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**A COMPILATION OF  
OBSERVATIONS FROM MOORED  
CURRENT METERS**

Volume XI

Currents, Temperature and Pressure  
in the Drake Passage During  
F Drake 76

February 1976-January 1977

by  
F. Sciremammano, Jr.  
R. D. Pillsbury  
J. S. Bottero  
R. E. Still

Data Report 68

Reference 78-2

March 1978

National Science Foundation  
Grant No. OCE 74-12558 A02

School of Oceanography  
Oregon State University  
Corvallis, Oregon 97331

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### Abstract

Self-recording instruments were installed in Drake Passage in February 1976 and recovered in January 1977. The instrument array consisted of eleven Aanderaa current meters on seven moorings and two tide gauges. The data were sampled at one hour intervals.

In this report the measurements are summarized through pertinent statistics, progressive vector diagrams, real time plots, stick figures, and rotary spectra.

## TABLE OF CONTENTS

Introduction . . . . .	1
The Current Meter Program . . . . .	1
Description of the Processed Data . . . . .	5
Acknowledgments . . . . .	6
References . . . . .	6
Installations	
Diana . . . . .	11
Ann . . . . .	25
Seventy-Six . . . . .	41
Nineteen . . . . .	51
Karie . . . . .	55
Elizabeth . . . . .	59
Hero Bay Tide Gauge . . . . .	75

## Introduction

FDRAKE 75, a field experiment designed to study circulation and transport processes in the region of the Drake Passage, began in January of 1975 with extensive hydrographic and chemical data collection (Anon., 1976 and Nowlin et al., 1977) supplemented by an array of both short and long term current meter moorings (Pillsbury et al. 1976, 1977). This experiment was continued in January of 1976 (FDRAKE 76) with the collection of additional hydrographic data and the setting of a second long term current meter array by the R/V T. G. THOMPSON. The current meter array was recovered by the R/V MELVILLE in January of 1977 as a part of FDRAKE 77.

These experiments were a part of the International Southern Ocean Studies (ISOS), a component of the International Decade of Ocean Exploration. They were designed to study the time and space scales of flow variations near the Drake Passage and to expand our knowledge of the distribution of water mass properties and their dynamics in this important region of the world's ocean.

In this report, a compilation of the data from the FDRAKE 76 long term current meter array is presented. The hydrographic data collected aboard the R/V T. G. THOMPSON are also available (Whitworth et al., 1978).

## The Current Meter Program

The configuration of the current meter moorings installed in the Drake Passage during 1976 is shown in Figures 1 and 2. The array consisted of 11 current meters on 7 moorings and two long-term, subsurface tide gauges. All moorings were recovered except mooring R. Both tide gauges were also recovered. The Cape Horn gauge malfunctioned, and no data were obtained from it. The length of record from each meter is shown in Figure 3.

All of the current meter moorings were subsurface, taut-wire moorings. Their design followed in large part the Woods Hole Oceanographic Institution intermediate mooring scheme (Heinmiller and Walden, 1973). The current meters used were Aanderaa RCM 5's and are described by Pillsbury et al. (1974). The tide gauges were Aanderaa tide gauges which are described in the appendices of Pillsbury et al. (1976).

The Aanderaa current meters recorded temperature, speed, direction, and pressure. The narrow range of temperatures expected in the Drake Passage allowed us to restrict the range of the temperature sensors to  $-2^{\circ}\text{C}$  to  $+6^{\circ}\text{C}$  on those meters which could be so equipped. The resolution for this range is  $\pm 0.008^{\circ}\text{C}$ . All calibrations for temperature were done with an NBS traceable quartz thermometer and the pre- and post-calibrations agreed within  $\pm 0.02^{\circ}\text{C}$  on average.

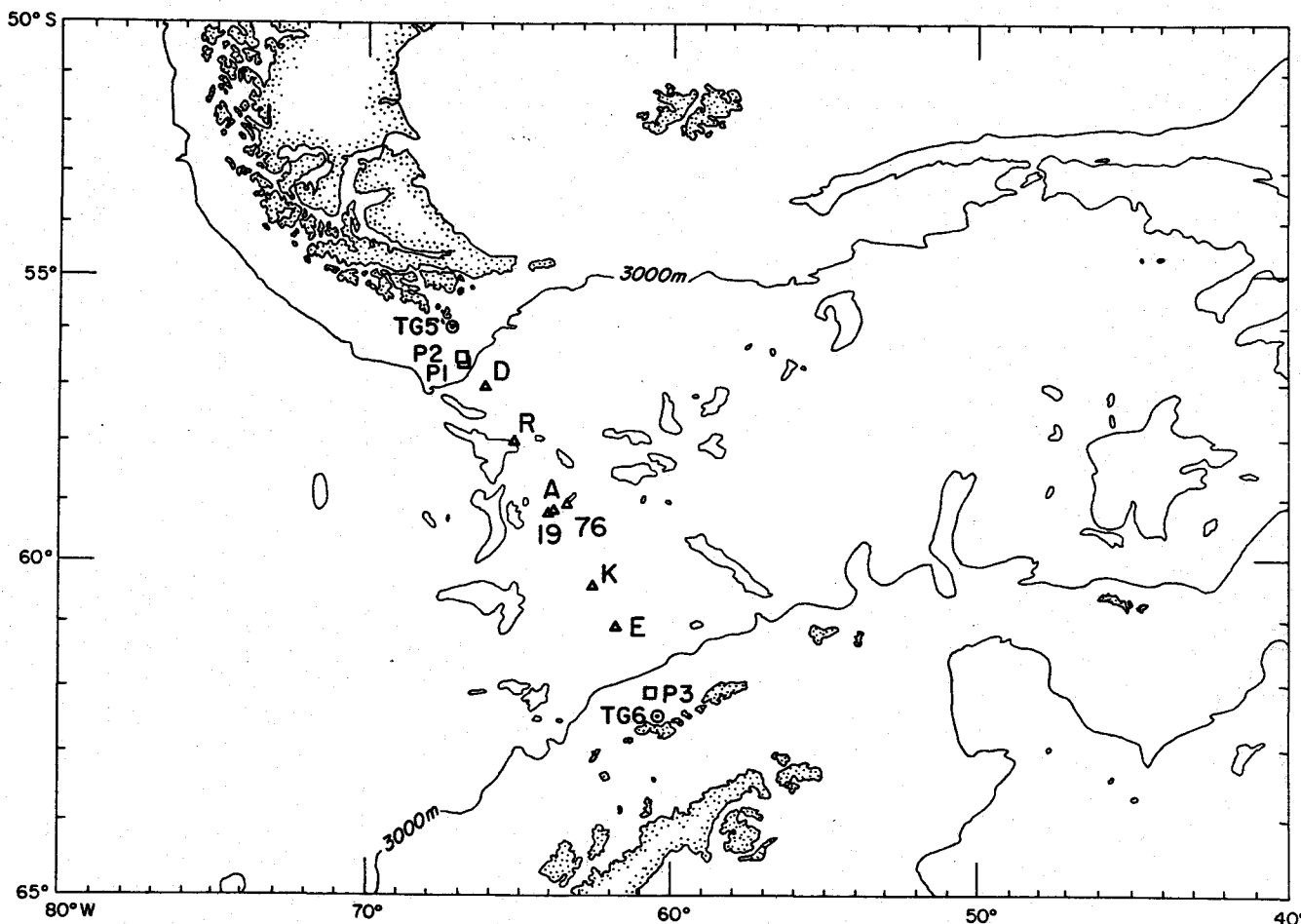


Figure 1. Distribution of moored instruments during F DRAKE 76.

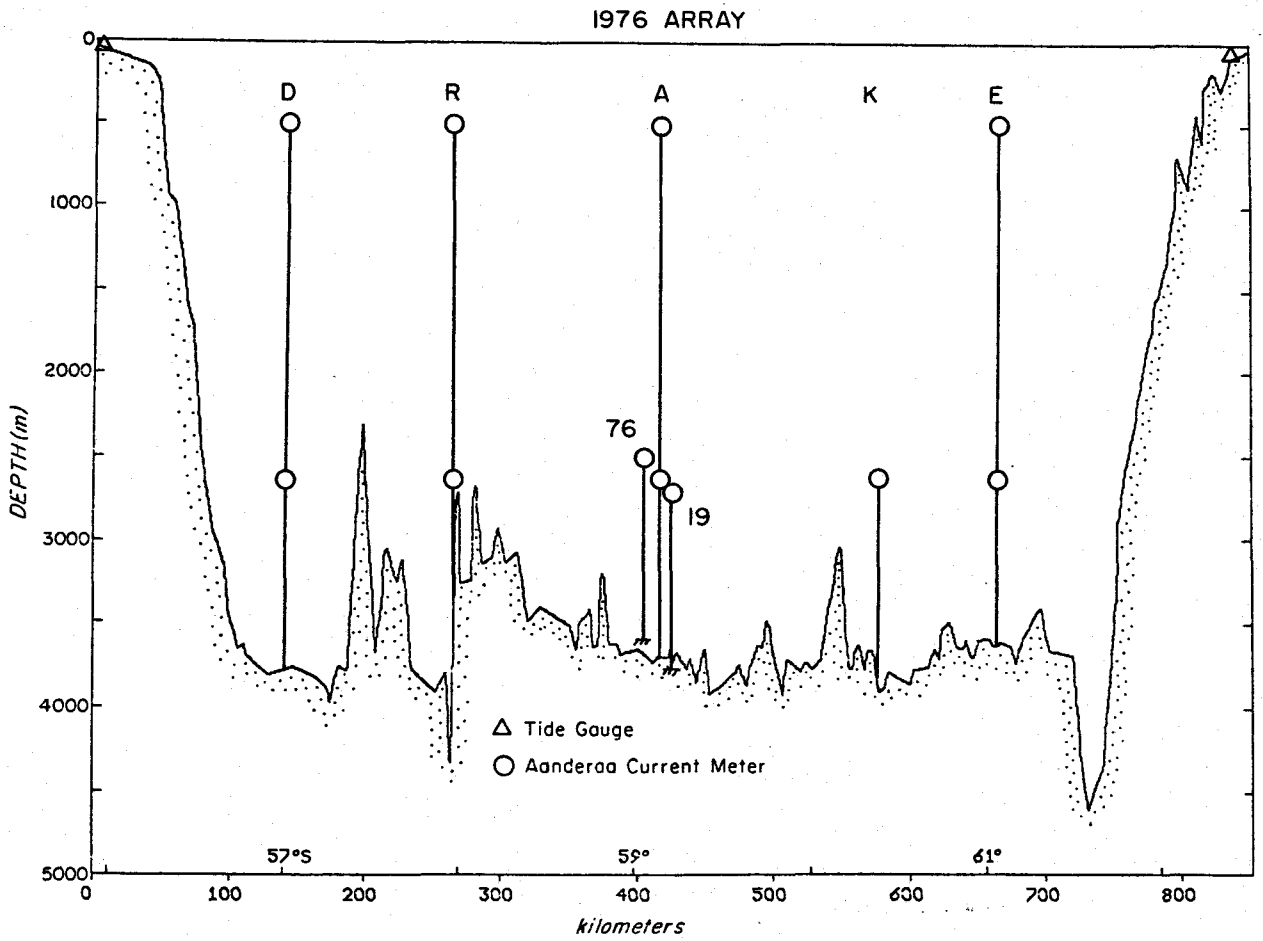


Figure 2. Distribution of moored instruments during F DRAKE 76.

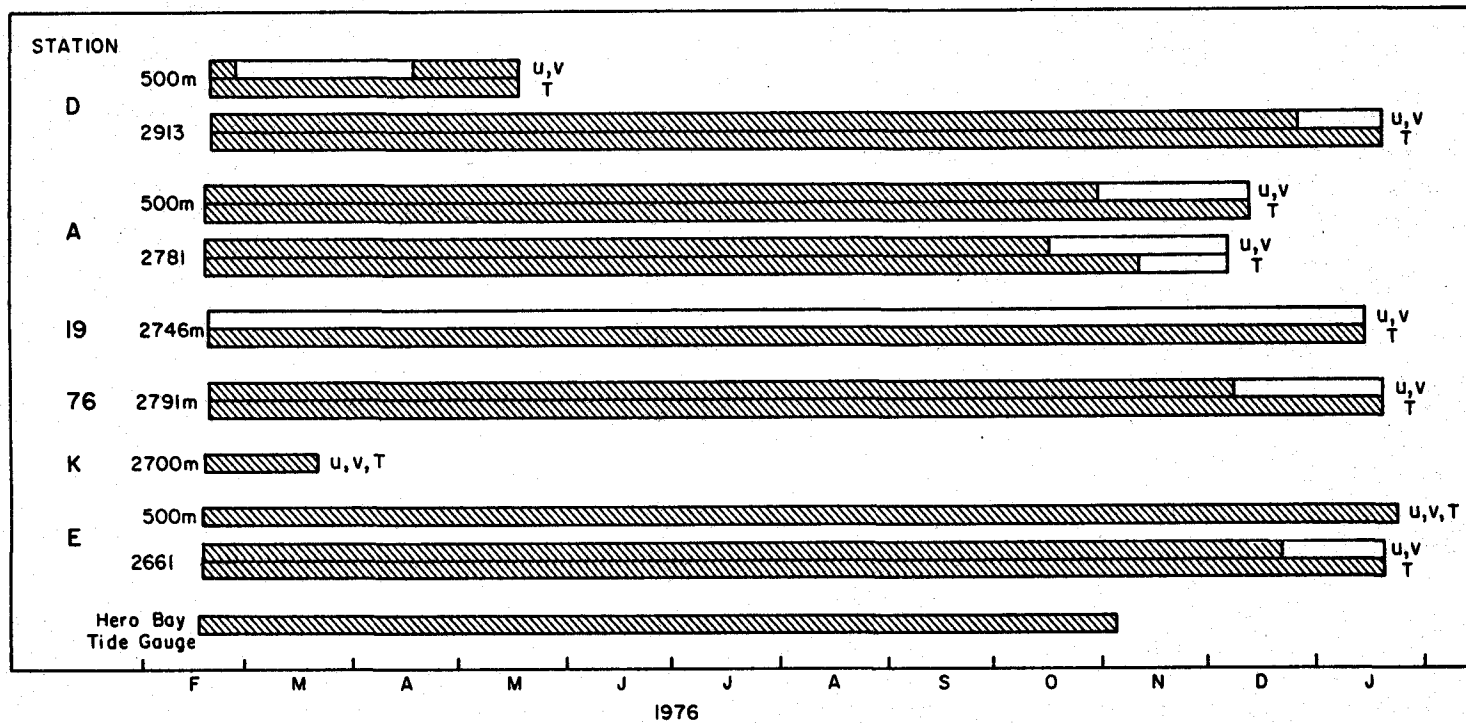


Figure 3. Operation time of moored instruments during F DRAKE 76.



The Aanderaa tide gauges recorded pressure averaged over 400 seconds once per hour. They are capable of resolving pressure changes resulting from 0.5 cm changes in water depth. The calibration of the tide gauges was done by Aanderaa Instruments Ltd., Victoria, British Columbia, using a Barnet dead weight tester.

The current meters were fitted with Vernitron Corp. Model 3000 potentiometer type gauge pressure transducers. The range of the shallow meters was set at 0-1000 psig and the range of the deep meters was set at 0-5000 psig. They have an accuracy of 1% of range and a resolution of 0.1% of range. Excursions beyond the 1000 psig limit were experienced by all the shallow pressure gauges which caused them to fail and resulted in the loss of data from the meters equipped with them. Data are available from the deep pressure gauges.

The Aanderaa current meters were calibrated before and after the experiment and all units exhibited satisfactory, reproducible data. The method of calibration and subsequent procedures used in the data processing are generally described by Pillsbury et al. (1974).

#### Description of the Processed Data

Data from each installation are presented separately. The header page gives information about the mooring location, instrumentation, data interval and a statement describing the kind of data collected at that point and the quality of the record.

Each of the deep meters had an intended depth of 2700 m and each of the shallow meters an intended depth of 500 m. The bathymetry in the Drake Passage showed a great deal of local relief, and it was not possible to place the meters at precisely those depths. The deep meters gave usable pressure records from which it was possible to estimate their depths. This has been done assuming a water column with a constant density of  $1.025 \text{ g cm}^{-3}$  above each meter. The shallow meters did not give a usable pressure record and their depths should be considered estimates.

Each meter has a serial number assigned to it by the manufacturer. Each successive tape recorded by that machine is numbered with the serial number and the tape number. Thus, 485/10 indicates the tenth tape recorded by machine 485.

The table of statistics following the header page gives the arithmetic mean, standard deviation, skewness, kurtosis, maximum value, minimum value and the number of hourly values of the record length for each variable measured. U is the true east-west velocity component and V is the true north-south velocity component.

The directional stability parameter presented for each current record is as discussed by Neumann (1968, pp. 53-55) and is given by

$$\text{directional stability} = \frac{\frac{1}{N} \left| \sum_{i=1}^N \vec{u}_i \right|}{\frac{1}{N} \sum_{i=1}^N \left| \vec{u}_i \right|} \times 100\%$$

where  $\vec{u}_i$  = the current vector observed at time  $i$ , and  $N$  = number of observations. This parameter is the ratio of the averaged vectorial velocity and the averaged arithmetical velocity expressed in percent. It can vary from 0 to 100% and is a rough measure of the "steadiness" of the current direction. A value of 100% indicates a uni-directional observed current with variations only in its magnitude. A small value indicates that the current varies significantly over all directions of the compass rose. This parameter was calculated for the current data after it was passed through a low pass filter (LLP data) which removes tidal and inertial oscillations as discussed below.

Progressive vector diagrams, real time plots, stick figure plots, and rotary spectra follow the table of statistics. Data were taken every hour and plots which show each point are too long to be easily included in this report. To reduce the plots and still present the important low frequency fluctuations, the data were filtered with a 60 + 1 + 60 point, Cosine Lanczos filter with a half-amplitude at 34.3 hours and a half-power at 40 hours. The data was then resampled at 6 hour intervals. This filter was designed to remove both tidal and inertial oscillations.

#### ACKNOWLEDGMENTS

The funds for the program came from the National Science Foundation grant OCE 74-12558 A02 which is gratefully acknowledged. Appreciation is also expressed to *B. Moore* and *D. Barstow* for calibration and preparation of the instruments and to *D. Root* for data processing.

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- Whitworth, T., W. D. Nowlin, L. I. Gordon, and G. C. Anderson. 1978. Oceanographic Data Collected Aboard R/V T. G. THOMPSON during FDRAKE 76, Legs I and II. Texas A&M University, Department of Oceanography, College Station, Texas. Reference 78-1-D.

INSTALLATIONS

## DIANA

Position: 57°01.0'S, 66°12.0'W

Depth of Water: 3813 m

Set at 1942 UCT 20 February 1976 by R/V T. G. THOMPSON

Retrieved at 1728 UCT 19 January 1977 by R/V MELVILLE

Data Interval: 2106 UCT 20 February 1976 to 1606 UCT 19 January 1977

InstrumentationIntended DepthRCM5 Serial No./Tape No.

500 m  
2700 m

1530/8  
1534/5

Data were recorded once per hour. Instrument 1530 recorded speed, direction and temperature. The speed sensor failed at 1646 UCT 27 February 1976 until 0246 UCT 4 April 1976 when the data appear good again. A second failure occurred at 2046 UCT 18 April 1976. The temperature data are good throughout the interval of 27 February to 18 May.

Instrument 1534 recorded speed, direction, pressure and temperature. The direction sensor failed at 1206 UCT 26 December 1976, but temperature, speed and pressure are good until recovery.

## DIANA

713 m

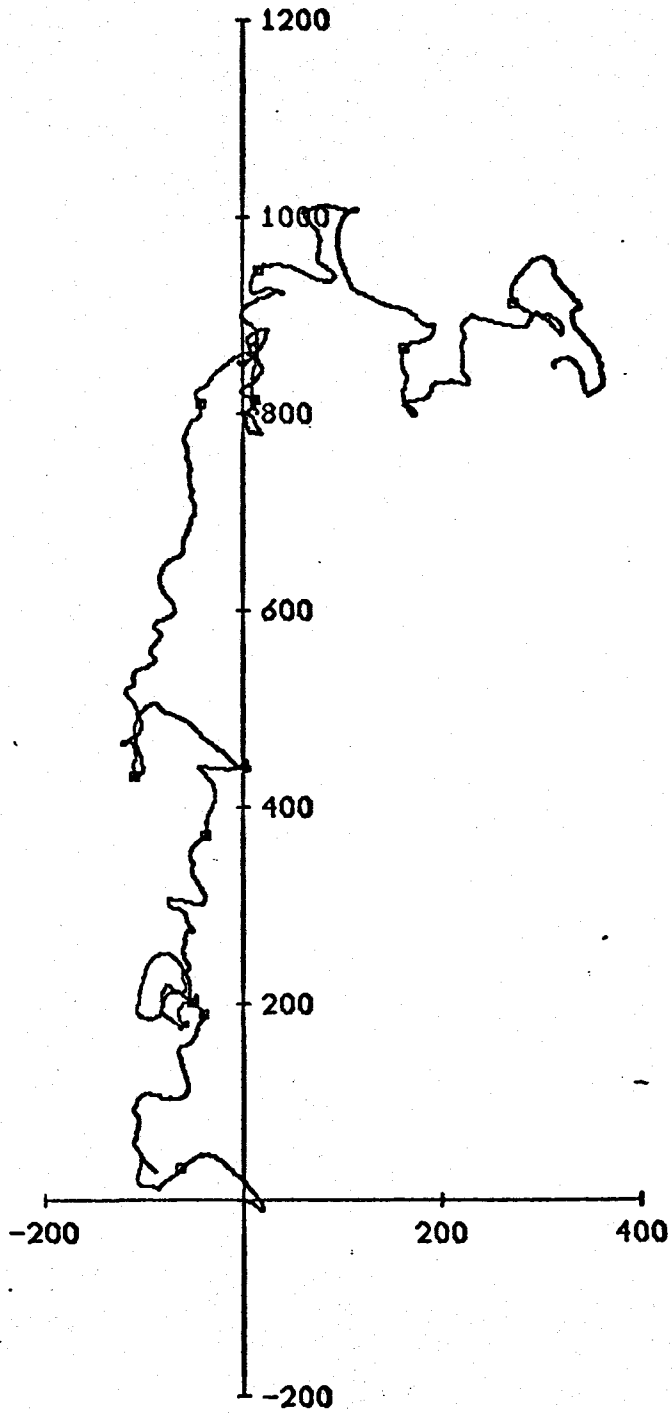
	MEAN	S.D.	SKEW	KURT	MAX	MIN	N
S (cm/sec)	38.17	13.73	-.61	2.57	68.30	3.20	901
U (cm/sec)	31.11	18.58	-.98	3.40	63.30	-37.60	901
V (cm/sec)	11.59	14.05	.70	3.87	64.10	-26.40	901
T (°C)	3.27	.67	.02	1.81	4.61	1.90	2112

Directional Stability of the LLP Current = 92%

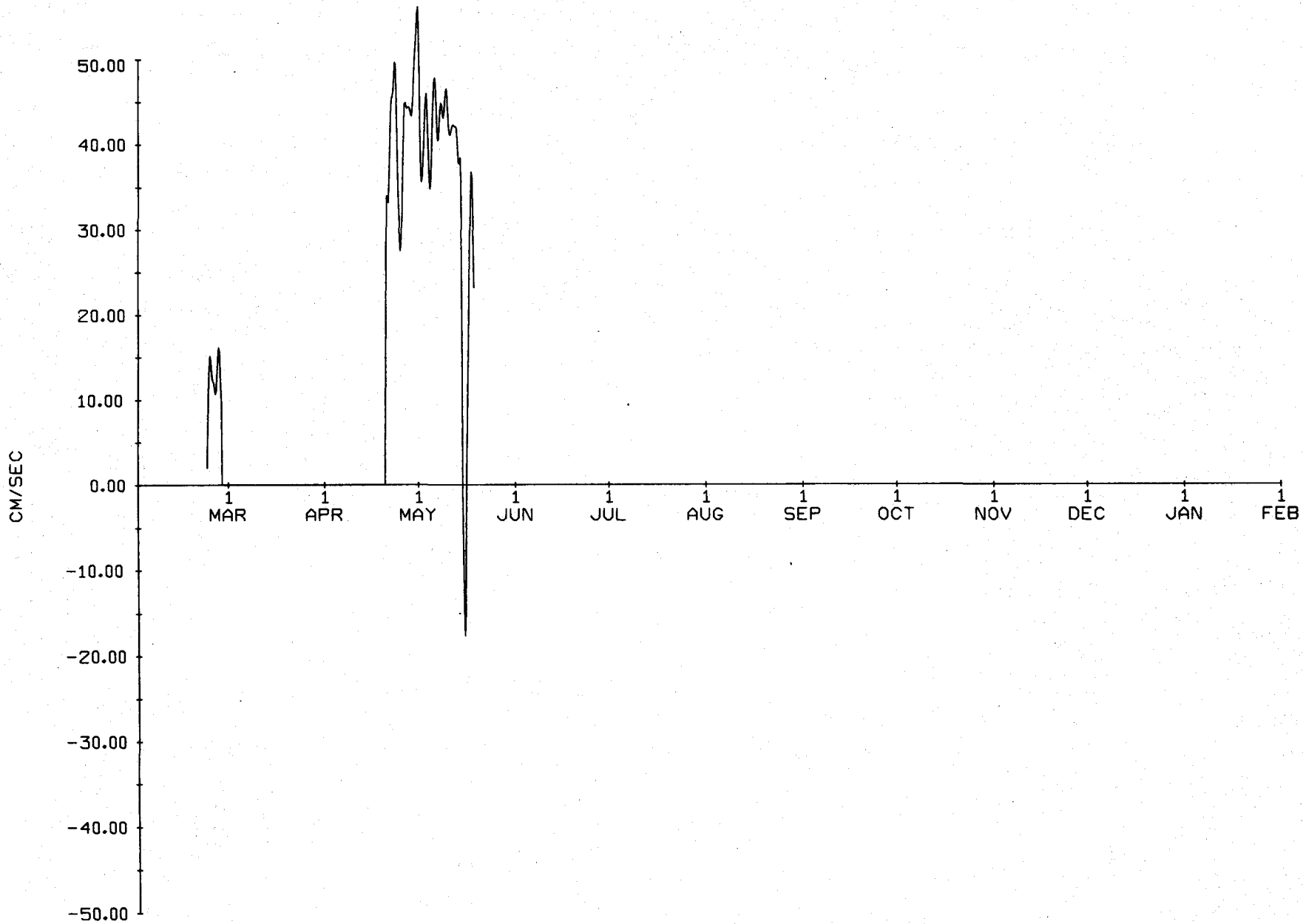
2913 m

S (cm/sec)	15.13	8.36	.66	3.31	53.80	.80	8012
U (cm/sec)	1.17	11.77	.41	3.71	51.50	-43.80	7432
V (cm/sec)	3.16	11.98	-.11	2.58	36.00	-35.20	7432
T (°C)	1.81	.11	-.43	2.86	2.10	1.44	8012
P (X10 <sup>4</sup> pascal)	2928.50	111.30	.86	3.06	3276.00	2787.80	8012

Directional Stability of the LLP Current = 25%

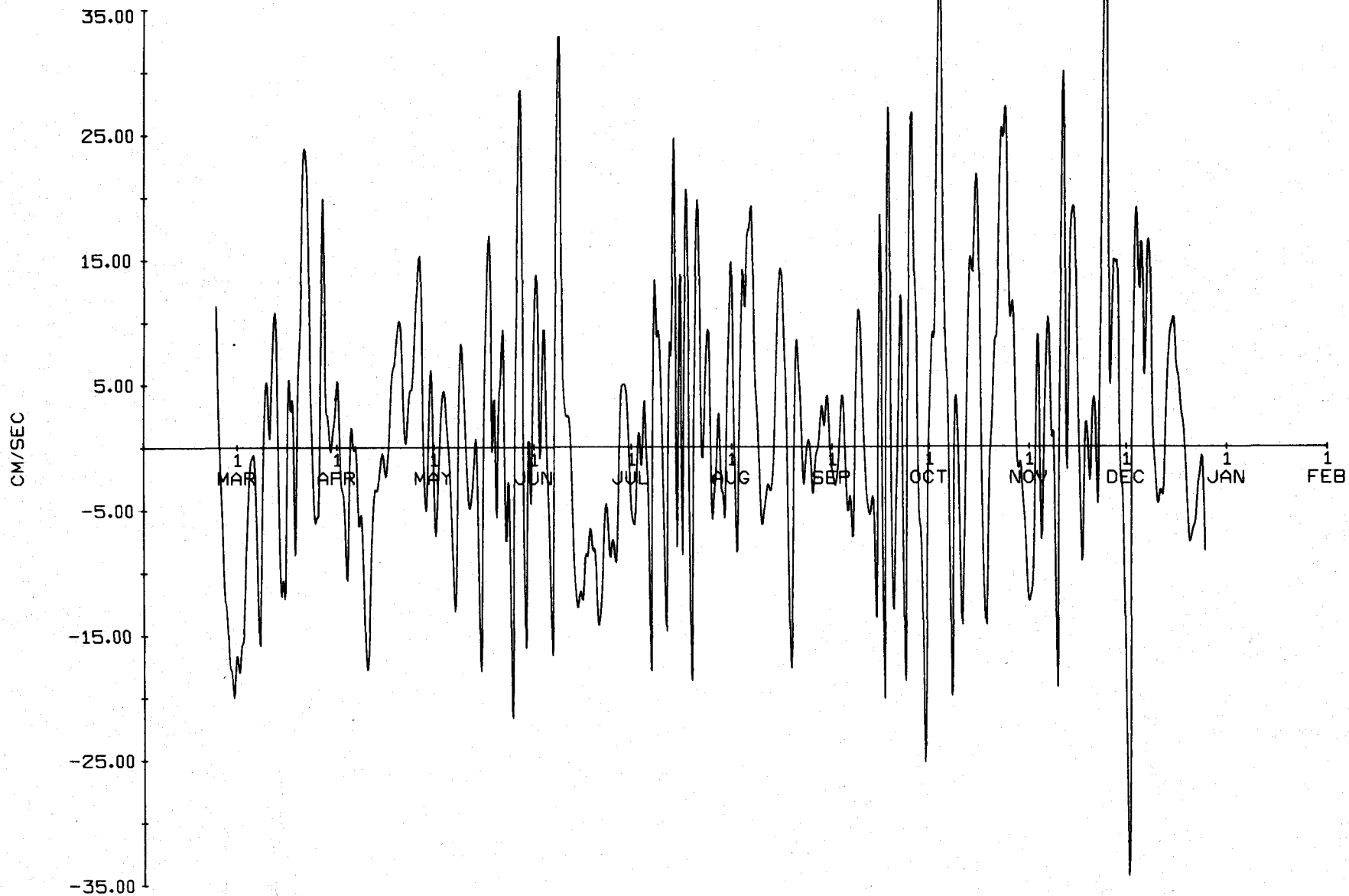


2913 M AT FDRAKE 76 STN DIANA. 20 FEB 76 - 26 DEC 76.

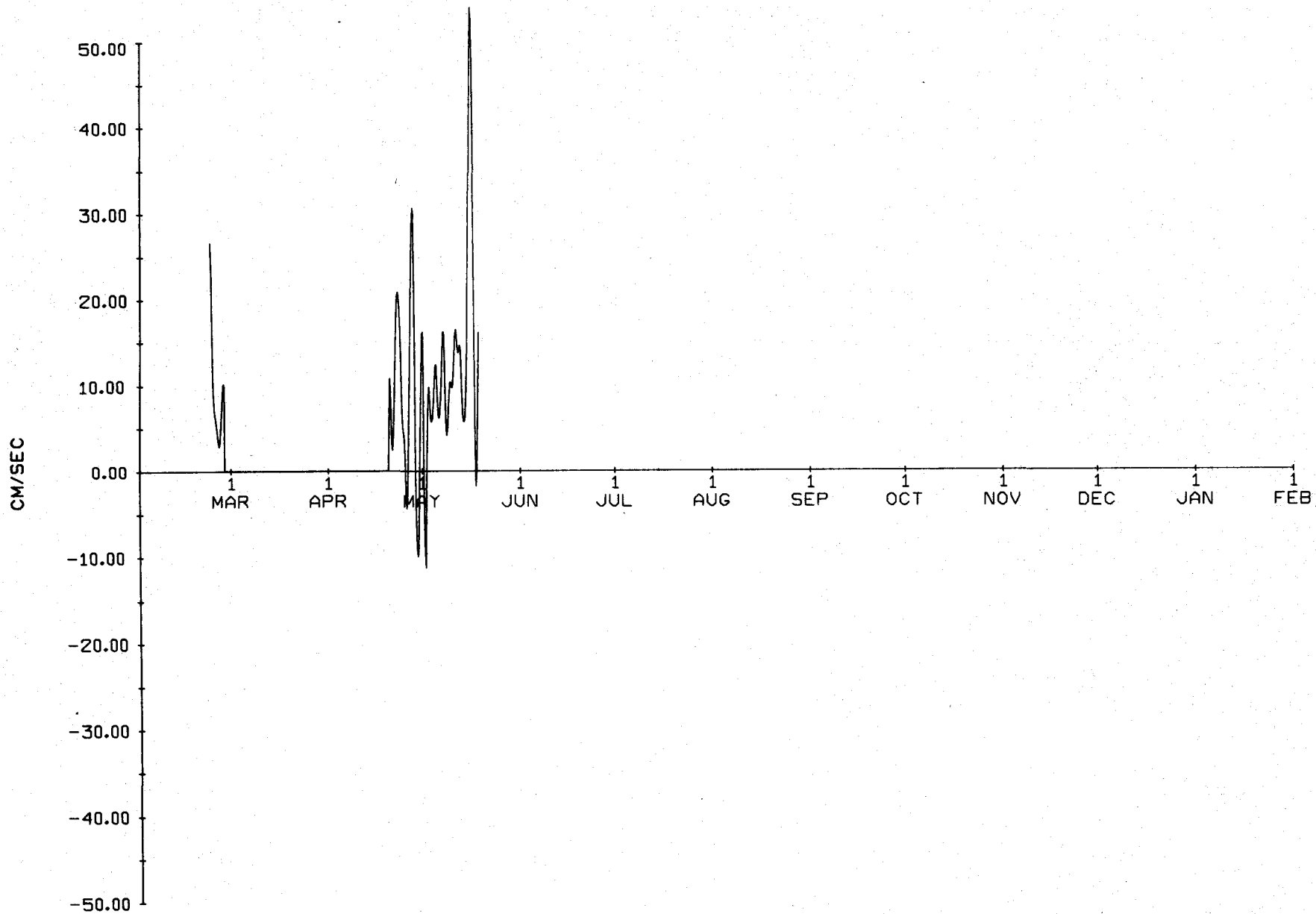


STATION DIANA, 500 METERS  
LLP DATA, U COMPONENT

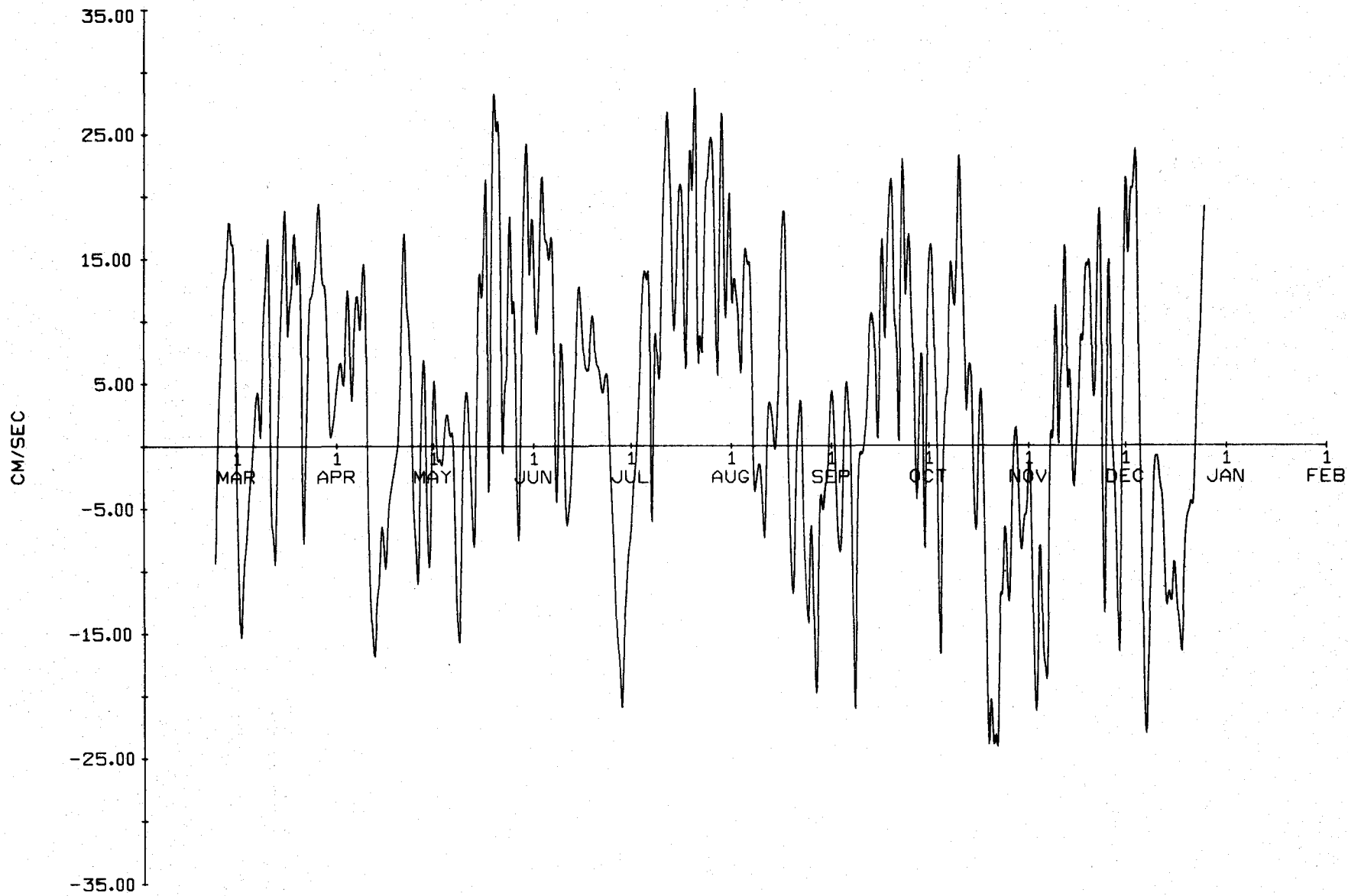




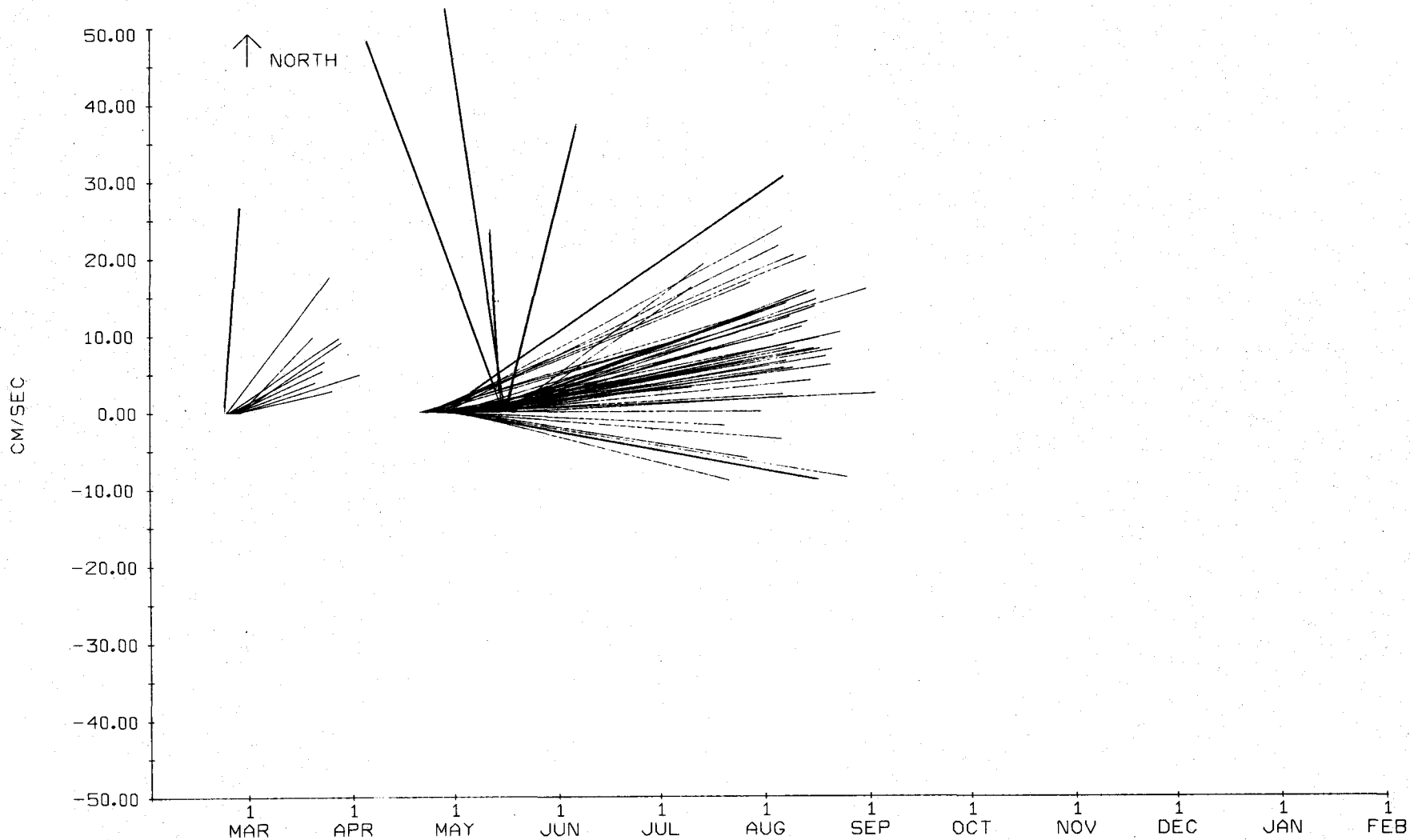
STATION DIANA, 2913 METERS  
LLP DATA, U COMPONENT



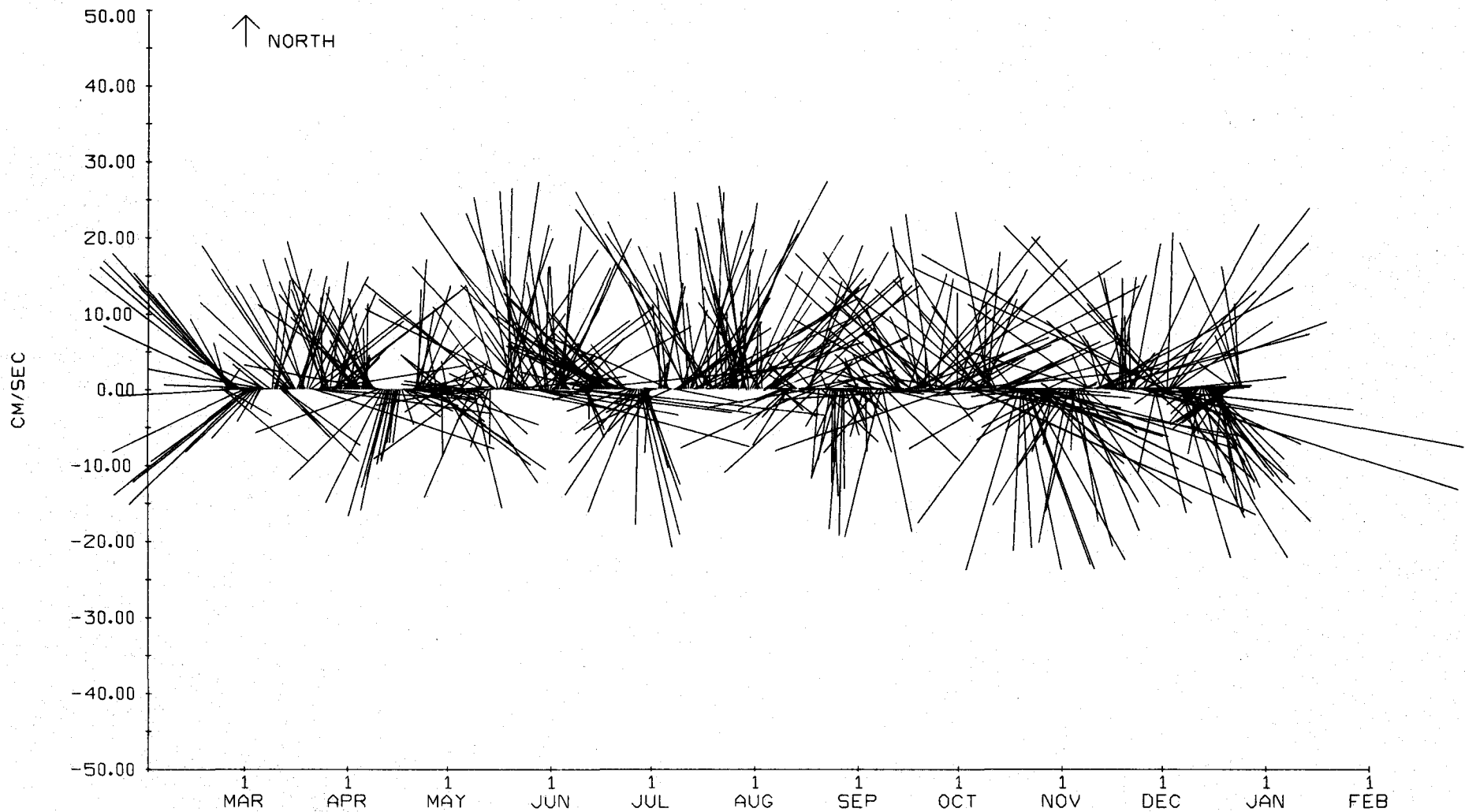
STATION DIANA, 500 METERS  
LLP DATA, V COMPONENT



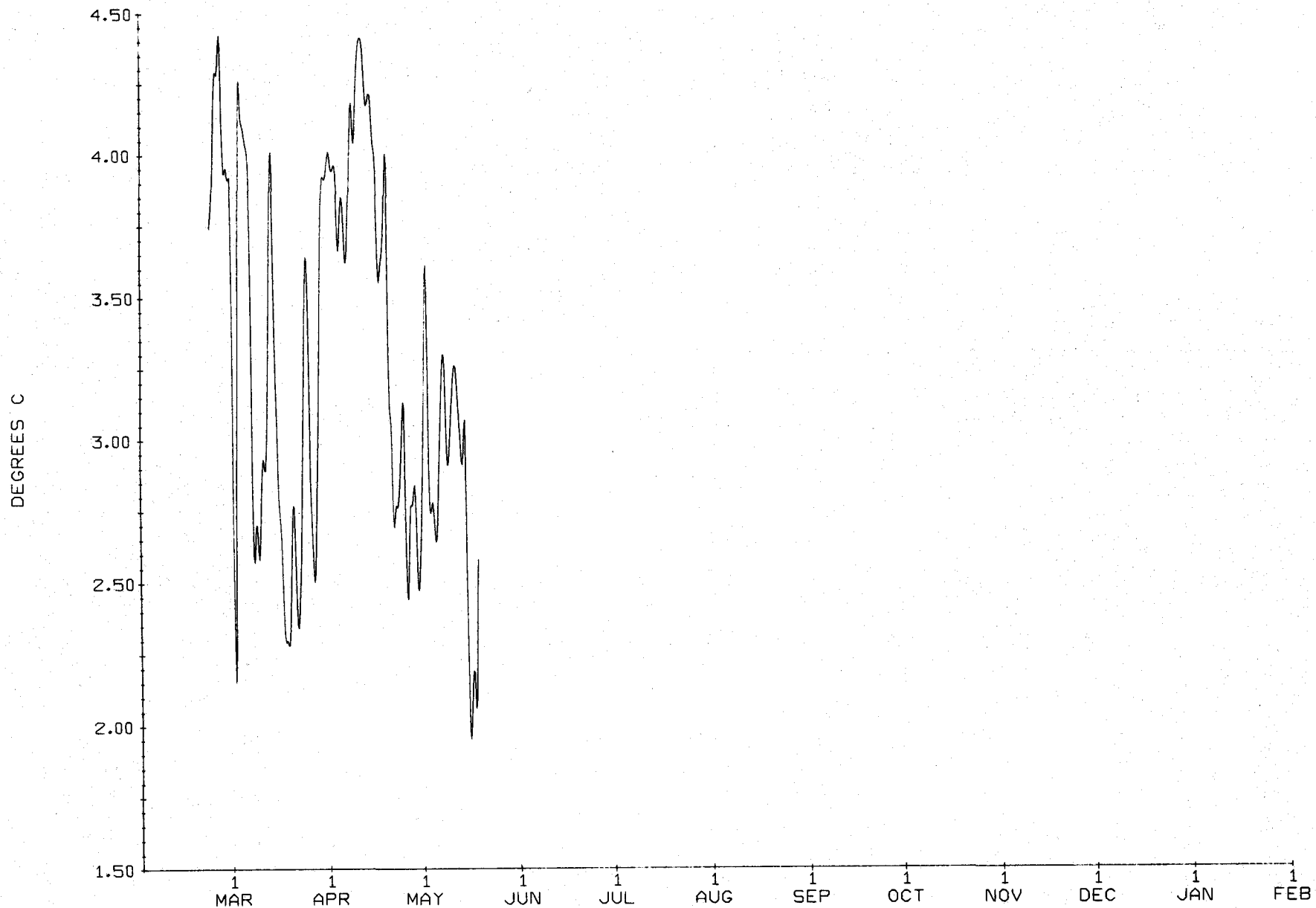
STATION DIANA, 2913 METERS  
LLP DATA, V COMPONENT



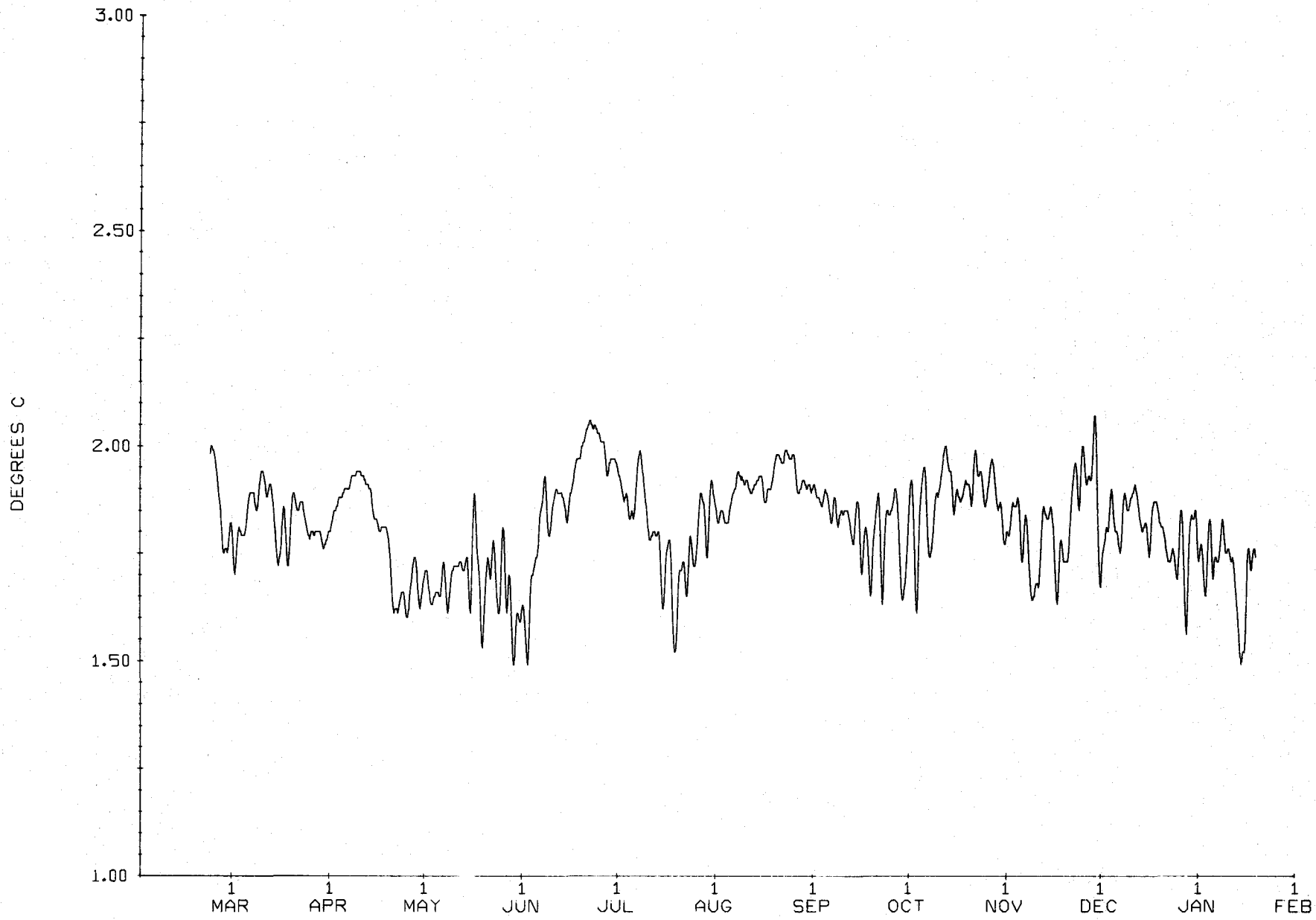
STATION DIANA, 500 METERS  
LLP CURRENT



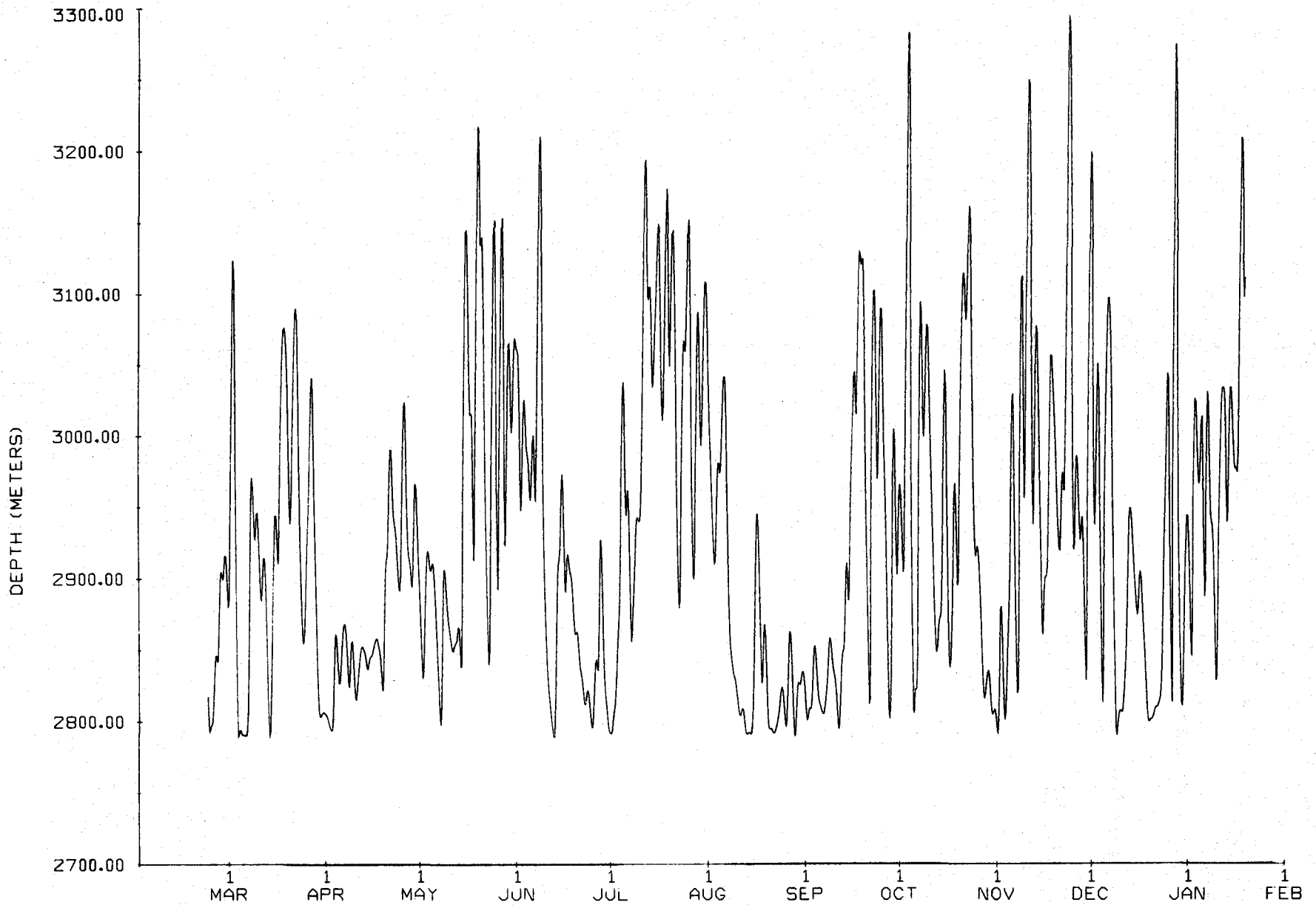
STATION DIANA, 2913 METERS  
LLP CURRENT



STATION DIANA, 500 METERS  
LLP DATA, TEMPERATURE



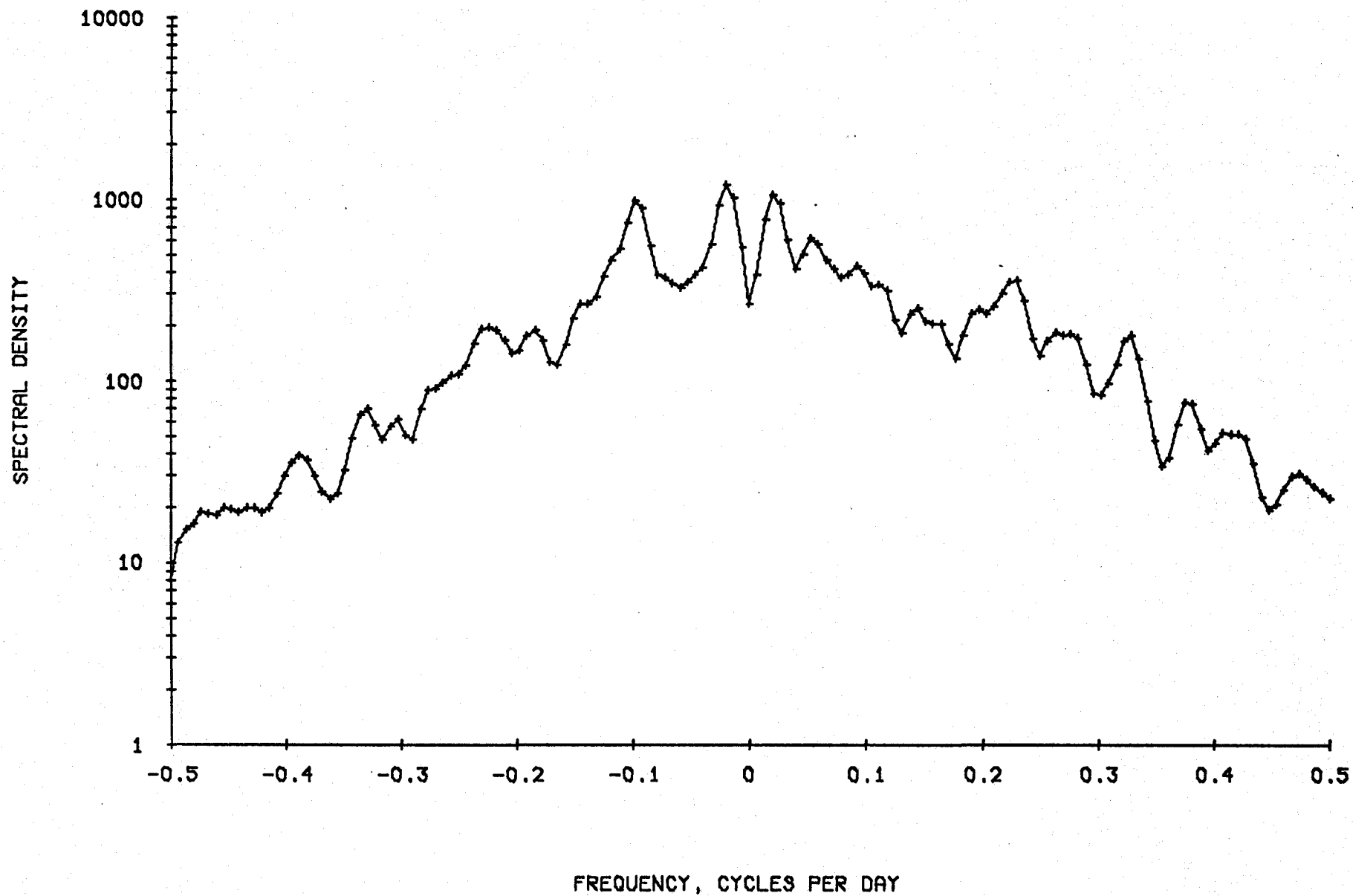
STATION DIANA, 2913 METERS  
LLP DATA, TEMPERATURE



LLP DATA, PRESSURE AS DEPTH  
STATION DIANA, 2913 METERS



LLP CURRENT AT 2913 M, STN D. 304 DAYS STNG 0000 22 FEB 76.



## ANN

Position: 59°08.8'S, 63°55.6'W

Depth of Water: 3765 m

Set at 2033 UCT 18 February 1976 by R/V T. G. THOMPSON

Retrieved at 2000 UCT 21 January 1977 by R/V MELVILLE

Data Interval: 2100 UCT 18 February 1976 to 0855 UCT 12 December 1976

InstrumentationIntended DepthRCM5 Serial No./Tape No.

500 m  
2700 m

1533/8  
1536/6

Instrument 1533 recorded speed, direction, and temperature once per hour. The direction sensor failed at 0555 UCT 29 October 1976.

Instrument 1536 recorded speed, direction, temperature, and pressure once per hour. The direction sensor failed at 1500 UCT 16 October 1976 and the temperature and pressure sensors failed at 1600 UCT 11 November 1976.

## ANN

581 m

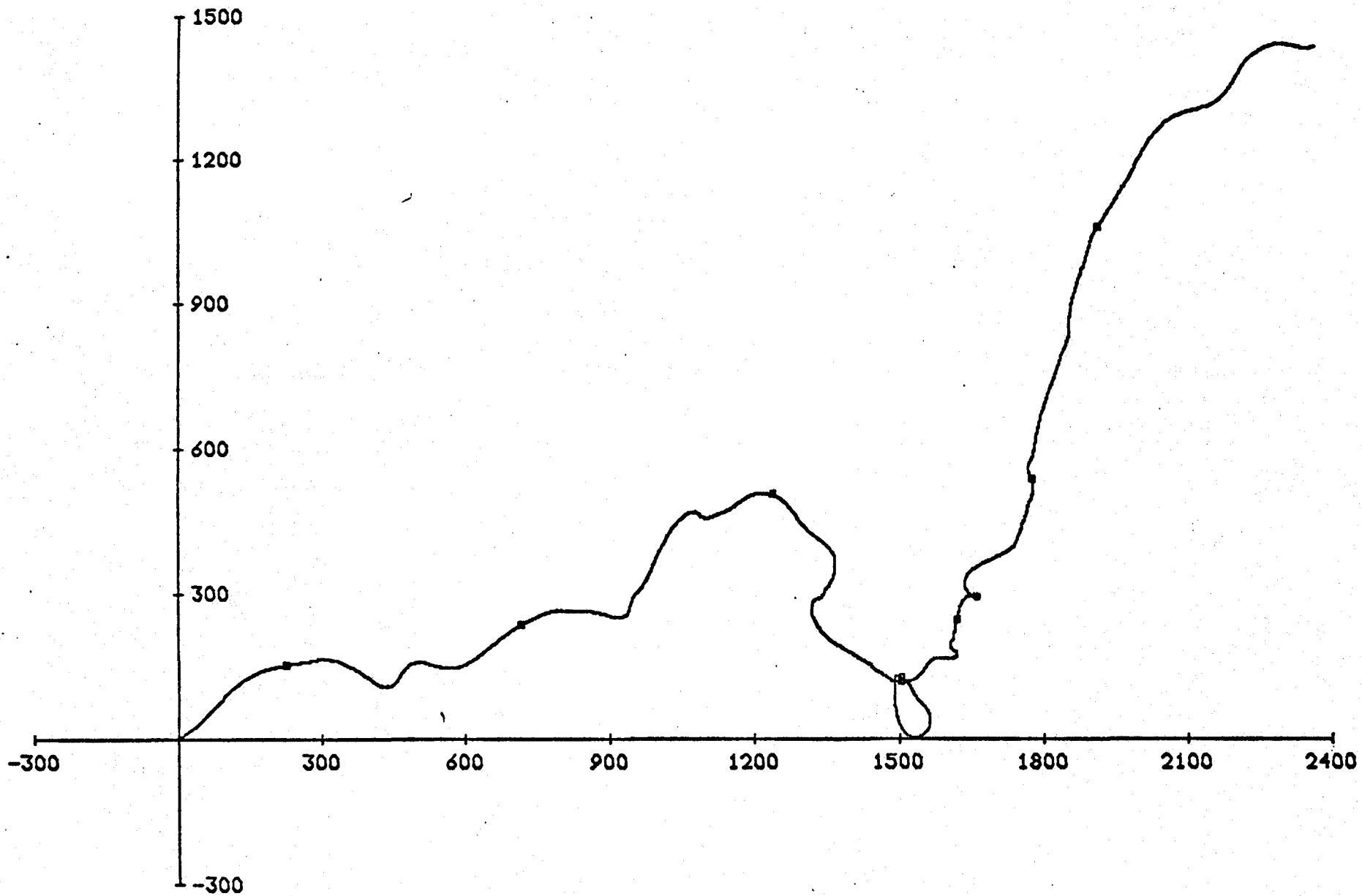
	MEAN	S. D.	SKEW	KURT	MAX	MIN	N
S (cm/sec)	19.25	9.40	.53	3.25	62.50	.80	7140
U (cm/sec)	10.82	11.67	.14	2.95	51.80	-21.70	6081
V (cm/sec)	6.56	13.85	-.34	2.81	40.10	-43.50	6081
T (°C)	2.16	.18	1.29	6.75	3.21	1.54	7140

Directional Stability of the LLP Current = 65%

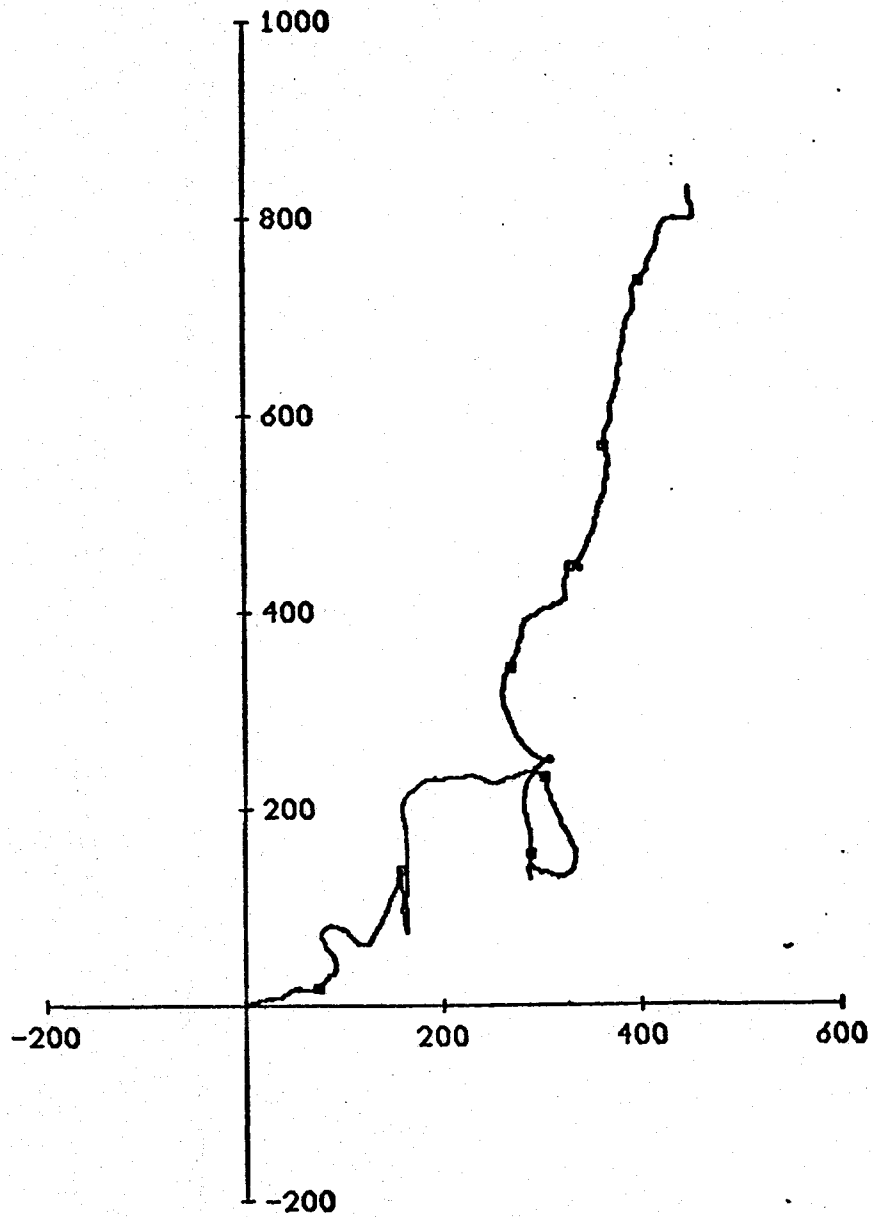
2781 m

S (cm/sec)	8.47	4.96	1.58	6.98	39.90	.80	7011
U (cm/sec)	2.15	5.46	.29	4.13	25.50	-20.40	5779
V (cm/sec)	3.99	7.21	-.95	7.28	29.50	-37.10	5779
T (°C)	.89	.21	.80	2.75	1.49	.57	6404
P (X10 <sup>4</sup> pascal)	2795.50	53.70	3.17	16.89	3183.80	2743.20	6404

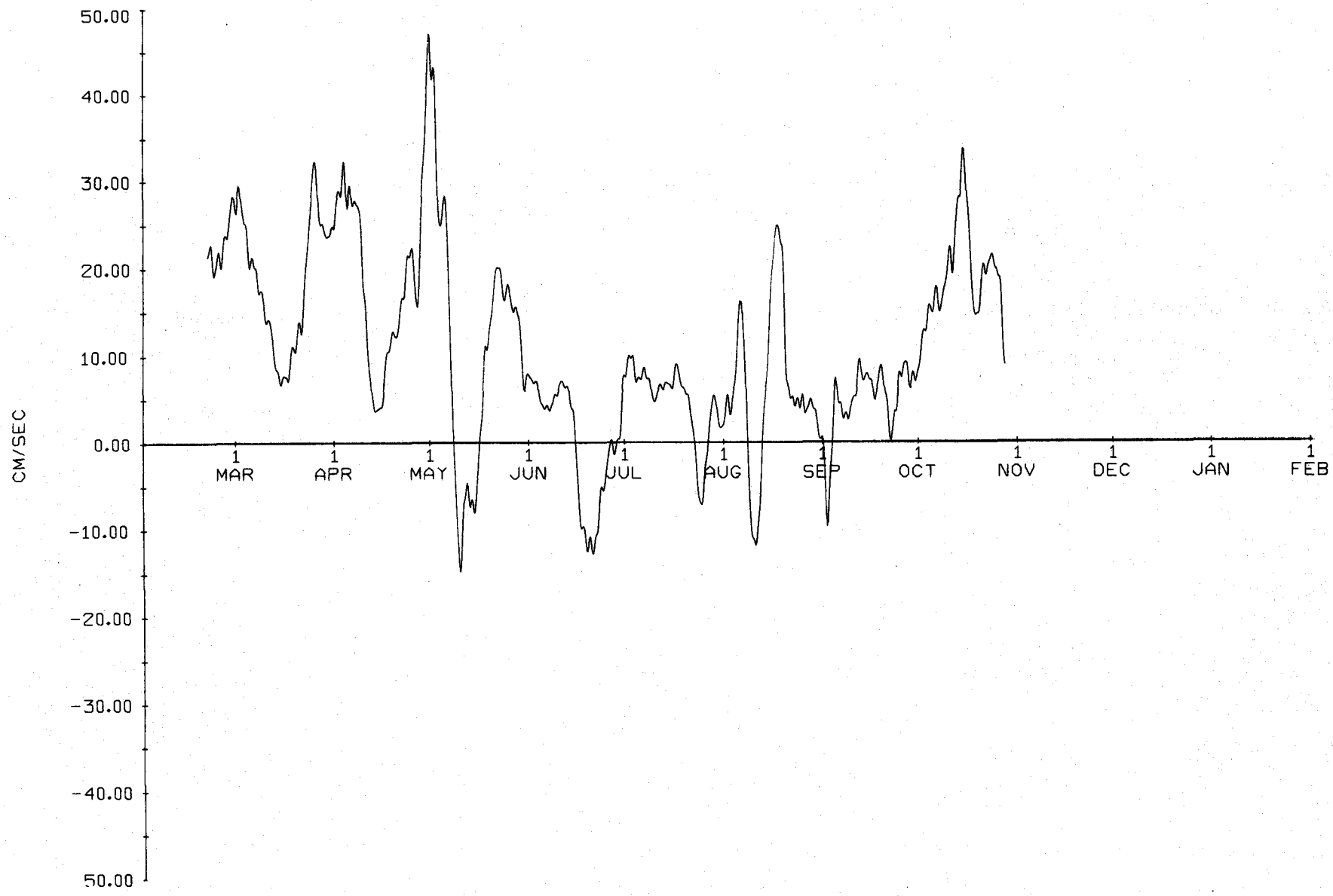
Directional Stability of the LLP Current = 56%



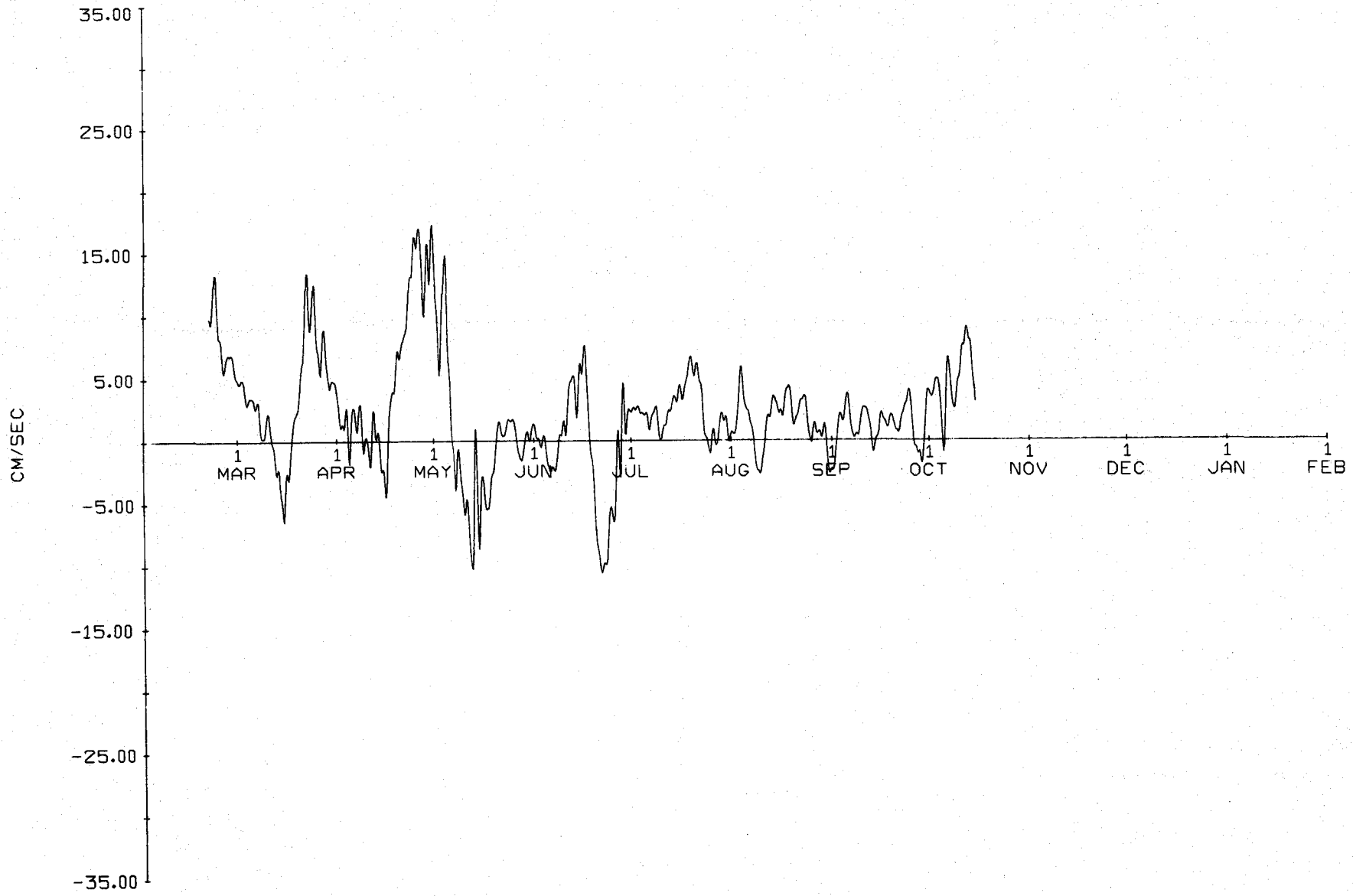
500 METERS AT FDRAKE 76 STN ANN. 18 FEB 76 - 29 OCT 76.



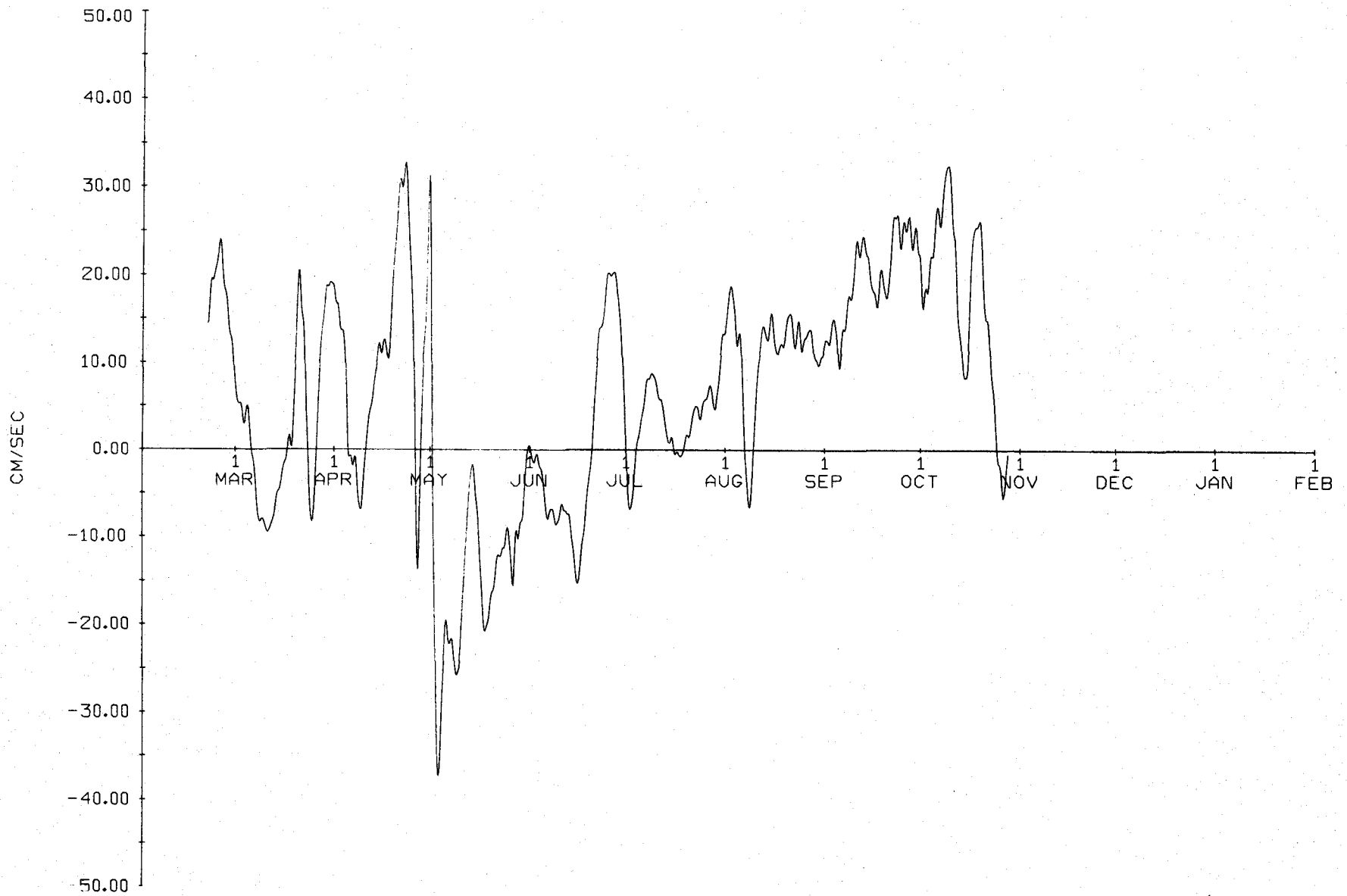
2781 M AT FDRAKE 76 STN ANN. 18 FEB 76 - 16 OCT 76.



STATION ANN, 500 METERS  
LLP DATA, U COMPONENT

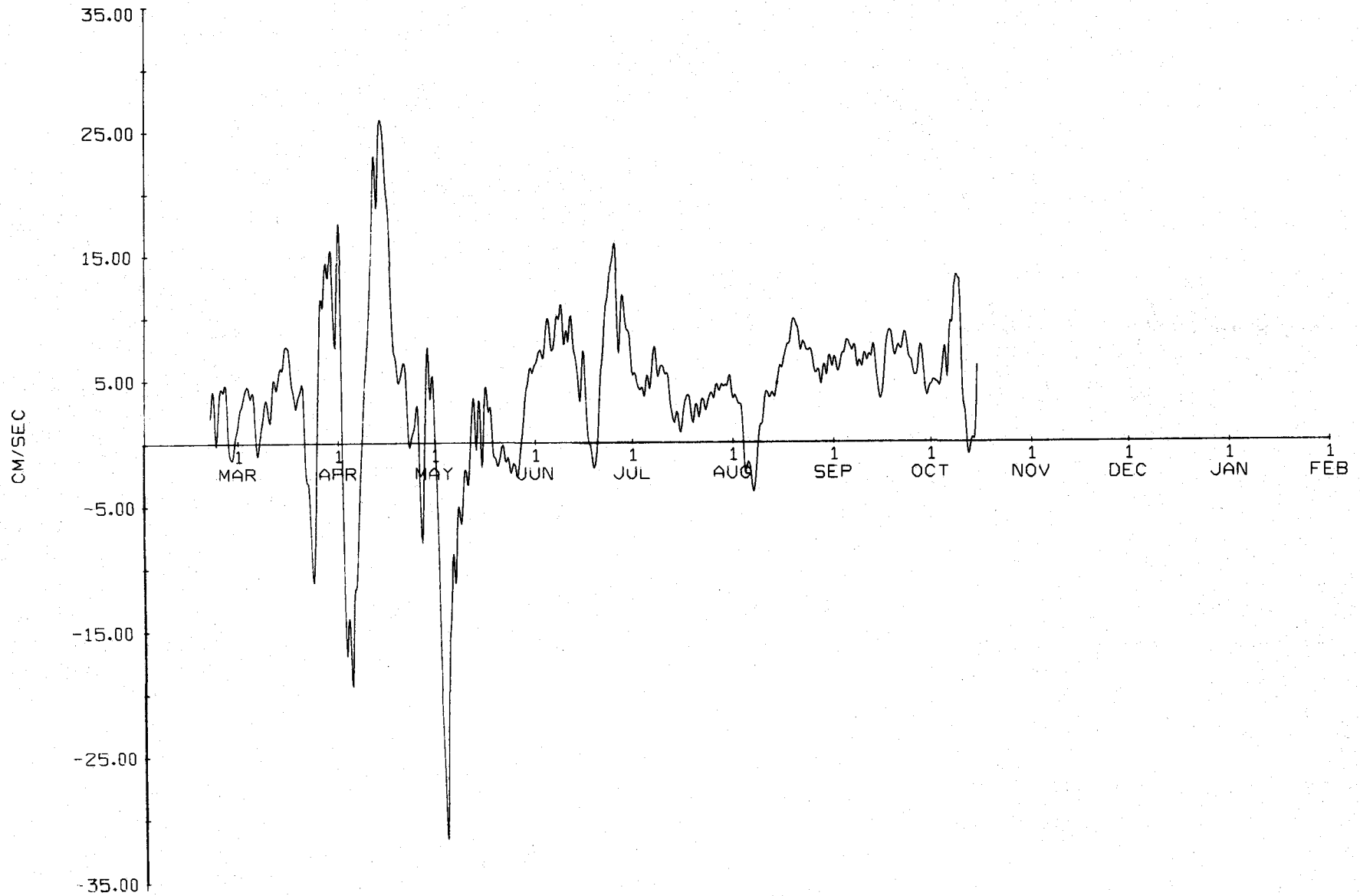


STATION ANN, 2781 METERS  
LLP DATA, U COMPONENT

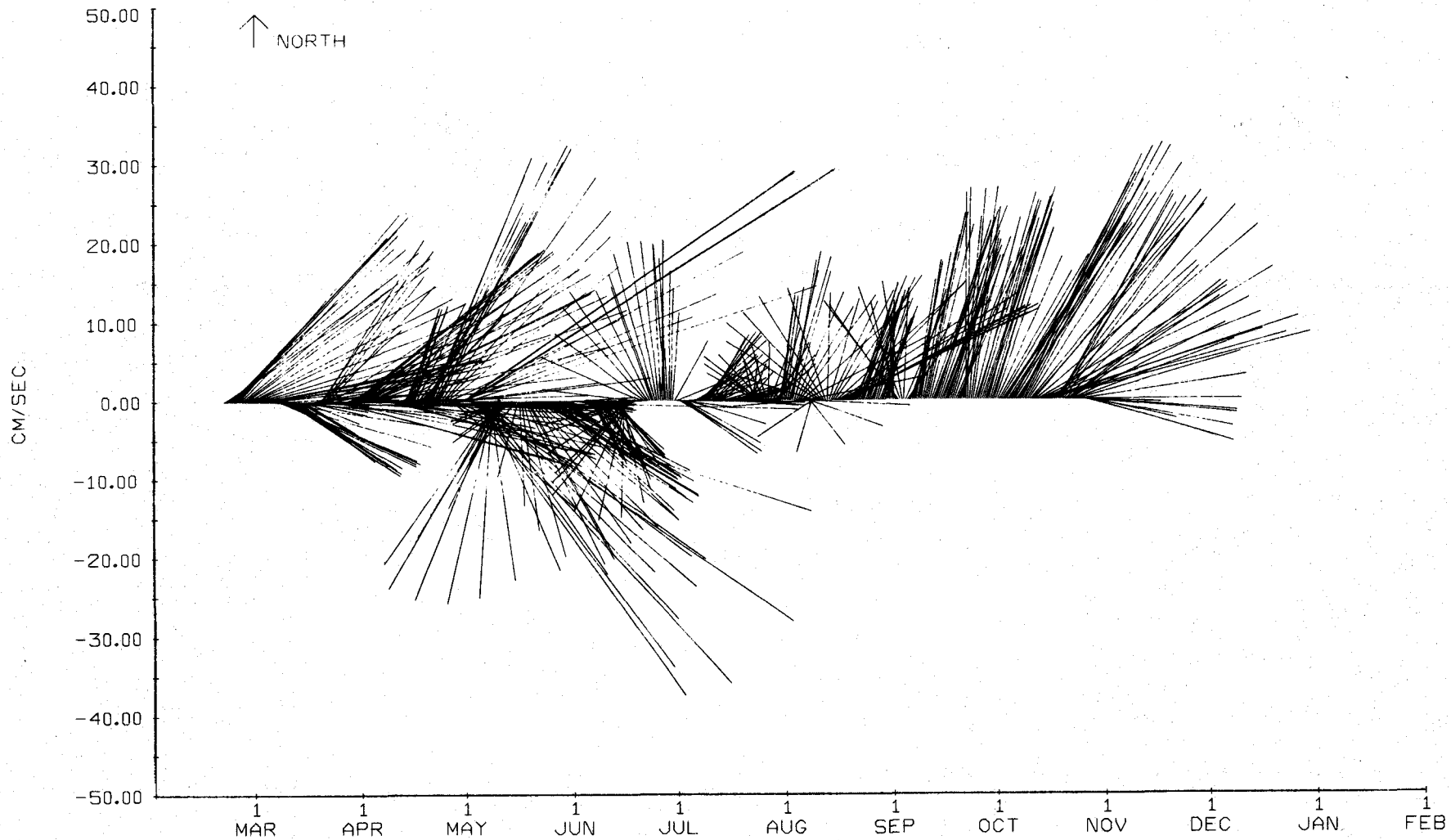


STATION ANN, 500 METERS  
LLP DATA, V COMPONENT

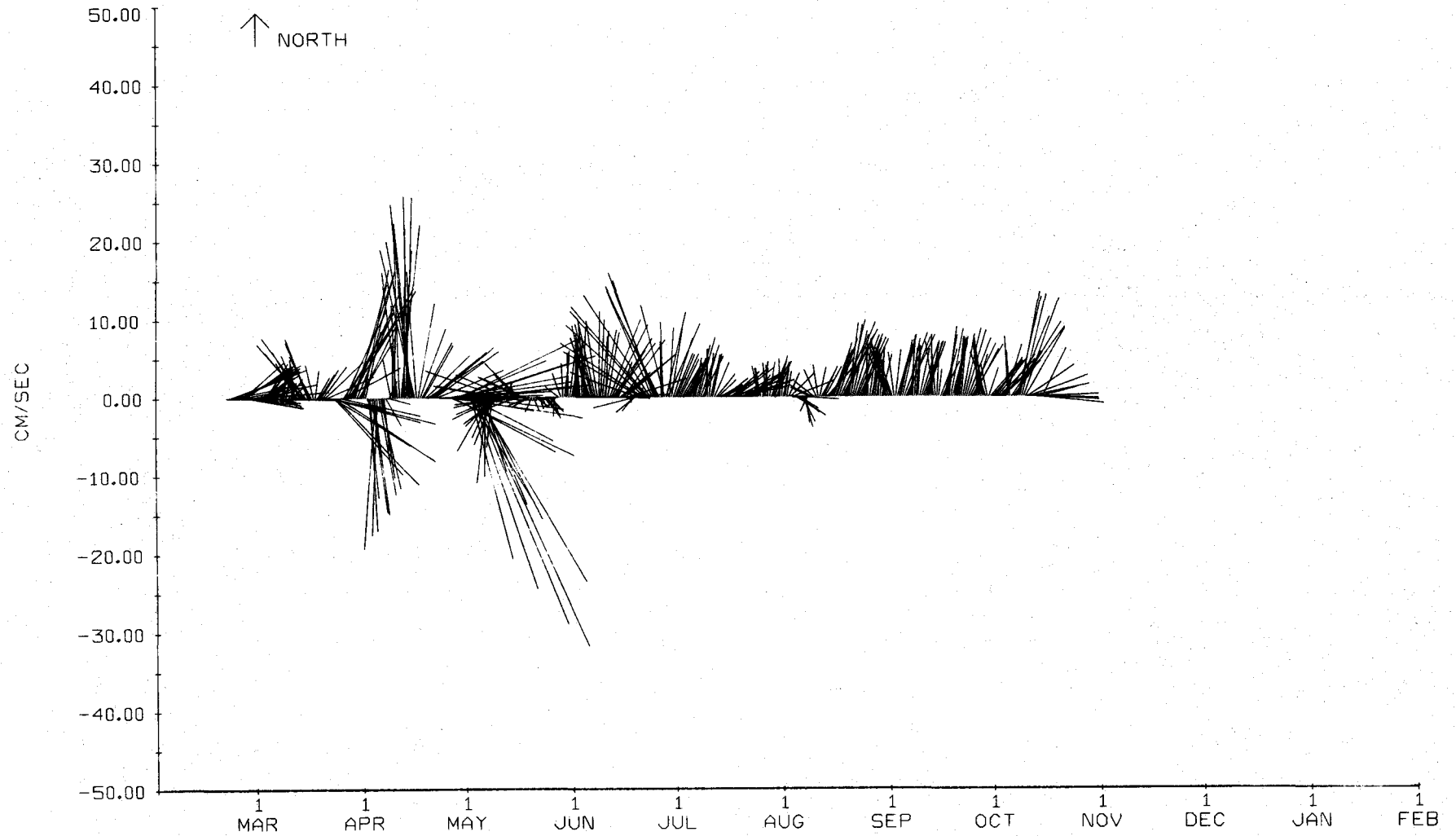




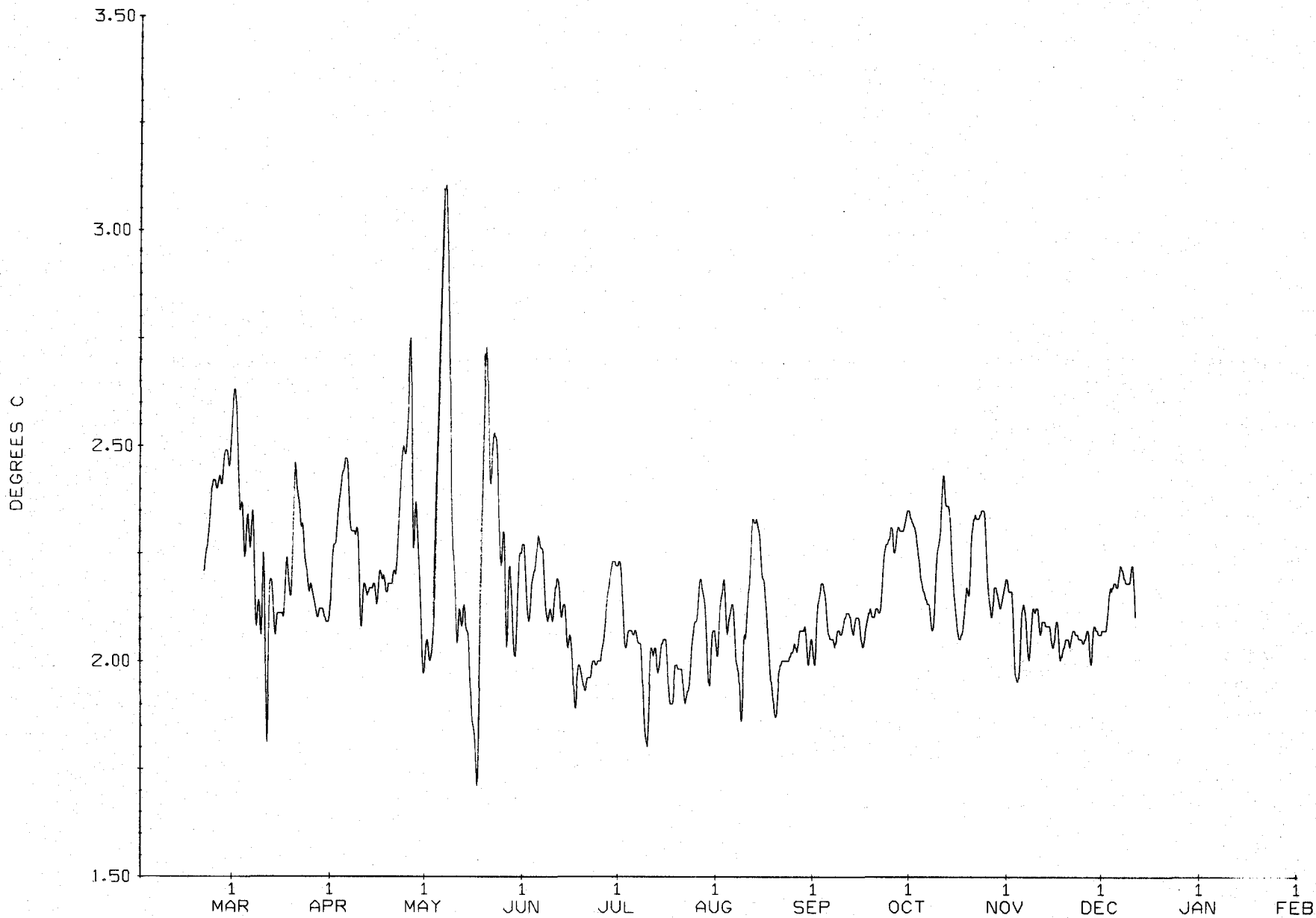
STATION ANN, 2781 METERS  
LLP DATA, V COMPONENT



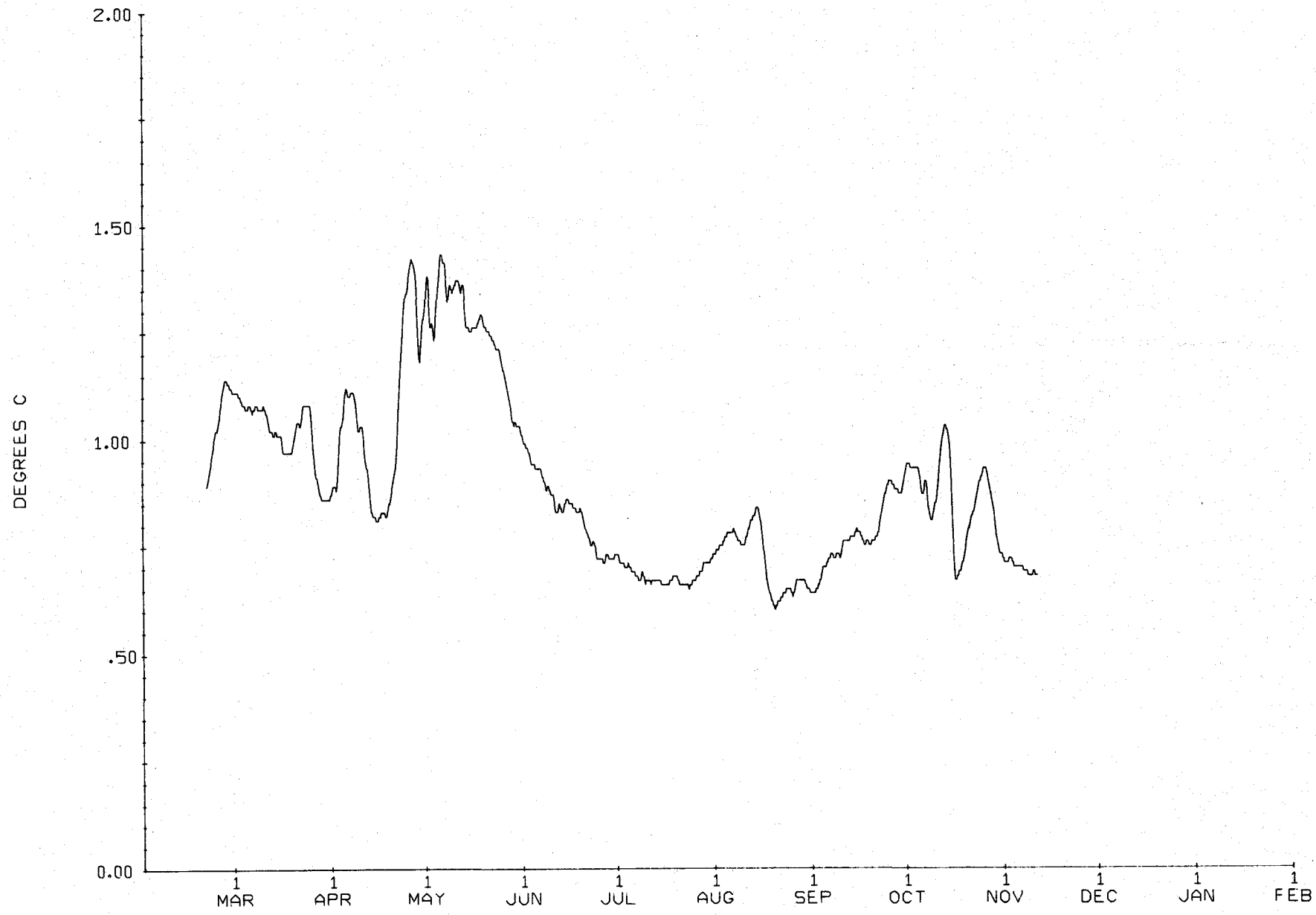
STATION ANN, 500 METERS  
LLP CURRENT



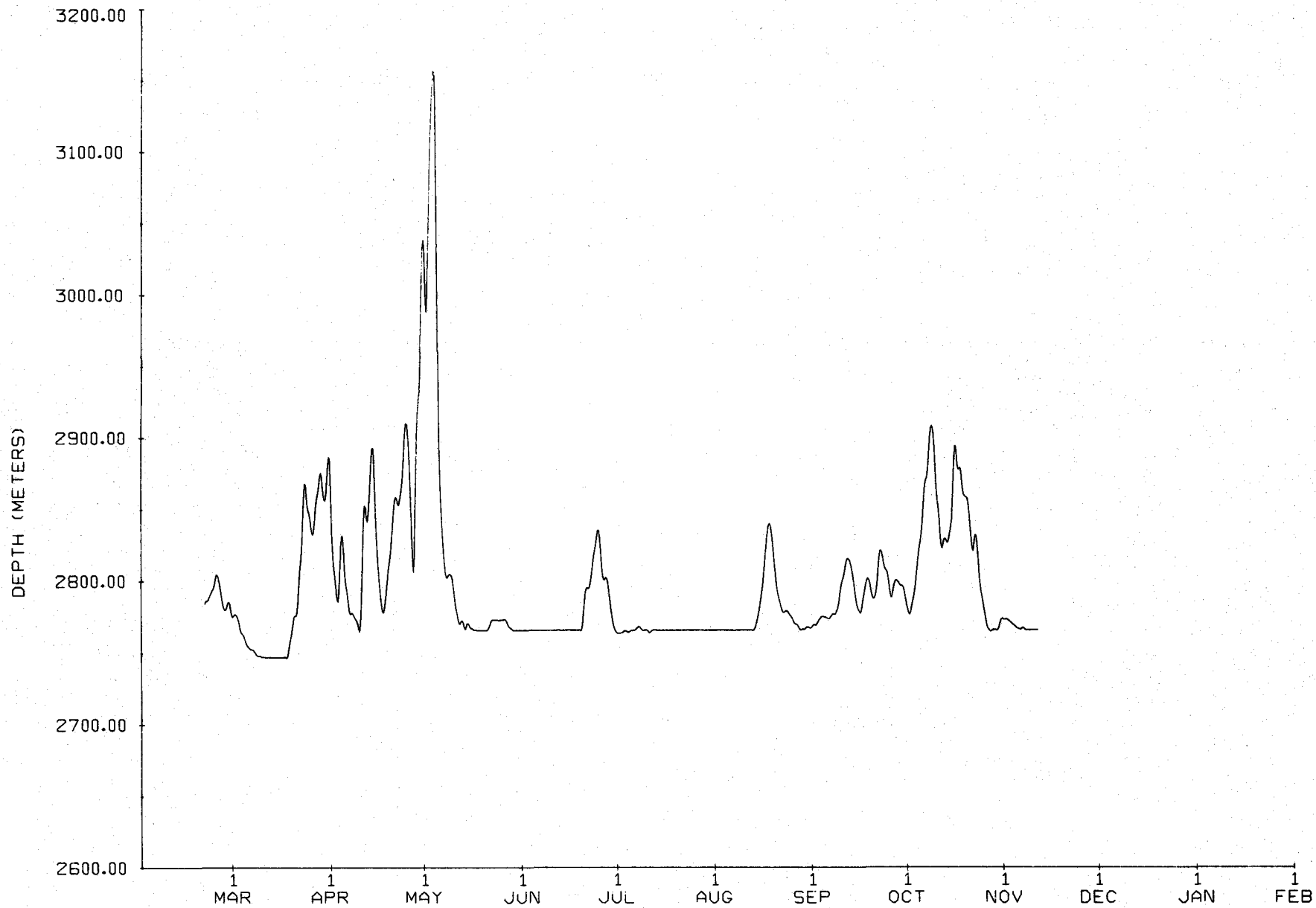
STATION ANN, 2781 METERS  
LLP CURRENT



STATION ANN, 500 METERS  
LLP DATA, TEMPERATURE



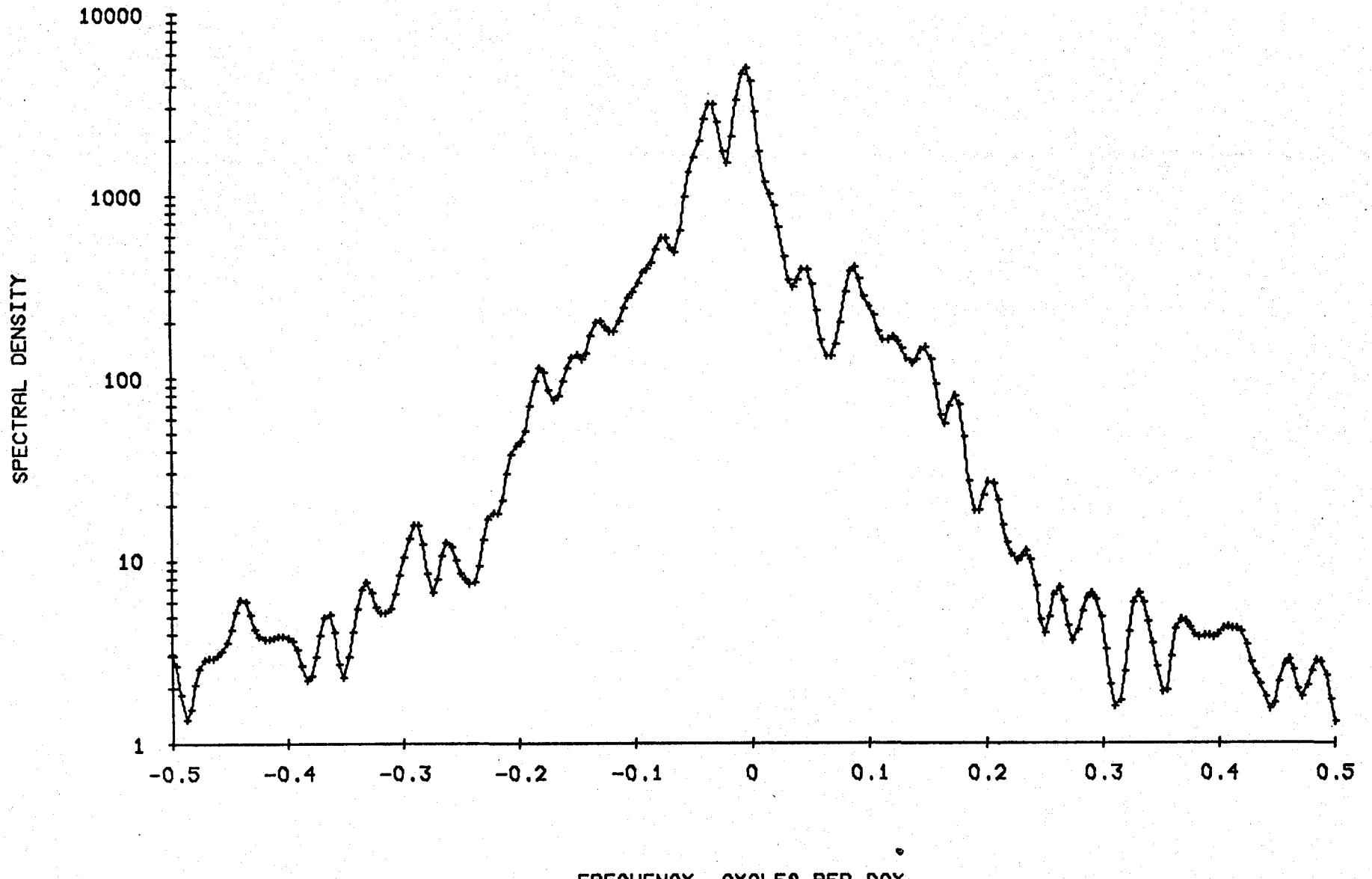
STATION ANN, 2781 METERS  
LLP DATA, TEMPERATURE



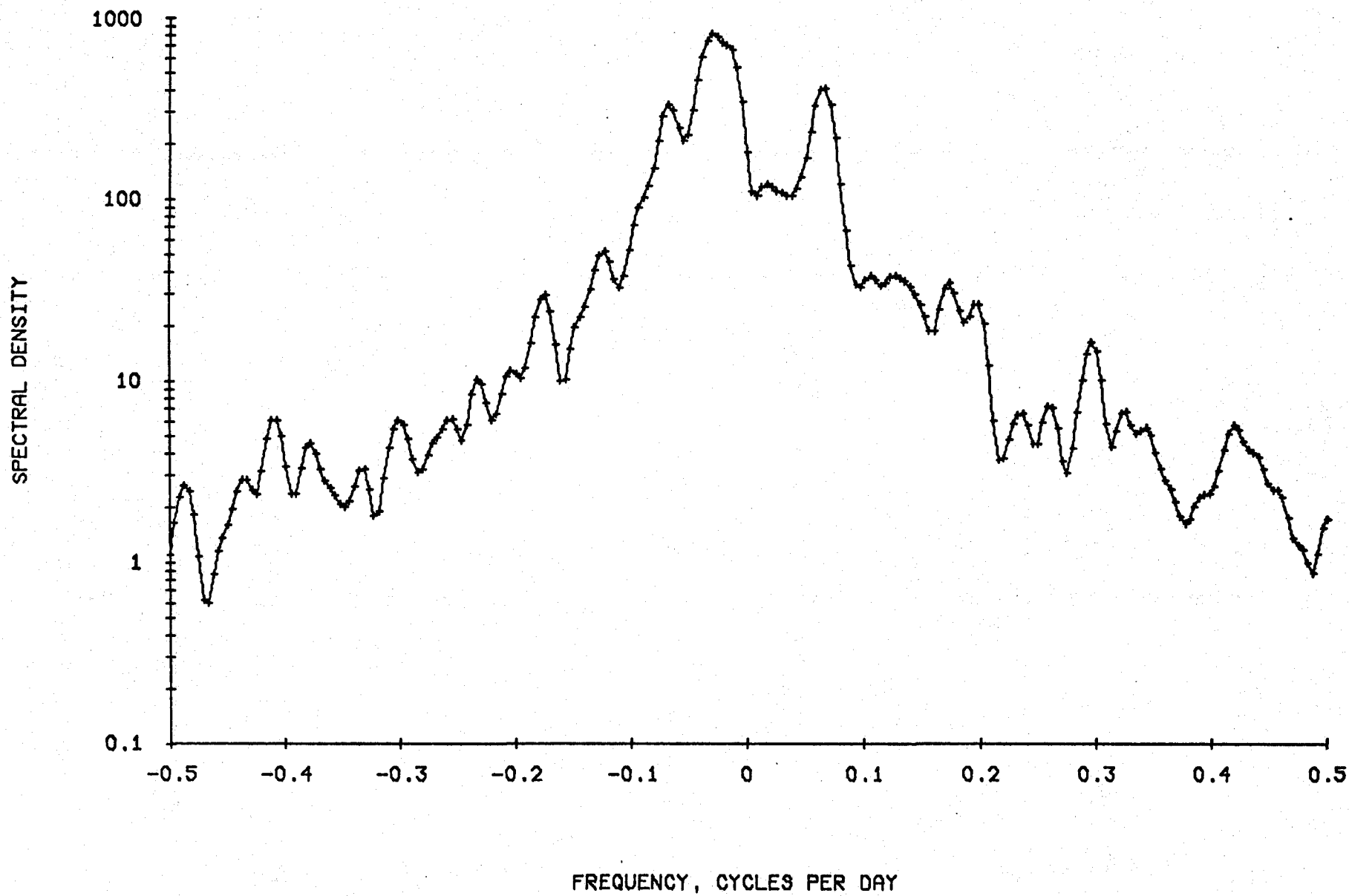
LLP DATA, PRESSURE AS DEPTH  
STATION ANN, 2781 METERS

LLP CURRENT AT 500 M, STN A. 248 DAYS STNG 0000 20 FEB 76.

38



LLP CURRENT AT 2781 M, STN A. 236 DAYS STNG 0000 20 FEB 76.





## SEVENTY-SIX

Position: 59°03.7'S, 63°29.4'W

Depth of Water: 3940 m

Set at 1419 UCT 19 February 1976 by R/V T. G. THOMPSON

Retrieved at 2333 UCT 21 January 1977 by R/V MELVILLE

Data Interval: 1611 UCT 19 February 1976 to 1811 UCT 19 January 1977

InstrumentationIntended DepthRCM5 Serial No./Tape No.

2700 m

1541/6

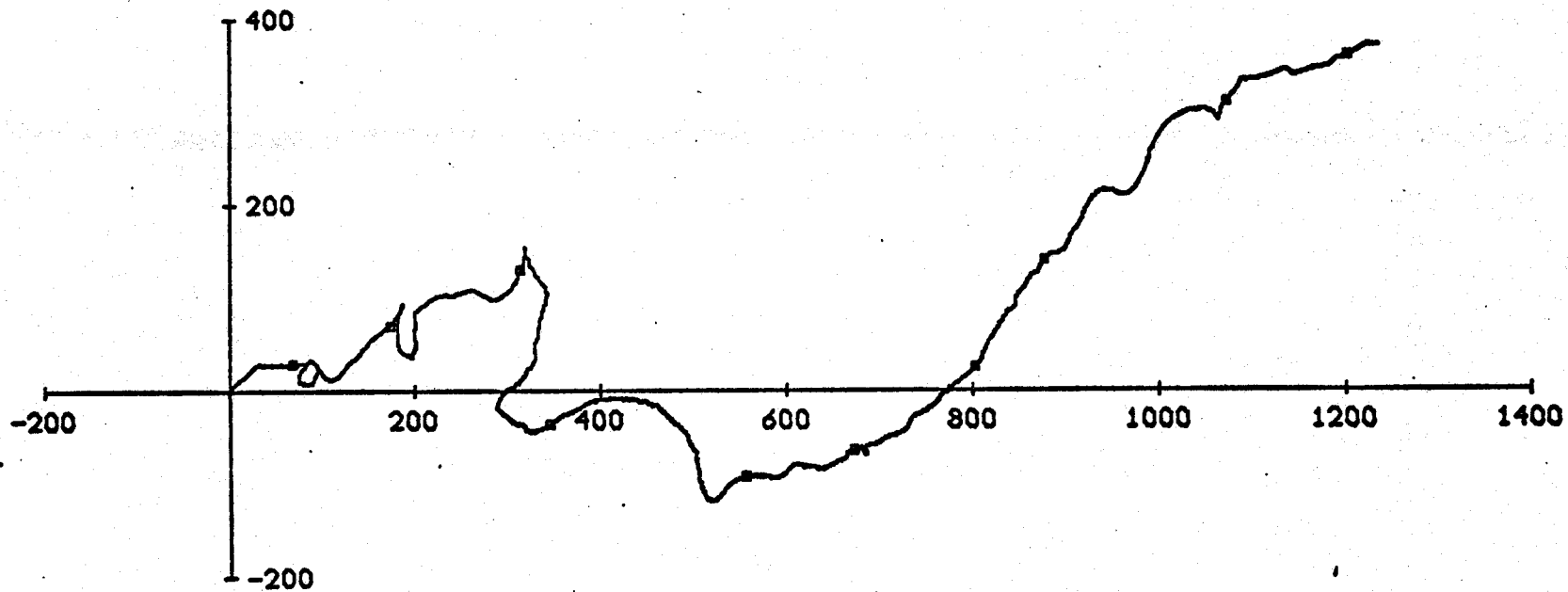
Instrument 1541 recorded speed, direction, temperature, and pressure once per hour. The speed sensor failed at 1611 UCT 8 December 1976. The direction sensor failed at 1811 UCT 17 December 1976.

## SEVENTY-SIX

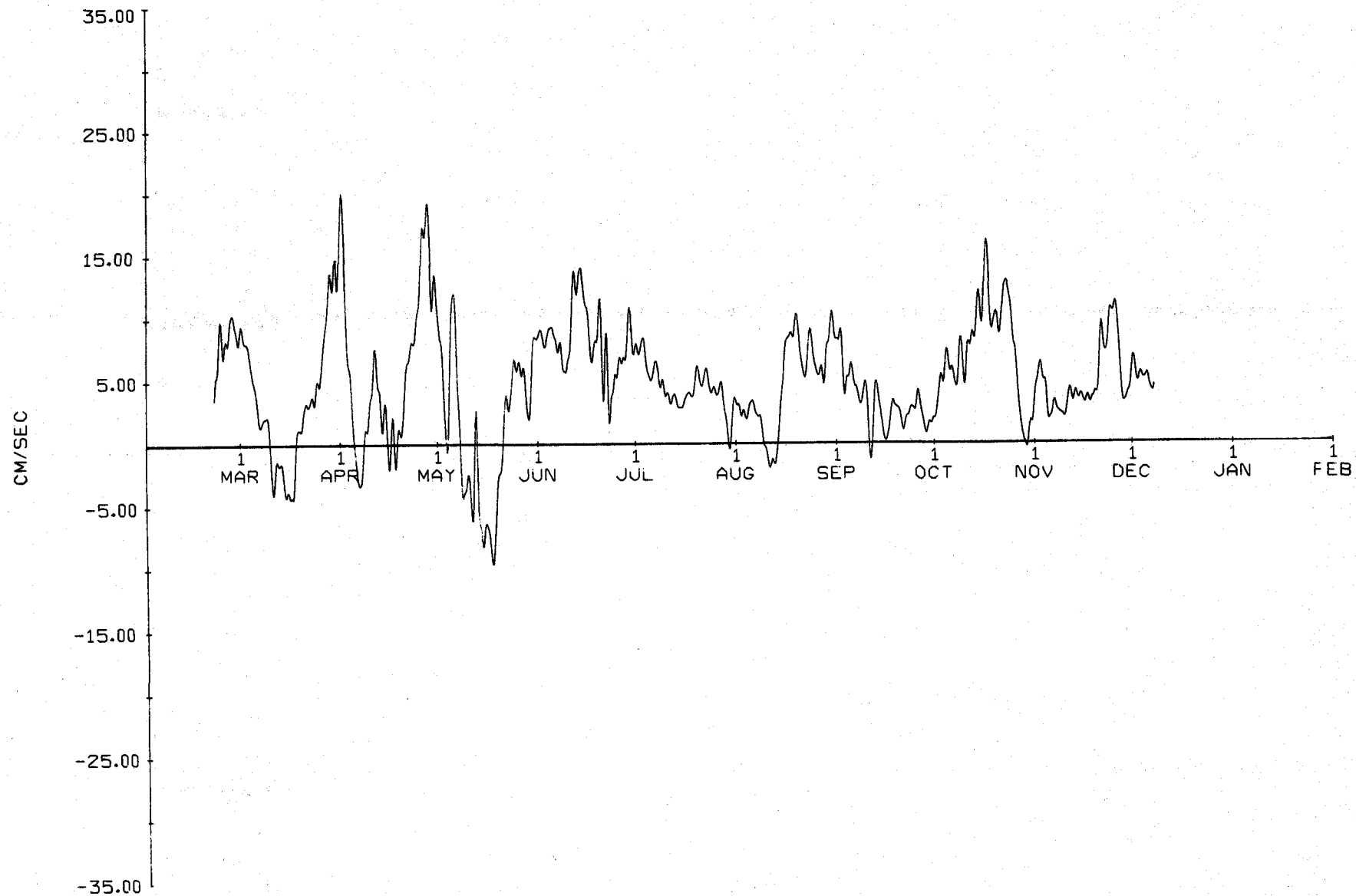
2791 m

	MEAN	S.D.	SKEW	KURT	MAX	MIN	N
S (cm/sec)	9.00	5.59	1.18	4.74	37.30	.80	7033
U (cm/sec)	4.88	5.54	.01	3.68	28.40	-19.00	7033
V (cm/sec)	1.46	7.46	-.26	5.14	33.20	-30.50	7033
T (°C)	.85	.22	1.12	3.60	1.73	.56	8043
P (X10 <sup>4</sup> pascal)	2861.20	25.70	4.45	27.61	3056.00	2791.30	8043

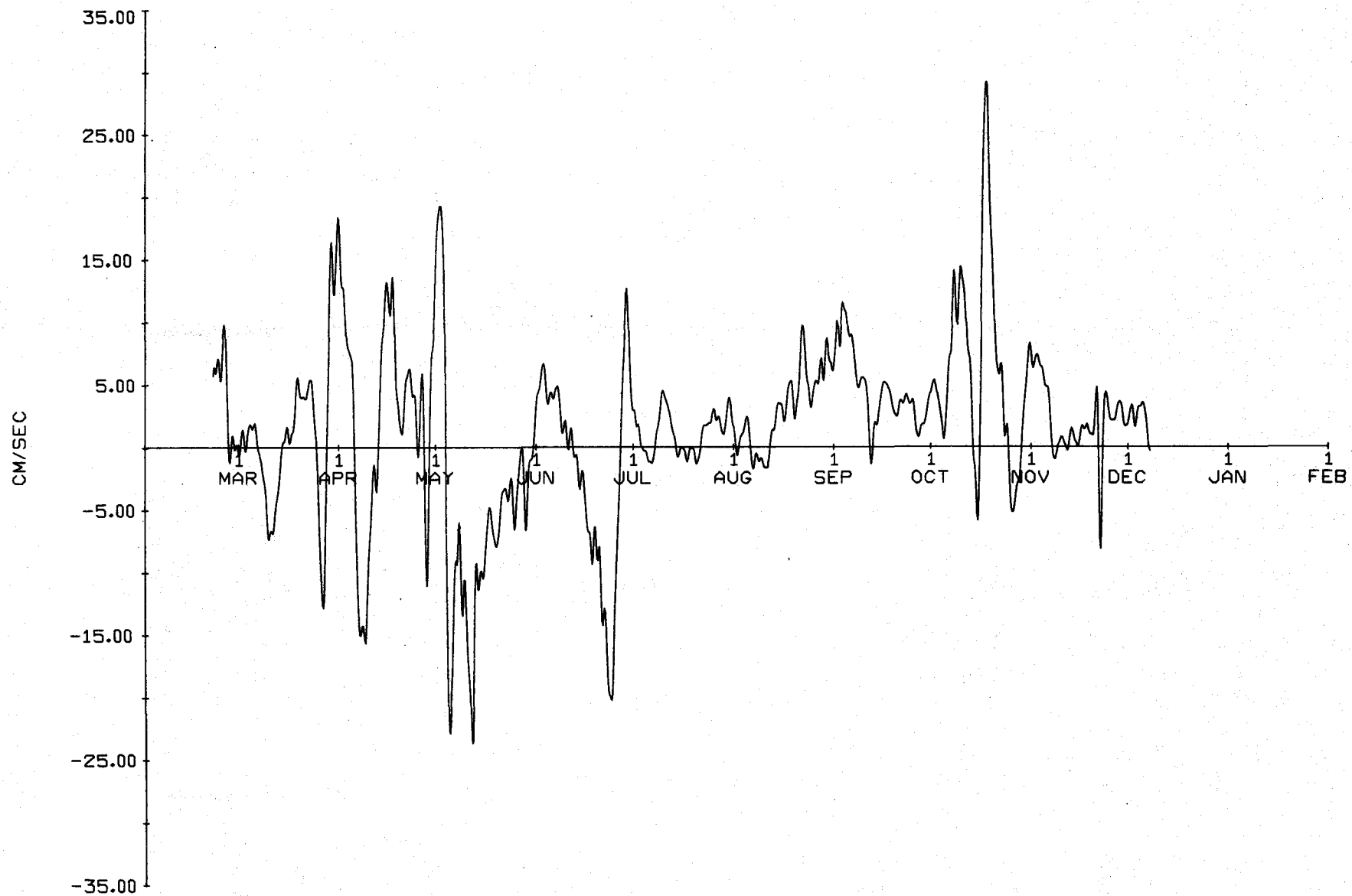
Directional Stability of the LLP Current = 61%



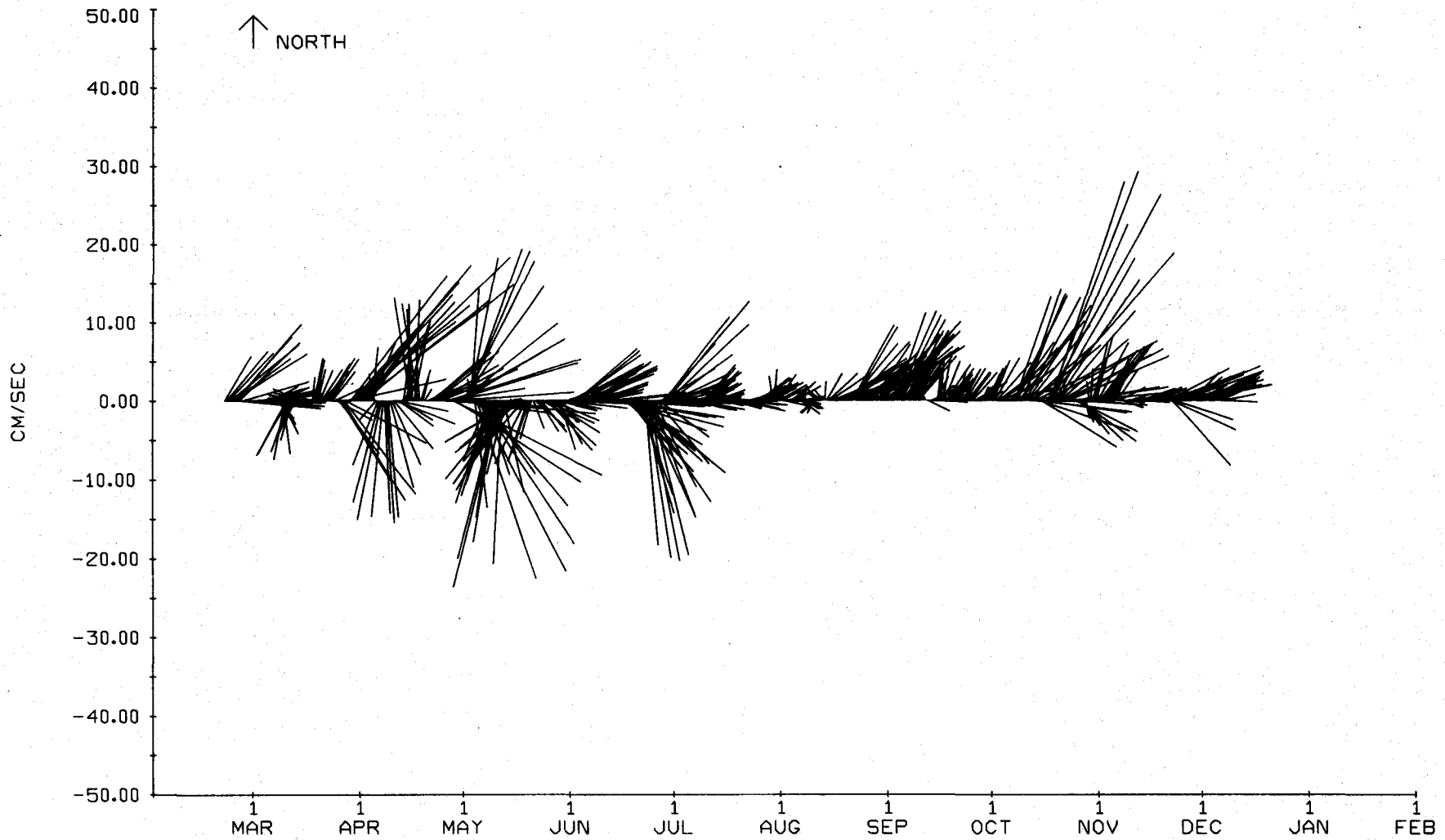
2791 M AT FDRAKE 76 STN 76. 19 FEB 76 - 8 DEC 76.



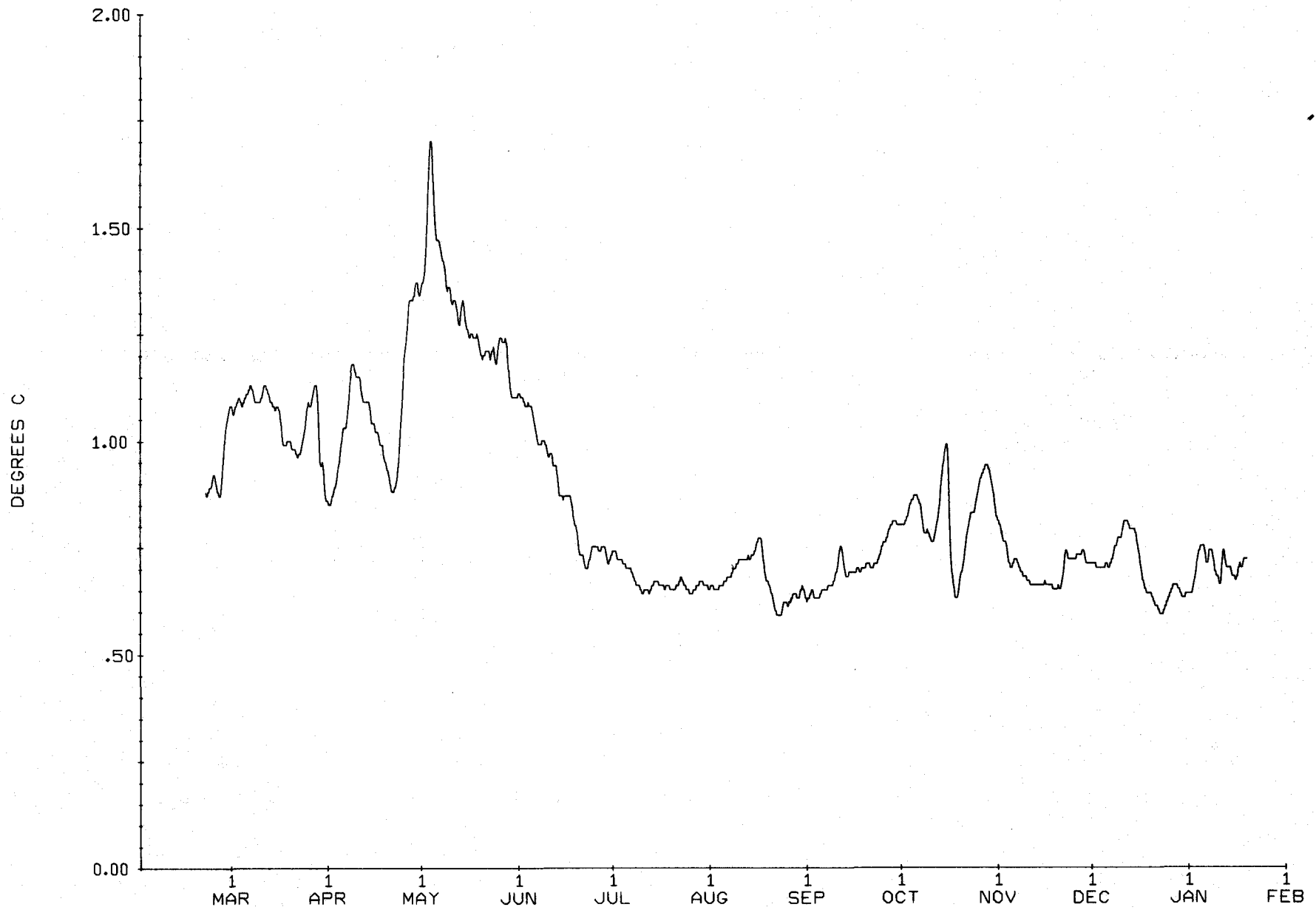
STATION 76, 2791 METERS  
LLP DATA, U COMPONENT



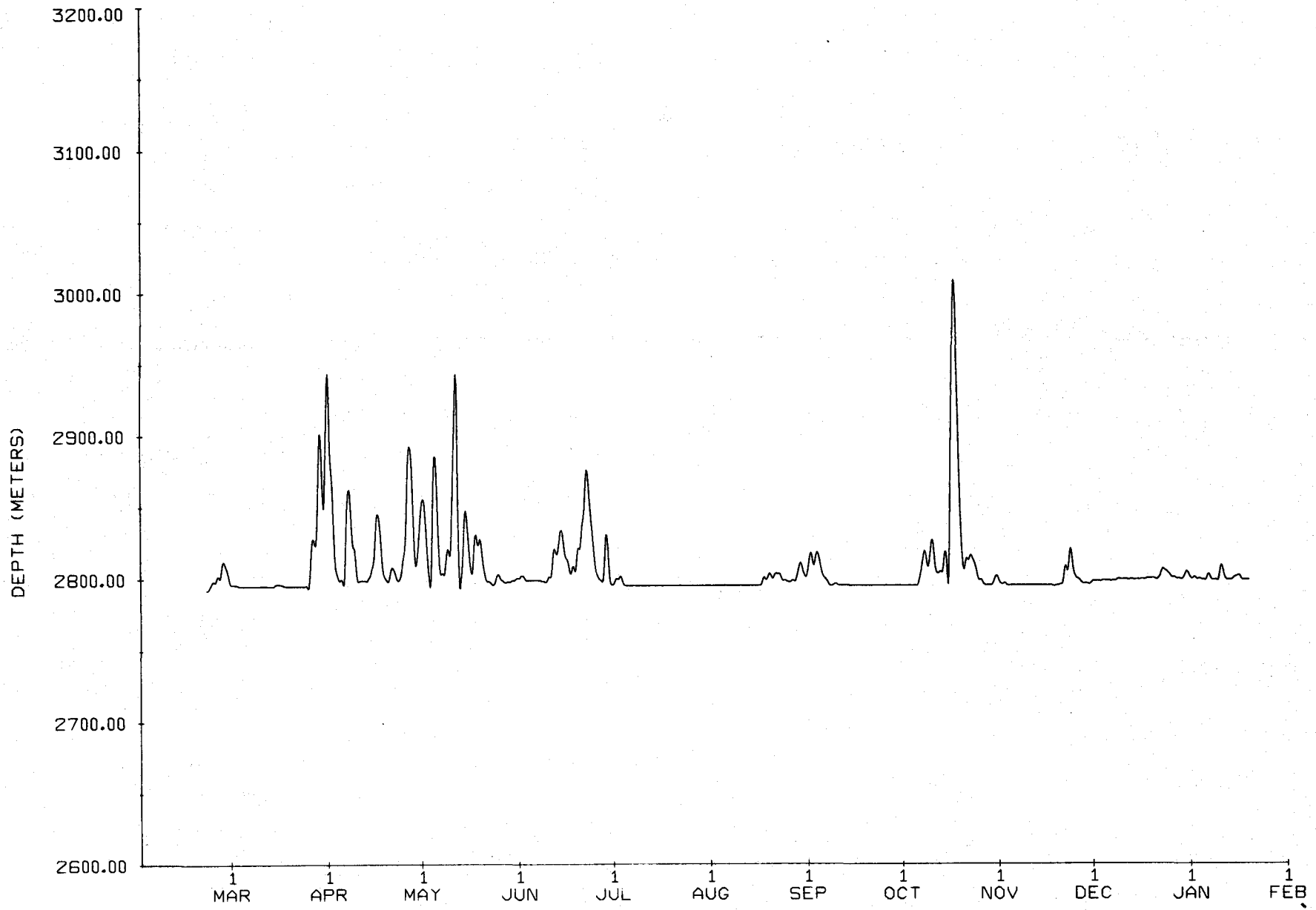
STATION 76, 2791 METERS  
LLP DATA, V COMPONENT



STATION 76, 2791 METERS  
LLP CURRENT



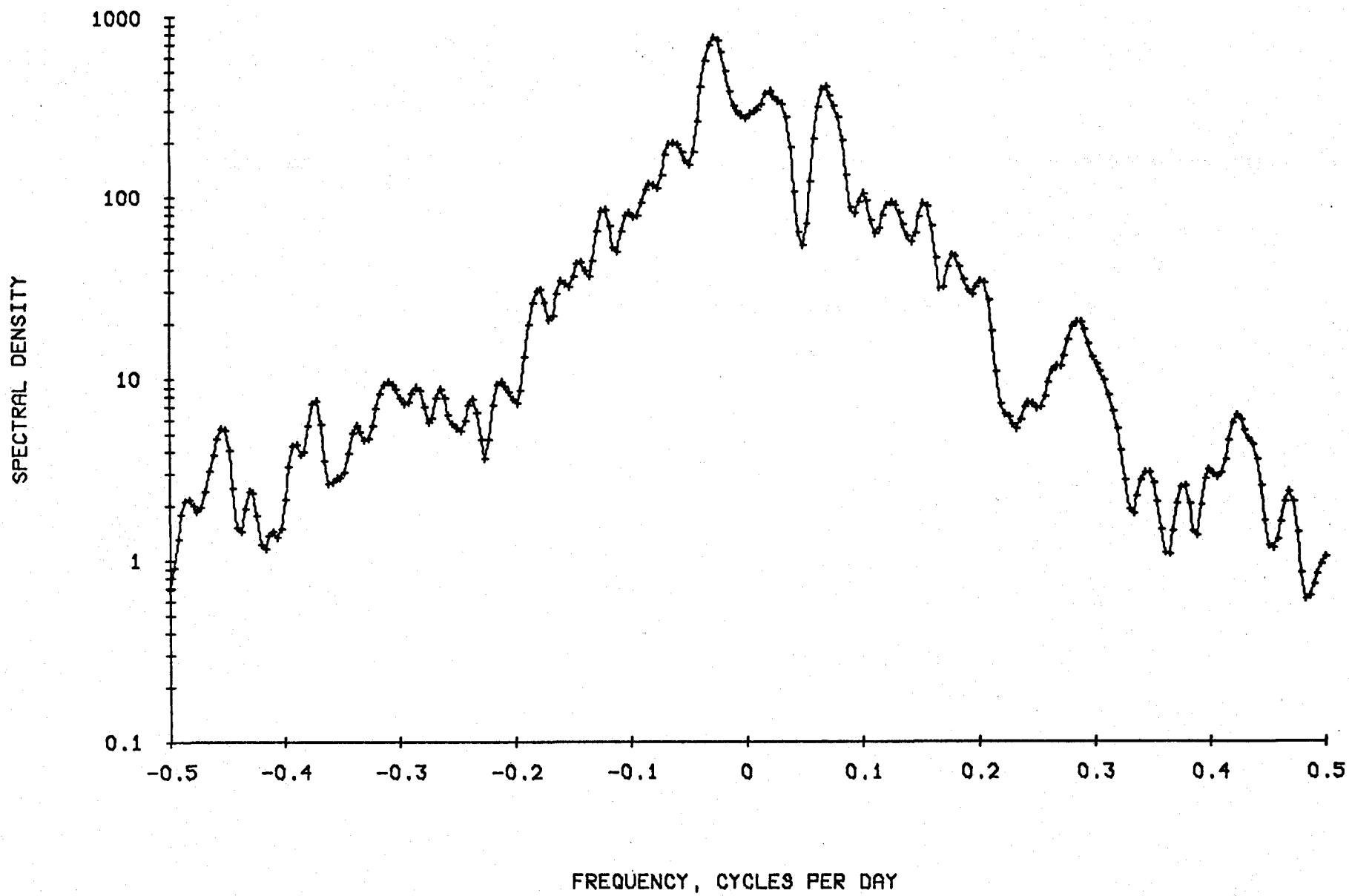
STATION 76, 2791 METERS  
LLP DATA, TEMPERATURE



LLP DATA, PRESSURE AS DEPTH  
STATION 76, 2791 METERS



LLP CURRENT AT 2791 M, STN 76. 288 DAYS STNG 1800 20 FEB 76



## NINETEEN

Position: 59°11.1'S, 64°05.0'W

Depth of Water: 3710 m

Set at 0022 UCT 19 February 1976 by R/V T. G. THOMPSON

Retrieved at 1710 UCT 21 January 1977 by R/V MELVILLE

Data Interval: 0506 UCT 19 February 1976 to 2006 14 January 1977

InstrumentationIntended Depth

2700 m

RCM5 Serial No./Tape No.

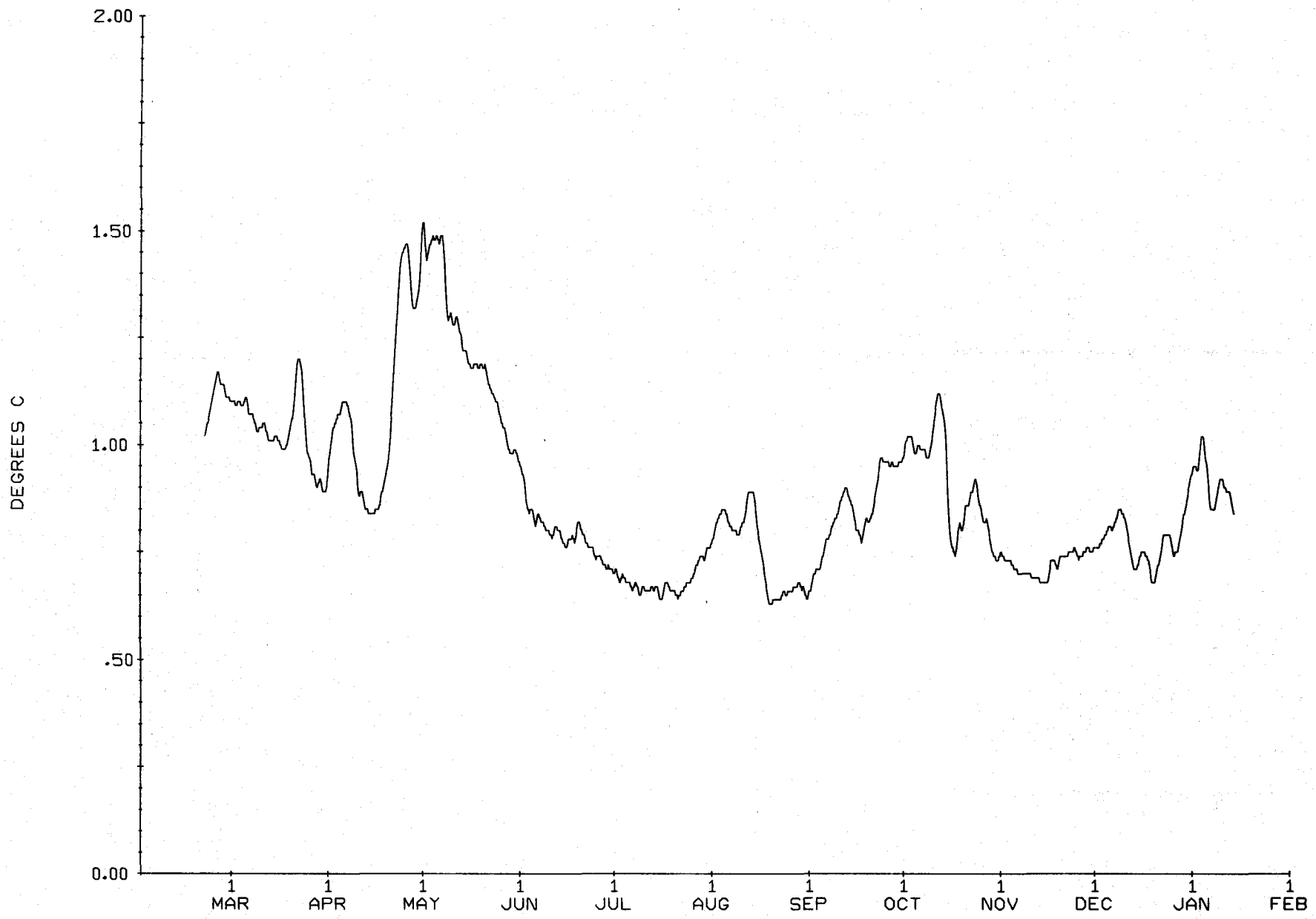
1540/6

Instrument 1540 recorded speed, direction, temperature, and pressure once per hour. The direction sensor malfunctioned and no direction data was obtained. The speed sensor failed at 0806 27 December 1976.

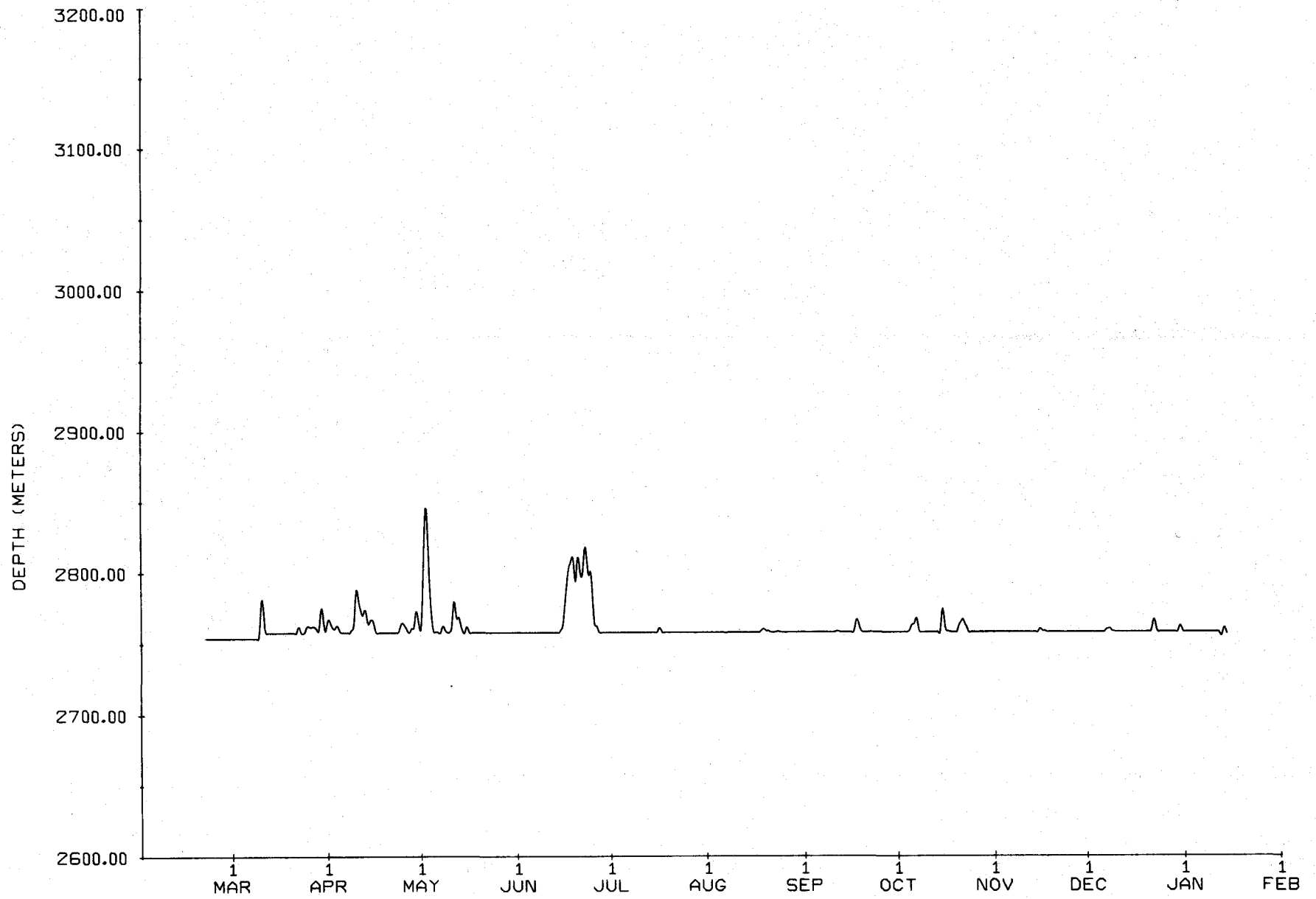
## NINETEEN

2746 m

	MEAN	S.D.	SKEW	KURT	MAX	MIN	N
S (cm/sec)	6.25	3.11	.51	3.32	18.40	.80	7492
T (°C)	.89	.20	1.09	3.82	1.56	.58	7936
P (X10 <sup>4</sup> pascal)	2760.00	10.23	5.17	35.61	2877.50	2753.70	7936



STATION 19, 2746 METERS  
LLP DATA, TEMPERATURE



LLP DATA, PRESSURE AS DEPTH  
STATION 19, 2746 METERS

## KARIE

Position: 60°23.1'S, 62°37.9'W

Depth of Water: 3784 m

Set at 2207 UCT 17 February 1976 by R/V T. G. THOMPSON

Retrieved at 1553 UCT 22 January 1977 by R/V MELVILLE

Data Interval: 0013 UCT 18 February 1976 to 1613 UCT 21 March 1976

InstrumentationIntended Depth

2700 m

RCM5 Serial No./Tape No.

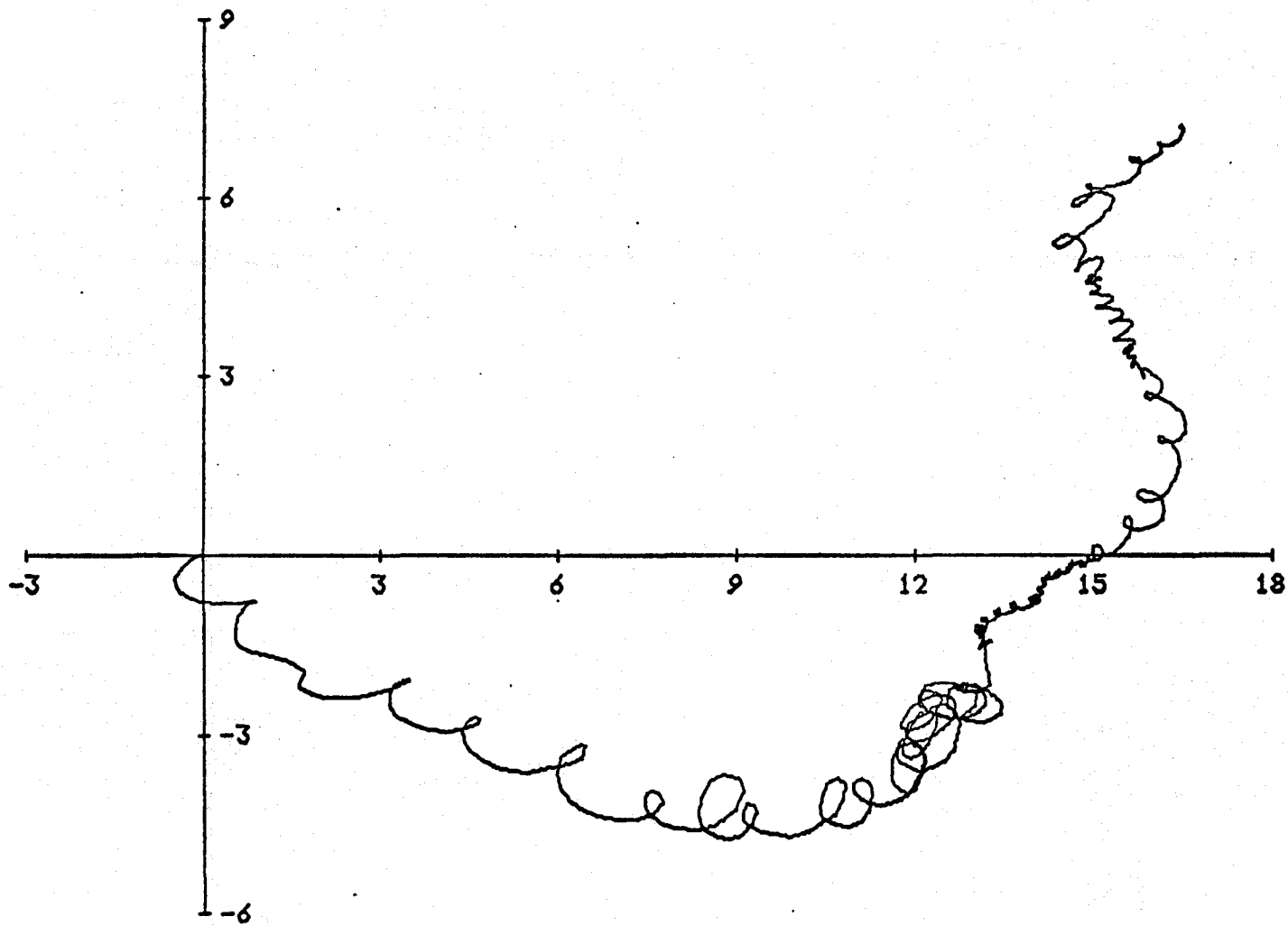
1537/8

Instrument 1537/8 recorded speed, direction, and temperature once per hour. The instrument failed after approximately one month of operation. Because of the short record length, no LLP data were generated.

## KARIE

2700 m

	MEAN	S.D.	SKEW	KURT	MAX	MIN	N
S (cm/sec)	2.76	2.33	1.02	3.18	12.30	.80	785
U (cm/sec)	.58	2.80	.64	4.46	12.10	-6.90	785
V (cm/sec)	.25	2.19	-.09	4.58	8.10	-7.40	785
T (°C)	.60	.02	.34	3.30	.66	.55	785



2700 M AT FDRAKE 76 STN KARIE. 18 FEB 76 - 21 MAR 76.



## ELIZABETH

Position: 61°02.8'S, 61°52.8'W

Depth of Water: 3683 m

Set at 1512 UCT 17 February 1976 by R/V T. G. THOMPSON

Retrieved at 0820 UCT 23 January 1977 by R/V MELVILLE

Data Interval: 1804 UCT 17 February 1976 to 704 UCT 23 January 1977

InstrumentationIntended DepthRCM5 Serial No./Tape No.

500 m  
2700 m

1543/7  
1539/9

Instrument 1543 recorded speed, direction, and temperature once per hour. Instrument 1539 recorded speed, direction, temperature, and pressure once per hour. The direction sensor on instrument 1539 failed on 21 December 1976.

## ELIZABETH

461 m

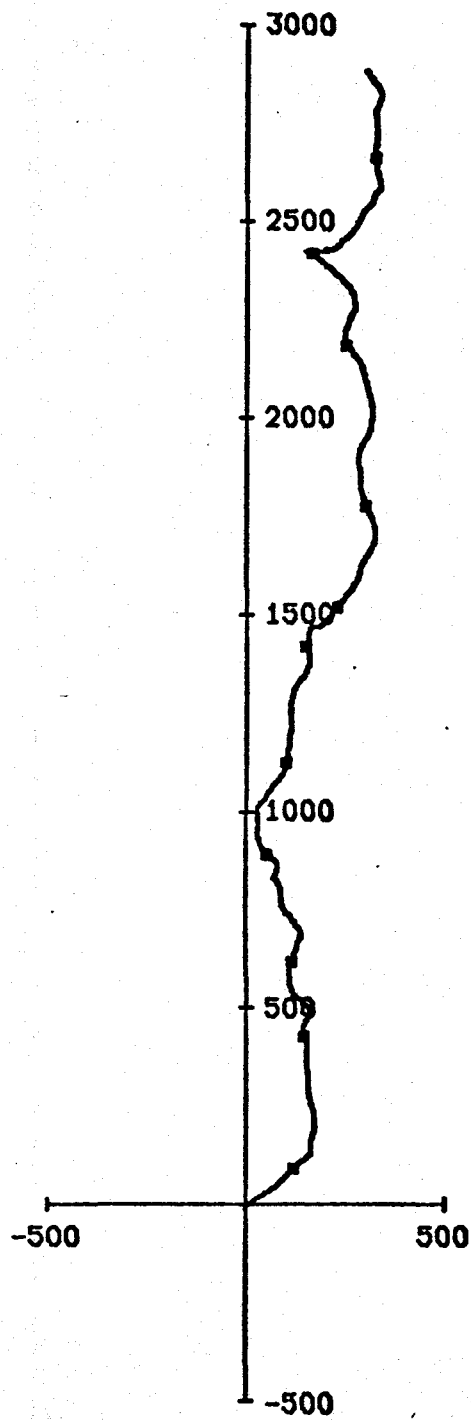
	MEAN	S.D.	SKEW	KURT	MAX	MIN	N
S (cm/sec)	12.59	6.08	.44	3.09	39.20	.80	8174
U (cm/sec)	1.00	7.43	-.45	3.31	26.00	-29.00	8174
V (cm/sec)	9.81	6.56	.24	2.82	33.60	-7.40	8174
T (°C)	2.10	.07	-.18	3.60	2.28	1.65	8174

Directional Stability of the LLP Current = 86%

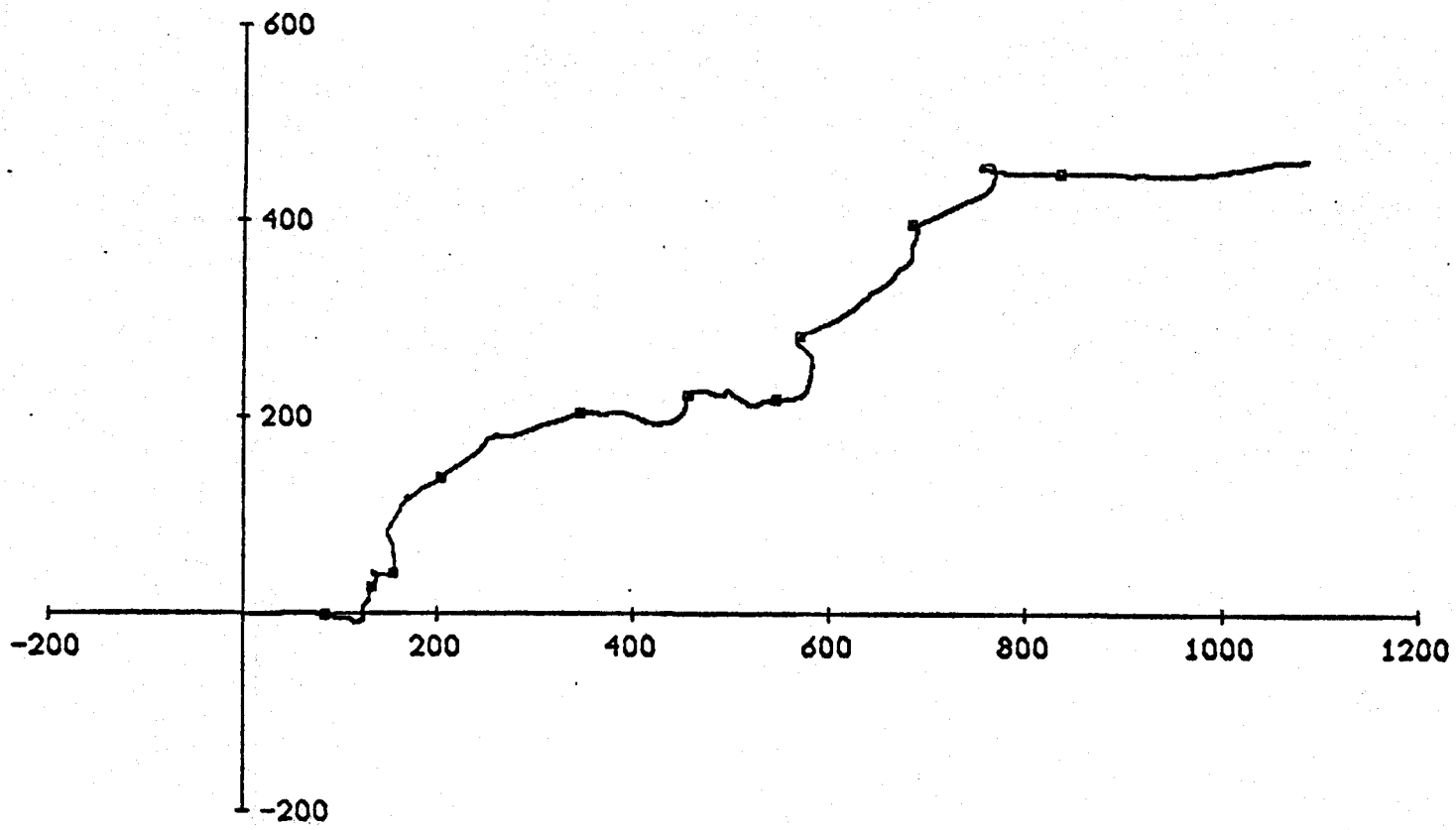
2661 m

S (cm/sec)	6.60	3.94	.91	4.02	26.70	.80	8118
U (cm/sec)	4.07	5.34	.33	3.33	26.60	-12.00	7397
V (cm/sec)	1.73	3.25	.41	3.49	15.00	-9.20	7397
T (°C)	.64	.04	-.45	3.45	.76	.49	8118
P (X10 <sup>4</sup> pascal)	2674.60	15.70	2.42	9.65	2790.10	2661.00	8118

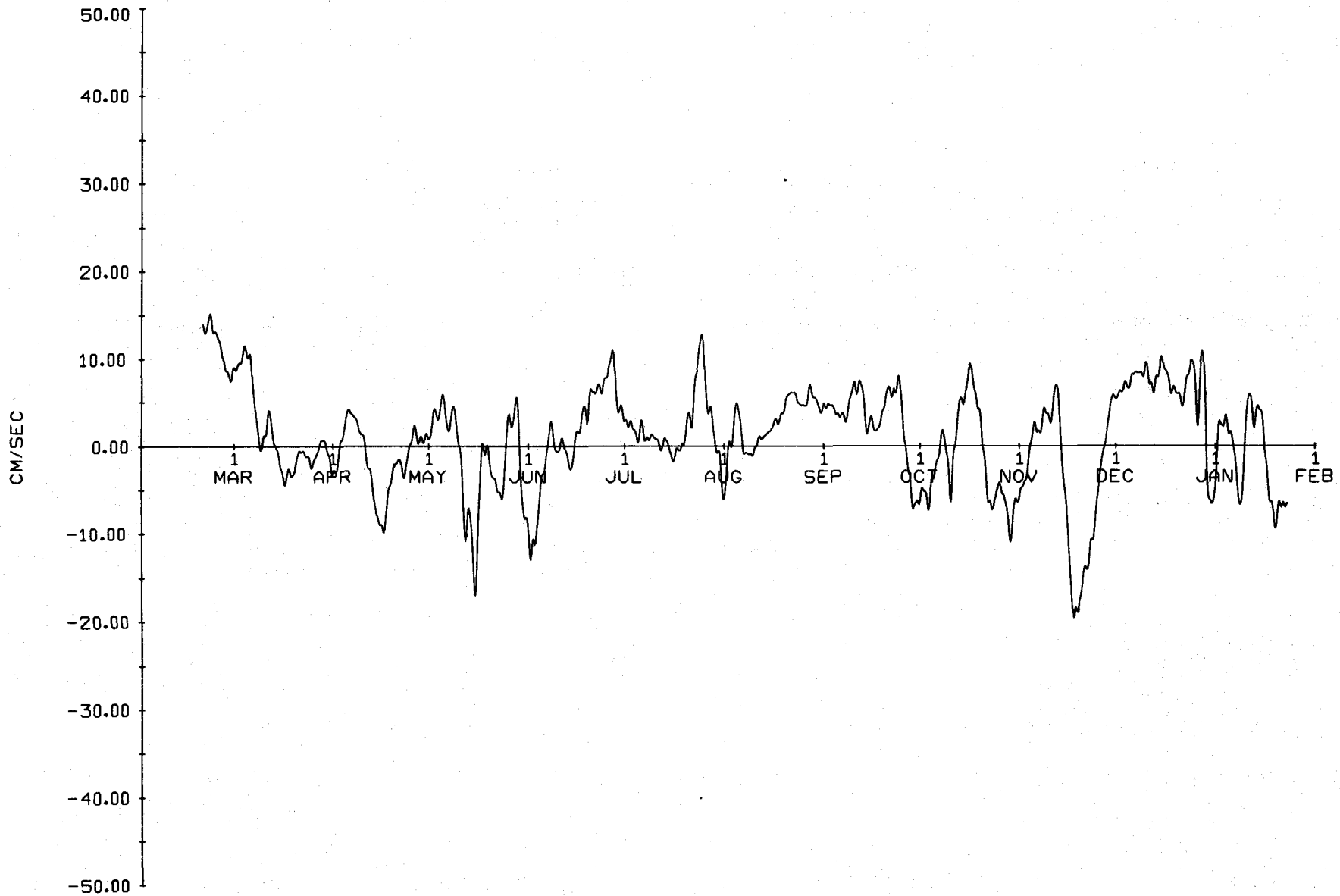
Directional Stability of the LLP Current = 79%



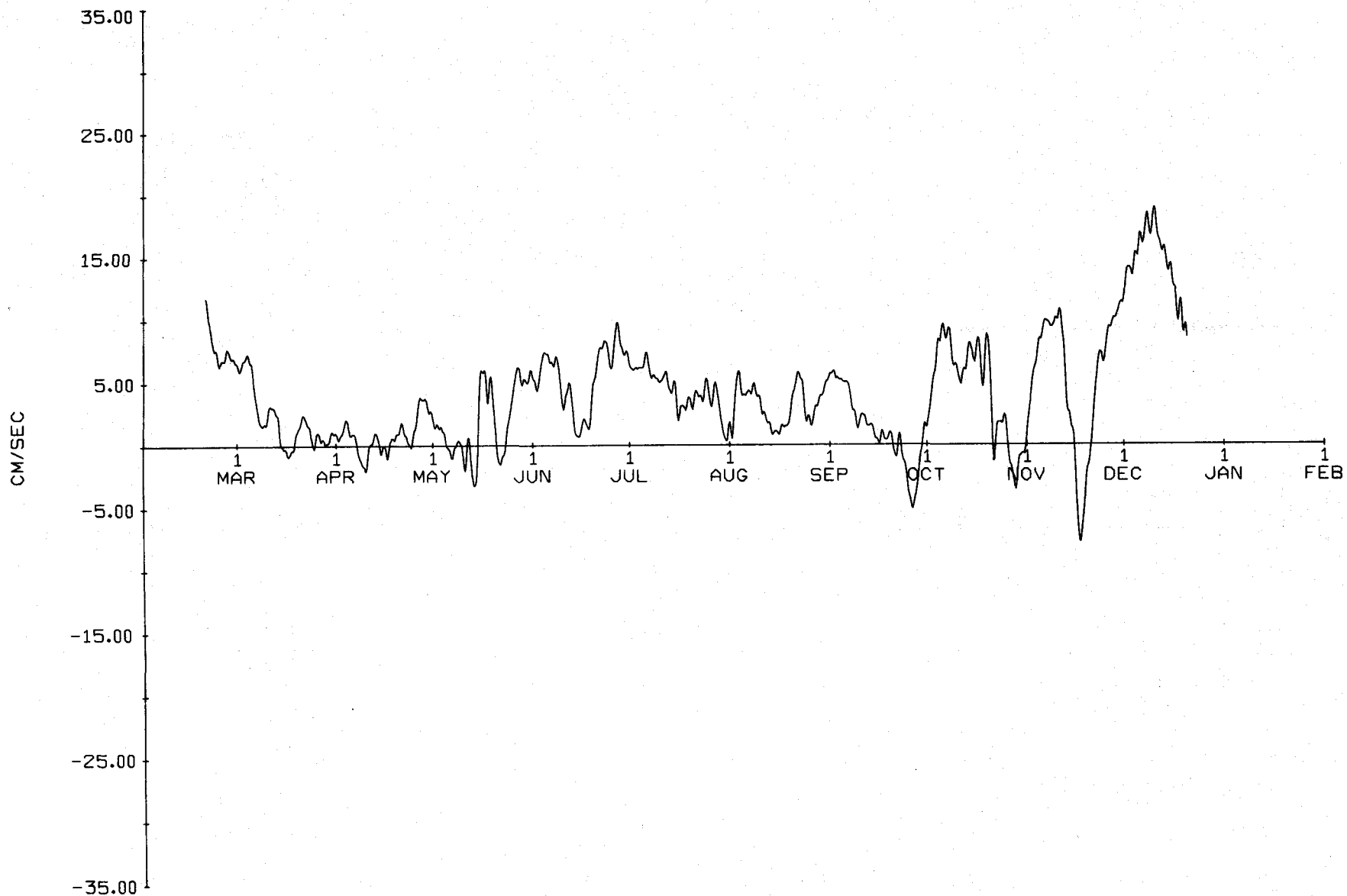
500 M AT FDRAKE 76 STN ELIZABETH. 17 FEB 76 - 23 JAN 77.



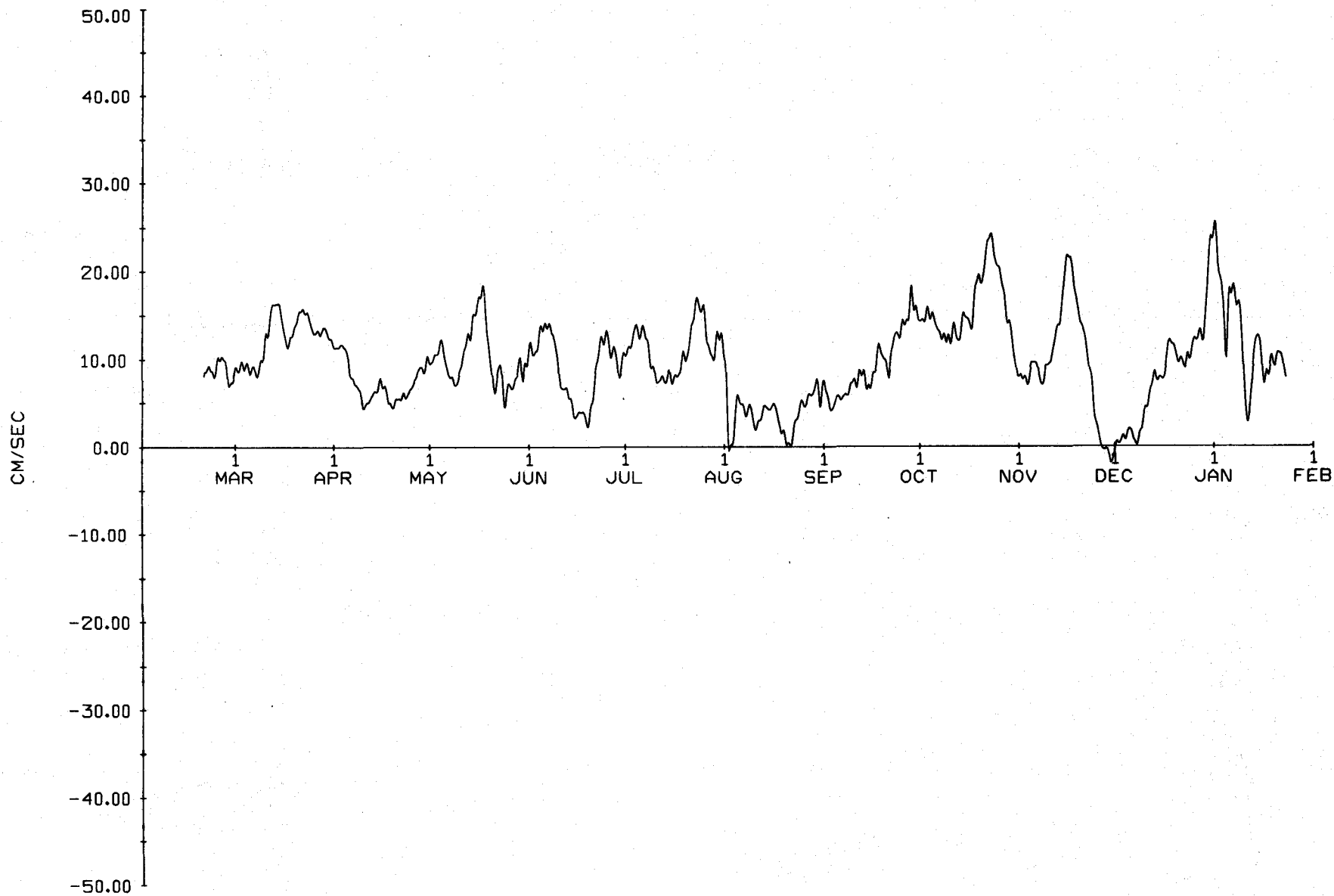
2661 M AT FDRAKE 76 STN ELIZABETH. 17 FEB 76 - 21 DEC 76.



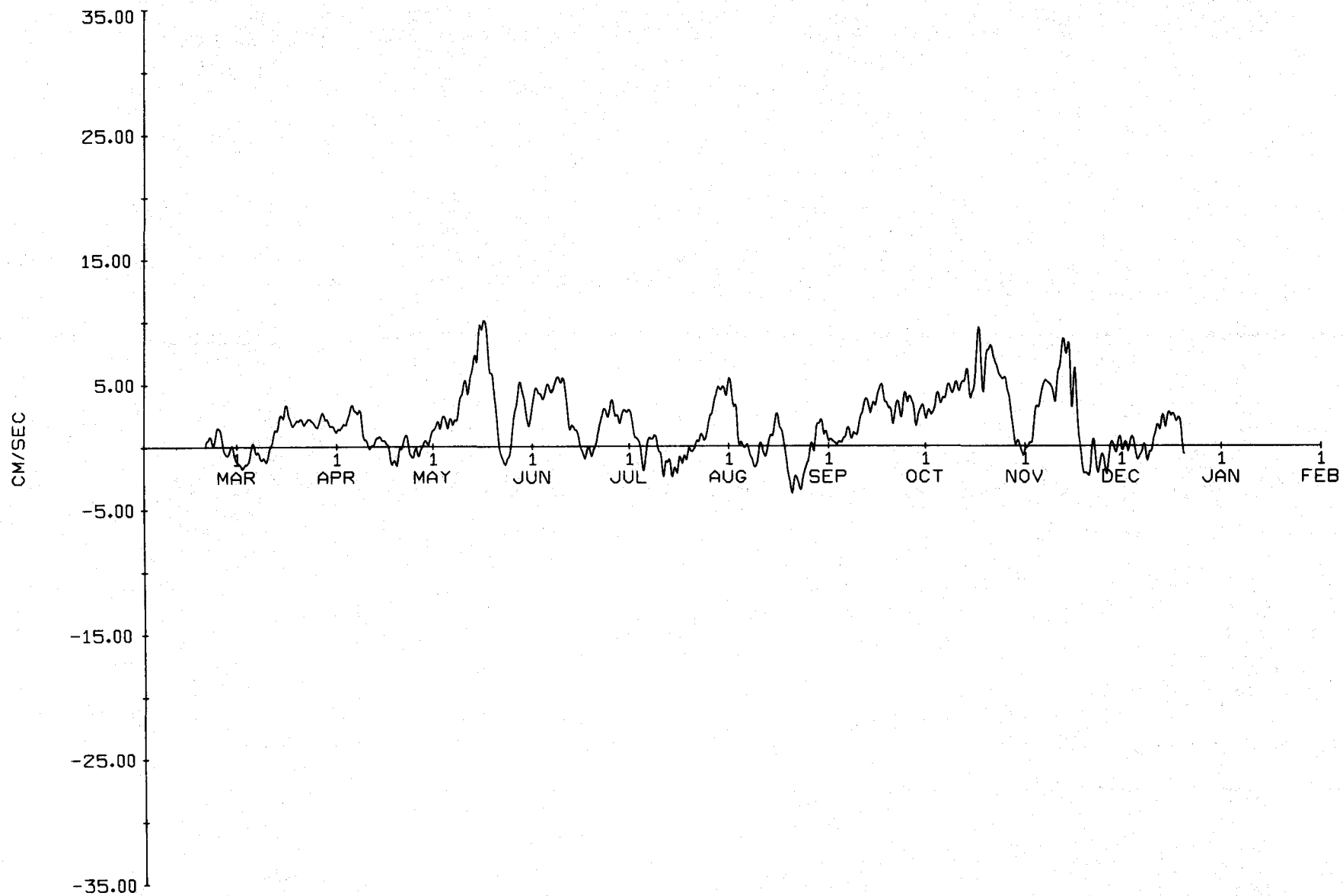
STATION ELIZABETH, 500 METERS  
LLP DATA, U COMPONENT



STATION ELIZABETH, 2661 METERS  
LLP DATA, U COMPONENT

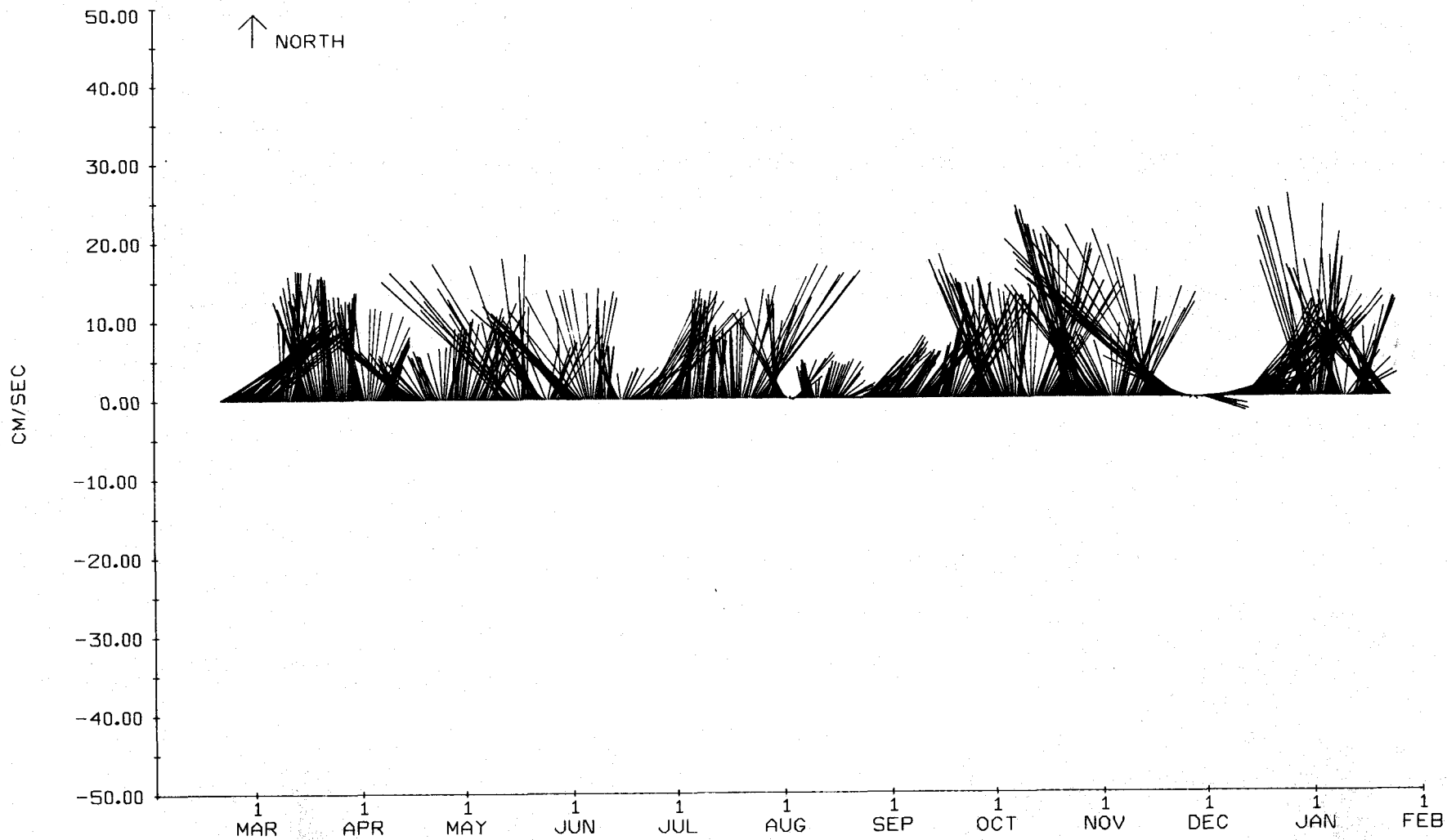


STATION ELIZABETH, 500 METERS  
LLP DATA, V COMPONENT

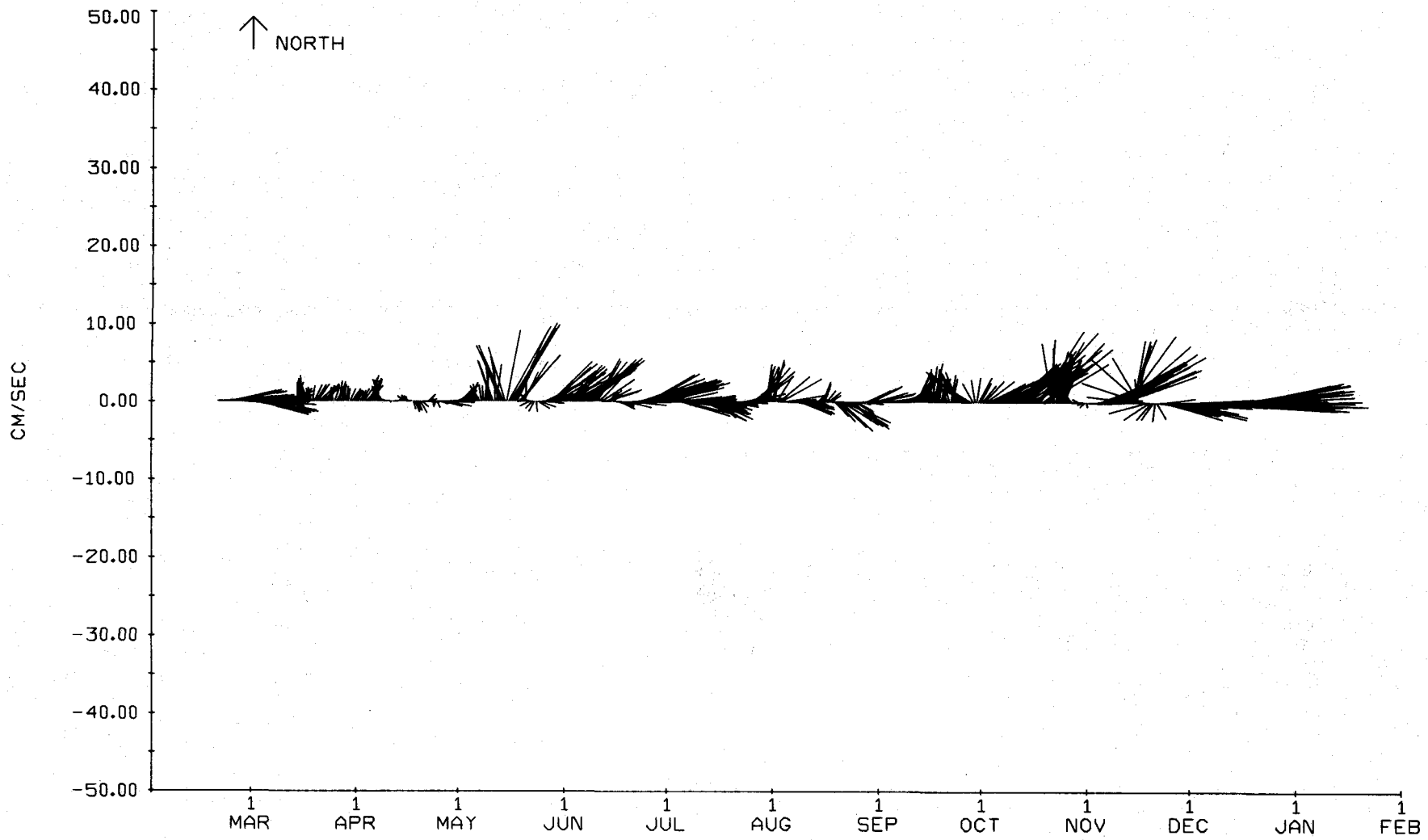


STATION ELIZABETH, 2661 METERS  
LLP DATA, V COMPONENT

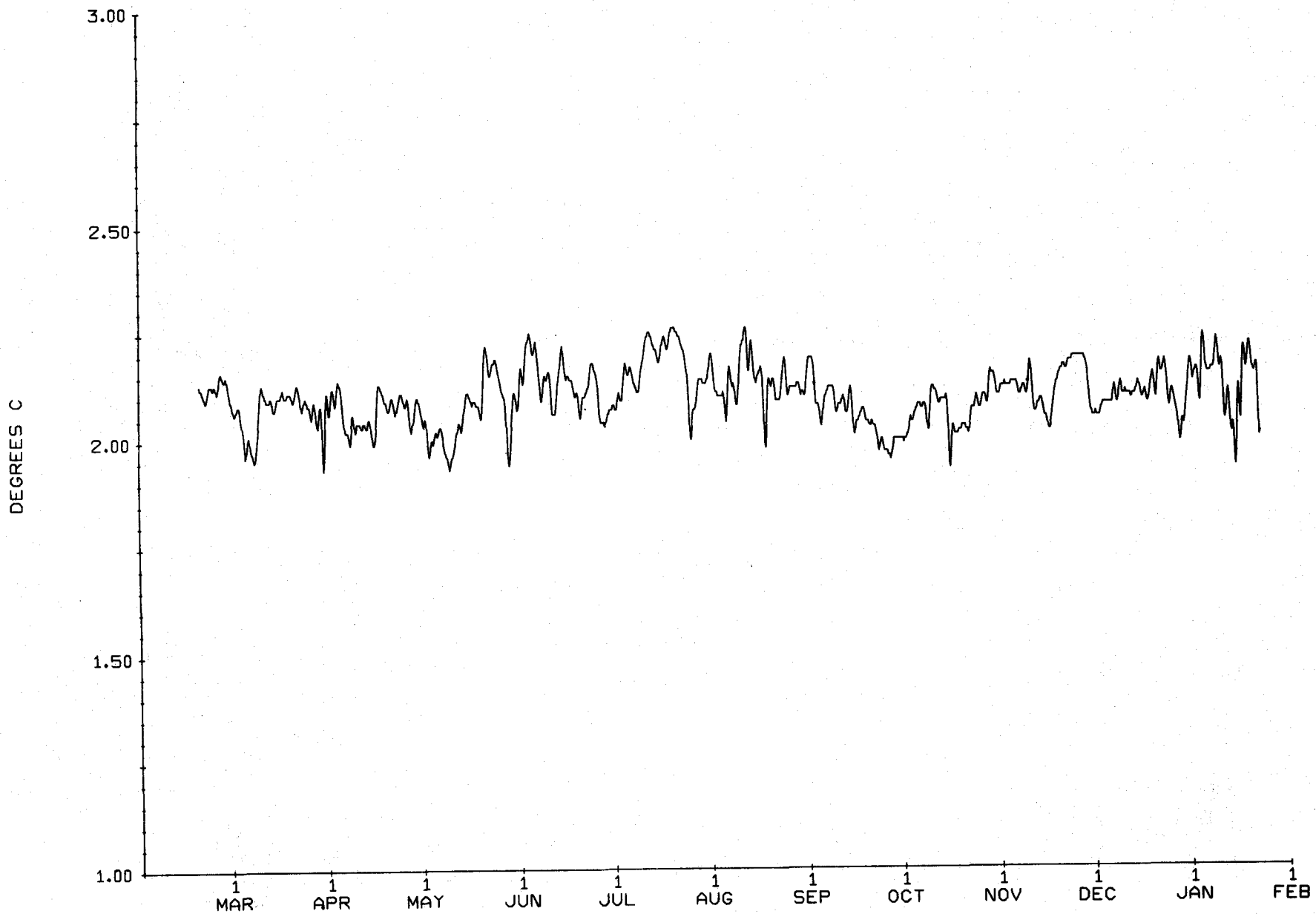




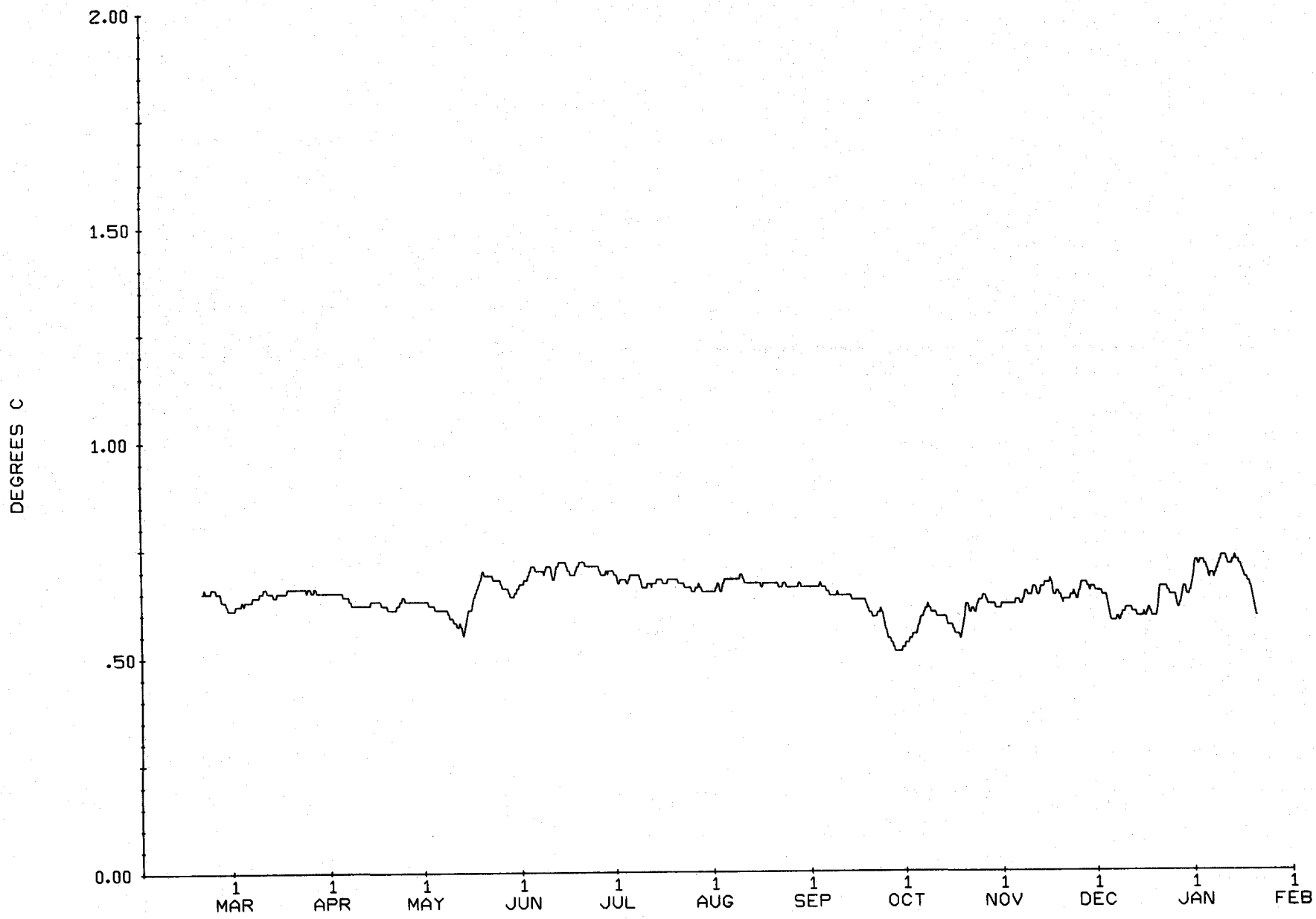
STATION ELIZABETH, 500 METERS  
LLP CURRENT



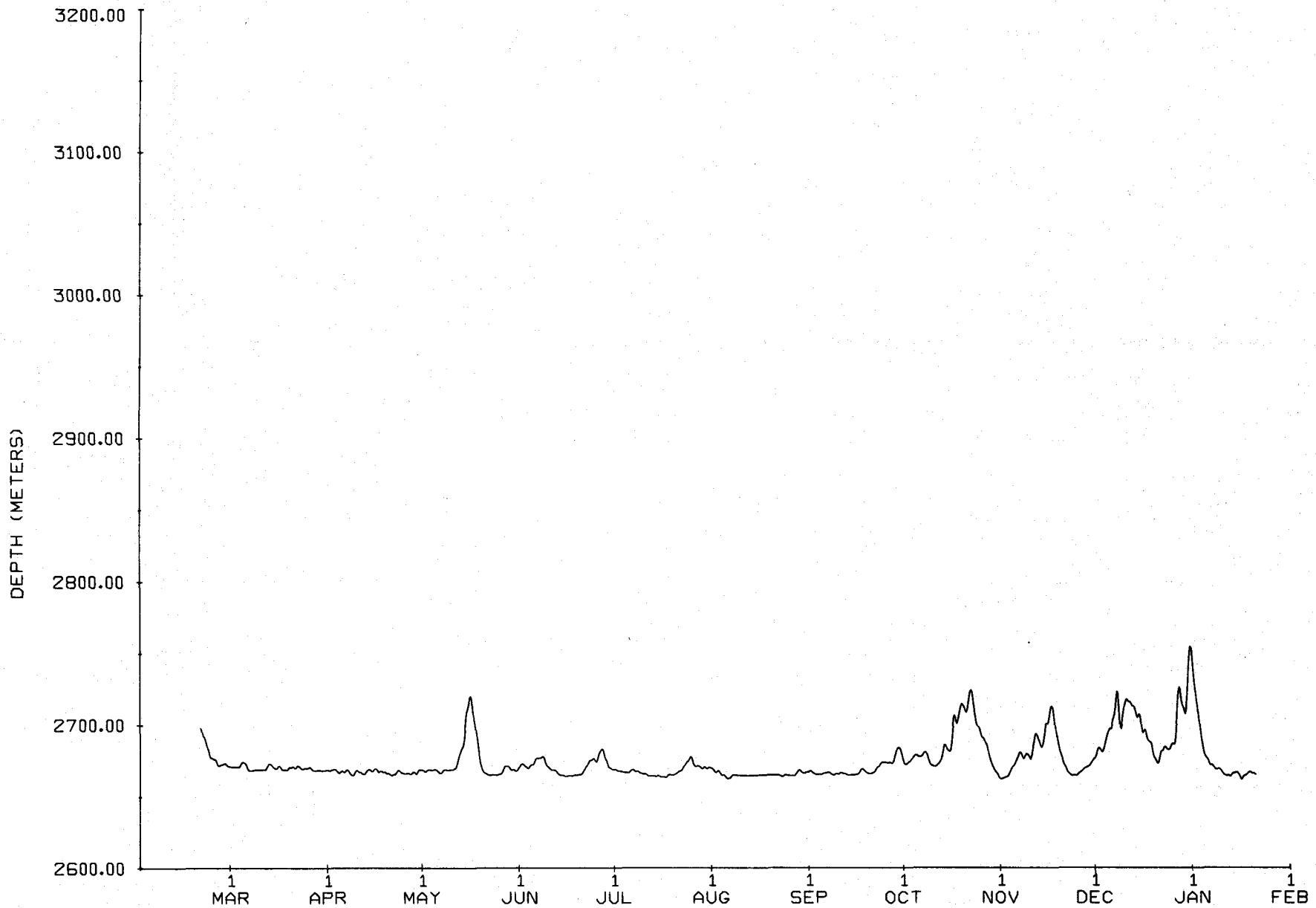
STATION ELIZABETH, 2661 METERS  
LLP CURRENT



STATION ELIZABETH, 500 METERS  
LLP DATA, TEMPERATURE



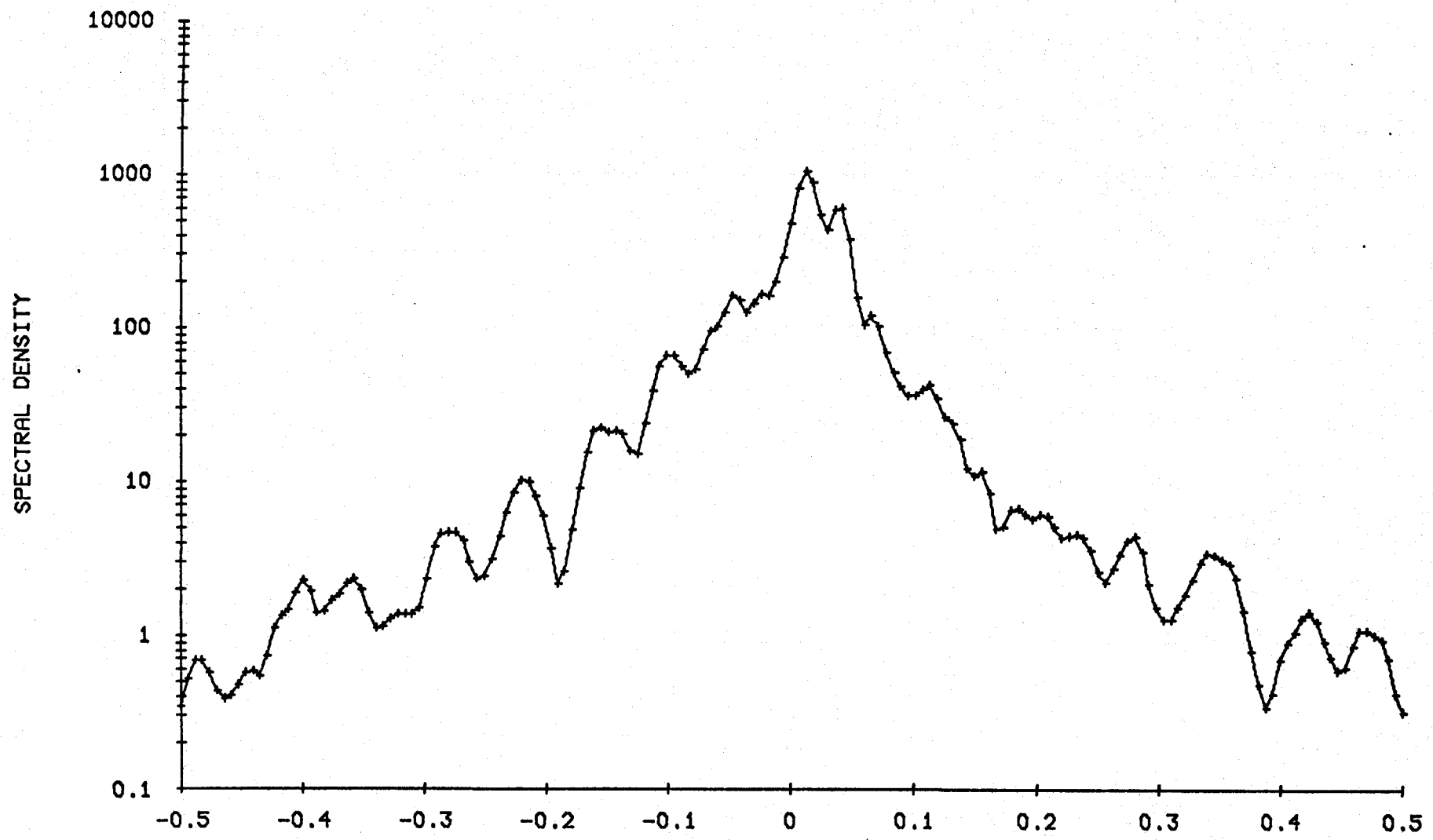
STATION ELIZABETH, 2661 METERS  
LLP DATA, TEMPERATURE



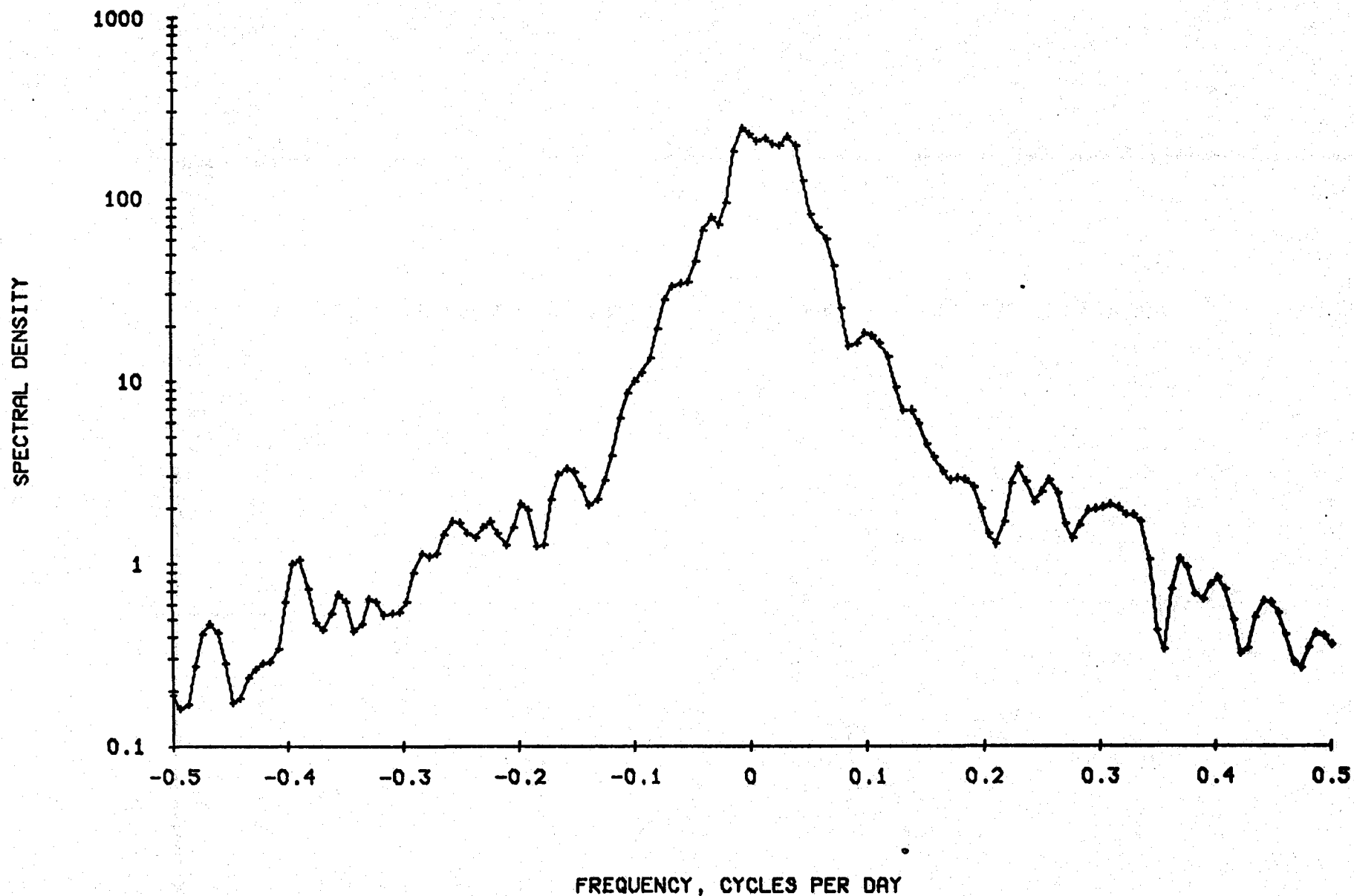
LLP DATA, PRESSURE AS DEPTH  
STATION ELIZABETH, 2661 METERS

LLP CURRENT AT 500 M, STN E. 336 DAYS STNG 0000 19 FEB 76.

72



LLP CURRENT AT 2661 M, STN E. 304 DAYS STNG 0000 19 FEB 76.



## HERO BAY TIDE GAUGE

Position: 62°28.0'S, 60°27.4'W

Depth of Water: 96 m

Set at 2015 UCT 16 February 1976 by R/V T. G. THOMPSON

Retrieved at 1745 UCT 24 January 1977 by R/V MELVILLE

Data Interval: 2016 UCT 16 February 1976 to 1346 UCT 4 November 1976

InstrumentationIntended Depth

100 m

TG Serial No./Tape No.

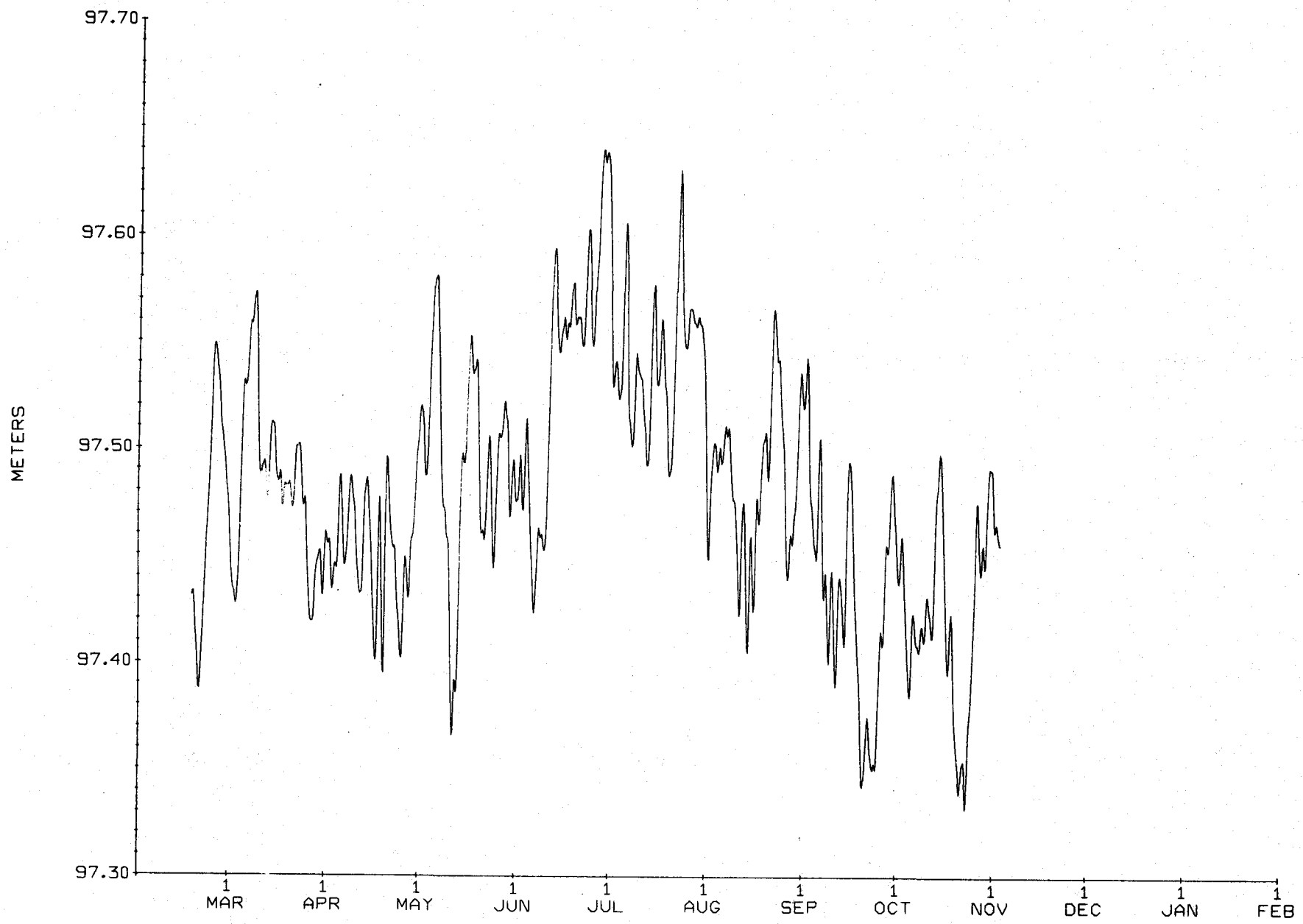
50/3

Pressure was recorded once per hour. The pressure recorded was integrated for 400 seconds by the tide gauge just prior to the hour recorded.



## HERO BAY TIDE GAUGE

	MEAN	S.D.	SKEW	KURT	MAX	MIN	N
Pressure (Bars)	10.8119	.0351	-.3872	2.4854	10.8871	10.7042	12564
Depth (Meters)	97.4807	.3487	-.3872	2.4852	98.2290	96.4090	12564



HERO BAY TIDE GAUGE  
LLP DATA, DEPTH OF WATER

