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SOUTHERN CALIFORNIA AIR QUALITY STUDY (SCAQS)
DESCRIPTION OF MEASUREMENT ACTIVITIES
FINAL REPORT

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ABSTRACT

The goal of the Southern California Air Quality Study (SCAQS) was to develop a data base for the Los Angeles Basin that can be used to test, evaluate, and improve models for oxidants, PM_{10}, fine particles, toxic air contaminants, and acidic species. In addition, SCAQS data will be used to address questions regarding the emission, transport, transformation, and deposition of pollutants. SCAQS measurements were conducted in the Los Angeles Basin over 13 weeks in the summer and fall of 1987. Routine air quality and meteorology measurements were made continuously throughout the study period. On 17 selected intensive study days, measurements were made at several locations throughout the Basin of: reactive and toxic gases (including PAN, H_2O_2, speciated hydrocarbons, and carbonyls), aerosol chemistry, aerosol size distribution, selected aerosol chemical species as a function of size, and light scattering and extinction. LIDAR backscatter and aerosol and reactive gas measurements were also made by aircraft. Time lapse photographs were taken from two locations, upper air meteorological measurements were made from either six or eight sites six times per day, and nine tracer studies were performed.

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Several parts of this program summary were prepared by other staff members at STI. Hilary Main and Elaine Prins contributed to the technical report. Julie Conklin edited the text, and Maria Howard, Sue Hynek, Lisa Emmert, and Cheryl Cordtz prepared the figures and text under tight schedules. Dr. Ted Smith (consultant) prepared meteorological and air quality summaries to describe the SCAQS study period.

Many sponsors and participants provided information or comments for this program summary and contributed their time to review the text. The list of such people is too long to include here, but most of them are listed in Appendix A.

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DISCLAIMER

The statements and conclusions in this report are those of the contractors 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.

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LIST OF ACRONYMS AND ABBREVIATIONS

AGL	Above ground level
AIHL	Air & Industrial Hygiene Laboratory
AQML	SCE Air Quality Measurements Lab
AQMD	South Coast Air Quality Management District
ARB	California Air Resources Board
AREAL	Atmospheric Research and Exposure Assessment Laboratory (US EPA)
BRC	Biospherics Research Corp.
AV	AeroVironment, Inc.
B_{abs}	Light absorption coefficient
B_{scat}	Light scattering coefficient
CADMP	California Acid Deposition Monitoring Program
CIT	California Institute of Technology (Caltech)
CMU	Carnegie Mellon University, Pittsburgh, PA
CRC	Coordinating Research Council
DGA	Daniel Grosjean and Assoc., Ventura, CA
DMA	Differential mobility analyzer
DNPH	2,4-dinitrophenylhydrazine
DOAS	Differential Optical Absorption Spectroscopy
DP	Dew point
DRI	Desert Research Institute, Reno, NV
DRUM	U.C. Davis rotating universal multistage impactor
EAA	Electrical Aerosol Analyzer
EC	Elemental carbon
ECD	Electron capture detection
EC-GC	Electron capture gas chromatography
EMSI	Environmental Monitoring Services Inc., Camarillo, CA
EPA	Environmental Protection Agency
EPA-GKP	EPA Gas and Kinetics Branch, Research Triangle Park, NC
EPA-LV	EPA Las Vegas, Nevada
EPA-NSI	EPA Northrup Services Inc.
EPA-SSB	EPA Stationary Source Branch, Research Triangle Park, NC
EPRI	Electric Power Research Institute
ENSR	ENSR Corp., formerly ERT, Camarillo, CA
EWG	Emissions working group
FAST	Forward alpha scattering technique
Ford	Ford Motor Co., Dearborn, MI
FPD	Flame photometric detection
FTIR	Fourier Transform infrared spectroscopy
GC	Gas chromatography
GC-EC	Gas chromatography with electron capture detector
GC-MS	Gas chromatography, mass spectrometry
GMRL	General Motors Research Laboratories, Warren, MI
GGC	Global Geochemistry Corp., Canoga Park, CA
GM	General Motors, Warren, MI
HC	Hydrocarbon
HiVol	High volume sampler
HPLC	High performance liquid chromatography
IC	Ion chromatography
IIT	Illinois Institute of Technology, Chicago, IL

LIST OF ACRONYMS AND ABBREVIATIONS (cont.)

INAA	Instrumental neutron activation analysis
IPM	Integrating plate method
LADWP	Los Angeles Department of Water and Power
LAX	Los Angeles International Airport
LBL	Lawrence Berkeley Laboratories, Berkeley, CA
LEMSCO	Lockheed Environmental Monitoring Services Co.
LIDAR	Light detection and ranging
LORAN	LOng RAnge Navigation
LPI	Low pressure impactor
LT	Local time
MAG	Management advisory group
Met WG	Meteorology working group
MOUDI	Multi-orifice uniform deposit impactor
MSL	Mean sea level
MWG	Model working group
MVMA	Motor Vehicle Manufacturers Association
NBS	National Bureau of Standards (Now called National Institute of Standards and Technology)
NEA	NEA Inc., Beaverton, Oregon
NMHC	Non-methane hydrocarbon
NSI	Northrop Services, Inc.
NWS	National Weather Service
OC	Organic carbon
OEN	Operational Evaluation Network
OGC	Oregon Graduate Center, Beaverton, OR
OPC	Optical Particle Counter
PAH	Polycyclic aromotic hydrocarbons
PAN	Peroxyacetylnitrate
PDT	Pacific daylight time
PESA	Proton Elastic Scattering Analysis
PIXE	Particle induced X-ray emission
$PM_{2.5}$	Particle mass less than 2.5 μm
PM_{10}	Particle mass less than 10 μm
POHPAA	P-hydroxyphenyl acetic acid
PST	Pacific Standard Time
QA	Quality Assurance
QC	Quality Control
RH	Relative humidity
RPS	Richmond Photographic Services
RR	Radiance Research
RSC/SAC	Research Screening Committee/Science Advisory Committee
RTP	Research Triangle Park, NC
SCAQMD	South Coast Air Quality Management District
SCAQS	Southern Califonia Air Quality Study
SCE	Southern California Edison
SoCAB	South Coast Air Basin
SOP	Standard operating prodecure
SSI	Size Selective Inlet
STI	Sonoma Technology Inc.
SwRI	Southwest Research Institute

LIST OF ACRONYMS AND ABBREVIATIONS (cont.)

T	Temperature
TBS	T & B Systems
TFR	Transition Flow Reactor
THC	Total hydrocarbons
TSD	Technical Services Division of the SCAQMD
TT	Tracer Technologies
UCD	University of California, Davis, CA
UCLA	University of California, Los Angeles, CA
UCR	University of California, Riverside, CA
UDEN	University of Denver, Denver, CO
UI	University of Illinois, Champagne, IL
UM	University of Minnesota, Minneapolis, MN
Unisch	Unisearch Associates
UV	Ultraviolet
UV	University of Vienna
UW	University of Washington, Seattle, WA
WD	Wind Direction
WOGA	Western Oil & Gas Association
WS	Wind speed
XRF	X-ray fluorescence

Southern California Air Quality Study (SCAQS)
Description of Measurement Activities

1. INTRODUCTION

1.1 BACKGROUND AND ISSUES

In recent years in California, the mix and spatial distribution of pollutant emissions have changed substantially, and several new classes of pollutants have gained the public's attention. In the next few years, many difficult regulatory issues relating to these changes will confront the California Air Resources Board (ARB), the Environmental Protection Agency (EPA), and the South Coast Air Quality Management District (SCAQMD). Resolution of these issues and development of effective control strategies to ameliorate California's air quality problems requires a better understanding of the relationships among the sources, receptors, and effects of the pollutants in question. This understanding is developed through measurement, data analysis, and modeling in an iterative fashion. Design and evaluation of alternative control strategies must be done using models which embody our best understanding of the above relationships. As the first step in providing the tools necessary to make effective regulatory decisions, the Southern California Air Quality Study (SCAQS) was formulated.

Although similar problems are faced by most California air basins, the focus of the SCAQS is the South Coast Air Basin (SoCAB) since that is where the problems are most severe. Also, the SoCAB is one of the most well documented and intensively researched airsheds in the world. The study, including extensive measurements and data analysis, is intended to provide a data base for the development and evaluation of air quality models as well as an improved understanding of pollutant transport and transformation processes.

Since the scope of the study is quite ambitious, and since the results of the study will affect the actions of both government and industry, SCAQS was organized as a cooperative project. Coordinated sponsorship by both government and industry has helped to assure that funding is adequate to meet the goals of the study. In addition, because the study was performed in accordance with a protocol which was approved by the parties affected by the results, conflict about technical issues should be minimized during the regulatory process.

SCAQS was designed to meet the goals and objectives agreed upon by the sponsors. The program plan resulted from a two year open planning process which entailed extensive consultation with the modeling and measurement communities. The final design attempted to satisfy the needs expressed by the technical community to meet the stated objectives. Feedback from potential sponsoring agencies and data users regarding their relative priorities and levels of resources was used to refine the design. Lists of the people and organizations who were involved in the planning process and the field measurements are included in Appendix A. Extensive background information and

a detailed study design resulting from the planning process were published in a program plan by Blumenthal et al. (1987).

This report provides an introduction to the SCAQS measurements. It summarizes the background of the study and the study goals and objectives. Descriptions of the measurements made during the SCAQS and summaries of the meteorology and air quality on sampling days are presented. This report also provides a guide to other SCAQS documentation and data.

The SCAQS is a large multi-sponsor, multi-participant program. Ten sponsors provided over $10 MM for the planning and field measurements. The data analysis and modeling which result from the SCAQS will require several million dollars more. The field measurements involved over 50 technical groups and over 300 individuals. The field study was performed in the summer and fall of 1987. Routine measurements were made over 13 weeks, and extensive specialized measurements were made on 17 intensive study days. Data from the study started to become available for analysis and modeling in the summer of 1989. It is expected that the analysis and modeling process will continue for five years or more.

The SCAQS addresses the following pollutants and issues: ozone and the roles of nitrogen oxides (NO_x) and hydrocarbons in ozone formation, NO_2, PM_{10}, fine particles, visibility, toxic air contaminants, and atmospheric acidity. The first five items are addressed in depth, and adequate information should result from this project for the development and testing of descriptive and prognostic models. Understanding of the latter two items will be greatly improved by the SCAQS, but this study alone will not necessarily provide the information required to develop and test prognostic models.

The primary focus of the SCAQS field program was to provide measurements which related source emissions to ambient pollutant concentrations, including spatial and temporal distributions. SCAQS also included some source and effects related measurements. Once the archiving of the data is complete, extensive analyses of the data will be performed, and the data will be used to test and evaluate models which predict or describe the ambient distribution of pollutants. These models, in turn, will be used to develop and assess control strategies.

The development and use of models can be a controversial subject because the model results have direct implications in terms of emissions controls. To minimize controversy and to expedite the measurements, the SCAQS was designed to focus on measurements and data analysis but not directly to include modeling efforts. This modeling will be performed by the sponsors at a later date.

1.2 GOALS AND OBJECTIVES

The overall goals of the SCAQS are:

1. To develop a comprehensive and properly archived air quality and meteorological data base for the South Coast Air Basin which can be used to test, evaluate, and improve elements of air quality simulation models for oxidants, NO_2, PM_{10}, fine particles, visibility, toxic air contaminants, and acidic species. The data base should be adequate:

   > to test models proposed for the design of attainment strategies for PM_{10}, ozone, and NO_2; and

   > to clarify the hydrocarbon/NO_x/O_3 relationships so that ozone prediction models can be improved and new strategies to meet federal "reasonable efforts" requirements can be developed and tested;

2. To evaluate measurement methods for PM_{10}, fine particles, acidic species, and important nitrogen and carbon species; and

3. To enhance our understanding of the relationships between emissions and the spatial and temporal distributions of pollutants so that air quality simulation models and, ultimately, air quality management strategies can be improved.

The data obtained in the SCAQS should be of use in the development and testing of air quality models of known accuracy, precision, and validity which can be used to design and evaluate the effect of proposed attainment strategies for O_3, NO_x, PM_{10}, and selected toxic air contaminants.

To meet these goals, a set of technical objectives was defined. The SCAQS objectives are listed below.

Objective 1: Obtain a data base representative of the study area and sampling periods, with specified precision, accuracy, and validity, which can be used to develop, evaluate, and test episodic source and receptor models for O_3, NO_2, PM_{10}, fine particles, and atmospheric optical properties as well as annual average models for PM_{10}.

Objective 2: Identify the characteristics of emissions from specific sources or source types for use in receptor modeling of both gases and aerosols with emphasis on sources of organic and toxic emissions.

Objective 3: Assess the dependence of particle and O_3 formation and removal mechanisms upon selected meteorological and precursor variables.

Objective 4: Assess how the spatial and temporal distributions of particles, O_3, O_3 precursors, and NO_x depend upon emission height and selected meteorological variables.

Objective 5: Quantify the contributions of aerosols in an upwind source region and in an eastern basin receptor region to atmospheric acidity, mutagenicity, and visibility degradation.

Objective 6: Evaluate the validity of methods of measuring PM_{10}, fine particles, and precursor species in quantifying atmospheric constituents as they exist in the atmosphere during sampling.

The primary goal of SCAQS is to develop a data base for use by modelers. Although modeling is not a part of the SCAQS, the expected objectives of future modeling efforts include the following:

> Perform model sensitivity tests to identify the sensitivity of model results to uncertainties in the model input data obtained during SCAQS,

> Evaluate the physical and chemical bases for air quality models which describe photochemical and aerosol processes in the SoCAB,

> Test the performance of air quality models in predicting concentrations of PM_{10}, ozone, and important precursor and intermediate species as a function of space and time.

1.3 ELEMENTS OF THE SCAQS

SCAQS includes the following elements:

> project management and coordination;

> planning and preparation;

> Nitrogen and Carbonaceous Species Measurement Methods Comparison Studies in 1985 and 1986 respectively, designed to evaluate sampling techniques and analytical methods for inclusion in the SCAQS field study;

> a summer and a fall field measurement program and associated quality assurance activities;

> an emissions inventory assessment and enhancement for the study period;

> emissions characterization studies for important source types;

> data archiving and distribution;

> data analysis activities; and

> reports and presentations.

Complementary model development and evaluation are to be conducted separately, independent of SCAQS.

This report describes the summer and fall field measurement programs, the associated emissions characterization and inventory activities, the quality assurance, and the data archiving. The project management and planning are described in the Program Plan (Blumenthal et al. 1987). The measurement methods comparison studies were conducted in 1985 and 1986 and are described by Lawson (1988), Hering and Lawson et al. (1988), Lawson and Hering (1989), and Hering et al. (1989). The results of these studies were incorporated into the SCAQS measurement program. Other elements of the study are described in the Program Plan and in other reports discussed in Section 1.6.

1.4 COMPONENTS OF THE SCAQS FIELD STUDY

The SCAQS field study was conducted in the South Coast Air Basin during the summer and late fall of 1987. Eight different one-day to three-day periods were selected on the basis of air quality forecasts for intensive study. A total of 11 summer and six fall days of intensive study were performed.

The field study included simultaneous measurements of both ground-based (surface) and upper-air air quality and meteorological parameters. It also provided for specialized state-of-the-art measurements for specific pollutants and processes. Some measurements were performed explicitly for SCAQS, others were taken from existing monitoring networks. All are considered part of the SCAQS field study and are included in the data base. Some measurements were performed continuously throughout the study periods (nine weeks in summer and four weeks in fall), but most were concentrated on the intensive study days.

The field study included the following components:

> surface air quality and meteorology measurements from the existing network of air quality monitoring stations (called "C" sites);

> surface measurements of reactive gases, aerosol size distribution and chemistry, aerosol species size distributions, and toxic air contaminants at selected sites (called "B" sites), primarily on intensive study days;

> specialized measurements by universities and research institutions at selected research stations (called "A" sites);

- surface and upper-air meteorological measurements, including extensive upper-air measurements on intensive study days;
- airborne LIDAR and air quality measurements to characterize the three-dimensional pollutant distribution on intensive study days;
- tracer studies on selected intensive study days;
- a quality assurance program including independent systems and performance audits;
- assembly of all SCAQS data into a single SCAQS data archive; and,
- assembly and archiving of complementary data from existing data sources.

1.5 SPONSORS AND MANAGEMENT

The field study consisted of a number of closely coordinated projects funded by several co-sponsors including the ARB, the EPA, the SCAQMD, the Coordinating Research Council (CRC), the Electric Power Research Institute (EPRI), the Ford Motor Company, the General Motors Research Laboratories (GMRL), the Motor Vehicle Manufacturers Association (MVMA), Southern California Edison (SCE), and the Western Oil and Gas Association (WOGA).

The field study was coordinated by Sonoma Technology Inc. (STI) with funding from the ARB. STI prepared the program plan (Blumenthal et al. 1987) and the field study was conducted according to that plan. Four committees played critical roles in the design and management of the SCAQS. A Management Advisory Group (MAG) was made up of representatives of the sponsors and was headed by the ARB. All program design decisions were debated and approved by the MAG. Then the MAG divided the elements between the sponsors so that funding and sponsorship of each element was identified.

A Model Working Group (MWG) developed a priority list of the data needs of the modelers. A quantitative analysis of the needs of photochemical grid models for input and testing data also was undertaken by the MWG (Seinfeld et al. 1986, 1987). The study design was reviewed with the MWG and was revised until it was consistent with their needs. Subsequent to the field program a Data Analysis Advisory Group prepared analysis and modeling recommendations for the field data (Seinfeld et al. 1988; Seinfeld, 1989).

A Meteorological Working Group (Met WG) helped design the spatial and temporal distribution of meteorological measurements, planned the tracer studies, and prepared criteria and a protocol for forecasting and determining study days (Cassmassi and Zeldin, 1989; Cassmassi, 1989).

An Emissions Working Group (EWG) was set up on a long term basis to carry out a plan for preparing the SCAQS emissions inventory (Oliver et al. 1987; Mirabella and Nazemi, 1989). Since the emissions inventory work will continue long after the field study, this group was set up to operate in parallel with the rest of the planning process. A short term goal of the EWG was to obtain day-specific data during SCAQS to assure that any inventory developed after the fact would account for any unusual emission occurrences on the study days. The long term goal was to develop a gridded, quality assured emissions inventory for the South Coast Air Basin for the summer and fall of 1987 (Yotter and Wade, 1989; Shah and Heisler, 1989; Iwai, 1989; Dickson and Oliver, 1989; Ingalls, 1989; Oliver and Thompson, 1989). The EWG studies are consistent with the model input needs determined by the Model Working Group.

A program of the size and complexity of SCAQS requires a great deal of cooperation between the investigators and a thorough understanding on the part of each investigator of his/her role in the project. Protocols and standard operating procedures (SOPs) were developed before the project to define these roles. A management structure was designed for SCAQS which required each investigator to take full responsibility for his/her own measurements. The role of the management team was to coordinate the interfaces between investigators and to provide information and logistical support to the investigators.

The field management structure consisted of the following functions and groups:

Program Coordinator - The program was directed by the ARB Research Division with the support of STI. The ARB/STI coordinators were responsible for day-to-day coordination of the field operations. The coordinators maintained the field headquarters office where investigators could report the status of their activities and also obtain information and logistical support. On a daily basis, the coordinator obtained status reports from each investigator and weather/pollutant forecasts from the forecast team (see below). Intensive measurements were made on a forecast basis and the coordinators made daily go/no-go decisions based on the forecast and the logistical readiness of the investigators. The coordinators also documented the daily activities of the field study and made the daily decisions and forecasts available to the investigators.

Forecasting - Forecasts were prepared and updated daily by the SCAQMD in consultation with the ARB meteorology section and SCE. The summer forecasts were keyed to preset criteria for ozone and PM_{10}. To call an intensive study day, the ozone and PM_{10} concentrations in the Basin each had to be forecast to be in the upper 50th percentile of exceedance days or either one had to be forecast to exceed the 75th percentile. The fall forecasts were similar using PM_{10}, NO_2, and CO as the criteria (Cassmassi and Zeldin, 1989).

Field Operations Coordinator - Many of the major monitoring sites served several investigators. The "A" site operations were coordinated by

STI. The "B" site activities were managed by AeroVironment who set up the sites and allocated space and power to the investigators.

Quality Assurance - An independent quality assurance (QA) contractor (ENSR), with the support of ARB and the SCAQMD, was responsible for determining the precision, accuracy, and validity of the measurements and for assuring that these attributes were within acceptable limits. The QA coordinator reviewed the SOPs and performed systems audits. The ARB and SCAQMD performed performance audits. Discrepancies were resolved with the cooperation of the investigators. Some problems required special experiments and intercomparisons. (Fujita and Collins, 1989).

Data Management - The data management contractor (ENSR) was responsible for acquiring the data from each investigator, assuring that the uncertainties of the data were documented, assembling the data into a computer archive, performing simple consistency checks on the data, documenting the archive, and providing the archive to ARB for distribution to the public (Croes and Collins, 1989).

An organization chart showing the SCAQS management organizations and personnel is shown in Figure 1-1. The Acronyms are listed after the table of contents. Names of the sponsors, project participants, and working group members are included in Appendix A.

1.6 REPORTS OF SCAQS MEASUREMENTS

Over 50 groups participated in the SCAQS field study, and there will be dozens of reports describing the SCAQS measurements. An archive of SCAQS-related reports and papers will be maintained at ARB along with the data archive (see Section 9).

This report provides an overview of the field study and describes the measurements made. Other reports describe the Quality Assurance activities, the Data Archive, and the measurement sites and activities. A list of reports available to date is included in Appendix B.

The following reports provide an overview of the core elements of the field study.

Surface Measurement Sites

The "A" and "B" site locations, layouts, measurements, and operations are described in the final report by Chan and Durkee (1989) of AeroVironment.

M. Chan and K. Durkee. "Southern California Air Quality Study - "B" Site Operations". AeroVironment Inc., ARB Contract No. A5-196-32. Final Report, February, 1989.

The chemical analyses of the samples collected at the "A" and "B" sites are described in numerous reports listed in Appendix B.

11/28/89

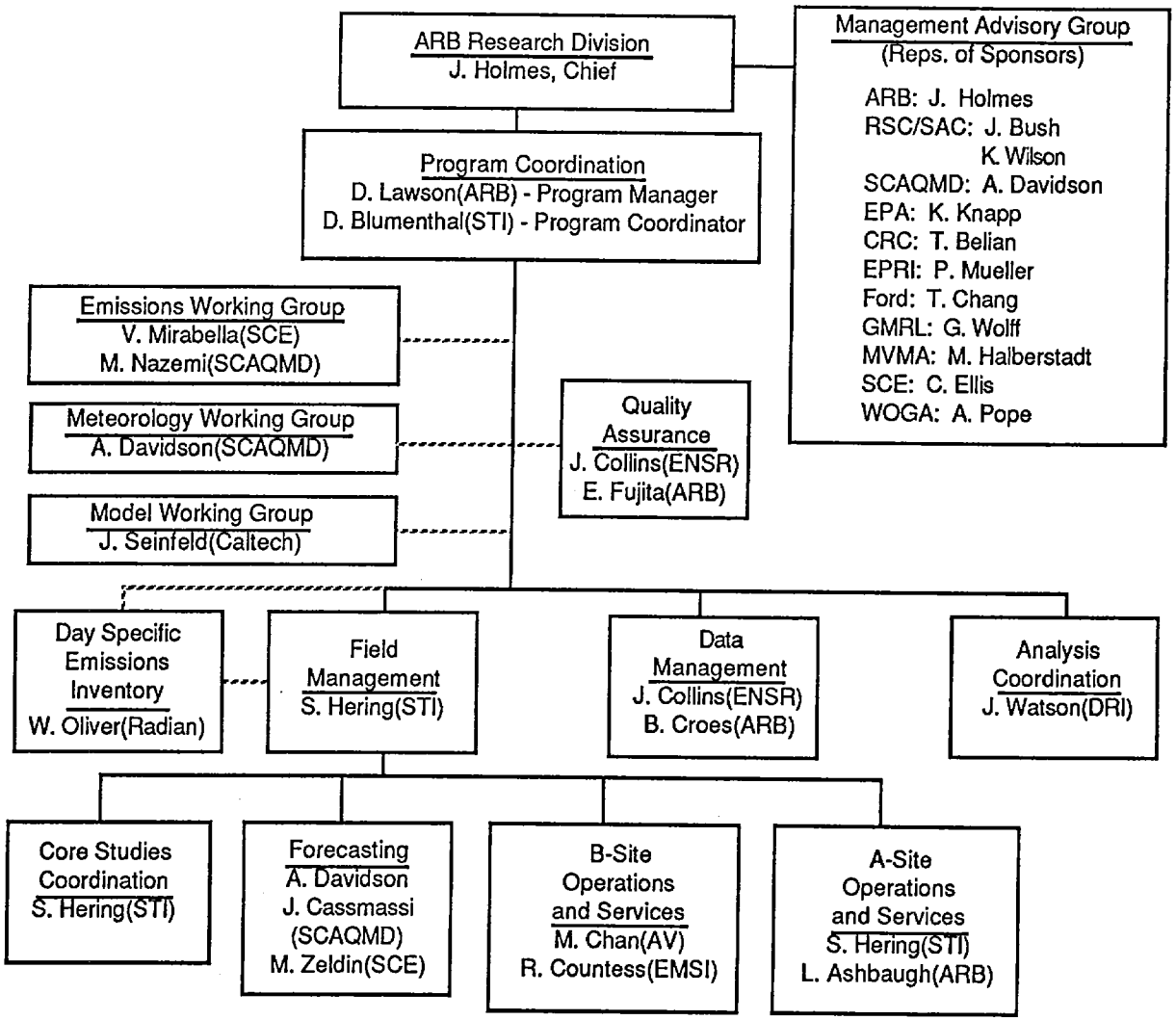


Figure 1-1. SCAQS Organization Chart

Aircraft Measurements

The aircraft measurements, flight patterns, and operational procedures are described in the following reports by Sonoma Technology Inc., University of Washington, and EPA at Las Vegas.

J.A. Anderson, J.C. Koos, R.G.M. Hammarstrand. "Summary of SCAQS Upper-Air Measurements Performed by the STI Aircraft." Sonoma Technology Inc. ARB Contract A6-098-32, Final Report, April 1989.

D.A. Hegg and P.V. Hobbs. "Cloud and Precipitation Scavenging Processes in the South Coast Air Basin." University of Washington. ARB Contract A4-143-32. Final Report, July, 1988. [Despite the title, this report describes the University of Washington aircraft measurement during SCAQS]

J.L. McElroy, D.H. Bundy, S.A. Edmonds, W.H. Hankins, S.M. Kroth. "Operations/Data and Report for 1987 SCAQS." Internal report, United States Environmental Protection Agency. Las Vegas, NV, September, 1988.

Upper-Air and Surface Meteorology Measurements

The upper-air and SCAQS surface meteorology measurement activities are described in the final report by Technical and Business Systems.

D.E. Lehrman, W.R. Knuth, N. Alexander, H. Giroux, L. Lehrman. "Southern California Air Quality Study Meteorological Support Program." Technical and Business Systems, ARB Contract A6-097-32. Final Report, October, 1988.

Tracer Measurements

The perfluorocarbon tracer experiments performed during SCAQS are described in detail in the following final reports prepared by Tracer Technologies.

Tracer Technologies. "Southern California Edison SCAQS Tracer Study." February 1989.
- Appendix A - Tracer Concentration Data
- Appendix B - Normalized Tracer Concentration Data
- Appendix C1 - SCAQS Tracer Data - Experiment 1
- Appendix C2 - SCAQS Tracer Data - Experiment 2
- Appendix C3 - SCAQS Tracer Data - Experiment 3
- Appendix C4 - SCAQS Tracer Data - Experiment 4
- Appendix C5 - SCAQS Airborne Tracer Data

Tracer Technologies. "Southern California Edison SCAQS Tracer Study Field Test Plan." June 1987.

Tracer Technologies. "Quality Assurance Plan for SCAQS Tracer Study." June 1987.

Tracer Technologies. "SCAQS Perfluorocarbon Tracer Data Analysis Plan." June 1989.

R.S. Horrell, M. Deem, P. Wyckoff, F. Shair and N. Crawford, "Ground release SF6 tracer experiments used to characterize transport and dispersion of atmospheric pollutants during the Southern California Air Quality Study of 1987" (1989) AWMA Paper No. 89-138.2. Presented at the 82nd Annual Meeting of the Air & Waste Management Association, Anaheim, California, 25-30 June 1989.

Quality Assurance

Extensive QA activities were performed during SCAQS. The accuracy, precision, and validity of the data were determined through these activities. The QA activities and results are described in a report prepared by ENSR and ARB. See Section 8 of this report for more details.

J. Collins and E. Fujita. "Quality Assurance for the Southern California Air Quality Study." ENSR Corporation, ARB Contract no. A6-122-32. Draft Report, May, 1989.

Data Archive

The SCAQS data have been collected into a central archive. This archive includes the data base on magnetic media and the data reports and summaries from the participants. The data archive and data access procedures will be described in the SCAQS Data Base Users Guide being prepared by ENSR. This guide will also include selected data summaries to help investigators focus on those time periods of particular interest. See Section 9 of this report for more details.

2. SYNOPSIS OF THE SCAQS FIELD PROGRAM AND INTENSIVE STUDY DAYS

2.1 STUDY REGION

The SCAQS region included the area within the jurisdiction of the SCAQMD, the upwind portions of Ventura County, and adjacent offshore areas. The jurisdiction of the SCAQMD includes Los Angeles and Riverside Counties and adjoining portions of Orange and San Bernardino Counties. The area includes all of the Los Angeles Basin, and is bounded by mountains to the north and east, and by the ocean to the south and west.

2.2 SCAQS STUDY PERIODS AND THEIR RATIONALE

The dates of the SCAQS field program were as follows:

Summer SCAQS: June 10 - July 23, 1987 and
August 18 - September 4, 1987;

Fall SCAQS: November 9 - November 18, 1987 and
December 2 - December 12, 1987.

Nine weeks of sampling were performed in the summer and four weeks in the fall. During these periods, several one- to three-day episodes were selected for intensive sampling for a total of 17 intensive sampling days.

The summer sampling period was chosen to study conditions of high oxidant and particulate matter. Typically, June is a period of coastal fogs and high relative humidities, conducive to heterogeneous aerosol formation processes, while July through late August is typified by high oxidant and photochemical aerosol formation. The summer study period began on June 10 and was originally scheduled to conclude on July 25. However, unseasonably cool temperatures aloft resulted in generally clean conditions; thus the summer study was suspended after July 23, pending a change in the weather conditions. Sampling was resumed on August 18.

The fall sampling period was chosen to study stagnant conditions which result in episodes of high nitrogen dioxide, carbon monoxide or particle loadings. The low inversions and cool temperatures during the fall tend to favor the accumulation of primary pollutants. The fall study extended from November 9 through November 18 and December 2 through December 12, 1987, with no sampling performed during the week of November 20th.

2.3 TYPES OF SCAQS SITES AND MEASUREMENTS

The SCAQS field program included surface air quality measurements at a variety of sites, surface and upper-air meteorology measurements, upper level air quality measurements, studies of pollutant transport, emissions

evaluation, and a quality assurance program. These components of the field program and the sites used for each type of measurement are enumerated below.

Surface Air Quality Measurements

These were conducted at four types of sites:

> "C" sites, consisting of 36 existing routine air quality monitoring stations of the SCAQMD, the Ventura County Air Pollution Control District, and other agencies;

> "B" sites, consisting of a network of nine summer and six fall sites for uninterrupted sampling of aerosols and gases during intensive study days (several of these sites were collocated with "C" sites);

> "B+" sites, consisting of three summer and two fall "B" sites selected for aerosol and chemical species size distribution measurements; and

> "A" sites, consisting of two summer and one fall "B+" sites and for specialized measurements and research efforts by cooperating investigators.

Surface and Upper-air Meteorological Observations

Surface meteorological data were obtained from:

> Ventura AQMD sites, surface observations from "B" sites, "C" sites, National Weather Service stations, California Irrigation Management Service sites and Mineral Management Services buoy sites;

> temporary meteorological stations operated during SCAQS (four summer sites, three fall sites); and

> ultraviolet radiation intensity at "B+" sites and at Mt. Wilson in Los Angeles during the summer.

Upper-air wind and meteorological data were obtained from:

> rawinsondes and Airsondes operated on all intensive days (eight summer sites, six fall sites);

> Doppler acoustic sounder (one site);

> aircraft measurements of temperature and dew point aloft (intensive sampling days only); and

- daily NWS soundings at Lompoc (Vandenberg Air Force Base) and San Diego (Montgomery Airport) and military soundings at San Nicolas Island and Pt. Mugu Naval Air Stations, and Edwards Air Force Base.

Upper Level Air Quality

On intensive study days, air quality parameters aloft were obtained from:

- aircraft measurements of pollutant gas concentrations, particle scattering, aerosol chemistry and particle size distributions; and

- aircraft based LIDAR measurements of aerosol backscatter.

Measurements of Pollutant Transport

Transport was assessed by:

- time-lapse and still photography for each intensive sampling day; and

- tracer studies on selected intensive sampling days.

Emissions Evaluation

Pollutant sources were assessed by:

- surveys of day-specific emissions from major sources for each intensive sampling day;

- vehicle emissions measurements in a parking garage and a tunnel; and

- source inventory updates based on literature data and source surveys.

Quality Assurance Program

Aspects of the quality assurance program include:

- review of standard operating procedures prior to the study;

- systems evaluations; and

- on-site performance audits.

The above field study components are discussed in detail in Chapters 3 - 8 of this report, followed by a discussion of data archiving.

2.4 MEASUREMENT SITE LOCATIONS

The primary SCAQS sampling sites for the summer and fall study periods are shown in Figure 2-1. The sites (not including "C" sites) used in the summer and fall are listed in Table 2-1. For the summer intensive sampling days, there were nine "B", "B+", and "A" sites in the ground network, six rawinsonde sites, and two Airsonde sites. Ground sites provided uninterrupted continuous aerosol and gas sampling throughout the study periods. The rawinsonde and Airsonde sites provided six upper-air soundings per site on each intensive sampling day. Two aircraft measured air quality parameters during the first phase of the summer study and one was used during the second phase. In the fall, six ground sites, five rawinsondes, one Airsonde, one air quality aircraft, and the LIDAR aircraft were operated.

The "A" and "B+" sites were collocated with "B" sites, and many of the "B" sites were collocated with SCAQMD monitoring stations, as indicated in Table 2-1. The "B", "B+" and "A" sites were operated specifically for SCAQS. Nine "B" sites and two "A" sites were operated during the summer study. The "B" sites were located at Anaheim, Azusa, Burbank, Hawthorne, San Nicolas Island, Los Angeles, Rubidoux, Long Beach and Claremont. The two "A" sites were at Long Beach and Claremont. The fall study "B" site network consisted of Anaheim, Burbank, Hawthorne, Long Beach, Los Angeles, and Rubidoux, with one "A" site at Long Beach.

Of the nine summer "B" sites, seven (Hawthorne, Long Beach, Anaheim, Los Angeles, Azusa, Claremont and Rubidoux) were chosen to lie along typical air trajectories. The Burbank site was selected to represent the San Fernando Valley. The San Nicolas Island site was chosen to provide upwind, background values. The two "A" sites, Long Beach and Claremont, were chosen to represent, respectively, an upwind coastal source area and a downwind receptor area.

Since the fall study period was designed to look at stagnation conditions, most sites were concentrated along the source-rich coastal regions. The single "A" site was located in the refinery-rich region of Long Beach. Burbank was included to represent the San Fernando Valley because of historically high reported values for elemental carbon and carbon monoxide at that site. Rubidoux was included because of high PM_{10} readings at that site.

The Anaheim, Azusa, Burbank, Hawthorne, Los Angeles, and Rubidoux sites were collocated with SCAQMD monitoring sites. The Claremont site was located in an unused parking lot at Claremont McKenna College, and was bordered by a lightly used campus street to the north, athletic fields to the south and east, and campus buildings to the west. The Long Beach site was located at Long Beach City College, 100 meters from the nearest street. It was bordered by a track field to the north and a McDonnell-Douglas aircraft assembly plant to the south. The San Nicolas Island site was located on the naval station, 20 m east of the island's meteorological station, 1 km from the northeast shore. Detailed descriptions of the sites are given in the SCAQS Ground Site Operations Report prepared by AeroVironment (Chan and Durkee, 1989).

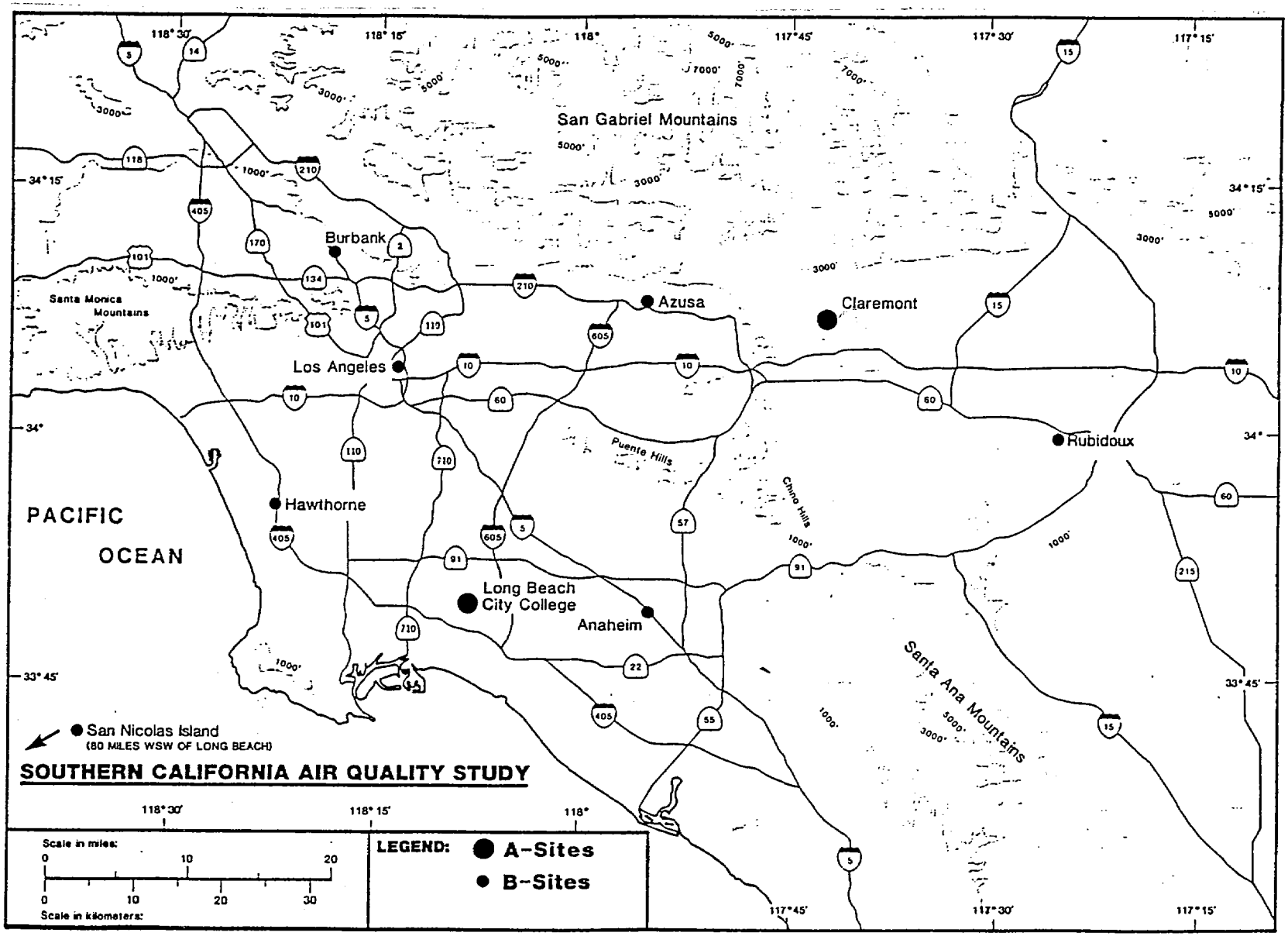


Figure 2-1. Primary SCAQS Sampling Sites. (Site locations are given in Table 2-1.)

Table 2-1. Primary SCAQS Sampling Sites.

(8/20/89)

"B", "B+", and "A" Surface Air Quality Sites *

Abbrv.	Site	Location	Summer			Fall		
			"B" Site	"B+" Site	"A" Site	"B" Site	"B+" Site	"A" Site
LBCC	Long Beach	Long Beach City College	√	√	√	√	√	√
CLAR	Claremont	Claremont McKenna College	√	√	√			
RIVR	Rubidoux	SCAQMD Monitoring Station	√	√		√		
CELA	Los Angeles	SCAQMD Monitoring Station	√			√	√	
HAWT	Hawthorne	SCAQMD Monitoring Station	√			√		
ANAH	Anaheim	SCAQMD Monitoring Station	√			√		
BURK	Burbank	SCAQMD Monitoring Station	√			√		
AZUS	Azusa	SCAQMD Monitoring Station	√					
SNI	San Nicolas Is.	Naval Station	√					

Upper Air Meteorology Sites

Abbrv.	Site	Location	Summer		Fall	
			Rawins	Airsns	Rawins	Airsns
BUR	Burbank	Burbank Airport	√		√	
EMUA	El Monte	Air Resources Board	√		√	
LBCC	Long Beach	Long Beach City College	√		√	
LMUA	Loyola Marymount	Loyola Marymount Univ.	√		√	
ONT	Ontario	Ontario Airport	√		√	
RAL	Riverside	Riverside Airport	√			
GLUA	Glendora	Adj. to SCAQMD AQ site		√		
YLUA	Yorba Linda †	Yorba LInda Park		√		
SFUA	Sante Fe Springs †	SCE Maintenance Yard		√		
FUUA	Fullerton					√

Surface Meteorological Stations

Abbrv.	Site	Location	Summer	Fall
CA	Catalina Is.	Catalina Airport	√	√
KH	Kellogg Hill	San Dimas	√	√
PV	Palos Verdes Pen.	San Pedro Hill	√	√
HF	Henninger Flats	N. of Pasadena	√	

* See geographical locations on map of Figure 2.1.

† Airsondes operated at Santa Fe Springs instead of Yorba Linda on SCE tracer study days (6/25, 8/27, 8/28)

2.5. INTENSIVE SAMPLING DAY DEFINITION AND SELECTION CRITERIA

2.5.1 Intensive Sampling - Definition

The SCAQS was designed to provide the necessary data for testing, evaluating and improving elements of air quality simulation models and for addressing specific technical questions regarding pollutant emission, transport, transformation, and removal. As such, the study emphasized the simultaneous collection of meteorological and air quality data on the ground and aloft. It also included specialized state-of-the-art measurements for assessing specific pollutants and processes. Since such sampling is labor intensive and expensive, many of the measurements were made only on selected intensive sampling days. These days were selected on a forecast basis, based on their expected pollutant concentrations. The selection criteria are described in Section 2.5.2.

Intensive sampling was conducted on 17 selected days to obtain time-resolved, three-dimensional coverage of the Basin during episodes of poor air quality. Intensive sampling began at midnight PST, and continued for 24, 48 or 72 hours. Measurements conducted only on these days include:

> around-the-clock measurements of aerosol and selected gas species at "A", "B", and "B+" sites;

> aerosol species size distributions at "B+" sites;

> upper-air measurements of winds and temperatures;

> three-dimensional measurements of pollutant concentrations using the air quality and LIDAR aircraft;

> photography and tracer studies for assessing transport; and

> surveys of day-specific emission from major sources.

The study efforts were coordinated with the routine air quality and meteorological monitoring of the SCAQMD and the Ventura County Air Pollution Control District in the Basin.

2.5.2 Selection Criteria Intensive Sampling Days

Most intensive sampling periods were selected on the basis of air quality forecasts and logistical readiness. A forecasting team, consisting of meteorologists from the SCAQMD, SCE, and the ARB issued daily outlooks for the following 48 hour period. The SCAQS field manager provided input on experimental readiness. Tentative decisions were posted 33 hours in advance, with the final decision posted nine hours in advance of the scheduled commencement of sampling.

The selection criteria for summer intensive study days were based on the predicted ozone and PM_{10} (particle mass less than 10 μm diameter).

Categories of low, medium and high were established for the predicted hourly maximum ozone and 24 hour averaged PM_{10}. The categories corresponded to the lower 50th percentile, 50th to 75th percentile and greater than 75th percentile concentration levels as determined from the historical record for June and July 1984 - 1986 for O_3 and May - August, 1985 for PM_{10}. Concentrations for each are shown in Table 2-2.

Table 2-2. Summer Air Quality Categories

Parameter (Units)	High	Medium	Low
O3, 1-hr maximum (pphm)	$\geq$ 24	19 - 23	< 19
PM_{10}, 24-hr average ($\mu g/m^3$)	$\geq$105	88- 104	< 88

To be placed in the moderate or high ozone category, predicted concentrations had to reach the indicated level at three or more of the 30 SCAQMD ozone stations. For PM_{10}, predicted concentrations had to reach the indicated levels at three SCAQMD stations. Two- or three-day episodes with either ozone or PM_{10} in the high category, or both ozone or PM_{10} in the moderate or low category were considered acceptable for intensive sampling.

The fall study period air quality selection criteria were based on stagnation conditions conducive to the build-up of NO_2, PM_{10} and CO. Forecasts employed four categories characterizing stagnation: none, light, moderate and high. Forecasts were based on meteorological parameters rather than pollutant concentrations. Meteorological criteria for the condition of high stagnation are shown in Table 2-3.

These conditions were chosen to represent the transition between offshore to onshore gradients, which are generally conducive to high NO_2 and high PM_{10}. They are typically observed in the mid-to-late fall when an upper-level ridge of high pressure is located over the west coast. The offshore surface pressure gradients generally promote low-level or surface inversions. The onshore tendency in the 24-hour change of the pressure gradient field indicates a relaxation in the offshore forcing, or a dying Santa Ana condition. This sequence defines a relatively dry, stable period conducive to high NO_2 concentrations immediately followed by a period of stable marine influence and high PM_{10} concentrations. If all four of the conditions in Table 2-3 were met, then conditions were classified as "high" stagnation. If only some conditions were met, then the forecast was issued for "moderate" or "low" stagnation. If none were met, then the forecast was for no stagnation. Conditions in the moderate or high categories for two or more consecutive days were considered acceptable for intensive sampling.

Table 2-3. Fall Criteria for High Stagnation Category

Parameter	Value
1. Height at 500 mb[1]	500 mb height > 5780 m
2. Morning inversion base height	Inversion base < 305 m (1000 ft.)
3. Pressure gradient sum[2] (SumPG)	- 20.0 mb ≤ SumPG ≤ 0.0 mb
4. 24 hour change in pressure gradient sum	Δ SumPG > 0.0 mb

1 Refers to the elevation at which ambient pressure is 500 mb. Data are taken from the upper-air sounding conducted each morning at Vandenberg Air Force Base (Lompoc).

2 Pressure gradient sum is (SAN - LAS) + (LGB - DAG) + (SBD - VCV) where SAN, LAS, LGB, DAG, SBD and VCV are surface pressure observations at San Diego, Las Vegas, Long Beach, Daggett, San Bernardino, and Victorville at 0700 PST (1500 GMT) respectively. A positive value indicates onshore flow.

2.6 SYNOPSIS OF MEASUREMENTS, AIR QUALITY, AND METEOROLOGY ON INTENSIVE STUDY DAYS

2.6.1 Measurement Summary for Intensive Study Days

The SCAQS intensive study dates and the corresponding measurements on those days are given in Table 2-4. During the summer there were eleven intensive sampling days grouped into five episodes: one 24-hour episode, two 48-hour episodes, and two 72-hour episodes. All but one intensive sampling day were weekdays. During the fall there were six intensive sampling days, grouped in three episodes of 24, 48, and 72 hours in duration. All of the fall study period sampling days were weekdays.

The extent of measurements on each of the intensive days is also indicated in Table 2-4. During the summer there were nine "B" sites, six rawinsonde sites, two Airsonde sites and four SCAQS surface wind sites operating on each intensive study day. Additionally, an ultraviolet photometer was located on Mt. Wilson. In the fall there were six "B" sites, five rawinsonde sites, one Airsonde site, and three meteorological stations. There were three aircraft in the study, one each operated by Sonoma Technology Inc., the University of Washington and EPA Las Vegas. The individual flights for each are indicated in Table 2-4, including the approximate time of day (morning, midday or afternoon). Selected intensive study days were chosen

Table 2-4. Summary of Measurements on Intensive Study Days.

(08/19/89)

	Date	(Julian)	Wkdy	Grnd Ntwk	Surf. Met	UV@MW	Photo.	Rawins	Airsns	STI Arcft				UW Arcft			EPA Arcft			Tracers		Day Spec.
	1987			(B, B+ & A)						am	md	pm	#	am	pm	#	am	pm	#	SCE	CIT	Emissions
S1	6/19	(170)	Fri	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	√	3	m	√	1	-	√	1	-	-	√
S2	6/24	(175)	Wed	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	√	3	√	-	1	-	-	0	-	-	√
S3	6/25	(176)	Thu	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	√	3	√	√	2	√	√	2	√	-	√
S4	7/13	(194)	Mon	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	√	3	√	-	1	√	√	2	-	-	√
S5	7/14	(195)	Tue	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	√	3	√	√	2	√	√	2	-	-	√
S6	7/15	(196)	Wed	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	m	m	1	√	√	2	√	√	2	-	√	√
S7	8/27	(239)	Thu	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	√	3	-	-	-	m	m	0	-	-	√
S8	8/28	(240)	Fri	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	m	m	1	-	-	-	m	m	0	√	-	√
S9	8/29	(241)	Sat	9 sites	4 sites	√	3 sites	6 sites	2 sites	m	m	m	0	-	-	-	m	m	0	-	-	√
S10	9/2	(245)	Wed	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	√	3	-	-	-	m	m	0	-	-	√
S11	9/3	(246)	Thu	9 sites	4 sites	√	3 sites	6 sites	2 sites	√	√	m	2	-	-	-	m	m	0	-	√	√
F1	11/11	(315)	Wed	6 sites	3 sites	-	3 sites	5 sites	1 site	√	-	√	2	-	-	-	-	-	0	√	-	√
F2	11/12	(316)	Thu	6 sites	3 sites	-	3 sites	5 sites	1 site	√	-	√	2	-	-	-	-	-	0	√	√	√
F3	11/13	(317)	Fri	6 sites	3 sites	-	3 sites	5 sites	1 site	√	-	√	2	-	-	-	-	-	0	-	-	√
F4	12/3	(337)	Thu	6 sites	3 sites	-	3 sites	5 sites	1 site	√	-	√	2	-	-	-	√	√	2	-	-	√
F5	12/10	(344)	Thu	6 sites	3 sites	-	3 sites	5 sites	1 site	√	-	√	2	-	-	-	√	m	1	√	√	√
F6	12/11	(345)	Fri	6 sites	3 sites	-	3 sites	5 sites	1 site	√	-	√	2	-	-	-	m	m	0	-	-	√

Code:

√ = data collected (flights completed or tracer released)

m = missing.

- = no measurement planned

am = morning

md = midday

pm = afternoon

for tracer studies conducted by both Caltech and Southern California Edison (with Tracer Technologies Inc.), as shown. Inventories of day-specific emissions were conducted for each intensive study day for both the summer and fall.

2.6.2 Air Quality and Meteorology Summary for Intensive Study Days

The 850 mb temperature tends to be a good predictor of the air quality in the South Coast Air Basin. High 850 mb temperatures are associated with high pressure systems, subsidence, and poor ventilation in the Basin. Typically, 850 mb temperatures higher than about 20°C in the summer and 15°C in the fall are necessary for an air pollution episode.

Figure 2-2 presents an overview of the meteorology and air quality for the summer SCAQS study periods. The daily morning 850 mb temperature at Loyola Marymount College (LMUA) and the daily maximum O_3 at the SCAQMD Upland monitoring station (near Claremont on Figure 2-1) are plotted for June through September. The study periods are indicated by the dashed line at the bottom of the ozone plot. The peaks in the dashed line indicate intensive study days. The Upland site is typically among the sites with the highest ozone in the Basin. For comparison purposes, three-day running averages of the LMUA 850 mb temperature and the Upland ozone maxima for the years 1978-1986 are also plotted. It is clear that the July portion of the study period was much cooler and cleaner than normal. For this reason the study was re-activated at the end of August when the weather was more like the norm. The average 850 mb temperature for July 1987 was 17.1°C compared to 21.1°C for the 1978-1986 period. The average maximum ozone at Upland for July 1987 was 13.8 pphm compared to 19.0 pphm for the 1978-1986 period.

Figure 2-3 is a similar plot for the fall 1987 sampling period with the Basin maximum NO_2 plotted in place of the ozone. The fall period was much more similar to the long term averages.

For both the summer and fall, the SCAQS forecasting procedure (Cassmassi and Zeldin, 1989) worked quite well and the intensive study days coincided with the days of highest pollutant concentrations during the periods of the field studies.

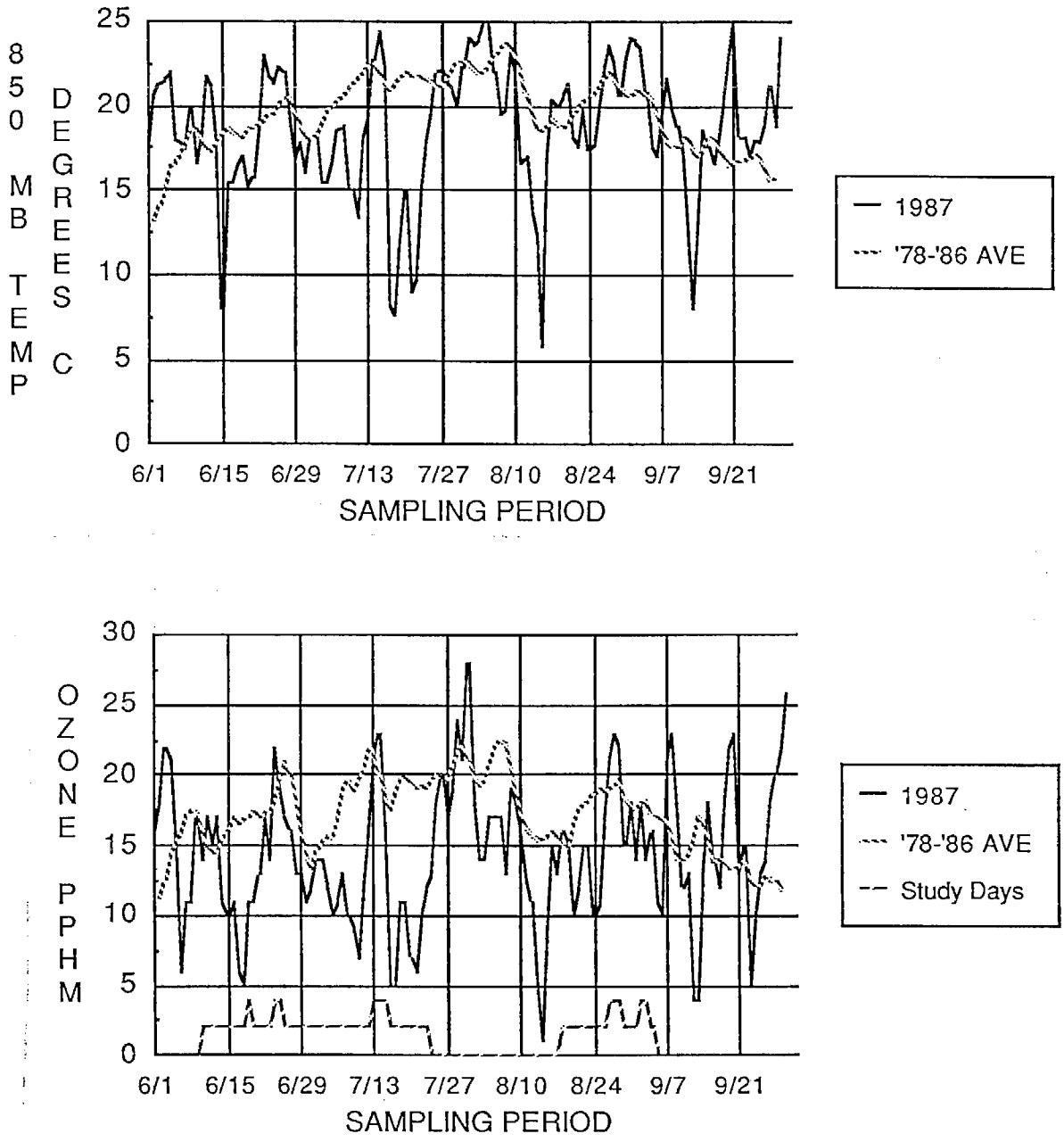


Figure 2-2. Summer SCAQS Period Meteorology and Air Quality. Upland daily maximum ozone and Loyola Marymount morning 850 mb temperature data for the summer SCAQS measurement periods and corresponding three-day running averages for 1978-86. (Intensive study days are shown by the spikes in the dashed line on the ozone plot.)

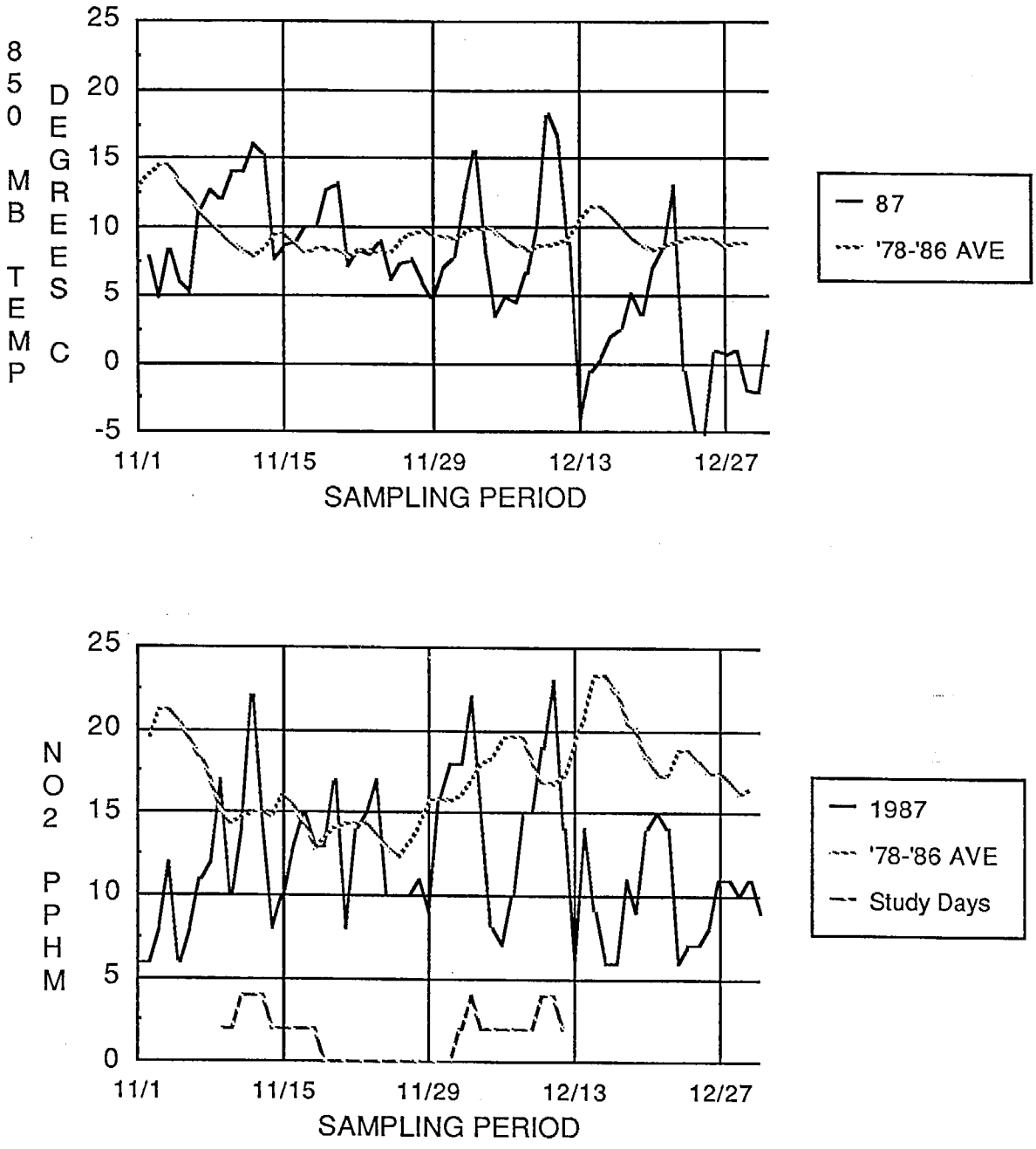


Figure 2-3. Fall SCAQS Period Meteorology and Air Quality. Basin daily maximum NO_2 and Loyola Marymount morning 850 mb temperature data for the fall SCAQS measurement periods and corresponding three-day running averages for 1978-86. (Intensive study days are shown by the spikes in the dashed line on the NO_2 plot.)

3. GROUND BASED AIR QUALITY MEASUREMENTS

3.1 "C" SITE MEASUREMENTS

The "C" sites included 31 monitoring stations operated by the SCAQMD, three stations operated by Ventura County Air Pollution Control District, one site operated by a Federal agency, and one site operated by Southern California Edison Co. Most of these sites are shown in Figure 3-1. Parameters from each site which reported pollutant concentrations are listed on Table 3-1.

3.2 "B" SITE MEASUREMENTS

3.2.1 Overview of "B" Site Measurement Parameters

Table 3-2 summarizes parameters measured at the "B" and "B+" sites, and gives the frequency of measurement. These parameters include speciation of reactive gases and detailed physical and chemical characterization of aerosols in addition to parameters routinely measured at "C" sites, as described below. Table 3-2 also indicates sites used for specialized measurements.

As shown in Table 3-2, a set of core measurements was replicated at all "B" sites. These included O_3, CO, NO, NO_2, winds, temperature, dew point and particle scattering, which were recorded hourly throughout the study period. Additionally, every "B" site had a SCAQS sampler (described below), a carbonyl sampler, a C1-C12 hydrocarbon canister collection system and PM_{10} high volume samplers (HiVols) which were operated on intensive sampling days. Sulfur dioxide monitors were operated at all but the San Nicolas Island "B" site. PAN was measured at all "B" sites during the June-July intensive sampling days, but was not measured at San Nicolas Island and Hawthorne during the August-September intensive sampling days, and not at Rubidoux during the November-December intensive sampling days.

Some measurements were restricted to a few "B" sites. Hydrogen peroxide was measured only during the summer study period, and only at the Claremont, Long Beach, downtown Los Angeles, and Rubidoux sites. Toxics samplers were deployed at these same four sites in the summer, and at Long Beach and downtown Los Angeles in the fall. Solar ultraviolet radiation flux was measured at Long Beach, Los Angeles, Claremont, Rubidoux and Mt. Wilson during the summer and at Long Beach and Los Angeles in the fall. It was also recorded aboard the STI aircraft.

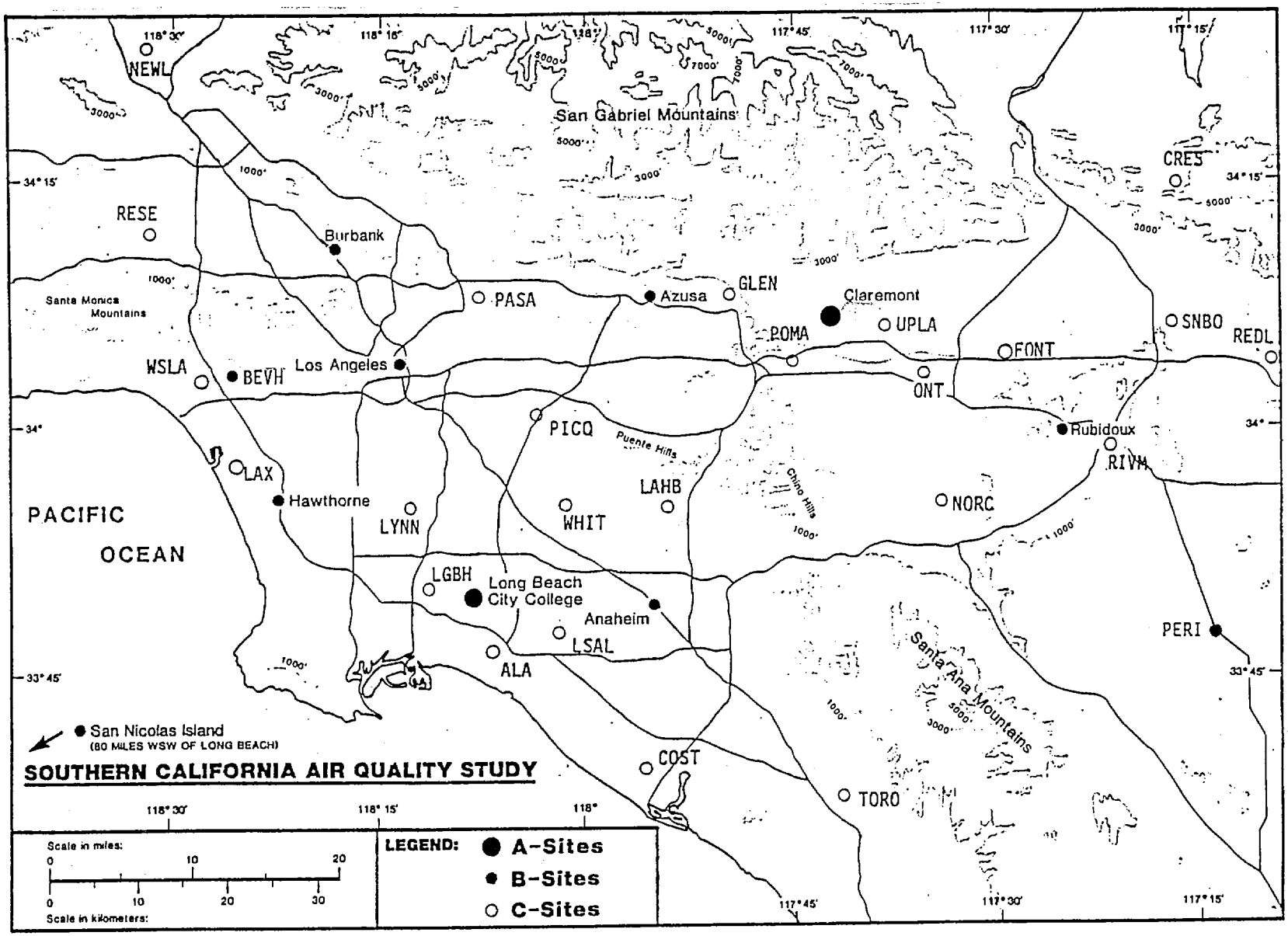


Figure 3-1. SCAQS "A", "B" & "C" Sites (Site abbreviations are listed in Tables 2-1 and 3-1).

Table 3-1. SCAQS "C" Sites and Parameters Measured at Each.

Sampling Site*	Site Acronym	O3	NO/NOx	CO	SO2	THC	NMHC	TSP/ PM-10	Pb	SO4	NO3	Temp	WS/WD
Alamitos Gen. Station	ALA	X	X	X	X							X	X
Anaheim	ANAH	X	X	X	X			X	X	X	X	X	X
Azusa	AZUS	X	X	X	X	X		X		X	X	X	X
Banning	BANN	X						X		X	X		X
Beverly Hills	BEVH	X											
Burbank	BURK	X	X	X	X			X	X	X	X	X	X
Costa Mesa	COST	X	X	X	X								X
El Toro	TORO	X		X				X		X	X		X
Fontana	FONT	X	X	X	X			X		X	X		X
Glendora	GLEN	X	X									X	X
Hemet	HEME	X											X
La Habra	LAHB	X	X	X	X	X							X
Lake Gregory	CRES	X						X		X	X		X
Hawthorne	HAWT	X	X	X	X	X		X	X	X	X	X	X
Long Beach	LGBH	X	X	X	X	X	X	X	X	X	X		X
Los Alamitos	LSAL	X			X			X		X	X		X
Los Angeles	CELA	X	X	X	X	X	X	X	X	X	X	X	X
Lynwood	LYNN	X	X	X	X	X	X	X	X	X	X		X
Newhall	NEWL	X											X
Norco	NORC	X											X
Ontario Airport	ONT							X		X	X	X	X
Pasadena	PASA	X	X	X	X			X		X	X	X	X
Perris	PERI	X						X		X	X		X
Pico Rivera	PICO	X	X	X	X			X	X	X	X	X	X
Piru	PIRU	X						X					
Pomona	POMA	X	X	X								X	X
Redlands	REDL	X											
Reseda	RESE	X	X	X	X	X	X						X
Riverside - Magnolia	RIVM			X				X	X	X	X		
Rubidoux	RIVR	X	X	X	X	X		X	X	X	X	X	X
San Bernardino	SNBO	X	X	X	X			X	X	X	X		X
Simi Valley	SIMI	X	X	X	X	X	X	X	X	X	X	X	X
Thousand Oaks	THOU	X										X	
Upland	UPLA	X	X	X	X			X	X	X	X	X	X
West Los Angeles	WSLA	X	X	X	X	X	X	X		X	X		X
Whittier	WHIT	X	X	X	X								X

* Locations within the study area are shown on Figure 3-1.

12/13/89

Table 3-2. Measurements at SCAQS Surface Sites.

(12/08/89)

Parameter	Summer Sites^ ANAH	AZUS	BURK	HAWT	SNI	CELA	RIVR	LBCC	CLAR	Fall Sites^ ANAH	BURK	HAWT	RIVR	CELA	LBCC	Samples/day Routine	Intensive	Schedule
"B" Site Routine Measurements																		
O3, NO/NOx, CO	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	24	con't.	Continuous
SO2	√	√	√	√	n	√	√	√	√	√	√	√	√	√	√	24	con't.	Continuous
T, DP	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	24	con't.	Continuous
Wind speed and wind direction	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	24	con't.	Continuous
PM-10 mass	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	1/6*	1	24-hr. beginning @ 00 PST
Light scattering	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	24	con't.	Continuous
UV radiation intensity	n	n	n	n	n	√	√	√	√	n	n	n	n	√	√	24	con't.	Continuous
"B" Site Aerosol and Trace Gases																		
HNO3, NH3, SO2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	5	00 PST & 06, 10, 14, 18 LT**
Aerosol mass and elements <2.5 µm & <10 µm	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	5	00 PST & 06, 10, 14, 18 LT**
Aerosol OC† and EC <2.5 µm & <10 µm	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	5	00 PST & 06, 10, 14, 18 LT**
Aerosol NH4+, Cl-, SO4=, NO3- <2.5 µm & <10 µm	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	5	00 PST & 06, 10, 14, 18 LT**
Aerosol Na+ for < 10 µm	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	5	00 PST & 06, 10, 14, 18 LT**
Particle absorption for aerosol <2.5 µm	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	5	00 PST & 06, 10, 14, 18 LT**
Carbonyls	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	3††	1 hr @ 07,12,16 LT**
C1-C12 hydrocarbons	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	0	3††	1 hr @ 07,12,16 LT**
PAN, methyl nitrate	√	√	√	√	√	√	√	√	√	√	√	√	n	√	√	0	con't.	Continuous
Perchloroethylene, methyl chloroform	√	√	√	√	√	√	√	√	√	√	√	√	n	√	√	0	con't.	Continuous
H2O2	n	n	n	n	n	√	√	√	√	n	n	n	n	n	n	0	8	
Toxics Tedlar bag collectors	n	n	n	n	n	√	√	√	√	n	n	n	n	√	√	0	1	24-hr
Toxics canister collectors	n	n	n	n	n	√	√	√	√	n	n	n	n	√	√	0	1	24-hr
"B+" Type Measurements																		
Physical size distr. 0.01 - 7 µm dia.	n	n	n	n	n	n	√	√	√	n	n	n	n	√	√	24	con't.	Continuous
Carbon aerosol size distr. 0.04-3.16 µm	n	n	n	n	n	n	√	n	√	n	n	n	n	√	√	0	4	06, 10, 14, 18 LT**
Inorganic aerosol size distr. 0.06-8 µm	n	n	n	n	n	n	√	√	√	n	n	n	n	√	√	0	4	06, 10, 14, 18 LT**
Elemental size distr. 0.07-8.5 µm	n	n	n	n	n	n	√	√	√	n	n	n	n	√	√	6†††	6	02, 06, 10, 14, 18, 22 LT**
"A" Site and Other Specialized Measurements																		
Specialized Experiments	n	n	n	n	n	s	s	√	√	n	n	n	n	s	√	√	√	Various

* One sample collected every sixth day.

** LT=PDT for summer study, PST for fall study. Sample start times are listed. Unless otherwise indicated, sampling continued until within 30 min of the next start time.

† OC=Organic carbon, EC=nonvolatile carbon

†† 6/day at LBCC & CLAR (summer) and at LBCC & CELA (fall)

††† summer only

√ = Measured at this site

n = not measured at this site.

s = some specialized measurements at this site

^ Sites defined in Table 2-1.

3.2.2 Routine "B" Site Measurements

Some measurements, referred to as routine, were conducted throughout the study period, including non-intensive as well as intensive study days. These parameters, listed in the upper portion of Table 3-2, include continuous monitoring for ozone, nitrogen oxides, carbon monoxide, particle scattering and meteorological parameters. The data were collected by different groups at different sites, as shown in Table 3-3. In some cases, the type of instrumentation varied, however, representative sites were subject to a field audit, as described in Chapter 8. All values are reported with one-hour averaged data on both intensive and non-intensive sampling days. Additional values with 3 to 10 min. averaging times are available on intensive sampling days.

Routine measurements included monitoring for PM_{10} at the SCAQMD "B" sites. Sampling was conducted every sixth day using HiVol samplers equipped with an Andersen 321A (Atlanta, GA) inlet. Samples were 24 hours in duration, beginning at midnight PST, in accordance with routine sampling procedures. PM_{10} monitoring at the "B" sites was also conducted on every intensive study day, as described below.

3.2.3 "B" Site Sampling for Aerosol Chemistry and Trace Gases

"B" site aerosol and trace gas measurements, listed in the second portion of Table 3-2, operated on intensive sampling days only. Sampling began at 0100 PDT in the summer and at 0000 PST in the fall. Sampling ended at the same time 24 to 72 hours later. Sample collection schedules are shown in Table 3-4; methods are described briefly below.

SCAQS Sampler: Fine and PM10 Aerosol Chemistry, NH3, HNO3 and SO2

Aerosol samples at the "B" sites were obtained using the SCAQS sampler which was developed specifically for this study by Fitz and Chan, (1989). This sampler provided samples for aerosol chemistry in two particle size fractions, corresponding to aerodynamic particle diameters of less than 2.5 μm and less than 10 μm. It also provided samples for fine particle absorption, nitric acid, ammonia and sulfur dioxide. Fine and PM_{10} aerosol samples were analyzed for mass, elemental composition, inorganic ions, and organic and nonvolatile carbon.

The sampler has 14 collection substrates, as shown in Figure 3-2. The fine, 2.5μm particle precut was attained with a Sensidyne 240 cyclone. PM_{10} sampling was performed with a General Metal Works Model 254-1 inlet, modified to prevent leakage. Below the inlets, the flow was divided among several sampling legs, with flow rates, substrate types and analyses indicated in the figure. Fine particle and PM_{10} samples were collected on 47 mm Teflon filters for mass, elemental and inorganic ion analyses and on 47 mm prefired quartz fiber filters for organic and nonvolatile carbon. A 47 mm Nuclepore filter was used for particle absorption determinations. Nitric acid and fine particle nitrate were measured using a denuder difference method with an AIHL cyclone precut at 2.5μm, MgO denuder tubes and Teflon-Nylasorb filter sandwich

Table 3-3. Instruments and Operators for Routine "B" Site Measurements.

Parameter	Instrument (measurement method)	Group(s)*	PI	Summer Site(s)*	Fall Site(s)*
Gases					
CO	Bendix 8501 (NDIR)	SCAQMD	Bope	ANAH, AZUS, BURK, HAWT, RIVR, CELA	ANAH, BURK, HAWT, RIVR, CELA
CO	Dasibi 3003	GMRL	Wolff	CLAR	LBCC
CO	Dasibi 3003	ARB-HS	Kowalski	LBCC	LBCC
CO	Dasibi 3003	AV	Chan	SNI	
NO, NOx	Thermo-electron 14B (chemiluminescence)	SCAQMD	Bope	ANAH, AZUS, BURK, HAWT, RIVR, CELA	ANAH, BURK, HAWT, RIVR, CELA
NO, NOx	Monitor Labs 8840 (chemiluminescence)	GMRL	Wolff	CLAR	LBCC
NO, NOx	Monitor Labs 8840 (chemiluminescence)	ARB-HS	Kowalski	CLAR,LBCC	LBCC
NO, NOx	Monitor Labs 8440 (chemiluminescence)	AV	Chan	SNI	
NO2	Dasibi 2008, modified	ARB-HS	Kowalski	LBCC	LBCC
O3	Dasibi 1003 (UV absorption)	SCAQMD	Bope	ANAH, AZUS, BURK, HAWT, RIVR, CELA	ANAH, BURK, HAWT, RIVR, CELA
O3	Dasibi 1003AH (UV absorption)	GMRL	Wolff	CLAR	LBCC
O3	Monitor Labs 8410 (chemiluminescence)	GMRL	Wolff	CLAR	LBCC
O3	Dasibi 1003AH (UV absorption)	ARB-HS	Kowalski	LBCC	LBCC
O3	Dasibi 1001-AH (UV absorption)	AV	Chan	SNI	
SO2	Thermo-electron 43 (pulsed fluorescence)	SCAQMD	Bope	ANAH, AZUS, BURK, HAWT, RIVR, CELA	ANAH, BURK, HAWT, RIVR, CELA
SO2	Meloy SA 285 (flame photometric)	GMRL	Wolff	CLAR	LBCC
SO2	Thermo-electron 43 (pulsed fluorescence)	ARB-HS	Kowalski	LBCC	LBCC
Total HC	Total nonmethane hydrocarbons	SCAQMD	Bope	CELA	CELA
Total HC	Beckman 400: THC (including CH4)	GMRL	Wolff	CLAR	LBCC
Aerosols					
Bsp	MRI#1561 Nephelometers (heated inlet)	AV/SCAQMD	Chan/Bope	ANAH, AZUS, BURK, HAWT, CELA	ANAH, BURK, HAWT, RIVR, CELA
Bsp	MRI 1550 Nephelometer (Waggoner mod., heated)	GMRL	Wolff	CLAR	LBCC
Bsp	MRI #1561 Nephelometer (heated inlet)	AV	Chan	CLAR, LBCC, RIVR, SNI	LBCC
Coeff. of Haze	RAC tape sampler	ARB-HS	Kowalski	LBCC	LBCC
PM-10 mass	Andersen#321A SSI HiVol (filter collection)	AV/SCAQMD	Chan/Bope	All 9 B sites	All 6 B Sites
Meteorological Parameters					
DP	EGG Cambridge 880 (cooled mirror)	ARB-HS	Kowalski	LBCC	LBCC
T	Weathermeasure T621	ARB-HS	Kowalski	LBCC	LBCC
T	Platinum temperature probes @ 3 heights	GMRL	Wolff	CLAR	LBCC
T, DP		SCAQMD	Bope	ANAH, AZUS, BURK, HAWT, RIVR, CELA	ANAH, BURK, HAWT, RIVR, CELA
T, DP	Climatronics	GMRL	Wolff	CLAR	LBCC
T, DP	MET #1002 Meteorological instr	AV	Chan	SNI	
WS, WD	(cup anemometer, wind vane)	SCAQMD	Bope	ANAH, AZUS, BURK, HAWT, RIVR, CELA	ANAH, BURK, HAWT, RIVR, CELA
WS, WD	Climatronics	GMRL	Wolff	CLAR	LBCC
WS, WD	(cup anemometer, wind vane)	ARB-HS	Kowalski	LBCC	LBCC
WS, WD	MET #1002 Meteorological instr.	AV	Chan	SNI	
UV radiation	Eppley UV pyranometer (photometer)	GMRL	Wolff	CLAR	LBCC
UV radiation	Eppley UV pyranometer (photometer)	AV	Chan	CELA, LBCC, RIVR	CELA, LBCC
Total solar rad.	Eppley total solar radiation (photometer)	GMRL	Wolff	CLAR	LBCC

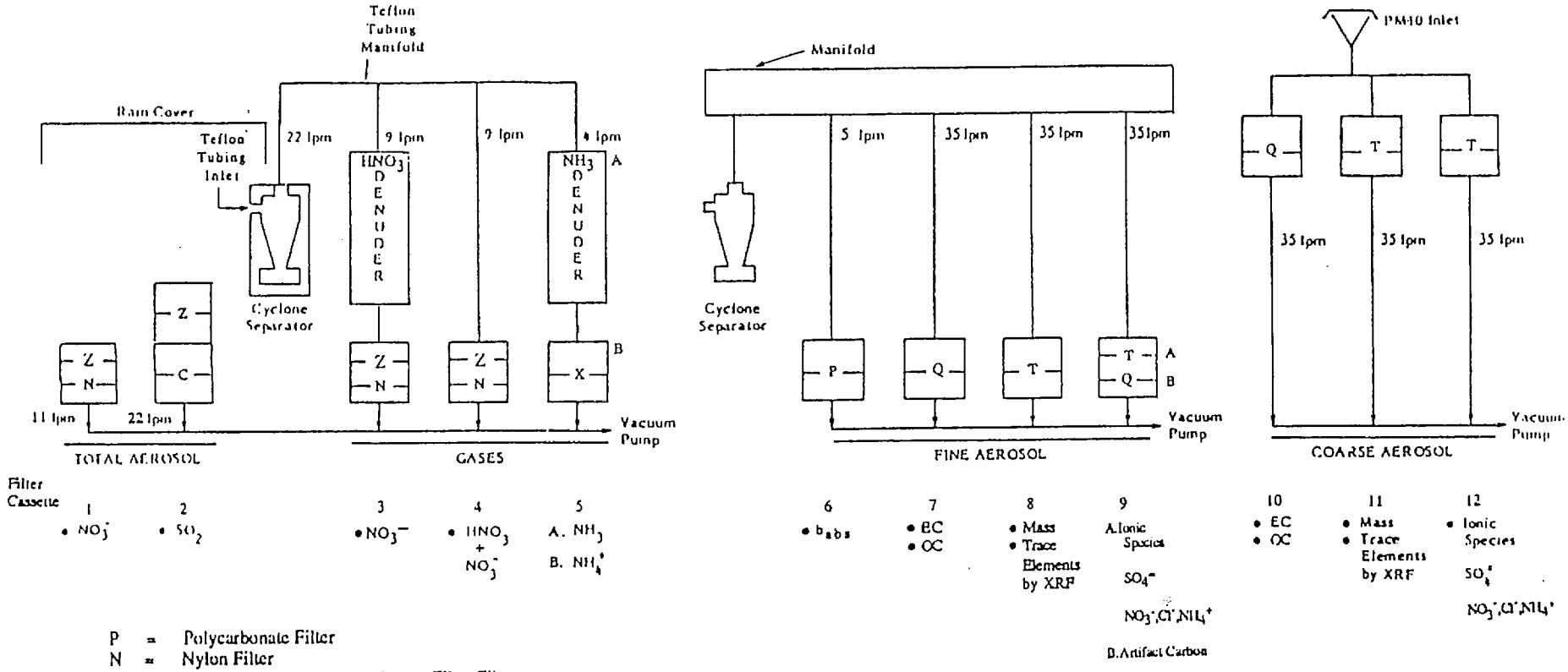
* Site abbreviations are given in Table 2-1.
Group abbreviations are given in Table 3-6a.

(08/20/89)

Table 3-4. Sampling Schedules For Intensive Study Days.

Sampler	Summer Schedule (PDT)	Fall Schedule (PST)
SCAQS Sampler	0100-0550 0600-0950 1000-1350 1400-1750 1800-0050	0000-0550 0600-0950 1000-1350 1400-1750 1800-2350
C2-C12 HC and Carbonyls		
At CLAR and LBCC:	0500-0600 0700-0800 0900-1000 1200-1300 1400-1500 1600-1700	At CELA and LBCC: 0500-0600 0700-0800 0900-1000 1200-1300 1400-1500 1600-1700
At all other "B" Sites:	0700-0800 1200-1300 1600-1700	At all other "B" Sites: 0700-0800 1200-1300 1600-1700
Hydrogen Peroxide	0100-0550 0600-0950 1000-1350 1400-1455 1500-1555 1600-1655 1700-1755 1800-0050	none
PM-10 HiVol	0100-0100	0000-0000
MOUDI & Berner Impactors	0600-0930 1000-1330 1400-1730 1800-0530	0600-0930 1000-1330 1400-1730 1800-0530
On final day:	1800-0100	On final day: 1800-0000
DRUM Impactors	0200-0600 0600-0930 1000-1400 1400-1800 1800-2200 2200-0200	0200-0600 0600-0930 1000-1400 1400-1800 1800-2200 2200-0200

(11/28/89)



P = Polycarbonate Filter
N = Nylon Filter
X = Oxalic Acid Impregnated Quartz Fiber Filter
Q = Quartz Fiber Filter
T = (Teflo) Teflon Filter
C = Carbonate Impregnated Cellulose Filter
Z = (Zefluor) Teflon Filter

Figure 3-2. SCAQS Sampler Flow Diagram.

on each leg. An open face Teflon-Nylasorb filter sandwich provided a measure of total nitrate plus nitric acid. Both filters from all Teflon-Nylasorb sandwiches were extracted and analyzed together, as a single substrate. SO_2 was collected using a carbonate impregnated filter, and ammonia was collected using an oxalic acid coated denuder tube.

The SCAQS sampler collected five samples/day on intensive study days, with sampling periods of 4 hr (daytime) and 5-7 hr (nighttime) duration. Samples were changed at 0100, 0600, 1000, 1400 and 1800 PDT in the summer, and at 2400, 0600, 1000, 1400 and 1800 PST in the fall (see Table 3-4). Substrate kits were prepared by EMSI (R. Countess); samplers were operated by AeroVironment (M. Chan, PI). Filters and other sampling substrates were changed in the field; technicians wore both gloves and face masks to reduce contamination. Dynamic blanks were obtained at the onset of each intensive sampling period by loading substrates into the sampler, pulling air through the sampler for approximately one minute while recording all flow rates, allowing the substrates to sit for one-half hour with no air flow, then repeating the one minute flow measurement. Blanks were handled and stored along with all other samples collected during the study period. Samples were stored in a specifically dedicated refrigerator at each site, and transferred to an ice chest for transport to the laboratory. Samples from all sites for each intensive study period were gathered at AeroVironment, and sent as a unit by air conditioned automobile to the EMSI laboratory; from there they were distributed for analysis.

Chemical analyses were performed by several laboratories as shown in Table 3-5. Inorganic ions and gravimetric mass determinations were performed by EMSI (Countess, 1988, 1989), organic and nonvolatile carbon analyses were done by ENSR (formerly ERT), elemental concentrations were determined by X-ray fluorescence at EPA North Carolina (Knapp and Stockburger, 1989), and particle absorption measurements were made by Radiance Research (RR, Seattle, WA).

Because many different laboratories were involved in the analysis of the SCAQS sampler data, it was necessary to handle blank corrections and uncertainty calculations in a consistent manner. For each analysis and filter type, blanks were inspected by F-ratio and Student's t tests for systematic variability among sites and between the summer and fall study periods, and grouped accordingly. Analytical precision was determined by replicate analyses at several concentration values. Imprecision in sample volumes was determined from uncertainties in the measurement of flow rates. All three sources of uncertainty were combined to determine the overall sample uncertainty.

PM10 HiVol Samplers

High volume samplers with Andersen 321A inlets collected a single 24-hour sample on each intensive sampling day. In accordance with federally mandated PM_{10} sampling, samples began at midnight PST (0100 PDT). Samples were collected on Whatman QMA quartz fiber filters, and analyzed for nitrate, sulfate and PM_{10} mass. At Long Beach and Claremont, the samplers were operated by AeroVironment personnel, with samples changed in the field at

Table 3-5. SCAQS Sampler Chemical Analyses 11/28/89

Leg	Species	Collection Method (Substrate ID)	Analysis Method	Analysis Laboratory*
Gas and Total Particles (open-faced collectors beneath rain shield):				
1.	HNO3 plus total particle NO3-	Zeflour & Nylon filters in series, analyzed together (N1)†.	IC for NO3-	EMSI
2.	Sulfur dioxide	Na2CO3/Glycerine impregnated Whatman #541 cellulose filter (C2) mounted behind Zefluor prefilter.††	IC for SO4=	EMSI
Gases and Volatile Fine Particles (collectors follow Teflon-coated AIHL cyclone):				
3.	Particle nitrate < 2.5 µm	Zeflour-Nylon filters in series behind MgO diffusion denuder for HNO3. Filters analyzed together (N3)†.	IC for NO3-	EMSI
4.	HNO3 plus nitrate < 2.5 µm	Zeflour-Nylon filters in series, analyzed together (N4)†.	IC for NO3-	EMSI
5.	NH3	Oxalic acid coated denuder (D5).	Colorimetry for NH4+	EMSI
	NH4+	Oxalic acid impregnated quartz filter (X5) behind Leg 5 denuder.	Colorimetry for NH4+	EMSI
Fine Particles (collectors follow Sensidyne Model 240 Cyclone):				
6.	Particle absorption	Polycarbonate filter (P6)	Integrating plate	RR
7.	Organic and elemental carbon	Quartz filter (Q1)	Thermal technique	ENSR
8.	Mass Elements (atomic nos. ≥11)	Teflon filter (T8) "	Gravimetric X-ray fluorescence	EMSI EPA-SSB
9.	SO4=, NO3-, Cl- NH4+	Teflon filter (T9) "	IC for anions Colorimetry for NH4+	EMSI
	Organic carbon artifact	Quartz filter (Q2), behind filter T9	Thermal technique	ENSR
Particles < 10 µm diameter (collectors follow GMW-254-1 PM10 Inlet):				
10.	Organic and elemental carbon	Quartz filter (Q3)	Thermal technique	ENSR
11.	Mass Elements (atomic nos. ≥11)	Teflon filter (T11) "	Gravimetric X-ray fluorescence	EMSI EPA-SSB
12.	SO4=, NO3-, Cl- NH4+ Na	Teflon filter (T12) " "	IC for anions Colorimetry for NH4+ Atomic absorption	EMSI EMSI EMSI

IC=ion chromatography

* Laboratory abbreviations given in Table 3-6a.

† Zefluor filter used only to prevent clogging of Nylon filter. Filters extracted and analyzed as single substrate.

†† Zefluor filter not analyzed.

midnight. At Hawthorne, Anaheim, downtown Los Angeles, Azusa, Burbank, and Rubidoux, the samplers were operated by the SCAQMD. Although different groups were responsible for collecting these samples, all filters were provided, weighed and analyzed by the SCAQMD.

Carbonyl Samplers

C_1 to C_7 carbonyl compounds were collected using cartridges impregnated with purified 2,4-dinitrophenylhydrazine (DNPH) and phosphoric acid (Grosjean and Fung 1982; Kuwata et al. 1983). Aldehydes react with the DNPH to form hydrazones, which are quantitated by high performance liquid chromatography. For SCAQS, air was sampled through the cartridges at 1 L/min for one hour intervals, as shown in Table 3-4. Sampling was done with an automated sampler which allowed for the collection of duplicates and dynamic blanks, and sampling flow rates were controlled using a critical orifice. Analyses were performed by ENSR using an internal standard obtained by spiking the cartridges, followed by elution in 2 mL of acetonitrile and analysis by high performance liquid chromatography (Fung and Grosjean 1981; Fung and Kawaguchi, 1989). Reagents were purified to permit measurement at sub-ppb levels (Fung and Wright 1986). Specific compounds measured are formaldehyde, acetaldehyde, acrolein, acetone, propanal, butanal, methylethylketone, pentanal, 2- and 3-methylpentanal, cyclohexanone, and benzaldehyde. Cartridges and samplers were provided by ENSR, operated in the field by AV, and transported with other samples via EMSI to ENSR after each group of intensive study days.

Hydrocarbon Sampling

Hydrocarbon canister samples operated on the same schedule as the carbonyls, with one-hour sample collection, three to six times per intensive sampling day. Collection times were 0700, 1200 and 1600 PDT at all "B" sites, with an additional three samples at 0500, 0900 and 1400 at Long Beach and at Claremont (summer) or Los Angeles (fall). The hydrocarbon canisters were 6 L stainless steel vessels, which were initially evacuated and filled to approximately 10 psig by means of a stainless steel bellows pump and flow controller. The canisters were provided by Biospherics Research Corp. (BRC), and analyzed by gas chromatography by the EPA (Stockburger et al. 1989). Selected samples were reanalyzed by the EPA and by the Oregon Graduate Center (OGC) using gas chromatography - mass spectrometry (GC-MS) (Fujita and Collins, 1989).

PAN Measurements

Peroxyacetylnitrate (PAN) was measured by Daniel Grosjean and Associates (DGA) using a gas chromatograph with electron capture detection (ECD) (Williams and Grosjean, 1989). Samples were collected continuously at nine sites in the summer and five sites in the fall, except that no samples were collected at San Nicolas Island or Hawthorne during the August-September summer extension period. Chromatograms were recorded on a Hitachi D-2000 electronic integrator. The chromatogram peak corresponding to PAN was identified by observing its disappearance when removing PAN from the air stream using an alkaline trap. Retention times were verified in the field

using a portable PAN generator (Grosjean et al. 1984). Each instrument was calibrated against a reference gas chromatogaph. With the exception of the Azusa site, the PAN analyzers operated on a one-hour cycle, with an instantaneous collection around the half hour, followed by gas chromatographic analysis. At Azusa, a shorter column was used in the gas chromatograph enabling the collection of a sample every 30 minutes. PAN concentrations were detected at ppb level.

Hydrogen Peroxide Sampling

Hydrogen peroxide was measured at four sites during the summer SCAQS study period using impinger collection and enyzme catalyzed fluorescence detection as described by Downs et al. (1989) and Tanner et al. (1986). Measurements were conducted by Environmental Monitoring Services Inc. (EMSI) in cooperation with Brookhaven National Labs. The sampling schedule was the same as for the SCAQS samplers except that sample changes were made hourly between 1400 and 1800 PDT, so that a total of eight samples were collected on each test day. Ambient air was sampled through two impingers connected in series, each containing 10 mL of 2 millimolar HCHO in water. The first impinger collected the hydrogen peroxide; the second impinger was analyzed to correct for sampling artifacts. Ozone, which gives a positive interference, was eliminated by adding 15 cm^3/min of 200 ppm nitric oxide in nitrogen to the 500 cm^3/min air sample upstream of the impingers. Sulfur dioxide, which gives a negative interference, was eliminated by the HCHO in the impinger solution. The sampling line was wrapped with heating tape to prevent water condensation and absorption of H202. A large bubbler containing DNPH followed the pump to absorb gaseous HCHO from the impingers so as to eliminate interference with aldehyde measurements at the site. Immediately after sampling, a derivatizing solution containing (p-hydroxyphenyl) acetic acid (POHPAA) was added to the sample. The H202 reacts with the POHPAA to form a dimer, the concentration of which was analyzed in the laboratory by fluorometry. The laboratory fluorometer was calibrated using aqueous hydrogen peroxide solutions.

Toxics Sampling

Toxics samplers were operated at four of the summer and two of the fall "B" sites, as shown in Table 3-2. Two types of samplers were used. The ARB collected 24-hr samples in a 50 L Tedlar bag. Biospherics Research Corp. (BRC) collected 24-hr samples in a 15 L electroplated stainless steel canister. Both groups performed analyses by gas chromatography with photoionization and electron capture detection. Measured compounds included benzene, toluene (BRC only) and halogenated hydrocarbons (such as chlorobenzene, ethylene dibromide, ethylene dichloride, methylbromide, dichloromethane, chloroform, methylchloroform, trichloroethylene, perchloroethylene, and carbon tetrachloride).

3.3 "B+" SITE MEASUREMENTS

At selected "B" sites, called "B+" sites, size resolved particle chemistry (impactor) and aerosol size distribution measurements supplemented the regular "B" site measurements. Impactors provided size distributions for aerosol organic and nonvolatile carbon, inorganic ions, and elements on

intensive study days. Optical counters and electrical aerosol analyzers provided physical size distributions throughout the study periods. The summer "B+" sites were Claremont, Long Beach, and Rubidoux. The fall "B+" sites were Long Beach and downtown Los Angeles.

"B+" site instrumentation is listed in the third portion of Table 3-2. With the exception of the micro-orifice impactor (MOUDI), which was not operated at Long Beach during the summer, the instrumentation was the same for all "B+" sites. Measurement methods are briefly described below.

Schedules for "B+" site measurements are given in Table 3-4. The Berner impactor, used for inorganic ion size distributions, and the MOUDI, used for organic and nonvolatile carbon size distributions, followed a modified SCAQS sampler schedule, wherein the two nighttime samples were combined together. The DRUM impactor, which provided elemental size distributions, collected six four-hour samples per day. The optical particle counter (OPC) data were averaged over one-hour periods for non-intensive sampling days, and over five minute periods for intensive sampling days. Electrical Aerosol Analyzer (EAA) data were collected continuously throughout the study periods.

Aerosol Inorganic Ion Size Distributions

Particle size distributions for sulfate, nitrate, ammonium ion, chloride and sodium were obtained by ion chromatographic measurements of samples collected with a Berner Impactor. In addition, hydrogen ion concentrations were determined by pH analysis of the sample extract. The Berner Impactor provides eight particle size fractions, with experimentally determined 50% collection efficiency cutpoints at 0.082, 0.13, 0.21, 0.43, 0.96, 2.1, 4.2, and 8.6 μm aerodynamic diameter (Wang and John, 1988; John et al. 1989). The two smallest size cuts are obtained by impactor stages operating at reduced pressures of 0.5 and 0.8 atmospheres, respectively. Samples were collected on fluorocarbon grease coated Tedlar foil substrates, and stored in argon-filled containers kept in dry ice. Sample volumes were 7 m^3 (day) and 22 m^3 (night), yielding detection limits of 0.1 $\mu g/m^3$ for most analytes. The data were reduced using a Twomey inversion algorithm which incorporates measured impactor stage characteristics to produce smooth particle species size distributions. All sample collection, analysis and data reduction was handled by the Air and Industrial Hygiene Laboratory (AIHL-J, W. John, et al. 1989).

Carbonaceous Aerosol Size Distributions

Organic and nonvolatile carbon fractions were collected with a micro-orifice impactor, which provides eight size cuts with 50% collection efficiency at cutpoints of 0.04, 0.075, 0.19, 0.28, 0.56, 1.78, and 3.16 μm aerodynamic diameter for the impactor operated at Rubidoux (summer) and Long Beach (fall), and 0.05, 0.095, 0.17, 0.28, 0.56, 1.78, and 3.16 μm aerodynamic diameter for the impactor operated at Claremont (summer) and Los Angeles (fall). Both impactors were preceded by AIHL cyclones with a 2.2 μm cutpoint. All samples were collected on uncoated 37 mm aluminum foil which had been cleaned by baking three hours at 600° C. Samples were stored in a freezer

prior to analysis by ENSR using a thermal manganese dioxide oxidation technique (Fung, 1989). Typical sample volumes were 7 m^3 (day) and 22 m^3 (night). Detection limits for daytime samples were 0.5 $\mu g/m^3$ (substrate for nonvolatile carbon) and 1 $\mu g/m^3$ (substrate of organic carbon). The data were reduced using inversion algorithms to produce smoothed carbonaceous aerosol size distributions. The MOUDI was operated by the University of Minnesota (P. McMurry, PI), samples were analyzed by ENSR. Data reduction and inversions were performed by the University of Minnesota (McMurry and Anderson, 1989).

Elemental Size Distributions

A DRUM impactor, with cutpoints at 0.07, 0.24, 0.34, 0.56, 1.15, 2.1, 4.3 and 8.5 μm aerodynamic diameter, was used to obtain samples for elemental analysis by PIXE (particle induced X-ray emission). The DRUM impactor employs one jet per stage, which concentrates the sample and enables direct analysis without sample extraction. Impactor substrates were Apiezon L coated mylar. The collecting surface rotates slowly to provide four-hour time resolution. Particles penetrating the final stage are collected on a 25 mm filter and are subjected to the same analyses. The sampler flow rate was controlled by a critical orifice at 1.1 L/min. For shipment from the field, samples were left mounted on the impactor drums. Reported elements are Al, Si, K, Fe, Cu, Zn, Pb, Br, Cl, and S. Detection limits are $\leq$ 5 ng/m^3. Measurements were collected every day from June 10 to July 23, and on intensive days during the late summer and fall study periods. All DRUM impactor operations and analyses were handled by the University of California at Davis (T. Cahill, PI). Impactor calibration is given by Raabe et al. (1988). Measurements are described by Cahill et al. (1989).

Physical Size Distributions (Optical Particle Counters and Electrical Aerosol Analyzers)

Physical size distributions were obtained using a Climet 208 white light OPC for particles greater than 0.5 to 7 μm diameter, a Particle Measuring Systems LAS-X active scattering laser counter for particles 0.09 to 3 μm, and an EAA (TSI Model 3030, St. Paul, MN), for particles from 0.01 to 0.056 μm. The EAA sampled from a 160 L metal container to provide a constant aerosol during the four minute measurement period. Output voltage pulses from the Climet optical particle counter were processed by a 1024 channel Nucleus (Oak Ridge TN) pulse height analysis card installed in a personal computer, and grouped into 80 channels evenly spaced with respect to the logarithm of particle diameter for data storage. The LAS-X particle counter provided a single 32 channel output spanning the entire particle size range, and this was recorded directly. During intensive study days data were acquired with an averaging time of four minutes, coincident with individual cycles of the EAA. On nonintensive days the optical counter data were averaged over one-hour periods, but the collection of EAA data was unchanged. Instrument calibrations were checked using polystyrene latex spheres prior to each intensive study period. The data acquisition system was constructed by Sonoma Technology Inc. (M. Stoelting), the instrument calibrations, operations and data reduction were handled by AeroVironment (M. Chan and K. C. Moon).

3.4 "A" SITE AND OTHER SPECIALIZED MEASUREMENTS

The "A" sites were located at Claremont and Long Beach in the summer and Long Beach in the fall. The "A" sites were the site of numerous special experiments designed to complement the monitoring efforts at the "B" sites. They also served as the field headquarters for cooperating SCAQS investigators.

During the summer SCAQS most of the specialized measurements were concentrated at the upwind Claremont site. Some were duplicated at both Long Beach and Claremont. During the fall, many of the measurements which had been located only at Claremont for the summer study were relocated to the Long Beach site. The SCAQS field headquarters was also relocated from Claremont to Long Beach for the fall. Some specialized measurements were conducted at the Los Angeles and Rubidoux sites.

"A" site measurements and specialized experiments at other sites are listed in Tables 3-6 and 3-7. They are grouped into the following categories: reactive gases, aerosol measurements, acidic particle and vapor samplers, dry deposition measurements, visibility parameters, and specialized experiments. Gaseous measurements included continuous measurement of nitric acid, formaldehyde and hydrogen peroxide, and integrated measurements of aldehydes and organic acids. Aerosol measurements included continuous measurement of PM_{10} mass, aerosol sulfur and carbonaceous particles, and highly resolved physical size distributions. Integrated aerosol measurements included polycyclic compounds and mutagenic species, various measures of chemical species size distributions and visibility parameters. Other special studies included measurements of fog acidity, smog chamber studies, and a comparison of various samplers for acidic gases and particles. Most of these experiments were located at the "A" sites, but in some cases other locations were used, as indicated.

Table 3-6. "A site" And Other Specialty Measurements During The Summer Study Period.

(11/28/89)

Group(s)†	PI	Measurement	Site†	No. of Samples Non-Int.	Inten.	Sampling Times(PDT)††	Parameters
Meteorological Measurements							
Ford	Adams	WS/WD	CLAR	0	cont.*	-	Support for spectrophone, data will not be reported
GMRL	Wolff	Acoustic sounder	CLAR	cont.*	cont.*	-	
Reactive Gaseous Species							
ARB-HS	Kowalski	Modified Dasibi 1008 for NO2	CLAR	cont.	cont.	-	NO2
DGA	Grosjean	Impingers (H2O, chloroform, 0.16L/m)	CLAR	0	6	1-hr@05,07,09,12,14,16	Organic acids
DGA	Grosjean	KOH cartridges (1.5L/m)	CLAR	0	6	1-hr@05,07,09,12,14,16	Organic acids
DGA	Grosjean	Teflon filter (30 L/m)	CLAR	0	6	1-hr@05,07,09,12,14,16	Organic acids
EMSI	Lev-On	Liquid Argon trap, aldehydes, ketones	CLAR	0	6	grab@05,07,09,12,14,16	Aldehydes and ketones
EPA-GKP	Lonneman/Ellenson	Aldehydes (DNPH SEP packs)	CLAR	3	3	06-09,12-15,15-18	Aldehydes (by HPLC analysis)
EPA-GKP	Lonneman/Ellenson	HC canisters	CLAR	3	3	06-09,12-15,15-18	C1-C12 hydrocarbons by GC analysis of canisters
EPA-GKP	Lonneman/Ellenson	Monitor Labs 8840 NOx with Nylon prefilter	CLAR	cont.*	cont.*	-	NOx less HNO3 (removed by Nylon prefilter)
EPA-GKP	Lonneman/Ellenson	PAN (GC-ECD)	CLAR	cont.*	cont.*	-	PAN
GGC	Gordon	GGC carbon cartridges for alcohols	CLAR	0	5	01, 06, 10, 14, 18	Ethanol, methanol
GMRL	Wolff	Beckman 400: total hydrocarbons (including CH4)	CLAR	cont.*	cont.*	-	Total hydrocarbons
UCR	Winer	DOAS for NO3, HNO2, HCHO	CLAR	0	cont.*	-	NO2, HNO2, HCHO
UD	Stedman	UD chemical amplification for RO-	CLAR	cont.*	cont.*	-	Free radicals
UD	Stedman	UD GC: luminol detector for PAN	CLAR	cont.*	cont.*	-	PAN
UD	Stedman	UD luminol detection of HNO3	CLAR	cont.*	cont.*	-	Nitric acid
Uni	Mackay	Unisearch formaldehyde	CLAR	0	cont.*	-	HCHO
Uni	Mackay	Unisearch H2O2	CLAR	cont.*	cont.*	-	H2O2
Uni	Mackay	Unisearch HNO3	CLAR	cont.*	0	-	HNO3
Uni	Mackay	Unisearch Luminox	CLAR	cont.*	cont.*	-	NO2
Aerosol Measurements							
ARB-HS	Kowalski	RAC tape sampler	CLAR	24	24	hourly	Filter reflectance
ARB-Sacr.	Croes	MDA BAM sampler (Beta gauge)	CLAR	24	24	hourly	PM-10 mass, hourly averages
EPA-SSB	Knapp	3 quartz in series (47mm)	CLAR	0	2	00, 12	OC, EC
EPA-SSB	Knapp	Open faced 47mm quartz	CLAR		2		OC, EC
EPA-SSB	Knapp	HiVol: 12 hour samples	CLAR	2	2	00, 12	OC, EC, perhaps speciated HC
EPA-SSB	Knapp	HiVol: multiday	CLAR		multiday	-	OC, EC, perhaps speciated HC
GGC	Gordon	HiVol: contemporary carbon (C14)	CLAR	0	1	09-09	C12/C14 ratios
GMRL	Wolff	SSI HiVol	CLAR	cont.*	cont.*	-	Mutagenicity
GMRL	Wolff	SCAQS sampler	CLAR	2	0	06, 18	Aerosol chemistry, HNO3, NH3, SO2
OGC	Huntzicker	Single port for Pb/Br	CLAR	0	5	06, 10, 14, 18, 22	Pb, Br
OGC	Huntzicker	Six-port, cumulative OC, EC distribution	CLAR	1	1	00-05	Cumulative OC, EC (0.3, 0.5, 1, 2.5, 10)
OGC	Huntzicker	Continuous sulfate	CLAR	cont.*	cont.*	-	Continuous fine particle SO4
OGC	Huntzicker	In-situ carbon	CLAR	~12	~12	semi-cont.*	Semi-continuous OC, EC
UCD	Cahill	IMPROVE cyclone: glass denuder, nylon filter	CLAR	5	5	01, 06, 10, 14, 18	PM-2.5 nitrate
UCD	Cahill	IMPROVE cyclone: K2CO3 impregnated filter	CLAR	5	5	01, 06, 10, 14, 18	SO2
UCD	Cahill	IMPROVE cyclone: nylon filter	CLAR	5	5	01, 06, 10, 14, 18	PM-2.5 nitrate
UCD	Cahill	IMPROVE cyclone: quartz filter	CLAR	5	5	01, 06, 10, 14, 18	PM-2.5 carbon
UCD	Cahill	IMPROVE cyclone: Teflon filter	CLAR	5	5	01, 06, 10, 14, 18	PM-2.5 elements & mass (grav,PIXE,FAST,PESA)
UCLA-1	Allen	LPI/FTIR	CLAR	0	5	01, 06, 10, 14, 18	Aerosol functional groups distribution (0.05,0.075,0.12,0.26,0.5,1,2μm)
UCLA-1	Allen	LPI/NO3	CLAR	0	2	11, 15	Nitrate distribution (0.05,0.075,0.12,0.26,0.5,1,2μm)
UCLA-1	Allen	LPI/S	CLAR	0	3	08, 11, 15	Aerosol sulfur distribution (0.05,0.075,0.12,0.26,0.5,1,2μm)
UCLA-2	Friedlander	LPI/Pb	CLAR	0	1/3	1 per intensive	Pb distribution (0.05,0.075,0.12,0.26,0.5,1,2μm)
UCLA-2	Friedlander	Dichotomous carbon	CLAR	0	5	01, 06, 10, 14, 18	PM-10 and PM-2.5 OC, EC
UCLA-2	Friedlander	Dichotomous mass, XRF	CLAR	0	5	01, 06, 10, 14, 18	PM-10 and PM-2.5 mass, elements
UCLA-2	Friedlander	Dichotomous NO3, SO4	CLAR	0	5	01, 06, 10, 14, 18	PM-10 and PM-2.5 SO4, NO3
UCR	Atkinson	HiVol for PAH	CLAR	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UCR	Atkinson	HiVol with PUF	CLAR	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UCR	Atkinson	PM-10 HiVol for PAH	CLAR	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UM	McMurry	MOUDI for mass	CLAR	0	2	06, 10, 14, 18	Size resolved mass
UV	Relschl	Classifier for fine dN/dDp	CLAR	cont.*	cont.*	-	dN/dlogDp 0.003-0.15 μm

Table 3-6. "A site" And Other Specialty Measurements During The Summer Study Period.

(11/28/89)

Group(s)†	PI	Measurement	Site†	No. of Samples Non-Int.	No. of Samples Inten.	Sampling Times(PDT)††	Parameters
Acidic Particle and Vapor Samplers							
ARB-HS	Kowalski	Denuder difference for HNO3, NO3-	CLAR	0	5	01, 06, 10, 14, 18	HNO3, fine NO3-
DRI	Bowen	CADMP-DRI acid sampler #1	CLAR	1	2	06, 18	PM-10 & PM-2.5 mass, SO4, NO3, Cl, NH4, Mg, K, Na, Ca, SO2, NO2, NH3, HNO3
DRI	Bowen	CADMP-DRI acid sampler #2	CLAR	1	2	06, 18	PM-10 & PM-2.5 mass, SO4, NO3, Cl, NH4, Mg, K, Na, Ca, SO2, NO2, NH3, HNO3
EPA-GKP	Ellenson	Annular denuder (on roof)	CLAR	0	5	01, 06, 10, 14, 18	NO2, NO3, SO4
EPA-GKP	Ellenson	Annular denuder (on roof)	CLAR	2	1	12-15, 15-18 or 12-15	NO2, NO3, SO4
EPA-GKP	Ellenson	Annular denuder (on roof)	CLAR	2	0	06, 18	NO2, NO3, SO4
EPA-SSB	Knapp	Trans flow Rtr (Cycl -TFR(Ny,Nl)-T,N,CA)	CLAR		1	01 (24hr)	SO4, NO3, HNO3, NH3, NH4
EPA-SSB	Knapp	Trans flow Rtr (Cycl-TFR(Ny,Nl)-T,N,CA,TEA)	CLAR		5	01, 06, 10, 14, 18	SO4, NO3, HNO3, NH3, NH4, SO2, NO2
EPA-SSB	Knapp	Trans flow Rtr (Funnel-TFR(Ny,Nl)-T,N,CA)	CLAR		5	01, 06, 10, 14, 18	SO4, NO3, HNO3, NH3, NH4
ENSR	Heisler	OEN Smplr: Trans Flow Rtr (TFR-T, Ny, K2CO3, citric acid)	CLAR	2	4	06,18 or 06,10,14,18	HNO3, NH3, SO2, SO4, NO3, NH4
Dry Deposition Measurements							
CMU	Davidson	Dry deposition foils	CLAR	2	4	06, 18, 06, 10, 14, 18	SO4 and NO3 dry deposition rates
CMU	Davidson	Dry deposition foils	CLAR	2	4	06, 18, 06, 10, 14, 18	SO4 and NO3 dry deposition rates
CMU	Davidson	Dry deposition onto plants	CLAR	multiday		-	SO4 and NO3 dry deposition rates
IIT	Noll	Coarse particles	CLAR	2	5	06,18 or 01, 06, 10, 14, 18	Distribution of coarse SO4, NO3 and mass (cutpts.: 6.5,11.5,24.7,36.5µm)
IIT	Noll	Deposition plate	CLAR	1	1		Deposition flux of mass, SO4 and NO3
Visibility Parameters							
Ford	Adams	HiVol for black carbon	CLAR	0	cont.*	-	Support for spectrophone, data will not be reported
Ford	Adams	Nephelometer	CLAR	0	cont.*	-	Support for spectrophone, data will not be reported
Ford	Adams	Spectrophone	CLAR	0	cont.*	-	Continuous aerosol optical absorption
LBL	Novakov	Aethalometer	CLAR	cont.*	cont.*	-	Black carbon and b absorption
STI-R	Richards	Path transmittance and radiance	CLAR	cont.*	cont.*	-	Optical transmittance and path radiance
UI	Rood	Nephelometer experiment	CLAR	-	cont.*	-	Particle scattering and humidigraphs
UV-vis	Hitzenberger	Telephotometer: 10 wavelengths	CLAR	cont.*	cont.*	-	Contrast: 10 wavelengths (400-750 nm)
Other Measurements and Special Experiments							
DRI	Rogers	Urban tracers	CLAR	4	4		Part of GLADIS study of long range transport from LA
EPA-SSB	Knapp	Hydrocarbon analyses	CLAR	-	-	-	Hydrocarbon analyses of SCAQS network canisters
GMRL	Nelson	GM smog chambers	CLAR	yes	yes	July 5 - September 3	Captive air photochemistry experiments
UM	McMurry	Reaction & growth DMA's	CLAR	yes	0	-	Particle size change with chemical reaction
UM	McMurry	RH tandem DMA's	CLAR	0	yes	08, 11, 15	Particle size change with RH
UM	McMurry	DMA/OPC calibrations	CLAR	some	0		Ambient aerosol calibration of PMS-LASX
Meteorological Measurements							
AIHL-A	Appel	EG&G 911: T, RH	LBCC	0	cont.*	-	T, RH
Reactive Gaseous Species							
AIHL-A	Appel	Dasibi 1003: O3	LBCC	0	cont.*	-	O3
AIHL-A	Appel	Teco 14B/E with Na2CO3 denuder: NO,NOx	LBCC	0	cont.*	-	NO, NOx, NOy=NO2 interferents
AIHL-A	Appel	Teco 43: SO2	LBCC	0	cont.*	-	SO2
DGA	Grosjean	Impingers (H2O, Chloroform, 0.16L/m)	LBCC	0	6	1-hr@05,07,09,12,14,16	Organic acids
DGA	Grosjean	KOH cartridges (1.5L/m)	LBCC	0	6	1-hr@05,07,09,12,14,16	Organic acids
DGA	Grosjean	Teflon filter (30 L/m)	LBCC	0	6	1-hr@05,07,09,12,14,16	Organic acids
EPA-GKP	Lonneman/Ellenson	Aldehydes (DNPH SEP packs)	LBCC	1	1	06-09	Aldehydes (by HPLC analysis)
EPA-GKP	Lonneman/Ellenson	HC canisters	LBCC	1	1	06-09	C1-C12 hydrocarbons by GC analysis of canisters
GGC	Gordon	GGC carbon cartridges for alcohols	LBCC	0	5	01, 06, 10, 14, 18	Ethanol, methanol
GGC	Gordon	GGC carbon cartridges for alcohols	LBCC	0	5	01, 06, 10, 14, 18	Ethanol, methanol
UCR	Winer	DOAS for NO3, HNO2, HCHO, NO3	LBCC	0	cont.*	-	NO2, HNO2, HCHO

Table 3-6. "A site" And Other Specialty Measurements During The Summer Study Period.

(11/28/89)

Group(s)†	PI	Measurement	Site†	No. of Samples Non-Int.	Inten.	Sampling Times(PDT)††	Parameters
Aerosol Measurements							
AIHL-A	Appel	Continuous particle sulfur	LBCC	0	cont.*	-	Particle sulfur
GGC	Gordon	HiVol: contemporary carbon (C14)	LBCC	0	1	09-09	C12/C14 ratios
UCD	Cahill	IMPROVE cyclone, Teflon filter	LBCC	5	5	01, 06, 10, 14, 18	PM-2.5 elements & mass (grav,PIXE,FAST,PESA)
UCR	Atkinson	HiVol for PAH	LBCC	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UCR	Atkinson	HiVol for PAH	LBCC	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UCR	Atkinson	HiVol with PUF	LBCC	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UV	Reischl	Classifier for fine dN/dDp	LBCC	cont.*	cont.*	-	dN/dlogDp 0.003 - 0.15 µm
Acidic Particle and Vapor Samplers							
AIHL-A	Appel	Annular denuder #1 for HNO2, HNO3	LBCC	0	5	01, 06, 10, 14, 18	HNO2, HNO3 (Na2CO3-glycerol coating)
AIHL-A	Appel	Annular denuder #2 for NH3	LBCC	0	5	01, 06, 10, 14, 18	NH3 (citric acid - glycerol coating)
EPA-SSB	Knapp	Trans Flow Rtr (Funnel-TFR(Ny,Nl)-T,N,CA,TEA)	LBCC	0	5	01, 06, 10, 14, 18	SO4, NO3, HNO3, NH3, NH4, SO2, NO2
SCE/AV	Ellis/Filek	AV 2000 Doppler acoustic sounder	LBCC	hourly	hourly	-	Winds aloft to 750 m AGL, mixing & inversion heights, stability.
TBS	Lehrman	Rawinsonde	LBCC	0	6	00, 05, 08, 11, 14, 17, 22	T, DP, WS, WD, Press
Specialty Measurements at Other Ground Sites							
GGC	Gordon	HiVol: contemporary carbon (C14)	RIVR	0	1	09-09	C12/C14 ratios
UCD	Cahill	IMPROVE Cyclone, Teflon filter	RIVR	5	5	01, 06, 10, 14, 18	PM-2.5 elements & mass (grav,PIXE,FAST,PESA)
EPA-SSB	Knapp	Trans Flow Rtr (Funnel-TFR(Ny,Nl)-T,N,CA,TEA)	RIVR	0	5	01, 06, 10, 14, 18	SO4, NO3, HNO3, NH3, NH4, SO2, NO2
UI	Rood	UI nephelometer experiment	RIVR	-	cont.*	-	Particle scattering and humidigraphs
SCE/AV	Ellis/Thelen	Edison AQML: measure temperature, dewpoint	LSAL	hourly	hourly	-	T, DP
SCE/AV	Ellis/Thelen	Edison AQML: measure winds	LSAL	hourly	hourly	-	WS, WD
ARB-HS	Kowalski	Eppley UV pyranometer	MWS	cont.*	cont.*	-	UV light intensity
SCE/AV	Ellis/Thelen	Edison AQML: Beckman 866 CO	LSAL	hourly	hourly	-	CO
SCE/AV	Ellis/Thelen	Edison AQML: CSI 1600 NOx	LSAL	hourly	hourly	-	NO, NOx
SCE/AV	Ellis/Thelen	Edison AQML: Dasibi 1003 AH	LSAL	hourly	hourly	-	O3
SCE/AV	Ellis/Thelen	Edison AQML: Meloy SA 285E SO2	LSAL	hourly	hourly	-	SO2
SCE/AV	Ellis/Thelen	Edison AQML: Beckman dichotomous sampler	LSAL	0	2	00, 12	PM-10, PM-2.5 elements by XRF, ions (IC)
SCE/GGC	Ellis/Gordon	Dichotomous samplers	DU	1	1	12-18	PM<3.5µm, PM>3.5µm, elements by PIXE.
SCE/GGC	Ellis/Gordon	PM3.5 HiVol	DU	1	1	12-18	PM-3.5, SO4, NO3, NO2, PO4, CL, F, Br, NH4, H
SCE/UCLA-1	Ellis/Allen	Low pressure impactor/FTIR	DU	1	1	24 hr sample @ 6 am	Aerosol functional groups distribution (0.05, 0.075, 0.12, 0.26, 0.5, 1, 2µm)
UCLA-K	Kaplan	Peroxide	DU				H2O2
EPA-GKP	Lonneman/Ellenson	Aldehydes (DNPH SEP packs)	CELA	1	1	06 - 09	Aldehydes (by HPLC analysis)
EPA-GKP	Lonneman/Ellenson	HC canisters	CELA	1	1	06 - 09	C1-C12 Hydrocarbons by GC analysis of canisters
UCLA-2	Friedlander	Tunnel sampling: emissions	VNT	-	-	Misc. during September	Tunnel Pb size distribtutions (LPI)
DRI	Bowen	CADMP-DRI acid sampler	AZUS	1	2	06, 18	PM-10 & PM-2.5 mass, SO4, NO3, Cl, NH4, Mg, K, Na, Ca, SO2, NO2, NH3, HNO3
DRI	Bowen	CADMP-DRI acid sampler	CELA	1	2	06, 18	PM-10 & PM-2.5 mass, SO4, NO3, NH4, SO2, NO2, NH3, HNO3
DRI	Bowen	CADMP-DRI acid sampler	LBGH	1	2	06, 18	PM-10 & PM-2.5 mass, SO4, NO3, Cl, NH4, Mg, K, Na, Ca, SO2, NO2, NH3, HNO3
CIT-fog	Hoffmann	Cloud/fog water chemistry	-				
GMRL	Kelly	GMRL smog chambers	CELA	yes	yes	June 10 - July 4	Captive air photochemistry experiments

† Group abbreviations are in Table 3-6a. Most site abbreviations are in Tables 2-1 and 3-1. Other sites are: DU=Duarte, MWS=Mt. Wilson, VNT=Van Nuys tunnel.

†† Sampling times are expressed as PDT unless otherwise stated. Times listed are sample start times. Unless otherwise stated, sampling extended to within 30 minutes of the next start time.

* Continuous sampling =cont.

** Located at Seaver Hall (Pomona College chemistry building) for sampling from June 15 through July 24; at Headquarters Trailer (CLAR) for sampling from August 18 through September 4.

Table 3-6a. Abbreviations for Research Groups Listed in Tables 3-3, 3-5, 3-6, and 3-7.

AIHL-A	B. Appel, AIHL, California Dept. Health Services, Berkeley, CA 94704
AIHL-J W.	W. John, AIHL, California Dept. Health Services, Berkeley, CA 94704
ARB-HS	J. Kowalski, California Air Resources Board, El Monte, CA 91731
ARB-Sacr.	B. Croes, California Air Resources Board, Sacramento, CA 95812
AV	M. Chan, J. Thelen, AeroVironment, Monrovia, CA 91016
BRC	R. Rasmussen, Biospherics Research Corp., Hillsboro, OR 97124
C-E	C-E Environmental, Inc., formerly EMSI
CIT-fog	M. Hoffmann, California Institute of Technology, Pasadena, CA 91125
CMU	C. Davidson, Carnegie-Mellon University, Pittsburgh, PA 15213
CSI	Columbia Scientific, Inc.
DGA	D. Grosjean, Daniel Grosjean and Associates, Ventura, CA 93003
DRI	J. Bowen, D. Rogers, Desert Research Institute, Reno, NV 89506
EMSI	W. Keifer, R. Countess, M. Lev-On, Environmental Monitoring and Services, Inc., Camarillo, CA 93010, now called C-E Environmental, Inc.
EPA-GKP	W. Lonneman, Gas and Kinetics Branch, USEPA, Research Triangle Park, NC 27711
EPA-NSI	W. Ellenson, Northrop Services, Inc., Research Triangle Park, NC 27709
EPA-SSB	K. Knapp, Stationary Source Branch, EPA, Research Triangle Park, NC 27711
ENSR	B. Wright, K. Fung, S. Heisler, formerly ERT, Camarillo, CA 93010
Ford	K. Adams, Ford Company, Dearborn, MI 48121
GGC	R. Gordon, Global Geochemistry Inc., Canoga Park, CA 91303
GMRL	G. Wolff, N. Kelly, General Motors Research Labs., Warren, MI 48090-9055
IIT	K. Noll, Illinois Institute of Technology, Chicago, IL 60616
LBL	T. Novakov, Lawrence Berkeley Labs., Berkeley, CA 94720
NEA	J. Cooper, NEA Inc., Beaverton, OR 97005
OGC	J. Huntzicker, Oregon Graduate Center, Beaverton, OR 97006-1999
RR	R. Weiss, Radiance Research, Seattle, WA, 98177
SCAQMD	W. Bope, South Coast Air Quality Management District, El Monte, CA 91731
SCE	C. Ellis, Southern California Edison Company, Rosemead, CA 91770
STI-R	L.W. Richards, Sonoma Technology, Inc., Santa Rosa, CA 95403-1083
TBS	D. Lehrman, Technical & Business Systems, Santa Rosa, CA 95404
Tracer	Tracer Technologies, San Diego, CA 92121
UCD	T. Cahill, University of California, Davis, CA 95616
UCLA-1	D. Allen, University of California, Los Angeles, CA 90024
UCLA-2	S. Friedlander, University of California, Los Angeles, CA 90024
UCLA-K	I. Kaplan, University of California, Los Angeles, CA 90024
UCR	A. Winer, R. Atkinson, University of California, Riverside, CA 92521
UD	D. Stedman, University of Denver, Denver, CO 80208-0179
UI	M. Rood, University of Illinois, Urbana-Champaign, Urbana, IL 61801
UM	P. McMurry, University of Minnesota, Minneapolis, MN 55455
Uni	G. Mackay, Unisearch Associates, Concord, Ontario L4K 1B5 Canada
UV	R. Reischl, University of Vienna, A-1090 Vienna, Austria
UV-vis	R. Hitzenberger, University of Vienna, A-1090 Vienna, Austria
UW	University of Washington, Seattle, WA

Table 3-7. "A site" And Other Specialty Measurements During The Fall Study Period.

(11/28/89)

Group(s)†	PI	Measurement	Site†	No. of samples Non-Int	No. of samples Inten.	Sampling Times(PST)††	Parameters
Meteorological Measurements							
AIHL-A	Appel	Dasibi 1003: O3	LBCC	0	cont.*	-	O3
AIHL-A	Appel	EG&G 911: T, RH	LBCC	0	cont.*	-	T, RH
GMRL	Wolff	Acoustic sounder	LBCC	cont.*	cont.*	-	
TBS	Lehrman	Rawinsonde	LBCC	0	6	05, 08, 11, 14, 17, 22	T, DP, WS, WD, Press
Reactive Gaseous Species							
AIHL-A	Appel	Teco 14B/E with Na2CO3 denuder: NO, NOx	LBCC	0	cont.*	-	NO,NOx, NOy=NO2 interferents
DGA	Grosjean	Impingers (H2O, chloroform, 0.16L/m)	LBCC	0	6	1-hr@05,07,09,12,14,16	Organic acids
DGA	Grosjean	KOH cartridges (1.5L/m)	LBCC	0	6	1-hr@05,07,09,12,14,16	Organic acids
ENSR	Fung	Integrated PAN sampler	LBCC	-	8	06,10,12,13,14,15,16,18	PAN on 12/3, 12/10 &12/11 only
GGC	Gordon	GGC carbon cartridges for alcohols	LBCC	0	5	00, 06, 10, 14, 18	Ethanol, methanol
UCR	Winer	DOAS for NO2, HNO2, HCHO	LBCC	cont.*	cont.*	-	NO2, HNO2, HCHO
UCR	Atkinson	Tenax column for PAHs	LBCC	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
Uni	Mackay	Dasibi 1008AH: O3	LBCC	cont.*	cont.*	-	O3
Uni	Mackay	NO2, NO+NO2 by Luminox	LBCC	cont.*	cont.*	-	NO2, NO+NO2
Uni	Mackay	O3 by Eysin dye chemiluminesence	LBCC	cont.*	cont.*	-	O3
Uni	Mackay	PAN by GC Luminox	LBCC	cont.*	cont.*	-	PAN
Uni	Mackay	TDLAS for H2O2, HCHO	LBCC	cont.*	cont.*	-	H2O2, HCHO
Aerosol Measurements							
ARB-Sacr.		MDA BAM sampler (Beta gauge)	LBCC	24	24	hourly	PM10 mass, hourly averages
DGA	Grosjean	Teflon filter (30 L/m)	LBCC	0	6	1-hr@05,07,09,12,14,16	Organic acids
EPA-SSB	Knapp	Three quartz in series (47mm)	LBCC	0	2	00, 12	OC, EC
EPA-SSB	Knapp	HiVol with quartz filters	LBCC	0	2	00, 12	OC, EC, perhaps speciated HC
EPA-SSB	Knapp	HiVol with quartz filters	LBCC		multiday	-	OC, EC, perhaps speciated HC
EPA-SSB	Knapp	Open faced quartz	LBCC	0	2	00, 12	OC, EC
EPA-SSB	Knapp	Tefl-Nyl Filter Pack	LBCC	0	5	00, 06, 10, 14, 18	HNO3, NO3-
GGC	Gordon	HiVol: contemporary carbon	LBCC	0	1	09-09	C12/C14 ratios
GM	Wolff	SCAQS sampler	LBCC	2	2	06, 18	Aerosol chemistry, HNO3, NH3, SO2
OGC	Huntzicker	Single port for Pb/Br	LBCC	0	1	00-05	Pb, Br
OGC	Huntzicker	Six-port, cumulative OC, EC distribution	LBCC	0	5	06, 10, 14, 18, 20	Cumulative OC, EC (0.3,0.5,1,2.5,10 µm)
OGC	Huntzicker	In-situ carbon	LBCC	~12	~12	semi-cont.*	Semi-continuous OC, EC
UCD	Cahill	IMPROVE cyclone, Teflon filter	LBCC	0	5	00, 06, 10, 14, 18	Elements & mass (grav,PIXE,FAST,PESA)
UCR	Atkinson	Two SSI HiVols	LBCC	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UCR	Atkinson	HiVol with PUF	LBCC	0	2	06, 18	PAHs, nitro & dinitro PAHs (gc-ms)
UV	Reischl	Classifier for fine dN/dDp	LBCC	cont.*	cont.*	-	dN/dlogDp 0.003-0.15 µm
Acidic Particle and Vapor Samplers							
AIHL-A	Appel	Annular denuder #1 for HNO2, HNO3	LBCC	0	5	00, 06, 10, 14, 18	HNO2, HNO3 (Na2CO3-glycerol coating)
AIHL-A	Appel	Annular denuder #2 for NH3	LBCC	0	5	00, 06, 10, 14, 18	NH3 (citric acid - glycerol coating)
EPA-SSB	Knapp	ERT-type Trans Flow Rtr	LBCC	0	5	00, 06, 10, 14, 18	HNO3
EPA-SSB	Knapp	Trans Flow Rtr (Cycl -TFR(Ny,Nl)-T,N,CA)	LBCC	0	1	00-24	SO4, NO3, HNO3, NH3, NH4
EPA-SSB	Knapp	Trans Flow Rtr (Cycl-TFR(Ny,Nl)-T,N,CA,TEA)	LBCC	0	5	00, 06, 10, 14, 18	SO4, NO3, HNO3, NH3, NH4, SO2, NO2
EPA-SSB	Knapp	Trans Flow Rtr (Funnel-TFR(Ny,Nl)-T,N,CA)	LBCC	0	5	00, 06, 10, 14, 18	SO4, NO3, HNO3, NH3, NH4
Visibility Parameters							
LBL	Novakov	Aethalometer	LBCC	cont.*	cont.*	(started 12/3/87)	Black carbon and b absorption
UV-vis	Hitzenberger	Nuclepore filter for Babs	LBCC	0	5	00, 06, 10, 14, 18	Particle absorption
UV-vis	Hitzenberger	Telephotometer: 10 wavelengths	LBCC	0	cont.* day		Contrast: 10 wavelengths (400-750 nm)

Table 3-7. "A site" And Other Specialty Measurements During The Fall Study Period.

(11/28/89)

Group(s)†	PI	Measurement	Site†	No. of samples Non-Int	No. of samples Inten.	Sampling Times(PST)††	Parameters
Other Measurements and Special Experiments							
CIT-fog	Hoffmann	Fog sampler & filters (on GM van roof)	LBCC	-	-	Collection during fog events	Fog: SO4, NO3, Na, Cl, Ca, Mg, pH, S(IV), carbonyls, organic acids
EPA-SSB	Knapp	GC (in-situ hydrocarbon canister analyses)	LBCC	-	-	-	Hydrocarbon analyses of SCAQS network canisters
EPA-SSB	Knapp	GC-mass spec. (in-situ HC analyses)	LBCC	-	-	-	Hydrocarbon analyses of SCAQS network canisters
Special Measurements at Other Sites							
UCD	Cahill	IMPROVE cyclone, Teflon filter	CELA	0	5	00, 06, 10, 14, 18	PM-2.5 elements & mass (grav,PIXE,FAST,PESA)
UV	Reischl	Classifier for fine dN/dDp	CELA	cont.*	cont.*	-	dN/dlogDp 0.003-0.15 µm
EPA-SSB	Knapp	Trans Flow Rtr (Funnel-TFR(Ny,Nf)-T,N,CA,TEA)	CELA	0	4	06, 10, 14, 18	SO4, NO3, HNO3, NH3, NH4, SO2, NO2
SCE/GGC	Ellis/Gordon	Dichotomous samplers	DU	1	1	12-18	PM<3.5µm, PM>3.5µm, elements by PIXE.
SCE/GGC	Ellis/Gordon	PM-3.5 HiVol	DU	1	1	12-18	PM-3.5, SO4, NO3, NO2, PO4, CL, F, Br, NH4, H
SCE/AV	Ellis/Filek	AV 2000 Doppler acoustic sounder	ESUA	hourly	hourly	-	Winds aloft to 750 m AGL, mixing & inversion heights, stability.
SCE/AV	Ellis/Thelen	Edison AQML: Beckman 866 CO	HAWT	hourly	hourly	-	CO
SCE/AV	Ellis/Thelen	Edison AQML: CSI 1600 NOx	HAWT	hourly	hourly	-	NO, NOx
SCE/AV	Ellis/Thelen	Edison AQML: Dasibi 1003 AH	HAWT	hourly	hourly	-	O3
SCE/AV	Ellis/Thelen	Edison AQML: Meloy SA 285E SO2	HAWT	hourly	hourly	-	SO2
SCE/AV	Ellis/Thelen	Edison AQML: Weathermeasure T, DP	HAWT	hourly	hourly	-	T, DP
SCE/AV	Ellis/Thelen	Edison AQML: Weathermeasure winds	HAWT	hourly	hourly	-	WS, WD
CIT-fog	Hoffmann	Fog sampler & filter sampler	LBS	-	-	Collection during fog events	Teflon/Nylon filters: SO4, NO3, Na, Cl, Mg, HNO3
CIT-fog	Hoffmann	Fog sampler & filter sampler	RIVR	-	-	Collection during fog events	Teflon/Oxalic acid filters: NH3, SO4, NO3, Na, Cl, Mg
CIT-fog	Hoffmann	Fog sampler & filter sampler	RIVM	-	-	Collection during fog events	Same set-up at all four sites.

† Group abbreviations are in Table 3-6a. Most site abbreviations are given in Tables 2-1 and 3-1. Other sites are: DU=Duarte, ESUA=El Segundo power plant, and LBS=Long Beach State University.

†† Times are sample start times. Unless otherwise stated, sampling extended to within 30 minutes of the next start time.

* cont.=continuous sampling

4. SURFACE AND UPPER AIR METEOROLOGY MEASUREMENTS

4.1 SITES AND THEIR LOCATIONS

Sites for surface and upper air meteorological measurements are shown in Figure 4-1, and listed in Table 4-1. These include existing monitoring networks as well as sites added specifically for SCAQS. Surface measurements refer to measurements within 10 m of the ground. Upper air sites were locations used to obtain vertical profiles of meteorological parameters from the surface to altitudes of 10,000 feet (3000 m) msl or higher. The surface meteorological sites are designated as "A", "B", "C", "M", or "S" sites. "A", "B", and "C" sites were defined in Section 2.3. Sites labeled as "M" are the surface meteorological sites installed specifically for SCAQS. Sites labeled "S" are supplemental meteorological sites for which data will be archived. Sites labeled "U" are the SCAQS upper-air sounding locations. Surface meteorological parameters reported from each site are listed in Table 4-1 and described below.

4.2 SURFACE METEOROLOGY MEASUREMENTS

4.2.1 Data From Existing Monitoring Networks

Most surface observations were obtained from the following existing monitoring networks:

> SCAQMD air quality monitoring stations
> Ventura Co. APCD air quality monitoring stations
> National Weather Service stations
> Mineral Management Services buoy sites
> California Irrigation Management Information Service sites
> Department of Defense military bases

The air quality monitoring stations report hourly averaged values for wind speed and wind direction. Some also report hourly averaged temperature and humidity.

Most of the National Weather Service stations and military sites are located at airports and report hourly observations for wind speed and direction, temperature, dew point, pressure, cloud cover and visual range. Generally, these observations are made 15 to 10 minutes before the hour. Observations at airports are restricted to hours of control tower operations, and often are not available during nighttime hours. One NWS station, located on Mt. Wilson, reports only four observations per day, at 0400, 1000, 1600 and 2200 PST.

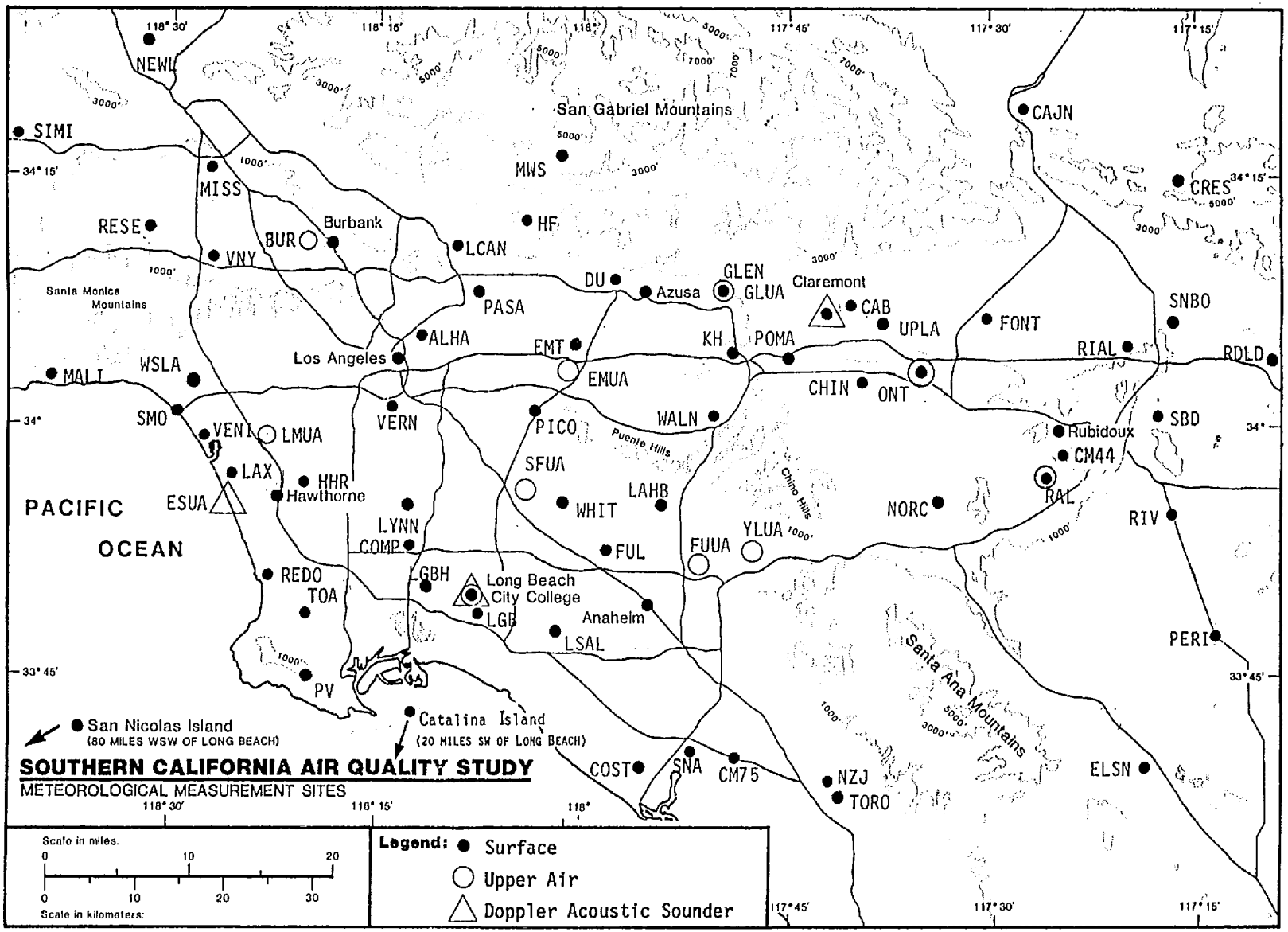


Figure 4-1. SCAQS Surface and Upper Air Meteorology Measurement Locations. (Site codes are listed in Tables 4-1 and 4-2.)

Table 4-1. SCAQS Meteorology Measurement Sites

Code	Type*	Site Name	Latitude	Longitude	Elev. (m msl)	County	WS	WD	T	RH
CLAR	A	Claremont College	34 6' 7"	117 42'14"	364	Los Angeles	*	*	*	*
LBCC	A/U	Long Beach City College	33 49'49"	118 8'18"	17	Los Angeles	*	*	*	
ANAH	B	Anaheim	33 49'16"	117 55' 7"	41	Orange	*	*	*	*
AZUS	B	Azusa	34 8' 9"	117 55'23"	90	Los Angeles	*	*	*	*
BURK	B	Burbank	34 10'58"	118 18'27"	168	Los Angeles	*	*	*	*
CELA	B+	Los Angeles-North Main	34 4' 2"	118 13'31"	87	Los Angeles	*	*	*	*
HAWT	B	Hawthorne	33 55'23"	118 22' 9"	21	Los Angeles	*	*	*	*
RIVR	B+	Riverside-Rubidoux	33 59'59"	117 25' 1"	214	Riverside	*	*	*	*
SNI	B	San Nicolas Island	33 15'24"	119 29' 9"	122	Ventura	*	*	*	*
ALA	C	Alamitos Generating Station	33 46'13"	118 6' 7"		Los Angeles	*	*	*	*
BANN	C	Banning-Allesandro	33 55'40"	116 52'25"	722	Riverside	*	*		
COST	C	Costa Mesa-Placentia	33 39'22"	117 55'47"	25	Orange	*	*		
FONT	C	Fontana-Arrow Highway	34 5'58"	117 30'18"	381	San Bernardino	*	*		
GLEN	C	Glendora-Laurel	34 8'35"	117 51' 4"	275	Los Angeles	*	*	*	
HEME	C	Hemet-State Street	33 45'57"	116 58'10"	469	Riverside	*	*		
LAHB	C	La Habra	33 55'34"	117 57' 3"	82	Orange	*	*		
LGBH	C	North Long Beach	33 49'25"	118 11'19"	7	Los Angeles	*	*	*	
LSAL	C	Los Alamitos-Orangewood	33 47'45"	118 1'55"	10	Orange	*	*		
LYNN	C	Lynwood	33 55'45"	118 12'35"	27	Los Angeles	*	*		
NEWL	C	Newhall-County Fire Station	34 23'15"	118 32' 1"	375	Los Angeles	*	*		
NORC	C	Norco-Norconian	33 55'14"	117 34'17"	220	Riverside	*	*		
PASA	C	Pasadena-Wilson	34 8' 1"	118 7'37"	250	Los Angeles	*	*	*	
PERI	C	Perris	33 47' 0"	117 14' 0"	439	Riverside	*	*		
PICO	C	Pico Rivera	34 0'54"	118 3'30"	69	Los Angeles	*	*	*	
POMA	C	Pomona	34 4' 1"	117 45' 3"	270	Los Angeles	*	*		
RESE	C	Reseda	34 11'58"	118 32' 0"	226	Los Angeles	*	*		
SIMI	C	Simi Valley-5400 Cochran	34 16'39"	118 41' 5"	310	Ventura	*	*	*	
SNBO	C	San Bernardino	34 6'26"	117 16'24"	317	San Bernardino	*	*		
TORO	C	El Toro	33 40' 0"	117 44' 0"	117	Orange	*	*		
UPLA	C	Upland ARB	34 6'13"	117 37'42"	369	San Bernardino	*	*	*	
WHIT	C	Whittier	33 55'25"	118 1'29"	58	Los Angeles	*	*		
WSLA	C	West Los Angeles-VA Hospital	34 3' 3"	118 27'19"	91	Los Angeles	*	*		
CA	M	Santa Catalina Island	33 24' 0"	118 25' 0"	482	Los Angeles	*	*		
HF	M	Henninger Flats	34 12' 2"	118 4'43"	1006	Los Angeles	*	*		
KH	M	Kellogg Hill	34 4'48"	117 49'19"	381	Los Angeles	*	*		
PV	M	Palos Verdes-San Pedro Hill	33 44'46"	118 20'12"	442	Los Angeles	*	*		
ALHA	S	Alhambra	34 5'30"	118 8'37"		Los Angeles	*	*		
BARS	S	Barstow	34 53'38"	117 1'24"	692	San Bernardino	*	*		
BU23	S	Buoy 46023-Point Conception	34 18' 0"	120 42' 0"	0	Pacific Ocean	*	*	*	*
BU25	S	Buoy 46025-Catalina Ridge	33 42' 0"	119 6' 0"	0	Pacific Ocean	*	*	*	*
BUO	S	Beaumont	33 56' 0"	116 57' 0"	792	Riverside	*	*	*	*
CAB	S	Cable Airport - Pomona	34 07'	117 41'	442	Los Angeles	?			
CAJN	S	Cajon Summit	34 20' 0"	117 25' 0"	1219	San Bernardino	*	*	*	*
CASI	S	BLM-Casitas/Los Padres NF	34 24' 0"	119 22' 0"	189	Ventura	*	*	*	*
CHIL	S	BLM-Chilao/Angeles NF	34 19'48"	118 2'12"	1661	Los Angeles	*	*	*	*
CHIN	S	Chino	34 0'39"	117 41'15"		San Bernardino	*	*		
CM36	S	CIMIS-Blythe	33 38'53"	114 33'40"	82	Riverside	*	*	*	*
CM44	S	CIMIS-U.C. Riverside	33 57'54"	117 20' 8"	311	Riverside	*	*	*	*
CM50	S	CIMIS-Thermal	33 38'47"	116 14'30"	-9	Riverside	*	*	*	*
CM55	S	CIMIS-Palm Desert	33 43'50"	116 22'57"	61	Riverside	*	*	*	*
CM58	S	CIMIS-Santa Paula	34 18' 6"	119 7' 8"	53	Ventura	*	*	*	*
CM60	S	CIMIS-Barstow	34 54'12"	117 6'54"	664	San Bernardino	*	*	*	*
CM62	S	CIMIS-Temecula	33 29'25"	117 13'20"	433	Riverside	*	*	*	*
CM75	S	CIMIS-Irvine	33 41'19"	117 43'14"	125	Orange	*	*	*	*
COMP	S	Compton Airport	33 53'19"	118 14'17"	29	Los Angeles	*	*		
CRES	S	Lake Gregory-Crestline	34 14'38"	117 16'27"	1384	San Bernardino	*	*		
DAG	S	Barstow-Daggett Airport	34 51'12"	116 47'12"	587	San Bernardino	*	*	*	*
DU	S	Duarte	34 08'	117 57'	220	Los Angeles	?			
ELRI	S	El Rio-Rio Mesa School	34 15'15"	119 8'36"	34	Ventura	*	*	*	
ELSN	S	Elsinore	33 40'30"	117 20'55"		Riverside	*	*		
EMT	S	El Monte Airport	34 5'12"	118 2' 0"	90	Los Angeles	*	*		

Table 4-1. SCAQS Meteorology Measurement Sites

Code	Type*	Site Name	Latitude	Longitude	Elev. (m msl)	County	WS	WD	T	RH
ESUA	S	El Segundo - SCE Power Plant	33 55'	118 25'	35	Los Angeles				
FUL	S	Fullerton Municipal Airport	33 52'18"	117 58'42"	29	Orange	*	*	*	*
HESP	S	Hesperia-17288 Olives	34 25' 5"	117 17' 5"	1000	San Bernardino	*	*		
HHR	S	Hawthorne Muncipal Airport	33 55'24"	118 20' 6"	19	Los Angeles	*	*		
LANC	S	Lancaster	34 42'44"	118 8'21"	709	Los Angeles	*	*		
LAX	S	Los Angeles International Airport	33 56'36"	118 24'24"	38	Los Angeles	*	*	*	*
LCAN	S	La Canada	34 12'42"	118 12'49"		Los Angeles	*	*		
LGB	S	Long Beach-Daugherty Field	33 49' 6"	118 9' 0"	17	Los Angeles	*	*	*	*
MALI	S	Malibu	34 1'59"	118 41'23"		Los Angeles	*	*		
MISS	S	Mission Hills	34 16'23"	118 27'55"		Los Angeles	*	*		
MWS	S	Mount Wilson	34 14' 0"	118 4' 0"	1741	Los Angeles	*	*	*	*
NUC	S	San Clemente Island Airport	33 1' 0"	118 35' 0"	276	Los Angeles	*	*	*	*
NZJ	S	Santa Ana-El Toro Airport	33 40' 0"	117 43' 0"	119	Orange	*	*	*	*
OJAI	S	Ojai-1768 Maricopa Highway	34 26'48"	119 16'13"	231	Ventura	*	*	*	
OXR	S	Oxnard Airport	34 12' 6"	119 12'24"	13	Ventura	*	*	*	*
PLSP	S	Palm Springs-Fire Station	33 51' 9"	116 32'25"	171	Riverside	*	*		
PMD	S	Palmdale	34 38' 0"	118 5' 0"	774	Los Angeles	*	*		
POC	S	La Verne-Brackett Field	34 5'30"	117 46'54"	308	Los Angeles	*	*		
PSP	S	Palm Springs Municipal Airport	33 49'36"	116 30'12"	141	Riverside	*	*	*	
RDLD	S	Redlands-Dearborn	34 3'36"	117 9'35"	520	San Bernardino	*	*		
REDO	S	Redondo Beach	33 50'51"	118 23' 1"		Los Angeles	*	*		
RIAL	S	Rialto	34 7'33"	117 24'24"		San Bernardino	*	*		
RIV	S	Riverside-March AFB	33 54' 0"	117 15' 0"	467	Riverside	*	*	*	*
SBA	S	Santa Barbara Municipal Airport	34 25'36"	119 50'24"	3	Santa Barbara	*	*	*	*
SBD	S	San Bernardino-Norton AFB	34 6' 0"	117 14' 0"	352	San Bernardino	*	*	*	*
SMO	S	Santa Monica Muncipal Airport	34 1' 0"	118 27' 6"	53	Los Angeles	*	*	*	*
SNA	S	Santa Ana-John Wayne Airport	33 40'30"	117 52' 0"	16	Orange	*	*	*	*
TANB	S	BLM-Tanbark/Angeles NF	34 12'15"	117 45'30"	792	Los Angeles	*	*	*	*
TEME	S	BLM-Temescal/Los Padres NF	34 29' 0"	118 36' 0"	323	Ventura	*	*	*	*
TOA	S	Torrance Muncipal Airport	33 48'12"	118 20'18"	31	Los Angeles	*	*	*	*
TRM	S	Thermal Airport	33 37'36"	116 9'48"	-36	Riverside	*	*	*	*
TRON	S	Trona-Market Street	35 45'35"	117 42'25"	506	San Bernardino	*	*		
VCTC	S	Victorville-Civic Drive	34 30'35"	117 19'10"	876	San Bernardino	*	*		
VCV	S	Victorville-George AFB	34 35' 0"	117 23' 0"	876	San Bernardino	*	*	*	*
VENI	S	Venice Beach	33 59' 4"	118 28'13"		Los Angeles	*	*		
VENT	S	Ventura-Emma Wood State Beach	34 17'24"	119 18'49"	3	Ventura	*	*	*	
VERN	S	Vernon	33 59'56"	118 13' 9"		Los Angeles	*	*		
VNY	S	Van Nuys Airport	34 12'36"	118 29'24"	244	Los Angeles	*	*	*	*
WALN	S	Walnut	34 2'57"	117 50'30"		Los Angeles	*	*		
WJF	S	Lancaster-Gen. William J. Fox Airfield	34 44'30"	118 13' 6"	715	Los Angeles	*	*	*	*
WSPR	S	BLM-Warm Springs/Angeles NF	34 35'44"	118 34'44"	1225	Los Angeles	*	*	*	*
ZUMA	S	Zuma Beach	34 1'20"	118 49'37"		Los Angeles	*	*		
EMUA	U	El Monte-9528 Telstar	34 4' 4"	118 3'39"	76	Los Angeles				
FUUA	U	Fullerton-SCE Maintenance Yard	33 52' 0"	117 56'54"	30	Orange				
GLUA	U	Glendora-near SCAQMD site 7000591	34 8'39"	117 51' 0"	277	Los Angeles				
LMUA	U	Loyola Marymount Univ.-Engng Bldg	33 58'40"	118 24'48"	45	Los Angeles				
SFUA	U	Santa Fe Springs-Public Works Yard	33 56'19"	118 3'37"	37	Los Angeles				
YLUA	U	Yorba Linda County Park	33 56' 1"	117 46'18"	88	Orange				
BUR	U/S	Burbank/Glendale/Pasadena Airport	34 12' 0"	118 21'30"	236	Los Angeles	*	*	*	*
EDW	U/S	Edwards AFB	34 54' 0"	117 52' 0"	702	Kern County	*	*	*	*
MYF	U/S	San Diego-Montogomery Airport	32 48' 0"	117 8'24"	128	San Diego				
NSI	U/S	San Nicolas Island	33 14' 0"	119 27' 0"	14	Ventura	*	*	*	*
NTD	U/S	Pt. Mugu Naval Weapons Test Center	34 7' 0"	119 7' 0"	2	Ventura	*	*	*	*
ONT	U/S	Ontario International Airport	34 3'24"	117 36'12"	290	San Bernardino	*	*		
RAL	U/S	Riverside Municipal Airport	33 57' 6"	117 26'42"	249	Riverside	*	*		
VBG	U/S	Vandenberg AFB	34 43' 0"	120 34' 0"	112	Santa Barbara				

* "A", "B", and "C" sites are defined in Section 2.3. Other site types are: M=SCAQS surface meteorology sites, S=supplemental meteorology sites, U=upper-air meteorology sites. Those site locations in the study area are shown on Figure 4-1.

Meteorological parameters reported by the buoy sites operated by the Mineral Management Services include wind speed and direction, temperature, dew point, sea temperature, and pressure. The California Irrigation Management Information System network gives hourly averaged winds, temperature, and humidity at 2 m.

4.2.2 Data From SCAQS Sites

Surface meteorological data obtained specifically for SCAQS included observations at:

> SCAQS "B" sites which were not collocated with existing SCAQMD sites at San Nicolas (summer), Claremont (summer) and Long Beach (summer and fall); and

> meteorology only sites at remote hillside locations on Catalina Island, Palos Verdes and Kellogg Hill (San Dimas), and in the summer at Henninger Flats (north of Pasadena).

All of the SCAQS "B" Sites reported hourly averaged temperature and dew point as well as hourly averaged winds. At their Hawthorne, Los Angeles, Anaheim, Burbank, Azusa and Rubidoux sites, the SCAQMD installed temperature and dew point instruments as needed and these data are available for both the summer and fall study periods. At the San Nicolas Island and Claremont "B" sites, the hourly averaged surface temperature, dew point and winds are available for the summer study period only. At the Long Beach "B" site, surface data were collected during both the summer and fall studies. Groups responsible for these measurements at each "B" site are listed in Table 3-3.

The four SCAQS meteorological stations provided hourly averaged temperature, wind direction and speed throughout the study periods. Three of these sites, Kellogg Hill, San Pedro Hill and Catalina Island, were used in the fall study. The Catalina Island site was picked to give winds offshore; the Kellogg Hill site was chosen to give ridgetop winds in the region separating the western and eastern portions of the Basin; the Henninger Flats site was used to measure slope flows representative of the mountain regions. Palos Verdes and Kellogg Hill give winds at 451 and 381 m above sea level, respectively. These measurements were obtained with battery powered, mechanical weather stations (MRI, now Belfort Instruments). The temperature sensor is a bimetallic strip with a resolution of 0.2 ^{o}C. Winds are detected by a wind vane and three cup anemometer.

4.3 UPPER AIR METEOROLOGY MEASUREMENTS

4.3.1 Overview

Most of the measurements of vertical profiles of winds, pressure, temperature and humidity were obtained using rawinsondes and Airsondes, which are small, radio-equipped weather balloons. The rawinsondes used in this study use a LORAN tracking system for deriving winds and report all data up to

altitudes of 3300 m (700 mb) or higher. Airsondes measure temperature and humidity data to the same altitudes, but because the wind data are derived by visual tracking, the vertical range for winds may be limited by cloud cover and visibility. In SCAQS, the rawinsonde and Airsonde data were supplemented by a Doppler acoustic sounder and by aircraft measurements of temperature and dew point aloft.

4.3.2 Rawinsonde and Airsonde Data from Existing Monitoring Stations

Upper air data are gathered routinely at a SCAQMD Airsonde site at Loyola Marymount University (Los Angeles, approximately 2.5 km north of LAX) and at rawinsonde sites operated by military personnel at Vandenberg Air Force Base (Lompoc) and for the NWS at Montgomery Airport (San Diego). At Loyola Marymount, sondes are launched twice daily (0500 and 1100 PST) May through October, and once daily (0500 PST) November through April. At Vandenberg and San Diego, sondes are launched twice daily (0400 and 1600 PST) throughout the year. Additional rawinsonde data are available from the military at Pt. Mugu and San Nicolas Island Naval Stations, and Edwards Air Force Base. Times of observations are variable and dependent on their operations. Site locations are listed in Table 4-1. The data from these sites during the SCAQS study periods have been incorporated into the SCAQS data base.

4.3.3 SCAQS Rawinsonde and Airsonde Measurements

Since the existing upper air monitoring data provide relatively little coverage for the Los Angeles Basin, a fairly extensive rawinsonde and Airsonde network was operated specifically for SCAQS. These measurements were conducted on intensive study days only, and included six soundings per day at each of eight summer (six fall) sites. The SCAQS rawinsonde data yield vertical profiles of temperature, humidity, pressure, wind speed and wind direction from the surface to either 700 mb or 500 mb (10000 ft msl or 18000 ft msl respectively). The Airsondes gave temperature and humidity data up to 700 mb.

SCAQS upper air sites are shown in Figure 4-1. Launch times are listed in Table 4-2. On the summer intensive study days, rawinsondes were launched from Burbank Airport, El Monte ARB Haagen-Smit Laboratories, Loyola Marymount College, Long Beach "A" site, Ontario Airport and Riverside Airport. Airsondes were launched from a site in Glendora, at the foot of the San Gabriel mountains. A second Airsonde unit was operated at Yorba Linda on all but days of tracer releases, when it was located at Sante Fe Springs (see Chapter 6). On fall SCAQS intensive study days, rawinsondes were launched from Long Beach, Loyola Marymount, Burbank, Ontario and El Monte, and Airsondes were launched from Fullerton.

Table 4-2. Upper Air and Surface Meteorological Measurements Performed Specifically for SCAQS

Upper Air Soundings Performed on Summer Intensive Study Days

Method	Sites	Code	Launch Times (PDT)	Parameters
Rawinsondes	Long Beach	LBCC	05, 08,11, 14, 17, 22	Temperature, dew point, pressure, wind speed & direction
"	Loyola Marymount	LMUA	05, 08,11, 14, 17, 22 *	"
"	Burbank Airport	BUR	05, 08,11, 14, 17, 22	"
"	Ontario Airport	ONT	05, 08,11, 14, 17, 22 *	"
"	El Monte	EMUA	05, 08,11, 14, 17, 22 *	"
"	Riverside Airport	RAL	05, 08,11, 14, 17, 22	"
Airsonde	Glendora	GLUA	05, 08,11, 14, 17, 22	Temperature, dew point, pressure, winds when clear
"	Yorba Linda Park or Sante Fe Springs (on tracer days)	YLUA SFUA	05, 08,11, 14, 17, 22	"

Upper Air Soundings Performed on Fall Intensive Study Days

Method	Sites	Code	Launch Times (PST)	Parameters
Rawinsondes	Long Beach	LBCC	05, 08,11, 14, 17, 22	Temperature, dew point, pressure, wind speed & direction
"	Loyola Marymount	LMUA	05, 08,11, 14, 17, 22 *	"
"	Burbank Airport	BUR	05, 08,11, 14, 17, 22	"
"	Ontario Airport	ONT	05, 08,11, 14, 17, 22 *	"
"	El Monte	EMUA	05, 08,11, 14, 17, 22	"
Airsonde	Fullerton	FUUA	05, 08,11, 14, 17, 22	Temperature, dew point, pressure, winds when clear

* Midnight launch at the beginning of episode in place of 2200 launch at end of episode.

Ground-based Meteorological Measurements for SCAQS

Method	Sites	Code	Periods of Operation	Parameters
Mechanical Met	Catalina Is. Airport	CA	Summer and Fall SCAQS	Temperature, wind speed and direction
"	Kellogg Hill	KH	Summer and Fall SCAQS	"
"	San Pedro Hill, PV	PV	Summer and Fall SCAQS	"
"	Henninger Flats	HF	Summer SCAQS only	"

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Airsondes and rawinsondes were released at each site within 30 minutes of the following times:

0500	PDT (summer) or PST (fall)
0800	"
1100	"
1400	"
1700	"
2200	"

On the first of several consecutive intensive sampling days, rawinsondes were released at midnight from the Loyola, Ontario and El Monte sites in place of the 2200 launch on the last day of the sampling day episode.

Optimally, all the sites would have launched simultaneously to provide a snapshot of the prevailing winds and temperature structure within the Basin. However, as only three rawinsonde broadcast frequencies were available, launch times were staggered to avoid radio interference. Releases from the Burbank, Long Beach and Riverside sites occurred 20 minutes before the hour, using rawinsondes which were configured to cease broadcasting after reaching 700 millibars or 10,000 ft. The ascent required 20 minutes, permitting releases from the El Monte, Loyola Marymount and Ontario sites on the hour. Rawinsondes from these latter three sites were tracked to 500 millibars, or approximately 18,000 ft.

The SCAQS rawinsondes and Airsondes were operated by T & B Systems (D. Lehrman, PI) (Lehrman, et al. 1988). The rawinsondes systems were Beukers W-8000 RP+ Upper Air Measuring Systems (VIZ Manufacturing Co., Philadelphia, PA) and consisted of LO-CATE 1500 LORAN-C Microsondes (the meteorological measurement and radio transmitter package which attaches to the weather balloon) and a ground based receiving and data acquisition system. The Microsondes were modified to broadcast in a narrow, $\pm$ 0.5 MHz frequency range so that three units could be broadcast simultaneously without interference within the 395-410 MHz range for which the telemetry systems were designed. The Microsondes were carried aloft by a 100 g helium-filled weather balloon. Temperatures were measured with a rod thermistor to a manufacturer's stated accuracy of 0.2^{o}C. Humidity was measured with a carbon hygristor with a listed accuracy of 2%, and pressure was determined using an aneroid cell commutator bar system with an accuracy of 1 mb. Wind speed and direction were derived from the balloon position, which was determined using a LORAN-C Navaid system. The Microsonde unit relayed the signals from one master and two secondary LORAN stations to the ground based receiver, where the balloon position was determined by phase differences between stations. A data set of pressure, temperature, relative humidity, and LORAN time-differences was transmitted and recovered every 15 seconds. Data were processed immediately on site, and both reduced and raw data were stored on computer diskettes. In the initial phases of the study some difficulties were experienced with the LORAN system, and theodolites served as a backup means for tracking the balloon positions.

The Airsondes and ground receiving systems were manufactured by A.I.R., Inc.. An Airsonde is comprised of an aneroid capacitor barometer to measure pressure, two bead thermistors (one of which has a muslin wick attached to measure the wet bulb temperature) and a radio transmitter which operates in the 403 MHz range. The Airsondes were carried aloft by 30 g helium-filled balloons. The manufacturer's stated temperature accuracy is +/- 0.5 degrees C, with a resolution of 0.1 degrees. The pressure sensor is accurate to +/- 3 millibars with a 1 millibar resolution. Data are sent and received every six seconds and processed by the ground receiving equipment. Temperature, wet bulb temperature, pressure, and height are calculated and printed every 30 seconds. Wind speed and direction are determined from azimuth and elevation angles obtained by optically tracking the balloon with a single theodolite and recording the angles every 30 seconds. The temperature, pressure, height, and wind data were input to a microcomputer, dew point and relative humidity computed from the dry and wet bulb temperature, and a 30 second averaged wind was computed from the height, elevation angle, and azimuth angle.

4.3.4 Measurements from the Doppler Acoustic Sounder and Aircraft

The Doppler acoustic sounder was operated by AV at Long Beach City College during the summer study, and at the El Segundo Generating Station during the fall study. The Doppler acoustic sounder was operated to provide data supplemental to the upper air soundings and to complement the tracer study data base. The sounder reports continuous readings of winds and turbulence aloft by means of a three directional acoustic sounder. The upper bound of the sounder is ~ 1000 m agl, however, AV recommends that data are reliable to only about 500 m. Data were available continuously throughout most of the study period.

As part of their flight pattern, the STI aircraft provided vertical sounding data for temperature, humidity and air quality parameters from within 100 m of the surface to an altitude of 5000 feet (1500 m) msl. These data were acquired during a spiral flight pattern whereby the aircraft descended or climbed over a fixed point on the ground. During the summer intensive study days, the aircraft conducted 18-24 spiral soundings per day, divided among six to eight spiral points per flight. The aircraft flight plans and measurements are discussed in Chapter 5.

5. AIRCRAFT UPPER LEVEL AIR QUALITY MEASUREMENTS

5.1 TYPES OF AIRCRAFT AND THEIR MEASUREMENT OBJECTIVES

Three twin engine aircraft were operated during the SCAQS. Two of these, one operated by the University of Washington (UW) (D. Hegg, PI) and one by Sonoma Technology Inc. (STI) (J. Anderson, PI), were instrumented for real time measurements of air quality parameters such as ozone, SO_2, nitrogen oxides, and particle size distributions. Both were equipped to collect filters and other integrated samples for chemical analyses. The third aircraft, operated by the EPA Environmental Monitoring Systems Laboratory in Las Vegas (EPA LV) (J. McElroy, PI) was equipped with a LIDAR for the vertical mapping of aerosol backscatter.

The UW aircraft was a large Convair 240. The STI aircraft was a six-seat Piper Aztec, and the EPA aircraft was a slightly larger AeroCommander 680V.

The UW aircraft was used only during the June and July summer sampling period and was used primarily to collect integrated samples and document pollutant concentrations at fixed locations over the ground. The STI aircraft and EPA aircraft were used during all summer and fall sampling periods. The STI aircraft was used to measure the three-dimensional distribution of pollutants during the first summer sampling period and, in addition, to collect integrated samples during the other two periods. The EPA aircraft mapped the three-dimensional distribution of aerosol backscatter throughout the Basin and at the boundaries of the study region.

5.2 FLIGHT PATTERN OVERVIEW

Each of the SCAQS aircraft flew different types of flight patterns. These patterns were made up, in various combinations, of:

> spirals,
> orbits, and
> traverses.

Spirals are flown over a fixed location on the ground. In a spiral, the aircraft descends (or ascends) in a turn with about a 2 km diameter, tracing a helix, at a rate of about 150 m/min (500 ft/min). Spirals are usually made from about 1500 m msl down to within 30 m of the surface. Spirals are typically flown over airports where it is possible to descend all the way to the ground, or over the ocean. Spirals are used to document vertical pollutant gradients; they provide vertical profiles for parameters measured continuously. Vertical resolution is approximately 2 m to 20 m, depending on instrument response time.

Orbits are circular or elliptical paths flown at a constant altitude above a fixed point on the ground. The aircraft flies repeatedly over the same path to provide sufficient sample time for collection of integrated samples for chemical analyses. In SCAQS, typical orbit durations were 30 minutes. Orbit diameters were in the range of 5 km. Altitudes for individual orbits were constant, but varied among different orbits from 300 to 750 m msl (1000 to 2500 ft msl).

Traverses are straight paths flown between predetermined points. Aircraft altitudes during traverses may be constant, as was the case for the LIDAR aircraft, or may change in a consistent manner, as was the case for STI aircraft traverses between spiral and orbit points.

The UW aircraft flight pattern consisted of four orbits during each flight. In the morning, two orbits were made offshore to measure the upwind boundary conditions and two were made over the western Basin source regions. During afternoon flights, two orbits each were made over the western and eastern parts of the Basin to document both source and receptor regions. Typically, morning orbits were flown above the surface layer to document pollutants which were carried over from the day before. Afternoon orbits were flown in the upper portion of the mixed layer.

The STI flight pattern consisted of a series of spirals throughout the Basin and offshore during all study periods. These spirals documented the vertical distribution of pollutants throughout the Basin and at the upwind (over water) boundary. During the late summer and fall study periods, the STI aircraft also performed up to two orbits per flight. In summer morning flights, two orbits were flown in western Basin source areas. In summer afternoon flights, one orbit each was made in the western source area and in the eastern Basin receptor region. In the fall, both morning and afternoon flights included two orbits in the western source regions.

The EPA flight pattern was designed to map the three-dimensional aerosol distribution throughout the Basin and at the boundaries. The aircraft typically flew at about 3000 m msl, with the LIDAR mapping the aerosol distribution from the aircraft down to the surface. The flights consisted of a series of traverses across the Basin as well as offshore and over the mountains to the north of the Basin. The EPA aircraft also continued some flights into the Coachella Valley to look at transport downwind of the Basin. The LIDAR aircraft was especially useful for mapping the vertical pollutant distribution over complex terrain which was not accessible to the other aircraft.

The details of the flight patterns for each aircraft are presented in Sections 5.3 and 5.4.

5.3 UW AND STI AIRCRAFT INSTRUMENTATION AND FLIGHT SUMMARIES

5.3.1 Aircraft Instrumentation

Instrumentation for both aircraft is listed in Table 5-1. The instruments are divided into three categories: continuous monitors which collected data throughout the flights, integrated samplers which were operated during orbits only, and grab samplers which were operated during orbits and some spirals. Both aircraft had continuous monitors for O_3, SO_2, NO-NO_x, particle scattering, temperature, dew point, altitude, and position. The STI aircraft also had monitors for ultraviolet and total solar radiation, and turbulence.

Integrated samplers were the same on both aircraft and were designed to mimic methods used in the ground-based "B" site network. Fine particle samples were collected downstream of a Bendix 240 cyclone (now Sensidyne, Largo, FL) which has a 2.5 μm cutpoint. Fine particle mass was measured gravimetrically on a Nuclepore filter. Fine particle organic and nonvolatile carbon were measured by collection on a quartz fiber filter (Pallflex) with analysis by MgO thermal oxidation performed by ENSR. Sulfur dioxide concentration was measured by collection on a carbonate impregnated filter behind a Teflon Zeflour filter downstream of the Bendix cyclone.

Integrated sampling also included a denuder difference method for fine particle nitrate and nitric acid. Identical systems were provided to each aircraft by ARB El Monte Laboratories (J. Horrocks). Each consisted of two Teflon AIHL cyclones, of which one was followed by a MgO denuder (to remove nitric acid) and a Teflon-nylon filter pack. The other was followed by the filter pack only. Fine particle nitrate (less than 2.5 μm diameter) was measured by the filter pack downstream of the denuder, and nitric acid was obtained by difference.

Particle sulfate, nitrate, chloride, ammonium ion, and gaseous ammonia were measured on a teflon oxalic acid impregnated filter pack. The upper size of particles collected was not well defined, and depended on losses in the sampling lines. PAN was measured on alkaline impregnated filters operated downstream of a teflon filter, with analyses performed by gas chromatography and electron capture detection by DGA (See Section 3.2.3). Aldehydes were measured by DNPH cartridges prepared and analyzed by ENSR.

Sample sets for all integrated sampling were provided through EMSI and were loaded into filter cassettes prior to each flight by the aircraft personnel. Substrates were refrigerated or stored in ice chests before and after sample collection. Filters were also stored in ice chests aboard the aircraft. Analyses were performed by the same laboratories and with the same analytical methods as used in the analysis of the SCAQS sampler substrates, as described in Section 3.2.3.

Hydrocarbon samples were collected in canisters of the same general type used for the "B" site ground sampling network, as described in Section 3.2.2. The canister samples were collected in two ways. Aboard the

Table 5-1. SCAQS Aircraft Instrumentation

Parameters	Aircraft	Analytical Laboratory*	Measurement	Sampling Frequency
Continuous measurements for gases				
NO, NOx	STI	-	Monitor Labs 8440 NO/NOx	continuous throughout flight.
NO, NO2, NOx	UW	-	Modified Monitor Labs 8840: NO/NOx	continuous throughout flight.
O3	STI	-	Monitor Labs 8410E:O3	continuous throughout flight.
O3	UW	-	Monitor Labs 8410A: O3	continuous throughout flight.
SO2	STI	-	Meloy 285:S02	continuous throughout flight.
SO2	UW	-	Teco SP43:SO2	continuous throughout flight.
Continuous measurements for particles				
Particle light scattering	STI	-	MRI#1569 Nephelometer	continuous throughout flight.
Particle light scattering	UW	-	MRI #1567 Nephelometer	continuous throughout flight.
Particle size distributions 0.1-3μm	STI	-	PMS ASASP-X Aer Size Distr	continuous throughout flight.
Continuous measurements for meteorological parameters				
T, DP	STI	-	YSI/MRI Temperature, Cambridge #137 Dew pt.	continuous throughout flight.
Turbulence	STI	-	MRI #1120 Turbulence (pressure fluctuations)	continuous throughout flight.
UV and Broad band radiation	STI	-	Eppley broad band and UV pyranometers	continuous throughout flight.
Integrated sampling for gases and particles				
Carbonyls	STI & UW	ENSR	DNPH cartridges	collected during orbits
Fine particle mass	STI & UW	EMSI	Cy-Nuclepore (Mass)	collected during orbits
Fine particle OC, EC	STI & UW	ENSR	Cy-quartz for OC,EC	collected during orbits
HNO3, fine particle NO3-	STI & UW	EMSI	Denuder Difference for HNO3/NO3-	collected during orbits
NH3, particle NH4+, SO4=, NO3-, Cl-	STI & UW	EMSI	Teflon - Oxalate acid filter pack	collected during orbits
PAN	STI & UW	DGA	Teflon - impreg. filter	collected during orbits
SO2	STI & UW	EMSI	Cy-Zeflour-Carbonate(SO2)	collected during orbits
Speciated C2-C10 Hydrocarbons	STI & UW	EPA & BRC	HC cans	collected during orbits
Tracer sampling				
Perfluorocarbon tracer aloft	STI	Tracer	Aluminized Mylar bags	4-12 per flight in spirals, on tracer days
SF6 tracer aloft	STI	Caltech	Syringes pulled from PFT sample bags	4-12 per flight in spirals, on tracer days
Aircraft position				
Position/Altitude	STI		Apollo-I Loran-C and Validyne Altitude	continuous throughout flight.

UW= University of Washington
STI=Sonoma Technology, Inc.

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* Laboratory names and locations are listed in Table 3-6a.

STI aircraft, samples were collected during portions of preselected spirals. A single sample would be collected for about 2 min, covering about 20% of the spiral. In the summer study, the portion of the spiral used for collection was chosen to represent the top of the mixed layer. In the fall study, the sample was integrated over a portion of the mixed layer near the ground surface, often between 30 to 200 m AGL. The exact spiral segment for sampling was determined during flight, based on indicated ozone or nitrogen oxide concentrations. Aboard the UW aircraft, hydrocarbon canisters were collected during all orbits. Aircraft canisters were analyzed by EPA-SSB, with selected canisters analyzed by the OGC, following the same procedures as used for the "B" site hydrocarbon canisters.

Two types of tracers were also sampled by the STI aircraft as part of the tracer releases discussed in Chapter 6. Perfluorocarbon tracers (PFT's) were released by SCE on nine days at various times from SCE's Alamitos and El Segundo power plants (see Table 6-2). Both ground level and stack releases were made. PFT's were sampled in 3.5 L "aluminized" mylar bags. Four to twelve samples were collected per flight on tracer days during spirals. Tracer Technologies Inc. analyzed these samples.

Caltech made four ground level releases of SF_6 tracers from Vernon. Samples for SF_6 were collected using 30 cc plastic syringes that were provided by Caltech. During one flight, (September 3, 1987) syringes were taken every 150 m (55 ft) at each of the seven spiral locations. Syringes taken during flights were filled to about 20 cc's and required only one to two seconds to fill. The remaining SF_6 releases occurred during PFT release periods. Thus, syringe samples could be drawn from bag samples collected for perfluorocarbon sampling. The syringe samples were taken from the bags after a sampling flight had been completed. Normally, the sample transfer was done on the day of the flight, but in one instance it was done on the following day. Samples were analyzed by Caltech.

Details concerning the configuration of aircraft instrumentation and sample lines, and operational and calibration procedures are given by Anderson et al. (1989) and Hegg and Hobbs (1988).

5.3.2 UW and STI Flight Summaries

The flight dates and times, the spiral and orbit points for each flight, and the corresponding samples collected by the UW and STI aircraft are shown in Tables 5-2 and 5-3. Spiral and orbit points refer to those shown on Figure 5-1. A total of 37 flights by STI and nine flights by UW were made during the study.

Spirals were only flown by the STI aircraft and provided vertical profiles for O_3, NO, NO_x, SO_2, particle light scattering, aerosol size distribution, and temperature and dew point. Except when operational difficulties interfered, spiral flights were flown three times per intensive sampling day during the summer and twice per intensive sampling day during the fall. In the summer, 169 of 231 scheduled spirals were completed. In the fall, 68 of 72 scheduled spirals were completed. Summer spiral points were located offshore (PADDR intersection) and at Hawthorne, Fullerton, Burbank,

Table 5-2. University of Washington Aircraft Flights (June-July 1987)

Flight Patterns:

Orbit Locations (to collect filter sets for integrated samples)

Morning Flights	Afternoon Flights
AMTRA Intersection	AMTRA Intersection
Long Beach	Long Beach
DOYLE or TANDY Intersection	Pomona
PADDR Intersection	Riverside

Spirals: None

Log of Individual Flights:

Date	Start (PDT)	Flight Duration	Base Airport	No. of Orbits	Orbit Locations and Altitudes (feet MSL) AMTRA	LBCC	POMA	RAL	DOYLE	PADDR	Comments
6/19	1359	5.9 h	Ontario	4	2600	2500	2500	2500	-	-	
6/24	0404	4.5 h	Ontario	4	3000	2600	-	-	2400	2000	SO2 inoperative
6/25	0400	4.9 h	Ontario	4	2500	2000	-	-	2500*	2000	*Orbit @ 5 miles S. of TANDY
6/25	1257	3.7 h	Ontario	4	2500	2500	2600	2600	-	-	Partial SO2 data (pump failure)
7/13	0347	4.9 h	NASNI	4	2000	2000	-	-	1600	1700	All OK
7/14	0335	5.4 h	NASNI	4	3000	3000	-	-	2500	2000	Some problems with NO
7/14	1339	4.5 h	NASNI	4	2100	2500	2500	2600	-	-	All OK
7/15	0335	5.1 h	NASNI	4	3200	2500	-	-	2200	2500	All OK
7/15	1352	4.7 h	NASNI	4	2500	2500	2500	2500	-	-	All OK

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NASNI = North Island Naval Air Station located in San Diego

Table 5-3. SCAQS STI Aircraft Measurements

Summer Flight Pattern

Spirals (for vertical profiles of O3, NOx, SO2, bscat etc.)

Location	Altitude (MSL)
Cable Airport CAB	5000' to ~1550' (<100'AGL)
El Monte Airport EMT	5000' to ~400' (<100'AGL)
Burbank Airport BUR	5000' to ~900' (<100'AGL)
Hawthorne Airport HHR	4900' to 63' (surface)
Fullerton Airport FUL	5000' to ~160' (<100'AGL)
Riverside Airport RAL	5000' to ~900' (<100'AGL)
PADDR intersection (off-shore	5000' to <200'
Zero spiral @ PADDR	5000' to <200'

Orbits, Aug-Sept only (collect filter sets for integrated samples)

Location	Altitude (AGL)
AMTRA Intersection (am & pm	~1000'
Long Beach (am flight) LBCC	~1000'
Riverside (pm flight) RAL	~1000'
No orbits on midday flight	

Fall Flight Pattern

Spirals (for vertical profiles of O3, NOx, SO2, bscat etc.)

Location	Altitude (MSL)
El Monte Airport	5000' to 296' (surface)
Burbank Airport	5000' to 775' (surface)
Hawthorne Airport	4900' to 63' (surface)
Fullerton Airport	5000' to 96' (surface)
Riverside Airport	5000' to 816' (surface)
PADDR intersection (off-shore)	5000' to < 200'
Zero spiral @ PADDR	5000' to <200'

Orbits (collect filter sets for integrated samples)

Location	Altitude (AGL)
AMTRA Intersection	~1000'
Long Beach LBCC	~1000'

Log of Flights:

Date	Take-off (LT)	Flight Duration	No. of Spirals	No. of Orbits and Filter Sets	No. of HC Cans	Tracers SCE	Tracers CIT	Comments
6/19	1510	2.3 h	8	0	0	0	0	Temperature inop.
6/19	1010	2.4 h	7	0	0	0	0	Temperature recorded manually, No zero spiral
6/19	1459	2.4 h	8	0	0	0	0	Temperature recorded manually
6/24	0430	2.4 h	8	0	0	0	0	NO/NOx inoperative
6/24	1258	2.5 h	8	0	0	0	0	All OK
6/24	1630	2.7 h	8	0	0	0	0	Spiral at Whiteman instead of Burbank
6/25	0442	2.6 h	8	0	4	7	0	SCE tracer samples
6/25	0936	2.4 h	8	0	1	6	0	SCE tracer samples
6/25	1458	2.5 h	8	0	0	7	0	SCE tracer samples
7/13	0457	2.5 h	8	0	0	0	0	Loran inoperative
7/13	1011	2.2 h	8	0	0	0	0	Loran inoperative
7/13	1507	2.2 h	8	0	0	0	0	All OK
7/14	0503	2.4 h	8	0	0	0	0	All OK
7/14	1009	2.2 h	8	0	0	0	0	All OK
7/14	1459	2.8 h	8	0	0	0	0	All OK
7/15	0525	2.4 h	8	0	0	0	0	All OK
7/15	-	-	-	-	-	-	-	Cancelled due to data system failure
7/15	-	-	-	-	-	-	-	Cancelled due to alternator failure
8/27	0514	1.2 h	2	1	1	0	0	Aborted, electrical failure. CAB, EMT, AMTRA
8/27	1109	2.1 h	8	0	2	0	0	All OK
8/27	1445	4.1 h	8	2	2	0	0	Ozone inoperative
8/28	0503	4.1 h	7	2	3	8	0	Aborted, electrical failure. No Riverside spiral.
8/28	-	-	-	-	-	-	-	Cancelled due to electrical problems
8/28	-	-	-	-	-	-	-	Cancelled due to electrical problems
9/2	0514	3.5 h	8	2	3	0	0	All OK
9/2	1019	2.1 h	8	0	0	0	0	All OK
9/2	1435	3.5 h	8	2	3	0	0	SO2 inoperative
9/3	0501	3.7 h	8	2	3	0	9	All OK
9/3	1035	2.1 h	8	0	0	0	64	SF6 syringes in all spirals
9/3	-	-	-	-	-	-	-	Cancelled due to electrical problems
11/11	0504	3.7 h	7	2	4	0	0	All OK
11/11	1305	3.9 h	7	2	4	4	0	All OK
11/12	0451	3.5 h	7	2	4	12	12	All OK
11/12	1312	3.7 h	6	2	4	12	12	SO2 inoperative. No zero spiral.
11/13	0459	4.4 h	6	2	4	10	10	All OK. No zero spiral.
11/13	1257	3.9 h	6	2	4	10	10	All OK. No zero spiral.
12/3	0507	3.5 h	7	2	4	0	0	All OK
12/3	1300	3.7 h	7	2	4	0	0	All OK
12/10	0934	2.1 h	2	2	4	4	0	Data set problem. HHR, Full spirals, both orbits.
12/10	1304	3.6 h	7	2	4	12	12	Power loss during first orbit.
12/11	0449	3.5 h	7	2	4	12	12	All OK
12/11	1254	3.8 h	7	2	3	12	12	All OK

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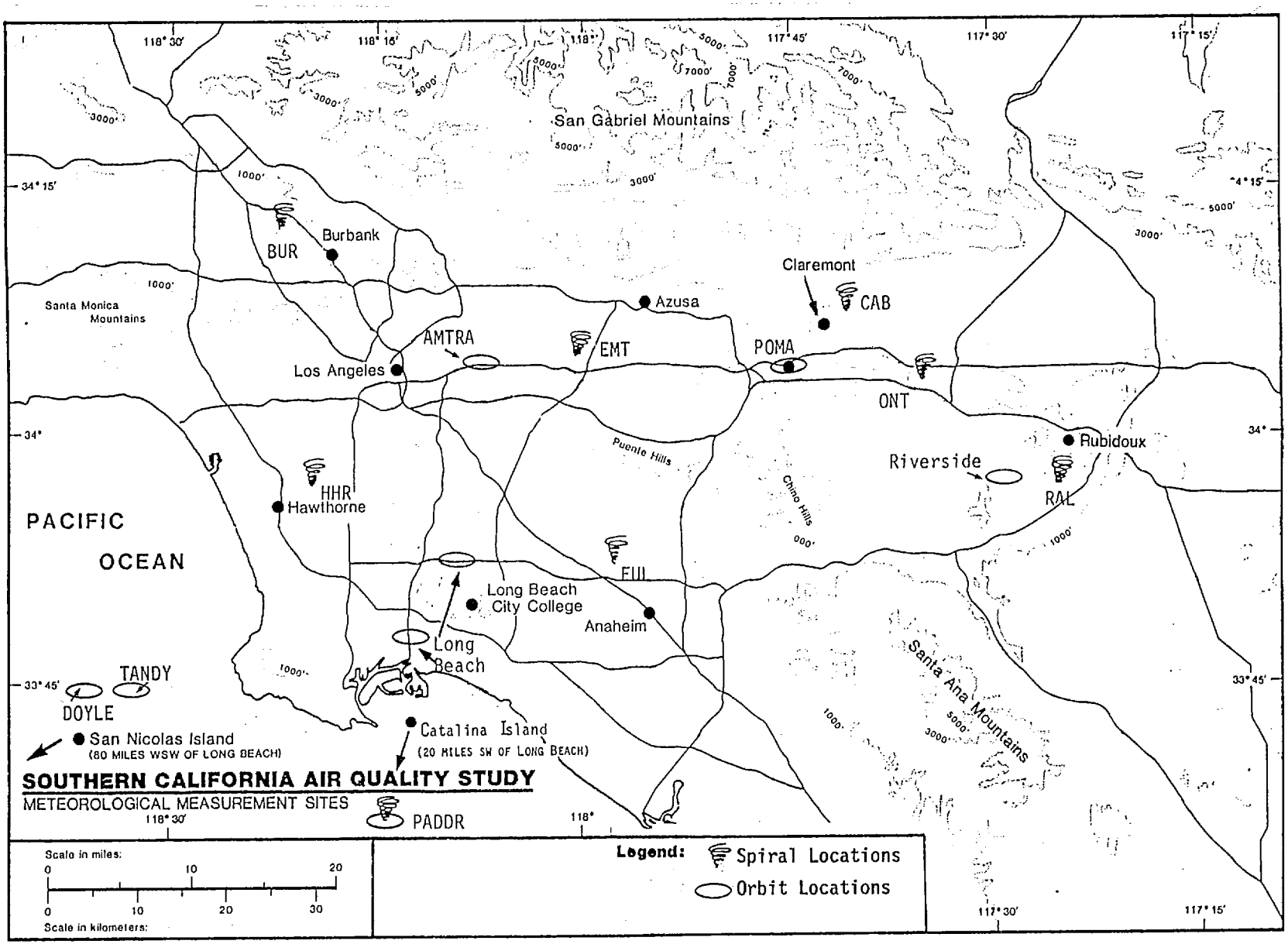

Figure 5-1. SCAQS Aircraft Spiral and Orbit Points. (Site codes other than airway intersections are listed in Table 4-1.)

El Monte, Cable (Upland) and Riverside airports. Fall spirals were located at PADDR intersection, and at Hawthorne, Fullerton, Burbank, El Monte and Ontario airports.

During the first phase of the summer study period, June 10-July 23, 1987, all orbits were flown by the UW aircraft. These flights were made once or twice per intensive study day. Morning flight orbit locations included two offshore locations (PADDR and DOYLE airway intersections), one coastal location near Long Beach, and one inland location at AMTRA airway intersection. On afternoon flights orbits were flown at the Long Beach and AMTRA orbit locations, and at Pomona and Riverside. The offshore locations were not used.

During the second summer study period (August 18-September 4) and during the fall study, orbits were flown by the STI aircraft. In the summer, STI flew morning orbits at Long Beach and the AMTRA intersection and afternoon orbits at AMTRA and Riverside. No orbits were flown during the mid-day flight. During the fall, orbits were flown at Long Beach and AMTRA during both morning and afternoon flights. Typical flight patterns are shown in Figures 5-2 - 5-5.

5.4 EPA AIRCRAFT LIDAR SYSTEM AND FLIGHT PATTERNS

5.4.1 LIDAR System Description

The EPA aircraft was equipped with a two frequency LIDAR. This system measures the vertical distribution of aerosol backscatter below the aircraft. Data are obtained with a vertical resolution of 6 m from about 150 m below the aircraft to the surface (or to the tops of clouds if they are present). The horizontal resolution of the system during SCAQS was about 45 m at a firing rate of 0.5 hz and an aircraft speed of about 90 m/s. The LIDAR data were recorded on magnetic tape in digital format and also on video tape in a grey-scale format. The specifications for the system are listed in Table 5-4. More details of the measurement system and flight operations have been reported by McElroy et al. (1988).

5.4.2 LIDAR Flight Summaries

Nine LIDAR data collection flights were conducted during the summer study periods and four during the fall. The LIDAR flights consisted of a series of traverses at a constant altitude. Typically, the aircraft would fly above the haze at an altitude of about 3000 m msl. The dates, flight times, and flight routes are listed in Table 5-5. The traverse end points listed in Table 5-5 are shown on Figure 5-6.

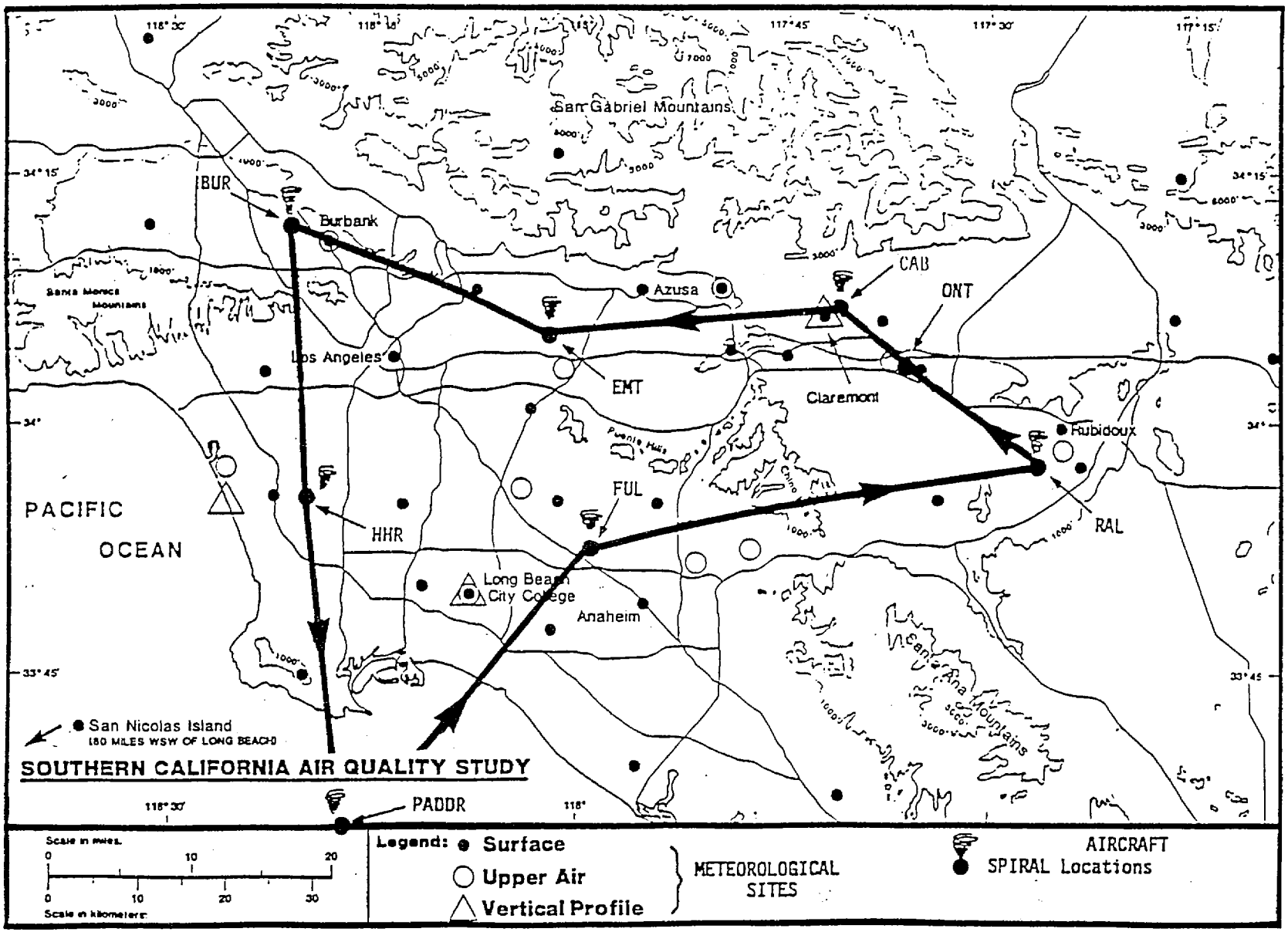

Figure 5-2. Typical STI Flight Plan for the First Summer Study Period.

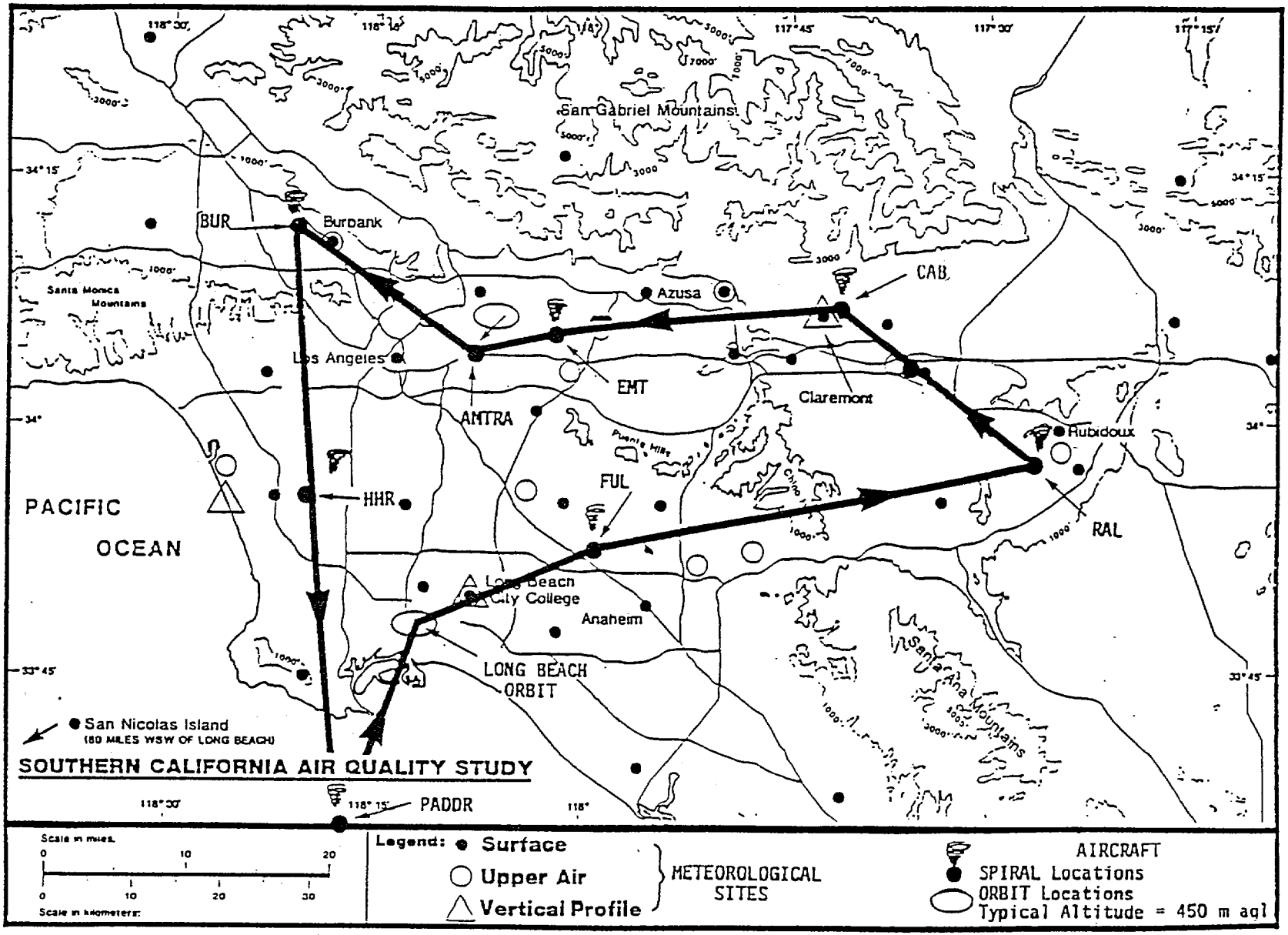

Figure 5-3. Typical STI Flight Plan for an Early Morning Sampling Flight During the Second Summer Study Period.

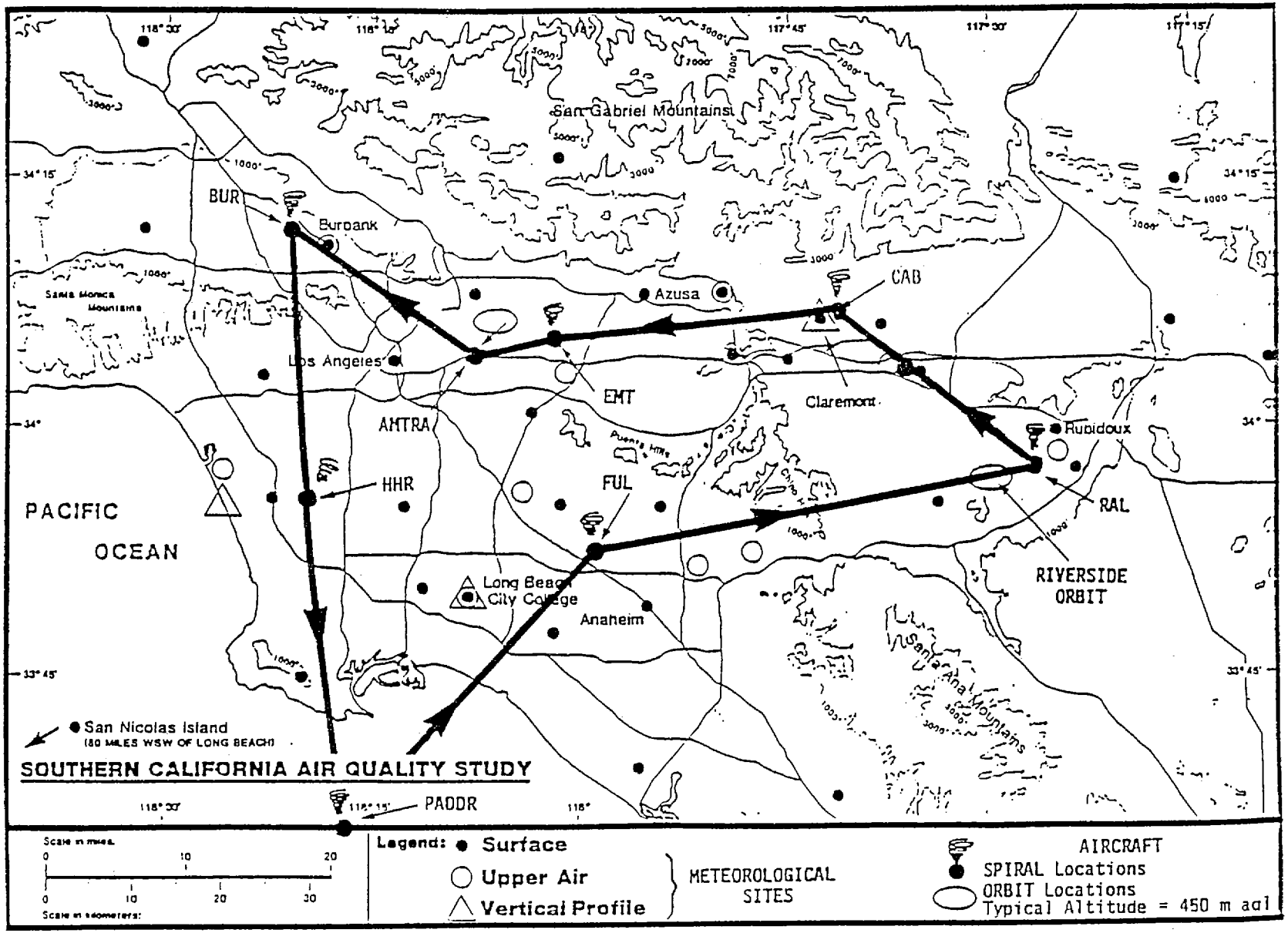

Figure 5-4. Typical STI Flight Plan for an Afternoon Sampling Flight During the Second Summer Study Period.

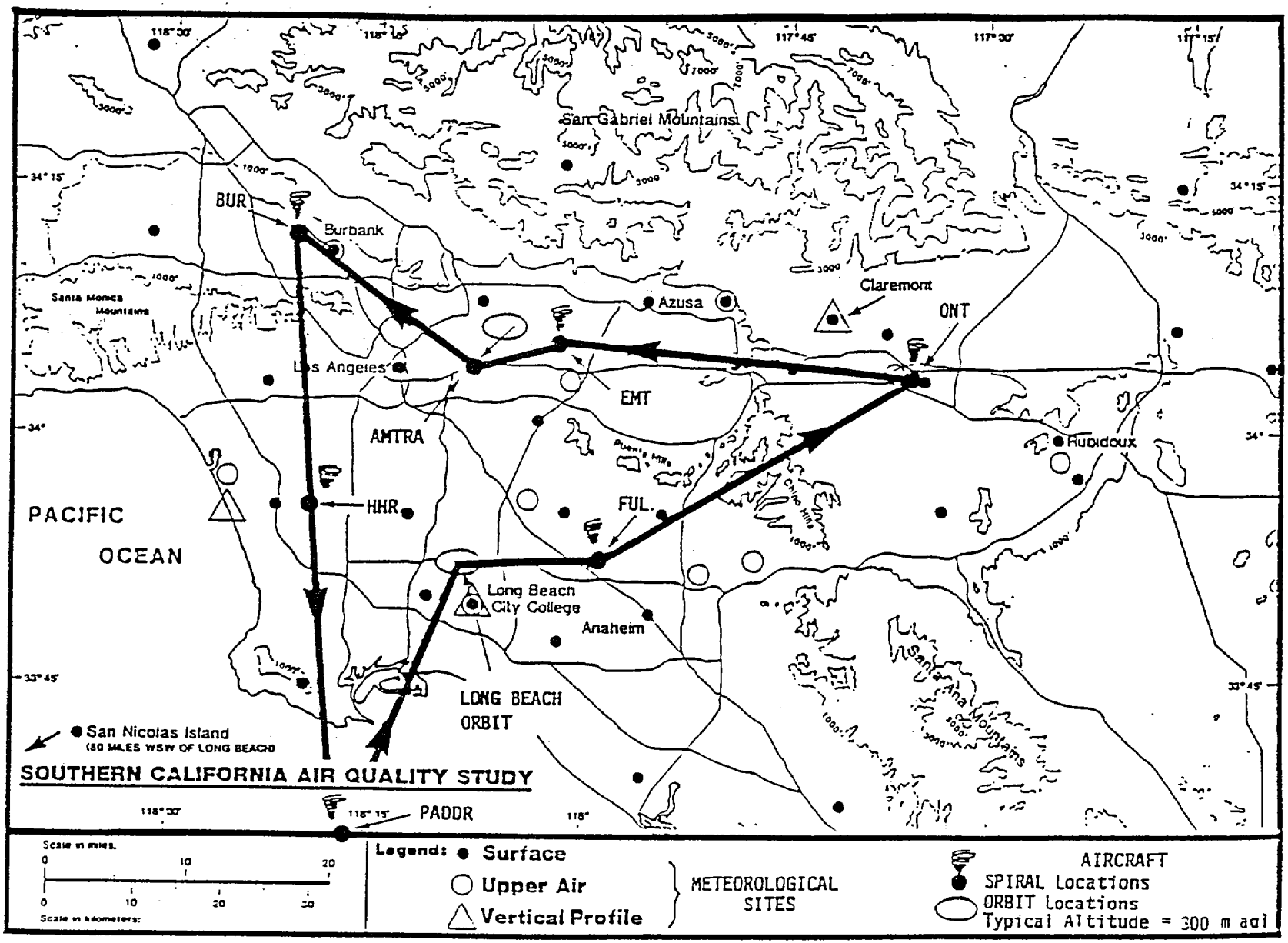

Figure 5-5. Typical STI Flight Plan for the Fall Study Period.

Table 5-4. System and Operational Parameters for the Two-Frequency Airborne Downward-Looking Lidar

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System Parameters

Weight: 250 kg (including power inverters and navigational system)

Volume: 0.95 m^3
Electronics Data Processor Rack - 0.3 m^3
Data Acquisition Rack - 0.2 m^3
Lidar Assembly - 0.4 m^3

Power Consumption: 28 VDC-50 A (1400 watts)

Wavelength: 0.532 μm and 1.064 μm

Firing Rate: 10, 5, 2, 1, 0.5, 0.2, 0.1 pulses per second

Output Format: 8-bit resolution

Digitization Inverval: 40 nanoseconds (nominal) (20 or 80 nanoseconds, optional)

Navigational Support: Dedicated Loran C system

Operational Parameters

Aircraft Type: small twin-engine cargo

Minimum Operational Altitude: 1500 m AGL

Smallest Horizontal Resolution Element: 10 m at 90 m per second

Vertical Resolution Element: 6 m nominal (3 or 12 m, optional)

Ground Footprint: Variable, 4-30 mrad beam divergence

Power Output: Combined - 125 mJ
Green (0.532 μm) - 25 mJ
Infrared (1.064 μm) - 100 mJ

Table 5-5. Summary of Airborne LIDAR Flights During SCAQS

Date	Time	Traverse End Points
Summer Flights		
06-19-87	1400-1705 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino - Banning Pass - Palm Springs - Indio - Ontario
06-25-87	0500-0845 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino
06-25-87	1340-1610 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino - Banning Pass - Palm Springs - Indio - Ontario
07-13-87	0555-0815 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino
07-13-87	1415-1645 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino - Banning Pass - Palm Springs - Indio - Ontario
07-14-87	0650-0840 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino
07-14-87	1700-1930 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino - Banning Pass - Palm Springs - Indio - Ontario

Table 5-5. Summary of Airborne LIDAR Flights During SCAQS (Continued)

Date	Time	Traverse End Points
Summer Flights		
07-15-87	0650-0840 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino
07-15-87	1430-1620 (PDT)	Ontario - San Bernardino - Corona - Long Beach - San Pedro Bay - Santa Monica Bay - Downtown Los Angeles - Covina - Mt. Williamson - Mt. Gleason - South Pasadena - San Bernardino
Fall Flights		
12-3-87	0715-0915 (PST)	Ontario - El Monte - TANDY* - Burbank - STABO* - PADDR* - N. El Monte - MINOE* - OLLIE* - Ontario
12-3-87	1430-1630 (PST)	Ontario - El Monte - TANDY - Burbank - STABO - PADDR - N. El Monte - MINOE - OLLIE - Ontario
12-10-87	0715-0915 (PST)	Ontario - El Monte - TANDY - Burbank - STABO - PADDR - N. El Monte - MINOE - OLLIE - Ontario
12-10-87	1345-1430 (PST)	Ontario - El Monte - TANDY

* Airway intersections

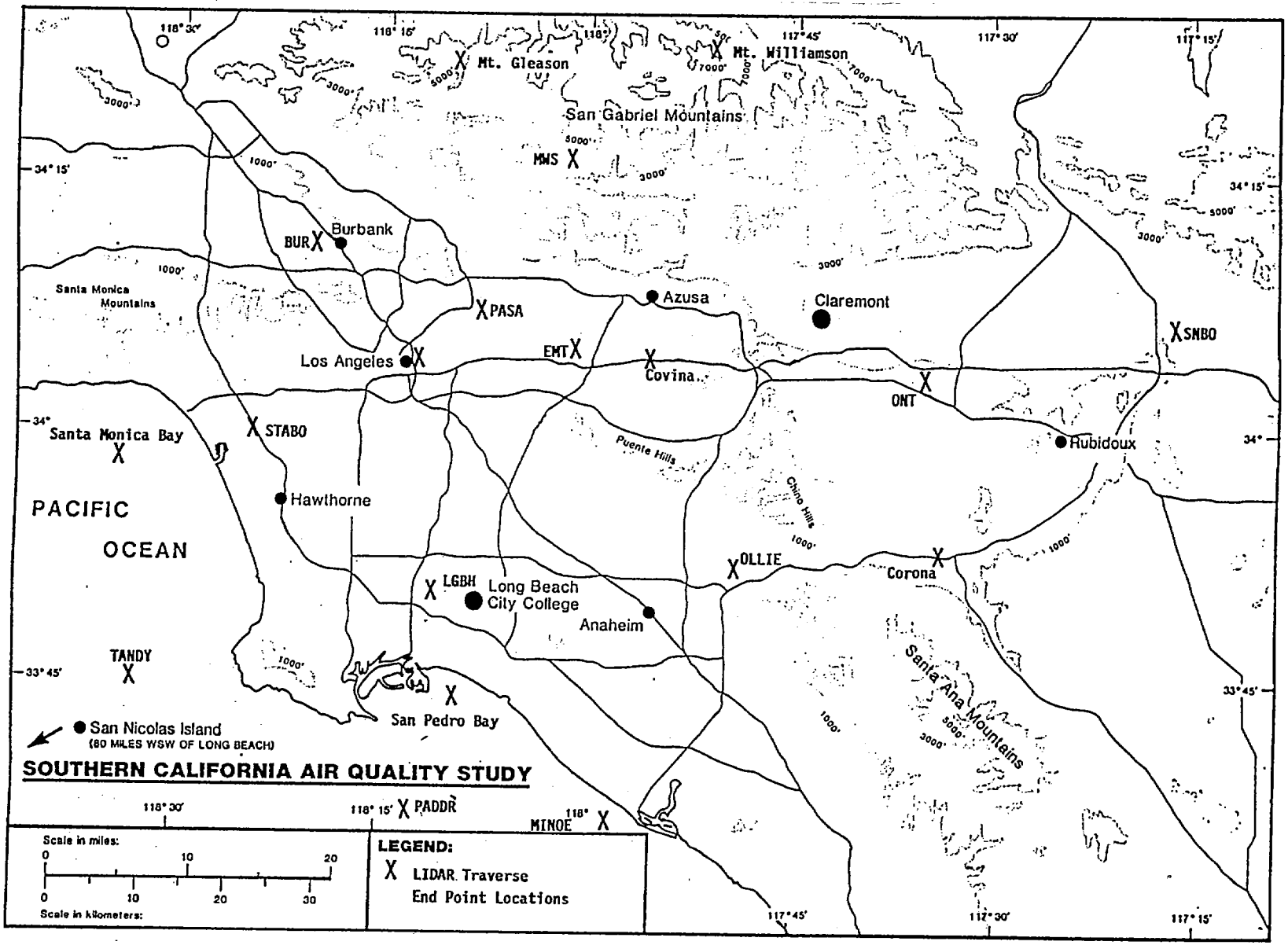

Figure 5-6. SCAQS LIDAR Aircraft End Point Locations. (Sites are listed in Table 5-5.)

6. EVALUATIONS OF POLLUTANT TRANSPORT

6.1 TYPES OF EVALUATIONS FOR POLLUTANT TRANSPORT

Pollutant transport was evaluated in two ways: time lapse photography to trace the urban haze and tracer studies. The photography measurements were conducted on each intensive day, with still and time lapse photographs from two sites overlooking the basin and from a third site with a view outward from the Basin.

Tracer studies were conducted on selected days. There were four separate tracer studies in the summer, two conducted by Southern California Edison in conjunction with Tracer Technologies (England et al. 1989), and two conducted by Caltech (Horrell et al. 1989). During the fall study period, there were two cooperative studies, with coordinated tracer releases between Caltech and SCE.

6.2 PHOTOGRAPHIC STUDIES

Still life and time lapse photography were conducted on each intensive study day by Earl Richmond Photographics as shown in Table 6-1. Two sites with cameras located on top of Mt. Wilson and the Palos Verdes Peninsula were operated specifically for SCAQS with views overlooking the Los Angeles Basin. The third site at San Jacinto was operated for a Coachella Valley study funded by SCAQMD to view transport out of the Los Angeles Basin. Each site had one time lapse camera operating at 1 frame/min. for the first six intensive study days and at 4 frames/min. for the remainder of the study. Still photographs (35 mm) were taken once every 30 minutes with views to either side of the time lapse camera views. Magnetic orientations for the cameras are listed in Table 6-1. Time lapse photography is available as a VCR tape or as a 16 mm film. Still life photographs can be obtained as 35 mm slides.

6.3 TRACER STUDIES

6.3.1 Overview

Two groups performed tracer release studies, as summarized in Table 6-2. Caltech conducted four SF6 tracer releases, with ground releases at Vernon, located four miles SSE of downtown. SCE and Tracer Technologies conducted another four tracer studies during the SCAQS period using perfluorocarbon tracers. Their studies used multiple tracers, and included both ground level and stack releases from SCE power plants at Alamitos and El Segundo. In the summer study, the releases from the two groups were independent. In the fall, the efforts of the two groups were coordinated to give four to five types of tracers for each tracer study.

Table 6-1. Still Life and Time Lapse Photographs on SCAQS Intensive Study Days.

Site	Camera	Orientation	Type of Photos
Palos Verdes	16 mm motion picture	390 ° magnetic	Time Lapse @ 4 frames/min.
Palos Verdes	35 mm still	0 ° magnetic	Still photos, 1 picture every 30 min.
Palos Verdes	35 mm still	50 ° magnetic	Still photos, 1 picture every 30 min.
Mount Wilson	16 mm motion picture	210 ° magnetic	Time Lapse @ 4 frames/min.
Mount Wilson	35 mm still	150 ° magnetic	Still photos, 1 picture every 30 min.
Mount Wilson	35 mm still	230 ° magnetic	Still photos, 1 picture every 30 min.
San Jacinto	16 mm motion picture	40 ° magnetic	Time Lapse @ 4 frames/min.
San Jacinto	35 mm still	30 ° magnetic	Still photos, 1 picture every 30 min.
San Jacinto	35 mm still	55 ° magnetic	Still photos, 1 picture every 30 min.

Operational Dates: All SCAQS intensives, summer and fall, 24 hr each day.

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Table 6-2. Summary Of Tracer Releases

		SCE Perfluorocarbon Tracers			Caltech SF6 Tracers	
Day	Date	Tracer*	Time & Site of Release	Amount	Time & Site of Release	Amount
S3	25-Jun	PP4	04-10 PDT: Alamitos Unit#5 stack	0.8 kg/hr		
"	"	PP3	04-10 PDT: Alamitos ground	0.3 kg/hr		
"	"	PP1/2	10-15 PDT: Alamitos Unit#5 stack	4.9 kg/hr		
"	"	PP2	10-16 PDT: Alamitos ground	4.4 kg/hr		
S6	15-Jul				06-09 PDT: Vernon ground	25.6 kg/hr
-	26-Jul	PP2	10-16 PDT: Alamitos Unit#5 ground	7.2 kg/hr		
-	28-Jul	PP2	10-16 PDT: Alamitos Unit#5 ground	7.2 kg/hr		
S8	28-Aug	PP4	07-11 PDT: Alamitos Unit#5 stack	6.3 kg/hr		
"	"	PP3	07-11 PDT: Alamitos ground	1.2 kg/hr		
"	"	PP1/2	11-16 PDT: Alamitos Unit#5 stack	5.9 kg/hr		
"	"	PP2	11-16 PDT: Alamitos ground	4.9 kg/hr		
S11	3-Sep				06-09 PDT: Vernon ground	69.1 kg/hr
F1	11-Nov	PP1/2	16-19 PST: El Segundo Unit#4 stack	5.8 kg/hr		
"	"	PP2	16-19 PST: Alamitos Unit#3 stack	7.3 kg/hr		
"	"	PP3	16-19 PST: Vernon ground	3.3 kg/hr		
F2	12-Nov	PP4	06-09 PST: El Segundo Unit#4 stack	4.6 kg/hr	06-09 PST: Vernon ground	46.4 kg/hr
F5	10-Dec	PP1/2	06-09 PST: El Segundo Unit#4 stack	6.7 kg/hr	16-19 PST: Vernon ground	81.8 kg/hr
"	"	PP2	06-09 PST: Alamitos Unit#3 stack	6.9 kg/hr		
"	"	PP4	06-09 PST: Vernon ground	3.6 kg/hr		

* PP1/2 = Perfluoromethylcyclopentane
PP2 = Perfluoromethylcyclohexane
PP3 = Perfluoro-1,1-dimethylcyclohexane
PP4 = Perfluorotrimethylcyclohexane

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6.3.2 Scenarios for Tracer Releases

SCE Summer SCAQS Tracer Studies

SCE conducted two similar releases during the summer to determine the impacts of elevated and ground level emission sources under both offshore and onshore flow conditions. Releases were made from the stack of the Alamitos Generating Station, Unit 5, and from the ground level below the stack. The power plant output was held constant for the duration of the tracer release. Four different perfluorocarbon tracers were used for each study. The first two tracers were released simultaneously from the stack and ground during early morning hours under an offshore flow regime. When the wind flow changed from offshore to onshore, the release of the first two tracers was stopped and release of a second pair of tracers from the same release points was initiated. This procedure tagged four different air masses, those from the stack and surface during offshore flow regime, and from the stack and surface during the subsequent onshore flow regime. Sampling sites are shown on Figure 6-1. Details are given in Table 6-2.

As part of a separate study associated with the interagency SCENES visibility study, two large tracer releases were made to examine transport from the Los Angeles Basin into the desert regions to the east and northeast. These releases were on July 26th and 28th, during the break in the summer SCAQS measurements.

Caltech Summer Releases

During the summer SCAQS, Caltech conducted two similar tracer studies. These were designed to emulate traffic sources, and were conducted to help calibrate models of area source dispersion. Releases were made from 0600 to 0900 PDT on July 15 and September 3, 1987 from a ground site at the SCE Power Generation Plant in the city of Vernon, located four miles SSE of downtown Los Angeles. The second of these two studies captured more data relevant to the dispersion of the tracer.

Fall Tracer Studies

In the fall, two tracer studies were conducted using both perfluorocarbon and SF_6 tracers. Efforts were coordinated between SCE and Caltech. The objectives were to track emissions from two power plants, the El Segundo and the Alamitos Generating Stations, and from mobile source emissions in the central Los Angeles area. The study was also designed to separately tag evening and morning emissions, with tracer releases at 1600-1900 PST and 0600-0900 PST. The SCE monitoring sites are shown in Figure 6-1. The release and sampling sequences are given in Tables 6-2 and 6-3.

6.3.3 Tracer Monitoring (Sites, Collection and Analysis Methods)

The locations of the SCE (Tracer Technologies) tracer release sites and collection network are given in Figure 6-1. The Alamitos Generating Station, used for all of the SCE tracer releases, is located in Long Beach at the intersection of the 605 and 405 freeways. The stack of Unit 5, used for

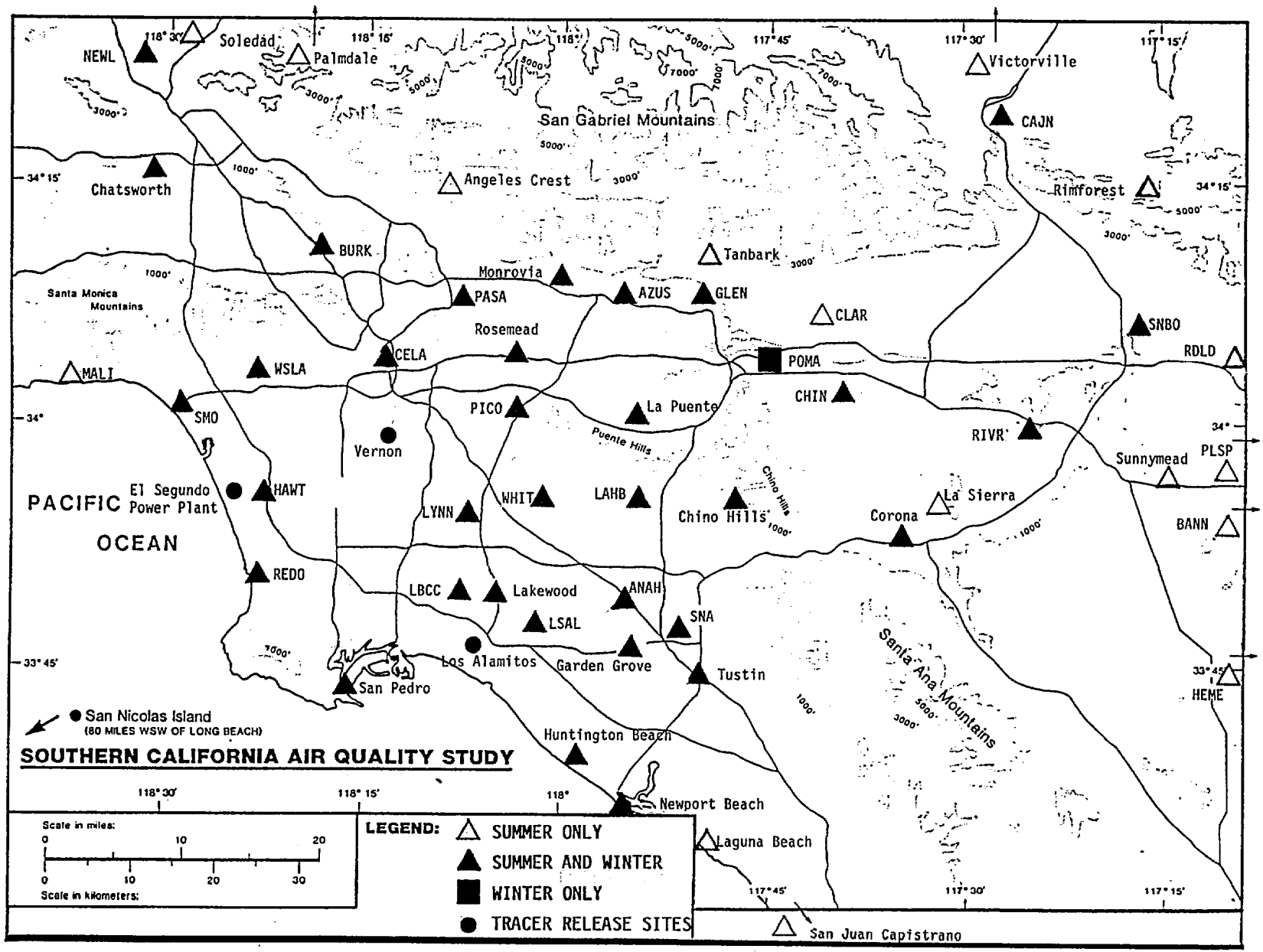

Figure 6-1. Tracer Study Sampling Sites (See Table 4-1 for site acronyms.). Arrows indicate sites which are off this map.

Table 6-3. Summary of Multiple Tracer Studies Conducted During Fall SCAQS

Objective: To trace stack emissions from two power plant stacks and surface emissions from one ground site in central Los Angeles.

Tracers Released on 11/11/87 -11/12/87

Date/Time (PST): / Site	11/11/87 1600-1900	11/12/87 0600-0900	11/13/87 0600
Alamitos Stack (Unit 4)	PP2		
El Segundo Stack (Unit 3)	PP1/2	PP4	
Vernon Ground	PP3	SF6	
PFC Monitoring	xxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxx
SF6 Monitoring		xxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxx

Tracers Released on 12/10/87

Date/Time (PST): / Site	12/10/87 0600-0900	12/10/87 1600-1900	12/11/87 1800
Alamitos Stack (Unit 3)	PP2		
El Segundo Stack (Unit 4)	PP1/2		
Vernon Ground	PP4	SF6	
PFC Monitoring	xxxxxxxxxxxxx xxxxxxxxxxxxx	xxxxxxxxxxxxx xxxxxxxxxxxxx	xxxxxxxxxxxx
SF6 Monitoring		xxxxxxxxxxxxx xxxxxxxxxxxxx	xxxxxxxxxxxx

Notes: 11/28/89

PP1/2=perfluoromethylcyclopentane
PP2 = perfluoromethylcyclohexane
PP3 = perfluoro-1,1-dimethylcyclohexane
PP4 = perfluorotrimethylcyclohexane
SF6 = sulfur hexafluoride
PFC Monitoring refers to monitoring for all perfluorocarbons.

the summer perfluorocarbon tracer releases is 201.5 ft (61.4 m) in height. The stacks of units 3 and 4, used for the fall tracer releases, are 200 ft (61 m) in height. The El Segundo Generating Station, used in the fall tracer studies, has 200 ft (61 m) stacks for both units 3 and 4.

For the perfluorocarbon tracer studies conducted by SCE, monitoring was initiated two hours prior to release and continued for 36 hours. Hourly averaged samples were collected in 3 L aluminized Mylar bags via an automated bag collection system throughout the Basin, at locations shown in Figure 6-1. Samples were also collected in spirals aboard the STI aircraft, as described in Chapter 5. After collection, samples were analyzed by electron capture gas chromatography by Tracer Technologies. Detection limits for the perfluorocarbon tracers were in the femtoliter/L range.

The SF_6 tracers were monitored by "auto traverses" and by automatic sampling "boards" deployed throughout the Basin. Auto traverses consist of driving a car along freeway routes likely to intercept the tracer cloud and gathering samples in 50 ml syringes at 1 min intervals (Figure 2-1 shows major freeway routes). Traverses were chosen to determine the position, size and concentration of the SF_6 cloud. Auto traverses were generally conducted immediately after the release, as shown in Table 6-4. Most automatic sampling boards were programmed to begin sampling at the time of release, and to continue for 12 to 24 hours, depending on the site. Additional samples were also collected aboard the STI aircraft as described in Chapter 5. Samples were analyzed by Caltech using gas chromatography with electron capture detection, which provided quantification of SF_6 to 1 ppt.

Table 6-4. Caltech SF_6 Tracer Study Sampling Details.

DATE	RELEASE TIME*	AUTO TRAVERSE (Grab Samples) START TIME	END TIME	ROUTE
7-15-87	0600-0900 PDT	0900 PDT	0950 PDT	Caltech to 210, W to 134, W to 101, S to 110, N to Caltech.
		0900 PDT	1024 PDT	Caltech to 210, W to 134, W to 5, S to 605, return same route.
		0858 PDT	0947 PDT	Caltech to 110, S to Manchester, S to 110, N to Caltech.
11-12-87	0600-0900 PST	0610 PST	0803 PST	Caltech to 210, E to 605, S to 91, E to 56, N to 10, W to 110, N to Caltech.
12-10-87	1600-1900 PST	1854 PST	1928 PST	Caltech to 110, S to 5, S to 710, S to 91.
12-11-87		0735 PST	0901 PST	Caltech to 110, S to 405, S To 55.
		1400 PST	1421 PST	Caltech to 110, S to 5, S to 405, N on 405 to Imperial Highway.

*All releases made at Vernon

7. EMISSIONS

7.1 TYPES OF EMISSIONS CHARACTERIZATION STUDIES

The compilation of emissions data was coordinated through the Emissions Working Group in parallel with other SCAQS efforts. Components of emissions evaluation include:

> Surveys of day-specific emissions from major sources for each intensive sampling day;

> vehicle source profile measurements;

> source inventory updates based on literature data and source surveys.

To date, the first two components have been completed. The Emissions Working Group is continuing efforts to incorporate these data into an updated, gridded emissions data base appropriate for modeling of the SCAQS intensive study days.

7.2 DAY-SPECIFIC EMISSIONS

Day-specific emissions were collected during the SCAQS field study periods by Radian Corporation (Sacramento, CA). Their efforts included the survey of hourly operations and emissions data from power generating stations, day-specific data on oil refinery operations, and cataloging of specific emissions events such as fires. The purpose was to gather the data needed to assess emissions specific to the intensive study days, including hourly emissions for each major source. When hourly, day-specific data could not be obtained, information was collected to determine whether or not emissions were normal.

The sources which were inventoried, and the types of data obtained from each are shown in Table 7-1. Hourly emissions and operations data were obtained for each intensive study day from the five electric power utilities operating in the Basin and the General Motors facility in Van Nuys. Daily operations data were obtained from thirteen of the fourteen refineries in the Basin. Airport traffic data were obtained from Los Angeles International Airport, and some freeway traffic data were obtained from Caltrans. The day-specific emissions information includes reports of individual emission events such as fires and results from the MVMA survey of the July 15, 1987 motor vehicle fuel composition in the Los Angeles Basin.

Power plant data include hourly values for load (MW); fuel type, sulfur content and consumption rate; emission rates for organic gases, nitrogen oxides, sulfur oxides and particulate matter; and stack flow rates and temperature. Refinery data include daily values for crude oil input, percent of production capacity, and fuel consumption by fuel type (purchased

Table 7-1. Day-specific Emissions Data Obtained on Intensive Study Days. (Inventories Conducted by Radian)

1. Data on specific sources:

Category	Specific Sources	Type of Data Collected for Category
Power Plants	SCE LADWP Burbank Glendale Pasadena	Hourly emissions of total organic gases, NOx, particulate matter, SOx. Hourly exhaust gas flow rate and temperature Hourly load (MW) and hourly fuel consumption Fuel type (oil or gas), sulfur content (wt %)
Refineries	Chevron, El Segundo Mobil, Torrance Unocal, Wilmington Edgington, Long Beach Golden West, Santa Fe Springs Arco, Carson Texaco, Wilmington Shell Oil, Carson Huntway, Wilmington Union Pacific Resources, Wilmington MacMillan Ring Free Oil, Signal Hill Newhall Refining, Newhall Paramount Petroleum Inc., Paramount Fletcher, Wilmington	Daily crude input. Daily percent of production capacity. Daily fuel consumption, including amounts of purchased gas, refinery gas and fuel oil and sulfur content of each. Daily log of start-ups, shut-downs, unplanned shut-downs, maintenance procedures and abnormal operations. Estimated emissions for specific abnormal events.
Industry	General Motors, Van Nuys Assembly Plant	Percent maximum operation, day specific. Hourly organic gases and nonmethane hydrocarbon emissions Hourly stack gas flow rates and temperatures
Airports	LAX	Day-specific landings and take-offs for air carriers, air taxis, general aviation and military.

2. Data on types of sources:

Category	Information Source	Type of Data Collected for Category
Traffic	Caltrans District 7 Caltrans District 8 LA Department of Transportation Southern California Association of Governments Radio station personnel (June-July only) Newspapers	Traffic counts/speed on some freeways and freeway ramps Traffic accident reports
Gasoline/Diesel Fuel Sales	Motor Vehicle Manufacturers Association	Amount and composition of each type sold. Data for summer and fall periods, not day-specific.
Fires	US Forest Service LA County Fire Dept. City fire departments Local and regional newspapers.	Fire name, location and size, estimated damage.
Emission Events	Newspaper reports (LA Herald, Orange Co. Register, San Fernando Daily News)	Reported events not yet catalogued.

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gas, refinery gas or fuel oil), fuel sulfur content, and a catalog of refinery operations, such as startups, shutdowns, maintenance procedures, downtime of air emissions systems and operation on variance from permit requirements. Data gathered from the General Motors Assembly Plant in Van Nuys include hourly emissions of reactive organic gases, the total flow rate of stack effluents and stack temperature. Data from Los Angeles International Airport include the landing and take-offs for four types of aircraft: air carrier, air taxi, general aviation and military.

Vehicle traffic data include Caltrans tapes of freeway traffic counts in the central Los Angeles area for the intensive study days, and archives of radio station and newspaper traffic reports. Fire reports were obtained from the Los Angeles city and county fire departments, and include the size and location of each fire. The size of structural fires is indicated by the estimated dollar loss, and the size of brush fires is given by the number of acres burned and the estimated mass loading per acre. Local and regional newspapers from the day following each intensive have been archived to provide a record of emission events.

Review of the day-specific emissions data conducted to date indicate that the intensive study days were generally normal from an emissions standpoint. Exceptions include: a fire in a sulfur recovery unit on June 19; the emergency shutdown of a catalytic cracking unit on June 25; the opening of a refinery relief hatch and subsequent emission of 10,000 lb SO_2 over a 10 minute period on September 2, and a cogeneration startup beginning December 11.

7.3 VEHICLE SOURCE PROFILE MEASUREMENTS

Vehicle source profiles were measured by Southwest Research Institute (SwRI). The purpose of this project was to obtain emission factors representative of the vehicle mix and driving conditions for the Los Angeles Basin during the SCAQS. Emission rates and emission profiles were obtained from in-use vehicles during the fall of 1987. Running emissions, corresponding to median vehicle speeds of 40-45 mph were sampled in a 0.24 km (790 foot) tunnel located on a surface street, Sherman Way, which passes under the major runway at Van Nuys Airport in Los Angeles. Slow speed, evaporative and cold start emissions were sampled from the Los Angeles Mall Parking Garage in downtown Los Angeles. Pollutant concentrations were measured at the inlet and exhaust of these enclosed spaces, and the difference attributed to the vehicular contribution. Air flow, vehicle volume, and vehicle speed were measured for each sampling period, and were used to derive the average emission rate per vehicle.

Sampled species included regulated emissions: namely total hydrocarbons, carbon monoxide, oxides of nitrogen, and particle mass; and unregulated emissions: C_1 to C_{10} hydrocarbons, aldehydes, ketones, alcohols, organic and elemental aerosol carbon, sulfate and particulate elemental concentrations. C_1 to C_4 hydrocarbons were collected in Tedlar bags and analyzed on site by gas chromatography and flame ionization detection. C_5 to C_{10} hydrocarbons were collected on Tenax, and analyzed at SwRI by GC-MS.

Aldehydes and ketones were collected by impinger and analyzed by liquid chromatography with UV detection at SwRI. Light alcohols and carboxylic acids were also collected by impinger and analyzed by gas chromatography and ion chromatography respectively. Fine and PM_{10} particulate measurements were conducted using the SCAQS sampler, which is the same sampler as that used for the ambient SCAQS sampling described in Chapter 3. Aerosol samples were collected on Teflon-coated quartz (Pallflex TX40), quartz (Pallflex QAO) and Teflon (Fluoropore membrane) filters for mass, carbon, and trace metal determinations, respectively. Carbon analyses were performed by ENSR using the thermal combustion technique. Trace metals were determined by x-ray fluorescence by EPA at Research Triangle Park, NC.

Air flow measurements in the parking garage were obtained from velocity measurements in the exhaust ventilation ducts. In the tunnel, the opposing lanes of traffic were separated by a solid wall, and ventilation was provided by the vehicle ram air. Tunnel airflow was obtained using SF_6 tracer gas injected at the tunnel entrance portal. The tracer was measured at the tunnel exit for each sample period. Additionally, airflow velocities were measured at the tunnel exit portal. Vehicle speed and traffic volume were obtained using pairs of tape switches attached to the road surface in each lane. Speeds were checked with a radar gun. Vehicle mix was recorded by video taping.

The parking garage measurements were conducted over 2-hr intervals, with 450 vehicles parked and 340 in motion. Median speeds were 10 to 12 mph, vehicle mix was 8.5 to 13% light and medium duty trucks, 6.4 to 10% noncatalyst light duty vehicles. In the Van Nuys Tunnel, 21 sets of samples were collected corresponding to over 38,000 vehicles. Vehicle counts varied from 700 to 2300 per hour. Median speeds generally were between 40 to 45 mph, with maximum speeds as high as 74 mph. On one occasion, traffic was slow with a median speed of 11 mph. Vehicle mix varied between runs and was 7 to 15% light duty (LD) noncatalyst, 13 to 26% light and medium duty truck, 0.3 to 3% heavy duty (HD) gasoline, and 0.25 to 2.8% HD diesel, 0.13 to 1.7% motorcycle. Further details are provided by Ingalls, et al. (1989) and Ingalls (1989).

8. QUALITY ASSURANCE PROGRAM

8.1 COMPONENTS OF THE QUALITY ASSURANCE PROGRAM

Quality assurance includes two types of activities: quality control (QC) efforts and quality assurance (QA) audits. The QC activities are on-going activities performed by measurement and data processing personnel. They consist of documented standard operating procedures for sample collection and analysis, data processing, and auditing. These procedures define schedules for periodic calibrations and performance tests. They specify predefined tolerances which are not to be exceeded by performance tests and the actions to be taken when they are exceeded. The QC procedures employed during SCAQS were developed, documented and implemented by each measurement group, and reviewed for completeness by the quality assurance auditor.

Quality assurance auditing is an external function performed by personnel who are not involved in normal operations. The purposes of the QA audits are to determine whether the QC procedures are adequate and are being followed and whether the tolerances for accuracy and precision are being achieved in practice. The QA auditing function consists of two components: system audits and performance audits. System audits include a review of the operational and QC procedures to assess whether they are adequate to assure valid data which meet the desired levels of accuracy and precision. Performance audits establish whether the predetermined specifications for accuracy are being achieved in practice by challenging the measurement system with a known standard sample which is traceable to a primary standard. For some SCAQS measurements the comparison studies were conducted among laboratories. These comparisons were conducted when appropriate traceable primary standards were not available, such as the analysis and speciation of gaseous hydrocarbons in the ambient air. Audits and intercomparisons conducted for SCAQS are listed by measurement in Table 8-1, and described in more detail below. The quality assurance activities were coordinated by ENSR. Many of the QA activities were performed by ARB staff.

8.2 SYSTEM AUDITS

8.2.1 Review of SOPs

System audits consisted of a review of standard operating procedures (SOPs) provided by each participating group, and on-site inspection of operations for specific groups. Prior to the field study, each participating research group and laboratory was asked to submit their SOPs to ENSR for review. When procedures were found lacking, the laboratory was contacted, and corrections to procedures were arrived upon by mutual agreement.

8.2.2 Laboratory System Audits

System audits were conducted prior to the field study for many of the analytical procedures; including hydrocarbon speciation by GC and GC-MS at the EPA Atmospheric Research and Exposure Assessment Laboratory (AREAL),

Table 8-1. Audits and Intercomparisons During SCAQS

Type of Evaluation	Sites Operated	Audit Sites/dates	Auditor	Lab Audited
SCAQS Sampler	All B Sites			
Results of SOP review				
Pre-study testing: HNO3 losses		5/87 @ AV	ENSR	AV
Pre-study testing: NH3 losses and collection efficiency		5/87 @ AV	ENSR/EMSI	AV
Pre-study testing: Flow splitting precision		5/87 @ AV	ENSR	AV
Pre-study testing: Side-by-side precision		5/87 @ AV	ENSR/EMSI	AV
On-site Performance Audit		-	ENSR	AV
Flow Audits: Summer		All B Sites except CLAR	SCAQMD	AV
Flow Audits: Fall		All B Sites	SCAQMD	AV
Ion Chemistry				
Nylasorb NO3,SO4, Cl: CSI spiked filters		6/87	-	EMSI
Carbonate filters for SO2: CSI spiked filters		7/87	-	EMSI
Carbonate filters for SO2: CSI spikes, second set		9/87	-	EMSI
Carbonate filters for SO2: ENSR spiked filters		11/87	-	EMSI
Oxalic Acid Impreg. filter NH4: CSI spiked filters		7/87	-	EMSI
Oxalic Acid Impreg. filter NH4: CSI, second set		9/87	-	EMSI
Oxalic Acid Impreg. filter NH4: ENSR spiked filters		11/87	-	EMSI
Oxalic Acid Impreg. filter NH4: EMSI spikes		9/87	-	-
Oxalic Acid Denuder Tubes: EMSI spikes		9/87	-	EMSI
Teflon NH4, NO3, SO4, Cl: CSI Spiked Filters		-	-	EMSI
Teflon NH4, NO3, SO4, Cl: Ambient sample comparison		6/87	-	EMSI
XRF Round Robins				
Teflon XRF: Comparison with NEA on SCAQS samples		7/87	ARB	NSI
Teflon XRF: ARB-HS analyses of same samples		11/87	ARB	NSI
Teflon XRF: Analysis of SRMs		9/88	ARB	NSI
PIXE Scans				
Carbon and b abs				
Quartz Filters: Carbon Study Round Robin		8/86	-	ENSR
Nuclepore Babs: Carbon Study filters		-		UCD
Reconciliation of Audit Discrepancies				
Hydrocarbon Cans	All B Sites & UW/STI Aircraft		Comparison Study	
Results of SOP Review				
Round Robins				
EPA (Stockburger) Replicates by GC-MS		6/10/87	ARB	
EPA (Stockburger) replicate analysis of some cans		6/10/87	ARB	
EPA (Lonneman) replicate analysis		6/10/87	ARB	
OGC (Rasmussen) replicate analysis		6/10/87	ARB	
WSU (Westburg) replicate analysis		6/10/87	ARB	
SCAQS Samples				
EPA(Stockburger) replicate by GC/MS		7/87-7/88	ARB	
EPA (Stockburger) replicate analysis		12/87	ARB	
EPA (Stockburger) storage study		12/87	ARB	
Replicate by OGC and EPA (Lonneman)			ARB	
Carbonyls	All B Sites			
Results of SOP Review				
Flow Audits -Summer		all B sites except CELA	SCAQMD	ENSR
Flow Audits -Fall		all B sites	SCAQMD	ENSR
Hydrogen Peroxide - Summer only	LBCC. CELA, CLAR, RIVR			
Results of SOP Review				
PAN	All B sites except RIVR in Fall			
Results of SOP Review				
Audits				
DGA calibrator tests - Summer		9/5/87 @ CLAR	-	DGA
Comparison between Lonneman & DGA (ambient)		8/27-29/87 @ CLAR	-	DGA
DGA calibrator check with Lonneman		9/7-9/88 @ RTP	ARB/NSI	DGA
Comparison between DGA and Unisearch (PAN gen. output)		12/14/87 @ LBCC	ARB/NSI	DGA
Impactors (Berner, MOUDI, UCD DRUM)	B+ Sites			
Results of SOP Review				
Audits				
Flow Audits: Summer		LBCC, CLAR, RIVR	SCAQMD	AIHL, UM, UCD
Flow Audits: Fall		LBCC, CELA	SCAQMD	AIHL, UM, UCD

Table 8-1. Audits and Intercomparisons During SCAQS

(11/28/89)

Type of Evaluation	Result
SCAQS Sampler	
Results of SOP review	
Pre-study testing: HNO3 losses	System redesigned until losses only 5%
Pre-study testing: NH3 losses and collection efficiency	System redesigned until losses neg., and coll. eff. 90%.
Pre-study testing: Flow splitting precision	Flow splitting precision 3%-4%, two PM2.5 inlets 6%.
Pre-study testing: Side-by-side precision	Precision 5% - 10% in side-by-side testing.
On-site Performance Audit	
Flow Audits: Summer	All good
Flow Audits: Fall	Under evaluation
Ion Chemistry	
Nylasorb NO3,SO4, Cl: CSI spiked filters	Lab results agreed with spiked values
Carbonate filters for SO2: CSI spiked filters	Initial results using peak height low, 9/87 analyses with procedure change OK.
Carbonate filters for SO2: CSI spikes, second set	Procedure change to peak area gave agreement within 4% of ref.
Carbonate filters for SO2: ENSR spiked filters	Results within 10% of reference value.
Oxalic Acid Impreg. filter NH4: CSI spiked filters	EMSI results low and irratic, but most QA lab results close to spiked value.
Oxalic Acid Impreg. filter NH4: CSI, second set	EMSI results within 15% of ref., with no procedure changes.
Oxalic Acid Impreg. filter NH4: ENSR spiked filters	EMSI results within 10% of ref. above 6 µg/fltr.
Oxalic Acid Impreg. filter NH4: EMSI spikes	Internal check of extraction eff. gave 88 - 93% recovery
Oxalic Acid Denuder Tubes: EMSI spikes	Internal check of extraction eff. gave >95% recovery
Teflon NH4, NO3, SO4, Cl: CSI Spiked Filters	Test invalidated due to poor spiked filters.
Teflon NH4, NO3, SO4, Cl: Ambient sample comparison	Almost all EMSI values within 10% of QA lab results.
XRF Round Robins	
Teflon XRF: Comparison with NEA on SCAQS samples	Precision good; some systematic differences between EPA and NEA due to nonuniform deposit.
Teflon XRF: ARB-HS analyses of same samples	Intermediate values, closer to EPA than NEA.
Teflon XRF: Analysis of SRMs	Results within ±10 % of the reference values.
PIXE Scans	Study underway.
Carbon and b abs	
Quartz Filters: Carbon Study Round Robin	ENSR values close to the average.
Nuclepore Babs: Carbon Study filters	UCD analysis high, but did not have individual filter blanks.
Reconciliation of Audit Discrepancies	Reanalysis by Radiance Reasearch. Results correlate well with EC.
Hydrocarbon Cans	
Results of SOP Review	
Round Robins	
EPA (Stockburger) Replicates by GC-MS	8% lower than mean. Poor resolution of C2 and C3 hydrocarbons.
EPA (Stockburger) replicate analysis of some cans	
EPA (Lonneman) replicate analysis	9% higher than the mean.
OGC (Rasmussen) replicate analysis	5% lower than the mean.
WSU (Westburg) replicate analysis	4% higher than the mean.
SCAQS Samples	
EPA(Stockburger) replicate by GC/MS	Confirmed GC peak ID.
EPA (Stockburger) replicate analysis	Precision better than ± 10% for HC > 5 ppbc.
EPA (Stockburger) storage study	All compounds stable except styrene and acetone.
Replicate by OGC and EPA (Lonneman)	Under analysis.
Carbonyls	
Results of SOP Review	
Flow Audits -Summer	ANAH 25% high, CELA not checked, all others good.
Flow Audits -Fall	ANAH 15% high, all others good.
Hydrogen Peroxide - Summer only	
Results of SOP Review	
PAN	
Results of SOP Review	
Audits	
DGA calibrator tests - Summer	Good correlation, DGA 36% lower than Lonneman.
Comparison between Lonneman & DGA (ambient)	Excellent correlation, DGA 22% higher than Lonneman.
DGA calibrator check with Lonneman	No significant difference between calibration methods.
Comparison between DGA and Unisearch (PAN gen. output)	DGA = 0.98(Unisearch) - 0.33 R = 0.99
Impactors (Berner, MOUDI, UCD DRUM)	
Results of SOP Review	
Audits	
Flow Audits: Summer	MOUDI OK, Berner OK, some question yet in check of DRUM.
Flow Audits: Fall	All good.

Table 8-1. Audits and Intercomparisons During SCAQS

Type of Evaluation	Sites Operated	Audit Sites/dates	Auditor	Lab Audited
Continuous Particle Size Distributions	B+ Sites			
Results of SOP Review				
Audits				
EAA and Climet Flow Audits: Summer		LBCC, CLAR, RIVR	SCAQMD	AV
EAA and Climet Flow Audits: Fall		LBCC, CLAR	SCAQMD	AV
PMS Probe Flow Audits: Summer		none	SCAQMD	AV
PMS Probe Flow Audits: Fall		LBCC, CLAR	SCAQMD	AV
On-site Performance Audit		LBCC, CLAR, RIVR	ERT	AV
SSI HiVol PM10 Flows	All B sites			
Summer checks		CLAR, LBCC, 6/12/87	SCAQMD	AV/SCAQMD
		CLAR, 6/18/87; CELA, 6/16/87 - ARB		AV/SCAQMD
Fall checks		none		
Meteorological audits	All B sites			
Results of SOP Review				
T, RH, Wind speed /direction - Summer		ANAH, BURK, AZUS, HAWT, CLAR 6/8/87	ARB	SCAQMD/GMRL
T, RH, Wind speed /direction - Fall			SCAQMD	AV
Ground Site Gaseous Pollutants				
Results of SOP Review				
Audit Results				
SCAQMD Sites - Summer (HAWT, ANAH, CELA, AZUS, BURK, RIVR)	6 B-sites	CELA, 6/16/87	ARB-Sacr	SCAQMD
SCAQMD Sites - Fall (HAWT, ANAH, CELA, BURK, RIVR)	5 B-sites	CELA, 11/19//87	ARB-Sacr	SCAQMD
ARB-HS Site - Summer	LBCC	6/17/87	ARB-Sacr	ARB-HS
ARB-HS Site - Fall	LBCC	11/17/87	ARB-Sacr	ARB-HS
GMRL - Summer (ARB audit)	CLAR	6/18/87	ARB-Sacr	GMRL
GMRL - Summer (ARB audit)	CLAR	6/27/87	ARB-Sacr	GMRL
GMRL - Summer (NO/NOx check by ARB-HS)	CLAR	7/3/87	ARB-HS	GMRL
GMRL - Internal check of calibration gases.	-	8/87	-	GMRL
GMRL - Summer (SCAQMD audit)	CLAR	9/4/87	SCAQMD	GMRL
GMRL - Fall	LBCC	11/17/87	ARB-Sacr	GMRL
Reconciliation of Audit Results				
Nephelometer Audits	All B Sites			
Results of SOP Review				
Audit Results				
Summer		All B Sites but SNI	SCAQMD	AV
Fall		All B Sites	SCAQMD	AV
Reconciliation				
UW Aircraft	Summer Phase I only			
Results of SOP Review				
Audits				
Filter flow audits		-	-	UW
Filter Chemistry		-		
HC Cans		-		
Summer ARB audit - O3, NO, NOx, CO		6/23/87	ARB-Sacr	UW
Summer ARB audit -		6/26/87	ARB-Sacr	UW
STI calibrator		7/27/87	STI	UW
UW internal evaluations			-	UW
UW internal evaluations			-	UW
STI Aircraft	Summer and Fall			
Results of SOP Review				
Audits				
Filter flow & neph audits		-	-	STI
Met instrumentation audit		6/22/87		STI
Filter Chemistry		-		
HC Cans		-		
Summer ARB audit - O3, NO, NOx, CO		6/22/87	ARB-Sacr	STI
Fall ARB audit -		11/18/87	ARB-Sacr	STI
TBS Upper Air Soundings	8 sites Summer, 6 Fall			
Results of SOP Review				
Performance Audit			ENSR	TBS
Intercomparison with aircraft			-	TBS

Table 8-1. Audits and Intercomparisons During SCAQS

(11/28/89)

Type of Evaluation	Result
Continuous Particle Size Distributions	
Results of SOP Review	
Audits	
EAA and Climet Flow Audits: Summer	OK
EAA and Climet Flow Audits: Fall	OK
PMS Probe Flow Audits: Summer	Not tested
PMS Probe Flow Audits: Fall	Error audit value.
On-site Performance Audit	
SSI HiVol PM10 Flows	
Summer checks	All results within 5%.
Fall checks	All results within 5%.
Meteorological audits	
Results of SOP Review	
T, RH, Wind speed /direction - Summer	All good
T, RH, Wind speed /direction - Fall	Not checked
Ground Site Gaseous Pollutants	
Results of SOP Review	
Audit Results	
SCAQMD Sites - Summer (HAWT, ANAH, CELA, AZUS, BURK, RIVR)	O3, THC, CH4, SO2, NO2, CO, SSI Good
SCAQMD Sites - Fall (HAWT, ANAH, CELA, BURK, RIVR)	Good
ARB-HS Site - Summer	O3, NO2, CO good, SO2 high (25%)
ARB-HS Site - Fall	O3, NO2, CO good, SO2 high (28%)
GMRL - Summer (ARB audit)	O3, CO not checked, SO2 low(22%), NO2 low(35%)
GMRL - Summer (ARB audit)	O3 good, SO2, NO2, CO all low (25%, 27% & 55%)
GMRL - Summer (NO/NOx check by ARB-HS)	NO2 low (40.6%)
GMRL - Internal check of calibration gases.	good
GMRL - Summer (SCAQMD audit)	CO, NO2 good
GMRL - Fall	O3, NO2, CO good
Reconciliation of Audit Results	
Nephelometer Audits	
Results of SOP Review	
Audit Results	
Summer	Good except RIVR 28% high
Fall	Not Available
Reconciliation	
UW Aircraft	
Results of SOP Review	
Audits	
Filter flow audits	Not tested
Filter Chemistry	Same as for SCAQS sampler
HC Cans	Same as for SCAQS sampler
Summer ARB audit - O3, NO, NOx, CO	CO good, O3, SO2, NO2 high (75%,43%,112%)
Summer ARB audit -	O3, SO2, NO2 high (90%,50%,80%)
STI calibrator	O3, SO2, NO high (120%, 140%, 91%)
UW internal evaluations	NO2, SO2, O3: traced error to calibration systems. SO2: bad permeation tube.
UW internal evaluations	NO2: error in permeation calculation. O3: Incorrectly calibrated O3 generator.
STI Aircraft	
Results of SOP Review	
Audits	
Filter flow & neph audits	Not tested
Met instrumentation audit	Good
Filter Chemistry	Same as for SCAQS sampler
HC Cans	Same as for SCAQS sampler
Summer ARB audit - O3, NO, NOx, CO	O3, SO2 good, NO2 low (21%)
Fall ARB audit -	O3, NO2 good
TBS Upper Air Soundings	
Results of SOP Review	
Performance Audit	
Intercomparison with aircraft	

elemental analysis by XRF (X-ray fluorescence) at NSI Technology Services Corporation, ion analysis and mass measurements at C-E Environmental, Inc. (C-E) (formerly EMSI), and continuous gases at the SCAQMD. The system audits were conducted through interviews and completion of detailed questionnaires. The system audits included review of documentation, training, analytical methodologies, instrumentation, source and preparation of reagents, standards, work space, sample handling, data processing, quality control, and use of quality control data.

8.2.3 Field Audits

"B" Site Operations

ENSR conducted system audits early during the summer study to determine whether the procedures specified in the SOPs were being followed and the operating personnel were properly trained. The audit focused on the operation of the SCAQS aerosol/gas samplers, hydrocarbon canister samplers, carbonyl samplers, PAN samplers, and nephelometers. Audits were conducted at the following sampling sites: Azusa, Burbank, Claremont, Hawthorne, Long Beach, and San Nicolas Island. After interviewing the operator, the auditor observed the operator perform routine duties such as the SCAQS sampler filter change procedure. On-site documentation was reviewed for completeness, and the condition and setup of the SCAQS instrumentation was evaluated. QC procedures for continuous gas analyzers were also evaluated.

"B" site operators' knowledge of all procedures and schedules were good at all locations except for nephelometer measurements. AeroVironment's training, scheduling and sample handling procedures were excellent. On-site documentation and data recording forms were good at all sites except station logs were not available at some sites. Instrument setup and location was good at all sites with the exception of the HC canister sampler at three sites. All the identified problems were rectified quickly by AV.

Aircraft and Upper Air Measurements

Field system audits were also conducted at the Ontario Airport for upper air soundings, and the airborne air quality and meteorological measurements aboard the University of Washington and Sonoma Technology Inc. aircraft. These audits showed that all parameters were within specification. More detailed results are given in the UW and STI final reports (Anderson, et al., 1989, and Hegg and Hobbs, 1988).

8.3 PERFORMANCE AUDITS CONDUCTED PRIOR TO FIELD STUDY

8.3.1 SCAQS Sampler Precision Testing

Prior to the field study, all ten SCAQS samplers were operated side-by-side by AeroVironment to verify equivalency and to determine precision of the results. Overall, the precision testing results showed agreement within 5 to 10% for most analytes. However, some specific problems were identified and corrected prior to the field study. A number of anomalous data values

were found. These were attributed to specific operator errors that occurred because the operators were still being trained while conducting the precision tests. Specific operator checks of filter deposit and filter holder tightness on unloading the filter holders in the field were recommended by ENSR and incorporated into the operator checklist. The precision testing and a review of laboratory methodology indicated that accuracy, precision, and detection of ammonia/ammonium determinations on oxalic acid impregnated filters could be significantly improved. As a result, a new filter was selected for ammonium particle collection, and prevention of contamination to active filters was given extra attention to reduce the magnitude and variability of filter blanks. Results from this work are given by Fitz and Zwicker, 1988.

8.3.2 Filter Analyses

A preliminary performance audit was conducted for filter ion chemistry at C-E Environmental. The performance audit consisted of challenging the laboratory with spiked filter samples prepared by Columbia Scientific, Inc. (CSI). The audit included the following analytes: sulfate from carbonate impregnated cellulose ester fiber filters; nitrate from nylon filters; sulfate, nitrate, chloride and ammonium from Teflon filters; and ammonium from oxalic acid impregnated quartz filters. The audit sample set consisted of 32 filters (two duplicate sets of the four filters at four concentration levels, including blanks). The filters used in the audit were taken from the lots purchased by C-E for the SCAQS field study. The cellulose and quartz filters were impregnated by C-E and sent to CSI for spiking. The spiked Teflon filters were later determined to be invalid. Rather than prepare a new set of Teflon spikes, a duplicate set of Teflon filters from the precision test of the SCAQS samplers was sent to C-E Environmental and ENSR for analysis, and the results were compared in lieu of the performance audit. The results initially reported by C-E for the spiked oxalic acid and carbonate impregnated filters were poor. Changes in calibration and data reduction procedures led to improved results. For confirmation, a second set of spiked oxalic acid and carbonate impregnated filters were prepared by ENSR and analyzed by C-E.

The laboratory performance audit required several iterations as problems were discovered and corrected. Problems were initially encountered with the analysis of the carbonate impregnated and oxalic acid impregnated filters. The problem with the carbonate impregnated filter was attributed to use of peak height rather than peak area in data reduction. This change was adopted by C-E, and subsequent analyses showed good results. The initial problems with the analysis of oxalic acid impregnated filters could not be explained. C-E was eventually instructed to proceed with the analysis of the oxalic acid impregnated filters from the SCAQS samplers after subsequent audits showed good results.

8.4 PERFORMANCE AUDITS CONDUCTED DURING THE FIELD STUDY

8.4.1 Flow Rate Audits

The SCAQMD Technical Services Division (TSD) conducted flow rate performance audits for the SCAQS Samplers and carbonyl samplers. In addition to these core samplers, the flow rate audits were conducted for the DRUM and MOUDI impactors, and the Climet OPC, PMS Probe, and the TSI EAA aerosol particle counters. The ARB Quality Assurance Section audited flow rates for HiVols and SSI PM_{10} HiVols, including SSI PM_{10} HiVols installed and calibrated by SCAQMD TSD at the Long Beach and Claremont "A" sites. Flow accuracy was determined by the ARB using a certified BGI variable orifice and a differential pressure gauge. The BGI orifice is certified against an NBS traceable Roots Meter. The results of the flow rate audits are generally very good. Differences between the flows measured by the operators and the audit values were almost always within 10 percent. Some significant differences were observed and attempts were made to resolve the differences.

8.4.2 Nephelometer Audits

The SCAQMD TSD audited the nephelometers installed and maintained by AV at the SCAQS "B" sites. The nephelometers were MRI model 1560 series adjusted to measure zero for Rayleigh scattering of pure air, and thus measured particle scattering directly. The instruments were spanned by AV with Freon-22 and Freon-12 to read 0.88 and 1.92 per 10,000 meters, respectively. AV checked the nephelometers between each intensive period and adjusted the instruments if necessary. The auditor challenged the instrument with Freon-12. The results for the performance audits of the nephelometers were generally good except at Rubidoux. In this case, the instrument response was noisy, probably due to dust in the light chamber. AV's frequent calibration checks showed occasional problems such as occurred at Rubidoux during the audit. These occasional problems were routinely caught and corrected between intensive study periods.

8.4.3 Audits of Gas Analyzers

The ARB QA Section conducted performance audits of CO, SO_2, O_3, NO_X, and THC analyzers and meteorological instruments at the following sampling sites: Long Beach, Claremont, Los Angeles (N. Main) during the summer; and Long Beach and Los Angeles (N. Main) during the fall. Gas analyzers aboard the UW and STI aircraft were also audited. The ARB's performance audit procedures conformed to EPA requirements in 40 CFR Part 58, Appendix A. The audits were conducted by challenging a gaseous pollutant analyzer with pollutant-free zero air and with known concentrations of the respective pollutants through the site's intake probe. The ozone standard is traceable to an NBS photometer and all other gases to NBS compressed gas Standard Reference Materials.

The gas analyzer audits identified a number of problems. To help resolve these problems, calibration checks were also provided by ARB's Air Quality Surveillance Branch, by SCAQMD, and by STI. The problems were identified in all cases and the data adjusted accordingly. The poor results

initially were obtained by the GMRL at Claremont. These audit results were traced to problems with the calibration system. These problems were subsequently corrected and later audits of the GMRL analyzers at Claremont by the SCAQMD, and at Long Beach by the ARB QA Section showed good results for NO_2 and CO. Poor results for the analyzers aboard the University of Washington aircraft were traced to an error in the permeation tube calculation for NO_2, an erratic permeation rate for SO_2, and an incorrectly calibrated ozone generator.

8.4.4 Meteorological Instrument Audits

Performance audits of meteorological instruments involved a single point check of wind speed using a Sims model DIC hand held anemometer and of humidity using a Bendix model 566 battery operated psychrometer. Temperature was checked against an NBS traceable thermometer and alignment of wind direction was visually inspected.

8.5 SPECIAL STUDIES AND INTERCOMPARISONS

8.5.1 Objectives of Intercomparison Studies

Several of the measurements, such as the PAN and hydrocarbon speciation measurements were not conducive to NBS traceable performance audits. For these parameters the quality assurance program consisted of an intercomparison among laboratories, as described below.

8.5.2 Speciated Hydrocarbons

Three ambient air samples were provided by the Oregon Graduate Center (OGC) and were analyzed by gas chromatography at EPA's Atmospheric Research and Exposure Assessment Laboratory (AREAL) and at OGC. At EPA, the samples were analyzed by L. Stockburger (EPA-SSB), and by W. Lonneman (EPA-GKP). The samples were analyzed in round-robin fashion over a course of six months and analyzed a minimum of three times by each laboratory. The samples were also analyzed once at Washington State University. The SCAQS samples were analyzed by EPA-SSB for C_4-C_{10} hydrocarbons and by OGC for C_2 and C_3 hydrocarbons. Quality assurance included reanalysis of 60 SCAQS samples by gas chromatography-mass spectrometry and a study of the effect of sample storage by EPA-SSB. Results of the sample storage study are documented by Stockburger et al. (1989). In addition, 10% of the SCAQS samples were reanalyzed by OGC and 24 samples were reanalyzed by EPA-GKP.

Results of the laboratory comparison for speciated hydrocarbon analysis were within acceptable ranges. The coefficients of variation among the four laboratories were generally within 10% when the concentration was above 5 ppbC. Hydrocarbons with apparent identification problems were deleted from the comparison. Such hydrocarbons accounted for 10-15% of the total concentration.

8.5.3 Peroxyacetyl Nitrate

Several informal measurement comparisons were arranged by DGA during the summer field study. Measurements of the diluted outputs of the DGA PAN generator by DGA (EC-GC) were compared separately with side-by-side measurements made by the GMRL (EC-GC), University of Denver (UD) (Luminol-GC), and EPA (EC-GC). Ambient measurements of PAN during the summer field study by DGA, UD, and EPA-GKP were also compared. Side-by-side measurements of the PAN generator outputs were made during the fall study by DGA and Unisearch Associates, Inc. (Luminol-GC). A comparison of calibration methods was conducted at EPA-GKP in Research Triangle Park, NC in September 1988 to resolve differences between the ambient PAN measurements by EPA and DGA.

The ambient measurement of PAN by DGA and EPA-GKP show good correlation (i.e. good precision) but a consistently large bias (i.e. poor accuracy). The mean relative difference for concentrations above 5 ppb is 28.3% $\pm$ 11.6%. A comparison of the alkaline hydrolysis method of calibration used by DGA and the FTIR method used by EPA-GKP showed no significant difference between methods. DGA reported a relative measurement uncertainty of 11 to 50% with typical values in the range of 13 to 18%.

8.5.4 Light Absorption

Optical extinction by absorption (b_{abs}) was measured on the SCAQS polycarbonate filters by Radiance Research using the Integrating Plate Method (IPM). The filters were originally analyzed at UCD by IPM. However, UCD's results were too high and the samples were reanalyzed by Radiance Research. Because of the lack of prior optical tare measurements and the excessive variability in the transmittance of the blank filters, the unsampled edge of each filter was used by Radiance Research to measure the transmittance tare. Light absorption data for forty SCAQS samples were correlated well with concentrations of elemental carbon reported by ENSR for the same time periods and the corresponding adsorption coefficient of 10.8 m^2/g is reasonable. The forty samples were also analyzed by IPM at NEA, Inc. and for a second time by UCD after modifications were made to their method.

8.5.5 Elemental Analysis

Twelve Teflon filters (three pairs of $PM_{2.5}$ and three pairs of PM_{10} samples from collocated SCAQS samplers) were analyzed by wavelength dispersive XRF at EPA-NSI Technology Services Corp. (SCAQS laboratory), NEA, Inc., and the Monitoring and Laboratory Division of the ARB. One sample from each pair was later analyzed by wavelength dispersive XRF at DRI followed by Instrumental Neutron Activation Analysis (INAA) at the University of Maryland. Five of the second set of filters were analyzed by Particle Induced X-ray Emission (PIXE) at UCD. A set of eight single element (Al, Si, K, Ca, V, Fe, Cu, and Pb) Micromatter standards and two multi-element NBS standards were analyzed by NSI, DRI and ARB. NEA obtained much higher values than EPA-NSI for soil-related elements while excellent agreement was obtained for sulfur which is found mostly in fine particles. Differences among labs were

attributed to nonuniformity in the filter deposit. A correction procedure is being developed to account for the nonuniform deposit.

9. DATA MANAGEMENT

9.1 INTRODUCTION

Data from all of the participants in SCAQS, and relevant concurrent data from other measurements in the SoCAB are being compiled into a single SCAQS data base. The objective is to produce an integrated, comprehensive and properly archived air quality and meteorological data base for the South Coast Air Basin for evaluating and improving elements of air quality models for oxidants, NO_2, PM_{10}, fine particles, visibility, toxic air contaminants and acidic species. Most of this chapter has been excerpted from Croes and Collins (1989).

The data base must meet several requirements, namely:

> The data base is complete, it contains all the meteorological, air quality and other data required by the data analysts and modelers.

> The data base is accessible, it can accommodate a large variety of requests.

> The data base includes measurement uncertainties, i.e. the precision and accuracy limits for each value are explicitly stated.

> The data base is documented, it contains information on who took the measurements, where they were made, what instruments were used, how blanks, uncertainties and audit results are incorporated in data reduction.

> The data base is maintained, with a central contact for obtaining and updating the data.

> The data are validated, including review by participants (Level 1) and internal consistency checks upon data compilation (Level 2).

The SCAQS data management program was funded by the ARB, and implemented by ENSR Consulting and Engineering, Sonoma Technology Inc. and ARB staff. John Collins of ENSR Consulting and Engineering is the SCAQS data manager.

9.2 DATA BASE MANAGEMENT STRUCTURE

For SCAQS, the data management team consists of the data manager, a data inventory and review group, measurement-specific data managers, a modeling liaison and a data distribution contact. The data manager is ultimately responsible for the integrity of data. For submittal of new data and updates of existing data, the data manager does the following:

> Receives data from participants, reviews for obvious errors, reformats into the data base, and provides time series, minimum, maximum and other univariate statistics to measurement-specific data managers and participants;

> provides validation results between data set variables (NO + NO_2 vs. NO_X, sum of species vs. PM_{10}, O_3 vs. HNO_3 and other multivariate statistics) to measurement-specific data managers and participants;

> maintains a log of all data submitted and of changes to the database;

> coordinates communication between reviewers of data;

> produces documentation of the data base; and

> produces a report containing selected displays of data.

A data inventory and review group ensures that the SCAQS data set is complete and consistent. This group consists of the SCAQS program and field managers, as these individuals were most familiar with the measurements that were taken. This group also reviewed the Level 1 validation results for data completeness.

Measurement-specific data managers identify and resolve problems with specific subsets of the data such as the meteorological data, gas-phase species or aerosol data. The responsibilities of these measurement-specific data managers are to:

> contact participants and develop validation statistics;

> review data and results of validation checks; resolve incomplete data, inconsistencies, and other problems with participants; maintain a log of data error resolution;

> review quality assurance results to determine accuracy of measurements; work with participants to ensure that proper units, blank corrections, uncertainty calculations and data flagging are being used; recommend specific manipulations of the data to produce a coherent set of concentration data; and ensure consistency between groups and measurements.

A modeling liaison was chosen to work with modelers to establish that all necessary data are contained within the data base in an accessible format.

A data distribution contact at ARB was chosen to fulfill requests for data. A log of requests will be maintained so that a notice of updates to the data base can be sent to all those who need it. The data distribution contact is also a resource for those using the data base.

9.3 ACCURACY AND PRECISION

The SCAQS data base includes a field for measurement uncertainty to accompany each data value. The SCAQS participants submit an estimate of uncertainty with their data. The uncertainty field may represent precision or a combination of accuracy and precision, depending on how the uncertainty was determined. The data manager reviews the basis for measurement uncertainty in conjunction with the measurement-specific data managers, compares this with quality assurance (QA) audit or methods comparison results where possible, and compiles an assessment of measurement accuracy and precision for each measurement.

Most uncertainties determined through internal quality control checks (i.e. checks applied by the participant while collecting data), such as replicate sampling, frequent calibration checks, or X-ray counting statistics, generate measures of precision. Manufacturers' specifications, e.g., for meteorological instrumentation, often report accuracy and precision. However, these should be considered precisions by the data base user. Errors usually involve improper calibration or operation that result in inaccurate data, e.g., a wind direction sensor not accurately aligned with true north.

External QA checks such as system and performance audits provide accuracy checks for the components of a measurement. For example, flow rate audits and chemistry laboratory audits can confirm the accuracy of sample volume and filter concentration determinations for particle samplers. Assumptions regarding transport of particles and gases through the sampler to the filter, filter collection efficiency, filter artifacts, sample handling, etc. remain untested. System audits review assumptions and procedures, and attempt to verify that well characterized, accurate procedures are being used.

External QA checks such as comparisons among different methods provide accuracy checks for an overall measurement. For example, the integrating plate method for measuring the light absorption of an aerosol collected on a filter is known to overestimate the aerosol's atmospheric absorption coefficient. A correction factor is applied, but the factor is not known accurately. Comparison of the integrating plate method with measurements of elemental carbon, or with absorption coefficients determined through teleradiometry, provides a check on accuracy of the final measurement without checking component measurements or assumptions.

The SCAQS measurements are diverse and the issues affecting accuracy and precision are correspondingly diverse. While the results of external QA

audits are quantitative, they are generally too few to summarize statistically, and are not available for all measurements. Further, accuracy information usually applies to an entire measurement set, whereas it is often appropriate to calculate precisions for individual data values using propagation of errors. Thus, uncertainties in the SCAQS data base depend primarily on internal QC data, and primarily represent precision. Issues affecting data accuracy are being compiled into a table that includes a discussion for each measurement in the SCAQS data base. The discussions compare audit and methods comparison results with accuracies and precisions reported by the participants.

9.4 DATA VALIDATION PROCESS

Data validation is performed on three levels. Level 1 validation is performed by participants prior to submission of their data. It includes:

> eliminating data which are known to be invalid because of instrument malfunctions;

> flagging data when significant deviations from measurement assumptions have occurred;

> flagging as suspect any single data average which contains less than 70% recovery of valid individual measurements;

> adjusting measurement values for quantifiable calibration or interference biases; and

> verifying listing of data base sent by the data manager against original data sheets or computer file.

Level 2 validation is performed by the management team in conjunction with the participants after submission of the data to the data manager. It consists of checks against known physical limits and relationships including:

> comparisons against known physical limits for minimums, maximums, rate of change;

> internal consistency checks between related or redundant parameters;

> review of time series plots;

> review of scatterplots between related measurements;

> review of correlations between the same measurement at neighboring sites.

Level 3 validation consists of identification of errors and inconsistencies by users of the data during data analysis activities. Examples include wind data that do not match the tracer tests, and ammonia data that are inconsistent with thermodynamic equilibrium.

The data validation process produces two results. First, problems are identified, documented and corrected where feasible, thus improving the quality of data in the data base. Second, the results of data validation tests are incorporated as flags and comments in the data base, thus enhancing its usefulness.

9.5 DATA BASE STRUCTURE

9.5.1 Components of the Data Base

The major components of the data base include: the Data Set, Raw Data Archive, and Auxiliary Data Volumes. Different portions of the data base will be made available in the most appropriate and useful forms. ENSR has identified two groups: the owners, ARB, and the users. ENSR will supply ARB with the Data Set, the Owner's Software and Software Guide, Raw Data Archive, Auxiliary Data Volume Masters, and the SCAQS Data User's Guide.

The Owner's Software is written in SAS and FORTRAN 77 programming languages delivered on magnetic tape. This software will allow the owner to enter new data, update existing data, run validation checks, and produce user data sets. The Owner's Software Guide provides hardcopy and instructions for use of all owner's software. It also includes a discussion of the data structures and stratagems for generating new user data sets.

The Raw Data Archive is a compilation of data received from participants, on the original media accompanied by the original documentation.

The Auxiliary Data Volume Masters contains original or 'camera ready' material suitable for reproduction of auxiliary data volumes.

The SCAQS Data User's Guide consists of several sections. The Introduction and Study Description provide an overview of the objectives, study dates, sampling locations and general descriptions of the measurements. An Overview of Air Quality and Meteorology is a narrative summary of air quality and meteorology during the study periods with an emphasis on intensive periods. The data processing, validation, flags, uncertainties and identification of measurement variables are described in the Data Description section. A section containing Data Formats and Media also provides information on the data retrieval process. Finally, the date capture frequency broken down by study and intensive periods and the status of data validation are discussed in Data Capture and Validation Statistics.

The SCAQS User Data Sets contain the full data, working data, data subsets, and summary data. The Auxiliary Data Volumes consist of summaries of daily weather, aircraft flights, and univariate statistics.

Researchers using the Data Archives will generally focus on specific areas and data sets. However, most researchers will need an overview of results in many areas to better concentrate their research and to place it in context. The Data Base User's Guide will provide this initial context. The Auxiliary Data Volumes will provide information essential for efficient research and will serve as the starting point for investigation of the data base. Auxiliary Data Volumes are outlined below. Since some of these data volumes will be voluminous or difficult to reproduce, summaries or extracts from the Data Volume will be included in an Auxiliary Data Summary. In many cases, this summary will be all a researcher requires. Items listed after "Summary" in the following paragraphs will be included.

Daily Weather Summaries -
Synopsis, maps, plots, and tables for each study day, plus satellite photos for each intensive day.
Summary: Maps, soundings and a selection of tables for intensive days only.

Aircraft Data Volume -
Synopsis, maps, plots, and tables describing air quality and meteorology for each aircraft flight.
Summary: Flight summary pages.

Summary Statistics Volume -
Univariate statistics for primary measurements in the data base (e.g. minimum, maximum, mean, histogram, timeseries). Basic multivariate statistics for primary measurements in the data base (e.g. isopleth maps, correlations).
Summary: Selected displays for selected variables.

Tracer Data Volumes I and II -
Isopleth and timeseries plots of tracer concentrations. IBM-PC compatible data set and software to produce the above plots. Analysis and interpretation.
Summary: Selection of key plots and brief text illustrating principal results and interpretation of the analyses.

Upper Air Soundings -
Plots showing sounding data on intensive days.
Summary: None. Two sounding plots per day are already included in the Daily Weather Summaries produced by SCE.

Photographs -
On intensive days: 35 mm slides for three views hourly or half-hourly, and 16 mm time lapse or VHS for two views.
Summary: Illustrative set of photos; selection and media being investigated. (e.g. Media may be four color reproduction or slides in three ring binder pages. Selection may illustrate good, medium, and poor air quality for each view.)

LIDAR Data -
LIDAR data profile plots.
Summary: Being investigated.

Day Specific Emissions -
Being investigated.
Summary: Being investigated.

Quality Assurance Report -
Compiled by ENSR, description of the methods and results of the QA program which included system audits by ENSR, performance audits by the ARB and SCAQMD and several laboratory intercomparison studies coordinated by the ARB. System audits included review of standard operational and quality control procedures submitted by all study participants.
Summary: Final report available; see Table 8-1 of this report.

"B" Site Operations Report -
Compiled by AV, aerial and ground photographs and descriptions of all the "B" sites. Measurements taken, sampling schedules, procedures for sample and data collection and for data processing and lists of all samples collected.
Summary: Final report available.

"A" Site and Special Studies Reports -
Papers and reports generated by individual researchers.
Summary: Bibliography available.

9.5.2 Data Base Structure

The many types of data collected during SCAQS do not allow a single structure for the data base. However, the majority of the data can be classified into three types: surface and upper air (vertical sounding) data from fixed monitoring sites, and aircraft spirals, orbits and traverses. In designing the structure for the surface data file, priority was given to flexibility of data access rather than compactness. Thus, the entry for each data value contains information on the source, location, time, etc. of the measurement. This type of structure was necessary because of the many different sample averaging times used by the participants, and large variety of measurements taken at each site. The upper air sounding sites and aircraft did not have this variety of measurements, so the structure of those files are more compact. Software has been written to fulfill users' requests for subsets of the data base with different structures.

Validation results will be archived as two fields associated with each measurement value. The first field, QCCODE, is used to specifically record the results of validation checks. This field is eight characters long, and holds up to four two-character quality check (QC) codes. A QC code identifies a specific validation check that was failed, or a specific comment indicating a problem with the data. For example, OT may indicate that the point is an outlier, MB that a mass balance check was failed, and PI that the participant considered the data invalid.

Due to the variety of measurements and validation tests being conducted, the number of QC codes is large. To condense the validation results into a usable form, a second field is provided, VALIDITY. This field is two characters long and indicates whether the data value is considered valid, suspect, invalid, or unvalidated. The VALIDITY field also indicates the level of the validation check, 1, 2, or 3, used to make the status assessment. The status implications of the various validation checks are determined by the measurement-specific data managers in conjunction with the participants.

The data base contains several auxiliary files that give detailed information on some of the variables in the data files. These auxiliary files describe the source (i.e. group, principal investigator), site (i.e. name, location), value (i.e. units, sampling and analysis method) and QC code fields in the data base.

9.6 DATA REQUESTS

All data requests by SCAQS participants and sponsors can be made to:

Bart Croes
Research Division
Air Resources Board
PO Box 2815
1800 15th Street
Sacramento, CA 95812
Phone (916) 323-1534
Fax (916) 322-4357

There will be no charges for these requests.

The rest of the scientific community and the general public should send their written requests to:

Dr. John R. Holmes, Chief
Research Division
Air Resources Board
PO Box 2815
1800 15th Street
Sacramento, CA 95812

There will be a nominal charge to recover the ARB's costs for processing these requests. The only restriction on distribution of the data is that no one can make a profit on the data base, and the ARB must be informed as to who receives the data base. This will allow ARB to notify all users of any updates to the data base as a result of Level 3 validation. Also, three copies of any journal articles, conference papers or reports that result from the use of the data base should be sent to the ARB as a courtesy.

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APPENDIX A. SCAQS PARTICIPANT AND WORKING GROUP LISTS

This Appendix includes lists of members of the SCAQS Management Advisory Group and of the Emissions, Meteorology, and Model Working Groups. Also included is a list of study participants and their organizations.

Table A-1. Southern California Air Quality Study Management Advisory Group

Organization	Representative
California Air Resources Board	John Holmes
ARB Research Screening Committee and Scientific Advisory Committee	Katherine Wilson
	Jan Bush (Former member)
South Coast Air Quality Management District	Alan Lloyd
	Art Davidson (Former member)
Environmental Protection Agency	Ken Knapp
Coordinating Research Council	Tim Belian
Electric Power Research Institute	Peter Mueller
Ford Motor Company	Robert Hammerle
	William Pierson (Former member)
	Tai Chang (Former member)
General Motors Research Laboratories	George Wolff
Motor Vehicle Manufacturers Association	Marcel Halberstadt
Southern California Edison	Carol Ellis
Western States Petroleum Association	Art Pope
	Kent Hoekman

Table A-2. Emissions Working Group

Members	Organization	
Mike Nazemi	SCAQMD	Chairman
Vince Mirabella	SCE	Former Chairman
Paul Allen	ARB	
Tim Belian	CRC	
Rich Bradley	ARB	
Glen Cass	Caltech	
Anton Chaplin	UnoCal (Western States Petroleum Association, WSPA)	
Art Davidson	SCAQMD	
Paul Davis	Chevron (WSPA)	
Marty Ferman	GM Research Laboratories	
John Grisinger	SCAQMD	
Marcel Halberstadt	MVMA	
Steve Heisler	ENSR	
Kent Hoekman	Chevron	
Ken Knapp	EPA	
Ron Lantzy	Rohm and Hass (Formerly at Exxon)	
Peter Mueller	EPRI	
Bill Oliver	Radian	
Jack Paskind	ARB	
Bill Pierson	DRI (Formerly at Ford)	
Art Pope	Arco (WSPA)	
Andy Ranzieri	ARB	
Paul Roberts	STI (Formerly at Chevron)	
Christian Seigneur	ENSR (Formerly at Bechtel)	
John Watson	DRI	
George Wolff	GM Research Laboratories	
Wayne Zwiacher	SCAQMD	

Table A-3. Meteorology Working Group

Members	Organization
Art Davidson	SCAQMD Chairman
Chuck Bennett	ARB
Don Blumenthal	STI
Joe Cassmassi	SCAQMD
Frank DiGenova	ARB
Eric Fujita	ARB
Jack Horrocks	ARB
Bob Kessler	SAI
Bill Knuth	T&B Systems
Doug Lawson	ARB
Don Lehrman	T&B Systems
Frank Ludwig	SRI International
Stan Marsh	SCE
Ken Schere	EPA
Fred Shair	Caltech
Ted Smith	Ted B. Smith and Associates
Jack Suder	ARB
Mel Zeldin	SCAQMD (Formerly at SCE)

Table A-4. Model Working Group

Members	Organization
John Seinfeld	Caltech Chairman
Praveen Amar	ARB
Roger Atkinson	UC Riverside
Glen Cass	Caltech
Tai Chang	Ford
Anton Chaplin	UnoCal (WSPA)
Alan Dunker	GM Research Laboratories
Michael Fosberg	US Forest Service
Robert Kessler	Systems Applications, Inc.
Chung Liu	SCAQMD
Alan Lloyd	SCAQMD (Formerly at ENSR)
Fred Lurmann	STI (Formerly at ENSR)
Vince Mirabella	SCE
Andrew Ranzieri	ARB
Philip Roth	WSPA
Kenneth Schere	EPA
Christian Seigneur	ENSR (Formerly at Bechtel)
Christine Sloane	GM Research Laboratories
Thomas Tesche	Radian
Gary Whitten	Systems Applications, Inc.

Table A-5. SCAQS Field Study Participants (Measurements, Quality Assurance, Forecasting)

	Organization	Program Manager	Participants	11/28/89
1.	AIHL	Appel	Bruce Appel	
2.	AIHL	Appel	Vince Povard	
3.	AIHL	Appel	Yosh Tokiwa	
4.	AIHL	Appel	R. Wu	
5.	AIHL	John	Walter John	
6.	AIHL	John	Joel Ondo	
7.	AIHL	John	Stephen Wall	
8.	AIHL	John	Hwa-Chi Wang	
9.	AIHL	John	Wolfgang Winklmayr	
10.	AQMD	Bope	Bill Bope	
11.	AQMD	Cassmassi	Joseph Cassmassi	
12.	AQMD	Cassmassi	Jerry Arnold	
13.	AQMD	Cassmassi	Bruce Seleck	
14.	AQMD	Ryan	Sandy Ryan	
15.	AQMD	Ryan	Cass Allers	
16.	AQMD	Ryan	Don Kent	
17.	ARB-HS	Shikiya	Jim Shikiya	
18.	ARB-HS	Shikiya	Don Daymon	
19.	ARB-HS	Shikiya	Pat Harrington	
20.	ARB-HS	Shikiya	Jack Horrocks	
21.	ARB-HS	Shikiya	John Jung	
22.	ARB-HS	Shikiya	John Kowalski	
23.	ARB-HS	Shikiya	Lee Lewis	
24.	ARB-HS	Shikiya	Gary Skousen	
25.	ARB-HS	Shikiya	Rupee Torre	
25.	ARB-Sacr	Effa	Robert Effa	
26.	ARB-Sacr	Effa	Kevin Kalthoff	
27.	ARB-Sacr	Effa	Ron Lewis	
28.	ARB-Sacr	Holmes	John Holmes	
29.	ARB-Sacr	Holmes	Lowell Ashbaugh	
30.	ARB-Sacr	Holmes	Chuck Bennett	
31.	ARB-Sacr	Holmes	Bart Croes	
32.	ARB-Sacr	Holmes	Frank DiGenova	
33.	ARB-Sacr	Holmes	Eric Fujita	
34.	ARB-Sacr	Holmes	Doug Lawson	
35.	ARB-Sacr	Holmes	Chuck Unger	
36.	AV	Chan	Michael Chan	
37.	AV	Chan	Alex Barnett	
38.	AV	Chan	Kurt Bumiller	
39.	AV	Chan	Don Christopherson	
40.	AV	Chan	Nic Contreras	
41.	AV	Chan	Dennis Fitz	
42.	AV	Chan	Steve Kirchner	
43.	AV	Chan	Eric Larson	
44.	AV	Chan	K. C. Moon	
45.	AV	Chan	Paul Pruss	
46.	AV	Chan	Jerry Thelen	
47.	AV	Chan	Dave Wilbur	
48.	AV-site op.	Chan	Ruth Barili	
49.	AV-site op.	Chan	John Connor	

Table A-5. SCAQS Field Study Participants (Measurements, Quality Assurance, Forecasting)

	Organization	Program Manager	Participants	11/28/89
50.	AV-site op.	Chan	Slavko Cvencek	
51.	AV-site op.	Chan	Kevin Durdee	
52.	AV-site op.	Chan	Gordon Eichorst	
53.	AV-site op.	Chan	Joanne Engelke	
54.	AV-site op.	Chan	Jeff Gray	
55.	AV-site op.	Chan	Foel Herr	
56.	AV-site op.	Chan	Valerie Hoffman	
57.	AV-site op.	Chan	Steve Hymes	
58.	AV-site op.	Chan	Peter Iskandar	
59.	AV-site op.	Chan	Bong Mann Kim	
60.	AV-site op.	Chan	Xiaoming Li	
61.	AV-site op.	Chan	Hoang Ly	
62.	AV-site op.	Chan	Elizabeth Martinez	
63.	AV-site op.	Chan	Tom McDowell	
64.	AV-site op.	Chan	Joanne Nowak	
65.	AV-site op.	Chan	Joe Petrini	
66.	AV-site op.	Chan	Julie Phillips	
67.	AV-site op.	Chan	Bill Reid	
68.	AV-site op.	Chan	Cheryl Sandifer	
69.	AV-site op.	Chan	Lisa Scheinost	
70.	AV-site op.	Chan	Keith Shannon	
71.	AV-site op.	Chan	David Shimnei	
72.	AV	Filek	Jack Filek	
73.	AV	Filek	Jeff Bradley	
74.	AV	Huang/Thelen	Andy Huang	
75.	AV	Huang/Thelen	Jerry Thelen	
76.	AV	Huang/Thelen	Don Christopherson	
77.	AV	Huang/Thelen	Steve Kirchner	
78.	AV	Huang/Thelen	Keith Pettus	
79.	Biospherics	Rasmussen	Rei Rasmussen	
80.	CIT-cloud	Hoffmann	Michael Hoffmann	
81.	CIT-cloud	Hoffmann	Jeff Collett	
82.	CIT-cloud	Hoffmann	Bruce Daube	
83.	CIT-cloud	Hoffmann	Bill Munger	
84.	CIT-tracer	Shair	Fred Shair	
85.	CMU	Davidson	Cliff Davidson	
86.	CMU	Davidson	Yee Lin Wu	
87.	DGA	Grosjean	Daniel Grosjean	
88.	DGA	Grosjean	Eric Grosjean	
89.	DGA	Grosjean	Fabrice Grosjean	
90.	DGA	Grosjean	Antoinette Van Neste	
91.	DGA	Grosjean	Sucha Parmer	
92.	DGA	Grosjean	Edwin Williams	
93.	DRI	Rogers,D.	Dave Rogers	
94.	DRI	Rogers,D.	Heidi Bastable	
95.	DRI	Rogers,D.	David Miller	
96.	DRI	Rogers,D.	Linda Piehl	
97.	DRI	Rogers,D.	Suzanne Raftery	
98.	DRI	Rogers,D.	David Shorran	
99.	DRI	Rogers,D.	Patti Walsh	

Table A-5. SCAQS Field Study Participants (Measurements, Quality Assurance, Forecasting)

	Organization	Program Manager	Participants	11/28/89
100.	DRI	Watson	John Watson	
101.	DRI	Watson	John Bowen	
102.	DRI	Watson	Judy Chow	
103.	DRI	Watson	Alan Gertler	
104.	EMSI	Keifer	William Keifer	
105.	EMSI	Keifer	Richard Countess	
106.	EMSI	Keifer	Roger Olson	
107.	EMSI	Keifer	Wilma Seltzer	
108.	EMSI-BNL	Lev-On	Miriam Lev-On	
109.	EMSI-BNL	Lev-On	Jerry Downes	
110.	EMSI-BNL	Lev-On	David Perotti	
111.	EMSI-BNL	Lev-On	Roger Tanner	
112.	EPA-GKB	Lonneman	Bill Lonneman	
113.	EPA-GKB	Lonneman	Robert Seila	
114.	EPA-LV	McElroy	Jim McElroy	
115.	EPA-LV	McElroy	Don Bundy	
116.	EPA-LV	McElroy	Curt Edmonds	
117.	EPA-LV	McElroy	Tom Mace	
118.	EPA-RTP	Knapp	Ken Knapp	
119.	EPA-RTP	Knapp	Tom Ellestad	
120.	EPA-RTP	Knapp	Len Stockburger	
121.	ERT (Now ENSR)	Collins	John Collins	
122.	ERT (Now ENSR)	Collins	Chris Lanane	
123.	ERT (Now ENSR)	Fung	Kochy Fung	
124.	ERT (Now ENSR)	Heisler	Steve Heisler	
125.	ERT (Now ENSR)	Heisler	Jeff Harrison	
126.	ERT (Now ENSR)	Wright	Barbara Wright	
127.	ERT (Now ENSR)	Wright	Lynn Dachtler	
128.	ERT (Now ENSR)	Wright	Ellen Soppe	
129.	ERT (Now ENSR)	Wright	Amy Taketomo	
130.	Ford	Adams	Karen M. Adams	
131.	Ford	Adams	L. I. Davis	
132.	Ford	Adams	David R. Finley	
133.	Ford	Adams	Steven M. Japar	
134.	GGC	Gordon	Robert Gordon	
135.	GGC	Gordon	Joe Babbitt	
136.	GGC	Gordon	Richard Brewer	
137.	GGC	Gordon	M. Roughn	
138.	GGC	Gordon	Spencer Steinberg	
139.	GGC	Gordon	Niru Trivedi	
140.	GGC	Gordon	Brian Wilcher	
141.	GM	Wolff	George Wolff	
142.	GM	Wolff	Carolina Ang	
143.	GM	Wolff	Marty Ferman	
144.	GM	Wolff	Gene Fincham	
145.	GM	Wolff	Nelson Kelly	
146.	GM	Wolff	Patricia Korsog	
147.	GM	Wolff	Jerry Morris	
148.	GM	Wolff	Patricia Mulawa	
149.	GM	Wolff	Marty Ruthkowsky	

Table A-5. SCAQS Field Study Participants (Measurements, Quality Assurance, Forecasting)

	Organization	Program Manager	Participants	11/28/89
150.	GM	Wolff	Christine Sloane	
151.	GM	Wolff	David Stroup	
152.	IIT	Noll	Kenneth Noll	
153.	IIT	Noll	Julianne Caron	
154.	IIT	Noll	Ken Fang	
155.	LBL	Novakov	Tihomir Novakov	
156.	LBL	Novakov	Tony Hansen	
157.	LEMSCO	Richardson	E. L. Richardson	
158.	LEMSCO	Richardson	Jerry Grandlund	
159.	LEMSCO	Richardson	Bill Hankins	
160.	Northrop	Kellogg	Robert Kellogg	
161.	NSI	Ellenson	Bill Ellenson	
162.	NSI	Ellenson	Chris Fortune	
163.	NSI	Ellenson	Bruce McElhoe	
164.	OGC	Huntzicker	James Huntzicker	
165.	OGC	Huntzicker	Don Buchholz	
166.	OGC	Huntzicker	Barbara Turpin	
167.	Radian	Oliver	Bill Oliver	
168.	Radian	Oliver	Richard Boyd	
169.	Radian	Oliver	Ronald Dickson	
170.	Radian	Oliver	Martha Hyder	
171.	Radian	Oliver	Michael Thompson	
172.	RPS	Richmond	Earl Richmond	
173.	SCE	Ellis	E. C. Ellis	
174.	SCE	Ellis	Larry Bregman	
175.	SCE	Ellis	Laura Games	
176.	SCE	Ellis	Stan Marsh	
177.	SCE	Ellis	Mel Zeldin	
178.	STI	Blumenthal	Don Blumenthal	
179.	STI	Blumenthal	Jerry A. Anderson	
180.	STI	Blumenthal	Susanne Hering	
181.	STI	Blumenthal	John Koos	
182.	STI	Blumenthal	Paul Roberts	
183.	STI	Blumenthal	Mark Stoelting	
184.	STI	Richards	L. Willard Richards	
185.	STI	Richards	David Bell	
186.	STI	Richards	Adrian Gonzalez	
187.	STI	Richards	Susan Nies	
188.	STI	Richards	Mark Stoelting	
189.	SWRI	Ingalls	Mel Ingalls	
190.	TBS	Lehrman	Don Lehrman	
191.	TBS	Lehrman	Leigh-Anne Lehrman	
192.	TBS	Lehrman	Nancy Alexander	
193.	TBS	Lehrman	Robert Bergeron	
194.	TBS	Lehrman	Larry George	
195.	TBS	Lehrman	Hans Giroux	
196.	TBS	Lehrman	William Knuth	
197.	TBS	Lehrman	Richard Sweeney	
198.	TS	Smith	Ted B. Smith	
199.	TT	England	Walt England	

Table A-5. SCAQS Field Study Participants (Measurements, Quality Assurance, Forecasting)

	Organization	Program Manager	Participants	12/13/89
200.	TT	England	D. England	
201.	TT	England	J. Hertel	
202.	TT	England	Patti Hobson	
203.	TT	England	S. Kerrin	
204.	TT	England	S. Kharod	
205.	TT	England	T. J. Rappolt	
206.	TT	England	L. H. Teuscher	
207.	UCD	Cahill	Cathy Cahill	
208.	UCD	Cahill	Tom Cahill	
209.	UCD	Cahill	Olaf Beckman	
210.	UCD	Cahill	Pete Beveridge	
211.	UCD	Cahill	Ken Bowers	
212.	UCD	Cahill	James Cordova	
213.	UCD	Cahill	Steve Eldred	
214.	UCD	Cahill	David Everett	
215.	UCD	Cahill	Phil Gravey	
216.	UCD	Cahill	Chris Hawkins	
217.	UCD	Cahill	Robert Matsumura	
218.	UCD	Cahill	Brian Perley	
219.	UCD	Cahill	Marcelle Surovik	
220.	UCD	Cahill	Paul Wakabayashi	
221.	UCD	Cahill	Kent Wilkinson	
222.	UCD	Cahill	Ian Wittmeyer	
223.	UCLA-1	Allen	David T. Allen	
224.	UCLA-1	Allen	Sam Chon	
225.	UCLA-1	Allen	Susanne V. Hering	
226.	UCLA-1	Allen	Ed Palen	
227.	UCLA-1	Allen	Todd Pickle	
228.	UCLA-1	Allen	Darioush Sahmedini	
229.	UCLA-2	Friedlander	Sheldon Friedlander	
230.	UCLA-2	Friedlander	Hilary Main	
231.	UCLA-2	Friedlander	Hossein Pourmand	
232.	UCR	Winer	Arthur Winer	
233.	UCR	Winer	Janet Arey	
234.	UCR	Winer	Roger Atkinson	
235.	UCR	Winer	Chris Berglund	
236.	UCR	Winer	Heinz Biermann	
237.	UCR	Winer	Travis Dinhoff	
238.	UCR	Winer	Li Li Parker	
239.	UCR	Winer	Ernesto Tuazon	
240.	UCR	Winer	Barbara Zielinska	
241.	UD	Stedman	Don Stedman	
242.	UD	Stedman	Mark Burkhardt	
243.	UD	Stedman	Benard Ghim	
244.	UI	Rood	Mark Rood	
245.	UI	Rood	David Covert	
246.	UI	Rood	Rick Manner	

Table A-5. SCAQS Field Study Participants (Measurements, Quality Assurance, Forecasting)

	Organization	Program Manager	Participants	11/28/89
247.	UM	McMurry	Peter McMurry	
248.	UM	McMurry	Anand Gupta	
249.	UM	McMurry	Catie Hudrlik	
250.	UM	McMurry	Mark Stolzenburg	
251.	UM	McMurry	Dagang Tang	
252.	UM	McMurry	Ye Tao	
253.	UM	McMurry	Xin Qui Zhang	
254.	Unisearch	Mackay	Gervase Mackay	
255.	Unisearch	Mackay	John Drummond	
256.	Unisearch	Mackay	Janice Green	
257.	Unisearch	Mackay	Dave Karecki	
258.	Unisearch	Mackay	John Pisano	
259.	UV	Horvath	Helmuth Horvath	
260.	UV	Horvath	Regina Hitzenberger	
261.	UV	Reischl	George Reischl	
262.	UV	Reischl	Axel Berner	
263.	UV	Reischl	Wolfgang Winklmayr	
264.	UW	Hegg	Dean Hegg	
265.	UW	Hegg	William S. Allan	
266.	UW	Hegg	Mary Barth	
267.	UW	Hegg	David Curtis	
268.	UW	Hegg	Mark Dickinson	
269.	UW	Hegg	Steven Domonkos	
270.	UW	Hegg	David Erickson	
271.	UW	Hegg	Ron Ferek	
272.	UW	Hegg	Peter V. Hobbs	
273.	UW	Hegg	Michael D. King	
274.	UW	Hegg	J. Lyons	
275.	UW	Hegg	Steven Nickells	
276.	UW	Hegg	Margaret Orphan	
277.	UW	Hegg	Jamie L. Radke	
278.	UW	Hegg	Larry F. Radke	
279.	UW	Hegg	Jack Russell	
280.	UW	Hegg	Maxwell Strange	
281.	UW	Hegg	H. Terry	
282.	UW	Hegg	Cynthia Twohy	
283.	UW	Hegg	Donald O. Veach	

Total no. of groups = 58

APPENDIX B. BIBLIOGRAPHY OF SCAQS PUBLICATIONS

Papers Presented at the 1989 Meeting of the Air and Waste Management Association.	B-2
Atmospheric Environment Papers	B-8
ARB-Sponsored SCAQS Final Reports	B-10
CRC-Sponsored SCAQS Final Reports	B-12
Other SCAQS Final Reports	B-14

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