PROJECT BASIN

FINAL REPORT
TO THE CALIFORNIA AIR RESOURCES BOARD

(STATE OF CALIFORNIA CONTRACT A3-104-32)

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1. Introduction

Los Angeles has often been referred to as the "smog capital" of the world. Automobile exhaust in regions of heavy traffic and industrial pollutants are considered to be the major sources of hydrocarbons, oxides of nitrogen, and other precursors which lead to respiratory problems and eye irritation in many humans and significant damage to many species of plant life. The airflow in the Los Angeles Basin which transports this pollution is not easy to model since it is known to be the complex result of a variety of pressure gradients, and thermal and topographic influences (e.g., sea-land breezes, mountain-valley breezes). The degree of concentration or dilution of contaminants in the atmosphere critically depends on these factors which had not been studied in a complete manner before the summer of 1984. As a result, funds were requested and granted from the California Air Resources Board (State of California Contract A3-104-32) to design and execute the most comprehensive field investigation of airflow and air quality in the Los Angeles Basin during the 1984 Summer Olympics. This paper is the final report of the contract describing how the funds were spent over the past three years.

2. Project BASIN

There were three objectives for designing the BASIN Project:

1. To determine the diurnal variation of the upper-level three- dimensional wind field, and temperature and dew-point temperature field over the Los Angeles BASIN and its relationship with the mixed layer and the concentration of pollutants;

2. To determine the effect of the elevated heat source of the mountain slopes on the inversion height and the transport of pollutants;

3. To use the information collected during the field project to form a

complete data base to be used in present and future dispersion models.

After several months of planning, an experimental design of the observational network was determined and is shown in Figure 1 of Appendix 1. This two page announcement describing the BASIN project was published in the Bulletin of the American Meteorological Society. In addition to the BASIN network a list of the collaborating scientists is included.

A field document (Appendix 2) was assembled for all participants explaining the network design, aircraft flight plans, operation plans, and a complete description of the field sites. This document help to minimize any confusion during operational days.

At 11 sites balloons were launched, with radiosondes or airsondes attached, every 4 hours for three days (0600PDT 8 August - 0200 PDT August 10 and 1700 PDT 17 August - 1300 PDT 18 August). In addition to these launchings, the following observational activities were performed:

a. Tracer gas (SF_6) was released and sampled at selected sites by the California Institute of Technology.

b. An instrumented aircraft operated by California Air Resources Board collected temperature soundings and vertical measurements of SF_6.

c. Lidar measurements were made from an aircraft provided by the Environmental Protection Agency (EPA).

d. High resolution balloon soundings (a total of six per day) were launched by the U.S. Naval Pacific Missile Test Center, Point Mugu.

e. Nine Portable Automated Mesonet (PAM) stations from NCAR located at the 1984 Summer Olympic venue sites.

f. 28 surface monitoring stations measuring wind speed and direction, plus O_3, NO_2, NO, CO, SO_2, and hydrocarbons concentrations from the SCAQMD.

g. Seven automated stations in mountainous areas operated by J. Edinger

and the White Sands Missile Range.

h. Two Doppler acoustic sounders.

Considering that all of the balloon sites were manned by students from UCLA and California State University, Northridge, many of whom had never launched an instrumented package, the data collection was outstanding. A summary of the success rate is shown below:

- Upper air soundings at 11 BASIN stations: 191/198 soundings = 96% data capture.
- Half-hourly surface data from 10 BASIN stations: 1429/1440 = 99% data capture.
- Simultaneity: 173/190 balloons launched at ± 15 minutes of schedule time = 91% launches.
- Pressure levels reached by temperature soundings: 700 mb - 200 mb: Average level: ~ 400 mb.
- Continuous mixing height data from acoustic sounders at four BASIN sites.
- 15-minute averaged wind profiles from Doppler acoustic sounders at two BASIN sites, up to 500 m.
- Airborne lidar data over the Los Angeles basin for 3/9 flights.
- Thrice daily sounding data from Pt. Mugu and San Nicolas Island.

3. Data Reduction

In the months following the termination of the field phase of BASIN a great deal of work was spent on data reduction until a BASIN data tape was produced with the following information:

1. Upper-air weather data;
2. Surface weather data (National Weather Service);
3. Surface weather data (SCAQMD);

4. Surface weather data (White Sands Missile Range);
5. Doppler acoustic sounder data;
6. Surface weather data (NCAR).

Appendix 3 is a copy of the master file for reading the BASIN data tape. It should be mentioned that this data tape was primarily the result of the hard work of Mike Beeson and Dan Landau.

4. Research

Once the BASIN data had been archived, a research effort was undertaken with the remaining funds from the Contract. As a result Appendices 4, 5, and 6 are three papers that were published acknowledging support from the Air Resources Board:

1) Wakimoto, R. M., K. R. Durkee, and D. Landau, 1986:
The Catalina Eddy: An effective remover of pollutants over Los Angeles. Preprints, 5th Joint Conference on Applications of Air Pollution Meteorology with APCA, Chapel Hill, Amer. Meteor. Soc., 182-185.

In this paper, a mesoscale circulation off the southern California coast centered near Catalina Island is shown to have a dramatic effect on the horizontal distribution of ozone from Los Angeles to Santa Barbara. The evolution of this circulation is accompanied by a deepening of the marine layer and the development of a persistent stratus deck that frequently appears as a spiral feature on a visual satellite image. Air pollutants within the Los Angeles Basin are hypothesized to mix vertically and hence become diluted within the deeper marine layer with resulting transport through mountain passes. It is

shown that once the eddy forms, much of the pollution from Los Angeles advects into the Santa Barbara/Ventura area.

2) Wakimoto, R. M., 1987: The Catalina Eddy and its effect on pollution over southern California. Mon. Wea. Rev., 115, to be published.

This article is an expansion of the previous conference paper. It is concluded that there is a topographic influence in the generation of this eddy. Detailed surface and upper-air data over Los Angeles illustrate the effect of the eddy on the boundary layer and on the transport of ozone out of the Basin. Isentropic analyses are consistent with visual satellite images of the phenomena. The Catalina Eddy is shown to extend throughout the entire depth of the strong temperature inversion that exists over Los Angeles, with maximum wind speeds within the inversion. Surface ozone levels downwind of the eddy are shown to vary depending on the local circulations.

3) Wakimoto, R. M., J. L. McElroy, 1986: Lidar observation of elevated pollution layers over Los Angeles. J. Climate. Appl. Meteor., 25, 1583-1599.

This article examines elevated pollution layer over Los Angeles with an aircraft equipped with a downward-looking lidar. For the first time, detailed ancillary upper-air kinematic and thermodynamic data were collected simultaneously to aid in the interpretation of these elevated layers. It is concluded that upper-level winds within the inversion, orographic effects, and thermally-induced changes in the depth of the mixed layer control the evolution of these layers. It is important that these elevated layers be incorporated in

numerical modeling efforts since the aerosols can be re-entrained into a deepening boundary layer at subsequent times near their origin or at other locales resulting in surface pollution concentrations that can be much higher than predicted.

5. Summary

This report has shown that the State of California Contract A3-104-32 has been used effectively to execute a major field project, reduce and archive an enormous amount of data, and finally to produce several research articles of interest to the Air Resources Board. In addition to all of the above, it is my understanding that the BASIN data tape has been used extensively by several organizations for modeling work. All users have been very pleased with the data quality.