GA/S-T-80-004 c.2

Technical Report Series
Number 80-5

CIRCULATING COPY
Sea Grant Depository

DATA REPORT #2 OCEANOGRAPHIC AND METEOROLOGICAL DATA 15 KM OFF THE COAST OF GEORGIA

J. O. Blanton
L. L. Bailey
D. W. Hayes
and
A. S. Dicks

Georgia Marine Science Center
University System of Georgia
Skidaway Island, Georgia

DATA REPORT #2

OCEANOGRAPHIC AND METEOROLOGICAL DATA 15 KM OFF THE COAST OF GEORGIA

J. O. Blanton*

L. L. Bailey*

D. W. Hayes**

and

A. S. Dicks**

*Skidaway Institute of Oceanography
P. O. Box 13687
Savannah, Georgia 31406

**Savannah River Laboratory, Aiken, South Carolina

August 1979

Technical Report Series 80-5

The Technical Report Series of the Georgia Marine Science Center is issued by the Georgia Sea Grant Program and the Marine Extension Service of the University of Georgia on Skidaway Island. It was established to provide dissemination of technical information and progress reports resulting from marine studies and investigations mainly by staff and faculty of the University System of Georgia. In addition, it is intended for the presentation of techniques and methods, reduced data and general information of interest to industry, local, regional, and state governments and the public. Information contained in these reports is in the public domain. If this pre-publication copy is cited, it should be cited as an unpublished manuscript.

ACKNOWLEDGEMENTS

We wish to thank Dan McIntosh and Linda Land for their assistance in preparing and typing the text and data plots and drafting the location map.

This work resulted from research sponsored by the U. S. Department of Energy under Contract ED-AS09-77SROID25-3.

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any or their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights.

This report is published as a part of the Georgia Marine Science Center's Technical Report Series issued by the Georgia Sea Grant Program under NOAA Office of Sea Grant #04-6-158-44115.

TABLE OF CONTENTS

Page

Acknowledgements..... i

List of Tables and List of Figures..... iii

Abstract..... iv

Introduction..... 1

Study Location..... 3

Instrumentation..... 3

a. Sensors..... 3

b. Data return..... 5

Data Processing..... 7

a. Smoothing of 10-min data..... 7

b. Removal of daily fluctuations..... 9

c. Plotting of data..... 9

The Data

a. Weekly plots of hourly data..... 12

b. Monthly plots of 40-hour low-pass data..... 45

LIST OF TABLES

Page

Table 1. Time over which usable data were obtained for the period 26 May through 19 September, 1977 4

Table 2. Data files that resulted from smoothing the 10-min data. These files contain the data plotted in Section VIII 8

LIST OF FIGURES

Fig. 1. Location of SNLT. Depth contours are at 2-m intervals 3a

Appendix A. Weekly plots of hourly data from 26 May through 19 September, 1977. Air temperature is denoted on the plots. Water temperature was not significantly different from top to bottom. Shallow temperatures are somewhat higher. Numbers denote depth in meters 11

Appendix B. Monthly plots of 40-hour low-pass data from 30 May through 15 September, 1977. Air temperature is denoted on the plots. Water temperature was not significantly different from top to bottom. Shallow temperatures are somewhat higher. Numbers denote depth in meters 44

ABSTRACT

This series of data reports provides graphical display of environmental data from the nearshore continental shelf off the Georgia coast. The data are automatically recorded on the Savannah River Navigational Light Tower located about 15 km offshore at an ocean depth of 16 meters. Meteorological data consist of air temperature, wind velocity and barometric pressure. Oceanographic data include ocean temperature at 6 depths and ocean currents at 2 depths. The graphical presentations consist of displays of the hourly averages over a 16-week period from May to September 1977. The data are also smoothed and displayed as 6-hourly averages from which the tidal and other short period fluctuations have been removed.

INTRODUCTION

The emphasis of many oceanographic studies has shifted to areas closer to the shore because these areas are increasingly being used for recreation and resource development. Coastal nuclear and fossil power plants and other energy-related activities in the coastal zone are seen by many to conflict with man's use of this zone as a recreational and food source. Thus, the data described in this report have been collected in order to attain an understanding of the characteristics of coastal currents. This understanding is essential before one can evaluate their effect on biological, chemical and geological processes occurring in the nearshore region or even determine the transport, dispersion and fate of energy-related pollutants. The causes of the natural variations in these processes must be determined before one can assess man's impact on them.

Much of the oceanographic research conducted by Savannah River Laboratory and Skidaway Institute of Oceanography under U. S. Department of Energy (DOE) sponsorship has this objective: to characterize, in a climatological sense, coastal water movements that are of particular relevance to the dispersive characteristics of nearshore waters on the continental shelf. The flow field in this environment is extremely complex due to the interaction of a number of hydrodynamic and meteorological variables such as wind stress, tidal action, bottom friction and density and sea-surface pressure gradients. Deterministic predictions are not feasible at present, a situation which is confounded by Georgia's lack of a "solid" shore boundary. Its boundary is perforated by tidal inlets whose average spacing is only 10 to 20 km. For the immediate future, a statistical or climatological approach appears to be realistic. This requires several years of data in a region.

The objective of this series of data reports is to provide documentation and visual display of experimental data from the nearshore continental shelf off the Georgia and South Carolina coast. This is of use not only to those programs within the sponsoring agency but is of value in other research programs in this area of the coast along the southeastern U. S.

Data Report #1* covered the period 17 February through 17 May, 1977. The data reported here (Data Report #2) cover the period 26 May to 19 September, 1977.

*Blanton, J. O., L. L. Bailey, W. S. Chandler, D. W. Hayes and A. S. Dicks. Data Report #2: Oceanographic and meteorological data 15 km off the Coast of Georgia. Georgia Marine Science Center, technical report series No. 78-6. 49p.

STUDY LOCATION

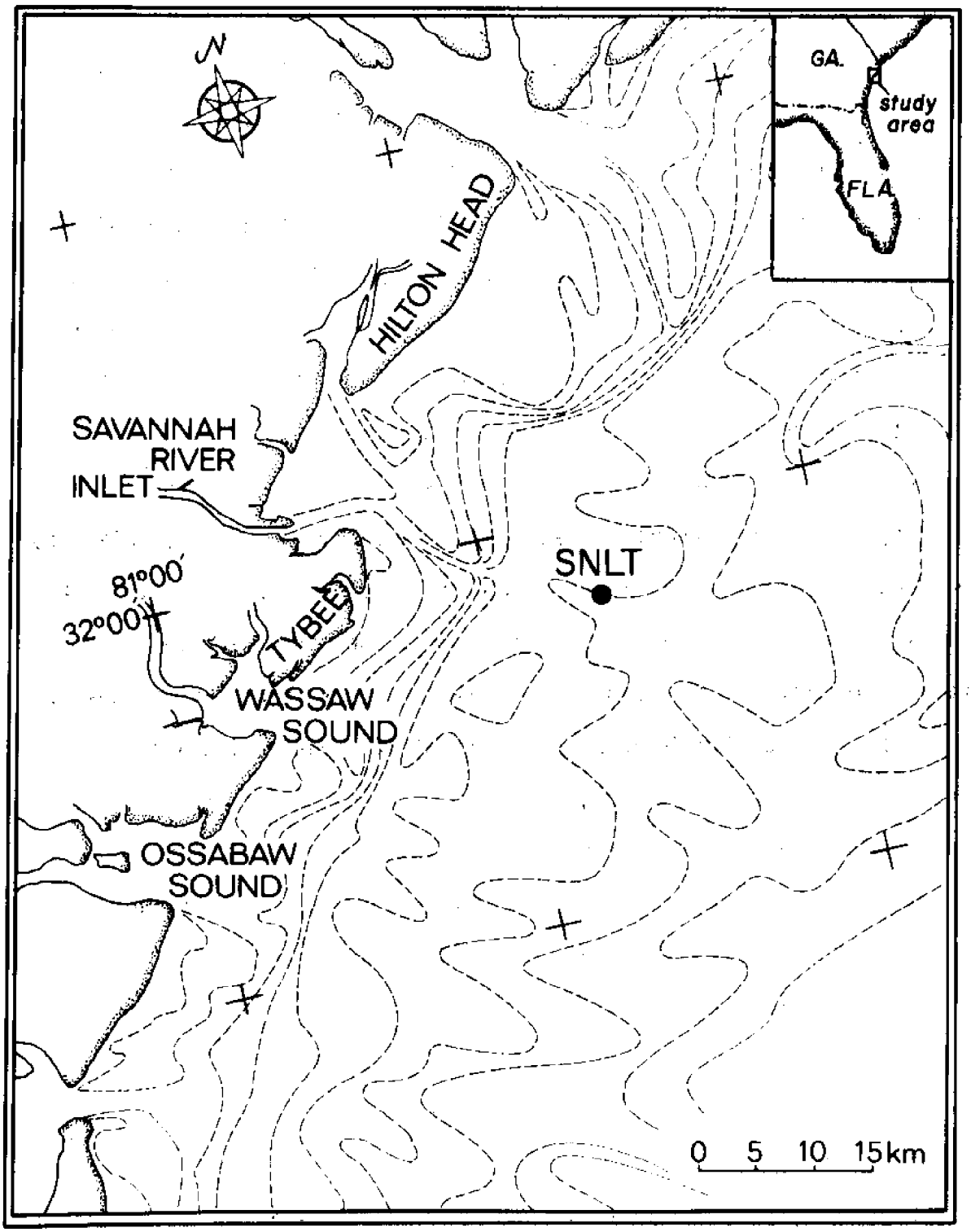
The Savannah Navigational Light Tower (SNLT) is located about 17 km (9 nautical miles) offshore (Figure 1). The water is 16 m deep at mean low water. The dredged channel for the Savannah River entrance is found on a bearing west northwest from SNLT and the major axes of the near-surface and near-bottom tidal current ellipses at SNLT lie approximately along this bearing. The tidal range at the mouth of the Savannah River varies between 2 and 3 m, the largest range on the Atlantic coast of the U. S. south of Cape Cod. The flood and ebb tidal flow into and out of the Savannah River appears to influence measurements of ocean currents at SNLT.

The SNLT is located in a region of the southeast U. S. Atlantic coast that is typical of the nearshore region from Cape Romain, South Carolina to Fernandina Beach, Florida. The coastline is interrupted every 10 to 20 km by tidal inlets (of which the Savannah River is one) that feed an extensive network of interconnected sounds and waterways. Many inlets are mouths of major rivers such as the Savannah, Altamaha and Pee Dee. Discharges of these rivers can range from 100 to 1000 m^3/s. Other inlets are no more than pocket estuaries where freshwater input is essentially zero. Nevertheless, the large tidal range and the extensive network of shallow sounds and salt marshes act together to form a 10 - 20 km wide band of turbid, relatively low-salinity water along this coast. The SNLT is located within this regime.

INSTRUMENTATION

Sensors

The SNLT is instrumented with a set of meteorological and oceanographic sensors whose output is sent to a programmable Esterline Angus multi-channel data logger. Wind velocity is measured with a MRI Model 1074-20 cup and vane


N
GA.
study area
FLA
HILTON HEAD
SAVANNAH RIVER INLET
81°00'
32°00'
TYBEE
WASSAW SOUND
OSSABAW SOUND
SNLT
0 5 10 15km

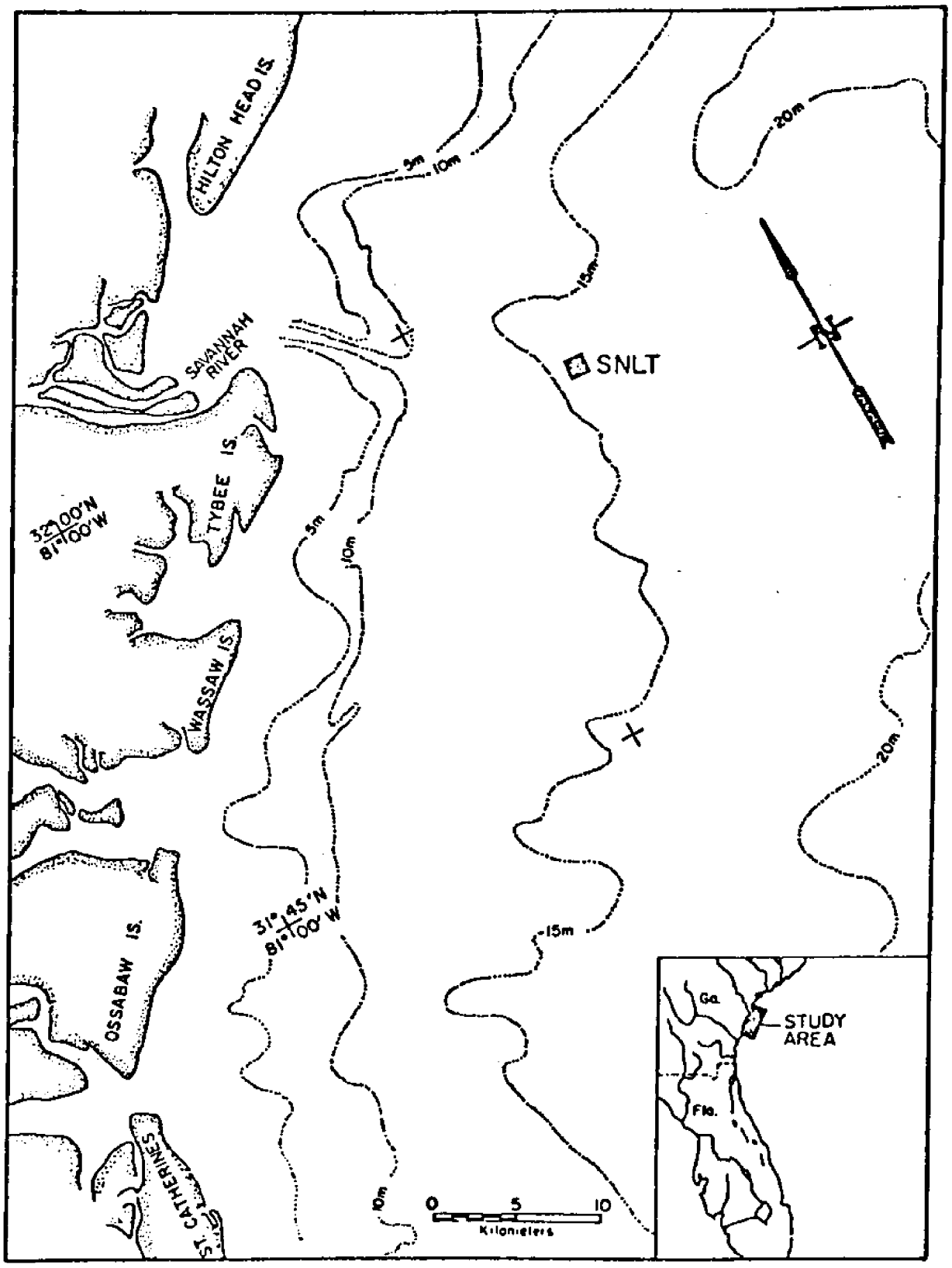


Figure 1. Location of SNLT. Depth contours are at 2-m intevals.

Table 1. Time over which usable data were obtained from each sensor for the period 26 May through 19 September 1977.

	MAY	JUNE	JULY	AUG	SEPT	Percent of Usable data*
Wind direction, 27 m		XXXXXXXXXXXXXXX				40%
Wind speed, 27 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Barometric pressure		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Sea level				XXX		9%
Air temperature		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Temperature, 1m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Temperature, 3 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Temperature, 7 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Temperature, 10 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Temperature, 14 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
Temperature, 16 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
North current, 4 m			(DATA NOT ACCEPTED)			0%
East current, 4 m			(DATA NOT ACCEPTED)			0%
North current, 13 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%
East current, 13 m		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				100%

*Time period 21 - 26 July was not considered in percentages because data collection was interrupted.

anemometer. Currents are measured with Marsh-McBirney Model 511 electromagnet current meters. Air and water temperatures are measured with thermocouples made from Constantan wire with cold junction compensation performed by the data acquisition system. Also mounted on the tower are a bubbler tide gauge with a Robinson-Halpern pressure transducer and an aneroid cell barometer, Model #B-242, by Weathermeasure Corporation. Sensor accuracies as derived from specifications from manufacturers are ± 0.5 m/s and ± 4° at speeds of up to 20 m/s for wind velocity, ± 2 cm/s at speeds of up to 100 cm/s for each component of ocean current, ± 0.6°C for air and ocean temperature, ± 5 cm for sea level up to 3 m above mean low water (MLW) and ± 1 mb for barometric pressure. A quartz crystal in the data logger measures time to ± 1 min/month.

Wind velocity is measured at height of 27 m above MLW. Three thermocouples are located 18 m above MLW and we average their data to report air temperature. Sea level is measured relative to MLW. North and east components of ocean currents are measured with electromagnetic current meters at 4.3 m and 13.4 m below MLW. Six thermocouples measure ocean temperature at 1.5 m, 3.0 m, 6.7 m, 10.4 m, 14.0 m and 15.8 m, respectively, below MLW.

Data Return

Usable data excludes those 10-min values that were designated with 99999.99 or asterisks as well as those values that we judge were unrealistic. Table 1 indicates a 100% data return from all but five sensors. Four of the same five sensors also malfunctioned during the winter-spring 1977 covered by Data Report #1.

Wind direction sensor operated continuously for the first six weeks after which the data became usable. The 40% return (Table 1) reflects the total usable hourly data we were able to extract. Sea level data were so sporatic in quality that only 9% usable data resulted. All temperature sensors

functioned 100% of the time.

The velocity sensors were operating over 6 months without recalibration. A long term drift of the sensors cannot be presently ruled out. We have rejected velocity data at 4.3 m based on a lack of response in the north-south component during reversals in wind direction (Table 1). The currents at 13.6 meters responded as expected to wind reversals. Therefore, these data are reported, but we must caution the reader to keep in mind that a drift in the "zero" voltage in these data cannot be ruled out.

DATA PROCESSING

The primary data were acquired for each sensor by the data logger on magnetic tape at a time interval of ten minutes. These data were converted to engineering units and bad data fields filled with 99999.99 for unrealistic or erroneous values. The 10-min data form the basic data set for this report.

If less than five values were found to be bad in any particular field, the values were inserted by linear interpolation and the field reported to be 100% good.

Smoothing the 10-min data

The irregularities in the 10-min data were smoothed with a symmetric Lanczos-squared filter containing 13 weights.[1] This filter removes one-half of the amplitude of fluctuations having 2-hour periods and removes 90% of the amplitude of fluctuations with periods of one hour. Higher attentuation occurs at periods below one hour. We have sacrificed a sharp cutoff (i.e., an abrupt attentuation of higher frequencies) by keeping our data loss to a minimum. These filtered data are selected at one-hour intervals and placed on a pile for plotting. Irregularities occurring at frequencies less than 0.5 cycles per hour (cph) are retained and tidal fluctuations are easily resolved. Table 2 summarizes the characteristics of the file of hourly data that result from the basic 10-min data. This file is hereafter referred to by the term "hourly data file".

---

[1]The weights (w_j) were computed according to the formula

$$w_j = \frac{\sin[\pi(j-1)/M]}{\pi(j-1)/M}^{a}$$

where $j = 1, 2, \ldots\ldots\ldots M$
M = (no. of weights + 1)/2
$a = 2$ for Lanczos-squared filters
$a = 1$ for Lanczos filters

Table 2. Data files that resulted from smoothing the 10-min data. These files contain the data plotted in Section VIII.

File Characteristics	2-hr low-pass	40-hr low-pass
Data interval	1 hr	6 hr
0.5 amplitude period (frequency)	2 hr (0.5 cph)	40 hr (0.6 cpd)
0.1 amplitude period (frequency)	1 hr (0.1 cph)	34 hr (0.7 cpd)
Filter type	[Lanczos-squared]	Lanczos
Number of weights	13	193
Data loss, each end	1 hr	4 days
File 1		
Beginning date, hr (EST)	1977 May 26,0000	May 30,0000
End date, hr (EST)	1977 July 21,0000	July 17,0000
File 2		
Beginning date, hr (EST)	1977 July 27,0000	July 31,0000
End date, hr (EST)	1977 Sept. 20,0000	Sept. 16,0000

Removal of tidal and daily fluctuations

During the 16 weeks covered by this report, the tidal and daily fluctuations often obscure the slow changes in water currents and temperature induced by changes in weather. Thus a second file of data was created that removed all fluctuations that occurred more frequently than once about every 30 hours. A large symmetric Lanczos filter containing 193 weights was applied to the hourly data file. A new file of data was created that contained values every six hours (Table 2). While data loss was large, the filter had a sharp cutoff. This filter is identical to that used by the University of Miami and North Carolina State University in smoothing their ocean current data. This facilitates comparison of the many data currently being obtained in the U. S. South Atlantic Bight under the sponsorship of DOE and the U. S. Department of Interior. This file is hereafter called the "40-hour low-pass data file". The sea level data were too few to apply the 40-hour low pass filter.

Plotting of hourly and six-hourly data

The two basic data files (Table 2) form the basis of this report. Each file is maintained internally formatted on a CDC-CYBER-74. These files were translated into statements that were plotted on a Tektronix 4662 digital plotter.

The hourly data file is conveniently broken into seven-day increments. The oceanographic and meteorological data are placed on two plots for each week. The first plot contains all available wind and ocean current data in the form of hourly vector plots. Barometer pressure is also included. The vectors point along the direction toward which air and water are going. We caution the reader that these plots appear to give vectors perpendicular to the time axis more emphasis than those that plot more nearly parallel to the

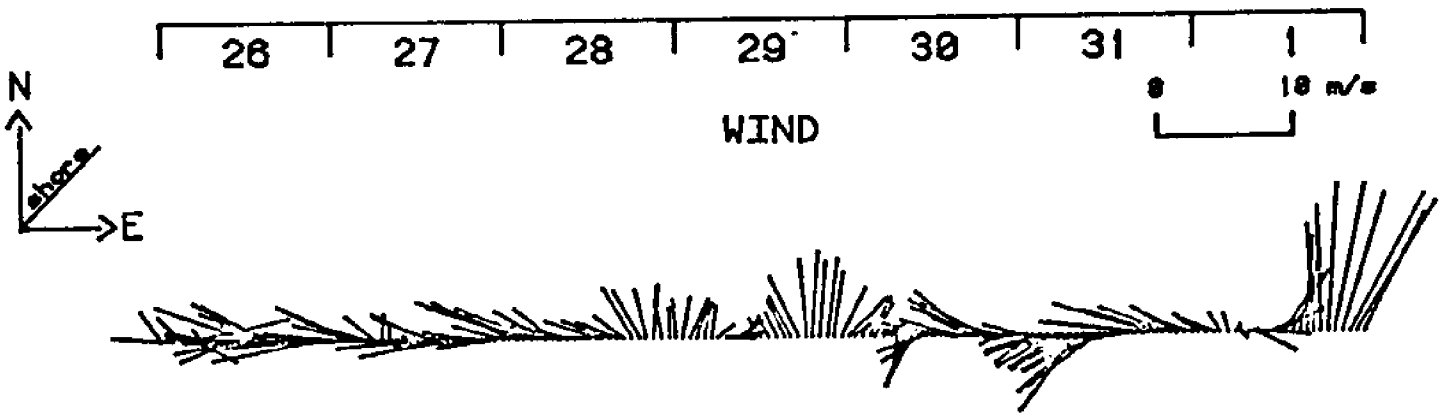
axis (in this case, east or west winds or currents). The second plot for each week contains all available air and ocean temperature data.

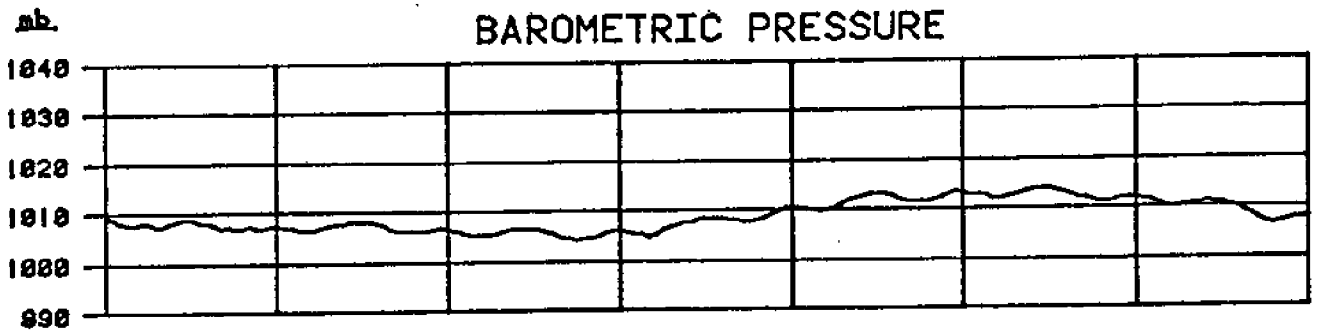
No data were recorded for a five-day period in July (Table 1). Therefore, each data file used for plotting was broken into two parts. The weekly plots have a break between 21 July and 27 July (Table 2).

The 40-hour low-pass data file is broken into monthly segments. Each segment covers an entire calendar month even though data may not be available for the entire month. The first plot contains the vector plot of 40-hour low-pass wind followed by the respective alongshore and offshore component of ocean velocity. The shoreline near SNLT trends NE-SW, so the original north and east ocean current components were transformed to an alongshore axis bearing northeast and an offshore axis bearing southeast. The second monthly plot contains the 40-hour low-pass temperature and barometric pressure along with the same vector winds plotted on the first monthly chart.

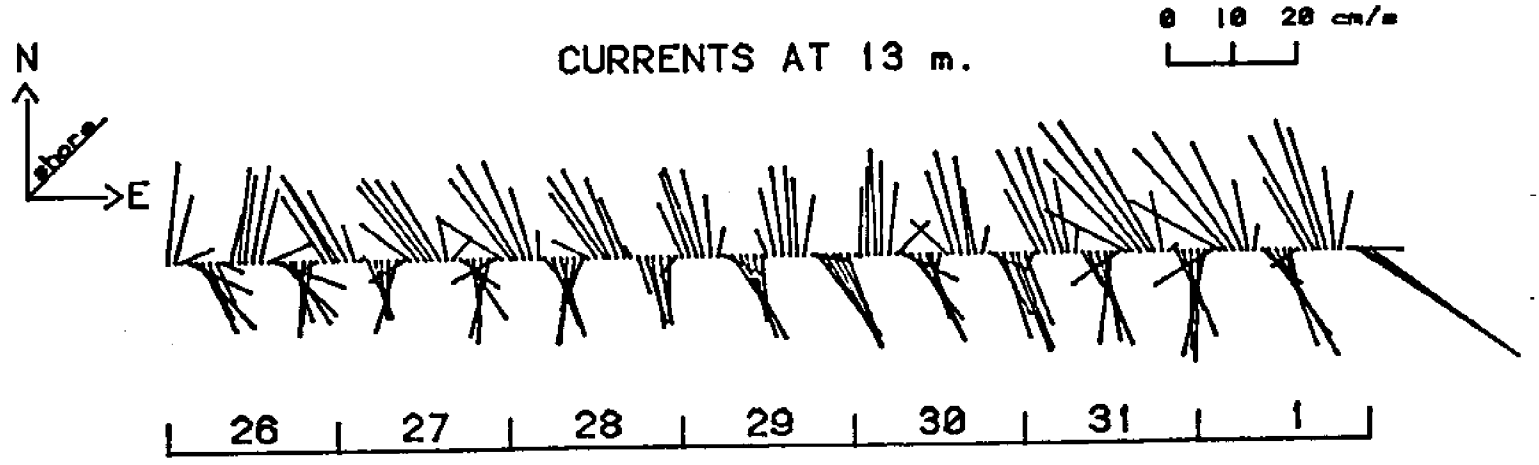
APPENDIX A. Weekly plots of hourly data from 26 May through 19 September 1977. Air temperature is denoted on the plots. Water temperature was not significantly different from top to bottom. Shallow temperatures are somewhat higher. Numbers denote depth in meters.

MAY

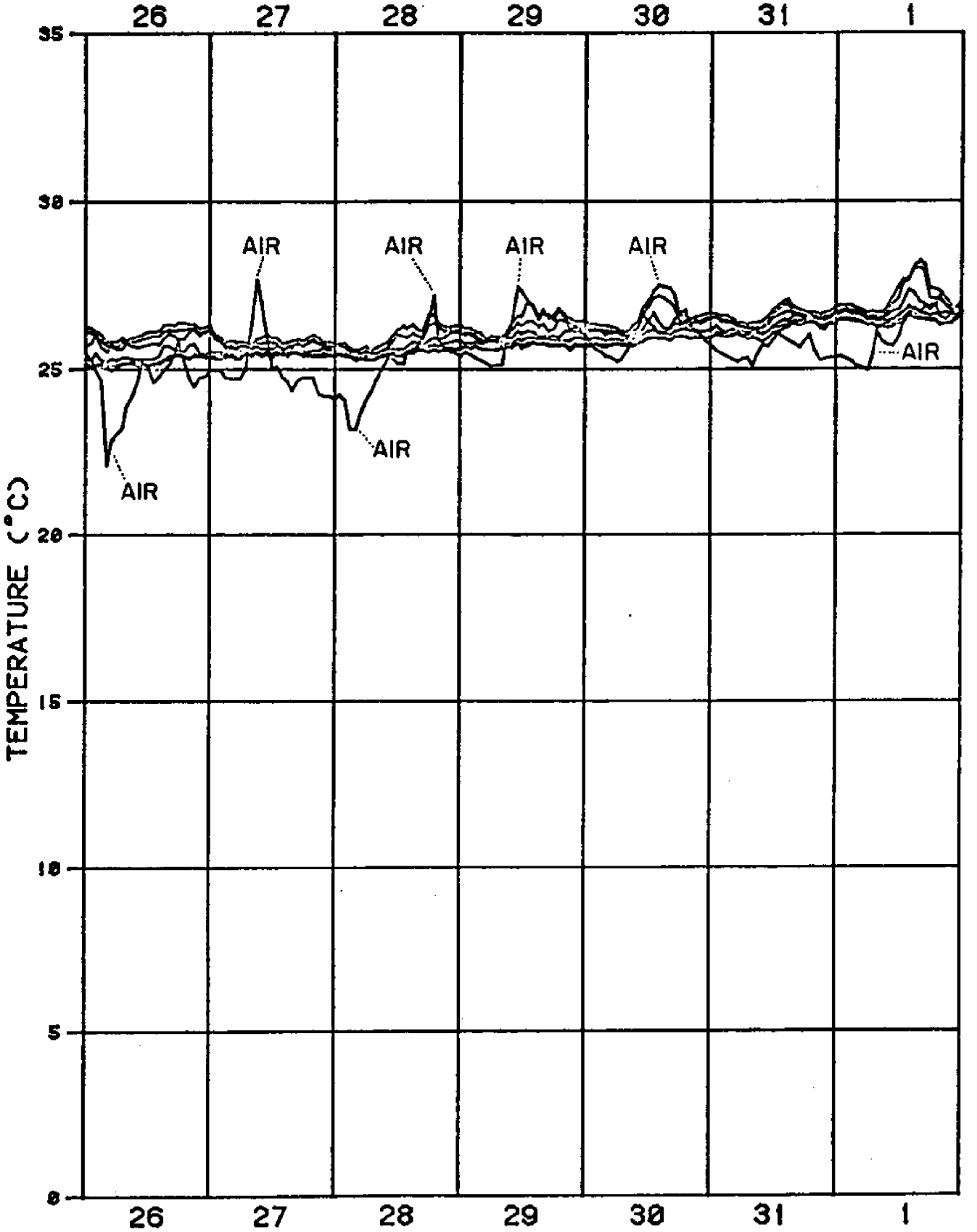




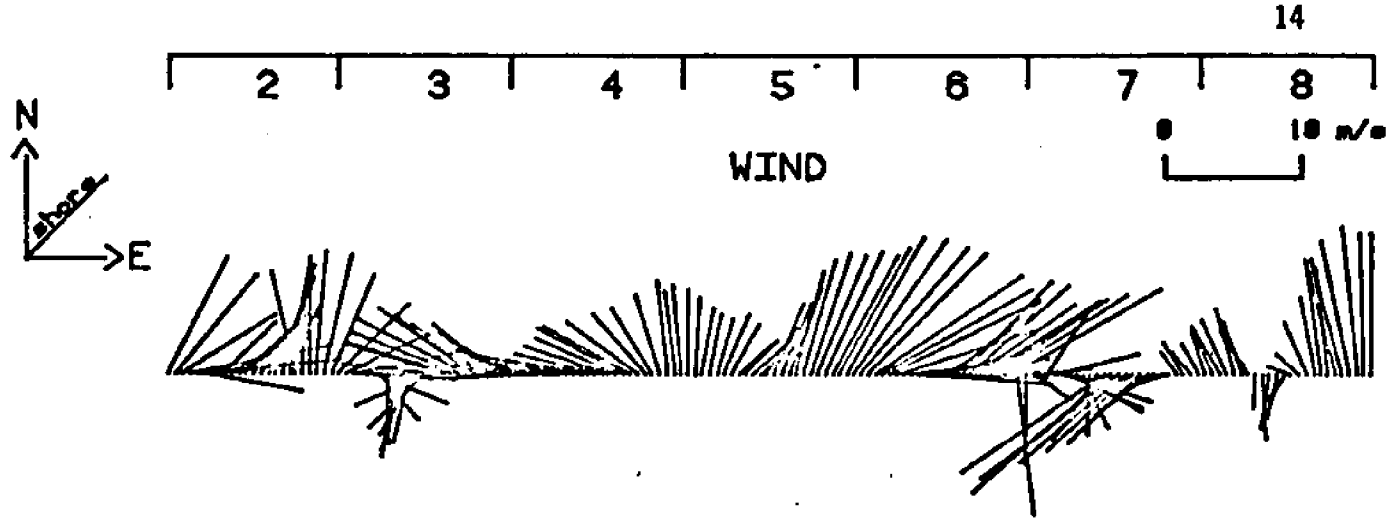
SEA LEVEL

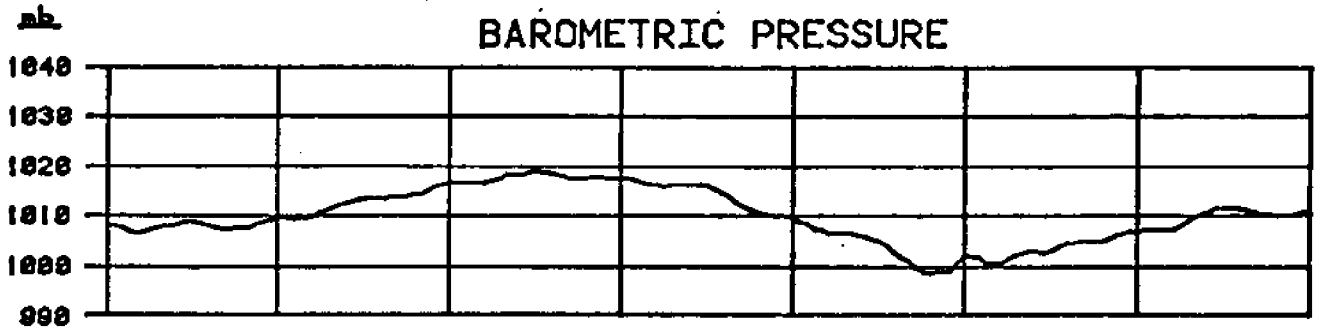


MAY

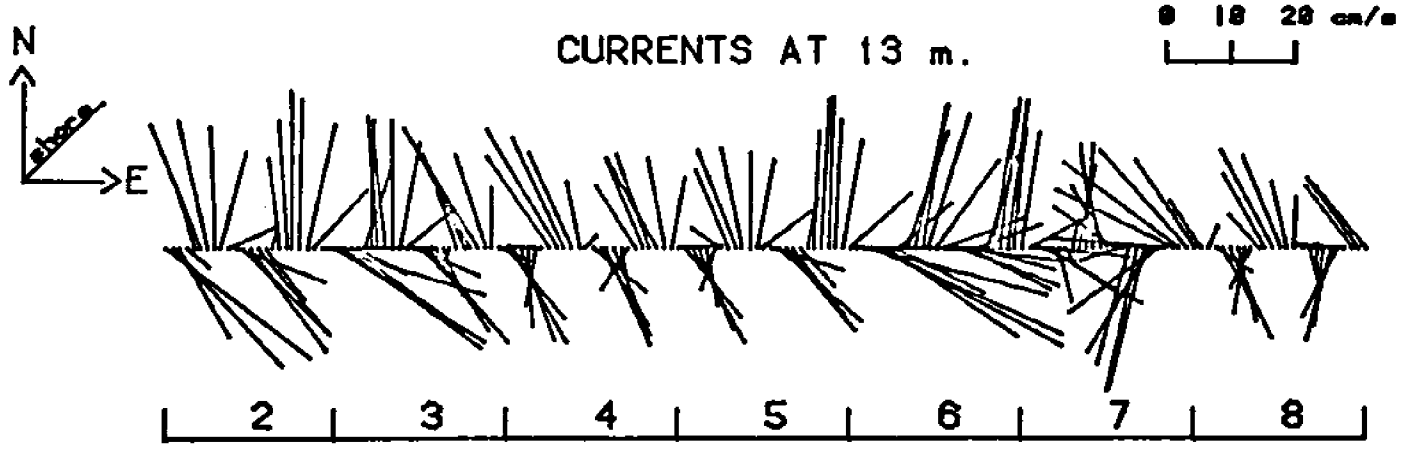

26
27
28
29
30
31
1
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR
AIR
AIR
AIR
AIR
AIR

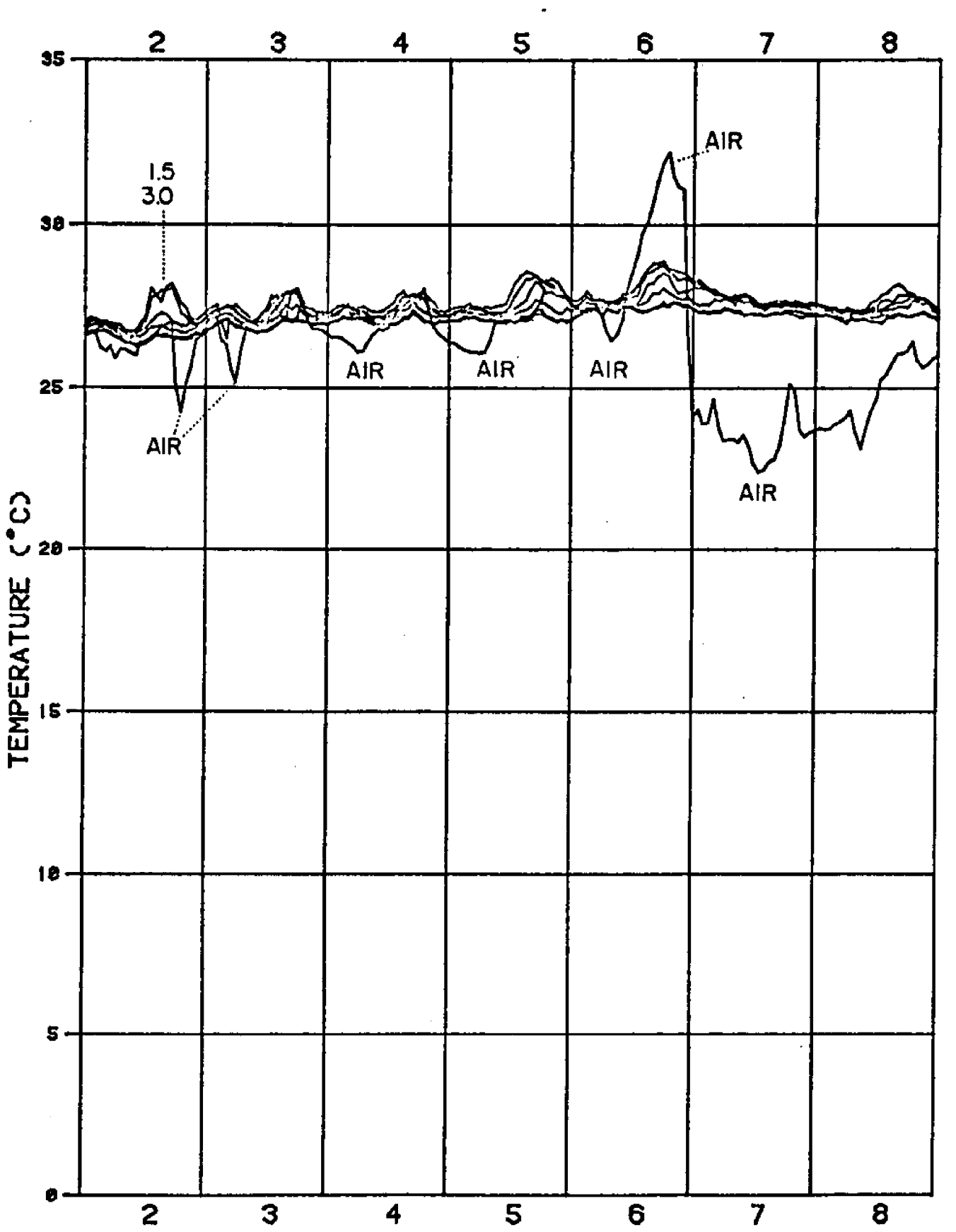
JUNE



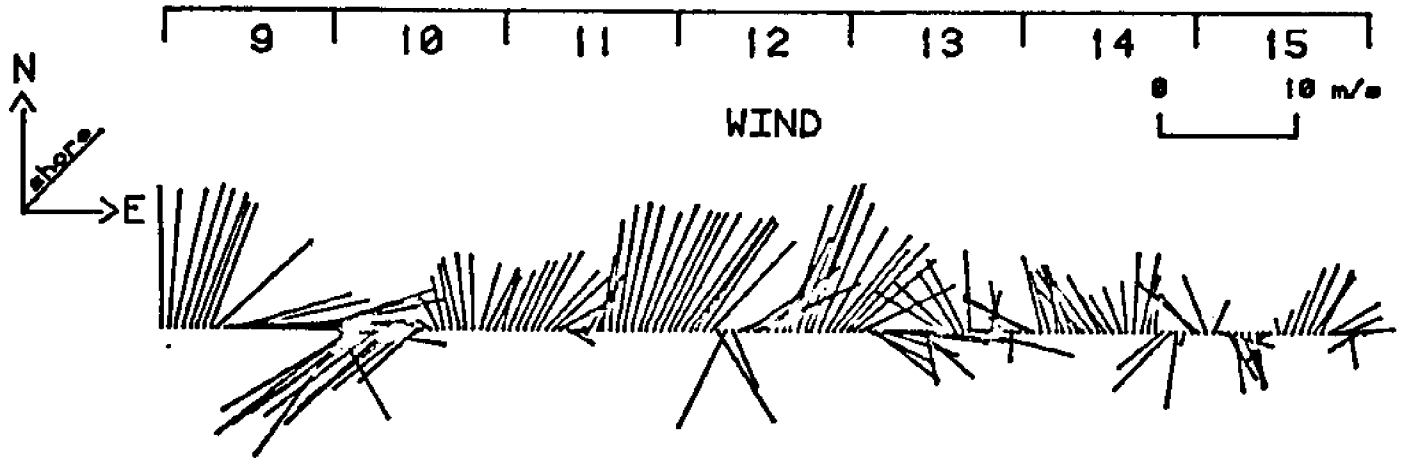


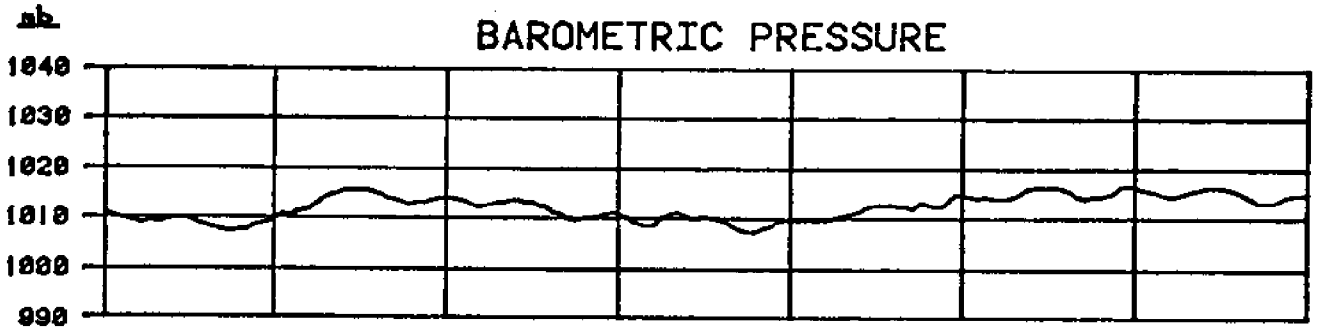
SEA LEVEL



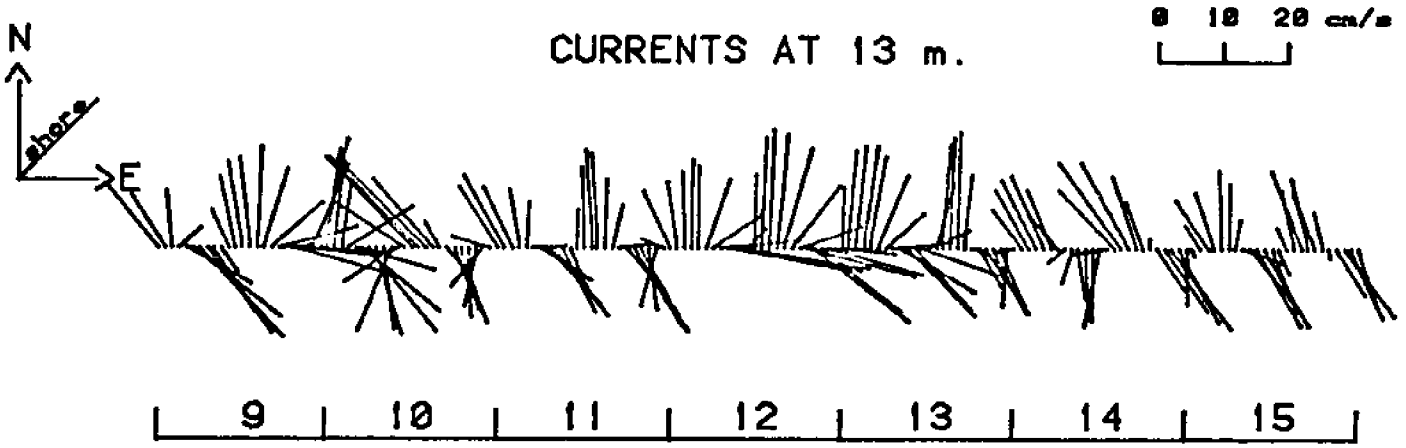

JUNE
2
3
4
5
6
7
8
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
1.5
3.0
AIR
AIR
AIR
AIR
AIR
AIR

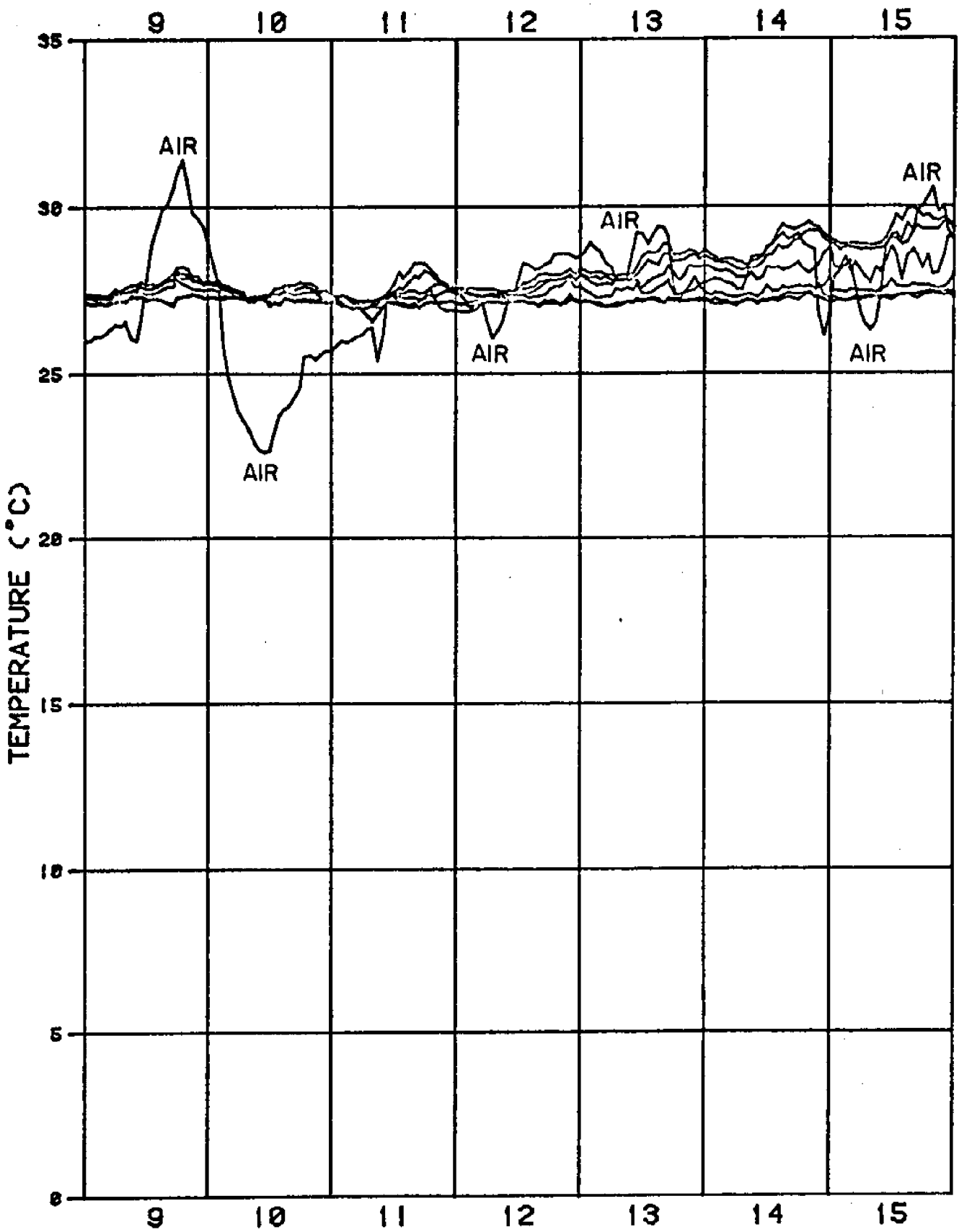
JUNE

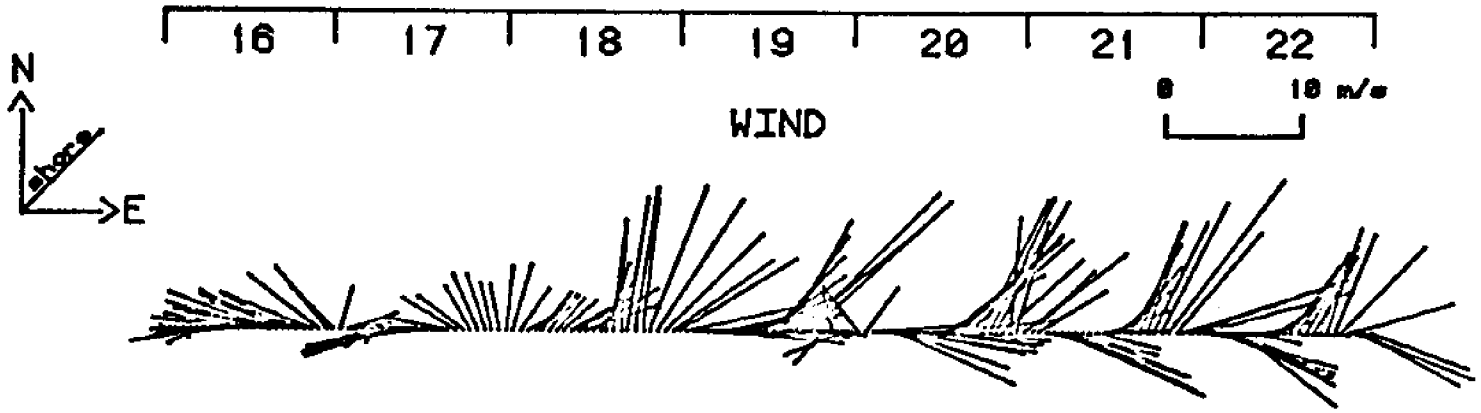


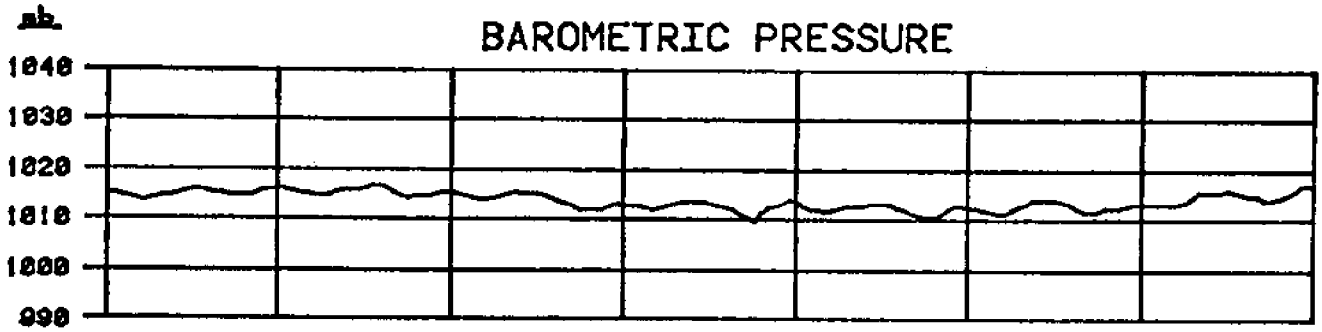


SEA LEVEL

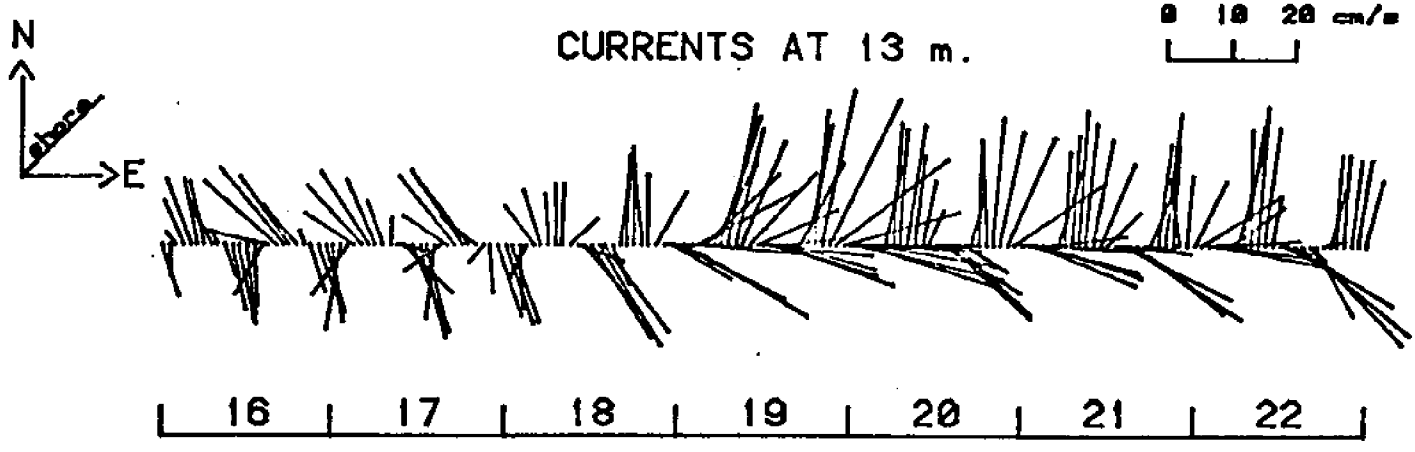



JUNE
9
10
11
12
13
14
15
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR
AIR
AIR
AIR

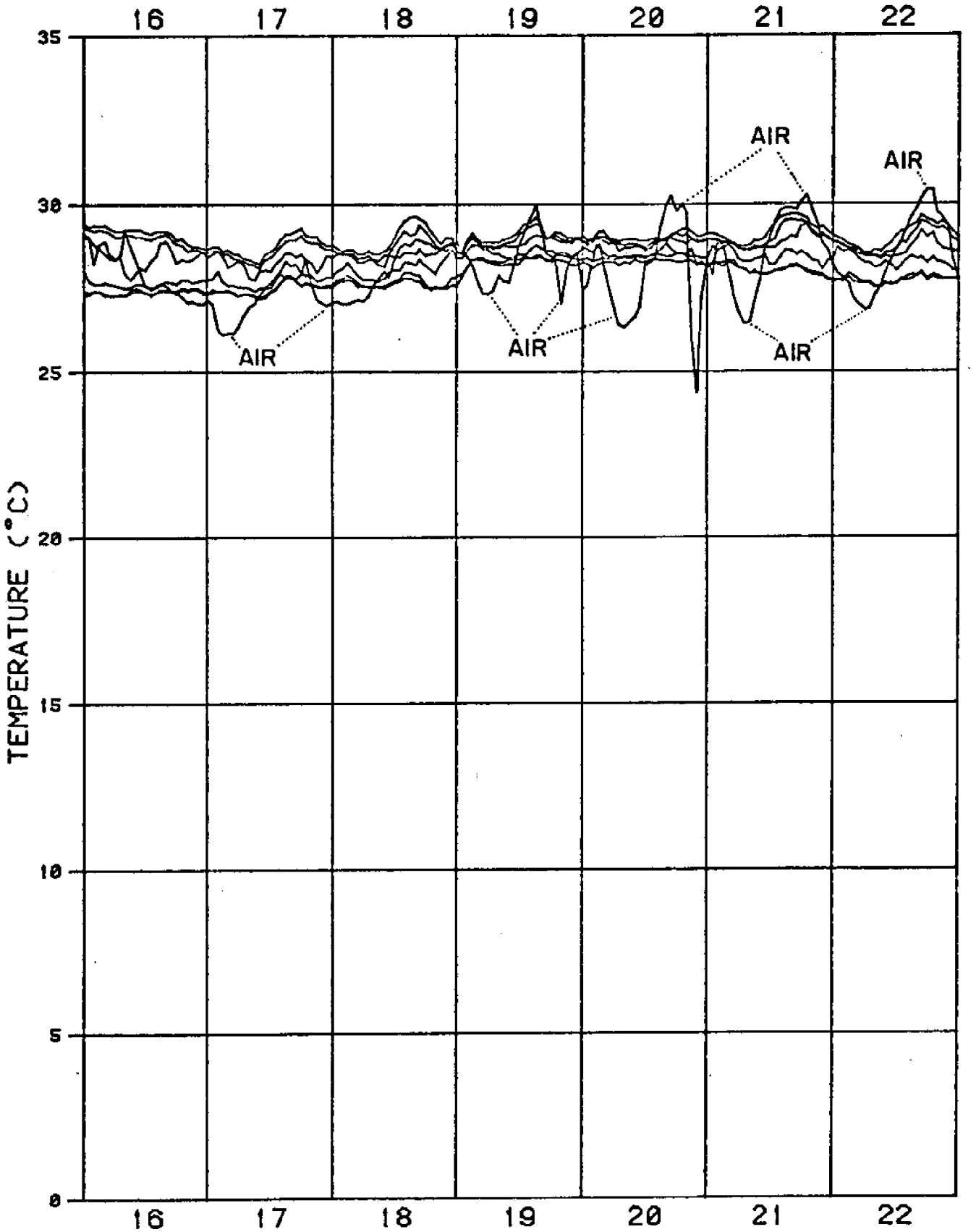

16
17
18
19
20
21
22
N
E
WIND
0 10 m/s


mb.
BAROMETRIC PRESSURE
1040
1030
1020
1010
1000
990

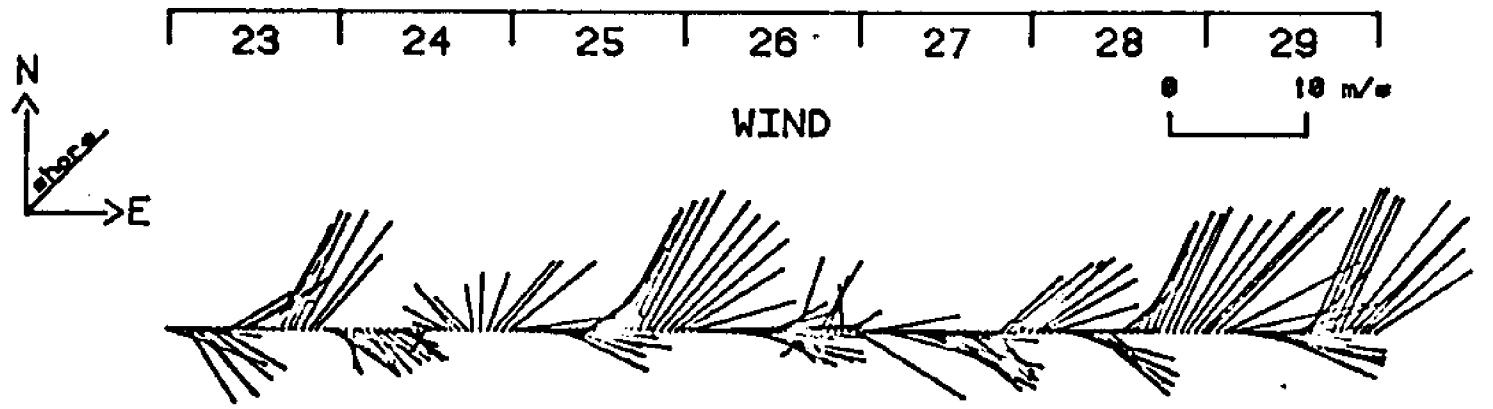
SEA LEVEL

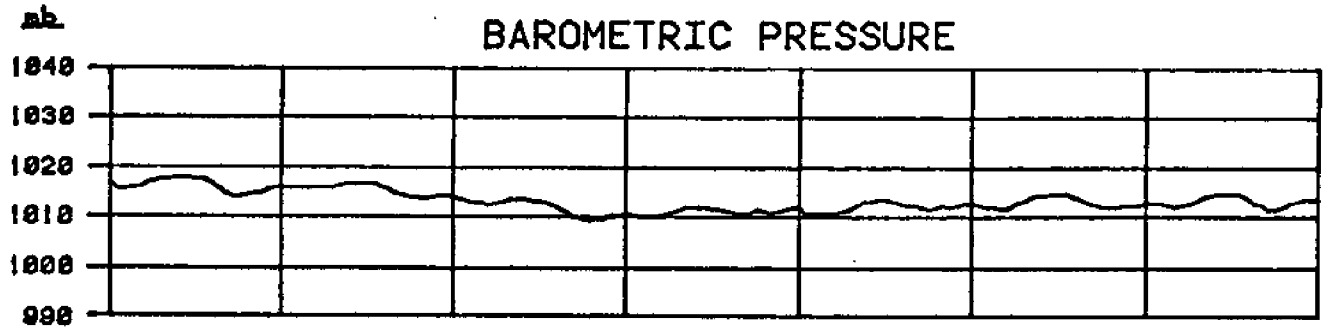

N
E
CURRENTS AT 13 m.
0 10 20 cm/s
16
17
18
19
20
21
22

JUNE

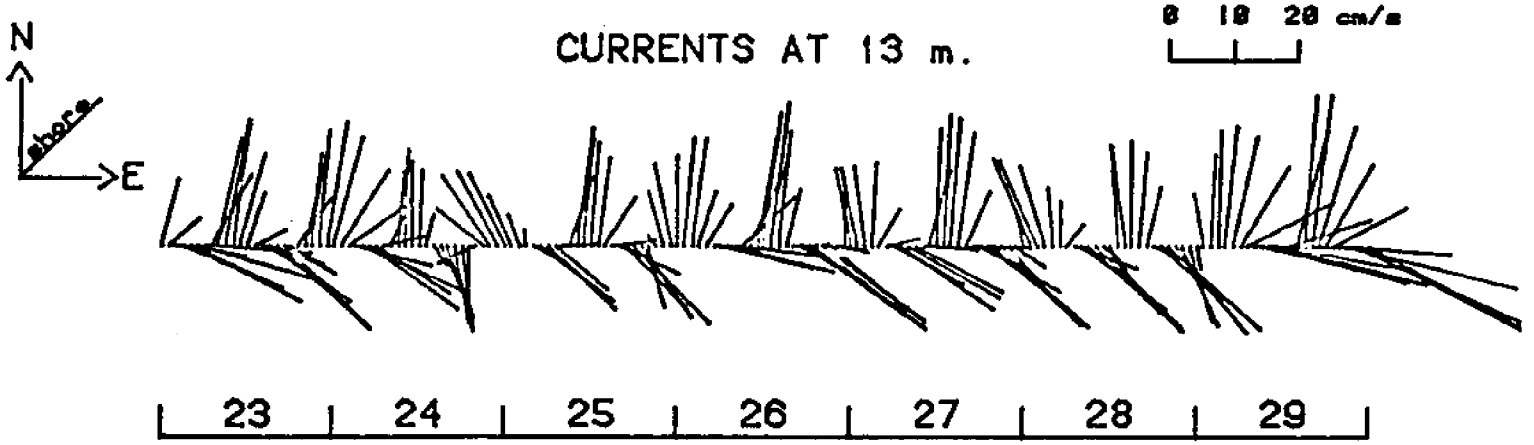

16
17
18
19
20
21
22
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR
AIR
AIR
AIR

JUNE

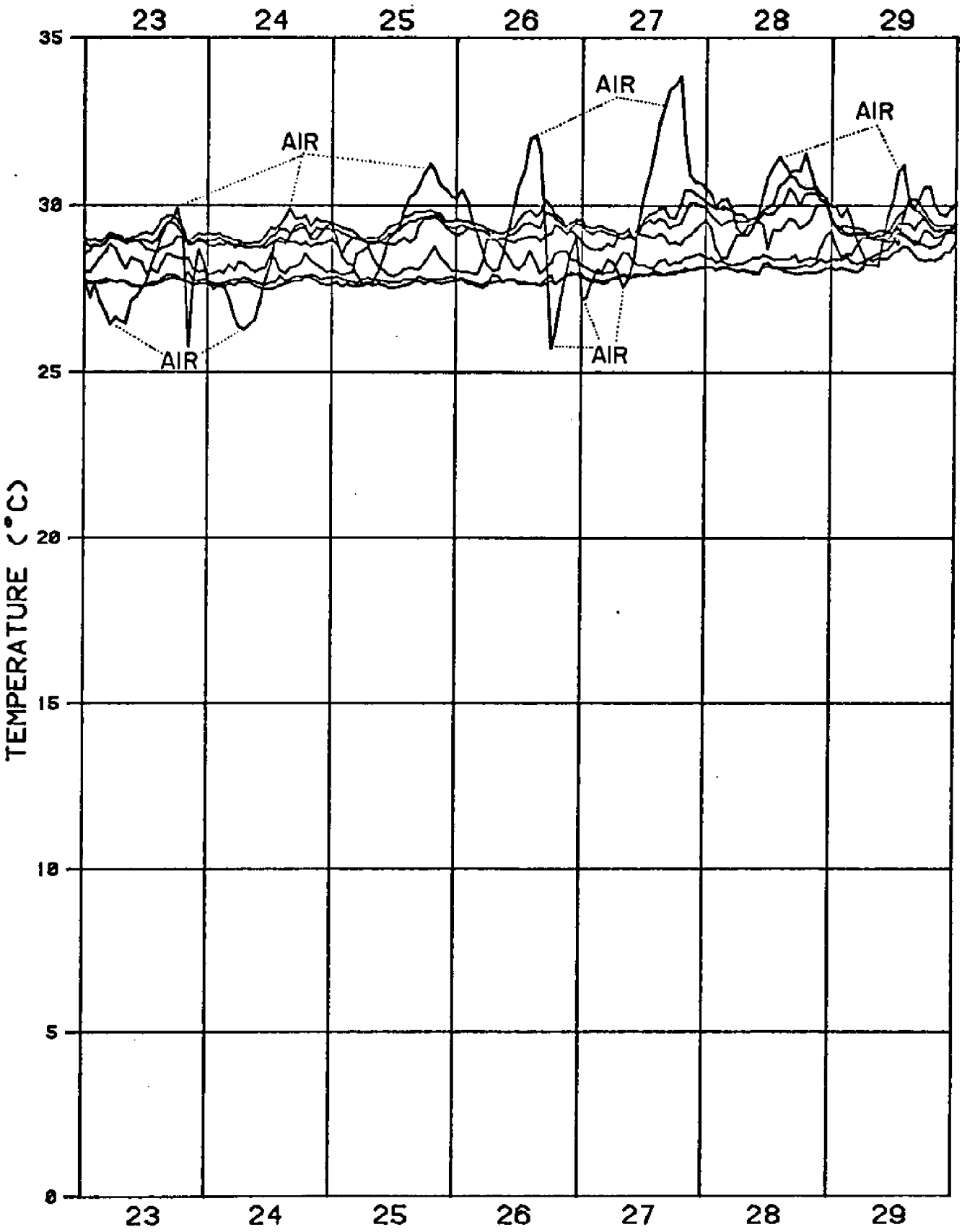




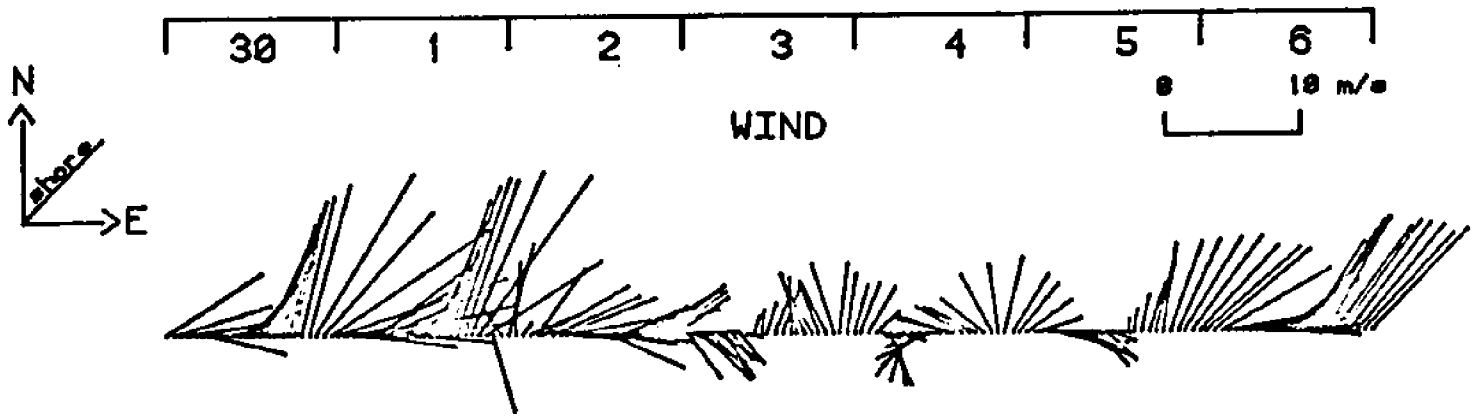
SEA LEVEL

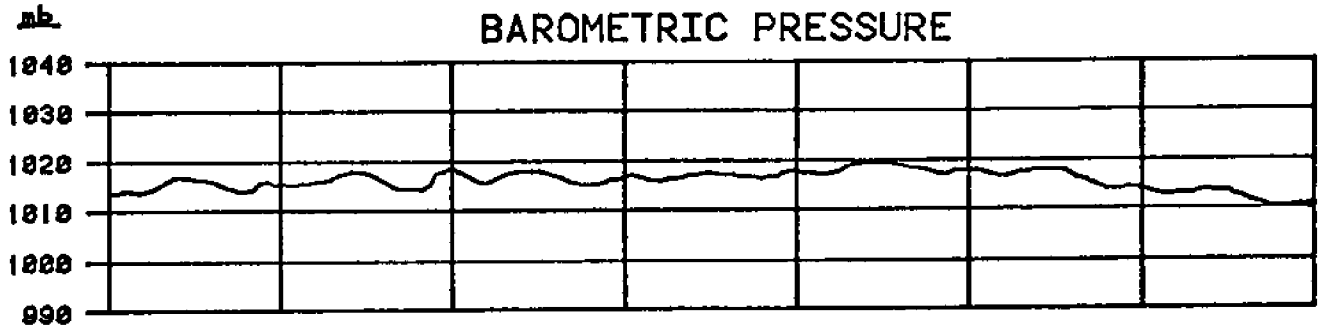


JUNE

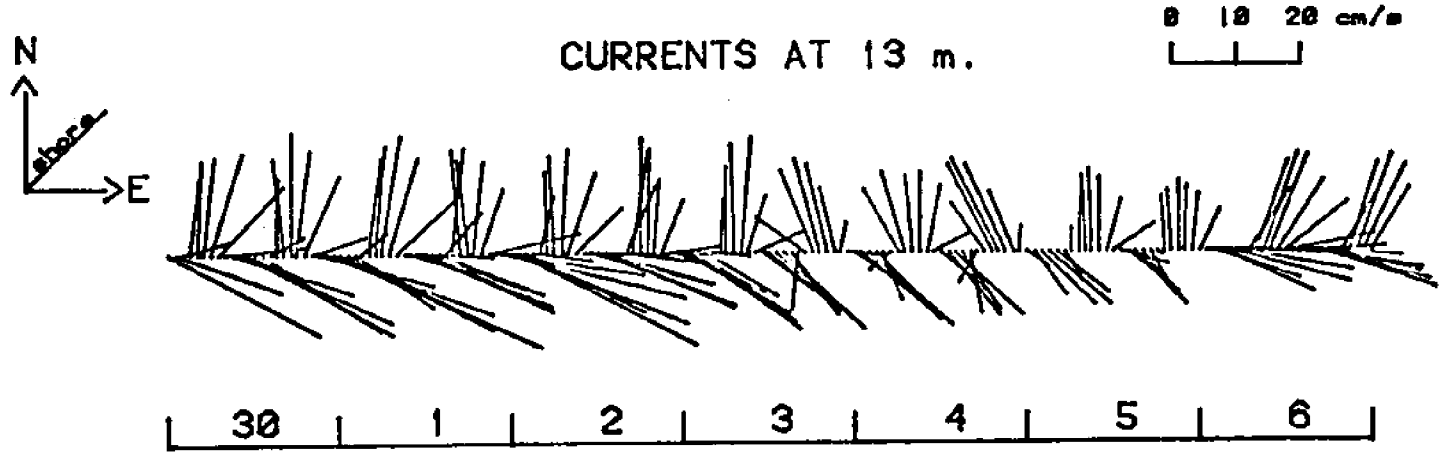

23
24
25
26
27
28
29
35
30
25
20
15
10
5
0
AIR
AIR
AIR
AIR
AIR
TEMPERATURE (°C)

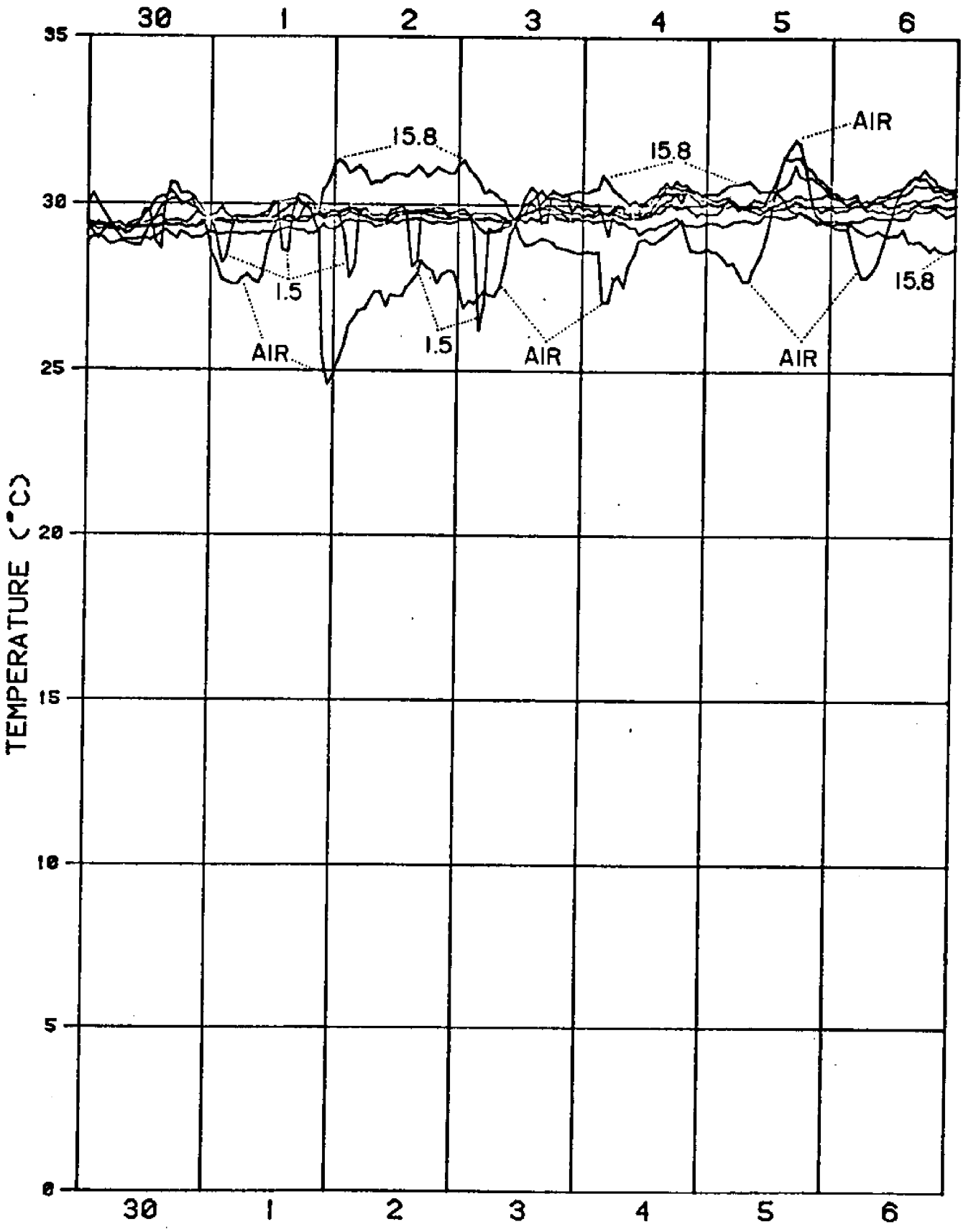
JUNE

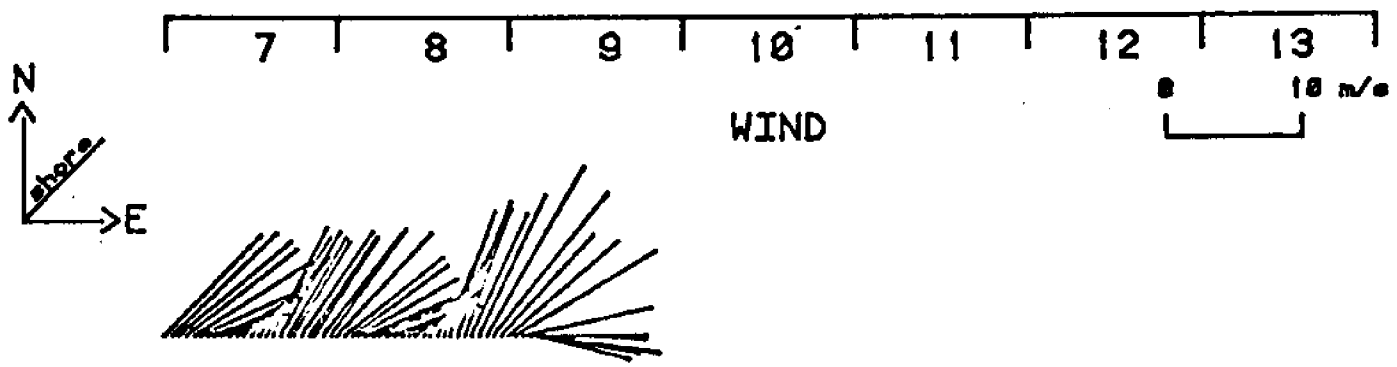


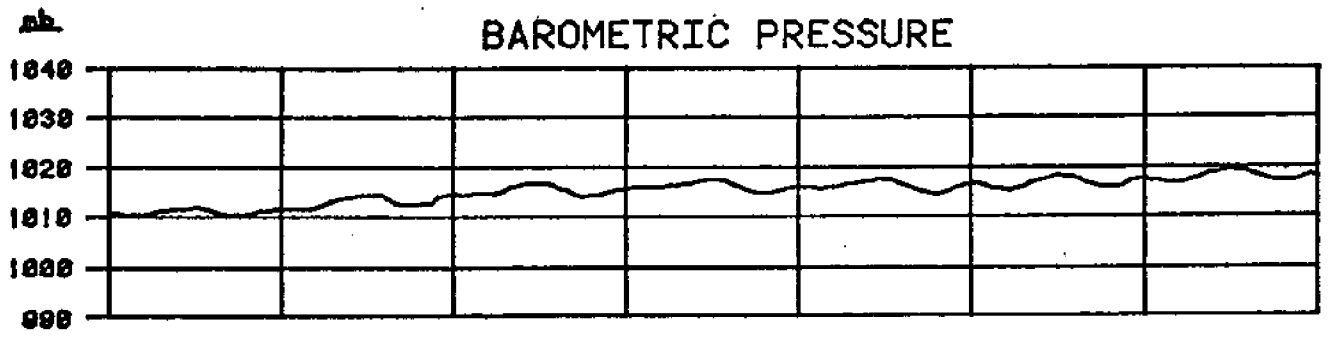


SEA LEVEL

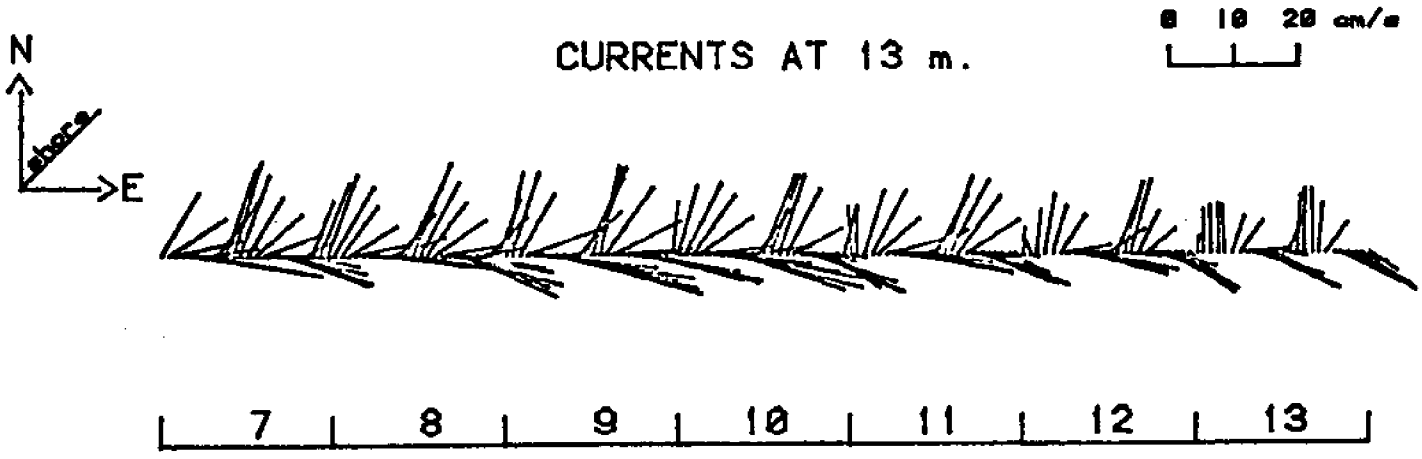


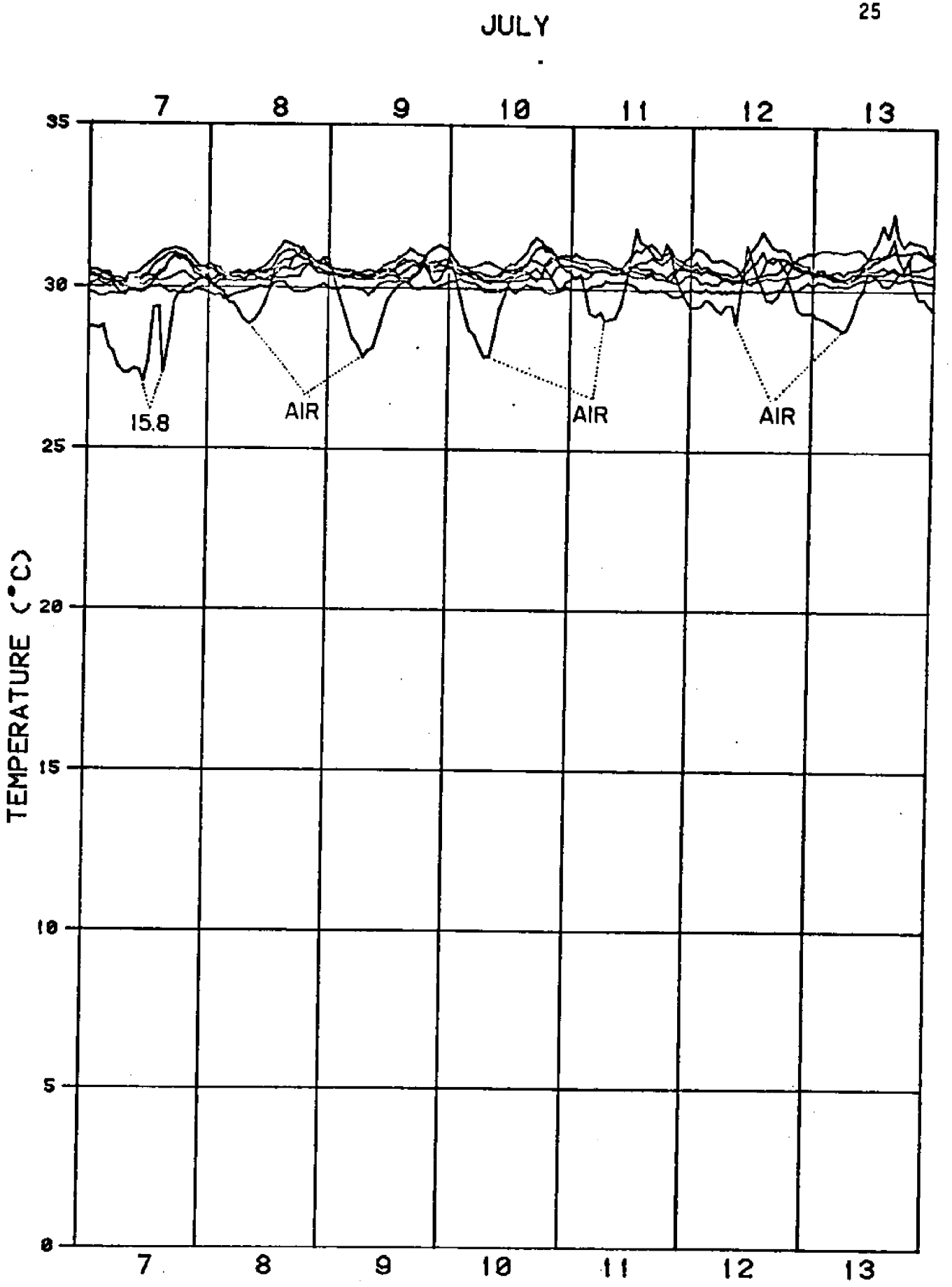

JUNE
30
1
2
3
4
5
6
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
15.8
15.8
AIR
1.5
AIR
1.5
AIR
AIR
15.8


7
8
9
10
11
12
13
0 10 m/s
WIND
N
shore
E


mb
BAROMETRIC PRESSURE
1040
1030
1020
1010
1000
990

SEA LEVEL

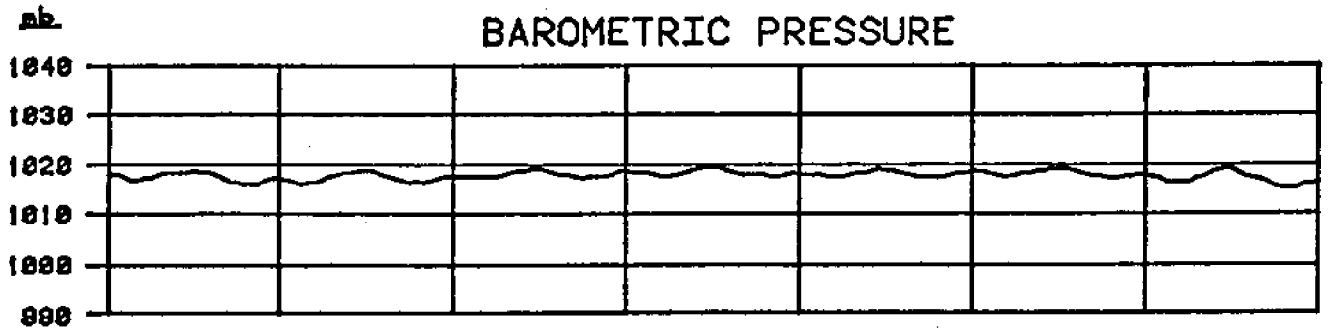

0 10 20 cm/s
CURRENTS AT 13 m.
N
shore
E
7
8
9
10
11
12
13


JULY
7
8
9
10
11
12
13
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
15.8
AIR
AIR
AIR

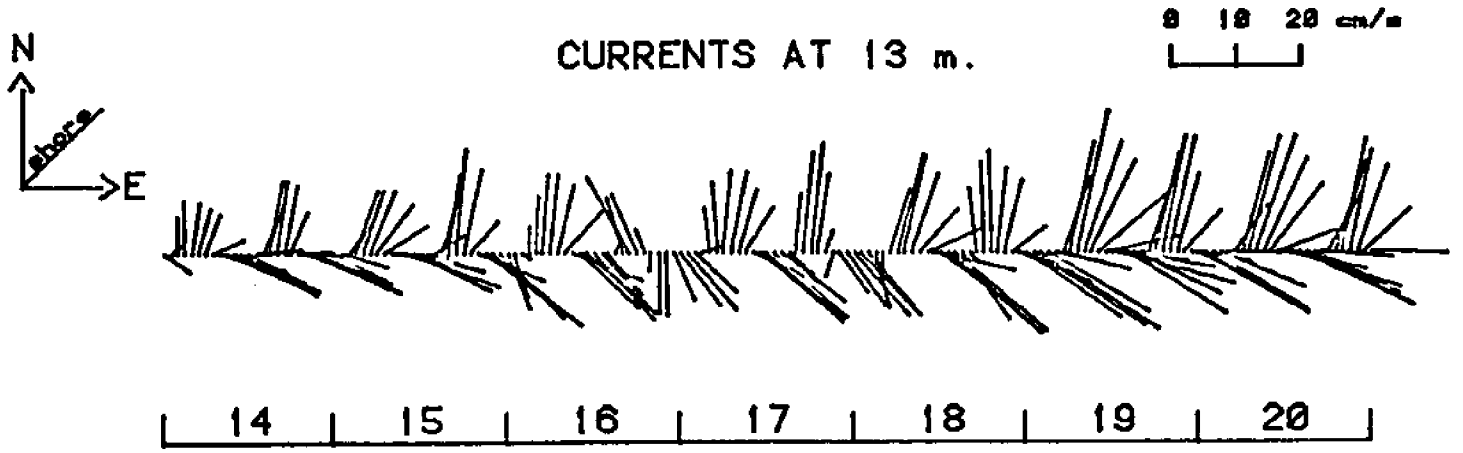
JULY

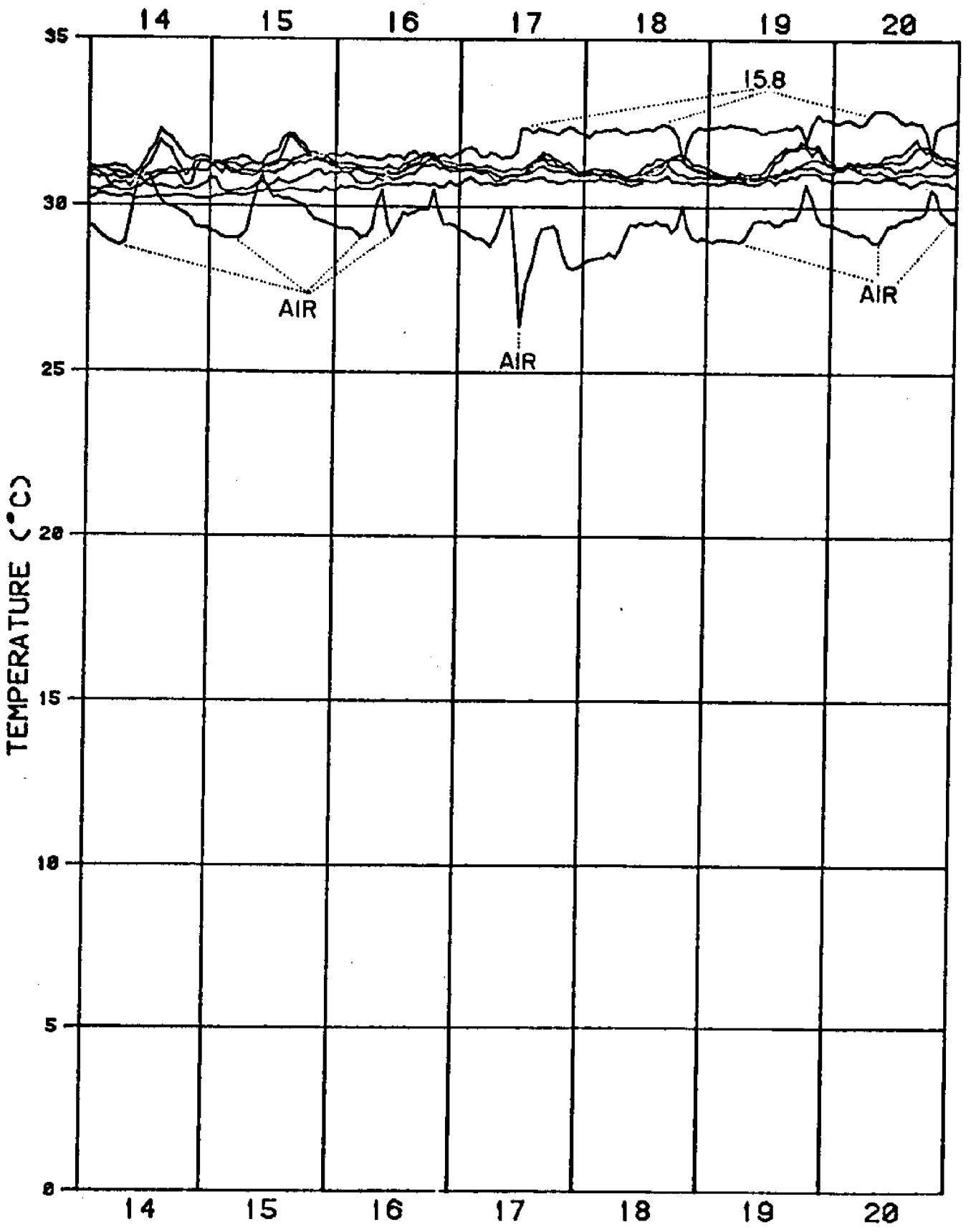
14 15 16 17 18 19 20

WIND



SEA LEVEL



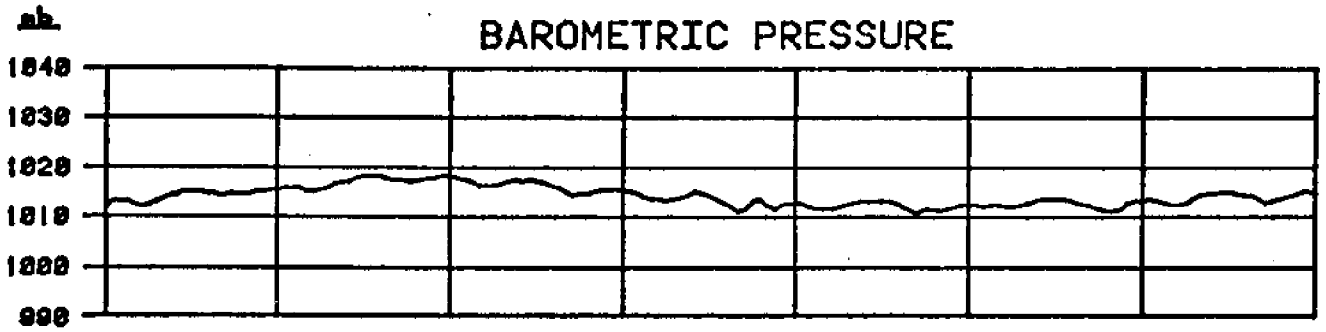

JULY
14
15
16
17
18
19
20
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
15.8
AIR
AIR
AIR

JULY

27 | 28 | 29 | 30 | 31 | 1 | 2

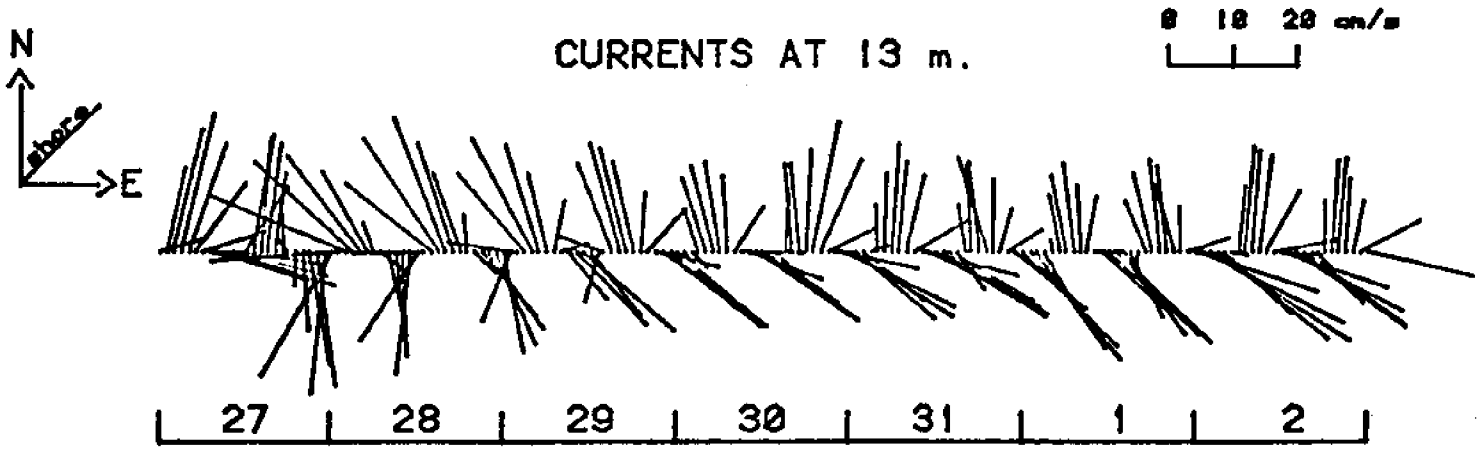
WIND

BAROMETRIC PRESSURE

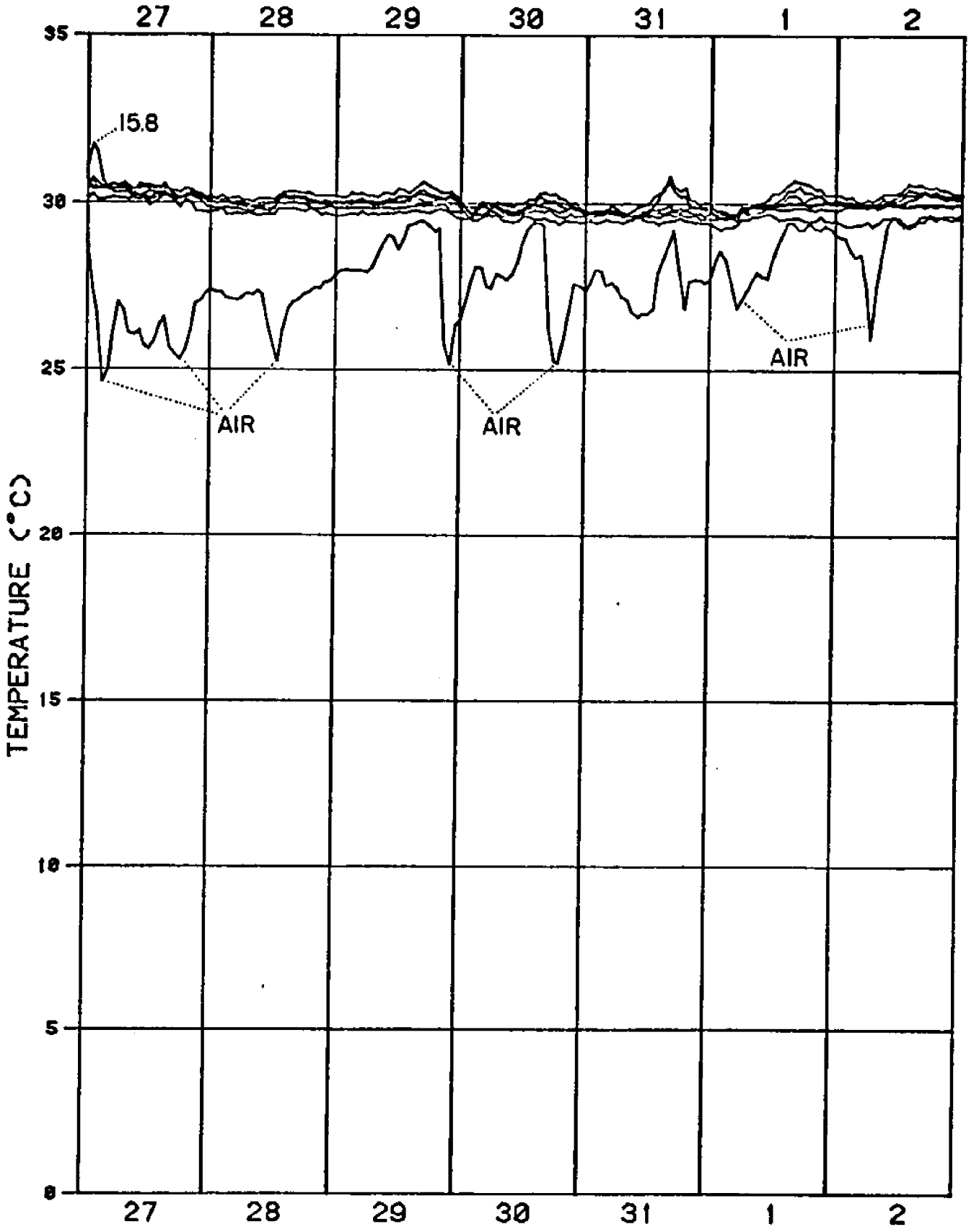


SEA LEVEL

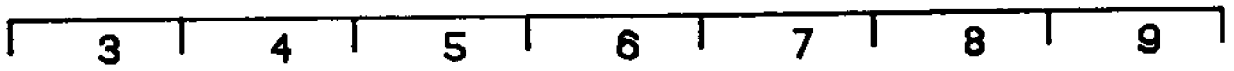
CURRENTS AT 13 m.



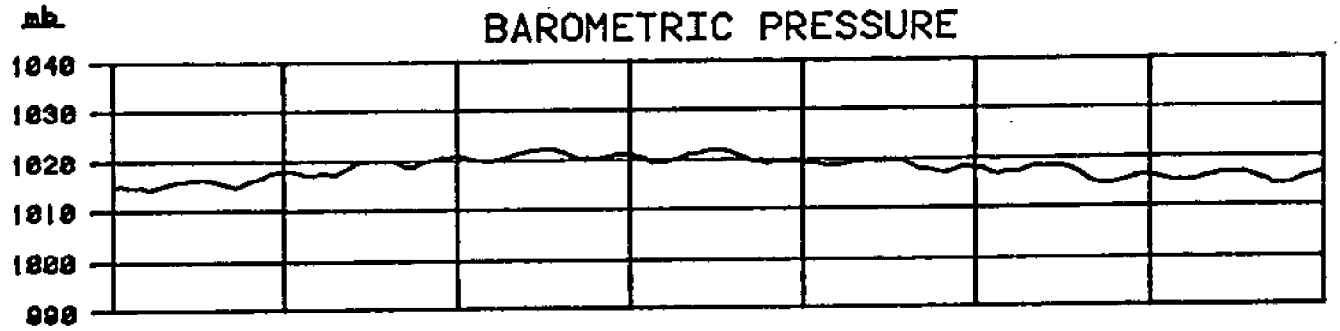
JULY

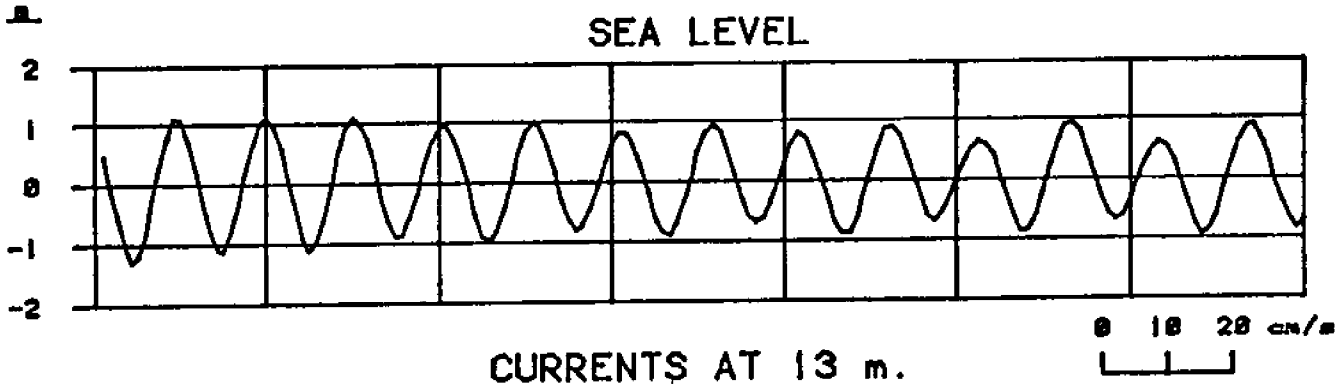

27
28
29
30
31
1
2
35
30
25
20
15
10
5
0
15.8
AIR
AIR
AIR
TEMPERATURE (°C)

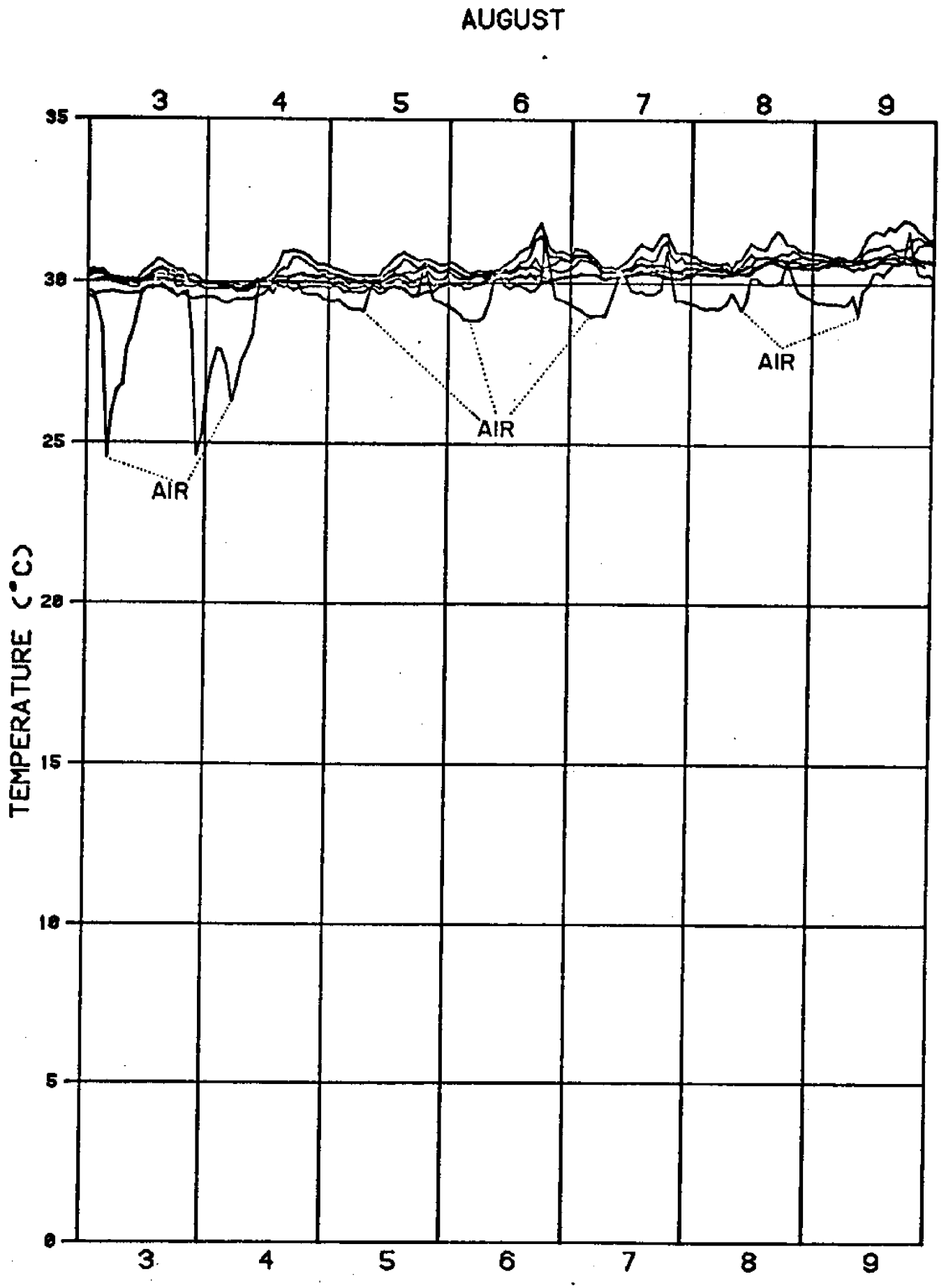
AUGUST

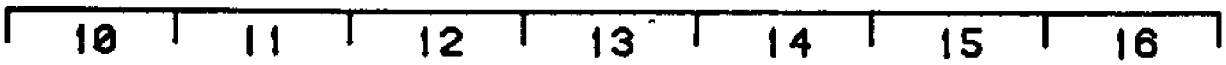

3
4
5
6
7
8
9

WIND

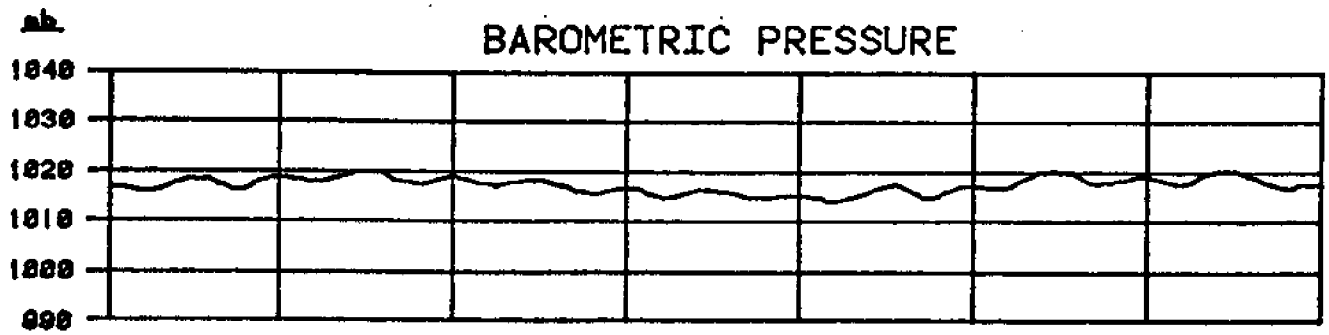

mb
BAROMETRIC PRESSURE
1040
1030
1020
1010
1000
990

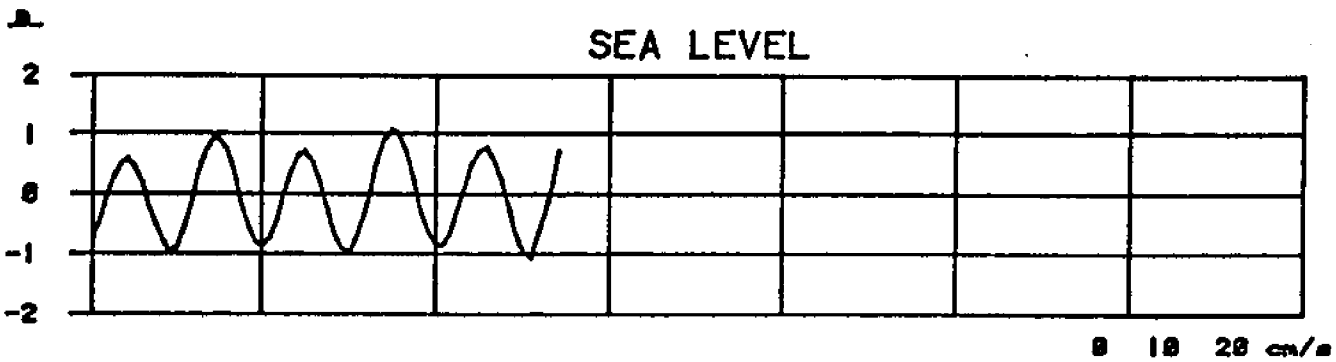

m
SEA LEVEL
2
1
0
-1
-2
0 10 20 cm/s
CURRENTS AT 13 m.
N
E
3
4
5
6
7
8
9

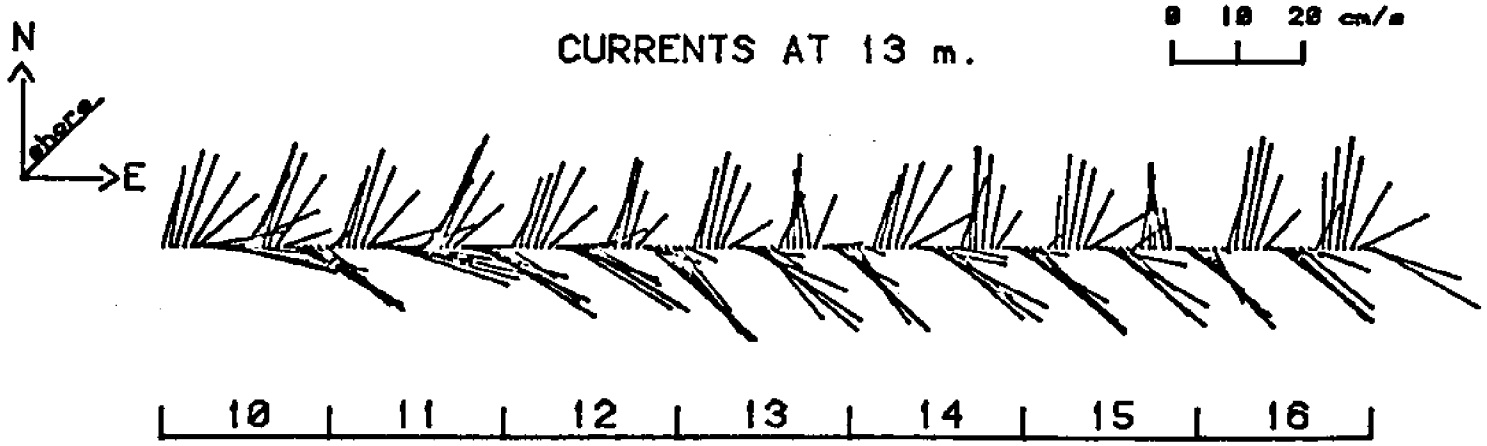

AUGUST
3
4
5
6
7
8
9
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR
AIR

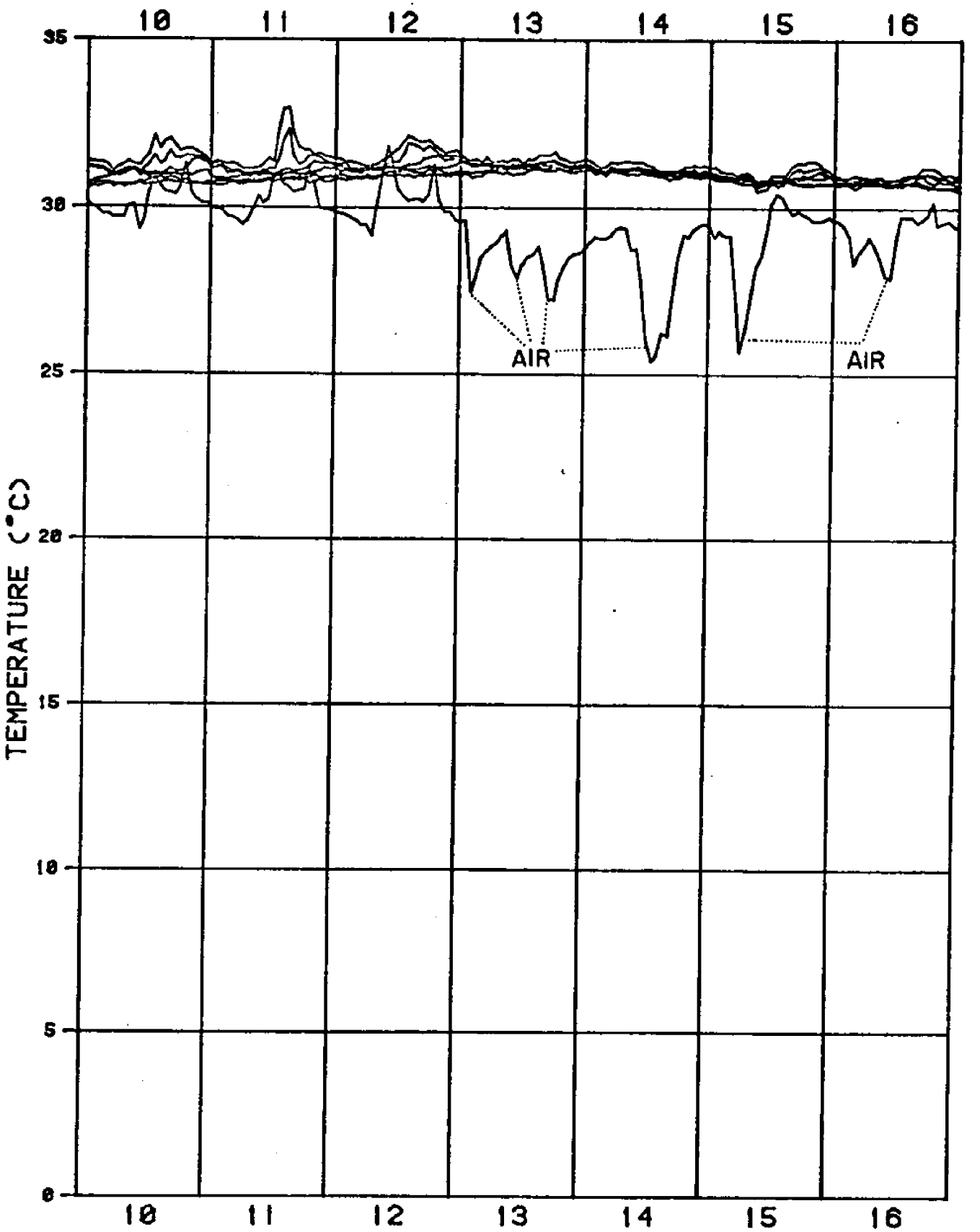

10
11
12
13
14
15
16

WIND

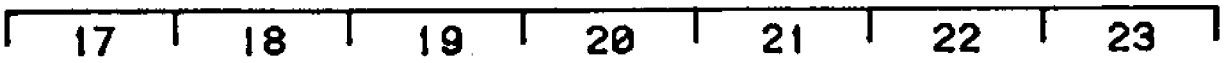

mb
BAROMETRIC PRESSURE
1040
1030
1020
1010
1000
990


m
SEA LEVEL
2
1
0
-1
-2

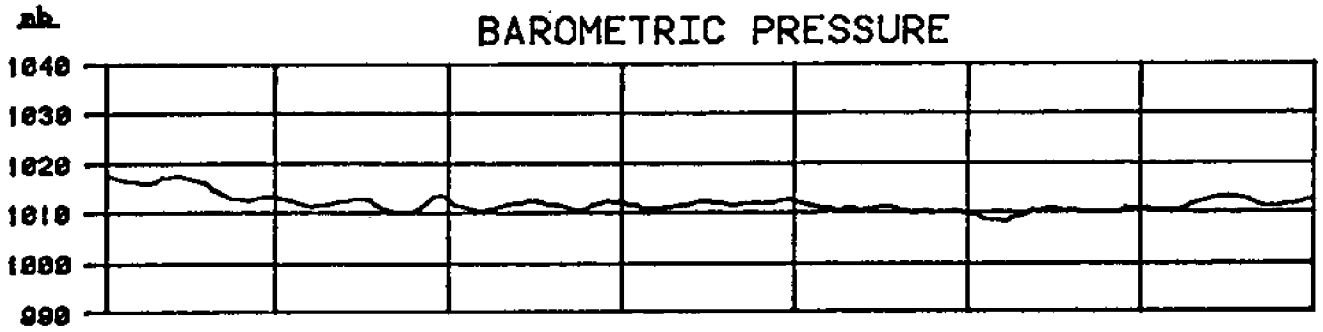

0 10 20 cm/s
CURRENTS AT 13 m.
N
shore
E
10
11
12
13
14
15
16


10
11
12
13
14
15
16
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR

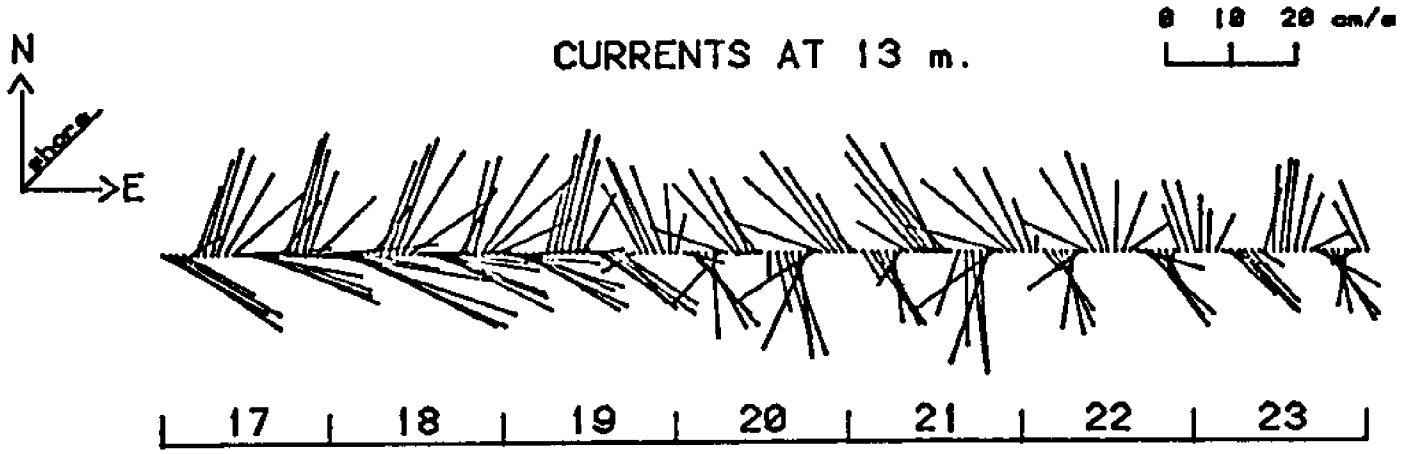
AUGUST

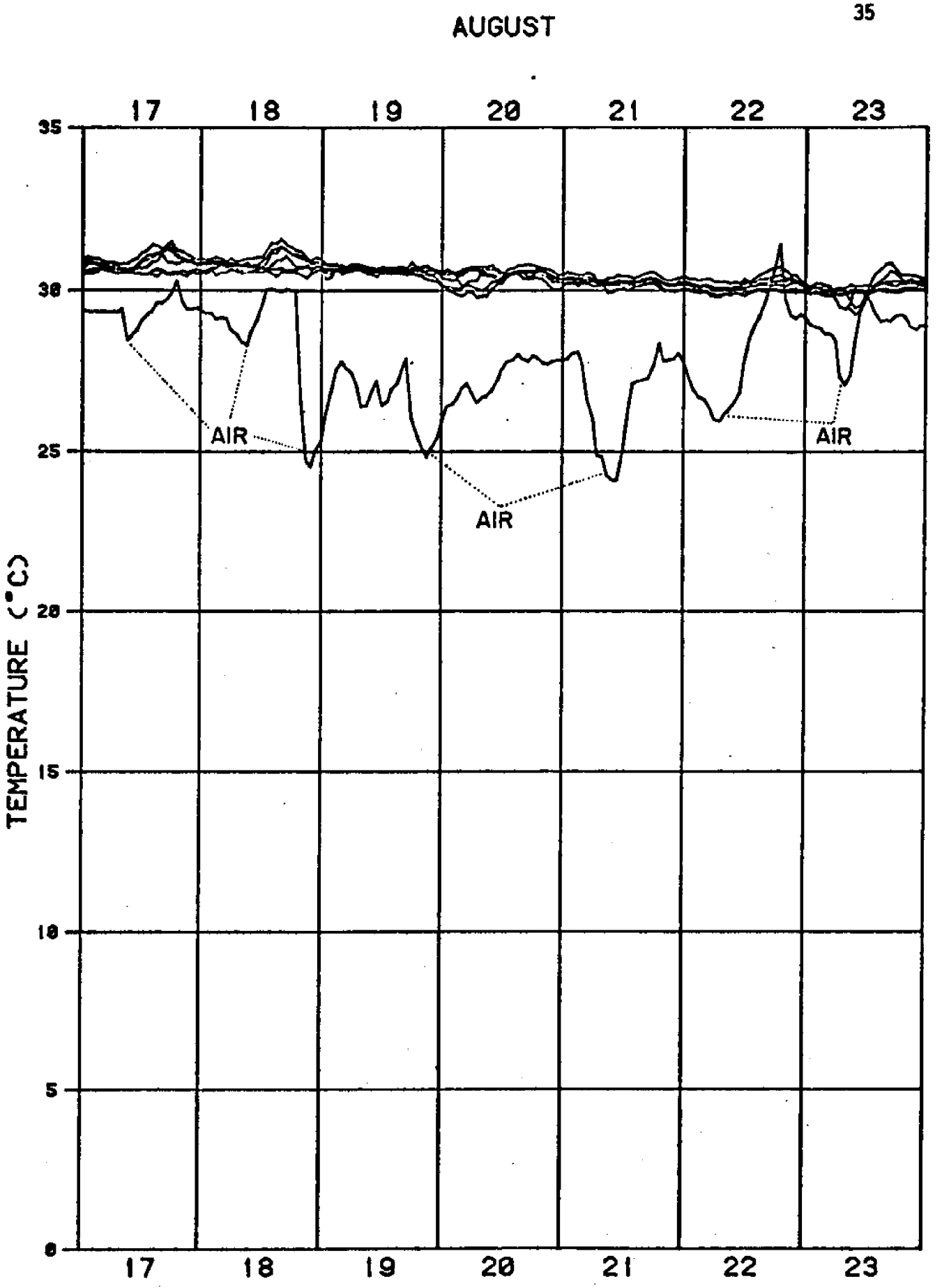


WIND

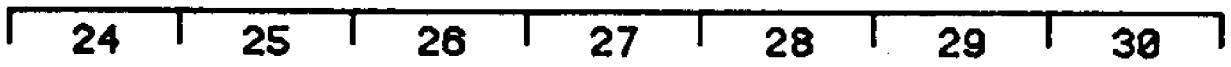


SEA LEVEL

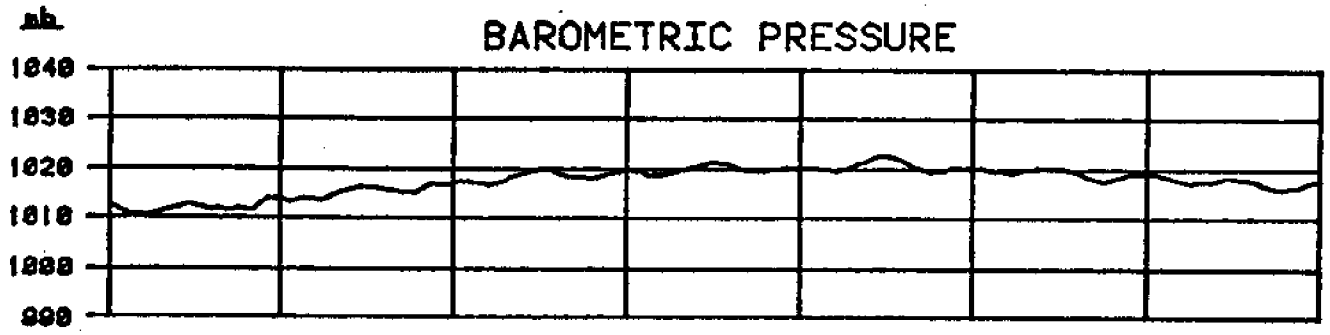



AUGUST
17
18
19
20
21
22
23
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR
AIR

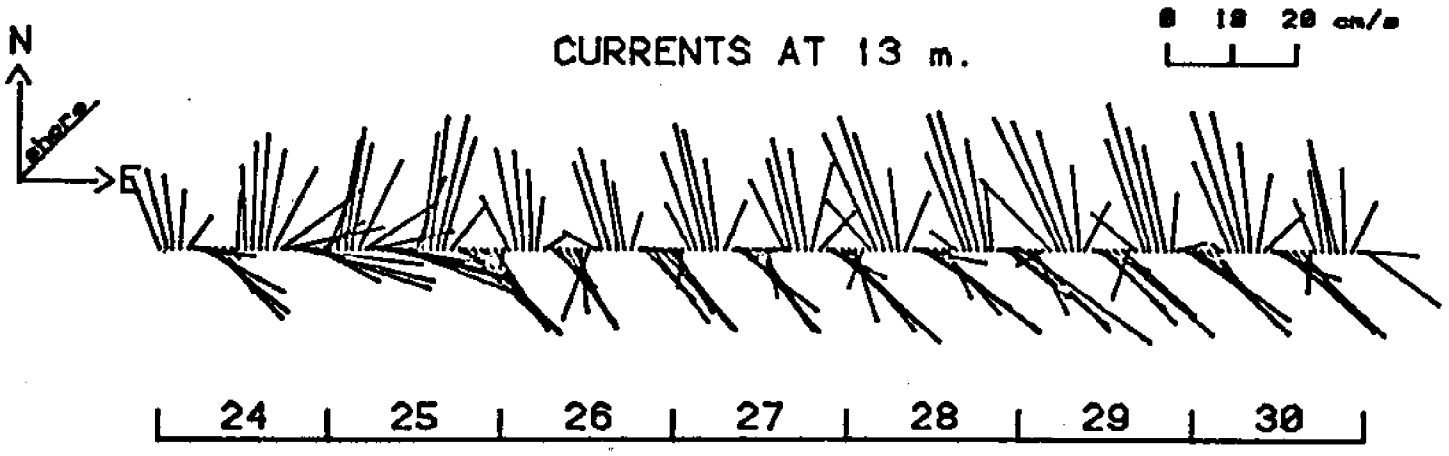
AUGUST



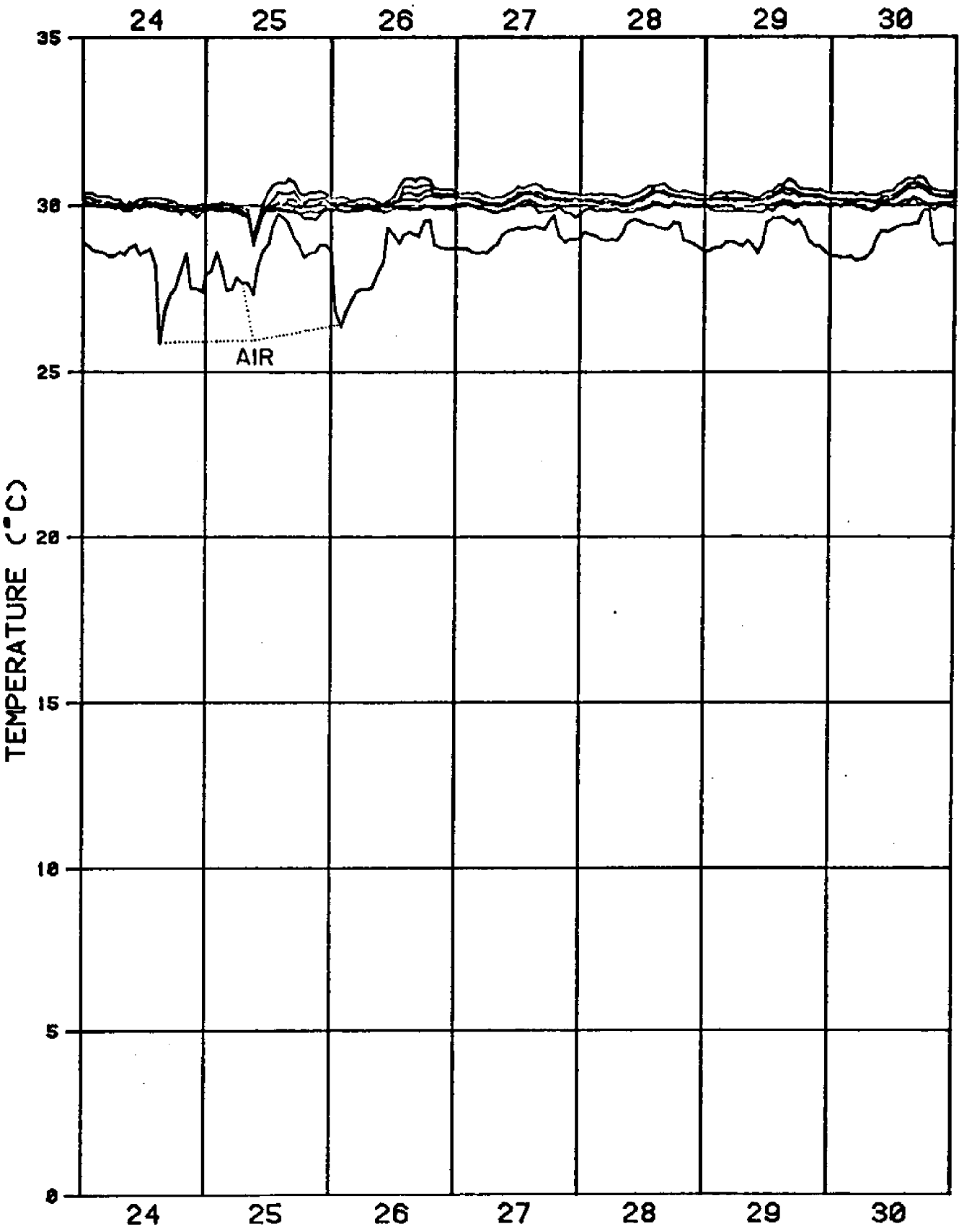
WIND



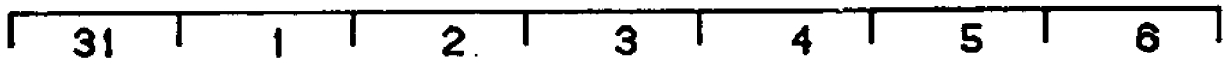
SEA LEVEL



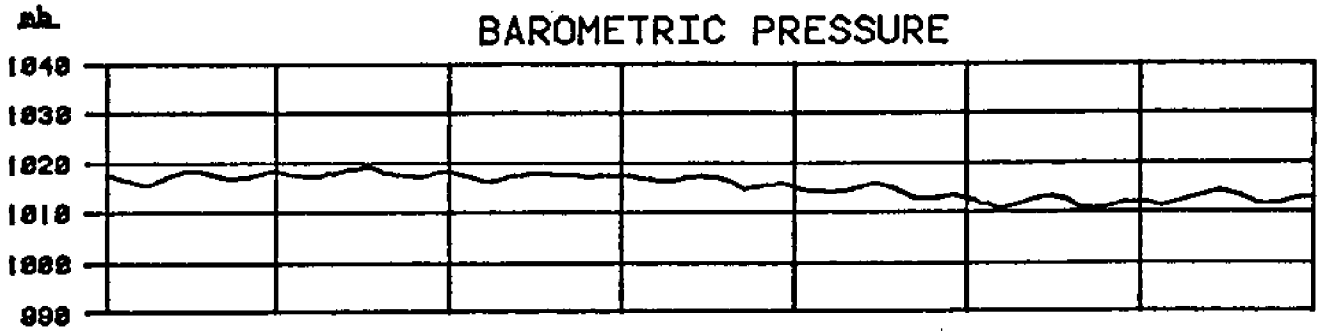
AUGUST



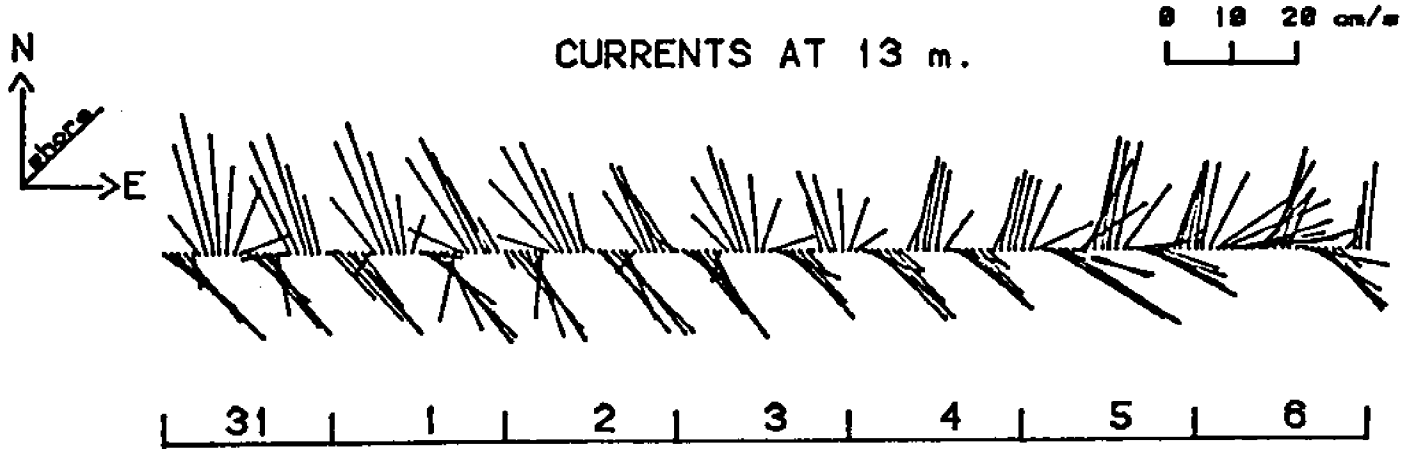
AUGUST



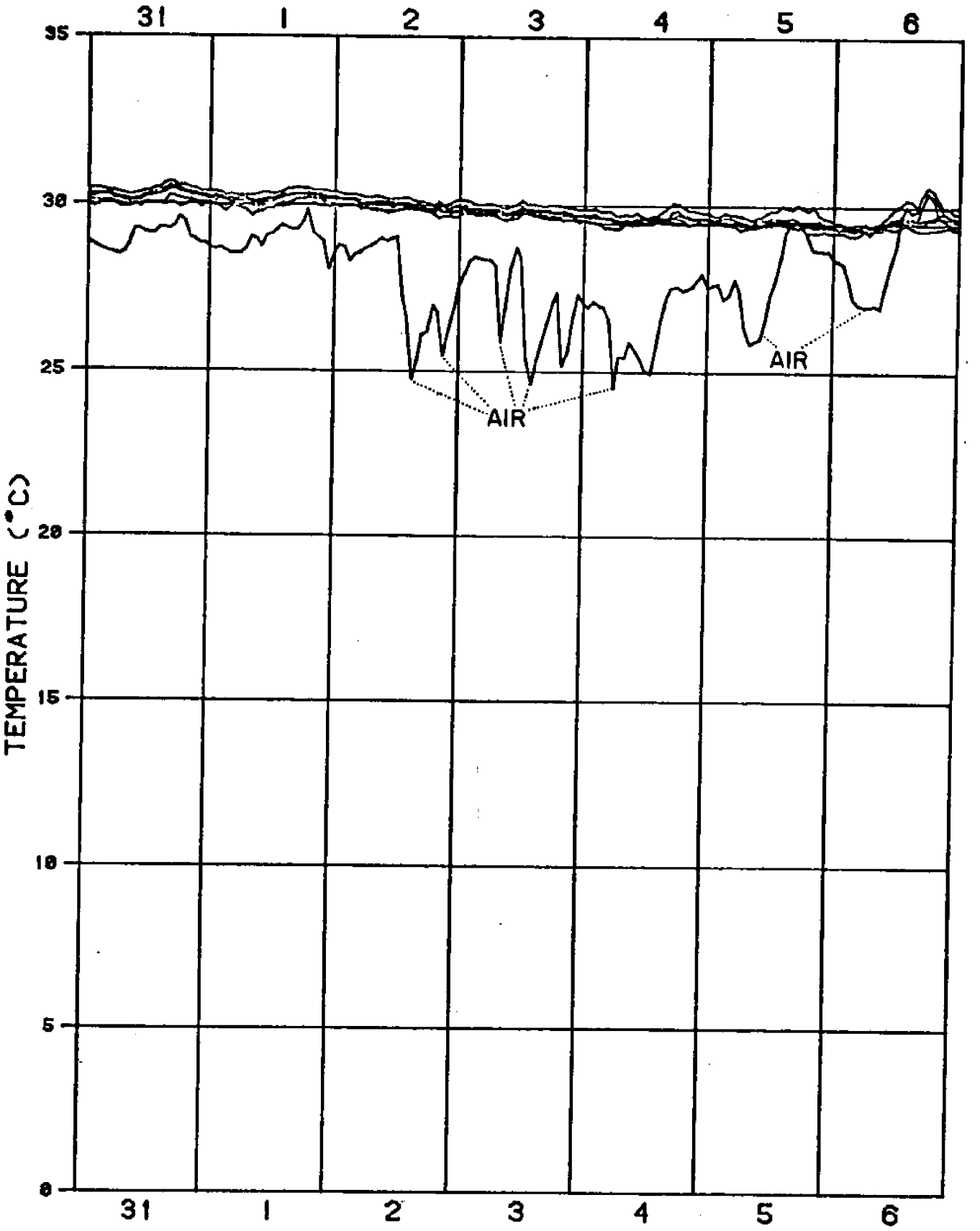
WIND



SEA LEVEL



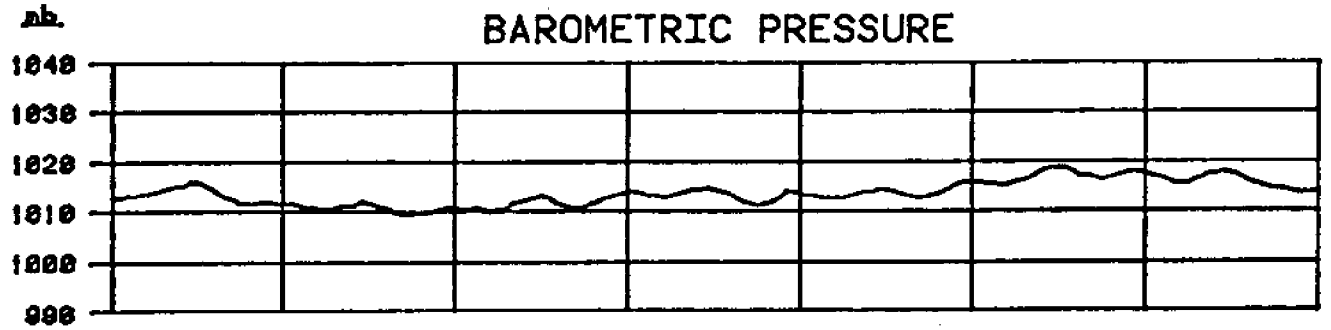
AUGUST



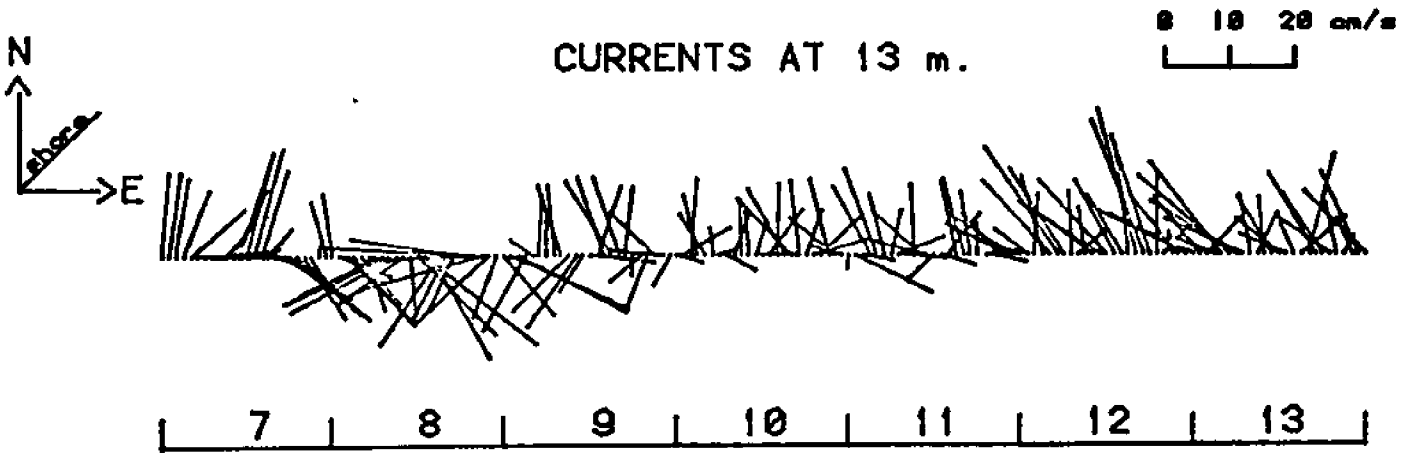
SEPTEMBER

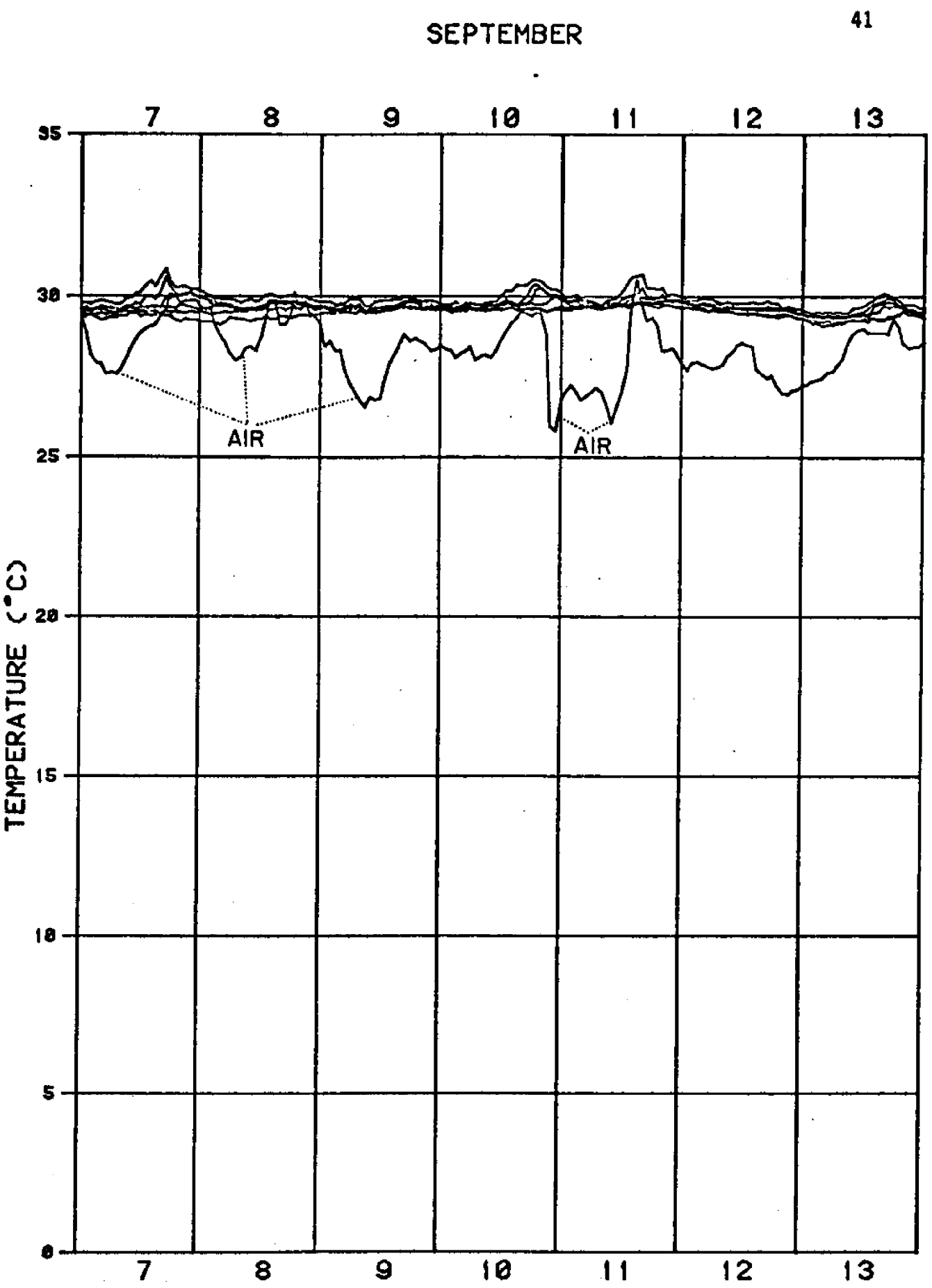
7 8 9 10 11 12 13

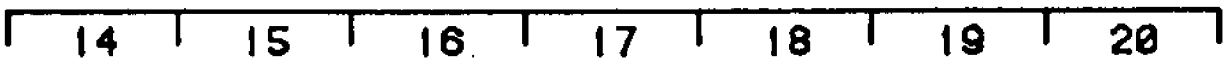
WIND



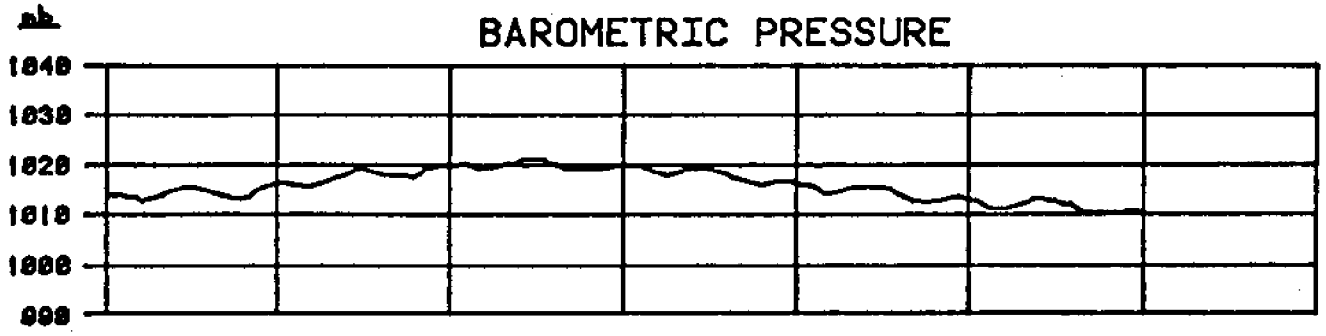
SEA LEVEL



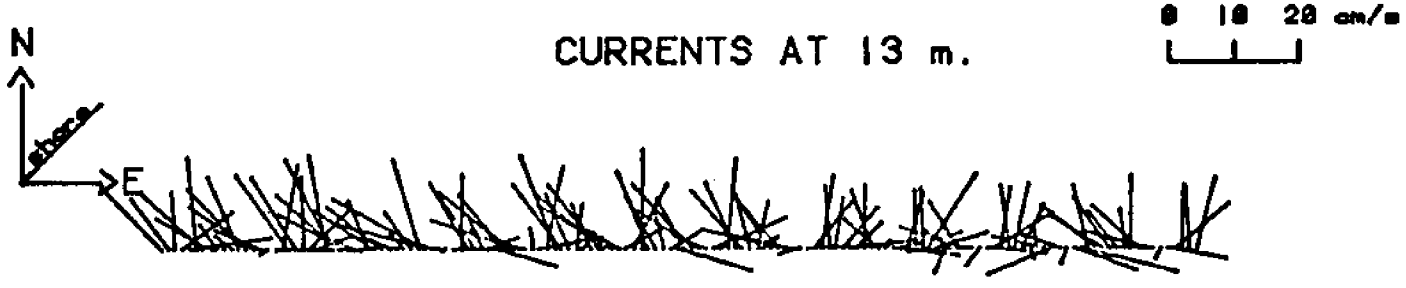

SEPTEMBER
7
8
9
10
11
12
13
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR

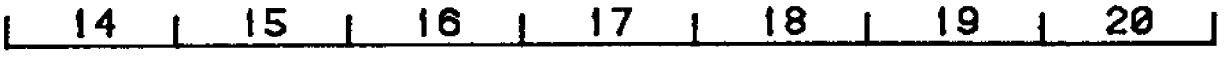


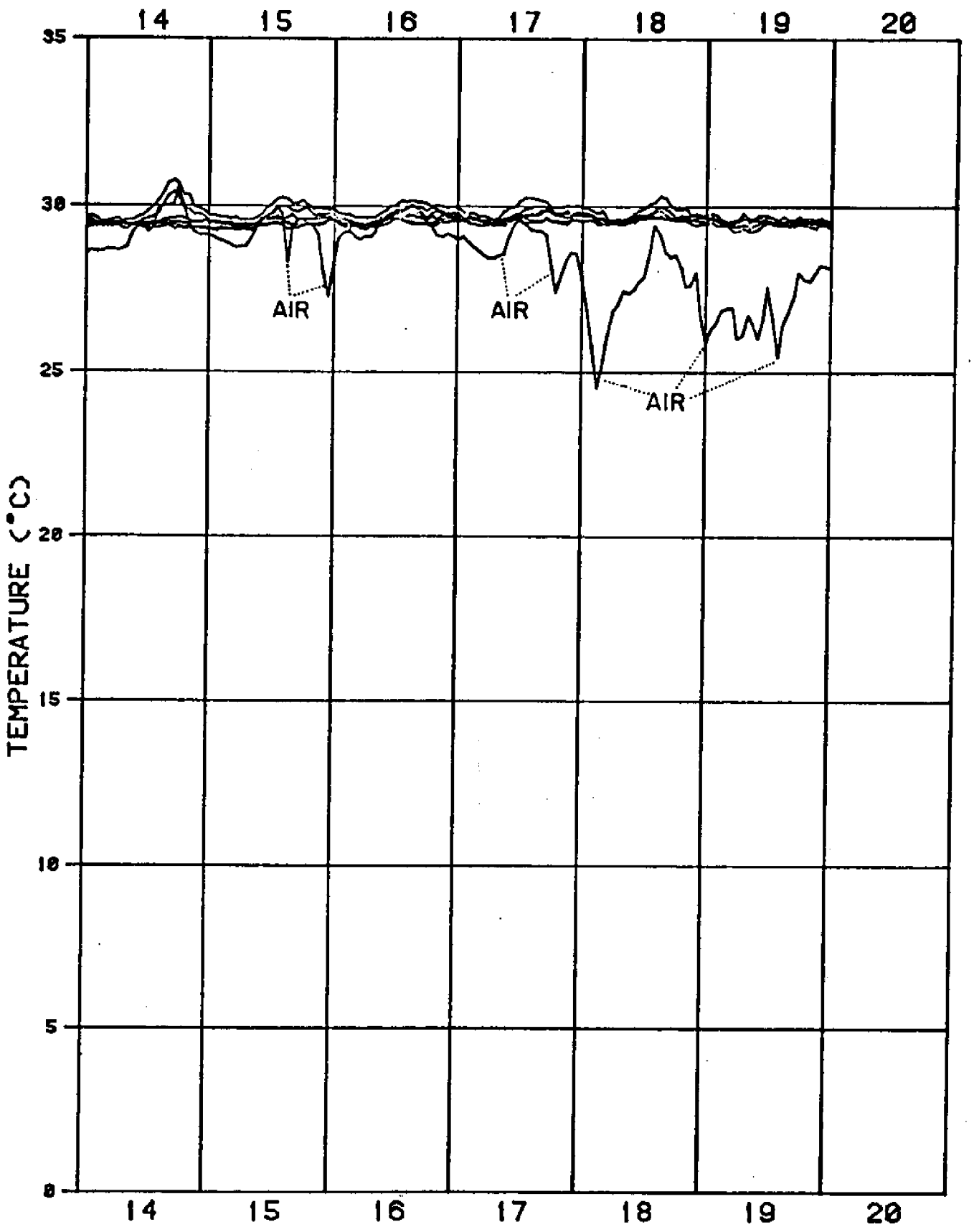
WIND



SEA LEVEL

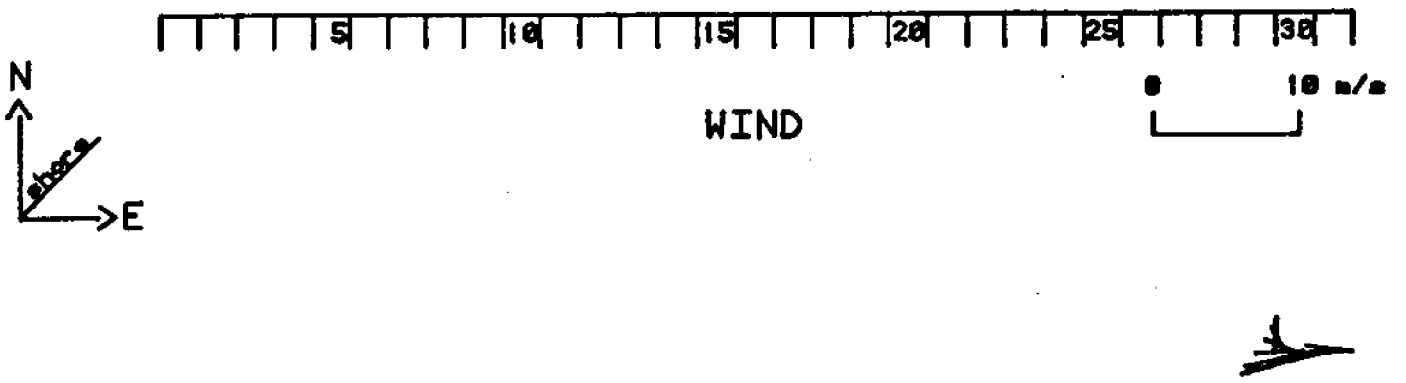


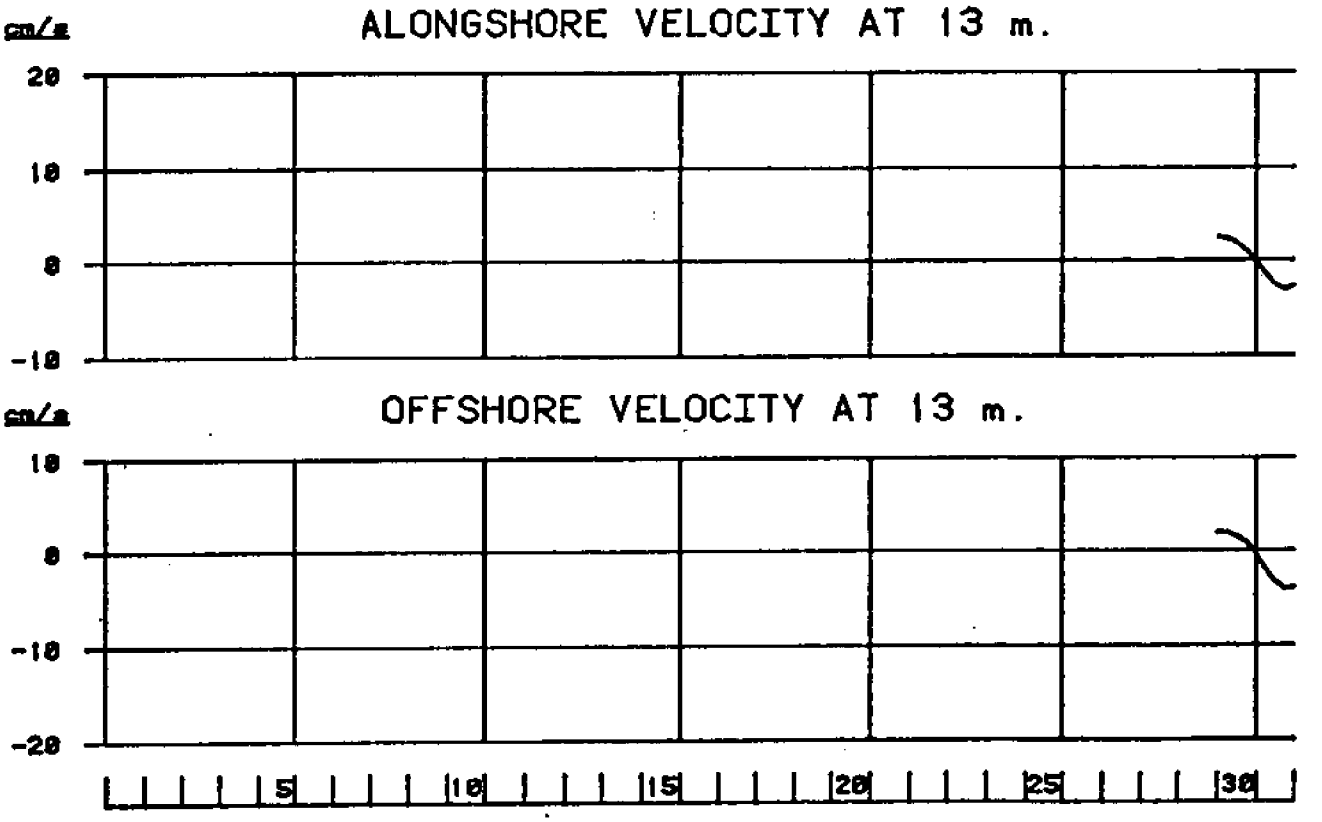



SEPTEMBER
14
15
16
17
18
19
20
35
30
25
20
15
10
5
0
TEMPERATURE (°C)
AIR
AIR
AIR

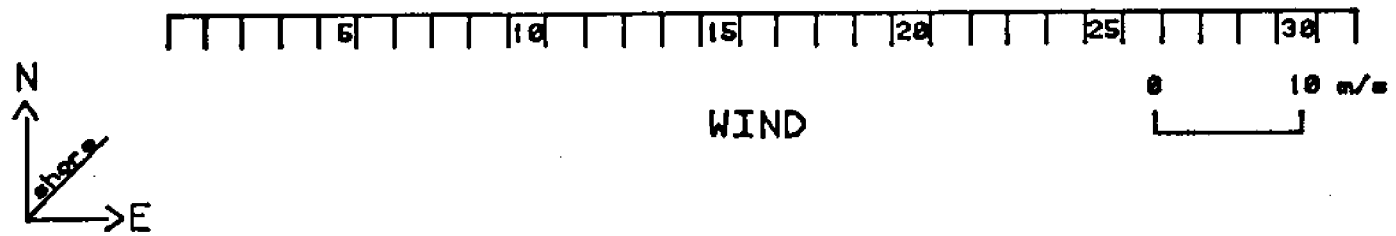
APPENDIX B. Monthly plots of smoothed six-hourly data from 30 May through 15 September, 1977. Air temperature is denoted on the plots. Water temperature was not significantly different from top to bottom. Shallow temperatures are somewhat higher. Numbers denote depth in meters.

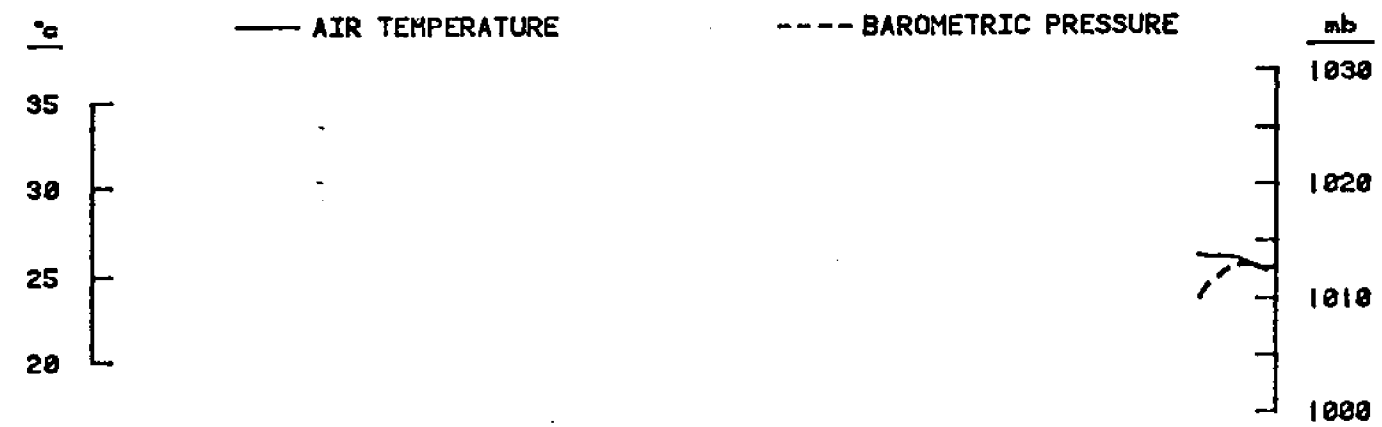
MAY

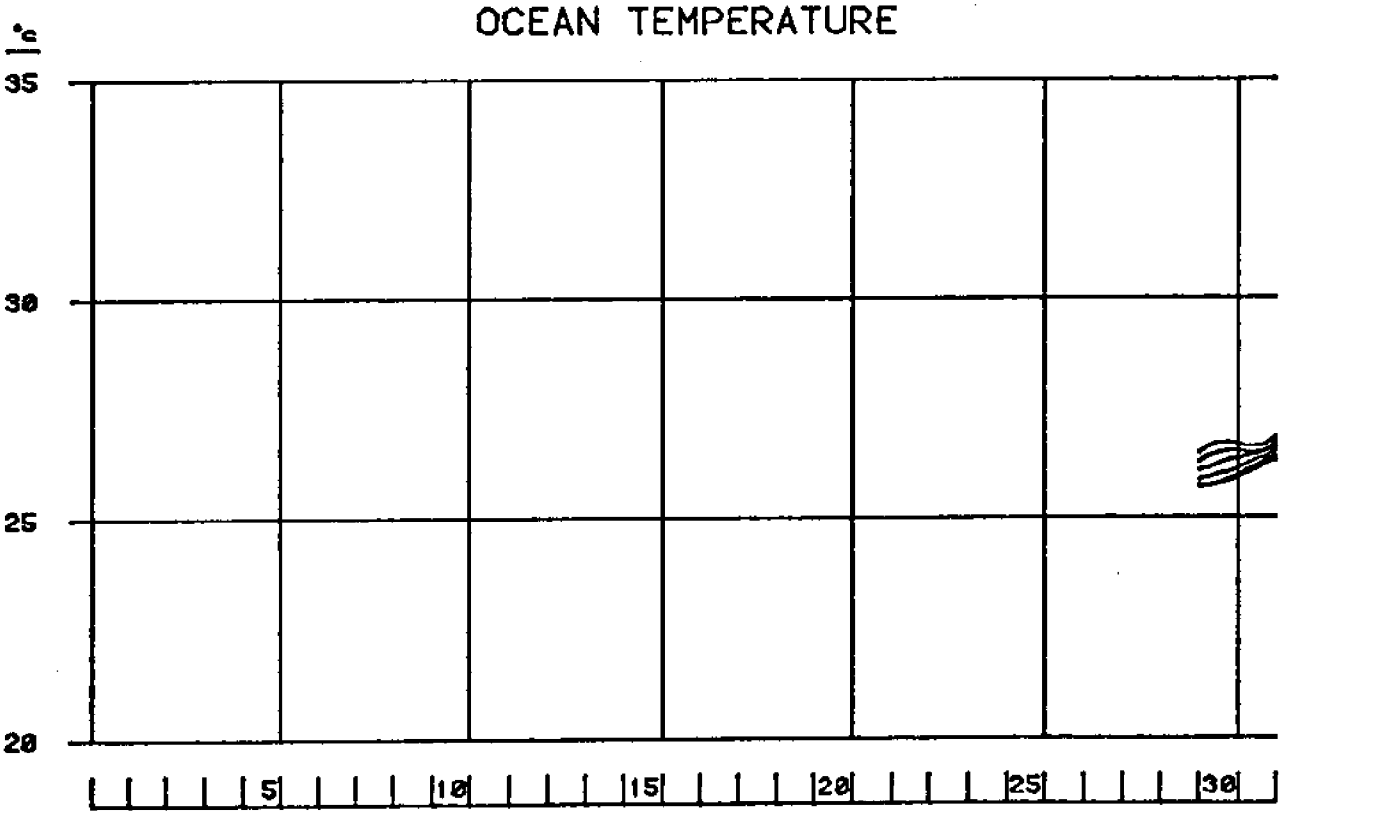

5
10
15
20
25
30
N
E
0
10 m/s
WIND


cm/s
ALONGSHORE VELOCITY AT 13 m.
20
10
0
-10
cm/s
OFFSHORE VELOCITY AT 13 m.
10
0
-10
-20
5
10
15
20
25
30

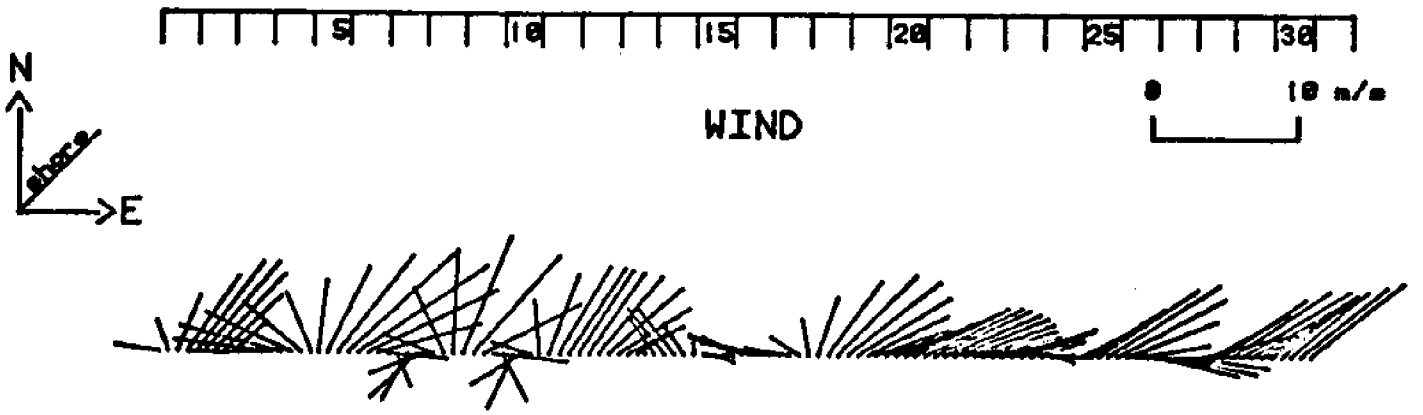
MAY

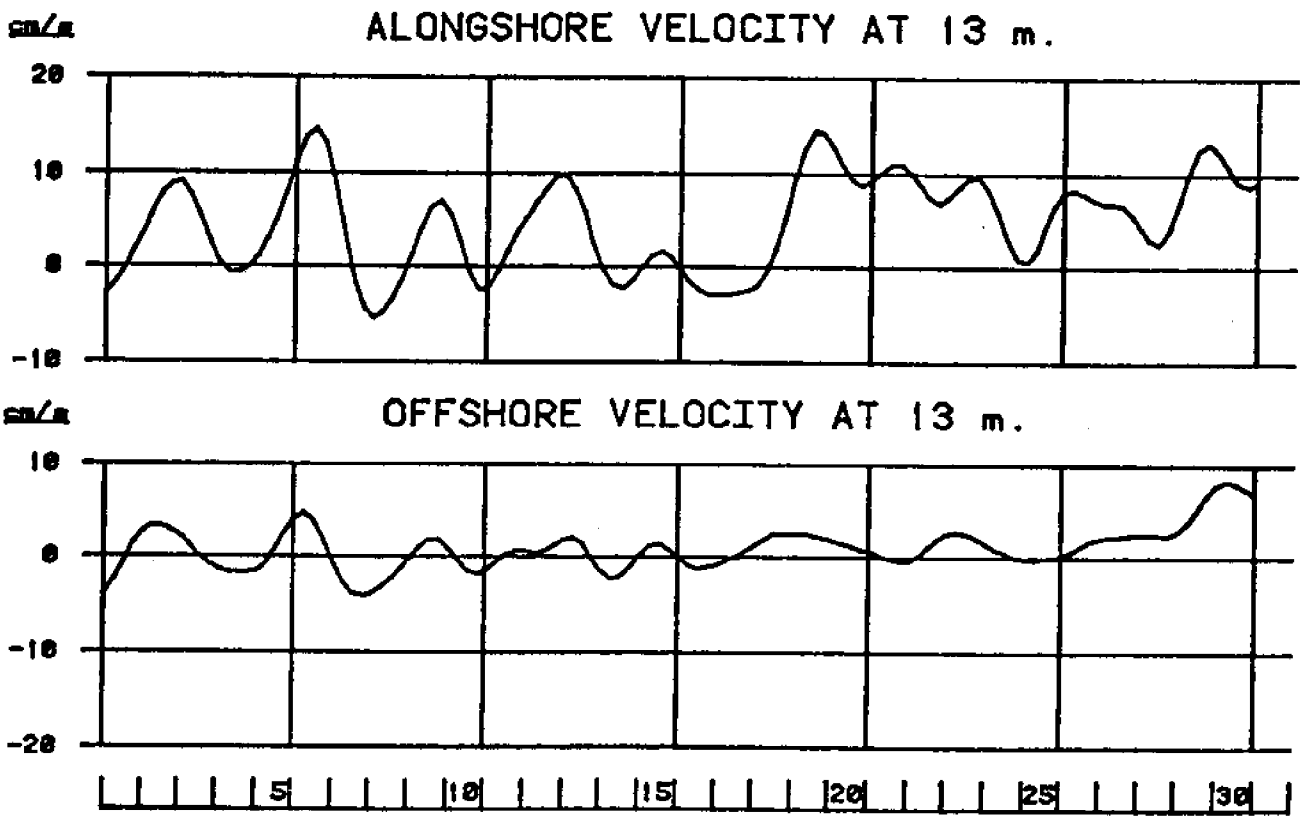

5
10
15
20
25
30
N
E
0
10 m/s
WIND


°c
AIR TEMPERATURE
BAROMETRIC PRESSURE
mb
35
30
25
20
1030
1020
1010
1000

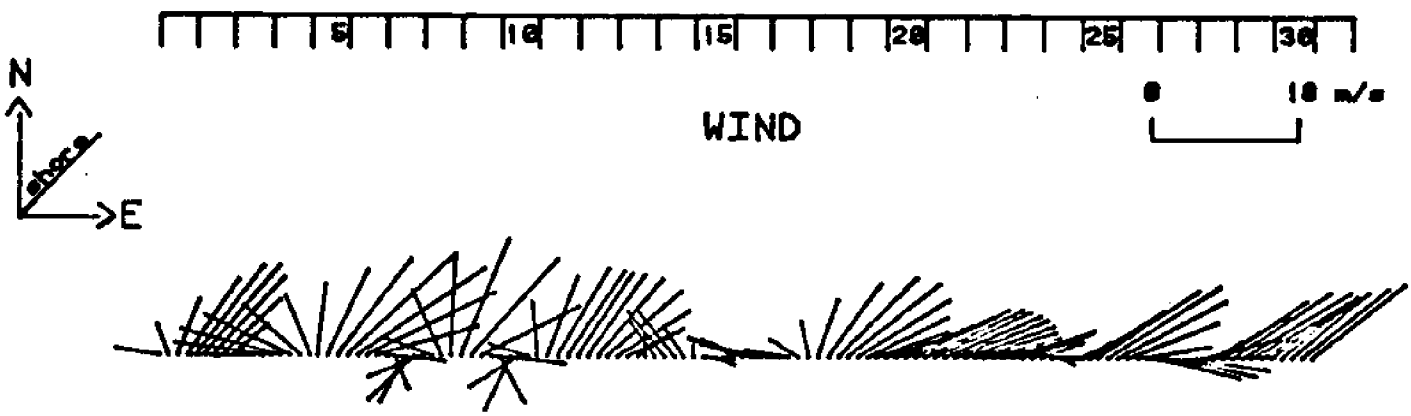

OCEAN TEMPERATURE
°c
35
30
25
20
5
10
15
20
25
30

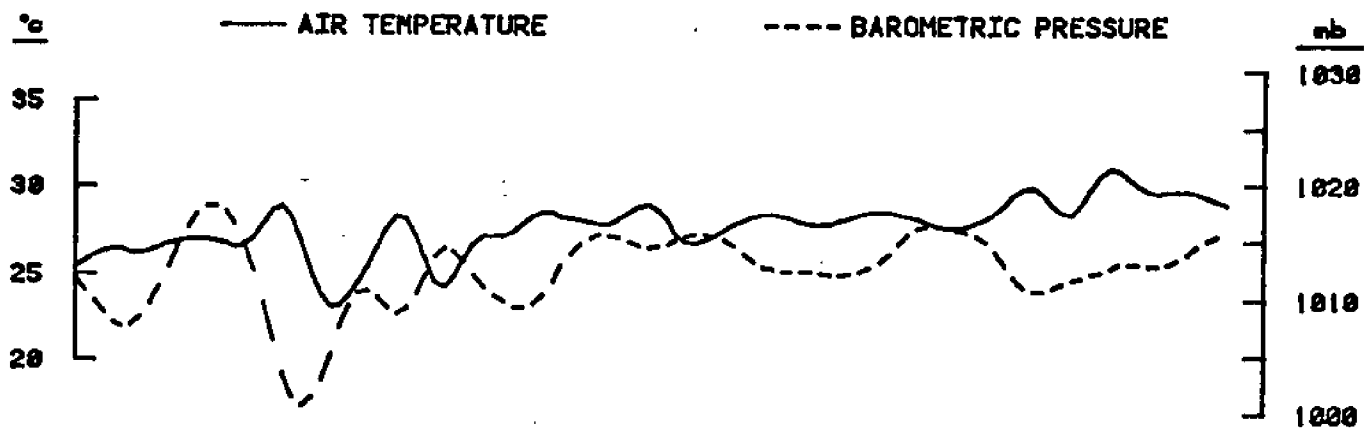
JUNE

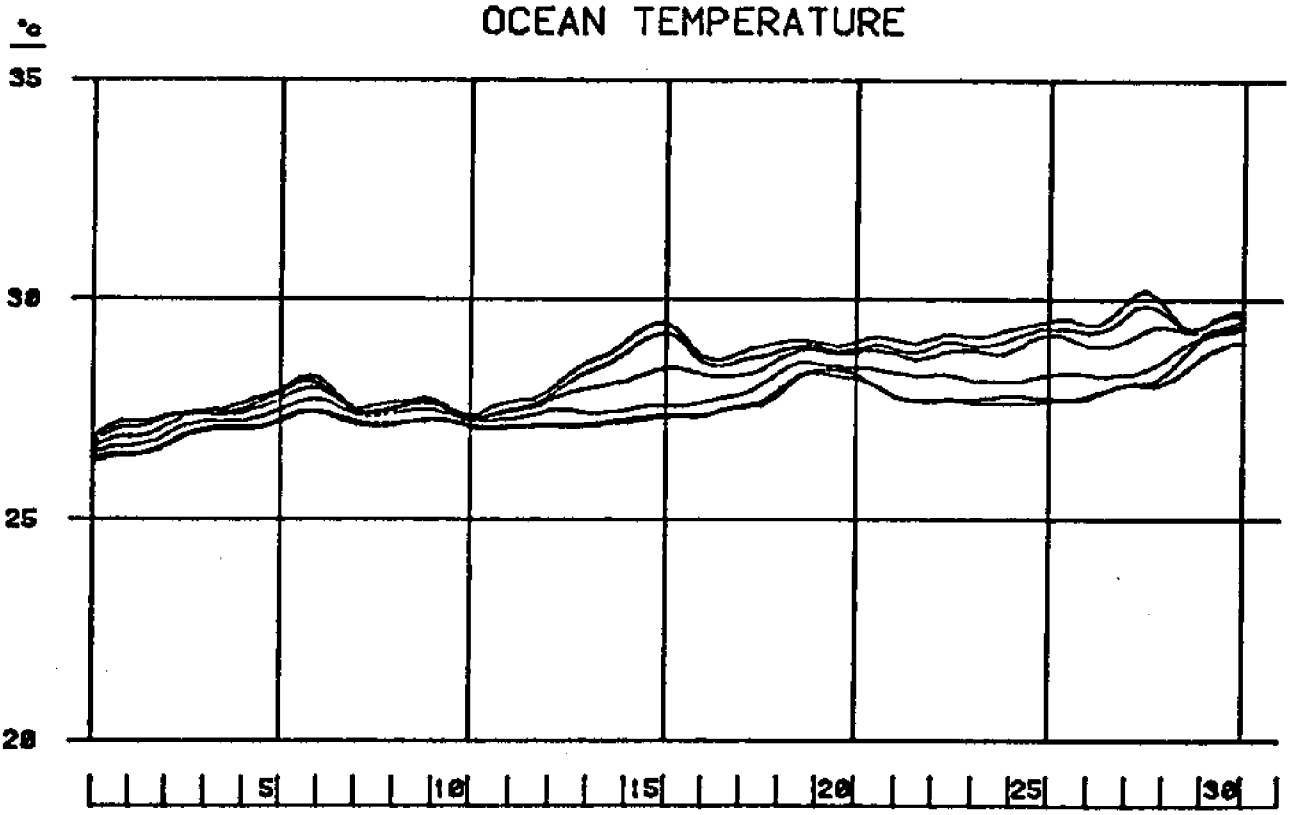

5
10
15
20
25
30
N
E
0
10 m/s
WIND

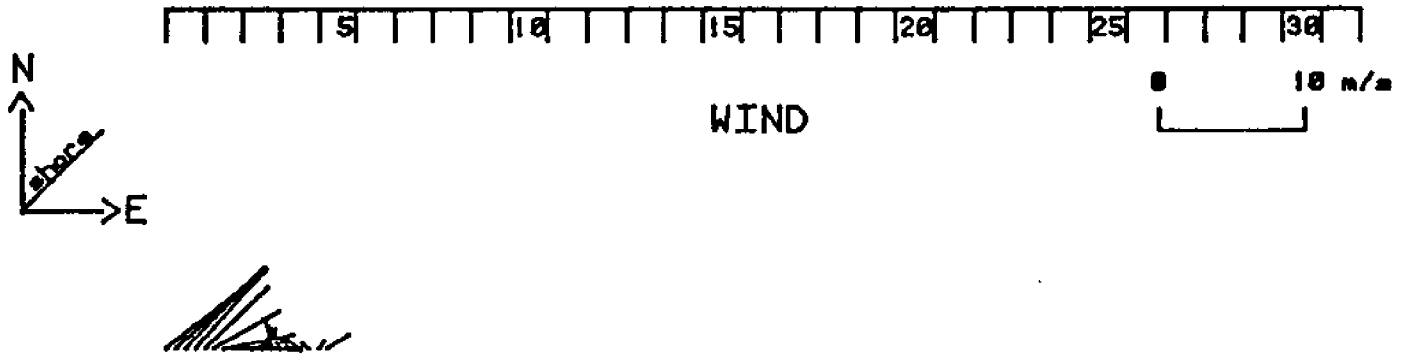

cm/s
ALONGSHORE VELOCITY AT 13 m.
20
10
0
-10
cm/s
OFFSHORE VELOCITY AT 13 m.
10
0
-10
-20
5
10
15
20
25
30

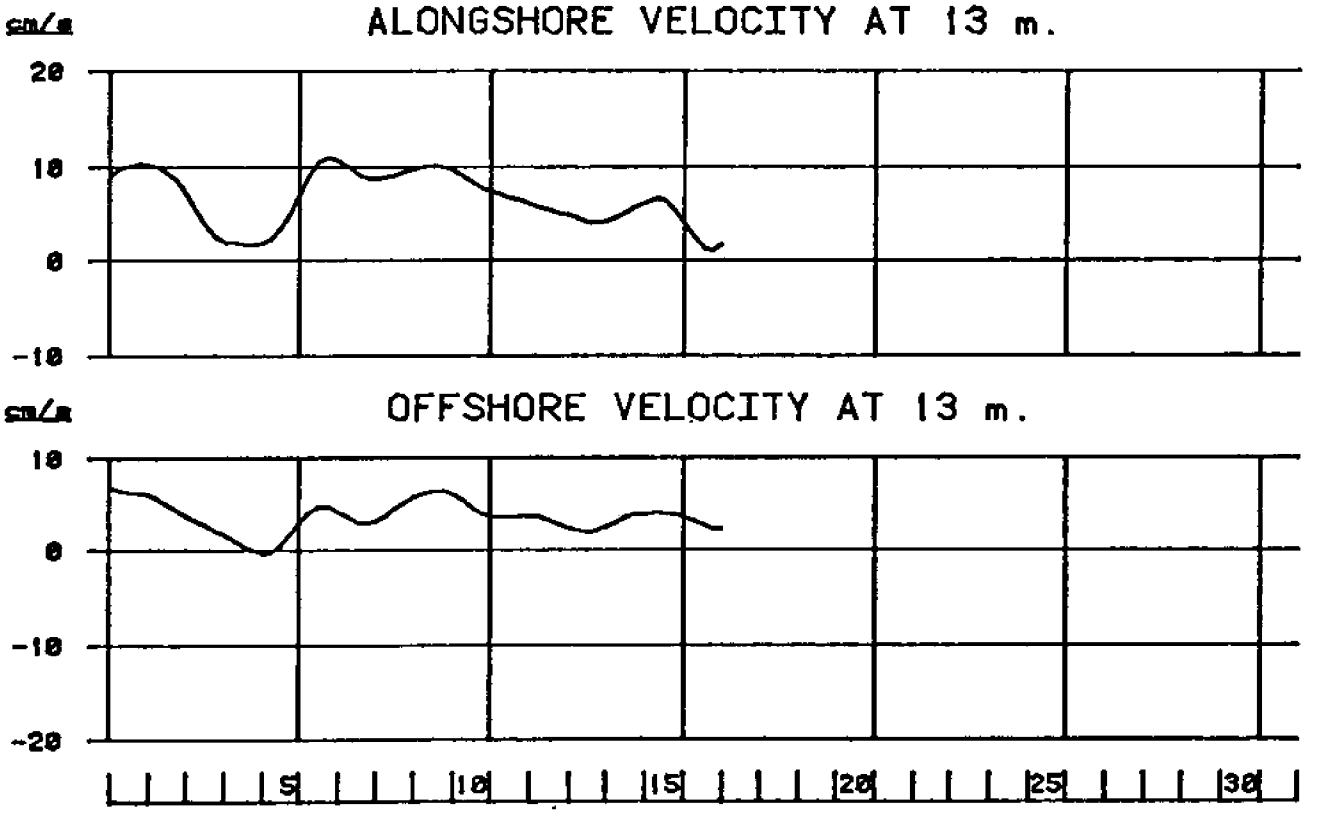
JUNE


5
10
15
20
25
30
N
E
0
10 m/s
WIND

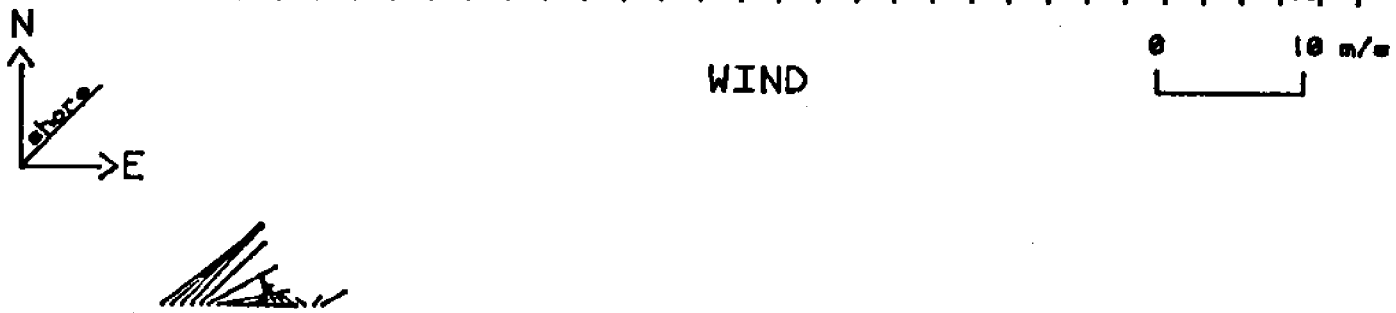

°c
AIR TEMPERATURE
BAROMETRIC PRESSURE
mb
35
30
25
20
1030
1020
1010
1000

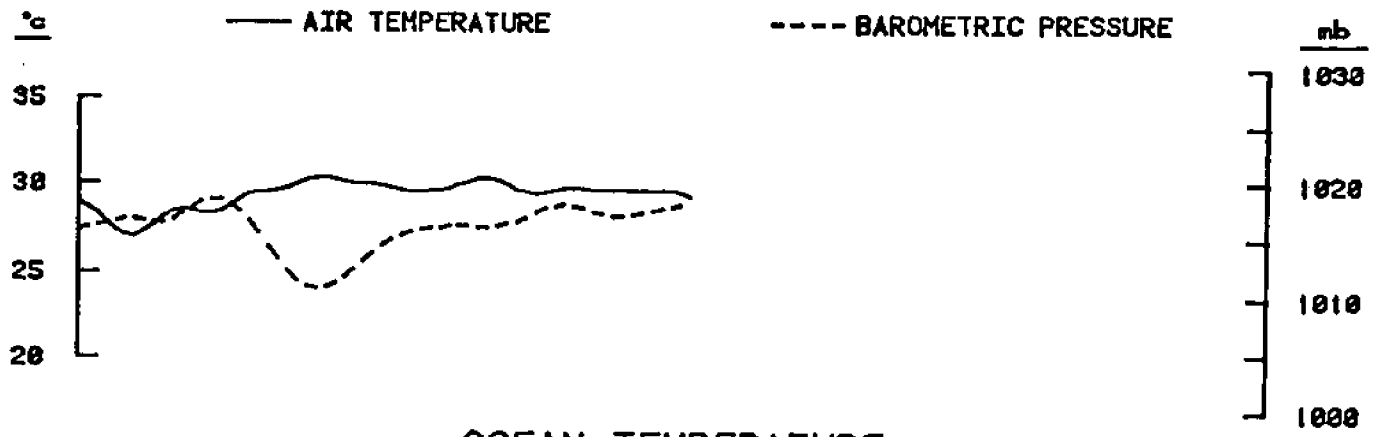

OCEAN TEMPERATURE
°c
35
30
25
20
5
10
15
20
25
30


5
10
15
20
25
30
N
shore
E
0
10 m/s
WIND

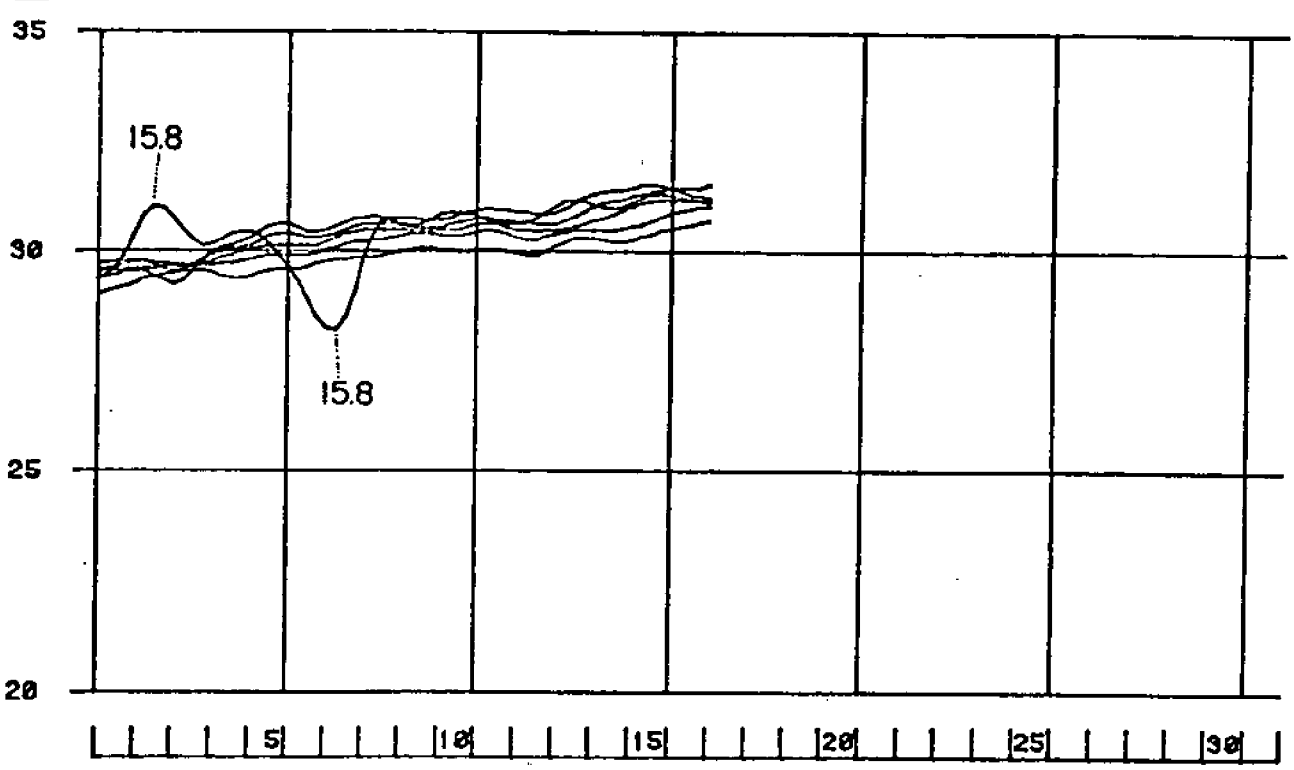

cm/s
ALONGSHORE VELOCITY AT 13 m.
20
10
0
-10
cm/s
OFFSHORE VELOCITY AT 13 m.
10
0
-10
-20
5
10
15
20
25
30

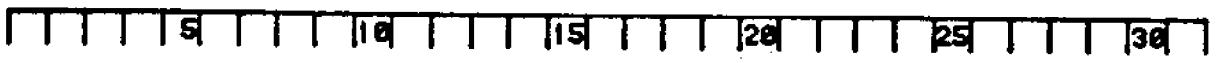
JULY



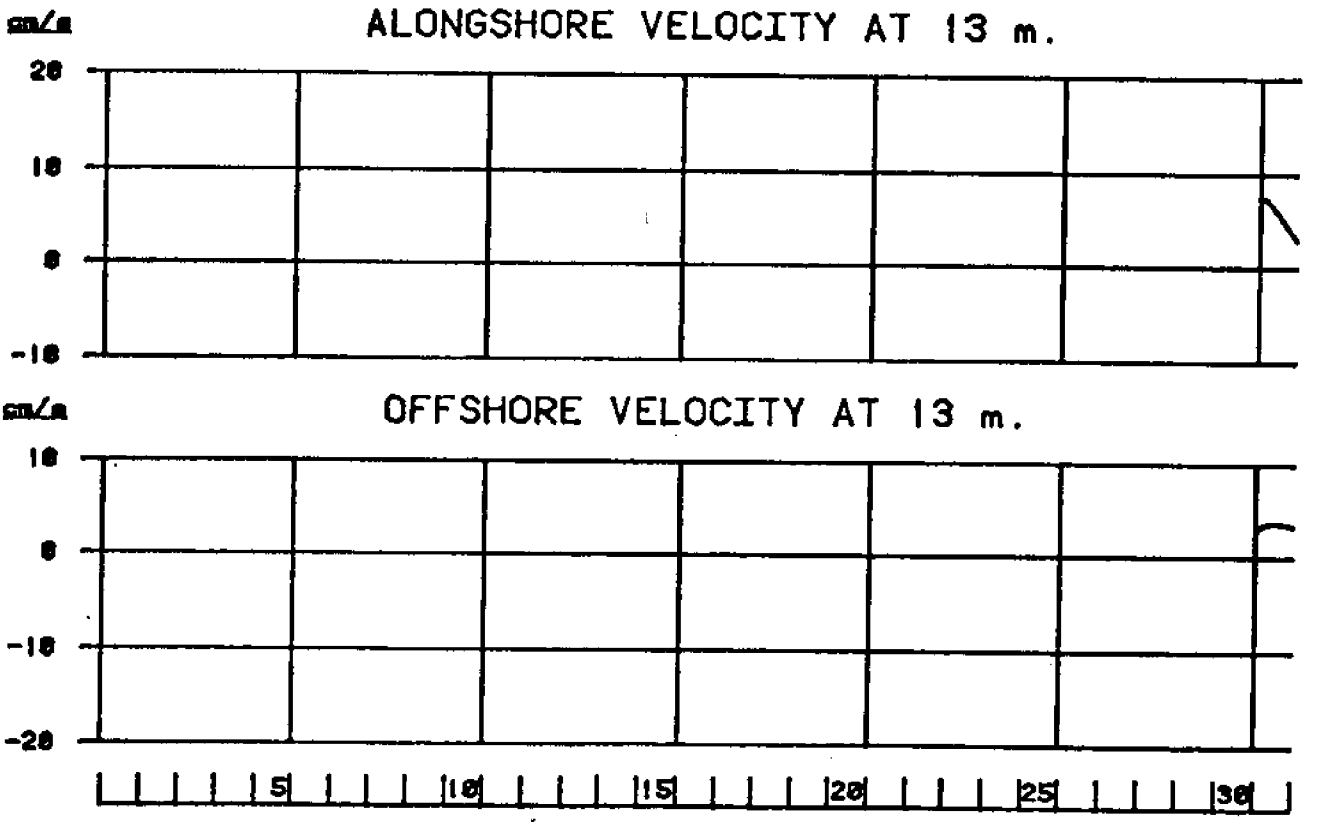


OCEAN TEMPERATURE



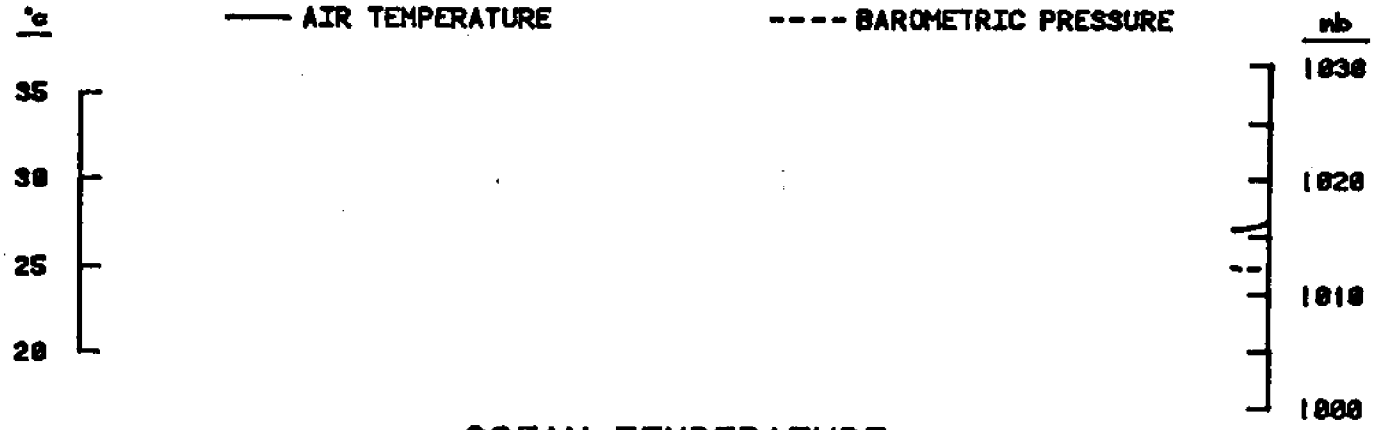

5
10
15
20
25
30

WIND

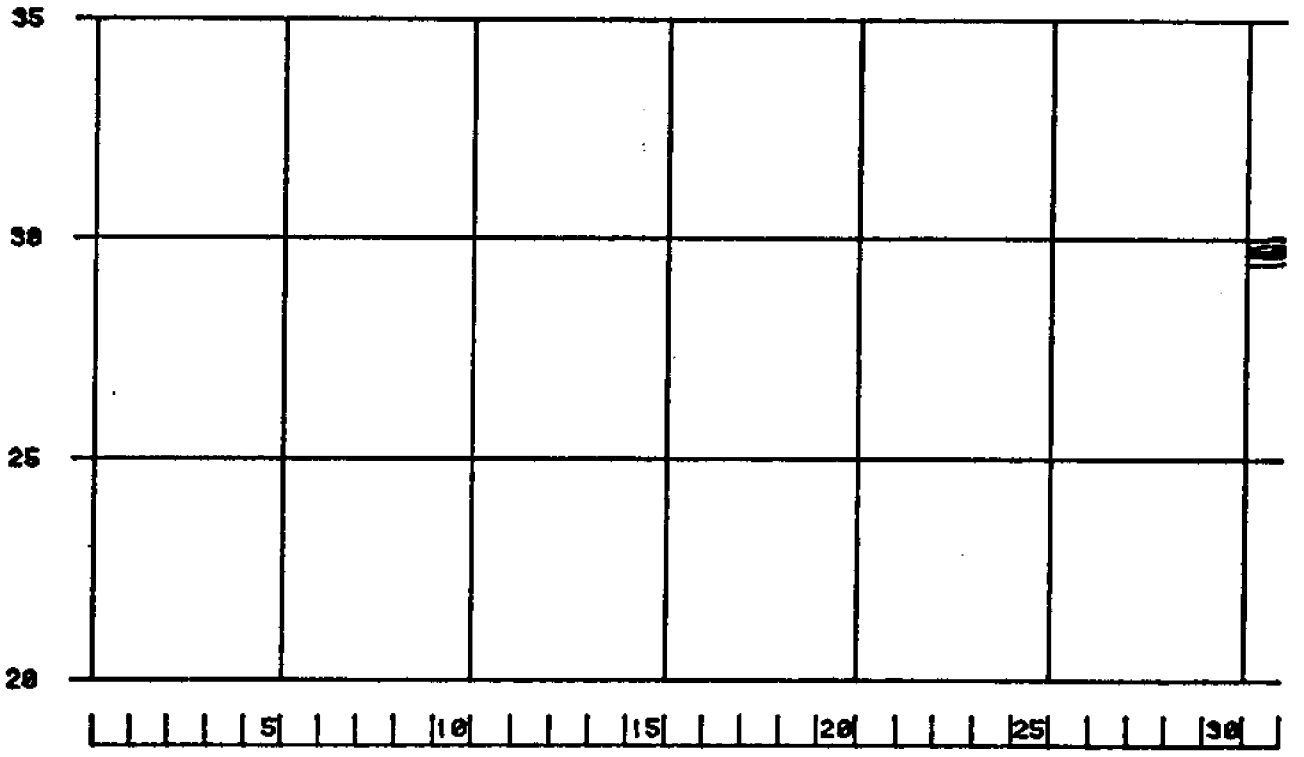

cm/s
ALONGSHORE VELOCITY AT 13 m.
20
10
0
-10
cm/s
OFFSHORE VELOCITY AT 13 m.
10
0
-10
-20
5
10
15
20
25
30

JULY

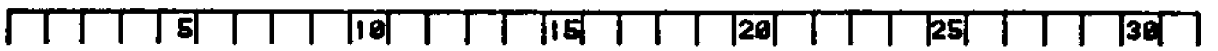
WIND



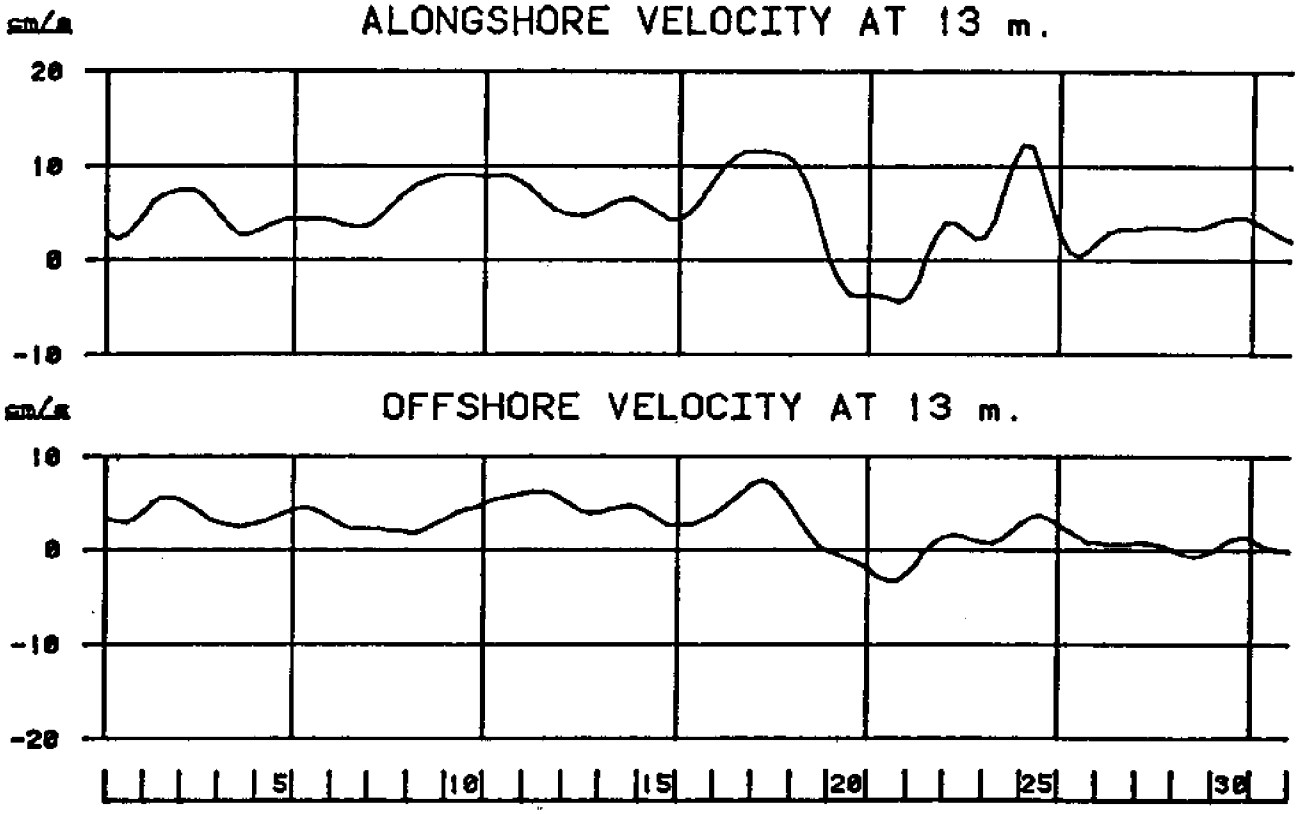
OCEAN TEMPERATURE



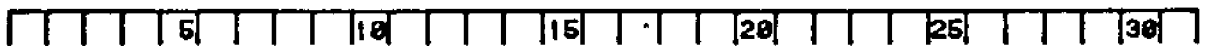
AUGUST


5
10
15
20
25
30

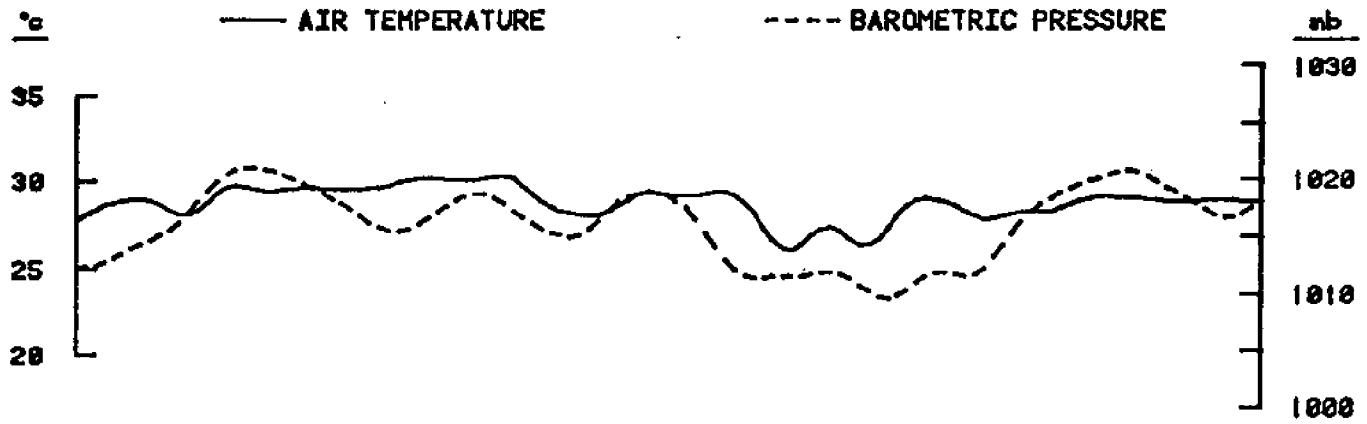
WIND


cm/s
ALONGSHORE VELOCITY AT 13 m.
20
10
0
-10
cm/s
OFFSHORE VELOCITY AT 13 m.
10
0
-10
-20
5
10
15
20
25
30

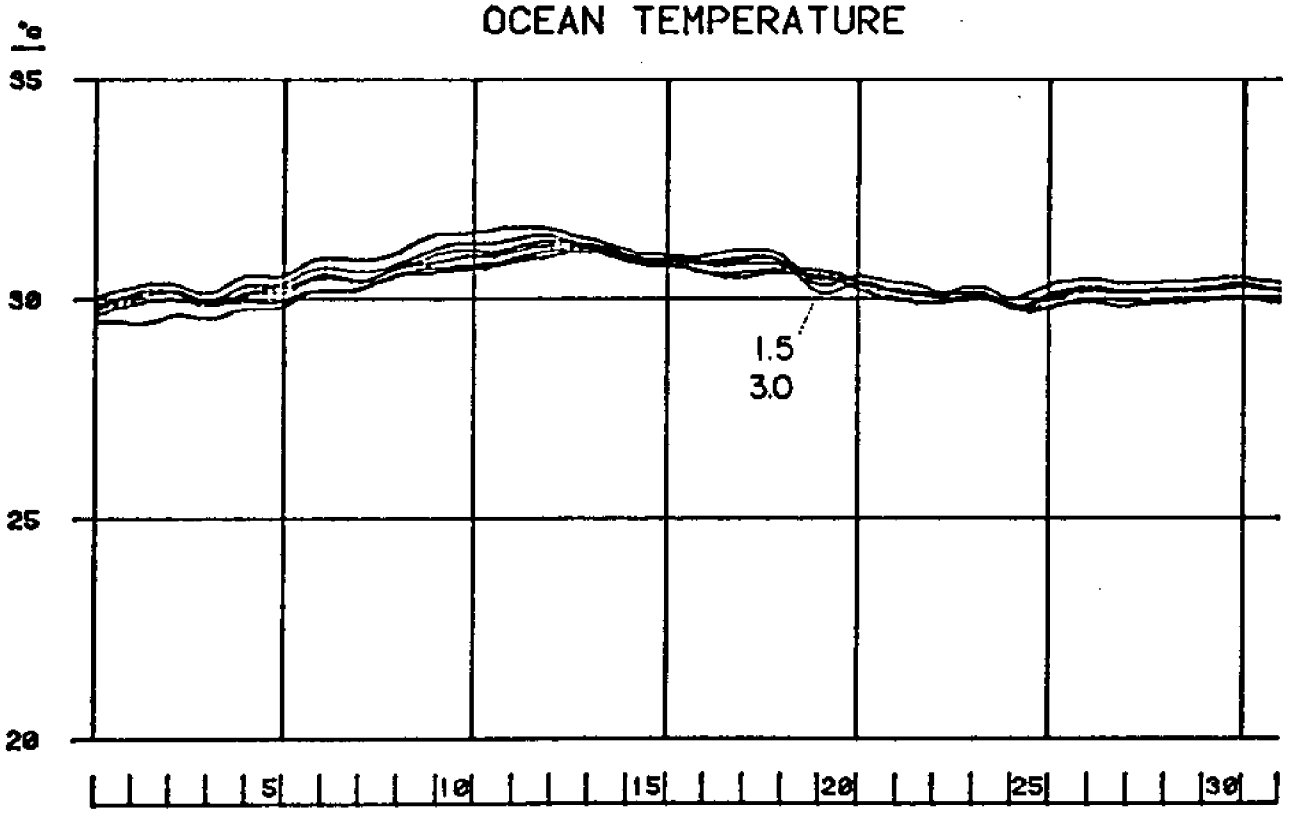
AUGUST



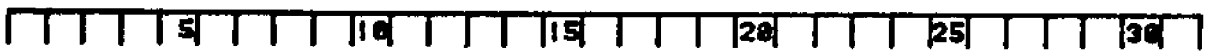
WIND



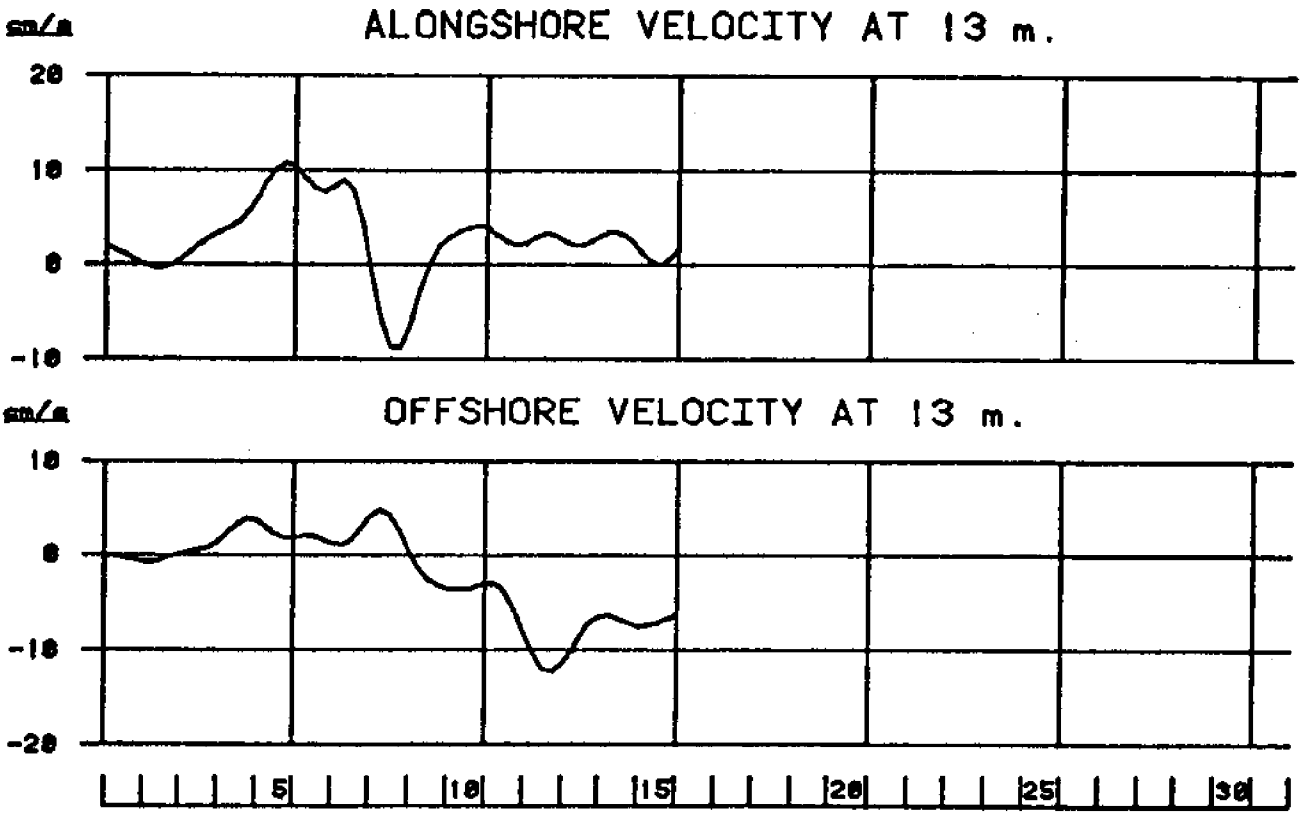
OCEAN TEMPERATURE



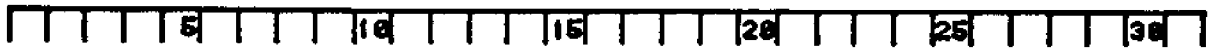
SEPTEMBER



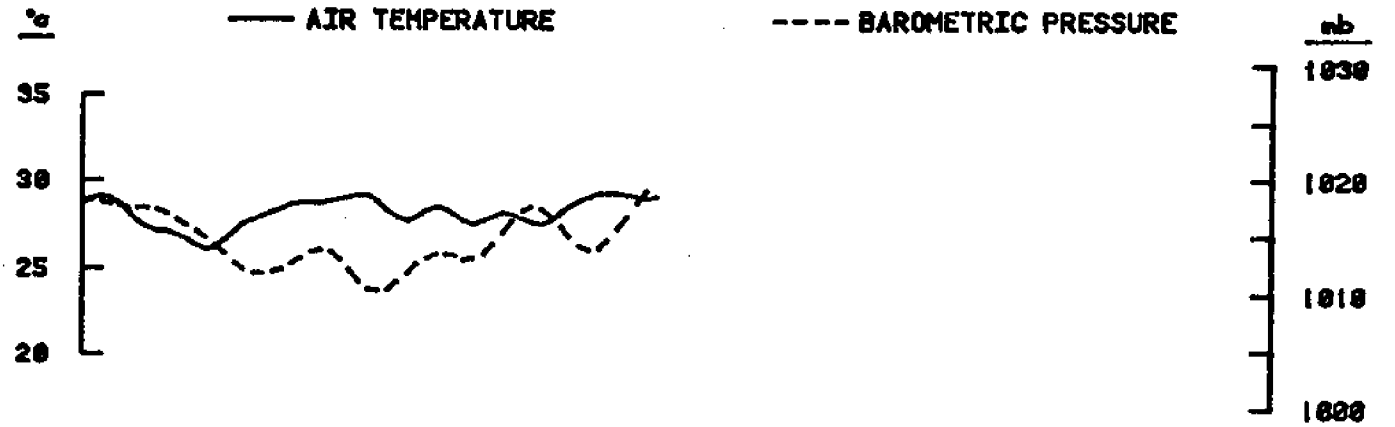
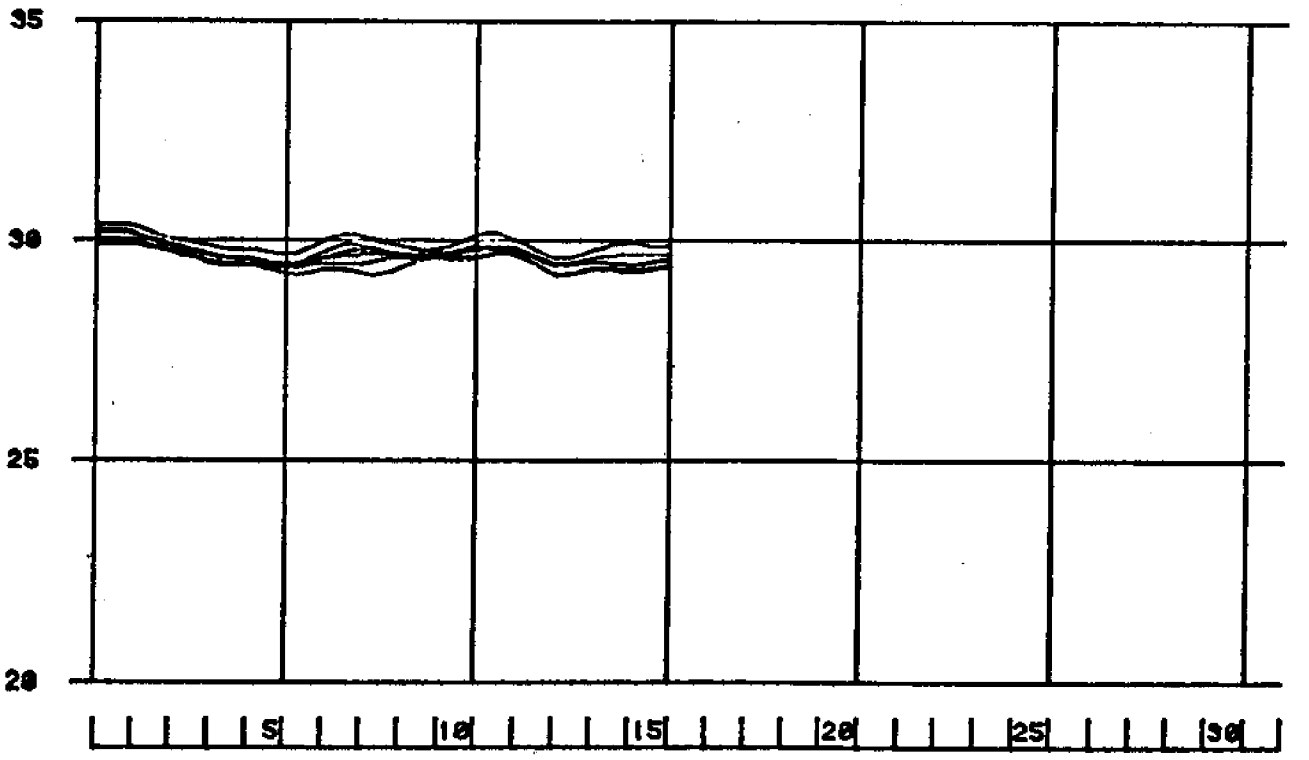
WIND



SEPTEMBER



WIND



OCEAN TEMPERATURE