3.4.4 Tracer Results - Test 4

Release Location: South Fontana
Date: July 22, 1981
Time: 1300-1700 PDT
Release Rate: 10.4 g/sec. SF_6

Surface winds at the South Fontana release site were moderate in velocity during the release period, averaging 3.7 m/s. Wind directions were consistently from the west-southwest. Figs. 3.4.21 and 3.4.22 show the streamline patterns for 14 and 18 PDT on July 22. Flow through Cajon and San Gorgonio Passes was well established by 14 PDT with moderately strong velocities. In the Victorville area, westerly winds were present at 14 PDT which shifted to southerly by 18 PDT, reflecting the start of transport from Cajon Pass. In the Coachella Valley, northwesterly winds had already started at Palm Springs with the boundary of the northwest flow passing Indio by 18 PDT.

Flow into the Coachella Valley was stronger than average, as indicated by the early occurrence of northwesterly winds. This reflected the relatively strong coast-to-inland pressure gradients present on July 22.

July 22

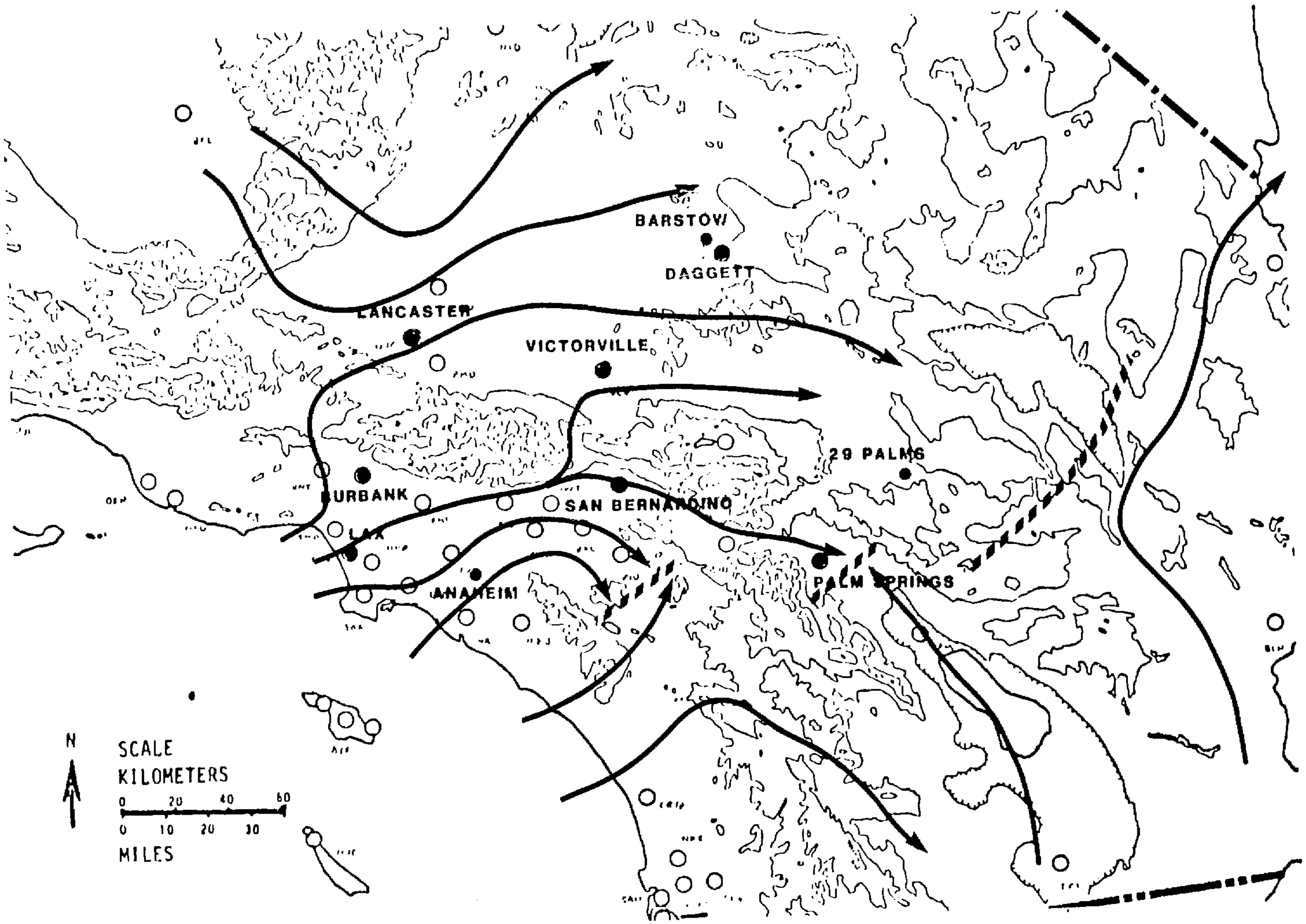
The summary of the tracer trajectories observed on July 22 is shown in Fig. 3.4.23. The primary plume moved through San Gorgonio Pass into the Coachella Valley and eastward through Desert Center. Secondary branches of the plume moved southeastward through the Coachella Valley as far as Bombay Beach along the eastern shore of the Salton Sea and into the Morongo Valley and 29 Palms. A one-hour concentration of 36 ppt was observed at Amboy at 10 PDT on July 23. Concentrations as high as 80 ppt were found on an automobile traverse between Big Bear and Lake Arrowhead about 18 PDT on July 22. There was no significant transport of tracer material through Cajon Pass into the eastern Mojave Desert. A one-hour value of 17 ppt was observed at Blythe at 18 PDT on the following day (July 23).

Several aircraft spirals were made in the tracer plume during the afternoon of July 22. These are summarized in Table 3.4.10.

Table 3.4.10

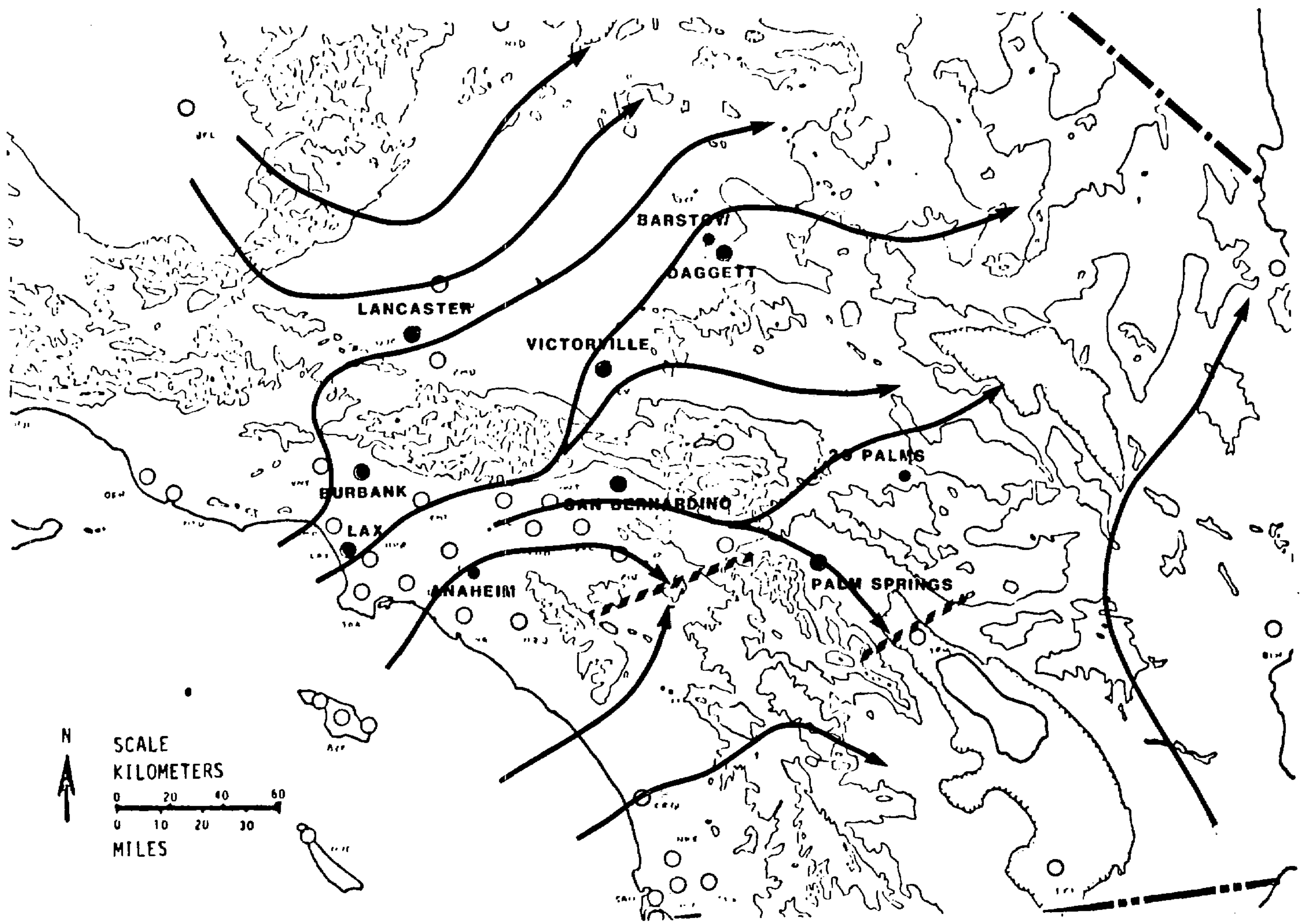
AIRCRAFT SPIRAL SF_6 DATA

Location	Time	Depth of Plume	Maximum Concentration
Rialto	1635 PDT	2600 ft. (agl)	21 ppt
Intersect.10/111	1846 PDT	2500 ft. (agl)	58 ppt
Palm Springs	1924 PDT	1300 ft. (agl)	170 ppt



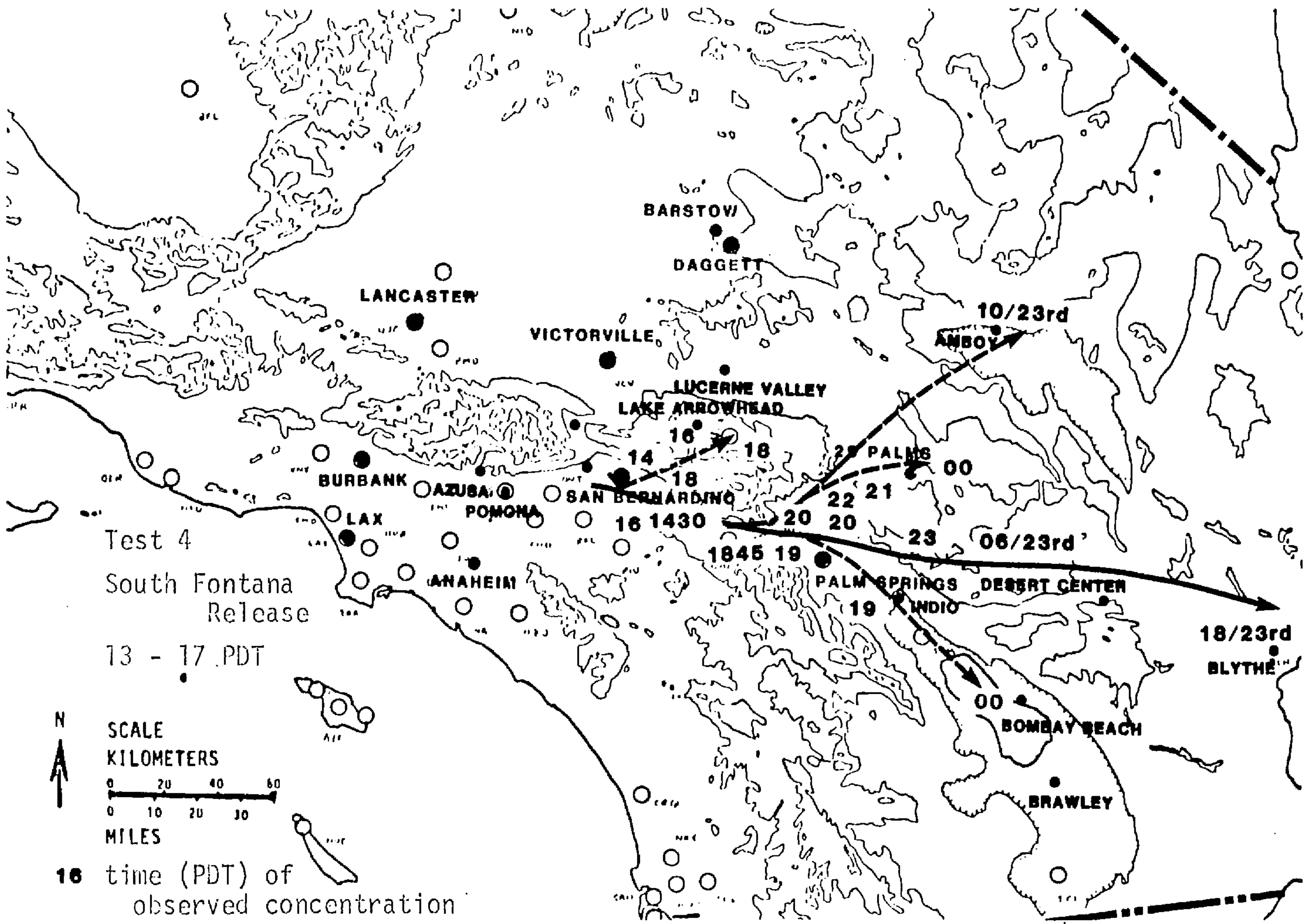
STREAMLINE MAP (14 PDT) - July 22,1981

Fig. 3.4.21



STREAMLINE MAP (18 PDT) - July 22,1981

Fig. 3.4.22



TRACER TRAJECTORIES - July 22,1981

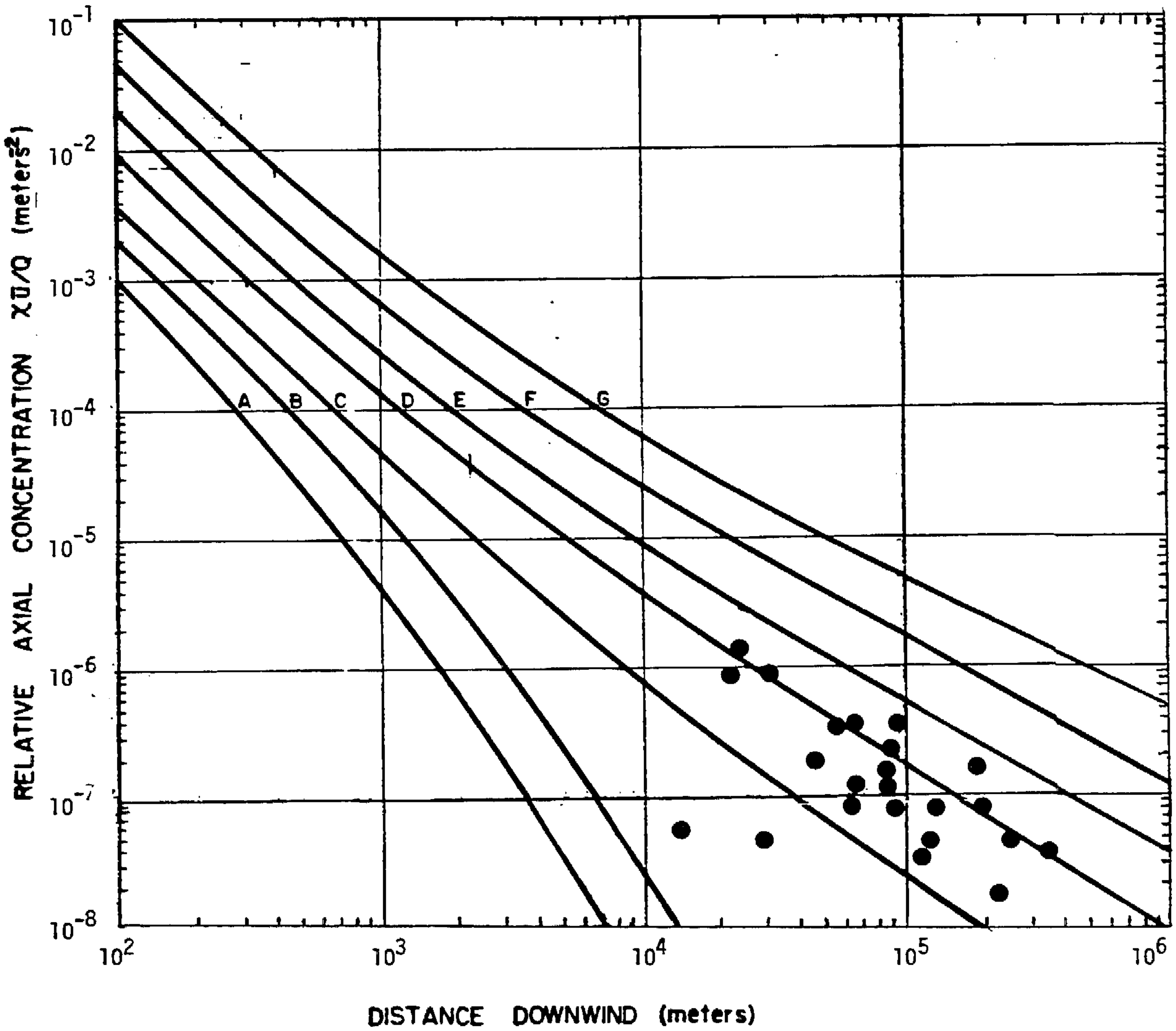
Fig. 3.4.23

Calculated values of Xu/Q are plotted in Fig. 3.4.24. The values were calculated from the average wind speed observed at South Fontana (3.7 m/s) during the release period. The plotted values generally correspond to C-D stabilities.

July 23

Automobile traverses were conducted throughout the desert during the day on July 23 to look for possible tracer carry-over. The area from Amboy to 29 Palms to Brawley, the San Bernardino Mts. and the Victorville/Lucerne Valley area were covered during the traverses. No significant concentrations were found in the desert areas.

SF_6 concentrations as high as 137 ppt were found in the Azusa to Pomona areas on July 23 as a result of mobile traverses. This pattern was similar to that observed during Test 2. Morning concentrations appeared to peak in the Pasadena - Azusa area with the maximum apparently shifted further east to near Pomona by mid to late afternoon. A number of hourly concentrations between 10 and 37 ppt were also observed during the morning of July 22 at Pasadena and Azusa.



CALCULATED XU/Q VALUES - Test 4

July 22,1981

Fig. 3.4.24

3.5 Test 5 27-28 July 1981, Garden Grove Release (0500-0900 PDT, 7/27/81)

3.5.1 Meteorology

General

A well developed thermal trough was present at the surface on July 27 (Figure 3.5.1) extending as far north as Washington and Oregon. The flow aloft was dominated by a weak ridge offshore on July 27, moving onshore by July 28. Winds aloft were generally light and variable over the Southern California area.

Table 3.5.1 gives the meteorological parameters of interest in and near the Los Angeles Basin for July 27. The 850 mb temperature (22°C) at Vandenberg AFB was slightly warmer than average for the month of July. Pressure gradients from the coast to Daggett and Bakersfield were relatively large, suggesting moderate transport into the desert areas. The morning inversion height at UCLA of 613 m was relatively high; over 80 percent of the morning inversions at LAX in July are less than this height (Keith, 1980). Maximum temperature at Ontario was only 92°F but was a warm 111°F at Palm Springs.

July 27 can be classed as a day with only moderate air pollution potential due to the relatively high marine layer and moderately strong wind transport into the desert.

Transport Winds

Surface winds at the release site at Garden Grove are shown in Table 3.5.2:

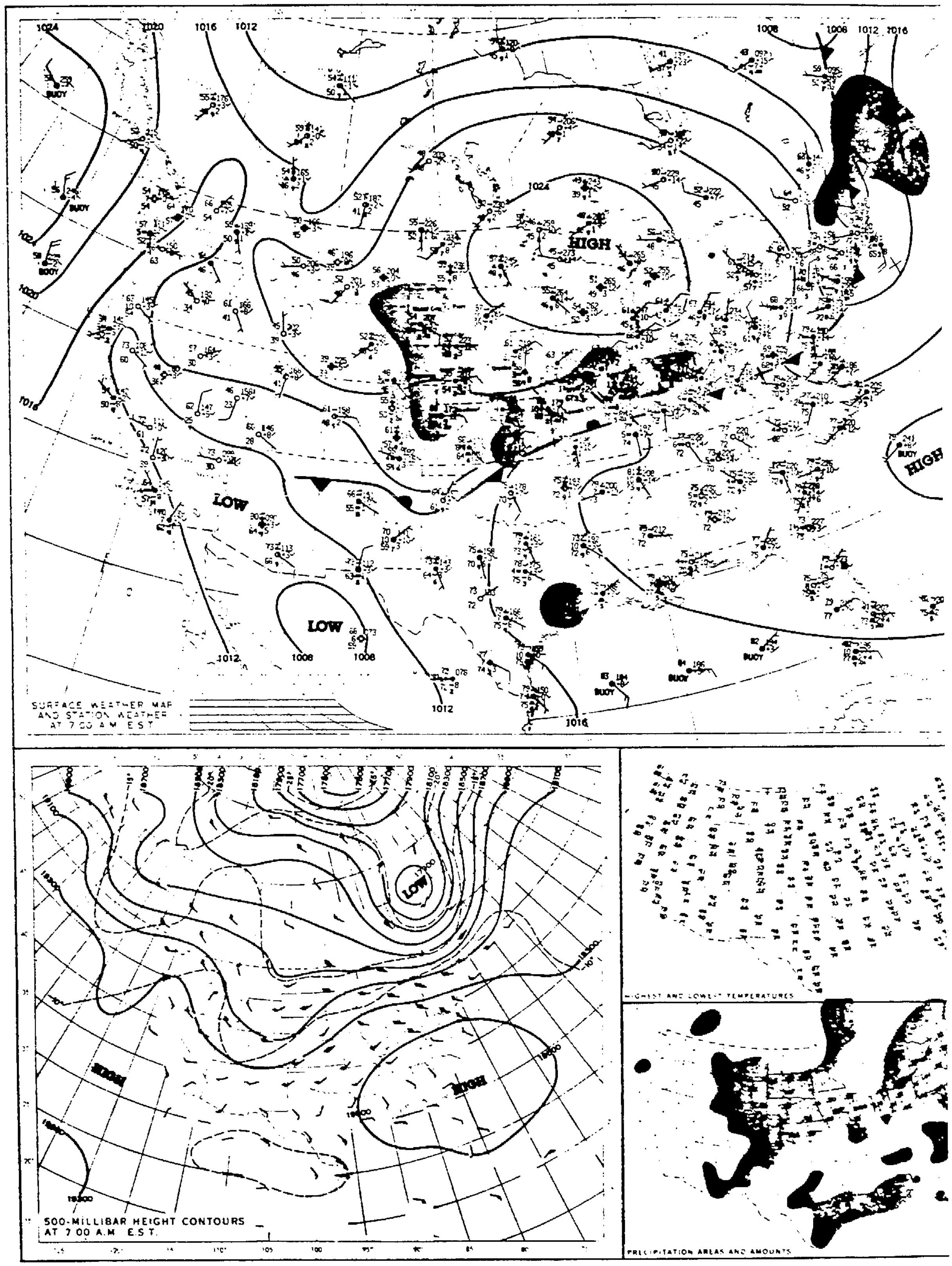
Table 3.5.2

SURFACE WINDS AT GARDEN GROVE DURING RELEASE

JULY 27, 1981

Time (PDT)	Direction (°)	Speed (m/s)
06	300	0.3
07	180	0.3
08	360	0.3
09	300	0.5
10	340	0.9
11	330	0.8
12	300	1.2
13	280	1.5

MONDAY, JULY 27, 1981



WEATHER MAP

July 27,1981

Fig. 3.5.1

Table 3.5.1

METEOROLOGICAL PARAMETERS

JULY 27, 1981

850 mb Temperature		
Vandenberg AFB	(0500 PDT)	22.0°C
Edwards AFB	(0545 PDT)	25.7
Ontario	(0830 PDT)	-
UCLA	(0600 PDT)	21.4
Pressure Gradients	(0800 PDT)	
LAX - Daggett		3.5 mb
LAX - Bakersfield		2.4
Maximum Surface Temperature		
Ontario		92°F (33.3°C)
Palm Springs		111 (43.9)
Inversion Base Height* and Temperature		
UCLA	(0600 PDT)	13.3°C (613 m)
San Bernardino	(0700 PDT)	15.4 (Surface)
Ontario	(0830 PDT)	-
Inversion Top Height* and Temperature		
UCLA	(0600 PDT)	22.1°C (1421 m)
San Bernardino	(0700 PDT)	21.3 (1120 m)
Ontario	(0830 PDT)	-

* All heights are msl

Surface winds during the release (05-09 PDT) were light and variable, permitting tracer concentrations to build up close to the release prior to moving inland. Following the end of the release, a light northwesterly wind developed, gradually increasing in velocity.

Table 3.5.3 shows the surface winds at Lancaster, Victorville and Palm Springs for July 27 and 28. At Lancaster, moderately strong flow through Mint Canyon into the desert started about 14 PDT on July 27 and by 11 PDT on July 28. Light and variable winds occurred during the late night and early morning hours.

At Victorville, flow from Cajon Pass developed by 16 PDT on July 27 and by 13 PDT on July 28. On both days the southerly flow at Victorville lasted only until 19-20 PDT.

At Palm Springs the northwesterly flow from San Gorgonio commenced by 17 PDT on July 27 but was delayed until 20 PDT on July 28.

Mixing Heights

Observed and predicted mixing layer tops for July 27 are shown in Table 3.5.4. In spite of the relatively high mixing layer depths observed at UCLA during the morning and afternoon the mixing layer tops in the inland areas did not show the afternoon increases typical of previous tracer days. The Ontario sounding at 1430 PDT indicated a top of 930 m (msl) while the aircraft sounding at Rialto showed 1100 m later in the afternoon. There was no marked increase in visibility observed at San Bernardino or Ontario on July 27 (Table 3.5.5). Observed and predicted mixing layer depths in the desert and over Lake Gregory were also correspondingly low compared to previous tracer days.

Table 3.5.5

OBSERVED VISIBILITIES - JULY 27, 1981

Time (PDT)	San Bernardino	Ontario
10	2-1/2 miles	1-1/2 miles
12	3	2
14	4	3
16	4	5
18	5	5

Table 3.5.3

SURFACE WINDS - JULY 27-28, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	280°/ 2.1 m/s	160°/3.1 m/s	-
08	Calm	170 /3.1	170°/2.1 m/s
10	Calm	220 /3.1	Calm
12	090 / 2.6	080 /1.0	180 /2.6
14	290 / 3.1	080 /2.1	120 /4.1
16	250 / 9.8	220 /4.1	090 /3.1
18	250 /12.4	190 /7.2	300 /9.3
20	240 /10.3	210 /4.1	270 /5.1
22	240 / 6.2	Calm	270 /6.2
24	240 / 6.7	190 /2.1	-
02	230 / 2.1	230 /2.1	-
04	010 / 3.1	Calm	-
06	250 / 4.1	180 /2.1	-
08	Calm	150 /1.6	110 /4.6
10	Calm	Calm	080 /3.1
12	250 / 4.1	200 /3.1	240 /2.6
14	280 / 9.3	170 /7.2	090 /5.1
16	220 /11.8	180 /8.2	100 /5.1
18	250 /10.3	200 /6.2	090 /5.1

Table 3.5.4

MIXING HEIGHTS - JULY 27, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT	613 m	150 m
	1200	617	150
Ontario	0830	600	290
	1430	920	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Rialto AP	1619 PDT	1100 m	450 m
Lake Gregory	1639	1600	1350
Victorville	1712	1600	900
I-10 and 111	1828	1500	350

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	1280 m	290 m
San Bernardino	1300 +	360
Edwards AFB	1830	725

3.5.2 Regional Pollutant Levels

A map of the peak hourly ozone concentrations for July 27 in the Los Angeles basin and the desert areas is shown in Figure 3.5.2. Maximum hourly concentration observed (25 pphm) was at San Bernardino. Fontana recorded a value of 24 pphm and the highest at Mt. Baldy was 23 pphm. A number of stations in the Mojave Desert exceeded the state ozone standard as did Palm Springs and Indio in the Coachella Valley.

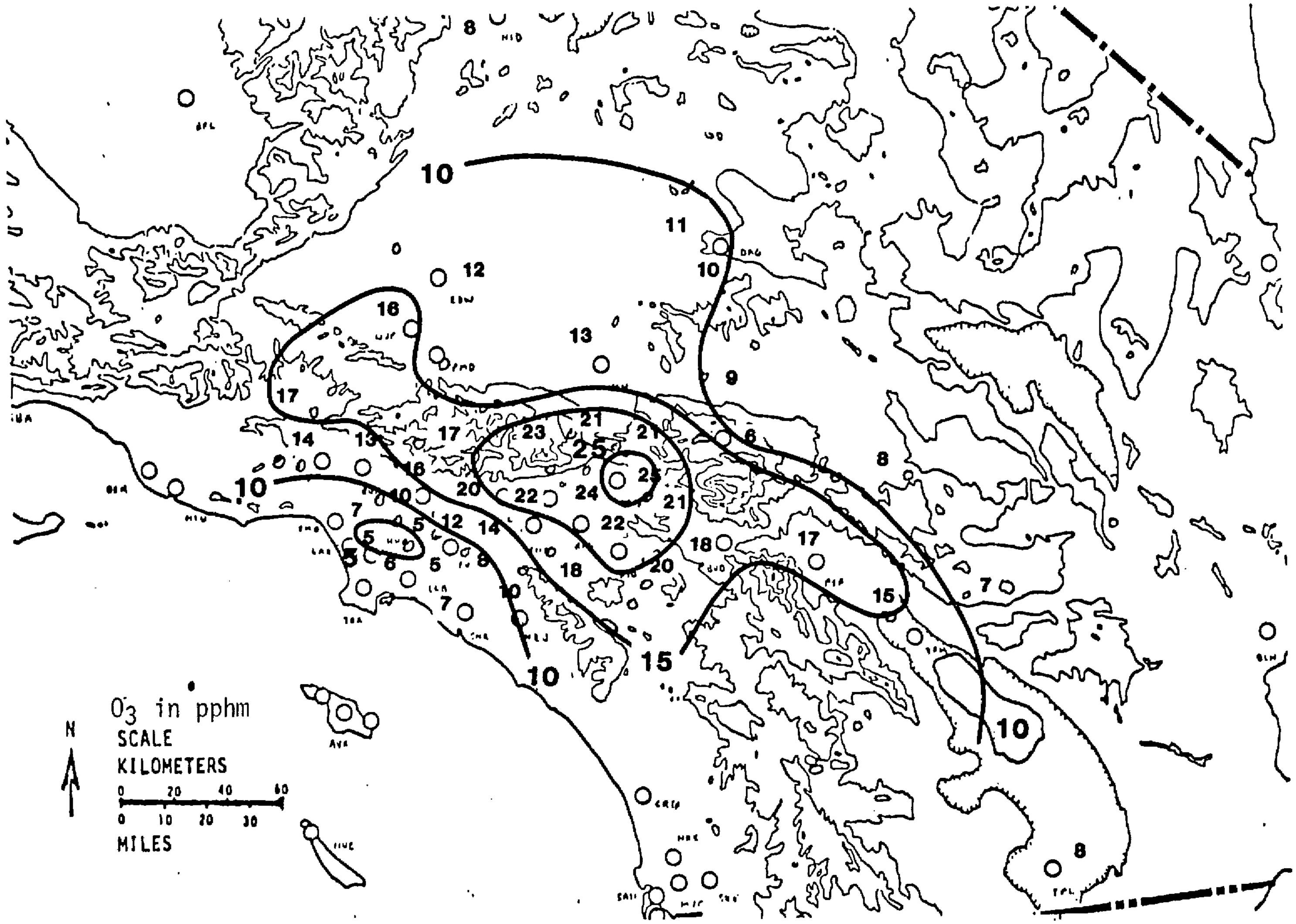
The times of the peak hourly ozone concentrations in the area are plotted on the map in Figure 3.5.3. Stations in the western Mojave Desert all show peak ozone occurrences in the late afternoon or early evening. Twenty-nine Palms, Palm Springs and Indio show similar arrival times for the ozone and precursors from the basin. The remainder of the stations including Barstow, Daggett and Lucerne Valley do not show evidence of transport from the basin on July 27. Indications from Figure 3.5.3 are that the pollutant material passing through Cajon Pass moved northwestward and did not impact Lucerne Valley and the Daggett areas.

Figure 3.5.4 shows hourly ozone concentrations along the transport route to the Coachella Valley for July 27. The timing of the peak concentrations shows a regular progression through San Gorgonio Pass to Indio. As on most days the arrival of the ozone-laden air at Indio is quite abrupt. The timing of the peak concentrations at Mt. Wilson, Mt. Baldy and Lake Gregory is similar to previous days in showing slightly later peak occurrences for the eastern stations. Fawnskin, in this case, shows no evidence of transport from the basin. The small peak shown in the figure appears to be locally generated, based on the time of occurrence.

Figure 3.5.5 shows the hourly concentrations along the route through Mint Canyon and Cajon Pass. Transport through Cajon to Victorville is indicated in the figure. A local peak (11 PDT) appears also at Victorville. The character of the hourly concentrations at Barstow (peak at 16 PDT) does not correspond to transport through either Mint Canyon or Cajon Pass. Evidence is indicated in the figure of transport from Newhall to Edwards AFB on July 27.

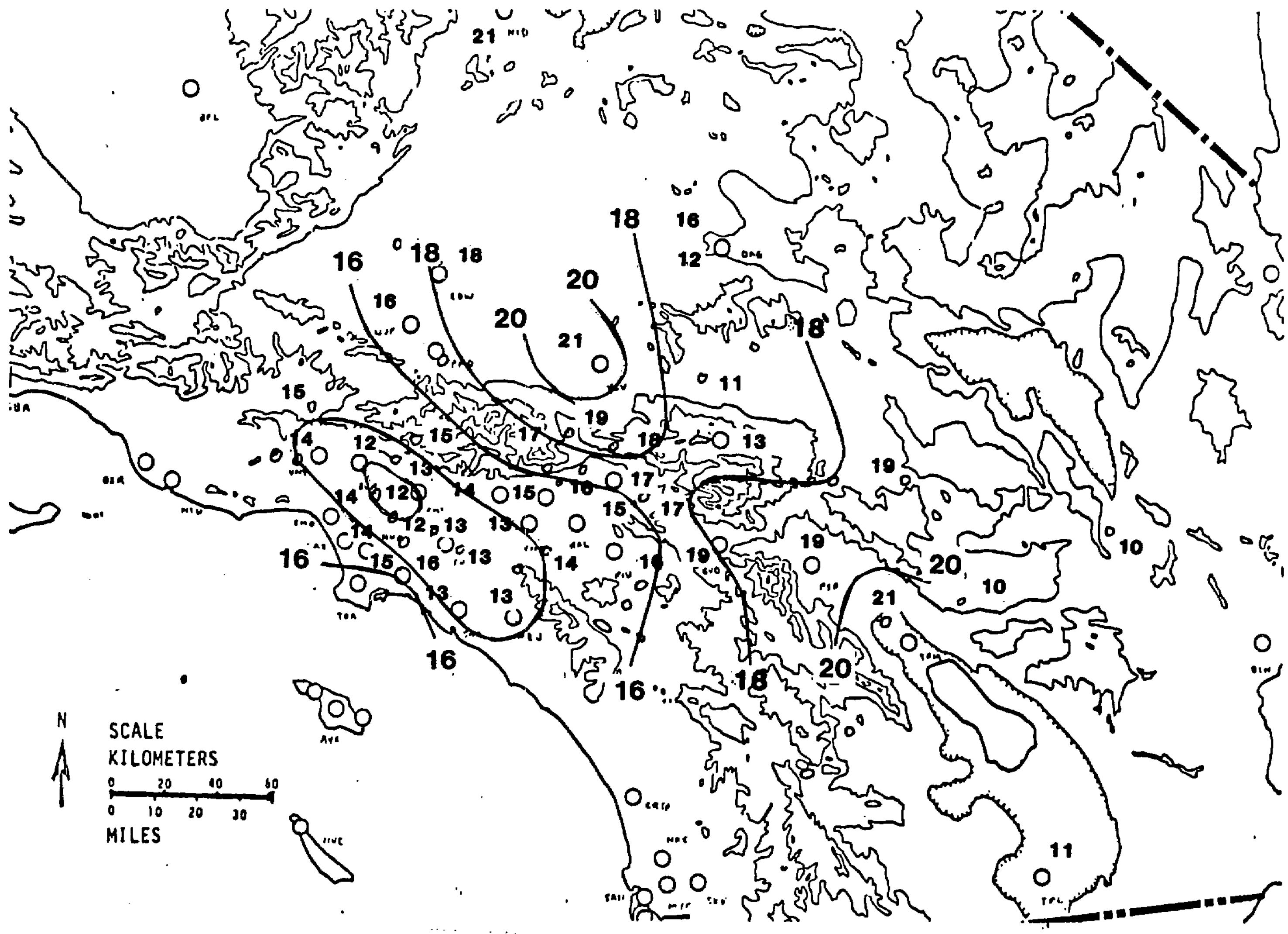
3.5.3 Aircraft Sampling - July 27, 1981

The air quality aircraft on July 27 sampled extensively in Cajon and San Gorgonio Passes and the immediate downwind areas. Principal objective was to compare the characteristics of the pollutant transport along the two exit routes from the basin. Figure 3.5.6 shows the flight pattern on July 27 and the locations of the designated points on the map are described in Table 3.5.6. Table 3.5.7 gives further details of the flight pattern.



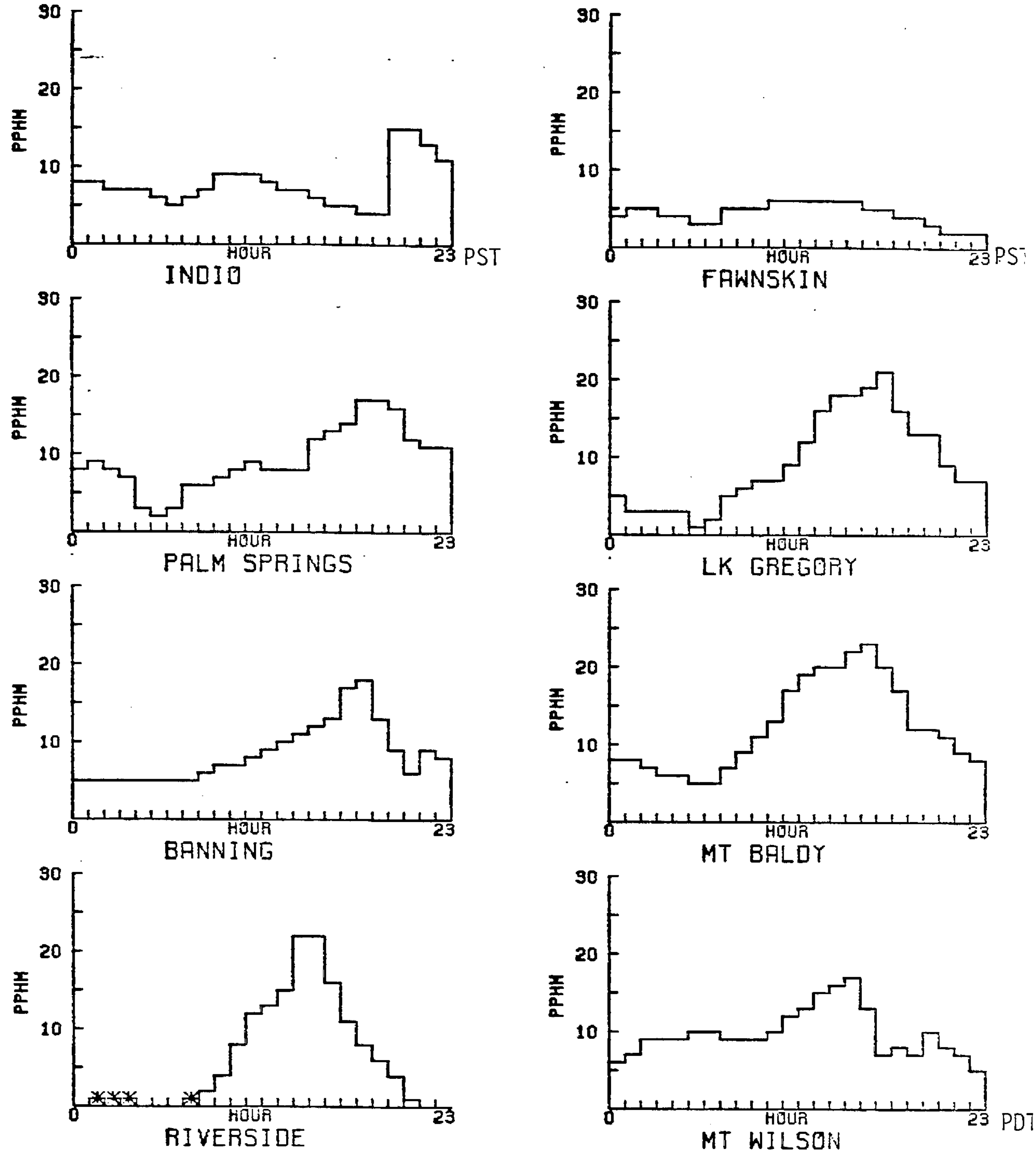
MAXIMUM HOURLY OZONE CONCENTRATIONS - July 27,1981

Fig. 3.5.2



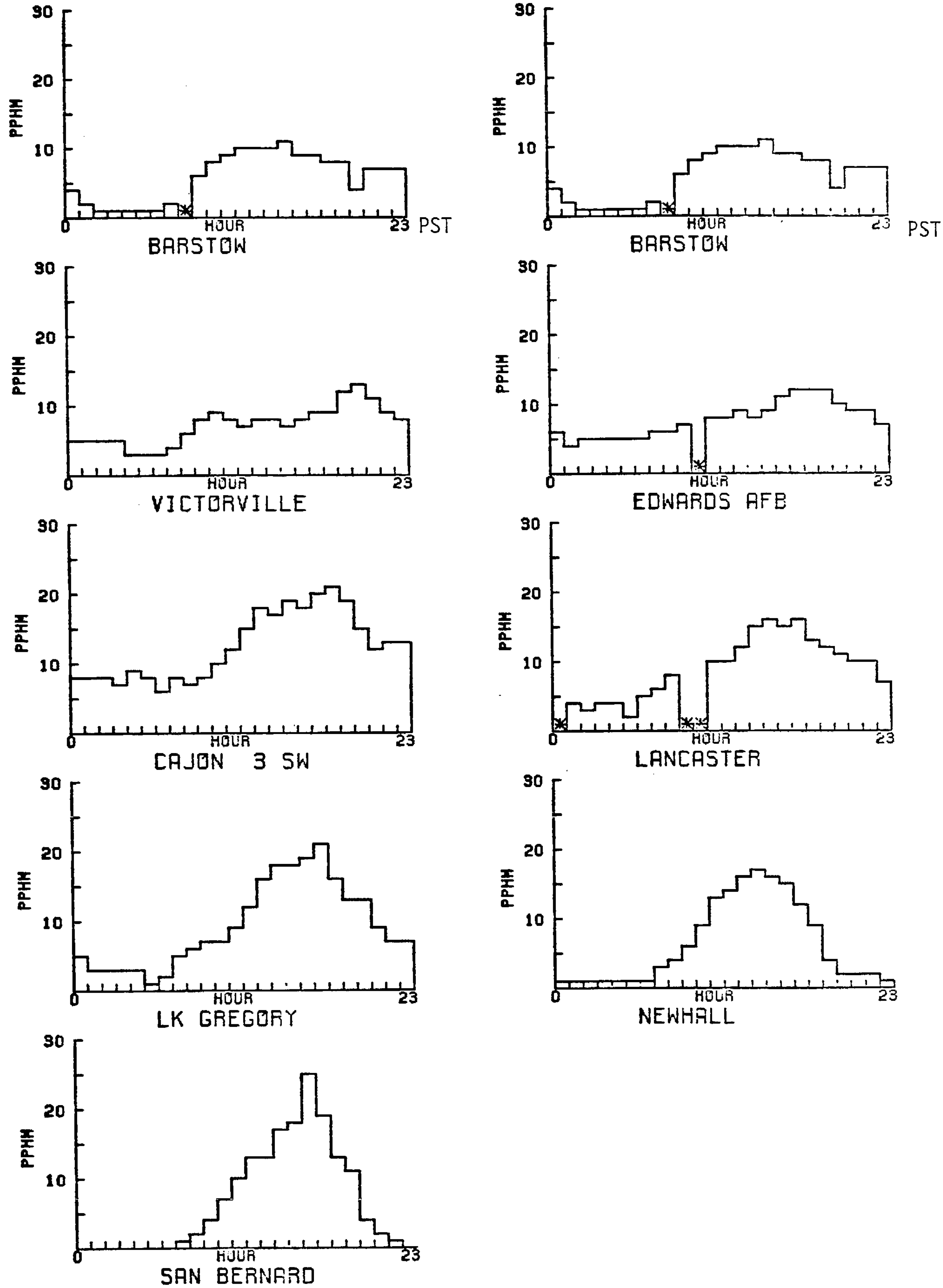
TIME OF MAXIMUM HOURLY OZONE CONCENTRATIONS - July 27,1981

Fig. 3.5.3

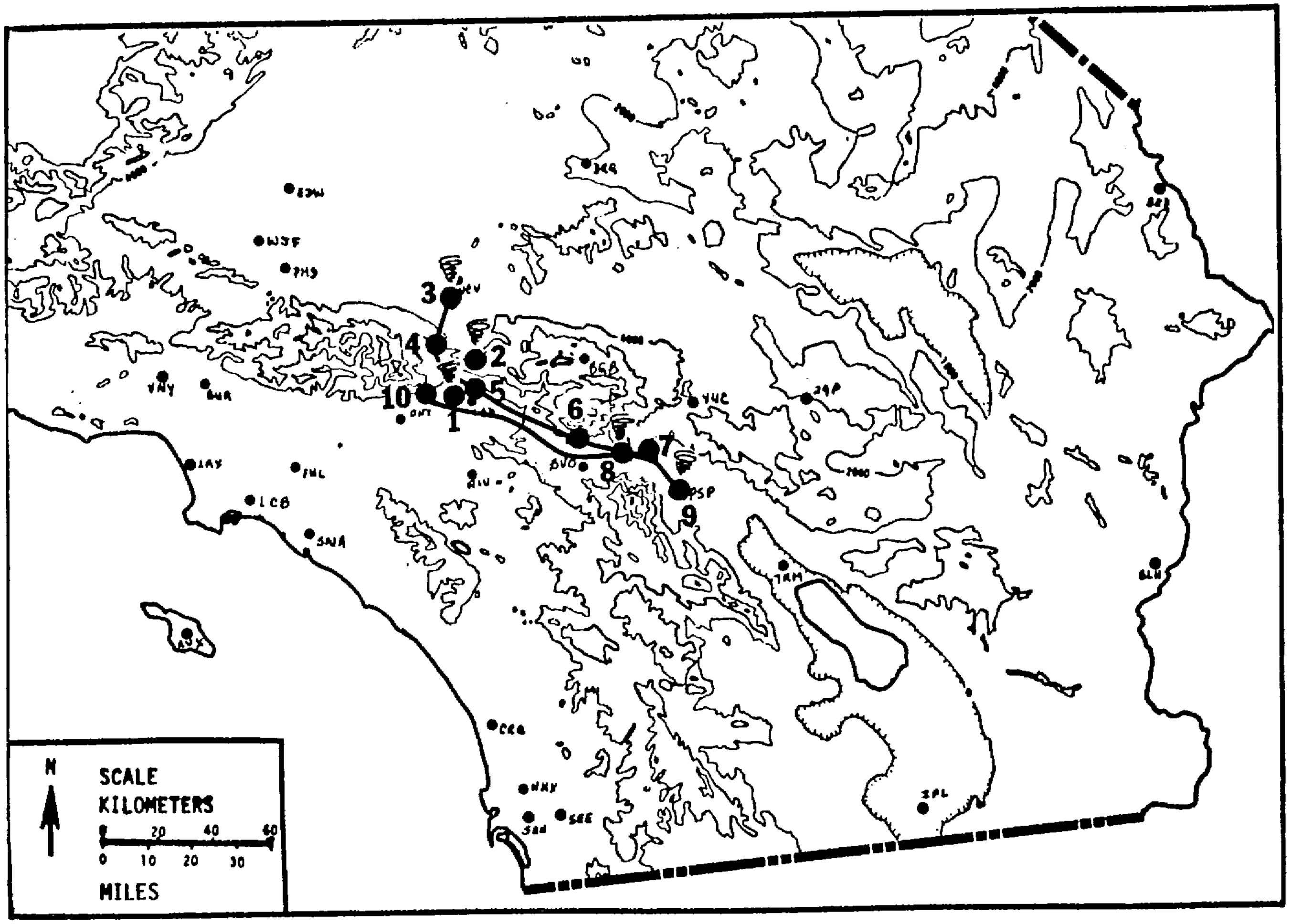


HOURLY OZONE CONCENTRATIONS - July 27,1981

Fig. 3.5.4



HOURLY OZONE CONCENTRATIONS - July 27,1981



MRI SAMPLING FLIGHT - July 27,1981

Fig. 3.5.6

Table 3.5.6

27 July 1981 Tape #258

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°07.5'	117°23'	Rialto Airport
2	34°14.5'	117°16.0'	Lake Gregory
3	34°31.2'	117°18.8'	Victorville Drive-In
4	34°18.8'	117°28.5'	Cajon Junction
5	34°09.2'	117°17.0'	Highland
6	33°56.0'	116°59.5'	West of Beaumont
7	33°55.5'	116°32.5'	7 miles east of intersection of Hwys 10 & 111
8	33°55.2'	116°40.5'	Intersection of Hwys 10 & 111
9	33°49.5'	116°30.5'	Palm Springs Airport
10			Devore Fwy

MRI FLIGHT SUMMARY

Date: July 27, 1981

SOUTHEAST DESERT OZONE TRANSPORT STUDY

Tape #: 258

Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start	End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1619	1635	Spiral	1	427	2134	N.A.	H1-12	Sfc Elev = 422 m
2	1639	1702	Spiral	2	1554	3658	N.A.	H13-27	Sfc Elev = 1372 m
3	1712	1733	Spiral	3	3658	945	N.A.	H28-46	Sfc Elev = 915 m
4	1737	1745	Traverse	3 - 4	1067	1433	27.4 Km.	H47-55	
5	1746	1753	Traverse	4 - 5	1219	1006	24.2 Km.	H56-63	
6	1754	1805	Traverse	5 - 6	1006		41.9 Km.	H64-75	
7	1807	1817	Traverse	6 - 7	1006		40.3 Km.	H76-87	
8	1828	1858	Spiral	8	366	3353	N.A.	H88-107	Sfc Elev = 360 m
9	1903	1923	Zero Spiral		3353	152	N.A.		Instrument calibration
10	1927	1933	Spiral	9	122	914	N.A.	H109-130	Sfc Elev = 122 m
11	1936	2012	Traverse	9 - 10	305	975	104.7 Km.	H131-136	

Table 3.5.7

The initial sounding on July 27 was made at 1619 PDT at Rialto Airport in order to document the vertical structure of the pollutants in the basin (Figure 3.5.7). A low-level layer of ozone was present to a depth of about 800 m above the terrain. Peak concentration in the layer was about 22 pphm. Ozone concentrations aloft to 2000 m (msl) were near background levels.

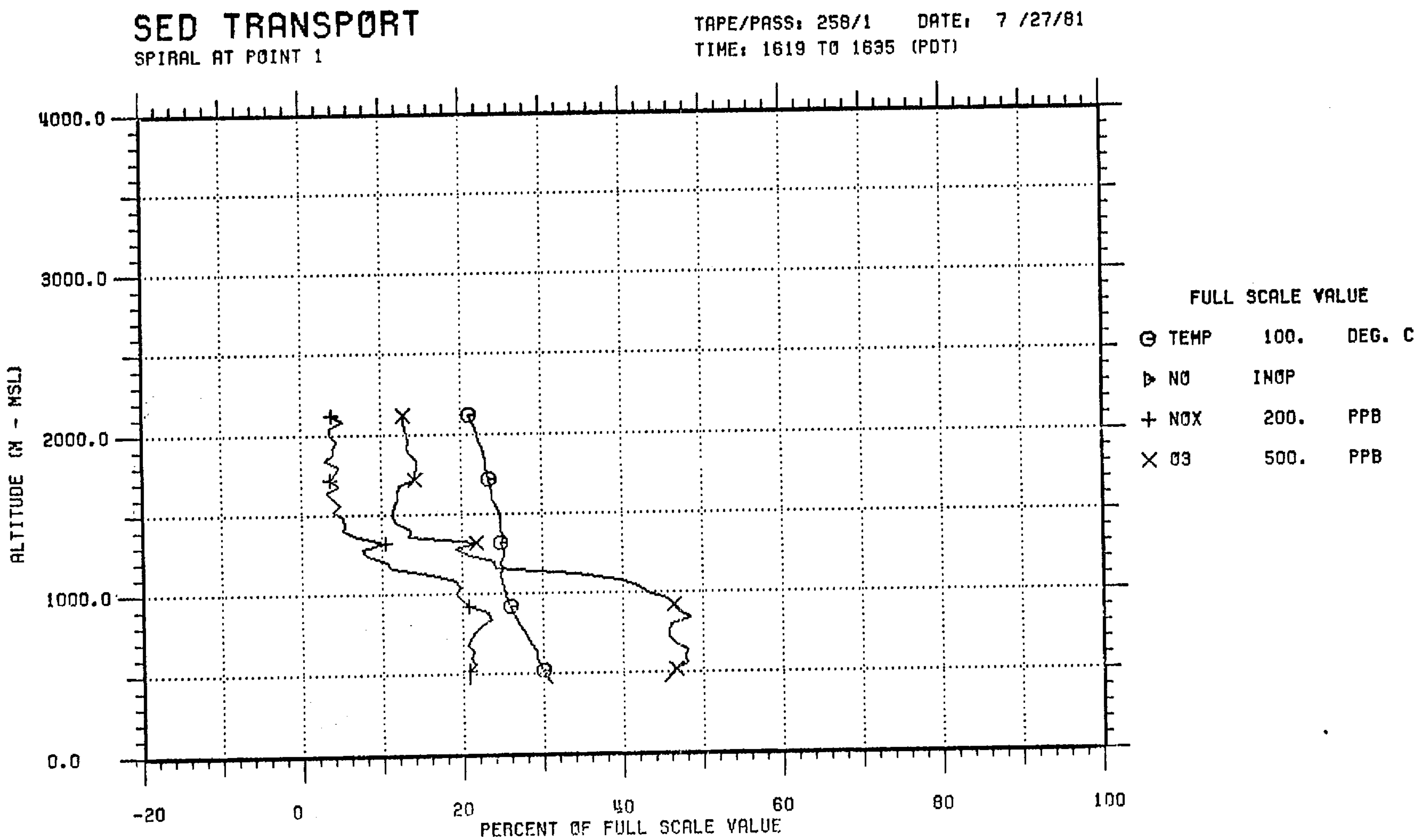
The next sounding was made over Lake Gregory at 1639 PDT (Figure 3.5.8). A shallow ozone layer to about 300 m above the terrain is present in the sounding. Similar layers were seen in previous soundings on July 9 and July 22. Winds in the surface layer at Lake Gregory were from the south at 10-14 m/s. A similar upslope wind was observed on July 9. Peak ozone concentration measured by the aircraft was about 13 pphm. The surface ozone value at the time was 18 pphm.

Another ozone layer was observed at a higher level (centered at 2800 m - msl) over Lake Gregory. Peak concentration in this layer was about 11 pphm. Winds in the layer were from the north and northeast. It is likely that the layer aloft represents the return of some of the pollutants which were carried upslope at an earlier time during the day.

A sounding was then made at Victorville at 1712 PDT. In the lowest 600 m, ozone concentrations were uniform at less than 10 pphm. Winds at Victorville in this layer were from the south-southwest, probably indicating flow from the Cajon Pass area. Above this layer larger ozone concentrations were observed. Peak concentration was 12 pphm at 3000 m (msl). Winds aloft within the upper layer at Victorville were from the southwest to northwest at 18 PDT. Earlier, however, winds aloft at Victorville at 14 and 16 PDT showed evidence of a deep layer of south to southeast winds within the upper ozone layer shown in Figure 3.5.9. It is suggested that these winds transported ozone from the mountain areas prior to the time of the aircraft sounding.

Horizontal traverses were then flown by the aircraft from Victorville to Cajon Junction (Figure 3.5.10), Cajon Junction to Highland (Figure 3.5.11), Highland to near Beaumont (Figure 3.5.12) and from Beaumont through San Gorgonio Pass to a point in the desert about seven miles east of the intersection of Highways 10 and 111 (Figure 3.5.13).

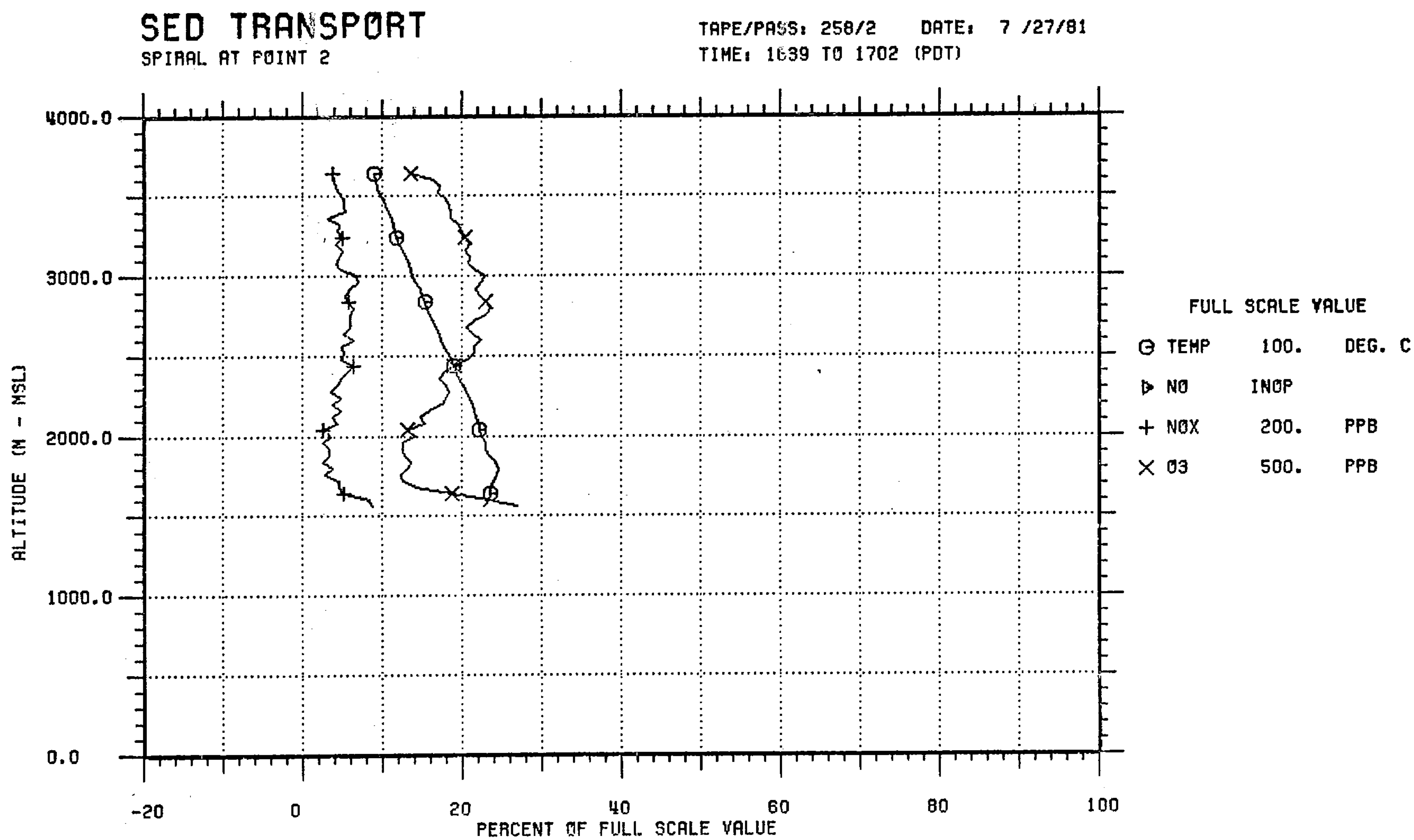
The leg from Victorville to Cajon Junction (Figure 3.5.10) started at about 1000 m (msl) increasing to 1430 m (msl) through the pass. Near Cajon Junction the flight altitude was reduced to 1200 m (msl). The ozone concentration increased markedly during this descent indicating the aircraft had entered the top of the pollutant layer. Highest ozone concentration observed on this descent was about 13 pphm although the surface hourly ozone reading at Cajon was 18 pphm at the time. Depth of the ozone layer in the pass was approximately 500 m according to the data shown in Figure 3.5.10.



AIRCRAFT SOUNDING AT RIALTO AIRPORT - July 27,1981

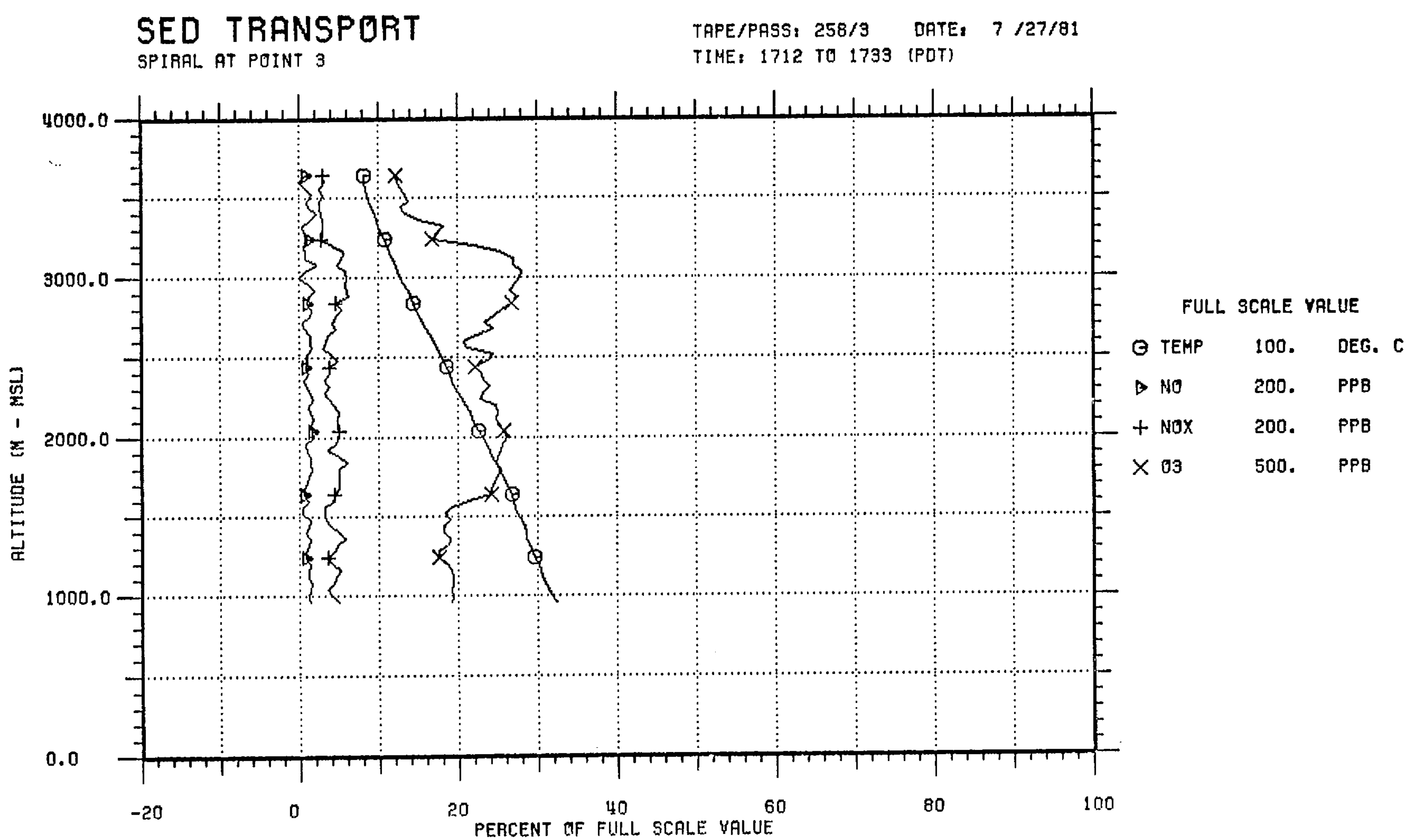
800925.1
20:51:47

Fig. 3.5.7



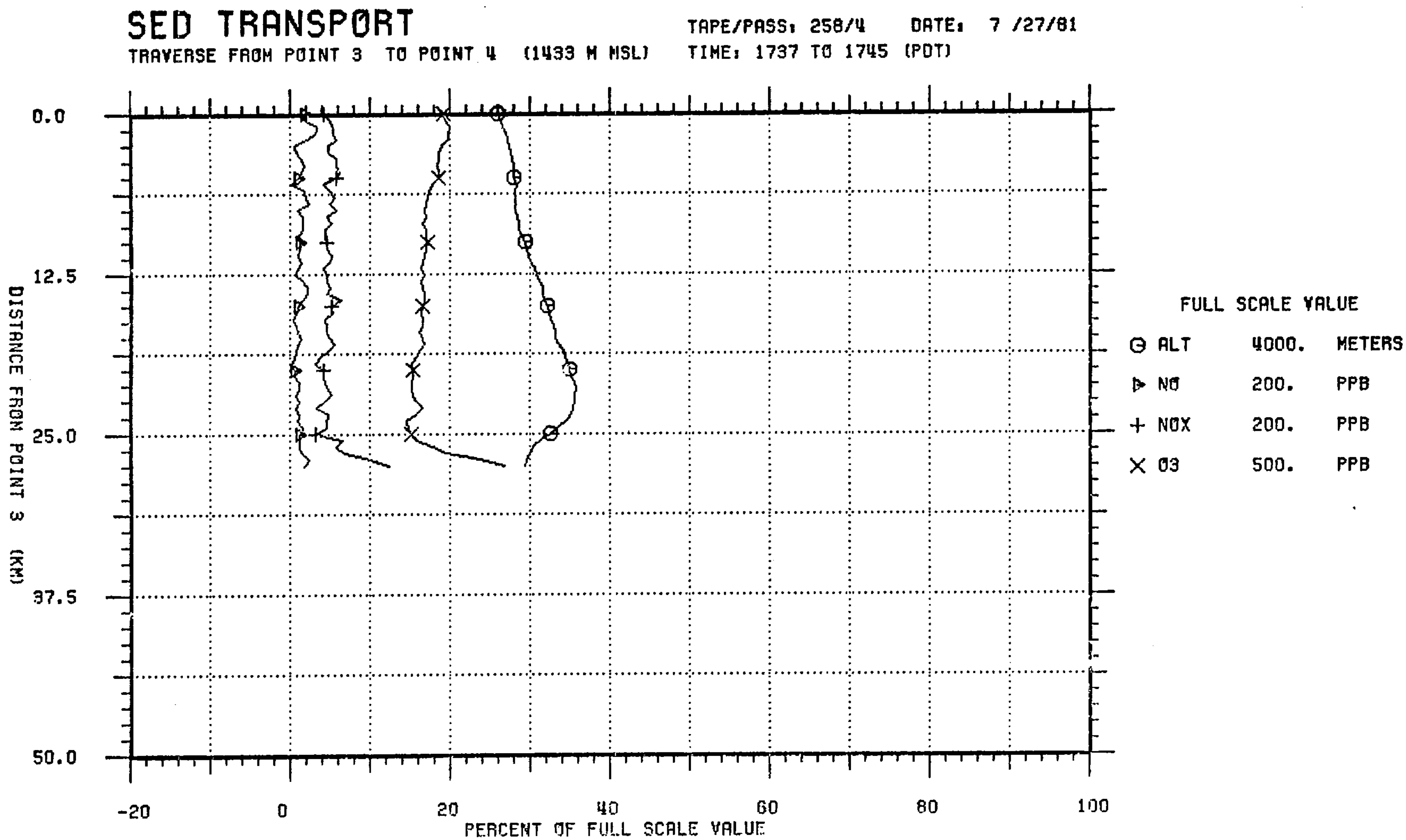
AIRCRAFT SOUNDING AT LAKE GREGORY - July 27,1981

Fig. 3.5.8



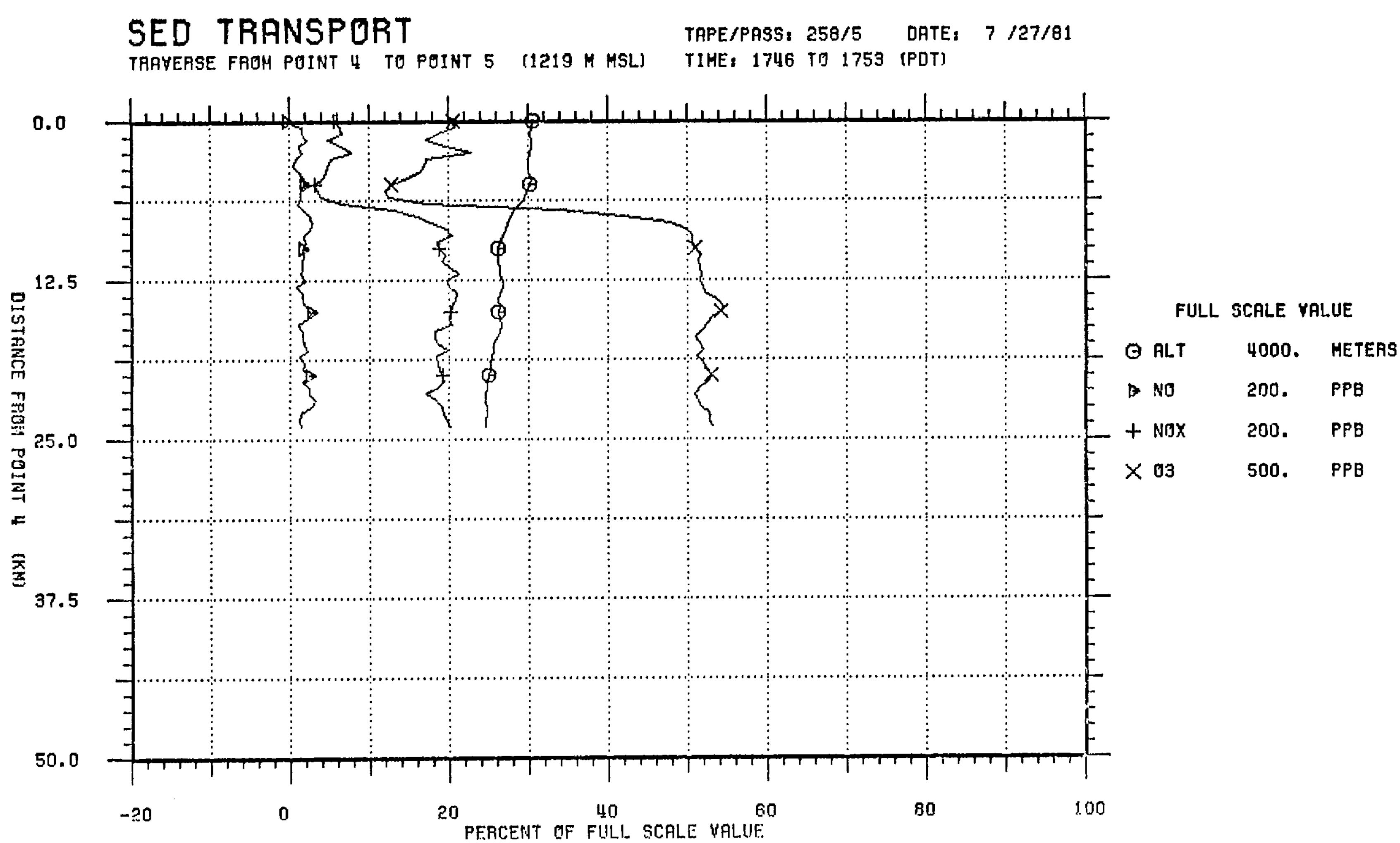
AIRCRAFT SOUNDING AT VICTORVILLE - July 27,1981

Fig. 3.5.9



AIRCRAFT TRAVERSE FROM VICTORVILLE TO CAJON JUNCTION - July 27,1981

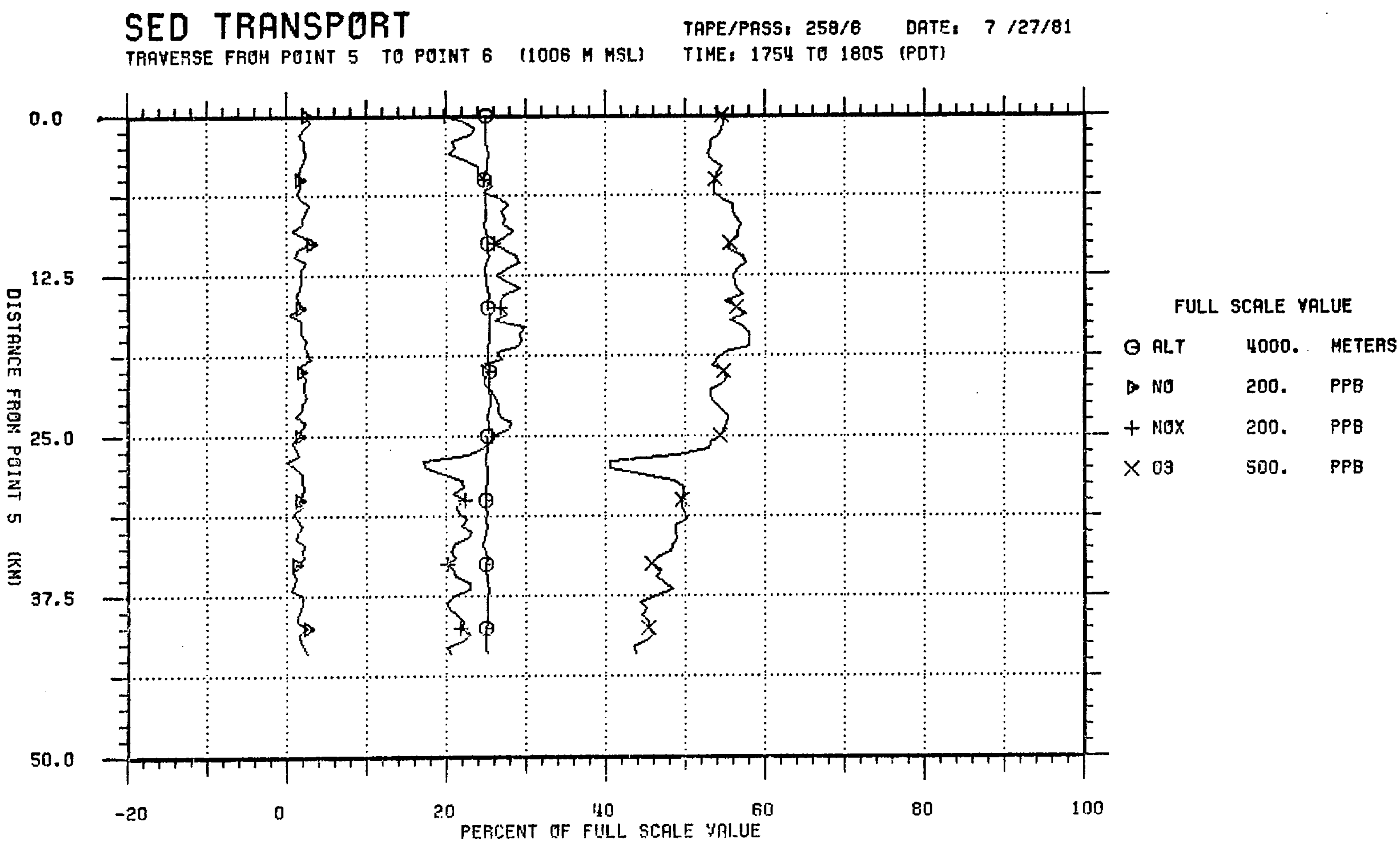
Fig. 3.5.10



AIRCRAFT TRAVERSE FROM CAJON JUNCTION TO HIGHLAND - July 27,1981

800925.1
21:18:54

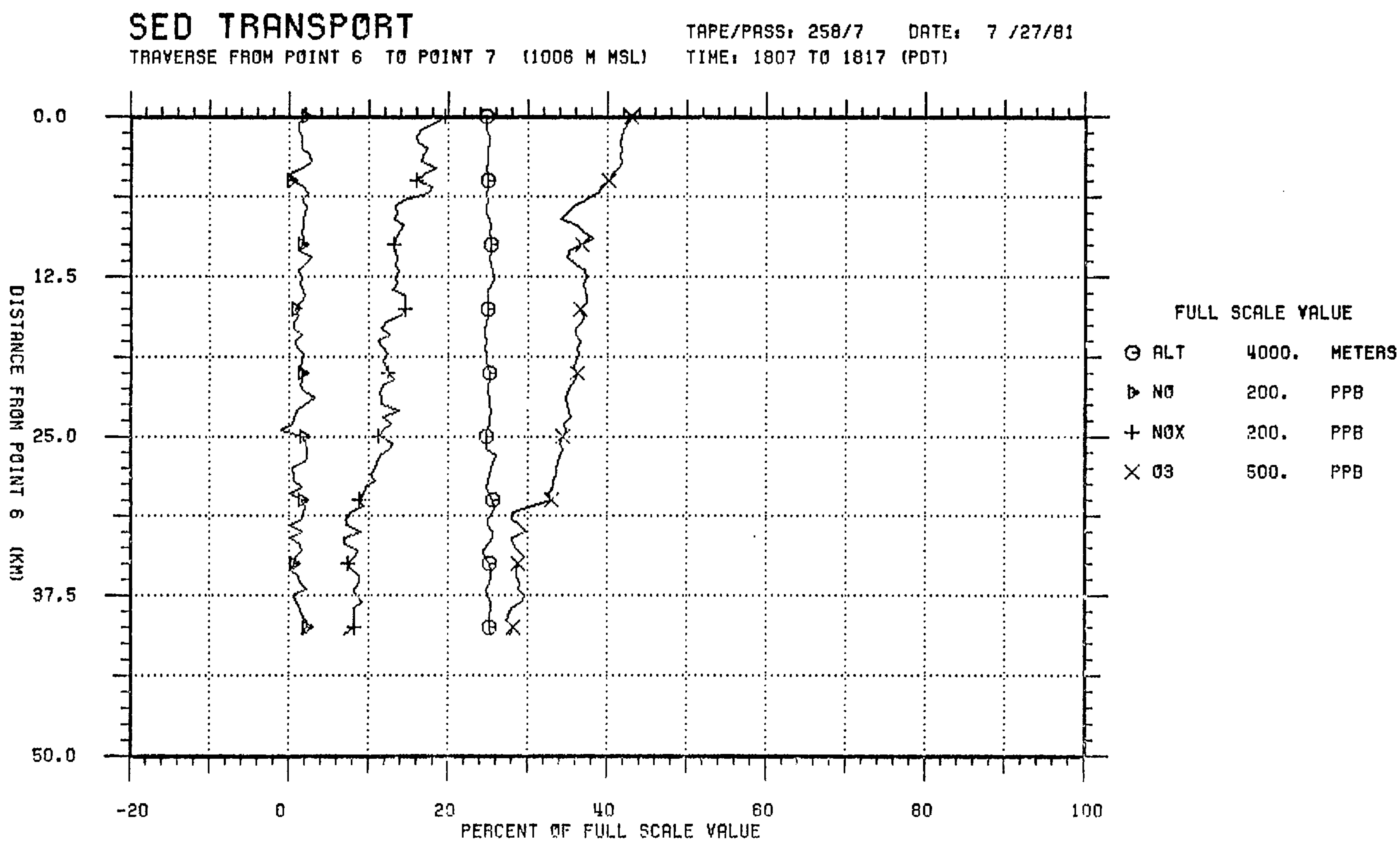
Fig. 3.5.11



AIRCRAFT TRAVERSE FROM HIGHLAND TO W OF BEAUMONT - July 27,1981

Fig. 3.5.12

800925.1
21:16:54



AIRCRAFT TRAVERSE FROM W BEAUMONT TO 7 MI E INTSCT I -10/111 - July 27,1981

600925.1
21:18:54

Fig. 3.5.13

The flight continued at 1200 m (msl) to the southern end of Cajon Pass. At that time the flight altitude was reduced to about 1000 m. An abrupt increase in ozone concentrations is indicated in Figure 3.5.11 as the aircraft entered the ozone layer in the basin. This flight altitude corresponds to a level near the top of the layer found at Rialto (Figure 3.5.7). Ozone concentrations continued at over 25 pphm for the balance of the leg to Highland.

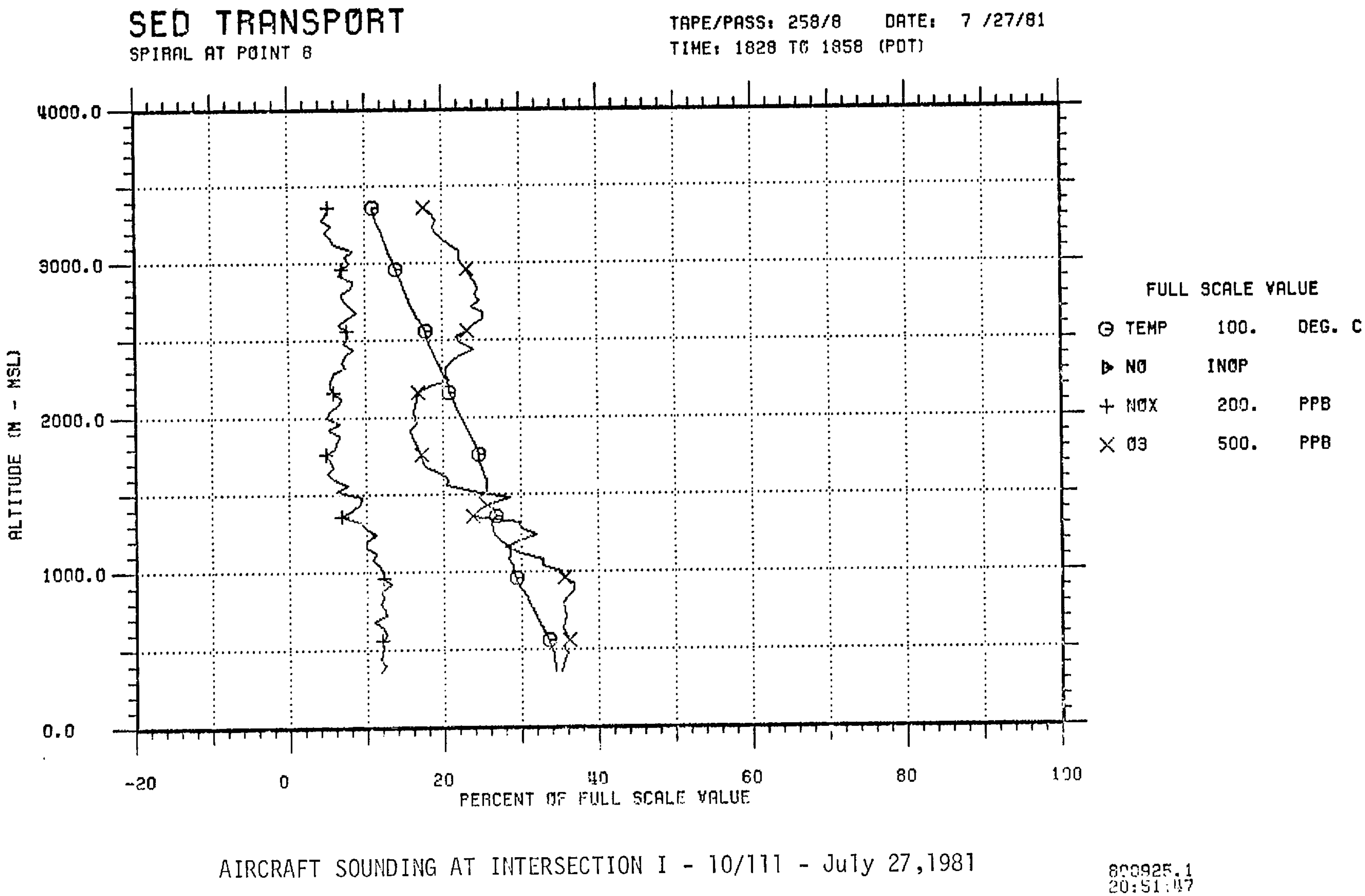
The flight from Highland to Beaumont (Figure 3.5.12) maintained the same altitude of 1000 m (msl). Ozone concentrations remained high at 27-29 pphm for two-thirds of the leg decreasing to 22 pphm near Beaumont.

The flight altitude continued at 1000 m (msl) through San Gorgonio Pass into the desert (Figure 3.5.13). Ozone concentrations at flight level steadily decreased to about 14 pphm in the desert. Hourly surface ozone concentration at Banning was 17 pphm at the time of the flight through the pass. Slightly higher concentrations existed aloft.

Figure 3.5.14 shows a sounding made at 1828 PDT at the intersection of Highways 10 and 111. The sounding shows a deep layer of ozone (to 1500 m - msl) being advected into the desert through the pass. Peak concentrations were 18 pphm in the low levels in good agreement with the surface concentrations observed at Banning. The ozone layer aloft appears to be the same one observed at Lake Gregory sometime earlier.

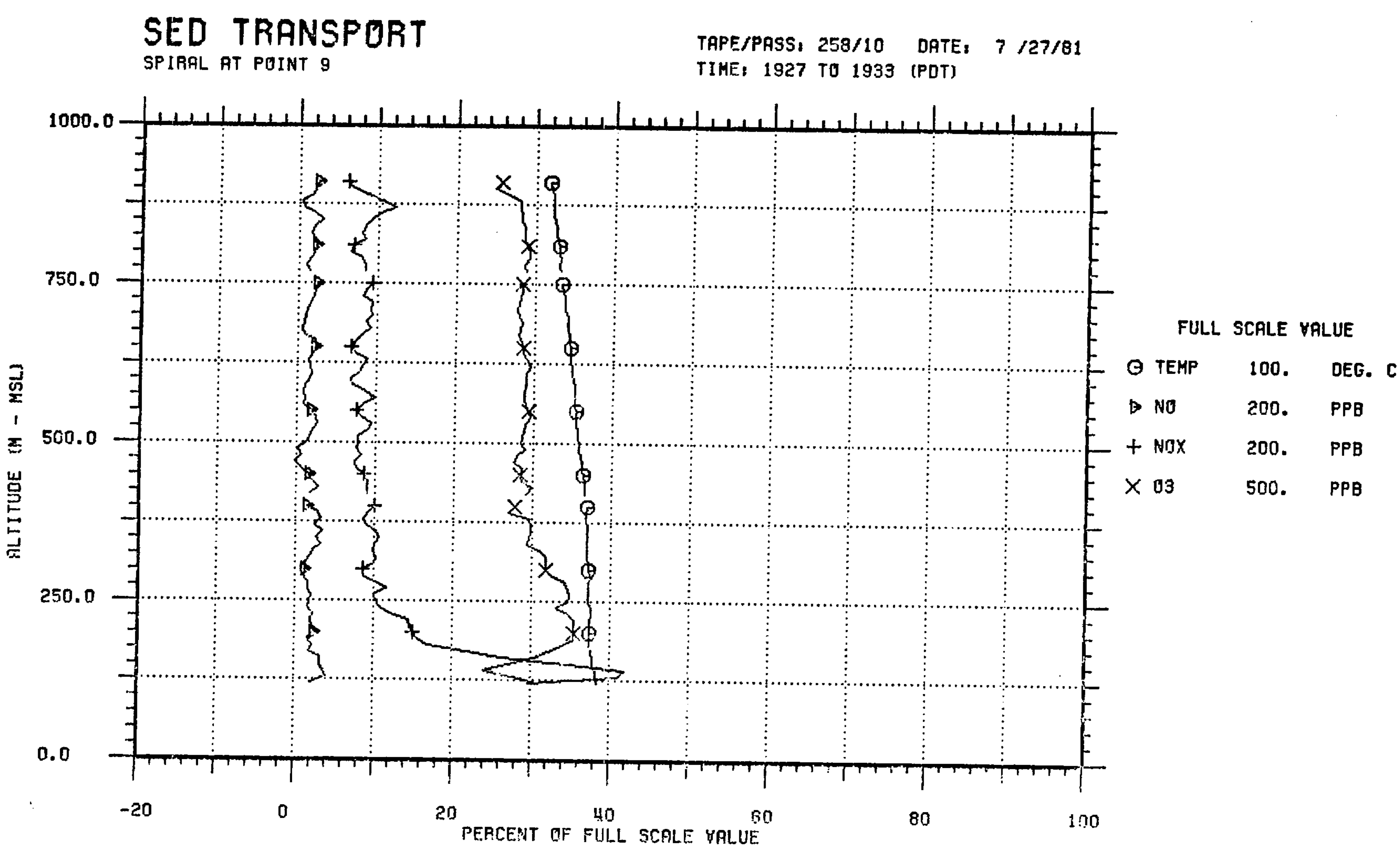
Figure 3.5.15 represents a sounding at Palm Springs Airport at 1927 PDT. Ozone concentrations were relatively uniform at about 15 pphm to a height of 900 m (msl). A shallow surface layer with high NO_x concentrations contributed to a local reduction of ozone in the lowest layers. According to the surface winds and the surface ozone concentrations, ozone transported from the basin arrived in Palm Springs at about 16 PDT on July 27. Peak hourly concentrations of 17 pphm occurred at 19 and 20 PDT. The sounding in Figure 3.5.15 was therefore made within the basin air carried southeastward from San Gorgonio Pass.

The final portion of the flight on July 27 was a traverse from Palm Springs back to the basin, ending slightly west of Rialto (Figure 3.5.16). Flight altitude to about 1000 m (msl) through the pass, decreasing to 750 m (msl) near the end of the traverse. Ozone concentrations peaked at about 23 pphm within San Gorgonio Pass decreasing to about 15 pphm on either end of the traverse.



AIRCRAFT SOUNDING AT INTERSECTION I - 10/111 - July 27,1981

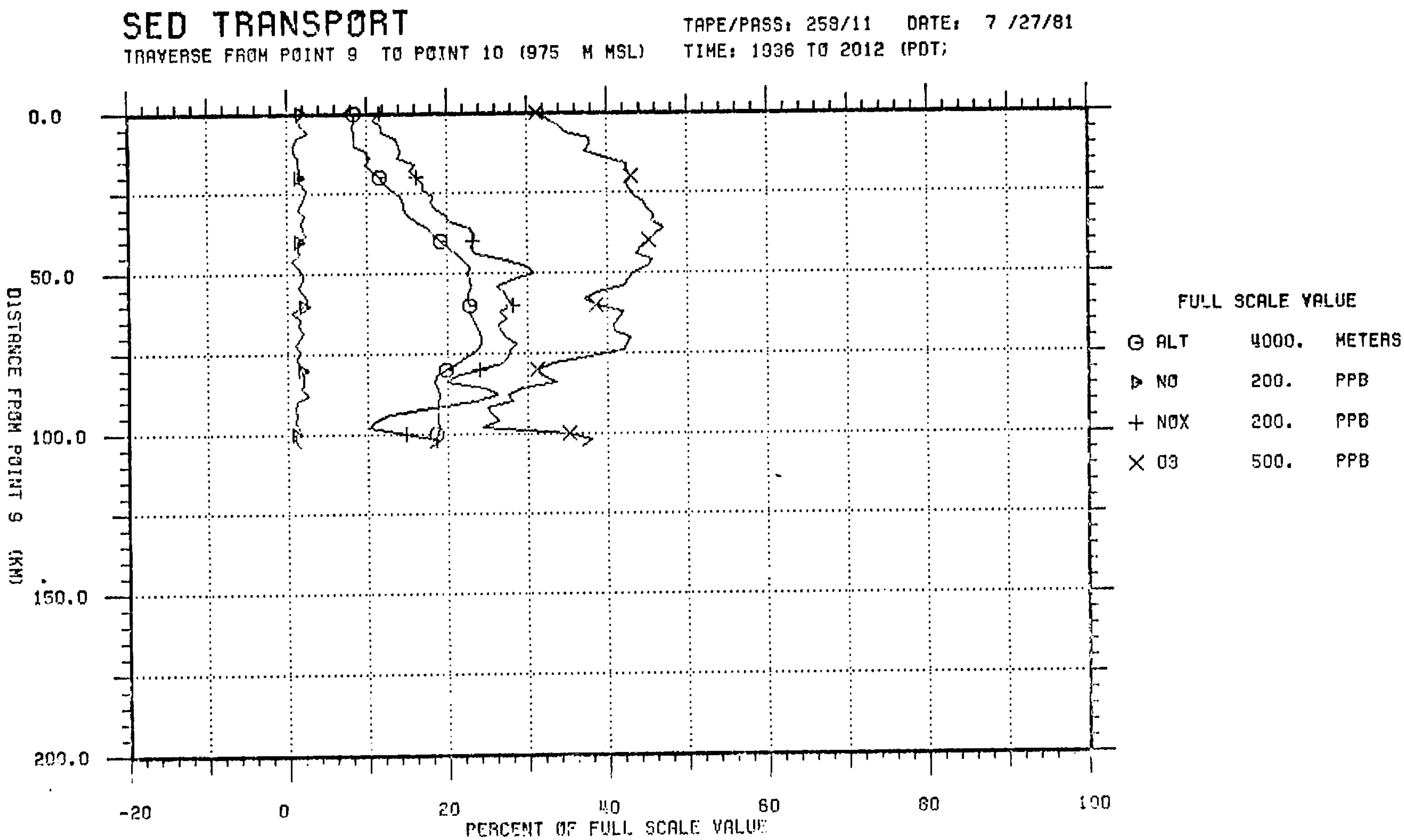
Fig. 3.5.14



AIRCRAFT SOUNDING AT PALM SPRINGS AIRPORT - July 27,1981

Fig. 3.5.15

800925.1



AIRCRAFT TRAVERSE FROM PALM SPRINGS TO DEVORE FREEWAY - July 27,1981

890925.1
21:10:54

Fig. 3.5.16

3.5.4 Tracer Results - Test 5

Release Location: Garden Grove
Date: July 27, 1981
Time: 0500-0900 PDT
Release Rate: 12.1 g/sec. SF_6

Surface winds at the release site were light and variable, averaging less than 0.5 m/s during the release period. The velocities began to increase late in the release and thereafter. Starting about 09 PDT the wind direction became organized into a west-northwesterly direction. Streamline patterns for 10 and 16 PDT on July 27 are shown in Figs. 3.5.17 and 3.5.18. Moderate pressure gradients into Bakersfield and Daggett suggested good transport into the desert areas and flows through Cajon and San Gorgonio Passes were established by 10 PDT.

July 27

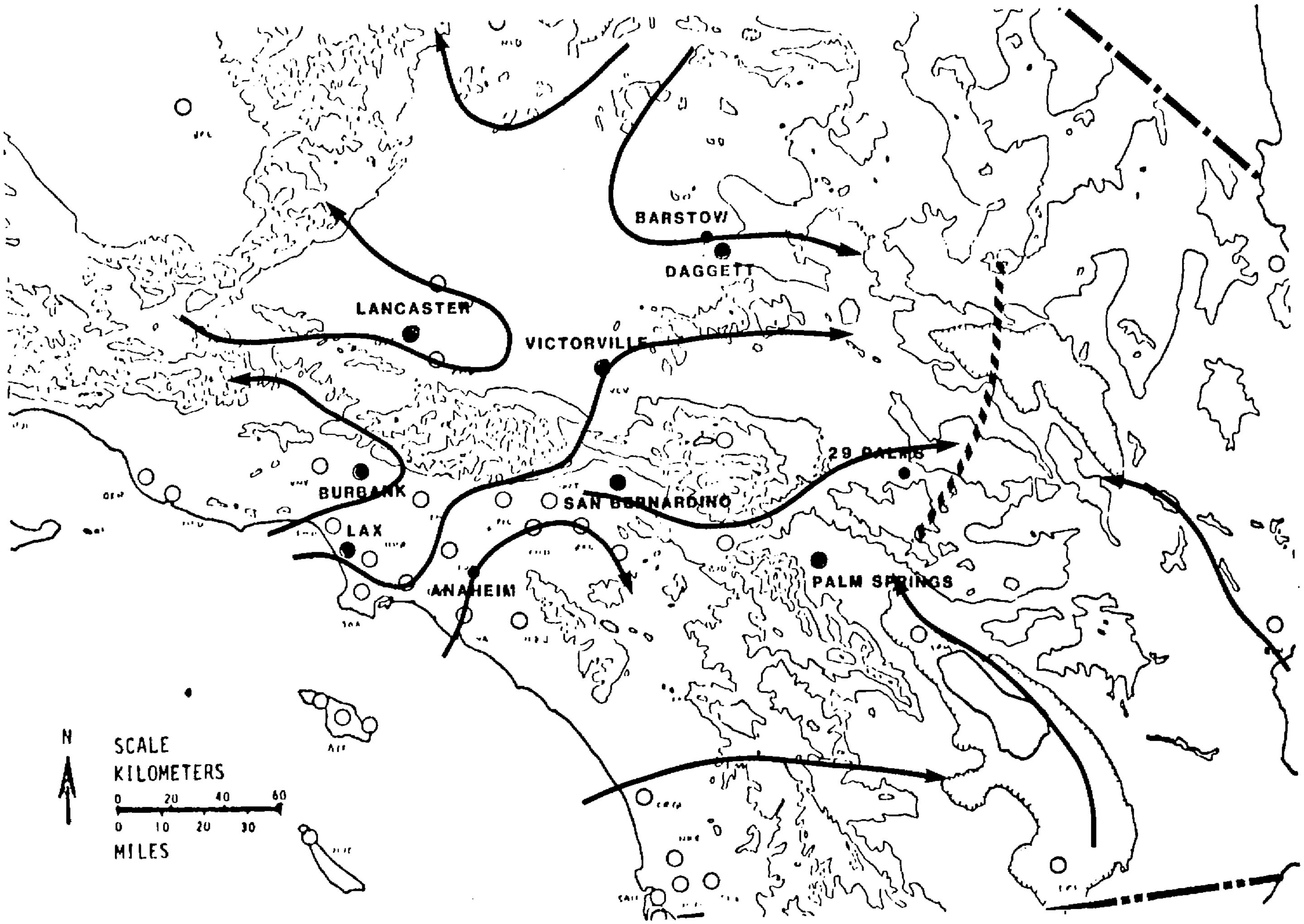
Fig. 3.5.19 shows the estimated tracer trajectories on July 27. The principal plume moved eastward through Anaheim and Corona, thence southeastward to Elsinore. In keeping with the low wind velocities during the release and the initial build-up of tracer material in the Garden Grove area, observed concentrations downwind were quite high. Concentrations over 1000 ppt were found as far east as Corona with over 100 ppt at Elsinore. The material carried southeastward to the Lake Elsinore vicinity is believed to have been introduced into the Elsinore convergence zone and transported aloft.

A later and secondary portion of the tracer plume moved northeastward and was observed during the afternoon at Cajon, San Bernardino and Lake Arrowhead but with generally smaller concentrations then were observed along the southeastward route. A portion of this plume moved into the Coachella Valley during the late evening and was observed at Indio and possibly at Desert Center.

Calculated Xu/Q values for the Garden Grove release are plotted in Fig. 3.5.20. The values were obtained by using the average wind at Garden Grove during the release period (0.35 m/s). The values shown in the figure correspond to C-D stability except for a number of points at 40 km or more downwind which show lower concentrations (B-C).

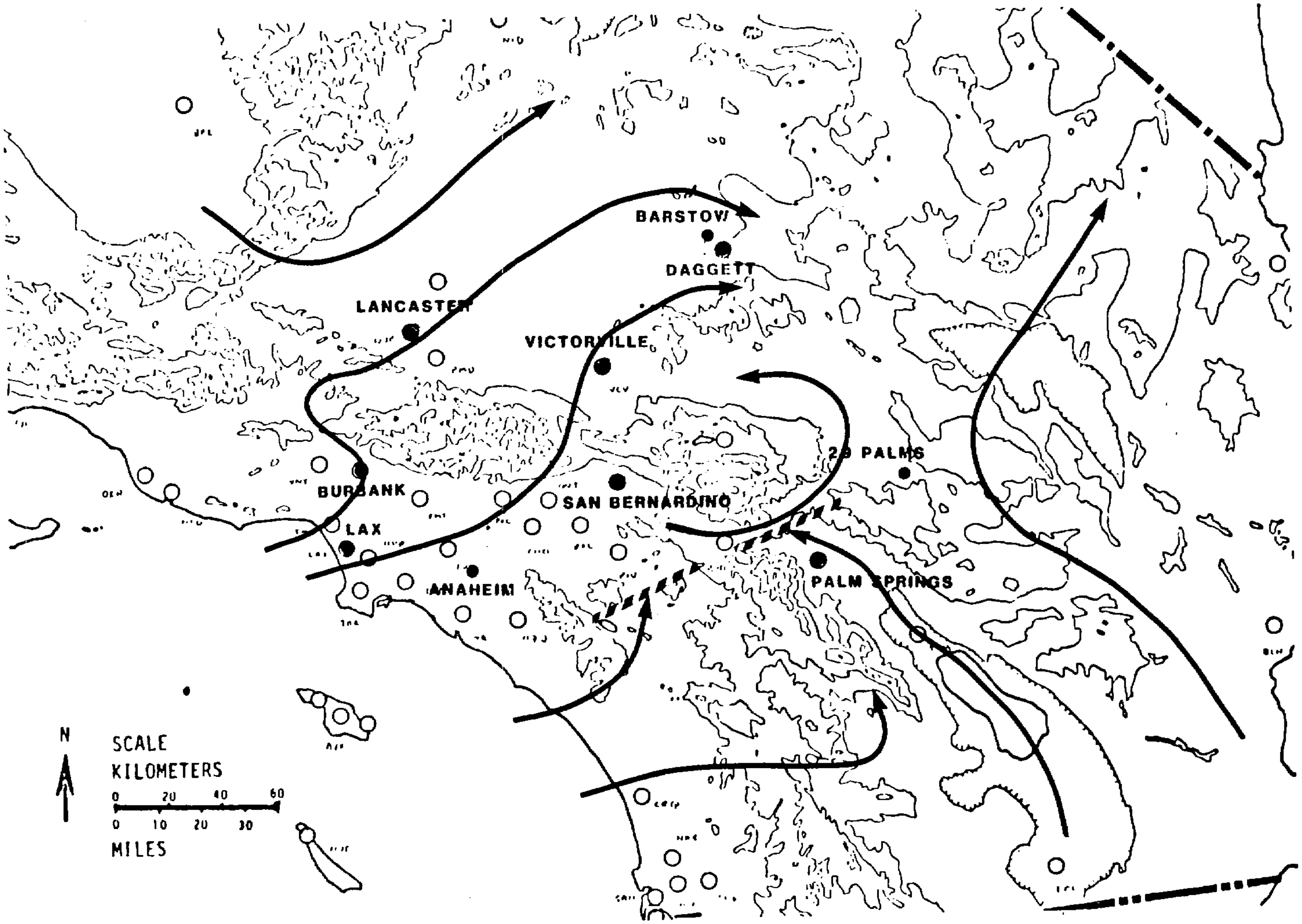
July 28

Automobile traverses were made on July 28 in the Coachella Valley and in the San Bernardino Mts. No significant tracer concentrations were found in the desert. Scattered SF_6 concentrations were found in the San Bernardino Mts. (peak value 17 ppt).



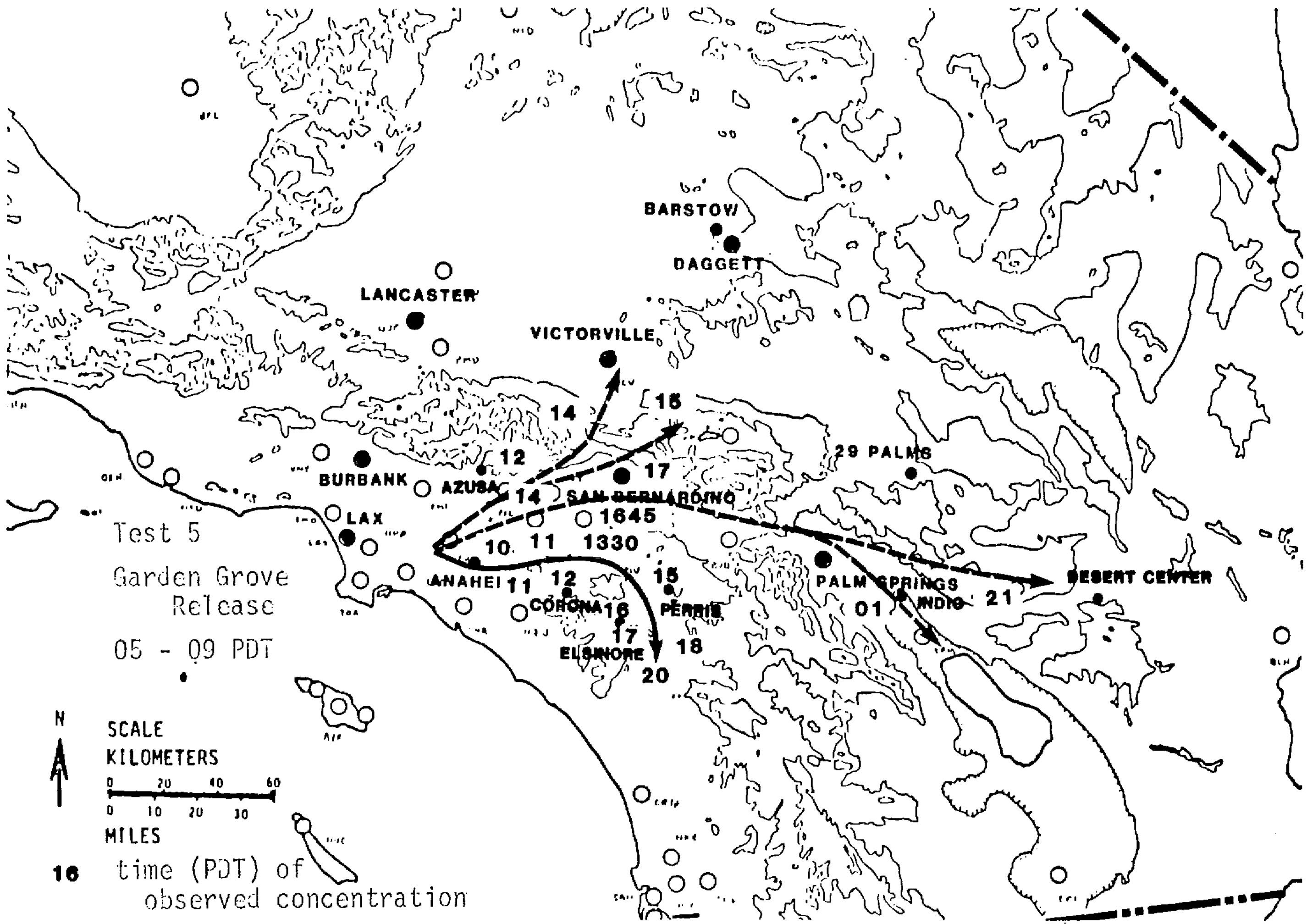
STREAMLINE MAP (10 PDT) - July 27,1981

Fig. 3.5.17



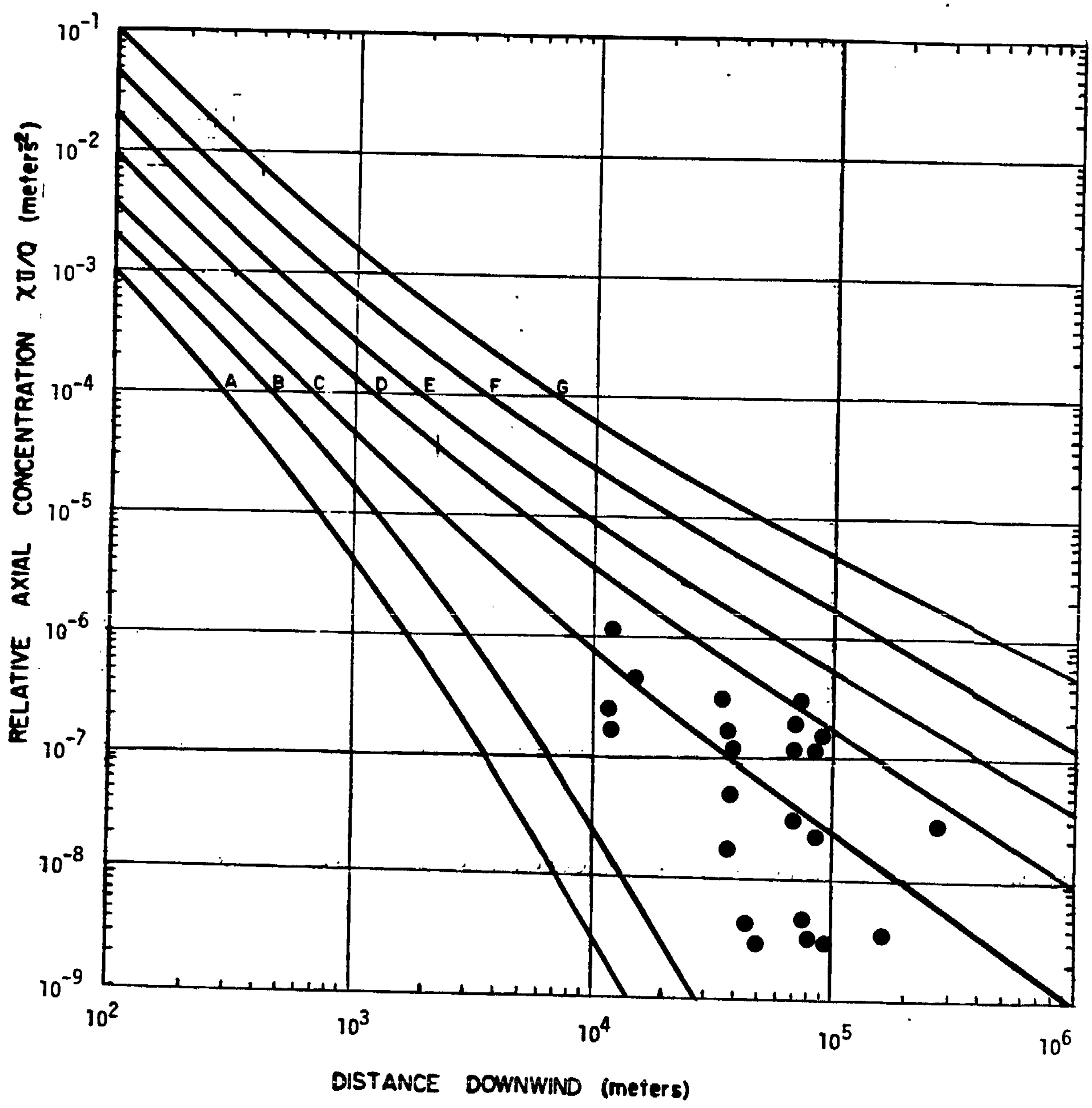
STREAMLINE MAP (16 PDT) - July 27,1981

Fig. 3.5.18



TRACER TRAJECTORIES - July 27,1981

Fig. 3.5.19



CALCULATED XU/Q VALUES - Test 5

July 27,1981

Fig. 3.5.20

Additional traverses were made in the Los Angeles basin in the triangle from Perris to San Bernardino to Pasadena. A maximum value of 10 ppt was found in the Perris area. Scattered concentrations of up to 28 ppt were observed between San Bernardino and Pasadena. No significant concentrations were found in Pasadena or Azusa on July 27 or 28.

Aircraft sampling near Elsinore at about 07 PDT on July 28 indicated a maximum concentration of 74 ppt, suggesting a small carry-over in that area from the larger concentrations observed during the previous evening.

3.6 Test 6 30-31 July 1981, Carson Release (0500-0900 PDT, 7/30/81)

3.6.1 Meteorology

General

A moderate low pressure trough aloft dominated the western part of the U.S. on July 30 (Figure 3.6.1). Winds aloft over Southern California were from the southwest with the southern portion of the trough remaining offshore. A moderate thermal trough was present at the surface, centered in southern Nevada and extending northwestward into northwestern California.

Table 3.6.1 shows the meteorological parameters of interest on July 30. The 850 mb temperature at Vandenberg AFB was near to slightly above normal for July. Surface maximum temperatures at Ontario and Palm Springs were also moderate by comparison with seasonal averages. Pressure gradients to the inland areas were relatively strong. The morning inversion base at UCLA of 753 m is quite high for July; over 90 percent of the observed base heights at LAX were below this value (Keith, 1980).

July 30 can be classed as a below average pollution potential day due to the relatively deep marine layer and the moderate transport winds into the desert.

Transport Winds

Surface winds at Carson during the tracer release are shown in Table 3.6.2:

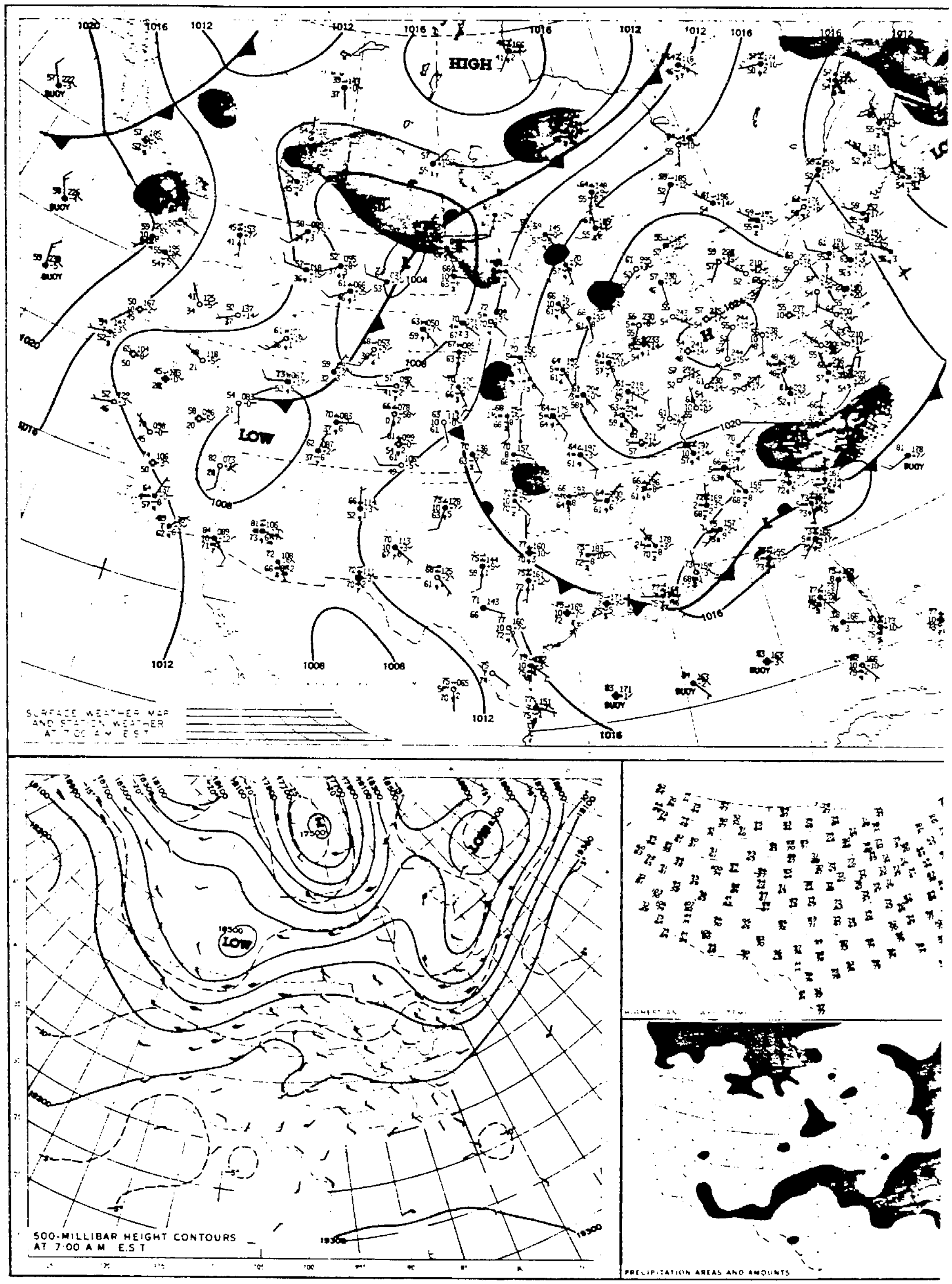
Table 3.6.2

SURFACE WINDS AT CARSON DURING AND AFTER RELEASE

JULY 30, 1981

Time (PDT)	Direction (°)	Speed (m/s)
06	320	0.6
07	260	0.7
08	150	1.0
09	180	0.6
10	360	1.0
11	170	1.5

THURSDAY, JUL



WEATHER MAP

July 30,1981

Fig. 3.6.1

Table 3.6.1

METEOROLOGICAL PARAMETERS

JULY 30, 1981

850 mb Temperature		
Vandenberg AFB	(0500 PDT)	21.0°C
Edwards AFB	(0545 PDT)	24.3
Ontario	(0830 PDT)	22.0
UCLA	(0600 PDT)	21.1
Pressure Gradients	(0800 PDT)	
LAX - Daggett		4.3 mb
LAX - Bakersfield		3.4
Maximum Surface Temperature		
Ontario		91°F (32.8°C)
Palm Springs		106 (41.1)
Inversion Base Height* and Temperature		
UCLA	(0600 PDT)	12.4°C (753 m)
Rialto	(0700 PDT)	15.5 (Surface)
Ontario	(0830 PDT)	13.7 (680 m)
Inversion Top Height* and Temperature		
UCLA	(0600 PDT)	21.1°C (1496 m)
Rialto	(0700 PDT)	25.5 (1350 m)
Ontario	(0830 PDT)	22.6 (1100 m)

* All heights are msl

Surface winds at Carson during the release period (05-09 PDT) were light and variable with no organized flow pattern being established through 11 PDT. After 11 PDT a south to southwest wind prevailed in the area during the afternoon.

Surface winds at Lancaster, Victorville and Palm Springs for July 30 and 31 are given in Table 3.6.3. Winds at Lancaster were consistently from the west-southwest with moderately strong velocities with the exception of 08 PDT on July 31. From 10 to 18 PDT on July 30 wind velocities exceeded 10 m/s in response to the strong pressure gradients from the coastal to the inland areas.

At Victorville the flow from Cajon Pass was apparent from 12 to 16 PDT and, in a somewhat stronger manner, from 12 to 18 PDT on July 31.

The northwesterly flow from San Gorgonio Pass into Palm Springs began at 18 PDT on July 30 and at 15 PDT on July 31. As at Victorville, this flow was somewhat stronger on July 31 in spite of slightly smaller pressure gradients compared to July 30.

Mixing Heights

Observed and predicted mixing heights for July 30 are shown in Table 3.6.4. Observed heights at UCLA (750 m - msl) were relatively high for a July day. Observed and predicted heights in the inland basin areas, however, were only modestly increased from the morning values. Ontario showed 930 m at 1430 PDT while a Redlands aircraft sounding indicated 1350 m at 1602 PDT. The desert areas in the Coachella Valley likewise did not show extensive mixing layer depths. There was no marked increase in visibility at Ontario or San Bernardino and it did not appear that the inversion was broken in the inland basin areas during the afternoon (Table 3.6.5).

Table 3.6.5

OBSERVED VISIBILITIES - JULY 30, 1981

Time (PDT)	San Bernardino	Ontario
10	2 miles	1 miles
12	2	1-1/2
14	3	3
16	5	3
18	4	3

Table 3.6.3

SURFACE WINDS - JULY 30-31, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	260°/ 5.1 m/s	150°/0.5 m/s	-
08	250 / 7.7	Calm	Calm
10	240 /11.3	Calm	310°/4.1 m/s
12	240 /10.3	160 /3.1	050 /2.6
14	250 /10.3	200 /2.6	110 /4.6
16	220 /10.3	160 /2.6	120 /3.6
18	240 /10.3	260 /4.1	290 /6.7
20	230 / 8.2	200 /2.1	280 /7.7
22	260 / 6.7	230 /1.0	280 /6.2
24	250 / 8.2	180 /1.6	-
02	270 / 4.1	180 /0.5	-
04	270 / 5.1	Calm	-
06	260 / 2.6	Calm	-
08	Calm	150 /2.6	Calm
10	260 / 5.1	090 /1.6	110 /4.1
12	230 / 9.8	210 /4.1	Calm
14	230 / 7.7	120 /4.6	040 /2.6
16	260 /13.4	170 /2.1	280 /6.2
18	240 / 9.3	190 /6.2	290 /7.7

Table 3.6.4

MIXING HEIGHTS - JULY 30, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT	752 m	150 m
	1200	758	150
Ontario	0830	670	290
	1430	930	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Hesperia	1532 PDT	1500 m	1000 m
Redlands AP	1602	1350	450
Hi Desert AP	1734	2400	700
I-10 and 111	1818	1250	350
Palm Springs AP	1845	1500	150

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	1350 m	290 m
San Bernardino	1300	360
Edwards AFB	2285	725

3.6.2 Regional Pollutant Levels

A map of the maximum hourly ozone concentrations for July 30 is shown in Figure 3.6.2. Highest observed concentration was at Mt. Wilson (27 pphm). Fontana recorded a value of 26 pphm while Mt. Baldy and Azusa both experienced a maximum of 23 pphm. The desert areas of Lancaster and the Coachella Valley received concentrations above the state standard. The balance of the recorded desert observations were 10 pphm or below.

Figure 3.6.3 gives a map of the hours when peak ozone concentrations were observed in the area. Peak arrival times in the Mojave Desert were early evening with the exception of China Lake and Lucerne Valley which showed no significant evidence of advection of ozone from outside areas. Desert Center showed a small (6 pphm) peak which lasted from 16 to 22 PDT and may indicate a minor effect of the basin.

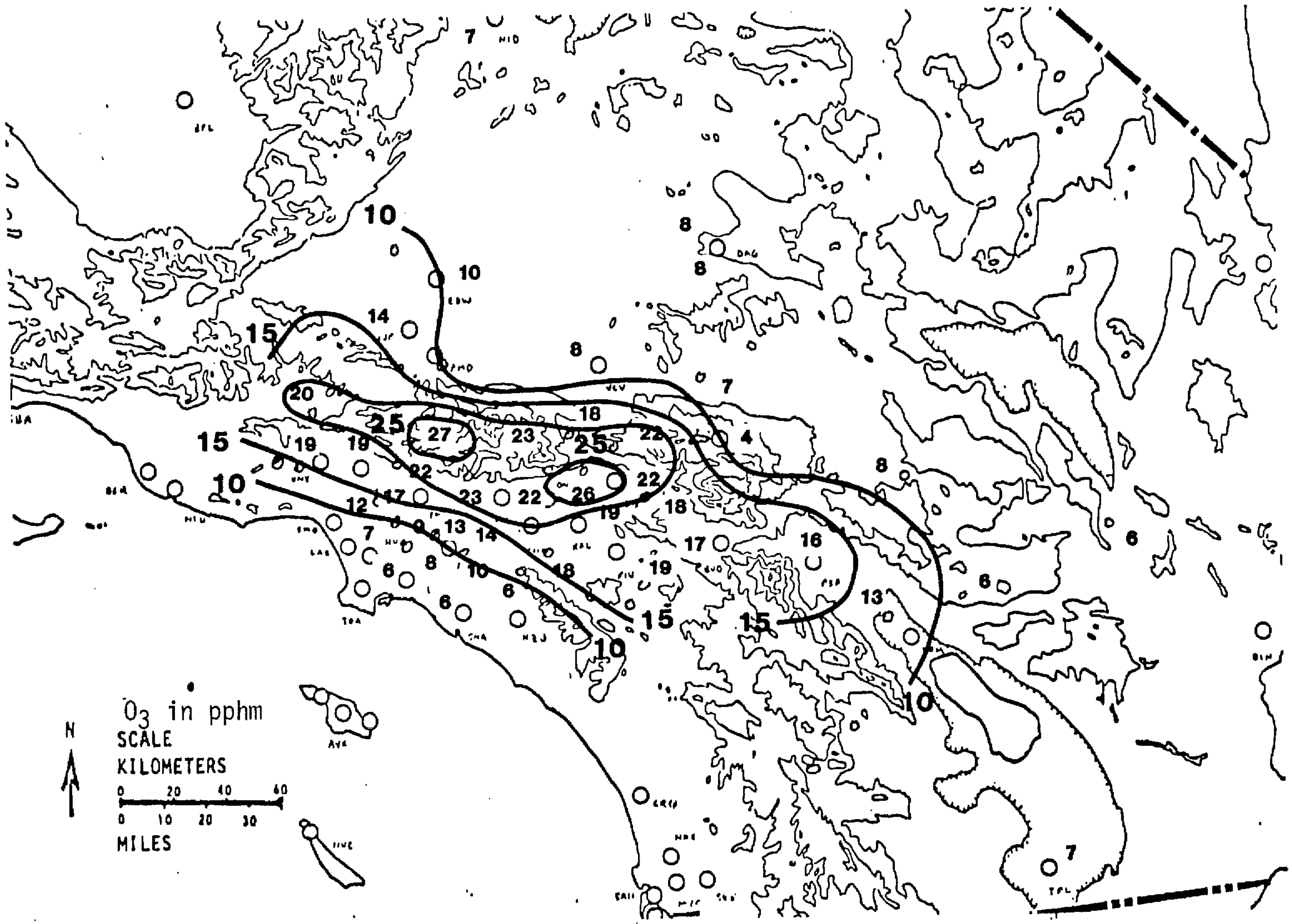
Figure 3.6.4 shows hourly concentrations along the route from the basin into the Coachella Valley and in the mountain areas. The peak concentration time progresses successively from Riverside to Indio although the time between Riverside and Banning is unusually long. The mountain stations show slightly later peak times for the eastern stations. Fawnskin has a very small peak between 18 and 20 PDT which suggests a minor effect from the basin area.

Hourly concentrations along the routes through Newhall and Cajon Pass are shown in Figure 3.6.5. Transport from San Bernardino to Lake Gregory and Cajon Pass is indicated. The peaks at Victorville and Barstow, however, are relatively minor although they appear at appropriate times to suggest transport into these areas. Transport is also indicated from Newhall to Edwards AFB by the timing of the peak concentrations along this route.

Both Barstow and Edwards AFB show that peak concentrations were low but the timing was in agreement with the concept of transport from Newhall/Mint Canyon. Winds at Barstow during the evening were west-southwest to west, suggesting that material observed at Barstow may have arrived via the Newhall/Mint Canyon route.

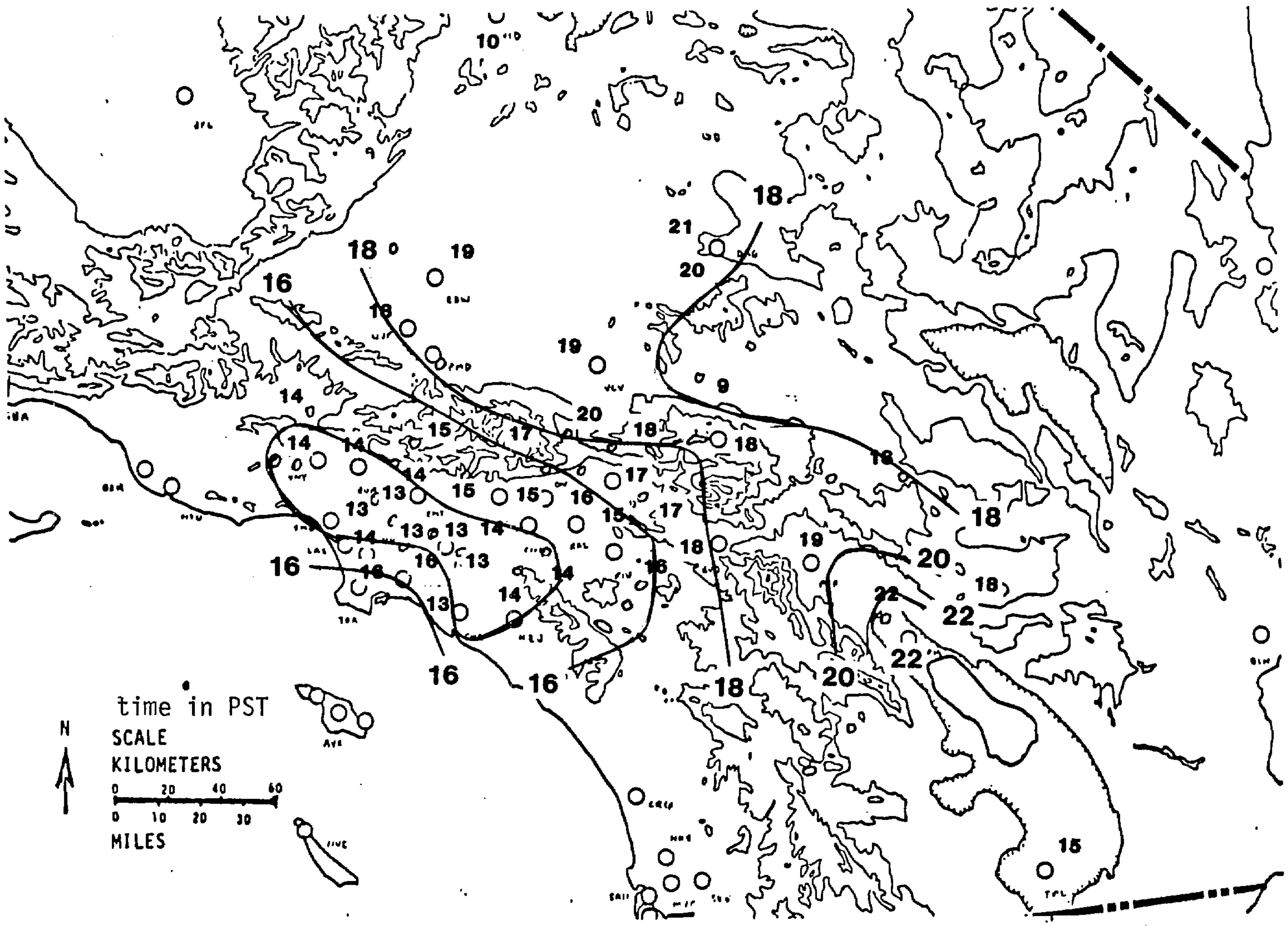
3.6.3 Aircraft Sampling - July 30, 1981

The MRI air quality aircraft sampled in the vicinity of Cajon Pass, San Gorgonio Pass and Yucca Valley on July 30. The principal objective was to compare the flux of pollutants through the two passes. A secondary objective was to evaluate the Santa Ana River Valley east of San Bernardino as a potential transport route for pollutants out of the basin. The flight pattern on July 30 is shown in Figure 3.6.6 and the locations designated on the map are listed in Table 3.6.6. A further description of the flight path is given in Table 3.6.7.



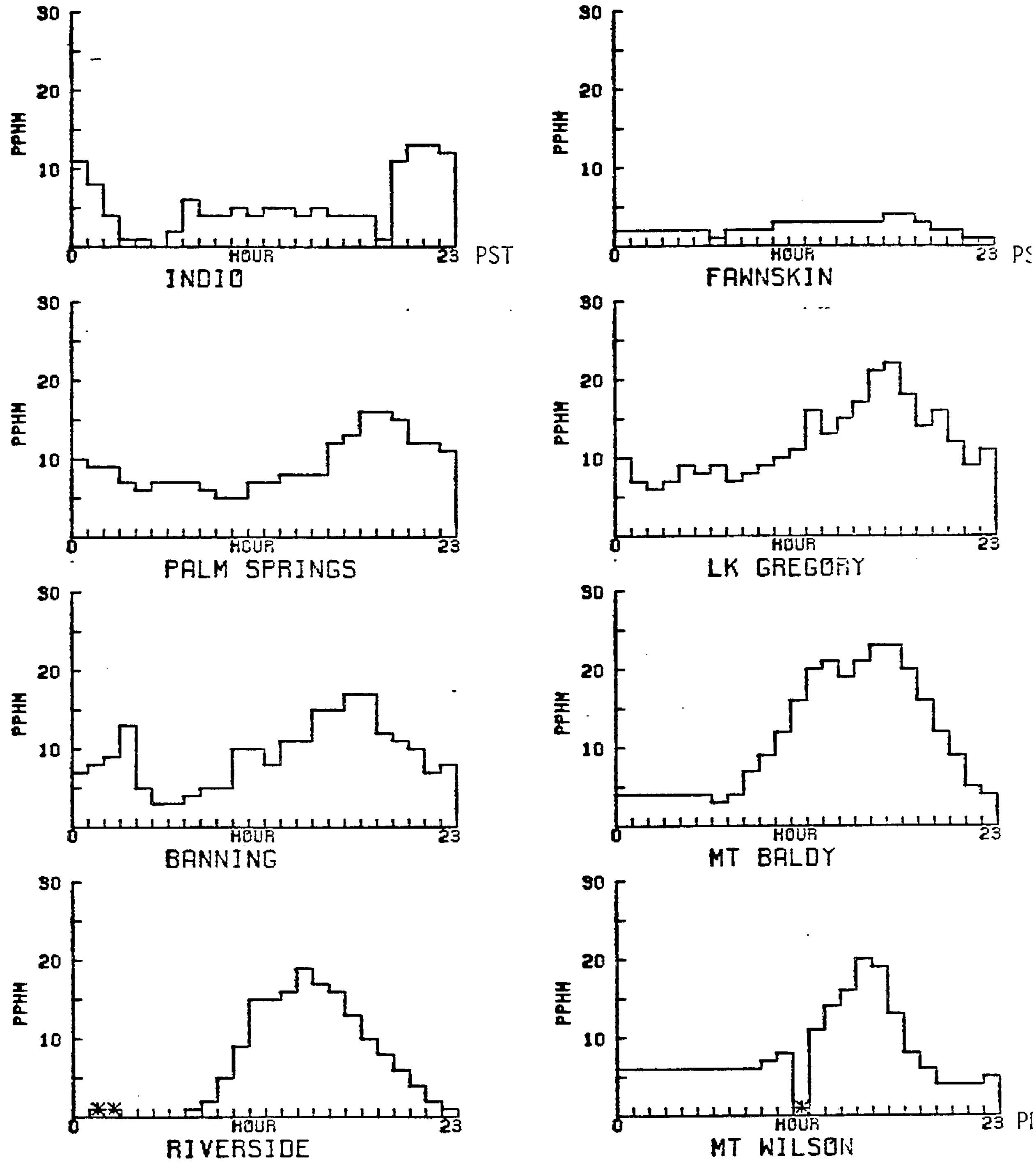
MAXIMUM HOURLY OZONE CONCENTRATIONS - July 30,1981

Fig. 3.6.2



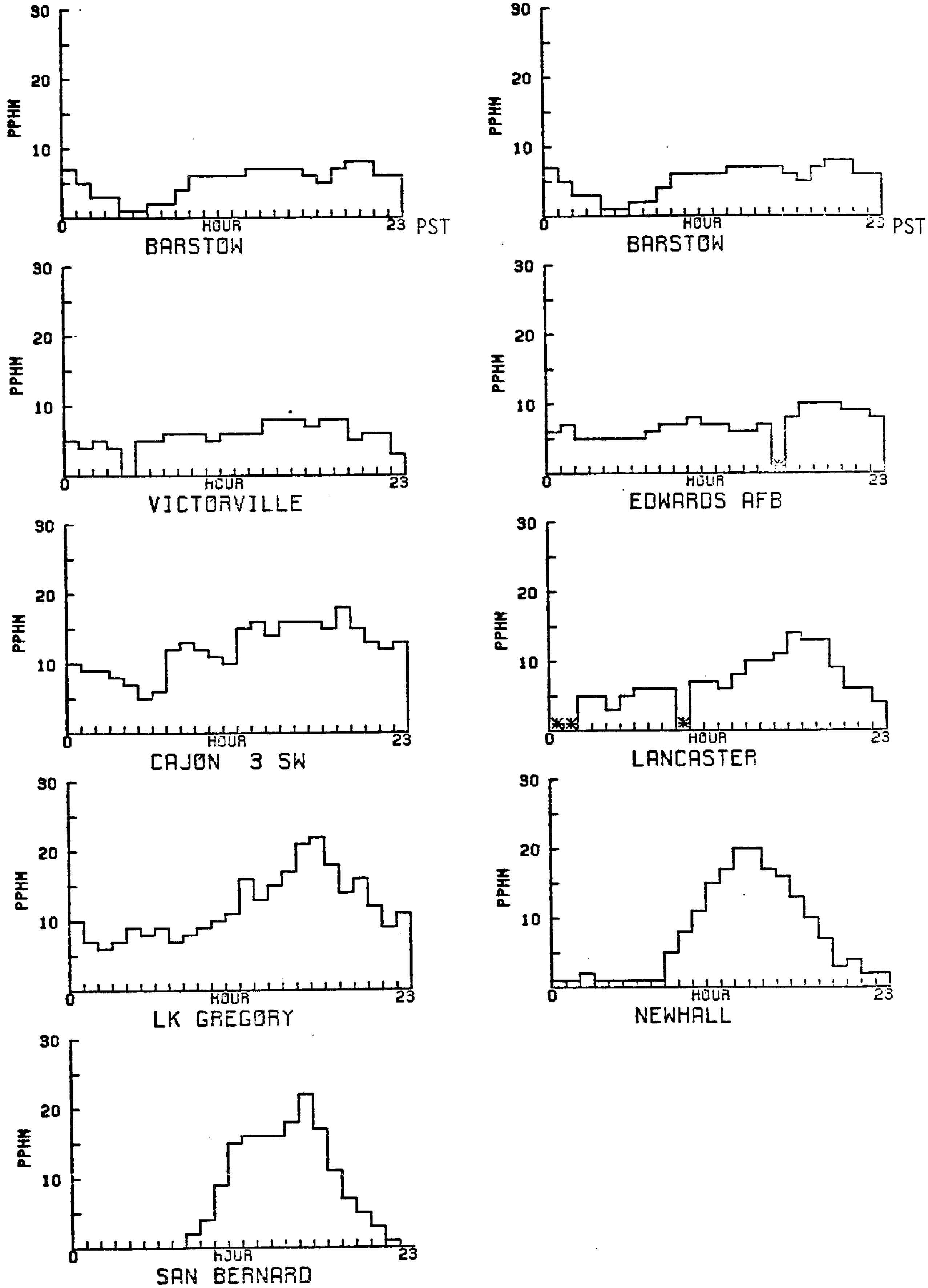
TIME OF MAXIMUM HOURLY OZONE CONCENTRATION - July 30,1981

Fig. 3.6.3



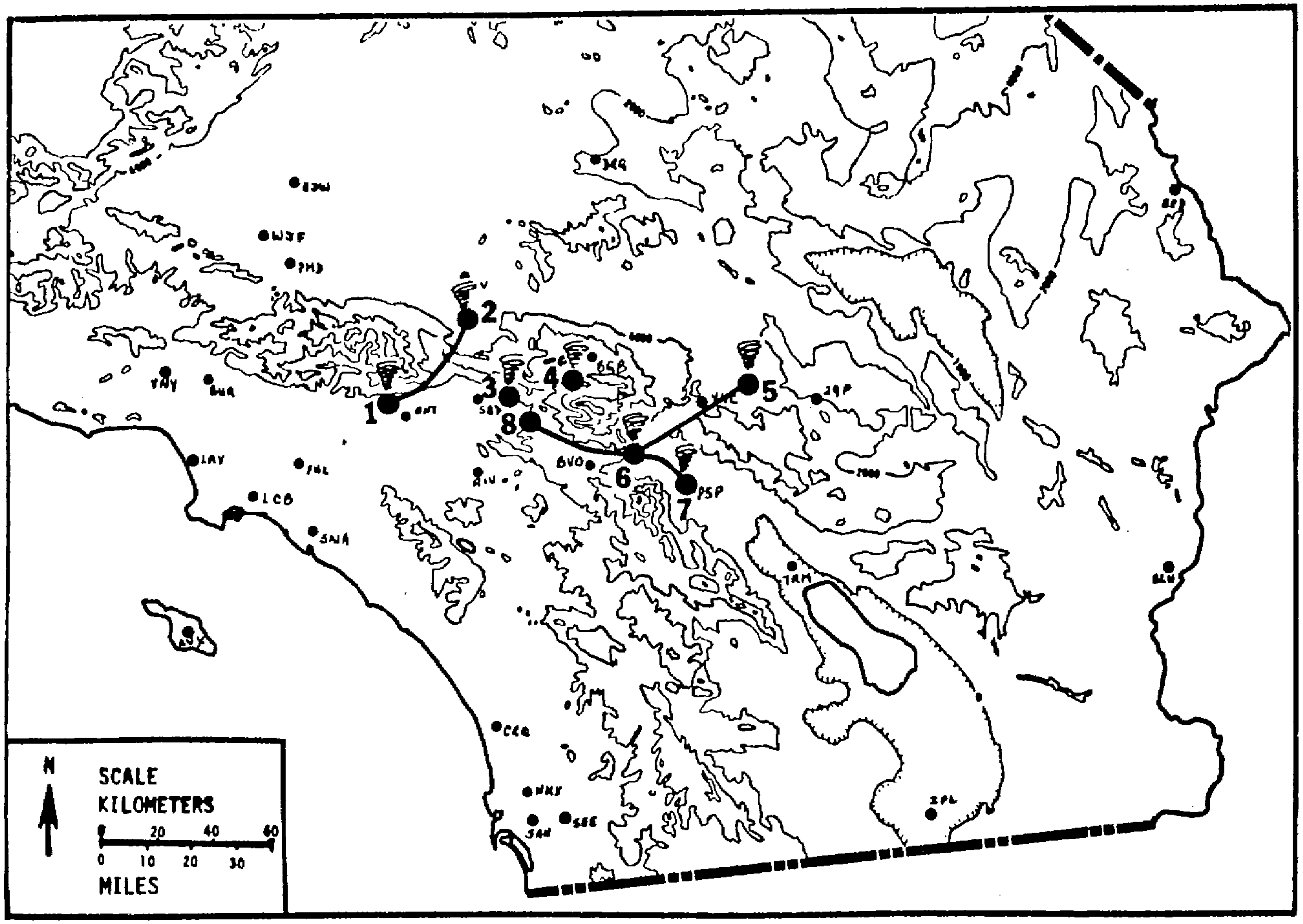
HOURLY OZONE CONCENTRATIONS - July 30,1981

Fig. 3.6.4



HOURLY OZONE CONCENTRATIONS - July 30,1981

Fig. 3.6.5



MRI SAMPLING FLIGHT - July 30,1981

Fig. 3.6.6

Table 3.6.6

30 July 1981 Tape #259

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°07.0'	117°41'	Cable Airport
2	34°22.5'	117°18.5'	Hesperia
3	34°05.0'	117°8.8'	Redlands Airport
4	34°10.0'	116°55.5'	Santa Ana River Canyon
5	34°9.0'	116°15.2'	High Desert Airport
6	33° 55.2'	116°40.5'	Intersection of Hwys 10 & 111
7	33°49.5'	116°30.5'	Palm Springs Airport
8	34°01.2'	117°06.0'	Downtown Redlands

MRI FLIGHT SUMMARY

SOUTHEAST DESERT OZONE TRANSPORT STUDY

Date: July 30, 1981

Tape #: 259

Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start	End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1513	1529	Traverse	1 - 2	640	1463	48.3 Km.	I1-18	
2	1532	1549	Spiral	2	1006	2743	N.A.	I19-31	Sfc Elev = 998 m
3	1603	1617	Spiral	3	2743	884	N.A.	I39-54	Sfc Elev = 442 m Data system crash
4	1626	1634	Spiral	3	451	1524	N.A.	0	Redid bottom part of Pass 3
5	1655	1706	Spiral	4	3658	1737	N.A.	I55-67	Bottom of canyon ≈1556 m
6	1734	1756	Spiral	5	3962	701	N.A.	I68-90	Sfc Elev = 694 m
7	1759	1816	Traverse	5 - 6	610	1372	46.7 Km.	I91-108	Within 305 m of terrain
8	1818	1838	Spiral	6	366	2134	N.A.	I109-121	Sfc Elev = 351 m
9	1845	1900	Spiral	7	2134	107	N.A.	I122-135	Sfc Elev = 107 m Airplane landed for 2 hrs
10	2121	2139	Spiral	7	104	2134	N.A.	I136-150	Sfc Elev = 104 m
11	2140	2156	Zero Spiral		2134	116	N.A.	0	Instrument calibration
12	2159	2218	Traverse	7 - 8	305	975	62.1 Km.	I151-163	Within 305 m of terrain

Table 3.6.7

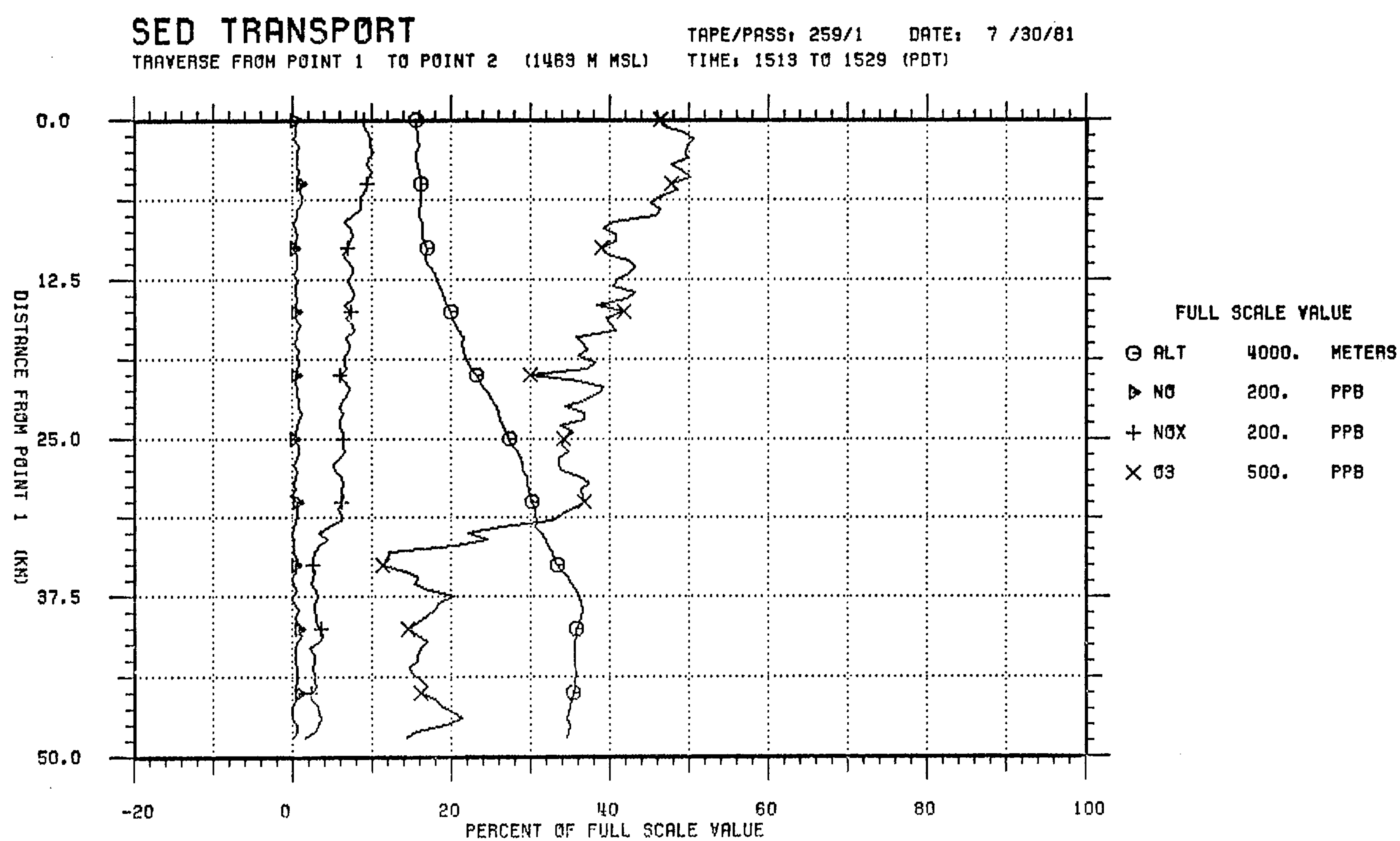
Figure 3.6.7 shows flight data taken on a traverse from Cable Airport to Hesperia beginning at 1513 PDT. Flight altitude started at 600 m (msl) and ended at 1400 m (msl). Ozone concentrations were about 25 pphm at the beginning of the traverse and decreased to about 18 pphm on the upwind side of Cajon Pass. On the desert side of the summit ozone concentrations at flight altitude dropped significantly to an average around 8 pphm.

Figure 3.6.8 is a sounding taken at Hesperia at 1532 PDT. There was a shallow ozone layer in the lowest 500 m with peak concentrations of 10 pphm. Above this layer ozone concentrations were near background levels to 2800 m (msl).

Figure 3.6.9 represents a sounding made at Redlands Airport beginning at 1603 PDT. A moderate ozone layer was present to 1500 m (msl) or 1100 m above the terrain. Peak concentrations were near 19 pphm with background levels observed above 1500 m (msl). This sounding was partially repeated at 1628 PDT in order to obtain a better description of the lower layer (Figure 3.6.10). Maximum concentrations to 20 pphm were found near the surface with a top of the mixed layer near 1400 m (msl). Winds measured at Redlands at this time were westerly within the surface ozone layer. This flow should tend to transport the surface layer pollutants eastward into Mill Creek Valley to the south of Mt. San Gorgonio.

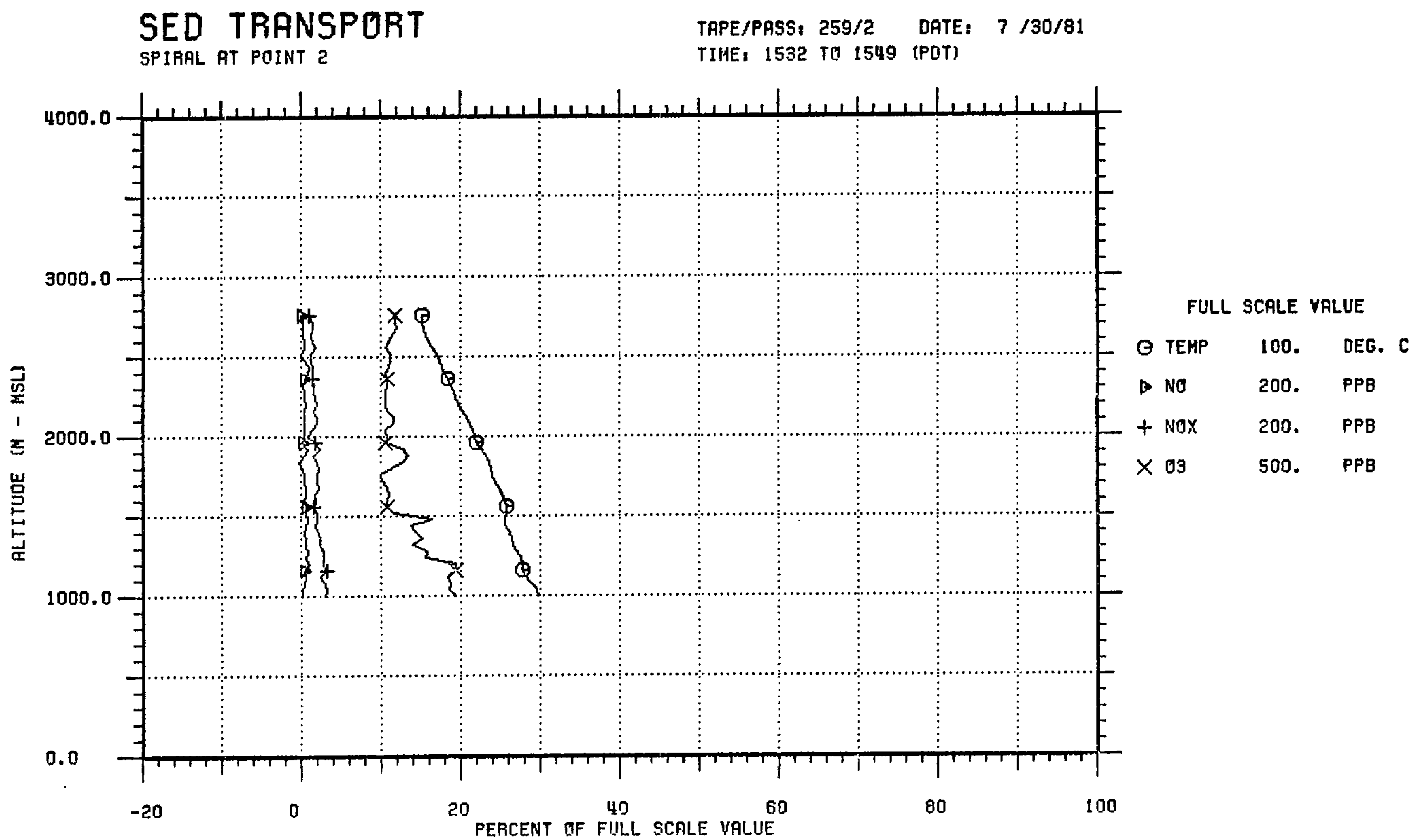
The next sounding was made at 1655 PDT about 20 km downwind of Redlands within the Santa Ana River Canyon (Figure 3.6.11). A surface layer of ozone extended to a depth of about 900 m (top 1400 m-msl) over the bottom of the canyon. Peak concentration measured was 13 pphm although the spiral was only conducted to within 200-300 m of the bottom of the canyon. At higher levels a slight increase in ozone was observed above the surface ozone layer. At 16 PDT the surface ozone concentrations at San Bernardino and Redlands were 18 and 16 pphm, respectively. Surface winds at San Bernardino were from the west-southwest and from the west-northwest at Redlands. It would therefore appear that there was a divergent zone between San Bernardino and Redlands which caused the primary pollutant transport to pass to the south of Mt. San Gorgonio or northeastward from San Bernardino. On July 30, in any case, the Santa Ana River Valley was not impacted to the extent expected from the pollutant burdens in the eastern basin.

The next sounding was made over the High Desert Airport near Twenty Nine Palms at 1734 PDT (Figure 3.6.12). The sounding shows a well-mixed ozone layer in the lowest 1000 m with an average concentration near 11 pphm. Concentrations aloft averaged between 8 and 9 pphm. Peak hourly surface concentration at Twenty Nine Palms on July 30 was 8 pphm recorded at 18 and 19 PDT. Winds at Twenty Nine Palms in the ozone layer were from the west-southwest. Figure 3.6.12, therefore, represents an example of late afternoon incursion of pollutants into the Twenty Nine Palms area.



AIRCRAFT TRAVERSE FROM CABLE AIRPORT TO HESPERIA - Jluy 30,1981

Fig. 3.6.7



AIRCRAFT SOUNDING AT HESPERIA - July 30,1981

Fig. 3.6.8

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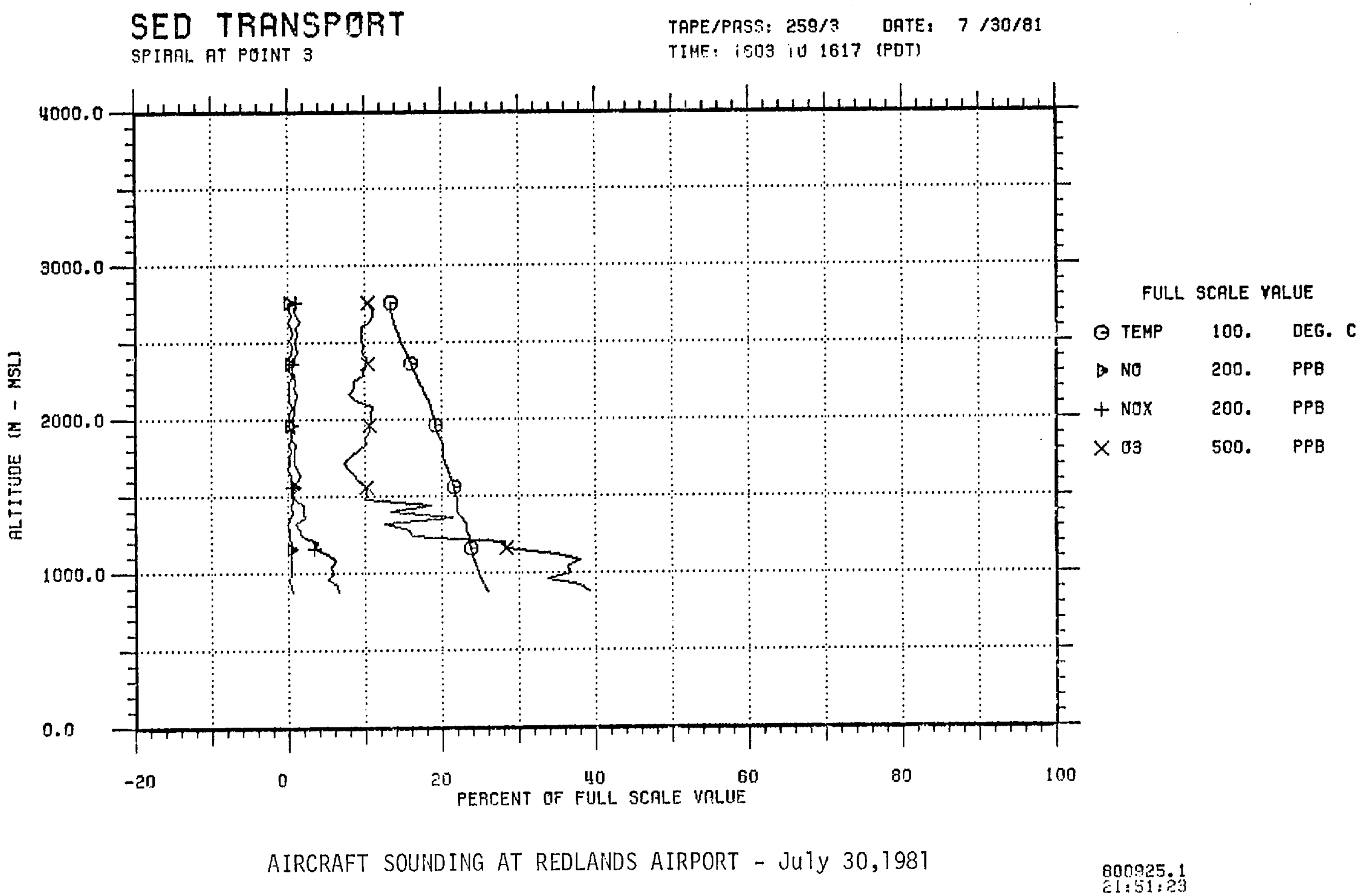
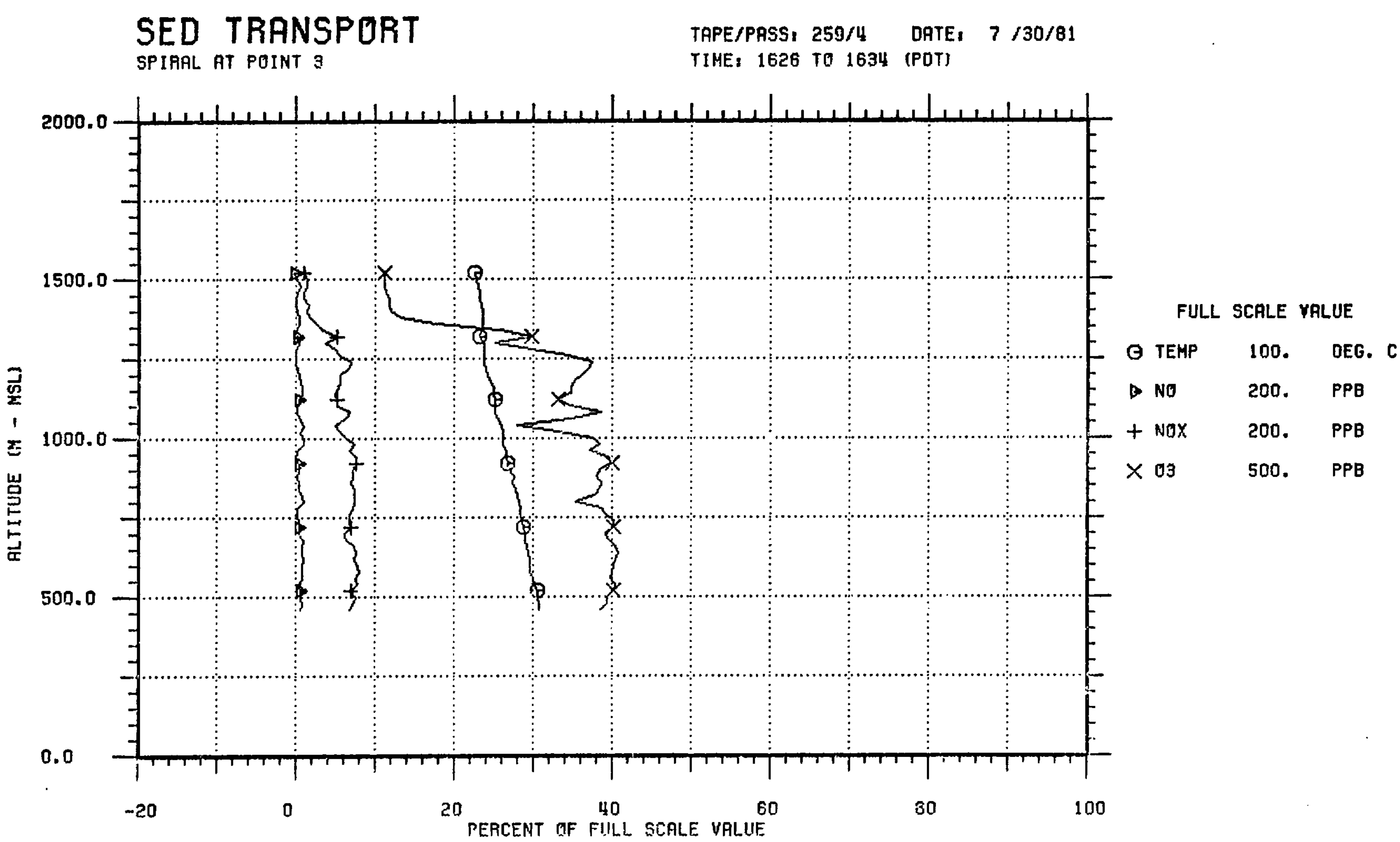
21:51:23



AIRCRAFT SOUNDING AT REDLANDS AIRPORT - July 30,1981

Fig. 3.6.9



AIRCRAFT SOUNDING AT REDLANDS AIRPORT - July 30,1981

Fig. 3.6.10

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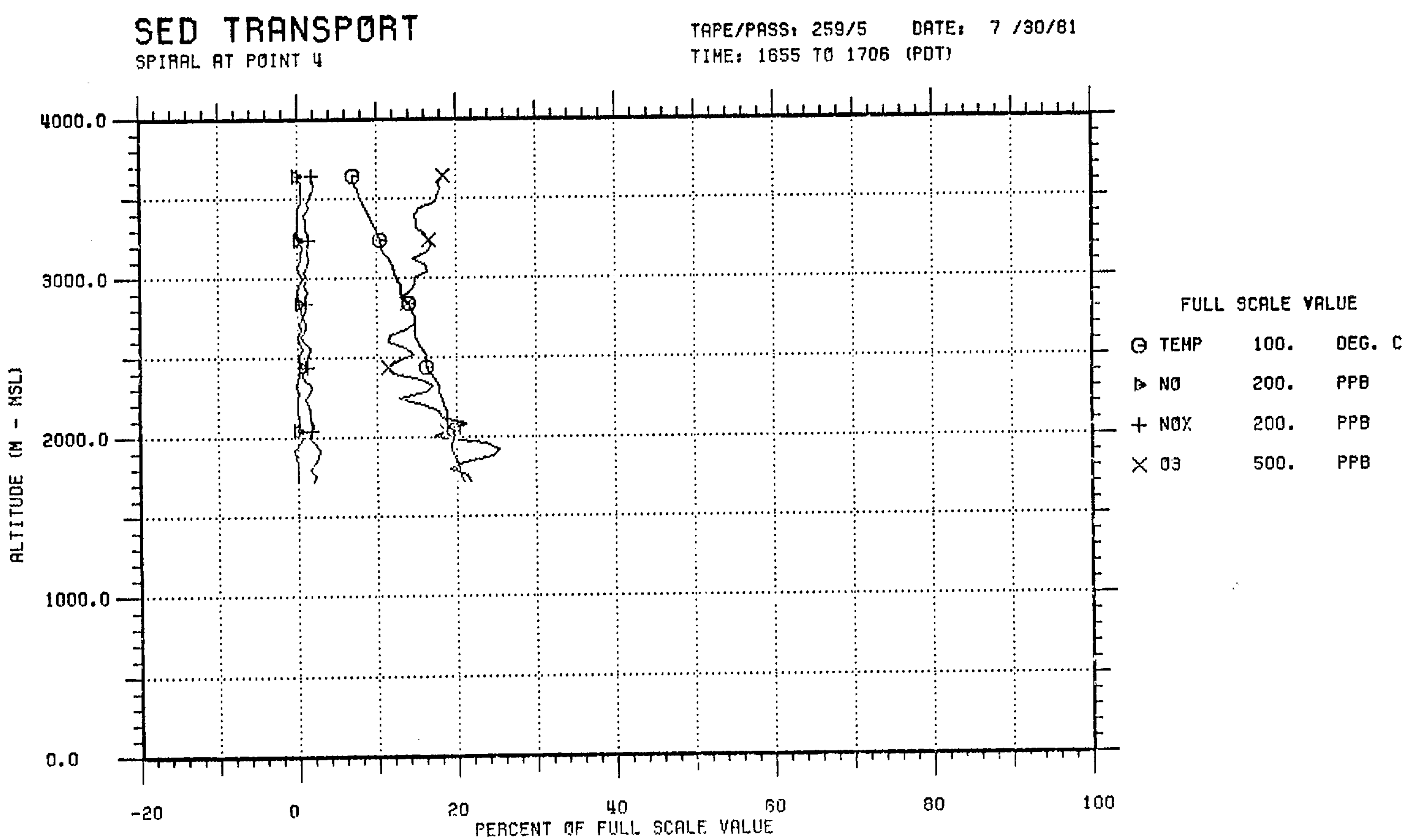
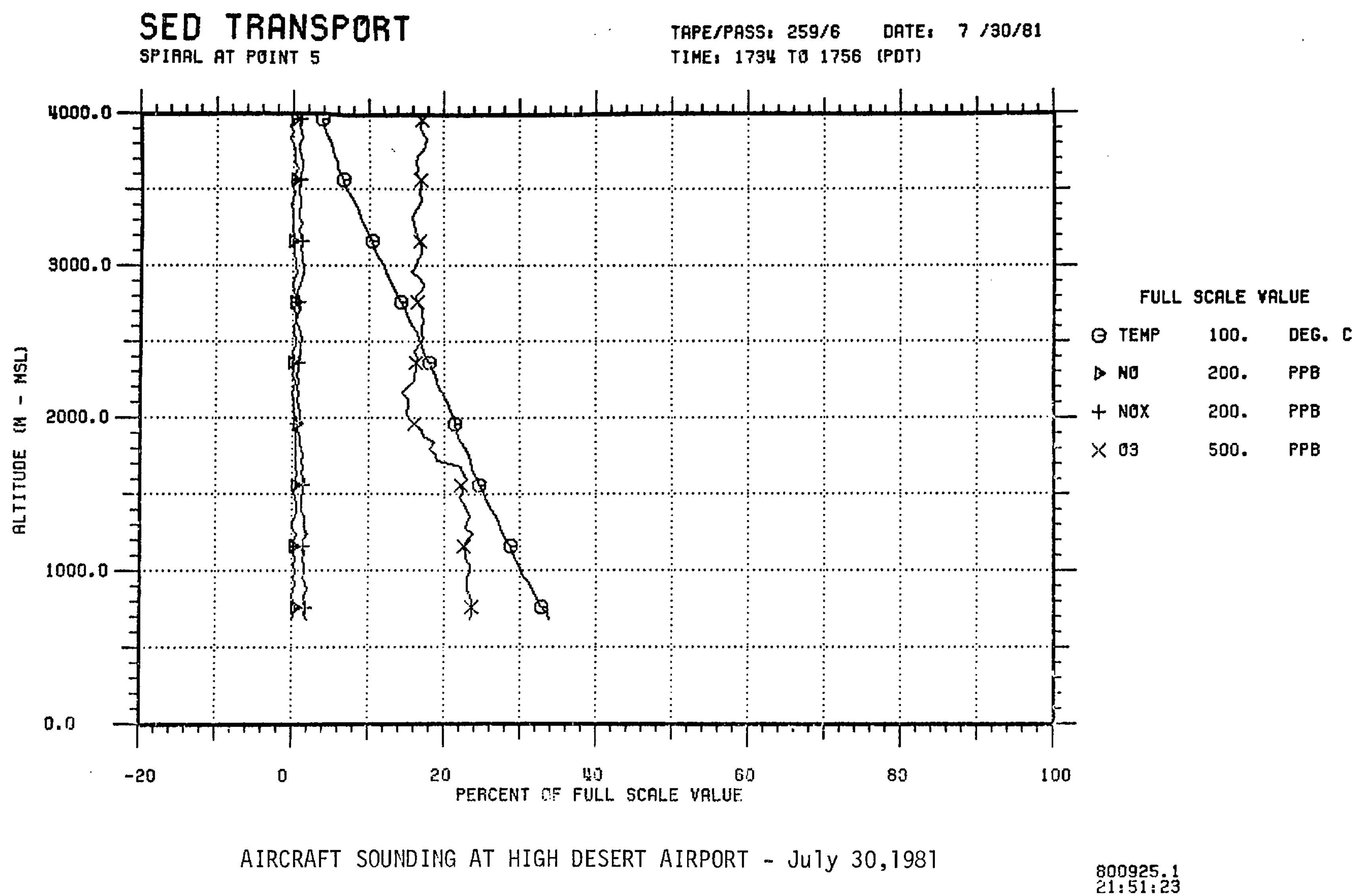
21:51:23



AIRCRAFT SOUNDING AT SANTA ANA RIVER CANYON - July 30,1981

800925.1
21:51:23

Fig. 3.6.11



AIRCRAFT SOUNDING AT HIGH DESERT AIRPORT - July 30,1981

Fig. 3.6.12

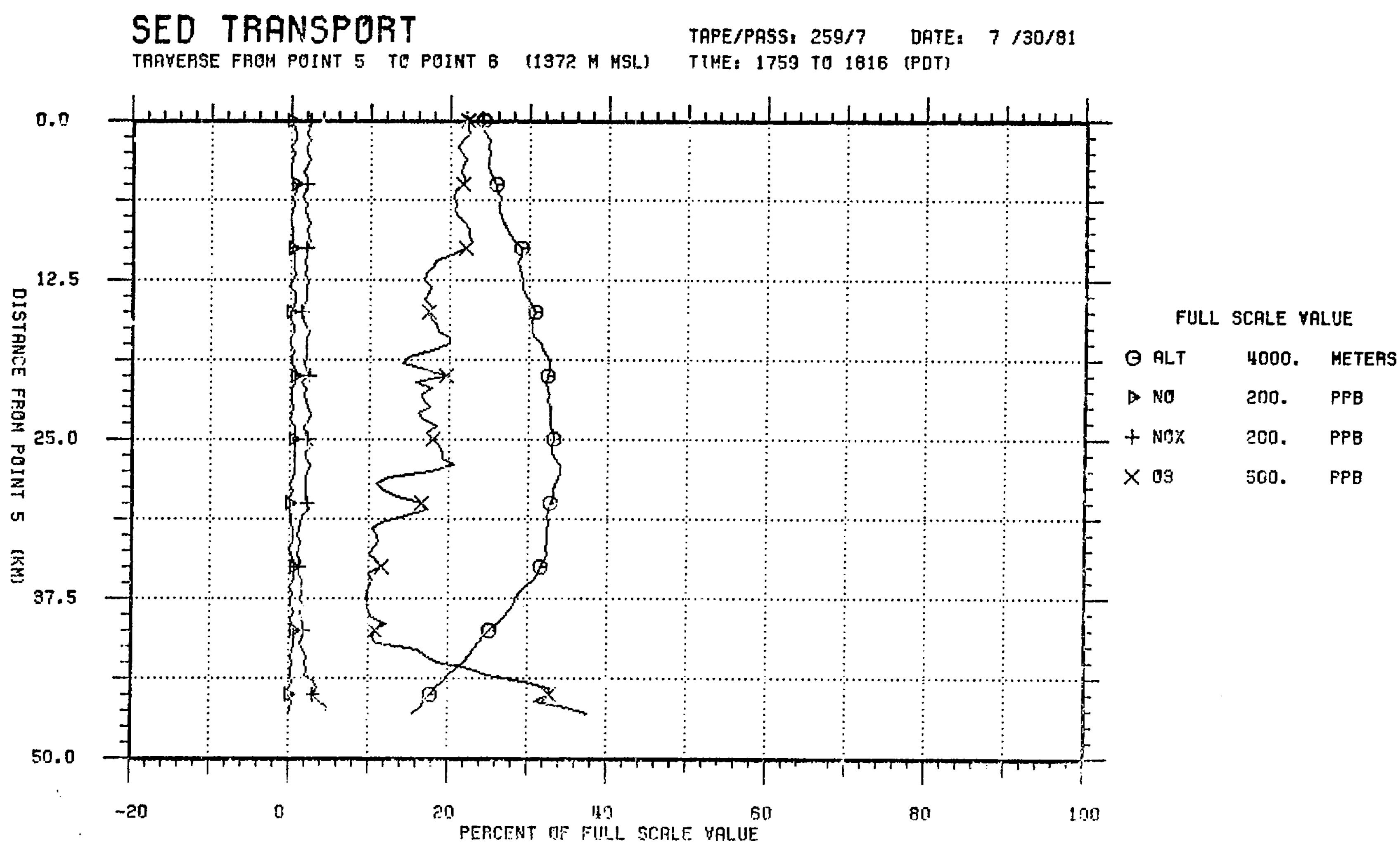
A traverse was then flown from the High Desert Airport to the intersection of Highways 10 and 111 at the east end of San Gorgonio Pass (Figure 3.6.13). Flight altitude started at about 300 m over the terrain, well within the mixed layer indicated in Figure 3.6.12. Ozone concentrations at flight level decreased steadily until the area of the intersection was reached. It would appear that the latter part of the traverse may have been flown in the clean air above the surface mixed layer. As the aircraft descended near the end of the traverse the ozone concentration increased significantly.

A sounding was then made at the intersection of Highways 10 and 111 at 1818 PDT (Figure 3.6.14). A surface layer of ozone was present to a level of about 1000 m above ground level. Peak concentrations of 19 pphm were observed near the ground. Surface concentration at Banning at 18 PDT was 17 pphm. The vertical structure of the ozone concentrations in Figure 3.6.14 do not indicate a well-mixed layer in the lowest 1000 m. Similar profile structures were observed on July 9 and 27 at the same location. It is suggested that the higher concentrations near the ground reflect the effects of wave motion over and through San Gorgonio Pass. Through the wave action in the lee of the pass, pollutants are brought to the surface layers rather than be well-mixed in a turbulent wake downwind of the pass.

The next sounding was made at 1845 PDT at the Palm Springs Airport (Figure 3.6.15). Surface ozone concentrations were about 15 pphm decreasing steadily to near background levels at 2000 m (msl). A plot of additional parameters recorded on the same sounding is shown in Figure 3.6.16. The dew point profile clearly defines the top of the basin air at about 1500 m (msl). Examination of the surface ozone values at Palm Springs indicates that transport from the basin commenced at about 17 PDT. A peak hourly concentration of 16 pphm was recorded at 19 and 20 PDT. Figure 3.6.15, therefore, represents the vertical structure of the basin air as it impacted the Palm Springs area on July 30.

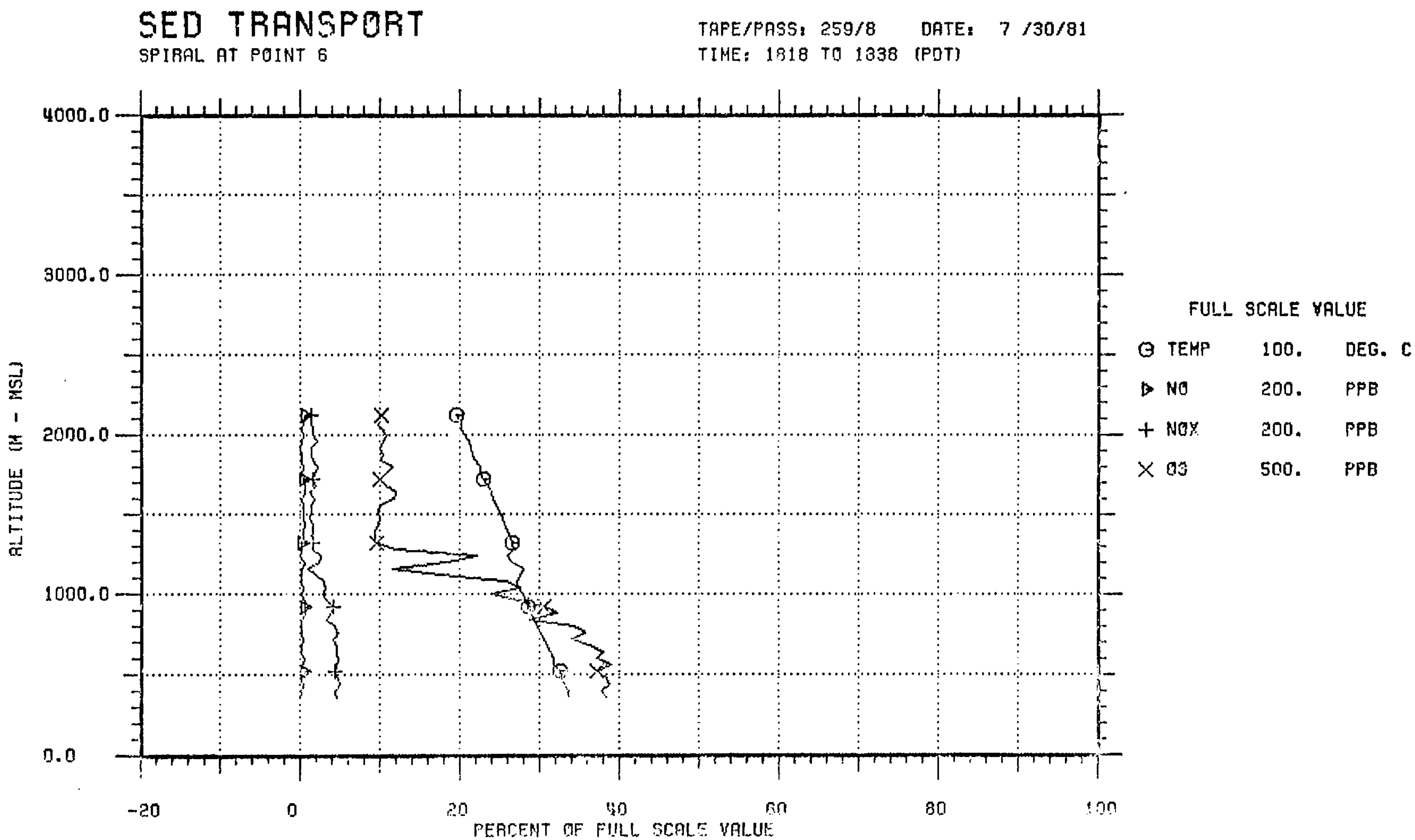
The aircraft landed at the Palm Springs Airport and remained on the ground for about two hours. After takeoff another sounding was made at the Palm Springs Airport at 2120 PDT. This sounding is shown in Figure 3.6.17. The top of the ozone layer is more clearly defined at 1500 m (msl) than in Figure 3.6.15. Low-level ozone concentrations were observed to be about 14 pphm. Surface winds at Palm Springs had continued from the west-northwest at 6-7 m/s for the two-hour interval between soundings. Some 50 km of basin air, measured along the direction of travel, passed through the Palm Springs area between the two soundings without appreciable change in the vertical structure characteristics.

The final portion of the July 30 flight (Figure 3.6.18) was a traverse from Palm Springs to Redlands through San Gorgonio Pass, beginning at 2158 PDT. The flight altitude began about 300 m (msl) and increased to 1000 m (msl) at the end of the traverse. A significant increase in ozone concentration at flight level was encountered near the east end of the pass. Thereafter, ozone values averaged about 16 pphm for the balance of the flight.



AIRCRAFT TRAVERSE FROM HIGH DESERT AIRPORT TO INTSCT I - 10/111 - July 30,1981

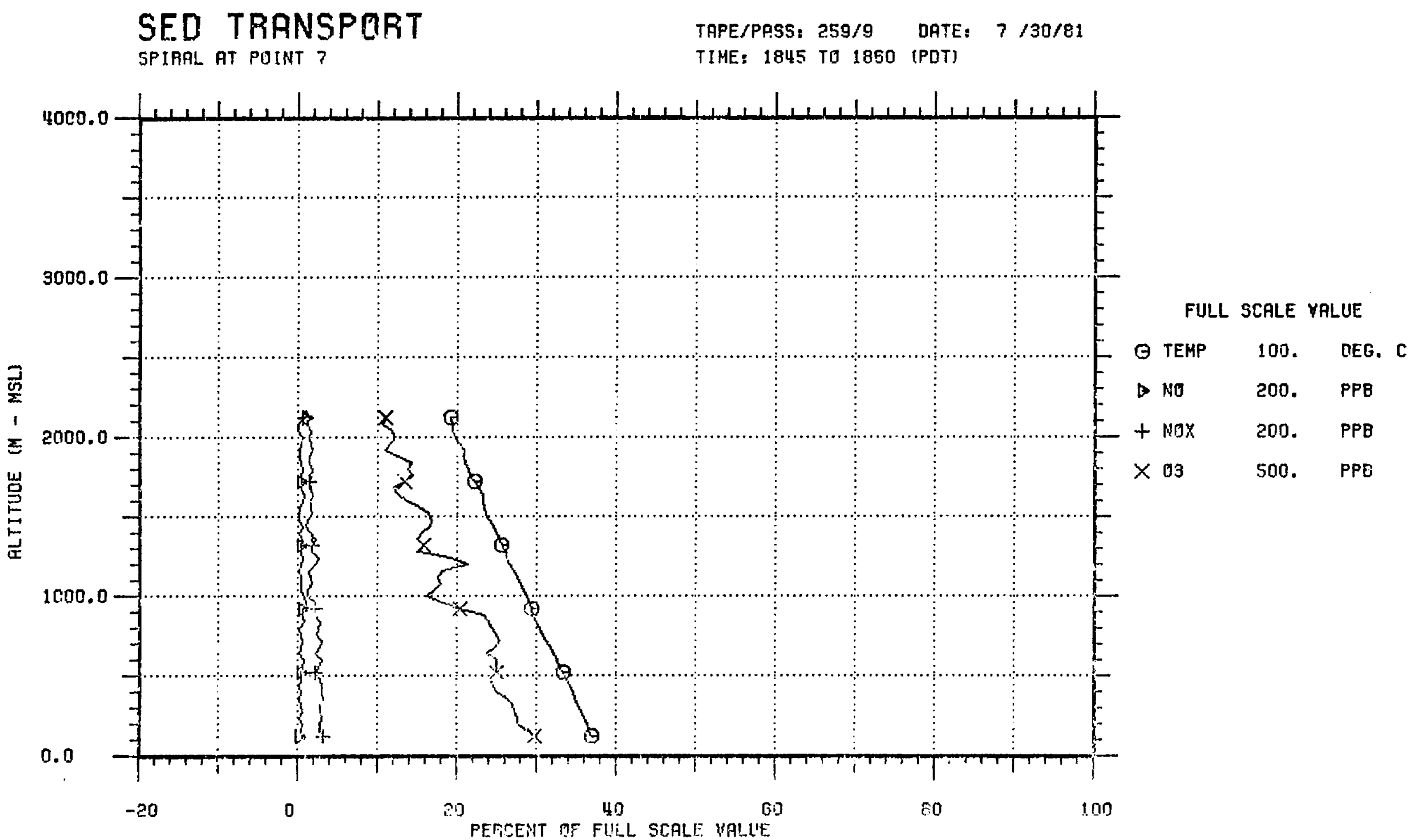
Fig. 3.6.13



AIRCRAFT SOUNDING AT INTERSECTION OF I - 10/111 - July 30,1981

Fig. 3.6.14

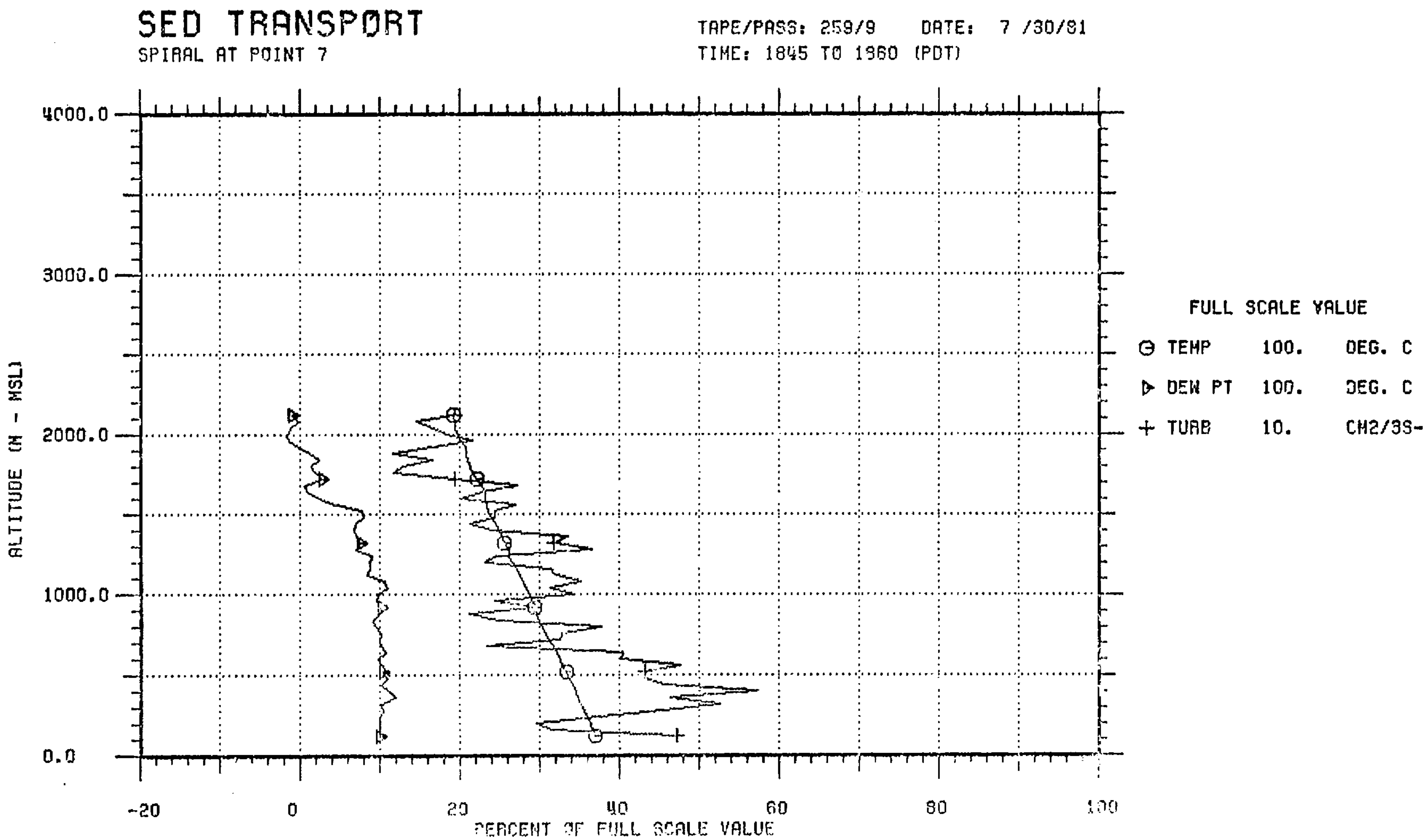
300925.1
21:51:23



AIRCRAFT SOUNDING AT PALM SPRINGS AIRPORT - July 30,1981

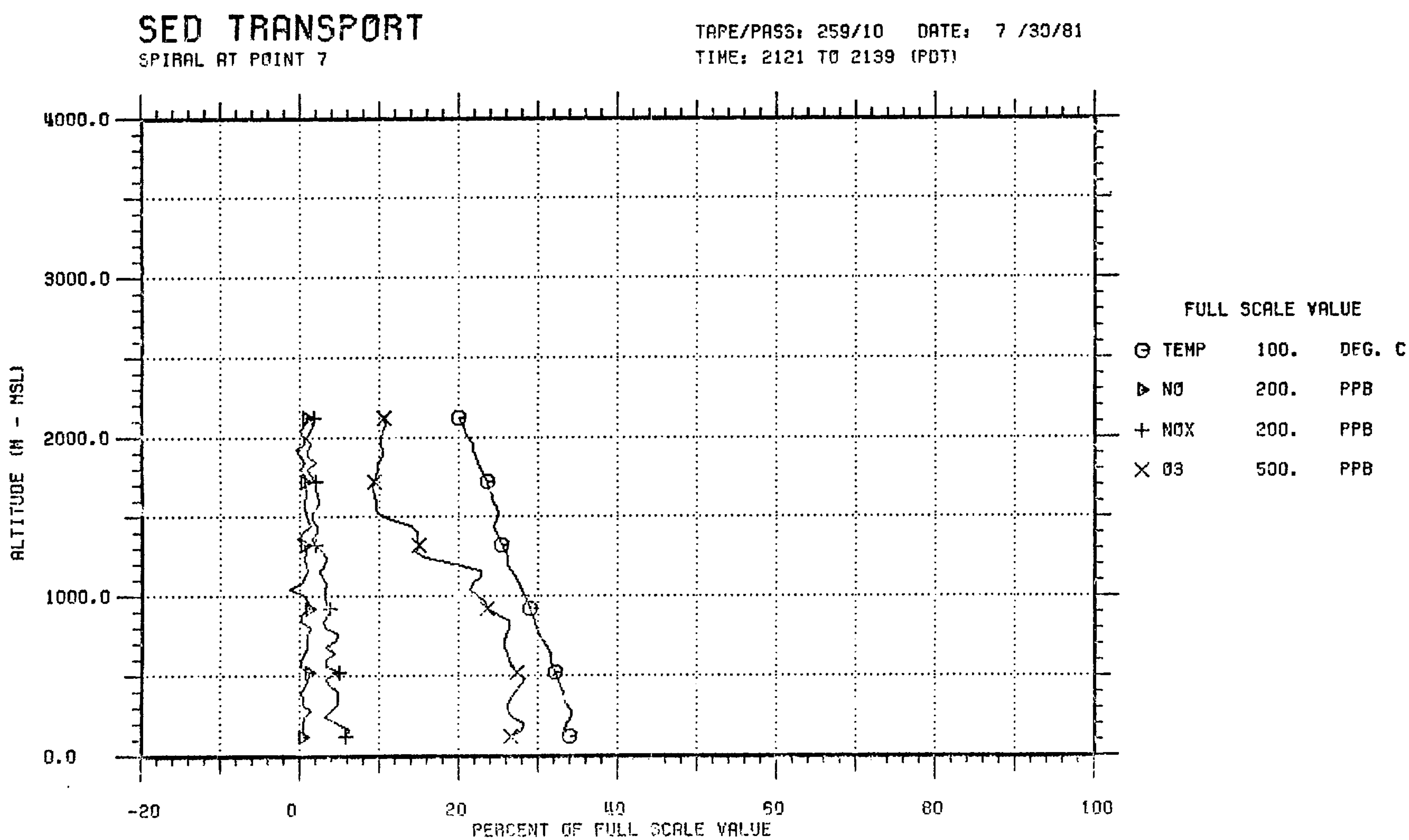
Fig. 3.6.15

800925.1



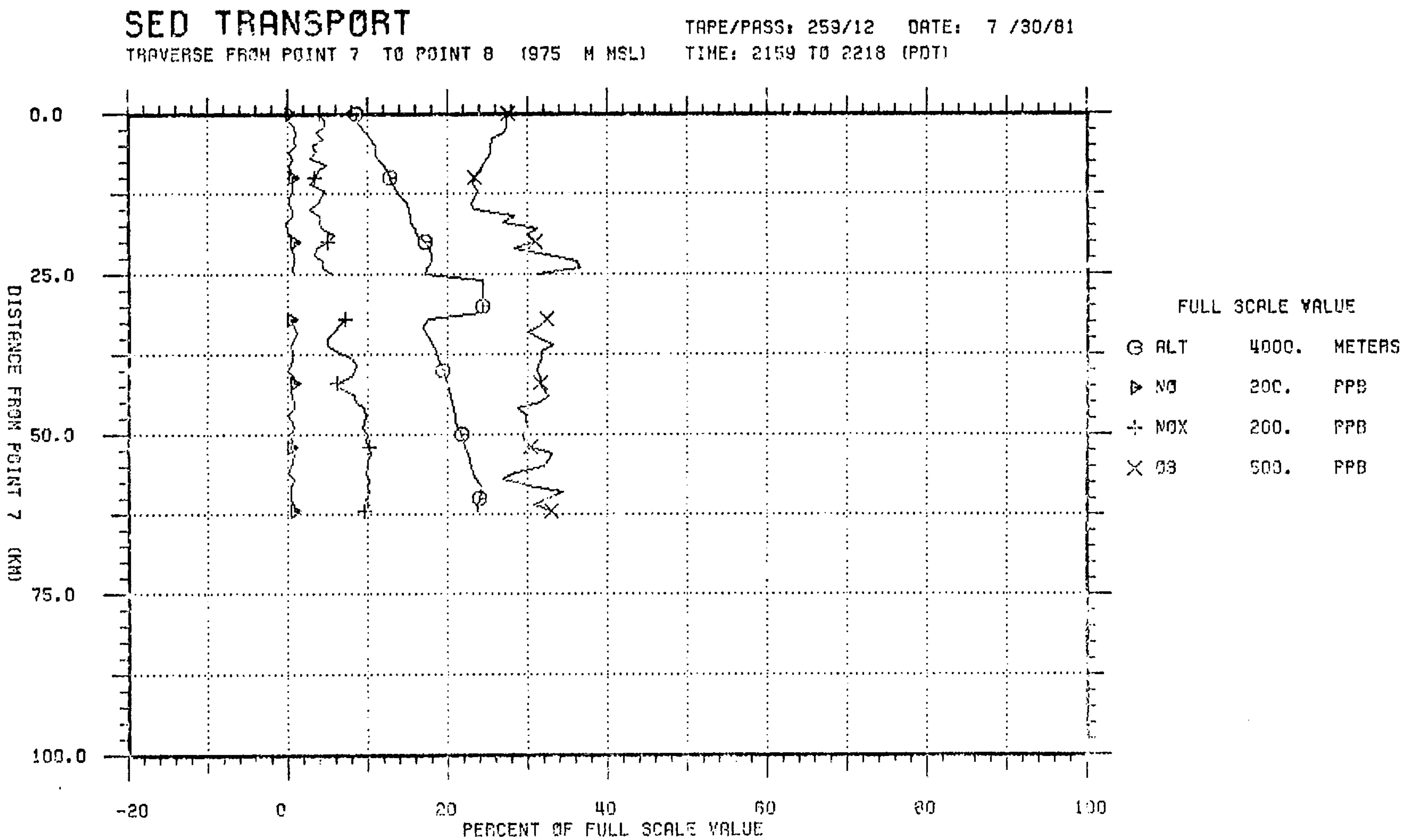
AIRCRAFT SOUNDING AT PALM SPRINGS AIRPORT - July 30,1981

Fig. 3.6.16



AIRCRAFT SOUNDING AT PALM SPRINGS AIRPORT - July 30,1981

Fig. 3.6.17



AIRCRAFT TRAVERSE FROM PALM SPRINGS TO REDLANDS - July 30,1981

Fig. 3.6.18

3.6.4 Tracer Results - Test 6

Release Location: Carson
Date: July 30, 1981
Time: 0500-0900 PDT
Release Rate: 11.3 g/sec. SF_6

Surface winds at the release site were light and variable during the release period. Average velocities were less than one m/s. Streamline patterns for 10 and 16 PDT are shown in Figs. 3.6.19 and 3.6.20. At 10 PDT the wind flow in the western part of the Los Angeles basin was light and southerly in direction. By 16 PDT the wind directions had shifted to west-southwest in better agreement with the normal afternoon pattern. Morning pressure gradients to the interior were relatively strong. These were reflected in moderate wind flow through Soledad Canyon and Cajon Pass by 10 PDT, increasing by 16 PDT.

July 30

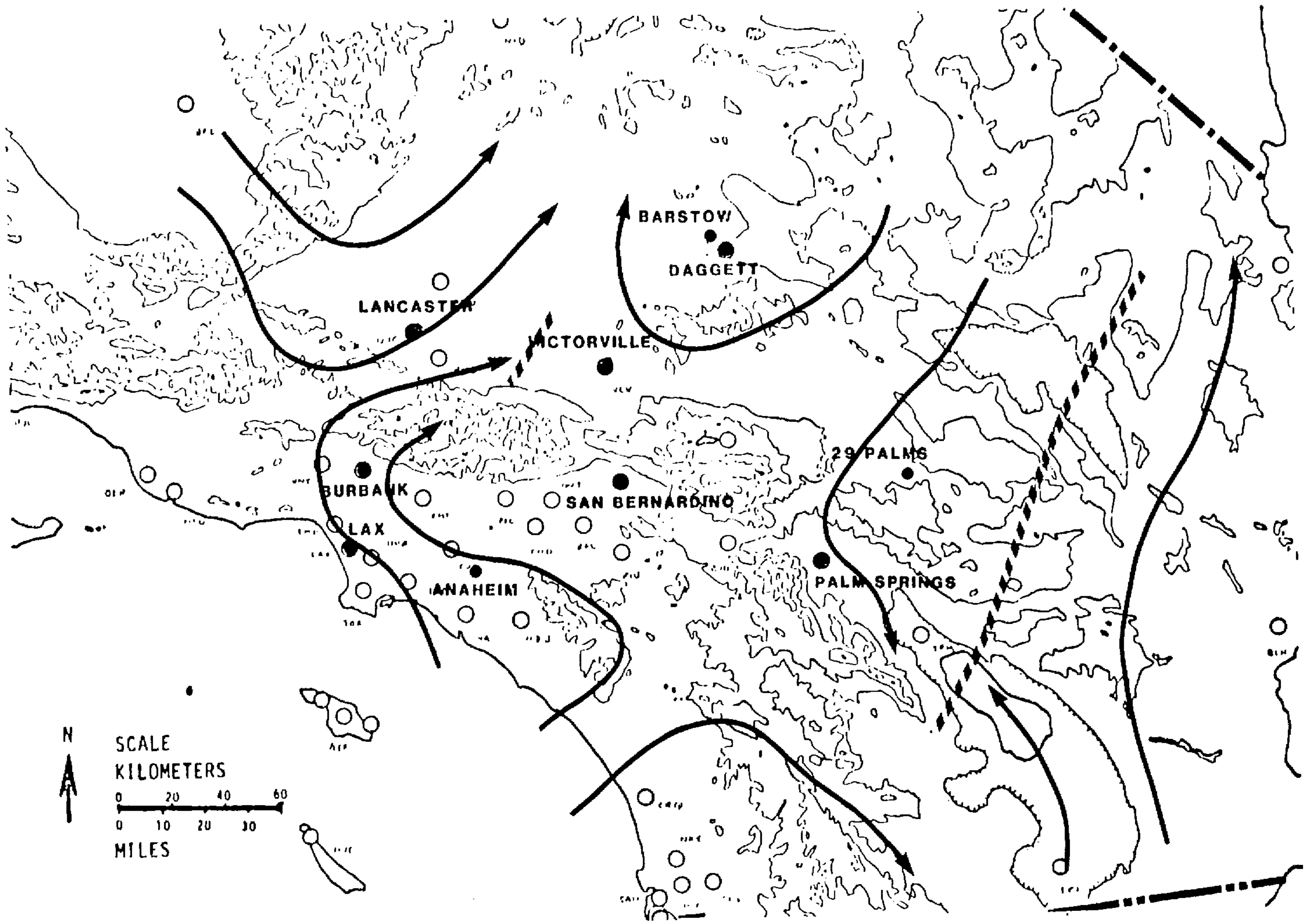
Estimated tracer trajectories for July 30 are shown in Fig. 3.6.21. The main tracer plume initially moved northward into Los Angeles before turning abruptly eastward about 12 PDT in agreement with the shift in wind direction. Thereafter, the tracer material moved along the southern edge of the San Bernardino Mts. with one branch going through Cajon Pass to Barstow. A second branch moved through San Gorgonio Pass and into the Coachella Valley as far south as Indio. Travel times to Barstow represented an average velocity of 2.7 m/s and 3.2 m/s into Indio. A small concentration (14 ppt) was observed at Lake Arrowhead at 18 PDT. As a consequence of the light winds at release time, initial impact of the tracer in the areas near Carson was quite large. Concentrations over 100 ppt were observed as far east as the intersection of Highways 605 and 210 and near Pomona.

Calculated values of Xu/Q are shown in Fig. 3.6.22. These calculations were based on an average wind speed of 0.7 m/s as observed at Carson during the release period. The Xu/Q values correspond to stability conditions C-D as indicated in the figure.

July 31

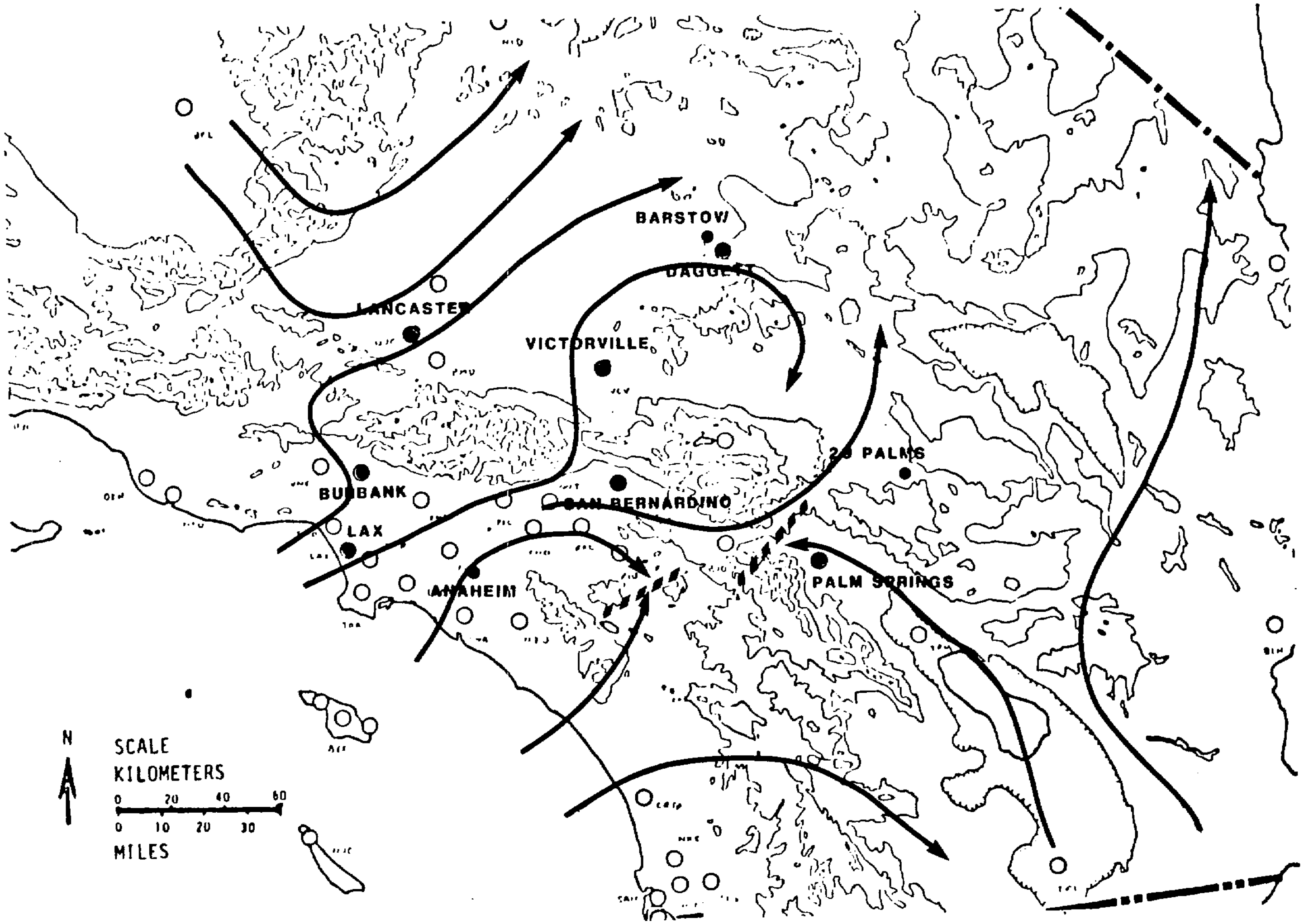
Extensive automobile traverses were performed on July 31. Desert areas from Amboy to 29 Palms and southward into the Coachella Valley were explored for evidence of carry-over from the previous day. No significant concentrations were found in these areas on July 31.

Scattered SF_6 concentrations were found in the Los Angeles basin during the day. Highest observed concentrations were 93 ppt near Santa Fe Springs, 44 ppt near San Bernardino and 34 ppt at Upland.



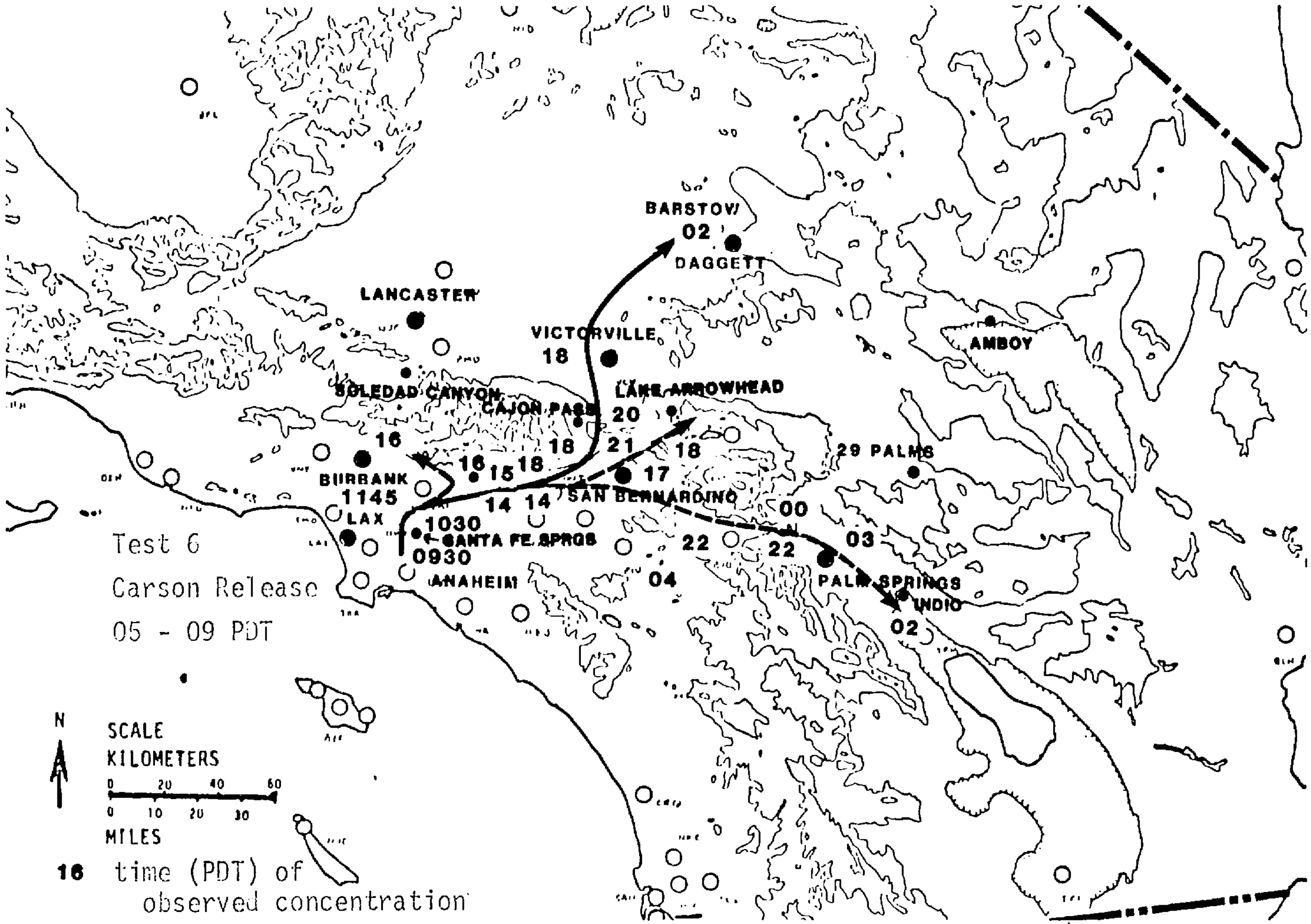
STREAMLINE MAP (10 PDT) - July 30,1981

Fig. 3.6.19



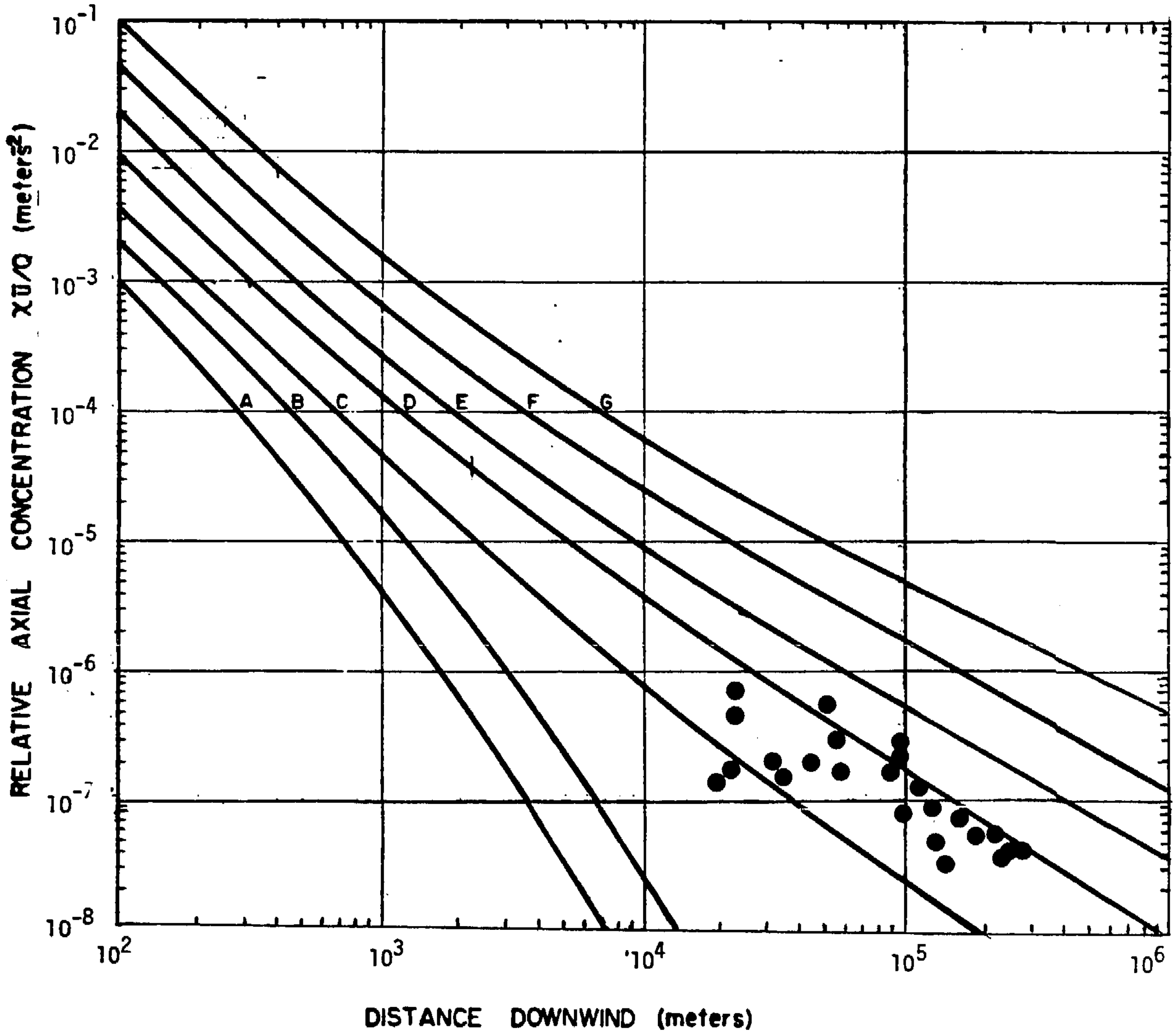
STREAMLINE MAP (16 PDT) - July 30,1981

Fig. 3.6.20



TRACER TRAJECTORIES - July 30,1981

Fig. 3.6.21



CALCULATED XU/Q VALUES - Test 6

July 30,1981

Fig. 3.6.22

Hourly samples at Azusa and Pasadena showed concentrations of 13-23 ppt and 10-16 ppt, respectively, beginning at 04-05 PDT on July 31 and continuing for over six hours at each location. These occurrences are similar to those observed on several previous tests during the field program.

3.7 Test 7 3-4 August 1981, Dual Release (SF_6 Ontario 0500-0900, 8/3/81 and $CBrF_3$ Indio 0500-0900 PDT, 8/4/81)

3.7.1 Meteorology

General

A moderate low pressure trough aloft existed along the northwest coast on August 3 (Figure 3.7.1), moving onshore by August 4. A surface pressure ridge extended into the Pacific Northwest resulting in the thermal trough being displaced to the east and southeast of its normal position.

Meteorological parameters for August 3 are given in Table 3.7.1. 850 mb temperatures were relatively cool (18°C at Vandenberg AFB) but the morning inversion height at UCLA was near the median value for that time of year. Surface pressure gradients into the inland areas were primarily directed from west to east. A near-zero gradient existed in the morning between LAX and Bakersfield. Both of these gradients had decreased by the morning of August 4. Maximum surface temperatures were moderate at Ontario but warm at Palm Springs.

August 3 was characterized by low pressure gradients and a moderately low inversion height in the morning. Cool temperatures aloft, however, would be expected to permit significant deepening of the marine layer during the day.

Transport Winds

Surface winds during the Ontario release on August 3 are shown in Table 3.7.2:

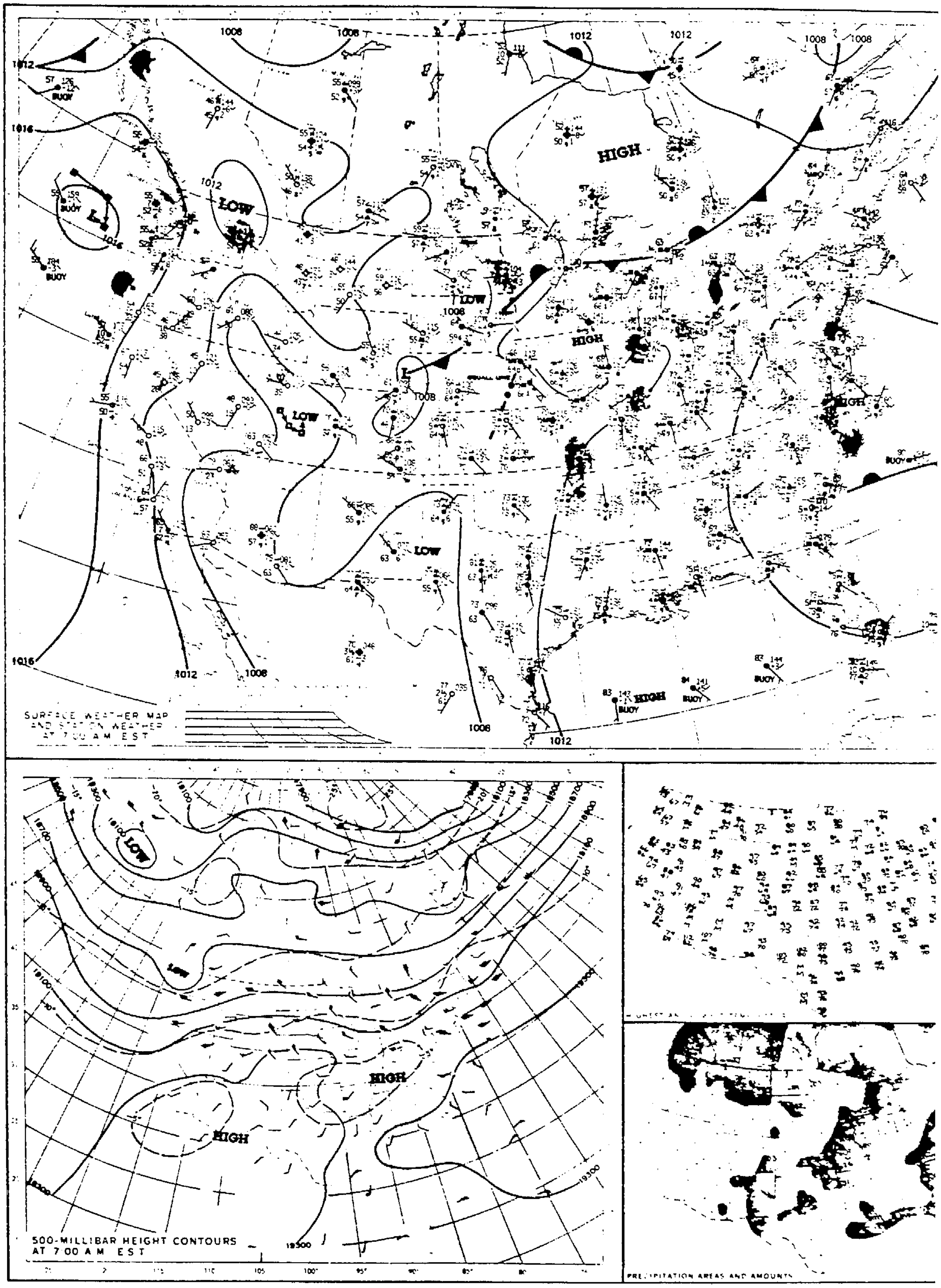
Table 3.7.2

SURFACE WINDS AT ONTARIO DURING RELEASE

AUGUST 3, 1981

Time (PDT)	Direction (°)	Speed (m/s)
06	060	1.2
07	120	1.2
08	200	1.1
09	250	1.6
10	270	1.8

MONDAY, AUGUST 3, 1981



WEATHER MAP

August 3,1981

Fig. 3.7.1

Table 3.7.1

METEOROLOGICAL PARAMETERS

AUGUST 3, 1981

850 mb Temperature		
Vandenberg AFB	(0500 PDT)	18.0°C
Edwards AFB	(0545 PDT)	21.8
Ontario	(0830 PDT)	20.6
UCLA	(0600 PDT)	19.6
Pressure Gradients	(0800 PDT)	
LAX - Daggett		3.4 mb
LAX - Bakersfield		-0.1
Maximum Surface Temperature		
Ontario		92°F (33.3°C)
Palm Springs		110 (43.3)
Inversion Base Height* and Temperature		
UCLA	(0600 PDT)	15.9°C (413 m)
Rialto	(0700 PDT)	15.5 (Surface)
Ontario	(0830 PDT)	16.5 (370 m)
Inversion Top Height* and Temperature		
UCLA	(0600 PDT)	20.5°C (1076 m)
Rialto	(0700 PDT)	21.1 (1050 m)
Ontario	(0830 PDT)	20.6 (880 m)

* All heights are msl

Surface winds at Ontario during the release period (05 to 09 PDT) were light and variable during the first half of the release period. During the last half and subsequent to the release the wind flow became organized into a west to southwest flow typical of the daytime conditions in the area.

The surface wind observations at Victorville, Lancaster and Palm Springs are given in Table 3.7.3. The flow at Lancaster from Mint Canyon was consistent and strong throughout August 3, decreasing only during mid-day on August 4. Peak velocity at Lancaster was 14 m/s at 16 PDT. It is of interest to note that the morning pressure gradient to Bakersfield was near zero on August 3 and 4 but the gradient from LAX to Daggett was relatively strong.

At Victorville the southerly flow from Cajon Pass was only minimally apparent (14-16 PDT) on August 3 but was more significant on August 4 after 17 PDT.

The northwesterly flow into Palm Springs occurred on both August 3 and 4 but was more pronounced on August 3. Commencement of the flow on August 3 was at 15 PDT but was delayed until 19 PDT on August 4.

Mixing Heights

Observed and predicted mixing layer heights for August 3 are shown in Table 3.7.4. A marked increase in mixing layer height was observed at Ontario from the morning to afternoon sounding (360 to 1230 m). A further increase at Rialto to 1400 m was observed by the aircraft at 1620 PDT. Predicted maximum top at San Bernardino was 1520 m. Under these conditions the visibility at San Bernardino and Ontario improved to 10-15 miles by early afternoon (Table 3.7.5). Observed and predicted mixing layer tops in the desert ranged from 1700 to 2000 m (msl).

Table 3.7.5

OBSERVED VISIBILITIES - AUGUST 3, 1981

Time (PDT)	San Bernardino	Ontario
10	7 miles	3 miles
12	10	4
14	10	7
16	7	15
18	7	15

Table 3.7.3

SURFACE WINDS - AUGUST 3-4, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	260°/ 4.6 m/s	180°/2.1 m/s	-
08	260 / 4.1	230 /0.5	180°/2.6 m/s
10	280 / 7.7	Calm	Calm
12	290 / 7.7	270 /2.1	Calm
14	270 /12.4	210 /0.5	Calm
16	260 /14.4	190 /2.6	310 /9.3
18	260 /13.4	290 /5.7	300 /9.3
20	260 / 7.7	260 /5.1	290 /9.3
22	250 / 8.8	210 /3.6	270 /7.7
24	270 / 9.3	230 /2.1	-
02	270 / 8.2	160 /2.1	-
04	270 /10.3	Calm	-
06	270 / 7.7	180 /3.1	-
08	250 / 3.1	170 /2.6	Calm
10	270 / 3.6	290 /1.6	Calm
12	070 / 2.6	180 /1.0	Calm
14	Calm	310 /1.0	050 /4.1
16	270 / 6.7	300 /3.1	110 /4.6
18	260 /10.3	200 /6.7	090 /5.1

Table 3.7.4

MIXING HEIGHTS - AUGUST 3, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT	413 m	150 m
	1200	391	150
Ontario	0830	360	290
	1430	1230	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Rialto AP	1620 PDT	1400 m	450 m
Cajon Pass	1640	1400	800
Santa Ana R. Cyn.	1727	2000	1550
Banning AP	1754	1750	650
I-10 and 111	1836	1700	400

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	1540 m	290 m
San Bernardino	1520	360
Edwards AFB	2075	725

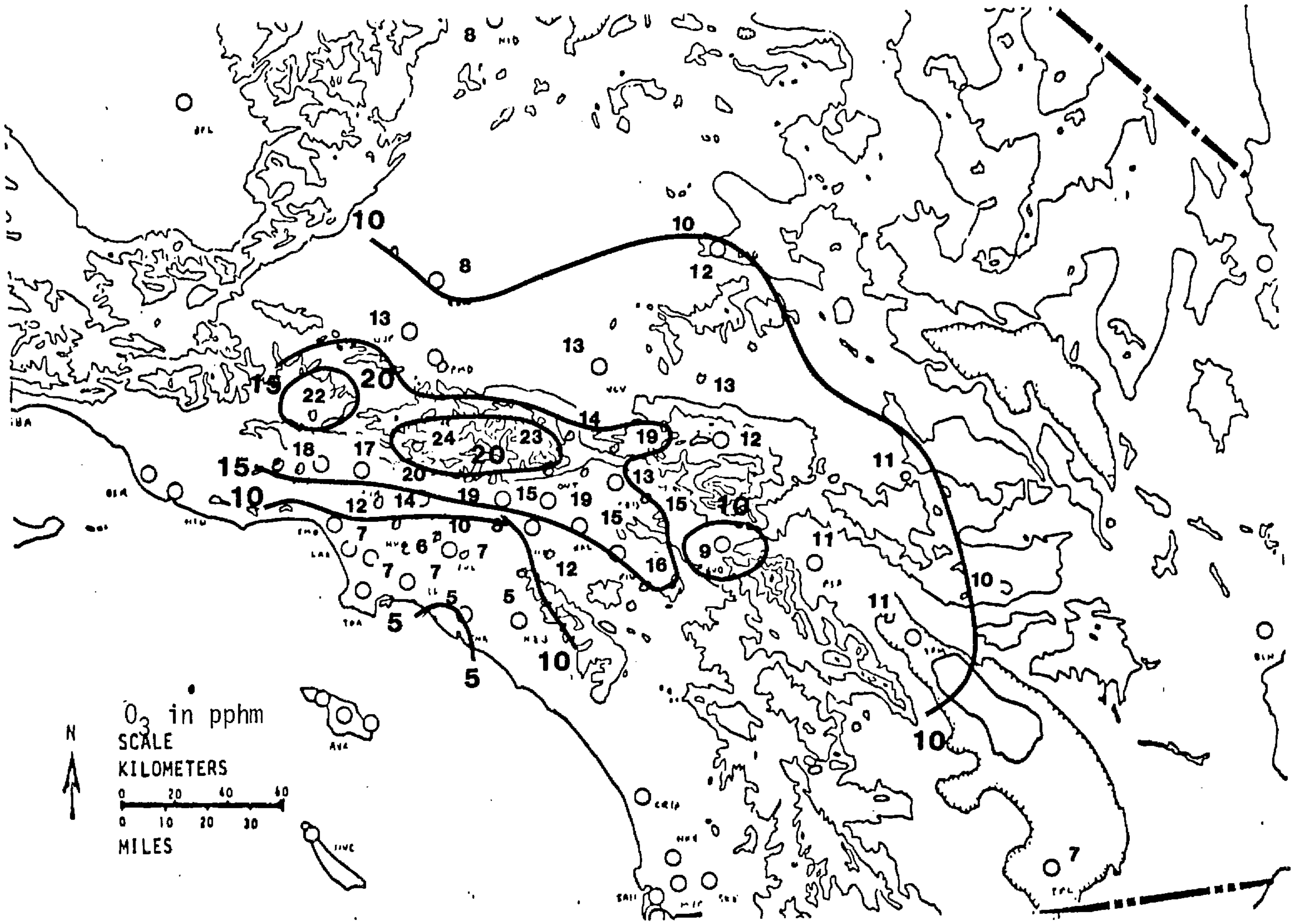
3.7.2 Regional Pollutant Levels

Figure 3.7.2 shows a map of the peak hourly concentrations of ozone observed on August 3 in the Los Angeles basin and nearby desert areas. Maximum ozone concentrations in the basin were relatively low on August 3. Highest value observed in the basin itself was 20 pphm at Pasadena. Mt. Wilson, however, showed a peak ozone concentration of 24 pphm and Mt. Baldy recorded a value of 23 pphm. Highest concentration observed in the desert was 13 pphm at Lancaster, Victorville and Lucerne Valley.

A map of the time of peak ozone occurrence in the area is shown in Figure 3.7.3. Many of the desert stations show the late afternoon or evening peak arrival times which are typical of transport from the basin. Victorville, however, recorded a peak at 10 PDT that could not be attributed to same-day transport from the basin. It is probable that the ozone and precursors from Cajon Pass were carried eastward into Lucerne Valley on this day. Another unusual feature in Figure 3.7.3 are the early peak occurrences in the eastern part of the basin. Perris and Riverside both recorded peak ozone concentrations at 14 PDT. Note also that all peak times from Burbank to San Bernardino were 14 or 15 PDT. This is not the usual pattern of peak occurrences and suggests minimum ozone effects in the east basin from transport from the central urban area.

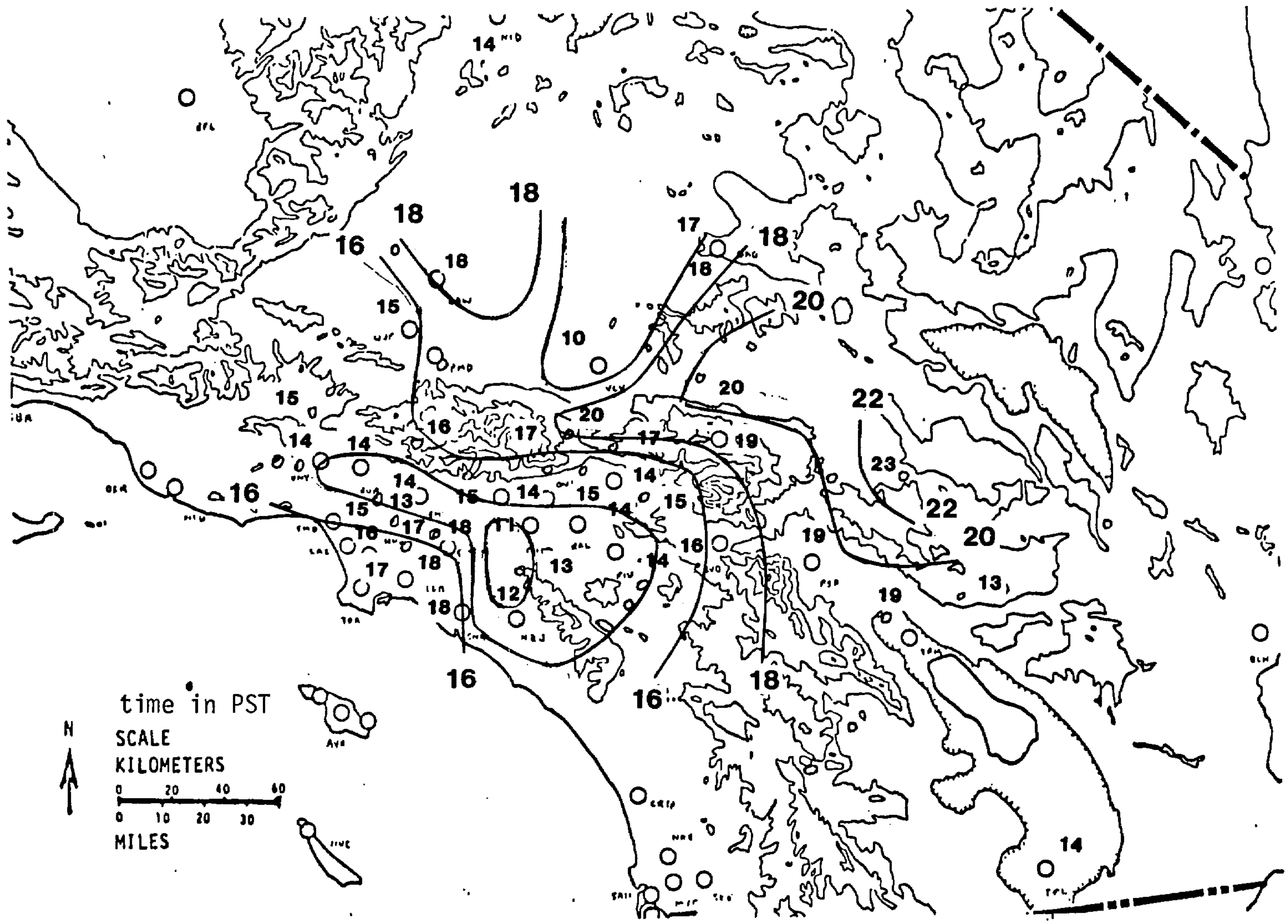
Figure 3.7.4 shows the hourly ozone concentrations along the route from Riverside to Indio and in the mountain areas. A pulse of ozone moving into the desert past Banning is indicated in the figure. The magnitude of the pulse, however, was relatively small. A higher background than usual existed in the desert prior to the arrival of the peak. Peak occurrences in the mountain areas showed their usual progression in time from west to east. An unusually pronounced impact from the basin was observed at Fawnskin with a peak ozone concentration of 12 pphm at 19 PDT.

Figure 3.7.5 shows the hourly ozone concentrations along the transport route from San Bernardino and Newhall. The progression of peak times from San Bernardino to Cajon suggest an effective ozone transport route which did not appear at Victorville. It is not likely that the small peaks observed at Barstow were associated with transport through Cajon Pass. Surface winds at Barstow were from the west-southwest or west after 07 PDT. The Newhall to Edwards AFB transport route is also suggested in Figure 3.7.5. However, the large peak at Newhall is substantially decreased in the Lancaster and Edwards AFB hourly sequences. The late peak at Barstow (23 PDT) may have arrived from the Lancaster-Edwards AFB area.



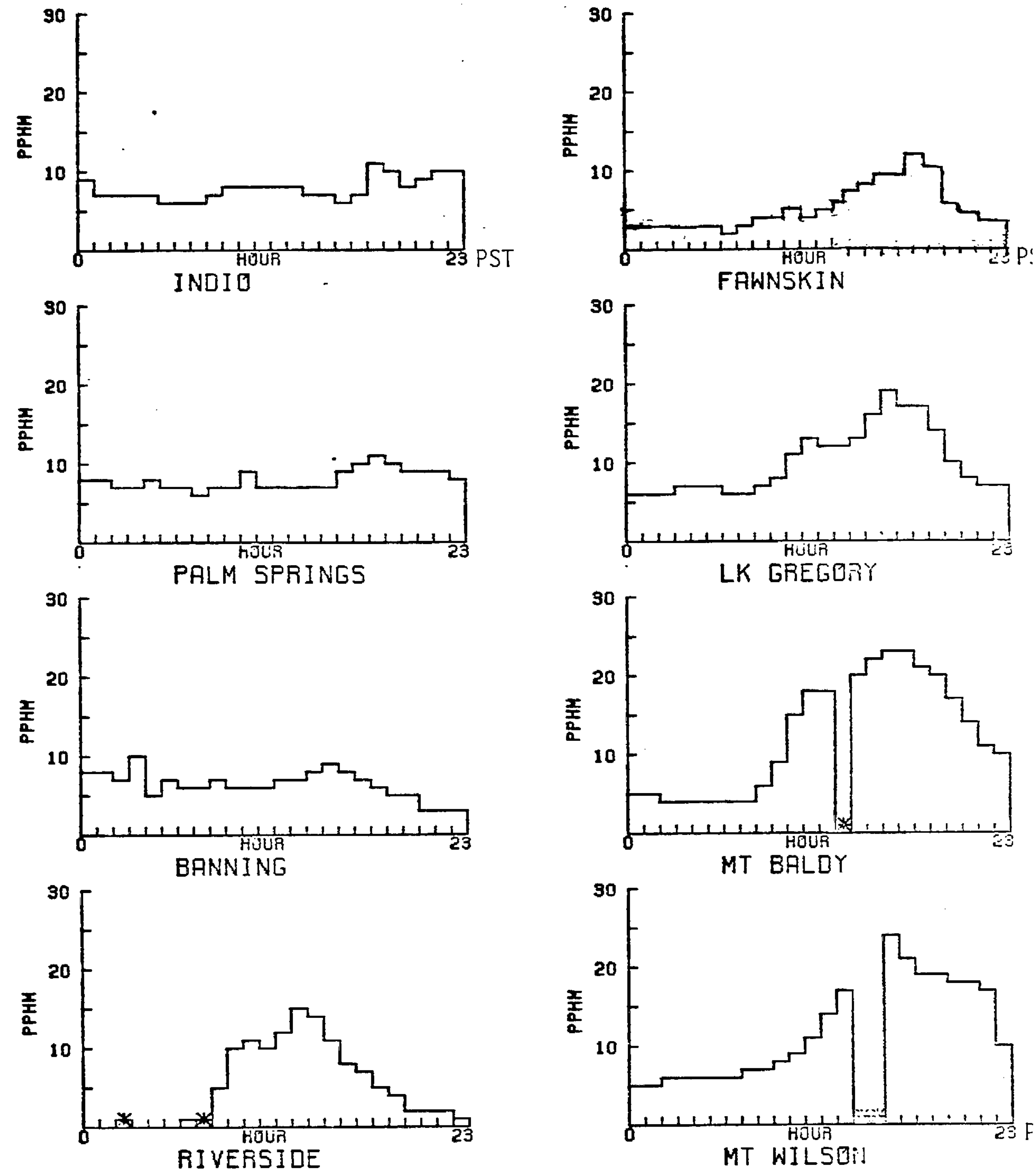
MAXIMUM HOURLY OZONE CONCENTRATIONS - August 3,1981

Fig. 3.7.2



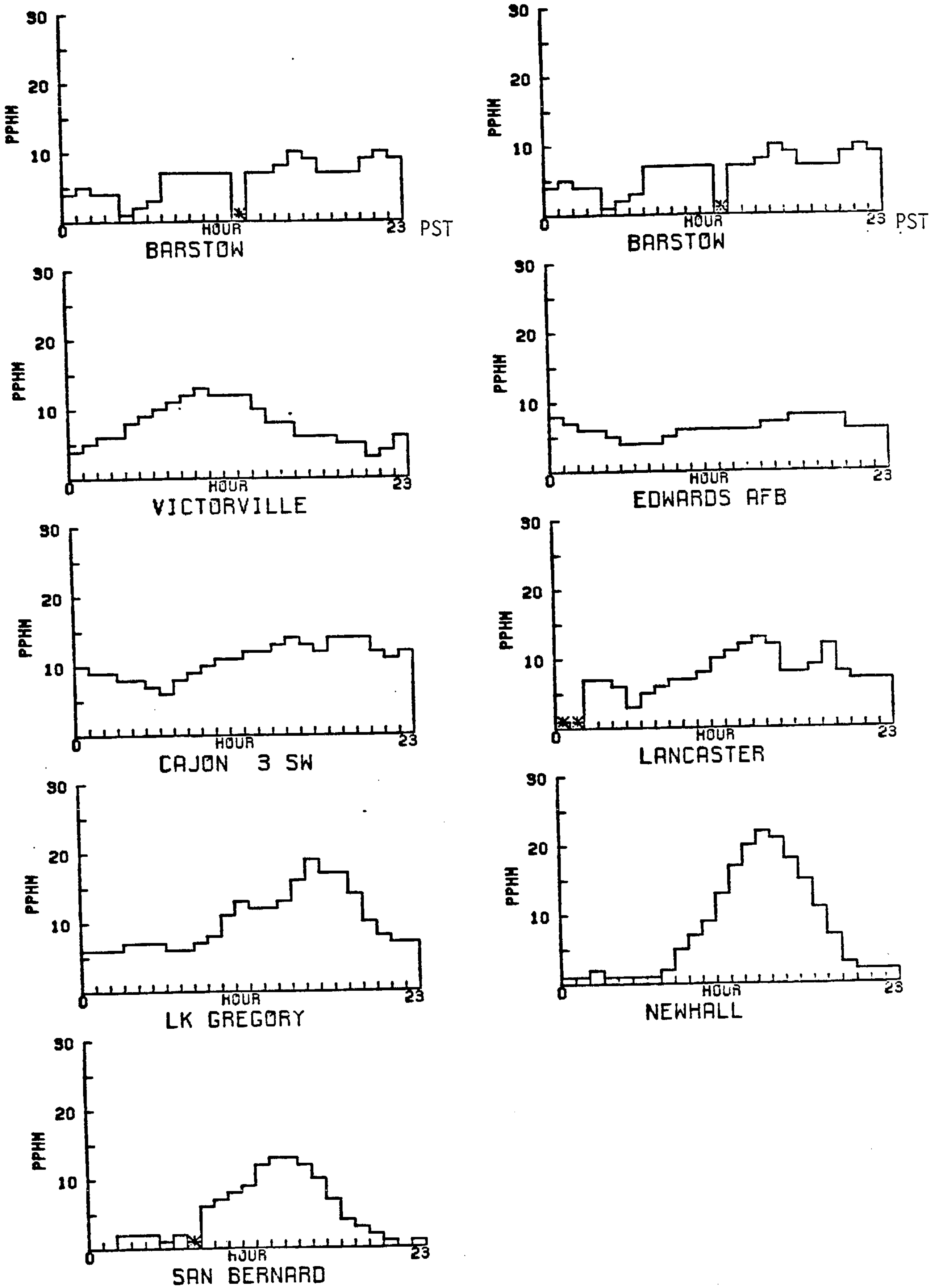
TIME OF MAXIMUM HOURLY OZONE CONCENTRATION - August 3,1981

Fig. 3.7.3



HOURLY OZONE CONCENTRATIONS - August 3,1981

Fig. 3.7.4



HOURLY OZONE CONCENTRATIONS - August 3,1981

Fig. 3.7.5

3.7.3 Aircraft Sampling - August 3, 1981

The MRI air quality aircraft sampled primarily in the vicinity of Cajon Pass and San Gorgonio Pass on August 3. The principal objective was to examine the transport of pollutants through the two passes. Figure 3.7.6 shows the flight pattern and the locations designated on the map are described in Table 3.7.6. Table 3.7.7 gives further details on the flight.

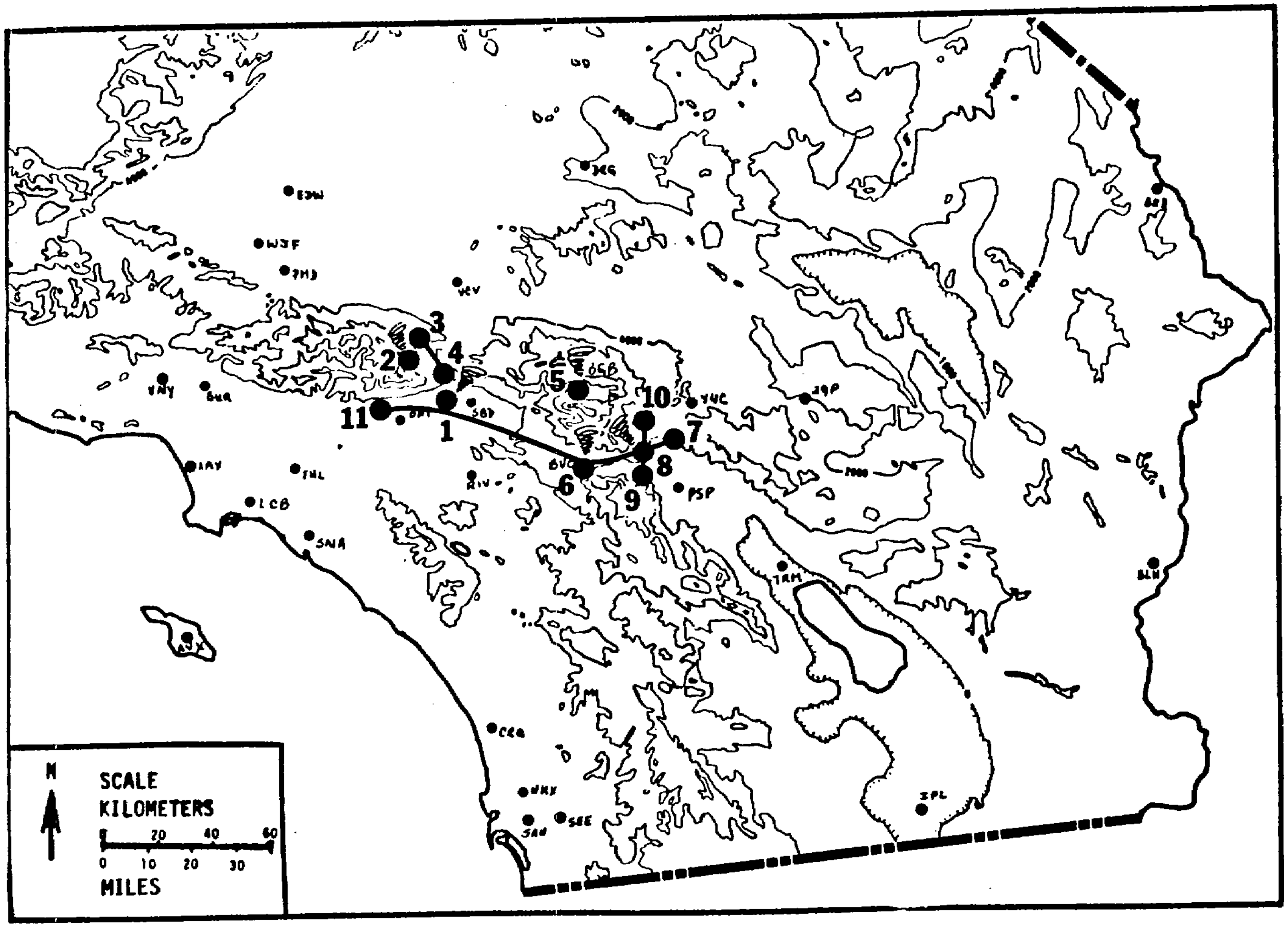
The initial sounding on August 3 was made at Rialto Airport (Figure 3.7.7) at 1620 PDT for the purpose of describing the vertical pollutant structure in the basin. A well-mixed ozone layer extended from the surface upward to 1300 m (msl) or 800 m above ground level. Peak concentrations in this layer were slightly over 20 pphm. The ozone concentrations decreased rapidly at higher elevations.

The second sounding took place near Cajon Junction at 1645 PDT (Figure 3.7.8). A surface layer extended upward to 1500 m (msl) or 700 m above the terrain at the location of the sounding. Near-surface ozone concentrations were about 17 pphm. The hourly ozone concentration at the ground station in Cajon Pass was 14 pphm at 16 PDT. A strong ozone layer existed aloft centered at about 2500 m (msl). Peak concentration at this level was over 20 pphm. The structure of this upper ozone layer is similar to one observed at Cajon Junction on July 18. Winds aloft (measured at Ontario) were from the west-southwest within this layer on both days, reflecting the transport of ozone from the southern slopes of the San Gabriel Mountains to the southwest of the sounding location.

Figure 3.7.9 represents a traverse flown from Cajon Junction southeastward toward San Bernardino and within Cajon Pass. Flight altitude was about 300 m above the terrain. A uniform ozone concentration of 16-17 pphm was observed along the entire flight path.

Figure 3.7.10 shows the results of a sounding made in the Santa Ana River Canyon at 1727 PDT at the same location as the sounding of July 30. A shallow ozone layer with peak concentration of 17 pphm was present near the surface to a depth of 500 m above the canyon floor. Two other layers are indicated above the surface layer but with lower concentrations. Surface ozone concentrations measured at San Bernardino indicated 10 pphm at 17 PDT and a peak value of 15 pphm at 15 PDT. Surface winds at San Bernardino were west-southwest at 17 PDT and westerly at Redlands. The surface wind directions on August 3 were more appropriate for transport into Santa Ana River Canyon than on July 30 and the low-level concentrations in the canyon indicate that transport from the eastern basin occurred more readily on August 3.

Figure 3.7.11 is a sounding made at Banning Airport at 1754 PDT. An elevated ozone layer is present in the sounding with peak concentration of 20 pphm at 1500 m (msl) or 800 m above the terrain. Near the surface the concentrations decreased to 13 pphm. Winds aloft at Banning at the time of



MRI SAMPLING FLIGHT - August 3,1981

Fig. 3.7.6

Table 3.7.6

3 August 1981 Tape #260

TRAVERSE END POINT AND SPIRAL LOCATIONS

POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	34°07.5'	117°23'	Rialto Airport
2	34°17.3'	117°27.5'	2 miles south of Cajon Junction
3	34°18.8'	117°28.5'	Cajon Junction
4	34°13.2'	117°24.5'	Intersection of I15 and Devore Fwy
5	34°10.0'	116°55.5'	Santa Ana River Canyon
6	33°55.0'	116°51.3'	Banning
7	33°55.5'	116°32.5'	7.5 miles east of Point 8
8	33°55.2'	116°40.5'	Intersection of Hwys 10 & 111
9	33°53.7'	116°41.7'	South side Banning Pass
10	33°58.5'	116°38.8'	North side Banning Pass
11	34°07.0'	117°41.0'	Cable Airport

MRI FLIGHT SUMMARY

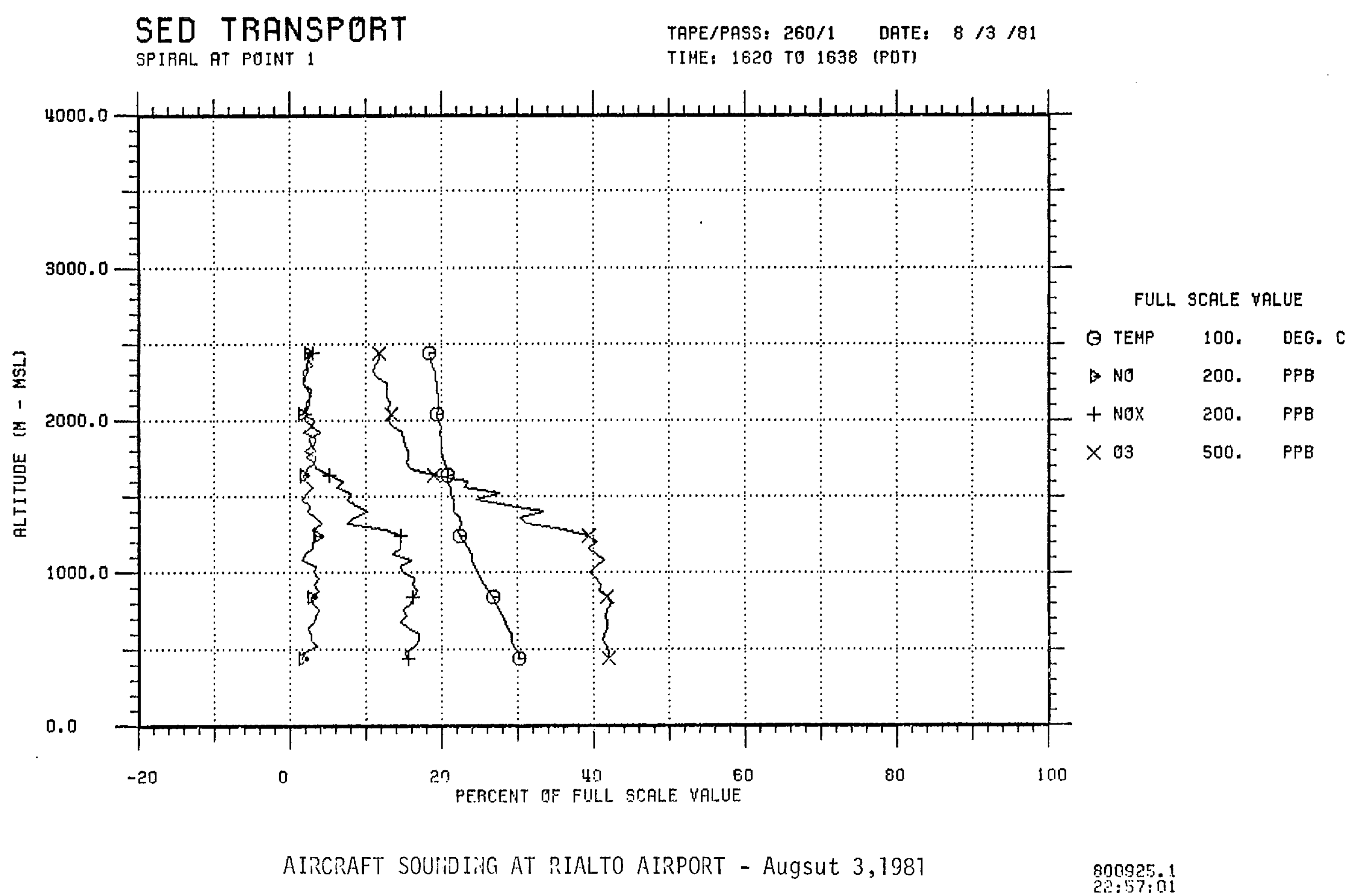
Date: August 3, 1981

SOUTHEAST DESERT OZONE TRANSPORT STUDY

Tape #: 260

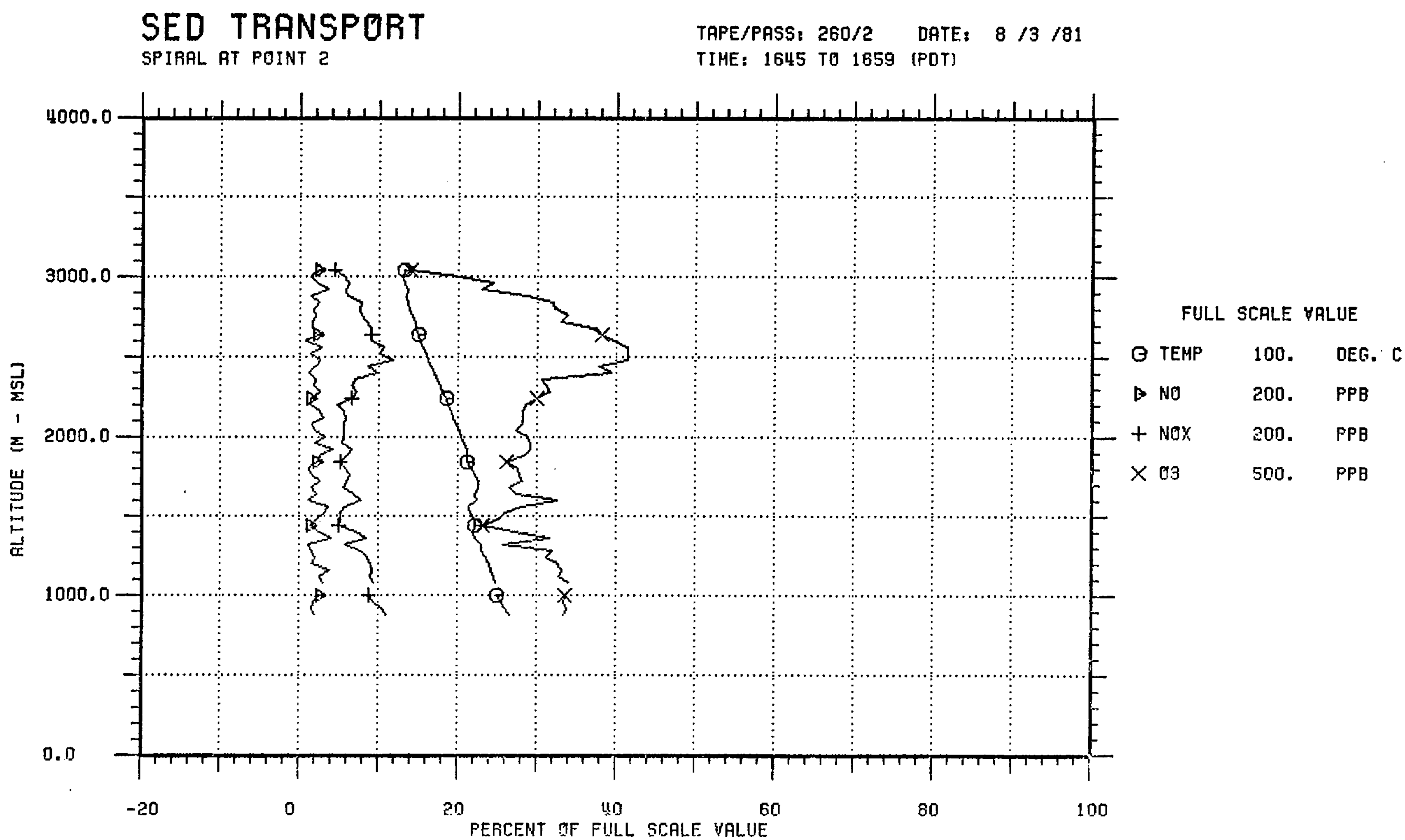
Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start	End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1620	1638	Spiral	1	462-2438		N.A.	J1-14	Sfc Elev = 457 m
2	1645	1659	Spiral	2	3048- 884		N.A.	J15-29	Sfc Elev = 793 m
3	1703	1706	Traverse	3 - 4	1189-1113		12.1 Km.	J30-34	Within 305 m of terrain
4	1727	1740	Spiral	5	3505-1676		N.A.	J35-47	Bottom of canyon ≈1556 m
5	1754	1814	Spiral	6	3353- 664		N.A.	J48-66	Sfc Elev = 659 m
6	1821	1830	Traverse	6 - 7	1524		29.0 Km.	J67-74	
7	1836	1901	Spiral	8	427-3048		N.A.	J75-92	Sfc Elev = 418 m
8	1903	1921	Zero Spiral		3048- 762		N.A.	0	Instrument calibration
9	1926	1928	Traverse	9 - 10	1219		9.7 Km.	J93-98	
10	1931	2003	Traverse	8 - 11	1067		93.4 Km.	J99-115	

Table 3.7.7



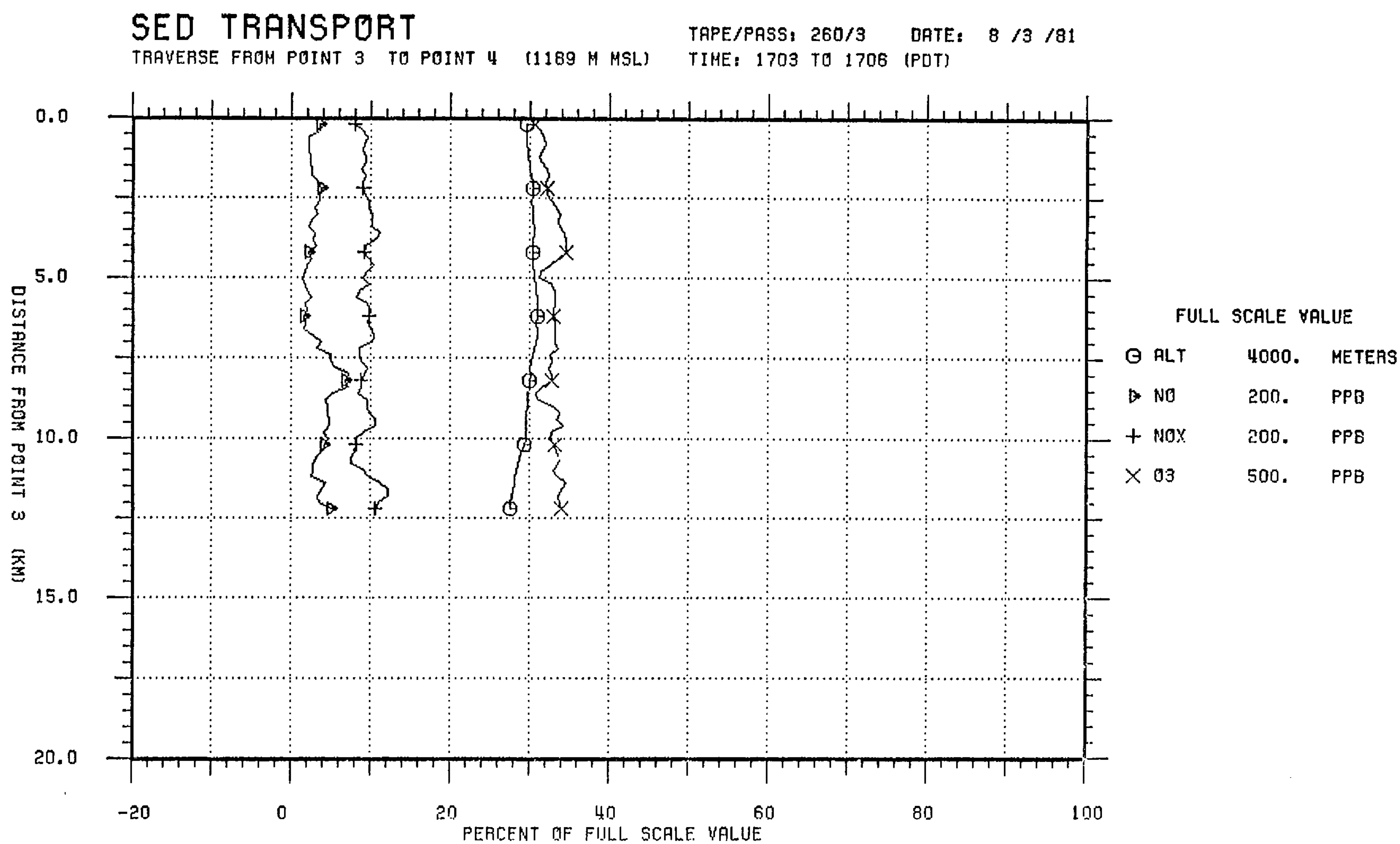
AIRCRAFT SOUNDING AT RIALTO AIRPORT - Augsut 3,1981

Fig. 3.7.7



AIRCRAFT SOUNDING 2 MI S CAJON JUNCTION - August 3,1981

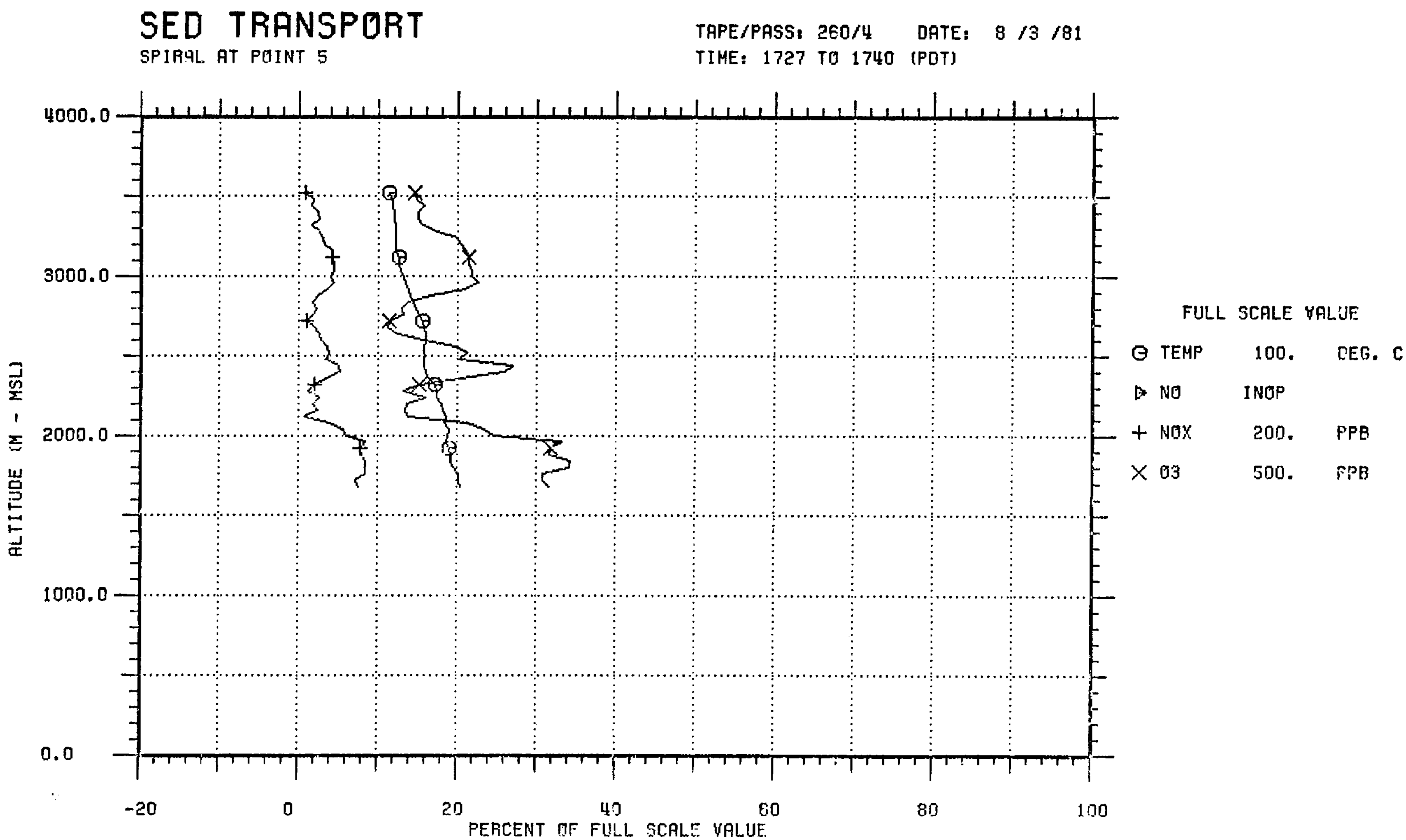
Fig. 3.7.8



AIRCRAFT TRAVERSE FROM CAJON JCT TO INTSCT 115/DEVORE FREEWAY - August 3,1981

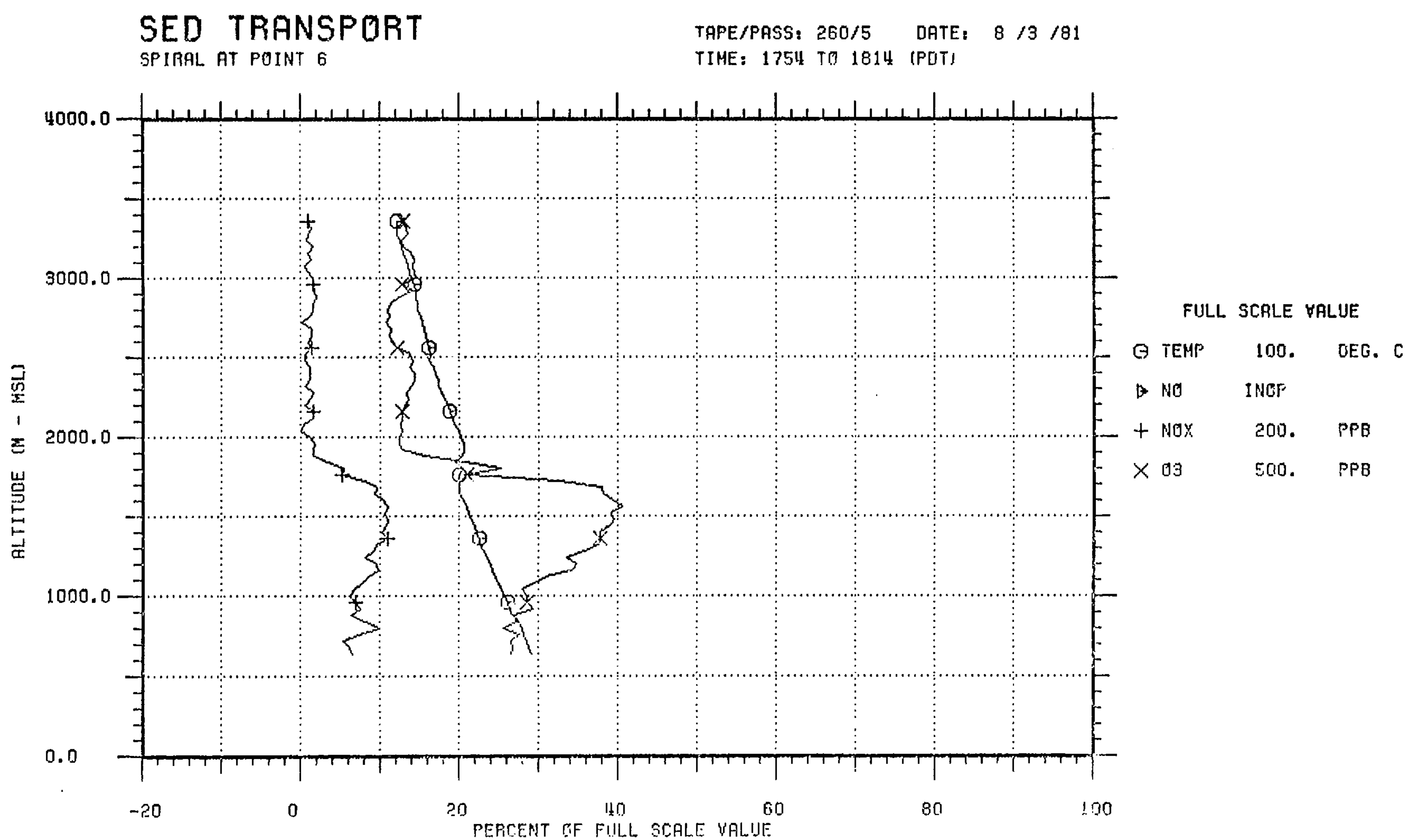
800925.1
23:40:11

Fig. 3.7.9



AIRCRAFT SOUNDING AT SANTA ANA RIVER CANYON - August 3,1981

Fig. 3.7.10



AIRCRAFT SOUNDING AT BANNING - August 3,1981

Fig. 3.7.11

820925.1
22:57:01

the sounding were southwesterly in the low levels becoming west to west-southwest in the upper level ozone layer. Surface ozone concentration at 18 PDT recorded at the Banning ground sampling station was 7 pphm having decreased from a peak value of 9 pphm at 16 PDT. The sounding indicates that much more ozone was being transported through the pass on August 3 than was observed by the surface station at Banning.

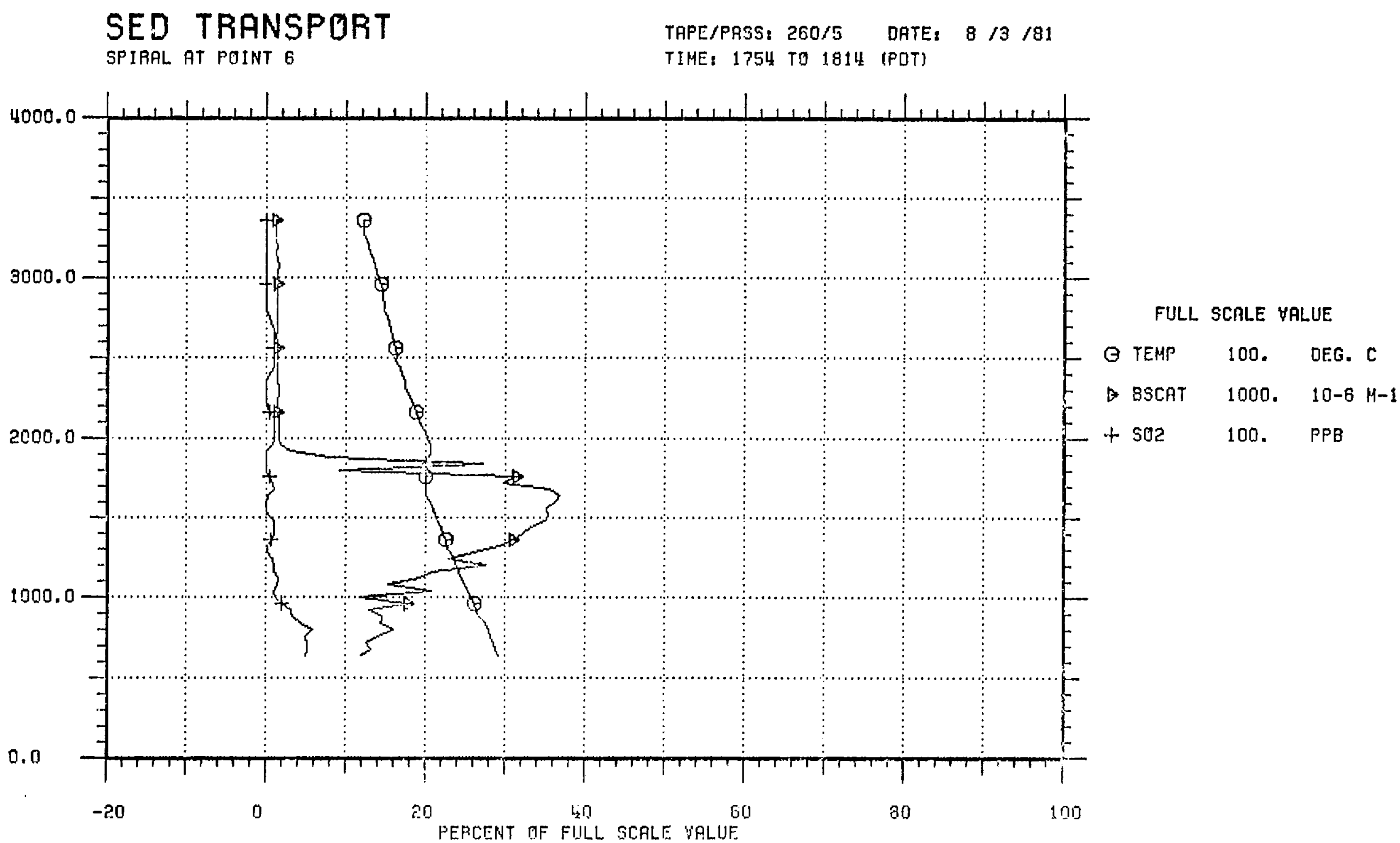
Figure 3.7.12 shows additional parameters for the same sounding at Banning. b_{scat} values in the low layers are strongly reduced from those characterizing the layer aloft. Figure 3.7.11 also shows that the NO_x levels were reduced in the lower layers. The low b_{scat} and NO_x values in the surface layer suggest that the low ozone values shown in Figure 3.7.11 are not the result of reduction by NO. It is apparent that relatively clean air undercut the main pollutant layer in the sounding area as well as at the site of the surface ozone measurements.

After the sounding at Banning a traverse was made from Banning to a point about 10 km east of the intersection of Highways 10 and 111. This traverse is shown in Figure 3.7.13. Flight altitude was constant near 1500 m (msl). Ozone concentrations at flight level started at 20 pphm through the pass but decreased rapidly to about 8 pphm at the end of the traverse.

It is clear from the sounding made at 1836 PDT (Figure 3.7.14) that the top of the ozone layer in the vicinity of the highway intersection was about 1700 m (msl). Figure 3.7.13, however, shows that the aircraft was above the ozone layer at 1500 m (msl) by the end of the traverse shown. It is implied, therefore, that the top of the layer decreased east of the highway intersection in accordance with the lee wave action suggested earlier.

Figure 3.7.15 shows a horizontal traverse across the exit from San Gorgonio Pass from south to north. Flight altitude was about 1200 m (msl) which is about 800 m above the terrain. Peak ozone concentrations downwind of the pass were about 19 pphm at flight level. The crosswind width of the plume was at least 8 km of relatively high concentrations.

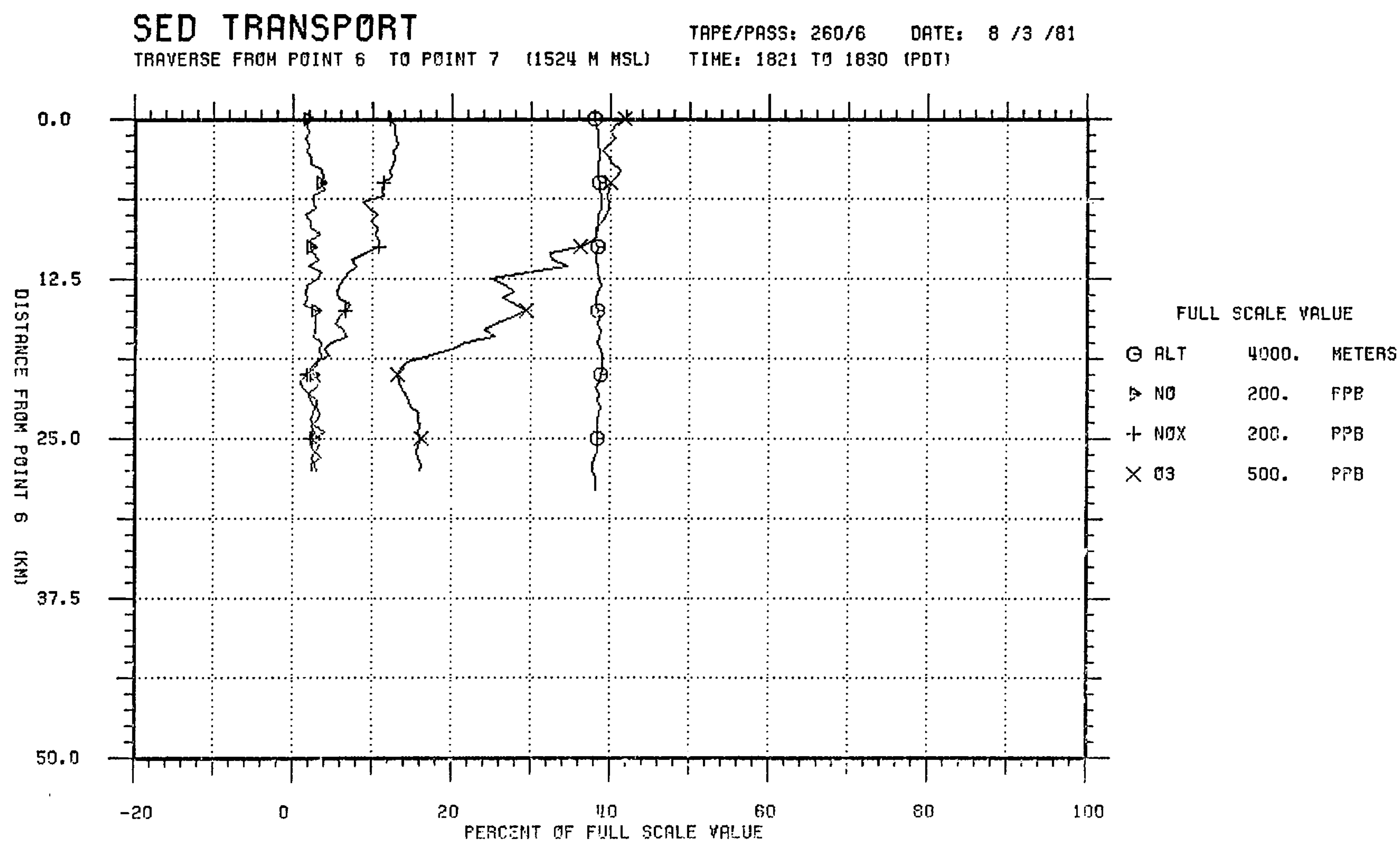
The final traverse on August 3 was flown from the intersection of Highways 10 and 111 to Cable Airport beginning at 1931 PDT (Figure 3.7.16). Flight altitude was 1000-1100 m (msl). Ozone concentrations to 18 pphm were present at the start of the traverse. After passage through the pass the values decreased to average 10-12 pphm for the balance of the flight.



AIRCRAFT SOUNDING AT BANNING - August 3,1981

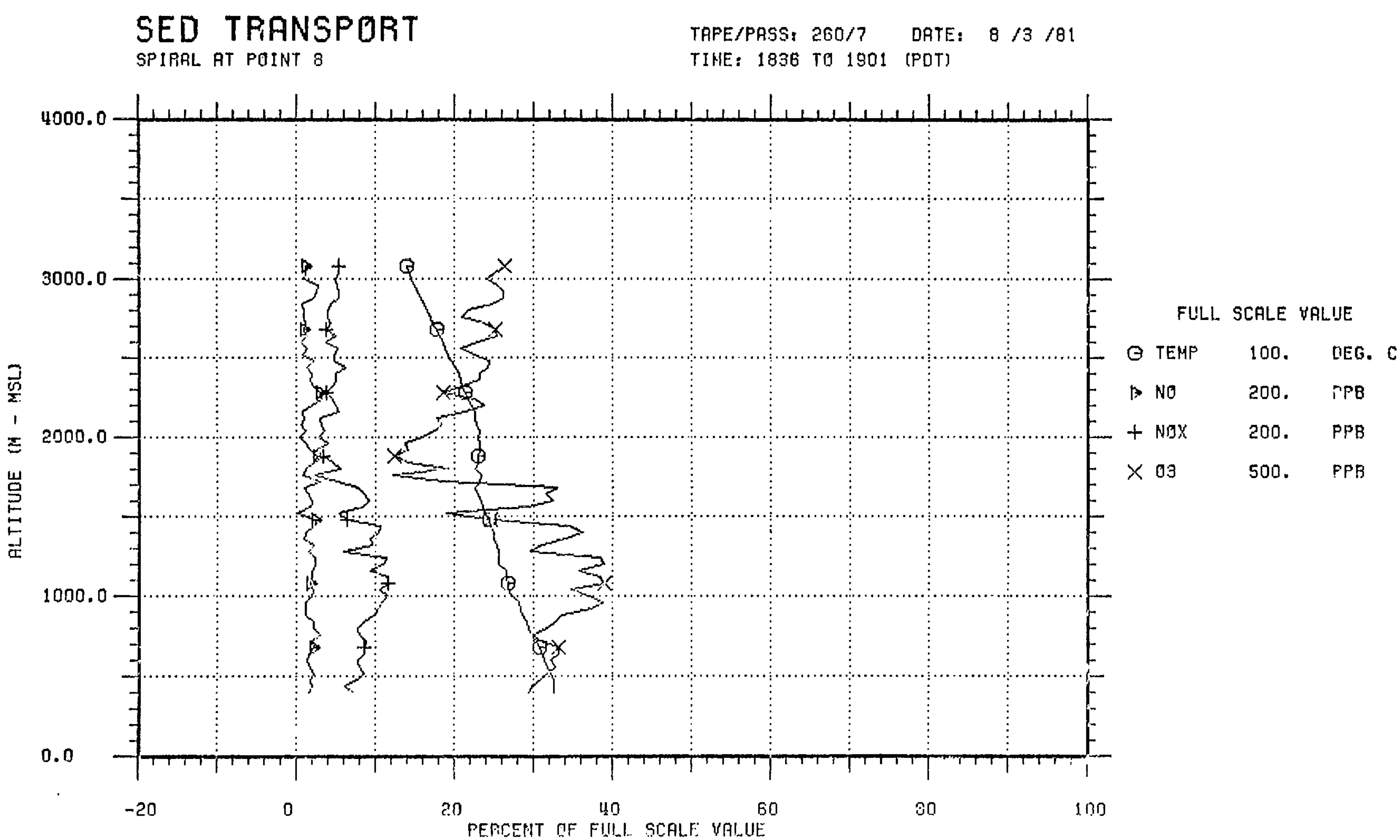
Fig. 3.7.12

890925.1
20:57:01



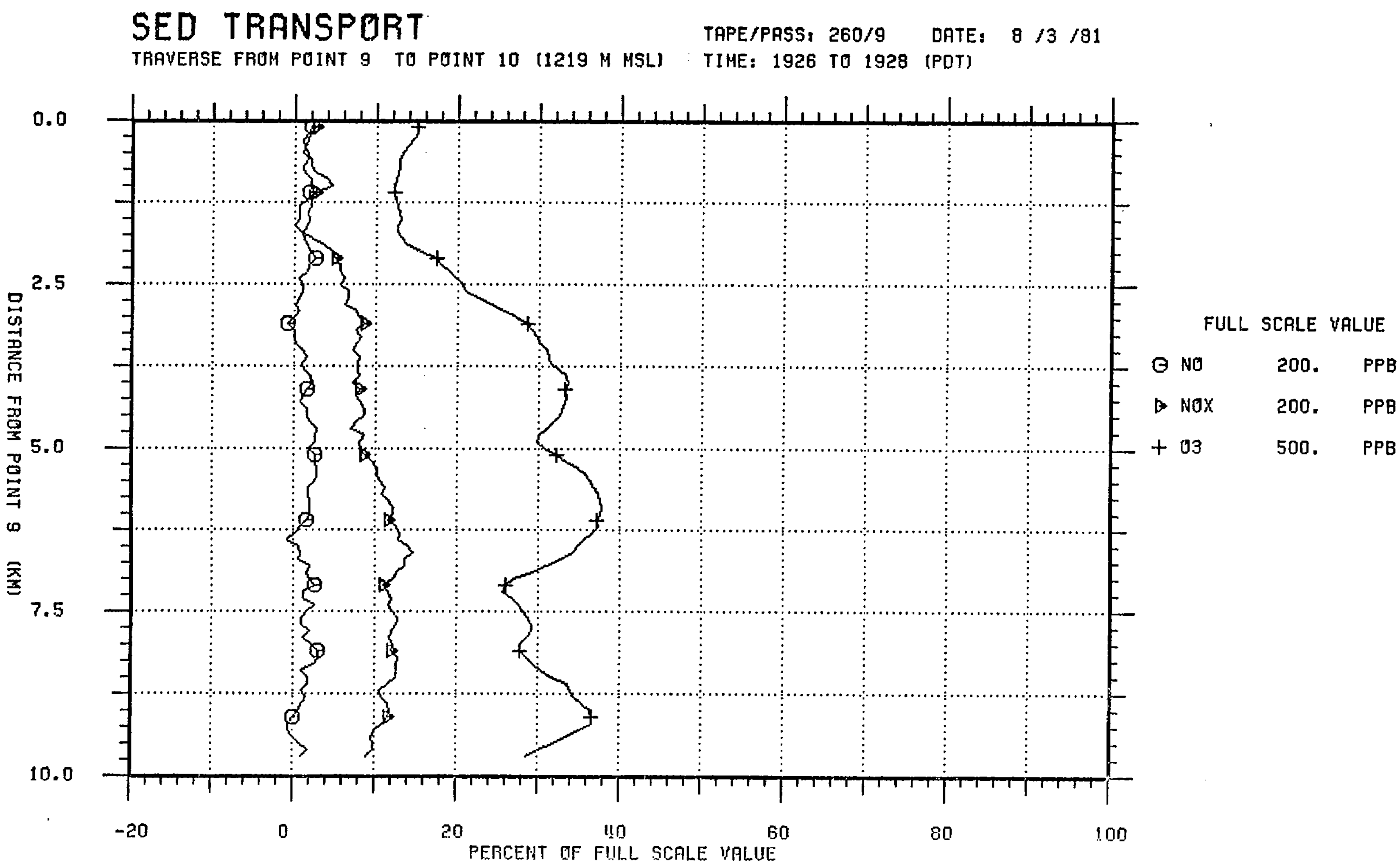
AIRCRAFT TRAVERSE FROM BANNING TO 7 MI E INTSCT I - 10/111 - August 3,1981 800925.1 23:40:11

Fig. 3.7.13



AIRCRAFT SOUNDING AT INTERSECTION I - 10/111 - August 3,1981

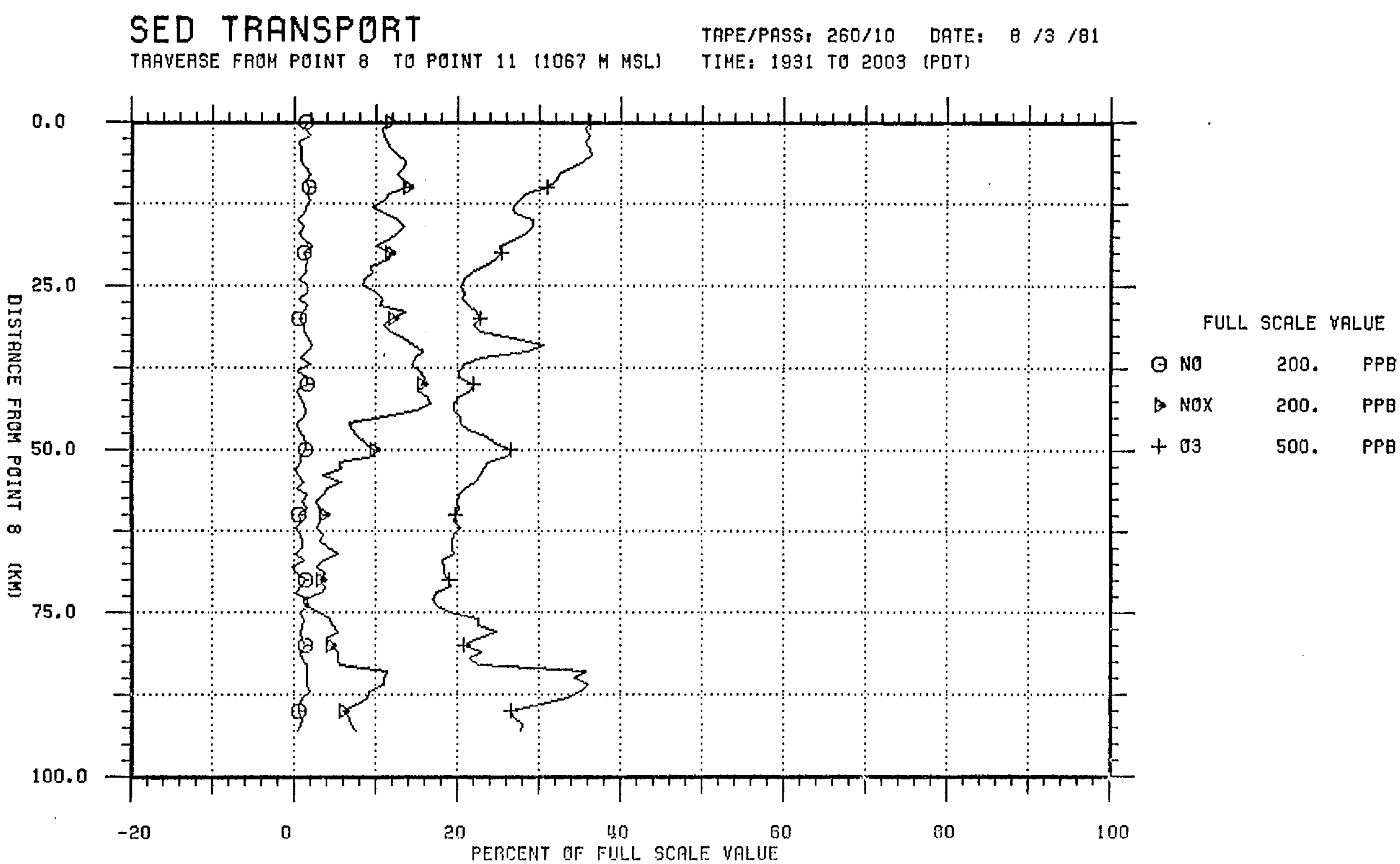
Fig. 3.7.14



AIRCRAFT TRAVERSE FROM S TO N ACROSS BANNING PASS - August 3,1981

Fig. 3.7.15

820404.1
12:34:17



AIRCRAFT TRAVERSE FROM INTSCT I -10/111 TO CABLE AIRPORT - August 3,1981

020404.1
12:34:17

Fig. 3.7.16

3.7.4 Tracer Results - Test 7

Release Location: Ontario
Date: August 3, 1981
Time: 0500-0900 PDT
Release Rate: 8.8 g/sec. SF_6

Surface winds during the release period at Ontario were light and variable becoming west to west-southwest and increasing in velocity toward the end of the release. Average wind velocity during release was 1.3 m/s. Streamline patterns at 10 and 16 PDT for August 3 are shown in Figs. 3.7.17 and 3.7.18. Under rather flat pressure gradient conditions the flow through Soledad Canyon and Cajon Pass was not well established by 10 PDT. The wind pattern in the Mojave Desert was dominated by flow from the San Joaquin Valley. By 16 PDT the flow through the passes was somewhat greater and the San Joaquin Valley influence continued quite strong.

August 3

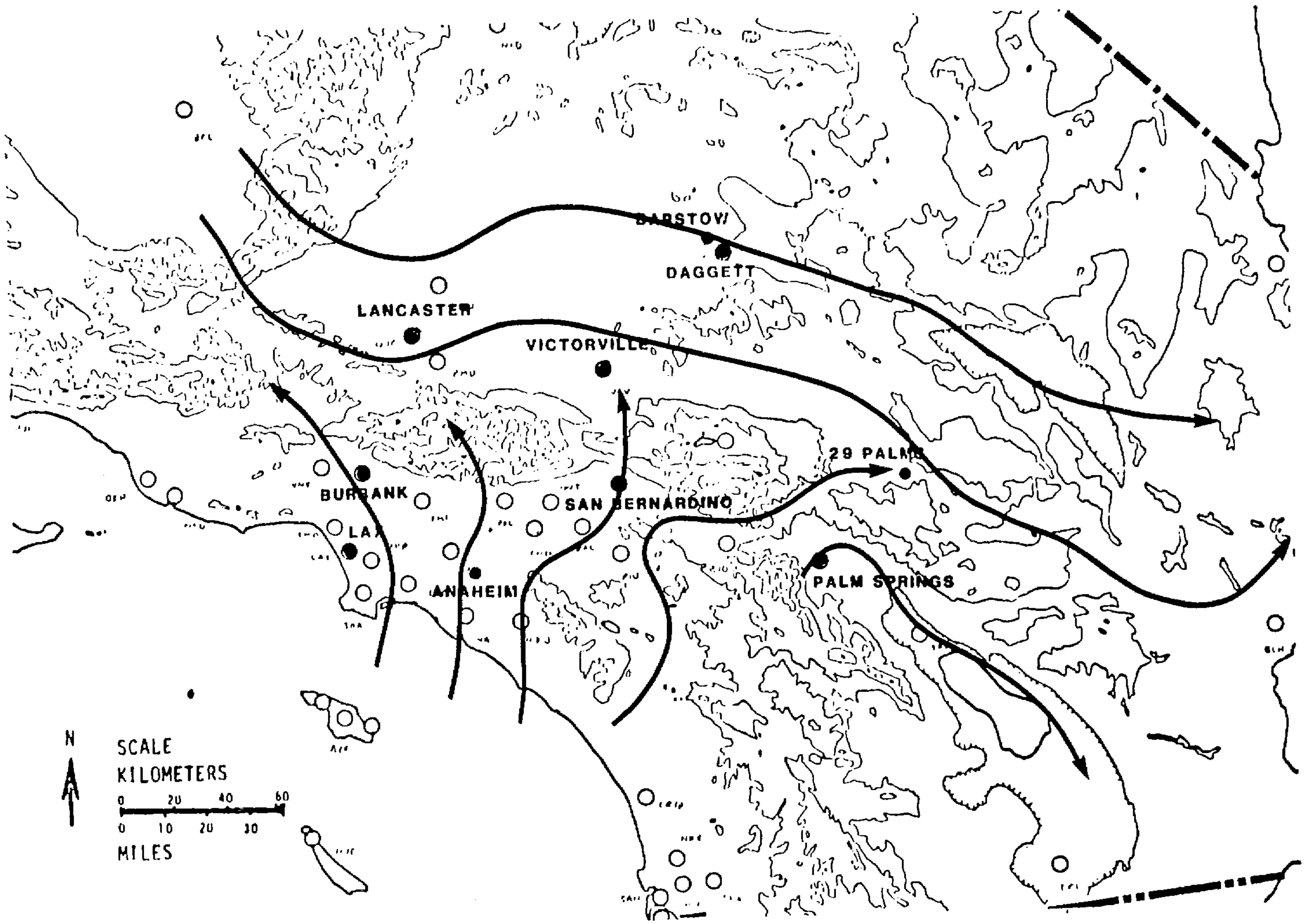
Plume trajectories for August 3 are shown in Fig. 3.7.19. Initially, the main plume started toward the northwest. Observed concentrations near Upland and Pomona between 09 and 11 PDT were very high in light of the low wind speeds during the release period. Thereafter, the tracer material moved toward the northeast through Cajon Pass in response to the development of flow into the desert. The Victorville sampler was not operative early in the day and no evidence of plume passage was obtained at that location. By mid-afternoon small concentrations were observed at Lucerne Valley (11 ppt). There were no other significant concentrations observed that could be attributed to the plume impact.

Fig. 3.7.20 shows the Xu/Q values calculated from the observed tracer concentrations on August 3. Average wind speeds during the release period were used in the calculations. Xu/Q values in the figure correspond to stability conditions C-D except for one sample in which the centerline concentration was probably not adequately sampled.

August 4

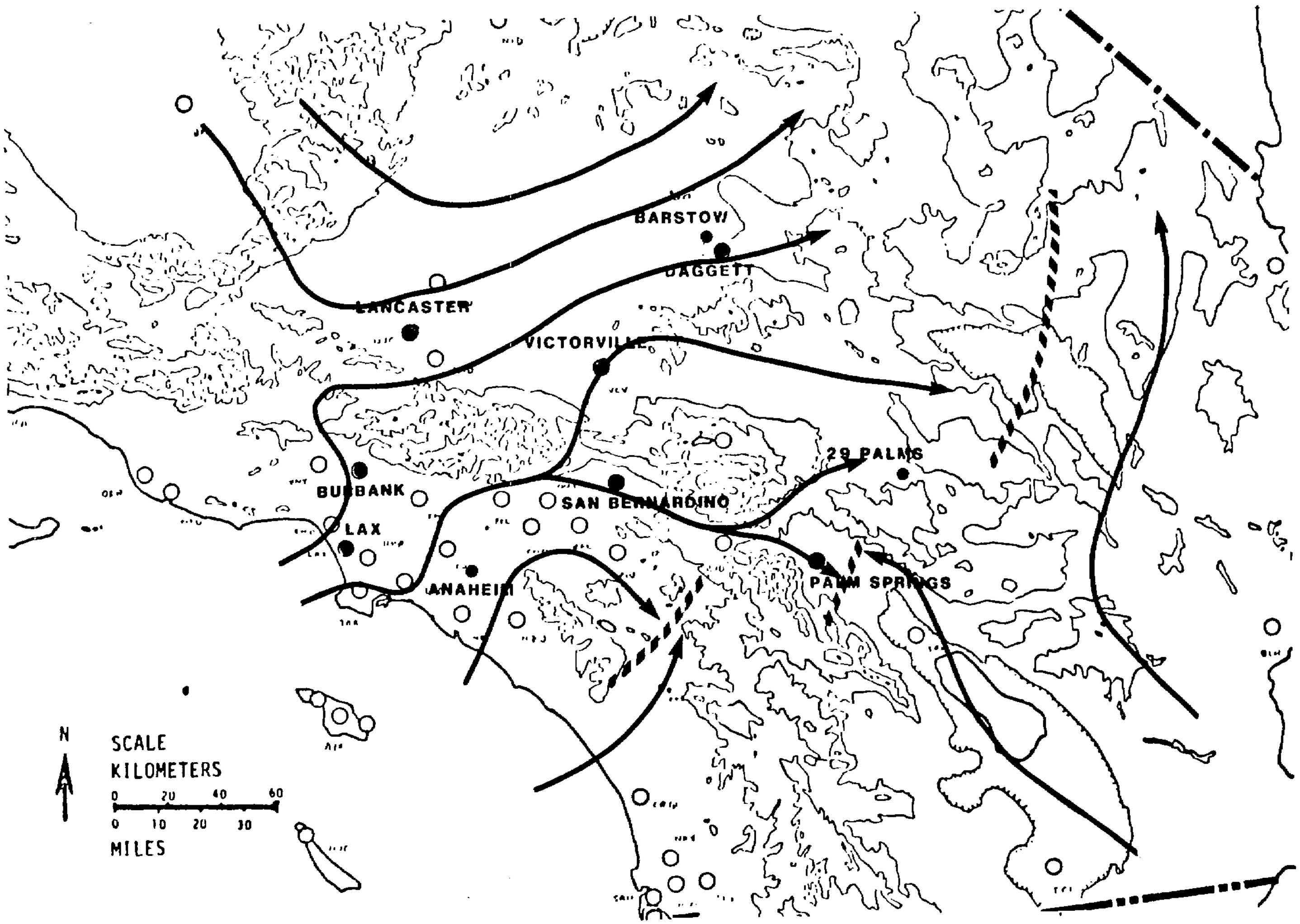
Automobile sampling was carried out on August 4 in the desert from Niland to Joshua Tree to Victorville. Tracer concentrations were generally very low (10 ppt or less) and are not considered to be significant.

Sampling in the Los Angeles basin generally covered the area from San Bernardino to Pasadena. Scattered, sizeable SF_6 concentrations were observed, particularly from San Bernardino to Pomona. A peak concentration of 55 ppt was found near Colton about 10 PDT. A value of 64 ppt was observed near Pomona between 19 and 20 PDT. Most of the samples, however, showed less than 10 ppt and a coherent pattern of SF_6 was not present. Hourly samples at Pasadena and Azusa on August 4 did not show appreciable SF_6 concentrations.



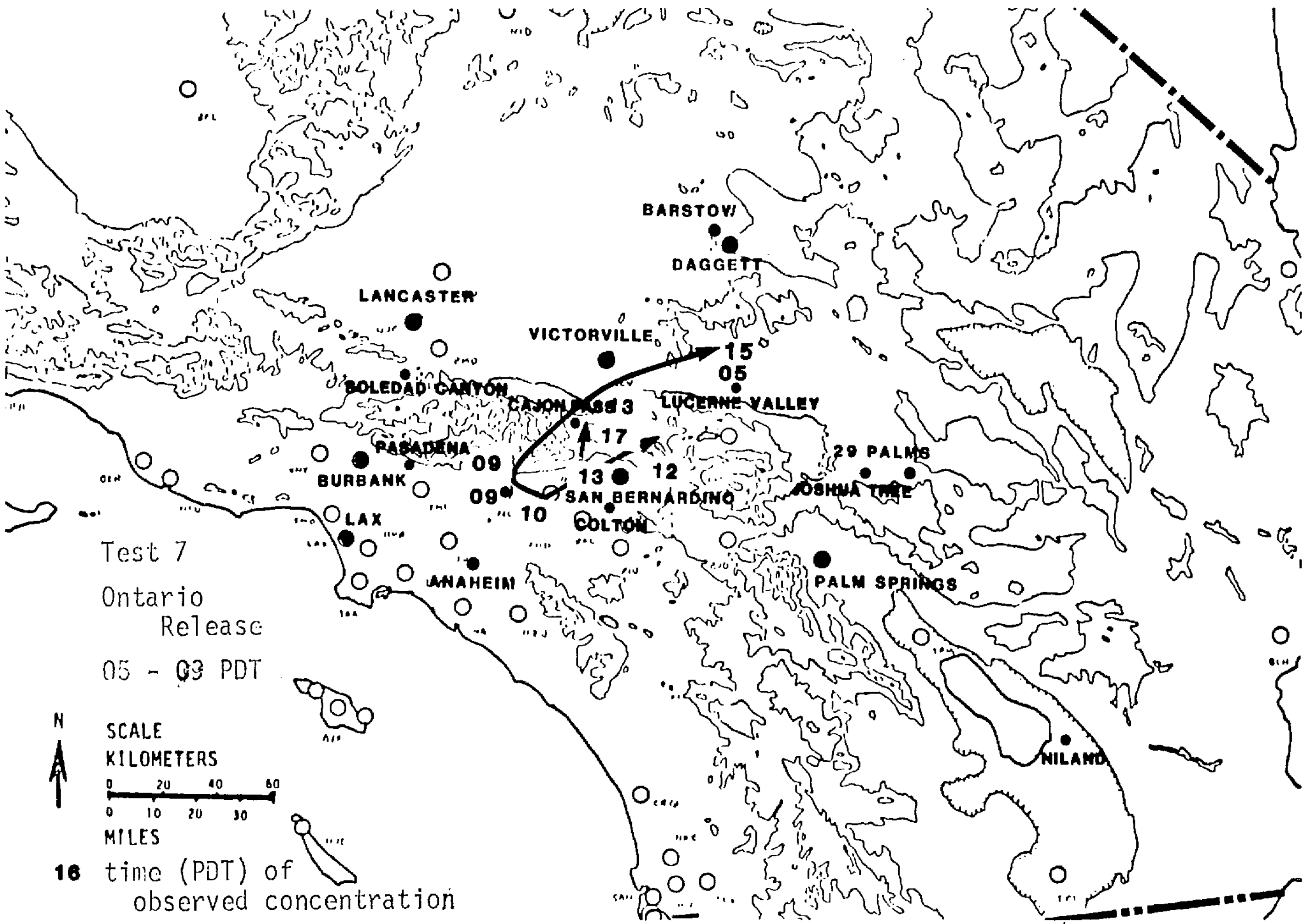
STREAMLINE MAP (10 PDT) - August 3,1981

Fig. 3.7.17



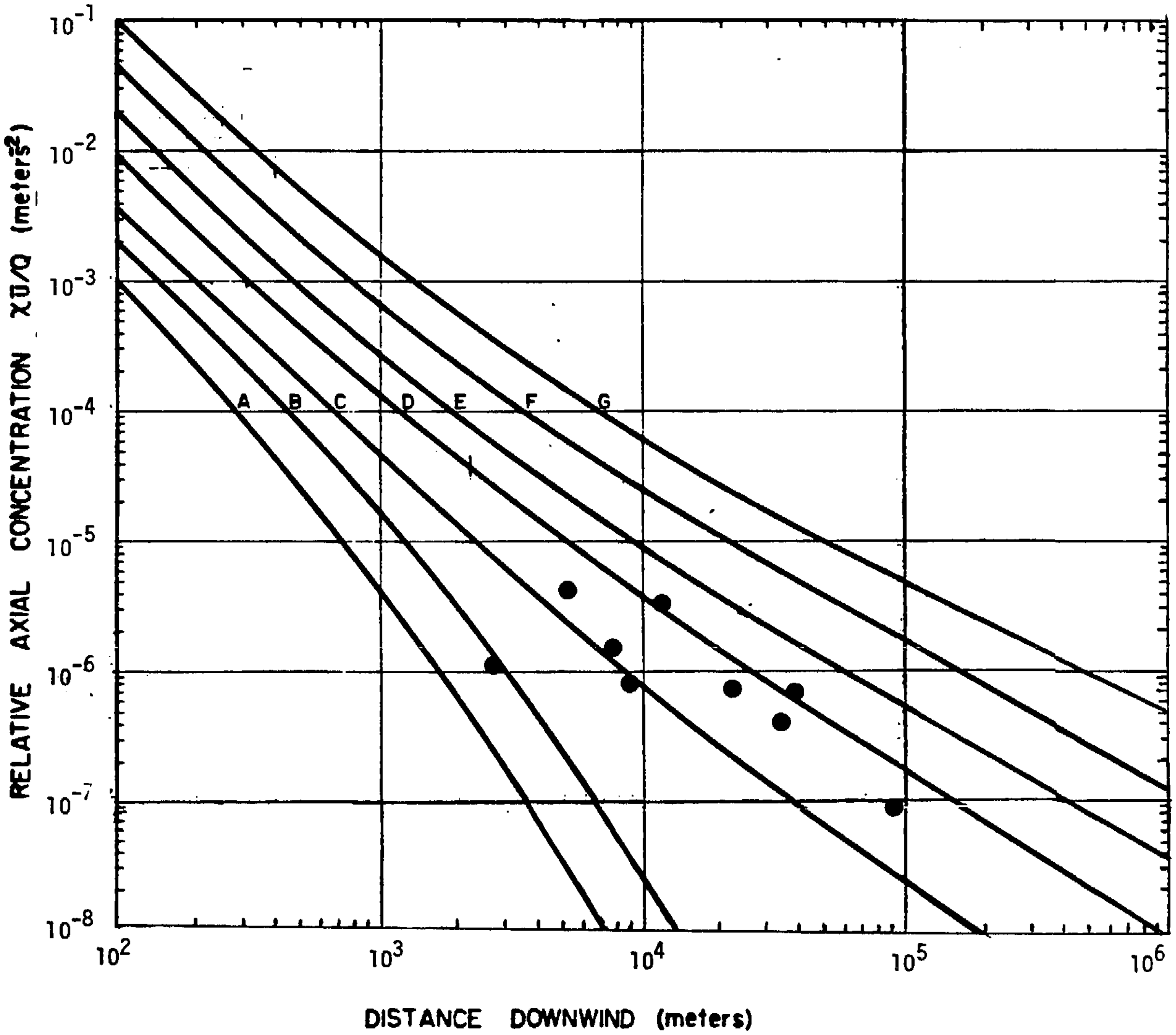
STREAMLINE MAP (16 PDT) - August 3,1981

Fig. 3.7.18



TRACER TRAJECTORIES - August 3,1981

Fig. 3.7.19



CALCULATED XU/Q VALUES - Test 7

August 3,1981

Fig. 3.7.20

3.8 Test 8 11-12 August 1981, Brawley Release (0600-0850 PDT, 8/11/81)

3.8.1 Meteorology

General

An extensive high pressure area aloft dominated the west coast from August 6-9. By August 10-11 the upper level ridge was most pronounced in the northwest and a weak trough moved southward along the eastern side of the ridge into southern Nevada (Figure 3.8.1). A thermal trough at the surface extended as far north as Washington.

Meteorological parameters for August 11 are given in Table 3.8.1. The 850 mb temperature at Vandenberg AFB was above average for the time of year. Pressure gradients inland, however, were relatively light. The base of the morning inversion at UCLA (801 m) was quite high, permitting mixing of the basin pollutants through a relatively deep layer.

August 11-12 followed a very warm period with maximum temperatures of 100°F at Ontario on August 6, 8 and 9. Moderately strong pressure gradients developed on August 9-10, resulting in a rather deep marine layer on August 11. Surface pressure gradients decreased on August 11 from the previous two days, reflecting the eastward movement of a weak trough away from the desert areas.

Transport Winds

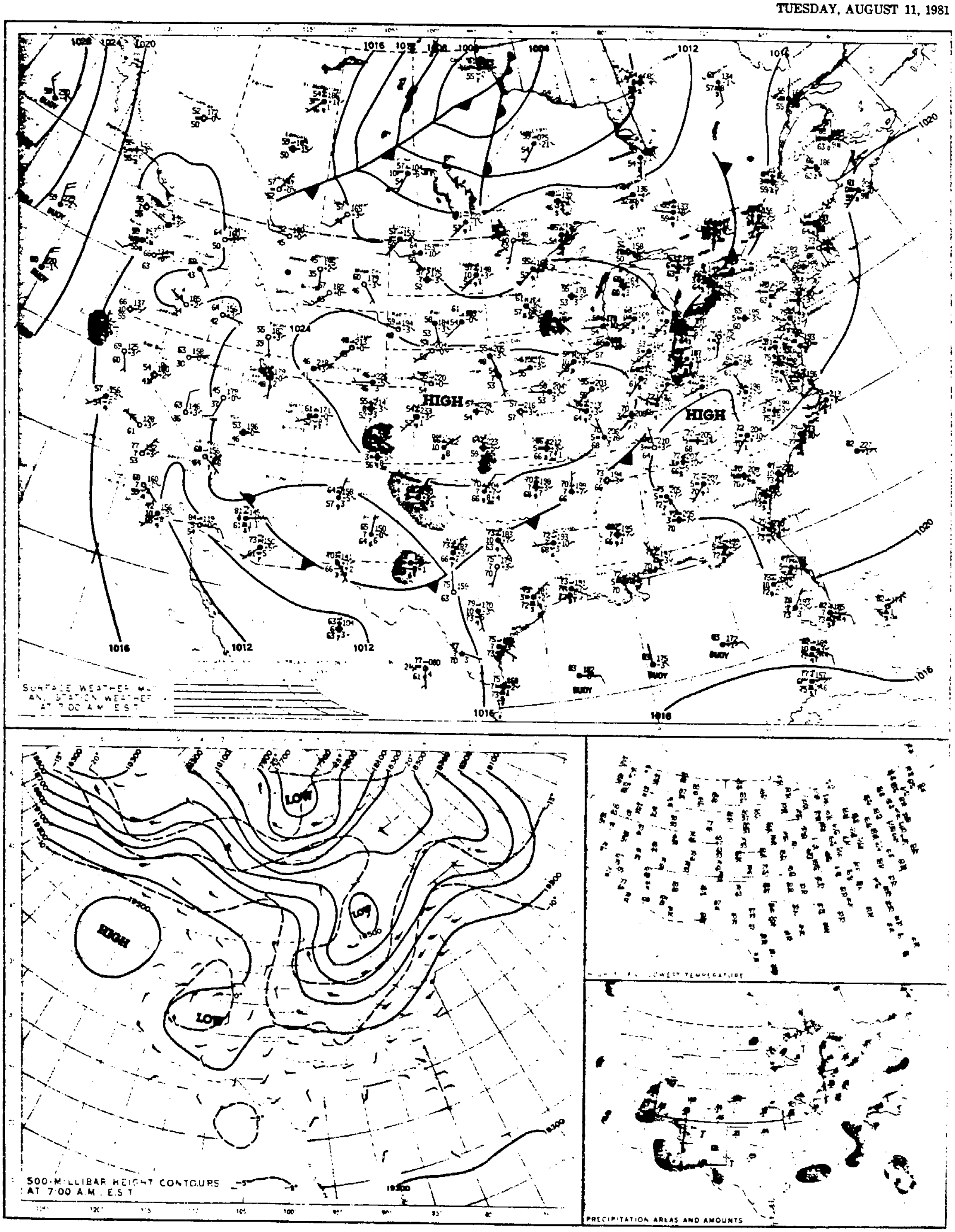
Surface winds at the release site in Brawley on August 11 are shown in Table 3.8.2:

Table 3.8.2

SURFACE WINDS AT BRAWLEY DURING AND AFTER RELEASE

AUGUST 11, 1981

Time (PDT)	Direction (°)	Speed (m/s)
06	300	1.5
07	290	1.2
08	280	1.6
09	280	1.7
10	280	1.2
11	200	0.9
12	210	0.9



WEATHER MAP
August 11,1981

Fig. 3.8.1

Table 3.8.1

METEOROLOGICAL PARAMETERS

AUGUST 11, 1981

850 mb Temperature			
Vandenberg AFB	(0500 PDT)	23.0°C	
Edwards AFB	(0545 PDT)	-	
Ontario	(0830 PDT)	20.5	
UCLA	(0600 PDT)	-	
Pressure Gradients	(0800 PDT)		
LAX - Daggett		2.1 mb	
LAX - Bakersfield		1.8	
Maximum Surface Temperature			
Ontario		94°F	(34.4°C)
Palm Springs		104	(40.0)
Inversion Base Height* and Temperature			
UCLA	(0600 PDT)	-	
Rialto	(0700 PDT)	16.7	(Surface)
Ontario	(0830 PDT)	18.4	(400 m)
Inversion Top Height* and Temperature			
UCLA	(0600 PDT)	-	
Rialto	(0700 PDT)	22.8	(740 m)
Ontario	(0830 PDT)	22.5	(1130 m)

* All heights are msl

Surface winds during the release period (0600-0850 PDT) were generally light from a west-northwesterly direction. After the release had terminated a more southerly, but light, wind developed.

Surface winds at Lancaster, Victorville and Palm Springs for August 11 and 12 are shown in Table 3.8.3. Winds at Lancaster showed a moderate flow out of Mint Canyon on August 11 until early morning on the 12th. A stronger flow into the desert developed during the day on August 12 and reflected increased pressure gradients toward the interior on that day.

The flow through Cajon Pass impacted on Victorville in a significant fashion from 18-24 PDT on August 11 and from 16-20 PDT on August 12.

A flow from San Gorgonio Pass commenced at Palm Springs at about 21 PDT on August 11 but the flow did not appear to have reached Palm Springs during the evening of August 12.

Mixing Heights

Observed and predicted mixing layer heights for August 11 are shown in Table 3.8.4. Mixing layer depths were relatively high along the coast and increased only moderately at Ontario by 1430 PDT. At San Bernardino, however, the surface temperature was high enough to break the inversion, based on the morning temperature sounding. Visibility at San Bernardino increased significantly about 12 PDT, increasing to 20 miles at 14 PDT in support of the inversion prediction. Visibility at Ontario improved to 7 miles at about the same time (Table 3.8.5). Mixing layer heights in the Imperial/Coachella Valley were measured by aircraft during the morning and near noon. Layer tops increased from 600 m to 1300 m (msl) in response to the diurnal heating.

Table 3.8.5

OBSERVED VISIBILITIES - AUGUST 11, 1981

Time (PDT)	San Bernardino	Ontario
10	7 miles	3 miles
12	10	4
14	20	7
16	15	7
18	10	7

Table 3.8.3

SURFACE WINDS - AUGUST 11-12, 1981

Time (PDT)	Lancaster	Victorville	Palm Springs
06	280°/ 5.1 m/s	170°/4.6 m/s	-
08	Calm	140 /5.7	270°/2.1 m/s
10	Calm	160 /3.6	070 /3.1
12	140 / 3.6	240 /3.1	060 /3.6
14	Calm	290 /2.6	080 /6.2
16	250 / 4.1	110 /1.0	090 /5.1
18	250 /10.3	180 /6.2	090 /4.1
20	250 /10.3	190 /4.6	110 /3.6
22	240 /11.3	190 /3.6	270 /6.7
24	260 / 8.2	140 /2.1	-
02	260 / 7.7	080 /2.1	-
04	270 / 7.7	190 /2.1	-
06	Calm	Calm	-
08	270 / 5.1	Calm	290 /6.2
10	250 / 8.2	290 /2.1	-
12	250 /10.3	230 /3.6	090 /4.1
14	250 /11.8	210 /5.1	080 /3.1
16	240 /11.8	180 /6.7	050 /2.6
18	-	160 /7.2	-

Table 3.8.4

MIXING HEIGHTS - AUGUST 11, 1981

1. Observed by Rasonde

	Time	Height (msl)	Terrain Height
UCLA	0600 PDT		150 m
	1200		150
Ontario	0830	400	290
	1430	940	290

2. Observed by Aircraft Sounding

Location	Time	Height (msl)	Terrain Height
Brawley	1046 PDT	600 m	-30 m
Palm Desert	1230	1300	0

3. Predicted from Maximum Surface Temperature

	Height (msl)	Terrain Height
Ontario	1780 m	290 m
San Bernardino	Inv. Broken	360
Edwards AFB	-	725

3.8.2 Regional Pollutant Levels

Figure 3.8.2 shows the maximum hourly ozone concentrations observed in the Los Angeles basin and nearby desert areas on August 11. Highest hourly concentrations observed were 18 pphm at Mt. Baldy and Cajon Pass. Lancaster experienced a peak value of 16 pphm but only Lancaster and Victorville exceeded the state ozone standard on August 11. Most of the peak concentrations in the Los Angeles basin were relatively low for an August day.

A map of the times of peak ozone occurrences in the area is given in Figure 3.8.3. All of the desert locations with the exception of Desert Center and El Centro show late afternoon and evening peaks which correspond to transport from the basin.

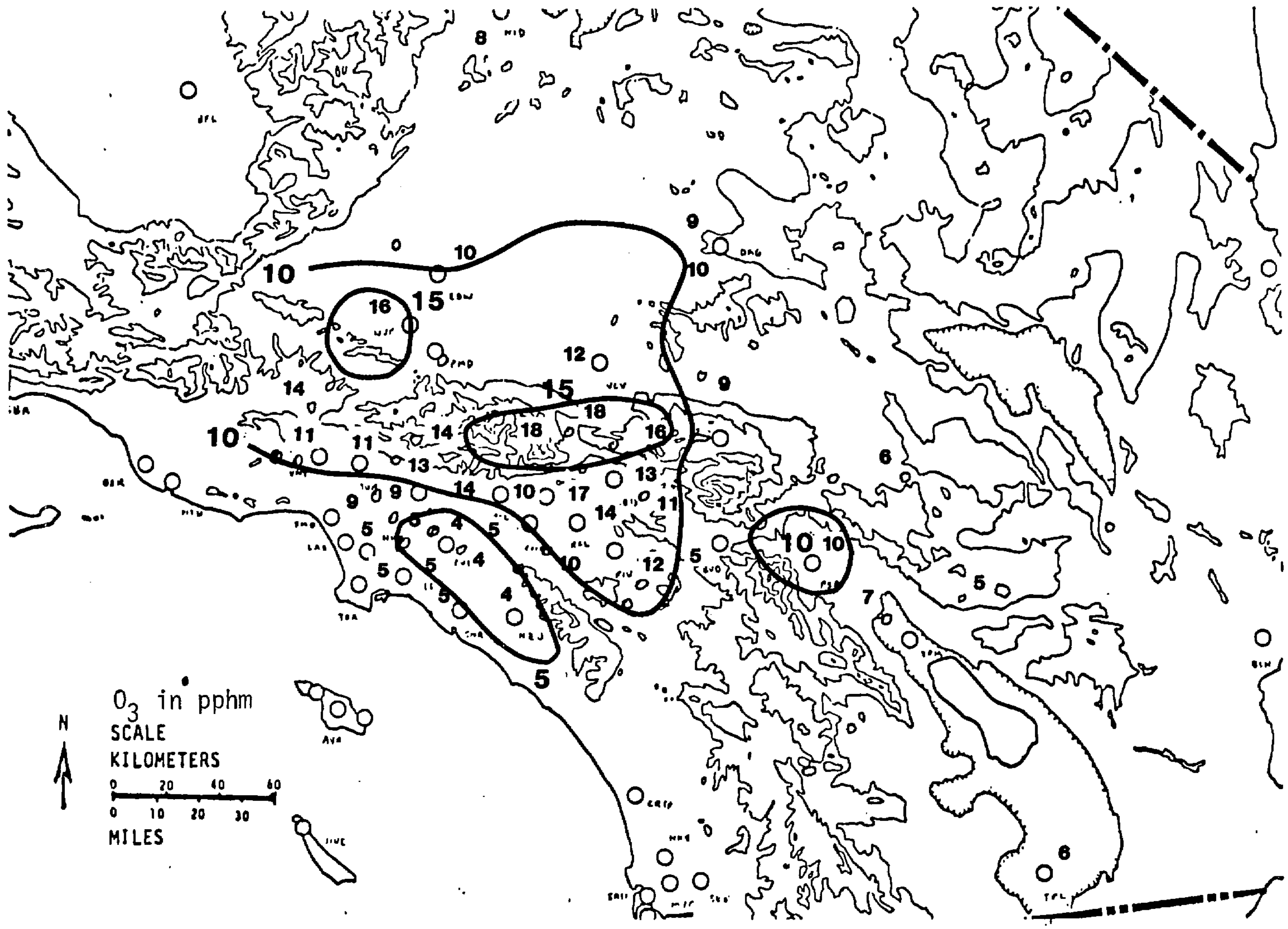
Figure 3.8.4 gives the hourly ozone concentrations along the transport route from the basin into the Coachella Valley. There is evidence of a minor ozone peak traveling from Banning through Palm Springs to Indio. The magnitude of the peak, however, was relatively small. For the mountain areas, the data show the typical upslope effects leading to peak ozone concentrations in the mid-afternoon. There was no data taken at Fawnskin on August 11.

Figure 3.8.5 shows the hourly ozone concentrations along the routes from Newhall and San Bernardino into the Mojave Desert. Both routes show a progression of the times of peak ozone occurrences along the routes from Newhall to Barstow and San Bernardino to Barstow. The wind directions at Barstow during the late evening ozone peak were from the southwest and it is probable that the Barstow peak was associated with the flow through Cajon Pass rather than through Mint Canyon. The peak concentration at Edwards AFB was not very large and there are indications of a small, local peak occurring at 12 PDT.

3.8.3 Aircraft Sampling - August 11, 1981

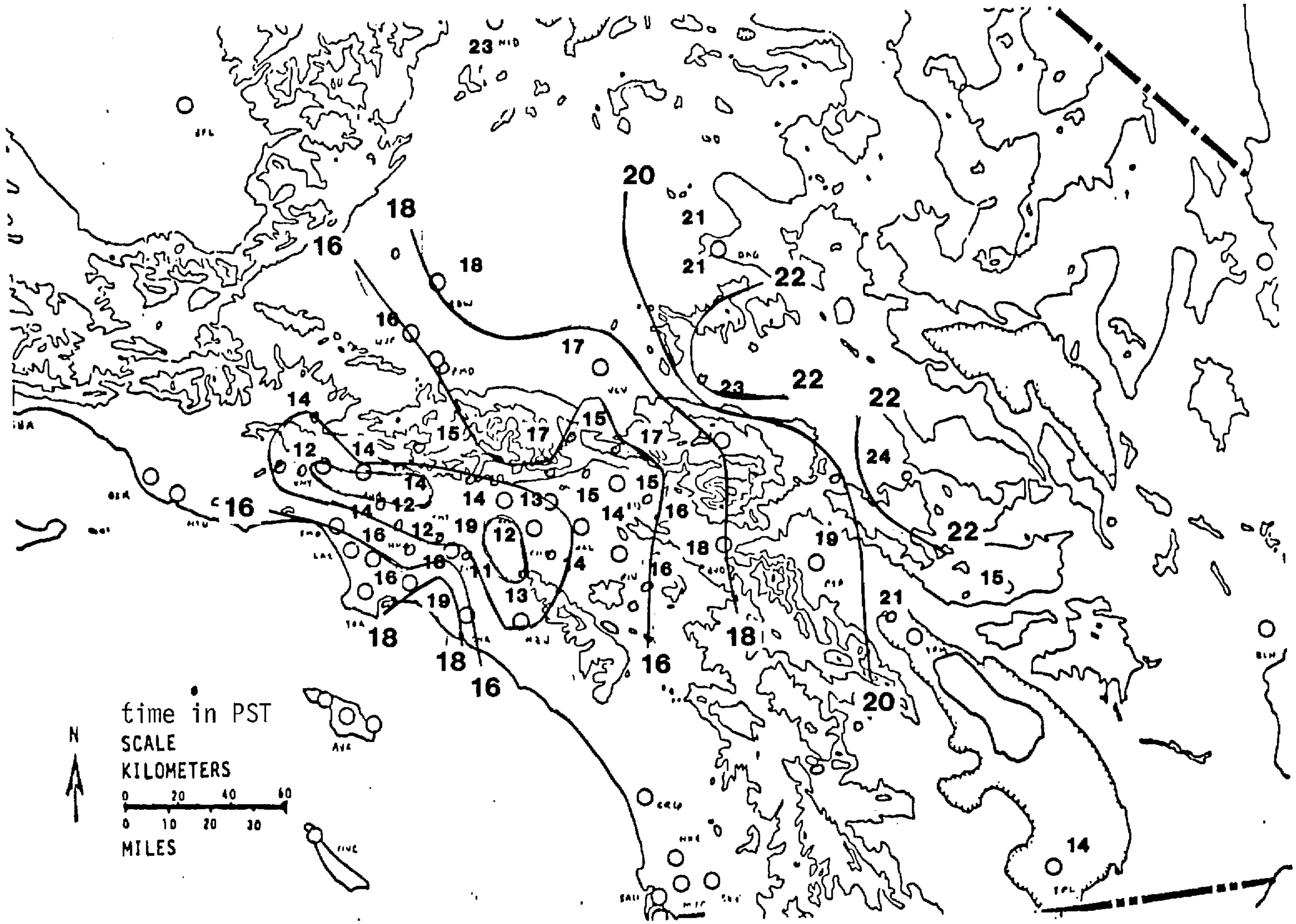
The air quality aircraft sampling on August 11 was carried out in the Coachella and Imperial Valleys in support of a tracer release from Brawley. Figure 3.8.6 shows the flight pattern on August 22 while the locations shown on the map are described in Table 3.8.6. Further details on the flight pattern are given in Table 3.8.7.

Figure 3.8.7 is a sounding made at Brawley Airport at 1046 PDT. Ozone concentrations were relatively low throughout the sounding but with some slight variations. Winds in the layer from the surface to 1500 m (msl) were from the south to southeast. Above this level the winds shifted abruptly to a westerly direction. The increase in ozone aloft was therefore associated with air advected in from the west. The low-level layer of slightly higher ozone concentrations may be the result of local effects.



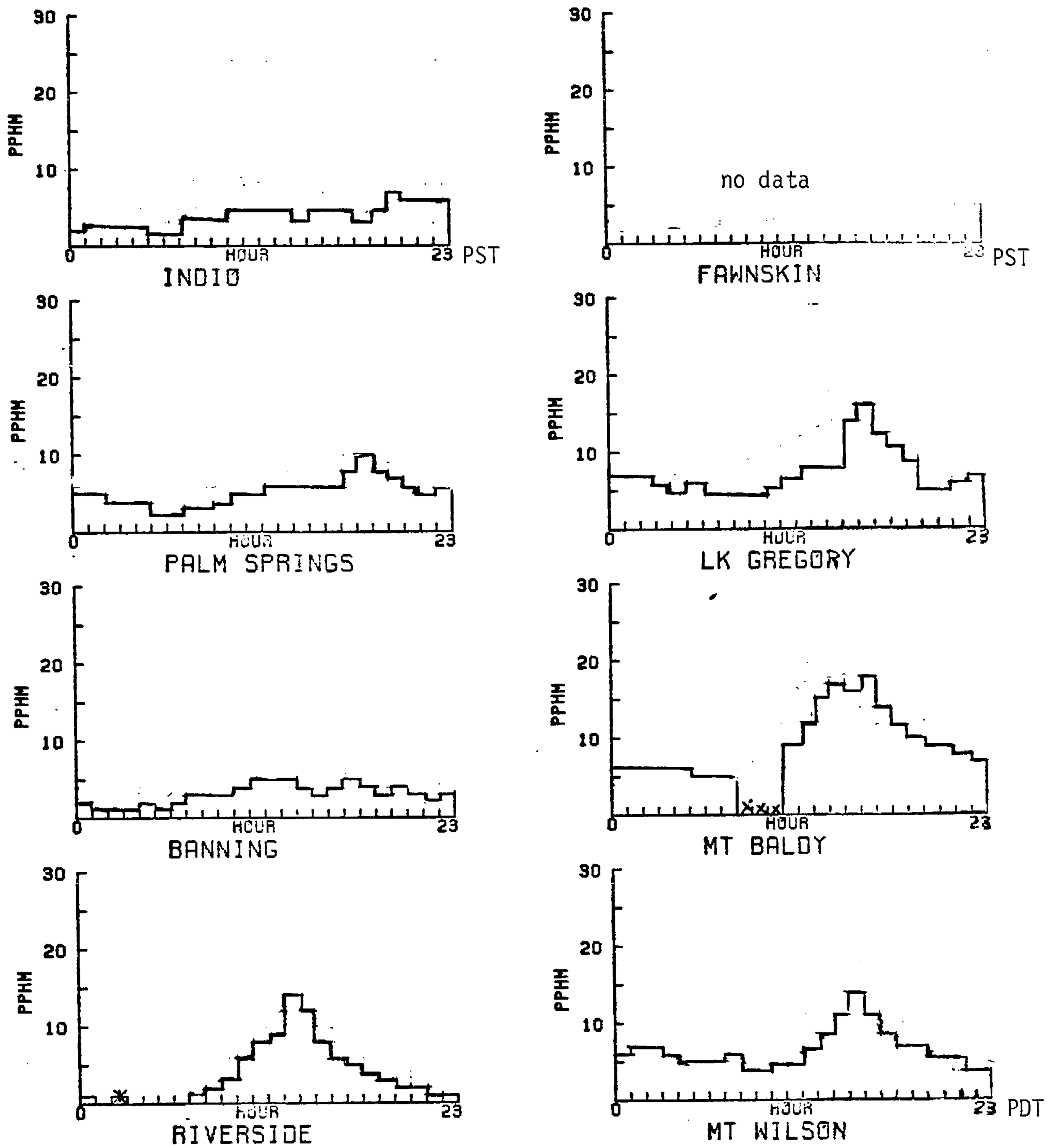
MAXIMUM HOURLY OZONE CONCENTRATIONS - August 11,1981

Fig. 3.8.2



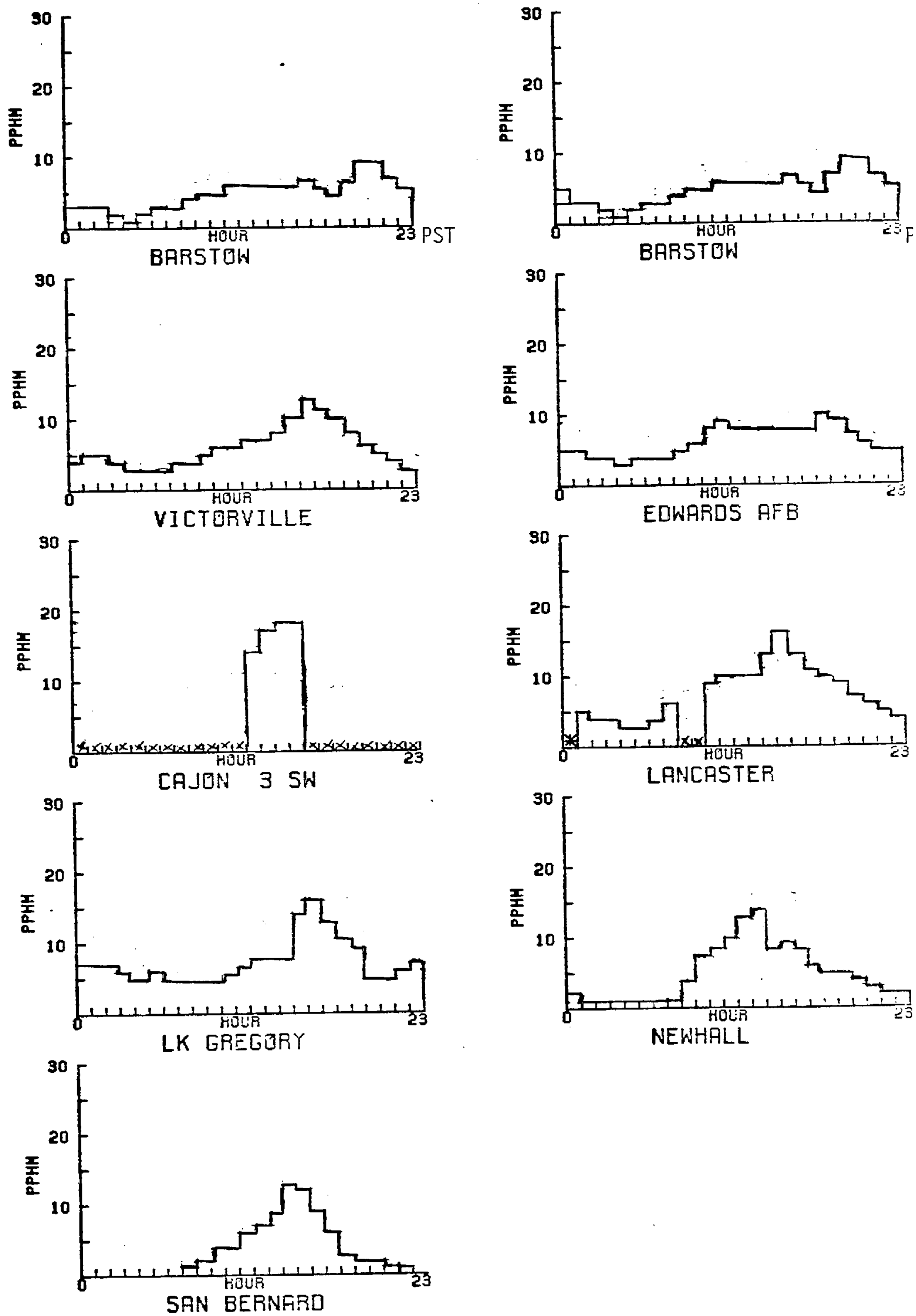
TIME OF MAXIMUM HOURLY OZONE CONCENTRATION - August 11,1981

Fig. 3.8.3



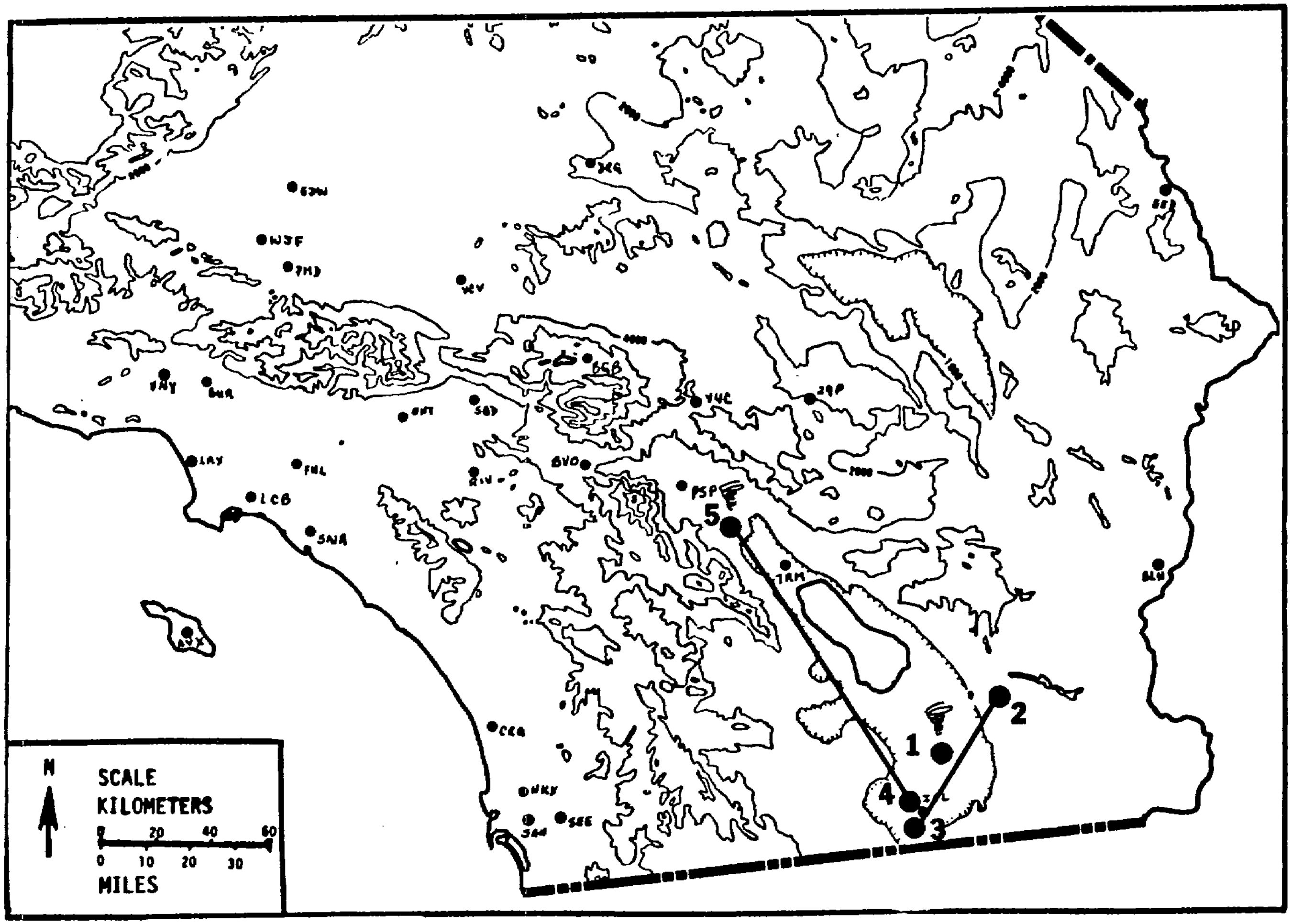
HOURLY OZONE CONCENTRATIONS - August 11,1981

Fig. 3.8.4



HOURLY OZONE CONCENTRATIONS - August 11,1981

Fig. 3.8.5



MRI SAMPLING FLIGHT - August 11,1981

Fig. 3.8.6

Table 3.8.6

11 August 1981 Tape #261

TRAVERSE END POINT AND SPIRAL LOCATIONS

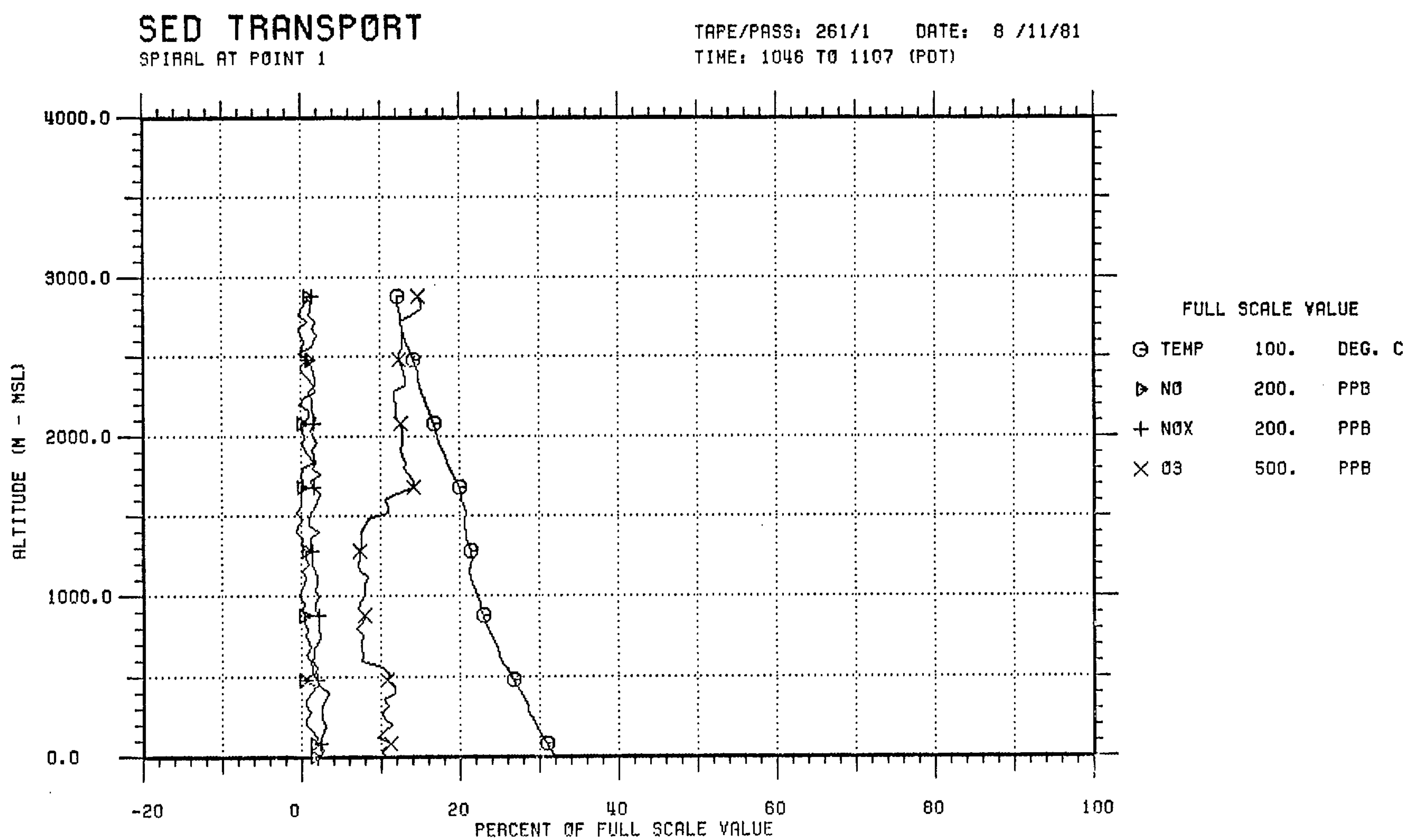
POINT	LATITUDE	LONGITUDE	DESCRIPTION
1	$32^o59.1'$	$115^o31.5'$	Brawley Airport
2	$33^o07.6'$	$115^o16.2'$	Amos
3	$32^o46.4'$	$115^o37.2'$	West of El Centro
4	$32^o50.0'$	$115^o37.1'$	West of El Centro Airport
5	$33^o44.0'$	$116^o16.0'$	Bermuda Dunes Airport

Table 3.8.7

MRI FLIGHT SUMMARY

Date: August 11, 1981 — SOUTHEAST DESERT OZONE TRANSPORT STUDY — Tape #: 261

Pass No.	Sampling Times (PDT) Start	End	Flight Type	End Points	Sampling Altitude m MSL Start	End	Traverse Length or Orbit Time	Tracer Samples	COMMENTS
1	1046	1107	Spiral	1	2896-	-28	N.A.	K1-20	Sfc Elev = -40 m
2	1128	1142	Traverse	2 - 3	305		50.6 Km.	K21-35	
3	1149	1226	Traverse	4 - 5	274-	305	120.7 Km.	K41-77	
4	1229	1249	Spiral	5	30-	2743	N.A.	K78-96	Sfc Elev = 21 m
5	1300	1329	Zero Spiral		2743-	442	N.A.	0	Instrument calibration



AIRCRAFT SOUNDING AT BRAWLEY AIRPORT - August 11,1981

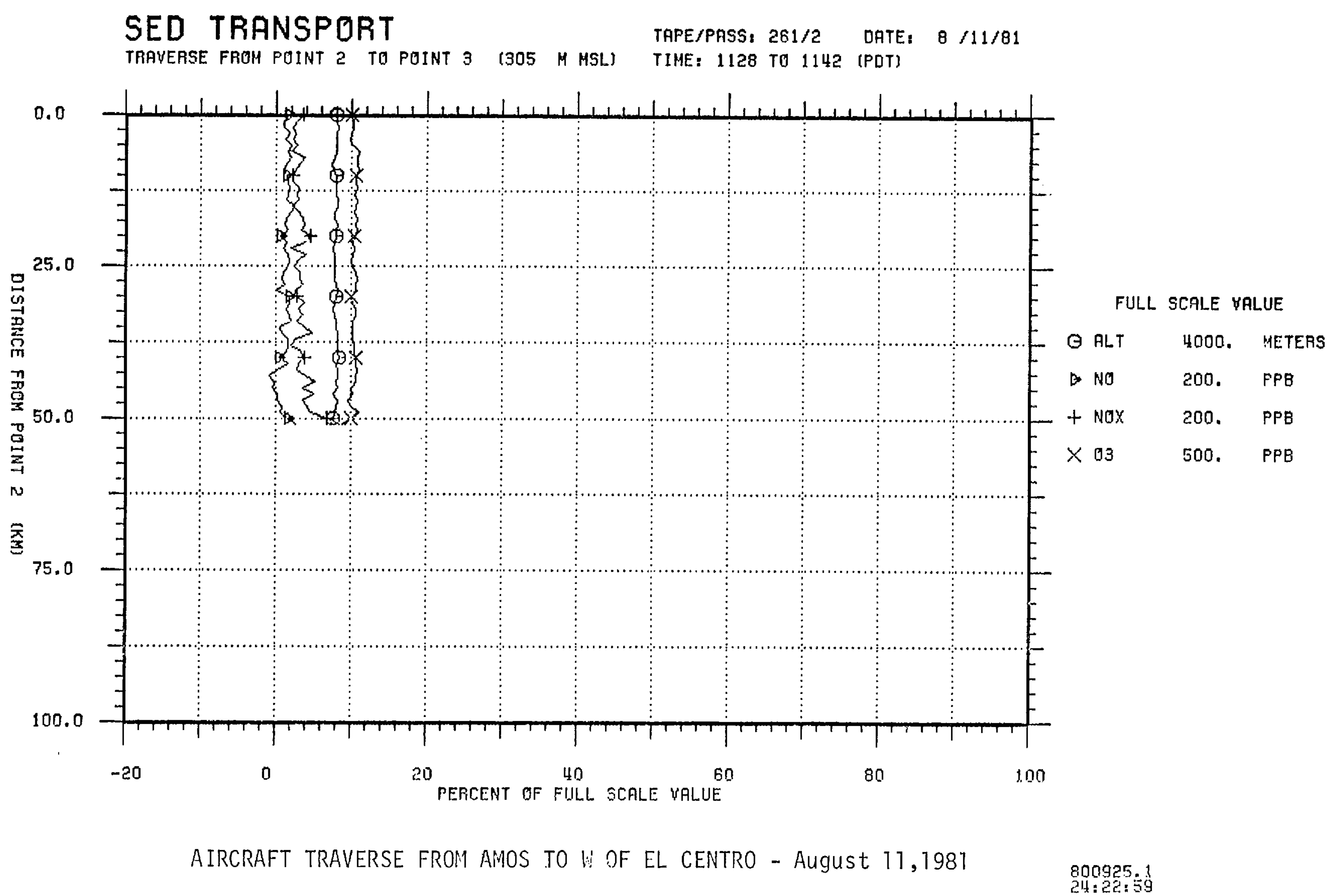
Fig. 3.8.7

800925.1
24:08:54

Figure 3.8.8 gives the data from a traverse across the Imperial Valley from northeast to southwest at an altitude of 300 m. Ozone concentrations were uniform at about 5 pphm. A similar result is shown in Figure 3.8.9 which represents a traverse from near El Centro to the Bermuda Dunes Airport, south of Palm Springs. Flight altitude was again at 300 m and no appreciable variations in ozone concentration from 5 pphm were observed.

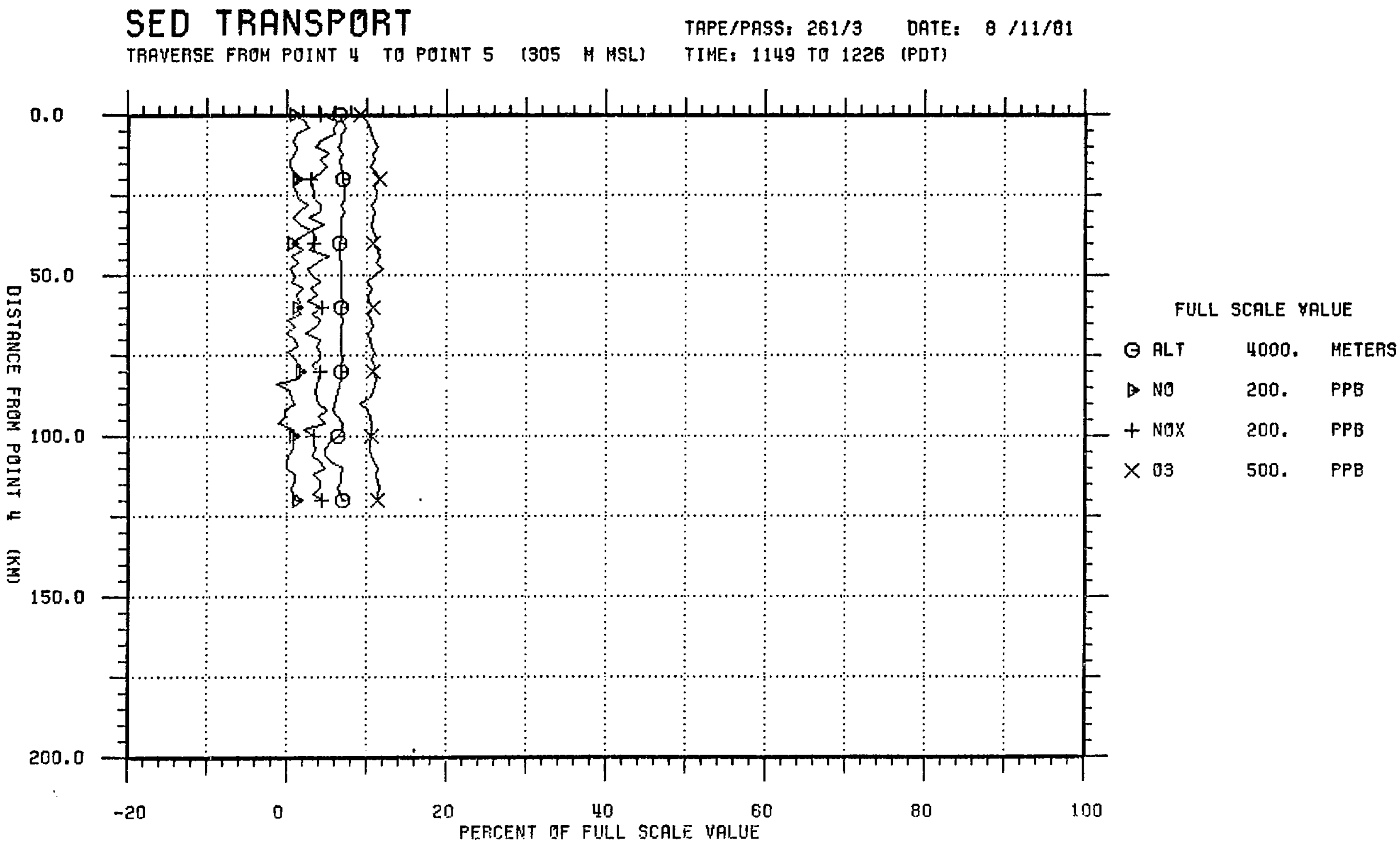
Figure 3.8.9 shows a sounding made at 1229 PDT at Bermuda Dunes Airport. Ozone concentrations of 5-6 pphm characterized the sounding to 2700 m (msl). A mixed layer to 1500 m (msl) is indicated by the slight change in temperature lapse rate.

The results of the sampling suggest that there was no significant carry over of ozone or precursors in the Coachella/Imperial Valley on the morning of August 11.



AIRCRAFT TRAVERSE FROM AMOS TO W OF EL CENTRO - August 11,1981

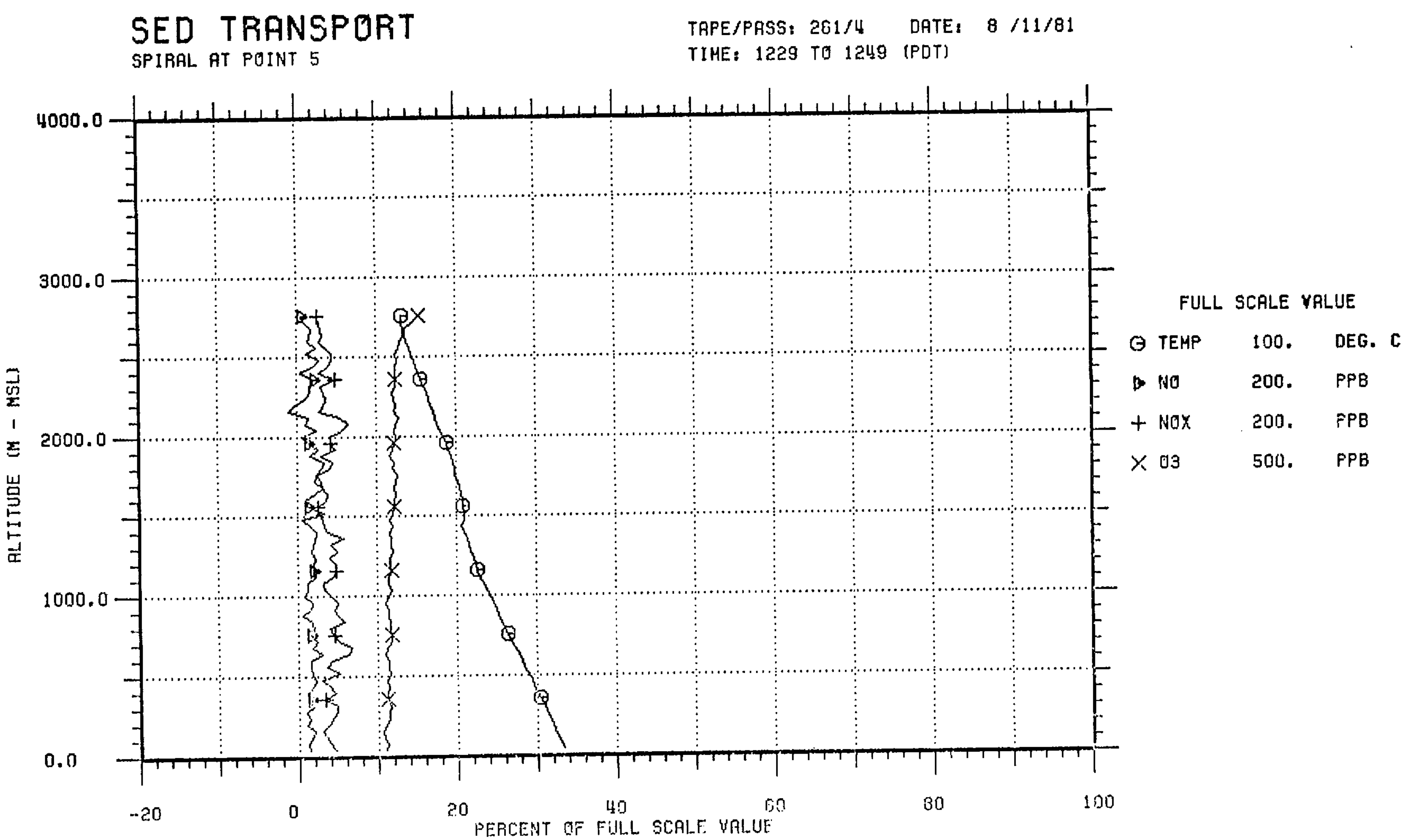
Fig. 3.8.8



AIRCRAFT TRAVERSE FROM W OF EL CENTRO TO BERMUDA DUNES AIRPORT - August 11,1981

5.1
24:22:59

Fig. 3.8.9



AIRCRAFT SOUNDING AT BERMUDA DUNES AIRPORT - August 11,1981

Fig. 3.8.10

3.8.4 Tracer Results - Test 8

Release Location: Brawley
Date: August 11, 1981
Time: 0600-0850 PDT
Release Rate: 8.1 g/sec. SF_6

Surface wind conditions at Brawley were light, west-northwesterly during the release period. Average wind speed was 1.5 m/s during the release. By 11 PDT the wind direction had shifted to south-southwest with a velocity of less than one m/s. Figs. 3.8.11 and 3.8.12 show the streamline patterns for 10 and 16 PDT on August 11. Under relatively light pressure gradients, the flow through the passes was not well established by 10 PDT but had increased by 16 PDT. A light southeasterly flow was present throughout the Imperial/ Coachella Valley, extending past Palm Springs.

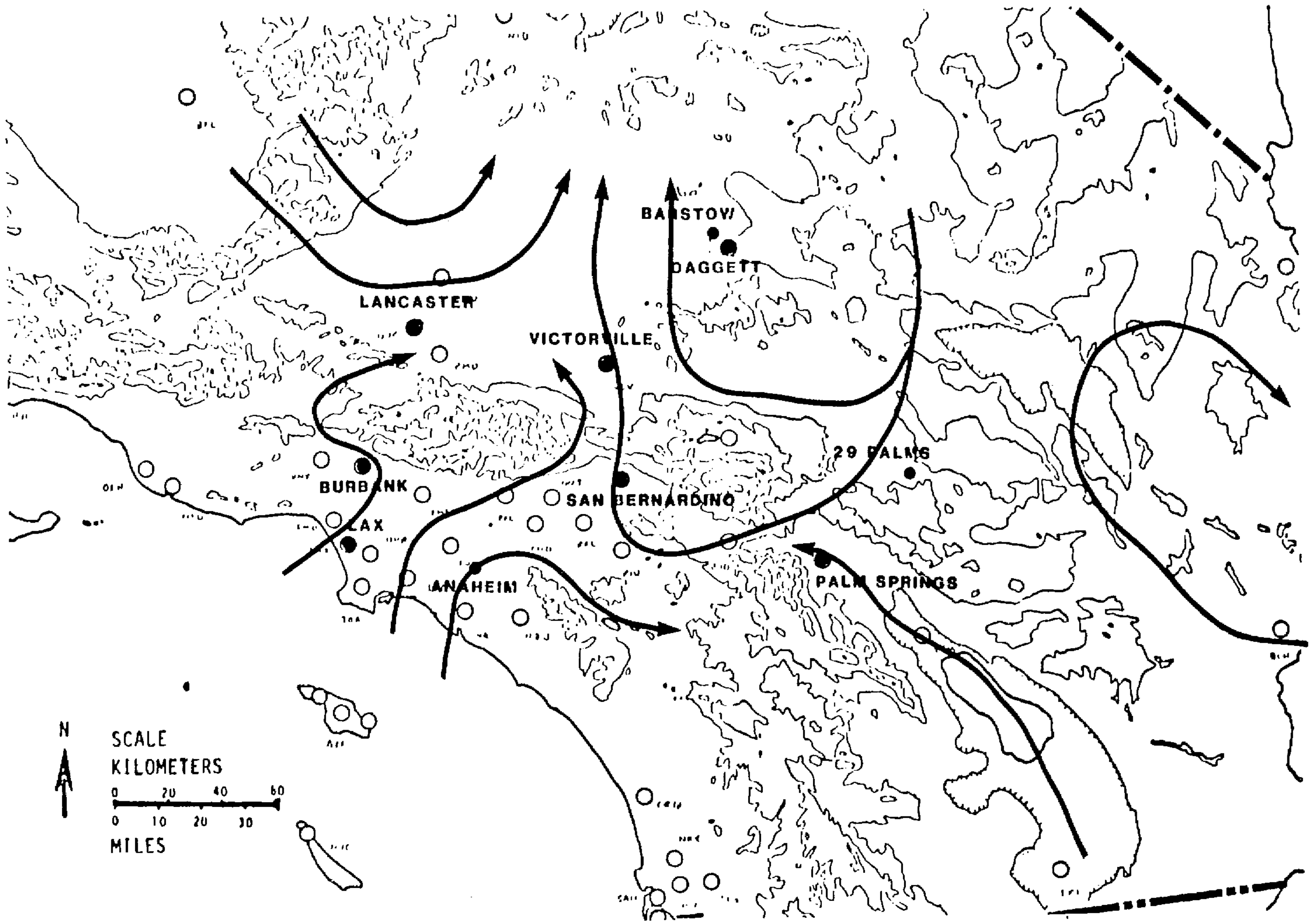
August 11

Under light wind conditions at the release site there was little transport during the early morning. By noon the southeasterly flow had become more organized and the main tracer plume moved slowly toward the northwest. Although the sampling data were limited the main body of the plume apparently continued northwestward toward Anza/Borrego. A portion of the plume, however, moved northward and was observed the following morning at Indio. The arrival of the plume at Indio was coincident with a wind shift to the south. Southerly winds continued at Indio from 08 to 16 PDT. SF_6 concentrations up to 42 ppt were observed beginning at 08 PDT and continuing through 1250 PDT. Transport velocity into Indio averaged about one m/s for the period after the release.

Fig. 3.8.13 shows the Xu/Q values calculated from the SF_6 sampling data for August 11. An average wind speed of 1.5 m/s during the release period was used to obtain the Xu/Q data. All of the data points correspond to a C stability condition as defined by a Gaussian model.

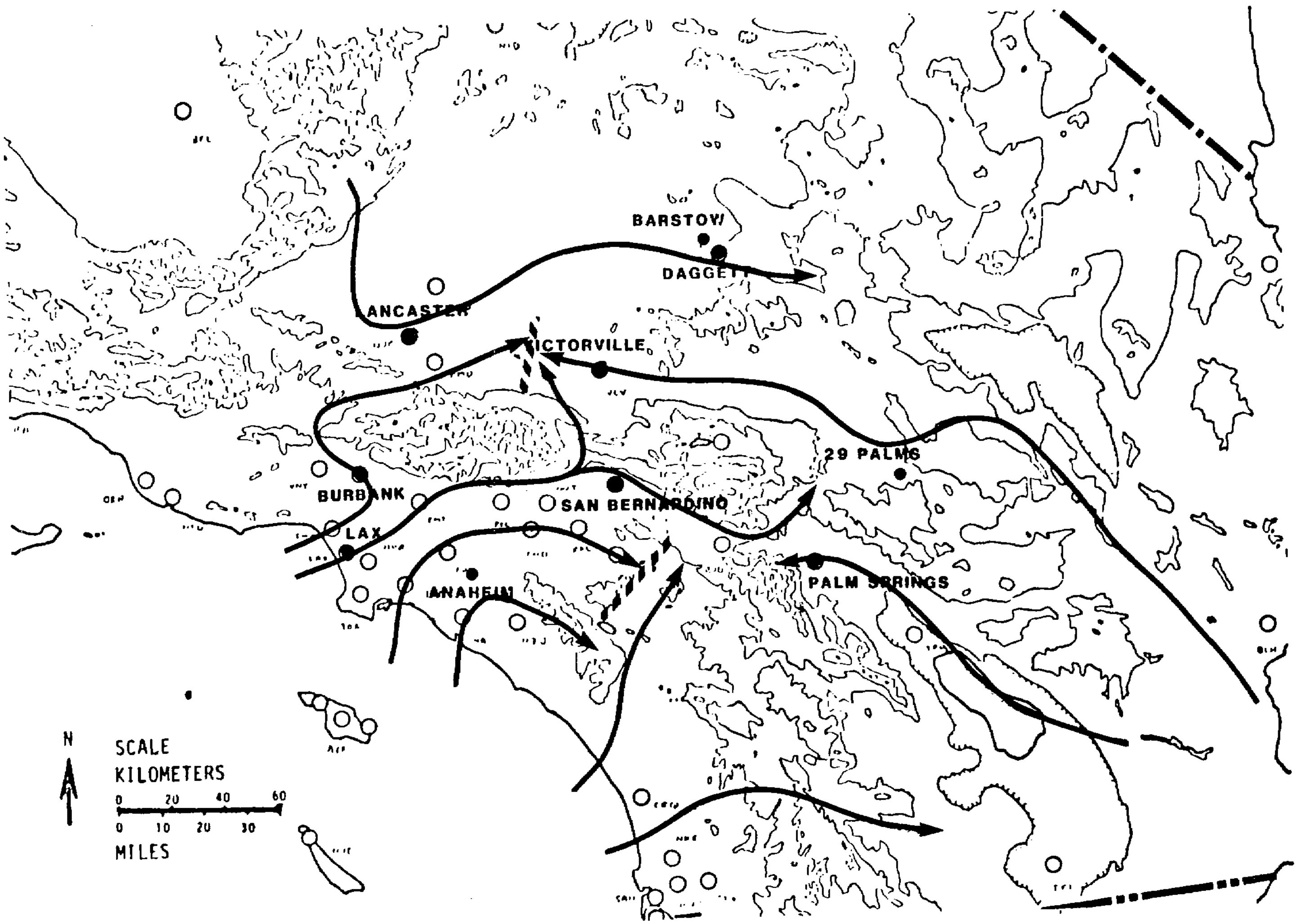
August 12

Automobile traverses on August 12 from 10 to 12 PDT covered the area from Indio to Brawley along both sides of the Salton Sea. No significant SF_6 concentrations were found. The area from Palm Springs to Amboy was also explored without appreciable concentrations. Low concentrations (about 20 ppt) were again found to the west of Pomona along Highway 210. The Azusa and Pasadena hourly samplers did not operate during this test.



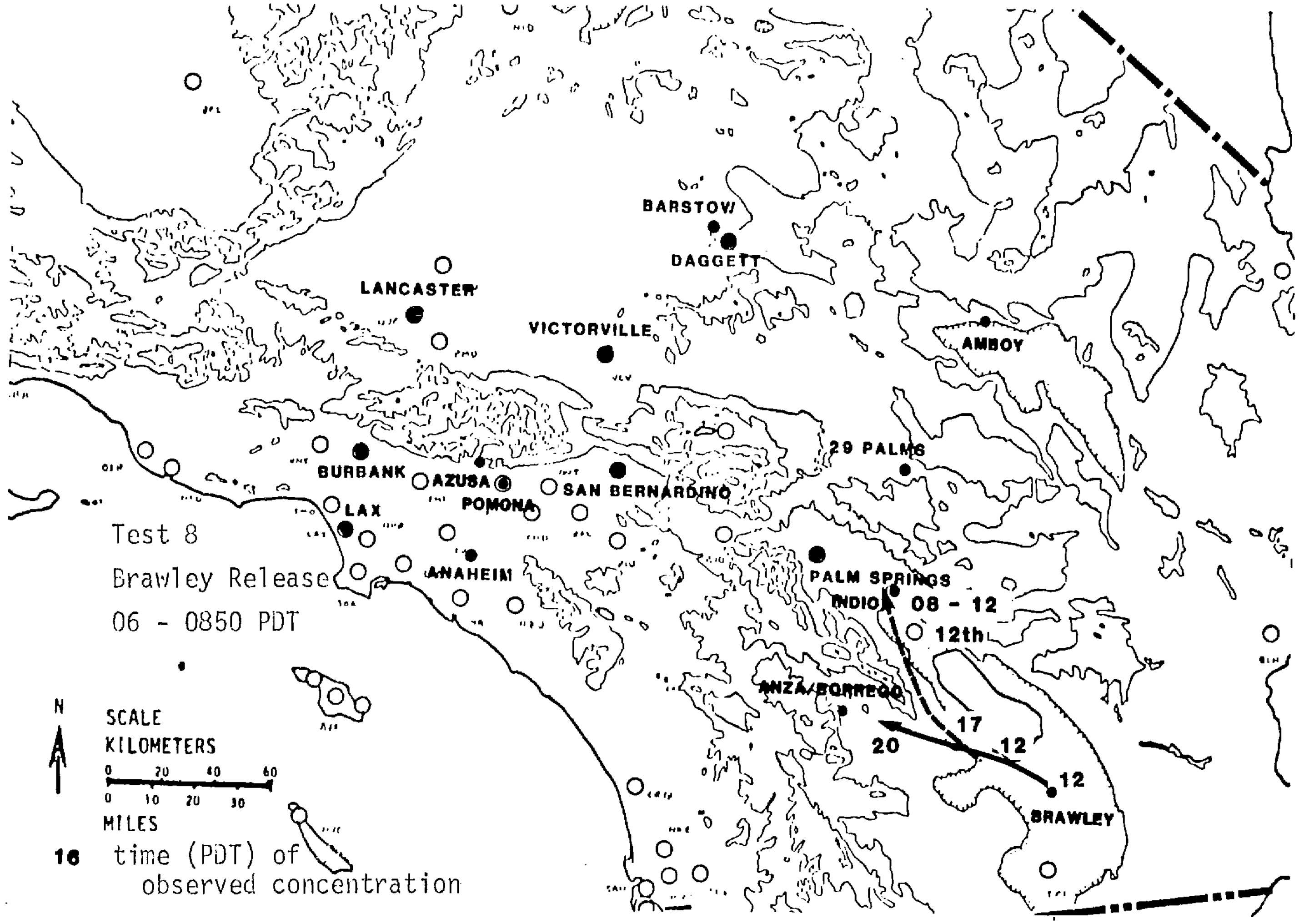
STREAMLINE MAP (10 PDT) - August 11,1981

Fig. 3.8.11



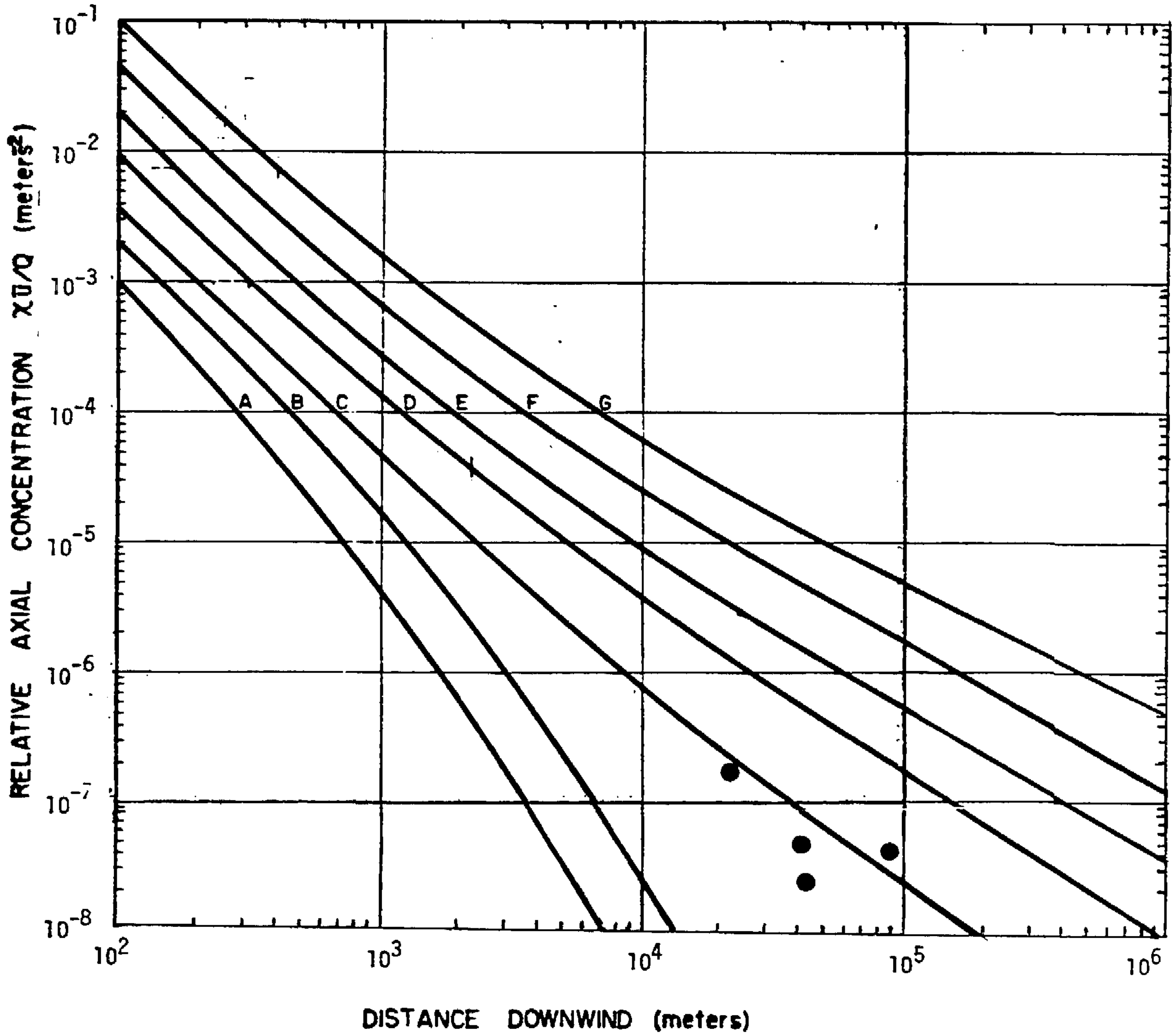
STREAMLINE MAP (16 PDT) - August 11,1981

Fig. 3.8.12



TRACER TRAJECTORIES - August 11,1981

Fig. 3.8.13



CALCULATED XU/Q VALUES - Test 8

August 11,1981

Fig. 3.8.14

4. DISCUSSION AND SPECIAL STUDIES

4.1 Slope Effects on Pollutant Transport

It was shown in Section 2 that Mt. Wilson, Mt. Baldy and Lake Gregory experience hourly ozone concentrations that are frequently comparable to the highest values observed in the Los Angeles basin. Fawnskin (Big Bear area), however, characteristically shows considerably lower values than the other high elevation stations. Elevations of the various stations employed in the July-August 1981 program are shown in the following table:

Table 4.1.1

ELEVATIONS OF OZONE STATIONS

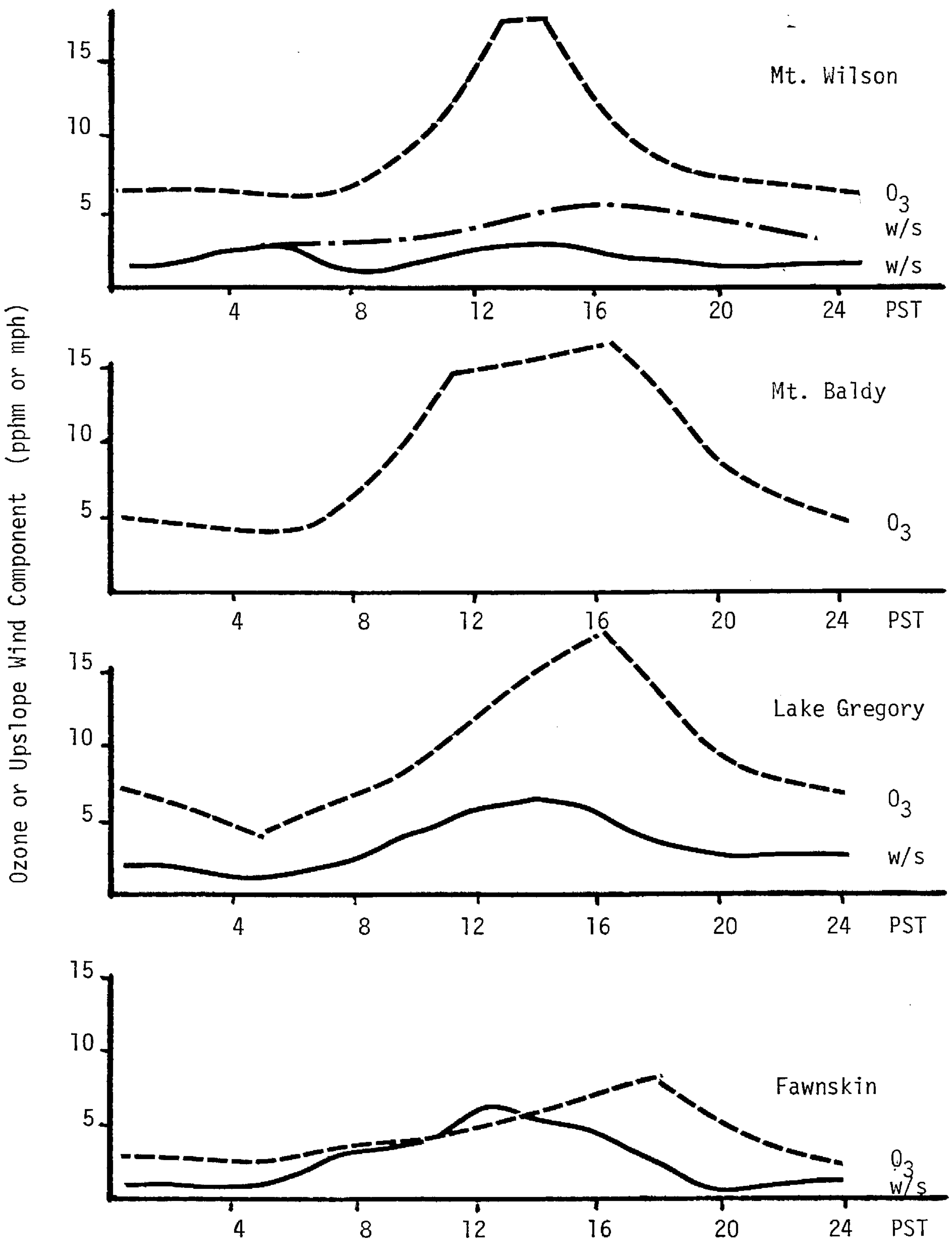
Location	Elevation (ft msl)	Upslope Wind Direction (degrees)
Mt. Wilson	5700	210
Mt. Baldy	4300	-
Lake Gregory	4500	SW
Fawnskin	6800	250

The maximum height of the afternoon mixing layer in the Los Angeles basin during the field program was characteristically observed in the range of 1200 to 1400 m (3900 to 4600 ft) above sea level. It is therefore apparent that upslope motion due to heating during the afternoon is necessary to transport the pollution into the higher elevation stations.

Figure 4.1.1 shows the average hourly ozone concentrations at the four high elevation stations during the July-August 1981 observational period. Also shown in the figure for three of the stations are the average upslope wind components for each hour. Upslope directions were considered to be those given in Table 4.1.1. Two wind stations were located on Mt. Wilson, one of these reported only four times per day. Wind velocities were measured near ground level and are undoubtedly lower than the effective transport speed due to local roughness effects.

At each high elevation station, the average upslope wind component peaked at 1300-1400 PST. Average ozone concentrations, however, show progressively later peaks from Mt. Wilson eastward to Fawnskin. In addition, the curve of peak average ozone broadens considerably east of Mt. Wilson, suggesting a more variable pollutant trajectory to the station. Maximum average ozone concentrations at Mt. Wilson, Mt. Baldy and Lake Gregory were similar. Fawnskin shows much lower ozone concentrations.

Peak upslope wind velocity and ozone concentrations at Mt. Wilson occur at approximately the same time (14 PST) indicating that the source of the pollution is relatively close to the area from which the upslope air is drawn. To the east, the peak ozone concentrations occur after the peak in the



DIURNAL VARIATIONS IN OZONE AND UPSLOPE WIND SPEED

Average for July - August 1981

Fig. 4.1.1

upslope flow, suggesting that the pollution had to travel some distance to reach the area where it could be drawn into the upslope flow. This is in keeping with previous trajectories (Section 2) indicating central Los Angeles as a main source area. On the average, then, local or nearby sources are not as effective as contributors to peak ozone concentrations in the areas east of Mt. Wilson.

The influence of local source areas is further examined in Figure 4.1.2. Variations in the time of maximum ozone occurrence are shown for each of the four stations. This figure indicates for Mt. Baldy, Lake Gregory and Fawnskin that the maximum hourly ozone concentration for the day frequently occurred before the time of arrival of the pollution from the upwind sources (e.g., Los Angeles). Mt. Baldy shows bimodal frequency maxima at 12 and 16 PST. The early maxima may represent the influence of residual pollution in the east San Gabriel Valley coupled with local sources which is drawn into the upslope flow prior to the arrival of new pollutants from upwind sources.

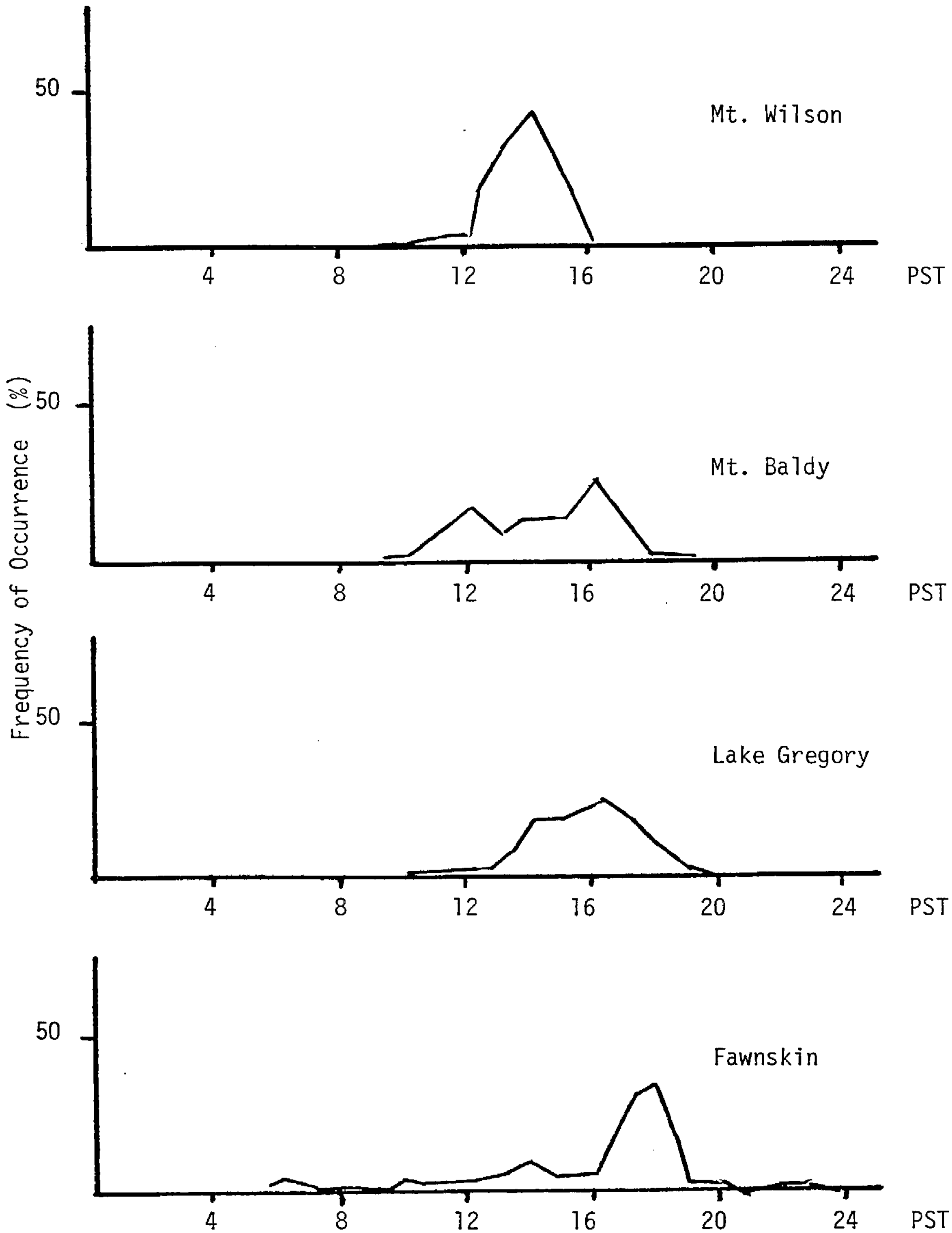
On some occasions, the trajectory from the upwind sources does not carry their pollutants into the upslope flow and the early maximum is the only significant peak for the day. Most frequent wind directions at 13 PST for a number of foothill stations are shown in Table 4.1.2.

Table 4.1.2

MOST FREQUENT WIND DIRECTIONS (13 PST)

Location	Direction	Location	Direction
El Monte	190°	Redlands	WNW
La Verne	250	San Bernardino	WSW
Pomona	WSW	Chino	240°
Pasadena	S	Fontana	WSW
Azusa	SW	Ontario	240°
Upland	SW	Norton AFB	270°
Rialto	WSW		

Of the stations listed only for El Monte, Pasadena, Azusa and Upland are the winds directed significantly toward the slopes of the San Gabriel Mts. Such locations as Pomona, Rialto and Fontana show wind flow more nearly oriented along the slopes. In the eastern part of the basin San Bernardino and Fontana winds are directed toward the western portion of the San Bernardino Mts. while the Redlands wind direction shows a flow more nearly parallel to the slopes. Time variations of these wind directions during the day do not exhibit strong upslope influences and it is concluded that the upslope flow draws air primarily from the nearby foothill regions and that small changes in the pollutant trajectory from upwind sources might prevent the central Los Angeles pollution from reaching the slopes in a significant manner.



VARIATIONS IN TIME OF MAXIMUM OZONE

Fig. 4.1.2

Pibal observations were made at approximately two hour intervals at a number of foothill and ridge locations during the tracer field program. These permit calculation of air flux estimates for each location and for various times of day. These estimates are given in Table 4.1.3. The fluxes were computed only for the upslope components of the winds. The upslope directions are shown in the table. Depths of the mixed layer are also shown.

On July 9 and 10 (Test 1) pibals were observed at Lake Gregory and at Highland (northeast of San Bernardino). Maximum flux at Lake Gregory occurred in the late afternoon with a minimum during the night. At Highland the maximum flux also occurred during the afternoon but drainage during the early morning reversed the flux through 08 PDT. Afternoon flux values at Lake Gregory were about twice as great as at Highland. The upslope direction at Highland (260°) apparently tends to feed air into the eastern slopes of the San Bernardino Mts. whereas the flux into the western slopes (e.g., Lake Gregory) is considerably greater.

On July 18 (Test 3) pibals were released at Crestline between 1310 and 1747 PDT. Flux estimates ranged between 3000 and 5000 m^2/s with peak values in the late afternoon. These values are comparable to but slightly less than those estimated at Lake Gregory on July 9-10.

Pibals were again taken at Lake Gregory on July 27-28. Flux estimates within the mixed layer ranged from 1600 to 6400 m^2/s with peak values in the afternoon. Thus, all of the flux estimates near the ridge of the San Bernardino Mts. were in substantial agreement.

Pibal measurements were made in the Santa Ana River Canyon (elevation 6300 ft msl) on July 30-31 to investigate this valley as a potential exit region for pollution from the basin. Flux estimates indicate values to 5000 m^2/s in the late afternoon with down-canyon drainage flow from 20 PDT to 08 PDT on the following morning.

At Redlands on July 30 the flux in the afternoon was estimated to be 3900 m^2/s by late afternoon based on an upslope wind direction of 270 degrees.

The Highland location (northeast of San Bernardino) has a mean upslope wind direction of about 260 degrees and lies at the downwind end of a trajectory which originates in the southern portion of Los Angeles. The consistent wind direction from the west-southwest at that location during the afternoon and evening indicates that the mountain slopes to the east-northeast of Highland do not offer much resistance to upslope flow as long as the slopes are heated. Total air flux at Highland over the period from 10 PST to 22 PST from the July 9-10 data was estimated to be 0.8×10^8 m^2. Assuming a nominal 10 km crosswind distance centered in Highland, 8×10^{11} m^3 of air would pass through the Highland area within the mixing layer during such an upslope day. By comparison, the Los Angeles basin includes a volume of approximately 5×10^{12} m^3 if a uniform mixing layer depth of 600 m is assumed. It is therefore apparent that a significant part of the basin air moves upslope past the San Bernardino area each day.

Table 4.1.3

ESTIMATES OF AIR FLUX WITHIN MIXED LAYER

Location	Date (1981)	Time (PDT)	Depth of Layer (m)	Flux (m^2/s)
Lake Gregory	7/9	1417	550	6030
		1645	550	6060
Upslope Direction		1800	550	6180
200°		2010	440	5770
		2200	450	3720
	7/10	0018	450	5010
		0200	550	5050
		0410	500	4100
		0600	450	3490
		0800	600	4560
		1000	650	5360
		1200	550	5140
Highland	7/9	1241	850	2180
		1400	850	2940
Upslope Direction		1603	900	2130
260°		1800	700	1920
		2003	400	1060
		2204	200	200
	7/10	0213	400	- 240
		0625	450	- 300
		0800	400	- 700
		0955	450	320
		1205	650	1600
Crestline	7/18	1310	350	3540
		1402	450	3860
Upslope Direction		1510	350	2900
200°		1604	350	4210
		1703	350	4500
		1747	500	5010
Lake Gregory	7/27	1415	300	2260
		1600	600	3630
Upslope Direction		1800	450	4040
200°		2025	450	3820
		2202	450	2730

Estimates of Air Flux Within Mixed Layer (Continued)

Location	Date (1981)	Time (PDT)	Depth of Layer (m)	Flux (m^2/s)
Lake Gregory	7/28	0006	350	1760
		0445	450	1640
		0823	700	3770
		1010	700	3900
		1200	650	6380
		1400	400	3650
		1600	550	4920
		1800	550	5830
		2032	400	4660
Santa Ana River Canyon	7/30	1503	950	5140
		1639	900	4820
		1800	800	3580
Upslope Direction 300°		2035	400	- 630
		2206	400	- 900
	7/31	0000	300	- 630
		0647	500	- 920
		0800	200	- 180
		1000	550	2450
		1203	1000	2770
		1400	1100	3260
		1600	1050	4990
		1800	1050	3330
		1933	700	1280
		2030	700	-1410
Redlands	7/30	0958	450	860
		1410	650	2490
Upslope Direction 270°		1604	1000	3950
		1800	750	3920
		2036	500	2740

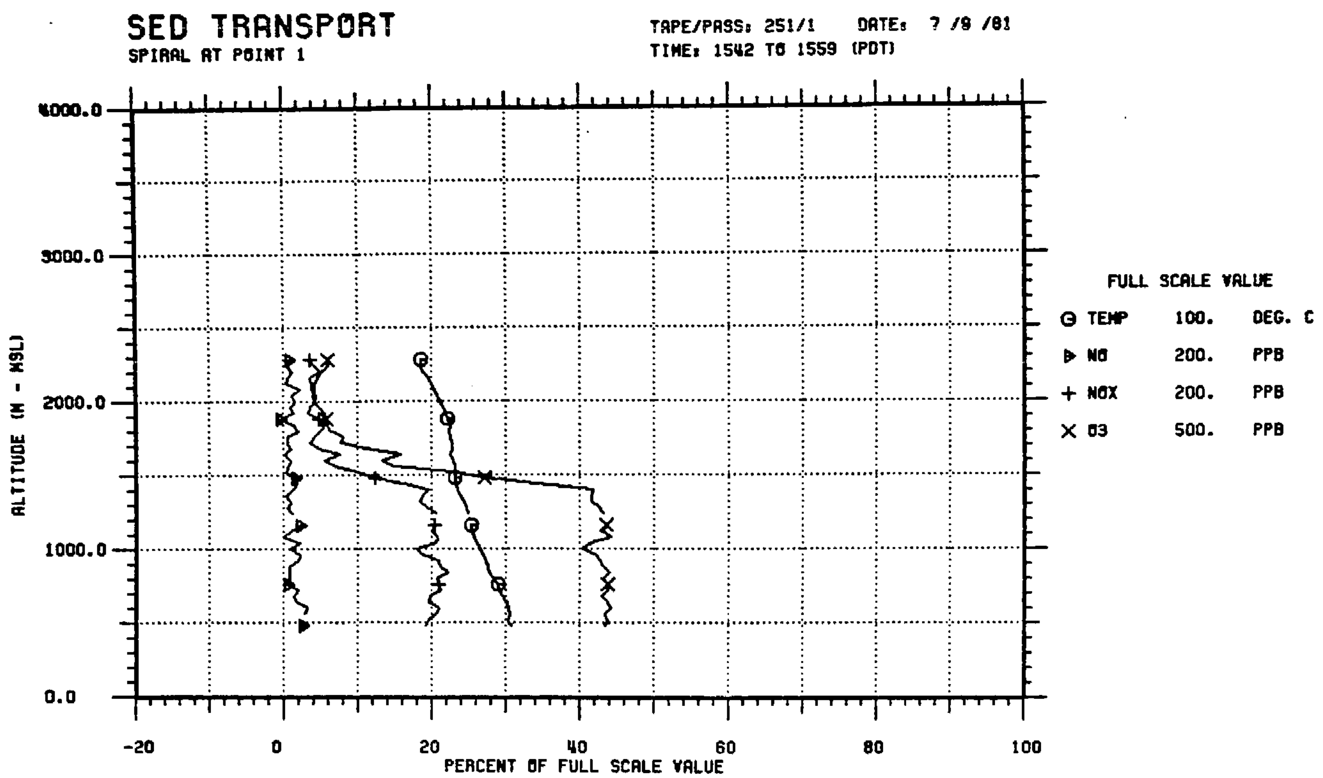
Aircraft soundings were made at two ridge-top locations to measure the depth of the pollutant layer passing over the ridge. Several of these soundings are shown in Figures 4.1.3.

In Figure 4.1.3a a vertical sounding was taken near Highland at about 1542 PDT near the location where pibal winds were being measured. The figure shows a well-mixed ozone layer to 1400 m (msl) followed by a sharp decrease above the mixed layer. Figure 4.1.3b shows a similar sounding made over Lake Gregory at 1602 PDT on the same day. The top of the layer over Lake Gregory was about 1750 m (msl) while the depth was about 450 m compared to the 900 m depth at Highland. Reference to Table 4.1.3 shows that the air flux within the mixed layer at Highland was about 2100 m^2/s at 16 PDT while the flux at Lake Gregory was about 6000 m^2/s at 1645 PDT.

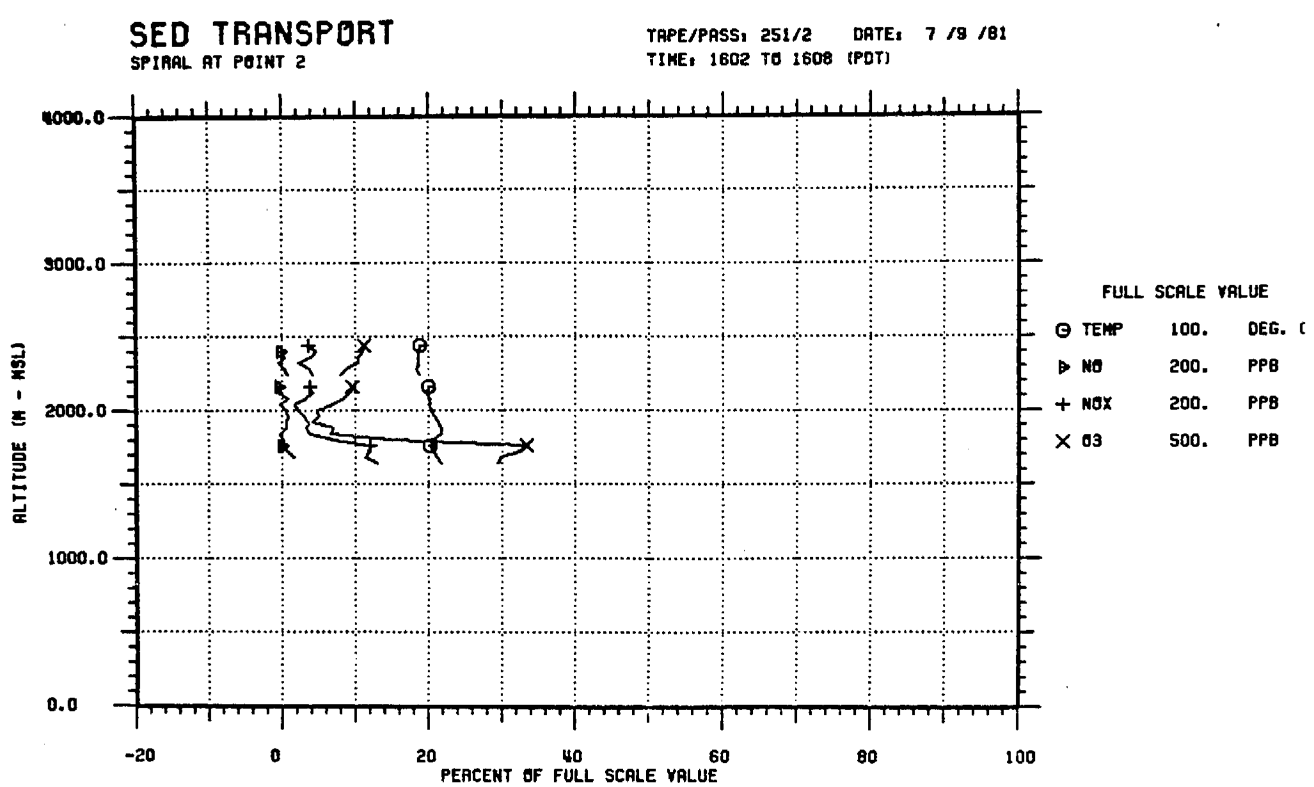
Ozone loadings as estimated from the aircraft soundings are summarized in a later section. These loadings and the air flux estimates can be used to calculate ozone flux estimates for Highland and Lake Gregory. At Highland the ozone flux estimate was 0.79 g/m sec within the mixed layer while the comparable value at Lake Gregory was 1.28 g/m sec. Average wind speeds in the mixed layer were 2.4 m/s and 10.7 m/s, respectively. It is concluded that the ozone flux over the ridge at Lake Gregory was somewhat higher than in the upslope motions at Highland in spite of a higher average ozone concentration (21 pphm) than at Lake Gregory (17 pphm).

An aircraft sounding was made on July 30 within the Santa Ana River Canyon at 1655 PDT, accompanied by pibal observations. Ozone flux was estimated at 0.27 g/m sec with an average wind speed of 5.4 m/s and an average concentration of 9 pphm within the mixed layer.

These few ozone flux estimates point toward decreasing fluxes from Lake Gregory eastward along the San Bernardino Mts. This pattern also was apparent in the characteristics of hourly ozone concentrations at Lake Gregory and Fawnskin.



a. Highland



b. Lake Gregory

AIRCRAFT SOUNDINGS - July 9,1981

Fig.4.1.3

4.2 Transport Through the Passes

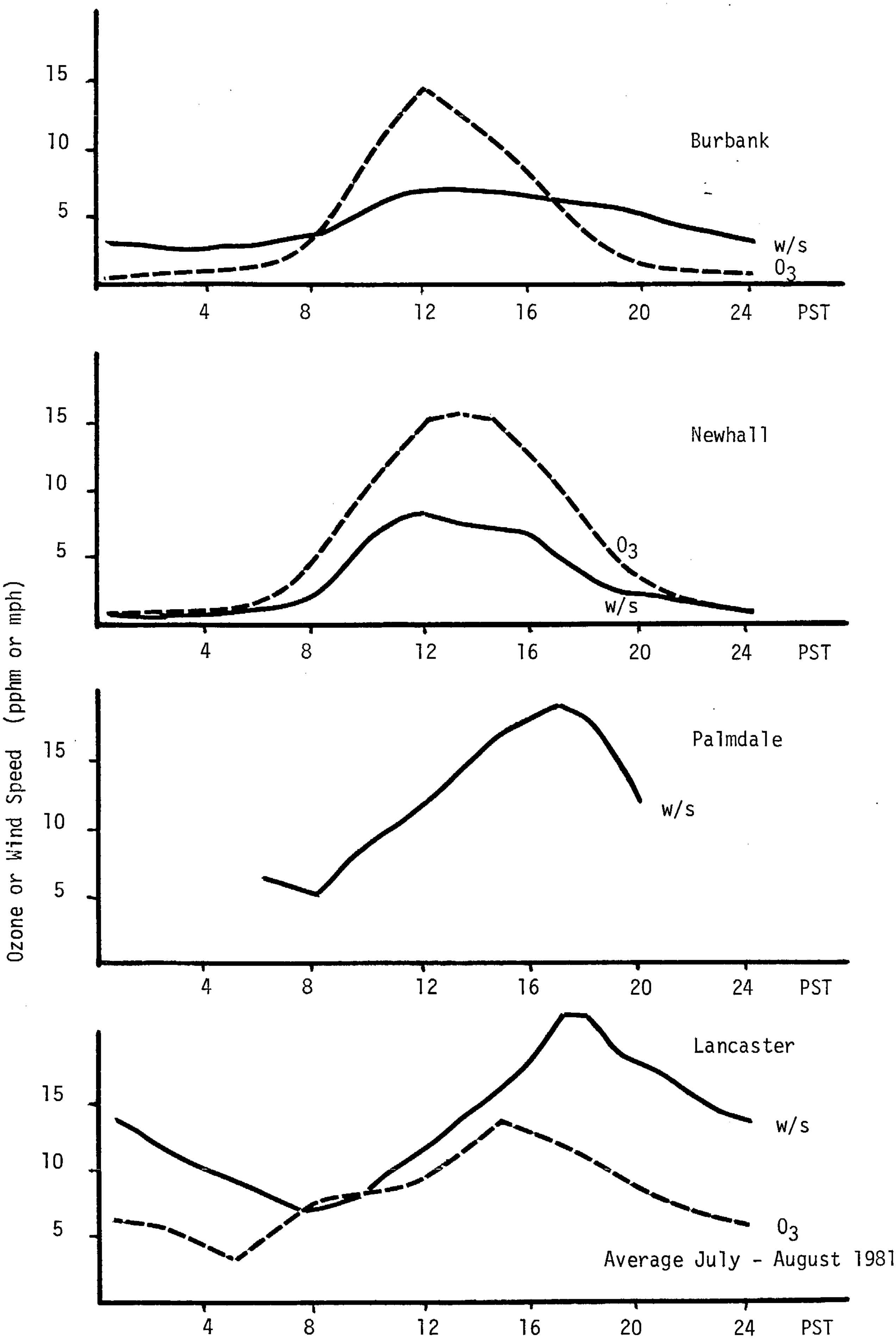
Flow through the passes is controlled largely by diurnal variations in pressure gradients between the coast and desert areas. Diurnal changes in average wind speed and ozone concentrations are shown in Figures 4.2.1 and 4.2.2 for several stations along the transport routes through the various passes. Predominant wind directions at the time of maximum average wind speed are also shown.

Figure 4.2.1 shows a progressive change in the time of the peak velocity occurrence from Burbank to Palmdale and Lancaster with an anomalous early peak at Newhall, perhaps due to morning heating of nearby slopes. The pollution peak follows a similar progression but with the peak ozone concentrations leading the wind speed maximum by 1-2 hours. The total time of travel for the ozone peak from Burbank to Lancaster (3 hours) is in keeping with the travel distance of 40-50 miles and transport wind velocities of about 15 mph.

Figure 4.2.2 shows a similar series of diurnal curves from San Bernardino to Victorville through Cajon Pass. Approximately two hours difference in peak ozone concentrations is indicated between San Bernardino and Victorville, corresponding to a travel distance of about 30 miles. Cajon Pass, however, shows bimodal peaks in both wind speed and ozone concentrations. Neither of the peaks fits in with the indicated transport from San Bernardino to Victorville. The early peak (13 PST) at Cajon probably reflects the effects of morning slope heating. The source area for the accompanying ozone peak is undoubtedly the eastern Los Angeles basin rather than the central Los Angeles area. The later ozone peak (18 PST) occurs after both the San Bernardino and Victorville peaks and must reflect the effects of a complex flow structure within the pass.

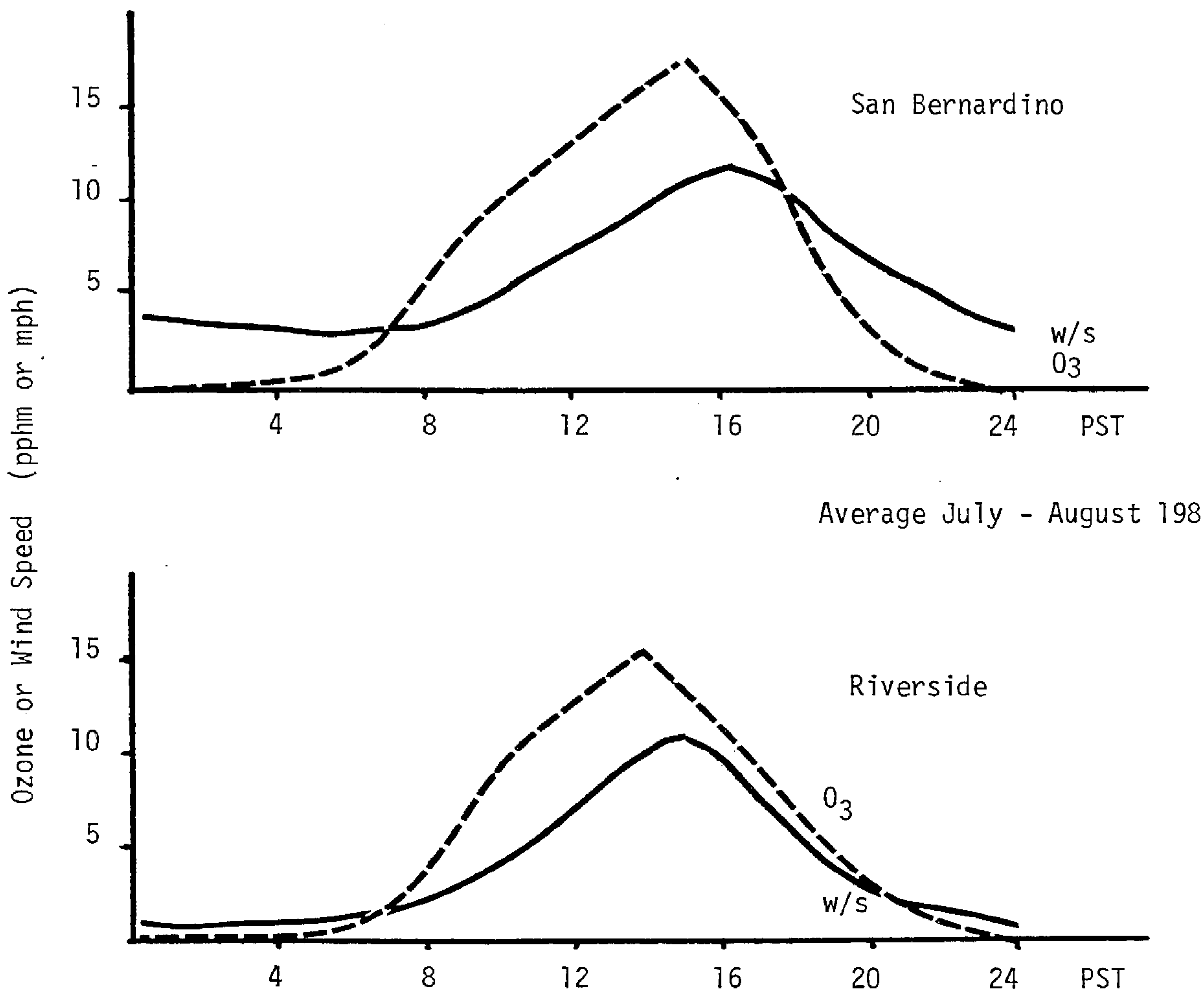
Figure 4.2.3 shows a series of average diurnal variations in wind speed and ozone concentrations from Riverside (Rubidoux) to Palm Springs through Banning. Peak ozone concentrations indicate a total travel time of 3-4 hours over the distance of 50 miles from Riverside to Palm Springs. It is of interest to find the peak average concentration at Palm Springs somewhat higher than at Banning. As will be shown later, the flow structure through San Gorgonio Pass is sufficiently complex that highest ozone concentrations occasionally go through the pass as an elevated layer while surface concentrations at Banning remain relatively low.

Pibal observations were made on several occasions in each of the passes. Figure 4.2.4 shows a time-section of the wind component (along 260°) through Soledad Canyon at Acton. The top of the surface mixed layer is shown by a dashed line as determined from wind shear indications. The mixed layer was about 1000 m deep through most of the afternoon on July 14, increasing near midnight. Wind flow was west to west-southwest in the mixed layer and ozone concentrations averaged 15 pphm (Figure 4.2.5). Above the mixed layer there was another layer (see Figure 4.2.5) with average ozone concentrations of about 18 pphm. Wind directions in this layer were from the south to southwest, indicating a source region along the western slopes of the San Gabriel Mts.



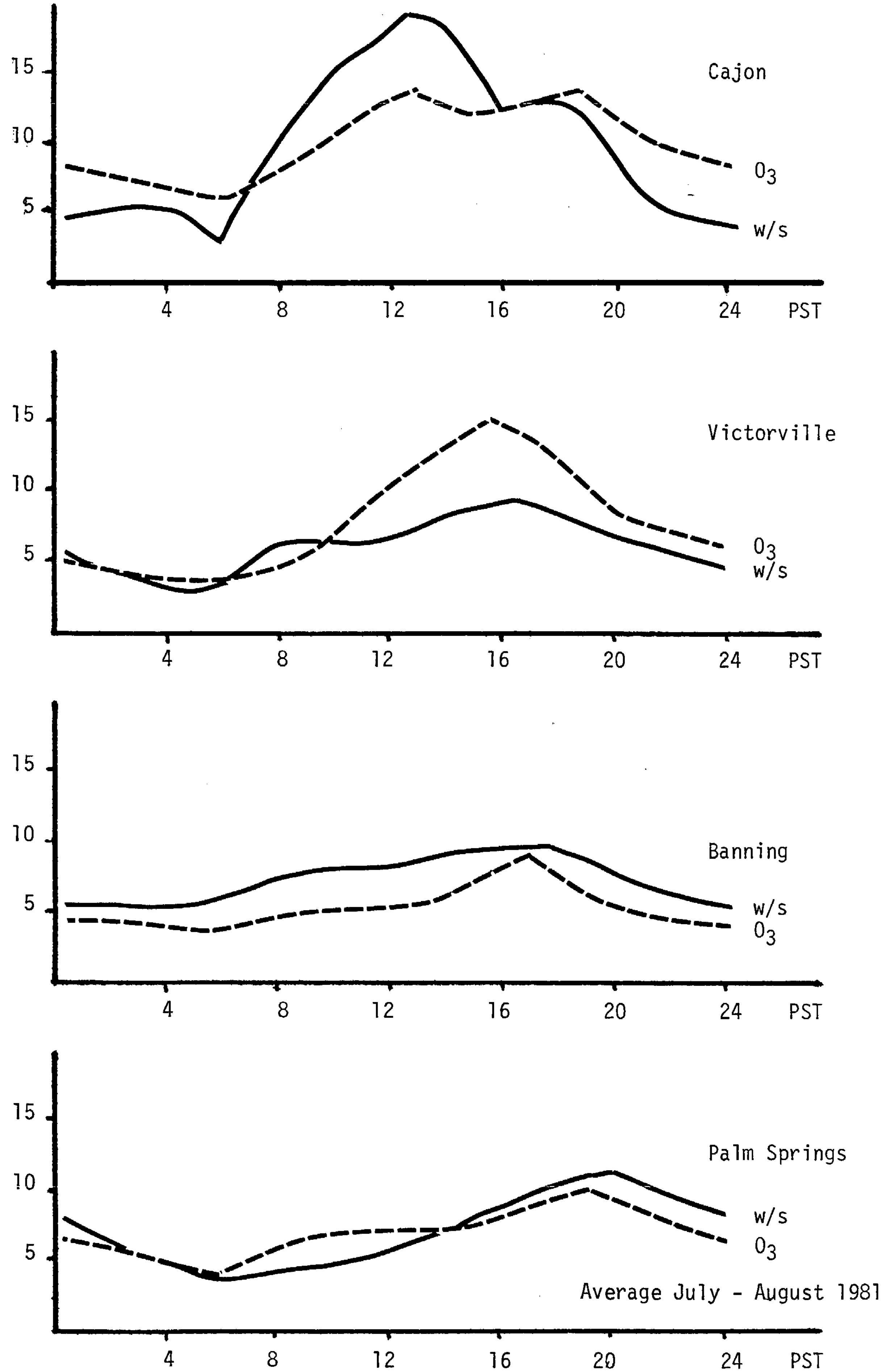
DIURNAL VARIATIONS IN OZONE AND WIND SPEED

Fig. 4.2.1



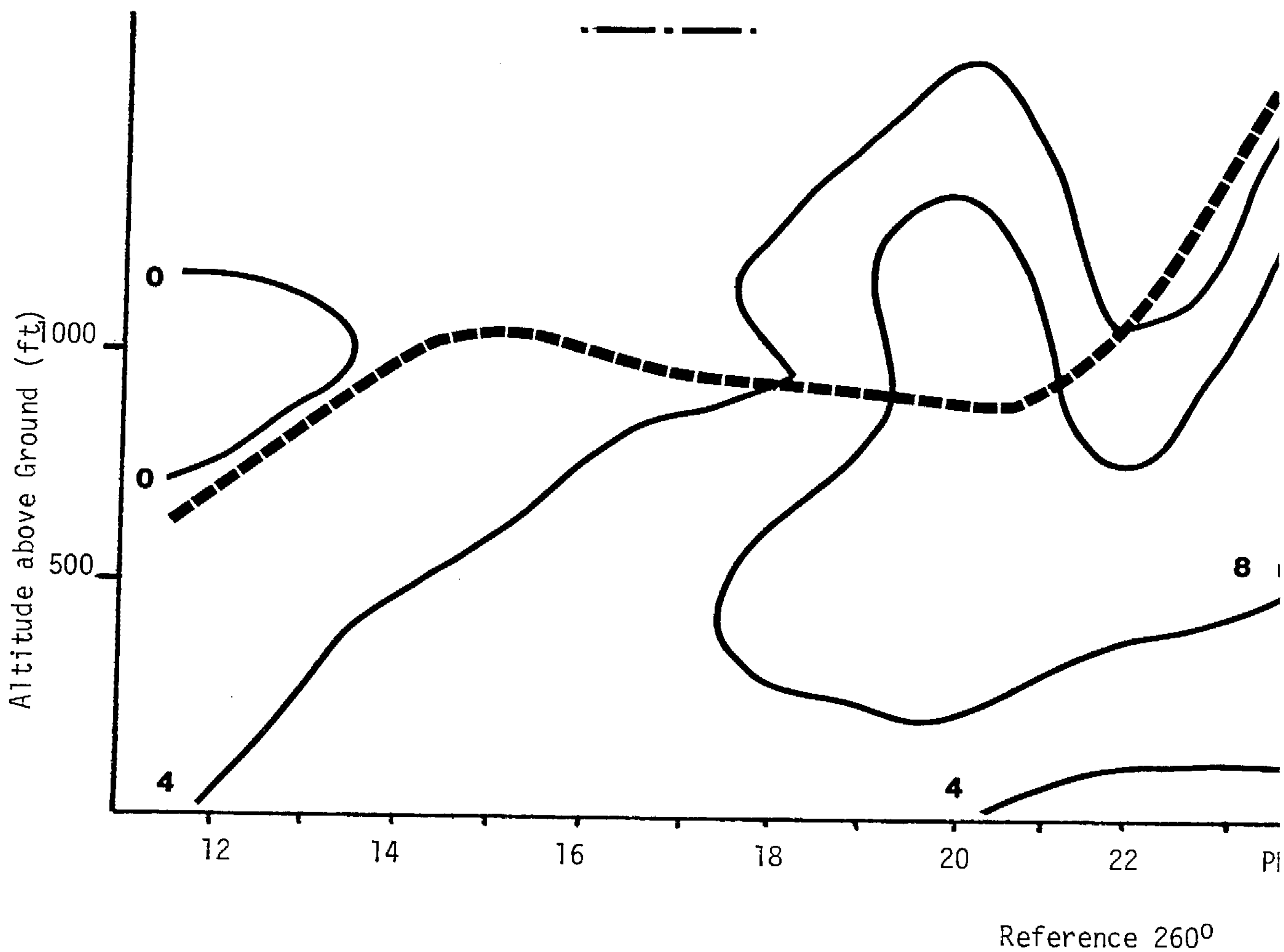
DIURNAL VARIATIONS IN OZONE AND WIND SPEED

Fig. 4.2.2



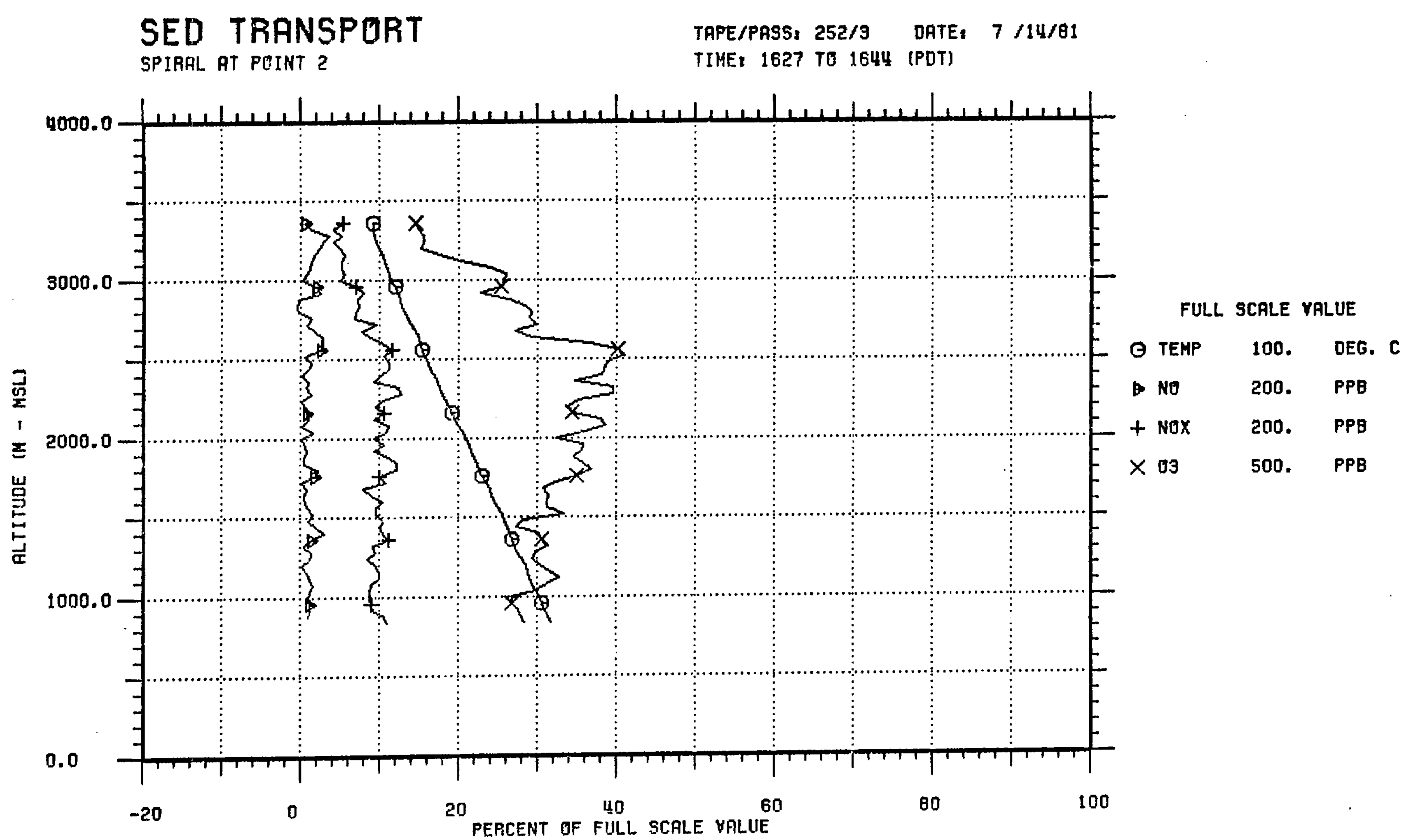
DIURNAL VARIATIONS IN OZONE AND WIND SPEED

Fig. 4.2.3



TIME - SECTION OF WIND COMPONENTS AT
ACTON - July 14,1981

Fig. 4.2.4



AIRCRAFT SOUNDING AT ACTON - July 14,1981

800925.1
02:12:08

Fig. 4.2.5

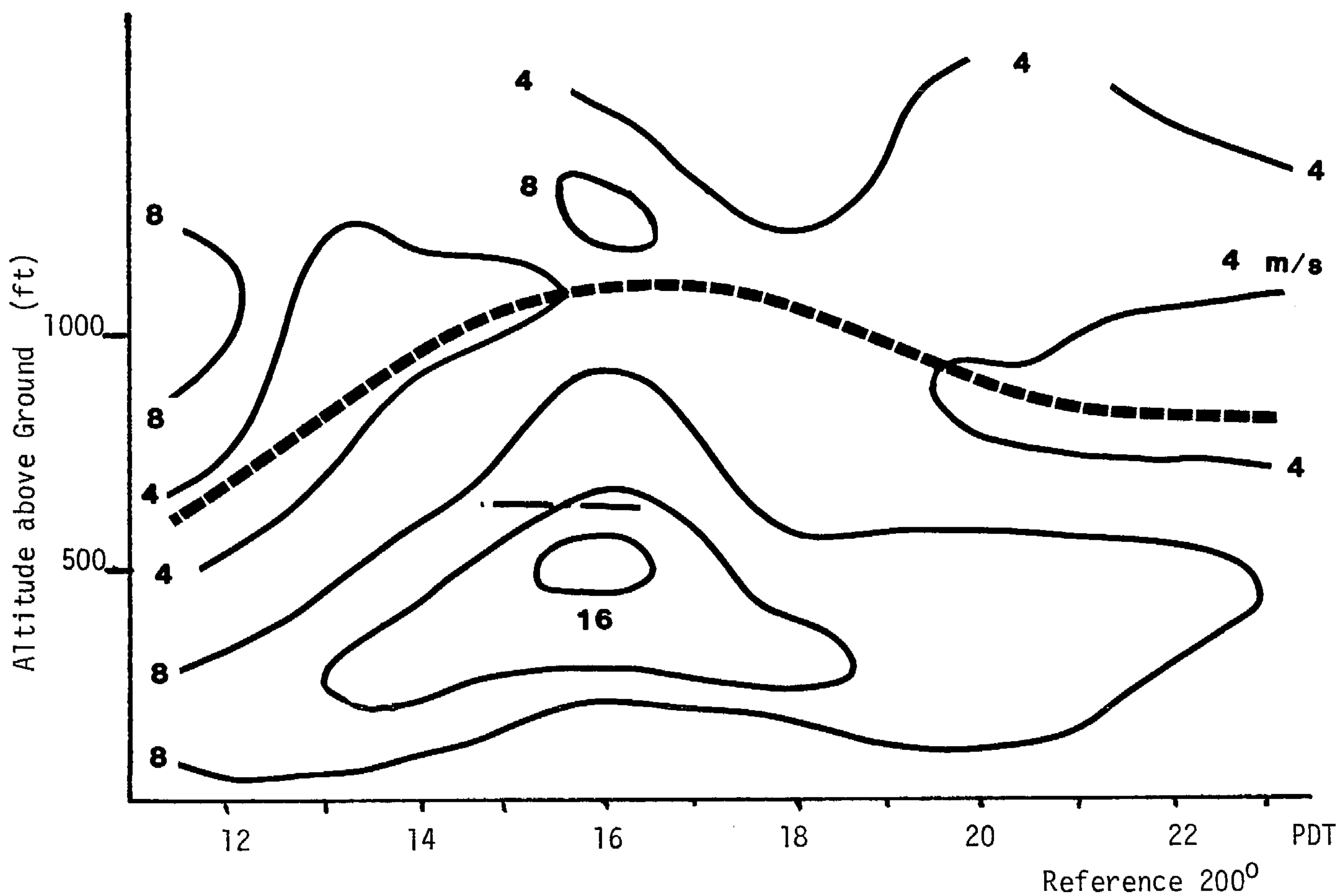
Figure 4.2.6 gives a vertical time-section of the wind component (along 200°) through Cajon Pass on July 18. Peak velocities occurred about 16 PDT and the height of the low level, mixed layer also reached a peak at that time (about 1000 m above ground level). Figure 4.2.7 shows an aircraft sounding made at Cajon Junction at 1549 PDT on July 18. A low ozone layer of 600 m depth was observed by the aircraft. The top of the ozone layer corresponded to the height of the wind maximum as indicated by the horizontal dashed line in Figure 4.2.6. A higher ozone layer was present from 1800 to 3100 m msl. Winds in the lower layer were southerly along the main axis of the pass. Winds in the upper ozone layer were southwest to west, indicating transport from the eastern slopes of the San Gabriel Mts.

Figure 4.2.8 shows a vertical time-section of the wind component (along 260°) through San Gorgonio Pass on August 3. The low-level, mixing layer rose to about 1300 m by early evening. Aircraft soundings were made at Banning (1754 PDT) and at the intersection of Highways I-10 and 111 (1836 PDT). Tops of the observed ozone layers are shown as horizontal, dashed lines in Figure 4.2.8. The sounding at Banning (Figure 4.2.9) shows an elevated ozone layer with a peak value of 20 pphm at 1500 m msl. Lowest-level concentrations were measured by the aircraft at 13 pphm. Peak hourly ozone concentration measured by the surface station at Banning was 9 pphm at 15 PST.

The sounding in Figure 4.2.10 was taken at the intersection of I-10 and 111. The same elevated ozone layer is found in the sounding with peak concentrations aloft near 19 pphm. It is of interest to note that the highest hourly ozone reading at Palm Springs on August 3 was 11 pphm at 18 PST. Although Palm Springs recorded a higher ozone value than Banning, neither experienced the high concentrations which were observed aloft.

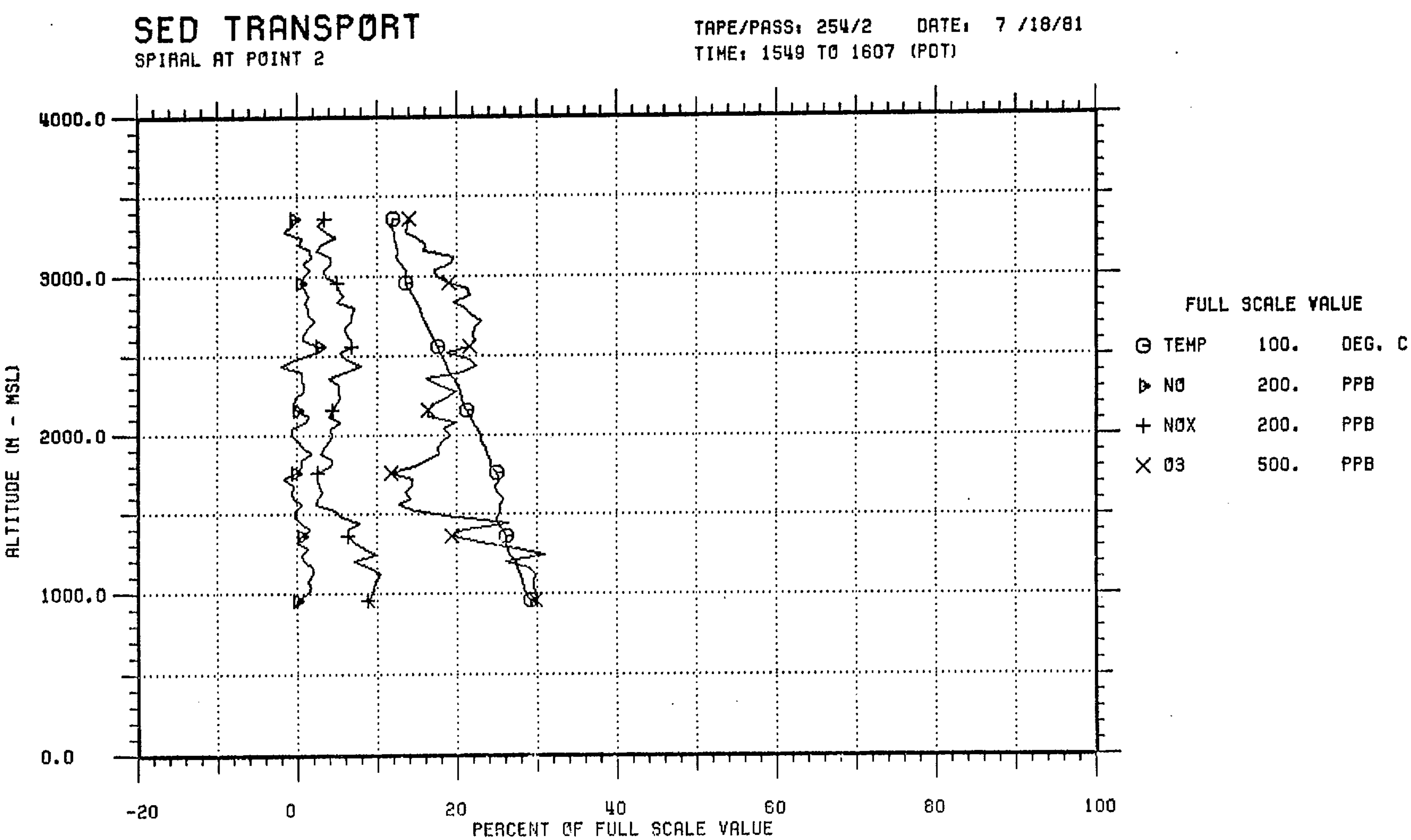
Air flux estimates were made from the pibal data obtained in each of the passes during the field program. The depth of the flow was intended to include the layer carrying the pollutants out of the Los Angeles basin. This depth was determined from the aircraft soundings, when available, and/or from the wind shear information provided by the pibals. In the case of Cajon Pass the two layers defined by the aircraft and by the wind shear were not necessarily the same as indicated in Figure 4.2.7.

The air fluxes estimated from the pibal data are shown in Table 4.2.1. These fluxes represent the total volume of air flow in a vertical column one meter wide within a layer depth as shown in the table. These flux estimates were generated in the same manner as those shown in 4.1.3. The actual numbers, however, are somewhat larger than shown in Table 4.1.3, reflecting primarily the increased depth of the pollutant layers through the passes compared to the flow up the slopes or over the ridges. This, in turn, is a consequence of the convergent air flow through the passes which raises the depth of the mixed layer relative to the depth observed over the basin. Effective air flow through all of the passes occurs over a total crosswind width of 8-10 km. In spite of the higher air flow rate through the passes the total flow out of the basin must be primarily due to upslope flow in view of the larger areas involved (90 km along the slopes of the San Gabriel Mts. alone).



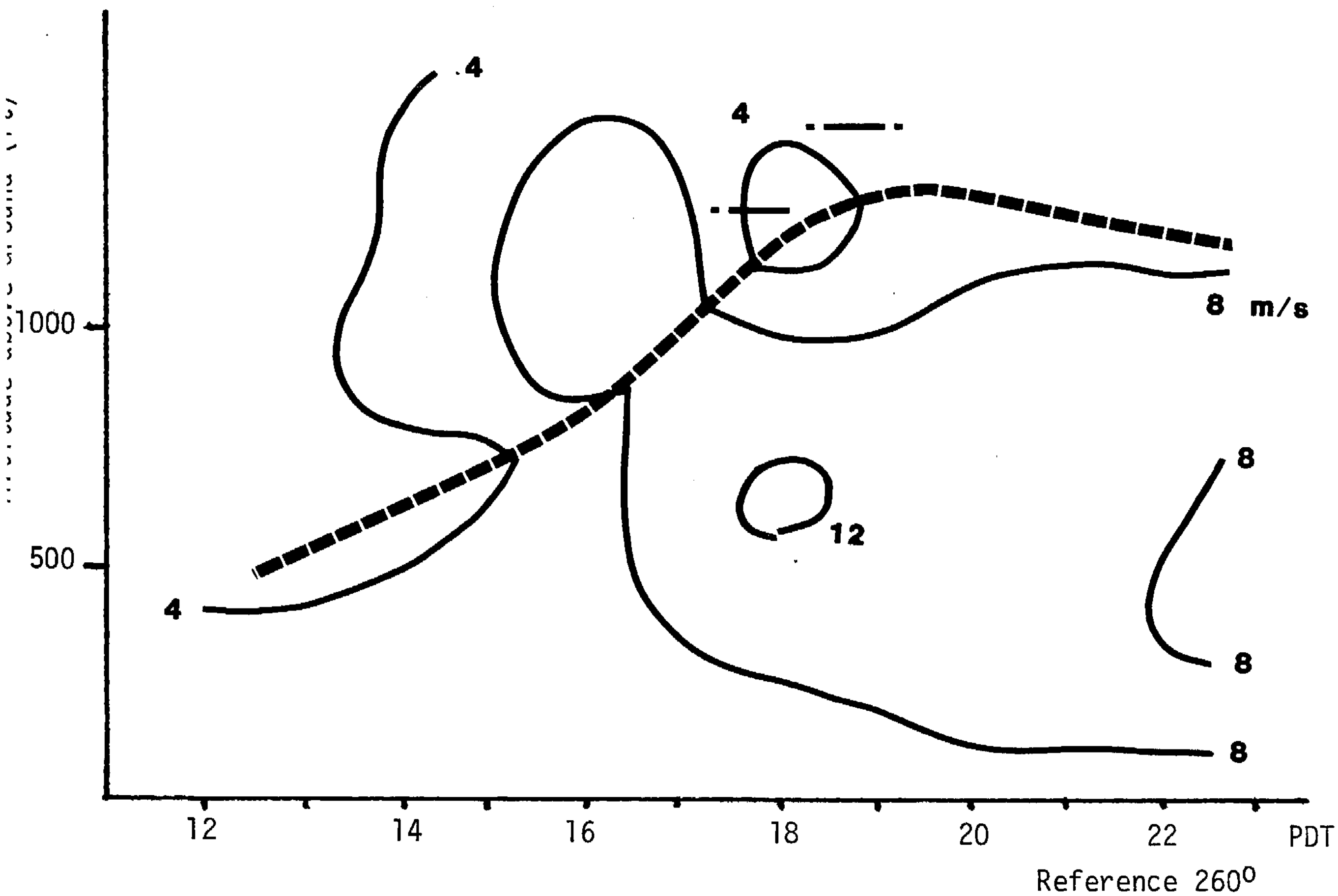
TIME - SECTION OF WIND COMPONENTS AT
CAJON JCT - July 18,1981

Fig. 4.2.6



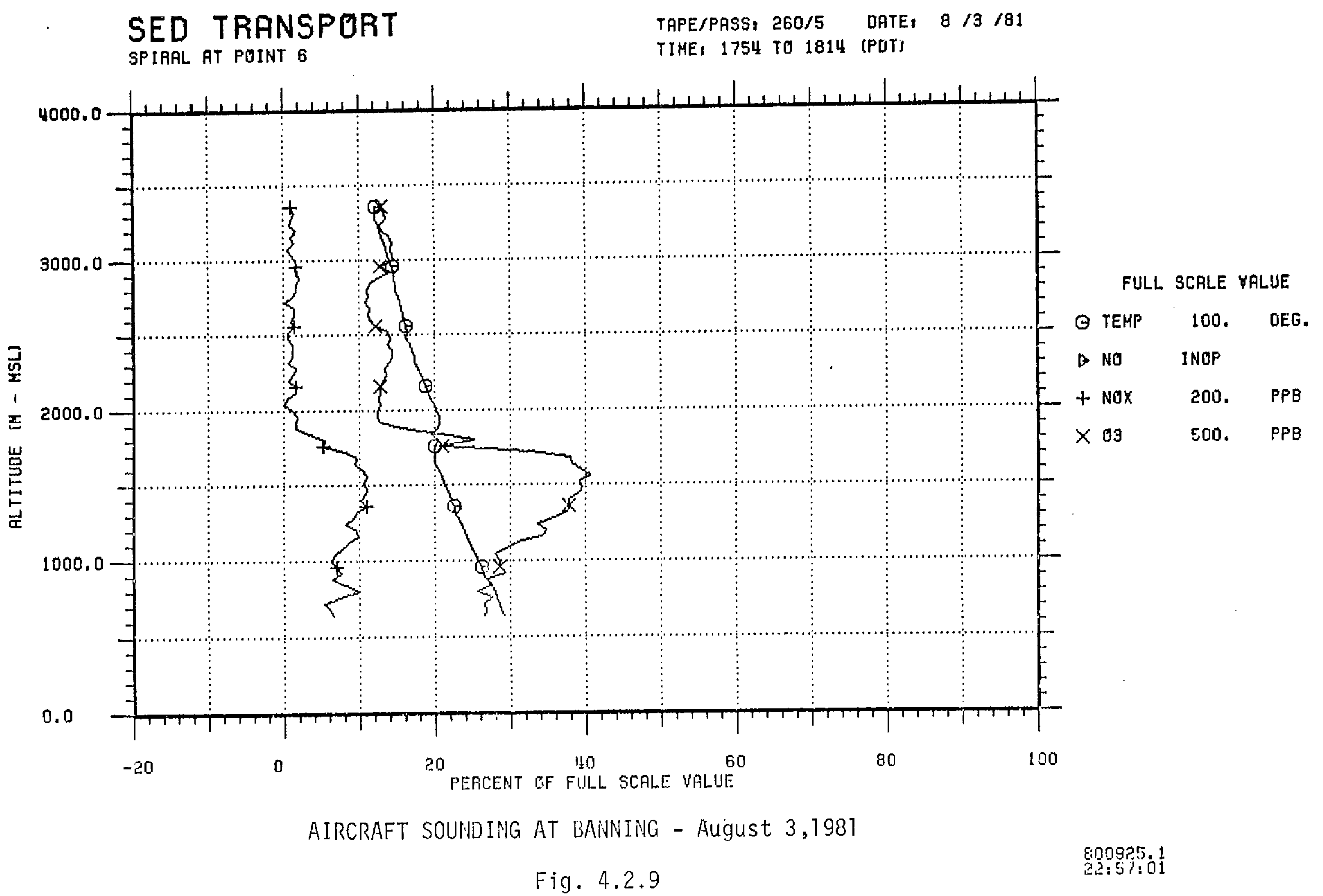
AIRCRAFT SOUNDING AT CAJON JUNCTION - July 18,1981

Fig. 4.2.7



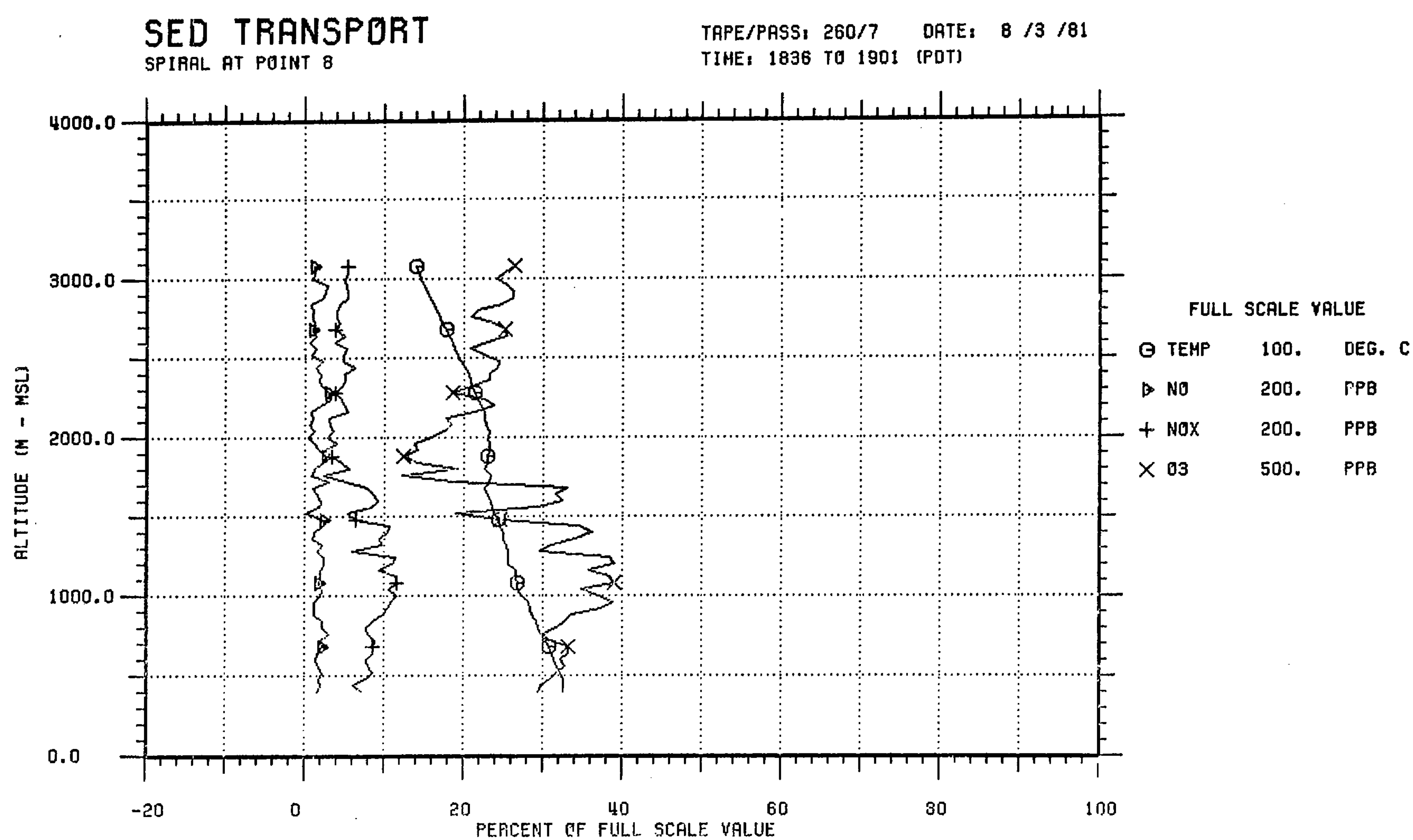
TIME - SECTION OF WIND COMPONENTS THROUGH
SAN GORGONIO PASS - August 3,1981

Fig. 4.2.8



AIRCRAFT SOUNDING AT BANNING - August 3,1981

Fig. 4.2.9



AIRCRAFT SOUNDING AT INTERSECTION I - 10 and 111 - August 3,1981

Fig. 4.2.10

Table 4.2.1

AIR FLUX ESTIMATES

	Date	Time (PDT)	Mixed Layer (m^2/s) Depth	Mixed Layer (m^2/s) Flux	Ozone Layer (m^2/s) Depth	Ozone Layer (m^2/s) Flux
Banning	7/09	1239	1,100	7,560		
		1417	1,400	8,250		
		1607	1,300	8,240		
		1809	1,200	7,270		
		2010	1,100	8,990		
		2210	1,050	7,740		
Cajon Summit	7/09	1155	1,200	7,860	400	4,130
		1358	1,400	16,800	600	8,690
		1601	1,300	13,150	450	5,670
		1758	900	10,250	350	4,680
		1956	750	9,310	250	3,630
		2214	400	3,120	200	2,100
Acton	7/14	1206	700	1,270		
		1433	1,050	4,430		
		1632	950	6,010		
		1805	950	7,160		
		2004	900	7,790		
		2212	1,100	6,750		
		2357	1,500	13,070		
Cajon Junction	7/18	1210	700	4,300	200	1,590
		1401	950	8,340	250	2,050
		1605	1,100	10,840	600	6,140
		1800	1,050	7,920	450	3,020
		2010	850	5,670	300	2,130
		2240	850	4,570	400	1,790
Banning	7/22	1443	1,200	6,730		
		1606	1,250	11,990		
		1759	1,250	9,170		
		2022	1,300	13,900		
		2159	1,050	8,380		
Banning	7/27	1426	1,050	4,980		
		1553	1,350	10,230		
Banning	8/03	1400	600	3,440		
		1609	800	4,530		
		1817	1,150	9,030		
		2007	1,250	10,670		
		2002	1,200	9,570		

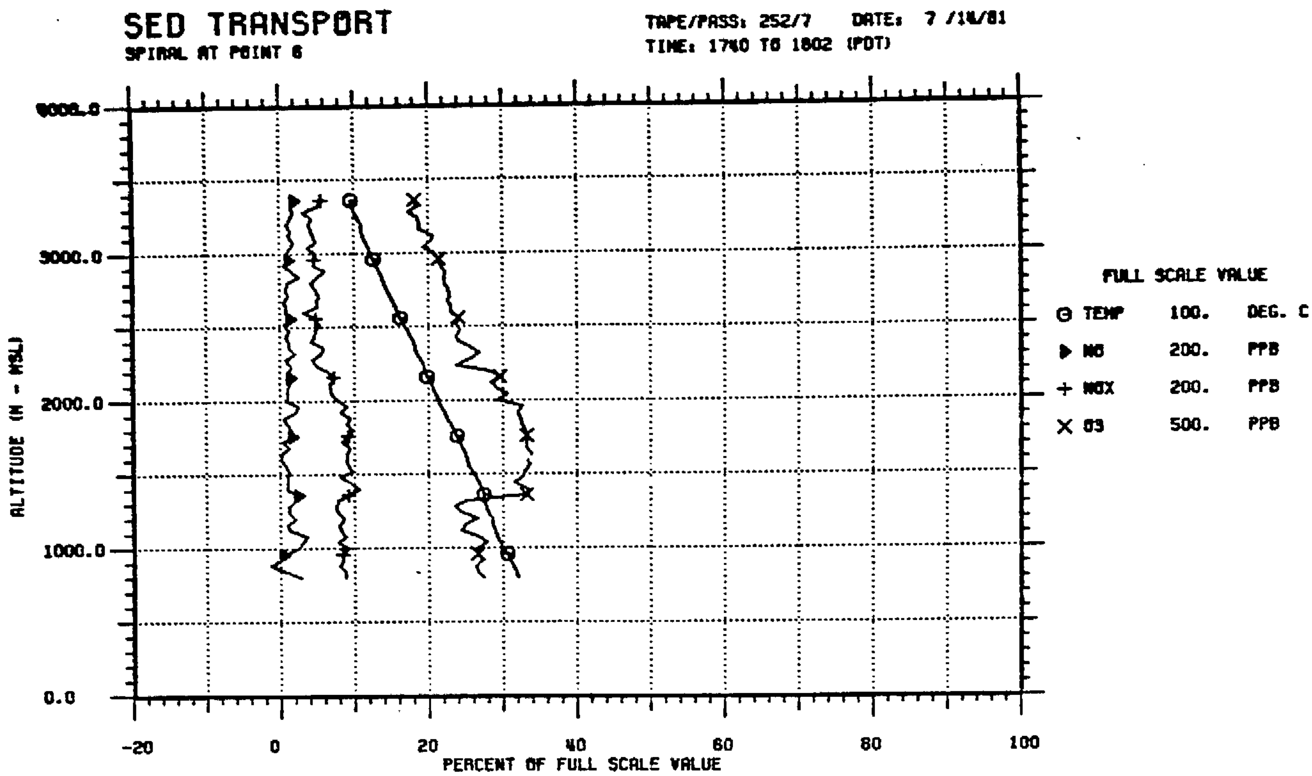
A number of aircraft flights were made immediately downwind of the passes to document the impact of the transport through the passes on the desert areas. The soundings in Figure 4.2.11 were made on July 14 in the Mojave Desert. Two layers of ozone are shown with the interface between the two layers at about 1300 m msl. The upper layer apparently originates along the southwestern slopes of the San Gabriel Mts. while the lower layer is directly transported through the pass. Note that the base of the upper layer is maintained at the same height above sea level from Palmdale to Adelanto (near Victorville). Depth of the layer over the desert was about 400-500 m above ground level.

A horizontal traverse was flown by the aircraft from just north of Lancaster to near Victorville at 1832-1858 PDT. A plot of the ozone measured along the track is shown in Figure 4.2.12. The height of the traverse was 1676 m msl which corresponds to the upper ozone layer shown in the previous figure. Peak ozone measured along the traverse was 18 pphm. On the basis of the traverse and nearby winds aloft, a probable trajectory of the ozone plume is shown in the figure. The significant feature of the data is that the layer aloft maintained its identity (and strength) across the Mojave Desert to near Victorville without being disrupted by surface heating.

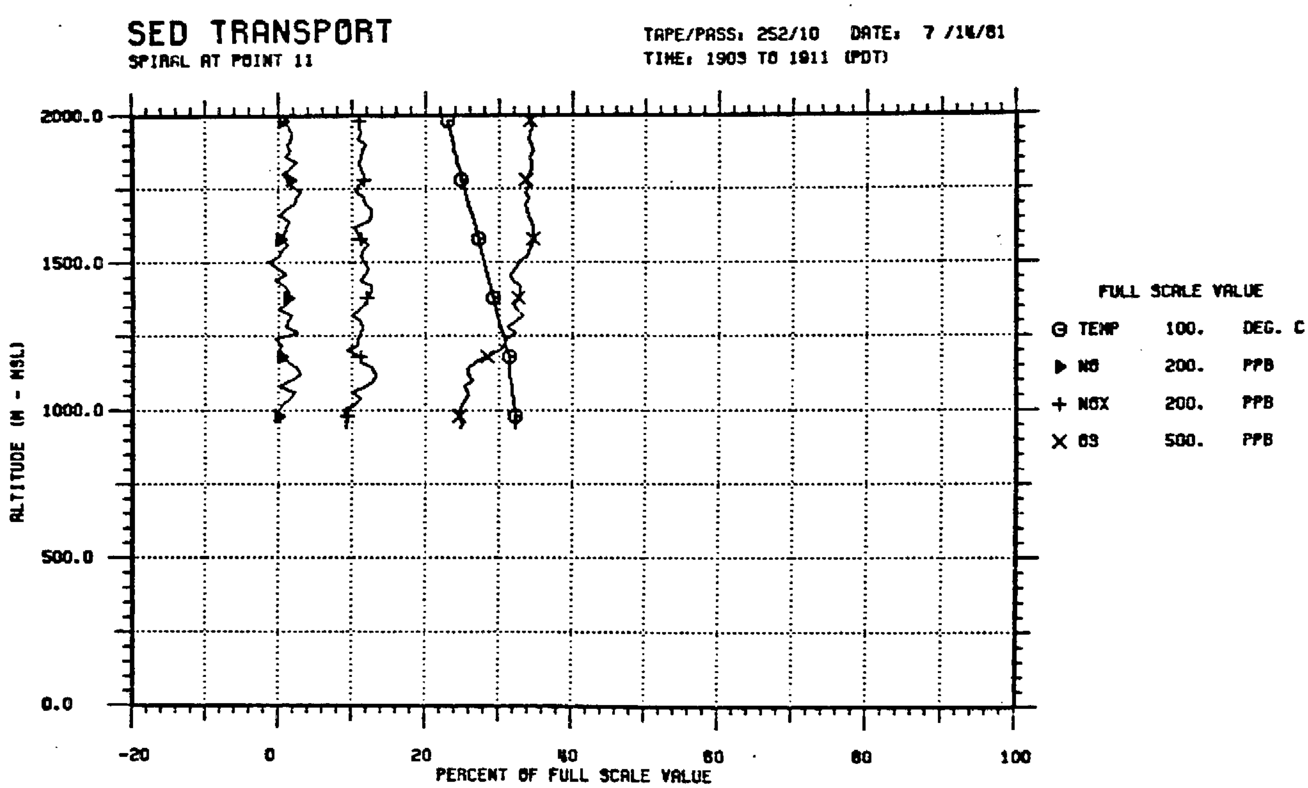
The sounding in Figure 4.2.13 was made at 1712 PDT on July 27 near Victorville. The low-level ozone layer shows an average concentration of 9-10 pphm to a height of 600 m above ground level. Farther aloft are one or two ozone layers with a peak ozone concentration of 18 pphm. Peak hourly surface concentration observed at Victorville on July 27 was 13 pphm at 20 PST. Similar low-level layers were observed in the Victorville/Hesperia area on July 9, 18 and 30 as well as on July 27. In each case the depth of the layers was 400-600 m above ground level. On some occasions, however, the upper ozone layer was not present, apparently due to differences in wind direction aloft.

Figure 4.2.10 showed an aircraft sounding made at the intersection of Highways I-10 and 111 (immediately downwind of Banning) on August 3. An elevated ozone layer was indicated in the sounding. Figure 4.2.14 shows a sounding made at the same location on July 30 at 1818 PDT. In this case, the peak ozone of 19 pphm was at ground level. Peak surface ozone measured at Banning on July 30 was 17 pphm at 17 and 18 PST. In spite of the surface elevation differences between Banning and the highway intersection (Banning is 300 m higher) the surface ozone shows little dilution in the downwind travel to the highway intersection. The action of the lee wave flow documented by Kauper (1971) serves to keep the surface concentrations relatively high immediately downwind of the pass.

Soundings were made at the highway intersection on five days (July 9, 22, 27, 30 and August 3). The soundings on July 22 and August 3 showed peak ozone layers aloft. In the remaining soundings the peak concentration at the highway intersection occurred at the surface.



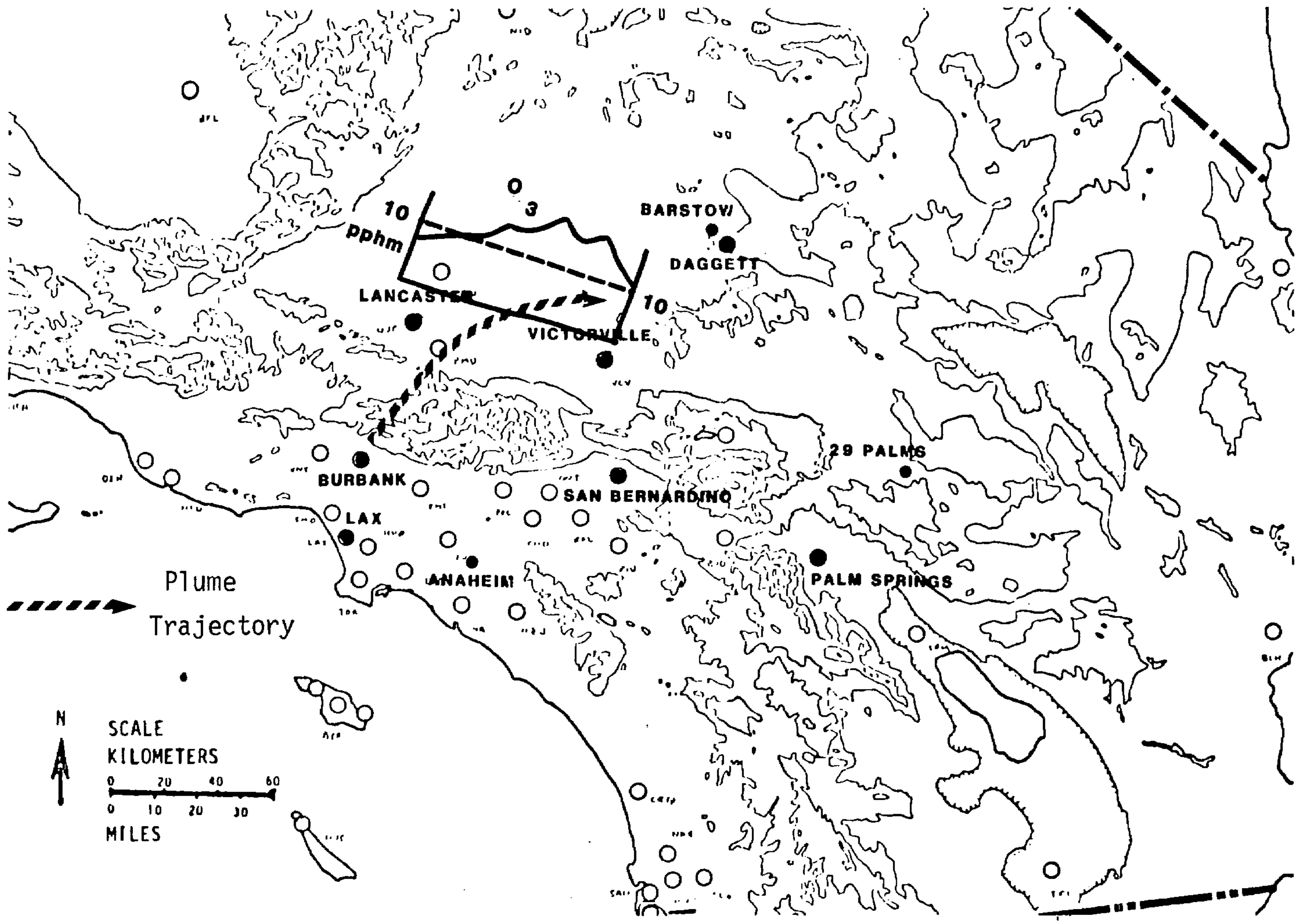
a. 5 mi W of Palmdale



b. Adelanto

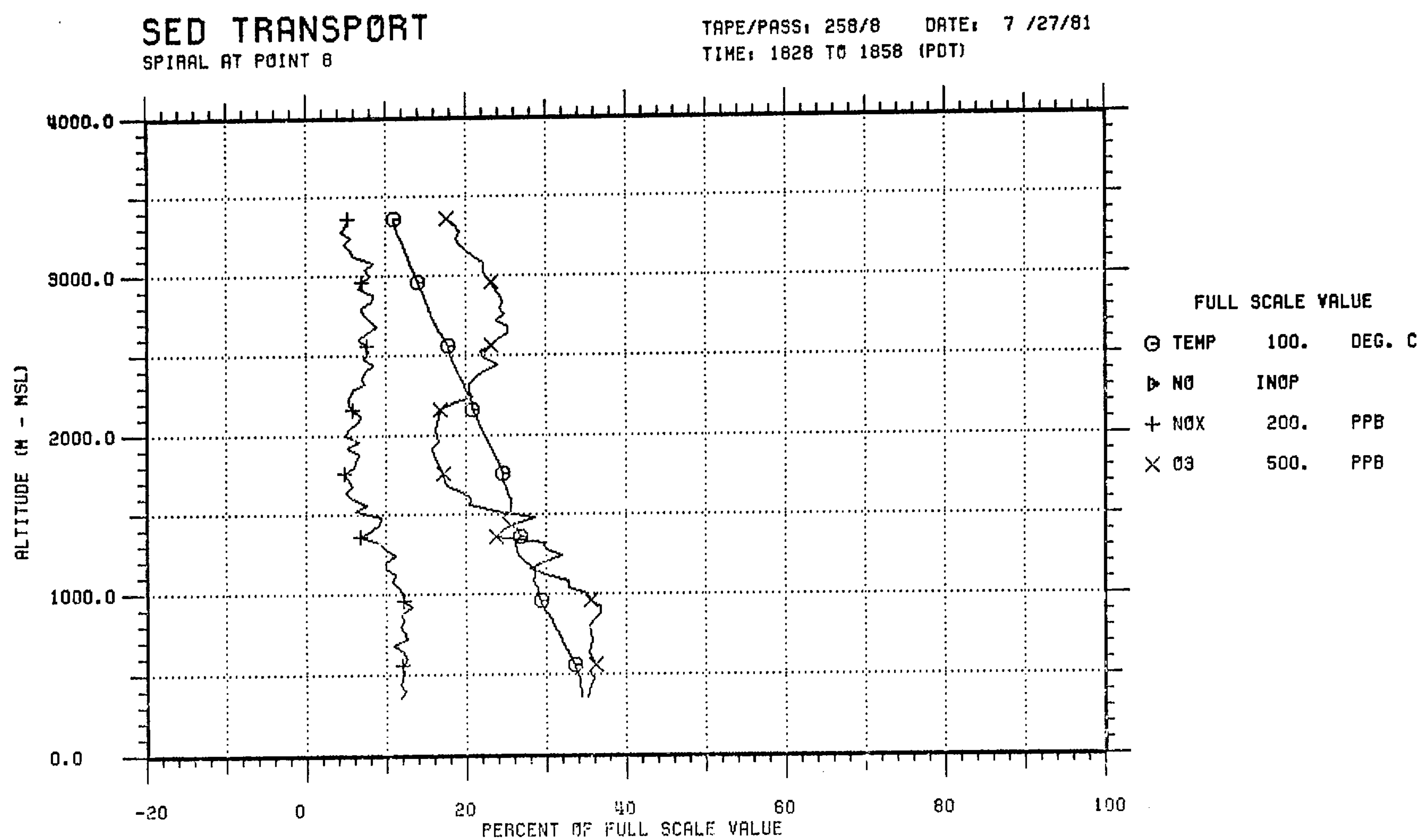
AIRCRAFT SOUNDINGS - July 14,1981

Fig. 4.2.11



HORIZONTAL AIRCRAFT TRAVERSE - July 14,1981

Fig. 4.2.12



AIRCRAFT SOUNDING AT INTERSECTION I - 10 and 111 - July 27,1981

Fig. 4.2.13

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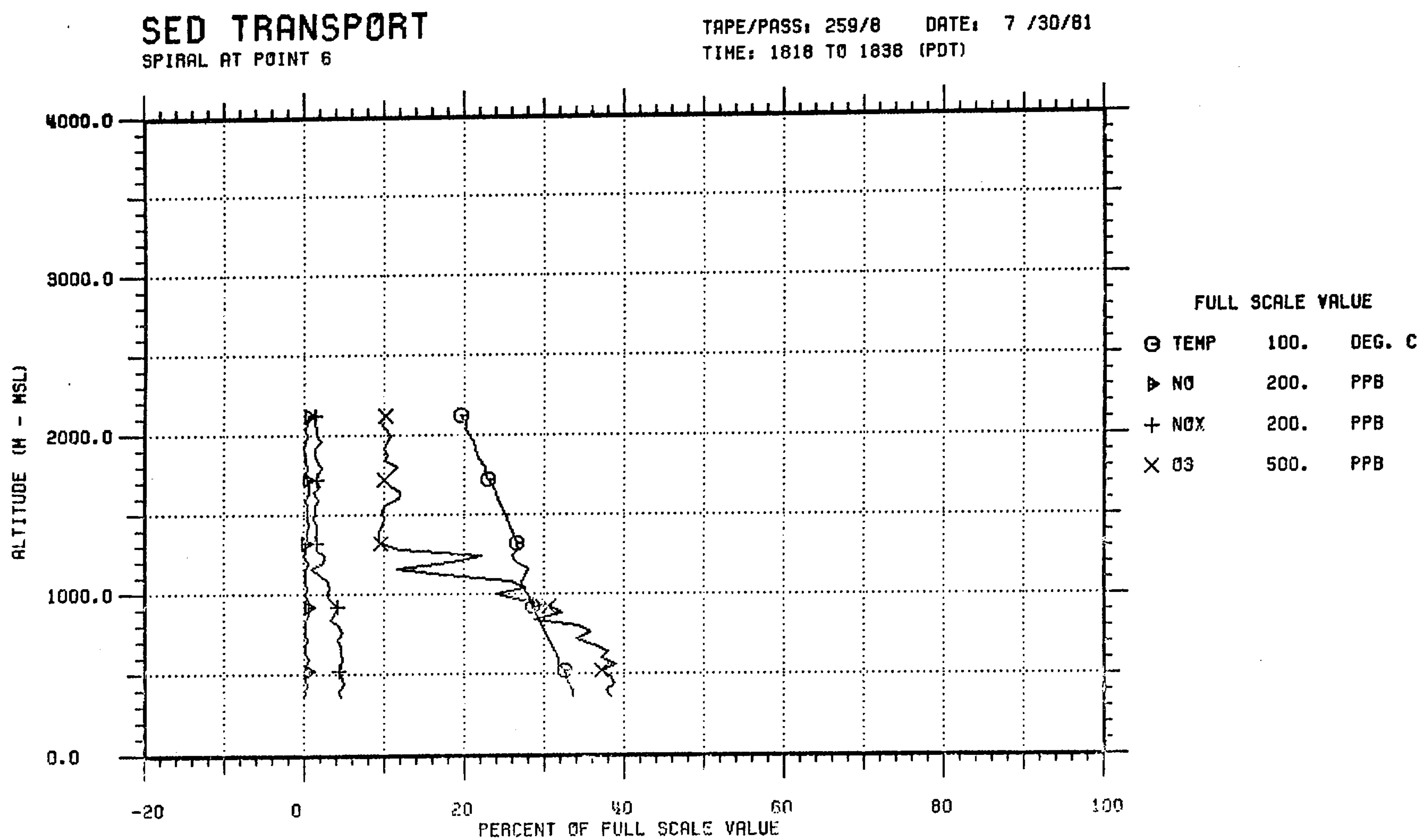
20:51:47



AIRCRAFT SOUNDING AT INTERSECTION I -10 and 111 - July 30,1981

Fig. 4.2.14

Figure 4.2.15 represents an aircraft sounding made at Palm Springs Airport at 2121 PDT on July 30. An ozone layer about 1400 m deep is shown in the figure with peak concentrations in the low layers near 14 pphm. Peak hourly ozone concentration observed at Palm Springs on July 30 was 16 pphm at 17 and 18 PST. The ozone layer at Palm Springs observed on July 30 was somewhat deeper and with somewhat lower surface concentrations than observed at the highway intersection in Figure 4.2.14.

Additional soundings were made at Palm Springs on July 22 and July 27. These soundings show ozone layers to a depth of about 1200 m or less, depending on the time of the sounding relative to the intrusion of ozone into the area. From these observations the indications are that the ozone layers penetrating into the Coachella Valley are somewhat deeper than those moving into the Mojave Desert.

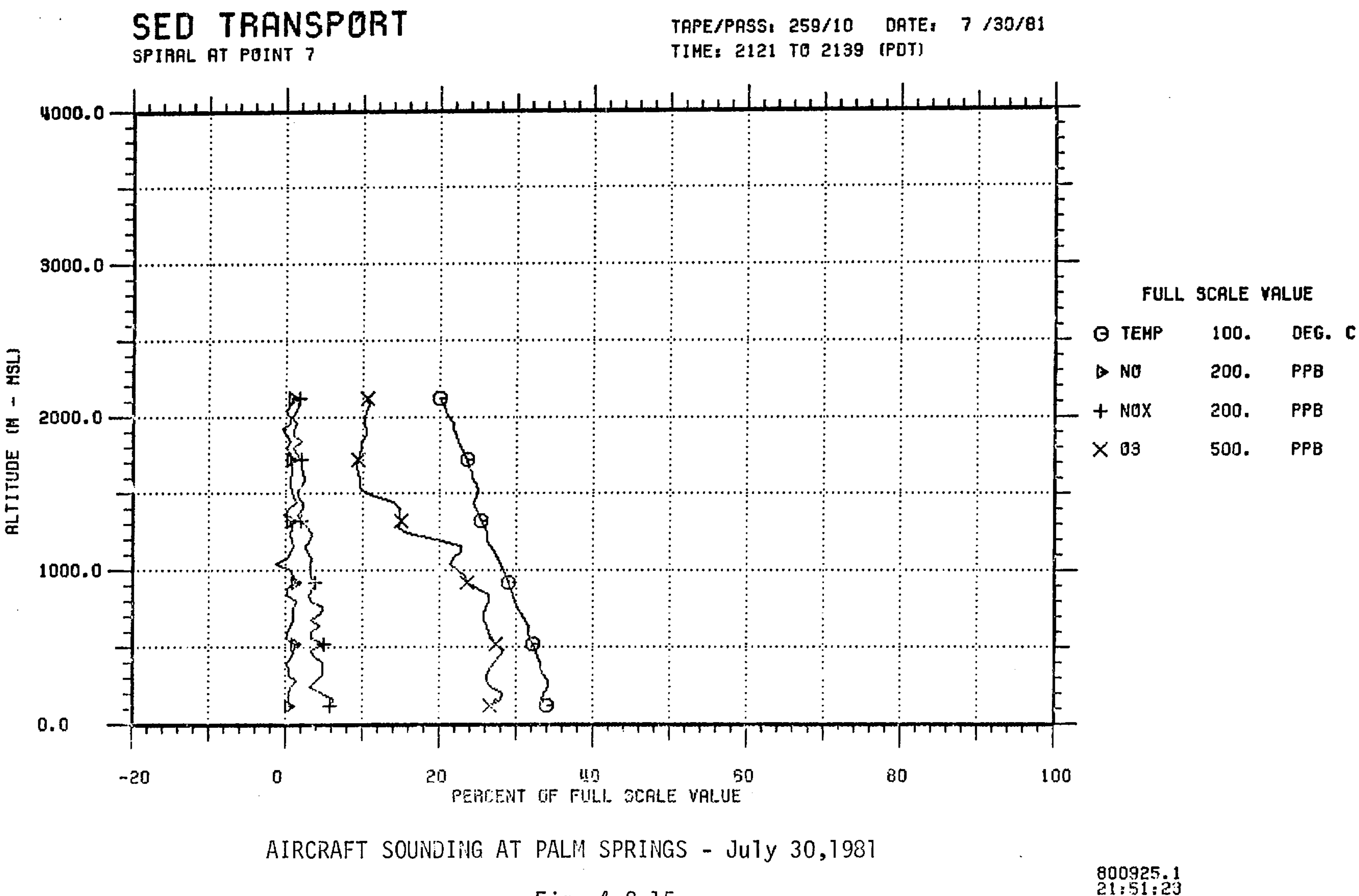
4.3 Transport Through the Desert

Streamline maps presented in Section 2 show the typical flow patterns occurring in the desert during the summer. Key features of the patterns are flow from the San Joaquin Valley and through Soledad Canyon into the Mojave Desert, flow through Cajon Pass into the eastern Mojave Desert and penetration of Los Angeles Basin air into the Coachella Valley and into Morongo Valley.

Figure 4.3.1 shows average hourly variations in wind speed and ozone concentrations for the July-August 1981 period at three locations in the Mojave Desert. Most frequent wind directions are indicated at the time of maximum wind speed. Nighttime levels of ozone at China Lake and Edwards AFB are near 5 pphm, decreasing slightly by about 05 PST. These values represent the ozone background levels to be expected in the area. Barstow, however, shows lower values at night with a low of less than 2 pphm at 05 PST. Daggett (not shown), on the other hand, corresponds to China Lake and Edwards AFB. It is assumed that local highway traffic near Barstow is responsible for the reduced ozone values at night at that location.

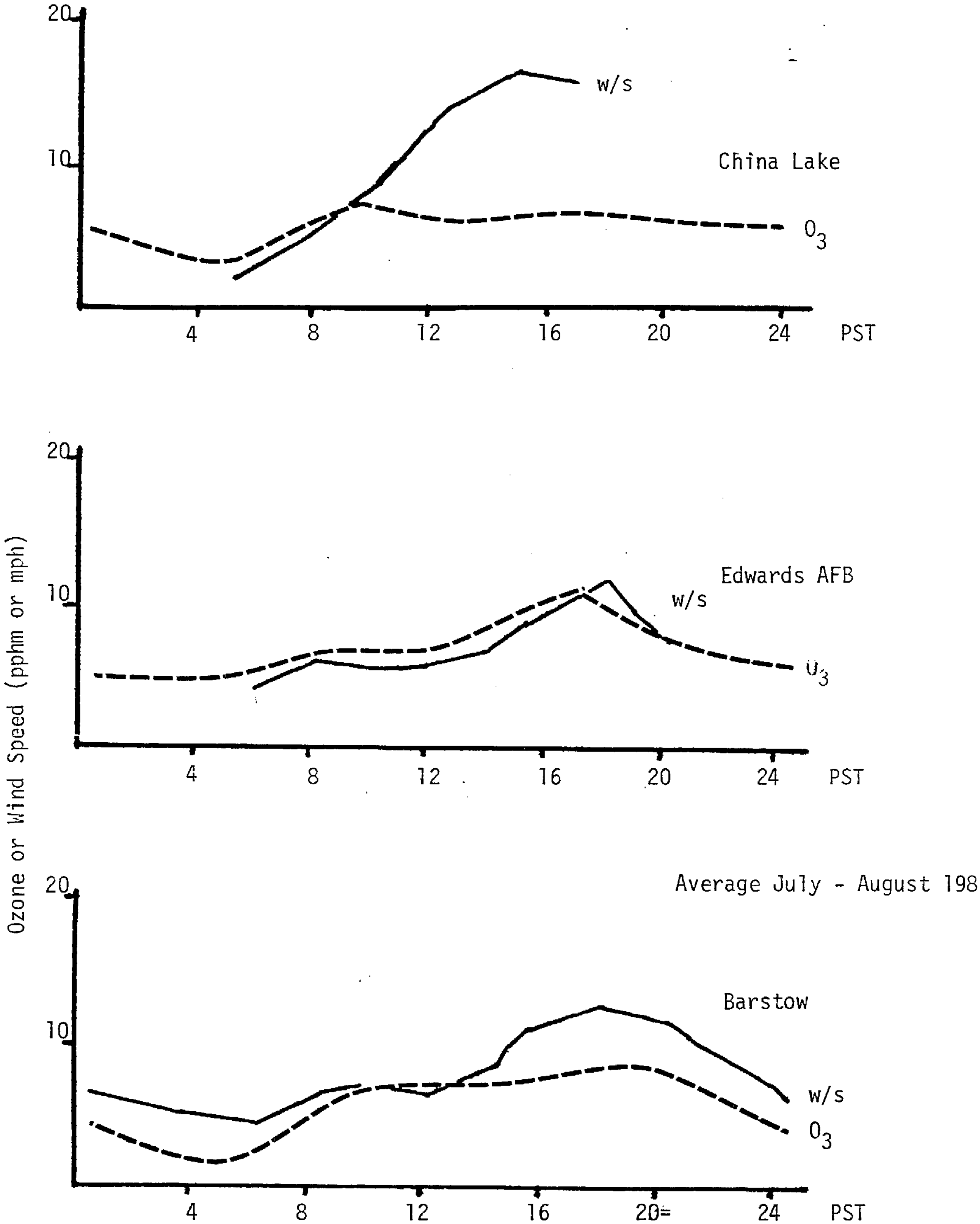
All three locations exhibit slight ozone peaks in the forenoon (09-11 PST) of the order of 7 phm which are attributable to local effects. On an average basis, there is little ozone transport indicated at China Lake associated with the higher wind velocities during the afternoon. At Edwards AFB, however, the afternoon ozone concentrations are clearly associated with increased transport from the southwest. At Barstow, a minor ozone peak in the late afternoon corresponds to the peak transport from the west to southwest.

Data from the 1980 wind energy study (Berry et al., 1981) have been used to examine the wind flow characteristics across the northern portion of the Mojave Desert. Locations of the stations used in the present study are shown in Figure 4.3.2. Diurnal variations in average wind speeds at the four locations during July-August 1980 are shown in Figure 4.3.3. A progressive shift in the time of maximum average wind speed from Antelope to Daggett is indicated. Total distance between the two stations is about 95 miles. The total shift in peak times is four hours.



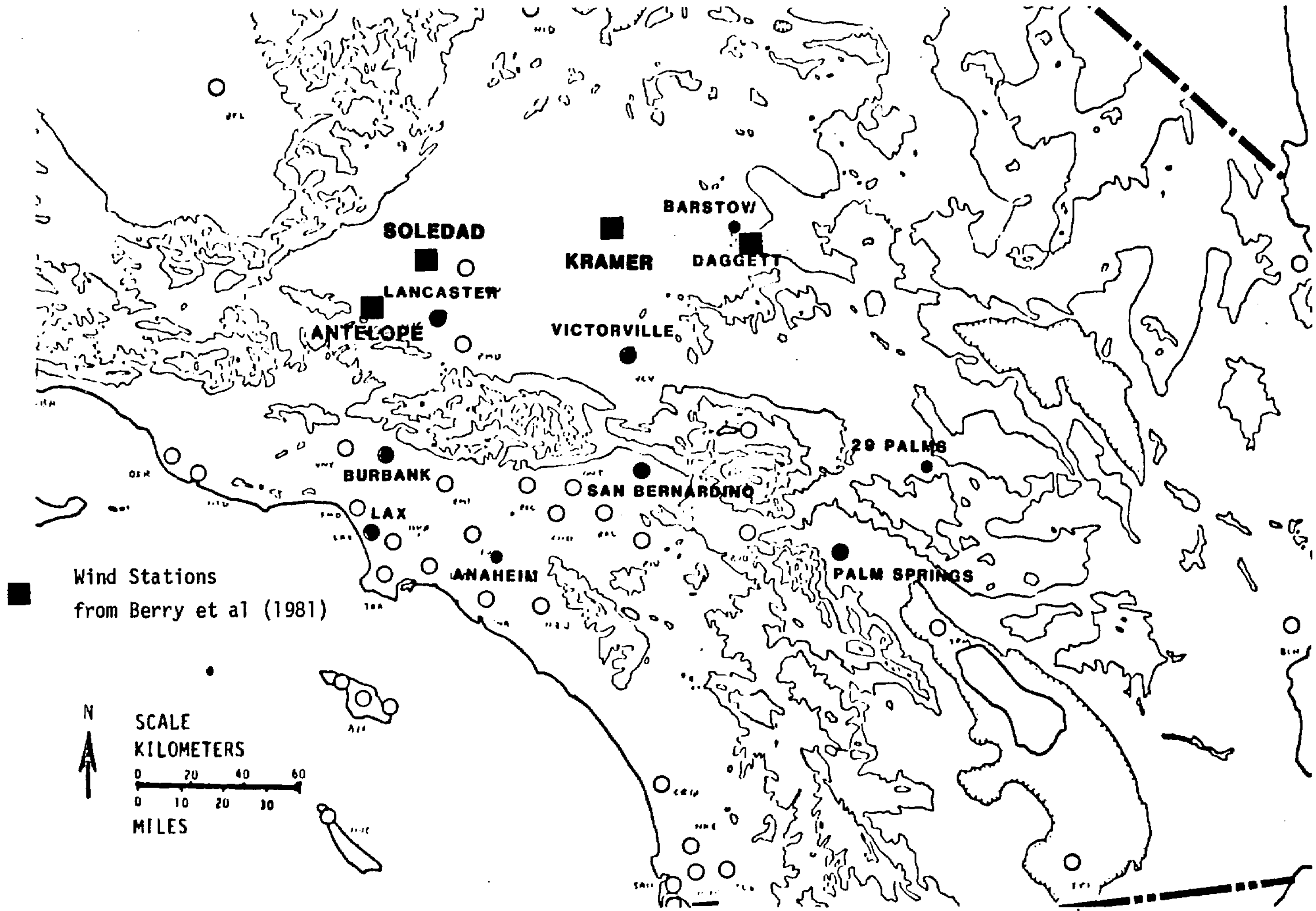
AIRCRAFT SOUNDING AT PALM SPRINGS - July 30,1981

Fig. 4.2.15



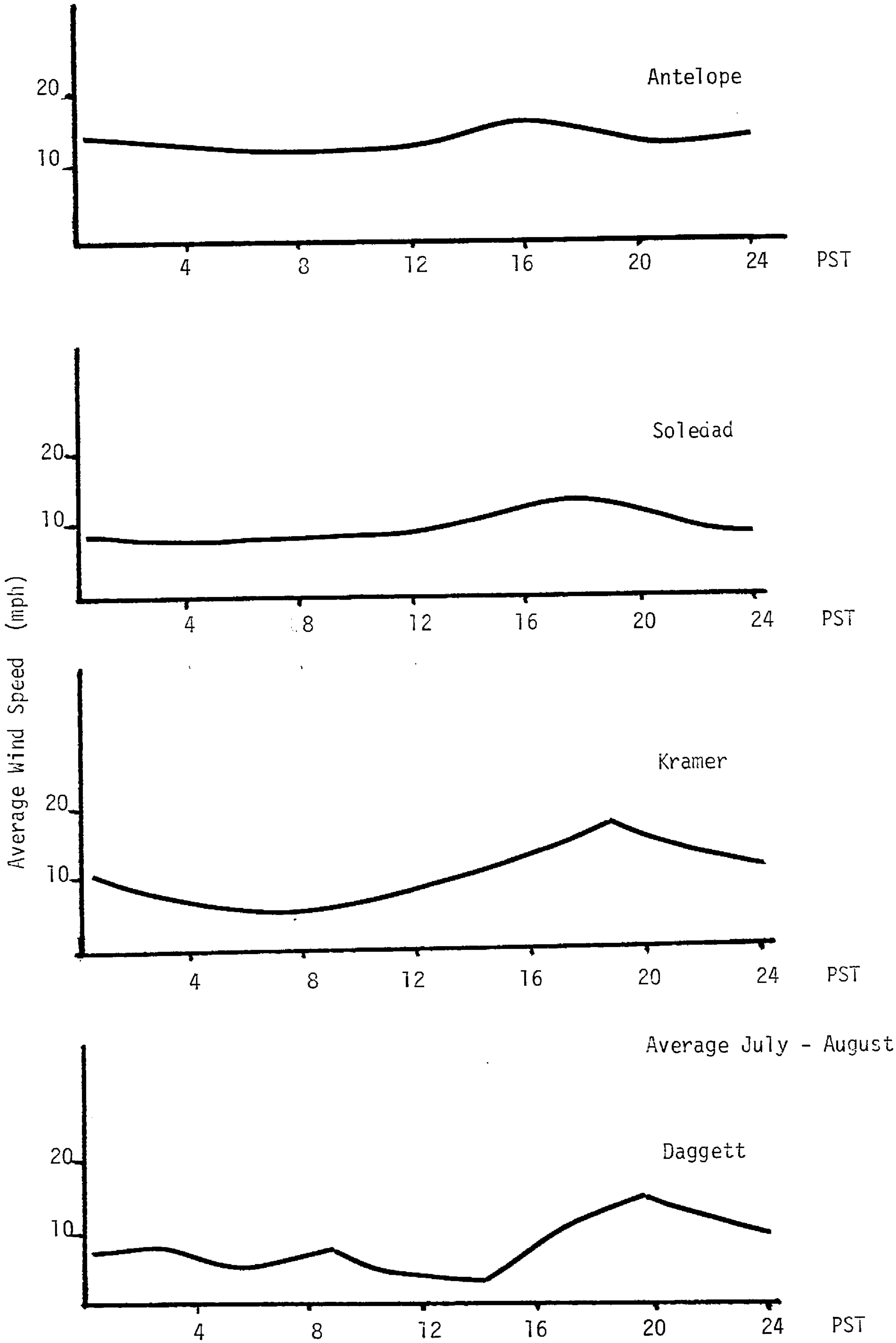
DIURNAL VARIATIONS IN OZONE AND WIND SPEED

Fig. 4.3.1



LOCATIONS OF WIND STATIONS

Fig. 4.3.2



DIURNAL VARIATIONS IN WIND SPEED

Fig. 4.3.3

Figure 4.3.4 shows isochrones of the time of peak average wind speed throughout the Southeast Desert Air Basin. Immediately downwind of the Tehachapi Mts. and boundaries of the Los Angeles Basin peak average wind speeds occur from 15-18 PST. A surge of air flow seems to move across the desert thereafter but does not usually reach the Arizona or Nevada border. As indicated in the figure a favored trajectory appears to be eastward and southeastward through 29 Palms.

The frequency of wind surge occurrences in the Mojave Desert can be judged from the 1980 wind data collected by Berry et al. (1981) in Table 4.3.1.

Table 4.3.1

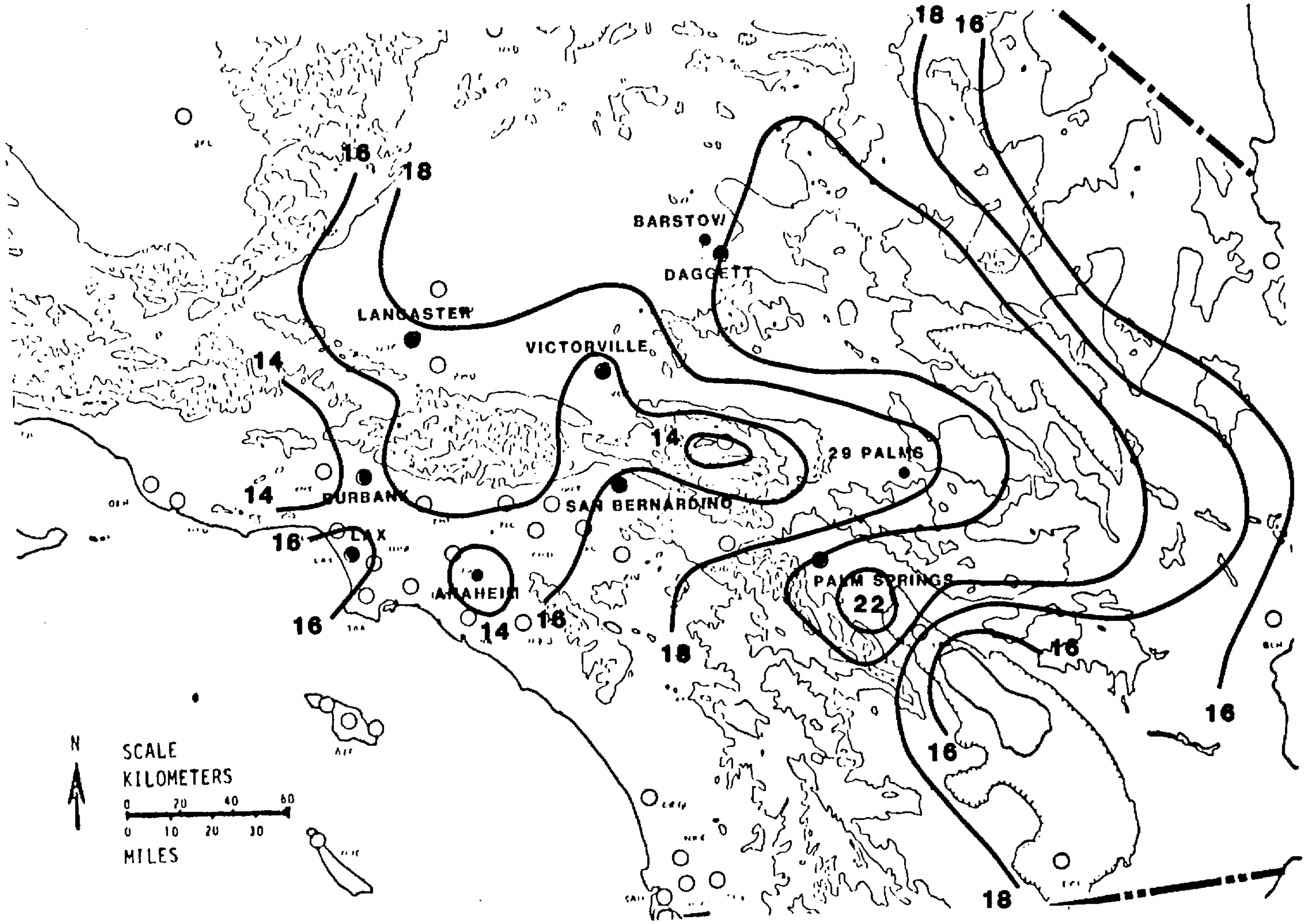
FREQUENCY OF WESTERLY WINDS >10 mph

Time (PST)	Antelope (%)	Soledad (%)	Kramer (%)	Daggett (%)
20	90	72	98	78
24	93	49	79	100
04	80	37	41	83
08	67	34	34	72

Moderate to strong westerly winds occur in the northern Mojave Desert on most evenings with the frequency of occurrence decreasing somewhat by the following morning. This flow provides transport from the San Joaquin Valley into the desert on a highly frequent basis but also serves to ventilate the desert and prevent local pollutants from accumulating on most occasions.

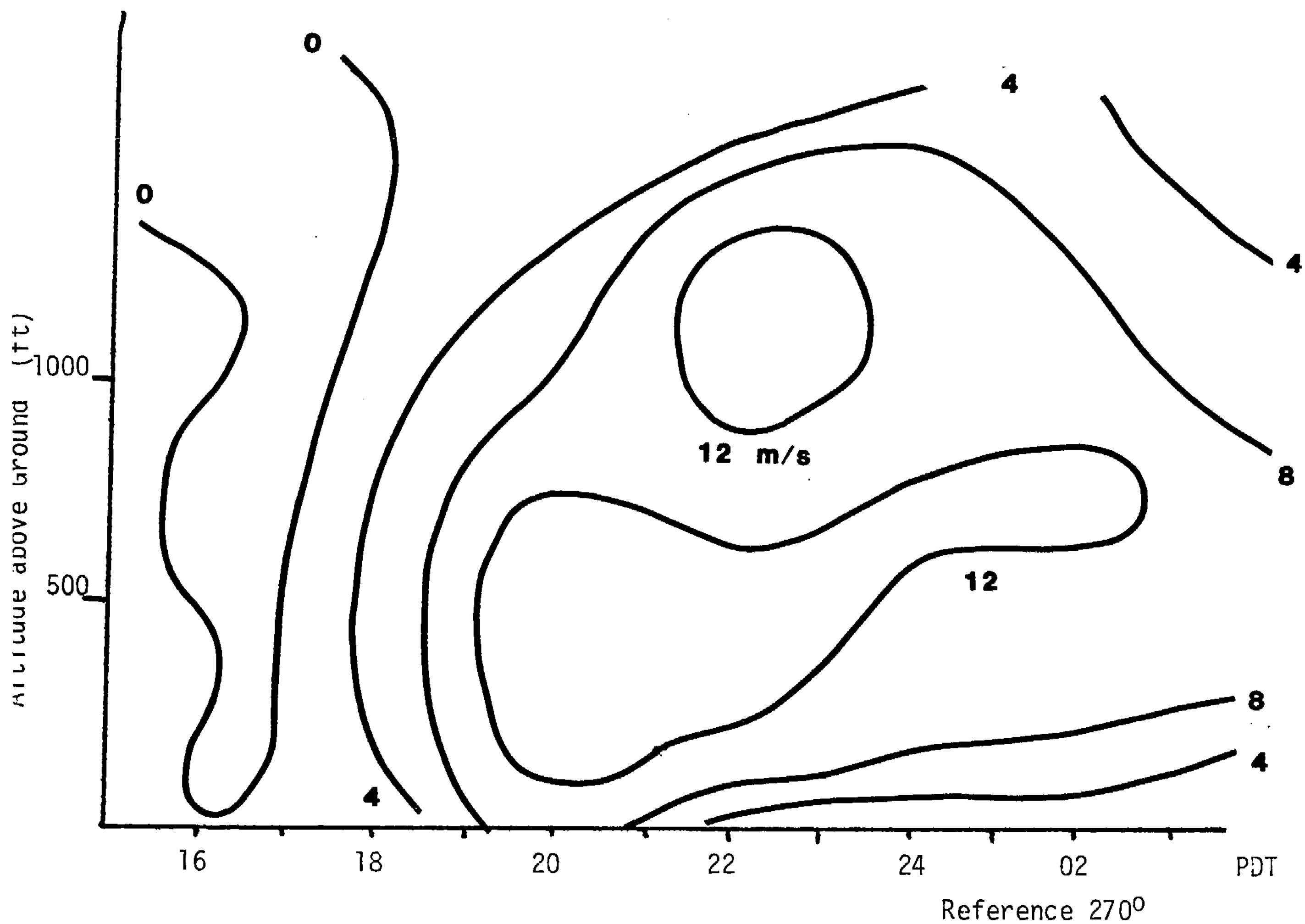
Several examples of the wind flow structure in the desert are shown in Figures 4.3.5 to 4.3.7 in the form of vertical-time sections oriented along the mean wind directions which characterize the typical evening flows. In Figure 4.3.5 the wind components at Barstow along a 270° direction are plotted for July 14-15. On the evening of July 14 the wind surge commenced abruptly between 16 and 18 PDT and accelerated to peak velocities between 20 and 22 PDT. Depth of the flow was over 1500 m and indications of the flow remained as late as 06 PDT on the following morning.

The flow pattern at Desert Center in Figure 4.3.6 has been referenced to 240°. On the night of July 22 the wind surge commenced abruptly between 16 and 18 PDT and continued through 08 PDT on July 23. The depth of the flow was much shallower than indicated in Figure 4.3.5 but the peak velocities were also recorded between 20 and 22 PDT.



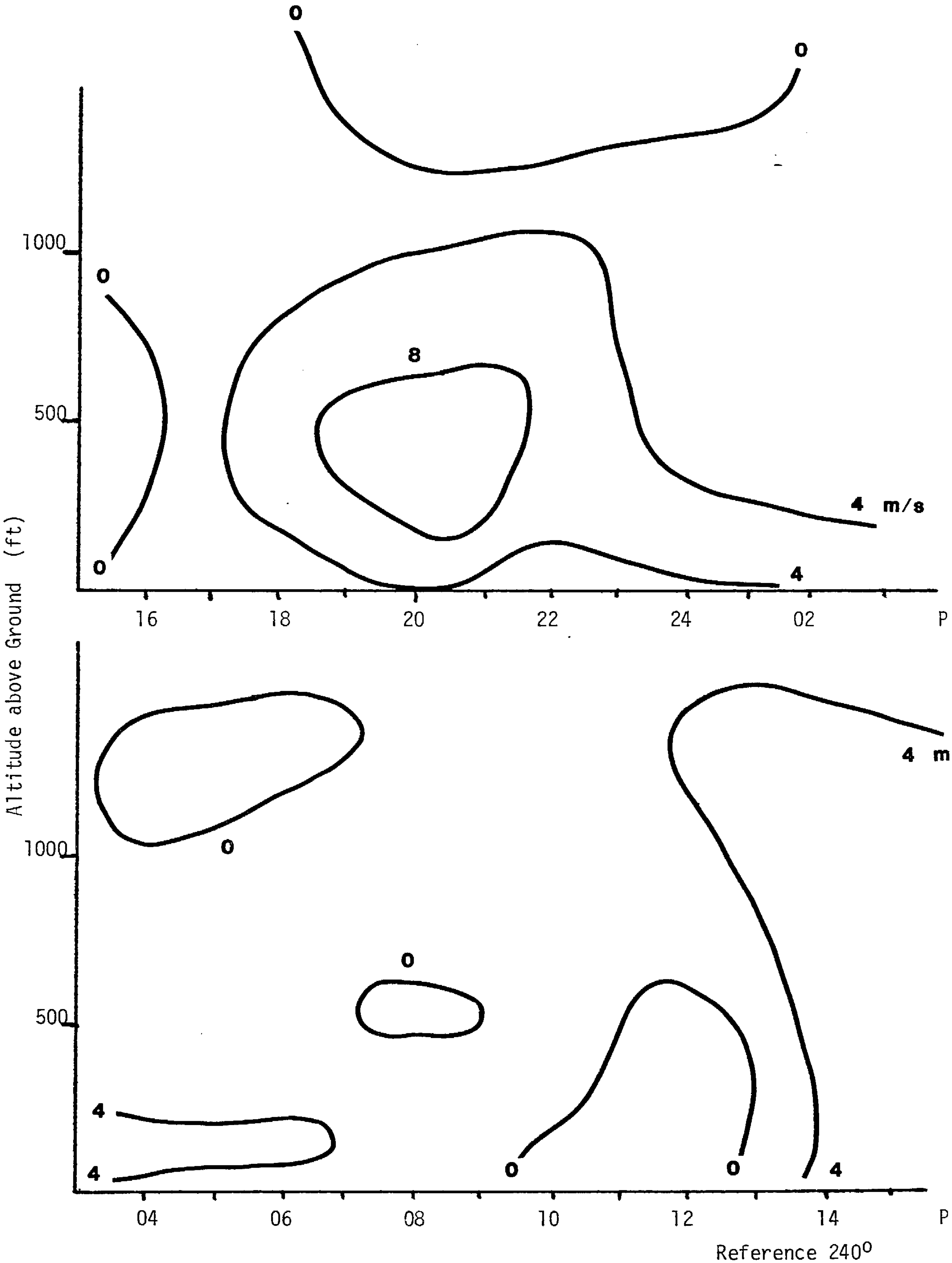
TIME OF MAXIMUM AVERAGE WIND SPEED

Fig. 4.3.4



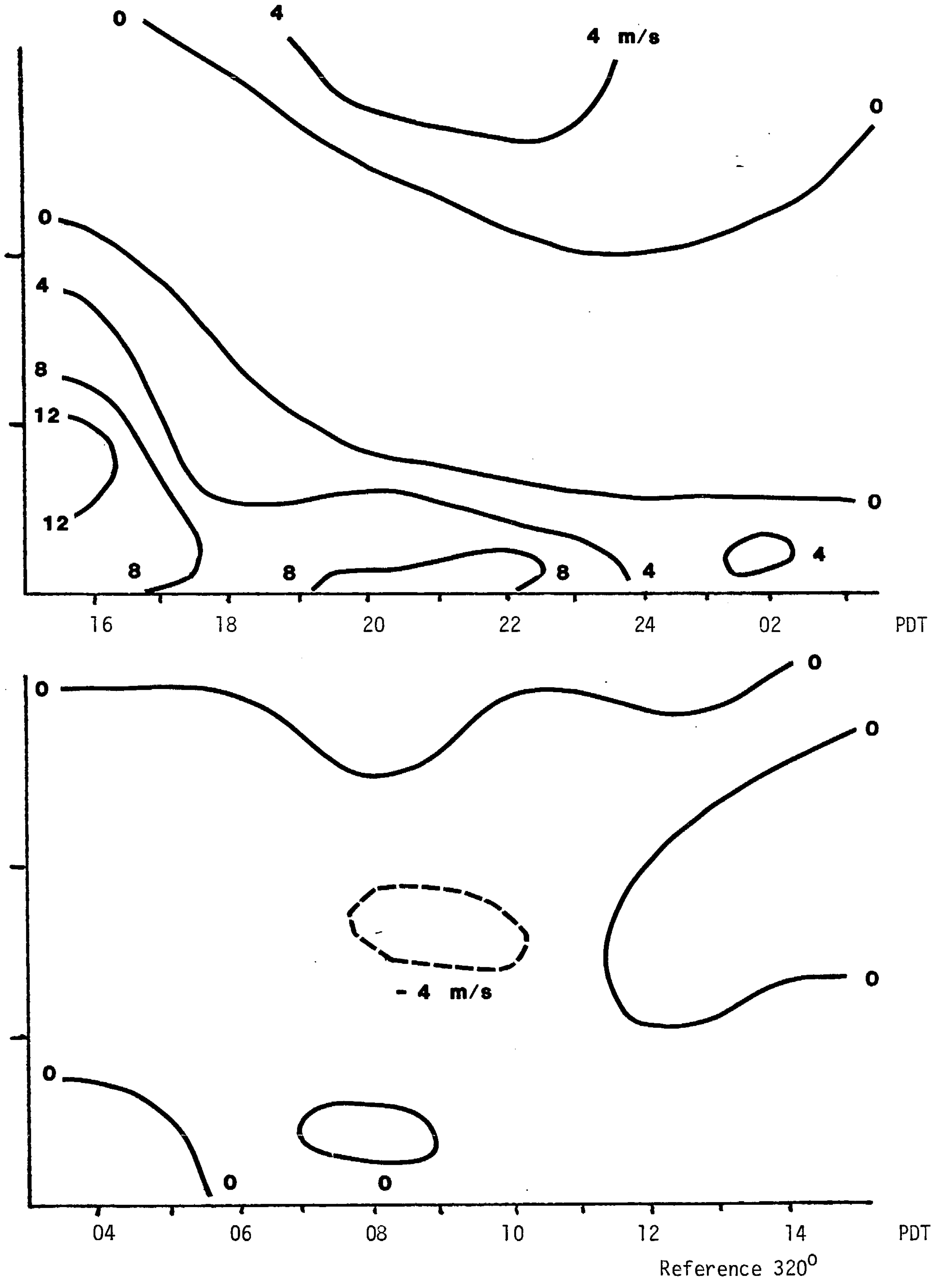
TIME - SECTION OF WIND COMPONENTS AT BARSTOW - July 14,1981

Fig. 4.3.5



TIME - SECTION OF WIND COMPONENTS AT DESERT CENTER - July 22-23,1981

Fig. 4.3.6



TIME - SECTION OF WIND COMPONENTS AT PALM SPRINGS - July 22-23,1981

Fig. 4.3.7

Flow characteristics at Palm Springs on July 22-23 are shown in Figure 4.3.7. Wind components in the figure have been referenced to 320°. The wind surge was already present when the series of observations commenced at 16 PDT. Depth of the flow was about 1100 m but this decreased rapidly during the evening. Shallow remnants of the northwesterly flow continued through 04 PDT on July 23. The balance of the flow pattern was characterized by southeasterly winds.

The map in Figure 4.3.4 suggests that the wind surge through the northern Coachella Valley frequently reaches Palm Springs and Indio but often does not get as far as Thermal before losing its momentum. This is examined further in Table 4.3.2 which shows the percentage of northwesterly winds at Palm Springs, Indio and Thermal for various times of the day in July-August 1981:

Table 4.3.2

PERCENTAGE OF NORTHWESTERLY WINDS
(North through West)

Time (PDT)	Palm Springs (%)	Indio (%)	Thermal (%)
15	40.4	2.7	0.0
18	72.3	8.5	2.8
21	95.7	76.6	51.4
24	100.0	87.2	51.4
03	93.6	87.2	60.0
06	74.5	74.5	25.7
09	19.1	27.6	20.0

The frequent penetration of air from San Gorgonio Pass as far as Palm Springs is shown in the table. However, the northwesterly flow often does not extend as far as Thermal as indicated by the lower percentage values.

Reible et al. (1982) have demonstrated that pollutants from the San Joaquin Valley can be transported over the Tehachapi Mts. into the Mojave Desert. This transport is further substantiated by the wind energy studies of Berry et al. (1981) in which west to northwest winds throughout the western part of the Antelope Valley have been shown to be a substantial wind energy resource.

Reible et al. (1982) also documented the flow from the Los Angeles Basin through Soledad Canyon by means of a release in the San Fernando Valley. The present study (Test 2-July 14) again demonstrated this transport route with a release at Sylmar. Concentrations of SF_6 were observed at Palmdale, Edwards AFB and Barstow. The center of the tracer cloud apparently passed to the south of Edwards and Barstow after leaving Soledad Canyon.

The relative influence of these two transport routes on the pollutant levels in the Mojave Desert must vary somewhat from day to day, depending on slight changes in regional pressure gradients. The mean streamlines shown in Section 2 (Figures 2.5.1 to 2.5.7) suggest that the zone of confluence between the San Joaquin Valley and Soledad Canyon flows generally lies near or slightly to the north of Edwards AFB. To the north of this zone the area is largely under the influence of San Joaquin Valley flow and within the Soledad Canyon flow to the south.

One method of investigating the relative influence of the San Joaquin Valley and Soledad Canyon flows is to examine the daily peak ozone concentrations at Lancaster and Edwards AFB. Edwards is located about 15 miles to the northeast of Lancaster without intervening significant sources or sinks of ozone. If Edwards was directly downwind of Lancaster (along the line of the Soledad Canyon flow) dilution should be the primary reason for differences in peak concentrations between the two locations. Peak ozone differences are shown in Table 4.3.3.

Table 4.3.3

PEAK OZONE CONCENTRATION DIFFERENCES

LANCASTER MINUS EDWARDS AFB (JULY-AUGUST 1981)

Peak Ozone Difference (pphm)	Percent of Cases (%)
0	2.8
1	11.4
2	2.8
3	14.3
4	22.9
5	22.9
6	8.6
7	5.7
8	2.8
9	0.0
10	2.8
11	0.0
12	0.0
13	2.8

Data in the table indicate that peak daily ozone concentrations are usually 4 to 5 pphm lower at Edwards AFB than at Lancaster. In 17 percent of the cases, however, the peak concentrations are within 2 pphm. Presumably, these cases reflect direct transport from Lancaster to Edwards AFB.

It is to be noted that the peak ozone difference between Lancaster and Edwards AFB on July 14 was 6 pphm. On this occasion, tracer and aircraft sampling indicated that the center of the Soledad Canyon plume moved to the south of Edwards AFB although SF_6 concentrations were observed at Edwards. It is reasonable to assume, therefore, that in 22 percent of the cases (6 pphm difference or more) the center of the ozone plume from Soledad Canyon did not pass through Edwards AFB. The bulk of the peak differences occur at 4 to 5 pphm which suggest significant but not maximum impact of the Soledad Canyon plume.

On a qualitative basis, therefore, it is assumed that a direct impact of the Soledad Canyon plume occurs at Edwards AFB in a limited number of cases and a near-miss also occurs to a limited degree. It can be argued from the comparative ozone concentrations and timing of the peak concentrations that moderate impact at Edwards occurs in the bulk of the cases. This suggests a mean trajectory for the ozone plume somewhat to the south of Edwards AFB, continuing toward Barstow and Daggett. This is in conformance with the mean streamline patterns given in Section 2.

4.4 Pollutant Carry-over in the Desert

Average ozone concentrations for a number of locations in the desert are shown in Figures 4.2.1, 4.2.2 and 4.3.1 for the period July 1 to August 15, 1981. At each of the locations average ozone concentrations tend to rise to a plateau or small peak at around 09-10 PST. Increased ozone concentrations in the early forenoon have been attributed to the effects of local emissions or to the carry-over of pollutants or precursors transported into the area during the previous day. One of the objectives of the present study was to examine the relative importance of these two effects insofar as possible.

A summary of the early forenoon ozone concentrations in the desert is given in Table 4.4.1. Frequency distributions of ozone concentrations at 09 PST are given for the available desert stations. Most frequent concentrations range from 6 to 8 pphm at all locations except Indio and El Centro which have most frequent values of 4 and 5 pphm, respectively. Indio, however, shows a secondary peak of 7 pphm, in agreement with the Palm Springs distribution. It is presumed that local traffic around Indio frequently results in a reduction in morning ozone concentrations. Greater interest, however, centers in the number of high morning ozone concentrations (e.g., 10 pphm or more). These occur most frequently at Lancaster, Daggett, Victorville, Indio and Palm Springs.

Table 4.4.1

FREQUENCY OF O_3 CONCENTRATIONS AT 09 PST (%)

(JULY 1 - AUGUST 15, 1981)

O_3 Conc. (pphm)	China Lake	Lancaster	Edwards AFB	Barstow	Daggett	Victor-ville	Lucerne	29 Palms	Indio	Palm Springs	El Centro
1											
2								2.3	2.3		2.2
3						2.2		4.5	13.6	4.3	4.3
4	4.5		7.5	4.4	2.2	6.7		11.4	25.0	13.0	21.7
5	6.8	4.8	10.0	17.8	6.7	8.9	7.9	20.5	11.4	13.0	32.6
6	36.4	9.5	20.0	24.4	4.4	33.3	10.5	22.7	9.1	13.0	23.9
7	29.5	9.5	27.5	24.4	28.9	22.2	39.5	20.5	13.6	19.6	6.5
8	20.4	30.9	20.0	20.0	35.5	13.3	31.6	13.6	6.8	19.6	6.5
9	2.3	23.8	12.5	6.7	8.9	4.4	5.3	4.5	2.3	4.3	2.2
10		19.0	2.5	2.2	13.3	4.4	2.6		11.4	4.3	
11		2.4				2.2	2.6		2.3	4.3	
12										2.2	
13						2.2				2.2	
14											
15											
16									2.3		

All cases of 10 pphm ozone at 09 PST in Table 4.4.1 were examined individually and one of the following scenarios was found in each case:

1. Moderate wind transport occurred at the desert location throughout the night, continuing through 09 PST. Under these conditions there is no likelihood of local emission effects since there is no opportunity for accumulation of precursors. Ozone concentrations therefore must result from solar radiation acting on the transported pollutants.

2. Moderate wind transport occurred most of the night but light wind conditions were present for at least several hours prior to 09 PST. In this case pollutants are transported into the area during the night but the light winds early in the morning permit possible contribution from local sources. The most significant of these cases are distinguished by high (10 pphm or more) concentrations at the station as late as 23 PST during the previous evening.

3. Light wind transport occurs throughout most of the night, limiting significant transport into the area during the night when relatively poor vertical mixing exists. Carry-over from the previous day is then likely to result only from transport during the previous afternoon, if any. In this case, local sources have a better opportunity of contributing significantly to the morning ozone concentrations.

The following comments were derived from an examination of the individual cases of 10 pphm or greater as shown in Table 4.4.1.

<u>Lancaster</u>

During the July 1-August 15, 1981 period there were eight days when the ozone concentration at 09 PST was 10 pphm or more. On four of these occasions moderate transport out of Soledad Canyon continued through 09 PST (scenario #1 above). For these cases there was little opportunity for local effects to be operative. On three occasions transport into the area continued until midnight or early morning with light, variable winds thereafter. Ozone and precursors from the Los Angeles basin were in the area during the early forenoon but the light winds made it possible for some contribution to be made by local sources.

On one occasion (July 4) there was relatively little transport from the Los Angeles basin during the previous day and evening. Ozone concentrations of 10 pphm occurred as early as 08 PST. Local sources may have contributed in this case but transport from the San Joaquin Valley during the night may also have been a factor.

Edwards AFB

There was only one case (August 7) of 10 pphm ozone at 09 PST at Edwards AFB between July 1 and August 12, 1981. In this case transport from the Los Angeles area continued through 01 PST followed by light winds until 09 PST. Both Lancaster and Edwards AFB experienced ozone concentrations of 10 pphm or more at 09 PST on August 7. Victorville and Daggett also recorded concentrations of 10 pphm on that day. It is therefore reasonable to assume that carry-over from the previous day was widespread throughout the Mojave Desert.

Victorville

High ozone concentrations (10 pphm or more) occurred on four days during the July 1-August 15 period. On two of the days (August 7 and 8) high ozone concentrations were observed at Victorville during the night and it was clear that carry-over from the previous day was sufficient to account for the high ozone readings at 09 PST. In the remaining two cases southerly winds (from Cajon Pass) existed at Victorville until about midnight but without a strong pollutant impact during the evening at Victorville. The major impact may have missed Victorville during the evening and been transported into Victorville during the early forenoon. Alternatively, local sources may have contributed on these two days.

Barstow

A concentration of 10 pphm at 09 PST was observed on July 24. A high concentration was also observed during the night prior to the 09 PST observation. Transport into the area therefore occurred during the night. Light winds in the early morning permitted the solar radiation to operate on the pollutants left over from the previous night.

Daggett

Occurrences of 10 pphm ozone at 09 PST were observed on five days at Daggett. In all cases high ozone concentrations (10 pphm) were observed near midnight on the previous night at Daggett or Victorville. Clear evidence of transport into the eastern Mojave Desert was therefore apparent in all cases and the influence of local sources was probably minimal.

Lucerne

Ozone concentrations of 10 pphm or more at 09 PST occurred on two days at Lucerne during the July 1-August 15 period. In both cases light wind transport from the west continued all night through 07 PST, followed by light and variable winds to 09 PST. Given the evidence of westerly winds during the night and the lack of significant local sources the high ozone concentrations observed in the morning are attributed to transport of pollutant precursors into the area followed by irradiation in the early forenoon.

Indio

Concentrations of 10 pphm or more at 09 PST occurred at Indio on seven days in the period July 1-August 15. In all cases, there were northwest winds through the night until at least 06 PST, usually becoming light southerly thereafter. In six of the cases ozone concentrations near midnight at Indio were at least 10 pphm, indicating strong transport from San Gorgonio Pass. In one case (July 9) no evidence of high concentrations was observed at Indio or Palm Springs although northwest winds continued through 06 PST. In the absence of transport evidence, there is therefore a possibility on this day of local effects in the Indio-Palm Springs area.

Palm Springs

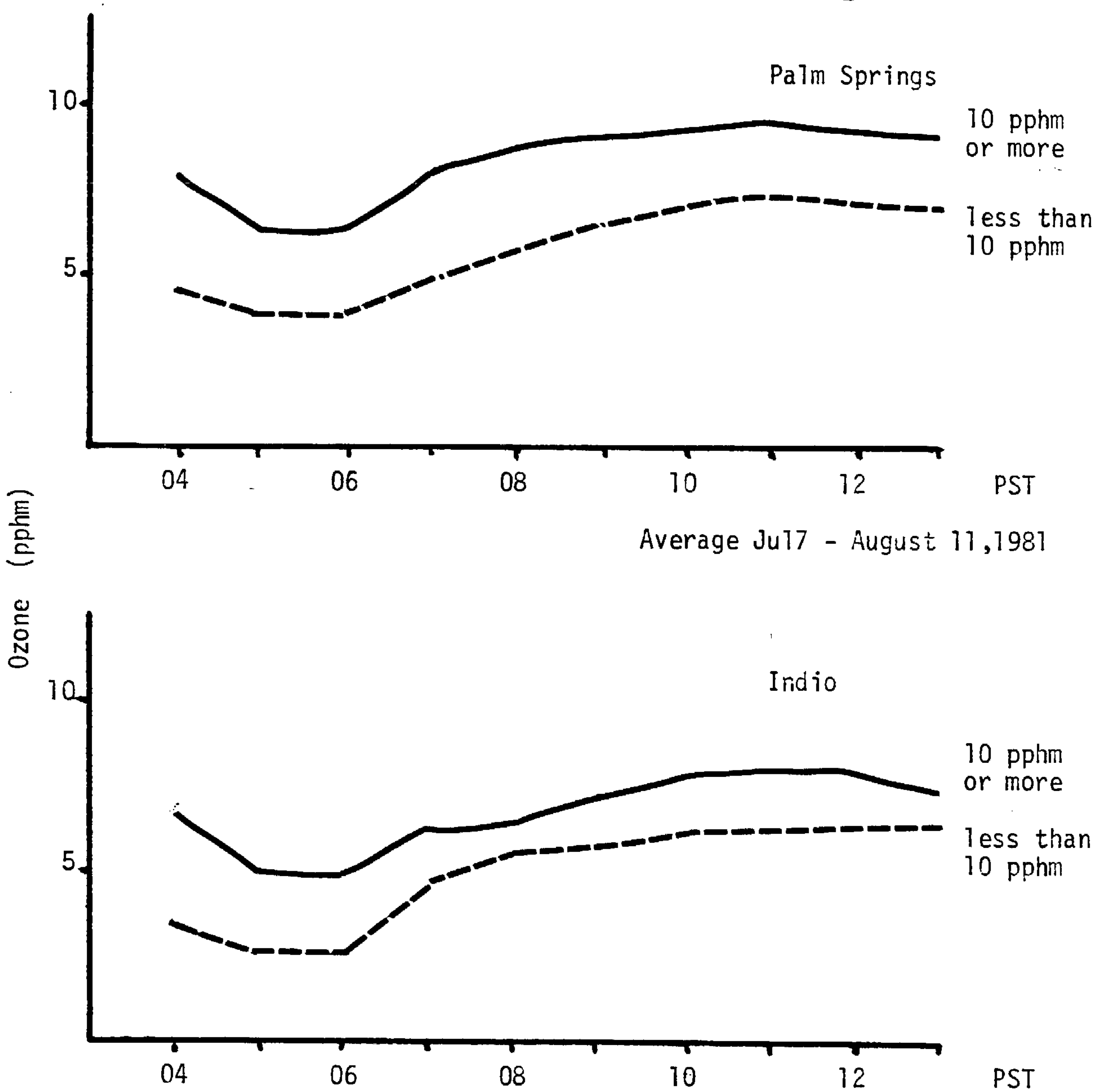
Ozone concentrations of 10 pphm or more occurred at 09 PST on six days during the period July 1-August 15. In all cases, northwest winds continued through the night to at least 04 PST before becoming light and variable. Concentrations of 8-13 pphm were observed at 23 PST during the previous evening The evidence was clear for transport into the area, followed by light winds in the early morning.

The percentage frequency of northwest winds at 23 PST at Palm Springs a Indio was shown in Table 4.3.2 to be 100 and 87.2%, respectively. The existenc of northwest winds through the night at Indio or Palm Springs is not necessaril evidence of carry over for the following morning. High ozone readings at 23 PST, however, can be used to indicate those specific nights when pollutants hav clearly been transported into the area and should be available for irradiation on the following day.

Occurrences of 10 pphm ozone or more at 23 PST at Indio and Palm Sprin were separated from cases of less than 10 pphm for the period July 7 to August 11. Average ozone readings for the two data sets are shown in Fig. 4.4.1. For both Indio and Palm Springs average hourly concentrations for the period 04 to 13 PST were higher when the 23 PST ozone on the previous night was 10 pphm or more. Average differences amount to about 2 pphm during all of the forenoon hours. Increases from the morning minimum (about 05 PDT) to the midday maximum average between 3 and 4 pphm regardless of location or the occurrence of high ozone during the previous night. This suggests that the main effect of the carry over pollutants is to raise the background level and that these transported pollutants are not contributing significant reactive components which will be subjected to radiation on the following day.

Aircraft Sampling

Aircraft soundings were made in the desert in the early morning on four days during the field program. One objective of the flights was to examine the pollutant levels in the desert prior to the early forenoon buildup of the secondary ozone maximum.



DIURNAL VARIATIONS IN OZONE RELATED TO PREVIOUS 23PST VALUE

Fig. 4.4.1

On two of the aircraft days, morning soundings were made in an area where 09 PST ozone concentrations reached 10 pphm. These soundings were made at Lucerne Valley on July 19 and in the Indio/Palm Springs area on July 23. In both cases, a relatively deep layer of ozone was present over the location where the early morning maximum of 10 pphm ocurred. On both days, the ozone layers aloft showed peak concentrations of 11 pphm with layer depths of 700 m at Lucerne Valley and 1250 m near Indio. These data indicate that a deep layer of relatively high ozone concentrations existed over the desert a few hours prior to the 09 PST surface reading. This layer was clearly a result of transport left over from the previous day since the surface mixing layer could not have extended to these depths at the time of the sounding. On the remaining days of morning aircraft sampling, relatively deep (600 to 1800 m) layers of ozone existed over the desert but with peak concentrations of 5-8 pphm. Evidence of some carry-over from the previous day was therefore found on each of the aircraft sounding days.

Summary

In summary, most occurrences of high ozone concentration at 09 PST in the desert are associated with transport during the previous afternoon and night. In most cases, this transport slows down significantly just prior to the 09 PST observation time. For several cases in Lancaster, however, moderate transport continued through the 09 PST time period. In a few cases, significant transport into the desert was not observed at any of the locations available. These few cases offer the principal opportunity for demonstrating the effects of local sources although transport might have occurred but been undetected in substantial quantities by the observing network.

Data from the tracer releases are an additional source of information on carry-over in the desert. Both fixed hourly samples and mobile automobile traverses in the desert were continued through the night following the release and into the next day. Small concentrations of tracer (around 10 ppt or less) were observed frequently in some areas, particularly the Coachella Valley. These concentrations, however, are near the noise level of the tracer measurement system and cannot be attributed positively to the effects of carry-over. A few concentrations greater than 10 ppt (10-15 ppt) were observed in the desert on a carry-over basis but in isolated locations and at isolated times. The evidence for significant carry-over of tracer material was therefore not conclusive.

4.5 Pollutant Loadings

Aircraft soundings of the vertical pollutant structure provide an opportunity to estimate the total pollutant loading at each of the sounding locations. Ozone and NO_x concentrations were summed vertically to the height where a background concentration appeared to have been reached or to the top of the sounding. Apparent ozone backgrounds in the Los Angeles basin averaged 4.9 pphm and 6.3 pphm in the desert areas for the same days.

Tables 4.5.1 and 4.5.2 give the results of the summations. Total loadings are given in units of g/m^2 which represents concentration times a layer depth. Afternoon values are shown in Table 4.5.1 while morning loadings are given in Table 4.5.2.

It is of interest to compare the pollutant loadings in the Los Angeles basin with those measured in the mountains or desert areas. On most afternoons the total loadings measured in the desert are a substantial fraction of the amount observed within the basin itself. This provides strong evidence for interbasin transport during the afternoons. Loadings in the three pass areas are particularly high in comparison to the comparable basin values. Variable loadings observed in the desert suggest non-uniform distributions of pollutant transport as might be expected from the limited number of transport routes available.

Morning values of NO_x loadings (Table 4.5.2) are of more interest than the ozone loadings due to diurnal influences on ozone values. As shown in the table, NO_x loadings in the desert can equal or exceed comparable values found in the basin during the early morning. These data provide further evidence of carry-over of pollutants in the desert from interbasin transport during the previous afternoon.

Table 4.5.1

POLLUTANT LOADINGS (AFTERNOON)

Location	Time (PDT)	Layer Depth (m)	Loadings (g/m^2) NO_x	O_3	O_3 (Above Background)
July 9					
Highland	1542	1310	0.86	0.46	0.40
Lake Gregory	1602	430	0.19	0.14	0.12
E Hesperia	1615	680	0.22	0.17	0.13
Cajon Pass	1648	2100	0.30	0.26	0.18
W Cajon Pass	1713	1700	0.42	0.31	0.17
I-10/111	1809	1190	0.53	0.41	0.29
Lake Arrowhead	1843	200	0.03	0.03	0.02
E Hesperia	1854	580	0.12	0.08	0.05
July 14					
Cable Airport	1535	500	0.64	0.33	0.28
Acton	1627	2370	0.81	0.74	0.42
5 W Palmdale	1740	1470	0.50	0.41	0.21
Adelanto	1903	1060	0.45	0.31	0.16
July 18					
Rialto	1521	1160	0.79	0.45	0.36
Cajon Jct.	1549	2410	0.53	0.47	0.18
Hesperia	1622	1470	0.13	0.30	0.12
W Cajon Pass	1652	1860	0.21	0.44	0.22
Victorville	1810	1680	0.38	0.35	0.15
July 22					
Rialto	1635	2110	0.97	0.62	0.37
Lake Gregory	1711	1230	0.20	0.30	0.15
Cajon Jct.	1742	2210	0.59	0.56	0.33
I-10/111	1846	3340	0.89	0.79	0.23
Palm Springs	1942	2780	0.35	0.49	0.09
Palm Springs	1956	310	0.09	0.07	0.01
July 27					
Rialto	1619	730	0.52	0.28	0.20
Lake Gregory	1639	1930	0.36	0.37	0.12
Victorville	1712	2180	0.33	0.49	0.22
I-10/111	1828	2240	0.76	0.57	0.21
Palm Springs	1927	725	0.46	0.31	0.11

Table 4.5.1 (Continued)

Location	Time (PDT)	Layer Depth (m)	Loadings (g/m^2) NO_x	O_3	O_3 (Above Background)
July 30					
Hesperia	1532	500	0.30	0.08	0.02
Redlands	1603	980	0.24	0.35	0.25
Santa Ana Canyon	1655	1890	0.11	0.32	0.09
High Desert AP	1734	2810	0.09	0.36	0.10
I-10/111	1818	750	0.11	0.22	0.15
Palm Springs	1845	1990	0.18	0.36	0.14
Palm Springs	2121	1300	0.19	0.29	0.16
August 3					
Rialto	1620	1240	0.60	0.43	0.29
Cajon Jct.	1645	2210	0.57	0.64	0.34
Santa Ana Canyon	1727	1600	0.29	0.34	0.16
Banning	1754	1140	0.36	0.34	0.21
I-10/111	1836	2380	0.58	0.64	0.34

Table 4.5.2

POLLUTANT LOADINGS (MORNING)

Location	Time (PDT)	Layer Depth (m)	Loadings (g/m^2) NO_x	O_3	O_3 (Above Background)
July 15					
Cable Airport	0834	1260	0.58	0.20	0.02
5 W Palmdale	0906	1570	0.18	0.17	0.05
Barstow	0959	1920	0.40	0.24	0.05
July 19					
Cable Airport	0657	960	-	0.16	0.05
Victorville	0732	480	0.07	0.07	0.01
Lucerne	0759	800	0.15	0.13	0.04
Barstow	0827	670	0.15	0.10	0.02
July 23					
Cable Airport	0652	1610	0.38	0.25	0.11
Yucca Valley	0743	1130	0.13	0.17	0.08
Indio	0817	2220	0.51	0.36	0.15
Palm Springs	0850	2690	0.37	0.45	0.21
August 11					
Brawley	1046	2040	0.13	0.23	0.07
Bermuda Dunes	1229	1300	0.20	0.15	0.01

4.6 Restricted Visibility in the Coachella/Imperial Valleys

Visibilities in the Coachella/Imperial Valleys are frequently restricted during the summer in spite of the presence of strong surface heating and vigorous low-level mixing. During the field period from July 7 to August 11, 1981 lowest visibilities reported at Palm Springs, Thermal and Imperial airports were 5, 4 and 3 miles, respectively. Sources of the visibility restrictions are transport of pollutants from upwind sources, local anthropogenic sources, blowing dust and nearby forest fires.

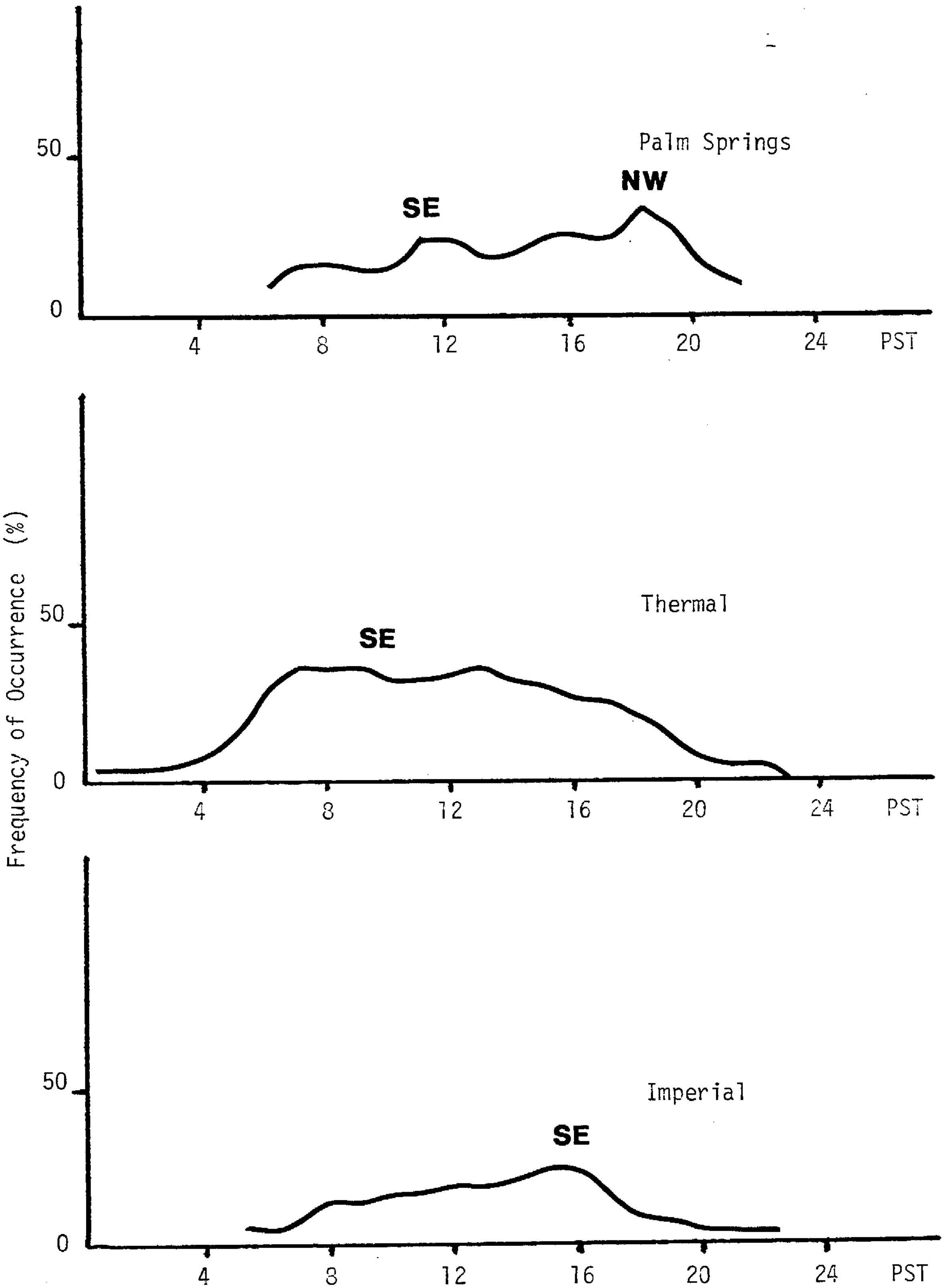
Hourly records for the three airport stations were examined for evidence of visibility restrictions during the field program. Remarks such as "Hazy" or "Haze All Quadrants" were considered to be evidence of at least mild visibility reduction. The frequency of days with such restrictions is plotted in Fig. 4.6.1 for each hour at the three airport locations. It is readily apparent that the highest frequency of restrictions occurred at Thermal where visibility was considered to have been reduced on over one-third of the days during the field program. The overall frequencies shown for Palm Springs and Thermal may be somewhat higher than normal due to a major forest fire near Idyllwild on August 3 which lasted for several days and clearly influenced the Coachella Valley.

Diurnal variations in the occurrence of restricted visibilities are also shown in Fig. 4.6.1. Peak frequencies are identified with the prevailing wind direction at that hour of the day.

The principal peak at Palm Springs occurs at 18 PST and is associated with direct transport from the northwest. A smaller peak occurs at 11-12 PDT and is accompanied by southeasterly winds. There are also two peaks at Thermal (08 and 13 PST) but these are both associated with southeast winds.

It was indicated in Section 4.4 that high 23 PST ozone levels at Indio or Palm Springs provided an indication of potential pollutant carry over on the following morning. Of the ten such high ozone occurrences at Palm Springs (July 7 to August 11) seven of the cases showed restricted visibility on the following morning. Similary, Indio had fifteen cases of high ozone at 23 PST of which eleven exhibited reduced visibility at Thermal during the following morning. Palm Springs had four cases of reduced visibility during the morning (excluding forest fires) which were not associated with high ozone during the previous night. Thermal also experienced restricted visibility during the morning on seven additional days which were not preceded by ozone values of 10 pphm or more at 23 PST on the previous night.

These data suggest that visibility restrictions in the Coachella Valley tend to be associated with the occurrence of high ozone episodes resulting from transport out of the Los Angeles basin. However, there are a number of cases of restricted visibility at both Indio and Palm Springs which do not fit this relationship. These cases point to contributions from local sources (particularly near the northern Salton Sea area) or, possibly, from transport northward from the Imperial Valley.



DIURNAL VARIATIONS IN FREQUENCY OF RESTRICTED VISIBILITY

Fig. 4.6.1

Data from Imperial Airport (Fig. 4.6.1) show the lowest frequency of visibility restrictions of the three airports shown. Peak frequency occurred at 15-16 PST and was associated with southeast winds. Reported visibility was less than 10 miles on 12 days with some visibility restriction reported on fifteen days between July 7 and August 11.

The high frequency of days with visibility less than 10 miles suggests the presence of local sources. These include fugitive dust, agricultural burning and plowing and possibly transport from Mexico.

Results of tracer test No. 8 suggest the possibility of transport from the Imperial Valley northwestward into the Coachella Valley in a period of 24 hours or less. In this case, there should be a tendency for restricted visibility in the Imperial Valley to be followed by restrictions in the Coachella Valley. Of the twelve cases of less than 10 mile visibility as reported at Imperial Airport, seven of these cases were followed by visibility restrictions at Thermal on the following day. All of these seven cases, however, are included in those previously associated with transport from the Los Angeles basin or from local sources near Thermal. The evidence for transport from the Imperial Valley is therefore uncertain at this time.

4.7 Summary of Tracer Results

Trajectories

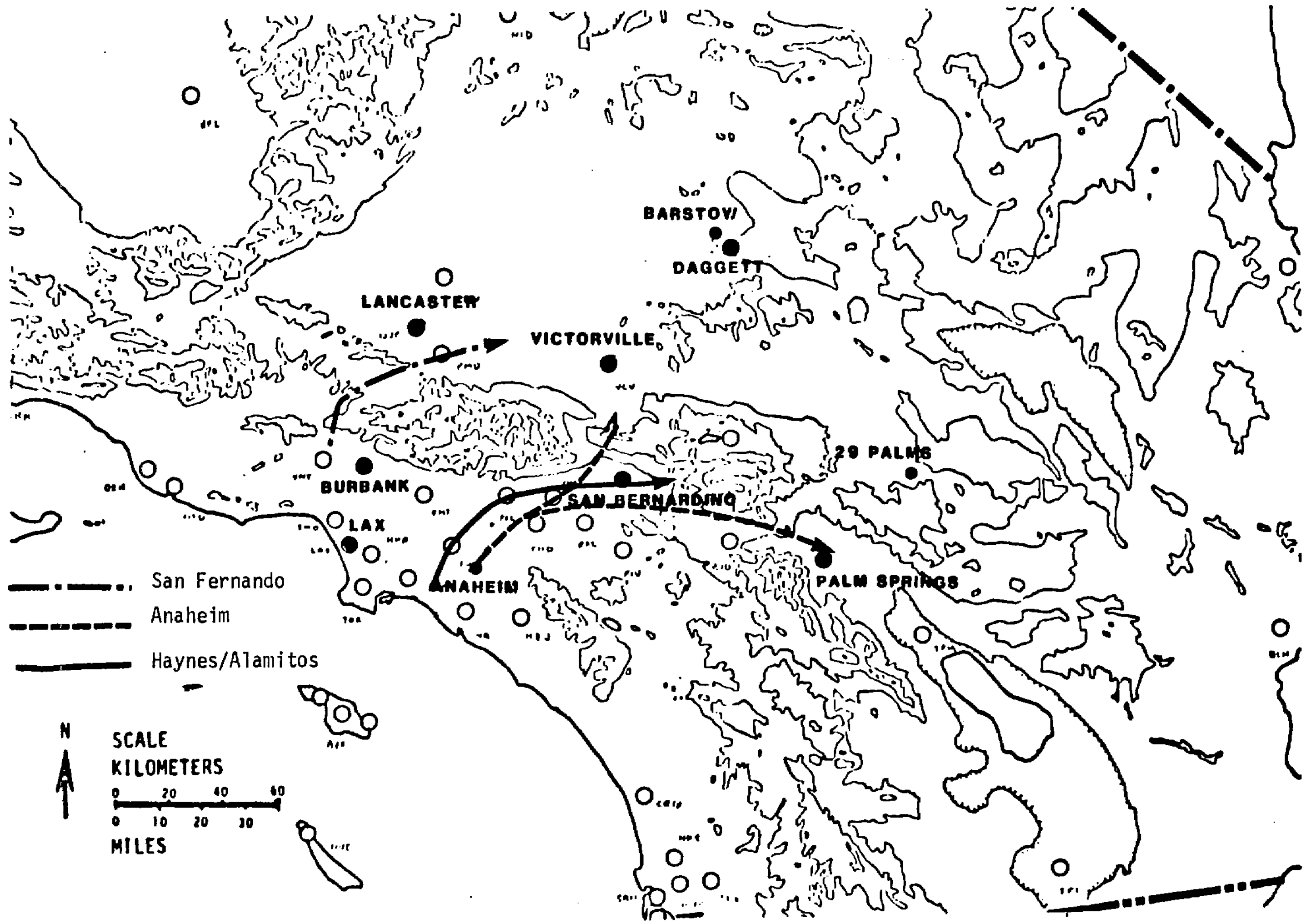
In addition to the tracer tests conducted during the present study, several other tests have been carried out previously under CARB sponsorship. These include six releases from the Haynes/Alamitos power plants (Drivas and Shair, 1974) and a release from the San Fernando Valley (Reible, Ouimette and Shair, 1982). Observed trajectories from these releases are shown in Fig. 4.7.1. The trajectories for the six releases from Haynes/Alamitos can be readily approximated by the one trajectory shown in the figure.

All trajectories for releases made in the Los Angeles basin exhibit considerable similarity. Using the trajctory maps in Section 3, Fig. 4.7.1 and the most frequent wind directions shown in Figs. 2.5.1 to 2.5.7, two figures have been constructed (Figs. 4.7.2 and 4.7.3) to show conceptually the effects of release location in the Los Angeles basin on expected trajectory. A pronounced wind shift to a more westerly direction typically occurs in the western part of the basin between 10 and 12 PDT during the summer. For this reason the trajectory information has been divided into releases made prior to 10 PDT and those made in the late forenoon.

Fig. 4.7.2 outlines three areas in the basin. In the northwest area the trajectory of pollutants is characteristically out through the San Fernando Valley and Soledad Canyon. In the southern section, pollutants released should generally be transported into the Elsinore convergence ozone. Finally, there is a central sector where pollutants should be carried eastward into the eastern San Gabriel Valley and out of the basin through Cajon or San Gorgonio Pass or upslope along the San Gabriel or San Bernardino Mts.

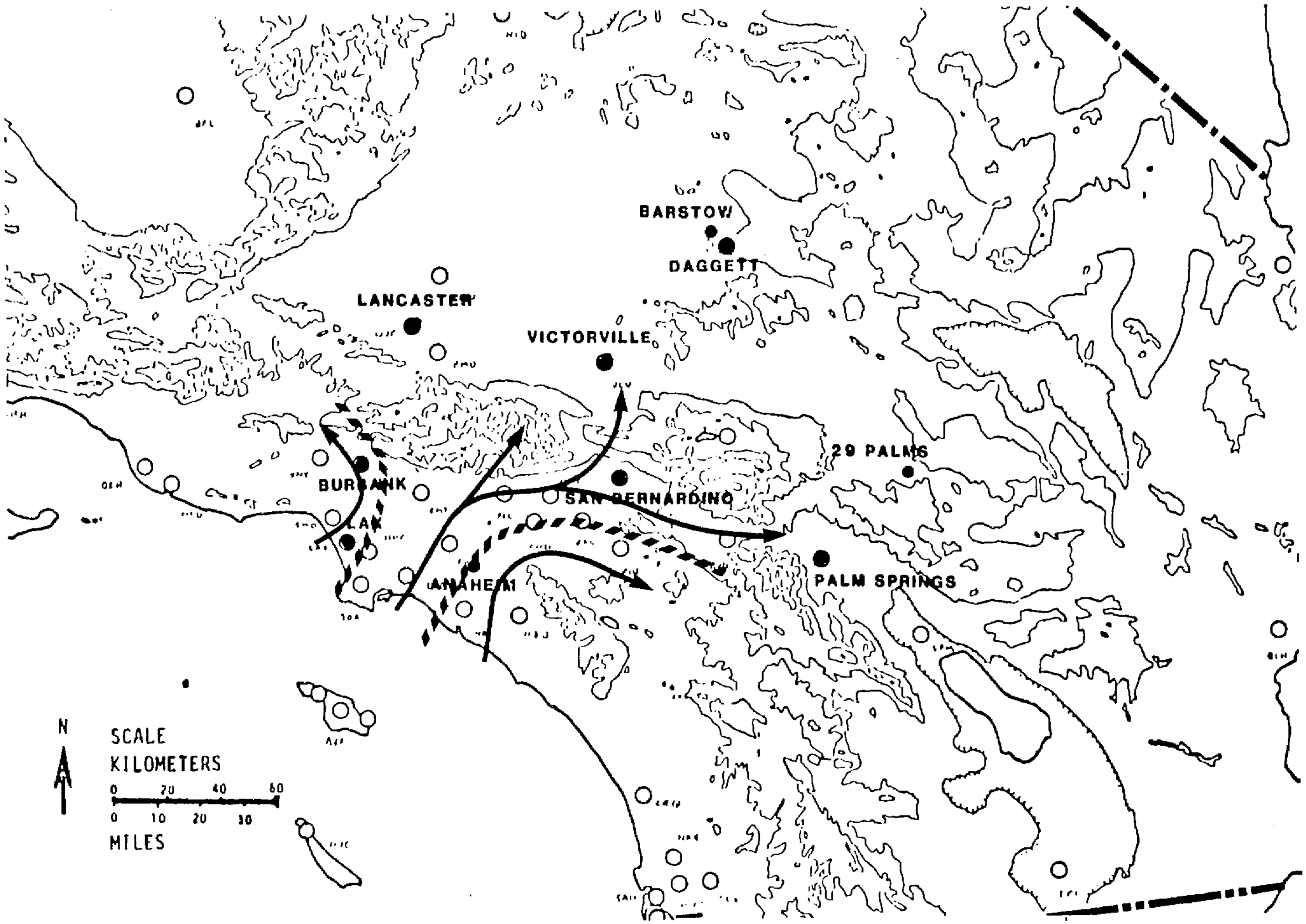
Fig. 4.7.3 shows similar sectors for releases later in the morning. The effect of the shift toward a more westerly wind is to expand the central sector at the expense of both the northwestern and southern sectors. Transport into the eastern San Gabriel Valley therefore becomes a more effective route by late forenoon.

The sector boundaries shown in the figures are not fixed and distinct. Day-to-day variations in surface pressure gradients will shift the boundaries somewhat and, as indicated, time of day also has an effect on boundary locations. The purpose in presenting the figures is to provide a conceptual picture which will aid in the understanding of the importance of release location in determining exit routes for pollutants leaving the Los Angeles basin.



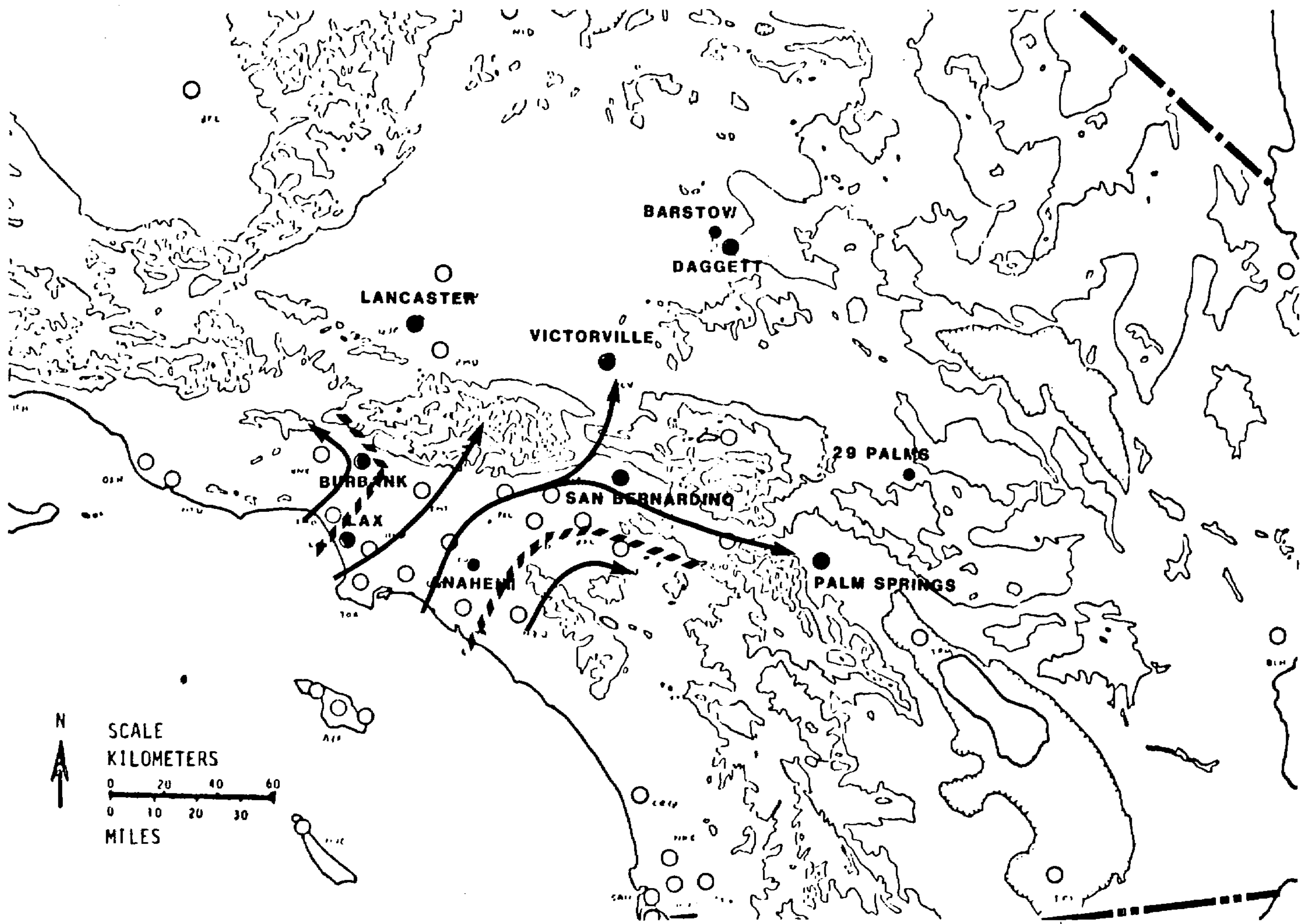
TRAJECTORIES OF PREVIOUS TRACER RELEASES

Fig. 4.7.1



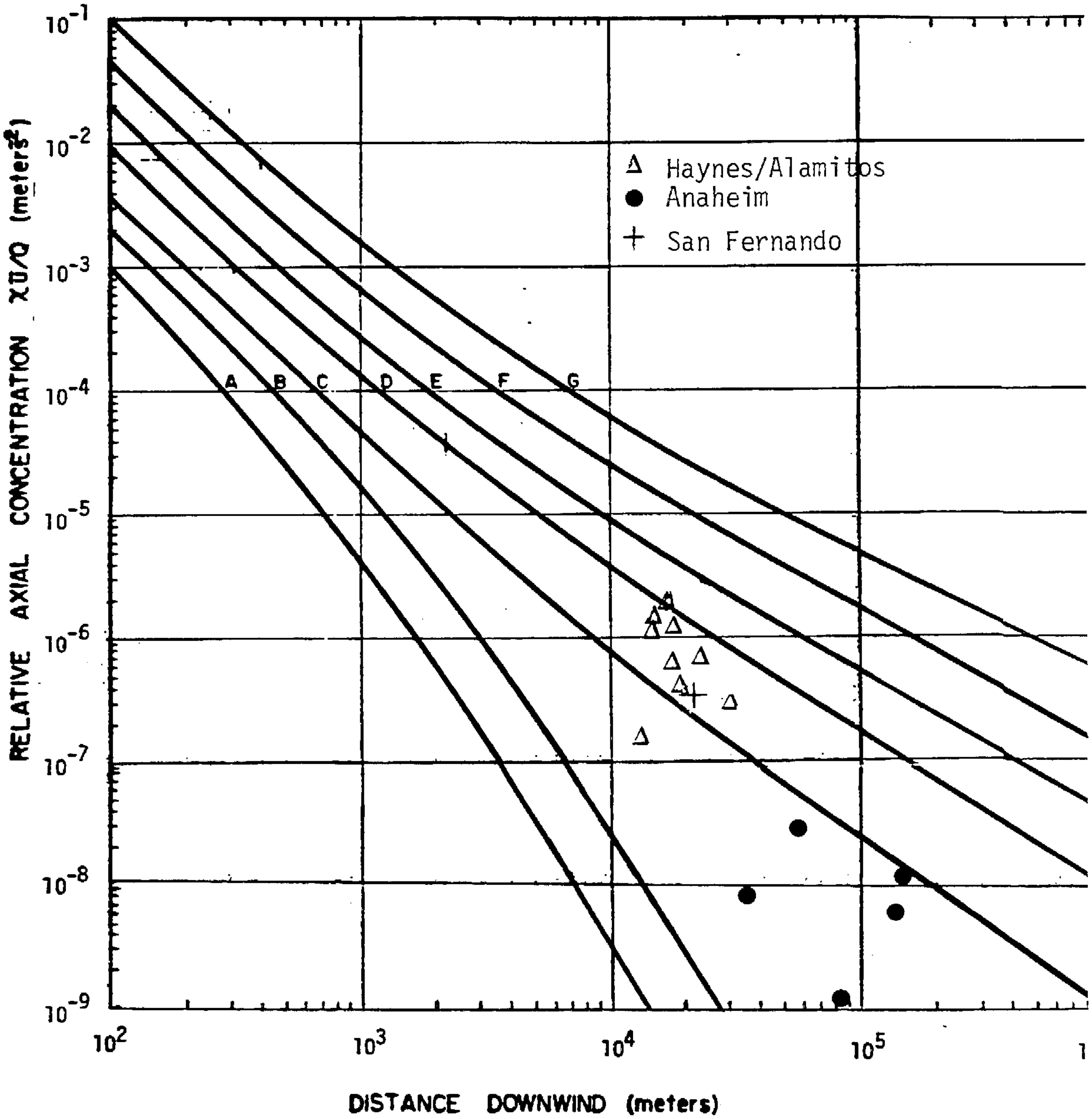
SCHEMATIC VIEW OF SOURCE AND RECEPTOR LOCATIONS - MORNING RELEASES

Fig. 4.7.2



SCHEMATIC VIEW OF SOURCE AND RECEPTOR LOCATIONS - MIDDAY RELEASES

Fig. 4.7.3



XU/Q VALUES FOR PREVIOUS TRACER RELEASES

Fig. 4.7.4

Concentrations

Calculated values of Xu/Q for the earlier CARB tracer tests are shown in Fig. 4.7.4. Plotted values correspond to C-D stability conditions as defined by the Gaussian model. Values for the Anaheim release suggest slightly lower concentration values but the sampler density was quite limited.

All of the tracer results from the present study together with those shown in Fig. 4.7.4 are in substantial agreement in showing C-D stability conditions, despite the differences in wind speed, terrain etc. Given daytime releases and summer heating conditions, the concentrations are not at all surprising. Within the limitations of the sampling density there appears to be little difference in concentrations measured in the basin and the desert locations when compared to the Gaussian model. Variations in wind speed appear to have been accounted for adequately by use of an average wind speed during release for Xu/Q calculations in spite of a more than 10-fold variation in release site wind speeds.

The observed concentration data were treated as though maximum centerline concentrations had been observed. In a program of the present geographical scale, this assumption will frequently not be realistic. More weight should therefore be given to the upper bound values of Xu/Q than the lower concentrations which may have been influenced by the inability to sample the true centerline maximum. A range in upper bound values from C to slightly over D covers all tracer tests analyzed.

For reference purposes, all calculated Xu/Q values are shown in Tables 4.7.1 through 4.7.8.

Cloud Widths

Although the tracer tests were not designed to obtain data on cloud widths specifically, data from a few traverses can be used to estimate widths in terms of σ_y. The area of greatest interest for such estimates is immediately downwind of the principal pass areas. Releases from Sylmar (Test 2) and Cajon Junction (Test 3) provide a small amount of data for those estimates.

Table 4.7.9 shows calculated values of σ_y for two traverses immediately downwind of Cajon Pass and one downwind of Soledad Canyon.

Table 4.7.9

CALCULATED CLOUD WIDTHS (σ_y)

Date	Release Location	Time	Downwind Distance	σ_y	σ_y for A Stability
July 14	Sylmar	19 PDT	112 km	12.3 km	12.0 km
July 18	Cajon Jct.	18 PDT	18 km	2.3 km	2.7 km
July 18	Cajon Jct	18 PDT	26 km	4.0 km	5.1 km

Table 4.7.1

Xu/Q CALCULATIONS

TEST 1 - Culver City Release (13.0 g/sec. from 06-10 PDT)
July 9, 1981

(average wind during release 1.0 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q ($m^{-2}x10^{-7}$)
Hourly					
Banning	67	1800	144	4.4	.308
Azusa	51	1200	42	3.9	.235
Bombay Beach	19	2100	275	6.4	.087
Indio	36	2000	210	5.3	.166
Arrowhead	37	1700	108	3.7	.170
Palm Springs	13	2000	178	4.5	.060
Riverside	46	1500	93	4.3	.212
San Bernardino	75	1600	101	4.0	.345
Palmdale	13	2200	83	1.8	.060
Auto					
Highway 134	1627	1130	22	2.4	7.48
San Fernando	522	1300	33	2.3	2.40
Sunland	242	1400	33	1.8	1.11
San Fernando	208	1400	35	1.9	.957
Palmdale	30	1600	94	3.7	.138
Barstow	14	1830	203	5.9	.064
Airplane					
San Fernando	134	1400	33	1.8	.616
Barstow	26	1800	203	6.3	.120
Banning	123	1800	144	4.4	.566

Table 4.7.2

Xu/Q CALCULATIONS

TEST 2 - Sylmar Release (9.9 g/sec. from 11-15 PDT)
July 14, 1981

(average wind during release 2.0 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q ($m^{-2}x10^{-7}$)
Hourly					
Barstow	10	2000	152	6.0	.121
Edwards AFB	25	1700	82	5.7	.302
Palmdale	36	1500	43	6.0	.435
Auto					
E of Newhall	96	1430	15	4.2	1.16
SW of Lancaster	85	1645	42	3.1	1.03
N of Victorville	119	1900	118	5.5	1.48
Victorville	78	2200	121	3.7	.942

Table 4.7.3

Xu/Q CALCULATIONS

TEST 3 - Cajon Junction Release (9.4 g/sec. from 13-17 PDT)
July 18, 1981

(average wind during release 6.9 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q ($m^{-2}x10^{-7}$)
Hourly					
Lucerne Valley	14	2000	50	2.8	.614
Victorville	33	2200	26	1.0	1.45
Auto					
NW of Cajon	288	1545	15	5.5	12.64
NW of Cajon	117	1615	24	5.3	5.14
WSW of Victorville	44	1645	24	3.8	1.93
W of Victorville	29	1910	34	2.3	1.27
W of Barstow	19	2200	79	3.1	.834
E of Barstow	14	2215	88	3.4	.615
Airplane					
N of Cajon Pass	153	1710	15	1.9	6.72
N of Cajon Pass	122	1730	15	1.7	5.35
WNW of Barstow	24	1730	83	9.2	1.05
Victorville	51	1820	25	2.1	2.24
SW of Barstow	26	1900	60	4.2	1.14

Table 4.7.4

Xu/Q CALCULATIONS

TEST 4 - South Fontana Release (10.4 g/sec from 13-17 PDT)
July 22, 1981

(average wind during release 3.7 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q ($m^{-2}x10^{-7}$)
Hourly					
Big Bear	42	1800	59	5.5	.894
Indio	23	1900	120	8.3	.489
Lake Arrowhead	22	1600	27	7.5	.468
Joshue Tree	17	2100	118	5.5	.362
Riverside	27	1600	13	3.6	.574
29 Palms	35	0000	136	4.2	.745
Amboy	36	1000	186	2.7	.766
Blythe	17	1800	276	2.8	.362
Bombay Beach	10	0000	189	5.8	.213
Desert Center	22	0600	202	3.7	.468
Auto					
San Bernardino	600	1400	22	6.1	12.76
W of Redlands	421	1430	20	3.7	8.96
Highland	432	1800	30	2.8	9.19
Big Bear	84	1730	43	4.8	1.79
I-10/111	97	2000	87	4.8	2.06
Desert Hot Springs	34	2215	96	3.7	.723
W of Desert Center	67	2300	170	5.9	1.42
Airplane					
Banning	163	1845	57	4.2	3.47
San Bernardino	157	1810	39	3.4	3.34
Banning	52	1830	65	5.2	1.11
I-10/111	58	1900	87	6.0	1.23
I-10/111	62	2015	87	4.6	1.32
Desert Hot Springs	170	1940	96	5.7	3.62

Table 4.7.5

Xu/Q CALCULATIONS

TEST 5 - Garden Grove Release (12.1 g/sec. from 05-09 PDT)
July 27, 1981

(average wind during release 0.5 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q ($m^{-2}x10^{-7}$)
Hourly					
Corona	654	1200	35	2.4	1.62
Cajon	83	1400	83	3.8	.205
Desert Center	117	2100	262	5.6	.289
Lake Arrowhead	14	1500	90	3.6	.035
Indio	13	0100	179	2.9	.032
Perris	49	1500	70	2.8	.121
San Bernardino	21	1700	77	2.4	.052
Upland	20	1200	45	3.1	.049
Auto					
SE of Anaheim	4379	1000	12	1.7	10.82
E of Anaheim	902	1030	12	1.3	2.23
Corona	206	1100	34	3.1	.509
E of Anaheim	1776	1100	16	1.5	4.39
SE of Anaheim	594	1050	12	1.2	1.47
Corona	1251	1200	34	2.4	3.09
E of Corona	536	1330	37	1.9	1.32
SE of Pomona	70	1400	33	1.5	.173
SE of Pomona	13	1430	48	2.0	.032
Lake Elsinore	118	1600	68	2.4	.292
San Bernardino	21	1645	72	2.3	.052
Lake Elsinore	106	1610	73	2.5	.262
Elsinore	72	1700	73	2.3	.178
Airplane					
Elsinore	59	1800	92	2.5	.141
Elsinore	47	2000	82	1.9	.116

Table 4.7.6

Xu/Q CALCULATIONS

TEST 6 - Carson Release (11.4 g/sec. from 05-09 PDT)
July 30, 1981

(average wind during release 0.7 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q ($m^{-2} x10^{-7}$)
Hourly					
Azusa	51	1600	43	1.5	.187
Barstow	16	0200	177	2.7	.059
Cajon	33	2000	102	2.4	.121
Lake Arrowhead	14	1800	112	3.1	.051
Pasadena	40	1600	32	1.1	.147
San Bernardino	24	1700	98	3.0	.088
Upland	45	1800	56	1.6	.165
Victorville	27	1800	126	3.5	.099
Indio	19	0200	206	3.2	.070
Palm Springs	17	0300	176	2.6	.062
Perris	16	0400	120	1.7	.059
Auto					
W of Carson	2560	0930	2	2.4	9.40
S Los Angeles	34	1030	19	2.1	.125
S Los Angeles	37	1145	22	1.6	.136
Highway 605	130	1400	22	1.0	.477
Highway I-5	153	1400	22	1.0	.562
S of Pomona	51	1340	30	1.5	.187
NW of Pomona	176	1545	51	1.8	.646
SE of Azusa	76	1645	55	1.7	.279
SE of Azusa	76	1830	95	2.5	.279
SE of Azusa	48	2130	93	1.9	.176
SE of Azusa	54	2100	94	2.0	.198
NW Palm Springs	20	2200	155	3.1	.073
N Palm Springs	22	2345	168	3.0	.081
Airplane					
Banning	26	2210	136	2.7	.095

Table 4.7.7

Xu/Q CALCULATIONS

TEST 7 - Ontario Release (8.8 g/sec. from 05-09 PDT)
August 3, 1981

(average wind during release 1.3 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q ($m^{-2}x10^{-7}$)
Hourly					
Cajon	70	1300	35	1.9	.618
Upland	3457	0900	11	3.0	30.54
San Bernardino	44	1200	32	2.2	.389
Lucerne Valley	11	1500	95	3.8	.106
Auto					
E Pomona	4577	0930	5	0.9	40.43
E Pomona	1532	1030	7	0.8	13.53
E Pomona	1237	1045	3	0.3	10.93
E Ontario	94	1330	9	0.5	.830
Airplane					
Rialto	67	1650	21	0.7	.768

Table 4.7.8

Xu/Q CALCULATIONS

TEST 8 - Brawley Release (8.1 g/sec. from 06-0850 PDT)
August 11, 1981

(average wind during release 1.5 m/s)

Location	X max (ppt)	Time (PDT)	Distance (km)	Travel Velocity (m/s)	Xu/Q (m^{-2}x10^{-7})
Auto					
S Salton Sea	147	1220	21	1.2	1.63
W Salton Sea	24	1700	40	1.2	.266
W Salton Sea	44	2045	42	0.9	.487
Indio	42	13/12	98	1.0	.465

It can be seen from the table that the observed cloud widths correspond closely to A stability conditions in spite of the Xu/Q values which suggest that C-D would be more appropriate. If the few cloud widths observed are indicative, it would be assumed that horizontal divergence accompanied by vertical convergence occurs immediately downwind of the pass exits where the unconstricted flow from the passes is allowed to spread horizontally.

Tracer Impact on Desert Areas

Tables 4.7.10 and 4.7.11 summarize the maximum tracer impact (Xu/Q) values observed at various desert stations. These data were taken from Tables 4.7.1 through 4.7.8 and were divided into Table 4.7.10 (impact from western Los Angeles basin) and Table 4.7.11 (impact from eastern basin and pass ares). These values were the highest observed during the tracer tests but may not represent the true maximum because of incomplete sampling of the centerline concentrations.

Table 4.7.10

MAXIMUM TRACER IMPACT FROM WESTERN LOS ANGELES BASIN

Test No.	Release Location	Sampling Location	Maximum Xu/Q
1	Culver City	Barstow	$.0064 \times 10^{-6} m^{-2}$
1	Culver City	Palmdale	.0138
6	Carson	Palm Springs	.0081
1	Culver City	Indio	.0166
1	Culver City	Bombay Beach	.0087
6	Carson	Victorville	.0099

Table 4.7.11

MAXIMUM TRACER IMPACT FROM BASIN BOUNDARIES

Test No.	Release Location	Sampling Location	Maximum Xu/Q
2	Sylmar	Barstow	$.0121 \times 10^{-6} m^{-2}$
2	Sylmar	Edwards AFB	.0302
2	Sylmar	Palmdale	.0435
2	Sylmar	Victorville	.0942
3	Cajon Jct.	Lucerne	.0614
3	Cajon Jct.	Victorville	.1449
3	Cajon Jct.	Barstow	.0834
4	South Fontana	Indio	.0489
4	South Fontana	Joshua Tree	.0362
4	South Fontana	29 Palms	.0745
4	South Fontana	Amboy	.0716
4	South Fontana	Blythe	.0362
4	South Fontana	Bombay Beach	.0213
4	South Fontana	Desert Center	.0468
4	South Fontana	Desert Hot Springs	.0723

Tracer Carry Over

A major effort was made during the study to sample tracer concentrations in the desert areas on the day following the tracer release. A principal objective of the study was focused on the potential carry over of pollutants transported into the desert and their influence on pollutant level during the followng day.

In spite of extensive sampling there was little evidence of a coherent pattern of carry over tracer of as much as 10 ppt. The few cases observed with higher concentrations were isolated and not convincingly related to the previous day's release. The one exception was a series of nine samples taken at Indio between 0800 and 1250 PDT on August 12. These samples ranged from 17 to 42 ppt. and are believed to have come from the previous day's release at Brawley.

From the standpoint of tracer concentrations the evidence for pollutant carry over is very minor.

San Gabriel Valley Concentrations

During the course of a large number of automobile trips between Pasadena and San Bernardino a number of relatively high SF_6 concentrations were observed. Many of these appeared somewhat unrelated to tracer releases.

Details of the concentrations observed are given in Section 3 for each of the tracer tests. Table 4.7.12 summarizes the maximum concentrations measured between Pasadena and San Bernardino on the day following each of the tracer tests.

Table 4.7.12

MAXIMUM SF_6 CONCENTRATIONS PASADENA TO SAN BERNARDINO

Test No.	Date	Maximum Concentration
1	July 10	127 ppt
2	July 15	>150
3	July 19	none
4	July 23	137
5	July 28	28
6	July 31	44
7	August 4	55
8	August 12	20

The most frequent location for the highest observed concentration was to the west of Pomona in the vicinity of the intersection of Highways 210 and 605.

There are several factors which might contribute to the presence of these concentations:

1. There may be a sporadic, extraneous source of SF_6 in the area.

2. There is a possibility that some of the observed material released on one day may be recirculated back into the basin through drainage flows during the night and early morning.

3. Small amounts of tracer may be carried over within the basin from day-to-day. Buildings, terrain, trees, and bushes all provide sheltered areas where the tracer material may remain after the primary cloud has passed.

This question should receive further attention prior to the conduct of further SF_6 tests near the San Gabriel/San Bernardino Mts. slopes.

5. CONCLUSIONS

1. The northern portion of the Mojave Desert is affected primarily by flow from the San Joaquin Valley. The southern portion is influenced primarily by flow through Soledad Canyon from areas to the south and southwest. The zone of confluence is located in the vicinity of Edwards AFB, shifting north or south on a day-to-day basis.

   The portion of Los Angeles County emissions which feed into the Soledad Canyon flow represents about twice the total emissions of NO_x and THC produced by Kern County. Consequently, the impact of transport from Los Angeles County into the Mojave Desert is significantly greater than the contribution of Kern County.

2. A southeasterly monsoon flow covers the southern and eastern portions of the Southeast Desert Air Basin. This flow dominates the Coachella and Imperial Valleys until late afternoon. The western boundary of the southeasterlies shifts to the east during the late afternoon and evening and moves back westward by the following morning.

3. A strong wind surge from the west and northwest frequently occurs during the night, particularly in the Mojave Desert. Peak velocities are reached around 20-22 PDT with a layer depth of 1500 m or less.

4. Convergent zones occur during the night between the westerly and southeasterly flows, and between separate branches of the sea breeze flow. Convergent areas include the Coachella Valley, Elsinore, El Mirage and the vicinity of the Ord Mts., south of Daggett.

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

6. Backward trajectories from the average time of peak ozone at desert locations indicate a source region in central Los Angeles from Burbank to Anaheim. Two desert areas, (Daggett-Barstow and Edwards AFB), however, suggest trajectories from the San Joaquin Valley on a most frequent basis.

7. High altitude locations in the San Gabriel and western San Bernardino Mts. frequently experience high ozone occurrences. The hourly ozone concentrations during the July-August 1981 field program was 35 pphm at Mt. Baldy, Lake Gregory and Fontana. Mt. Wilson experienced a peak value of 29 pphm.

8. A significant portion of the basin air exits through the region from Mt. Baldy to Lake Gregory. The pollutant flux decreases sharply to the east of Lake Gregory but increases again through San Gorgonio Pass. Peak hourly ozone occurrence at Fawnskin was 15 pphm during the field program. The Santa Ana River Canyon was not a major exit region for pollutants on the two days when sampling took place in the area.

9. Ozone concentrations at Mt. Baldy and Lake Gregory frequently showed a midday peak value associated with local pollutant sources in the eastern San Gabriel Valley as well as an afternoon peak which was related to transport from the central Los Angeles area.

10. In each of the three major passes there was evidence of two or more layers of ozone being transported into the desert. The lower layer consisted of direct transport through the low levels of the pass. The upper layer was associated with up slope flow along the shoulders of the pass which delivered pollutants to a level where they could be transported through the upper portion of the pass. This, in effect, substantially increased the transport through the pass region.

11. Downwind of San Gorgonio Pass the upper layer was brought to the surface, on occasion, by the effects of lee wave action on the desert side of the pass. This led to higher ozone concentrations in the desert than were observed in the pass at Banning. Downwind of Soledad Canyon and Cajon Pass the upper layer continued aloft across the desert without surfacing on those days when observations were made.

12. On each of four mornings when aircraft flights were made in the desert, relatively deep layers (700 to 1200 m) of ozone were observed, particularly in the Coachella and Lucerne Valley areas. Peak ozone concentrations were 10-11 pphm on two of the days. These layers were associated with transport into the area during the previous afternoon and evening.

13. Total NO_x loadings as measured by morning aircraft spirals in the desert were comparable to those in the Los Angeles basin. Afternoon loadings were highest in the basin and in the immediate vicinity of the passes. These data provide another indication of transport and carry over into the desert areas.

14. On 10-15% of the days during the field program high ozone concentrations (10 pphm or more) were present at 09 PST at Indio and Palm Springs. These high concentrations were associated with transport from the Los Angeles basin. Diurnal ozone increases on these days, however, were similar to observed increases on days with low morning concentrations. It is suggested that the principal effect of the carry over is to provide a high background level of ozone rather than to provide additional precursors.

15. Morning visibility restrictions observed in the Coachella Valley are generally associated with transport from the Los Angeles basin but evidence of local contributions is apparent. Local sources are the primary contribution to restriction in the Imperial Valley.

16. Tracer trajectories carried SF_6 material along the San Fernando-Newhall-Lancaster route, through Cajon Pass and San Gorgonio Pass, up the slopes of the San Gabriel and San Bernardino Mts. and into the Elsinore convergence zone, depending on release location and time. Primary tracer impacts in the desert from Los Angeles basin releases were found at Palmdale, Victorville, and Indio. Smaller impacts were noted as far as Barstow, Amboy, Blythe and Bombay Beach. There was no evidence of tracer impact at China Lake from any of the releases in spite of extensive sampling at that location.

17. Similarities in tracer trajectory routes led to a schematic perspective in which source regions in the northwest fed into Soledad Canyon, regions in the south fed into the Elsinore convergence zone and, in the central zone, sources fed into Cajon and San Gorgonio Passes as well as the San Gabriel/San Bernardino Mts. slopes. The boundaries of the zones shift somewhat from day-to-day and diurnally.

18. Maximum observed tracer impacts from Culver City were comparable at Palmdale and Indio. From Carson the maximum impacts were similar at Victorville and Palm Springs.

19. An area of anomalous SF_6 concentrations was observed on a number of occasions between Pasadena and Pomona. Further investigation is recommended before additional tracer studies are made near the mountain slopes.

6. RECOMMENDATIONS

1. It has been determined from the present program and from previous studies that slope flow along the San Gabriel and San Bernardino Mts. provides a significant mechanism for removal of pollutants from the Los Angeles basin. There is, however, considerable variation along the ridge line with a major contribution observed in layers within an extended crossection of Cajon Pass. Because of this east-west variation in effectiveness it is difficult to quantify the total pollutant burden exiting from the basin along this route. In addition, the fate of the upslope pollutants is not clear. There is considerable evidence that they form a layer aloft (subject to upper level wind direction) which may or may not subsequently contribute to ground concentrations elsewhere. Additional studies of this mechanism would aid in the development of more realistic modeling of the basin and would determine whether significant downwind impacts could be associated with the effects of the upslope flow.

2. The relative contribution of the Los Angeles basin and the San Joaquin Valley to pollutants in the Mojave Desert is a matter of considerable interest. Evidence suggests that the northern part of the desert is influenced by the San Joaquin Valley and the southern part by the Los Angeles basin. Through the use of aircraft and pibal soundings, pollutant flux calculations could be made along a vertical plane (e.g. from south of Palmdale to north of Mojave). These would permit delineation of the effects of the two flows and permit the requirements for upwind control to be better evaluated.

3. The eastern San Gabriel Valley (Pomona - San Bernardino - Riverside) appears to be a light-wind reservoir where late afternoon pollutants from Los Angeles can reside overnight and combine with local pollutants to produce significant local contributions during the following morning. These affect the mountain slopes as well as the eastern basin. Under some episode conditions, the residence time of pollutants in the area may be longer than one 24-hour period. With the forecasts of rapid population growth in the area, the ventilation of the eastern basin under episode conditions should be examined.

4. The hypothesis was advanced in this study that carry-over of pollutants in the Coachella Valley contributes to the background ozone level but that the reactive component of these pollutants did not seem to contribute greatly to local concentrations. This could easily be checked by reactive hydrocarbon measurements in the Palm Springs - Indio area under a range of morning background ozone levels.

5. Suggestive indications of transport from the Imperial Valley into the Coachella Valley were obtained during this study. A more serious study could evaluate the extent of this contribution from the Imperial Valley.

6. A number of apparently extraneous SF_6 concentrations were observed in the eastern San Gabriel Valley during the field program. Although they did not create a major problem for the present study, they may limit the usefulness of tracer techniques in certain areas of the basin. A few mobile surveys of the area might be able to define the extent of the potential problem.

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