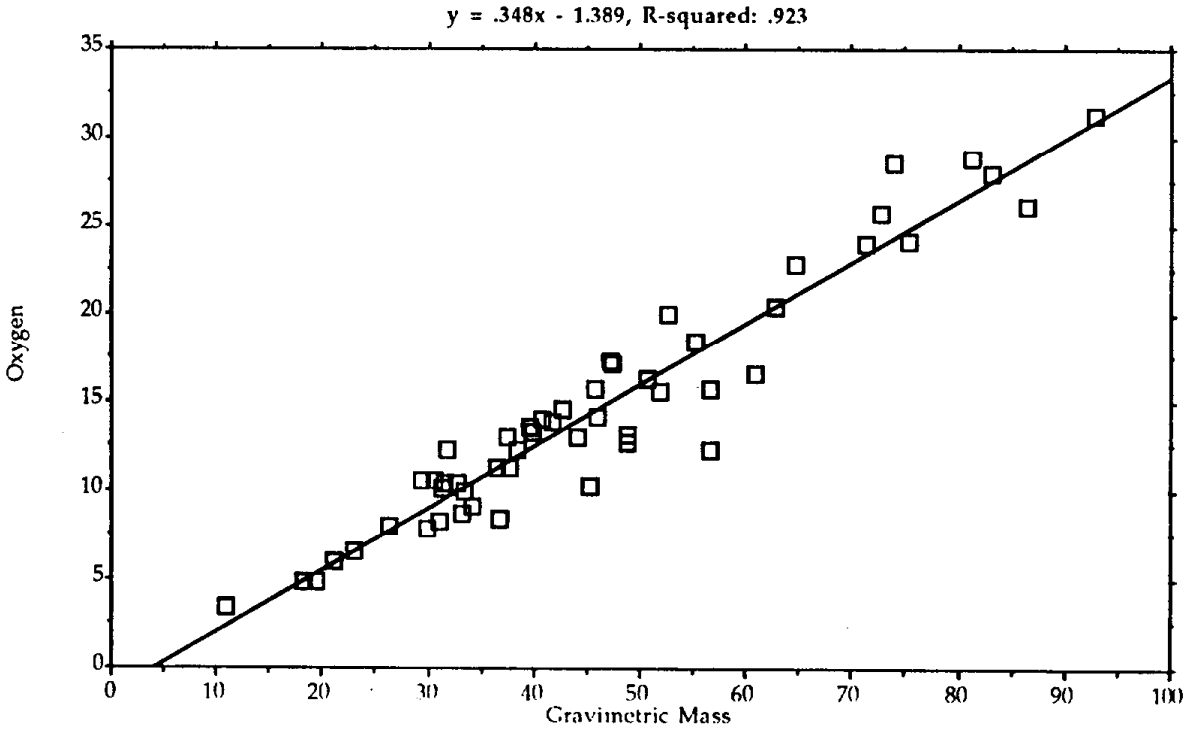
(units in micrograms/m**3)



Claremont - Summer

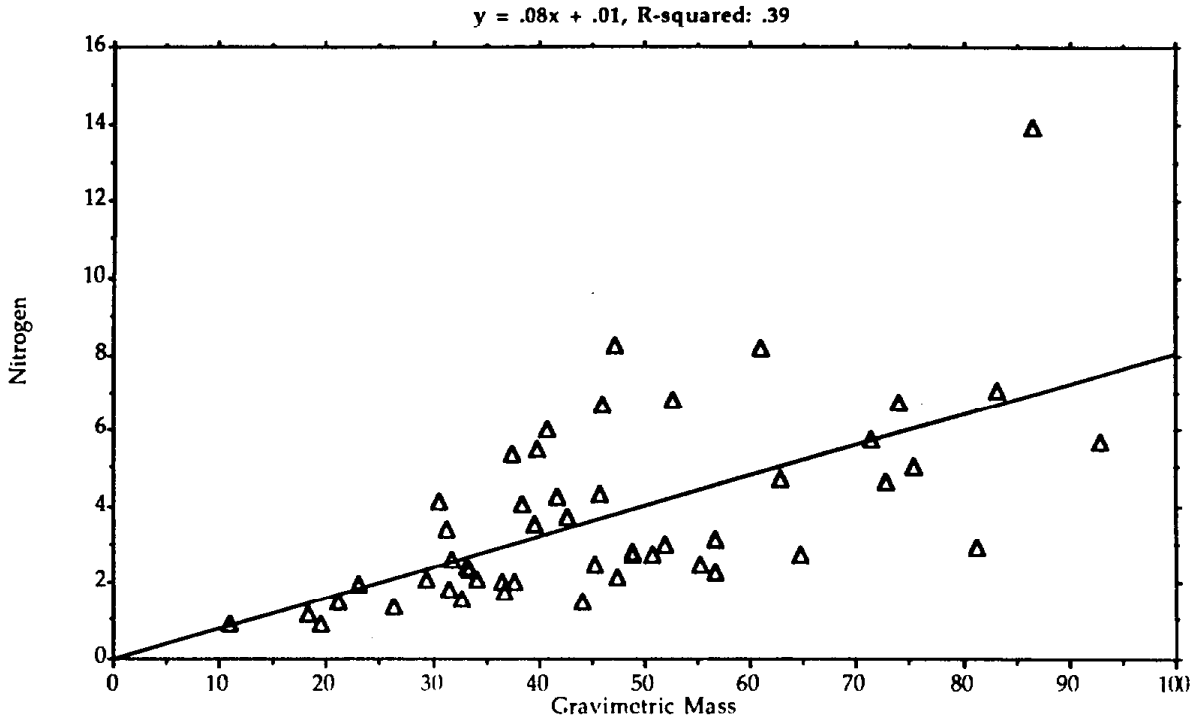
(units in micrograms/m**3)

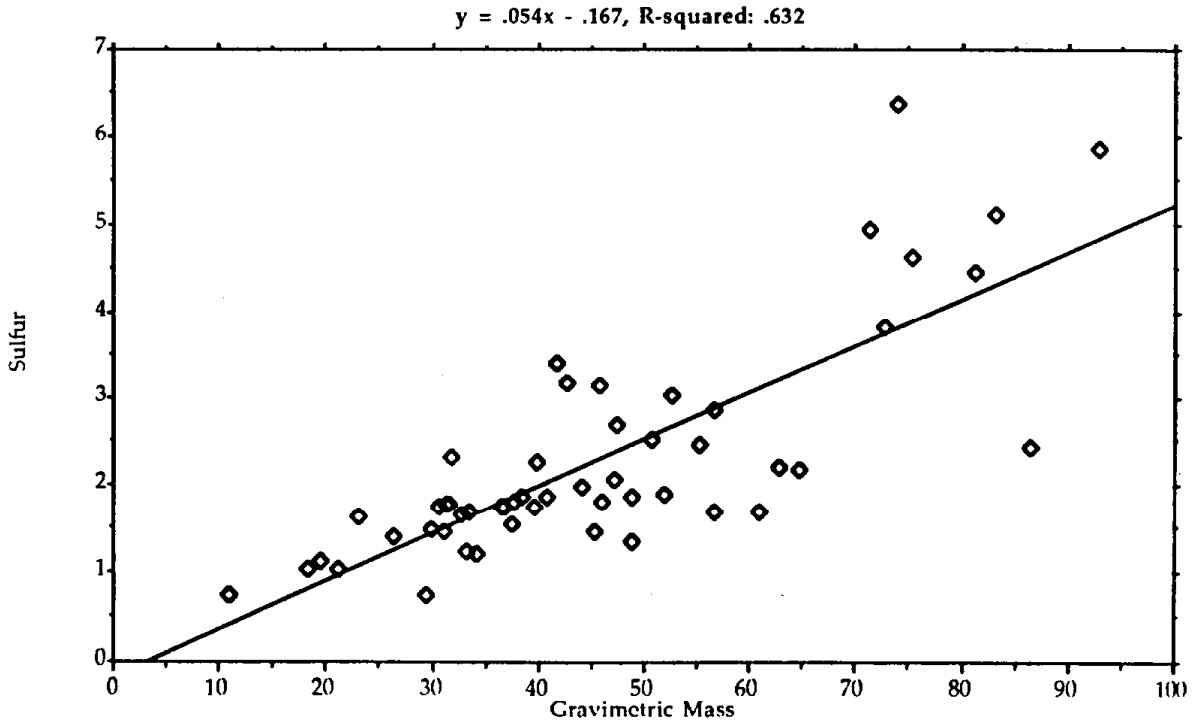




Claremont - Summer

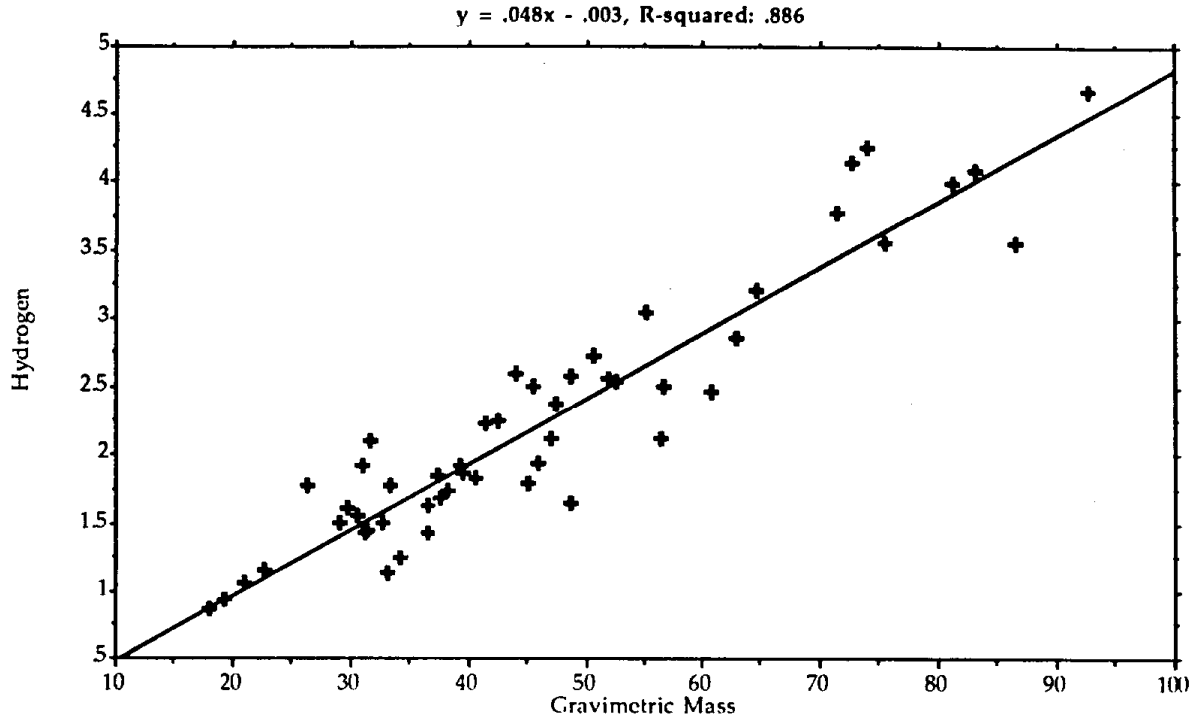
(units in micrograms/m**3)

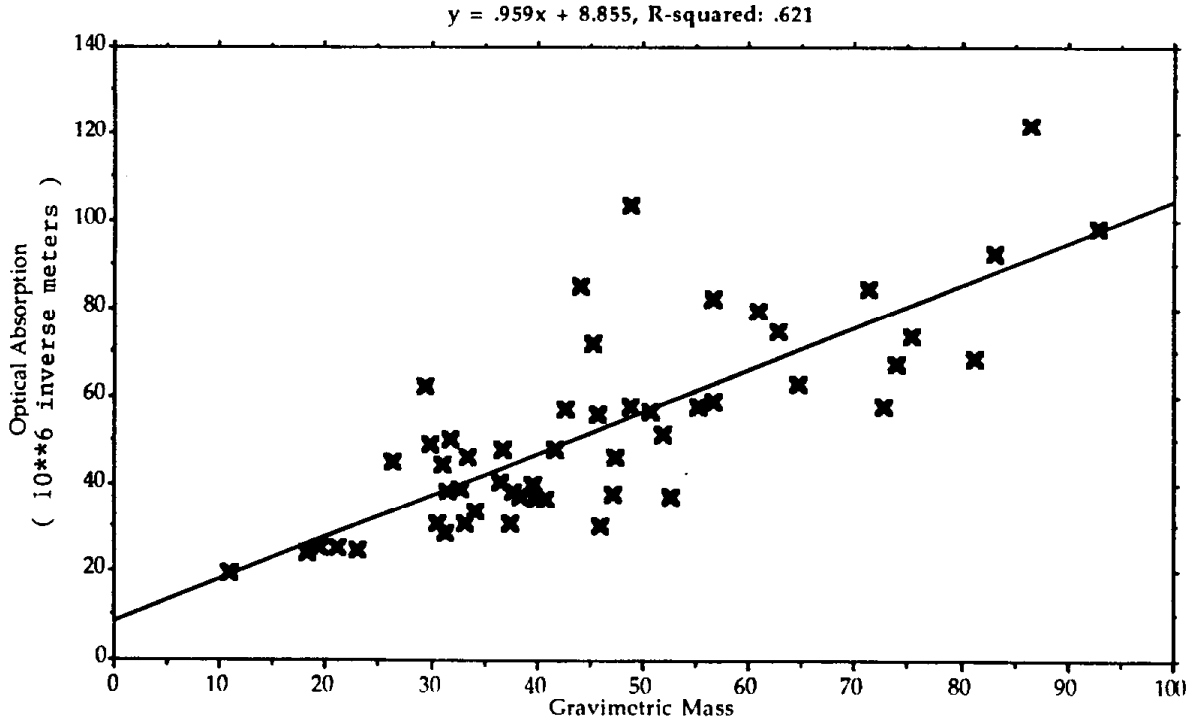




Claremont - Summer

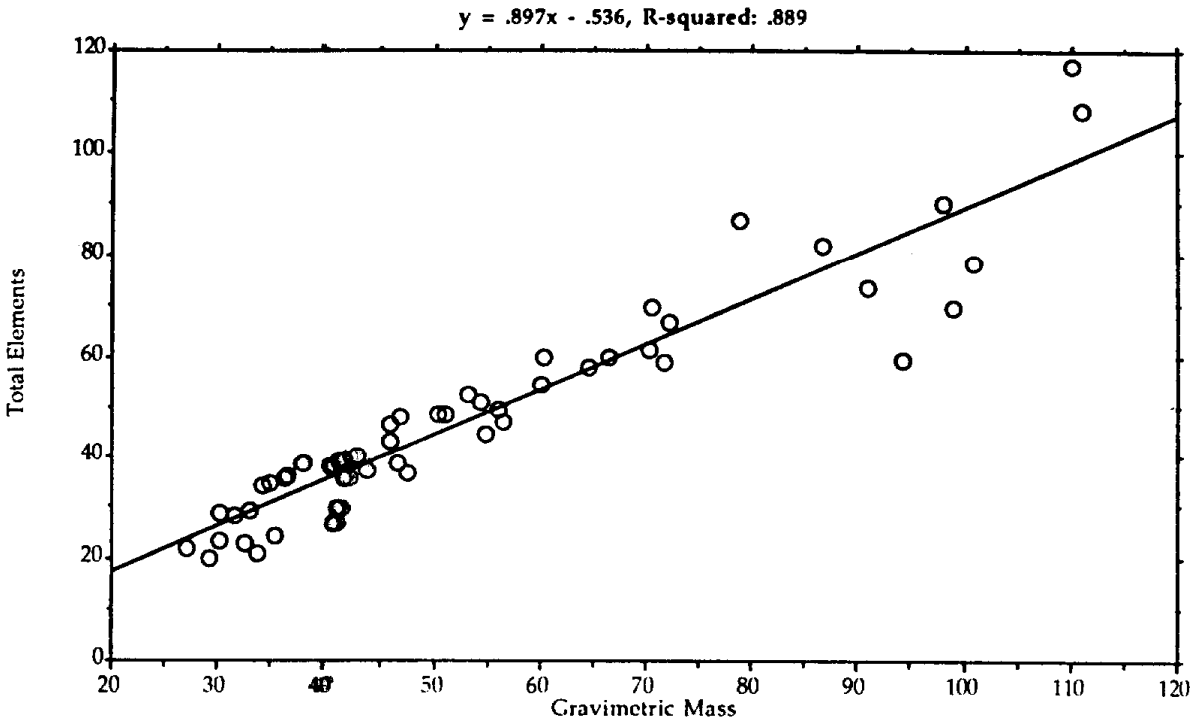
(units in micrograms/m**3)





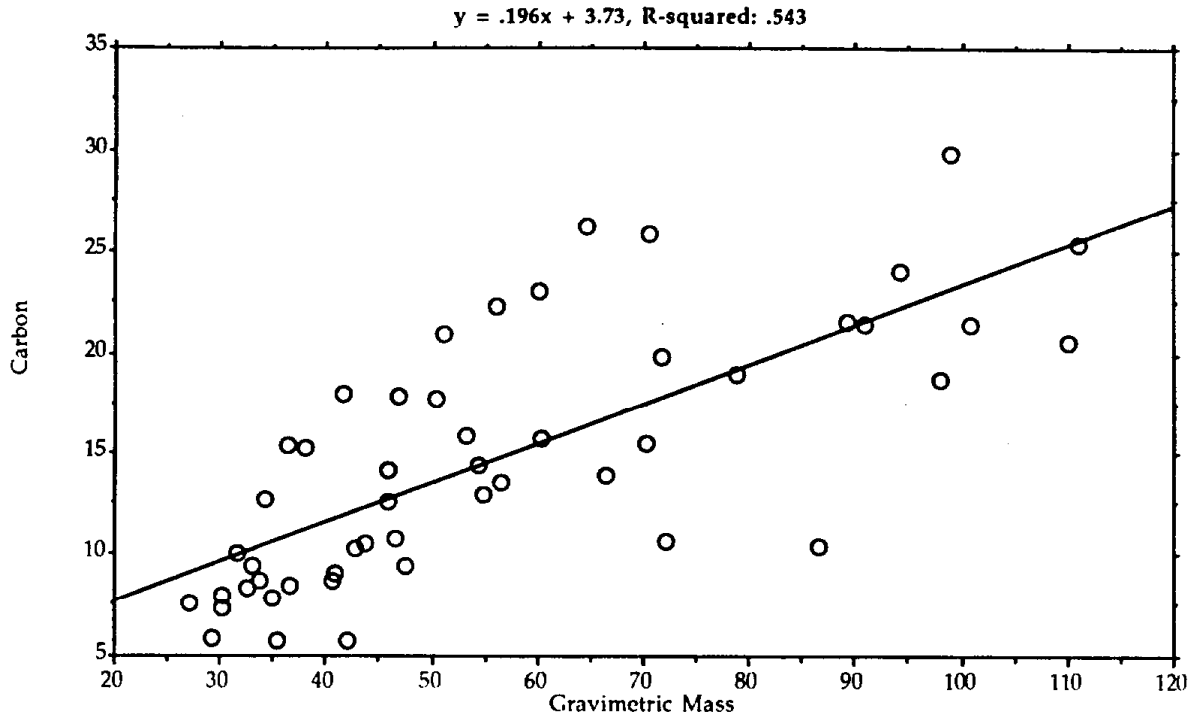
Rubidoux - Summer

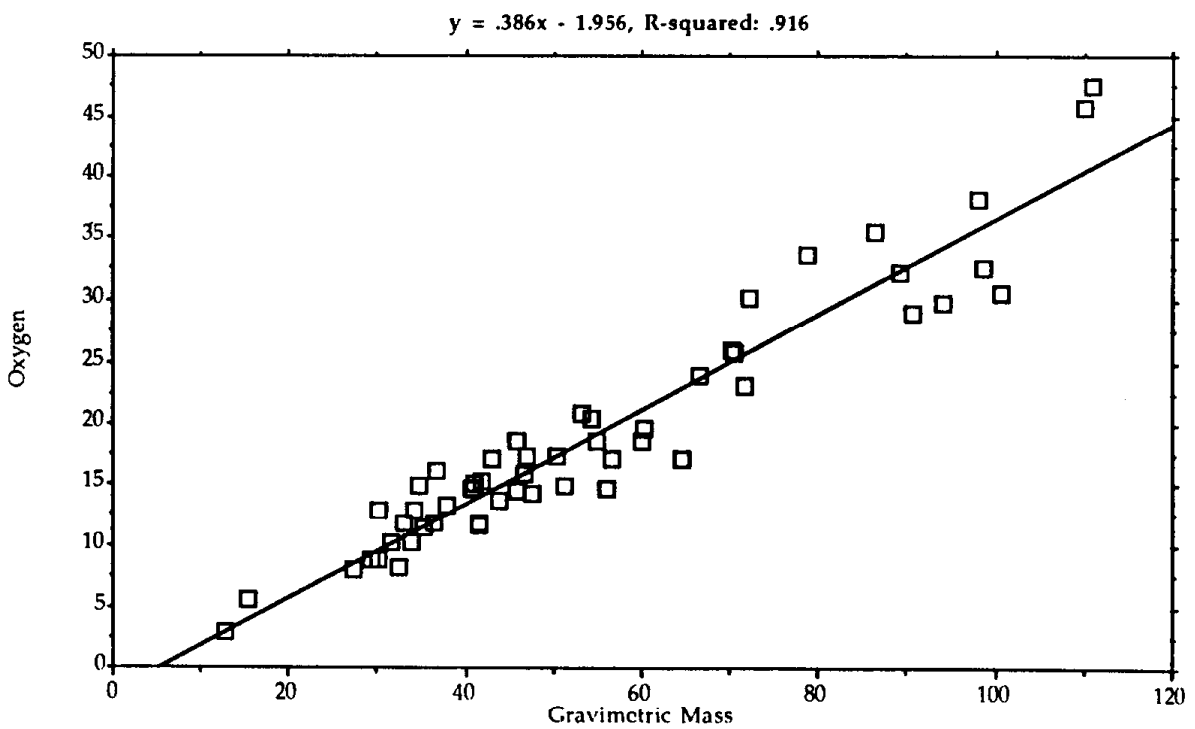
(units in micrograms/m**3)



Rubidoux - Summer

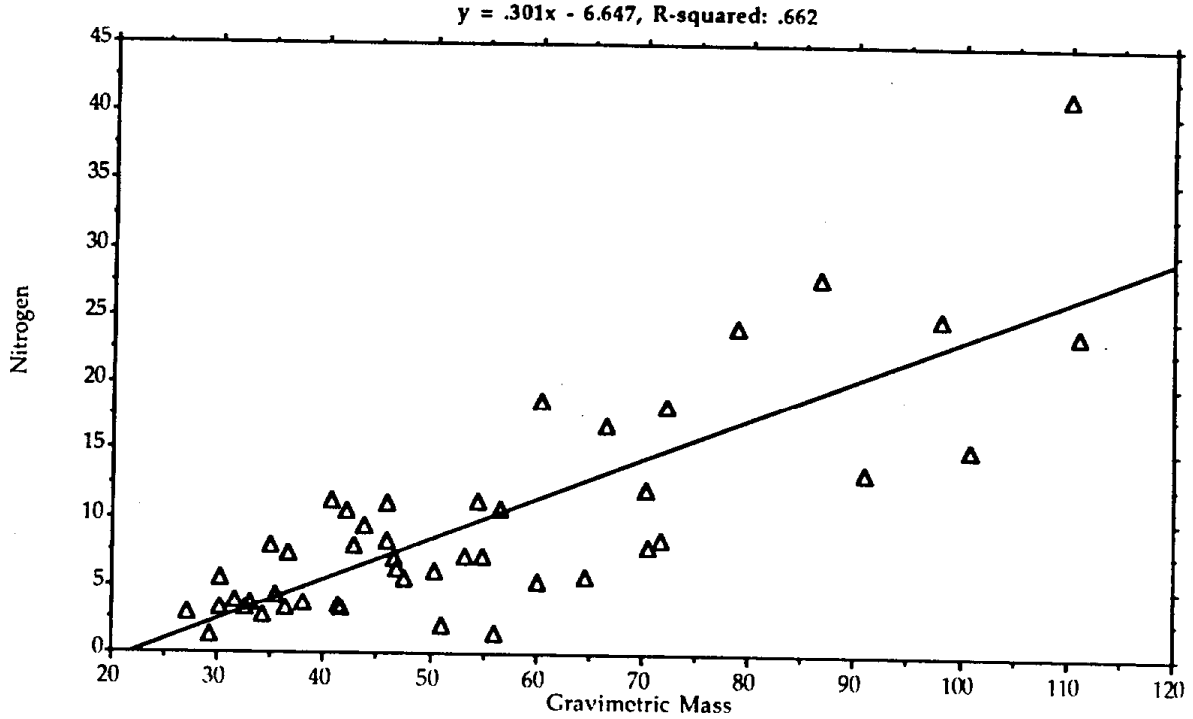
(units in micrograms/m**3)

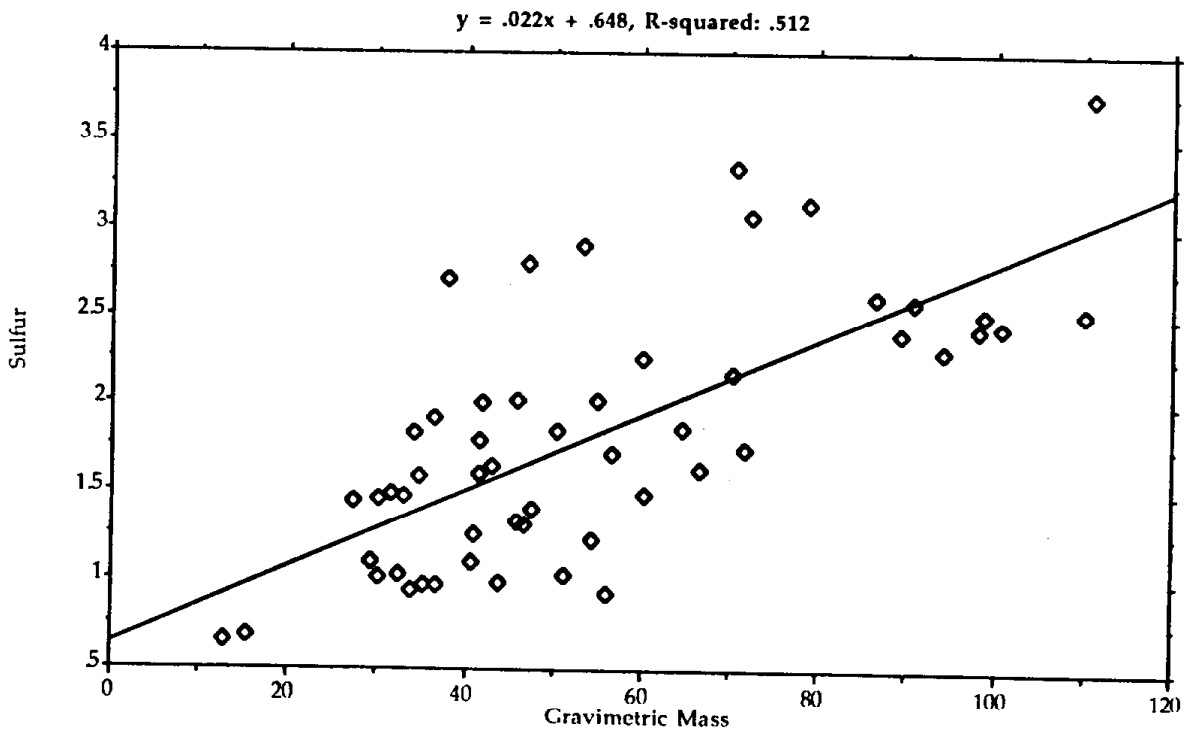




Rubidoux - Summer

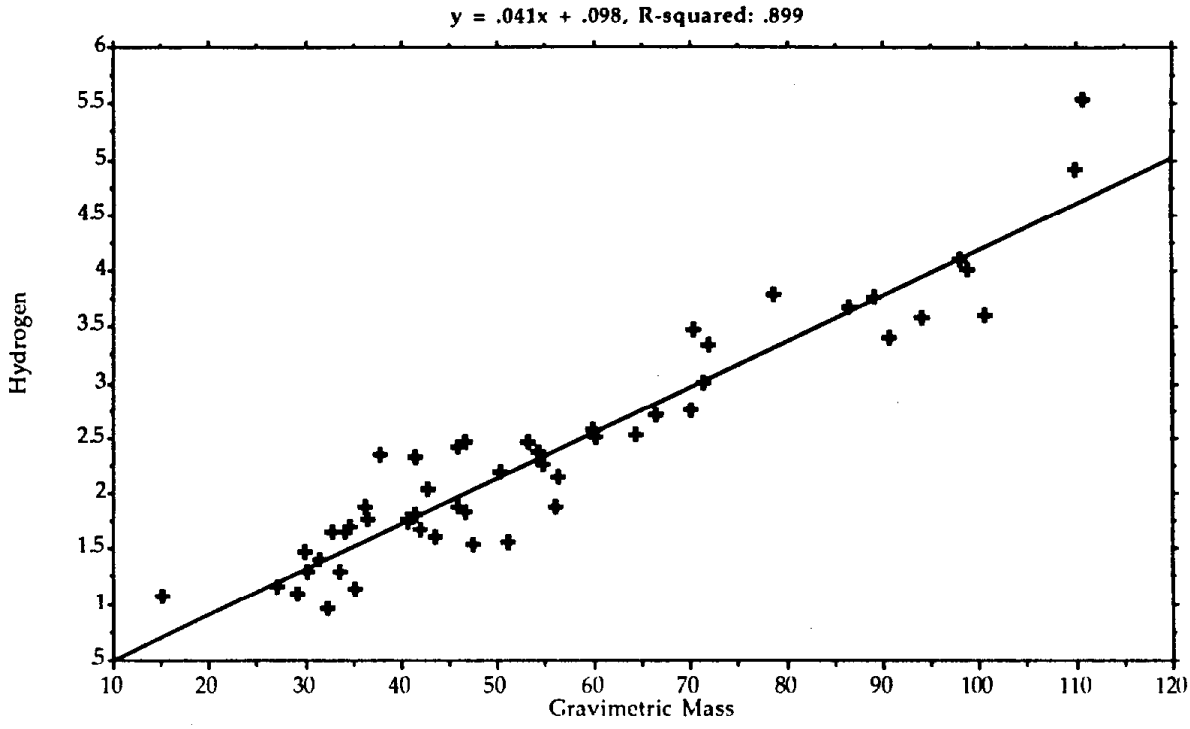
(units in micrograms/m**3)

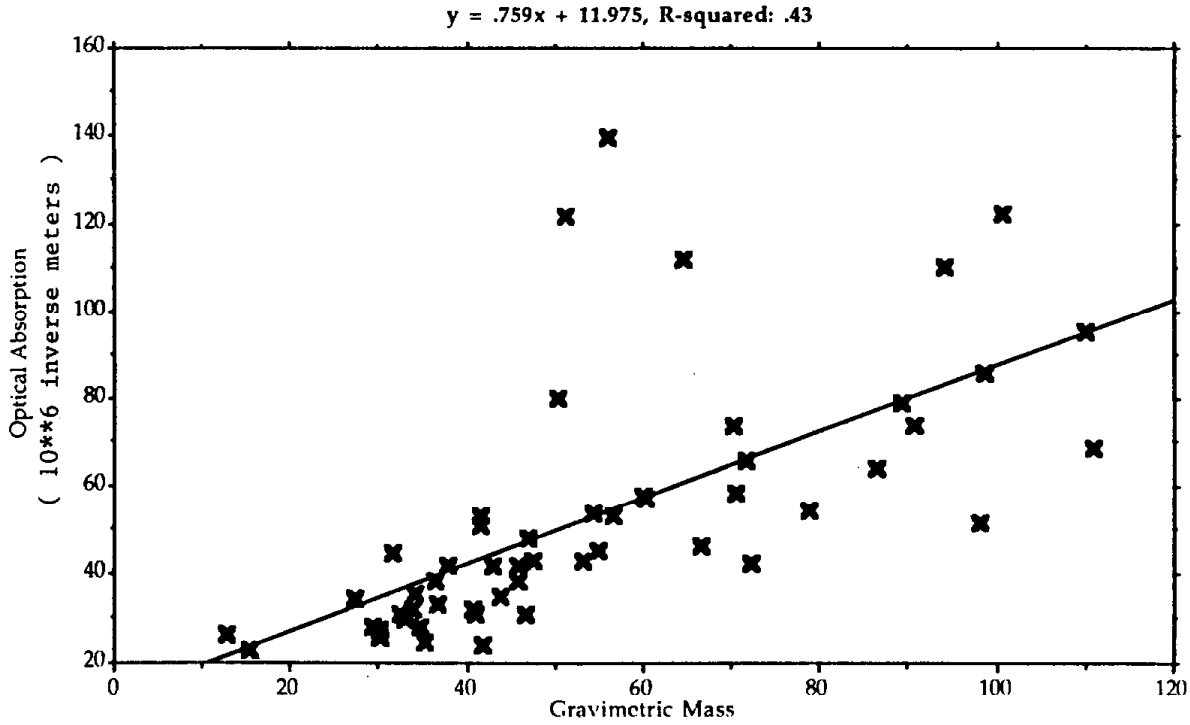




Rubidoux - Summer

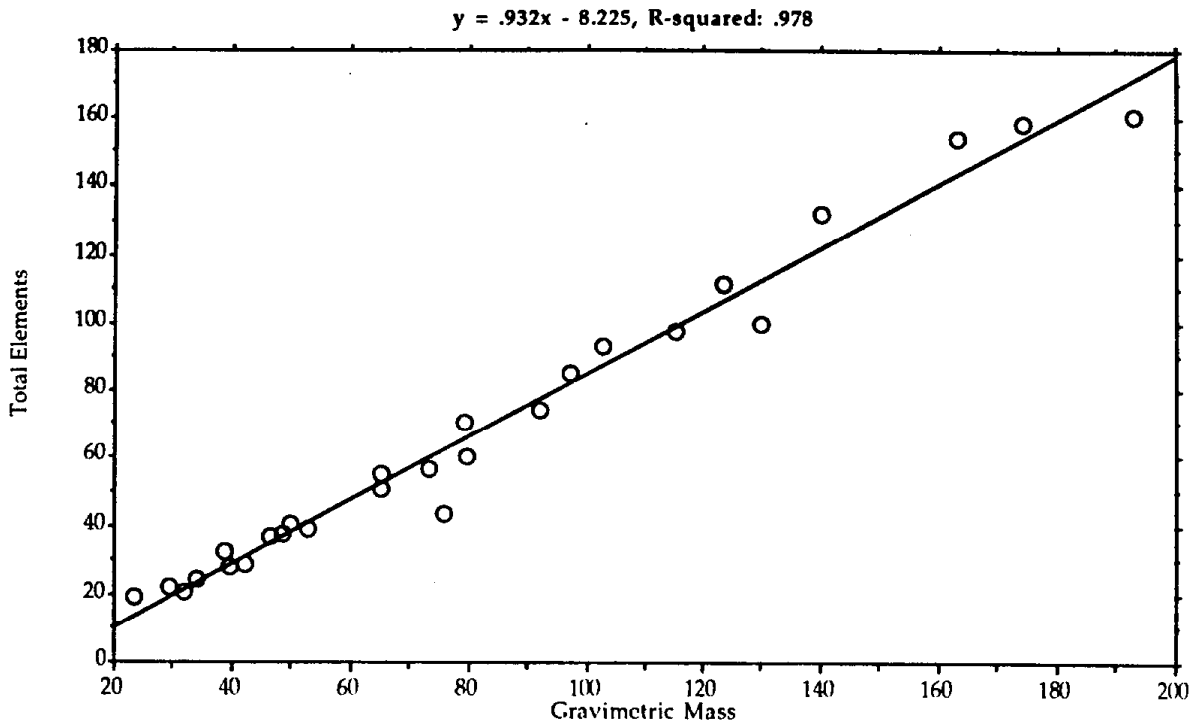
(units in micrograms/m**3)





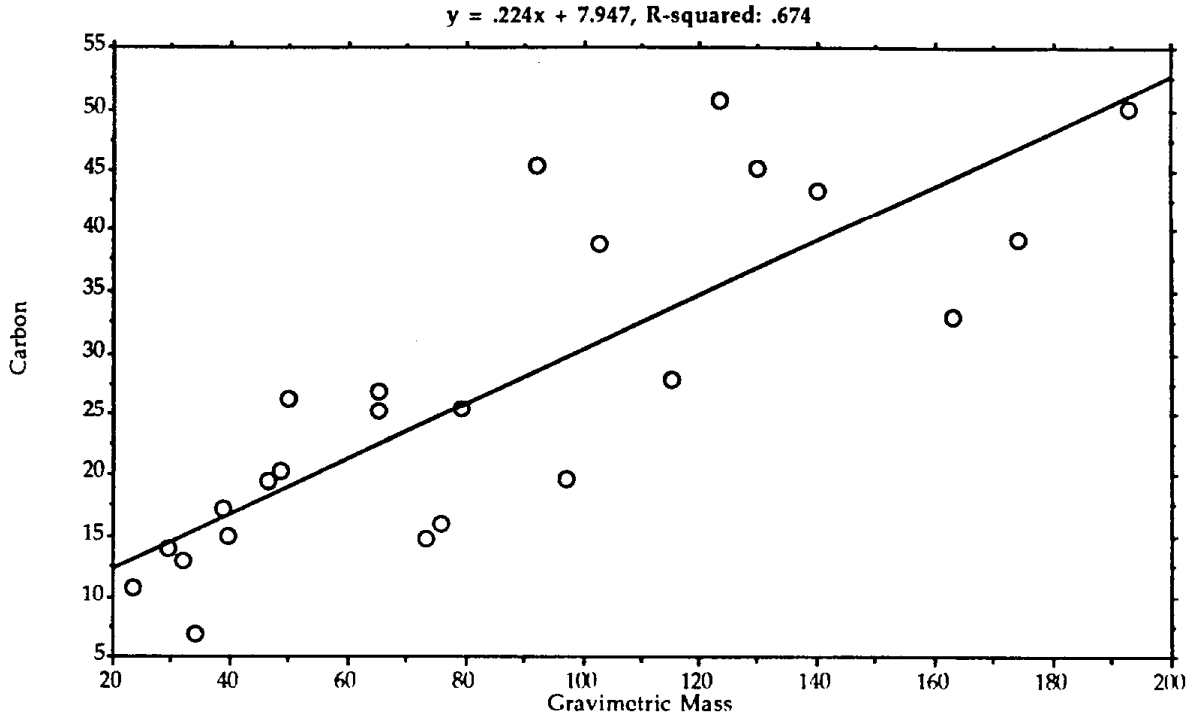
Long Beach - Fall

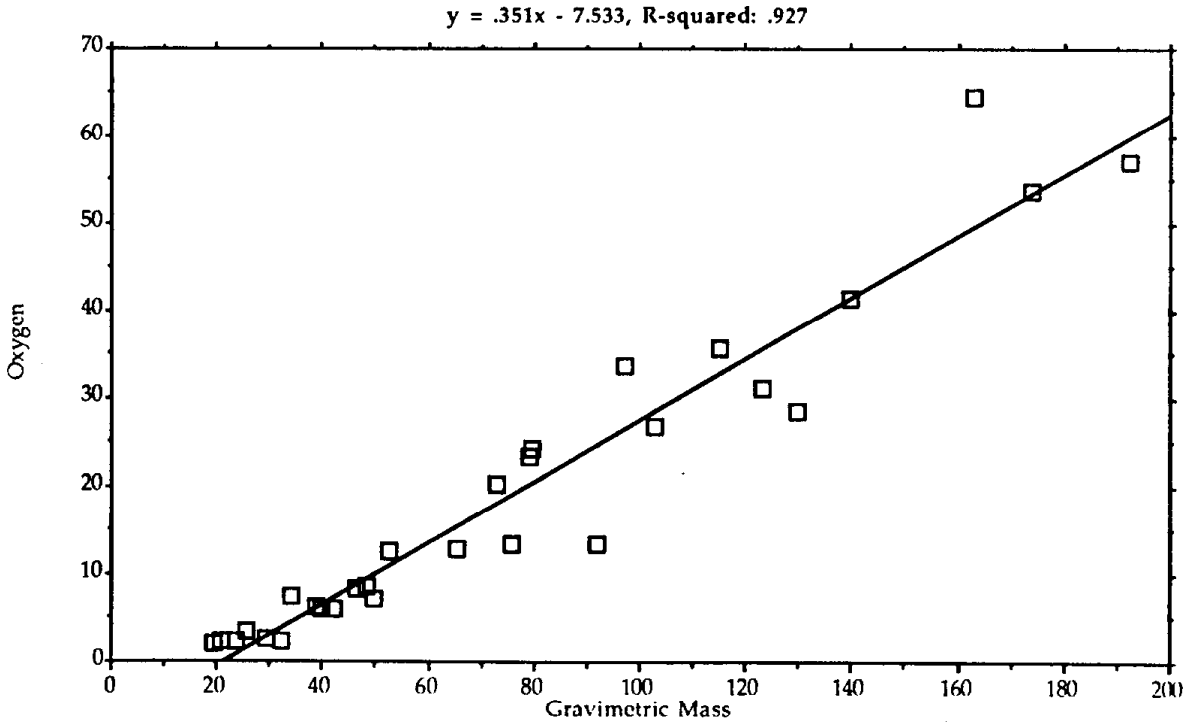
(units in micrograms/m**3)



Long Beach - Fall

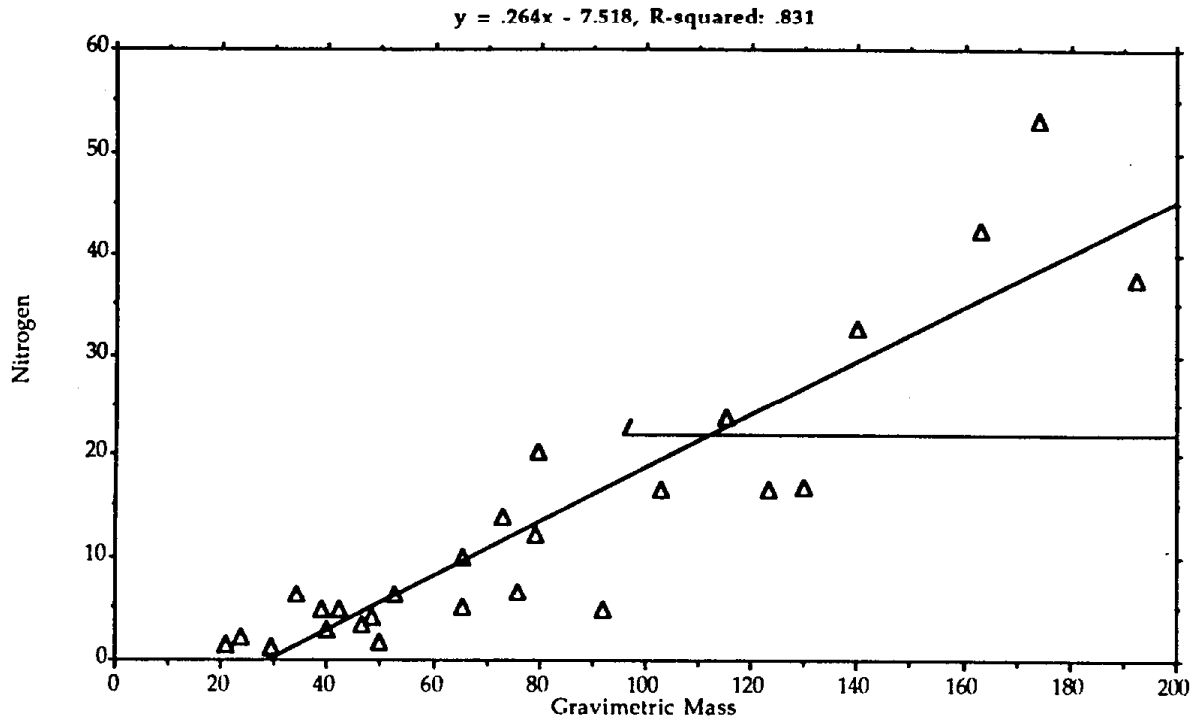
(units in micrograms/m**3)

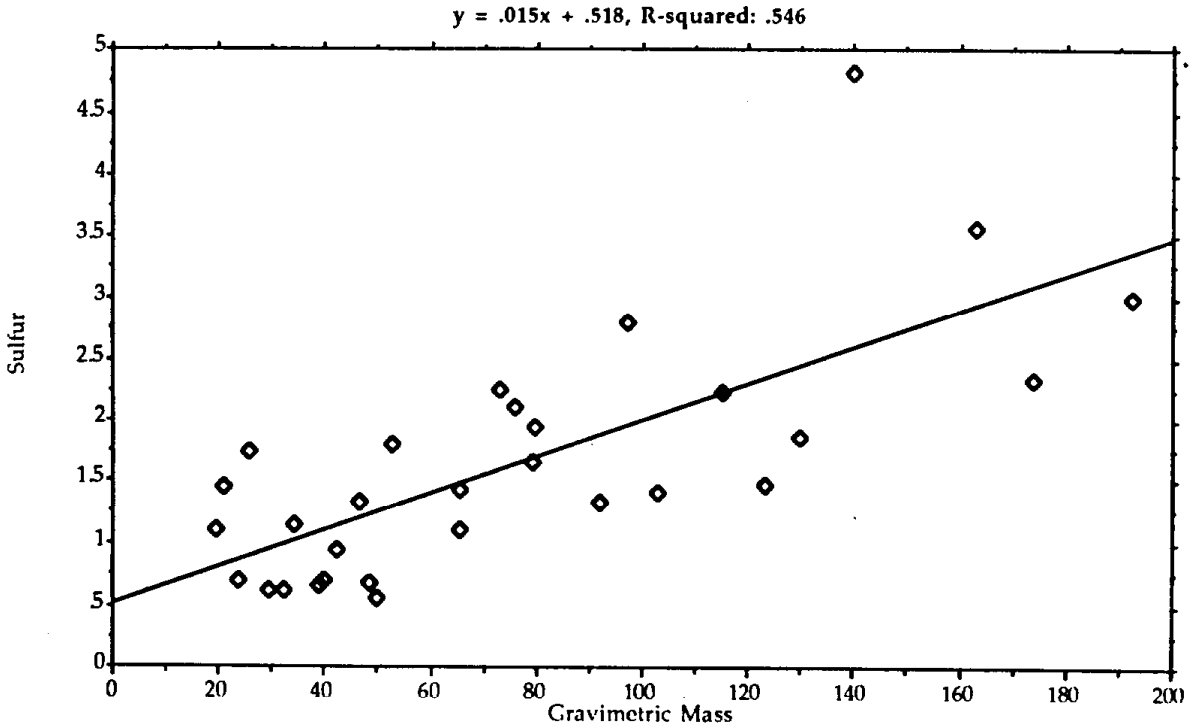




Long Beach - Fall

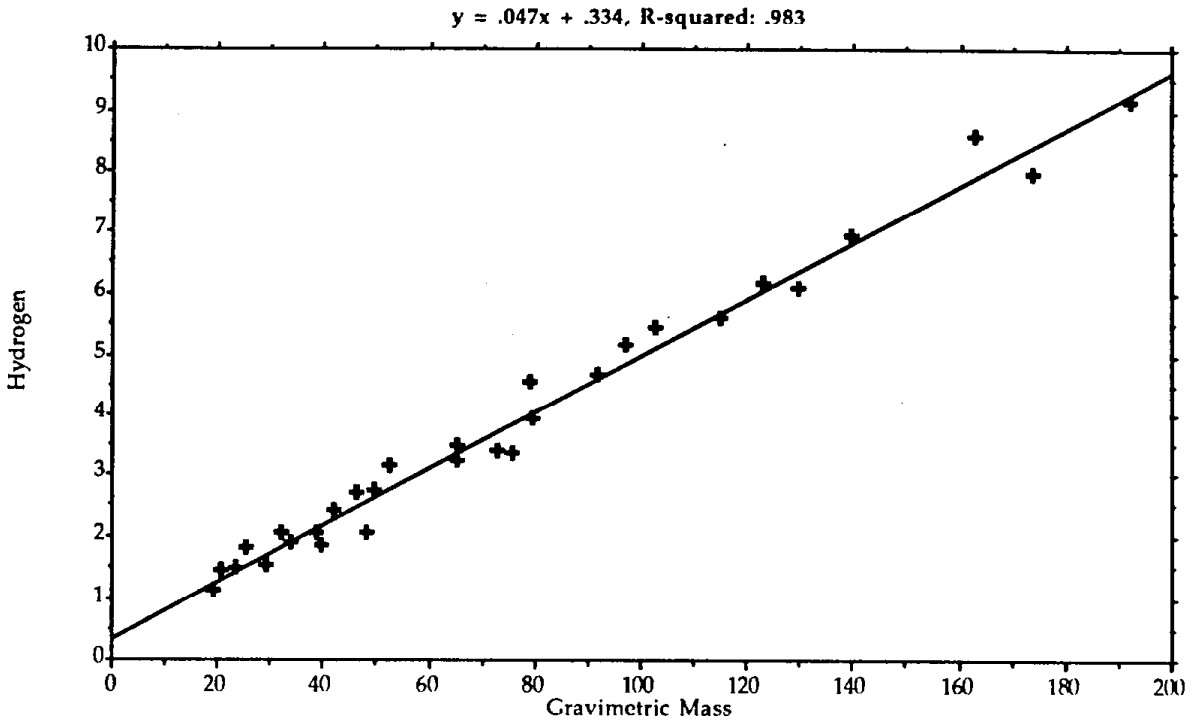
(units in micrograms/m**3)

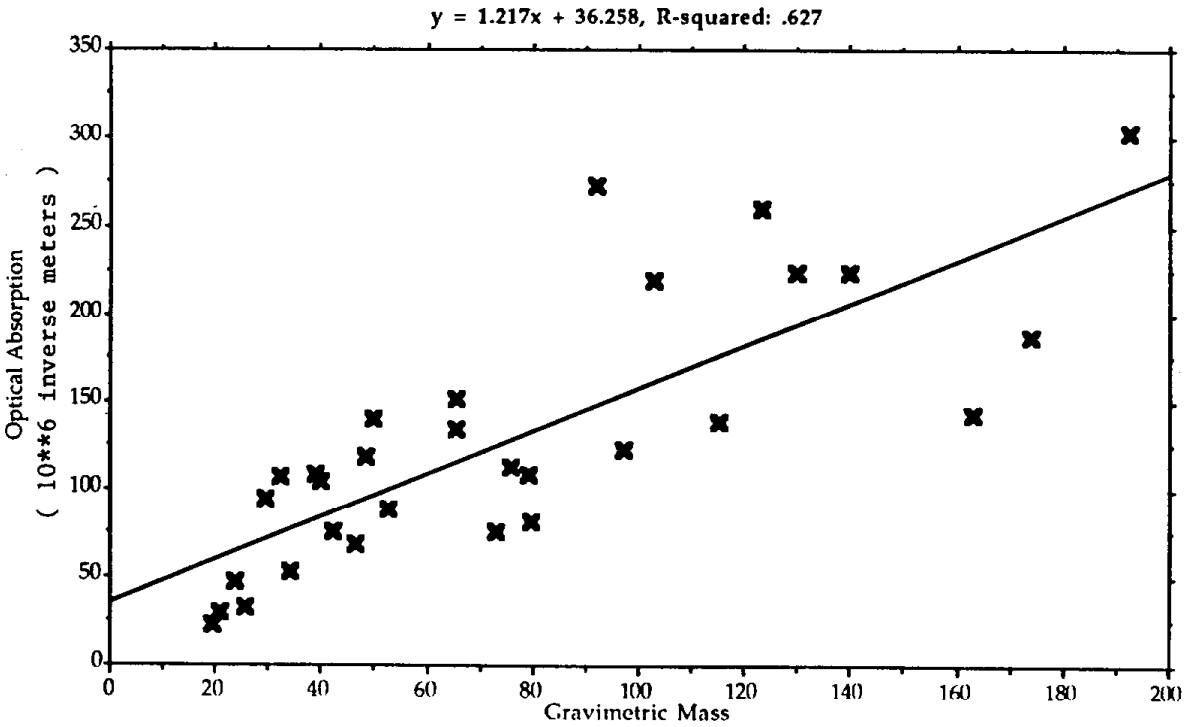




Long Beach - Fall

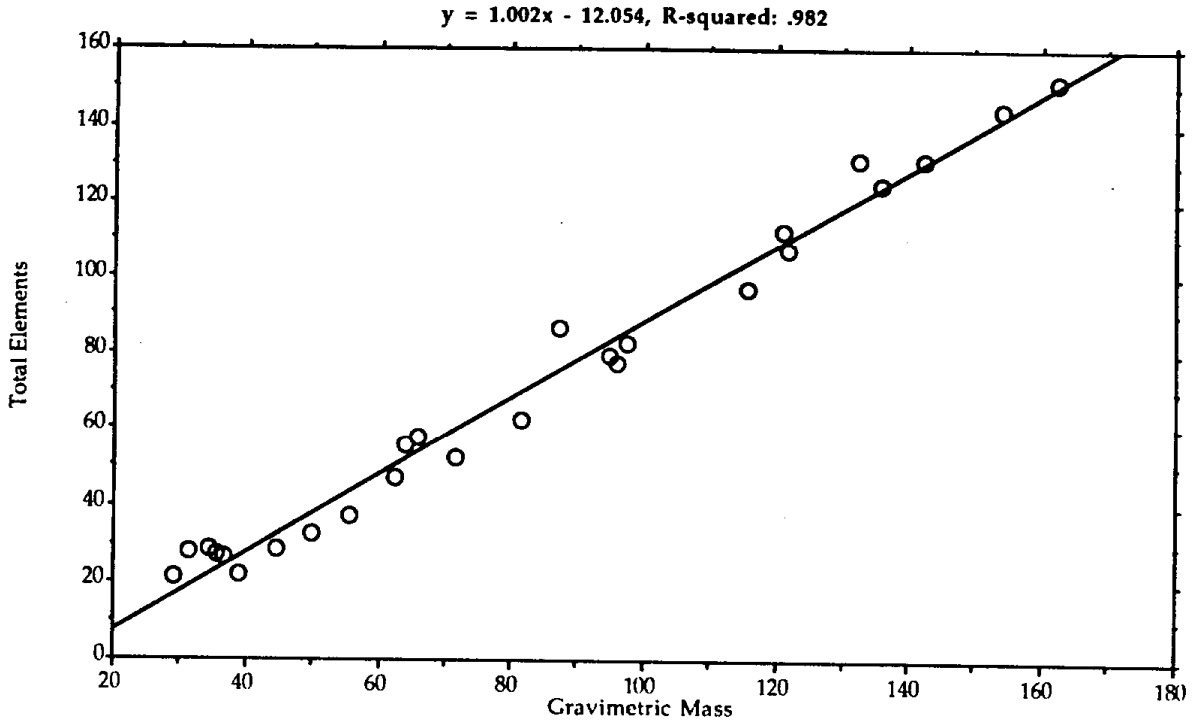
(units in micrograms/m**3)





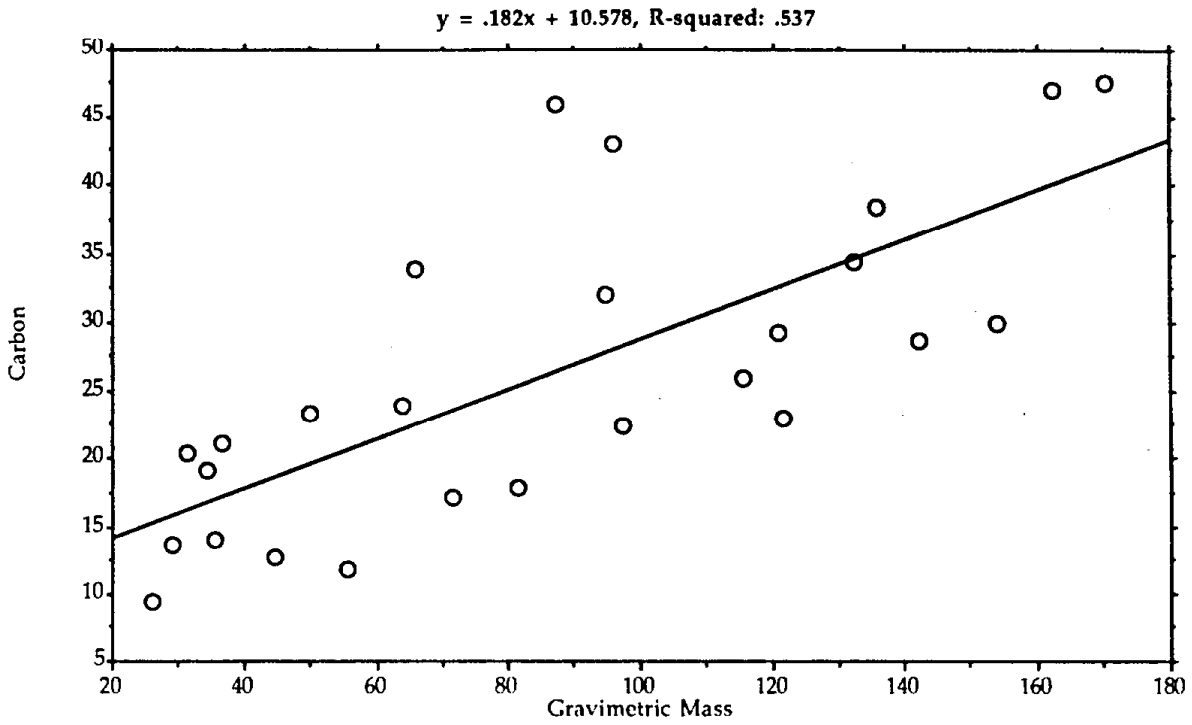
Los Angeles - Fall

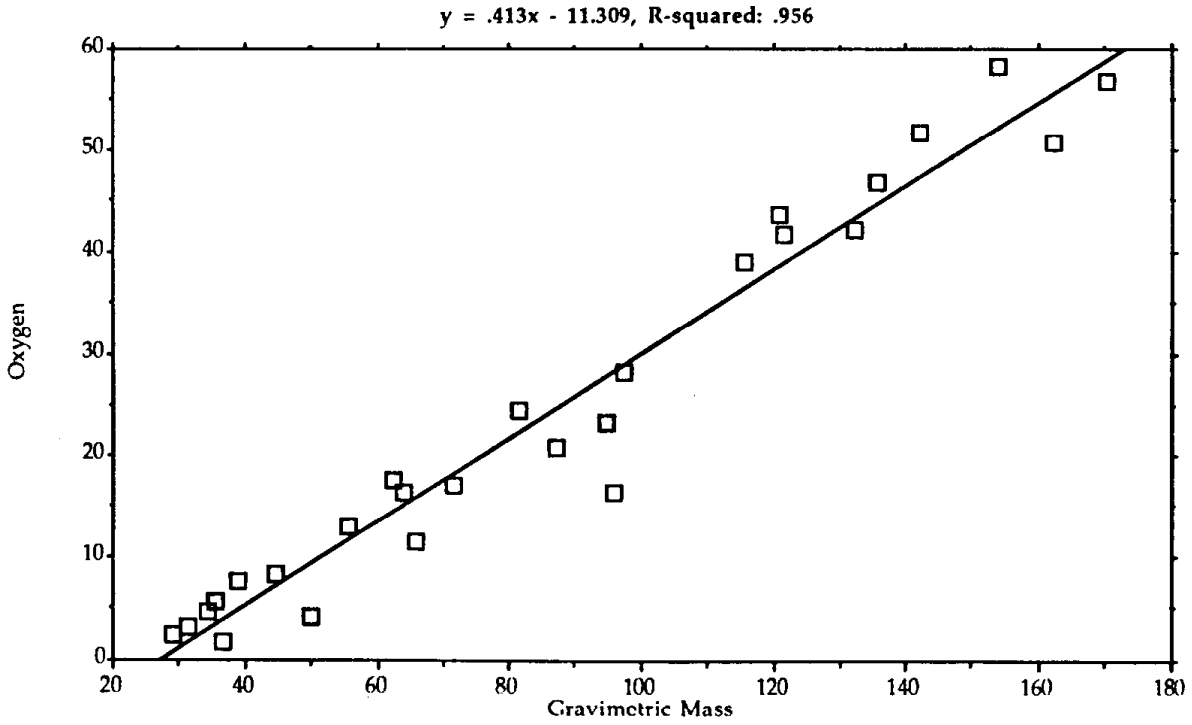
(units in micrograms/m**3)



Los Angeles - Fall

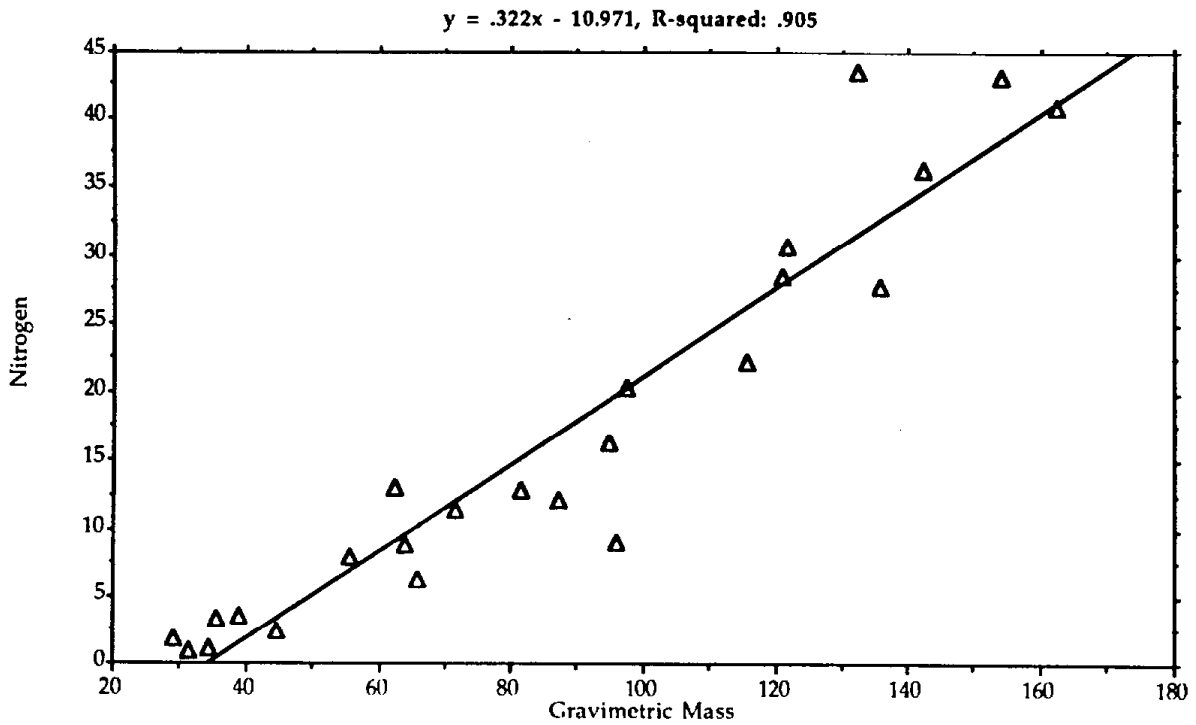
(units in micrograms/m**3)

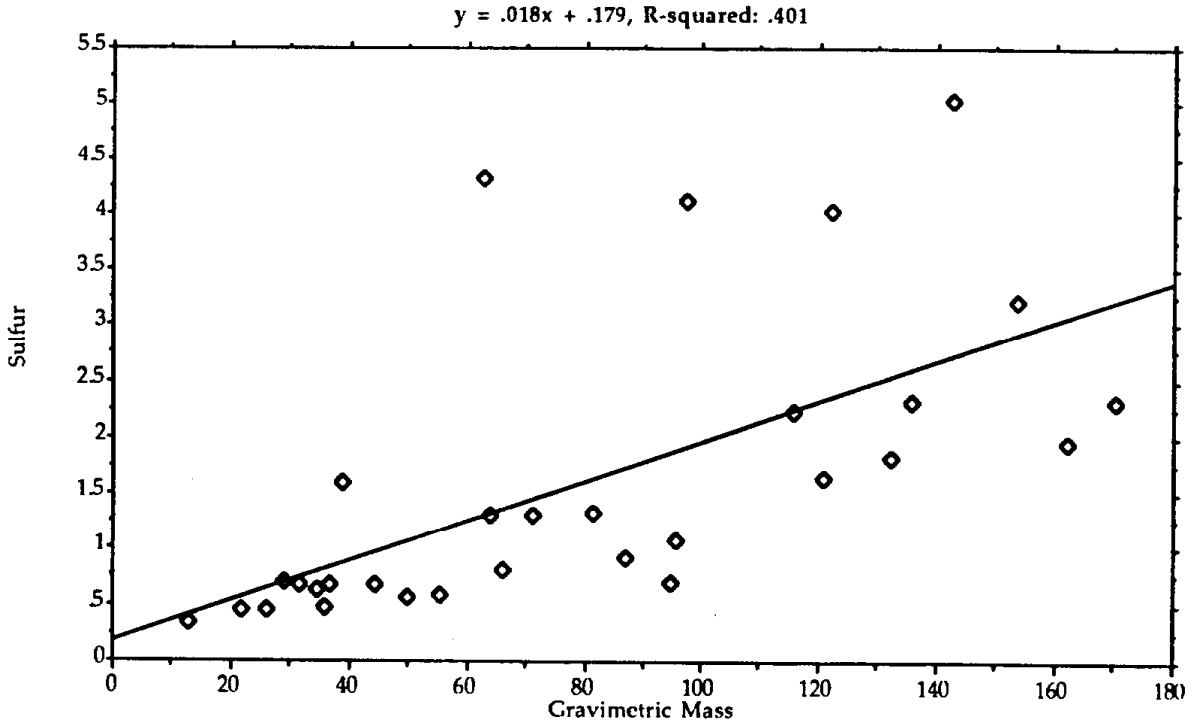




Los Angeles - Fall

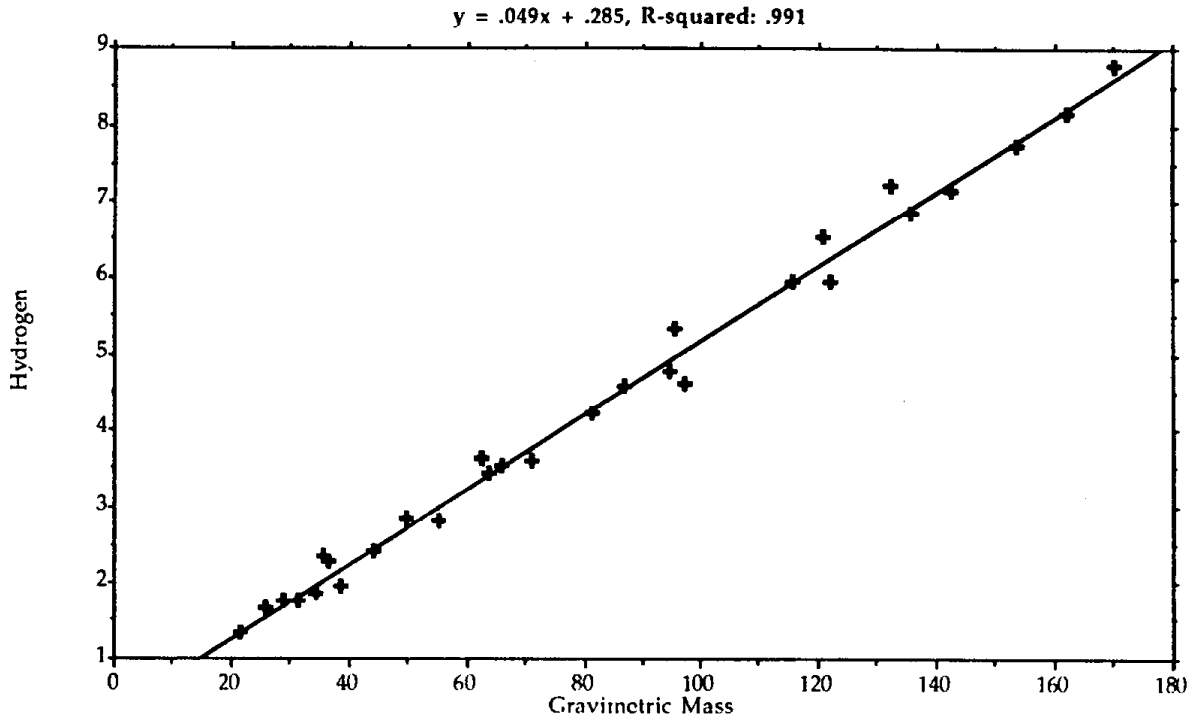
(units in micrograms/m**3)

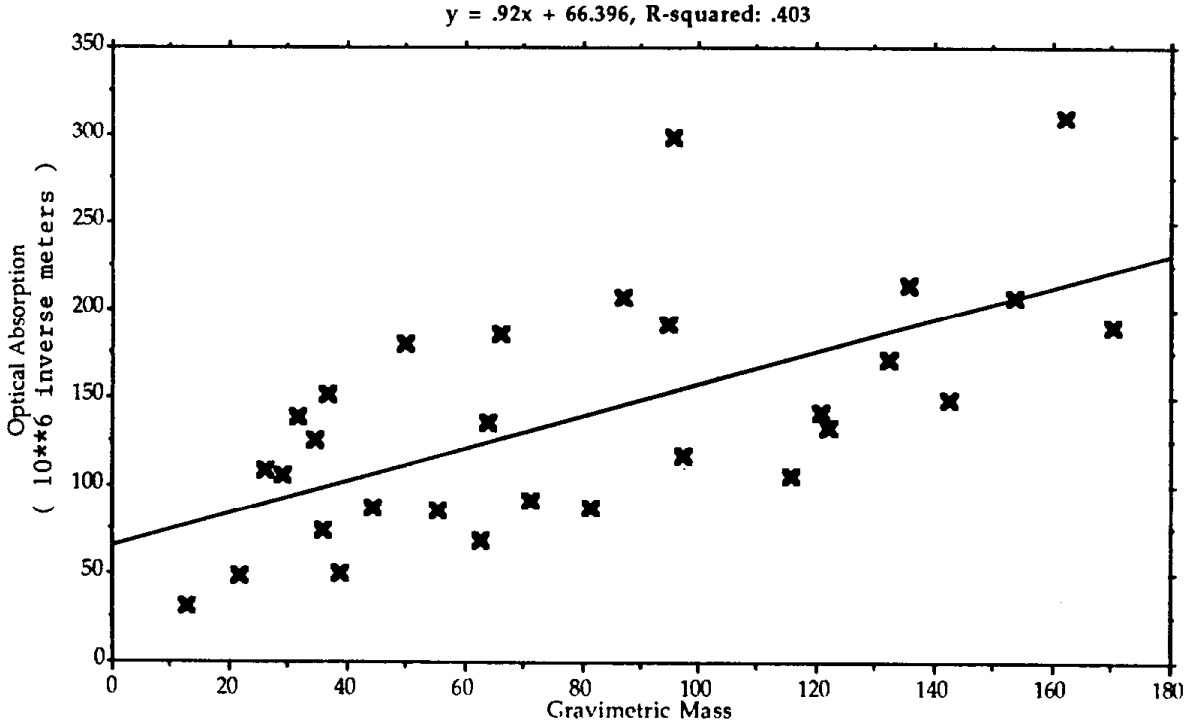




Los Angeles - Fall

(units in micrograms/m**3)





Appendix C

Size-Resolved Sulfur: DRUM and IMPROVE Filters

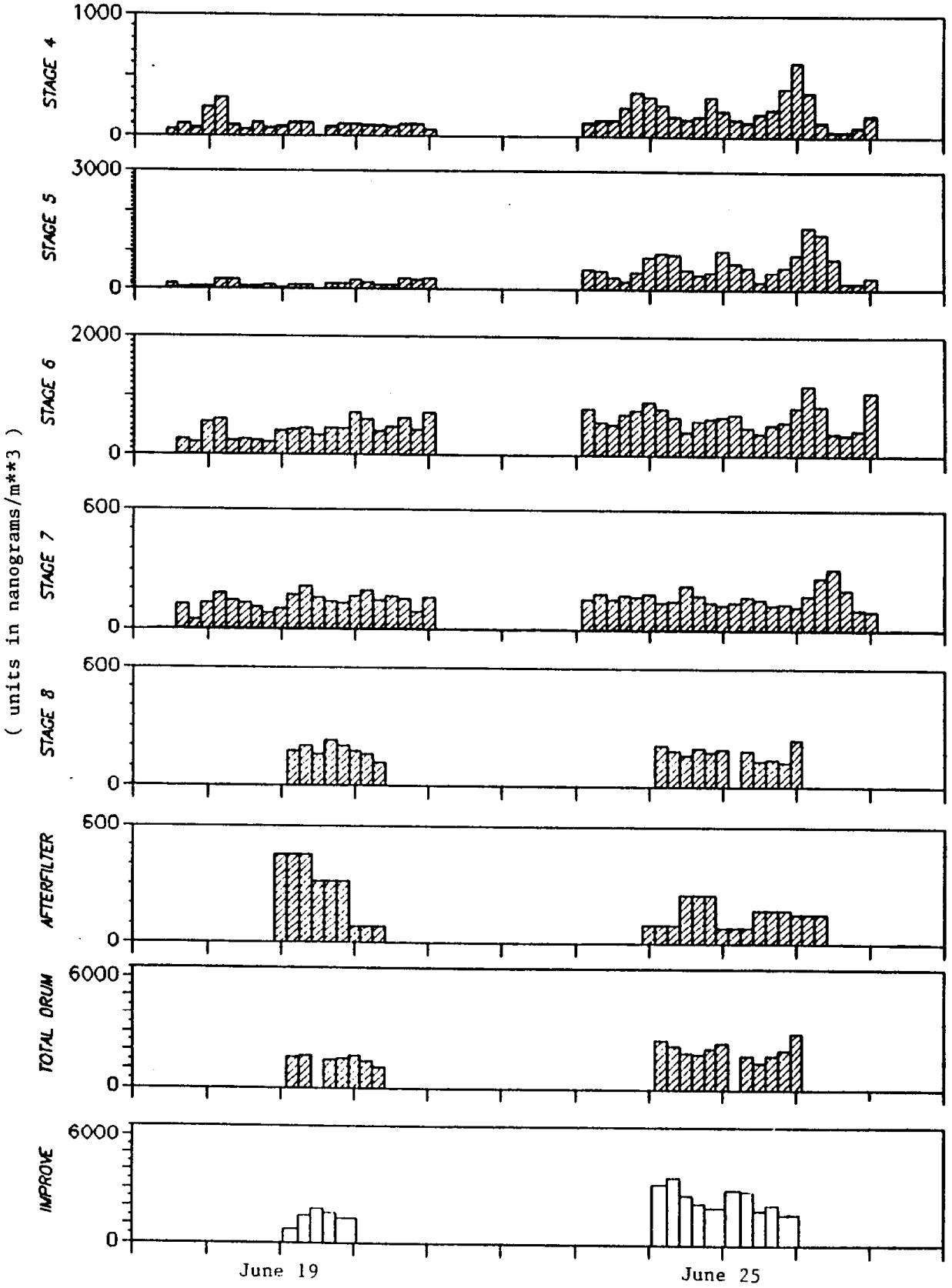
Appendix C contains timeplots of size-resolved sulfur sampled by DRUM and IMPROVE cyclone samplers. The top 6 plots of each page separates sulfur into the following 6 size ranges or DRUM stages:

Stage 4	2.12 - 1.15μm diameter*
Stage 5	1.15 - 0.56μm diameter
Stage 6	0.56 - 0.34μm diameter
Stage 7	0.34 - 0.24μm diameter
Stage 8	0.24 - 0.069μm diameter
Afterfilter	0.069 - 0.00μm diameter

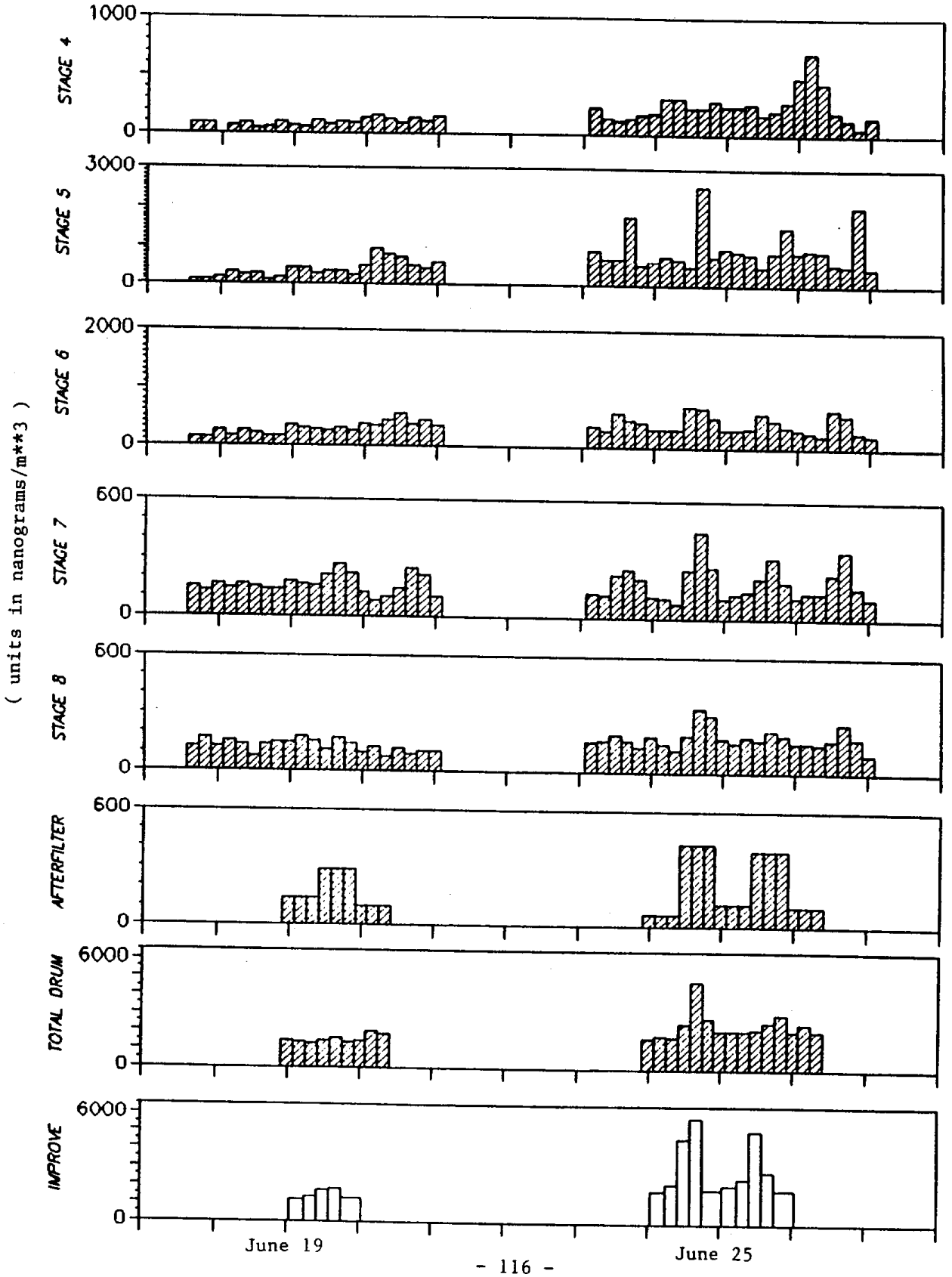
*Effective Cut-off Aerodynamic Equivalent Diameter

The bottom 2 plots of each page show total DRUM sulfur (0.0 to 2.12μm) and fine sulfur (PM2.5) IMPROVE teflon filters. Units are in nanograms per cubic meter. Note the different scales of each plot.

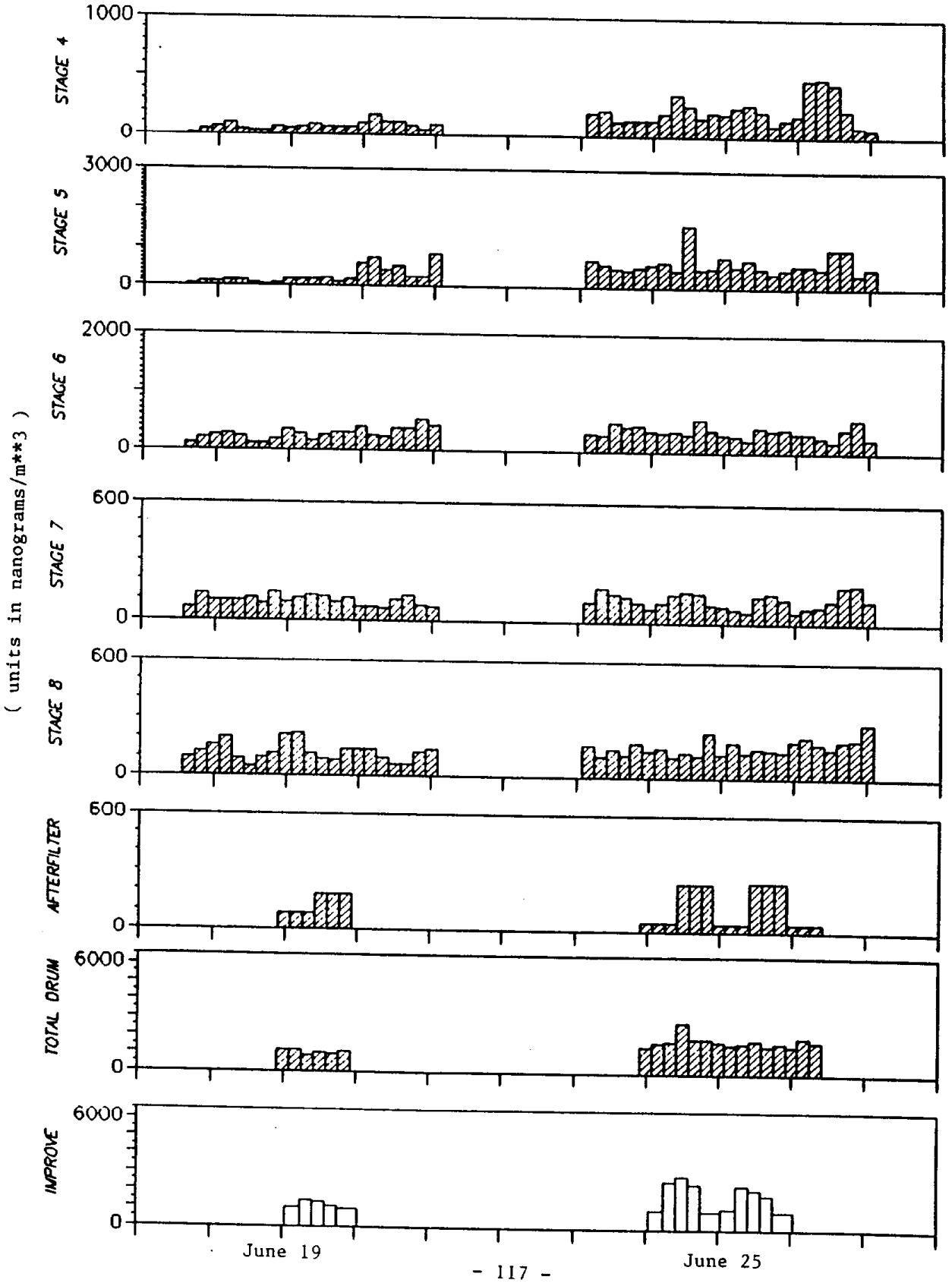
LONG BEACH SULFUR
JUNE 17-28



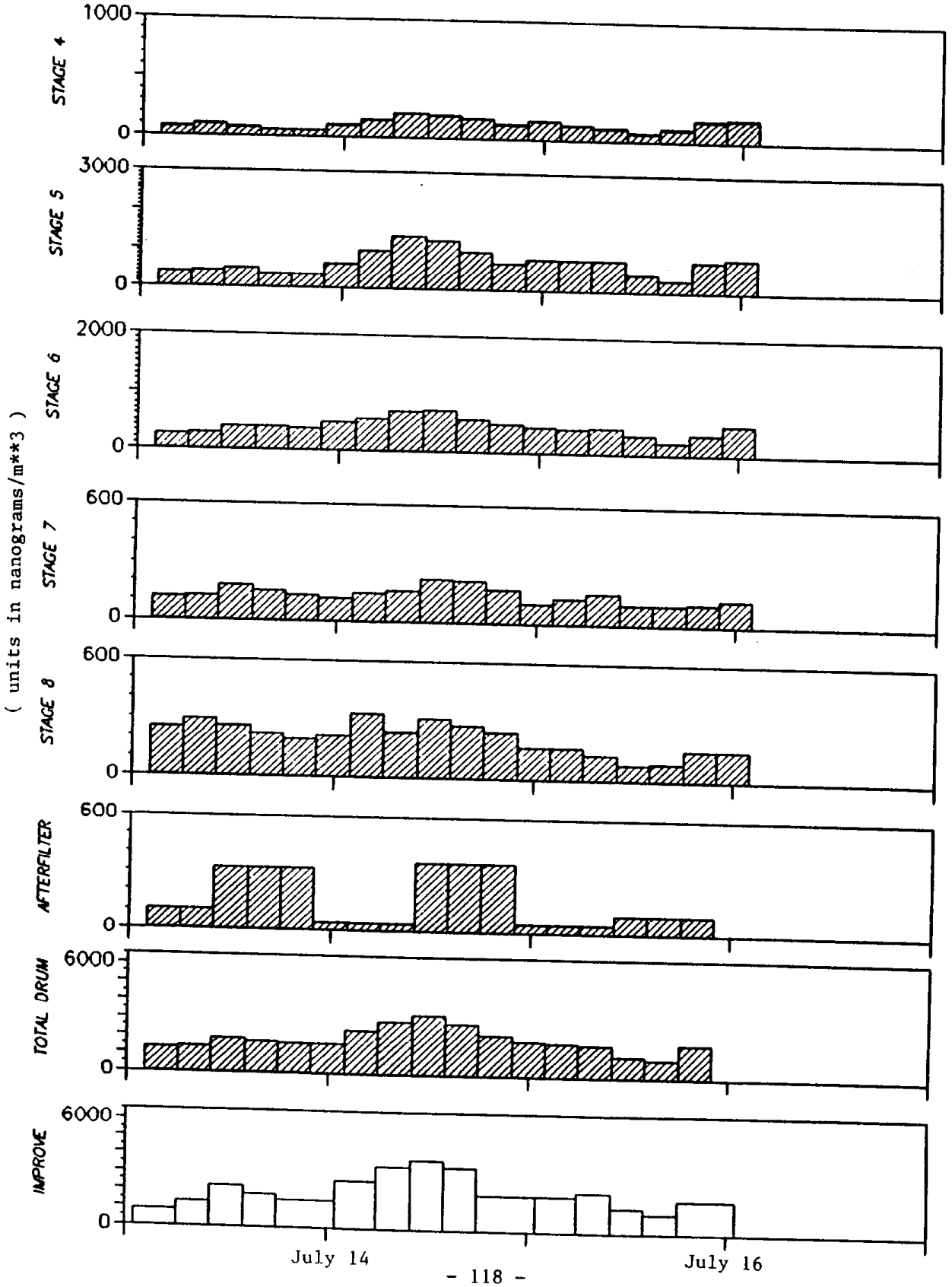
CLAREMONT SULFUR
JUNE 17-28



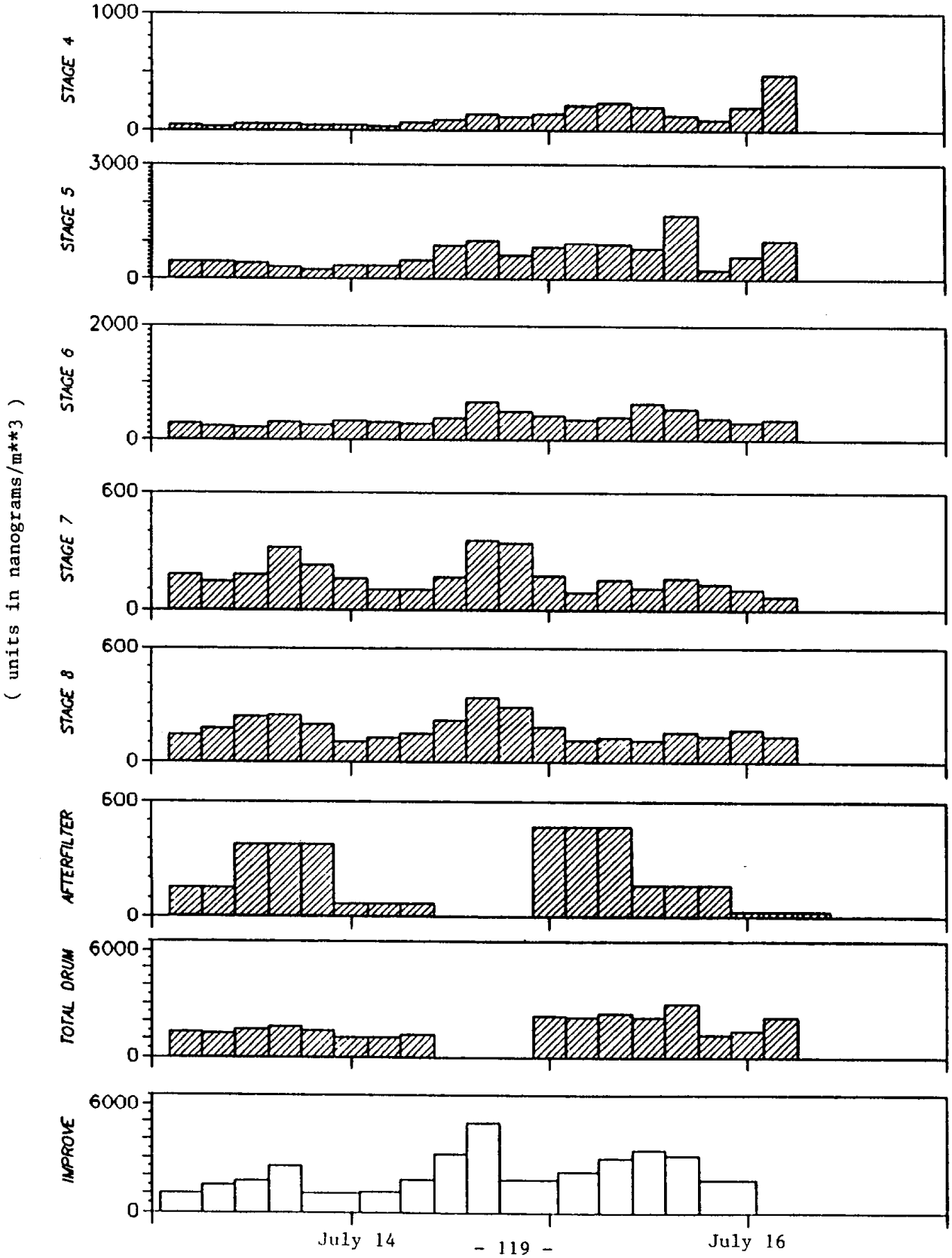
RUBIDOUX SULFUR
JUNE 17-28



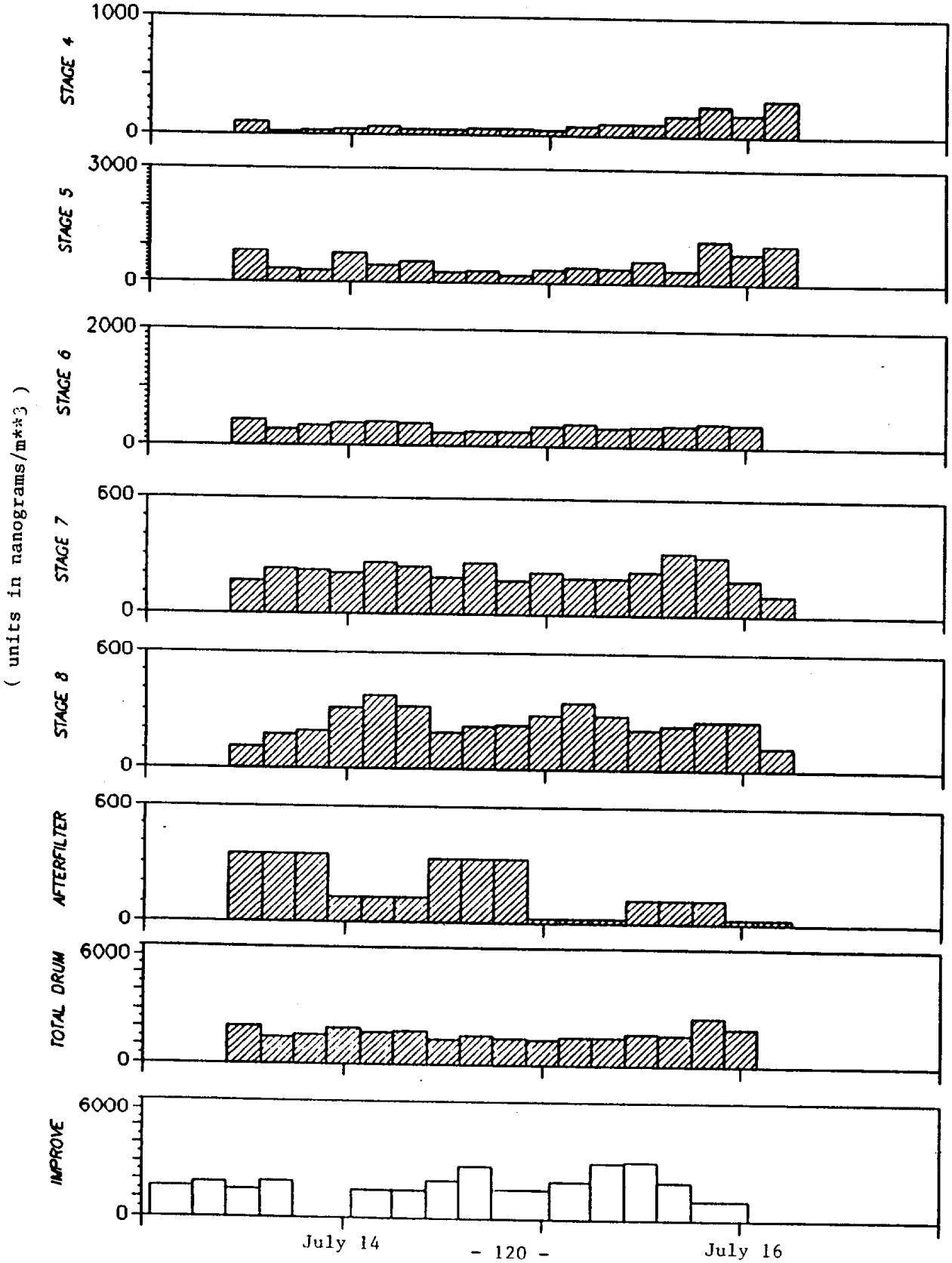
LONG BEACH SULFUR
JULY 13-17



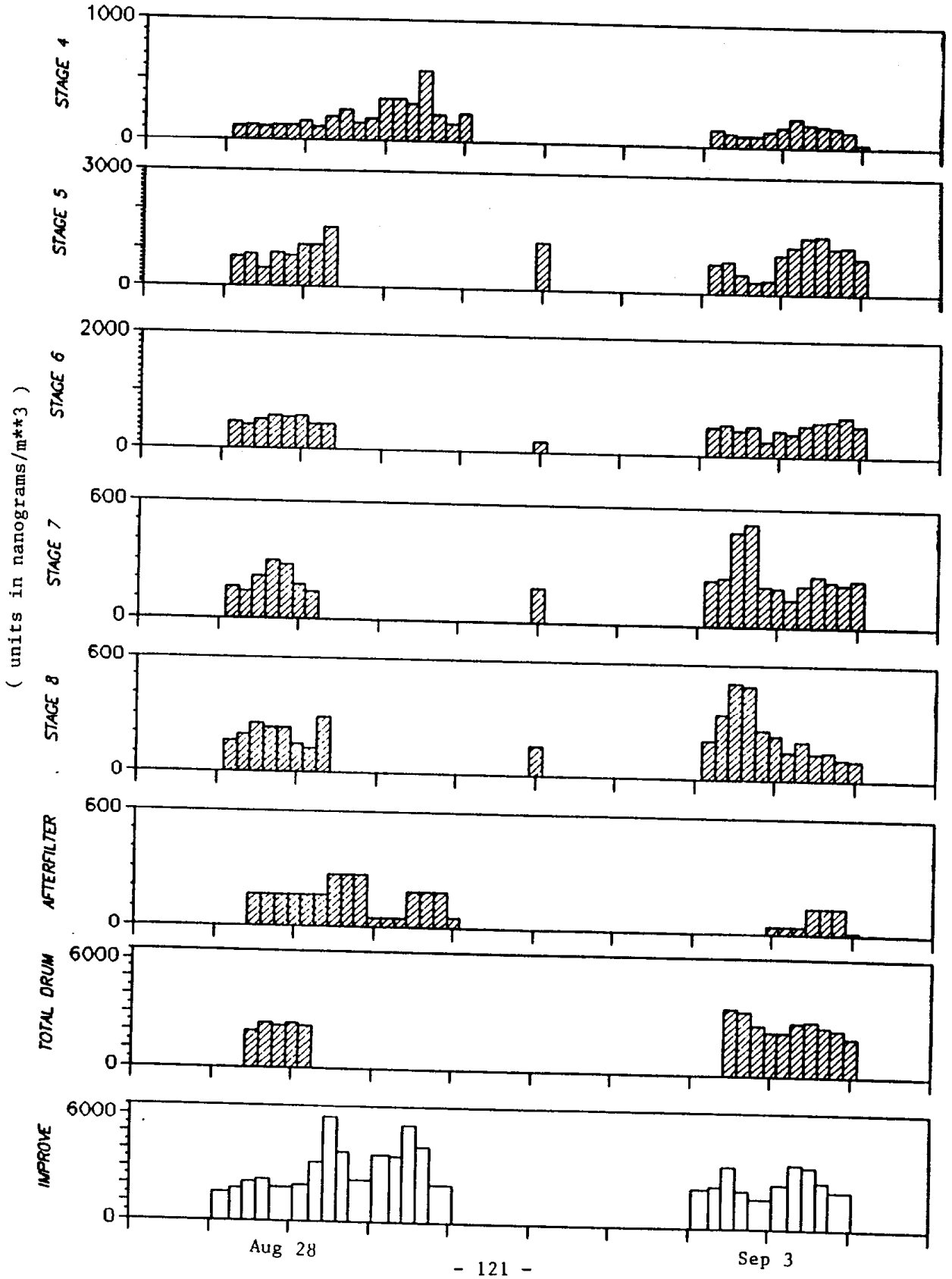
CLAREMONT SULFUR
JULY 13-17



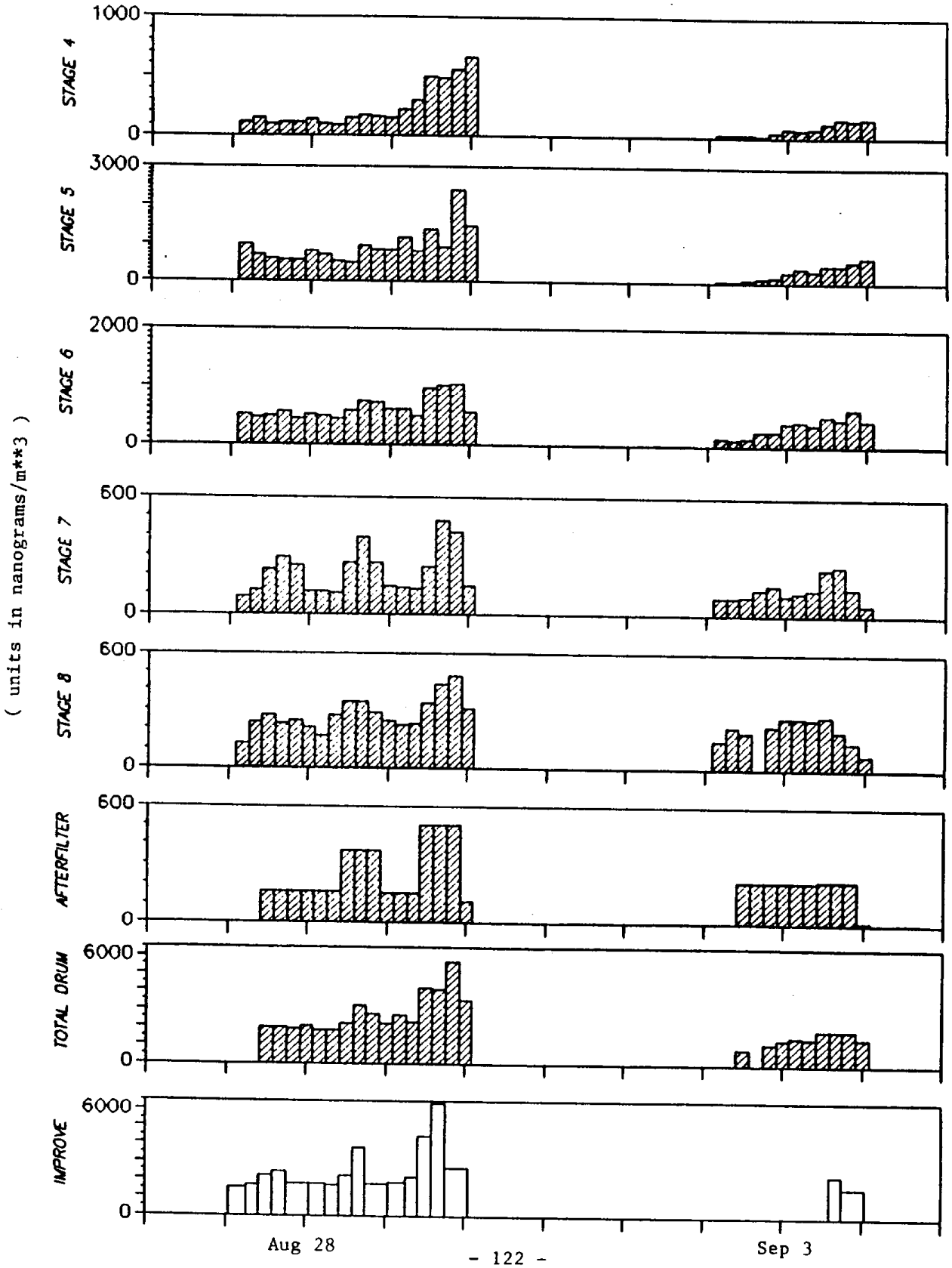
RUBIDOUX SULFUR
JULY 13-17



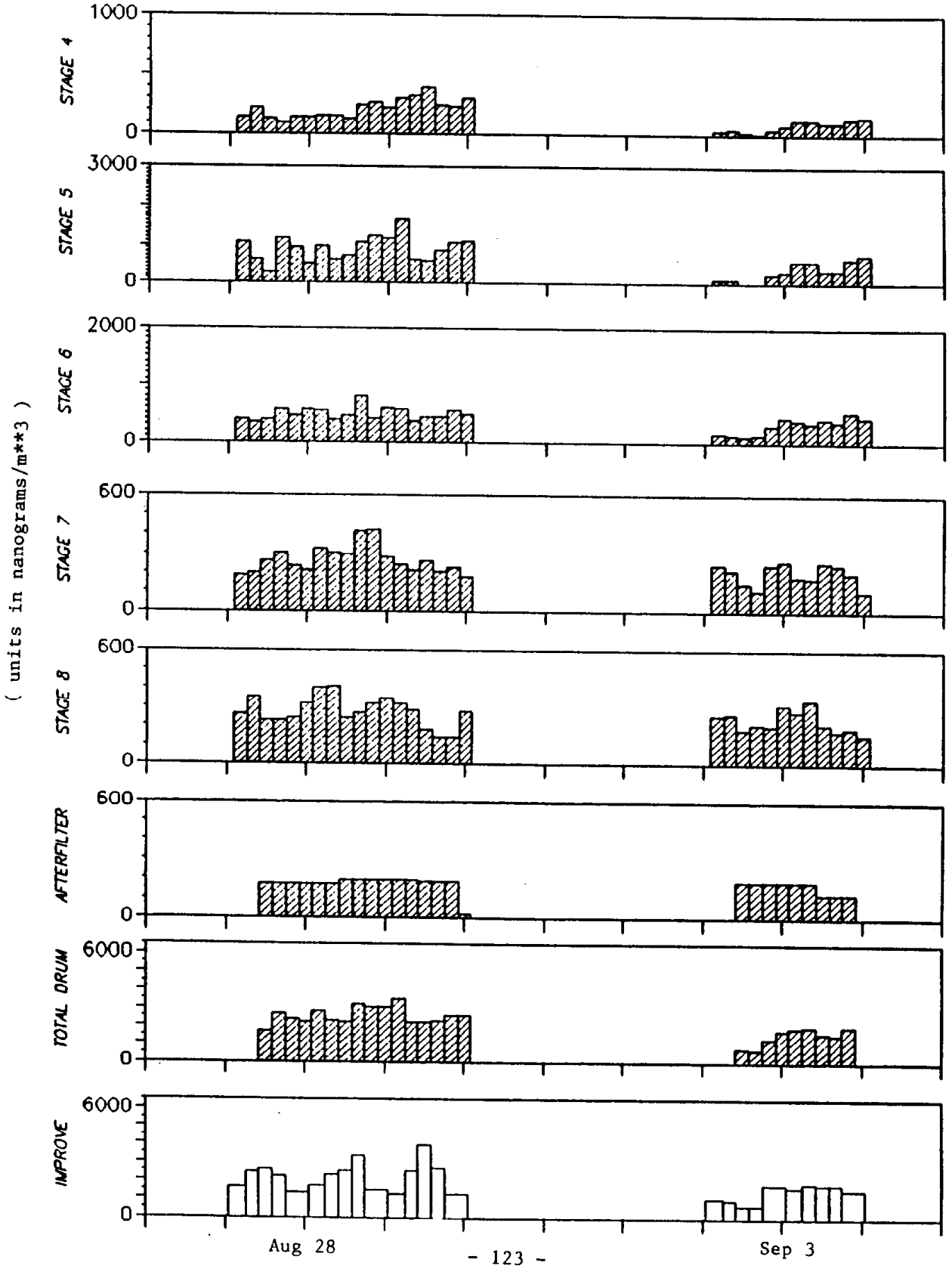
LONG BEACH SULFUR
AUG 26-31, SEP 1-5



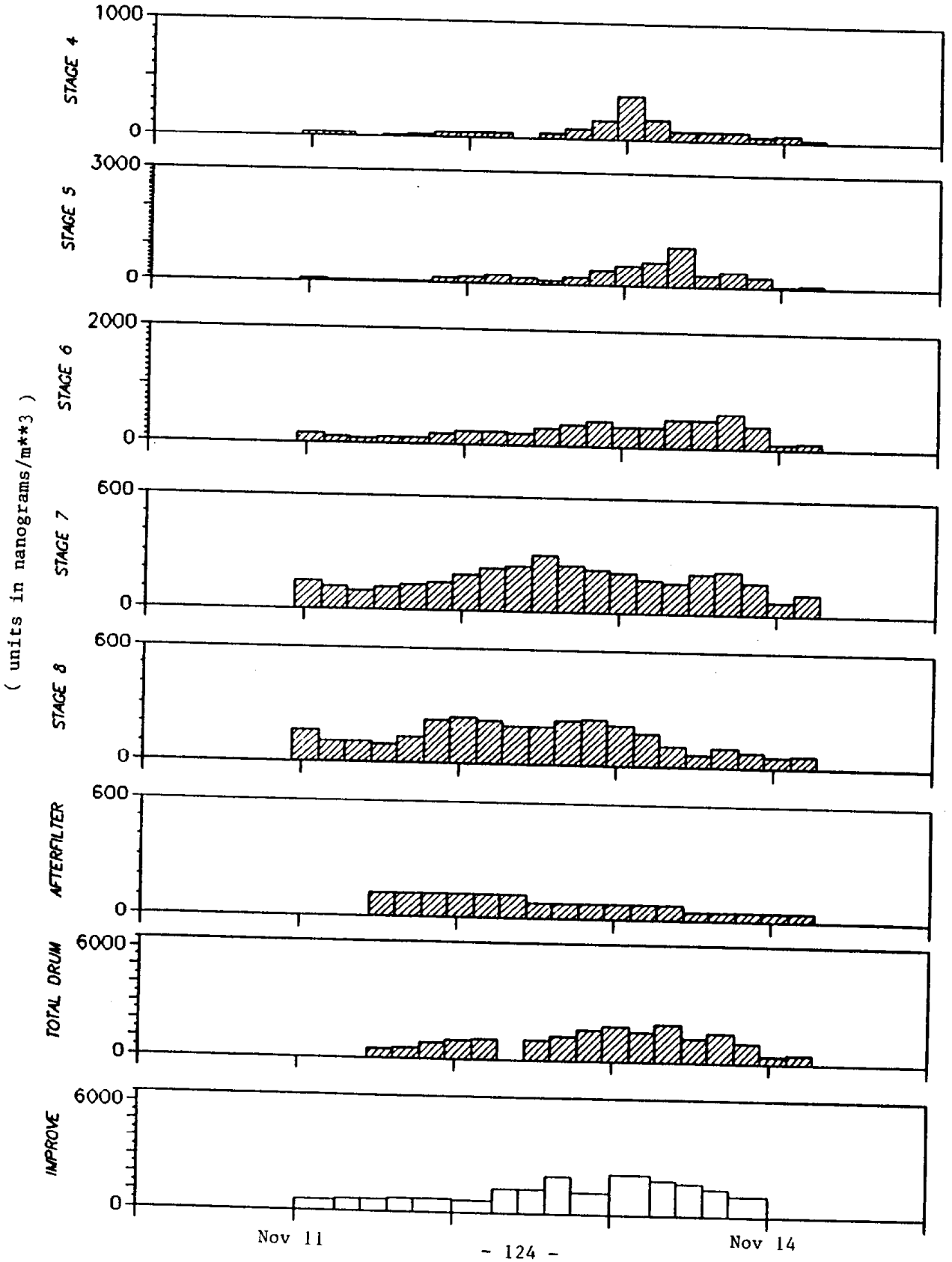
CLAREMONT SULFUR
AUG 26-31, SEP 1-5



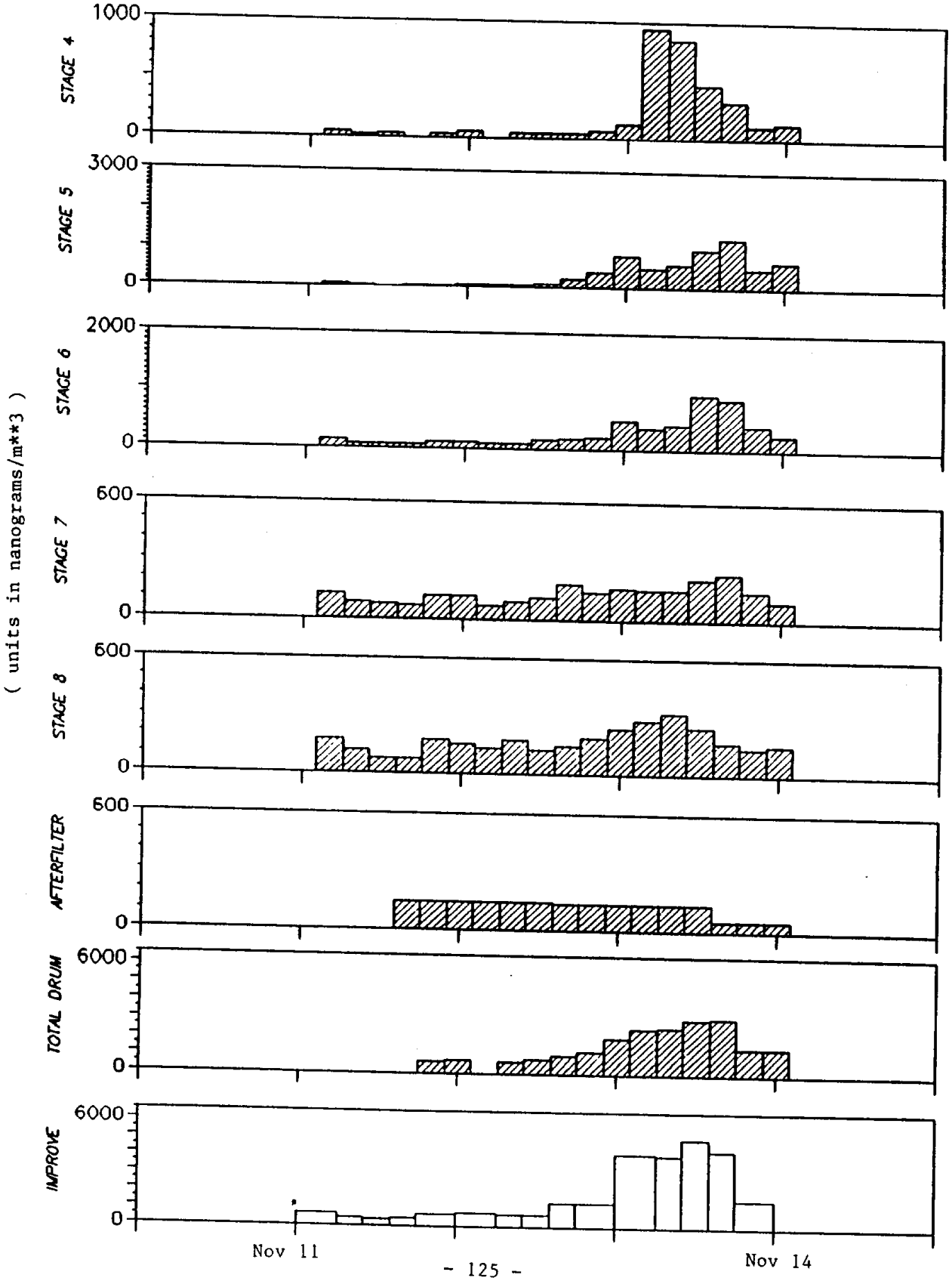
RUBIDOUX SULFUR
AUG 26-31, SEP 1-5



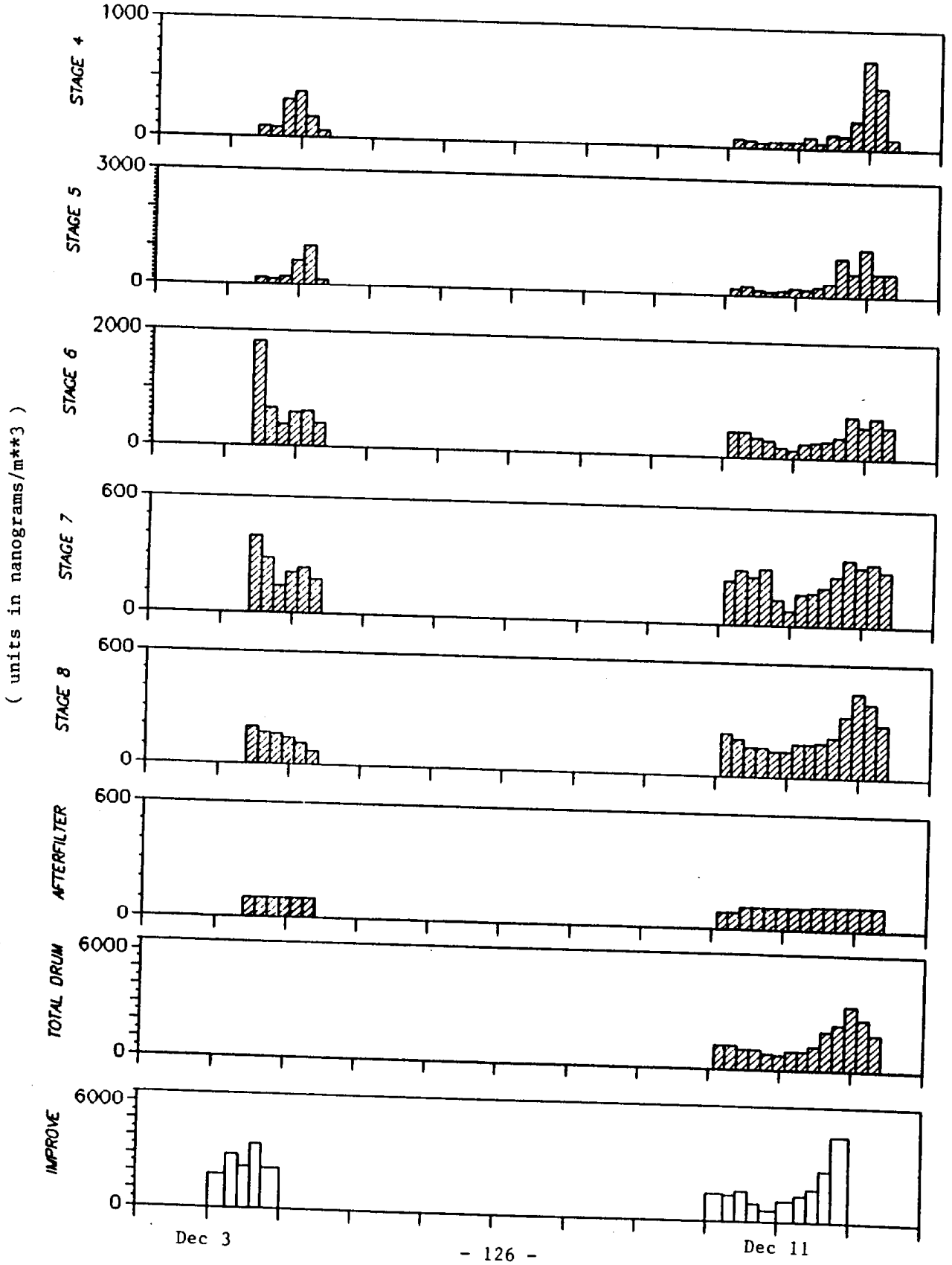
LONG BEACH SULFUR
NOV 10-15



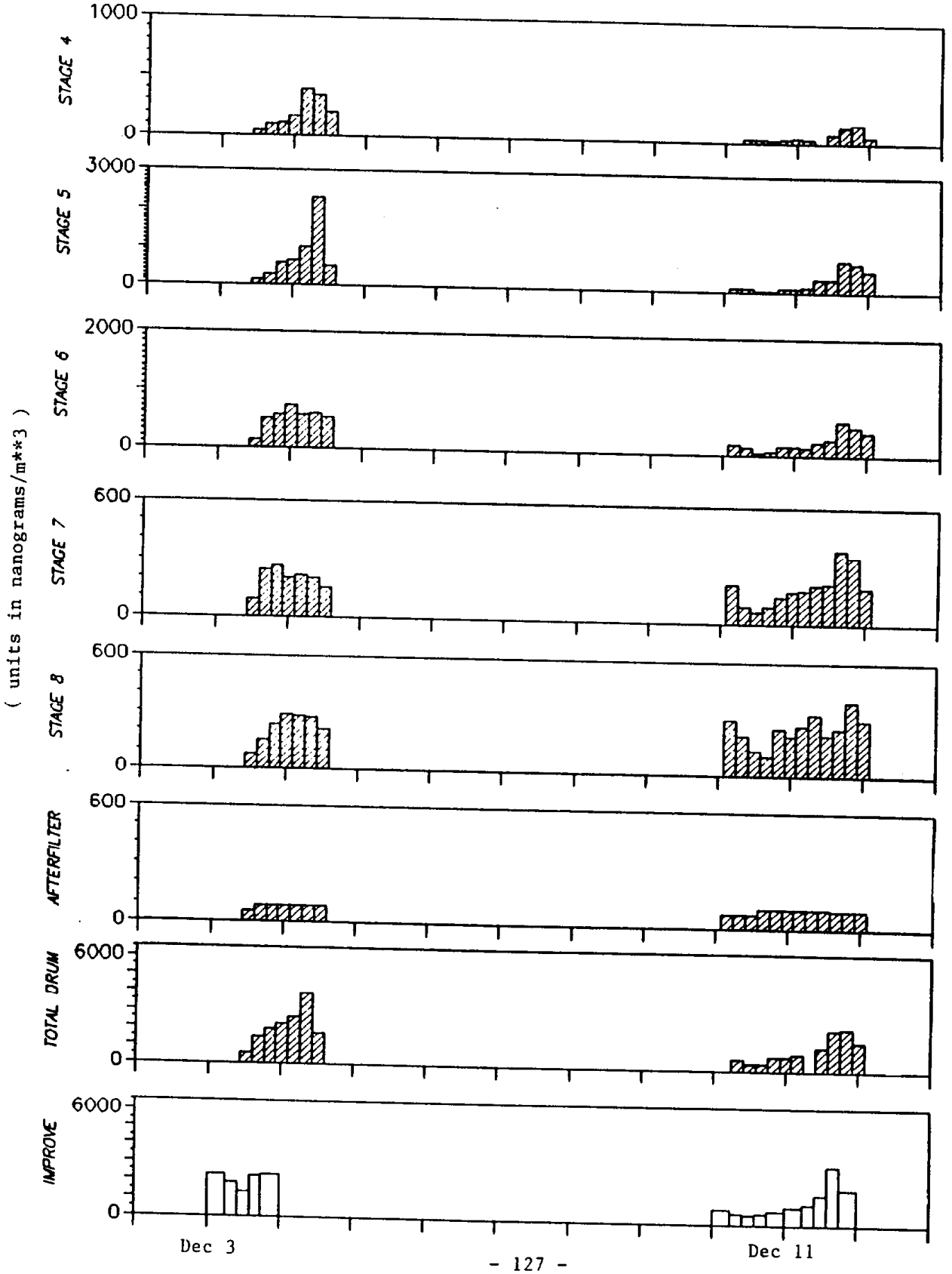
LOS ANGELES SULFUR
NOV 10-15



LONG BEACH SULFUR
DEC 2-13



LOS ANGELES SULFUR
DEC 2-13



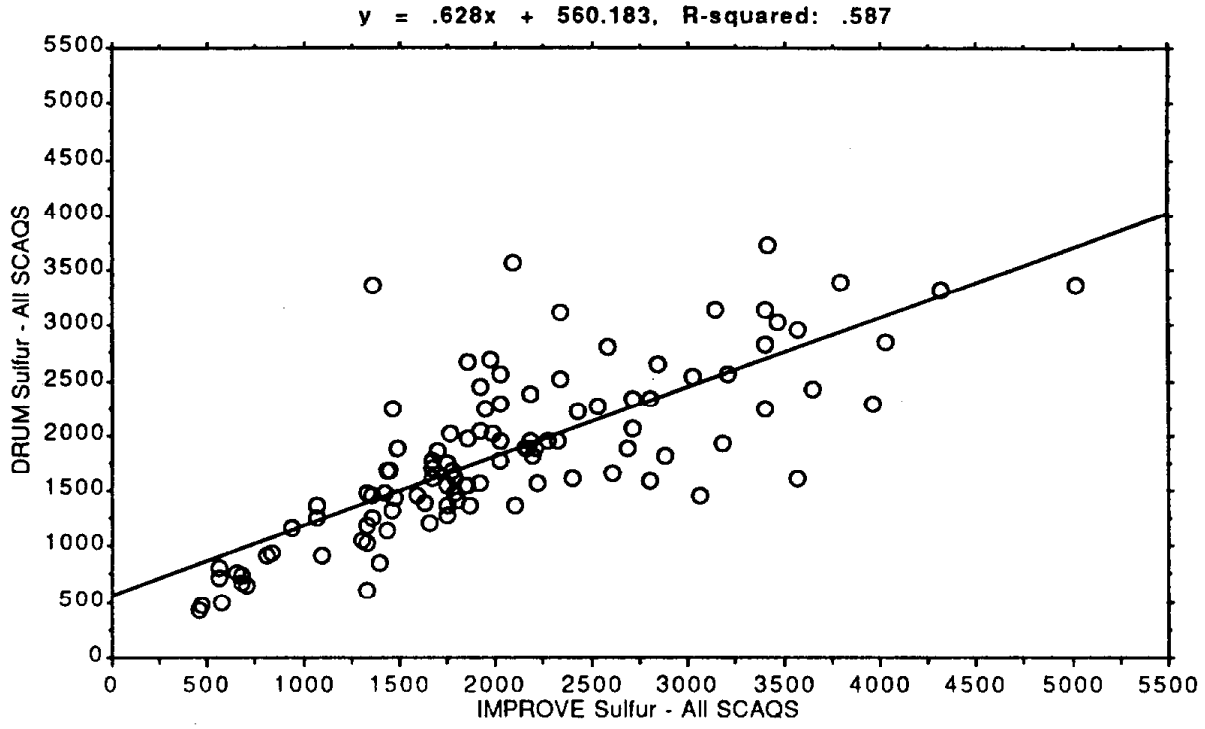
Appendix D

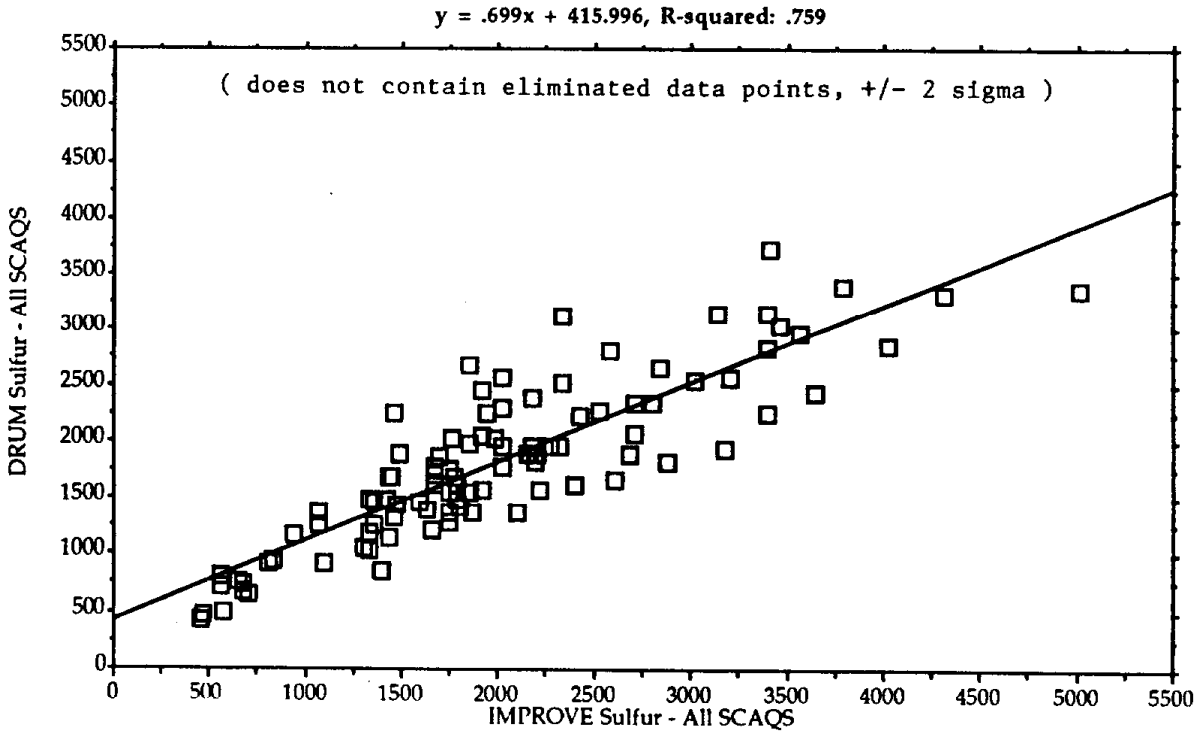
Linear Regressions Between Total DRUM and IMPROVE Filter Sulfur

Appendix D contains figures of linear regressions between total DRUM sulfur (0.0 to 2.12μm) and IMPROVE filter sulfur. Figures are arranged by site and sample period in the same order as in Table 8 of QUALITY ASSURANCE AND DATA VALIDATION, Sulfur Comparison Between DRUM Samples and IMPROVE Filters. The bottom figures (denoted by square symbols) do not contain data which has been eliminated. Data was eliminated if the ratio of of total DRUM sulfur to IMPROVE filter sulfur was not within +/- 2 standard deviations of the mean of all matching sulfur values. Units are in nanograms per cubic meter.

All SCAQS

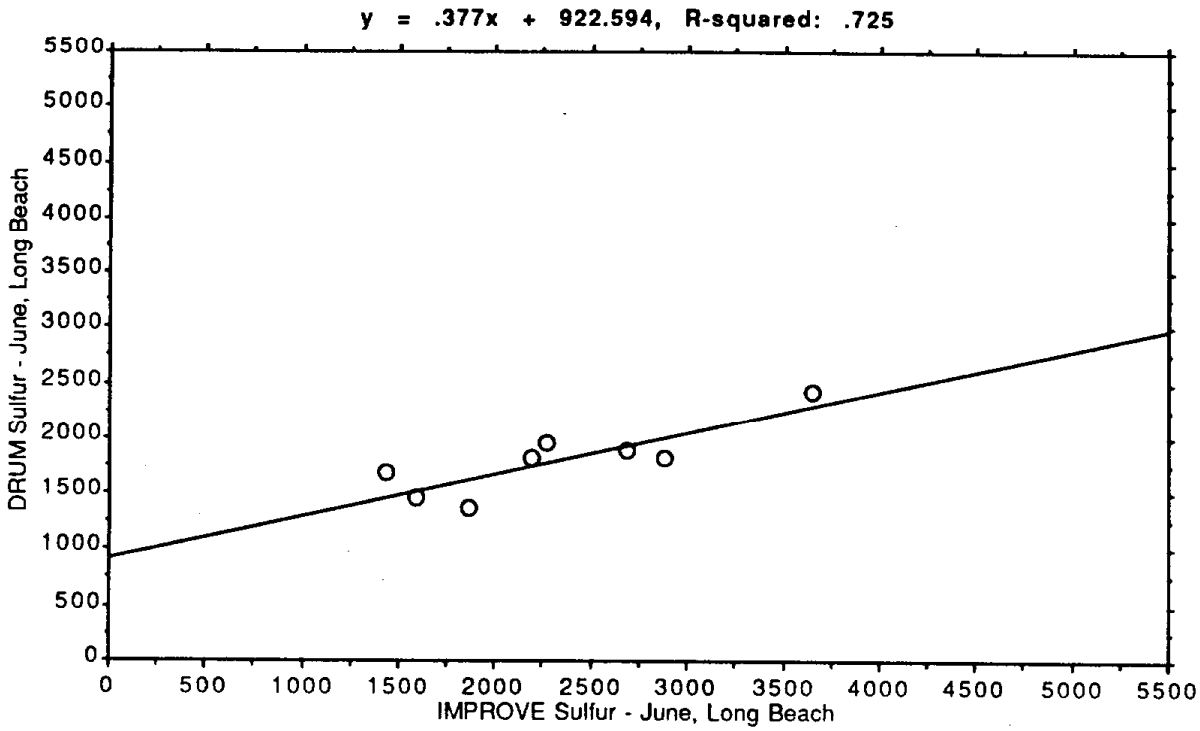
(units in nanograms/m**3)





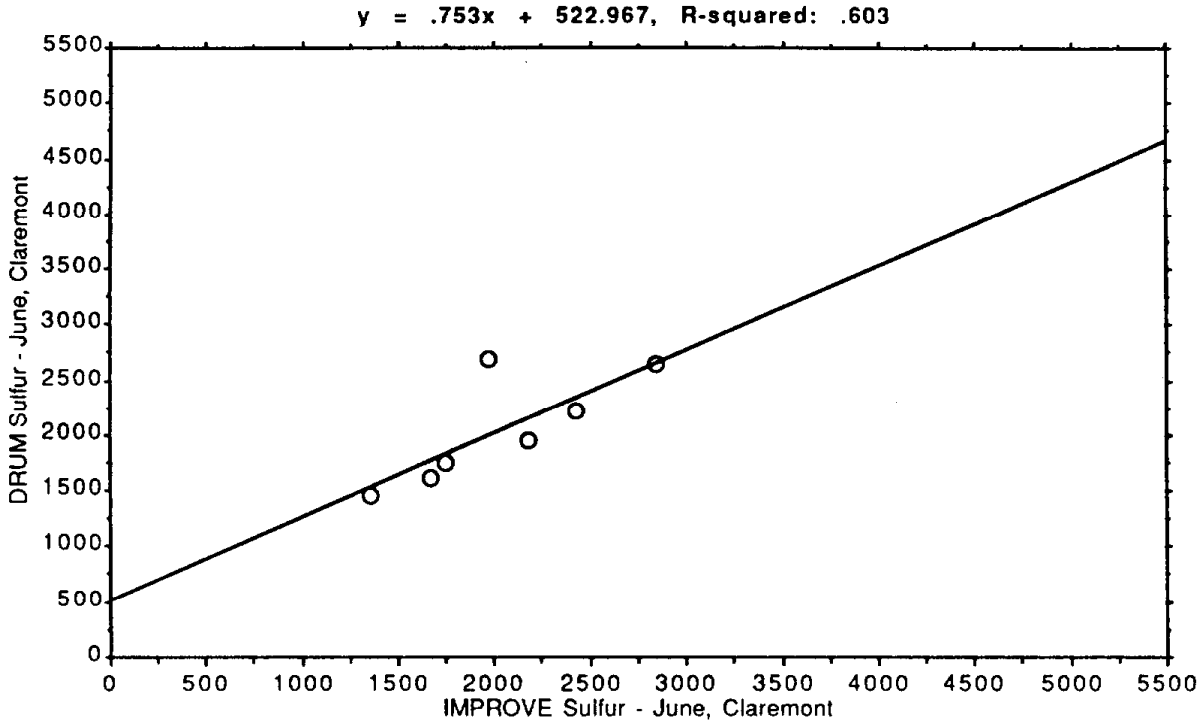
Long Beach - June

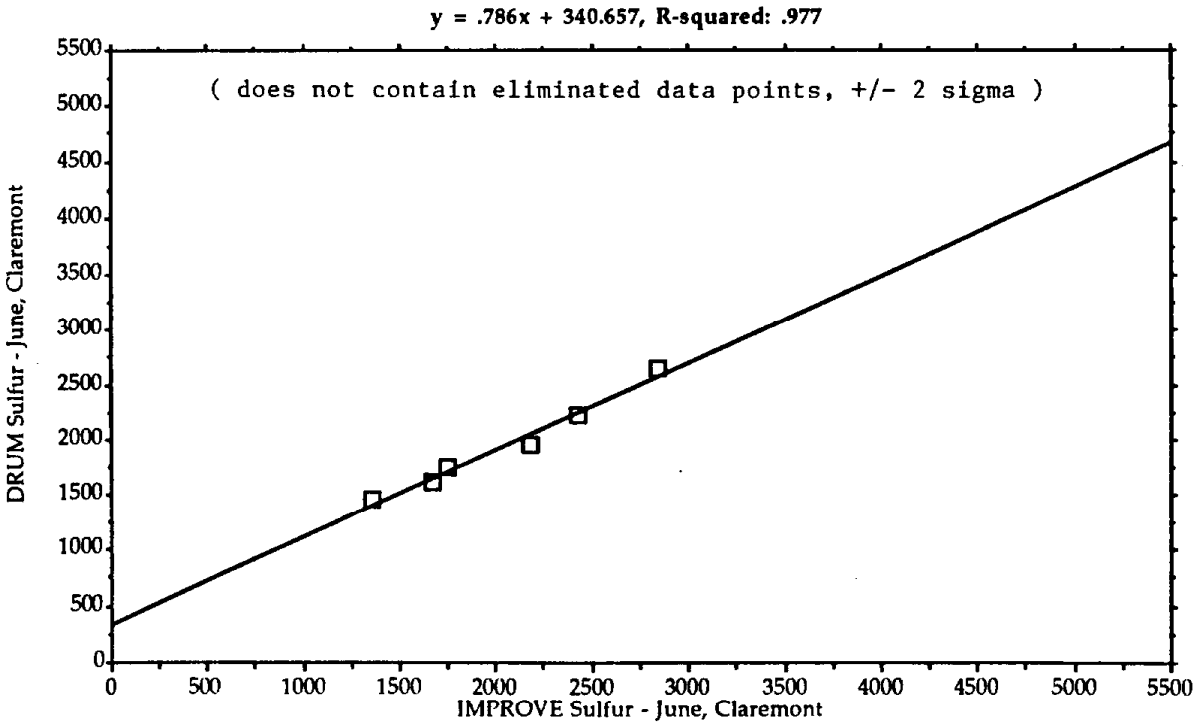
(units in nanograms/m**3)



Claremont - June

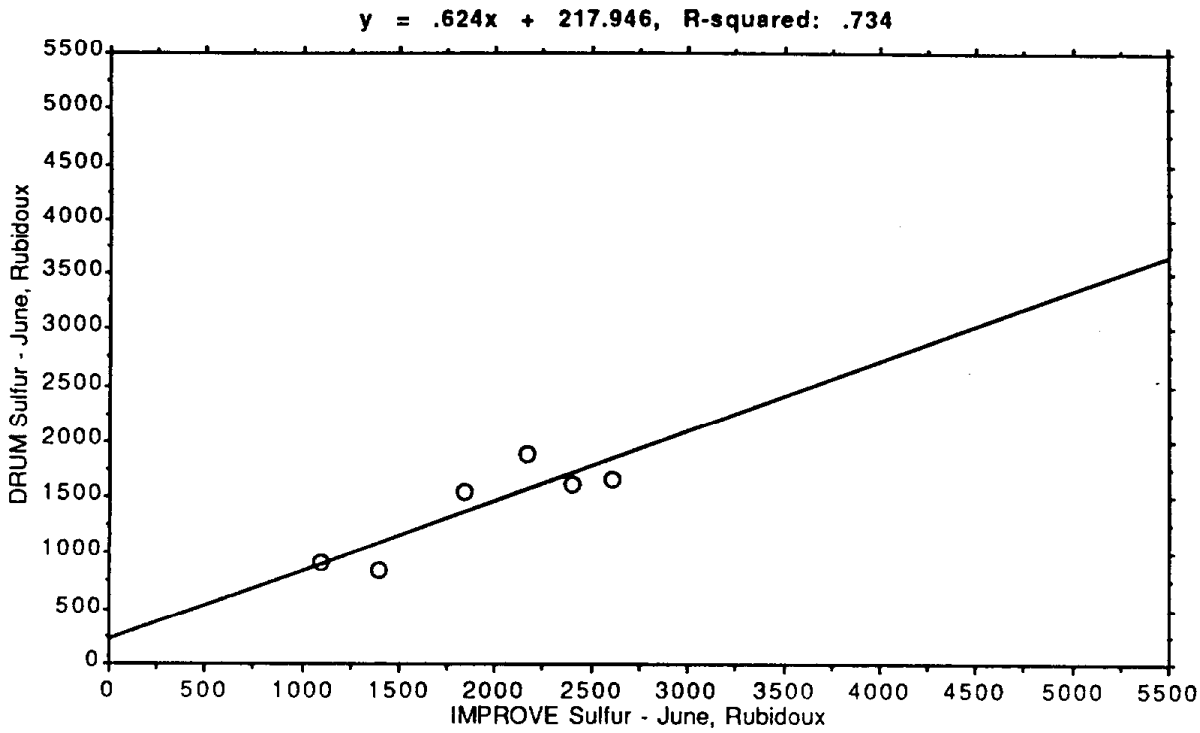
(units in nanograms/m**3)





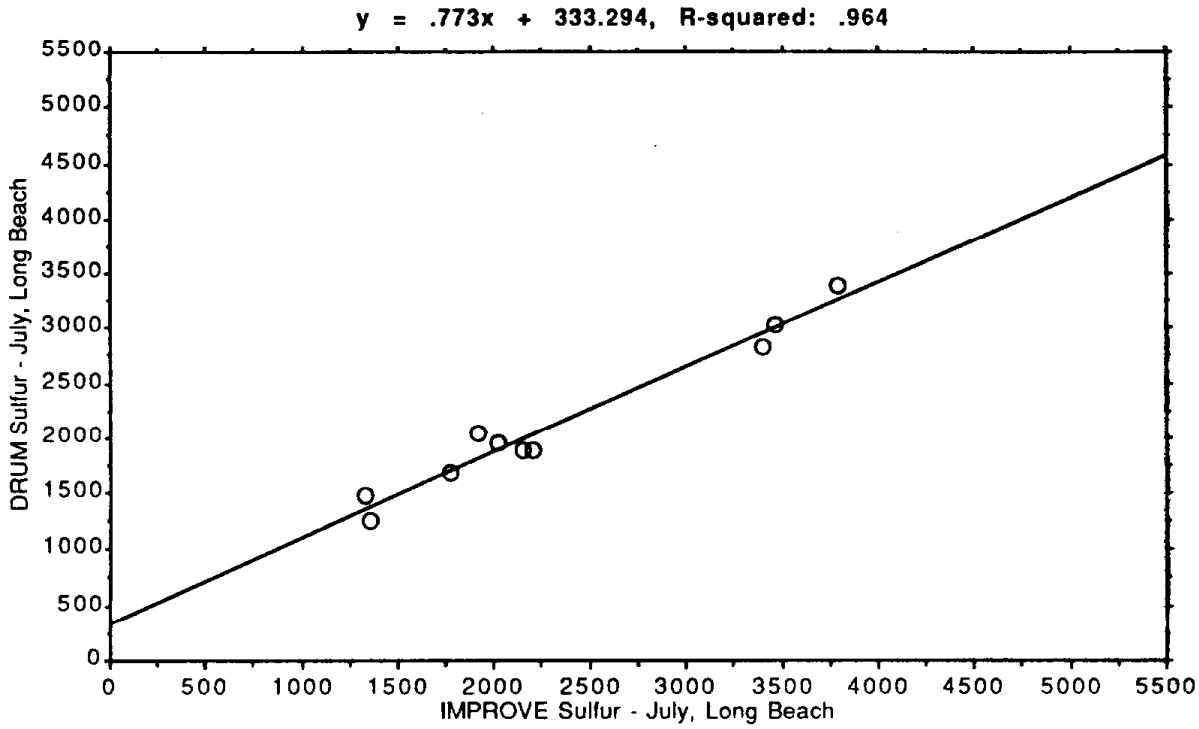
Rubidoux - June

(units in nanograms/m**3)



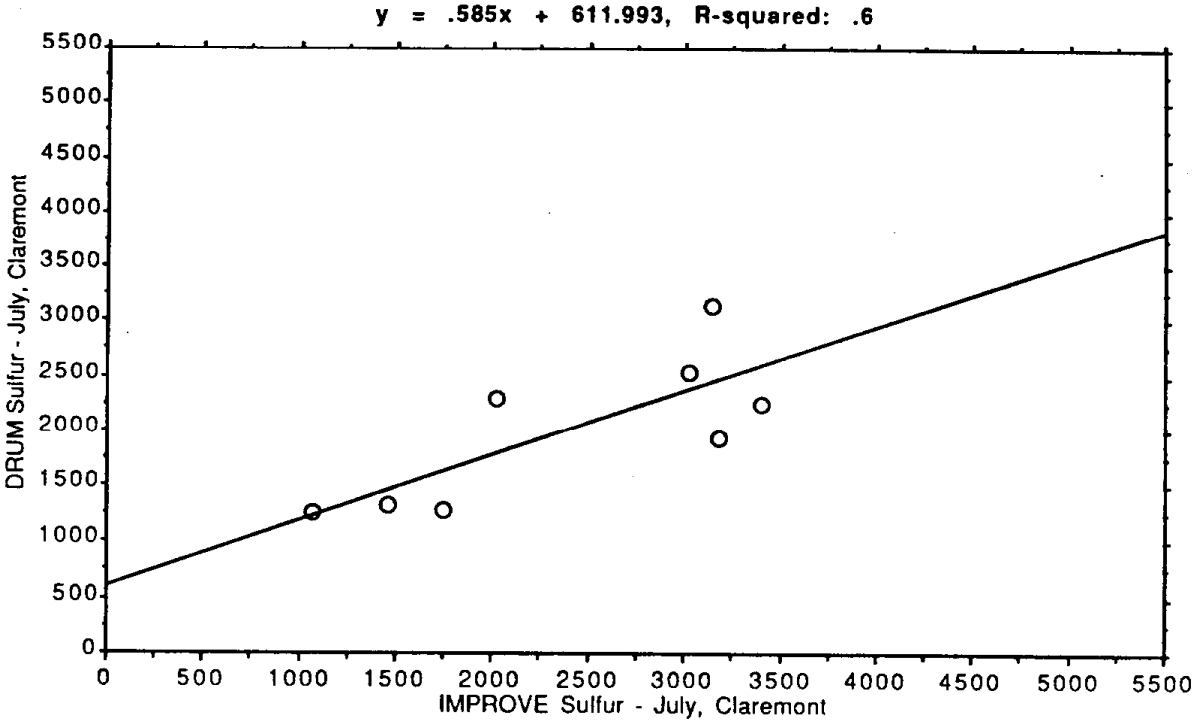
Long Beach - July

(units in nanograms/m**3)



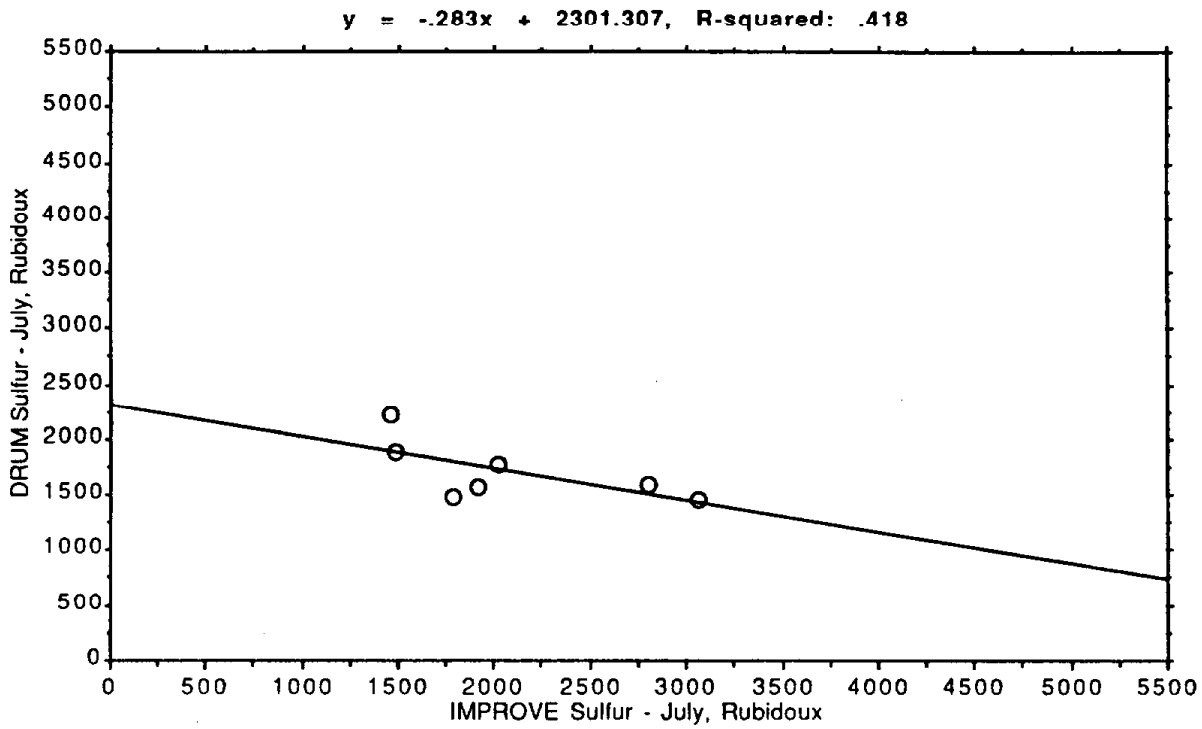
Claremont - July

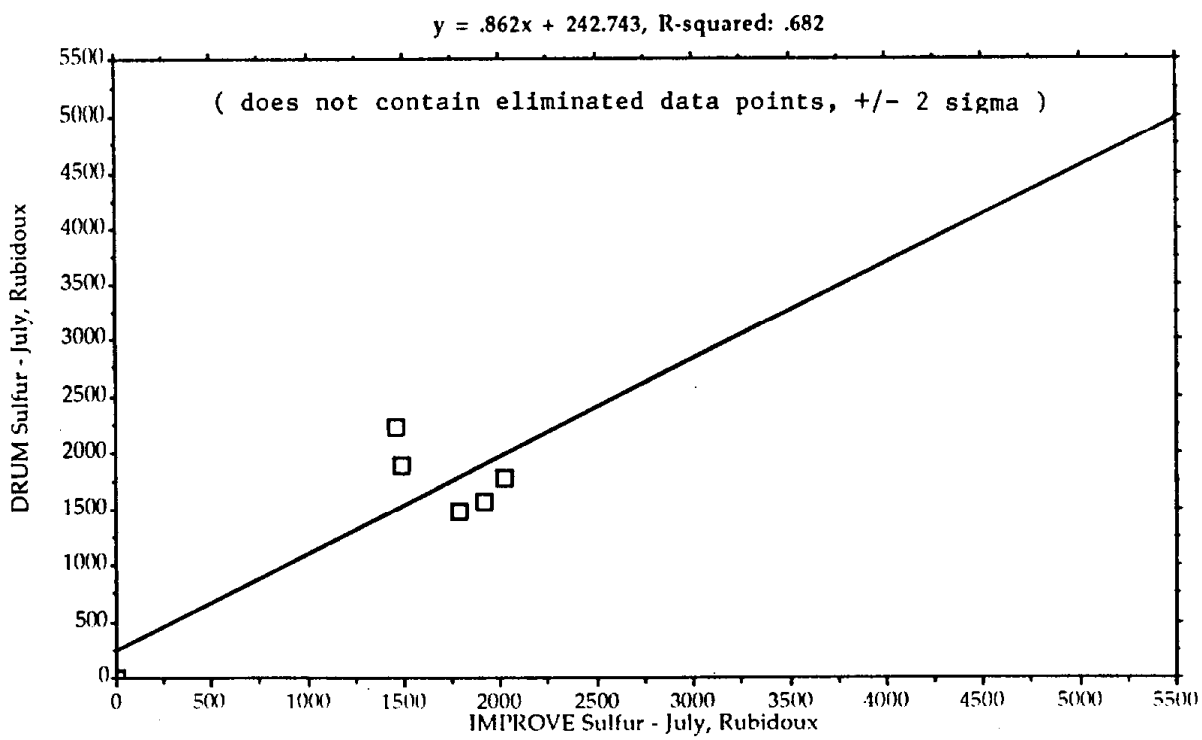
(units in nanograms/m**3)



Rubidoux - July

(units in nanograms/m**3)

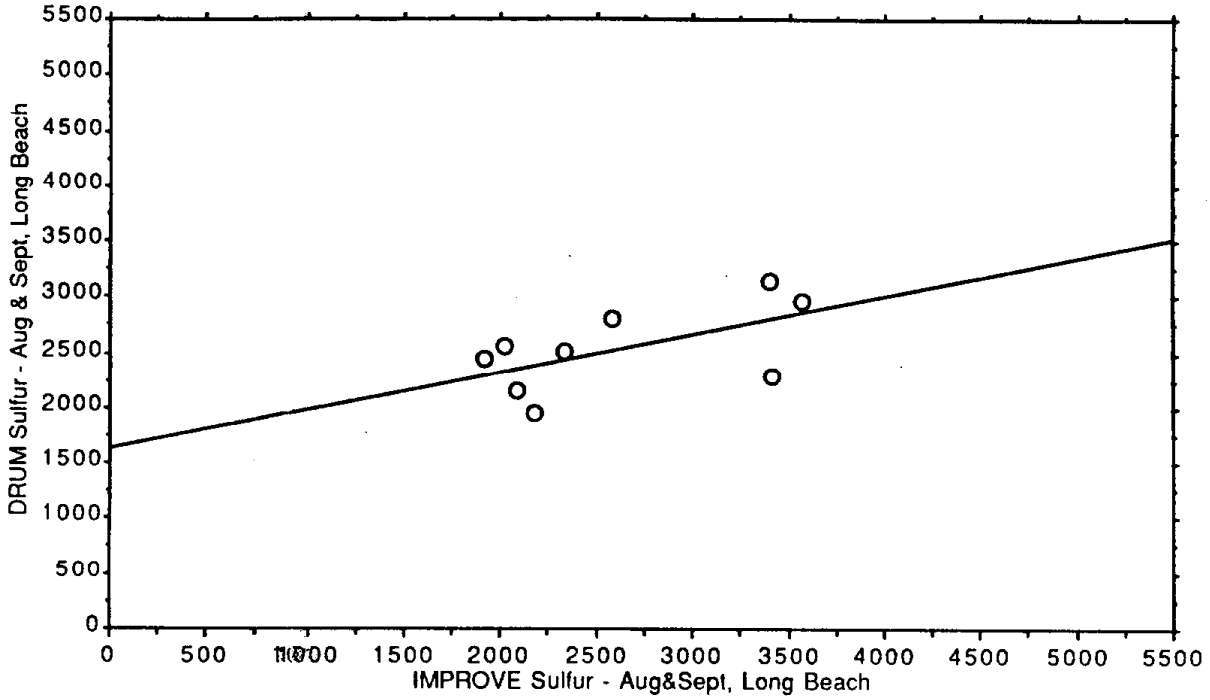




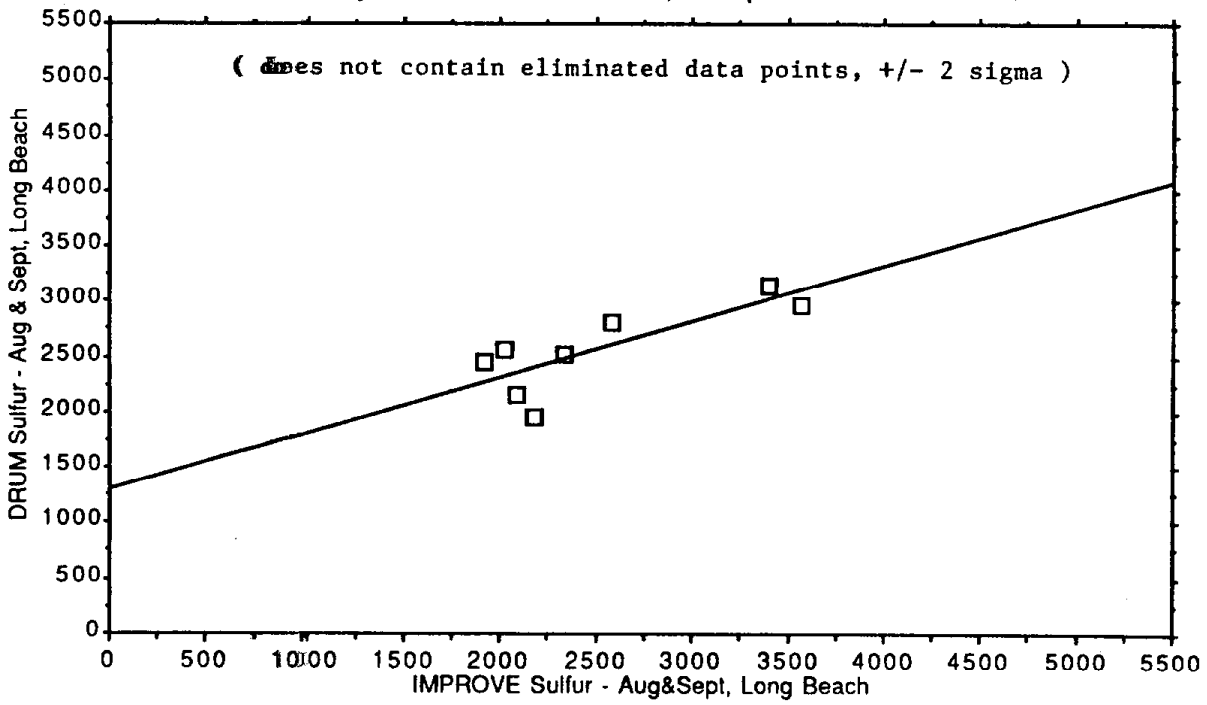
Long Beach - August and September

(units in nanograms/m**3)

y = .342x + 1643.819, R-squared: .349

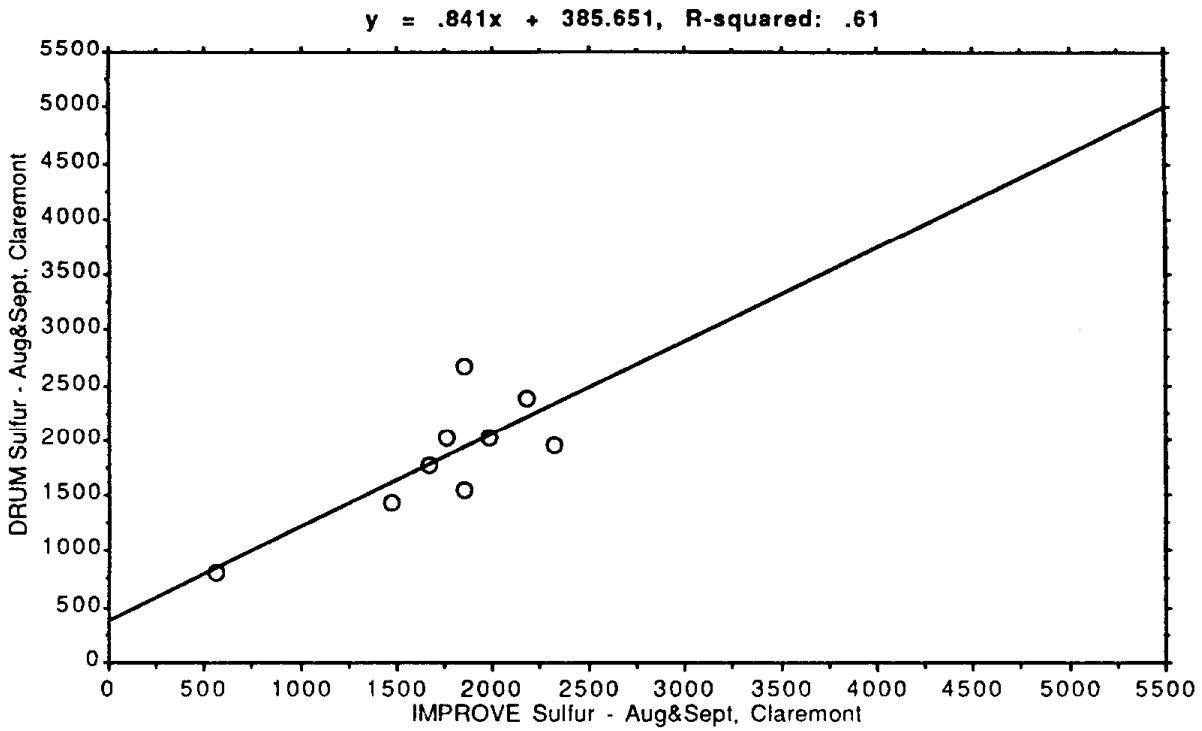


y = .507x + 1293.639, R-squared: .647



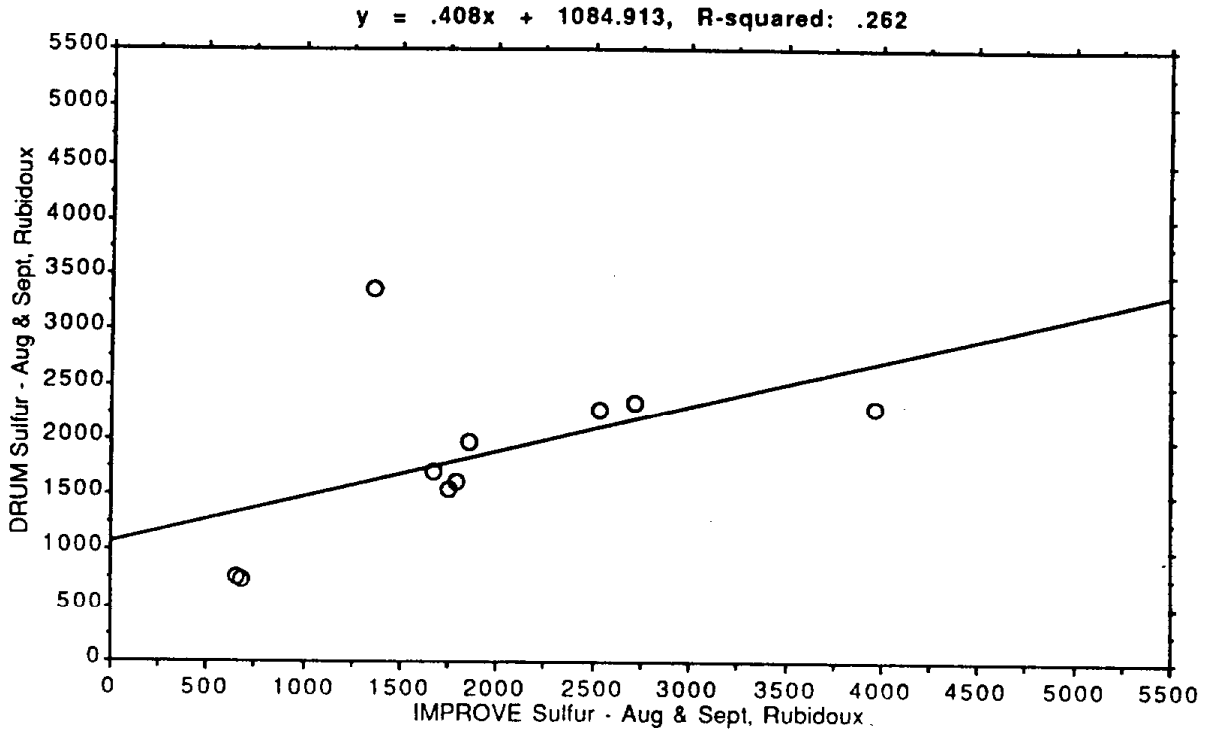
Claremont - August and September

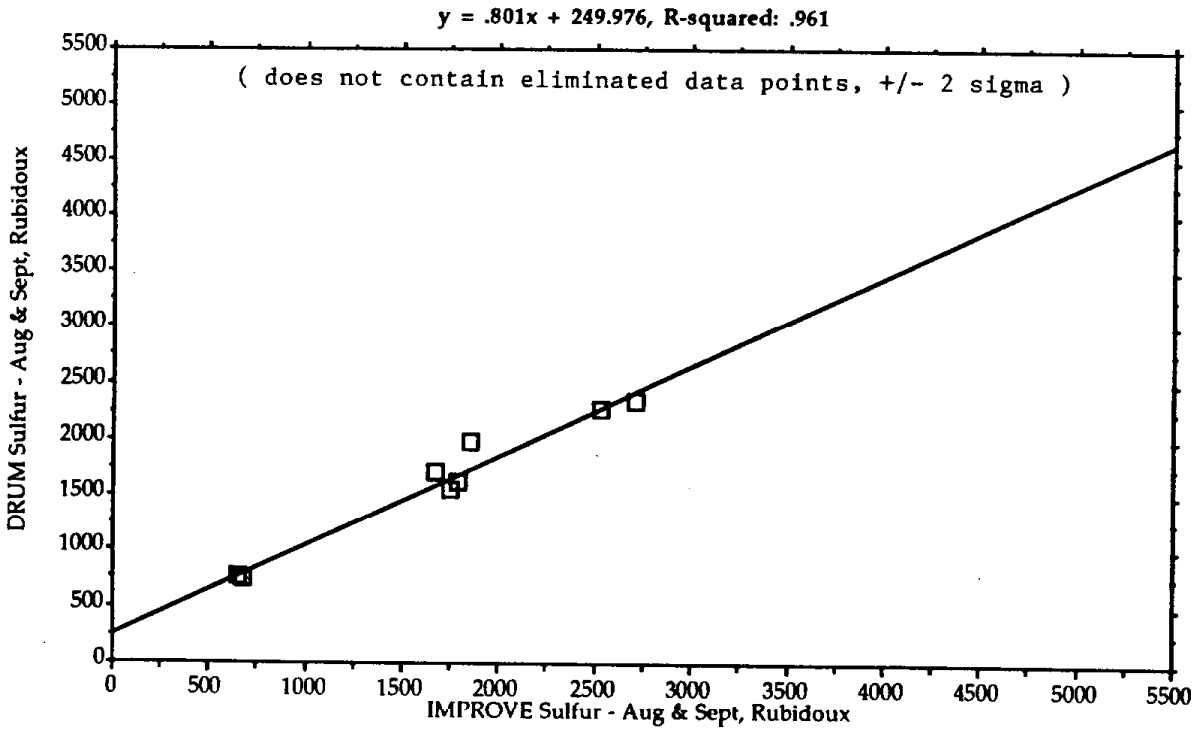
(units in nanograms/m**3)



Rubidoux - August and September

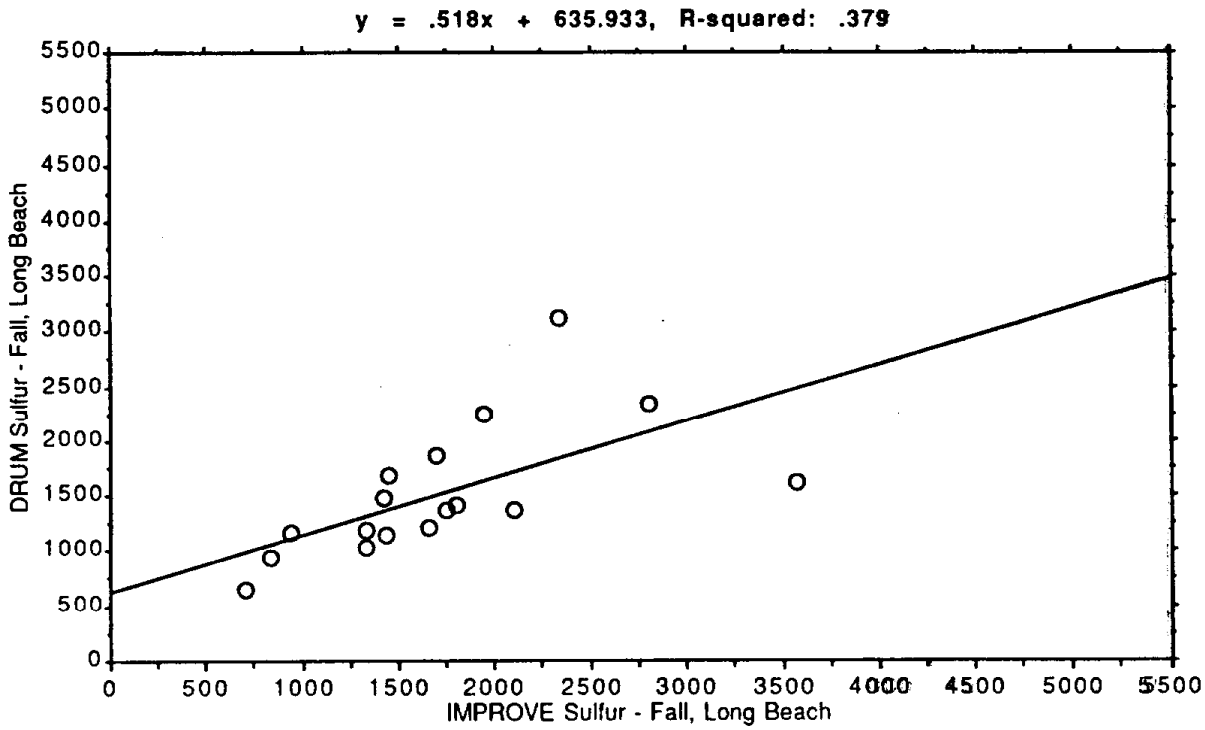
(units in nanograms/m**3)

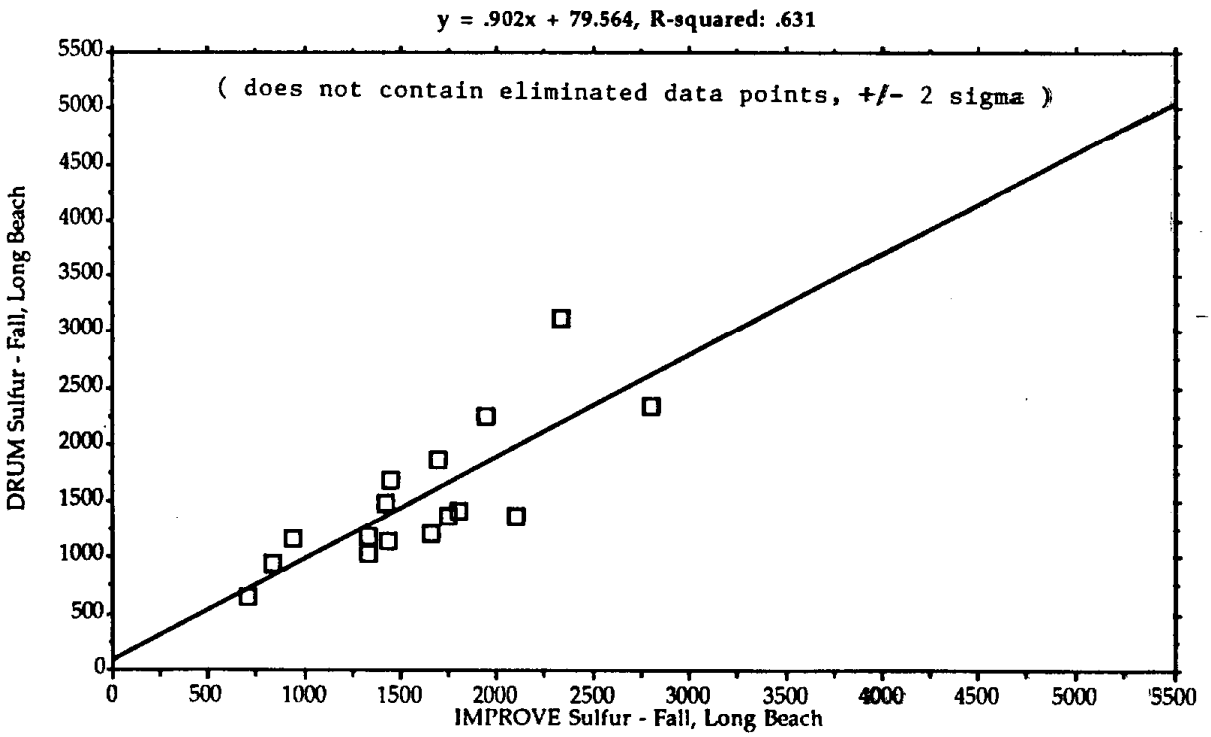


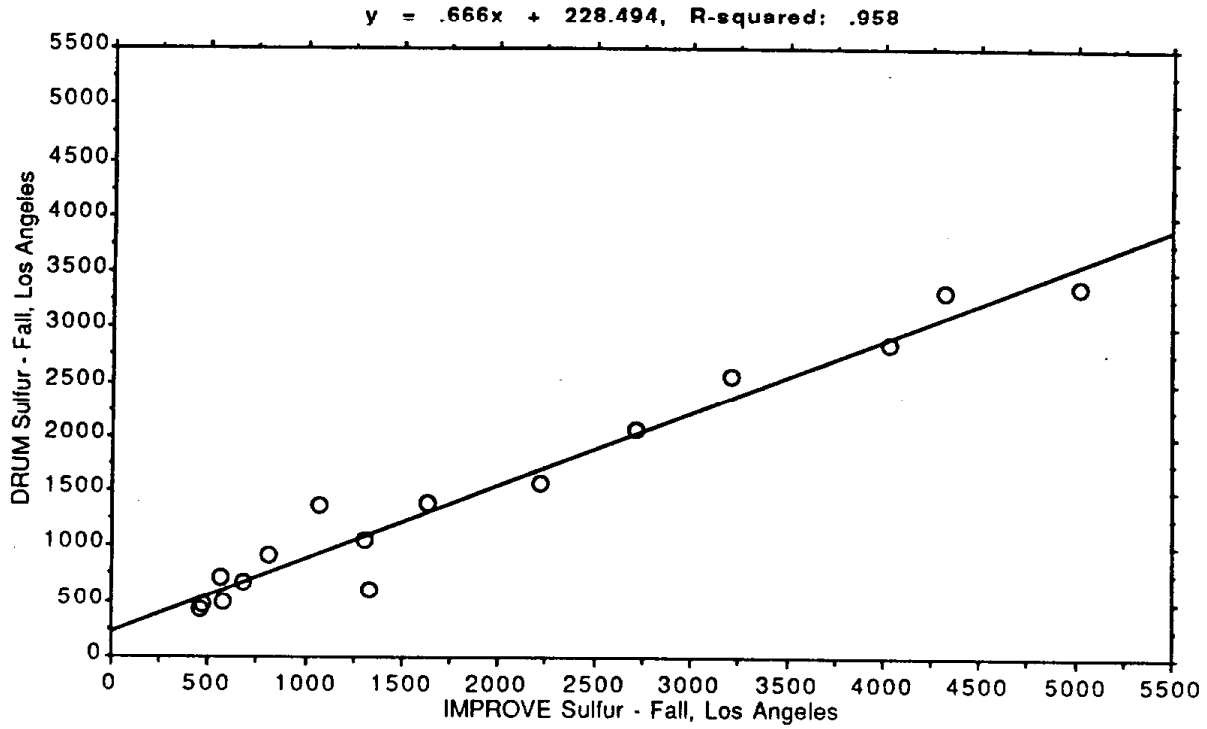
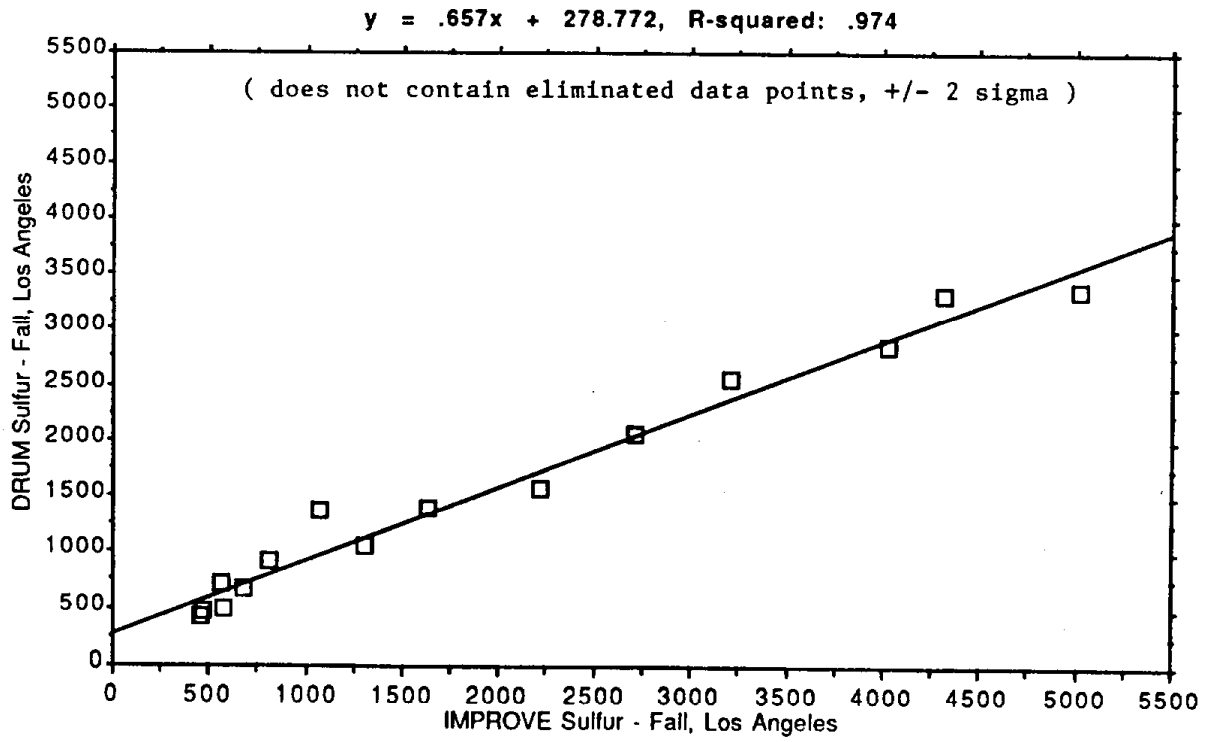


Long Beach - Fall

(units in nanograms/m**3)





Los Angeles - Fall

(units in nanograms/m**3)