State of California
AIR RESOURCES BOARD

Proposed Identification of Districts Affected by Transported Air Pollutants which Contribute to Violations of the State Ambient Air Quality Standard for Ozone

October 1989*

Staff Report

Prepared by

Meteorology Section
Modeling and Meteorology Branch
Technical Support Division

*Third Printing (with handout)

HANDOUT - TRANSPORT I.D. REPORT

This handout is to accompany the staff report "Proposed Identification of Districts Affected by Transported Air Pollutants which Contribute to Violations of the State Ambient Air Quality Standard for Ozone" prepared by the Meteorology Section, ARB Technical Support Division, in October 1989 for an ARB Board hearing held in Los Angeles on December 14, 1989.

At this public hearing the Board approved some modifications to the proposed regulation, Section 70500 of Title 17, California Code of Regulations. The first attachment, dated February 15, 1990, reflects these modifications and includes a revised "Transport Identification Table" (labelled as Table 1 in the original staff report).

Although not part of the regulation, the Board also made some changes to the staff report's Table 2, "Potential Transport Areas Requiring Further Research". A copy of the revised Table 2, also dated February 15, 1990, has been included as the second attachment to this handout.

(B13720/A.L/17May90)

State of California
AIR RESOURCES BOARD

Public Availability of Modified Text

PUBLIC HEARING TO CONSIDER THE ADOPTION OF A REGULATION WHICH IDENTIFIES THE AREAS IN WHICH TRANSPORTED AIR POLLUTANTS CONTRIBUTE TO VIOLATIONS OF THE STATE AMBIENT AIR QUALITY STANDARD FOR OZONE AND THE AREAS OF ORIGIN OF THE POLLUTANTS

Public Hearing Date: December 14, 1989
Public Availability Date: February 15, 1990

On December 14, 1989, the Air Resources Board (the "Board") conducted a public hearing to consider the adoption of a regulation identifying the areas in which transported air pollutants contribute to violations of the state ambient air quality standard for ozone and the areas of origin of the pollutants, Title 17, California Code of Regulations, Section 70500.

The Board approved the regulation as set forth in the originally proposed text with a few clarifying modifications proposed by staff at the meeting and the addition to the Transport Identification Table of the San Francisco Bay Area as an area impacted by the transport of air pollutants from the Broader Sacramento Area. The attached text of the regulation indicate these modifications.

In Resolution 89-100, the Board directed the Executive Officer to consider information and data submitted by the Bay Area Air Quality Management District and determine whether there was sufficient evidence to include in the Transport Identification Table the San Francisco Bay Area as an area impacted by the transport of air pollutants from the North Central Coast Air Basin. Based on a review of the information, the Executive Officer has determined that there is insufficient evidence to support this identification at this time and therefore does not propose to add it to the regulation.

In accordance with Section 11346.8(c) of the Government Code, and pursuant to the direction of the Board as set forth in Resolution 89-100, the Executive Officer will adopt the amendments to the regulations after making them available to the public for comment for a period of at least 15 days, provided that the Executive Officer shall consider written comments concerning the changes and make minor modifications to the language as appropriate in response to comments, and shall present the regulation for further consideration if he determines that this is warranted in light of the written comments received.

Comments must be submitted to the Board Secretary, Air Resources Board, P.O. Box 2815, Sacramento CA 95812, no later than March 2, 1990, for consideration by the Executive Officer.

Attachment

State of California
AIR RESOURCES BOARD

Resolution 89-100

December 14, 1989

Agenda Item No.: 89-20-3

WHEREAS, Sections 39600 and 39601 of the Health and Safety Code authorize the Air Resources Board (the "Board") to adopt standards, rules and regulations and to do such acts as may be necessary for the proper execution of the powers and duties granted to and imposed upon the Board by law;

WHEREAS, the Legislature enacted the California Clean Air Act of 1988 (the "Act," Stats. 1988, ch. 1568) declaring that it is necessary that the state ambient air quality standards be attained by the earliest practicable date to protect the public health, particularly the health of children, older people, and those with respiratory diseases;

WHEREAS, in order to attain these standards, the Act mandates a comprehensive program of emission reduction measures and planning requirements for the state and local air pollution control districts ("districts") in areas where the standards are not attained;

WHEREAS, as directed by the Act, the Board has established criteria for designating an air basin attainment or nonattainment for each state ambient air quality standard and has designated each air basin which is in attainment and each air basin which is in nonattainment for each standard;

WHEREAS, the Act in Health and Safety Code Section 39610(a) directs the Board to identify, not later than December 31, 1989, each district in which transported air pollutants from upwind areas outside the district cause or contribute to a violation of the ozone standard and to identify the district of origin of transported pollutants, based upon the preponderance of the evidence;

WHEREAS, the Board is also directed in Health and Safety Code Section 39610(a) to identify and determine the priorities of information and studies needed to make a more accurate determination, including but not limited to emission inventories, pollutant characterization, ambient air monitoring and air quality models;

WHEREAS, the Board is to make every reasonable effort to supply air pollution transport information to heavily impacted districts prior to the development of plans to attain the state ambient air quality standards;

WHEREAS, the Act requires that any district which is a receptor or contributor of transported air pollutants, as determined by the Board, shall prepare and submit its plan for attaining and maintaining the ozone standard not later than June 30, 1991 (Health and Safety Code Section 40911(b);

WHEREAS, Health and Safety Code Section 40912 mandates that the attainment plans for districts responsible for or affected by air pollutant transport shall provide for attainment and maintenance of the state and federal standards in both the upwind and downwind districts;

WHEREAS, staff has proposed a regulation which identifies the areas in which transported air pollutants from upwind areas cause or contribute to a violation of the state ambient air quality standard for ozone and which identifies the district of origin of the transported pollutants, based upon the preponderance of available evidence;

WHEREAS, staff has also included a table in the Staff Report which sets forth the proposed priorities for information and studies which are necessary for making more accurate transport determinations;

WHEREAS, the California Environmental Quality Act and Board regulations require that no project which may have significant adverse environmental impacts be adopted as originally proposed if feasible alternatives or mitigation measures are available to reduce or eliminate such impacts;

WHEREAS, a public hearing and other administrative proceedings have been held in accordance with the provisions of Chapter 3.5 (commencing with Section 11340), Part 1, Division 3, Title 2 of the Government Code;

WHEREAS, the Board finds that:

The regulation as proposed by the staff and as amended by the Board fulfills the requirements of Health and Safety Code Section 39610(a);

The proposed identification of transport couples is based on the preponderance of evidence which is currently available;

Further study of other potential transport corridors is necessary;

The proposed priorities for information and studies necessary to make more accurate transport determinations are appropriate; and

The identification of transport couples will have no adverse environmental impacts.

NOW, THEREFORE, BE IT RESOLVED that the Board hereby approves Section 70500, Title 17, California Code of Regulations, as amended by the Board and as set forth in Attachment A hereto.

BE IT FURTHER RESOLVED that the Board directs the Executive Officer to evaluate the data provided by the Bay Area Air Quality Management District and determine whether the North Central Coast Air Basin should be identified in the regulation as impacting the San Francisco Bay Area Air Basin and, if so, to make appropriate modifications to the regulation.

BE IT FURTHER RESOLVED that the Board further directs the Executive Officer to adopt Section 70500, Title 17, California Code of Regulations, as amended, after making it available to the public for a period of 15 days, provided that the Executive Officer shall consider such written comments as may be submitted during this period, shall make modifications as may be appropriate in light of the comments received, and shall present the regulation to the Board for further consideration if he determines that this is warranted.

BE IT FURTHER RESOLVED that the Board approves the priorities for additional information and studies as set forth in the table in the Staff Report and as modified at the Board meeting and directs the Executive Officer to make all reasonable efforts to supply air pollutant transport information to the impacted districts as it becomes available.

I hereby certify that the above is a true and correct copy of Resolution 89-100, as adopted by the Air Resources Board.

Cary Allison, Board Secretary

Amend Subchapter 1.5. Air Basins and Air Quality Standards, Title 17, California Code of Regulations, by adding Article 5. Transported Air Pollutants Identification, Section 70500, as follows:

Article 5. Transported Air Pollutants

70500. Transport Identification

(a) Purpose.

This regulation identifies the areas in which transported air pollutants from upwind areas cause or contribute to a violation of the state ambient air quality standard for ozone and the areas of origin of the transported pollutants. All areas identified in the table are air basins except as otherwise specifically described and defined.

(b) Definitions.

(1) "California Coastal Waters" includes the area between the California coastline and a line starting at the California-Oregon border at the Pacific Ocean; thence to 42.0 degrees North, 125.5 degrees West; thence to 41.0 degrees North, 125.5 degrees West; thence to 40.0 degrees North, 125.5 degrees West; thence to 39.0 degrees North, 125.0 degrees West; thence to 38.0 degrees North, 124.5 degrees West; thence to 37.0 degrees North, 123.5 degrees West; thence to 36.0 degrees North, 122.5 degrees West; thence to 35.0 degrees North, 121.5 degrees West; thence to 34.0 degrees North, 120.5 degrees West; thence to 33.0 degrees North, 119.5 degrees West; thence to 32.5 degrees North, 118.5 degrees West; and ending at the California-Mexican border at the Pacific Ocean.

(2) "Upper Sacramento Valley" includes the Colusa, Butte, Glenn, Tehama, and Shasta County Air Pollution Control Districts.

(3) "Broader Sacramento Area" includes Nevada County; the Sacramento, Yolo-Solano, Sutter, and Yuba, County Air Pollution Control Districts; and the Nevada, El Dorado and Placer County Air Pollution Control Districts (excluding the portions which are located within the Lake Tahoe Air Basin).

(c) Transport Identification Table

OZONE AREAS IMPACTED BY TRANSPORT:	AREAS OF ORIGIN OF TRANSPORT:
1. North Central Coast	San Francisco Bay Area
2. South Central Coast	South Coast
	California Coastal Waters
3. South Coast	South Central Coast
4. San Diego	South Coast
5. Upper Sacramento Valley	Broader Sacramento Area
6. Broader Sacramento Area	San Francisco Bay Area
	San Joaquin Valley
7. San Joaquin Valley	San Francisco Bay Area
	Broader Sacramento Area
8. Great Basin Valleys	Undetermined
9. Southeast Desert	South Coast
	San Joaquin Valley
10. San Francisco Bay Area	Broader Sacramento Area

Authority cited: 39600, 39601, and 39610(a) of the Health and Safety Code.
Reference: 39610(a) of the Health and Safety Code.

TABLE 2
(Revised February 15, 1990)
POTENTIAL TRANSPORT AREAS REQUIRING FURTHER RESEARCH

A. General Areas for Transport Research

1. Assess the applicability of photochemical regional transport models to California.

B. Specific Areas for Transport Research

Ozone Nonattainment Areas Possibly Impacted by Transport:	Transport Possibly Originates from the Following Areas:
1. "Upper Sacramento" Valley*	San Francisco Bay Area A.B.
2. "Broader Sacramento" Area**	Upper Sacramento Valley
3. South Coast A.B.	Outer Continental Shelf Southeast Desert A.B.
4. San Diego A.B.	Mexico Outer Continental Shelf
5. San Francisco Bay Area A.B.	San Joaquin Valley A.B. North Central Coast A.B. Outer Continental Shelf
6. Mountain Counties A.B.	San Francisco Bay Area Upper Sacramento Valley A.B.
7. Southeast Desert A.B.	San Diego A.B. Mexico
8. Great Basin Valleys A.B.	South Coast A.B. San Joaquin Valley A.B. Mountain Counties A.B.
9. San Joaquin Valley A.B.	North Central Coast A.B. South Central Coast A.B. South Coast A.B.
10. North Central Coast A.B.	Outer Continental Shelf
11. South Central Coast A.B.	North Central Coast A.B. San Joaquin Valley A.B.
12. Tahoe A.B.***	Undetermined

* The "Upper Sacramento Valley" includes the Colusa, Butte, Glenn, Tehama and Shasta County Air Pollution Control Districts.
**"Broader Sacramento Area" includes Nevada County; the Sacramento, Yolo-Solano, Sutter, and Yuba County Air Pollution Control Districts; and the El Dorado and Placer County Air Pollution Control Districts (excluding the portions which are located within the Lake Tahoe Air Basin).
***The Tahoe A.B. is listed but is not yet classified as nonattainment.

State of California
AIR RESOURCES BOARD

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October 1989

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ACKNOWLEDGMENTS

This report was developed with the assistance of the entire Meteorology staff as well as the staff from other branches of the Air Resources Board. Joseph P. Hennessey, Jr. was the principal author of Chapters III and V. Appendix B was adapted from an unpublished manuscript by J. R. R. Kinney.

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TABLE OF CONTENTS*

*The page numbers in the table of contents and text have been corrected in this reprinting.

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The California Clean Air Act of 1988 (the "Act"), authored by Assemblyman Byron Sher, significantly revised Division 26 of the Health and Safety Code by adding requirements concerning plans and control measures to attain and maintain the state ambient air quality standards. Specifically, Section 39610(a) of the Health and Safety Code requires the Air Resources Board (the "Board" or "ARB") to identify each air pollution control district in which transported air pollutants from upwind areas outside the district cause or contribute to a violation of the state ambient air quality standard for ozone in a downwind district. These identifications are to be based upon the preponderance of available evidence. Section 39610(a) also requires that the Board identify and determine the priorities of information and studies needed to assess transport more accurately.

The transport of air pollutants from one district to another occurs when there are winds of sufficient speed, duration, and direction. Transport may occur either in the surface layer or aloft. Both ozone and ozone precursors, including hydrocarbons and nitrogen oxides, may be transported.

The staff's analyses show that transport from an upwind area can contribute to a measured violation of a standard in a downwind area under certain conditions. First, the air parcel at the time and location of the violation must be shown to have originated from the upwind area, and second the travel time must be reasonable (no more than two days).

The state standard for ozone is violated in ten of the State's 14 air basins. Based on the wind patterns within the air basins, the staff has identified transport by district, by air basin, or in some cases by multi-district subregions. In five of the State's nonattainment areas, the air pollution control district boundaries are the same as the air basin boundaries. In three of the remaining five nonattainment areas, the staff has identified interbasin transport because within these three air basins transport frequently occurs back and forth among districts in the same air basin, with districts both upwind and downwind of each other. In some cases, air parcels return to a district after passing over several other districts. Because of this sharing of air within these air basins, the staff did not attempt to identify intrabasin transport that occurred routinely. The remaining two nonattainment air basins, the Sacramento Valley and Mountain Counties Air Basins, are addressed as multi-district subregions based on the transport of ozone and ozone precursors within these areas.

The staff used two approaches to identify transport. Both rely upon currently available data. The first is a review of past transport studies. The staff reviewed all available California air pollution transport studies and reports. The results from these studies are summarized by air basin in Chapter III of this report. Where past studies show that emissions from an upwind air basin contribute to ozone standard violations in a downwind air basin, the staff recommends that the upwind and downwind air basins be identified in Title 17 as transport contributors and receptors (transport couples).

In the second approach, where past studies either have not been conducted or are not adequate to identify transport, the staff performed surface air trajectory analyses (if enough meteorological data were available to do so). This work is summarized in Chapter IV of this report. The procedures used by the staff to construct surface trajectories (both forward and backward) by both manual and computerized means are described in Appendices C and D, respectively. Some of these analyses have corroborated air pollution transport established by other studies, and some studies have identified additional air basins whose emissions contribute to violations of the ozone standard in downwind air basins. These cases are reflected in the proposed regulations.

Once the ARB has adopted the proposed regulation, the Act also requires the ARB to assess the transport couples identified in the proposed regulation or Table 1. Specifically, the ARB must assess the quantity of material transported and its relative contribution to a downwind ozone violation (Section 39610(b)) as well as establish mitigation requirements commensurate with the level of contribution. A report on the assessment of the transport couples identified in Table 1 is planned for the summer of 1990. The staff will bring this matter back before the Board in three years as required by law, or possibly sooner if new data become available that warrant earlier reconsideration.

Several air quality studies currently underway or planned for the near future will shed additional light on the transport of pollutants in some of California's air basins. Information is so scarce in some areas of the state that further research efforts will be necessary to identify other potential transport routes. Recommendations made for further research are presented in Chapter II.

CHAPTER II

RECOMMENDATIONS

A. Identification of Areas Affected by Transport and Source Regions

The staff has identified a number of transport couples shown in Table 1 below. The staff recommends that the Board adopt this Table as Section 70500 of Title 17 of the California Code of Regulations. The proposed regulation to accomplish this is set forth in Attachment A. (In Tables 1 and 2, "A.B." stands for air basin.)

TABLE 1

PROPOSED TRANSPORT IDENTIFICATIONS

AREAS IMPACTED BY TRANSPORT:	AREAS OF ORIGIN OF TRANSPORT:
1. North Central Coast A.B.	San Francisco Bay Area A.B.
2. South Central Coast A.B.	South Coast A.B. California Coastal Waters
3. South Coast A.B.	South Central Coast A.B.
4. San Diego A.B.	South Coast A.B.
5. "Upper Sacramento" Valley*	"Broader Sacramento" Area**
6. Broader Sacramento Area	San Francisco Bay Area A.B. San Joaquin Valley A.B.
7. San Joaquin Valley A.B.	San Francisco Bay Area A.B. Broader Sacramento Area
8. Great Basin Valleys A.B.	Uncertain
9. Southeast Desert A.B.	South Coast A.B. San Joaquin Valley A.B.

*The "Upper Sacramento Valley" includes the Colusa, Butte, Glenn, Tehama, and Shasta County Air Pollution Control Districts.
**The "Broader Sacramento Area" includes the Sacramento, Yolo-Solano, Sutter, Yuba, Nevada, and El Dorado County Air Pollution Control Districts.

B. Further Research Needs

Additional research is needed for two purposes. First, research is needed to identify other transport couples where existing information is insufficient. Second, research is needed to provide information and methods to quantify the amount of material transported and its impact on downwind ozone as well as to identify mitigation requirements. Table 2 presents the staff's recommendations for further research. The items are listed in what the staff believes to be the priority order for acquisition of more information.

TABLE 2

POTENTIAL TRANSPORT AREAS REQUIRING FURTHER RESEARCH

A. General Areas for Transport Research

1. Assess the applicability of photochemical regional transport models to California

B. Specific Areas for Transport Research

Ozone Nonattainment Areas Possibly Impacted by Transport:	Transport Possibly Originates from the Following Areas:
1. "Upper Sacramento" Valley*	San Francisco Bay Area A.B.
2. "Broader Sacramento" Area*	Upper Sacramento Valley
3. South Coast A.B.	Outer Continental Shelf Southeast Desert A.B.
4. San Diego A.B.	Mexico Outer Continental Shelf
5. San Francisco Bay Area A.B.	Broader Sacramento Area Outer Continental Shelf
6. Mountain Counties A.B.	San Francisco Bay Area Upper Sacramento Valley A.B.
7. Southeast Desert A.B.	San Diego A.B. Mexico
8. Great Basin Valleys A.B.	South Coast A.B. San Joaquin Valley A.B. Mountain Counties A.B.
9. San Joaquin Valley A.B.	North Central Coast A.B.
10. North Central Coast A.B.	Outer Continental Shelf

*The "Upper Sacramento Valley" includes the Colusa, Butte, Glenn, Tehama and Shasta County Air Pollution Control Districts.
**The "Broader Sacramento Area" includes the Sacramento, Yolo-Solano, Sutter, Yuba, Nevada, and El Dorado County Air Pollution Control Districts.

A significant amount of additional data is necessary to identify transport couples as well as to assess the contribution of transport to air pollution. However, given the limited funding available for research, the staff expects to focus on the initial assessment of only a few areas with extensive data. The information necessary to establish which of these potential transport couples exist and to provide information for transport assessment includes: (1) wind direction and speed data, both surface and aloft, (2) vertical temperature profiles, (3) tracer studies, and (4) field measurements of the concentrations of ozone and ozone precursors in the corridors between the basins in each couple. In some cases, air quality simulation modeling will be used to further define and quantify transport.

The Legislature has appropriated $600,000 for the Board to conduct research into transport.

CHAPTER III

TRANSPORT IMPACTED DISTRICTS PREVIOUSLY IDENTIFIED

A. Background

One of the reasons for the difficulties in understanding air pollution transport in California is the significant variability of the geography and meteorology throughout the State. These characteristics vary from the cool, rainy areas of the northwest coast to the arid regions of the Mojave and Colorado Deserts in the Southwest, and from the mountainous terrain of the Sierra Nevada to the flatlands of the Sacramento and San Joaquin Valleys. Because of this great variability, the State has been subdivided into airsheds, or air basins, each of which comprises areas of similar meteorological and geographic conditions (Figure 1).

The studies of the statewide air pollution potential began with Bell's 1958 summary of the surface wind directions and speeds, temperature variations, regional circulation patterns, upper air stability, and temperature inversion heights. Much has been accomplished since then (Holtzworth, 1972; ARB, 1974). The more complicated issue of transport among the various air basins was first discussed in an ARB report (Kinney, 1977).

Probably the first thorough, statewide study of the wind in California was Goodridge and Bingham (1978). Since that time, considerable work has been done. In 1979, the ARB published its *Summary of California Upper Air Meteorological Data* (Lorenzen, 1979). The report describes both temperature inversions and winds aloft; work is currently underway to update this report. In 1984, the ARB published *California Surface Wind Climatology* (Hayes *et al.*, 1984); one of its more important results, the seasonal predominant surface wind flow charts, has been included in this report as Appendix A. Appendix B shows the predominant 3,000 feet above ground level (AGL) seasonal wind flow charts that will be published in the revised edition of Lorenzen (1979).

A number of large scale studies provide much useful information. All climatological and transport studies available in the early 1980s were summarized in Smith *et al.* (1984). This report attempted to describe the air pollution potential throughout the State from a meteorological viewpoint, and it largely succeeded. More detailed, case-by-case discussions of well documented transport corridors follow. For the much-studied regions like the Los Angeles Basin there is almost too much material to summarize. In other areas, very little information is available.

The following sections of this chapter begin with a discussion of the basins and districts at the southern end of the State, and then the discussions work northward.

B. South Coast Air Basin to San Diego Air Basin

The airflow patterns along the coast of Southern California can generally be characterized by the seven types of airflow patterns discussed

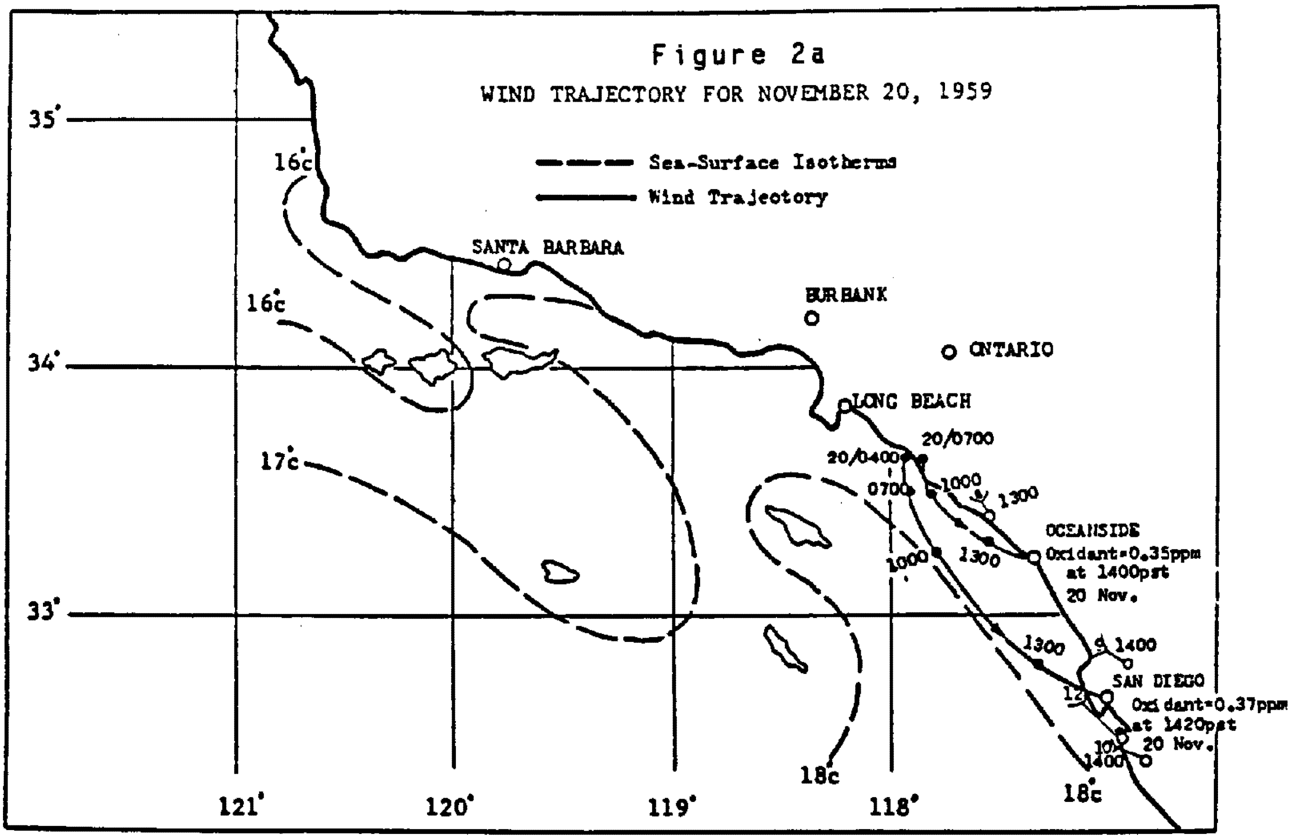
Figure 1:

CALIFORNIA AIR BASINS

in Hayes *et al.* (1984). The percentage occurrence of these airflow patterns as they vary by six-hourly intervals and by season of the year are also included in that report. Since the predominant wind flow is westerly, transport from the South Coast Air Basin to San Diego County does not usually take place. However, with weak offshore flows contaminated air masses in the Los Angeles Basin move to the coastal zone or a little ways offshore. This event occurs 23 percent of the time in winter, 17 percent of the time in spring, 14 percent of the time in summer, 21 percent of the time in fall, and 18 percent of the time on a yearly basis. Whenever this happens, pollutants can be transported to San Diego County *if* northwesterly winds subsequently develop.

Not every instance of transport from the South Coast Air Basin to San Diego County causes a significant air quality impact. Low inversions along the coast are also necessary to concentrate the ozone and its precursors in the shallow, stable marine layer below the inversion. Studies of this transport phenomenon seem to have begun in 1959 when Bell (1960) investigated the meteorological conditions associated with oxidant episodes in coastal San Diego County during October and November of 1959. Two examples of Bell's trajectories are shown as Figures 2a and 2b. Subsequent studies also document this transport (e.g., Brown, 1975, Sklarew *et al.*, 1975, Kauper, 1977a, Kauper and Niemann, 1977).

The most significant results of all these studies are shown in Table 3. The impact of transport from the South Coast Air Basin on San Diego County is particularly important on the high ozone days. More than a decade ago, *all* of the high ozone occurrences in San Diego were thought to be the result of the transport of pollutants from the South Coast Air Basin (Kauper and Niemann, 1977). In a recent study (Ireson *et al.*, 1988), the authors studied 158 days in 1985 and 1986 during which the maximum ozone concentration was 12 pphm or greater. About half the time (49 percent), ozone or precursor emissions were transported from the South Coast Air Basin, and a little over a quarter of the time (28 percent) no transport was found to impact San Diego.



Sources: U.S. Weather Bureau and Scripps Institution of Oceanography

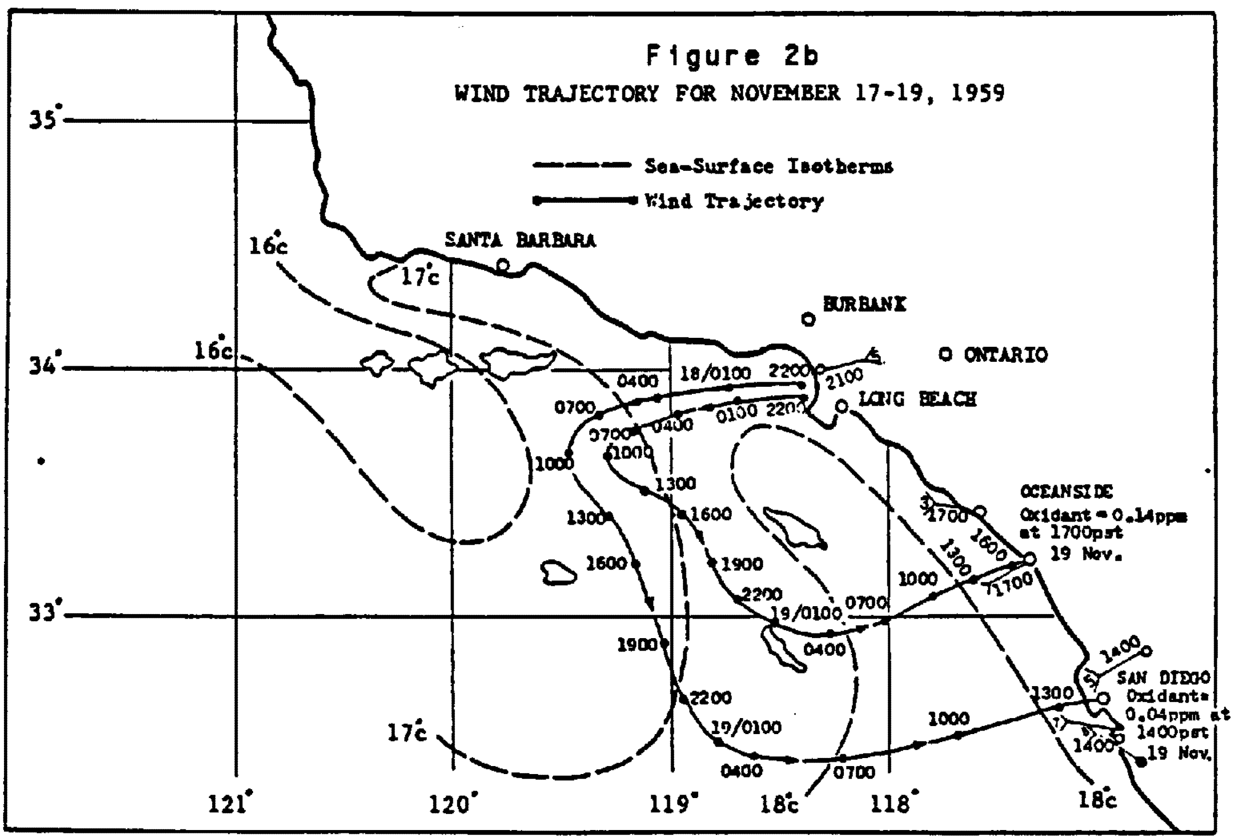


Figure 2: Examples of Trajectories (from Bell, 1960)

TABLE 3

SAN DIEGO COUNTY DAILY ONE-HOUR AVERAGE, MAXIMUM OZONE AND PERCENTAGE OF TIME THE ASSOCIATED TRAJECTORIES ORIGINATED IN OR NEAR THE SOUTH COAST AIR BASIN

Ozone Max. (pphm)	Percent in or near SCAQMD
$\geq$ 30	100
25 - 29	100
20 - 24	63
15 - 19	66
10 - 14	30
09 or less	40

(94 cases were studied, from Kauper 1977b.)

Considerable work has been done to plan a late summer 1989 field study to collect the data necessary to use the Urban Airshed numerical model in the San Diego Air Basin (Ireson *et al*., 1988). If this study gets favorable meteorological conditions then it should be possible to determine the relative importance of each of the potential contributors to ozone concentrations which exceed the standards (including those from any significant Outer Continental Shelf (OCS) development).

The staff concludes that ozone transport does take place between the South Coast Air Basin and the San Diego Air Basin[1].

C. South Coast Air Basin to Southeast Desert Air Basin

The contrast between the clear desert air of the Southeast Desert Air Basin and the hazy, polluted air of the Los Angeles Basin delineates the transition between the "coastal" and "desert" air so sharply that the boundary between the two air masses can easily be seen with the naked eye. This visible transport phenomenon is sometimes called a smog front. There is a good set of pictures documenting the existence of the smog front in Miller and Lester (1977). The smog front moves into the desert through the

1. Transport also takes place in the other direction when there is southerly flow. However, these flows are associated with deep marine layers, oxidant transport is not thought to be significant (Keith, 1980).

major passes (Figure 3); to a lesser extent, the smog front moves up the mountain slopes with the upslope flows generated during the heat of the day leaking over the mountains and causing elevated laminae or layers of pollution.

1. South Coast Air Basin to the Coachella Valley

There is only one major pass, San Gorgonio Pass, connecting the Los Angeles Basin and the Colorado (low) Desert. The northern wall of the pass is the foothills and lower ridges of the San Bernardino Mountains which build up to Mount San Gorgonio (11,502 ft MSL). The more imposing southern wall rises abruptly toward Mount San Jacinto (10,805 ft MSL) in the San Jacinto Mountains. The floor of the pass begins about two miles west of Banning (about 2,300 ft MSL) and slopes downward at about 80 feet per mile to its eastern end about two miles east of Whitewater (about 1,000 ft MSL). The first known description of what goes on here is still one of the best (Blake, 1857):

> ...the wind is not an ordinary shifting breeze, but a constant and powerful current of air sweeping through the pass from the west. It pours in from the Pacific in an apparently unbroken, unvarying stream, passing over the surface with such violence that all the fine grains of sand are lifted from the dry channels of the streams and are driven along the descending slope until they find a final resting place in the leeward of the projecting spurs of (San Jacinto)...the pass is a great draught channel from the ocean to the interior, through which air flows with peculiar uniformity and persistence thus supplying the partial vacuum caused by the ascent of heated air from the surface of the parched plains and deserts....

The first study of transport into the Coachella Valley seems to have been Kauper (1971). Twenty-four trajectories were calculated for the highest ozone values reported during the study period. At least 18 (75 percent) of the trajectories definitely originated in the coastal areas west of San Gorgonio Pass. Three trajectories appeared to have moved through the pass, but the evidence was inconclusive. The last three trajectories originated north of the Coachella Valley (to the north are the Little San Bernardino Mountains and the Morongo Valley connecting the High and Low Deserts). Based on the analyses of the aerometric data from surface stations, pibals (pilot balloon measurements), and aircraft measurements of temperature and ozone aloft, the study concluded that the "Coachella Valley is subject to the intrusion of the aged photochemical pollution cloud from the coastal area of Southern California." Kauper also noticed that pollutants appear to have been brought down to the surface from aloft by waves set up to the lee of the Pass in strong wind situations.

In 1973, Edinger studied the vertical distribution of smog in the Los Angeles Basin and the development of layers of laminae of high oxidant injected into the inversion layer by the heating of mountain slopes. He also noted that any laminae coming through San Gorgonio Pass or over the surrounding mountains can be brought to the Coachella Valley floor in nighttime drainage flows; this mechanism would explain any nighttime high ozone concentrations.

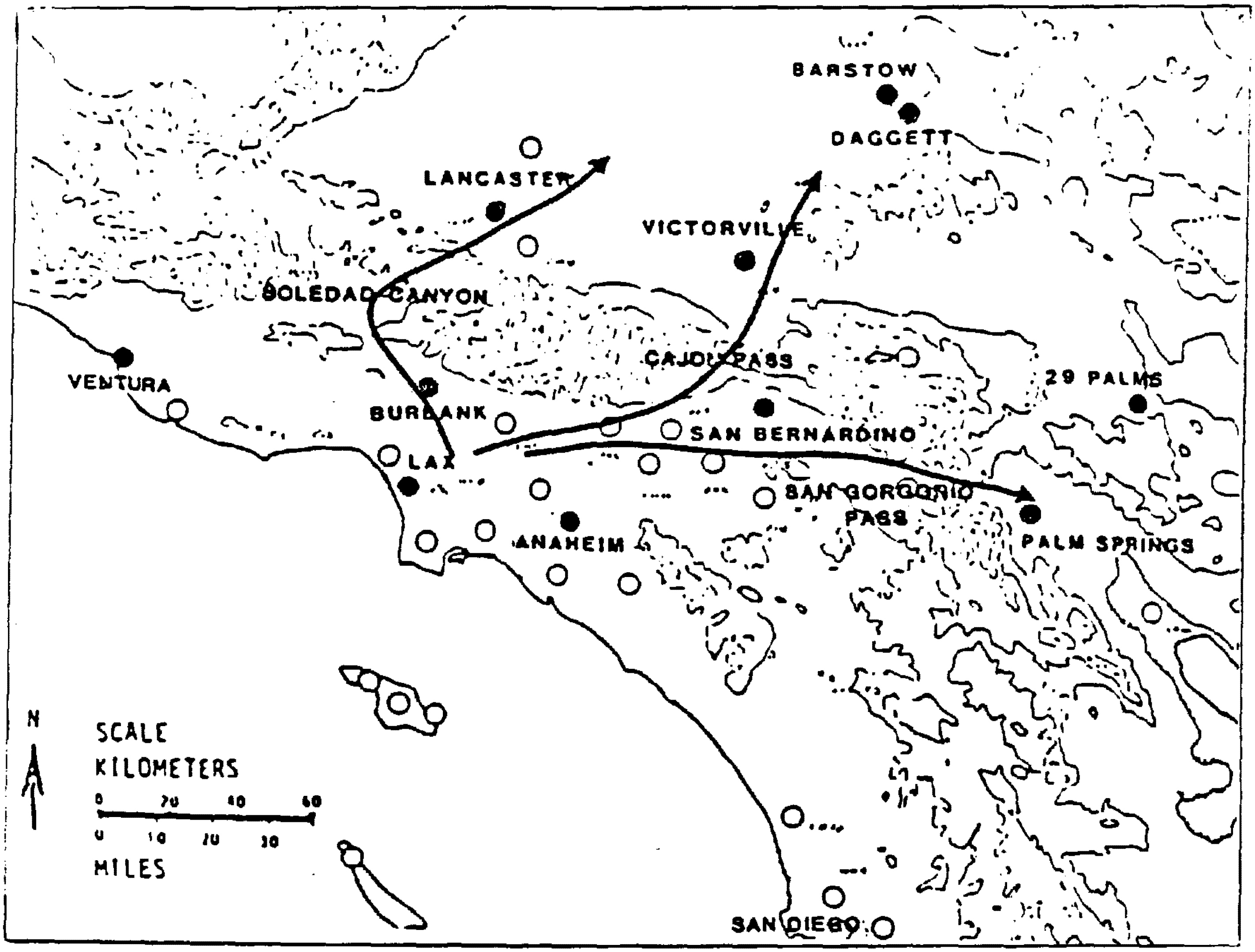


Figure 3: Interbasin Transport Corridors Through the Mountain Passes Between the South Coast Air Basin and the Southeast Desert Air Basin (Soledad Canyon 3,300 ft; Cajon Pass 4,200 ft; San Gorgonio Pass 2,300 ft) (from Smith et al. 1984)

In 1974, Drivas and Shair did their well-known tracer study of pollutant transport and dispersion in the Los Angeles Basin. This study was also the first one that directly measured transport from the Los Angeles Basin to the Southeast Desert Air Basin (in this case from Anaheim to Palm Springs).

In 1978, the focus of the Lester and Simon study was the California Desert. They collected four days of aircraft and balloon measurements, and they were able to make the initial estimate of the fluxes of pollutants through passes such as San Gorgonio. The most recent estimate of the flux through San Gorgonio Pass is reported in Smith and Edinger (1984); they estimated that at least in the summertime as much as 10 percent of the volume of air in the Los Angeles Basin east of central Los Angeles[2] moves through the Pass each hour.

Under certain meteorological conditions, Lester and Simon (1978) found that the mass of particles transported into the desert in elevated haze layers across the mountains between Mt. San Gorgonio and Mt. Palomar (some 50 miles to the south) is twice the amount moving through San Gorgonio Pass. No estimate was made of how much ozone or its precursors were embedded in these haze layers.

The definitive study to date is Smith *et al.* (1983a), which is based on a 1981 field study specifically designed to examine the transport of pollutants from the South Coast Air Basin into the Southeast Desert Air Basin. The field study included tracer studies, airsondes, and automobile traverses as well as the more common aircraft soundings, pibals, and network of surface aerometric stations. The principal results are summarized below:

a. The most frequent wind directions for high ozone episodes in the desert indicate a trajectory through the various passes.

b. Backward trajectories begun at the average time of peak ozone at desert locations indicate a source region in the South Coast Air Basin.

c. High altitude locations in the western San Bernardino Mountains frequently experience high ozone occurrences.

d. In major passes like San Gorgonio, there is evidence that two or more layers of ozone are being transported into the desert. The lower layer consists of direct transport through the lower levels of the pass. The upper layers associated with upslope flow along the shoulders of the pass move pollutants to a level where they can be transported through the upper portion of the pass. This, in effect, substantially increases the transport through the pass.

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2. Approximately 3 x 10^{12} cubic km if a mixed layer of 500 m is assumed.

e. Downwind of the San Gorgonio Pass, the upper layer of ozone laden air is occasionally brought to the surface by the effects of a lee wave action on the desert side of the pass. This results in higher ozone concentrations in the desert than at Banning on the upwind side of the pass.

f. The carry-over of the ozone transported into the Coachella Valley on the previous day sometimes results in higher than normal background concentrations.

The staff concludes that there is ozone transport from the South Coast Air Basin to the Coachella Valley in the Southeast Desert Air Basin.

2. South Coast Air Basin to the Mojave Desert

Through a number of studies, researchers have established that there is ozone transport from the South Coast Air Basin to the High Desert. The High Desert is the western portion of the Mojave Desert (elevation about 2,000 feet MSL) located north of the San Gabriel and San Bernardino Mountains, and it includes the Antelope Valley (Palmdale and Lancaster) and the Apple Valley (Victorville). The Soledad Canyon connects the San Fernando and the Antelope Valleys, and the Cajon Pass connects the Antelope Valley with the eastern end of the Los Angeles Basin (Figure 3).

Ozone transport into these passes was first suspected[3] because of the ozone damage to the needles of the ponderosa pine in the mountains forming the northern and eastern limits of the South Coast Air Basin as well as the known wind flow patterns [*e.g.*, DeMarrais *et al.* (1965) and Keith and Selik (1977)]. Over the years, a wealth of information has been collected: Edinger *et al.* (1972), AeroVironment (1972), Edinger (1973), Niemann *et al.* (1973), Blumenthal *et al.* (1974a), Bennett (1975), Kauper and Niemann (1975), Huning (1978), Lester and Simon (1978), Keith (1980), Reible *et al.* (1982), Smith *et al.* (1983a), Smith and Edinger (1984), Myrup and Flocchini (1984).

Smith *et al.* (1983a) are still the state of the knowledge. Some of their conclusions are summarized below:

a. The southern portion of the High Desert is influenced primarily by air flow through the Soledad Canyon from areas to the south and southwest (Figure 3).

b. Backward trajectories constructed from the average time of peak concentrations ozone at desert locations indicate a source region in central Los Angeles between Burbank and Anaheim. Two desert areas, Daggett-Barstow and Edwards AFB, most frequently have trajectories that originate in the San Joaquin Valley.

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3. One of the earliest reports is in Bell (1958).

c. High ozone concentrations frequently occur at high altitude locations in the San Gabriel and western San Bernardino Mountains.

d. A significant portion of the South Coast Air Basin's air exits through the region from Mt. Baldy to Lake Gregory.

e. Tracer trajectory routes show that source regions in the northwest part of the South Coast Air Basin feed into the Soledad Canyon, source regions in the southern basin feed into the Elsinore convergence zone, and source regions in the central part feed into Cajon and San Gorgonio Passes as well as up the slopes of the San Gabriel and San Bernardino Mountains.

The staff concludes that ozone transport takes place from the South Coast Air Basin into the Mojave Desert in the Southeast Desert Air Basin.

D. San Joaquin Valley Air Basin to Southeast Desert Air Basin

The San Joaquin Valley Air Basin is a well defined climatic region with topographic barriers on three sides: the Sierras to the east, the Coastal Range to the west, and the Tehachapi Mountains to the south at the upper end of the valley[4]. The air flow patterns for the basin and the seasonal percentages of occurrence for each wind flow type have been published in Hayes *et al.* (1984).

In the summertime, air frequently enters the San Joaquin Valley from the San Francisco Bay Area and flows in a southeasterly direction up the valley toward the Tehachapi Mountains. Some of this air and the pollution carried with it moves through Tehachapi Pass (elevation 3800 ft.) and over the crest of the mountains into the Mojave Desert (Morgan, 1974; Unger, 1974; and Bennett, 1975; Lindley, 1977; Zambrano, 1980; Berry *et al.*, 1981; and Zalay *et al.*, 1983).

In 1978-79, a major field study investigated the origin and fate of airborne pollutants in the San Joaquin Valley. The results were published in Smith *et al.* (1981); two of them are pertinent here:

1. The primary transport route out of the valley is over the Tehachapi Mountains, and this flow contributes significantly to the pollutant burden in the Mojave Desert.

2. The increased growth in the southern part of the valley will impact significantly on the Mojave Desert because of the photochemical processes which will occur as well as the generally good air quality the desert now enjoys.

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4. Note: In geographical descriptions, "up the valley" is toward the higher terrain, so the south end of the San Joaquin is the upper end.

The important tracer results from the 1978-79 study were published with the final, detailed analyses in Reible *et al.* (1982). Two conclusions of interest are:

1. During apparently typical summer meteorological conditions, airborne pollutants in the southern San Joaquin Valley clearly impact the northern Mojave Desert.

2. The south end of the Sierras between Lake Isabella and Tehachapi is only 5,000 to 6,000 feet in elevation; these mountains do not pose a significant barrier to transport of air pollutants.

Subsequent studies have increased our understanding of these transport processes [Smith *et al.* (1983a), Myrup and Flocchini (1984), Blumenthal *et al.* (1985)]. An extensive field study will be done in 1990; technical studies to prepare for it are underway this year. According to Roth *et al.* (1987), this study will document the three-dimensional spatial and temporal distributions of pollutants during episode conditions, and it will determine the details of the transport processes into the Mojave Desert. This study will define the state of the knowledge for the foreseeable future and will help quantify the amount of transport taking place.

The staff concludes that ozone transport takes place from the San Joaquin Valley Air Basin to the Southeast Desert Air Basin.

E. Between the South Coast Air Basin and the South Central Coast Air Basin

The South Central Coast Air Basin includes San Luis Obispo, Santa Barbara, and Ventura Counties. San Luis Obispo County and that portion of Santa Barbara County north of the Santa Ynez Mountains, an area in the Central Coast Climatic Zone, is called the northern zone of the South Central Coast Air Basin.[5] The southern zone of this air basin includes Ventura County, the Santa Barbara channel with its off shore oil and gas activities, and the Southern Coastal strip of Santa Barbara County.

The main topographic features are shown in Figure 4. The narrow Santa Barbara coastal strip, described by Richard Henry Dana in *Two Years Before the Mast* as a plain with its amphitheater of high hills and distant mountains, is only a few miles wide and is bordered on the inland side by mountain ridges extending upwards to about 4,000 feet above mean sea-level. The coastal strip has the same climate as the broader Oxnard plain in Ventura County. To the south, the 2,500-3,000-foot Santa Monica Mountains go down to the sea at Point Mugu, blocking any direct connection between Ventura and the Los Angeles Basin to the East. Just north of the Santa

5. Ireson *et al.* (1989) discusses where to add ozone monitoring stations should transport in the northern end of this zone be considered a potential problem.

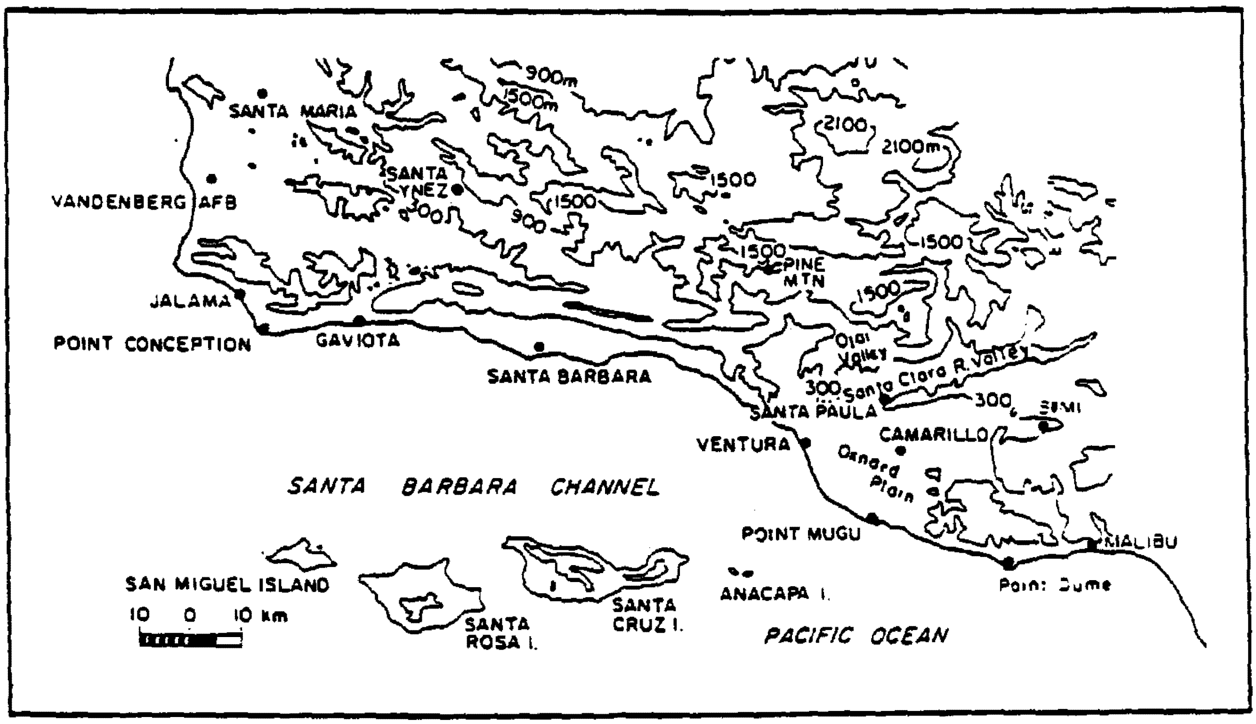

Figure 4: Topographic Map of the SCCCAMP Region (from Hanna, 1989)

Monica Mountains is the east-west Russell Valley and further north and over the Simi Hills the Simi Valley connects the Oxnard plain with the San Fernando Valley. Still further inland and northward, the Santa Clara Valley runs eastward, connecting with the Castaic, Saugus, Newhall area which is just north of the San Fernando Valley.

The interaction of the topography and the meteorology (inversions, sea breezes, and drainage flows) noted by Smith *et al.* (1983b) prompted them to conclude that the wind flows in the southern portion of the South Central Coast Air Basin are some of the most complex in California.[6] However, these flows have been studied for a long time and progress has been made. One reason has been the need to understand the causes of the peak ozone concentrations which occur in the interior of Ventura County and along the coast of either county. Another reason is the proximity of the South Coast Air Basin and the possibility that Ventura County's efforts to avoid high ozone concentrations might, at least in part, depend on the South Coast Air Basin's success in controlling its ozone levels (Kauper and Niemann, 1975).

Transport can take place in either direction, from the southern zone of the South Central Coast Air Basin to the South Coast Air Basin and *vice versa*, but transport of significant amounts of oxidant is mostly from the South Coast Air Basin to the South Central Coast Air Basin. There are two major transport routes. One is overland between the San Fernando Valley and eastern Ventura County; the other is over water across the Santa Monica Bay (Edinger and Helvey, 1961; Lea, 1968; Gloria *et al.*, 1974; Giroux *et al.*, 1973; and Giroux *et al.*, 1974). The first field study tailored to the transport problem seems to have been Kauper and Niemann (1975). Since then, an impressive amount of related work has been done: Lamb *et al.* (1977), Lorenzen (1975), Keith and Selik (1977), Lamb *et al.* (1978a), Sklarew and Chaplin (1975), Wales (1978), Kauper (1979), Lehrman *et al.* (1981a), Shair *et al.* (1982) and McRae *et al.* (1982).

Smith *et al.* (1983b) summarized the results of a 1980 field study conducted in the southern zone of the South Central Coast Air Basin. This study was designed to develop a data base for use in air quality modeling in this area. Although much was learned, the authors saw the need for additional studies, especially tracer studies designed "with the aim of identifying the ultimate fate and contributions along the offshore route."

In 1985, the South Central Coast Cooperative Aerometric Monitoring Program (SCCCAMP) took place under multi-agency sponsorship.[7] According to

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6. It is the only area with three types of mesoscale cyclonic eddies: the Gaviota eddy which forms immediately downwind of point Conception, the Catalina eddy that extends from Point Conception into the Los Angeles Basin, and the nocturnal "mid-channel eddy" described in Smith *et al.* (1983b).
7. Dabbert and Viezee (1987) list the 22 principal scientists, the 15 participating organizations, and the 15 cooperative organizations.

Dabberdt and Viezee (1987), this program was the most comprehensive mesoscale photochemical study of its type ever undertaken. In the neighboring South Coast Air Basin, the comprehensive Southern California Air Quality Study (SCAQS) took place in 1987. The results from these studies are beginning to come in: Dabberdt and Endlich (1986), ARB (1986), Pennell *et al.* (1986), Viezee *et al.* (1987), Strimaitis *et al.* (1989), Horrell *et al.* (1989) and Hanna (1989); they will be useful in quantifying the ozone transport.

The staff finds that ozone transport takes place between the South Coast Air Basin and the South Central Coast Air Basin.

F. The California Coastal Waters (CCW) Area to South Central Coast Air Basin

The term "Outer Continental Shelf" (OCS) refers to that portion of the continental shelf farther than three miles from the coastline. Much of the OCS is within a region where prevailing winds tend to transport offshore emissions into onshore areas. In recognition of this, in 1978, the Air Resources Board developed a definition of California Coastal Waters (CCW), an offshore area where emissions released over these waters are transported to the California coast. This area is not defined as a certain number of miles off the coast but by coordinates based on meteorological data (see Attachment A). The seaward boundary of this area is as close as 18 miles off the coastline at Point Conception, and more than 80 miles from the coast near the Mexican border. In most areas off the coast, this boundary is between 40 and 70 miles off the coast.

Areas as far as 100 miles from the coastline of southern California have been opened for oil and gas drilling activities, and drilling as far out as 150 miles appears to be technologically feasible.

Since the mid-1970s, the Air Resources Board's staff and the air pollution control districts have been concerned about the emissions from offshore oil and gas activities. The CCW area in the Santa Barbara Channel has been extensively studied (see Bureau of Land Management, 1975; ARB, 1978; Lehrman *et al.* 1981a; ARB, 1982; ARB, 1985; and also several of the reports cited in the preceding section). Modeling studies using the SCCCAMP 1984 and 1985 data demonstrate that transport from the CCW contributes to ozone standard violations in the South Central Coast Air Basin.

The staff concludes that transport from the CCW takes place to the South Central Coast Air Basin.

G. The San Francisco Bay Area Air Basin

In this region, the urban centers are clustered around a large bay which is surrounded by a double chain of north-south running coastal mountains reaching upwards as high as 4,200 feet mean sea level (Figure 5). To the west, a narrow range of mountains (the Santa Cruz Mountains south of the Golden Gate and the Marin Hills to the north) separates cities such as San Jose, San Mateo, and San Rafael from the Pacific Ocean. San Francisco is situated on the coastal hills where these hills descend down to Point Lobos and the Golden Gate. On the east side of the bay, cities such as

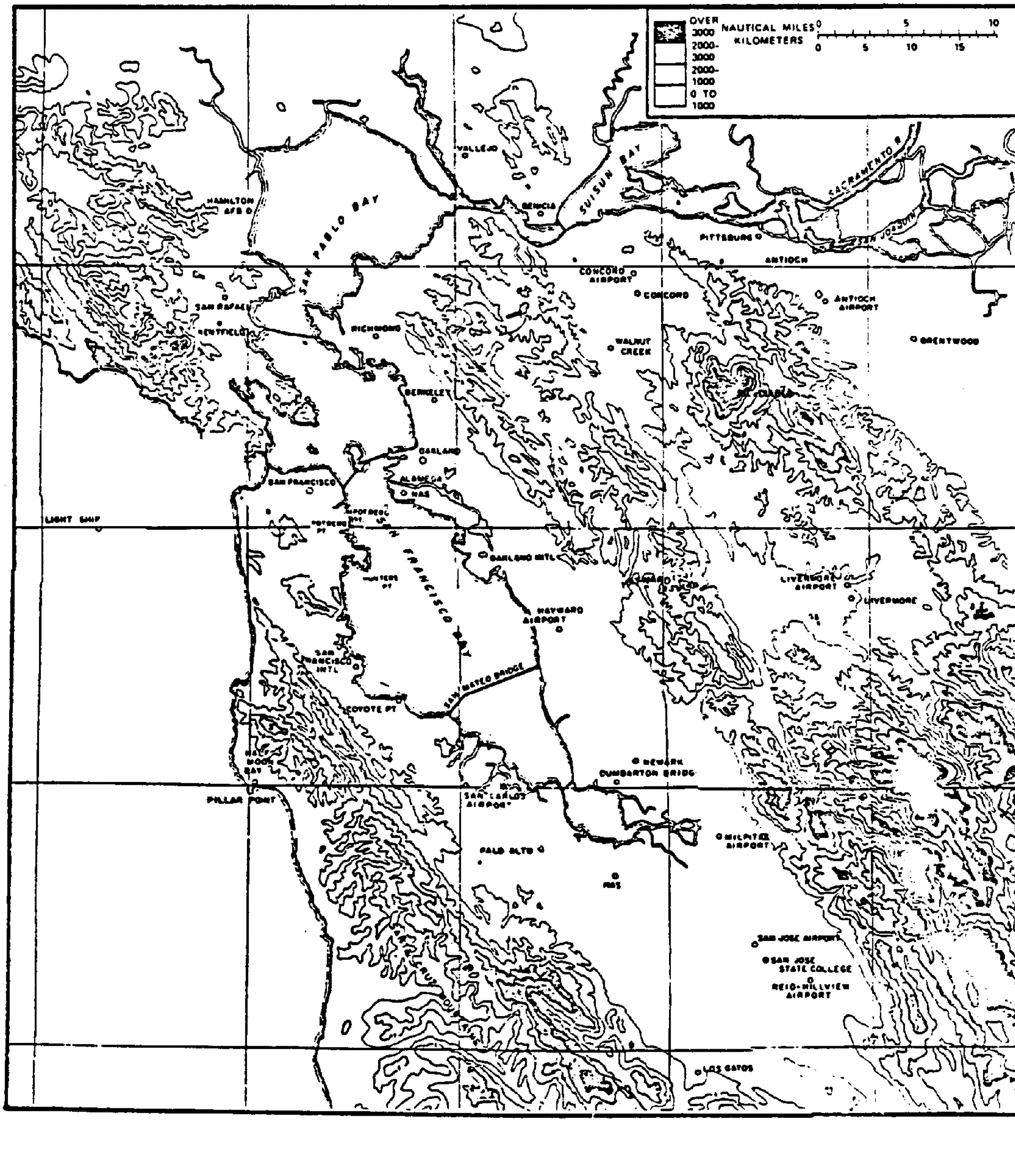

Figure 5: The Topography of the San Francisco Bay Region (from Ahrens and Miller, 1968)

Vallejo, Oakland, Hayward, and Fremont are separated from the Central Valley by the interior branch of the Coastal Ranges.

The air flow patterns are largely determined by the topography. As the prevailing westerlies(assault the California coast, they must either blow over the coastal mountains or be funneled through gaps. The lowest and largest gap in the coastal range is the Golden Gate, but other gaps exist that function as little Golden Gates. These include the Crystal Springs Gap here the San Andreas Fault cuts through the mountains,[8] and the San Bruno Gap between San Bruno Mountain and Montara Mountain. North of the Golden Gate there are the Elk Valley Gap and a higher gap above Muir Woods (near Mill Valley), the Nicasio Gap west of San Rafael, and the Petaluma (Estero) Gap.

On the eastern side of the Bay, the Carquinez Strait leading into the Sacramento River Valley is the major exit for westerly flow moving out of the region, but other outlets exist. Niles Canyon and Hayward Pass channel the flow from the Bay into the Livermore-Amador Valley; Altamont Pass (750-850 ft MSL) the principal gap in the Diablo Range of the Coastal Mountains is the outlet between the Livermore and the San Joaquin Valleys.

Beginning with Smalley (1957), a significant number of studies have been done to define the air pollution meteorology of this region. Smalley (1957) developed the first set of wind flow patterns. Sandberg *et al.* (1970) confirmed the usefulness of Smalley's patterns in predicting horizontal pollution distributions. Later Smalley's 40 patterns were simplified to 15 patterns (Basso *et al.*, 1974; Basso *et al.*, 1975). Today, the Air Resources Board's technical staff uses the seven basic patterns depicted in Hayes *et al.* (1984).

The San Francisco Bay Region with its ocean, bays, rivers, and complex topography is the meeting place for continental and oceanic air masses. The landward penetration of marine air and the structure of the sea breeze is discussed in Schroeder and Fosberg (1964) and Fosberg and Schroeder (1966). In 1975, Robinson began the study of the relationship between climatic conditions and air pollution potential in the region. Miller and Ahrens (1967) seem to have been the first to study the vertical structure of ozone and how ozone concentrations are related to the structure of the west coast temperature inversion (see also Johnson and Singh, 1980). The following year Ahrens and Miller (1968) also reported on the first extensive study of air trajectories in this region [100 tetroons (constant level balloons) launched in 1966 and 1967]. The first fluorescent tracer study was also done during this period (see Sandberg *et al.*, 1970). Holets (1976) and MacKay (1977) did case studies of high ozone episodes.

Regional scale modeling also began in the 1970s when the Livermore Regional Air Quality (LIRAQ) model was developed for the Bay Area after an extensive field program conducted to collect the three-dimensional data

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8. The flow through this gap is felt as far south as San Jose.

needed to run this model. The program is discussed in detail in MacCracken and Sauter (1975).

In 1978 there was another major field program, MABLES-WC (Marine Atmosphere Boundary Layer Experiment-West Coast) to increase the knowledge on the structure and variation of the marine layer, the temperature inversion at the top of the layer, the associated clouds and fogs, and pollution throughout the region. The MABLES-WC experiment is discussed in Lester (1979).

Last, a field study is now underway in the San Francisco Area Air Basin to collect the data needed for modeling in the 1991 Ozone Plan and to provide "information useful in designing full field studies in the future" (Umeda, 1989).

1. San Francisco Bay Area Air Basin to North Central Coast Air Basin

The North Central Coast Air Basin (NCCAB) is made up of Santa Cruz, Monterey, and San Benito Counties. The NCCAB is just south of the Bay Area Air Quality Management District (BAAQMD). The boundary line between these two basins runs southwesterly down the Santa Cruz Mountains, and then easterly along the relatively low hills between Gilroy and Hollister that separate the Santa Clara and Pajaro River Valleys (Figure 6). The climatology of the NCCAB is discussed in Unger (1975).

Although the principal wind flow regime in the NCCAB is the sea breeze that pushes in through Monterey Bay, there are cases when the wind flow is from the Bay Area into the NCCAB. Furthermore, preliminary studies such as Blumenthal *et al*. (1974a) have detected pollutants moving southeastward past San Jose. Thus, the potential for ozone transport from the Bay Area to the NCCAB warranted investigation.

Dabberdt (1983) discusses the results of a major field program done in 1980, which used gaseous tracers, airborne ozone mapping, and the usual surface based aerometric monitoring. All three potential transport routes were studied (Figure 6). Dabberdt's transport results are presented below:

> Transport up the Santa Clara Valley to Hollister--Route One--was observed to occur, though ineffectively and sporadically; the intrusion of marine air from Monterey Bay apparently sets up a convergence zone[9] in the northern San Benito Valley that generally inhibits transport south of Gilroy. However, this flow regime was observed during the tests to break down for short periods, enabling transport to Hollister from the NW. Two, significant ozone transport was not observed along proposed Route Two from Los Gatos to Scotts Valley and Aptos. Three, significant amounts and concentrations of ozone were transported on several days along offshore Route Three, resulting in exceedances of the ambient standard at several location

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9. A convergence zone is a line along which two wind flows from opposing directions meet, resulting in upward motion.

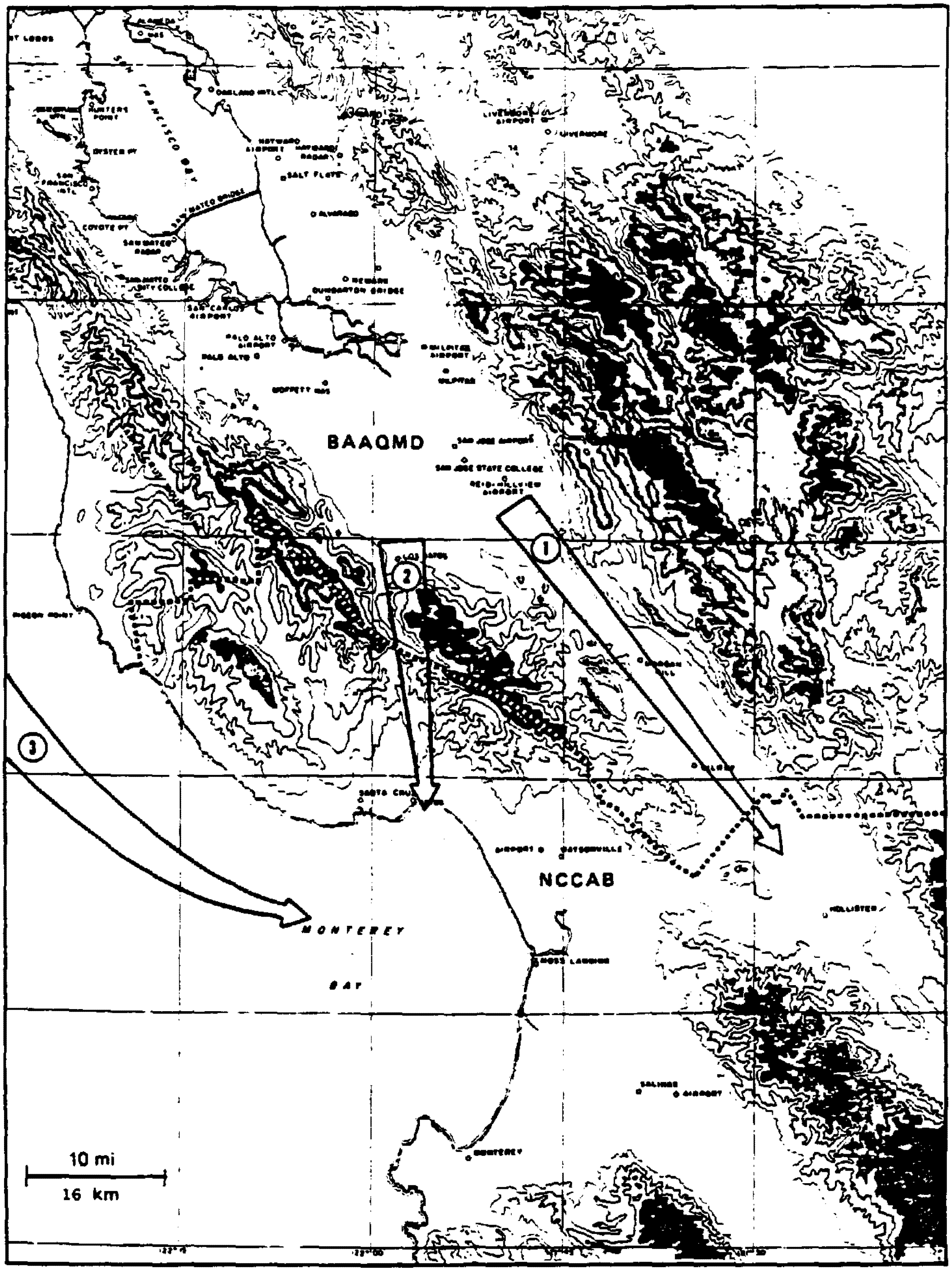

Figure 6: Possible Transport Routes from the San Francisco Bay Area Air Basin into the North Central Coast Air Basin (from Dabberdt, 1983)

in the NCCAB. The mass of ozone discovered offshore during two tests extended about 50-km off the coast from the vicinity of San Francisco on the north to (at least) Monterey on the south; concentrations increased rapidly from about 100 ppb at the coast to nearly 250 ppb and decreased very gradually. Similar concentrations were observed offshore on a third test, extending southward to Big Sur where they decreased rapidly. **The atmospheric dynamics of the phenomenon and the proportion of advected and locally generated ozone in the NCCAB remain to be determined.** [Emphasis added.]

As Dabberdt points out, further work is needed to understand exactly what is going on in this air basin and to quantify the magnitude of the impact of transported ozone and its precursors on the ozone levels in Monterey, Watsonville, Santa Cruz, and Hollister. In 1990, the AUSPEX (Atmospheric Utility Signatures--Predictions and Experiments) field program will be conducted in concert with the SJVAQS (San Joaquin Valley Air Quality Study). AUSPEX can be expected to further our understanding of transport between the Bay Area and the North Central Coast (Thuillier, 1989a and Thuillier, 1989b).

The staff concludes that transport can occur from the San Francisco Bay Area Air Basin to the Northern Central Coast Air Basin.

2. San Francisco Bay Area Air Basin to Great Central Valley Air Basin

The influx of cool marine air into the huge, relatively level Great Central Valley happens all year around, but it is most persistent in the summer when it is the controlling factor in the summertime weather of this region (Byers, 1930). As depicted in Figure 7, the sea breeze debouches into the Central Valley through gaps in the Coastal Mountains only to be deflected by the Sierra Nevada, a granite barrier rising from 10,000 to 14, 000 feet into the sky some 200 miles inland from the shores of the Pacific. The principal gaps connecting the Bay Area with the Central Valley are the Carquinez Strait, Altamont Pass, and Pacheco Pass (Figure 7).

The strength of this marine influx varies from day to day with its pronounced diurnal cycle as described in Schultz *et al*. (1976). This influx is weakest during morning lulls, which are usually of short duration. On about 86 percent of all summer days, the influx increases in the afternoon, often with an increase in the westerly flow during the night. The most remarkable features of this sea breeze regime are the eddies--the Fresno Eddy in the San Joaquin Valley and the Schultz Eddy in the Sacramento Valley--and the structure of the nighttime winds aloft. In the 1960s, when a 1,500 foot TV-tower at Walnut Grove was instrumented and the data analyzed, a high maximum wind speed between about 600 and 700 feet above the ground during the night was revealed. This phenomenon is usually called the "low-level jet" because it is reminiscent of the "low-level jet" which occurs over the Great Plains.

The influx of the marine air flushes out the Central Valley. When other weather patterns occur, as they do infrequently, then conditions are sometimes conducive to higher than normal concentrations of pollutants. [The characteristics of the marine influx are even used, in the case of

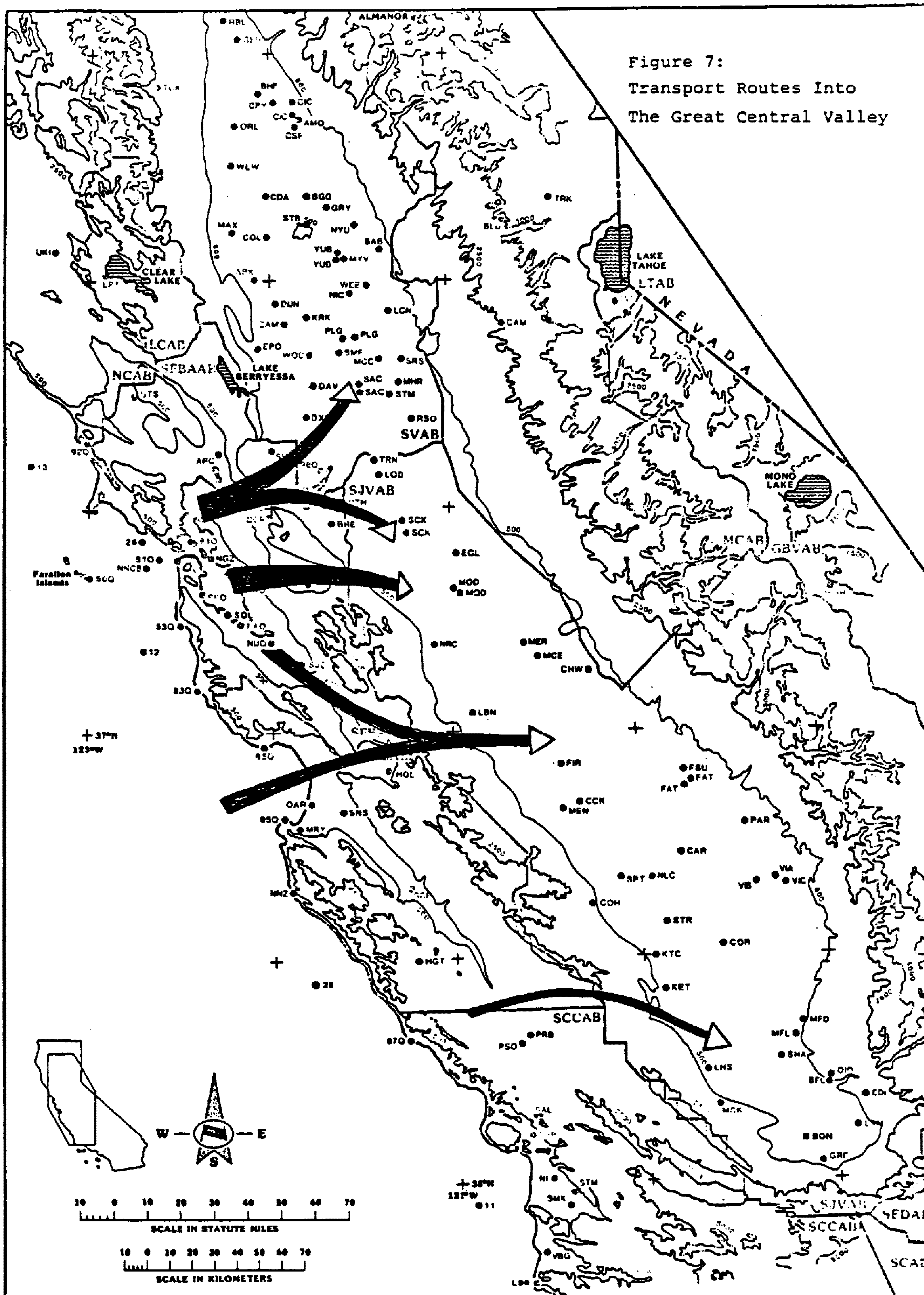

Figure 7: Transport Routes Into The Great Central Valley

agricultural burning, to control the placement of sources and the dispersion of pollutants (Duckworth, 1965).]

When studying transport from the Bay Area Air Quality Management District (BAAQMD) to the air basins in the Central Valley, one must bear in mind that the BAAQMD includes not only the industrialized areas along the Carquinez Strait, but also a large area east of the coastal mountains in Solano, Contra Costa, and Alameda Counties. The boundary between the BAAQMD and its eastern neighbors is an administrative one, unmarked by any topographical feature. Thus, there is nothing to prevent any pollutant originating in or transported to the eastern portion of the BAAQMD from being advected across this boundary.

a. San Francisco Bay Area Air Basin to San Joaquin Valley Air Basin

The part of Great Central Valley south of the delta formed at the confluence of the Sacramento and San Joaquin Rivers is called the San Joaquin Valley. The wind flow within and into this valley has been studied for years: Smalley (1957), Frenzel (1962), Fosberg and Schroeder (1966), Blumenthal *et al.* (1974b), Schultz *et al.* (1976), Carroll and Basket (1979), Giorgis (1983), and Smith et al. (1985)[10]. Mooney (1975) seems to have been the one who began documenting the flow into the San Joaquin Valley through Pacheco Pass (see also Starr, 1977). Morgan (1974) did the first detailed study of the "low-level jet." Tracer studies done in 1976 and reported in Lamb & Shair (1977), Smith *et al.* (1977) and Lamb *et al.* (1978b). Lamb *et al.* conclude that a portion of the Bay Area pollutants as well as pollutants from the Delta region are transported into the Stockton area.

One of the first large scale studies of the transport of pollutants in the Central Valley (Lehrman *et al.*, 1981b) revealed that, at least under the conditions of this study, morning emissions from the San Francisco Bay Area and the delta are usually carried eastward into the Sierra foothills and southeastward into the San Joaquin Valley. Transport northward into the Sacramento Valley tended to become significant only later on in the day.

Smith *et al.* (1981) were the first to study the transport of pollutants in the San Joaquin Valley, and they documented the existence of transport through the Altamont Pass and the ability of the "nocturnal jet" to transport pollutants the entire length of the valley. Smith *et al.* found no evidence of a significant impact of BAAQMD ozone or their precursors on the development of ozone in the valley; this fact was attributed to the size of the valley and the dilution of the pollutants as they were transported.

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10. One very practical application of the knowledge gained from these studies is objective methods of ozone predication (*e.g.* Mulberg, 1979 and 1980).

Smith *et al.*'s result is reasonable since it is the influx of cool marine air that flushes out the Central Valley. However, in certain instances, transport seems likely to cause a significant impact. For example, using 1978 data from Union Island, Giorgis (1983) found persistent daily ozone maxima near 15 pphm throughout a nine-day study period. The back trajectories from Union Island put the sources either in the Pittsburg-Antioch area or the Richmond-Berkeley area. Giorgis concluded that transport was highly probable.

Many questions about transport in this basin are expected to be answered by the San Joaquin Valley Air Quality Study (*e.g.*, Roth *et al.*, 1988; Blumenthal and Roth, 1988; ARB, 1989b). The San Joaquin Valley Air Quality Study includes a field program planned for 1990. Two of the objectives of this study are:

1) to make approximate estimations on the amounts of ozone and its precursors imported into the San Joaquin Valley, and

2) to make approximate estimations of the relative contributions to ozone exceedances in the valley of the transported pollutants as compared with the valley emissions.

The information from this unique study will be used extensively for years to come.

The domain of the San Joaquin Valley Air Quality Study (SJVAQS) is limited to the San Joaquin Valley. To maximize the amount of information, AUSPEX (Atmospheric Utility Signatures-Prediction and Experiments) will simultaneously study the areas surrounding the San Joaquin Valley (Thuillier, 1989a and 1989b). The results from the SJVAQS and AUSPEX will permit a more explicit treatment of the BAAQMD as a potential source of Valley pollutants.

The staff concludes that there is transport from the San Francisco Bay Area Air Basin to the San Joaquin Valley Air Basin.

b. San Francisco Bay Area Air Basin to the Broader Sacramento Area

The Sacramento Valley is another well-studied section of the Great Central Valley. On a typical day, the marine air invades the valley in the early afternoon and continues during the night. During the night, drainage that flows down the mountain slopes at the north end of valley and along the west side tends to fold the sea breeze back around on itself. By morning when the marine influx is weakest, the winds in the southern valley swirl around in a large eddy, the Schultz Eddy[11] (see Figure 8). As the atmosphere stabilizes in early evening and the inflow increases, a low-level southerly jet often develops with high speeds above ground-level. It is capable of transporting pollutants over large distances since speeds in

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11. At times, this eddy will migrate eastward as it fills.

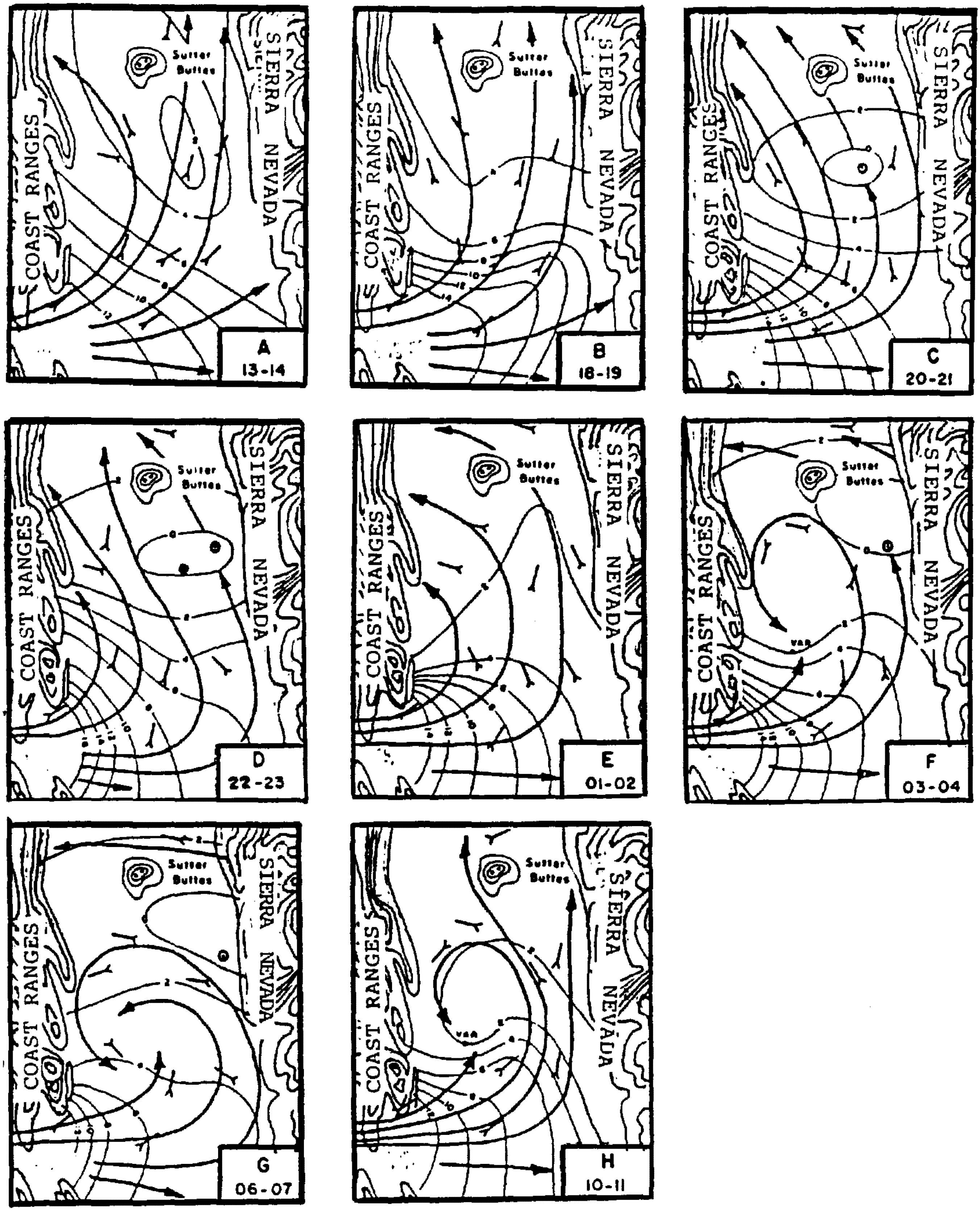

Figure 8: Formation of the Schultz Eddy - Streamline Diagrams of Surface Winds on July 28-29, 1966, During Hours Specified (after Fitzwater, 1966)

excess of 35 mph can be attained between 500 and 1,000 feet above the surface (Fitzwater, 1981; Schultz, 1975). The air quality in the valley is greatly dependent on the duration and depth of penetration of the sea breeze. On days when it weakens to a trickle, air pollution concentrations build up.

The Sacramento Valley has been studied for some time (Frenzel, 1962; Fosberg and Schroeder, 1966; Fitzwater, 1966; Lorenzen, 1974). In 1975, Schultz performed the detailed study of Sacramento Valley mesoscale wind patterns that identified the Shultz Eddy. Since then, there have been many studies including: Schultz *et al.* (1976), Lamb and Shair (1977), Lamb *et al.* (1978b), Lehrman *et al.* (1981b), Smith *et al.* (1981), Fitzwater (1981), Reible *et al.* (1983), Giorgis (1983), Smith *et al.* (1985). Anyone interested in studying the air pollution potential of the Sacramento Valley would do well to begin with the encyclopedic work of Giorgis (1983).

Increased ozone concentrations downwind from urban areas had been reported in may places, so it came as no surprise when the early studies of the urban plume from the Sacramento Metropolitan area showed transport downwind and up the major river canyons east of Sacramento (Unger, 1978; Duckworth and Crowe, 1979). In 1980, an elaborate field study was carried out to investigate the origin and transport of pollutants in the Sacramento Valley. This study (Lehrman *et al.*, 1981b) found that the slopes of the Sierras can be affected for a distance of at least 50-75 miles to the north of Sacramento. One of the principal conclusions of this study was:

> The most severely impacted area from the Sacramento ozone plume was found to be in the Sierra foothills between Highway I-80 and just south of Folsom Lake. Ozone concentrations in excess of 12 pphm were measured as far as 135 km [84 miles] from downtown Sacramento.

Downslopes flows at night return pollutants to valley areas.

Because of the frequent mixing of air between the lower Sacramento Valley counties and the middle counties of the Mountain Counties Air Basin, the staff has defined a Broader Sacramento Area, consisting of the Sacramento, Yolo-Solano, Sutter, Yuba, Nevada, El Dorado, and Placer County Air Pollution Control Districts. The western border of the Mountain Counties Air Basin is at 500-1,000 feet above sea-level. Pollutants in the valley are usually mixed throughout a layer more than 1,000 feet thick, with nothing to prevent transport between these two basins.

As the sea breeze flushes out the Central Valley and washes the Sierra slopes, sometimes to as high as the 3,000-foot level (Morgan, 1974), pollutants are carried within it. The depth ozone and its precursors can penetrate into the Sierras is still an open question, but some clues suggest that it might be a considerable distance. For example, high ozone levels have been measured at the Sierra Army Depot during periods of persistent westerly winds (Guzewich *et al.*, 1989) and at Kirkwood Meadows near the crest of the Sierra about 15 miles south of Lake Tahoe (Palmer *et al.*, 1975); and tracers released in the Central Valley have been found in low concentrations at Tahoe (Lehrman *et al.*, 1981b). The later study by Giorgis (1983) also found transport into the Sierras.

On the important question of transport from the BAAQMD to the Sacramento Valley, Giorgis (1983) concludes that:

> ...contribution to Sacramento Valley oxidant levels from Bay Area precursor emissions is secondary to contributions from sources in the Valley......shows that high oxidant concentrations at most Sacramento Valley stations result from local stagnation or transport from Sacramento. Receptor sites most susceptible to local stagnation were Sacramento, Woodland, and Redding. In other words, Sacramento Valley precursor emissions are the prime determinant of oxidant air quality in the Sacramento Valley, with the exceptions in the delta area, *e.g.*, Rio Vista and Sherman Island.

Giorgis has stated the typical case, but evidence from a tracer study suggests that at least under one set of circumstances transport from the Bay Area to Sacramento can take place on a day when there are exceedances of the ozone standard in Sacramento (at Citrus Heights). Lehrman *et al.* (1981b) report on an August 1980 morning tracer release from Vallejo. As expected, the bulk of the tracer moved into the delta region heading for the San Joaquin Valley; however, a smaller tracer plume moved up I-80. Small amounts of tracer were measured in Sacramento on that day, and on the next day small amounts were measured in Chico.

The staff finds that ozone transport can occur from the San Francisco Bay Area Air Basin to the Broader Sacramento Area.

CHAPTER IV

ARB STAFF ANALYSES TO IDENTIFY ADDITIONAL TRANSPORT IMPACTS

A. Introduction

The staff carried out a number of trajectory-based transport analyses for those areas of the State where pollutant transport studies have not been conducted or where available information is not sufficient to establish whether transport occurs.

The staff's approach was to examine days when ozone exceeded the state ambient air quality standard. Specifically, the staff identified the five highest ozone concentrations for each ozone monitoring site in ozone nonattainment areas during the last three years. The staff then analyzed the wind patterns to determine whether or not transport could have been possible and constructed trajectories where appropriate. Appendices C and D contain more information on how to construct surface wind trajectories (see Frenzel, 1962, and Lamb and Shair, 1977, for accounts of other trajectory analyses). Several problems exist with these methods. First, these methods account for only surface or horizontal wind patterns, yet air pollution transport also involves vertical wind flow patterns. A second problem is the terrain of an area may affect the accuracy of the trajectory constructed since physical barriers such as mountains alter air flow directions. In addition, increasing time and distance decrease the certainty of the trajectory, possibly rendering the trajectory unreliable.

In the following sections, the staff reviewed data, constructed trajectories, and drew the most likely conclusions.

B. Broader Sacramento Area to Upper Sacramento Valley

Trajectories constructed based on Sacramento Valley data are not affected by terrain barriers or time constraints. These trajectories indicate that on days when ozone concentrations exceeded the standard, air had been transported from the Broader Sacramento Area into the Upper Sacramento Valley. Figure 9 demonstrates one of these trajectories. Other evidence in support of this transport can be found in Porantoni (1970), Lehrman *et al*. (1981b) and Giorgis (1983).

The staff concludes that some transport occurs from the Broader Sacramento Area to the Upper Sacramento Valley.

C. Broader Sacramento Area to San Joaquin Valley Air Basin

The trajectories constructed based on Sacramento Valley and San Joaquin Valley data are not affected by terrain barriers or time constraints. On June 2, 1987, the ozone concentration reached 12 pphm at Stockton. The trajectory constructed indicates that when the ozone exceeded the standard, air had been transported from the Broader Sacramento Area into the San Joaquin Valley Air Basin. Additional evidence in support of this transport can be found in Duckworth and Crowe (1979) and Schwall (1981).

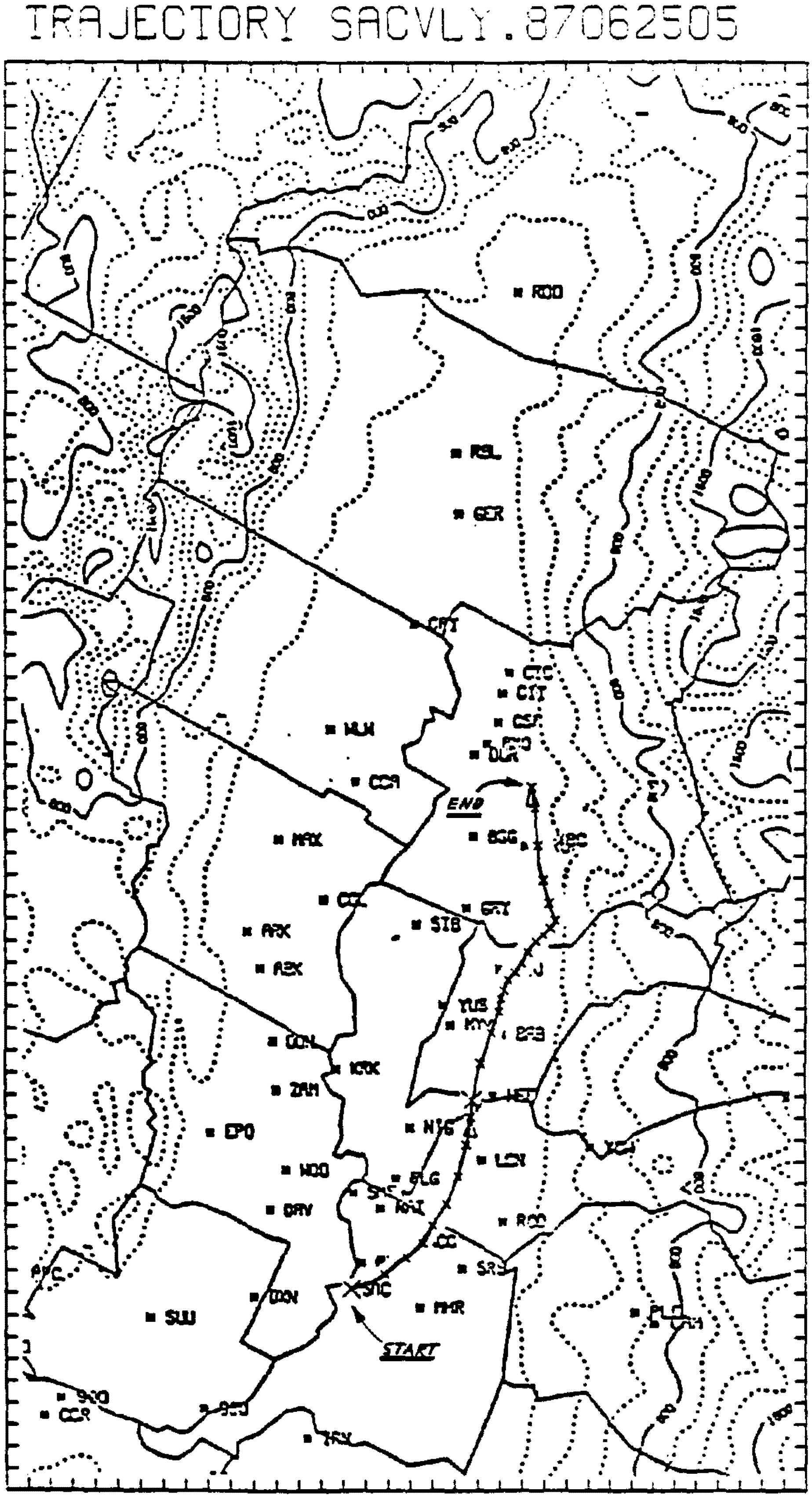

Figure 9: Trajectory Constructed for June 25-26, 1987, Showing Transport from the Broader Sacramento Area to the Upper Sacramento Valley

The staff concludes that ozone transport occurs from the Broader Sacramento Area to the San Joaquin Valley Air Basin.

D. San Joaquin Valley Air Basin to Broader Sacramento Area

Trajectories constructed based on San Joaquin Valley and Sacramento Valley data are not affected by terrain barriers or time constraints. On June 3, 1987, ozone reached 12 pphm at Folsom. The trajectory constructed indicates that when the ozone exceeded the standard, air had been transported from the San Joaquin Valley into the Broader Sacramento Area.

The staff finds that ozone transport occurs from the San Joaquin Valley Air Basin to the Broader Sacramento Area.

CHAPTER V

POTENTIAL TRANSPORT CORRIDORS REQUIRING FURTHER RESEARCH

A. Northern San Joaquin Valley to Great Basin Valleys Air Basin

The state ozone standard was exceeded on 10 days during the last three years at the Mammoth Lakes monitoring site in Mono County (maximum concentration of 10 pphm). Most of these exceedances occurred late at night, implying that (since ozone needs sunlight to form) transport of pollutants rather than local pollution sources could be responsible for these high concentrations. Three of these high ozone days at Mammoth Lakes were examined in greater detail. On each day, the upper levels combined flows associated with each of these cases could have contributed to transport into the Great Basin Valleys Air Basin from the San Joaquin Valley Air Basin.

Backward model trajectories could not be constructed from the Mammoth Lakes area since that area is outside of the model domain. However, a trajectory calculated backwards from Tioga Pass (approximately 15 miles northwest of Mammoth Lakes) for June 3, 1987, originated just east of Stockton on June 2 (Stockton's maximum ozone: 12 pphm). Since a similar trajectory on June 26 also began just east of the Stockton area, these nearby trajectories suggest that the San Joaquin Valley Air Basin could have contributed to the 10 pphm ozone exceedances measured in the Mammoth Lakes area.

Other researchers have found clues that suggested that there can be transport over the crest of the Sierras (*e.g.*, Lehrman *et al.*, 1981).

Even though the staff believes that transport is the reason for the Mammoth Lakes ozone exceedances, the staff believes that insufficient information is available at this time to determine positively whether transport occurs from the San Joaquin Valley Air Basin into the Great Basin Valley Air Basin.

B. Mountain Counties Air Basin to Great Basin Valleys Air Basin

Almost nothing is known about this potential transport couple (see Section *L* below). The most likely location of any source is Alpine County, but this county has not experienced any exceedance of the State ozone standard. The staff concludes that this question should be looked into further when more data are available.

C. South Coast Air Basin and Southern San Joaquin Valley to Great Basin Valleys Air Basin

A brief discussion of the climate and the unique topography of the Great Basin Valleys Air Basin can be found in Moore (1975); for more detail see Huning (1978). The basin is bounded on the west by the Sierras and on the east by the State of Nevada. The southern boundary of this basin is the Inyo-San Bernardino County Line. There is effectively no obstacle to transport northward from the Southeast Desert Air Basin.

Despite the remoteness of this area, its small population, and its lack of industry, additional ozone monitoring is needed to determine whether exceedances occur. For example, San Bernardino County has a measuring site at Trona less than five miles south of the Inyo-San Bernardino County Line, and data from this site demonstrate that the State standard was violated on six, eight, and ten days in 1986, 1987, and 1988, respectively. According to Dolislager *et al* (1989), the wind data on the high ozone concentration days show flow generally from the south (from Trona toward Inyo County). With few indigenous sources of ozone, it is necessary to understand how ozone is transported this far into the desert and how much further north than Trona it can be transported.

The mechanisms for getting ozone and its precursors into the California Desert are now well known. Air flow through canyons and venting over mountain crests were discussed earlier in Sections *C* and *D* of Chapter III in this report. Convergence zones also provide a way for lifting pollutants from the surface layers to the upper levels where they can be carried away by the gradient flow aloft (Smith *et al.*, 1984). Furthermore, it is known that ozone has a residence time long enough to permit long range transport to occur. Blumenthal *et al.* (1974a) found that ozone once formed and without other pollutants to scavenge it "is stable in the atmosphere at high concentrations for many hours, even in the absence of sunlight."

As early as 1977, Miller and Lester found evidence of long-range transport across the desert and into the Great Basin Valleys Air Basin. Their most remarkable measurements were of low (less than four pphm) ozone concentrations at Furnace Creek in Death Valley coincident with increased ozone levels (10 pphm) trapped in stable layers aloft (300-500 feet above ground level). Their conjecture was that this was due to the downward flux on the lee sides of the Argus and Panamint Mountain Ranges.

The Miller and Lester study concluded that oxidants can be found over the desert far from any source region in elevated laminae injected aloft above mountain ranges such as the San Gabriel and San Bernardino Mountains, and that these laminae of pollutants may be periodically mixed downward to the ground by convection.

An important and very interesting tracer study that was done in 1978 (Reible *et al.*, 1982) found that during typical summertime meteorological conditions:

1. Pollutants in the San Fernando Valley (South Coast Air Basin) have little or no impact on China Lake in the northwestern Mojave. The impact was on the southern Mojave Desert.

2. Pollutants in the southern San Joaquin Valley clearly impact the northern Mojave.

Furthermore, the tracer data suggest that air pollutants "released in the San Fernando Valley areas of Los Angeles and the San Joaquin Valley can impact southern Nevada and Arizona."

Smith *et al.* (1983a) confirmed the major findings of Reible and his colleagues when they released tracers in the Los Angeles Basin in all transport corridors. The resulting impacts were measurable as far into the desert as Barstow, Amboy, Blythe and Bombay Beach **but not** at China Lake. Most recently, Rogers and Bastable (1989), using commercial fluorocarbons as tracers, measured in a layer between 1000 and 2000 m AGL when the flow was southwesterly, halocarbons from the Los Angeles Basin along the California-Nevada border near Las Vegas.

The above studies, when taken collectively, suggest that there may be long range transport from the South Coast Air Basin and the San Joaquin Valley Air Basin into the desert, and that there might even be long range transport from these air basins into the Great Basin Valleys Air Basin. This matter will require further investigation.

D. California Coastal Waters (CCW) to California Coast

The term "Outer Continental Shelf" (OCS) refers to that portion of the continental shelf that is farther than three miles from the coastline. Much of the OCS is within a region where prevailing winds tend to transport offshore emissions into onshore areas. In recognition of this, in 1978, the Air Resources Board developed a definition of California Coastal Waters (CCW), an offshore area where emissions released over these waters are transported to the California coast. This area is not defined as a certain number of miles off the coast but by coordinates based on meteorological data (see Attachment A). The seaward boundary of this area is as close as 18 miles off the coastline at Point Conception, and more than 80 miles from the coast near the Mexican border. In most areas off the coast, this boundary is between 40 and 70 miles off the coast.

Since the mid-1970s, the Air Resources Board's staff and the air pollution control districts have been concerned about the emissions from offshore oil and gas activities. The OCS area in the Santa Barbara Channel has estimated oil and gas reserves amounting to approximately 4 percent of the United States' proven reserves and 25 percent of California's proven reserves; in other areas of southern California, the estimated reserves are smaller. In the OCS areas off northern and central California, the estimated oil and gas reserves are comparable to those in the Santa Barbara Channel. The Santa Barbara Channel has been extensively studied, but the other OCS areas are also important.

Since onshore flows frequently occur all along the California Coast (ARB, 1978), the staff concludes that the question of transport from these areas to their neighboring coastal areas requires deserves further study before it can be established whether the CCW areas significantly contribute to coastal ozone exceedances.

E. North Central Coast Air Basin to San Joaquin Valley Air Basin

There is wind flow from the North Central Coast Air Basin and the San Joaquin Valley Air Basin via passes in the Coastal Range (*e.g.*, Pacheco Pass); this is documented in Mooney (1975) and Starr (1977). Thus, ozone transport from the North Central Coast Air Basin into the San Joaquin Valley Air Basin seems possible.

Furthermore, the ARB staff has done some trajectory work for this region. The results are not conclusive because of the uncertainties associated with trajectories in complex terrain, but they are suggestive. Trajectories constructed June 2 and 3, 1987, showed flow along the San Benito River Valley reaching the Los Gatos Creek area and then the San Joaquin Valley. A second pattern was found that showed flow up the Salinas Valley around the Cholame Hills and down into the Antelope Valley near Kettlemen City. Ozone values reached nine pphm at Carmel Valley and Hollister on June 2 while in the Central Valley's Fresno area ozone values ranged from 10 to 16 pphm on June 2, and from 10 to 14 pphm on June 3.

Trajectories were very similar on June 25 and 26, 1987. They began at the central Monterey Bay Coast and traveled, via the Antelope Valley, into the San Joaquin Valley near Kettlemen City. North Central Coast ozone concentration values were four to eight pphm on June 25 and 26. In the Central Valley, McKittrick measured 11 pphm on June 25 and Fresno area readings ranged from 12 to 18 pphm on June 26.

The staff concludes that transport from the North Central Coast Air Basin to the San Joaquin Valley Air Basin appears to be possible and should be investigated. The studies currently planned for this area (see Section *III G*) will probably provide the needed answers.

F. Mexico to San Diego Air Basin

The San Diego County coastal plain is a fairly narrow strip with no topographic barriers between it and the coastal plain across the international border in Baja California. Physically, the entire area is one air basin.

Beginning with Grant (1973), concern has been expressed that the Tijuana area might eventually have an adverse impact on the air quality in San Diego County. Becker *et al.* (1976) present a plausible scenario: economic development in Tijuana south of the border will lead to rapid population increases there. More immediate problems than air pollution will preoccupy local Mexican officials. At the same time, north of the border more stringent pollution control will become increasingly effective. As a result, by the end of this century, Tijuana will become a much larger contributor to San Diego County's air pollution problem than it is today.

The meteorological data from the Tijuana area are limited, and little has been published about the wind flow in this area. Jauregui (1980) did a preliminary study and found a few situations during which "northward transport of pollutants across the border takes place for short periods of time." Mexican-border air quality monitoring data from the mid-1970s indicates little potential for pollution transport (Brown, 1989).

On the other hand, the scoping study[12] by Ireson *et al*. (1988) studied 158 days during which the maximum ozone concentration was 12 pphm or greater and found that, on about one-fifth of the days, transport from the Tijuana area could not be ruled out. These authors were unable to determine the magnitude of any transport.

The staff concludes that additional data and further study will be required to establish whether significant transport takes place from Mexico to the San Diego Air Basin on ozone exceedance days.

G. San Diego Air Basin to Southeast Desert Air Basin

It is almost certainly the case that oxidants are transported over the crest of the mountains and through the In Ko Pah Gorge into the desert. Whether or not the transport is associated with exceedances has not been determined. The staff concludes that this subject should be explored when the Mexico to Southeast Desert Air Basin transport is studied.

H. Mexico to Southeast Desert Air Basin

There have been exceedances reported at El Centro, less than 20 miles north of the Mexican border. The Mexicali area just over the border is growing rapidly. Prevailing summertime flow is across the border from south to north. Thus, the staff concludes that this matter should be investigated further to establish the transport contribution from Mexico to the ozone exceedances in the Southeast Desert Air Basin, if any.

I. Southeast Desert Air Basin to South Coast Air Basin

No past research has been conducted to document this potential transport couple. The staff concludes that this question should be looked into further when more data are available.

J. Broader Sacramento Area to San Francisco Bay Area Air Basin

There are two possibilities for this sort of transport. The more interesting one involves the return flow aloft which sometimes occurs during the summertime (Smith *et al*., 1985). The conjecture of Holets (1976) was that this might be a transport mechanism. The second and more likely possibility is that, during periods of stagnation, a weak north wind sometimes develops which causes transport between the Broader Sacramento Area and the San Francisco Bay Area Air Basin. The 1989 Bay Area Air Quality Management District field study should shed some light on this.

The staff concludes that this question warrants further data gathering and study to establish whether the Broader Sacramento Area's emissions contribute to the exceedances in the San Francisco Bay Area Air Basin.

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12. A review of the state of the knowledge with recommendations on what future work needs to be done, in this case a field study and numerical modeling.

K. Upper Sacramento Valley to San Francisco Bay Area Air Basin

Only the sparse information cited in Section I of Chapter III above is known about the possibility of transport between the Upper Sacramento Valley and the San Francisco Bay Area Air Basin. The staff concludes that further research is needed to establish whether or not transport occurs between these two areas.

L. San Francisco Bay Area Air Basin to Upper Sacramento Valley

This question of transport between the San Francisco Bay Area Air Basin and the Upper Sacramento Valley arises because the Sacramento Valley has been split into two sections. Current research and research planned for next year will provide further information on this subject. The staff concludes that further research is needed to establish whether not transport occurs from the San Francisco Bay Area Air Basin to the Upper Sacramento Valley can be established.

M. The Mountain Counties Air Basin

The Mountain Counties Air Basin (MCAB) covers most of the high Sierras between Lake Almanor and Yosemite National Park. Deep river valleys have been gouged in the western slopes of the Sierras by the winter runoff. Differential heating and cooling of mountain slopes cause upslope flow in daytime and downslope flow at night (*e.g.*, Defant, 1951).[13] The upslope flow carries pollutants up the Sierras, and the downslope flow carries pollutants down the mountains. The central portion of the Mountain Counties have been included in the Broader Sacramento Area. Because ozone is measured neither in the northern nor southern portions of the Mountain Counties Air Basin, the staff is not aware of transport contributing to any ozone violations.

More importantly, from the standpoint of transport, the Sierra Foothills are also included in this air basin which makes it easy for transport to take place. (See also Chapter III)

Because ozone is not measured in the southern MCAB, The staff is unaware of that transport from the San Joaquin Valley Air Basin contributes to any violations. The Mountain Counties Air Basin includes the Sierra Nevada as far south as Yosemite Park. As in the case of transport from the Sacramento Valley into the Sierras, there is a lot of evidence for transport from the southern San Joaquin Valley up the Sierra slopes (*e.g.*, Miller, 1972; Meteorology Research, Inc., 1976; Carroll and Baskett, 1979; Lehrman *et al.*, 1980a and 1980b; Blumenthal, 1985; Moore *et al.* (1987). Furthermore, there have been reports of ozone damage to trees in the southern Sierras at elevations as high as 7,000 feet (*e.g.*, Williams *et al.*, 1977; Prontos, 1978).

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13. For a review of what has been done since Defant (1951), see Yoshino (1975). U.S. Army Air Force Report 982 is still, arguably, the best introduction to local winds.

Transport up the river valleys of the northern San Joaquin Valley can therefore be expected to occur since the situation is analogous to the adjacent areas to the north and to the south. Schwall (1981) reports the following result:

> In the summer season (June through August 1979), the Rockwell monitoring systems were placed at the eastern edge of the valley at locations east of Modesto, Merced, and Madera. This allowed observation of the air masses turning from southbound main transport to eastbound upslope flows. The air pollution was well-correlated between these sites, both on an hourly and a daily basis. The ozone levels were high, with frequent exceedances of the national ambient air quality standard.

Other studies of interest are: Unger (1978), Smith *et al.* (1985), and Smith *et al.* (1985).

Transport from the northern San Joaquin Valley into the Mountain Counties is a good subject for further research. The 1990 San Joaquin Valley Air Quality Study (SJVAQS) will be the next step (for an explanation of this study see Blumenthal and Roth, 1988).

Again nothing is known about potential transport. The staff concludes that this potential transport corridor needs to be investigated.

The problem with transport from the Bay Area to the Mountain Counties is that the plume must pass through the Great Central Valley where its signature is masked by the pollutant sources in the Valley. This also makes it difficult to determine the relative contribution of Bay Area sources to any Mountain Counties ozone exceedance. Studies discussing transport from the Bay Area to the Mountain counties include Carroll and Basket (1979), MacKay (1977), and Lehrman *et al.* (1981).

In the case of smoke visible to the naked eye and thus easily tracked, we have a study (Lorenzen, 1981) documenting the transport of smoke from 1,000 acres of burned tules, a rush-like marsh plant, conducted by seven different duck clubs near Suisin Bay. Visibilities were reduced to less than seven miles as far into the Sierras as Colfax and Pollock Pines.

The staff concludes that more information is needed. More research relating to transport between the Bay Area and the Mountain Counties is being done this year and next.

CHAPTER VI

WORKSHOP AND COMMENTS RECEIVED

On August 11, 1989, a public workshop was held to obtain comments on the staff's proposed transport designations. Thirty-five people attended including representatives from both government and private industry. The staff discussed the California Clean Air Act requirements and presented a proposed list of Air Basins affected by transport of ozone or ozone precursors. The staff outlined areas previously documented in transport studies and included a bibliography of those studies. The staff described the calculation methods used to construct both manual and computer model trajectories.

The presentation ended with a discussion of the need for further data and study. During that discussion period, questions centered around the future requirements for counties and districts to mitigate their air pollution transport and the apparent lack of upper air data necessary to more accurately evaluate the transport potential in many areas of the State. Recommendations were made to identify the Outer Continental Shelf area as a source region for transport to the South Central Coast Air Basin and to monitor in the Great Basin Valleys Air Basin further. A Yuba County APCD representative expressed concerns about being included in the Broader Sacramento Area. [Attachment C includes a copy of the workshop notice, a list of attendees, and a copy of the comments received.]

CHAPTER VII

ALTERNATIVES

The identification of all areas of the state which are contributors or receptors of transported air pollutants with respect to the state ozone ambient air quality standard is mandated by law and must be based on a preponderance of the evidence. The process leaves little room for alternatives. Each identification proposed here is accompanied by discussion of the basis for the designation. Implicit in these discussions is consideration of the possible alternatives.

CHAPTER VIII

IMPACTS OF PROPOSED IDENTIFICATIONS

A. Environmental Impacts

The adoption of transport identifications pursuant to Section 39610(a) is not expected in itself to result in any adverse environmental effects. Identification by the Board of an area as a contributor or receptor of transported air pollutants will result in the Board and districts adopting plans in accordance with Chapter 10 of the Health and Safety Code which account for the transport. Therefore, the adoption of the proposed identifications may ultimately lead to environmental benefits. Any adverse environmental impacts identified with respect to specific plans and control measures will be included in the development and consideration of such plans and control measures.

B. Economic Impacts

The Board's Executive Officer has determined that the proposed amendments to the regulations will not create costs or savings, as defined in Government Code Section 11346.5(a)(6), to any state agency or in federal funding to the state, costs or mandate to any local agency or school district whether or not reimbursable by the state pursuant to Part 7 (commencing with Section 17500), Division 4, Title 2 of the Government Code, or other nondiscretionary savings to local agencies.

The air pollution control and air quality management districts responsible for areas designated nonattainment for ozone are required to develop and prepare plans pursuant to Health and Safety Code Section 40910 *et seq*. The costs incurred by the districts in connection with the planning process are not reimbursable by the state pursuant to Part 7 (commencing with Section 17500), Division 4, Title 2 of the Government Code because the statute does not mandate a new program or higher level of service of an existing program within the meaning of Section 6 of Article XIIIB of the California Constitution. In addition, the districts have the authority to levy fees sufficient to cover their costs for planning, enforcement, and other district programs. See Health and Safety Code Sections 42311 and 41512.5.

The Executive Officer has determined that the proposed amendments to the regulations will not have a significant adverse economic impact on small businesses.

The Executive Officer has also determined that there will be no, or an insignificant, potential cost impact on private persons or businesses (other than small businesses) directly affected resulting from the proposed action.

CHAPTER IX

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APPENDIX A

CALIFORNIA'S PREDOMINANT SURFACE WIND FLOW PATTERNS

Hayes *et al.* (1984) prepared the predominant surface wind flow patterns for the four seasons of the year using data from most of the then available stations in California and several nearby stations in other states which had at least one full season of data. The predominant wind is defined as the direction of the mid-point of the three-point sector (*i.e.*), a group of three contiguous points of the compass in a 16-point display) which holds the largest number of the total wind observations. For example, in the following portion of a wind rose:

Direction	Percentage of Time
N	1
NNE	3
NE	6
ENE	5
E	4

The predominant wind direction is ENE because the sector including the contiguous NE, ENE, and E directions contains the largest composite percentage of occurrence.

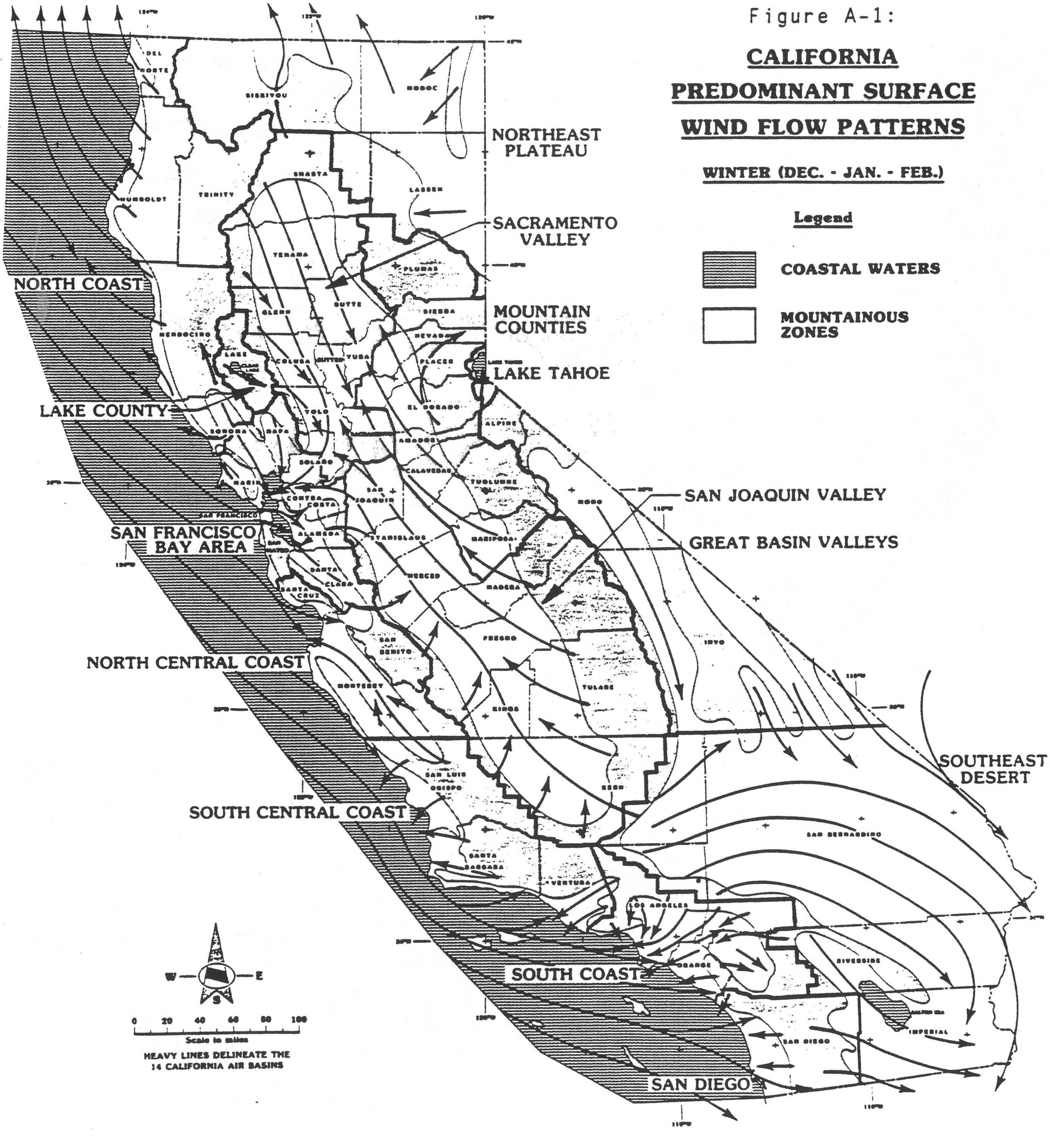
Charts for the four seasons are presented as Figure A-1 (Winter), Figure A-2 (Spring), Figure A-3 (Summer) and Figure A-4 (Fall). The location of the sites with wind data used in these analyses can be found in Figure D-1, Appendix D, and the tables in Appendix D of Hayes *et al.* (1984).

The wind flow patterns depicted in Figures A-1 thru A-4 consist of wind streamlines for most of the non-mountainous areas of California where the vast majority of the measurements were taken. In several instances, streamlines are shown in mountainous zones where data substantiate continuous streamlines from non-mountainous zones. These are generally regions where interbasin transport of air is evident and important to air pollution control. Streamlines based on data are continuous. However, those streamlines not connected to those from the data were based mostly on theoretical considerations. The final analyses were adjusted for compatibility with the analyses in the studies referenced by Hayes *et al.* (1984). Streamlines were developed for the ARB "California Coastal Waters" report using buoy, ship, island, and coastal station weather reports (see Appendix B, Hayes *et al.*).

Figure A-1:

CALIFORNIA PREDOMINANT SURFACE WIND FLOW PATTERNS

WINTER (DEC. - JAN. - FEB.)



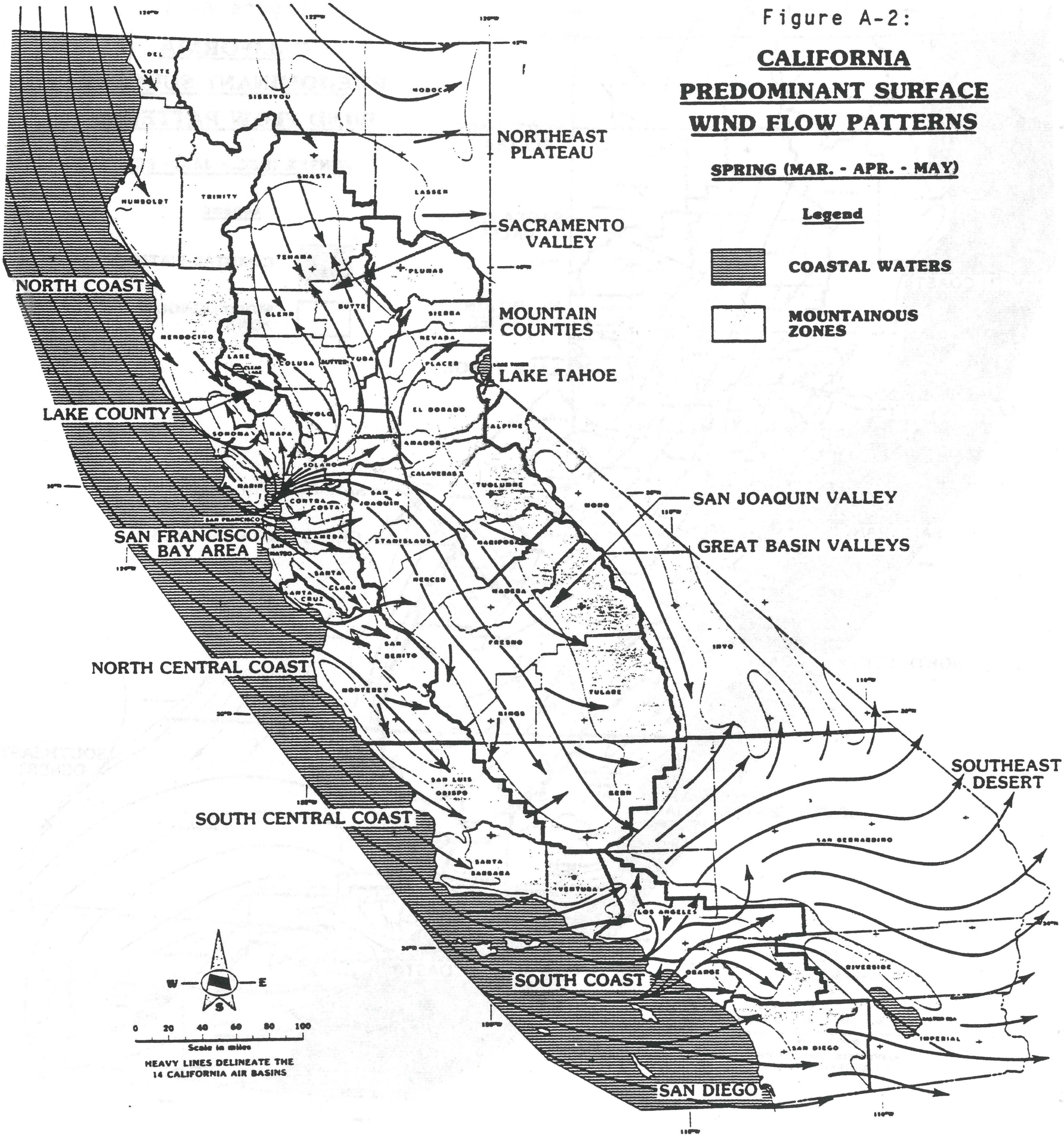


Figure A-2:

CALIFORNIA PREDOMINANT SURFACE WIND FLOW PATTERNS

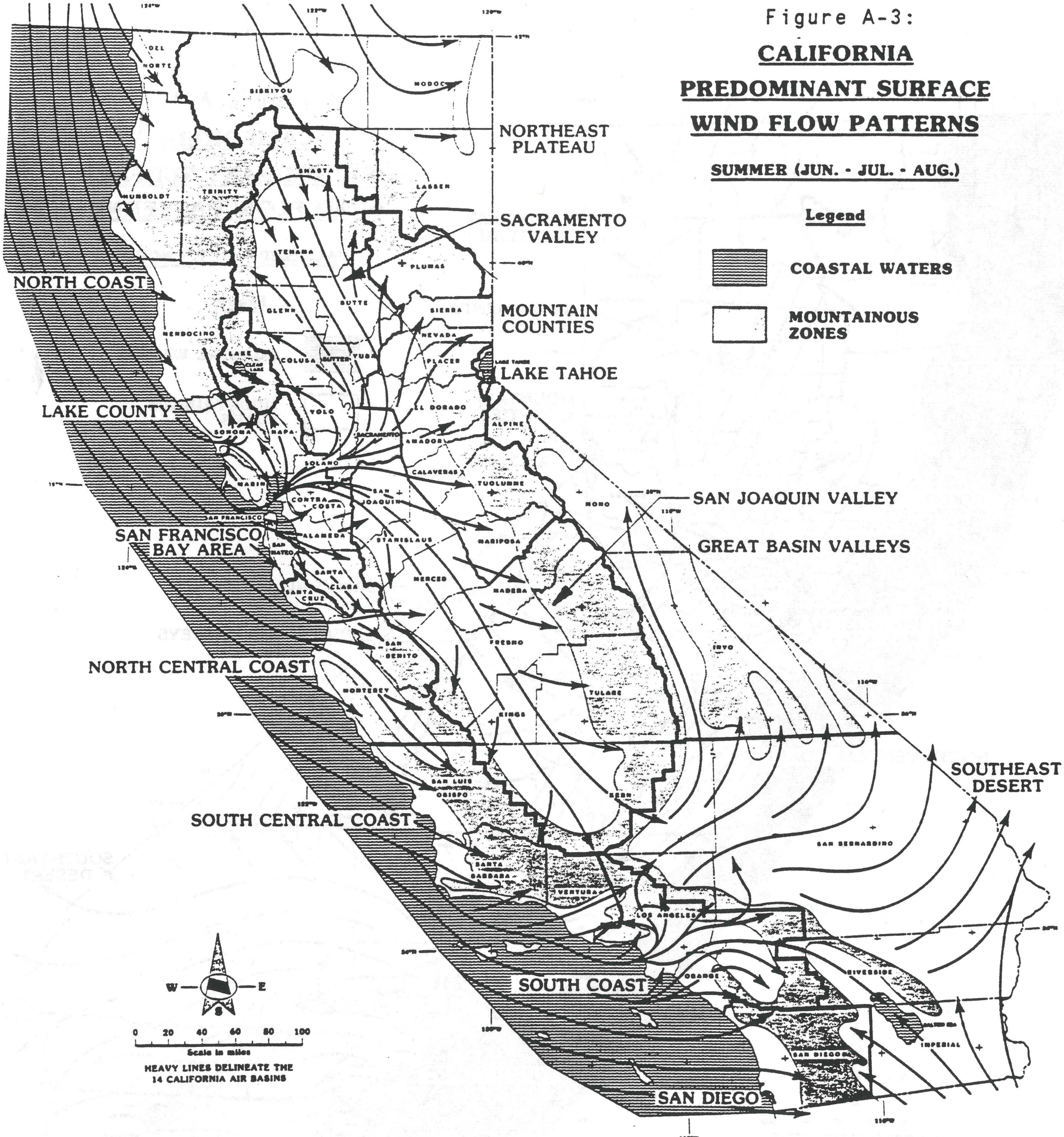
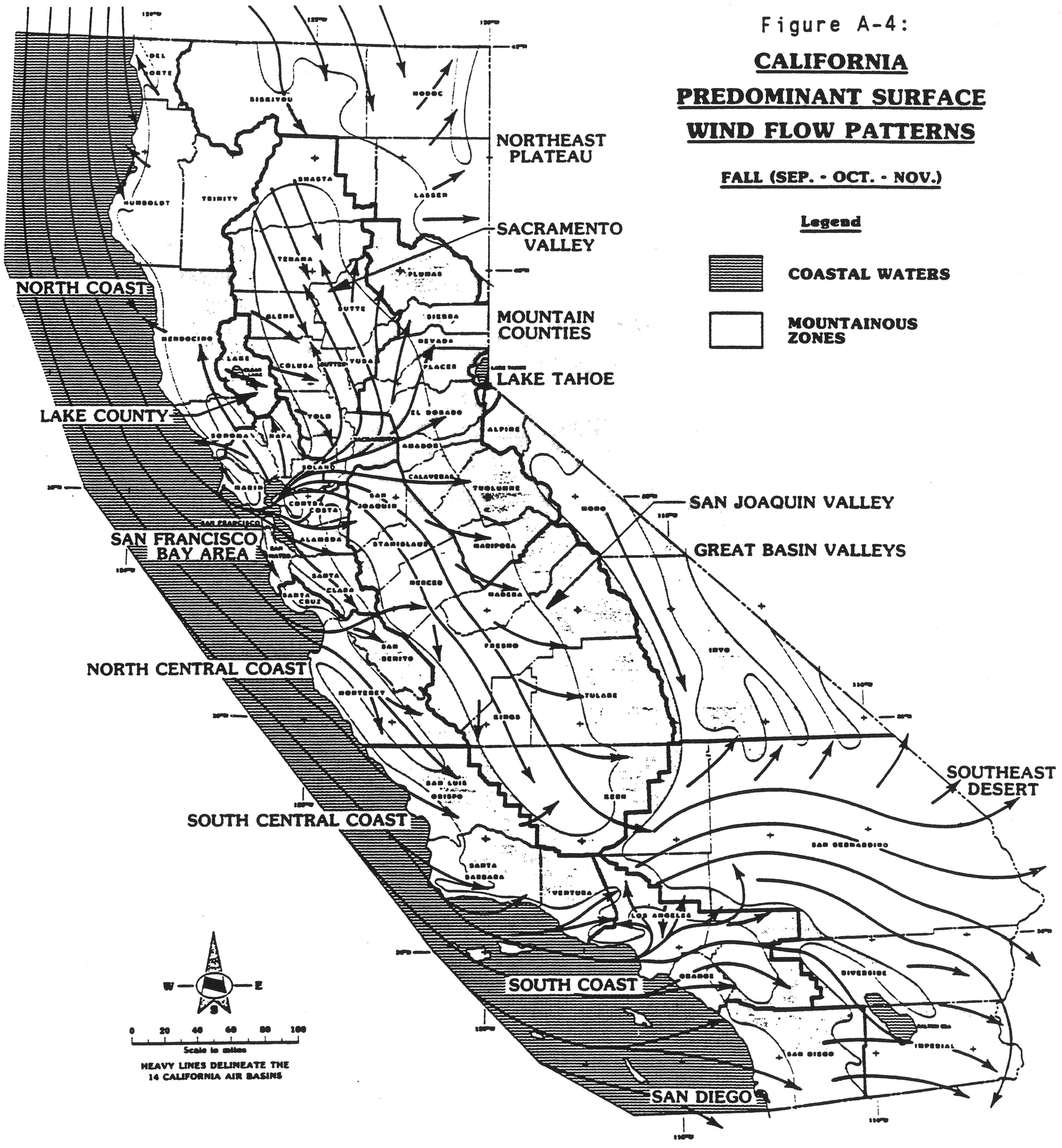


Figure A-3:
CALIFORNIA PREDOMINANT SURFACE WIND FLOW PATTERNS

Figure A-4:

CALIFORNIA PREDOMINANT SURFACE WIND FLOW PATTERNS

FALL (SEP. - OCT. - NOV.)



APPENDIX B

CALIFORNIA'S PREDOMINANT 3,000-FOOT ASL WIND FLOW PATTERNS

This section contains two analysis products of the upper air data contained in the rest of this report. These analyses pertain to the upper portion of the boundary layer which greatly influences air pollution concentrations near the ground. The first is seasonal predominant wind flow patterns for the 3,000-foot AGL (above ground level), for the morning and for the late afternoon. The second is a set of seasonal morning temperature patterns for the 3,000-foot AGL. From this analysis a table of seasonal morning stabilities (mean 3,000-foot - mean minimum temperature) was compiled for numerous locations throughout the state and offshore waters.

Predominant Winds Aloft

Predominant 3,000-foot AGL wind flow patterns have been prepared for the four seasons of the year using the upper air data available. Since there are sizable diurnal differences in the wind flows at this level and the majority of data were taken near dawn (1200Z) and in late afternoon (0000Z), a.m. and p.m. seasonal analyses were prepared. As used here, the predominant wind is defined as the direction of the mid-point of the 2-point sector (group of two contiguous points of the compass in a 12-point display) which holds the largest number of the total wind observations. This definition was used because most of the upper winds are summarized by 30^{o} segments (see Section 2) and the resultant predominant sector of 60^{o} compares favorably with that used in surface predominant wind determinations (mid-point of 3-point sector of a 16-point compass display which equals $67\text{-}1/2^{o}$).

Charts depicting predominant wind flows for the four seasons are presented in Figures 1 and 2 (Winter a.m. and p.m.), Figures 3 and 4 (Spring a.m. and p.m.), Figures 5 and 6 (Summer a.m. and p.m.), and Figures 7 and 8 (Fall a.m. and p.m.). The patterns consist of wind streamlines for mostly the non-mountainous areas of California where the vast majority of measurements were taken and where the wind flow is relatively regular because of uniform terrain. The final analyses are adjusted as necessary for compatibility with those that may have been available in the referenced documents (Appendix D) and the seasonal predominant surface wind flows found in the "California Surface Wind Climatology," ARB Report, June 1984.

Macro-scale wind is air movement generated by large scale atmospheric pressure differences which are caused by the earth's rotation and differential heating of the earth's surface by the sun. The earth's rotation is constant, while differential heating varies seasonably and as a function both of the latitude of an area and of the nature of the surfaces being heated, such as land or water surfaces.

In terms of hemispheric atmospheric circulation, California lies in the latitudinal range of prevailing westerly winds. The North Pacific high pressure cell is the dominant influence on the low level wind flow of the Eastern North Pacific Ocean and neighboring land areas in middle latitudes, particularly during the summer. It is a semi-permanent feature of the Northern Hemispheric large scale atmospheric circulation pattern, and it produces a predominantly northwesterly flow of maritime air over the California coastal waters. During winter, the Pacific high weakens and moves south, so its influence is lessened somewhat, resulting in weaker and less persistent northwesterly winds along the California coast than in the warm half of the year. The track of migratory storms moves southward to the vicinity of California during winter which, has a further influence on low level winds over the state.

This large scale circulation pattern is further modified to more westerly flow by continental influences as the air approaches the coast of California. The differential heating of the land area of California and the adjacent Pacific Ocean lying to the west enhances or weakens the predominant flow, enhancing it during the warm half of the year and weakening it during the cold portion.

Finally, on a local or regional basis the air flow in California is channeled by its mountain ranges, with the predominant wind direction in a valley coinciding with the valley's longitudinal axis in one direction and the second most prevalent wind in the opposite direction, again parallel to the valley's axis. The tendency for upvalley flow during hot months and downvalley flow during cold months is evident in the data contained herein. Also evident, but less pronounced, is the tendency for offshore flow during the coldest month, January. During the warm months, air flow is predominantly onshore because the land surfaces are generally warmer than the Pacific Ocean.

Winter (Figures B-1 and B-2). During winter, the predominant wind flow at 3,000 feet AGL over the coastal sections south of Mendocino County, at both times of the day, is mostly northwesterly in response to the flow around the subtropical high pressure cell located in the Eastern Pacific. The predominant flow north of Mendocino County is southwesterly, as a reflection of the migratory low pressure systems that frequently traverse the region from west to east during this season. The main exception to this onshore flow is in the South Coast, where the land breezes set up a westward flow along the southern slopes of the Santa Ynez and San Gabriel mountains during the morning. Northwesterly flow spreads over the area in the afternoon, with only weak remnants of easterly flow along the foothills.

The predominant flow, in the morning, is convergent in the Great Central Valley from the basic downvalley (drainage) components in each section. This flow becomes full north to south by afternoon except for a faint residual of the downvalley flow in the eastern San Joaquin Valley (possibly a reflection of the Fresno Eddy action). There appears to be a few incursions westward into the coastal valleys at some of the low points in the coastal ranges.

The morning airflow over the Southeast Desert is mostly drainage from the high desert to the low desert. During the afternoon the flow becomes more westerly--diverging into the interior regions of the great southwest.

Spring (Figures B-3 and B-4). During the spring, at both times the air flow at 3,000 feet AGL is mostly northwesterly along the coastal sections of California. There is a weak easterly current out of the northern portions of the South Coast during the morning which is totally eliminated by the sea breeze circulation during the afternoon. The afternoon turning of the wind into the San Fernando Valley is evident.

The morning flow in the Great Central Valley is northerly throughout. By afternoon the northern portion of this flow is reversed to a full upvalley flow in the Sacramento Valley, reinforced by the westerly flow through the delta region.

The flow throughout the Southeast Desert region is mostly westerly at both times.

Summer (Figures B-5 and 6). During the summer at both times the airflow at 3,000 feet AGL is northwesterly along the coastal regions of California. The offshore land breeze in the morning in the northern sections of the South Coast still persists and becomes completely obliterated by the afternoon sea breezes. The afternoon turning of the windflow into the San Fernando Valley is evident.

The airflow at both times in the Great Central Valley shows the massive influx of air through the delta region which thereafter splits into northern and southern upvalley branches. The minor exception to this is a short fetch of drainage flow during the morning in the extreme northern portion of the Sacramento Valley.

The flow throughout the Southeast Desert at both times is mostly southwesterly towards the hot deserts of the Southwestern United States.

Fall (Figures B-7 and B-8). During the fall, the air flow at both times at 3,000 feet AGL is mostly northwesterly along the coastal regions of California. There is a tendency for the air flow to become more westerly north of Cape Mendocino as the storm track begins its southward migration. The off-shore land breeze is still evident in the South Coast during the morning but again is wiped out by the afternoon sea breezes. The afternoon turning of the airflow into the San Fernando Valley is also still evident.

The air flow in the morning in the Great Central Valley is downvalley--converging in the Northern San Joaquin Valley. There is some flow outward through the delta from the Sacramento Valley branch. The airflow makes a complete reversal to upvalley flow throughout the Great Central Valley by afternoon except in the extreme north end of the Sacramento Valley.

Figure B-1:

PREDOMINANT A.M. WIND FLOW

3000' AGL

WINTER (DEC. - JAN. - FEB.)

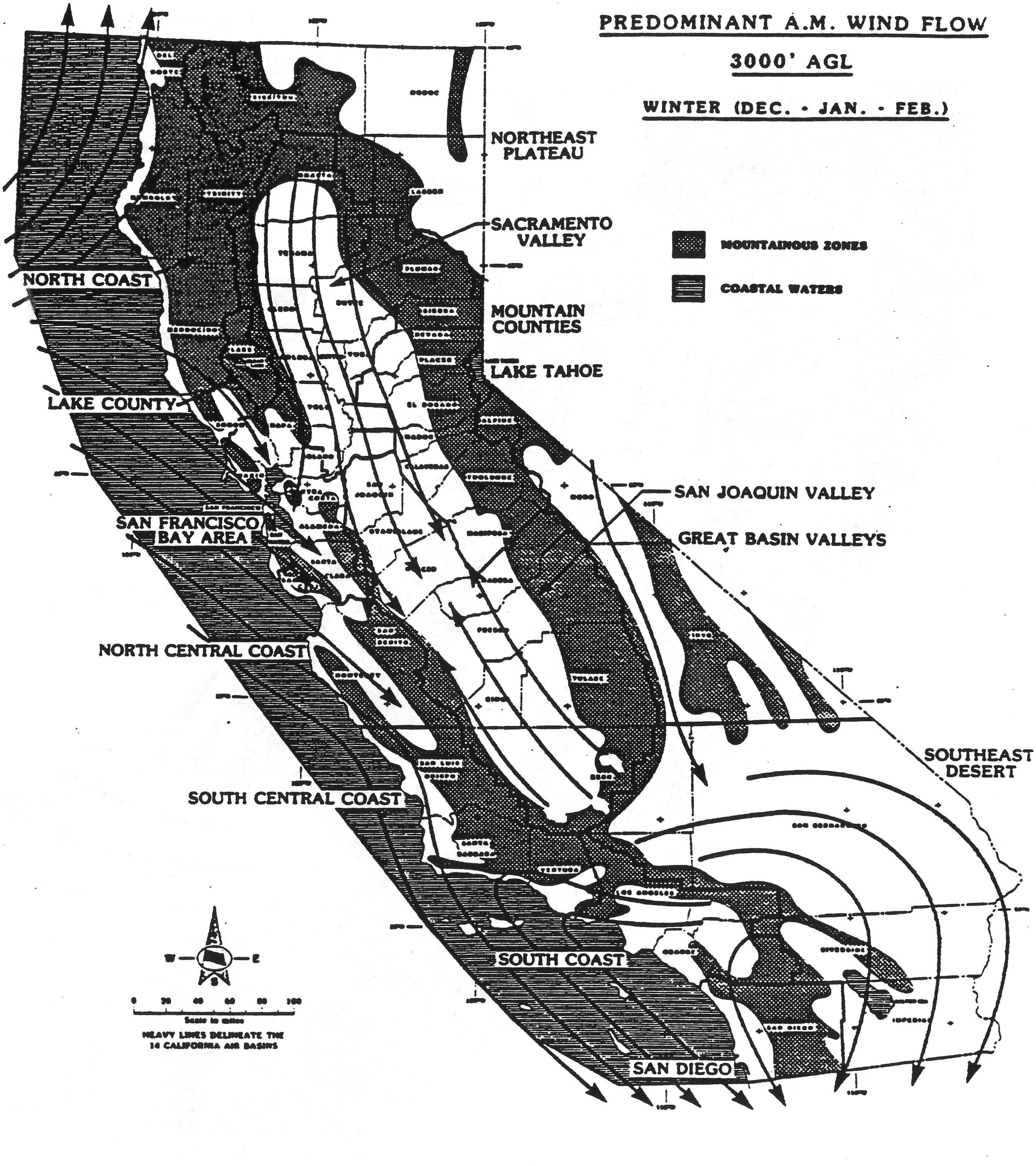


Figure B-2:

PREDOMINANT A.M. WIND FLOW

3000' AGL

SPRING (MAR. - APR. - MAY)

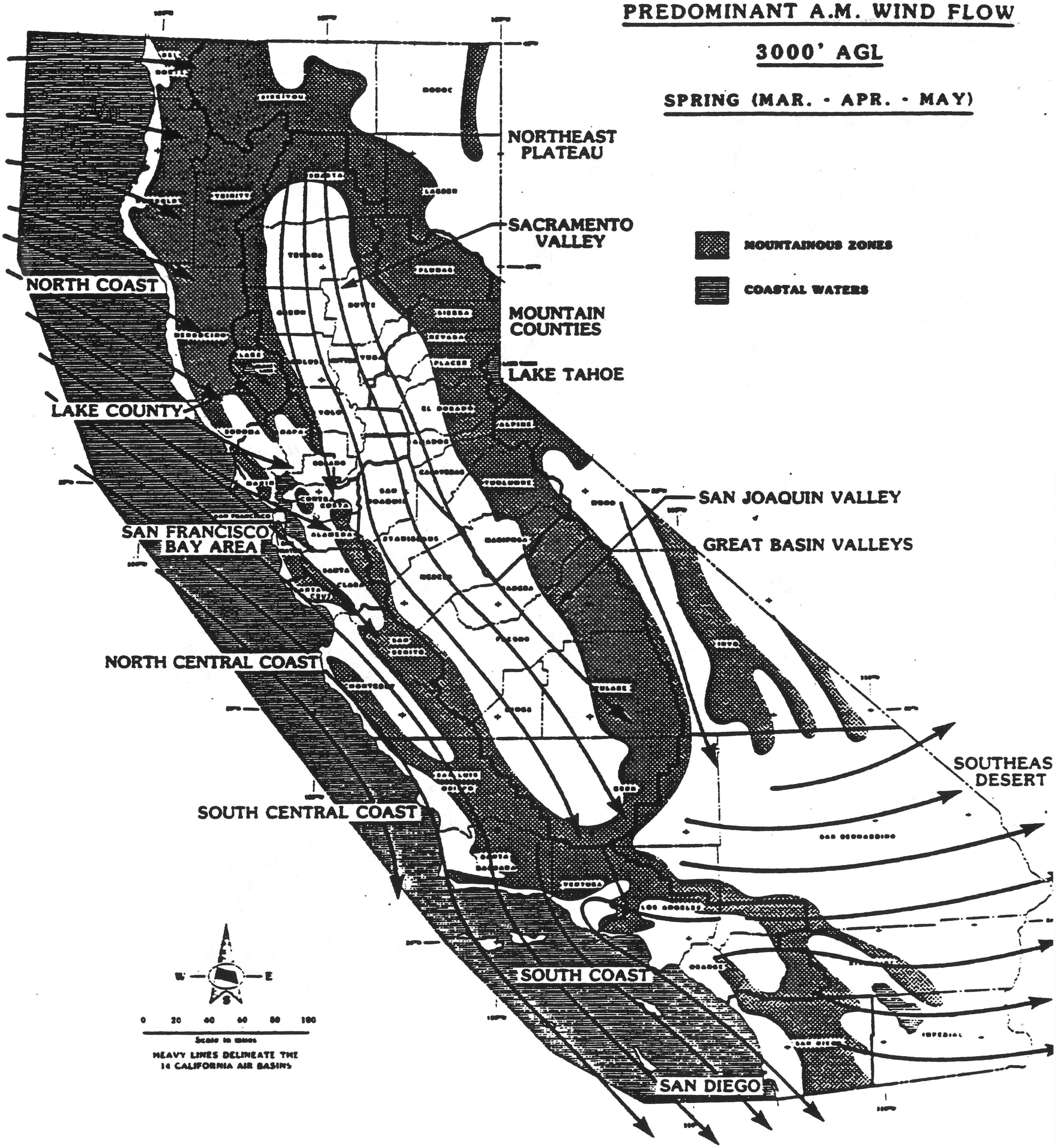


Figure B-3:

PREDOMINANT A.M. WIND FLOW

3000' AGL

SUMMER (JUN. - JUL. - AUG.)

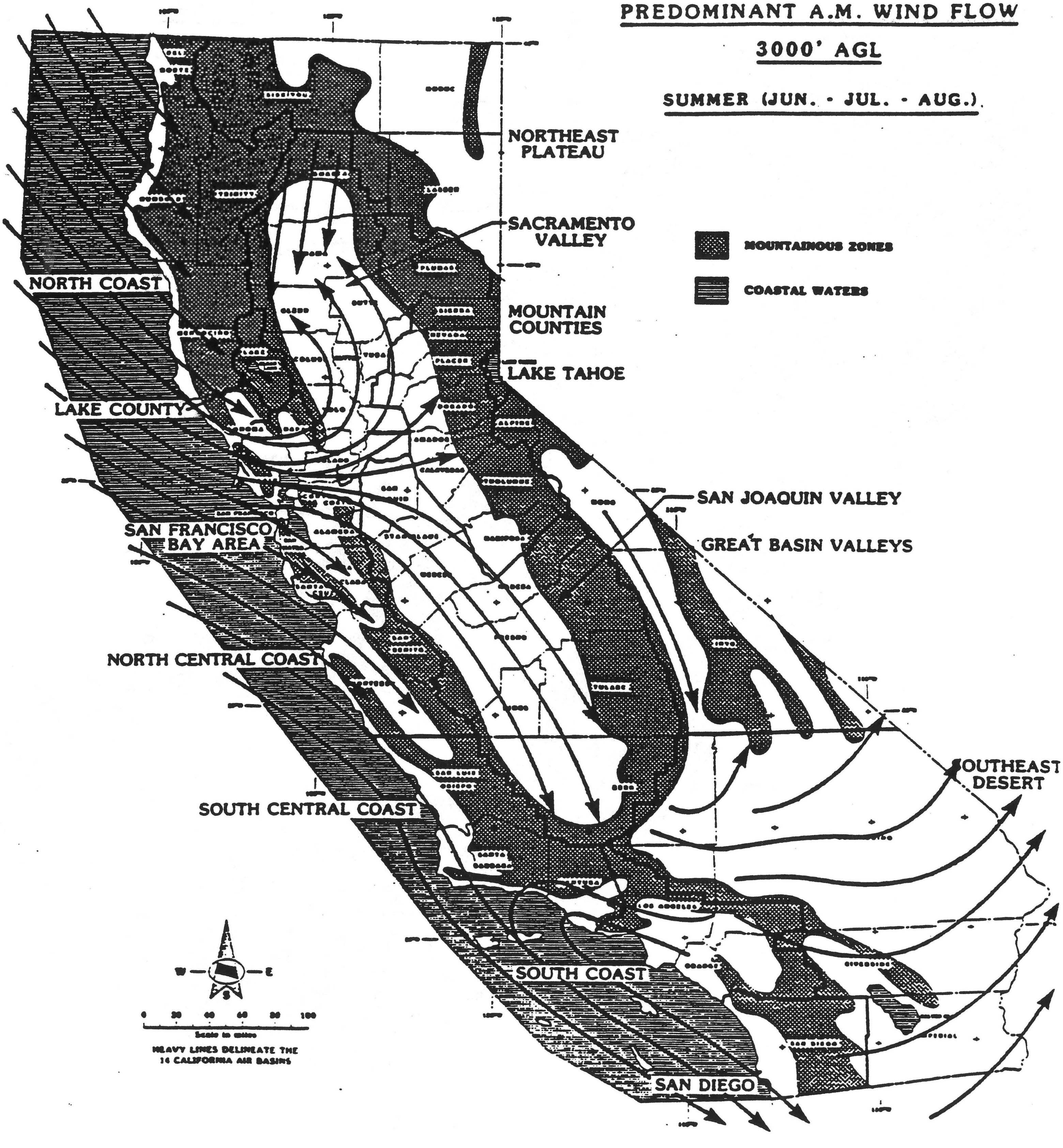


Figure B-4:

PREDOMINANT A.M. WIND FLOW

3000' AGL

FALL (SEP. - OCT. - NOV.)

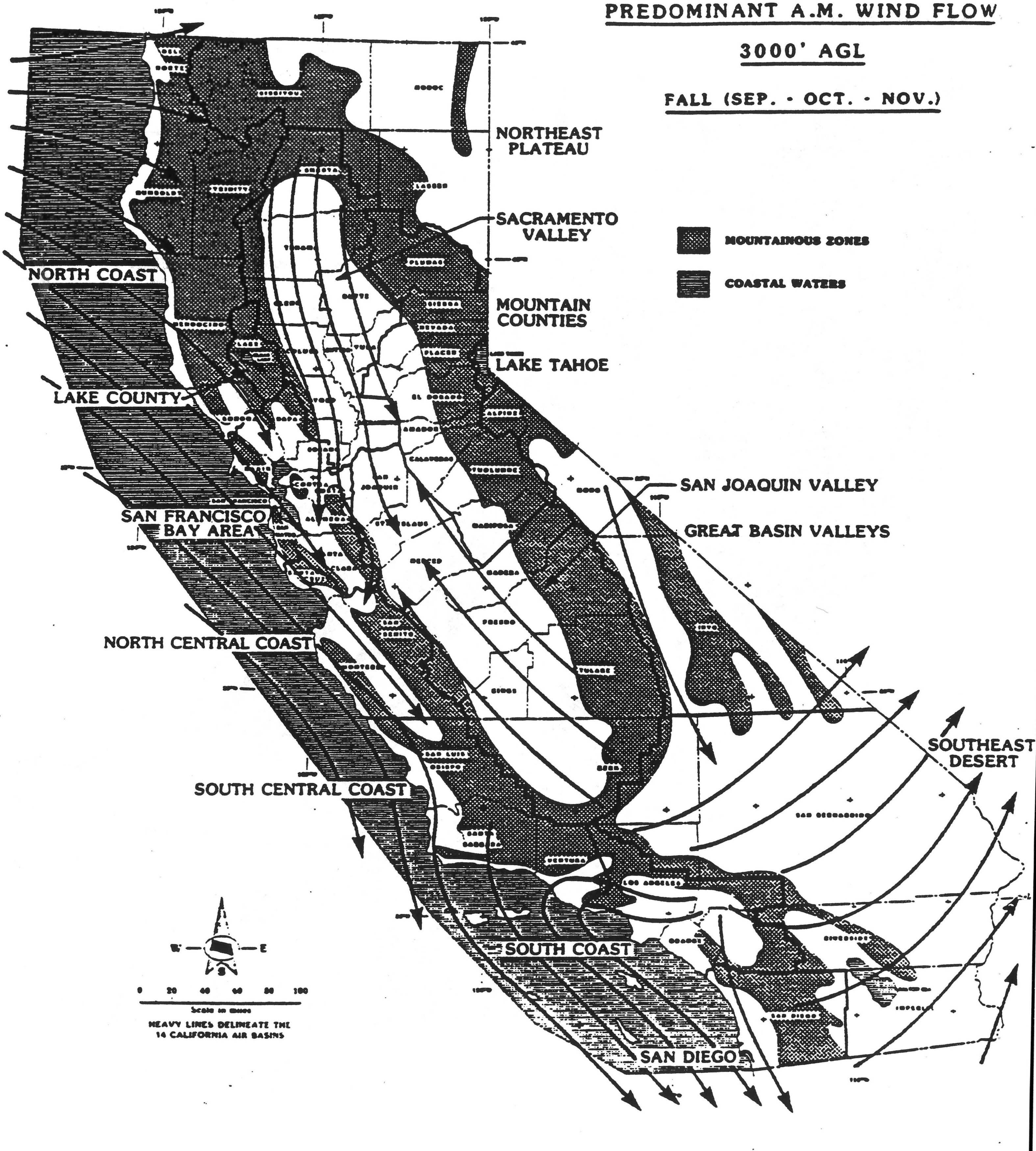


Figure B-5:

PREDOMINANT P.M. WIND FLOW

3000' AGL

WINTER (DEC. - JAN. - FEB.)

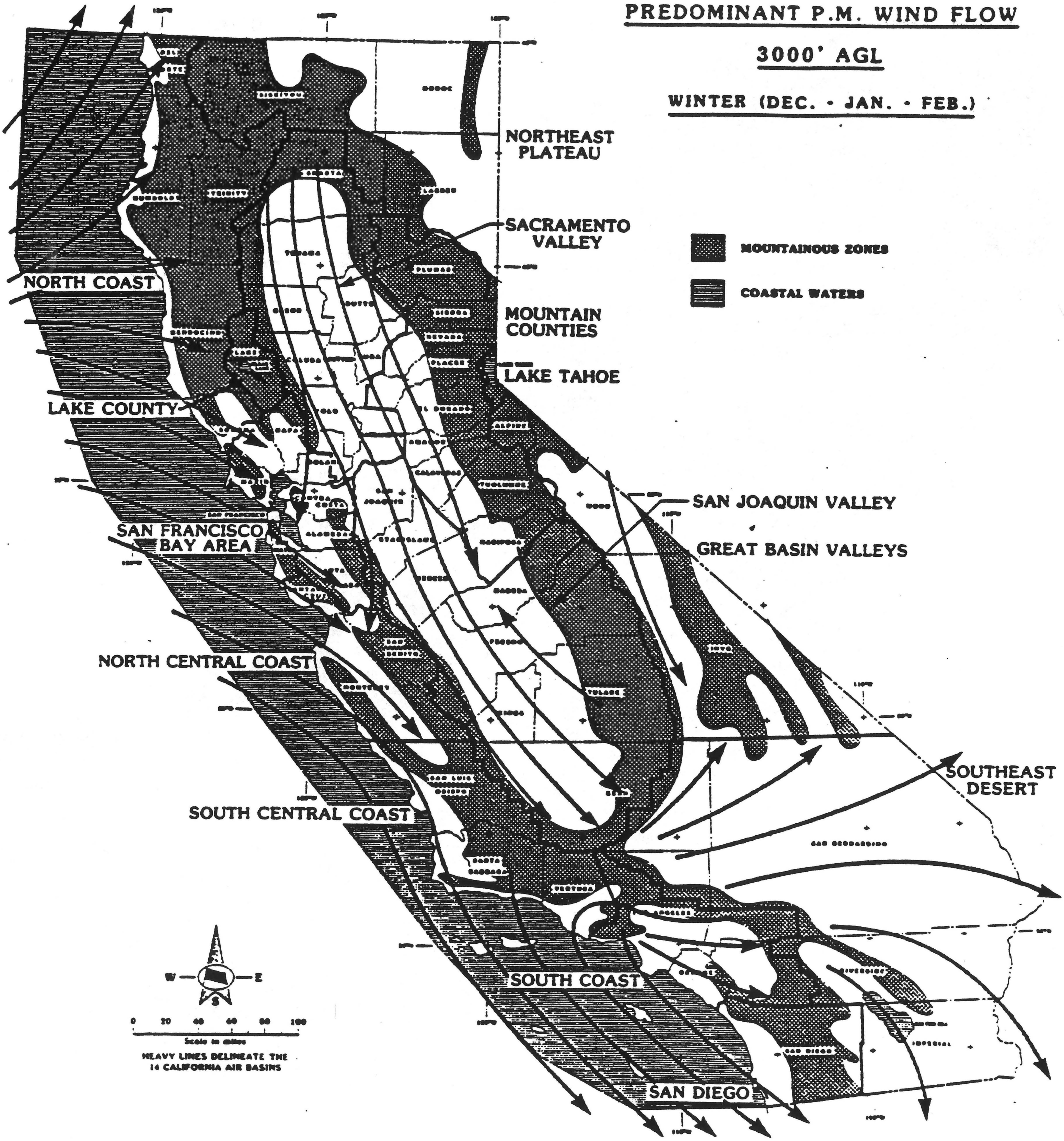


Figure B-6:

PREDOMINANT P.M. WIND FLOW

3000' AGL

SPRING (MAR. - APR. - MAY)

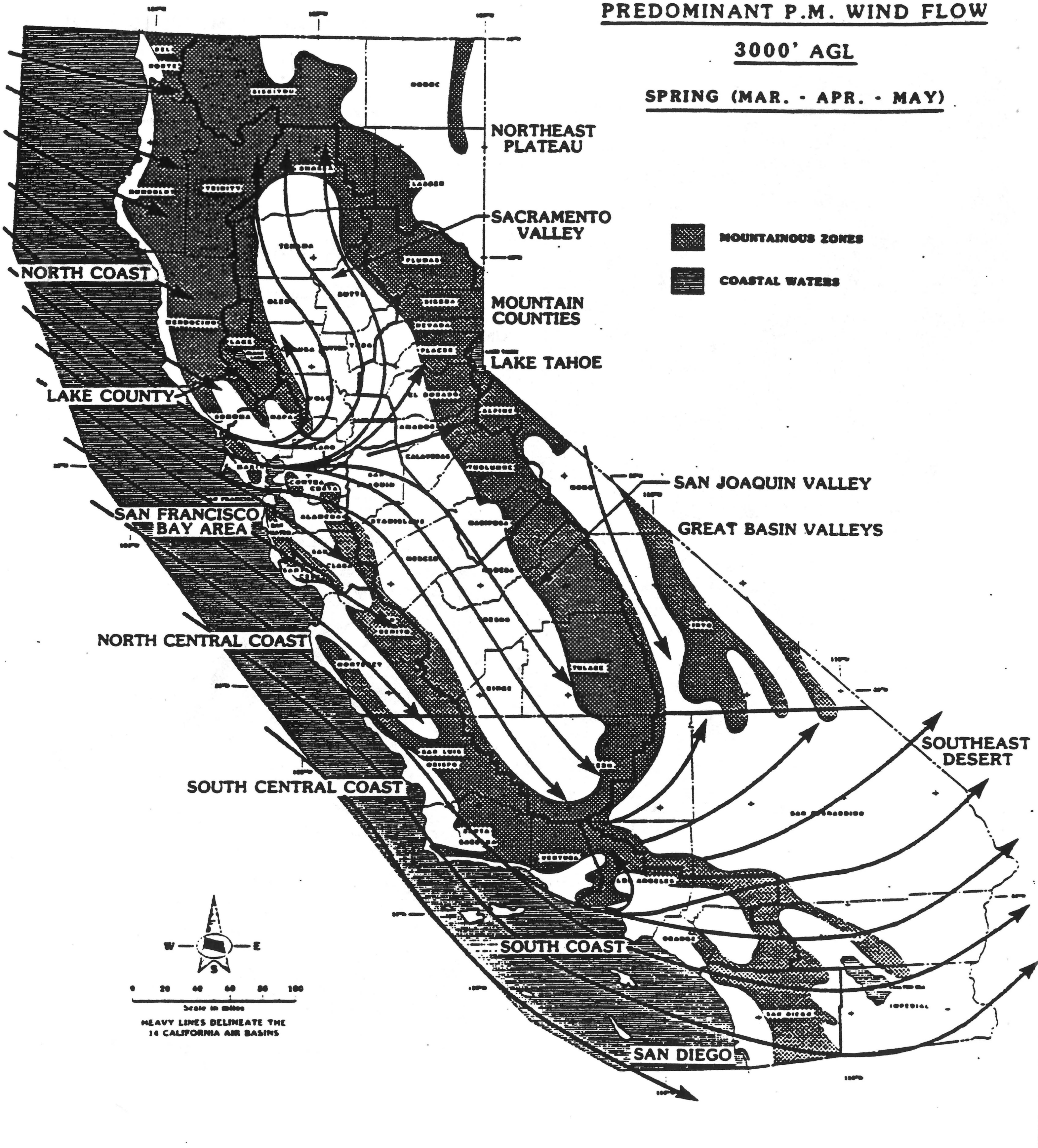


Figure B-7:

PREDOMINANT P.M. WIND FLOW

3000' AGL

SUMMER (JUN. - JUL. - AUG.)

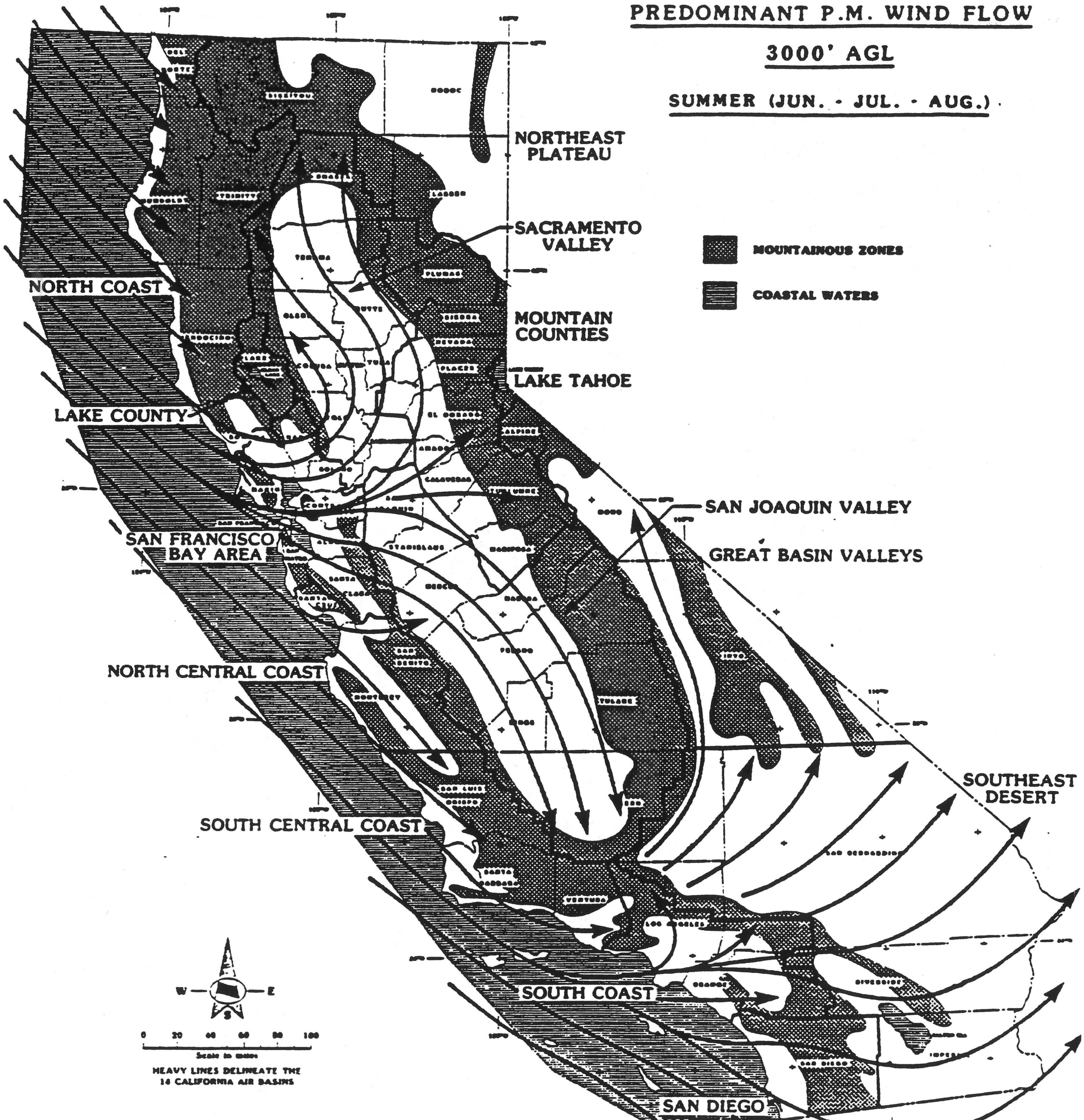
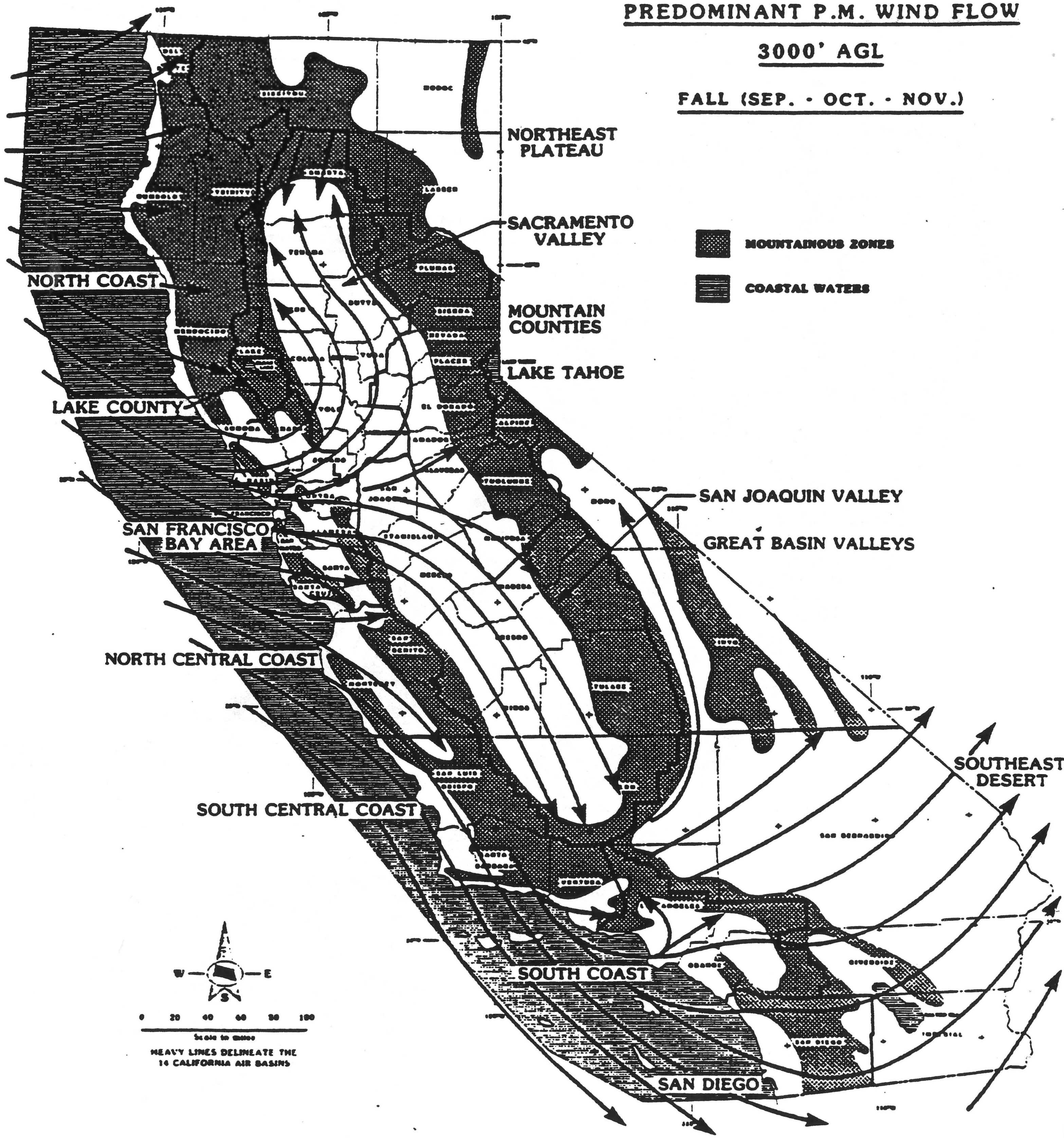


Figure B-8:

PREDOMINANT P.M. WIND FLOW

3000' AGL

FALL (SEP. - OCT. - NOV.)



APPENDIX C

HOW TO CONSTRUCT TRAJECTORIES

Over many areas of the state where little or no upper air data were available, the staff constructed hand drawn trajectories using surface winds. This method was selected because it has been tested and used before in California studies and it can be done with available data. Erwin K. Kauper (1955) noted that "the low level winds aloft measurements made during the summer season show small variations of wind with height below the inversion base, and thus indicate that surface wind reports may safely be used in construction of air pollution trajectories."

The actual construction techniques the ARB staff used were very similar to those described in Saucier's *Principles of Meteorological Analysis* (1953). The staff made the following assumptions:

1. Air movement is horizontal.
2. The parcel of air will follow the streamlines.
3. The movement assigned to this air parcel will depend on the resultant direction and speed of the wind.

Given these assumptions, the staff performed the following steps:

1. Selected high ozone concentration days,
2. Plotted the available wind data,
3. Drew streamlines to match the instantaneous path of the parcel,
4. Used a light table and overlayed two successive hourly streamline charts. Analyzed the resultant wind direction and speed 2nd, then plotted the path of the parcel of air accordingly.
5. The steps of this proceedure should be repeated on an hourly basis for a maximum of two days.

For greater detail on constructing trajectories see Saucier (1953).

APPENDIX D

THE WINDS-2D NUMERICAL MODEL

The Winds-2D numerical model was developed by Goodin *et al.* (1980) and was used because the "technique is easy to implement, computationally efficient, and offers promise as an attractive method for routine meteorological applications". The model was then modified to run on the ARB's prime computer. The area of interest was selected, wind availability identified and boundaries and barriers established for the basic model. Data from the high ozone days used in the manual analyses were put into the computer. Surface wind flow fields for each hour, similar to the hand drawn fields, were calculated. Then a simple ARB computer algorithm, also similar to the hand-drawn, method was used to calculate the trajectories either forward from a source or backward from a receptor area.

Amend Subchapter 1.5. Air Basins and Air Quality Standards, Title 17, California Code of Regulations, by adding Article 5. Transported Air Pollutants Identification, Section 70500, as follows:

Article 5. Transported Air Pollutants

70500. <u>Transport Identification</u>

(a) <u>Purpose</u>.

This regulation identifies the areas in which transported air pollutants from upwind areas cause or contribute to a violation of the state ambient air quality standard for ozone and the areas of origin of the transported pollutants. All areas identified in the table are air basins except as otherwise specifically described and defined.

(b) <u>Definitions</u>.

(1) "California Coastal Waters" includes the area between the California coastline and a line starting at the California-Oregon border at the Pacific Ocean; thence to 42.0 degrees North, 125.5 degrees West; thence to 41.0 degrees North, 125.5 degrees West; thence to 40.0 degrees North, 125.5 degrees West; thence to 39.0 degrees North, 125.0 degrees West; thence to 38.0 degrees North, 124.5 degrees West; thence to 37.0 degrees North, 123.5 degrees West; thence to 36.0 degrees North, 122.5 degrees West; thence to 35.0 degrees North, 121.5 degrees West; thence to 34.0 degrees North, 120.5 degrees West; thence to 33.0 degrees North, 119.5 degrees West; thence to 32.5 degrees North, 118.5 degrees West; and ending at the California-Mexican border at the Pacific Ocean.

(2) "Upper Sacramento Valley" includes the Colusa, Butte, Glenn, Tehama, and Shasta County Air Pollution Control Districts.

(3) "Broader Sacramento Area" includes the Sacramento, Yolo-Solano, Sutter, Yuba, Nevada, El Dorado, and Placer County Air Pollution Control Districts.

(c) *Transport Identification Table*

OZONE IMPACTED BY TRANSPORT:	AREAS OF ORIGIN OF TRANSPORT:
1. North Central Coast	San Francisco Bay Area
2. South Central Coast	South Coast California Coastal Waters
3. South Coast	South Central Coast
4. San Diego	South Coast
5. Upper Sacramento Valley	Broader Sacramento Area
6. Broader Sacramento Area	San Francisco Bay Area San Joaquin Valley
7. San Joaquin Valley	San Francisco Bay Area Broader Sacramento Area
8. Great Basin Valleys	Undetermined
9. Southeast Desert	South Coast San Joaquin Valley

Authority cited: 39600, 39601, and 39610(a) of the Health and Safety Code.
Reference: 39610(a) of the Health and Safety Code.

TITLE 17. CALIFORNIA AIR RESOURCES BOARD

NOTICE OF PUBLIC HEARING TO CONSIDER THE ADOPTION OF A REGULATION WHICH IDENTIFIES THE AREAS IN WHICH TRANSPORTED AIR POLLUTANTS CONTRIBUTE TO VIOLATIONS OF THE STATE AMBIENT AIR QUALITY STANDARD FOR OZONE AND THE AREAS OF ORIGIN OF THE POLLUTANTS.

The Air Resources Board (the "Board" or "ARB") will conduct a public hearing at the time and place noted below to consider adoption of regulations to identify areas in which transported air pollutants contribute to ozone violations and the areas of origin of those pollutants. The Board will also identify and determine priorities for additional studies of transport of pollutants.

DATE: December 14, 1989

TIME: 9:30 a.m.

PLACE: State Building Auditorium
Room 1138
107 S. Broadway
Los Angeles, CA

This item will be considered at a two-day meeting of the Board which will commence at 9:30 a.m., December 14, 1989, and will continue at 8:30 a.m., December 15, 1989. This item may not be considered until December 15, 1989. Please consult the agenda for the meeting which will be available at least 10 days before December 14, 1989, to determine the day on which this item will be considered.

INFORMATIVE DIGEST OF PROPOSED ACTION

Section Affected: Section 70500, Title 17, California Code of Regulations.

The California Clean Air Act was enacted in 1988. (Stats. 1988, ch. 1568, the "Act.") It significantly revised Division 26 of the Health and Safety Code by adding several requirements concerning plans and control measures to attain and maintain the state ambient air quality standards. One of these new requirements is for the Board, based upon the preponderance of available evidence, to identify each air pollution control district in which transported air pollutants from upwind areas outside the district cause or contribute to a violation of the state ambient air quality standard for ozone, as well as the district of origin of the transported pollutants. Health and Safety Code Section 39610(a). In addition, the Act requires that information needed to make a more accurate determination of transport be identified and prioritized.

The staff has identified several of the upwind air basins which contribute to the exceedances of the state ambient air quality standard for ozone in downwind air basins. These transport contributors and receptors are listed as transport couples in proposed Section 70500. All areas identified are air basins except as otherwise specifically described and defined. The regulation includes definitions of California Coastal Waters, Upper Sacramento Valley and the Broader Sacramento Area. The staff proposes the following transport identifications.

	Ozone Nonattainment Areas Impacted by Transport:	Transport Originates from the Following Areas:
1.	North Central Coast	San Francisco Bay Area
2.	South Central Coast	South Coast California Coastal Waters
3.	South Coast	South Central Coast
4.	San Diego	South Coast
5.	Upper Sacramento Valley	Broader Sacramento Area
6.	Broader Sacramento Area	San Francisco Bay Area San Joaquin Valley
7.	San Joaquin Valley	San Francisco Bay Area Broader Sacramento Area
8.	Great Basin Valleys	Undetermined
9.	Southeast Desert	South Coast San Joaquin Valley

Health and Safety Code Section 40911(b) requires any district which is a receptor or contributor of transported air pollutants, as determined under Health and Safety Code Section 39610(a), to prepare and submit a plan for attaining and maintaining specified state ambient air quality standards, including the ozone standard, to the state board not later than June 30, 1991.

AVAILABILITY OF DOCUMENTS AND CONTACT PERSON

The Board staff has prepared a Staff Report which includes the initial statement of reasons for the proposed action and a summary of the environmental impacts of the proposal. The Staff Report, the full text of the proposed regulation, and any other information on which the proposal is based will be available for inspection at the Board's Public Information Office, 1102 Q Street, Sacramento, CA 95814, (916) 322-2990, at least 45 days prior to the scheduled hearing. Copies of the documents may be obtained at the Board's Public Information Office.

Further inquiries regarding this matter should be directed to Don McNerny, Chief, Modeling and Meteorology Branch, (916) 322-6048, P.O. Box 2815, Sacramento, CA 95812.

COSTS TO PUBLIC AGENCIES AND TO BUSINESSES AND PERSONS AFFECTED

The Board's Executive Officer has determined that the regulation will not create costs or savings, as defined in Government Code Section 11346.5(a)(6), to any state agency or in federal funding to the state, costs or mandate to any local agency or school district whether or not reimbursable by the state pursuant to Part 7 (commencing with Section 17500), Division 4, Title 2 of the Government Code, or other nondiscretionary savings to local agencies.

The Executive Officer has determined that adoption of this regulation will not have a significant adverse economic impact on small businesses.

The Executive Officer has also determined that there will be no, or an insignificant, potential cost impact on private persons or businesses (other than small businesses) directly affected resulting from the proposed action.

In addition, the Board must determine that no alternative considered by the agency would be more effective in carrying out the purpose for which the regulation is proposed or would be as effective and less burdensome to affected private persons than the proposed action.

SUBMITTAL OF COMMENTS

The public may present comments relating to this matter orally or in writing. To be considered by the Board, written submissions must be addressed to and received by the Board Secretary, Air Resources Board, P. O. Box 2815, Sacramento, CA 95812, no later than 12:00 noon, December 13, 1989, or received by the Board Secretary at the hearing.

The Board requests but does not require that 20 copies of any written statement be submitted and that all written statements be filed at least 10 days prior to the hearing. The Board encourages members of the public to bring to the attention of staff in advance of the hearing any suggestions for modification of the proposed regulation.

STATUTORY AUTHORITY AND HEARING PROCEDURES

This regulation is proposed under that authority granted in Health and Safety Code Sections 39600, 39601, and 39610(a). The regulation is proposed to implement, interpret and make specific Health and Safety Code Section 39610(a).

The public hearing will be conducted in accordance with the California Administrative Procedure Act, Title 2, Division 3, Part 1, Chapter 3.5 of the Government Code.

Following the public hearing, the Board may adopt the proposed regulation as proposed or with nonsubstantial or grammatical modifications. The Board may also adopt the proposed regulation with other modifications if the regulation as modified is sufficiently related to the originally proposed text that the public was adequately placed on notice that the regulation as modified could result from the proposed regulatory action; in such event the full text of the regulation with the modifications clearly indicated will be made available to the public, for written comment, at least 15 days before they are adopted. The public may request that text of the modified regulation from the Board's Public Information Office, 1102 Q Street, Sacramento, CA 95814, (916) 322-2990.

James D. Boyd
Executive Officer

Date: October 17, 1989

STATE OF CALIFORNIA

GEORGE DEUKMEJIAN, *Governor*

AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

July 13, 1989

Dear Sir or Madam:

Public Consultation Meeting to Discuss the Identification of Districts in Which Transported Air Pollutants Contribute to the Violation of the State Ozone Standard Pursuant to the California Clean Air Act of 1988

This letter is to notify you of a consultation meeting the Air Resources Board staff will hold to discuss issues relating to the identification of Districts in which transported air pollutants contribute to state ozone standard violations (see Section 39610 of the Health and Safety Code as amended by the California Clean Air Act of 1988). The Air Resources Board is scheduled to consider adoption of such an identification list in December 1989.

The public consultation meeting will be held at the time and location noted below:

DATE: August 11, 1989

TIME: 9 AM to 1 PM

PLACE: State Library
914 Capitol Mall
Room 500, 5th Floor
Sacramento, CA 95814

Major topics for discussion include:

(1) legislative mandate and context for identifying districts;

(2) working definitions for terms such as "trajectories" and "transport";

(3) methods used to construct trajectories manually and by means of computer models;

(4) identification of transport impacted districts and origins of transport; and

(5) additional data needed to make transport determinations.

The purpose of the meeting is to obtain comments concerning the above issues. Should you have any questions, please contact Arndt Lorenzen, Chief Meteorologist, at (916) 322-6040.

Sincerely,

Terry McGuire, Chief
Technical Support Division

Attachment

cc: Arndt Lorenzen

HEALTH AND SAFETY CODE:

Section 39610. (a) Not later than December 31, 1989, the state board shall identify each district in which transported air pollutants from upwind areas outside the district cause or contribute to a violation of the state standard for ozone and shall identify the district of origin of the transported pollutants, based upon the preponderance of available evidence. The state board shall identify and determine the priorities of information and studies needed to make a more accurate determination, including, but not limited to, emission inventories, pollutant characterization, ambient air monitoring, and air quality models.

Air Resources Board
Technical Support Division
METEOROLOGY SECTION

LIST OF ATTENDEES AT THE
PUBLIC CONSULTATION MEETING TO DISCUSS THE IDENTIFICATION OF DISTRICTS IN WHICH TRANSPORTED AIR POLLUTANTS CONTRIBUTE TO THE VIOLATION OF THE STATE OZONE STANDARD PURSUANT TO THE CALIFORNIA CLEAN AIR ACT OF 1988

AUGUST 11, 1989
STATE LIBRARY, SACRAMENTO

ATTENDEE	ORGANIZATION	MAILING ADDRESS
R. H. Thuillier	P.G. & E.	77 Beale Street, Rm 1605B San Francisco, CA 94106
Jacqueline Switzer Vince Mirabella	SCE	2244 Walnut Grove Rosemead, CA 91770
Tom Murphy	Santa Barbara County APCD	105 E. Anapanu Street Santa Barbara, CA 93101
D.B. "Bernie" Engle	Yuba County APCD	938 14th Street Marysville, CA 95901
Al Perrin	Sutter County APCD	142 Garden Hwy, Yuba City, CA
Gaspar Torres	Imperial County APCD	150 South 9th Street El Centro, CA 92243-2850
Janet Brennen Doug Quetin	Monterey Bay UAQMD	1164 Monroe Street, #1000 Salinas, CA 93906
Gary O'Neil	Shell Western E & P	5060 California Ave. Bakersfield, CA 93309
Bruce Nixon	Sacramento County AQMD	8475 Jackson Road #215 Sacramento, CA 95826
Ellen Hardebeck Debra Lanhon	Great Basin APCD	157 Short Street Bishop, CA 93514
Linda Chester	Kern County APCD	2700 M Street, Suite 275 Bakersfield, CA 93301
Larry Allen	San Luis Obispo County APCD	2156 Sierra Way San Luis Obispo, CA 93401
Bill Schucot	Yolo/Solano County APCD	P. O. Box 1006 Woodland, CA 95695
Jeffrey D. Mott	Butte County APCD	9257 Midway, Suite 2D Durham, CA 95938

TRANSPORT I.D. WORKSHOP, Cont.

Hal Brown	San Diego APCD	9190 Chesapeake Drive San Diego, CA 92123
Rob DeMandel	Bay Area AQMD	939 Ellis Street San Francisco, CA 94109
Kee Tsang	P G & E	1 California Street, Rm 1659 San Francisco, CA 94106
Evan Shipp	Ventura County APCD	800 S. Victoria Avenue Ventura, CA 93009
Jim Thompson Vernon Peterson	El Dorado Co. APCD	7553 Green Valley Road Placerville, CA 95667-4197
Greg Vlasek	South Calif. Gas Co.	Box 3249 Terminal Annex Los Angeles, CA 90051
Leon Dolislager	ARB	P.O. Box 2815
Gary Honcoop		Sacramento, CA 95812
Roy Moore		"
Steve Gouze		"
Jerry Clark		"
Neil Wheeler		"
Susan State		"
Kit Wagner		"
Chuck Bennett		"
Ron Rothacker		"
Sue Ragen		"
Patrick Nevis		"