

**I.O.S.**

**MOORED CURRENT METER RECORDS  
CELTIC SEA MARCH-MAY, 1978.**

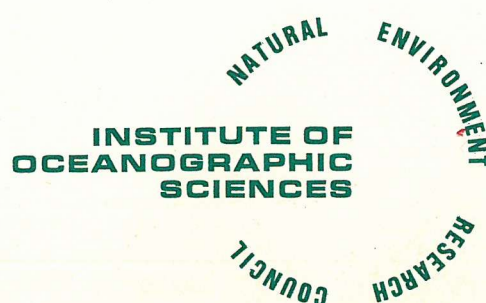
by

**M J HOWARTH AND J J EVANS**

**IOS Bidston moorings 142-154**

**Data Report No 18**

**1980**



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## ABSTRACT

This report describes the results from Aanderaa current meters and thermistor chains deployed at 9 stations in the Celtic Sea for about 45 days each. A brief description of the instruments, mooring configurations and data processing is followed by sets of plots for each meter together with details of its deployment and recovery.

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## 1. INTRODUCTION

From the end of March to mid May, 1978, equipment was moored at 8 stations (A-H) in the Celtic Sea and one station (I) in 4000m of water at the shelf edge. (See Pugh and Harrison, 1978, for the cruise report: Figure 1 for a map of station positions and Table 1 for a list of positions and times). At each of the stations currents (24 Aanderaa current meters were deployed) and bottom pressures were recorded. At 4 of the stations (C, F, G and H) Aanderaa thermistor chains were deployed and at 2 (A and B) combined bottom mounted current and pressure recorders were deployed. 67 casts of sea water conductivity and temperature against depth were taken during the cruises and sea surface temperature and conductivity were continuously monitored. This report displays the current meter and thermistor chain data.

No current or pressure information was obtained at station A and no current information at station H. The current meters recorded 20,500 hours of good data, 71% of planned, and the thermistor chains 1,600 hours, 48% of planned. Data losses were caused by equipment losses, presumably due to fishermen, 20%, faulty deployment invalidating direction records 9% and internal meter malfunctions 3%.

Mooring number	Station	Latitude N	Longitude W	Water Depth below chart datum (m)	Day launched 1978	Day recovered 1978	Height of meter above sea floor(m)	Type of meter	Tape number
142	A	51° 17.3'	5° 17.0'	68	24 March	12 May	35	CM	2573/3
143	A	51 15.6'	5 14.3'	68	24 March	-	0.75	CM/PR	1507/4
144	B	51 45.3'	6 37.8'	71	25 March	13 May	41 21	CM CM	1508/6 1139/9
145	B	51 45.0'	6 39.0'	69	25 March	13 May	0.75	CM/PR	1747/7
146	C	51 19.0'	6 34.8'	86	25 March	13 May	60 41 16	CM CM CM	567/9 3277/1 1506/4
147	C	51 19.0'	6 33.0'	94	25 March	13 May	78-28	TC	178/212/1
148	D	50 35.5'	6 08.1'	90	28 March	-	66 41 16	CM CM CM	1750/7 568/7 2969/1
149	E	51 27.5'	7 50.4'	88	30 March	14 May	60 41 16	CM CM CM	1867/5 1002/3 2971/1
150	F	50 32.0'	7 28.7'	109	30 March	15 May	65 25	CM CM	2576/3 2575/4
151	F	50 31.0'	7 31.0'	111	30 March	14 May	97-47	TC	245/260/1

Table 1/ continued

152	G	49° 37.3'	8° 35.5'	142	31 March 16 May	105 104-54 31	CM TC CM	2970/1 206/220/1 1865/3
153	H	48 55.0'	9 15.0'	157	1 April -	136 135-60 30	CM TC CM	1746/6 294/334 2574/3
154	I	47 47.2'	10 18.7'	3897	2 April 17 May	3360 2660 1960 1260 760 260	CM CM CM CM CM CM	1749/6 3257/1 3258/1 3259/1 3260/1 3261/1

Table 1. Summary of meter deployment times and positions.  
 CM current meter : TC thermistor chain : CM/PR  
 bottom mounted current meter/pressure recorder.



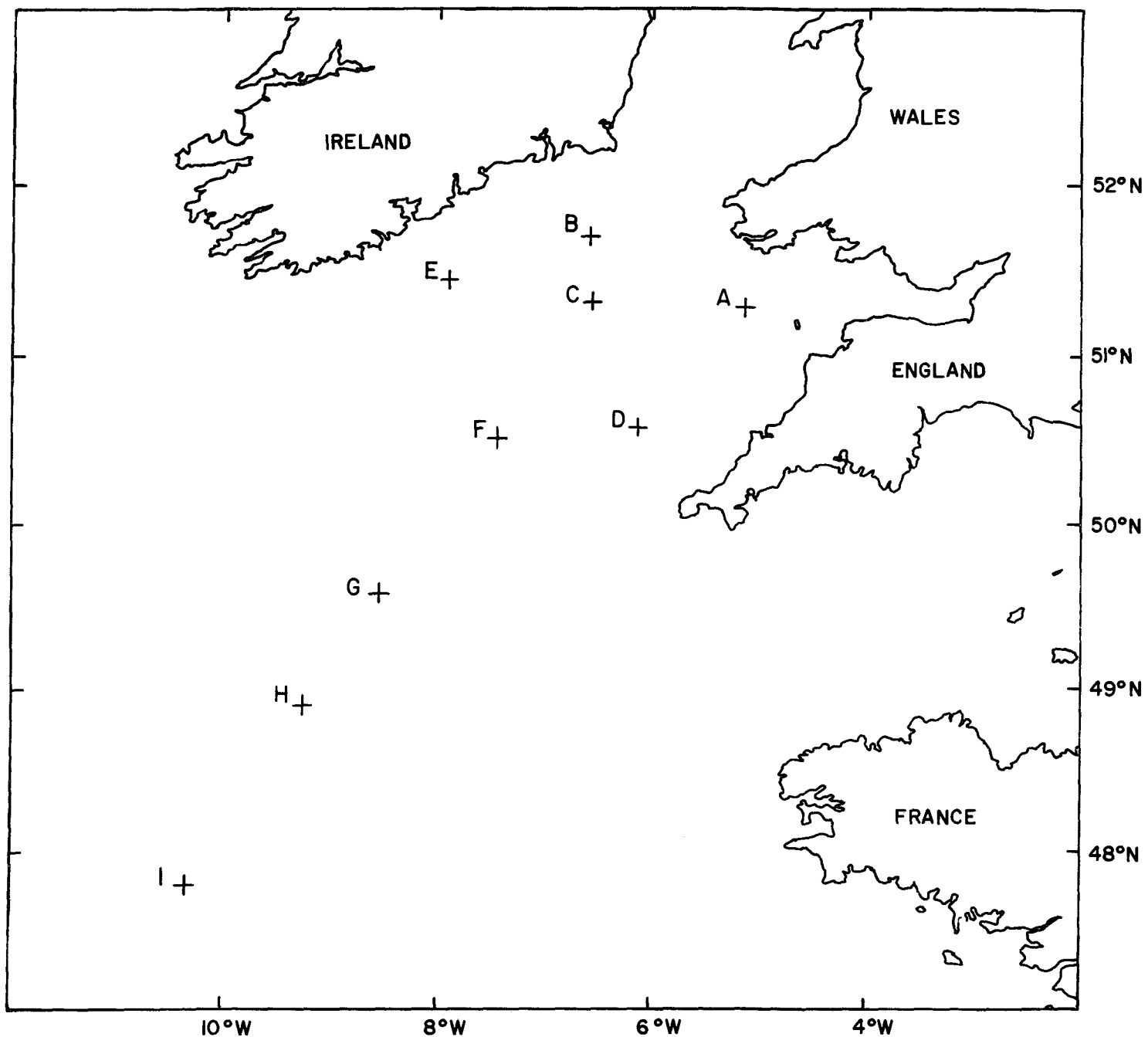


FIGURE 1 : STATION POSITIONS, MARCH - MAY 1978

## 2. INSTRUMENTATION

### 2.1 CURRENT METER

An Aanderaa RCM4 current meter is a self-contained instrument for measuring water temperature, integrated rotor count and direction. It consists of a recording unit, spindle and vane. The recording unit houses a rotor, thermistor, compass, quartz-crystal clock, tape deck for  $\frac{1}{4}$ " magnetic tape and encoder - a self-balancing bridge which converts the output from the sensors into a ten bit binary number. The spindle is spliced into the mooring wire and has a gimbal mounting which allows  $\pm 27^\circ$  tilt between the spindle and the meter. The vane aligns the meter with the flow and is a 1.00m x 0.37m PVC sheet to which is fitted a pair of small horizontal stabiliser fins and a weight to balance the meter.

Pressure sensors, made from a bourdon tube which drives a potentiometer, were fitted to 12 of the meters (4 with the range 0-100 psi, 7 with the range 0-200 psi and 1 with the range 0-500 psi) so that at least one current meter on each rig recorded pressure. The sampling interval for each of the current meters was 10 minutes. This was controlled by a clock rated at  $\pm 2$  seconds / day, an error which was exceeded by only one of the meters. 4 of the meters were fitted with IOS designed and built quartz crystal clocks and recorded elapsed time. Timing errors were determined by comparing the number of samples recorded with the difference between the times of starting and stopping the meters. The meters were started and stopped on board ship and had pre - and post - cruise checks performed on them in the laboratory. At station I 6 Aanderaa RCM5 current

meters were deployed. Internally they are identical to RCM4s but their pressure tubes and end plates are thicker to withstand pressures equivalent to 5000m of water. The pressure tubes and end plates were made locally.

All meters were calibrated before their launch and after their recovery. The thermistors were calibrated over the range  $-2^{\circ}\text{C}$  to  $20^{\circ}\text{C}$  in a water bath. A cubic polynomial was fitted to the results of each calibration. The compasses were calibrated every  $10^{\circ}$  from  $0$  to  $360^{\circ}$  and every degree through its dead-space. This calibration was performed outside the laboratory with the meters in a special jig. The results were used to create a table which contained the direction (to the nearest degree) corresponding to each meter reading. The pressure sensors were calibrated over the range  $0$  to  $8$  bars above atmospheric pressure using a dead weight tester and a straight line fitted to the results. The rotors were not calibrated and the manufacturer's formula was used since experience had shown this to be sufficiently accurate. The meters were balanced in a tank of water to ensure that the meter would be level in the sea.

## 2.2 THERMISTOR CHAIN

11 thermistors were spaced at equal intervals along an oil-filled PVC hose which had an internal strain wire. At stations C, F and G the thermistors were 5m apart and at station H 7.5m apart. The thermistors measured temperature in the range  $-2^{\circ}\text{C}$  to  $20^{\circ}\text{C}$  and had a thermal time constant of approximately 3.5 minutes to reach 63% of a step change. The

thermistor chains were calibrated in a water bath at IOS and cubic polynomials fitted to the results for each thermistor.

The standard recording unit was very similar to that for the Aanderaa current meter except that 12 channels (instead of 6) were recorded. To avoid aliasing by internal waves the sample interval was set at 3.75 mins. The instruments were deployed to record the development of the thermocline which was likely to be towards the end of the experiment. Hence, for the meters at C, F and G, a 10 day delay was fitted between the start of the meters and the start of data recording. Also to make the records last longer, only 5 thermistors (Nos. 1, 3, 5, 8 and 11) were sampled and slightly larger tape spools (3½" diameter) were fitted. The meters were fitted with quartz crystal clocks designed and built at IOS (and also rated at  $\pm 2$  secs/day) and recorded elapsed time every other scan.

### 2.3 BOTTOM MOUNTED CURRENT METER/PRESSURE RECORDER

This instrument has been designed and built at IOS. It consisted of a Digiquartz pressure sensor and a modified Aanderaa current meter in a frame 1.5m high with a tripod base whose legs were 0.7m long. The large fin of the current meter has been replaced with a small 0.07m x 0.08m vane mounted above the rotor which was 0.75m above the sea floor. The recording unit was modified to record data on both tracks and a new clock fitted so that elapsed time was recorded, as well as spot vane and rig orientation.

### 3. MOORING CONFIGURATION

#### 3.1 'u' Shaped Rig

8 of the rigs were 'u' shaped, shown schematically in Figure 2. The sub-surface buoy was a hollow steel sphere 0.8m in diameter and having a net buoyancy of 175kg. The surface buoy was a spar buoy made from a fibreglass shell filled with foam plastic and was 3m in overall length, of which about 1.5m showed above the surface. It contained an integral radar reflector and a flashing light. The meter wire was 8mm diameter galvanised, flexible steel wire rope and the ground line and surface buoy line were of 12 mm wire, respectively in length approximately 3 times and  $1\frac{1}{2}$  times the water depth. All wire terminations were made with tellurite ferrules and connections were made with D shackles, rings and reciprocal bearing swivels. The anchor weights were 500 kg of scrap chain. The rigs were deployed through the A frame at the stern of RRS Challenger sub-surface buoy first and were recovered either via the surface buoy or by dragging for the ground line. Navigation was by main chain Decca for most of the rigs and for G, H and I SATNAV was used as well.

The current meter spindles were spliced into the meter wire. Thermistor chains were deployed with the recording unit at the top, clamped to the wire, and the chain tied to the wire beneath it. An acoustic command pinger built at IOS was spliced into the meter wire beneath the bottom meter to aid re-location of the rig when recovery was attempted if the surface buoy was missing. Figure 3 shows the mooring configuration for the bottom mounted current meter/pressure recorder.

# CURRENT METER MOORING SYSTEM

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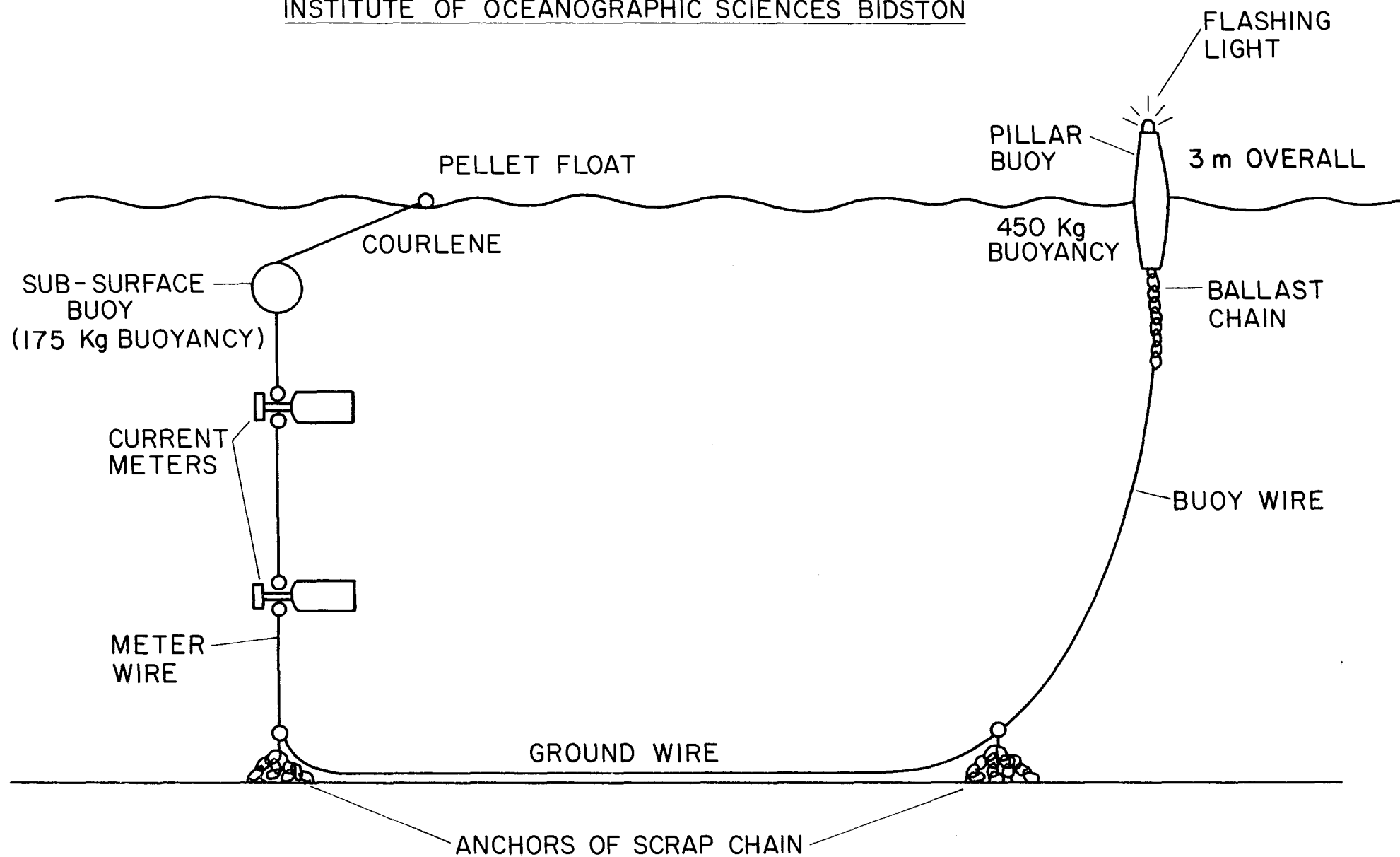


FIGURE 2

# BOTTOM MOUNTED CURRENT METER / TIDE GAUGE MOORING SYSTEM

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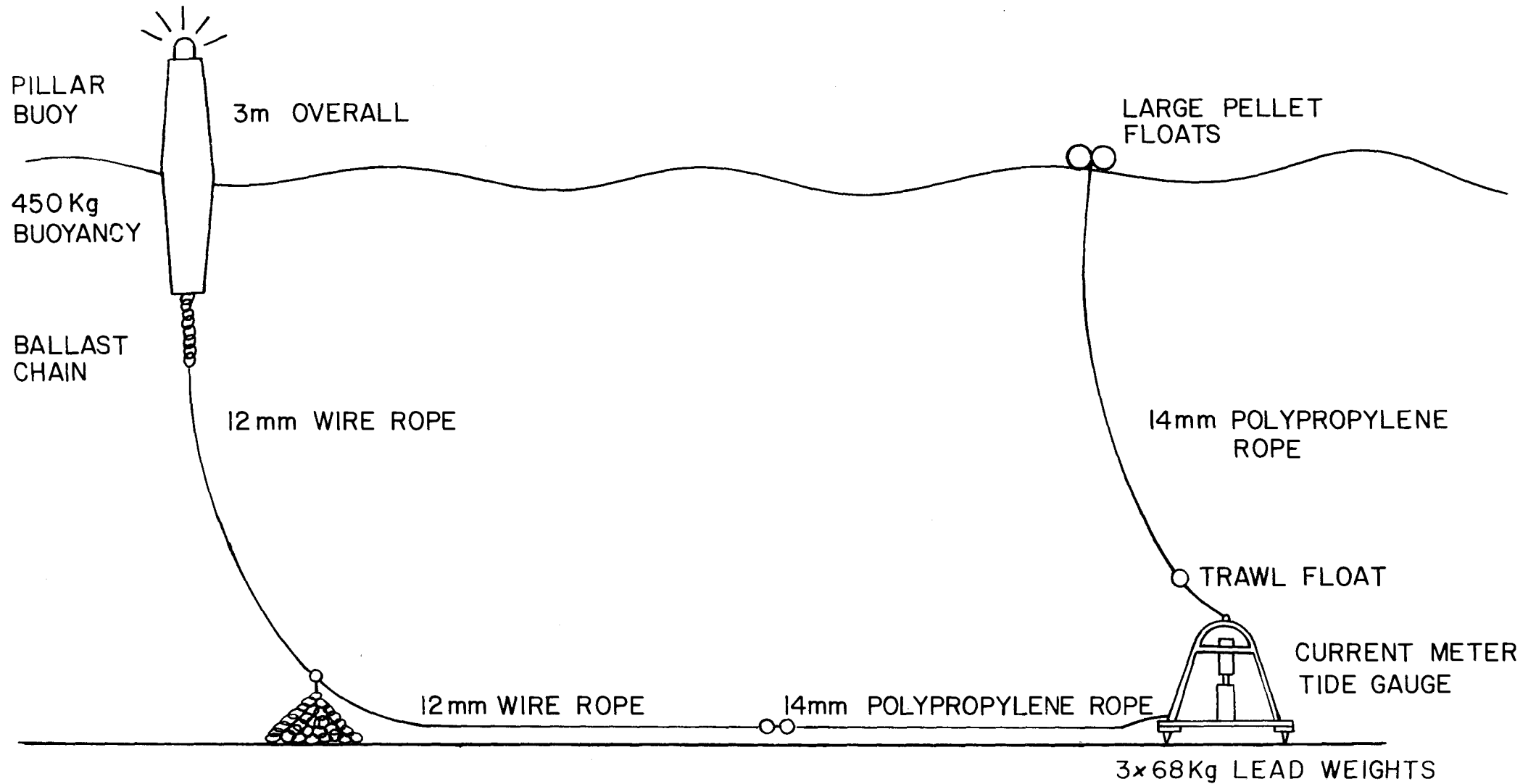


FIGURE 3

### 3.2 POP UP

5 of the rigs were single point pop up rigs using in the main similar equipment to that for the 'u' shaped rigs. At station H the diameter of the sub-surface buoy was 1m, giving a buoyancy of 320 kg and station I it was 1.2m, giving a buoyancy of 640 kg. At station I the meter wire was made from 8mm and 6mm diameter non-rotating wire rope and from 12 mm diameter Terylene/Polyester rope. All rigs were deployed sub-surface buoy first.

The skill and experience of the masters and crew of RRS Challenger contributed greatly to the success of the programme.



## DATA PROCESSING

The data on the magnetic tapes from the Aanderaa meters was translated at Bidston on to punched paper tape which was input into the Institute's Honeywell 66/20 computer. Errors in the data were discovered by noting either discontinuities in the records or consecutive readings with the same value; the most common errors being:-

- (a) A large change in direction between adjacent readings at times of reasonable speed -  $> 0.25 \text{ ms}^{-1}$ . This is probably caused by the meter's encoder misreading the compass.
- (b) The rotor count going backwards. This often occurs when the rotor potentiometer is in its dead-space.

The errors were corrected and the meter calibrations were then used to calculate the temperature, pressure and the North (true) and East components of velocity. Because the meter integrates the rotor count but records instantaneous directions, some further averaging was necessary to derive a simultaneous reading of speed and direction. Consider three adjacent readings of rotor count and direction at times  $t_1$ ,  $t_2$ ,  $t_3$ . The value for speed and direction at  $t_2$  was derived by associating the speed given by the rotor count at  $t_3$  minus that at  $t_1$  with the instantaneous measurement of direction at time  $t_2$ .

## FORMAT

The report is split into sections, one for each mooring, each section beginning with a page of mooring details showing:-

Mooring number : IOS Bidston reference number.

Position of rig : Station identification letter,  
latitude and longitude.

Depth of water : from the pressure sensor fitted to  
the top meter on the rig.

Meter information : the meter number, the type of meter,  
the height of the meter's rotor above  
the anchor.

Time of set : the time that the surface buoy was  
released from the ship.

Time of recovery : the time that the surface buoy was  
brought on board the ship.

Mooring : any additional information on the  
mooring.

Another page of information is included before the results from each meter. This contains:-

Meter information : manufacturer and meter identification  
numbers.

Tape number : identification of the record.

Times : the times when the meter was started  
and stopped together with the calculated  
timing error and the total number of  
readings.

Length of useful record : times of start and end of velocity time  
series, total length of useful data.

Comments : comments on the meter, its behaviour  
and the quality of the record.

The results are displayed in five graphs produced by the computer. The diagrams are:-

- (1) A plot of the temperature, pressure (if appropriate) and the North and East components of velocity against time. The whole data series obtained (10 minute values in this case) is used as the input for this graph. The lines on the time axis indicate midnight (0000 GMT).
- (2) Histograms of speed and direction. Plots of the percentage of the data which lie within a certain interval of speed or direction. The direction histogram is split into intervals of  $18^{\circ}$ , the speed range is flexible depending on the maximum speed recorded.
- (3) A scatter diagram of the North component of velocity against the East component. The scale is in  $\text{m s}^{-1}$ , each dot representing reading of the meter. The eccentricity of the tidal ellipse is clearly indicated, showing the contrast between the almost rectilinear tidal stream in the upper layer and the noticeably elliptical motion nearer the bed. This diagram is particularly useful in revealing malfunctions in the meter's compass or in the rig itself.
- (4) Two progressive vector diagrams. One uses the same data as diagram 1 ; the other uses the data filtered by applying a running average over a period of 24 hrs 50 mins (two tidal cycles) to remove most of the tidal signal and hence show the residual movement more clearly.

For any record, the scale (in kms) and orientation are the same for both graphs. A drift of  $1 \text{ km d}^{-1}$  is equivalent to a residual speed of  $0.012 \text{ ms}^{-1}$ . The crosses mark midday (1200 GMT) each day. Care is needed in interpreting these graphs, they indicate the time variation of the current vector at the meter and not the path of a particle.

## ACKNOWLEDGEMENTS

The authors would like to thank A. J. Harrison and D. Flatt for the care they have taken in maintaining and calibrating the instruments, D. L. Leighton for launching and recovering the rigs and the computer operators for their patience in producing the plots.

## REFERENCES

PUGH, D. T. and HARRISON, A. J. 1978

RRS CHALLENGER cruises 5/78 and 8/78

Institute of Oceanographic Sciences, Cruise Report No. 72

39 pages and 11 figures.

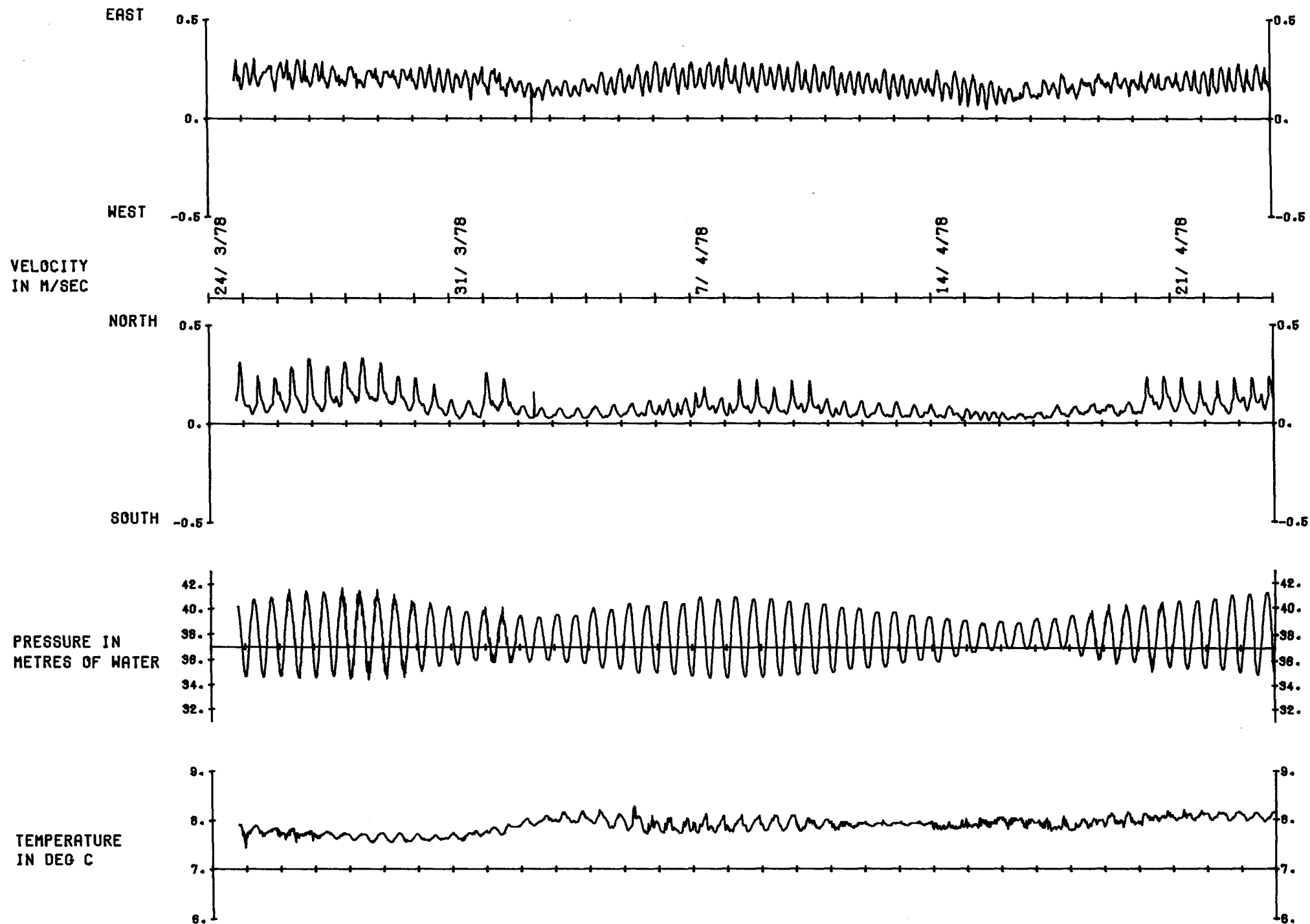
Mooring number : 142  
 Position of rig : Lat 51° 17.3' N Long 5° 17.0' W  
 (Station A)  
 Depth of water : 68m below chart datum  

Meter	Type	Height above sea floor (m)	Recording interval (min)
2573	Aanderaa RCM4	35	10

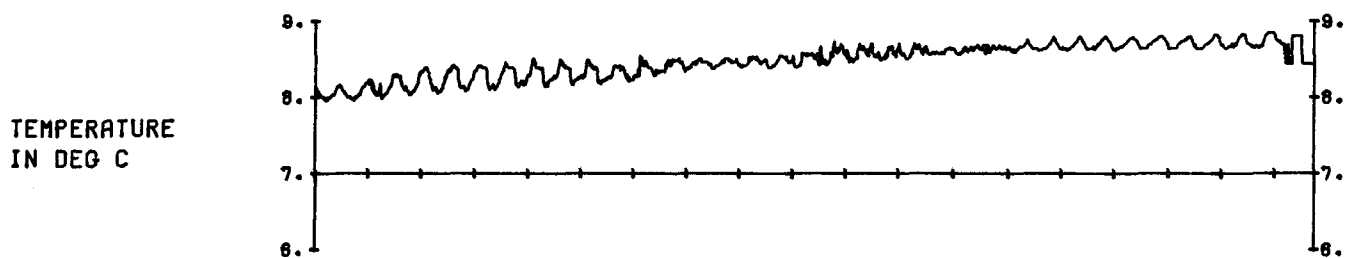
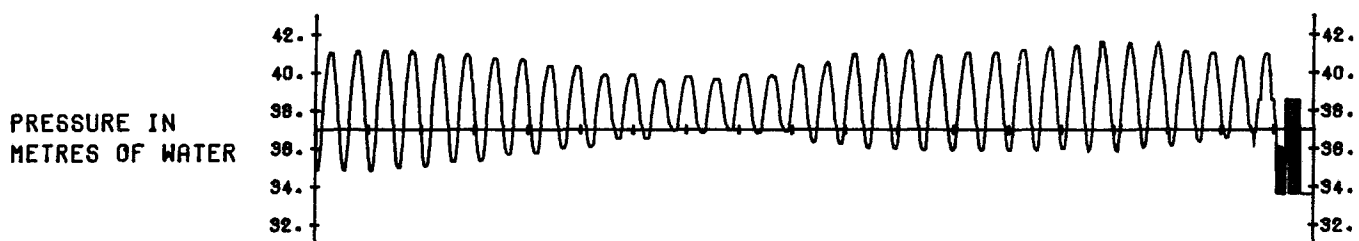
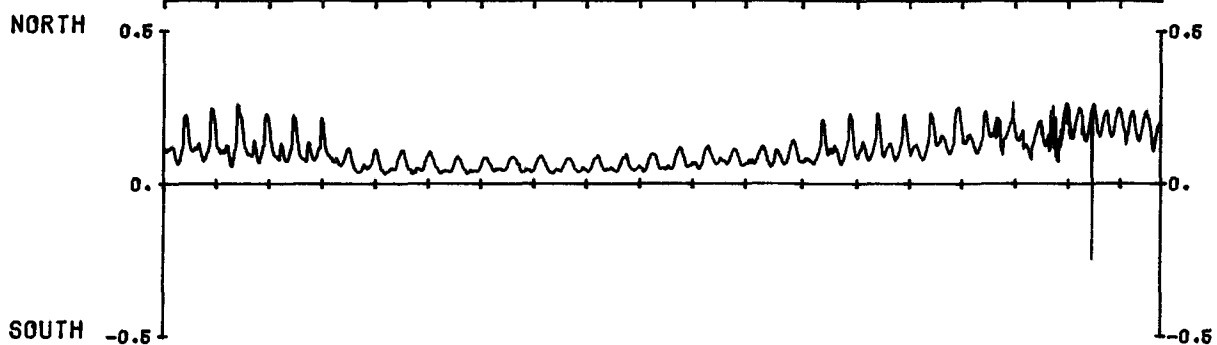
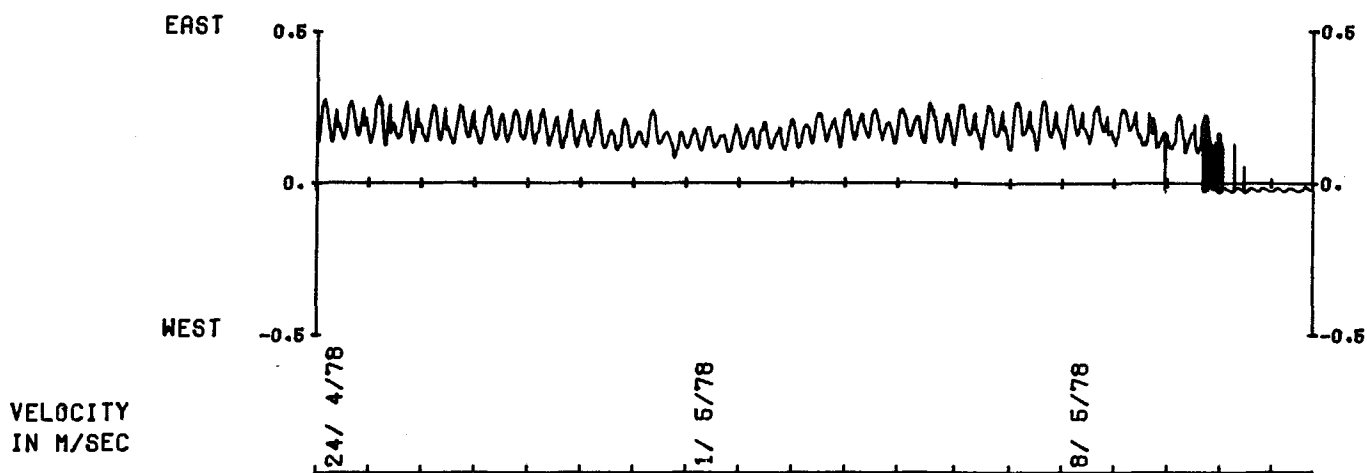
 Rig set : 18.49 GMT 24 March 1978  
 from RRS Challenger  
 Rig recovered : 18.45 GMT 12 May 1978  
 from RRS Challenger  
 Mooring : u shaped  
 Comments : During the first attempt to deploy  
 the rig the surface buoy wire  
 caught on the ship's propeller  
 guard and the rig was towed behind  
 the ship. The rig was recovered,  
 checked and re-deployed successfully.  
 The rig was successfully recovered  
 at the first attempt and was in  
 position.

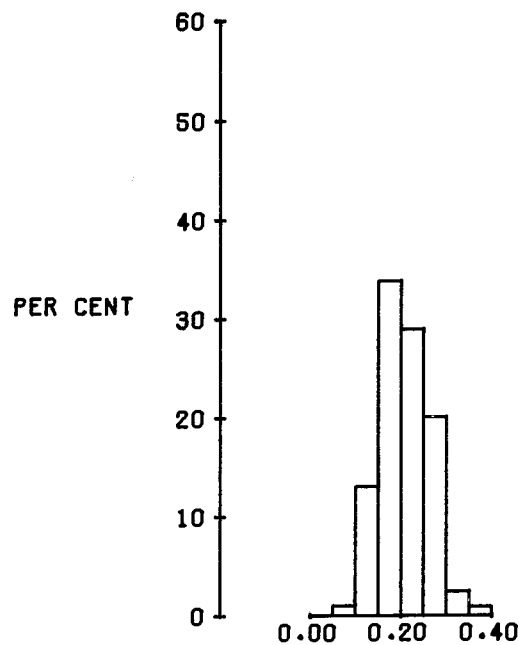
Meter	:	Aanderaa RCM4 No 2573
Tape number	:	2573/3
Meter started	:	12.30.00 GMT 24 March 1978
Meter stopped	:	11.49.48 GMT 15 May 1978
Total number of readings	:	7485
Timing error	:	12 s fast
Start of useful record	:	19.00 GMT 24 March 1978
End of useful record	:	18.30 GMT 12 May 1978
Length of useful record	:	1175 h
Comments	:	The meter was fitted with a 0-100 psi pressure sensor and recorded elapsed time. On recovery the meter had a bent spindle. This may have happened during the launch since the meter recorded currents in the north-east quadrant only, which is clearly wrong.

The temperature and pressure records are good until the last day, when there were some encoding faults.

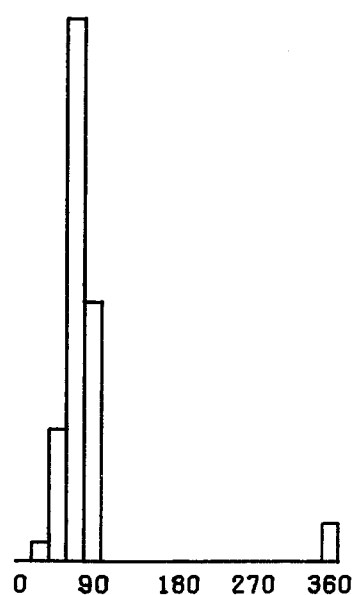




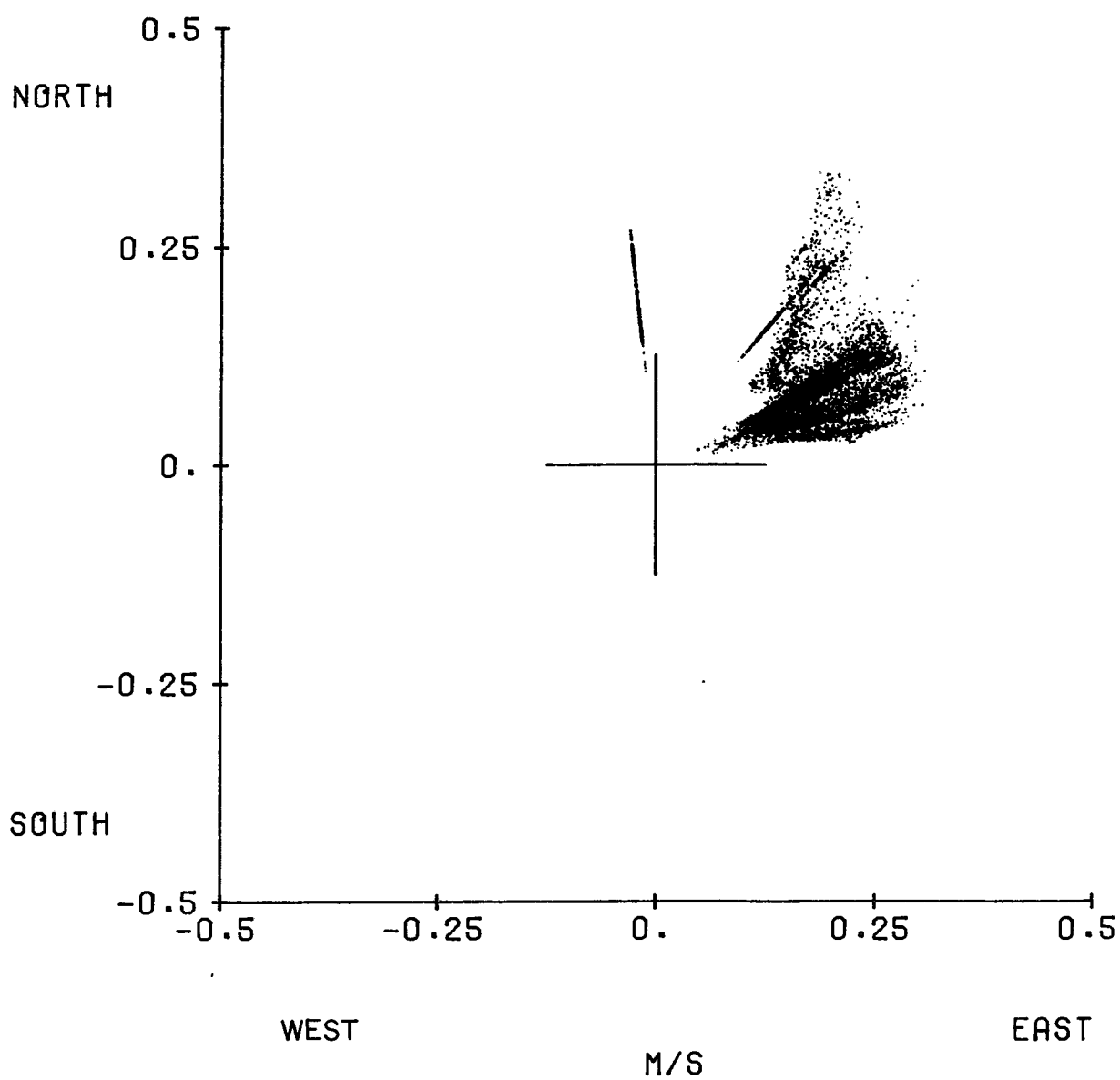


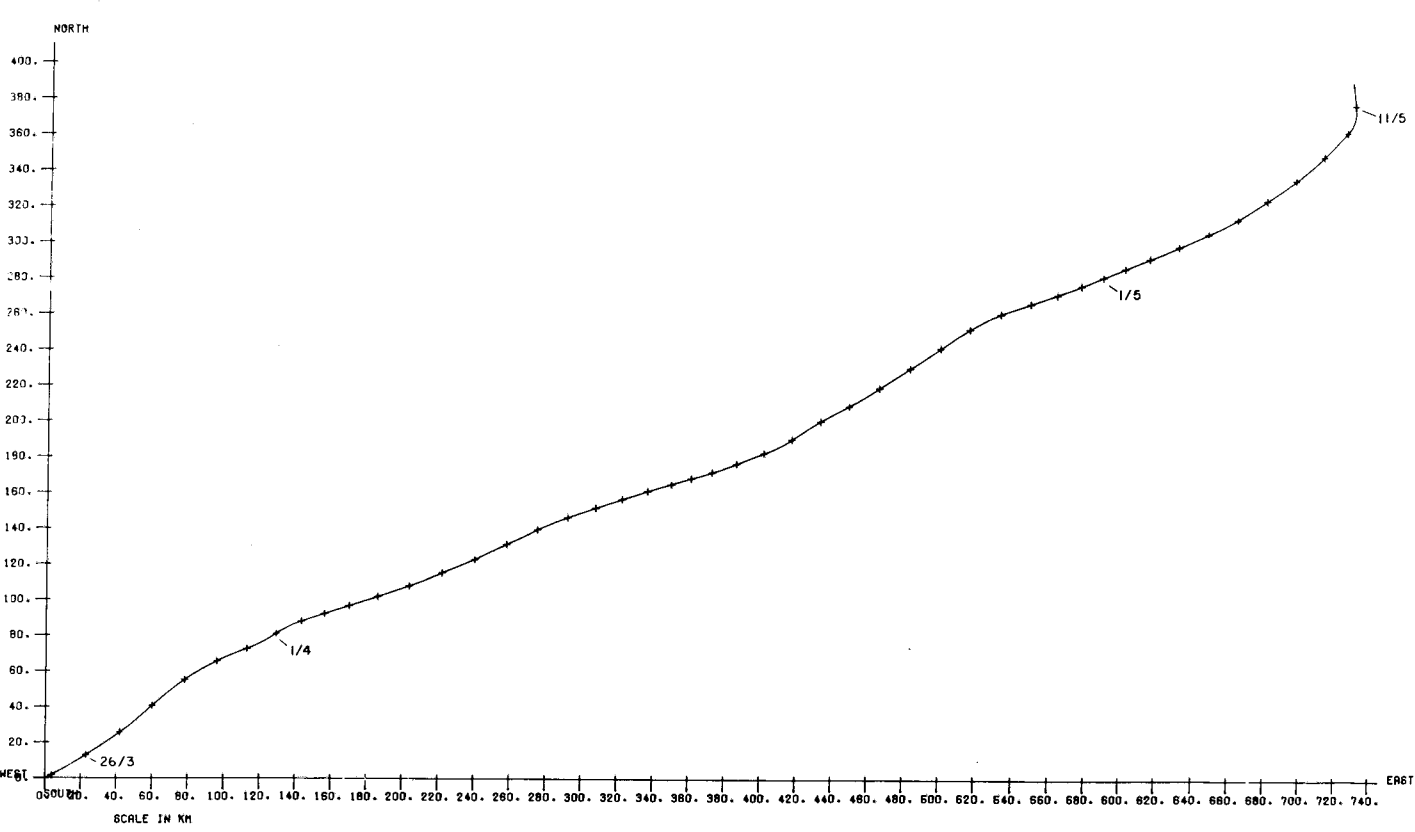
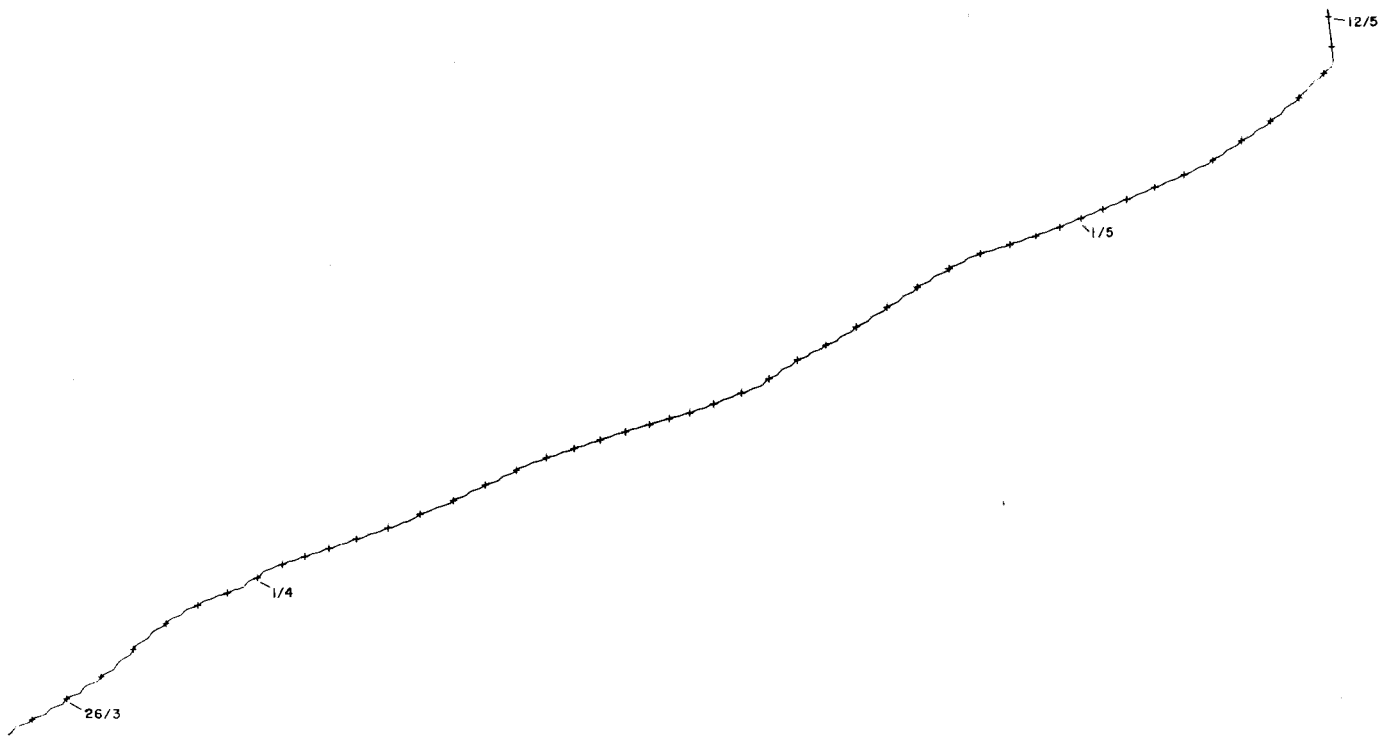


SPEED IN M/SEC



DIRECTION





Mooring number : 143  
 Position of rig : Lat 51° 15.6' N Long 5° 14.3' W  
 (Station A)  
 Depth of water : 68m below chart datum  

Meter	Type	Height above sea floor (m)	Recording interval (min)
1507	Aanderaa RCM4 in bottom frame 2	0.75	15

 Rig set : 15.43 GMT 24 March 1978  
 from RRS Challenger  
 Rig recovered : -  
 Mooring : u shaped, with bottom frame .  
 Comments : The rig was successfully deployed  
 at the first attempt.

The surface buoy and its anchor only  
 were recovered on 12 May. Further  
 acoustic and dragging searches on  
 20, 23 and 24 May could not locate  
 the bottom frame.

Meter	:	Aanderaa RCM4 No 1507
Tape number	:	1507/4
Meter started	:	-
Meter stopped	:	-
Total number of readings	:	-
Timing error	:	-
Start of useful record	:	-
End of useful record	:	-
Length of useful record	:	-
Comments	:	The bottom frame was not recovered.

Mooring number : 144  
 Position of rig : Lat 51° 45.3' N Long 6° 37.8' W (Station B)  
 Depth of water : 71m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
-------	------	----------------------------	--------------------------

1508	Aanderaa RCM4	41	10
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1139	Aanderaa RCM4	21	10
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Rig set : 09.18 GMT 25 March 1978  
 from RRS Challenger

Rig recovered : 10.09 GMT 13 May 1978  
 from RRS Challenger

Mooring : u shaped

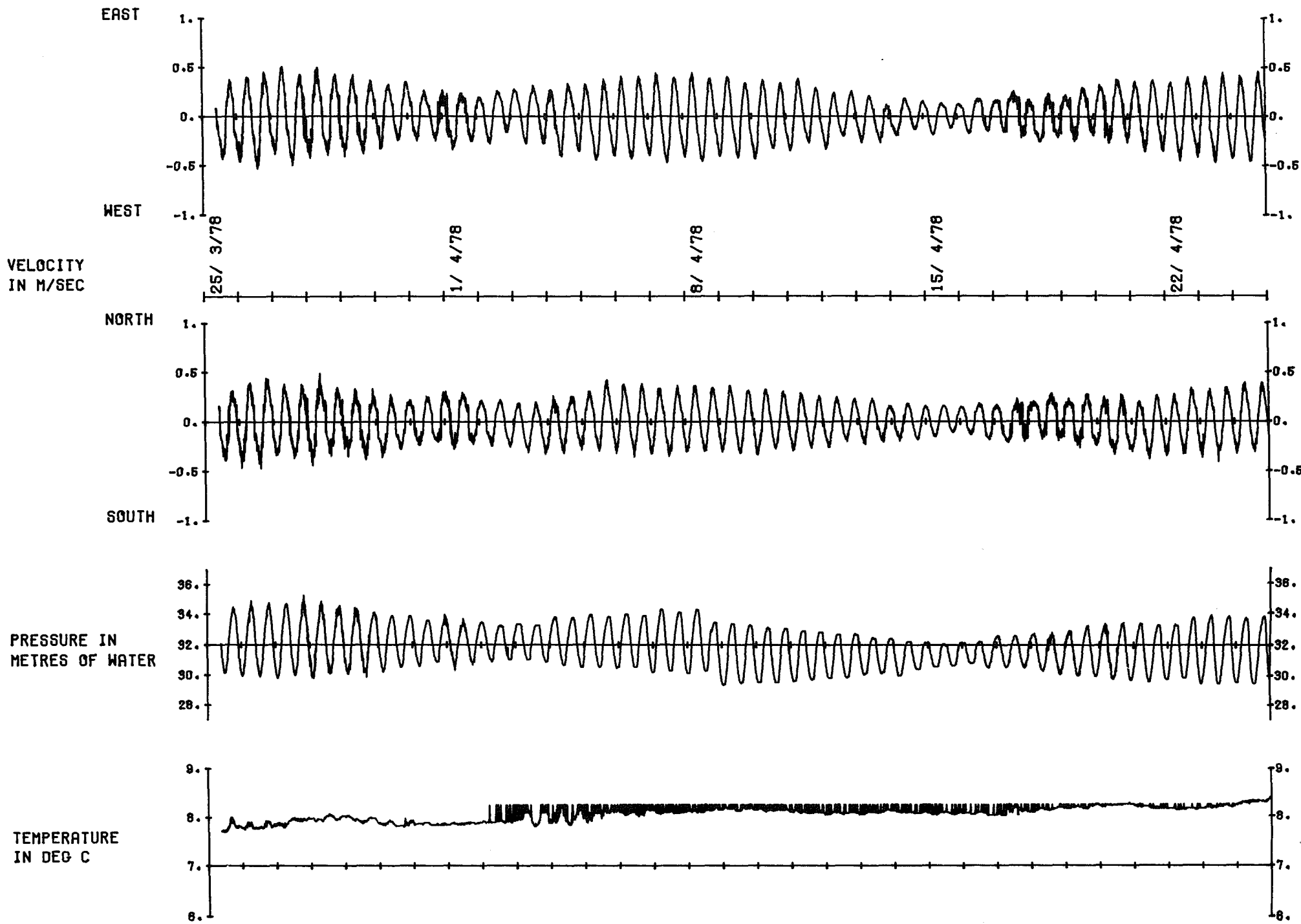
Comments : The rig was successfully deployed at the first attempt.

The surface buoy was missing when recovery was attempted but the acoustics were soon switched on. The rig was grappled, the grapnel catching in the meter wire between the acoustics and the bottom current meter. The rig was pulled in to discover that the surface buoy wire had stranded at one point leaving only one strand in tact, out of six, and that the surface buoy had been smashed, so that only parts of its fibreglass casing were recovered. The rig was in position.

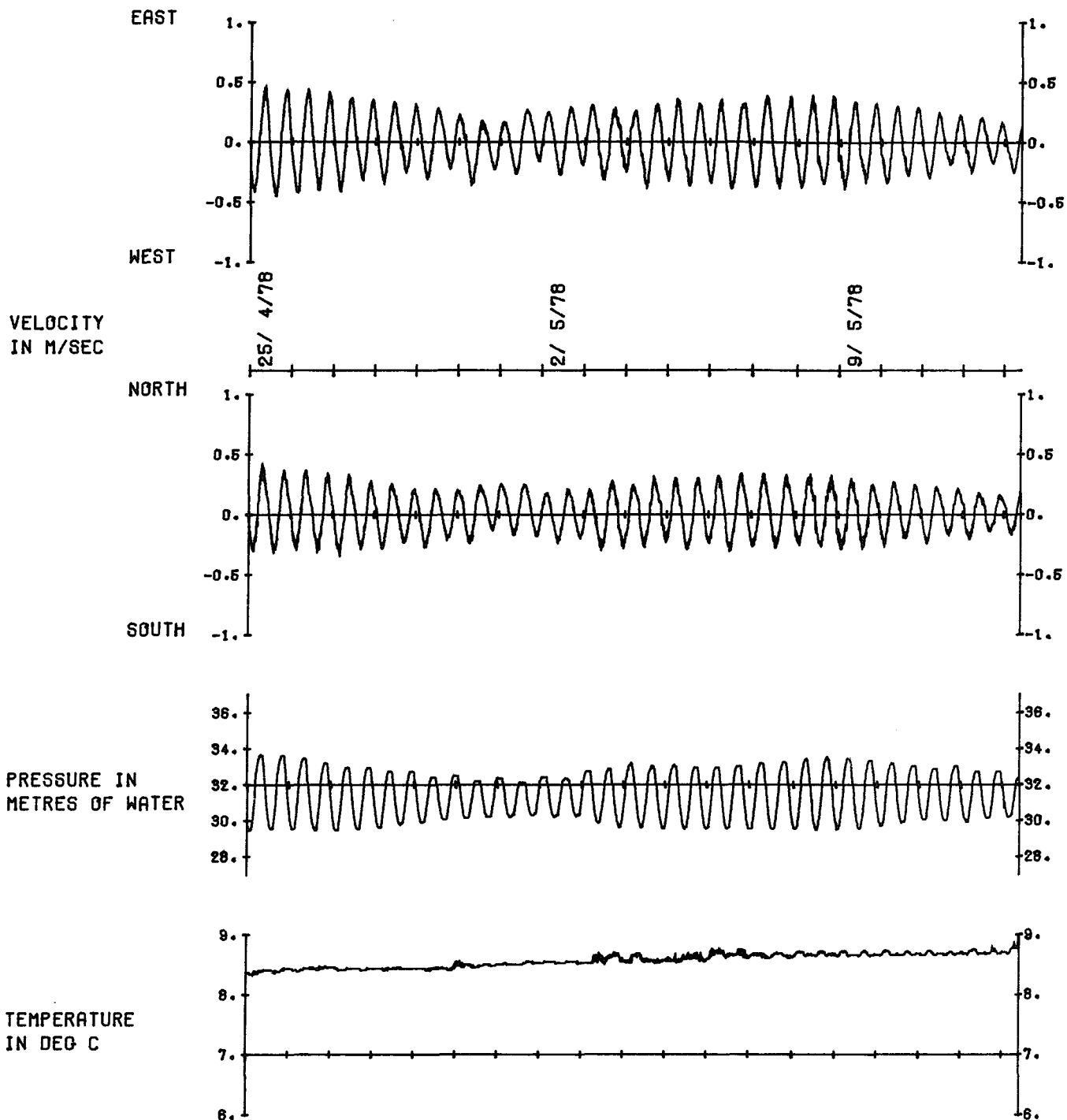
Meter : Aanderaa RCM4 No. 1508  
Tape number : 1508/6  
Meter started : 08.00.00 GMT 25 March 1978  
Meter stopped : 12.20.48 GMT 15 May 1978  
Total number of readings : 7371  
Timing error : 48 s slow  
Start of useful record : 09.30 GMT 25 March 1978  
End of useful record : 09.51 GMT 13 May 1978  
Length of useful record : 1176 h  
Comments : The meter was fitted with a 0-100 psi  
pressure sensor.

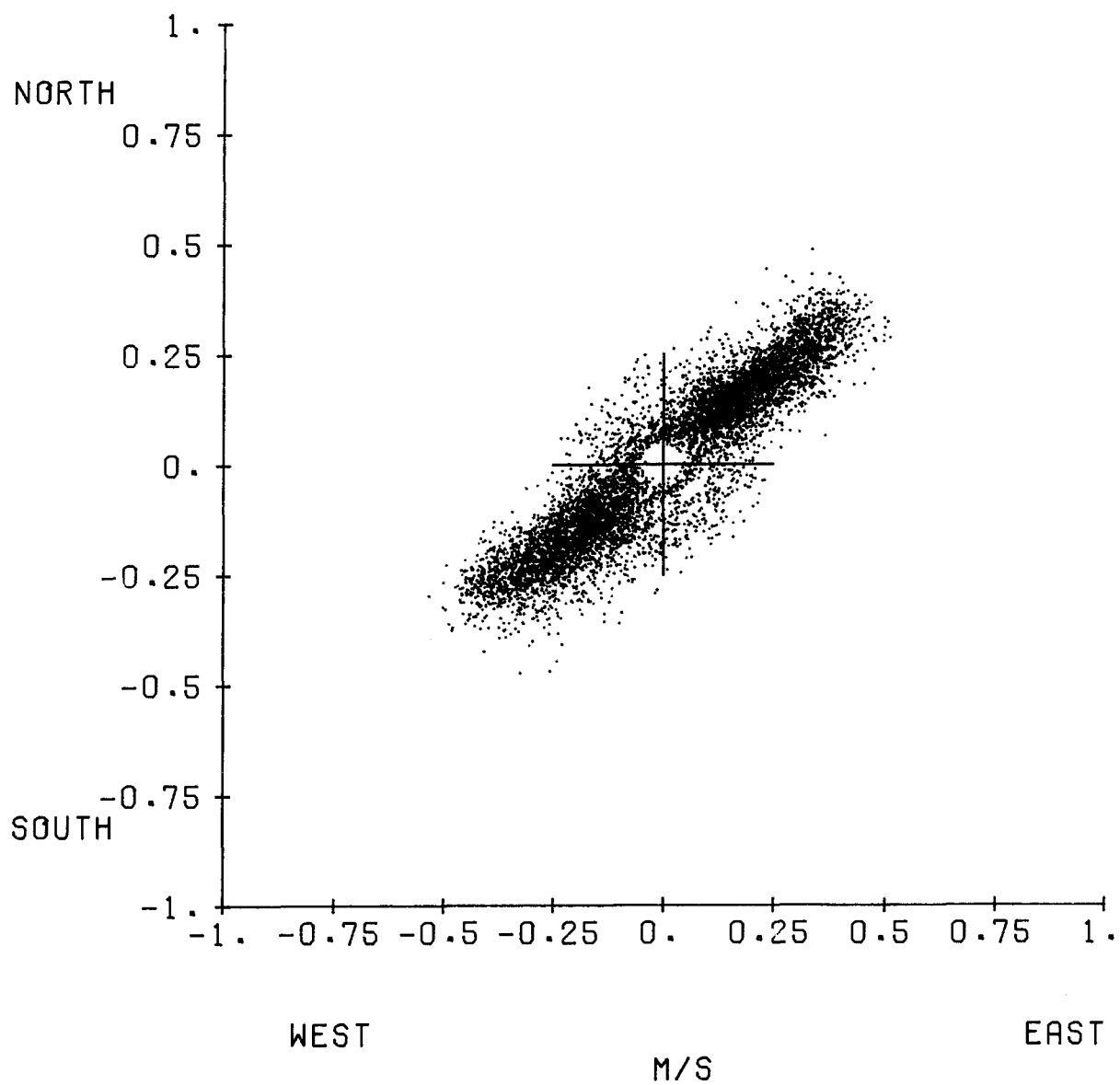
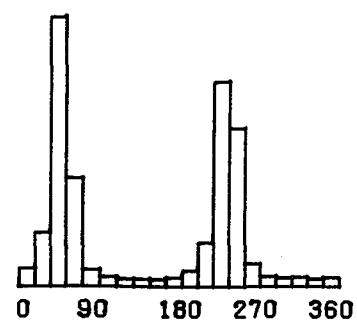
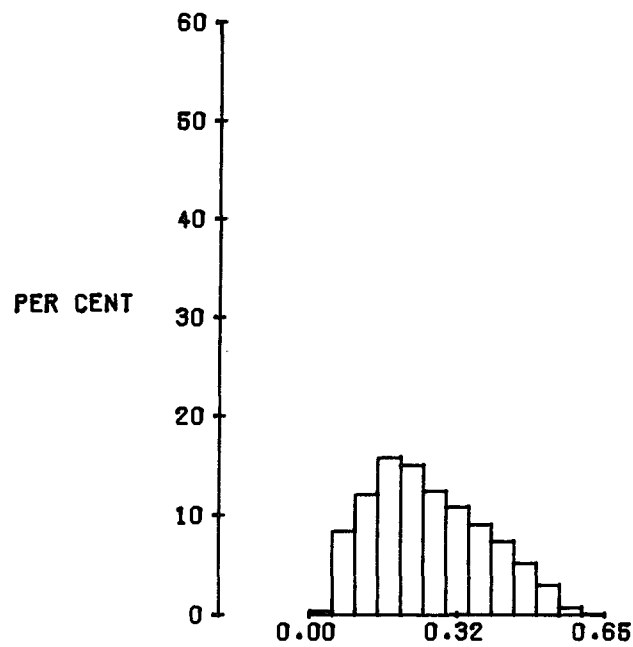
The meter was recovered in good  
condition .

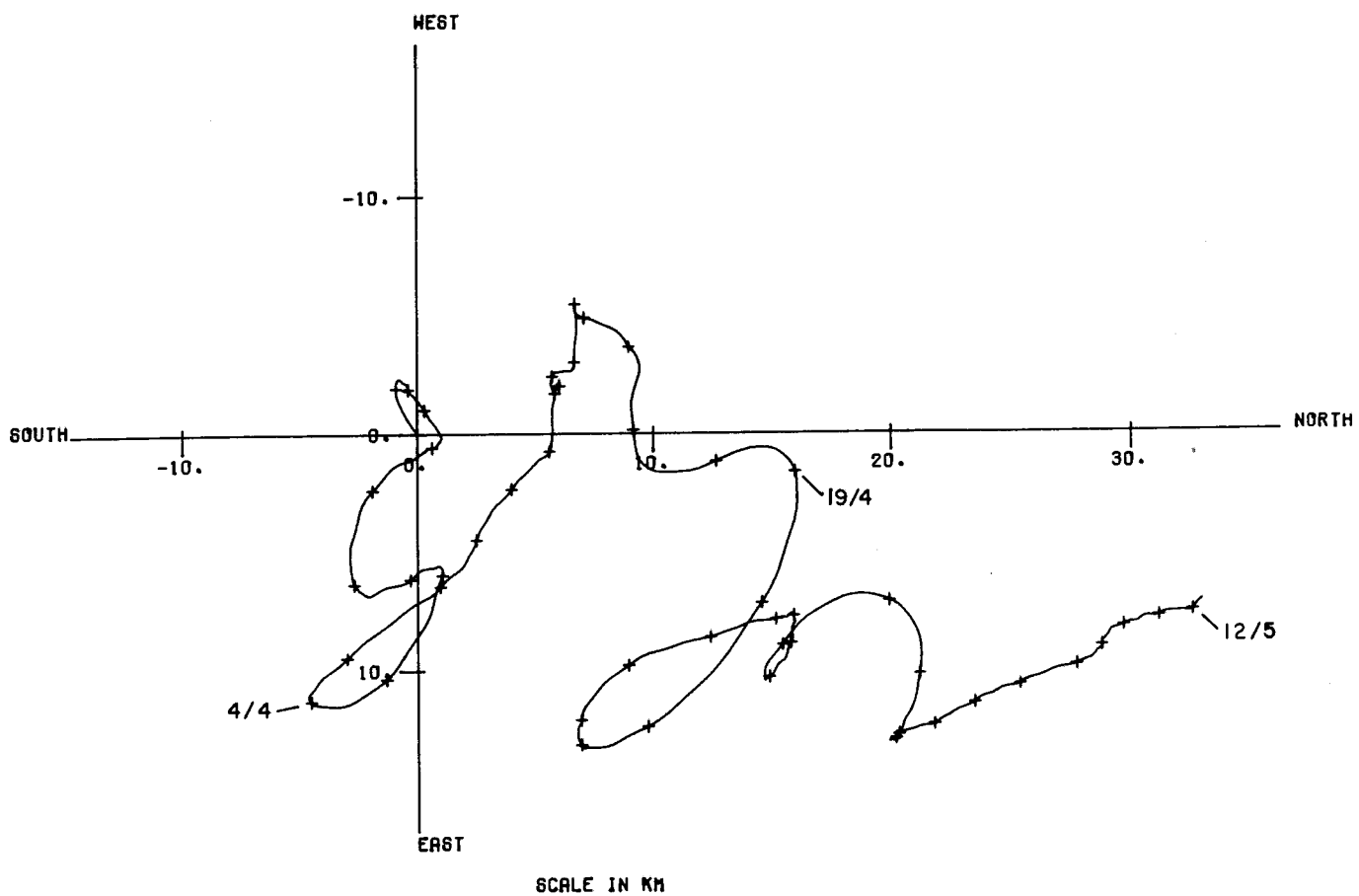
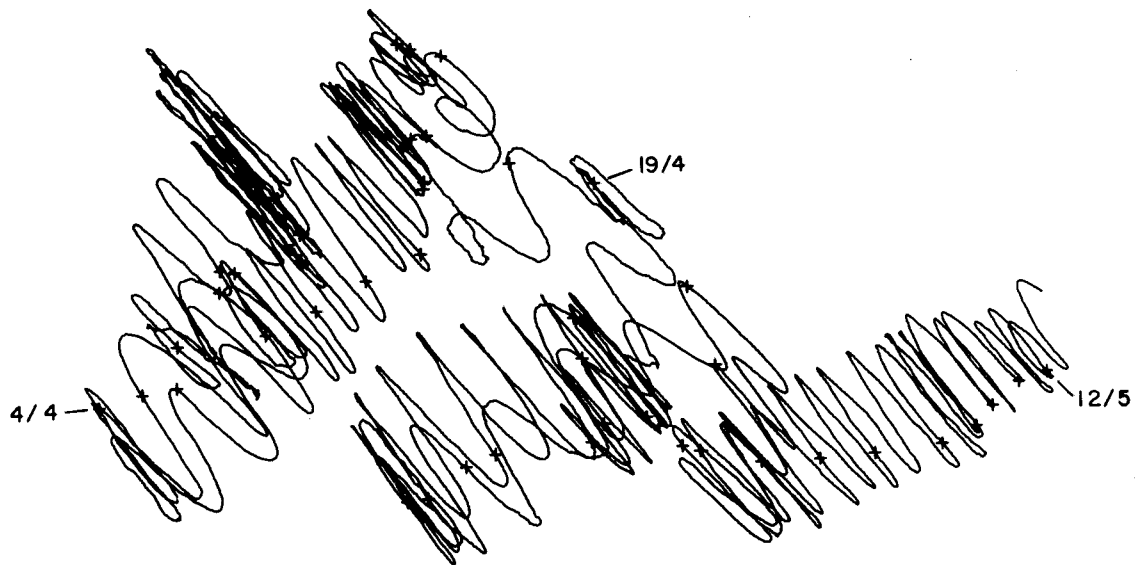
The current and pressure records  
were good but there was an encoding  
fault in the temperature record.







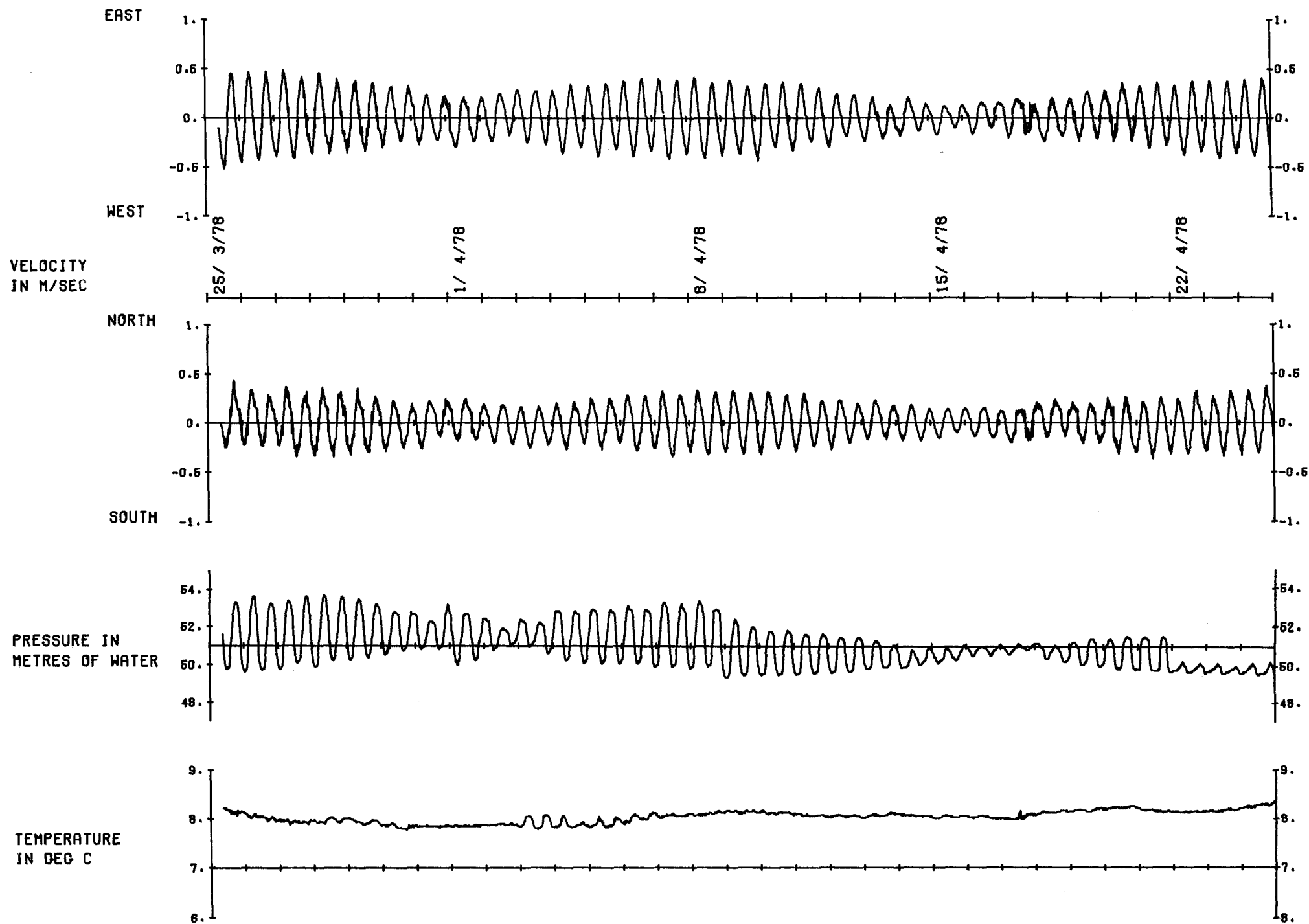


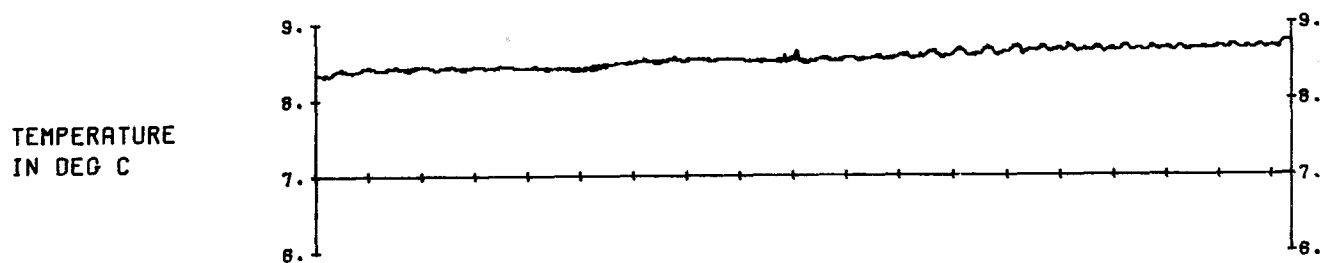
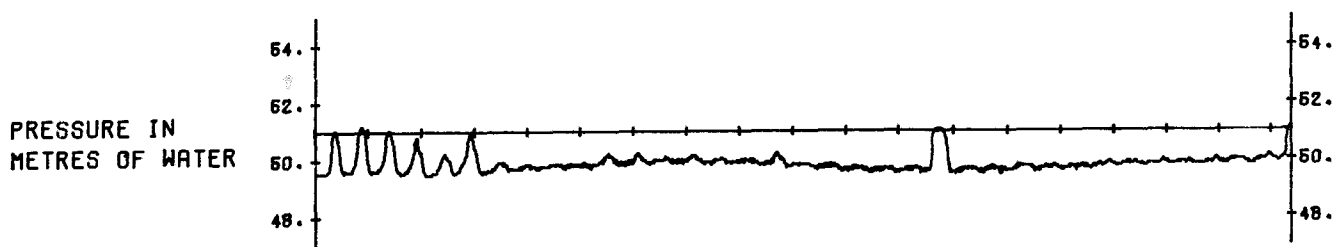
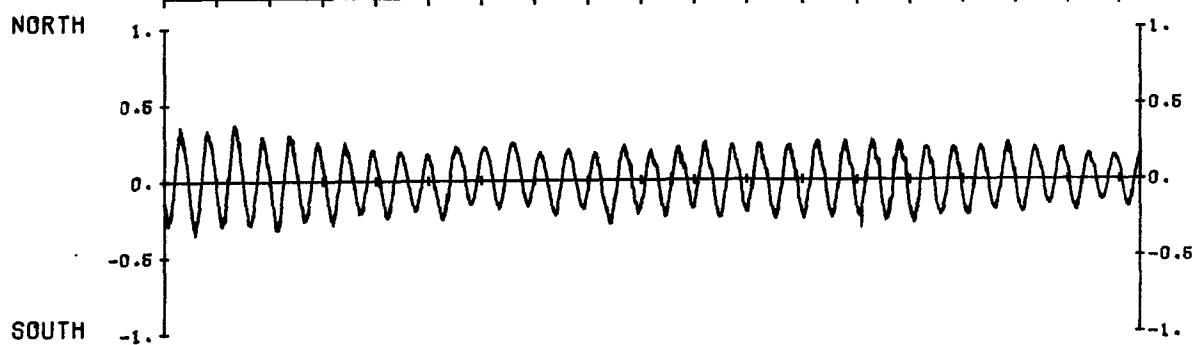
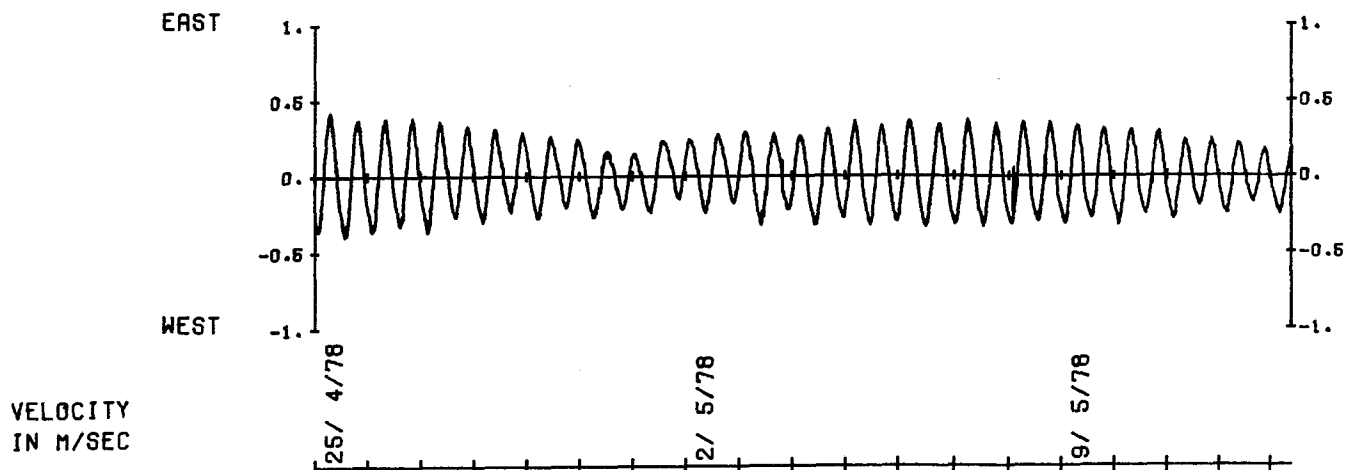


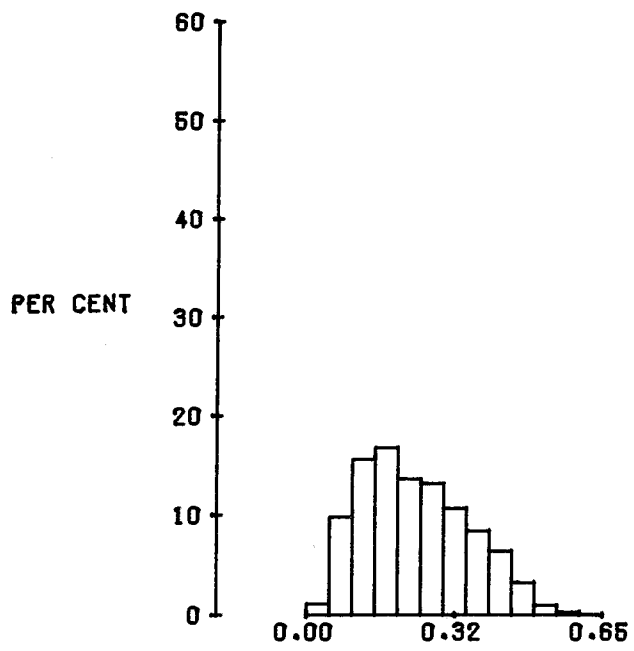
Meter : Aanderaa RCM4 No. 1139  
Tape number : 1139/9  
Meter started : 08.20.00 GMT 25 March 1978  
Meter stopped : 12.11.13 GMT 15 May 1978  
Total number of readings : 7368  
Timing error : 73 s slow  
Start of useful record : 09.30 GMT 25 March 1978  
End of useful record : 09.51 GMT 13 May 1978  
Length of useful record : 1176 h  
Comments : The meter was fitted with a 0-100 psi  
pressure sensor.

The meter was recovered in good  
condition.

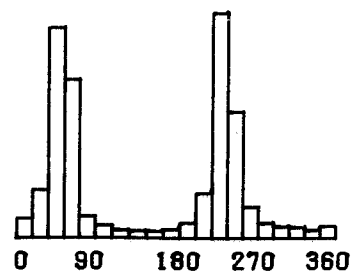
The current and temperature records  
were good but the pressure record  
deteriorated so that no tidal signal  
was recorded by the end.



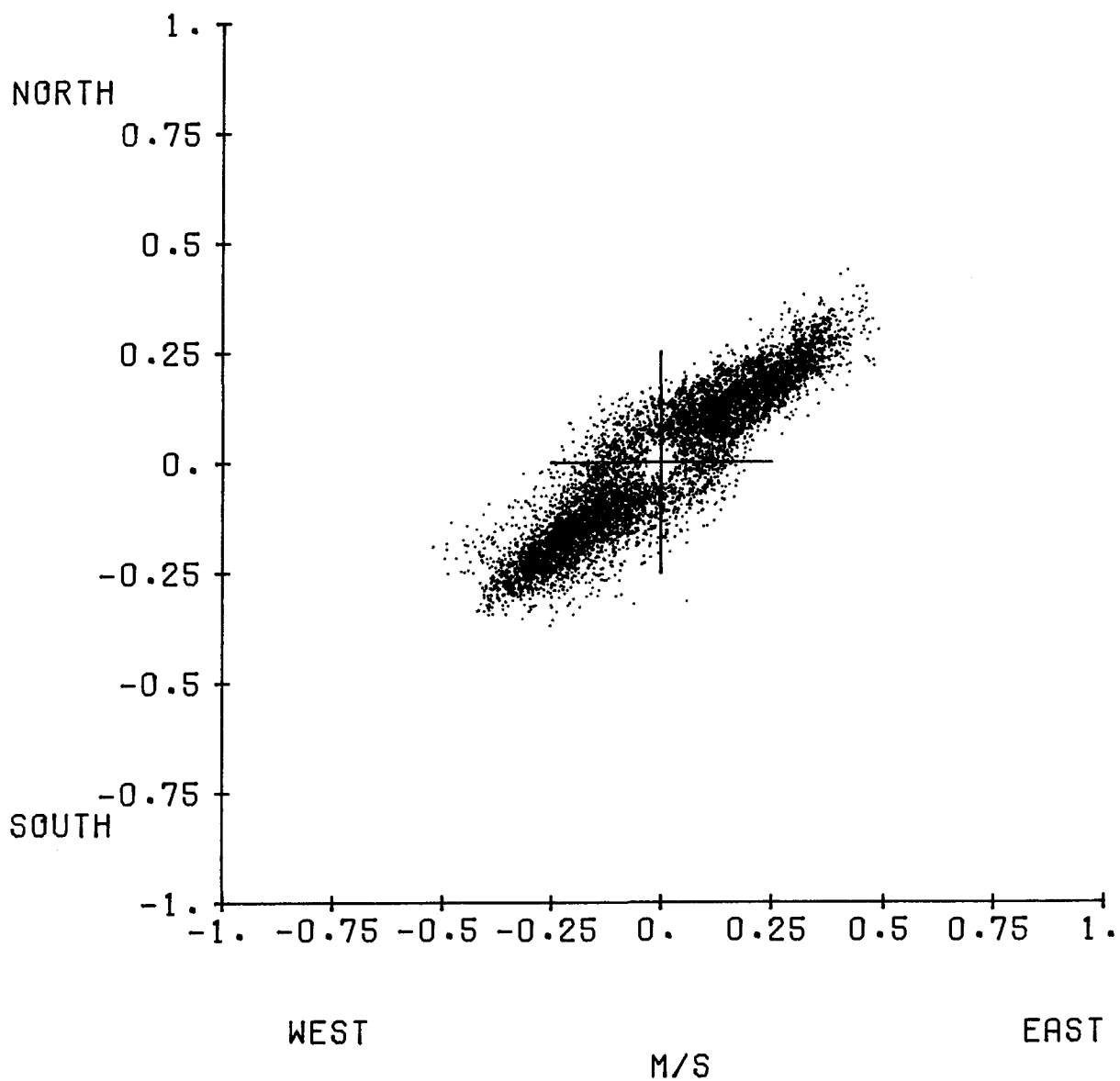


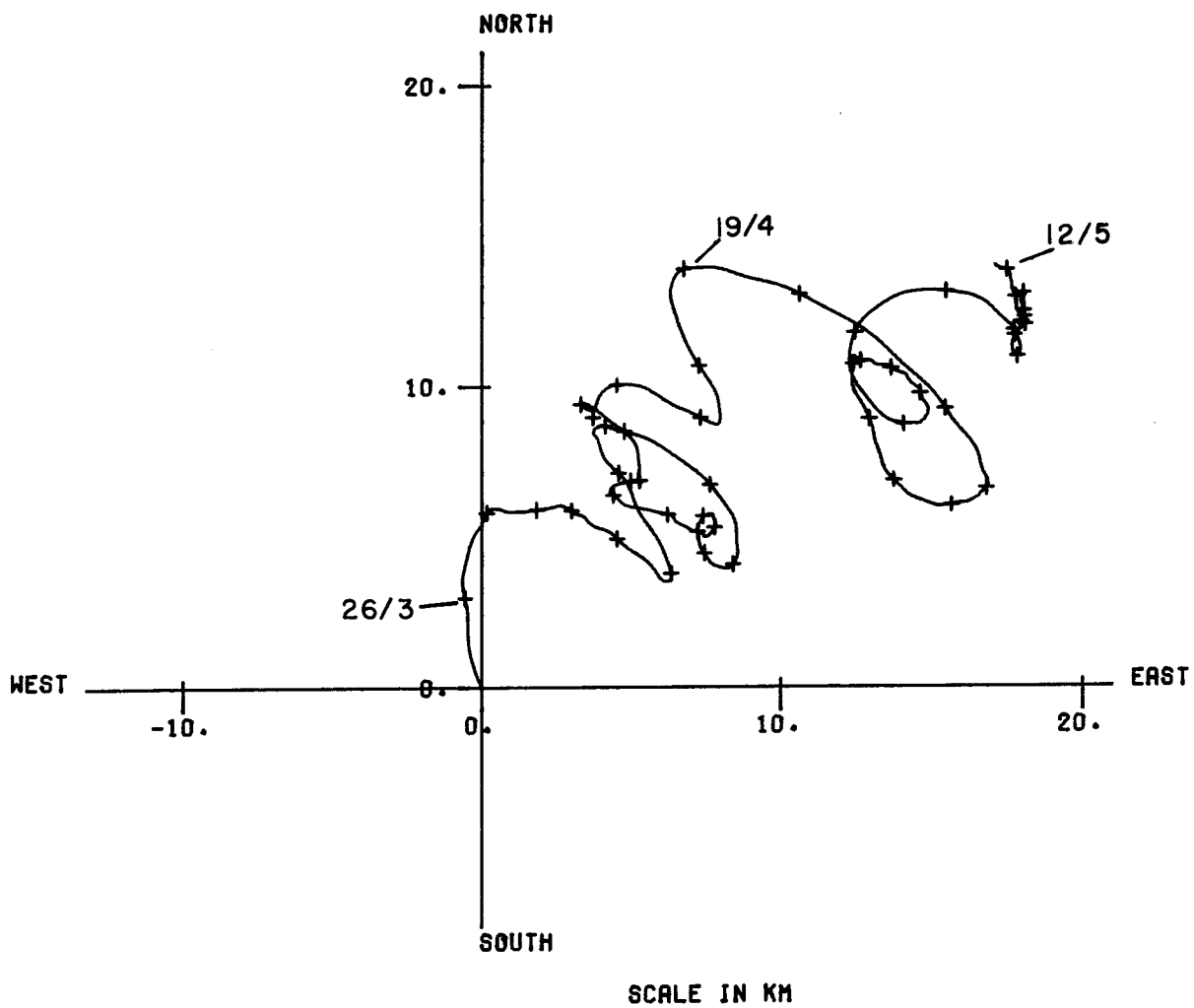
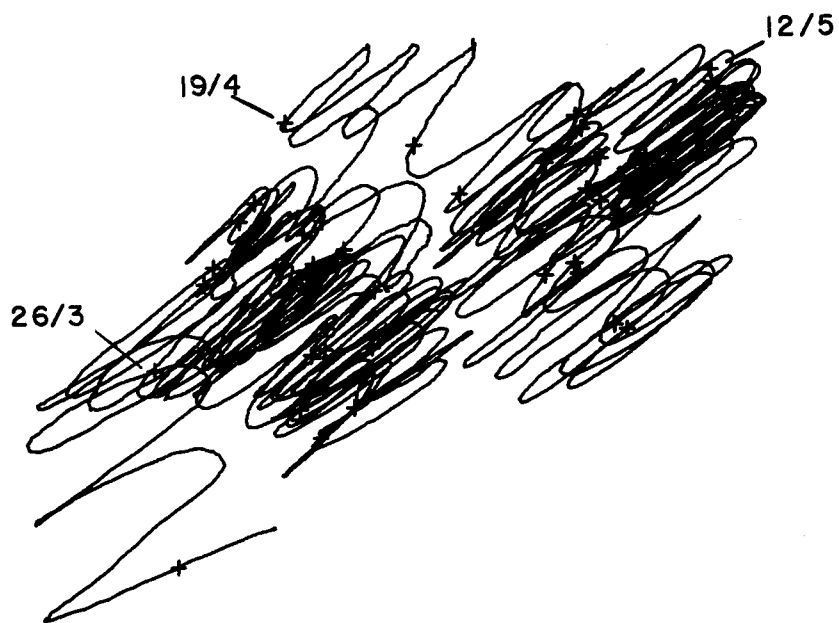


SPEED IN M/SEC



DIRECTION







Mooring number : 145  
 Position of rig : Lat 51° 45.0' W Long 6° 39.0' W (Station B)  
 Depth of water : 69 m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
1747	Aanderaa RCM4 in bottom frame 1	0.75	15

Rig set : 08.02 GMT 25 March 1978  
 from RRS Challenger

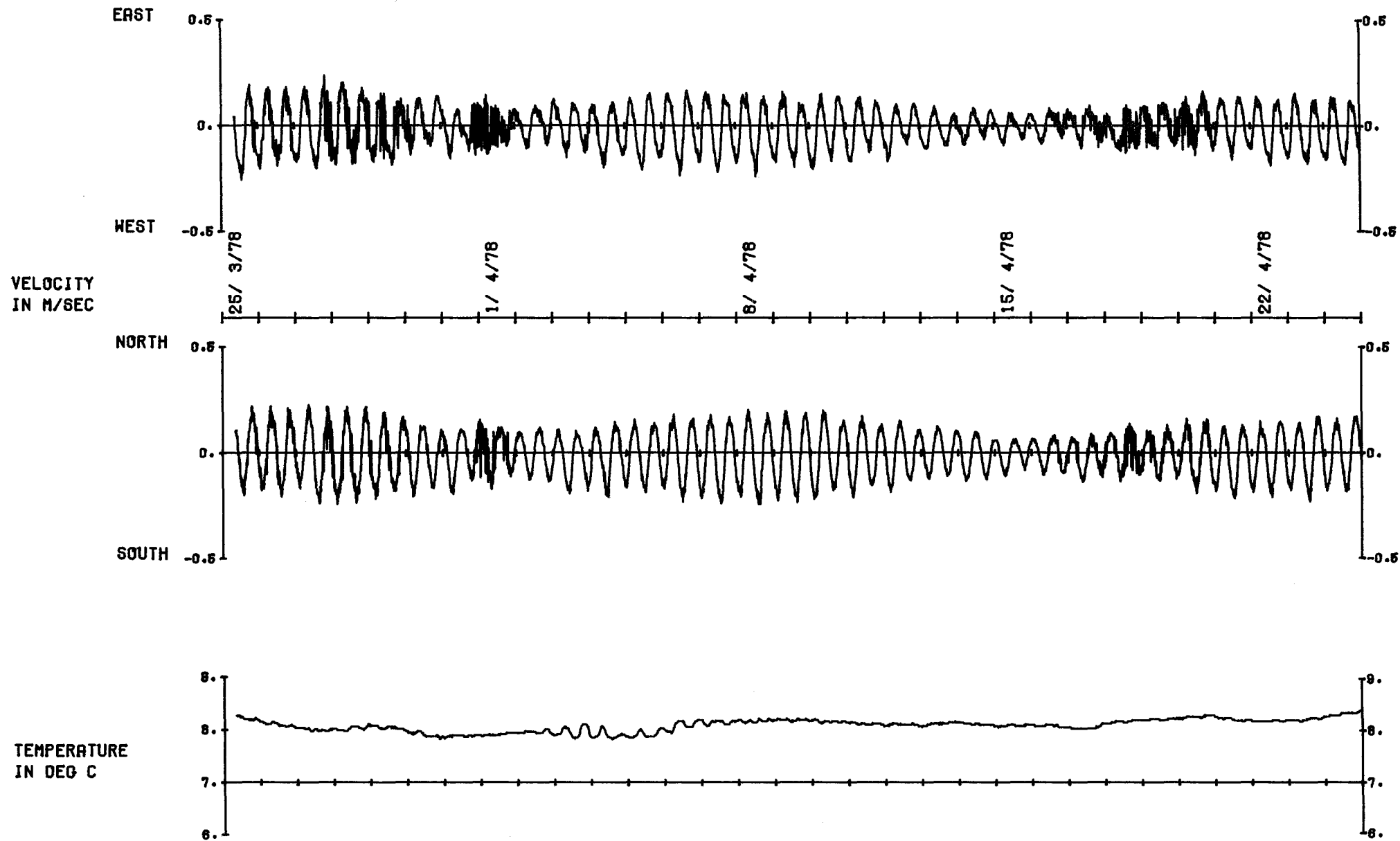
Rig recovered : 08.52 GMT 13 May 1978  
 from RRS Challenger

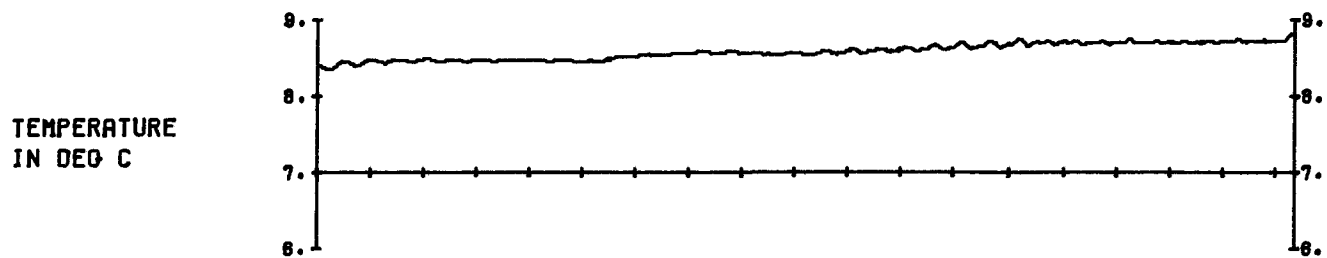
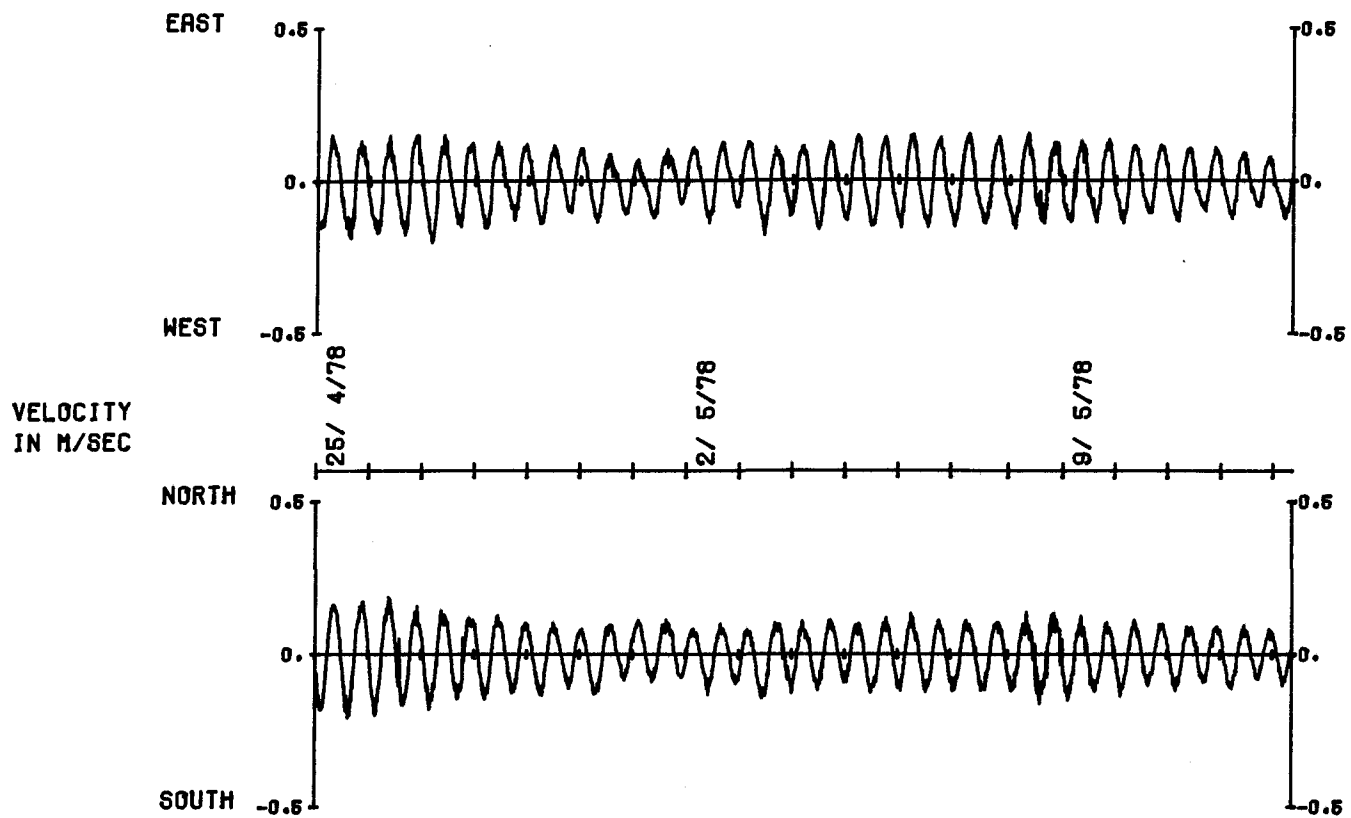
Mooring : u shaped, with bottom frame.

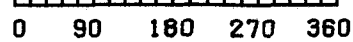
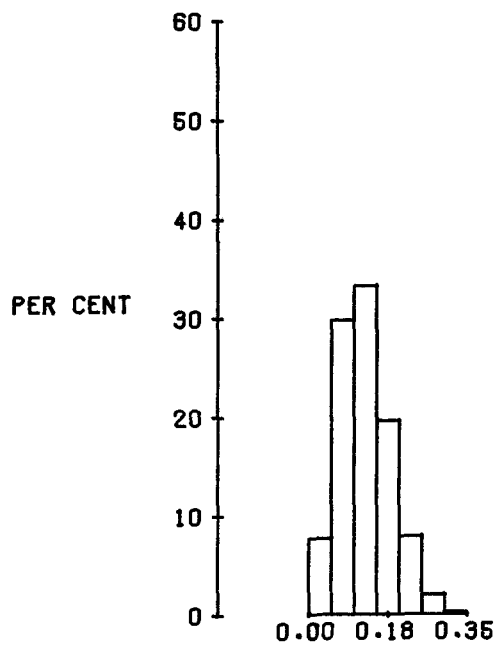
Comments : The rig was successfully deployed  
 at the first attempt.

When the surface buoy was recovered  
 the shackle connecting the surface buoy  
 anchor to the ground line was missing  
 The bottom frame was recovered  
 by grappling the pellet line and  
 pulling it in. The rig was in  
 position.

Meter : Aanderaa RCM4 No. 1747  
Tape number : 1747/7  
Meter started : 17.15.00 GMT 14 March 1978  
Meter stopped : -  
Total number of readings : 7923  
Timing error : -  
Start of useful record : 08.30 GMT 25 March 1978  
End of useful record : 08.30 GMT 13 May 1978  
Length of useful record : 1176 h  
Comments : The bottom frame was recovered in  
good condition and the record was  
good.

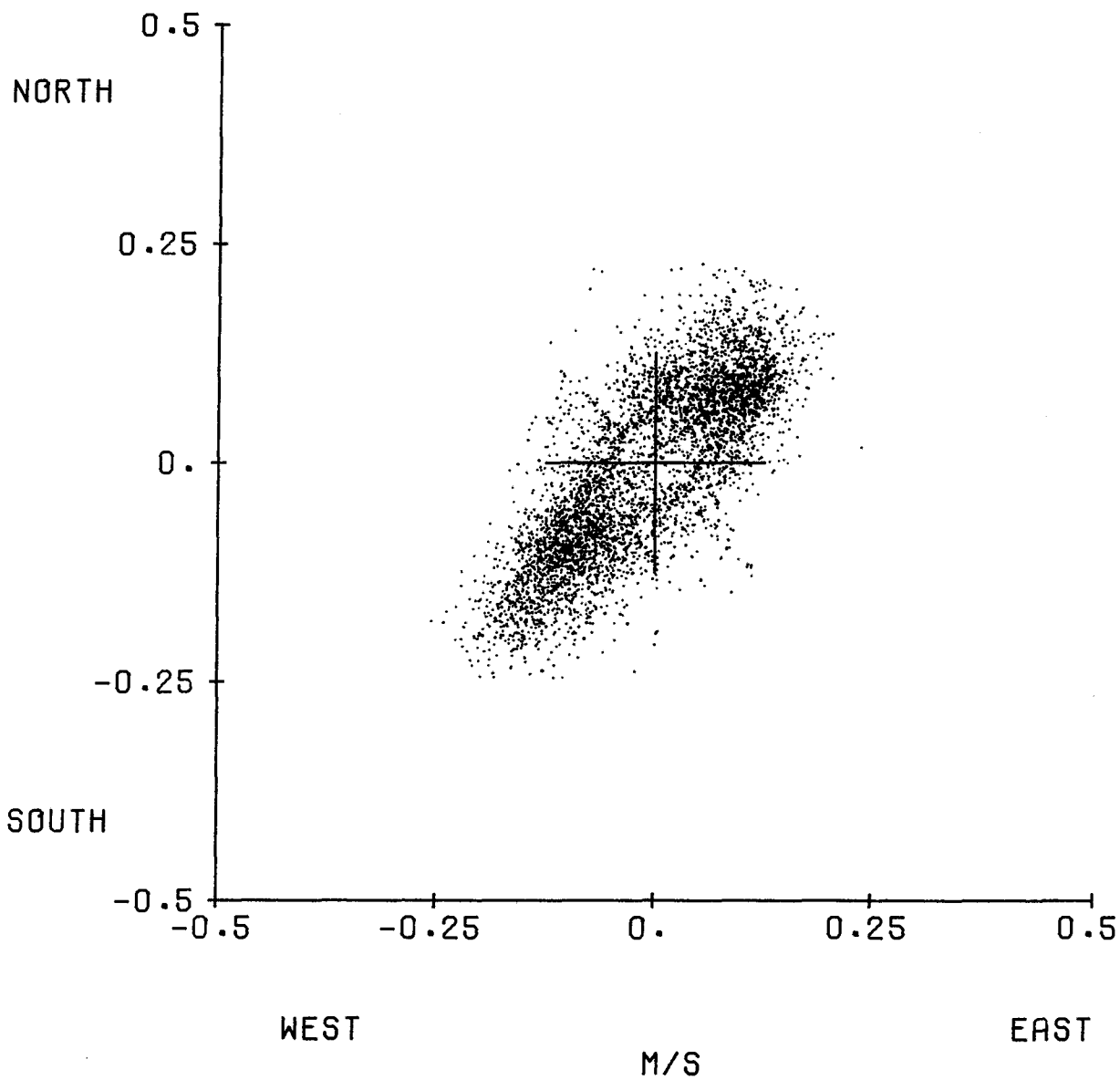


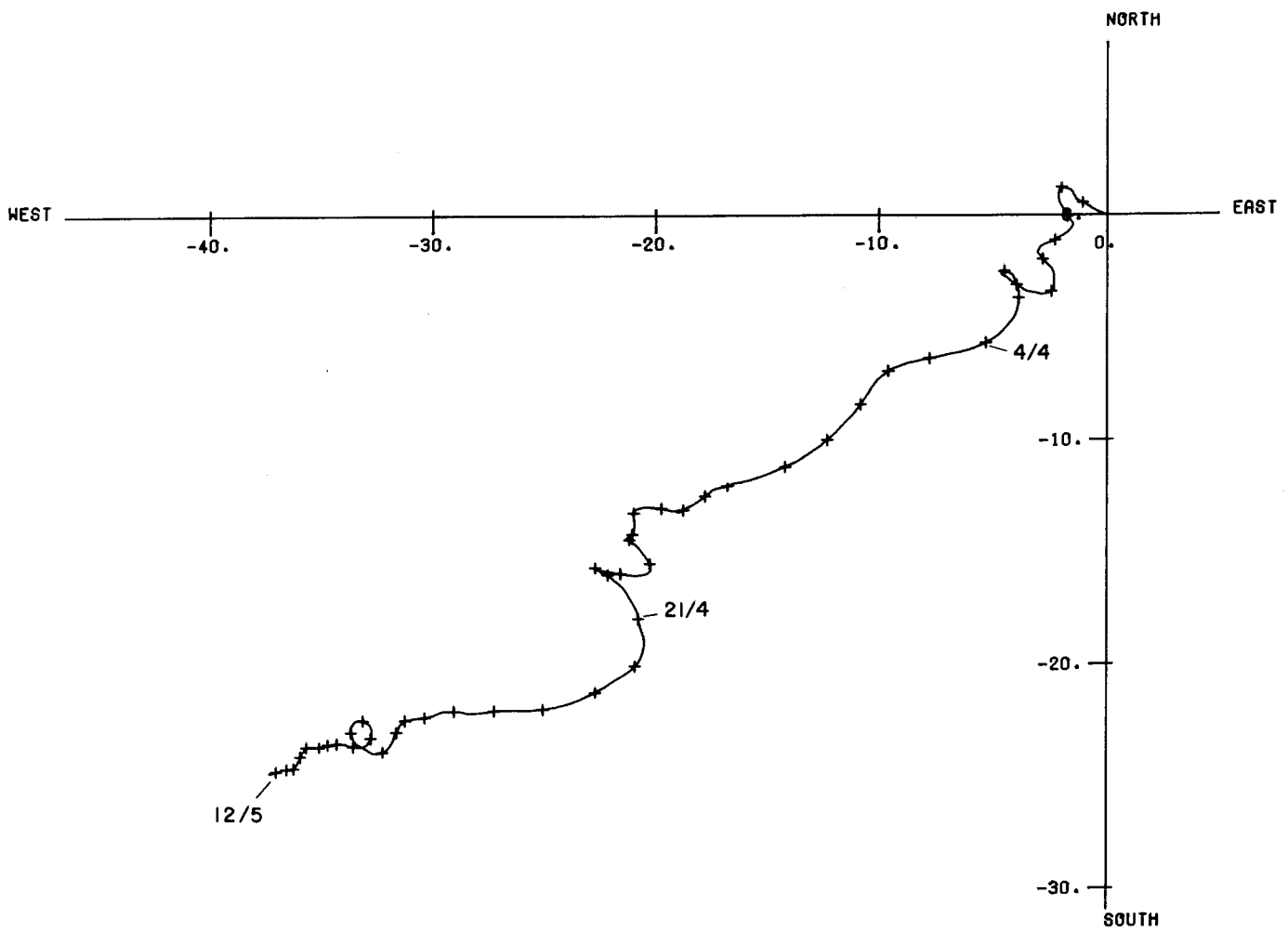
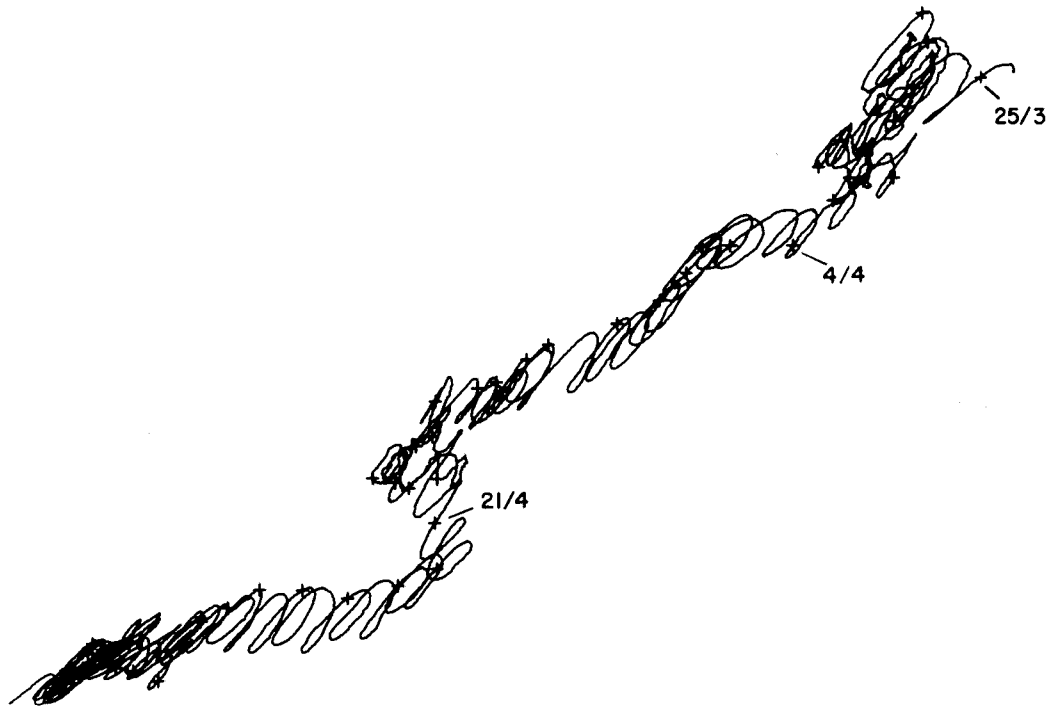




SPEED IN M/SEC

DIRECTION





SCALE IN KM

Mooring number : 146  
 Position of rig : Lat 51° 19.0' N Long 6° 34.8' W (Station C)  
 Depth of water : 86m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
567	Aanderaa RCM4	60	10
3277	Aanderaa RCM4	41	10
1506	Aanderaa RCM4	16	10

Rig set : 15.51 GMT 25 March 1978  
 from RRS Challenger

Rig recovered : 17.15 GMT 13 May 1978  
 from RRS Challenger

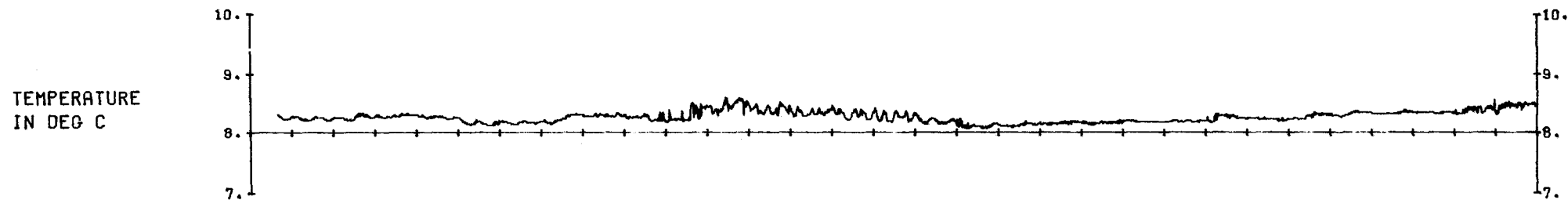
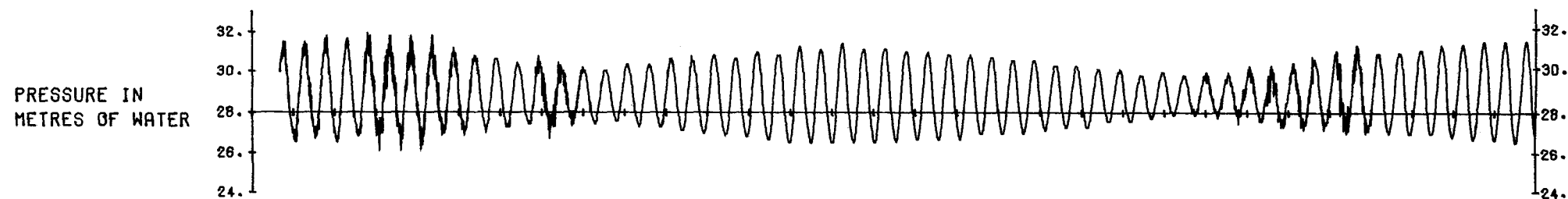
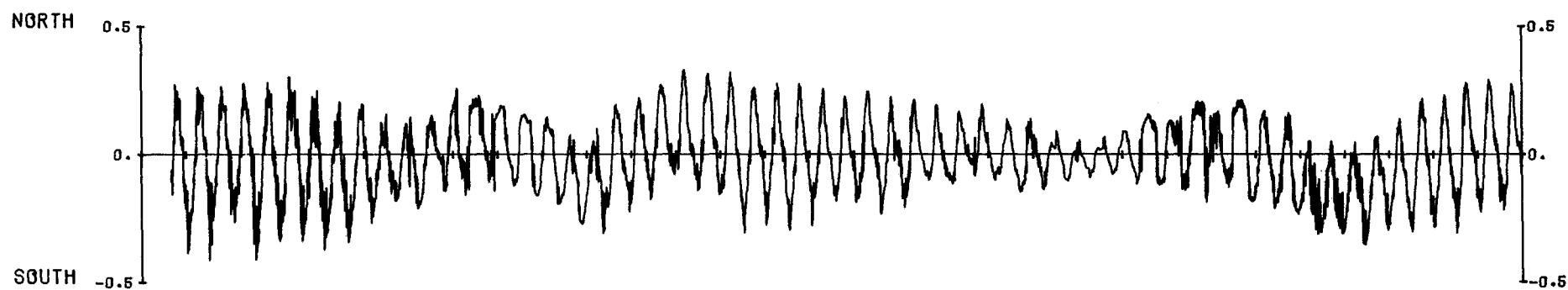
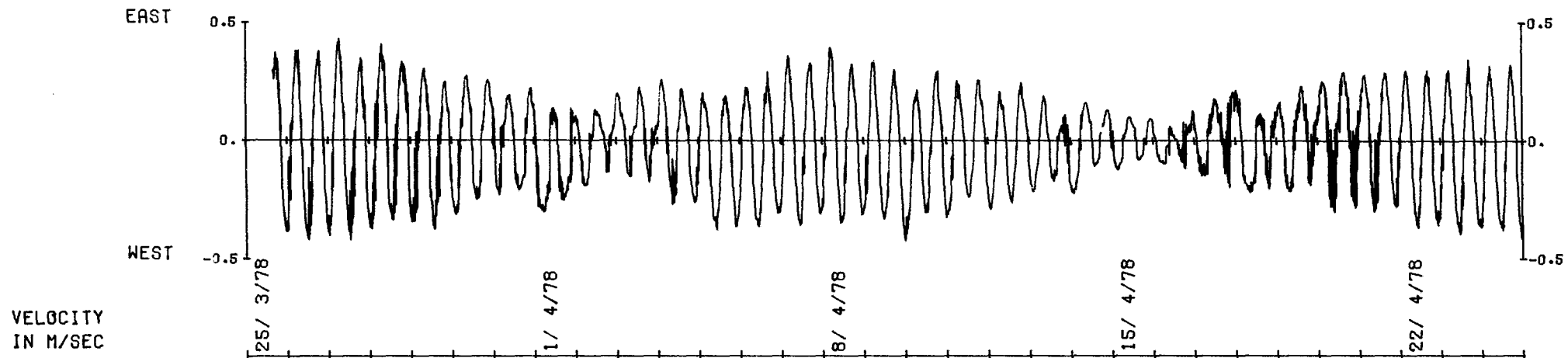
Mooring : Pop-up

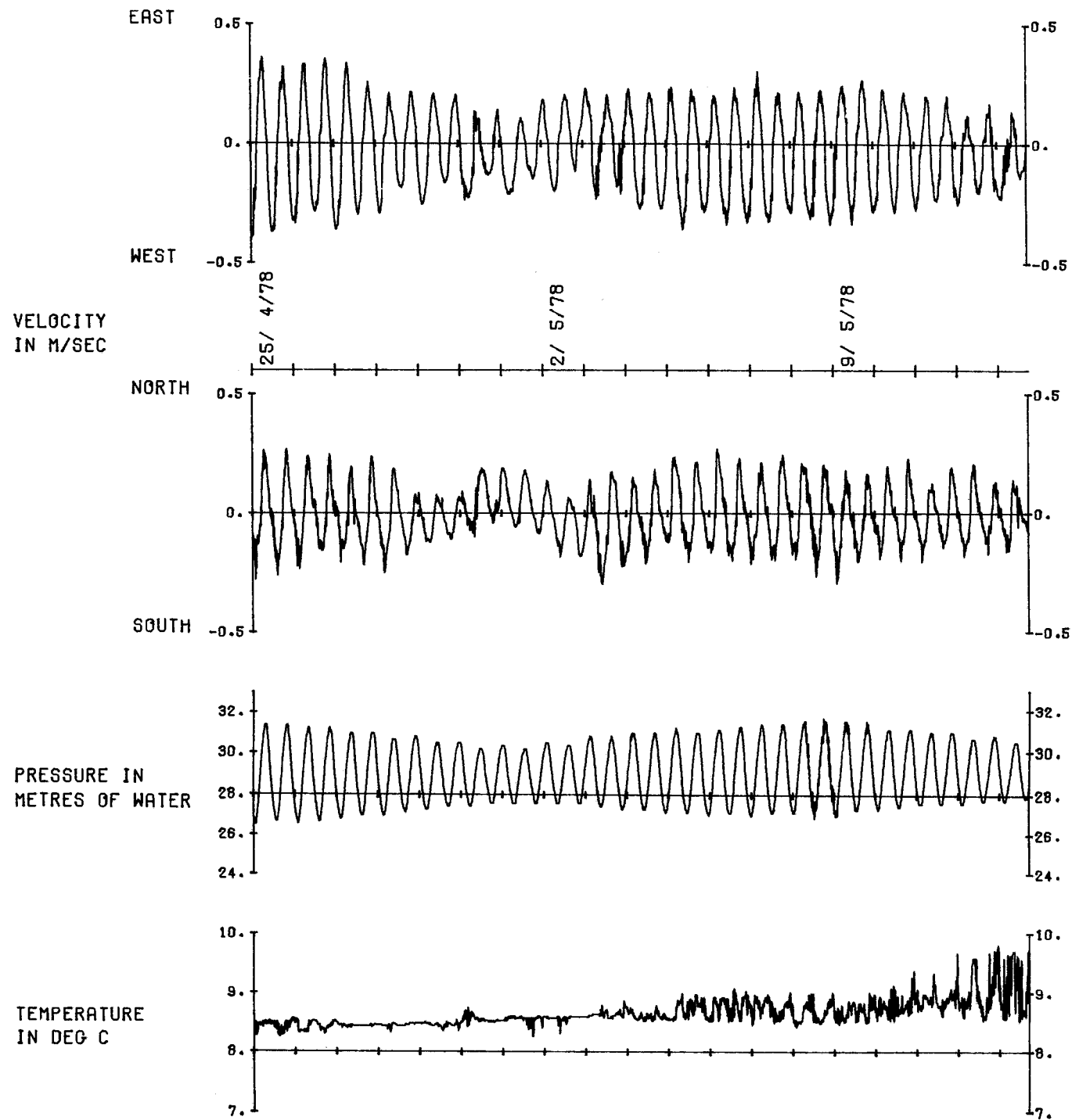
Comments : The rig was successfully deployed  
 at the first attempt in gale force  
 winds.

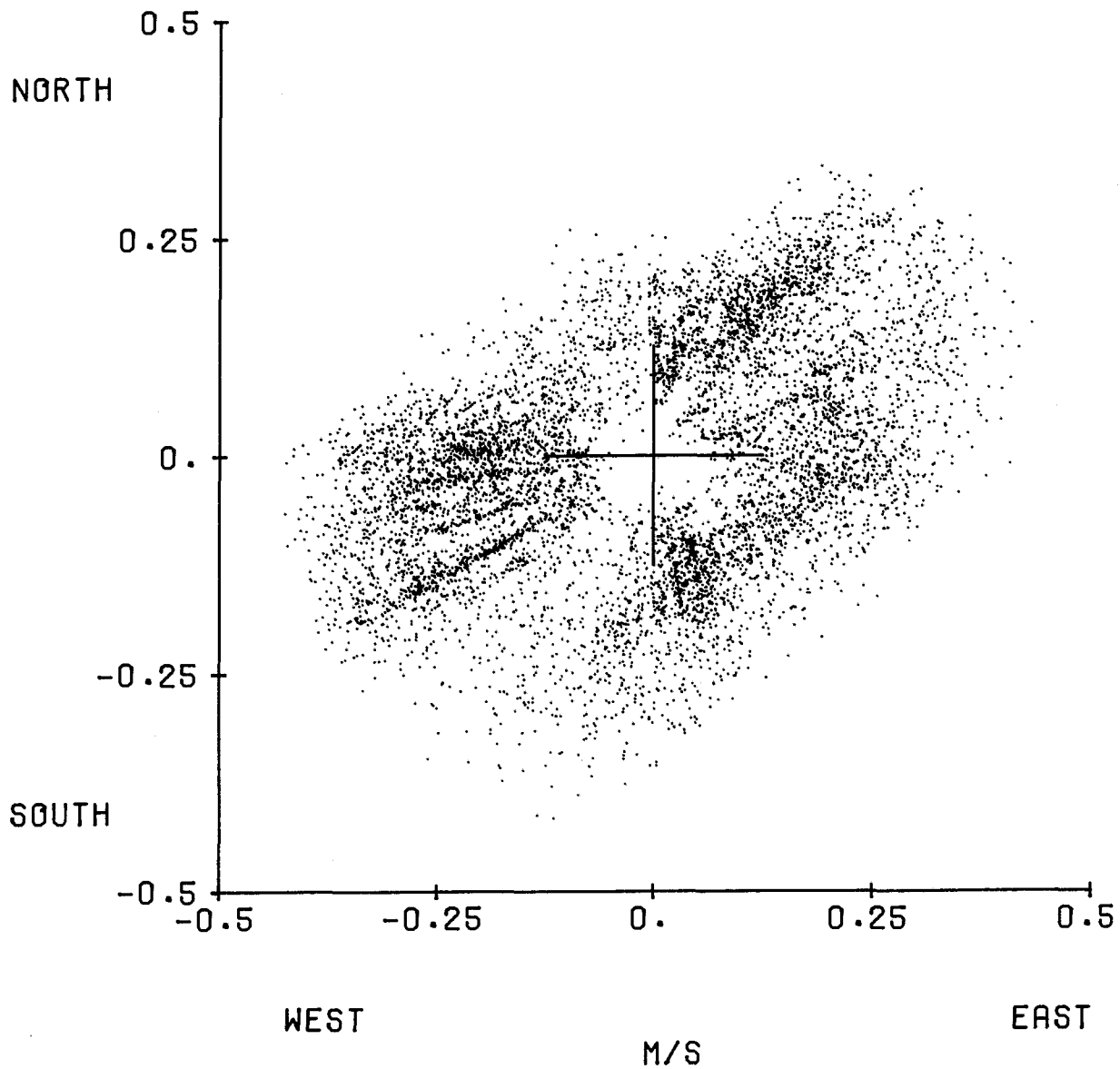
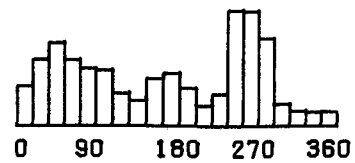
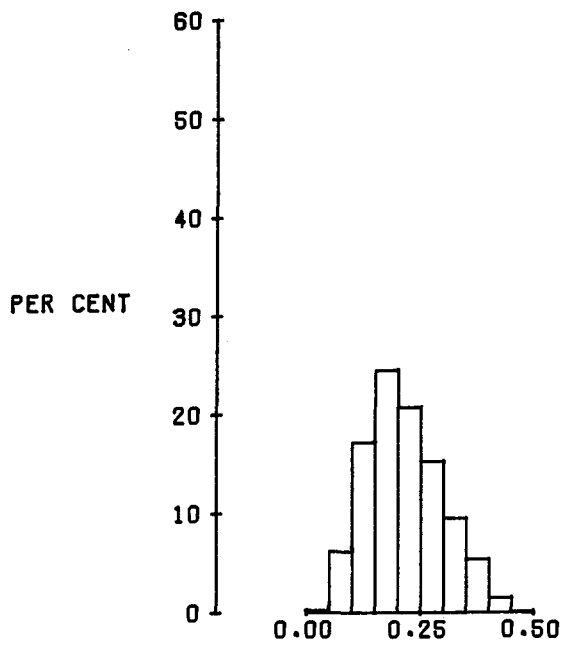
The rig was successfully recovered  
 at the first attempt. The meter wire  
 was tangled around the spindle of  
 the top meter. The rig was in  
 position.

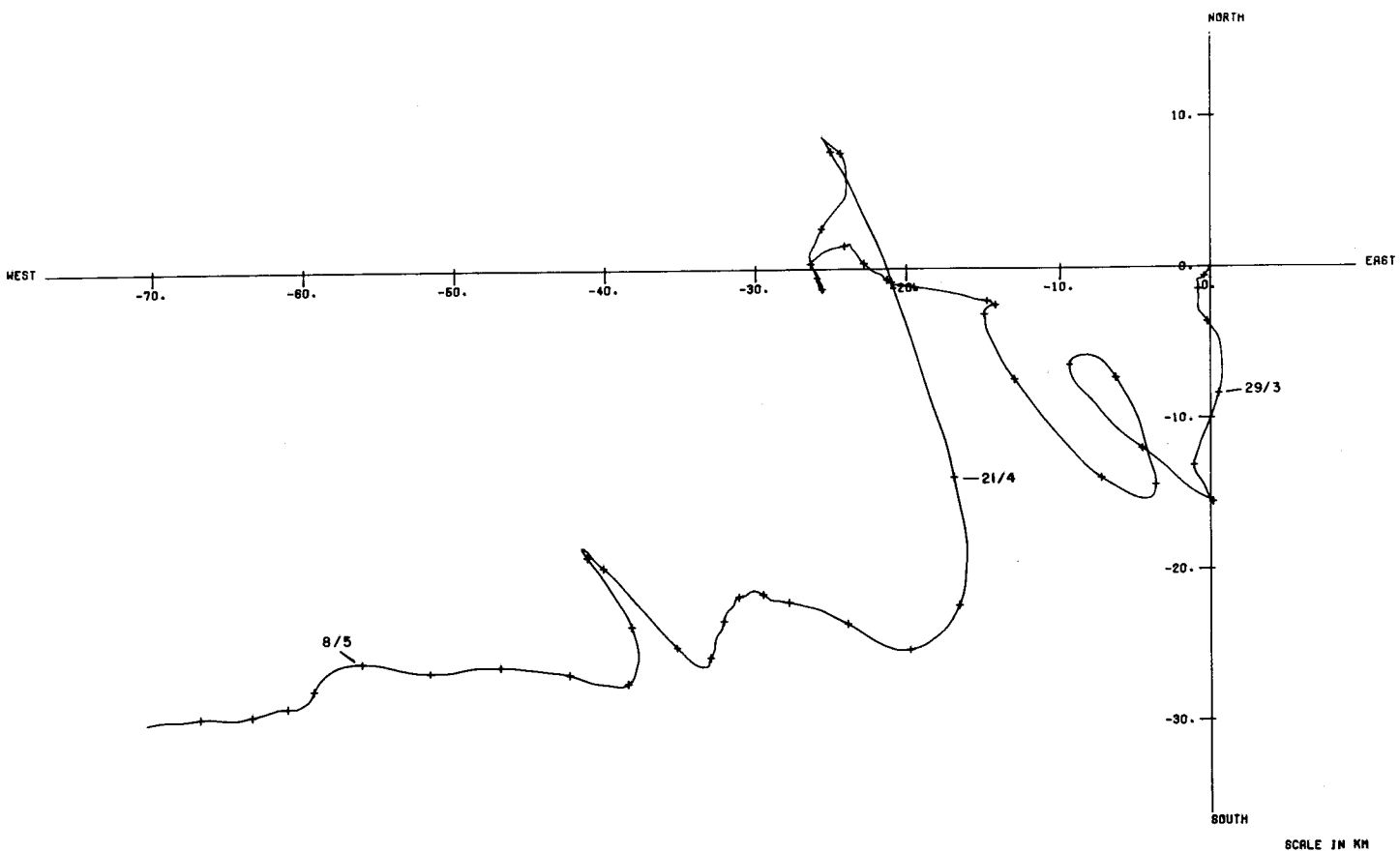
Meter : Aanderaa RCM4 No. 567  
Tape number : 567/9  
Meter started : 17.10.00 GMT 24 March 1978  
Meter stopped : 12.30.45 GMT 15 May 1978  
Total number of readings : 7461  
Timing error : 45 s slow  
Start of useful record : 16.10 GMT 25 March 1978  
End of useful record : 17.01 GMT 13 May 1978  
Length of useful record : 1176 h  
Comments : The meter was fitted with a 0-200 psi  
pressure sensor.  
The meter was recovered in good  
condition and its record was good.



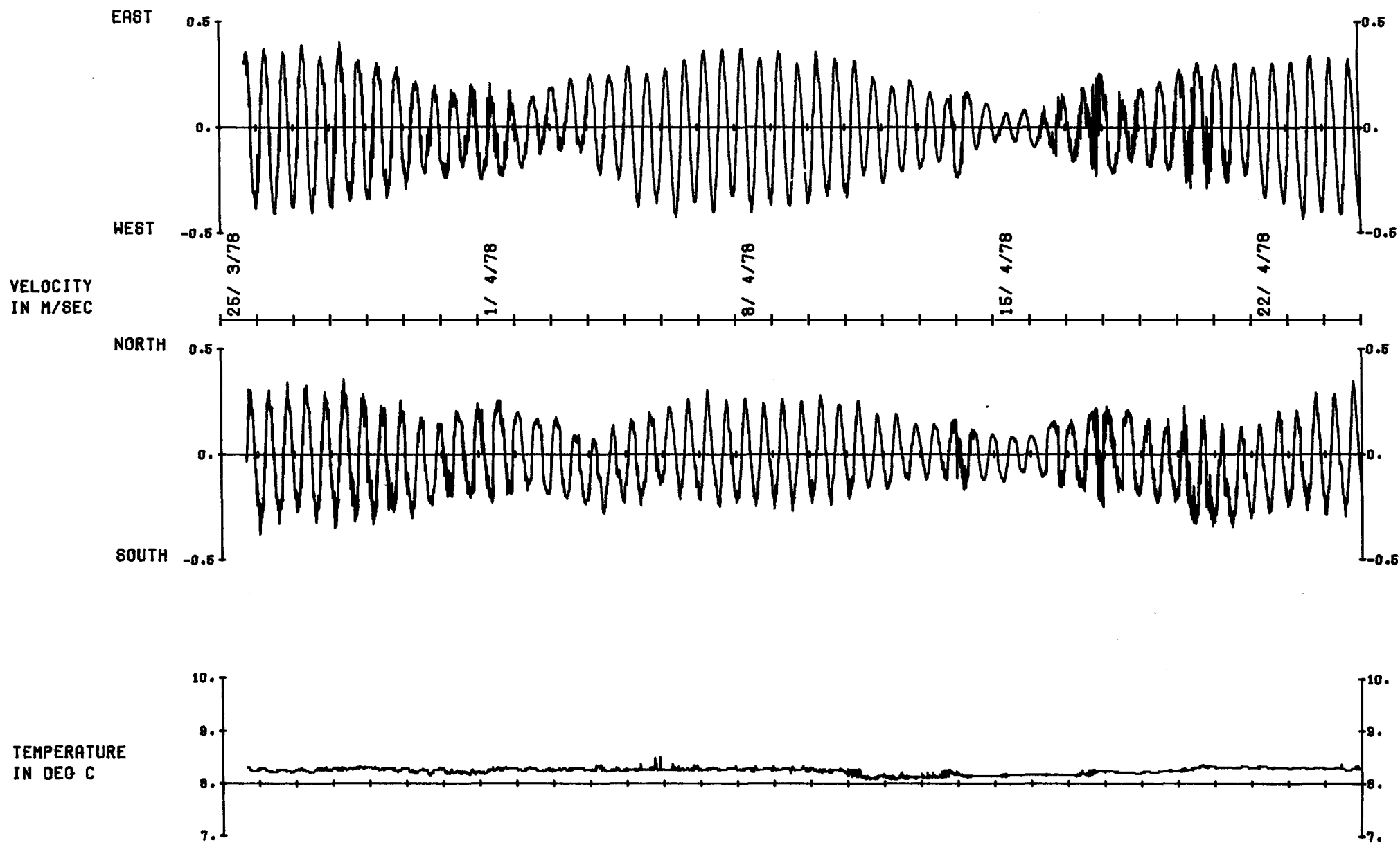


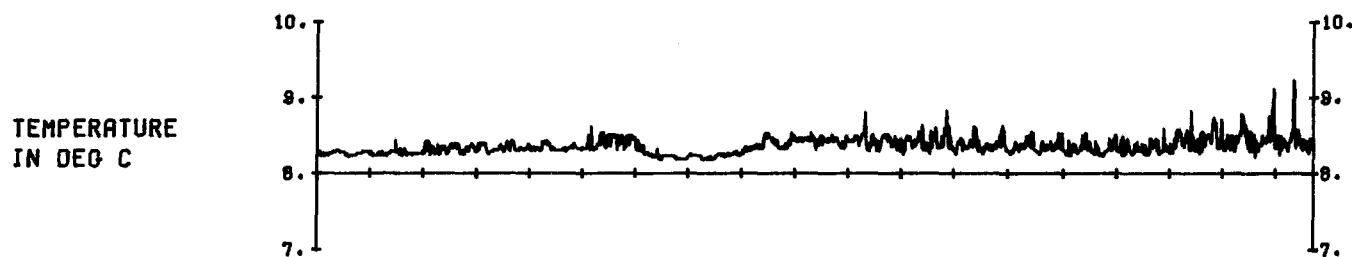
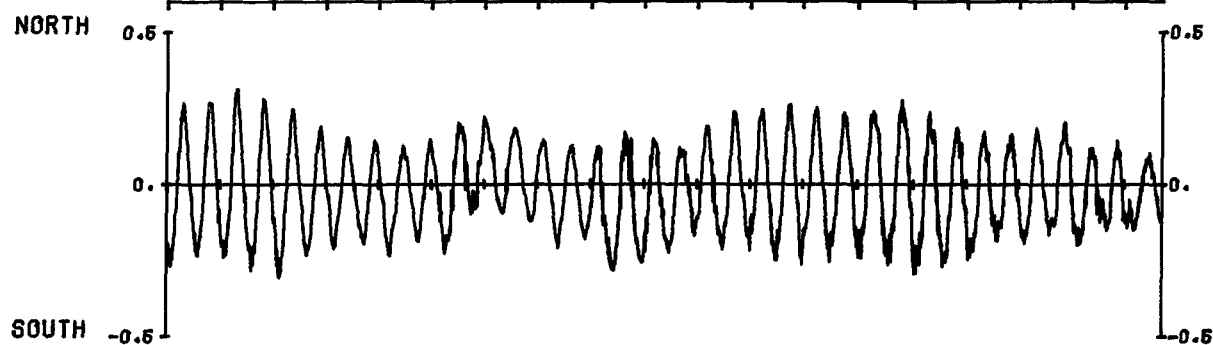
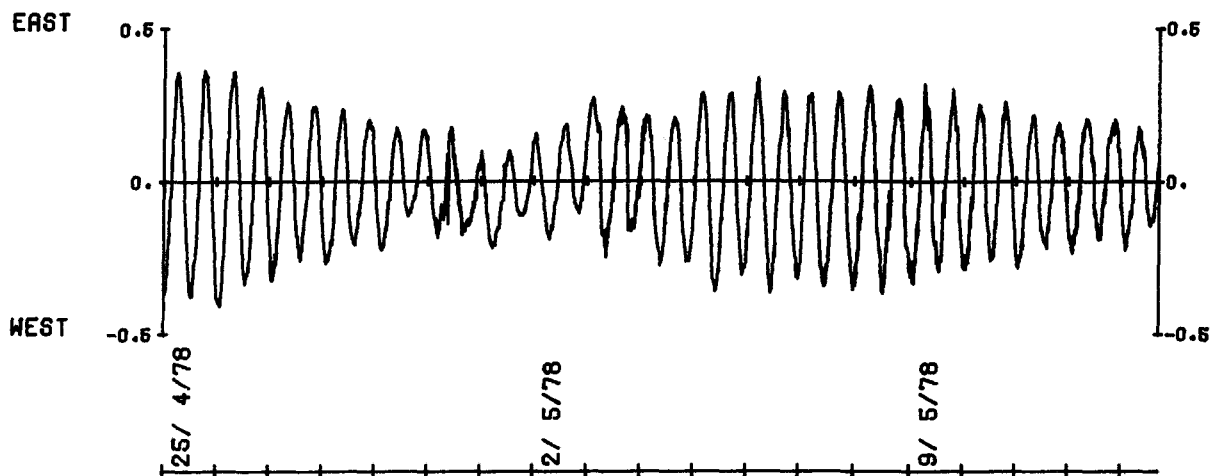


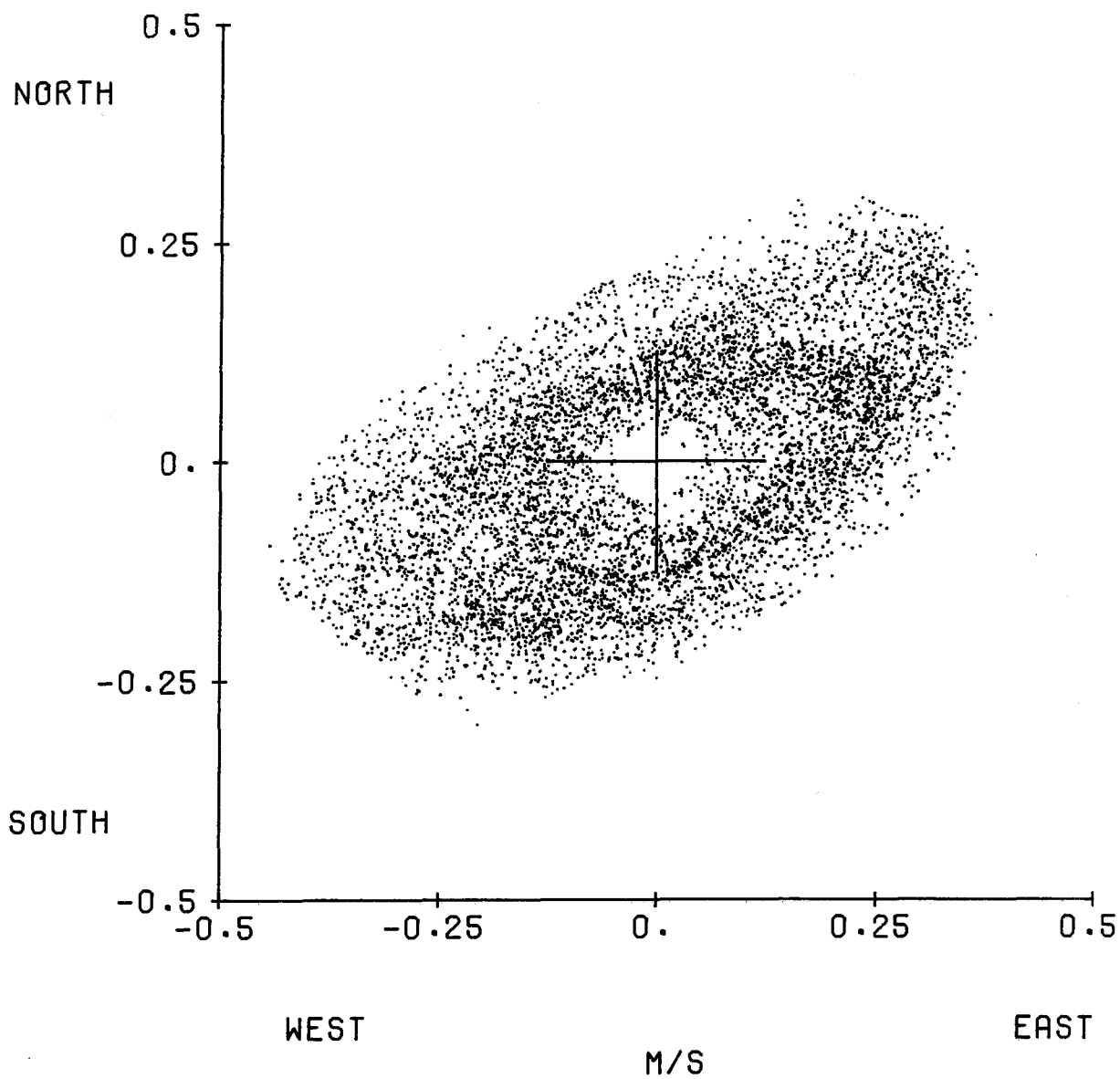
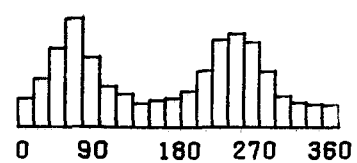
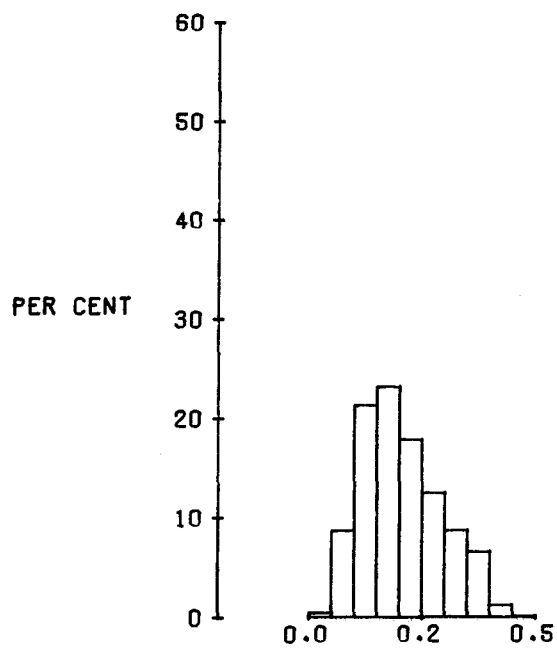




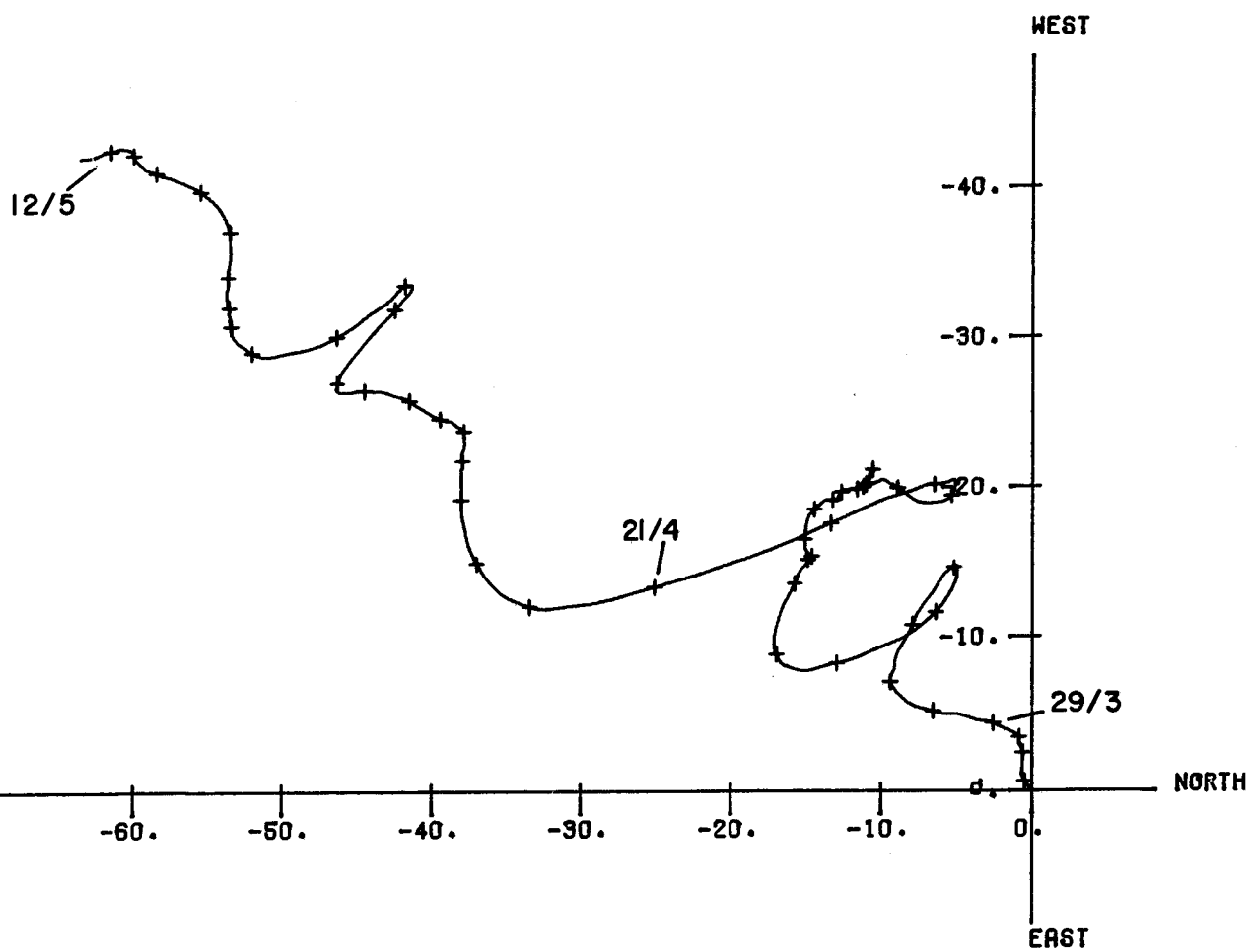
Meter	:	Aanderaa RCM4	No. 3277
Tape number	:	3277/1	
Meter started	:	11.20.00	GMT 25 March 1978
Meter stopped	:	11.27.45	GMT 15 May 1978
Total number of readings	:	7346	
Timing error	:	135 s	fast
Start of useful record	:	16.10	GMT 25 March 1978
End of useful record	:	16.58	GMT 13 May 1978
Length of useful record	:	1176 h	
Comments	:	The meter was recovered in good condition and its record was good.	





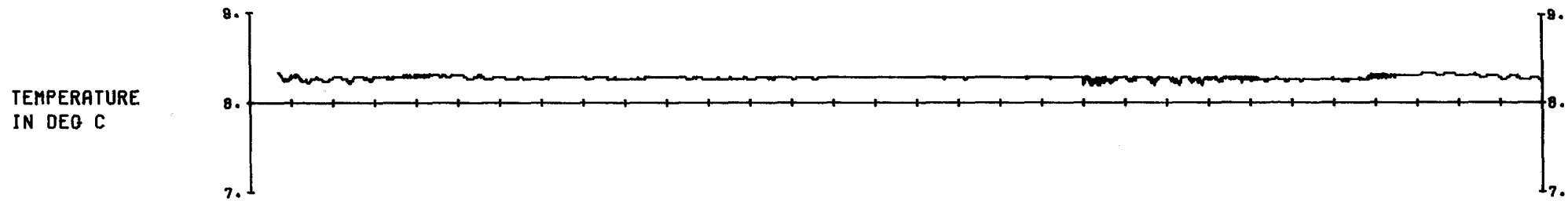
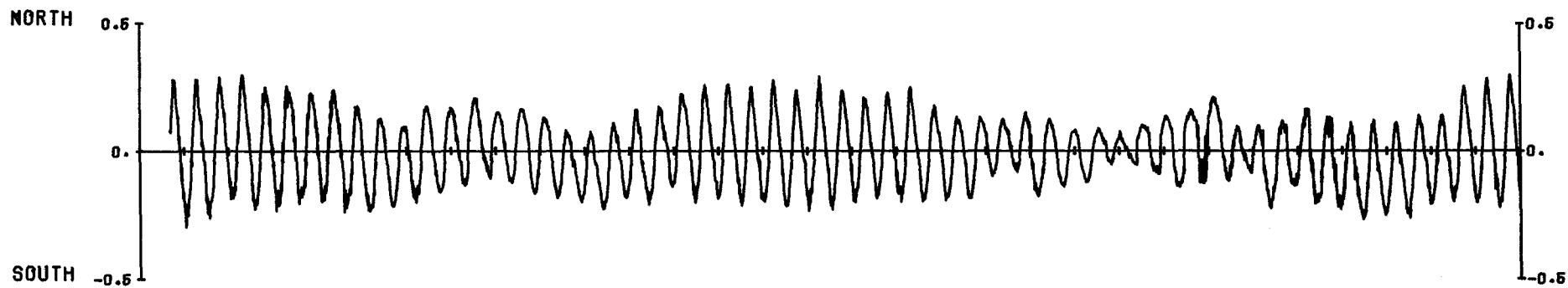
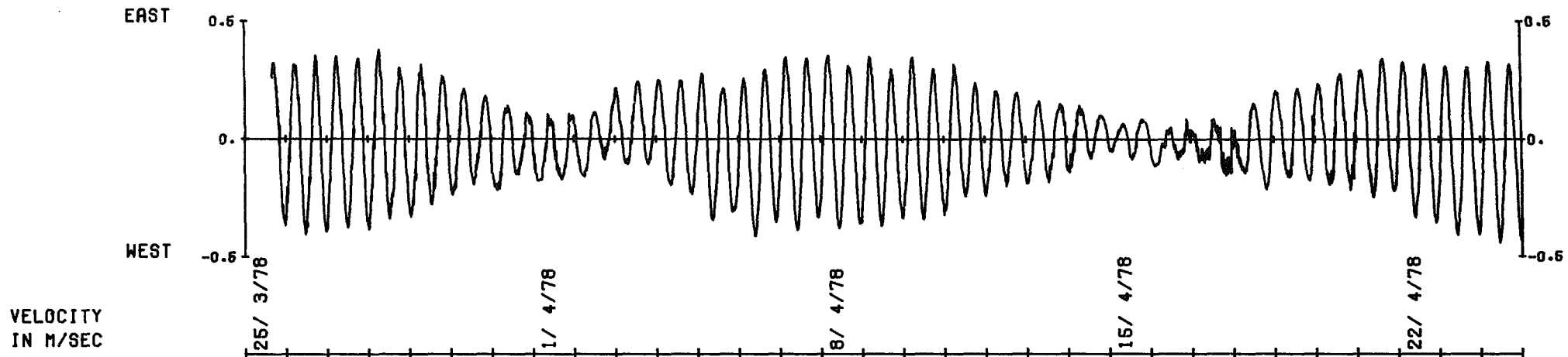


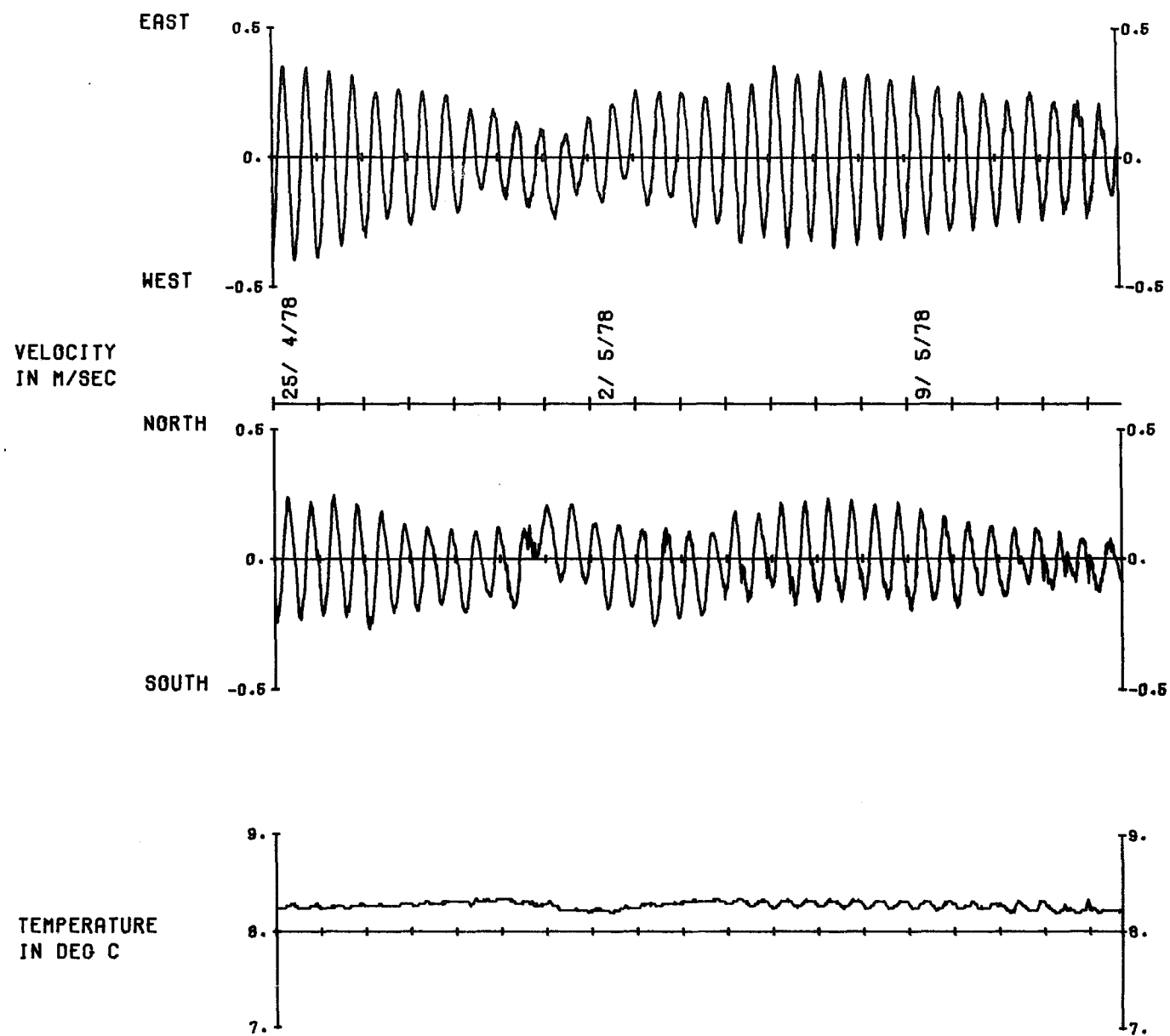


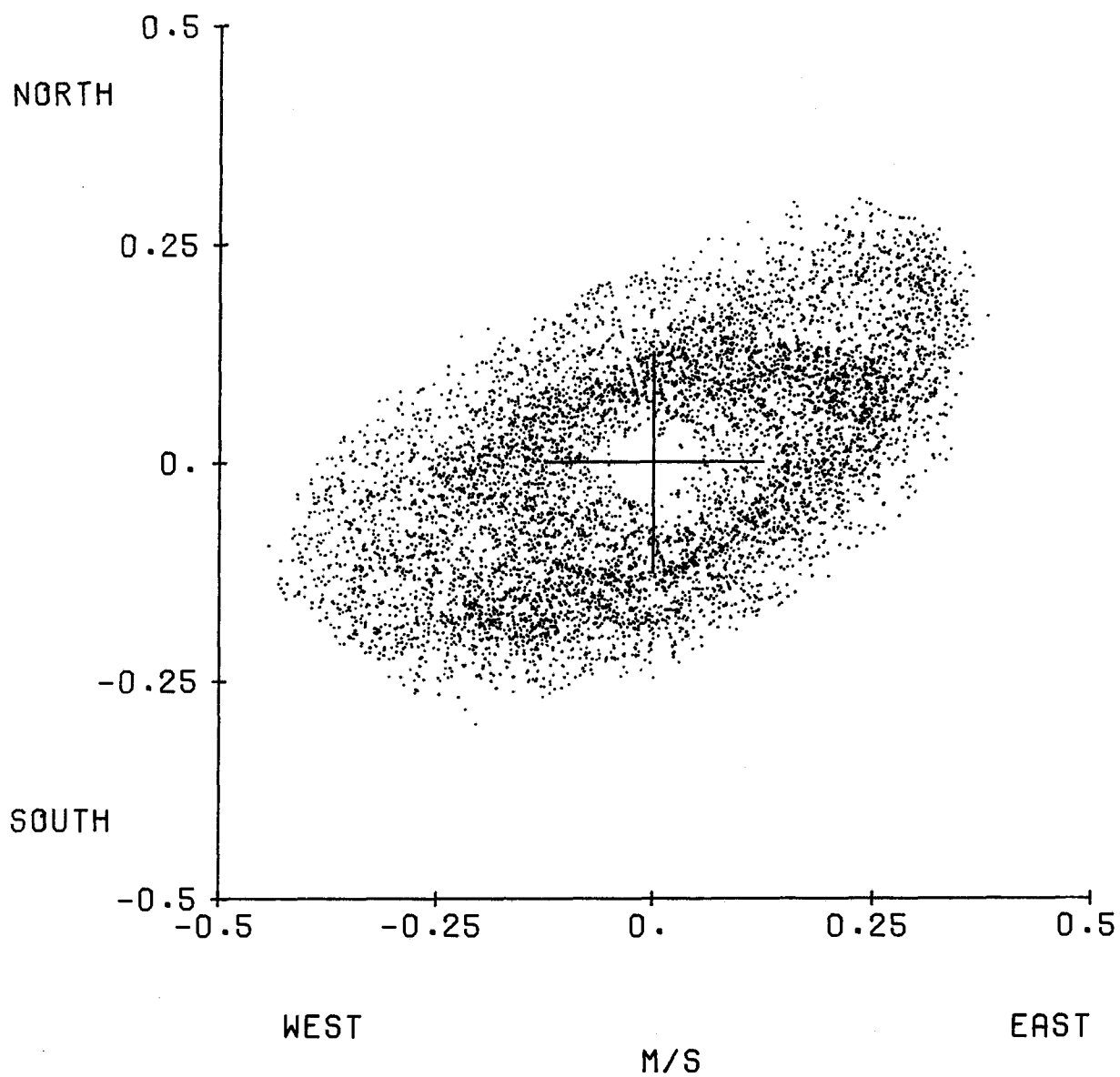
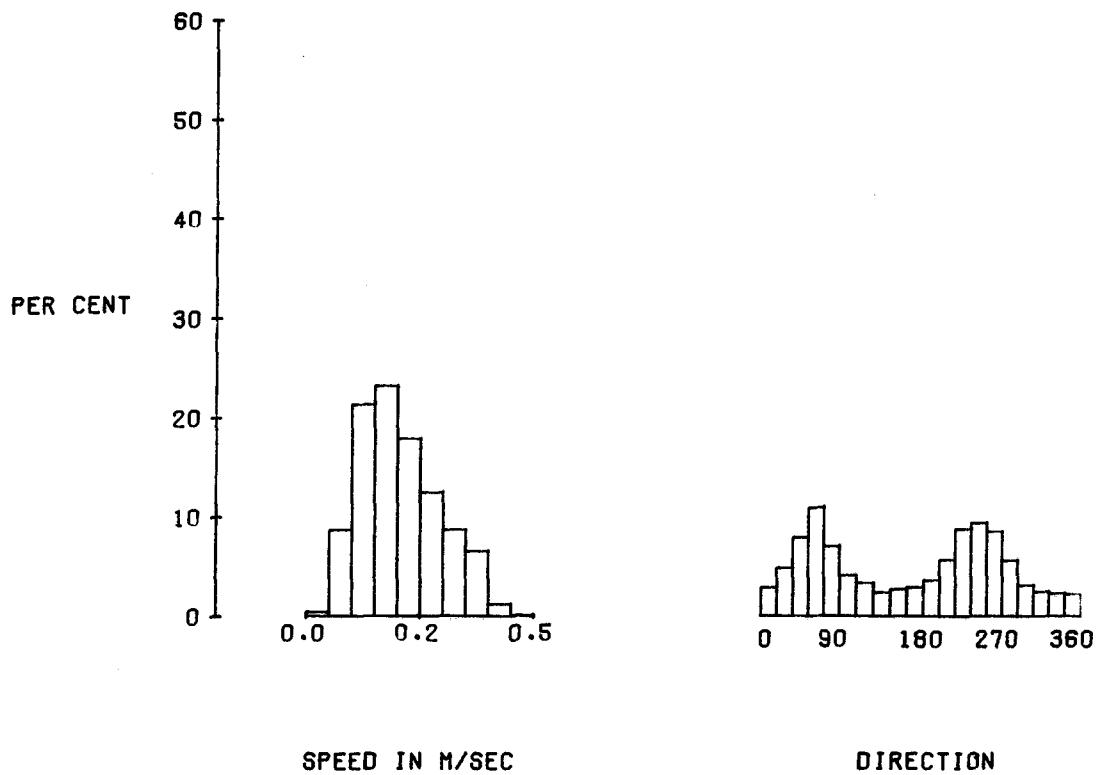


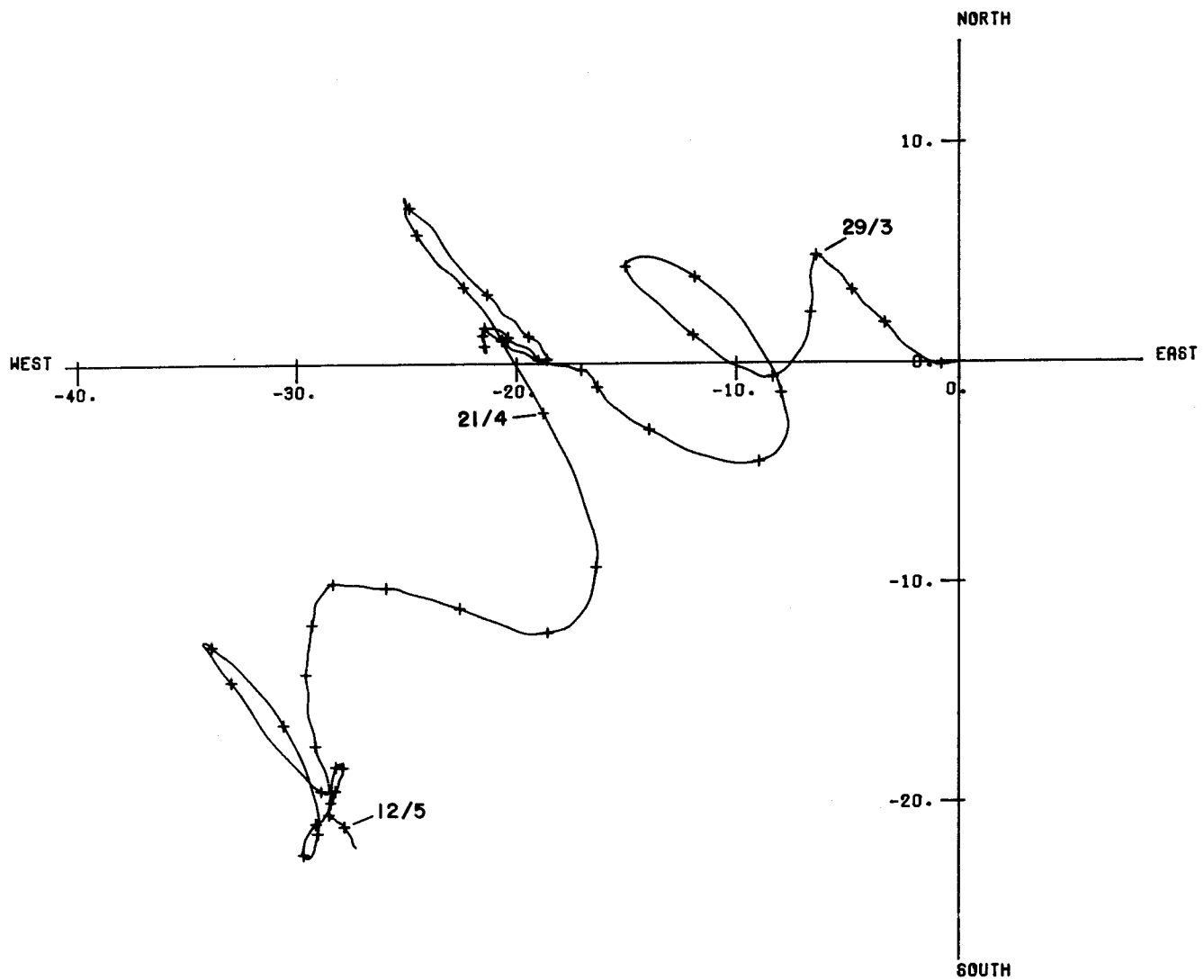
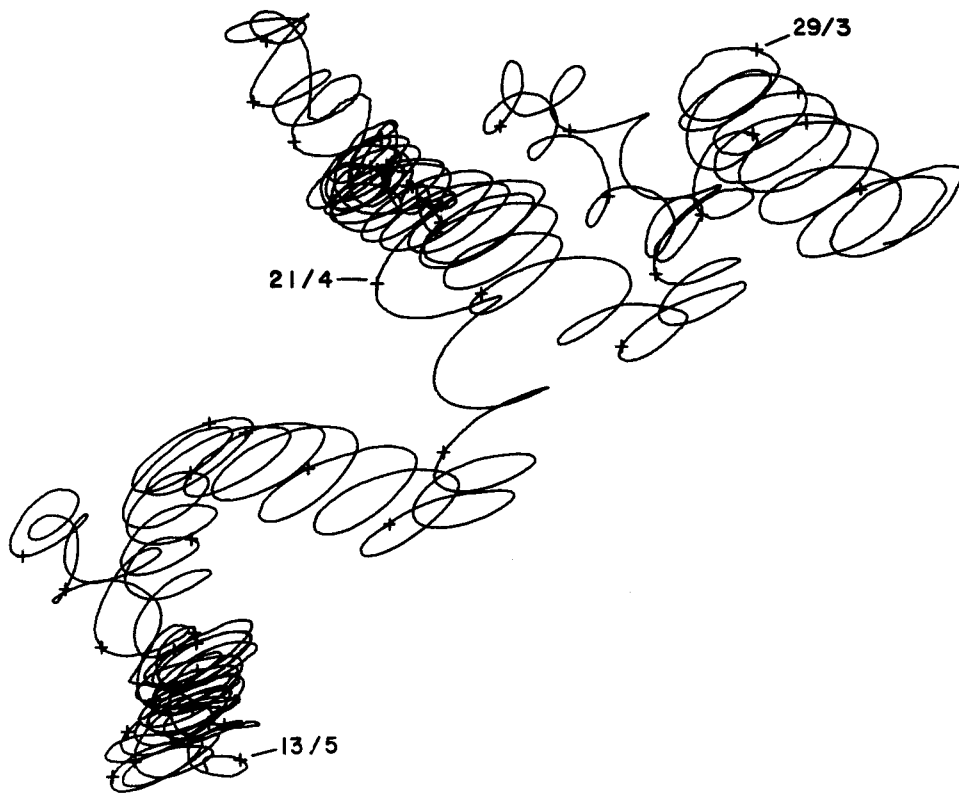
SCALE IN KM

Meter : Aanderaa RCM4 No. 1506  
Tape number : 1506/4  
Meter started : 11.40.00 GMT 25 March 1978  
Meter stopped : 11.59.41 GMT 15 May 1978  
Total number of readings : 7347  
Timing error : 19 s fast  
Start of useful record : 16.10 GMT 25 March 1978  
End of useful record : 17.00 GMT 13 May 1978  
Length of useful record : 1176 h  
Comments : The meter was recovered in good  
condition and its record was  
good.









SCALE IN KM

Mooring number : 147  
Position of rig : Lat 51° 19.0' N Long 6° 33.0' W (Station C)  
Depth of water : 94m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
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178	Aanderaa TR1	78-28	3.75
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Rig set : 15.38 GMT 25 March 1978 from RRS Challenger  
Rig recovered : 15.16 GMT 13 May 1978 from RRS Challenger

Mooring : u shaped, with a pressure recorder attached to the middle of the ground line.

Comments : The rig was successfully deployed at the first attempt in gale force winds.

It was successfully recovered at the first attempt and was in position.

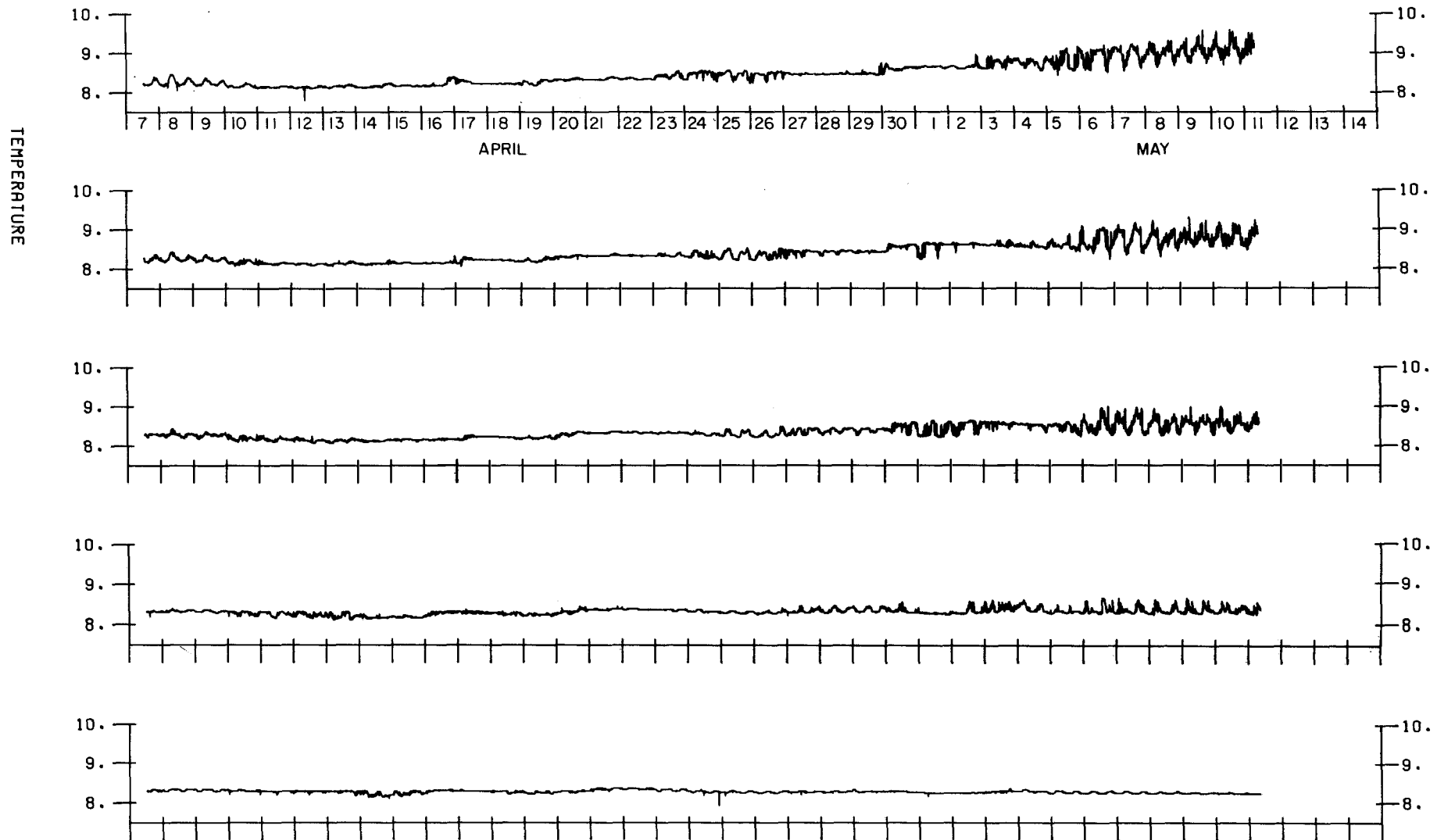
Meter : Aanderaa TR -1 178/212  
Tape number : 178/212/1  
Meter started : 12.30.00 GMT 25 March 1978  
Meter stopped : Tape ran out  
Total number of readings : 14140  
Timing error : -  
Start of useful record : 12.30.00 GMT 7 April 1978  
End of useful record : 08.11.15 GMT 11 May 1978  
Length of useful record : 811 h  
Comments : A circuit was connected to the clock  
so that there was a delay of 10 days  
between the start of the meter and  
the start of data recording.

The meter was recovered in good  
condition.

A high background level of magnetiza-  
tion made it difficult to translate  
the tape. 3 days of data at the start  
have been discarded and many short gaps  
interpolated.



# THERMISTOR CHAIN PLOT



TIME  
TC178/2 RIG C START= 7/4/78 12.30 END= 11/5/78 08.11.15 S I= 3.75MIN

Mooring number : 148  
 Position of rig : Lat 50° 35.5' N Long 06° 08.1' W  
 (Station D)  
 Depth of water : 90m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
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1750	Aanderaa RCM4	66	10
568	Aanderaa RCM4	41	10
2969	Aanderaa RCM4	16	10

Rig set : 06.50 GMT 28 March 1978  
 from RRS Challenger

Rig recovered : -

Mooring : u shaped with a pressure recorder  
 attached to the middle of the ground-  
 line.

Comments : The rig was successfully deployed at  
 the first attempt.

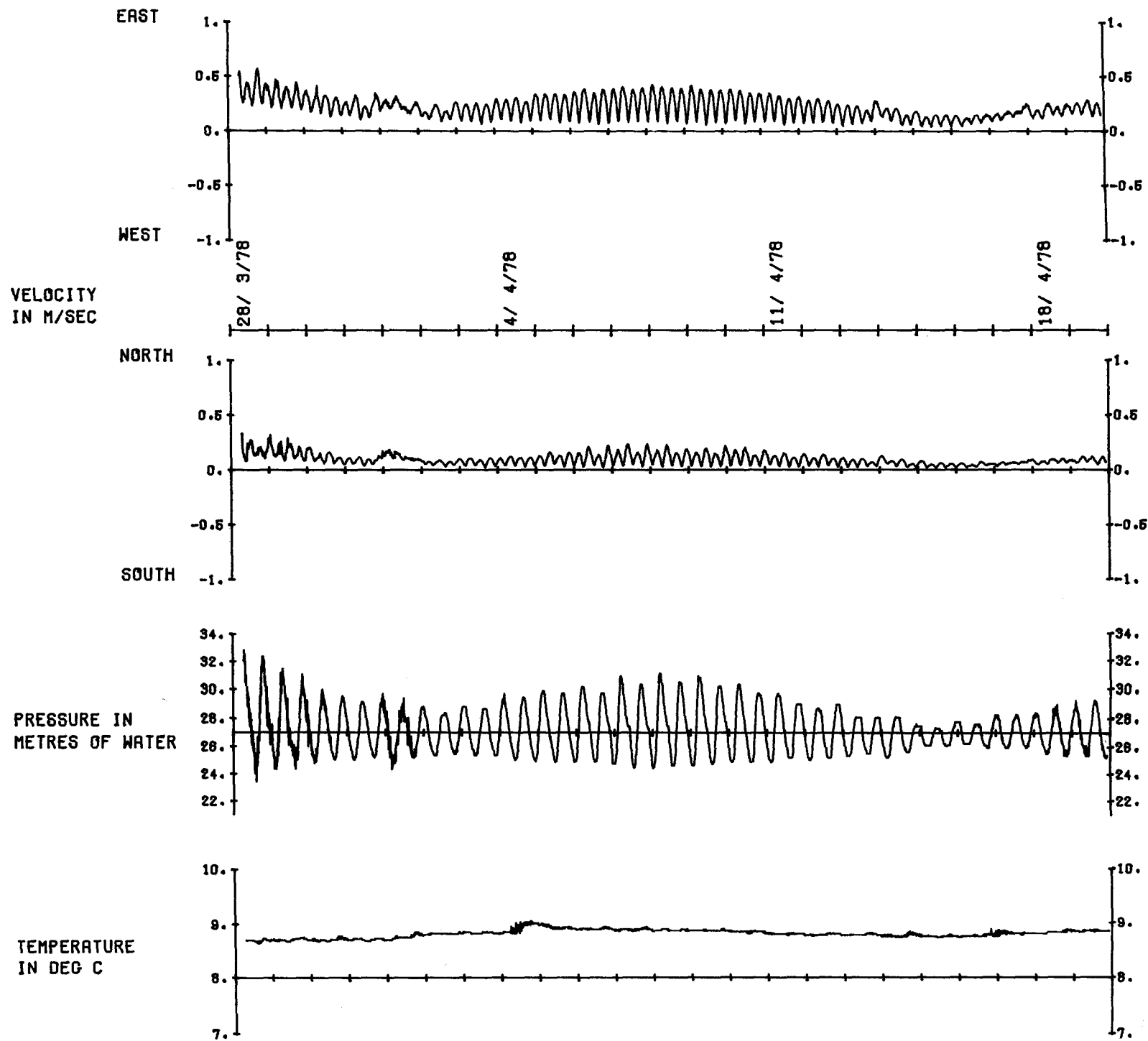
The sub-surface buoy and top two  
 current meters were recovered by a  
 fishing boat from Newlyn on 28 April  
 1978 at 50° 42' N 6° 16' W

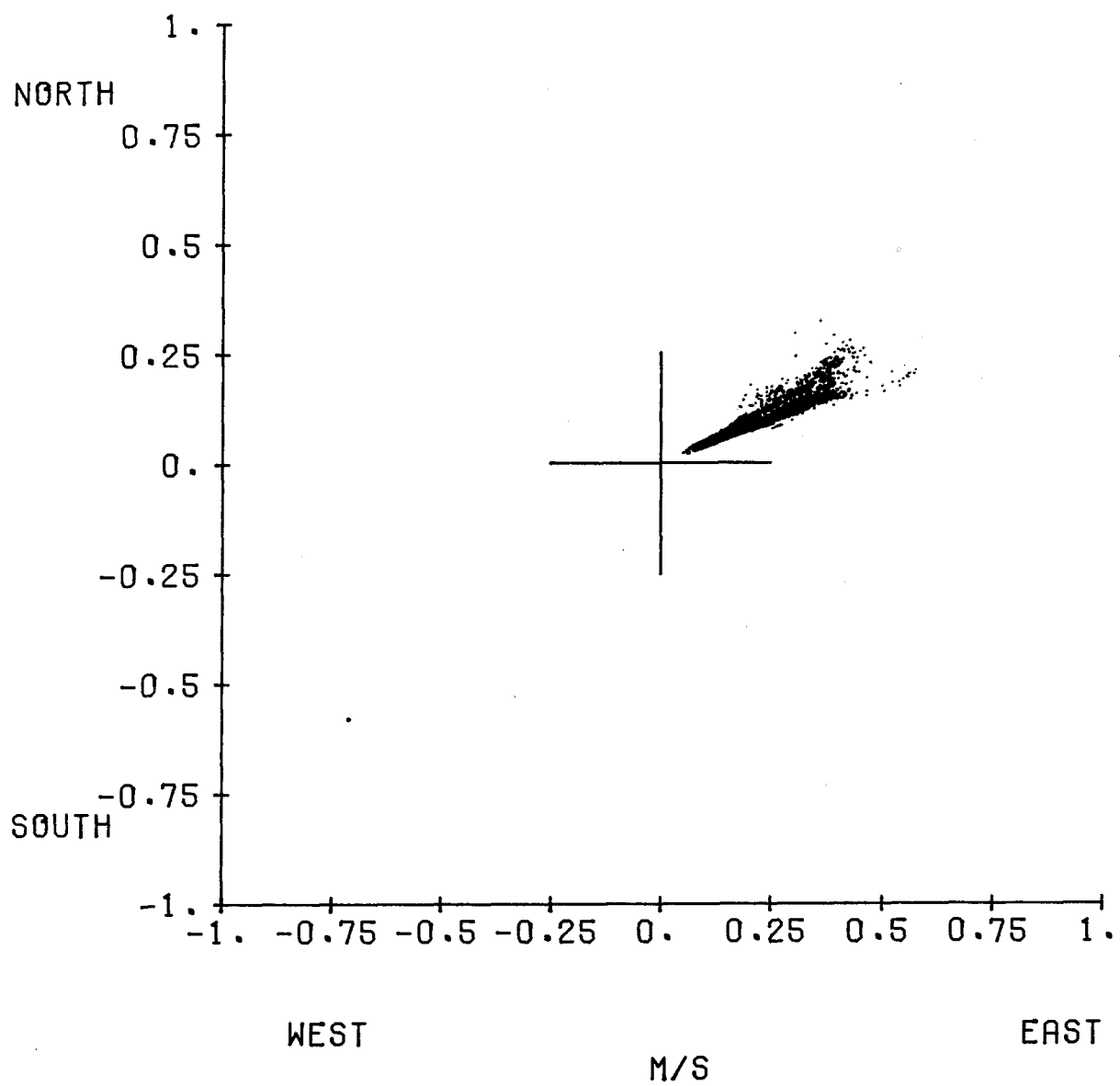
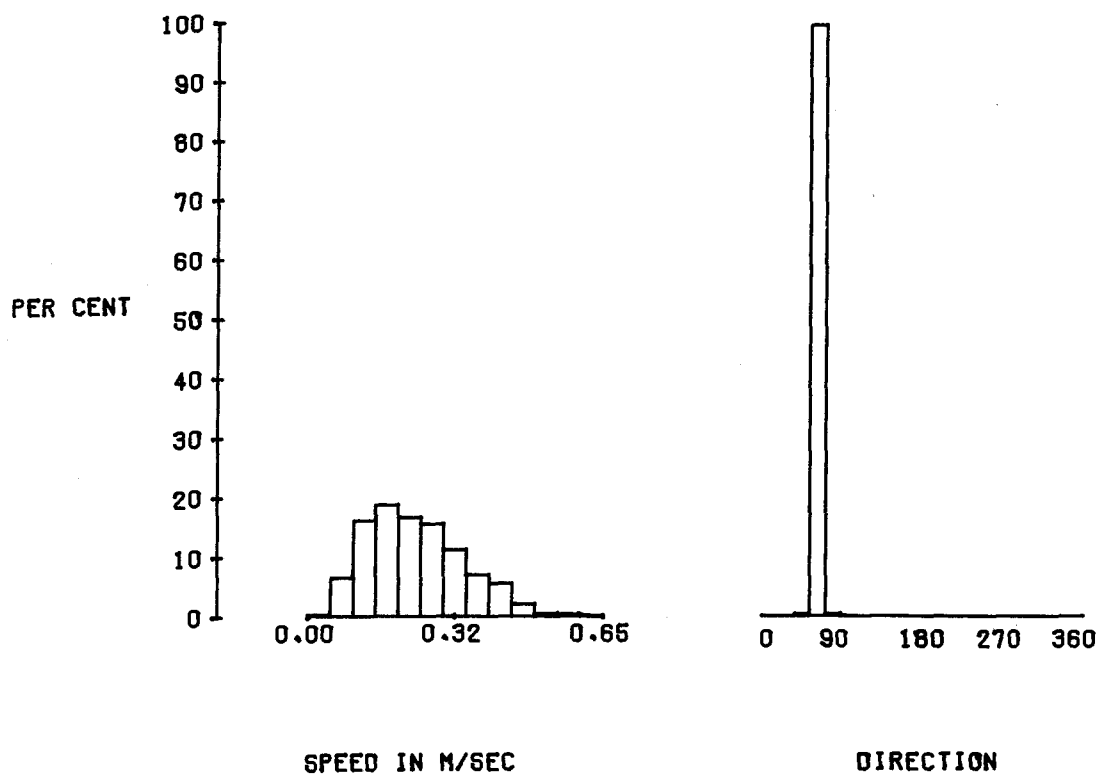
Acoustic and dragging searches for the  
 rest of the rig were executed on 15,  
 20 and 21 May. The rig was located  
 about one kilometre from where it was  
 deployed and the top of the tide gauge  
 frame and the bottom current meter  
 spindle were recovered.

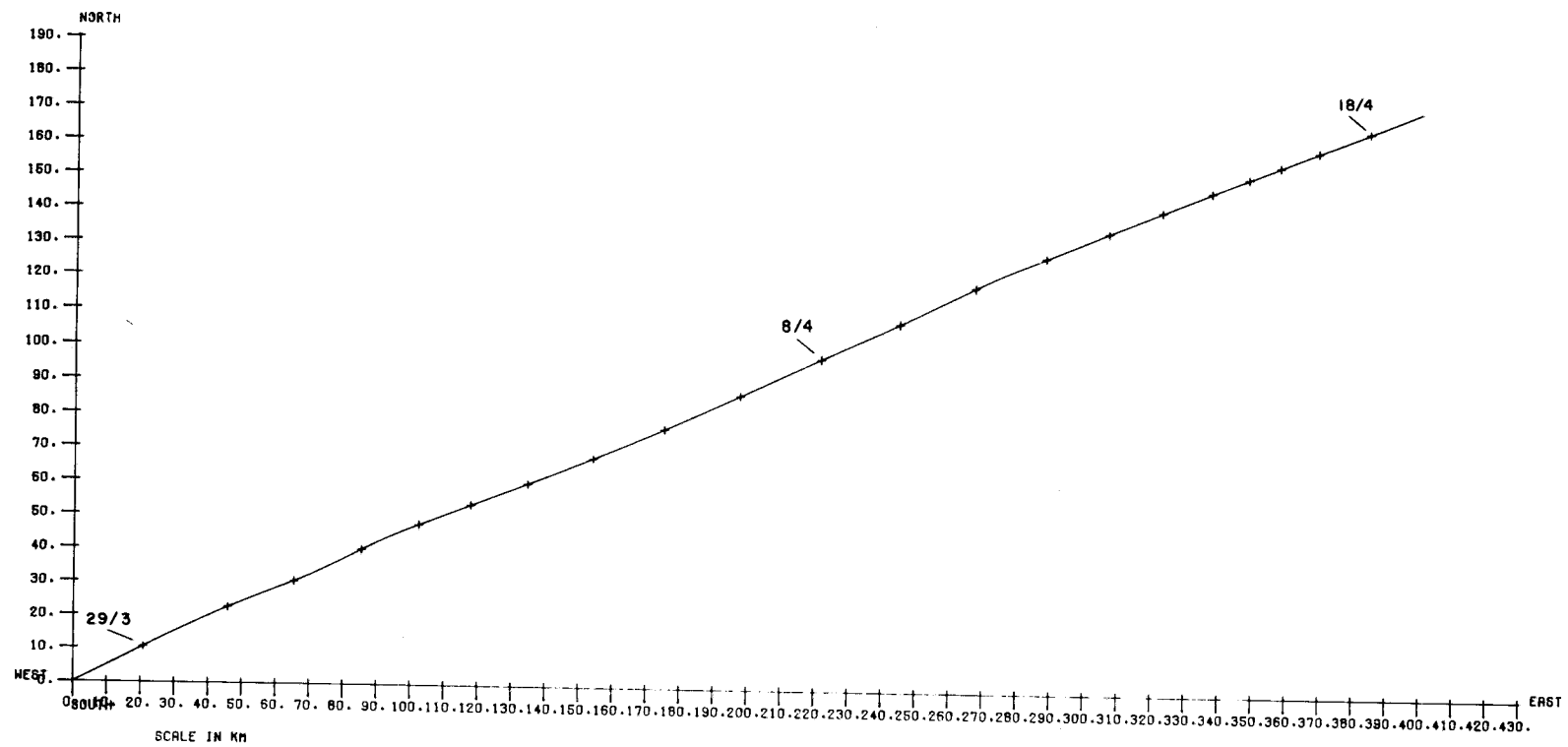
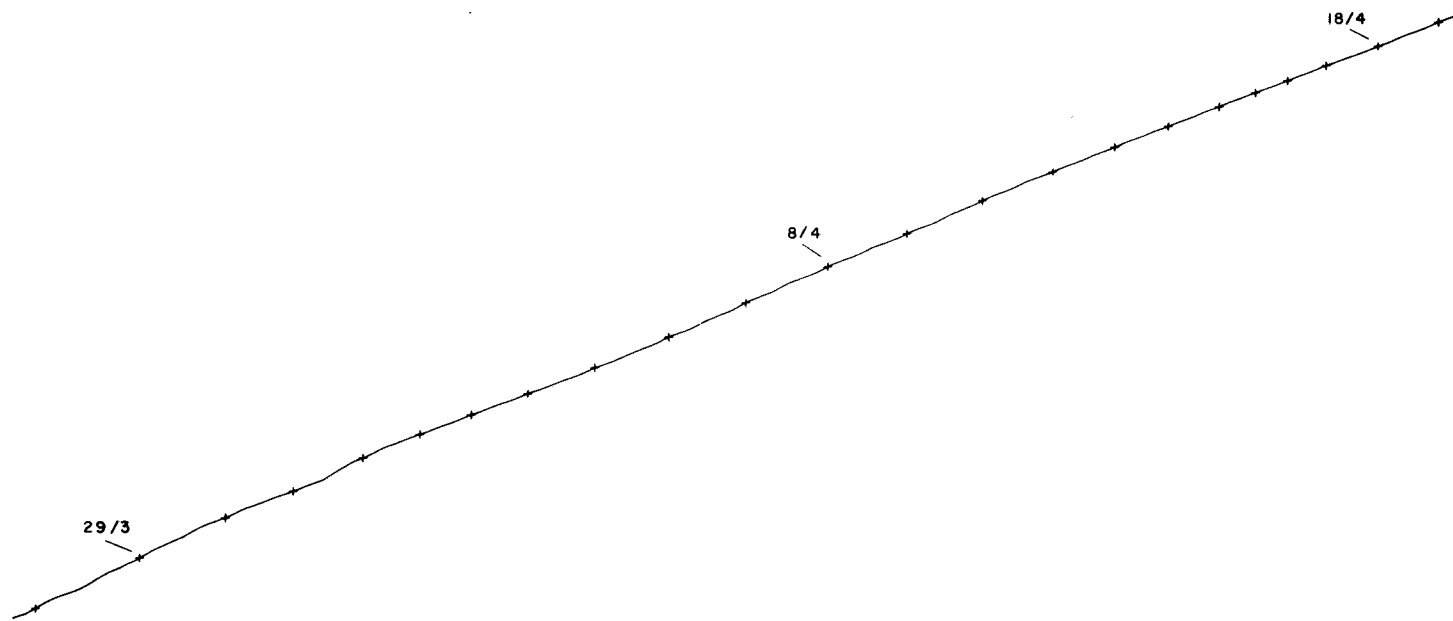
The rest of the tide gauge was  
 recovered on 13 September 1979 by  
 Royal Navy divers from M.V. Seaforth  
 Clansman.

Meter	:	Aanderaa	RCM4	No. 1750
Tape number	:	1750/7		
Meter started	:	04.50.00	GMT	27 March 1978
Meter stopped	:	10.10.04	GMT	26 May 1978
Total number of readings	:	8673		
Timing error	:	4 s	slow	
Start of useful record	:	07.00	GMT	28 March 1978
End of useful record	:	21.50	GMT	19 April 1978
Length of useful record	:	542h		
Comments	:	The meter was fitted with a 0-200 psi pressure sensor.		

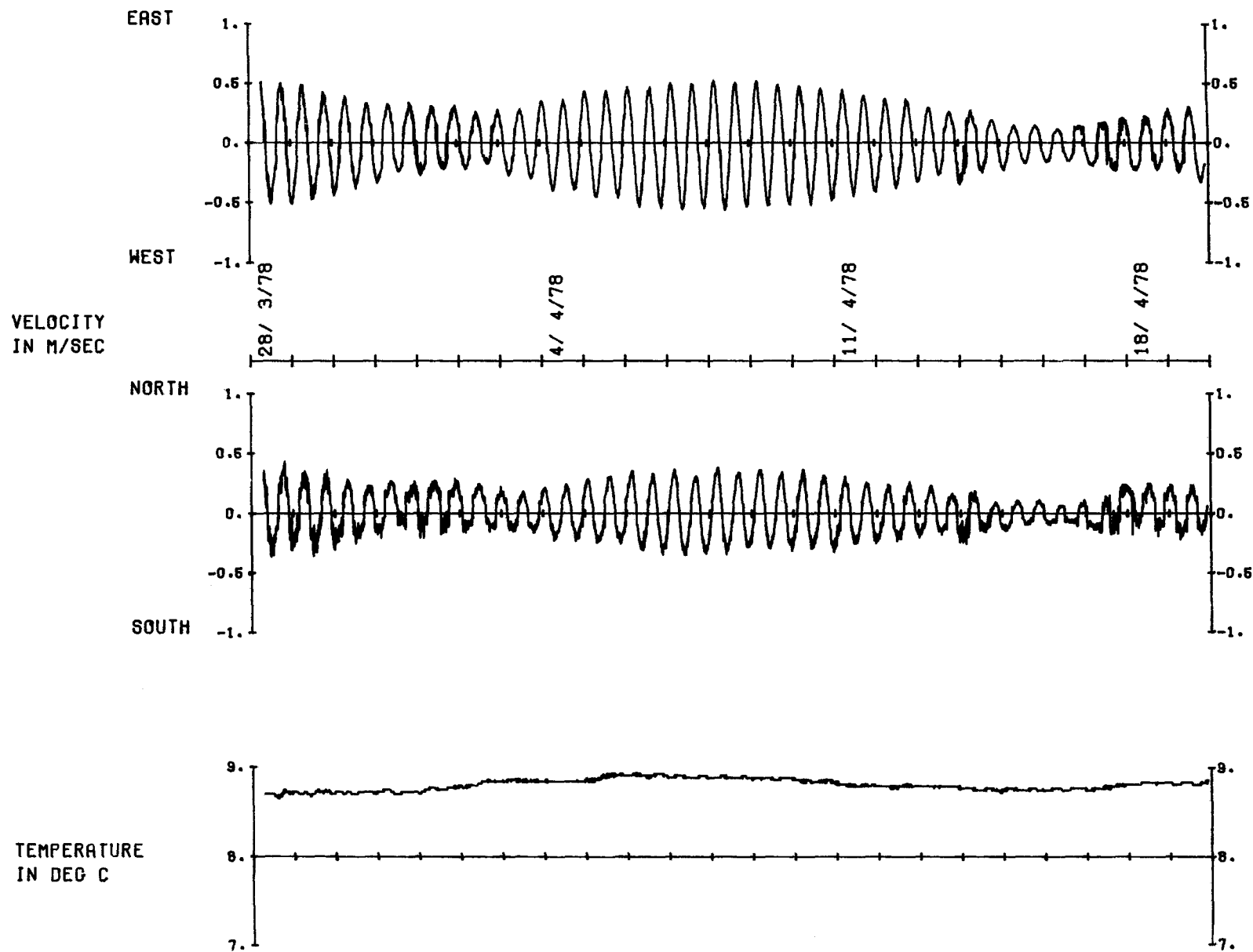
The temperature and pressure records were good but current directions were in the north-east quadrant only and so wrong.



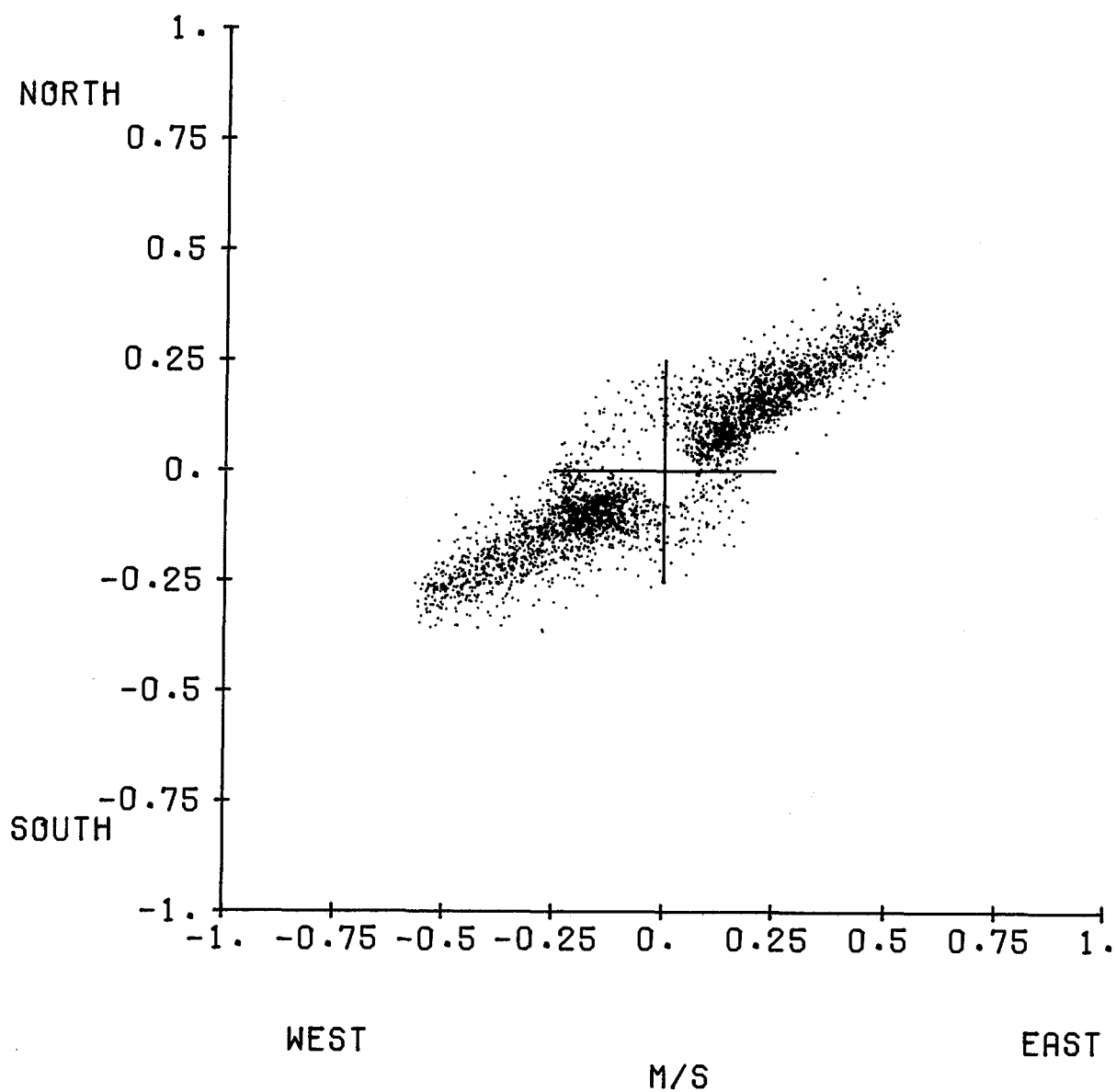
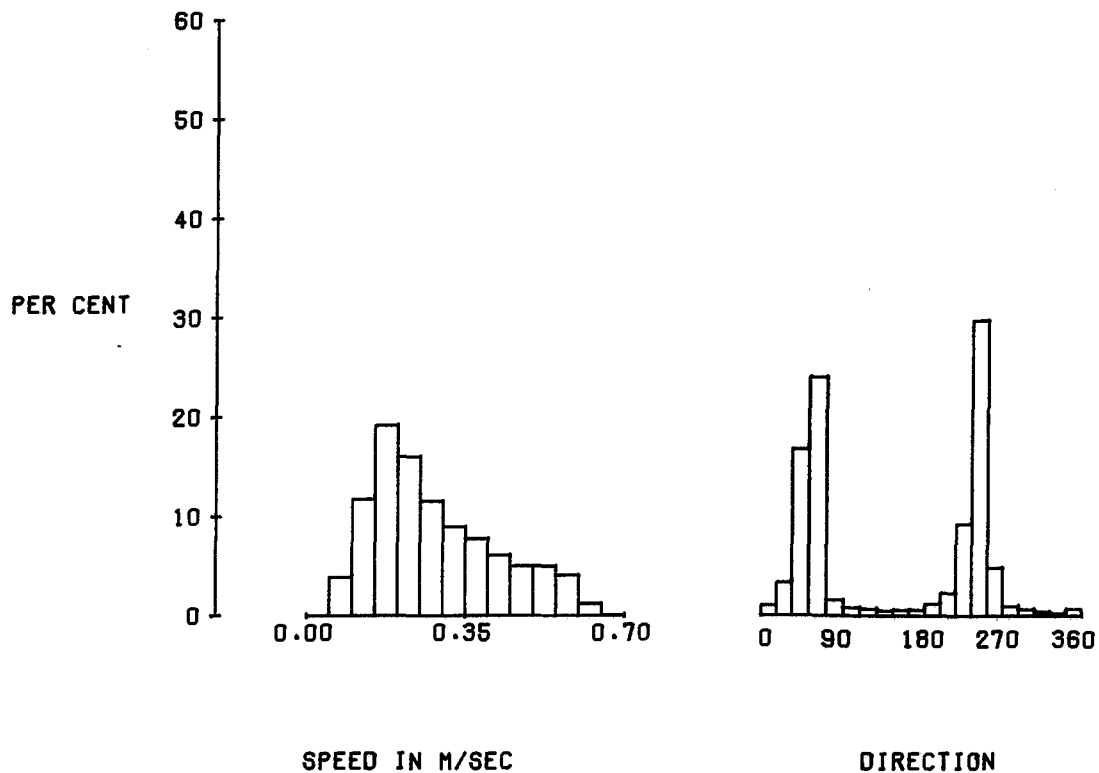


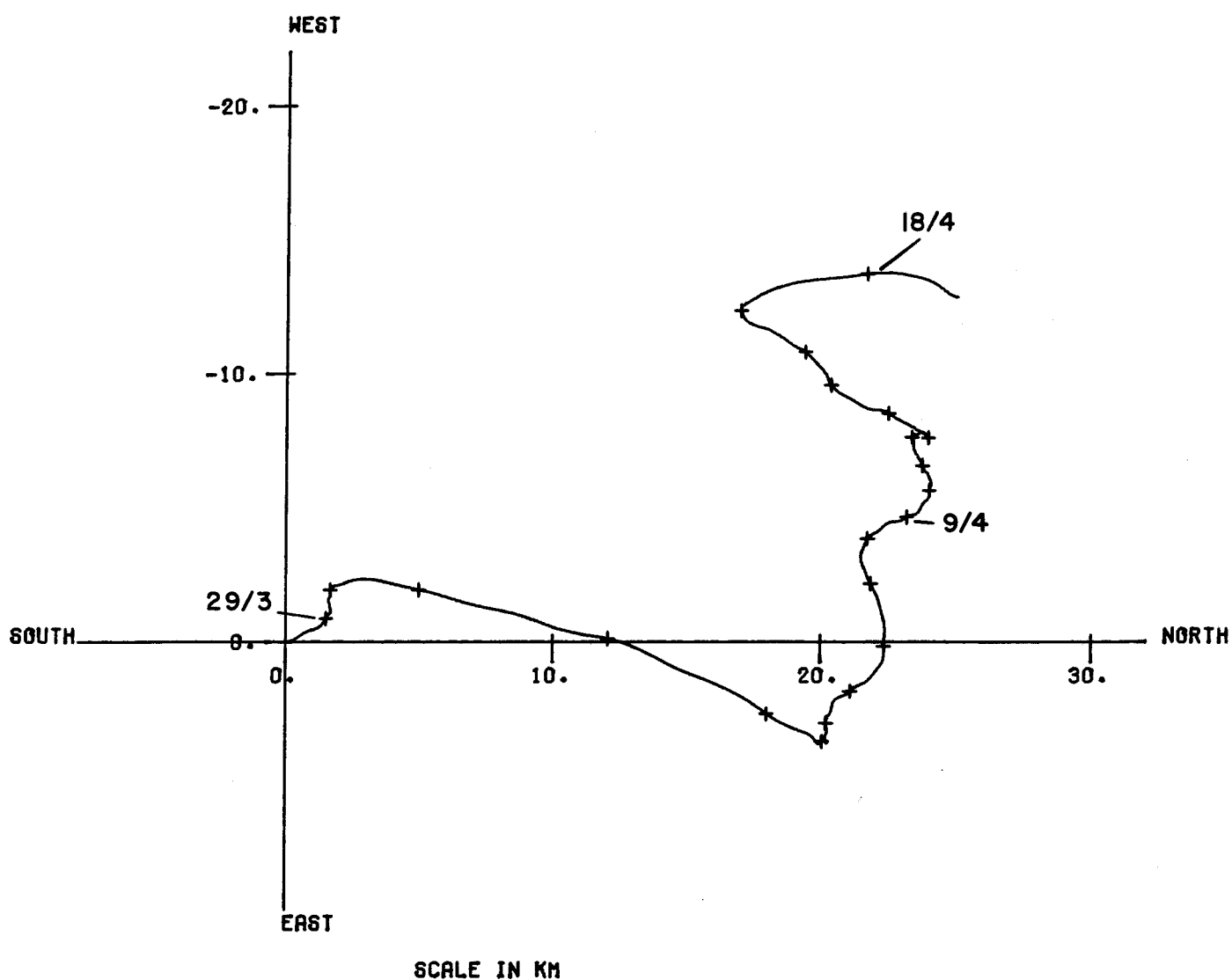
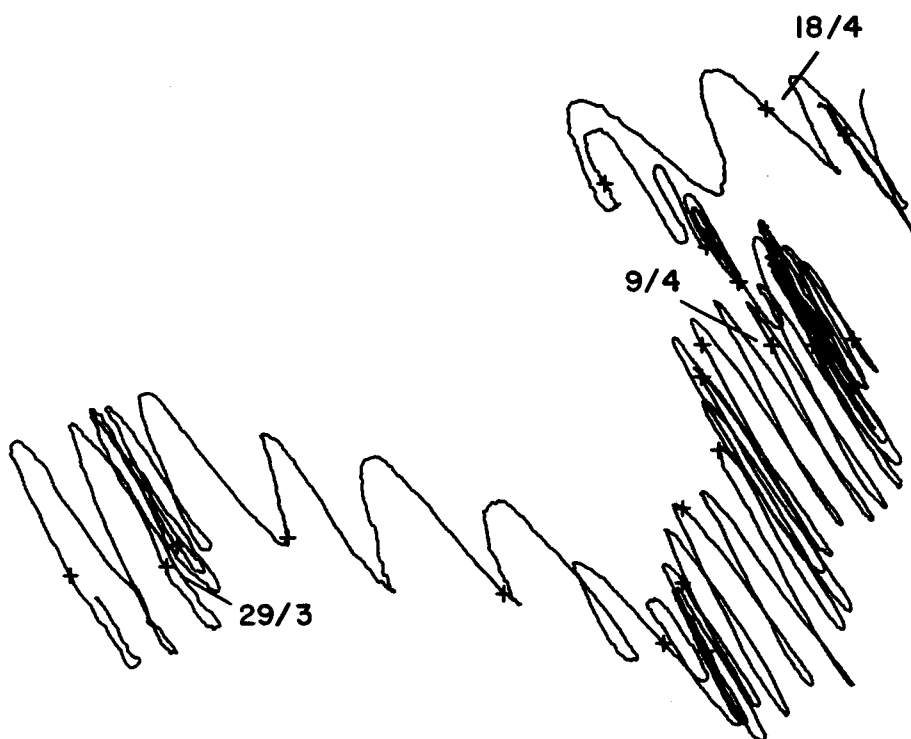


Meter : Aanderaa RCM4 No. 568  
Tape number : 568/7  
Meter started : 05.10.00 GMT 27 March 1978  
Meter stopped : 10.11.38 GMT 26 May 1978  
Total number of readings : 8671  
Timing error : 98 s slow  
Start of useful record : 07.00 GMT 28 March 1978  
End of useful record : 21.52 GMT 19 April 1978  
Length of useful record : 542 h  
Comments : Good record .









Meter	:	Aanderaa	RCM4	No. 2969
Tape number	:	2969/1		
Meter started	:	05.40.00	GMT	26 March 1978
Meter stopped	:	-		
Total number of readings	:	-		
Timing error	:	-		
Start of useful record	:	-		
End of useful record	:	-		
Length of useful record	:	-		
Comments	:	The meter was fitted with a 0-100 psi pressure sensor. Its rotor was damaged during the launch and replaced.  The meter was not recovered.		

Mooring number : 149  
Position of rig : Lat 51° 27.5'N Long 07° 50.4'W  
(Station E)  
Depth of water : 88m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
1867	Aanderaa RCM4	60	10
1002	Aanderaa RCM4	41	10
2971	Aanderaa RCM4	16	10

Rig set : 06.33 GMT 30 March 1978  
from RRS Challenger

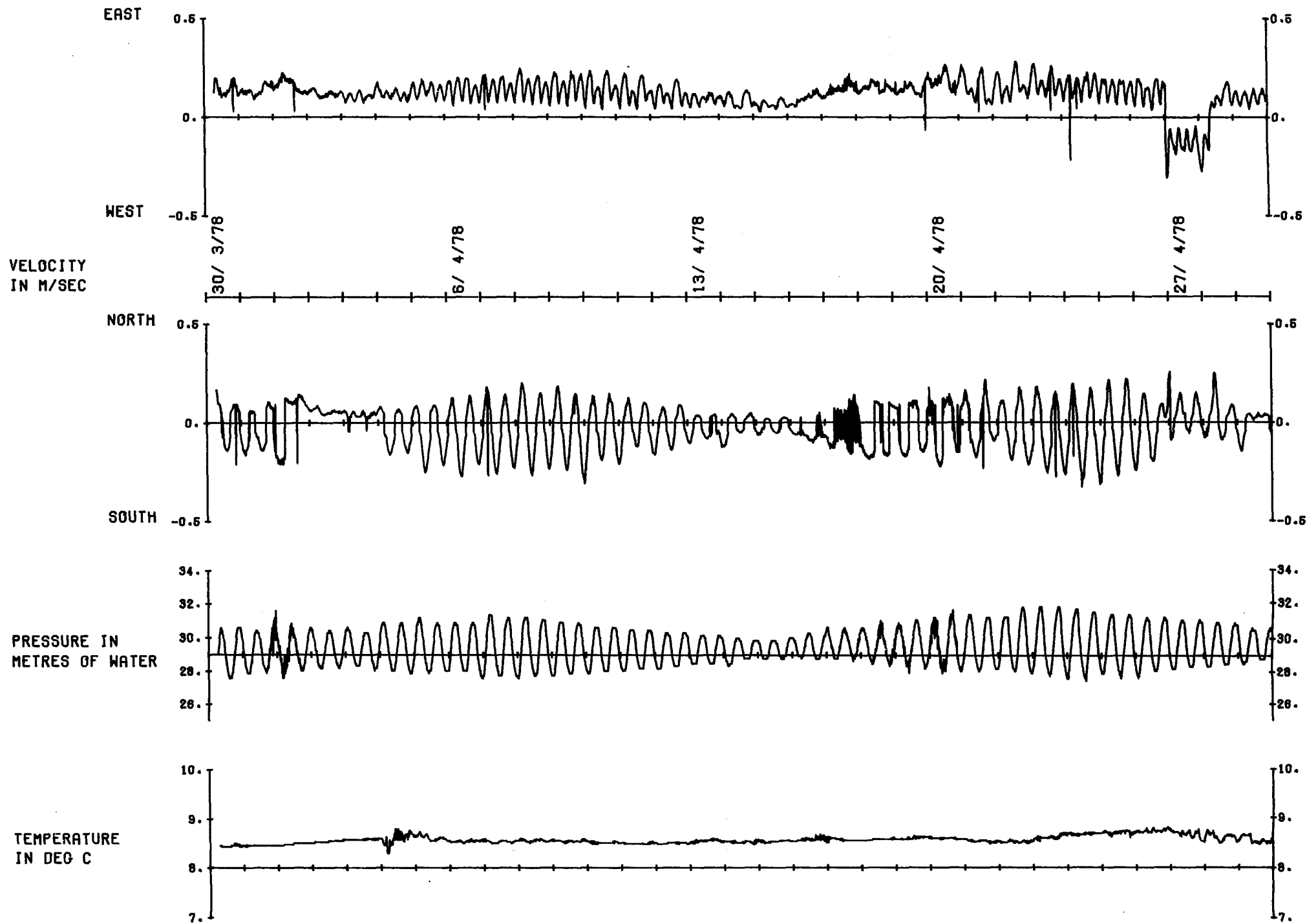
Rig recovered : 06.25 GMT 14 May 1978  
from RRS Challenger

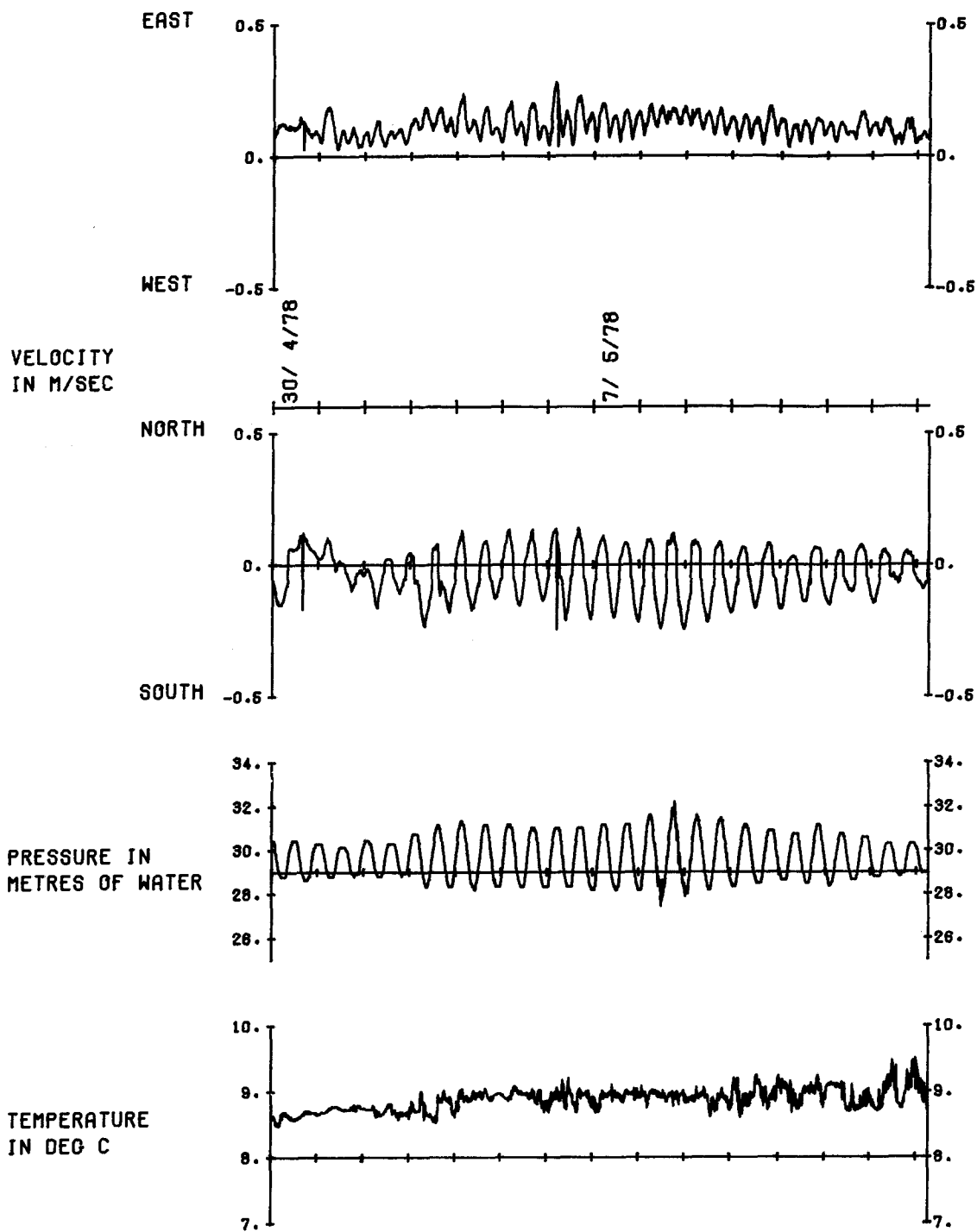
Mooring : u shaped with a pressure recorder  
attached to the middle of the  
ground-line.

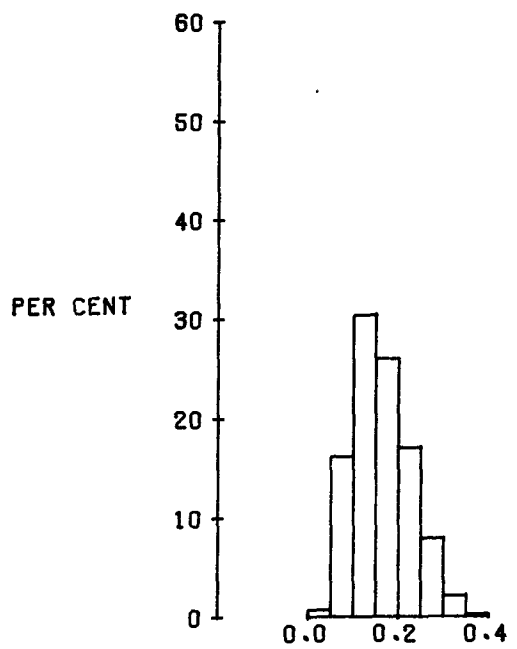
Comments : The rig was successfully deployed  
and recovered at the first attempt.  
It was in position. The meter wire  
was tangled round the spindle of  
the top current meter.

Meter : Aanderaa RCM4 No. 1867  
Tape number : 1867/5  
Meter started : 14.50.00 GMT 29 March 1978  
Meter stopped : 13.18.58 GMT 15 May 1978  
Total number of readings : 6760  
Timing error : 62 s fast  
Start of useful record : 06.50 GMT 30 March 1978  
End of useful record : 06.09 GMT 14 May 1978  
Length of useful record : 1079h  
Comments : The meter was fitted with a 0-200  
psi pressure sensor.

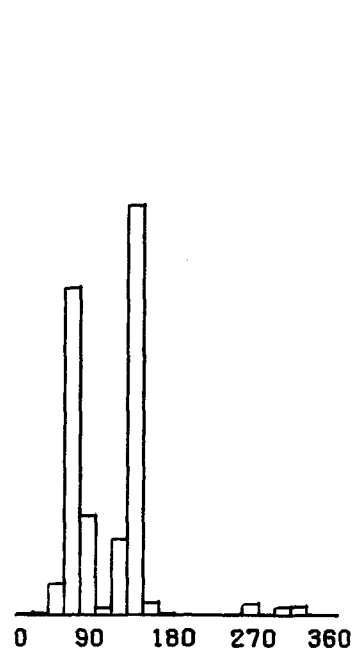
The pressure and temperature records  
were good but the direction record  
was wrong, perhaps the meter wire  
had tangled round the spindle  
during deployment.



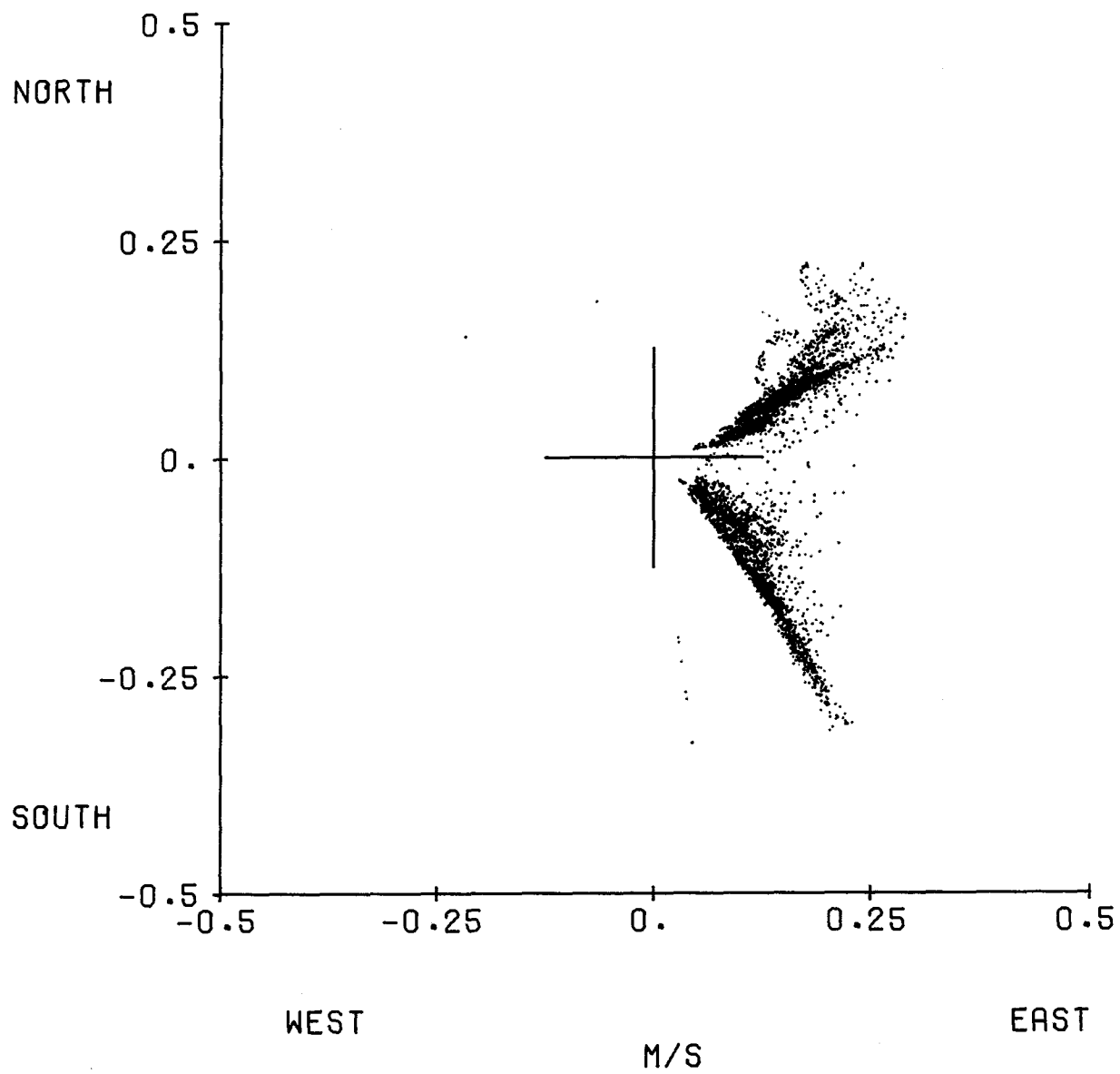




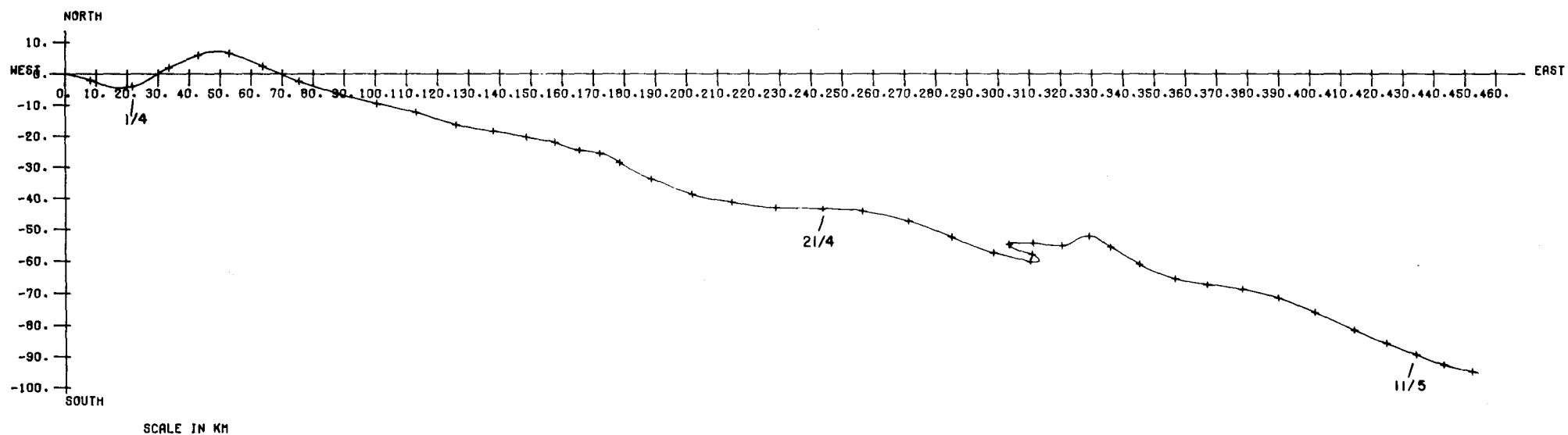
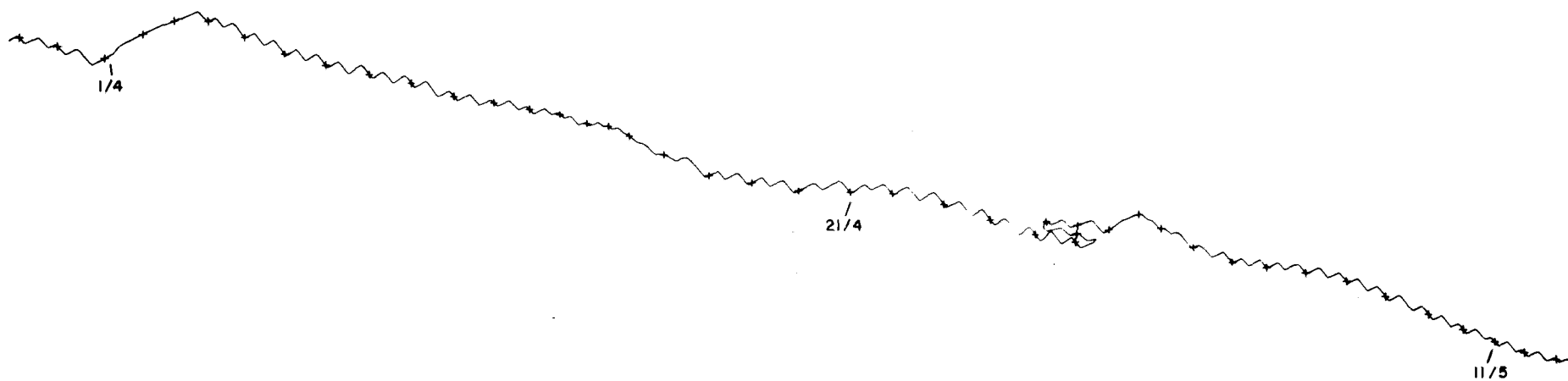
SPEED IN M/SEC



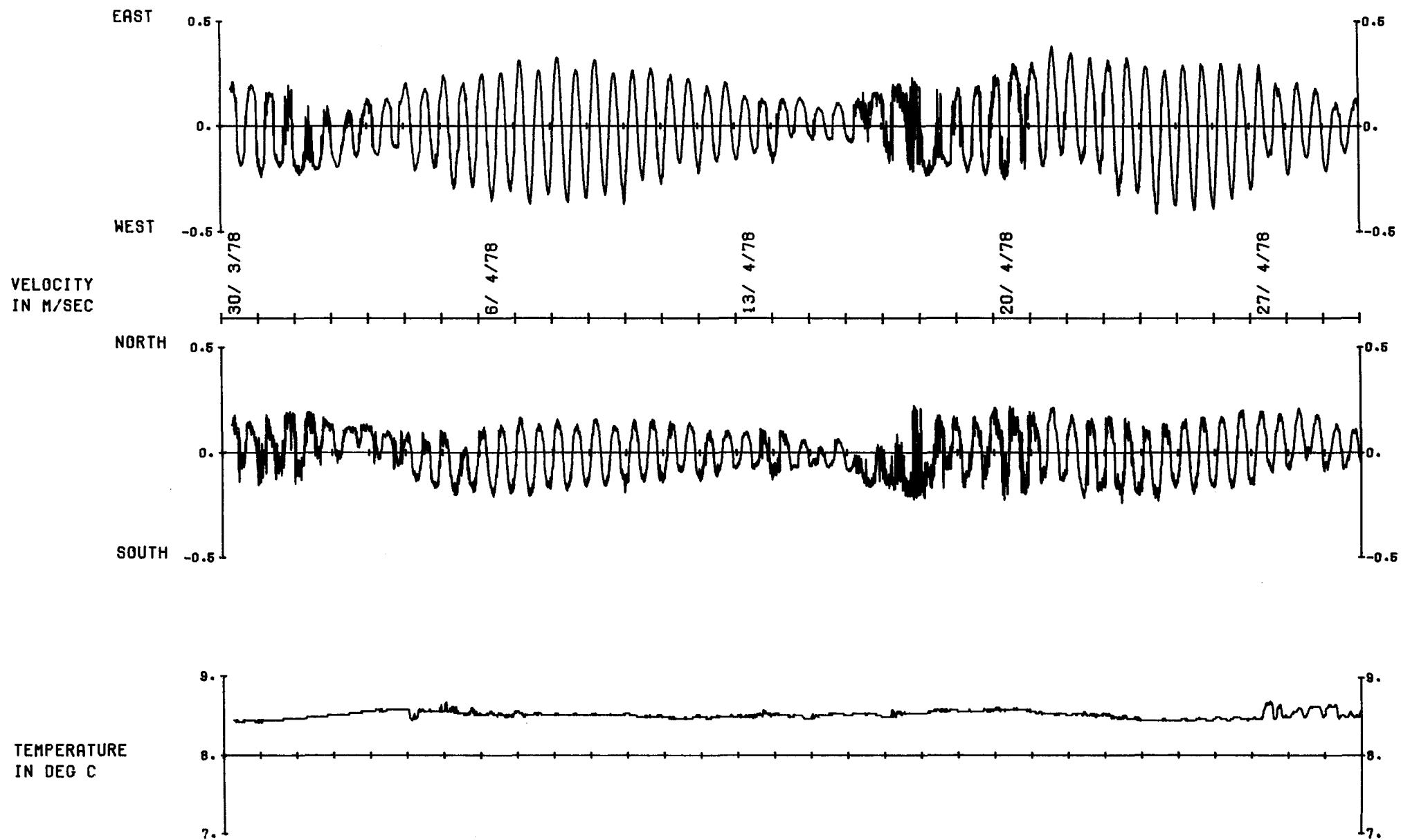
DIRECTION

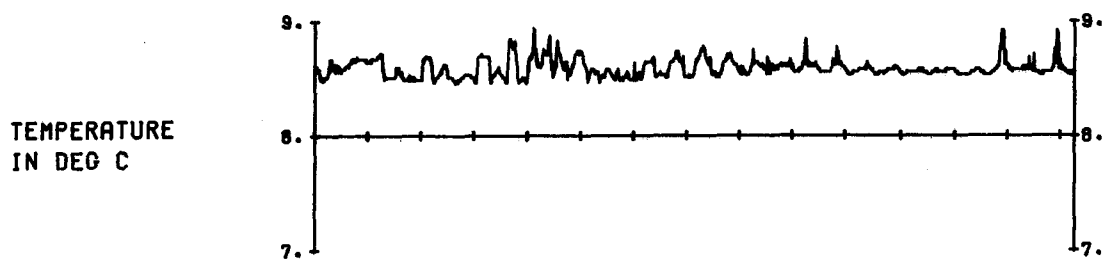
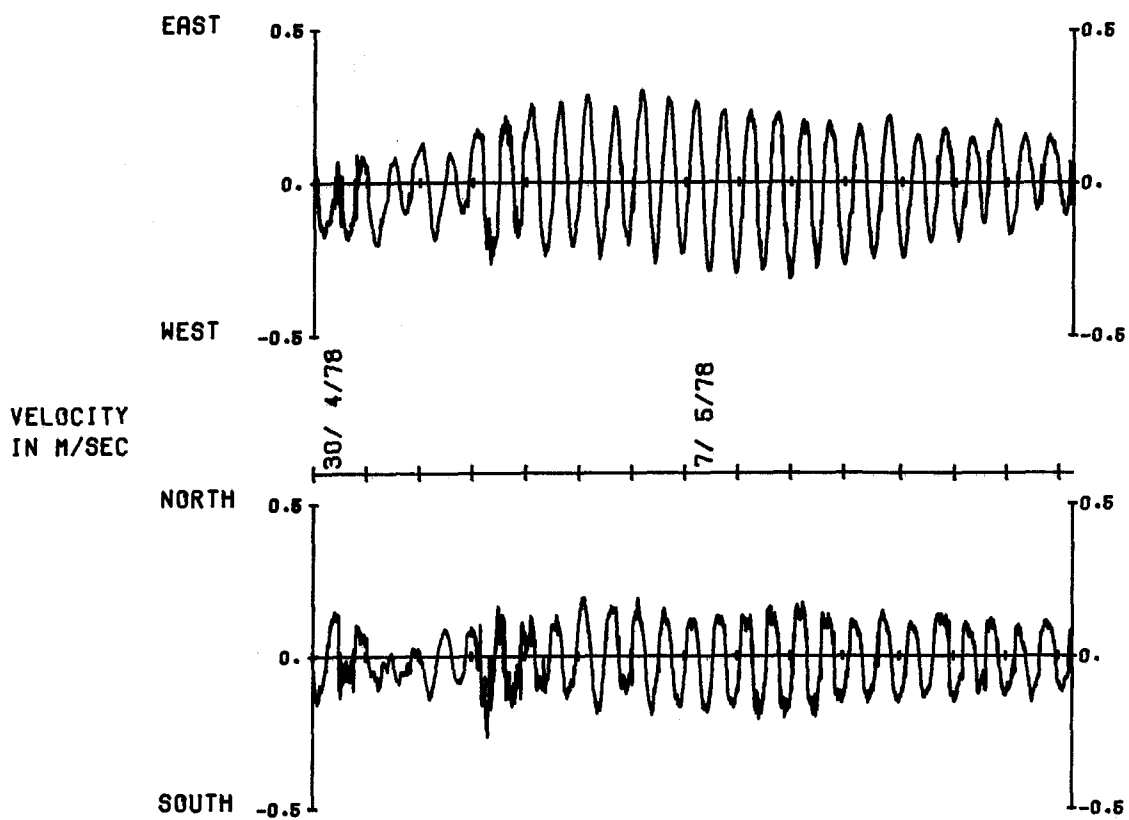


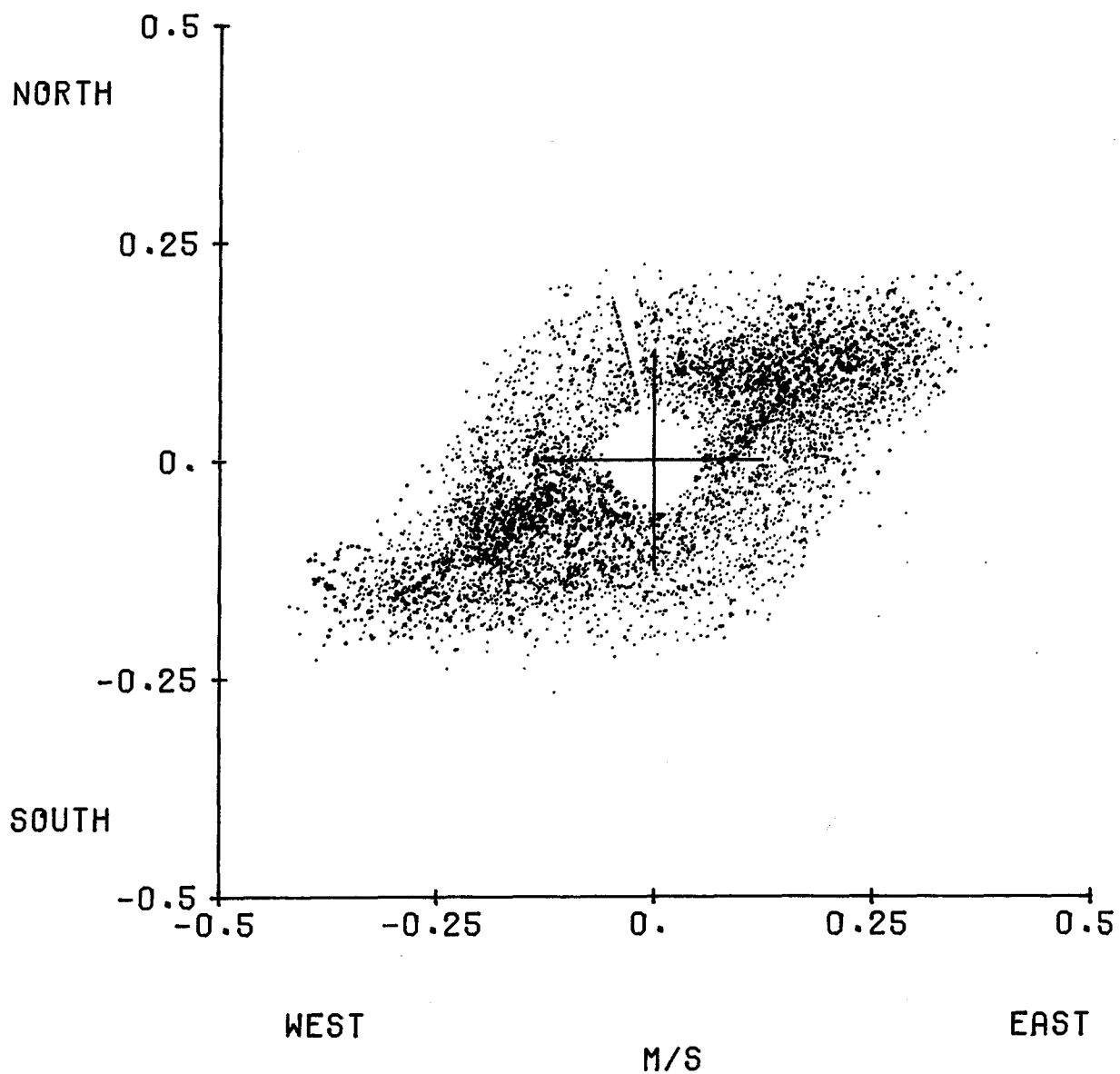
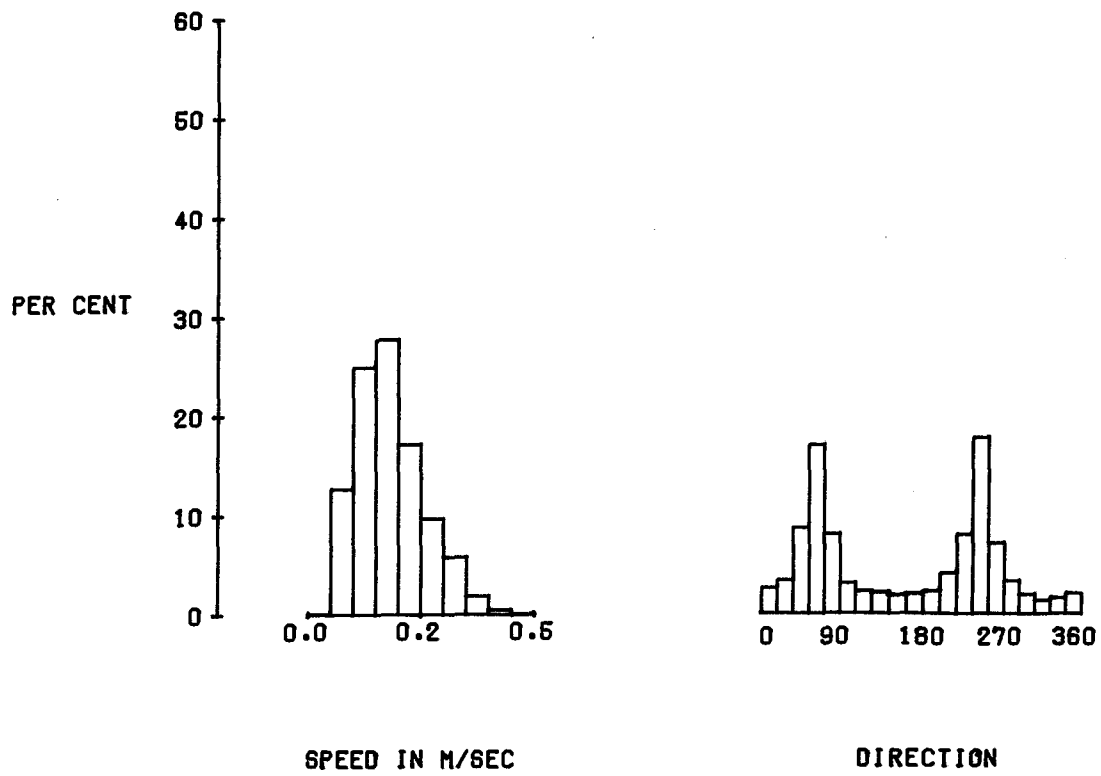


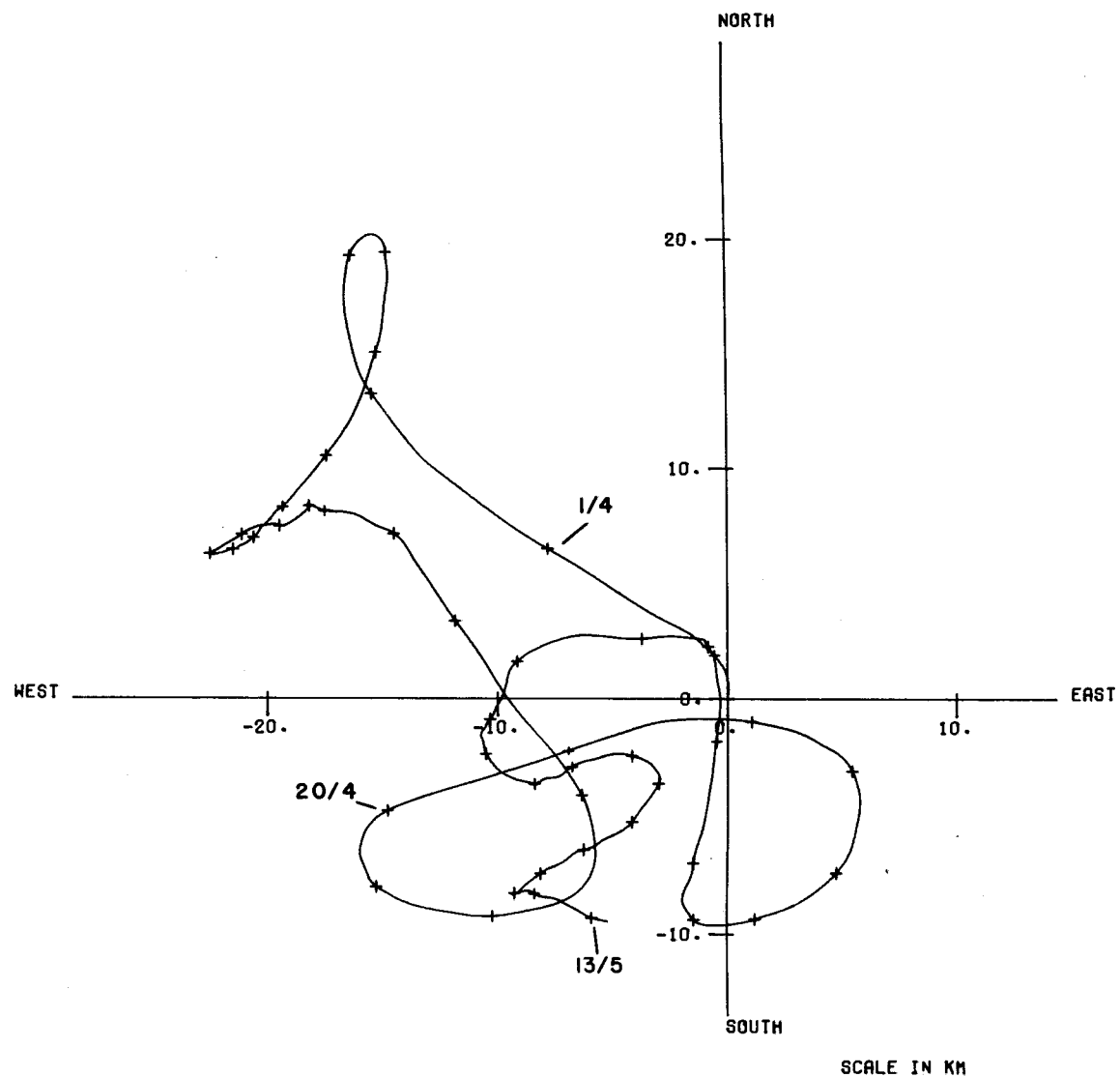
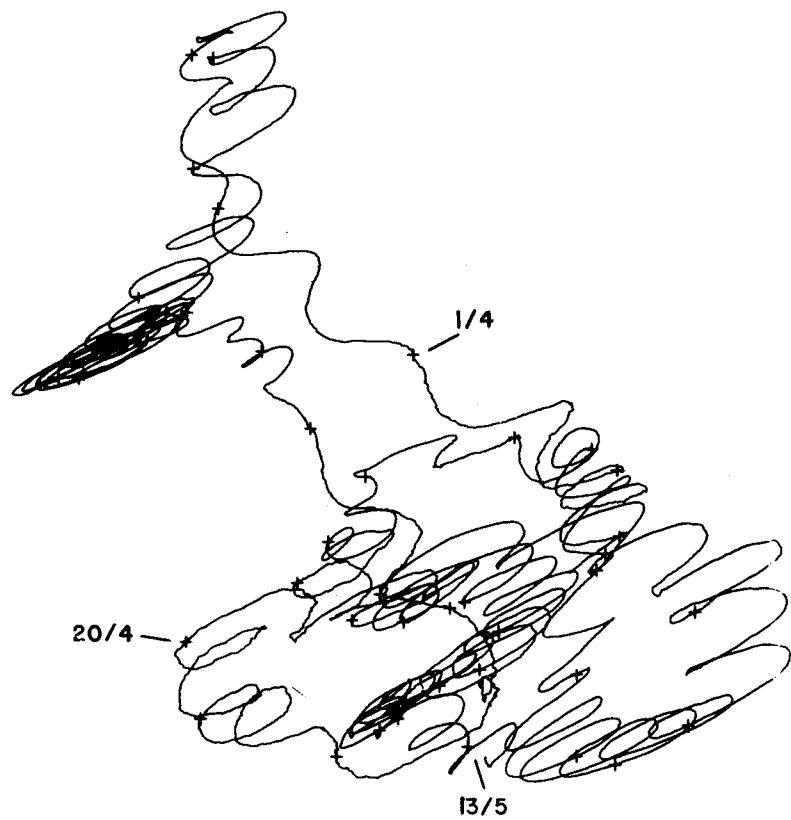


Meter	:	Aanderaa RCM4	No. 1002
Tape number	:	1002/3	
Meter started	:	15.10.00	GMT 29 March 1978
Meter stopped	:	13.39.48	GMT 15 May 1978
Total number of readings	:	6760	
Timing error	:	12 s	fast
Start of useful record	:	06.50	GMT 30 March 1978
End of useful record	:	06.10	GMT 14 May 1978
Length of useful record	:	1079 h	
Comments	:	The meter was recovered in good condition and its record was good.	

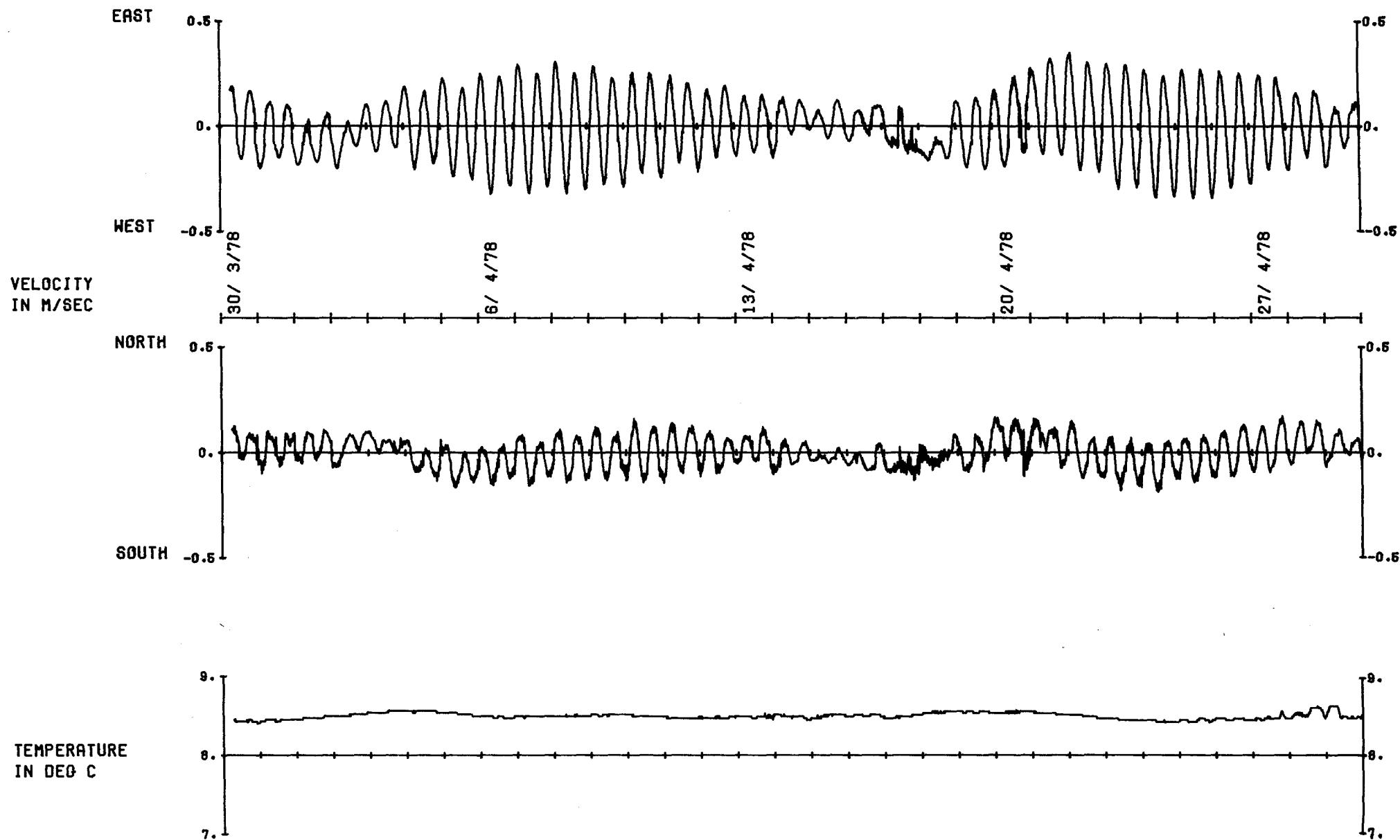




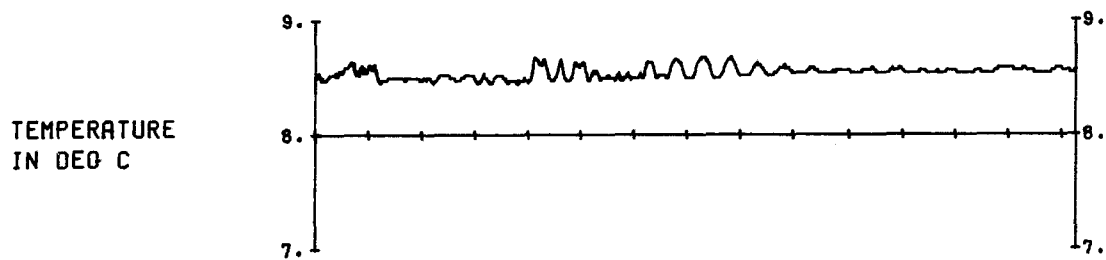
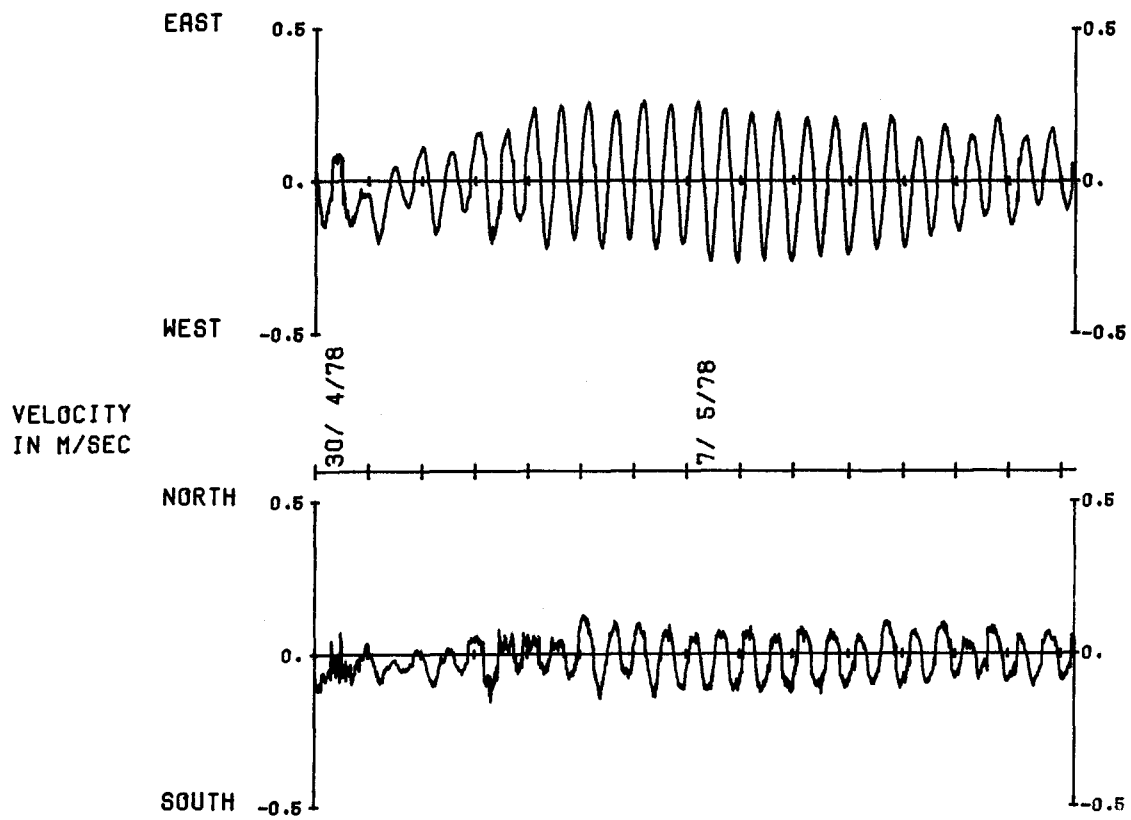


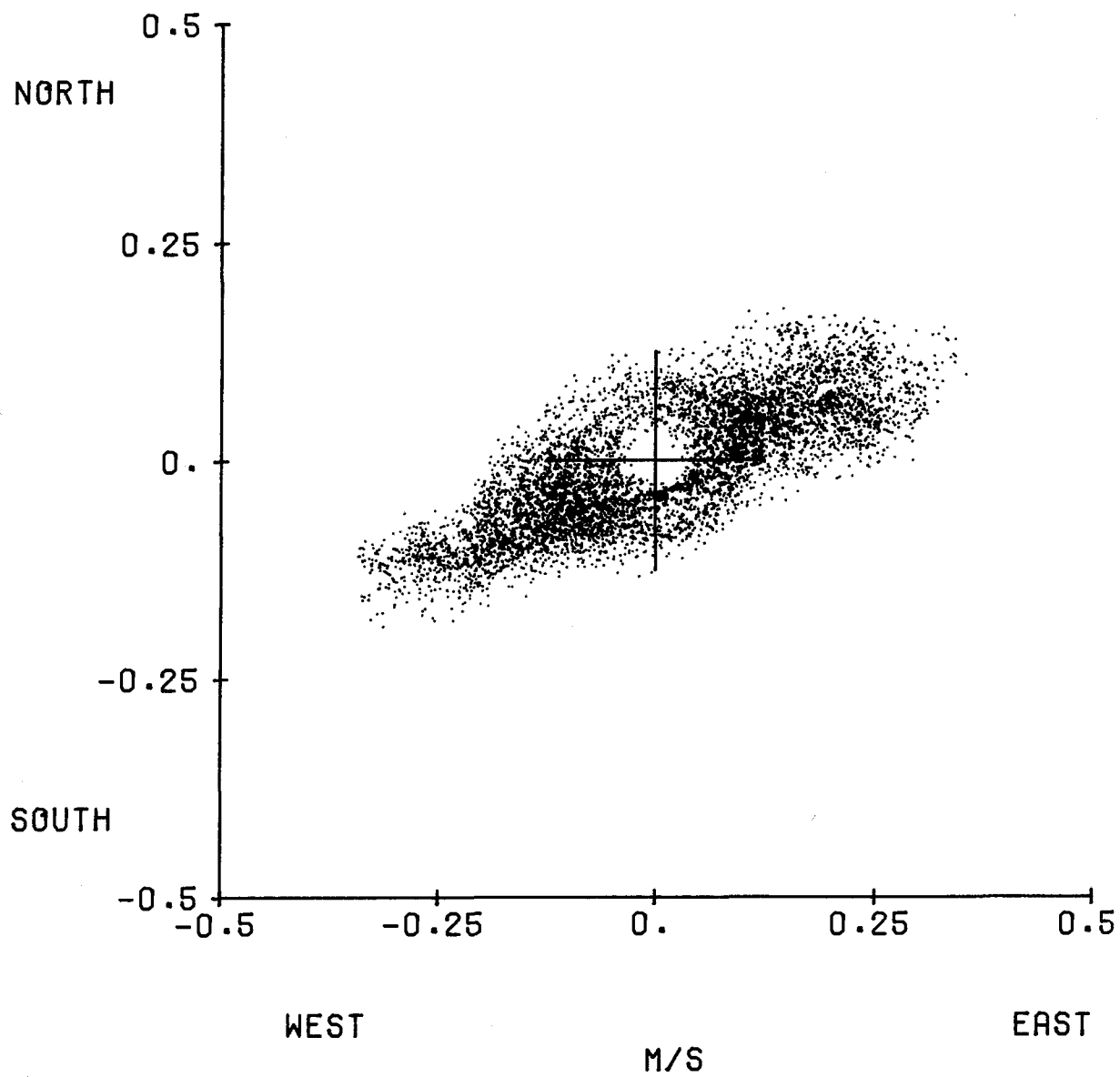
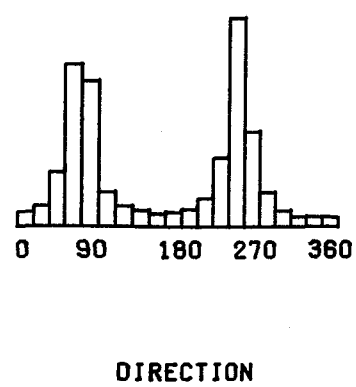
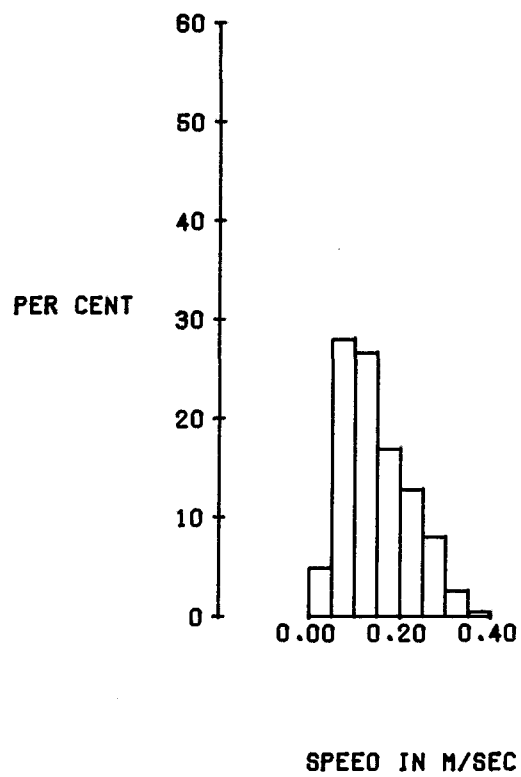


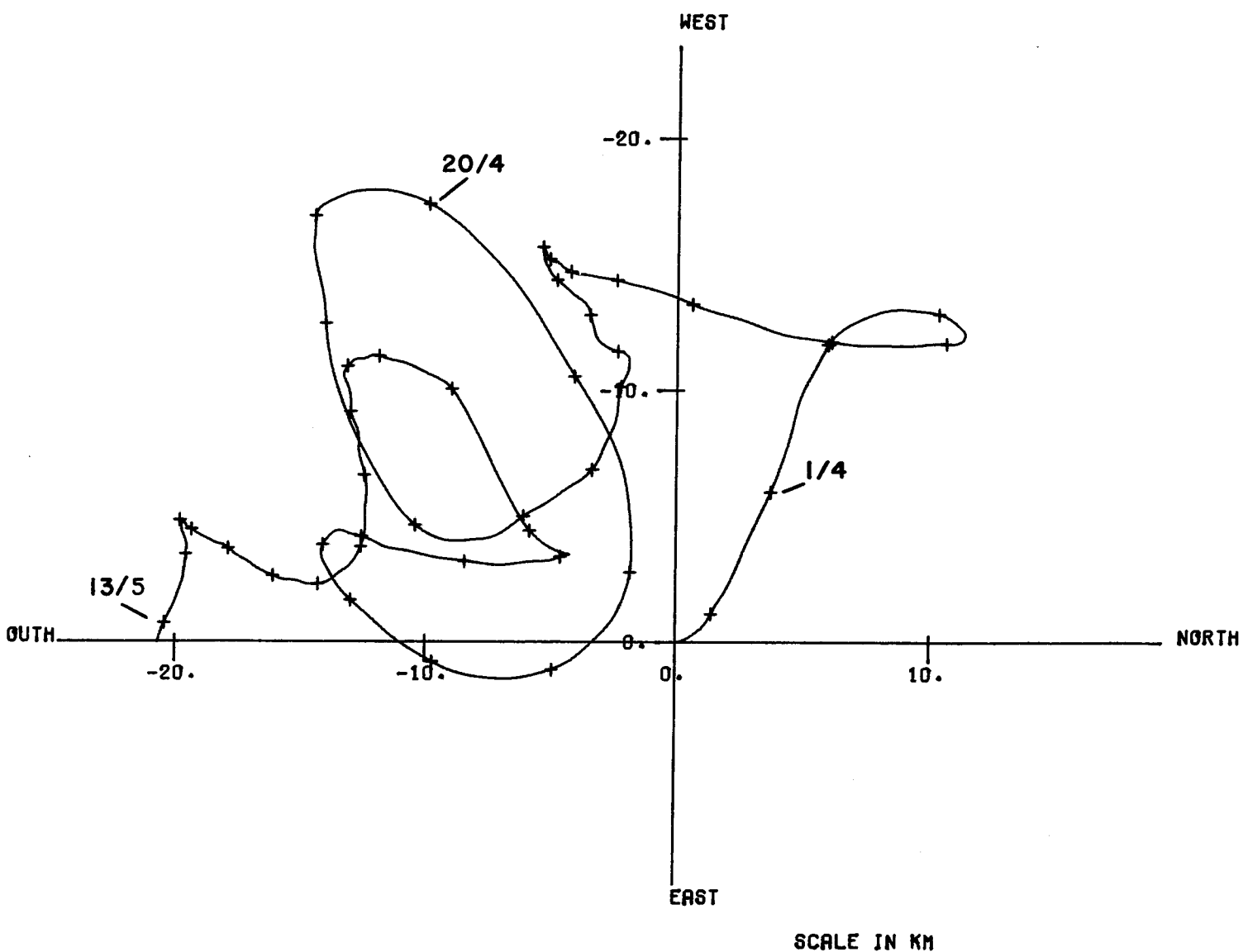
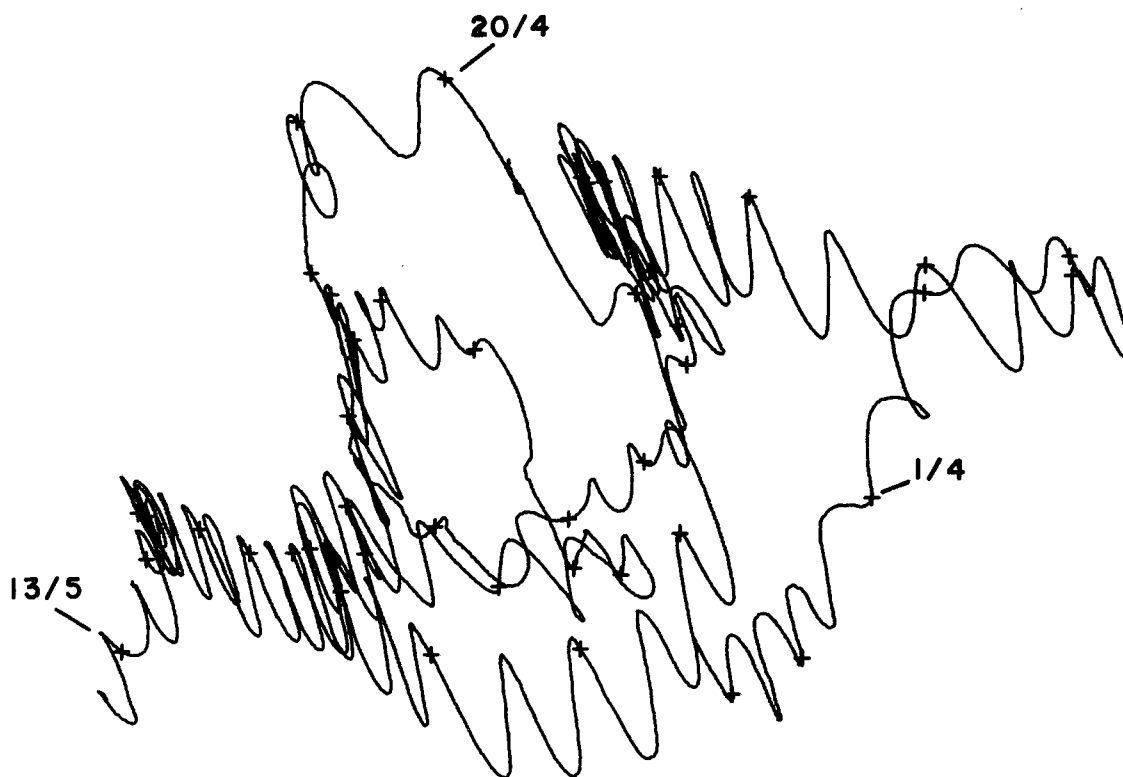
Meter	:	Aanderaa RCM4	No. 2971
Tape number	:	2971/1	
Meter started	:	05.10.00	GMT 30 March 1978
Meter stopped	:	13.30.00	GMT 15 May 1978
Total number of readings	:	6675	
Timing error	:	No error	
Start of useful record	:	06.50	GMT 30 March 1978
End of useful	:	06.10	GMT 14 May 1978
Length of useful record	:	1079h	
Comments	:	The meter was recovered in good condition and its record was good.	











Mooring number : 150  
 Position of rig : Lat 50° 32.0' N Long 7° 28.7' W (Station F)  
 Depth of water : 109m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
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2576	Aanderaa RCM4	65	10
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2575	Aanderaa RCM4	25	10
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Rig set : 13.40 GMT 30 March 1978  
 from RRS Challenger

Rig recovered : 00.53 GMT 15 May 1978  
 from RRS Challenger

Mooring : Pop-up with a bottom frame containing  
 a pressure recorder.

Comments : The rig was successfully deployed at  
 the first attempt. At recovery it  
 took seven hours to operate the release  
 pinger. The rig was in position.

Meter : Aanderaa RCM4 No. 2576

Tape number : 2576/3

Meter started : 11.50.00 GMT 30 March 1978

Meter stopped : 13.09.22 GMT 15 May 1978

Total number of readings : 6633

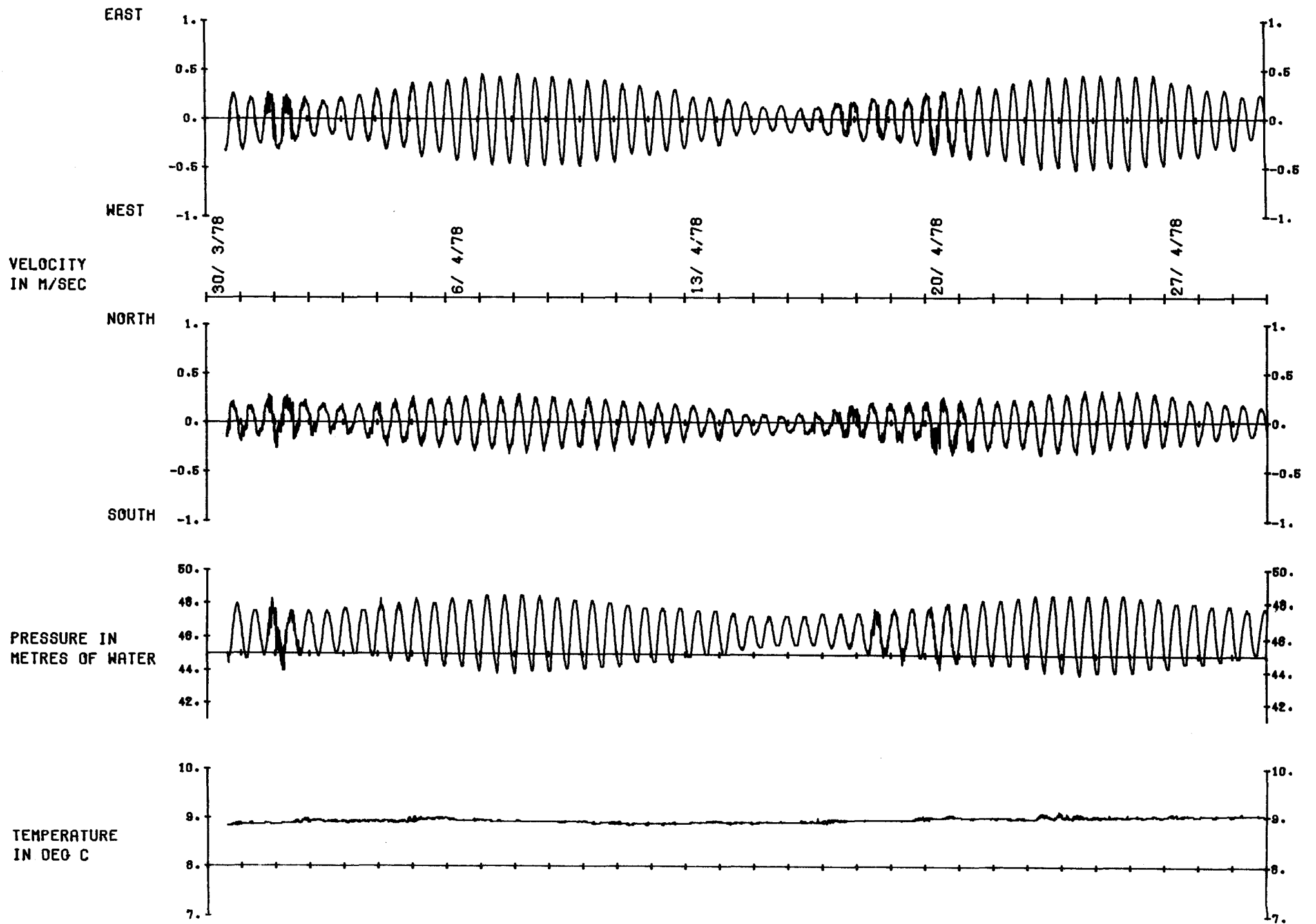
Timing error : 38 s fast

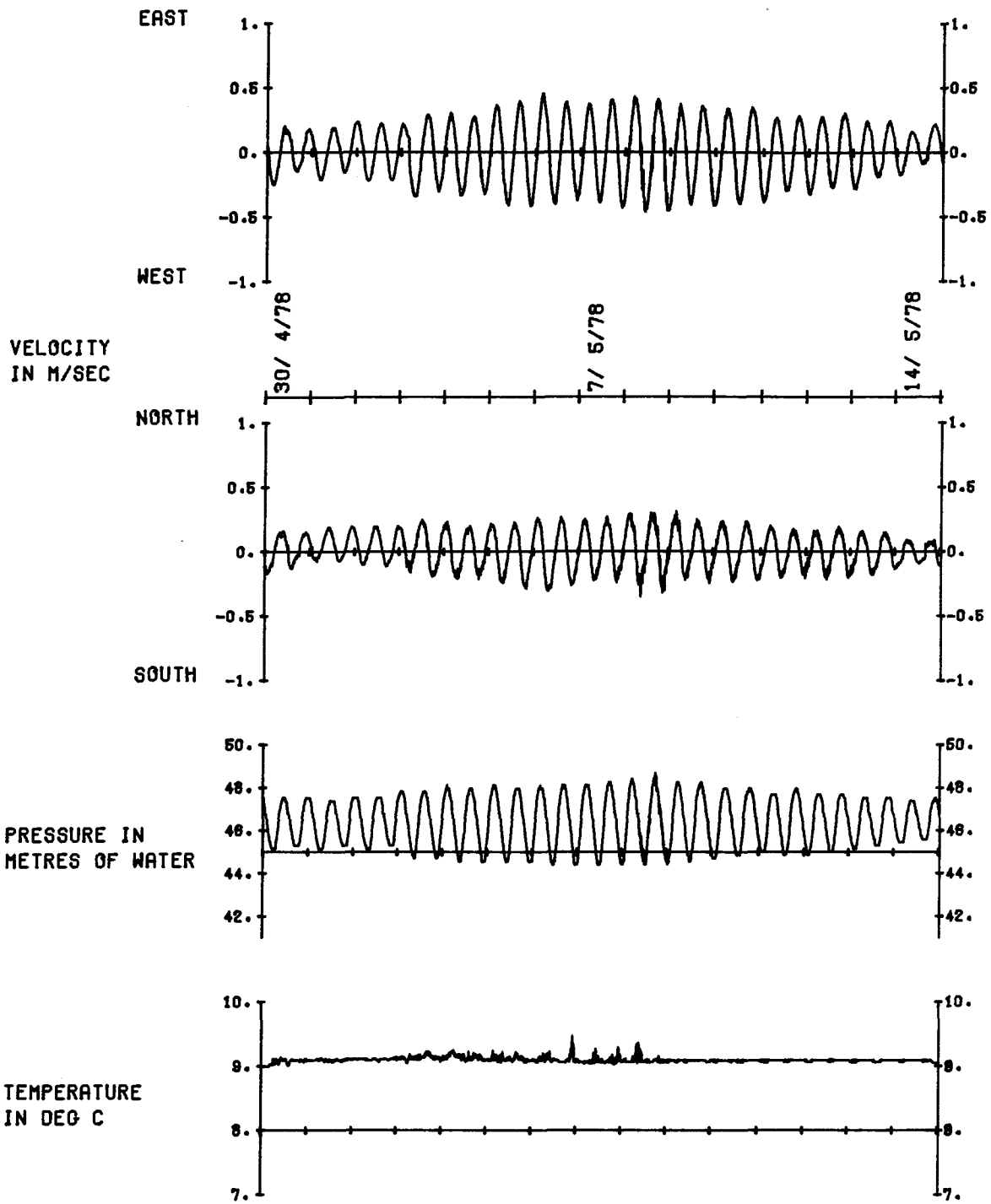
Start of useful record : 14.10 GMT 30 March 1978

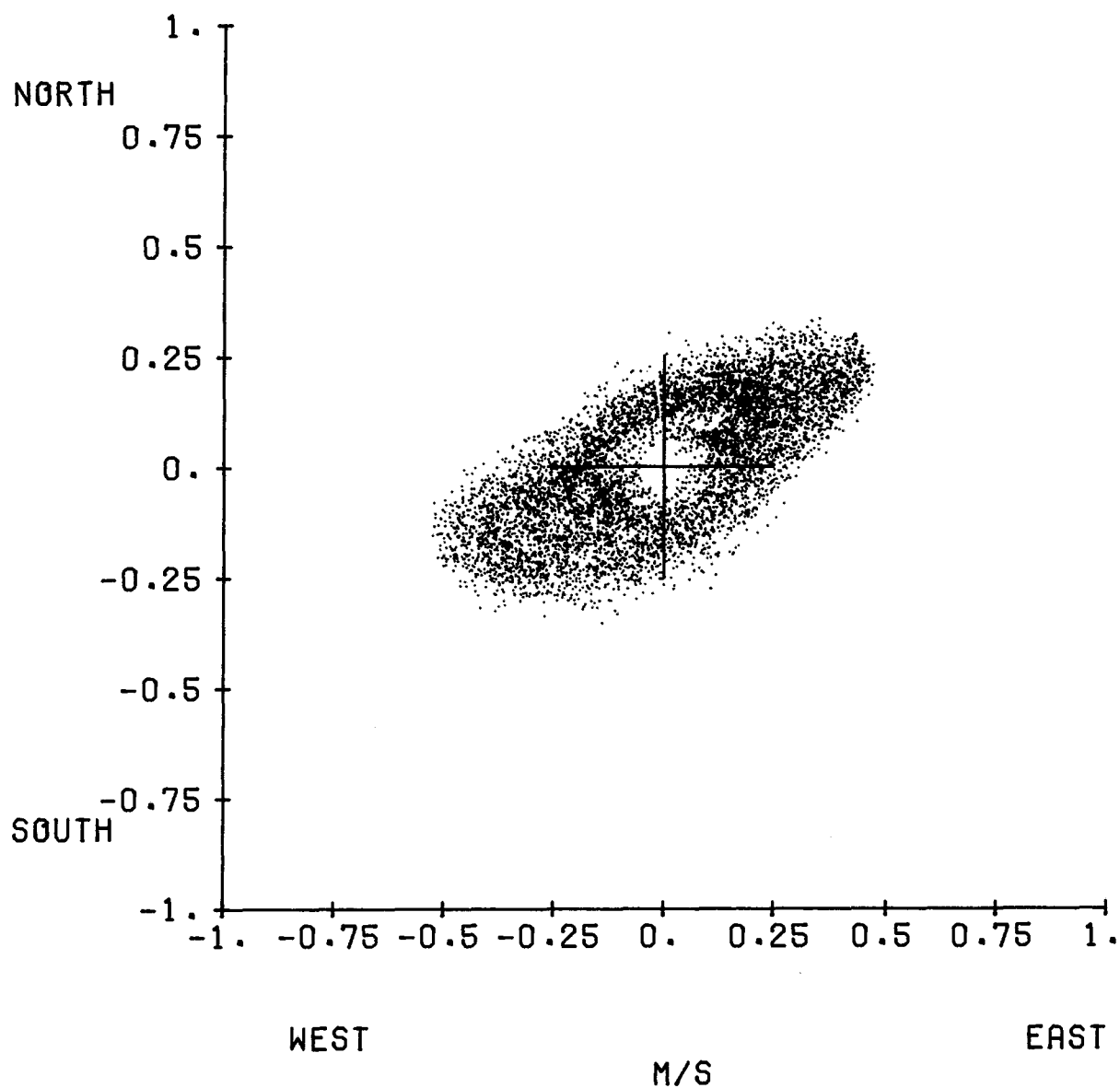
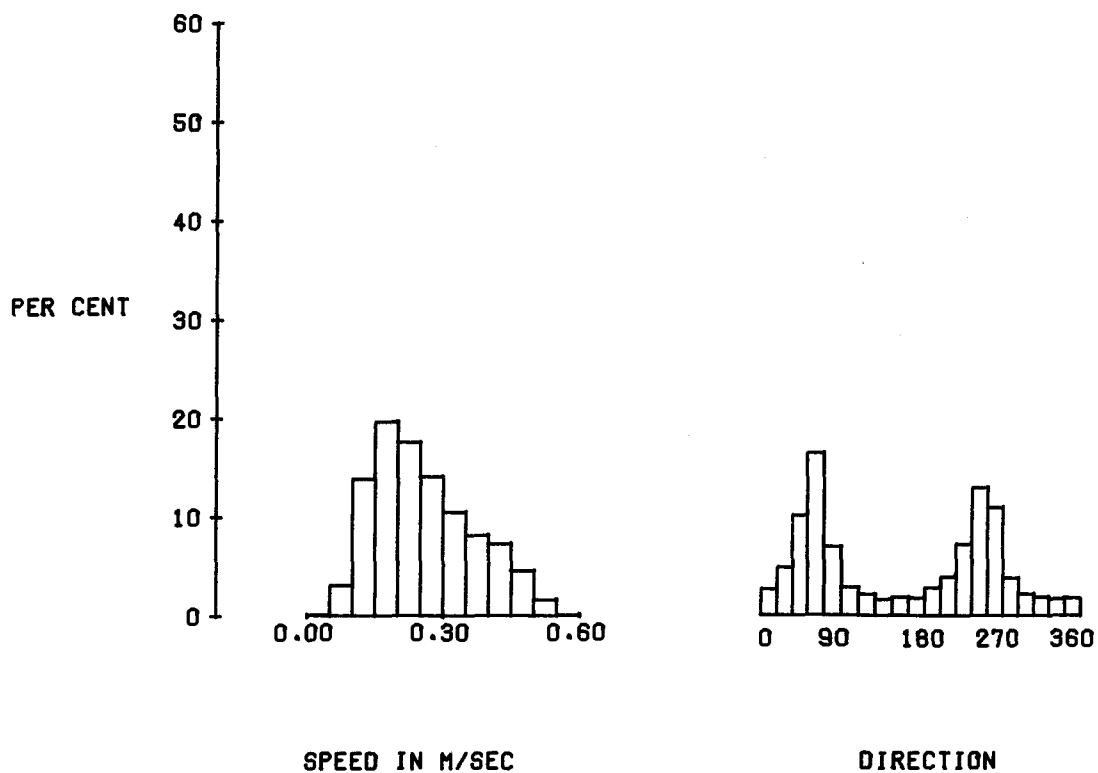
End of useful record : 00.29 GMT 15 May 1978

Length of useful record : 1090h

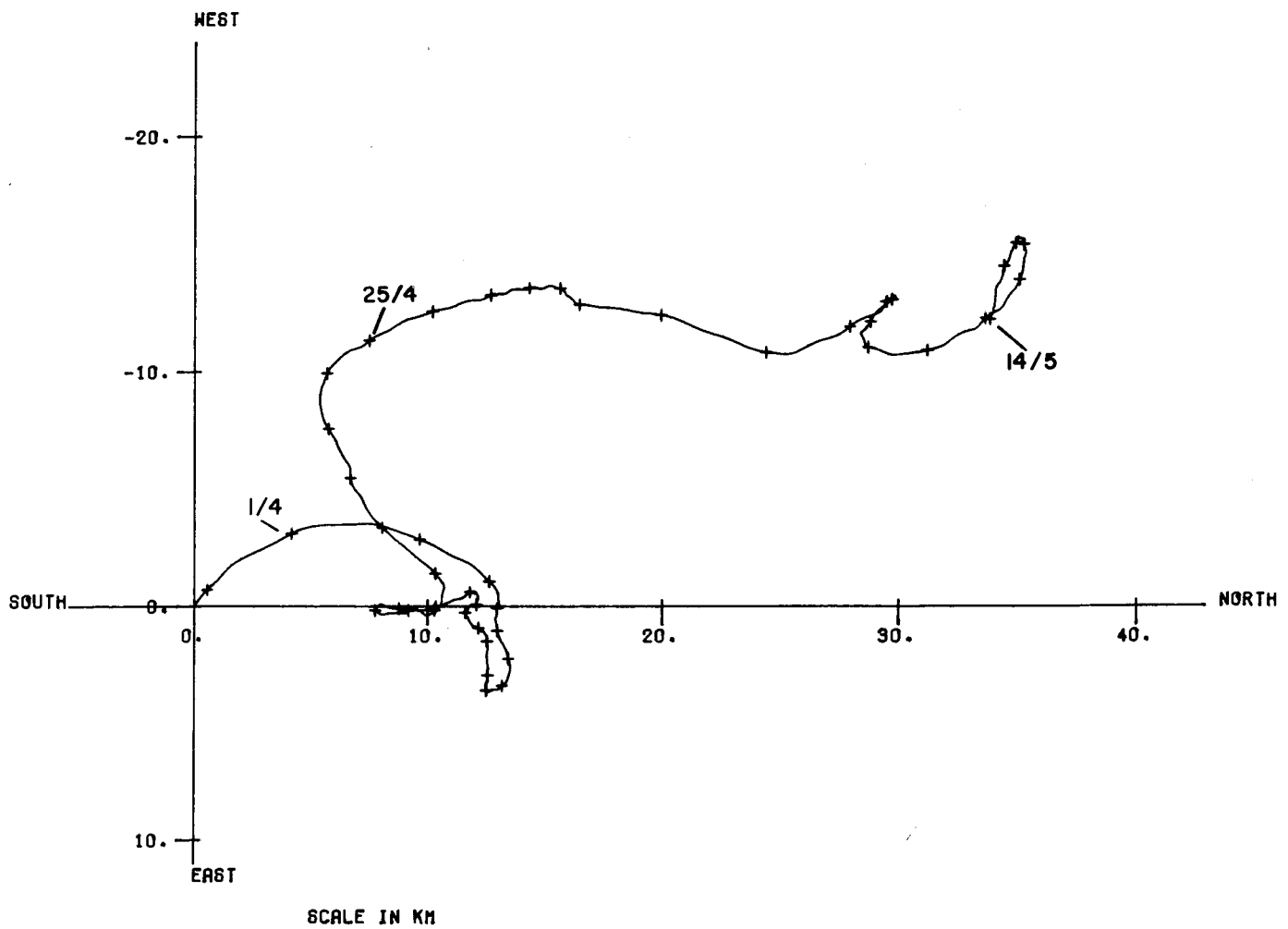
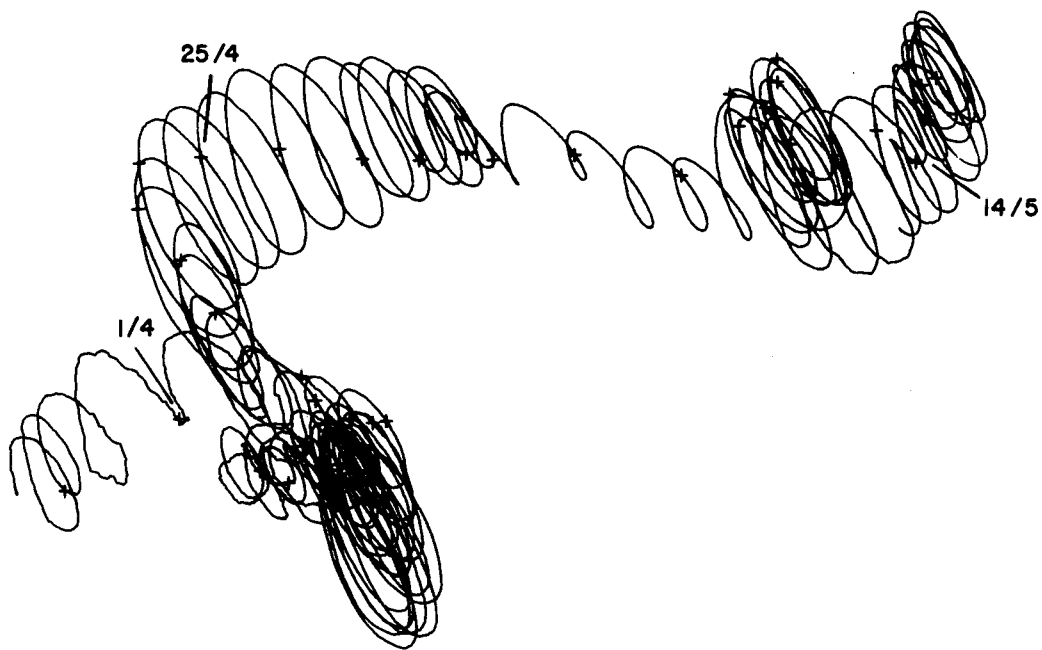
Comments : The meter was fitted with a 0-200  
psi pressure sensor and recorded  
elapsed time.  
  
The meter was recovered in good  
condition and its record was good.











Meter : Aanderaa RCM4 No. 2575

Tape number : 2575/4

Meter started : 11.30.00 GMT 30 March 1978

Meter stopped : 12.50.00 GMT 15 May 1978

Total number of readings : 6633

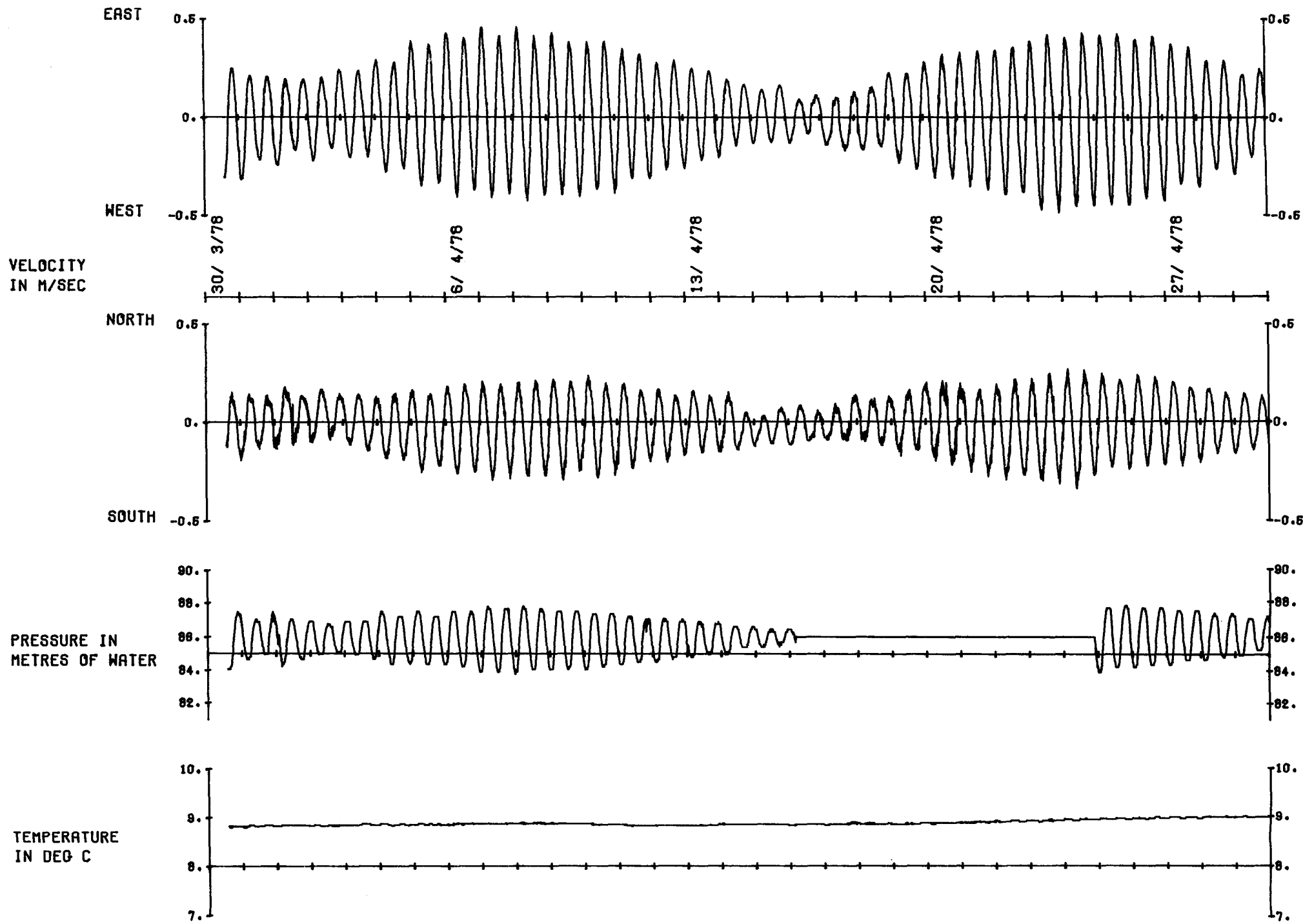
Timing error : No error

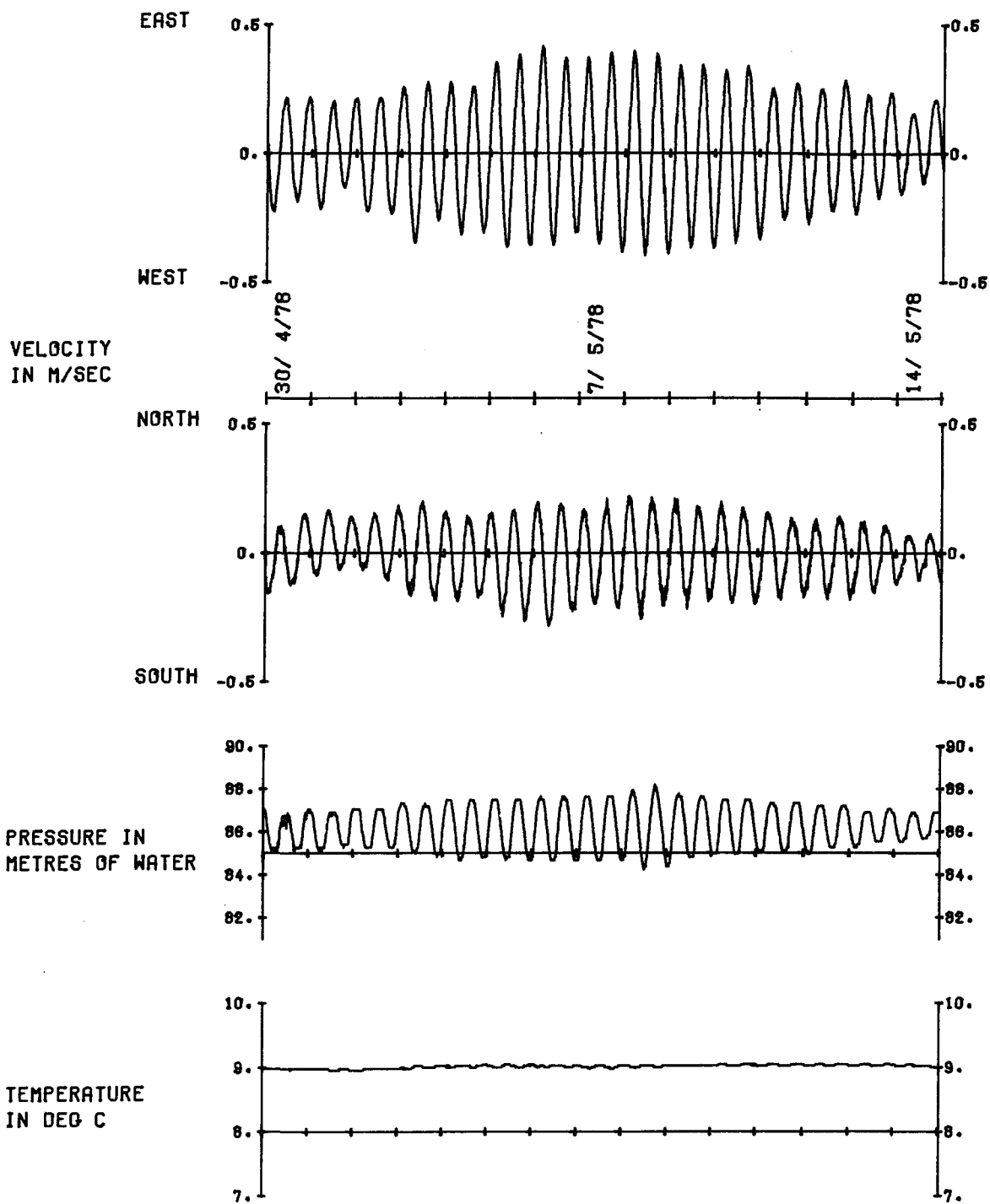
Start of useful record : 14.10 GMT 30 March 1978

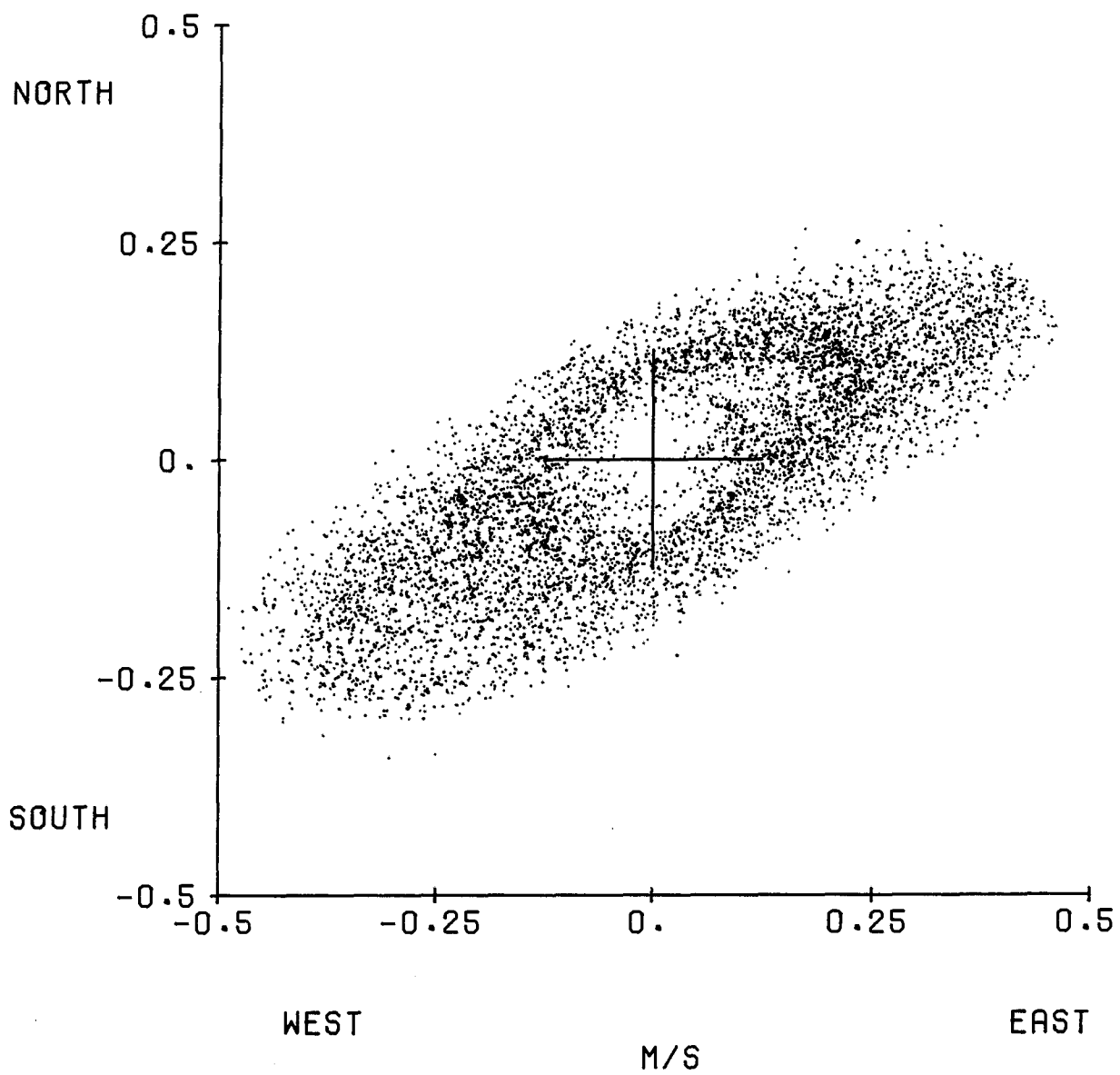
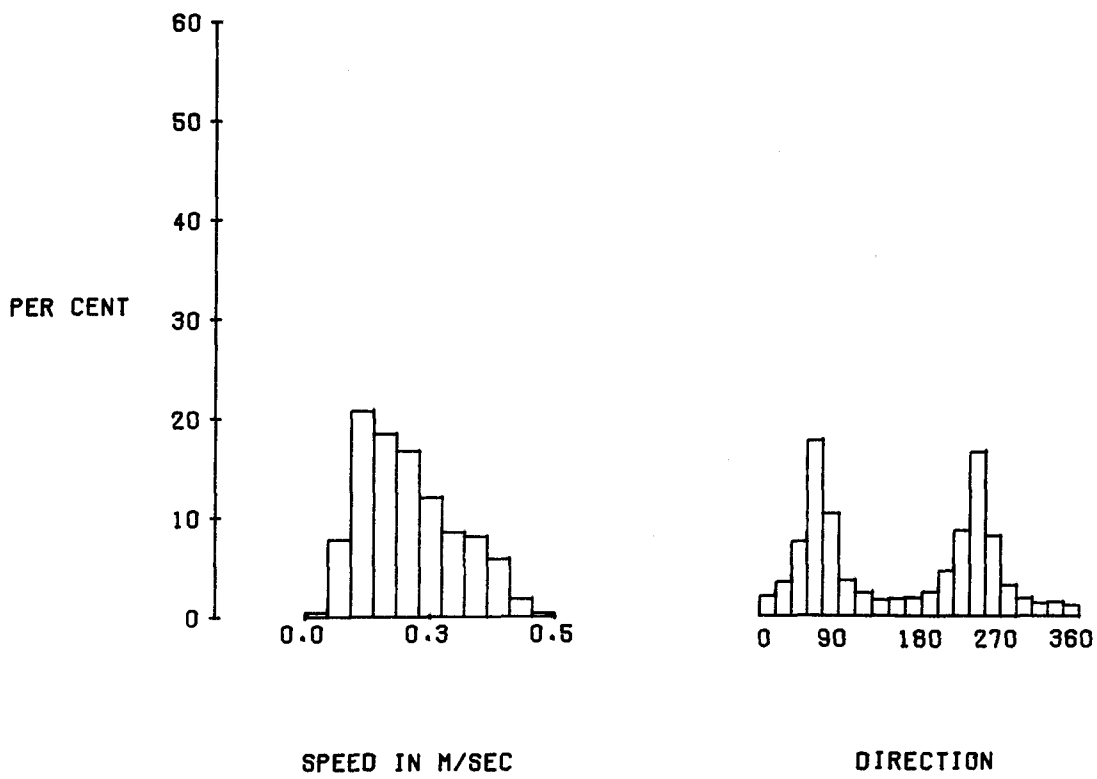
End of useful record : 00.30 GMT 15 May 1978

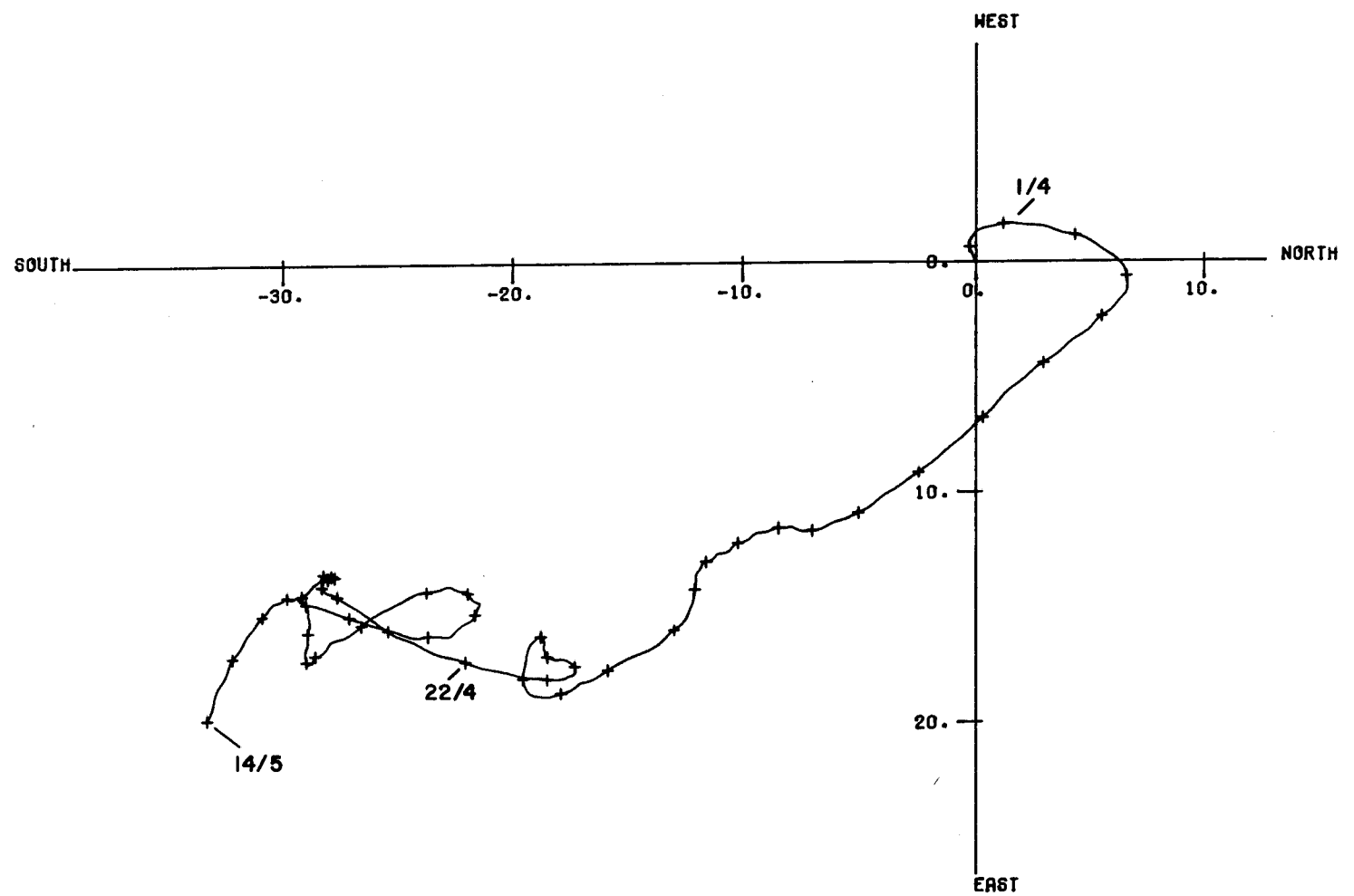
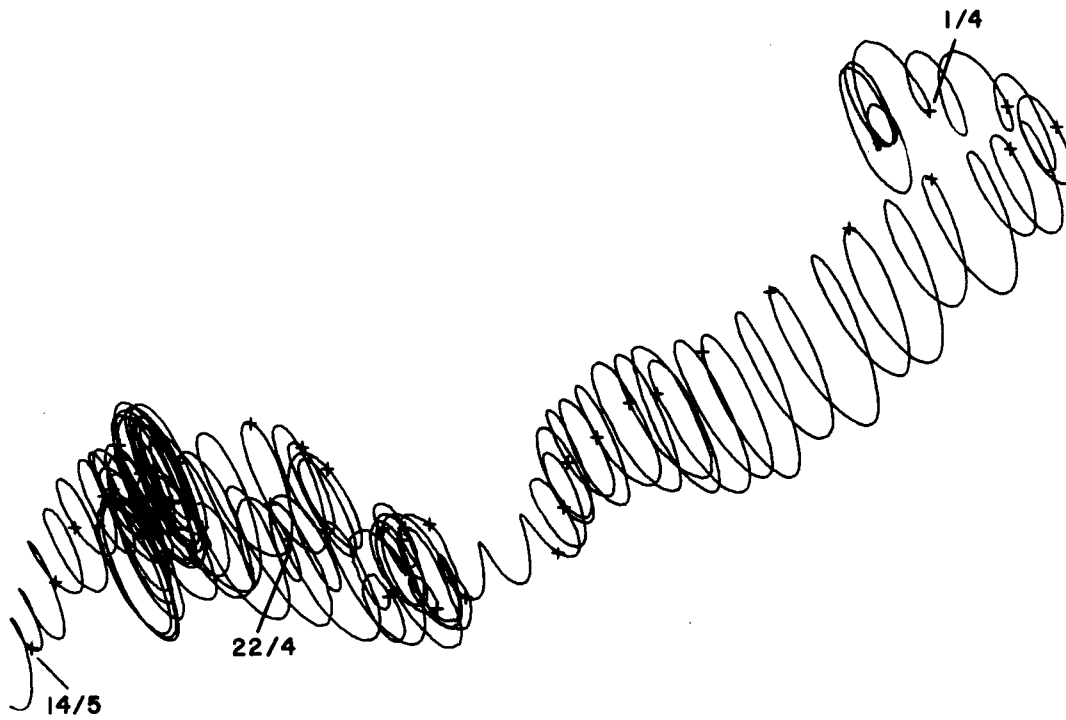
Length of useful record : 1090 h

Comments : The meter was fitted with a  
0-200 psi pressure sensor.  
The meter was recovered in good  
condition and its record was good,  
apart from 9 days of pressure  
values which have been replaced  
by a mean value.









SCALE IN KM

Mooring number : 151

Position of rig : Lat 50° 31' N Long 7° 31' W  
(Station F)

Depth of water : 111m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
245	Aanderaa TR-1	97-47	3.75

Rig set : 14.45 GMT 30 March 1978  
from RRS Challenger

Rig recovered : 14.44 GMT 14 May 1978  
from RRS Challenger

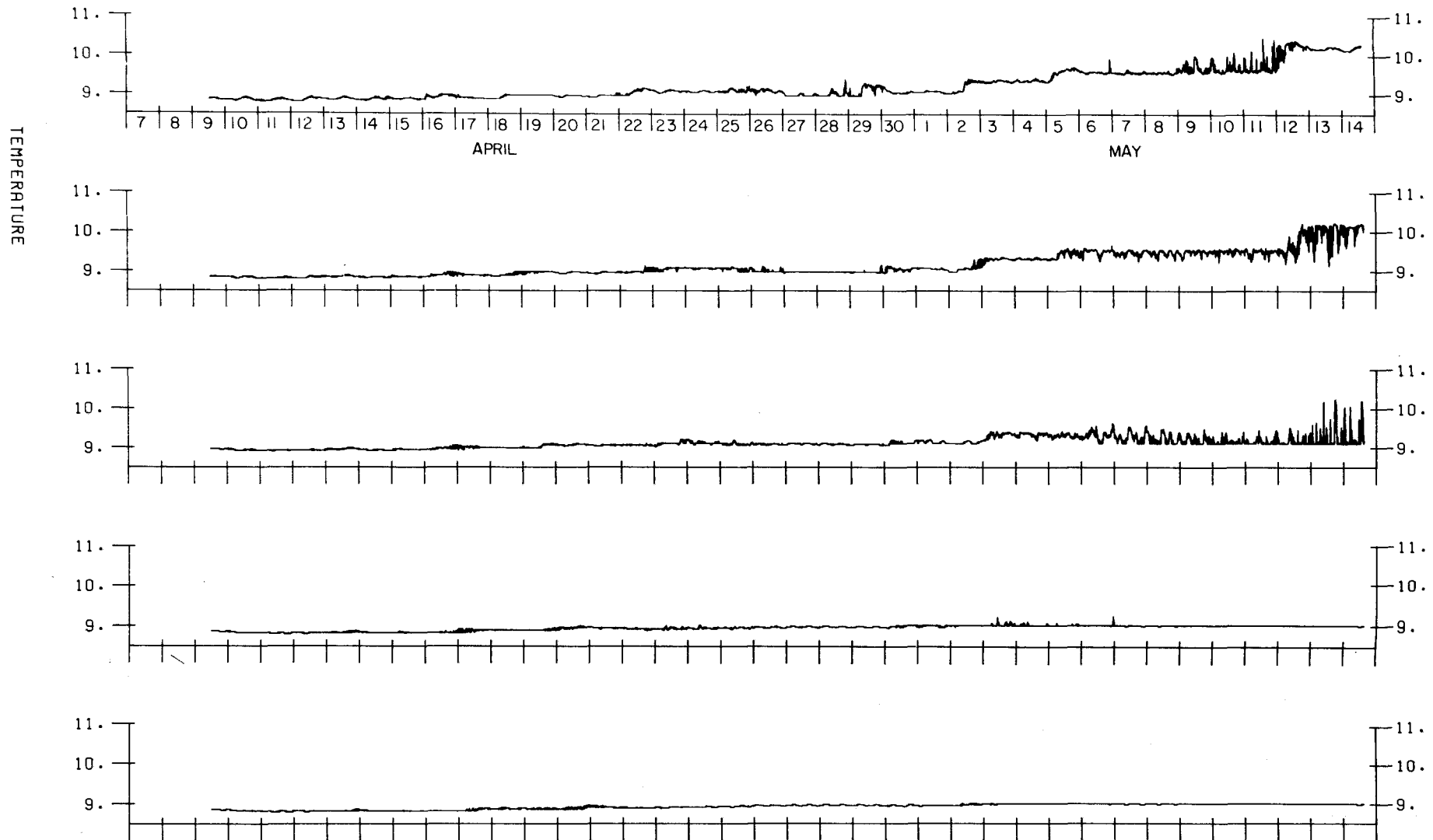
Mooring : u shaped

Comments : The rig was successfully deployed  
and recovered at the first attempt.  
It was in position.

Meter : Aanderaa TR-1 No. 245/260  
Tape number : 245/260/1  
Meter started : 12.10.00 GMT 30 March 1978  
Meter stopped : 16.51.40 GMT 14 May 1978  
Total number of readings : 13516  
Timing error : 25 s slow  
Start of useful record : 12.10.00 GMT 9 April 1978  
End of useful record : 14.59.10 GMT 14 May 1978  
Length of useful record : 842h  
Comments : A circuit was connected to the  
clock so that there was a delay  
of 10 days between starting the  
meter and the start of data  
recording.  
The meter was recovered in good  
condition and its record was good.



# THERMISTOR CHAIN PLOT



TIME  
TC245/2 RIG F START= 9/4/78 12.10 END= 14/5/78 16.47.5 S I= 3.75MIN

101

Mooring number : 152

Position of rig : Lat 49° 37.3' N Long 8° 35.5' W  
(Station G)

Depth of water : 142m below chart datum

Meter	Type	Height above sea floor (m)	Recording interval (min)
2970	Aanderaa RCM4	105	10
206	Aanderaa TR-1	104-54	3.75
1865	Aanderaa RCM4	31	10

Rig set : 06.22 GMT 31 March 1978  
from RRS Challenger

Rig recovered : 09.03 GMT 16 May 1978  
from RRS Challenger.

Mooring : Pop-up

Comments : The rig was successfully deployed  
and recovered at the first attempt.  
It was in position.

Meter : Aanderaa RCM4 No. 2970

Tape number : 2970/1

Meter started : 17.50.00 GMT 30 March 1978

Meter stopped : 12.55.35 GMT 16 May 1978

Total number of readings : 6739

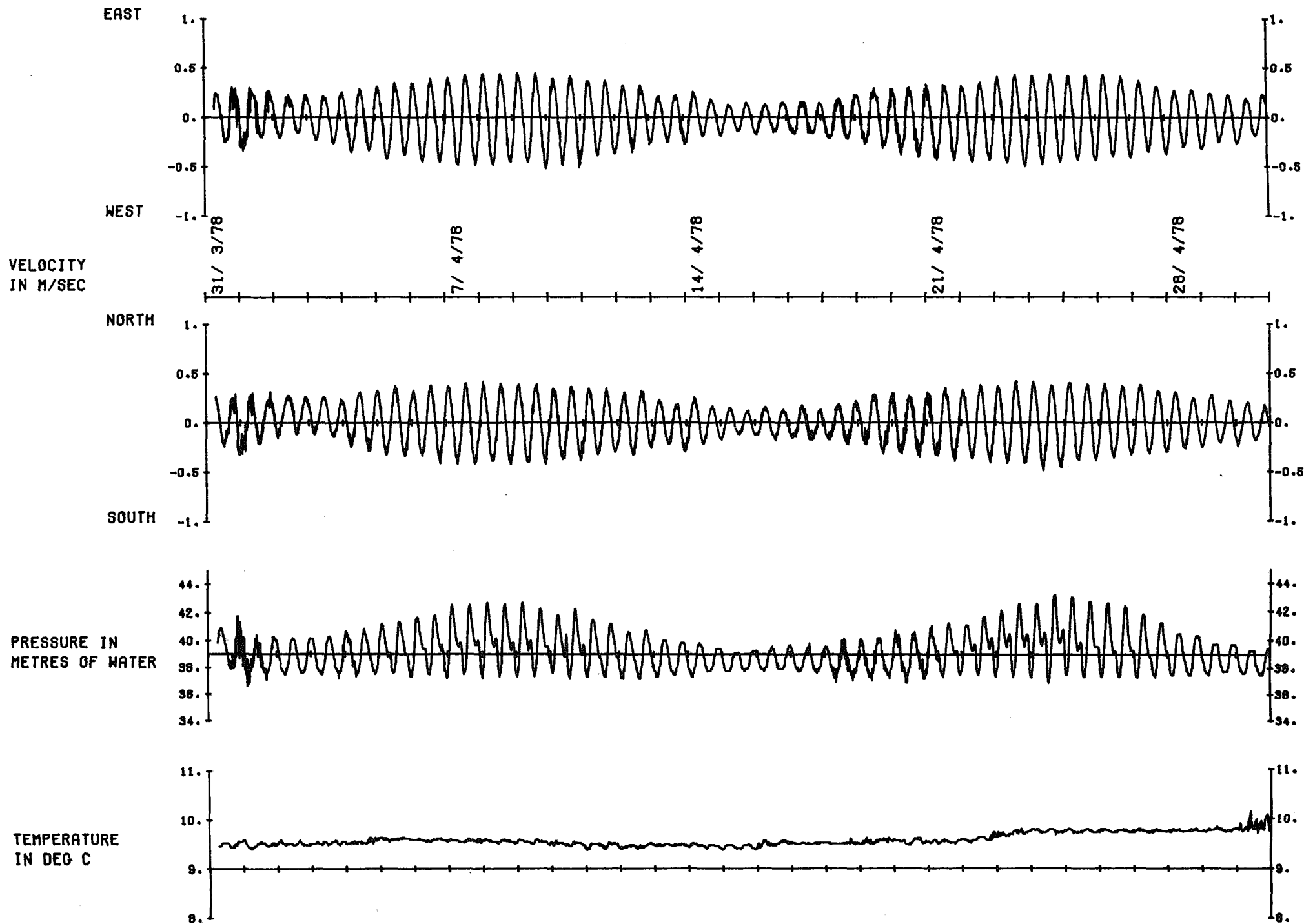
Timing error : 335 s slow

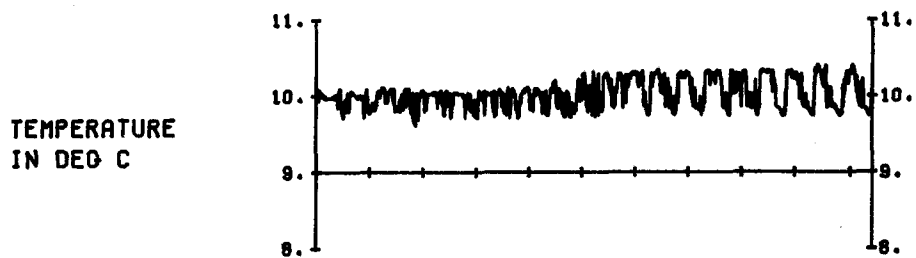
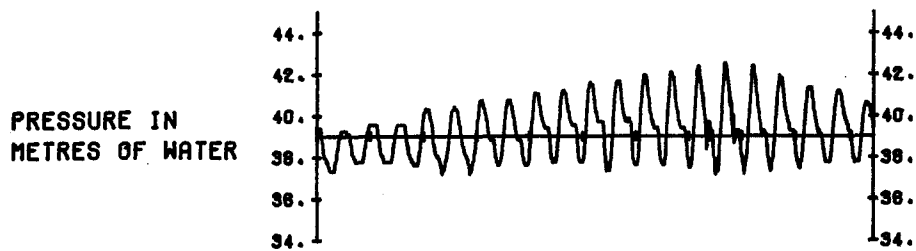
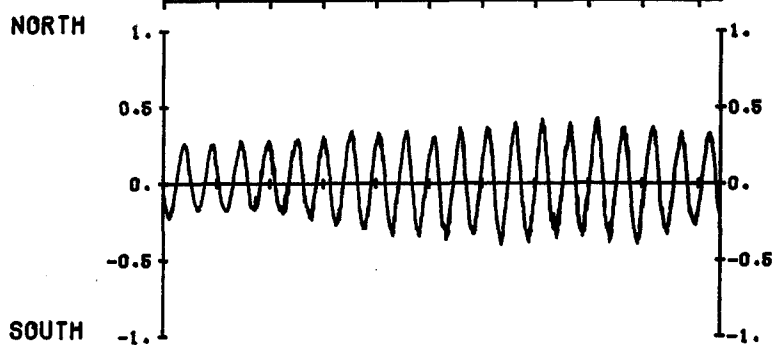
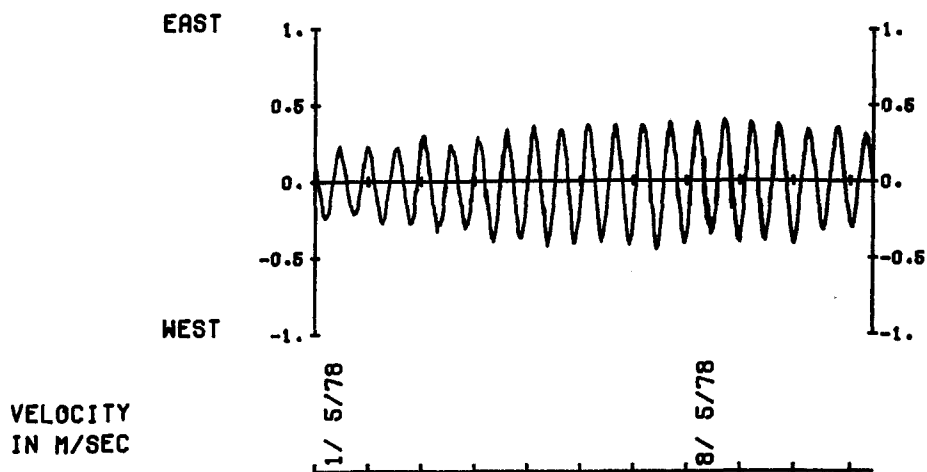
Start of useful record : 06.40 GMT 31 March 1978

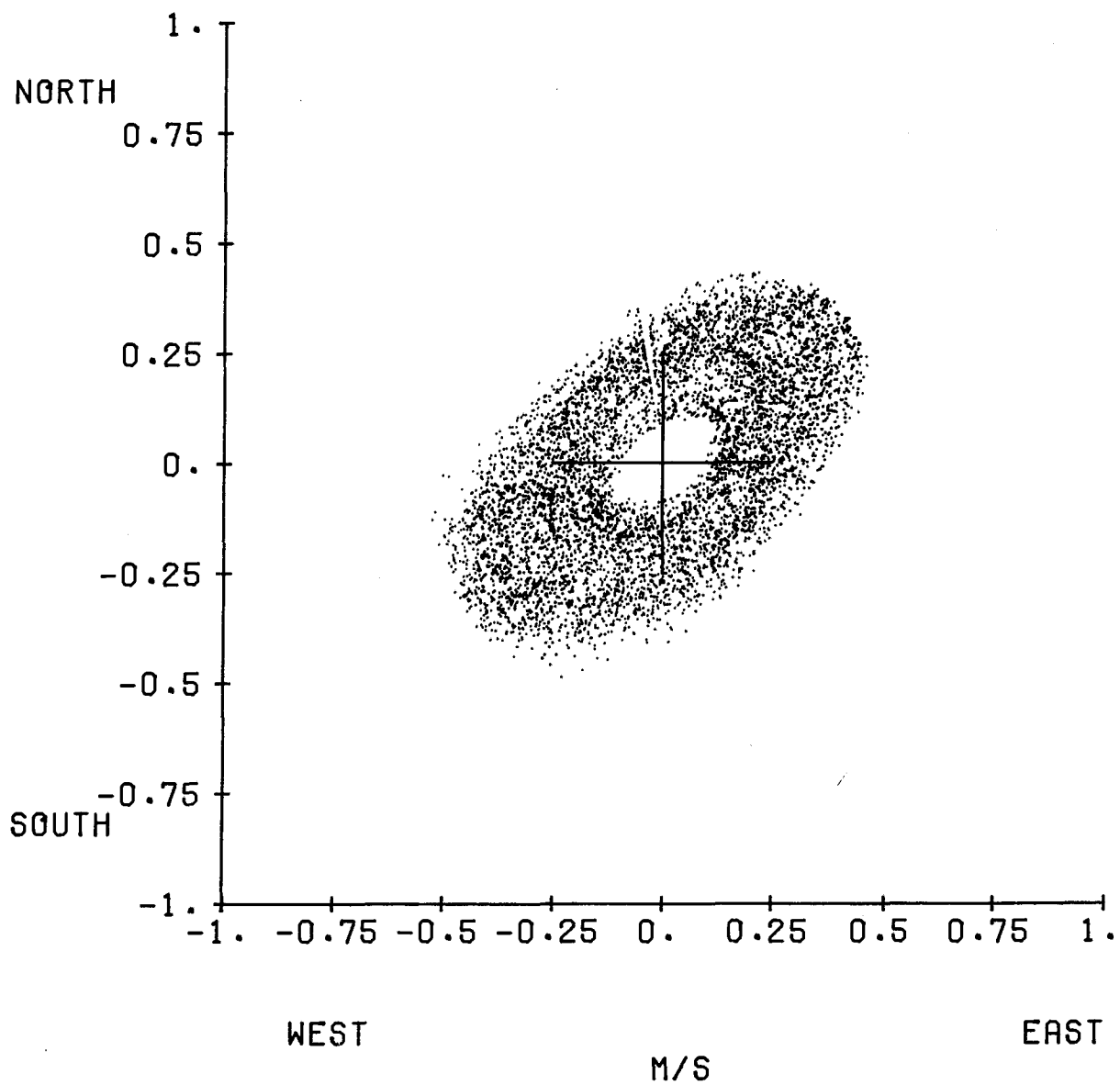
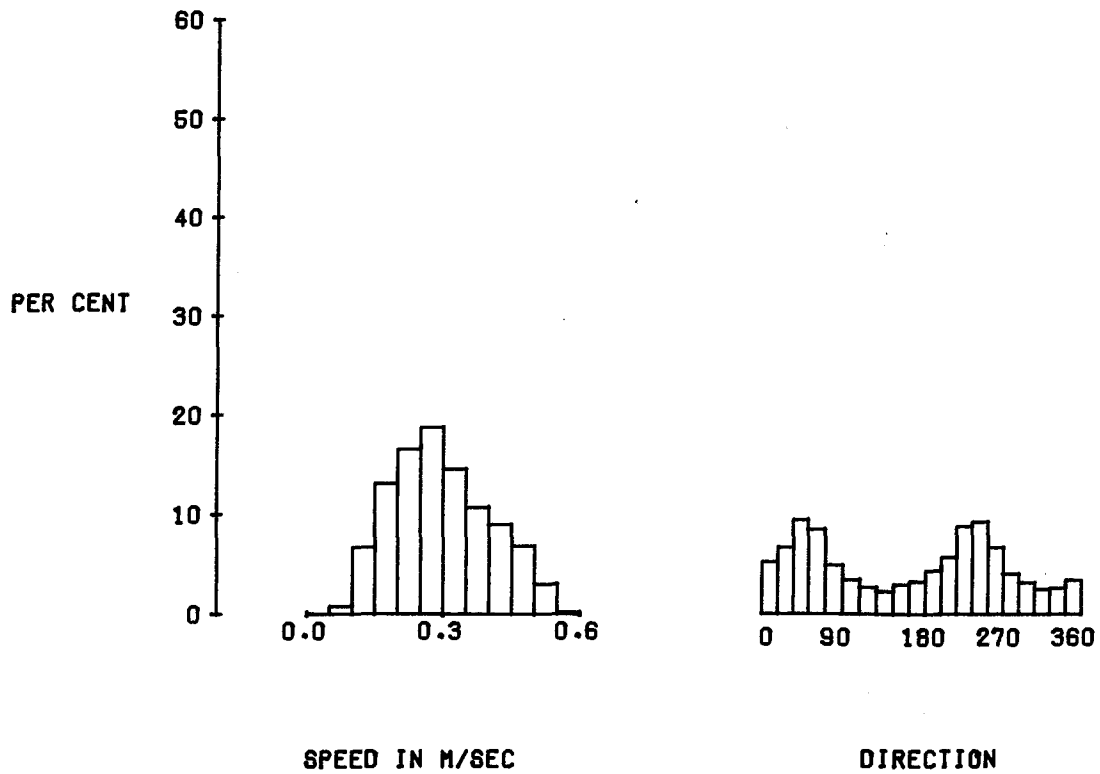
End of useful record : 09.46 GMT 11 May 1978

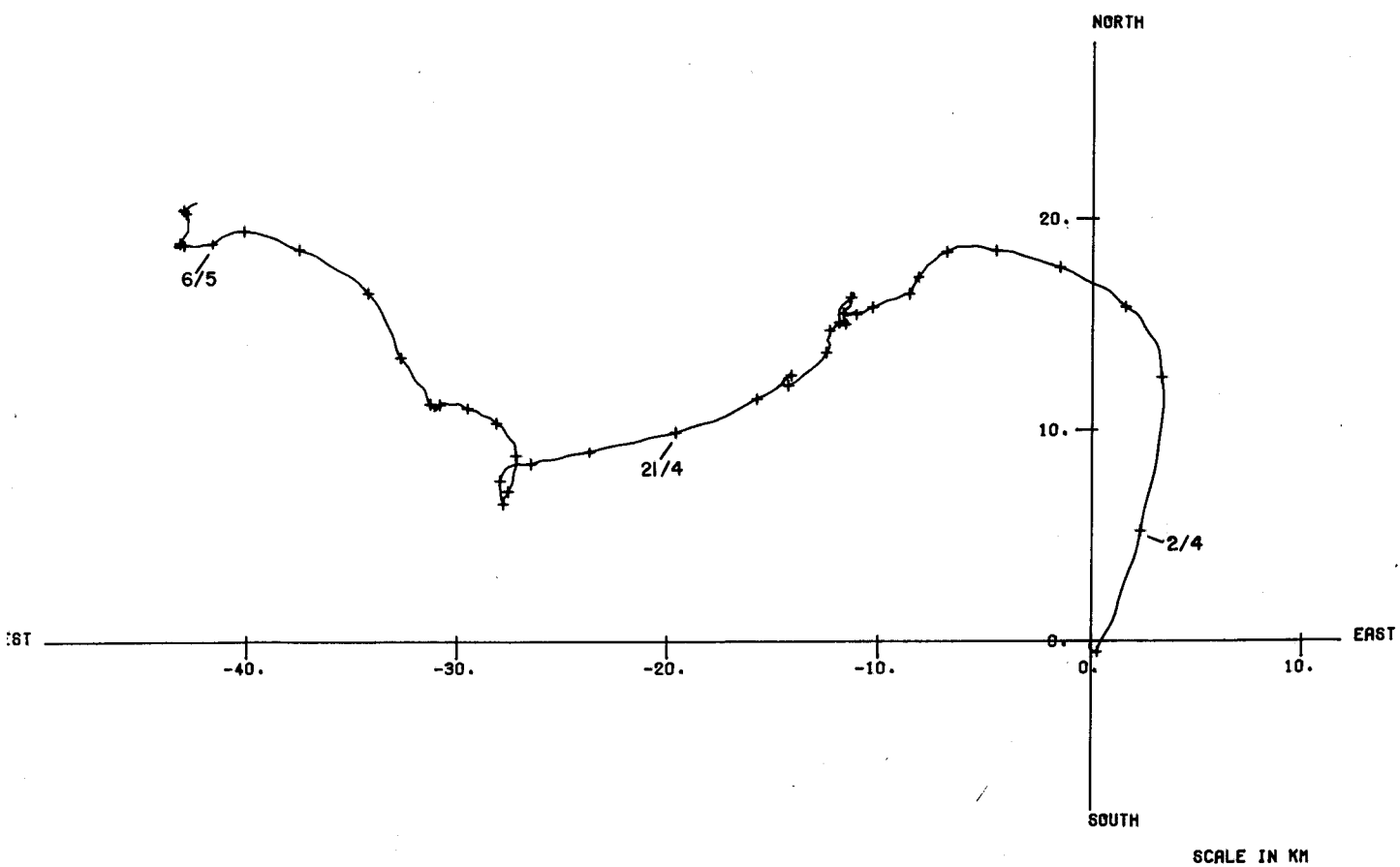
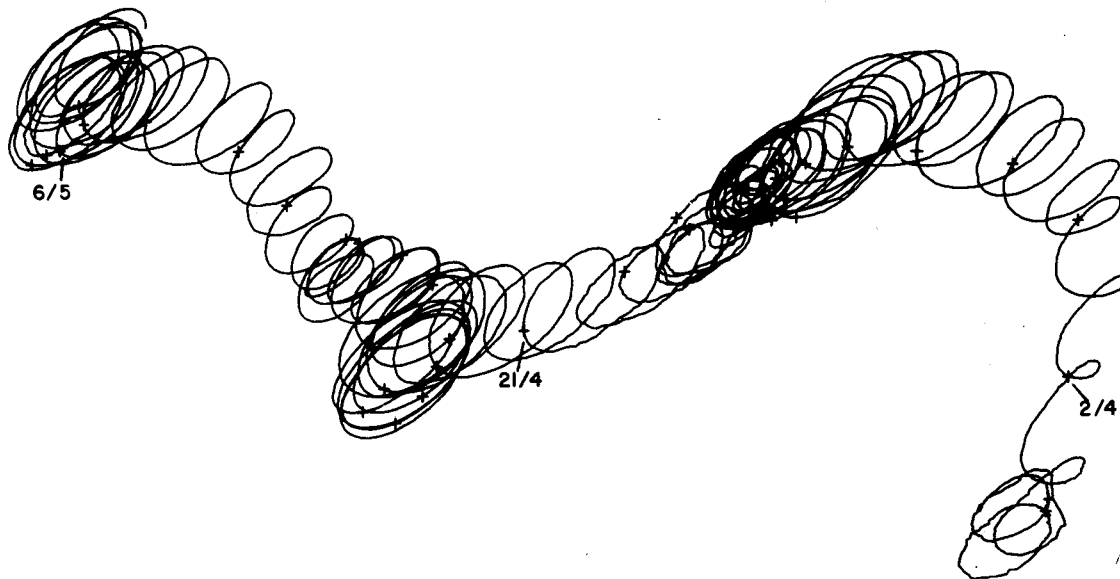
Length of useful record : 987 h

Comments : The meter was fitted with a  
0-200 psi pressure sensor and  
recorded elapsed time.  
The meter was recovered in good  
condition but its battery was  
flat. The record was good but 119  
hours short.





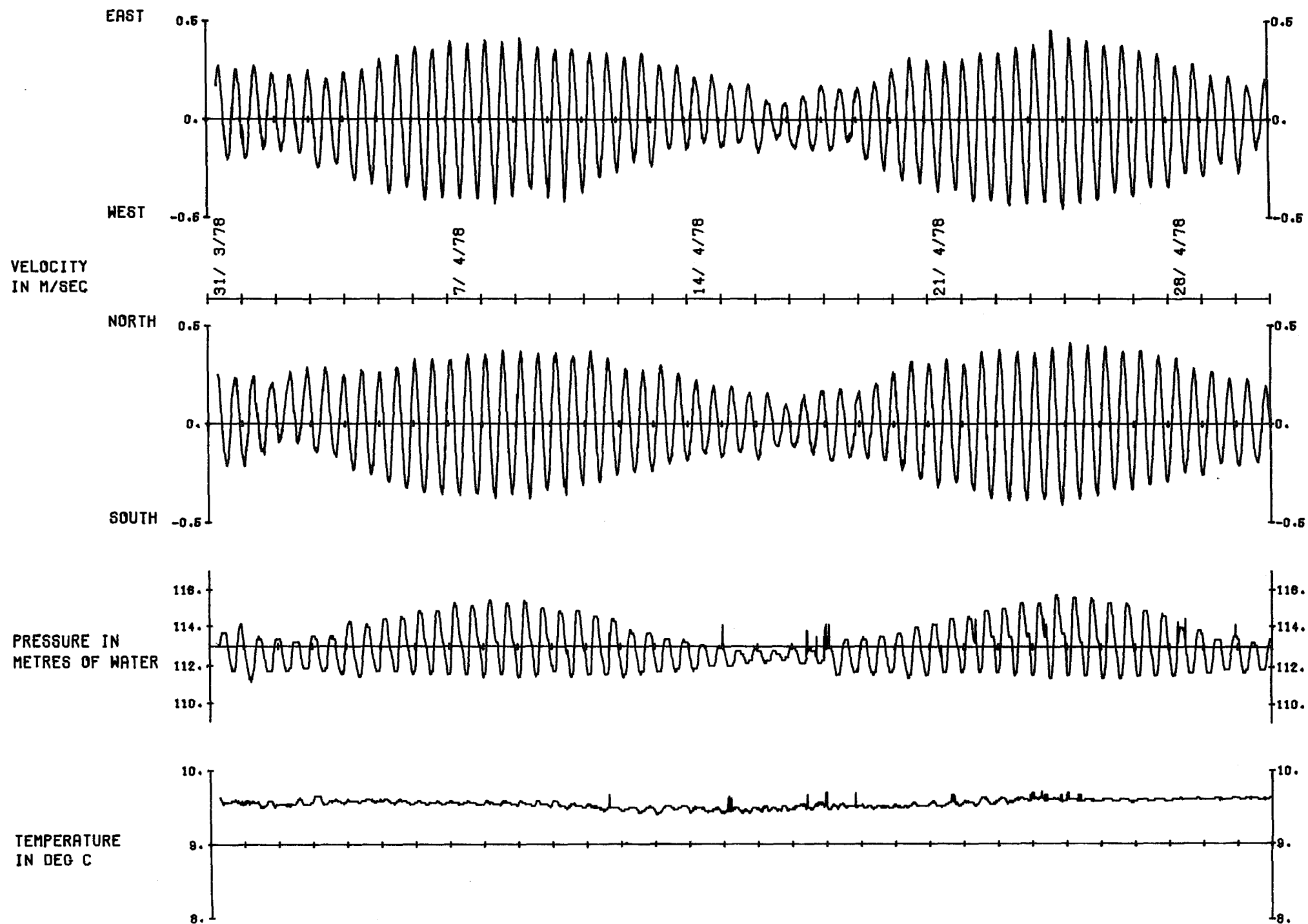


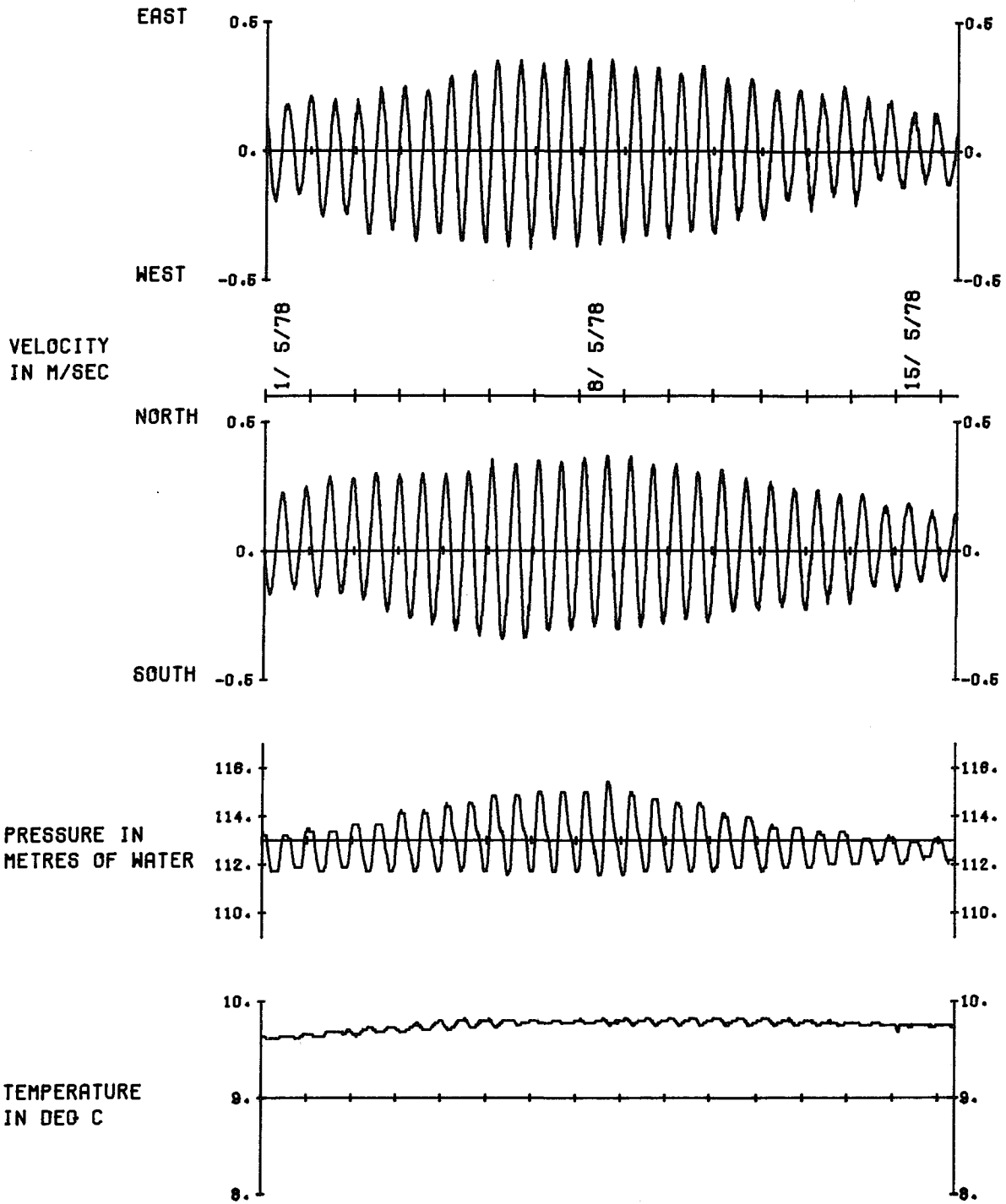


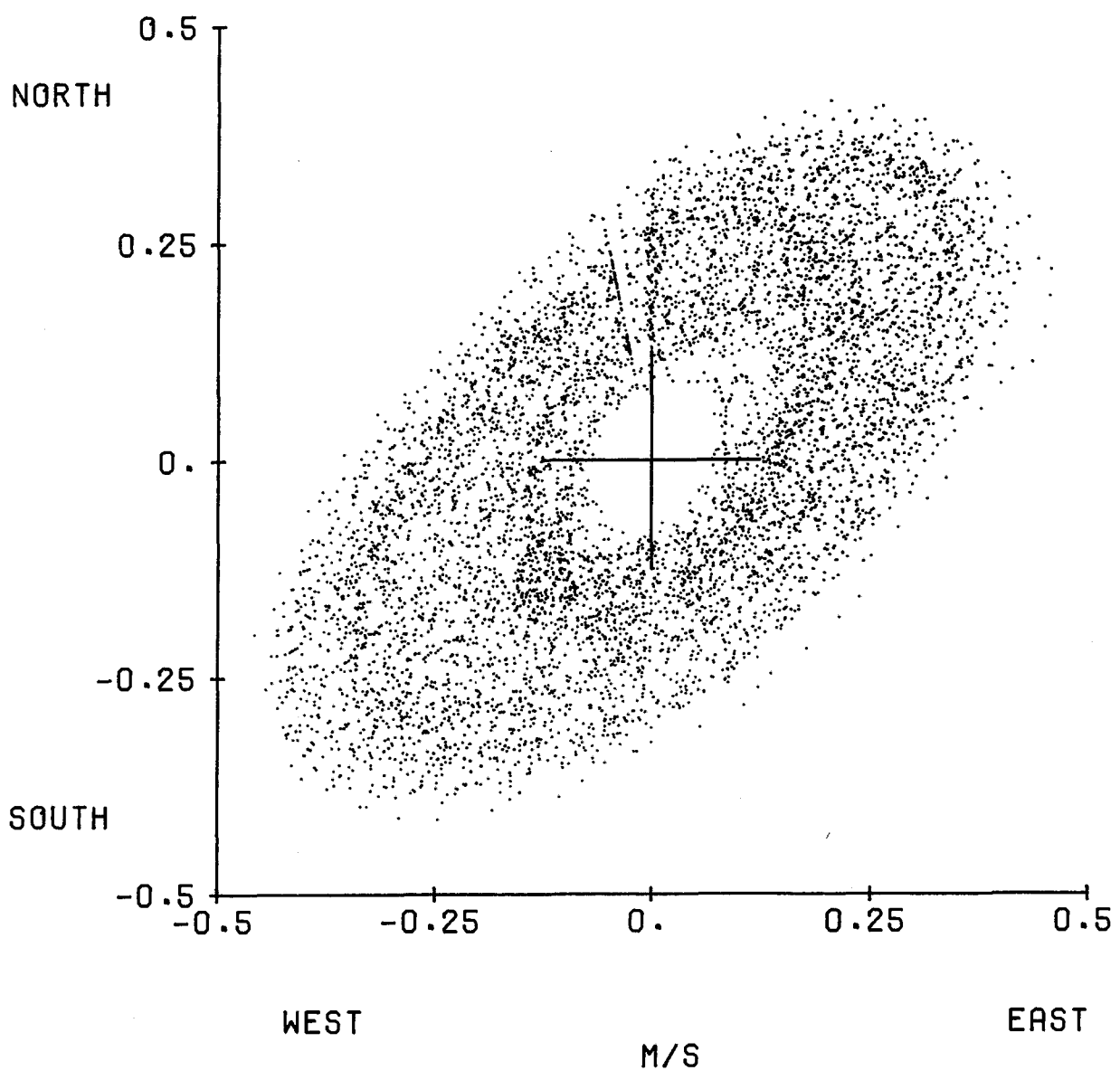
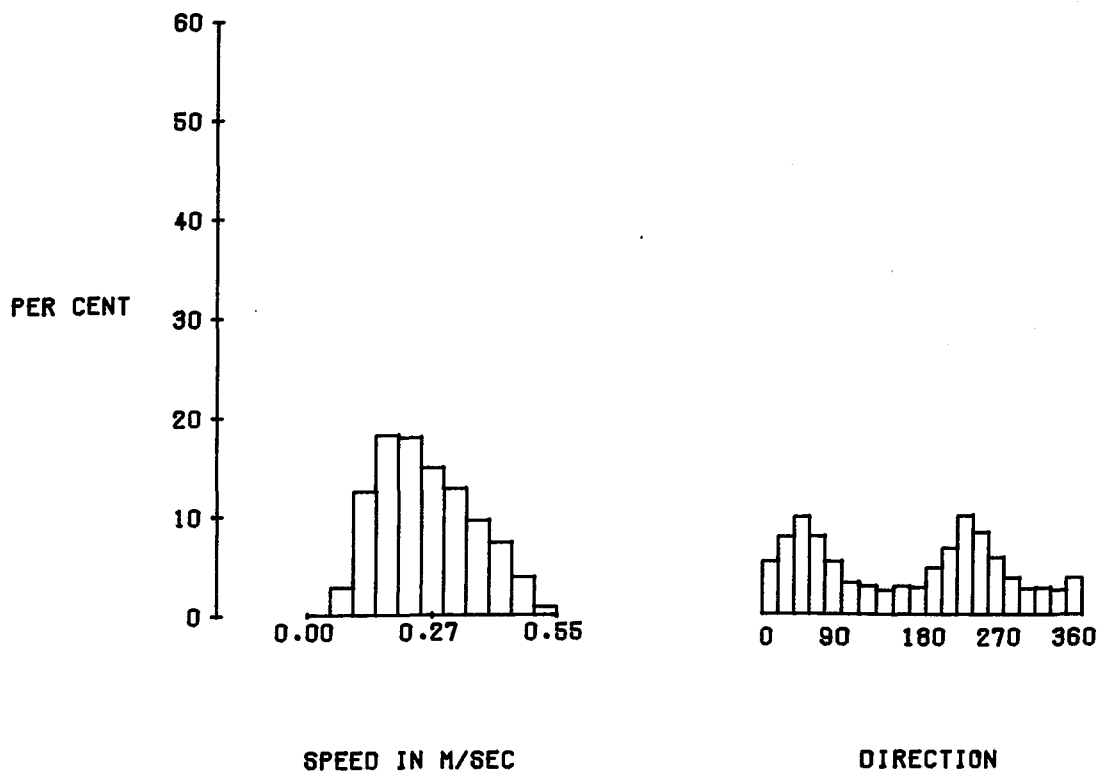
Meter	:	Aanderaa TR-1 No. 206/220
Tape number	:	206/220/1
Meter started	:	18.00.00 GMT 30 March 1978
Meter stopped	:	Tape ran out
Total number of readings	:	-
Timing error	:	-
Start of useful record	:	-
End of useful record	:	-
Length of useful record	:	-
Comments	:	A circuit was connected to the clock so that there was a delay of 10 days between starting the meter and the start of data recording. The meter was recovered in good condition. No data was recorded because of a loose connection to the tape head.

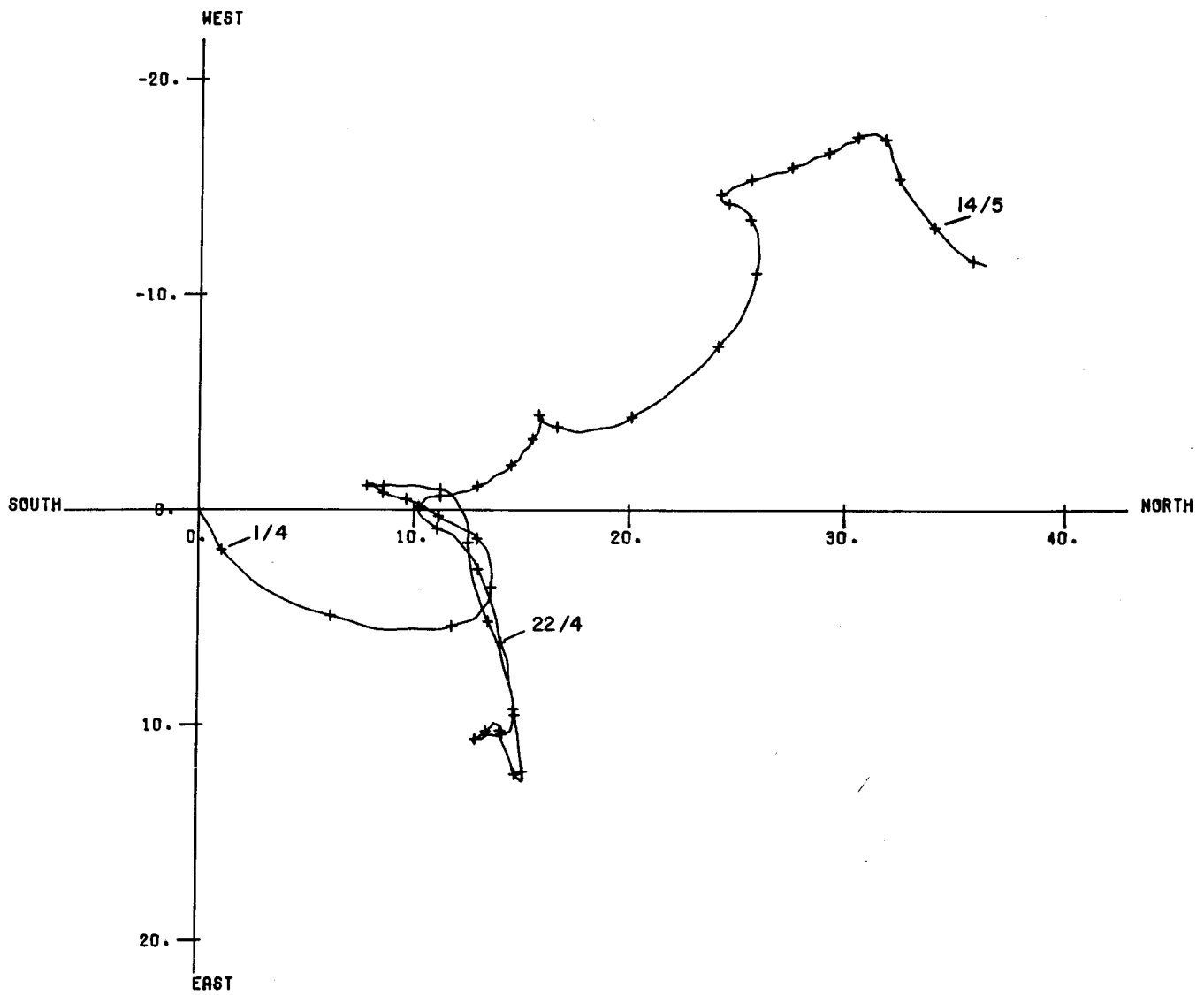
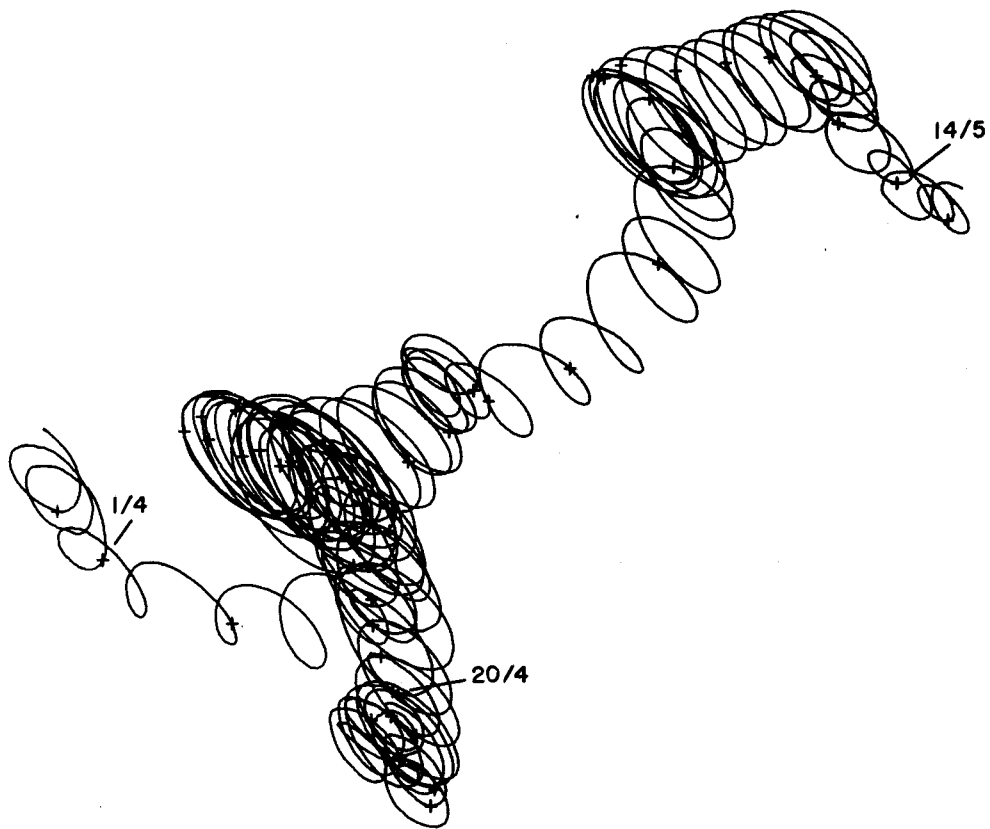


Meter : Aanderaa RCM4 No. 1865  
Tape number : 1865/3  
Meter started : 18.20.00 GMT 30 March 1978  
Meter stopped : 11.58.22 GMT 16 May 1978  
Total number of readings : 6731  
Timing error : 98 s fast  
Start of useful record : 06.40 GMT 31 March 1978  
End of useful record : 08.48 GMT 16 May 1978  
Length of useful record : 1106 h  
Comments : The meter was fitted with a  
0-200 psi pressure sensor and  
a fore-aft inclinometer. (The  
results from the inclinometer have  
not been presented.)  
The meter was recovered in good  
condition and its record was good.









SCALE IN KM

113

Mooring number : 153  
Position of rig : Lat 48° 55.0' N Long 9° 15.0' W (Station H)  
Depth of water : 157m below chart datum

Meter	Type	Height above see floor (m)	Recording interval (min)
1746	Aanderaa RCM4	136	10
294	Aanderaa TR-1	135-60	3.75
2574	Aanderaa RCM4	30	10

Rig set : 13.09 GMT 1 April 1978  
from RRS Challenger

Rig recovered : -

Mooring : Pop up with a 40 inch diameter sub-surface buoy.

Comments : The rig was successfully deployed at the first attempt.

The acoustic were switched on and the release fired on 16 May 1978 but nothing came to the surface. A French trawler later recovered the sub-surface buoy and top meter at 48° 30' N 9° 05' W. The current meter record showed that the sub-surface buoy had been cut free 17 hours after the rig had been deployed.

Meter : Aanderaa RCM4 No.1746  
Tape number : 1746/6  
Meter started : 11.10.00 GMT 1 April 1978  
Meter stopped : -  
Total number of readings : 8003  
Timing error : -  
Start of useful record : 13.30 GMT 1 April 1978  
End of useful record : 06.50 GMT 2 April 1978  
Length of useful record : 17 h  
Comments : The meter was fitted with a 0-500 psi  
pressure sensor and recorded elapsed  
time.  
No data from this record have been  
displayed in this report.

Meter : Aanderaa TR-1 No. 294/334  
Tape number : 294/334/1  
Meter started : 12.00 GMT 1 April 1978  
Meter stopped : -  
Total number of readings : -  
Timing error : -  
Start of useful record : -  
End of useful record : -  
Length of useful record : -  
Comments : The meter was not recovered.



Meter : Aanderaa RCM4 No. 2574  
Tape number : 2574/3  
Meter started : 11.40.00 GMT 1 April 1978  
Meter stopped : -  
Total number of readings : -  
Timing error : -  
Start of useful record : -  
End of useful record : -  
Length of useful record : -  
Comments : The meter was fitted with a fore-aft  
inclinometer. The meter was not  
recovered.

Mooring number : 154  
 Position of rig : Lat 47°47.2'N Long 10°18.7'W (Station I)  
 Depth of water : 3897 m

Meter	Type	Height above sea floor (m)	Recording interval (min)
1749	Aanderaa RCM5	3360	10
3257	Aanderaa RCM5	2660	10
3258	Aanderaa RCM5	1960	10
3259	Aanderaa RCM5	1260	10
3260	Aanderaa RCM5	760	10
3261	Aanderaa RCM5	260	10

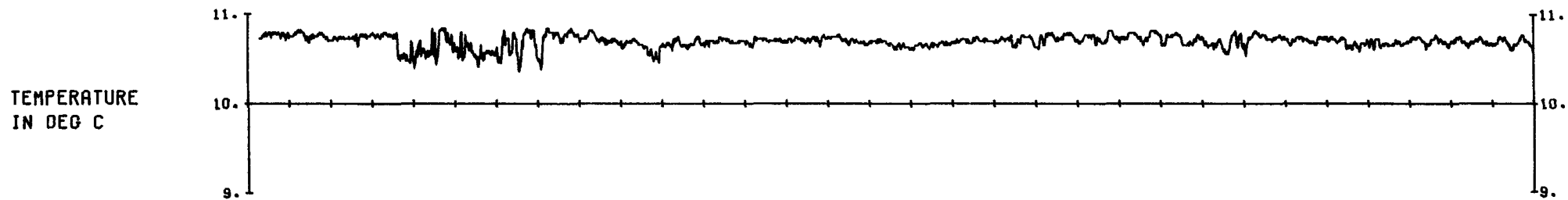
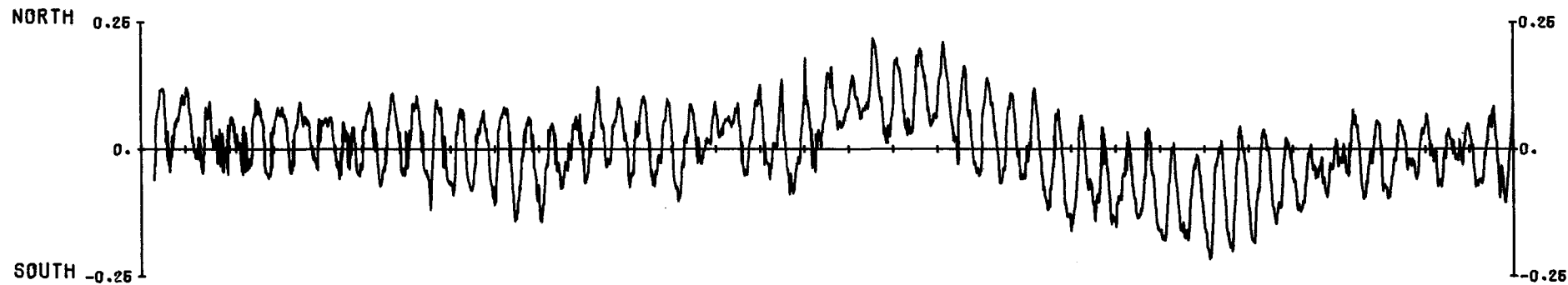
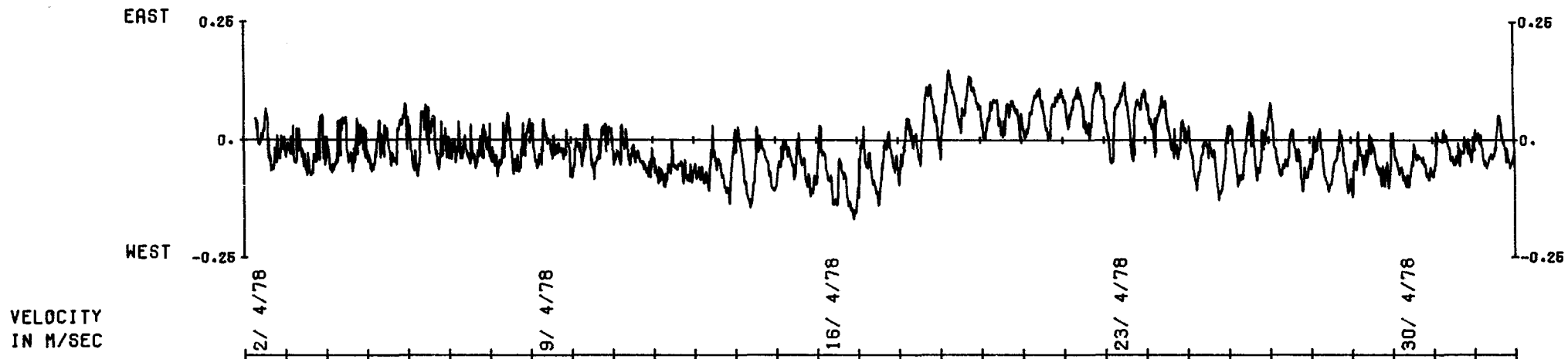
Rig set : 05.47 GMT 2 April 1978  
 from RRS Challenger

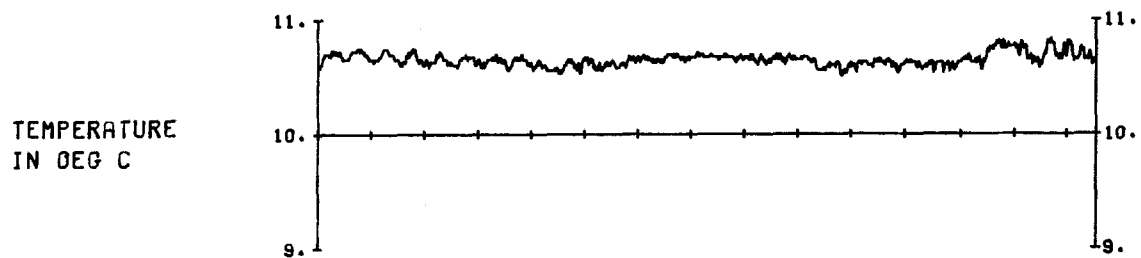
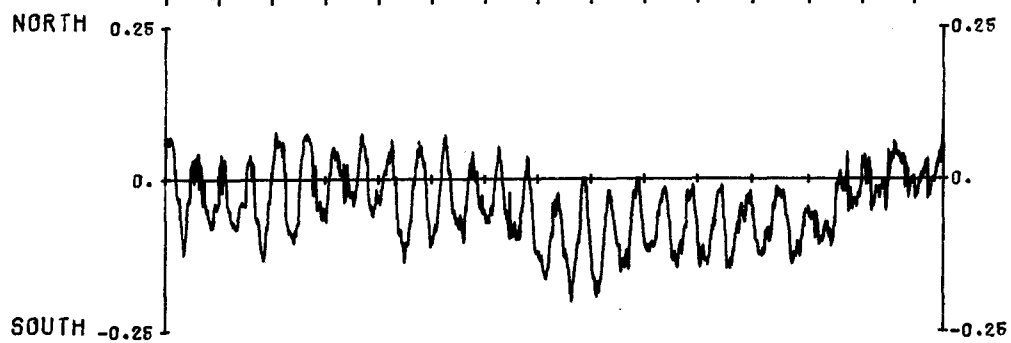
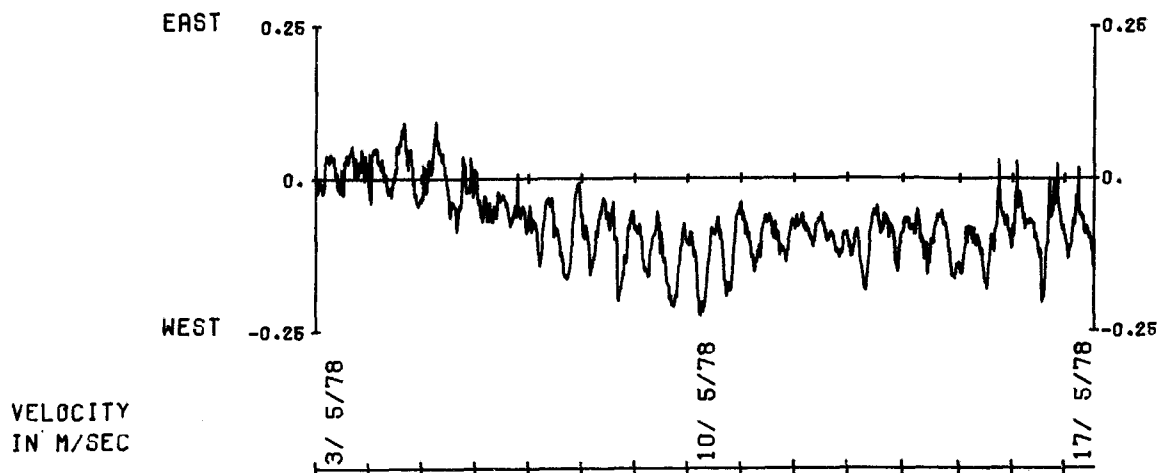
Rig recovered : 13.48 GMT 17 May 1978  
 from RRS Challenger

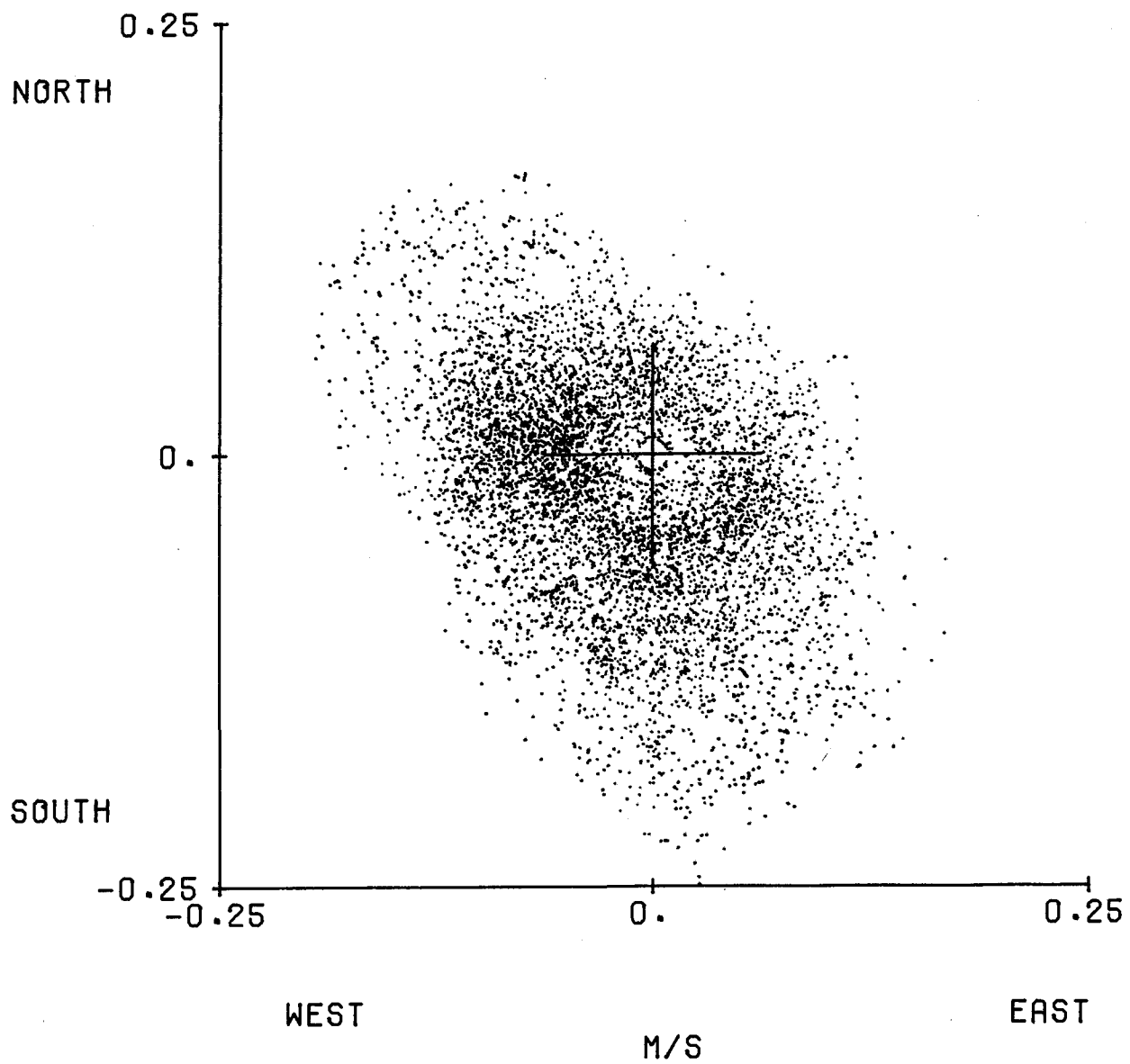
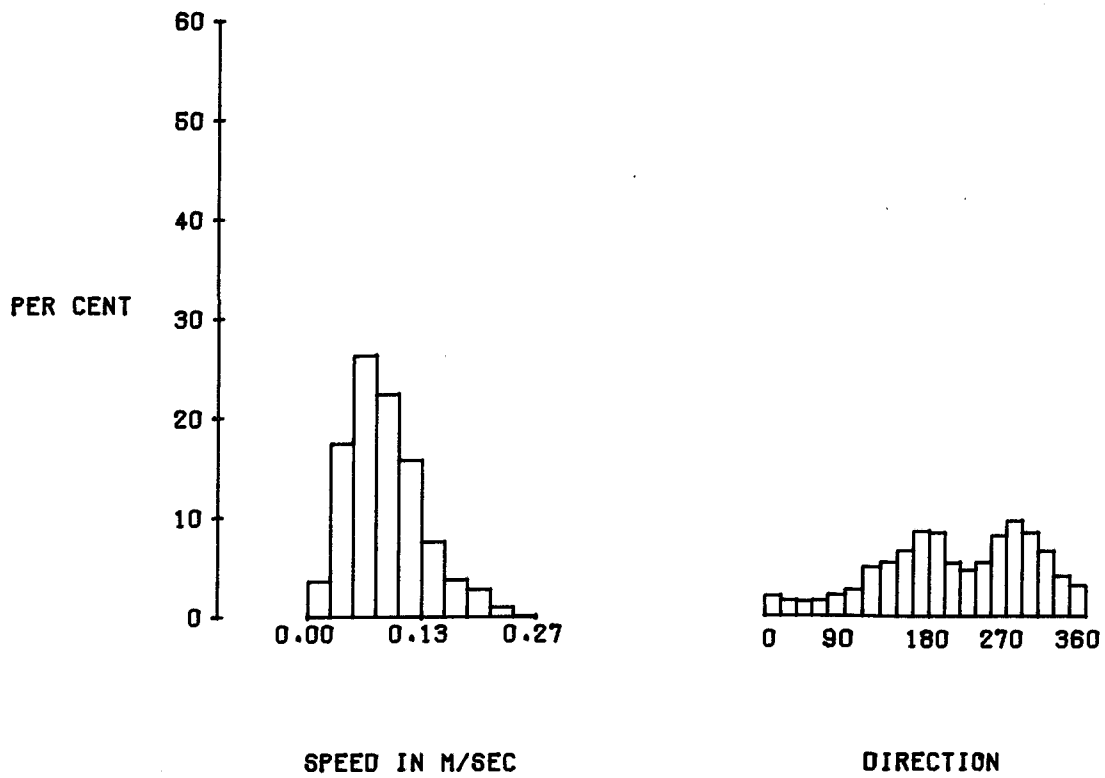
Mooring : Pop up, with a 48 inch diameter sub-  
 surface buoy.

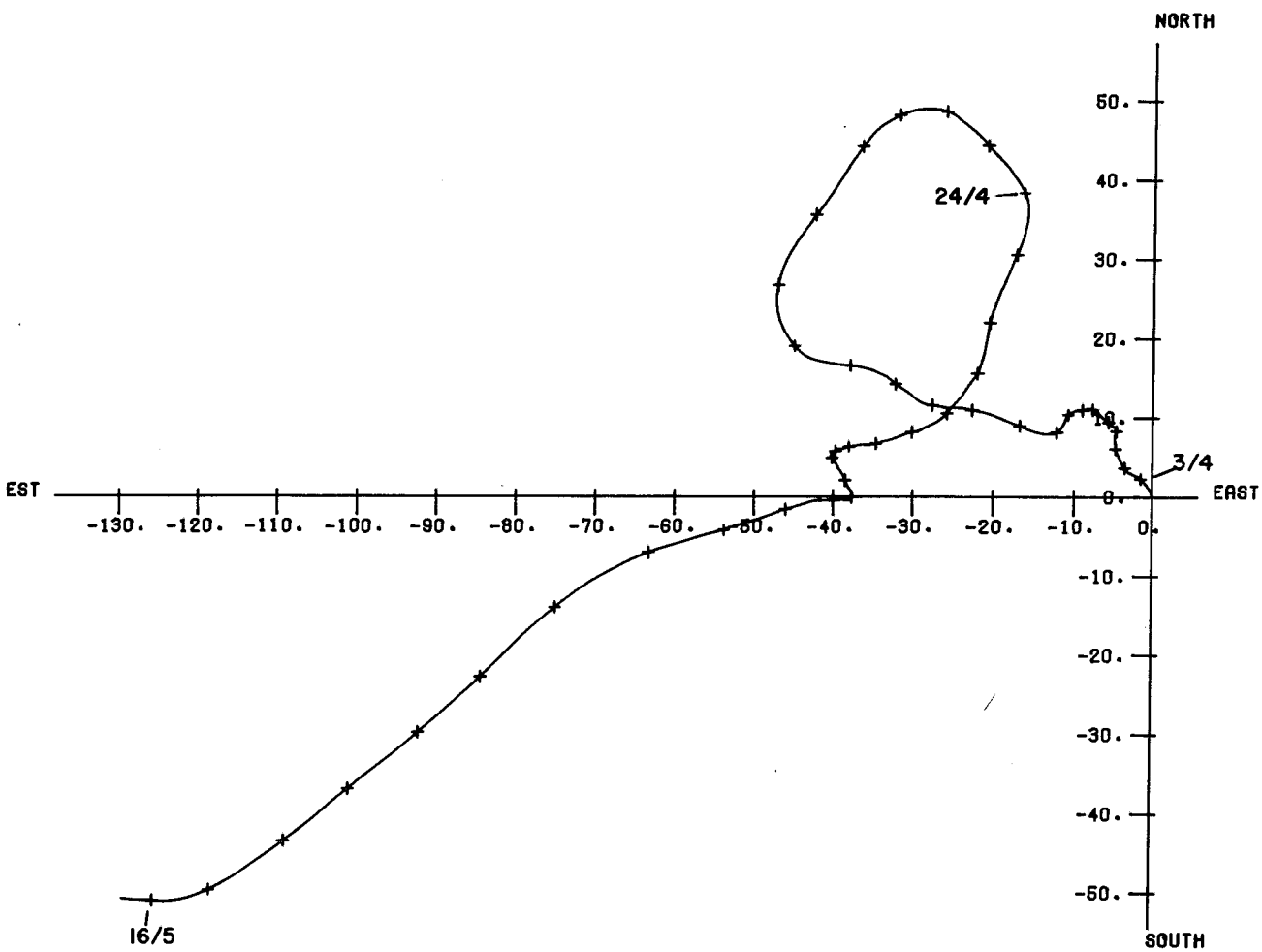
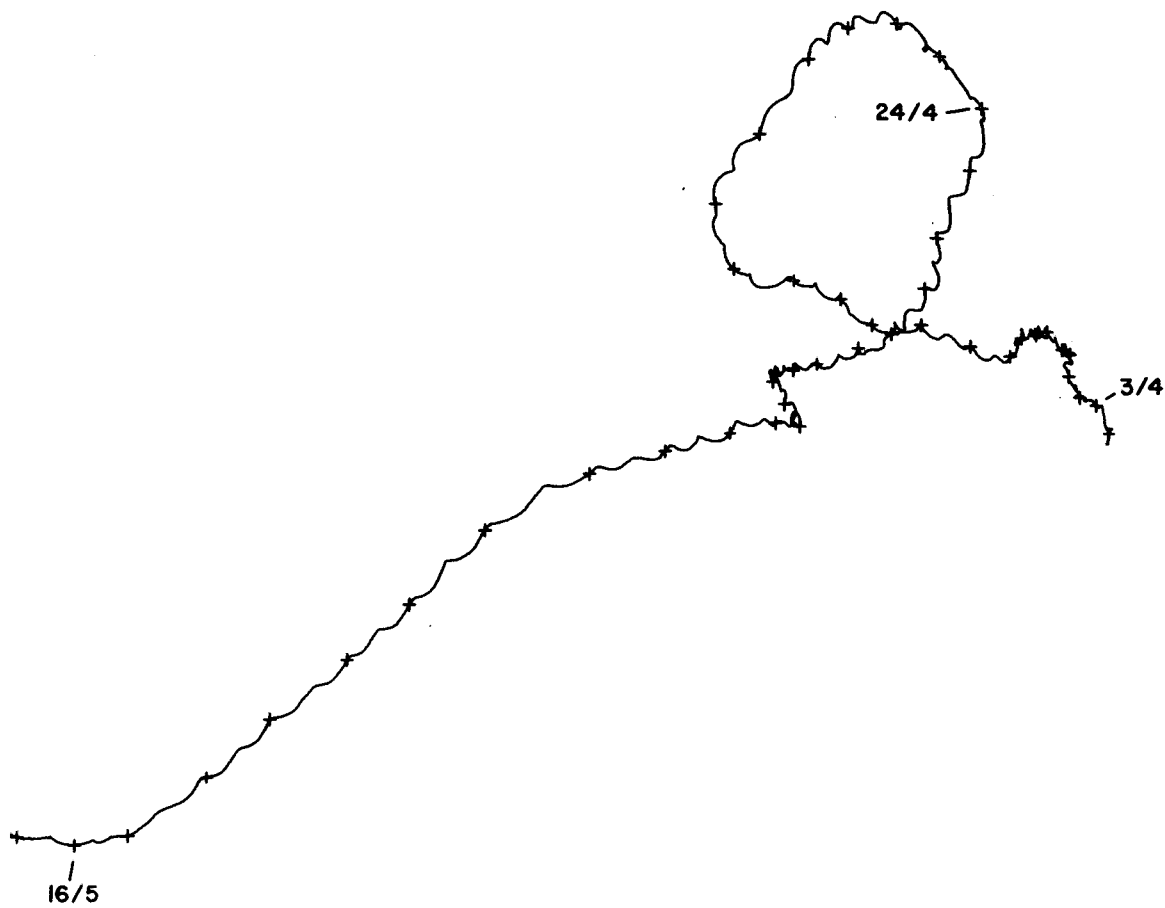
Comments : The rig was successfully deployed and  
 recovered at the first attempt. It was  
 in position.

Meter	:	Aanderaa RCM5	No. 1749
Tape Number	:	1749/6	
Meter started	:	22.00.00	GMT 1 April 1978
Meter stopped	:	13.38.21	GMT 19 May 1978
Total number of readings	:	6863	
Timing error	:	99 s	fast
Start of useful record	:	07.10	GMT 2 April 1978
End of useful record	:	13.28	GMT 17 May 1978
Length of useful record	:	1086h	
Comments	:	The meter was recovered in good condition. Its record was good, although there were about a hundred translation errors most of which were recovered.	









SCALE IN KM

Meter : Aanderaa RCM5 No. 3257

Tape number : 3257/1

Meter started : 01.10.00 GMT 2 April 1978

Meter stopped : 12.49.35 GMT 19 May 1978

Total number of readings : 6839

Timing error : 25s fast

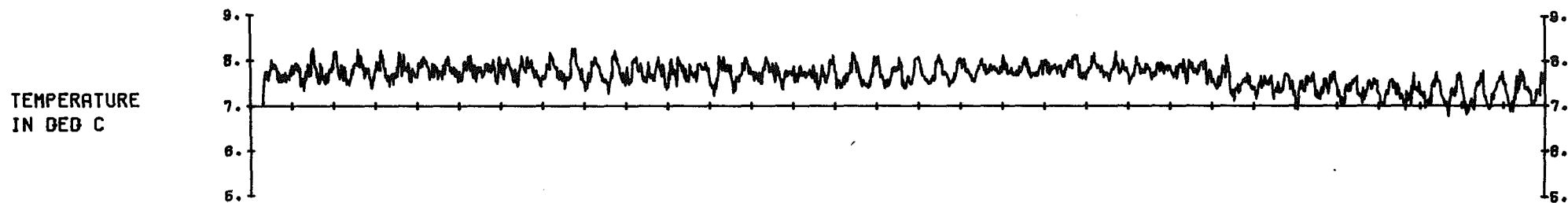
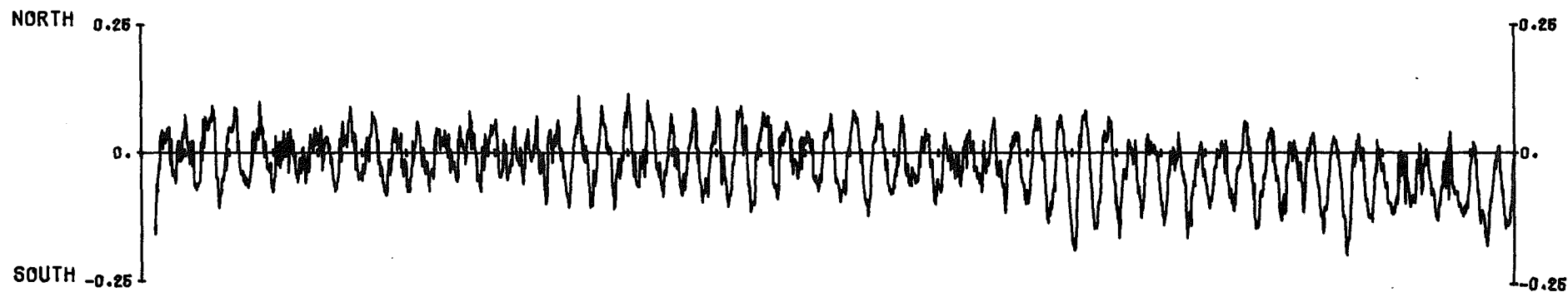
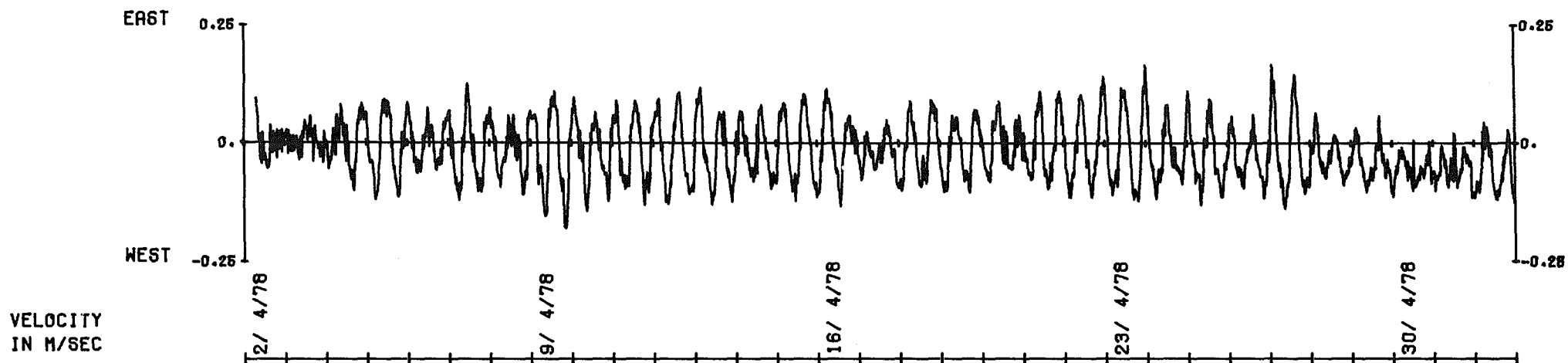
Start of useful record : 07.10 GMT 2 April 1978

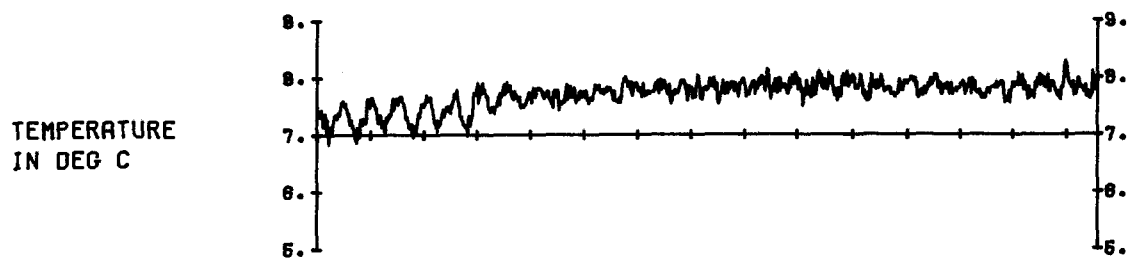
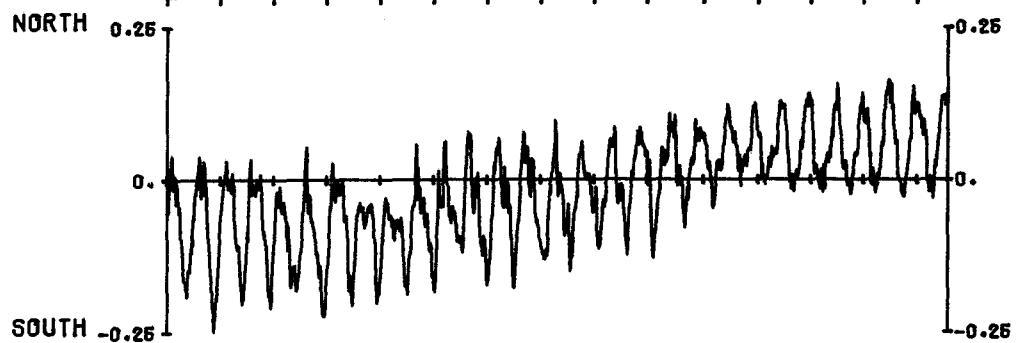
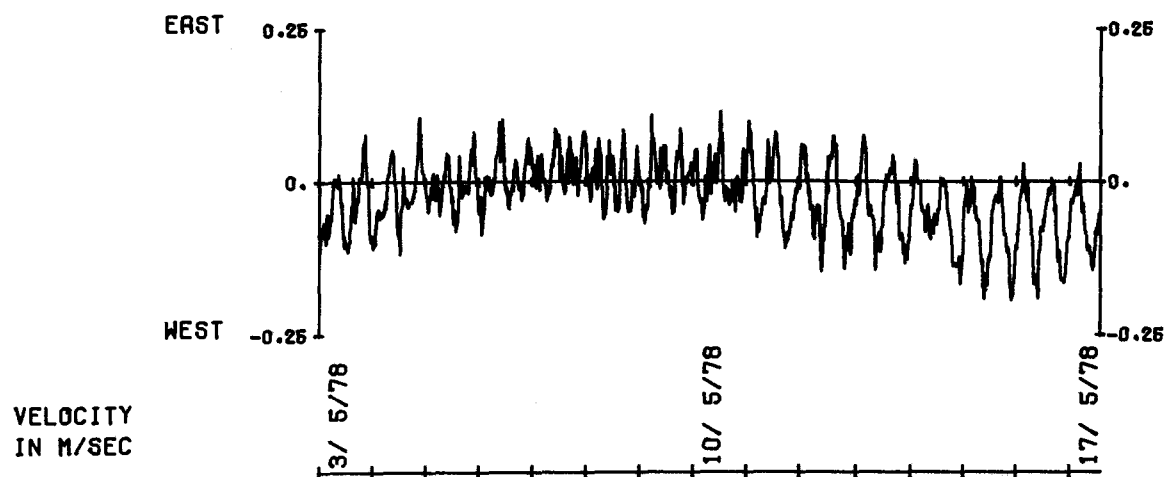
End of useful record : 13.30 GMT 17 May 1978

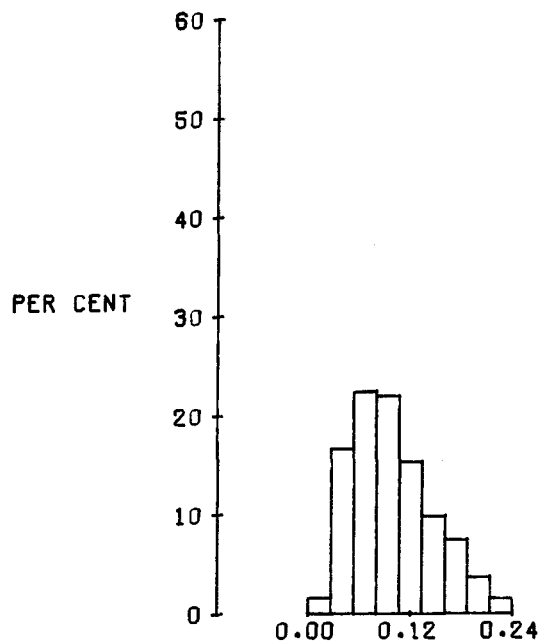
Length of useful record : 1086 h

Comments : The meter was borrowed from RVS,  
Barry. It was recovered in good  
condition. The data tape was  
difficult to translate because there  
was a high background magnetization  
level, and required interpolation of  
many short gaps.





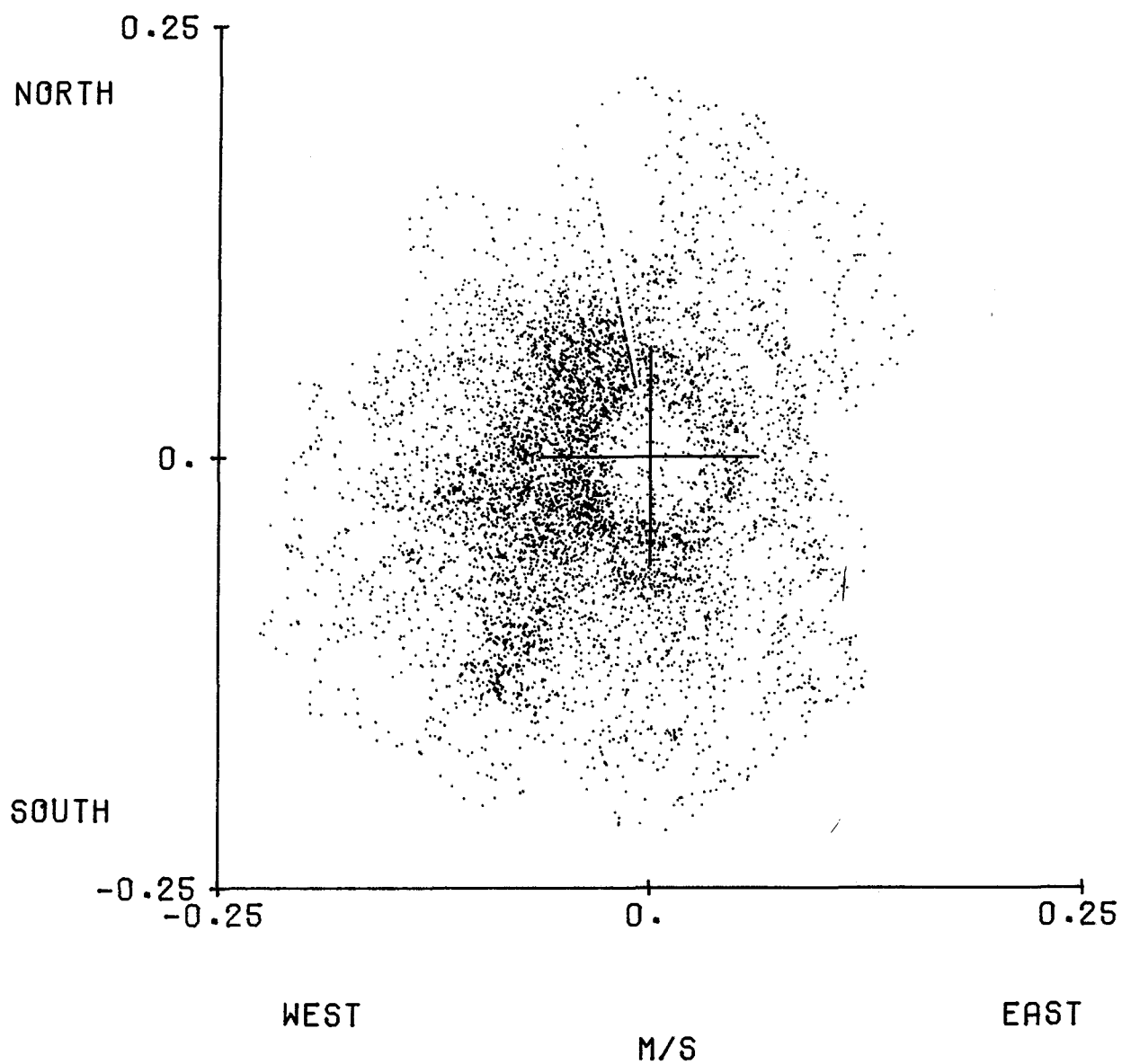


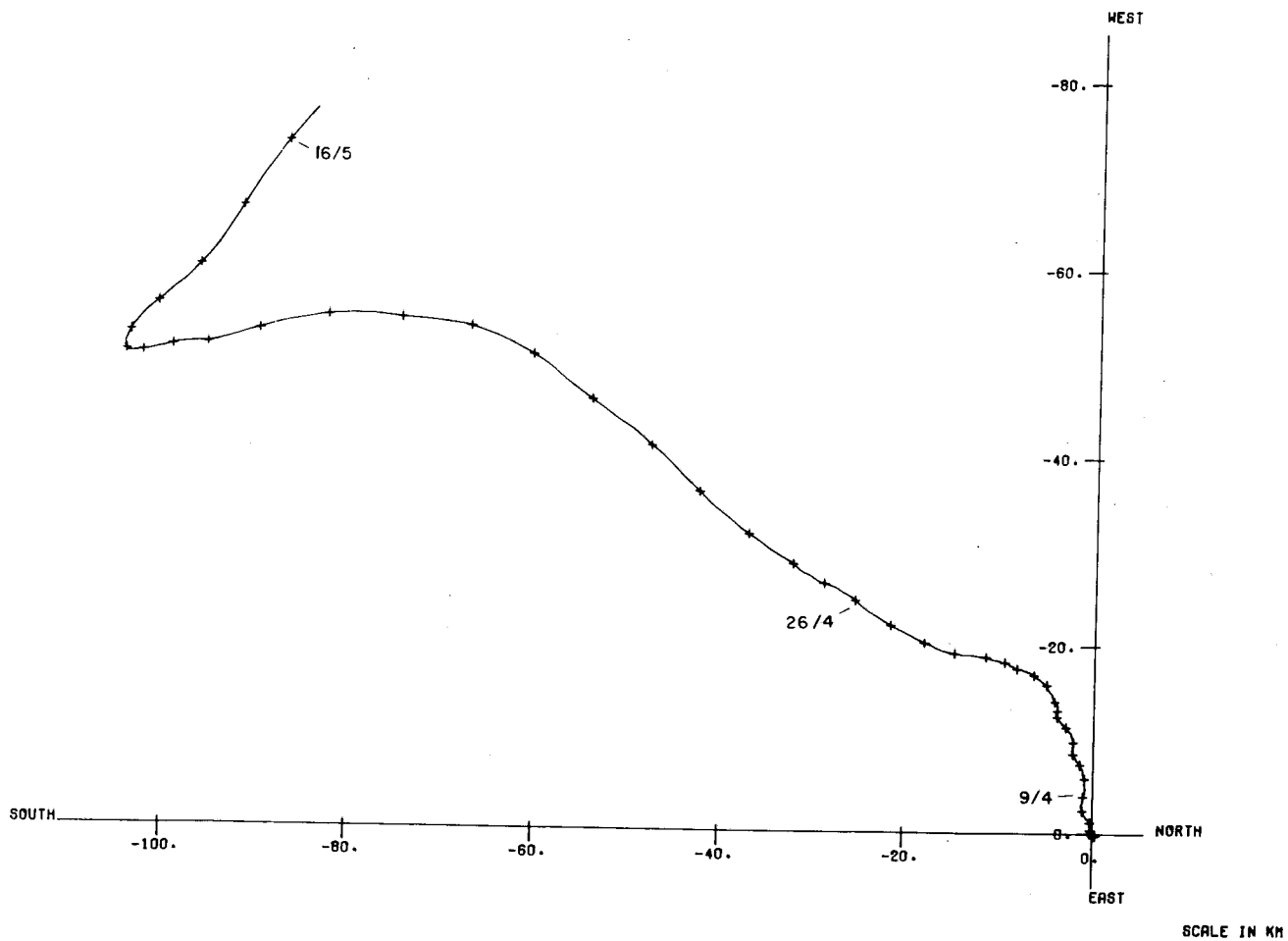
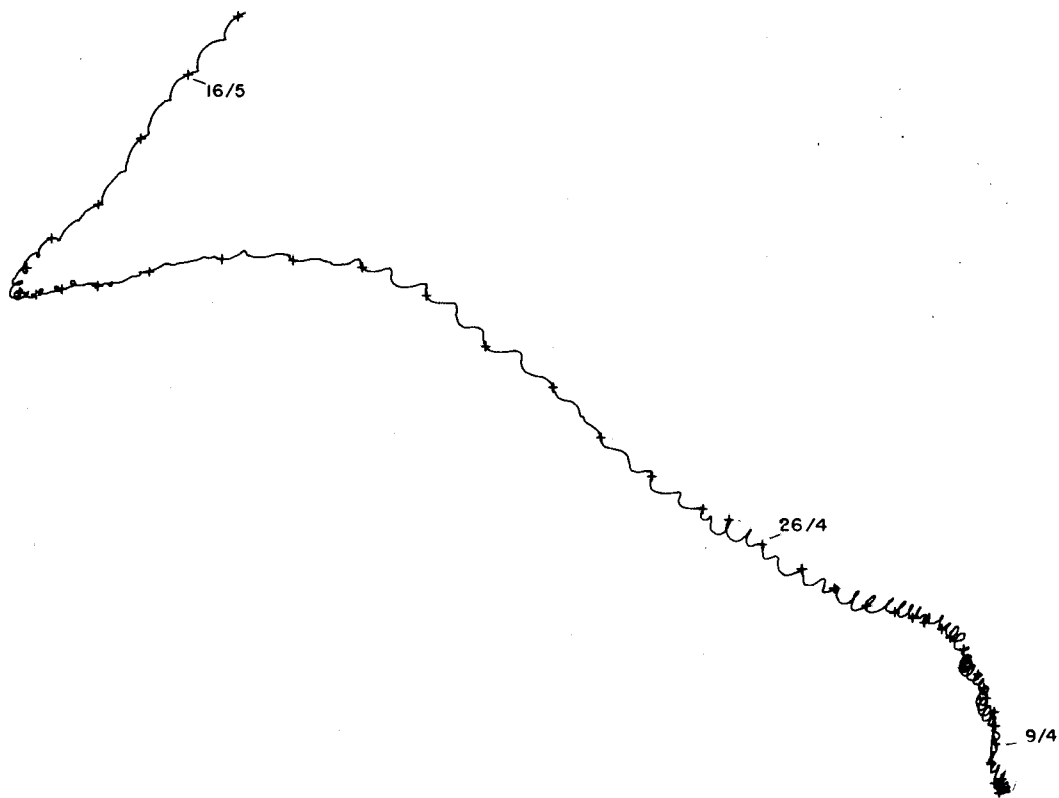


SPEED IN M/SEC

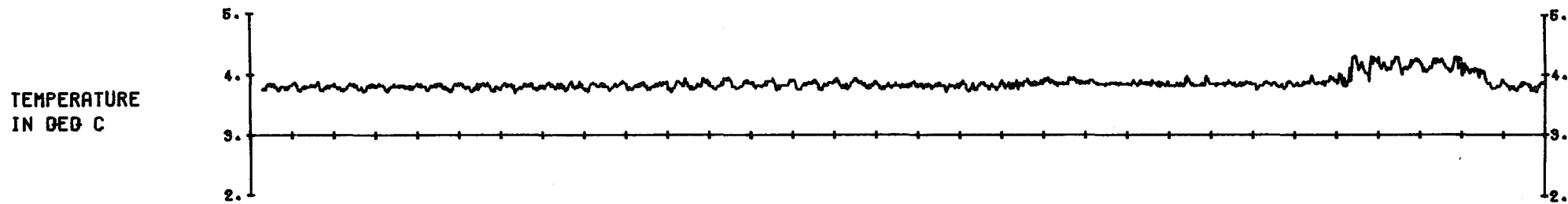
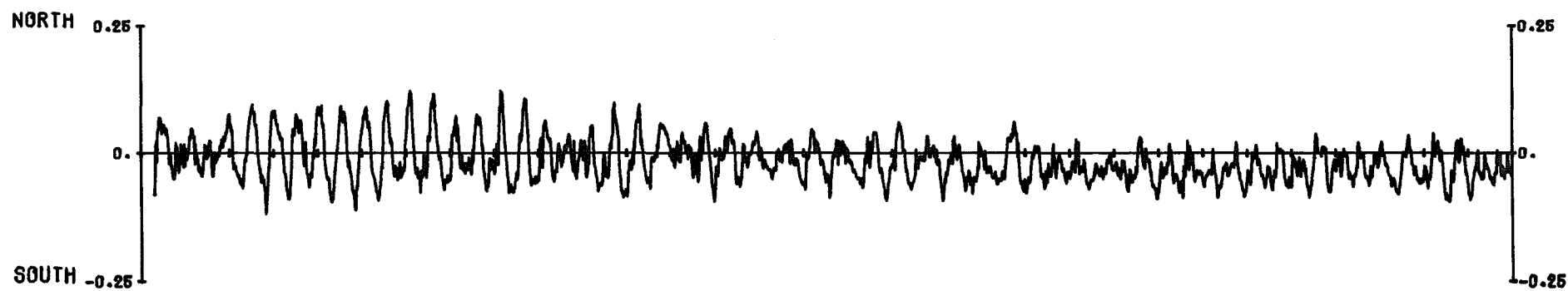
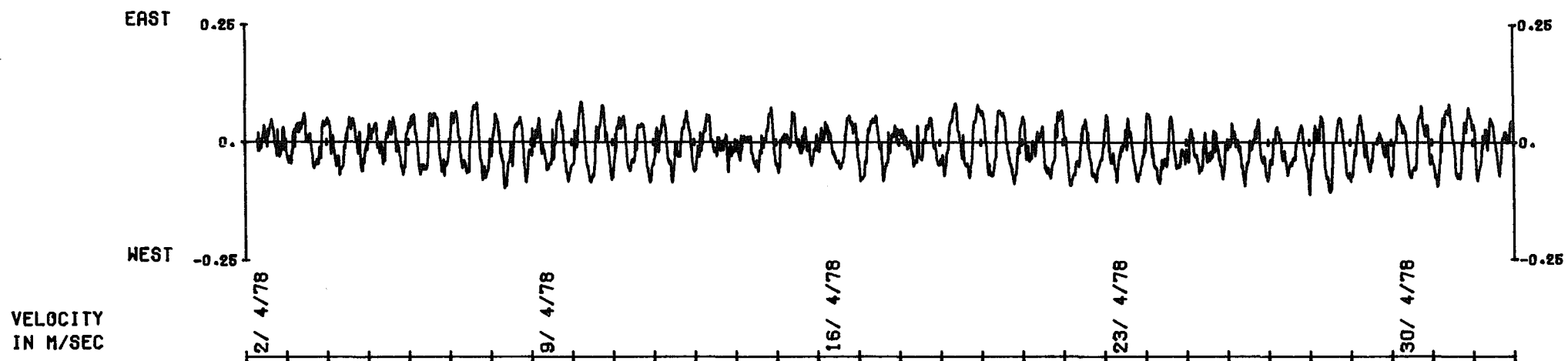


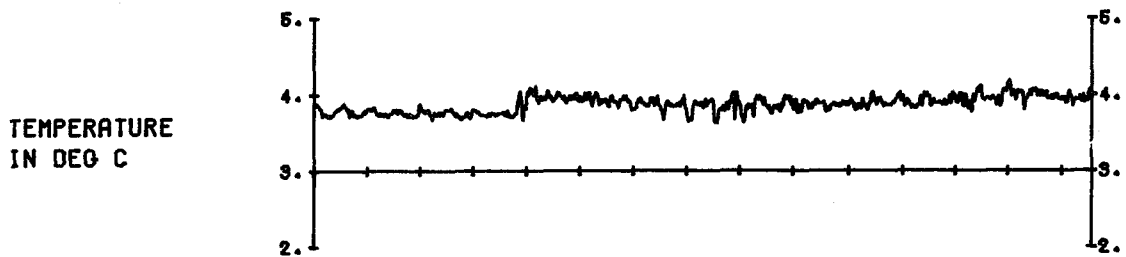
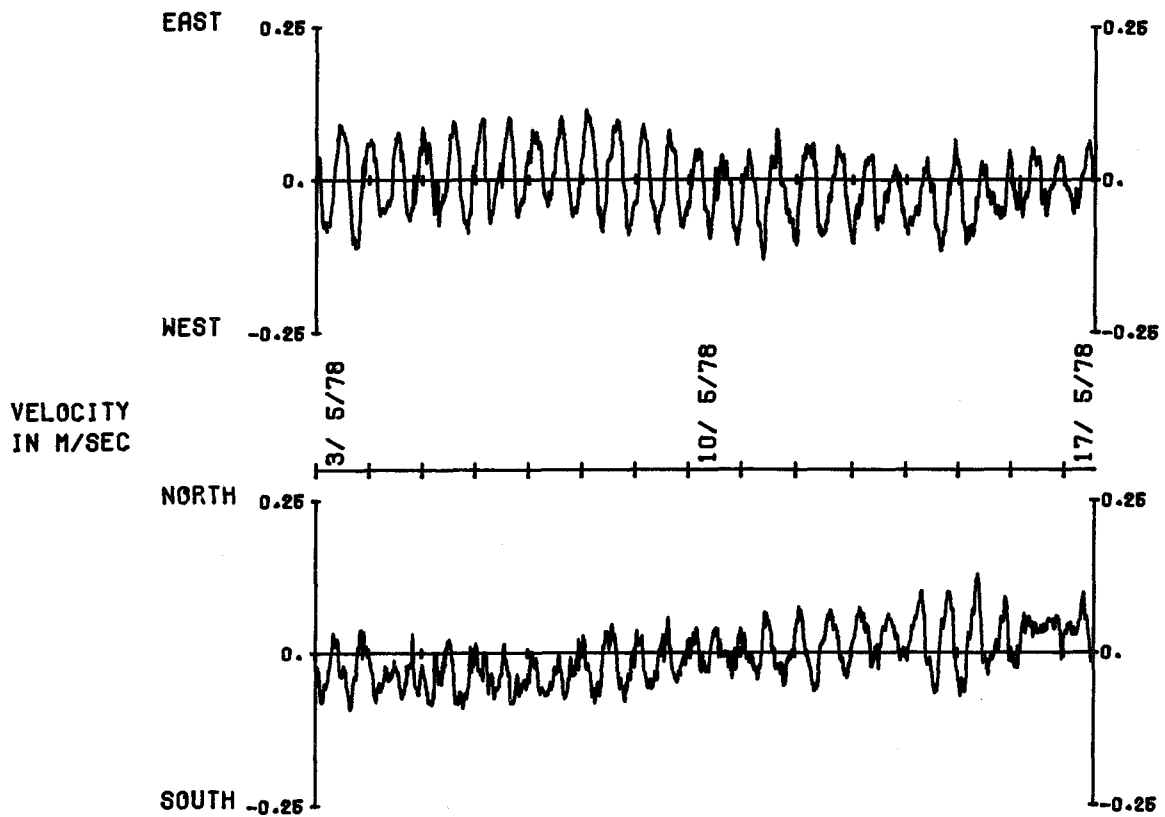
DIRECTION

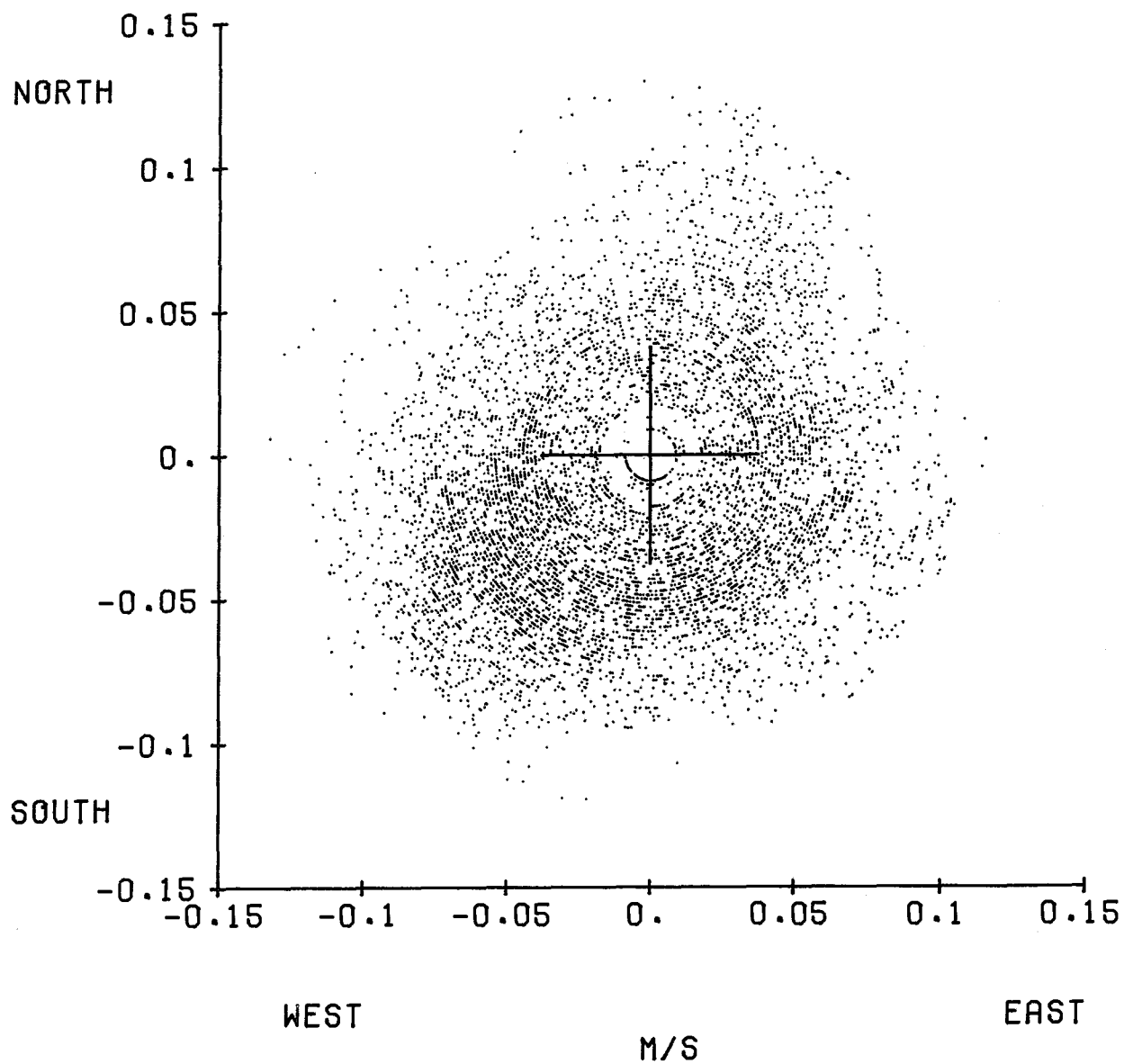
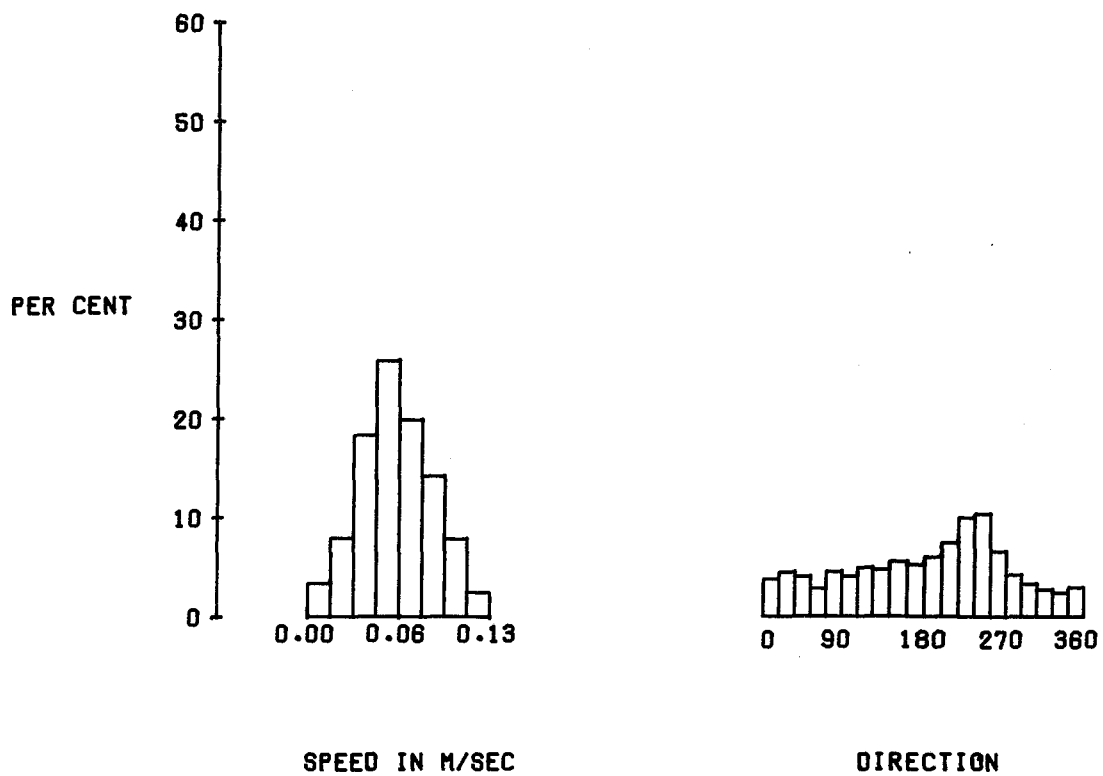




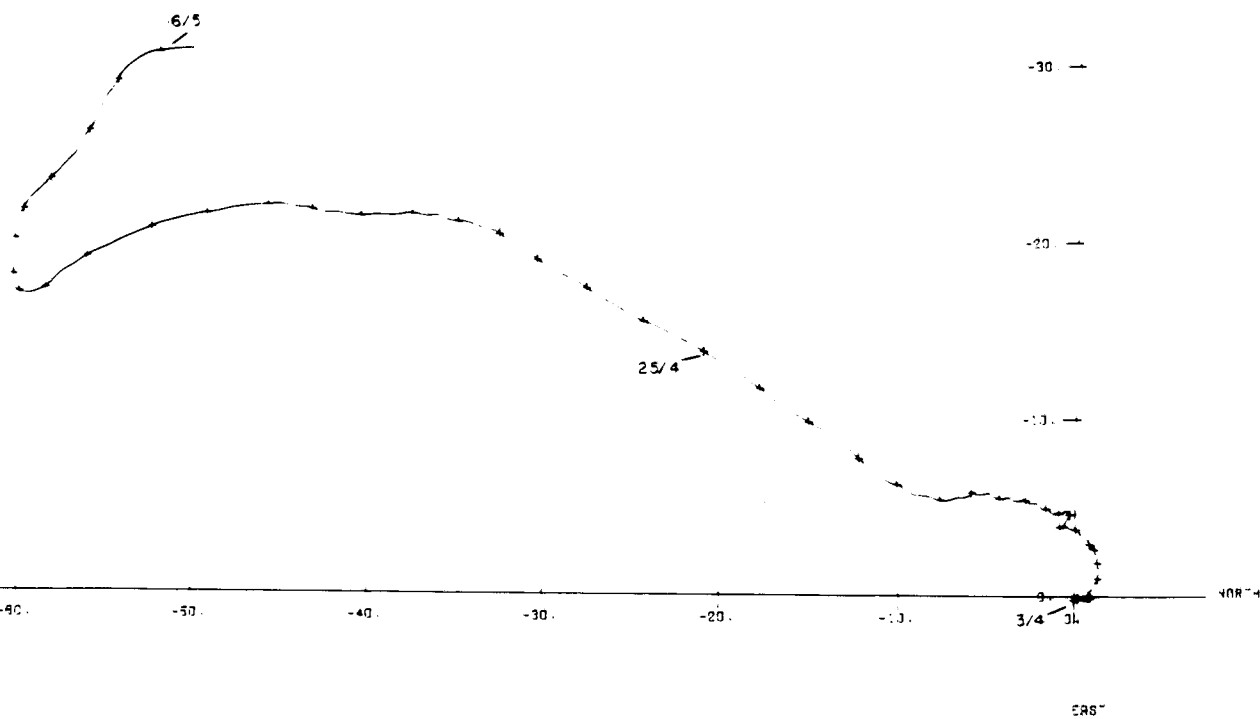
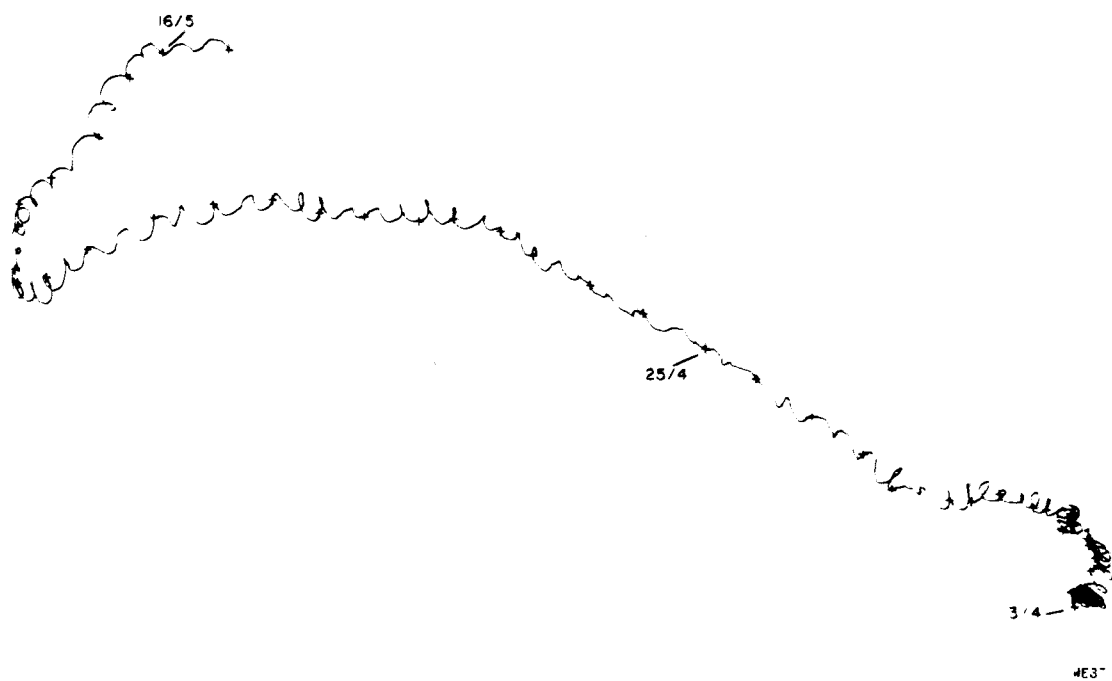
Meter : Aanderaa RCM5 No 3258  
Tape number : 3258/1  
Meter started : 00.50.00 GMT 2 April 1978  
Meter stopped : 14.10.16 GMT 19 May 1978  
Total number of readings : 6849  
Timing error : 16 s slow  
Start of useful record : 07.10 GMT 2 April 1978  
End of useful record : 13.30 GMT 17 May 1978  
Length of useful record : 1086 h  
Comments : The meter was borrowed from RVS,  
Barry. It was recovered in good  
condition and its record was good.



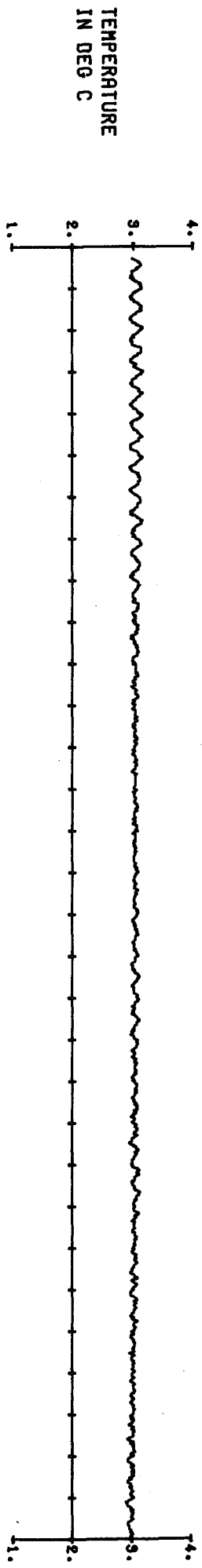
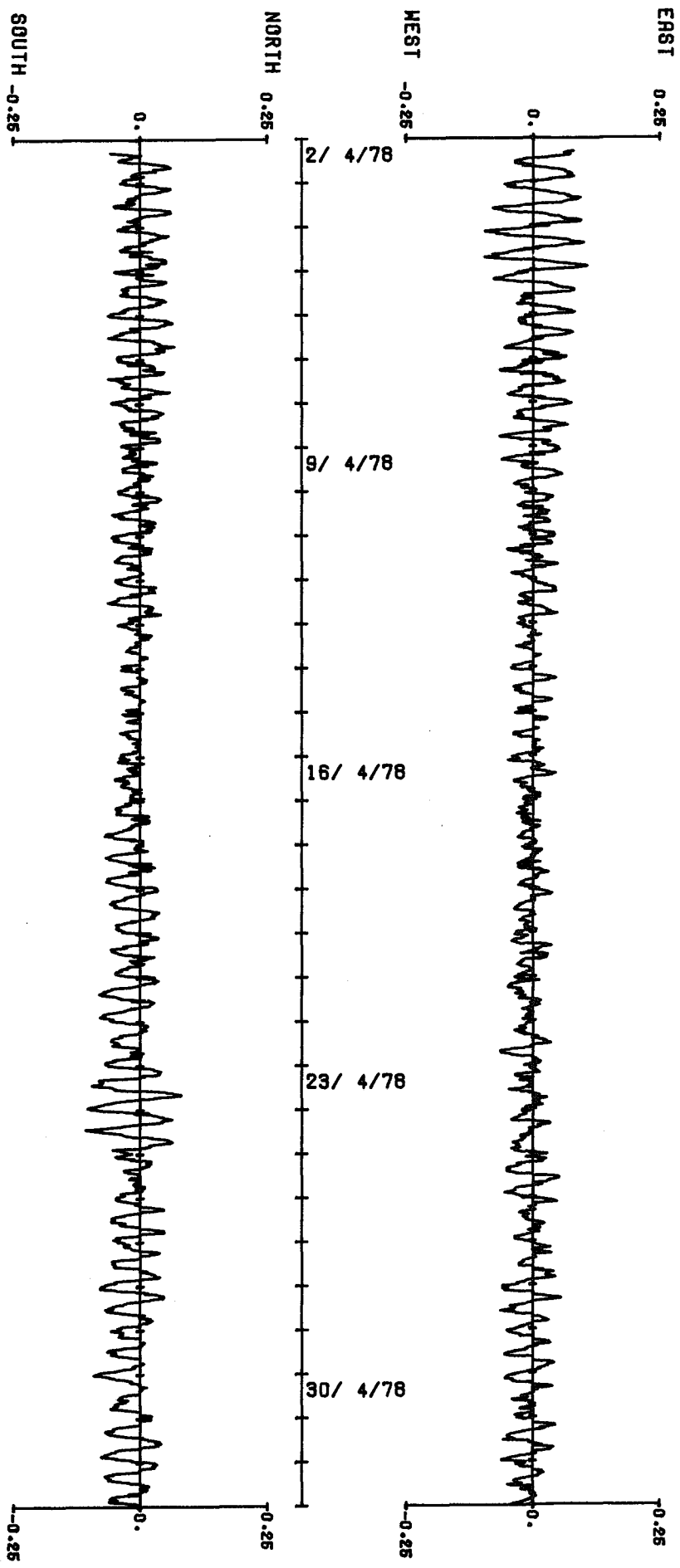


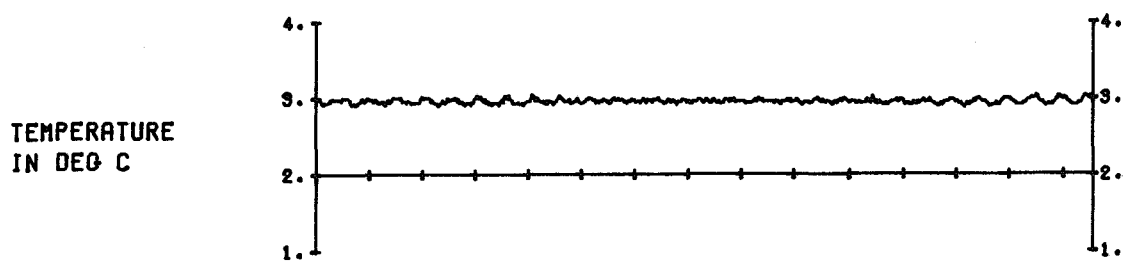
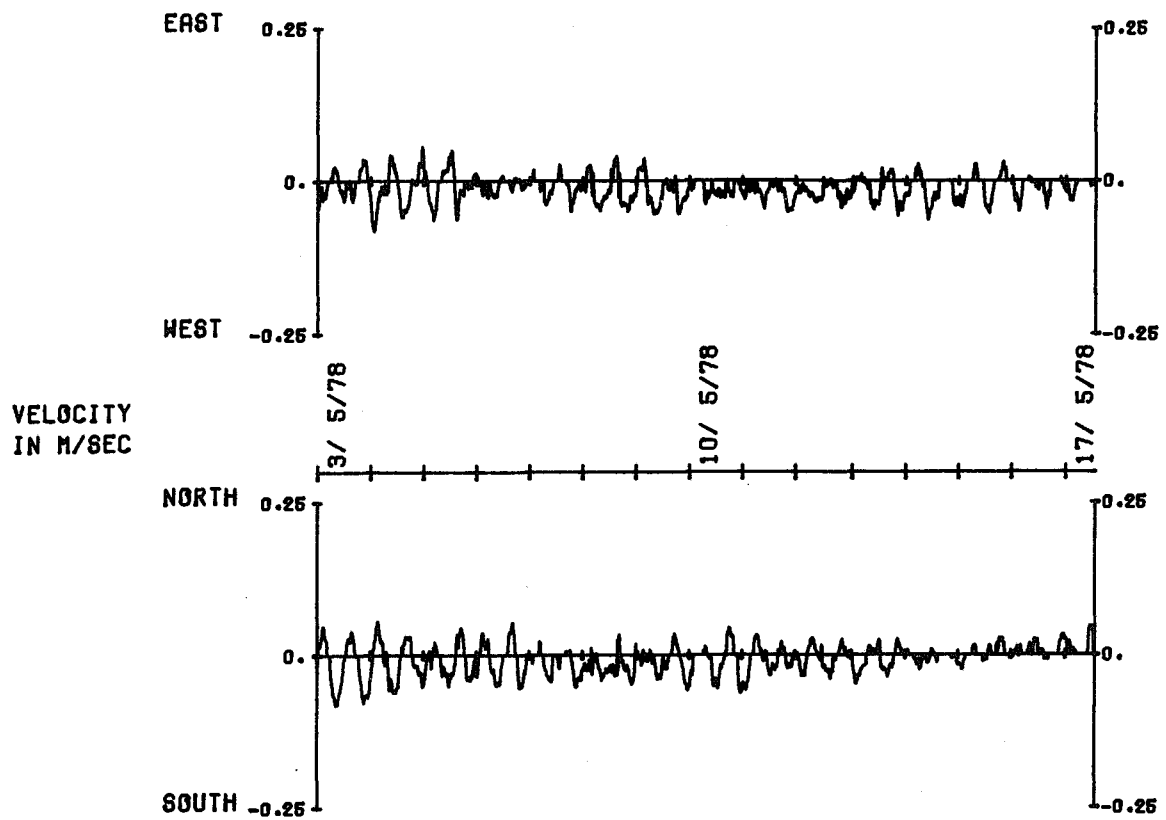


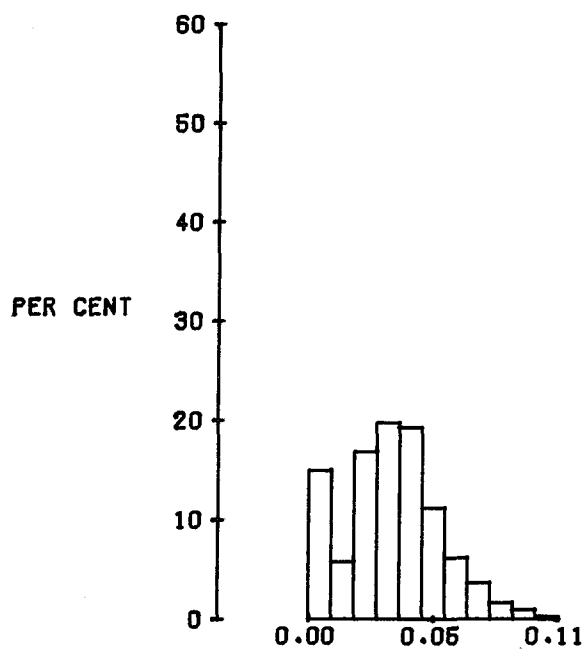




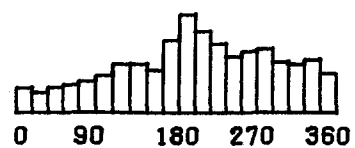
Meter : Aanderaa RCM5 No 3259  
Tape number : 3259/1  
Meter started : 00.30.00 GMT 2 April 1978  
Meter stopped : 12.00.30 GMT 19 May 1978  
Total number of readings : 6838  
Timing error : 30 s slow  
Start of useful record : 07.10 GMT 2 April 1978  
End of useful record : 13.30 GMT 17 May 1978  
Length of useful record : 1086 h  
Comments : The meter was borrowed from RVS,  
Barry. It was recovered in good  
condition and its record was good  
although there were 900 readings  
below the threshold speed of  
the rotor.



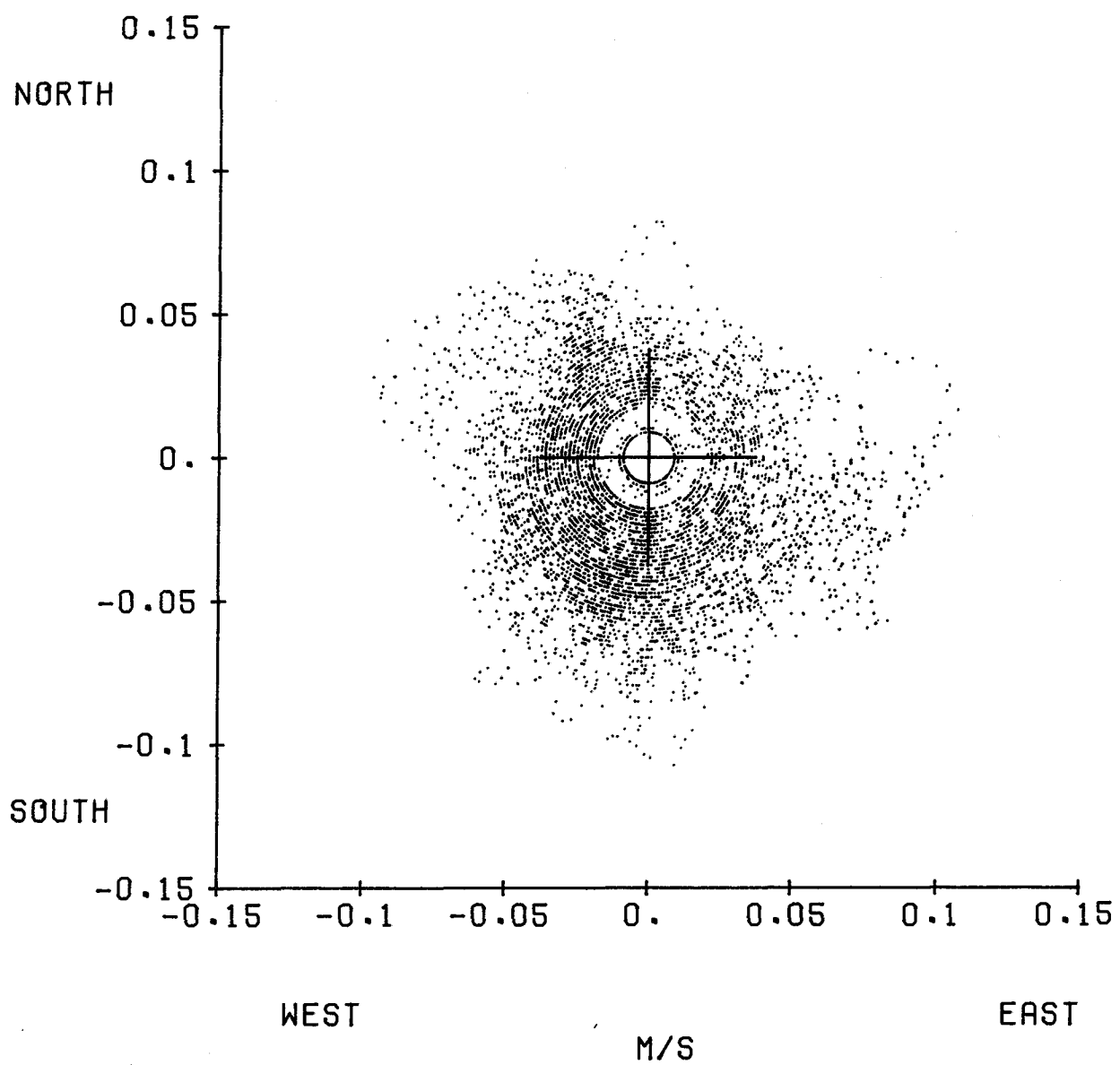


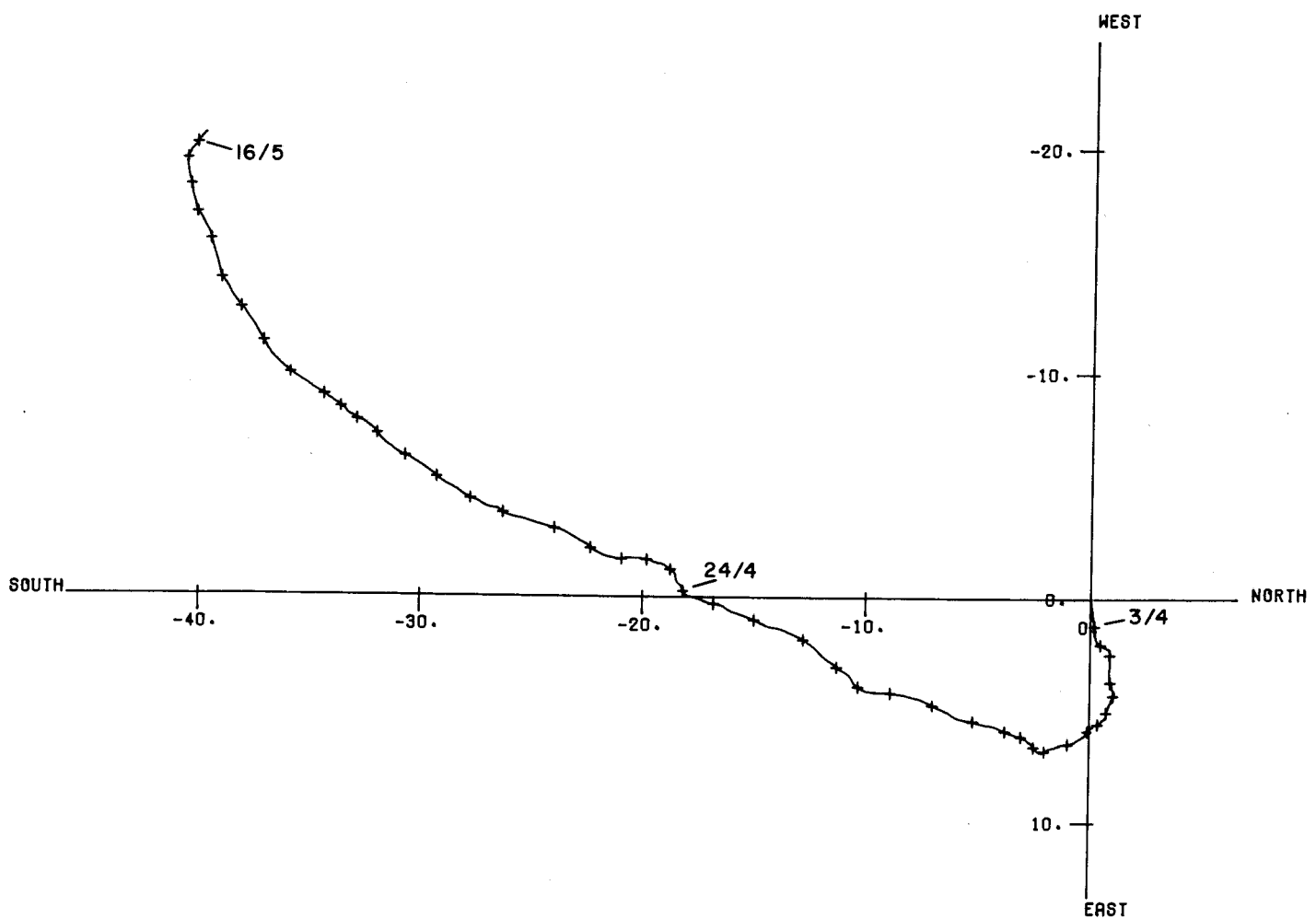
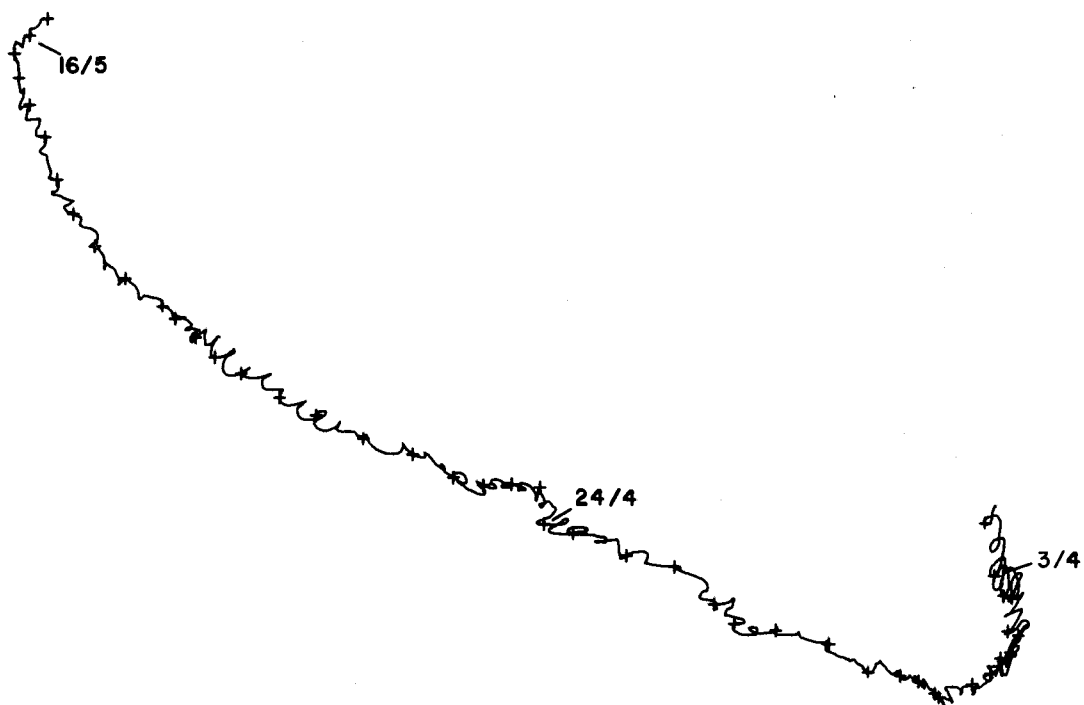


SPEED IN M/SEC



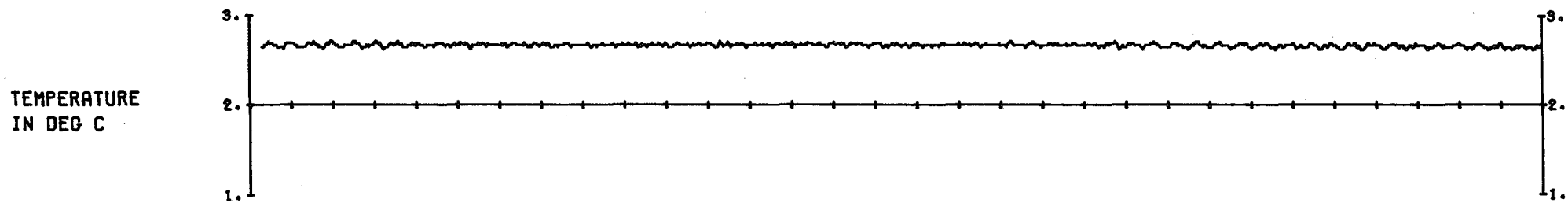
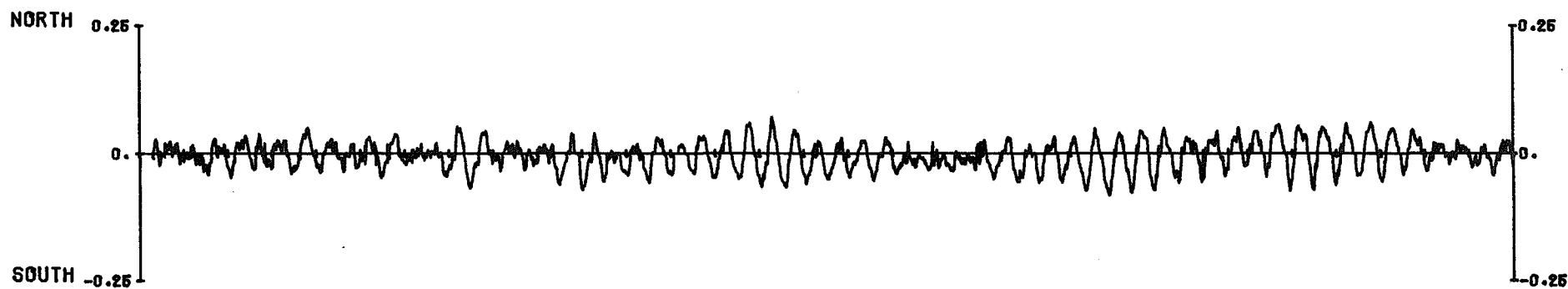
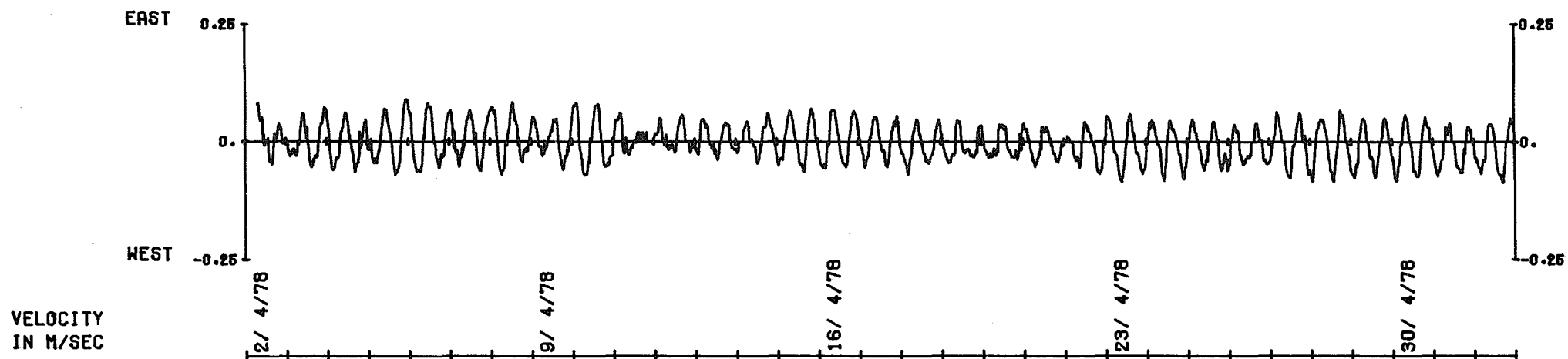
DIRECTION



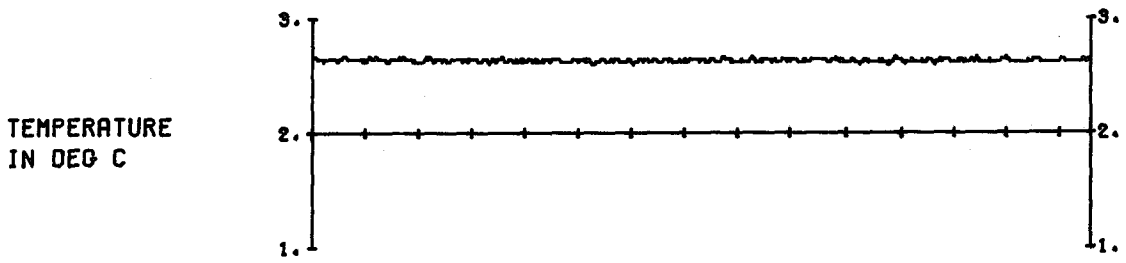
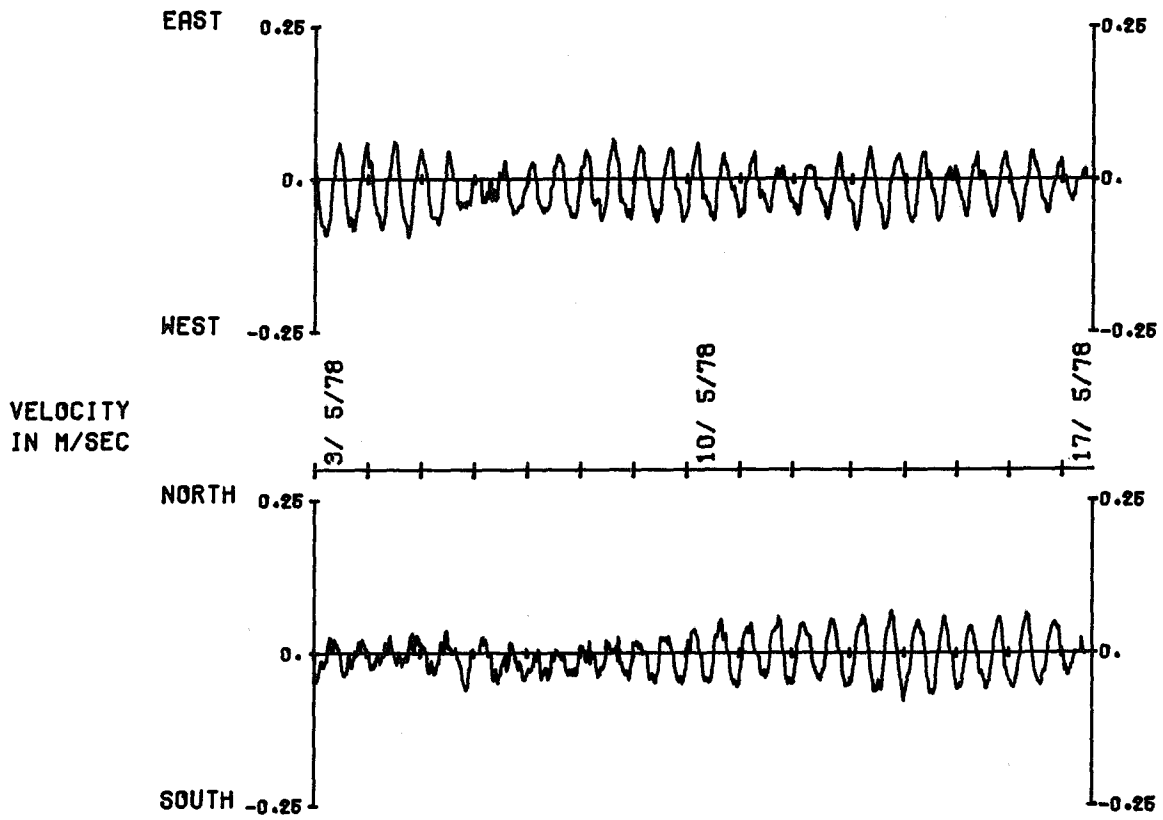


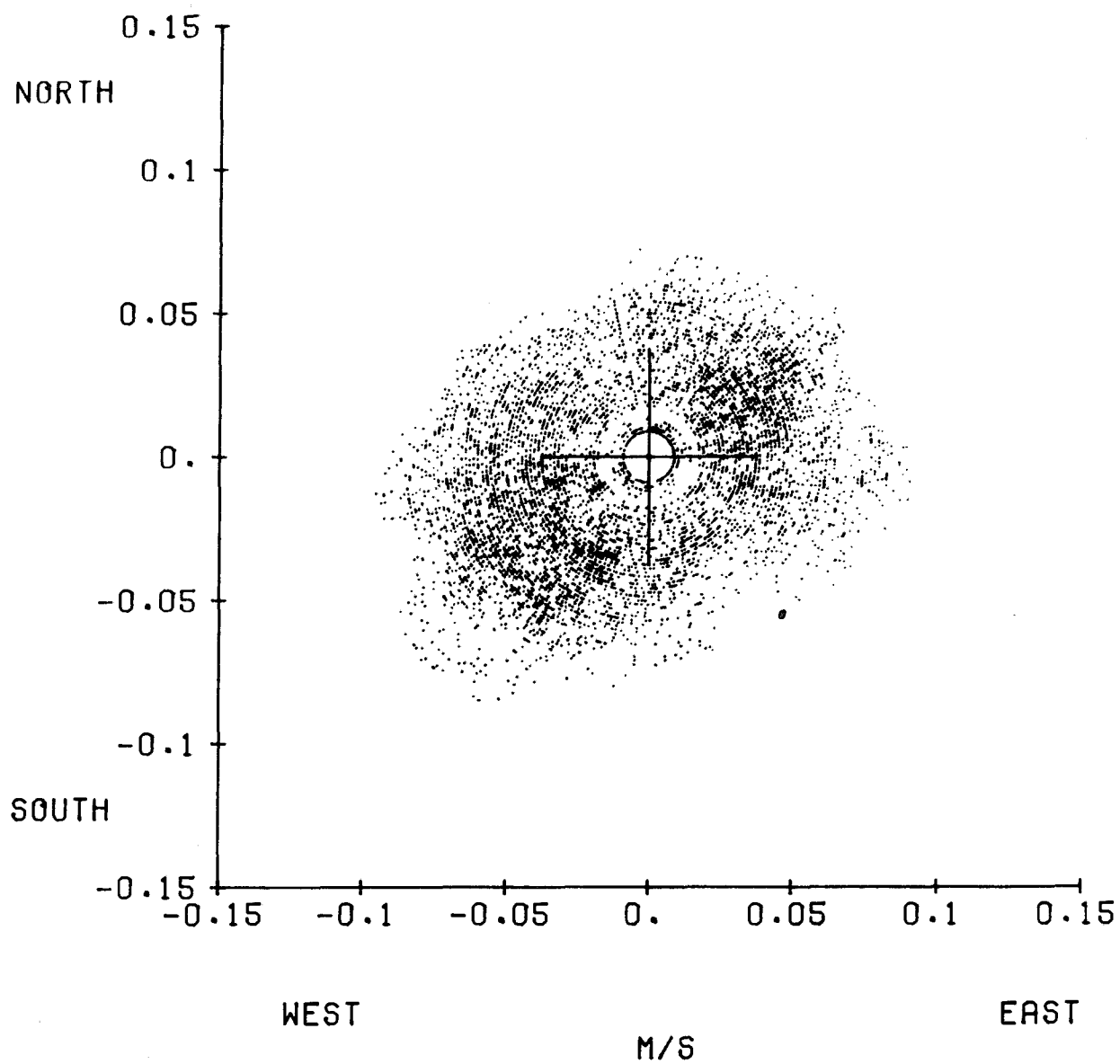
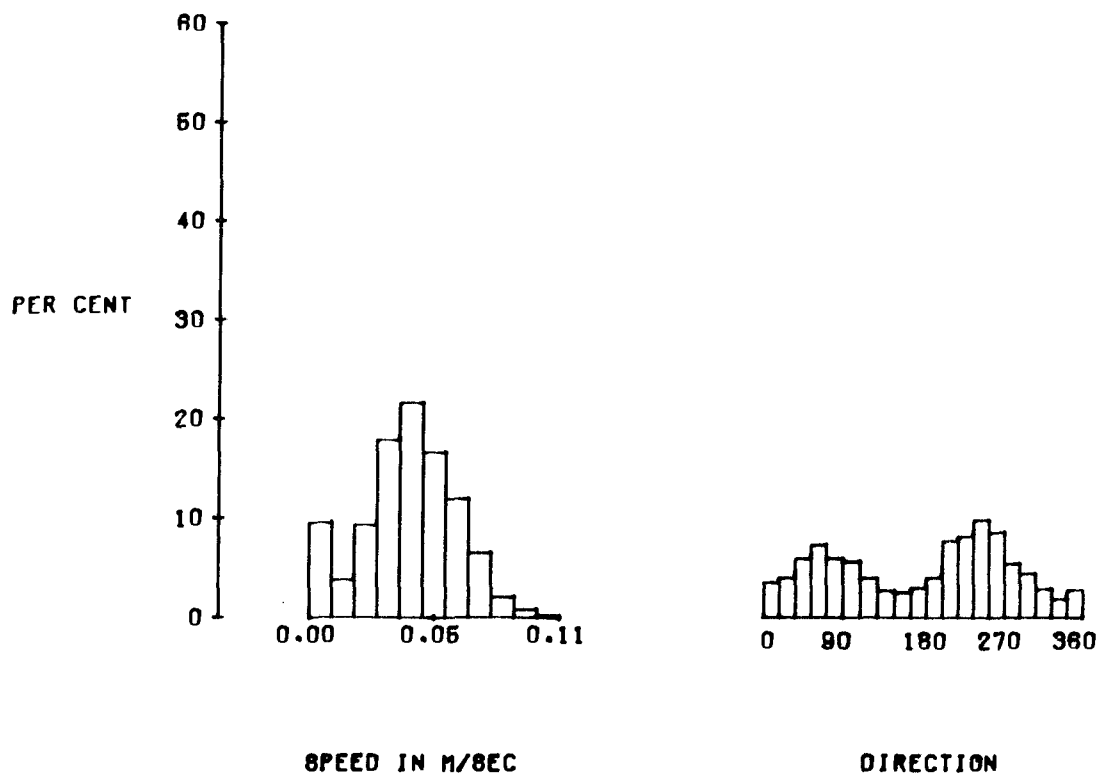
SCALE IN KM

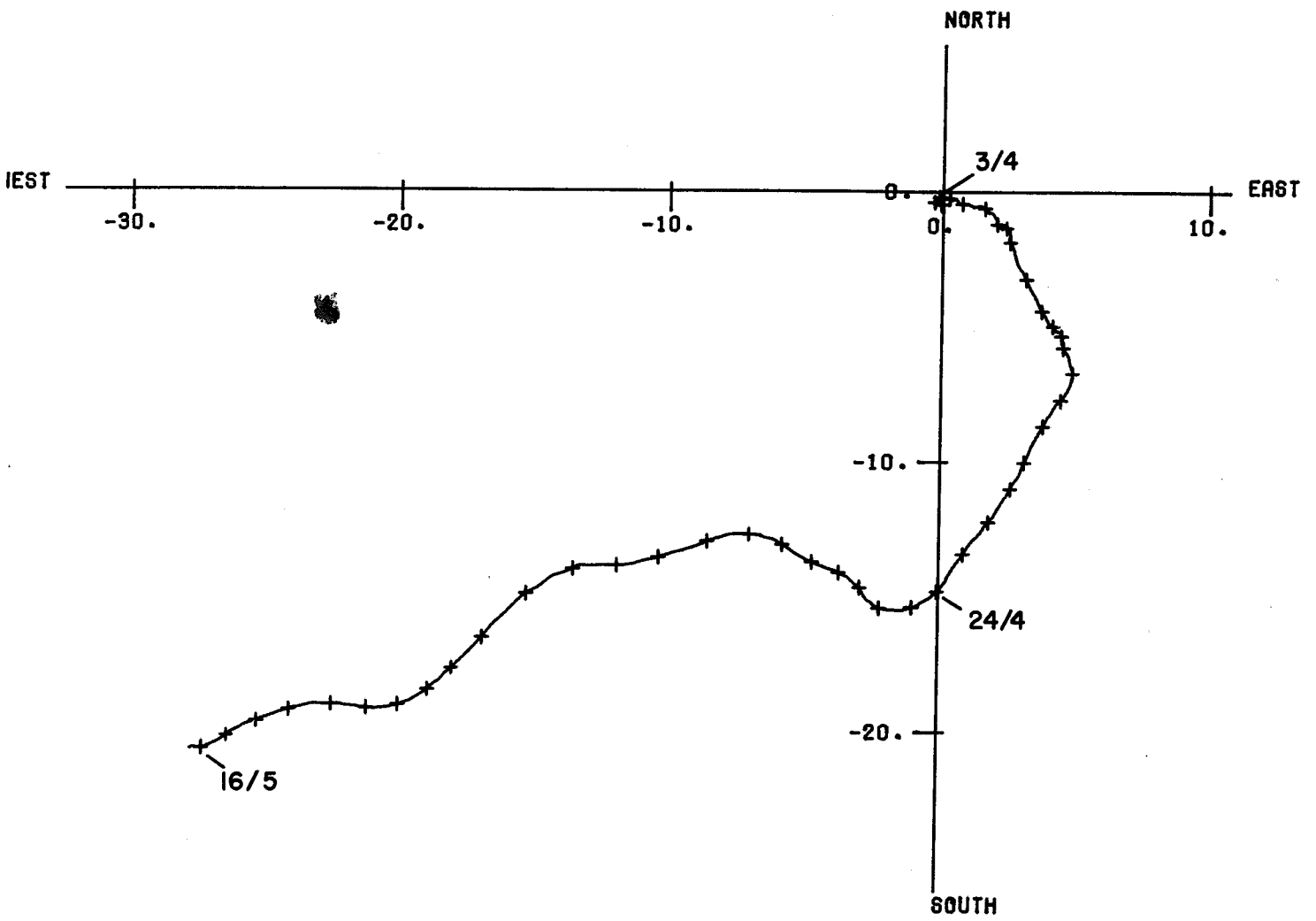
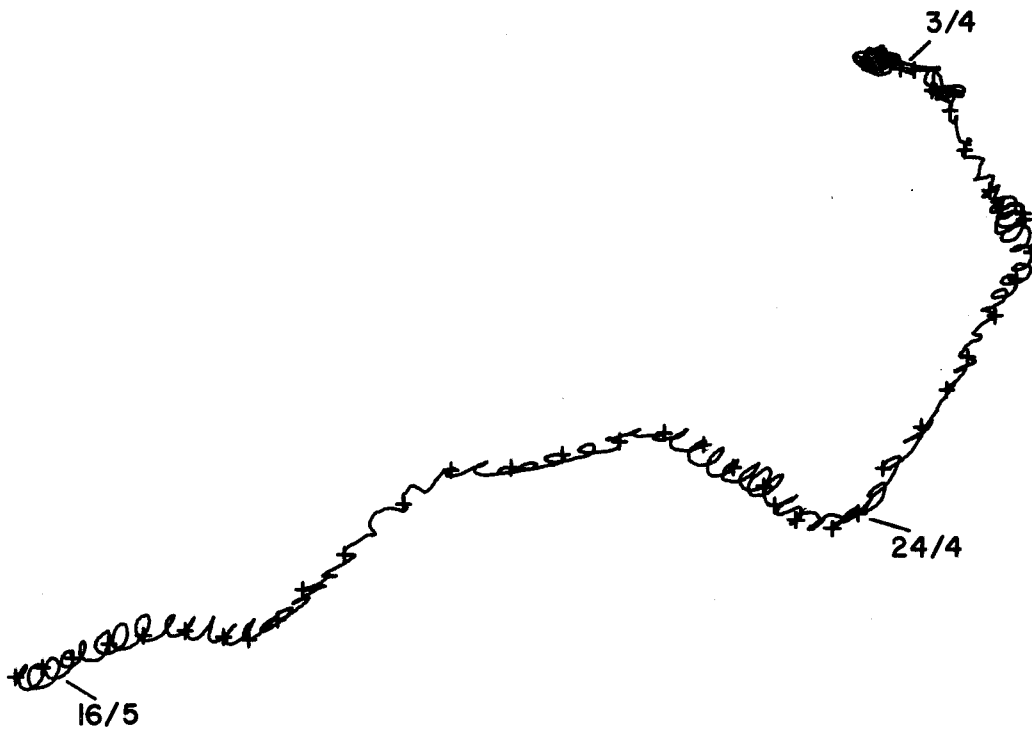
Meter : Aanderaa RCM5 No 3260  
Tape number : 3260/1  
Meter started : 23.50.00 GMT 1 April 1978  
Meter stopped : 14.19.05 GMT 19 May 1978  
Total number of readings : 6856  
Timing error : 55 s fast  
Start of useful record : 07.10 GMT 2 April 1978  
End of useful record : 13.29 GMT 17 May 1978  
Length of useful record : 1086 h  
Comments : The meter was borrowed from RVS,  
Barry. It was recovered in good  
condition and its record was good  
although there were 600 readings  
below the threshold speed of the  
rotor.











SCALE IN KM

Meter : Aanderaa RCM5 No. 3261

Tape number : 3261/1

Meter started : 22.30.00 GMT 1 April 1978

Meter stopped : 13.08.25 GMT 19 May 1978

Total number of readings : 6857

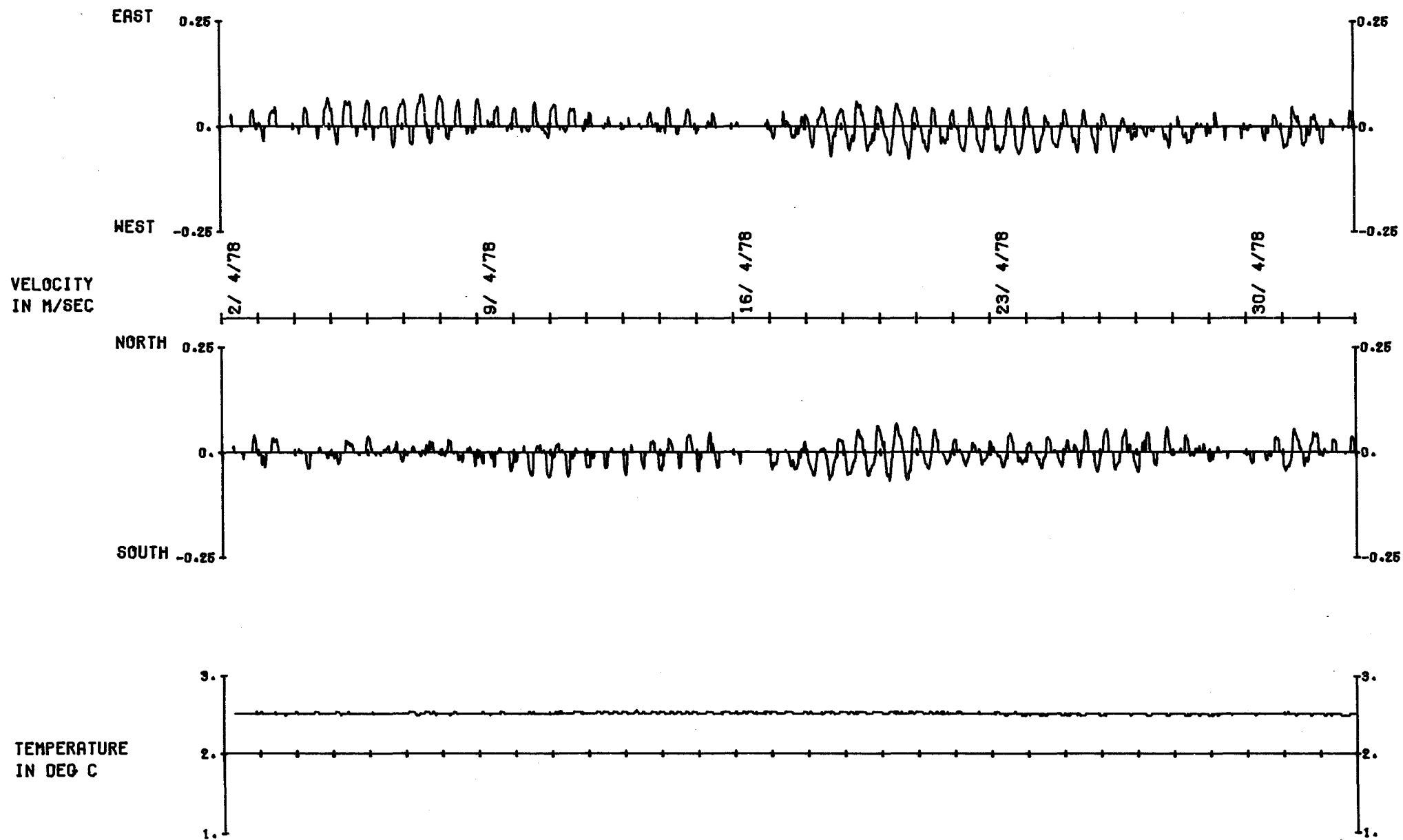
Timing error : 95 s fast

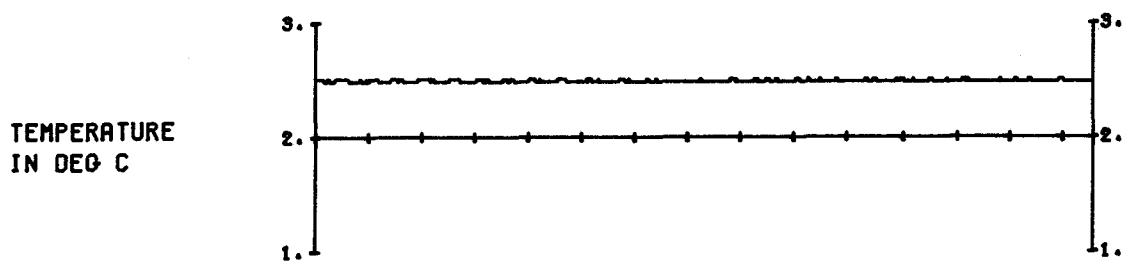
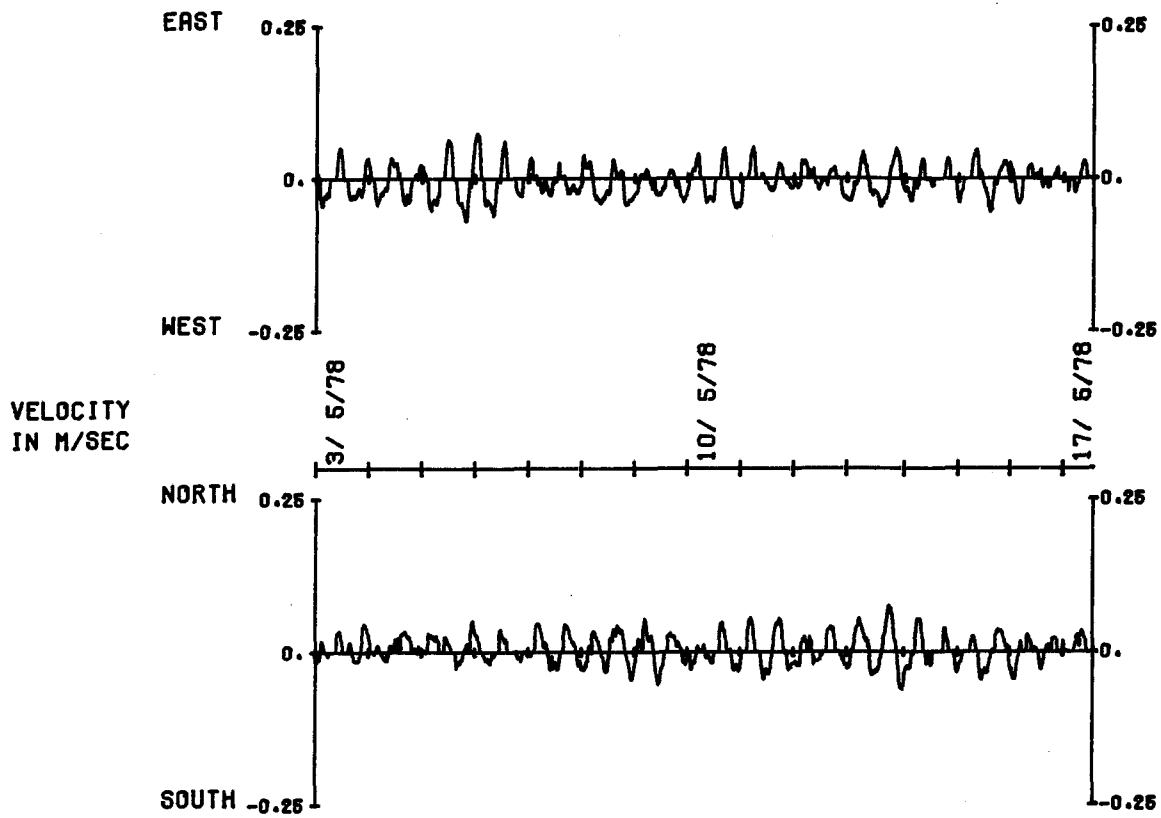
Start of useful record : 07.10 GMT 2 April 1978

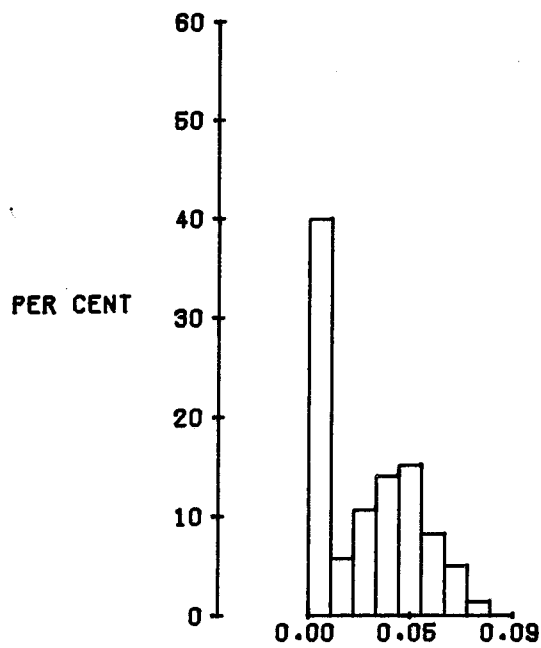
End of useful record : 13.28 GMT 17 May 1978

Length of useful record : 1086 h

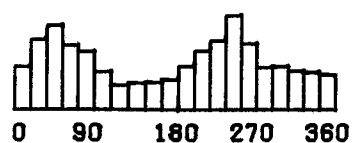
Comments : The meter was borrowed from RVS,  
Barry. It was recovered in good  
condition and its record was good  
although there were 2600 values below  
the threshold speed of the rotor.



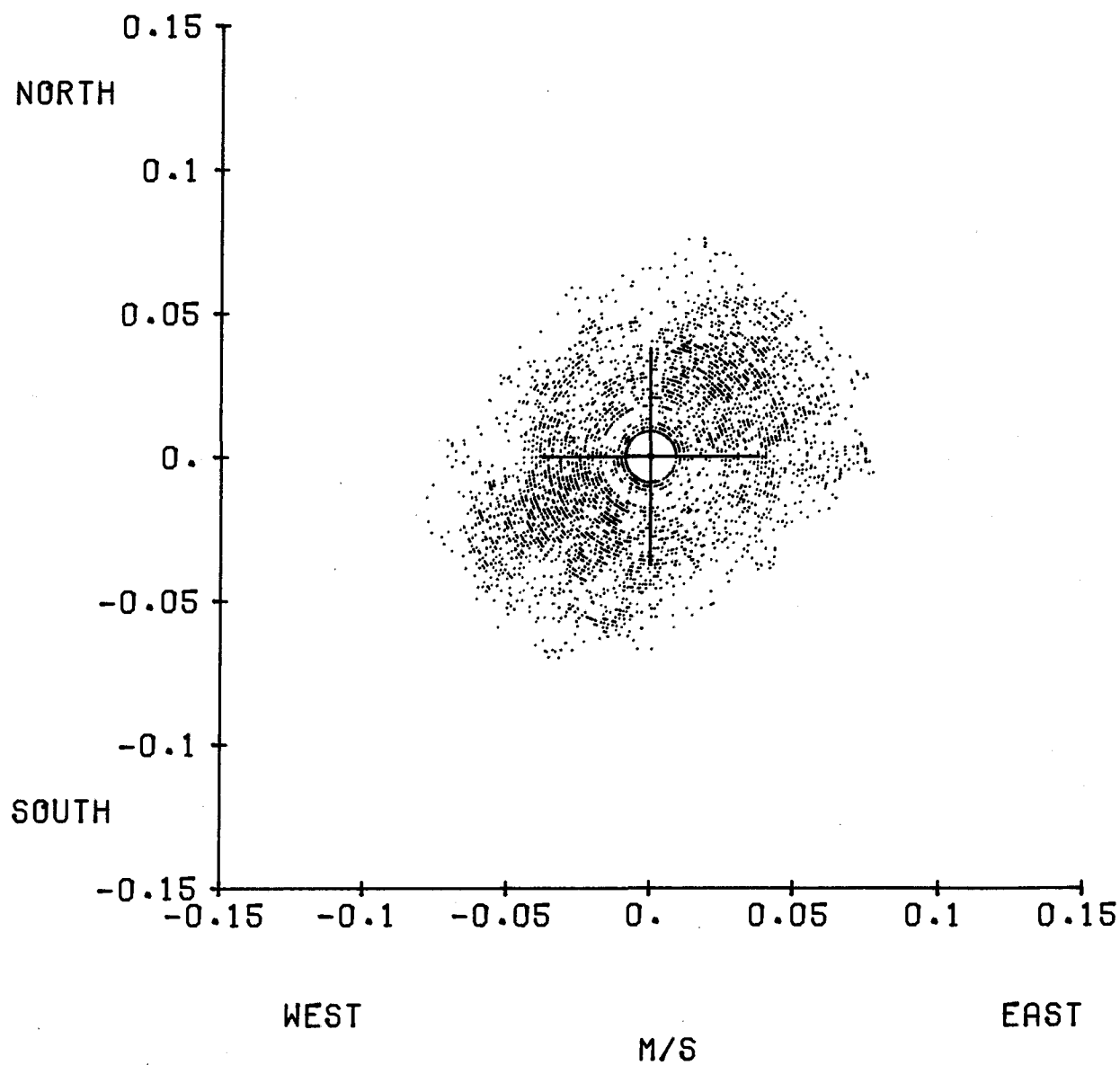


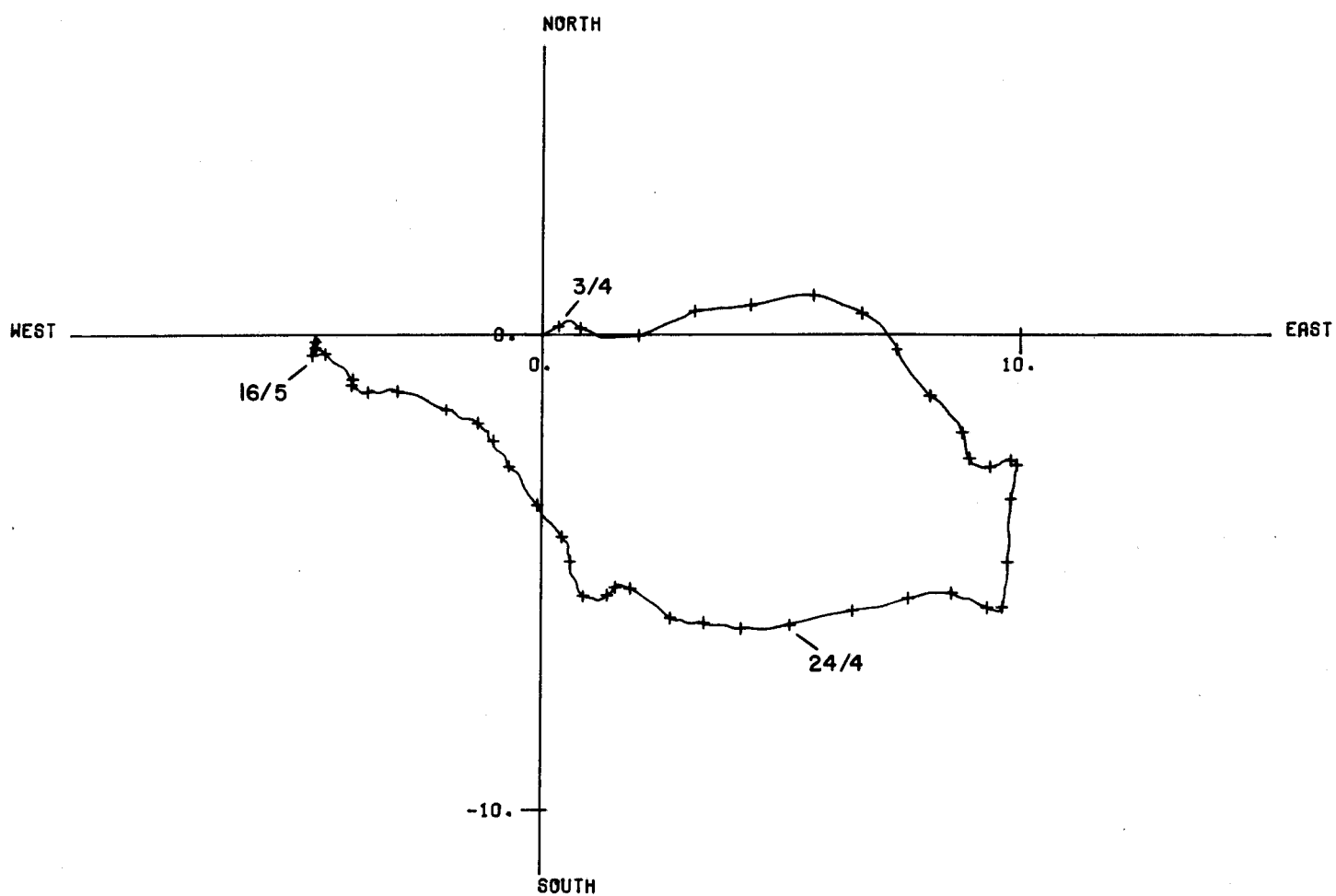
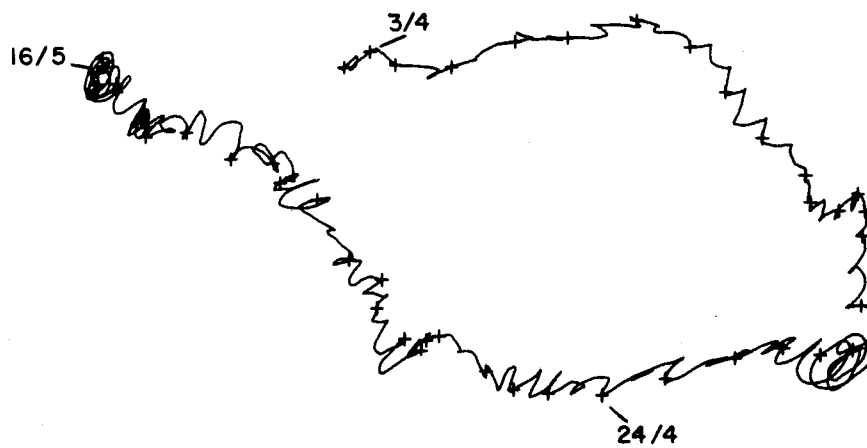


SPEED IN M/SEC



DIRECTION





SCALE IN KM





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