DRAFT

SJVAQS/AUSPEX AND SARMAP DATA MANAGEMENT

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INTRODUCTION

The purpose of this paper is to describe the database management system developed for data collected during the SJVAQS/AUSPEX 1990 summer field study. The task of developing the database management system was challenging due to the wide array of data sources, types, and the large volume of data involved. The data collected for the data archive came from two kinds of sources: 1) Primary (or project) data sources with

monitoring sites having at least one instrument installed specifically for the project's purpose. All of the additional equipment were removed at the end of the project.
2) Supplemental data sources with monitoring sites already in existence prior to the study with no new equipment added specifically for the study. The development of the database management system was an evolutionary process which utilized the lastest database software and computer technology. Developing the database system consisted of the following steps: 1) Determining what data should be collected; 2) Acquiring the data; 3) Selecting hardware and software; 4) Setting up the computer hardware, local area network, bulletin board system, and tape backup system; 5) Designing the relational aspects of an appropriate database system; 6) Determining data flow from source to end user; 7) Processing , validating, and importing data of differing formats into database files; 8) Exporting the data in various usable formats for end users. Through the course of the database management process, many lessons were learned. This paper will address the design and development of the database management system in sufficient detail to provide a guide for future field studies to avoid some of the problems experienced during this project.

The overall objective for the database management system is to meet the data requirements for the SJVAQS/AUSPEX Regional Model Adaptation Program (SARMAP) in a relatively short time period. SARMAP requires a high quality data archive which accurately represents the regional character of the monitored area to be used in air quality and wind model development and model performance evaluation. The data archive is critical to the success of SARMAP.

Many of the technical terms used to the describe the data management process are defined in the glossary section at the end of the paper.

OVERVIEW

Historical Perspective

Ideally, a database management system should be designed prior to data collection to accurately store, document, and flag the data. A well designed plan enhances the overall success of a field monitoring project. It helps to reduce uncertainity in the data archive, improve the efficiency and speed of the data processing, and provide end users a set of data which accurately represents the study domain. Unfortunately, a comprehensive data management plan was not fully developed before the field program began and this contributed to many of the challenges encountered by the data management team.

A single data management meeting was called in the winter of 1990 to discuss previous field programs, subsequent data archives, and the many problems to avoid. Many useful ideas were presented, and the information was documented (Niccum 1990, unpublished) and sent to the meeting participants. Unfortunately, no further meeting was called to formulate a solid plan for the data management when the field program ended. During the field program, data management focused on collecting raw data from monitoring sites via a telemetry system to computers at the Field Operations Center (FOC) in Fresno (Start 1993). The data were archived on Write Once Read Many (WORM) platters to provide an additional data backup system.

In the fall of 1990, contractors were asked to submit their data in ASCII files, Pacific Daylight Time(PDT) with the time referring to measurements made at the beginning of the hour. No standard format was specified and the data were received in a variety of formats. Also it was unclear to some contractors where to submit their data which resulted in some of the data being sent to National Oceanic Atmospheric Administration Environmental Research Laboratory (NOAA-ERL), and the rest being sent to the Air Resources Board (ARB). Eventually all of the data were sent to NOAA-ERL where software was being developed to read in the various formats and output the data in a common format. This task was time consuming and eventually abandoned.

At this time the data management team decided to have NOAA-ERL send all the data to Desert Research Institute (DRI) for importation into database files. Staff at the ARB reformated the supplemental data and provided it also to DRI. The initial file structure was similar to a mathematical spreadsheet format designed to meet the data analysis objectives described by Watson et al. (1993). The initial file structure is referred to hereafter as the Project Format. Upper-air file structures were also defined at this time.

An examination of the original project format files showed some processed data to be in error. Forms had not been completed to document the processing done to the data, and additional sponsor documentation was disorganized and located in several places. The uncertainity from all this prevented the completion of the unified database, and resulted in a new plan to reprocess the data.

The data management team decided to relocate the data management headquarters to the ARB, and eventually all the data management tasks were performed at the ARB after the purchase of adequate hardware and software to handle the large amounts of data. This included setting up a network of personal computers and developing a new normalized database structure to store all the surface data. The normalized database structure stores a single data value per record. Because the existing project files lacked traceablity, the whole process of building the new SARMAP surface database started over at the beginning with reprocessing and importing the original contractor data. This process was time consuming but produced a much more efficient and accurate database to meet the needs of all the end users. No additional time was available to restructure any of the non-surface database files.

The upper-air, aircraft, tracer, and hydrocarbon data were imported database files with the original Project Format design.. All the aircraft data processing were done outside the ARB. The time allotted for the production of the data archive was used up in the many steps of the data processing, and as a result the final database management system was formed under the pressure of advancing data distribution deadlines.

The resulting database management system was not as ideal as it could have been if it had been designed prior to the field study. For instance, much time could have been saved if the efficient database structure had been designed from the beginning. This paper will address many aspects of the developed database management system. Solutions to the problems that arose will be discussed in detail in the retrospective section.

Scope

The SARMAP database consists of air quality, meteorological, and tracer data collected from many surface and upper-air sites, and aircraft flights. An overview of the SJVAQS/AUSPEX field measurement program is given by Ranzieri, et al (1991). The surface monitoring network included nearly 300 primary and supplemental sites. Over two thirds of these sites existed as part of other monitoring networks. The 49 sites which made up the upper-air monitoring network were mostly primary sites. Figure 1 is a map of the study domain showing all the primary and supplemental surface sites. Figure 2 shows the locations of the upper-air sites. An ambitious effort was made to determine existing air quality and meteorological sites operated by various government agencies and private industries (Blumenthal 1989). Careful analysis of the types of measurements made and locations at each existing site provided valuable information for planning the primary sites. Primary site locations and types were chosen to fill in any large regional spacing gaps between existing sites and ensure well spaced measurements to accurately represent the study domain. An effort was made to choose sites which met the standard Environmental Protection Agency (EPA) site requirement for air quality monitoring sites (EPA 1975) and meteorological monitoring sites (EPA 1978). All the primary sites were photographed and well documented, and NOAA-ERL put together a very comprehensive site atlas (Start 1992).

The 76 primary sites set up specifically for the study measured O3, NO, NO2, NOz, PAN, wind speed, and wind direction continuously from July 8,1990 through August 31, 1990. Most of the sites measured both air quality and winds, but some were exclusively ozone or winds. A few sites measured total solar insolation. During the intensive monitoring periods when ozone measurements were expected to exceed the state of California standard (0.09 ppm, ARB n.d.), additional hydrocarbon samples were taken at various primary sites.

Some of the surface sites were co-located with upper-air monitoring equipment. Seven of the primary upper-air sites had radar wind profilers and six had Doppler Acoustic Sounders (DAS) which continuously monitored the upper-air winds during the entire study period. Many of the upper-air sites were balloon sites where up to eight soundings per day were made during the intensive monitoring periods. Rationale for balloon launch times are described by Blumenthal (1993). Descriptions of the upper-air monitoring network are given by Thuillier (1993) and Niccum (1993). Additional measurements during the intensive monitoring periods included a fleet of nine aircraft to measure upper-level air quality and meteorology, and tracer gas releases to determine particle trajectories and source attribution.

At the FOC in Fresno, a data acquisition system was developed by Ackermann (1993) to collect the raw data each hour from the primary sites using a telemetry system. The raw data were stored on WORM media for backup and to provide reference to the hourly averaged data to be contained in the final database. Figure 3 describes the path for the project data from field monitoring to the final database. All aspects of the data processing will be described in later sections of this paper.

A directory listing all possible existing sites and sponsors was created by Blumenthal (1989). Sponsors for the various surface monitoring networks included the Department of Water Resources (which operates the CIMIS network, California Irrigation Management Information System), the Air Resources Board, Pacific Gas and Electric Company, Chevron, Texaco, the National Park Service, Mineral Management Systems, the Department of Defense, the National Weather Service, and various county and regional air pollution control districts.

The sponsors were contacted by phone and were sent questionnaires to fill out. The purpose of the questionnaires was to collect information about the types of measurements made at each site, the instruments used, the quality control program implemented (if any), site locations, and directions to the sites. Many of the supplemental sites were visited, photographed, and notes were taken of site characteristics, but no supplementary site atlas is available yet. A more complete description of efforts made to obtain the supplemental data is given by Hackney et al. (1991).

The supplemental sites measured many additional pollutants and meteorological variables because the sites were part of existing environmental monitoring systems which vary in scope and purpose. For example, the Air Resources Board routinely gathers data measured at ARB sites and all the air pollution control district sites throughout the state of California. The data is analyzed, checked for quality, and then compiled into a large database for public use. Each region has particular pollutants of importance so the ARB database varies in content from site to site. In addition to O3, wind, NO, NO2, and NOx, some of the other variables measured from the existing monitoring networks included temperature, relative humidity, CO, CH4, SO2, total hydrocarbons (THC), non-methanated hydrocarbons (NMHC), and solar radiation. The supplemental upper-air sites consisted of seven DAS sites from PG&E and two National Weather Service balloon sites.

The form of the supplemental data varied widely from sponsor to sponsor in format, time reference, units, etc. The supplemental data needed to meet three requirements before being accepted as usable for the database: 1) No instantaneous data (must be able to be hourly averaged) 2) Regular QC/QA done on the instruments and data 3) Available on magnetic media (hard copies of data not acceptable). Figure 4 details the steps involved in obtaining and qualifying the supplemental data.

Table 1 describes the contents of the surface data network and lists the various sponsors and the type of measurements made by each. The upper-air monitoring data network is described in detail by Thuillier (1993). Understanding the range and content of the collected data was fundamental to the design of the database and determining what software and hardware would be required to effectively manage the data.

SOFTWARE

When the decision was made to use a commercial PC-based database manager, Microsoft's FoxPro version 2.0 was chosen. The software has proven to be effective for managing the SARMAP database for the following reasons:

Speed. FoxPro is one of the few full featured database management packages for DOS based PC's that is capable of processing the large quantity of SARMAP data in an efficient manner. Utilizing Rushmore query optimization, FoxPro is able to outperform other software/hardware solutions in the same price range, often by a factor of 10 or more.

Capacity. FoxPro is able to manage single database files up to 2 gigabytes in size and containing up to 1 billion records.

Relational Capability. Although FoxPro is not generally considered to be a fully relational database management system, it does include a number of powerful tools that support the development of a fully relational system. These tools include non-procedural methods for retrieving data from related tables, and a rich procedural language supporting 25 tables opened at one time. This is of importance when managing air quality data due to the complex relationships among data elements combined with the large volume of data that must be processed.

Platforms. FoxPro is currently available for DOS-based systems only. A subset of FoxPro, FoxBASE+, is currently available for both Mac and Unix systems. FoxPro will run FoxBASE+ program code and read FoxBASE+ data. Version 2.5 of FoxPro (version numbers 2.1-2.4 intentionally skipped by Microsoft, presumably for marketing reasons) is currently available. This new version has the additional benefit of running under Windows.

Xbase Standard. FoxPro conforms to the mainstream Xbase industry standard, including both procedural language and data format compatibility. Choosing an Xbase compatible product helps to ensure a cost-effective migration path that extends beyond the life-span of any single Xbase-compatible product. Also, Xbase is widely supported, offering the project nearly unlimited choices in the cost-effective acquisition of training, consulting, and programming services. In many cases these costs are further reduced since many project participants are already familiar with the Xbase standard and therefore have less need for assistance from the outside.

Integration. FoxPro supports direct importation of data from VisiCalc, Framework II, Multiplan, Paradox, RapidFile, 1-2-3, Symphony, and Excel. Data can be exported directly to VisiCalc, Multiplan, 1-2-3, Symphony and Excel. In addition, data can be imported and exported from and to a variety of ASCII formats, including comma delimited and SDF (System Data Format).

Multi-User Capability. The multi-user version of FoxPro fully supports file and record locking, an important consideration for any project requiring a team of programmers and/or users.

HARDWARE

The hardware configuration for the SARMAP data management is shown in figure 5. A local area network (LAN) of personal computers was set up to accommodate the size of the database, run FoxPro efficiently, and allow multi-user access to the database. The LAN consists of five main computers with the following configurations:

Main Server PC:	486/33 Mhz Processor 16 MB RAM 540 MB Hard Disk
Server #2 & BBS:	386/40 Mhz Processor 8 MB RAM 200 MB Hard Disk

PC Workstation #1: 386/33 Mhz Processor
4 MB RAM
350 MB Hard Disk

PC Workstation #2: 486/33 Mhz Processor
8 MB RAM
80 MB Hard Disk

PC Workstation #3: 486/33 Mhz Processor (Notebook)
8 MB Ram
120 MB Hard Disk

Peripherals to the LAN consist of an IBM Laserprinter 10, two Intel 14,400 BPS modems, a Panasonic WORM drive, and a Colorado Jumbo 250 MB tape drive for disk backups. All of the computers are equipped with Super VGA monitors and graphics cards. Lantastic hardware is used for the LAN which consists of 10 MB/sec twisted pair connections. Lantastic Network Operating System Version 4.1 by Artisoft is used for the LAN operatons.

A bulletin board system was originally set up on the secondary server PC to provide a forum for contractors, data analysts, modelers, and data management to exchange ideas, software, and data. At present, the primary purpose of the BBS is to distribute the level 2 data. The BBS is set up with PC Board 14.5A software developed by Clark Development Corporation. Currently the BBS has one outside phone line but the software can support up to ten nodes (phone lines) at one time.

DATABASE DESIGN- SURFACE DATA

This section details the treatment of *surface* data only. Due to the time constraints involved, treatment of the surface data was much more detailed than treatment of non-surface data (i.e. balloon, DAS, radar wind profiler, hydrocarbon, aircraft and tracer data), particularly in terms of relational database design. Because of these differences, treatment of the non-surface data is discussed in the next section, "DATABASE DESIGN- NON-SURFACE DATA".

Relational Design

For the SARMAP surface data, in order to best accommodate the wide diversity of both input and output structure, the structure of the primary database was based on the relational model for databases (Codd 1990). The many benefits of this structure include the elimination of storing data redundantly, which facilitate the ongoing maintenance of the data, and simplify data import and export procedures. Figure 6 includes the structure and sample records for the following related databases:

SURFACE.DBF. This file is used to store the results of measurements. Each record represents the results of a single measurement. Each result is uniquely identified by the date and hour the measurement was taken, the site at which the measurement was taken, the operator that took the measurement, and the specific type of measurement that was taken. The name SURFACE refers to the fact that this file contains measurement results that were taken within 30 meters of ground level.

SUBTYPE.DBF. This file is used to store information on specific types of measurements taken. Each record represents a single specific type of measurement. Each such specific measurement type is uniquely identified by a 4 character abbreviation stored in the SUBTYPE field. The name "SUBTYPE" refers to this file's relationship with TYPE.DBF. This file was used significantly as a look up table in the data exportation procedures.

TYPE.DBF. This file is used to categorize types of measurements taken and to store information that is specific to each category. Each record represents a single general category of measurement. Each measurement type is uniquely identified by a 2 character abbreviation stored in the TYPE field.

DOSIT.DBF This is the main site atlas file which is used for storing information about data collection sites. It includes site names, locations, elevations, and site measurement information. Each record represents a single site. Each site is uniquely identified by a 3 character abbreviation stored in the SITE field. DOSIT.DBF was designed at the same time as the Project Format. The first 2 characters of the file's name, "DO", are short for "documentation" and the last 3 characters, "SIT", are short for "site". The rational was that this file "documents sites".

CNTRCTR.DBF. This file is used to store information about data sources. Each record represents a single operator. Each operator is uniquely identified by a 2 character abbreviation which is stored in the CONTRACTOR field. The name "CNTRCTR" is short for "CONTRACTOR". The assignment of this name was based on the erroneous assumption that all site operators were contracted by SARMAP.

FLAGTYPE.DBF This file is used to categorize the processes used for importing and validating measurement results. Each record represents a single a single category. Each category is uniquely identified by a single character abbreviation.

FLAG.DBF This file is used to define the processes used for importing and validating measurement results. Each record represents a single process. Each process is uniquely identified by a 2 character abbreviation.

PLAN.DBF This file was never actually used in this particular project but the file was designed to define which specific types of measurements were taken at each site and by what operators. Each record represents a unique combination of specific measurement type, site, and operator. The name "PLAN" refers to its potential as a tool for planning which operators would conduct which types of measuring at which sites.

Relationships

Figure 7 shows the relationship between the various databases. The DOSIT, TYPE, CNTRCTR, and FLAGTYPE database files are used strictly as look-up tables. In other words, record pointer positioning for these files is always governed by the record pointer position in other files. DOSIT contains fields that represent site location and measurement types. The structure of DOSIT was maintained in it's entirety when it was inherited from the original Project Format, including this non-normalization portion of it's structure. These fields, however, have no direct bearing on it's relationship with TYPE, SUBTYPE, CNTRCTR and other files in the primary database's design.

SUBTYPE and FLAG might be described as look-up tables that subscribe to other look-up tables. SUBTYPE records, for example, are categorized by a single TYPE record, and FLAG records are categorized by a single FLAGTYPE record. Record pointer positioning in these files govern the record pointer position in their parent files, TYPE and FLAGTYPE. Other than these relationships with TYPE and FLAGTYPE, SUBTYPE and FLAG functions as simple look-up tables that are controlled by record pointer positioning of other files.

SURFACE utilizes DOSIT as a look-up table to find site information, SUBTYPE as a look-up table to find information on specific types of measurement, CNTRCTR as a look-up table to find information on the site operator, and FLAG as a look-up table to find information on the validity of the measurement result.

PLAN simply correlates sites in DOSIT with operators in CNTRCTR with specific measurement types in SUBTYPE. The function of PLAN is the same as the non-normalized fields in DOSIT as mentioned above. Unlike this portion of DOSIT, PLAN can be used for relational processing. FoxPro's Rushmore query optimization technology requires that certain indices be created for it's use. These indices are listed in Figure 8 7

Data Flow

The flow of data for the primary data differed somewhat from the supplemental data. The Primary site operators processed the raw data collected in the field and provided hourly averages with a preliminary level of quality assurance. Next, the primary site operator delivered the data to the SARMAP database manager. The hourly averaged supplemental data were received with no information about the raw data from which they were derived. Under the database manager's direction, all the data were consolidated into a common database structure with common units of measure, and time reference (PDT, hour beginning for the sample time). This process was followed by an final QC/QA review of the data by the QC manager (Gertler et. al 1992), with subsequent modifications made to the data.

The general flow of data is shown in Figure 8. As the figure indicates, the data were received from a specific data source, read into FoxPro and reformatted into a standardized data format (having standard unit and time conventions), then stored in the SARMAP data archive. Data contained in the archive were then exported in a variety of formats for use in validating measurements, via statistical tests and time-series plots, data analysis, as well as meteorological and air quality modeling.

Data Importation

There was an extensive variety of file types, formats, units of measure, and measurement conventions in the original data files received by the SARMAP Data Manager. Table 1 lists the measured parameters, number of sites for which the parameter was measured, units of measure, time reference and file types for each source of data for surface air quality and surface meteorology measurements. Nearly all data were received in some type of ASCII format, either fixed length SDF or delimited formats. Some examples of the "as received" data formats are listed below in Figure 9.

Data Processing

Importing the various "as received" surface data into the primary SARMAP database (SURFACE.DBF) consisted of several steps. First all non hourly data were averaged. This included processing wind data measurements having 1, 5, 10, and 15 minute sampling intervals into hourly averages for both scalar and resultant wind speed and wind direction. All computer programs used to do the averaging were checked for correctness against hand calculations and documented.

Second, the data were reformatted to match the normalized structure of SURFACE.DBF. This was accomplished using computer software written in FORTRAN, PASCAL, and FoxPro with the resulting output files either normalized text files or normalized database files. Unit and time conversions were not performed at this point so the quality assurance of the reformatting algorithms consisted only of checking the reformatted data against the original by tracking a few data points and logging the results (i.e. match or no match) on Program Quality Assurance forms. Reformatting was considered successful if all of the selected "as received" data matched the corresponding reformatted/normalized data.

The next step involved importing each normalized data file into a preliminary normalized database structure. The necessary unit and time conversions were performed at this point. All of the various unit and time conventions for both the SARMAP database and the "as received" data are listed in Table 1. Conversion factors are listed on the last page of Table 1. Before the data in the preliminary (normalized) database file were appended to the primary SARMAP database (SURFACE.DBF), the preliminary database file was subjected to a number of QC checks. First, two traceabilty checks per site and measured parameter were performed. An example of the traceablity check form is given in Figure 10. All information relating to these checks were logged onto the forms including "as received" units and time convention, original data values for two given dates and hours and the corresponding final values. In addition, the person doing the audit signed and dated the form, and provided hand calculations of unit and time conversions, if applicable. A box at the bottom of the form was checked if all the data points on the form matched; otherwise another box was checked to indicate an error was discovered.

When all of the traceability checks matched, a program was run which read in all of the data from the preliminary database file and performed a check on the maximum and minimum data values, maximum and minimum dates in the file and number of hours that data was measured for each site/measurement combination. The purpose of this check was twofold: it assisted in the identification of extreme outliers and also identified cases where data gaps or duplicate data existed. Once outliers, data gaps and duplicate records were resolved, the data were appended to the primary SARMAP database. All of the traceability check forms, hard copies of any reformatting/conversion programs and any other QC results for a data source were placed into a binder specifically for that data source.

DATABASE DESIGN- NON-SURFACE DATA

As mentioned above, in the "SURFACE DATABASE" section, this section details the treatment of *non-surface* data only (i.e. balloon, DAS, radar wind profiler, aircraft, hydrocarbon, and tracer data). The attempt to process non-surface data into normalized database files and incorporate the corresponding updates to the necessary "relational" files/look-up tables (PLAN.DBF, SUBTYPE.DBF, FLAGTYPE.DBF, FLAG.DBF) was abandonded due to the lack of time.

Upper-Air Data. Initial processing of the balloon data consisted of calculating dew point temperatures from relative humidity measurements. This was performed by the contractor. The balloon files received from the contractor were imported into database files for each site.

There were two files created for each balloon site, one containing the temperature,dew point temperature, pressure, and relative humidity measurements with height, and the other file containing the wind speeds and directions with height. The reason for this was because the wind and temperature measurements were not made at the same elevations. The files were split to keep these elevations separate.

The balloon database files have the following naming convention:

SSSXL.DBF

Where SSS denotes the three letter site abbreviation, **X** denotes the measurement parameter and **L** denotes the data validation level. For the measurement parameter if the X position is "T", the file contains temperature data and if the X position is "W", the file contains wind data.

The balloon *temperature* files have the following database file structure: site, julian date, hour, elevation, pressure, temperature, relative humidity, and dew point temperature. The balloon *wind* files have the following database file structure: site, julian date, hour, elevation, resultant (vector) wind speed, wind direction.

The radar profiler and DAS data were imported into similar files for each site. Conversions to the all the upper-air data consisted of converting the elevations in the files from "meters above ground level" to "meters above sea level". This involved adding the site elevation to each height value in the files. Traceablity forms were completed to verify importation and elevation conversion procedures. Ideally, these data should have been imported into normalized database files, however time did not permit this activity to occur.

The profiler database files have the following naming convention:

COSSSXL.DBF

Where CO denotes "continuous", SSS denotes the three letter site abbreviation, X denotes the measurement spacing where "P" is the normal resolution mode (measurements are made closer together) and "H" is the lower resolution mode (measurements are made further apart) . The wind profile extends higher into the atmosphere for the "H" mode. **L** denotes the data validation level.

The profiler files have the following database file structure: site, julian date, hour, elevation, resultant (vector) wind speed, wind direction.

<u>Aircraft Data.</u> Sonoma Technology, Inc.(STI) processed all the aircraft data. STI received the data from each contractor in a variety of formats. The data were imported into DBF files. File names, field names, units, missing codes, and QC codes were standardized for each file. Relative humidity data were calculated from temperature and dew point temperature measurements. Time series plots were made of all the data. A general inventory was made of the data to determine if all data flights were contained in the data archive. Using the time series plots, data glitches were identified and reviewed, and each glitch was invalidated manually.

Spiral sampling coordinates were identified and plotted on maps to verify locations. Additional database fields were added for flight path type, location,and pass number. The path type fields were filled with the letter "S" from the beginning to the end of each spiral path. The field was left blank for the transverse paths. The value of the pass number field identified each pass. Distances from the spiral locations to the surface sites were calculated, and if the sites were within 3 km of each other, the aircraft site code was changed to the surface site code. If the distance was greater than 3 km away from the site, a new unique 3-letter name was assigned to the aircraft spiral site location. These new sites are identified in a file called DOAIR.DBF.

Hydrocarbon Data. The hydrocarbon samples were individually processed and analyzed, and the data results were placed in spreadsheet files. Further processing of the data consisted of importing the spreadsheet files into database files.

Tracer Data. When the tracer data were received from the contractor, the data were plotted and suspect concentrations were identified. The contractor was asked to reprocess and resubmit the data. After the reprocessed data were imported into database files, problems were still detected with the data. These problems are still not resolved at this time.

DATA VALIDATION

Data validation levels were based on guidelines set forth by Watson et al.(1989). Level 0 or raw data were processed by the monitoring equipment, and archived by project contractors or supplemental sponsoring agencies, and also gathered by telemetry and stored at the FOC during the field study.

Level 1a data were generated by the sponsor by processing the raw data. This possibly involved averaging the data and reviewing instrument calibrations and field audits to provide baseline and span adjustments to the data. The most obvious invalid or suspect data points were flagged by the contractor or removed from the data set. Range checks on the data were also performed.

Level 1b data were achieved in several steps. This process included first averaging any non-hourly data, reformatting all received level 1a project and supplemental data into a normalized format, and finally converting all unit and time references to the SARMAP database units and time reference (PDT , hour beginning). Each task was carefully checked and documented on forms to quality assure the processing of the data from level 1a to level 1b. There was also a peer review of import and processing codes to verify correctness.

When the SARMAP database was compiled, additional checks for the data processing and data integrity were developed. This included making sure the data measured for each site was indeed in the database. The normalized database was then analyzed for total number of observations, and the number of missing data (-99). The data were checked for minimum and maximum values and also for duplicate records. An additional check was done to see if the time reference was done correctly by examining the last day and hour of the month and comparing it with the original data.

After the data were checked for consistency, the surface data were exported to the project format and sent to DRI for extensive level 2a independent QA/QC analysis (Gertler et al. 1992). DRI provided a report on suspect data with recommendations. After a review of the recommendations, some data were retained while other obvious invalid data were invalidated with the "-99 " convention, and the corresponding flag field updated to reflect the level 2 action.

Validation of the non-surface data included a review of the upper-air data by a team of data analysts and meteorologists. The data were plotted and suspect data values were invalidated. Data management staff visited the tracer data contractor to determine the cause of problems with the data and to verify procedures in processing the data. The original chromograph data were reprocessed and most of the problems with the data were resolved. The exception was some unknown high background tracer gas concentrations in the San Joaquin Valley which existed even before the gases were released in the Bay Area. A complete validation of the level 2b tracer data awaits more research into background tracer levels and possible sources in the San Joaquin Valley.

The QC procedures used to validate the hydrocarbon data consisted of first adding alkanes, alkenes, aromatics, and unidentified fractions together to check the reported total NMHC value. Second, the carbonyl data were integrated with the NMHC data by matching site, date, and time. During the process of integration, several inconsistencies between sampling times were discovered. These inconsistencies were resolved by going back to the original program plan. Next, each species was sorted in decreasing order of concentration to check for outliers. Any really high values were flagged as suspect, and this step was also performed on a percentage basis.

Duplicate/replicate data were resolved in one of two ways. If the duplicate/replicate data were within 30% of each other, they were averaged. Otherwise, the one with composition most closely resembling others for that site and time was used. Finally, samples were also flagged if the contractor noted a specific problem ie. a nonrepresentative sample or equipment malfunction.

All the aircraft data were reviewed for quality by STI. Baseline offset problems were found with some of the NO and NOx data, and these were reported back to the contractor. The data were reprocessed, plotted, and checked. After the "new" data were reimported into the aircraft database, additional adjustments were made to the data which included selecting a typical NO baseline value and either adding or subtracting the value to all the NO values measured during a flight. If the NOx baseline value was less than zero, a typical NOx value was selected and added to all the NOx values measured during a flight. When all validation of the aircraft data was completed, a copy of the aircraft data archive was sent to the ARB for level 2b distribution.

Upon completion of the revisions to the data, another two data point audit was performed on all of the data to verify traceablity and correctness. An external auditor also examined the database for correctness. At this point the file DOSIT was checked against the normalized database using Structure Query Language (SQL) SELECT to make a final verification of completeness. At level 2b validation, the SARMAP database is now available for use by the analysis and modeling community.

Level 3 validation will be ongoing as the database is analyzed by scientists and utilized in the SARMAP wind and air quality modeling program, and results are made available to the SARMAP database manager. Any changes to the database will be minor in nature.

DATA EXPORTATION

Output Formats

The normalized SARMAP surface database structure simplifies the exportation of data to any format. The task of exporting surface data from the SARMAP data archive is accomplished using the SQL SELECT command with two related database files, SURFACE.DBF and SUBTYPE.DBF. The databases are related by the index key SUBTYPE. See Figure 8 for a description of related index key files. During the export process, data is extracted from SURFACE.DBF, the normalized file containing all the surface data, and written to various files. Information in SUBTYPE.DBF directs where each portion of data from SURFACE.DBF is placed. For example, all scalar wind speeds that are measured at 10 meters above the surface are directed to the Project Format file called COS12.DBF. Generating output files from the upper-air data involves using the file DOSIT.DBF and relating the field called "SITE" to each upper-air file which contains the the three letter SITE field in the database file name (ALTW2.DBF for example).

In addition to the Project Format, various other output formats have been defined, each intended for its own specialized task. Figure 11 consists of sample records in the following formats:

<u>ENSR Formats.</u> Data exported into these formats are used as input to the models used in the SARMAP modeling program. There are four different format types for surface meteorology, surface air quality, and two for upper air data. The export programs were written in FoxPro and integrated into the FoxPro program menu system to allow for "push button" selection for each output format.

<u>SurfPlot Format.</u> The Surfplot format is used with Microsoft's Excel spreadsheet software to produce time-series plots.

<u>SFPlot ,SFMet, and UAPlot Formats</u>. Files exported in these formats are used as input files to either SFPlot, SFMet, or UAPlot which are computer graphics programs for the PC developed by the ARB modeling support section. SFPlot plots surface wind and air quality data on a map of the SARMAP study domain, and SFMet is a similar program which plots specifically all the surface meteorological data. UAPlot focuses on plotting upper-level interpolated wind and temperature data.

PROJECT FORMAT FILES

The Project Format, intended for general distribution of the SARMAP data, requires that data be exported to standard DBF formatted files for use with FoxPro and other DBF file compatible software products. A non-normalized, spreadsheet-style structure is specified. It is a compatible format with Microsoft Excel and other similar software packages. The basic structure for the surface databases consists of fields for date, hour, and each site identified with measuring the particular variable, O3 for example. Indices are not specified. Instead, data are physically sorted. This specialized structure has the following advantages:

- Compact size for efficient distribution via floppy diskette or modem.
- Matrix oriented structure is more familiar to those accustomed to using mathematical spreadsheet software for both data management and analysis.
- Data can be conveniently viewed using FoxPro's "browse" feature for both site-to-site and time-series comparisons.
- Certain analysis procedures were already designed to be used with this structure.

Relational Design

The SARMAP data are contained in a matrix of project format database files. Table 2 lists the directory and naming conventions used to describe the project format files. Figure 12 shows examples of the various project format files. One of the major components of this design is the master site file called DOSIT.DBF which is also used in the SARMAP relational database design and has been described previously. See Figure 6.

The Project Format database files for the continuous surface data are grouped together by measurement. The files are named like COO32.DBF, for example, where the "CO" represents continuous measurements, "O3" is the measurement type contained in the file, and the "2" represents the validation level 2. The continuous upper-air measurements for the entire study period are contained in individual site files named like "COBEND2.DBF", for example. The "CO" represents continuous upper-air measurements (winds in this example), " BEN" is the site identifier, "D" represents a DAS site, and the "2" is again the validation level 2. The radar wind profiler files are identified in a similar way except the file names contain either a "P" or "H" instead of the "D" for the DAS sites (COREEP2.DBF, for example).

The balloon soundings made during the intensive monitoring periods are stored in two files for each site, one for the temperature measurements, and the other for the wind measurements. The files are named "ALTT2.DBF" and "ALTW2.DBF" for example. The "ALT" is the site identifier, and the "T2" and "W2" represent the level 2 temperature and wind measurements respectively. Figure 13 lists the database file names and structures used for the hydrocarbon samples.

SECURITY

The current security system for the database involves frequent backups of the hard disk drives where the database is stored. The tape backup system consists of two parts: 1) A full system backup for all server disks is performed every Friday. A copy of the tape is stored off site and another copy is kept is a fireproof safe. The tapes are rotated periodically. 2) Each night all modified files are backed up, but this tape is rewritten weekly. Another system is in the process of being implemented which will provide a more historical backup. In addition, all data disks received from each data source have been backed up and placed in a fireproof safe.

The Lantastic software used for the LAN provides additional security but all of the features are not yet implemented. The BBS is available for anyone to sign on, register, and select his own password. However, access to downloading the data is password protected. A person must first submit a written request to the ARB to obtain a copy of the data, and upon approval, the person will receive the current password for access to the project files. It is impossible for a user on the BBS to access the restricted areas of the LAN and therefore the normalized database is secure from unauthorized access.

RETROSPECTIVE

What was learned from the problems encountered during the SARMAP Data Management Program can be useful to the planning of data management for future field programs. The following is a summary of recommendations:

1) All the data management team, QC manager, and prospective contractors should be called together for a meeting at least a year in advance of the beginning of the field measurement program. The purpose of the meeting should be to discuss possible problems and solutions, gain information, and formulate a suitable data management plan. This plan would describe who is responsible for what tasks, data flow from contractor to final database, specific units, conversions, algorithms, possible formats, and software to use. A subsequent meeting should be scheduled to finalize this plan and clarify any misunderstandings. Upon submitting a proposed contract for field measurements, the contractor would sign an agreement to comply with the set requirements for the data. Following the field study, the data must meet the data manager's approval before the contractor is paid. A Gant chart should be created to monitor each contractor's perfomance and to keep track of overall progress.

2) Data flags and data precision standards should be part of the up front planning process. Thoughtful consideration should be taken to create the most comprehensive and easy to

use flag system possible. An adequate flag system would provide a history of the data processing for traceablity and for verifying the validity of each data point. Data flags should be incorporated into the master database so as to maximize information for each data point. Data exported from the final database would have the option of containing the flags. Also data could be exported depending on the value of the flag.

3) Begin work on site documentation well before the field study. Visit each existing site, photograph and document site descriptions and instruments. Create a database containing this site information and as each primary site is chosen, add the site information to the database. Utilize video equipment to film each site to provide even better information and store the video shots from each site digitally in a database. The site database file can be related to final database to assist data selection criteria based on site description and instrument QC/QA. Create a site file similar to DOSIT but normalized in structure, as soon as possible to contain key information about site IDs, site names, locations, elevations, site measurement types, and site operators. This information should continually be updated to represent the latest accurate site information. This file should be made available to contractors, field managers, and the data management team. Set up the Bulletin Board System as early as possible to facilitate communication, software development, etc. Provide adequate training up front on how to use the BBS.

4) Require a cover letter from each contractor when the level 1 data is being submitted to the data manager. The letter should clearly and concisely describe the formats and units used, any any other pertinent information about the data. This would be in addition to the submitted data report. Request written documentation from supplemental site sponsors as early as possible. Maintain a log of correspondence to keep track of discussions concerning the documentation, sites, units, etc. to help clarify any vagueness in the data. This log should also be maintained in a database file to provide relatable information about the data. Request a sample data file to design software to read the format and process the data. Test out the software in advance so it is ready to use when all of the new data is received.

5) Create traceablity (audit trail) forms to check several points of data from source disks to final database and verify correctness in the data processing. Store forms with other documentation for each sponsor.

6) Determine one location for all the data processing and storage. Plan ahead to make sure there are adequate computers, peripherals, software and disk space to handle the large amount of data. Contract with a network specialist to assist in the setup of a LAN to reduce setup time, cost, and effort. Use the BBS as early as possible to assist communication between the data management team and the various contractors. Create a system for regular backup of data on disk and for any new data disks that arrive. Establish a system to track when backups are made and what version of data are stored on each tape. When ordering licensed equipment or software, have one person in charge of purchasing and keeping track of licenses.

7) Establish a service contract for all computer hardware before the project begins. During the data management process, breakdowns of computer equipment occured periodically. No firm maintenance contracts for any of the computer hardware were ever established which resulted in the data management team using valuable time to take the equipment to repair shops or fixing the equipment failures.

8) Establish a Standard Operating Procedure (SOP) for each dat set that are received from each contractor. Establish clear responsiblities for each member of the data management team.

9) If possible, keep data management and QC together at the same location. This would reduce the time it takes to transfer the revised data form the QC Manager to the Data Manager as well as foster better communication about the data. Arrange for an external auditor to come and examine the database for accuracy.

After much consideration and review of the overall performance of the project, the data management team recommends the following overall approach:

Provide written specifications for the primary measurement contractors to follow,and require each contractor to submit a level 1 quality assurance plan to the data-manager for approval before the field study begins. This will help to ensure that level 1 checks are performed as scheduled, including appropriate audits and calibrations. The level 1 data received from the contractor must be submitted to the data manager on time and in line with the unit convention, time reference, and other specifications. Otherwise, a substantial percentage of the contract payment will be withheld until the requirements are met.

Minimize the data processing requirement for the contractors to prevent each contractor from becoming a "data manager" and thus increasing the costs and time required to create a uniform database. The contractor would only need to submit the data with accurate flags along with a cover letter to detail information about the level 1 data validation. The data manager would process each set of data from the contractors and produce a normalized file for importation into the main database. Centralizing all data mangement efforts would allow the data managers to have more control over the data processing. This would reduce uncertainity and errors in the data, improve the efficiency and speed of producing the final archive, and help to minmize the overall costs of the project.

SUMMARY AND CONCLUSIONS

The process of developing the SARMAP database involved many steps. Initially the data management process was not well defined, but with time it evolved into a comprehensive system. The accomplishments of the data management team included identifying and gathering all suitable data from existing sources within the study domain , and collecting all project data and documentation from the various contractors to one location. The design of the SARMAP normalized relational database and project format databases were accomplished by creating an accurate site atlas database, verifying site measurement information, and understanding the needs of the end users. After obtaining adequate computer hardware, software, and establishing a LAN to maximize computer efficiency, the project data were combined with the supplemental data. The necessary averaging, reformatting, and conversions to the data were performed to prepare the data for importation into the SARMAP database. Extensive QC/QA was performed and well documented to ensure each step of the data processing was correct. The final step involved a successful exportation of the data from the SARMAP database to a variety of formats for level 2 validation, input for model runs, and general use in data analysis.

In past field studies, data management was always an "after the fact" effort. This resulted in significant delays in the availability of databases for use by the scientific community. One of the key goals for the SARMAP program was to produce a high quality database for modeling efforts in a relatively short time frame. Overall, this objective was achieved, but with more and better planning early on, many of the challenges which used up valuable time and money could have been avoided. With a well thought out plan utilizing the recommendations in this paper, data managers and contractors can work together using the latest computer technology to improve and streamline data management efforts. Future field studies can look forward to producing accurate and effective databases in significantly less time than ever before.

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DISCLAIMER

The statements and conclusions in this paper are those of the authors and not necessarily those of the Air Resources Board, Desert Research Institute, or Sonoma Technology. The mention of commercial products, their sources or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

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GLOSSARY

Database File - A component of a database that is comprised of fields, also known as a table.
Database - The entire collection of database files plus database language that manipulates the data.
Data Archive - The comprehensive set of data contained in the database plus all documentation.
Field - The smallest element in a database structure, also known as an attribute.
Format - Used in this document to refer to a specific technique of storing data on a mass storage device. A given DBMS product typically supports a single format as its native format. FoxPro's native format is the DBF format originally made popular by Ashton-Tate's dBASE II product. Computer Associate's CA-Clipper and dBFast, and Borland International's dBASE IV also support the DBF format as their native format. Other common formats include comma delimited, SDF, DIF, and SYLK.
Relational Database - A database that has a design based on the relational model introduced in 1970 by E. F. Codd. The two basic goals of relational design are data independence (separating the way in which the database is physically organized from the way the user views the database) and data integrity (avoiding data inconsistencies and anomalies that may be generated during processing).
Structure - Used in this document to refer to the design of a database, including field types and lengths, the combination of fields used to form a database file, and the combination of database files to form a data set or complete database.

TABLE 2-3

SARMAP Surface Data Network Information

Table 1. Surface Data Measurement Network

Data Source	Measured Parameters		Number of Sites	SARMAP DBF	SARMAP Units (1)	As Recei.. File Format
(AB) ABB Environmental	O3	Ozone	12	CO032	PPB	TEXT FILE
(AR) California Air Resources Board	CH4	Methane	17	COSC2	PPTMC	ARB SAROAD
	CO	Carbon Monoxide	42	COSC2	PPM	ARB SAROAD
	NO	Nitrogen Oxide (Chemiluminescent)	41	CONO2	PPB	ARB SAROAD
	NO2	Nitrogen Dioxide (Chemiluminescent)	41	CONO2	PPB	ARB SAROAD
	NOZ	Nitrogen Dioxide (Luminol)	2	CONP2	PPB	ARB SAROAD
	O3	Ozone	73	CO032	PPB	ARB SAROAD
	SO2	Sulfur Dioxide	30	COSC2	PPB	ARB SAROAD
	THC	Total Hydrocarbons	21	COSC2	PPTMC	ARB SAROAD
(AV) Aerovironment	NO	Nitrogen Oxide (Chemiluminescent)	11	CONO2	PPB	TEXT FILE
	NO2	Nitrogen Dioxide (Chemiluminescent)	11	CONO2	PPB	TEXT FILE
	O3	Ozone	13	CO032	PPB	TEXT FILE
	TS	Total Solar Insolation	2	COSR2	W/M**2	TEXT FILE
	US	Ultraviolet Solar Insolation	3	COSR2	W/M**2	TEXT FILE
(BA) Bay Area AQMD	DP	Dew Point	25	CORH2	DEG. C	CALCULATED
	RH	Relative Humidity	25	CORH2	%	TEXT FILE
	T	Temperature	25	COTT2	DEG. C	TEXT FILE
	TS	Total Solar Insolation	5	COSR2	LANG/HR	TEXT FI..
	WDU1	Unit Wind Direction (10m platform)	16	COU12	DEG	TEXT FI..
	WDV1	Vect Wind Direction (10m platform)	*A	COW12	*A	*A
	WSS1	Scalar Wind Speed (10m platform)	16	COS12	M/S	TEXT FILE
	WSV1	Vector Wind Speed (10m platform)	*A	COV12	*A	*A
(BN) Bay Area AQMD	WDU3	Unit Wind Direction (misc. height)	10	COU32	DEG	TEXT FILE
	WDV3	Vect Wind Direction (misc. height)	*A	COW32	*A	*A
	WSS3	Scalar Wind Speed (misc. height)	10	COS32	M/S	TEXT FILE
	WSV3	Vector Wind Speed (misc. height)	*A	COV32	*A	*A
(CA) Calif. Acid Dep. Study (ARB)	DP	Dew Point	1	CORH2	DEG. C	UNIQUE DBF
	O3	Ozone	1	CO032	PPB	UNIQUE DBF
	RH	Relative Humidity	1	CORH2	%	CALCULATED
	T	Temperature	1	COTT2	DEG. C	UNIQUE DBF
	TS	Total Solar Insolation	1	COSR2	W/M**2	UNIQUE DBF
	WDU3	Unit Wind Direction (misc. height)	1	COU32	DEG	UNIQUE DBF
	WDV3	Vect Wind Direction (misc. height)	1	COW32	DEG	UNIQUE DBF
	WSS3	Scalar Wind Speed (misc. height)	1	COS32	M/S	UNIQUE DBF
	WSV3	Vector Wind Speed (misc. height)	1	COV32	M/S	UNIQUE DBF
(CH) Chevron	CO	Carbon Monoxide	2	COSC2	PPM	SAROAD
	NO	Nitrogen Oxide (Chemiluminescent)	4	CONO2	PPB	SAROAD
	NO2	Nitrogen Dioxide (Chemiluminescent)	4	CONO2	PPB	SAROAD
	O3	Ozone	2	CO032	PPB	SAROAD
	SO2	Sulfur Dioxide	4	COSC2	PPB	SAROAD

TABLE 2-3
SARMAP Surface Data Network Information

Data Source	Measured Parameters		Number of Sites	SARMAP DBF	SARMAP Units (1)	As Received File Format
	WDU1	Unit Wind Direction (10m platform)	5	COU12	DEG	SAROAD
	WDV1	Vect Wind Direction (10m platform)	*A	COW12	*A	*A
	WSS1	Scalar Wind Speed (10m platform)	5	COS12	M/S	SAROAD
	WSV1	Vector Wind Speed (10m platform)	*A	COV12	*A	*A
(CI) California DWR (CIMIS)	DP	Dew Point	35*B	CORH2	DEG. C	TEXT FILE
	NS	Net Solar Insolation	37	COSR2	W/M**2	TEXT FILE
	RH	Relative Humidity	35*B	CORH2	%	TEXT FILE
	T	Temperature	35*B	COTT2	DEG. C	TEXT FILE
	TS	Total Solar Insolation	35*B	COSR2	W/M**2	TEXT FILE
	WDU2	Unit Wind Direction (2m platform)	*A	*A	*A	*A
	WDV2	Vect Wind Direction (2m platform)	37	COW22	DEG	TEXT FILE
	WSS2	Scalar Wind Speed (2m platform)	37	COS22	M/S	TEXT FILE
	WSV2	Vector Wind Speed (2m platform)	37	COV22	M/S	TEXT FILE
(DD) Department of Defense (CLNWC)	DP	Dew Point	3	CORH2	DEG. C	UNIQUE DBF
	NO	Nitrogen Oxide (Chemiluminescent)	2	CONO2	PPB	UNIQUE DBF
	NO2	Nitrogen Dioxide (Chemiluminescent)	2	CONO2	PPB	UNIQUE DBF
	O3	Ozone	2	COO32	PPB	UNIQUE DBF
	RH	Relative Humidity	3	CORH2	%	CALCULATED
	T	Temperature	3	COTT2	DEG. C	UNIQUE DBF
	WDU3	Unit Wind Direction (misc. height)	*A	COU32	*A	*A
	WDV3	Vect Wind Direction (misc. height)	4	COW32	DEG	UNIQUE DBF
	WSS3	Scalar Wind Speed (misc. height)	4	COS32	M/S	UNIQUE DBF
	WSV3	Vector Wind Speed (misc. height)	*A	COV32	*A	*A
(EN) ENSR Consulting Services	NO	Nitrogen Oxide (Chemiluminescent)	9	CONO2	PPB	TEXT FILE
	NO2	Nitrogen Dioxide (Chemiluminescent)	9	CONO2	PPB	TEXT FILE
	NOZ	Nitrogen Dioxide (Luminol)	10	CONP2	PPB	TEXT FILE
	O3	Ozone	8	COO32	PPB	TEXT FILE
	PAN	Peroxyacetyl Nitrate	11	CONP2	PPB	TEXT FILE
	TS	Total Solar Insolation	2	COSR2	W/M**2	TEXT FILE
(ES) ESC	WDU1	Unit Wind Direction (10m platform)	39	COU12	DEG	TEXT FILE
	WDV1	Vect Wind Direction (10m platform)	39	COW12	DEG	TEXT FILE
	WSS1	Scalar Wind Speed (10m platform)	39	COS12	M/S	TEXT FILE
	WSV1	Vector Wind Speed (10m platform)	39	COV12	M/S	TEXT FILE
(MI) Mineral Management Service	DP	Dew Point	2	CORH2	DEG. C	TEXT FILE
	PR	Atmospheric Pressure	2	COPP2	MB	TEXT FILE
	RH	Relative Humidity	2	CORH2	%	CALCULATED
	T	Temperature	2	COTT2	DEG. C	TEXT FILE
	TS	Total Solar Insolation	2	COSR2	W/M**2	TEXT FILE
	WDU3	Unit Wind Direction (misc. height)	*A	COU32	*A	*A
	WDV3	Vect Wind Direction (misc. height)	2	COW32	DEG	TEXT FILE
	WSS3	Scalar Wind Speed (misc. height)	*A	COS32	*A	*A

TABLE 2-3
SARMAP Surface Data Network Information

Data Source	Measured Parameters		Number of Sites	SARMAP DBF	SARMAP Units (1)	As Received File Format
	WSV3	Vector Wind Speed (misc. height)	2	COV32	M/S	TEXT FILE
(M5) Mineral Management Service	DP	Dew Point	2	CORH2	DEG. C	TEXT FILE
	PR	Atmospheric Pressure	2	COPP2	MB	TEXT FILE
	RH	Relative Humidity	2	CORH2	%	CALCULATED
	T	Temperature	2	COTT2	DEG. C	TEXT FILE
	TS	Total Solar Insolation	2	COSR2	W/M**2	TEXT FILE
	WDU3	Unit Wind Direction (misc. height)	*A	COU32	*A	*A
	WDV3	Vect Wind Direction (misc. height)	2	COW32	DEG	TEXT FILE
	WSS3	Scalar Wind Speed (misc. height)	*A	COS32	*A	*A
	WSV3	Vector Wind Speed (misc. height)	2	COV32	M/S	TEXT FILE
(MB) Monterey Bay APCD	DP	Dew Point	1	CORH2	DEG. C	TEXT FILE
	RH	Relative Humidity	1	CORH2	%	TEXT FILE
	T	Temperature	6	COTT2	DEG. C	TEXT FILE
	WDU3	Unit Wind Direction (misc. height)	6	COU32	DEG	TEXT FILE
	WDV3	Vect Wind Direction (misc. height)	6	COW32	DEG	TEXT FILE
	WSS3	Scalar Wind Speed (misc. height)	6	COS32	M/S	TEXT FILE
	WSV3	Vector Wind Speed (misc. height)	6	COV32	M/S	TEXT FILE
(NP) National Park Service	DP	Dew Point	3	CORH2	DEG. C	SAROAD
	O3	Ozone	8	COO32	PPB	SAROAD
	RH	Relative Humidity	3	CORH2	%	CALCULATED
	T	Temperature	3	COTT2	DEG. C	SAROAD
	TS	Total Solar Insolation	3	COSR2	W/M**2	SAROAD
	WDU1	Unit Wind Direction (10m platform)	*A	COU12	*A	*A
	WDV1	Vect Wind Direction (10m platform)	3	COW12	DEG	SAROAD
	WSS1	Scalar Wind Speed (10m platform)	3	COS12	M/S	SAROAD
	WSV1	Vector Wind Speed (10m platform)	3	COV12	M/S	SAROAD
(PG) Pacific Gas & Electric	T	Temperature	34	COTT2	DEG. C	TEXT FILE
	WDU1	Unit Wind Direction (10m platform)	20	COU12	DEG	TEXT FILE
	WDV1	Vect Wind Direction (10m platform)	20	COW12	DEG	TEXT FILE
	WSS1	Scalar Wind Speed (10m platform)	20	COS12	M/S	TEXT FILE
	WSV1	Vector Wind Speed (10m platform)	20	COV12	M/S	TEXT FILE
(PN) Pacific Gas & Electric	WDU3	Unit Wind Direction (misc. height)	17	COU32	DEG	TEXT FILE
	WDV3	Vect Wind Direction (misc. height)	17	COW32	DEG	TEXT FILE
	WSS3	Scalar Wind Speed (misc. height)	17	COS32	M/S	TEXT FILE
	WSV3	Vector Wind Speed (misc. height)	17	COV32	M/S	TEXT FILE
(PS) Pacific Gas & Electric	NO	Nitrogen Oxide (Chemiluminescent)	4	CONO2	PPB	TEXT FILE
	NO2	Nitrogen Dioxide (Chemiluminescent)	4	CONO2	PPB	TEXT FILE

TABLE 2-3
SARMAP Surface Data Network Information

Data Source	Measured Parameters		Number of Sites	SARMAP DBF	SARMAP Units (1)	As Received File Format
	O3	Ozone	4	COO32	PPB	TEXT FILE
	T	Temperature	5	COTT2	DEG. C	TEXT FILE
	TS	Total Solar Insolation	1	COSR2	W/M**2	TEXT FILE
	WDU1	Unit Wind Direction (10m platform)	8	COU12	DEG	TEXT FILE
	WDV1	Vect Wind Direction (10m platform)	8	COW12	DEG	TEXT FILE
	WSS1	Scalar Wind Speed (10m platform)	8	COS12	M/S	TEXT FILE
	WSV1	Vector Wind Speed (10m platform)	8	COV12	M/S	TEXT FILE
(SC) Sacramento Area Ozone Study (SACOG)	DP	Dew Point	5	CORH2	DEG. C	TEXT FILE
	NO	Nitrogen Oxide (Chemiluminescent)	1	CONO2	PPB	TEXT FILE
	NO2	Nitrogen Dioxide (Chemiluminescent)	1	CONO2	PPB	TEXT FILE
	O3	Ozone	6	COO32	PPB	TEXT FILE
	RH	Relative Humidity	5	CORH2	%	TEXT FILE
	T	Temperature	5	COTT2	DEG. C	TEXT FILE
	WDU1	Unit Wind Direction (10m platform)	*A	COU12	*A	*A
	WDV1	Vect Wind Direction (10m platform)	7	COW12	DEG	TEXT FILE
	WSS1	Scalar Wind Speed (10m platform)	*A	COS12	*A	*A
	WSV1	Vector Wind Speed (10m platform)	7	COV12	M/S	TEXT FILE
(SI) Pacific Gas & Electric (SIMP)	DS	Direct Solar Insolation	5	COSR2	W/M**2	TEXT FILE
	TS	Total Solar Insolation	11	COSR2	W/M**2	TEXT FILE
(SL) San Luis Obispo APCD	NO	Nitrogen Oxide (Chemiluminescent)	2	CONO2	PPB	TEXT FILE
	NO2	Nitrogen Dioxide (Chemiluminescent)	2	CONO2	PPB	TEXT FILE
	O3	Ozone	1	COO32	PPB	TEXT FILE
	T	Temperature	2	COTT2	DEG. C	TEXT FILE
	THC	Total Hydrocarbons	1	COSC2	PPTMC	TEXT FILE
	WDU1	Unit Wind Direction (10m platform)	2	COU12	DEG	TEXT FILE
	WDV1	Vect Wind Direction (10m platform)	2	COW12	DEG	TEXT FILE
	WSS1	Scalar Wind Speed (10m platform)	2	COS12	M/S	TEXT FILE
	WSV1	Vector Wind Speed (10m platform)	2	COV12	M/S	TEXT FILE
(TT) Tracer Technology	DCH	Perfluor-1 2-dimethylcyclohexane	71	CODH2	FL/L	TEXT FILE
	DCHC	Perfluor-1 2-dimethylcyclohexane	3	CODH2	FL/L	TEXT FILE
	MCH	Perfluoromethylcyclohexane	71	COMH2	FL/L	TEXT FILE
	MCHC	Perfluoromethylcyclohexane	3	COMH2	FL/L	TEXT FILE
	MCP	Perfluoromethylcyclopentane	71	COMP2	FL/L	TEXT FILE
	MCPC	Perfluoromethylcyclopentane	3	COMP2	FL/L	TEXT FILE
	TCH	Perfluorotrimethylcyclohexane	71	COTH2	FL/L	TEXT FILE
	TCHC	Perfluorotrimethylcyclohexane	3	COTH2	FL/L	TEXT FILE
(TX) Texaco	CH4	Methane	1	COSC2	PPTMC	TEXT FILE
	CO	Carbon Monoxide	3	COSC2	PPM	TEXT FILE
	NMH	Non-Methane Hydrocarbons	1	COSC2	UG/M**3	TEXT FILE
	NO	Nitrogen Oxide (Chemiluminescent)	4	CONO2	PPB	TEXT FILE
	NO2	Nitrogen Dioxide (Chemiluminescent)	4	CONO2	PPB	TEXT FILE
	SO2	Sulfur Dioxide	4	COSC2	PPB	TEXT FILE
	THC	Total Hydrocarbons	1	COSC2	PPM	TEXT FILE
	WDU1	Unit Wind Direction (10m platform)	2	COU12	DEG	TEXT FILE
	WDV1	Vect Wind Direction (10m platform)	*A	COW12	*A	*A

TABLE 2-3
SARMAP Surface Data Network Information

Data Source	Measured Parameters		Number of Sites	SARMAP DBF	SARMAP Units (1)	As Receiv[ed] File Form[at]
	WSS1	Scalar Wind Speed (10m platform)	2	COS12	M/S	TEXT FILE
	WSV1	Vector Wind Speed (10m platform)	*A	COV12	*A	*A

Footnotes to TABLE 2-3:

*A This surface wind parameter was not measured by the data source. Data for this site, however, is reported in the SARMAP DBF file as missing or invalid for the purpose of kee wind files the same size (i.e. all of the wind files have the same database structure and report data for all sites in the same order, whether data was collected or not).

*B Thirty-seven sites had this parameter measured but two sites were invalidated through the QA process (per conversations with CIMIS personell).

(1) **Units and Unit Conversions:**

UNIT	UNIT DEFINITION	CONVERSION
%	Percent	Ratio=(%)*100
CALCD	Parameter was calculated	DP=(((RH/100)^0.125)*(201.8+(1.62*TEMP))-201.8+(0.18*TEMP))/1.8
DEG	Direction: Degrees from North	No conversion made
DEG. C	Temperature: Degrees Centigrade	Deg. F= ((9/5)*C)+32
DEG0-540	Direction: Degrees from North	Deg(0-360)=(Deg(0-540))-360
DEG. F	Temperature: Degrees Fahrenheit	Deg. C= (5/9)*(F-32)
FL/L	Femtoliters per Liter	FL/L=1*10^-15 Liters/Liter
LANG/HR	Langleys per Hour	W/M^2=11.63*(LANG/HR)
LANG/MIN	Langleys per Minute	W/M^2=698.0*(LANG/MIN)
M/S	Meters per Second	MPH=2.24*(M/S)
MB	Millibars	No conversion made
MPH	Miles per Hour	M/S=0.447*(MPH)
PPB	Parts per Billion	PPM = 1000*PPB = PPM/1 PPTM = 100 *PPB = PPM/10 PPHM = 10 *PPB = PPM/100 PPB = 1 *PPB = PPM/1000
PPBC	Parts per Billion Carbon	see PPB (above)
PPHM	Parts per Hundred Million	see PPB (above)
PPM	Parts per Million	see PPB (above)
PPTM	Parts per Ten Million	see PPB (above)
PPTMC	Parts per Ten Million Carbon	see PPB (above)
UG/M**3	Micrograms per Cubic Meter	@stp (25 C&760mmHg) : SO2 ....PPB(so2) =(UG/M^3)*0.384 NO,NOx,NO2..........PPB(NO?)=(UG/M^3)*0.534 CO..........PPB(CO) =(UG/M^3)*0.877 O3..........PPB(O3) =(UG/M^3)*0.512
W/M**2	Watts per Square Meter	No conversion made

(2) **Data Collection Time References:**
(Standard SARMAP convention is PDT, beginning hour)

GMT	Greenwich Mean Time
LST	Local Standard Time (i.e. current local time at a specific geographic location)
PDT	Pacific Daylight Time (PDT=GMT-7 ;PDT=PST+1 hour)
PST	Pacific Standard Time (PST=GMT-8)
BEGIN.	Data collection started at *beginning* of "As Received Collection Interval"
END	Data collection started at *end* of "As Received Collection Interval"

(3) **As Received Validation Flags:**
(values used to mark invalid or missing data)

YES	Data source had unique system of data validation flags too long to list
NO	Data source had no system of data validation flags
##	Value used to indicate invalid or missing data values (## is an integer)
>##	Range of values used to indicate invalid or missing data (> indicates greater or *EQUAL* to in this case)

TABLE 1 2
Directory Structrue
for
SARMAP Database Files

F:\SARMAP\	SACO: Contains Continuous Surface Data	
	SADO: Contains SARMAP Documentation Files	
	SAHC: Contains Speciated Hydrocarbon Data	
	SAUA: Contains Upper Air Data	
	SAAC: Contains Aircraft Data	(not available at time of printing)

Table 2. Project File Directories and Naming Conventions

	FILE	SIZE	DATE	TIME	DESCRIPTION
F:\SARMAP\SACO	COATAD	525378	1/7/93	10:43a	Doppler: DAS Data
	COBEND	889438	1/14/93	3:52p	Doppler: DAS Data
	CODIAD	765330	1/14/93	3:53p	Doppler: DAS Data
	CODIXD	1071258	1/14/93	4:00p	Doppler: DAS Data
	CODVCD	765330	1/14/93	10:41a	Doppler: DAS Data
	COFUND	493338	1/14/93	4:01p	Doppler: DAS Data
	COHAYD	591258	1/14/93	12:59p	Doppler: DAS Data
	COLIND	963906	1/14/93	4:02p	Doppler: DAS Data
	COMORD	190050	1/7/93	10:54a	Doppler: DAS Data
	COMOSD	436335	1/14/93	3:15p	Doppler: DAS Data
	CONFKD	374658	1/7/93	11:38a	Doppler: DAS Data
	COOILD	992298	1/14/93	3:37p	Doppler: DAS Data
	COPETD	835818	1/15/93	1:29p	Doppler: DAS Data
	COPITD	799194	1/14/93	4:16p	Doppler: DAS Data
	COCARH	343954	1/7/93	11:06a	Profiler: High Resolution Data
	COCORH	640810	1/7/93	10:36a	Profiler: High Resolution Data
	COELNH	531442	1/7/93	10:46a	Profiler: High Resolution Data
	COHOLH	625186	1/7/93	11:11a	Profiler: High Resolution Data
	COMODH	812674	1/7/93	10:52a	Profiler: High Resolution Data
	CORAIH	718930	1/7/93	10:58a	Profiler: High Resolution Data
	COREEH	875170	1/14/93	11:38a	Profiler: High Resolution Data
	COCARP	233074	1/7/93	11:21a	Profiler: Normal Resolution Data
	COCORP	434170	1/7/93	10:39a	Profiler: Normal Resolution Data
	COELNP	360082	1/7/93	11:23a	Profiler: Normal Resolution Data
	COHOLP	423586	1/7/93	11:26a	Profiler: Normal Resolution Data
	COMODP	550594	1/7/93	11:15a	Profiler: Normal Resolution Data
	CORAIP	487090	1/7/93	10:42a	Profiler: Normal Resolution Data
	COREEP	592930	1/7/93	11:19a	Profiler: Normal Resolution Data
	CORH2	1176146	1/12/93	11:00p	Surface: Air Quality (DP,RH)
	COSC2	717425	1/12/93	11:53p	Surface: Air Quality (MISC.)
	CONO2	1202342	1/12/93	9:41p	Surface: Air Quality (NO,NO2)
	COO32	610345	1/12/93	10:31p	Surface: Air Quality (O3)
	CONP2	227042	1/12/93	10:36p	Surface: Air Quality (PAN,NO2)
	COPP2	62754	1/12/93	10:38p	Surface: Air Quality (PRES.)
	COS22	297426	1/13/93	1:59a	Surface: Scalar Wind Speed (2m)
	COS12	783106	1/13/93	1:48a	Surface: Scalar Wind Speed (10m)
	COS32	334786	1/13/93	2:11a	Surface: Scalar Wind Speed (misc.)
	COSR2	997602	1/13/93	12:12a	Surface: Solar Radiation (TS,NS,DS,US)
	COTT2	947490	1/12/93	11:43p	Surface: Temperature (T)
	COU22	187314	8/5/92	3:37p	Surface: Unit Wind Direction (2m)
	COU12	479554	1/13/93	12:33a	Surface: Unit Wind Direction (10m)

TABLE ~~1~~ 2
Directory Structrue
for
SARMAP Database Files

F:\SARMAP\
- SACO: Contains Continuous Surface Data
- SADO: Contains SARMAP Documentation Files
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- SAUA: Contains Upper Air Data
- SAAC: Contains Aircraft Data (not available at time of printing)

	FILE	SIZE	DATE	TIME	DESCRIPTION
	COU32	209794	1/13/93	12:41a	Surface: Unit Wind Direction (misc.)
	COW22	187314	1/13/93	1:13a	Surface: Vector Wind Direction (2m)
	COW12	479554	1/13/93	1:01a	Surface: Vector Wind Direction (10m)
	COW32	209794	1/13/93	1:23a	Surface: Vector Wind Direction (misc.)
	COV22	297426	1/13/93	2:41a	Surface: Vector Wind Speed (2m)
	COV12	783106	1/13/93	2:29a	Surface: Vector Wind Speed (10m)
	COV32	327314	1/13/93	2:49a	Surface: Vector Wind Speed (misc.)
	CODH2	174698	1/12/93	8:26p	Tracer : PDCH
	COMH2	174698	1/12/93	8:55p	Tracer : PMCH
	COMP2	174698	1/12/93	8:57p	Tracer : PMCP
	COTH2	174698	1/12/93	11:45p	Tracer : PTCH
F:\SARMAP\SADO	DOSIT	49300	1/4/93	8:50a	SARMAP site description file
	DOVAR	26358	8/24/92	3:01p	SARMAP variable description file
F:\SARMAP\SAHC	HCSCARB2	185700	7/9/92	3:11p	Hydrocarbon Data
	HCVS3	109071	6/24/92	5:02p	Hydrocarbon Data
	HCVS4	12530	6/1/92	1:17p	Hydrocarbon Data
	HCVS5	52109	6/1/92	1:15p	Hydrocarbon Data
	HCVSCARB	257666	8/5/92	9:48a	Hydrocarbon Data
F:\SARMAP\SAUA	ALTT2	775941	8/14/92	10:04a	Balloon: Temp. & RH
	ANGT2	358464	8/14/92	10:04a	Balloon: Temp. & RH
	BRET2	788403	8/14/92	10:09a	Balloon: Temp. & RH
	BUTT2	1224480	8/14/92	10:02a	Balloon: Temp. & RH
	CALT2	99831	1/7/93	4:23p	Balloon: Temp. & RH
	CROT2	1180336	8/14/92	10:12a	Balloon: Temp. & RH
	DELT2	1108540	8/14/92	10:06a	Balloon: Temp. & RH
	DEVT2	196799	1/15/93	10:12a	Balloon: Temp. & RH
	ELPT2	119857	1/7/93	4:41p	Balloon: Temp. & RH
	GLET2	271292	1/7/93	4:41p	Balloon: Temp. & RH
	KINT2	657552	8/14/92	10:10a	Balloon: Temp. & RH
	LI2T2	480666	8/14/92	10:10a	Balloon: Temp. & RH
	MADT2	579277	8/14/92	10:04a	Balloon: Temp. & RH
	MART2	1156776	8/14/92	10:09a	Balloon: Temp. & RH
	MRGT2	1064644	1/12/93	12:56p	Balloon: Temp. & RH
	OAKT2	263842	1/12/93	12:55p	Balloon: Temp. & RH
	OROT2	1190008	8/14/92	10:06a	Balloon: Temp. & RH
	PA2T2	431841	1/15/93	10:05a	Balloon: Temp. & RH
	PART2	512999	1/15/93	10:11a	Balloon: Temp. & RH
	PRBT2	1396716	8/14/92	10:07a	Balloon: Temp. & RH
	PTBT2	265588	1/15/93	1:24p	Balloon: Temp. & RH
	STOT2	901584	8/14/92	10:03a	Balloon: Temp. & RH
	THRT2	1185699	8/14/92	10:05a	Balloon: Temp. & RH
	TULT2	1102588	8/14/92	10:13a	Balloon: Temp. & RH
	VBGT2	196706	8/14/92	10:11a	Balloon: Temp. & RH
	VIST2	1894562	1/8/93	9:18a	Balloon: Temp. & RH
	WOOT2	506582	8/14/92	10:03a	Balloon: Temp. & RH
	YOST2	100823	1/7/93	4:41p	Balloon: Temp. & RH
	ALTW2	104880	8/14/92	10:04a	Balloon: Wind Data
	ANGW2	73574	1/15/93	1:53p	Balloon: Wind Data
	BREW2	105364	8/14/92	10:09a	Balloon: Wind Data
	BUTW2	209512	1/14/93	3:10p	Balloon: Wind Data
	CALW2	70868	8/14/92	10:03a	Balloon: Wind Data

TABLE ~~1~~ 2

Directory Structrue for SARMAP Database Files

F:\SARMAP\

- **SACO: Contains Continuous Surface Data**
- **SADO: Contains SARMAP Documentation Files**
- **SAHC: Contains Speciated Hydrocarbon Data**
- **SAUA: Contains Upper Air Data**
- **SAAC: Contains Aircraft Data** **(not available at time of printing)**

FILE	SIZE	DATE	TIME	DESCRIPTION
CROW2	198314	8/14/92	10:12a	Balloon: Wind Data
DELW2	198600	1/15/93	1:28p	Balloon: Wind Data
DEVW2	159396	8/14/92	10:07a	Balloon: Wind Data
ELPW2	85080	1/7/93	4:41p	Balloon: Wind Data
GLEW2	189866	1/14/93	2:03p	Balloon: Wind Data
KINW2	466670	1/15/93	1:30p	Balloon: Wind Data
LI2W2	341138	8/14/92	10:10a	Balloon: Wind Data
MADW2	76126	8/14/92	10:04a	Balloon: Wind Data
MARW2	195344	8/14/92	10:10a	Balloon: Wind Data
MRGW2	755574	1/14/93	3:23p	Balloon: Wind Data
OAKW2	145184	8/14/92	10:14a	Balloon: Wind Data
OROW2	201416	1/12/93	12:34p	Balloon: Wind Data
PA2W2	306598	8/14/92	10:11a	Balloon: Wind Data
PARW2	67634	8/14/92	10:08a	Balloon: Wind Data
PRBW2	974782	1/15/93	1:52p	Balloon: Wind Data
PTBW2	188502	8/14/92	10:04a	Balloon: Wind Data
STOW2	647092	8/14/92	10:03a	Balloon: Wind Data
THRW2	815260	8/14/92	10:05a	Balloon: Wind Data
TULW2	185708	1/14/93	3:48p	Balloon: Wind Data
VBGW2	139618	8/14/92	10:11a	Balloon: Wind Data
VISW2	1015702	1/7/93	4:41p	Balloon: Wind Data
WOOW2	66820	8/14/92	10:03a	Balloon: Wind Data
YOSW2	71572	1/7/93	4:44p	Balloon: Wind Data

FIGURE 1

SJVAQS/AUSPEX Surface Monitoring Sites

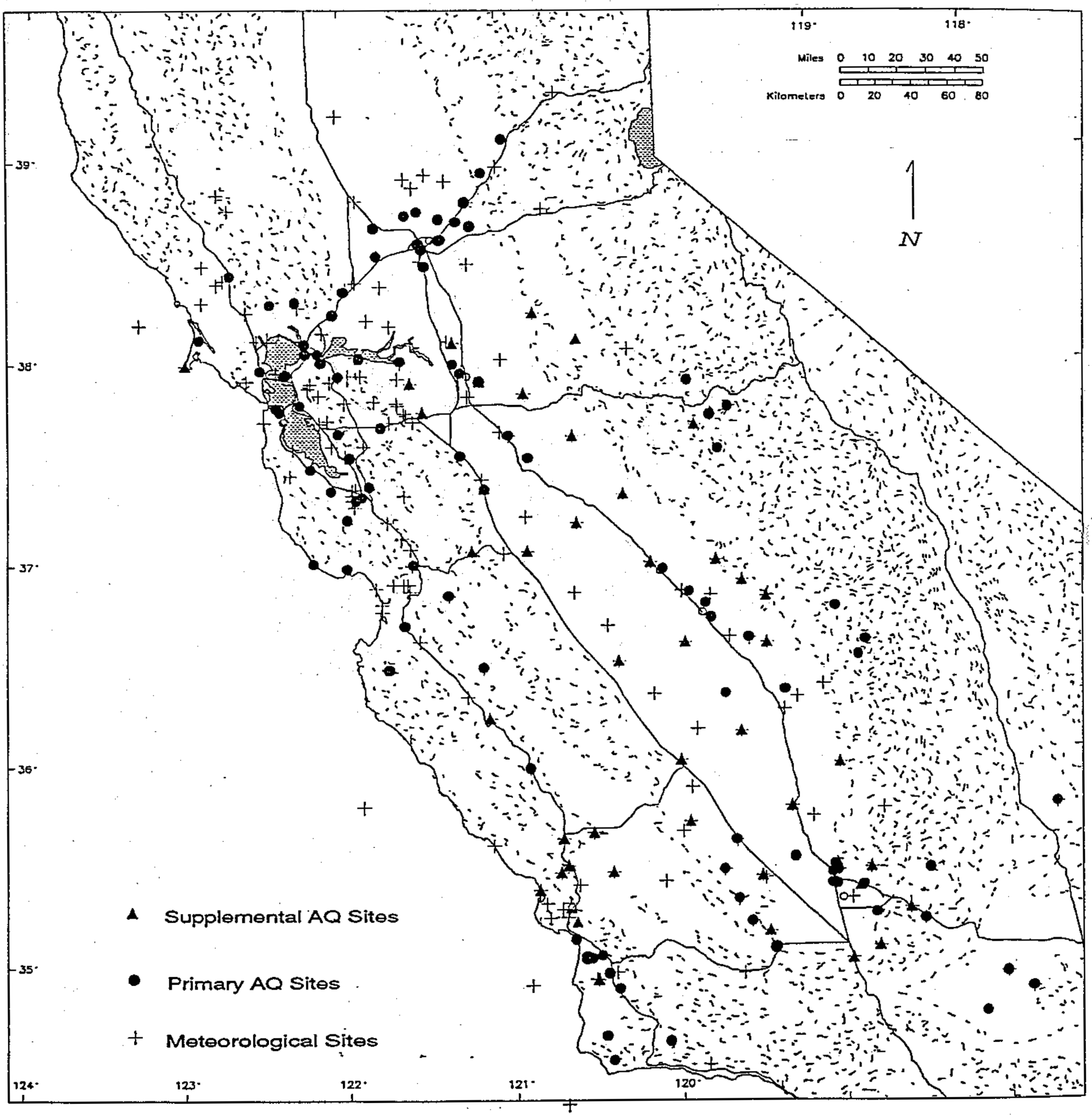
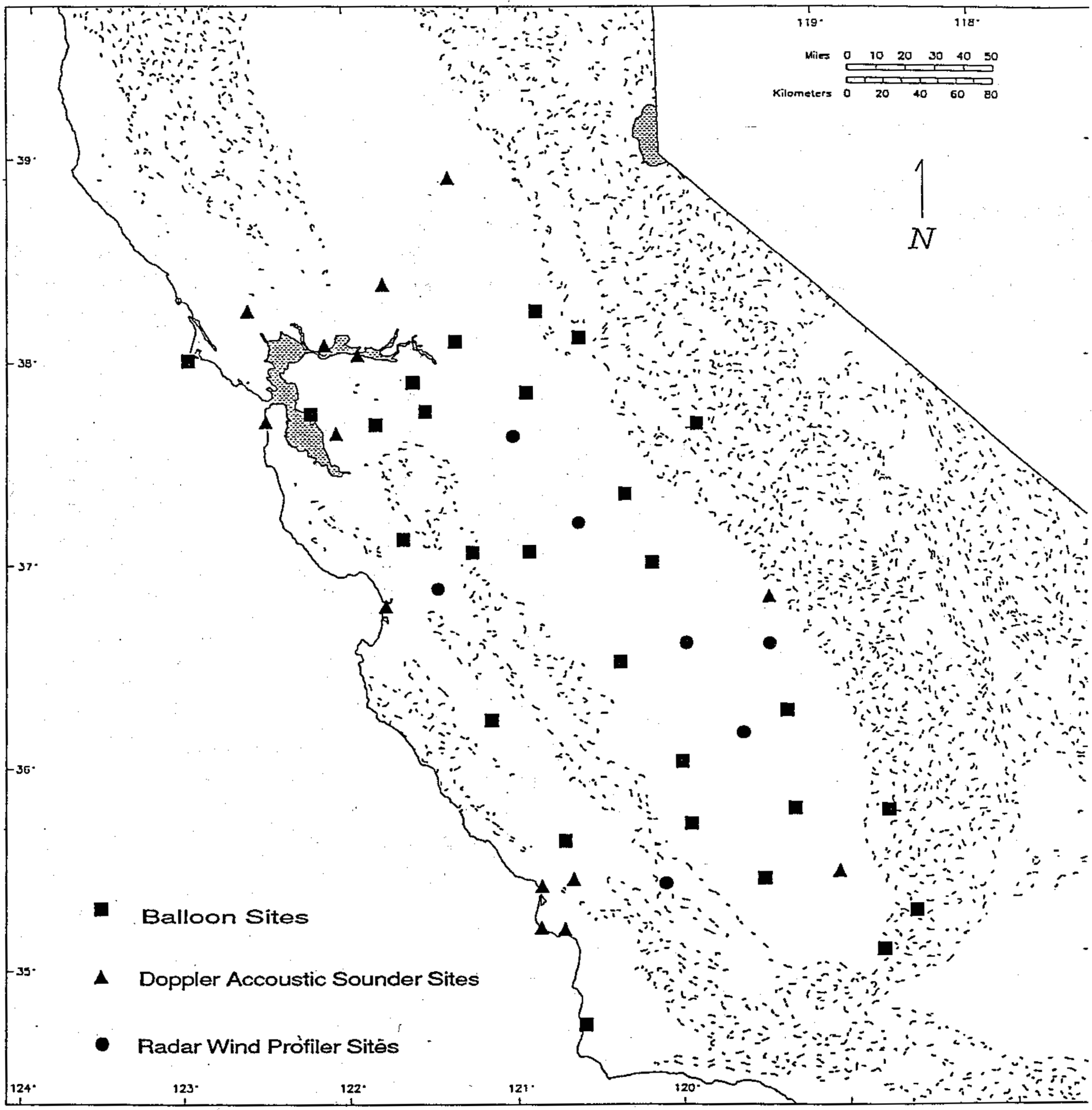
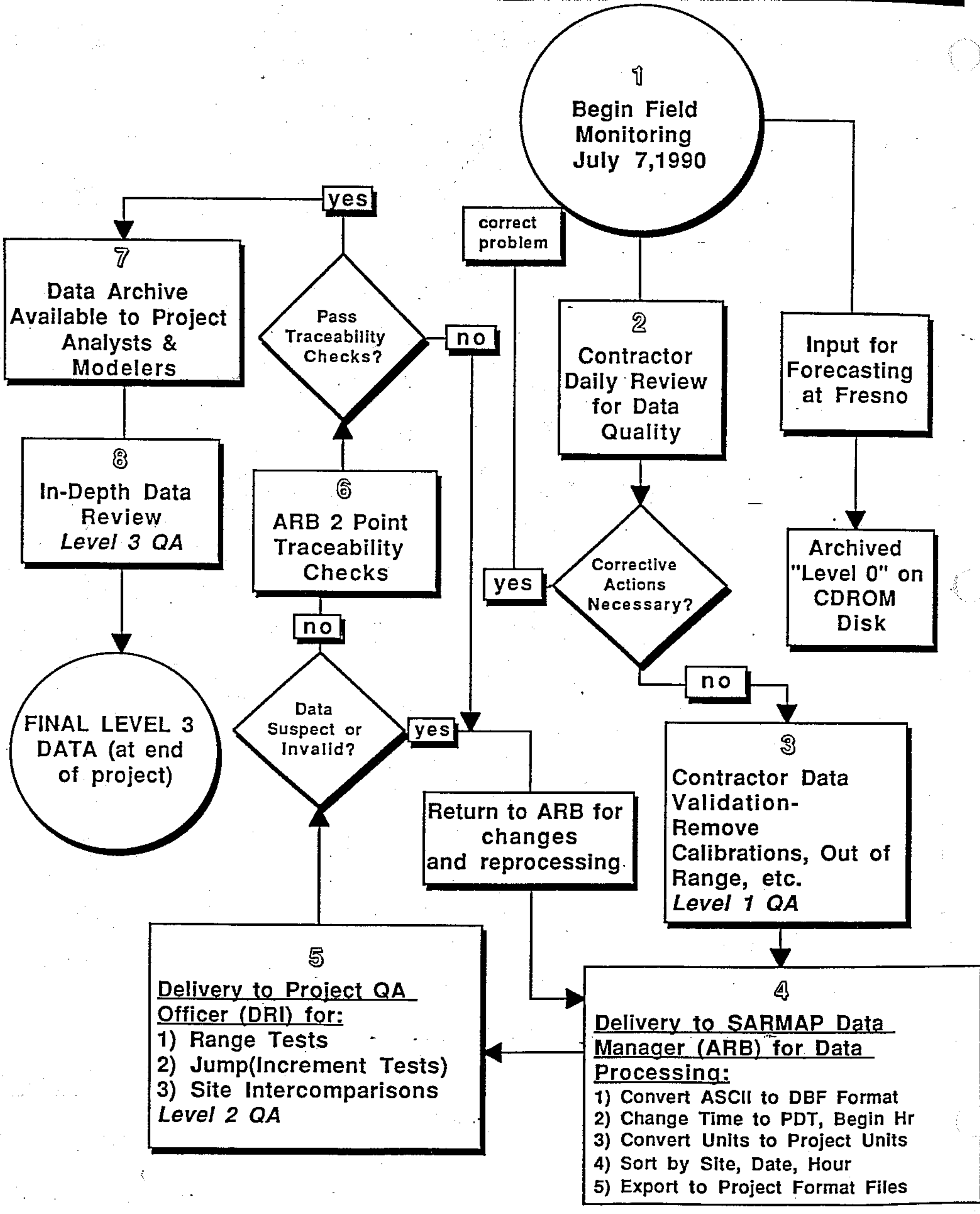


FIGURE 2

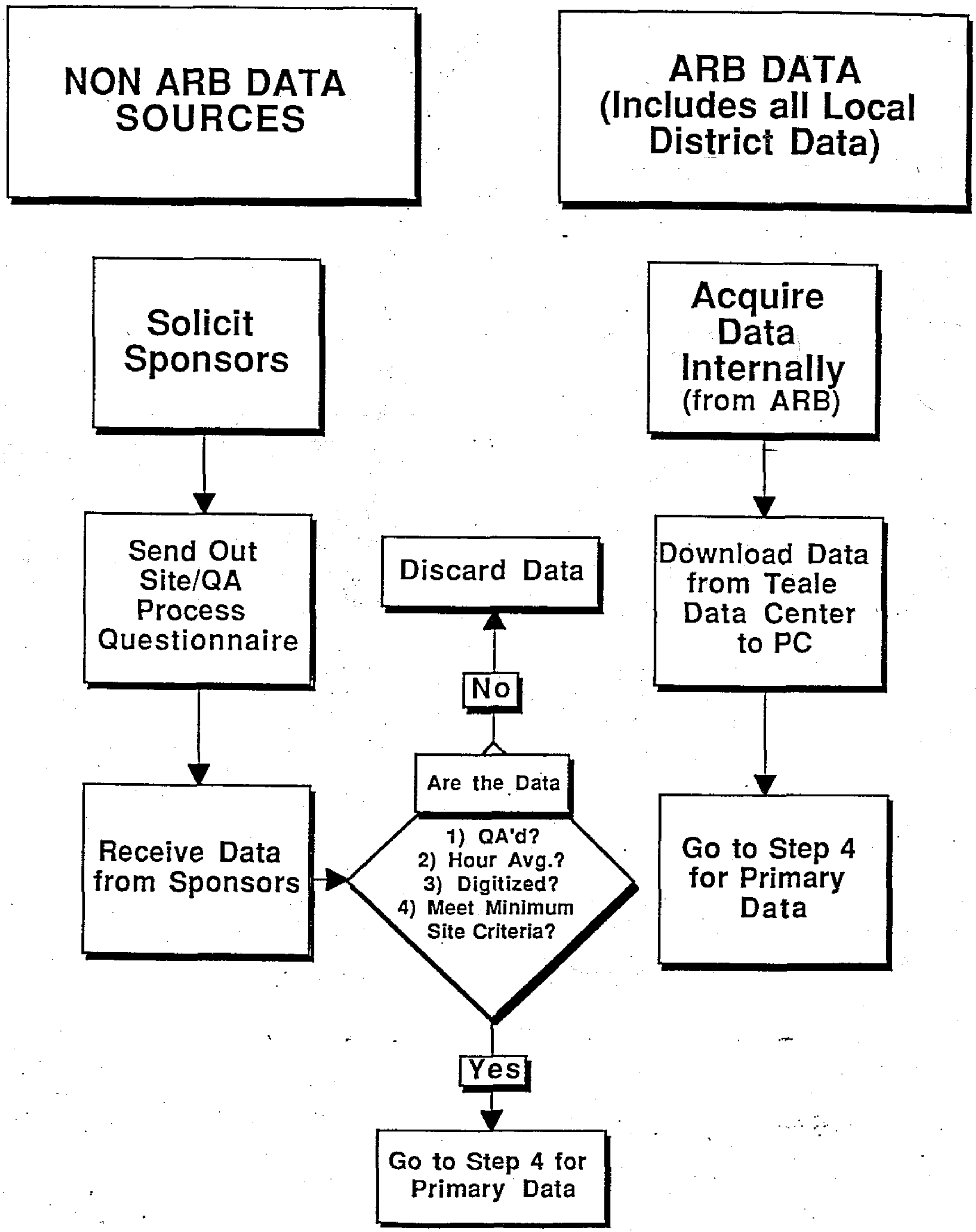
SJVAQS/AUSPEX Upper-Air Monitoring Sites



DATA PROCESSING / CHAIN OF CUSTODY FOR PROJECT DATA



DATA PROCESSING / CHAIN OF CUSTODY FOR SUPPLEMENTAL DATA



HARDWARE CONFIGURATION FOR DATA MANAGEMENT

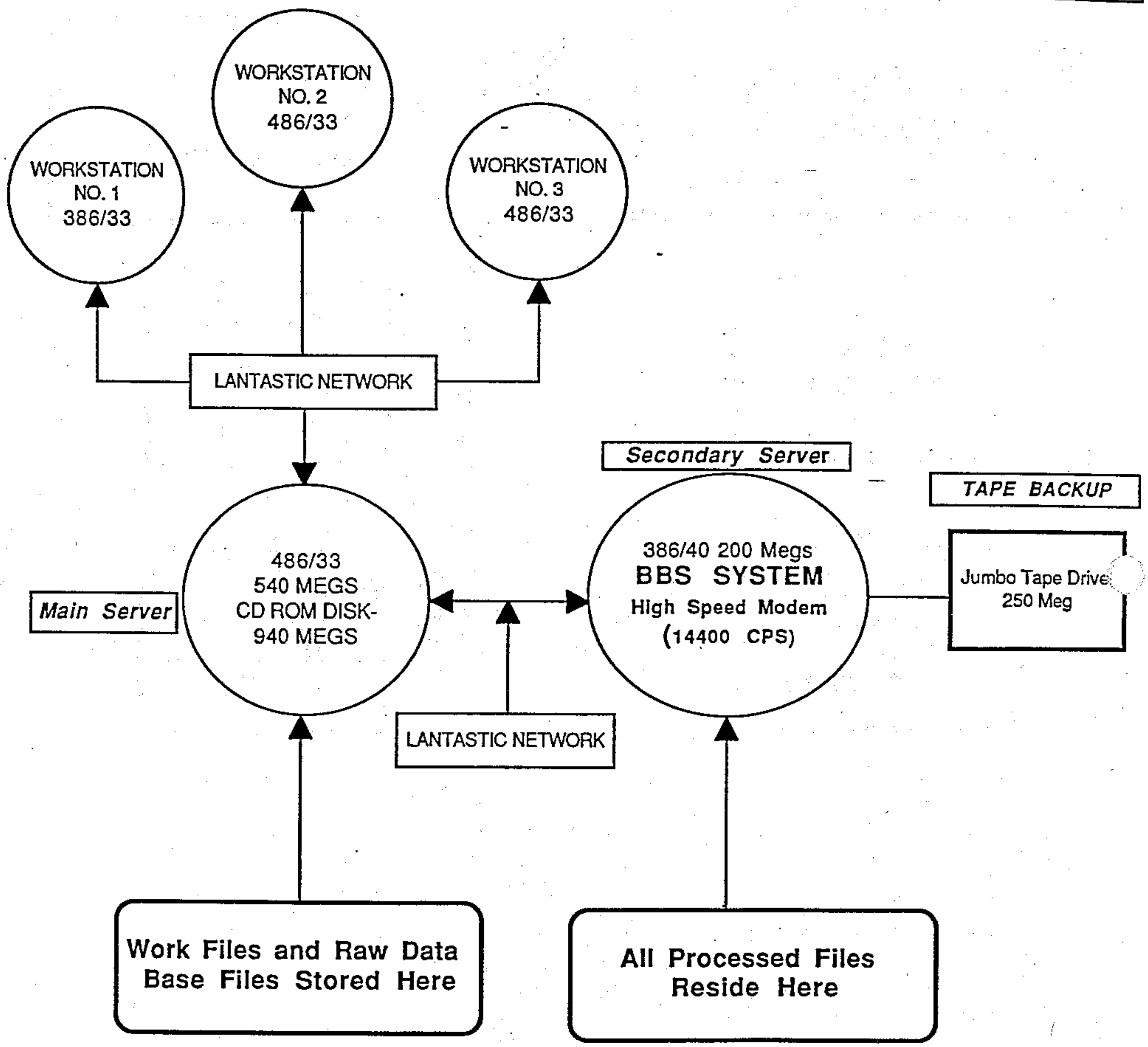


Figure 6

The SARMAP Surface Relational Database Files

Example records from SURFACE.DBF:

(These represent the values measured at site Academy for Julian day 217 and hour 15 PDT)

SITE	JDAT	HR	SUBTYPE	RESULT	FLAG
ACA	217	15	NO	0.50	*A
ACA	217	15	NO2	3.00	*A
ACA	217	15	NOZ	2.20	?0
ACA	217	15	O3	112.00	?0
ACA	217	15	PAN	0.48	
ACA	217	15	WDU1	293.00	*A
ACA	217	15	WDV1	297.00	*A
ACA	217	15	WSS1	2.48	*A
ACA	217	15	WSV1	2.13	*A

Records Contained in SUBTYPE.DBF:

Subtype	Name	Type	Unit	Digit	Hour-avgd	SM1-DBF	SM1_Field	Underscore	SM1_len	SM1-Dec
T	Temperature	TT	C		1	COTT2	T_	T	5	1
RH	Relative Humidity	RR	%		1	CORH2	RH	T	3	0
DP	Dew Point	RR	C	0	1	CORH2	DT	T	7	2
PR	Pressure	PR	MB	0	1	COPP2	PR	T	7	2
TS	Total Solar	ST	W/M2		1	COSR2	TS	T	6	1
DS	Direct Insolation	SD	W/M2		1	COSR2	DS	T	6	1
US	Ultraviolet Solar	SU	W/M2		1	COSR2	US	T	6	1
NS	Net UV Solar	SN	W/M2		1	COSR2	NS	T	6	1
NO	Nitrogen Oxide	N1	PPB		1	CONO2	NO	T	5	1
NO2	Nitrogen Dioxide	N1	PPB		1	CONO2	NO2	F	5	1
O3	Ozone	OO	PPB		1	COO32	O3	T	3	0
WDV1	Wind Direct Vector 10m	W1	DEG		1	COW12	WD	T	3	0
WSS1	Wind Speed Scalar 10m	W1	M/S		1	COS12	WS	T	5	1
WDV2	Wind Direct Vector 2m	W2	DEG		1	COW22	WD	T	3	0
WSS2	Wind Speed Scalar 2m	W2	M/S		1	COS22	WS	T	5	1

Figure 6

The SARMAP Surface Relational Database Files

WDV3	Wind Direct Vector Other	W3	DEG	1	COW32	WD	T	3	0
WSS3	Wind Speed Scalar Other	W3	M/S	1	COS32	WS	T	5	1
WSV1	Wind Speed Vector 10m	W1	M/S	1	COV12	WV	T	5	1
WSV2	Wind Speed Vector 2m	W2	M/S	1	COV22	WV	T	5	1
WSV3	Wind Speed Vector Other	W3	M/S	1	COV32	WV	T	5	1
WDU1	Wind Direct U. Vector 10m	W1	DEG	1	COU12	UD	T	3	0
WDU3	Wind Direct U. Vector Other	W3	DEG	1	COU32	UD	T	3	0
NOZ		N2		1	CONP2	NOZ	F	6	2
PAN		PN		1	CONP2	PAN	F	6	2
MCP	Tracer PMCP Sample	TR	FL/L	2	COMP2	MP	F	7	2
MCH	Tracer PMCH Sample	TR	FL/L	2	COMH2	MH	F	7	2
DCH	Tracer PDCH Sample	TR	FL/L	2	CODH2	DH	F	7	2
TCH	Tracer PTCH Sample	TR	FL/L	2	COTH2	TH	F	7	2
MCPC	Tracer PMCP Sample (colocated)	TR	FL/L	2	COMP2	MPC	F	7	2
MCHC	Tracer PMCH Sample (colocated)	TR	FL/L	2	COMH2	MHC	F	7	2
DCHC	Tracer PDCH Sample (colocated)	TR	FL/L	2	CODH2	DHC	F	7	2
TCHC	Tracer PTCH Sample (colocated)	TR	FL/L	2	COTH2	THC	F	7	2
MCP3	Tracer PMCP 3 Hour Release	TR	kg	3	COMP2	MP3	F	7	2
MCH3	Tracer PMCH 3 Hour Release	TR	kg	3	COMH2	MH3	F	7	2

Figure 6

The SARMAP Surface Relational Database Files

DCH3	Tracer PDCH 3 Hour Release	TR	kg	3	CODH2	DH3	F	7	2
TCH3	Tracer PTCH 3 Hour Release	TR	kg	3	COTH2	TH3	F	7	2
MCP4	Tracer PMCP 4 Hour Release	TR	kg	4	COMP2	MP4	F	7	2
MCH4	Tracer PMCH 4 Hour Release	TR	kg	4	COMH2	MH4	F	7	2
DCH4	Tracer PDCH 4 Hour Release	TR	kg	4	CODH2	DH4	F	7	2
TCH4	Tracer PTCH 4 Hour Release	TR	kg	4	COTH2	TH4	F	7	2
NMH	Non-methane hydrocarbons	HH	PPB	1	COSC2	NMH	F	5	1
THC	Total hydrocarbons	TH	PPB	1	COSC2	THC	F	5	1
CO	Carbon monoxide	CC	PPM	1	COSC2	CO	T	3	0
CH4	Methane	C4	PPB	1	COSC2	CH4	F	5	1
SO2	Sulfur Dioxide	SS	PPB	1	COSC2	SO2	F	3	0
WDEV	WD STD DEVIATION	W	DEG		WDDEV	DEV	F	5	1
WDU2	Wind Direct. Dummy for JW	W2	DEG	1	COU22	UD	T	3	0

Records Contained in TYPE.DBF:

TYPE	NAME	SM1_ORDER	COMMENTARY

Figure 6

The SARMAP Surface Relational Database Files

TR	Tracer	25	memo
TT	Temperature	8	Memo
OO	Ozone Concentration	13	Memo
RR	Relative Humidity	9	memo
W1	Wind (10m only)	1	memo
W2	Wind (2m only)	2	memo
W3	Wind (misc.)	3	memo
PP	Wind Profiler	10	memo
BB	Balloon	12	memo
DD	Dopler Wind	11	memo
N1	Oxides of Nitrogen	14	memo
N2	" (high sensitivity)	15	memo
PN	PAN	16	memo
CC	Carbon Monoxide	17	memo
C4	Methane	18	memo
TH	Total Hydrocarbons	19	memo
SS	Sulfur Dioxide	20	memo
HH	Hydrocarbons	21	memo
P1	Particulates	22	memo
C1	Carbonyl	23	memo
HC	Hydrocarbons?	24	Memo
PR	Pressure	26	memo
SD		5	memo
SN		7	memo
ST		4	memo
SU		6	memo

Figure 6

The SARMAP Surface Relational Database Files

First Record in DOSIT.DBF:

Field #	Field Name	Value
1	SITE	ACA
2	NAME	Academy
3	LATD	36
4	LATM	53
5	LATS	16
6	LOND	119
7	LONM	32
8	LONS	15
9	EV	163
10	LATF	36.8878
11	LONF	119.5375
12	UTMN	4087.8210
13	UTME	808.5920
14	TYPE	EX
15	W1	ES
16	W2	
17	W3	
18	ST	
19	SD	
20	SU	
21	SN	
22	TT	
23	RR	
24	PP	
25	DD	
26	BB	
27	OO	EN
28	N1	EN
29	N2	EN
30	PN	EN
31	CC	
32	C4	
33	TH	
34	SS	
35	HH	
36	P1	DR
37	C1	AT
38	HC	OG
39	TR	TT
40	PR	
41	SP	
42	OMMENTARY	Memo

Figure 6

The SARMAP Surface Relational Database Files

Records Contained in CNTRCTR.DBF:

Contractor	Name	Primary	Commentary
AR	Air Resources Board		
BA	BAAQMD (standard)		
CH	Chevron Oil Company		
CI	CIMIS		
M1	Minerals Management 10m		
M5	Minerals Management 5m		
NP	National Park Service		
SI	SIMP		
SL	SLOAQMD		
TX	Texaco Oil Company		
DD	DOD NWC		
PG	PG&E (standard)		
PN	PG&E (non-standard)		
PS	PG&E (San Louis Obispo)		
ES	ESC		
AB	ABB Environmental Co.		
AV	Aerovironment		
BN	BAAQMD (non-standard)		
CA	CADAMP		
EN	ENSR		
SC	SACOG		
TT	Tracer Technologies		
MN	MAQMD		
BN	BAAQMD Nonstandard	T	
PS	PG&E and San Luis District	T	
PN	PG&E Nonstandard	T	

Figure 6

The SARMAP Surface Relational Database Files

Records Contained in FLAGTYPE.DBF

Flag_type	Name
*	Valid
?	Unknown
M	Missing
I	Invalid
S	Suspect
C	Calculated

Records Contained in FLAG.DBF

Flag	Flag_type	Commentary
*A	*	
?A	?	
MA	M	
IW	I	
SF	S	
CA	C	
IA	I	
*B	*	
I2	I	

Example Records from PLAN.DBF for the ACA site

Site	Contractor	Subtype	No_data
ACA	ES	WDU1	F
ACA	ES	WDV1	F
ACA	ES	WSS1	F
ACA	ES	WSV1	F
ACA	EN	NO	F
ACA	EN	NOZ	F
ACA	EN	O3	F
ACA	EN	NO2	F
ACA	EN	PAN	F
ACA	TT	DCH	F
ACA	TT	MCH	F
ACA	TT	MCP	F
ACA	TT	TCH	F

Figure 8

Related SARMAP Database Files and Indices

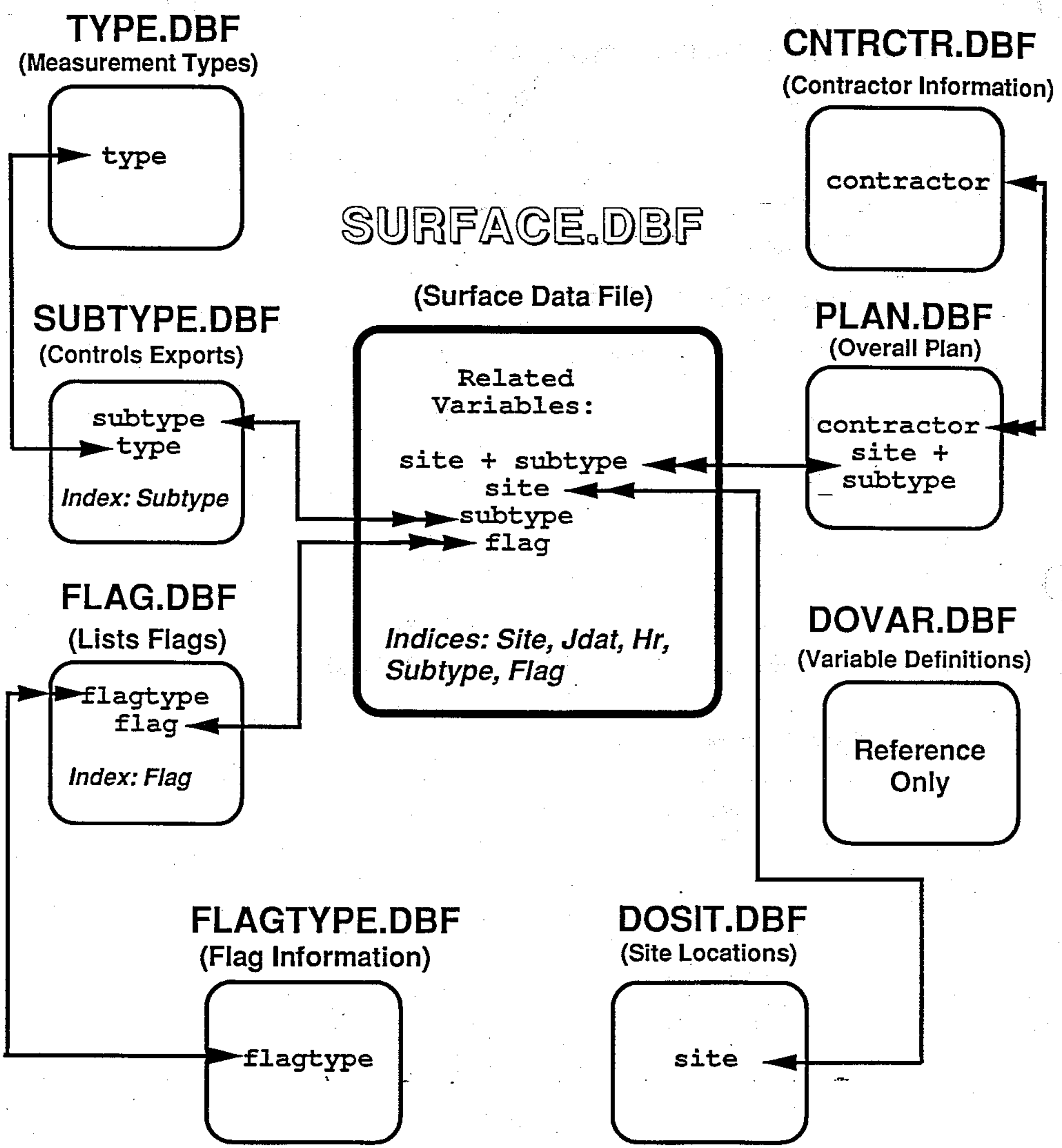


Figure 8

Date Flow For the SARMAP Surface Database

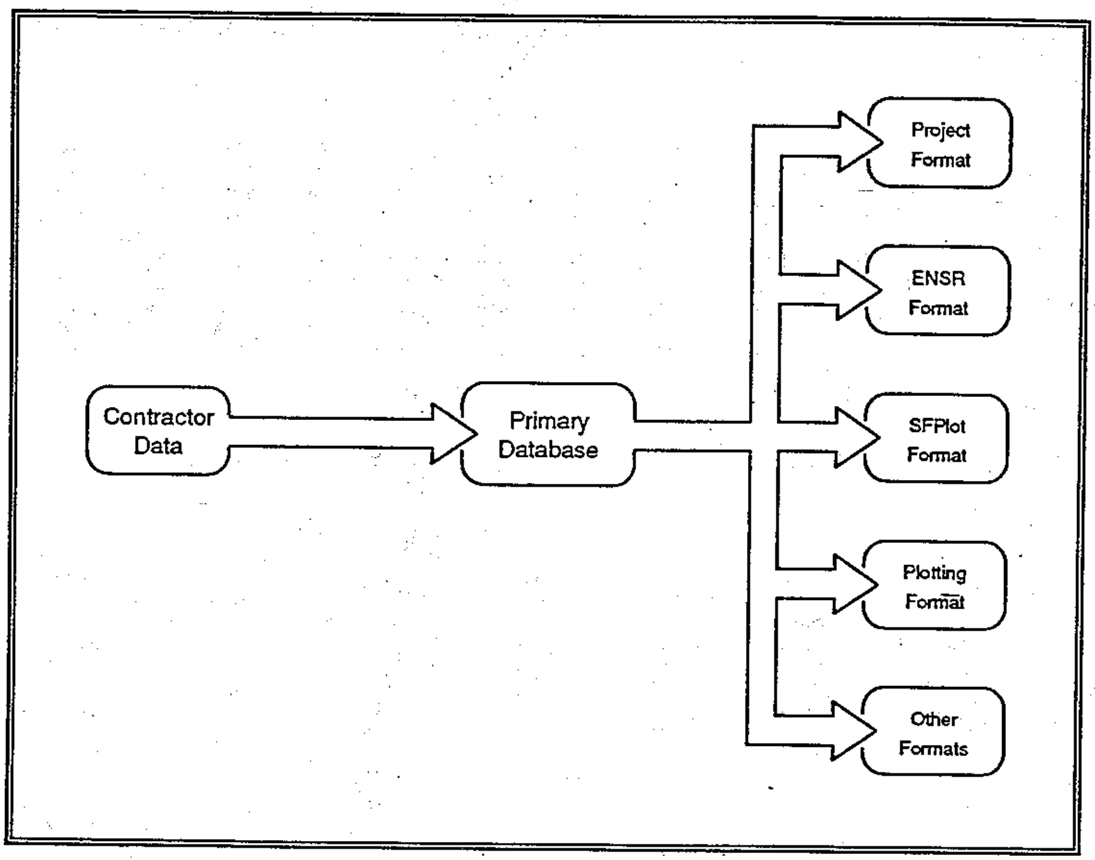


Figure 9 SURFACE

Examples of "As Received" Data

Sample Records from AeroVironment Surface Air Quality Data File Called S3.DAT:

04-AUG-90 09	0.012	00	0.002	0.020	00	0.005	0.008	00	0.005	0.034	00	0.002
04-AUG-90 10	0.009	00	0.002	0.013	00	0.005	0.004	00	0.005	0.046	00	0.002
04-AUG-90 11	0.008	00	0.002	0.011	00	0.005	0.003	00	0.005	0.061	00	0.003
04-AUG-90 12	0.010	00	0.002	0.017	00	0.005	0.007	00	0.005	0.084	00	0.004
04-AUG-90 13	0.009	00	0.002	0.011	00	0.005	0.002	00	0.005	0.086	00	0.004
04-AUG-90 14	0.006	00	0.002	0.008	00	0.005	0.002	00	0.005	0.094	00	0.005
04-AUG-90 15	0.007	00	0.002	0.009	00	0.005	0.002	00	0.005	0.096	00	0.005
04-AUG-90 16	0.004	00	0.002	0.010	00	0.005	0.006	00	0.005	0.087	00	0.004
04-AUG-90 17	0.007	00	0.002	0.008	00	0.005	0.001	00	0.005	0.085	00	0.004
04-AUG-90 18	0.007	00	0.002	0.012	00	0.005	0.005	00	0.005	0.090	00	0.005

Sample Records from ABB Surface Air Quality Data File called SJV9008.PRN:

ABB	ELPA	900804	0900	O3	76	00	3.00
ABB	ELPA	900804	1000	O3	83	00	3.00
ABB	ELPA	900804	1100	O3	90	00	3.00
ABB	ELPA	900804	1200	O3	96	00	3.00
ABB	ELPA	900804	1300	O3	100	00	3.00
ABB	ELPA	900804	1400	O3	102	00	3.00
ABB	ELPA	900804	1500	O3	106	00	3.00
ABB	ELPA	900804	1600	O3	108	00	3.00
ABB	ELPA	900804	1700	O3	110	00	3.00

Sample Records from Texaco Surface Air Quality Data File caleed KF90AUG.DAT

KERN FRONT
AUG 1990

JDY	DAY	HR	so2	nox	no	no2	thc	ch4	nmh	co
213	1	10	7.75	31.25	0.30	30.95	2.47	2.11	0.360	0.680
213	1	11	7.70	15.15	-0.45	15.60	2.42	2.08	0.336	0.475
213	1	12	5.70	4.85	-0.60	5.45	2.12	1.85	0.264	0.325
213	1	13	4.85	2.80	-0.65	3.45	2.00	1.75	0.246	0.280
213	1	14	4.45	1.95	-0.65	2.60	1.97	1.72	0.244	0.275
213	1	15	4.25	1.45	-0.75	2.20	1.96	1.72	0.246	0.265

CONTRACTOR: ____________

	HR = DATE		HR = DATE		HR = DATE		HR = DATE		HR = DATE	
VARIABLE										
UNITS: Variable Ref.Time	TXT	DBF	TXT	DBF	TXT	DBF	TXT	DBF	TXT	DBF
SITE										

☐ Values Match ☐ Recheck Date: Checked By:

Figure 11

Examples of SURFPLOT,ENSR EXPORT, SFMET,SFPLOT, and UAPLOT Files

SURFPLOT Example:

SITE	DATE	HR	O3	NO	NO2	WS	WD
ACA	08/03/90	0	30.00	1.20	16.20	0.92	211.00
ACA	08/03/90	1	31.00	1.50	14.40	0.88	157.00
ACA	08/03/90	2	25.00	0.90	14.10	1.64	151.00
ACA	08/03/90	3	22.00	1.60	14.50	1.35	131.00
ACA	08/03/90	4	20.00	2.70	14.90	1.65	146.00
ACA	08/03/90	5	14.00	8.20	21.20	0.47	143.00

ENSR Surface Air Quality File Example:

SITE	DATE	HR	O3_PPB	NO_PPB	NO2_PPB	NOZ_PPB	PAN_PPB
ACA	07/27/1990	0	34.00	0.50	15.80	15.55	-99.00	-99.00
ACA	07/27/1990	1	33.00	0.50	11.60	11.97	-99.00	-99.00
ACA	07/27/1990	2	37.00	0.50	8.10	8.50	-99.00	-99.00
ACA	07/27/1990	3	34.00	0.50	9.70	8.97	-99.00	-99.00
ACA	07/27/1990	4	24.00	0.90	21.50	22.42	-99.00	-99.00

ENSR Surface Meteorological Example:

SITE	DATE/HR	WS	WD	TEMP	RH
ACA	07/28/90/ 0	0.48	36	-99.0	-99
ACA	07/28/90/ 1	0.77	167	-99.0	-99
ACA	07/28/90/ 2	1.75	137	-99.0	-99
ACA	07/28/90/ 3	1.05	104	-99.0	-99

ENSR Upper-level Temperature File Example:

SITE	DATE	HR	EV	Pr	T	RH
BEN	07/25/90	0	81	-99	-99.0	-99
BEN	07/25/90	1	81	-99	-99.0	-99
BEN	07/25/90	5	81	-99	-99.0	-99

ENSR Upper-Level Wind File Example:

SITE	DATE	HR	EV	WS	WD
ALT	07/29/90	1	14	4.4	241
ALT	07/29/90	1	81	5.2	232
ALT	07/29/90	1	216	7.3	231

Figure 11 cont.

SFMET File Example:

Site	Hr	Sws	Vws	Rwd	Uwd	Temp	DPT	RH	TSR	NSR	USR
BUT	9	0.96	0.78	45.00	41.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	10	1.30	1.28	34.00	36.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	11	2.16	2.13	14.00	15.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	12	2.63	2.63	10.00	10.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	13	2.80	2.80	9.00	9.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	14	2.55	2.53	19.00	20.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	15	2.44	2.42	24.00	24.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	16	2.68	2.67	24.00	25.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	17	2.85	2.84	32.00	32.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00
BUT	18	2.16	2.15	43.00	43.00	-99.00	-99.00	-99.00	-99.00	-99.00	-99.00

SFPLOT File Example:

Site	Hr	SWS	VWS	RWD	UWD	Temp	O3	NO	NO2	TSR
ACA	5	0.47	0.29	143.00	138.00	-99.00	14.00	8.20	21.20	-99.00
ACA	6	0.90	0.80	49.00	51.00	-99.00	7.00	16.10	28.00	-99.00
ACA	7	0.47	0.36	120.00	88.00	-99.00	24.00	6.50	20.40	-99.00
ACA	8	1.99	1.78	186.00	184.00	-99.00	43.00	3.30	12.60	-99.00
ACA	9	3.14	3.11	184.00	185.00	-99.00	53.00	2.70	11.50	-99.00
ACA	10	3.94	3.90	175.00	175.00	-99.00	70.00	2.20	11.20	-99.00

UAPLOT File Example:

Site	Date	Hr	Ev	WS	WD	Temp	DPT
BRE	217	4	50	1.5	279.0	17.2	14.1
BRE	217	4	100	2.4	270.4	18.1	12.4
BRE	217	4	150	4.0	251.3	20.1	11.7
BRE	217	4	200	4.9	254.7	22.1	11.2
BRE	217	4	250	4.9	268.6	24.1	10.9
BRE	217	4	300	5.0	286.8	25.4	12.8
BRE	217	4	350	5.6	300.8	26.6	11.4
BRE	217	4	400	6.3	309.0	28.2	9.7
BRE	217	4	450	6.7	321.2	29.5	8.3
BRE	217	4	500	6.8	326.4	29.5	7.7

Figure 12. Examples of Project Format Files

Surface Air Quality Data:

The First 4 sites in COO32.DBF (Contains Surface Ozone Data):

Year	Month	Day	Date	Hour	O3 Aca	O3 Alt	O3 Ang	O3 Arv
1990	08	05	217	12	100	71	86	110
1990	08	05	217	13	103	74	84	110
1990	08	05	217	14	104	77	86	110
1990	08	05	217	15	112	70	98	110
1990	08	05	217	16	120	76	108	120

The First 2 sites in CONO2.DBF (Contains Surface NO and NO2 Data):

Year	Month	Day	Date	Hour	NO Aca	NO2 Aca	NO Alt	NO2 Alt
1990	08	03	215	10	2.2	11.2	13.5	20.7
1990	08	03	215	11	0.8	9.4	6.8	19.2
1990	08	03	215	12	0.7	14.1	3.5	14.5
1990	08	03	215	13	0.5	7.1	1.9	11.7
1990	08	03	215	14	0.5	5.4	1.7	11.7
1990	08	03	215	15	0.5	3.8	2.1	15.5

The First 2 sites in CONP2.DBF (Contains High Sensitivity NOx and PAN Data):

Year	Month	Day	Date	Hour	NOz ACA	PAN ACA	NOz ALT	PAN ALT
1990	08	03	215	10	10.97	1.30	12.20	0.65
1990	08	03	215	11	8.27	1.51	10.30	0.99
1990	08	03	215	12	12.62	1.73	7.40	0.88
1990	08	03	215	13	5.62	1.00	4.95	1.53
1990	08	03	215	14	3.00	0.74	3.90	1.75
1990	08	03	215	15	2.22	0.53	6.57	1.82

The First Site in COSC2.DBF (SO2,CO,THC,CH4 Surface Data):

Year	Month	Day	Date	Hour	CH4 Bak	CO Bak	SO2 Bak	THC Bak
1990	08	03	215	10	-99.0	-99	-99	-99.0
1990	08	03	215	11	18.0	1	0	22.0
1990	08	03	215	12	18.0	1	0	20.0
1990	08	03	215	13	17.0	1	0	20.0
1990	08	03	215	14	17.0	1	0	19.0
1990	08	03	215	15	17.0	1	0	19.0

Surface Meteorological Data

The First 4 Sites in COS12.DBF (Scalar Averaged Wind Speeds (m/s) at 10 meters above the surface:

Year	Month	Day	Date	Hour	WS ACA	WS ALT	WS ALV	WS ATL
1990	08	03	215	10	3.9	2.0	2.0	-99.0
1990	08	03	215	11	2.6	3.4	2.8	-99.0
1990	08	03	215	12	2.5	4.4	4.5	-99.0
1990	08	03	215	13	2.6	3.5	5.7	-99.0
1990	08	03	215	14	2.5	2.6	6.5	-99.0
1990	08	03	215	15	3.9	6.1	6.5	-99.0

**The First 4 Sites in COW12.DBF (Resultant Vector Wind Speeds At !0 meters above
the surface):**

Year	Month	Day	Date	Hour	WD Aca	WD Alt	WD Alv	WD Atl
1990	08	05	217	12	185	352	-99	337
1990	08	05	217	13	174	349	-99	348
1990	08	05	217	14	224	345	-99	234
1990	08	05	217	15	297	350	-99	224
1990	08	05	217	16	293	15	-99	230

The First 4 Sites in COTT2.DBF (Surface Temperature Data):

Year	Month	Day	Date	Hour	T Alv	T Atl	T B11	T B13
1990	08	05	217	12	-99.0	34.8	15.2	12.1
1990	08	05	217	13	-99.0	37.7	15.4	12.8
1990	08	05	217	14	-99.0	36.5	15.5	12.6
1990	08	05	217	15	99.0	33.0	15.4	12.9
1990	08	05	217	16	27.4	31.3	15.3	12.1

The First 2 Sites in CORH2.DBF (Dew Point Temperature and Relative Humidity Data):

Year	Month	Day	Date	Hour	DT Alv	RH Alv	DT B11	RH B11
1990	08	05	217	12	-99.00	-99	-99.00	-99
1990	08	05	217	13	-99.00	-99	-99.00	-99
1990	08	05	217	14	-99.00	-99	-99.00	-99
1990	08	05	217	15	-99.00	-99	-99.00	-99
1990	08	05	217	16	16.05	50	-99.00	-99

The First 4 Sites in COSR2.DBF (Solar Radiation Data):

Year	Month	Day	Date	Hour	TS Alt	TS Atl	TS Au2	TS B11
1990	08	05	217	12	927.5	808.9	958.8	418.4
1990	08	05	217	13	934.4	829.8	962.7	457.3
1990	08	05	217	14	885.6	781.0	904.4	394.5
1990	08	05	217	15	774.0	669.4	785.3	296.8
1990	08	05	217	16	613.7	523.0	631.6	275.5

Tracer Data:

The First 4 Sites in CODH2.DBF:

Year	Month	Day	Date	Hour	DH Aca	DH Alt	DH Ang	DH Arv
1990	08	05	217	10	0.00	0.00	0.00	0.00
1990	08	05	217	11	-99.00	-99.00	-99.00	-99.00
1990	08	05	217	12	0.00	0.00	0.00	0.00
1990	08	05	217	13	-99.00	-99.00	-99.00	-99.00
1990	08	05	217	14	0.00	0.00	0.00	0.00
1990	08	05	217	15	-99.00	-99.00	-99.00	-99.00

Hydrocarbon Samples:

The First 4 Sites in HC2CARB2.DBF:

Site	Year	Month	Day	Date	Hour	ID	Tot. HC	Alkane	Alkene	Aromatic
ACA	1990	07	27	208	8	EAX 149	56.80	33.90	10.40	12.50
ACA	1990	07	27	208	10	EAX 150	39.90	25.90	4.90	9.10
ACA	1990	07	27	208	12	EAX 151	39.90	27.80	5.10	7.00
ACA	1990	07	27	208	14	EAX 152	38.40	23.20	8.20	7.00
ACA	1990	07	28	209	8	EAX 157	40.70	24.80	7.70	8.20
ACA	1990	07	28	209	10	EAX 158	88.80	54.50	23.20	11.10

Upper-Air Data:

The First 7 Records in ALTW2.DBF (Balloon Sounding Wind Data):

Site	Date	Hour	Elevation	Speed	Direction
ALT	217	4	14	0.4	196
ALT	217	4	73	3.0	235
ALT	217	4	185	7.4	261
ALT	217	4	281	7.0	274
ALT	217	4	373	6.8	293
ALT	217	4	459	6.5	317
ALT	217	4	534	6.7	320

The First 7 Records in ALTT2.DBF (Balloon Sounding Temperature & Pressure Data):

Site	Date	Hour	Elevation	Pressure	Temperature	Relative Humidty	Dew Point Temperature
ALT	217	4	14	1013	17.7	73	12.7
ALT	217	4	33	1011	17.9	72	12.7
ALT	217	4	55	1008	18.5	69	12.6
ALT	217	4	77	1006	19.3	63	11.9
ALT	217	4	102	1003	19.8	60	11.7
ALT	217	4	128	1000	20.4	59	12.0
ALT	217	4	150	997	21.1	55	11.6

The First 7 Records in COREEP2.DBF (Radar Profiler Wind Data):

Site	Date	Hour	Elevation	Speed	Direction
REE	217	4	104	-99.0	-99
REE	217	4	404	3.3	150
REE	217	4	614	1.7	152
REE	217	4	814	1.3	323
REE	217	4	1014	4.4	331
REE	217	4	1214	6.9	329

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REE	217	4	1414	8.4	328

The First 7 Records in COBEND2.DBF (Doppler Accoustic Sounder Data):

Site	Date	Hour	Elevation	Speed	Direction
BEN	217	4	81	-99.0	-99
BEN	217	4	141	4.6	309
BEN	217	4	171	8.8	293
BEN	217	4	201	9.2	294
BEN	217	4	231	9.5	291
BEN	217	4	261	9.7	286
BEN	217	4	291	10.1	281

Aircraft Data

The following are data from NAS234P.DBF divided into three tables:

Site	Date	Hour	Minute	Second	Latitude	Longitude
NAS	234	13	55	0	35.7457	119.2482
NAS	234	13	55	2	35.7448	119.2477
NAS	234	13	55	4	35.7430	119.2460
NAS	234	13	55	6	35.7422	119.2457
NAS	234	13	55	8	35.7402	119.2438

Elevation	Temp.	Rel. Humid.	Dew Point	O3	NO	NOz	NOx	Backscatter	
1453	16.7	44	4.5	92	0.2	0.2	0.4	-1.40	9
1450	16.7	44	4.5	86	0.2	0.2	0.4	-1.30	8
1445	16.7	45	4.6	93	0.1	0.3	0.4	-1.30	8
1439	16.7	45	4.6	92	0.1	0.3	0.4	-1.30	8
1436	16.8	44	4.5	89	0.1	0.4	0.5	-1.20	8

Tdon2zbb	Path Type	Nearest Surf. Site	Pass Number
00077000	S-2	DEL	2
00077000	S-2	DEL	2
00077000	S-2	DEL	2
00077000	S-2	DEL	2
00077000	S-2	DEL	2

Figure 13

Hydrocarbon / Carbonyl Database Files

1

Database Names:

HCVSCARB.DBF	Hyrdocarbon and Carbonyl concentration data for 8/3-6
HCSCARB2.DBF	Hydrocarbon and Carbonyl concentration data for 7/27-29
HCVS3.DBF	Hydrocarbon concentration data for 8/22-24
HCVS4.DBF	Hydrocarbon concentration data for 7/13-14
HCVS5.DBF	Hydrocarbon concentration data for 7/21-22

Database Structure:

Variable Name	Variable Description	Format	Units
site	three letter site id	C 3	
date	calendar date	C 8	
jdat	julian date	N 3.0	
hour	begin hour of 2 Hour sample PST	C 2	
datehr	calendar date plus hour	C 9	
hid	hydrocarbon canister id	C 10	
tihc	total identified hydrocarbons	N 7.2	ppbC
alkane	total alkanes	N 6.2	ppbC
alkene	total alkenes	N 6.2	ppbC
aromatic	total aromatics	N 6.2	ppbC
carbonyls	total carbonyls	N 7.2	ppbC
tuhc	Total unidentified hydrocarbons	N 6.2	ppbC
nmhcs	Total non-methane hydrocarbons	N 7.2	ppbC
nmoc	Total non-methane organic carbon (hydrocarbons plus carbonyls)	N 7.2	ppbC
noxave	two hour average Nox	N 5.1	ppb
nmocnox	nmoc/nox ratio	N 6.2	
carbmon	carbon monoxide	N 8.2	ppbV
methane	methane	N 8.2	ppbV
ethane	ethane	N 6.2	ppbC
ethene	ethene	N 6.2	ppbC
ethyne	ethyne	N 6.2	ppbC
propane	propane	N 6.2	ppbC
propene	propene	N 6.2	ppbC
ibutane	isobutane	N 6.2	ppbC
ibutene	isobutene	N 6.2	ppbC
x1buten	1-butene	N 6.2	ppbC
x13butad	1,3-butadiene	N 6.2	ppbC
butane	Butane	N 6.2	ppbC
t2buten	trans-2-butene	N 6.2	ppbC

Figure 13 cont'

x22dpro	2,2-dimethylpropane	N 6.2	ppbC
c2buten	cis-2-butene	N 6.2	ppbC
x3m1bute	3-methyl-1-butene	N 6.2	ppbC
ipentane	isopentane	N 6.2	ppbC
pentene1	1-pentene	N 6.2	ppbC
x2m1bute	2-methyl-1-butene	N 6.2	ppbC
pentane	pentane	N 6.2	ppbC
isoprene	isoprene	N 6.2	ppbC
t2penten	trans-2-pentene	N 6.2	ppbC
c2penten	cis-2-pentene	N 6.2	ppbC
x2m2bute	2-methyl-2-butene	N 6.2	ppbC
x22mbuta	2,2-dimethylbutane	N 6.2	ppbC
cypenten	cyclopentene	N 6.2	ppbC
x4mpnte2	4-ethyl-2-pentene	N 6.2	ppbC
cypentan	cyclopentane	N 6.2	ppbC
x23mbuta	2,3-dimethylbutane	N 6.2	ppbC
c4mpnte2	cis-4-methyl-2-pentene	N 6.2	ppbC
x2mpenta	2-methylpentane	N 6.2	ppbC
x3mpenta	3-methylpentane	N 6.2	ppbC
x2mpnte1	2-methyl-1-pentene	N 6.2	ppbC
x1hexene	1-hexene	N 6.2	ppbC
hexane	hexane	N 6.2	ppbC
t2hexene	trans-2-hexene	N 6.2	ppbC
x2m2pnte	2-methyl-2-pentene	N 6.2	ppbC
c2hexene	cis-2-hexene	N 6.2	ppbC
mcypenta	methylcyclopentane	N 6.2	ppbC
x24mpnta	2,4-dimethylpentane	N 6.2	ppbC
benzene	benzene	N 6.2	ppbC
cyhexane	cyclohexane	N 6.2	ppbC
x2mhexan	2-methylhexane N 6.2		ppbc
x23mpnta	2,3-dimethylpentane	N 6.2	ppbC
x3mhexan	3-methylhexane N 6.2		ppbC
heptane	heptane	N 6.2	ppbC
mcyhexan	methylcyclohexane	N 6.2	ppbC
x24mhexa	2,4-dimethylhexane	N 6.2	ppbC
x234mpta	2,3,4-trimethylpentane	N 6.2	ppbC
toluene	toluene	N 6.2	ppbC
x23mhexa	2,3-dimethylhexane	N 6.2	ppbC
x2mhepta	2-methylheptane	N 6.2	ppbC
x3ethexa	3-ethylhexane	N 6.2	ppbC
octane	octane	N 6.2	ppbC
etcyhexa	ethylcyclohexane	N 6.2	ppbC
etbenzen	ethybenzene	N 6.2	ppbC
mpxylene	meta+para-xyleneN 6.2		ppbC
styrene	styrene	N 6.2	ppbC
oxylene	ortho-xylene	N 6.2	ppbC
nonane	nonane	N 6.2	ppbC
apinene	alpha-pinene	N 6.2	ppbC
iprobenz	isopropylbenzene	N 6.2	ppbC
nprpbenz	n-propylbenzene	N 6.2	ppbC
petoluene	para-ethyltoluene	N 6.2	ppbC
metoluene	meta-ethyltoluene	N 6.2	ppbC
x135tmbz	1m3m5-trimethylbenzene	N 6.2	ppbC
oetoluene	oetho-ethyltoluene	N 6.2	ppbC

bpinene	beta-pinene	N 6.2	ppbC
mstyrene	methylstyrene	N 6.2	ppbC
x124tmbz	1,2,4-trimethylbenzene	N 6.2	ppbC
decane	decane	N 6.2	ppbC
x123tmbz	1,2,3-trimethylbenzene	N 6.2	ppbC
x13dbenz	1,3-dmethylbenzene	N 6.2	ppbC
x14dbenz	1,4-dimethylbenzene	N 6.2	ppbC
x2233tbu	2,2,3,3-tetramethylbutane	N 6.2	ppbC
x244t1pe	2,4,4-trimethyl-1-pentene	N 6.2	ppbC
x244t2pe	2,4,4-trimethyl-2-pentene	N 6.2	ppbC
x25mhexa	2,5-dimethylhexane	N 6.2	ppbC
x22mhept	2,2-dimethylheptane	N 6.2	ppbC
x224mhxa	2,2,4-trimethylhexane	N 6.2	ppbC
formalde	formaldehyde	N 6.2	ppbC
acetalde	acetaldehyde	N 6.2	ppbC
acetone	acetone	N 6.2	ppbC
propanal	propanal	N 6.2	ppbC
mekbut	methylethylketone and butanal	N 6.2	ppbC
penpan	pentanal and pentanone	N 6.2	ppbC
cyhex	cyclohexanone	N 6.2	ppbC
hexhex	hexanal and hexanone	N 6.2	ppbC
benzalde	benzaldehyde	N 6.2	ppbC
flag	data validity flag	C 2	
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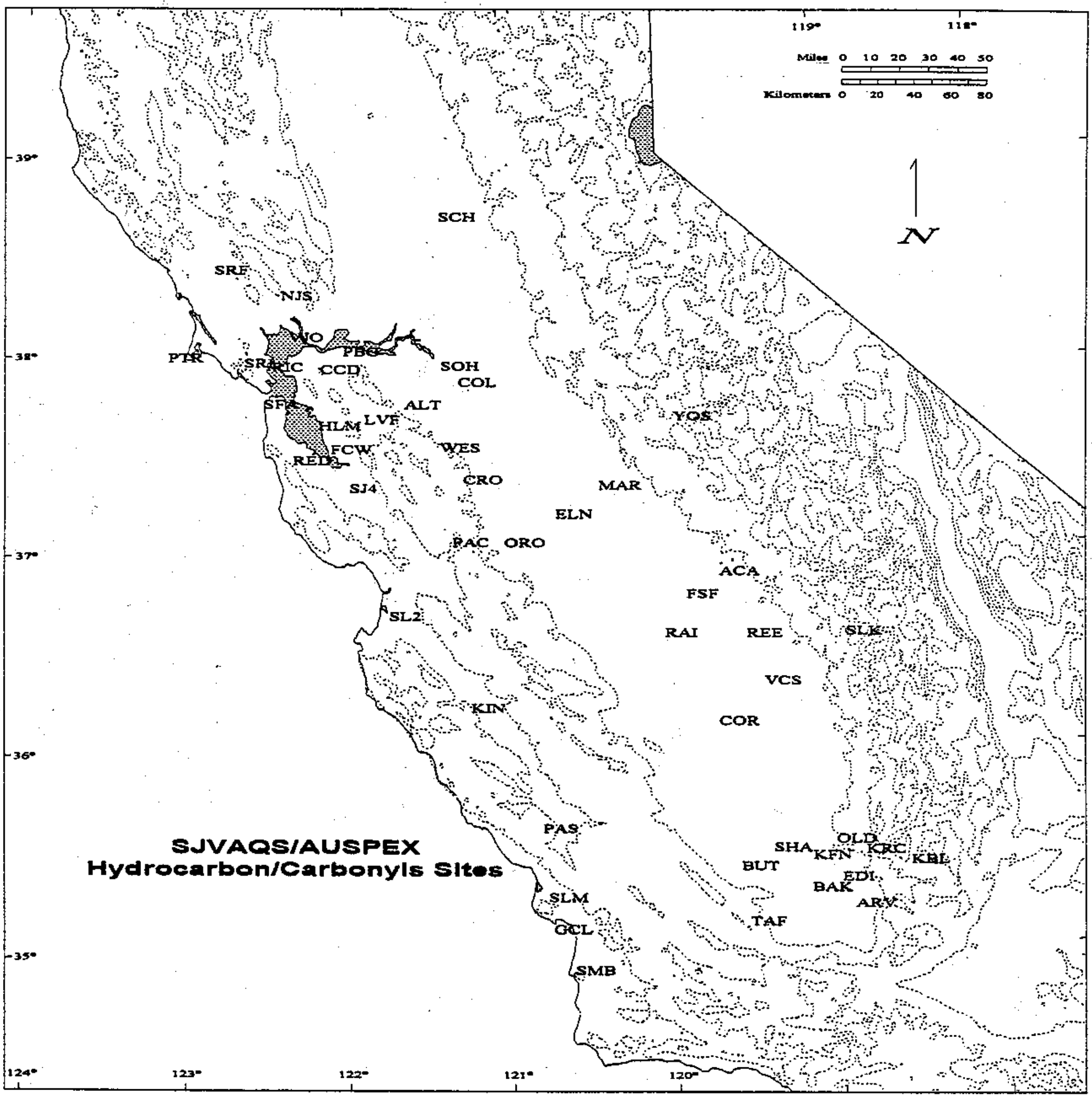
comm	comment field for hydrocarbons	C 20	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Kilometers 0 20 40 60 80
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37°
36°
35°
124°
123°
122°
121°
120°
SCH
SRF
NJS
PBG
PTR
SRA
RIC
CCD
SOH
COL
ALT
SFA
HLM
LVF
YOS
FCW
WES
RED
CRO
SJ4
MAR
ELN
PAC
ORO
ACA
FSF
SL2
RAI
REE
SLK
VCS
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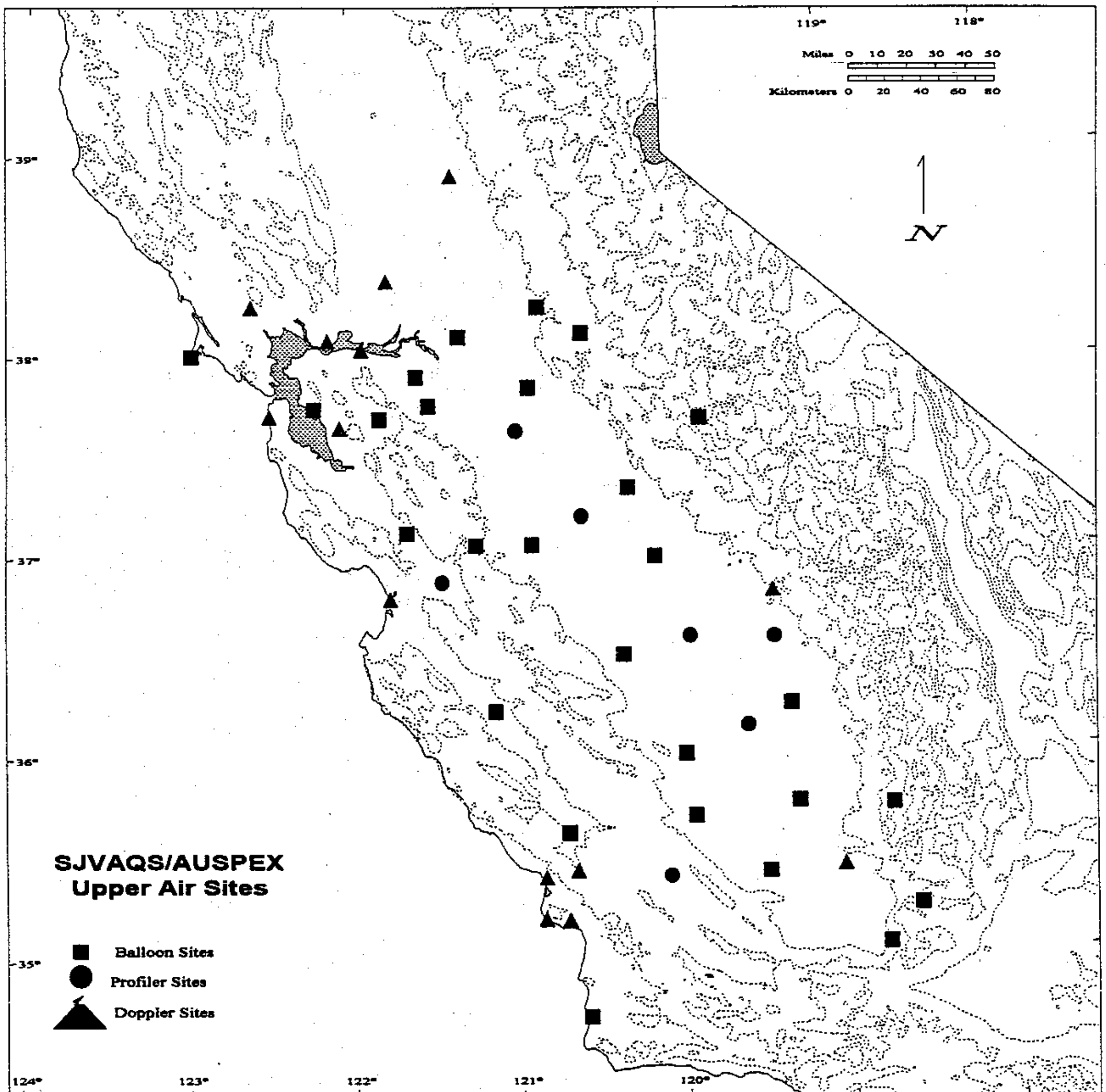
SMB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Miles 0 10 20 30 40 50
Kilometers 0 20 40 60 80
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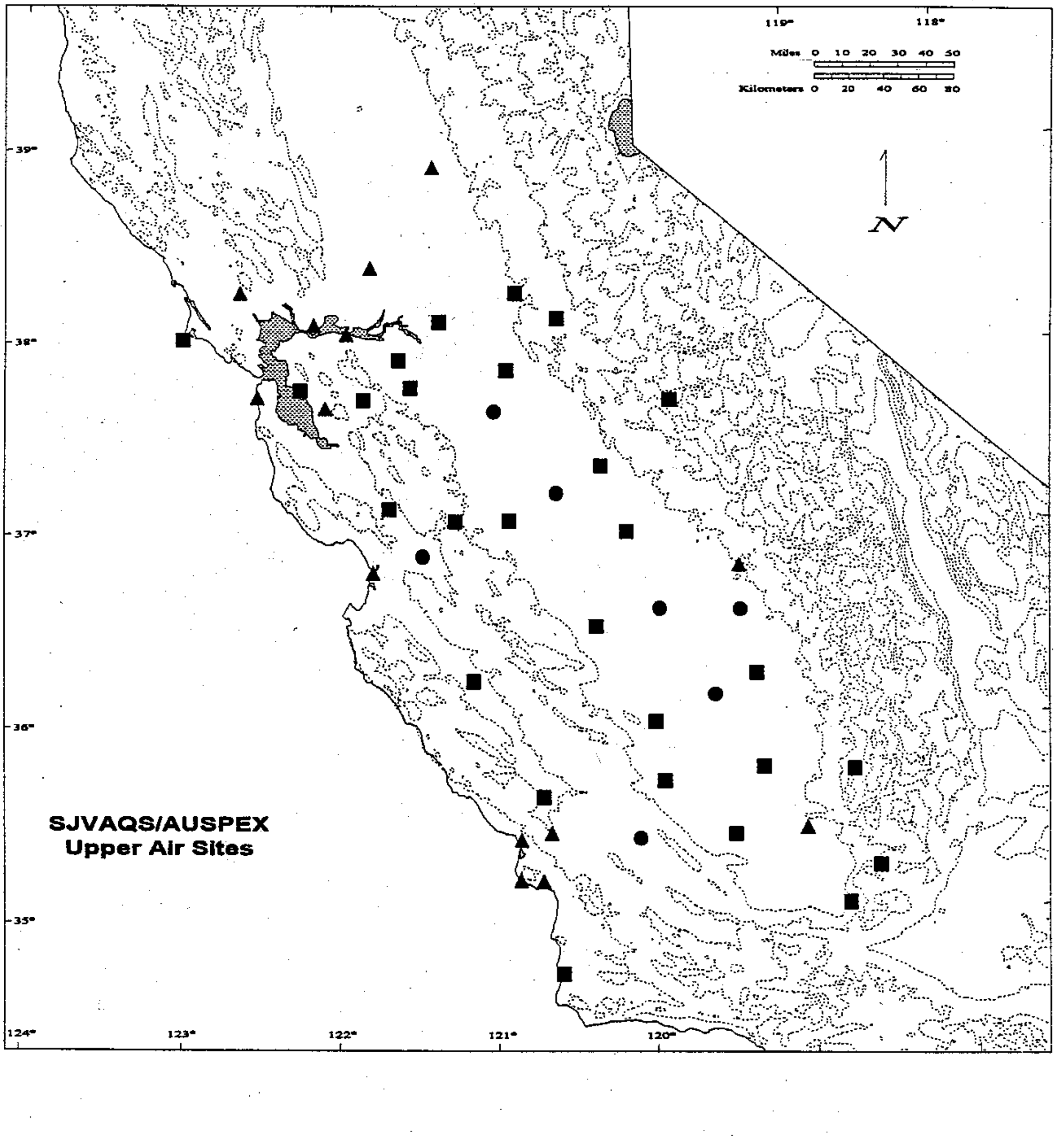
SJVAQS/AUSPEX
Upper Air Sites
Balloon Sites
Profiler Sites
Doppler Sites



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Kilometers 0 20 40 60 80
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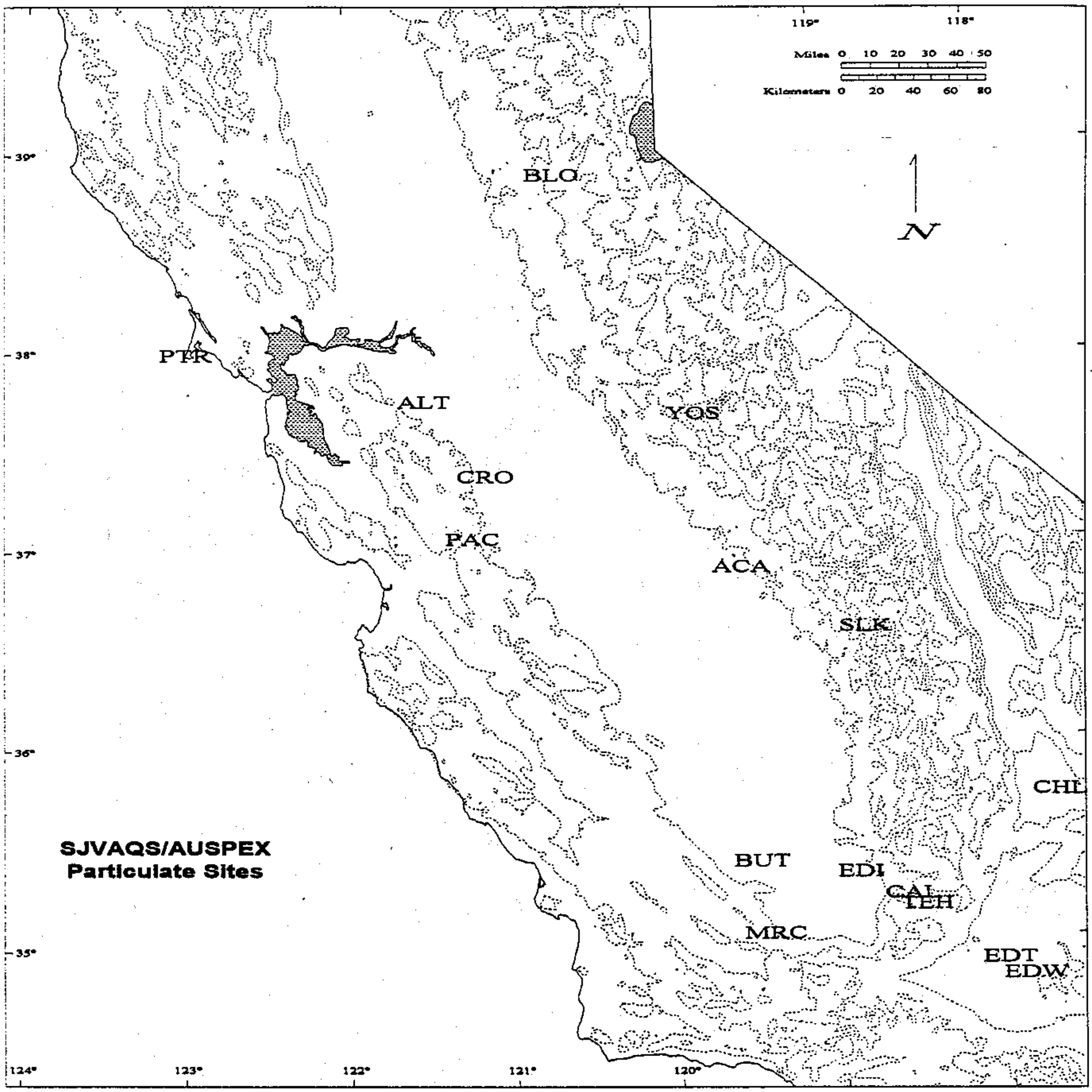
SJVAQS/AUSPEX
Upper Air Sites



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Miles 0 10 20 30 40 50
Kilometers 0 20 40 60 80
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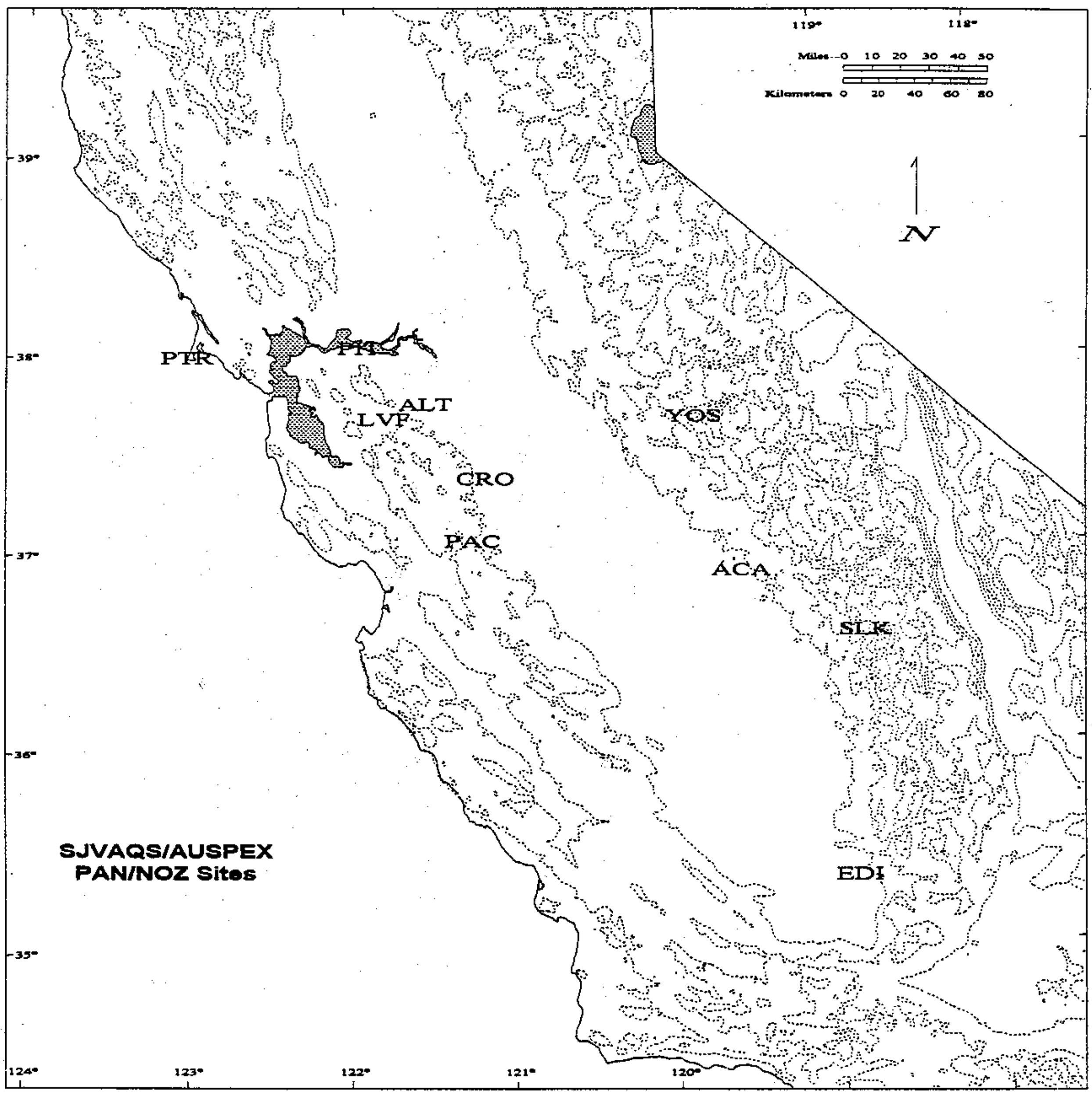
BUT
EDI
CAL
TEH
MRC
EDT
EDW
SJVAQS/AUSPEX
Particulate Sites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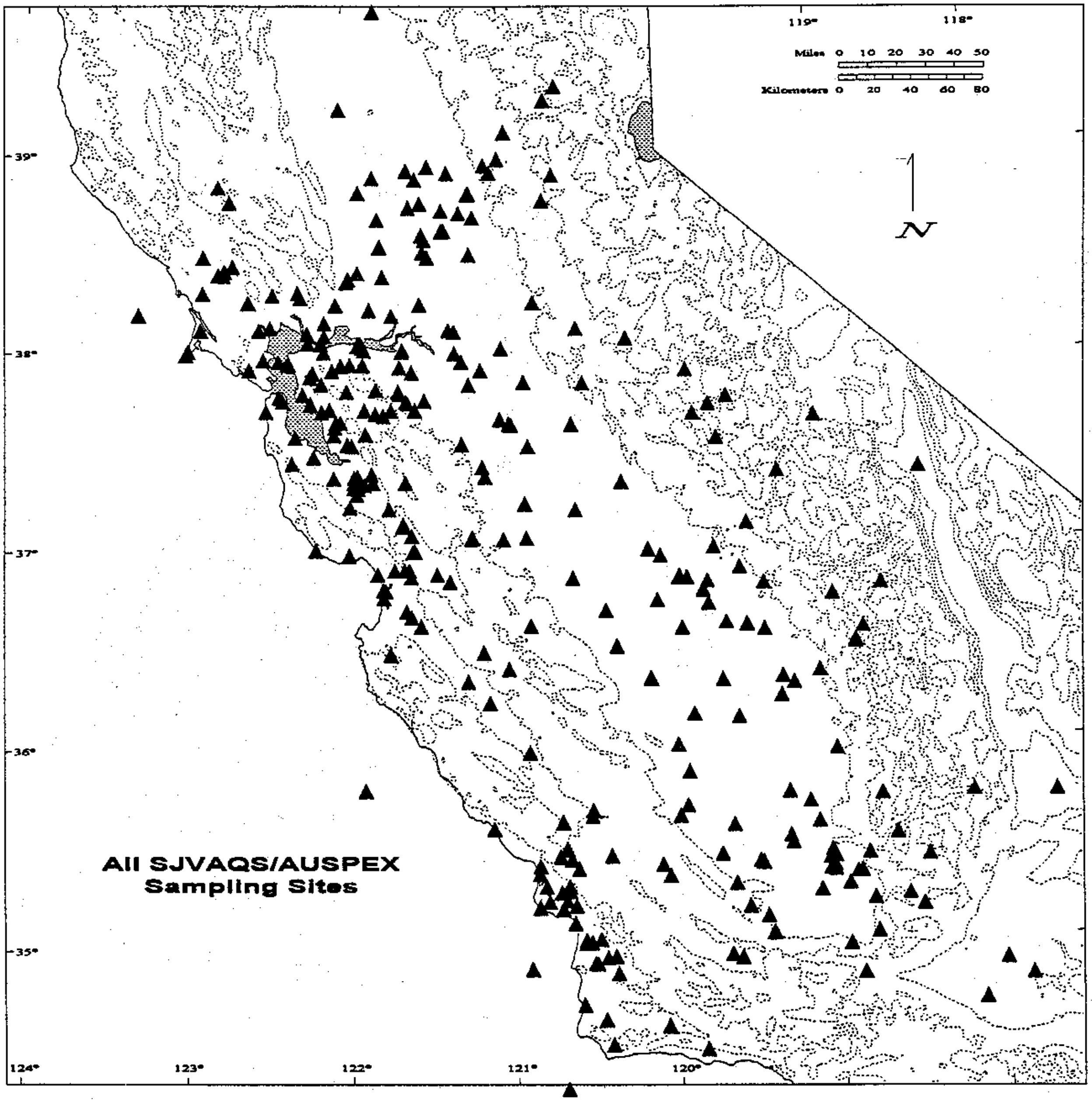
SLK
EDI
SJVAQS/AUSPEX
PAN/NOZ Sites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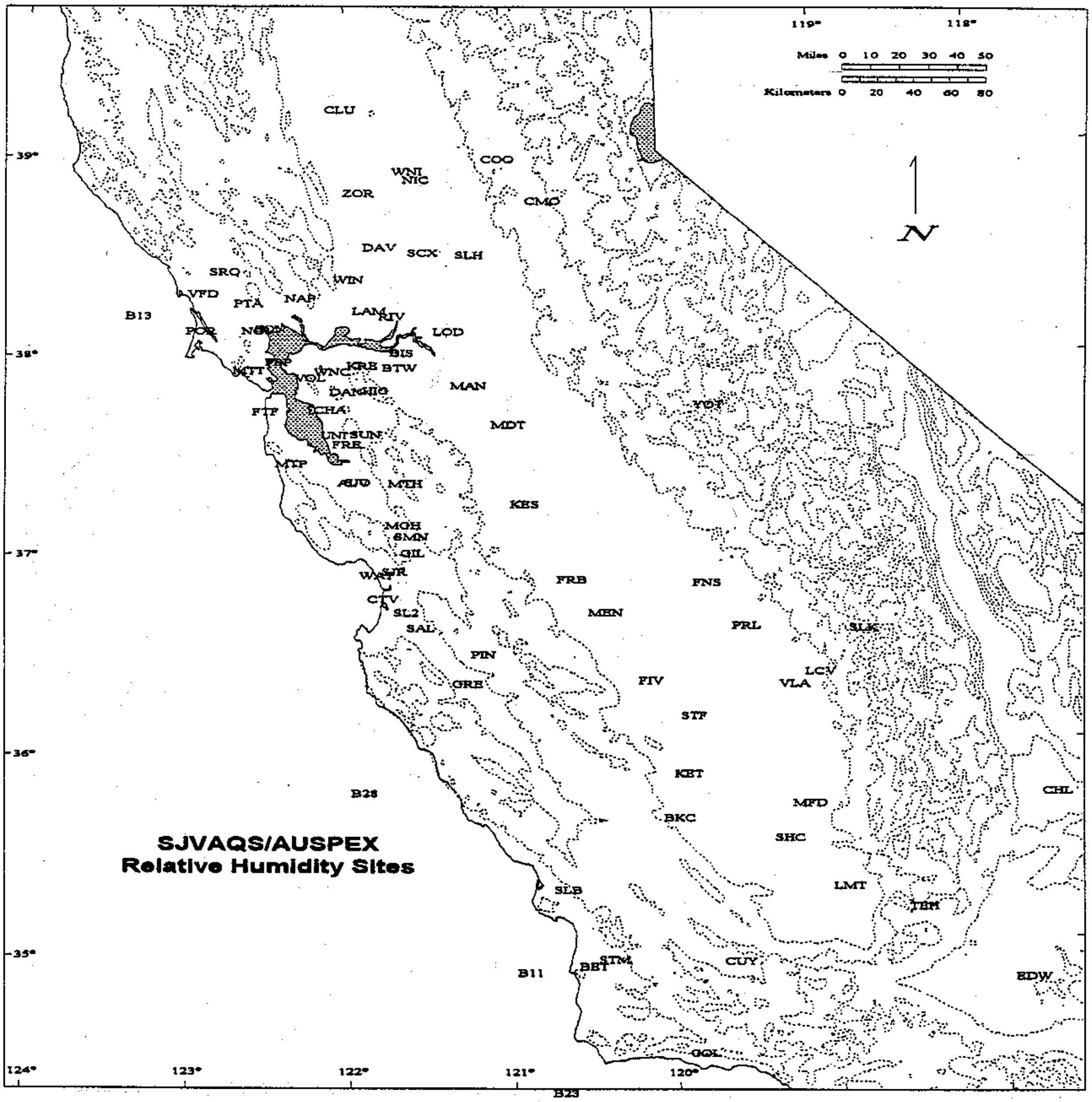
All SJVAQS/AUSPEX
Sampling Sites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DAV
SCX
SLH
SRQ
WIN
VFD
PTA
NAP
B13
LAM
RIV
LOD
POR
BIS
KRB
BTW
MAN
FTF
MDT
YOF
MTP
MTH
KES
MGH
SMN
GIL
FRB
FNS
CTV
SL2
SAL
MEN
PRL
SLK
PIN
LCV
GRE
FIV
VLA
STF
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CUY
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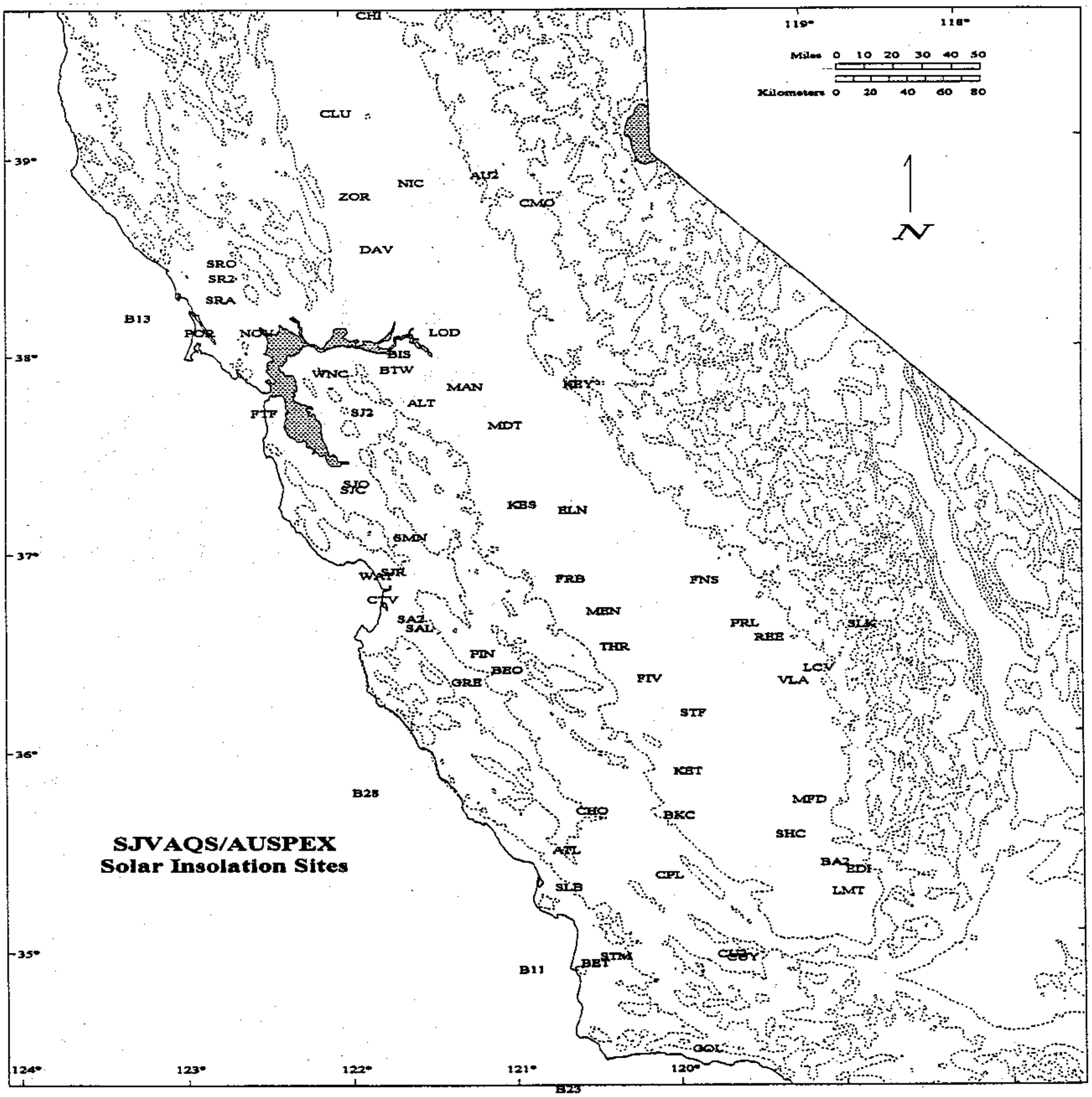
EDW
GOL
B23


SJVAQS/AUSPEX
Solar Insolation Sites
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Kilometers 0 20 40 60 80
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124°
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122°
121°
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119°
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ZOR
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DAV
SRO
SR2
SRA
B13
POR
LOD
BIS
WNC
BTW
MAN
KRY
SJ2
ALT
FTF
MDT
SJC
KBS
BLN
SMN
SJR
FRB
FNS
CTV
MEN
SA2
SAL
PRL
SLK
REE
THR
PIN
BEO
LCV
GRE
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VLA
STF
KST
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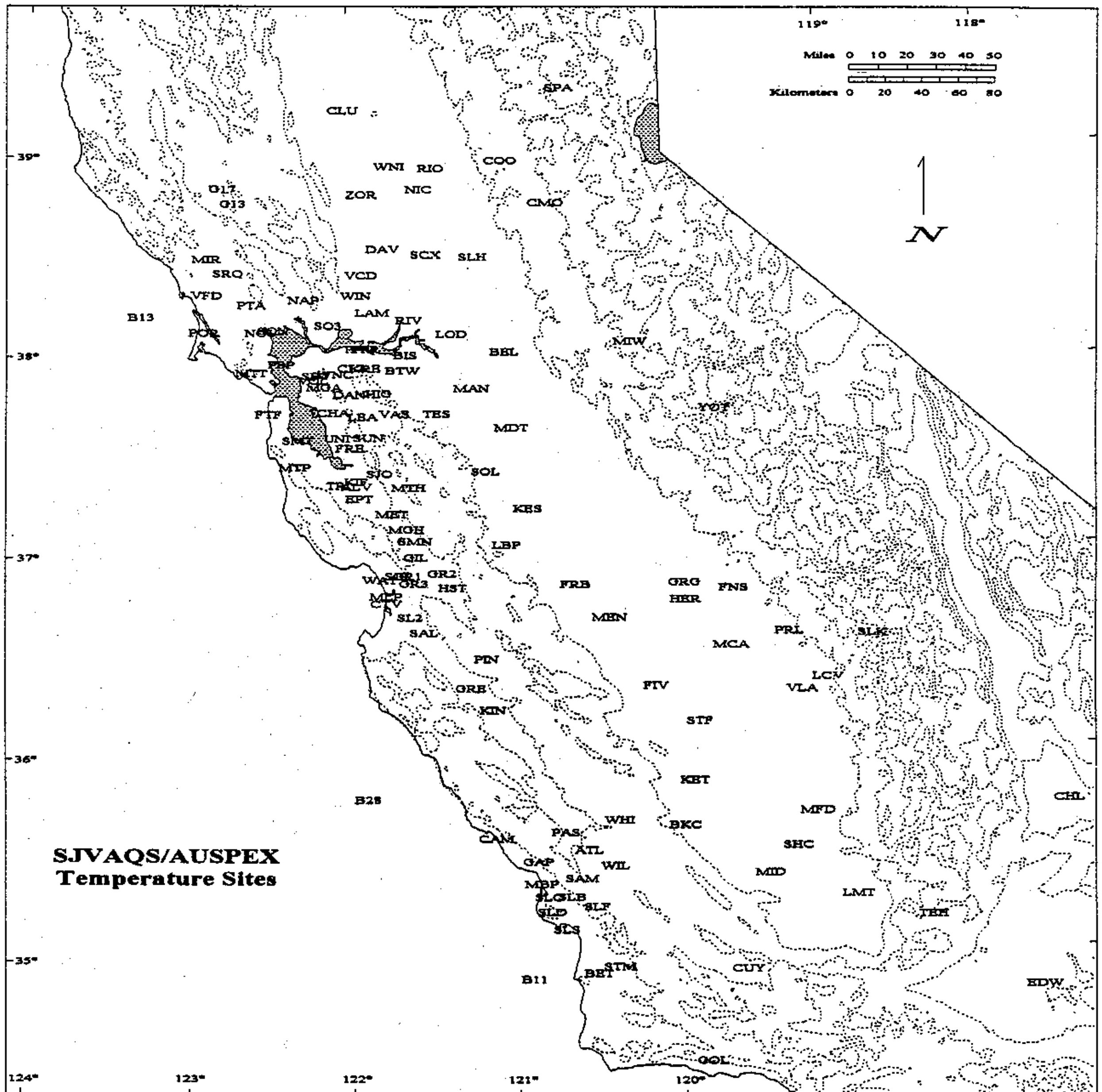
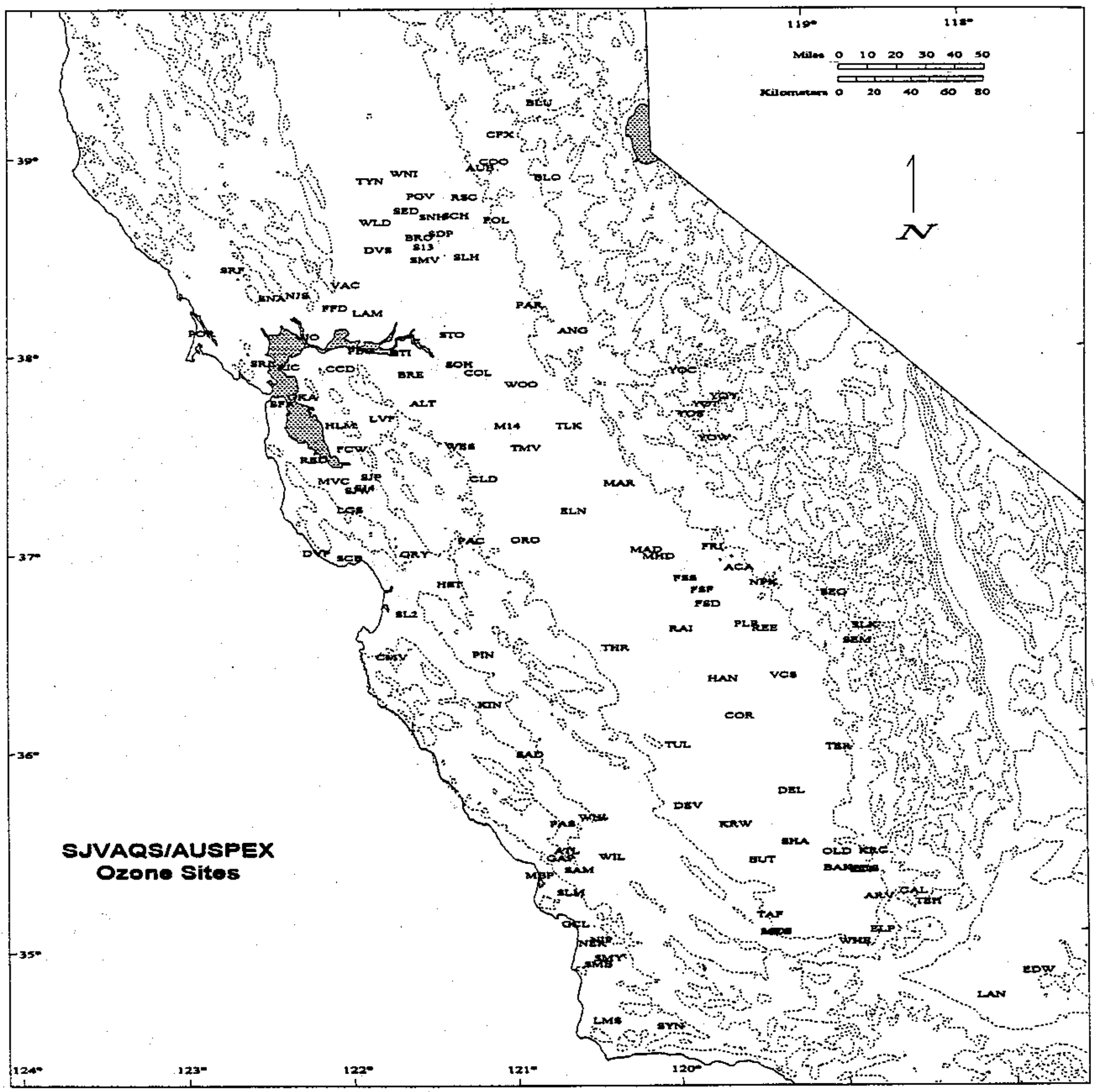
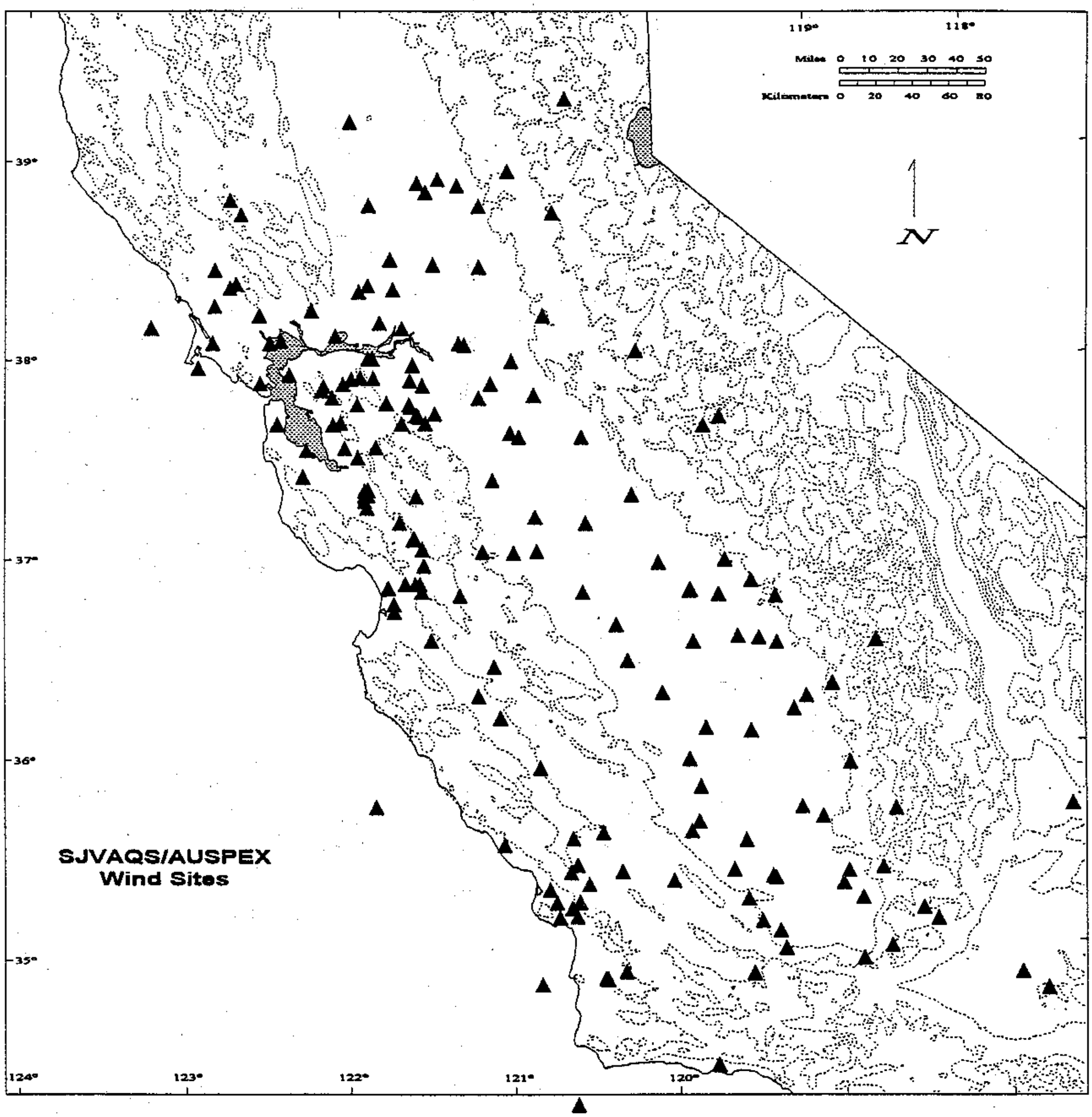


SJVAQS/AUSPEX
Temperature Sites



SJVAQS/AUSPEX
Ozone Sites



119°
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Miles 0 10 20 30 40 50
Kilometers 0 20 40 60 80
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36°
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124°
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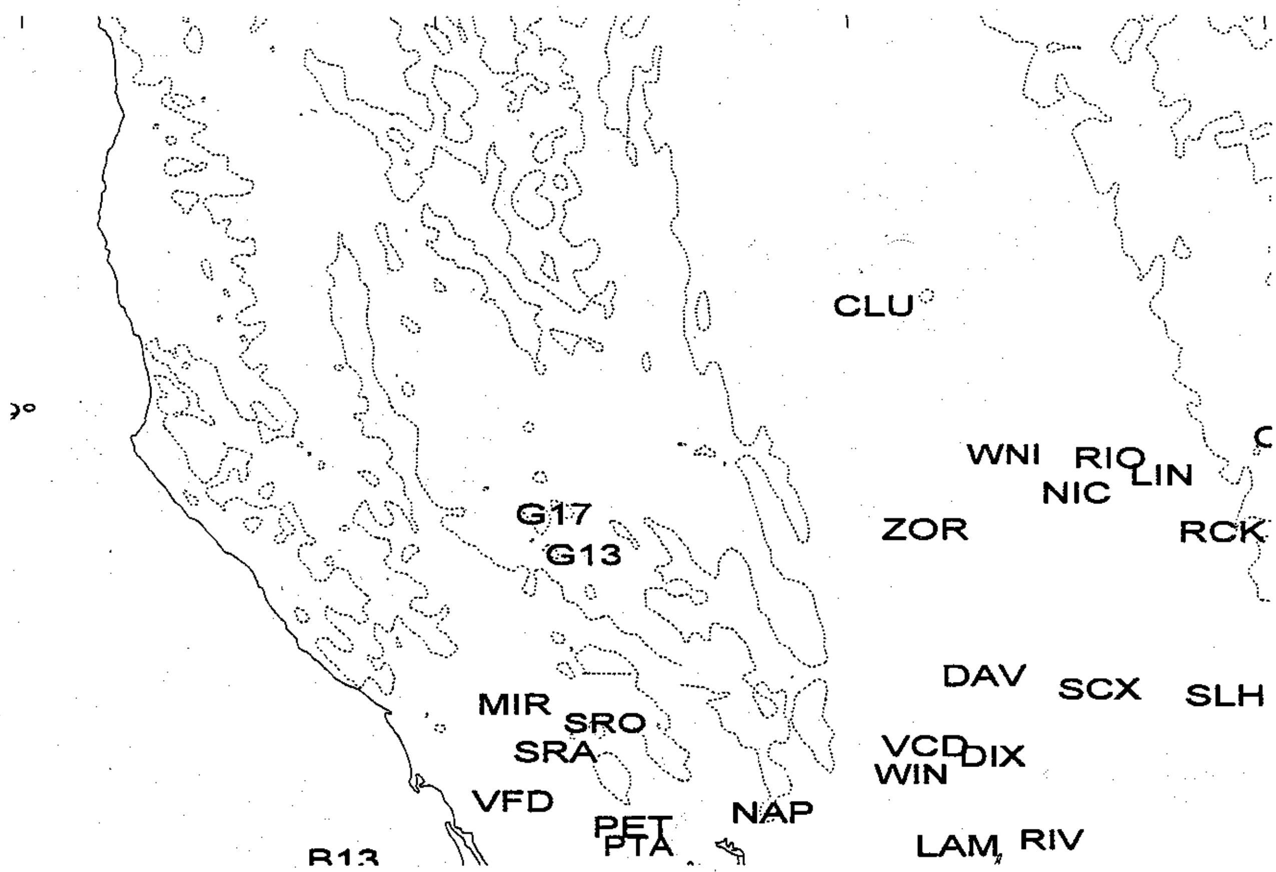
SJVAQS/AUSPEX
Wind Sites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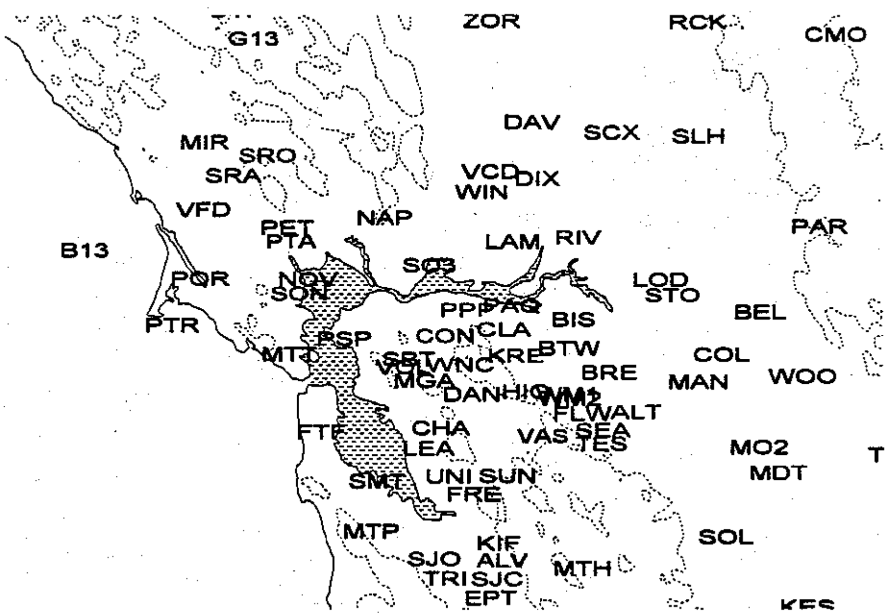
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PTA
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B13
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POR
NOV
SON
BEL
PTR
BIS
CON
CLA
MTT
PSP
BTW
COL
SBT
KRE
BRE
MAN
WOO
MGA
ALT
CHA
SEA
VAS
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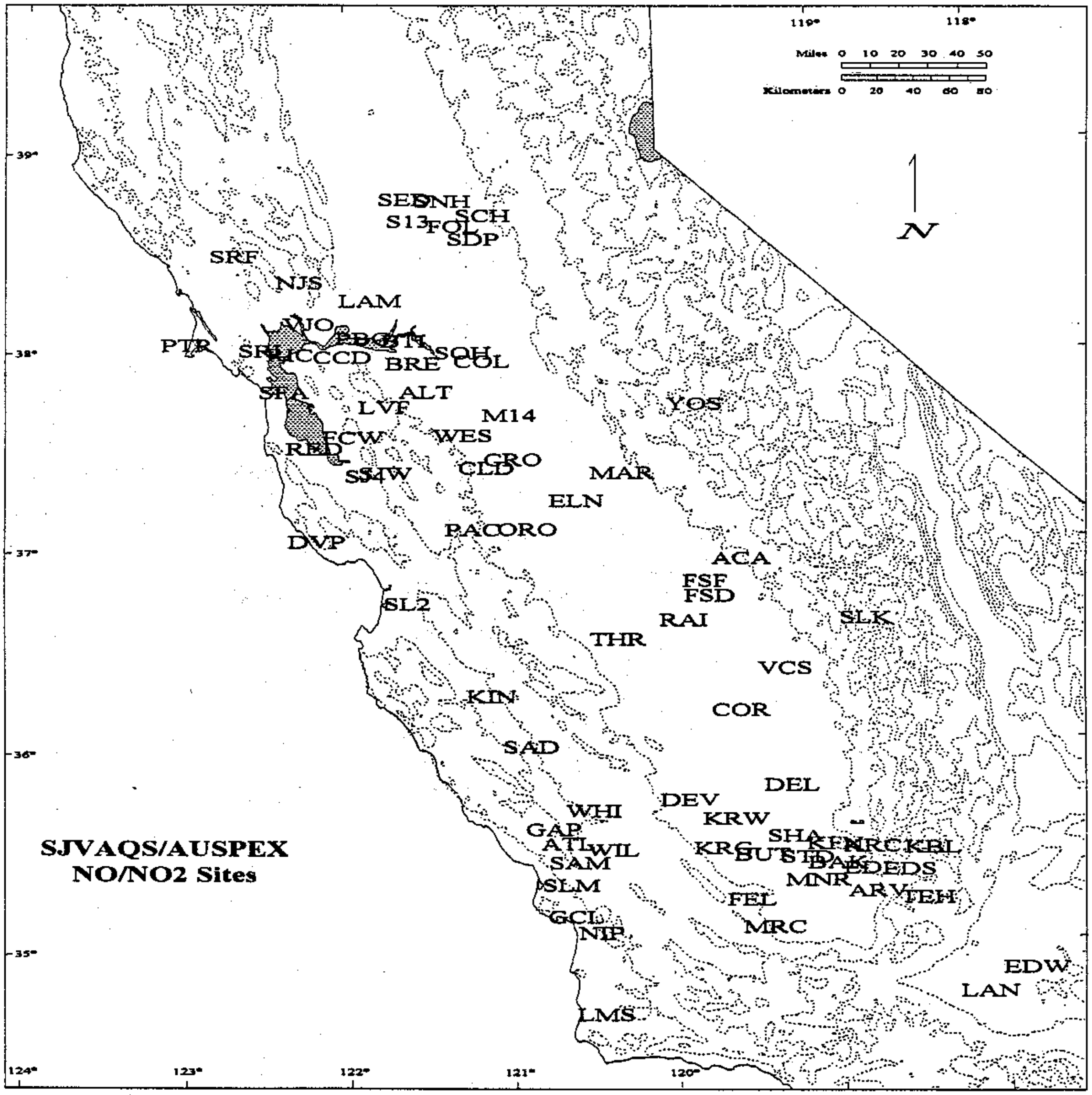

SJVAQS/AUSPEX NO/NO2 Sites