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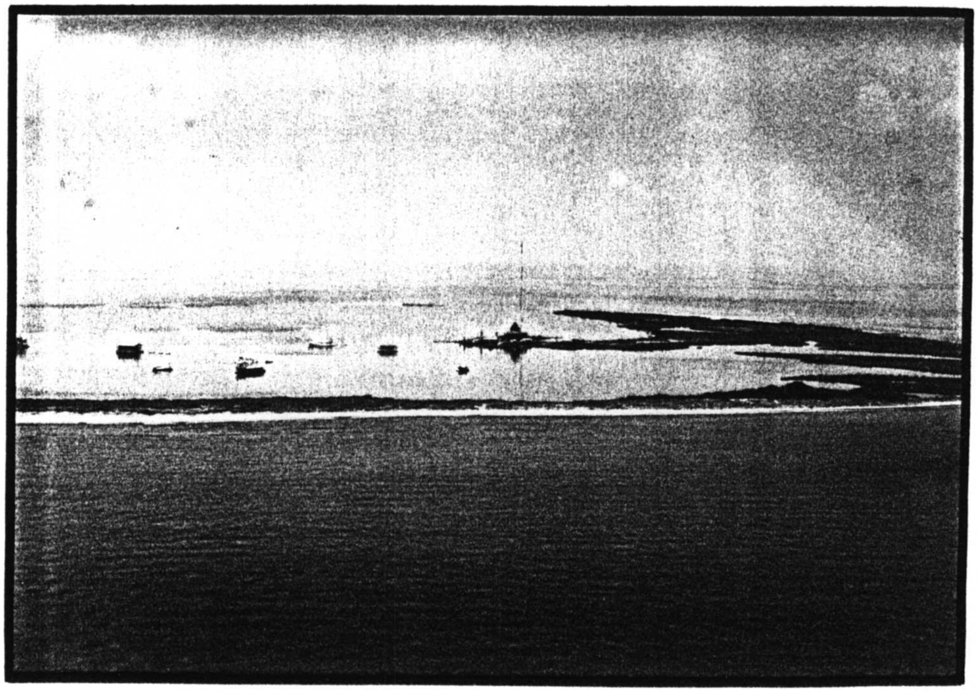
Long-Term Measurements of SO_2 and NO_2 Concentrations and Related Meteorological Conditions in the Northeastern Gulf of Mexico



MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

Cooperative Agreement
Coastal Marine Institute
Louisiana State University

OCS Study
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Long-Term Measurements of SO_2 and NO_2 Concentrations and Related Meteorological Conditions in the Northeastern Gulf of Mexico

Interim Report

Authors

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FRONT COVER

Aerial view of Breton Island, Louisiana. Large structure on island is the Kerr-McGee installation which housed the air quality monitors.

ABSTRACT

Air quality and meteorological data collected from remote near-coastal stations at Breton Island, Louisiana and Dauphin Island, Alabama during the period of October 1994 through April 1997 are analyzed and presented in this report. In addition, meteorological data from NOAA stations at Grand Isle (GDIL1), Dauphin Island (DPIA1), and offshore at buoys 42007 and 42040 are included in the discussion. Highest concentrations of SO_2 and NO_2 occurring at Dauphin Island during the measurement period were predominantly seen with northerly winds. Highest SO_2 concentrations at Breton Island were also associated with northerly winds, while high NO_2 was more distributed but most frequently related to southerly winds. Estimated mean annual concentrations of SO_2 and NO_2 at both monitoring stations was less than 5 ppb. Weak seasonal and diurnal trends are detected at Dauphin Island, but are not as pronounced at Breton Island. Monthly mean values of SO_2 appear to be higher at Dauphin Island than Breton, while mean NO_2 concentrations are nearly equivalent on average. Higher maximums and standard deviations occur at Breton Island, primarily due to isolated high concentration events. Stability characteristics over the offshore Breton Island area are projected to be free-convective for most of the year, and neutral to unstable otherwise. Seasonal variations of calculated mixing height at Breton Island resemble those at Grand Isle, with root mean square error of 165 m.

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We would like to express our sincere appreciation to Kerr-McGee Corporation and the Alabama Marine Resources Division for providing the facilities needed to establish and maintain our monitoring stations, particularly offshore at Breton Island. Thanks to the owners and staff of the *Chandeleur Islander* for their hospitality during extended offshore service trips, and to the pilots and groundcrews of Southern Seaplane. Despite numerous setbacks, an extensive data set continues to be compiled due largely to the professionalism and dedication of the Coastal Studies Institute (CSI) Field Support Group technicians, especially Mr. Bill Gibson and Mr. Steve Dartez. Brian Blanchard, also of CSI, participated in the field servicing, reduced the data, assisted in the analysis, and provided the layout and production of this document. Finally, our gratitude to Dr. William Hutzell, our COTR at MMS, for his continued guidance and understanding.

I. EXECUTIVE SUMMARY

Breton Island lies within the Chandeleur chain to the east of the Mississippi River Delta of Louisiana. Part of the Chandeleurs, including Breton, is contained in the Breton National Wilderness Area, which offers protected haven to the abundant marine waterfowl and wildlife inhabiting the islands. Dauphin Island lies just off the western inlet of Mobile Bay, Alabama (see Fig. 1), and is part of the Gulf Islands National Seashore. The Breton area has been designated as Class I by the U.S. Congress, and falls under the most stringent Prevention of Significant Deterioration (PSD) restrictions.

Two short-term (less than 3 month) air quality pilot studies were conducted by this institute during the summers of 1993 and 1994 in the Breton area. In general, hourly ambient concentrations of both SO_2 and NO_2 were found to be quite low, less than 5 ppb. On the other hand, the data indicated that the magnitude of concentration was a factor of transport direction; concentrations at Breton Island were higher than those at a separate station within the Mississippi River Delta (Pass-A-Loutre, approximately 25 miles south of Breton); and that hourly maximums showed high NO_x events occur randomly at Breton, typically associated with east-northeast winds.

In order to further our understanding of spatial and temporal variations of air pollutants and meteorological processes affecting the Class I areas, long-term data records are currently being gathered on site. The purpose of this Interim Report is to present the data collected during the period of October 1994 through April 1997.

The Dauphin Island station was established in March 1996. From that point through April 1997, the maximum values of SO_2 were 37 ppb, 27 ppb, and 9.9 ppb for 1 hour, 3-hour, and 24-hour averages, respectively. Maximum values for NO_2 were 58, 34 and 18.8 ppb for 1 hour, 3-hour, and 24-hour averages, respectively. The annual (period) mean SO_2 was 1.86 ppb with a coefficient of variation (C.O.V.) of 1.47 (where C.O.V. is defined as the ratio of the standard deviation to the mean) while for NO_2 4.58 ppb with a C.O.V. of 0.84. The majority of high pollutant measurements were associated with northwesterly to northeasterly wind flows. Seasonal SO_2 concentrations show only a slight increase in late summer and mid-winter, while NO_2 values clearly rise in fall and peak in winter. Diurnal SO_2 variations show little change but slightly higher in late morning; those for NO_2 often peak at mid-morning with a secondary maximum near evening.

Due to the discontinuity of the Breton Island dataset, a standard annual average could not be calculated. Therefore, "composite" years were compiled from those months most complete during the measurement period. Annual means from these years are for SO_2 1.14 ppb with a C.O.V. of 1.54 and for NO_2, 4.58 with a C.O.V. of 1.99. Maximum SO_2 values recorded during the entire period were 30, 16, and 8 ppb for 1 hour, 3-hour, and 24 hour averages, respectively. Maximum NO_2 values were 44, 31, and 18 ppb for 1 hour, 3-hour, and 24-hour averages, respectively. Note that although considerably higher concentrations were observed, they were generally associated with periods of questionable monitor performance and were therefore designated as unreliable in this report. High SO_2 concentrations were very strongly associated with north and northeasterly winds. On the other hand, high NO_2 concentrations were more distributed, but were most frequently seen with southeast and southerly flow. Seasonal trends were not prominent in the dataset; some diurnal variation was seen, particularly for NO_2 concentrations. The very high concentrations mentioned above were recorded during one of several similar episodes which appear throughout the dataset.

Monthly mean SO_2 values at Dauphin Island appear to be almost twice as high as those at Breton, while monthly mean NO_2 is nearly the same. For both pollutants, hourly maximums and standard deviations are larger at Breton, reflecting the influence of isolated high concentration events.

Calculated monthly stability at NOAA buoy 42007 shows free convective conditions to prevail during the summer months, with near-neutral stability during the remainder of the year. A theoretical relationship amongst the mixing height, the lifting condensation level, and the surface temperature dew-point spread is employed for our study area. Using this relationship and dew-point temperatures derived from Breton Island data, significant correlation is seen between the mixing height trends at Grand Isle, Louisiana and Breton Island during 1995.

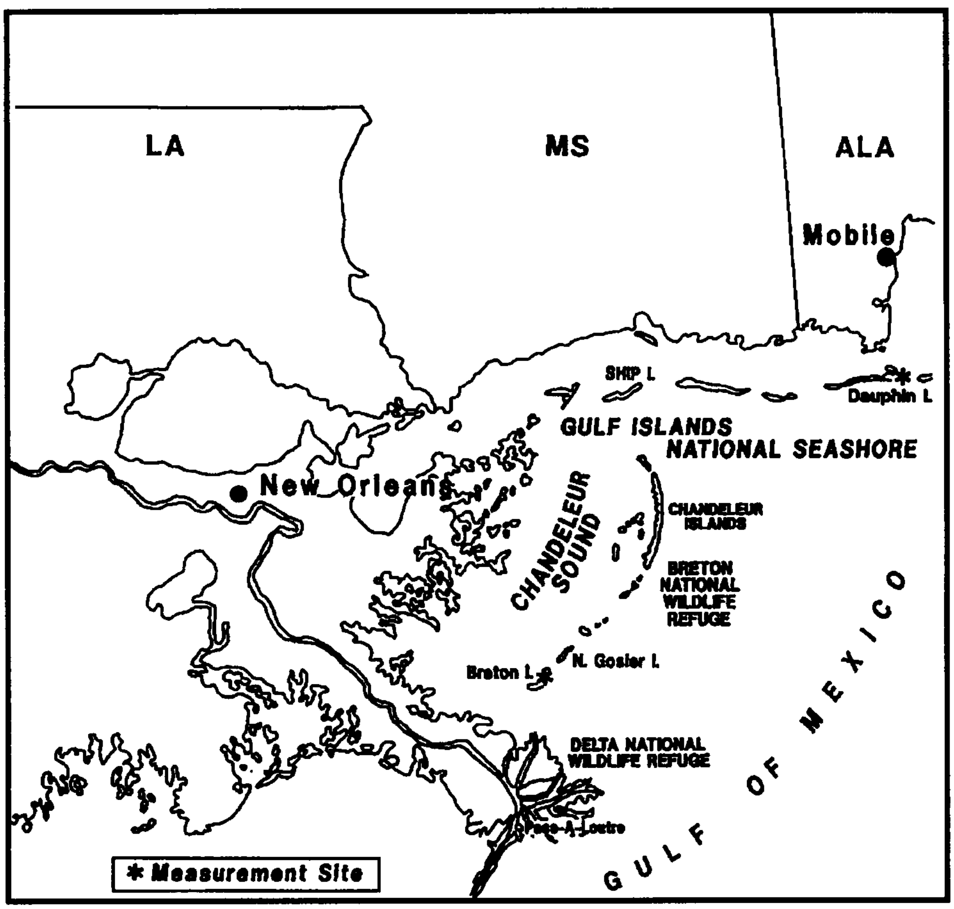


Figure 1. Location of air quality monitoring stations used in this study.

II. FIELD MEASUREMENTS

The environmental monitoring stations deployed at both Breton and Dauphin Islands were designed to operate unattended for extended periods of time. Sampling of various parameters and subsequent storage of the collected data was controlled on site by Campbell Scientific, Inc. CR10 dataloggers with SM192 (96000 data point) storage modules. Depending on the number of parameters being recorded and the recording interval, this system would generally allow 3 to 4 weeks of operation before approaching capacity (full memory). For the air quality data at both stations, the dataloggers were programmed for 10-second scan rates with output of 5-minute averages.

Site selection for our monitoring stations, particularly at Breton Island, was determined primarily by the availability of an environmentally-controlled building into which we would be allowed to install our equipment. Every effort was made to mount the sample intakes for the air quality monitors so that they would be exposed to the ambient airflow in all directions. However, due to the restricted choice of locations, it may be inevitable that pollutants emitted from nearby sources were detected by our analyzers. Both locations were likely subjected to a wide variety of permanent and transient sources, including auto and ship traffic and small generators used by campers and moored houseboats. In addition, the AC power at Breton Island is supplied by generators which are continuously in operation. The identification of these potential sources, and the magnitude of their contributions to the data record, is not addressed in this Interim report.

A. Instruments and Calibrations

1. Dauphin Island

After reconnaissance of the Dauphin Island area, it was determined that the building housing the Alabama Marine Resources Division provided the most favorable location for installation of our equipment. A rough layout of the immediate area is shown in Fig. 2. Due to the proximity of the NOAA C-MAN station DPIA1, no meteorological sensors were necessary at our site.

Instruments comprising the air quality monitoring suite were of Monitor Labs, Inc. manufacture. The ML9850 SO_2 analyzer utilized UV fluorescence spectroscopy while the ML9841A NO_x analyzer employed chemiluminescence for its measurement technique (see, e.g., Boubel et al., 1994 and Monitor Labs, 1993). These units have been designated by the U.S. EPA as an "equivalent method" as defined in 40 CFR Part 53. Minimal detectable ambient concentrations of pollutants was approximately 1 ppb. For calibration of the air quality monitors, an Environics Series 100 Multi-Gas Calibrator was installed. This calibrator is completely computer-controlled and contains two flow controllers, a mixing zone, a reaction chamber for gas phase titration, and an ozone generation module. It also meets all EPA requirements.

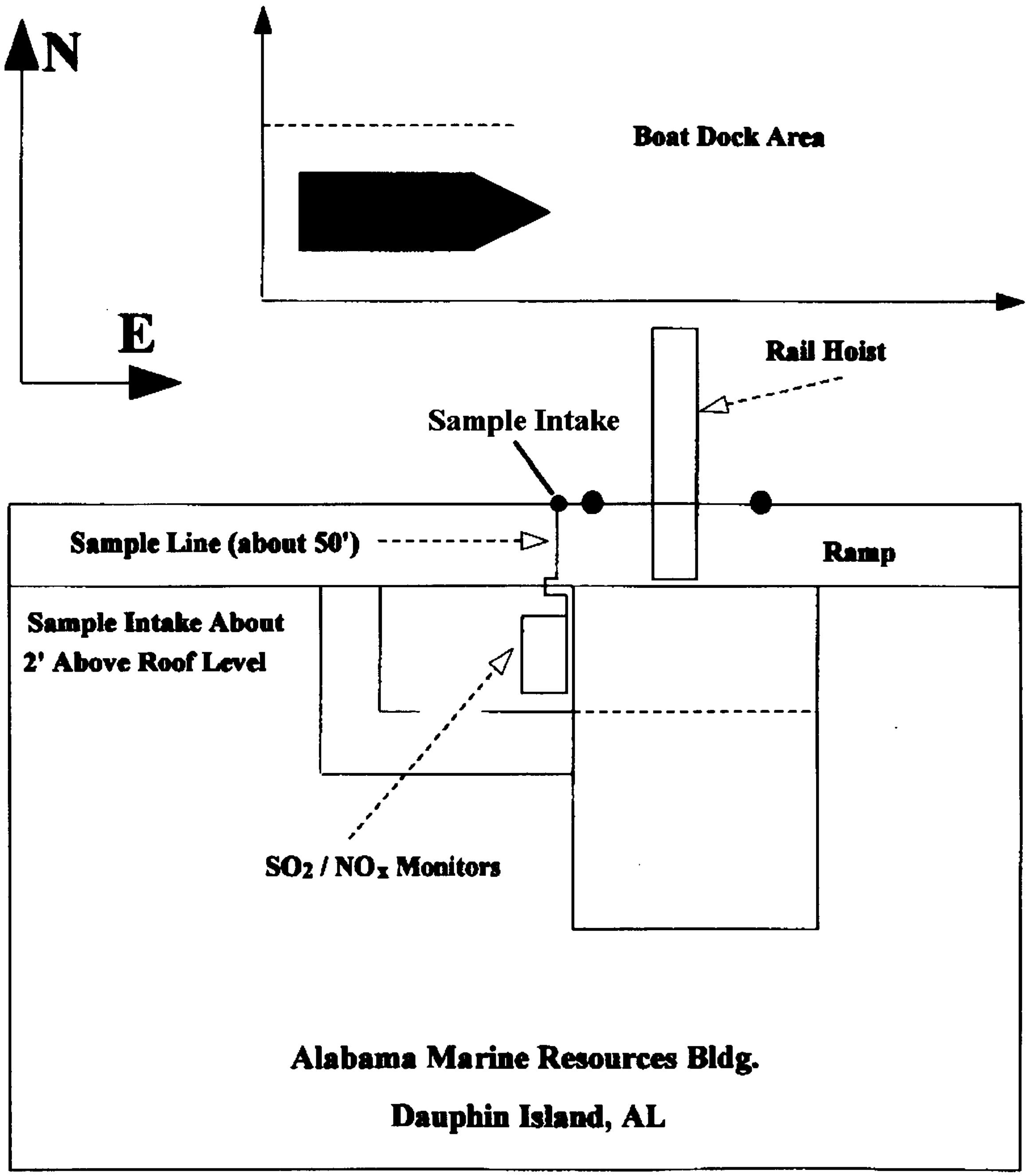


Figure 2. Schematic of the air quality station at Dauphin Island (distances are approximated).

The following brief synopsis lists all servicing dates and pertinent equipment and operational notes for Dauphin Island.

3/5/96 Station established. Full calibration of monitors and calibrator. New filters installed. Leak test performed on air quality monitors.

3/14/96 Download of data. Calibration of air quality monitors. Cleaned rear fan filters on monitors.

4/30/96 Download. Calibration of air quality monitors. Approximately 75 - 100' of sample line removed, intake now at rear of building about 5' above roof.

5/23/96 Download. NO_x monitor found offline due to failure of power supply. New power supply installed on 5/24. Calibration of air quality monitors; NO_x errors high due to short warm up time.

6/5/96 Download. Calibration of air quality monitors begun, found NO_x as on last service. Adjust gain and converter efficiency on NO_x and gain on SO_2. Changed and cleaned filters.

6/26/96 Download. Complete calibration of Calibrator flows and 5 point calibration of air quality monitors. Adjustments to SO_2 and NO_x gains and NO_2 converter efficiency as well as SO_2 full scale output voltage and NO_2 zero offset.

7/11/96 Download. Check response time on both air quality monitors - 95% within 2 minutes. Calibration of air quality monitors.

8/2/96 Download. Verified flows in Calibrator. Cleaned air filters and changed particulate filters. Checked sample flows. Calibration of air quality monitors.

8/13/96 Download. Changed charcoal in both SO_2 and NO_x monitors, leak tested. Recalibrated SO_2 sample flow rate. Verified Calibrator flows. Calibration of air quality monitors.

8/26/96 Download. Calibration of flows in Calibrator. Replaced internal filters. Recalibrated zero and span offsets in accordance with Monitor Lab procedures. Cleaned air filters. Calibration of air quality monitors.

9/26/96 Download. NO_x monitor - cleaned optical lens, replaced particulate filter and cleaned air filter, replaced desiccant bags and purged PMT housing, replaced O-ring on optical bench, leak tested, cleared memory and reset all offsets, gains and converter efficiency. SO_2 monitor - cleaned optical lenses, replaced desiccant, leak tested, reset all offsets and gains, performed UV lamp alignment, flow check. Failure of NO_x

monitor, possible damage to PMT tubes due to exposure. NO_x monitor returned to service on 9/27. Flow calibration. Calibration of air quality monitors.

10/9/96	Download. Verified scheduled power outage on 5 October. Changed PMT tubes on both monitors, leak tested. Changed Purifil and charcoal on zero air supply. Calibration of air quality monitors on 10/10 and span check on 10/11.
10/29/96	Download. Changed sample filters and cleaned air filters. Calibration of air quality monitors.
12/12/96	Download. Cleaned air filters and replaced sample filters. Verified power outage on 23 November. Calibration of air quality monitors. Cleaned vacuum pump on NO_x monitor and then purged with zero air; NO_x reading high but dropping. Calibration of air quality monitors.
1/8/97	Download. NO_x monitor - cleaned UV lens, replaced internal and external particulate filters, cleaned and leak tested. SO_2 monitor - cleaned UV and convex lens, replaced internal and external particulate filters, replaced charcoal in scrubbers, sample flow check. Calibrator - flow check. Adjustment to gain on both air quality monitors. Calibration of air quality monitors.
1/28/97	Download. Replaced UV and external particulate filters on both monitors, leak tested. Calibration of air quality monitors.
2/18/97	Download. Replaced particulate filters and cleaned air vent filters. Intermittent Cell Temperature failure on NO_x monitor, found that heat-sink grease on probe had dried out so that probe not seated properly, recoated with fresh grease to correct. Calibration of air quality monitors.
3/5/97	Download. Cleaned air filters and replaced particulate filters. Calibration of air quality monitors. Replaced desiccant on zero air supply.
3/18/97	Download. SO_2 monitor - replaced heat-sink grease on both heaters and temperature sensor, cleaned UV filter, replaced particulate filters and cleaned air filter. NO_x monitor - cleaned and replaced heat sink grease on Cell and manifold, replaced particulate filters and cleaned air filter. Leak tested. Replaced desiccant, charcoal and Purifil in zero air supply. Flow check on Calibrator. Zero, span and offsets adjusted on air quality monitors. Calibration of air quality monitors.
4/2/97	Replaced particulate filters. Found NO_2 Filter enabled on NO_x monitor causing very slow response times, Filter disabled. Calibration of air quality monitors.

4/16/97 Download. Replaced particulate filters and cleaned air filters. Calibration of air quality monitors.

4/30/97 Download. Changed particulate filters. Calibration of air quality monitors.

Tables 1 and 2 list the recommended procedures to be followed during routine service visits to the Breton and Dauphin Island air quality stations, respectively. In practice, this schedule could not be strictly adhered to, particularly at Breton Island. Unfavorable weather and other logistic complications associated with servicing an offshore location often produced extended periods between visits. Malfunctions of the monitoring equipment and support services (generators, etc.) occasionally consumed the technician's time on site, thereby preventing completion of these standard operations. In addition, time was required for servicing the meteorological sub-system on Breton. A better record was achieved at Dauphin Island, where ease of access allowed for longer time on site and a less extensive system is deployed. This operational list continues to evolve as more experience with the air quality monitors is gained in the field.

As described in the Code of Federal Regulations (40 CFR 58, App. B, 1994), the air quality monitors were calibrated by exposing them to known concentrations of the desired pollutants (SO_2 and NO) at several points from 0 to full scale (500 ppb). Test concentrations were obtained by diluting a 50/50 mixture of NO and SO_2 from compressed gas cylinders (traceable EPA Protocol gases) with zero air and ozone. If properly set up and operating, the monitor should exhibit a linear response, therefore the ambient measurement accuracy should be consistent from low to high concentrations.

Tables 3 through 6 list the calibration values obtained at multiple points for the SO_2 monitor. The interpretation is that, for any randomly selected point within the database represented, there is only a 5% probability that its accuracy is outside of the boundaries defined by the upper and lower 95% confidence limits. For the entire SO_2 record, accuracies with 5% were obtained. Slight drifts over time are evident, but only amounted to a 1 - 2% error increase and were not considered significant. Variations seen in the desired values result from changes in the gas flow rates and, in turn, calculated dilutions.

Table 1.
Breton Island Recommended Operations

Service Interval	Operation
2 Week	(1) Download datalogger and clear memory
	(2) Check AC voltage supply to instruments
	(3) Record events logs on analyzers and verify instrument status
	(4) Change zero air intake desiccant
	(5) Perform zero and 3-point calibration of analyzers
	(6) Download calibration data from datalogger and clear memory
	(7) Change intake particulate filters
3 Month	(1) Perform steps (1) - (4) above
	(2) Service external vacuum pumps (clean, grease, check vacuum)
	(3) Check calibrator flows with Gilobrator flowmeter
	(4) Compute calibration concentrations based on flow rates from (3)
	(5) Perform lens cleaning and leak test of analyzers
	(6) Change internal particulate filters
	(7) Perform zero and 5-point calibration of analyzers
	(8) Download calibration data from datalogger and clear memory
	(9) Change intake particulate filters
6 Month	(1) Perform 3 Month service
	(2) Change activated charcoal in analyzers and calibration device
	(3) Replace NO_x analyzer external pump
1 Year	(1) Perform 6 Month service
	(2) Inspect o-rings in analyzers and replace if necessary
	(3) Clean and replace heat sink grease in analyzers

Table 2.
Dauphin Island Recommended Operations

Service Interval	Operation
2 Week	(1) Purge calibrator
	(2) Replace external particulate filters
	(3) Clean air filters on analyzers
	(4) Record event logs on analyzers and verify instrument status
	(5) Download datalogger and clear memory
	(6) Perform zero and 3-point calibration of analyzers
	(7) Download calibration data and clear memory
	(8) Replace desiccant on zero air supply and drain water if any
3 Month	(1) Download datalogger and clear memory
	(2) Perform lens cleaning and leak test of analyzers
	(3) Replace internal particulate filters
	(4) Service vacuum pumps (clean, grease, check vacuum)
	(5) Check flow calibration of Calibrator per manufacturer's specifications
	(6) Purge calibrator
	(7) Record event logs on analyzers and verify instrument status
	(8) Perform zero and 5-point calibration of analyzers
	(9) Download calibration data and clear memory
	(10) Change intake particulate filters
6 Month	(1) Perform 3 Month service
	(2) Change activated charcoal in analyzers and zero air supply
	(3) Change purifil in zero air supply
	(4) Service NO_x vacuum pump (rebuild or replace)
1 Year	(1) Perform 6 Month service
	(2) Inspect o-rings in analyzers and replace if necessary
	(3) Clean and replace heat sink grease in analyzers

Table 3.
Dauphin Island SO_2 Monitor Zero Values

Date	Monitor Zero
3/7/96	1
3/14/96	1
4/30/96	1
5/23/96	1
6/5/96	1
6/27/96	2
7/11/96	1
8/2/96	1
8/14/96	1
8/27/96	1
9/27/96	1
10/10/96	1
10/30/96	3
12/13/96	3
1/10/97	-1
1/29/97	0
2/19/97	1
3/6/97	1
4/3/97	1
4/17/97	0
4/30/97	0

Table 4.
Dauphin Island SO_2 Monitor Calibration Points

Date	Desired	Actual	% Error
3/7/96	297	296	-0.34
6/27/96	296	296	0
9/27/96	297	295	-0.67
10/10/96	297	298	0.34
1/10/97	297	297	0
Sum			-0.67
Mean			-0.13
Standard Deviation			0.34
Upper 95% Limit			0.54
Lower 95% Limit			-0.80
3/7/96	97	96	-1.03
6/27/96	97	98	1.03
9/27/96	96	94	-2.08
10/10/96	96	94	-2.08
1/10/97	96	95	-1.04
Sum			-5.20
Mean			-1.04
Standard Deviation			1.14
Upper 95% Limit			1.19
Lower 95% Limit			-3.27

Table 5.
Dauphin Island SO_2 Monitor Precision Values

Date	Desired	Actual	% Error
3/7/96	208	207	-0.48
3/14/96	208	205	-1.44
4/30/96	208	205	-1.44
5/23/96	209	211	0.96
6/5/96	207	208	0.37
6/27/96	207	209	0.97
7/11/96	207	208	0.37
8/2/96	207	204	-1.45
8/14/96	208	204	-1.92
8/27/96	207	201	-2.90
9/27/96	207	206	-0.48
10/10/96	207	205	-0.97
10/30/96	207	208	0.48
12/13/96	207	208	0.48
1/10/97	207	206	-0.48
1/29/97	207	206	-0.48
2/19/97	207	207	0
3/6/97	207	207	0
4/3/97	207	206	-0.48
4/17/97	207	205	-0.97
4/30/97	207	206	-0.48
Sum			-10.34
Mean			-0.49
Standard Deviation			0.95
Upper 95% Limit			1.37
Lower 95% Limit			-2.35

Table 6.
Dauphin Island SO_2 Monitor Full Scale Calibration Values

Date	Desired	Actual	% Error
3/7/96	428	427	-0.23
3/14/96	428	428	0
4/30/96	428	428	0
5/23/96	429	434	1.17
6/5/96	428	438	2.34
	428	428	0
6/27/96	428	428	0
7/11/96	428	424	-0.93
8/2/96	428	419	-2.10
8/14/96	428	415	-3.04
	428	421	-1.64
8/27/96	427	417	-2.34
9/27/96	427	426	-0.23
10/10/96	428	430	0.47
10/30/96	428	430	0.47
12/13/96	428	428	0
1/10/97	428	429	0.23
1/29/97	428	430	0.47
2/19/97	428	427	-0.23
3/6/97	428	426	-0.47
4/3/97	428	426	-0.47
4/17/97	428	425	-0.70
4/30/97	428	425	-0.70
Sum			-7.93
Mean			-0.34
Standard Deviation			1.12
Upper 95% Limit			1.86
Lower 95% Limit			-2.54

Calibration values for the NO_x monitor are listed in Tables 7 through 12. Errors encountered here were somewhat higher than for the SO_2 monitor, however still were less than 10% for the record. The highest errors were seen on the 23 May and 5 June 1996 calibrations, which marked the measurement period following major repair to the monitor (see above). Insufficient time was allowed for the monitor to warm up and stabilize following the repairs. This was corrected during the 5 June calibration. While the greatest errors of the calibration record were encountered following these repairs, they were still less than 15% of the span value, and within suggested EPA guidelines (EPA, 1979). Therefore, although this deviation is noted, no correction was made to the data recorded during this period.

A 2 to 5 ppb zero offset is apparent in the NO_2 channel throughout the measurement period. This offset was subtracted from the recorded data. Zero offsets for the other parameters were generally 1 ppb or less (the minimal detectable concentration) and no correction was applied. In addition, the SO_2 monitor was programmed to perform a daily electronic zero adjustment.

Table 7.
Dauphin Island NO_x Monitor Zero Values

Date	NO	NO_2	NO_x
3/7/96	0	4	0
3/14/96	1	4	1
4/30/96	0	4.4	1
5/23/96	1	5.1	1.4
6/5/96	0	5	1
6/27/96	0	4	1
7/11/96	1	4	1
8/2/96	1	4	4
8/14/96	0	4	1
8/27/96	0	3	1
9/27/96	1	3	1
10/10/96	1	2	1
10/30/96	1	2	2
12/13/96	1	2	1
1/10/97	1	2	1
1/29/97	0	3	1

Table 7 continued.

2/19/97	0	2	1
3/6/97	0	2	1
4/3/97	1	2	1
4/17/97	1	2	0
4/30/97	0	2	0

Table 8.
Dauphin Island NO_x Monitor Calibration Points

Date	Desired	Actual NO	Actual NO_x	% Error NO	% Error NO_x
3/7/96	308	304	305	-1.30	-0.97
6/27/96	307	306	309	-0.33	0.65
Mean				-0.82	-0.16
3/7/96	100	97	97	-3.0	-3.0
6/27/96	100	98	100	-2.0	0
Mean				-2.5	-1.5

Table 9.
Dauphin Island NO_x Monitor Precision Values

Date	Desired	Actual NO	Actual NO_x	% Error NO	% Error NO_x
3/7/96	215	209	210	-2.79	-2.33
3/14/96	215	213	215	-0.93	0
4/30/96	215	212	216	-1.4	0.47
5/23/96	215	234	238	8.84	10.70
6/5/96	215	212	214	-1.40	-0.47
6/27/96	215	214	216	-0.47	0.47
7/11/96	215	211	213	-1.86	-0.93
8/2/96	215	210	212	-2.33	-1.40
8/14/96	215	212	213	-1.40	-0.93
8/27/96	214	210	212	-1.87	-0.93
9/27/96	214	208	210	-2.8	-1.87
10/10/96	214	212	214	-0.93	0
10/30/96	214	206	209	-3.74	-2.34
12/13/96	214	210	212	-1.87	-0.93
1/10/97	214	215	217	0.47	1.40
1/29/97	214	215	218	0.47	1.87
2/19/97	214	210	214	-1.87	0
3/6/97	214	211	215	-1.4	0.47
4/3/97	214	213	216	-0.47	0.93
4/17/97	214	215	219	0.47	2.34
4/30/97	214	210	214	-1.87	0
Sum				-19.15	6.52
Mean				-0.91	0.31
Standard Deviation				2.43	2.63
Upper 95% Limit				3.85	5.46
Lower 95% Limit				-5.67	-4.84

Table 10.
Dauphin Island NO_x Monitor Calibration Points

Date	Desired	Actual NO	Actual NO_x	% Error NO	% Error NO_x
3/7/96	444	442	445	-0.45	0.23
3/14/96	444	451	454	1.58	2.25
4/30/96	444	450	454	1.35	2.25
5/23/96	444	490	496	10.36	11.71
6/5/96	444	495	500	11.49	12.61
	444	442	446	-0.45	0.45
6/27/96	444	441	446	-0.68	0.45
7/11/96	444	438	442	-1.35	-0.45
8/2/96	444	434	437	-2.25	-1.58
8/14/96	444	436	441	-1.80	-0.68
8/27/96	443	437	441	-1.35	-0.45
9/27/96	443	442	445	-0.23	0.45
10/10/96	443	439	442	-0.90	-0.23
10/30/96	443	432	437	-2.48	-1.35
12/13/96	443	434	441	-2.03	-0.45
1/10/97	443	440	447	-0.68	0.90
1/29/97	443	442	448	-0.23	1.13
2/19/97	443	434	440	-2.03	-0.68
3/6/97	443	435	440	-1.81	-0.68
4/3/97	443	443	449	0	1.35
4/17/97	443	448	454	1.13	2.48
4/30/97	443	440	446	-0.68	0.68
Sum				6.51	30.39
Mean				0.30	1.38
Standard Deviation				3.54	3.58
Upper 95% Limit				7.24	8.40
Lower 95% Limit				-6.64	-5.64

Table 11.
Dauphin Island NO_x Monitor NO_2 Precision Values

Date	Desired	Actual	% Error
3/7/96	98	102	4.08
3/14/96	99	102	3.03
4/30/96	100	103	3.0
5/23/96	116	121	4.31
6/5/96	94	100	6.38
6/27/96	100	103	3.0
7/11/96	97	100	3.09
8/2/96	103	106	2.91
8/14/96	106	110	3.77
8/27/96	99	104	5.05
9/27/96	108	108	0
10/10/96	95	99	4.21
10/30/96	94	98	4.26
12/13/96	98	102	4.08
1/10/97	97	101	4.12
1/29/97	103	109	5.83
2/19/97	100	105	5.0
3/6/97	101	107	5.94
4/3/97	97	100	3.09
4/17/97	102	106	3.92
4/30/97	101	105	3.96
Sum			83.03
Mean			3.96
Standard Deviation			1.33
Upper 95% Limit			6.57
Lower 95% Limit			1.35

Table 12.
Dauphin Island NO_x Monitor NO_2 Calibration Points

Date	Desired	Actual	% Error
3/7/96	349	349	0
3/14/96	347	347	0
4/30/96	351	352	0.28
5/23/96	376	337	-10.37
6/5/96	352	355	0.85
6/27/96	356	357	0.28
7/11/96	357	359	0.56
8/2/96	363	366	0.83
8/14/96	371	369	-0.54
8/27/96	344	352	2.33
9/27/96	340	350	2.94
10/10/96	316	320	1.27
10/30/96	308	313	1.62
12/13/96	320	324	1.25
1/10/97	323	328	1.55
1/29/97	332	339	2.11
2/19/97	325	333	2.46
3/6/97	330	339	2.73
4/3/97	324	328	1.23
4/17/97	332	336	1.20
4/30/97	326	332	1.84
Sum			14.42
Mean			0.69
Standard Deviation			2.64
Upper 95% Limit			5.86
Lower 95% Limit			-4.48

2. Breton Island

Air quality and meteorological monitoring efforts at Breton Island over the measurement period of October 1994 through April 1997 can be separated into several phases, each initiated by a specific series of events. Most significant of these were the change in monitoring equipment in the Spring 1995; lightning damage and subsequent downtime in the Summer 1995; lightning damage and downtime in the Spring/Summer 1996; and monitor damage due to power supply and regulation in the latter part of 1996 and early 1997. These events and their effects will be described in more detail in the following sections.

Almost the entire data record, with the exception of the first two weeks of October 1994, was collected from our site located within the Kerr-McGee (KM) building on Breton Island proper. The air quality monitors and datalogger equipment were housed inside the third floor room at KM, as shown in Fig. 3. Outside access was provided by an exterior bracket installed on a window facing east-northeast. Prior to the KM installation, the monitors were on board the *Chandeleur Islander*, moored approximately 200 yards southeast of the KM facility.

The air quality monitoring suite initially employed consisted of a Thermo-Environmental (TECO) Model 42 NO_x monitor, Model 43A SO_2 monitor, and Model 146 Gas Calibrator. These instruments utilize the same detection methods as the Monitor Labs, Inc. units (see Sec. II.A.1.) and also meet EPA requirements. Lowest detectable concentrations were 1 ppb. The Model 146 was replaced with an Environics Calibrator on 1 November 1994. This setup remained in operation until 23 March 1995, at which point all air quality monitors and accessories were removed.

The station was re-deployed on 13 April 1995 with a newly-acquired suite of Monitor Labs, Inc. Units including a ML9850 SO_2 monitor, ML9841A NO_x monitor, and ML8550 Gas Calibrator (see Sec. II.A.1. for description). These instruments were chosen primarily for their ability to operate on either AC or DC power, and for their greater electronic capabilities which offered simpler operation and interfacing. Measurement specifications were similar for both the TECO and Monitor Labs analyzers, therefore no significant difference was introduced into the data record. On the other hand, it appears that the Monitor Labs units were more susceptible to both environmental conditions and power fluctuations, which eventually led to frequent failures.

Meteorological sensors deployed included a Weathertronics Stratavane wind sensor, a shielded Rotronics humidity sensor, a shielded thermistor for air temperature, and a Weathertronics atmospheric pressure sensor. The Stratavane, humidity and air temperature sensors were mounted on the KM microwave tower (see Fig. 3). Average wind speed and direction was recorded at 5-minute intervals while the remaining parameters were recorded hourly. On 16 October 1995, the Stratavane was replaced with an R. M. Young Aerovane mounted on the north-northeast roof of the KM building.

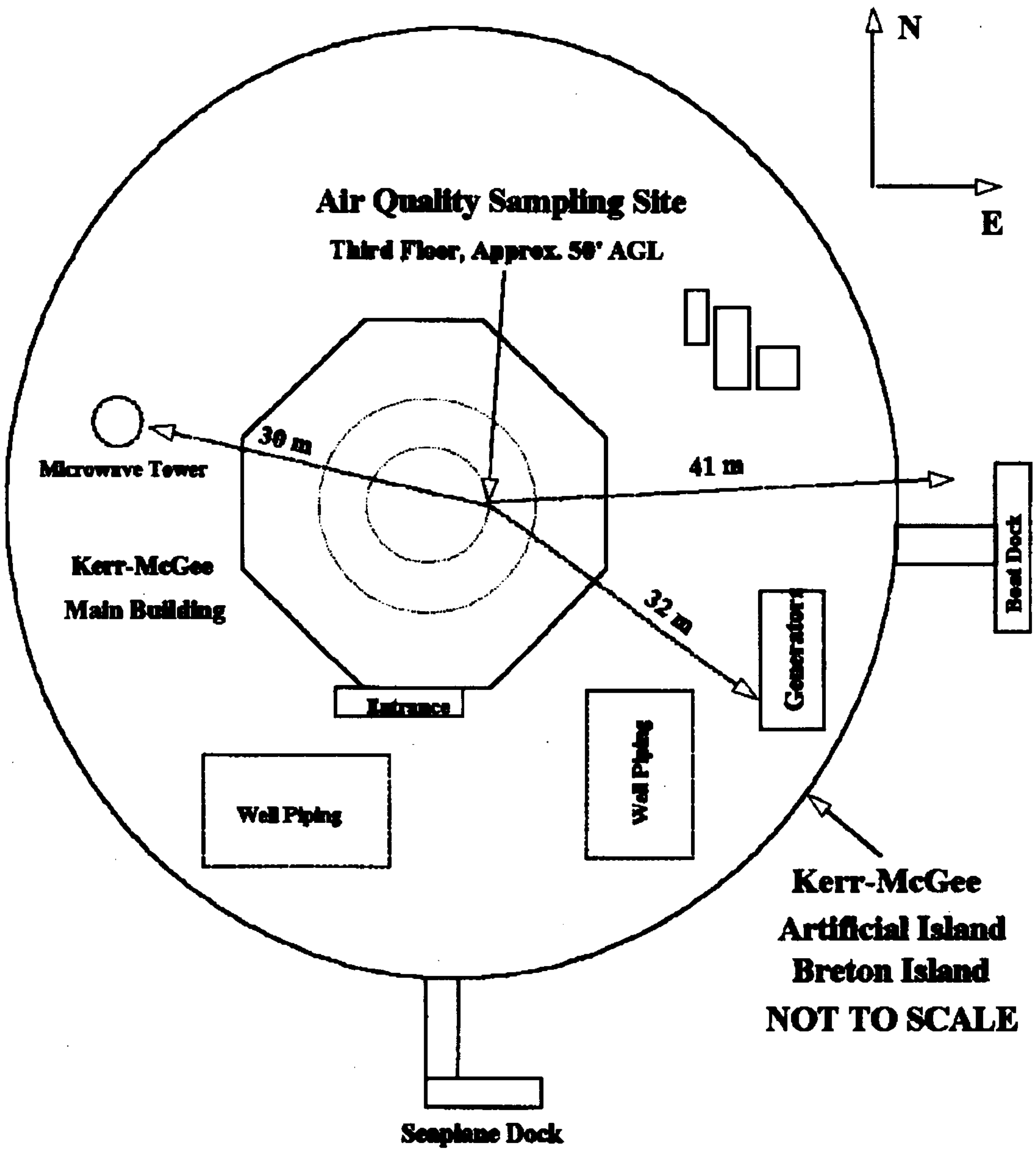


Figure 3. Schematic of the air quality station located at the Kerr-McGee facility on Breton Island. As shown in the figure, the intake for the air quality monitors was mounted on a bracket facing northeast from the third story window, about 50 feet above ground level.

Dates of station service and pertinent operational notes are briefly listed below.

10/4/94	Download of data at *Chandeleur Islander*. SO_2 analyzer found powered off but re-activated. NO_x analyzer did not appear to be functioning correctly and could not be calibrated. Good calibration on SO_2 analyzer.
10/13/94	Download. NO_x analyzer appears to have resumed normal operation. Calibration of air quality monitors. All equipment taken off line and removed from Chandeleur Islander.
10/22/94	Station established at Kerr-McGee. Good calibration on SO_2, partial on NO_x before failure of Gas Calibrator. Meteorological sensors installed on KM tower and checked against surface observations.
11/1/94	Download. Replaced TECO 146 with Environics Calibrator. Flows check with Gilibrator. Filters changed. Foam insulation placed on sample lines. Calibration of air quality monitors. Surface meteorological values checked.
11/14/94	Download. Surface meteorological values checked. Calibration of air quality monitors. Filters changed. Slight adjustment to NO_x zero-span.
11/30/94	Download. Surface meteorological values checked. Calibration of air quality monitors. Filters changed. Slight adjustment to NO_x.
12/20/94	Download. Surface meteorological values checked. Filters and NO_x desiccant canister changed. Calibration of air quality monitors.
1/4/95	Download. Surface meteorological values checked. Calibration of air quality monitors.
1/24/95	Download. Surface meteorological values checked. Slight adjustment to NO_x. Filters changed. Calibration of air quality monitors.
2/8/95	Download. Surface meteorological values checked. Filters changed. Calibration of air quality monitors.
2/21/95	Download. Surface meteorological values checked. Filters changed. Calibration of air quality monitors.
3/14/95	Download. Surface meteorological values checked. Charcoal and NO_x scrubber in zero air supply changed. Zero check.

3/23/95	Download. Surface meteorological values checked. Replaced NO_x unit desiccant and filters. Unable to calibrate due to Calibrator failure. All air quality equipment removed.
4/13/95	Download of meteorological data. Installed Monitor Labs equipment. Flow calibration. Calibration of air quality monitors.
4/24/95	Download. Zero check. Filters changed.
5/5/95	Download. Zero check. Filters changed.
5/17/95	Download. Desiccant canister on NO_x unit and zero air supply changed. Filters changed. Flow check. Problem with SO_2 calibration, unresolved. NO_x calibration good.
6/2/95	Download. Flow check. Calibration of air quality monitors. Filters and NO_x desiccant changed.
6/15/95	Download. Surface meteorological values checked. Desiccant canisters on NO_x and zero air supply changed as well as filters. Calibration of air quality monitors.
7/3/95	Download. Surface meteorological values checked. Desiccant canisters and filters changed. Calibration of air quality monitors.
7/21/95	Download. Surface meteorological values checked. Air quality monitors down due to lightning damage. Wind direction offline due to failure of directional potentiometer.
9/1/95	Download meteorological data. Surface meteorological values checked. CR10 module changed. Air quality monitors re-installed. Flow check. Calibration of air quality monitors.
9/19/95	Calibration of air quality monitors.
9/24/95	Download. Failure of pump on NO_x unit, re-activated.
10/16/95	Download. Failure of pump on NO_x unit; unit removed for repair. Installation of R. M. Young Aerovane. Surface meteorological values checked. Calibration of SO_2 monitor.
11/6/95	Download. Filters changed. New pump installed on NO_x unit. Calibration of air quality monitors. Air temperature and humidity found in error due to control card, corrected. Memory overwrite noted.

11/30/95	Download. Surface meteorological values checked. Charcoal canister changed. Filters changed. NO_x pump vibrating but appears functional. SO_2 offline and removed.
12/21/95	Download. Found NO_x pump non-operational. New NO_x unit installed 12/22. Flow check. Partial calibration of NO_x due to closing weather, good calibration SO_2.
1/26/96	Download. Surface meteorological values checked. Filters changed. Calibration of air quality monitors. Flow check. External pump installed on NO_x unit. Memory overwrite noted.
2/20/96	Download. Surface meteorological values checked. Filters changed. Calibration of air quality monitors.
3/12/96	Download. Filters changed. Calibration of air quality monitors.
3/22/96	Download. Filters changed. Calibration of air quality monitors.
3/29/96	Download. Air quality monitors offline due to lightning damage.
6/18/96	Air quality monitors re-deployed. DC power supplies installed, Gel-cell (UPS) batteries with battery chargers, Tripp-Lite surge suppressors. Two CR10s - one for air quality and the other for meteorological sensors. Humidity sensor damaged and offline. Flow check. Calibration of air quality monitors.
7/24/96	Download. NO_x monitor offline and removed. Calibration of SO_2 monitor. Filters changed.
8/22/96	Download. SO_2 monitor offline, failure of microprocessor board. Flow check. NO_x monitor installed. Calibration of NO_x monitor. Filters changed.
9/9/96	Download. Filters changed. NO_x monitor offline due to microprocessor failure. SO_2 monitor installed. Calibration of SO_2.
10/1/96	Download. Filters changed. SO_2 monitor down but re-activated. NO_x monitor installed. Lens cleaned on both monitors. New charcoal in SO_2. New power system - charger, battery, DC to AC inverter.
10/21/96	Download. Filters changed. Calibration of air quality monitors.
11/11/96	Download. Kerr-McGee no longer manned continuously. Calibration of air quality monitors.

1/20/97 Download. Both monitors down on entry. NO_x failure due to microprocessor board, removed. SO_2 due to tripped breaker in power inverter. Memory overwrite noted. Flow check. Filters changed. Calibration of SO_2 monitor.

2/7/97 Download. Filters changed. NO_x monitor installed. Calibration of SO_2, partial on NO_x.

3/17/97 Download. Filters changed. SO_2 monitor lens cleaned. Calibration of air quality monitors.

4/23/97 Download. Filters changed. SO_2 monitor down on entry but re-activated. Power inverter had failed due to prolonged Kerr-McGee AC outage. Calibration of air quality monitors. Failure of air temperature sensor.

Calibration of the air quality monitors at Breton Island was performed in the same manner as those at Dauphin Island (Sec. II.A.1.) Results of precision and accuracy points are given in Tables 13 through 22. As can be seen, almost all errors for both monitors are well within the 10% range, and no significant zero or span drift is detected. Similar calibration values were obtained for the TECO and Monitor Labs units. The highest errors result from insufficient instrument warm-up and stabilization, as noted by the site technician. Gas flow checks at both stations were conducted with a Gilian Gilibrator mass flowmeter (NIST traceable).

Zero offsets greater than 1 ppb were removed from the affected data. No other corrections were applied.

Table 13.
Breton Island SO_2 Monitor Zero Values

Date	Monitor Zero
10/4/94	3
10/13/94	3
10/22/94	2
11/1/94	2
11/14/94	2
11/30/94	2
12/20/94	3
1/4/95	2
1/24/95	2
2/8/95	2
2/21/95	2
4/13/95	0
4/24/95	2
5/5/95	0
6/2/95	1
6/15/95	-4
7/3/95	1
9/1/95	0
9/19/95	0
10/16/95	0
11/6/95	0
12/21/95	0
1/25/96	0
2/20/96	-2
3/12/96	-3
3/22/96	-4
6/19/96	1
7/24/96	0

Table 13 continued.

9/9/96	2
10/1/96	0
10/21/96	0
11/11/96	0
1/20/97	0
2/7/97	0
3/17/97	0
4/23/97	0

Table 14.
Breton Island SO_2 Monitor Calibration Points

Date	Desired	Actual	% Error
10/22/94	338	334	-1.2
4/13/95	301	300	-0.3
6/2/95	310	302	-2.6
9/1/95	310	303	-2.3
10/16/95	310	298	-3.9
11/6/95	310	301	-2.9
12/21/95	299	294	-1.7
1/25/96	301	304	1.0
6/19/96	252	246	-2.4
7/24/96	252	243	-3.6
9/9/96	253	249	-1.6
10/1/96	253	250	-1.2
10/21/96	253	251	-0.8
1/20/97	347	340	-2.0
Sum			-25.5
Mean			-1.82

Table 14 continued.

Standard Deviation			1.25
Upper 95% Limit			0.63
Lower 95% Limit			-4.27
10/22/94	202	194	-4.0
4/13/95	192	187	-2.6
6/2/95	196	183	-6.6
9/1/95	197	188	-4.6
10/16/95	197	185	-6.1
11/6/95	197	186	-5.6
12/21/95	191	183	-4.2
1/25/96	190	192	1.1
6/19/96	154	149	-3.2
7/24/96	154	145	-5.8
9/9/96	154	153	-0.6
10/1/96	154	151	-1.9
10/21/96	154	147	-4.5
11/11/96	154	151	-1.9
1/20/97	162	158	-2.5
Sum			-53.0
Mean			-3.53
Standard Deviation			2.09
Upper 95% Limit			0.57
Lower 95% Limit			-7.63

Table 15.
Breton Island SO_2 Monitor Precision Values

Date	Desired	Actual	% Error
10/4/94	71	73	2.8
10/13/94	71	75	5.6
10/22/94	71	66	-7.0
11/1/94	71	67	-5.6
11/14/94	71	71	0
11/30/94	71	71	0
12/20/94	71	72	1.4
1/4/95	71	76	7.0
1/24/95	71	71	0
2/8/95	71	72	1.4
2/21/95	71	73	2.8
4/13/95	101	98	-3.0
6/2/95	102	92	-9.8
6/15/95	102	93	-8.8
7/3/95	102	98	-3.9
9/1/95	102	99	-2.9
9/19/95	99	103	4.0
10/16/95	102	97	-4.9
11/6/95	102	99	-2.9
12/21/95	102	93	-8.8
1-25-96	101	100	-1.0
2/20/96	101	98	-3.0
3/12/96	101	95	-5.9
3/22/96	101	97	-4.0
6/19/96	92	89	-3.3
7/24/96	92	87	-5.4
9/9/96	91	92	1.1
10/1/96	91	90	-1.1

Table 15 continued.

10/21/96	91	86	-5.5
11/11/96	91	90	-1.1
1/20/97	96	95	-1.0
2/7/97	96	93	-3.1
3/17/97	96	94	-2.1
4/23/97	96	94	-2.1
Sum			-70.1
Mean			-2.06
Standard Deviation			3.92
Upper 95% Limit			5.62
Lower 95% Limit			-9.74

Table 16.
Breton Island SO_2 Monitor Full Scale Values

Date	Desired	Actual	% Error
10/1/94	430	443	3.0
10/13/94	430	449	4.4
10/22/94	430	435	1.2
11/1/94	430	430	0
11/14/94	430	432	0.5
11/30/94	430	440	2.3
12/20/94	430	442	2.8
1/4/95	430	450	4.7
1/24/95	430	433	0.7
2/8/95	430	436	1.4
2/21/95	430	435	1.2
4/13/95	434	433	-0.2
6/2/95	442	449	1.6
6/15/95	442	428	-3.2

Table 16 continued.

7/3/95	442	441	-0.2
9/1/95	437	437	0
9/19/95	437	433	-0.9
10/16/95	437	429	-1.8
11/6/95	437	435	-0.5
12/21/95	429	429	0
1/25/96	437	437	0
2/20/96	437	434	-0.7
3/12/96	437	435	-0.5
3/22/96	437	437	0
6/19/96	463	462	-0.2
7/24/96	463	462	-0.2
9/9/96	468	468	0
10/1/96	467	467	0
10/21/96	467	467	0
11/11/96	467	468	0.2
1/20/97	494	494	0
2/797	494	493	-0.2
3/17/97	494	494	0
4/23/97	494	494	0
Sum			15.4
Mean			0.45
Standard Deviation			1.54
Upper 95% Limit			3.47
Lower 95% Limit			-2.57

Table 17.
Breton Island NO_x Monitor Zero Values

Date	NO Zero Value	NO_x Zero Value	NO_2 Zero Value
10/13/94	7	9	2
10/23/94	1	3	2
11/1/94	1	2	1
11/30/94	1	2	1
12/20/94	1	2	1
1/4/95	1	2	1
1/24/95	0	1	0
2/8/95	0	1	1
2/21/95	1	2	0
4/13/95	-1	-1	1
4/24/95	0	0	0
5/5/95	0	0	0
6/2/95	0	1	1
6/15/95	1	1	1
7/3/95	0	1	0
9/1/95	0	0	0
9/19/95	0	0	0
11/6/95	0	3	3
11/30/95	0	-1	-1
12/20/95	0	3	3
1/25/96	0	2	2
2/20/96	0	1	1
3/12/96	0	1	1
3/22/96	0	1	1
6/19/96	0	3	3
8/22/96	0	2	2
10/1/96	0	1	2
10/21/96	0	2	2

Table 17 continued.

11/11/96	0	1	1
2/7/97	0	2	1
3/17/97	1	3	2
4/23/97	0	2	2

Table 18.
Breton Island NO_x Monitor Accuracy Values

Date	Desired NO	Desired NO_x	Actual NO	Actual NO_x	% Error NO	% Error NO_x
11/1/94	335	335	336	337	0.3	0.6
4/13/95	284	284	282	285	-0.7	0.4
6/2/95	278	278	261	261	-6.1	-6.1
9/1/95	278	278	281	280	1.1	0.7
11/6/95	278	278	272	278	-2.2	0
11/30/95	278	278	275	277	-0.7	-0.4
1/25/96	267	267	268	270	0.4	1.1
6/19/96	199	204	200	201	0.5	-1.5
8/22/96	195	201	195	197	0	-2.0
10/1/96	195	201	198	200	1.5	-0.5
10/21/96	195	201	199	200	2.1	-0.5
2/7/97	262	262	257	259	-1.9	-1.1
Sum					-5.7	-9.3
Mean					-0.48	-0.78
Standard Deviation					2.09	1.83
Upper 95% Limit					3.62	2.81
Lower 95% Limit					-4.58	-4.37

Table 18 continued.

Date	Desired NO	Desired NO_x	Actual NO	Actual NO_x	% Error NO	% Error NO_x
4/13/95	196	196	195	197	-0.5	0.5
6/2/95	193	193	178	178	-7.8	-7.8
9/1/95	192	192	192	193	0	0.5
11/6/95	192	192	187	192	-2.6	0
11/30/95	192	192	189	190	-1.6	-1.0
1/25/96	188	188	185	186	-1.6	-1.1
6/19/96	125	128	126	126	0.8	-1.6
8/22/96	124	127	123	124	-0.8	-2.4
10/1/96	124	127	123	125	-0.8	-1.6
10/21/96	124	127	124	125	0	-1.6
11/11/96	124	127	123	125	-0.8	-1.6
2/7/97	151	151	146	147	-3.3	-2.6
Sum					-19.0	-20.3
Mean					-1.58	-1.69
Standard Deviation					2.17	2.08
Upper 95% Limit					2.67	2.39
Lower 95% Limit					-5.83	-5.77

Table 19.
Breton Island NO_x Monitor NO_x Precision Values

Date	Desired NO	Desired NO_x	Actual NO	Actual NO_x	% Error NO	% Error NO_x
10/13/94	72	72	71	73	-1.4	1.4
10/23/94	72	72	71	72	-1.4	0
11/1/94	131	131	129	129	-1.5	-1.5
11/14/94	131	131	131	134	0	2.3
11/30/94	131	131	123	123	-6.1	-6.1

Table 19 continued.

12/20/94	131	131	122	125	-6.9	-4.6
1/4/95	131	131	123	125	-6.1	-4.6
1/24/95	131	131	120	121	-8.4	-7.6
2/8/95	131	131	123	123	-6.1	-6.1
2/21/95	131	131	122	124	-6.9	-5.3
4/13/95	88	88	86	87	-2.3	-1.1
6/2/95	87	87	80	81	-8.1	-6.9
6/15/95	87	87	85	85	-2.3	-2.3
7/3/95	87	87	86	86	-1.2	-1.2
9/1/95	87	87	86	86	-1.2	-1.2
9/19/95	87	87	85	85	-2.3	-2.3
11/6/95	87	87	83	86	-4.6	-1.2
11/30/95	87	87	84	86	-3.5	-1.2
12/21/95	81	81	69	70	-14.8	-13.6
1/25/96	85	85	84	84	-1.2	-1.2
2/20/96	85	85	85	86	0	1.2
3/12/96	85	85	83	84	-2.4	-1.2
3/22/96	85	85	85	86	0	1.2
6/19/96	76	78	77	77	1.3	-1.3
8/22/96	75	77	74	75	-1.3	-2.6
10/1/96	75	77	75	77	0	0
10/21/96	75	77	76	77	1.3	0
11/11/96	75	77	75	76	0	-1.3
3/17/97	69	69	68	70	-1.4	1.4
4/23/97	69	69	66	68	-4.3	-1.4
Sum					-93.1	-68.3
Mean					-3.10	-2.28
Standard Deviation					3.48	3.30
Upper 95% Limit					3.72	4.19
Lower 95% Limit					-9.92	-8.75

Table 20.
Breton Island NO_x Monitor Full Scale Values

Date	Desired NO	Desired NO_x	Actual NO	Actual NO_x	% Error NO	% Error NO_x
10/13/94	454	454	407	413	-10.4	-9.0
10/23/94	454	454	449	452	-1.1	-0.4
11/1/94	454	454	454	454	0	0
11/14/94	454	454	464	470	2.2	3.5
11/30/94	454	454	450	449	-0.9	-1.1
12/20/94	454	454	445	448	-2.0	-1.3
1/4/95	454	454	444	445	-2.2	-2.0
1/24/95	454	454	439	439	-3.3	-3.3
2/8/95	454	454	446	445	-1.8	-2.0
2/21/95	454	454	443	444	-2.4	-2.2
4/13/95	412	412	413	414	0.2	0.5
6/2/95	401	401	383	384	-4.5	-4.2
6/15/95	401	401	399	400	-0.5	-0.3
7/3/95	401	401	399	400	-0.5	-0.3
9/1/95	405	405	404	405	-0.3	0
9/19/95	405	405	397	400	-2.0	-1.2
11/6/95	405	405	397	404	-2.0	-0.3
11/30/95	405	405	404	406	-0.3	0.3
12/21/95	321	321	321	322	0	0.3
1/25/96	391	391	388	390	-0.8	-0.3
2/20/96	391	391	387	390	-1.0	-0.3
3/12/96	391	391	390	394	-0.3	0.8
3/22/96	391	391	391	395	0	1.0
6/19/96	416	427	426	427	2.4	0
8/22/96	408	418	416	418	2.0	0
10/1/96	408	418	415	418	1.7	0
10/21/96	408	418	416	419	2.0	0.2

Table 20 continued.

11/11/96	408	418	414	418	1.5	0
2/7/97	477	477	474	478	-0.6	0.2
3/17/97	477	477	470	476	-1.5	-0.2
4/23/97	477	477	469	477	-1.7	0
Sum					-28.1	-21.6
Mean					-0.91	-0.70
Standard Deviation					2.36	2.02
Upper 95% Limit					3.72	3.26
Lower 95% Limit					-5.54	-4.66

Table 21.
Breton Island NO_x Monitor NO_2 Precision Values

Date	Desired NO_2	Actual NO_2	% Error
10/13/94	121	130	7.4
11/1/94	153	151	-1.3
11/14/94	152	150	-1.3
11/30/94	150	154	2.7
12/20/94	156	154	-1.3
1/4/95	153	152	-0.7
1/24/95	148	147	-0.7
2/8/95	152	150	-1.3
2/21/95	151	149	-1.3
4/13/95	65	66	1.5
6/2/95	74	79	6.8
6/15/95	60	58	-3.3
7/3/95	54	55	1.9
9/1/95	48	49	2.1
11/6/95	47	51	8.5
11/30/95	29	35	20.7

Table 21 continued.

12/21/95	39	38	-2.6
1/25/96	47	49	4.3
2/20/96	46	50	8.7
3/12/96	48	49	2.1
3/22/96	50	53	6.0
6/19/96	44	48	9.1
8/22/96	44	47	6.8
10/1/96	54	50	-7.4
10/21/96	58	57	-1.7
11/11/96	51	52	2.0
3/17/97	71	78	9.9
4/23/97	60	60	0
Sum			79.6
Mean			2.74
Standard Deviation			5.43
Upper 95% Limit			13.38
Lower 95% Limit			-7.90

Table 22.
Breton Island NO_x Monitor NO_2 Accuracy Values

Date	Desired NO_2	Actual NO_2	% Error
10/13/94	331	336	1.5
10/1/94	353	352	-0.3
11/14/94	351	348	-0.9
11/30/94	347	348	0.3
12/20/94	349	344	-1.4
1/4/95	349	346	-0.9
1/24/95	344	343	-0.3
2/8/95	350	344	-1.7

Table 22 continued.

2/21/95	346	343	-0.9
4/13/95	303	303	0
6/2/95	340	343	0.9
6/15/95	314	310	-1.3
7/3/95	291	289	-0.7
9/1/95	272	271	-0.4
9/19/95	267	266	-0.4
11/6/95	259	260	0.4
11/30/95	210	209	-0.5
12/20/95	193	188	-2.6
1/25/96	246	247	0.4
2/20/96	244	246	0.8
3/12/96	258	258	0
3/22/96	259	263	1.5
6/19/96	251	247	-1.6
8/22/96	228	230	0.9
10/1/96	273	269	-1.5
10/21/96	285	285	0
11/11/96	275	276	0.4
3/17/97	272	276	1.5
4/23/97	308	307	-0.3
Sum			-7.1
Mean			-0.24
Standard Deviation			1.01
Upper 95% Limit			1.74
Lower 95% Limit			-2.22

B. Data Quality and Return

1. Dauphin Island

Hourly pollutant concentrations were calculated by arithmetic average. Hours less than 75% complete were discarded. Negative values, which have no physical meaning, were converted to zeros. This procedure was acceptable since the monitors were well-calibrated and the zero drift small. Cumulative zero drifts of 20 to 30 ppb may be observed before the monitor should be adjusted (EPA, 1979).

As seen from the service record and instrument calibration reports, air quality data observed at Dauphin Island was generally of good quality. An extremely high rate of data return was achieved for each parameter, as shown in Table 23. Only one month fell below 75% capture, as indicated by the shaded box. This resulted from the failure of the NO_x monitor during the period of 6 - 24 May 1996. Power outages produced missing data during October and November 1996. All other data gaps were produced during routine maintenance and calibration periods.

Table 23.
Percent Data Return - Dauphin Island

Month	# Samples	SO_2	NO_x
March 1996	583	78.4	78.4
April 1996	716	99.4	99.4
May 1996	738 (322)	99.2	43.3
June 1996	710	98.6	98.6
July 1996	740	99.5	99.5
August 1996	731	98.3	98.3
September 1996	669	92.9	92.9
October 1996	707	95.0	95.0
November 1996	718	99.7	99.7
December 1996	739	99.3	99.3
January 1997	673	90.5	90.5
February 1997	669	99.6	99.6
March 1997	664	93.3	93.3
April 1997	710	98.6	98.6

Monthly time-series plots of hourly SO_2 and NO_2 are shown in Figs. 4 through 31. The wind direction displayed in the graphs was measured at the NOAA C-MAN station DPIA1, and will be described in the Analysis and Results section.

2. Breton Island

All air quality data was reduced as with the Dauphin Island data. Negative values, particularly those recorded between good calibrations, were retained and converted to zeros. Hourly wind speed and direction was calculated via u and v component averaging. Hours less than 75% complete were removed from the dataset.

Table 24 lists the monthly percentage data return for each parameter recorded at Breton Island. Months less than 75% complete are shaded and detailed as follows.

October 1994. The NO_x analyzer could not be calibrated, data was lost from 1 - 4 October. All sensors were offline from 13 - 23 October as the station was re-located from the Chandeleur Islander to Kerr-McGee. True wind data was not obtained prior to 23 October.

March - April 1995. This data gap was created following the removal of the TECO monitoring suite on 23 March. Air quality monitoring was resumed on 14 April with the Monitor Labs, Inc. analyzers.

July - August 1995. This was the first incident of lightning-related damage to the air quality monitors. The damage was discovered during the routine service visit on 21 July. Review of the data record showed failure of the units on 9 July. The Kerr-McGee Operation Log noted damage to their equipment following severe weather on that date. The monitors were subsequently removed and returned to the manufacturer for repairs. It was also found that the directional potentiometer of the Stratavane wind sensor had failed on 10 July. Other meteorological data was lost from 21 July through 11 August due to memory overwrite.

The datalogging system in use consists of a CR10 control module and an SM192 memory module. The memory module has a fill and stop option; that is when capacity is reached, no more data is accepted. The CR10 also has its own internal ring-memory. Under normal operation, the CR10 writes data to its internal memory. When full, this data is dumped to the external memory module and purged from the CR10. If the external module is full, then the CR10 begins overwriting its memory in a circular fashion. There is no fill and stop function for the CR10 and, if left unattended for a prolonged period of time, the data is continuously replaced.

September 1995. Memory overwrites on 1 - 4 and 24 - 26 September. Wind sensor not functional.

October 1995. Air quality data missing from 3 - 6 and 16 - 17 October due to AC power failure of Kerr-McGee generators. The pump in the NO_x analyzer failed and the unit was removed on 16 October. An R. M. Young Aerovane was installed on 17 October and wind measurements resumed. The NO_x analyzer was re-deployed on 6 November 1995.

December 1995. SO_2 analyzer removed on 30 November for repairs and returned 22 December. The NO_x analyzer was replaced on 22 December with a new unit following repeated failure of the pump. AC power fluctuations caused the SO_2 analyzer to drop out from 30 December to 2 January 1996.

January 1996. Data gap from 11 - 23 January caused by memory overwrite. Inclement wintertime weather prevented safe transport offshore for almost one month.

April - June 1996. The period marked the second incident of lightning damage, except this time more extensive. Air quality data stops on 29 March and begins again on 19 June, when the repaired units were re-deployed. As before, damage to Kerr-McGee equipment due to weather was noted in their Operations Log on 29 March. The proximity of the 300' microwave tower to the location of the monitors (see Fig. 3) appears to have greatly enhanced the likelihood of this damage occurring. Failure of the humidity sensor is noted as well. Loss of meteorological data is due to memory overwrite.

June - September 1996. Variations in power supplies and isolation methods were implemented during these months with marginal success. When re-deployed on 19 June, the analyzers were converted to DC operation and equipped with Gel-cell batteries with chargers connected to heavy duty surge suppressors. It was thought that the batteries would stop any power surge from affecting the monitors. However, both monitors failed on 27 June. The SO_2 analyzer was re-activated on 24 July, at which point the NO_x analyzer was removed for repair. The SO_2 analyzer failed again on 30 July and was removed on 22 August when the NO_x analyzer was returned. After running for only 3 days, the NO_x analyzer failed and was removed on 9 September when the SO_2 analyzer was returned, only to fail again on 21 September. It was subsequently discovered that with the chargers on low setting, the power draw from the monitors would drain the battery, at which point the monitor would shut down, releasing the load and allowing the battery to charge, which would re-activate the monitor and begin the cycle again. Note that the monitors were forced to run off the batteries due to frequent failure of AC power from the generators. Also, detailed analysis of the power signal showed that the chargers introduced significant "noise" into the signal. These factors were combining to produce repeated failure of the microprocessors within the analyzers. A filtering system was installed, and the monitors were returned to AC operation through a DC - AC power inverter. Both monitors were returned to operation with this system in place on 1 October 1996.

November - December 1996. Data gap from 11 November through 14 December due to memory overwrite as unfavorable weather prevented station service for nearly 2 months.

January 1997. AC power outage caused the SO_2 power inverter to trip creating a gap from 17 - 21 January. Review of the data showed failure of the NO_x analyzer on 9 January; the unit was removed on 21 January and returned on 7 February.

March - April 1997. A long AC power outage again caused to inverter on the SO_2 analyzer to internally trip and shut off on 22 March. The unit was re-activated on 23 April. A second AC outage caused missing NO_x data from 5 - 7 April.

Other missing data was caused by routine station service, calibrations, and equipment maintenance. In addition, it was found that the AC line voltage from the Kerr-McGee generators was unsteady and often very low (< 90 VAC). This frequently caused the SO_2 analyzer to reset and enter a startup cycle, resulting in several hours of lost data.

All available air quality data and meteorological data measured at Breton Island is illustrated in Figs. 32 through 114 by month.

Table 24.
Percentage Breton Island Data Return

MM/YY	SO_2	NO_x	Wind	Tair	Pressure	Humidity
10/94	68.0	57.1	27.7	68.1	68.1	68.1
11/94	98.3	98.3	98.3	98.1	98.1	98.1
12/94	99.6	99.6	99.5	99.5	99.5	99.5
01/95	98.9	99.1	99.1	98.9	98.8	98.9
02/95	99.1	99.1	99.0	99.0	99.0	99.0
03/95	72.2	72.2	99.3	99.2	99.2	99.2
04/95	57.1	57.4	94.7	94.6	94.6	94.6
05/95	95.4	98.8	99.1	98.8	98.8	98.8
06/95	97.2	98.1	98.8	98.5	98.5	98.5
07/95	27.6	27.6	29.8	65.5	65.5	65.5
08/95	0.0	0.0	0.0	63.4	63.4	63.4
09/95	78.6	79.2	0.0	79.6	79.6	79.6
10/95	78.1	39.2	46.1	95.7	95.7	95.7
11/95	96.5	80.3	98.3	98.2	86.8	86.8
12/95	25.0	97.2	97.4	97.4	97.4	97.4
01/96	55.1	59.3	59.1	59.0	59.0	59.0

Table 24 continued.

02/96	98.4	98.9	99.1	99.3	99.3	99.3
03/96	90.6	91.4	98.7	92.1	92.1	92.1
04/96	0.0	0.0	50.6	0.0	0.0	0.0
05/96	0.0	0.0	0.0	0.0	0.0	0.0
06/96	24.7	24.7	38.1	37.9	37.9	0.0
07/96	19.1	0.0	98.9	98.9	98.9	0.0
08/96	0.0	7.8	100.0	99.9	99.2	0.0
09/96	34.6	0.0	99.9	99.9	99.9	0.0
10/96	96.1	96.1	99.9	99.7	99.6	0.0
11/96	35.6	35.6	35.6	35.7	35.7	0.0
12/96	56.9	56.9	42.2	42.1	42.1	0.0
01/97	90.2	25.8	98.8	98.8	98.8	0.0
02/97	99.3	76.0	99.9	99.9	99.9	0.0
03/97	67.1	95.4	100.0	99.9	99.9	0.0
04/97	23.9	92.5	100.0	37.8	100.0	0.0

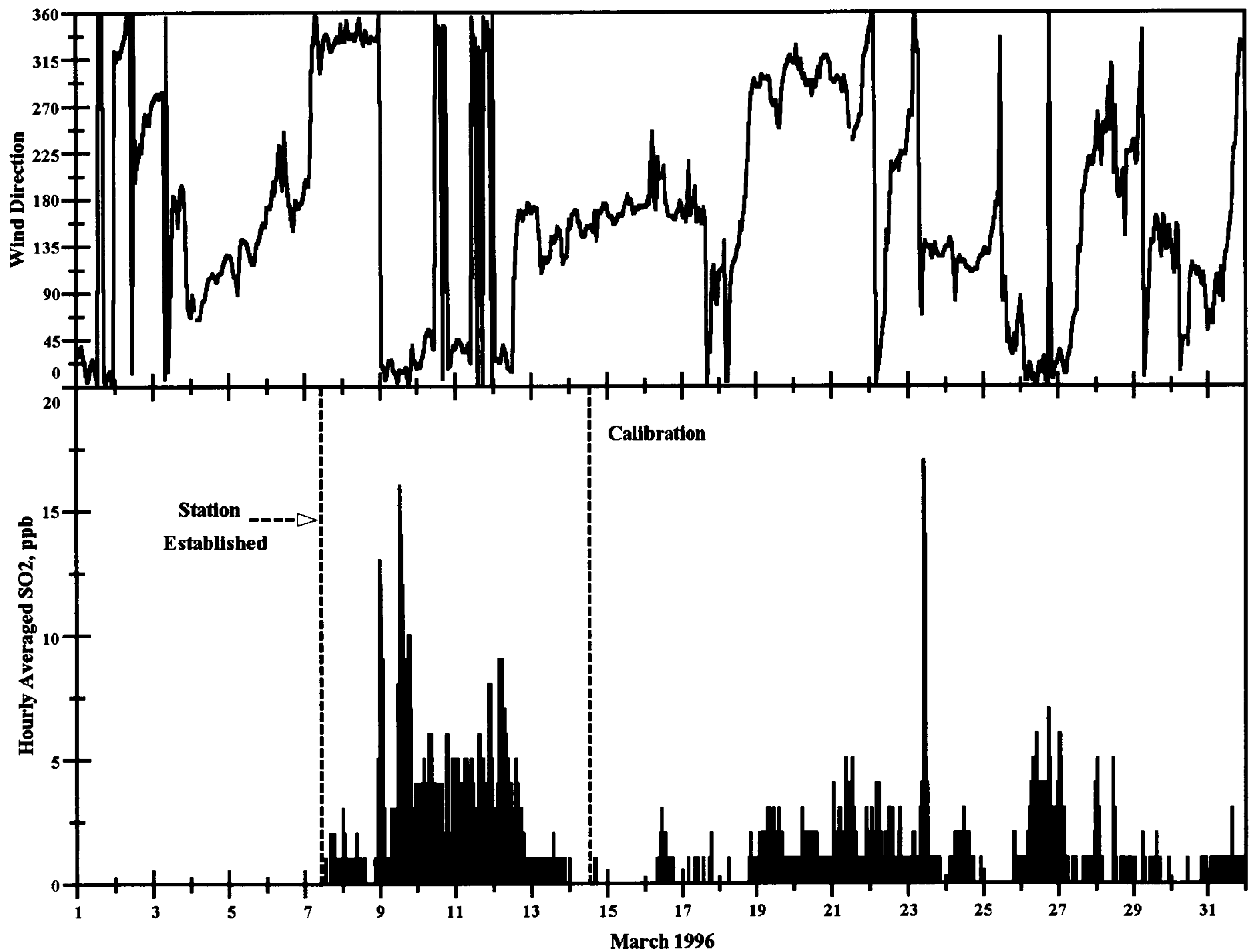


Figure 4. Average SO_2 concentrations (ppb) and wind direction for March 1996 at Dauphin Island.

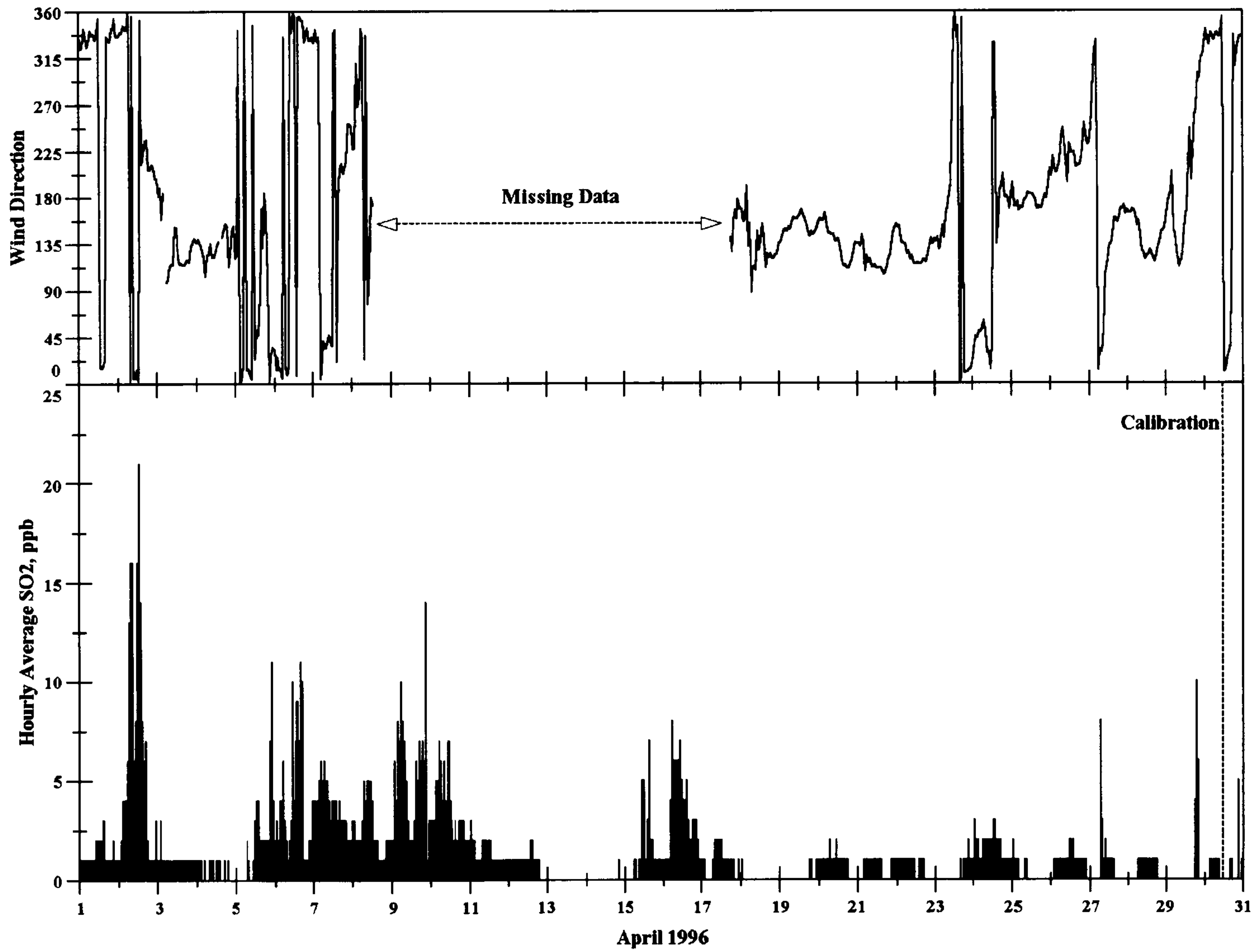


Figure 5. Average SO_2 concentrations (ppb) and wind direction for April 1996 at Dauphin Island.

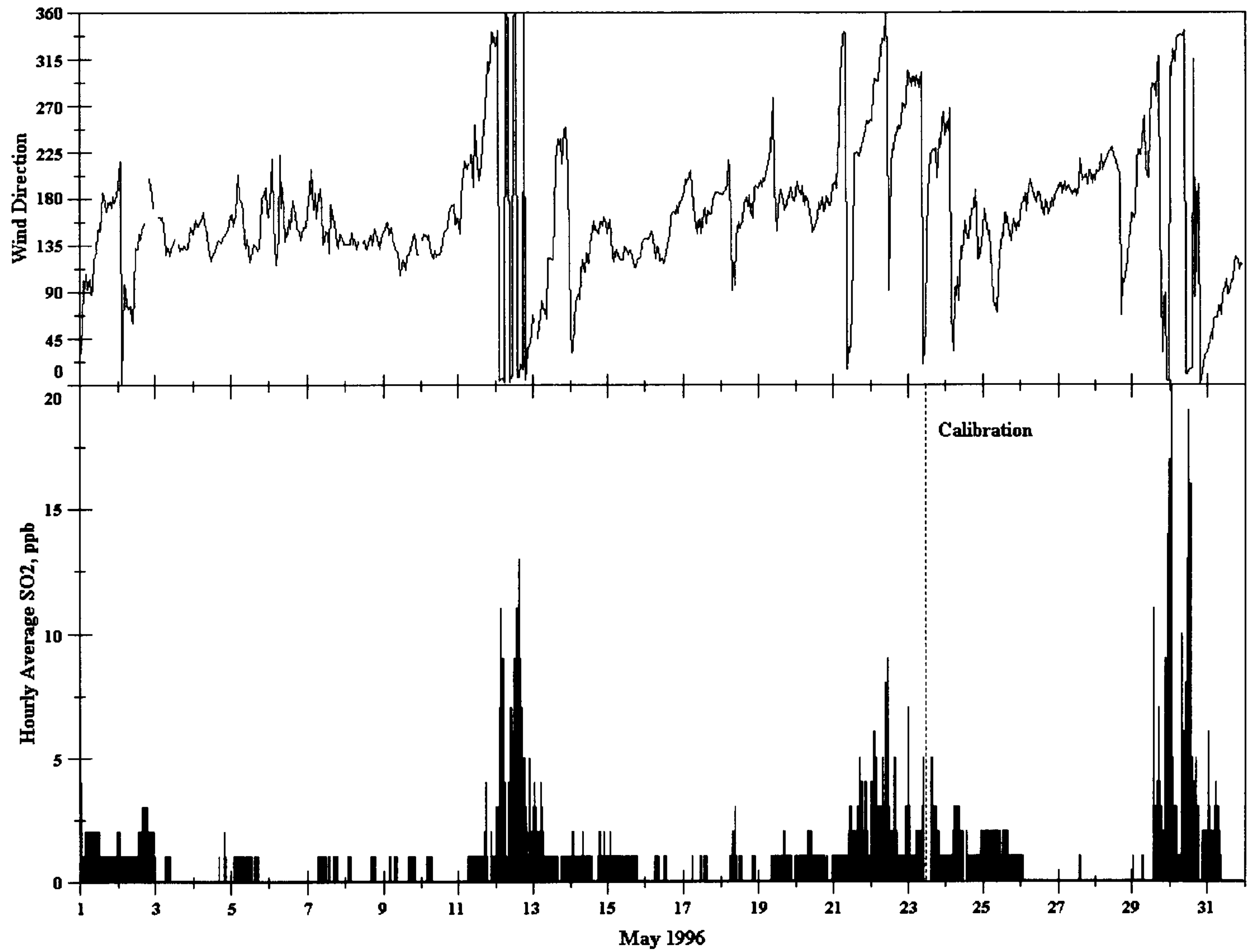


Figure 6. Average SO_2 concentrations (ppb) and wind direction for May 1996 at Dauphin Island.

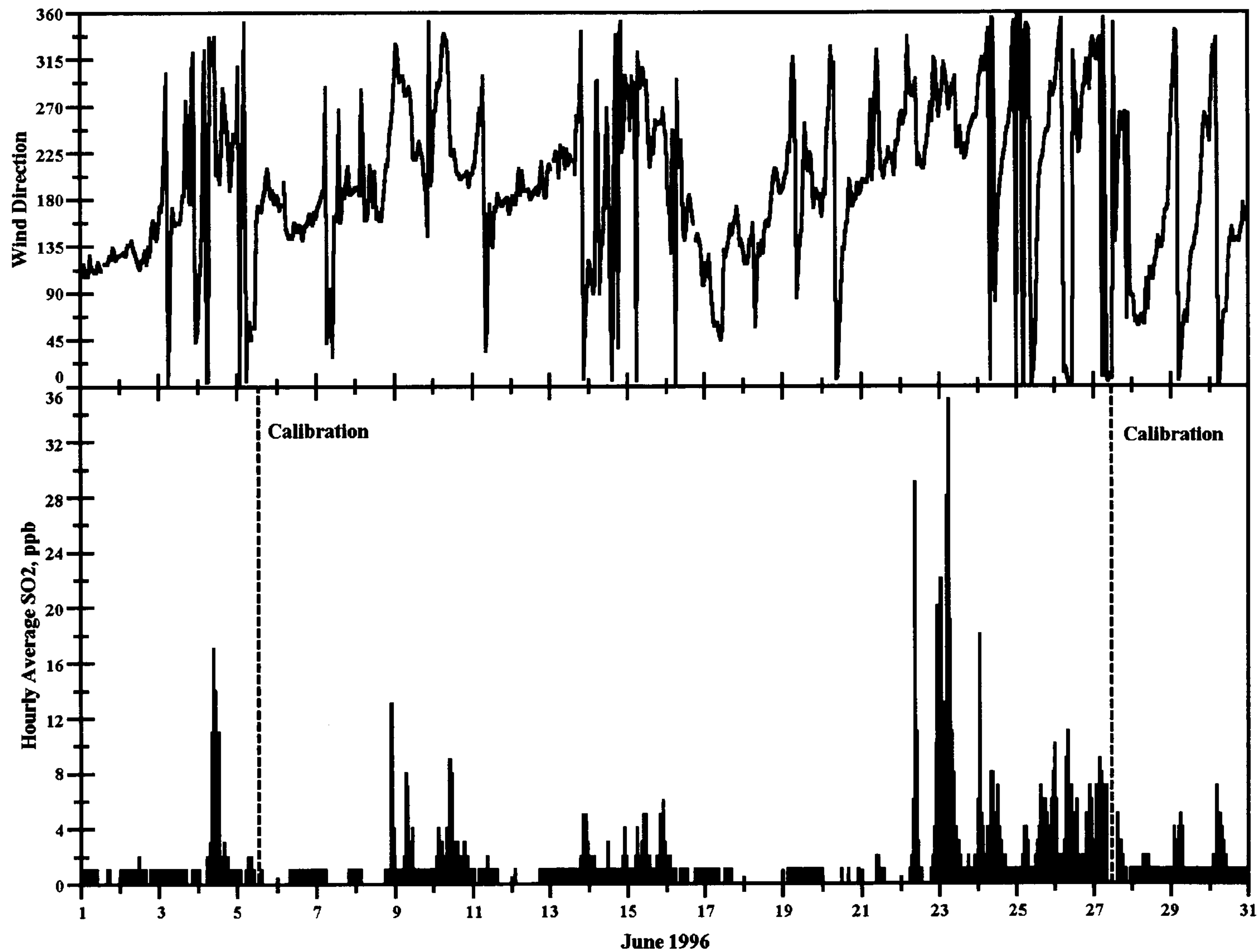


Figure 7. Average SO_2 concentrations (ppb) and wind direction for June 1996 for Dauphin Island.

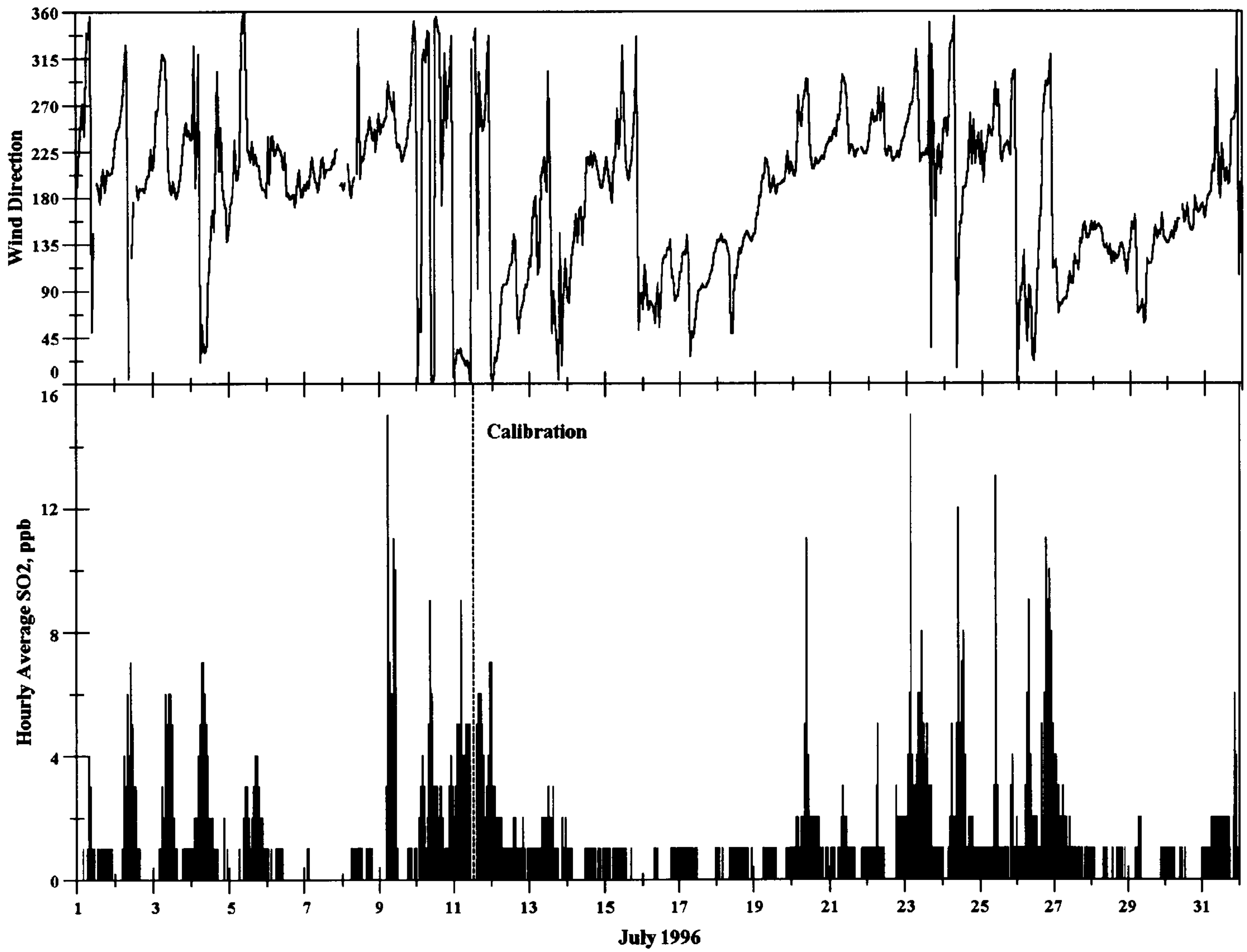


Figure 8. Average SO_2 concentration (ppb) and wind direction for July 1996 at Dauphin Island.

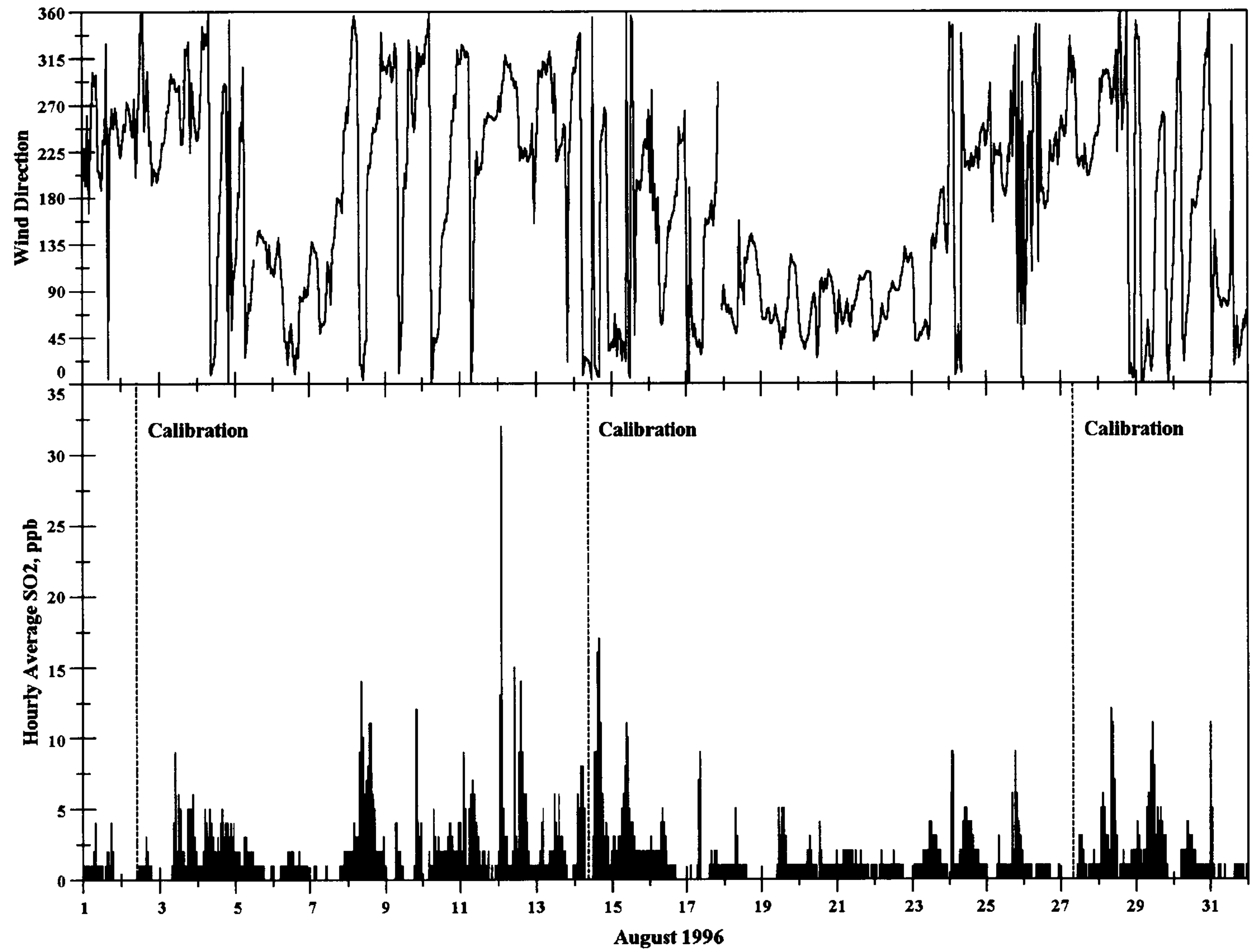


Figure 9. Average SO_2 concentrations (ppb) and wind direction for August 1996 at Dauphin Island.

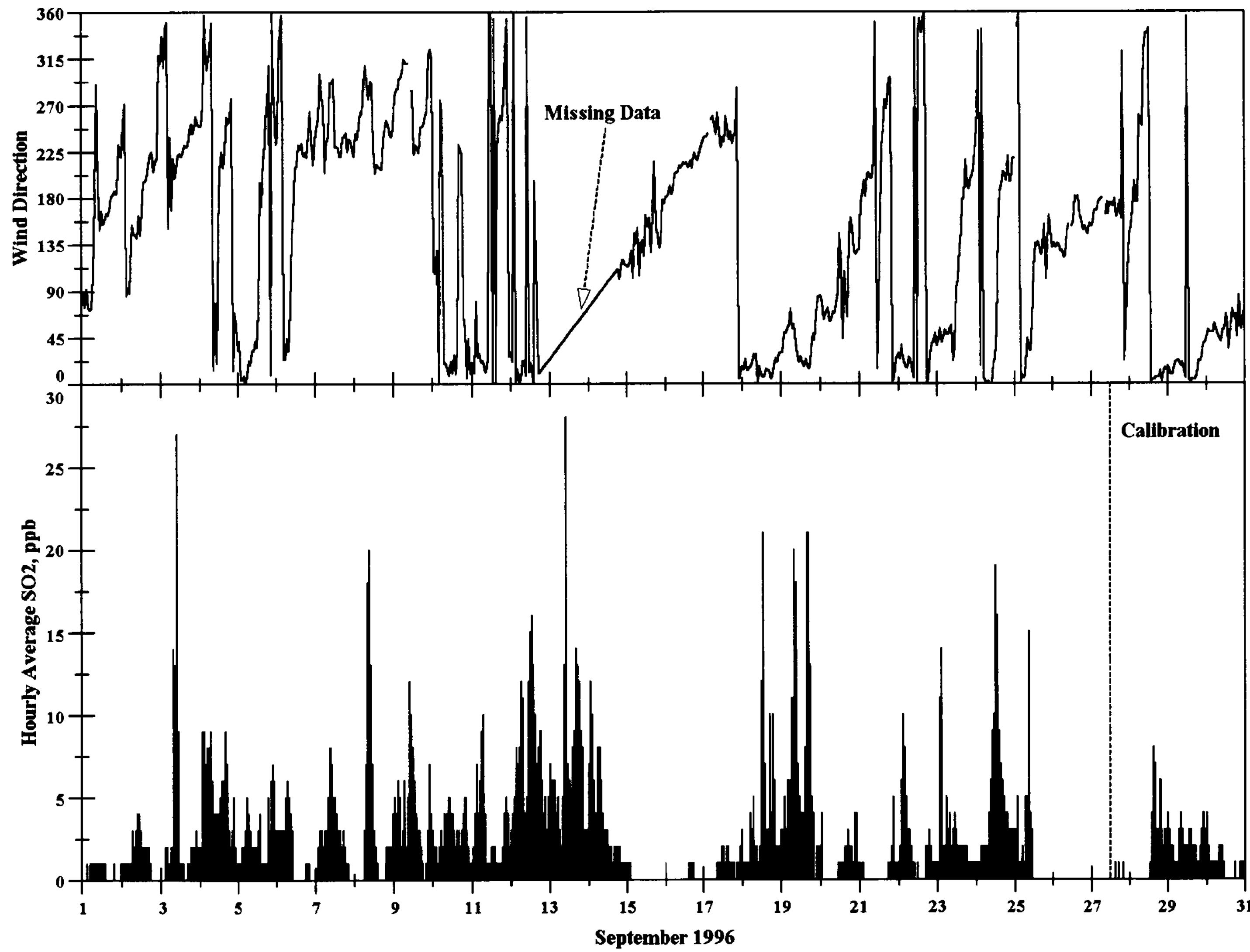


Figure 10. Average SO_2 concentrations (ppb) and wind direction for September 1996 at Dauphin Island.

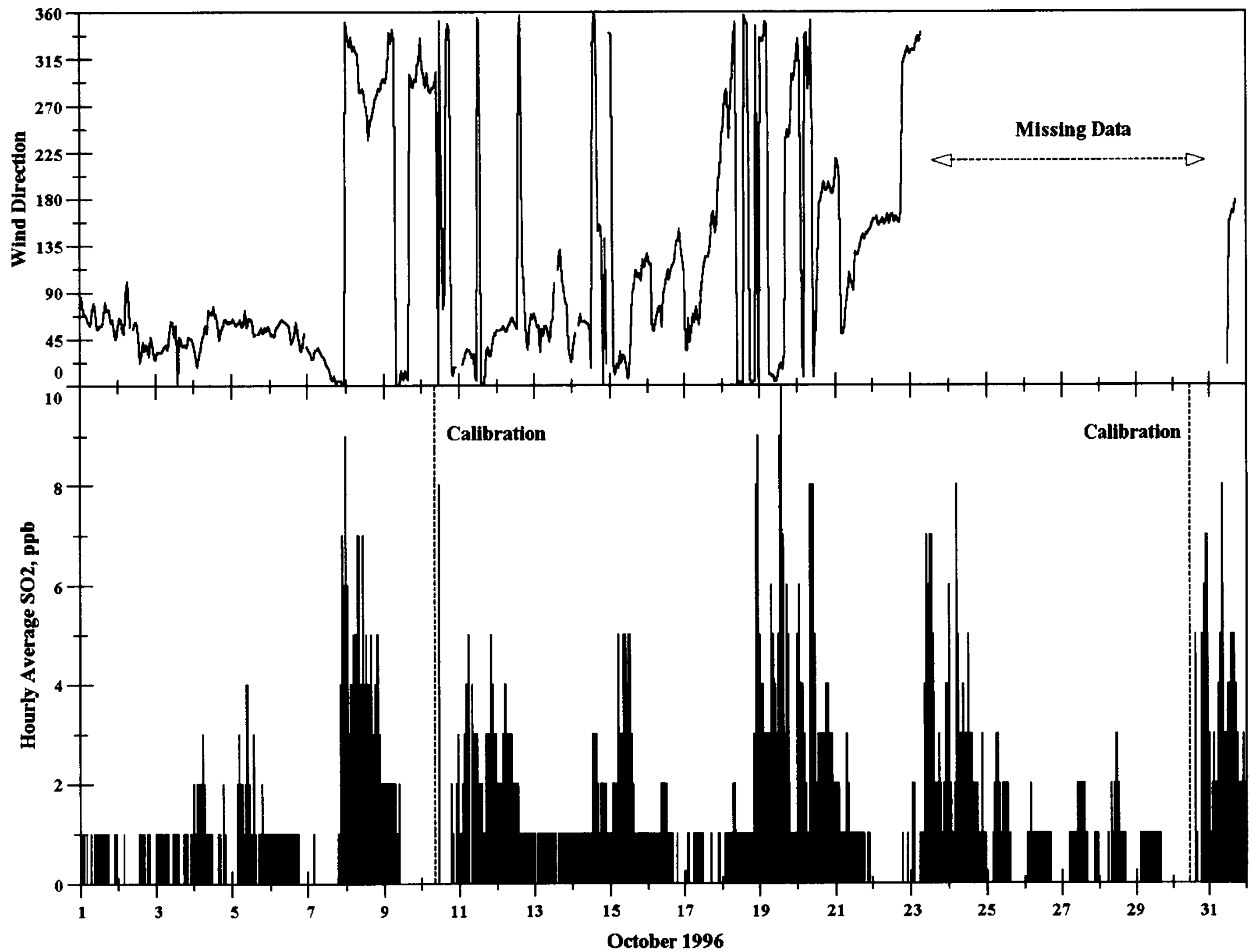


Figure 11. Average SO_2 concentrations (ppb) and wind direction for October 1996 at Dauphin Island.

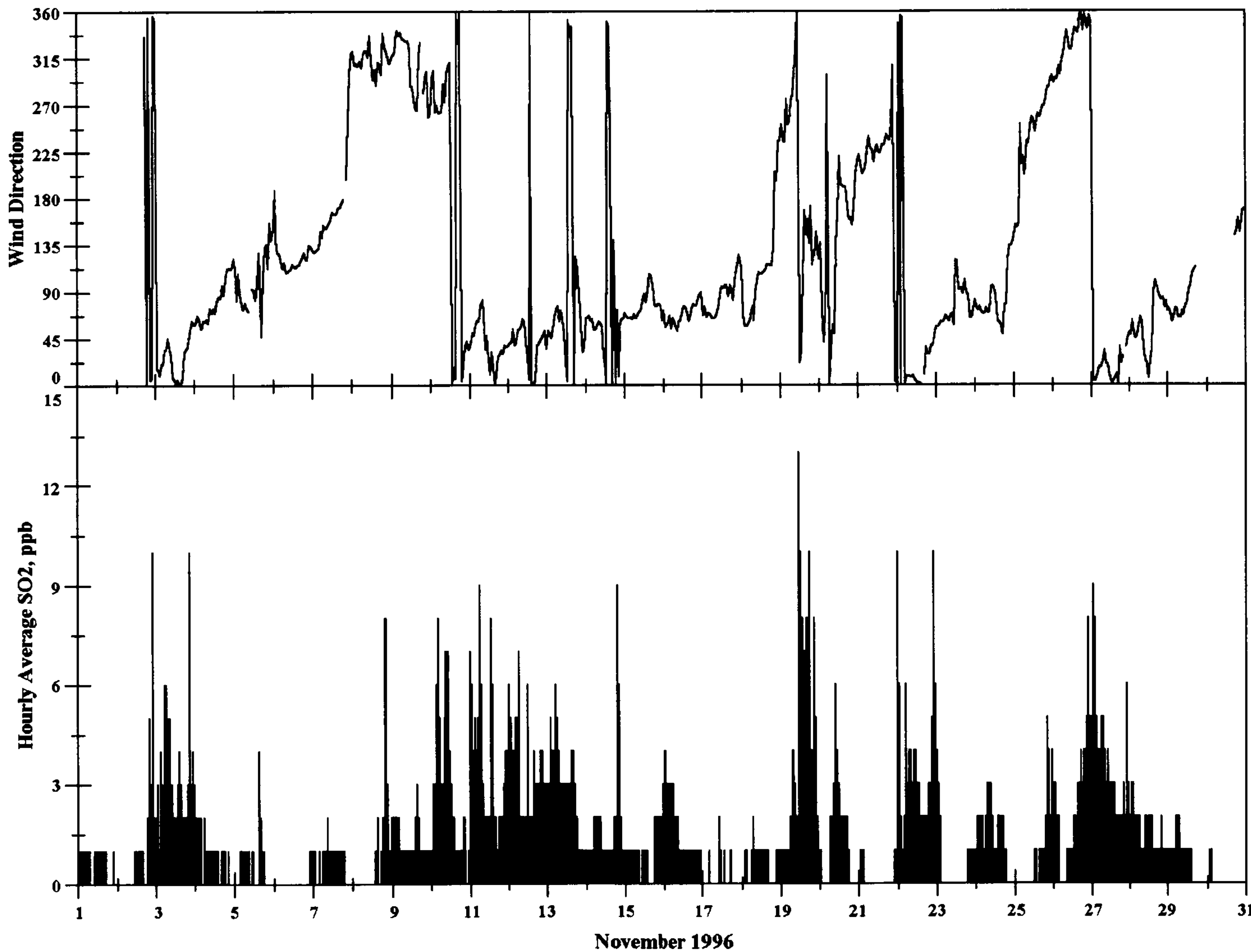


Figure 12. Average SO_2 concentrations (ppb) and wind direction for November 1996 at Dauphin Island.

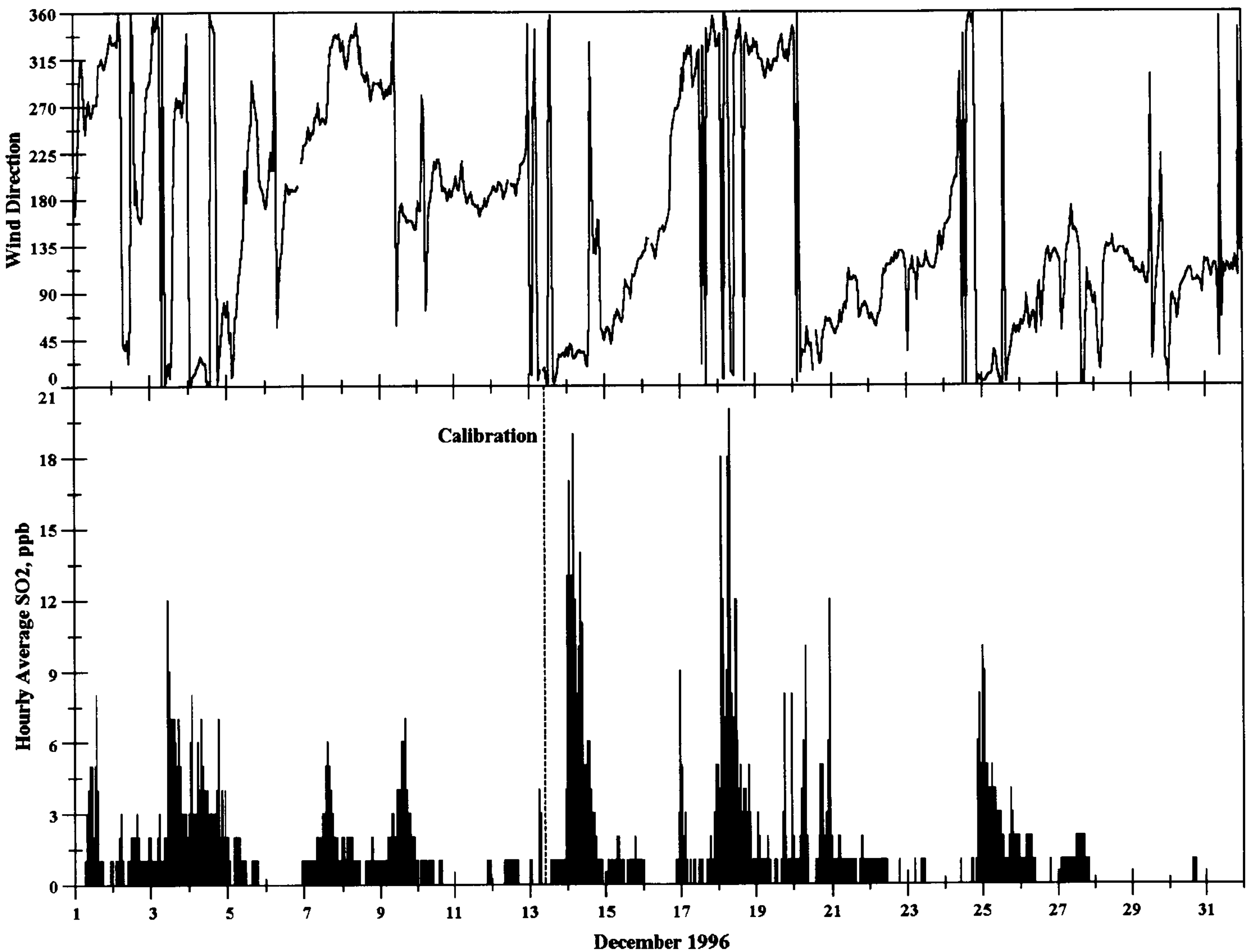


Figure 13. Average SO_2 concentrations (ppb) and wind directions for December 1996 at Dauphin Island.

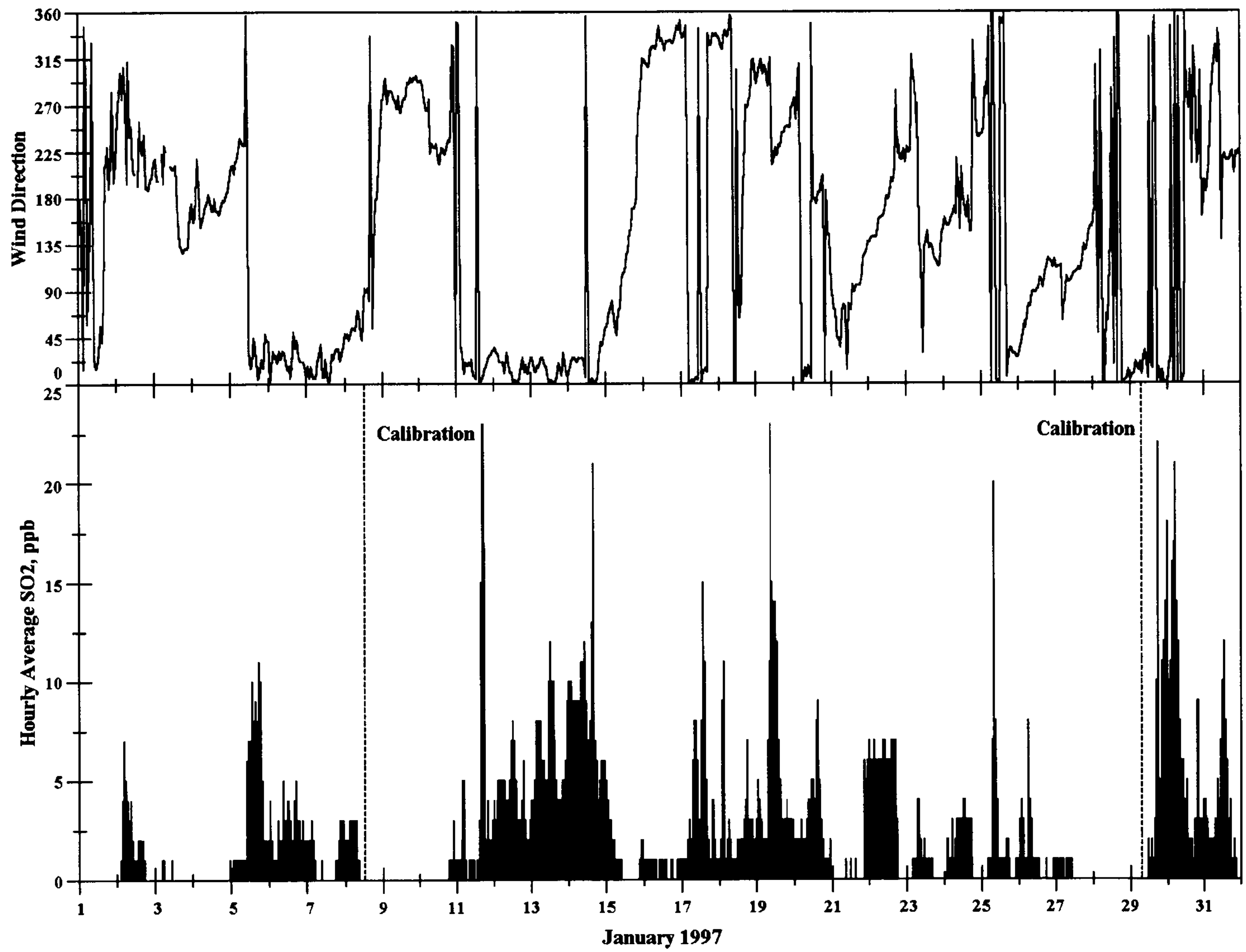


Figure 14. Average SO_2 concentrations (ppb) and wind direction for January 1997 at Dauphin Island.

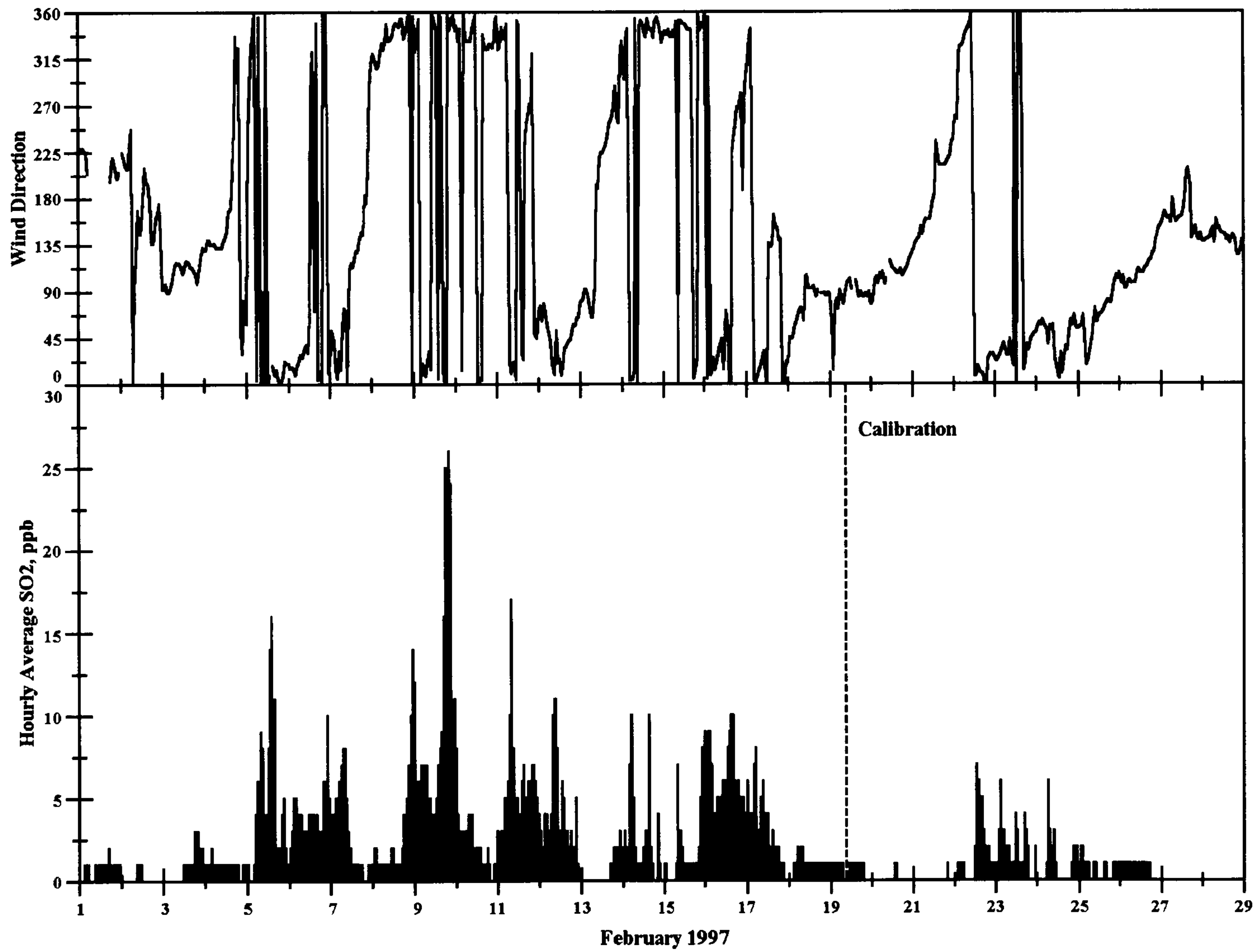


Figure 15. Average SO_2 concentration (ppb) and wind direction for February 1997 at Dauphin Island.

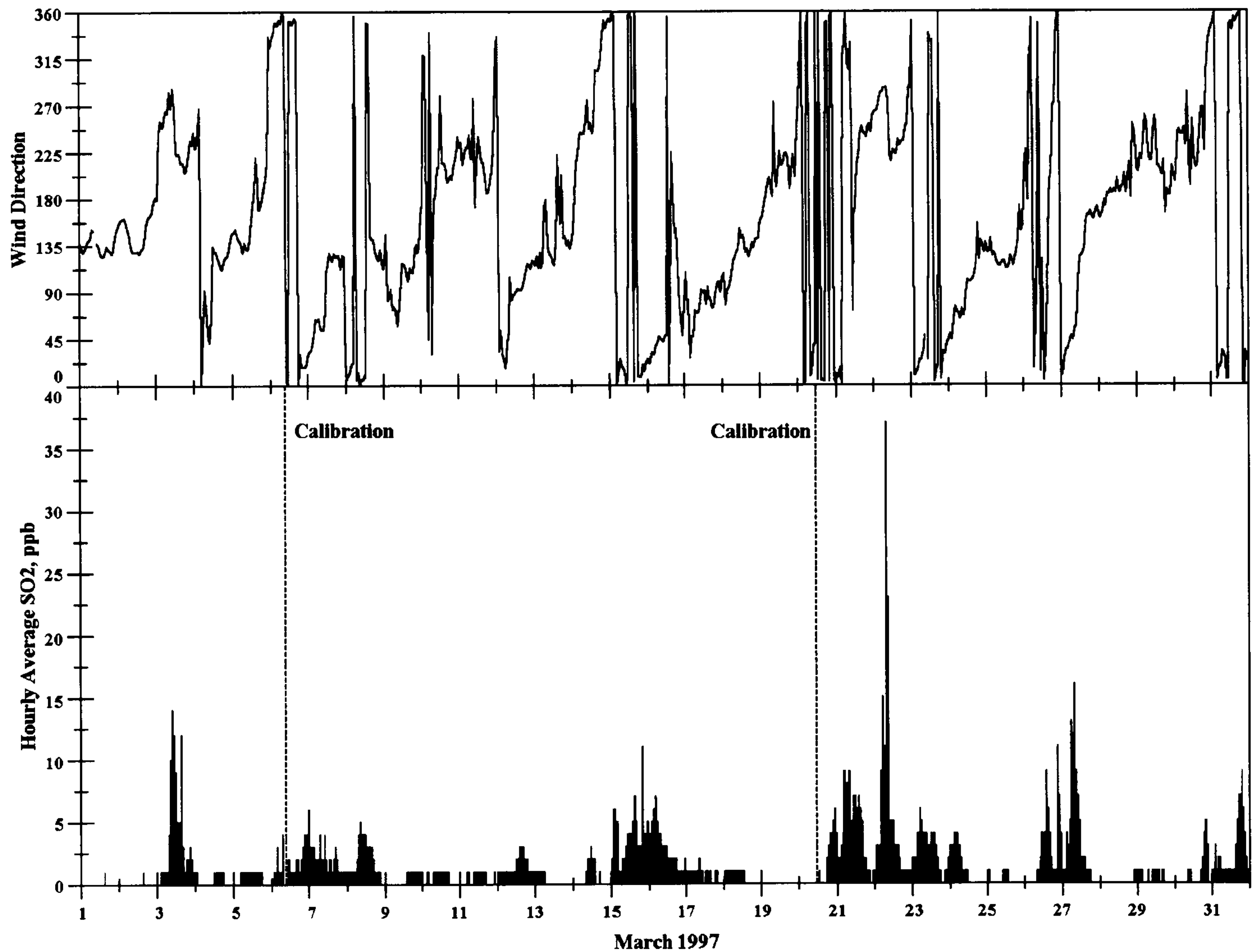


Figure 16. Average SO_2 concentrations (ppb) and wind direction for March 1997 at Dauphin Island.

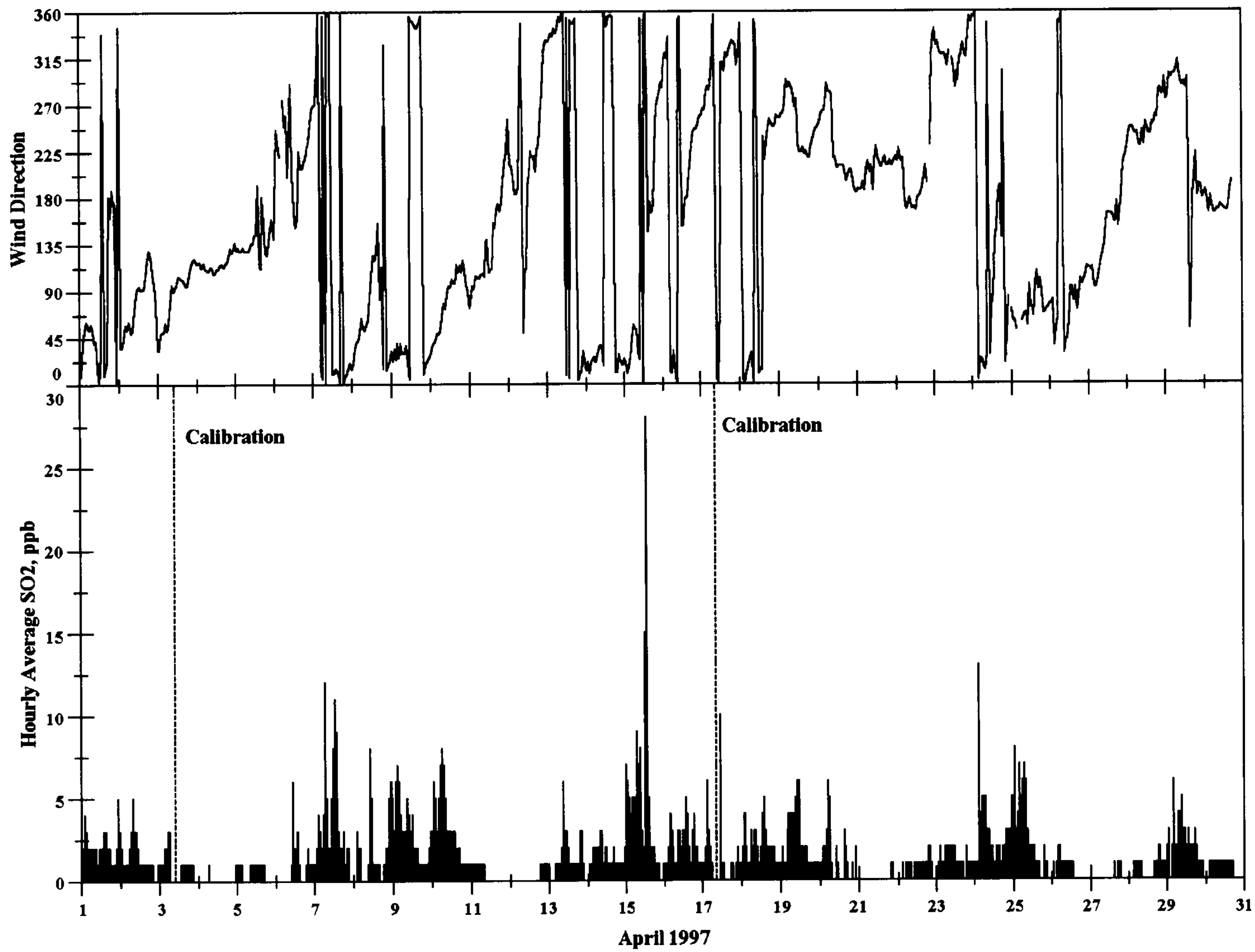


Figure 17. Average SO_2 concentrations (ppb) and wind direction for April 1997 at Dauphin Island.

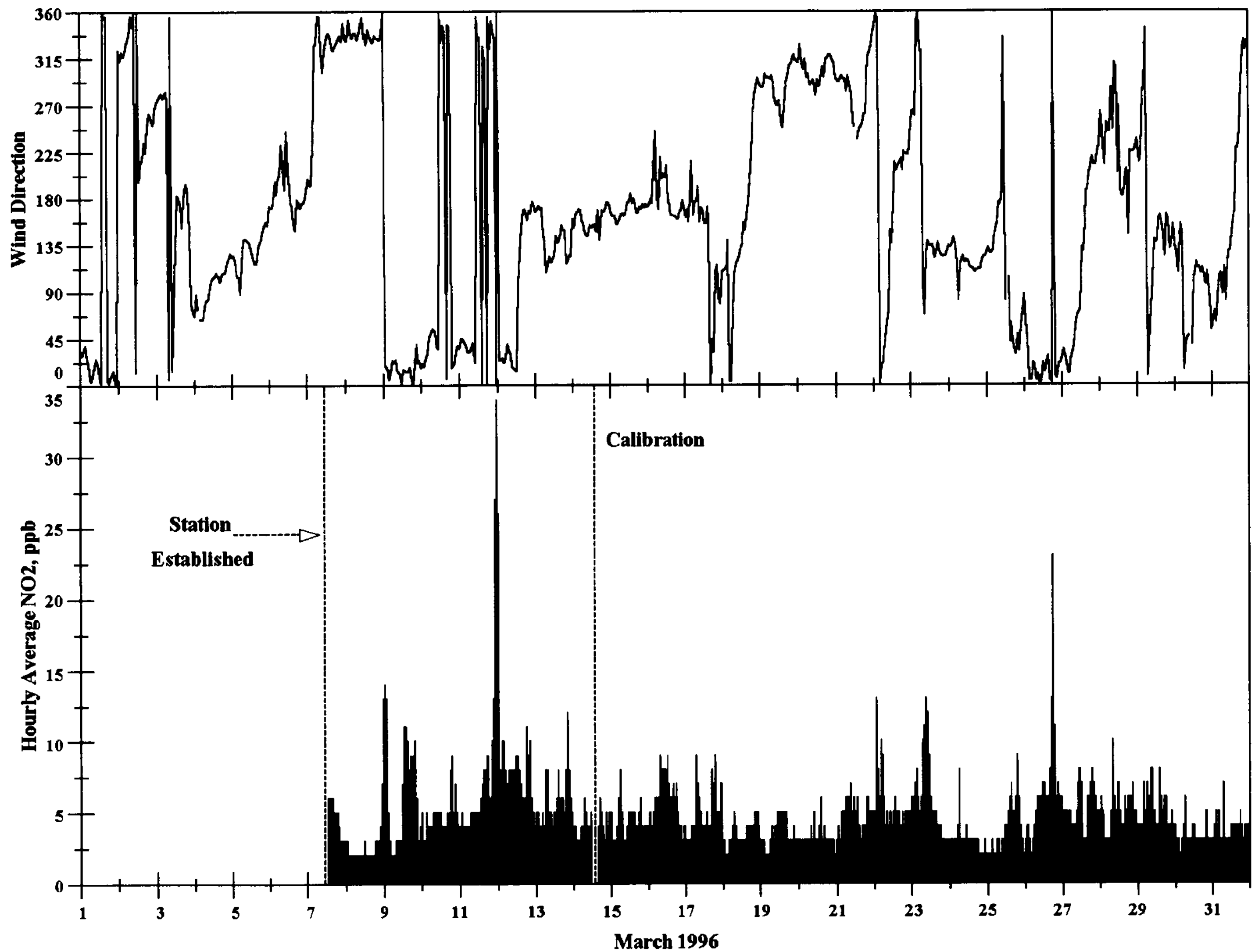


Figure 18. Average NO_2 concentrations (ppb) and wind direction for March 1996 at Dauphin Island.

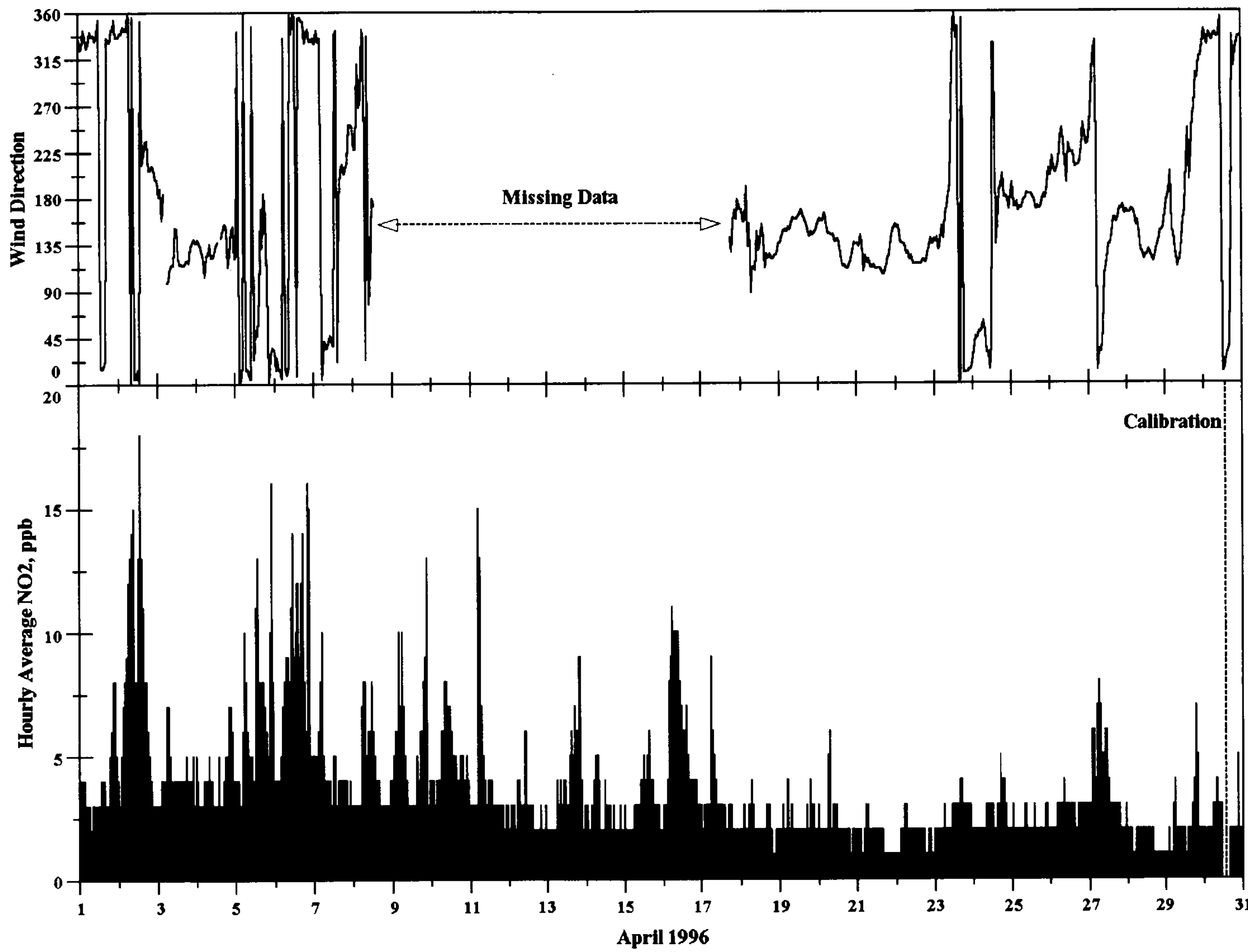


Figure 19. Average NO_2 concentrations (ppb) and wind direction for April 1996 at Dauphin Island.

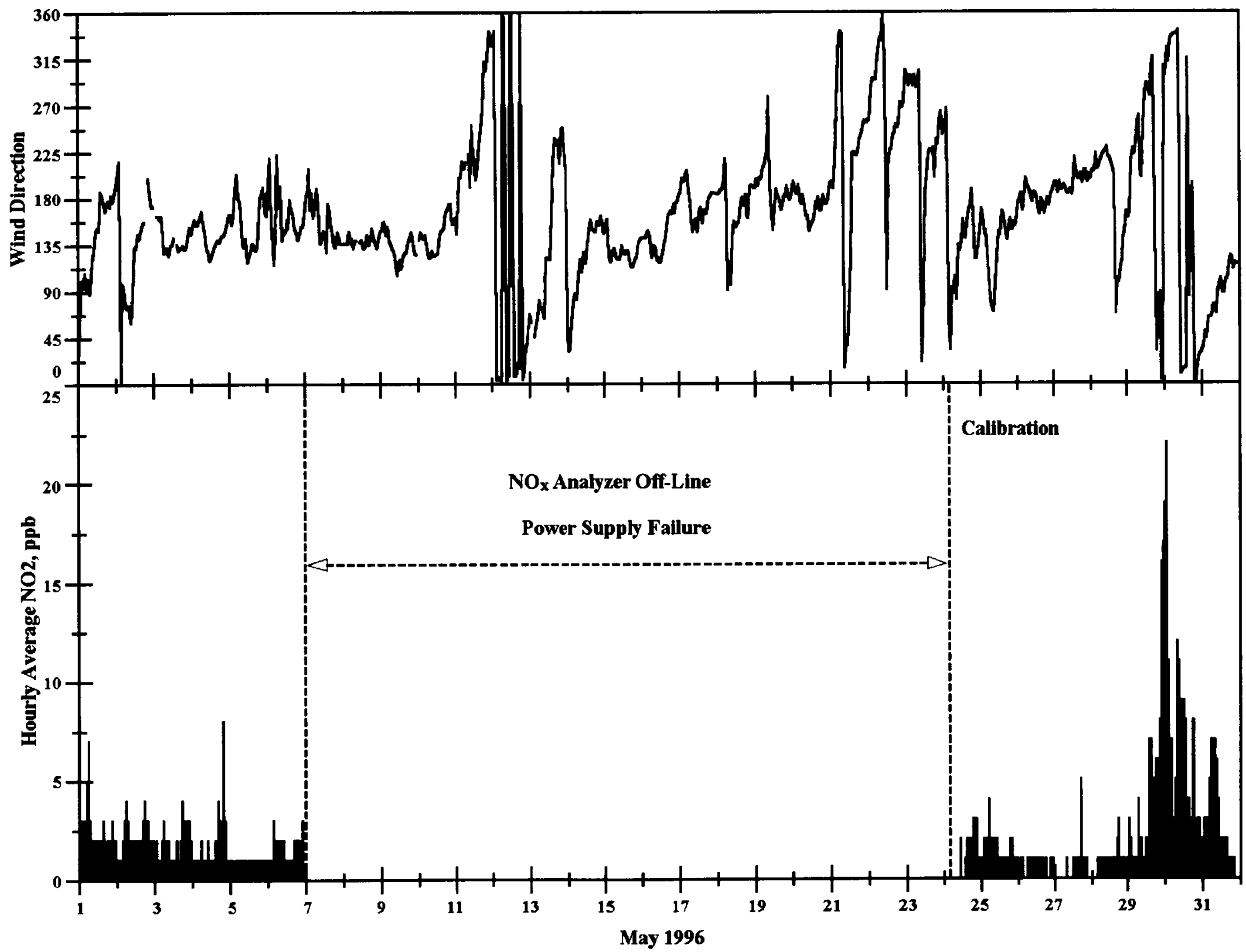


Figure 20. Average NO_2 concentrations (ppb) and wind direction for May 1996 at Dauphin Island.

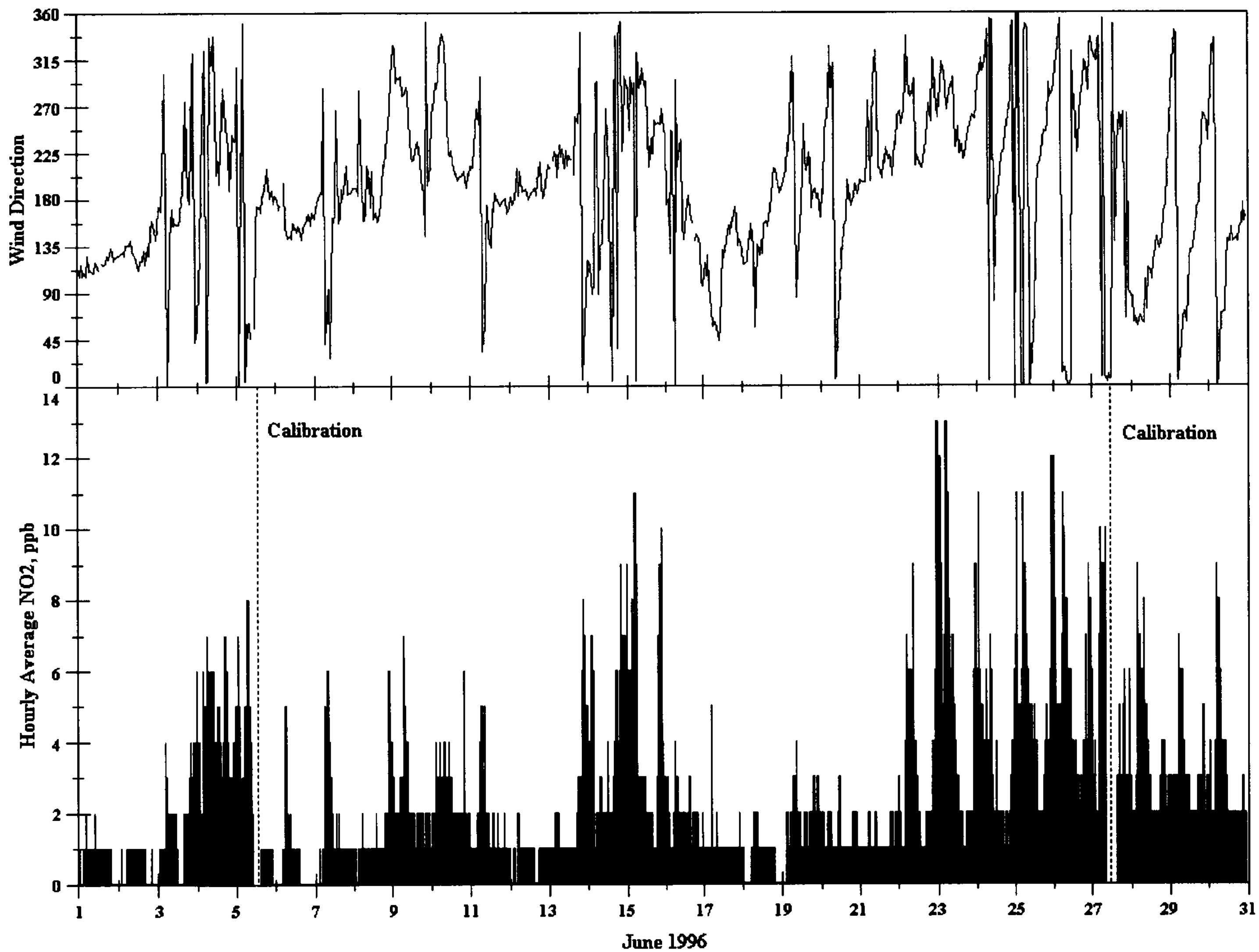


Figure 21. Average NO_2 concentrations (ppb) and wind direction for June 1996 at Dauphin Island.

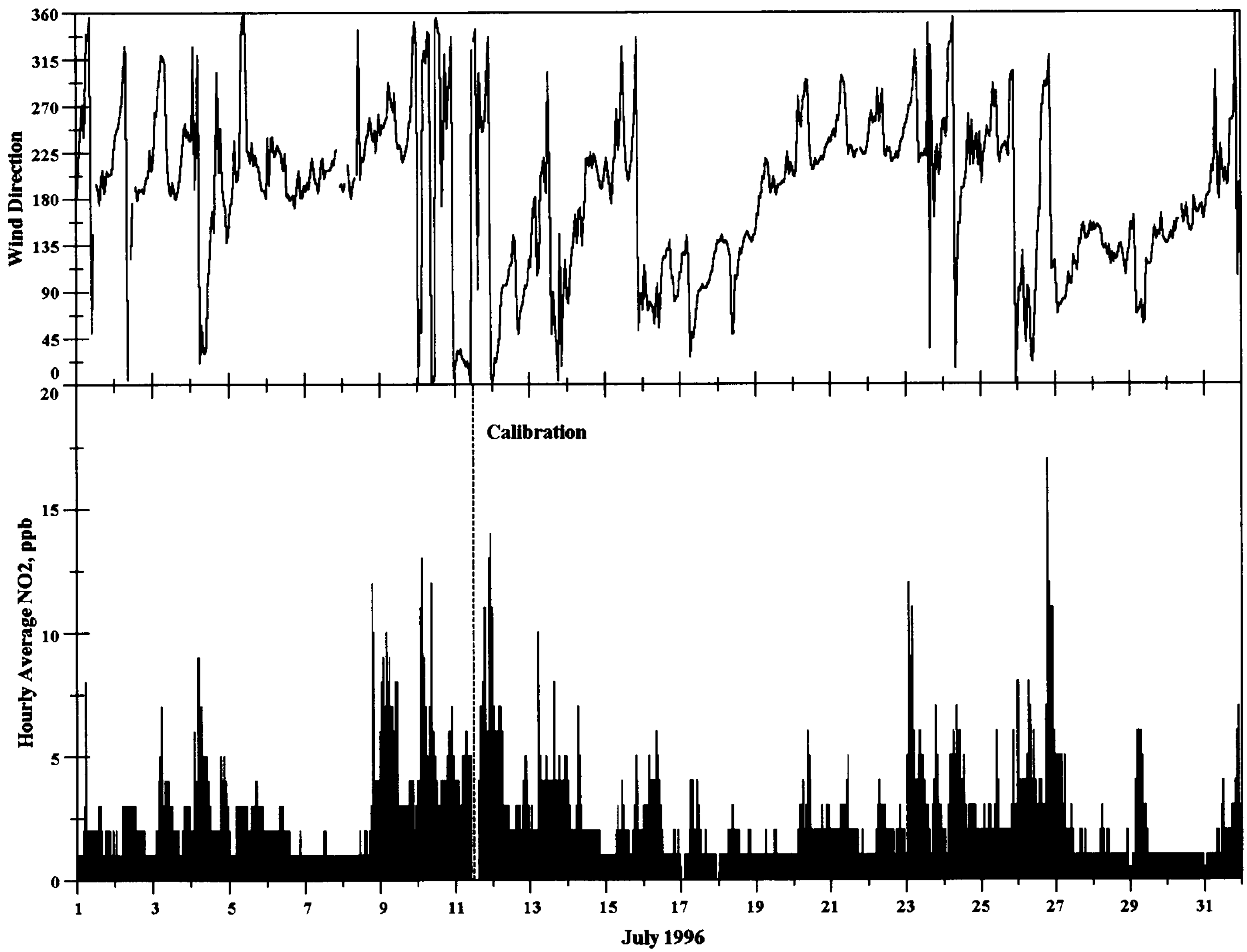


Figure 22. Average NO_2 concentrations (ppb) and wind direction for July 1996 at Dauphin Island.

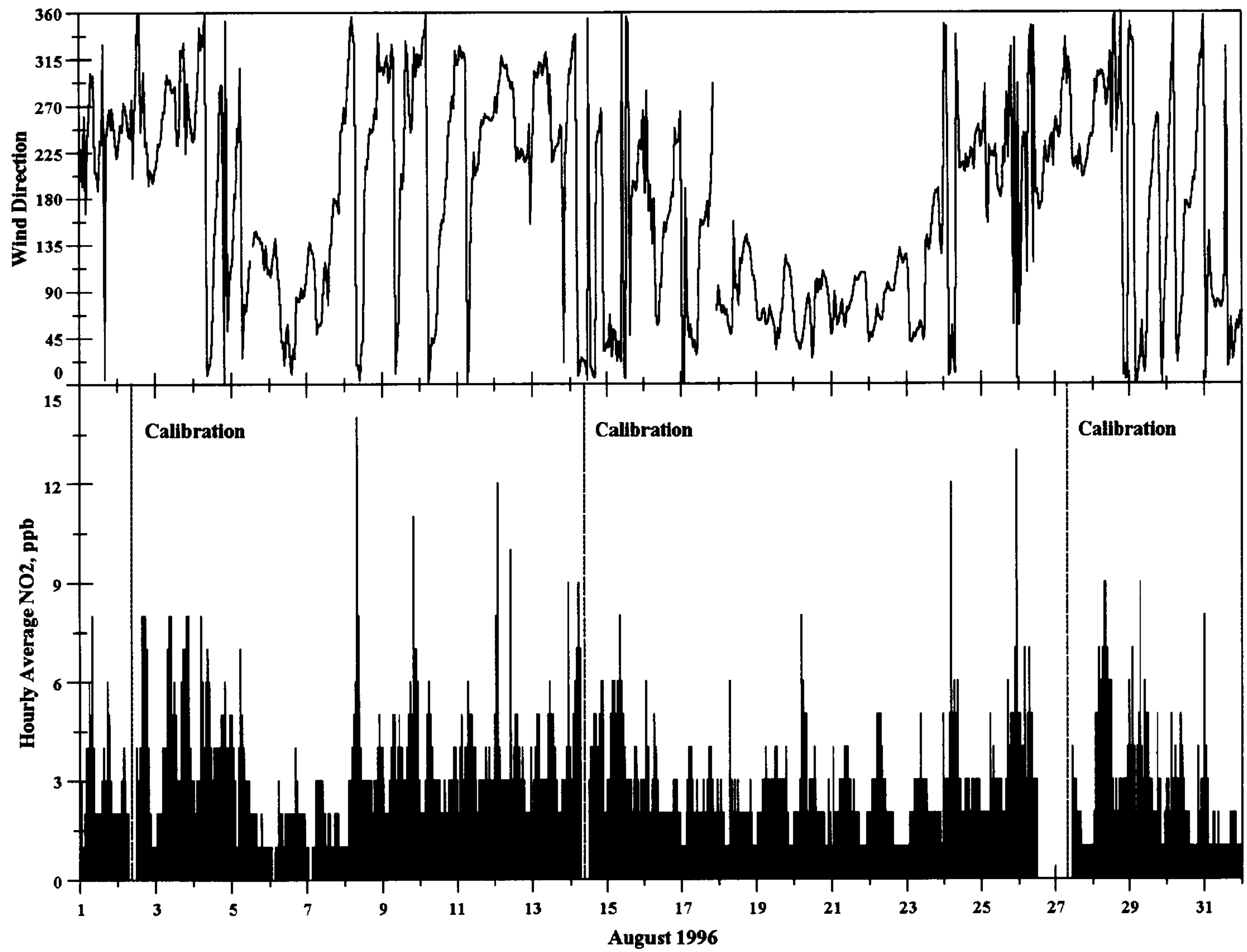


Figure 23. Average NO_2 concentrations (ppb) and wind direction for August 1996 at Dauphin Island.

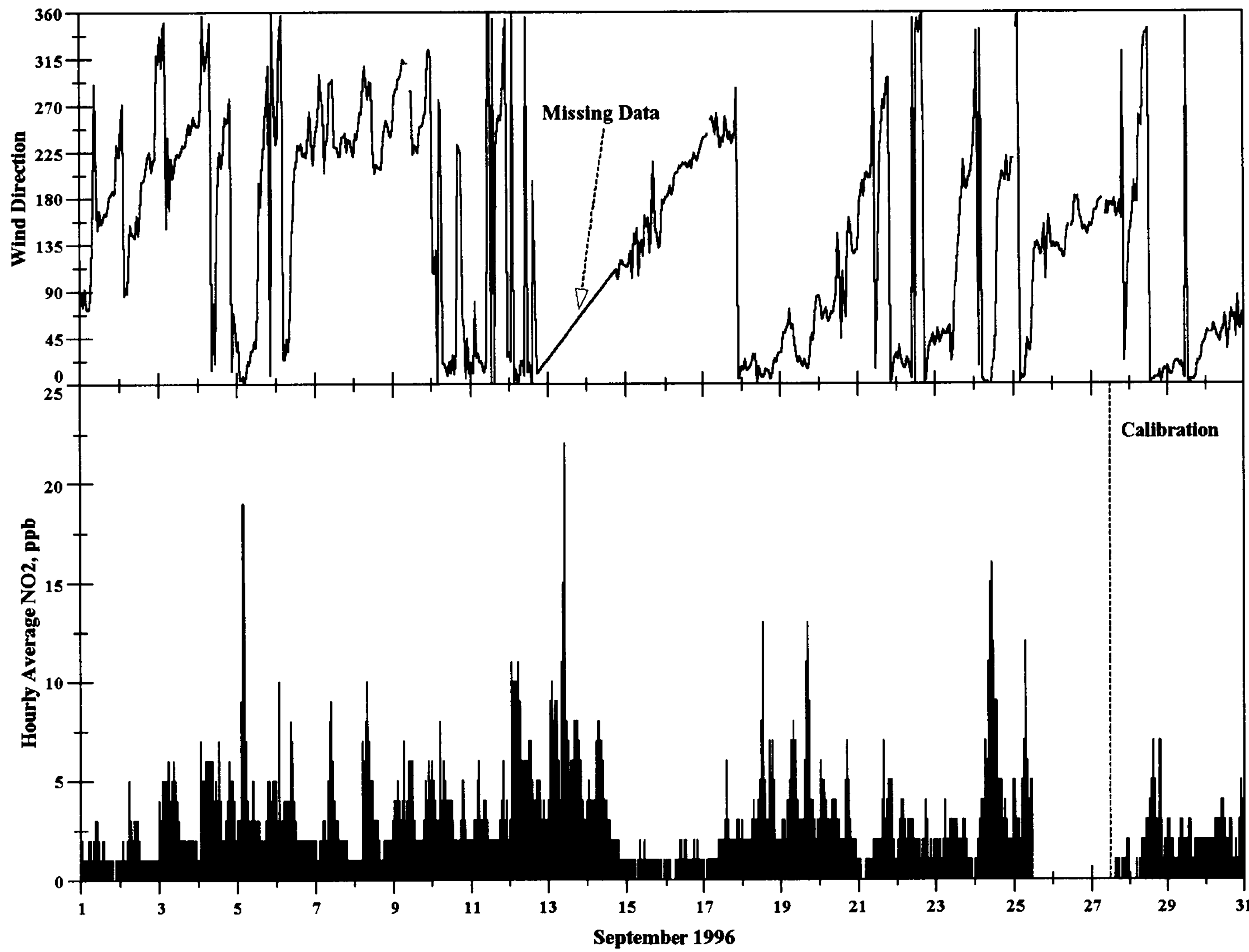


Figure 24. Average NO_2 concentrations (ppb) and wind direction for September 1996 at Dauphin Island.

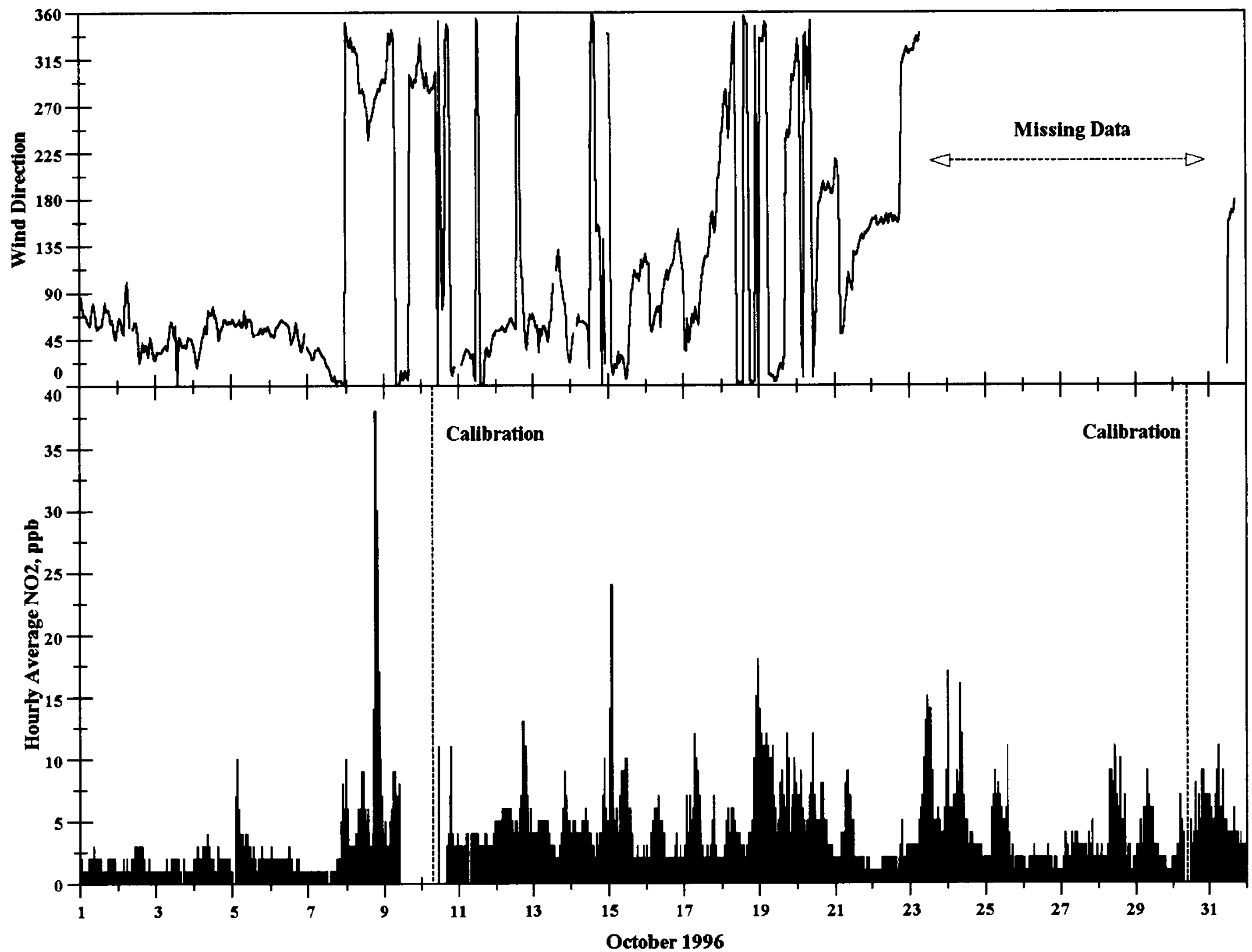


Figure 25. Average NO_2 concentrations (ppb) and wind direction for October 1996 at Dauphin Island.

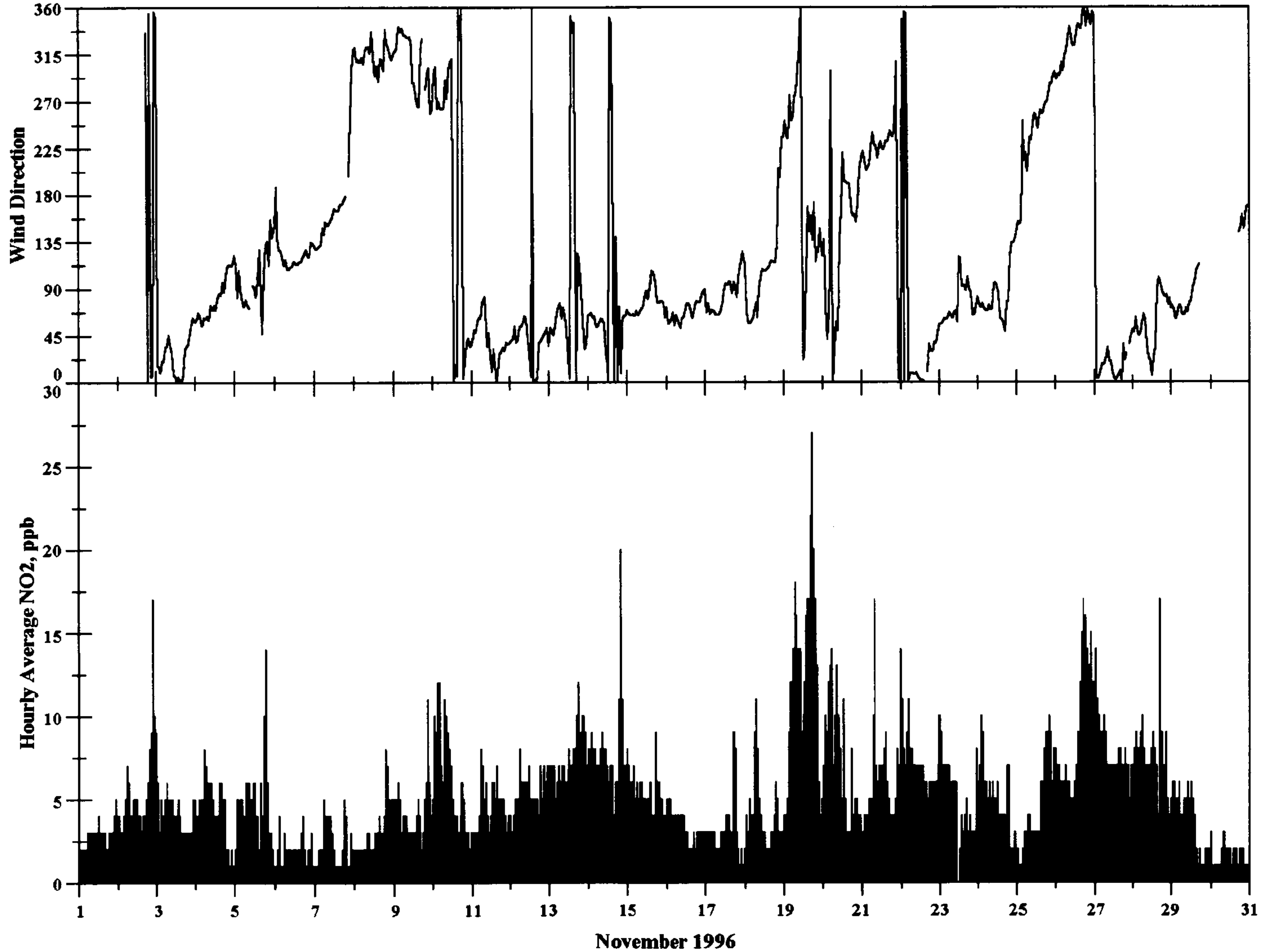


Figure 26. Average NO_2 concentrations (ppb) and wind direction for November 1996 at Dauphin Island.

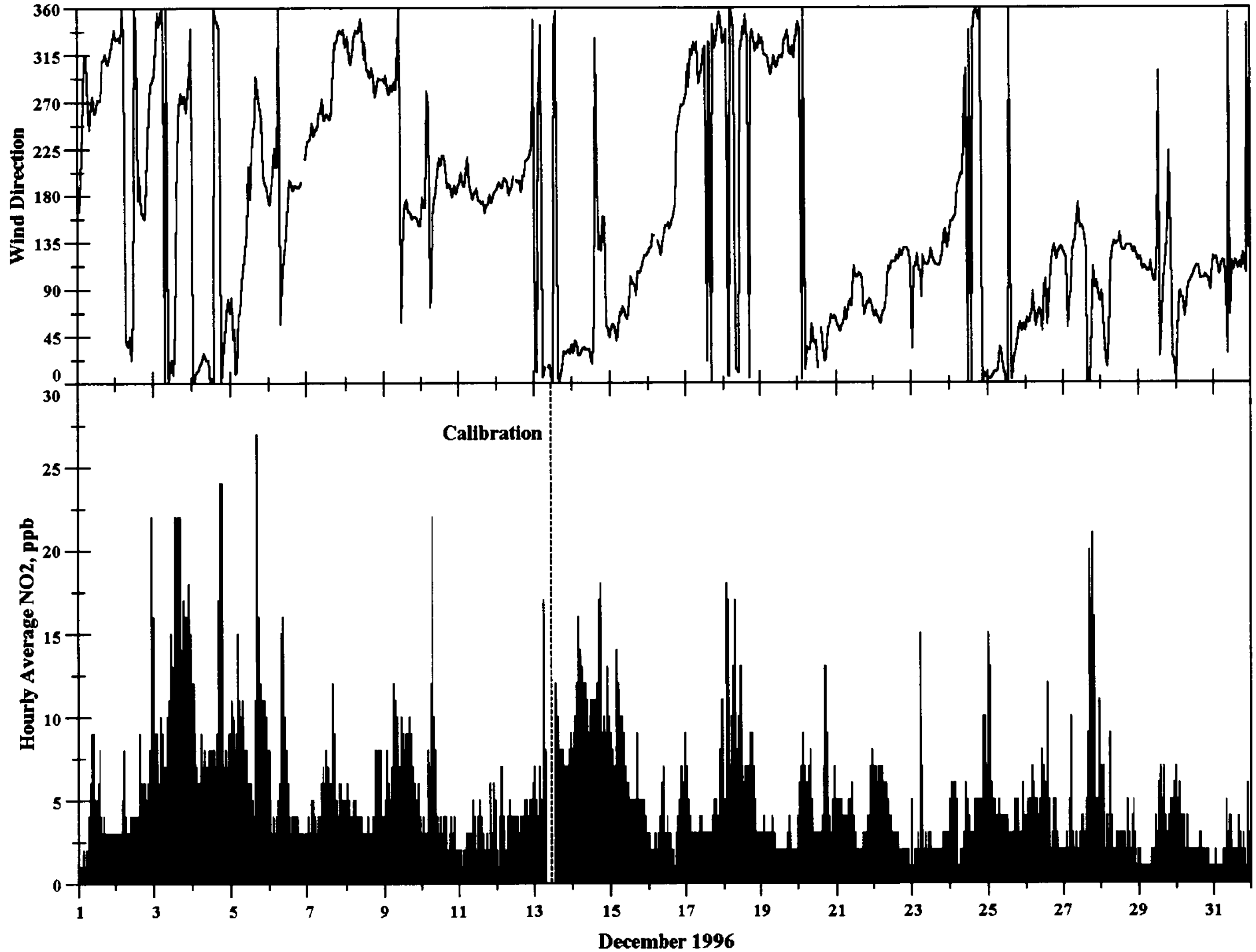


Figure 27. Average NO_2 concentrations (ppb) and wind direction for December 1996 at Dauphin Island.

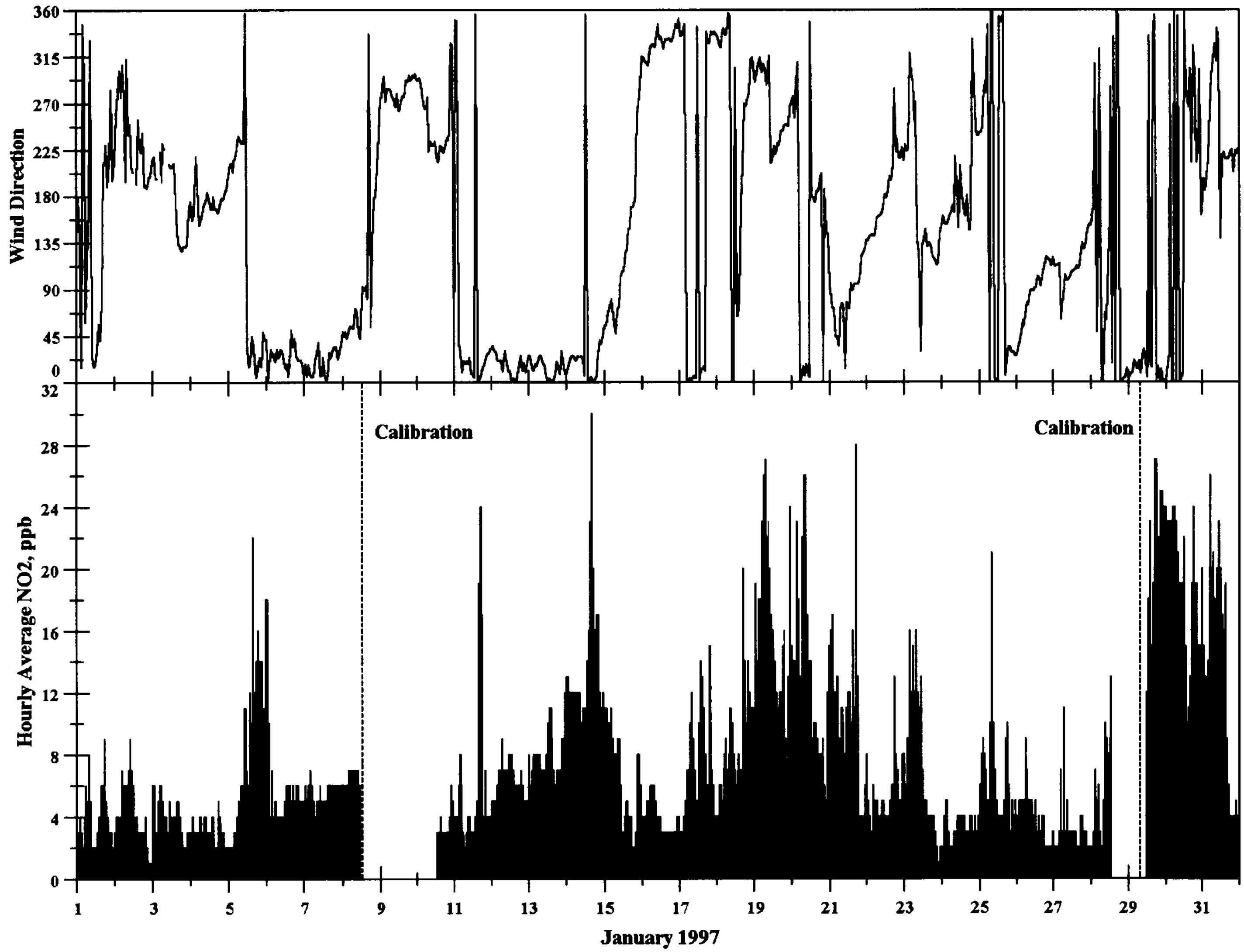


Figure 28. Average NO_2 concentrations (ppb) and wind direction for January 1997 at Dauphin Island.

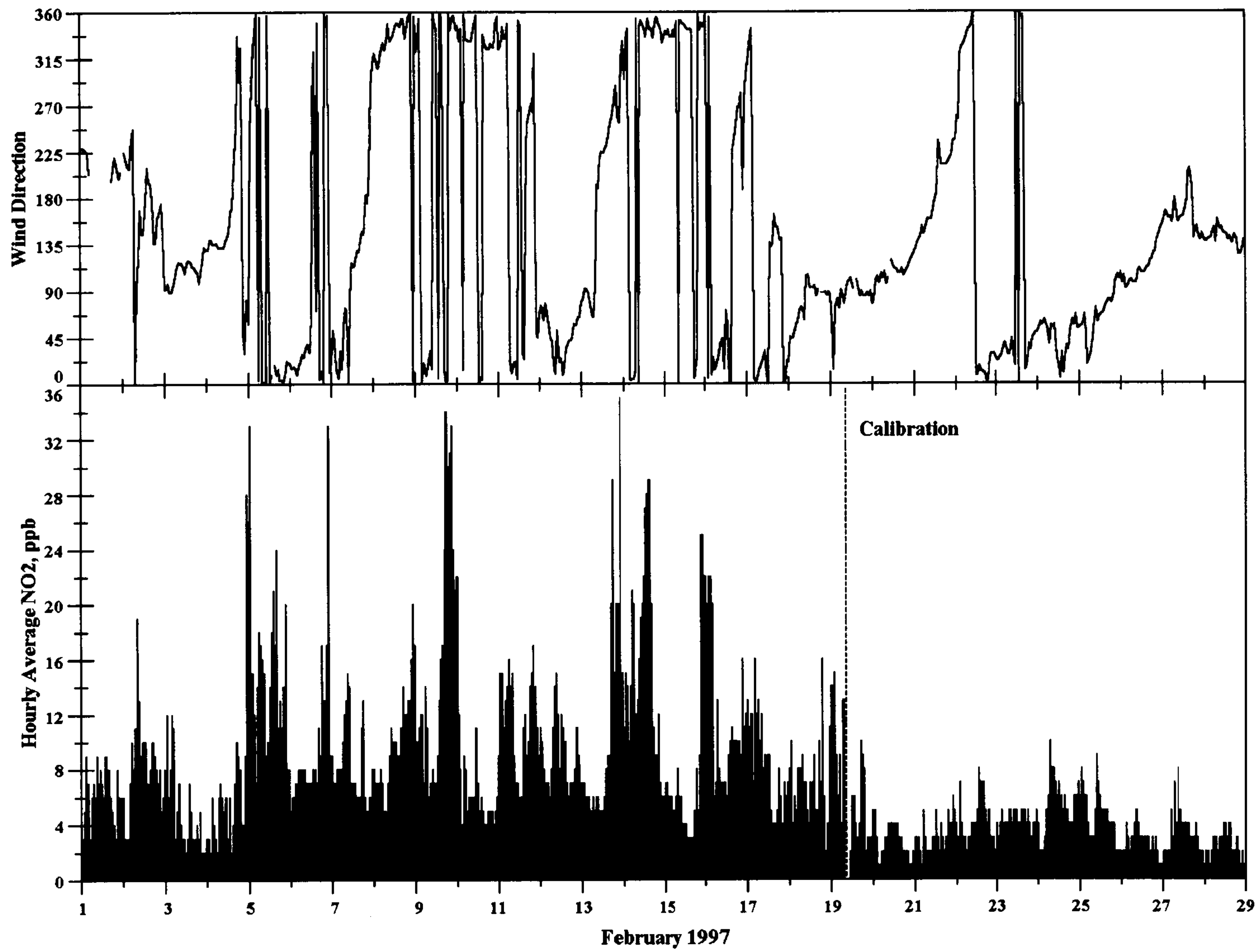


Figure 29. Average NO_2 concentrations (ppb) and wind direction for February 1997 at Dauphin Island.

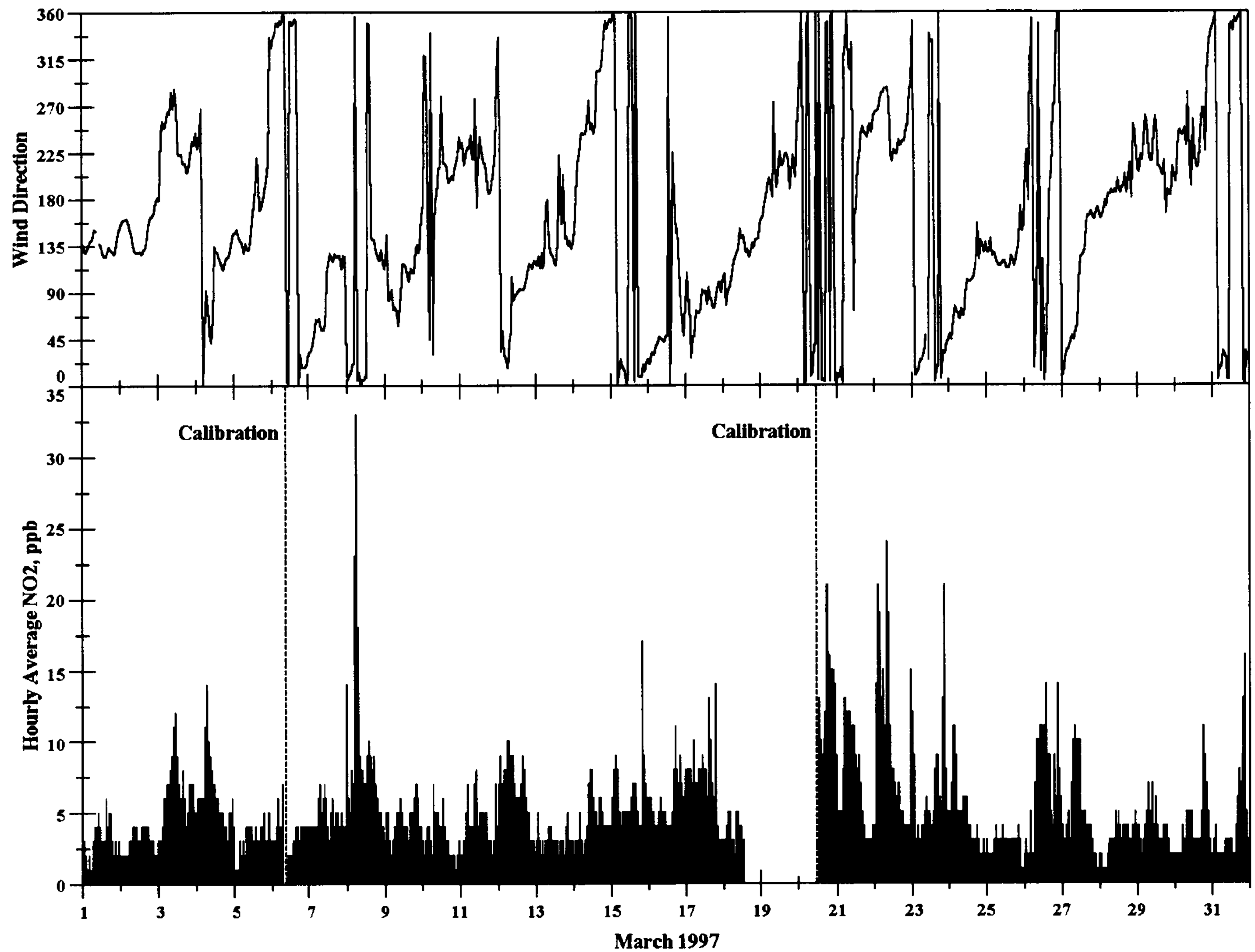


Figure 30. Average NO_2 concentrations (ppb) and wind direction for March 1997 at Dauphin Island.

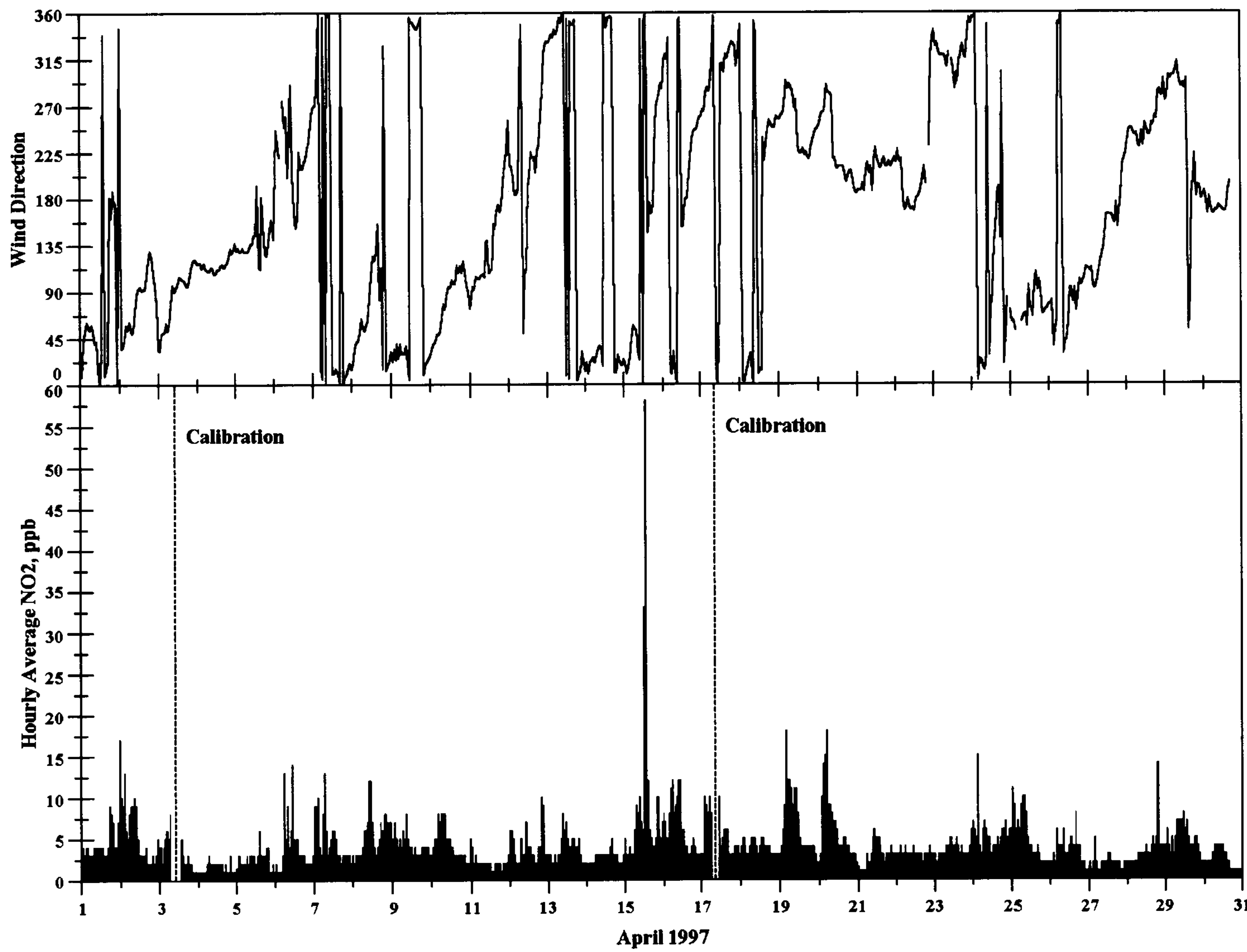


Figure 31. Average NO_2 concentrations (ppb) and wind direction for April 1997 at Dauphin Island.

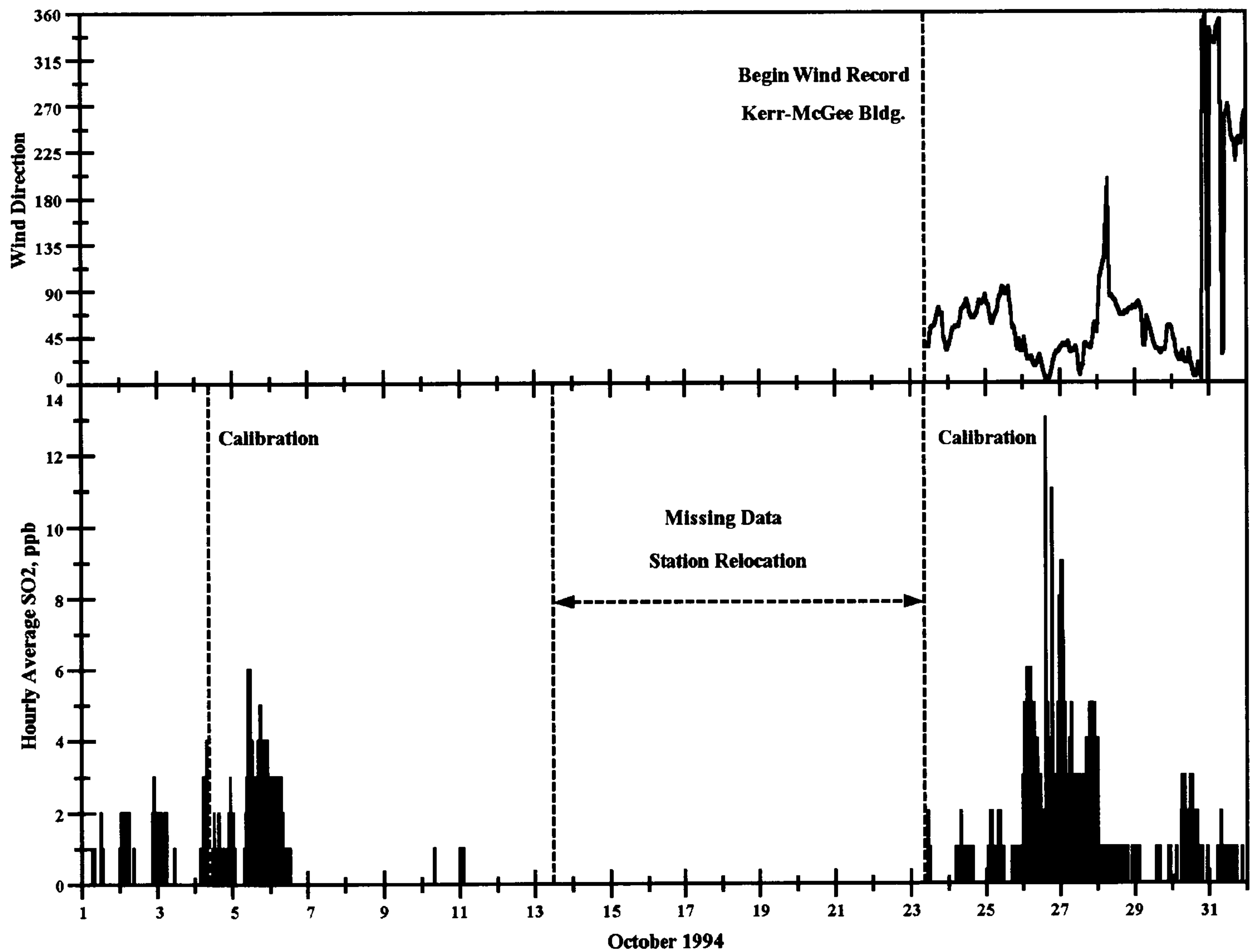


Figure 32. Average SO_2 concentrations (ppb) and wind direction for October 1994 at Breton Island.

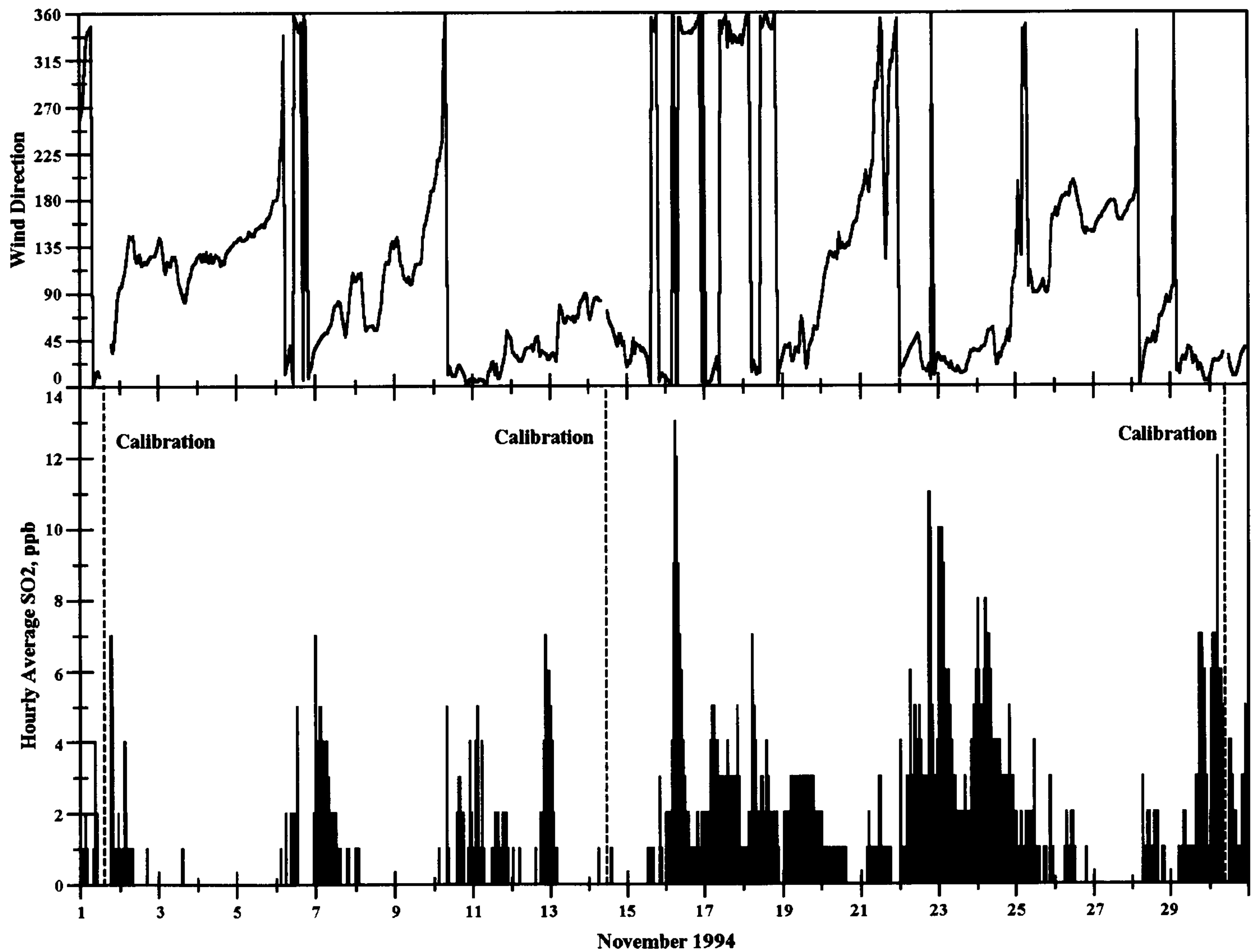


Figure 33. Average SO_2 concentrations (ppb) and wind direction for November 1994 at Breton Island.

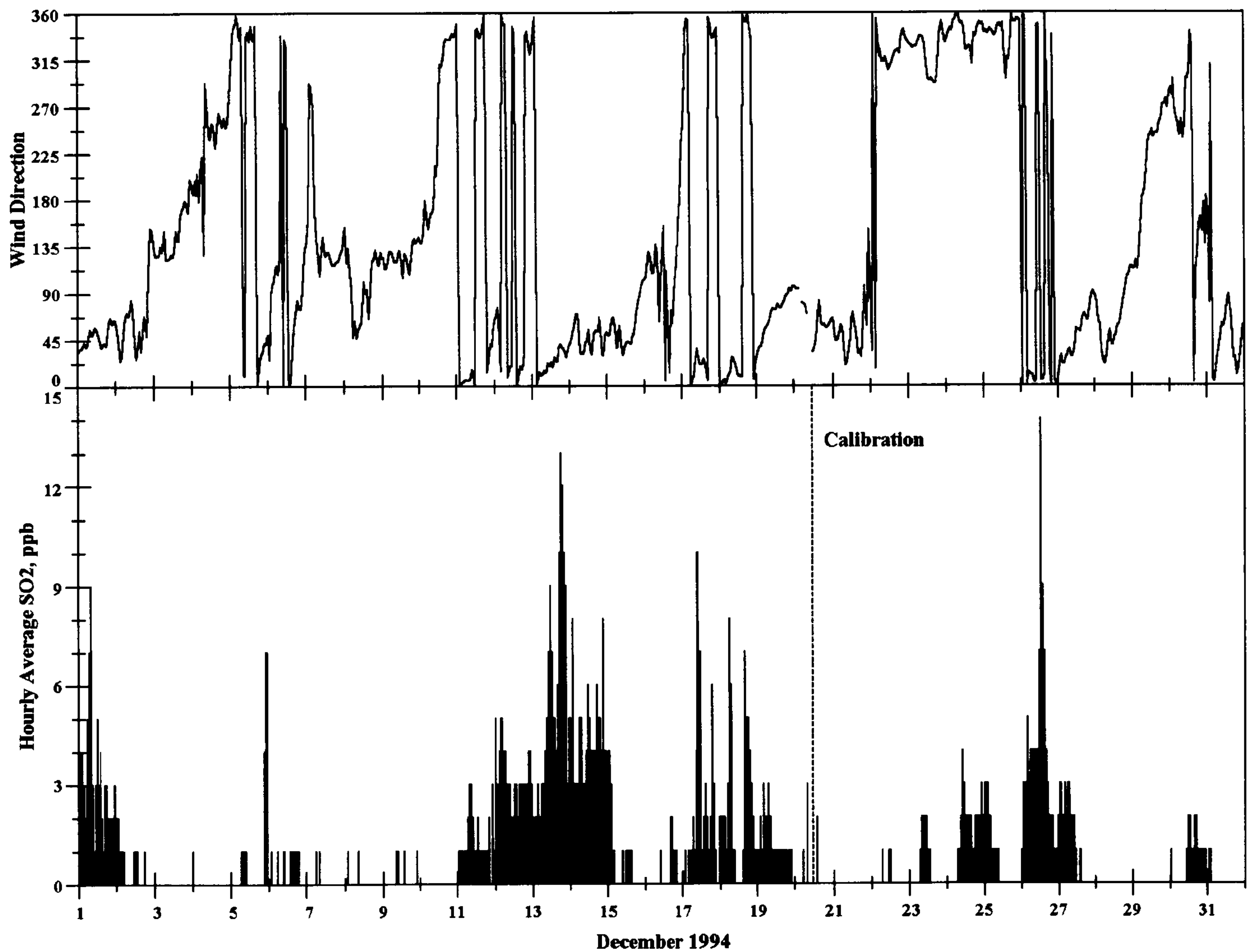


Figure 34. Average SO_2 concentrations (ppb) and wind direction for December 1994 at Breton Island.

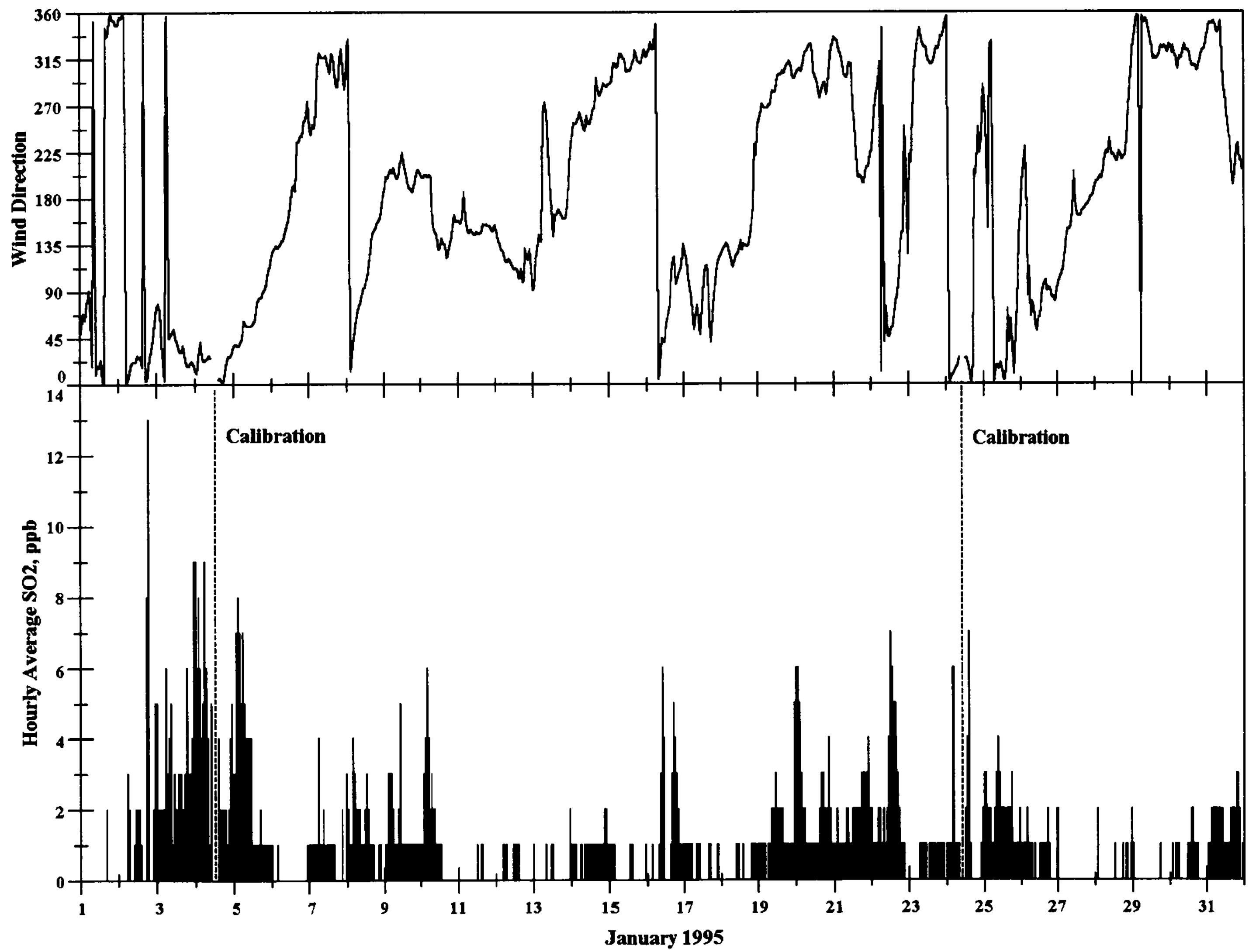


Figure 35. Average SO_2 concentrations (ppb) and wind direction for January 1995 at Breton Island.

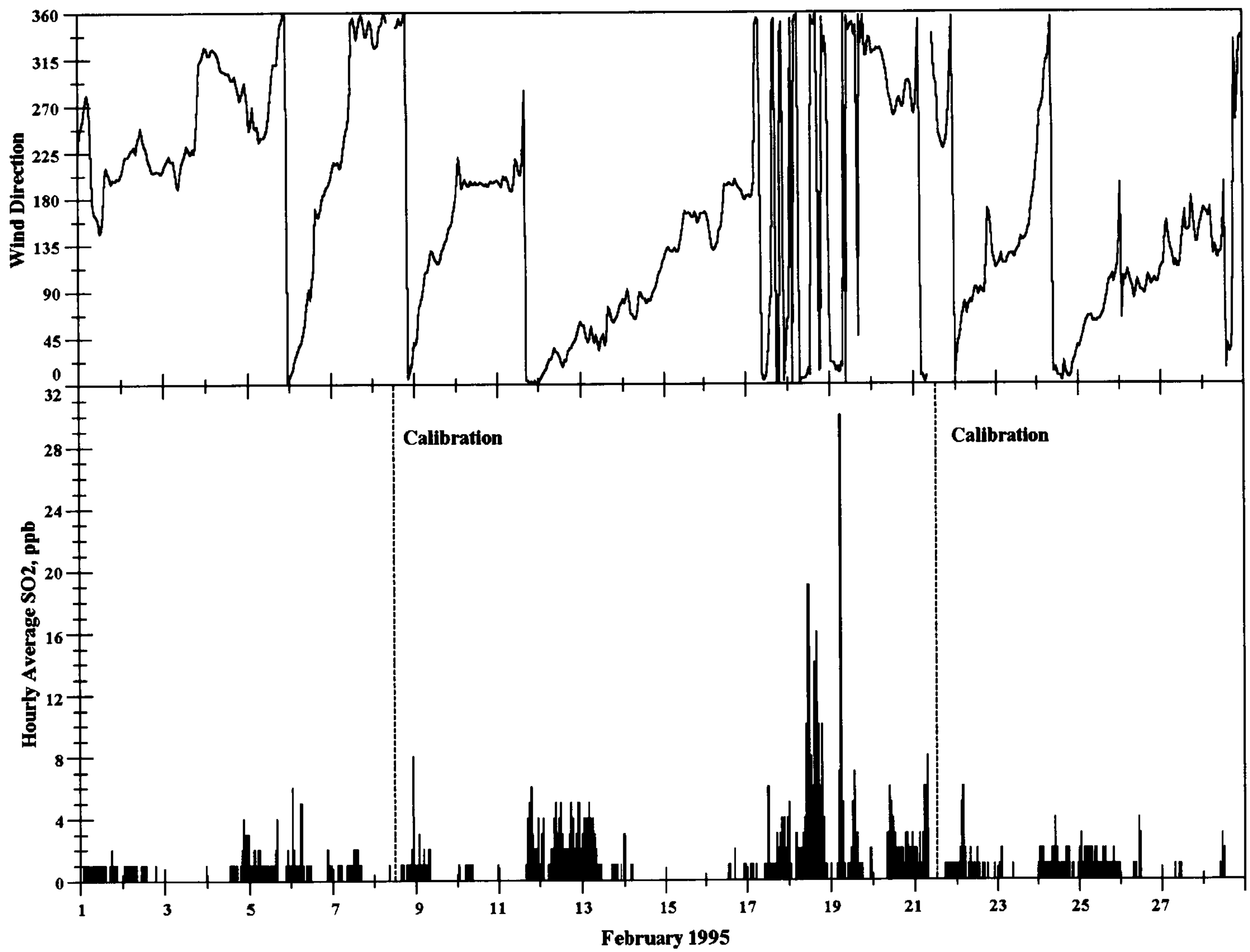


Figure 36. Average SO_2 concentrations (ppb) and wind direction for February 1995 at Breton Island.

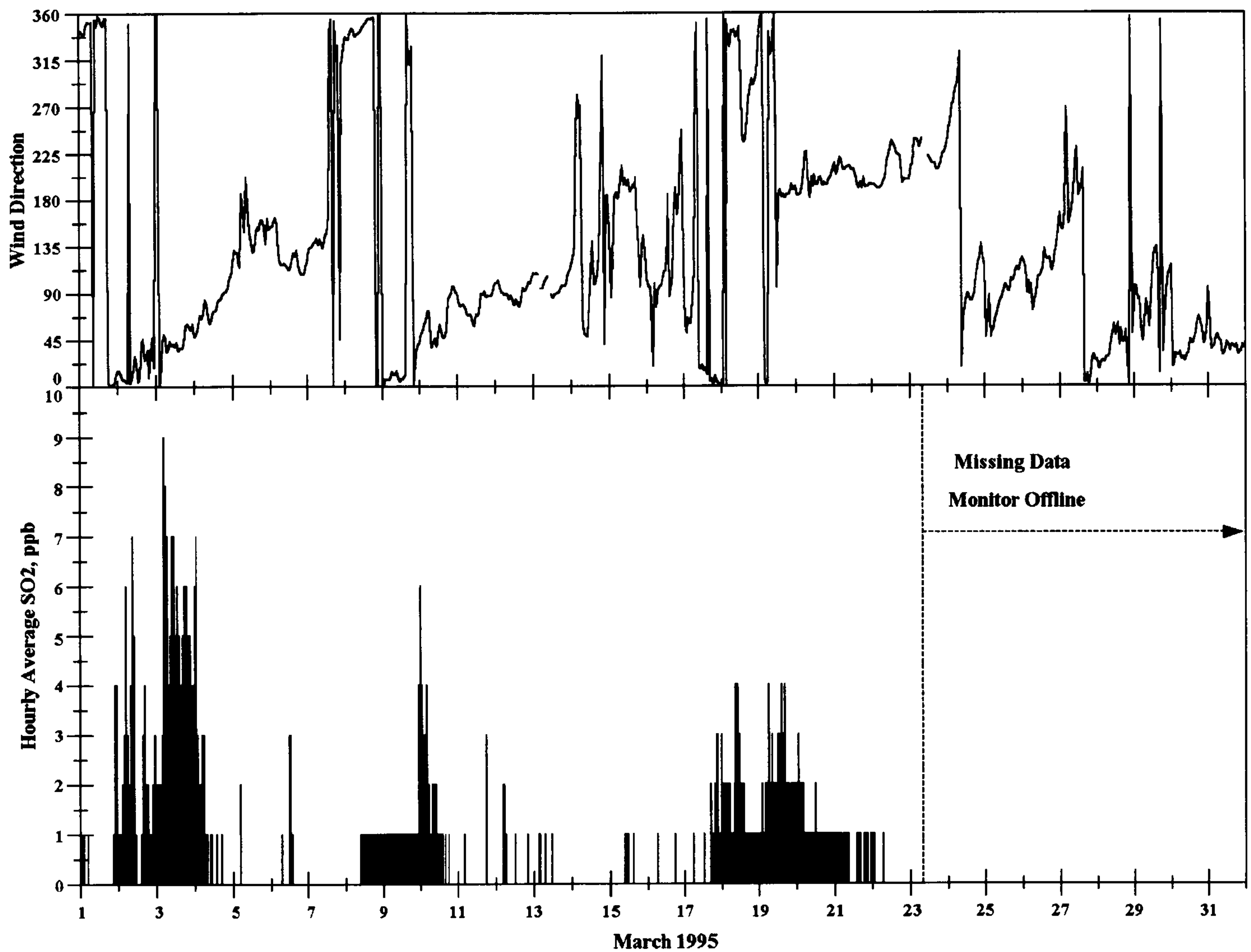


Figure 37. Average SO_2 concentrations (ppb) and wind direction for March 1995 at Breton Island.

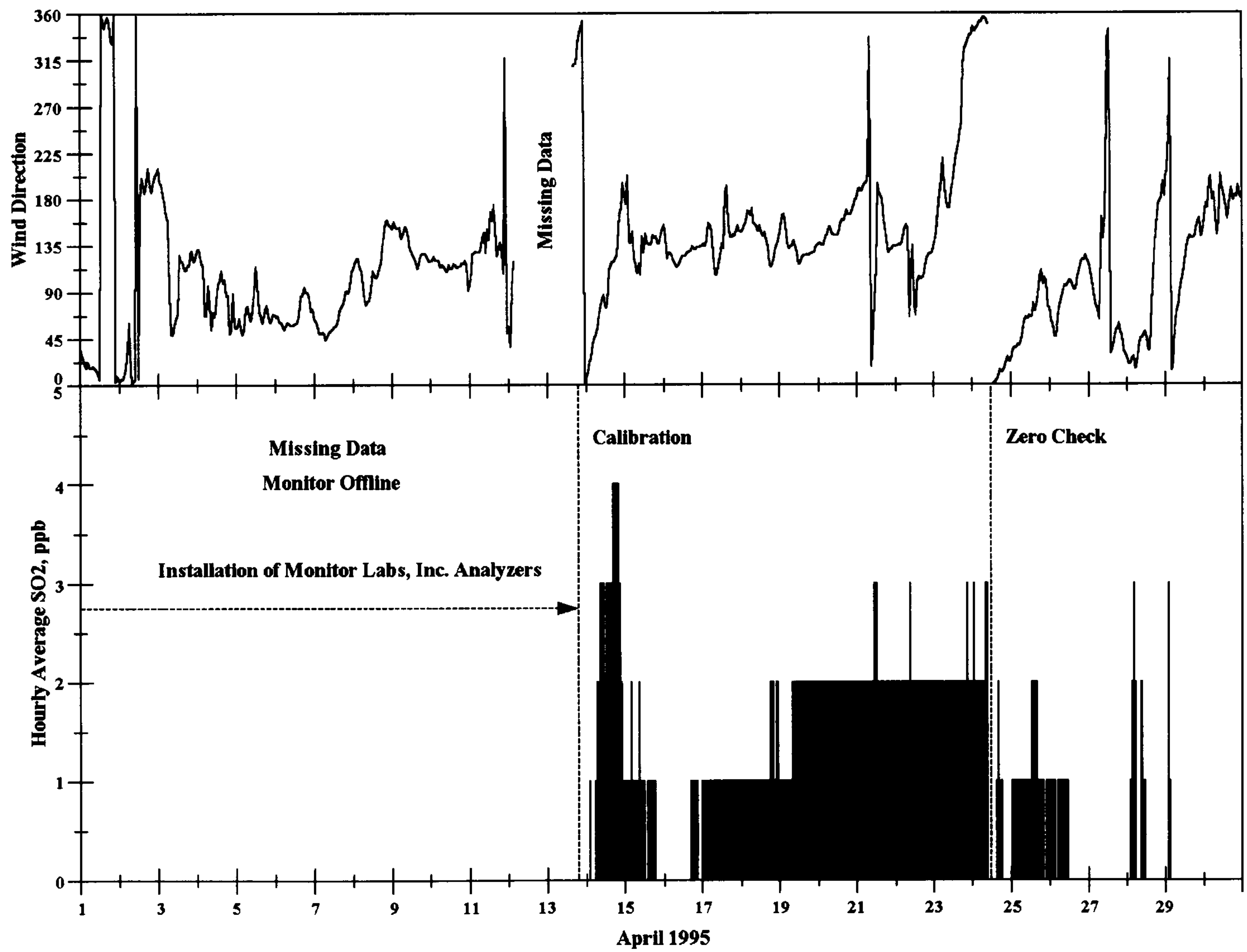


Figure 38. Average SO_2 concentrations (ppb) and wind direction for April 1995 at Breton Island.

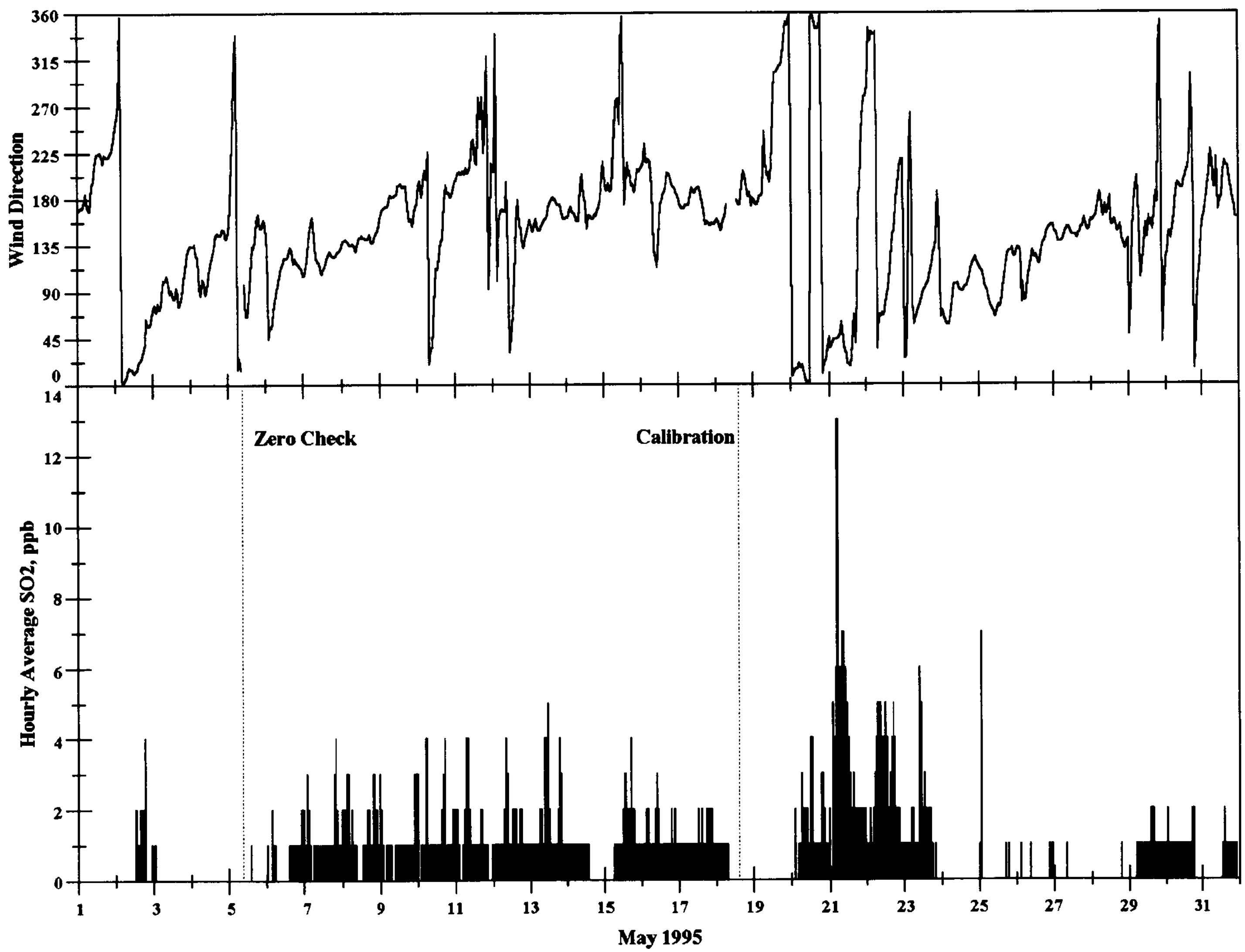


Figure 39. Average SO_2 concentrations (ppb) and wind direction for May 1995 at Breton Island.

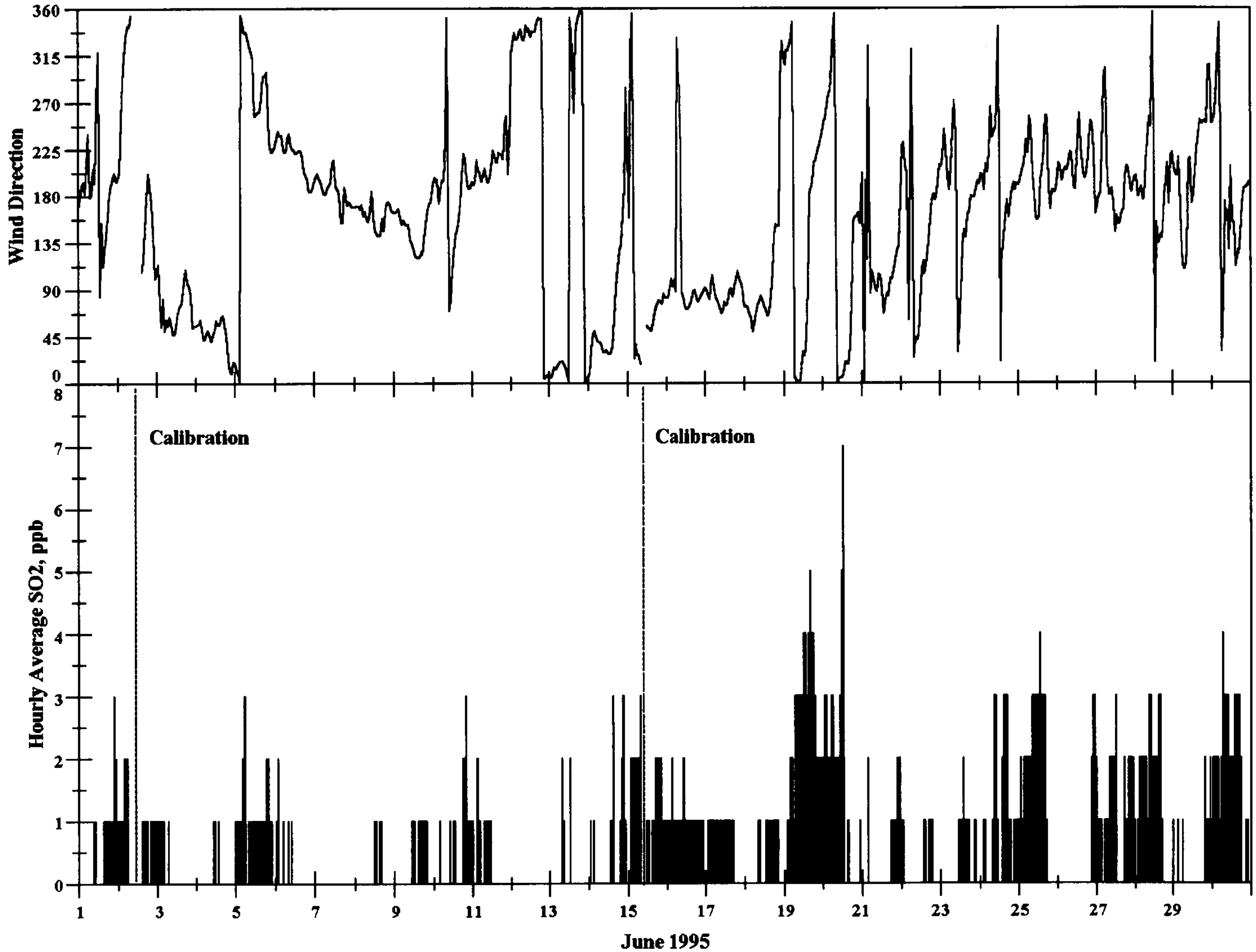


Figure 40. Average SO_2 concentrations (ppb) and wind direction for June 1995 at Breton Island.

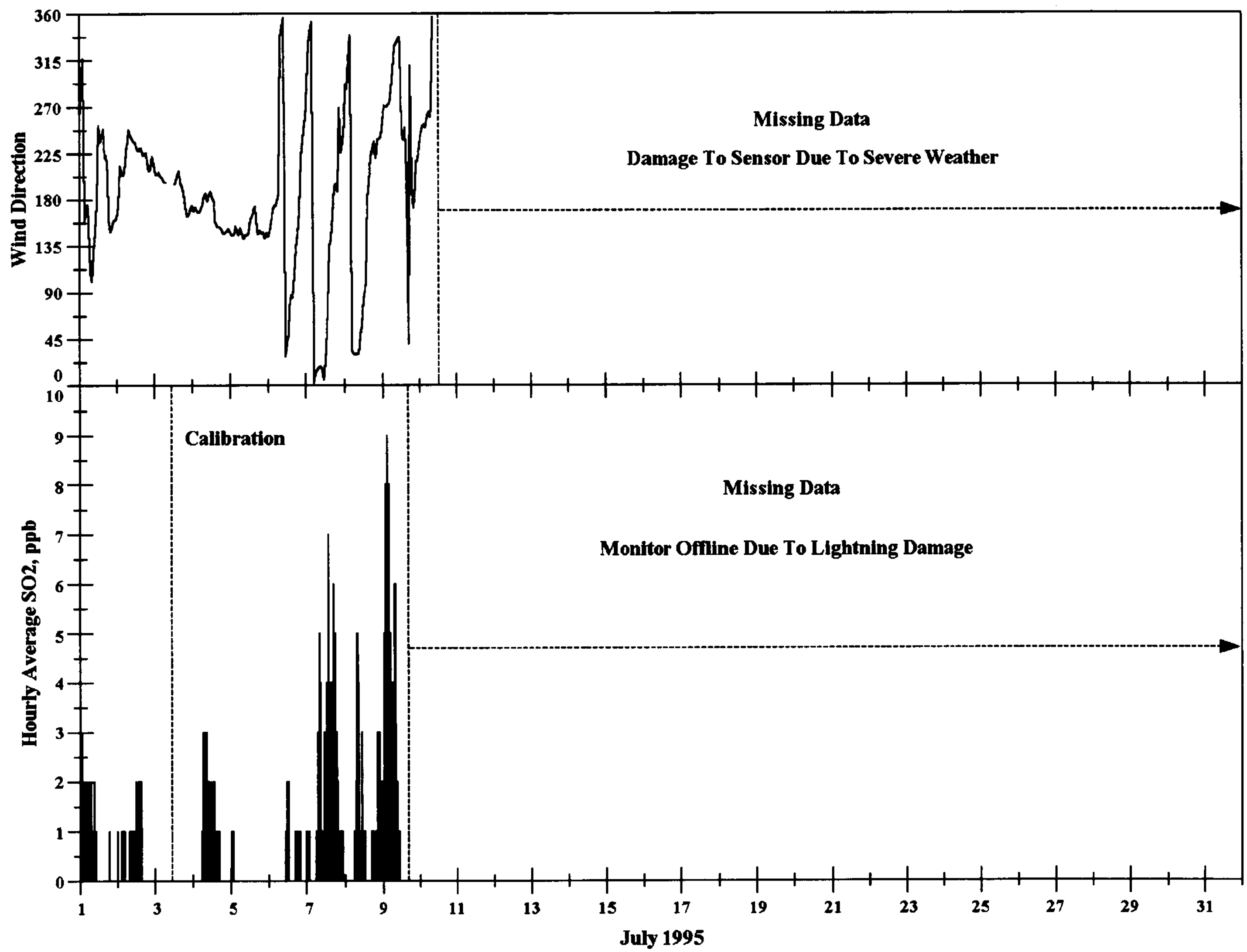


Figure 41. Average SO_2 concentrations (ppb) and wind direction for July 1995 at Breton Island.

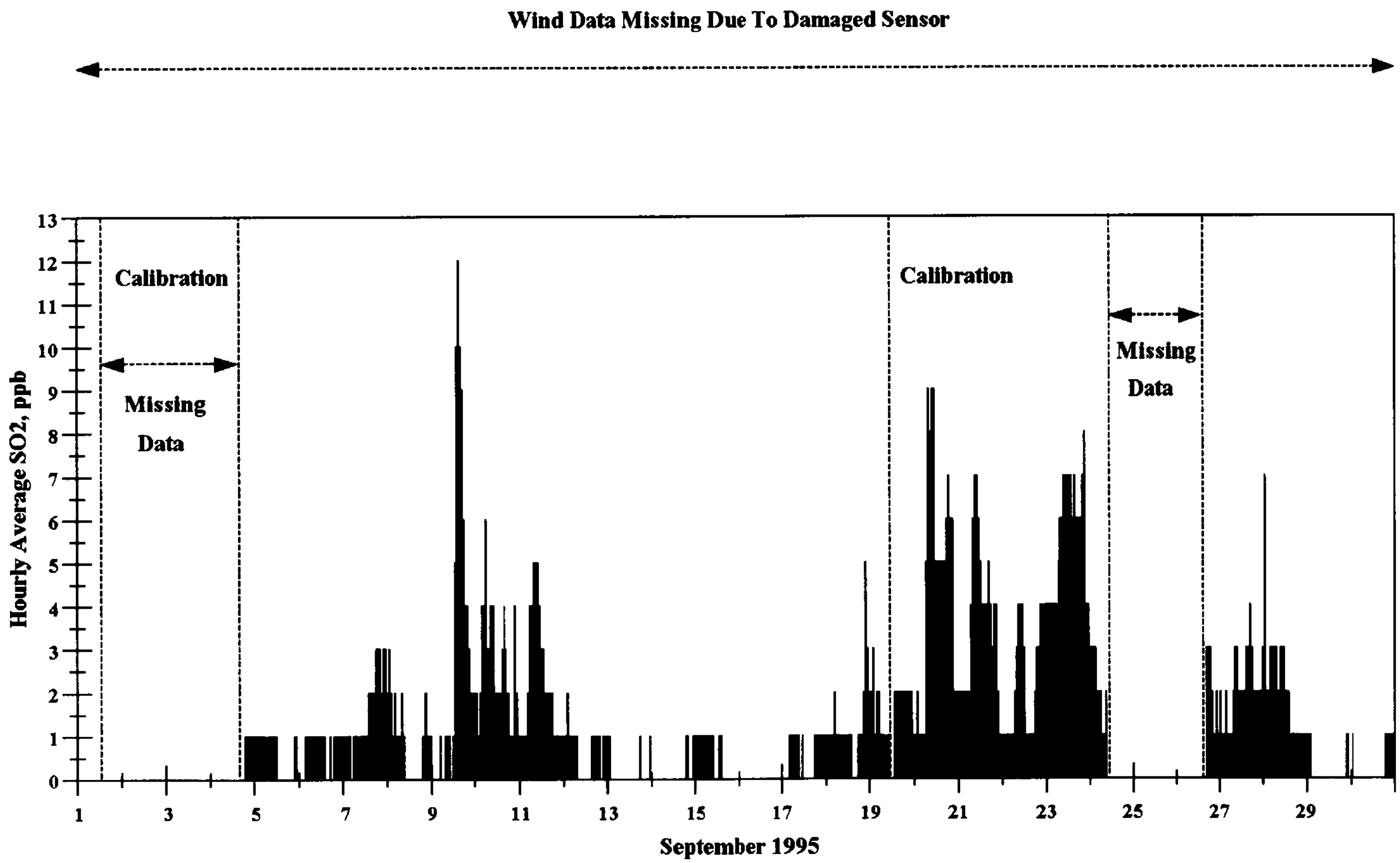


Figure 42. Average SO_2 concentrations (ppb) for September 1995 at Breton Island (wind sensor damaged).

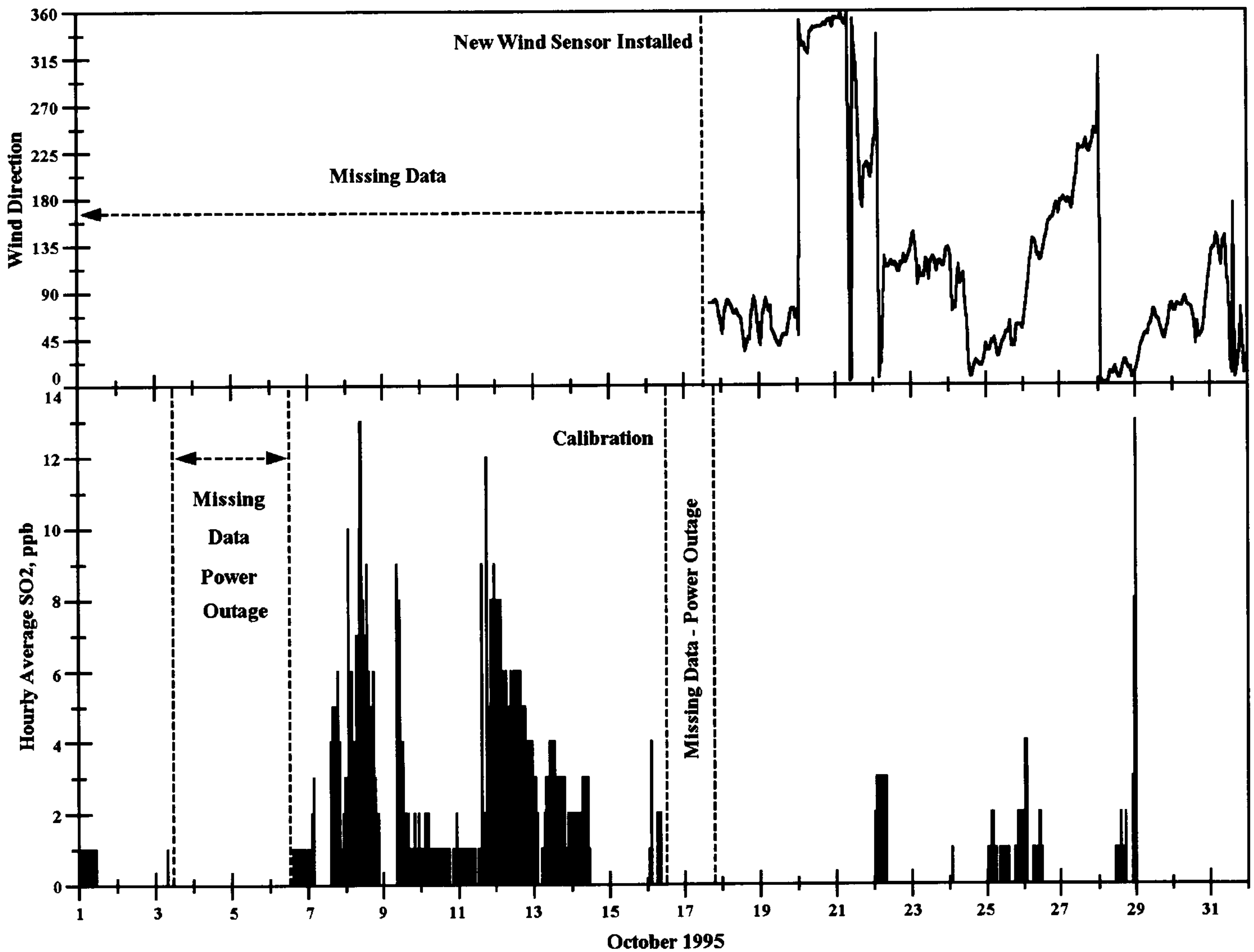


Figure 43. Average SO_2 concentrations (ppb) and wind direction for October 1995 at Breton Island.

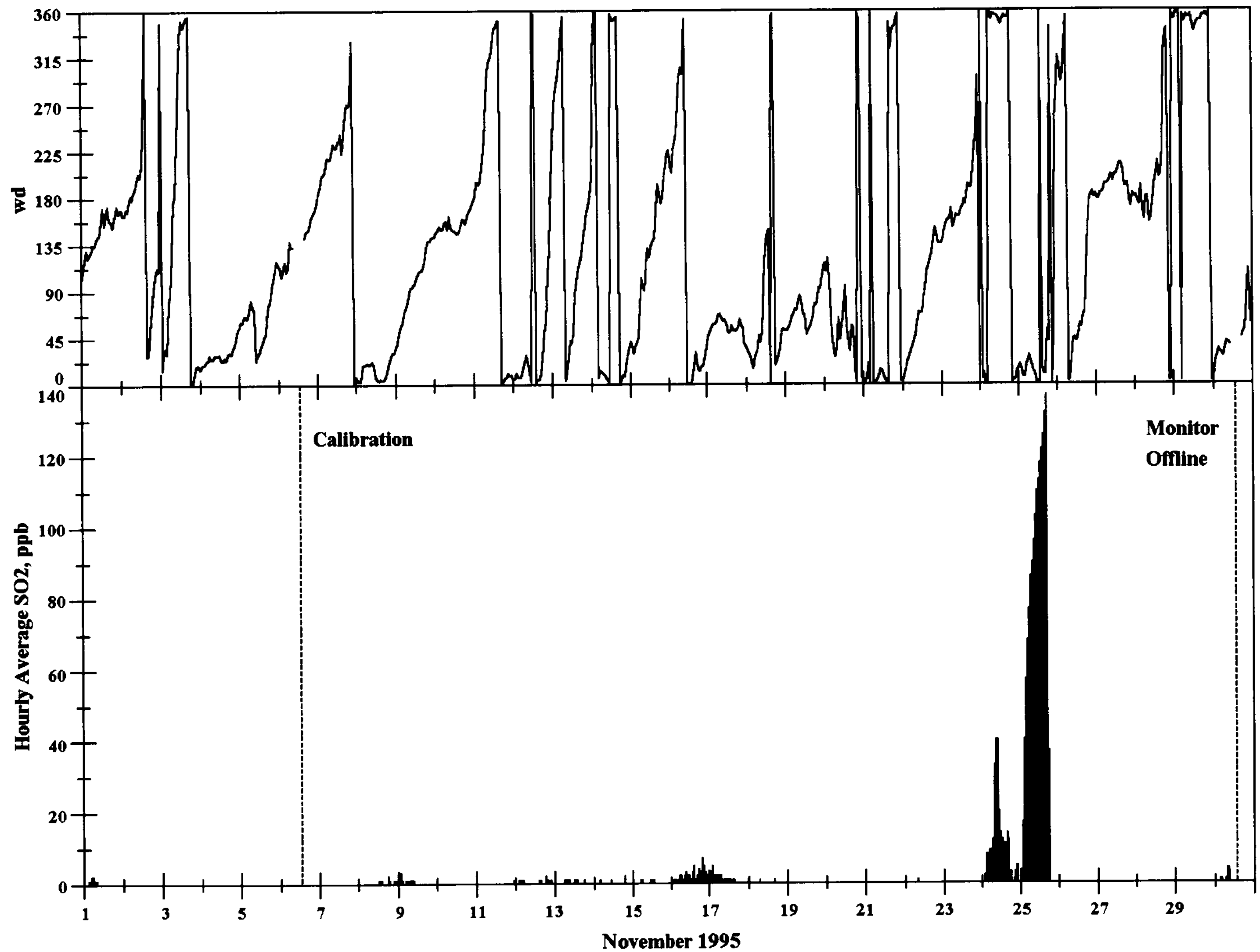


Figure 44. Average SO_2 concentrations (ppb) and wind direction for November 1995 at Breton Island.

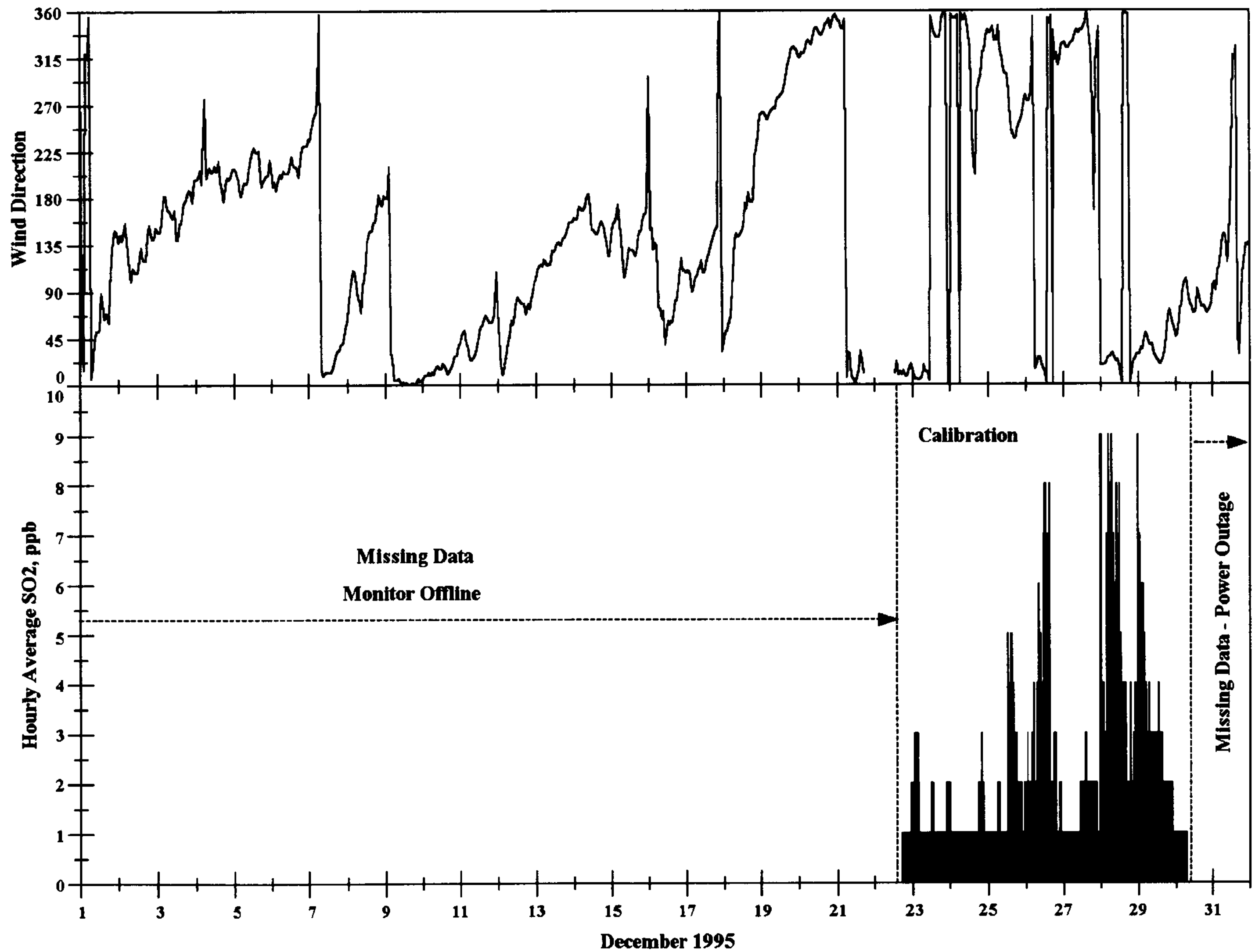


Figure 45. Average SO_2 concentrations (ppb) and wind direction for December 1995 at Breton Island.

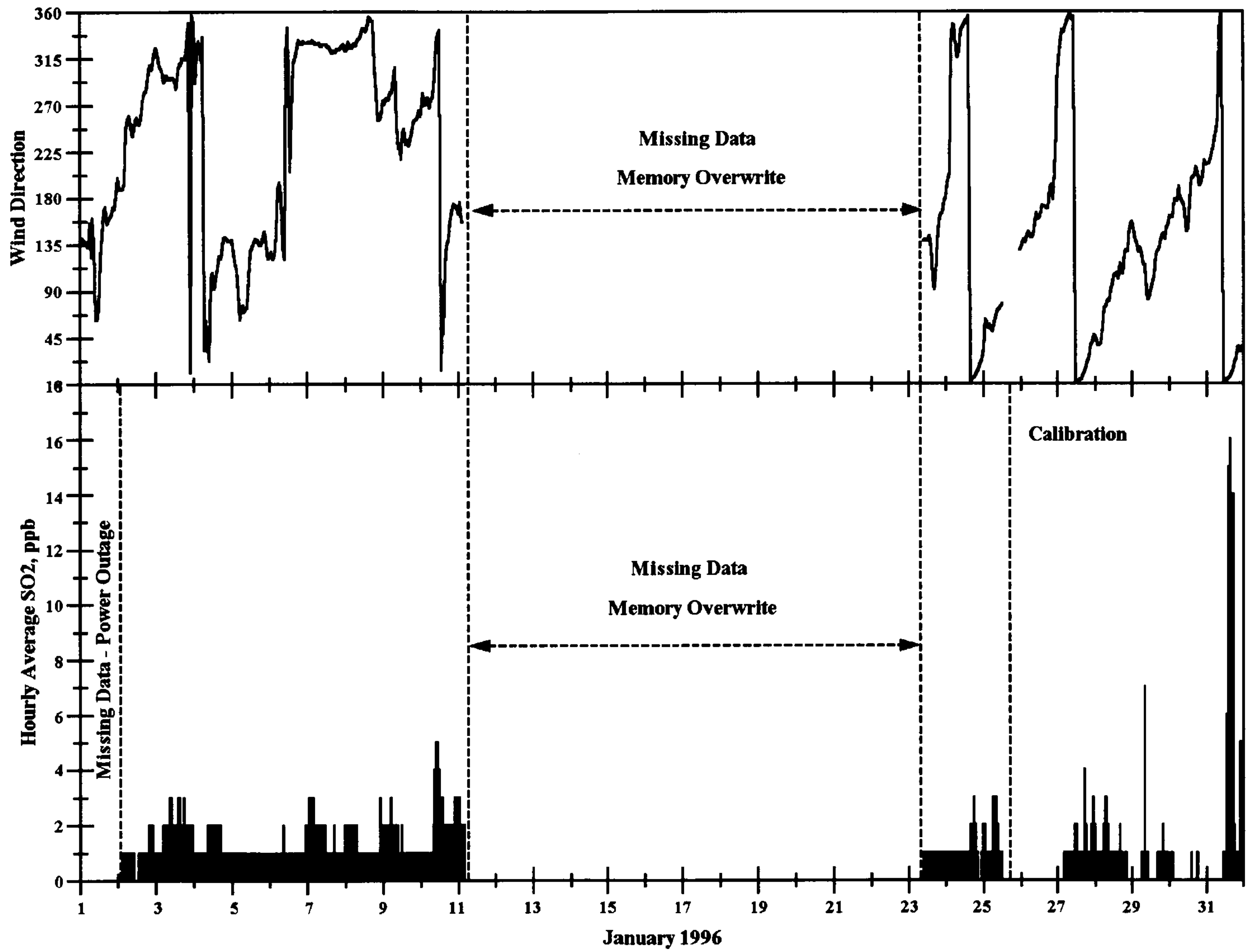


Figure 46. Average SO_2 concentrations (ppb) and wind direction for January 1996 at Breton Island.

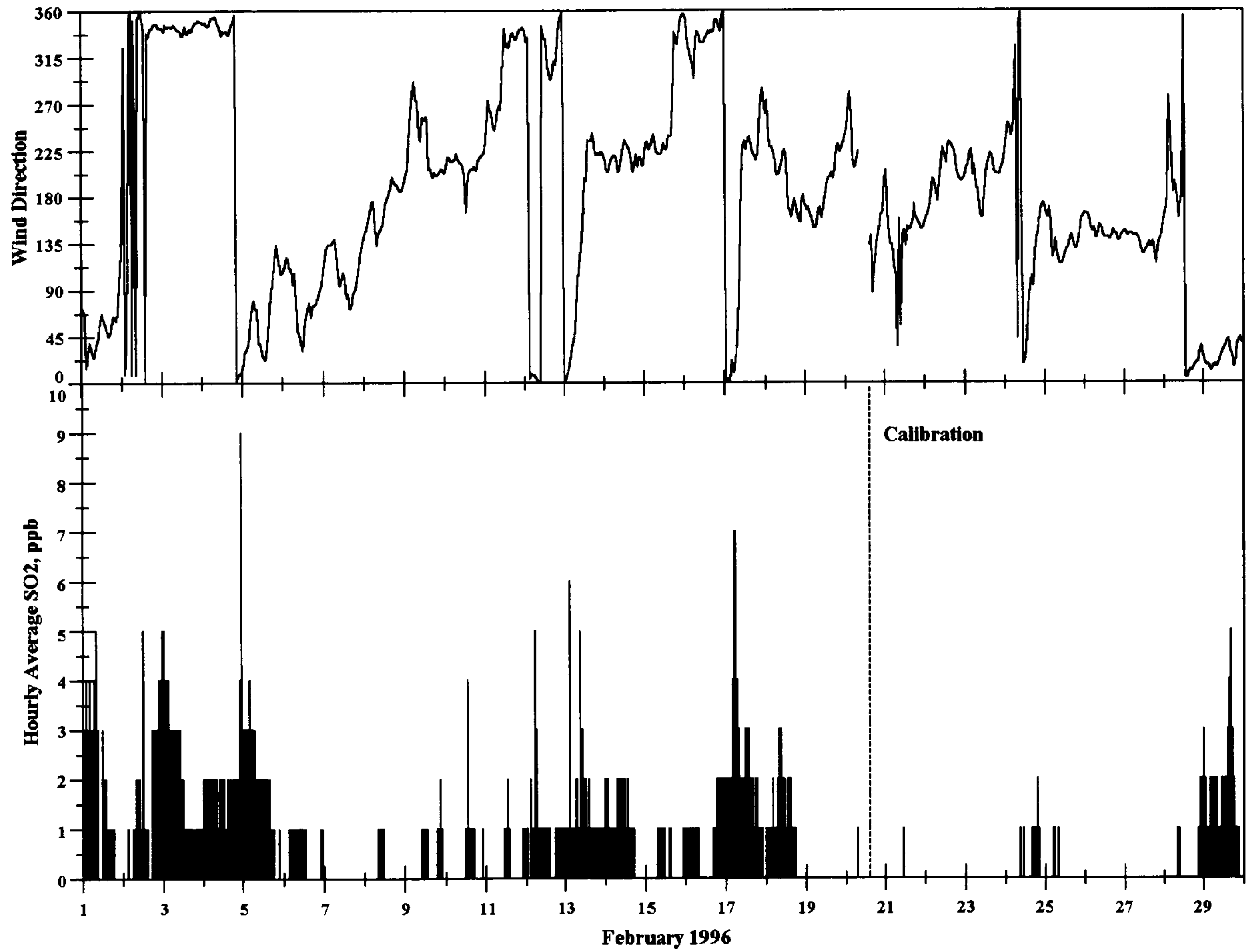


Figure 47. Average SO_2 concentrations (ppb) and wind direction for February 1996 at Breton Island.

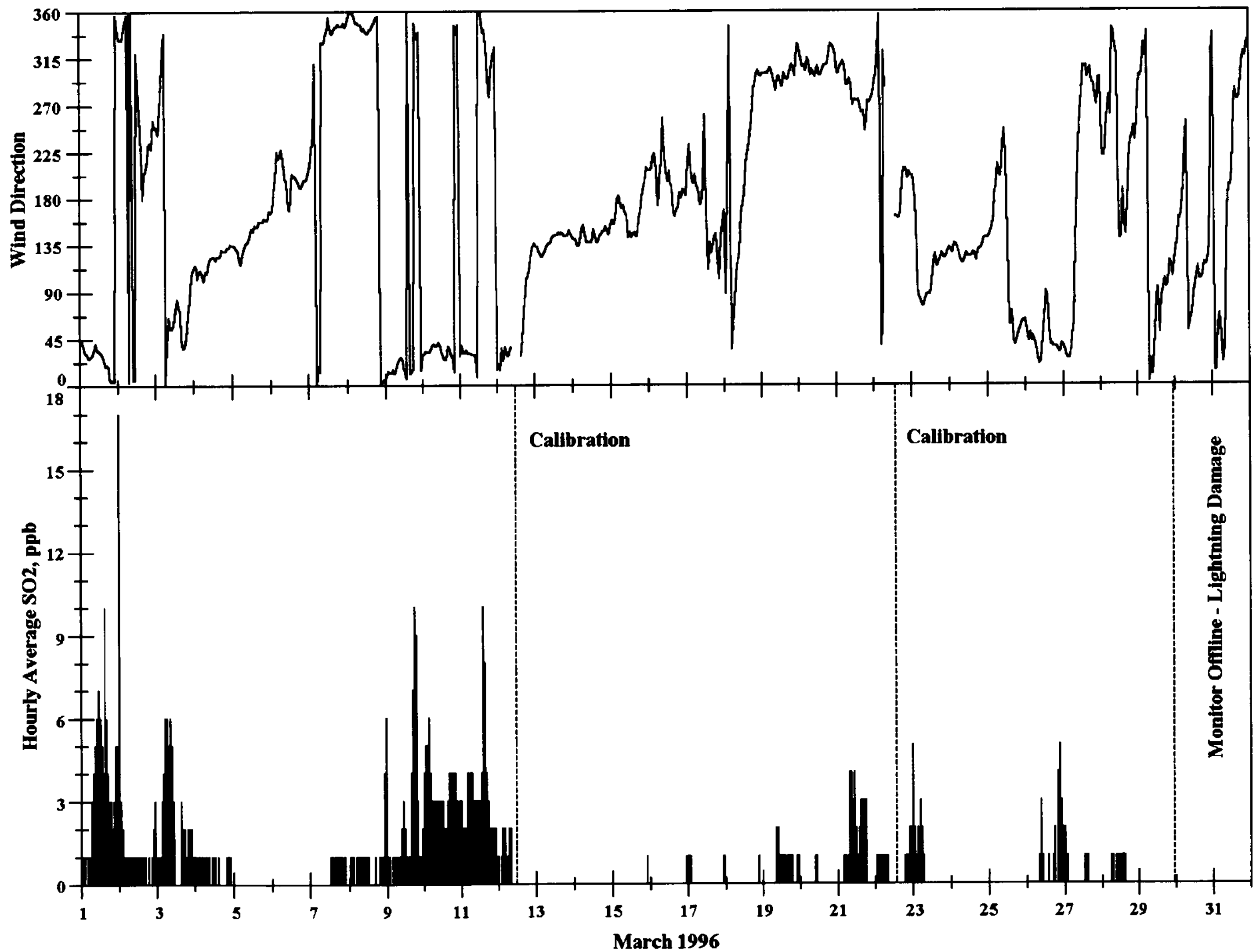


Figure 48. Average SO_2 concentrations (ppb) and wind direction for March 1996 at Breton Island.

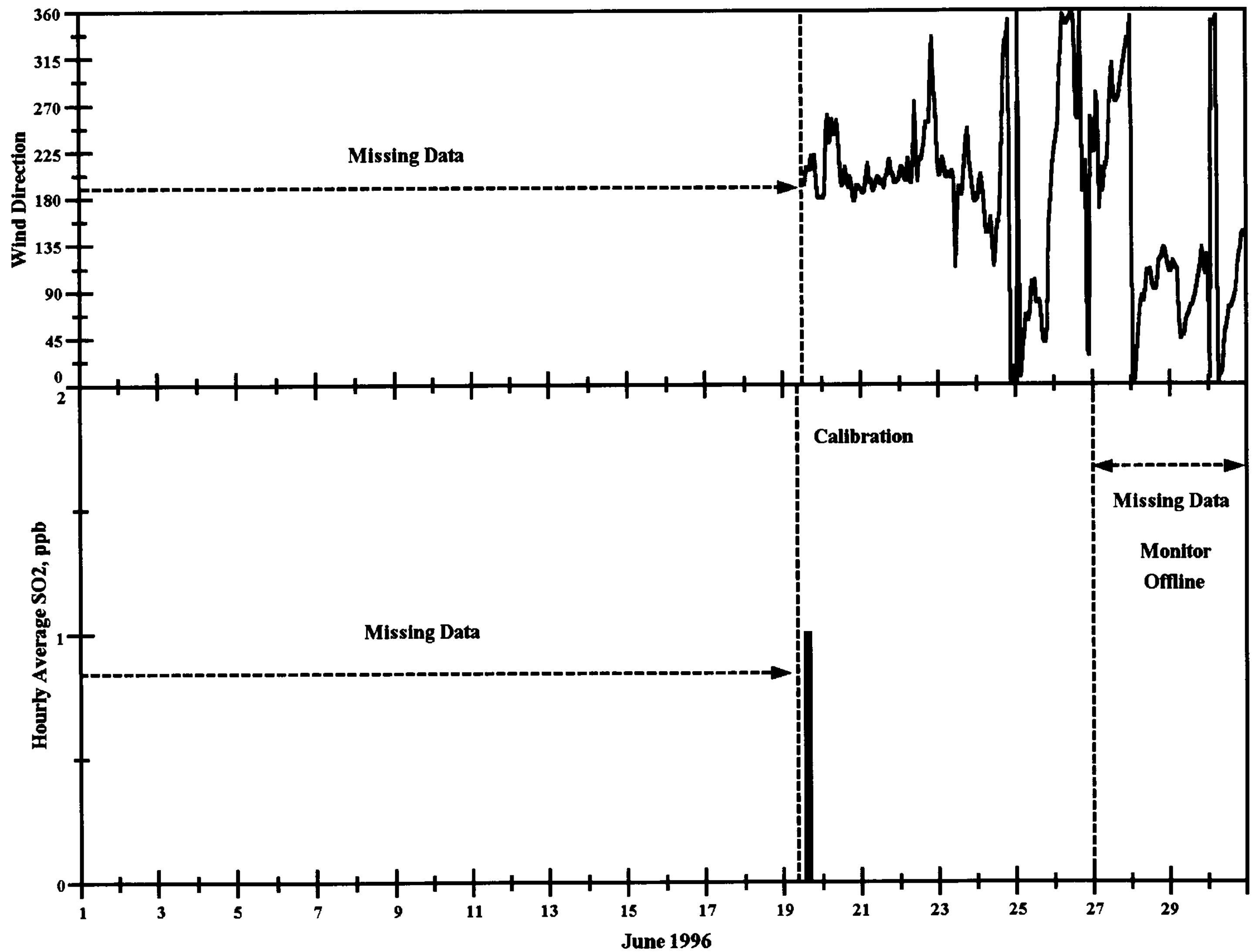


Figure 49. Average SO_2 concentrations (ppb) and wind direction for June 1996 at Breton Island.

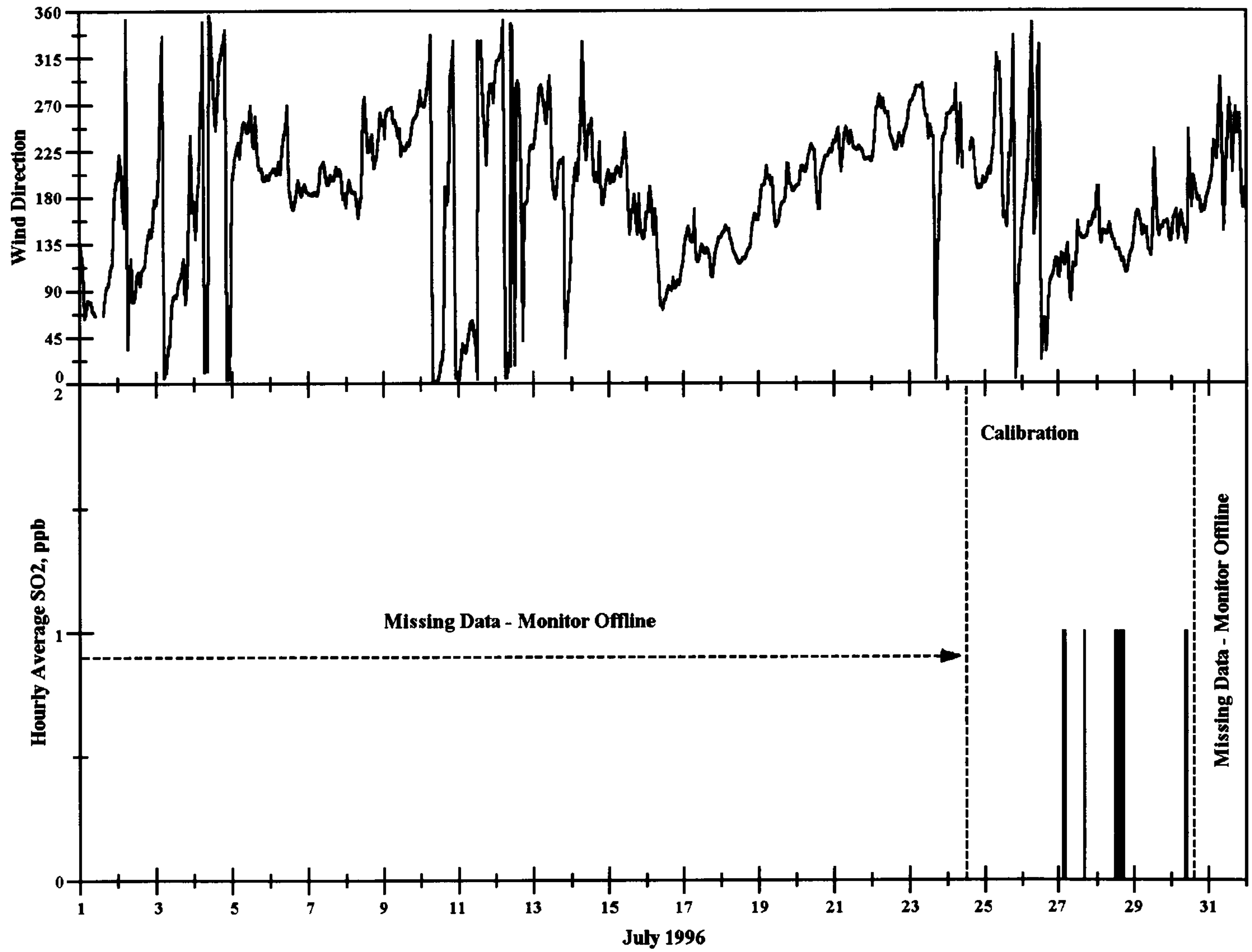


Figure 50. Average SO_2 concentrations (ppb) and wind direction for July 1996 at Breton Island.

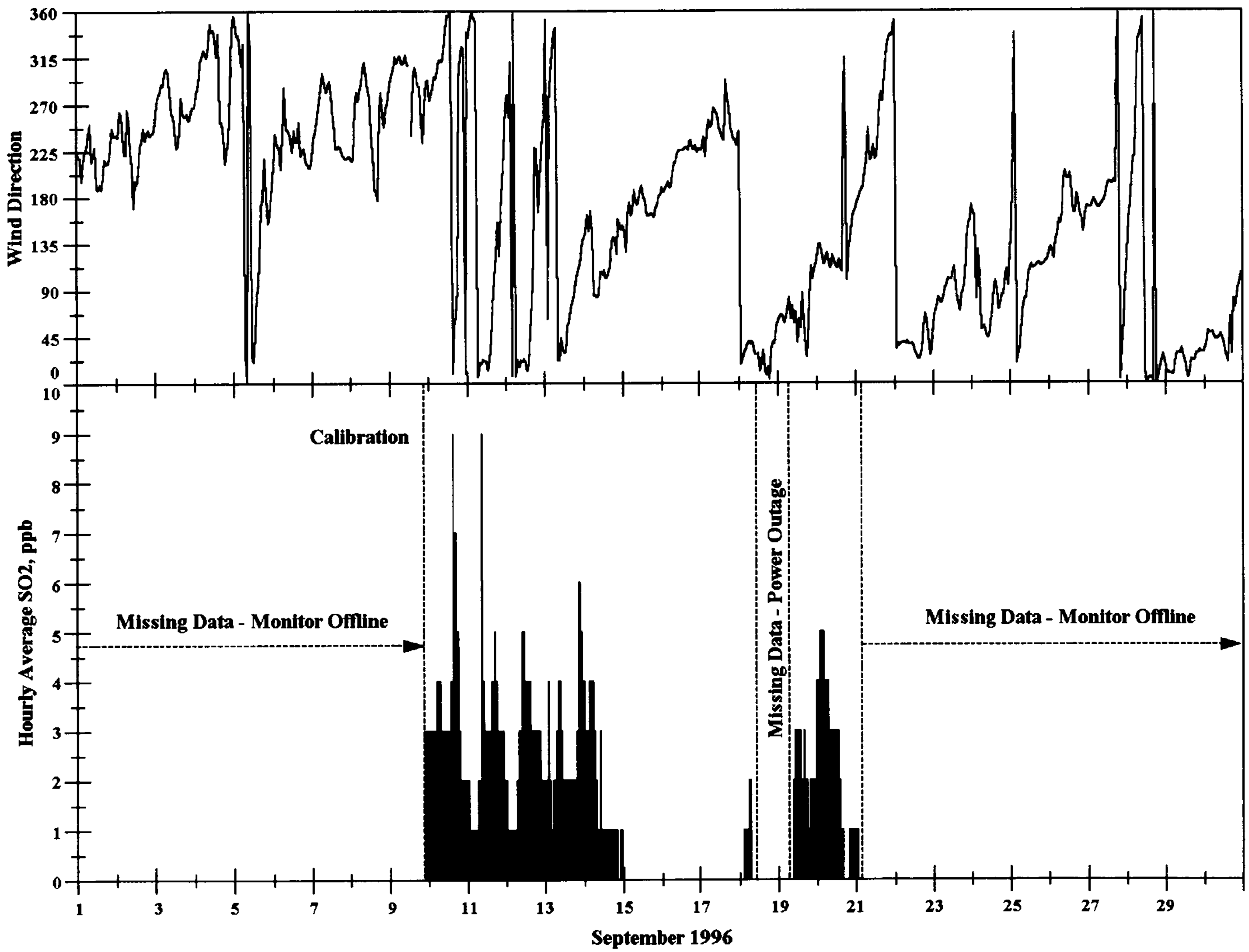


Figure 51. Average SO_2 concentrations (ppb) and wind direction for September 1996 at Breton Island.

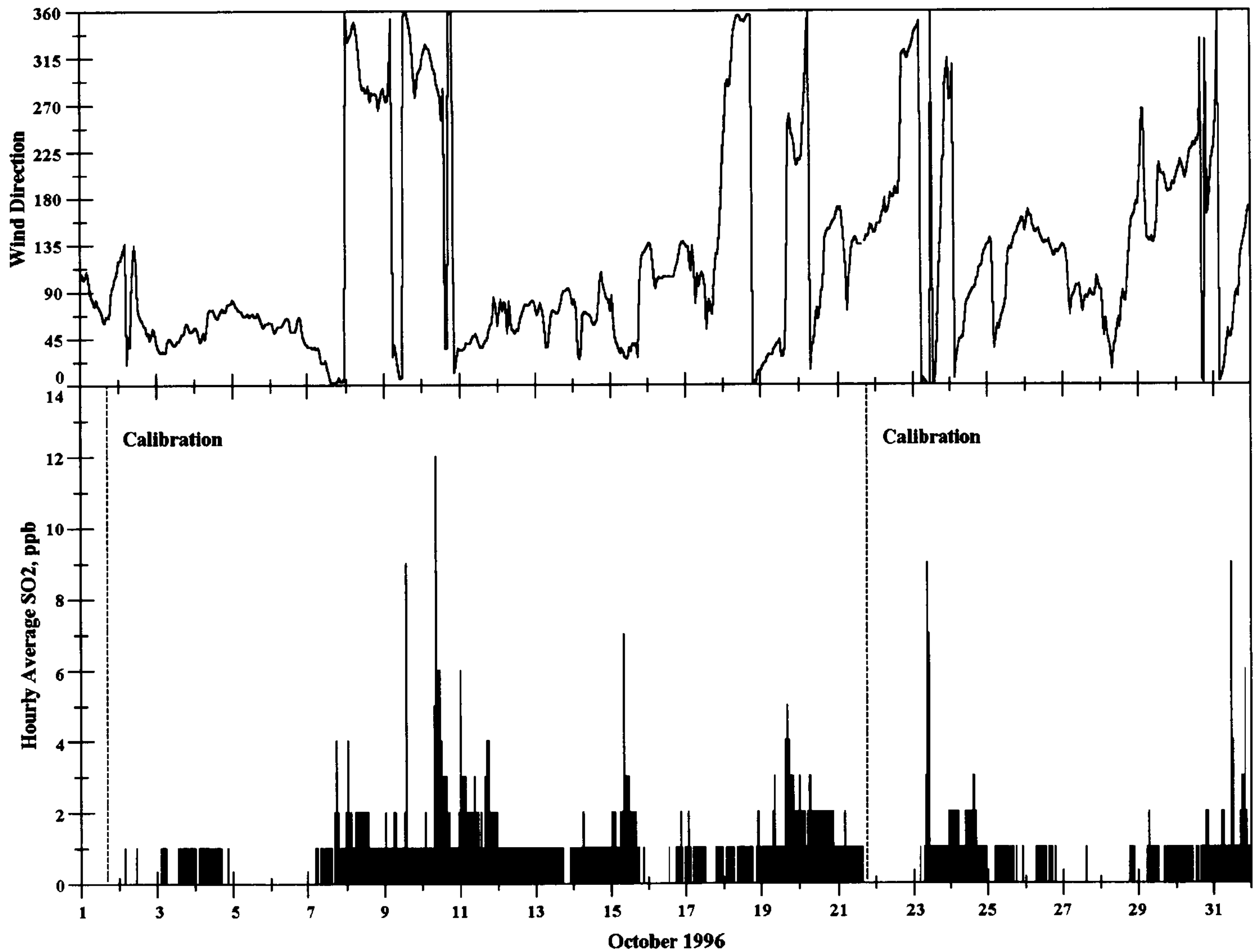


Figure 52. Average SO_2 concentrations (ppb) and wind direction for October 1996 at Breton Island.

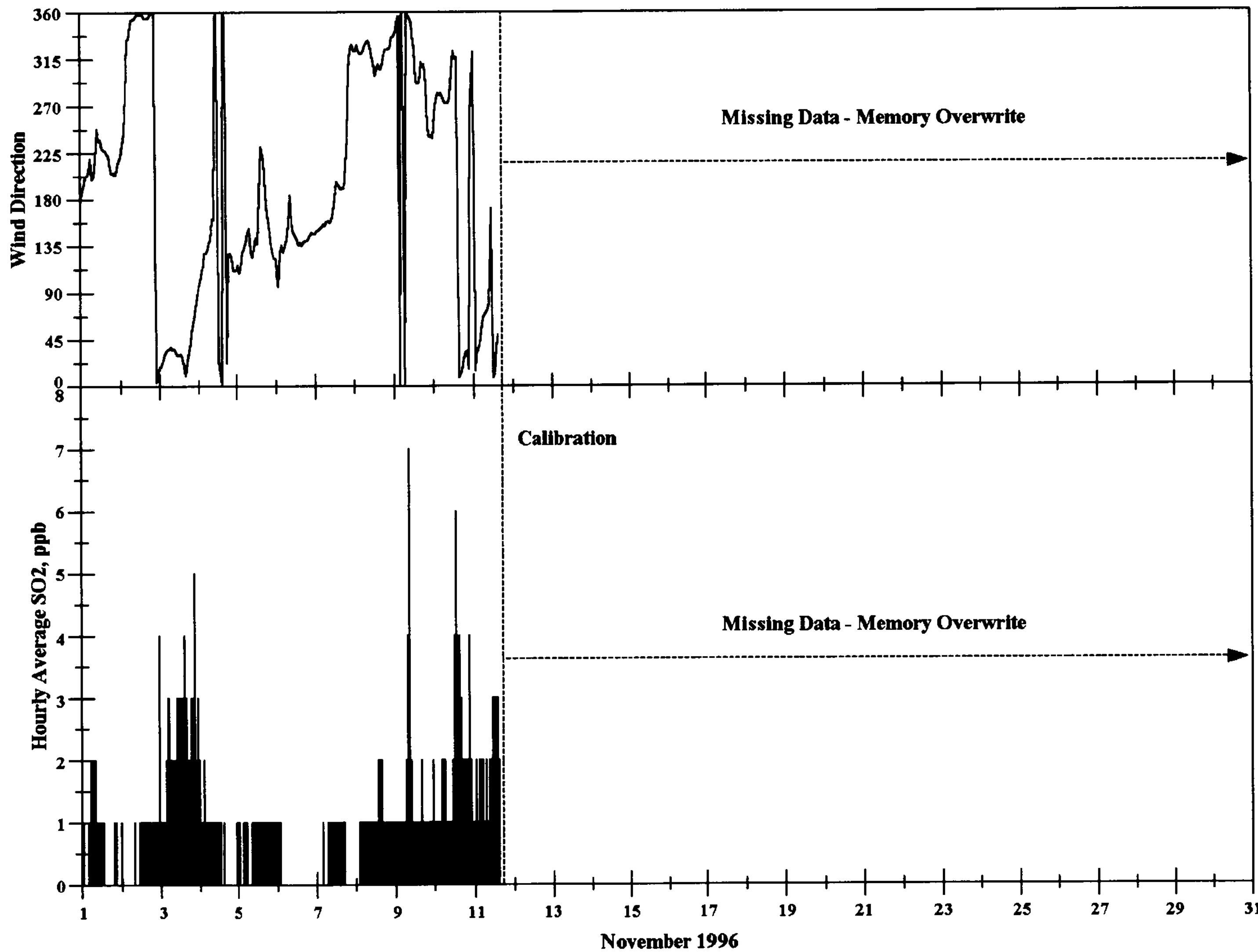


Figure 53. Average SO_2 concentrations (ppb) and wind direction for November 1996 at Breton Island.

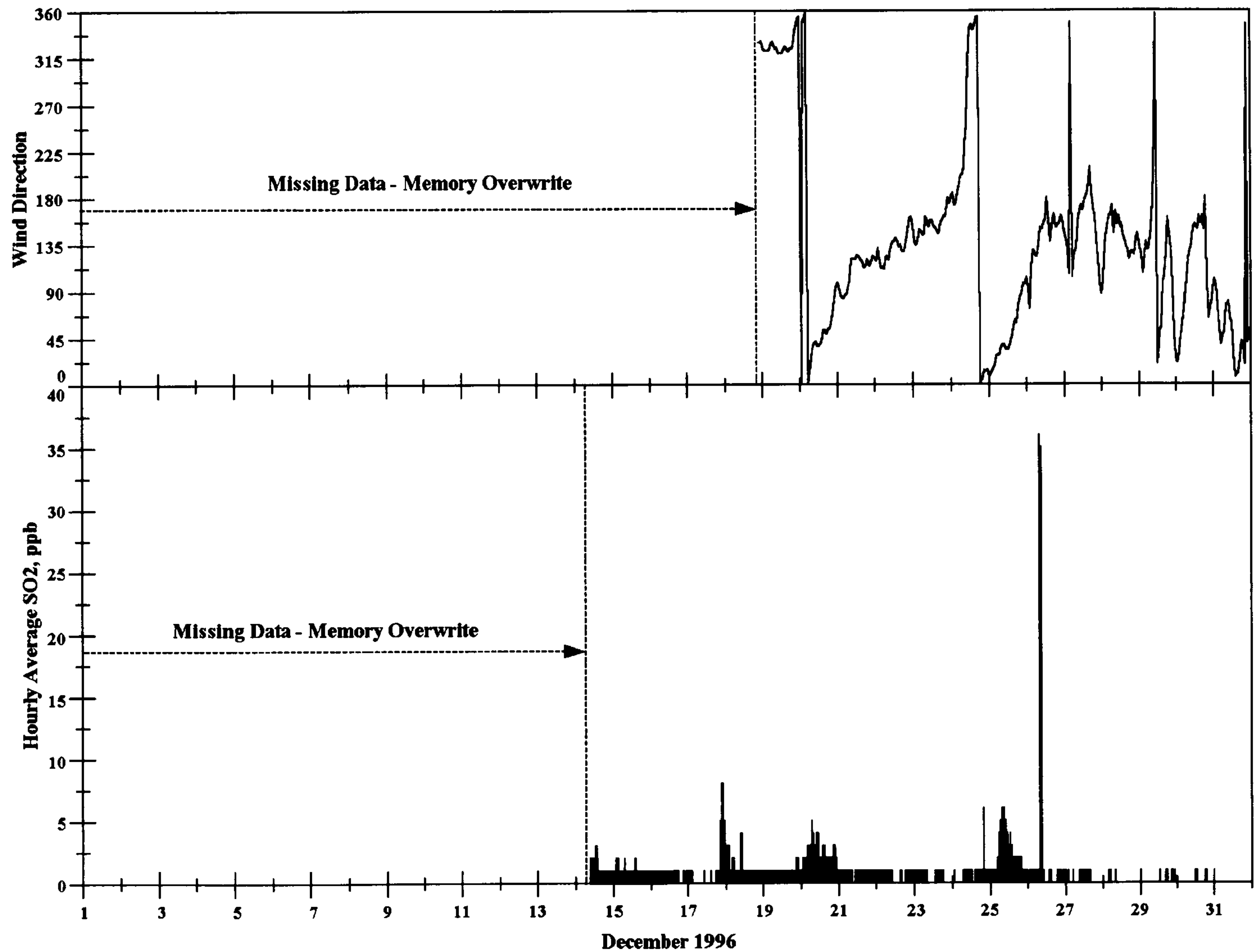


Figure 54. Average SO_2 concentrations (ppb) and wind direction for December 1996 at Breton Island.

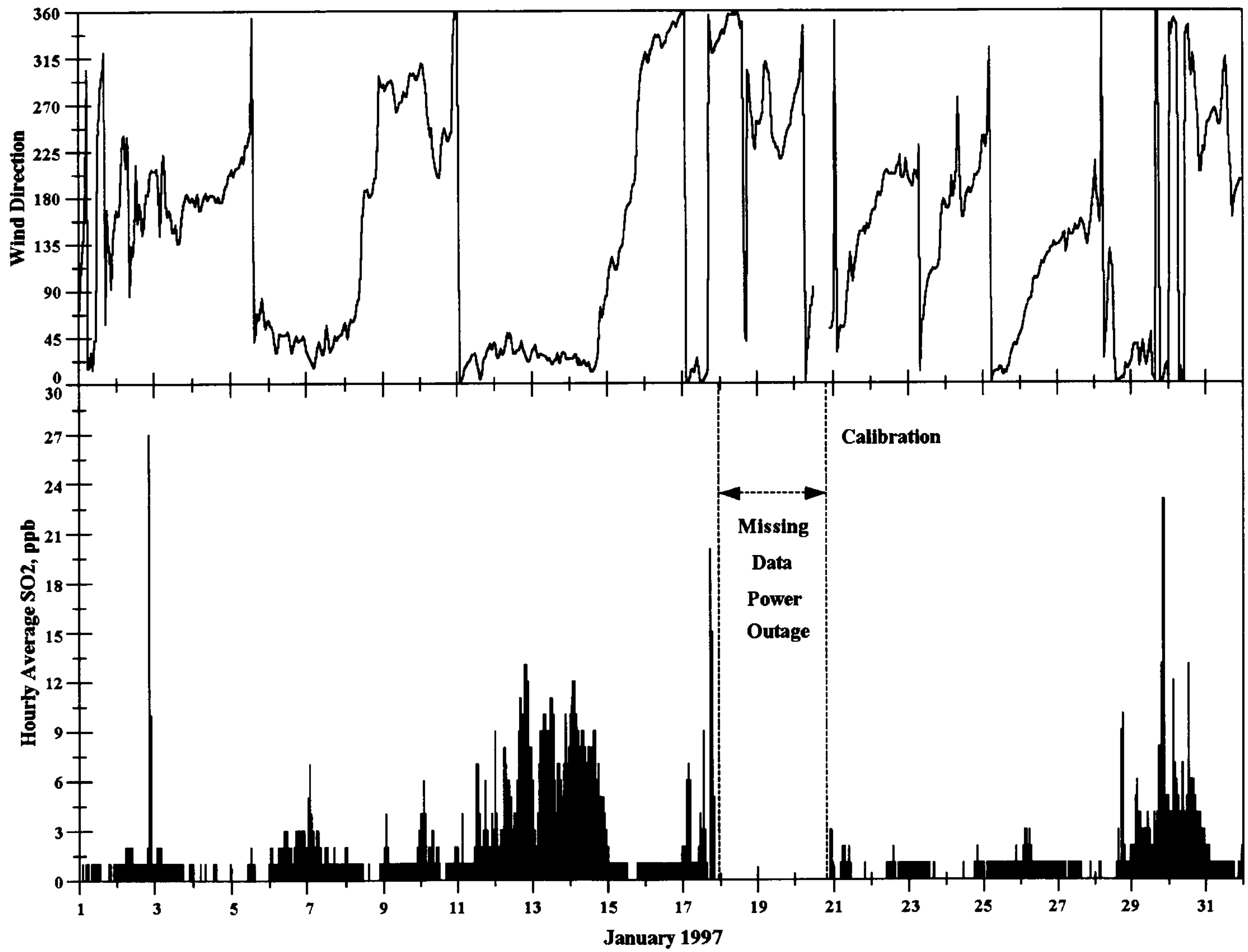


Figure 55. Average SO_2 concentrations (ppb) and wind direction for January 1997 at Breton Island.

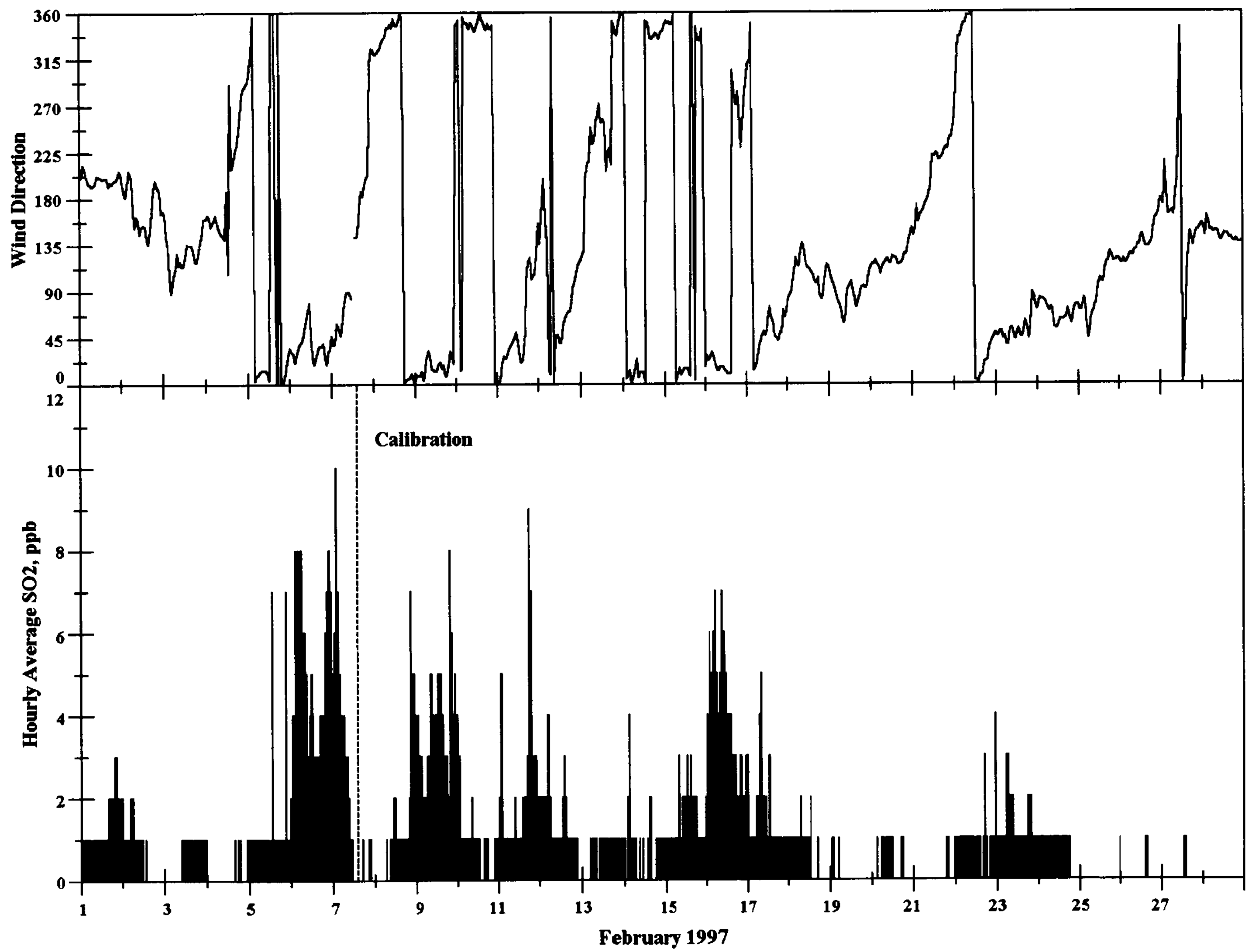


Figure 56. Average SO_2 concentrations (ppb) and wind direction for February 1997 at Breton Island.

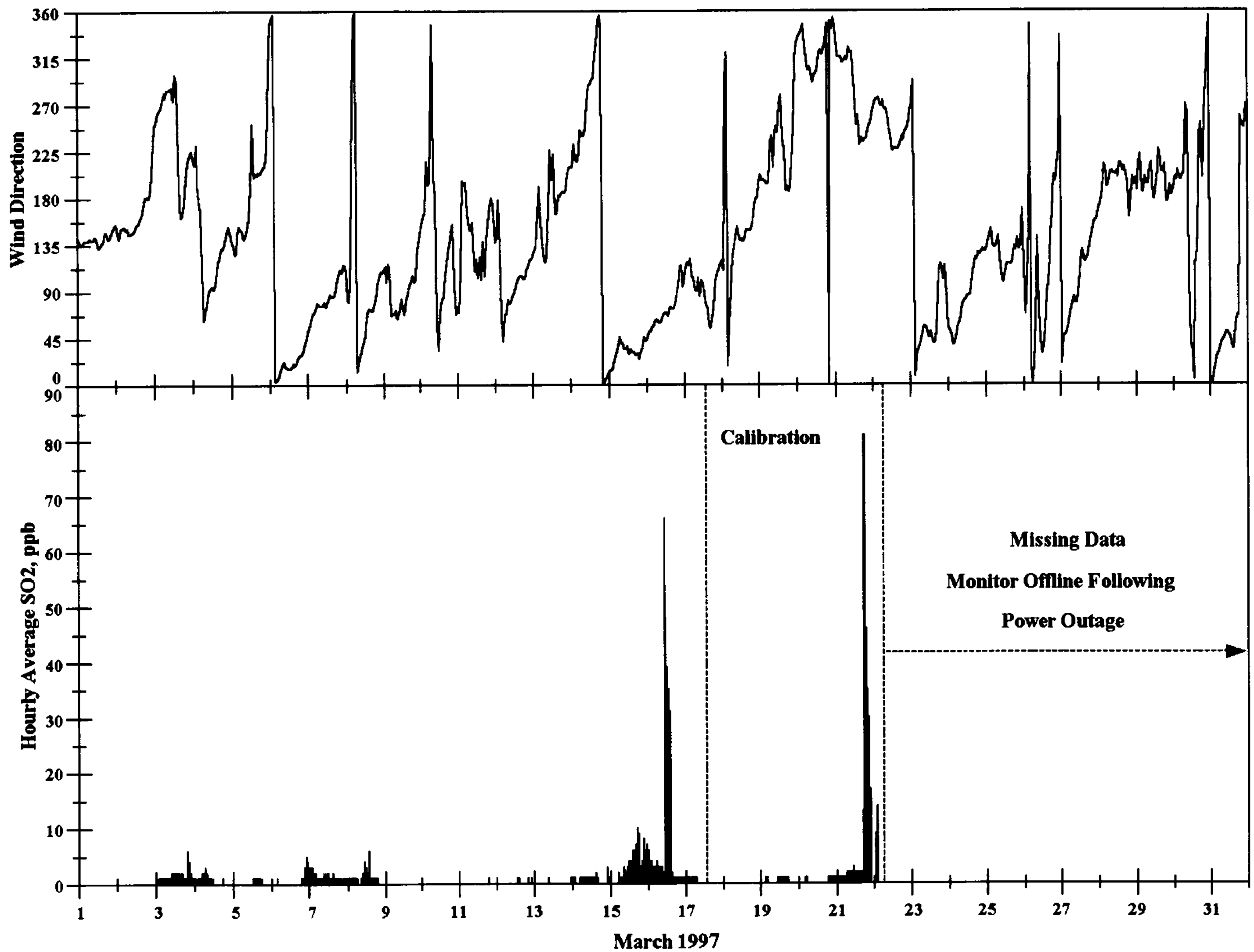


Figure 57. Average SO_2 concentrations (ppb) and wind direction for March 1997 at Breton Island.

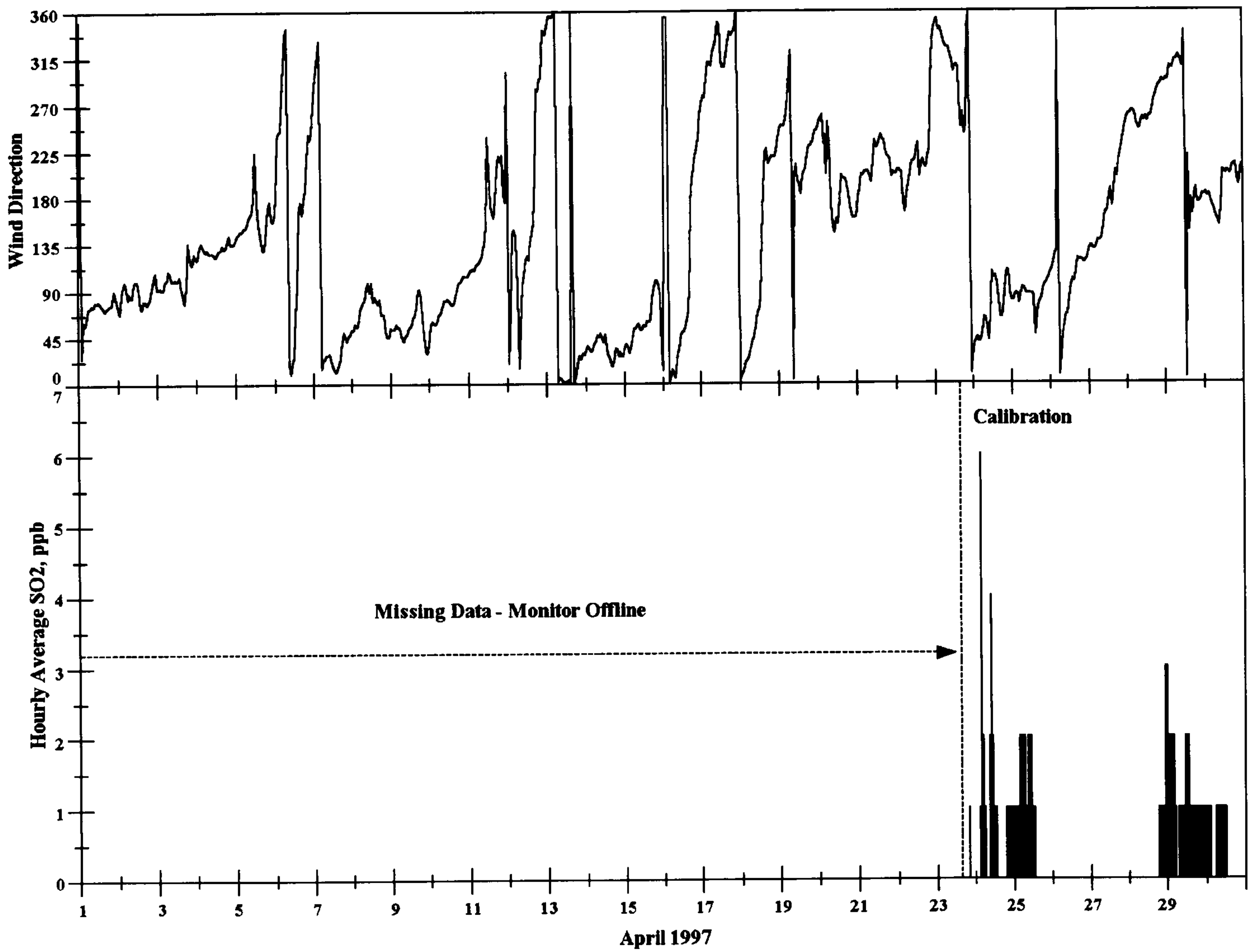


Figure 58. Average SO_2 concentrations (ppb) and wind direction for April 1997 at Breton Island.

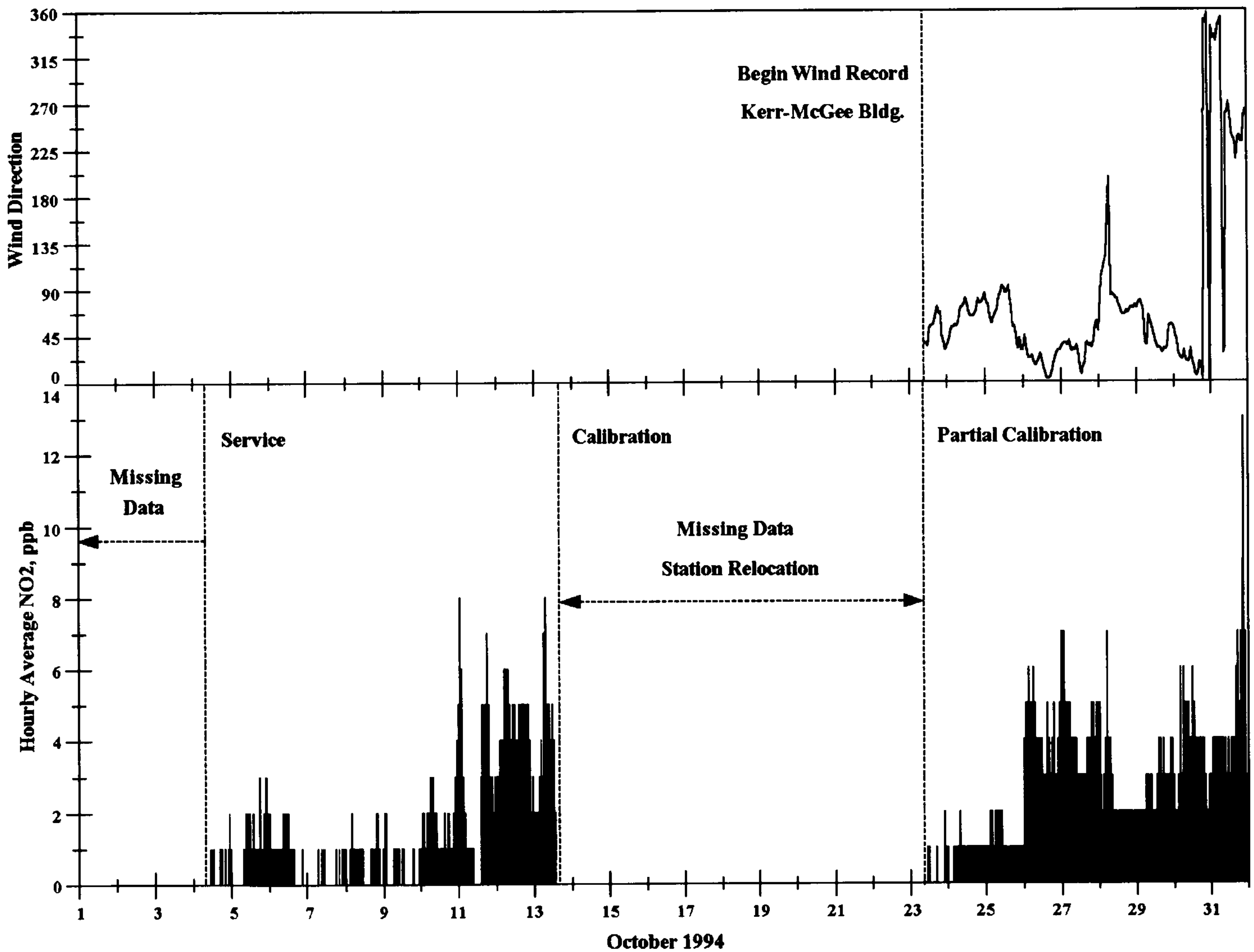


Figure 59. Average NO_2 concentrations (ppb) and wind direction for October 1994 at Breton Island.

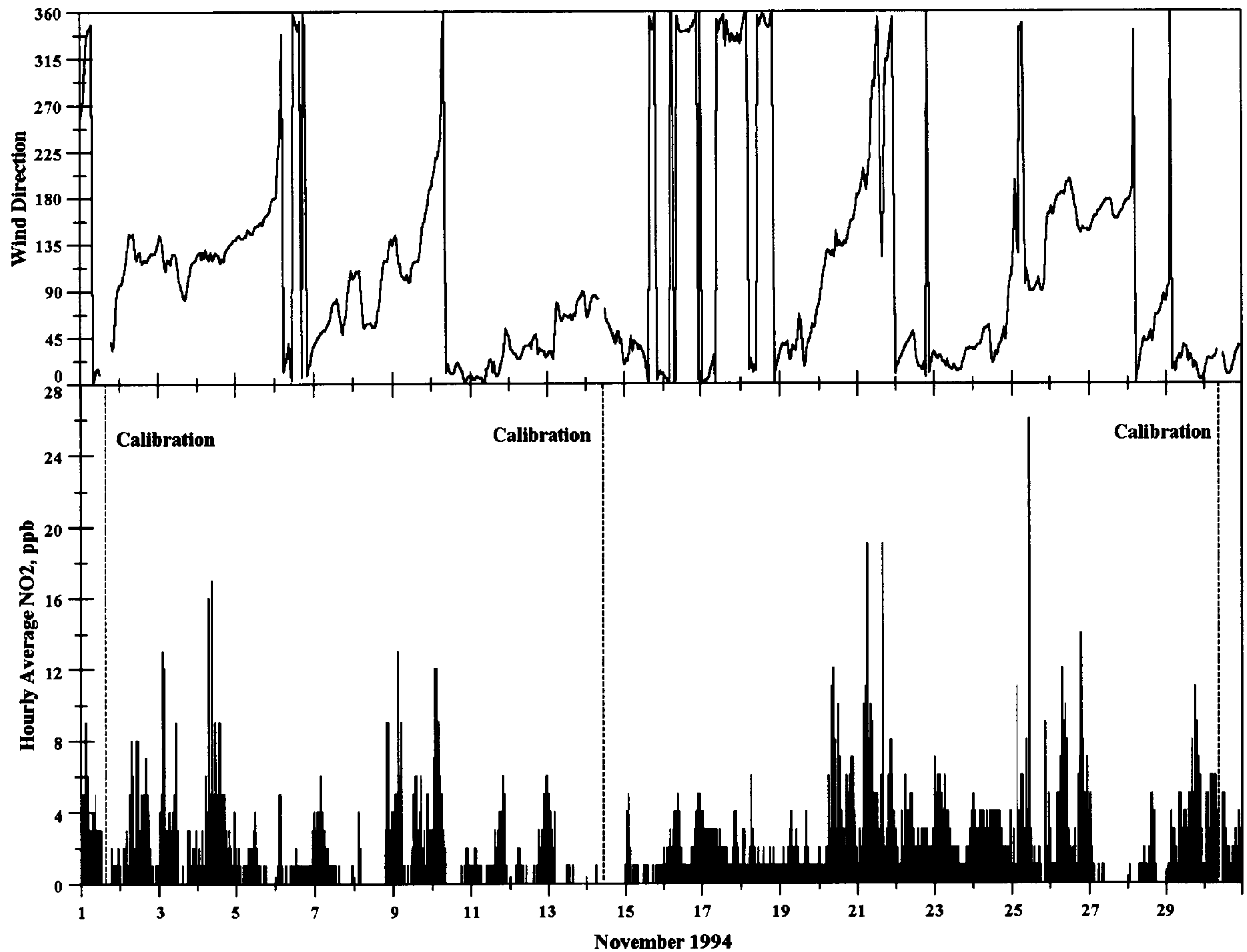


Figure 60. Average NO_2 concentrations (ppb) and wind direction for November 1994 at Breton Island.

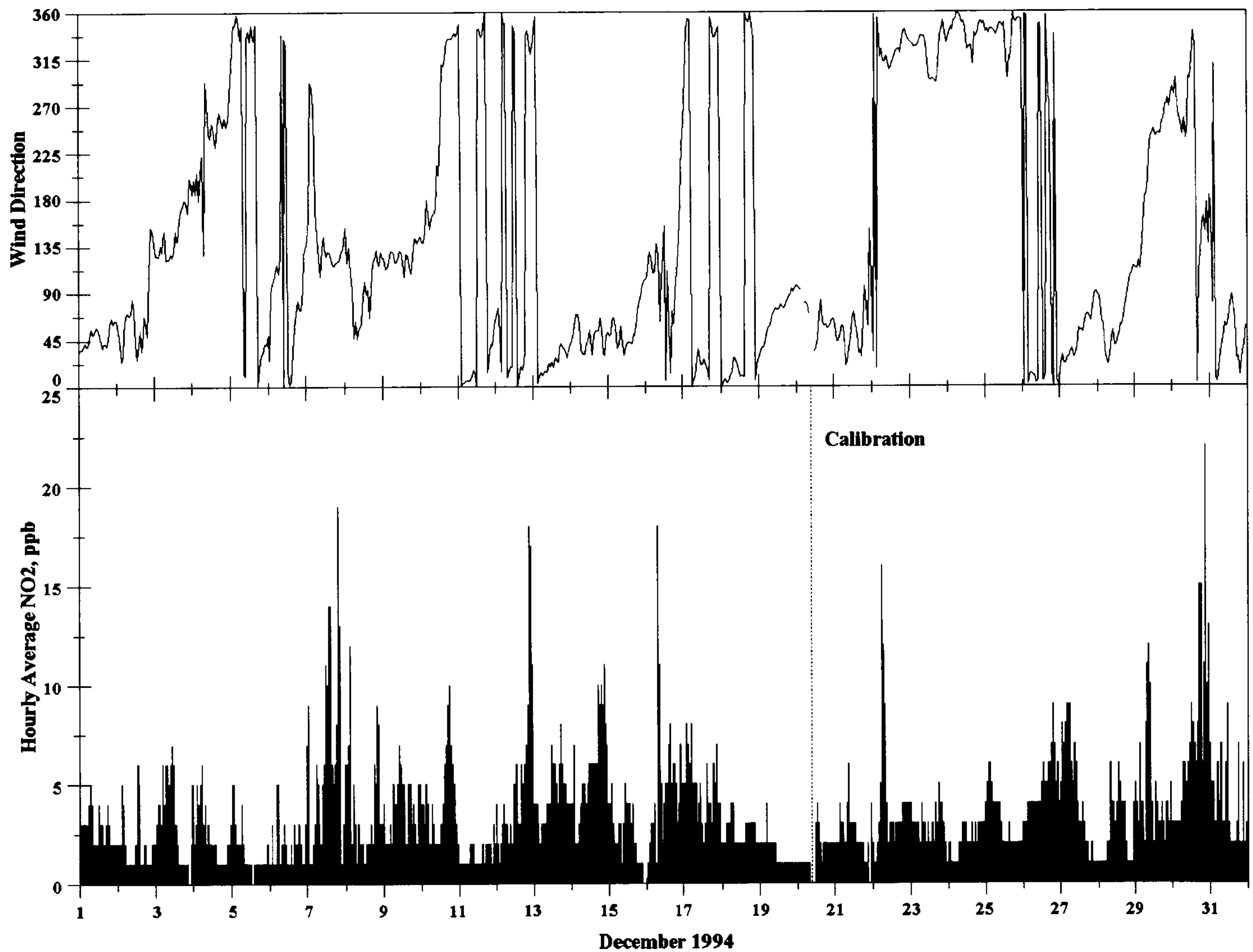


Figure 61. Average NO_2 concentrations (ppb) and wind direction for December 1994 at Breton Island.

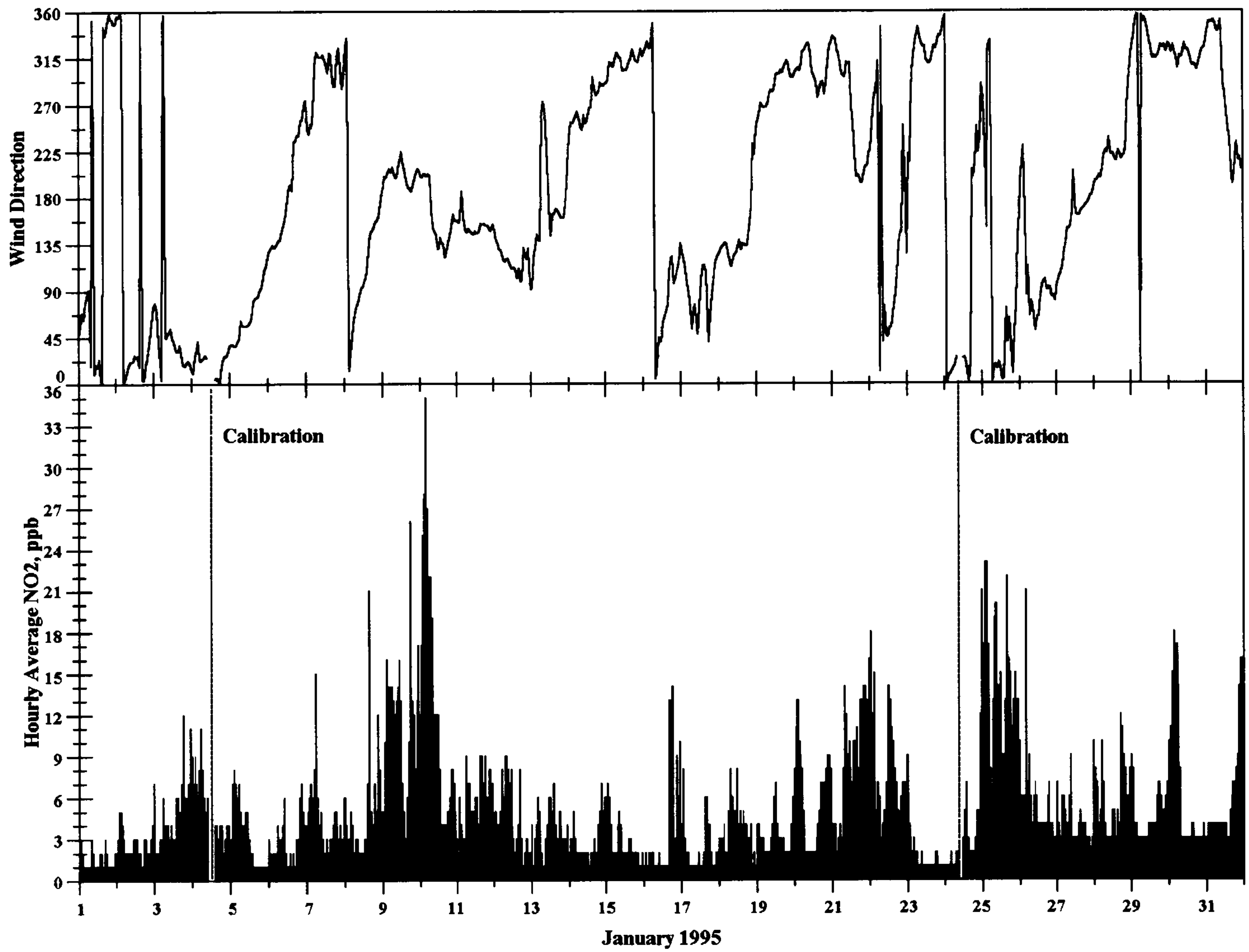


Figure 62. Average NO_2 concentrations (ppb) and wind direction for January 1995 at Breton Island.

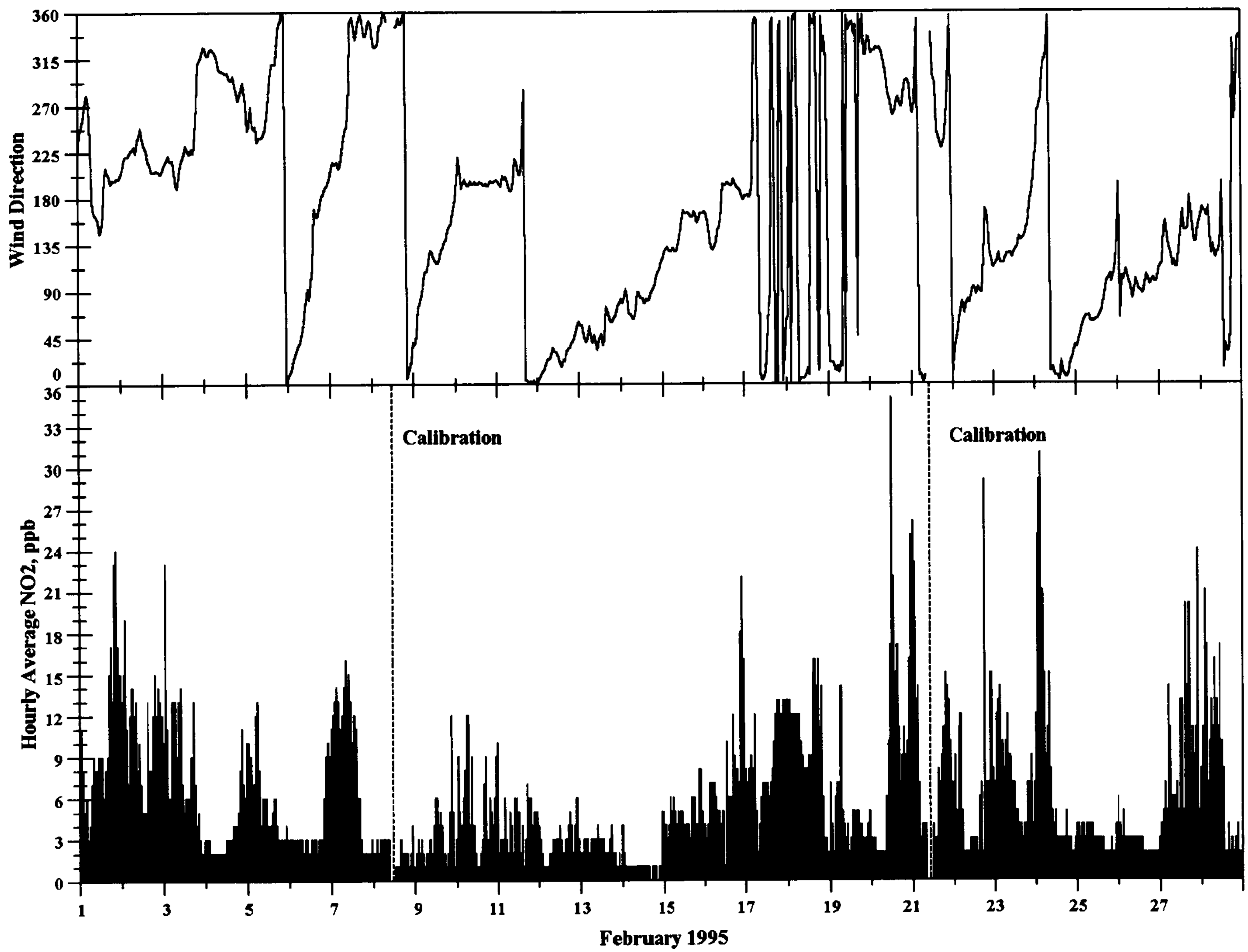


Figure 63. Average NO_2 concentrations (ppb) and wind direction for February 1995 at Breton Island.

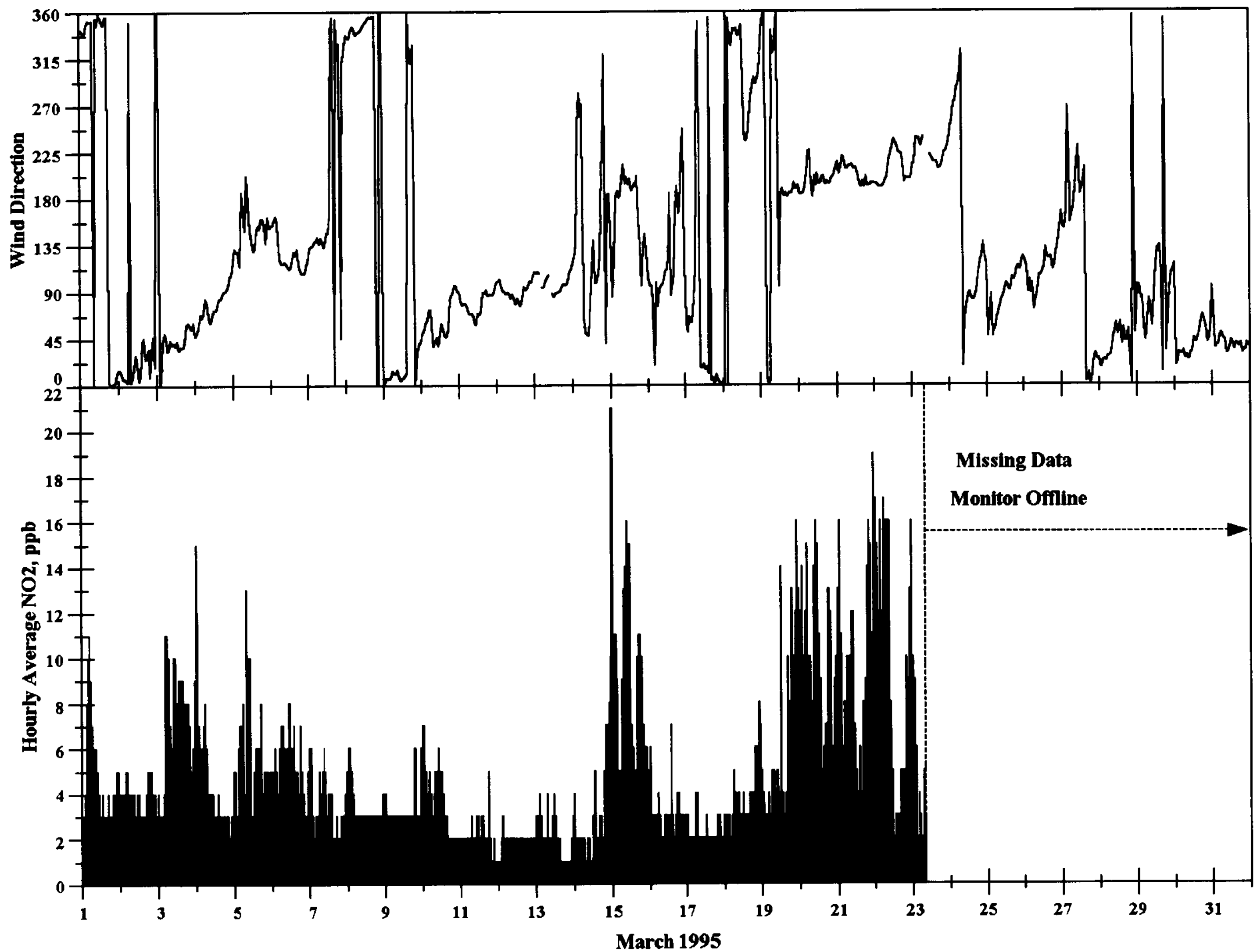


Figure 64. Average NO_2 concentrations (ppb) and wind direction for March 1995 at Breton Island.

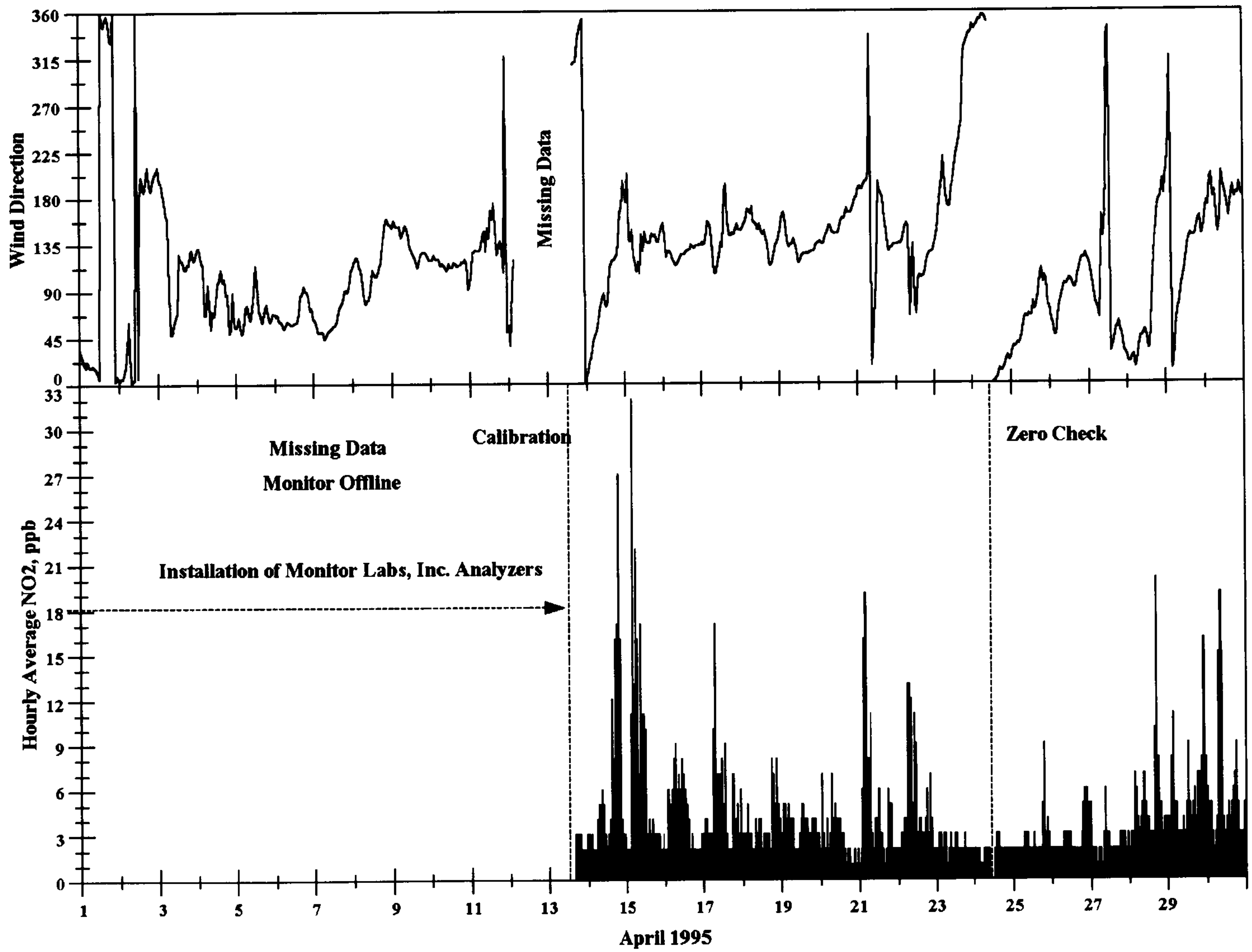


Figure 65. Average NO_2 concentrations (ppb) and wind direction for April 1995 at Breton Island.

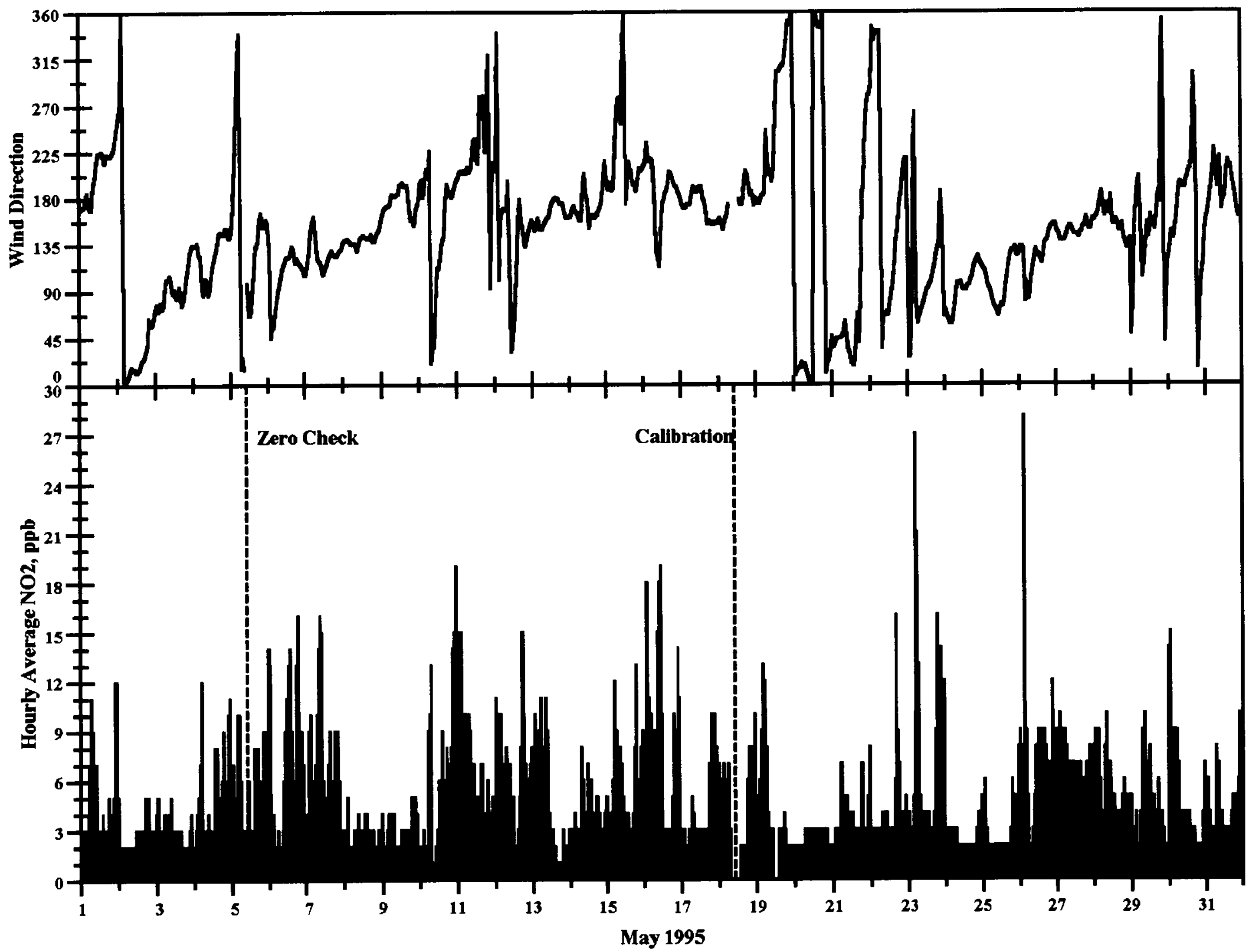


Figure 66. Average NO_2 concentrations (ppb) and wind direction for May 1995 at Breton Island.

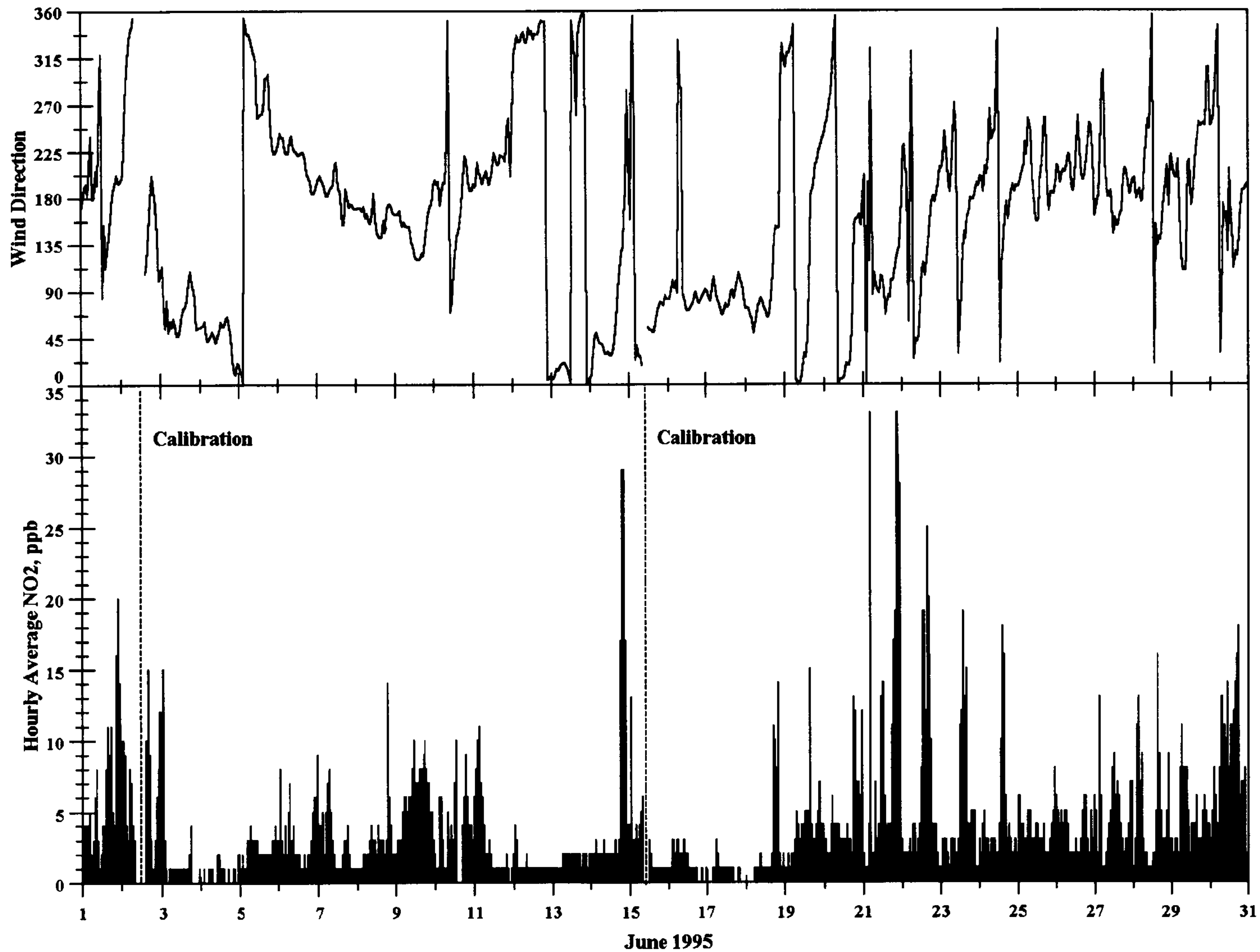


Figure 67. Average NO_2 concentrations (ppb) and wind direction for June 1995 at Breton Island.

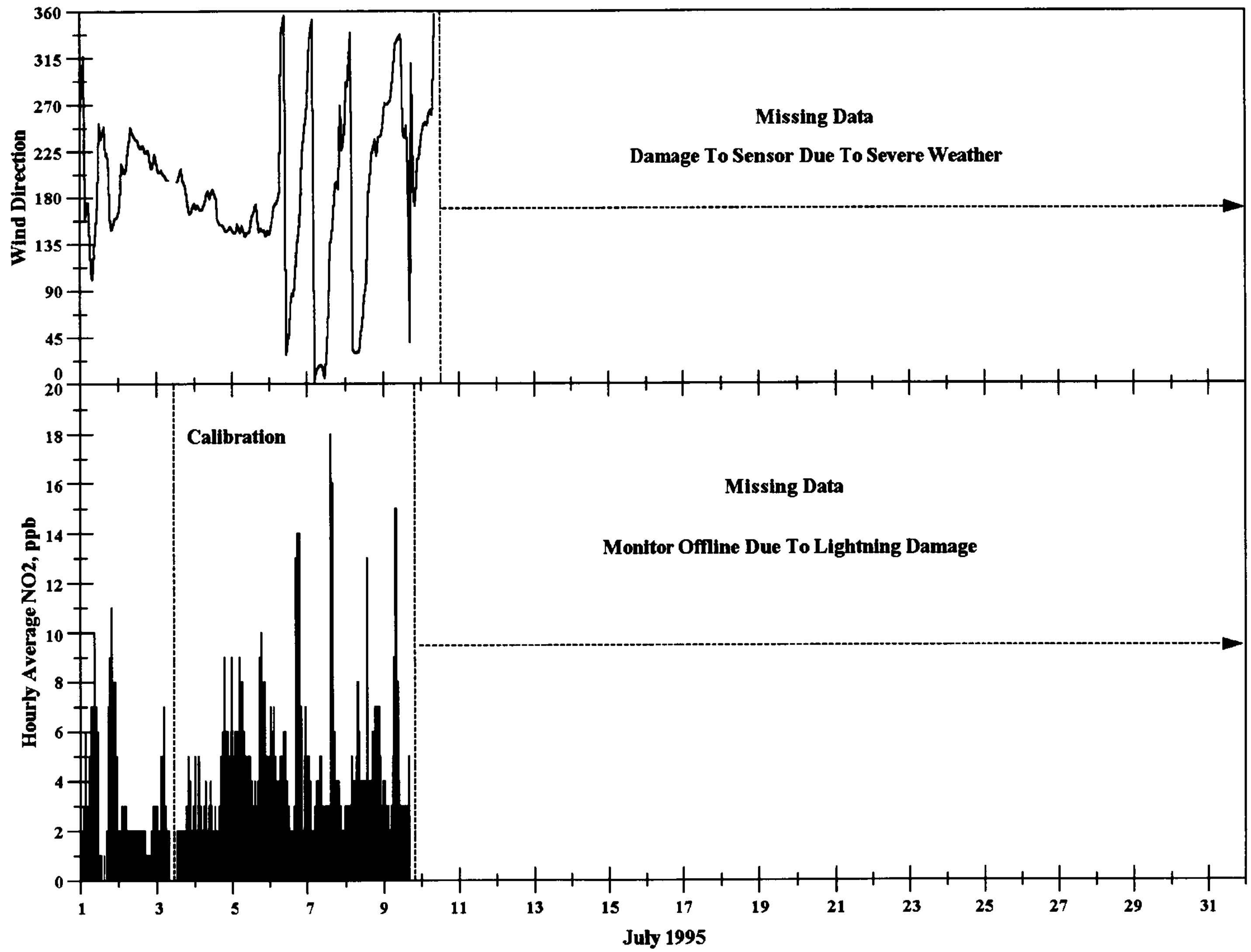


Figure 68. Average NO_2 concentrations (ppb) and wind direction for July 1995 at Breton Island.

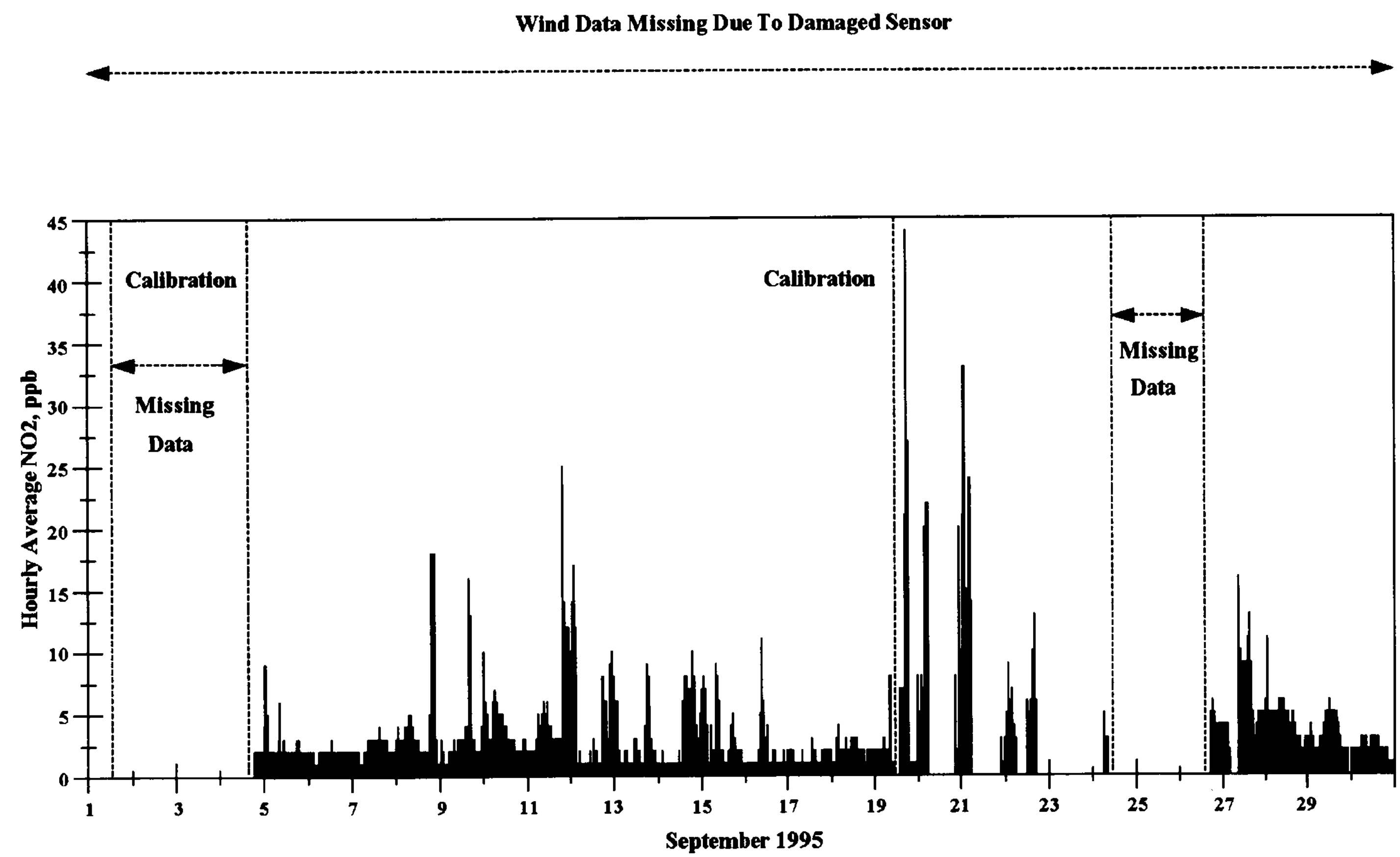


Figure 69. Average NO_2 concentrations (ppb) for September 1995 at Breton Island (wind sensor damaged).

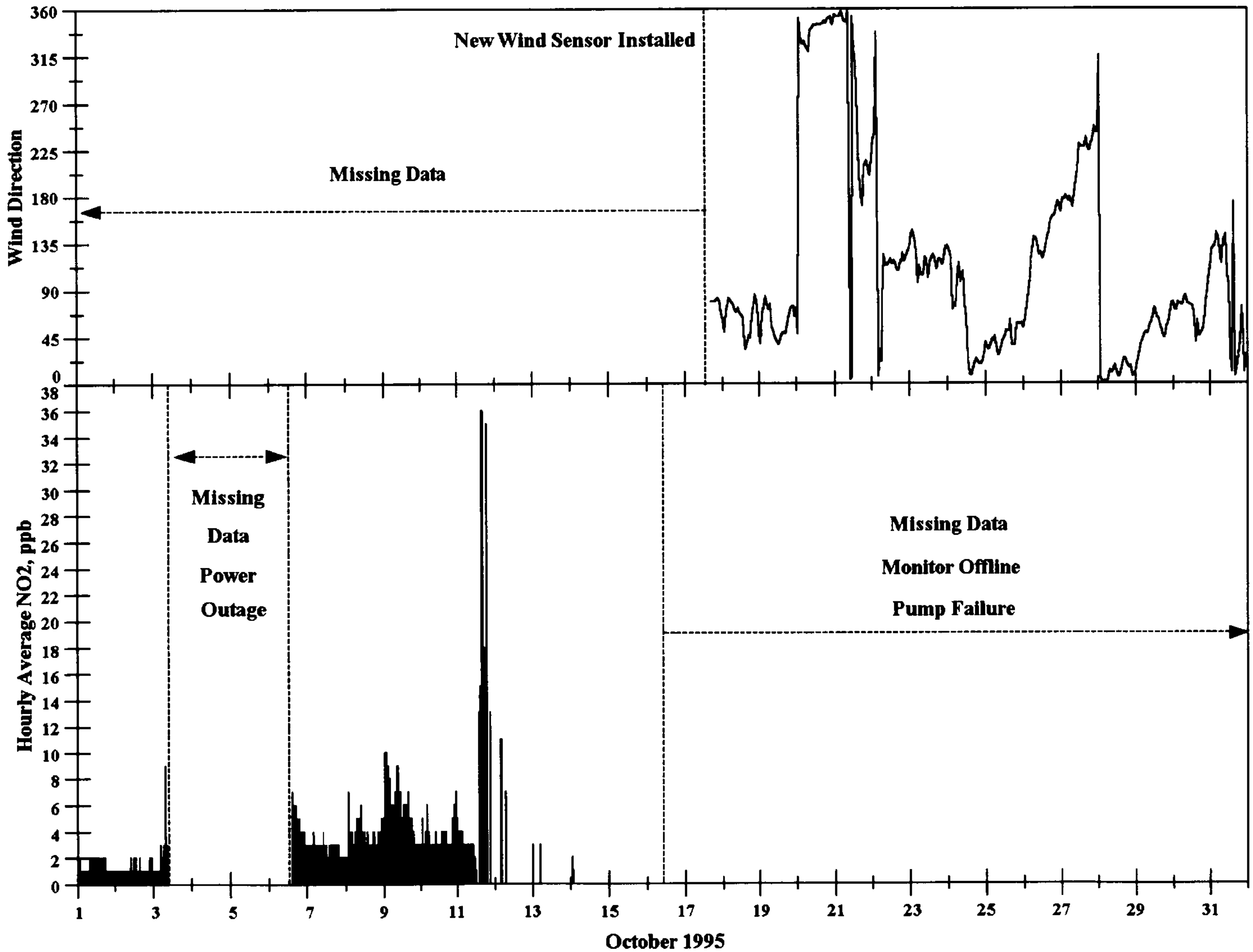


Figure 70. Average NO_2 concentrations (ppb) and wind direction for October 1995 at Breton Island.

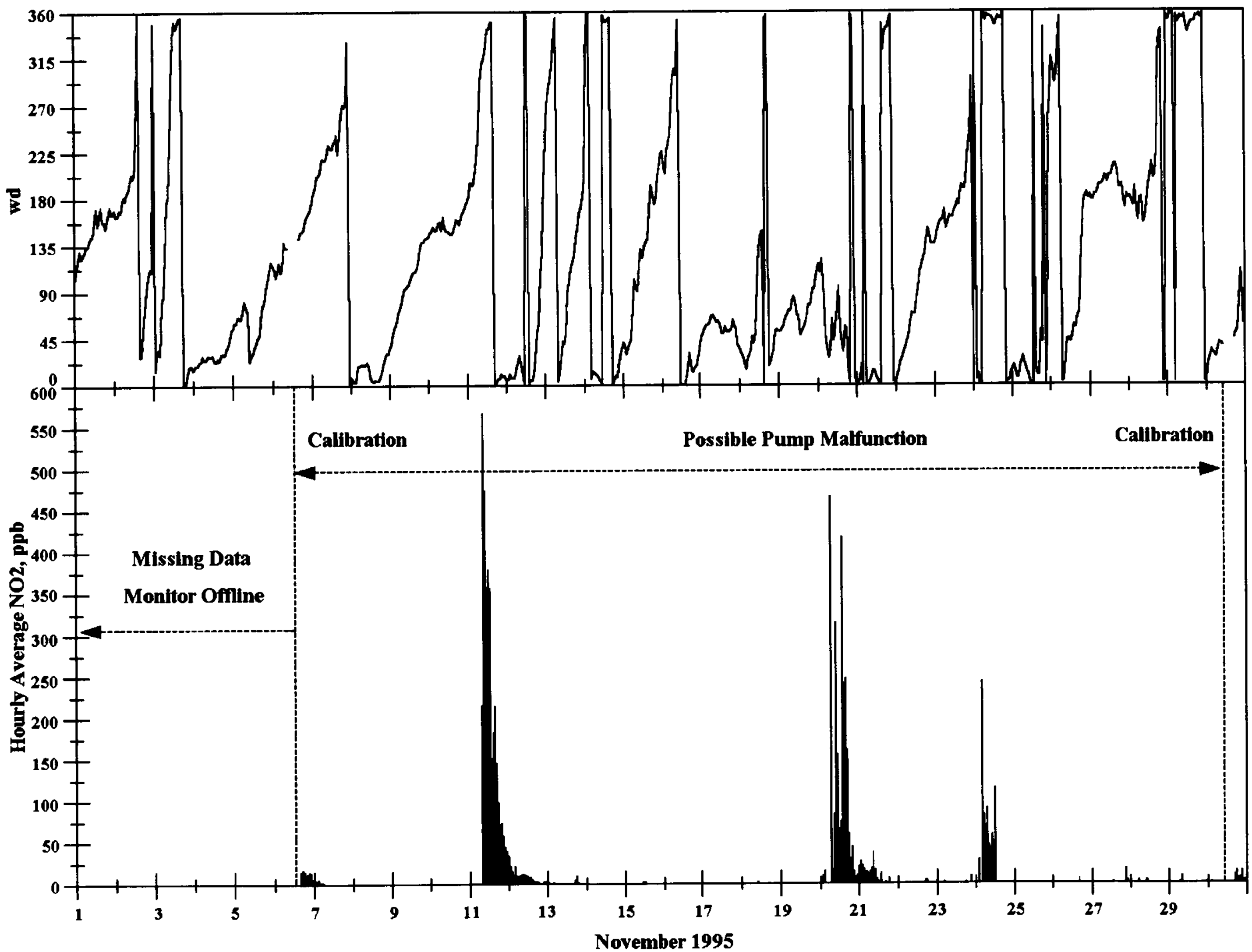


Figure 71. Average NO_2 concentrations (ppb) and wind direction for November 1995 at Breton Island.

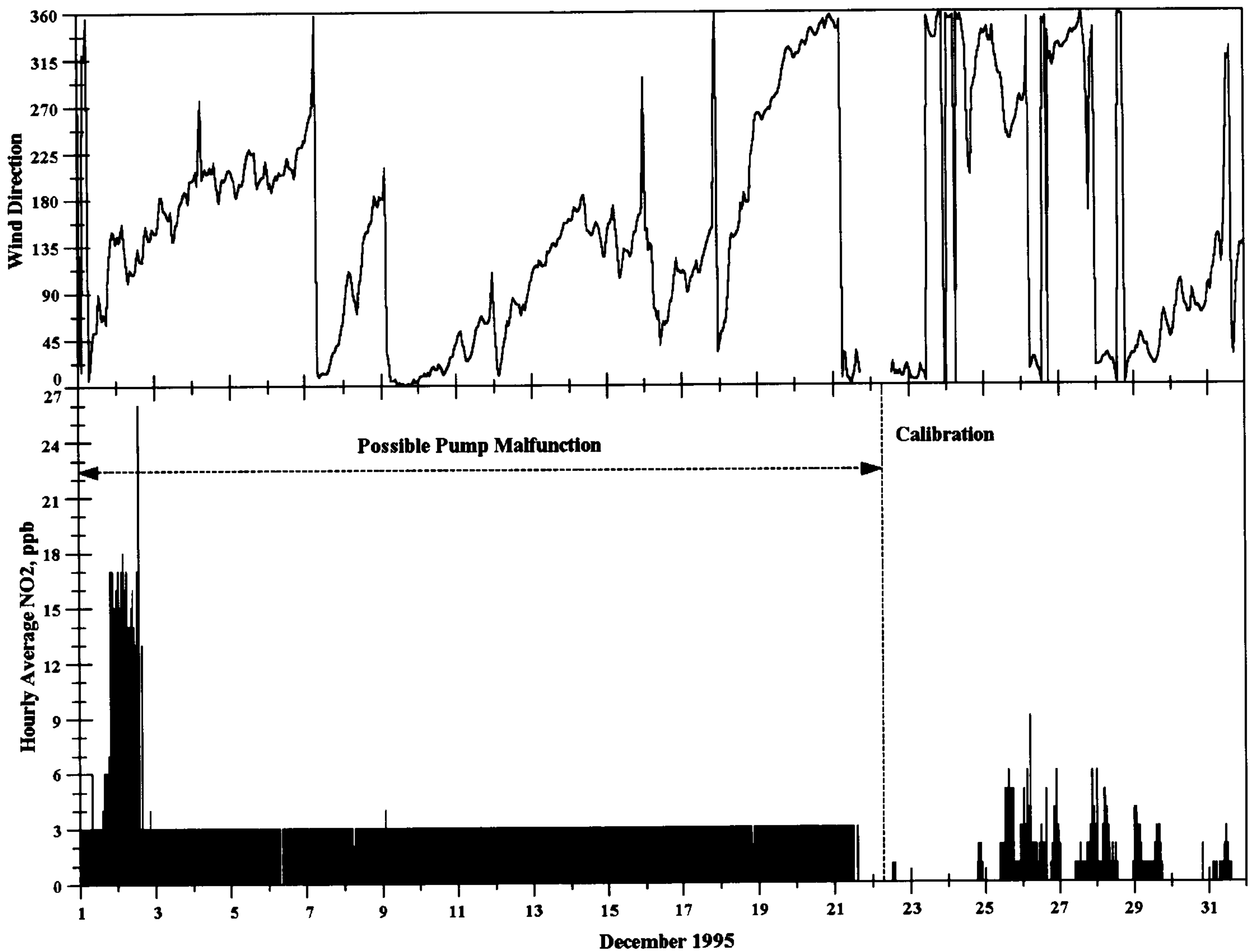


Figure 72. Average NO_2 concentrations (ppb) and wind direction for December 1995 at Breton Island.

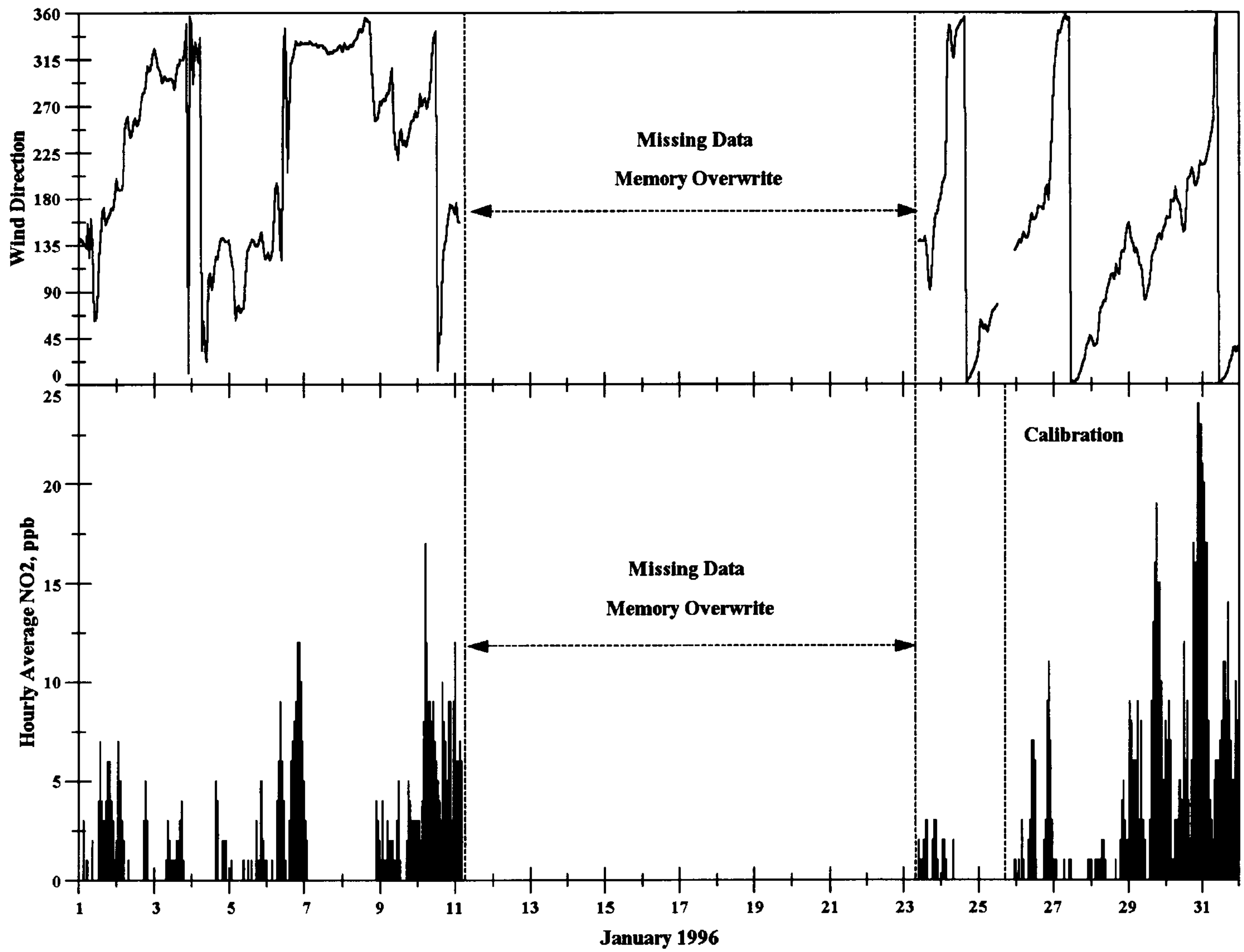


Figure 73. Average NO_2 concentrations (ppb) and wind direction for January 1996 at Breton Island.

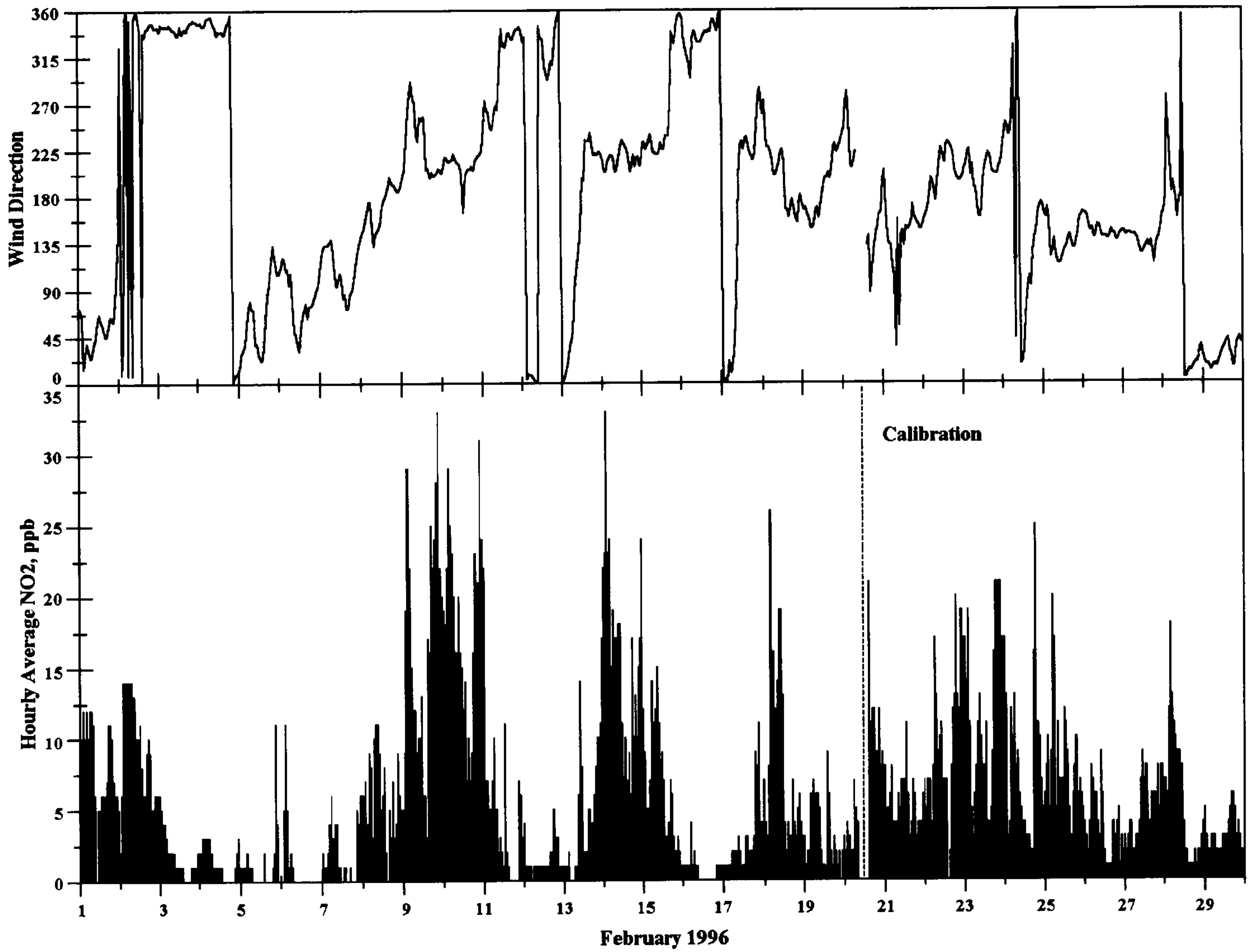


Figure 74. Average NO_2 concentrations (ppb) and wind direction for February 1996 at Breton Island.

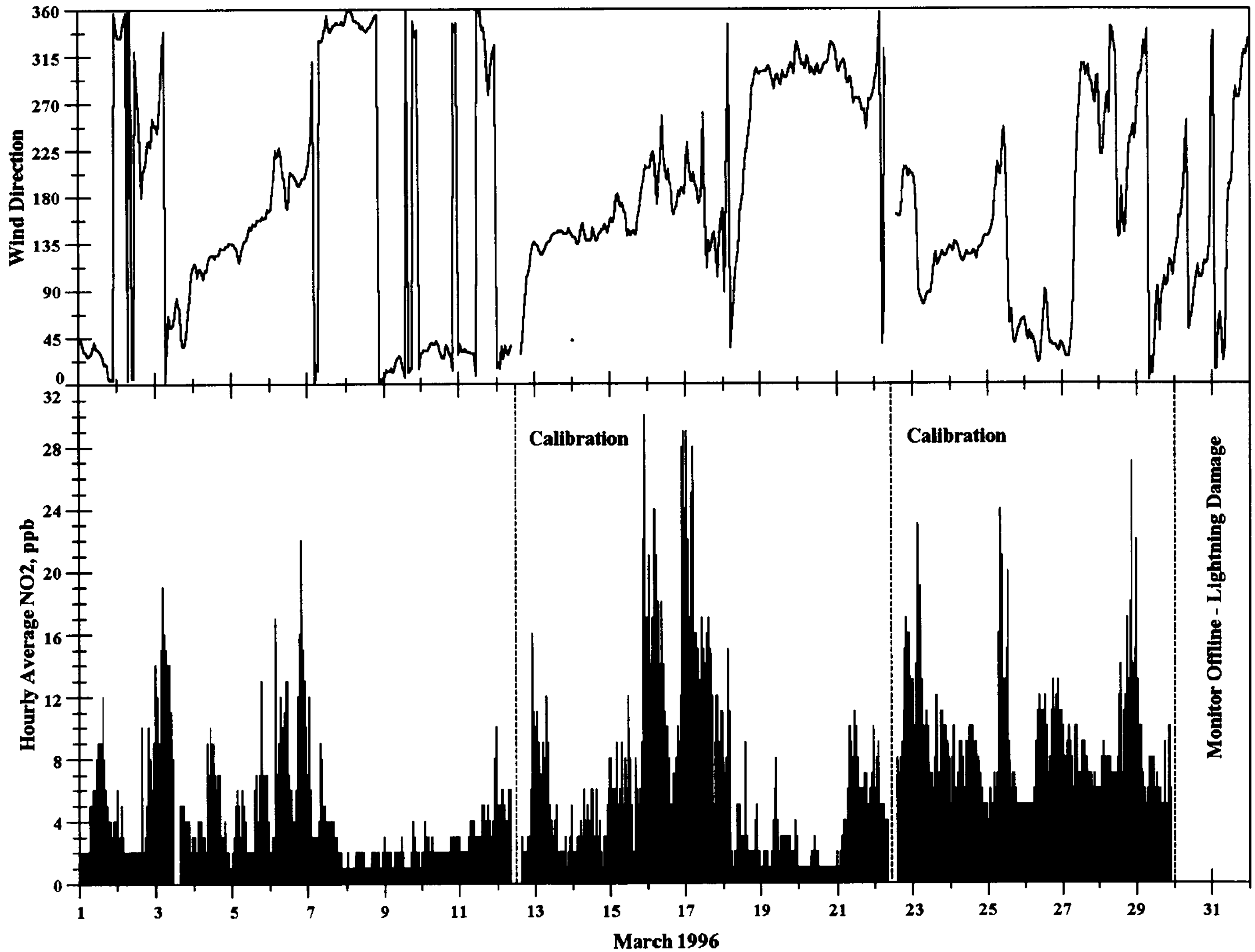


Figure 75. Average NO_2 concentrations (ppb) and wind direction for March 1996 at Breton Island.

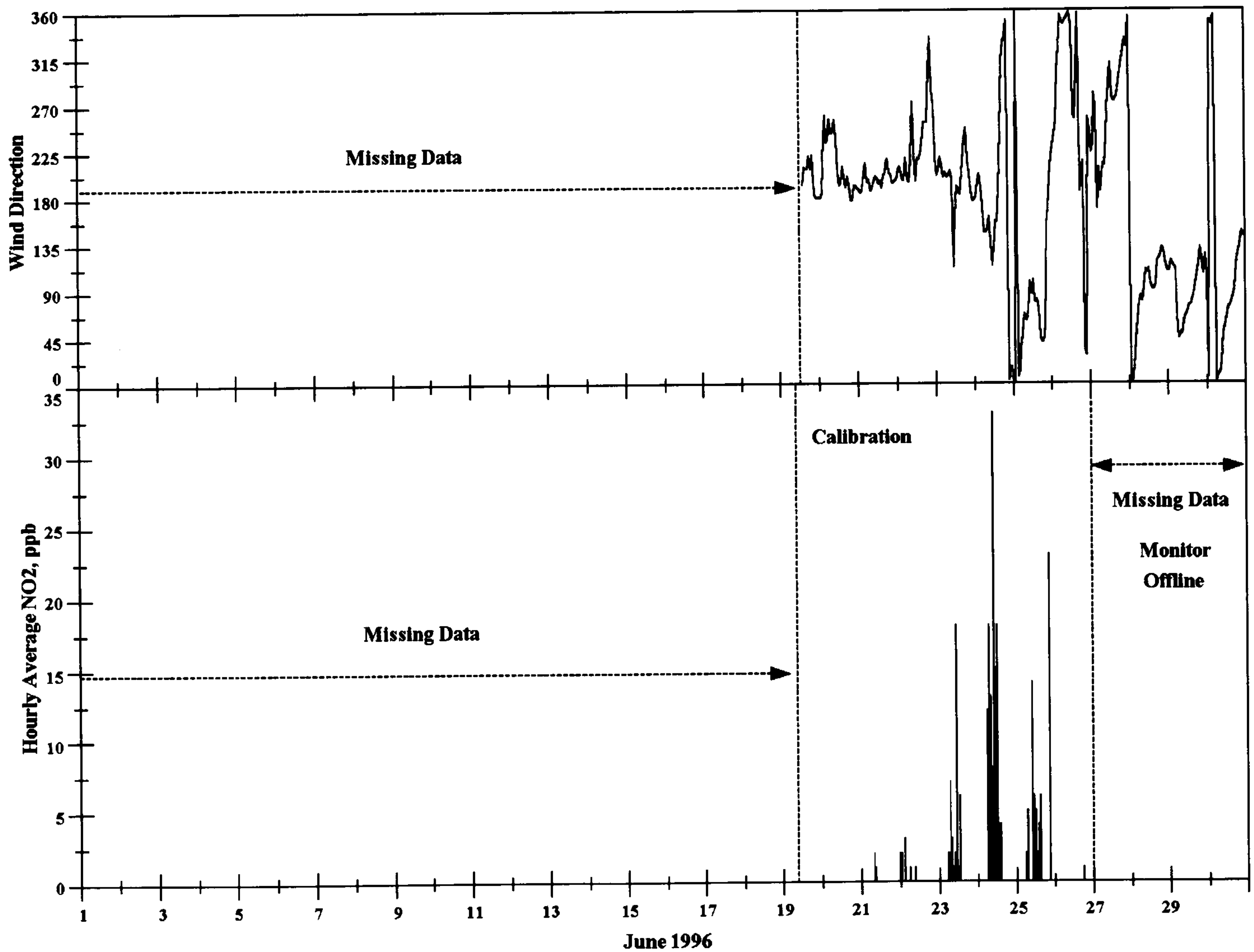


Figure 76. Average NO_2 concentrations (ppb) and wind direction for June 1996 at Breton Island.

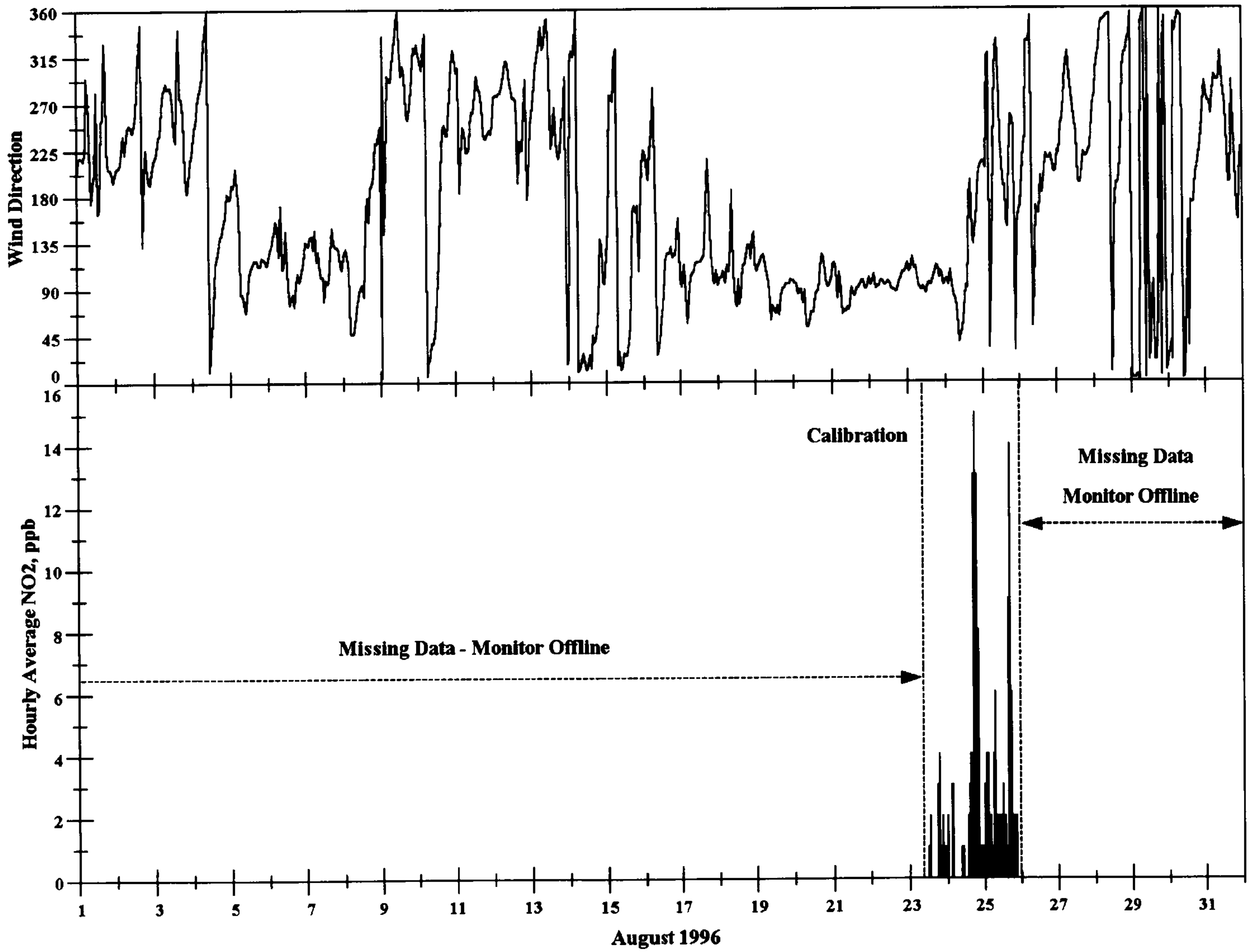


Figure 77. Average NO_2 concentrations (ppb) and wind direction for August 1996 at Breton Island.

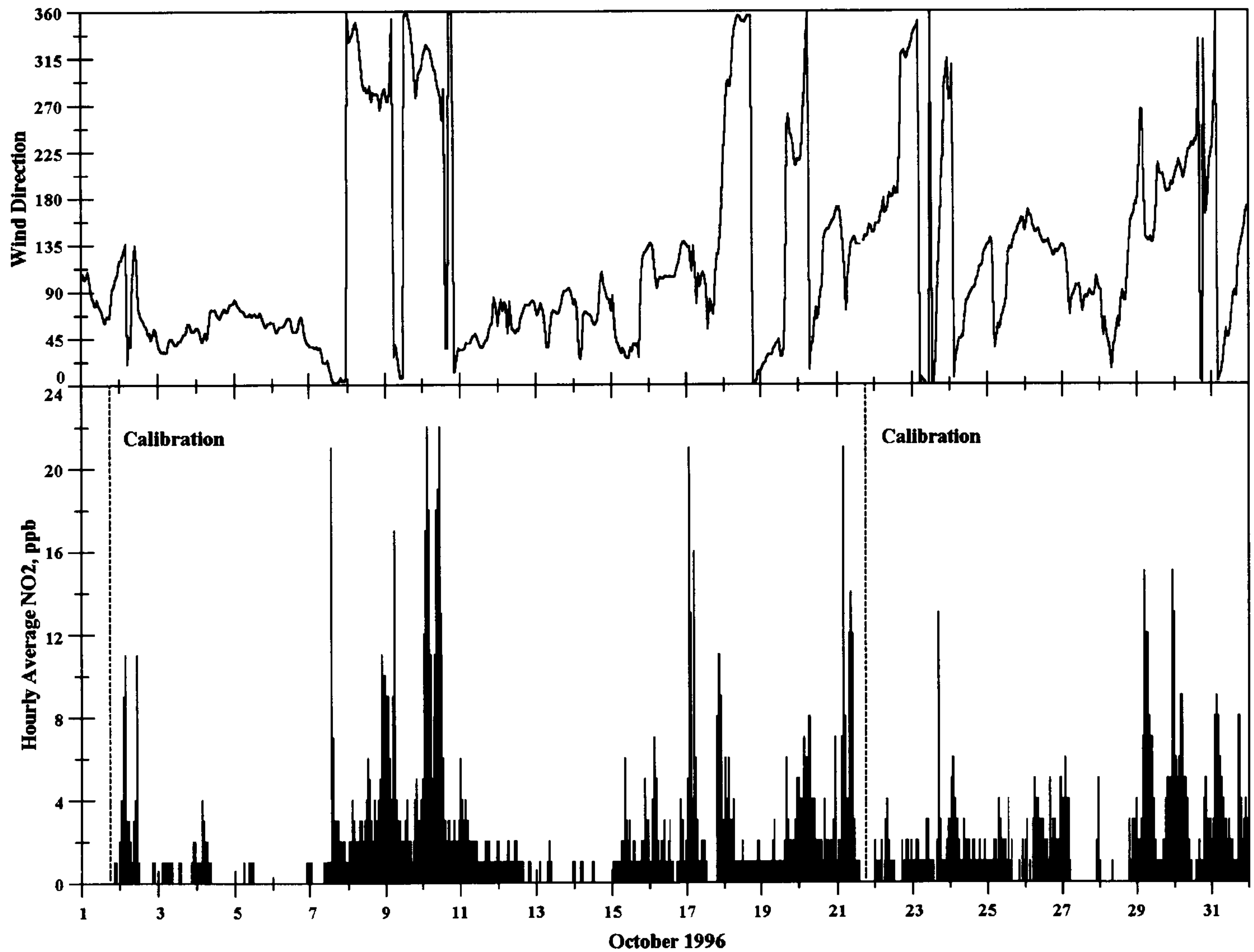


Figure 78. Average NO_2 concentrations (ppb) and wind direction for October 1996 at Breton Island.

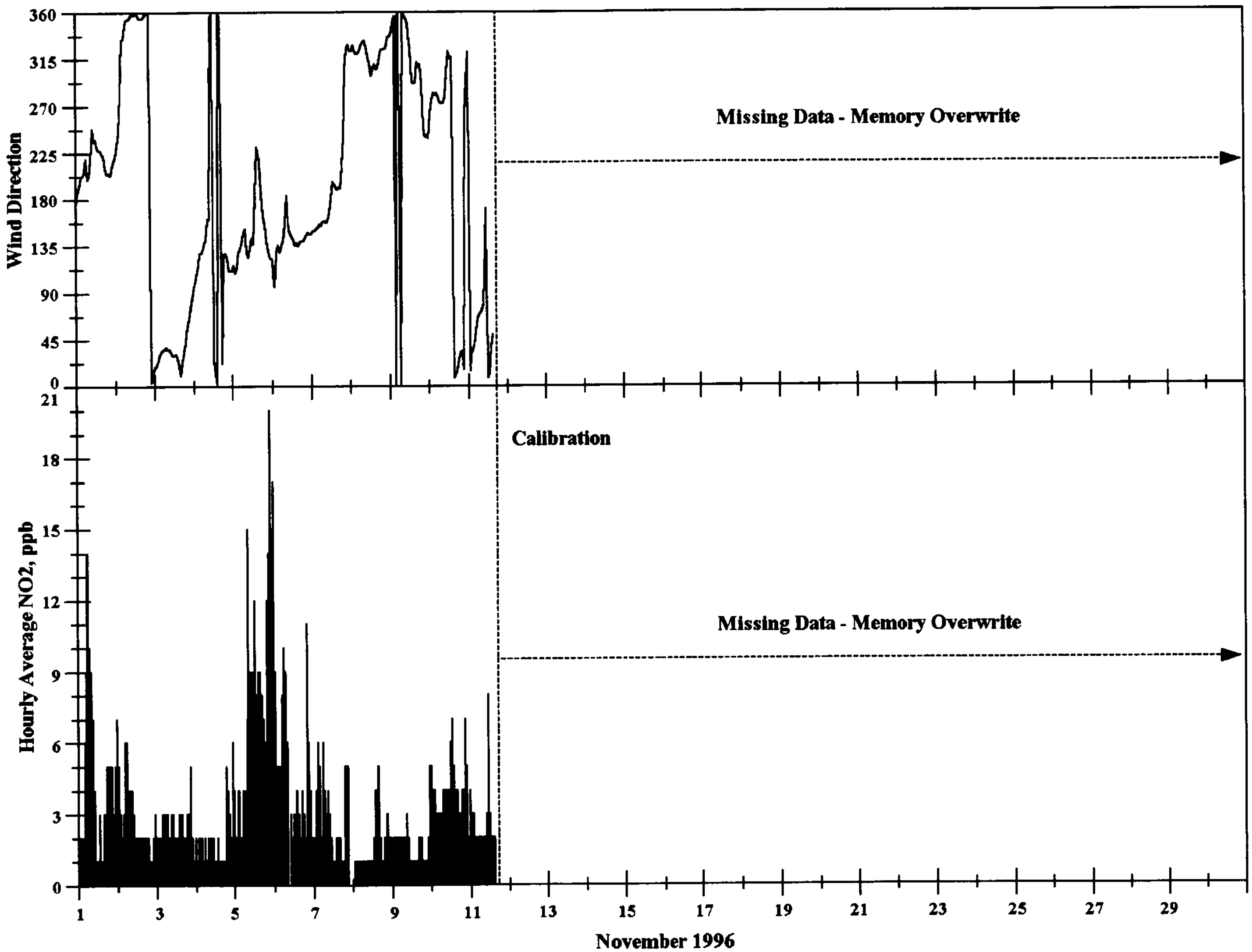


Figure 79. Average NO_2 concentrations (ppb) and wind direction for November 1996 at Breton Island.

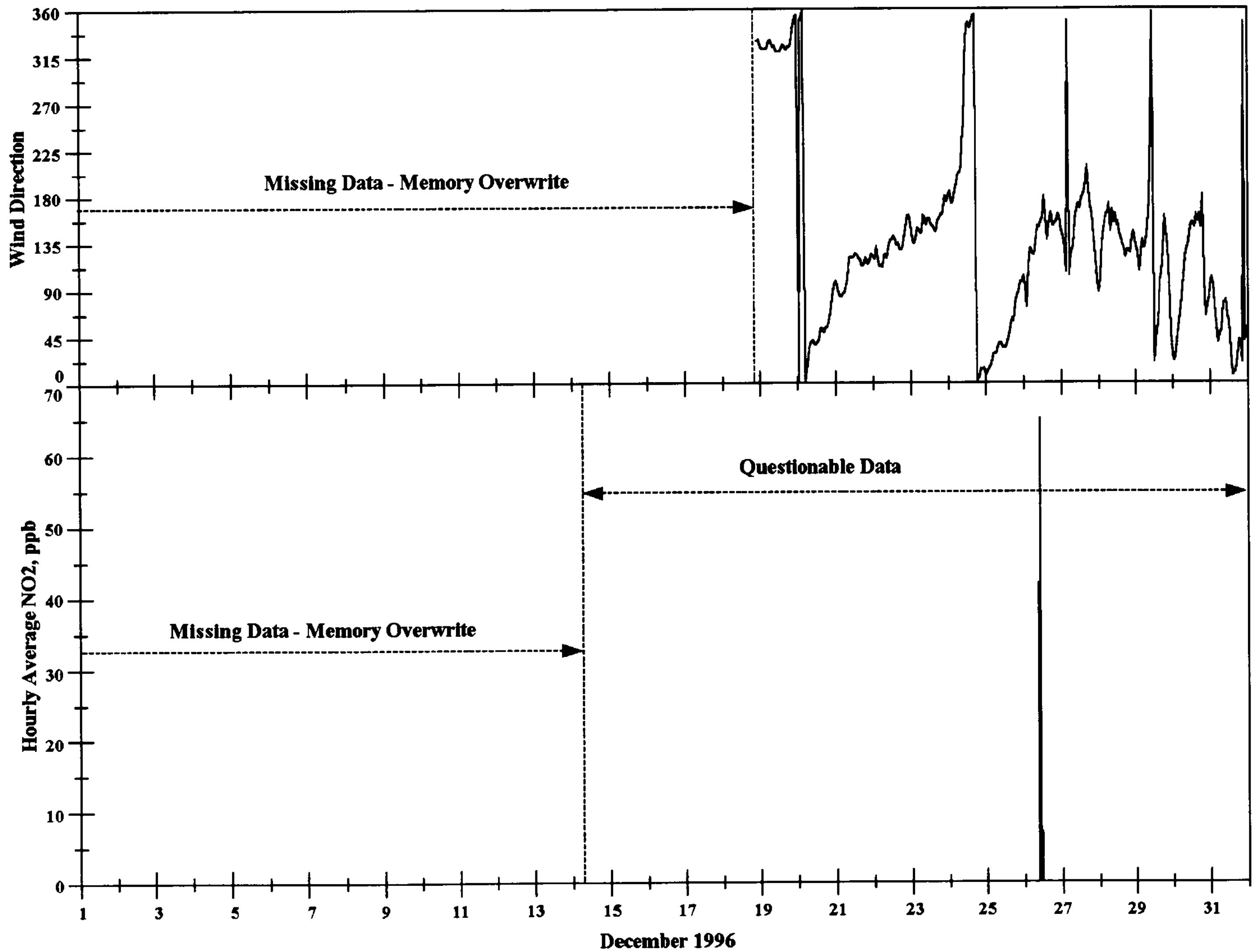


Figure 80. Average NO_2 concentrations (ppb) and wind direction for December 1996 at Breton Island.

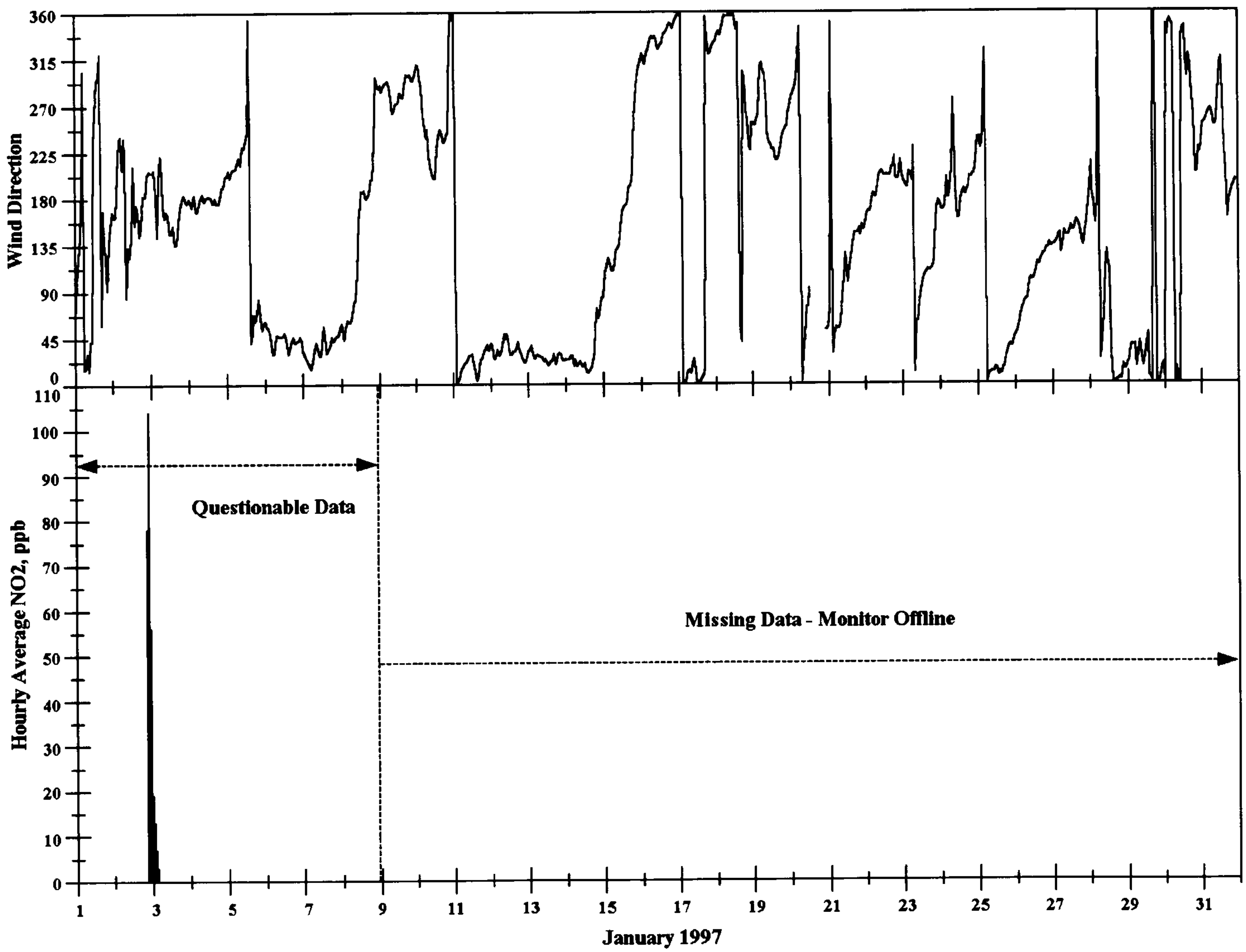


Figure 81. Average NO_2 concentrations (ppb) and wind direction for January 1997 at Breton Island.

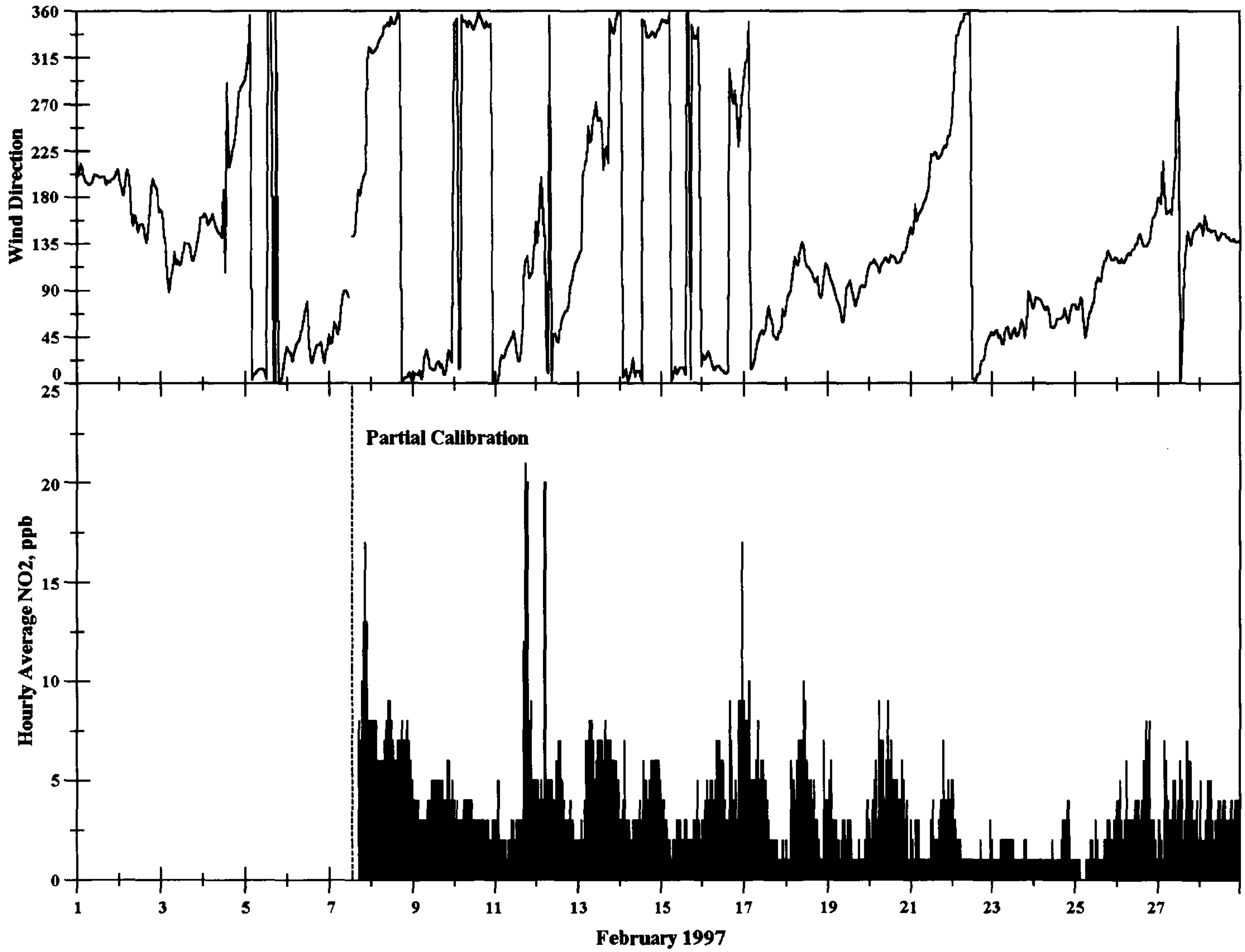


Figure 82. Average NO_2 concentrations (ppb) and wind direction for February 1997 at Breton Island.

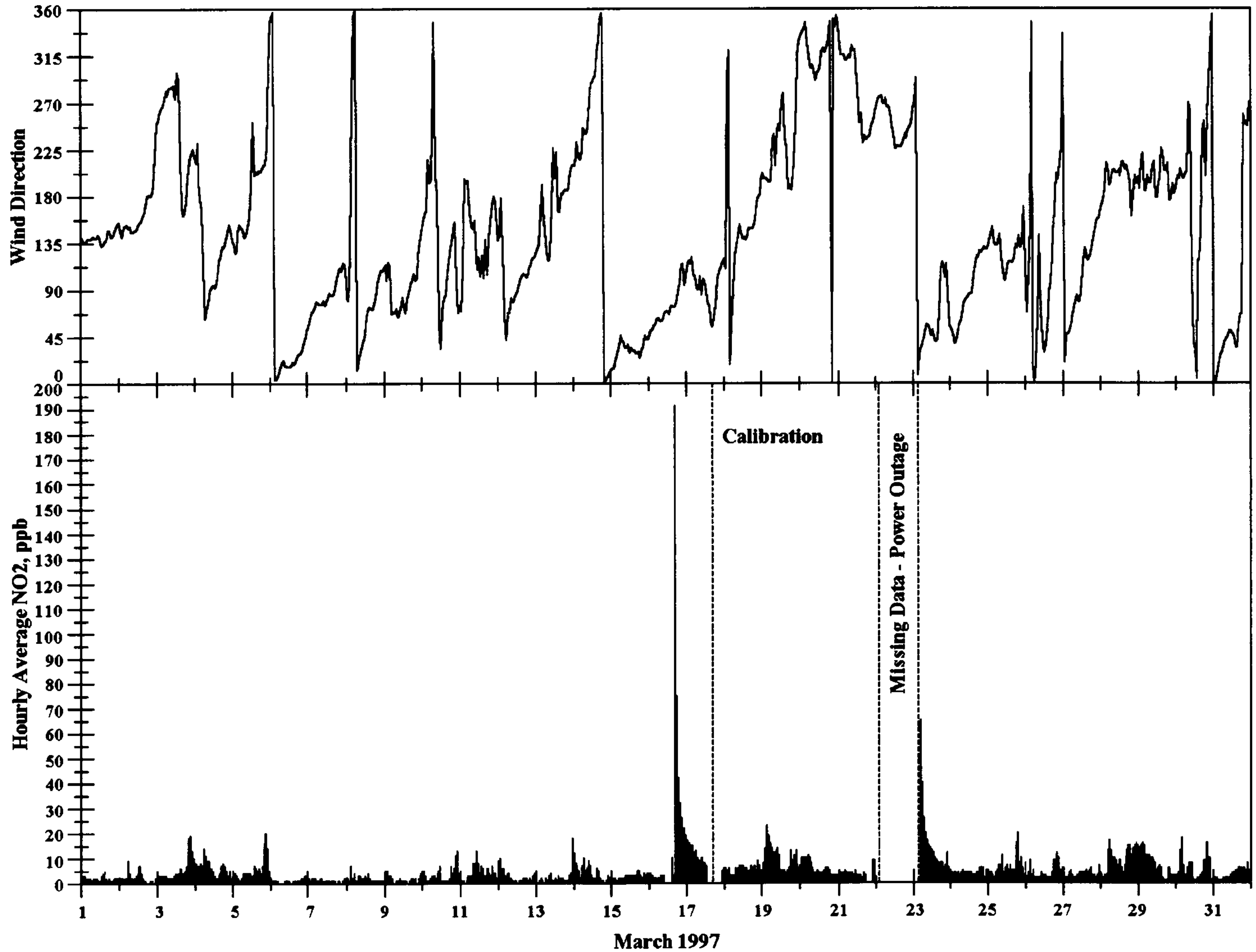


Figure 83. Average NO_2 concentrations (ppb) and wind direction for March 1997 at Breton Island.

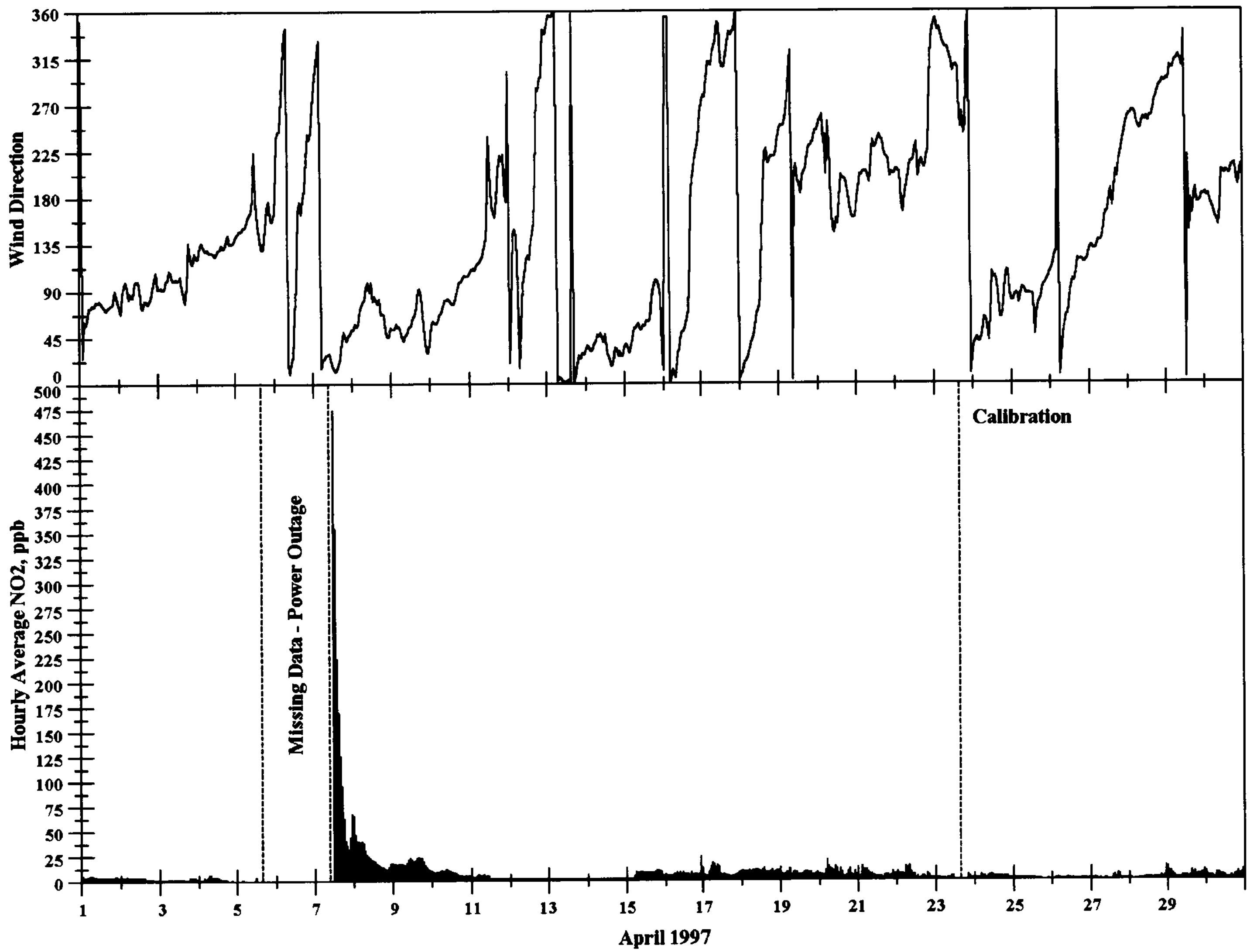


Figure 84. Average NO_2 concentrations (ppb) and wind direction for April 1997 at Breton Island.

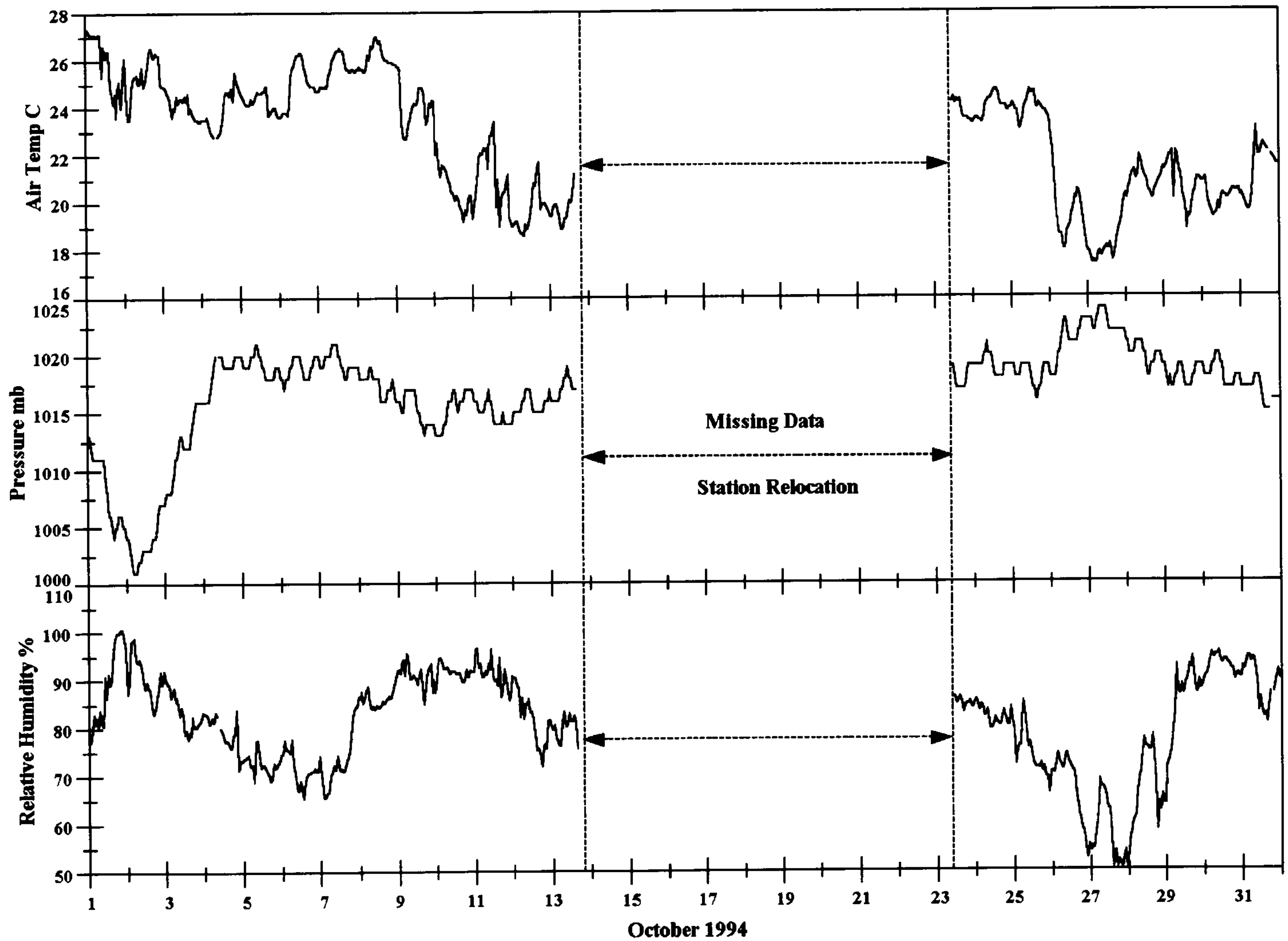


Figure 85. Breton Island October 1994 meteorological data.

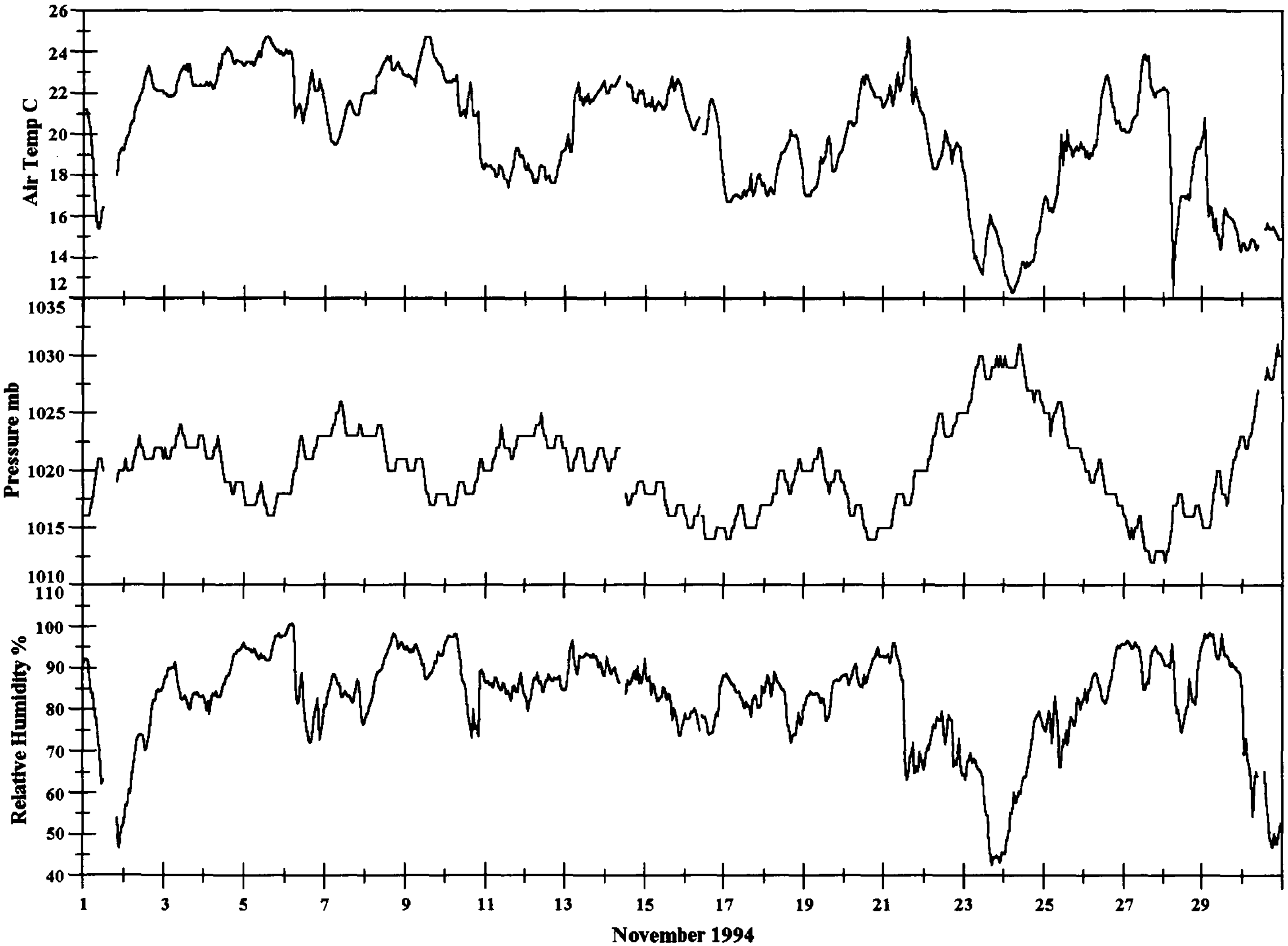


Figure 86. Breton Island November 1994 meteorological data.

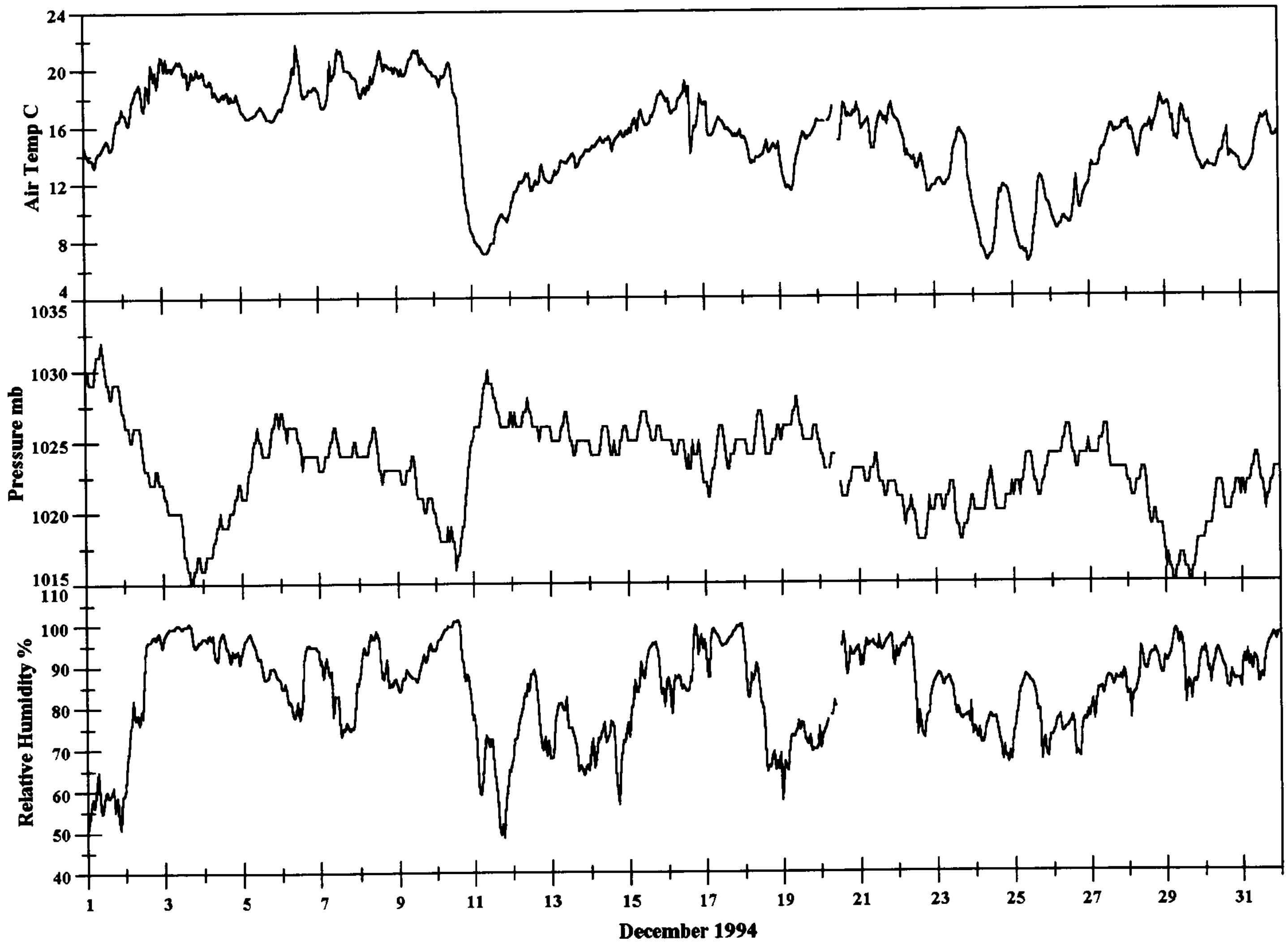


Figure 87. Breton Island December 1994 meteorological data.

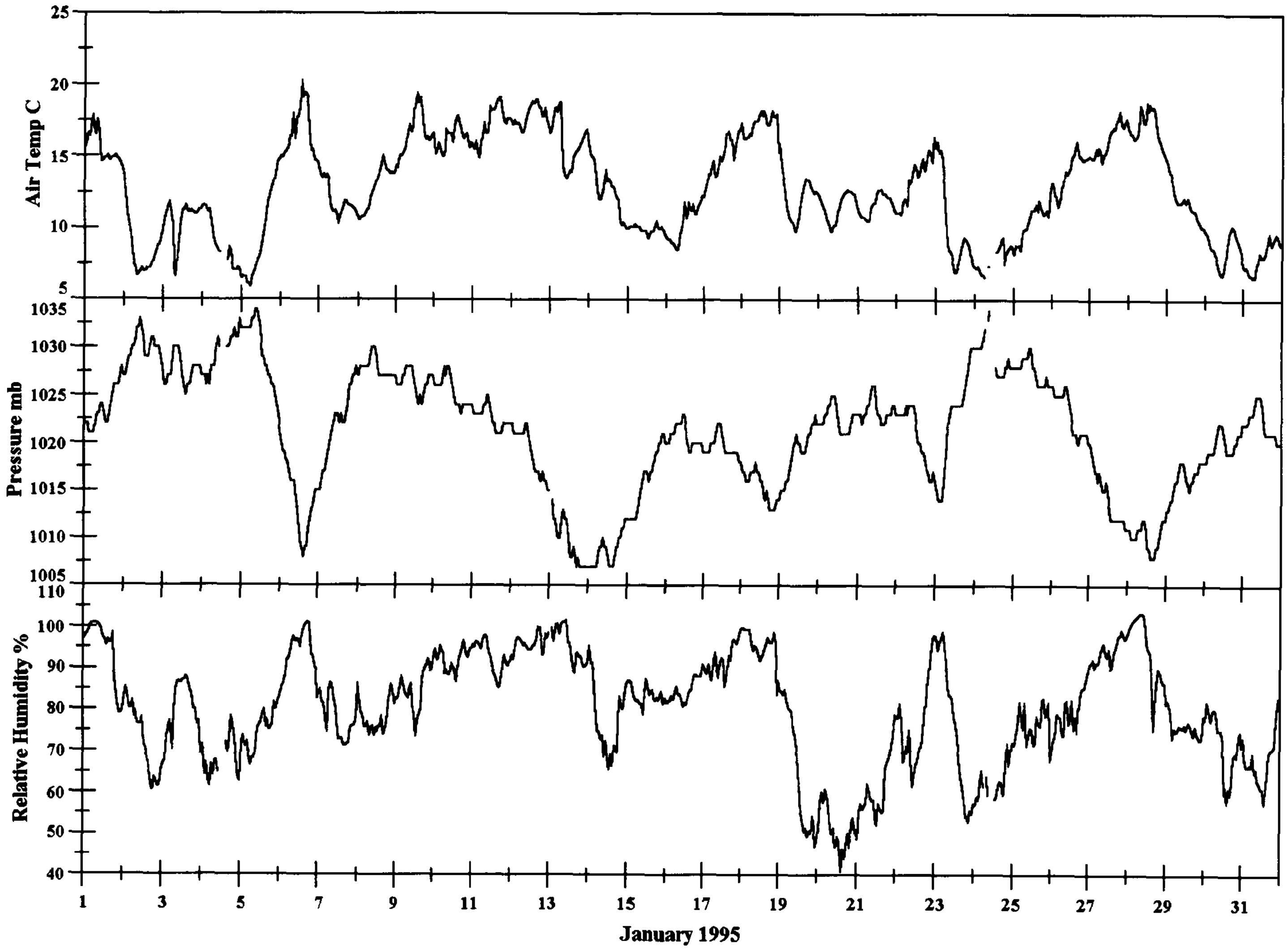


Figure 88. Breton Island January 1995 meteorological data.

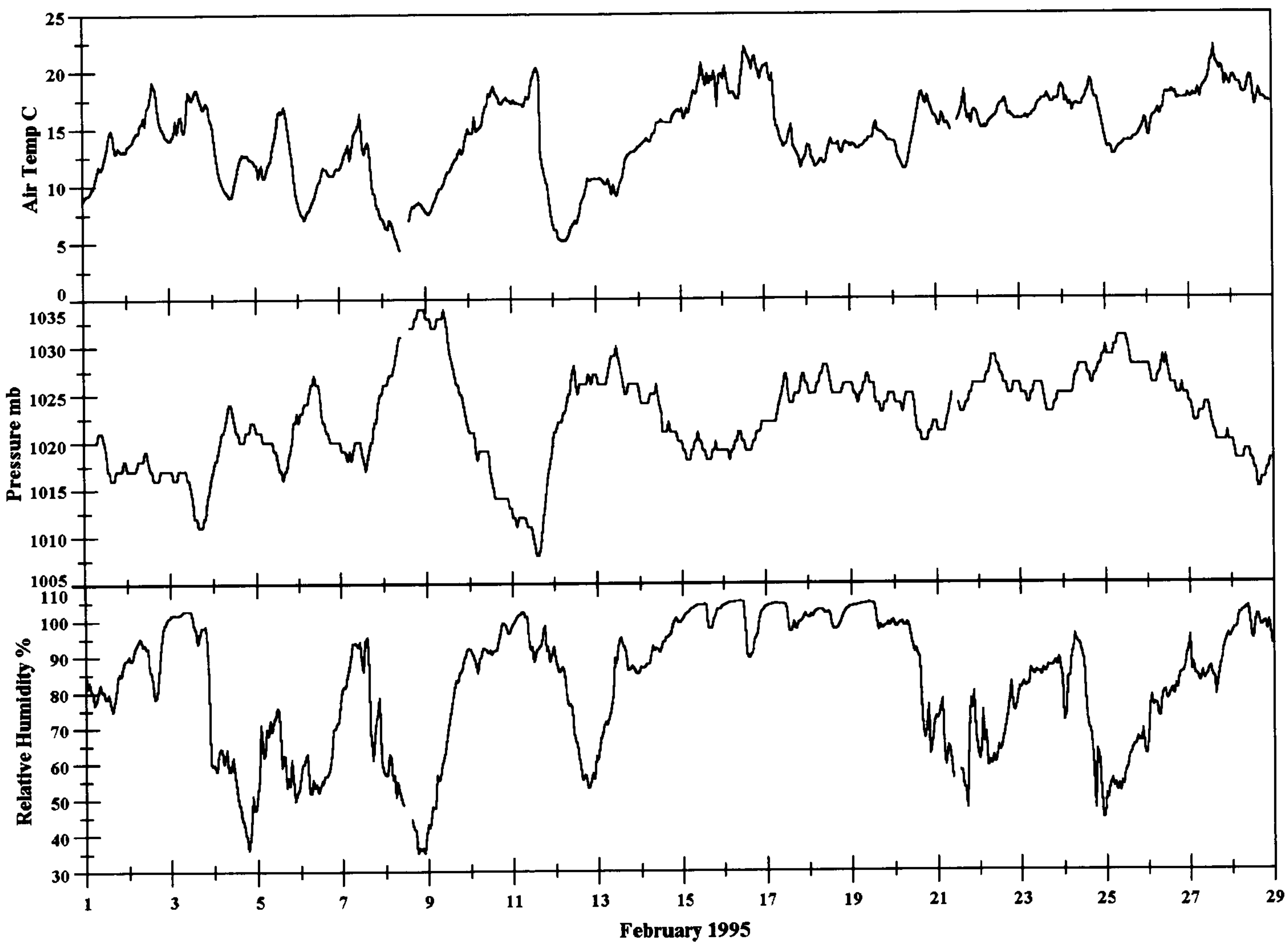


Figure 89. Breton Island February 1995 meteorological data.

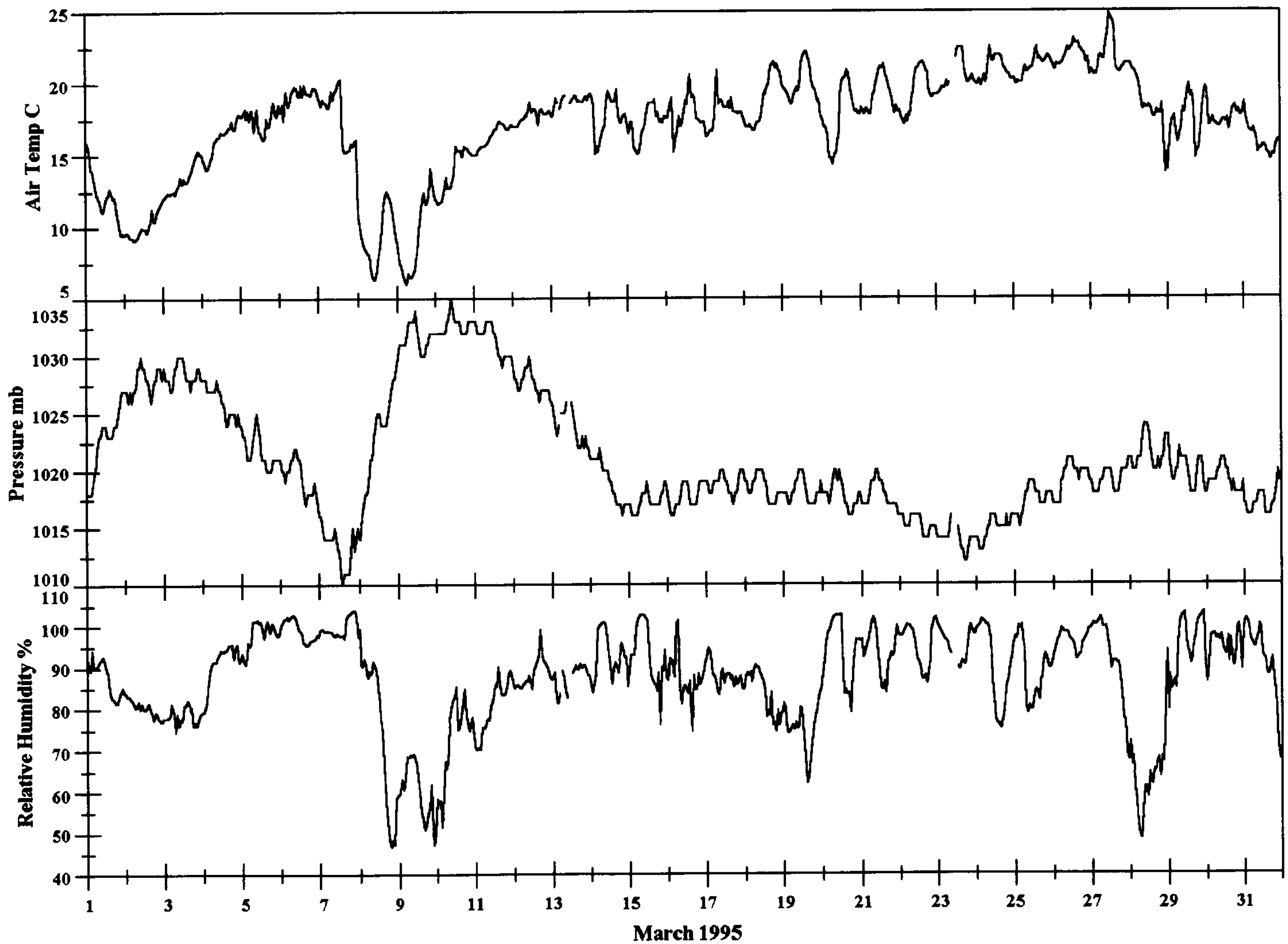


Figure 90. Breton Island March 1995 meteorological data.

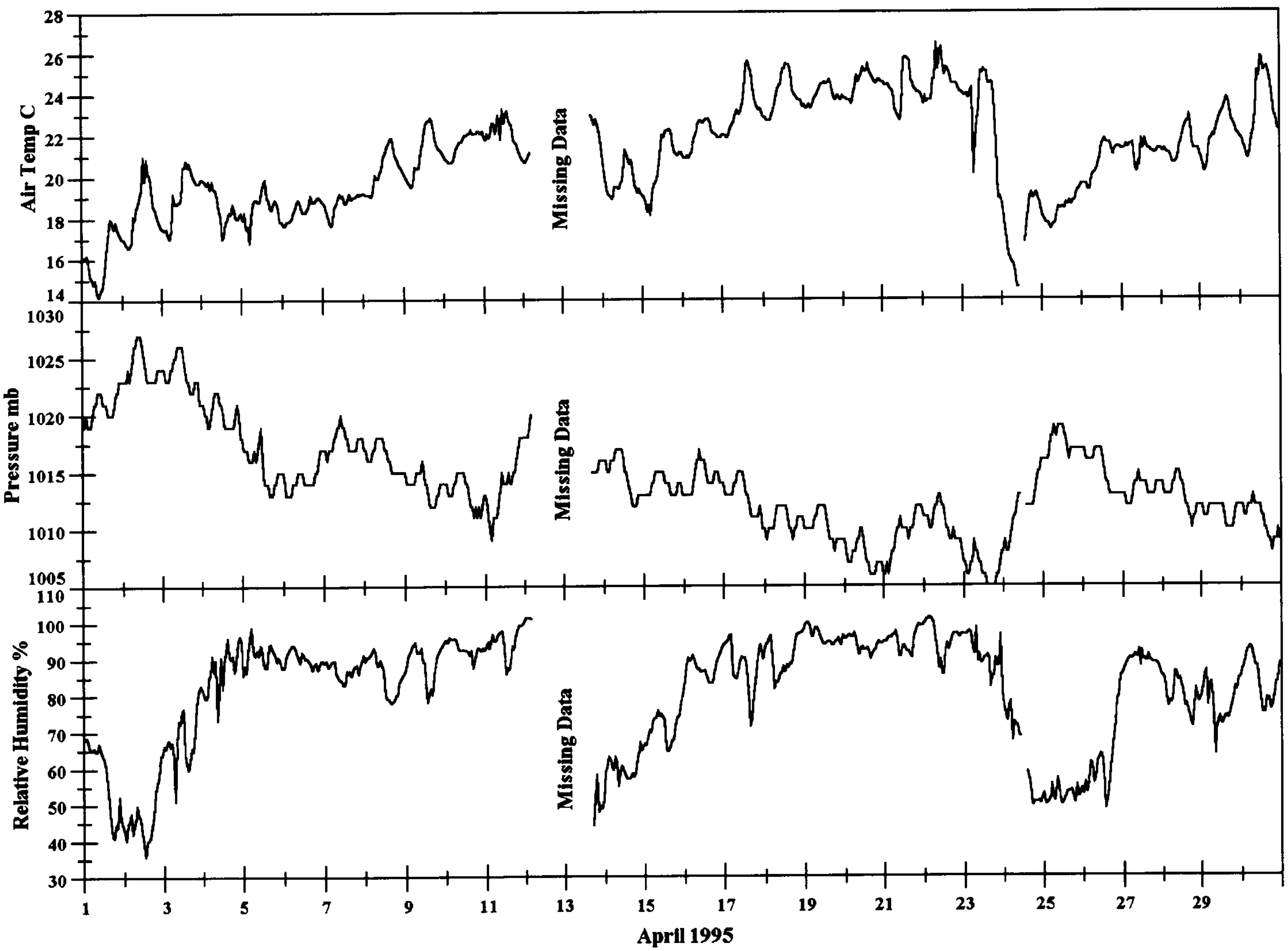


Figure 91. Breton Island April 1995 meteorological data.

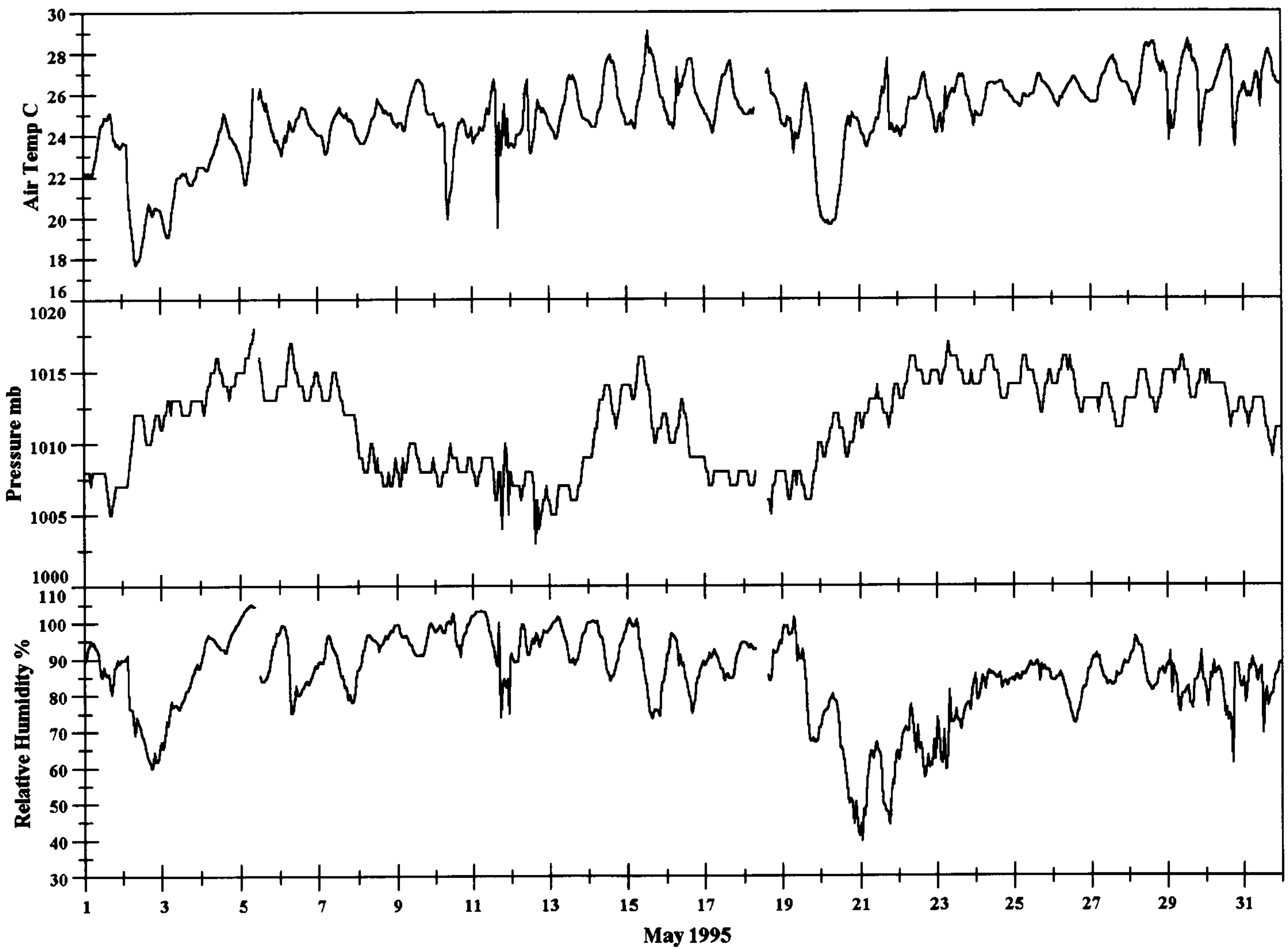


Figure 92. Breton Island May 1995 meteorological data.

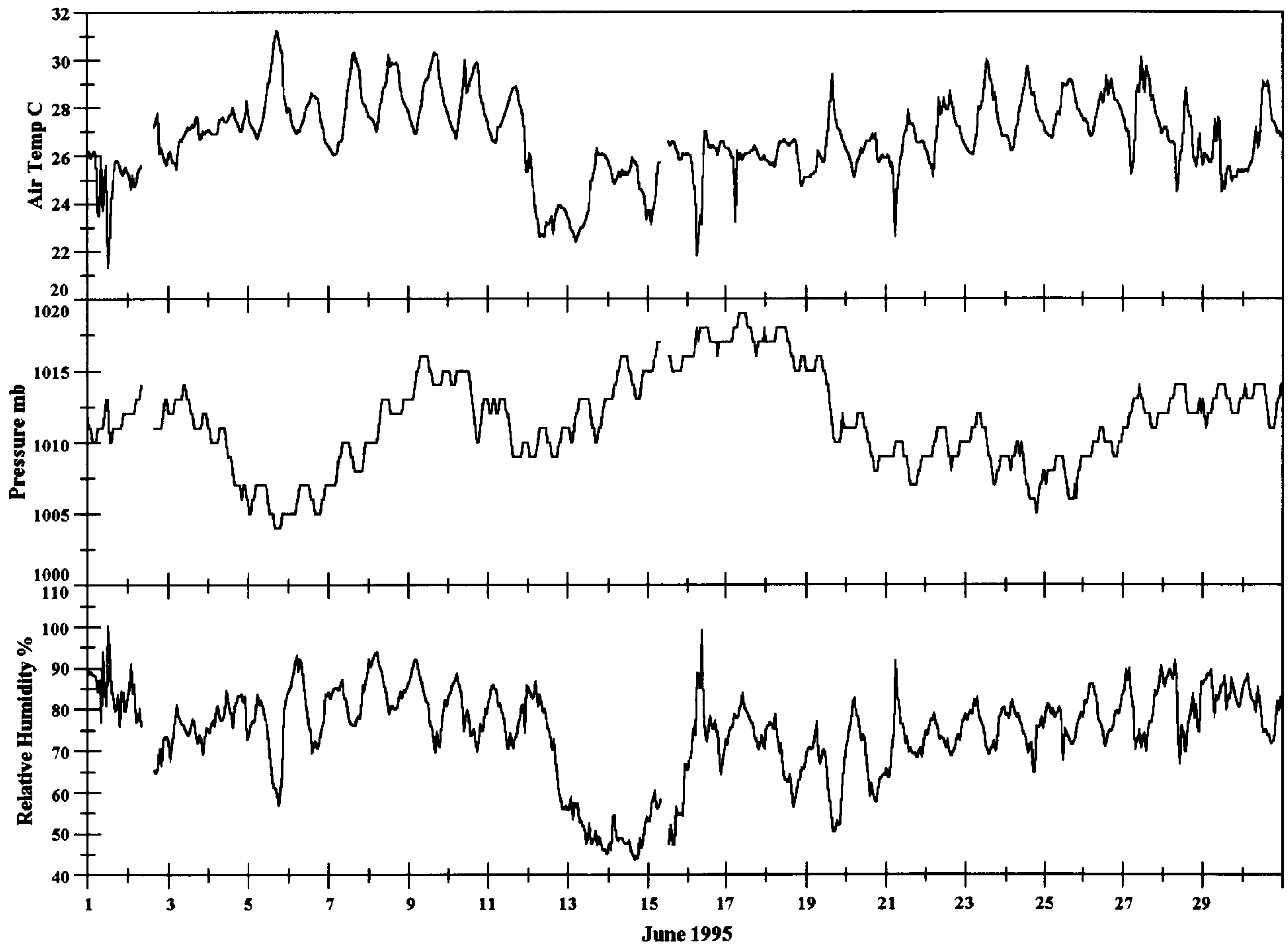


Figure 93. Breton Island June 1995 meteorological data.

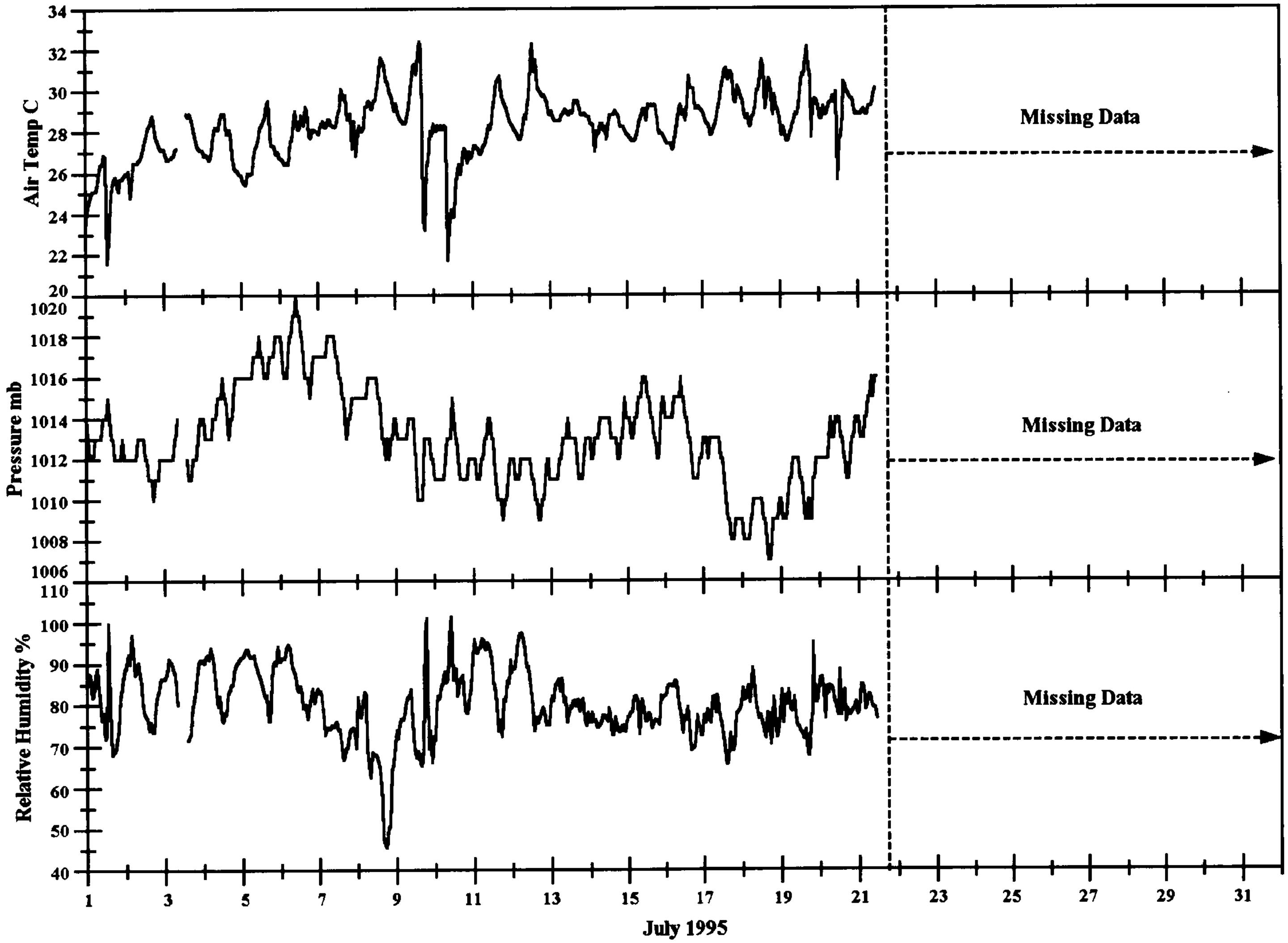


Figure 94. Breton Island July 1995 meteorological data.

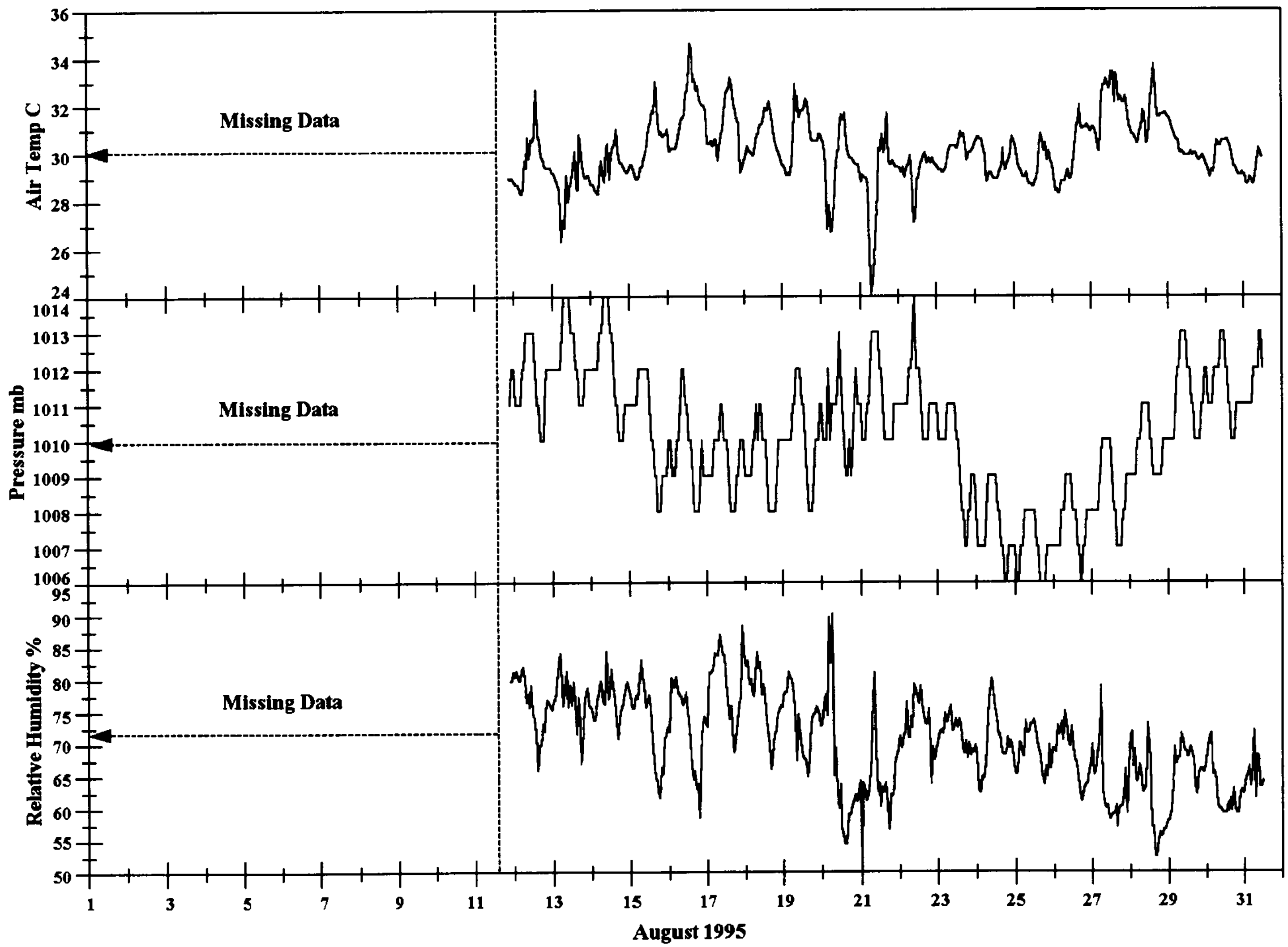


Figure 95. Breton Island August 1995 meteorological data.

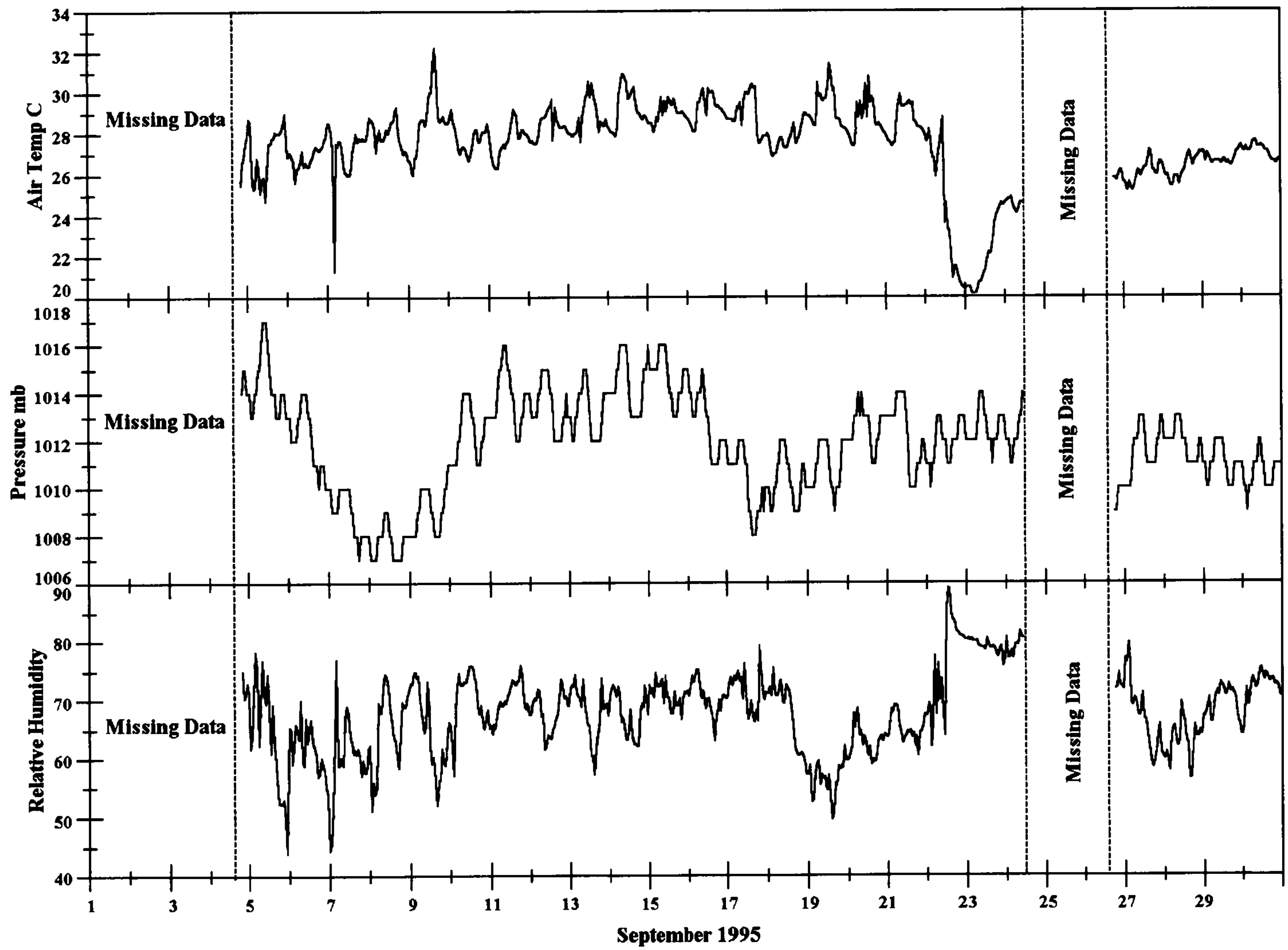


Figure 96. Breton Island September 1995 meteorological data.

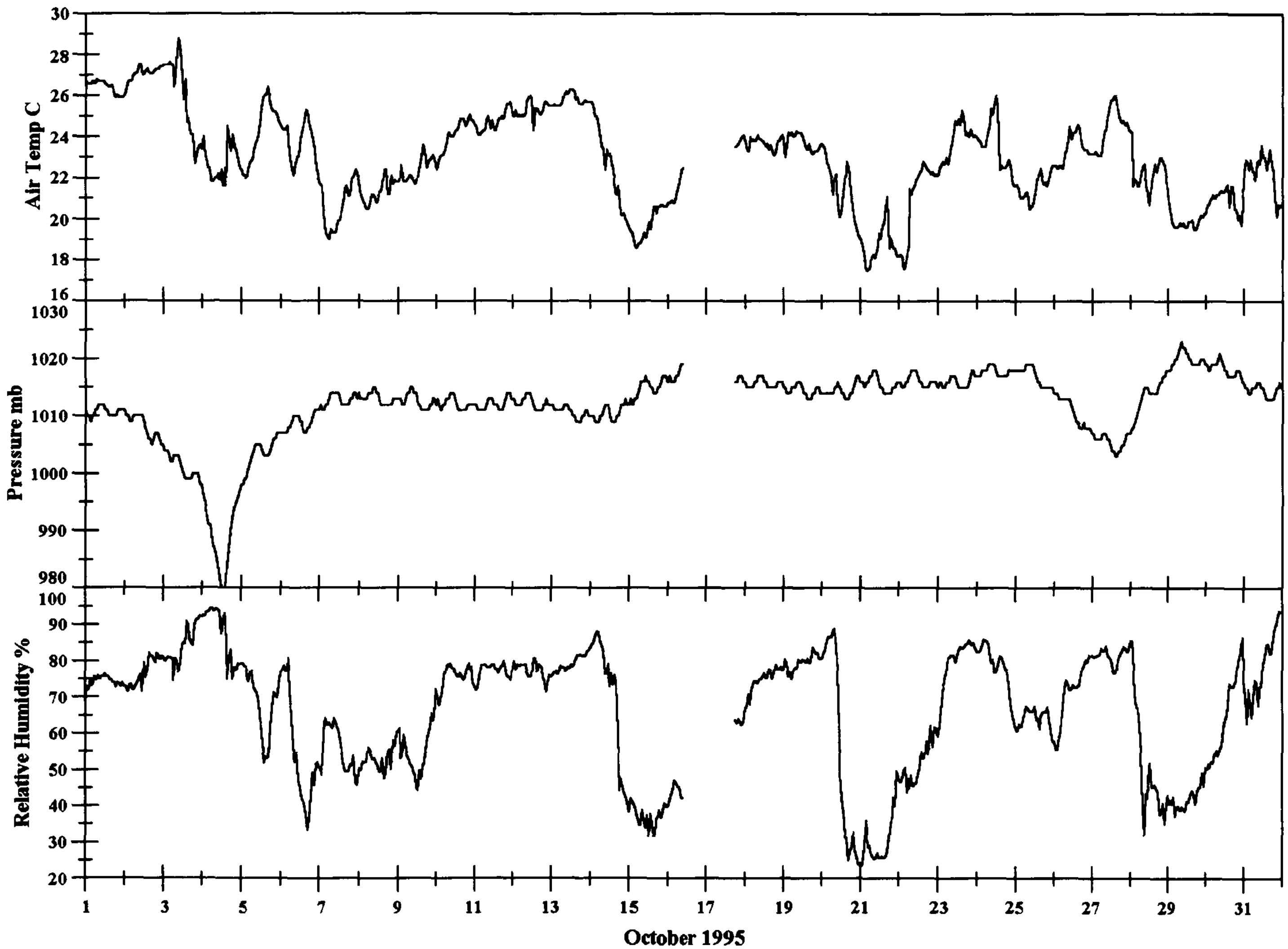


Figure 97. Breton Island October 1995 meteorological data.

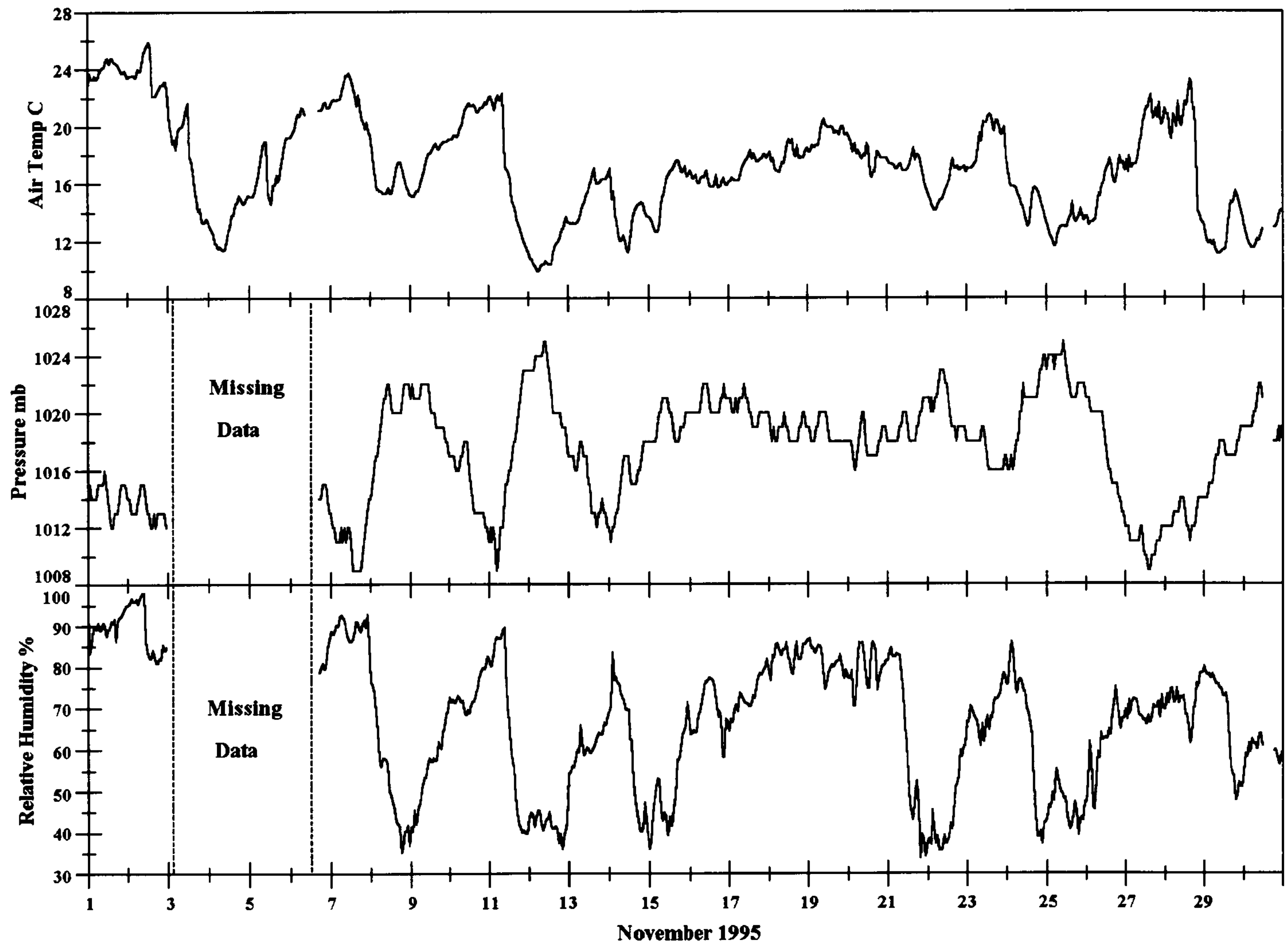


Figure 98. Breton Island November 1995 meteorological data.

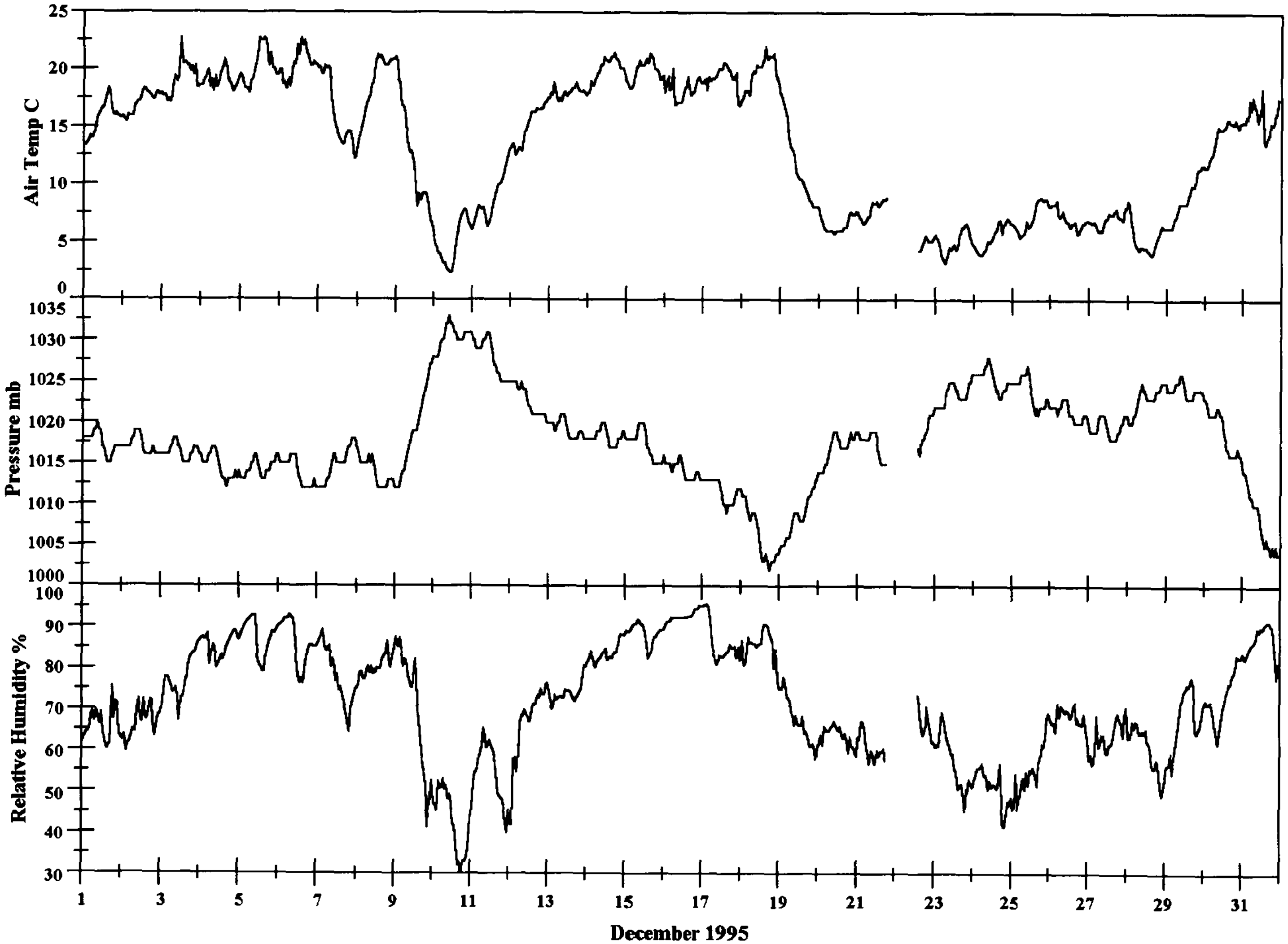


Figure 99. Breton Island December 1995 meteorological data.

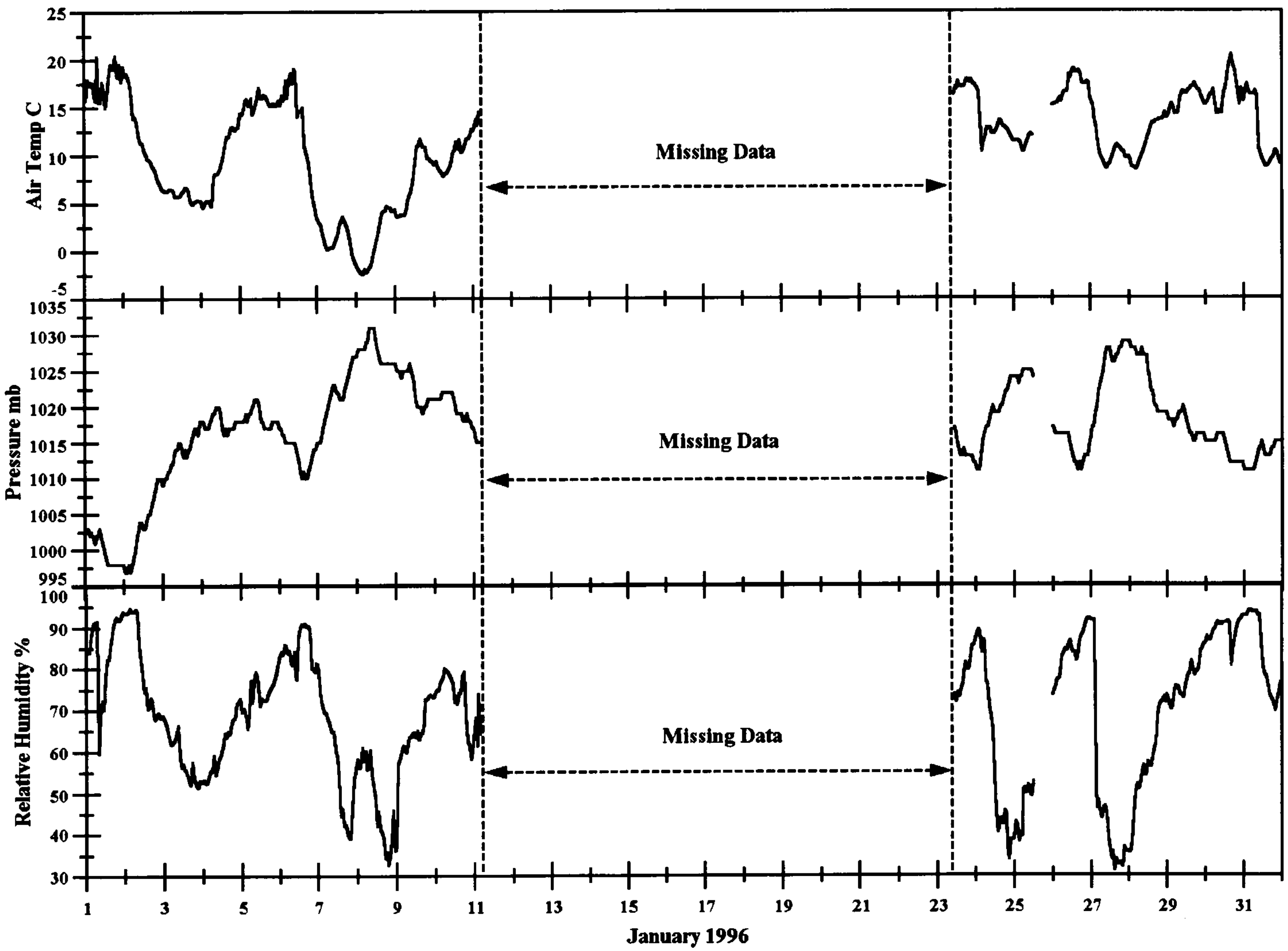


Figure 100. Breton Island January 1996 meteorological data.

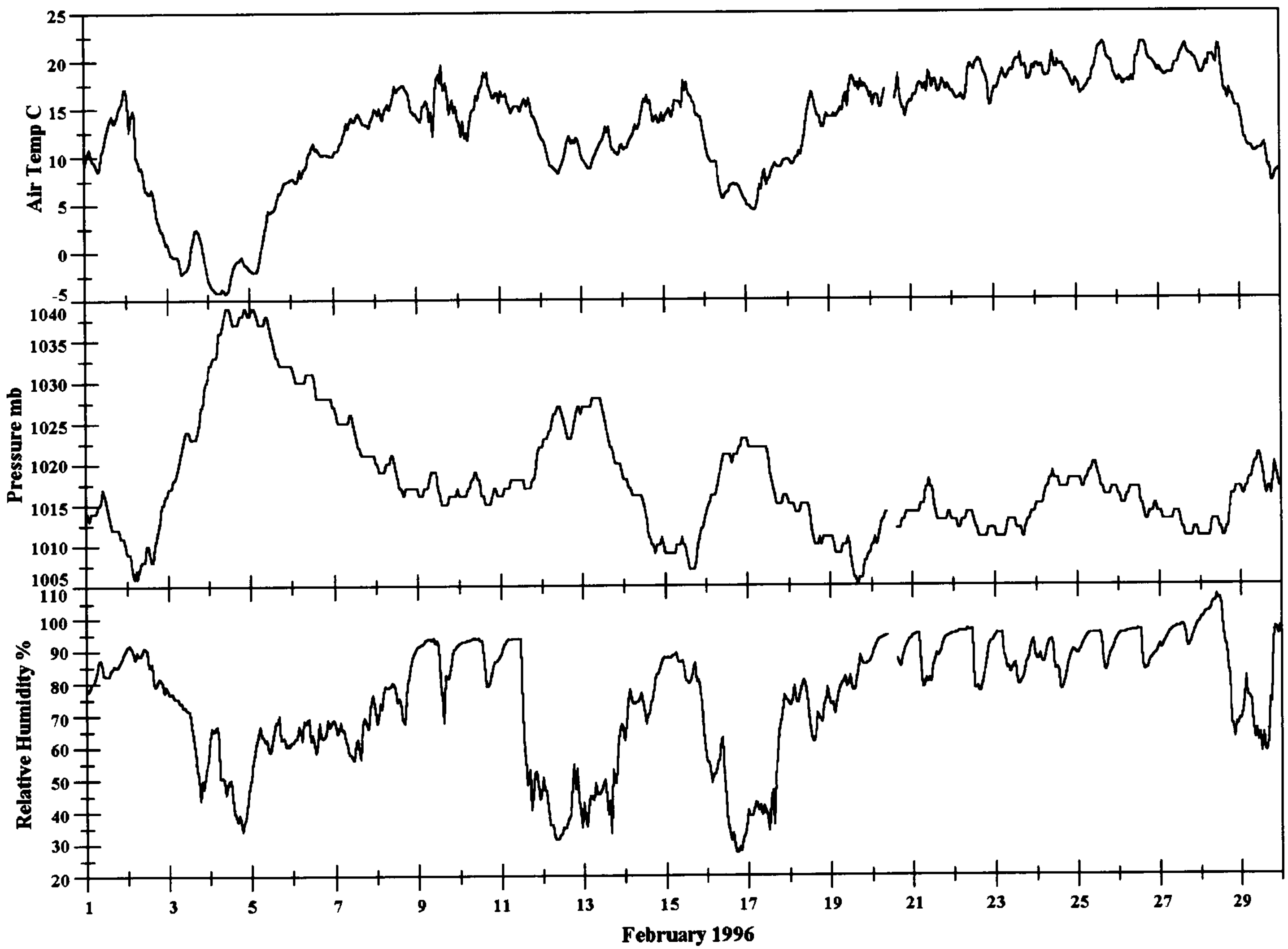


Figure 101. Breton Island February 1996 meteorological data.

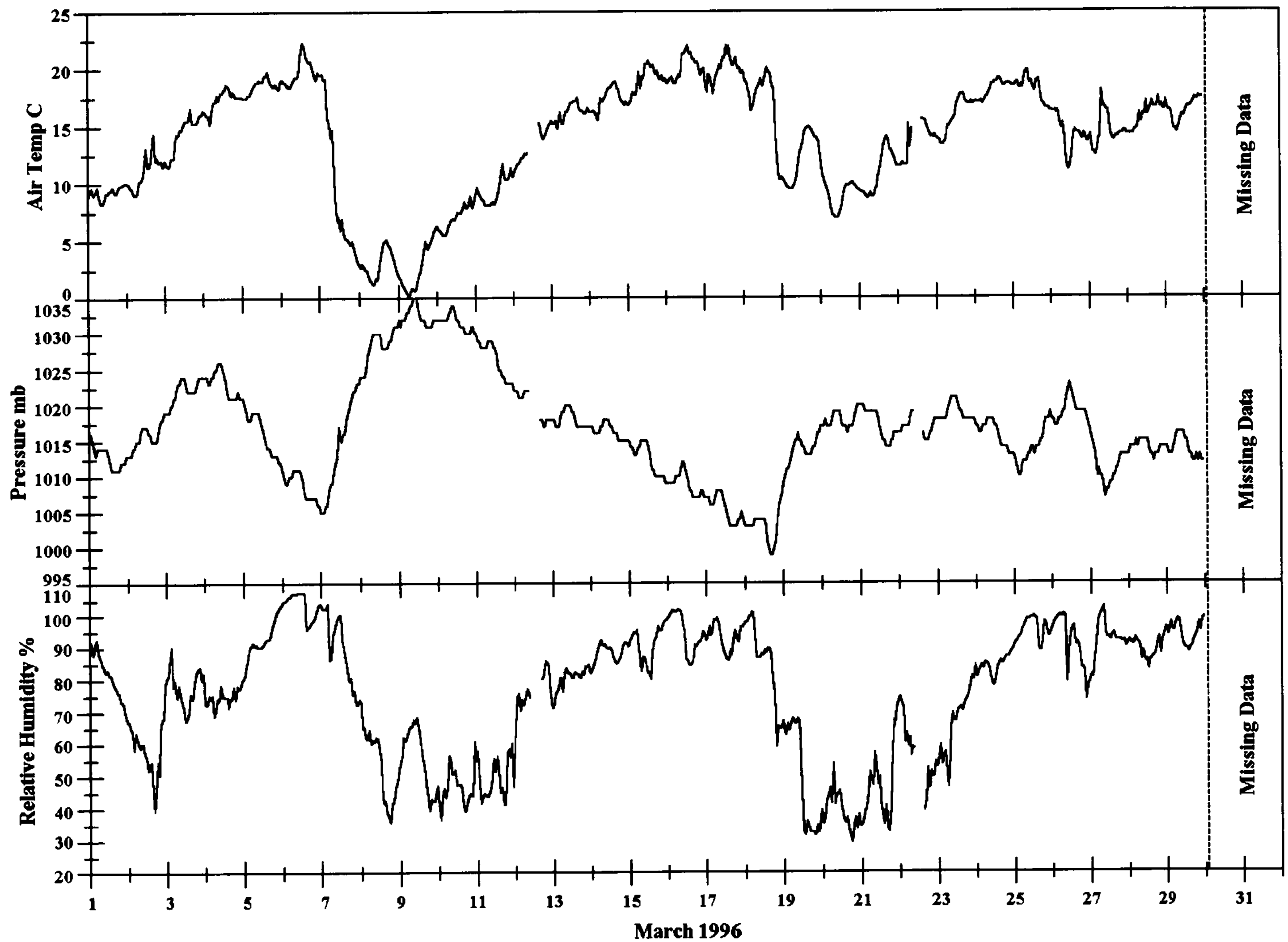
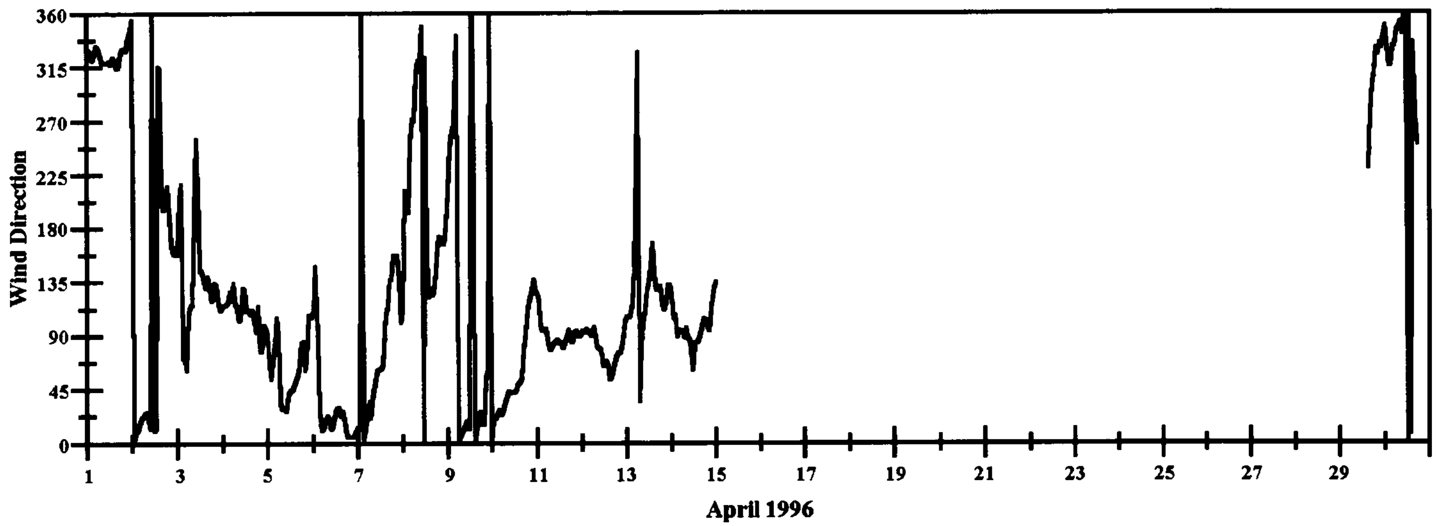


Figure 102. Breton Island March 1996 meteorological data.



Missing Data - Air Quality Monitors Damaged

Figure 103. Breton Island April 1996 meteorological data.

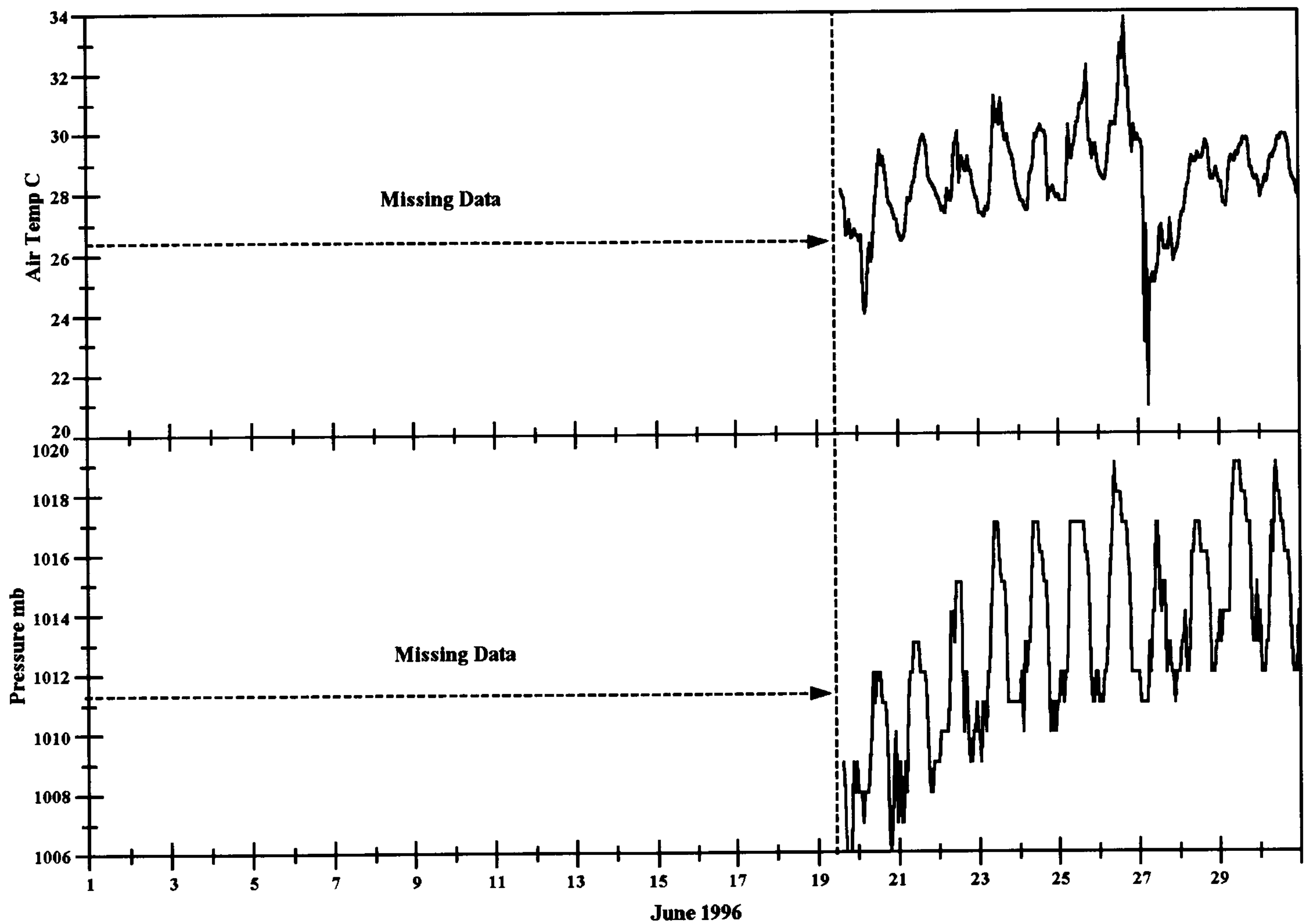


Figure 104. Breton Island June 1996 meteorological data.

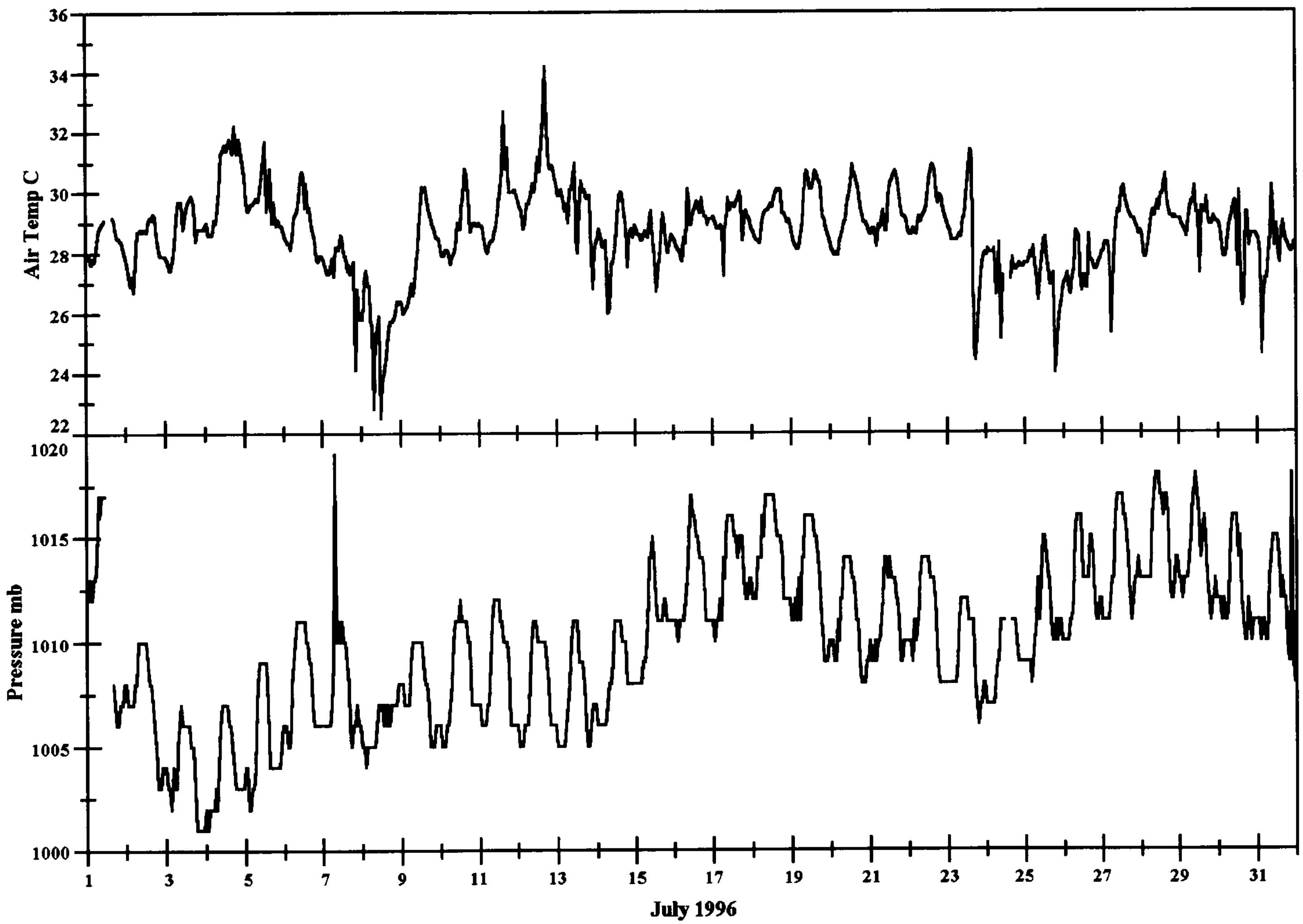


Figure 105. Breton Island July 1996 meteorological data.

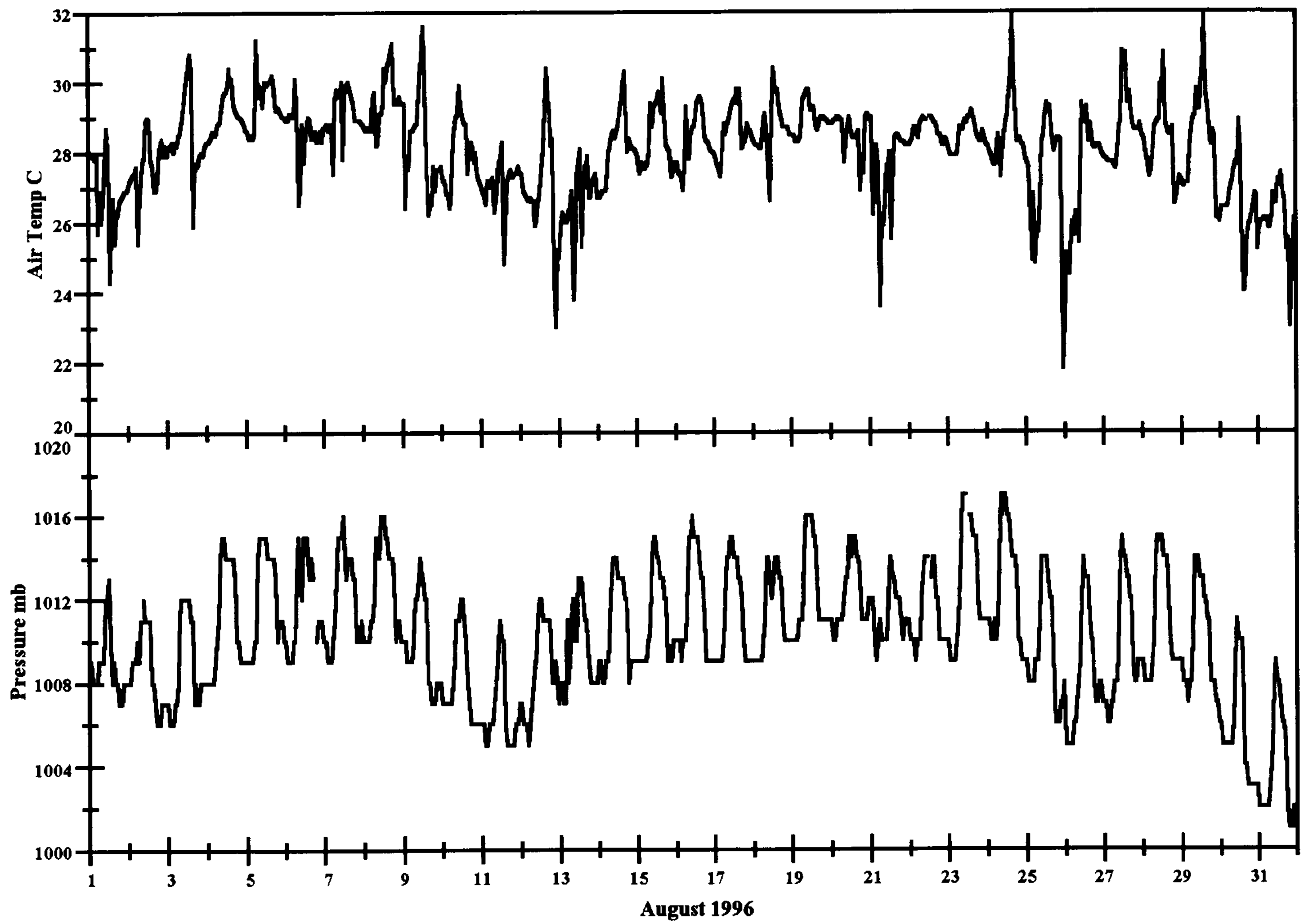


Figure 106. Breton Island August 1996 meteorological data.

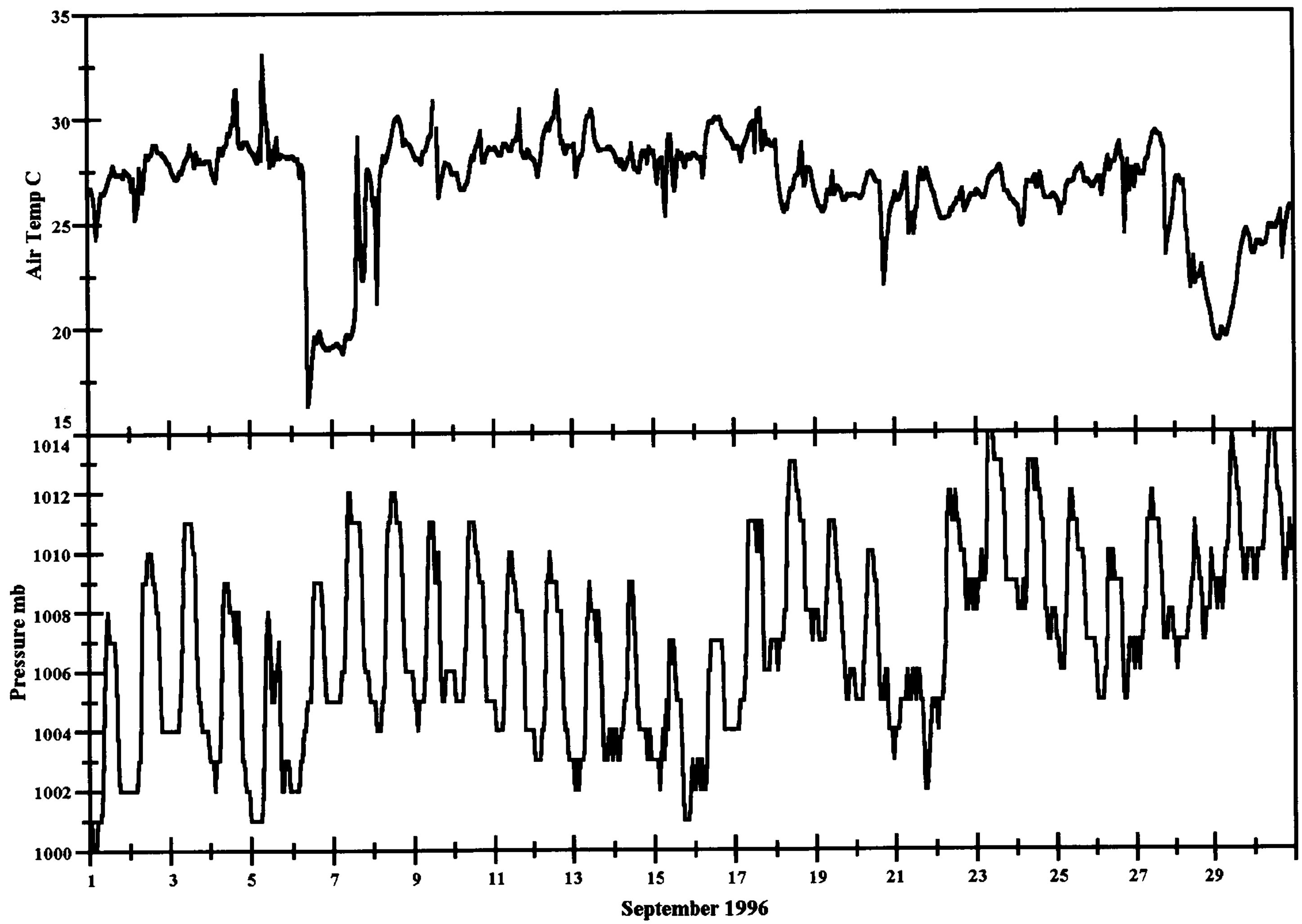


Figure 107. Breton Island September 1996 meteorological data.

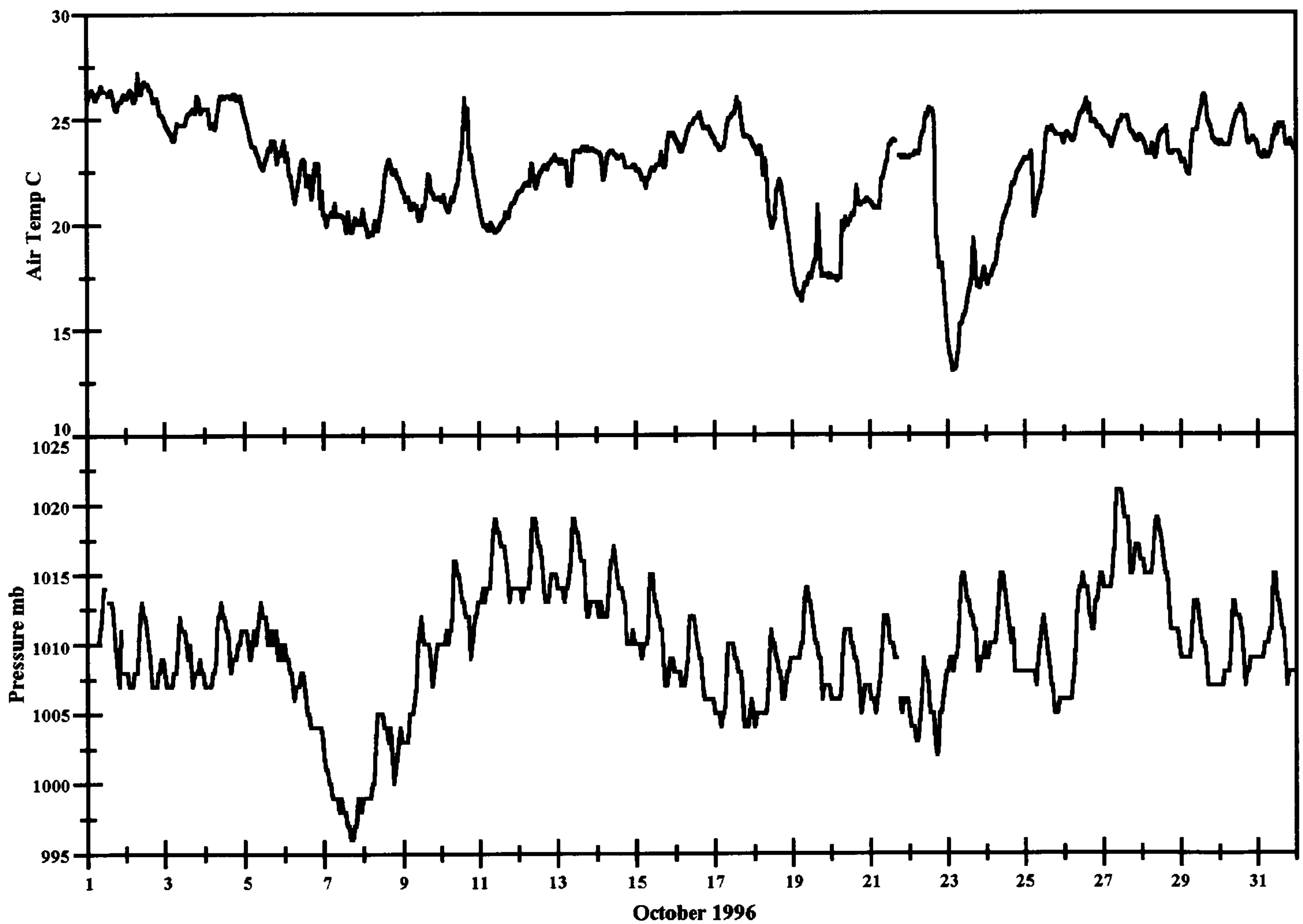


Figure 108. Breton Island October 1996 meteorological data.

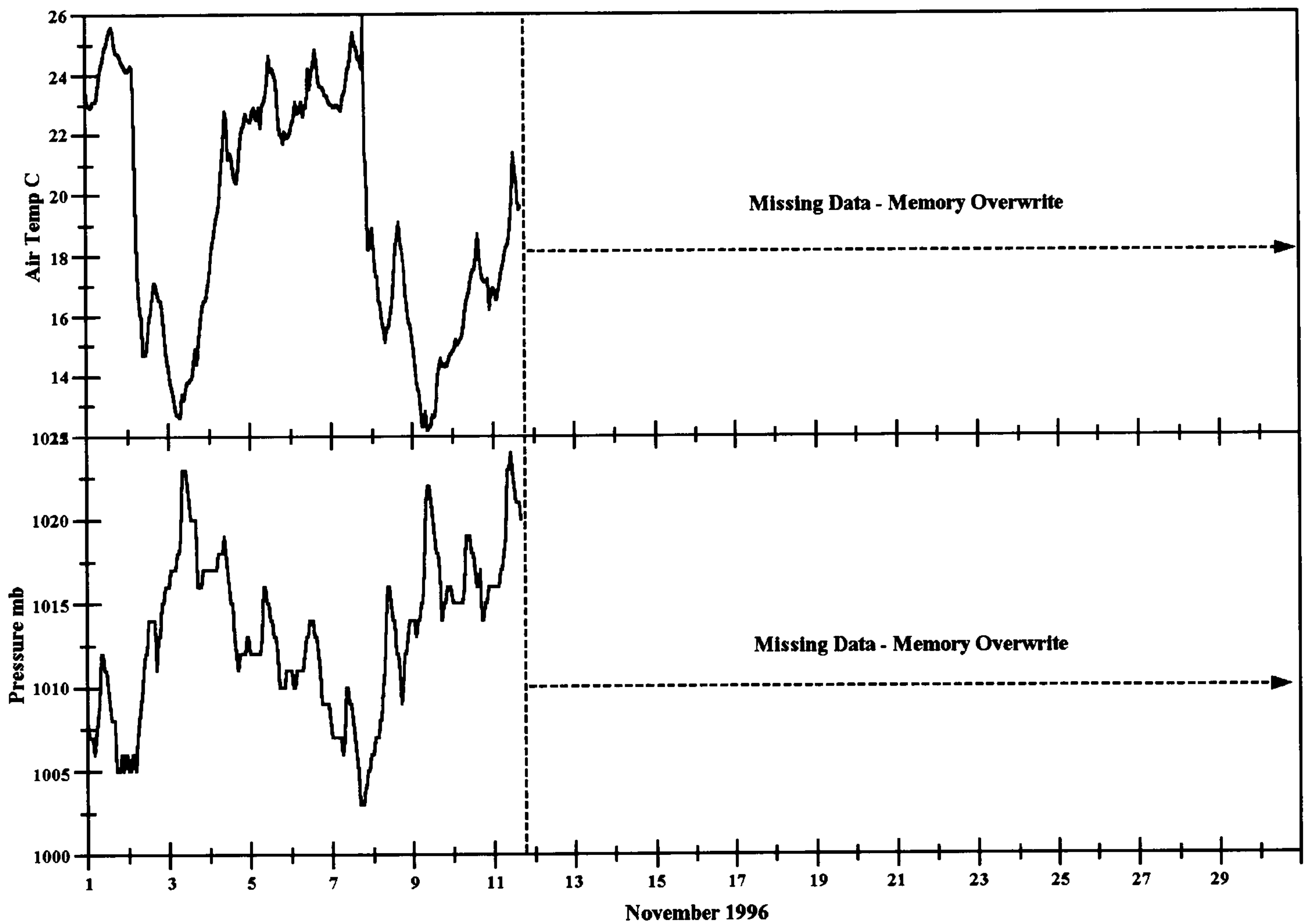


Figure 109. Breton Island November 1996 meteorological data.

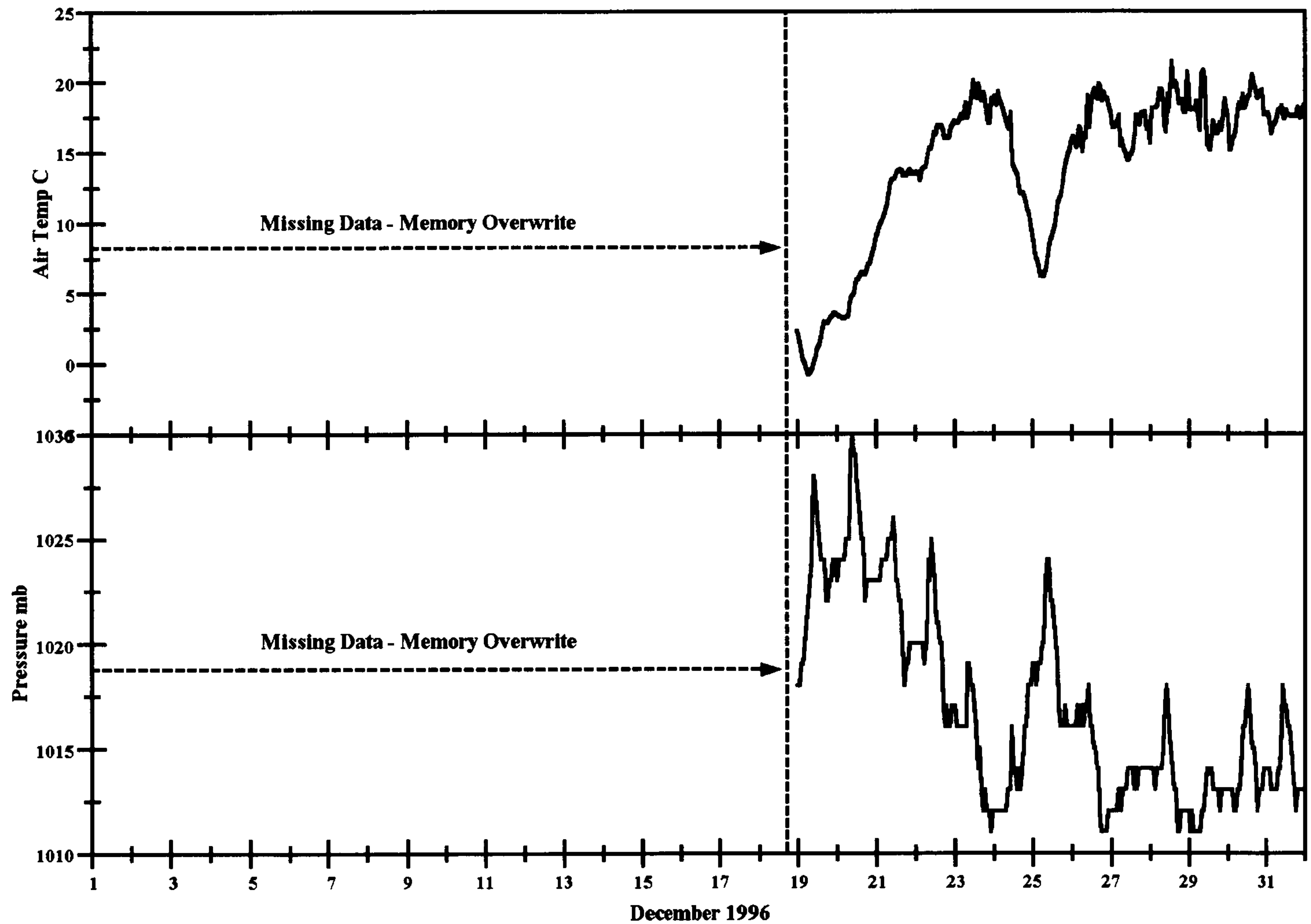


Figure 110. Breton Island December 1996 meteorological data.

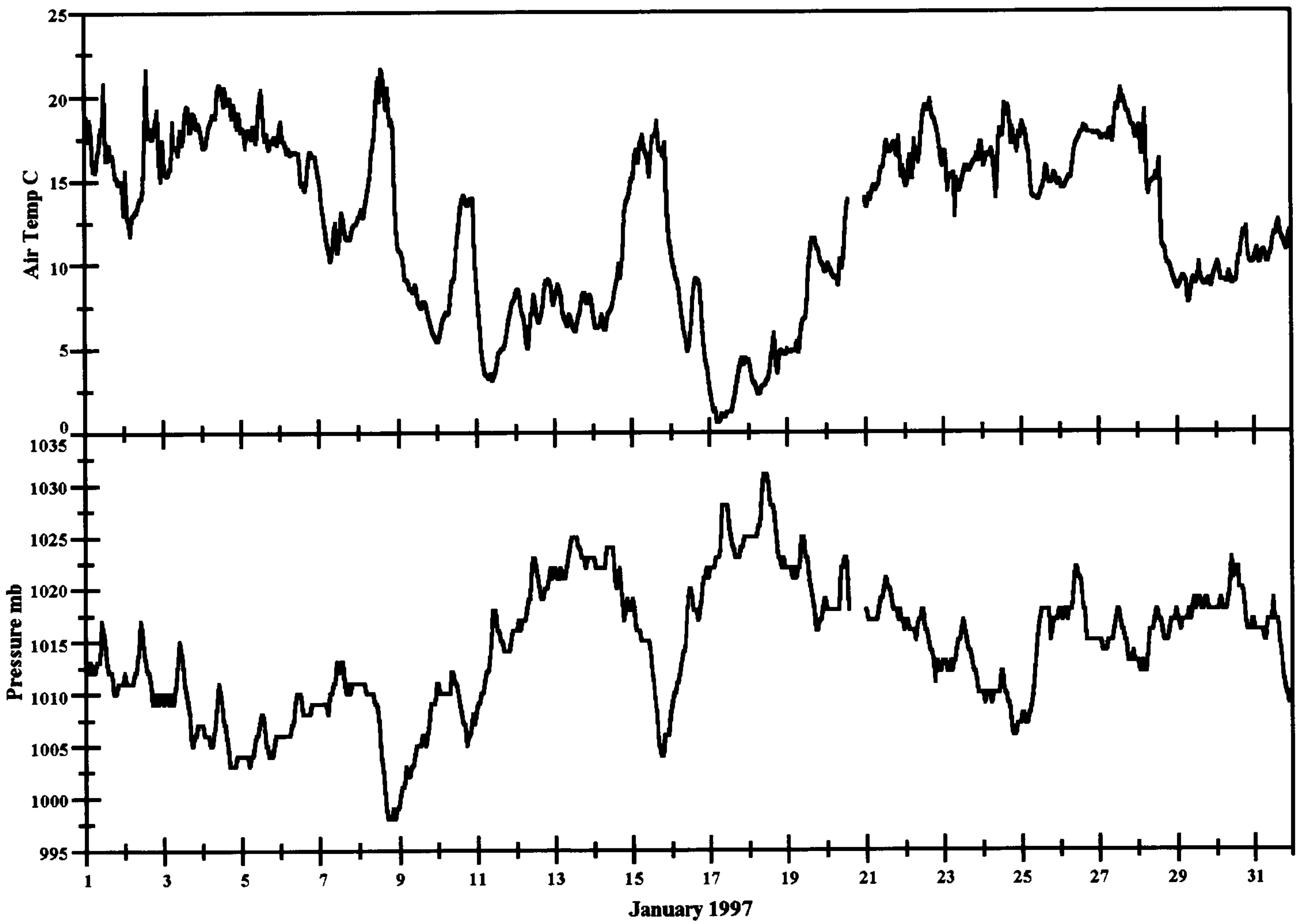


Figure 111. Breton Island January 1997 meteorological data.

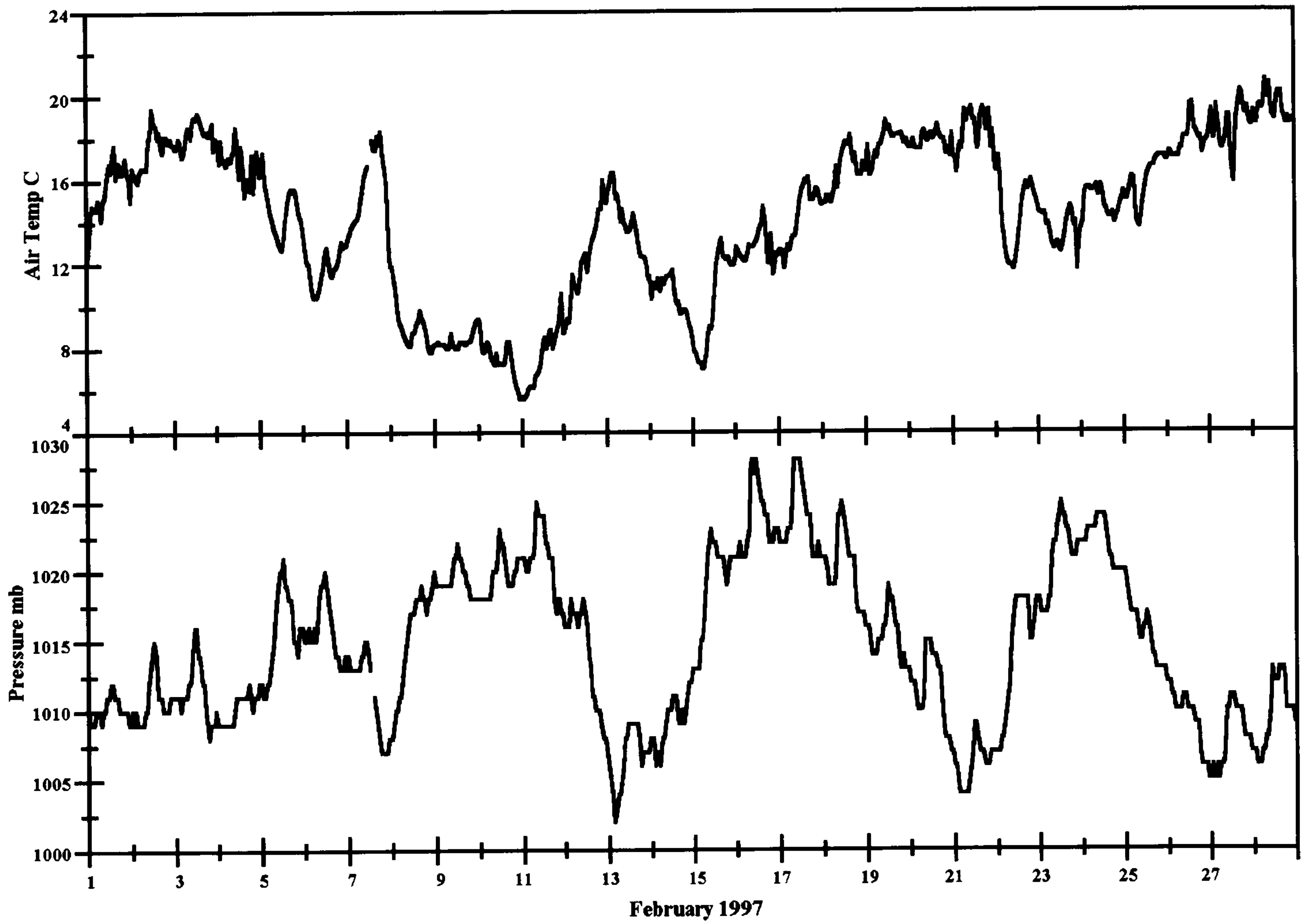


Figure 112. Breton Island February 1997 meteorological data.

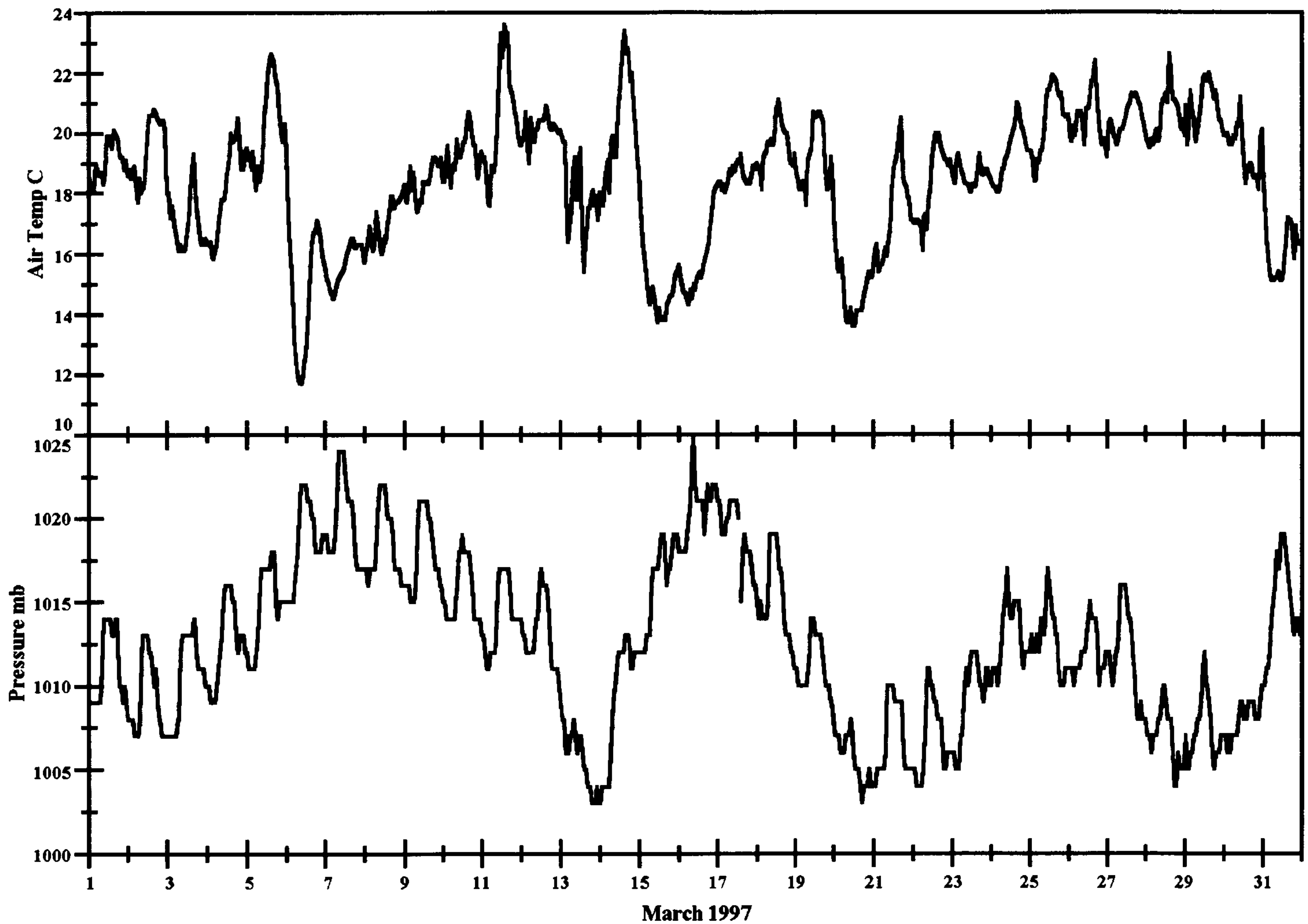


Figure 113. Breton Island March 1997 meteorological data.

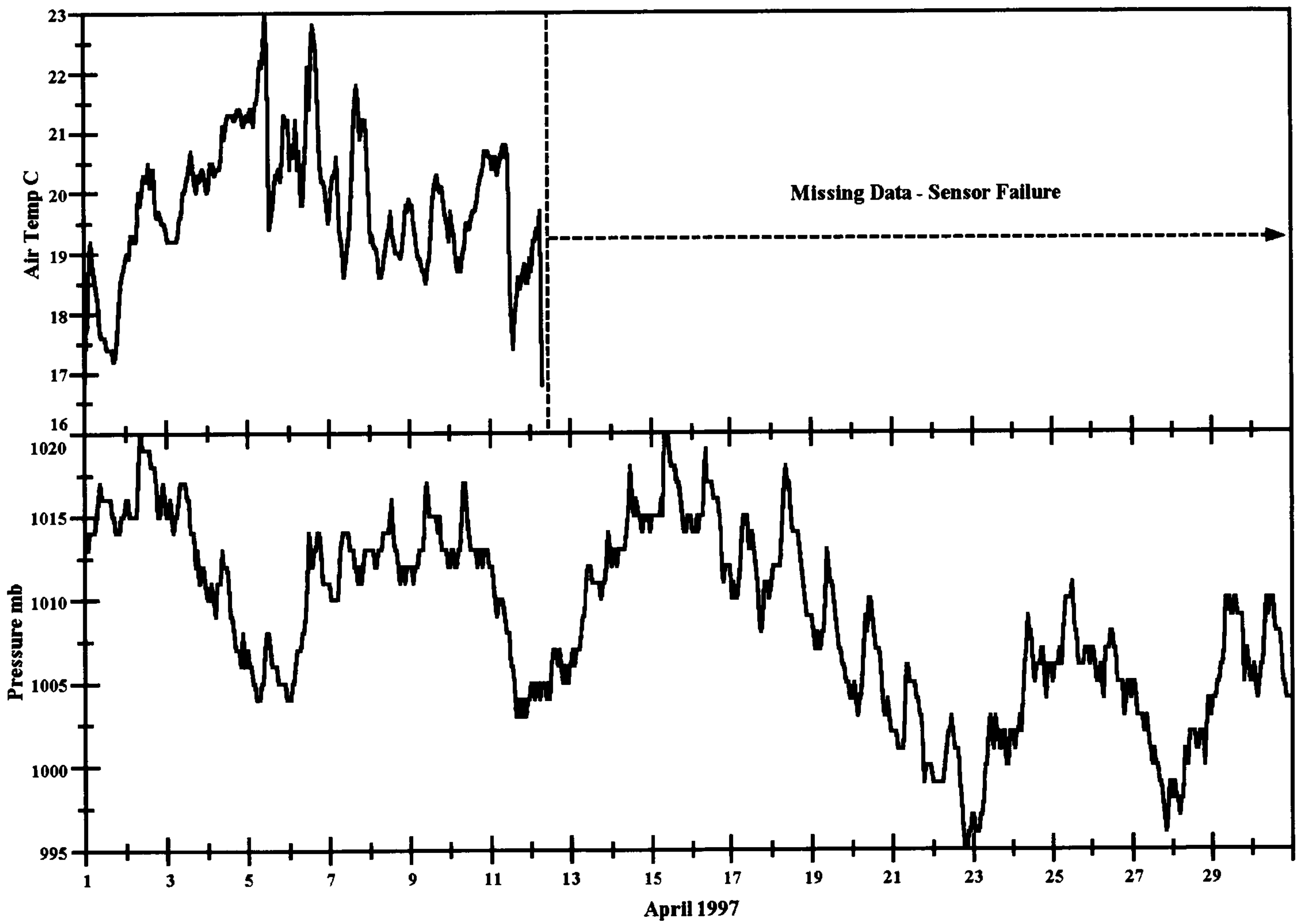


Figure 114. Breton Island April 1997 meteorological data.

III. ANALYSIS AND RESULTS

The Breton National Wildlife Area, containing Breton Island, has been designated as a Class I area, and is consequently subject to the most strict PSD restrictions. For reference, the U.S. Ambient Air Quality Standards and PSD Concentration Increments are listed in Table 25.

Table 25.
U.S. Federal Primary and Secondary Ambient Air Quality Standard
Source: 40 CFR § 50, July 1992
(From Boubel et al., 1994)

Pollutant	Type of Standard	Averaging Time	Frequency Parameter	Concentration $\mu g / m^3$	ppb
Sulfur Oxides (as sulfur dioxide)	Primary	24 hour	Annual Maximum*	365	138.7
		1 year	Arithmetic Mean	80	30.4
	Secondary	3 hour	Annual Maximum*	1300	494
Nitrogen Dioxide	Primary and Secondary	1 year	Arithmetic Mean	100	53

*Not to be exceeded more than once per year.

U.S. Federal PSD Concentration Increments For Class I Areas
Source: 40 CFR § 51.166, July 1992
(From Boubel et al., 1994)

	Increment	
Pollutant	$\mu g / m^3$	ppb
SO_2		
Annual Arithmetic Mean	2	0.8
24-hour Maximum	5	1.9
3-hour Maximum	25	9.5
NO_2		
Annual Arithmetic Mean	2.5	1.3

A. Dauphin Island

Daily average and maximum concentrations of SO_2 (ppb) are listed in Table 26 while those for NO_2 (ppb) are given in Table 27. The arithmetic mean for SO_2 for the entire measurement period (7 March 1996 through 30 April 1997, 9797 samples) is 1.86 ppb with a standard deviation of 2.73. First, second and third quartile values are 0, 1, and 2, respectively. The period mean for NO_2 (9379 samples) is 4.58 ppb with a standard deviation of 3.87. First, second and third quartile values are 2, 4, and 6, respectively. For comparison, these annual means are less than 10% of the NAAQS.

The monthly mean values for SO_2 appear to be fairly constant throughout the year with slight increase noticeable in August-September and January-February. On the other hand, mean NO_2 concentrations clearly begin to rise in the fall and peak in the winter season. This is illustrated in Figs. 115 through 120, which show annual time series of 3, 8, and 24-hour average pollutant concentrations.

The NOAA Coastal-Marine Automated Network (C-MAN) station at Dauphin Island served as source for wind data used in this station analysis. Monthly data files were downloaded via the National Data Buoy Center website. The C-MAN station DPIA1 is located at approximately 30.25°N 88.08°W, near the western entrance to Mobile Bay, Alabama and about 2 - 3 miles southeast of our site. The wind sensor is mounted 32' asl (NDBC, 1990). With the exception of April and October 1996, the percentage of usable data was greater than 90% (Table 28).

Monthly wind and pollution roses are shown in Figs. 121 through 134. The pollution roses were created by merging the air quality and wind datasets and removing those hourly records missing either parameter. This reduced the monthly sample sizes as shown in Table 28.

Table 26.
Dauphin Island SO_2 Maximums and Averages (ppb) based on 1 Hour Block Averages

	March 1996		April 1996		May 1996		June 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1			3	1.3	4	1.5	1	0.5
2			21	6.8	3	1.7	2	0.9
3			3	1.0	1	0.2	1	0.9
4			1	0.5	2	0.2	17	3.7
5			11	2.0	1	0.6	2	0.6
6			11	4.1	0	0	1	0.5
7	2	1.0	6	3.8	1	0.4	1	0.4
8	5	1.1	5	2.6	1	0.2	13	1.0
9	16	6.4	14	5.3	1	0.4	8	1.9
10	6	4.0	7	3.7	1	0.2	9	2.8
11	8	4.3	3	1.5	4	0.9	2	0.6
12	9	3.8	2	0.9	13	5.5	1	0.3
13	2	1.0	0	0	4	1.6	5	1.5
14	1	0.2	1	0	2	1.0	4	1.4
15	0	0	7	1.4	2	0.9	6	2.3
16	3	0.8	8	3.5	1	0.2	2	0.8
17	2	0.3	2	0.9	1	0.2	1	0.5
18	2	0.3	1	0	3	0.5	0	0
19	3	1.8	1	0.1	2	0.7	1	0.8
20	3	1.3	2	0.9	2	1.0	1	0.2
21	5	2.2	1	0.6	5	2.0	2	0.3
22	4	1.8	1	0.7	9	3.5	29	3.8
23	17	2.5	2	0.3	7	2.6	35	8.0
24	3	1.0	3	1.7	3	1.6	18	3.8
25	2	0.3	2	0.3	2	1.7	8	3.4
26	7	3.3	2	0.9	1	0.1	11	4.3
27	6	1.5	8	0.8	1	0	9	3.8
28	5	1.3	1	0.5	0	0	2	1.1
29	2	0.6	10	0.8	14	2.7	5	1.7
30	1	0.2	5	0.7	20	6.3	7	1.8
31	3	0.9			6	1.1		
# Hours	583		716		738		710	
Maximum	17		21		20		35	
Arith-Mean		1.69		1.60		1.26		1.77

Table 26 continued.

	July 1996		August 1996		September 1996		October 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	4	0.9	4	1.2	1	0.5	1	0.7
2	7	1.6	3	0.5	4	1.5	1	0.3
3	6	1.8	9	2.4	27	3.6	1	0.7
4	7	2.4	5	3.0	9	5.2	3	1.1
5	4	1.4	3	1.3	7	2.8	4	1.5
6	1	0.3	2	1.0	6	1.8	1	0.8
7	1	0.1	2	0.5	8	2.7	7	0.8
8	1	0.5	14	5.0	20	3.5	9	4.5
9	15	2.5	12	1.4	12	4.4	2	1.8
10	9	2.8	5	2.1	5	2.9	3	1.0
11	9	4.7	9	2.8	10	3.2	5	2.8
12	7	1.6	32	5.6	16	7.7	4	1.8
13	3	1.4	6	2.2	28	7.7	1	0.9
14	1	0.6	17	6.1	12	3.9	3	1.4
15	1	0.6	11	3.7	1	0.1	5	2.3
16	1	0.3	5	1.6	1	0.2	2	1.0
17	1	0.5	9	1.3	2	0.8	1	0.5
18	1	0.7	5	0.8	21	4.5	9	1.7
19	1	0.5	5	1.3	21	7.4	10	4.1
20	11	2.1	4	1.3	4	1.3	8	3.8
21	3	0.9	2	1.4	5	0.5	3	1.1
22	5	1.2	2	0.8	10	2.3	1	0.1
23	15	3.8	4	1.7	14	3.0	7	2.7
24	12	2.8	9	2.7	19	5.2	8	2.8
25	13	1.8	9	1.9	15	3.9	3	0.9
26	11	4.0	1	0.7			2	0.7
27	4	1.7	3	0.9	1	0.3	2	0.8
28	1	0.5	12	3.2	8	1.7	3	0.8
29	2	0.3	11	3.6	4	2.3	1	0.6
30	1	0.4	4	1.3	4	1.0	7	1.6
31	6	1.8	11	1.2			8	3.5
# Hours	740		731		669		707	
Maximum	15		32		28		10	
Arith-Mean		1.49		2.06		3.01		1.59

Table 26 continued.

	November 1996		December 1996		January 1997		February 1997	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	1	0.7	8	1.7	0	0	2	0.8
2	10	1.2	3	1.3	7	1.7	1	0.2
3	10	3.4	12	3.8	1	0.1	3	0.9
4	3	1.0	8	4.1	0	0	2	1.0
5	4	0.6	2	0.9	11	4.0	16	5.0
6	1	0.1	1	0	5	2.6	10	3.9
7	2	0.8	6	2.2	3	1.1	8	2.9
8	8	0.9	2	1.2	3	1.9	14	2.8
9	3	1.4	7	2.8			26	9.9
10	8	3.0	1	0.5	3	0.6	8	2.2
11	9	3.9	1	0.1	23	3.9	17	5.8
12	7	3.5	1	0.4	8	4.4	11	3.9
13	6	3.0	4	1.2	12	6.5	3	0.5
14	9	1.9	19	7.1	21	8.9	10	2.5
15	3	1.1	2	1.0	5	1.2	8	1.8
16	4	1.8	3	0.3	1	0.8	10	6.4
17	2	0.3	9	1.7	15	4.0	8	3.2
18	2	0.7	20	6.8	11	2.9	2	1.0
19	13	4.8	8	1.7	23	6.4	1	0.8
20	6	1.4	12	3.0	9	3.1	1	0.1
21	1	0.2	2	1.1	6	0.8	1	0
22	10	3.8	1	0.5	7	5.0	7	1.7
23	4	0.6	1	0.2	4	0.9	6	2.0
24	3	1.5	8	1.0	4	1.8	6	1.0
25	4	1.0	10	3.5	20	2.3	2	0.7
26	8	2.4	2	0.6	8	1.5	1	0.8
27	9	3.8	2	1.0	1	0.4	0	0
28	3	1.6	0	0	0	0	0	0
29	2	0.8	0	0	22	7.3		
30	1	0.1	1	0.1	21	7.5		
31			0	0	12	3.6		
# Hours	718		739		673		669	
Maximum	13		20		23		26	
Arith-Mean		1.70		1.61		2.86		2.20

Table 26 continued.

	March 1997		April 1997	
Day	Maximum	Average	Maximum	Average
1	1	0	5	2.2
2	1	0	5	1.5
3	14	3.9	3	1.2
4	1	0.4	1	0.1
5	1	0.6	1	0.6
6	4	1.8	6	0.8
7	6	2.2	12	3.6
8	5	2.0	8	1.8
9	1	0.4	7	3.0
10	1	0.6	8	3.3
11	1	0.4	1	0.4
12	3	1.5	1	0.2
13	1	0.3	6	1.4
14	3	0.6	3	1.5
15	11	3.9	28	5.2
16	7	2.9	5	2.3
17	2	0.8	10	1.7
18	1	0.9	5	2.2
19			6	2.4
20	6	2.3	6	1.4
21	9	4.2	1	0.1
22	37	6.1	2	0.8
23	6	2.7	2	1.3
24	4	1.2	13	3.0
25	1	0.3	8	2.8
26	11	2.5	2	0.5
27	16	3.6	1	0.2
28	1	0.1	2	0.6
29	1	0.5	6	2.3
30	5	0.7	1	0.7
31	9	2.6		
# Hours	694		710	
Maximum	37		28	
Arith-Mean		1.66		1.63

Table 27.
Dauphin Island NO_2 Maximums and Averages (ppb) based on 1 Hour Block Averages

	March 1996		April 1996		May 1996		June 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1			8	3.9	7	2.6	2	0.9
2			18	8.4	4	2.2	1	0.6
3			7	4.2	4	1.8	4	1.9
4			7	4.2	8	1.8	7	4.6
5			16	6.9	1	1.0	8	3.0
6			16	8.7	3	1.6	5	0.7
7	6	4.7	10	4.5			6	1.7
8	7	2.5	8	4.5			6	1.5
9	14	6.7	13	5.7			7	2.5
10	9	4.9	8	5.0			6	2.7
11	34	8.0	15	4.3			5	1.8
12	26	8.4	6	2.9			2	0.9
13	12	6.0	9	3.9			8	2.3
14	6	4.3	5	2.8			9	4.0
15	8	4.4	6	3.2			11	4.8
16	9	6.0	11	6.1			4	2.0
17	9	5.0	9	3.2			5	1.3
18	5	3.6	4	2.3			2	0.8
19	5	3.5	4	2.4			4	1.9
20	6	3.3	6	2.4			3	1.5
21	7	4.9	3	1.7			2	1.3
22	13	5.8	3	1.8			13	3.7
23	13	6.1	4	2.6			13	5.6
24	8	3.1	5	2.6	3	1.9	11	4.0
25	9	3.9	3	2.3	4	1.5	12	5.5
26	23	6.6	4	2.8	1	0.7	12	5.9
27	8	5.3	8	4.2	5	0.6	10	5.4
28	10	5.3	2	1.6	3	1.0	9	3.8
29	8	5.2	7	2.4	17	4.4	7	3.3
30	6	3.3	5	2.5	22	7.0	9	3.2
31	7	3.9			7	2.7		
# Hours	583		716		322		710	
Maximum	34		18		22		13	
Arith-Mean		5.0		3.80		2.21		2.74

Table 27 continued.

	July 1996		August 1996		September 1996		October 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	8	2.1	8	3.3	3	1.4	3	1.7
2	3	2.0	8	3.7	5	1.7	3	1.7
3	7	2.8	8	4.7	6	3.4	2	1.3
4	9	3.9	8	4.4	7	4.4	4	2.3
5	4	2.4	7	2.5	19	5.0	10	3.1
6	3	1.8	4	1.8	10	3.5	3	1.8
7	2	1.1	3	1.6	9	2.8	8	1.8
8	12	2.5	14	3.8	10	3.2	38	8.7
9	10	5.5	11	4.5	7	4.0	9	5.9
10	13	5.9	6	3.1	8	3.6	11	4.9
11	14	6.2	6	3.5	6	3.1	5	3.5
12	11	4.2	12	4.2	11	6.1	13	6.2
13	10	4.2	9	3.7	22	7.8	9	4.4
14	7	2.4	9	4.8	8	3.6	10	4.5
15	5	2.1	8	4.1	2	1.0	24	6.0
16	6	2.7	6	2.7	2	1.1	7	3.3
17	4	1.5	4	2.5	6	1.9	12	4.7
18	3	1.4	6	2.1	13	4.0	18	5.4
19	2	1.1	4	2.6	13	4.8	14	8.8
20	6	2.6	8	2.9	7	3.5	12	5.7
21	5	2.2	4	2.3	7	2.3	9	3.3
22	4	2.1	5	2.3	4	2.4	5	2.0
23	12	4.7	5	2.3	4	2.1	15	6.6
24	7	3.5	12	3.8	16	5.5	17	6.0
25	6	2.7	13	3.8	12	5.1	11	4.4
26	17	6.0	7	2.7			3	1.9
27	5	2.4	4	1.2	2	1.1	5	2.8
28	3	1.3	9	4.3	7	2.3	11	4.8
29	6	2.0	9	3.8	3	2.0	9	3.5
30	1	1.0	5	2.6	5	2.6	9	5.1
31	7	2.3	8	1.8			11	5.3
# Hours	740		729		669		707	
Maximum	17		14		22		38	
Arith-Mean		2.84		3.14		3.29		4.18

Table 27 continued.

	November 1996		December 1996		January 1997		February 1997	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	5	2.9	9	3.8	9	4.0	9	6.3
2	17	5.5	22	5.4	9	4.3	19	8.2
3	9	4.3	22	13.4	6	4.1	12	5.1
4	8	4.5	24	9.8	5	3.3	28	6.1
5	14	4.8	27	9.9	22	7.8	33	15.5
6	4	2.0	16	5.4	18	6.2	33	9.8
7	5	2.4	12	5.5	7	5.6	15	8.5
8	8	3.2	8	4.5	7	6.5	20	10.0
9	11	4.4	12	7.4			34	15.9
10	12	6.3	22	5.3	6	3.6	22	6.8
11	8	4.6	6	3.2	24	6.2	16	11.6
12	8	5.5	7	4.0	9	6.4	15	9.1
13	12	7.5	17	8.1	12	8.1	35	10.9
14	20	8.1	18	11.5	30	14.2	29	15.5
15	9	5.6	14	6.8	11	6.6	25	7.0
16	5	3.5	7	3.6	6	3.9	22	11.9
17	9	3.2	11	4.5	15	7.5	16	8.4
18	11	4.2	18	8.4	20	8.8	16	7.1
19	27	12.8	4	2.7	27	16.6	15	7.0
20	14	7.4	13	5.6	26	13.4	5	2.8
21	17	6.1	8	4.1	28	10.9	6	3.3
22	14	7.5	7	4.1	13	5.6	8	4.3
23	10	5.5	15	3.2	16	7.6	5	4.3
24	10	5.2	10	4.6	5	3.3	10	5.3
25	10	4.6	15	5.0	21	6.8	9	4.8
26	17	9.3	12	4.9	9	4.2	5	2.8
27	14	8.2	21	6.6	11	3.3	8	3.5
28	17	7.8	9	3.6	13	6.0	4	2.5
29	6	3.8	7	3.3	27	21.5		
30	3	1.6	7	2.8	24	18.8		
31			6	2.5	26	13.7		
# Hours	718		739		673		669	
Maximum	27		27		30		35	
Arith-Mean		5.41		5.58		7.86		7.65

Table 27 continued.

	March 1997		April 1997	
Day	Maximum	Average	Maximum	Average
1	6	3.0	14	4.8
2	4	3.0	17	6.0
3	12	6.5	8	3.3
4	14	6.5	3	1.6
5	5	3.2	6	2.5
6	7	3.7	14	4.0
7	7	4.8	13	4.8
8	33	9.5	12	5.5
9	7	4.4	8	4.4
10	7	3.4	8	4.4
11	8	4.2	5	2.2
12	10	6.4	10	4.1
13	5	3.1	8	3.8
14	8	4.5	5	2.8
15	17	6.3	58	9.3
16	11	5.7	12	6.5
17	14	7.5	10	5.6
18	5	3.6	5	3.9
19			18	6.6
20	21	13.6	18	6.3
21	13	7.1	6	3.0
22	24	10.2	4	3.1
23	21	6.5	6	3.6
24	11	4.6	15	5.5
25	4	2.8	11	5.1
26	14	7.2	8	3.4
27	11	5.0	5	2.0
28	5	3.2	14	3.6
29	7	3.8	8	4.9
30	11	4.0	4	2.3
31	16	4.5		
# Hours	694		710	
Maximum	33		58	
Arith-Mean		5.27		4.29

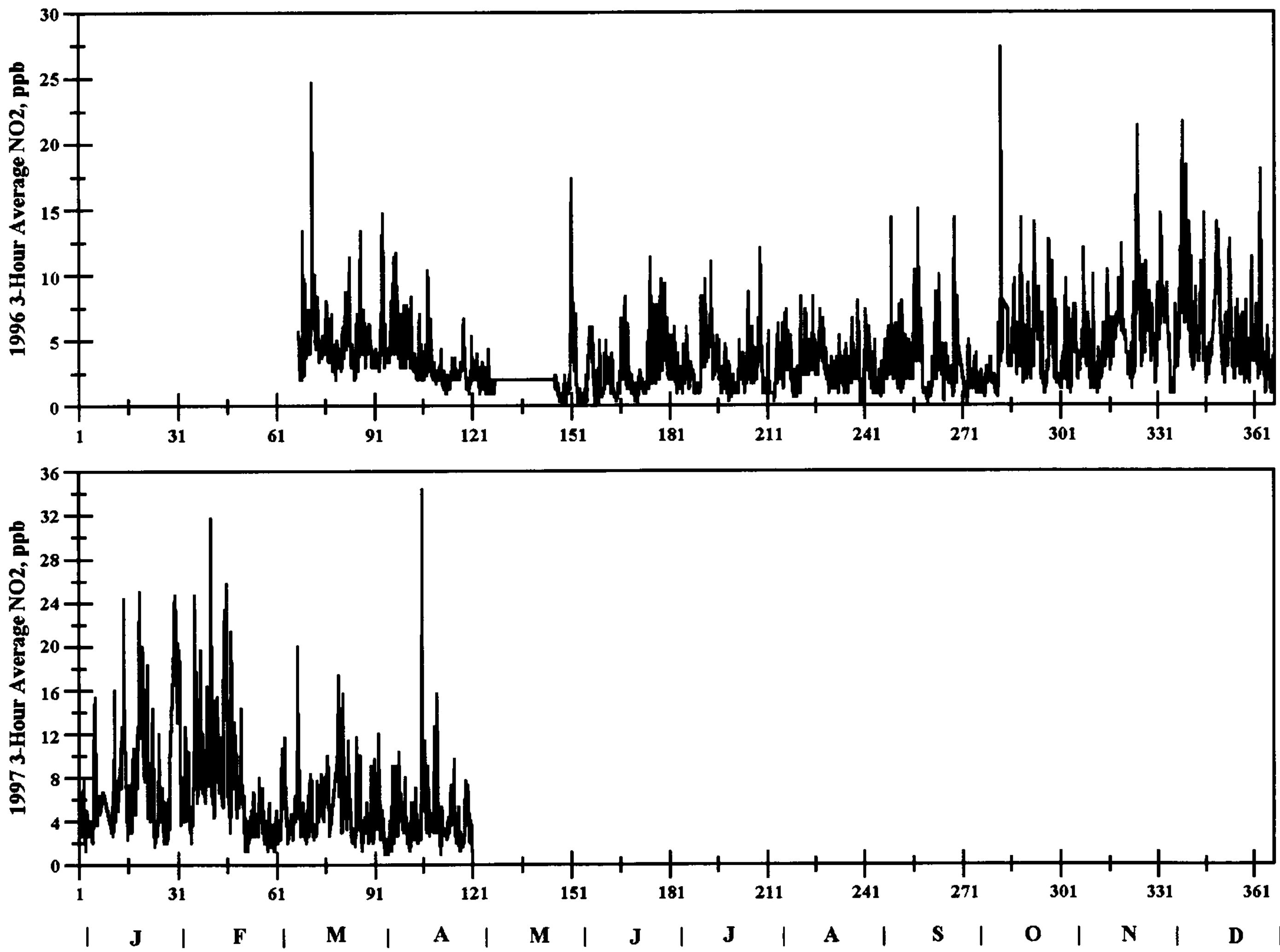


Figure 115. Dauphin Island 3-hour block averaged annual NO_2 trends.

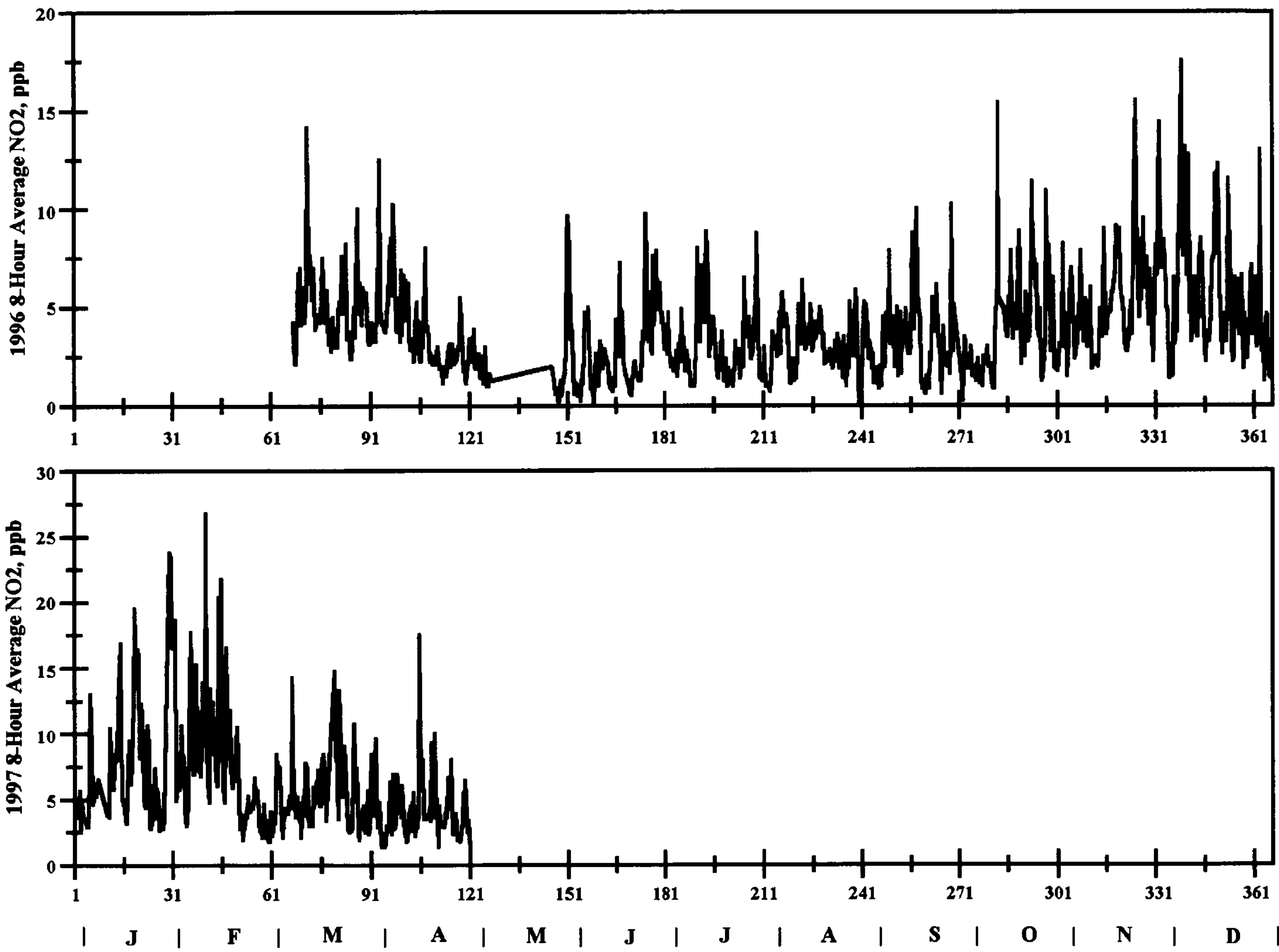


Figure 116. Dauphin Island 8-hour block averaged annual NO_2 trends.

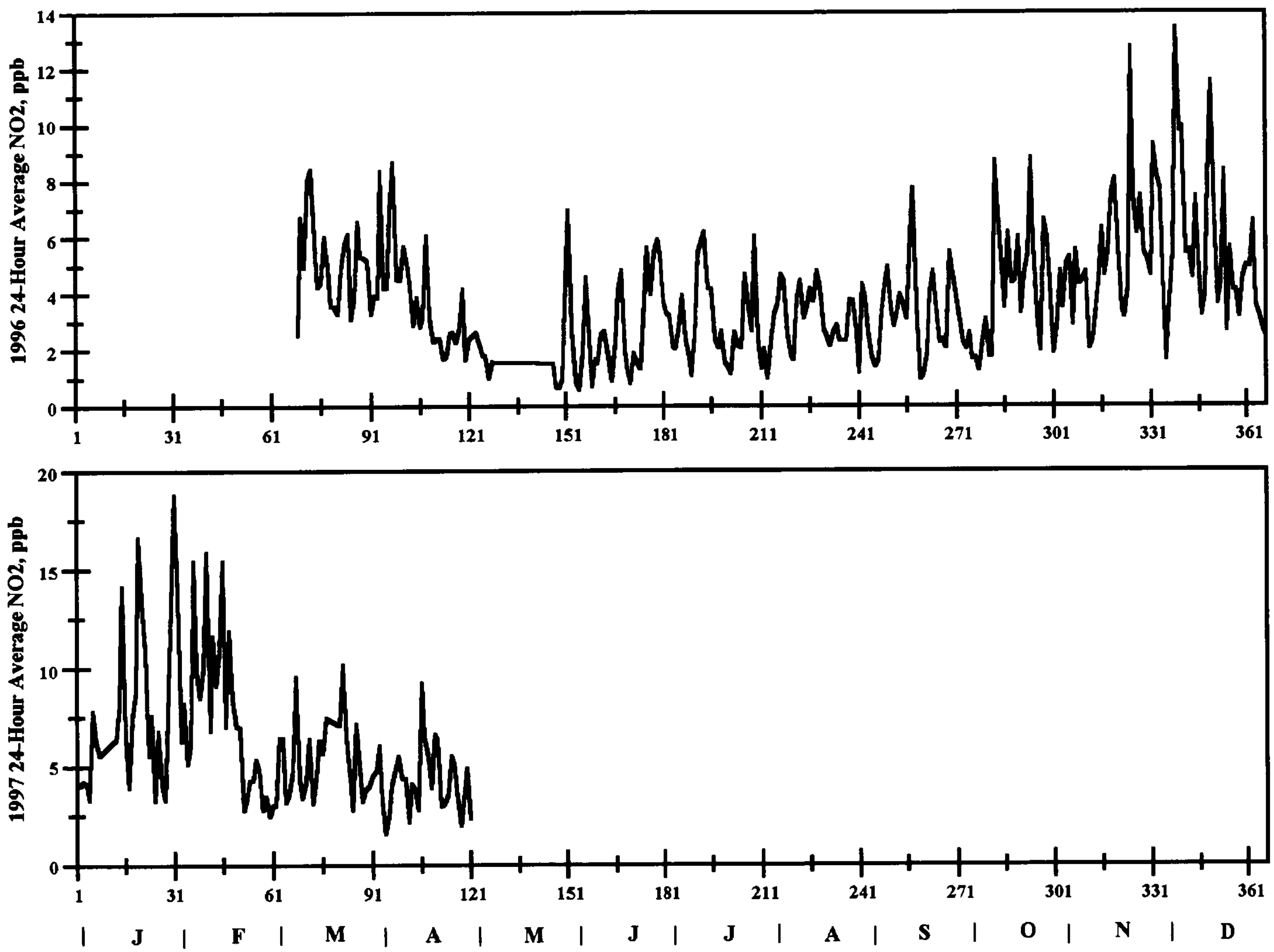


Figure 117. Dauphin Island 24-hour block averaged NO_2 trends.

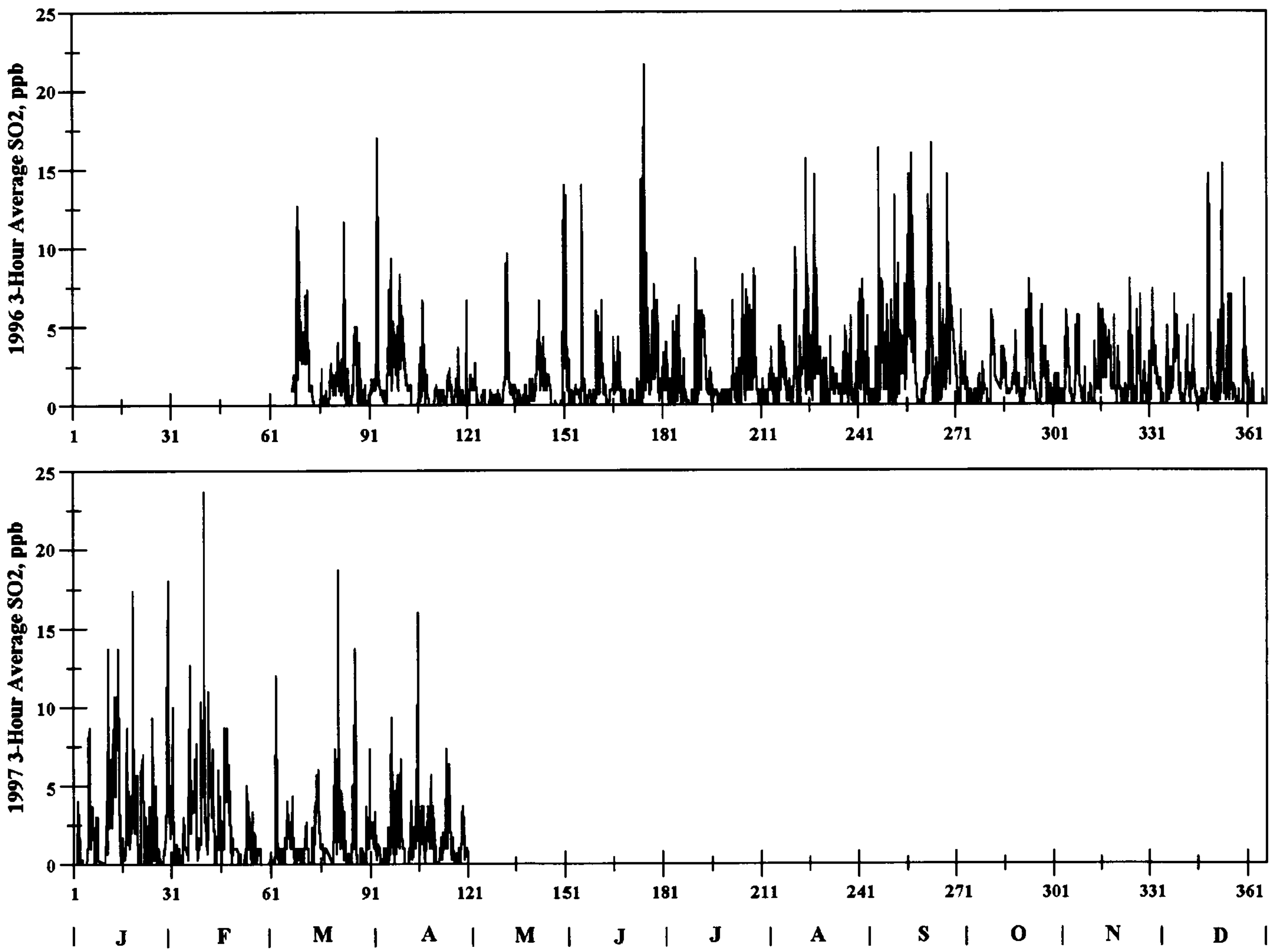


Figure 118. Dauphin Island 3-hour block averaged SO_2 trends.

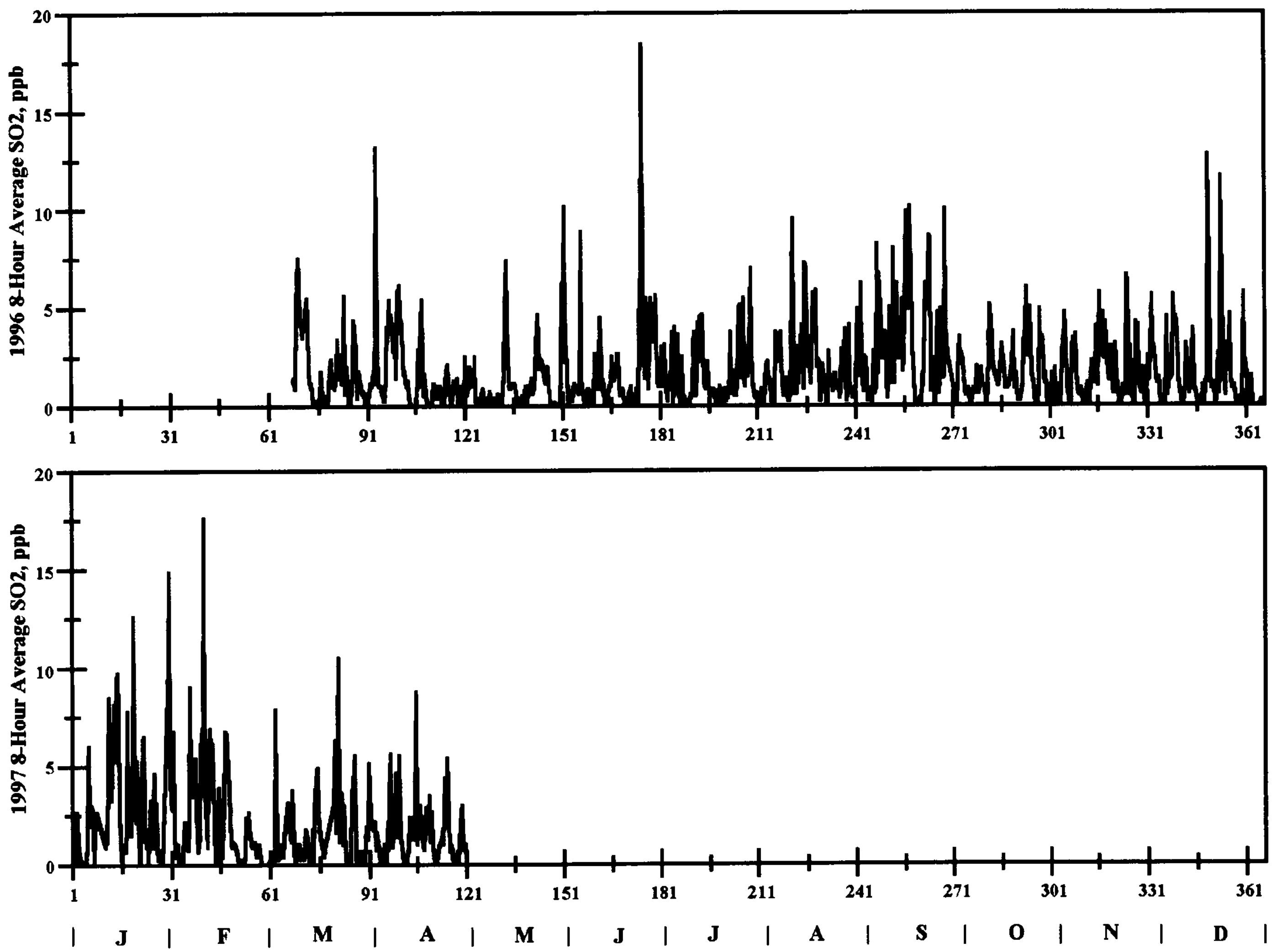


Figure 119. Dauphin Island 8-hour block averaged SO_2 trends.

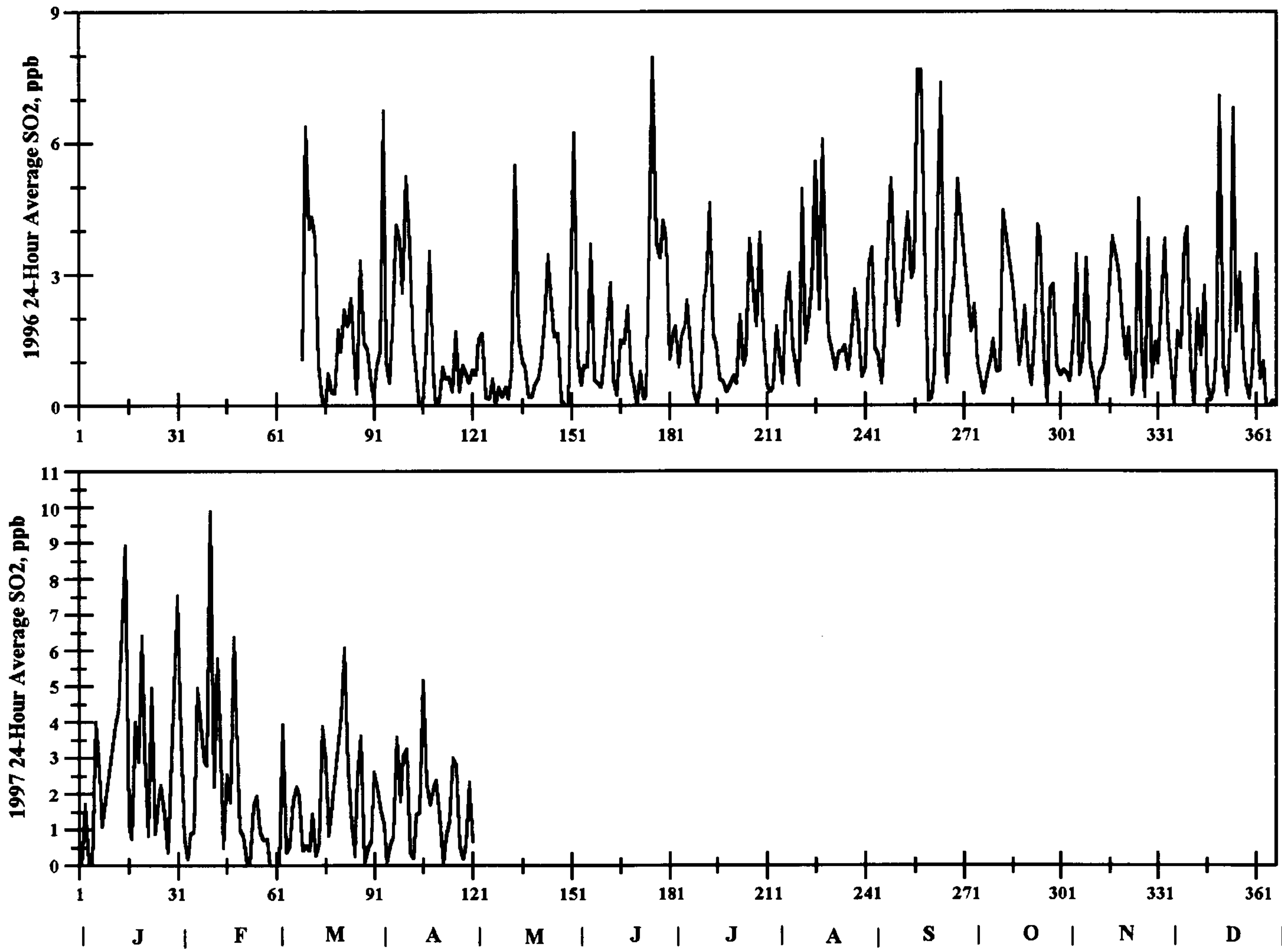


Figure 120. Dauphin Island 24-hour block averaged SO_2 trends.

Table 28.
Percentage Data Return - DPIA1 Wind Speed/Direction
and Combined Air Quality for Pollution Roses

	DPIA1 Wind Data		Combined AQ/Wind Data	
Month	# Samples	%	# Samples	%
March 96	741	99.6	580	78.0
April 96	509	70.7	505	70.1
May 96	736	98.9	730 (318 NO_2)	98.1 (42.7)
June 96	714	99.2	704	97.8
July 96	735	98.8	732	98.4
August 96	742	99.7	729	98.0
September 96	666	92.5	617	85.7
October 96	533	71.6	500	67.2
November 96	650	90.3	648	90.0
December 96	739	99.3	735	98.8
January 97	740	99.5	669	89.9
February 97	655	97.5	652	97.0
March 97	742	99.7	692	93.0
April 97	708	98.3	698	96.9

Monthly wind distributions appear to follow expected seasonal trends; i.e., stronger northerly winds in the winter months, lighter southerly flow in the summer, and more variable flow in fall and spring. Highest concentrations of SO_2 are mostly associated with northerly to west-northwesterly winds throughout the year, while NO_2 maximums are most commonly seen with more northerly flow. The dominance of onshore (southerly) flow during the summer months therefore seems directly related to the lower monthly mean NO_2 values measured.

The observation that the majority of pollutant maximums occur with westerly to northerly flow is further substantiated by Tables 29 and 30, which list 1, 3, and 24-hour maximums for SO_2 and NO_2, respectively. It is even more revealing to examine the highest 5% of the data record for each pollutant, as shown in Table 31. It can be seen that the winter season experiences the highest NO_2 concentrations and that the maximums are most likely associated with north-northeast winds. For SO_2, maximums are possible throughout the year, but slightly more so in late summer and winter, again, with northerly winds.

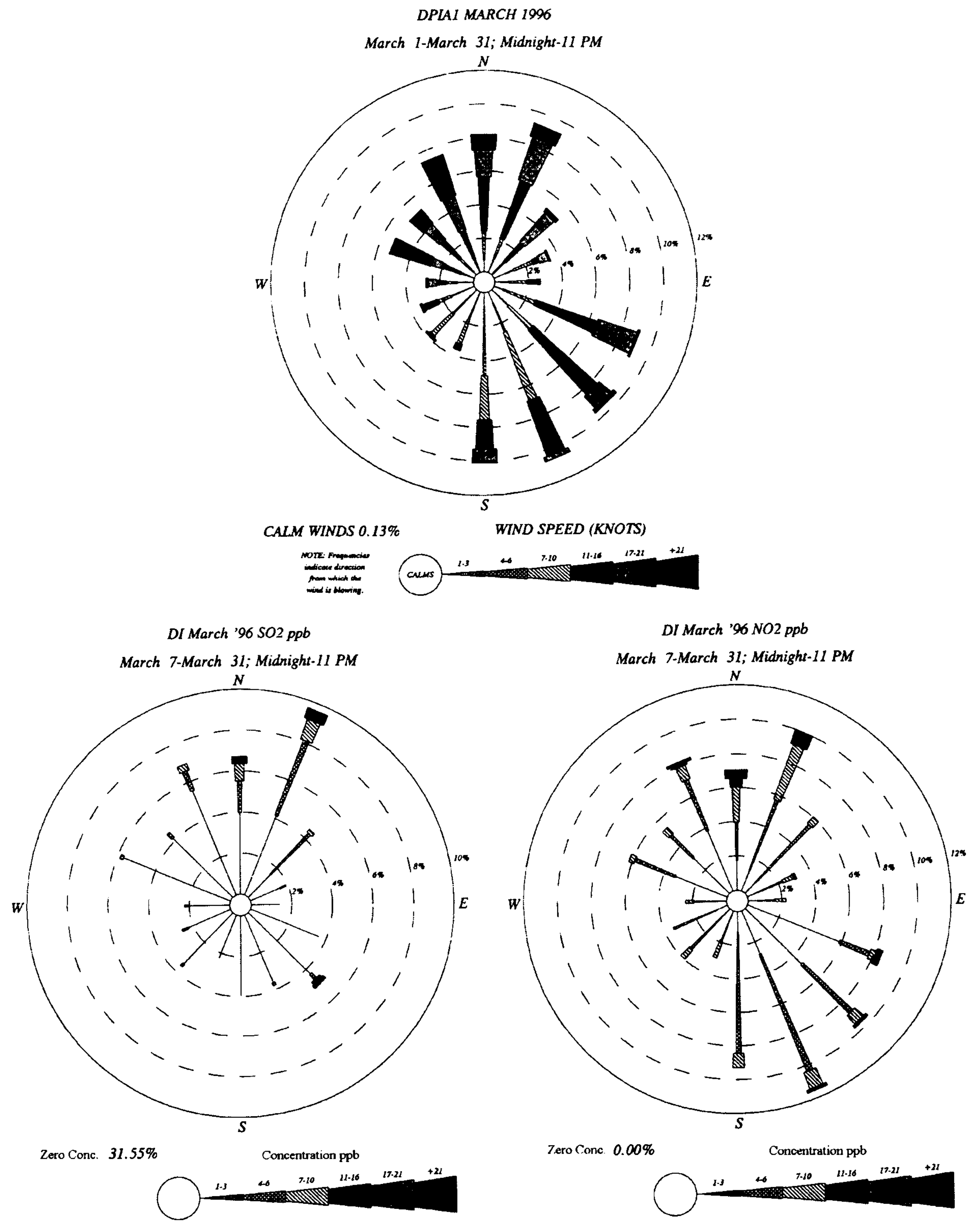


Figure 121. March 1996 wind and pollution roses from Dauphin Island.

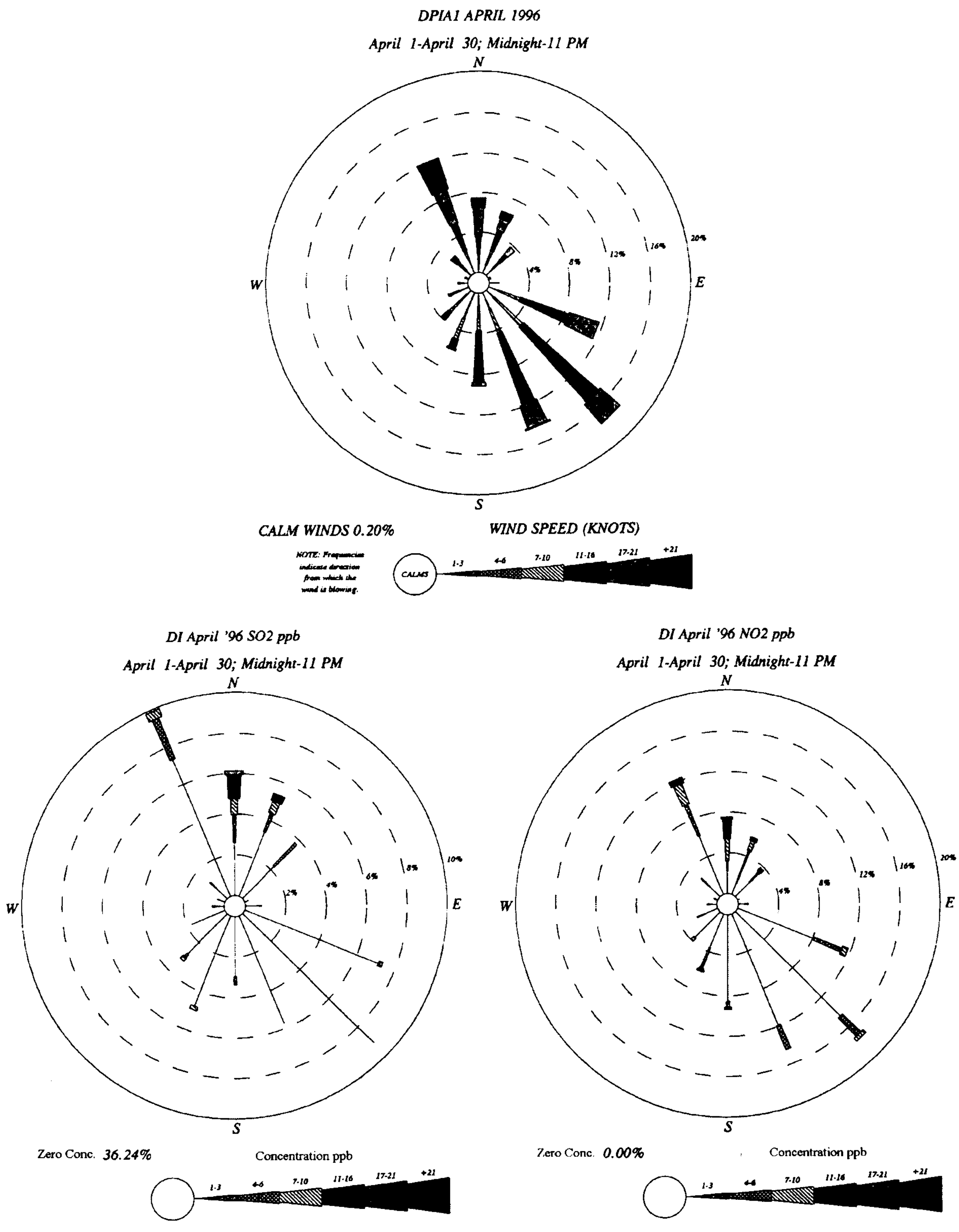


Figure 122. April 1996 wind and pollution roses from Dauphin Island.

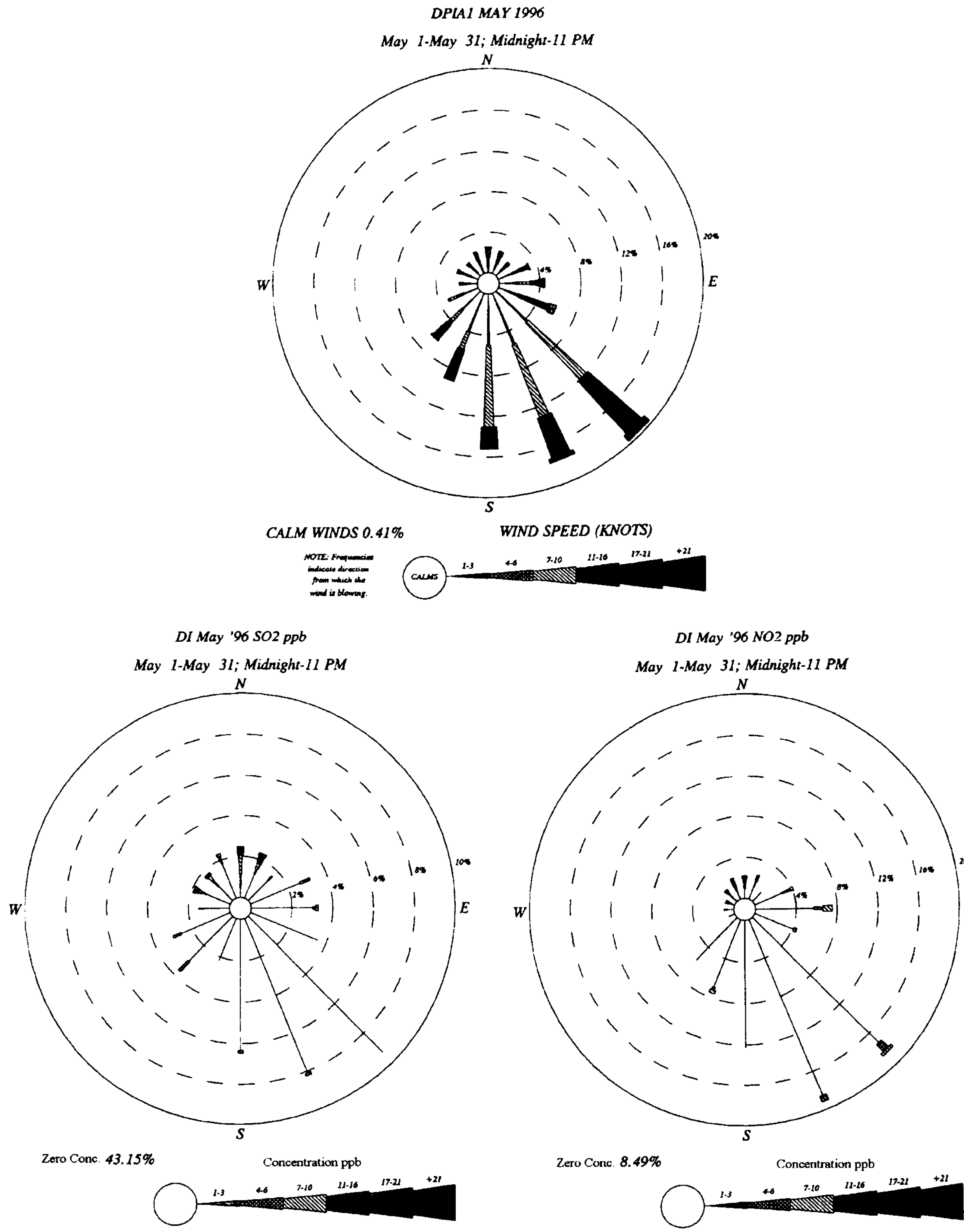


Figure 123. May 1996 wind and pollution roses from Dauphin Island.

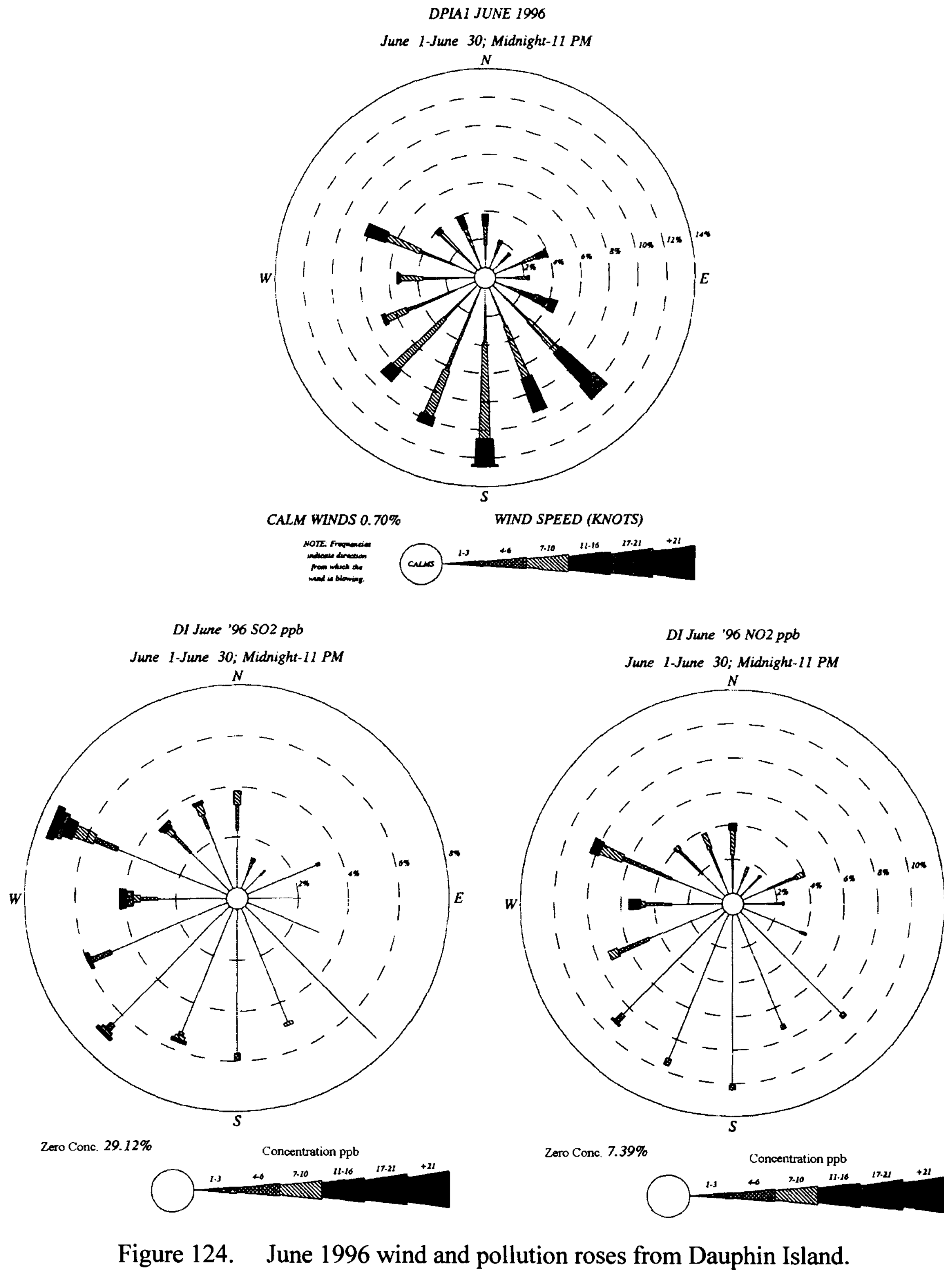


Figure 124. June 1996 wind and pollution roses from Dauphin Island.

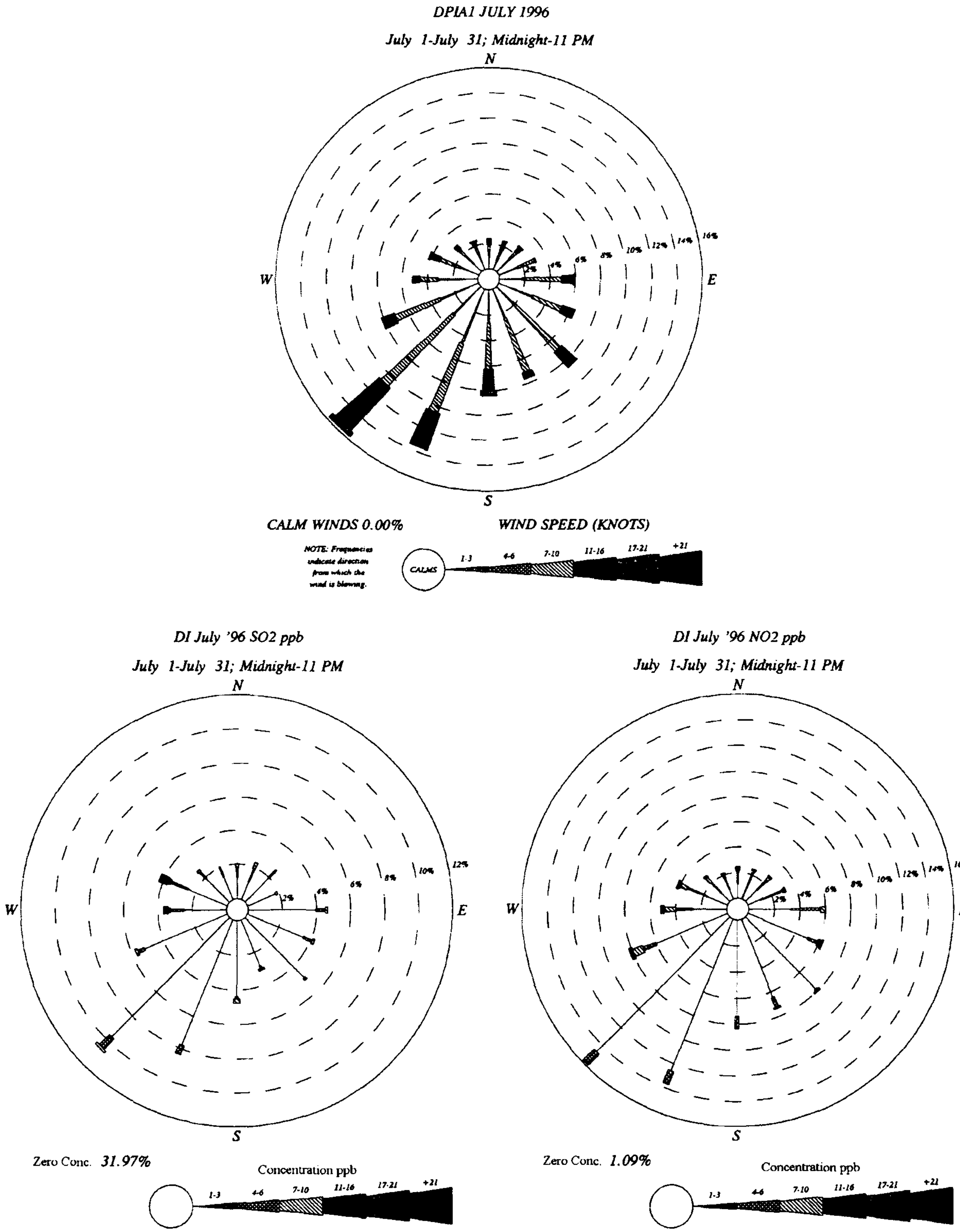


Figure 125. July 1996 wind and pollution roses from Dauphin Island.

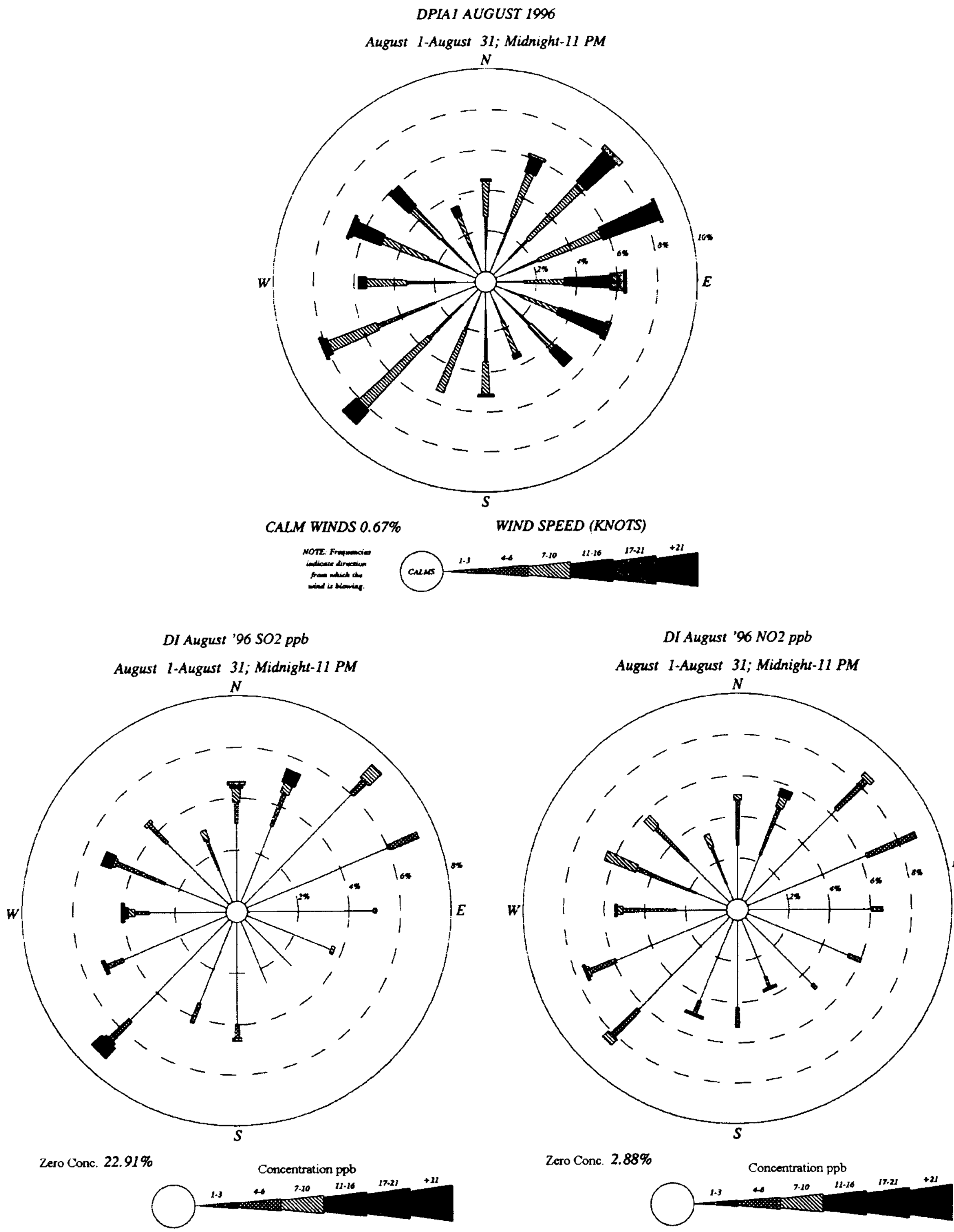


Figure 126. August 1996 wind and pollution roses from Dauphin Island.

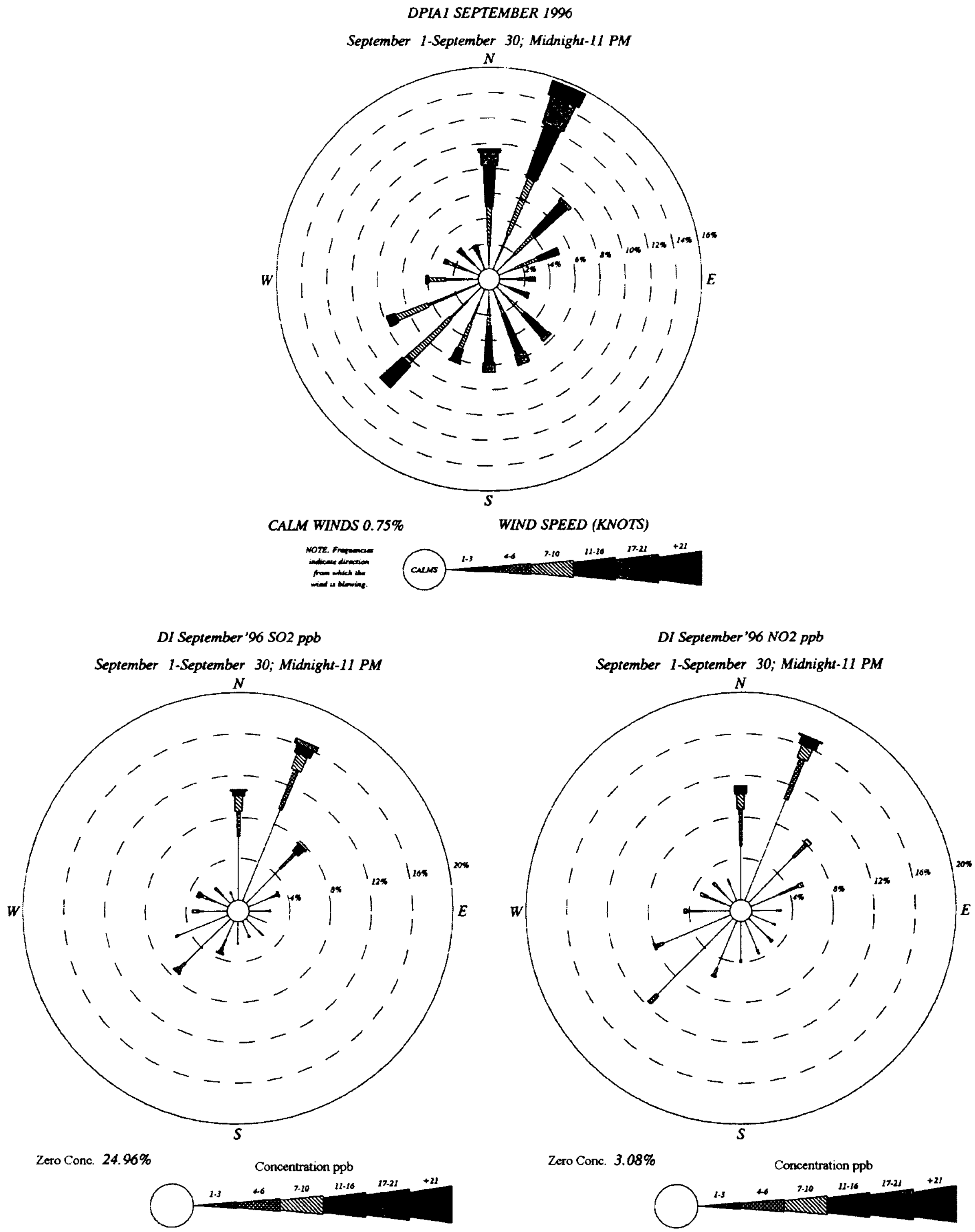


Figure 127. September 1996 wind and pollution roses from Dauphin Island.

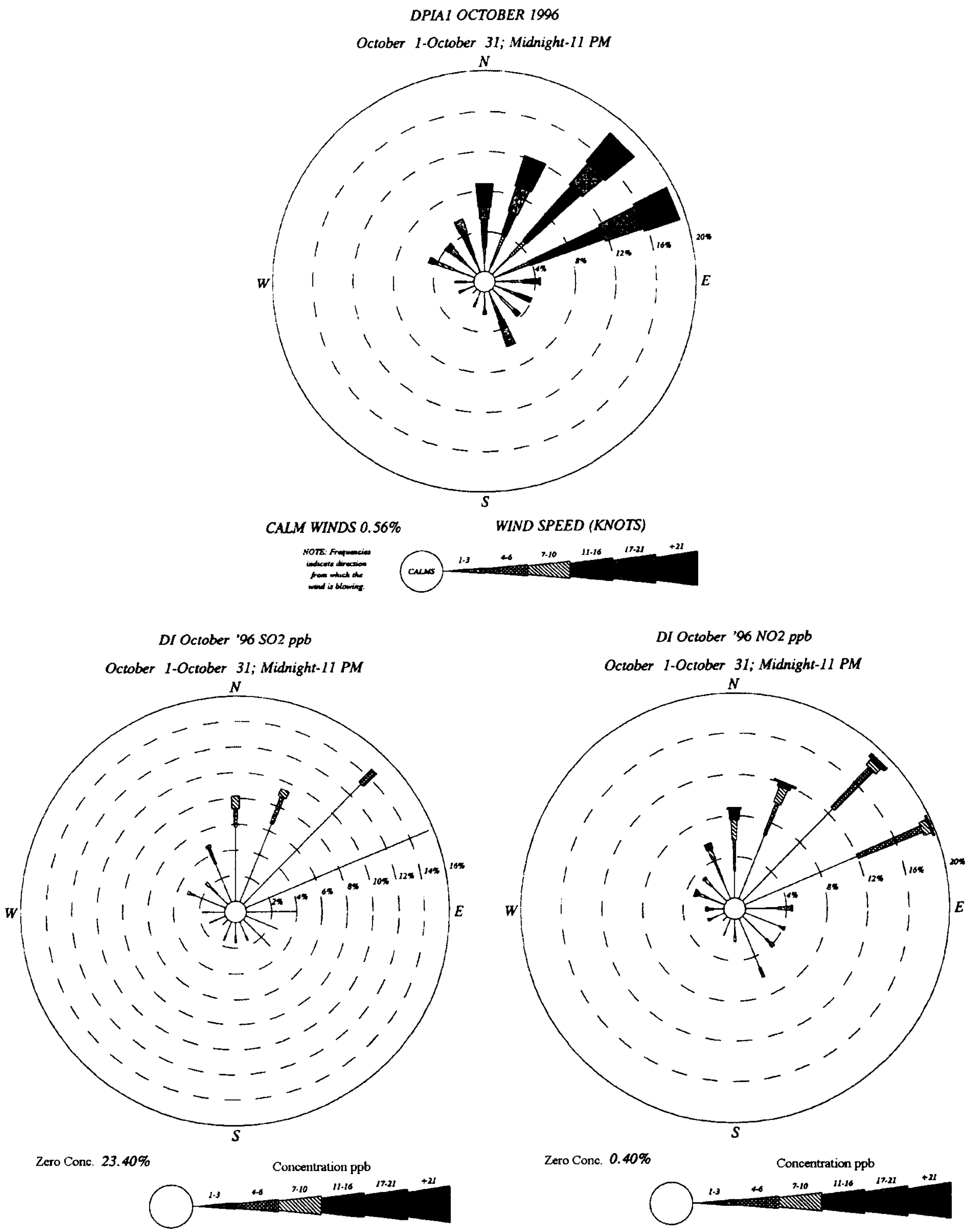


Figure 128. October 1996 wind and pollution roses from Dauphin Island.

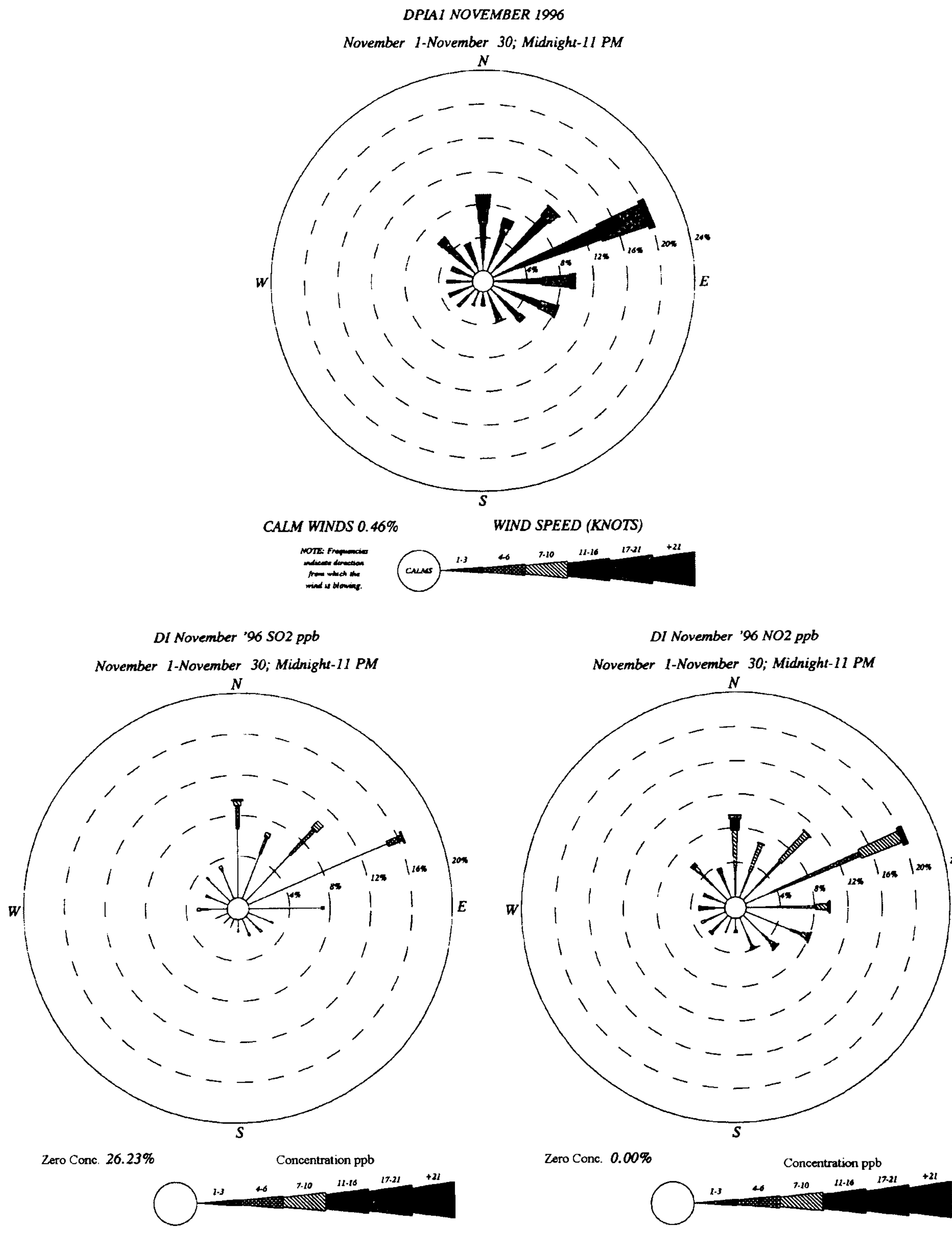


Figure 129. November 1996 wind and pollution roses from Dauphin Island.

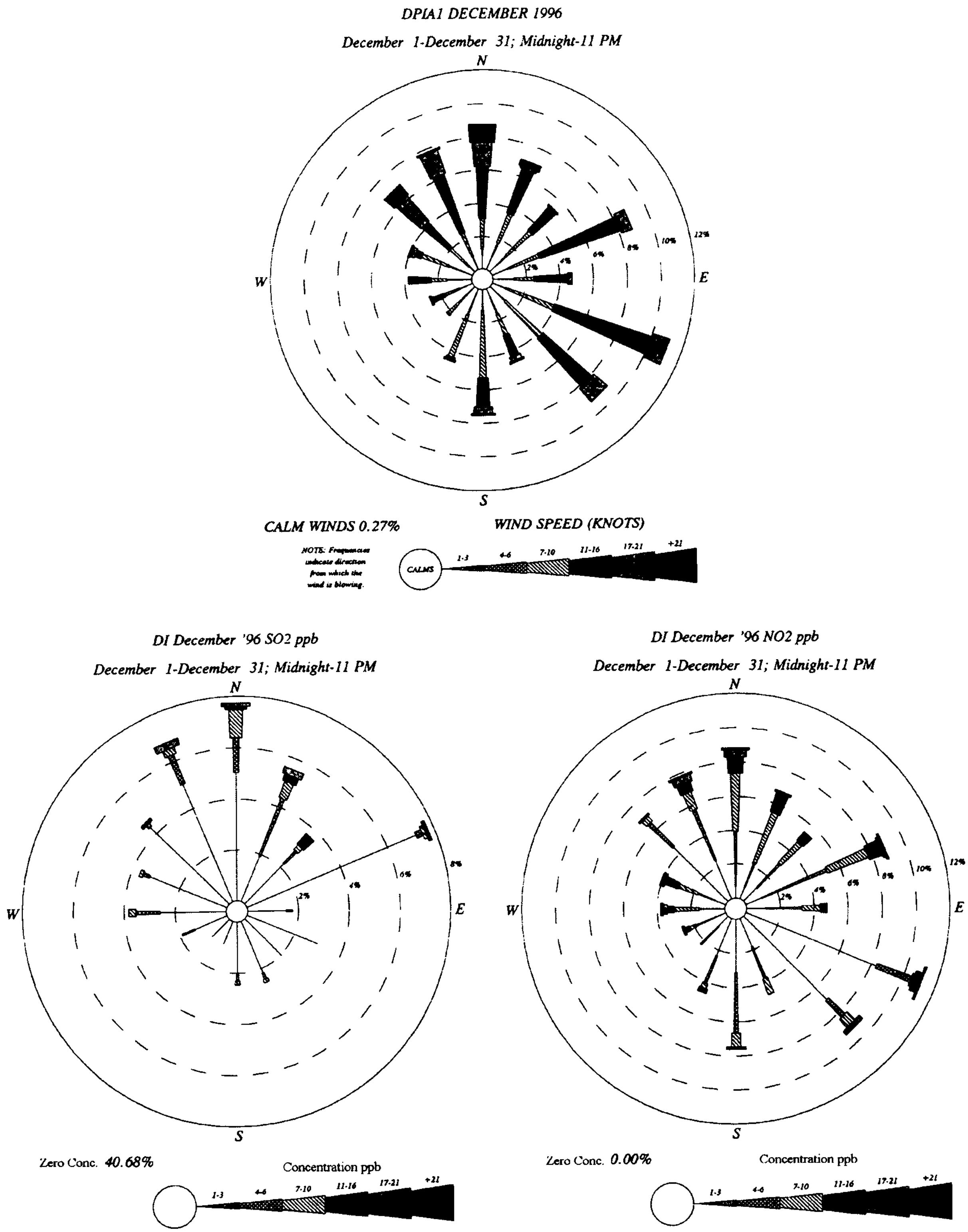


Figure 130. December 1996 wind and pollution roses from Dauphin Island.

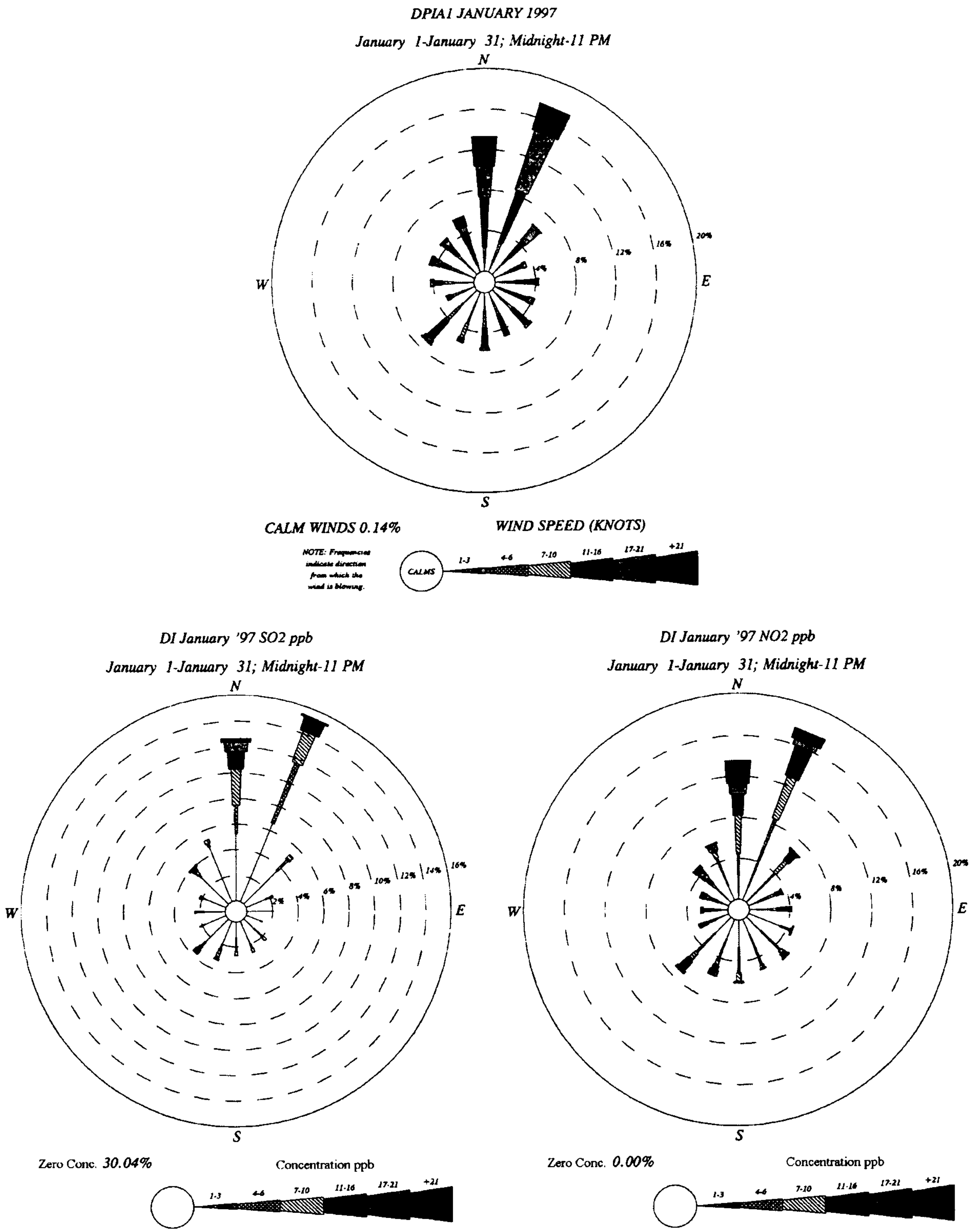


Figure 131. January 1997 wind and pollution roses from Dauphin Island.

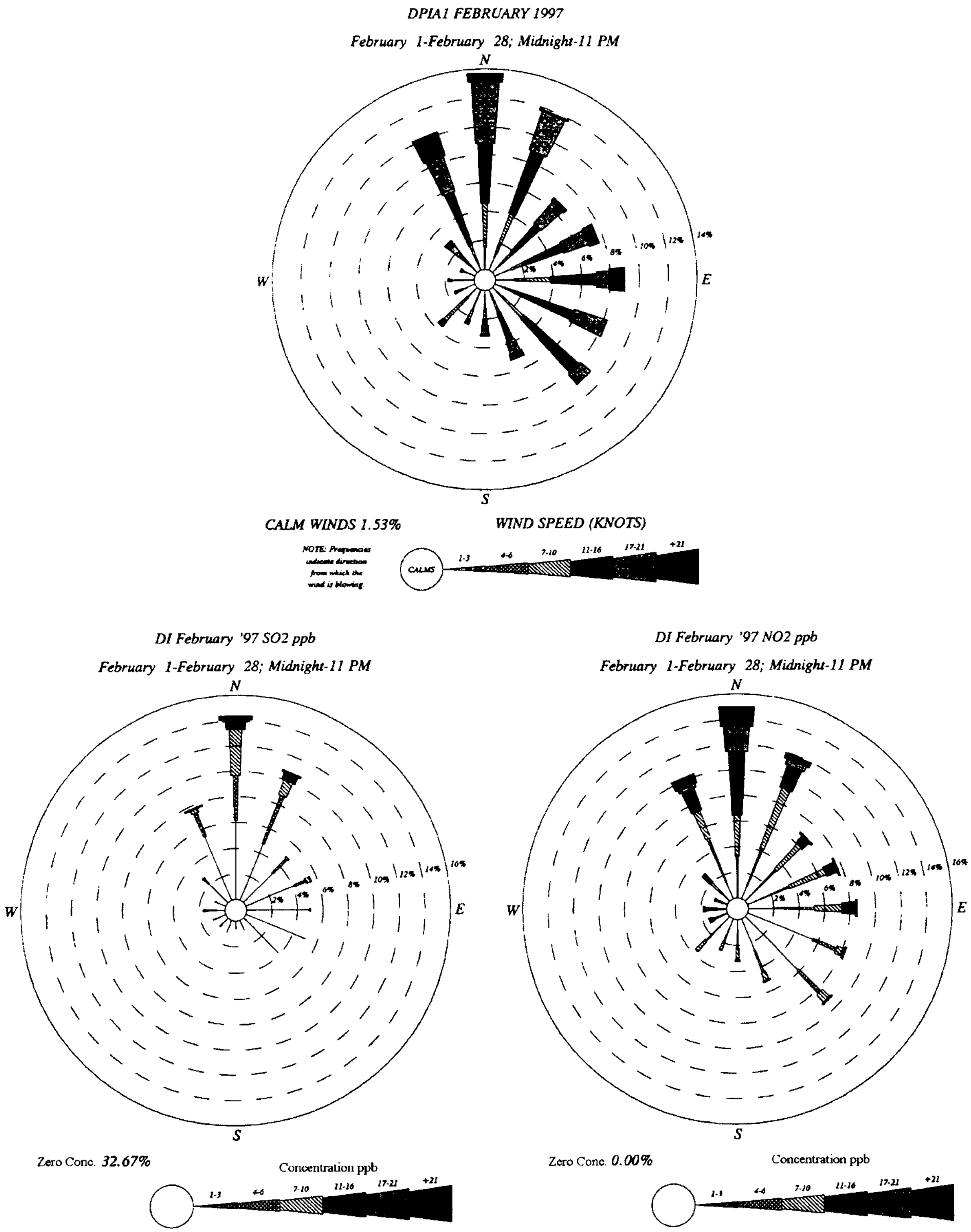


Figure 132. February 1997 wind and pollution roses from Dauphin Island.

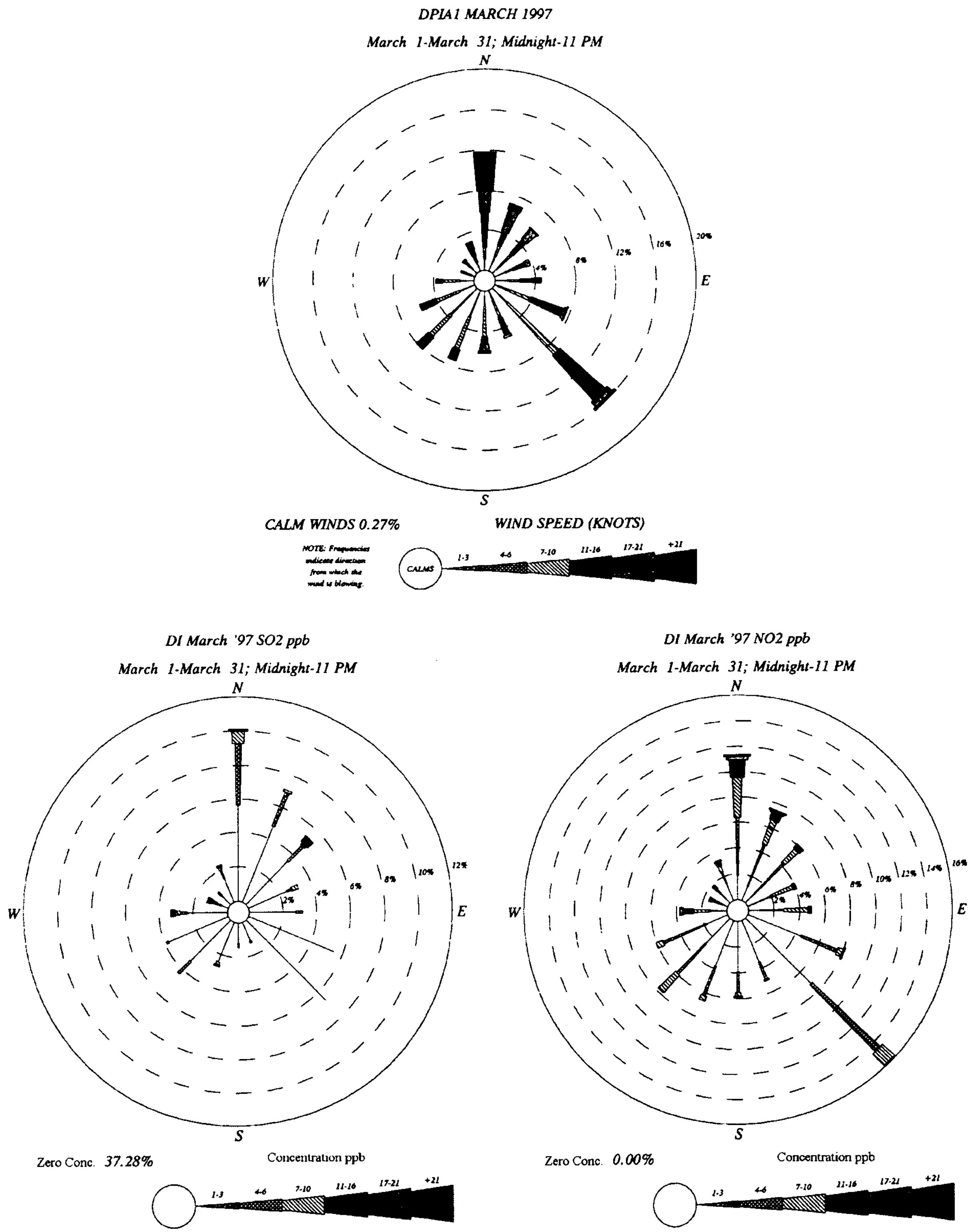


Figure 133. March 1997 wind and pollution roses from Dauphin Island.

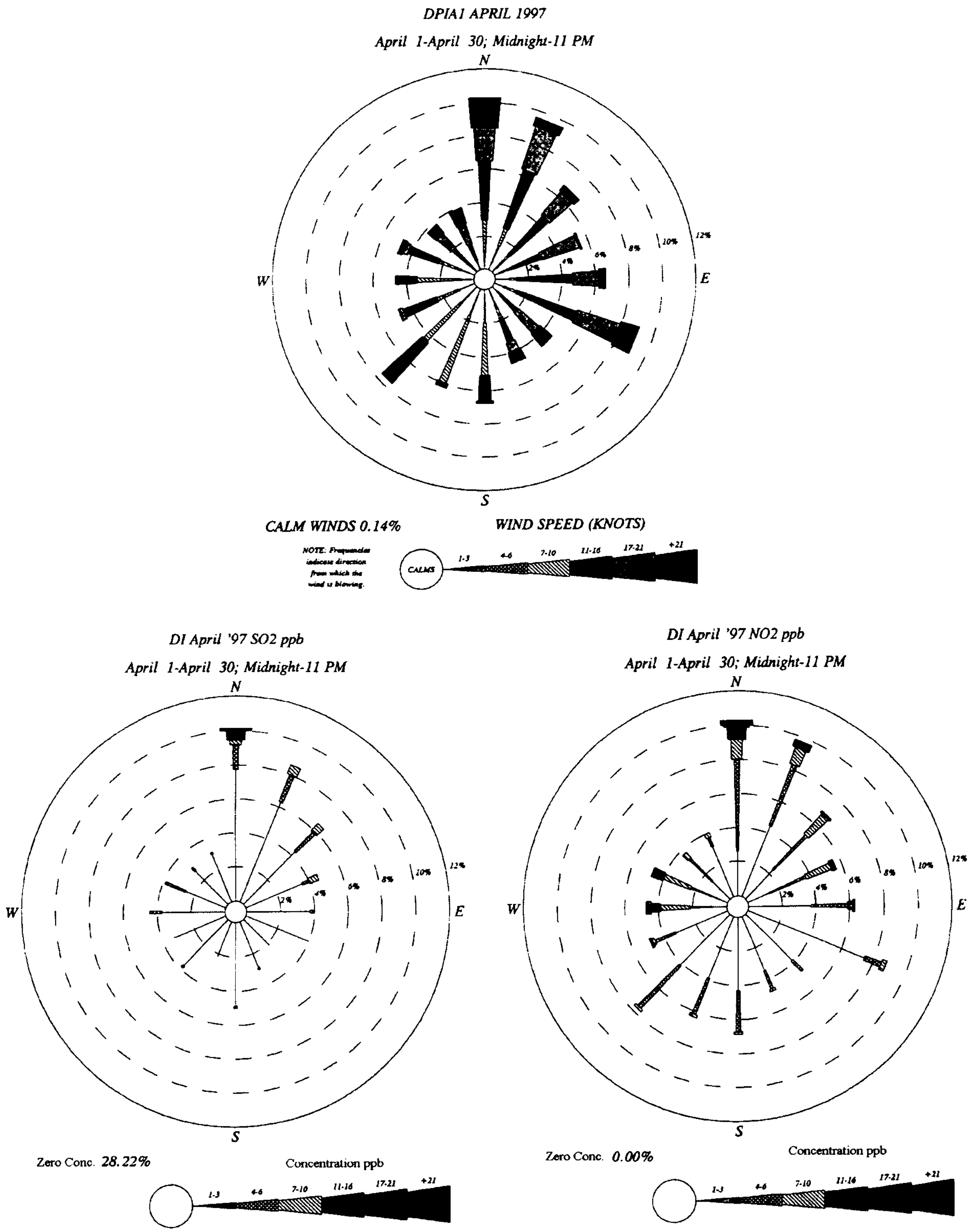


Figure 134. April 1997 wind and pollution roses from Dauphin Island.

Table 29.
Dauphin Island Maximum SO_2 Concentrations (ppb)

Month	Block Averaging Time	Maximum Concentration	Wind Speed (m/s)	Wind Dir	Day / Hour CST	
03 / 96	1 Hour	17	1.9	127	23	10
	3 Hour	14	6.3	015	09	13
	24 Hour	6.4			09	
04 / 96	1 Hour	21	2.3	003	02	13
	3 Hour	17	2.5	003	02	12
	24 Hour	6.8			02	
05 / 96	1 Hour	20	3.2	299	30	01
	3 Hour	17	2.2	324	29	23
	24 Hour	6.3			30	
06 / 96	1 Hour	35	2.0	266	23	06
	3 Hour	27	2.3	277	23	05
	24 Hour	8.0			23	
07 / 96	1 Hour	15 15	4.6 5.1	293 270	09 23	06 04
	3 Hour	10	1.0	301	26	19
	24 Hour	4.7			11	
08 / 96	1 Hour	32	5.1	263	12	02
	3 Hour	17	5.6	276	12	01
	24 Hour	6.1			14	
09 / 96	1 Hour	28	Miss	Miss	13	10
	3 Hour	18	4.3	018	19	16
	24 Hour	7.7 7.7			12 13	

Table 29 continued.

Month	Block Averaging Time	Maximum Concentration	Wind Speed (m/s)	Dir	Day / Hour CST	
10 / 96	1 Hour	10	6.1	022	19	14
	3 Hour	9	6.0	019	19	13
	24 Hour	4.5			08	
11 / 96	1 Hour	13	1.2	358	19	11
	3 Hour	10	1.5	018	19	11
	24 Hour	4.8			19	
12 / 96	1 Hour	20	8.1	340	18	07
	3 Hour	16	7.6	351	18	05
	24 Hour	7.1			14	
01 / 97	1 Hour	23 23	5.8 4.1	007 306	11 19	17 09
	3 Hour	18	6.2	009	11	16
	24 Hour	8.9			14	
02 / 97	1 Hour	26	3.1	359	09	20
	3 Hour	24	3.8	002	09	18
	24 Hour	9.9			09	
03 / 97	1 Hour	37	7.0	286	22	08
	3 Hour	23	6.4	286	22	07
	24 Hour	6.1			22	
04 / 97	1 Hour	28	3.5	349	15	13
	3 Hour	16	3.1	357	15	12
	24 Hour	5.2			15	

Table 30.
Dauphin Island Maximum NO_2 Concentrations (ppb)

Month	Block Averaging Time	Maximum Concentration	NO_2/NO_x	Wind Speed (m/s)	Dir	Day / Hour CST	
03 / 96	1 Hour	34	0.97	3	001	11	23
	3 Hour	29	0.97	3.2	351	11	22
	24 Hour	8.4				12	
04 / 96	1 Hour	18	0.75	2.3	003	02	13
	3 Hour	15	0.78	2.5	003	02	12
	24 Hour	8.7				06	
05 / 96	1 Hour	22	0.96	3.2	299	30	01
	3 Hour	19	0.95	2.2	324	29	23
	24 Hour	7.0				30	
06 / 96	1 Hour	13 13 13	1.00 0.93 0.81	1.9 3.3 1.4	282 259 288	22 23 23	23 00 05
	3 Hour	13	0.95	2.6	272	22	23
	24 Hour	5.9				26	
07 / 96	1 Hour	17	1.00	1.2	288	26	19
	3 Hour	13	0.95	1	301	26	19
	24 Hour	6.2				11	
08 / 96	1 Hour	14	0.70	3.9	019	08	08
	3 Hour	9	0.75	3	002	08	07
	24 Hour	4.8				14	
09 / 96	1 Hour	22	0.85	Miss	Miss	13	10
	3 Hour	16	0.84	Miss	Miss	13	08
	24 Hour	7.8				13	

Table 30 continued.

Month	Block Averaging Time	Maximum Concentration	NO_2/NO_x	Wind Speed (m/s)	Dir	Day / Hour CST	
10 / 96	1 Hour	38	0.81	2.8	276	08	19
	3 Hour	28	0.86	3	281	08	19
	24 Hour	8.8				19	
11 / 96	1 Hour	27	0.96	1.9	137	19	18
	3 Hour	23	0.97	1.6	157	19	17
	24 Hour	12.8				19	
12 / 96	1 Hour	27	0.96	3.4	294	05	17
	3 Hour	22	0.92	1.4	231	03	15
	24 Hour	13.4				03	
01 / 97	1 Hour	30	0.71	8.2	003	14	16
	3 Hour	25	0.92	4.7	304	19	05
	24 Hour	18.8				30	
02 / 97	1 Hour	35	0.88	1.5	253	13	22
	3 Hour	32	0.88	3.8	002	09	18
	24 Hour	15.9				09	
03 / 97	1 Hour	33	0.87	4.5	356	08	06
	3 Hour	25	0.86	4.8	008	08	05
	24 Hour	10.2				22	
04 / 97	1 Hour	58	0.50	3.5	349	15	13
	3 Hour	34	0.59	3.1	357	15	12
	24 Hour	9.3				15	

Table 31.
Dauphin Island Top 5% SO_2 and NO_2 Distribution

Month	SO_2 (405 samples)	NO_2 (393 samples)
March 96	17	11
April 96	20	15
May 96	19	4
June 96	31	3
July 96	16	4
August 96	34	2
September 96	65	8
October 96	10	16
November 96	19	30
December 96	29	44
January 97	69	115
February 97	41	97
March 97	22	30
April 97	13	14
Wind Direction	**SO_2 (384 samples)**	**NO_2 (381 samples)**
0 - 45	186	135
46 - 90	20	20
91 - 135	4	19
136 - 180	9	10
181 - 225	22	11
226 - 270	18	32
271 - 315	53	60
316 - 360	72	94

From Table 30, it is interesting to note the high ratios of NO_2 to NO_x observed with the 1 and 3-hour NO_2 maximums. These high ratios appear to be a characteristic of this NO_x dataset, as seen in Table 32 which lists the monthly mean NO_2/NO_x ratios. Note that, due to precision limitations of the analyzer, derived ratios slightly greater than one were set to the default value of one. Since conversion of NO to NO_2 in the atmosphere is a fairly rapid process (Manahan, 1993), the high ratio suggests the influence of a more aged air mass (longer residence time, more distant source). Wind speeds associated with the NO_2 maximums are mostly light (< 5 m/s) north-northwesterly, therefore this is consistent with a slow migration from onshore sources to the coastal region.

Table 32.
Monthly Mean and Standard Deviation of NO_2/NO_x Ratios - Dauphin Island

Month	# Samples	Mean	Standard Deviation
March 96	583	0.96	0.14
April 96	716	0.99	0.18
May 96	321	0.84	0.39
June 96	710	0.72	0.28
July 96	739	0.91	0.18
August 96	729	0.89	0.19
September 96	669	0.75	0.21
October 96	707	0.95	0.29
November 96	718	1.00	0.22
December 96	739	1.00	0.22
January 97	673	0.93	0.17
February 97	669	0.90	0.13
March 97	694	0.98	0.17
April 97	709	1.00	0.26

Figures 135 and 136 depict the diurnal variations of SO_2 and NO_2 concentrations as represented by quartile values. For most months, the median (2nd quartile) SO_2 values show little variation, with changes remaining within 1 ppb. Highest values occur during late morning to near noon CST. Median NO_2 values are higher and exhibit more variation. Maximums mostly occur after 0600CST, with a secondary peak often evident near 1800CST. This distribution is expected since, during daylight hours, the photoabsorption of solar radiation can cause NO_2 to dissociate into NO and O molecules (Bouble et al., 1994). The possible influence of other mechanisms may be involved. A local wind circulation (i.e., land-sea breeze) may be acting to transport or block pollutants which would otherwise affect our site. The maximum times also closely coincide with those expected for peak vehicular transportation ("rush hour"), and hence higher pollutant emissions. Research into these areas is continuing as more data is collected.

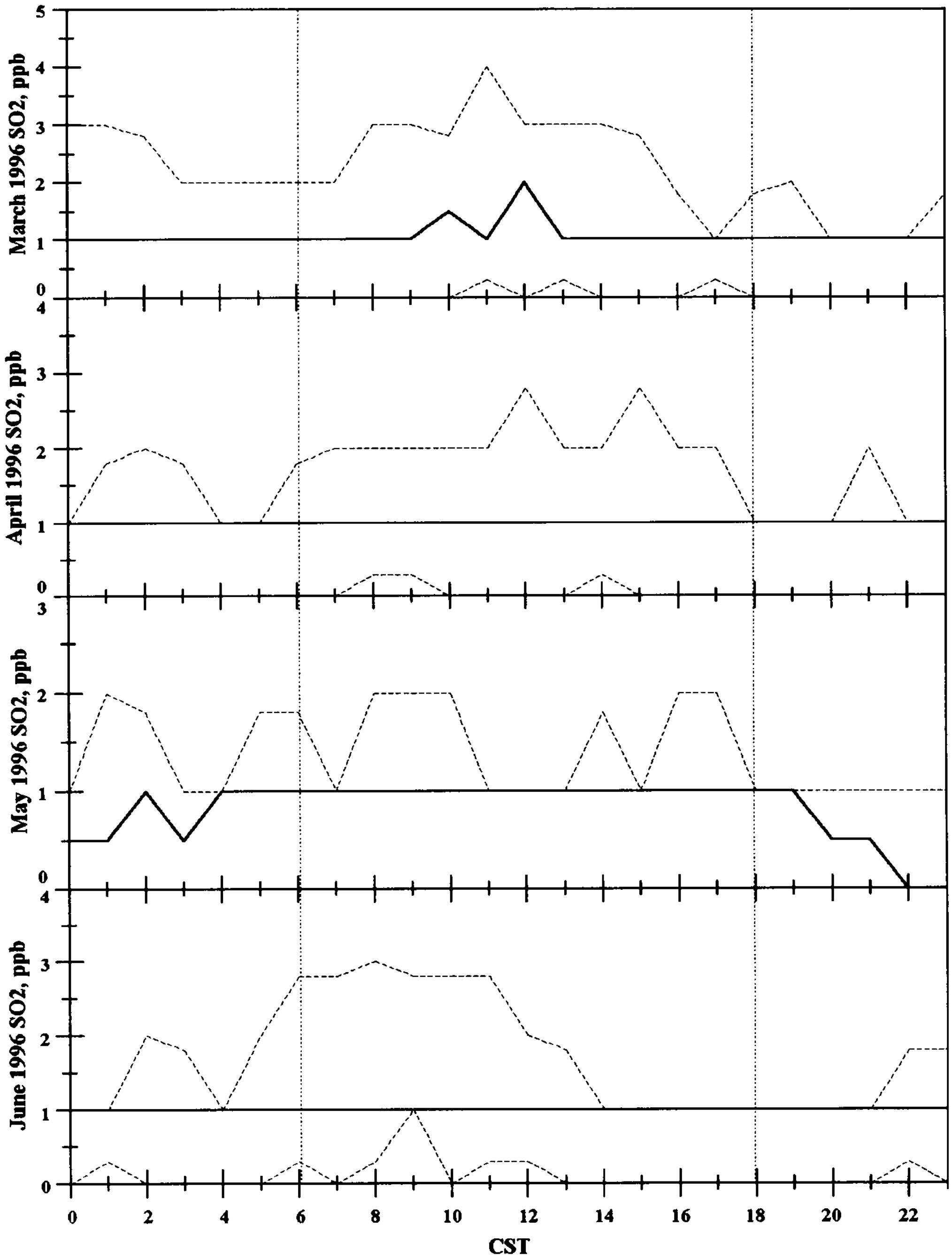


Figure 135. Diurnal variations of Dauphin Island SO_2 concentrations as represented by quartile values. CST (Central Standard Time) is GMT - 6 hours. Solid line is 2nd quartile (median), lower and upper dashed lines are 1st and 3rd quartiles.

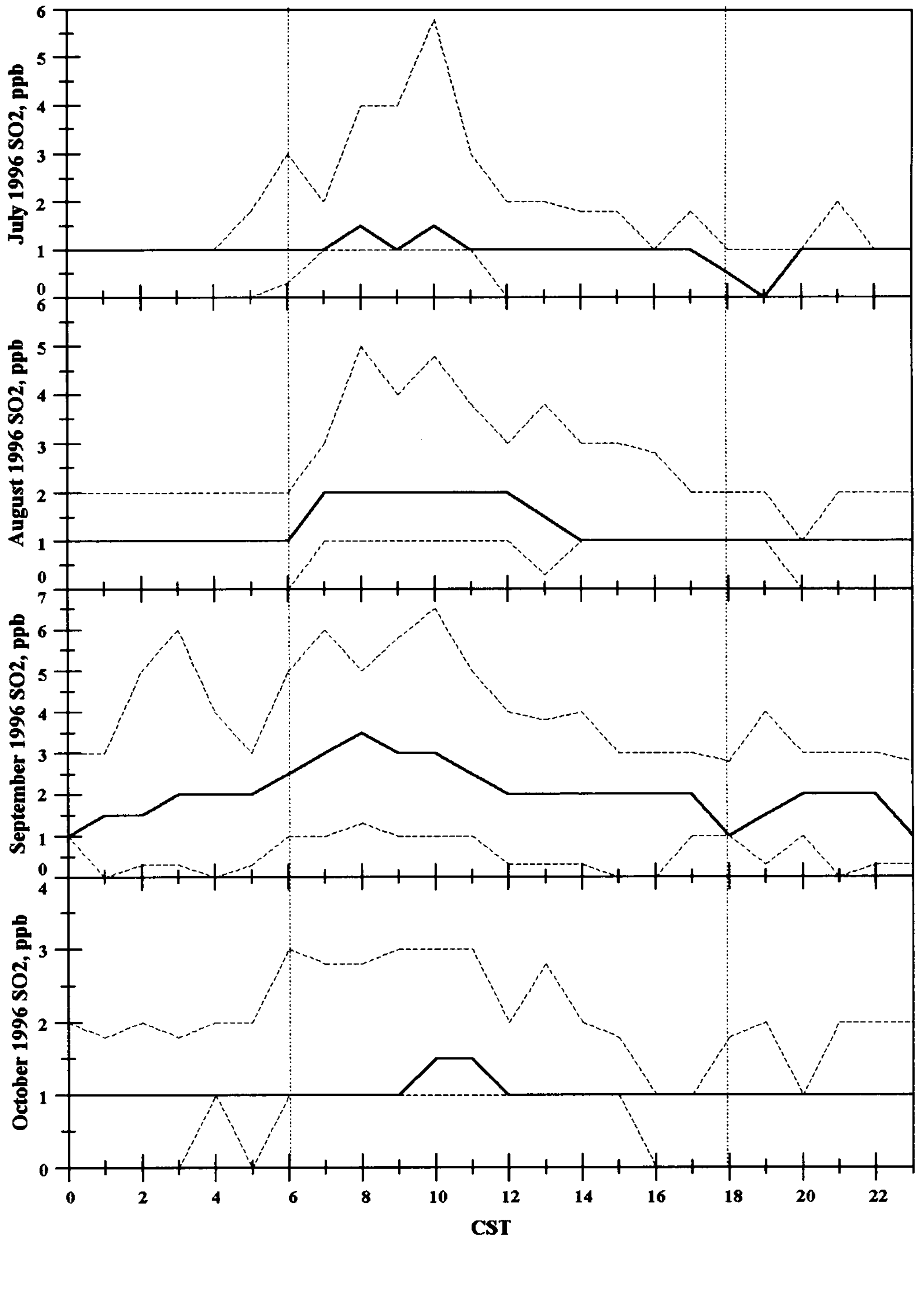


Figure 135 continued.

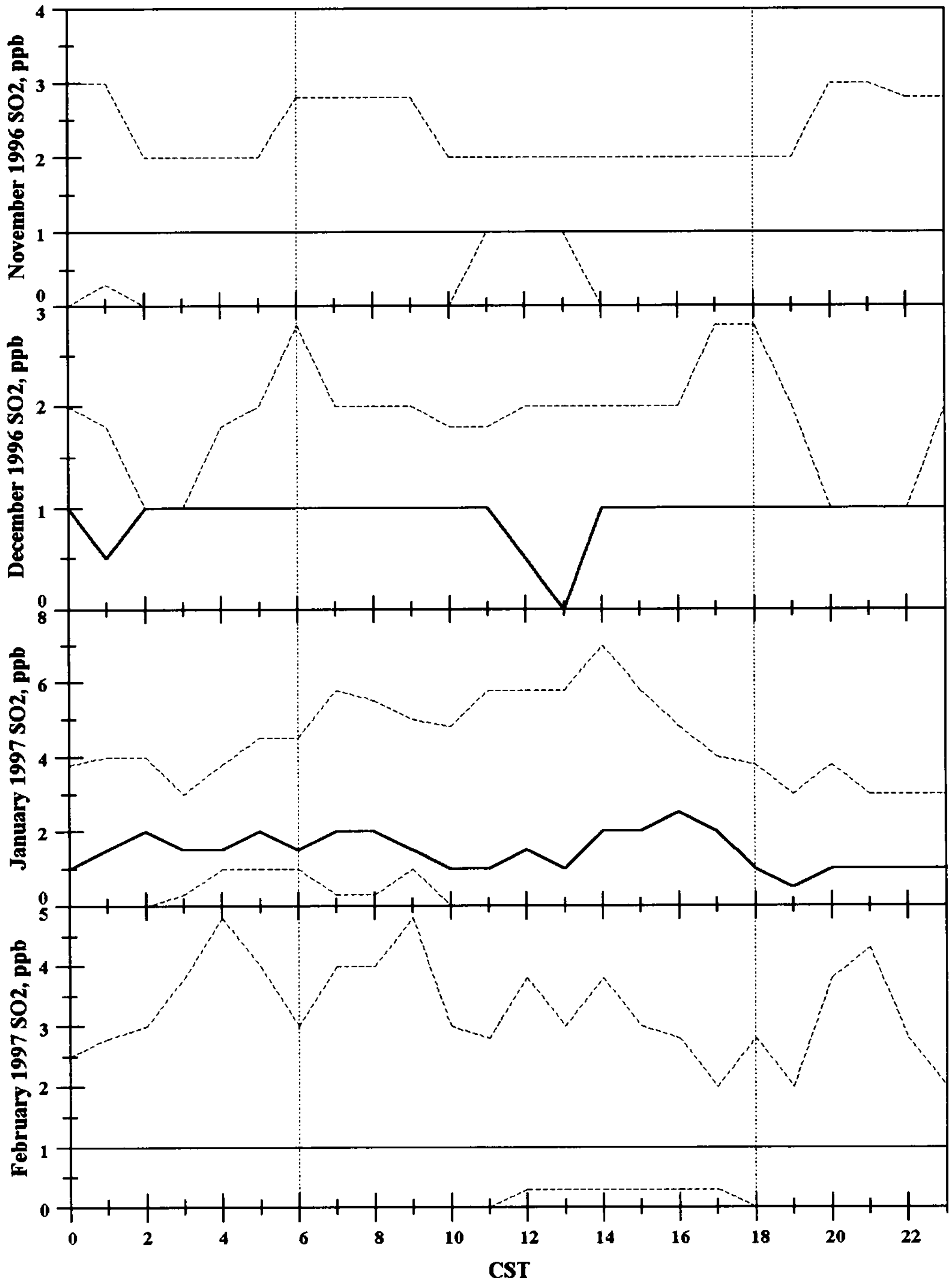


Figure 135 continued.

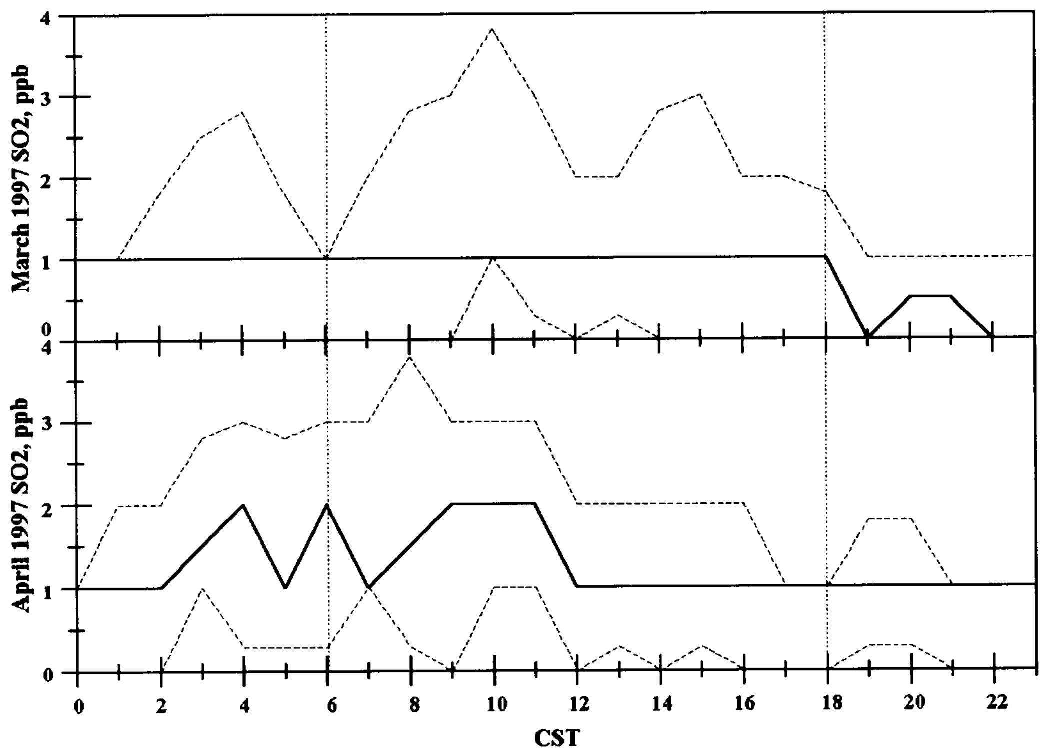


Figure 135 continued.

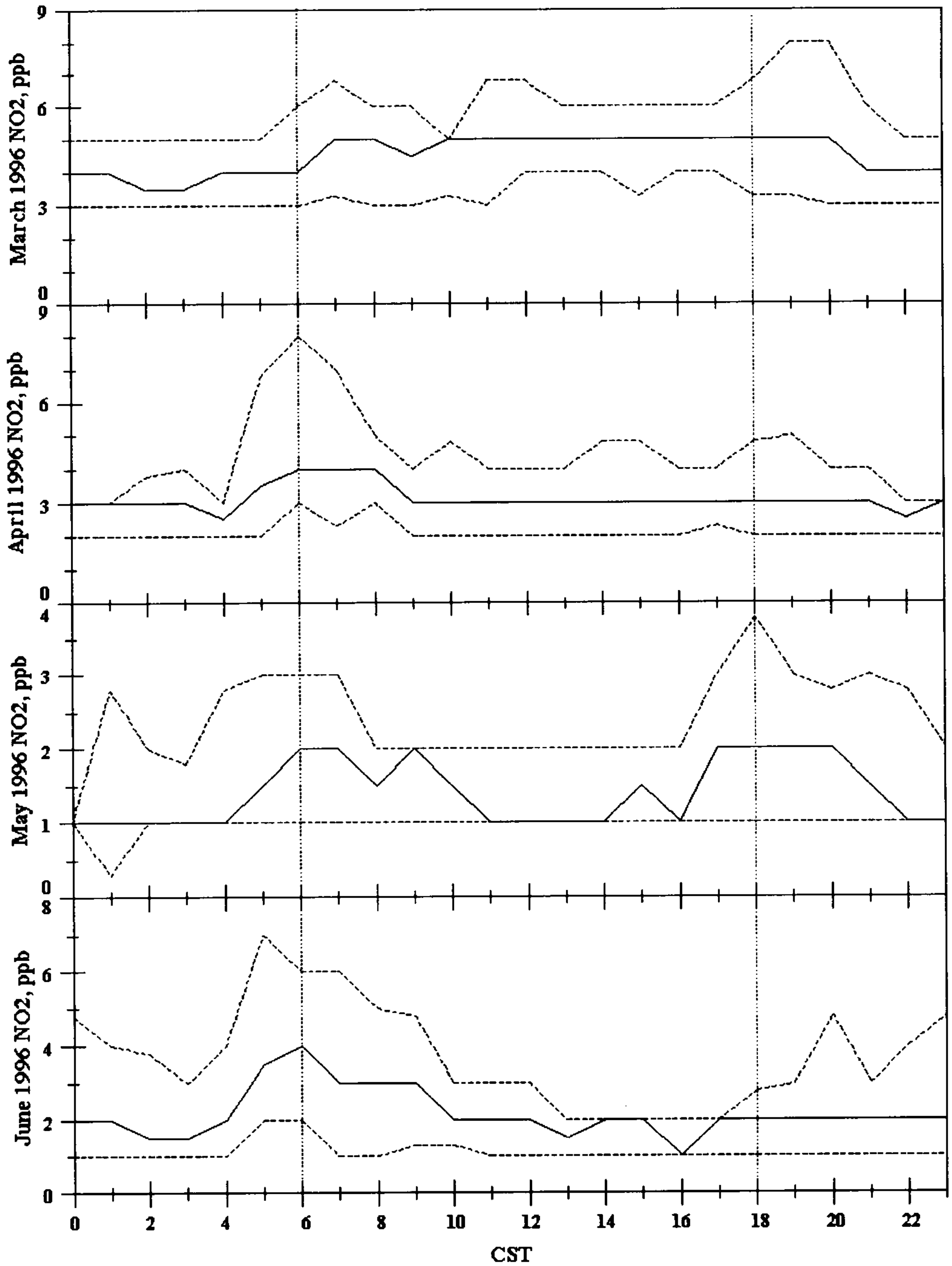


Figure 136. Diurnal variations of Dauphin Island NO_2 concentrations as represented by quartile values. CST (Central Standard Time) is GMT - 6 hours. Solid line is 2nd quartile (median), lower and upper dashed lines are 1st and 3rd quartiles.

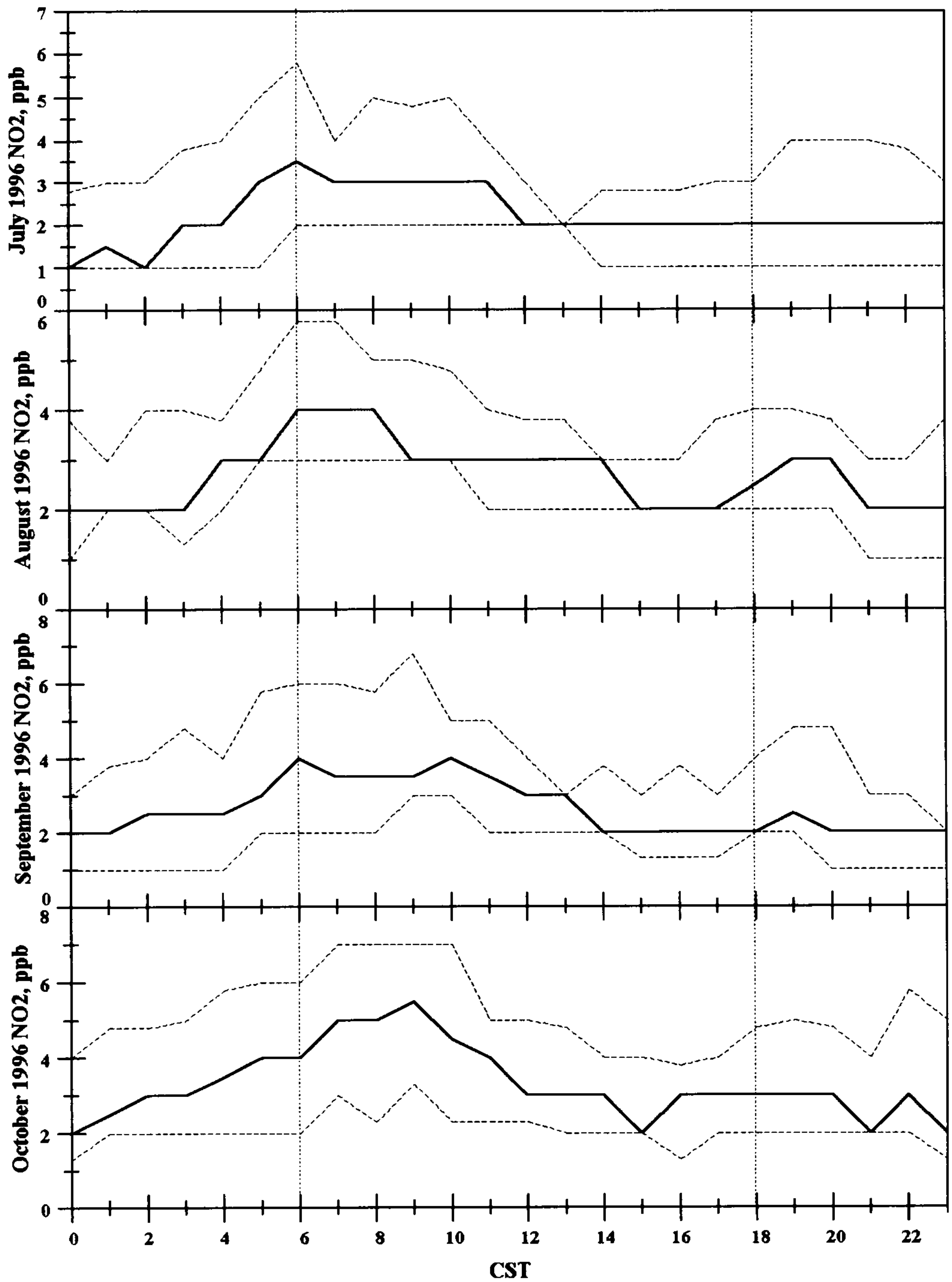


Figure 136 continued.

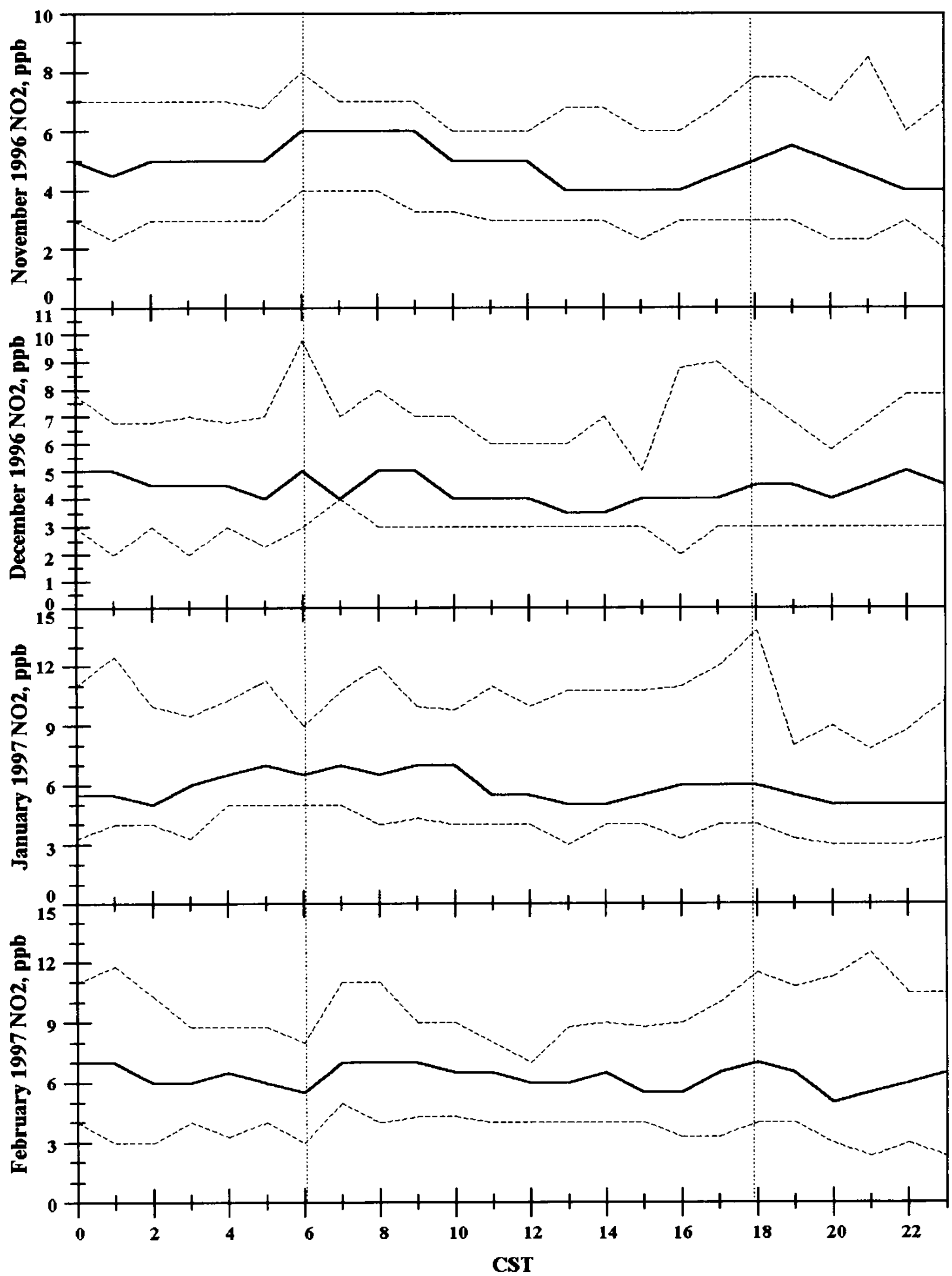


Figure 136 continued.

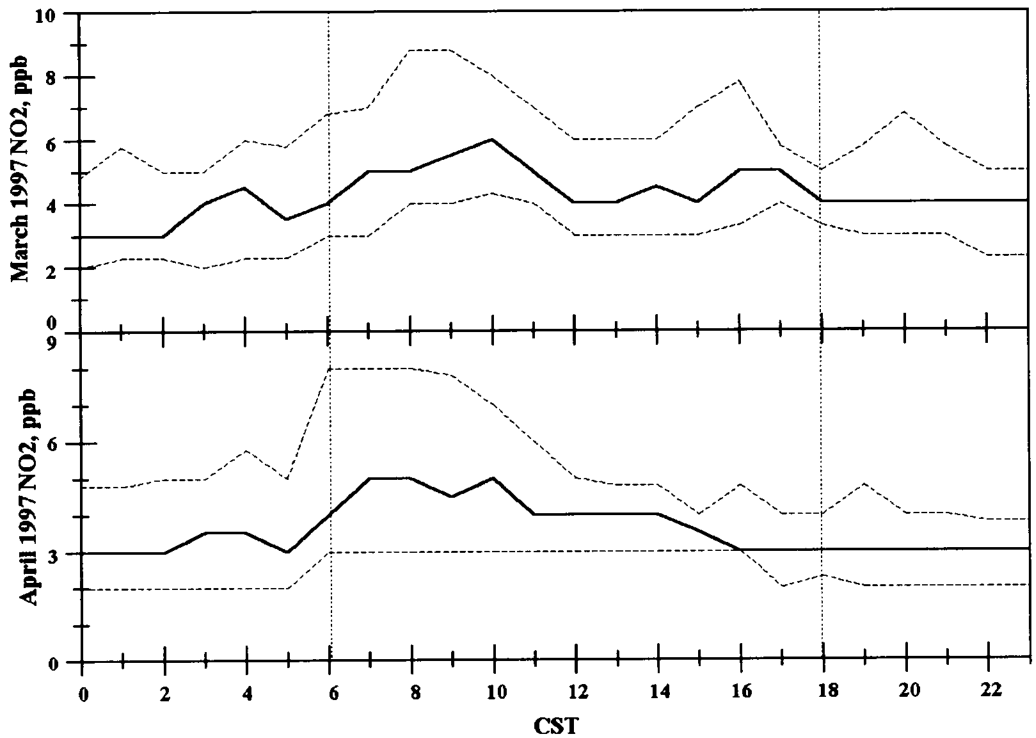


Figure 136 continued.

B. Breton Island

Monthly maximum and average concentrations are given in Tables 33 for SO_2 and 34 for NO_2. Average SO_2 concentrations for those months greater than 50% complete range from 0.8 ppb to 2.8 ppb with a median value of 1.1. For NO_2, the range is much larger, from 0.3 to 12.7 ppb with a median value of 4.3. Both SO_2 and NO_2 show slightly higher values during the winter and early spring months, however the trends are hard to discern due to the non-continuous nature of the dataset. This is illustrated clearly in Figs. 137 through 148, which show the 3, 8, and 24-hour average time series of SO_2 and NO_2, respectively.

In order to estimate annual air quality statistics, composite "years" were assembled from the most complete months during the measurement period. For SO_2, months used were November and December 1994, January through July 1995, and September and October 1995. For NO_2, November and December 1994, January through March 1995, April 1997, May through July 1995, September 1995, and October 1996. The annual arithmetic mean SO_2 concentration for the composite year (6561 samples, 75%) is 1.14 ppb with a standard deviation of 1.75. First, second and third quartile values were 0, 1 and 2, respectively. The annual mean NO_2 concentration (6986 samples, 80%) was 4.58 ppb with a standard deviation of 9.13. First, second and third quartile values were 2, 3, and 6, respectively. These derived annual statistics appear very representative of the actual data, as shown by Table 35.

Twenty-four hour average concentrations for the composite years are shown in Fig. 149. Again, slightly higher concentrations occur in winter and spring, but no distinct seasonal trend is evident.

Monthly wind and pollution roses for Breton Island are given in Figs. 150 through 180. For comparison, wind data from NOAA buoy 42007 (located at 30.1°N 88.8°W, about 45 miles north-northeast of Breton) are included when available. Seasonal rotation of the winds is evident, clockwise from north-northwest in winter to south-southwest in summer. Pollution roses were created for the most complete combined wind/air quality months as listed in Table 36.

Table 33.
Breton Island SO_2 Maximums and Averages (ppb) based on 1-Hour Block Averages

	October 1994		November 1994		December 1994		January 1995	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	2	0.2	7	1.5	9	3.3	2	0.2
2	3	0.9	4	0.5	2	0.5	13	1.7
3	2	0.5	1	0	0	0	9	3.2
4	4	1.2	0	0	1	0	9	4.4
5	6	2.5	0	0	7	0.6	8	3.1
6	3	1.3	5	0.7	1	0.4	1	0.1
7	0	0	7	2.1	1	0.1	4	1.0
8	0	0	1	0.1	1	0.1	4	1.5
9	0	0	0	0	1	0.2	5	1.5
10	1	0	5	1.1	0	0	6	1.3
11	1	0.1	5	1.5	3	1.3	1	0.1
12	0	0	7	1.2	5	3.2	1	0.3
13			5	0.5	13	5.5	2	0.3
14			1	0.1	8	4.5	2	1.0
15			3	0.3	4	0.8	1	0.3
16			13	3.8	2	0.3	6	1.5
17			5	3.0	10	2.3	1	0.5
18			7	2.1	8	2.4	1	0.3
19			3	2.5	3	1.3	5	1.5
20			2	0.7	3	0.3	6	2.3
21			3	0.8	0	0	4	1.8
22			11	3.8	1	0.1	7	2.3
23			10	4.4	2	0.5	1	0.6
24	2	0.5	8	4.6	4	1.4	7	1.5
25	2	0.9	4	1.3	3	0.8	4	2.0
26	13	4.4	2	0.5	14	4.0	2	0.8
27	9	4.2	0	0	3	1.2	2	0.1
28	4	1.0	3	0.7	0	0	2	0.3
29	1	0.4	7	2.0	0	0	2	0.2
30	3	1.2	12	4.1	2	0.8	2	0.5
31	2	0.6			1	0.1	3	1.6
# Hours	506		708		741		736	
Maximum	13		13		14		13	
Arith-Mean		0.9		1.5		1.2		1.2

Table 33 continued.

	February 1995		March 1995		April 1995		May 1995	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	2	0.8	4	0.5			0	0
2	1	0.5	7	2.3			4	0.6
3	0	0	9	4.9			1	0
4	4	0.8	7	1.3			0	0
5	4	1.3	2	0.1			1	0
6	6	1.0	3	0.3			2	0.7
7	2	0.6	0	0			4	1.4
8	8	0.8	1	0.6			3	1.5
9	3	0.5	4	1.1			3	1.2
10	1	0.3	6	1.5			4	1.6
11	6	1.2	3	0.2			4	1.3
12	5	2.8	2	0.2			4	1.5
13	5	1.7	1	0.2			5	1.8
14	3	0.2	0	0	4	2.1	1	0.6
15	0	0	1	0.2	2	0.8	4	1.2
16	2	0.3	1	0.1	1	0.2	3	1.4
17	6	1.5	3	0.5	1	1.0	2	1.2
18	19	6.0	4	1.8	2	1.2		
19	30	2.9	4	2.3	2	1.7		
20	6	1.8	3	1.3	2	2	4	1.6
21	8	1.8	1	0.7	3	2.1	13	3.9
22	6	1.3	1	0.1	3	2	5	3
23	2	0.2			3	2	6	1.5
24	4	1.4			3	1.3	0	0
25	3	1.5			2	1.1	7	0.4
26	4	0.4			1	0.5	1	0.2
27	1	0.1			0	0	1	0
28	3	0.3			3	0.5	1	0
29					3	0.2	2	0.9
30					0	0	2	0.9
31							2	0.5
# Hours	666		537		411		710	
Maximum	30		9		4		13	
Arith-Mean		1.1		0.9		1.1		1.0

Table 33 continued.

	June 1995		July 1995		September 1995		October 1995	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	3	0.5	3	0.9			1	0.5
2	2	1	2	0.7			0	0
3	1	0.3	0	0				
4	1	0.2	3	1.0				
5	3	1.1	1	0.1	1	0.6		
6	2	0.3	2	0.4	1	0.7		
7	0	0	7	2.5	3	1.6	6	1.8
8	1	0.2	5	1.2	3	0.9	13	5.7
9	1	0.3			12	3		
10	3	0.6			6	2.6	2	1.1
11	2	0.4			5	2.3	12	2.8
12	0	0			2	0.7	8	5.5
13	2	0.2			1	0.2	4	2.3
14	3	0.5			1	0.1		
15	3	1.4			1	0.5		
16	2	1.1			0	0		
17	1	0.7			1	0.5		
18	1	0.4			5	1.2	0	0
19	5	2.5			3	1.8	0	0
20	7	1.8			9	4.5	0	0
21	2	0.4			7	3.7	0	0
22	1	0.3			4	2.2	3	1.0
23	2	0.4			8	5.6	0	0
24	3	1.1					1	0
25	4	1.8					2	1
26	3	0.4					4	0.8
27	3	1.3			4	2.0	0	0
28	3	1.4			7	2.1	8	0.8
29	2	0.4			1	0.2	13	0.6
30	4	2.0			1	0.3	0	0
31							0	0
# Hours	700		205		566		581	
Maximum	7		9		12		13	
Arith-Mean		0.8		1.1		1.6		1.1

Table 33 continued.

	November 1995		December 1995		January 1996		February 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	2	0.3					5	2.1
2	0	0			2	1.2	5	1.7
3	0	0			3	2	5	2.2
4	0	0			2	1.3	9	2.2
5	0	0			1	1	4	1.9
6	0	0			2	1.1	1	0.5
7	0	0			3	1.7	0	0
8	2	0.3			3	1.4	1	0.2
9	3	0.5			3	1.5	2	0.4
10	0	0			5	2.3	4	0.4
11	1	0					2	0.3
12	2	0.5					5	1.1
13	1	0.3					6	1.6
14	2	0.2					2	1.1
15	1	0.2					1	0.3
16	7	2.2					2	0.9
17	5	1.2					7	2.5
18	1	0.1					3	1.3
19	0	0					0	0
20	0	0					1	0.1
21	0	0					1	0
22	1	0					0	0
23	0	0	3	1.5			0	0
24	40	11.1	3	1.3	3	1.1	2	0.3
25	137	63.7	5	2.2			1	0.1
26	0	0	8	3.6	0	0	0	0
27	0	0	3	1.5	4	1.2	0	0
28	0	0	9	5.3	3	1.1	2	0.3
29	0	0	9	3.5	7	0.8	5	1.9
30					1	0.2		
31					16	3		
# Hours	695		186		410		685	
Maximum	137		9		16		9	
Arith-Mean		2.8		2.5		1.3		0.8

Table 33 continued.

	March 1996		June 1996		July 1996		September 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	10	3.6						
2	17	1.8						
3	6	2.9						
4	1	0.7						
5	0	0						
6	0	0						
7	1	0.4						
8	4	0.8						
9	10	2.5						
10	6	3.5					9	3.7
11	10	3.3					9	2.9
12	2	0.7					5	2.7
13	0	0					6	2.7
14	0	0					4	1.8
15	1	0					0	0
16	1	0					0	0
17	1	0.2					0	0
18	1	0						
19	2	0.7						
20	1	0.1	0	0			5	2.5
21	4	1.5	0	0				
22	2	0.8	0	0				
23	5	0.7	0	0				
24	0	0	0	0				
25	0	0	0	0	0	0		
26	5	1	0	0	0	0		
27	2	0.3			1	0.1		
28	1	0.4			1	0.2		
29	0	0			0	0		
30								
31								
# Hours	674		178		142		249	
Maximum	17		1		1		9	
Arith-Mean		0.9		0		0.1		1.8

Table 33 continued.

	October 1996		November 1996		December 1996		January 1997	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1			2	0.7			1	0.6
2	1	0.1	4	0.8			27	2.7
3	1	0.5	5	2.4			2	1
4	1	0.7	2	0.8			1	0.3
5	0	0	1	0.8			2	0.3
6	0	0	1	0.1			3	2.1
7	4	0.9	1	0.5			7	2.1
8	4	1.6	2	1			2	0.7
9	9	1.5	7	1.5			4	1.3
10	12	2.6	6	2.2			6	1.9
11	6	2.4					7	2.5
12	1	1					13	6.8
13	1	0.8					11	7.4
14	2	1					12	7.9
15	7	1.7			2	1.2	2	0.8
16	2	0.3			1	0.9	1	1
17	2	0.8			8	1.1	20	4.4
18	2	0.8			4	1.5		
19	5	1.9			2	1.1		
20	3	2			5	2.7		
21					1	1	2	0.5
22	0	0			1	0.8	2	0.6
23	9	1.5			1	0.5	1	0.6
24	3	1.5			6	0.9	2	0.3
25	1	0.6			6	2.6	2	1
26	1	0.5			36	3.6	3	1.4
27	1	0			1	0.4	1	0.7
28	1	0.2			1	0.1	10	1.3
29	2	0.6			1	0.2	23	4.9
30	2	1.0			1	0.2	13	5.2
31	9	2			0	0	2	1.1
# Hours	715		256		423		671	
Maximum	12		7		36		27	
Arith-Mean		1.0		1.1		1.1		2.2

Table 33 continued.

	February 1997		March 1997		April 1997	
Day	Maximum	Average	Maximum	Average	Maximum	Average
1	3	1.5	0	0		
2	2	0.7	0	0		
3	1	0.6	6	1.6		
4	1	0.2	3	0.8		
5	7	1.5	1	0.3		
6	8	5.1	5	0.6		
7	10	2.8	3	1.5		
8	7	1.4	6	1.3		
9	8	3.9	0	0		
10	4	1.1	0	0		
11	9	2.3	1	0		
12	4	1.5	1	0.2		
13	1	0.8	1	0.1		
14	4	0.9	3	0.8		
15	3	1.5	10	3.7		
16	7	4	66	11		
17	5	1.7				
18	2	0.7	0	0		
19	1	0.1	1	0.4		
20	1	0.4	1	0.3		
21	1	0.1	81	10.4		
22	4	1.1				
23	3	1.4				
24	1	0.8			6	1
25	0	0			2	0.9
26	1	0.1			0	0
27	1	0.1			0	0
28	0	0			3	0.3
29					3	1.3
30					1	0.4
31						
# Hours	667		499		172	
Maximum	10		81		6	
Arith-Mean		1.3		1.6		0.6

Table 34.
Breton Island NO_2 Maximums and Averages (ppb) based on 1-Hour Block Averages

	October 1994		November 1994		December 1994		January 1995	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1			9	3.6	5	2.9	3	1.6
2			8	3.5	6	2.1	5	2.7
3			13	3.5	7	3.3	12	5.0
4			17	4.8	6	2.6	11	5.7
5	3	1.0	4	1.2	5	1.8	8	3.3
6	2	0.9	5	1.1	5	2.0	7	2.9
7	1	0.3	6	1.6	19	6.7	15	4.6
8	2	0.7	9	1.4	12	4.0	21	5.0
9	2	0.5	13	3.7	7	3.8	26	11.6
10	4	1.9	12	2.8	10	4.3	35	13.0
11	8	2.8	6	1.8	3	1.5	9	5.8
12	6	4.3	6	1.4	18	5.4	9	4.7
13			5	0.9	8	4.5	7	3.7
14			1	0.1	11	6.0	7	2.9
15			5	1.0	5	2.6	7	2.9
16			5	2.5	18	5.0	14	3.7
17			4	2.5	8	4.9	8	2.5
18			6	1.7	4	2.6	8	3.9
19			4	1.7	4	1.5	7	3.3
20			12	4.8	4	1.7	13	6.0
21			19	6.3	6	2.5	14	8.8
22			6	2.9	16	4.2	18	8.3
23			7	3.2	5	3.0	9	1.9
24	2	0.9	5	3.4	3	2.2	12	3.0
25	2	1.3	26	4.1	6	3.2	23	14.8
26	6	4.3	14	5.2	9	4.8	21	6.0
27	7	4.3	5	0.6	9	4.5	9	4.2
28	7	2.7	5	1.0	6	2.7	12	6.2
29	4	2.8	11	4.1	12	4.8	9	4.8
30	6	3.9	6	3.5	22	7.6	18	6.7
31	13	4.9			9	4.0	16	6.0
# Hours	425		708		741		737	
Maximum	13		26		22		35	
Arith-Mean		2.3		2.7		3.6		5.3

Table 34 continued.

	February 1995		March 1995		April 1995		May 1995	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	24	10.6	11	5.0			12	5.0
2	19	11.0	5	4.0			5	2.9
3	23	8.6	11	7.4			5	3.1
4	11	3.7	15	5.0			12	5.6
5	13	6.1	13	5.6			10	5.8
6	10	3.7	8	5.3			16	7.4
7	16	9.1	6	3.6			16	7.3
8	4	2.3	6	3.5			5	2.9
9	12	3.3	6	3.3			5	2.9
10	12	5.6	7	3.8			19	6.5
11	10	4.4	5	2.2			15	7.2
12	6	3.0	3	1.9			15	7.0
13	4	2.5	4	2.3			11	4.8
14	5	1.3	10	3.3	27	6.5	8	4
15	8	4.9	21	9.3	32	7.8	13	5.8
16	22	7.7	7	3.3	9	4.5	19	8.6
17	13	8.8	4	2.4	17	5.3	10	4.1
18	16	10.3	8	4	8	3.8	10	5.4
19	14	4.8	16	7.1	5	3.7	13	4.4
20	35	10.0	16	10.1	7	3.0	3	2.5
21	26	9.6	19	10.0	19	4.9	8	4.0
22	29	7.0	17	10.2	13	5.3	16	4.5
23	14	7.5			3	2.3	27	8.0
24	31	9.3			3	2.0	5	2.5
25	4	3.1			9	2.8	8	3
26	6	2.9			6	2.9	28	7.8
27	24	9.7			6	2.5	10	7.2
28	21	8.3			20	5.2	10	5.9
29					16	6.0	10	4.3
30					19	6.0	15	5.2
31							10	4.8
# Hours	666		537		413		735	
Maximum	35		21		32		28	
Arith-Mean		6.4		5.1		4.4		5.2

Table 34 continued.

	June 1995		July 1996		September 1995		October 1995	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	20	6.6	11	4.7			2	1.5
2	15	6.9	3	2			2	1.3
3	15	1.8	7	3.0				
4	2	0.8	9	4				
5	4	2.4	10	6	9	2.8		
6	8	3.3	14	5.7	3	2.0		
7	9	3.2	18	4.7	4	2.4	4	2.9
8	14	3	13	5	18	4.8	7	3.9
9	10	6			16	3.5	10	6
10	10	4			10	4.1	7	3.9
11	11	3.1			25	5.5	36	7.1
12	4	1.3			17	4.8	11	0.8
13	2	1.6			9	3	3	0.3
14	29	5.8			10	3.4	2	0.1
15	13	2.9			9	3.6	0	0
16	3	1.5			11	2.2		
17	3	0.8			3	1.6		
18	14	2.6			4	2.2		
19	15	4			44	7		
20	13	4.9			22	5.1		
21	33	10.3			33	5.3		
22	25	6.7			13	3.5		
23	19	5.2			0	0		
24	18	4.5						
25	8	3.8						
26	6	3.6						
27	13	4.9			16	5.7		
28	16	5			11	4.8		
29	11	4.8			6	3.5		
30	18	8.9			3	2.1		
31								
# Hours	706		205		570		292	
Maximum	33		18		44		36	
Arith-Mean		4.1		4.4		3.5		2.5

Table 34 continued.

	November 1995		December 1995		January 1996		February 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1			17	5.9	7	2.2	12	8.3
2			26	11.8	7	1.5	14	9.3
3			3	3	4	0.9	6	1.8
4			3	3	5	0.6	3	1.4
5			3	3	5	0.7	11	1.2
6			3	3	12	4.4	11	1
7	5	0.7	3	3	5	0.4	6	2
8	0	0	3	3	4	0.3	11	6.1
9	0	0	4	3	5	2.1	33	16.1
10	0	0	3	3	17	7	31	17.8
11	567	142.5	3	3			22	4.6
12	33	8.6	3	3			5	1.5
13	9	0.7	3	3			17	4.8
14	0	0	3	3			33	16
15	2	0.2	3	3			15	6.7
16	0	0	3	3			4	0.8
17	0	0	3	3			11	2.9
18	2	0.1	3	3			26	8.5
19	0	0	3	3			9	3.1
20	466	101	3	3			21	7.4
21	37	9.7	3	2.3			11	5.5
22	3	0.3					20	10.1
23	8	0.4	0	0			21	11.3
24	243	34.1	2	0.3	2	0.3	25	8.1
25	0	0	6	1.8			20	8.3
26	5	0.2	9	3	11	2.8	9	3.8
27	17	0.9	6	1.3	1	0.3	9	5
28	3	0.3	6	1.4	5	1.1	18	5.9
29	8	0.4	4	1.5	19	6.9	6	3.3
30	14	3.1	2	0.1	24	8.4		
31			3	0.6	21	9.1		
# Hours	578		723		441		688	
Maximum	567		26		24		33	
Arith-Mean		12.7		2.8		2.8		6.3

Table 34 continued.

	March 1996		June 1996		August 1996		October 1996	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	12	5.1						
2	10	4					11	2.5
3	19	9.4					2	0.6
4	10	4.8					4	0.7
5	13	4.5					1	0.2
6	22	9.1					1	0.1
7	12	4.3					21	2.2
8	2	1.5					11	3.7
9	4	1.9					17	4.7
10	4	2.5					22	8.8
11	10	3.8					6	2.1
12	16	5.2					2	0.9
13	12	5.2					2	0.3
14	6	3.5					1	0.2
15	30	8.5					6	1.9
16	29	13.9					7	2.1
17	29	15.6					21	4.5
18	15	4.5					6	2
19	8	2.8					6	1.9
20	3	1.3	0	0			8	3.8
21	11	6.1	2	0.1				
22	17	9	3	0.4			4	1.3
23	23	10.9	18	1.7			13	1.9
24	10	7.6	33	5.2	15	3.0	6	2.1
25	24	9.3	23	2.8	14	3.5	4	1.4
26	13	9.1	1	0			5	2.5
27	10	7.9					6	1.2
28	27	10.7					3	0.6
29	22	7.8					15	5.1
30							13	3.7
31							9	3.9
# Hours	680		178		58		715	
Maximum	30		33		15		22	
Arith-Mean		6.5		1.4		2.8		2.4

Table 34 continued.

	November 1996		December 1996		January 1997		February 1997	
Day	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average
1	14	4.5			0	0		
2	7	3			104	9.9		
3	5	2.5			19	1.8		
4	6	2			0	0		
5	20	7.9			0	0		
6	17	5.2			0	0		
7	6	2.8			0	0		
8	5	1.8			0	0	9	7.2
9	5	1.8					6	4.3
10	7	4.1					4	3.2
11							21	5.2
12							20	5
13							8	5.8
14							7	4.3
15			0	0			5	2.8
16			0	0			17	5.7
17			0	0			10	4.5
18			0	0			10	4.6
19			0	0			6	2.5
20			0	0			9	5
21			0	0			7	2.7
22			0	0			5	1.7
23			0	0			2	1.5
24			0	0			4	1.5
25			0	0			3	1.5
26			65	4.8			8	4.1
27			0	0			7	4
28			0	0			5	3.5
29			0	0				
30			0	0				
31			0	0				
# Hours	256		423		192		511	
Maximum	20		65		104		21	
Arith-Mean		3.5		0.3		1.5		3.9

Table 34 continued.

	March 1997		April 1997	
Day	Maximum	Average	Maximum	Average
1	5	2.2	5	3.6
2	9	2.3	4	2.6
3	19	5.3	3	1.8
4	14	6.4	6	2.1
5	20	5.5		
6	3	1		
7	2	1.3		
8	7	2	65	25.2
9	5	1.6	23	17.8
10	13	3.8	11	7.3
11	13	4.3	6	3.2
12	10	2.7	2	2
13	18	2.4	2	2
14	12	4.5	2	2
15	5	2.6	10	6.2
16	191	18.8	23	6.3
17			18	7.5
18	9	5.8	12	8.6
19	23	10.6	11	6.5
20	11	6	20	7.9
21	9	3.4	13	5.1
22			14	5.2
23	65	16		
24	6	4	5	2.9
25	20	6.6	2	1.4
26	12	4.7	2	1
27	7	3.7	6	1.4
28	17	9.5	13	1.9
29	16	7.8	9	4.5
30	18	5.9	9	4.2
31	8	3.6		
# Hours	710		666	
Maximum	191		474*	
Arith-Mean		5.3		7.8

*Maximum recorded during an incomplete day.

Table 35.
Breton Island Annual Mean and Standard Deviation

	SO_2			NO_2		
Year	# Samples	Mean	Deviation	# Samples	Mean	Deviation
1994	1955	1.2	1.9	1874	3.0	2.7
1995	5993	1.3	5.4	6162	5.3	17.9
1996	3732	1.0	1.6	3439	3.8	5.1
1997	2009	1.6	3.9	2079	5.4	16.4

Table 36.
Percent Data Return for Breton Island Pollution Roses

	SO_2		NO_2	
Month	# Samples	%	# Samples	%
11/94	708	98.3	708	98.3
12/94	740	99.5	740	99.5
01/95	736	98.9	737	99.1
02/95	665	99.0	665	99.0
03/95	535	71.9	535	71.9
05/95	710	95.4	735	98.8
06/95	700	97.2	706	98.1
11/95	695	96.5	578	80.3
12/95	0	0	723	97.2
02/96	685	98.4	688	98.9
03/96	674	90.6	680	91.4
10/96	715	96.1	715	96.1
01/97	671	90.2	0	0
02/97	667	99.3	0	0
03/97	0	0	710	95.4
04/97	0	0	666	92.5

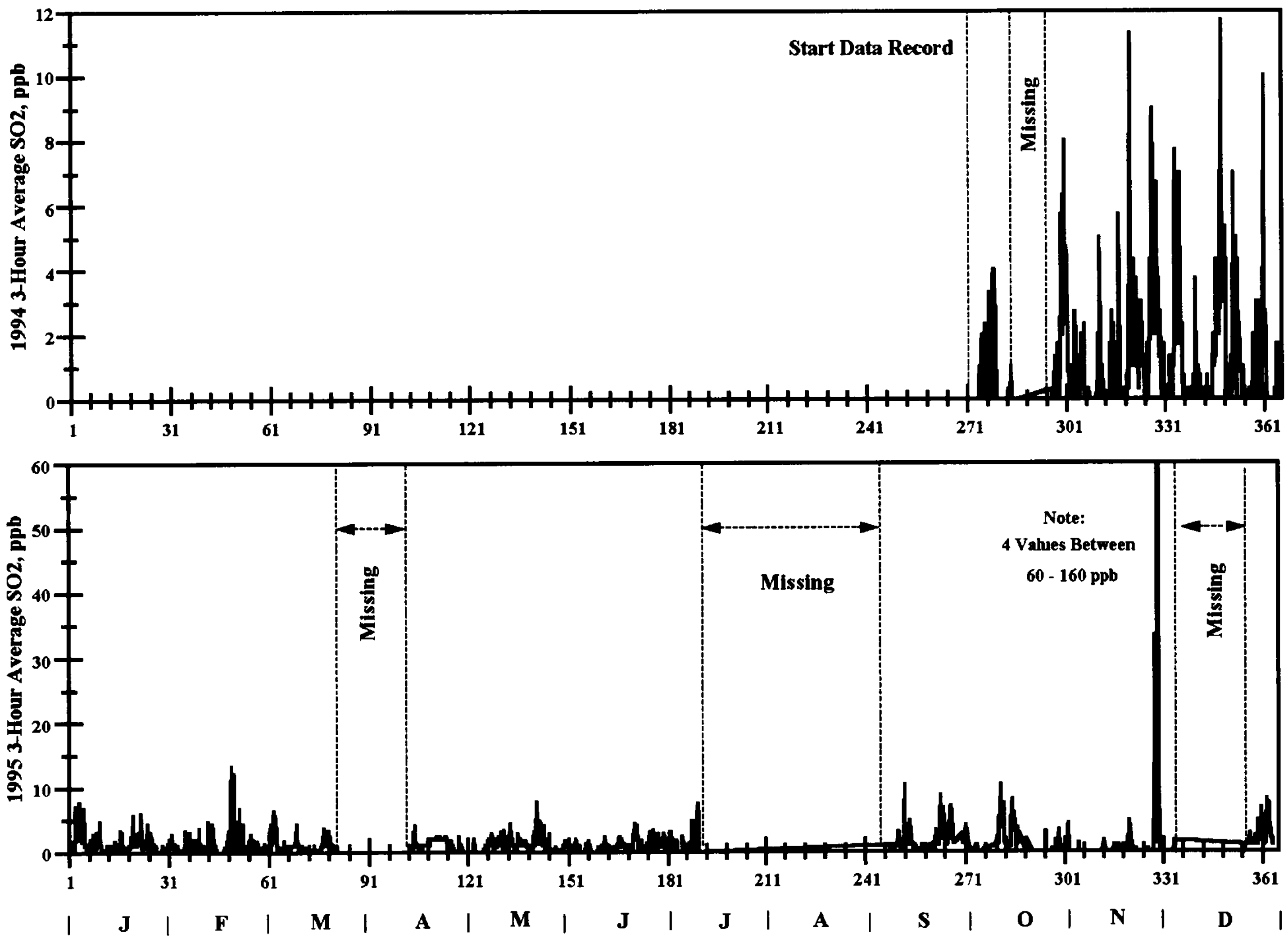


Figure 137. Breton Island 3-hour block averaged annual SO_2 trends for 1994 and 1995.

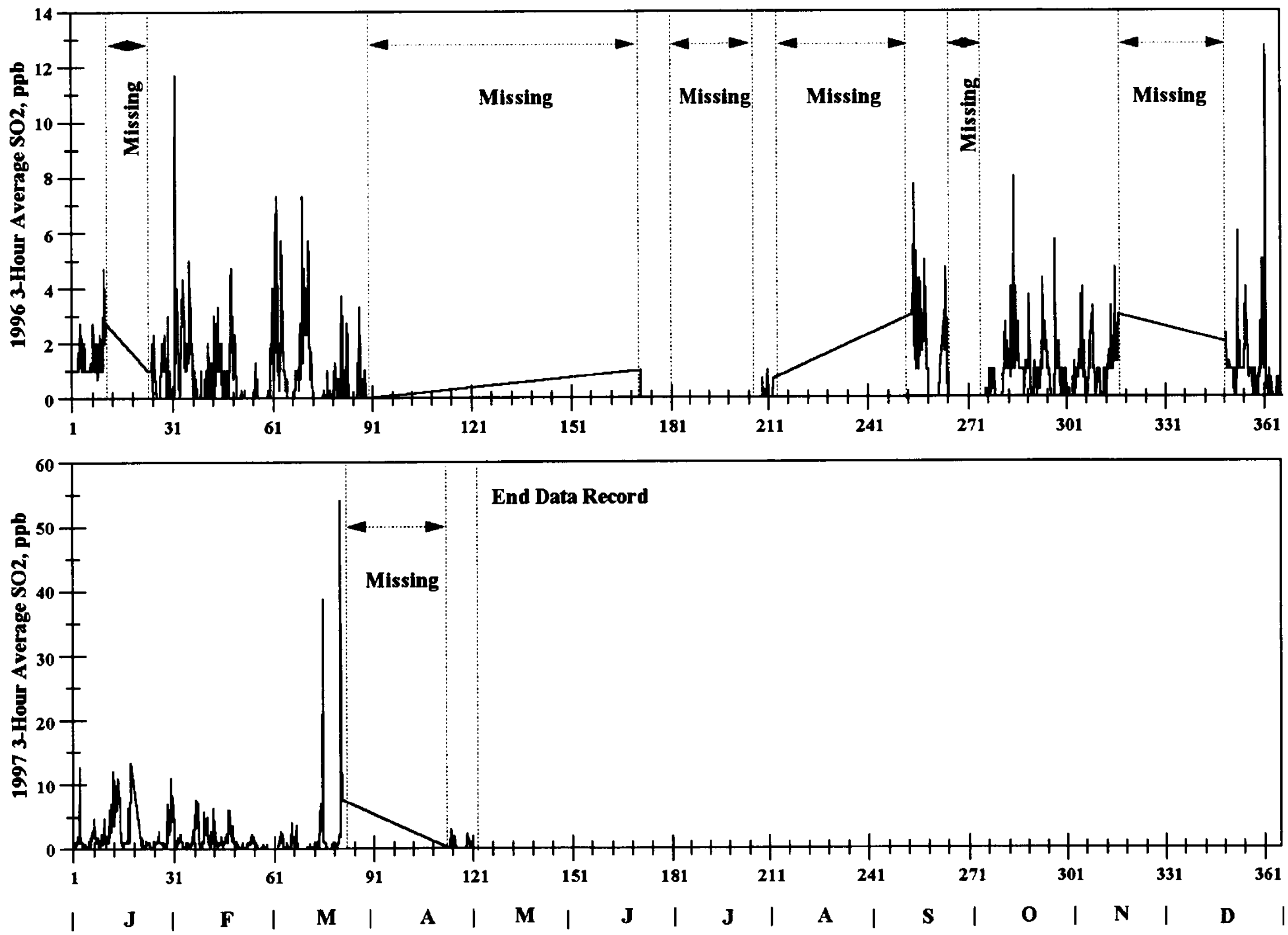


Figure 138. Breton Island 3-hour block averaged annual SO_2 trends for 1996 and 1997.

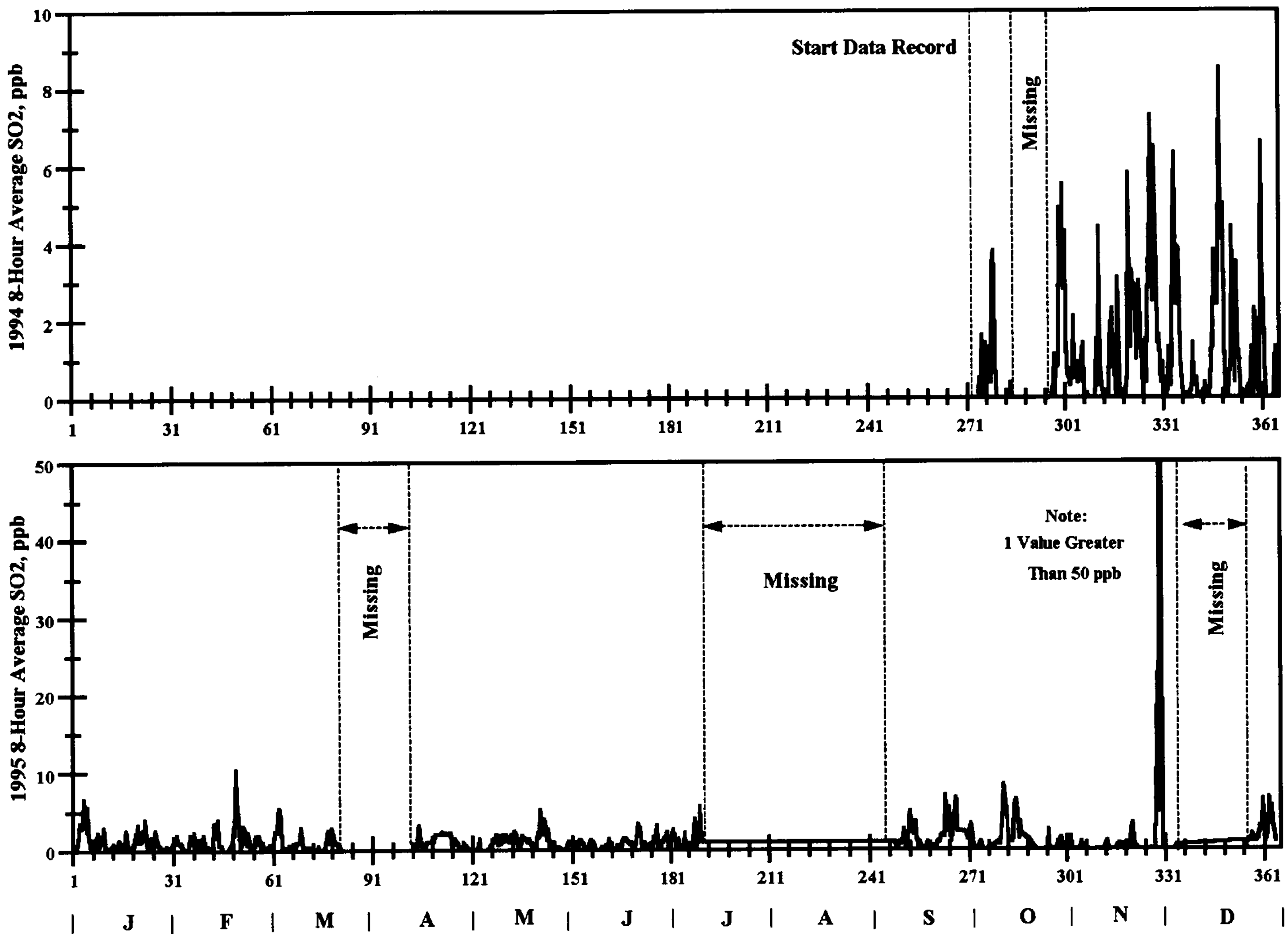


Figure 139. Breton Island 8-hour block averaged annual SO_2 trends for 1994 and 1995.

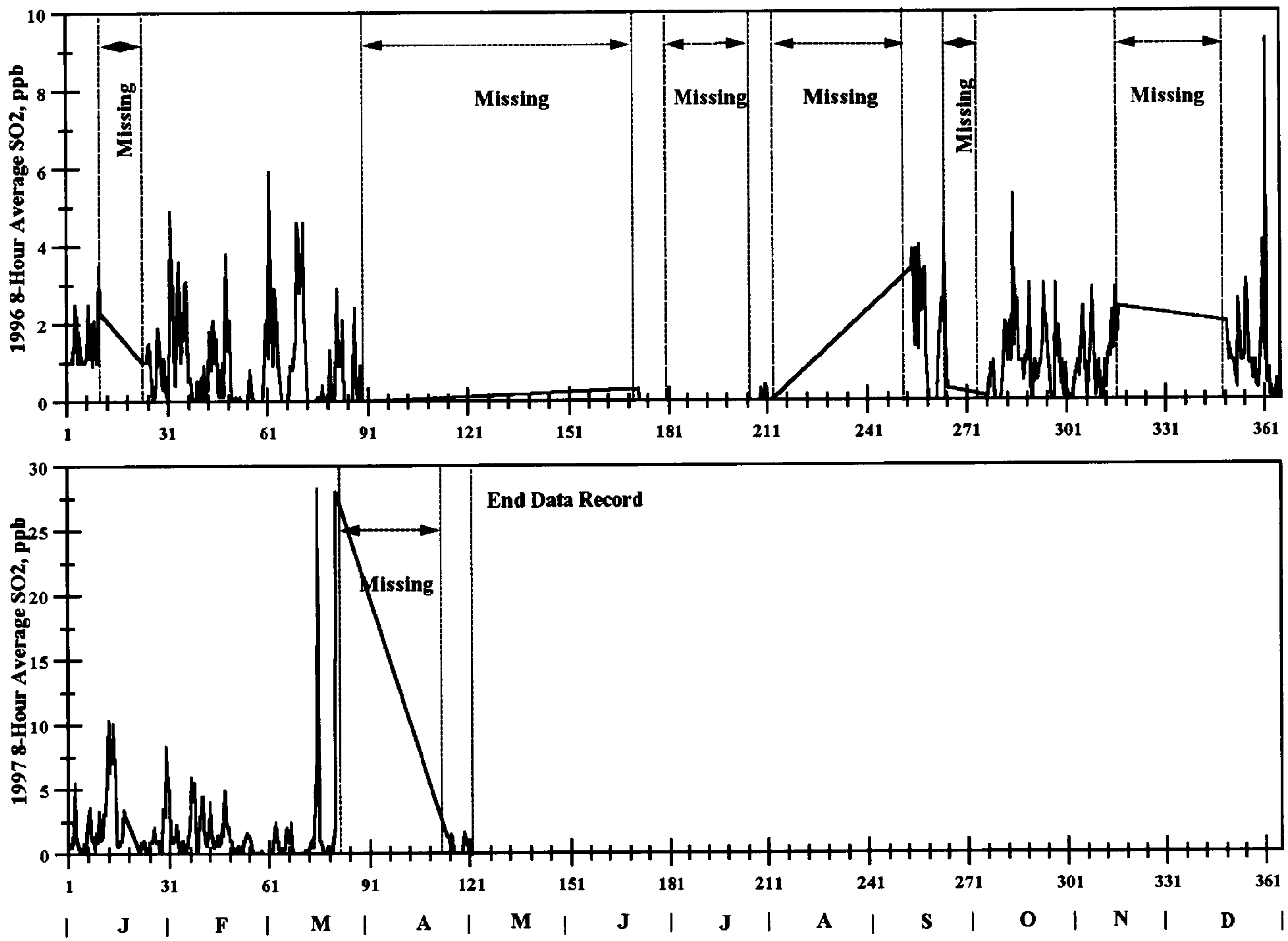


Figure 140. Breton Island 8-hour block averaged annual SO_2 trends for 1996 and 1997.

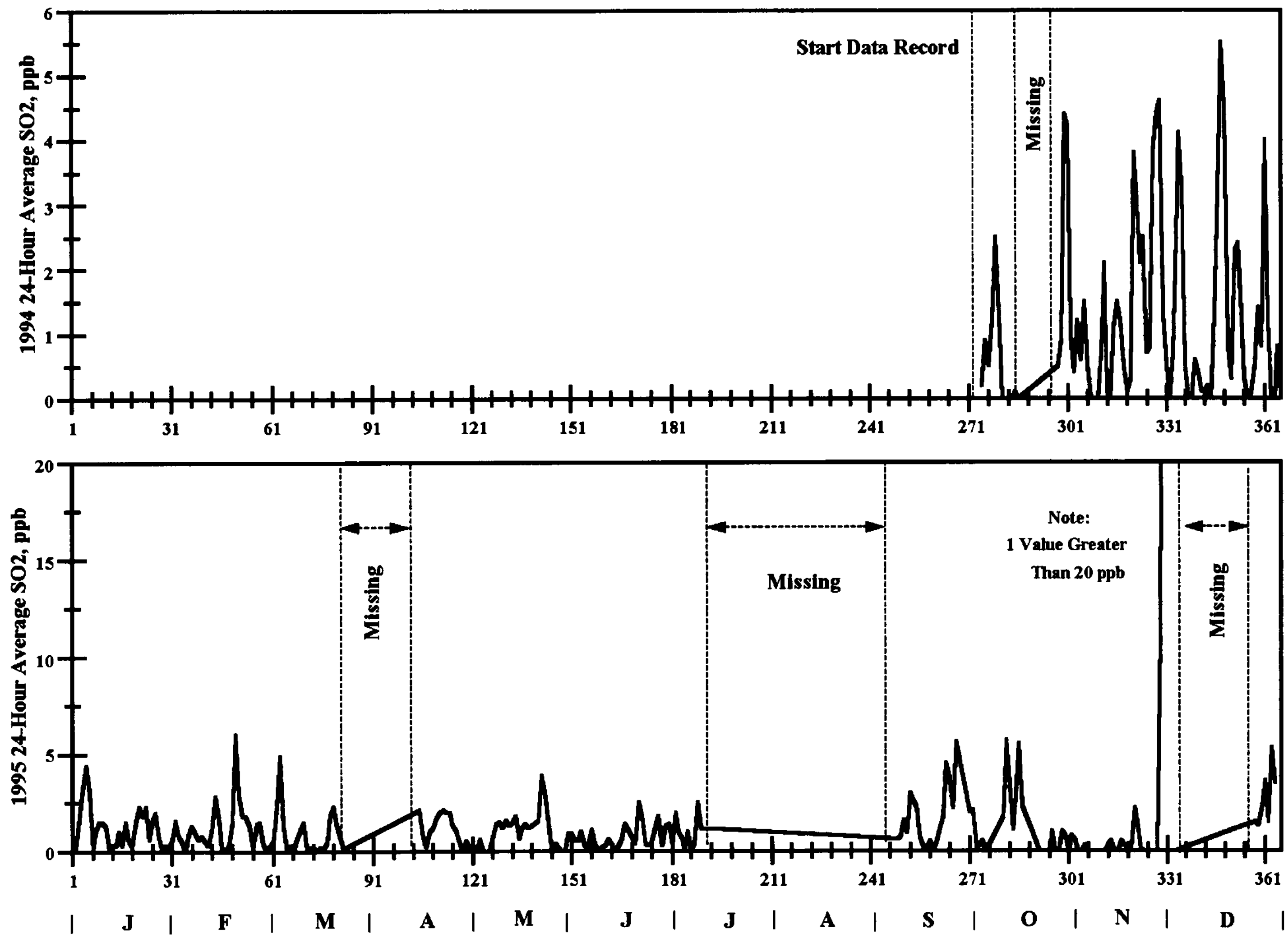


Figure 141. Breton Island 24-hour block averaged annual SO_2 trends for 1994 and 1995.

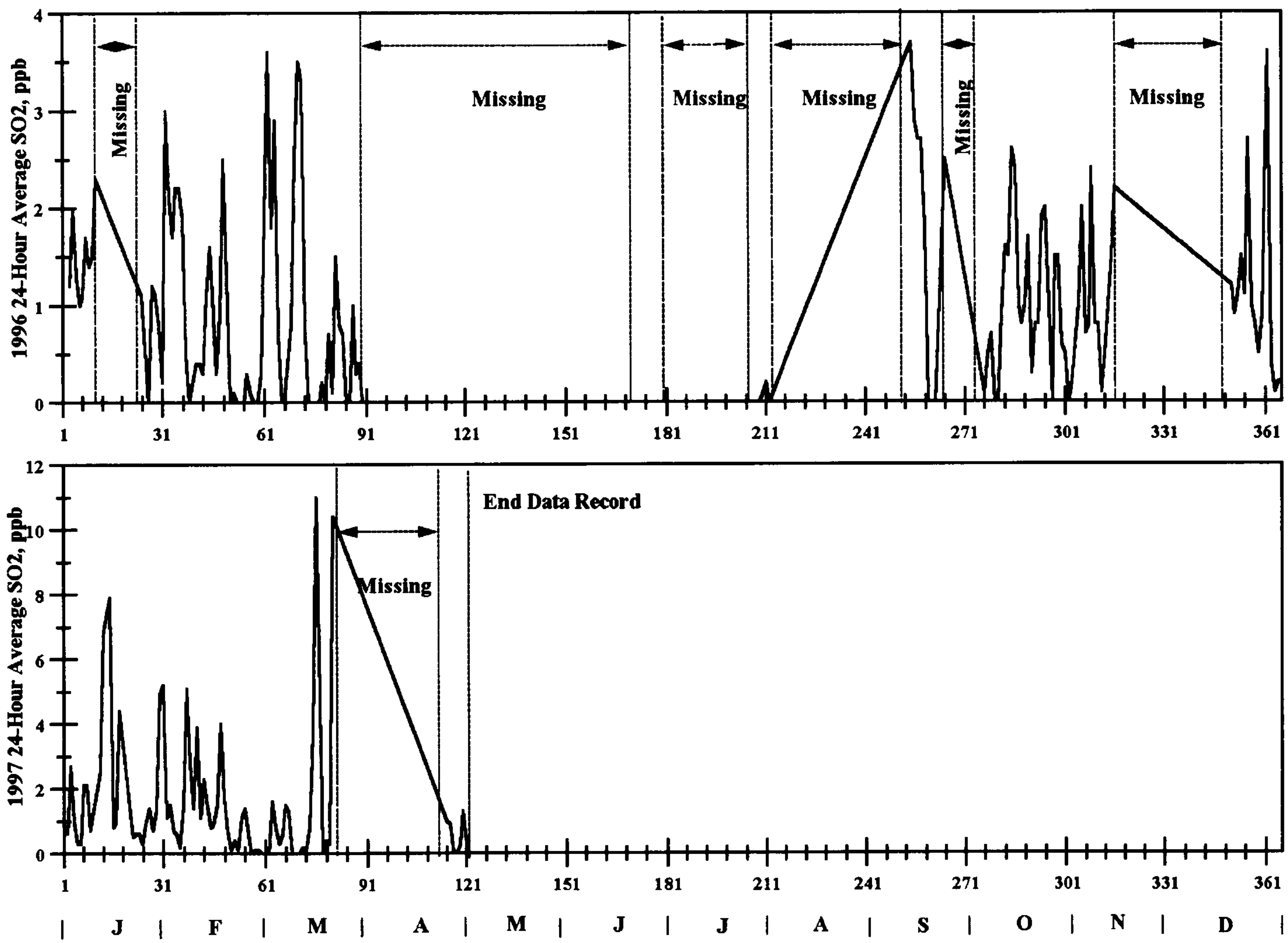


Figure 142. Breton Island 24-hour block averaged annual SO_2 trends for 1996 and 1997.

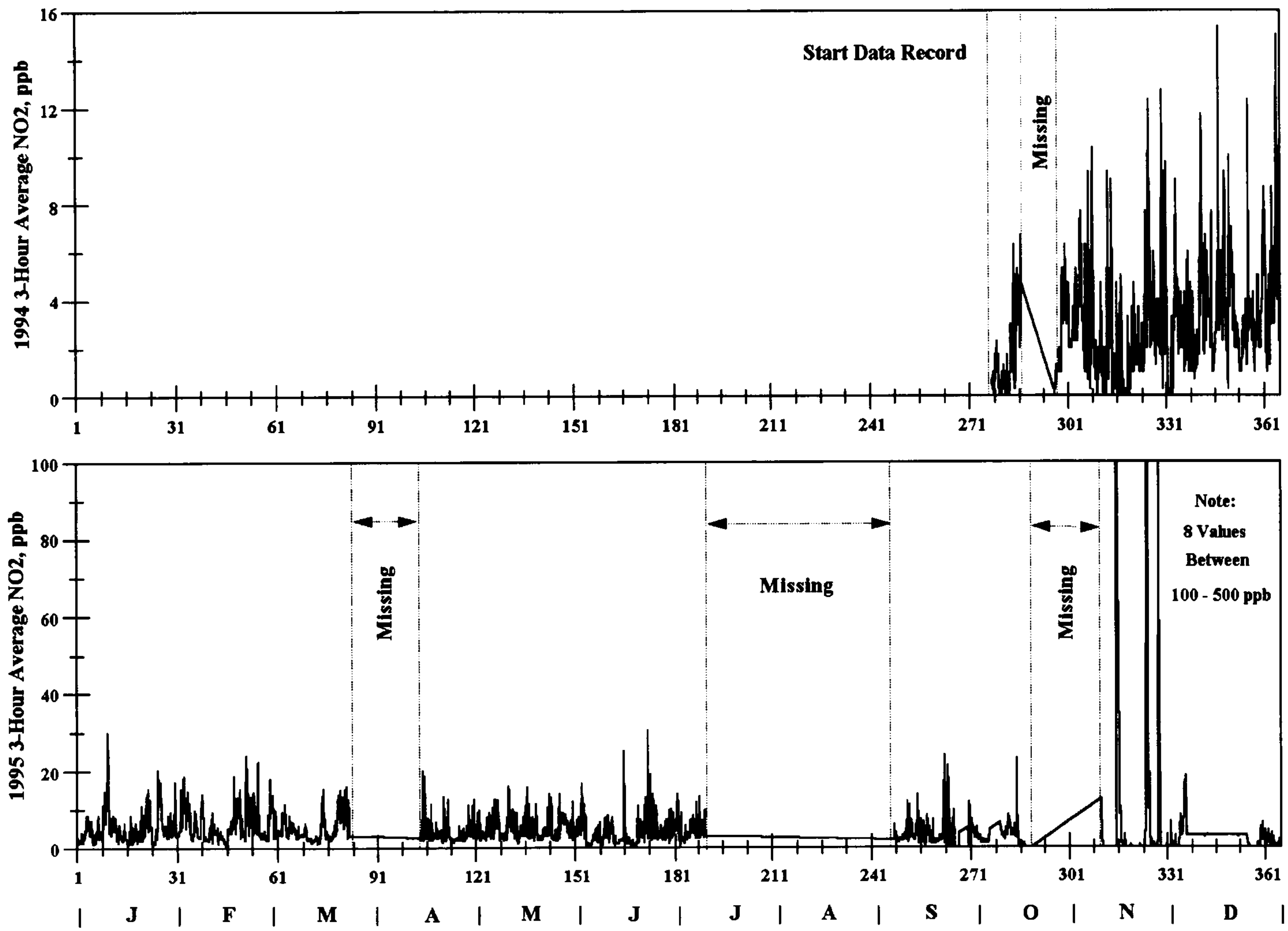


Figure 143. Breton Island 3-hour block averaged annual NO_2 trends for 1994 and 1995.

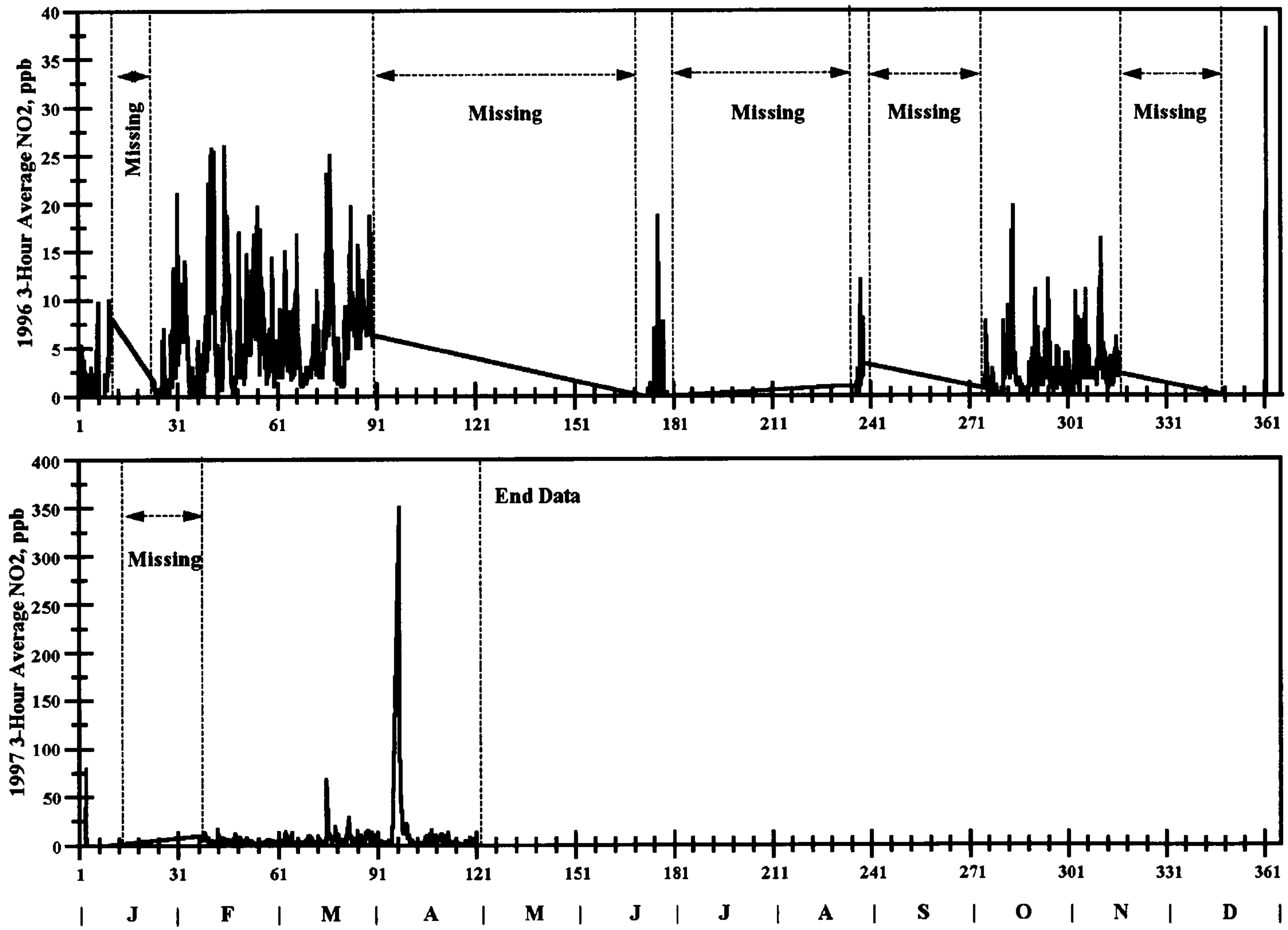


Figure 144. Breton Island 3-hour block averaged annual NO_2 trends for 1996 and 1997.

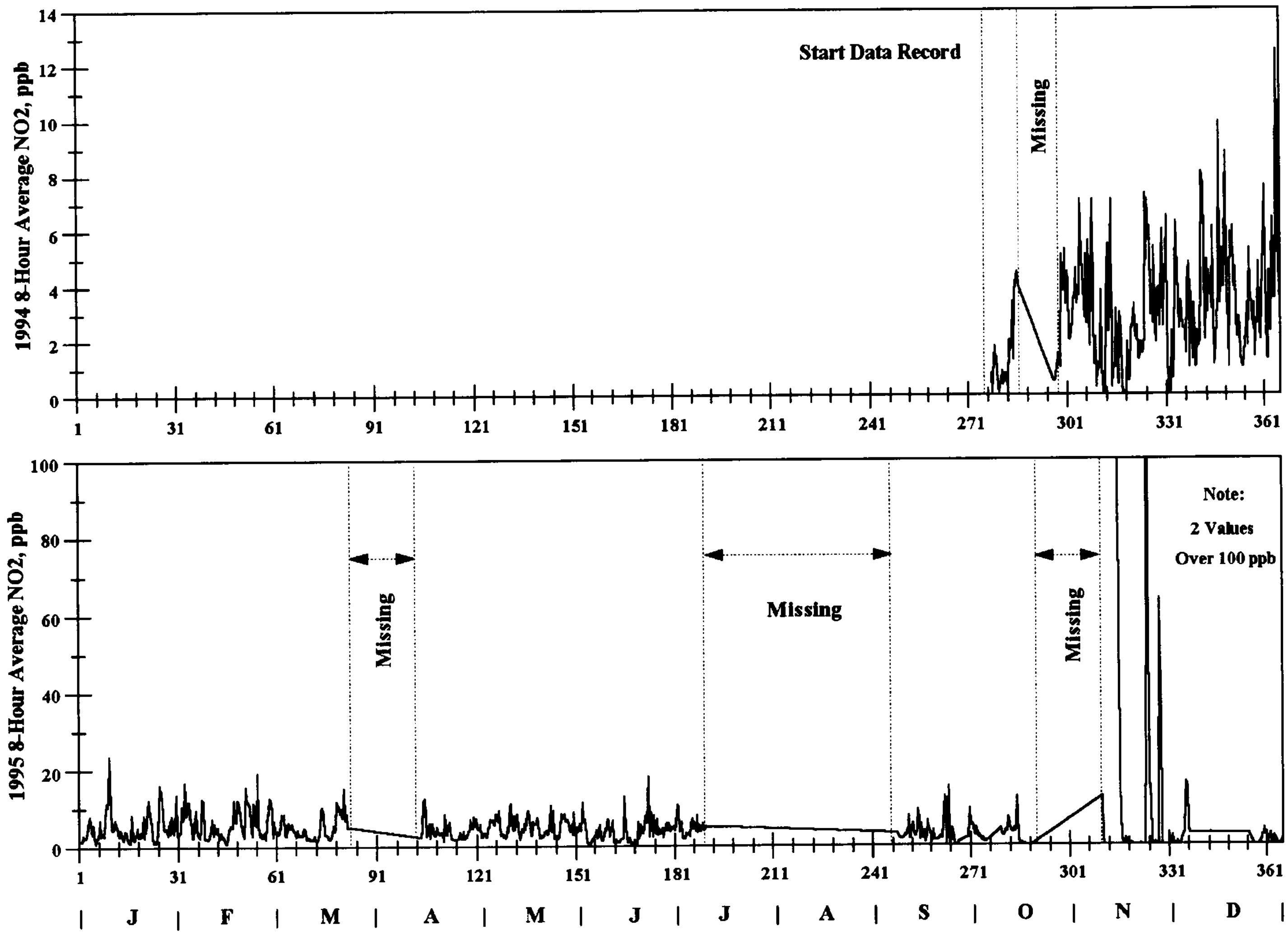


Figure 145. Breton Island 8-hour block averaged annual NO_2 trends for 1994 and 1995.

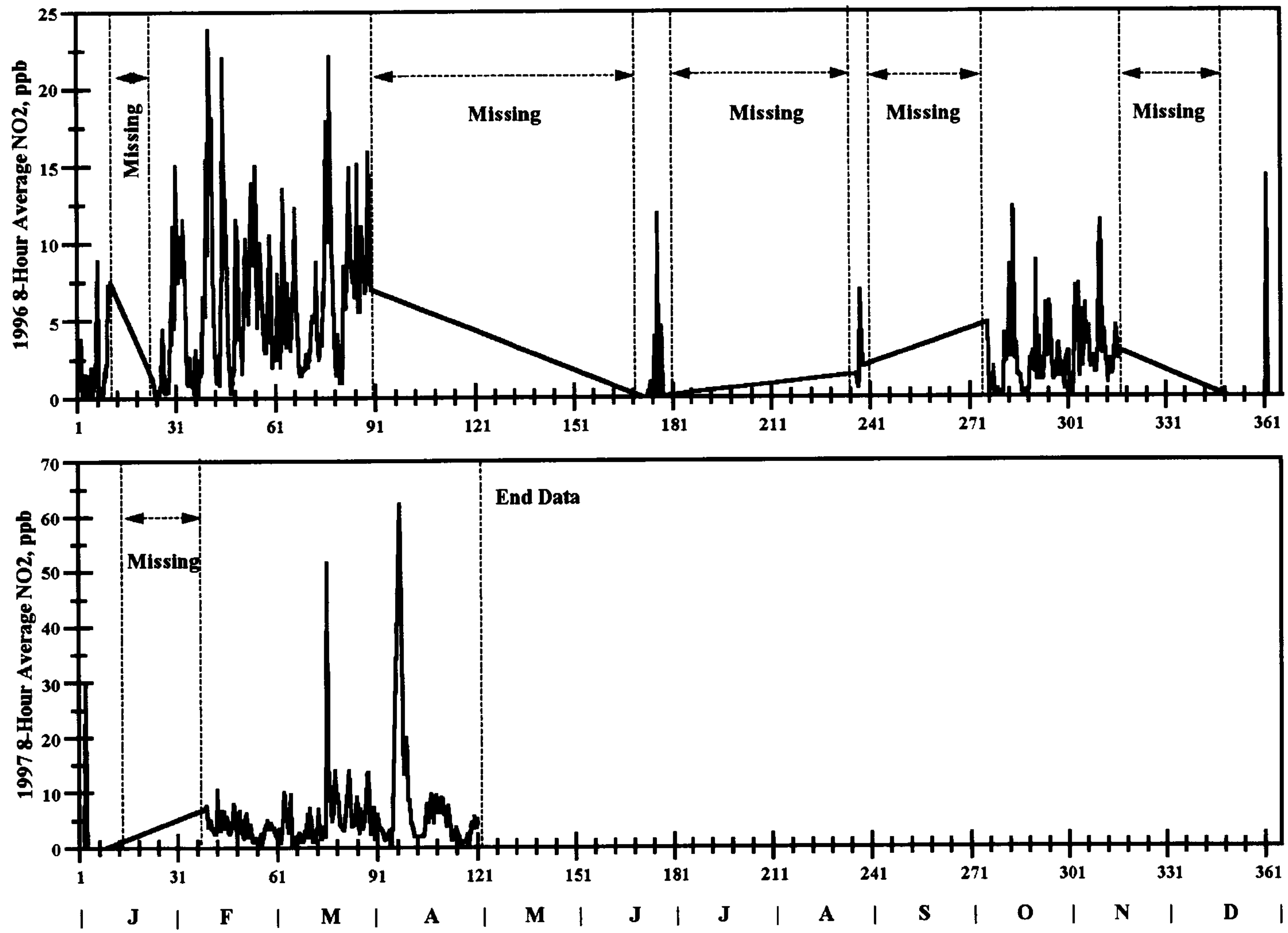


Figure 146. Breton Island 8-hour block averaged annual NO_2 trends for 1996 and 1997.

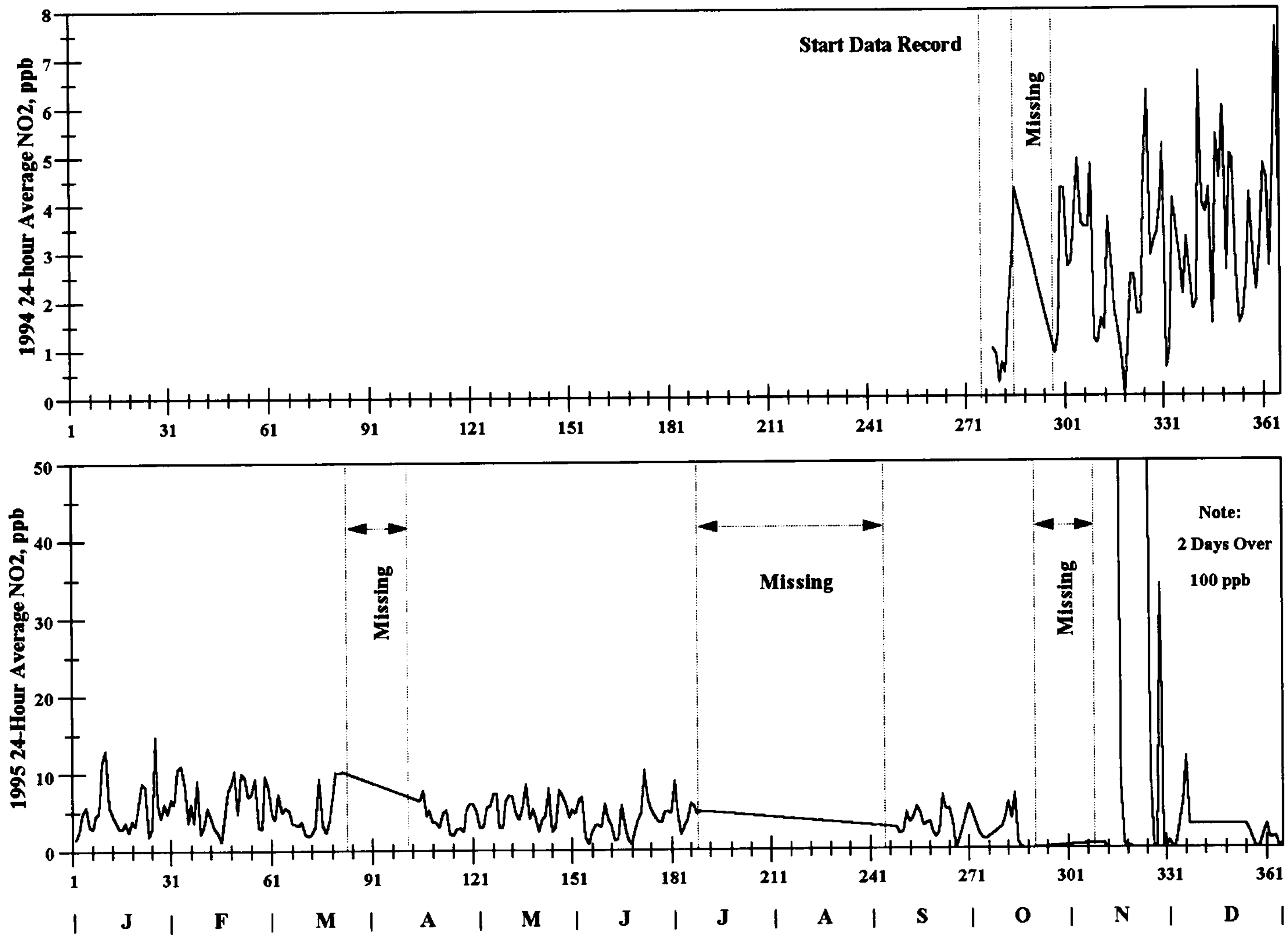


Figure 147. Breton Island 24-hour block averaged annual NO_2 trends for 1994 and 1995.

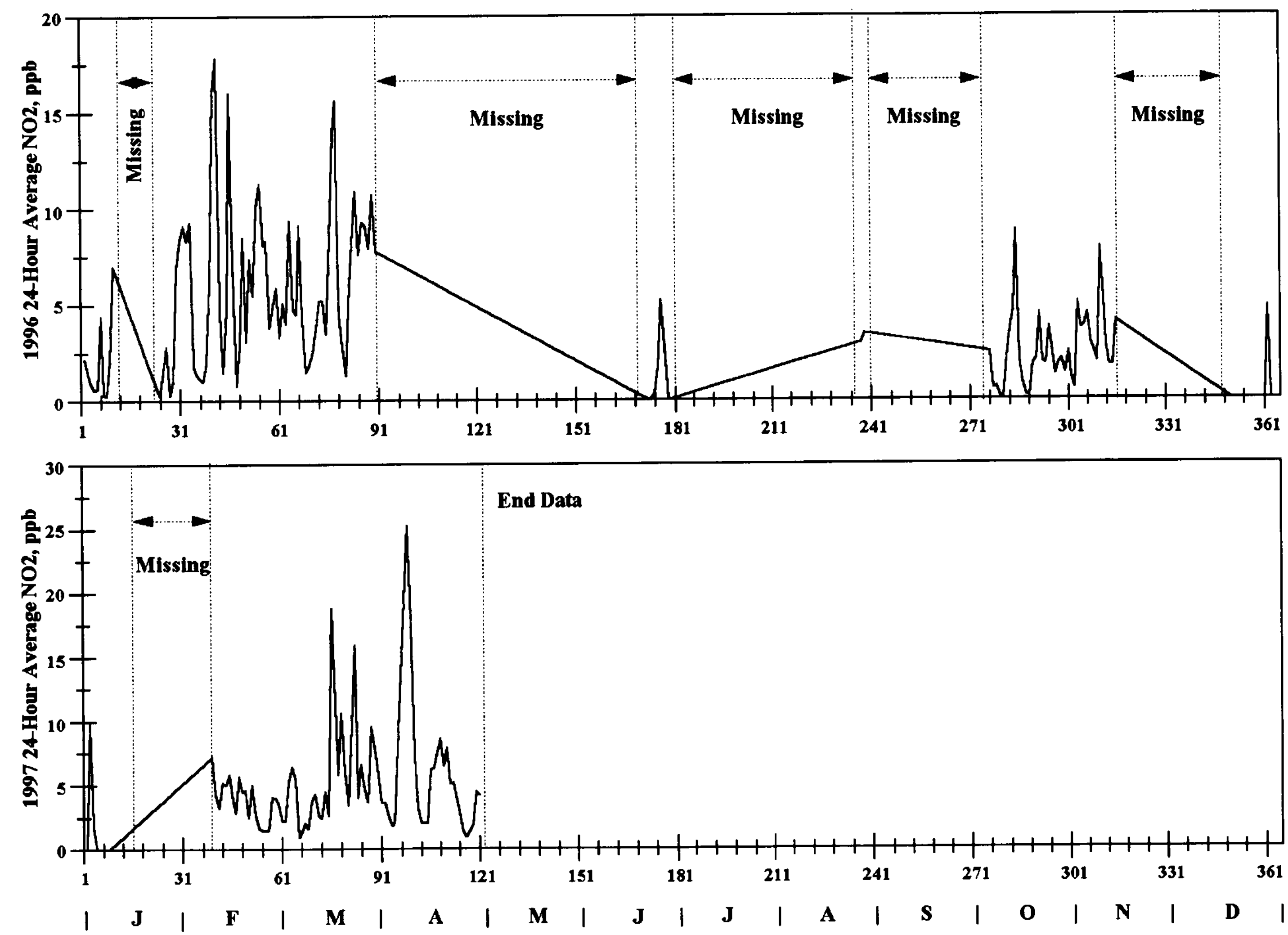


Figure 148. Breton Island 24-hour block averaged annual NO_2 trends for 1996 and 1997.

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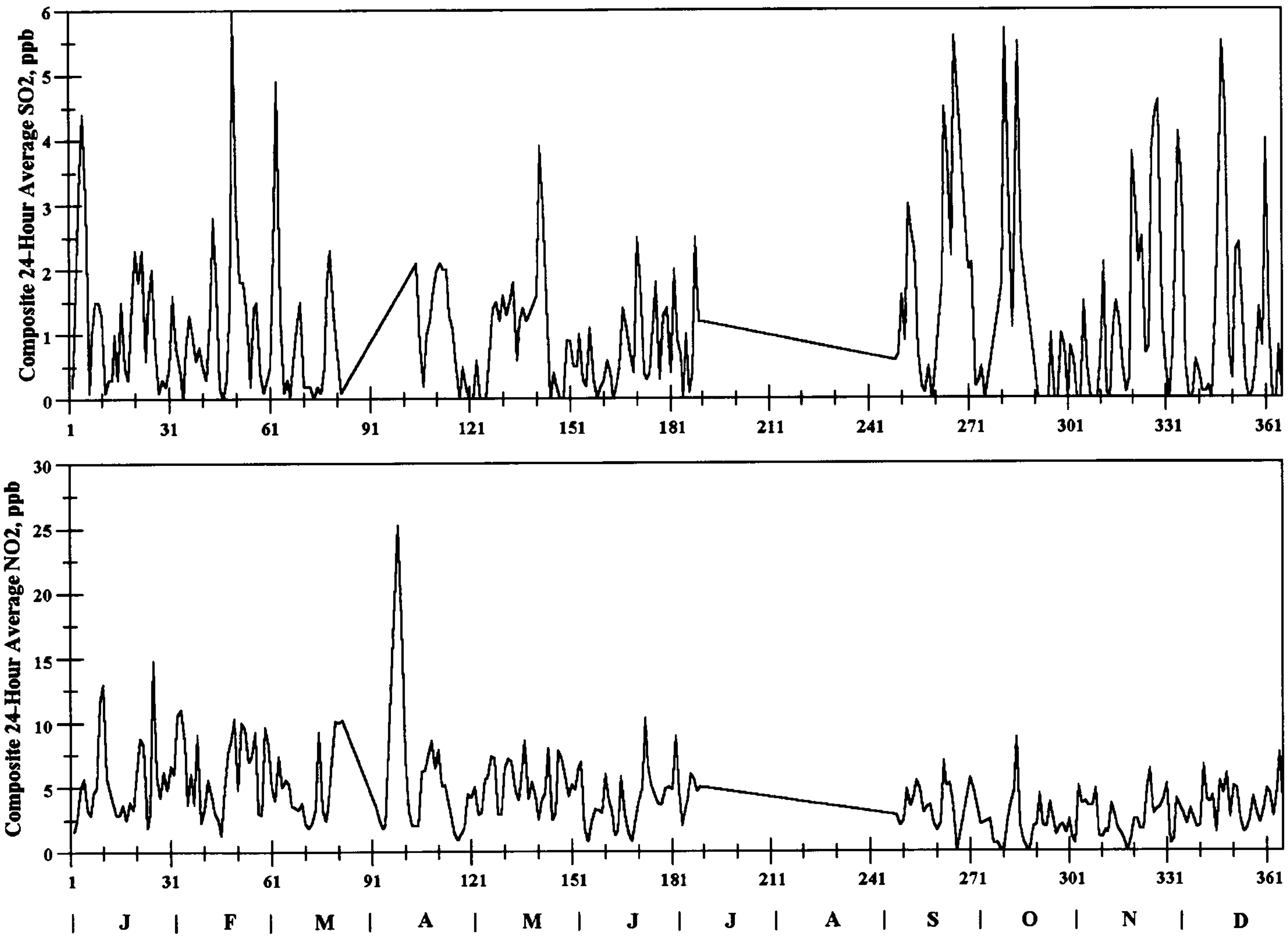


Figure 149. Breton Island 24-hour block averaged annual trends derived from composite years' data.

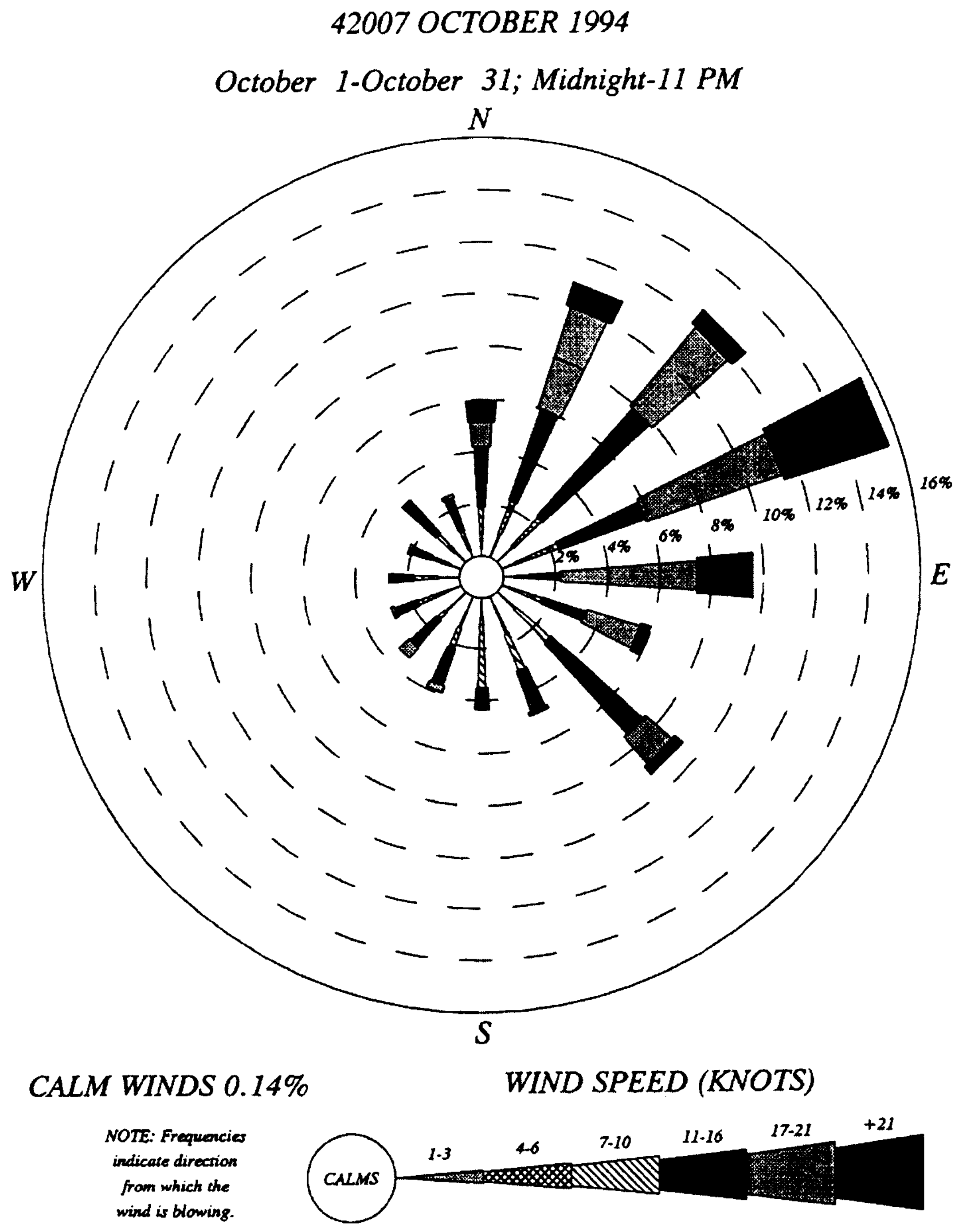


Figure 150. October 1994 wind rose for NOAA buoy 42007.

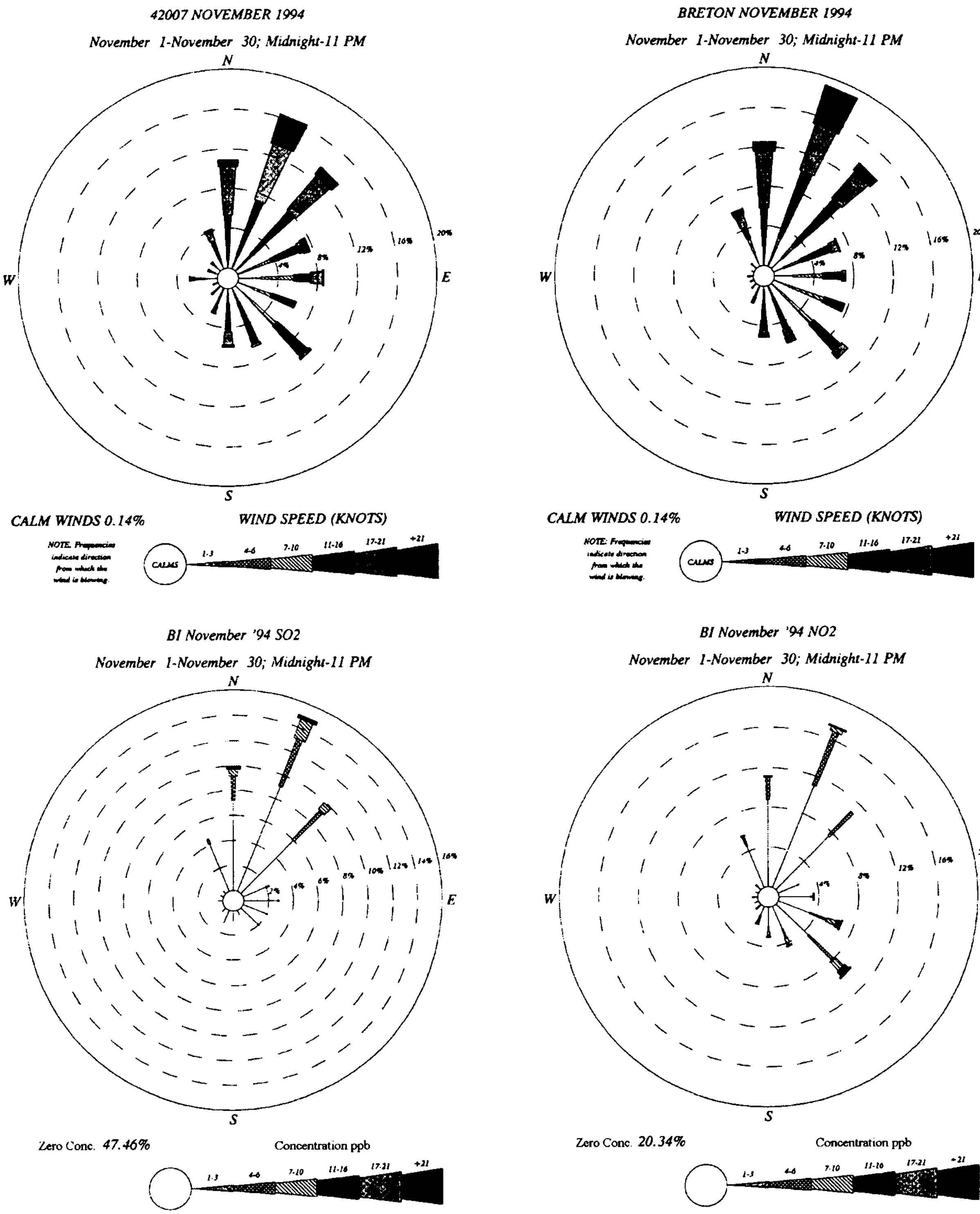


Figure 151. November 1994 wind and pollution roses from Breton Island and buoy 42007.

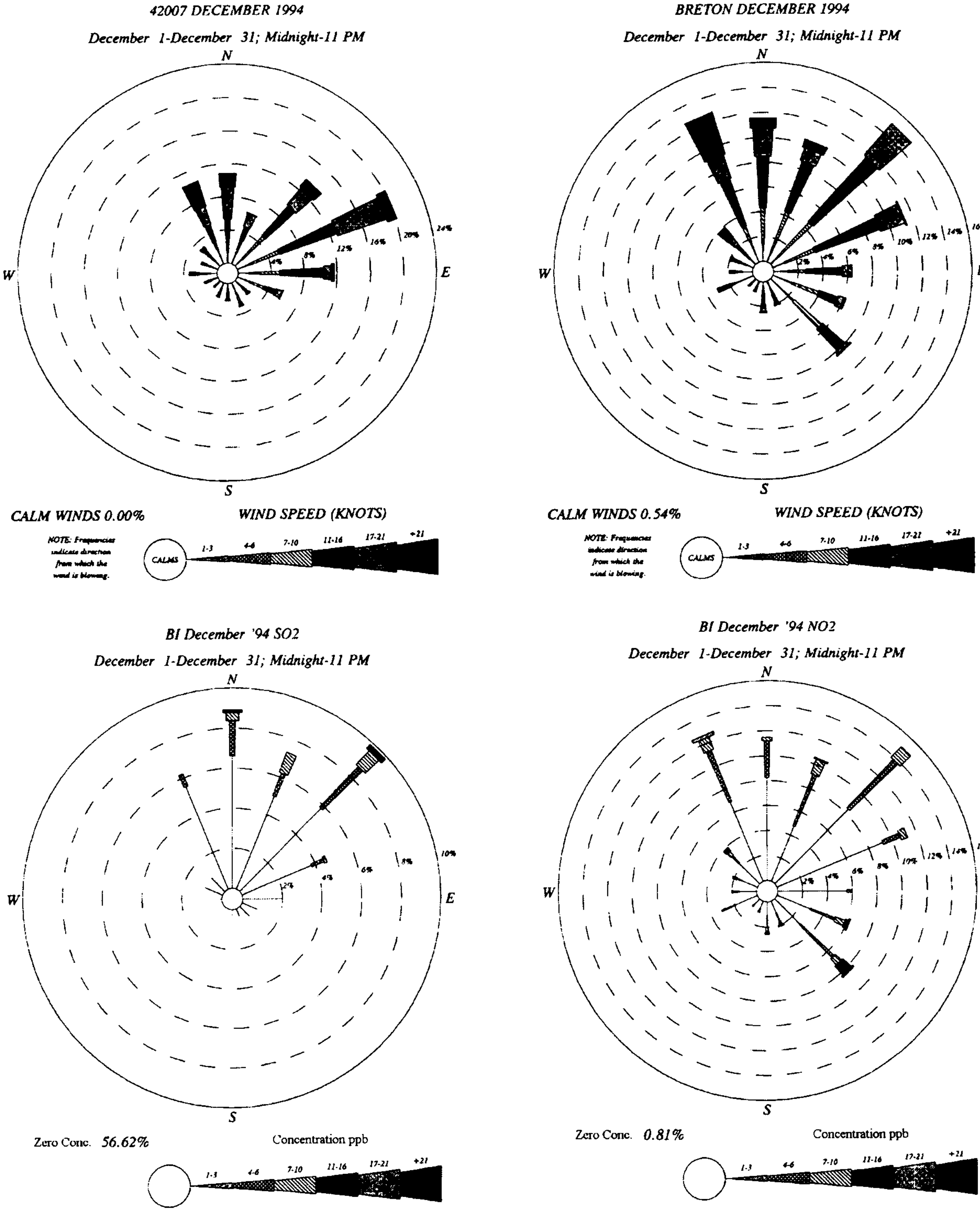


Figure 152. December 1994 wind and pollution roses for Breton Island and buoy 42007.

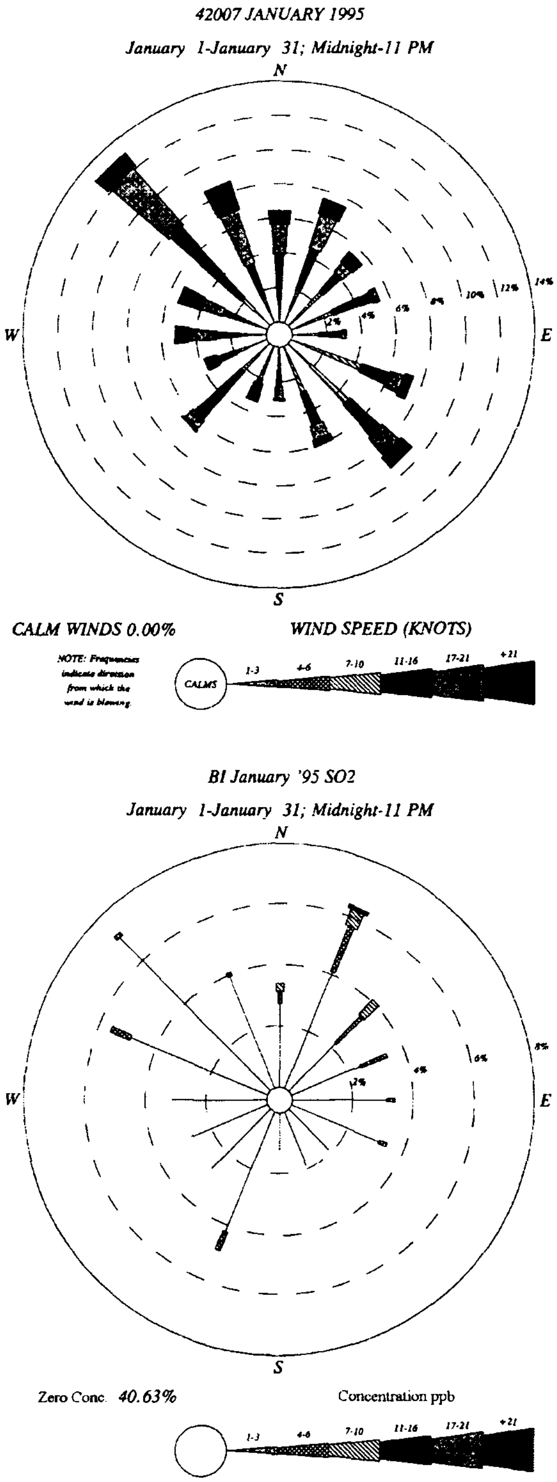


Figure 153. January 1995 wind and pollution roses for Breton Island and buoy 42007.

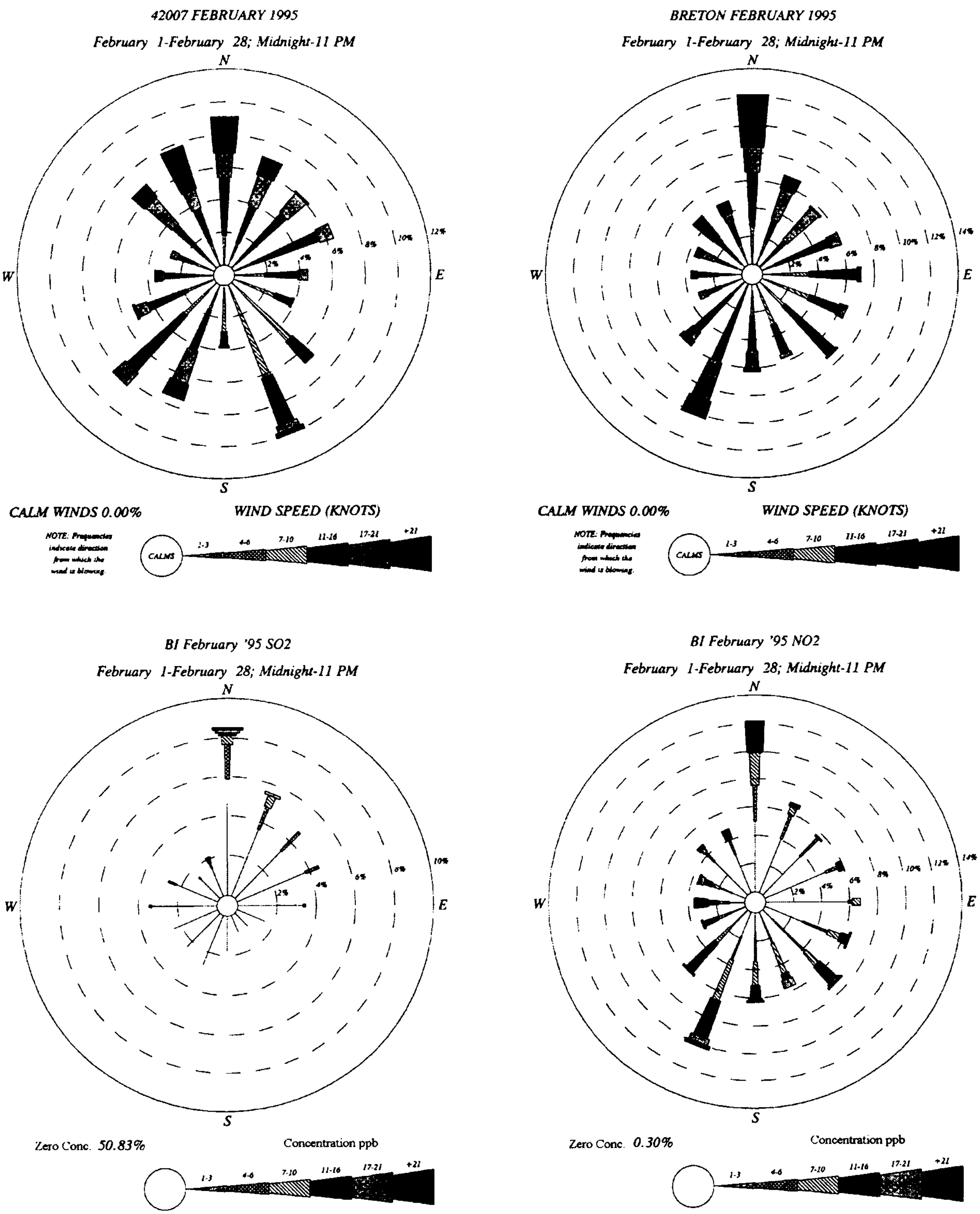


Figure 154. February 1995 wind and pollution roses for Breton Island and buoy 42007.

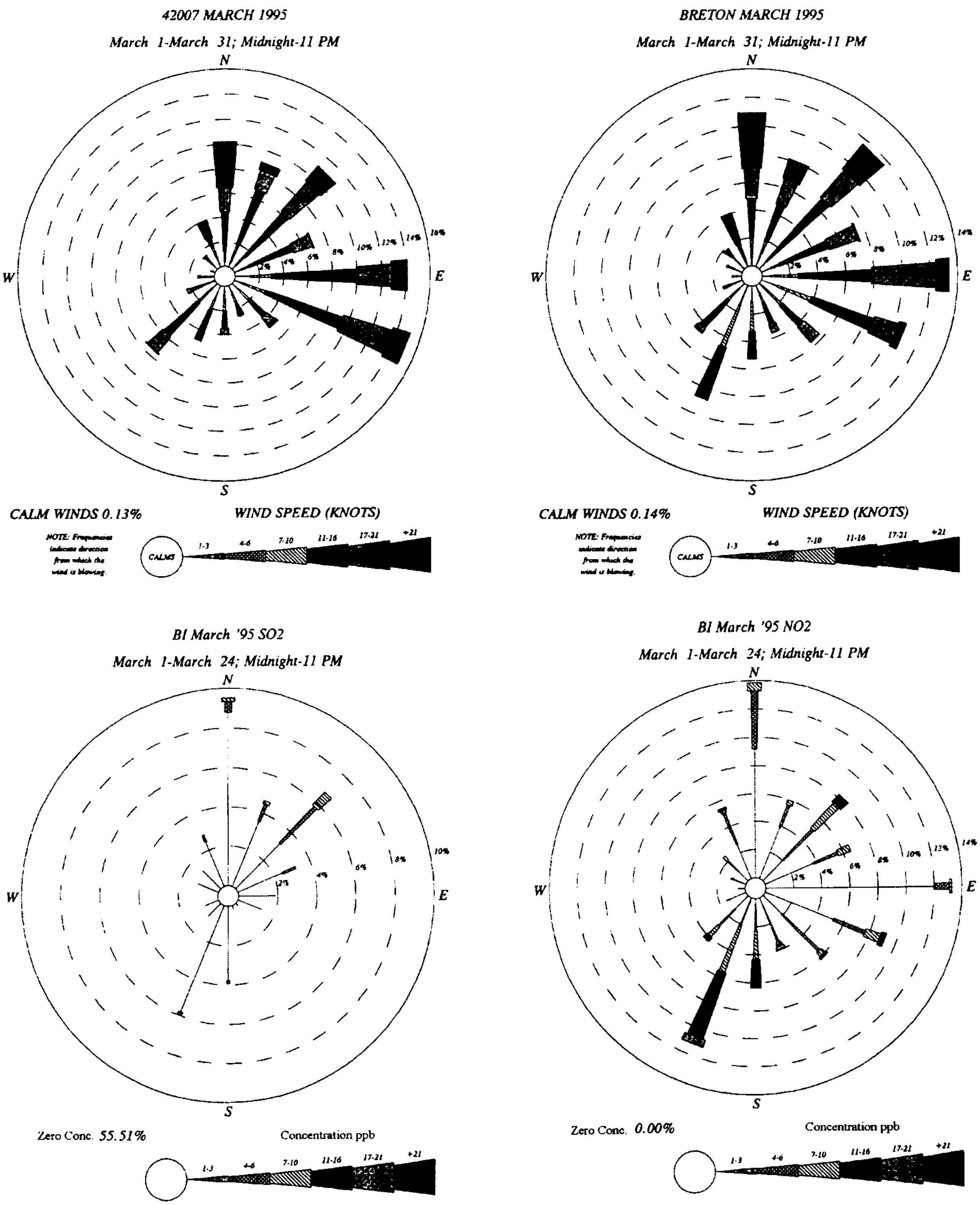


Figure 155. March 1995 wind and pollution roses for Breton Island and buoy 42007.

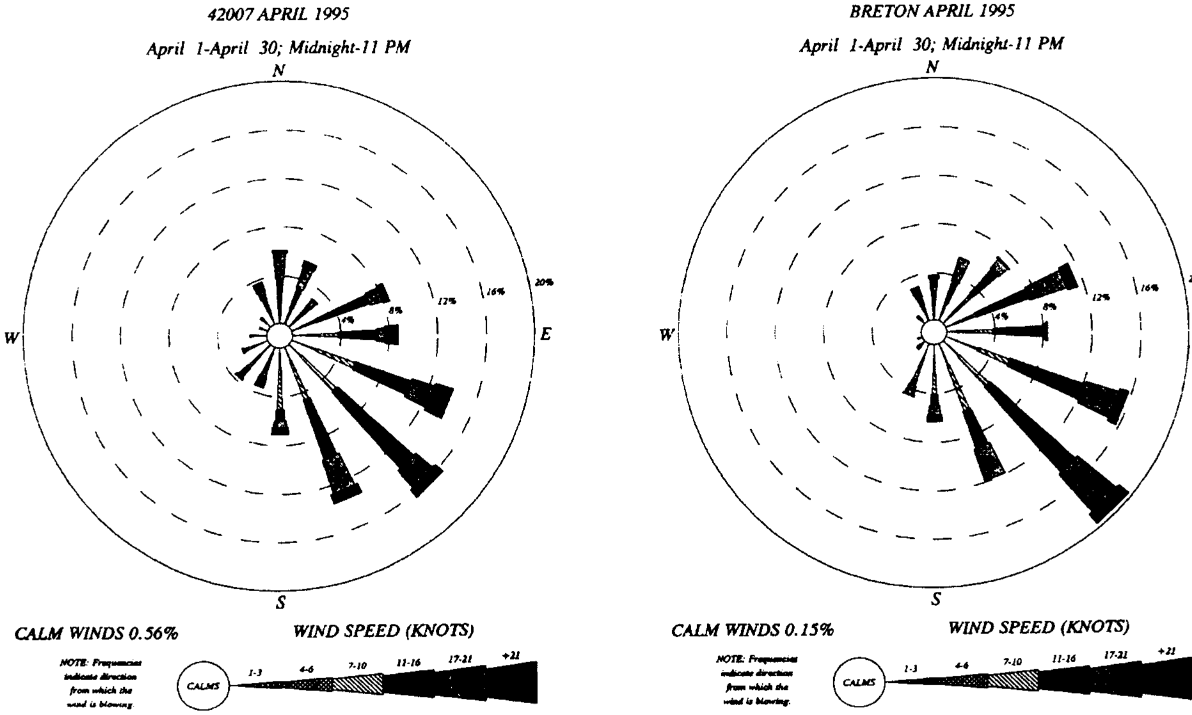


Figure 156. April 1995 wind roses for Breton Island and buoy 42007.

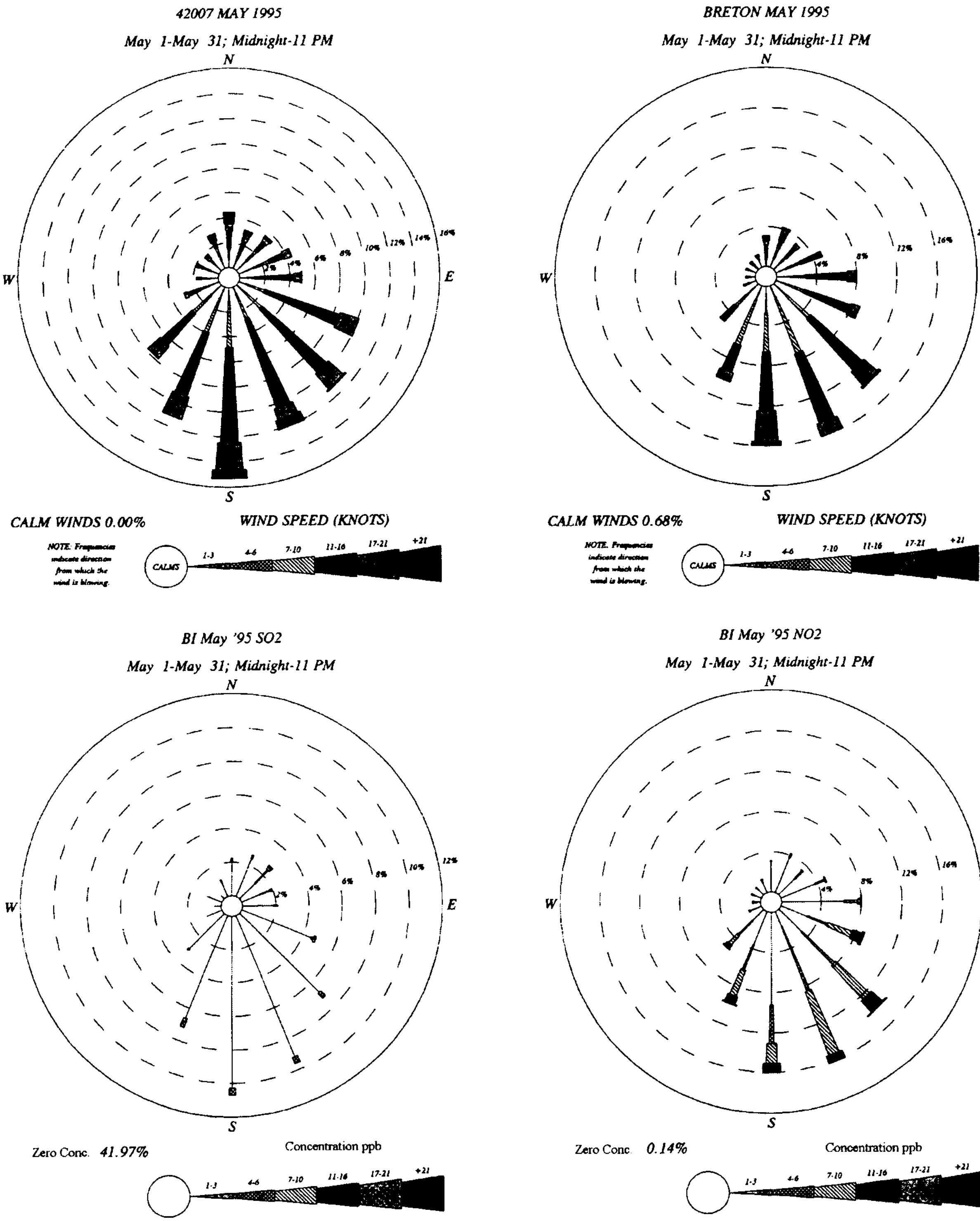


Figure 157. May 1995 wind and pollution roses for Breton Island and buoy 42007.

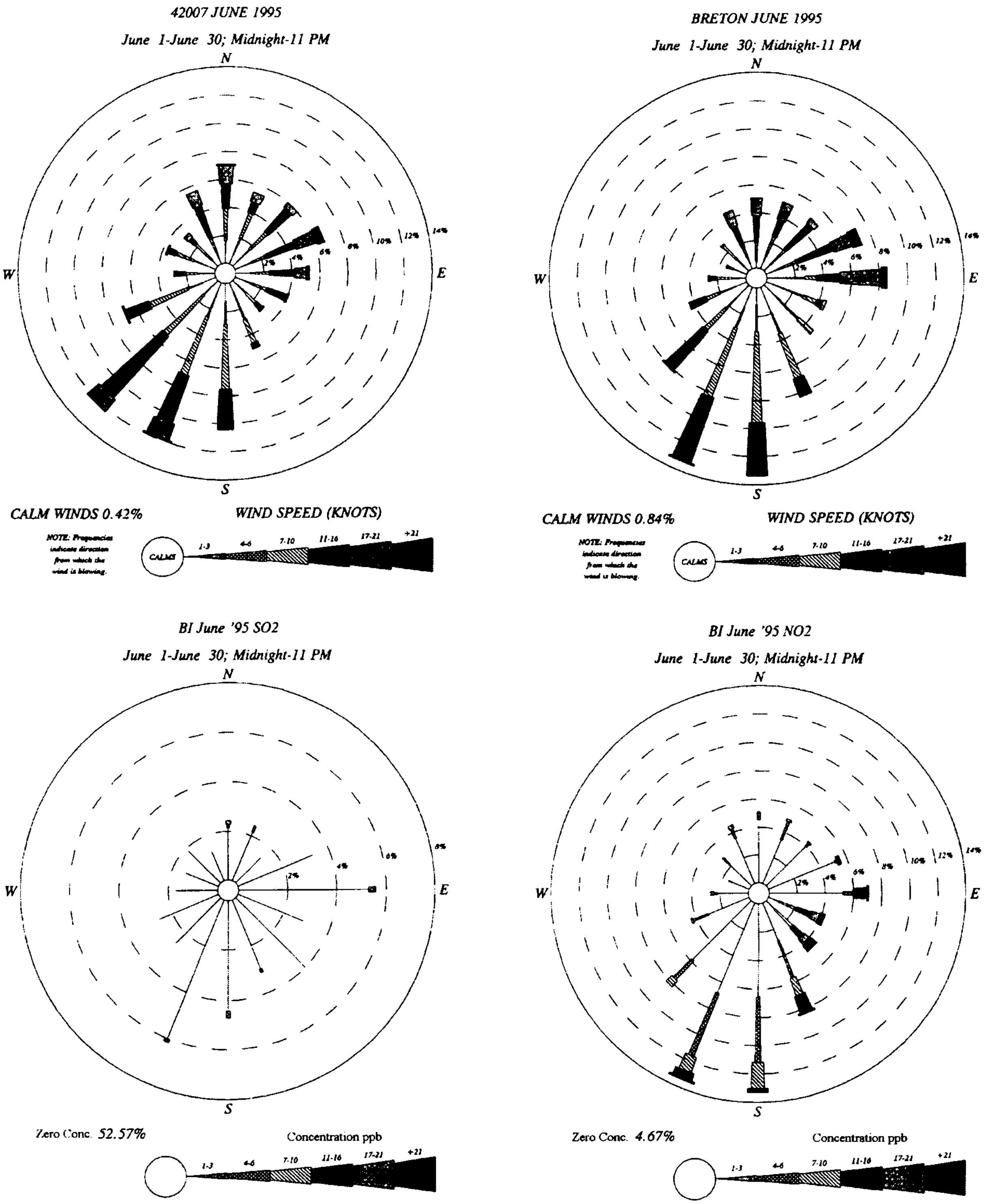


Figure 158. June 1995 wind and pollution roses for Breton Island and buoy 42007.

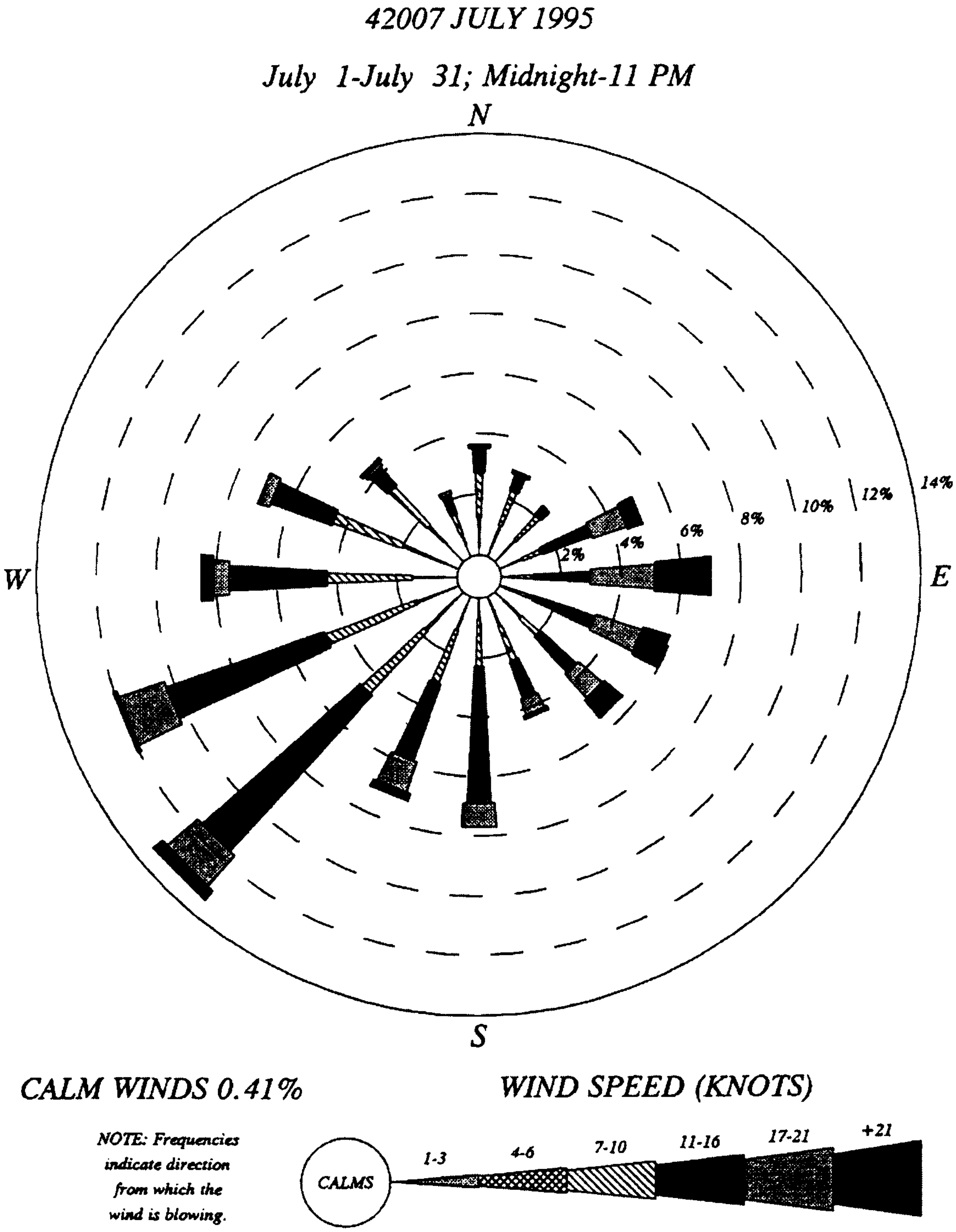


Figure 159. July 1995 wind rose for NOAA buoy 42007.

42007 AUGUST 1995

August 1-August 31; Midnight-11 PM

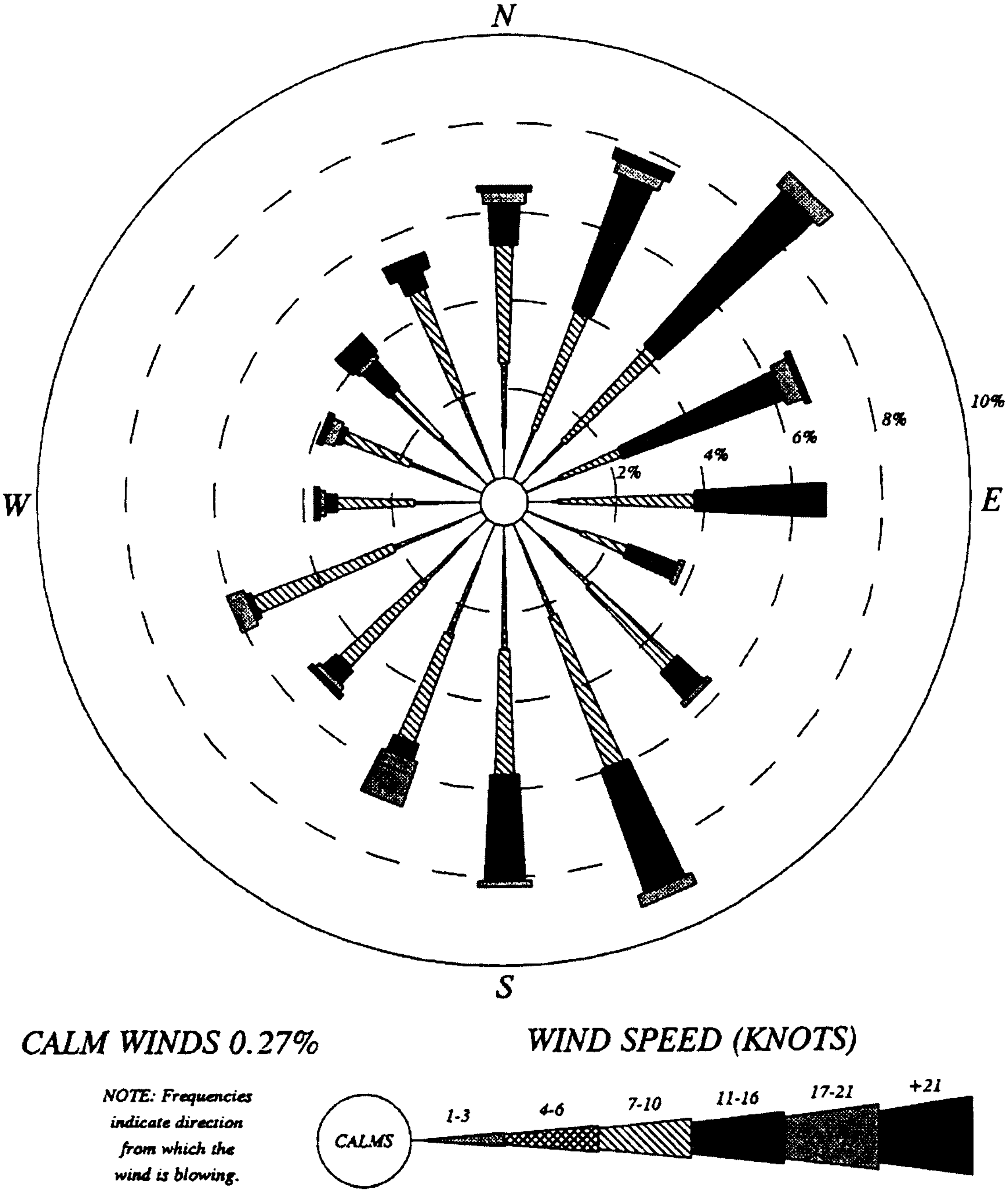


Figure 160. August 1995 wind rose for NOAA buoy 42007.

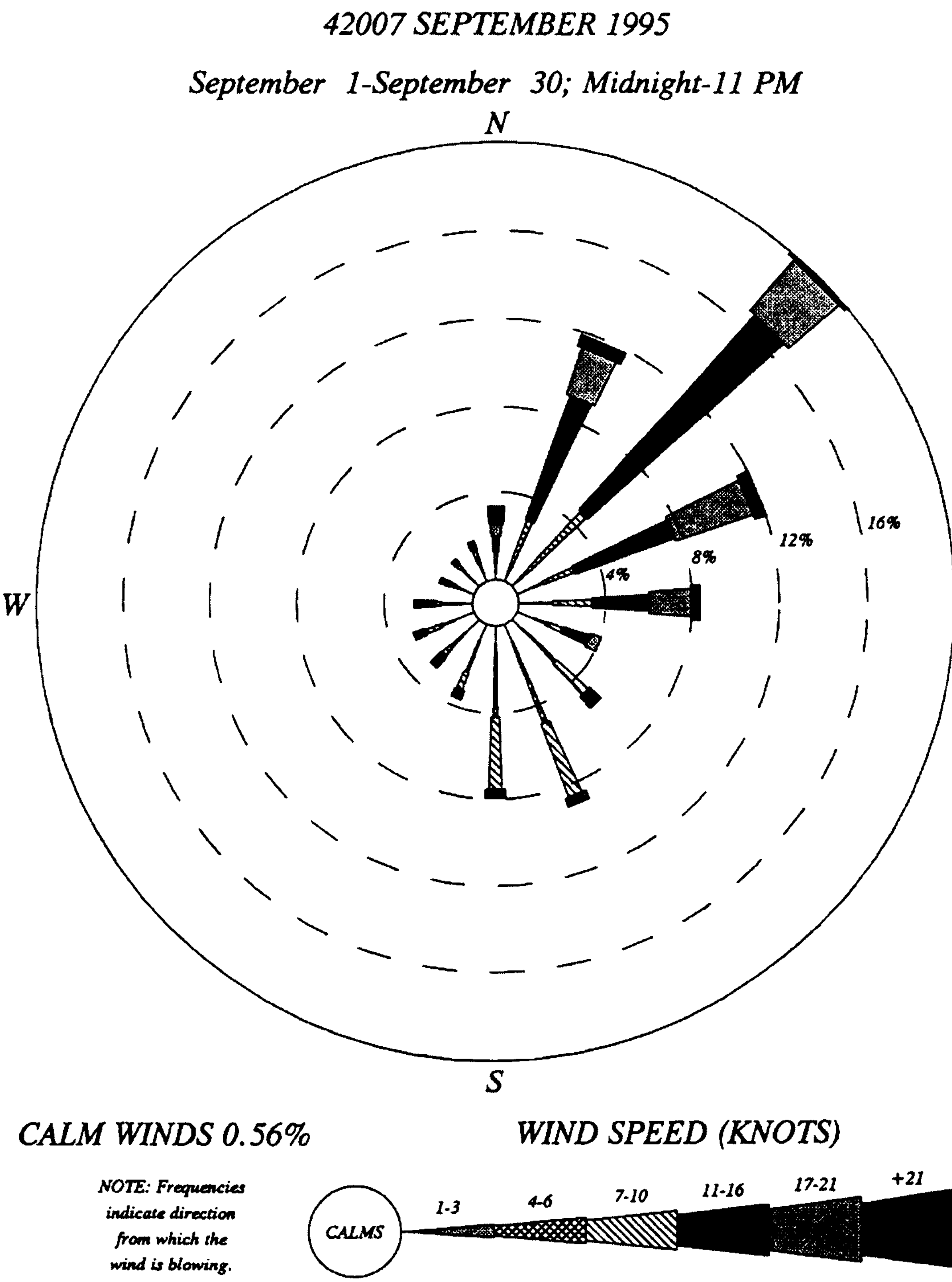


Figure 161. September 1995 wind rose for NOAA buoy 42007.

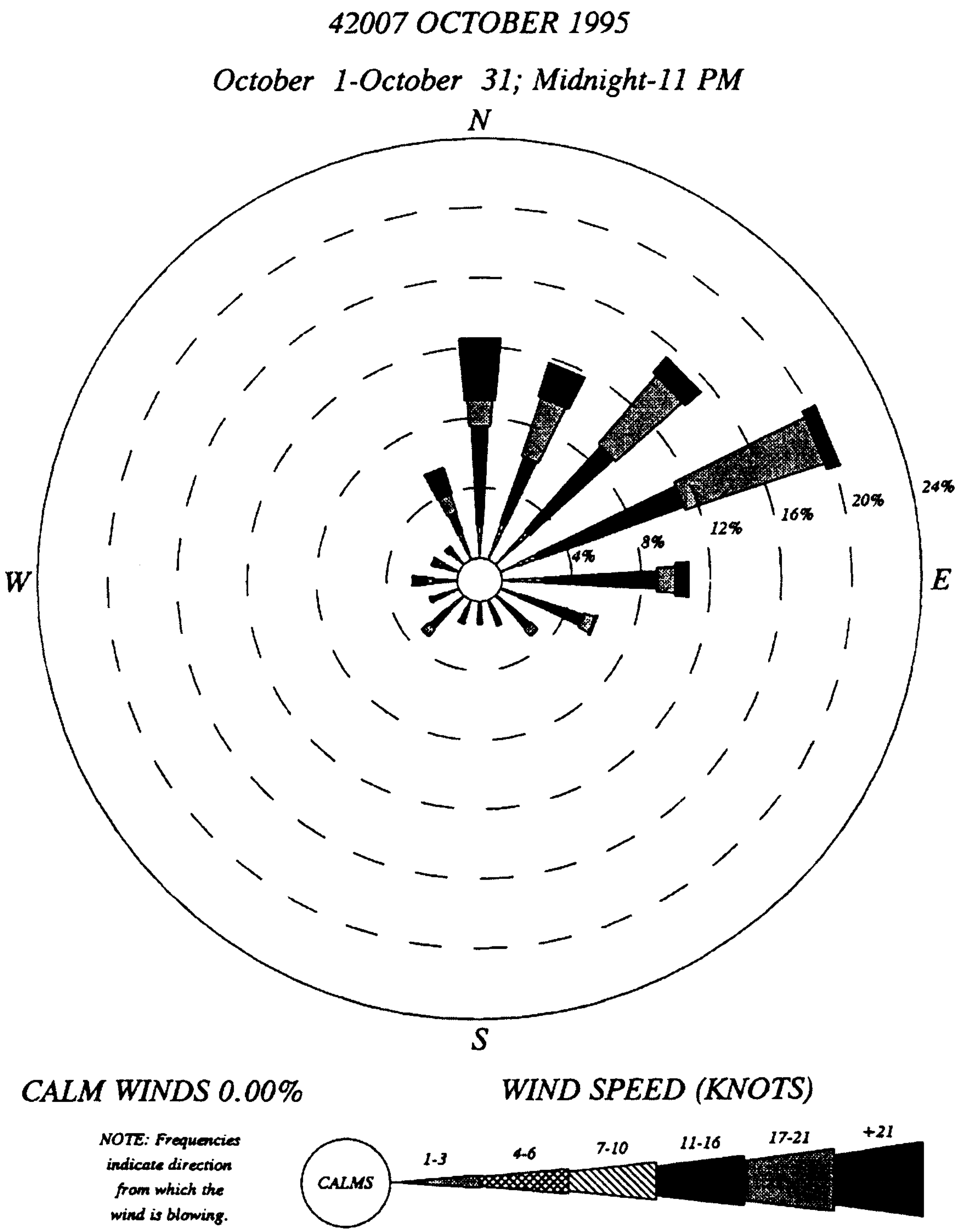


Figure 162. October 1995 wind rose for NOAA buoy 42007.

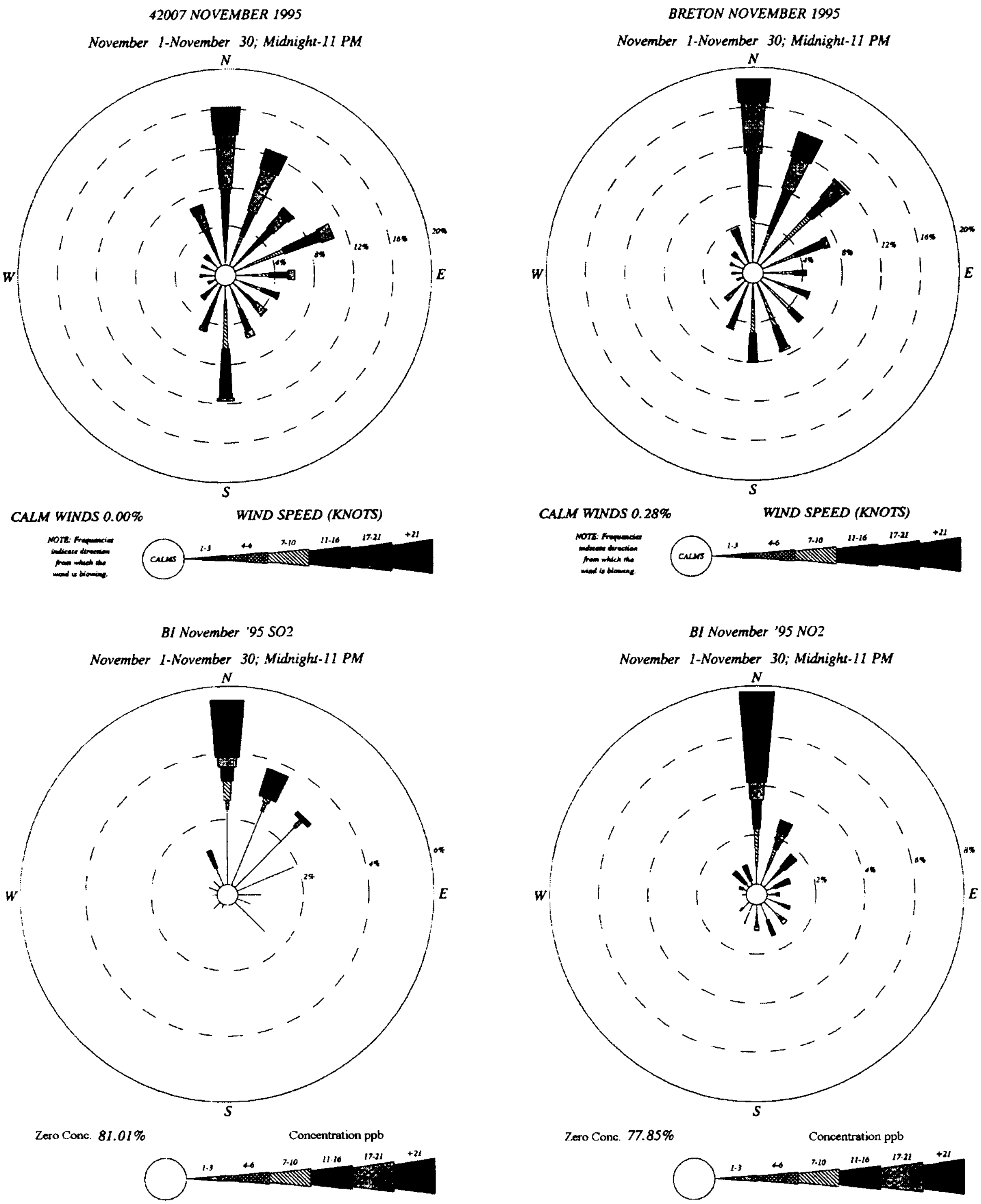
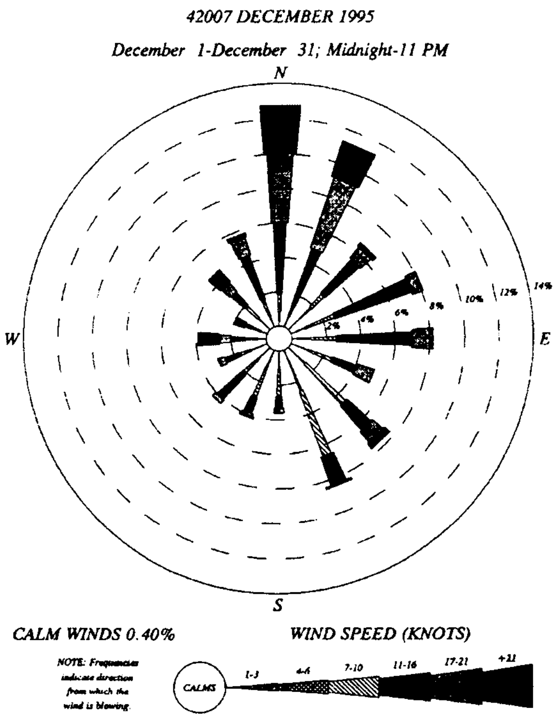
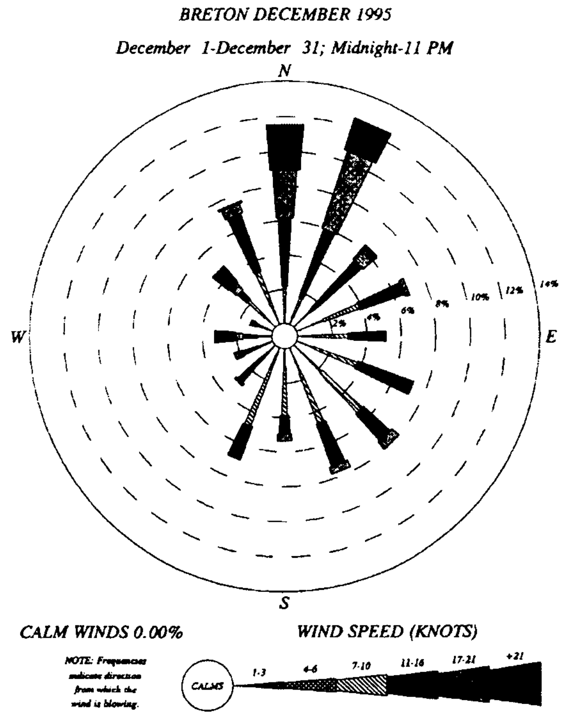


Figure 163. November 1995 wind and pollution roses for Breton Island and buoy 42007.





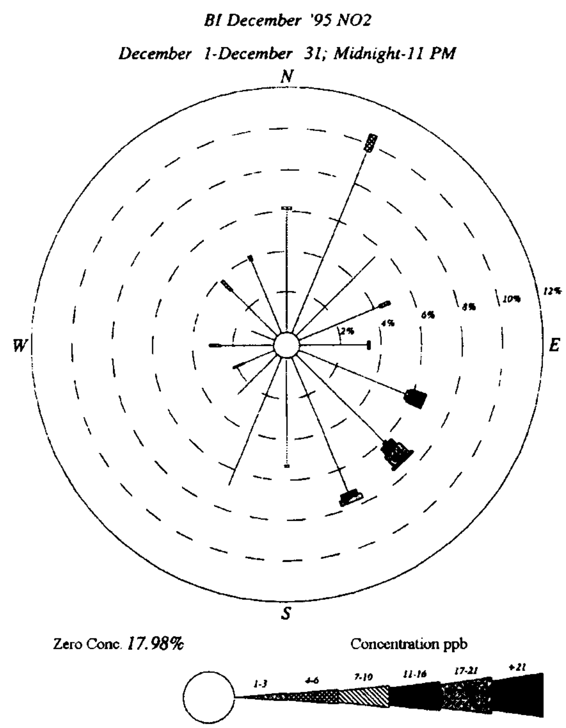


Figure 164. December 1995 wind and pollution roses for Breton Island and buoy 42007.

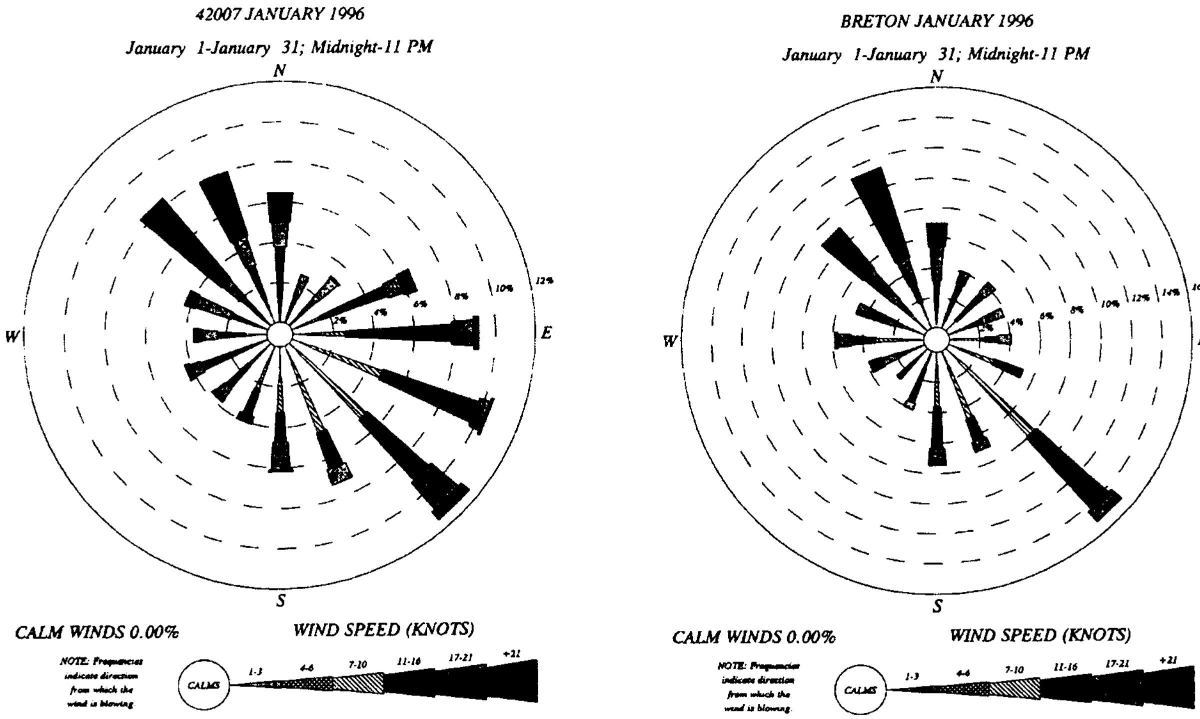


Figure 165. January 1996 wind roses for Breton Island and NOAA buoy 42007.

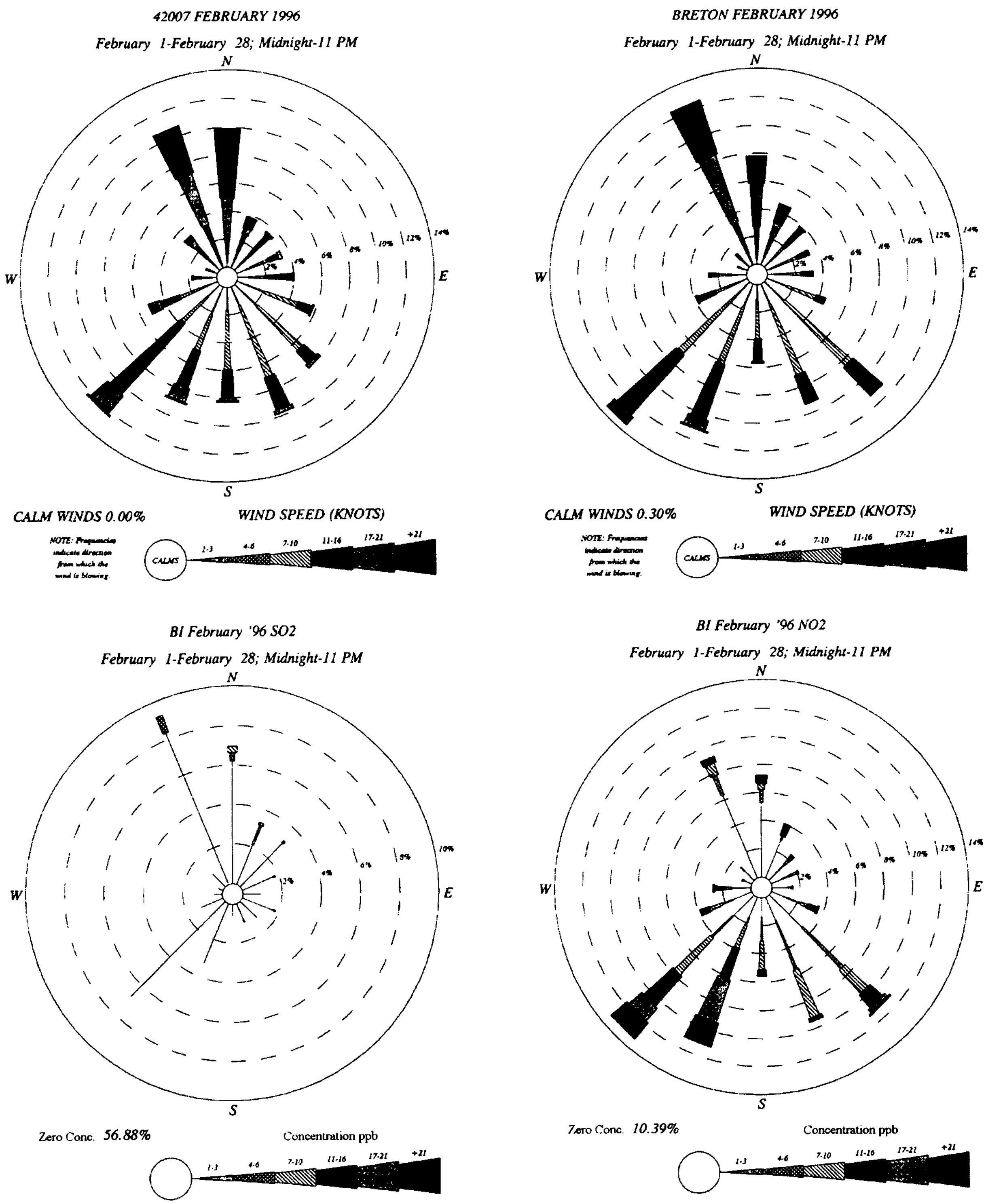


Figure 166. February 1996 wind and pollution roses for Breton Island and buoy 42007.

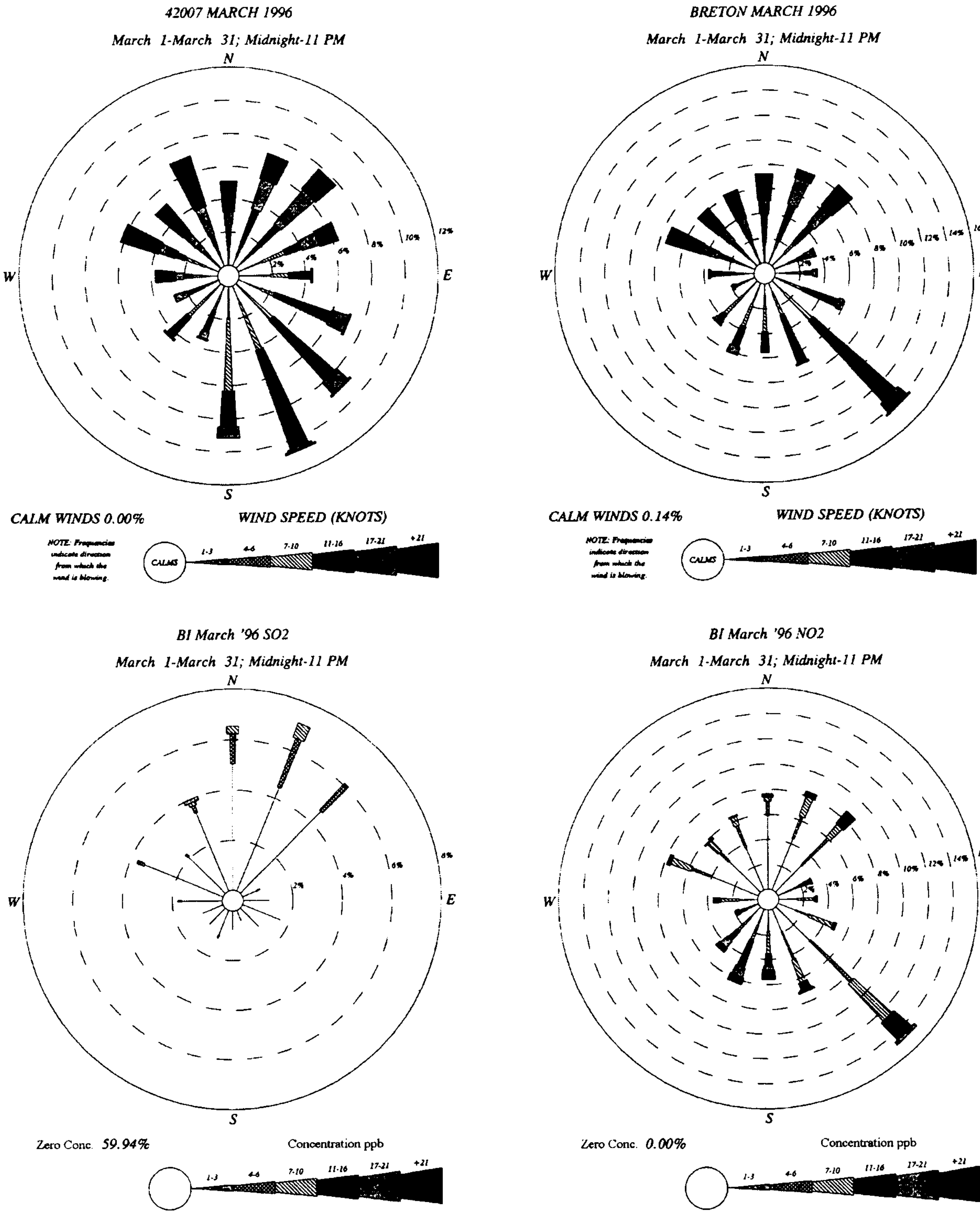


Figure 167. March 1996 wind and pollution roses for Breton Island and buoy 42007.

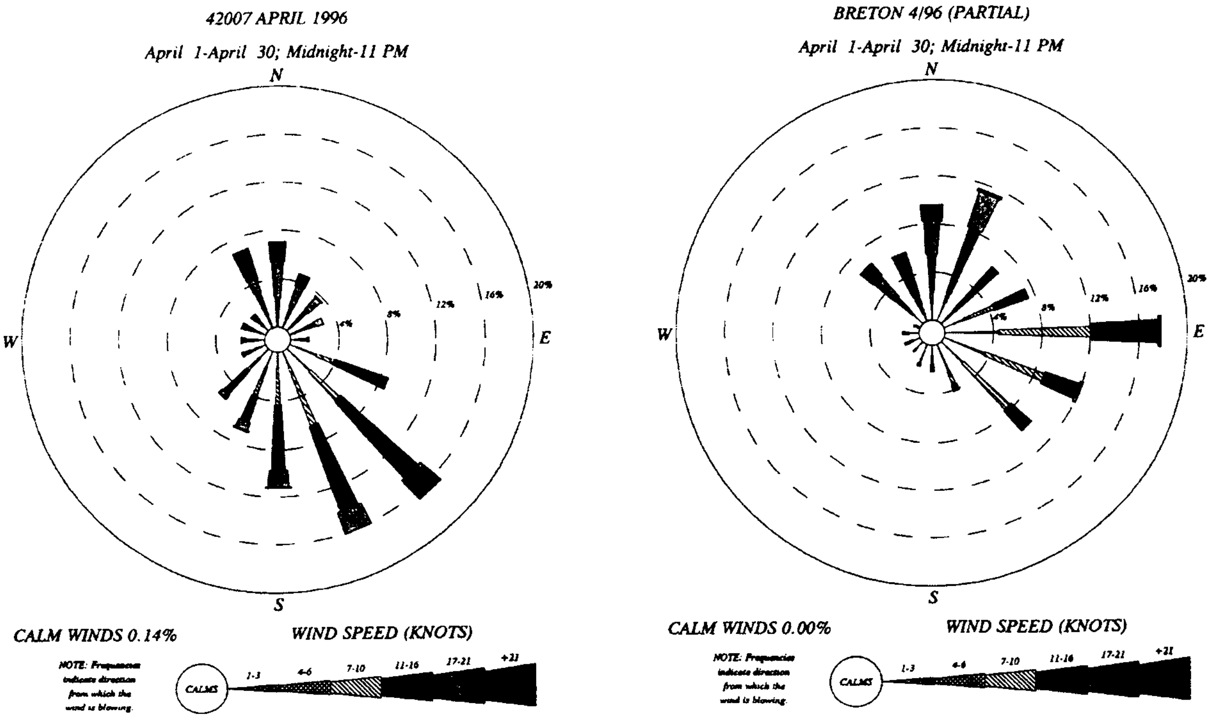


Figure 168. April 1996 wind roses for Breton Island (incomplete month) and buoy 42007.

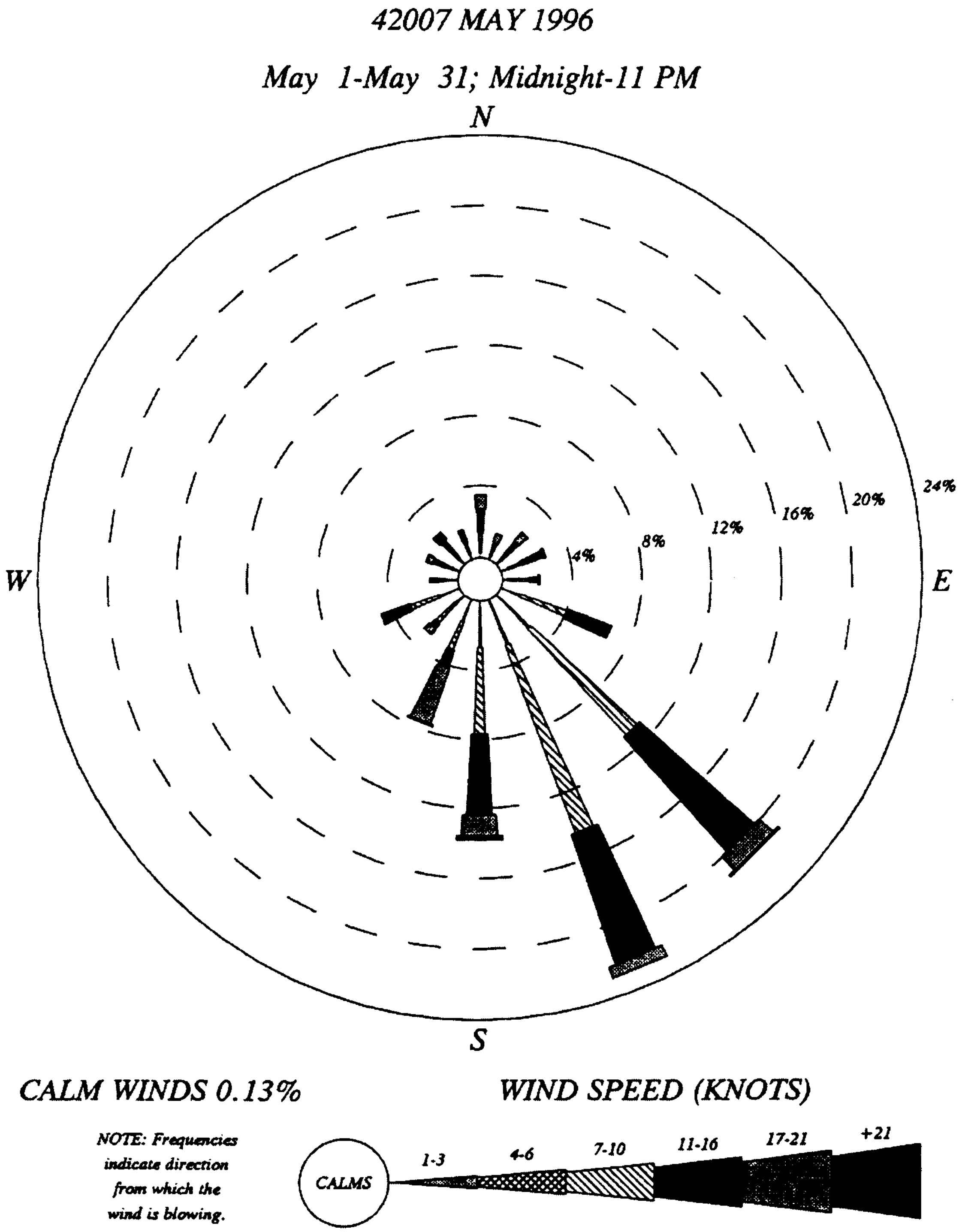


Figure 169. May 1996 wind rose for NOAA buoy 42007.

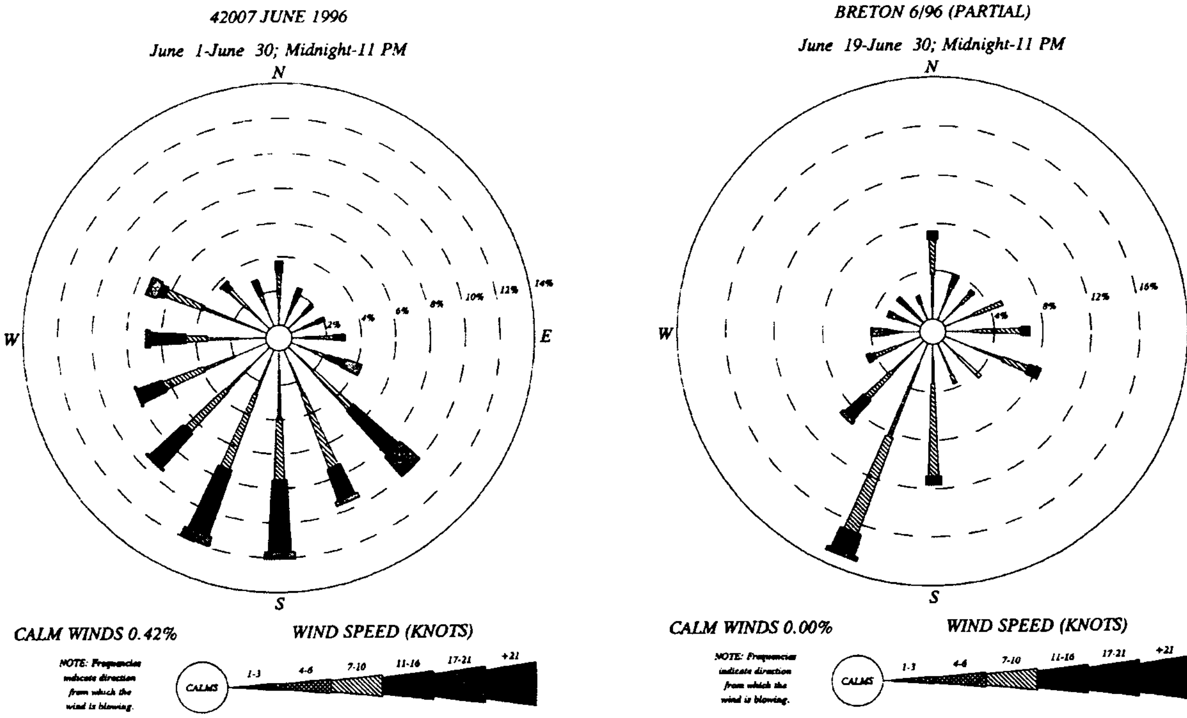
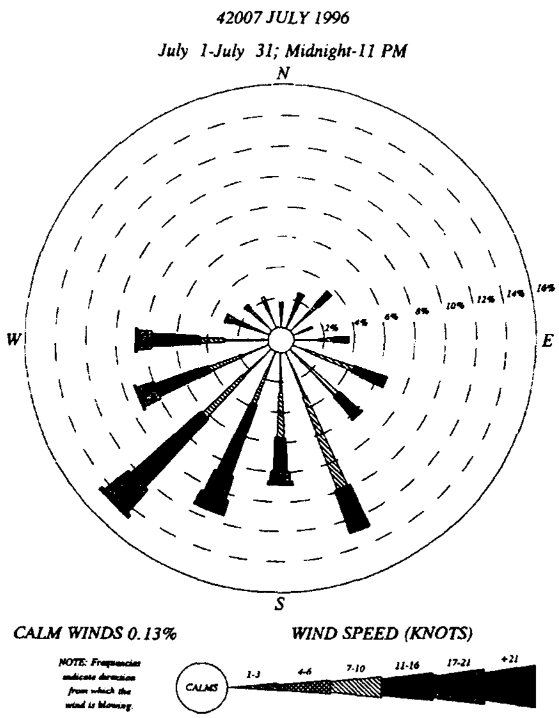


Figure 170. June 1996 wind roses for Breton Island (incomplete month) and buoy 42007.



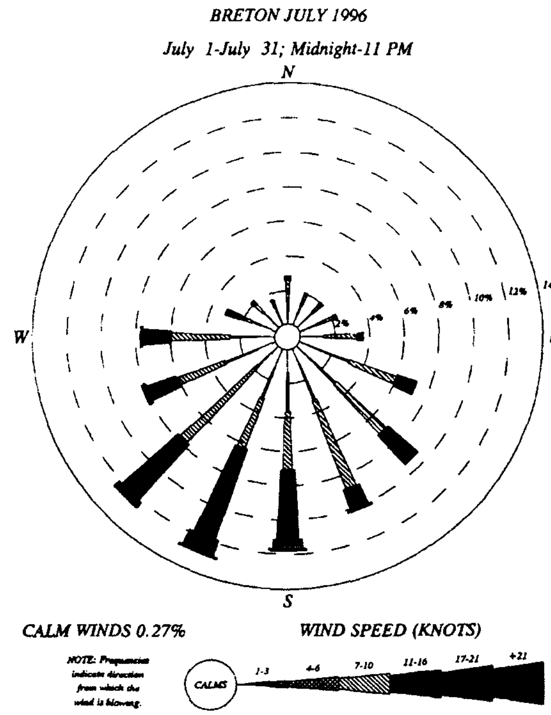
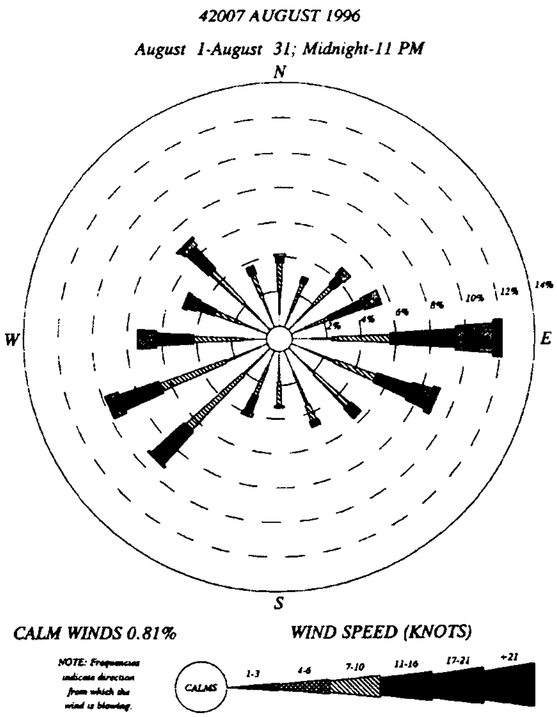


Figure 171. July 1996 wind roses for Breton Island and NOAA buoy 42007.



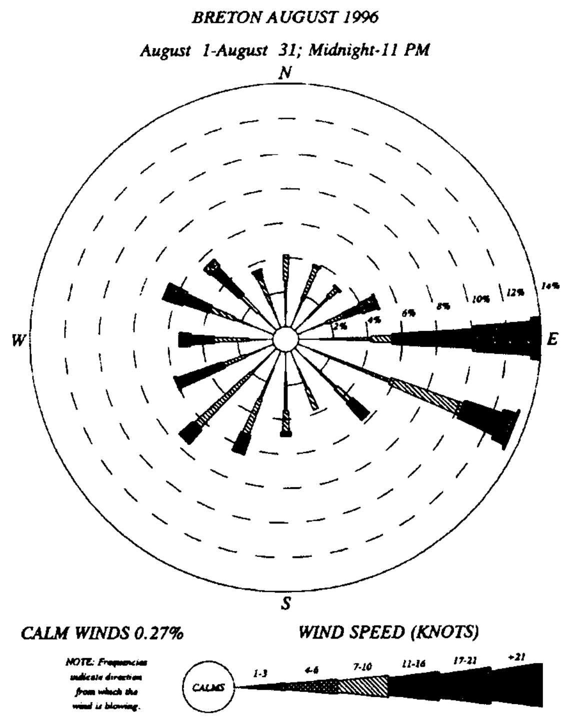


Figure 172. August 1996 wind roses for Breton Island and NOAA buoy 42007.

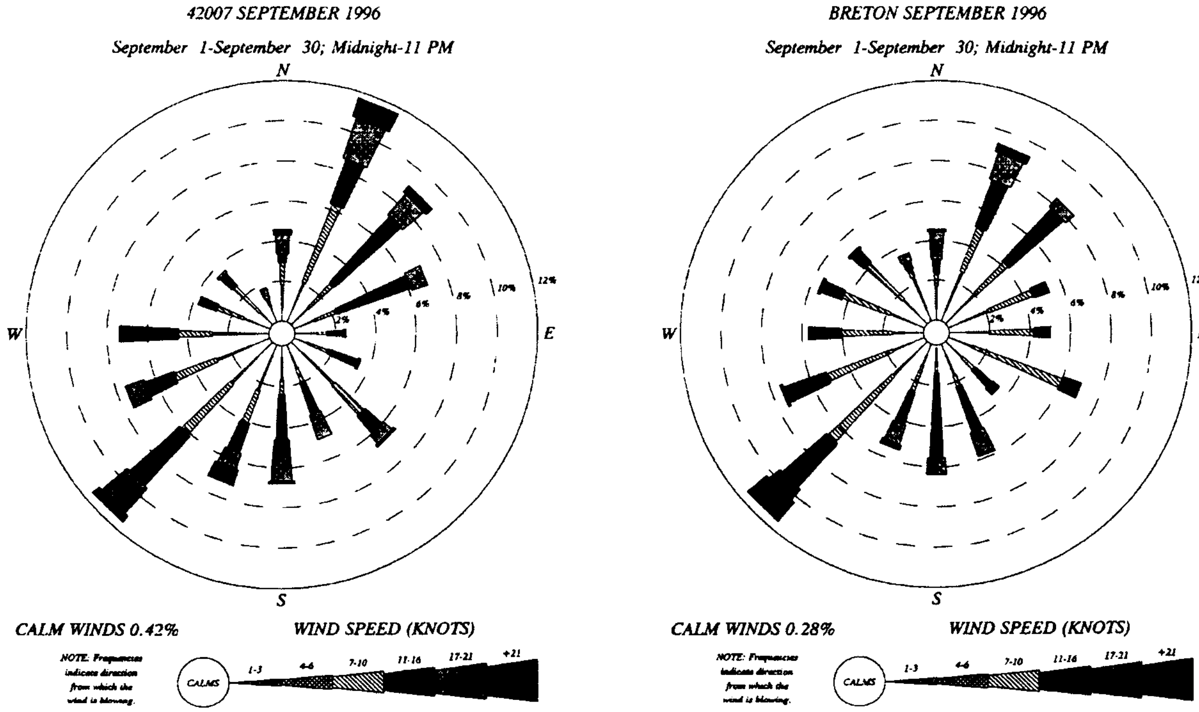


Figure 173. September 1996 wind roses for Breton Island and NOAA buoy 42007.

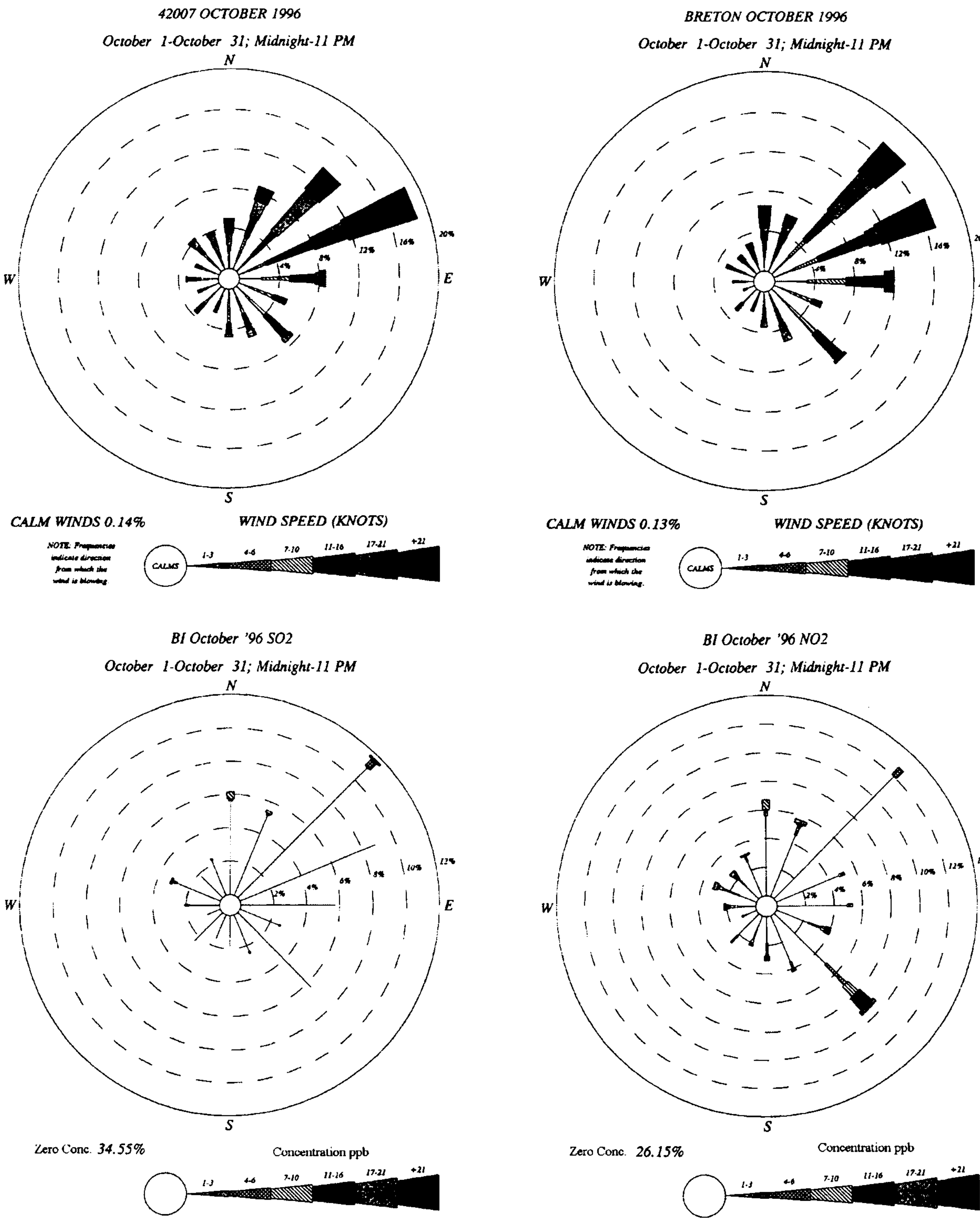


Figure 174. October 1996 wind and pollution roses for Breton Island and buoy 42007.

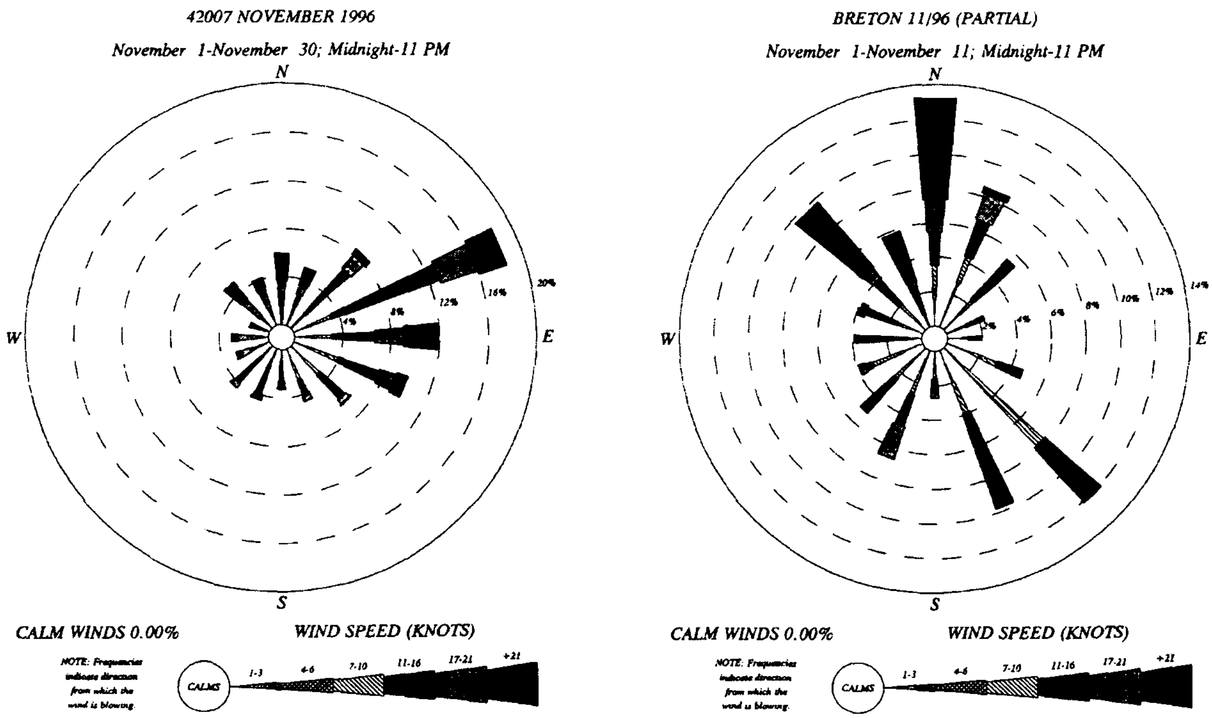
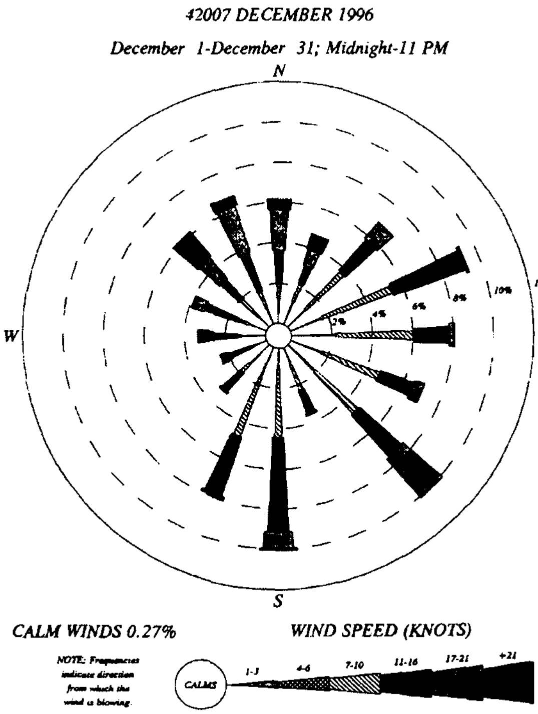


Figure 175. November 1996 wind roses for Breton Island (incomplete month) and buoy 42007.



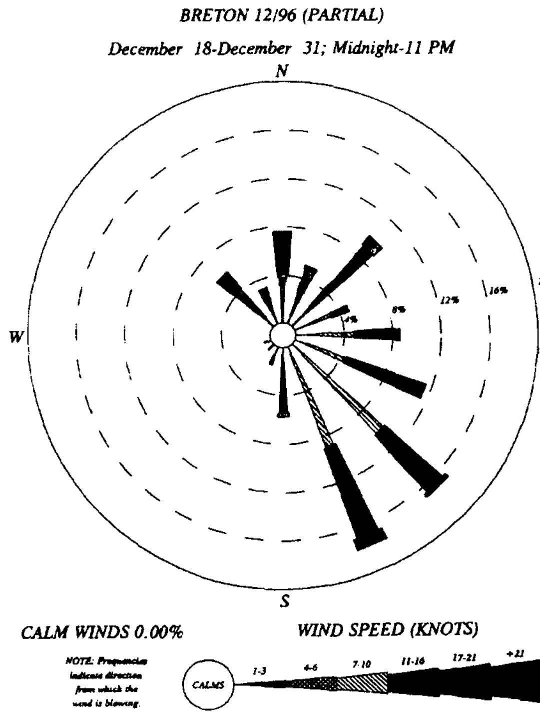


Figure 176. December 1996 wind roses for Breton Island (incomplete month) and buoy 42007.

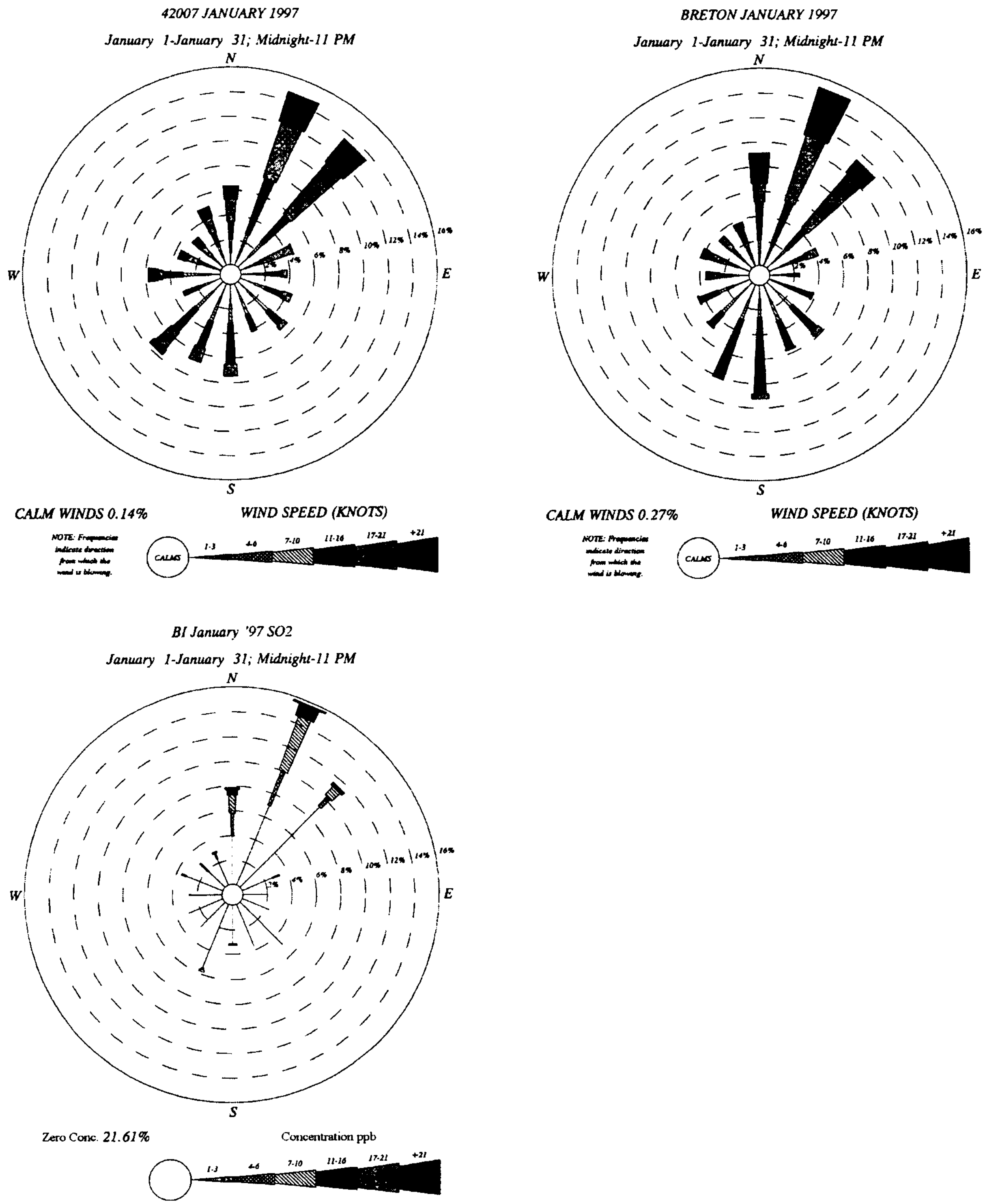


Figure 177. January 1997 wind and pollution roses for Breton Island and buoy 42007.

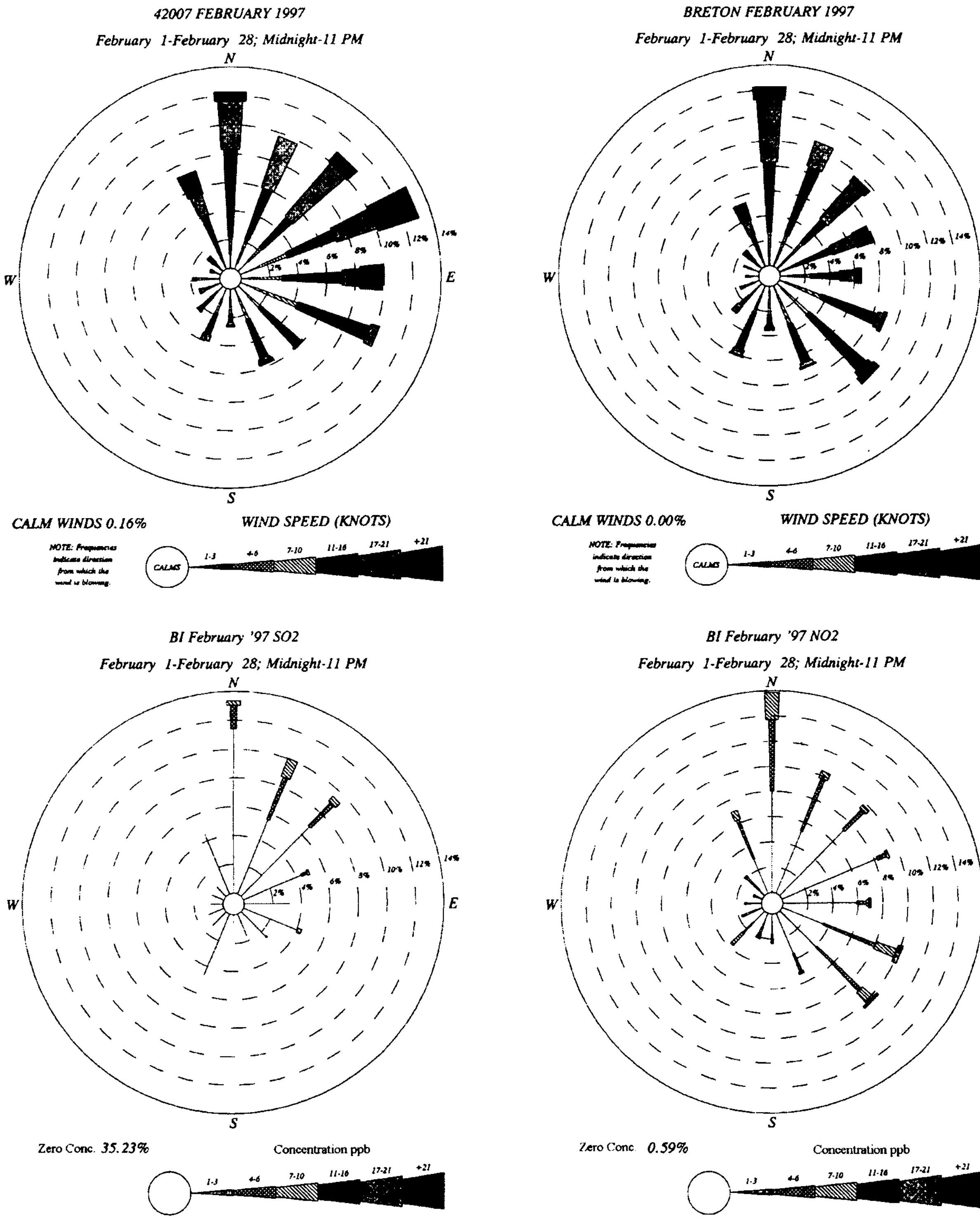


Figure 178. February 1997 wind and pollution roses for Breton Island and buoy 42007.

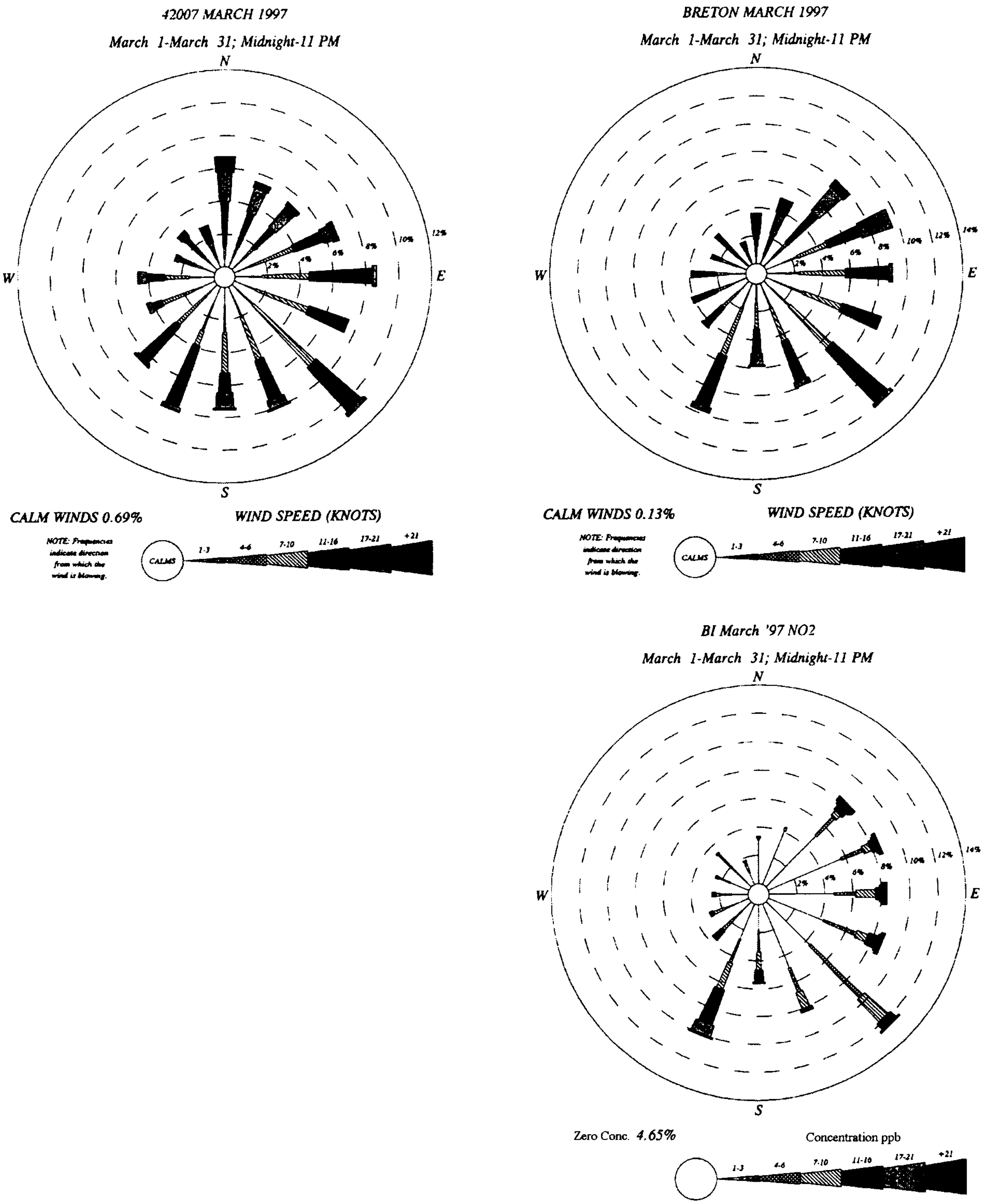


Figure 179. March 1997 wind and pollution roses for Breton Island and buoy 42007.

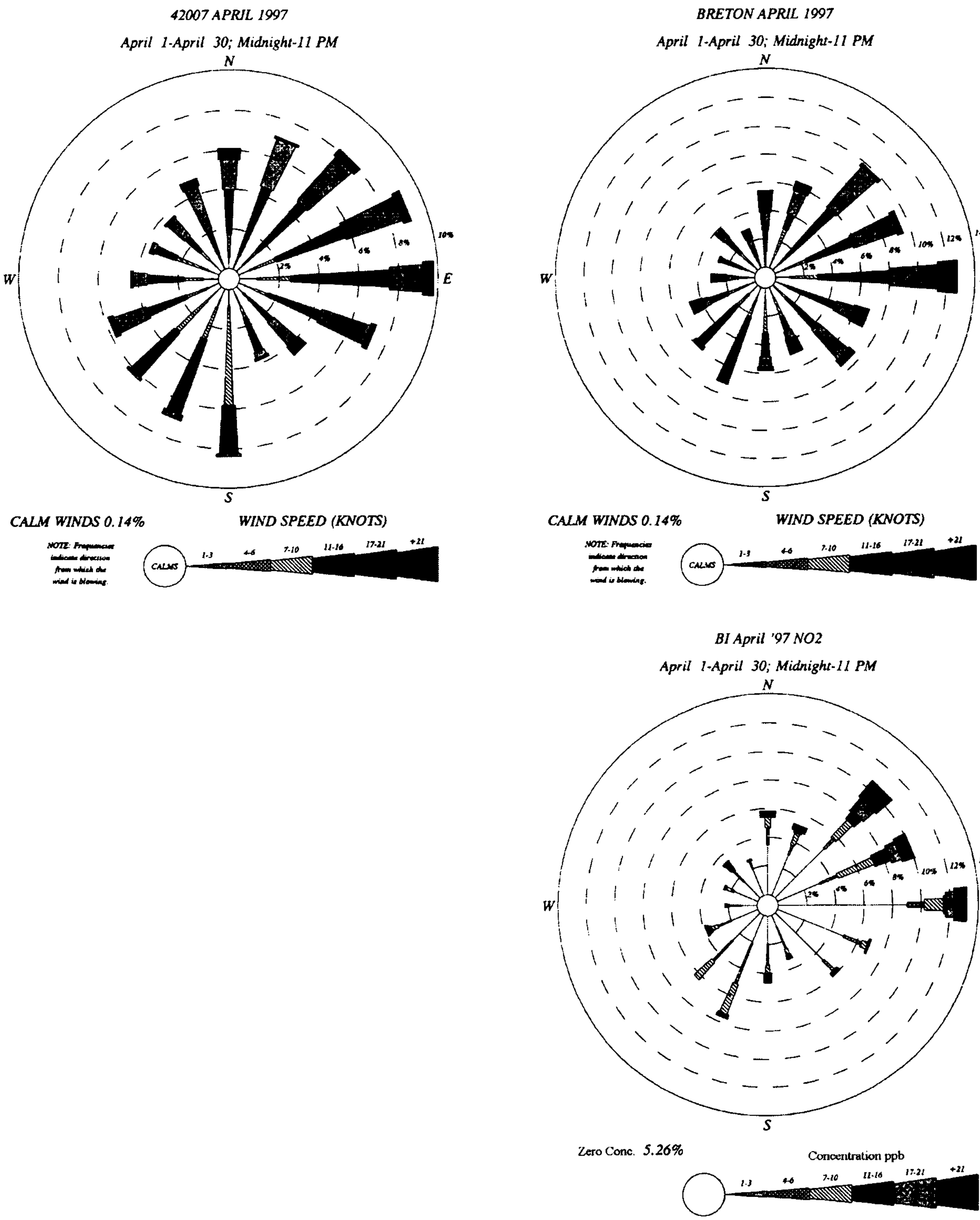


Figure 180. April 1997 wind and pollution roses for Breton Island and buoy 42007.

There is strong association between wind direction and maximum observed concentrations, with directions of high NO_2 concentrations almost completely opposite those for high SO_2. The greatest number of high SO_2 concentrations occur along with north-northeast winds. High NO_2 concentrations, while somewhat more varied, are mostly seen with south-southeast to south-southwest winds. This is especially true for the maximum hourly and 3-hour concentrations, as given in Table 37 for SO_2 and 38 for NO_2, respectively.

The frequency of occurrence of the top 5% SO_2 and NO_2 concentrations by month and wind direction are listed in Table 39. The high SO_2-northerly wind correlation is clear; high NO_2 occurs almost as often with northerly and easterly wind flow as with south.

From Table 38, the ratio of NO_2/NO_x corresponding to the maximum 1 and 3-hour NO_2 concentrations varies from 0.2 to 1.0. This implies the influence of different aged chemical air masses over the Breton Island area. On average, the monthly NO_2/NO_x ratios (Table 40) are around 1.0; however large standard deviations are observed. It should be noted that the monthly mean ratios at both Breton and Dauphin Islands are biased toward low concentrations. Typically, at low ambient concentrations, the analyzer records equivalent NO_2 and NO_x values, hence high ratios. During high NO_x events, much lower ratios are frequently obtained. It is particularly interesting to see from Table 38 that the lowest ratios mostly occur with southeast winds, suggesting a fresh air mass (little NO-NO_2 conversion) and a nearby source.

To investigate diurnal variations in concentrations, hourly quartile values were derived for the months in our composite years and are depicted in Figs. 181 for SO_2 and 182 for NO_2, respectively. Median (2nd quartile) SO_2 values are very low, generally 1 ppb or less, and no distinct diurnal peak is detected. Median NO_2 values are higher and more varied, and occasionally peak in the late evening - early morning hours.

Throughout the Breton Island air quality dataset, there are several episodes of extremely high NO_2 and SO_2 concentrations, generally of one day duration or less. In these cases, the air quality monitors were calibrated either before the event, or both before and after with no significant errors; and they were therefore assumed to be real measurements. On the other hand, the service logs often note failure of the analyzer (powered down) or subsequent performance problems. Additionally, large power fluctuations (which were frequently noted at Breton Island) can produce unpredicatable responses from the analyzers. Therefore, while presented here, these data are marked as unreliable. Hsu (1996) described similar NO_x events at Breton Island during field measurements in July - September 1994, but at lower concentrations. Table 41 lists maximum values obtained during previous air quality studies at Breton Island and several of the highest values recorded in this dataset. The multiple values were taken from different months and years to diminish the possibility of equipment or data error. Episodes of concentrations in excess of the annual pollutant concentration + 2 standard deviations (~ top 5%) are seen from 0 to 4 times per month. Extreme values such as these were probably not encountered in the previous studies due to their short measurement periods.

Table 37.
Breton Island SO_2 Maximum Concentrations (ppb)

Month	Block Averaging Time	Maximum Concentration	Wind Speed (m/s)	Dir	Day / Hour CST	
10 / 94	1 Hour	13	8	003	26	15
	3 Hour	8	8.6	036	27	00
	24 Hour	4.4			26	
11 / 94	1 Hour	13	10	357	16	06
	3 Hour	11.3	9.8	002	16	05
	24 Hour	4.6			24	
12 / 94	1 Hour	14	4.5	006	26	13
	3 Hour	11.7	4.6	039	13	17
	24 Hour	5.5			13	
01 / 95	1 Hour	13	7.8	019	02	19
	3 Hour	7.7	8	018	04	00
	24 Hour	4.4			04	
02 / 95	1 Hour	30	6.5	012	19	06
	3 Hour	16	5.6	011	18	10
	24 Hour	6.0			18	
03 / 95	1 Hour	9	6	051	03	05
	3 Hour	8	6.2	044	03	05
	24 Hour	4.9			03	
04 / 95	1 Hour	4	2	123	14	17
	3 Hour	4	2.4	123	14	17
	24 Hour	2.1			14, 21	

Table 37 continued.

Month	Block Averaging Time	Maximum Concentration	Wind Speed (m/s)	Dir	Day / Hour CST	
05 / 95	1 Hour	13	6.3	045	21	05
	3 Hour	8.3	6.3	045	21	04
	24 Hour	3.9			21	
06 / 95	1 Hour	7	4.7	010	20	13
	3 Hour	5	4.2	008	20	11
	24 Hour	2.5			19	
07 / 95	1 Hour	9	6.5	270	09	03
	3 Hour	8.3	6.8	270	09	02
	24 Hour	2.5			07	
09 / 95	1 Hour	12	Miss	Miss	09	15
	3 Hour	10.7	Miss	Miss	09	14
	24 Hour	5.6			23	
10 / 95	1 Hour	13 13	Miss 9.7	Miss 012	08 29	10 00
	3 Hour	10.3	Miss	Miss	08	09
	24 Hour	5.7			08	
11 / 95	1 Hour	137*	1.6	011	25	17
	3 Hour	131.7*	2.0	012	25	15
	24 Hour	63.7*			25	
12 / 95	1 Hour	9 9	9.7 9.6	030 030	28 29	07 00
	3 Hour	8.7	10.0	028	28	05
	24 Hour	5.3			28	

Table 37 continued.

Month	Block Averaging Time	Maximum Concentration	Wind Speed (m/s)	Dir	Day / Hour CST	
01 / 96	1 Hour	16	8.1	008	31	15
	3 Hour	12.3	7.8	006	31	13
	24 Hour	3			31	
02 / 96	1 Hour	9	8.8	010	04	23
	3 Hour	6	2.7	017	17	04
	24 Hour	2.5			17	
03 / 96	1 Hour	17	5.2	343	02	00
	3 Hour	9	5.4	355	01	22
	24 Hour	3.6			01	
06 / 96	1 Hour	1	4.3	209	19	14
	3 Hour	1	4.2	203	19	14
	24 Hour	0				
07 / 96	1 Hour	1	3.1	115	27	04
	3 Hour	1	2.9	121	28	15
	24 Hour	0.2			28	
09 / 96	1 Hour	9 9	2.7 6.0	010 020	10 11	15 09
	3 Hour	7.7	1.8	044	10	15
	24 Hour	3.7			10	
10 / 96	1 Hour	12	5.5	303	10	09
	3 Hour	8	4.3	293	10	09
	24 Hour	2.6			10	

Table 37 continued.

Month	Block Averaging Time	Maximum Concentration	Wind Speed (m/s)	Dir	Day / Hour CST	
11 / 96	1 Hour	7	6.6	357	09	09
	3 Hour	4.7	5.3	333	10	12
	24 Hour	2.4			03	
12 / 96	1 Hour	36	4.1	135	26	08
	3 Hour	24	5.2	146	26	07
	24 Hour	3.6			26	
01 / 97	1 Hour	27	6.0	182	02	21
	3 Hour	13.7	8.0	004	29	19
	24 Hour	7.9			14	
02 / 97	1 Hour	10	6.8	040	07	02
	3 Hour	7.7	8.9	029	06	03
	24 Hour	5.1			06	
03 / 97	1 Hour	81	7.5	234	21	18
	3 Hour	54	7.6	236	21	18
	24 Hour	10.4			21	
04 / 97	1 Hour	6	6.2	040	24	04
	3 Hour	3	6.7	043	24	04
	24 Hour	1.3			29	

*Unreliable data.

Table 38.
Breton Island NO_2 Maximum Concentrations (ppb)

Month	Block Averaging Time	Maximum Concentration	NO_2/NO_x	Wind Speed (m/s)	Dir	Day / Hour CST	
10 / 94	1 Hour	13	Miss	5.4	232	31	21
	3 Hour	9.7	Miss	5.3	240	31	20
	24 Hour	4.9				31	
11 / 94	1 Hour	26	0.5	2.4	090	25	11
	3 Hour	13.3	1.0	4.0	198	21	04
	24 Hour	6.3				21	
12 / 94	1 Hour	22	0.4	2.2	149	30	21
	3 Hour	15.3	1.0	4.0	330	12	21
	24 Hour	7.6				30	
01 / 95	1 Hour	35	1.0	5.3	204	10	04
	3 Hour	30	1.0	5.2	203	10	03
	24 Hour	14.8				25	
02 / 95	1 Hour	35	0.7	6.4	277	20	12
	3 Hour	28.3	0.9	3.5	255	24	01
	24 Hour	11				02	
03 / 95	1 Hour	21	0.4	1.8	149	15	00
	3 Hour	17	1.0	6.0	195	21	23
	24 Hour	10.2				22	
04 / 95	1 Hour	32	0.3	1.2	138	15	04
	3 Hour	22.3	0.4	1.6	137	15	04
	24 Hour	7.8				15	

Table 38 continued.

Month	Block Averaging Time	Maximum Concentration	NO_2/NO_x	Wind Speed (m/s)	Dir	Day / Hour CST	
05 / 95	1 Hour	28	0.3	2.1	131	26	03
	3 Hour	20.3	0.9	1.3	014	23	05
	24 Hour	8.6				16	
06 / 95	1 Hour	33 33	0.4 0.3	2.7 2.3	119 120	21 21	04 21
	3 Hour	30	0.3	1.9	127	21	21
	24 Hour	10.3				21	
07 / 95	1 Hour	18	0.3	1.8	136	07	15
	3 Hour	13.7	0.2	1.6	130	06	17
	24 Hour	6				05	
09 / 95	1 Hour	44	1.0	Miss	Miss	19	18
	3 Hour	30.7	1.0	Miss	Miss	19	17
	24 Hour	7				19	
10 / 95	1 Hour	36	1.0	Miss	Miss	11	16
	3 Hour	23	1.0	Miss	Miss	11	15
	24 Hour	7.1				11	
11 / 95	1 Hour	567*	1.0	11.6	309	11	09
	3 Hour	465.7*	1.0	13.5	313	11	09
	24 Hour	142.5*				11	
12 / 95	1 Hour	26	0.6	3.6	133	02	14
	3 Hour	18.7	0.8	3.7	122	02	12
	24 Hour	11.8				02	

Table 38 continued.

Month	Block Averaging Time	Maximum Concentration	NO_2/NO_x	Wind Speed (m/s)	Dir	Day / Hour CST	
01 / 96	1 Hour	24	1.0	5.3	202	30	21
	3 Hour	21.3	0.9	6.2	213	30	23
	24 Hour	9.1				31	
02 / 96	1 Hour	33 33	1.0 1.0	6.1 3.5	203 204	09 14	21 02
	3 Hour	28.3	1.0	5.8	202	09	19
	24 Hour	17.8				10	
03 / 96	1 Hour	30	0.8	6.4	197	15	22
	3 Hour	27.3	1.0	5.1	195	16	23
	24 Hour	15.6				17	
06 / 96	1 Hour	33	0.8	2.3	136	24	10
	3 Hour	22	0.7	2.9	127	24	10
	24 Hour	5.2				24	
08 / 96	1 Hour	15	0.2	1.6	132	24	18
	3 Hour	13.7	0.3	1.6	140	24	17
	24 Hour	3.5				24	
10 / 96	1 Hour	22 22	1.0 0.8	5.4 3.4	328 284	10 10	03 11
	3 Hour	19.7	0.8	4.3	293	10	09
	24 Hour	8.8				10	
11 / 96	1 Hour	20	0.3	2.4	130	05	22
	3 Hour	17.3	0.4	2.7	125	05	22
	24 Hour	7.9				05	

Table 38 continued.

Month	Block Averaging Time	Maximum Concentration	NO_2/NO_x	Wind Speed (m/s)	Dir	Day / Hour CST	
12 / 96	1 Hour	65*	0.8	6	150	26	10
	3 Hour	38*	0.7	5.2	155	26	09
	24 Hour	4.8*				26	
01 / 97	1 Hour	104*	0.9	4.3	204	02	22
	3 Hour	79.3*	0.9	4.6	198	02	21
	24 Hour	9.9*				02	
02 / 97	1 Hour	21	0.2	1.8	118	11	18
	3 Hour	17.7	0.2	1.7	114	11	17
	24 Hour	7.2				08	
03 / 97	1 Hour	191*	1.0	6.5	074	16	17
	3 Hour	102.7*	0.9	7.7	081	16	17
	24 Hour	18.8*				16	
04 / 97	1 Hour	474*	1.0	8.7	017	07	12
	3 Hour	350.7*	1.0	8.1	015	07	12
	24 Hour	25.2*				08	

*Unreliable data.

Table 39.
Breton Island Top 5% SO_2 and NO_2 Distribution

Month	SO_2 (651 samples)	NO_2 (151 samples)
10/94	21	1
11/94	59	
12/94	44	
01/95	37	7
02/95	34	12
03/95	20	
04/95		2
05/95	18	2
06/95	3	7
07/95	11	
09/95	48	5
10/95	46	2
11/95	37	42
12/95	26	1
01/96	9	2
02/96	11	18
03/96	26	10
06/96		2
09/96	13	
10/96	12	
11/96	3	
12/96	11	2
01/97	95	3
02/97	42	
03/97	24	9
04/97	1	24
Wind Direction	**SO_2 (553 samples)**	**NO_2 (144 samples)**
0 - 45	363	29
46 - 90	69	25
91 - 135	13	15
136 - 180	7	8
181 - 225	8	38
226 - 270	11	10
271 - 315	19	6
316 - 360	63	13

Table 40.
Breton Island Monthly Mean NO_2/NO_x Ratios

Month	# Samples	Mean	Standard Deviation
November 94	258	1.00	1.12
December 94	682	1.00	0.36
January 95	722	0.98	0.25
February 95	657	0.97	0.43
March 95	500	1.00	0.56
May 95	734	0.95	0.32
June 95	650	0.90	0.34
September 95	481	1.00	0.48
February 96	609	0.87	0.27
March 96	679	1.00	0.83
October 96	619	0.67	0.45
February 97	489	1.00	0.25
March 97	642	1.00	0.39
April 97	614	1.00	0.48

Table 41.
Comparison of SO_2 and NO_2 Maximums at Breton Island (ppb)
Source: Hsu, 1995a and 1996

	Maximum 1-Hour Conc.	Wind Speed m/s	Wind Direction	Maximum 3-Hour Conc.	Wind Speed m/s	Wind Direction	Maximum 24-Hour Conc.	Period Average
September 1993								
SO_2	22.2	3.8	45	11.9	1.1	106	6.3	2.8
NO_2	NA	NA	NA	NA	NA	NA	NA	NA
July - August 1994								
SO_2	25.0	1.7	143	13.3	6.2	52	2.8	0.8
NO_2	59.0	3.4	317	31.0	3.4	51	12.0	3.8
October 1994 - April 1997								
SO_2	137**	1.6	11	132**	2.0	12	63.7**	1.1*
	81	7.5	234	54	7.6	236	10.4	
	36	4.1	135	24	5.2	146	7.9	
	30	6.5	12	16	5.6	11	6.0	
NO_2	567**	11.3	309	466**	13.5	313	143	4.6*
	474**	8.7	17	351**	8.1	15	25.2	
	191**	6.5	74	103**	7.7	81	18.8	
	104	4.3	204	79	4.6	198	17.8	

*Annual mean from composite years (see text)
**Unreliable data

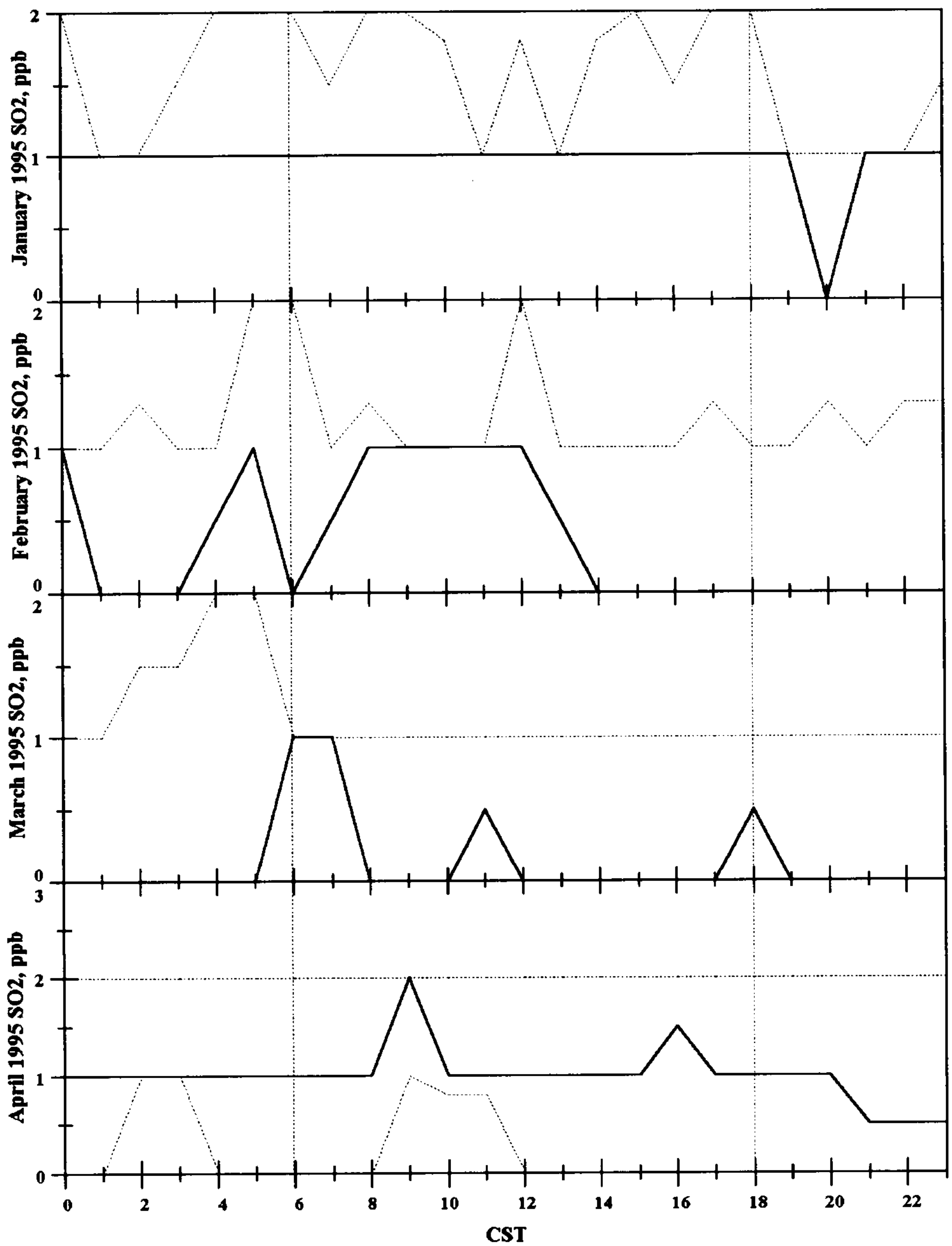


Figure 181. Diurnal variations of Breton Island SO_2 concentrations for the composite year as represented by quartile values. CST (Central Standard Time) is GMT - 6 hours. Solid line is 2nd quartile (median), lower and upper dashed lines are 1st and 3rd quartiles, respectively.

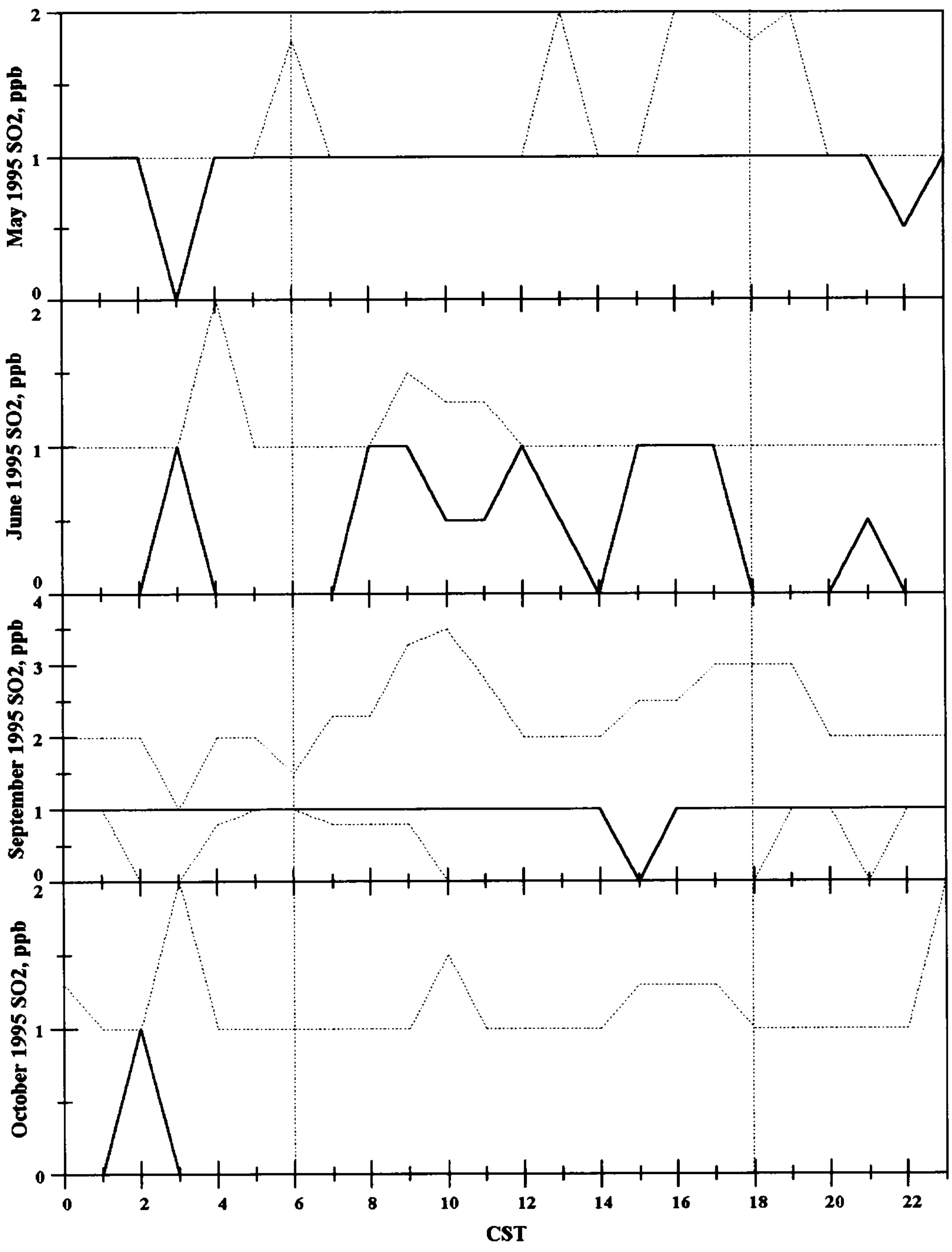


Figure 181 continued.

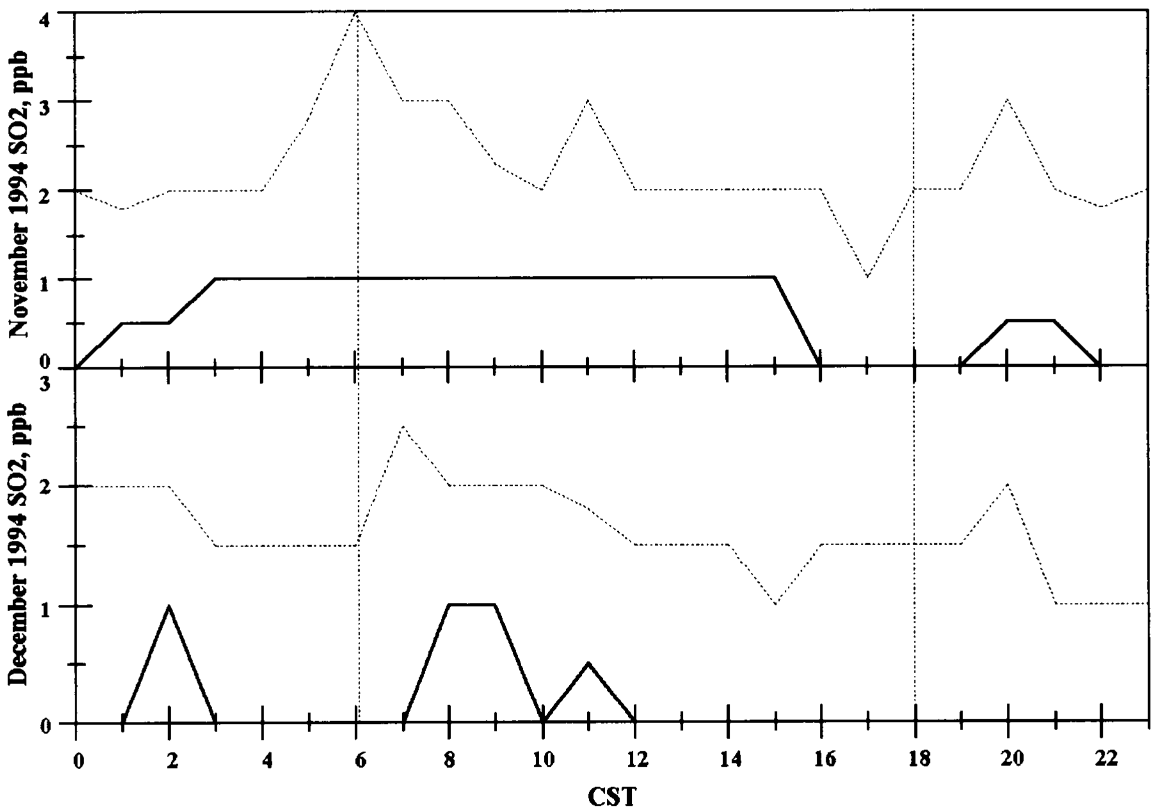


Figure 181 continued.

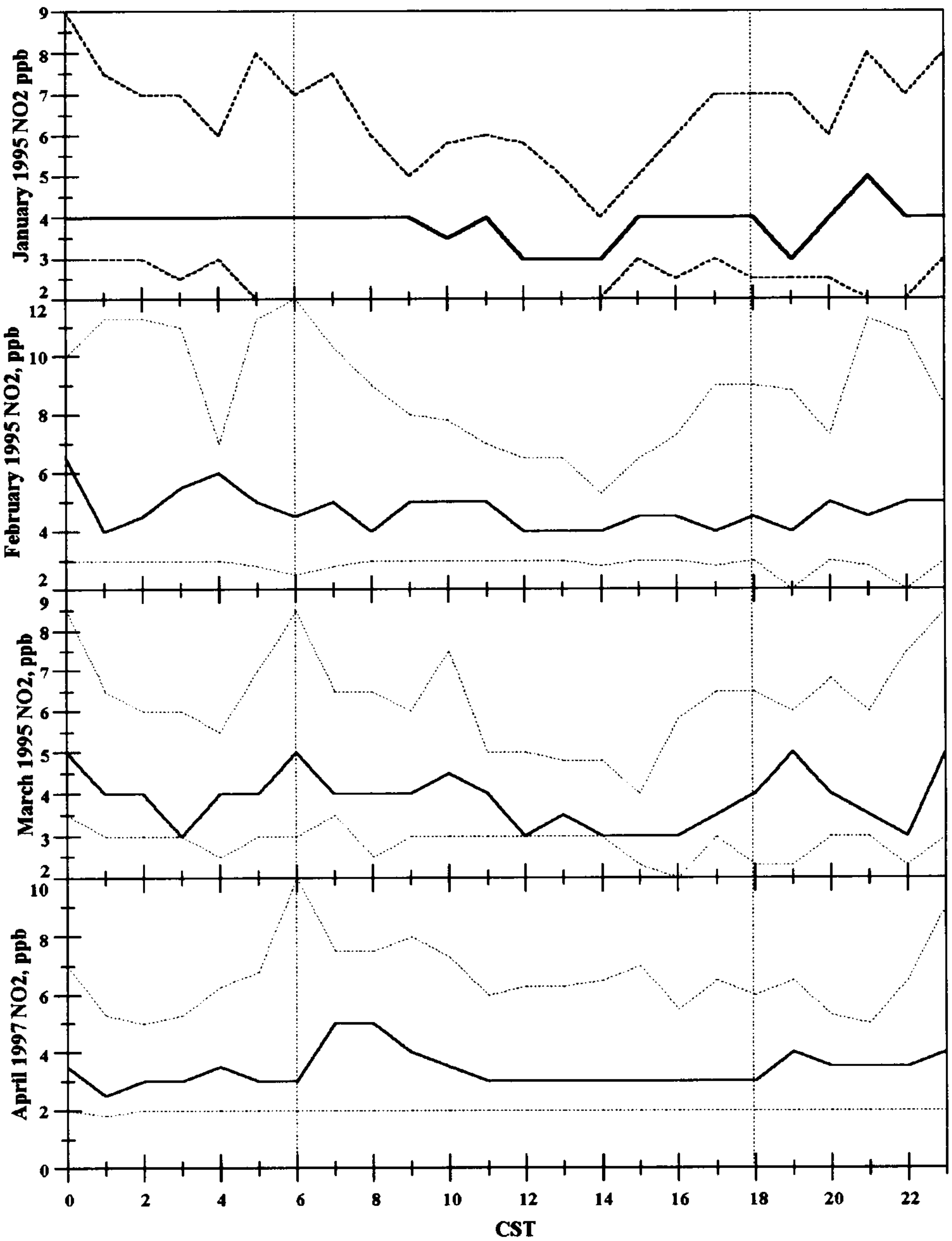


Figure 182. Diurnal variations of Breton Island NO_2 concentrations for the composite year (see text) as represented by quartile values. CST (Central Standard Time) is GMT - 6 hours. Solid line is 2nd quartile (median), lower and upper dashed lines are 1st and 3rd quartile, respectively.

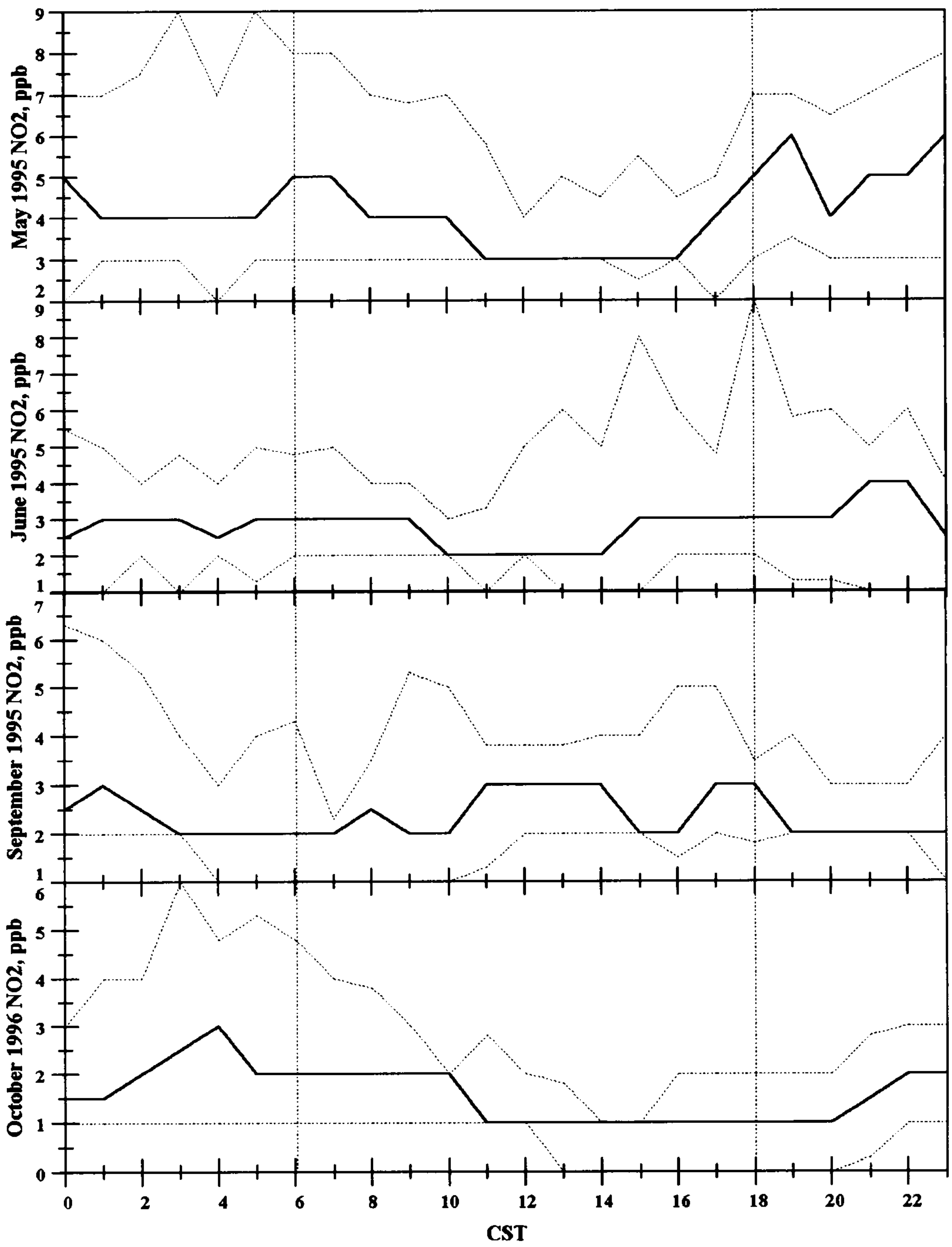


Figure 182 continued.

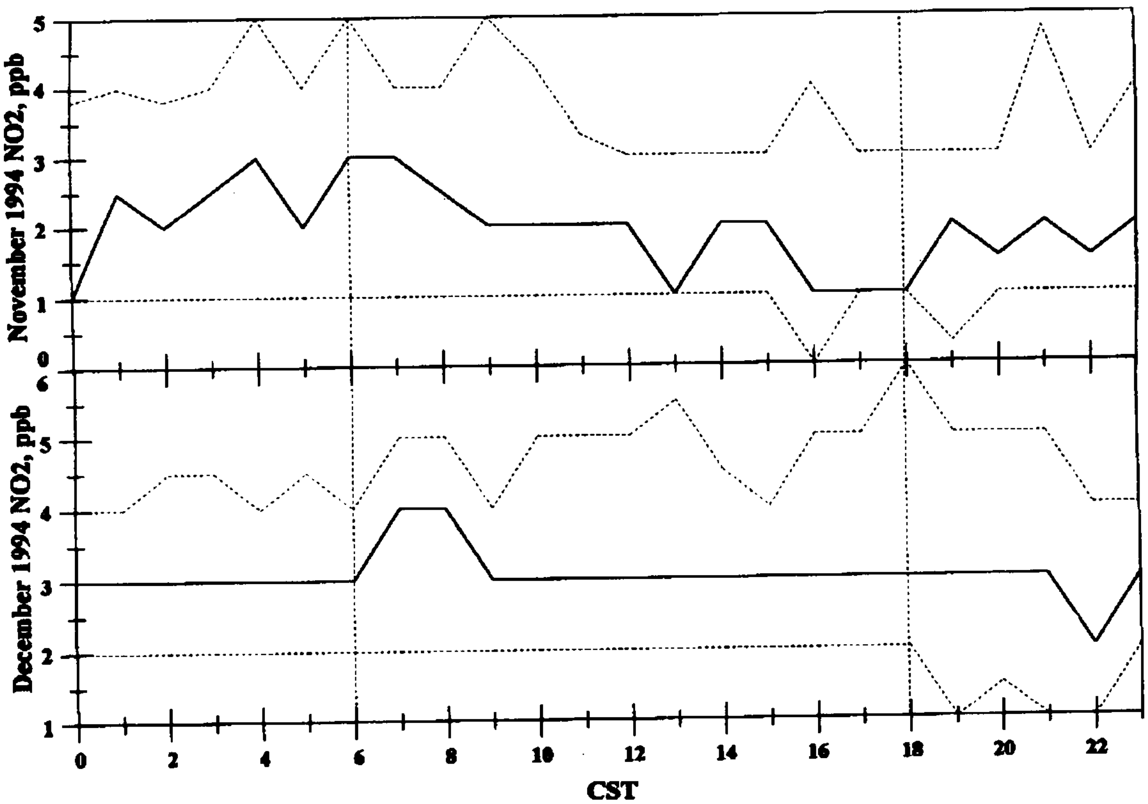


Figure 182 continued.

C. Station Comparison

From the measurement period covered in this report, only six months were available for valid comparison of the Breton and Dauphin Island air quality. These included March and October 1996, and January through April 1997. Mean data for these months is listed in Table 42. Dauphin Island is located approximately 80 miles northeast of Breton, at the inlet of Mobile Bay, Alabama. Considering its proximity to the mainland, it may be anticipated that local circulations (such as land/sea breezes) and frictional effects would act to produce a somewhat different wind distribution than that observed at Breton. Nevertheless, comparable distributions were obtained. These are mostly winter months, and larger scale forcings likely diminish to contribution of more local effects. The influence of cold frontal systems is revealed by dominant strong northerly winds with secondary maximums from the southeast.

Hourly maximum SO_2 concentrations were of similar magnitude for both Breton and Dauphin while monthly means were generally lower at Breton, sometimes by almost half. Slightly higher NO_2 maximums are seen at Dauphin; monthly means were nearly the same on average. Although they represent different time periods, it is interesting to compare the derived annual mean values for SO_2 and NO_2. The Dauphin Island annual mean SO_2 concentration is almost twice that found at Breton. Annual mean NO_2 values are the same, however the larger standard deviation at Breton implies a greater range of concentrations affecting that area.

Table 42.
Station Mean SO_2 and NO_2 Comparison

	Breton SO_2		Dauphin SO_2		Breton NO_2		Dauphin NO_2	
Month	Max	Avg	Max	Avg	Max	Avg	Max	Avg
03/96	17	0.9	17	1.7	30	6.5	34	5.0
10/96	12	1.0	10	1.6	22	2.4	38	4.2
01/97	27	2.2	23	2.9				
02/97	10	1.3	26	2.2	21	3.9	35	7.7
03/97	81*	1.6	37	1.7	191*	5.3	33	5.3
04/97					474*	7.8	58	4.3
Annual	Mean	Dev	Mean	Dev	Mean	Dev	Mean	Dev
	1.1	1.8	1.9	2.7	4.6	9.1	4.6	3.9

*Unreliable data

D. Atmospheric Stability

To characterize the atmospheric stability in our study area, the parameter Z/L is computed according to Hsu (1989)

$$\frac{Z}{L} = \kappa\, C_T\, C_d^{-\frac{3}{2}}\, R_b \tag{1}$$

where κ (= 0.4) is the Von Kàrmàn constant, C_T is the sensible heat flux coefficient, C_d is the wind stress drag coefficient, and from Hsu (1992)

$$R_b = \frac{g\,Z\left(T_{air} - T_{sea}\right)}{U_Z^2\left(T_{sea} + 273\right)} \tag{2}$$

where R_b is the bulk Richardson number, g (= 9.8 m sec^{-2}) is the gravitational acceleration, T_{air} and T_{sea} are the air and sea-surface temperatures in °C, respectively, and U_Z (m s^{-1}) is the wind speed at height Z (= 10 m) above the sea surface. Note that since R_b derived from Eq. (2) can be either positive (stable) or negative (unstable), Eq. (1) is valid for both stability conditions.

Using data from NOAA buoys 42007 and 42040 (located at 29.2°N 88.25°W, about 45 miles east-southeast of Breton Island) and methods as described in Hsu (1997), monthly values of Z/L were calculated. The monthly value was obtained from the average of the individual hourly data per month (i.e., about 720 samples). The value $C_T = 1.1 \times 10^{-3}$ for unstable conditions is adopted from Smith (1980), while the proper C_d formulation for the continental shelf of the Gulf of Mexico is based on Hsu (1995b), such that

$$C_d = \left[\frac{0.4}{11.0 - \ln\left(\dfrac{H_s}{\left(\dfrac{C_p}{U_{10}}\right)^{2.6}}\right)}\right]^2 \tag{3}$$

where H_s is the significant wave height, C_p is the phase speed of the waves at the spectral peak ($C_p = (g\,T_p) / 2\pi$), and T_p is the wave period at the spectral peak.

Satellite imagery has shown that sea-surface temperature difference between buoy 42007 and that surrounding Breton Island is generally within 1°C (see, e.g., Huh et al., 1978), therefore these stability values should be applicable to our study location.

The results are shown in Fig. 183. For buoy 42007, free convective conditions ($Z/L < -0.4$) are commonly observed during the summer months of May through September, with near-neutral stability prevailing during the remainder of the year. For buoy 42040 at the shelf break, free convection occurs year round. Since Z/L is negative, $T_{sea} > T_{air}$. The consequence of this excess heat flux is instability and the onset of convection. If sufficient moisture is present (as is commonly found over the ocean surface), deep thermals can reach their lifting condensation levels, or LCL, and lead to the formation of fair weather clouds. Both a sub-cloud and thin cloud layer can exist within the mixed layer, with the top of the subcloud layer being the cloud base, or LCL (Stull, 1988) as shown in Fig. 184. The mixed layer is typically capped by a stable layer, or even an inversion, which acts to prohibit further cloud growth. Strong thermals may overshoot and penetrate into this layer; they then generally become negatively bouyant and sink back into the mixed layer, entraining less turbulent free atmospheric air down. Thus, the top of the mixed layer, or entrainment zone, can be represented as an undulating surface with the actual height of the mixed layer being the average of the entrainment zone depth. Because the sea surface is relatively uniform over large areas (as compared to land surfaces), there is less variation in the LCL and entrainment zone heights. Furthermore, once condensation occurs, values of θ (potential temperature) and q (mixing ratio) are no longer near-constant (as in the mixed layer). Therefore, in the marine boundary layer, the LCL should provide a reasonable approximation to the mixed layer height.

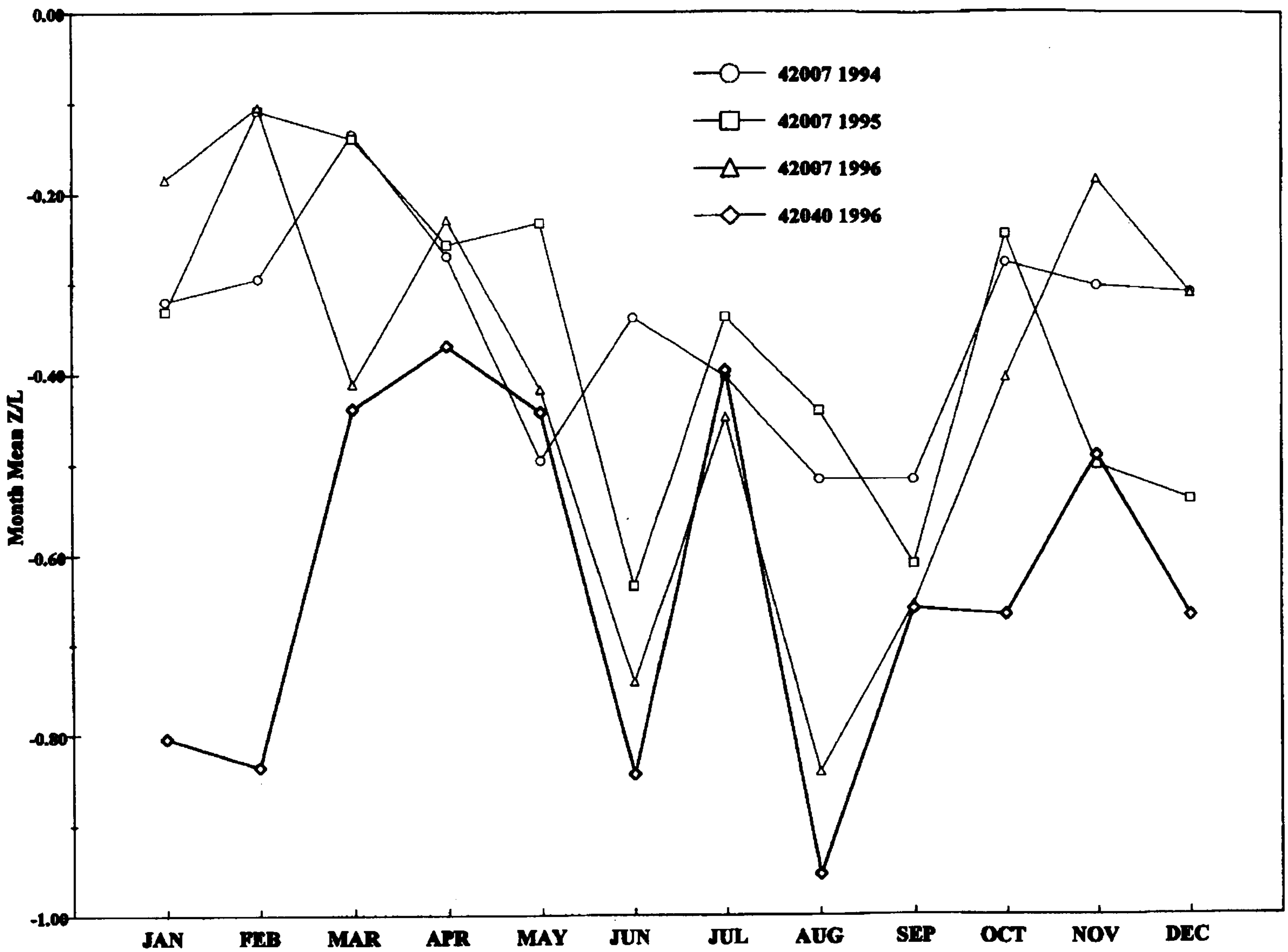


Figure 183. Monthly mean values of Z/L for NOAA offshore buoy stations 42007 (shallow water) and 42040 (shelf-break).

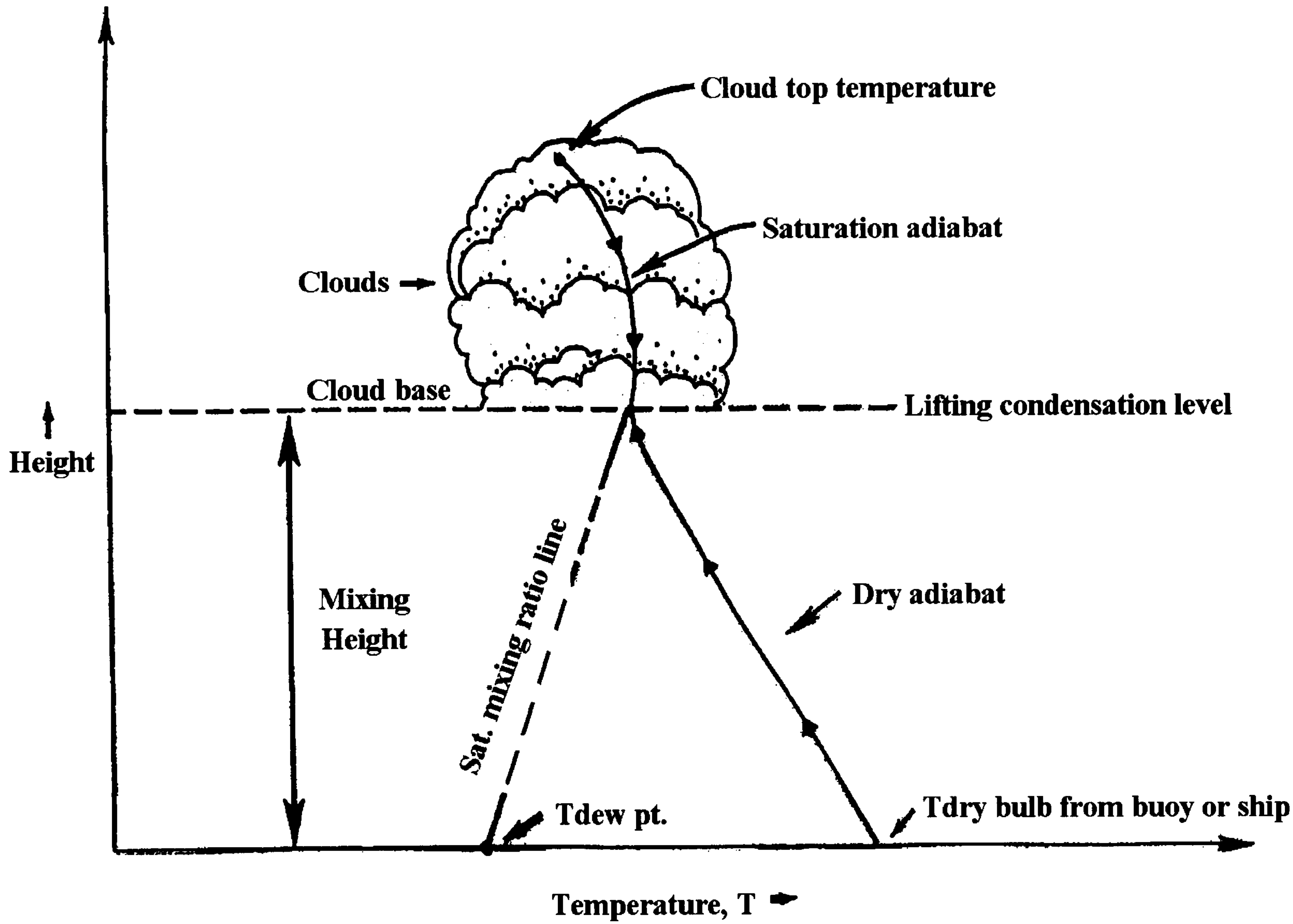


Figure 184. An illustration of thermodynamic characteristics used in this study.

E. Mixing Height

For overwater pollution transport, the mixing height is needed. Since routine offshore upper-air soundings are not available and the nearest NWS station is located in Slidell, Louisiana, we will estimate the atmospheric boundary layer height based on the following thermodynamic considerations:

For the dry-adiabatic lapse rate

$$\frac{dT}{dz} = -\frac{g}{C_p} = -\frac{0.98\,K}{100\ m} \tag{4}$$

where C_p is the specific heat at constant pressure for dry air (1004 J kg^{-1} K^{-1}) and g is the gravitational acceleration (9.8 m s^{-2}).

In a well-mixed atmospheric boundary layer from surface to the LCL,

$$T_{LCL} - T_{SFC} = -\frac{0.98\,K}{100\ m} H_{LCL} \tag{5}$$

or

$$T_{SFC} = \frac{0.98\,K}{100\ m} H_{LCL} + T_{LCL} \tag{5a}$$

For dew-point lapse rate (see, e.g., McIlveen, 1986, p. 151)

$$\frac{dT_{dew}}{dz} = -\frac{g}{L}\frac{R_v}{R} T_{dew} \tag{6}$$

where L is the specific heat of vaporization of water (2.5 MJ kg^{-1}), R_v is the specific gas constant for water vapor (462 J K^{-1} kg^{-1}), and R is the specific gas constant (287 J kg^{-1} K^{-1}).

For typical low tropospheric T_{dew} between 283 K (or 10°C) and 293 K (or 20°C), Eq. (5) becomes approximately

$$\frac{dT_{dew}}{dz} = -\frac{0.18\,K}{100\ m} \tag{7}$$

or

$$T_{dew\ LCL} - T_{dew\ SFC} = -\frac{0.18\ K}{100\ m} H_{LCL} \tag{8}$$

or

$$T_{dewSFC} = \frac{0.18\ K}{100\ m} H_{LCL} + T_{dewLCL} \tag{8a}$$

Subtracting Eq. (8a) from Eq. (5a) and recall that at the LCL, $T_{LCL} = T_{dewLCL}$,

$$T_{SFC} - T_{dewSFC} = \frac{0.98\ K}{100\ m} H_{LCL} + T_{LCL} - \left(\frac{0.18\ K}{100\ m} H_{LCL} + T_{dewLCL} \right) \tag{9}$$

$$T_{SFC} - T_{dew\ SFC} = \frac{0.80\ K}{100\ m} H_{LCL} \tag{10}$$

$$\therefore\ H_{LCL} = 125 \left(T_{SFC} - T_{dew\ SFC} \right) \tag{11}$$

where H_{LCL} is in meters and the dew-point depression at the surface in °C. Note that, due to evaporation and entrainment effects within the mixed layer, Eq. (11) can produce errors of approximately 10% (McIlveen, 1986).

Figures 185 and 186 show our verification of the preceding discussion based on 12 atmospheric profiles conducted in our study area during the summer of 1994 (see, e.g., Hsu, 1996). LCL heights predicted by Eq. (11) appear to be consistently higher than those obtained through thermodynamic profile (Skew-T Log P) with a root mean square error of 71 m, however they are extremely well correlated. It should be noted that the surface dew point temperatures of these profiles were often greater than 20°C, therefore Eq. (6) may overestimate actual conditions. Garratt (1992) has shown that, under cumulus cloud conditions, the mixing height is equal to the LCL. Figure 186 compares the calculated LCL heights with mixing heights derived through potential temperature-mixing ratio analysis. A slightly lower RMSE (135 m) is found between the mixing height and the LCL_p obtained from profile, however the attempt here is to provide a method for determining the mixed height over areas where upper air data is unavailable. Therefore, if one accepts the root mean square errors of approximately 70 and 150 m obtained from this small sample, then Eq. (11) is acceptable for operational use. A similar analysis of atmospheric profiles obtained over the Baton Rouge, Louisiana area during the summer of 1996 concluded that Eq. (11) provided a reasonable estimate of the mixing height in lieu of in-situ data (Hsu and Blanchard, 1997).

Simultaneous dewpoint temperature measurements from both NOAA C-MAN station GDIL1 (Grand Isle, Louisiana) and buoy 42040 are available for 1996. This provides an opportunity to compare monthly mean mixing height variations over a nearshore area versus the continental shelf-break region. Figure 187 illustrates our results such that GDIL1 experienced higher mixing heights in the summer than in the winter as expected, but the reverse occurred at the deep-water station.

Since Breton Island is located within the shallow water area, the characteristics of the mixing height should more closely resemble those at Grand Isle than 42040. Using standard meteorological formulations found in Hsu (1988), monthly mean dew point temperatures were derived from the relative humidity data collected at Breton during 1995 as follows:

$$RH = \frac{e}{e_s} \times 100 \qquad \textbf{(12)}$$

where RH is relative humidity, e is the vapor pressure, and e_s is the saturation vapor pressure over water given by

$$e_s = 6.1078 \times 10^{[7.5\,T/(237.3\,+\,T)]} \qquad \textbf{(13)}$$

From Eqs. (12) and (13), e can be determined. Hence,

$$T_{dew} = \frac{237.3 \log_{10}(e/6.1078)}{7.5 - \log_{10}(e/6.1078)} \qquad \textbf{(14)}$$

Computed monthly mean values are listed in Table 43, along with those from GDIL1. Results are shown in Fig.188. Very similar trends are obtained, however considerably higher mixing heights occurred over Breton during the latter part of the year. From Table 43, the difference is found to be due to higher dew point temperatures at GDIL1. This may be an effect of early season cold fronts, which often stall along the coastal areas and can produce overrunning and extensive precipitation. Overall, the root mean square error in mixing height between stations is 165 m (Fig. 189). Certainly, a more extensive simultaneous dataset needs to be compiled to refine these relationships.

Table 43.
1995 Monthly Mean Temperature Comparison
Breton Island and GDIL1 (Grand Isle, LA)

	Mean Air Temperature °C			Mean Dew Point Temp. °C		
Month	Breton	GDIL1	Diff	Breton	GDIL1	Diff
January	12.9	13.2	-0.3	9.4	8.7	0.7
February	14.4	14.8	-0.4	11.0	10.3	0.7
March	17.2	17.5	-0.3	14.9	14.0	0.9
April	21.0	21.2	-0.2	17.4	16.4	1.0
May	24.9	25.5	-0.6	22.1	21.3	0.8
June	26.8	26.8	0	21.7	21.4	0.3
July	28.2	28.7	-0.5	24.4	24.1	0.3
August	30.1	29.4	0.7	24.1	24.2	-0.1
September	27.5	27.4	0.1	20.9	22.1	-1.2
October	23.0	22.8	0.2	15.9	17.6	-1.7
November	17.2	17.4	-0.2	10.7	12.9	-2.2
December	13.5	13.4	0.1	8.3	9.9	-1.6

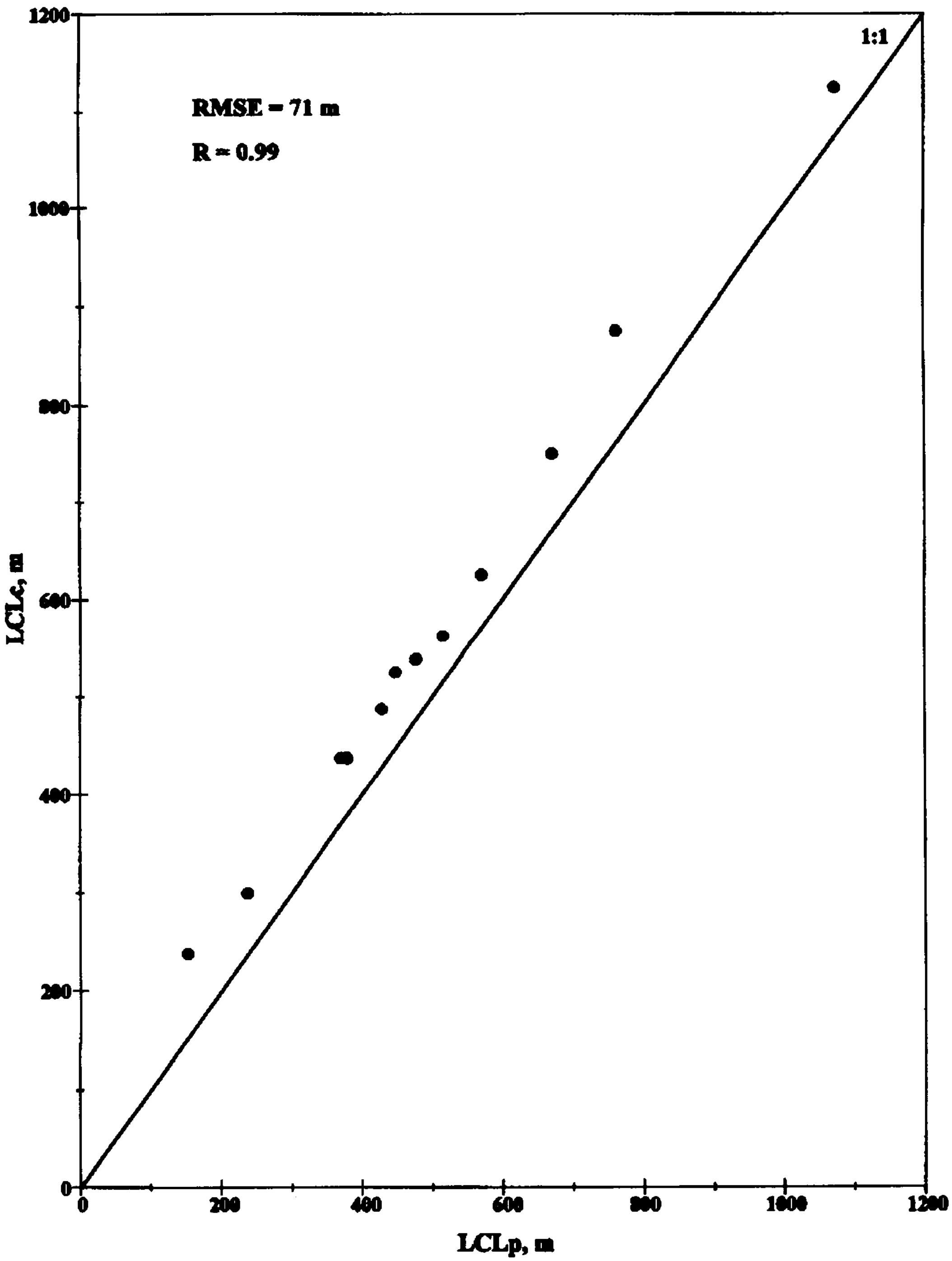


Figure 185. A comparison of calculated LCL values (LCLc) and those derived from Skew-T Log P thermodynamic analysis (LCLp) for 12 radiosondes launched in the Breton Island area during 1996.

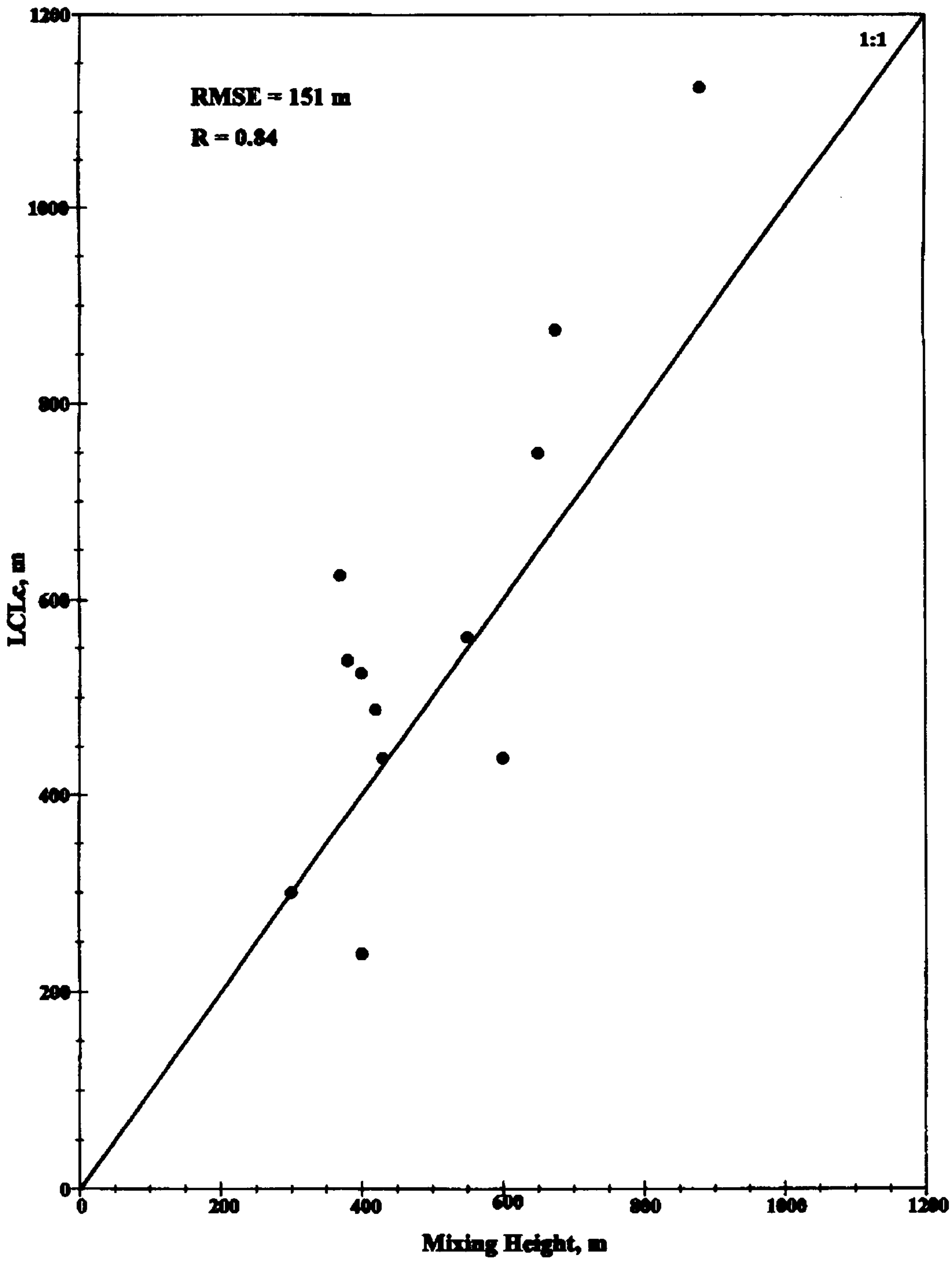


Figure 186. A comparison between calculated LCL values and mixing heights (from potential temperature / mixing ratio analysis) for 12 radiosondes launched in the Breton Island area during 1996.

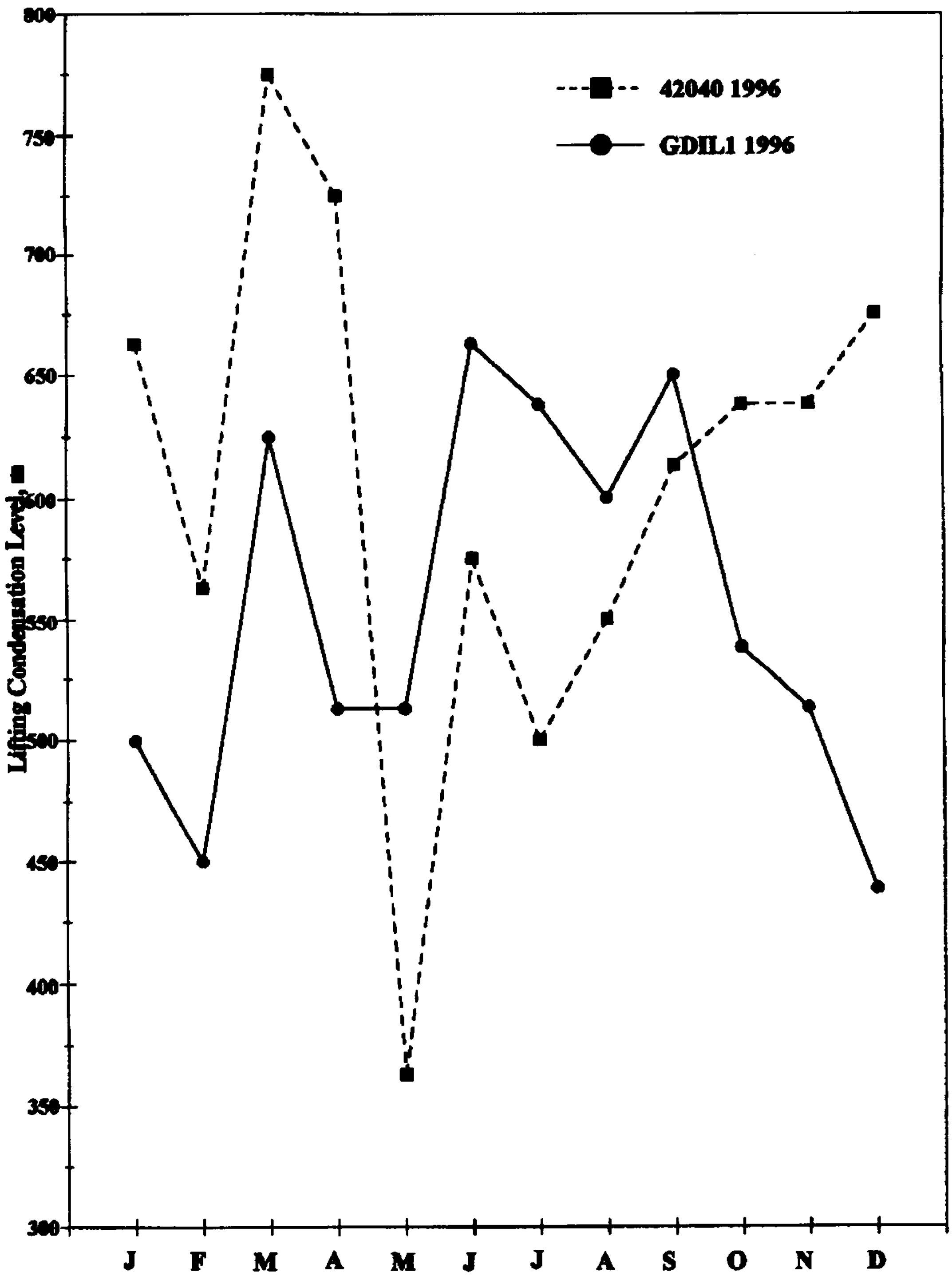


Figure 187. Variations in calculated LCL heights at GDIL1 (Grand Isle, LA) and buoy 42040 during 1996.

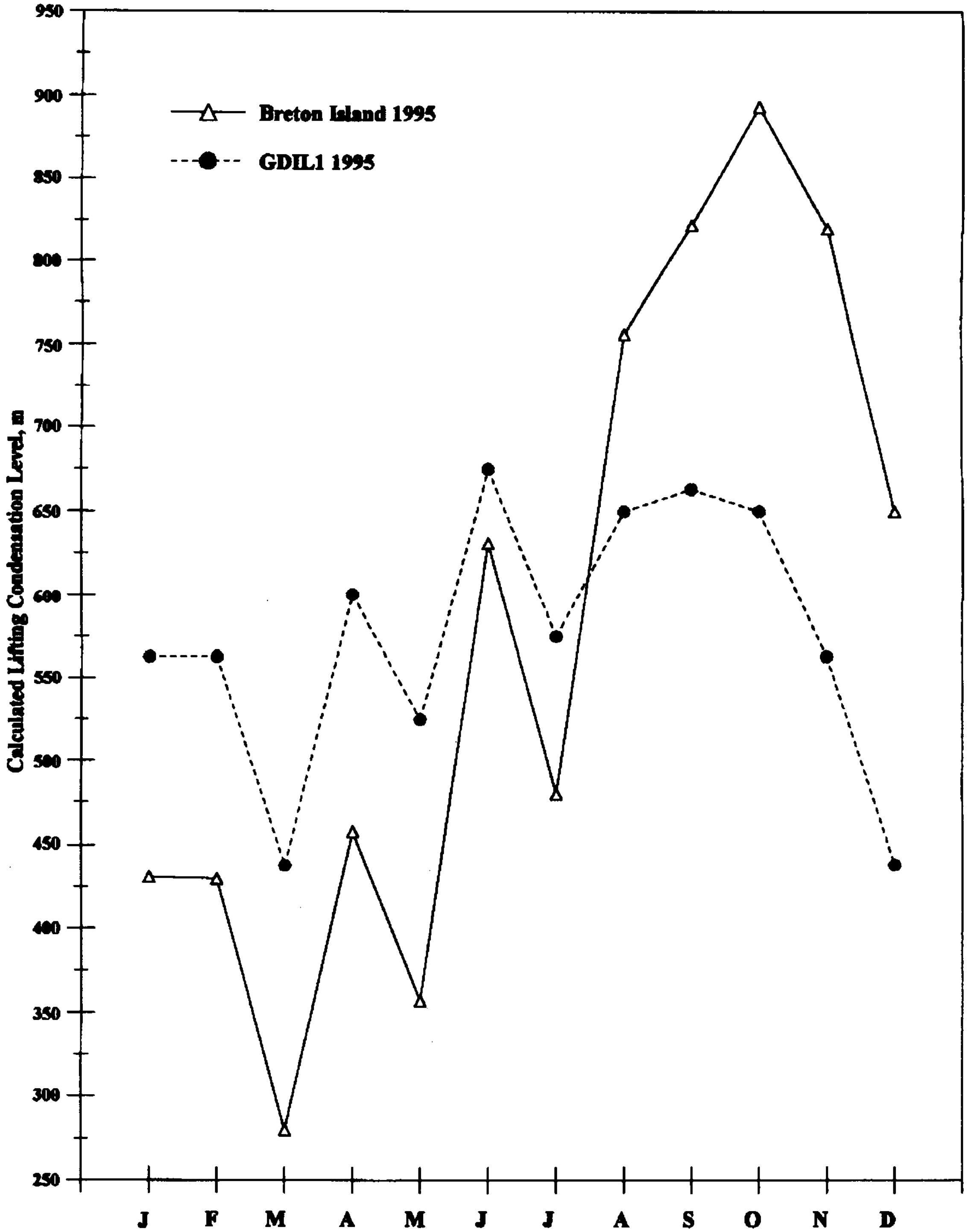


Figure 188. Variations in calculated LCL heights at GDIL1 (Grand Isle, LA) and those derived for Breton Island in 1995.

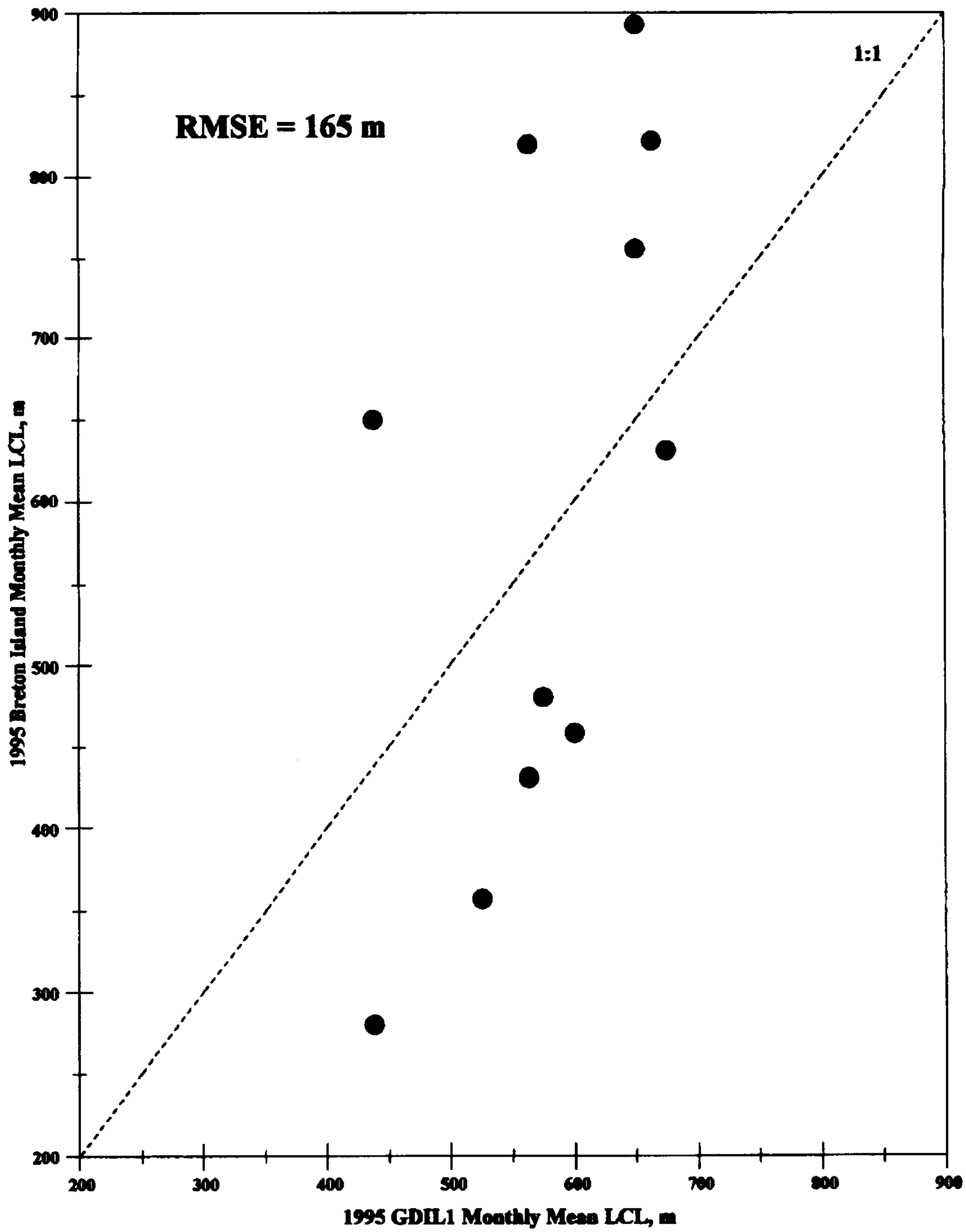


Figure 189. One-to-one comparison of LCL height calculated from monthly mean air and dew point temperatures at Breton Island and GDIL1 (Grand Isle, LA) during 1995. The implication is that Breton Island LCL (and hence, mixed height) may be estimated by conditions at GDIL1 with an error within 165 m.

IV. SUMMARY

Air quality and meteorological data acquired during the period of October 1994 through April 1997 from stations at Breton Island, Louisiana and Dauphin Island, Alabama, are presented in this report. It is shown that:

- Monthly mean SO_2 values appear to be higher at Dauphin Island than at Breton (often by a factor of 2), while mean NO_2 values are nearly the same. Hourly maximums and standard deviations of both pollutants are higher at Breton, the result of occasional short duration very high concentration events.

- Highest concentrations at Dauphin are mostly associated with northwesterly to northeasterly wind flow. This suggests that ambient air quality conditions affecting the island are largely influenced by the adjacent mainland, including the Mobile metro area and shipping activity in Mobile Bay. High SO_2 at Breton occurs primarily with north-northeasterly winds and high NO_2, though more varied, most frequently with southerly winds. North of Breton is the Chandeleur Sound, while Breton Sound and the Mississippi River Delta lie to the south.

- Dauphin Island NO_2 seasonal trends show a rise in the fall months and peak in winter; less prominent increases in summer and winter are noted for SO_2, with winter averages being slightly higher. NO_2 diurnal variations often show a maximum in morning (0600CST), with a secondary peak in evening (1800CST). Diurnal SO_2 also frequently peaked from mid-morning to noon. No distinct seasonal or diurnal trends are discernable from the Breton Island SO_2 data; nocturnal NO_2 concentrations were generally higher than those observed during daytime, as expected.

- Estimated annual mean values for SO_2 and NO_2 from both stations was less than 5 ppb.

- Isolated high NO_2 and SO_2 events, usually of less than one day duration, occur throughout the Breton Island data record.

- Based on data from buoy 42007, atmospheric stability at Breton Island is expected to be free convective during the summer months of May through September and neutral to unstable otherwise ($-0.4 < Z/L < 0$).

- A theoretical relationship amongst mixing height, lifting condensation level, and surface temperature dew-point depression is applied to Breton Island data. Seasonal trend in mixing height follows that derived for Grand Isle, Louisiana, with root mean square error of 165 m. Calculated mixing heights range from about 250 m in March to 950 m in October.

A more extensive collection of simultaneous data from Breton and Dauphin Islands is needed to verify these findings. In addition, the recent installation of humidity sensors at several offshore NOAA stations will add to our knowledge of overwater stability characteristics.

V. REFERENCES

Boubel, R. W., D. L. Fox, D. B. Turner, and A. C. Stern. 1994. Fundamentals of air pollution. San Diego: Academic Press, 574 pp.

Code of Federal Regulations. 1994. Title 40, Protection of Environment, Part 58, Appendix B, Quality assurance requirements for prevention of significant deterioration (PSD) air monitoring.

Environmental Protection Agency (EPA). 1979. Quality assurance handbook for air pollution measurement systems. Volume II - Ambient air specific methods. EPA-600/4-77-027a. May 1979. Available from U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory (MD-77), Research Triangle Park, NC.

Garratt, J. R. 1992. The atmospheric boundary layer. Cambridge University Press. 316 pp.

Hsu, S. A. 1988. Coastal meteorology. San Diego: Academic Press. 260 pp.

Hsu, S. A. 1989. The relationship between the Monin-Obukhov stability parameter and the bulk Richardson number at sea. J. Geophys. Res., 94(C6), 8053 - 8054.

Hsu, S. A. 1992. An overwater stability criterion for the offshore and coastal dispersion model. Bound.-Layer Meteor., 60, 397 - 402.

Hsu, S. A. 1995a. Measurements of SO_2 concentration and atmospheric structure in Delta and Breton Wildlife Refuges. OCS Study MMS 95-0019. U.S. Dept. Of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 74 pp.

Hsu, S. A. 1995b. A proper wind-stress drag coefficient formulation for computer modelling of seas and coastal regions. Computer Modelling of Seas and Coastal Regions II. C A. Brebbia, L. Traversoni, and L. C. Wrobel, Eds. Computational Mechanics Publications, 413 - 420.

Hsu, S. A. 1996. Analysis of ambient pollutant concentrations and meteorological conditions affecting EPA class I and II areas in southeastern Louisiana, Vol. 1: Technical Report. OCS Study MMS 96-0062. U.S. Dept. Of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 156 pp.

Hsu, S. A. 1997. Estimating overwater convective boundary layer height for routine meteorological measurements for diffusion applications at sea. J. Applied Meteor., 36, 1245 - 1248.

Hsu, S. A. And B. W. Blanchard. 1997. An analysis of mixing heights by rawinsonde over Baton Rouge during the summer of 1996, Vol. 1: Technical Report. Available from the Louisiana Dept. Of Environmental Quality, Air Quality Division, Baton Rouge, LA. 141 pp.

Huh, O. K., W. J. Wiseman, Jr., and L. J. Rouse, Jr. 1978. Winter cycle of sea surface thermal patterns, northeastern Gulf of Mexico. J. Geophys. Res., 83(C9), 4523 - 4529.

Manahan, S. E. 1993. Environmental chemistry. Lewis Publishers. 844 pp.

McIlveen, J. F. R. 1986. Basic meteorology. Van Nostrand Reinhold (U.K.) Co., Ltd. 457 pp.

Monitor Labs, Inc., 1993. ML9850 sulphur dioxide analyzer operator manual.

Monitor Labs, Inc., 1993. ML9841 nitrous oxide analyzer operator manual.

National Data Buoy Center (NDBC). 1990. Coastal-marine automated network (C-MAN) users guide. NOAA, National Data Buoy Center, Stennis Space Center, MS. 45 pp.

Smith, S. D. 1980. Wind stress and heat flux over the ocean in gale force winds. J. Phys. Oceanogr., 10, 709 - 726.

Stull, R. B., 1988. An introduction to boundary layer meteorology. Kluwer Academic Publishers, 666 pp.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.