

ADDENDUM TO REPORT NO. DOT-FAA-RD-81-99

B-747 VORTEX ALLEVIATION FLIGHT TESTS:
GROUND-BASED SENSOR MEASUREMENTS

The work described in this report included measurements of the vertical profiles of the meteorological parameters temperature, wind and relative humidity which were made by AeroVironment, Inc. When this report was prepared, not all of these measurements were included; only the temperature profiles for runs with numerical data were plotted and placed in Appendix G. This addendum includes plots of all the meteorological data collected, as well as some interpretation by AeroVironment in terms of Richardson Number and turbulence level.

At the present time, a number of stimulating analytical studies have attempted to describe vortex decay in terms of turbulence level, atmospheric stability and wind shear. This work has relied heavily on the one experimental data run in the prior Report No. FAA-RD-78-146, "Ground-Based Measurements of the Wake Vortex Characteristics of a B-747 Aircraft in Various Configurations," for which vortex descent was measured. It is hoped that the more extensive data set reported in the subject report will provide vortex decay researchers with additional data collected under different documented conditions and both in and out of ground effect. In order to assist in utilizing these data runs, the DOT Transportation Systems Center will attempt to improve the vortex descent data contained in the subject report by improving the determination of the descent velocity and then integrating the velocity to obtain the descent profile, as was done in the prior report.



AeroVironment Inc.

145 VISTA AVENUE • PASADENA, CALIFORNIA 91107 • U.S.A. • (213) 449-4392

6 June 1979

Dr. James Hallock (MC 521)
U.S. Department of Transportation
Transportation Systems Center
Kendall Square
Cambridge, MA 02142

REF: Purchase Order No. TS-16620

Dear Jim:

Enclosed is the reduced data from our measurements of Boeing 747 vortices at Moses Lake in February. The following data is enclosed.

- (1) Plots of vortex trajectories. The coordinate system origin is at our vertical (Site 1) camera. The aircraft is flying into the paper.
- (2) Tables of the data in the above plots.
- (3) Plots of tethersonde soundings of temperature and winds. Note that the units here are metric, whereas those of the vortex trajectories are English.
- (4) Sketches of the equipment layout on each test day.

The most successful day was the second one (2/10). We had problems with one camera on the first day, which weren't discovered until after the experiment was completed, and the tethersonde telemetry also misbehaved during the early part of that day. Thus the 2/9 trajectory and sounding data are both sparse. The visibility on the third day (2/12) made it impossible to find the vortices on the photos. Although we couldn't fly the tethersonde aloft either, we did fly it near the ground to collect wind data. (The surface wind was typically 1-2 m/s from 165° and the temperature was 4°C on that day).

To estimate turbulence from lapse rate, I made crude estimates based on the Richardson number of the flow between 200 and 250 m AGL. My guesses at the turbulence levels are as follows:

Day	Time	Approx $\epsilon^{1/3}$ ($\text{cm}^{2/3} \text{ s}^{-1}$)
2/9	1154	> 2
"	1217	1 - 2

Dr. James Hallock
6 June 1979

Page Two

Day	Time	
2/10	0933-0943	< 1
"	1033	1 - 2

The turbulence on 2/12 should have been weak ($\epsilon^{1/3} < 1$).

This completes our obligation to you under the referenced purchase order. I hope you'll find the data useful.

Cordially,

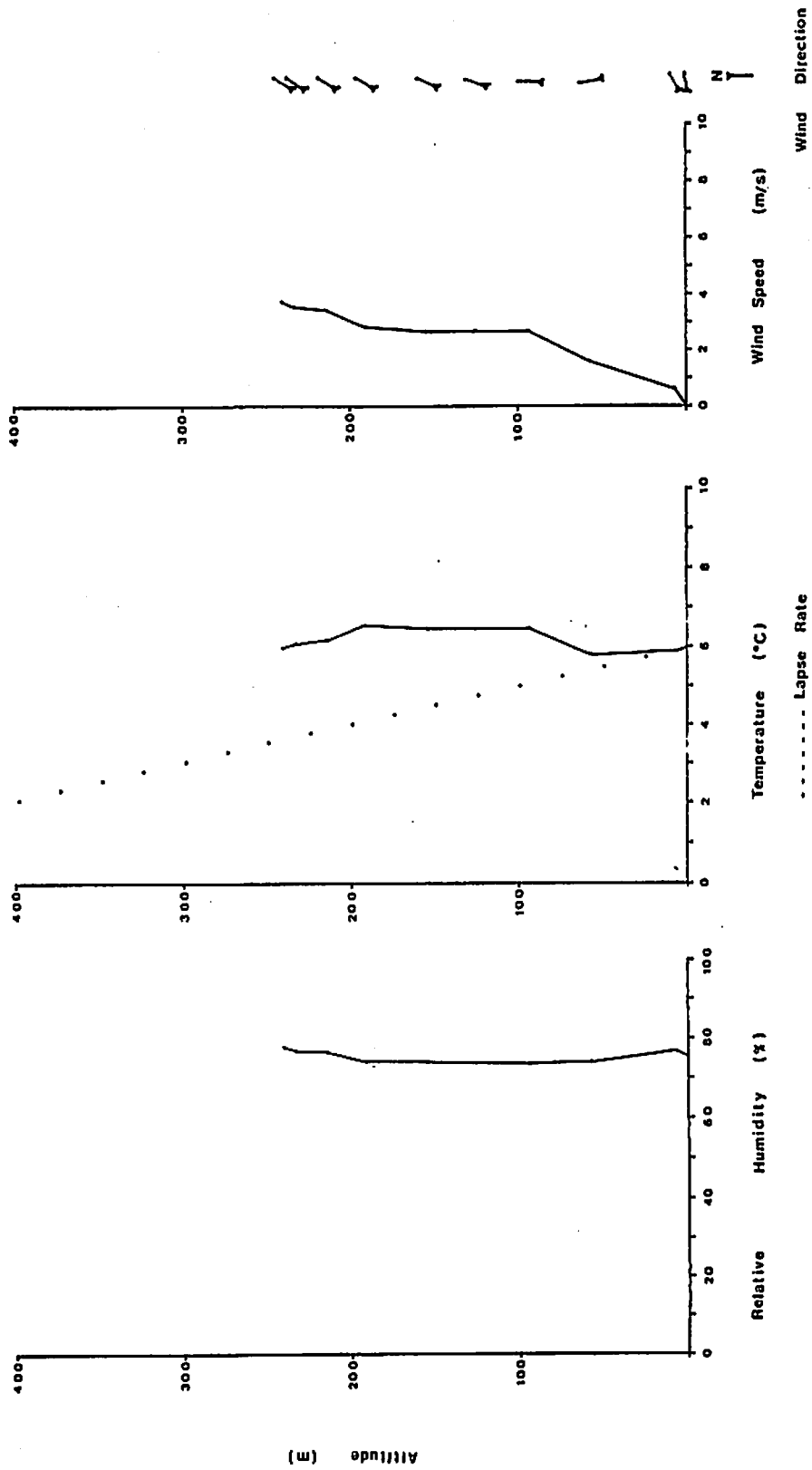


Ivar Tombach
Vice President,
Environmental Programs

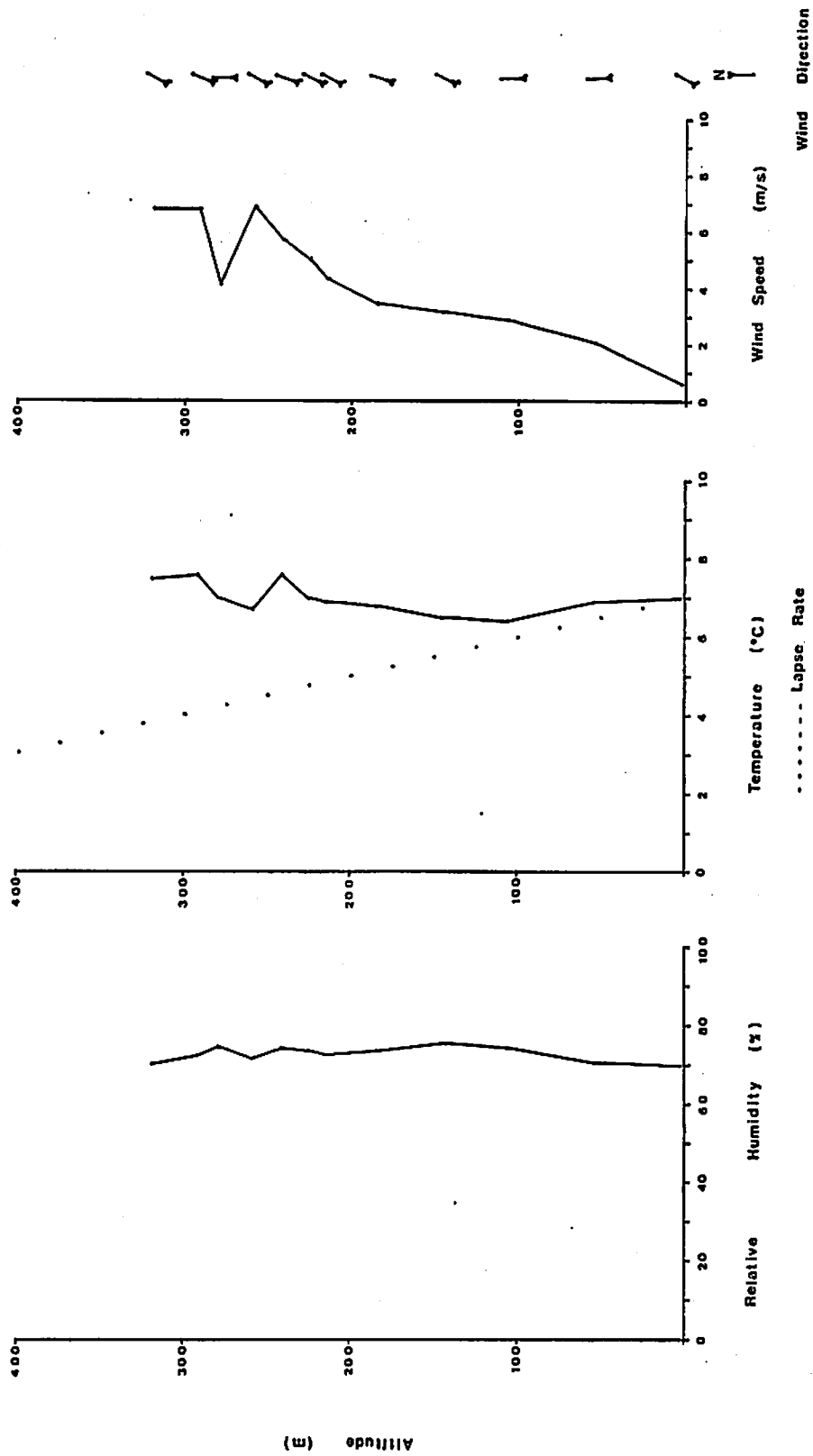
IHT:em

Enclosures

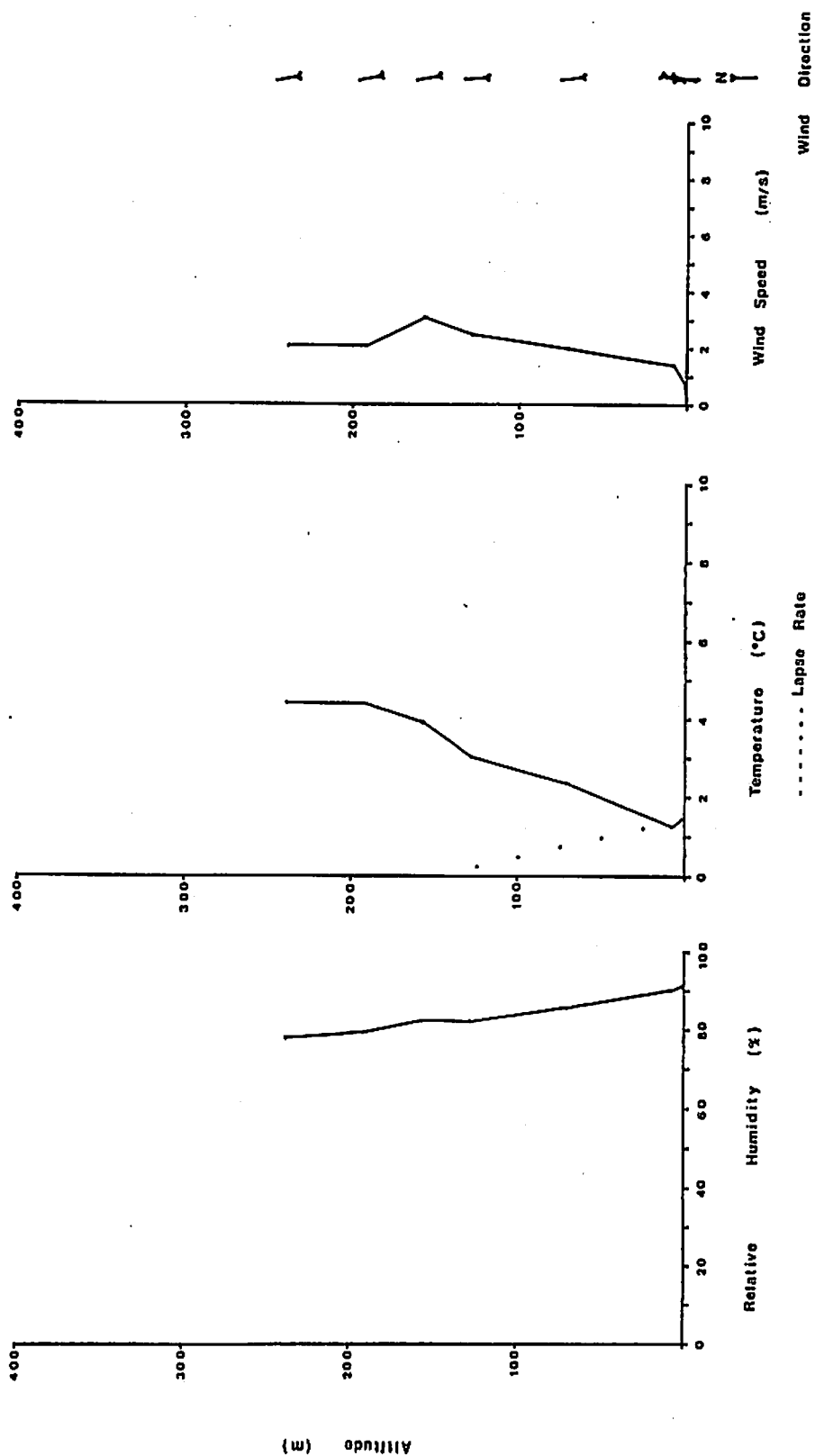
MOSES LAKE, WA
 TETHERSONDE DATA
 DATE: 2-9-79
 TIME: 1149-1154
 ASCENT



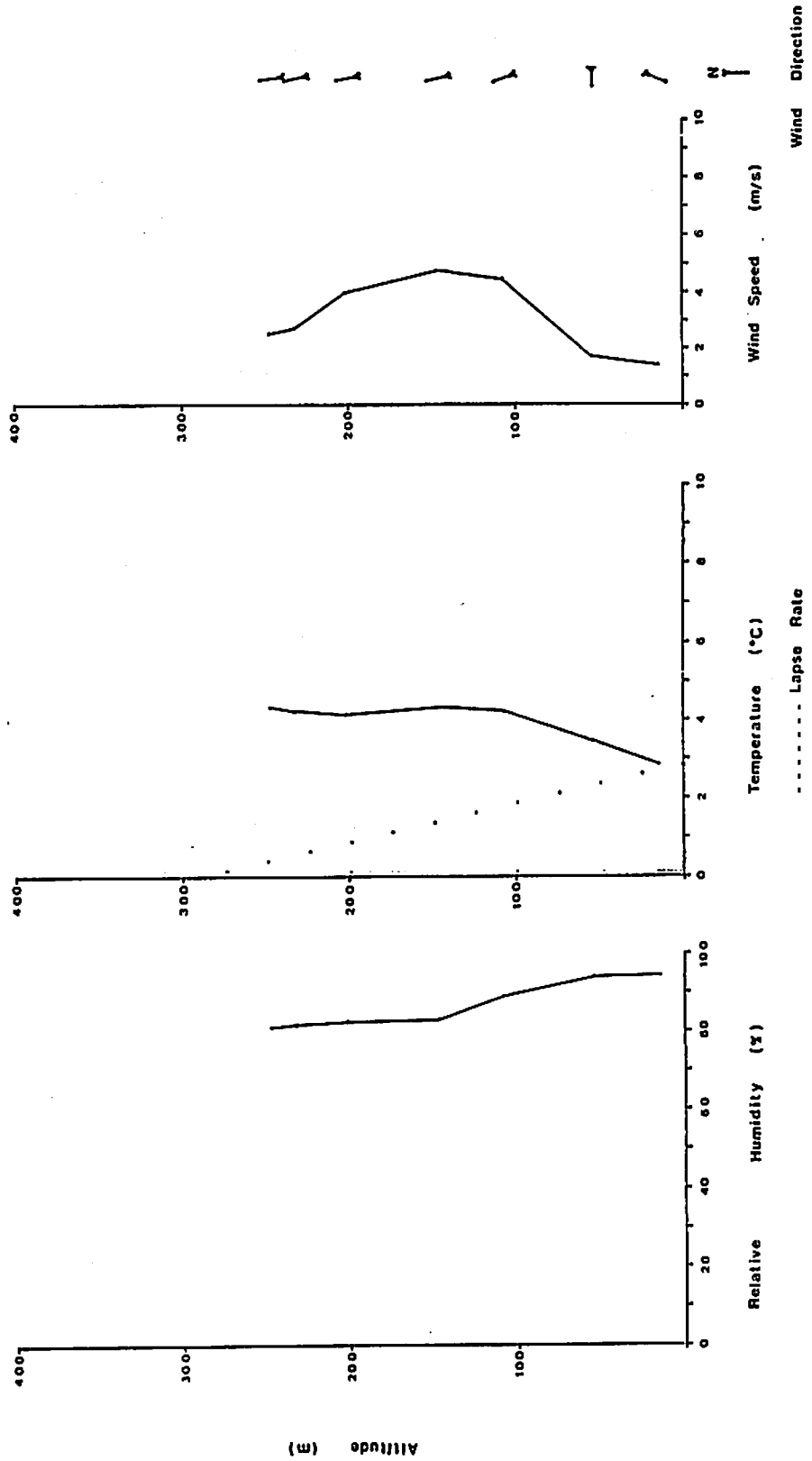
MOSES LAKE, WA
TETHERSONDE DATA
DATE: 2-9-79
TIME: 12:15-12:20
DESCENT



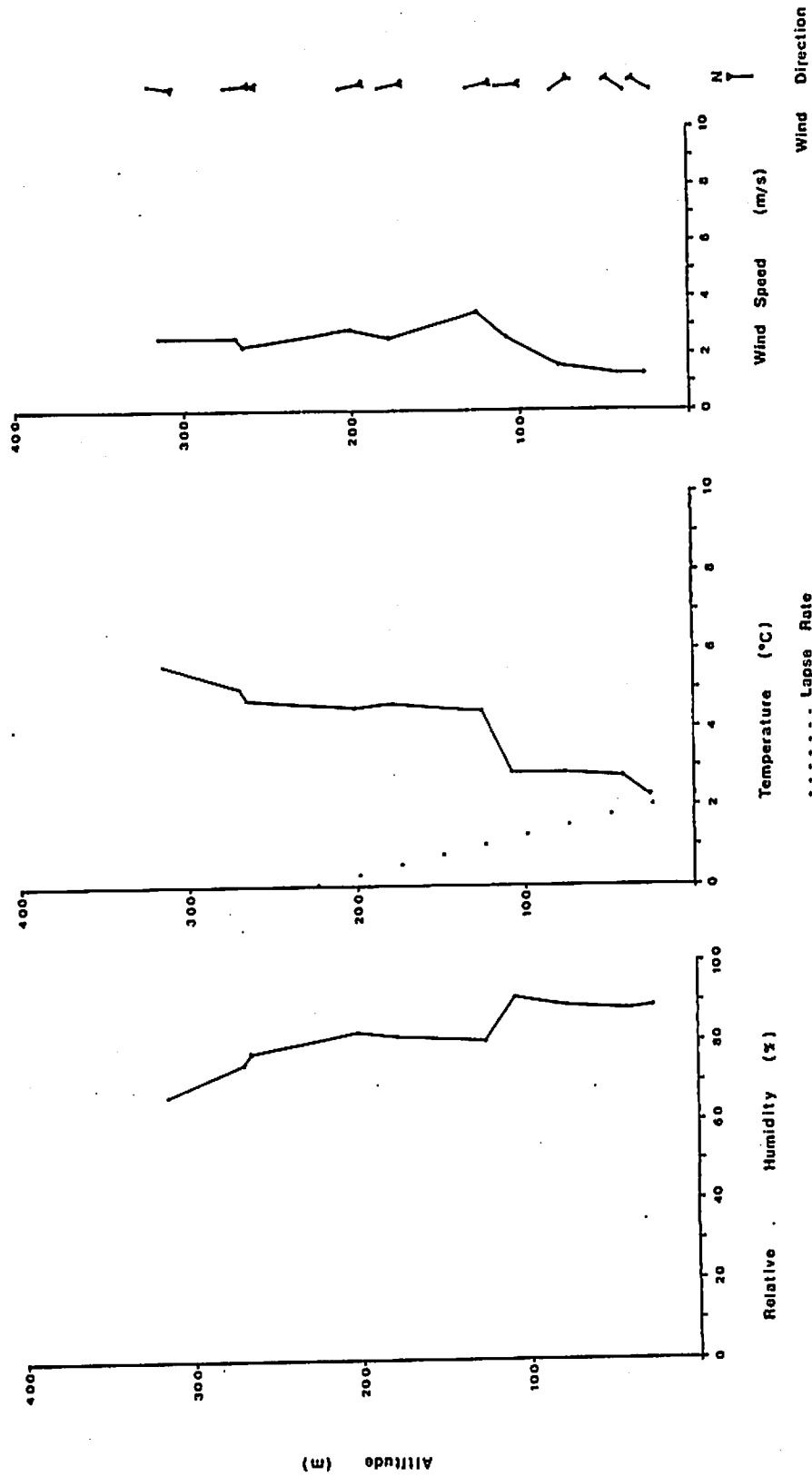
MOSES LAKE, WA
 TETHERSONDE DATA
 DATE: 2-10-79
 TIME: 0929-0935
 ASCENT



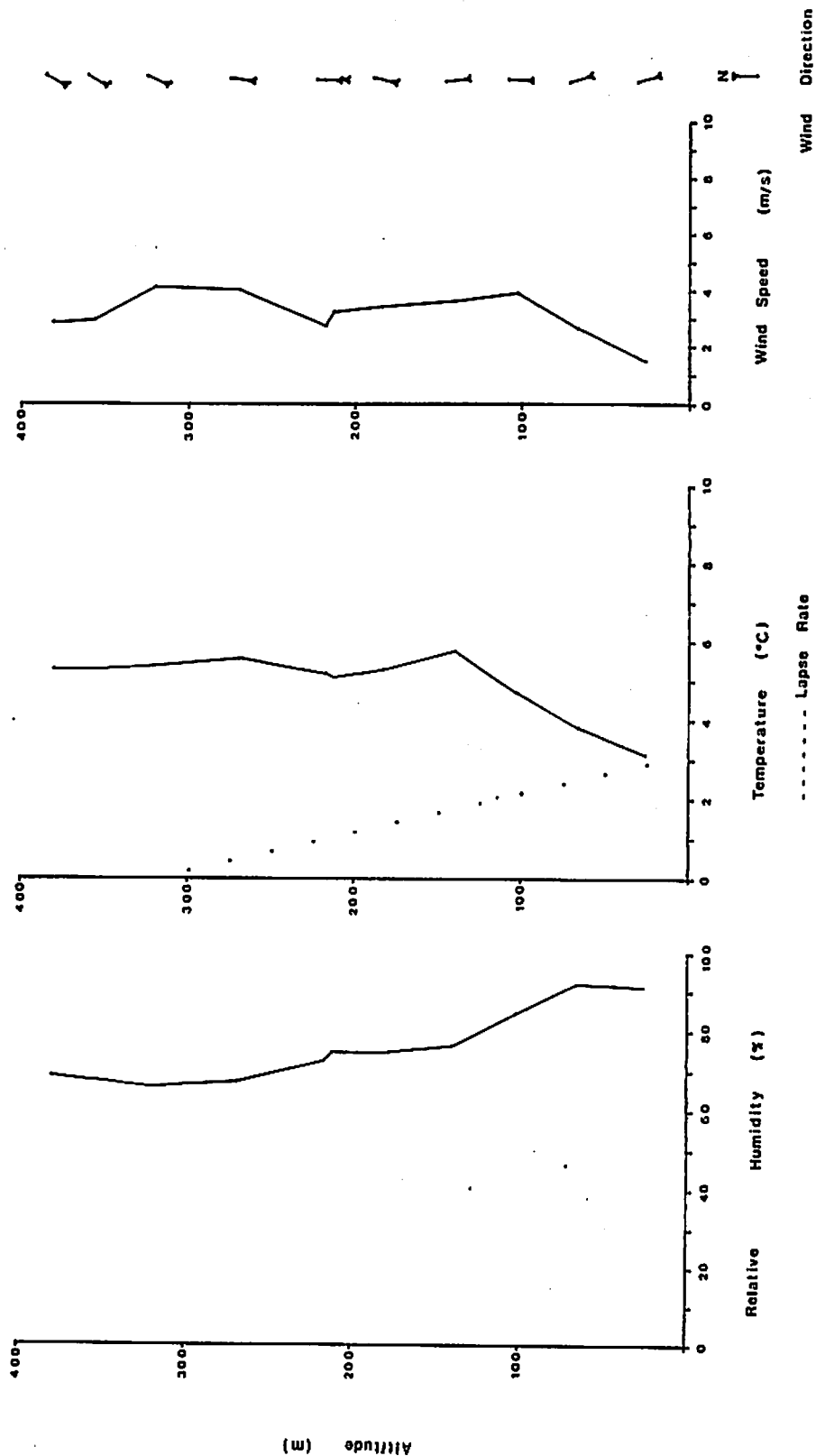
MOSES LAKE, WA
 TETHERSONDE DATA
 DATE: 2-10-79
 TIME: 0935-0938
 DESCENT



MOSES LAKE, WA
 TETHERSONDE DATA
 DATE: 2-10-79
 TIME: 0939-0943
 ASCENT



MOSES LAKE, WA
 TETHERSONDE DATA
 DATE: 2-10-79
 TIME: 1030-1035
 DESCENT





AEROVIRONMENT INC.

145 VISTA AVENUE

PASADENA, CALIFORNIA

91107

(213) 449-4392

February 1, 1980

Ian McWilliams
Department of Transportation
Transportation System Center
Kendall Square
Cambridge, MA 02142

REF: purchase Order No. DOT-TSC-1811

Dear Ian:

Enclosed is the reduced data from our meteorological soundings and photographic measurements of Boeing 747 vortex locations at China Lake on 2-3 November 1979. The following data is enclosed:

- (1) Plots of vortex trajectories. The coordinate system origin is at our vertical (camera 2) camera. The aircraft is flying into the paper.
- (2) Tables of the data in the above plots.
- (3) Plots of tethersonde soundings of temperature and winds. Note that the units here are metric, whereas those of the vortex trajectories are English. The Run number refers to the aircraft run number that the data was closest to.
- (4) Sketches of the equipment layout on each test day.

On the first day (11-2-79) we collected only tethersonde data. On the second day both tethersonde data and vortex position photographs were collected.

To estimate turbulence from lapse rate, Ivar made crude estimates based on the Richardson number of the flow between 50 and 100 m AGL.

LTR: pg. 2
2-1-80

Date	Run #	$\epsilon^1 /_3$ (cm ² / ₃ s ⁻¹) (Estimate for h=50-100 m AGL)
11/2	1	>2
11/2	2	1-2
11/2	3	<1
11/2	4	<1
11/2	5	1-2
11/2	6	<1
11/3	1	<1
11/3	8	1-2

This completes our obligation for the China Lake experiment. We expect to finish up the Edwards portion of the data and submit that to you shortly. If you have any questions please give me a call.

Sincerely,

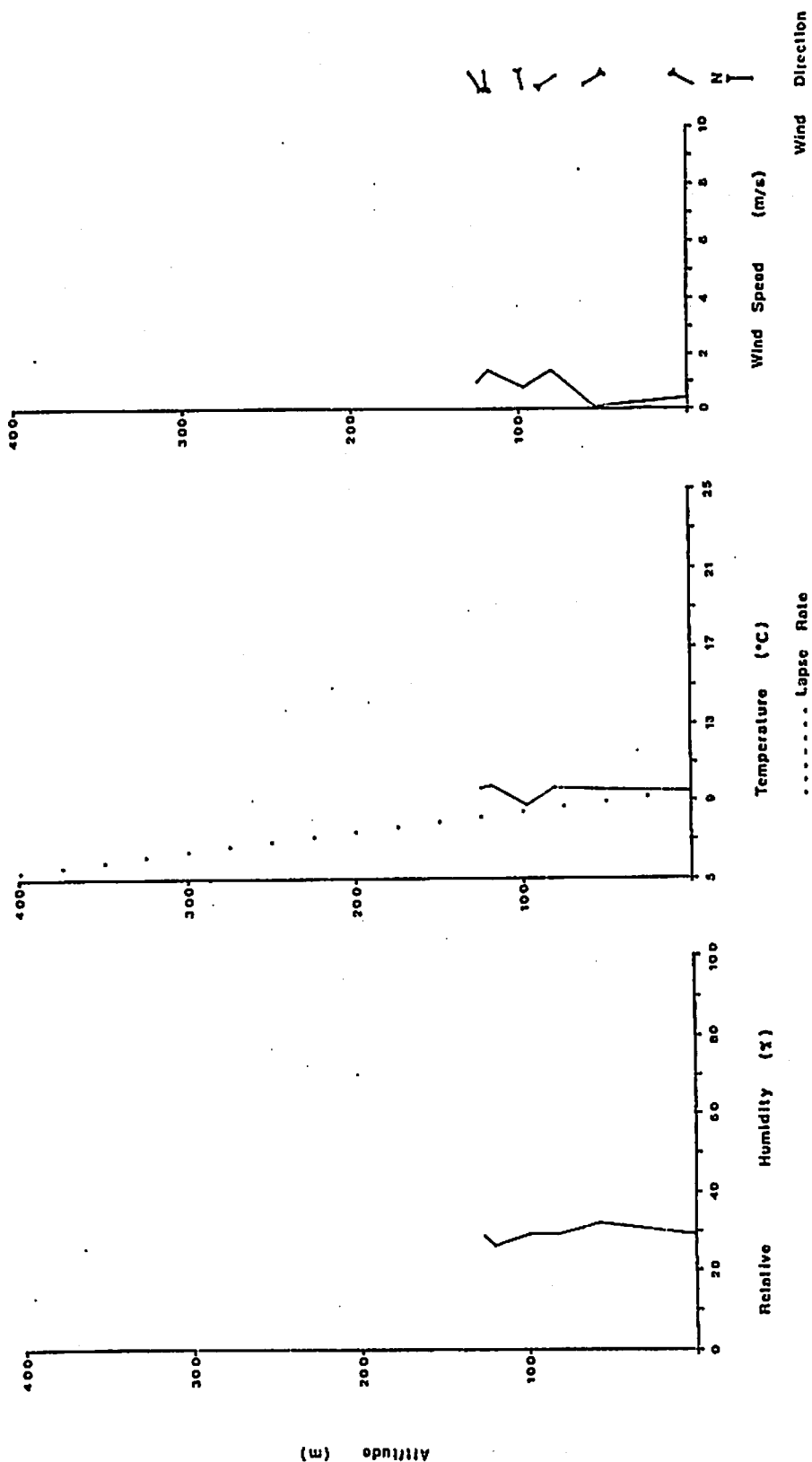


John G. Blair
Manager of Data Processing

JGB:rf
Encl.

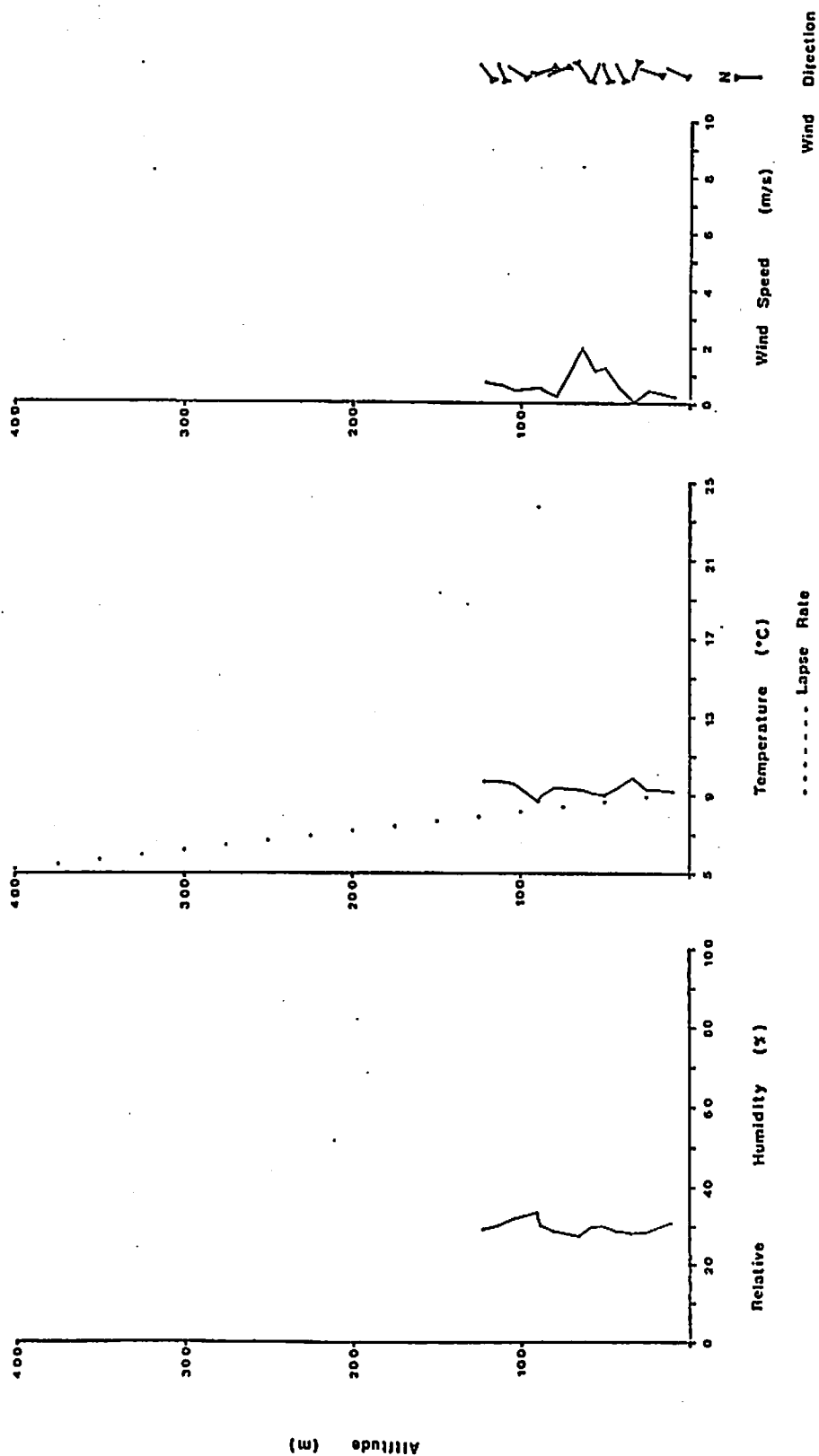
Run # 1

CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0823
ASCENT

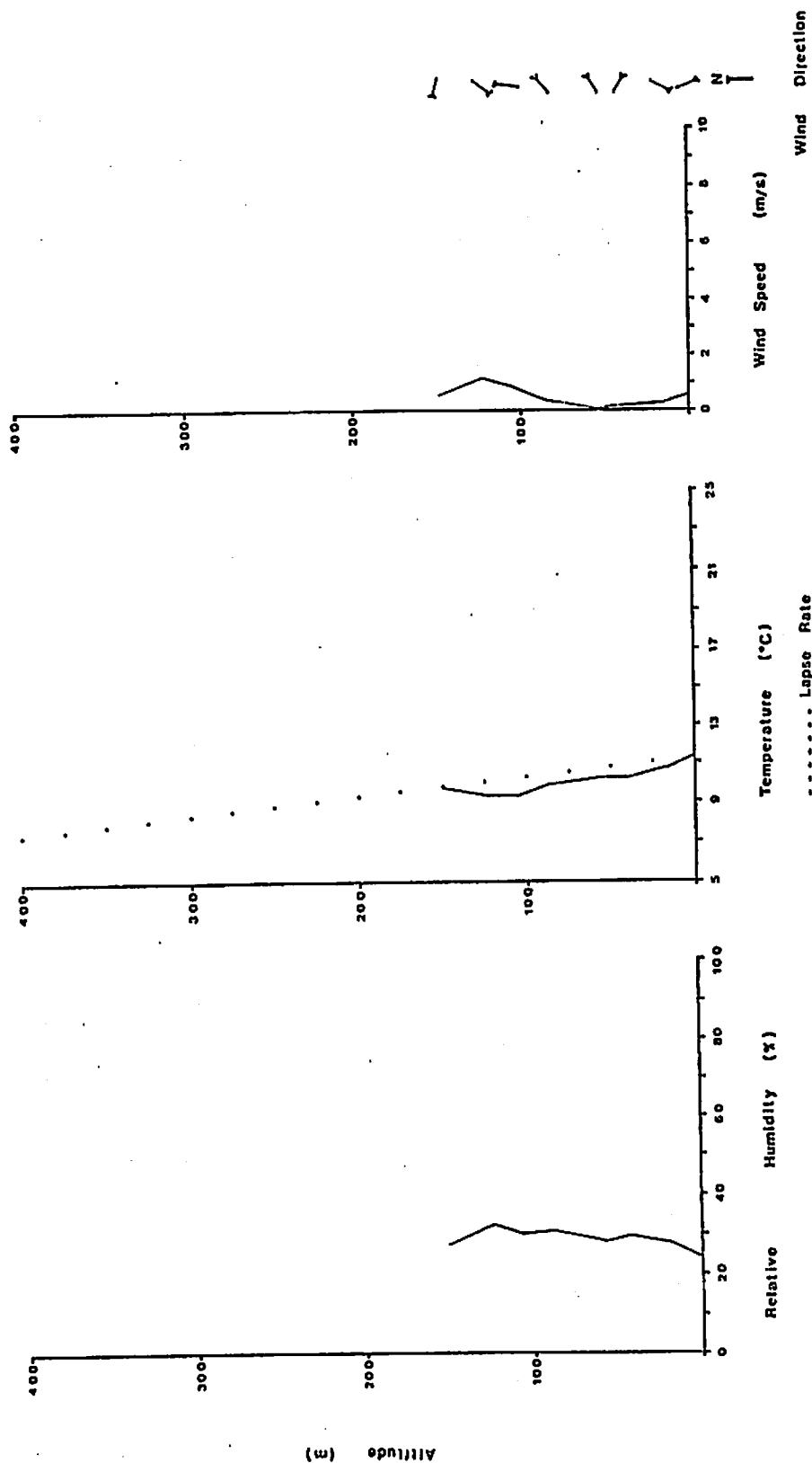


Run # 1

CHINA LAKE CA.
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0827
DESCENT

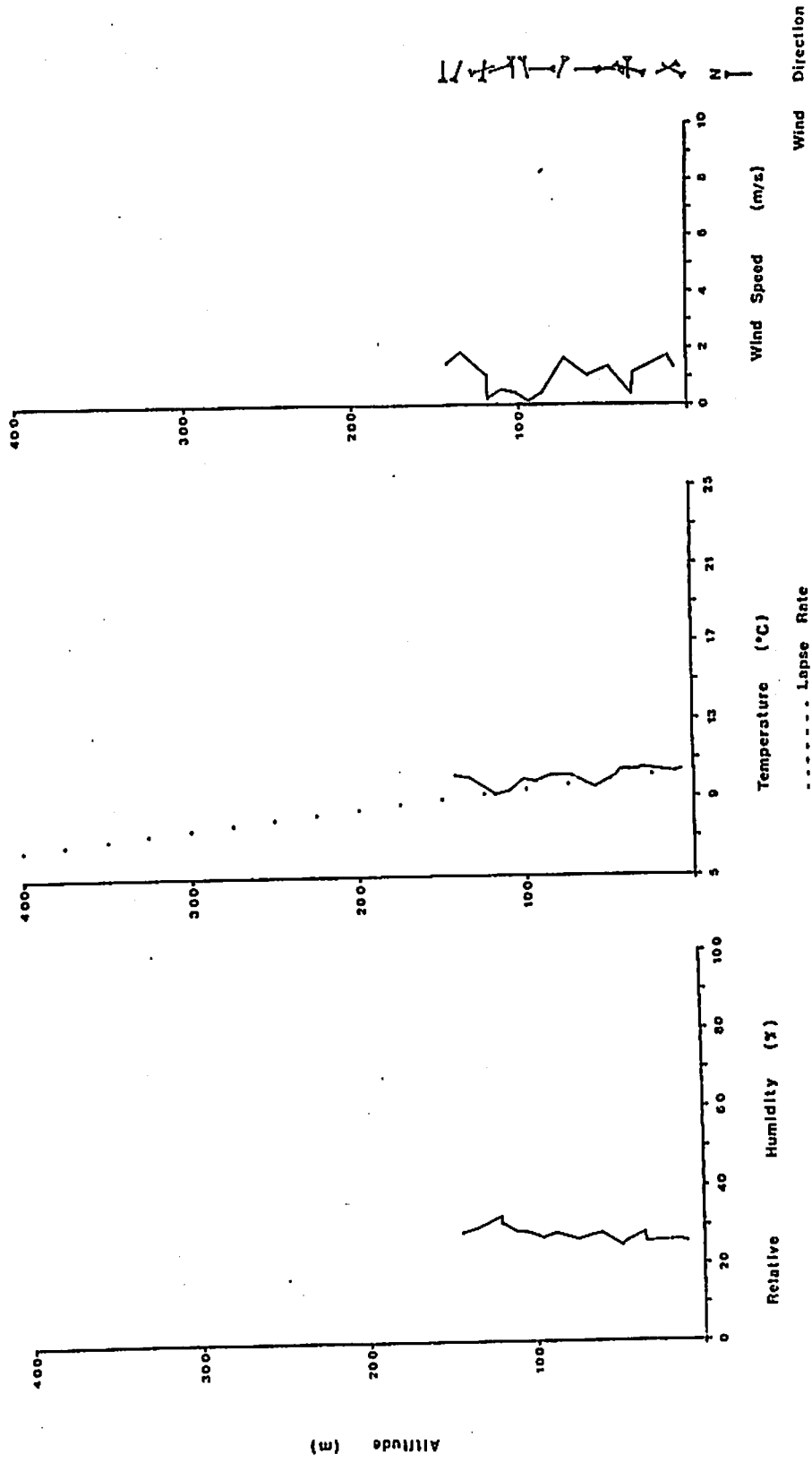


GIJNA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0835
ASCENT

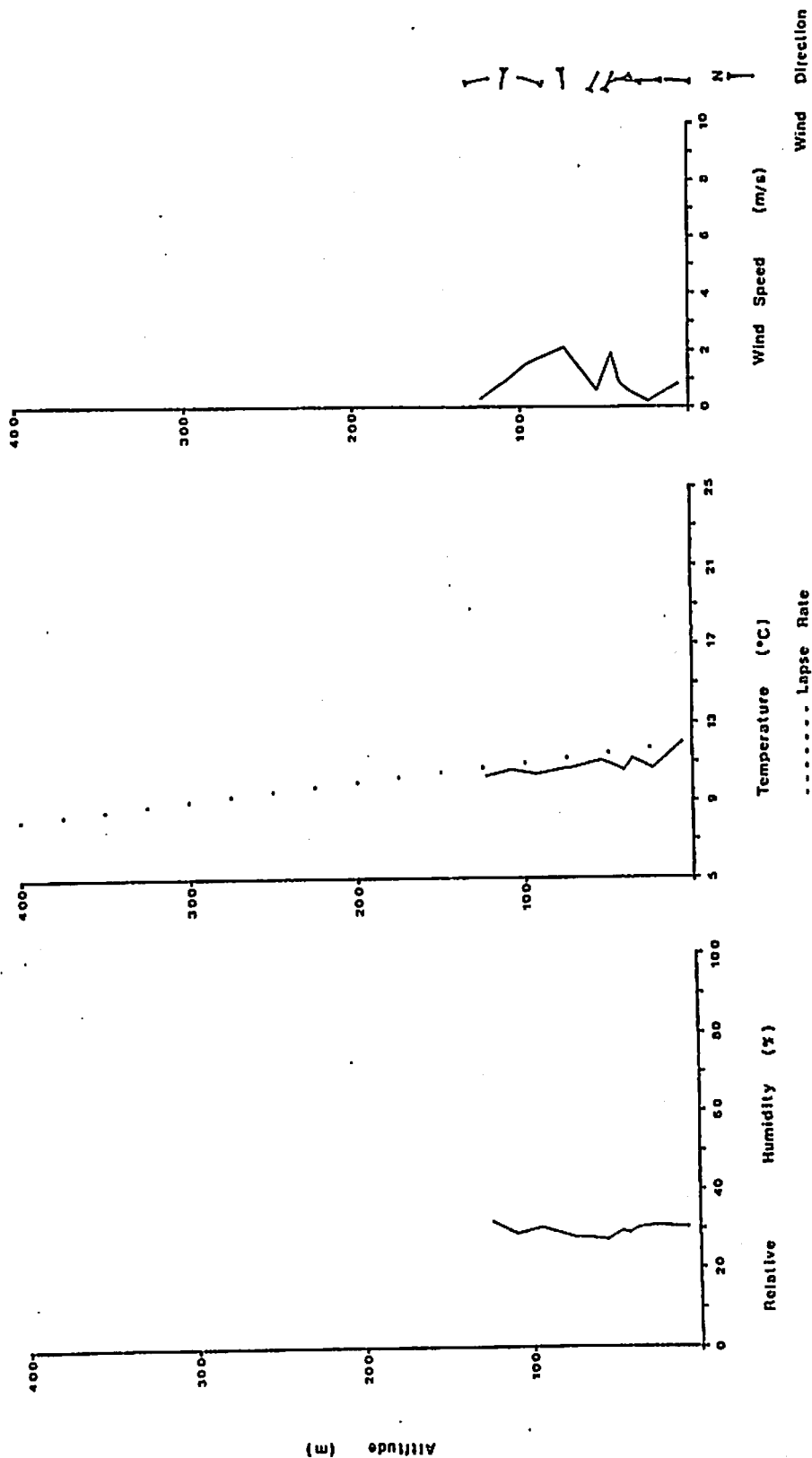


Run # 2

CHENA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0813
DESCENT

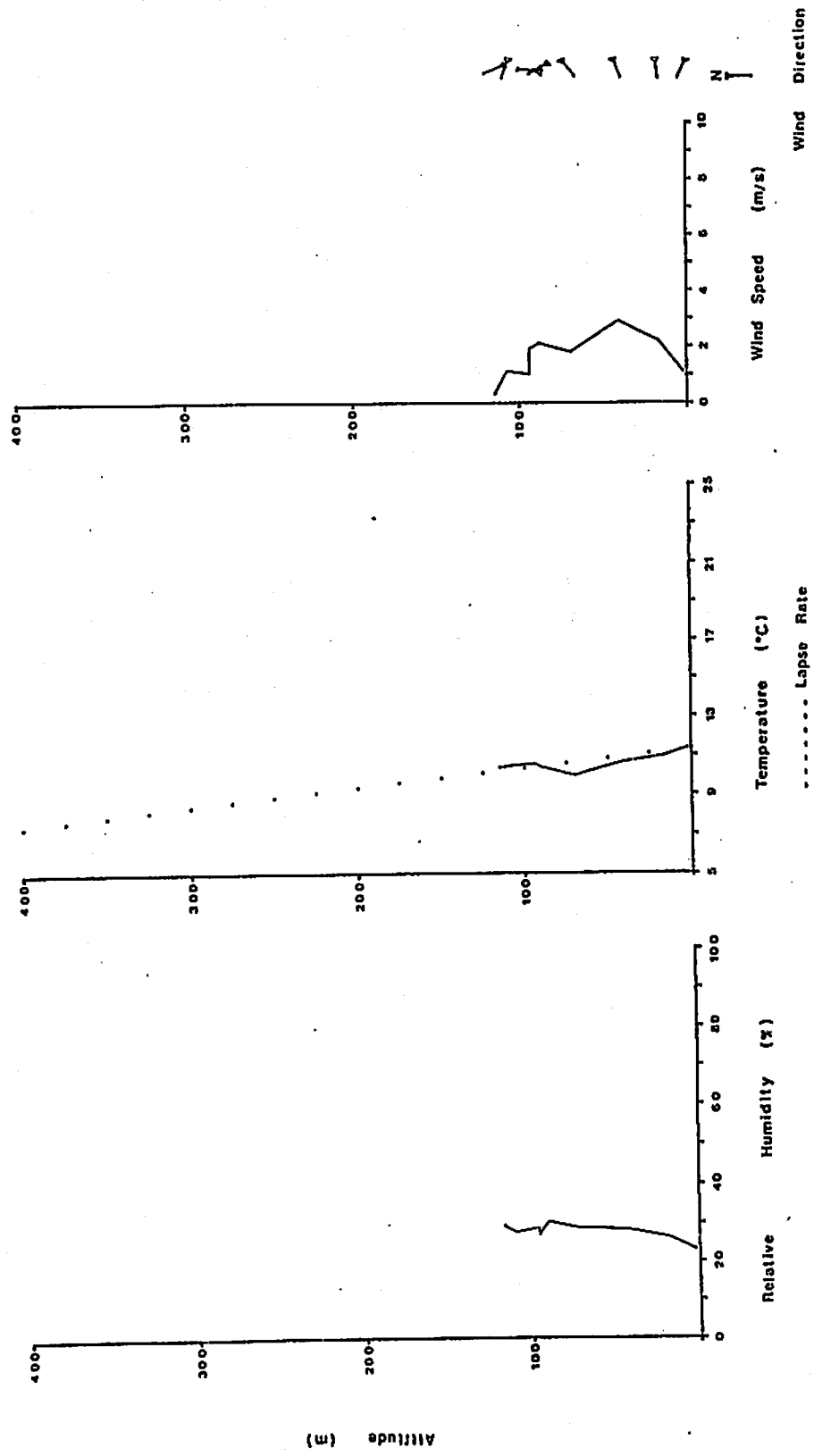


CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0850
ASCENT

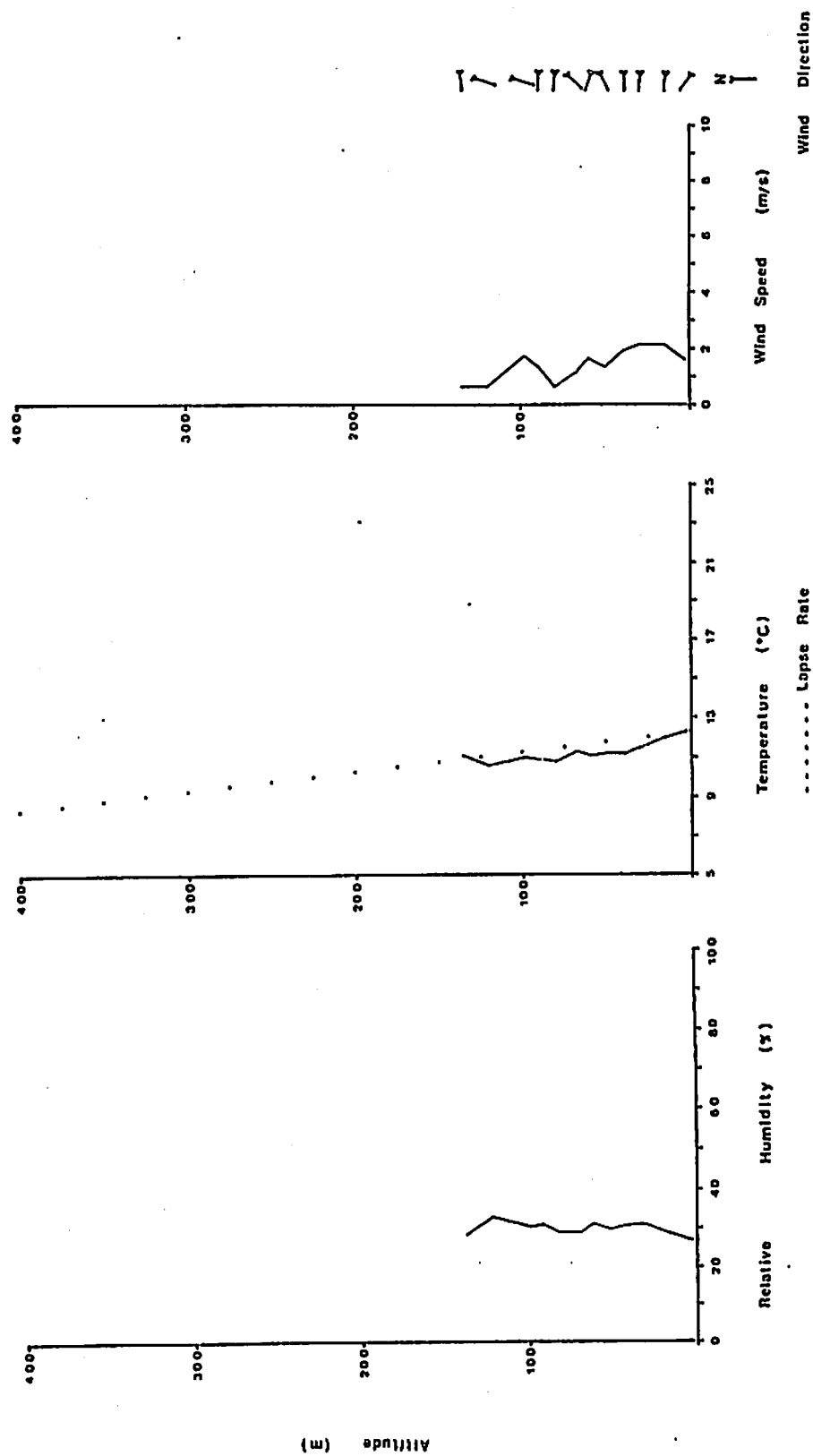


Run # 3

CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0900
DESCENT

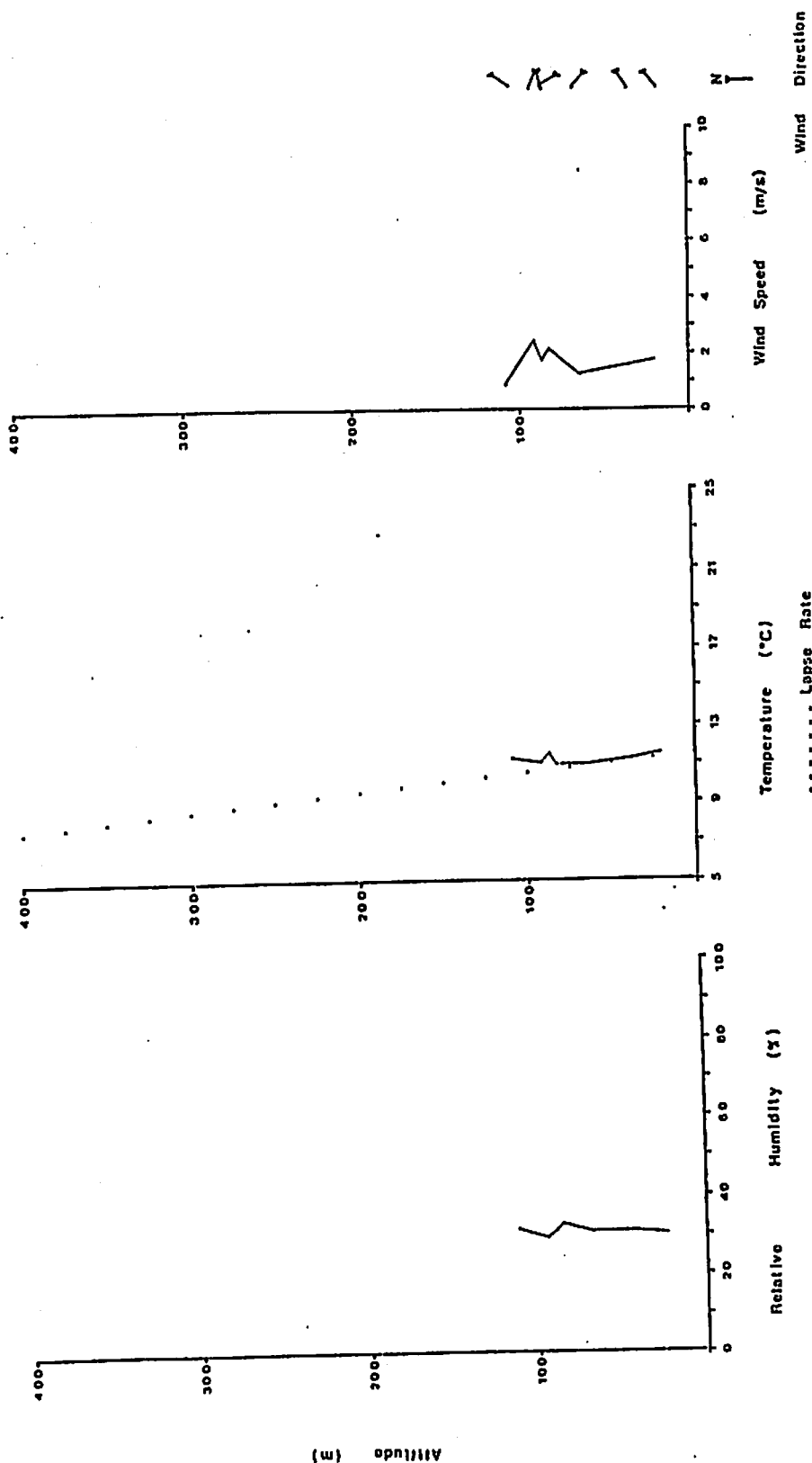


CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0903
ASCENT

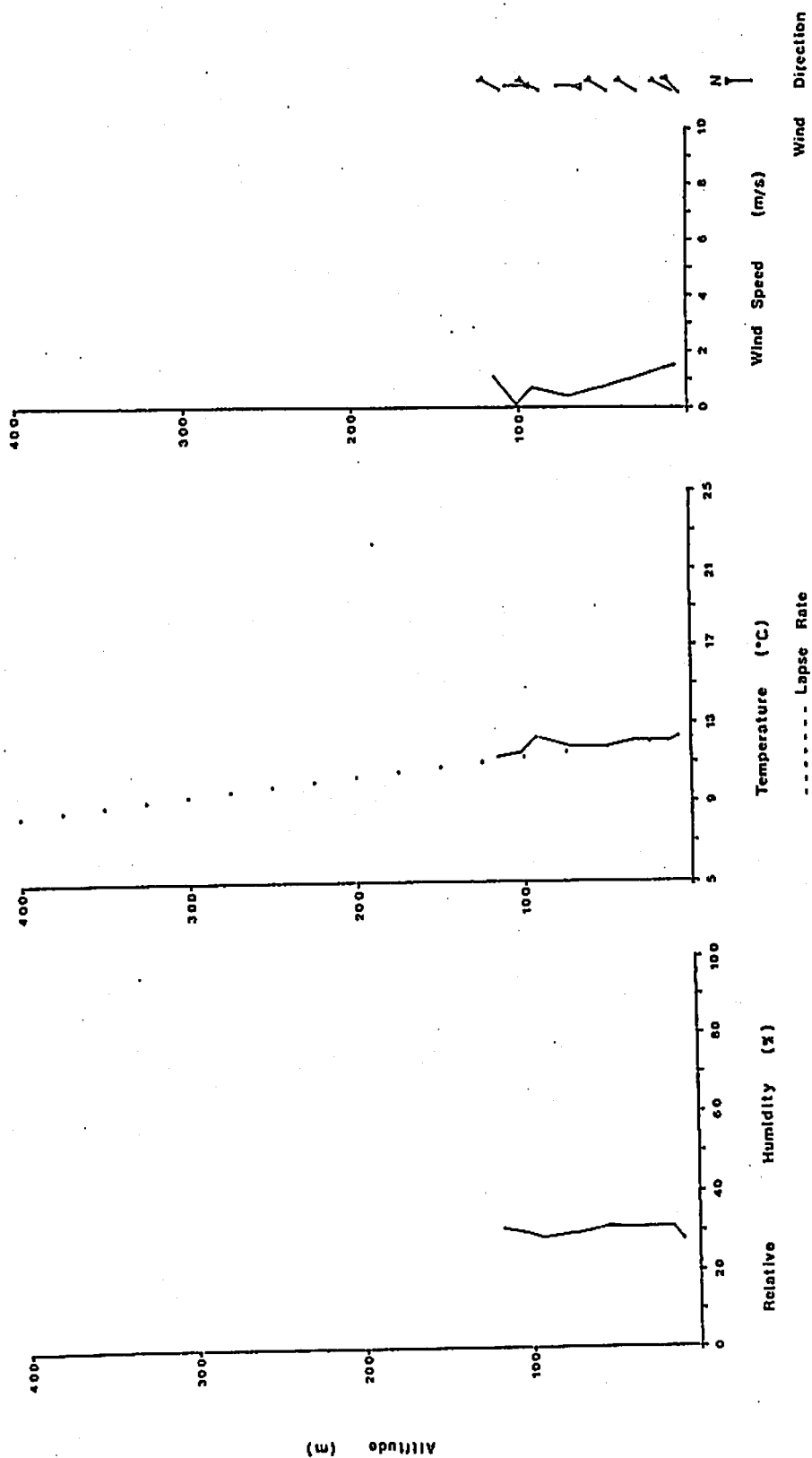


Run # 4

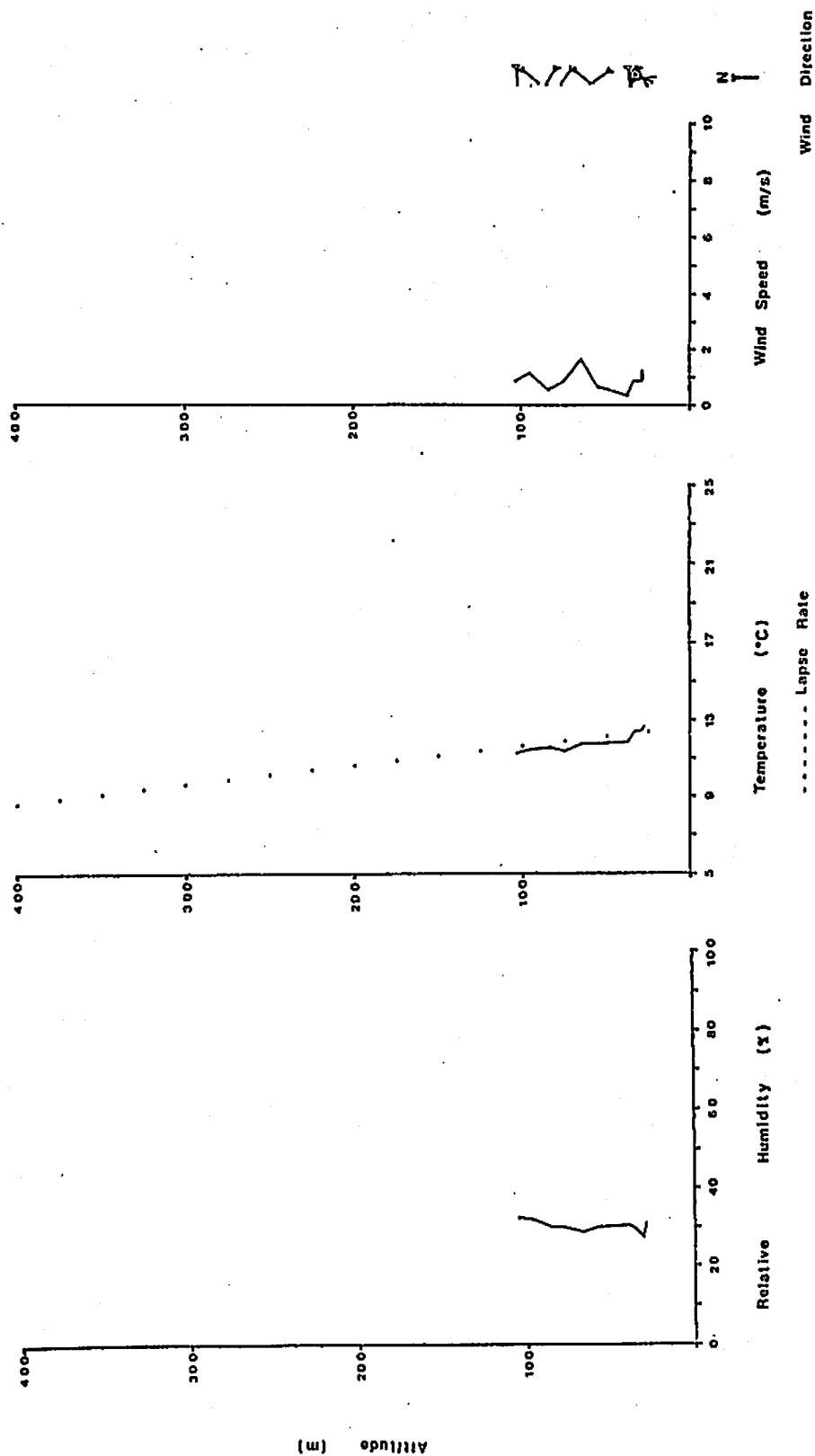
CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0913
DESCENT



CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0917
ASCENT

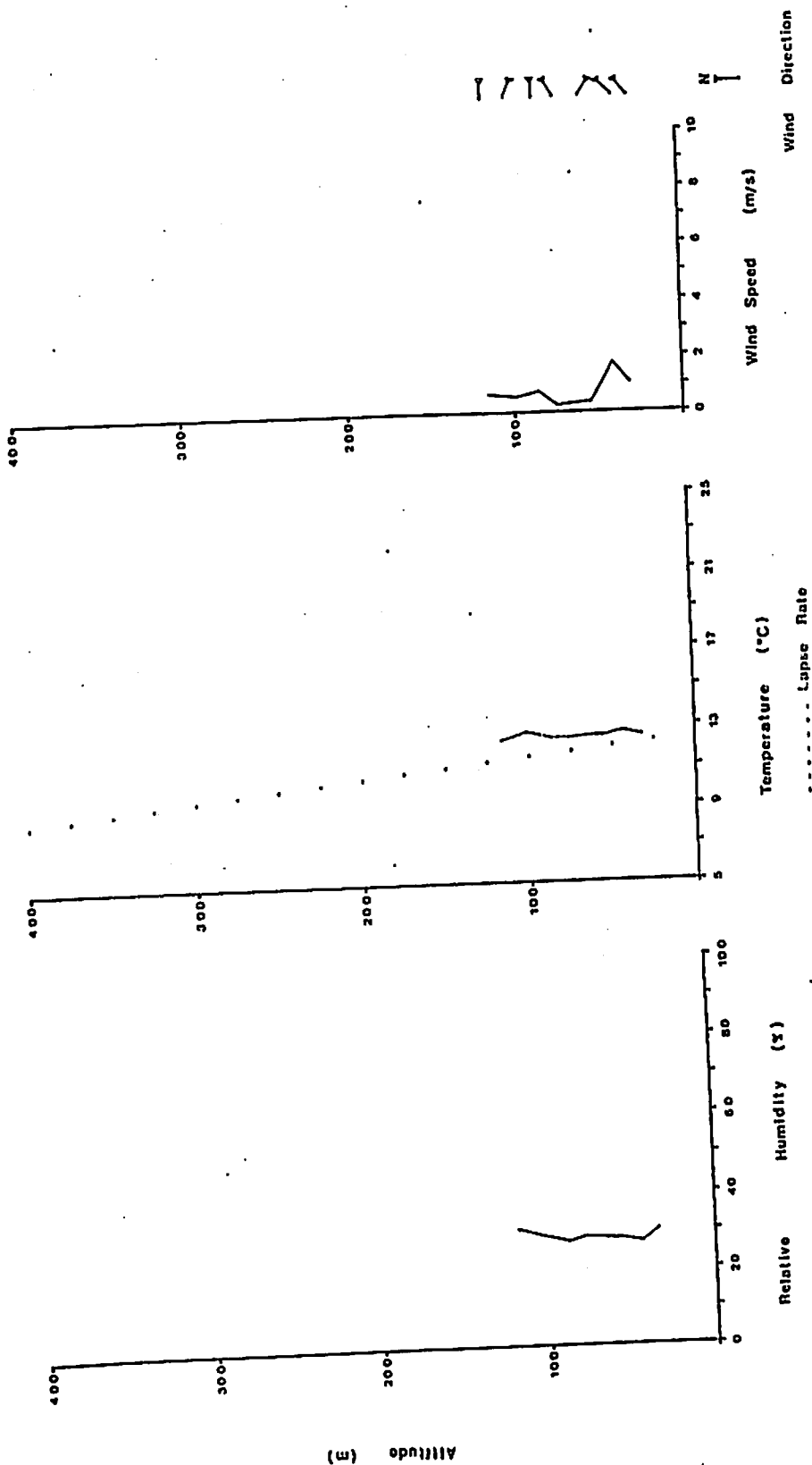


CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0926
DESCENT



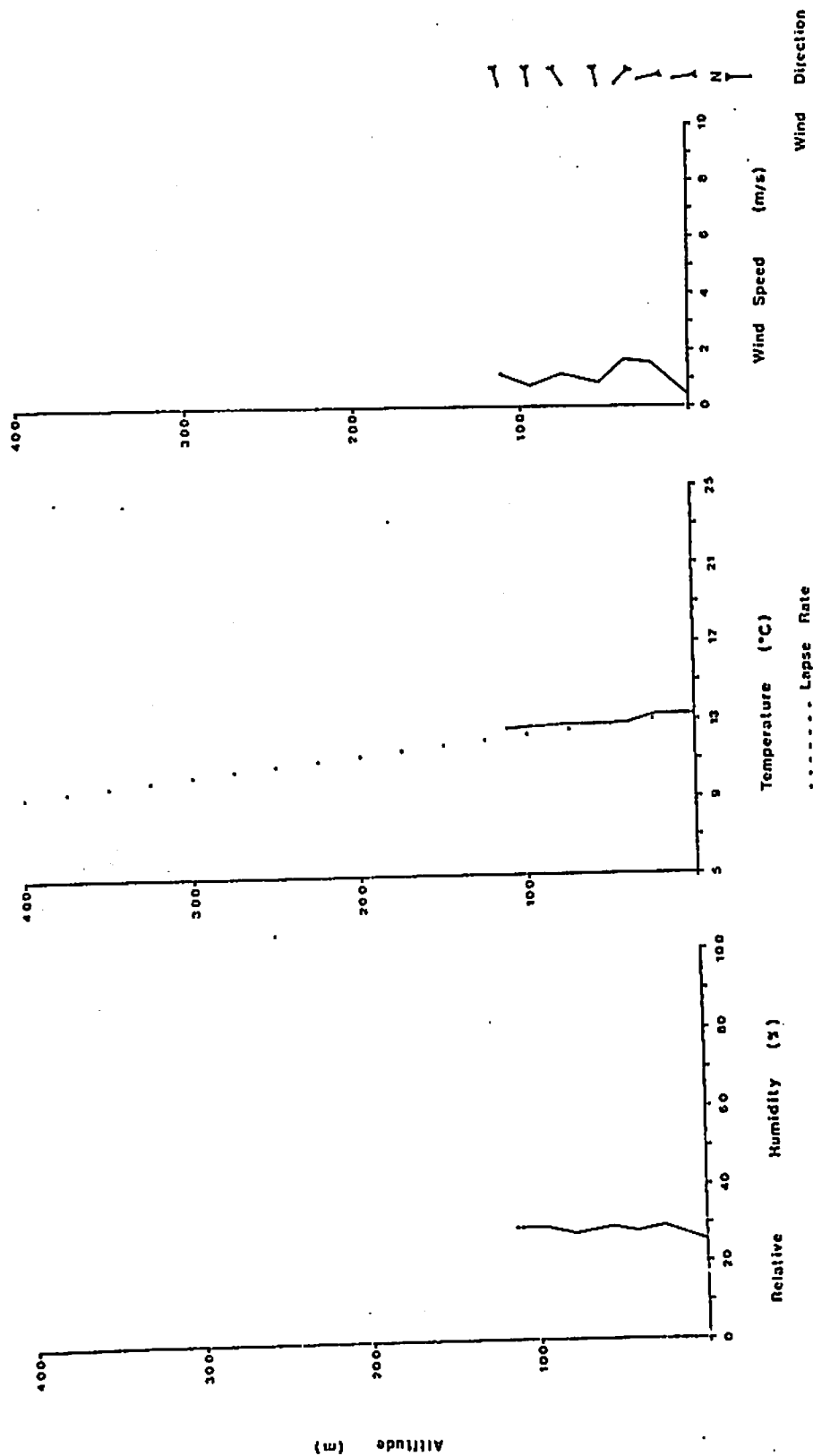
Run # 6

CHINA LAKE, CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0930
ASCENT



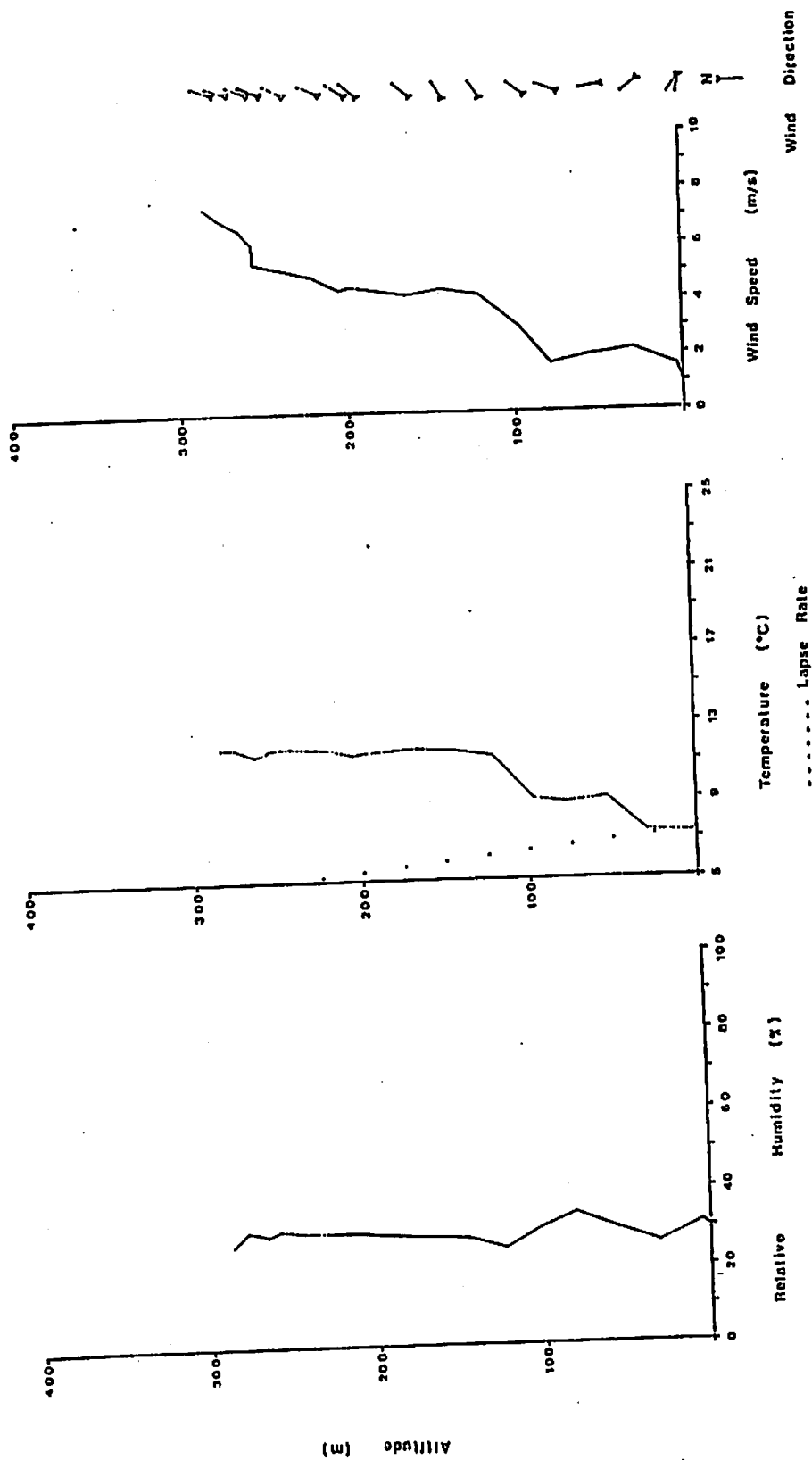
Run # 6

CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-2-79
TIME: 0917
DESCENT



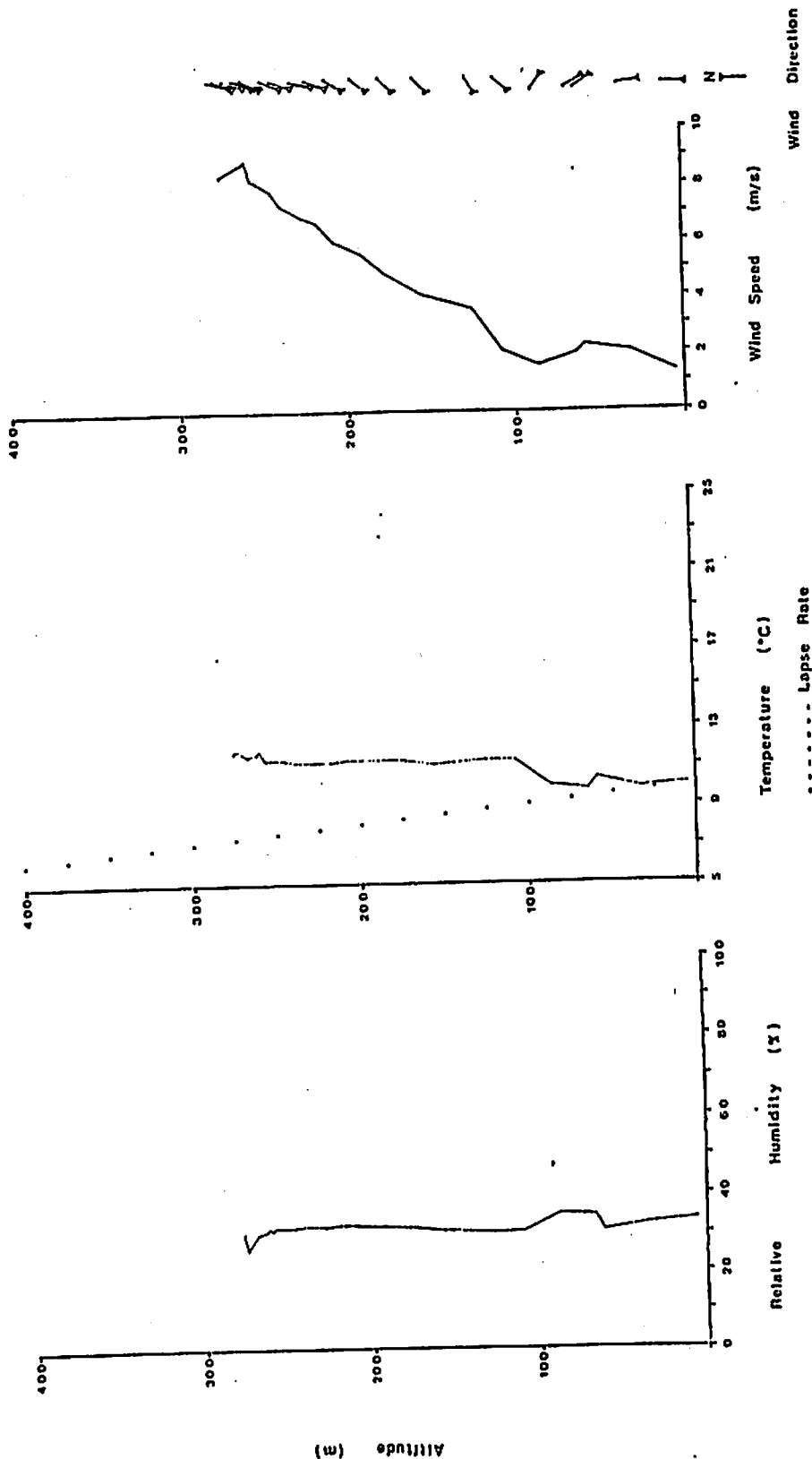
Run # 1

CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-3-79
TIME: 0615
ASCENT



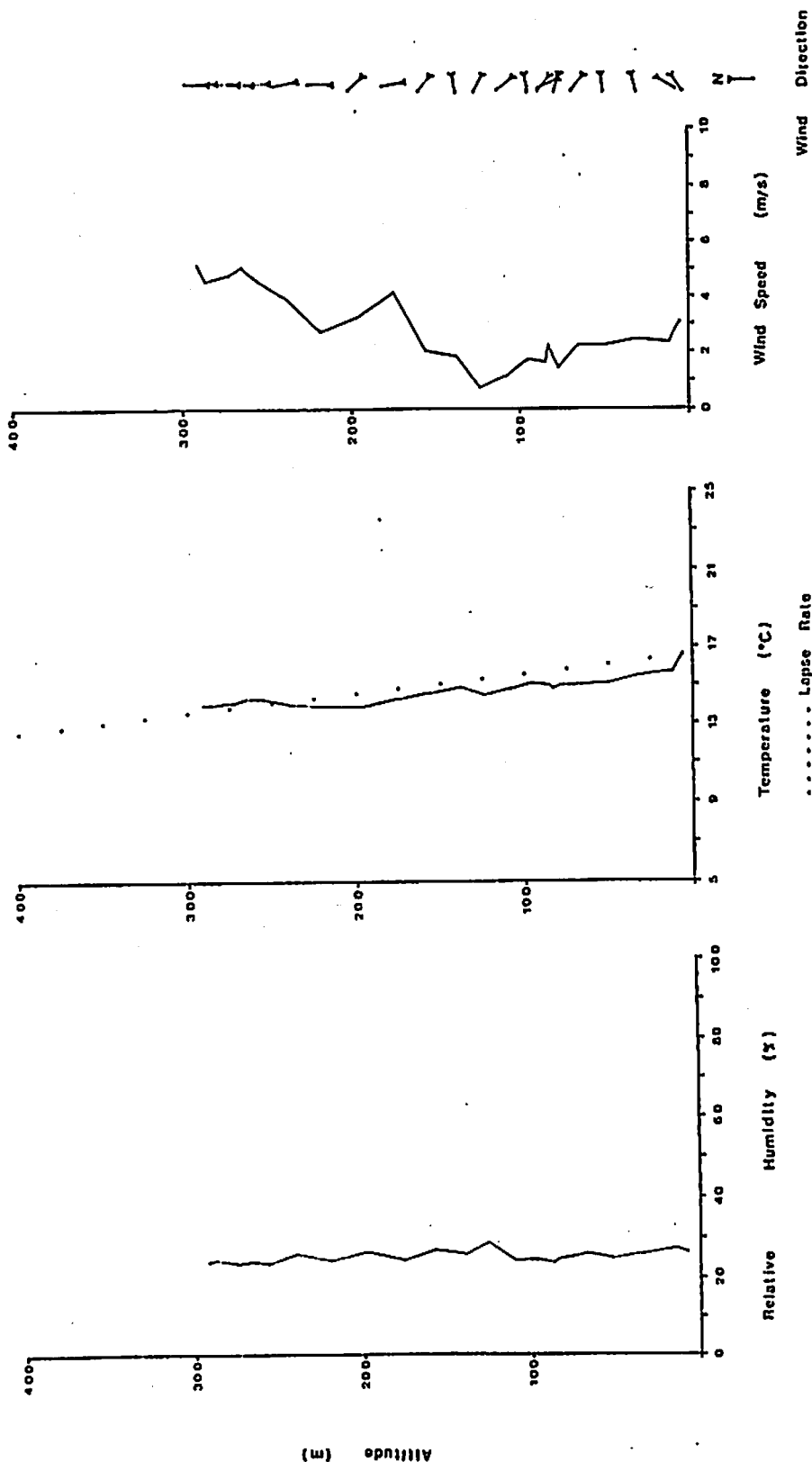
Run # 1

CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-3-79
TIME: 0828
DESCENT

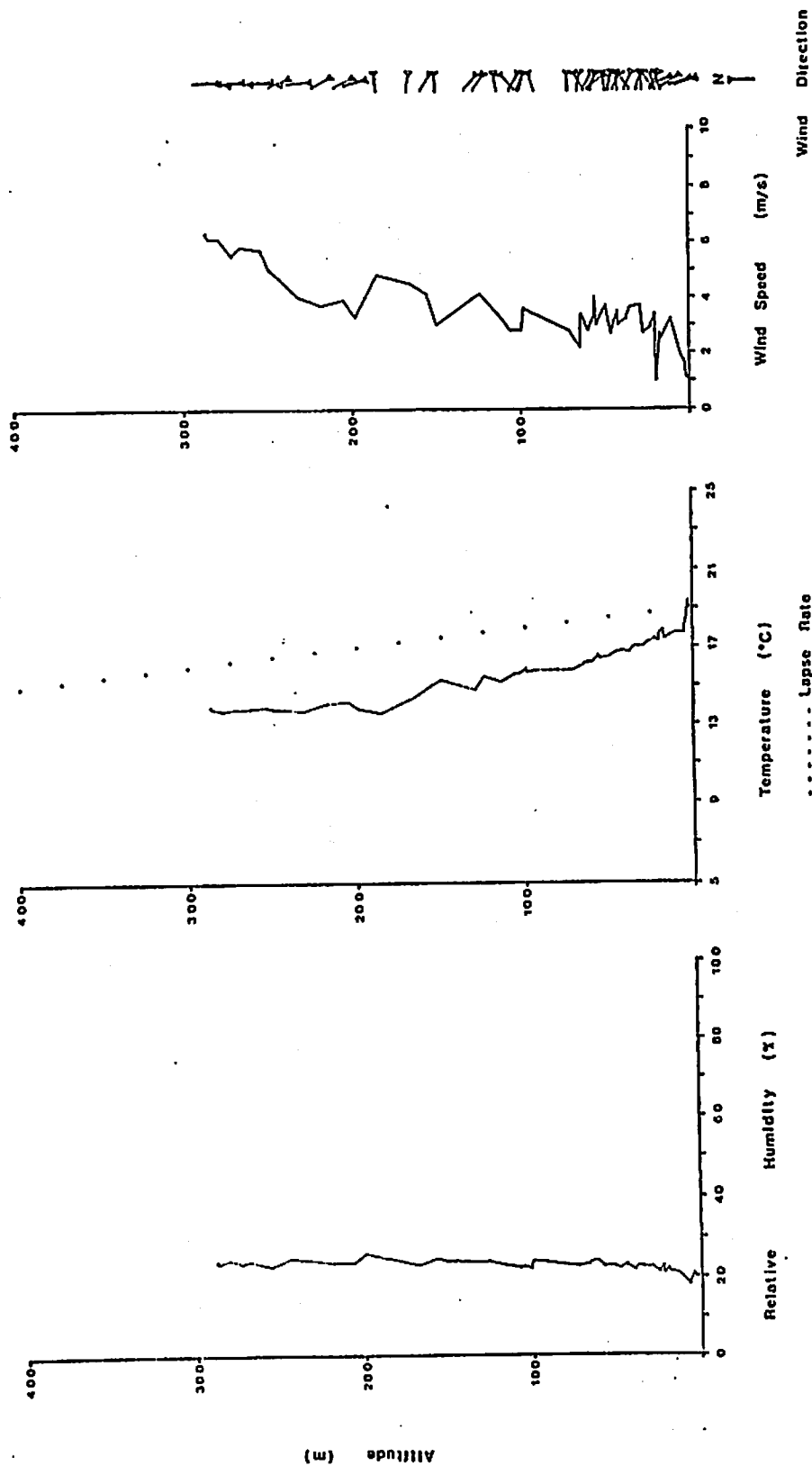


Run # 8

CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-3-79
TIME: 0925
ASCENT



CHINA LAKE CA
TETHERSONDE DATA
DATE: 11-1-79
TIME: 0940
DESCENT



Final Submission

VORTEX WAKE DATA

EDWARDS AIRFORCE BASE

November 1979

Contract #:
DOT-TSC-1811

Submitted to

Department of Transportation
Transportation System Center
Kendall Square
Cambridge, MA 02142

By

AeroVironment, Inc.
145 Vista Avenue
Pasadena, CA 91107



AeroVironment Inc.

145 VISTA AVENUE • PASADENA, CALIFORNIA 91107 • U.S.A. • (213) 449-4392

March 20, 1980

Ian McWilliams
Department of Transportation
Transportation System Center
Kendall Square
Cambridge, MA 02142

REF: Contract No. DOT-TSC-1811

Dear Ian:

Enclosed is the reduced data from our meteorological soundings and photographic measurements of Boeing 747 vortex locations at Edwards Air Force Base on 8 November 1979. The following data is enclosed:

- (1) Plots of vortex trajectories. The coordinate system origin is at our vertical (Camera 2) camera. The aircraft is flying into the paper.
- (2) Tables of the data in the above plots.
- (3) Plots of tethersonde soundings of temperature and winds. Note that the units here are metric, whereas those of the vortex trajectories are English. The Run number refers to the aircraft run number that the data was closest to.
- (4) Sketches of the equipment layout on each test day.

The side camera (Camera 1) malfunctioned during the test. We collected an entire run (run # 7) from an 8mm movie shot directly behind camera 1. We enlarged the film to 16mm and enclosed it along with the original slides from both the China Lake and Edwards Airforce Base experiments.

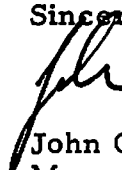
To estimate turbulence from lapse rate, Ivar made crude estimates based on the Richardson number of flow between 50 and 100 m AGL.

LTR: pg. 2

Date	Run #	$\epsilon^{1/3}$ (cm ^{2/3} s ⁻¹) (Estimate for h=50-100 m AGL)
11/8	1	< 1
11/8	3	< 1
11/8	4	< 1
11/8	5	< 1
11/8	6	1-2
11/8	7	1-2
11/8	8	1-2

This completes our obligation for the Edwards Air Force Base experiment.
Please call if you have any questions.

Sincerely,



John G. Blair
Manager of Data Processing

JGB:ct
Encl.

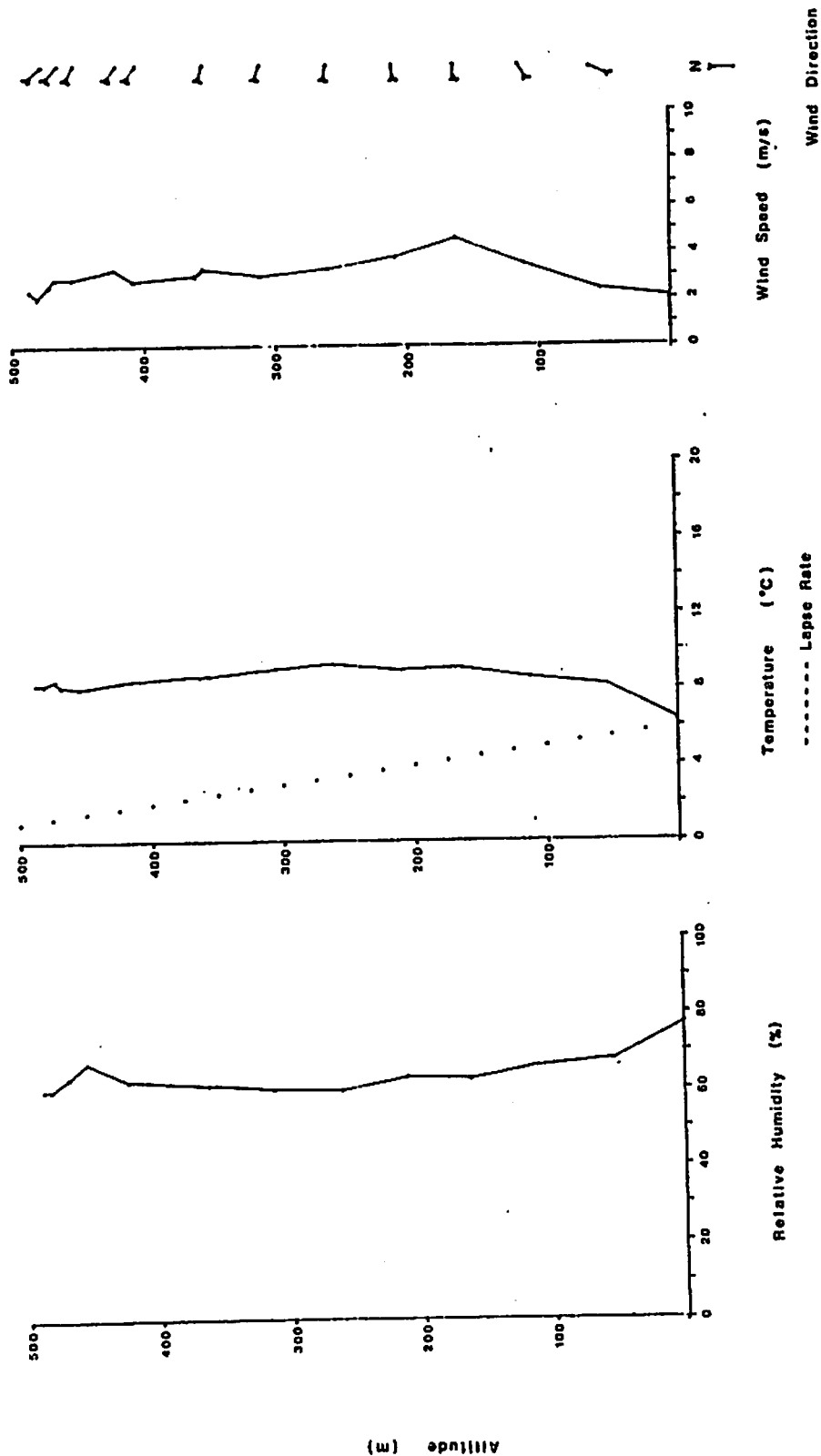
TETHERSONDE DATA

DATE: 11-8-79

TIME: 0700

Run #: 1

Ascent



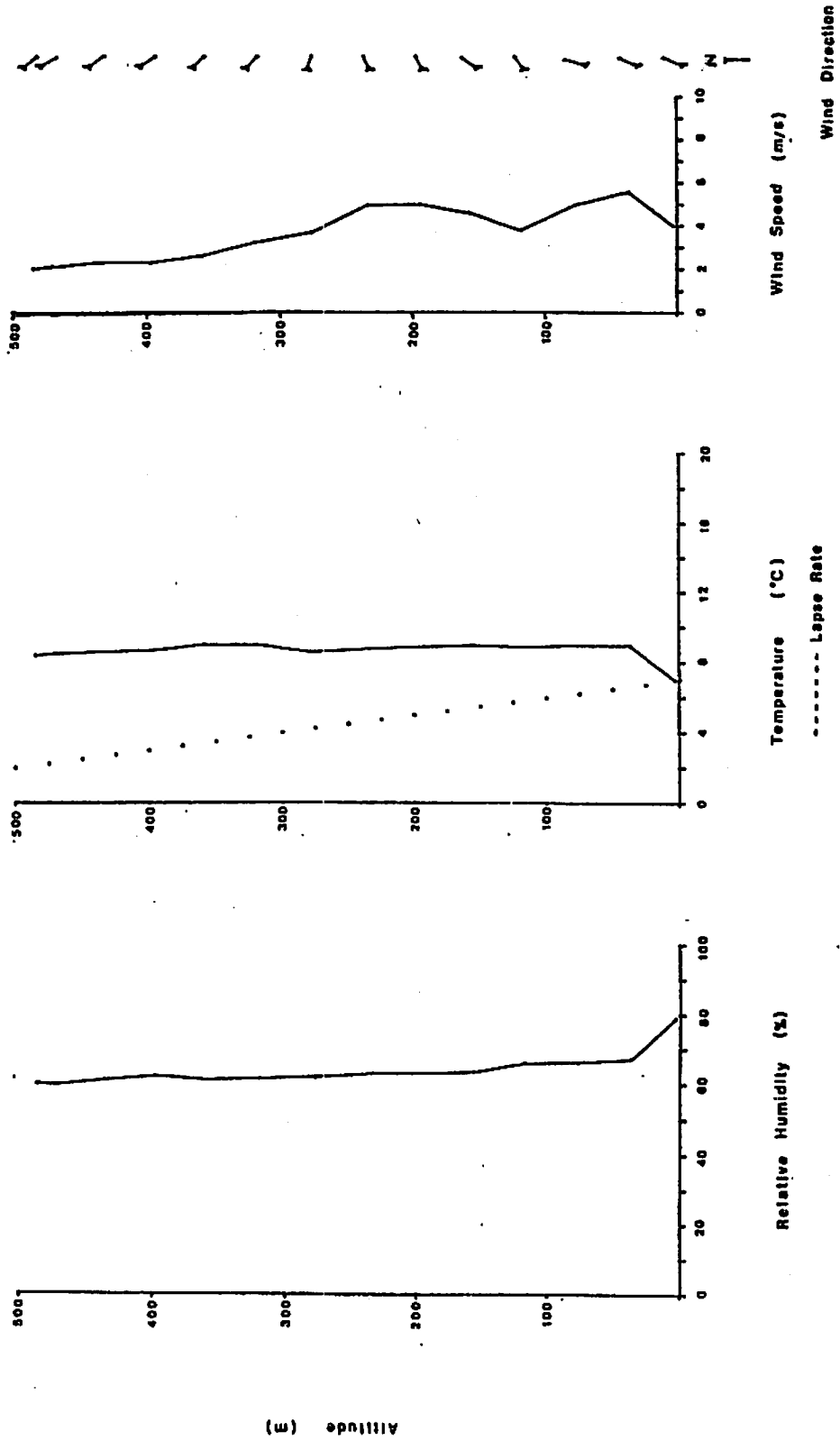
TETHERSONDE DATA

DATE: 11-3-79

TIME: 0713

Run #: 1

Descent



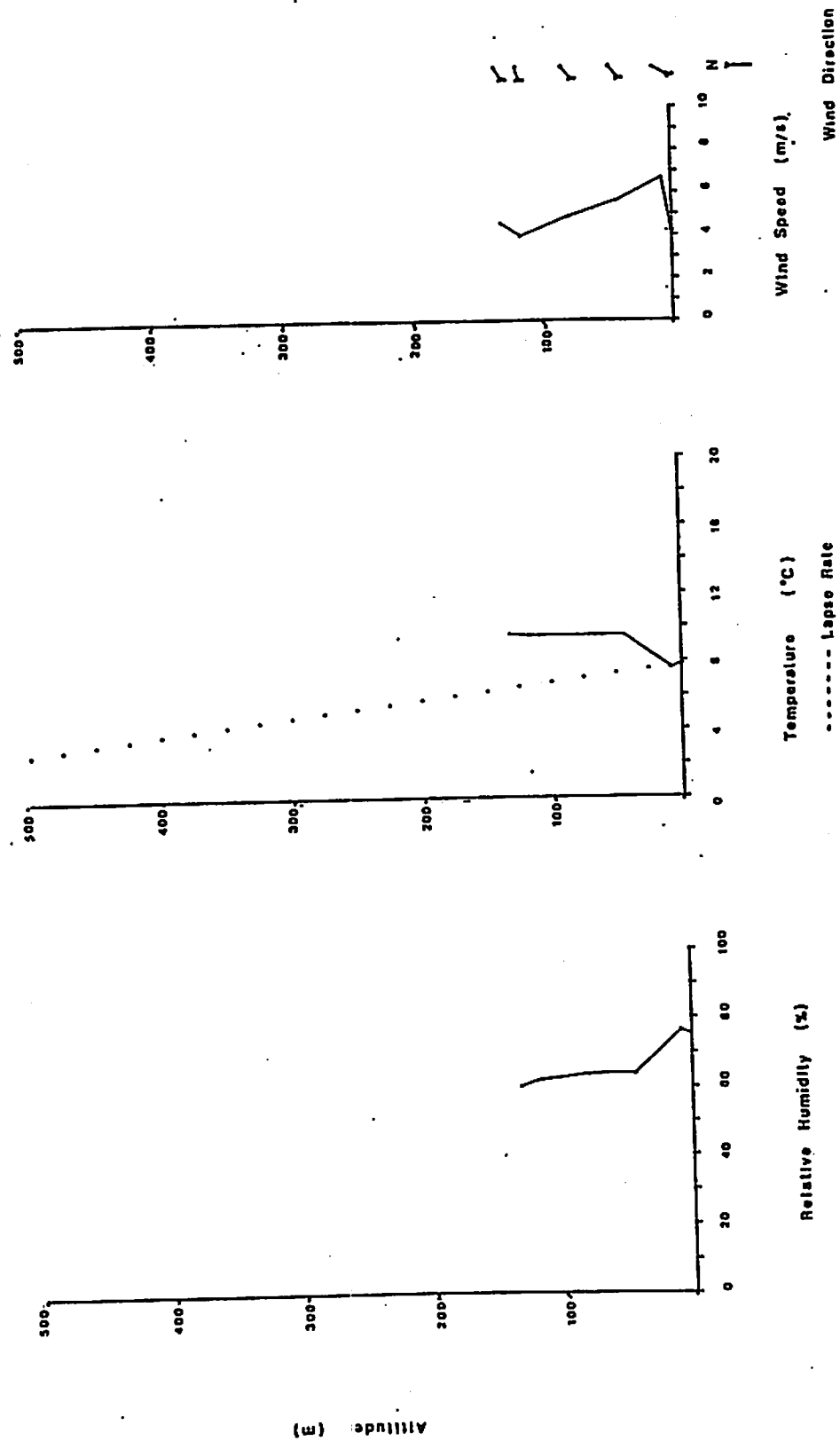
TETHERSONDE DATA

DATE: 11-8-79

TIME: 0712

Run #: 3

Ascent



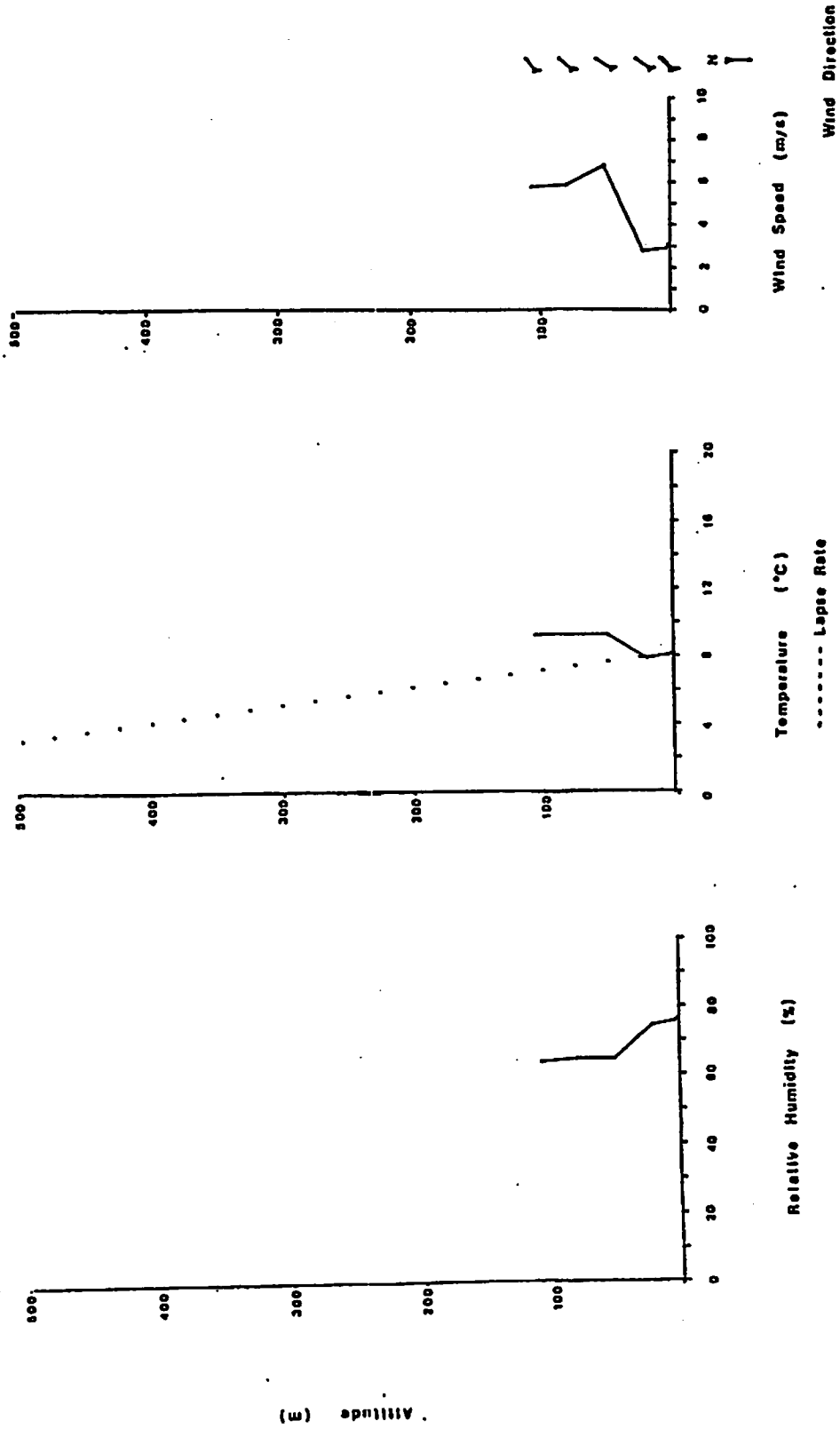
TETHERSONDE DATA

DATE: 11-6-79

TIME: 0734

Run #: 3

Descent

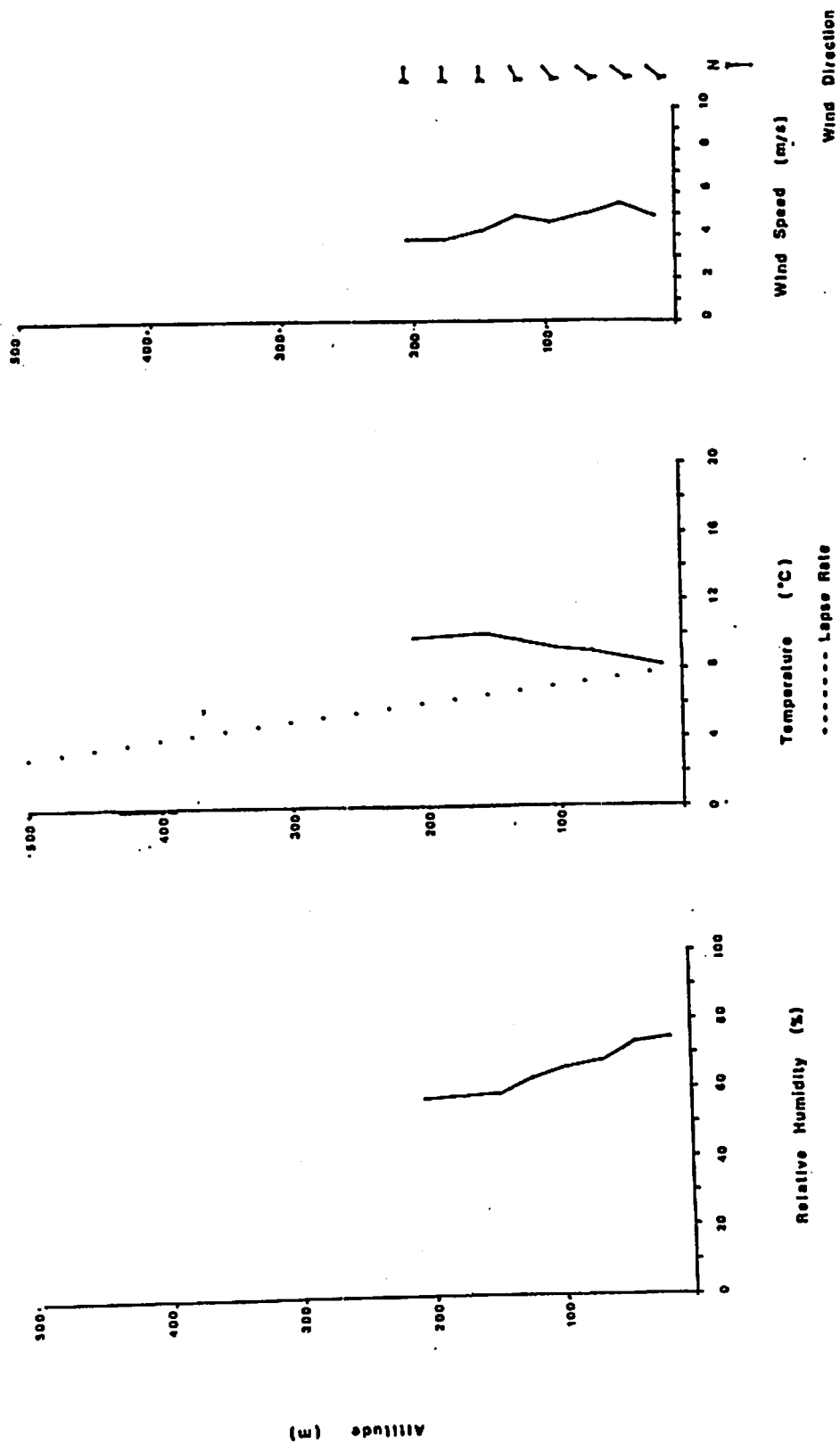


TETHERSONDE DATA

DATE: 11-8-79

TIME: 0746

Run #: 4
Ascent

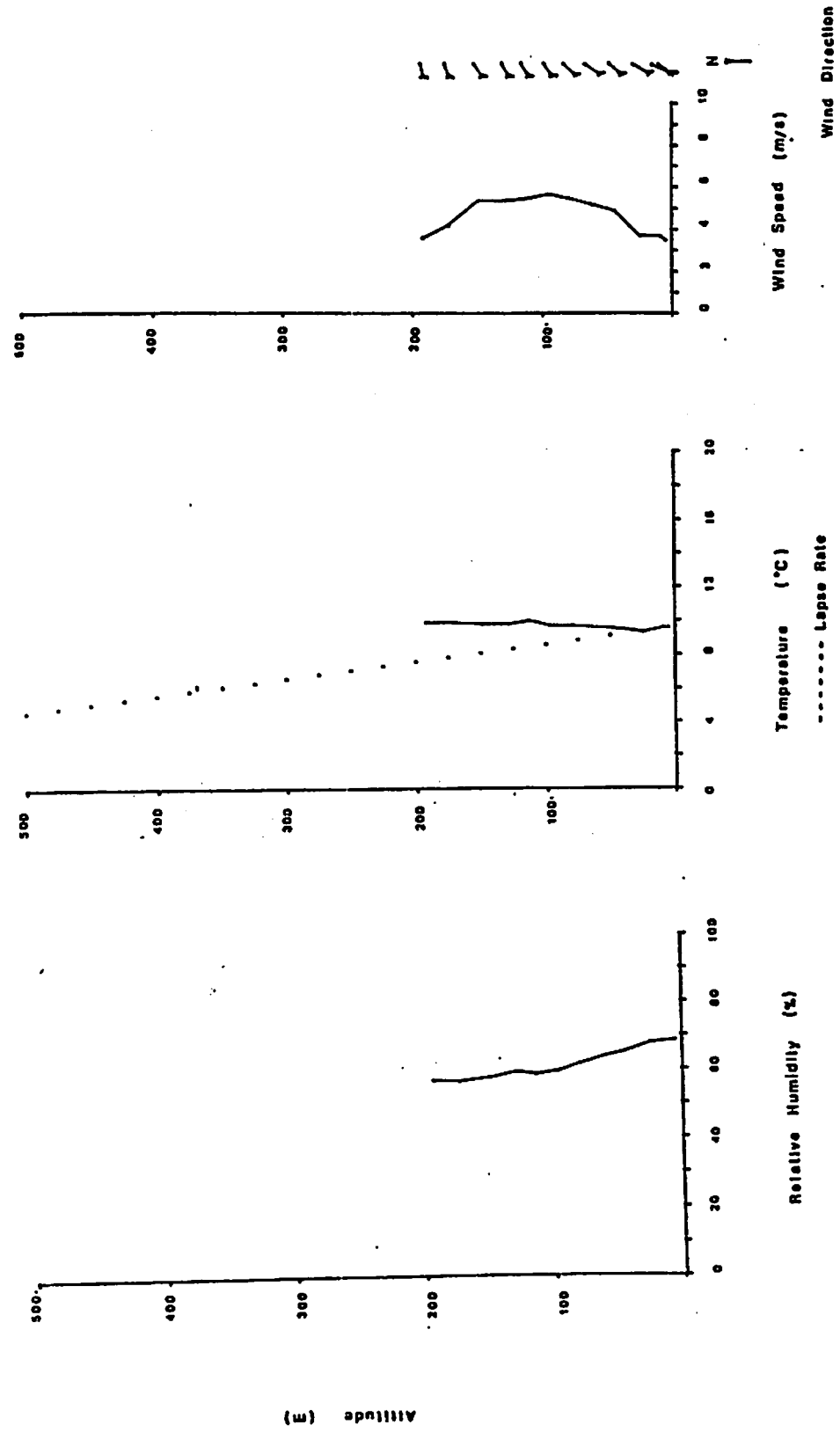


TETHERSONDE DATA

DATE: 11-5-79

TIME: 0751

Run # 4
Descent

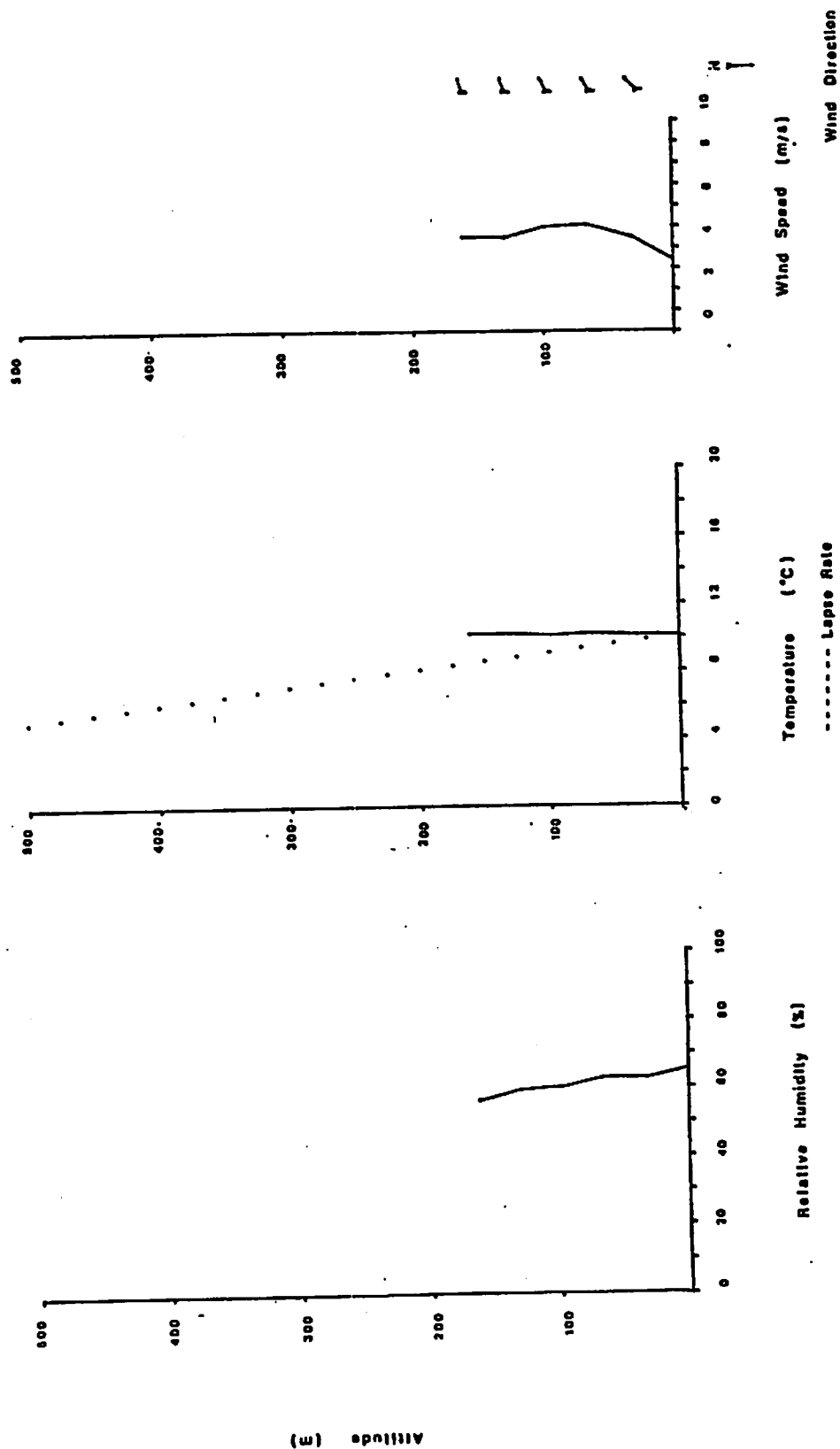


YETHERSONDE DATA

DATE: 11-8-79

TIME: 0802

Run #: 5
Ascent



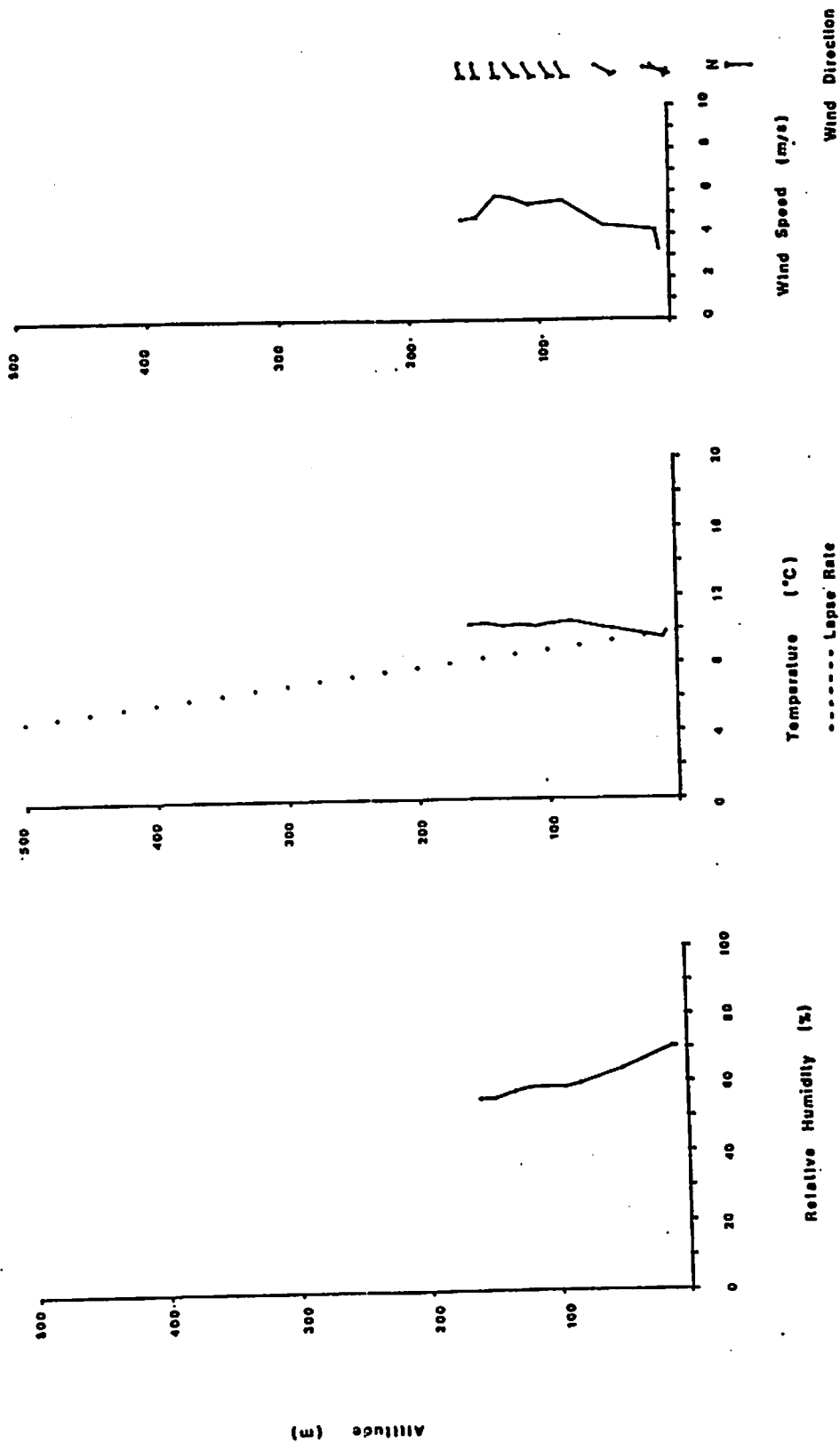
TETHERSONDE DATA

DATE: 11-5-79

TIME: 0307

Run #: 5

Descent



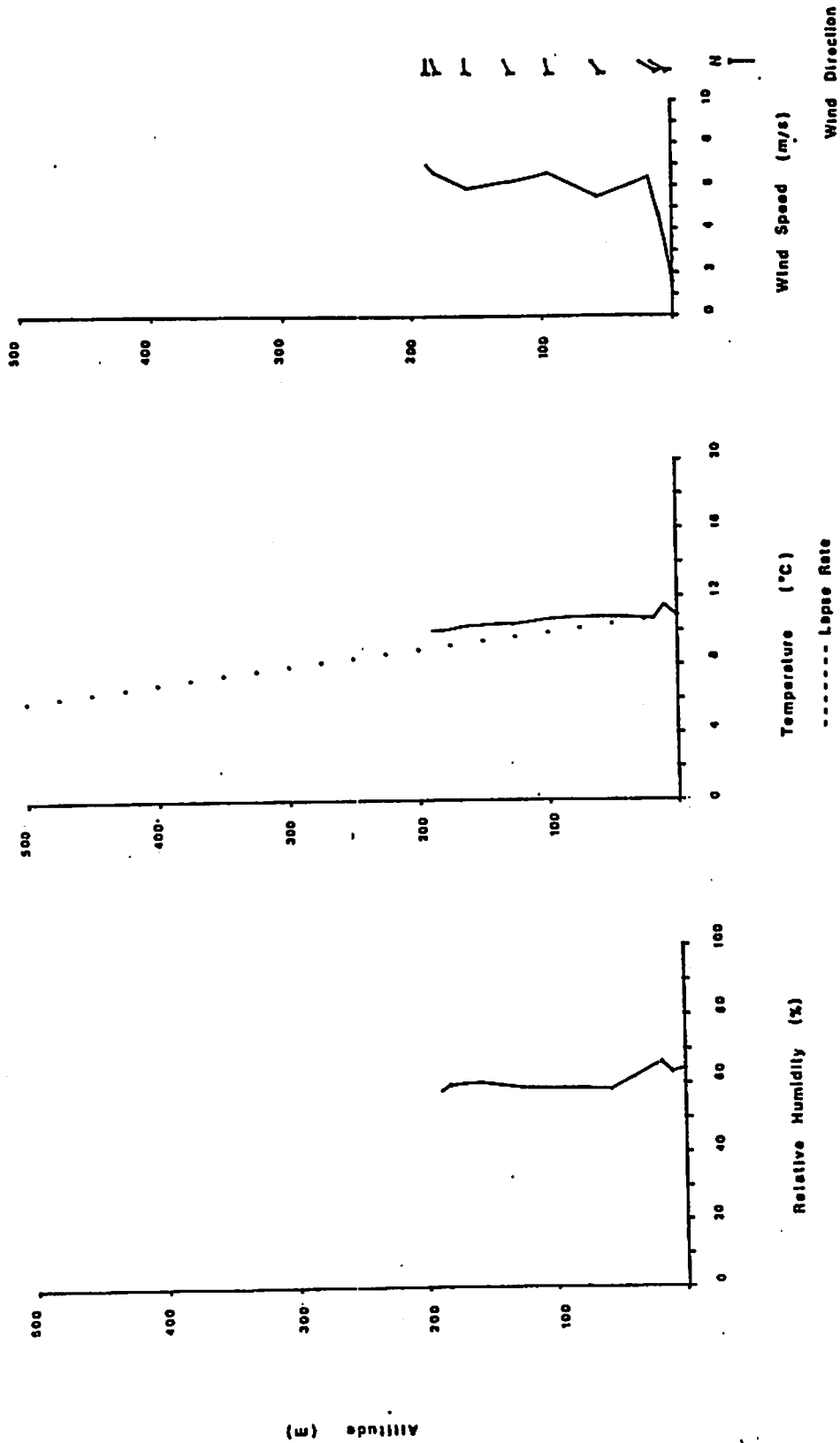
TETHERSONDE DATA

DATE: 11-8-79

TIME: 0816

Run #: 6

Ascent



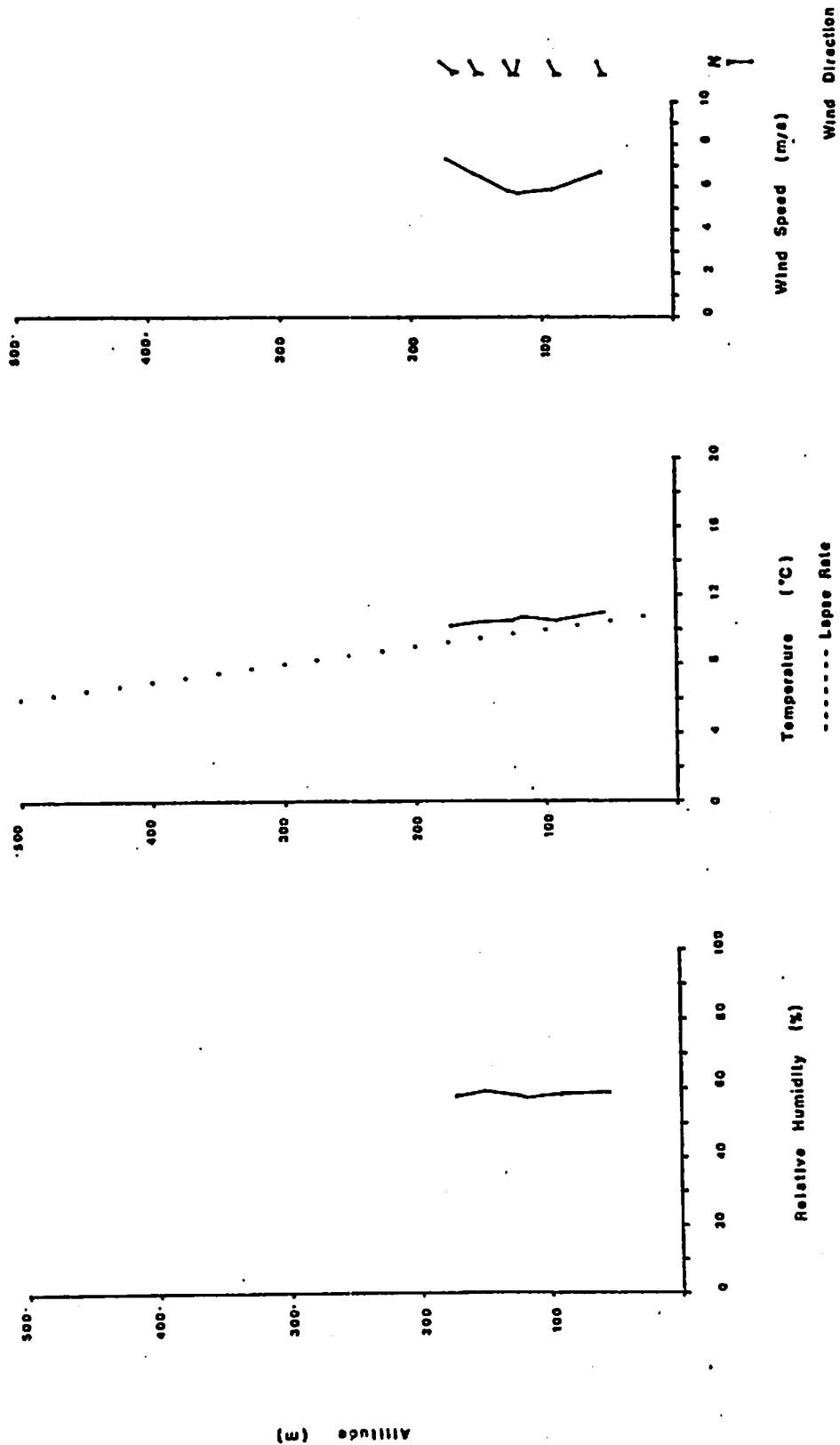
YETHERSONDE DATA

DATE: 11-8-79

TIME: 0321

Run #: 6

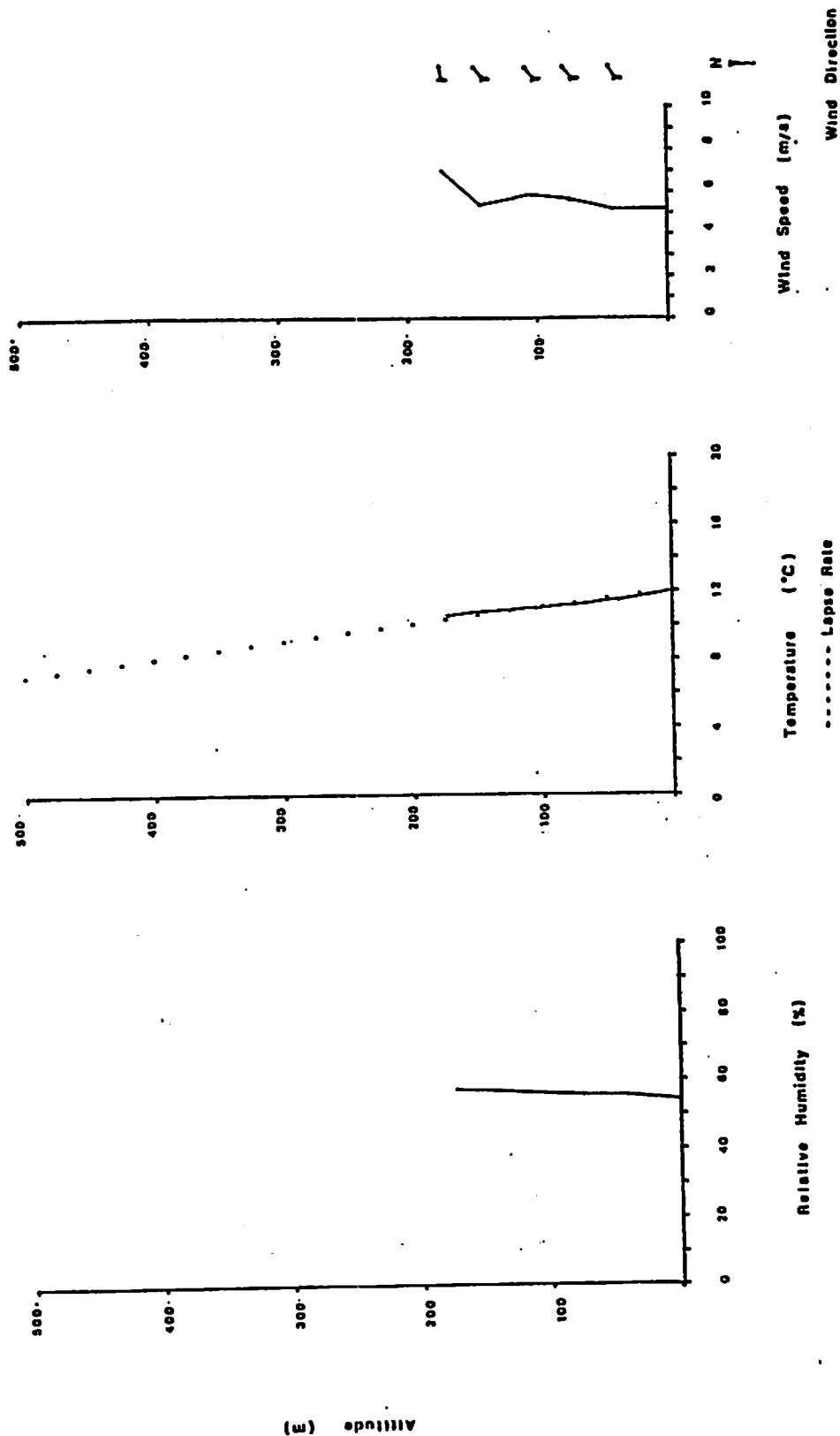
Descent



TETHERSONDF DATA

DATE: 11-8-75
TIME: 0829

Run #1: 7
Ascent

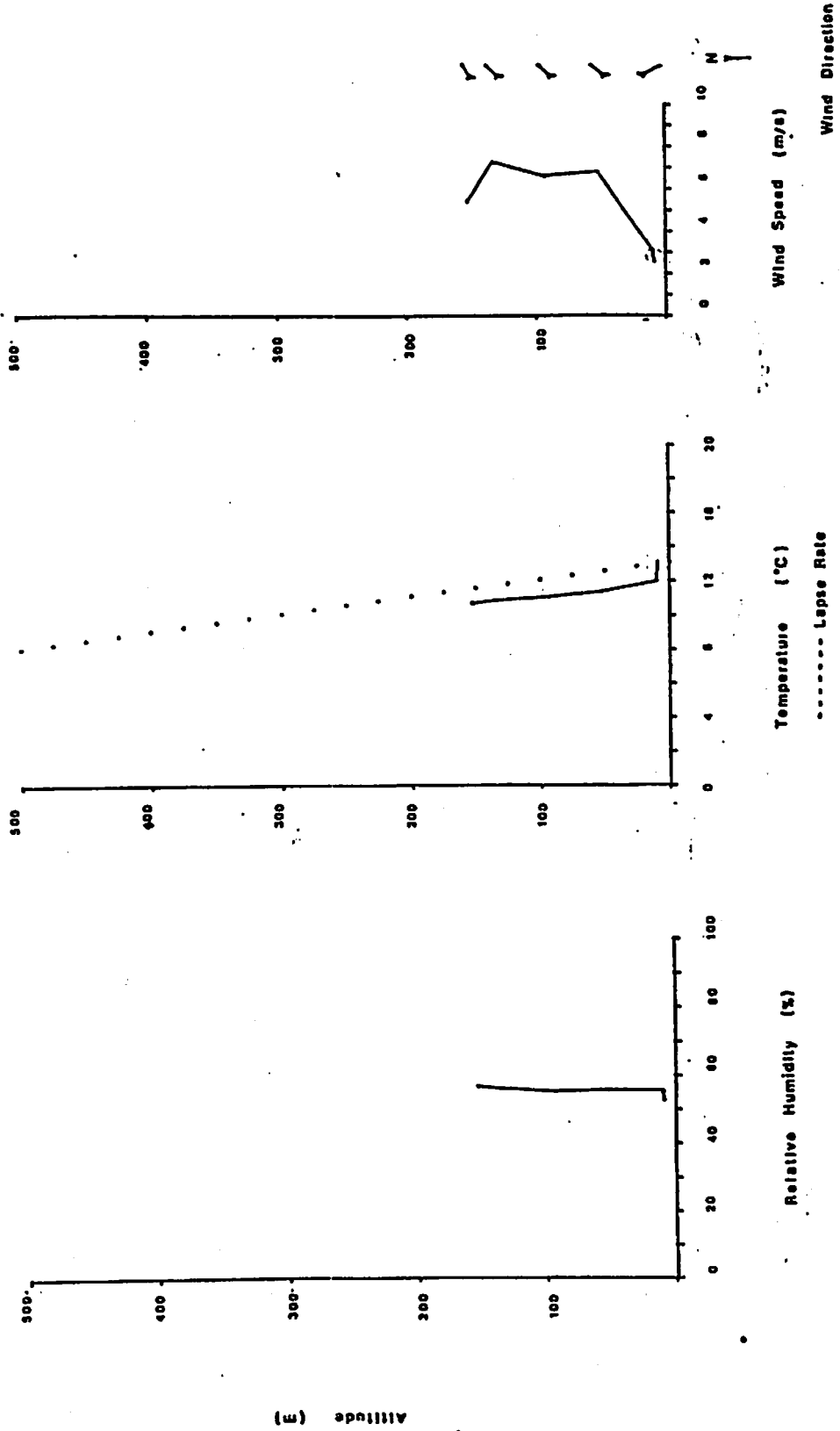


TEYHERSONDE DATA

DATE: 11-8-79

TIME: 0834

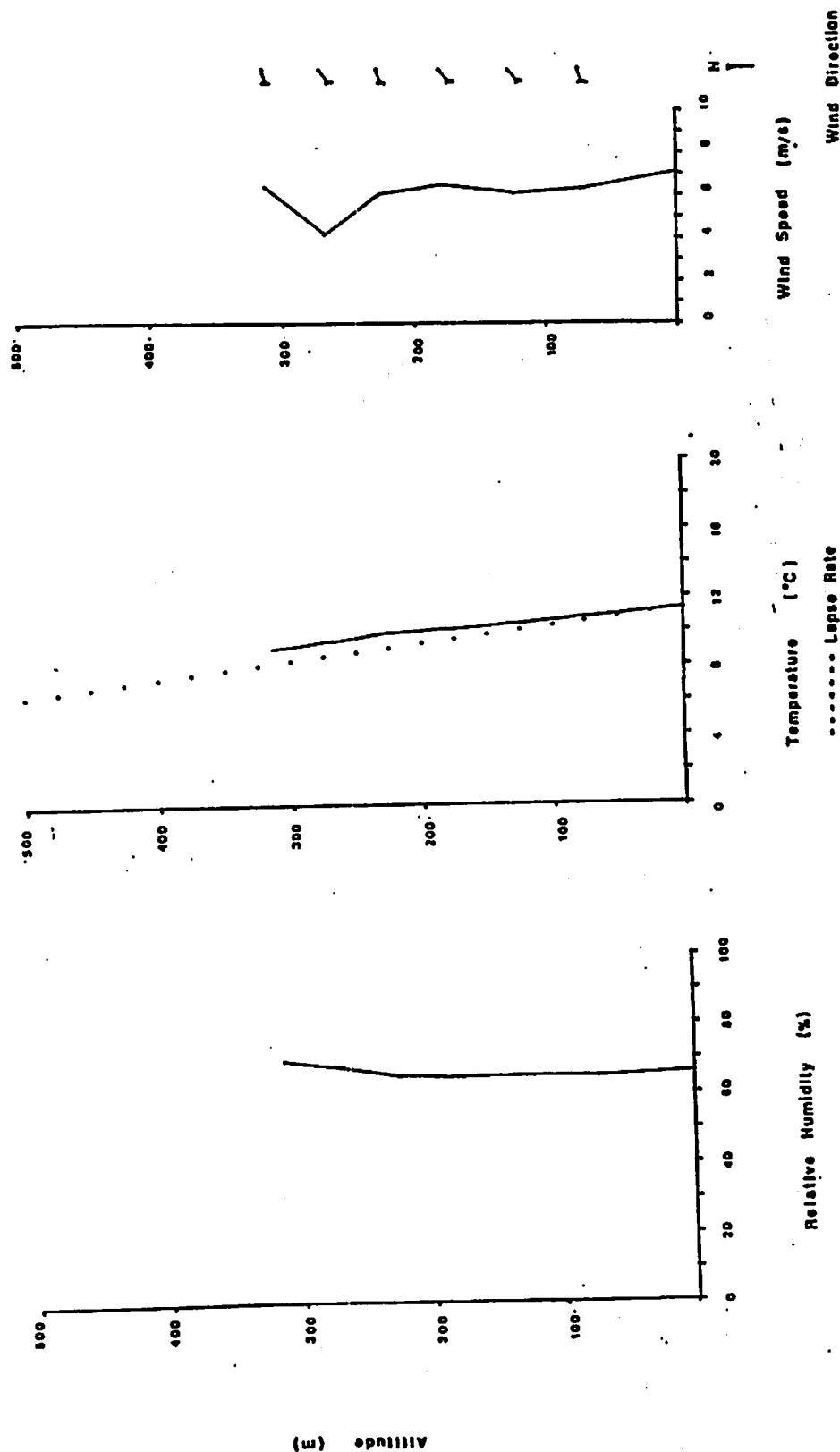
Run #: 7
Descent



TETHERSONDE DATA

DATE: 11-8-79
TIME: 0344

Run #: 8
Ascent



TETHERSONDE DATA

DATE: 11-8-79

TIME: 0852

Run #: 8

Descent

