

INTER-STATION CORRELATIONS OF OZONE CONCENTRATIONS
IN THE SAN FRANCISCO BAY AREA

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INTRODUCTION

This project was undertaken primarily to show how one might use SPSS (Statistical Package for the Social Sciences) to analyze air pollution data. As an example, this paper looks specifically at the ozone concentration correlation coefficients between the 25 BAAPCD's (Bay Area Air Pollution Control Districts) for the months of July, August and September 1978.

DATA

A file named \langle S.SWITZER \rangle AIRPOL.DAT on the Low Overhead Time Sharing(LOTS) system at Stanford University contains daily air pollution data for July 1, 1978 through September 30, 1978.

The data is formatted to be used with the following SPSS(Statistical Package for the Social Sciences)commands:

```
VARIABLE LIST  DOW, YEAR, MONTH, DAY, CMWS, VAMWS, SJMWS, CTEMP,
                VATEMP, SJTEMP, SFINSO, SRINSO, SJINSO, OASTAB,
                VASTAB, SJSTAB, SFO, SRC, RIO, PTO, CCO, WCO, OAO,
                SLO, HAO, FRO, LIO, ARO, SJC, GIO, LGO, SAO, MVO,
                RCO, BUO, PEO, STO, SCO, NPO, VAO, FFC, SFP, POP,
                SRF, RIP, PIP, CCP, FRP, LIP, SJP, GIP, SAP, RCP,
                BUP, STP, NPP, VAF, PARCOD
INPUT FORMAT   FIXED(1X, I1, 3I2, 3F4.1, 9I3, 25I2, 16I3, I1)
INPUT MEDIUM   [4, 3556]AIRPOL.DAT
N OF CASES     92
```

The definitions along with the code or units of the variables are presented in Table 1.

When there was a missing data point for ozone concentration, the following technique was used to estimate a data point to be placed in the data file:

(1) Compute M, the monthly mean of the ozone concentration using only the original data for the given station.

(2) Compute D, the daily mean of the ozone concentration using only the stations with original data.

(3) Compute A, the mean using all the original data used in (1) and (2).

(4) Compute the estimated data point, $X = M + D - A$.

When PARCOD = 2, the data points for the particulate concentration at all stations are equal to 999. When PARCOD = 1, the missing data points were estimated with the same technique used for ozone concentration.

TABLE 1. AIRPOL.DAT VARIABLE LIST

SPSS Variable Name	Definition	Code or Units
DOW	Day of week	1 = Sunday 2 = Monday 3 = Tuesday 4 = Wednesday 5 = Thursday 6 = Friday 7 = Saturday
YEAR	Year	78 = 1978
MONTH	Month	7 = July 8 = August 9 = September
DAY	Day of month	1 = 1, ... , 31 = 31
CMWS	Mean wind speed for Central averaged from San Francisco and Oakland Airports	miles/hour
VAMWS	Mean wind speed for North from BAAPCD Vallejo station	miles/hour
SJWMS	Mean wind speed for South from BAAPCD San Jose station	miles/hour
CTEMP	Mean maximum temperature for Central averaged from San Francisco, San Francisco Airport and Oakland Airport	°F
VATEMP	Mean maximum temperature for North from Vallejo	°F
SJTEMP	Mean maximum temperature for South from San Jose	°F
SFINSO	Insolation from San Francisco	Langleys/day
SRINSO	Insolation from San Rafael	Langleys/day
SJINSO	Insolation from San Jose	Langleys/day
OASTAB	Temperature at 2500 feet above Oakland minus that at the surface	°F
VASTAB	Temperature at 2500 feet above Vallejo minus that at the surface	°F
SJSTAB	Temperature at 2500 feet above San Jose minus that at the surface	°F

SPSS
Variable

<u>Name</u>	<u>Definition</u>	<u>Code or Units</u>
SFO	San Francisco BAAPCD high ozone concentration	Parts/100 million
SRO	San Rafael	"
RIO	Richmond	"
PTO	Pittsburg	"
CCO	Concord	"
WCO	Walnut Creek	"
OAQ	Oakland	"
SLO	San Leandro	"
HAO	Hayward	"
FRO	Fremont	"
LIO	Livermore	"
ARO	Alum Rock	"
SJO	San Jose	"
GIO	Gilroy	"
LGO	Los Gatos	"
SAO	Saratoga	"
MVO	Mountain View	"
RCO	Redwood City	"
BUC	Burlingame	"
PEO	Petaluma	"
STO	Santa Rosa	"
SOC	Sonoma	"
NPO	Napa	"
VAO	Vallejo	"
FFO	Fairfield	"
SFP	San Francisco BAAPCD 24-hour suspended particulate concentration	micrograms/m ³
POP	Portrero	"
SRP	San Rafael	"
RIP	Richmond	"
PTP	Pittsburg	"
CCP	Concord	"
FRP	Fremont	"
LIP	Livermore	"
SJP	San Jose	"
GIP	Gilroy	"
SAP	Saratoga	"
RCP	Redwood City	"
BUP	Burlingame	"
STP	Santa Rosa	"
NPP	Napa	"
VAP	Vallejo	"
PARCOD	Indicator of particulate data availability because data is available every six days (e.g., September 4, September 10)	1 = yes 2 = no

CORRELATIONS

The following commands were used to find the ozone concentration correlation coefficients between the 25 Bay Area Air Pollution Control Districts (BAAPCD's) during the month of July 1978:

```
SELECT IF      (YEAR EQ 78)
*SELECT IF     (MONTH EQ 7)
PEARSON CORR   SFO TO FFO
READ INPUT DATA
FINISH
```

Of the 300 correlation coefficients, the twenty with the highest values are between:

Sonoma, Napa	0.9461
Hayward, Fremont	0.9341
Alum Rock, Saratoga	0.9256
Petaluma, Sonoma	0.9225
Alum Rock, Los Gatos	0.9207
Hayward, Saratoga	0.9199
Hayward, Sonoma	0.9197
Concord, Livermore	0.9167
Alum Rock, San Jose	0.9151
Hayward, Alum Rock	0.9097
Saratoga, Napa	0.9080
Hayward, Napa	0.9078
Pittsburg, Sonoma	0.9074
Saratoga, Sonoma	0.9060
Concord, Napa	0.9059
Hayward, Redwood City	0.9054
San Leandro, Vallejo	0.9049
Saratoga, Redwood City	0.9024
Pittsburg, Napa	0.8995
Pittsburg, Concord	0.8993

In Figure 1, solid lines are used to connect the cities with the ten highest correlation coefficients. Broken lines are used to connect the cities with the next ten highest correlation coefficients.

Using (MONTH EQ 8) instead of (MONTH EQ 7) in the above sequence of commands, the 300 ozone correlation coefficients for the month of August 1978 were computed. The 20 coefficients with the largest values are:

Saratoga, Mountain View	0.9567
Concord, Walnut Creek	0.9380
Fremont, Alum Rock	0.9325
Fremont, Mountain View	0.9275
Los Gatos, Saratoga	0.9267
San Jose, Los Gatos	0.9176
Walnut Creek, Fairfield	0.9100
Los Gatos, Mountain View	0.9037
Alum Rock, Mountain View	0.9020
Pittsburg, Fairfield	0.8983

Livermore, Fairfield	0.8976
Walnut Creek, Livermore	0.8909
Concord, Mountain View	0.8907
Napa, Fairfield	0.8889
Mountain View, Fairfield	0.8855
Livermore, Mountain View	0.8796
San Jose, Mountain View	0.8761
Concord, Fairfield	0.8697
Fremont, Saratoga	0.8693
Alum Rock, Fairfield	0.8667

In Figure 2, solid lines are used to connect the cities with the ten highest correlation coefficients. Broken lines are used to connect the cities with the next ten highest correlation coefficients.

Lastly, (MONTH EQ 9) was used to obtain the correlation coefficients for September 1978. The highest twenty are:

Concord, Walnut Creek	0.9812
Alum Rock, San Jose	0.9676
San Leandro, Hayward	0.9664
Pittsburg, Walnut Creek	0.9615
Pittsburg, Concord	0.9602
Saratoga, Mountain View	0.9597
San Jose, Mountain View	0.9574
Hayward, Fresno	0.9521
Hayward, Alum Rock	0.9493
Los Gatos, Saratoga	0.9485

Alum Rock, Saratoga	0.9473
Richmond, Oakland	0.9471
San Jose, Saratoga	0.9468
San Rafael, Sonoma	0.9463
Sonoma, Napa	0.9425
Richmond, Santa Rosa	0.9416
Hayward, San Jose	0.9387
Oakland, Santa Rosa	0.9380
Fremont, Alum Rock	0.9371
Hayward, Los Gatos	0.9354

As with the correlation coefficients for July and August, the September coefficient relationships are indicated on a map. In Figure 3, solid lines are used to connect the cities with the ten highest correlation coefficients and broken lines are used to connect the cities with the next ten highest correlation coefficients for ozone concentration.

Before trying to determine if there is any significance to the patterns in the maps of Figures 1, 2 and 3, the following additional correlation coefficients were computed for the combined months of July, August and September 1978:

r between SJO and SJMWS = -0.4412

r between SJO and SJTEMP = +0.8227

r between SJO and SJSTAB = +0.6614

r between SJO and SJINSO = +0.0959

r between VAO and VAMWS = -0.8355

r between VAO and VATEMP = +0.5723

r between VAO and VASTAB = +0.5138

The two coefficients with the greatest magnitudes involve the mean wind speed and the mean maximum temperature. Therefore, these two weather factors will be considered in any explanations of Figures 1, 2 and 3.

In Figure 1, there seems to be a band of stations surrounding San Francisco Bay, where the ozone concentrations are highly correlated. This band consists of Petaluma, Sonoma, Napa, Pittsburg, Concord, Livermore, Hayward, Fremont, Alum Rock, San Jose, Los Gatos, Saratoga, and Redwood City. Santa Rosa and Fairfield fall outside this band while the other stations fall inside the band.

In Figure 2, there seems to be a similar band consisting of Napa, Fairfield, Pittsburg, Concord, Walnut Creek, Livermore, Fremont, Alum Rock, San Jose, Los Gatos, Saratoga, and Mountain View. All of the other stations fall inside the band.

In Figure 3, the zone of high correlation consists of only San Leandro, Hayward, Fremont, Alum Rock, San Jose, Los Gatos, Saratoga, and Mountain View.

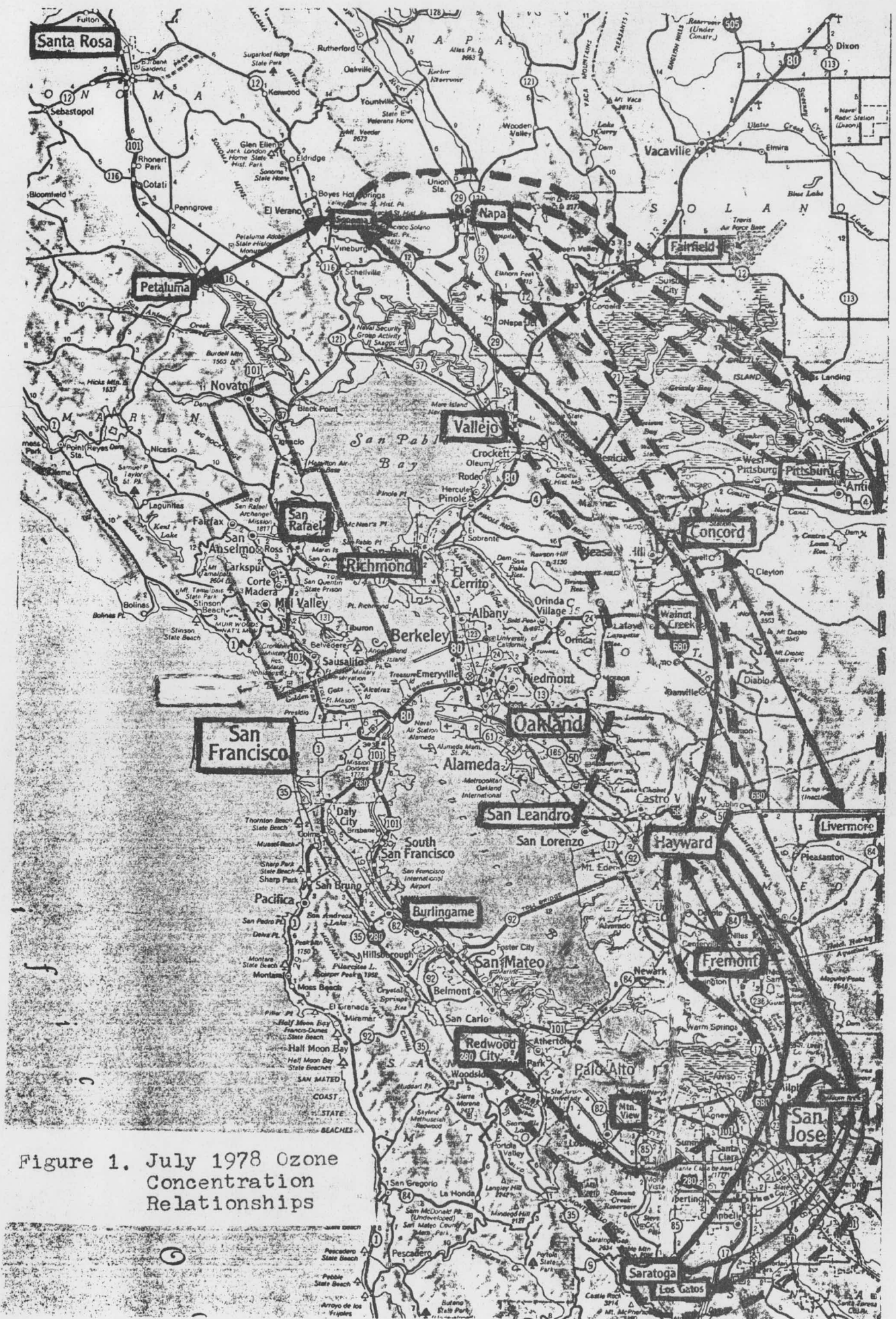


Figure 1. July 1978 Ozone Concentration Relationships

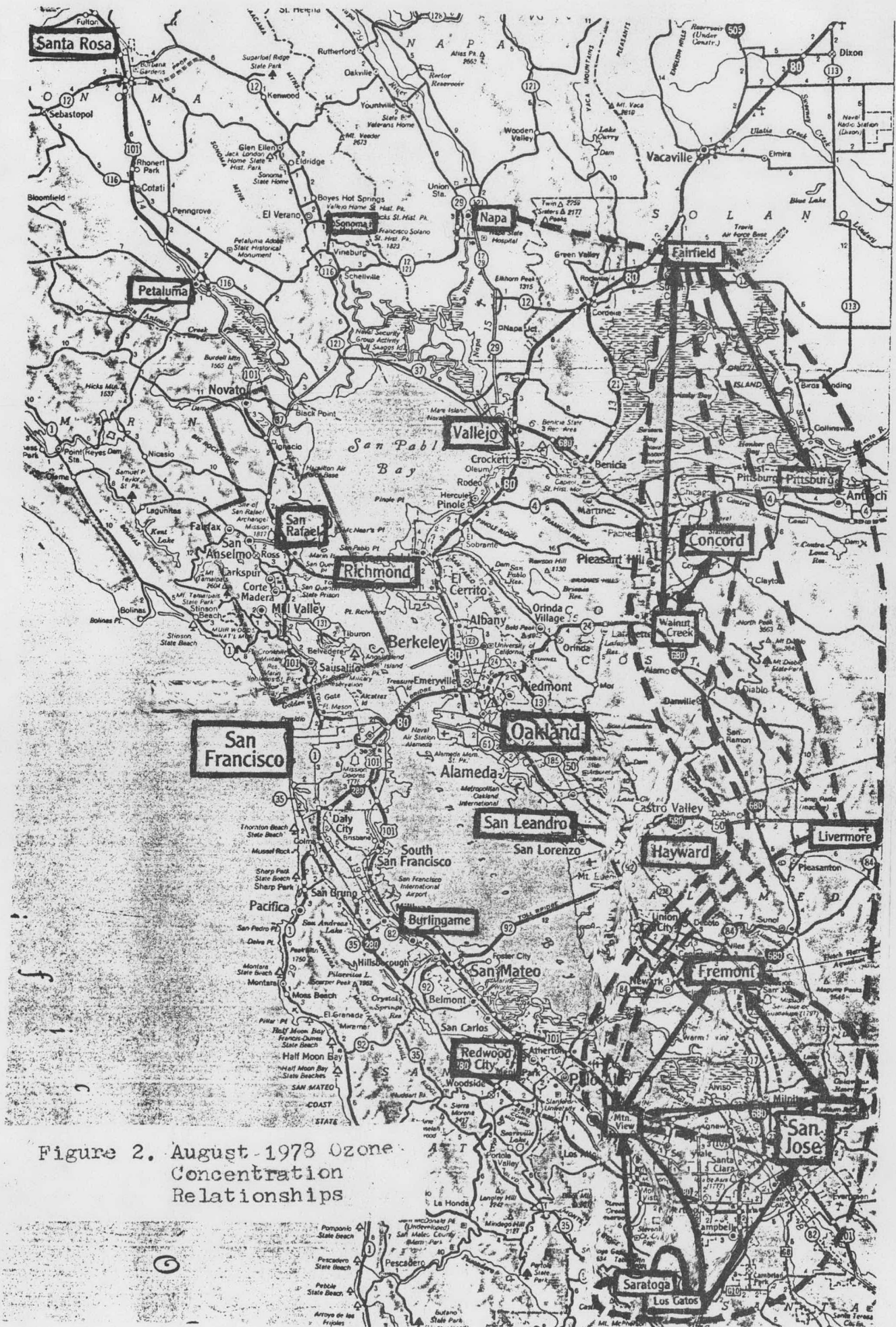


Figure 2. August-1973 Ozone Concentration Relationships

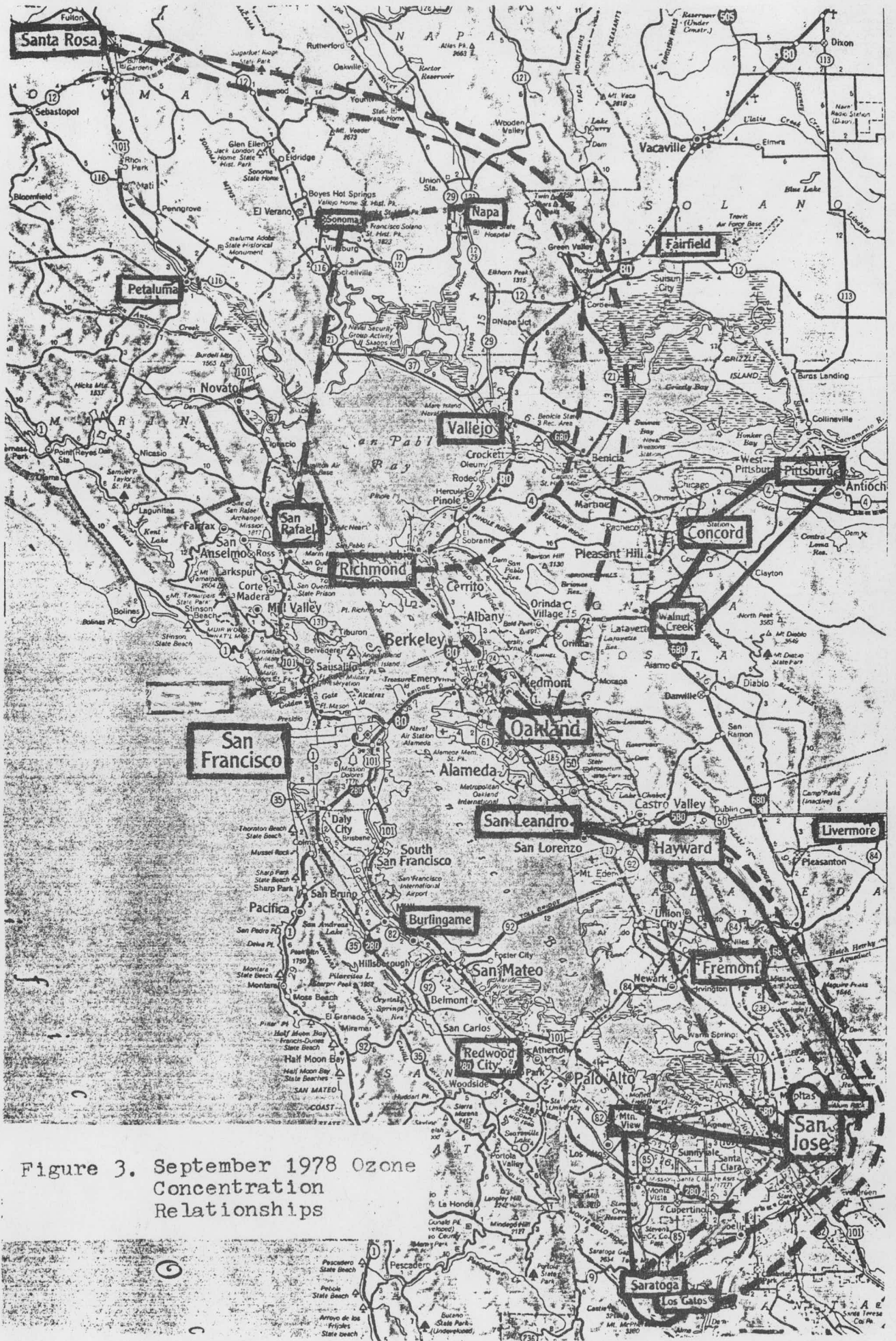


Figure 3. September 1978 Ozone Concentration Relationships