State of California

Memorandum

To: John Sanders
Acting Branch Chief
Environ. Monitoring and Pest Management

Date: September 3, 1992

Place: Sacramento

From: Department of Pesticide Regulation - Randy Segawa, Terre11 Barry, Carissa Gana
Environmental Hazards Assessment Program

Subject: Results of Off-Site Air Monitoring Following Methyl Bromide Chamber Fumigations and Evaluation of the ISCST Model

SUMMARY

The objective of this study was to determine if the Industrial Source Complex, Short Term (ISCST) simulation model could reliably estimate downwind air concentrations resulting from the venting of methyl bromide out of fumigation chambers. For five fumigations, stack emission rates, chamber specifications, and on-site meteorological data were input into the ISCST model. The model-predicted concentrations were then compared to measured, downwind air concentrations. Both stack and downwind measured air concentrations were initially high, but declined rapidly over time. Downwind concentrations measured during the first ten minutes of venting were as high as 6.8 ppm, 116 m from the stack, but the highest measured concentration after ten minutes was 0.79 ppm. The ISCST model generally overestimated the measured concentrations. Several factors were identified that could account for this. The tendency of the ISCST model to overestimate is health-conservative. Therefore, it can be used to supplement monitoring data and to help evaluate possible mitigation measures'.

INTRODUCTION

The Department's preliminary risk characterization of methyl bromide indicates that an inadequate margin of safety exists for several exposure scenarios (Nelson 1992). To determine which specific uses result in an unacceptable margin of safety, the air concentrations associated with each methyl bromide use pattern must be estimated. Since there are over 100 uses for methyl bromide in California, monitoring air concentrations under all possible combinations of uses and meteorological conditions is problematic. A computer simulation model that accurately estimates air concentrations could be used to supplement monitoring data and to help evaluate possible mitigation measures. The objective of this study was to determine if the Industrial Source Complex, Short Term (ISCST) model (Wagner 1987) could accurately estimate downwind air concentrations resulting from commodity chamber fumigations.

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SURNAME Ganapathy Barry Segawa

SITE AND FUMIGATION DESCRIPTION

Five chamber fumigations were monitored at four different sites: San Joaquin, Monterey (twice), Contra Costa, and Fresno. The descriptions and characteristics of each site are given in Table 1 and Figures 1 - 5. All sites were packing facilities that processed fresh fruit or nuts. The sampling areas for all sites were clear of any major obstacles, except for the San Joaquin site which had a cherry orchard in part of the sampling area. At one site, Contra Costa, the sampling terrain was elevated one to four meters above the stack base.

All fumigations were carried out in sealed chambers at ambient temperature and pressure. The fumigation procedures were typical, with the methyl bromide heated and piped into the chamber over a period of 3 to 15 min. The commodities were fumigated for 2 to 19 hr, after which the methyl bromide was vented out of a stack for 30 min to 6 hr.

MATERIALS AND METHODS

Air concentrations were measured in the chamber stack as well as at several downwind and one upwind locations. Downwind samplers were deployed at three to seven locations at distances of 50 to 250 m from the stack, depending on the site (Figures 1 - 5). All downwind samples were collected from a height of 1.2 m above ground level.

Air concentrations were measured primarily by two different methods. (1) The initial high concentrations in the stack were measured on a real time basis using a fumiscope. (2) After the concentrations were not detectable with a fumiscope, the charcoal tube method was used. In this method, two charcoal tubes (primary and backup), connected end-to-end, are attached to an air pump. Methyl bromide is trapped on the charcoal as air is drawn through the tubes by the air pump. The charcoal tubes are then analyzed in a laboratory. All downwind samples were collected using charcoal tubes. Sampling was initiated at the same time venting was started and continued for the entire venting period of 30 min to 6 hr. Fumiscope readings were recorded at 20 sec to 2 min intervals, while charcoal tube samples were collected for 5 to 30 min intervals. Air pump flow rates were adjusted to give a total of 11 L of air for each sample.

Laboratory analysis of the charcoal tube samples was conducted by Paul Lee and Jean Hsu of the California Department of Food and Agriculture's Chemistry Laboratory Services. The charcoal from each primary and backup tube was extracted separately with carbon disulfide. The resulting extract was then analyzed with a gas

chromatograph equipped with an electron capture detector. Laboratory spiked and blank samples were also analyzed for quality control. The detection limit was 0.2 μg/sample, equivalent to approximately 0.005 ppm.

Additional data collected for the ISCST model included stack air flow rates and meteorological information. Air flow rate through the chamber stack could only be measured at one site, Contra Costa. At this site, air velocity was measured using a pitot tube attached to a manometer. The air velocity was multiplied by the cross-sectional area of the stack to calculate the air flow rate. At the sites where air flow could not be measured, the fan capacity and stack cross-sectional area were used estimate air flow. Wind speed and direction, temperature, and humidity were recorded at each site in one minute intervals using a Met-l system.

The ISCST model is a gaussian plume dispersion model, which uses stack emission rates (calculated by multiplying the stack air concentration by the air flow rate), chamber characteristics, and meteorological data to predict downwind air concentrations. Downwind concentrations were modeled at one minute intervals because of the rapidly changing stack emission rates and to account for minute-to-minute wind changes. The measured air concentrations were compared to the modeled concentrations by averaging the one-minute model concentrations for the same time period and location as the corresponding air samples. Based on conversations with Air Resources Board personnel, the one-fifth power law adjustment for short period model estimates was not utilized (Turner 1970). Because the stack exit velocity influences the effective stack height, an adjustment was made to account for the reduction in exit velocity due to stack coverings (rain hoods). For stacks with roofs, the calculated vertical exit velocity was reduced by 75%. At one site, the stack exit was elbow-shaped; the vertical exit velocity was assumed to be almost zero.

MONITORING AND MODELING RESULTS

The downwind air concentrations measured at each of the sites probably do not represent the maximum ground-level air concentrations associated with these fumigations, for several reasons. First, the measured data indicate and the ISCST model predicts that concentrations are highly influenced by wind direction. In other words, samplers located directly downwind will have much higher levels than ones located away from the downwind centerline. This means that a large number of samplers at different angles would be needed to detect the maximum, many more than were deployed for this study. Second, many of the downwind backup

charcoal tubes were positive, indicating that the charcoal tube samples may not have trapped all of the methyl bromide present. Third, the 14 laboratory spikes had an average recovery of 83%, indicating that all of the methyl bromide may not have been extracted from the charcoal samples. The results were not adjusted for possible breakthrough or spike recovery.

Initial stack air concentrations and emission rates for all sites were very high, but declined rapidly over time in a biphasic manner. The initial stack concentration for all sites averaged 9400 ppm or 82% of the application rate, but even the slowest dissipation showed a decrease of 100X within one hour. It is estimated that greater than 90% of the total emissions occurred within the first 20% of the venting period (Figure 6). These estimates are still valid even though there is an apparent error in several of the emission rates (the error only affects the scales not shapes of the curves in Figure 6). For example, the total emissions calculated for the Monterey site were greater than the amount applied (Figure 6). The error is probably due to using the rated fan capacity to estimate the stack air flow rate, except for Contra Costa (Table 1). At the Contra Costa site, the measured air flow was less than half the fan capacity. This indicates that using the rated fan capacity probably resulted in an overestimation of the emission rate. Since the emission rate is a crucial variable in the ISCST model, this could lead to an apparent overestimation of downwind concentrations.

Downwind air concentrations followed the same time trend as the stack concentrations, high initial levels followed by a rapid decrease. The highest concentration measured was 6.8 ppm in a sample collected between five and ten minutes after the start of venting, while the highest concentration measured after ten minutes of venting was 0.79 ppm. Although determining the concentration pattern over space was not an objective, the 6.8 ppm maximum was found 116 m from the stack and methyl bromide was still detectable 250 m from the stack. None of the upwind samples contained a detectable amount of methyl bromide.

Generally, the ISCST model predicted concentrations higher than the measured concentrations (Figure 7). The log-transformed measured versus predicted values had a coefficient of determination (R^2) of 0.41, indicating that only 41% of the variability could be accounted for (not including points where both values were non-detects and assuming those points where one value was non-detect the concentration was one-half the detection limit). While this may seem low, it is comparable to other ISCST evaluation studies (Shulman and Hanna 1986) and is well within the range considered to indicate reasonable prediction skill (Godbole and Naperkoski 1984).

In addition, counting the number of over-predicted and under-predicted values may give a better measure of ISCST performance, particularly from a health protection point of view. The ISCST model over-predicted 42 (65%) of the measured values, under-predicted 4 (6%), and matched 19 (29% within a factor of 2).

Detailed results for each site are presented in the following section and in Figures 8 - 12 and Tables 2 - 6. Each of the Figures 8 - 12 is actually an overlay of three separate charts. The first chart, represented by the stars, show the relative positions of the sampling locations. Each star is located according to scale and labelled with the distance and angle relative to the stack. The second chart is represented by the graph of the wind data. Comparing the wind direction to the angles labeled on the stars gives an indication of how close each sampling location was to the downwind centerline (e.g., when the wind direction indicates 270" and a sampling location is at 270°, it is directly downwind). These two charts are essential for interpreting the third chart, represented by the graphs of methyl bromide air concentration. The air concentration (both measured and predicted) at each sampling location is shown on the separate small graphs within each figure. Note how the downwind concentrations change with the decreasing stack concentration and shifting wind direction.

San Joaquin - The results from this site are shown in Figure 8 and Table 2. The wind direction at this site shifted half way through the venting period. Also, four of the seven samplers were located in a cherry orchard. For these reasons, only one sampling location had detectable levels of methyl bromide. The highest downwind concentration detected was 0.24 ppm for a 30-min sample, 108 m from the stack. The comparison of measured and ISCST predicted concentrations showed good agreement. The ISCST model over-predicted two of the measured values, under-predicted one, matched one (within 2X), and agreed with 38 none detects.

Monterey (June 1) - This site was monitored twice. The first fumigation was monitored on June 1. The results for this fumigation are shown in Figure 9 and Table 3. Due to miscommunication, the field in the downwind area was not accessible, so only three downwind samplers could be deployed, and these had to be placed next to a major roadway. The highest concentration detected was 1.0 ppm in a 5-min sample, 75 m from the stack. The ISCST model over-predicted three of the measured values, under-predicted one, matched three (within 2X), and agreed with 13 none detects.

Contra Costa - The results for this site are shown in Figure 10 and Table 4. This site had one of the best sampler placements, with

five of the seven locations detecting methyl bromide. However, the exact locations of the samplers are questionable because the measured polar coordinates do not match with the location of the road and the terrain elevation could only be estimated. The highest concentration measured was 0.79 ppm in a 5-min sample, 52 m from the stack. Methyl bromide was still detectable at the furthest location, 250 m from the stack. Changes in concentration with shifts in wind direction are particularly evident. The decreases and increases in concentration over the first 15 min are primarily due to wind shifts, rather than dissipation. The ISCST model over-predicted 30 of the measured values, under-predicted two, matched 15 (within 2X), and agreed with 13 none detects.

Monterey (June 23) - The results for the second fumigation at this site are shown in Figure 11 and Table 5. This was another site where the measured coordinates of the sampling locations did not match known landmarks. A weather front moving through the area caused large shifts in wind direction prior to and during the monitoring period. In addition, the first five-minute samples were lost due to air sampler problems. Only two of the five locations detected methyl bromide. The ISCST model over-predicted eight measured values, and agreed with 13 none detects.

Fresno - This site was sampled cooperatively with the Air Resources Board. They sampled at four downwind locations, while we sampled at three locations. The Air Resources Board results are not available yet. Our results for this site are shown in Figure 12 and Table 6. Stack concentration data for this site are incomplete due to a faulty fumiscope. This site had the highest downwind concentration measured, 6.8 ppm in a five-minute sample, 116 m from the stack. The stable weather conditions at the time of the monitoring probably accounts for the high levels. There was no wind for the first five minutes and very low winds after that. Because of the low wind speeds and incomplete stack concentration data, the downwind concentrations could not be predicted with the ISCST model.

CONCLUSIONS

The ISCST model generally predicted higher concentrations than were measured in the field. However, several factors could account for this. First, the position measurements for several sampling locations may be in error. In some cases, the measured positions appear to be incorrect relative to known landmarks (e.g., measured sampler coordinates plotted on a map places the sampler on the wrong side of a road). Second, the quality control data, specifically the spike recoveries and breakthrough analyses, indicate that the true field concentrations may be higher than reported. Third, our model

adjustment for the stack coverings was very simplified and may be in error. Fourth, the emission rates calculated using the fan capacities may overestimate the true emission rate. It is most important to try to correct the last two factors, the stack covering adjustment and emission rate, since they are inputs for the model and affect its accuracy. The first two factors only affect the evaluation of the model. Even if all of the model inputs are correct, and the ISCST model actually over-predicts measured concentrations, it is still useful because it is health-conservative.

Note on Worker Exposure: The stack concentrations at the end of the venting still exceeded the methyl bromide Permissible Exposure Level (5 ppm) for several of the sites, while Drager tubes indicated no detectable amount inside the chambers. The low Drager tube readings were probably due to fresh air being drawn in by the ventilation fans. The ventilation fans were kept on until unloading had been completed. If the fans were turned off during unloading, high concentrations could develop inside the chamber.

FUTURE WORK

Monitoring data to be submitted by the commodity groups will be compared to the ISCST model results. Assuming the model still performs adequately, some worst-case situations will be modeled and the effects of some mitigation alternatives will be examined.

REFERENCES

Godbole, G.V. and G.J. Naperkoski. 1984; An Operational Evaluation of Industrial Source Complex Model. Fourth Joint Conference on Applications of Air Pollution Meteorology, 16-19 Oct, 1984. Portland, OR. pp. 70-74.

Nelson, L. 1992. Memorandum to Jim Wells, dated February 11, 1992. Methyl Bromide Preliminary Risk Characterization. Department of Pesticide Regulation.

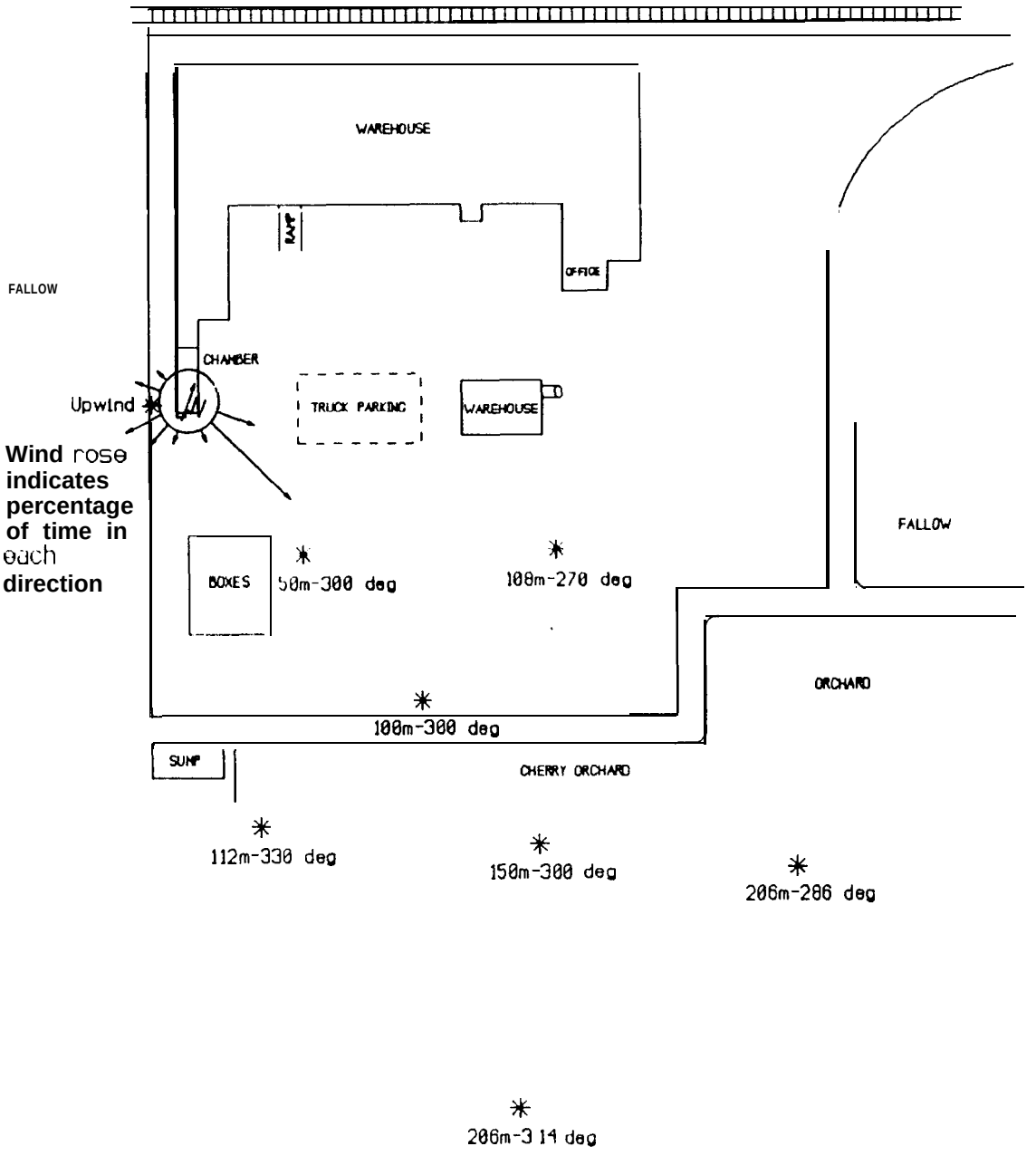
Shulman, L.L. and S.R. Hanna. 1986. Evaluation of Downwash Modifications to the Industrial Source Complex Model. JAPCA 36:258-264.

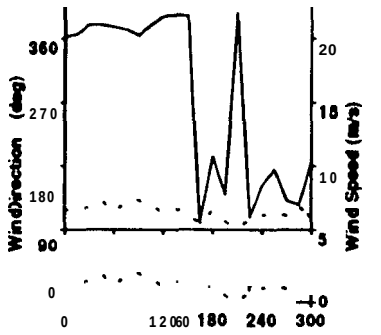
Turner, B.D. 1970. Workbook of Atmospheric Dispersion Estimates. PHS Publication No. 999-AP-26. U.S. Dept. of Health, Education and Welfare, National Air Pollution Control Administration, Cincinnati, Ohio.

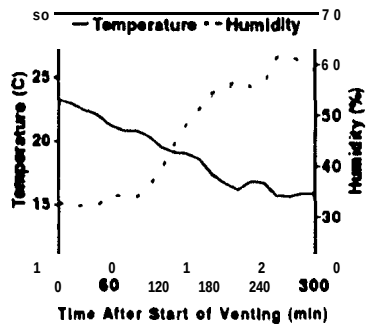
Table 1. Methyl Bromide Monitoring Site and Fumigation Specifications.

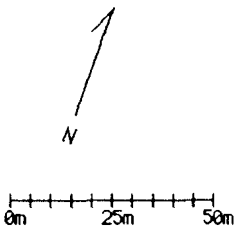
	San Joaquin	Monterey (Jun 1)	Contra Costa	Monterey(
Chamber Volume (m')	604	454	397	454
(ft^3)	21280	16000	14000	16000
Fan Capacity (m^3/min)	284	482	60	482
Measured Air Flow (m^3/min)	not measured	not measured	22.7	not meas
Stack Height (m)	11.3	10.1	7.9	1(
Stack Cross-Sectional Area (m^2)	0.84	1.74	0.013	:
Stack Covering	roof	roof	90° elbow	ro
Commodity	cherries	strawberries	walnuts	strawber/
Approximate Load (%) (chamber vol occupied by commodity)	75	<1	75	<1
Application Rate (ppm)	12400	12900	8840	12900
(lbs/1000 ft')	3	3.1	2.1	3
Total Amount Applied (kg)	29	23	14	23
(lbs)	64	50	30	5(
Date/Time Venting Started	5/21/92/2130	6/1/92/1453	6/5/92/0720	6/23/92/
Date/Time Venting Ended	5/22/92/0600	6/1/92/1525	6/5/92/1008	6/23/92/

Figure 11 Site Diagram and Weather Conditions for Methyl Bromide Air Monitoring in San Joaquin.









✳ Sampling Locations

Figure 21 Site Diagram and Weather Conditions for Methyl Bromide Air Monitoring in Monterey. June 1, 1992.

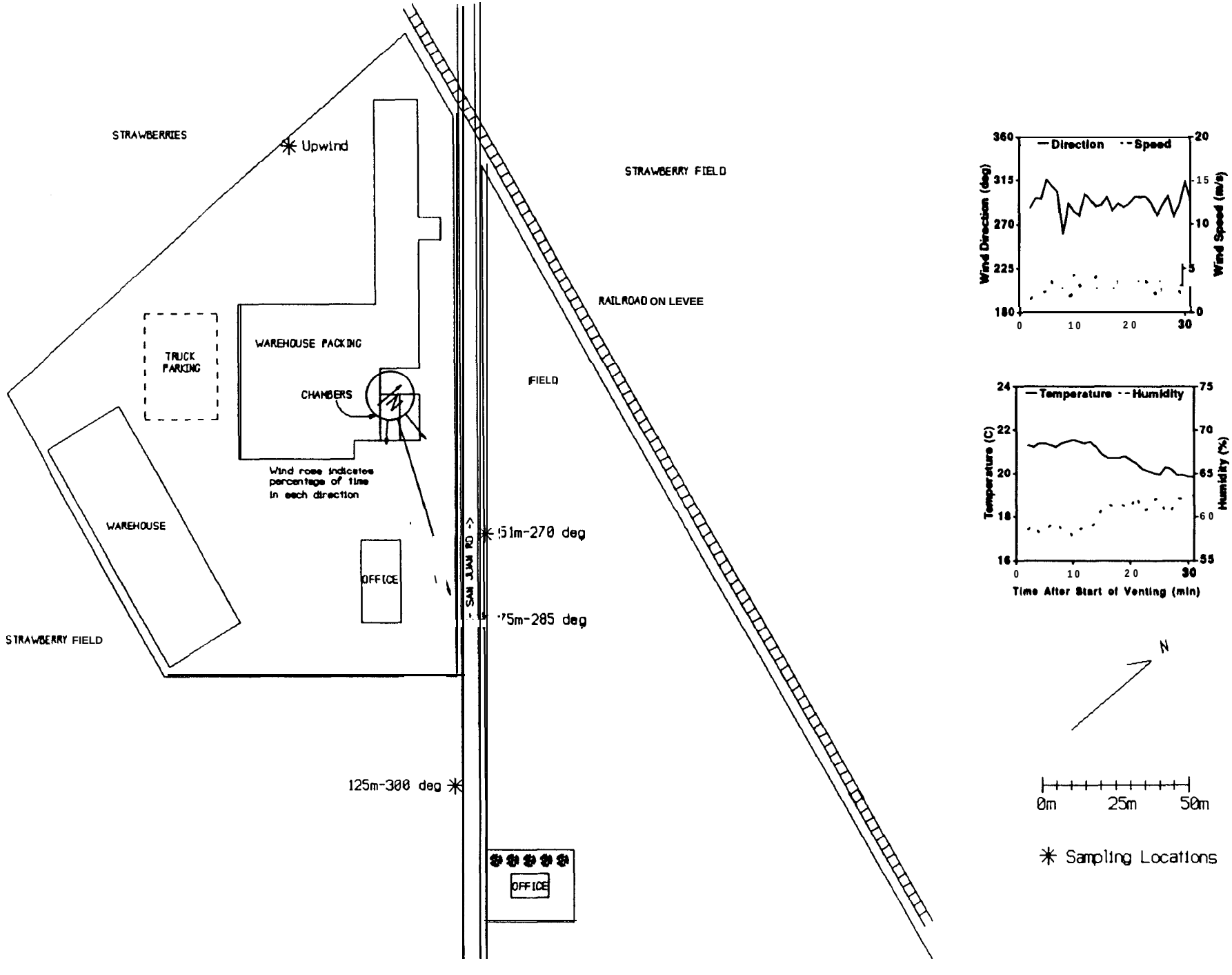
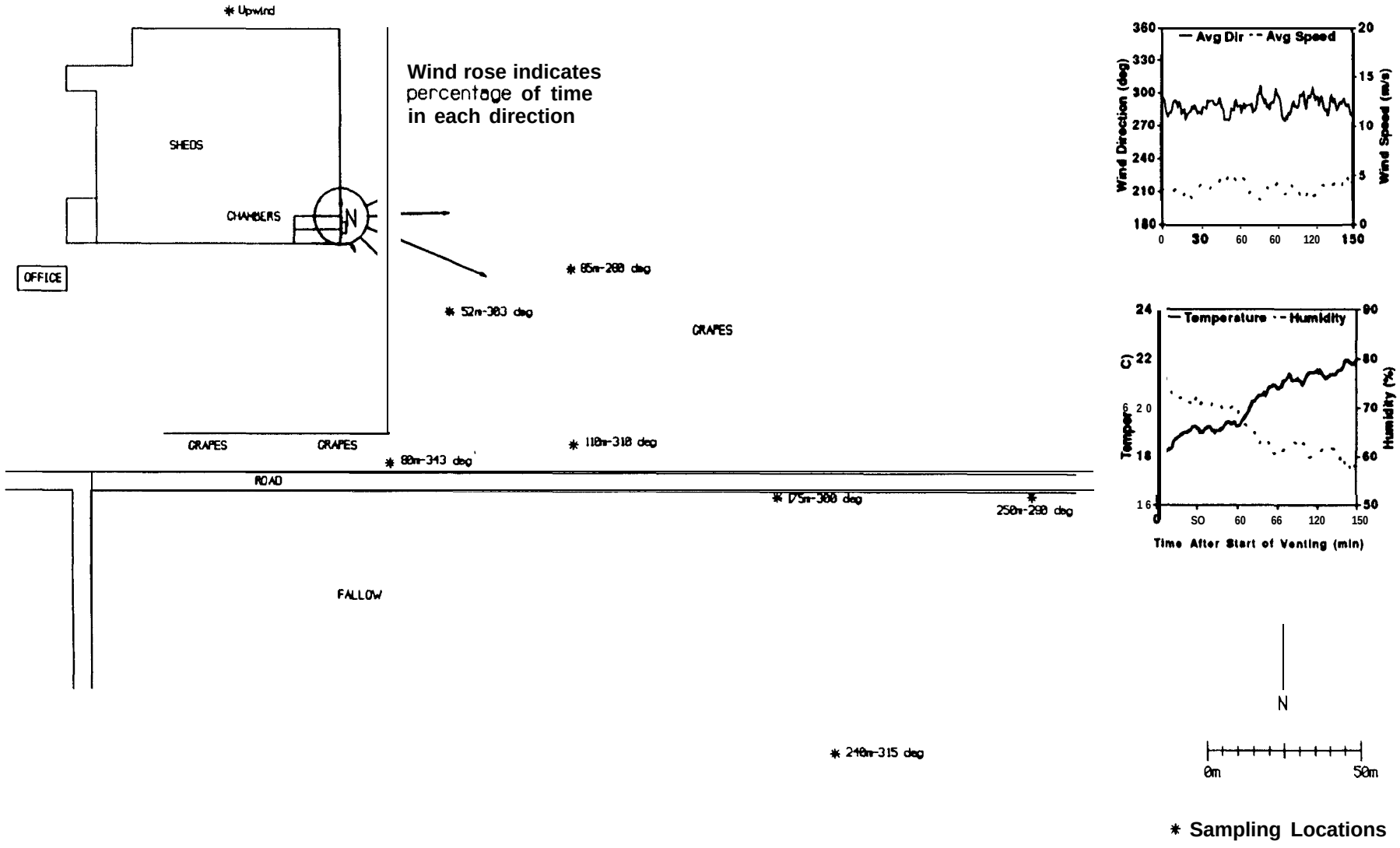


Figure 3. Site Diagram end Weather Conditions for Methyl Bromide Air Monitoring in Contra Costa.



* Sampling Locations

Figure 41 Site Diagram and Weather Conditions for Methyl Bromide Air Monitoring in Monterey June 23, 1992.

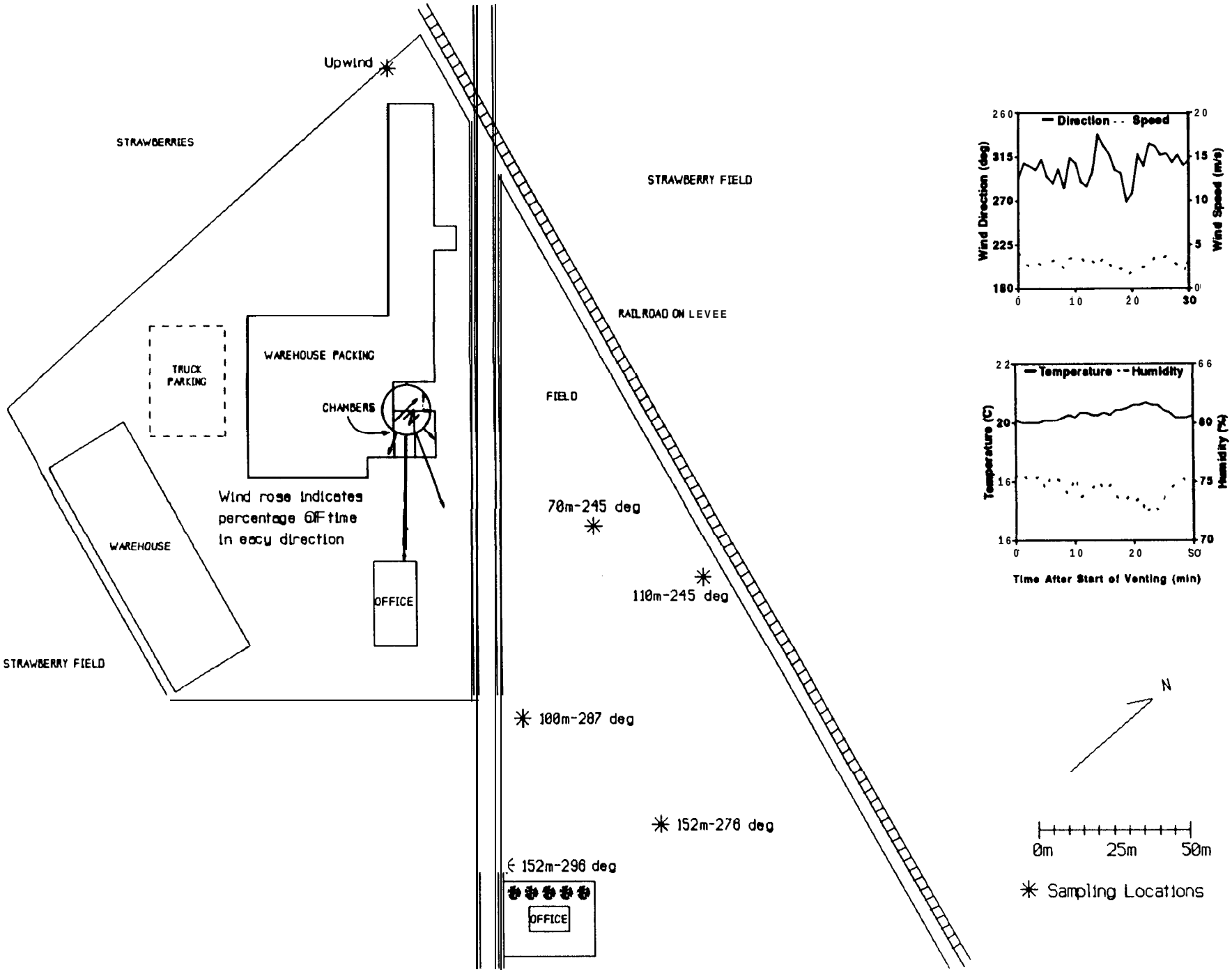


Figure 5: Site Diagram and Weather Conditions for Methyl Bromide Air Monitoring in Fresno.

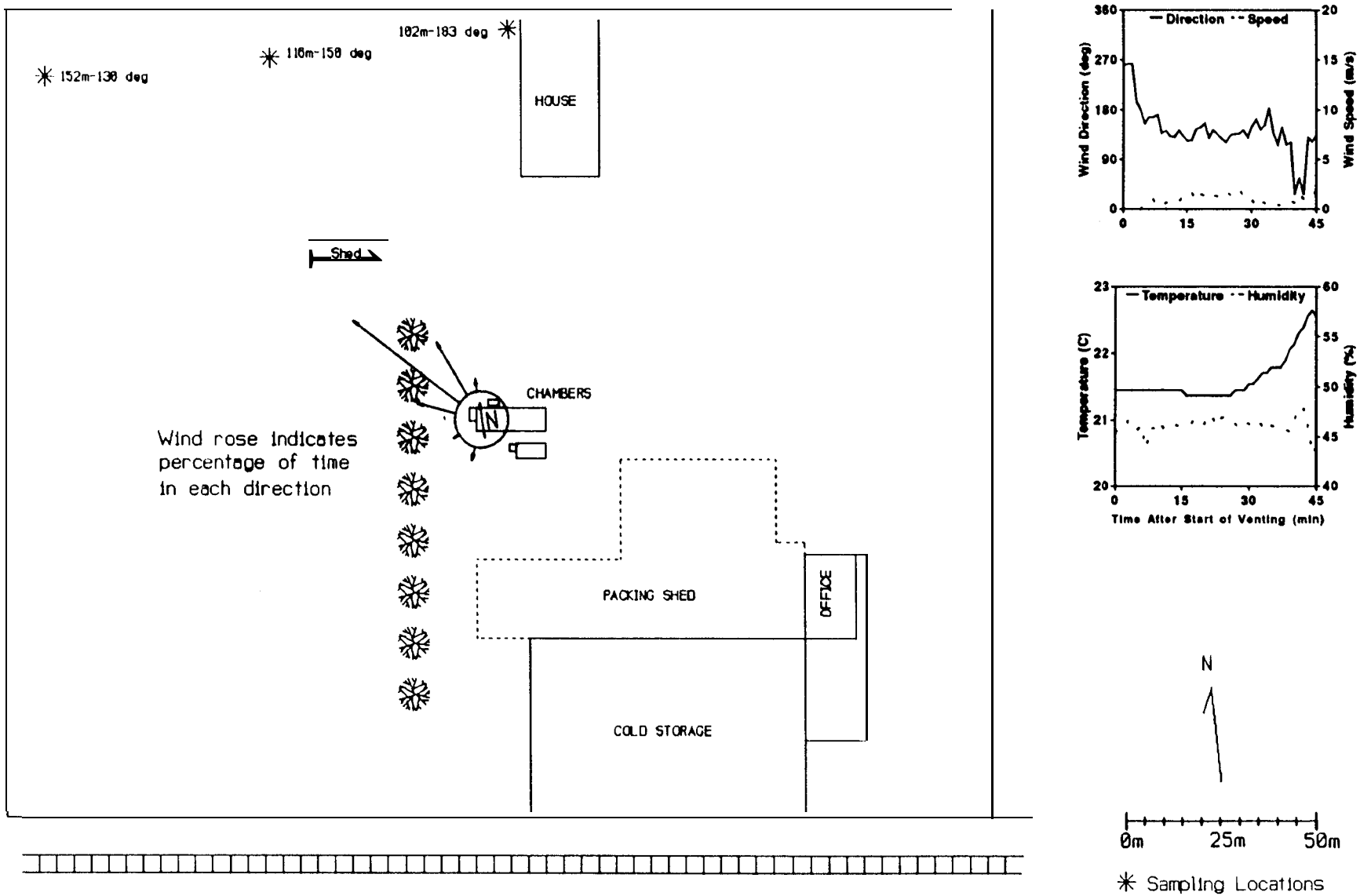
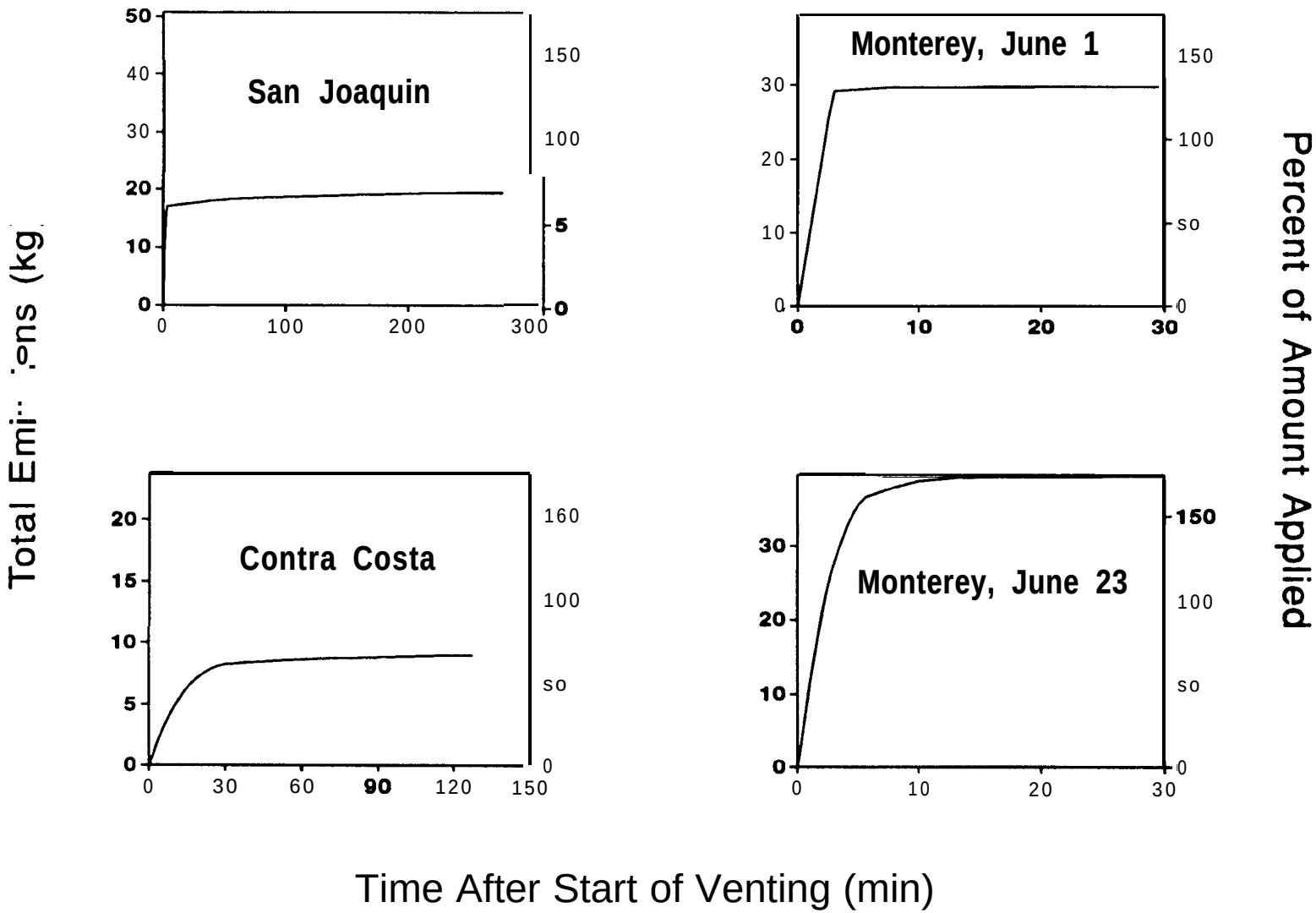


Figure 6. Methyl Bromide Emissions



Emission data for Fresno is incomplete

Figure 7. Comparison of Measured and Predicted Methyl Bromide Air Concentrations

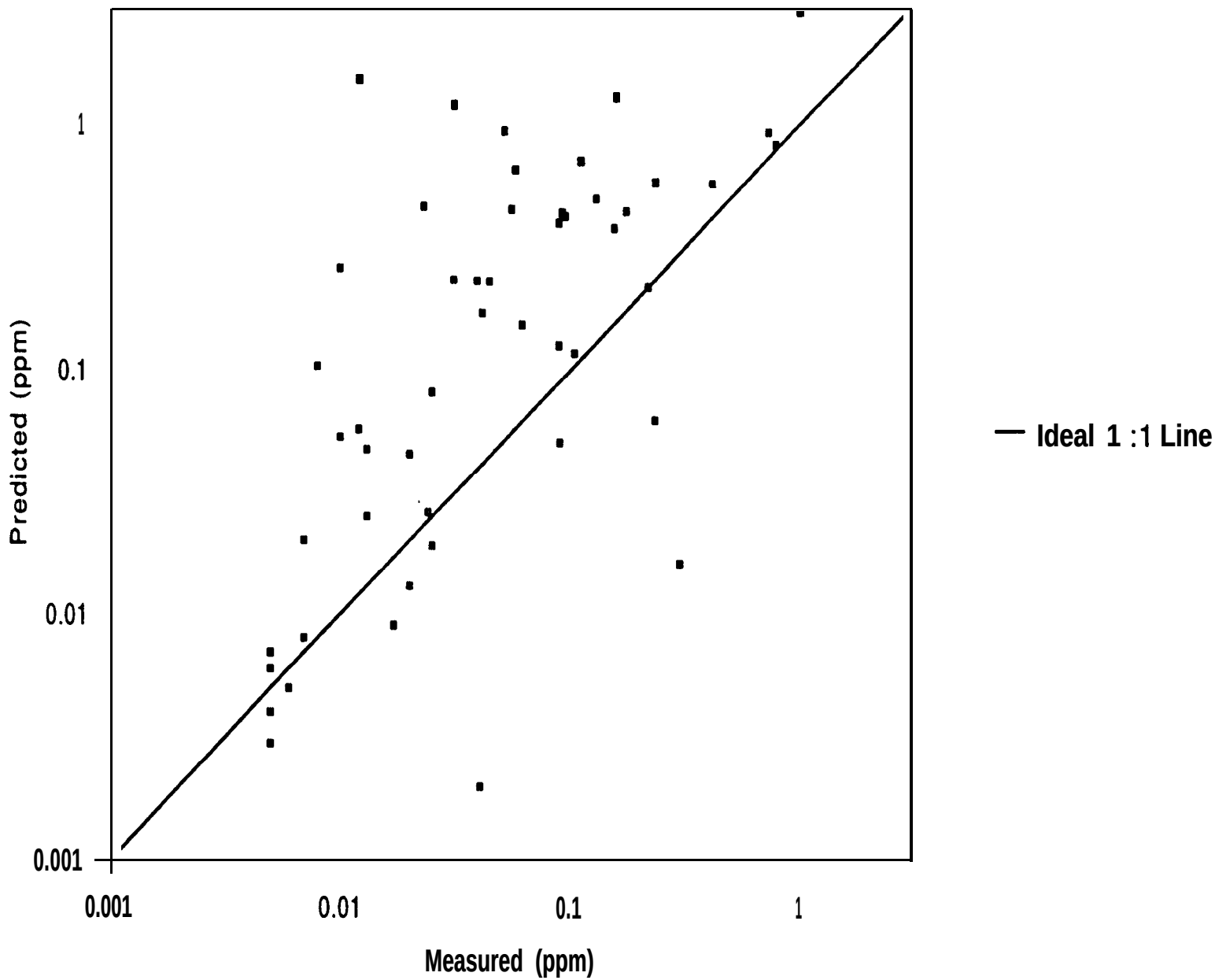


Figure 8. Sampler Layout and Results of Methyl Bromide Air Monitoring at San Joaquin

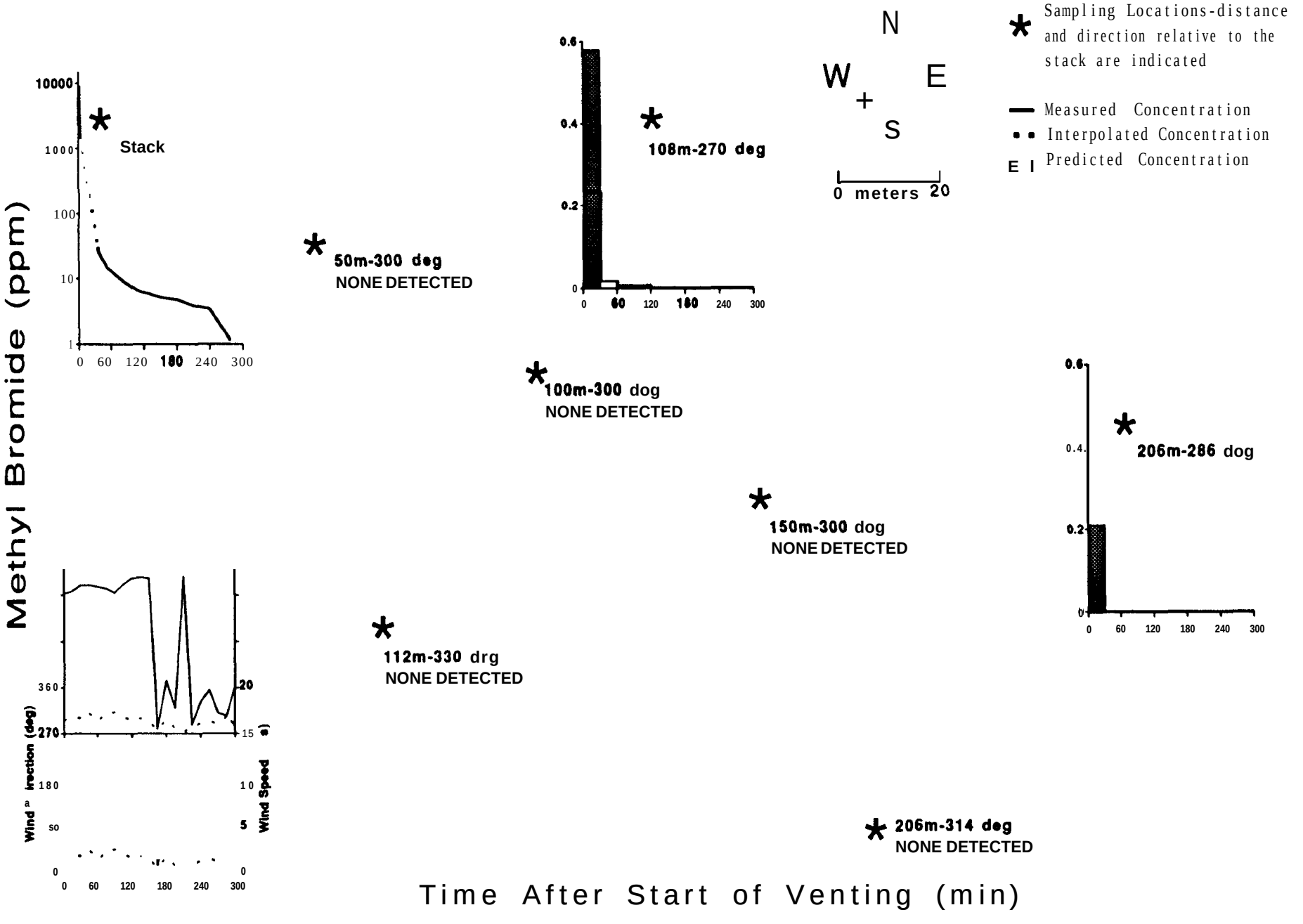


Table 2. Results of Methyl Bromide Air Monitoring at San Joaquin

Time On	Time Off	Sample Period (min)	Distance to Stack (m)	Angle to Stack (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
2130	2300	90	10	75	none detected	none detected	0.0038
2300	0	60	10	75	none detected	none detected	0.0058
0	100	60	10	75	none detected	none detected	0.0058
100	230	90	10	75	none detected	none detected	0.0038
2130	2200	30	50	300	none detected	none detected	0.0111
2200	2230	30	50	300	none detected	none detected	0.0111
2230	2330	60	50	300	me detected	none detected	0.0055
2330	30	60	50	300	none detected	none detected	0.0055
30	130	60	50	300	none detected	none detected	0.0055
130	230	60	50	300	none detected	none detected	0.0055
2130	2200	30	100	300	none detected	none detected	0.0113
2200	2230	30	100	300	none detected	none detected	0.0113
2230	2330	60	100	300	none detected	none detected	0.0057
2330	30	60	100	300	none detected	none detected	0.0057
30	130	60	100	300	none detected	none detected	0.0057
130	230	60	100	300	none detected	none detected	0.0057
2130	2200	30	108	270	0.235	0.579	0.0116
2200	2230	30	108	270	0.017	none detected	0.0116
2230	2330	60	108	270	0.006	0.005	0.0058
2330	30	60	108	270	none detected	none detected	0.0058
30	130	60	108	270	none detected	none detected	0.0058
130	230	60	108	270	none detected	none detected	0.0058
2133	2207	34	112	330	none detected	none detected	0.01
2207	2241	34	112	330	none detected	none detected	0.01
2241	2338	57	112	330	none detected	none detected	0.006
2338	40	62	112	330	none detected	none detected	0.0055
40	140	60	112	330	none detected	none detected	0.0057
140	248	68	112	330	none detected	none detected	0.005
2133	2204	31	150	300	none detected	none detected	0.0111
2204	2234	30	150	300	none detected	none detected	0.0115
2234	2333	59	150	300	none detected	none detected	0.0058
2335	35	60	150	300	none detected	none detected	0.0057
35	135	60	150	300	none detected	none detected	0.0057
135	235	60	150	300	none detected	none detected	0.0057

Table 2. Results of Methyl Bromide Air Monitoring at San Joaquin

Time On	Time	Sample Period (min)	Distance to Stack (m)	Angie to Stack (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
2133	2203	30	206	286	none detected	0.21	0.0114
2203	2233	30	206	286	none detected	none detected	0.0113
2233	2333	60	206	286	none detected	none detected	0.0057
2333	33	60	206	286	none detected	none detected	0.0057
33	133	60	208	286	none detected	none detected	0.0057
133	233	60	208	286	none detected	none detected	0.0057
2133	2206	33	206	314	none detected	none detected	0.0103
2206	2236	30	206	314	none detected	none detected	0.0113
2236	2336	60	206	314	none detected	none detected	0.0057
2336	36	60	206	314	none detected	none detected	0.0057
36	136	60	206	314	none detected	none detected	0.0057
136	236	60	206	314	none detected	none detected	0.0057
2130			stack		8747		
2131			stack		8747		
2132			stack		5146		
2133			stack		1544		
2145	2200	15	stack		brkthrgh		
2200	2215	15	stack		24.869		
2215	2230	15	stack		14.413		
2230	2245	15	stack		outiier		
2245	2300	15	stack		8.941		
2300	2315	15	stack		7.359		
2315	2330	15	stack		6.262		
2330	2345	15	stack		5.878		
2345	0	15	stack		5.347		
0	15	15	stack		5.03		
15	45	30	stack		4.759		
45	115	30	stack		3.832		
115	145	30	stack		3.408		
145	230	45	stack		1.142		

Figure 9. Sampler Layout and Results of Methyl Bromide Air Monitoring at Monterey, June 1, 1992

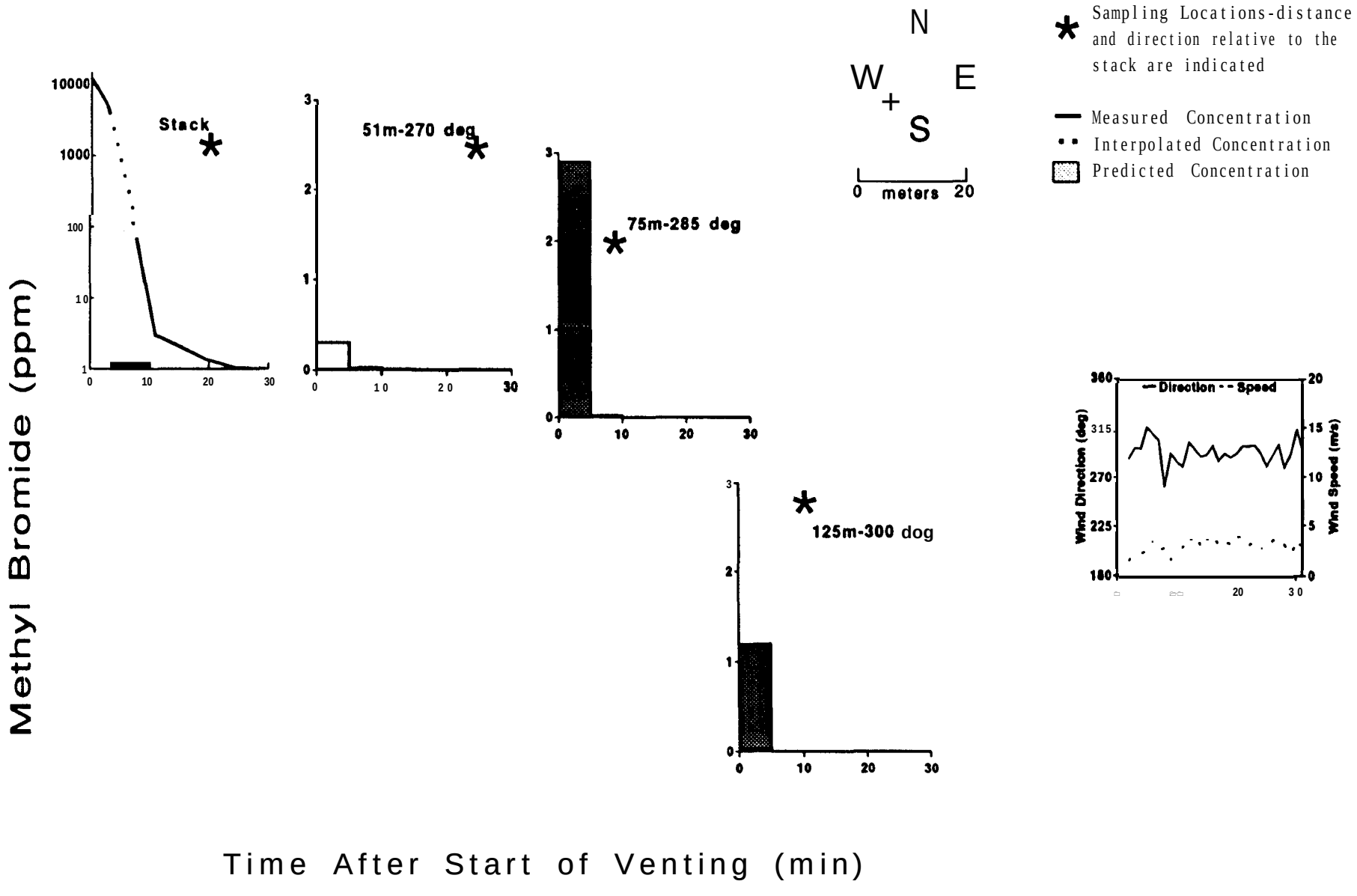


Table 3. Resultsof Methyl Bromide Air **Monitoring** at **Monterey, June** 1

Time On	Time Off	Sample Period (min)	Distance to Stack (m)	**Angle to Stack** (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
1455:OO	1500:O0	5	51	270	0.298	0.016	0.0052
1500:05	**1510:00**	4.92	51	270	0.024	0.026	0.0053
1505:05	**1510:03**	4.97	51	270	0.005	0.003	0.0052
1510:07	**1515:00**	4.88	51	270	nonedetected	nonedetected	0.0053
1515:05	**1520:00**	4.92	51	270	nonedetected	**none detected**	0.0053
1520:08	**1525:01**	4.88	51	270	nonedetected	nonedetected	0.0053
1455:00	**1500:08**	5.13	75	285	1.005	2.9	**0.005**
1500:08	**1505:01**	4.88	75	285	0.013	0.025	0.0053
1505:03	**1509:59**	4.93	75	285	nonedetected	nonedetected	0.0052
1510:02	1515:OO	4.97	75	285	nonedetected	nonedetected	0.0052
1515:02	**1519:59**	4.98	75	285	nonedetected	nonedetected	0.0052
152O:W	**1525:00**	5	75	285	nonedetected	nonedetected	0.0052
1450	1520	30	**100**	**upwind**	nonedetected	nonedetected	0.0049
1455:00	**1500:02**	5.02	125	300	0.031	1.2	0.0051
1500:25	**1505:01**	4.6	125	300	nonedetected	nonedetected	0.0056
1505:05	**1510:02**	4.95	125	300	nonedetected	nonedetected	0.0052
1510:05	**1515:04**	4.98	125	300	nonedetected	nonedetected	0.0052
1515:15	**1520:03**	4.8	125	300	nonedetected	nonedetected	**0.0053**
1520:05	1525:00	4.92	125	300	nonedetected	nonedetected	0.0052
1450			chamber		12349		
1455:30			chamber		5403		
1456:W			chamber		4116		
1457:00	1459:oo		stack		**>100**		
1500:00	**1502:00**		**stack**		60		
1503:00	**1505:00**		**stack**		3		
1505:27	1510:00	4.55	stack		2.112		
1510:oo	1515:oo	5	stack		1.355		
1515:00	152O:W	5	stack		1.033		
152O:W	1525:00	5	**stack**		0.965		

Figure IO. Sampler Layout and Results of Methyl Bromide Air Monitoring at Contra Costa

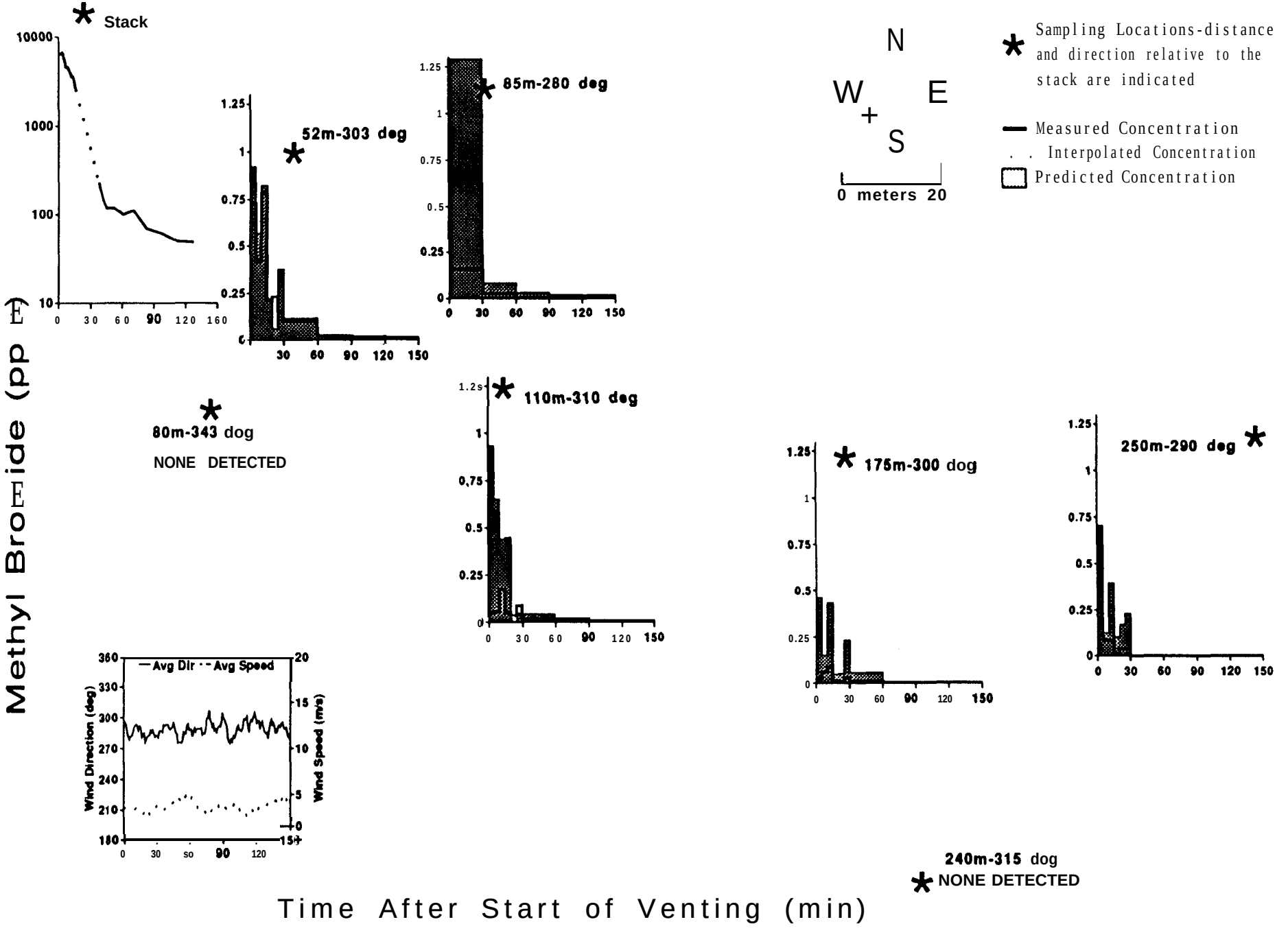


Table 4. Results of Methyl Bromide Air Monitoring at Contra Costa

Time On	Time Off	Sample Period (min)	Distance to Stack (m)	Angle to Stack (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
720	750	30	52	303	0.128	0.496	0.0049
0720:00	0725:00	5	52	303	0.729	0.923	0.0051
0725:04	0730:02	4.97	52	303	0.418	0.571	0.0052
0730:06	0735:00	4.9	52	303	0.786	0.823	0.0052
0735:03	0740:00	4.95	52	303	0.218	0.218	0.0052
0740:04	0745:01	4.95	52	303	0.233	0.062	0.0052
0745:04	0750:04	5	52	303	0.154	0.377	0.0051
750	820	30	52	303	0.103	0.117	0.0049
820	850	30	52	303	0.025	0.019	0.0049
850	920	30	52	303	0.02	0.013	0.0049
920	950	30	52	303	0.017	0.009	0.0049
720	911	111	80	130	none detected	none detected	0.0064
720	751	31	80	343	none detected	none detected	0.0048
751	821	29.82	80	343	none detected	none detected	0.005
821	851	30	80	343	none detected	0.019	0.0049
850	921	31	80	343	none detected	none detected	0.0048
921	951	30	80	343	none detected	none detected	0.0049
720	751	31.17	85	280	0.157	1.29	0.0048
751	821	29.7	85	280	0.025	0.081	0.005
821	851	29.97	85	280	none detected	0.03	0.005
851	921	30.13	85	280	none detected	0.018	0.0049
821	851	29.5	85	280	none detected	0.015	0.005
720	750	29.83	110	310	0.094	0.421	0.0049
0720:00	0724:50	4.83	110	310	0.051	0.935	0.0054
0724:59	0729:59	5	110	310	0.057	0.651	0.0052
0730:04	0734:59	4.92	110	310	0.174	0.441	0.0053
0735:03	0739:59	4.93	110	310	0.055	0.449	0.0053
0740:04	0744159	4.92	110	310	0.04	0.002	0.0053
0745:02	0750:00	4.97	110	310	0.089	0.05	0.0052
750	820	29.92	110	310	0.02	0.045	0.0049
820	850	29.93	110	310	0.007	0.02	0.0049
850	920	29.92	110	310	0.007	0.008	0.0049
920	950	29.95	110	310	0.007	0.008	0.0049

Table4. Resultsof Methyl Bromide Air Monitoring at Contra Costa

Time On	Time Off	Sampb Period (min)	Distance (m)	Angle to Stack (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
720	750	30	175	300	0.044	0.231	0.0049
0720:00	0725:00	5	175	300	0.023	0.463	0.0052
0725:09	0730:00	4.85	175	300	0.061	0.153	0.0053
0730:03	0735:01	4.97	175	300	0.091	0.435	0.0052
0735:04	0740:00	4.93	175	300	0.013	0.047	0.0052
0740:02	0745:00	4.97	175	300	0.01	0.053	0.0052
0745:03	0750:00	4.95	175	300	0.031	0.234	0.0052
750	820	30	175	300	0.012	0.057	0.0049
820	850	30	175	300	0.005	0.007	0.0049
850	920	30	175	300	0.005	0.006	0.0049
920	950	30	175	300	0.005	0.004	0.0049
720	750	30	240	315	nonedetected	0.127	0.0049
750	821	30.5	240	315	nonedetected	none detected	0.0048
821	851	30	240	315	nonedetected	nonedetected	0.0049
851	922	31.5	240	315	nonedetected	nonedetacted	0.0047
822	852	30	240	315	nonedetected	nonedetected	0.0049
720	750	29.6	250	290	nonedetected	0.289	0.005
0720:14	0725:00	4.77	250	290	0.11	0.705	0.0054
0725:00	0730:15	5.25	250	290	0.088	0.126	0.0049
0730:15	0735:10	4.92	250	290	0.088	0.395	0.0052
0735:10	0740104	4.9	250	290	0.008	0.104	0.0052
0740:04	0745:07	4.95	250	290	0.041	0.171	0.0052
0745:07	0745:00	4.88	250	290	0.039	0.232	0.0052
750	820	30.17	250	290	nonedetected	nonedetected	0.0049
820	850	30	250	290	nonedetected	nonedetected	0.0049
850	920	30	250	290	nonedetectsd	nonedetected	0.0049
920	950	30	250	290	nonedetected	nonedetected	0.0049
0720:30			stack		6432		
0720:45			stack		6432		
0721:00			stack		6432		
0722:00			stack		6432		
0723:00			stack		6689		
0724:00			stack		6432		
0724:30			stack		5917		
0725:00			stack		5660		
0725:30			stack		5403		

Table 4. Results of Methyl Bromide Air Monitoring at Contra Costa

Time On	Time Off	Sample Period (min)	Distance to Stack (m)	Angle to Stack (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
0726:00			stack		5146		
0726:30			stack		4631		
0727:30			stack		4631		
0728:00			stack		4631		
0729:00			stack		4374		
0730:00			stack		4116		
0731:00			stack		3859		
0732:00			stack		3602		
0733:00			stack		3602		
0734:00			stack		3345		
0735:00			stack		2830		
0736:00			stack		2573		
0737:00			stack		2316		
0738:00			stack		2058		
758	759		stack		200		
801	802		stack		150		
805	806		stack		120		
811	812		stack		120		
820	821		stack		100		
825	835	10	stack		111.811		
835	850	15	stack		69.882		
850	905	15	stack		61.718		
905	920	15	stack		49.779		
920	935	15	stack		48.894		
935	950	15	stack		43.338		

Figure 11. Sampler Layout and Results of Methyl Bromide Air Monitoring at Monterey, June 23, 1992

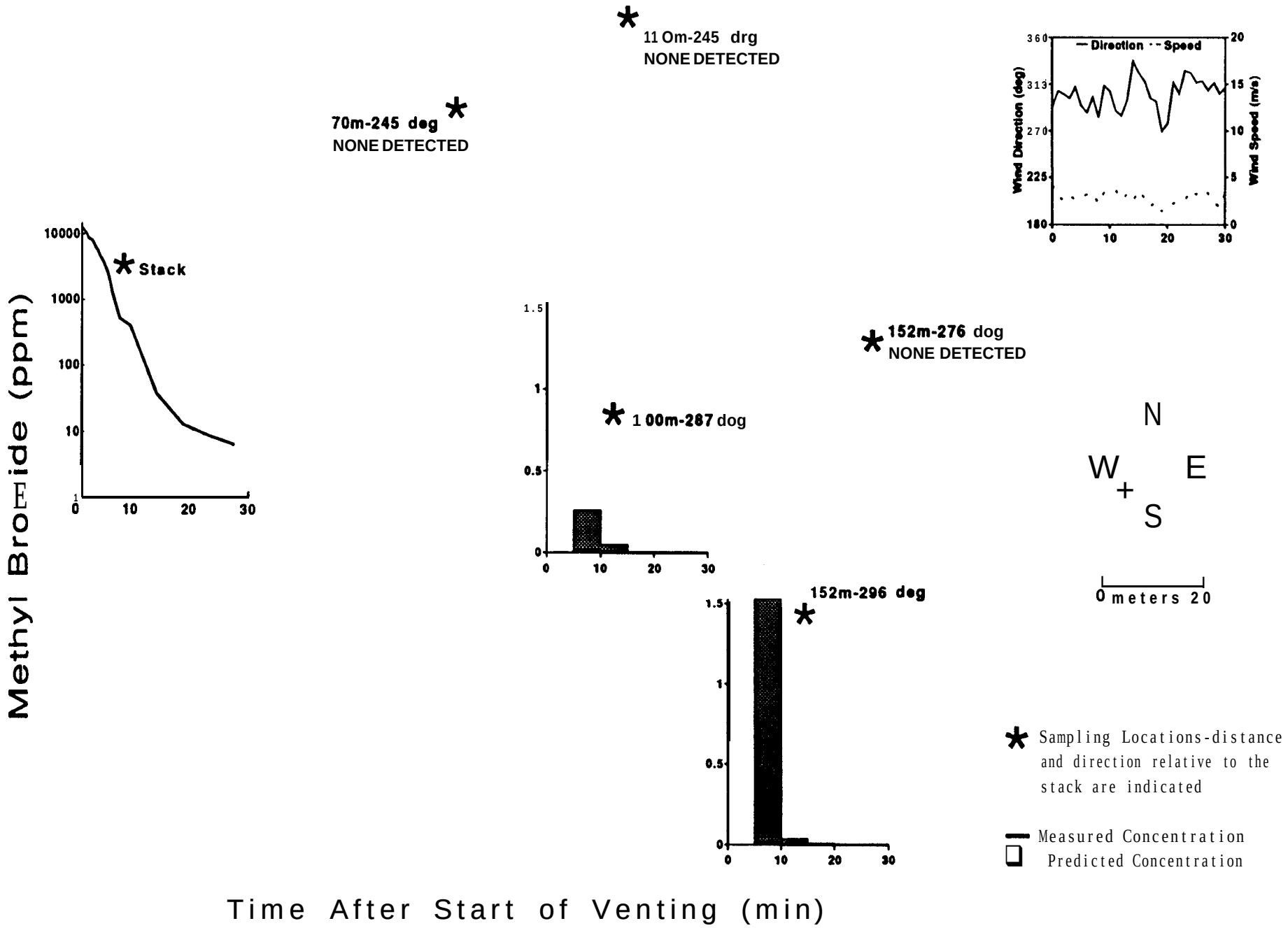


Table 5. Resultsof Methyl Bromide Air Monitoring at Monterey, June 23

Time On	Time Off	Sample Period (min)	Distance to Stack (m)	Angle to Stack (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
1414	1419	5.13	70	245	badsampte	nonedetected	0.005
1419	1424	4.59	70	245	nonedetected	nonedetected	0.0056
1424	1429	4.84	70	245	nonedetected	nonedetected	0.0053
1429	1434	4.87	70	245	nonedetected	nonedetected	0.0053
1434	1439	4.97	70	245	nonedetected	nonedetected	0.0052
1414	1419	5	100	287	bad sample	0.626	0.0052
1419	1424	4.93	100	287	0.01	0.261	0.0052
1424	1429	4.93	100	287	nonedetected	0.047	0.0052
1429	1434	4.94	100	287	nonedetected	nonedetected	0.0052
1434	1439	4.93	100	287	nonedetected	nonedetected	0.0052
1416	1419	2.29	110	245	badsampte	nonedetected	0.0112
1419	1424	5.01	110	245	nonedetected	nonedetected	0.0051
1424	1429	4.84	110	245	nonedetected	nonedetected	0.0053
1429	1434	5	110	245	nonedetected	nonedetected	0.0051
1434	1439	4.97	110	245	nonedetected	nonedetected	0.0051
1410	1435	25	120	160	nonedetected	nonedetected	0.0118
1414	1419	4.66	152	276	bad sample	nonedetected	0.0056
1419	1424	4.83	152	276	none detected	0.069	0.0054
1424	1429	4.67	152	276	nonedetected	0.09	0.0056
1429	1434	6	152	276	nonedetected	nonedetected	0.0043
1434	1439	5	152	276	nonedetected	0.006	0.0052
1414	1419	4.83	152	296	bad sample	5.48	0.0053
1419	1424	5	152	296	0.012	1.53	0.0052
1424	1429	5.02	152	296	nonedetected	0.035	0.0051
1429	1434	4.93	152	296	nonedetected	0.009	0.0052
1434	1439	4.93	152	296	nonedetected	nonedetected	0.0052
1409			chamber		12607		
1415:02			stack		10291		
1415:40			stack		8747		
1416:00			stack		7976		
1416:20			stack		7204		
1416:40			stack		6175		
1417:oo			stack		5660		

Table 5. Resuttsof Methyl Bromide Air Monitoring at Monterey, June 23

Time On	Time Off	Sample Period (min)	Distance to Stack (m)	Angle to Stack (deg)	Measured Methyl Bromide (ppm)	Predicted Methyl Bromide (ppm)	Detection Limit (ppm)
1417:20			stack		4888		
1418:00			stack		3859		
1418:20			stack		3345		
1418:40			stack		2830		
1419:oo			stack		2316		
1419:20			stack		1801		
1419:40			stack		1286		
1420	1422	1.96	stack		523.455		
1422	1424	1.79	stack		401.495		
1424	1427	2.4	stack		131.344		
1427	1429	2.39	stack		37.951		
1429	1435	6.91	stack		13.198		
1435	1439	4.08	stack		8.747		
1439	1444	5	stack		6.443		

Figure 12. Sampler Layout and Results of Methyl Bromide Air Monitoring at Fresno

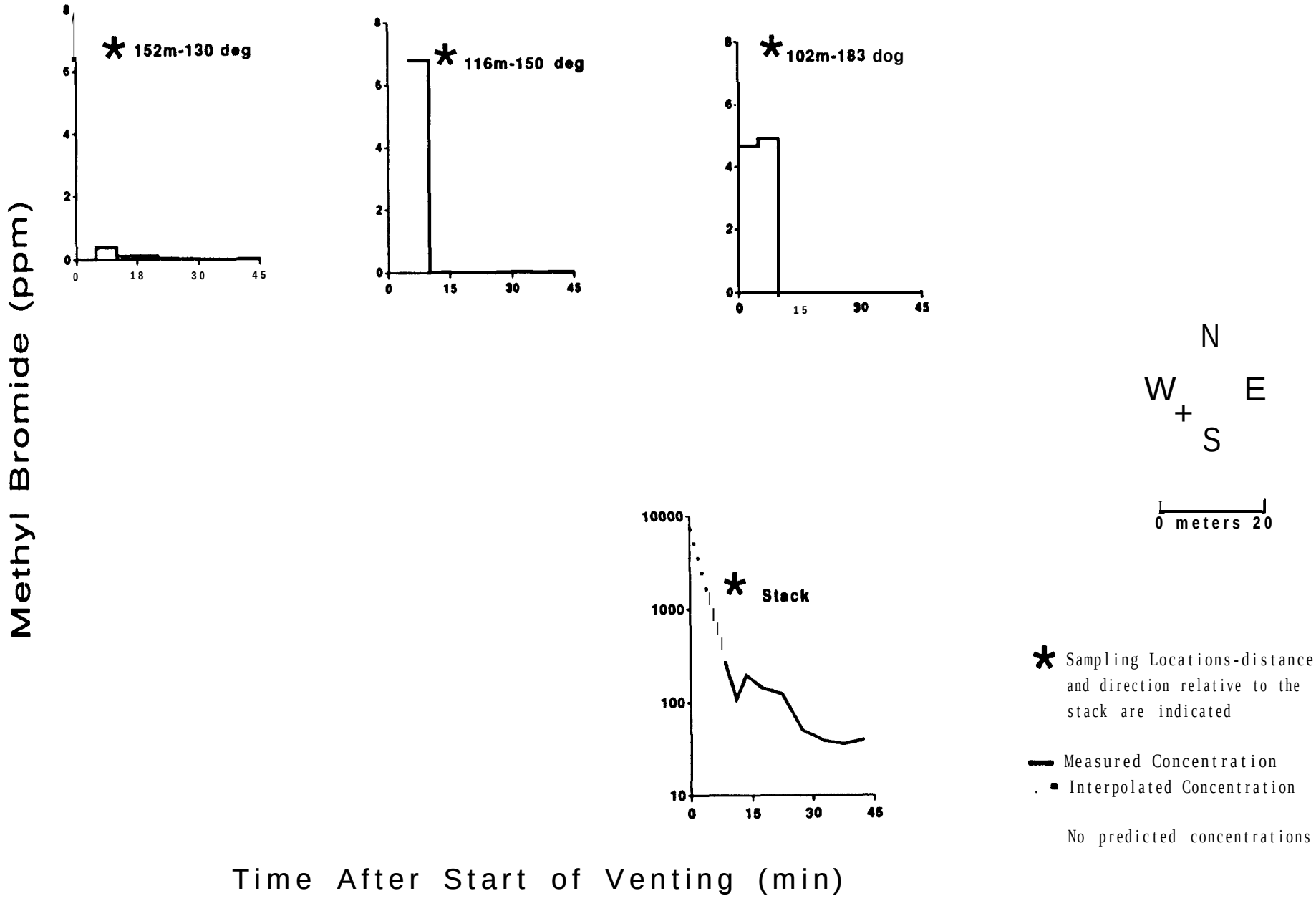


Table6. Resultsof Methyl Bromide Air Monitoring at Fresno

Time On	Time Off	Sample Period (min)	Distance to Stack (m)	Angle to Stack (deg)	Measured Methyl Bromide (ppm)	Detection Limit (ppm)
711	716	5	102	183	4.677	0.0052
716	721	4.92	102	183	4.9	0.0053
721	726	4.97	102	183	0.073	0.0052
726	731	4.92	102	183	0.011	0.0053
731	736	4.94	102	183	MM detected	0.0052
736	741	4.82	102	183	nonedetected	0.0054
741	746	4.94	102	183	nonedetected	0.0052
746	751	4.97	102	183	none detected	0.0052
751	756	4.95	102	183	nonedetected	0.0052
711	716	5.03	116	150	sample lost	
716	721	4.93	116	150	6.79	0.0052
721	726	5	116	150	0.026	0.0051
726	731	4.95	116	150	0.013	0.0052
731	736	4.9	116	150	nonedetected	0.0052
736	741	4.97	116	150	nonedetected	0.0051
741	746	5.07	116	150	0.02	0.005
746	751	4.87	116	150	nonedetected	0.0052
711	716	5	152	130	nonedetected	0.0052
716	721	4.93	152	130	0.375	0.0053
721	726	4.95	152	130	0.115	0.0052
726	731	4.95	152	130	0.107	0.0052
731	736	5	152	130	0.037	0.0052
736	741	4.98	152	130	0.01	0.0052
741	746	4.98	152	130	nonedetected	0.0052
746	751	4.98	152	130	nonedetected	0.0052
751	756	5.01	152	130	0.005	0.0052
711:30			stack		7461	
716	718	2.4	stack		198.875	
718	720	2.35	stack		261.528	
720	722	2.37	stack		108.539	
722	725	2.4	stack		195.984	
725	730	4.94	stack		143.474	
730	735	4.9	stack		124.415	
735	740	4.93	stack		51.382	
740	745	4.9	stack		39.073	
745	750	4.93	stack		36.147	
750	755	5	stack		39.764	