I.O.S.

MOORED CURRENT METER DATA FROM THE MADEIRA ABYSSAL PLAIN (GME) 2ND DEPLOYMENT (1984)

BY

P.M. SAUNDERS

REPORT NO. 228

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OCEAN DISPOSAL OF HIGH LEVEL RADIOACTIVE WASTE
A RESEARCH REPORT PREPARED FOR THE DEPARTMENT
OF THE ENVIRONMENT

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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WORMLEY

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RADIOACTIVE WASTE MANAGEMENT

Research Programme 1985/86

DoE Report No. DoE/RW/86.063

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Report Title: Moored Current Meter Data From the Madeira Abyssal Plain (GME), 2nd Deployment (1985).

Author: P.M. SAUNDERS

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Abstract (100-200 words as desired)

Near bottom currents have been measured at three closely spaced sites in the N.E. Atlantic for 22 months. This report describes the results for the period 13-22 months and closely follows the pattern used in describing the first 13 months of data (IOS Report No. 221, 1986).

The three locations were in the Great Meteor East study site area, near 31°30'N 25°W, one on the abyssal plain, one on top of a small abyssal hill about 400 m high and one on its eastern flank. For the period of this report current meters were moored 10,100 and 1000 m above the local bottom (5438 m, 5433 m and 4989 m) between February and November 1985.

The characteristics of the currents are displayed in numerous tables and figures: the mean currents for the 9 months are strikingly similar to those measured for the first 13 months. The variations in current strengths are also similar and yield eddy energies of between 2 and 3 cm^2 s^{-2} and horizontal (isopycnal) diffusivity of $2x10^2$ m^2s^{-1}. Currents in excess of 10 cm/s were considerably less frequent than found for the earlier data set.

Keywords: 126,299 - Ocean circulation/dispersal, DoE sponsored research

CONTENTS

PREFACE

The research described in this report is concerned with the scientific assessment of the feasibility of the disposal of heat generating radioactive waste (HGW) into the deep sea environment. It deals with the deep ocean water column and is aimed at understanding both the mechanism of and the rate of dispersion of a trace substance released from the sea bed. Interest is focussed on a fixed site [Great Meteor East - GME] near 31°30'N and 25°W where the tracer is imagined released but the dispersion of the tracer by currents requires investigation around the site too.

The Natural Environment Research Council, through the Institute of Oceanographic Sciences, has a contract with the Department of the Environment (DoE PECD 7/9/216-42/84) to complete at least 2 years of detailed water movements near the sea bed at the GME study site and to report on the oceanography of the area together with estimates of dispersion rates and the occurrence of strong currents.

This report summarises the results of current measurements at GME for months 13-22. Some comparisons are made with the first 12 months of data. The final deployment of instruments was made in December 1985 and will be recovered in September 1986 to yield a record whose duration exceeds two and a half years.

INTRODUCTION

Measurements of currents near the sea-bed in the very deep parts of N.E. Atlantic Ocean have been carried out in the past 5 years at IOS. Both moored current meters and drifting neutrally buoyant floats have been employed and the results have been reported in the literature[1]. Financial support for this work was provided by the Department of the Environment.

A new programme of measurements in the water column was started in 1984. These include observations of currents at a specific site (GME) employing moored current meters and measurements of dispersion using a group of neutrally buoyant floats drifting freely at a depth of 3000 m and tracked from acoustic listening stations. Both measurement programmes are to last at least 2 years.

After one year had elapsed (February 1985) the moorings at GME were recovered and a second deployment made. These have also been recovered (December 1985) and a third deployment made. It is planned to recover this instrumentation in September 1986 yielding a continuous record exceeding 2.5 years length. This report describes the moored current meter data for the second deployment lasting approximately 9 months. It follows very closely the pattern of the first report[2] which dealt with the first 13 months of data.

MOORING DESCRIPTION

Three moorings (IOS numbers 365-367) were recovered on cruise 1/85 of the RRS Charles Darwin in late February 1985 and were replaced by identical moorings 391, 389 and 387 respectively. In turn the second set of moorings were recovered on cruise 9A/85 of the same ship in November 1985 and replaced. This report is concerned with data from the second set of moorings. The mooring design was described in the earlier report[2] and here we will only draw attention to the tabulation of information on moorings and instrumentation in table 1 and the figures 1 and 2. As before we employ the following notation:- PLAIN for mooring 391 (earlier 365), HILL-FOOT for 389 (earlier 366) and HILL-TOP for 387 (earlier 367). Instruments on each mooring are numbered from the top down, vis 39101 is 1000 m above bottom and 39103 just 10 m above bottom, both on mooring 391.

TABLE 1 Mooring Information

Identification	Latitude, °N	Longitude, °W	Water depth, m*	Instrument depths, m*+
387 HILL-TOP	31 29.2	25 08.4	4989	3900,4882,4978
389 HILL-FOOT	31 30.4	25 03.1	5433	4341,5327,5422
391 PLAIN	31 30.2	24 45.2	5438	4347,5333,5427
- GMEBOX	31 14.9	25 26.6	5450	5447

* Corrected according to Carter's tables

\+ All instruments Aanderaa RCM5

With these nine records we have included a tenth; the latter of four months' duration deployed on RRS Discovery cruise 156 in July 1985 and recovered on RRS Charles Darwin cruise 9A/85 in November of the same year. This current meter was combined with a camera in a bottom mounted package known at IOS as BATHYSNAP. Its location was about 40 km SW of the HILL-TOP mooring, is shown on figure 1, and will be referred to as GMEBOX.

INSTRUMENTATION AND DATA QUALITY

The data were gathered with Aanderaa RCM5 current meters at a sampling interval of 1 hour. The earlier report[2] described our procedures for calibrating rotor speed, compass direction and temperature. Here we note the rotor calibration equations:-

for mooring 387 $s = 46.25\ \Omega + 1.8$

389 $s = 45.0\ \Omega + 1.5$

391 $s = 47.5\ \Omega + 1.7$

where Ω is the number of revolutions/second and s is the current in cm/s. For Ω = 0.2 revs/sec s = 11.0, 10.5, 11.2 cm/s respectively (compared with 10.9 cm/s for the group of instruments deployed for the first 12 months of

the experiment).

The data recovery was again very good; 7 of the instruments furnished full 9 month records, and one (39101) was 7.5 months long. Instrument 38903 failed after four months. GMEBOX was on location only 4 months and yielded a full-length record. Six of the temperature records were judged of high quality. See table 2 for a summary of this information.

TABLE 2 Duration and Quality of Records

Ident.	Depth, m	Start	End	Duration days	Comments
HILL-TOP					
38701	3900	24 Feb '85	18 Nov '85	267	
38702	4882	"	"	"	) Temps incompatible
38703	4978	"	"	"	) between 38702 and 38703
HILL-FOOT					
38901	4341	24 Feb '85	18 Nov '85	267	
38902	5327	"	"	"	
38903	5422	"	20 Jun '85	"	Short, temp. discarded
PLAIN					
39101	4347	27 Feb '85	5 Oct '85	220	Sltly short
39102	5333	27 Feb '85	18 Nov '85	264	Temp discarded
39103	5427	"	"	264	
GMEBOX	5447	19 Jul '85	19 Nov '85	122	Full-length

DATA PROCESSING

Data processing and the treatment of stalled rotor readings is adequately covered in the earlier data report[2].

SUMMARY OF RESULTS

The mean values for the 9 months-long records are presented in table 3 for the ten instruments. As noted earlier the currents are weak[3]. In general character the nine-month records are strikingly similar to those measured in the previous thirteen months[2]. In the lowest 100 m the mean currents have quite different directions at the three sites, viz: PLAIN - west, HILLFOOT - south and HILLTOP - east. At 1000 m above the bottom currents are generally (but not invariably) weaker as found previously and somewhat more alike.

TABLE 3 Record means of speed, direction and temperature

Ident.	Nom. ht above bottom, m	Speed cm/s	Direction °T	Temp. °C	Duration days
HILL-TOP					
38701	1000	0.27	326	2.486	267
38702	100	1.30	092	2.423?	267
38703	10	1.34	080	2.431?	267
HILL-FOOT					
38901	1000	0.82	182	2.435	267
38902	100	1.96	185	2.473	267
38903	10	2.25	204	-	116
PLAIN					
39101	1000	1.18	265	2.452	220
39102	100	0.35	275	-	264
39103	10	0.65	290	2.492	264
GMEBOX	2.5	1.89	321	2.494	122

A history of the currents at all four sites is shown in figures 3 and

4. In figure 3 arrows depict the currents four times a day with the tidal component removed. The similarity of the flow at all 3 levels is apparent at both the PLAIN and HILL-FOOT sites: at the HILL-TOP site there are substantial differences. In figure 4 the virtual displacement of water (integration of currents) is shown at all four sites, again emphasising the similarity of the flow at the PLAIN and HILL-FOOT sites and the differences at the HILL-TOP site. Comparison with the corresponding figure 4 of the earlier report reveals the stability of the regimes found around topography at abyssal depths.

STATISTICAL CHARACTERISTICS OF THE CURRENTS

Twenty pages of the report are given up to a statistical analysis of the variability of the measurements; these are found in table 5 at the end of this volume.

Part 1 is a statistical analysis of the approximately 6000 1 hourly values of currents and temperatures including estimates of semi-diurnal tides. Part II describes the statistics of a low-pass and sub-sampled version of the data. The earlier report[2] should be consulted for an explanation of much in these compilations.

ROTARY SPECTRA

Rotary spectra, resolving the variance into clockwise and anticlockwise components, for the three near bottom current records are shown in figure 5.

HORIZONTAL DIFFUSION BY EDDIES

The integral time scales for the east and north components of current have been derived from lagged autocorrelation estimates employing the 22 month data series at the three sites: these are reported in table 4. By combining the integral time scales with the variance of the current components we obtain eddy diffusivity values which range between 1.3 and 2.7×10^2 $m^2 s^{-1}$ and has an overall mean value of 2.0×10^2 $m^2 s^{-1}$ indistinguishable from the value reported earlier.

TABLE 4 Horizontal (isopycnal) diffusion by eddies

Ident.	Eulerian Integral time scale, days	Specific KE $cm^2\ s^{-2}$	Diffusivity $10^2\ m^2 s^{-1}$
387		(3.39	2.5
HILL-TOP	E - 8.5 N - 9	(2.50	1.8
		(3.16	2.3
389		(3.21	2.0
HILL-FOOT	E - 8.5 N - 6	(2.99	1.9
		(2.13	1.3
391		(2.26	1.5
PLAIN	E - 10 N - 5	(2.96	1.9
		(4.10	2.7

EXTREME CURRENTS

Strong currents near the bottom can scour the sea-bed, putting sediment into suspension and carrying it considerable distances before redeposition.

The frequency with which near bottom currents exceed 10 cm/s has been estimated at the four sites: see table 6. 'Strong' currents are less frequent on the plain than around the hill and everywhere they are only $^1/_3$ to $^2/_3$ of the frequency found in the first deployment.

The probability of an observation period having a speed less than a certain value is found an approximately linear function for a Weibull distribution. This allows extrapolation to be made and a 50-year return estimated at the right hand margin. Estimates for this data set are 3-5 cm/s lower than found for the first deployment.

TABLE 6 Hours per year for which hourly mean speed is exceeded

Speed (exceeded) in cm/s	Ht above PLAIN in m			Ht above HILL-FOOT in m			Ht above HILL-TOP in m			GMEBOX mab
	10	100	1000	10	100	1000	10	100	1000	3
13										6
12			7		1		3			9
11	4		21	(6)	7	3	37	7	1	27
10	12	1*	45	(31)	57	15	119	52	5	80
Mooring No.	391			389			387			-
Instrument No.	03	02	01	03	02	01	03	02	01	-

*This estimate suspect.

ACKNOWLEDGEMENTS

The author wishes to express his gratitude to Dr. W.J. Gould for his supervision of the design, deployment and recovery of the moorings. He also wishes to thank Mr. I. Waddington for the preparation of the mooring components and of the Aanderaa current meters; also to the officers and crew of the RRS Charles Darwin for their wholehearted assistance in the work at sea.

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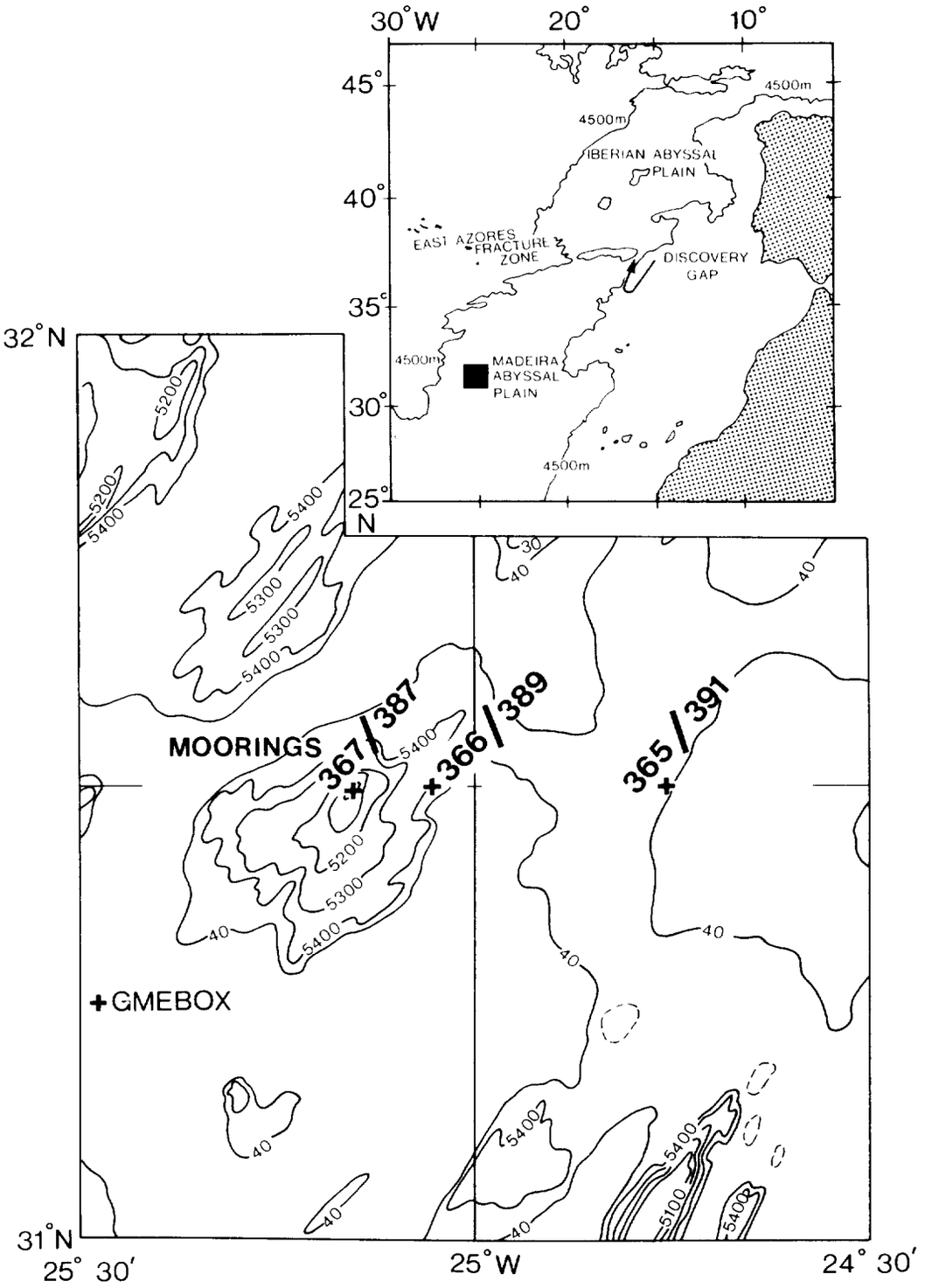
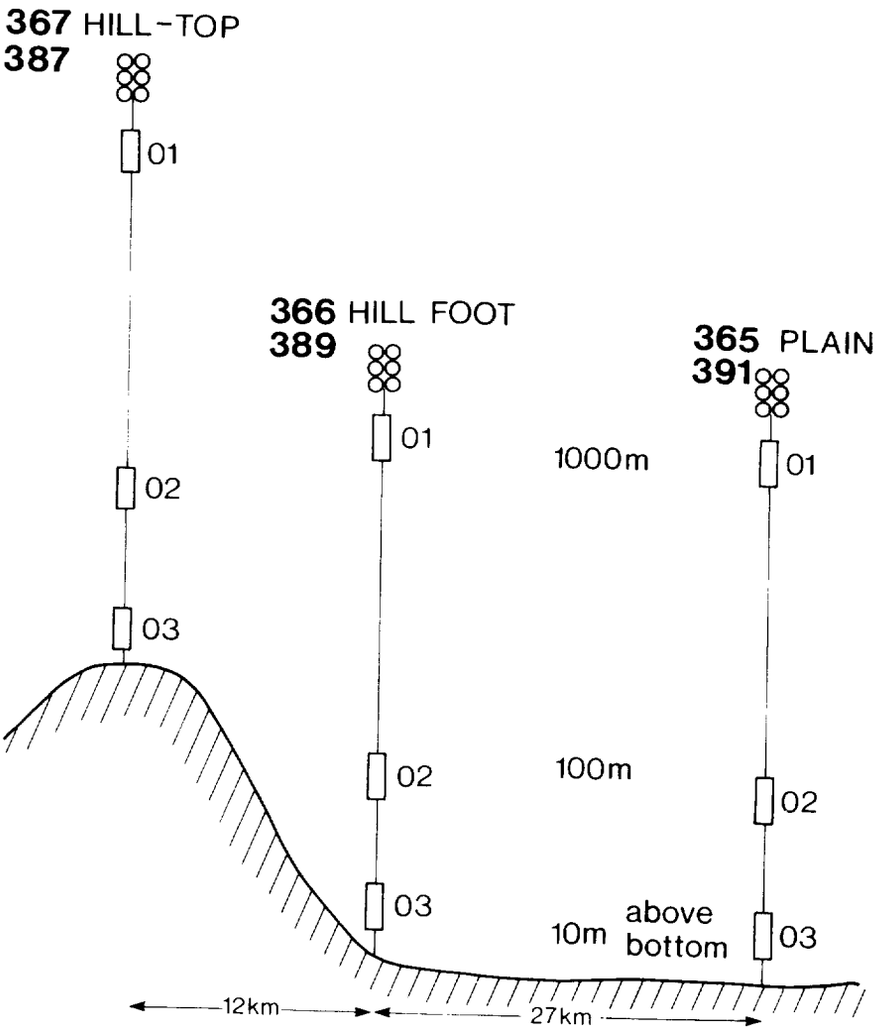
2. Saunders, P.M., 1986: Moored current meter data from the Madeira Abyssal Plain (GME) 1st deployment (1984). IOS Report No. 221, 47 pp.

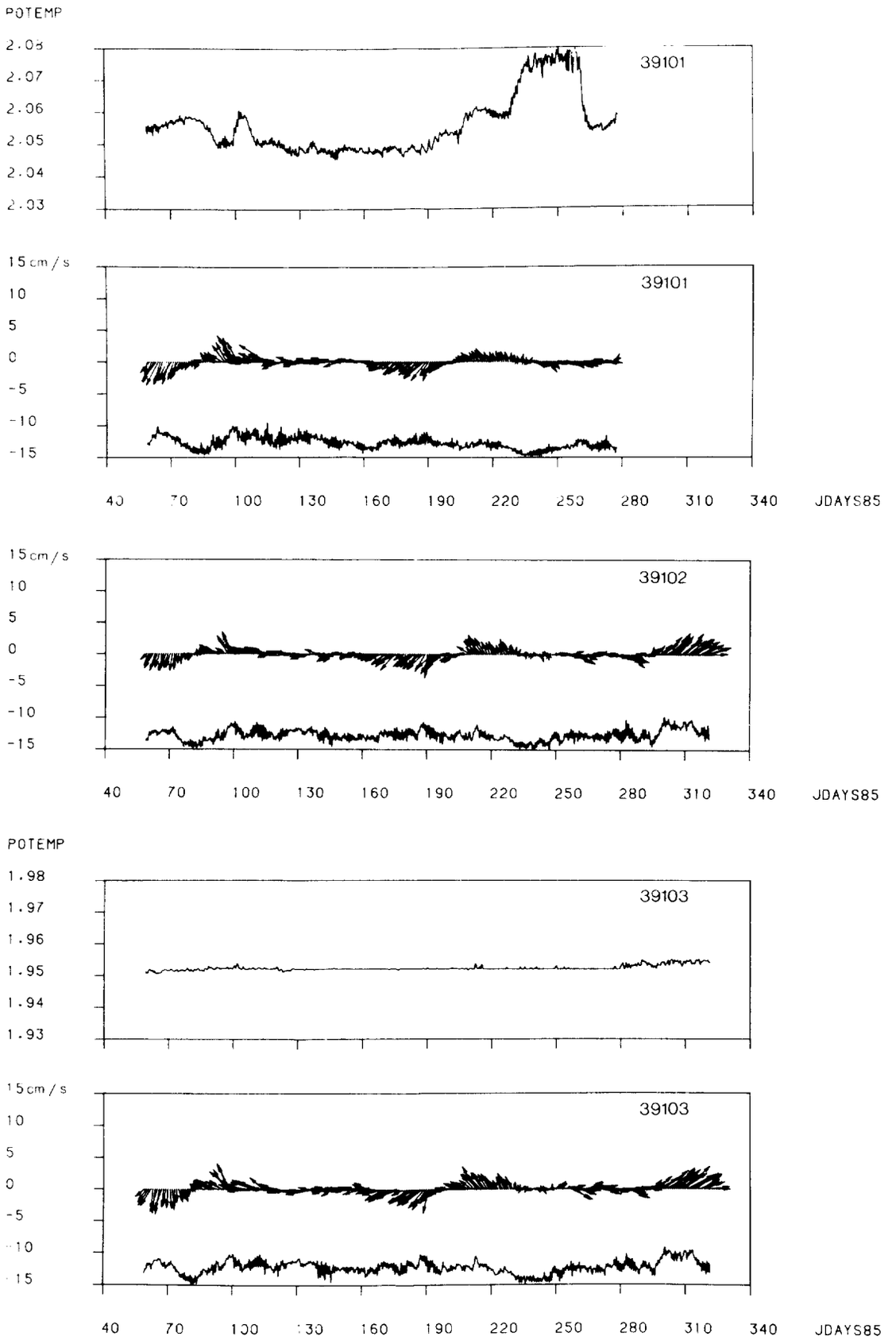
3. Dickson, R.R., 1983: Global summaries and Intercomparisons: Flow statistics from long-term current moorings. In 'Eddies in Marine Science', Ed. A.R. Robinson, Springer-Verlag. Berlin 278-353.



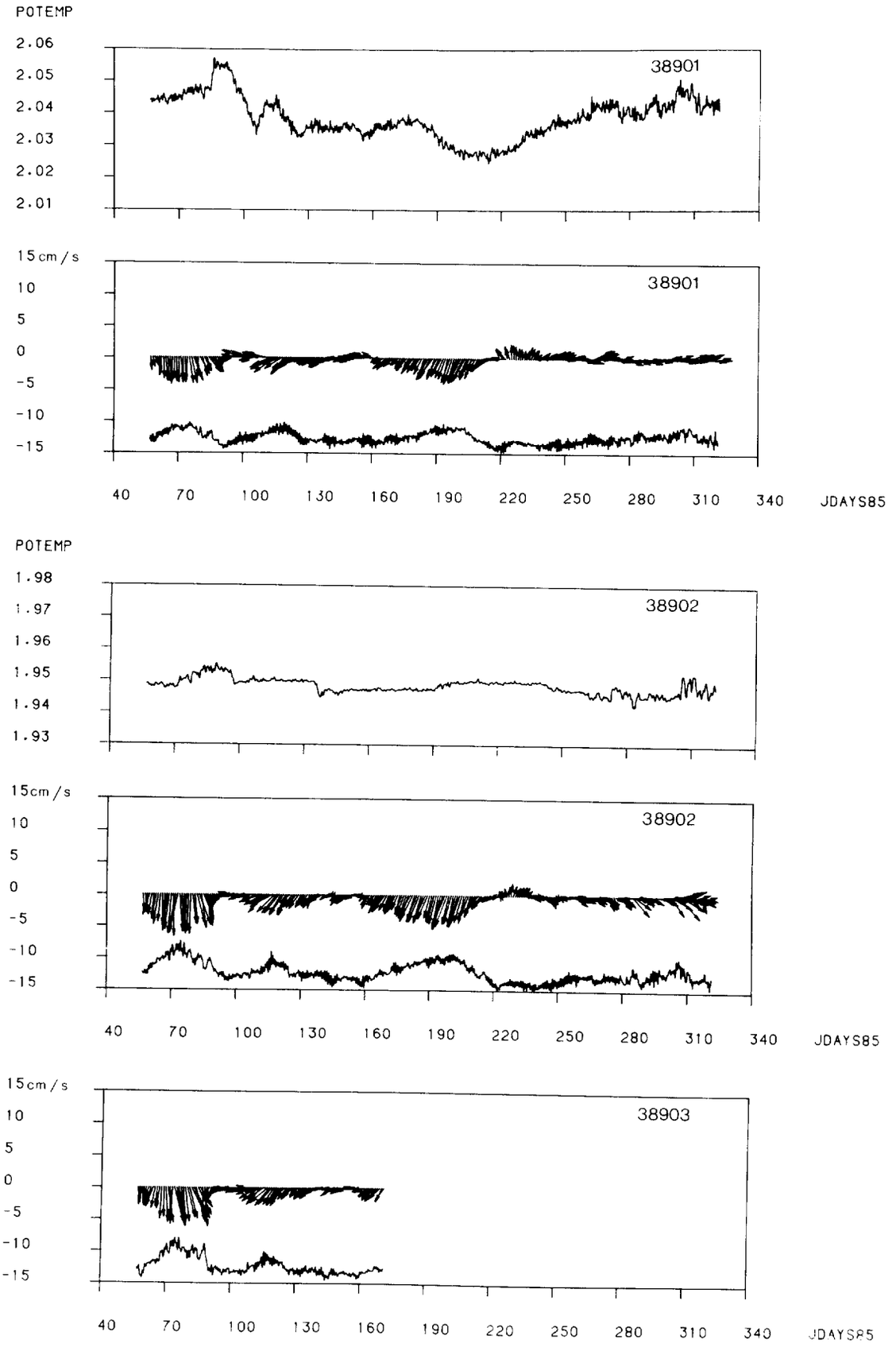
1. Map of GME study site showing moorings locations.



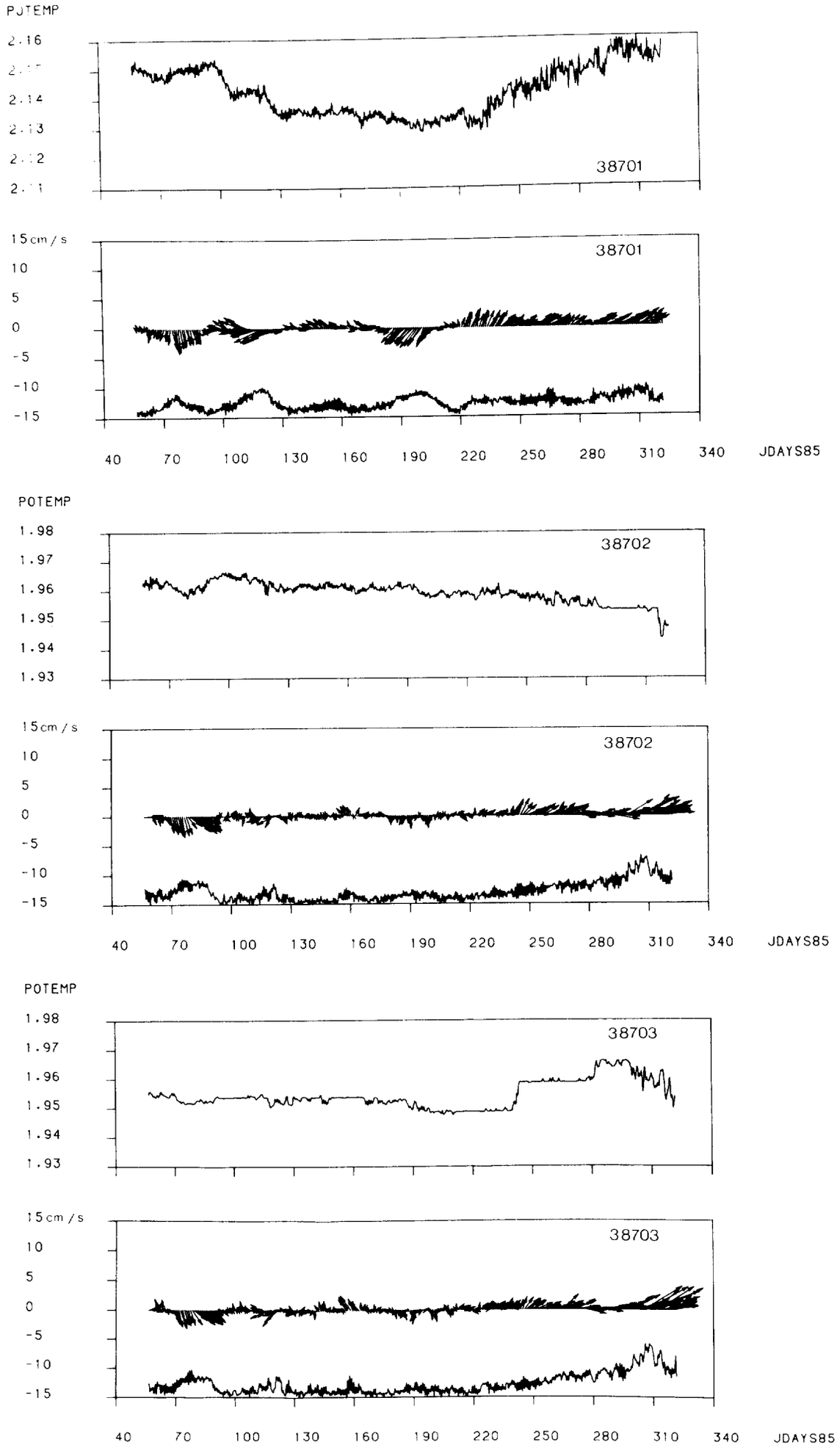
2. Schematic cross-section of the 3 moorings and 9 current meters described in this report



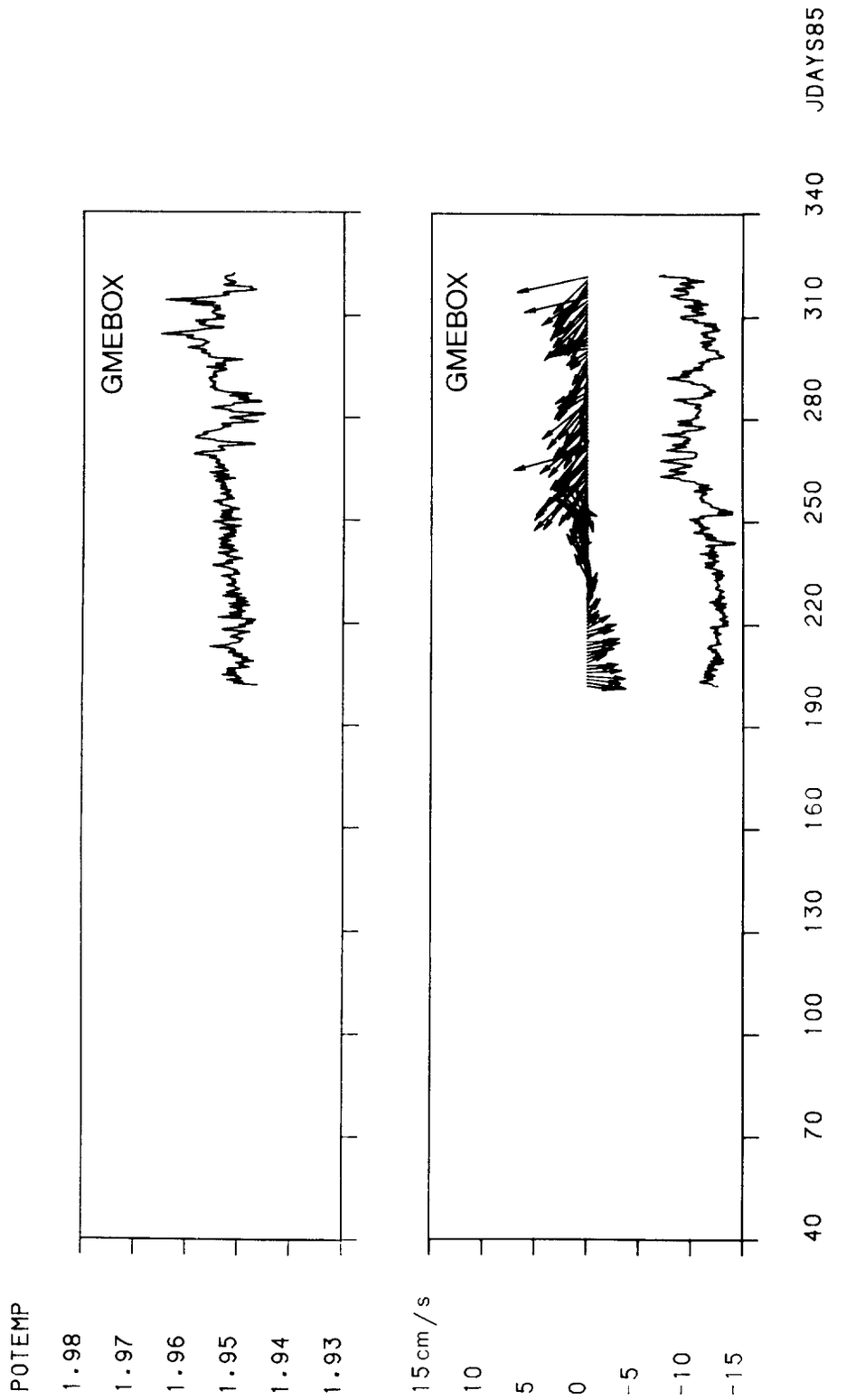
3. Time series of (potential) temperature, current and speed for mooring 391 PLAIN



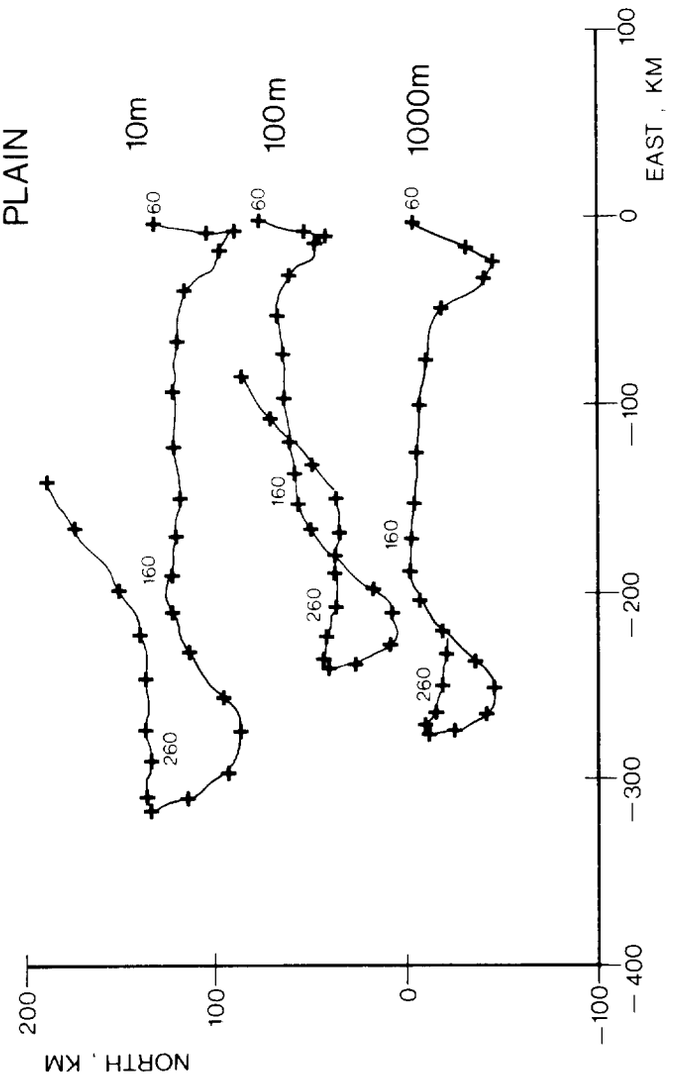
3. Time series of (potential) temperature, current and speed for mooring 389 HILL-FOOT



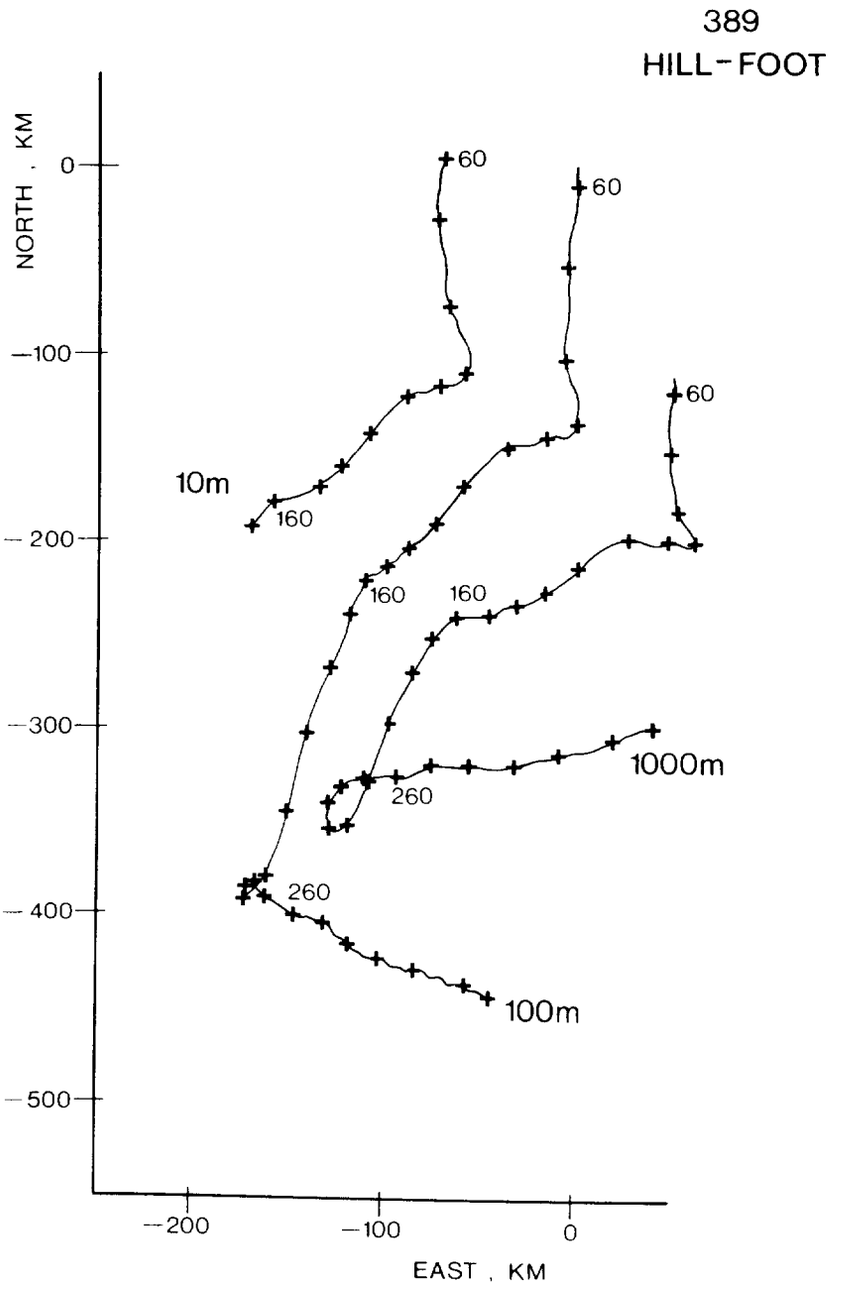
3. Time series of (potential) temperature, current and speed for mooring 387 HILL-TOP



3. Time series of (potential) temperature, current and speed for GMEBOX



4. Virtual displacement of water: 10 days intervals are indicated as +



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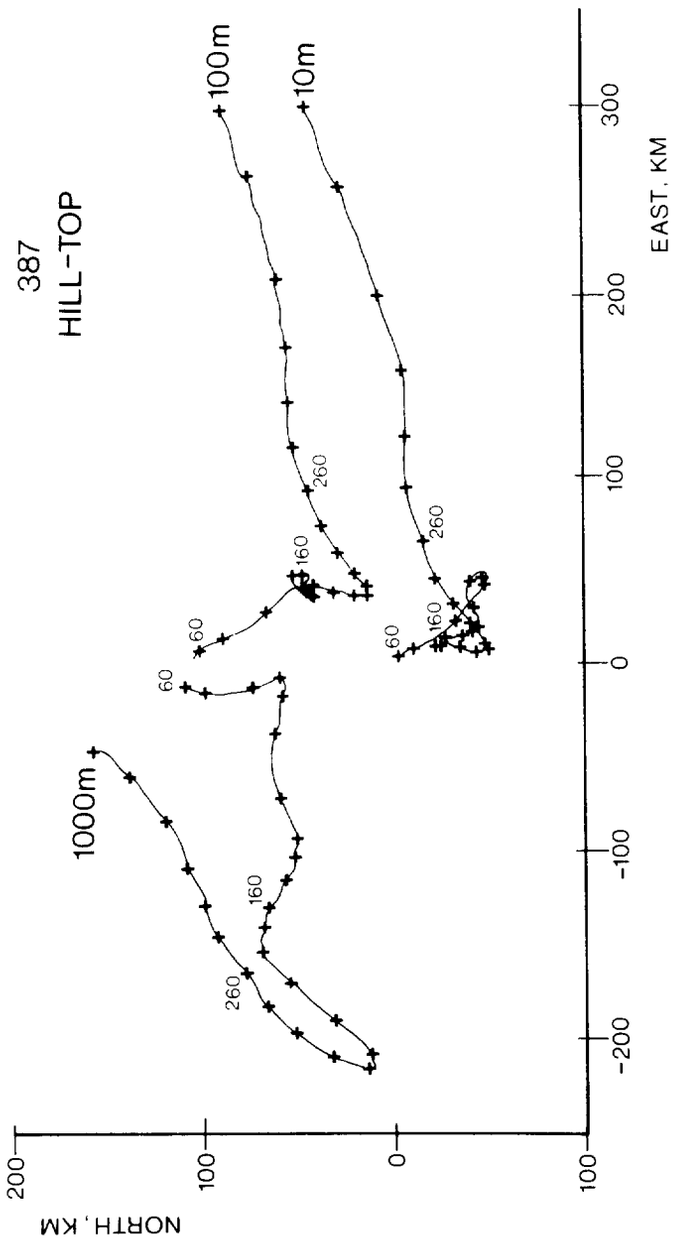

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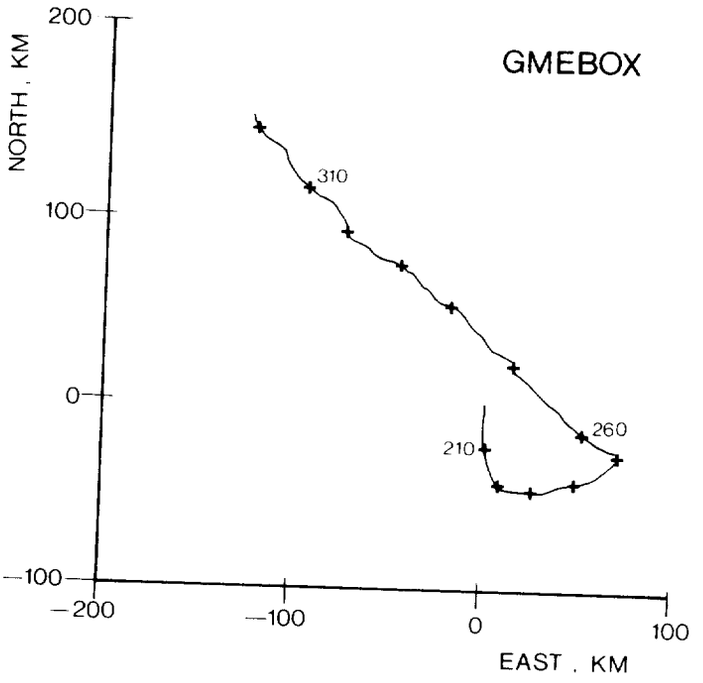

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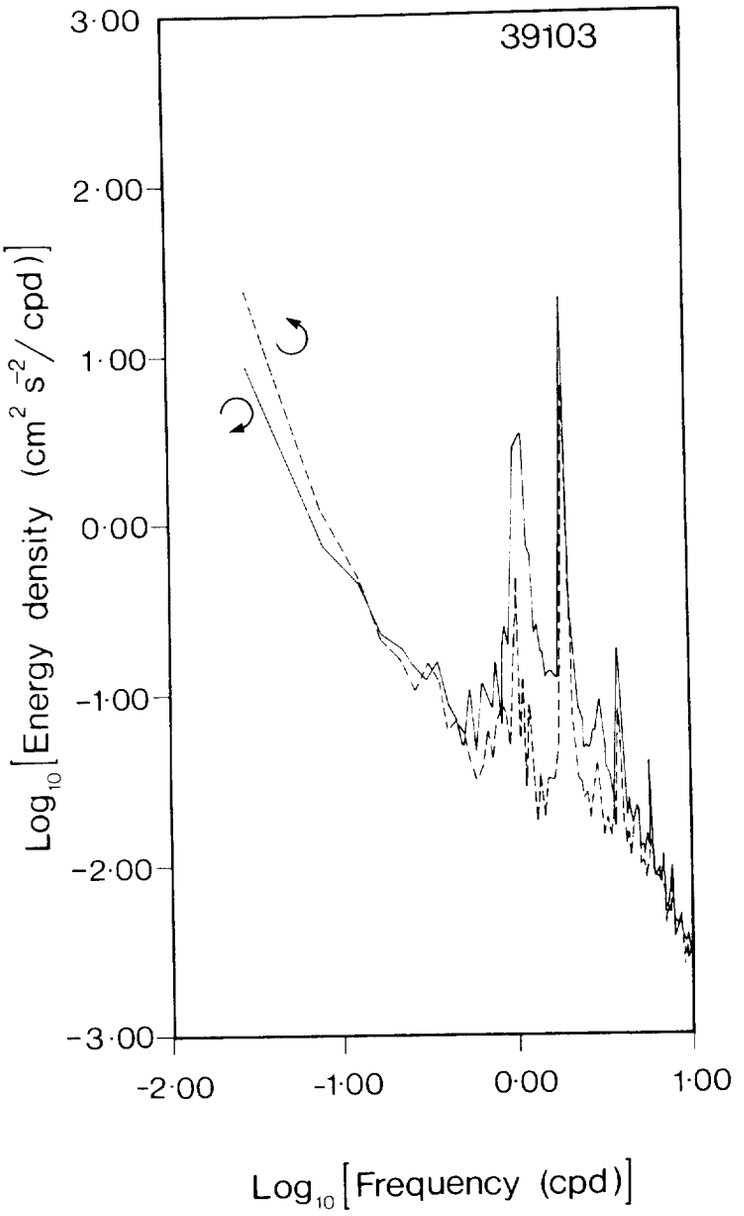
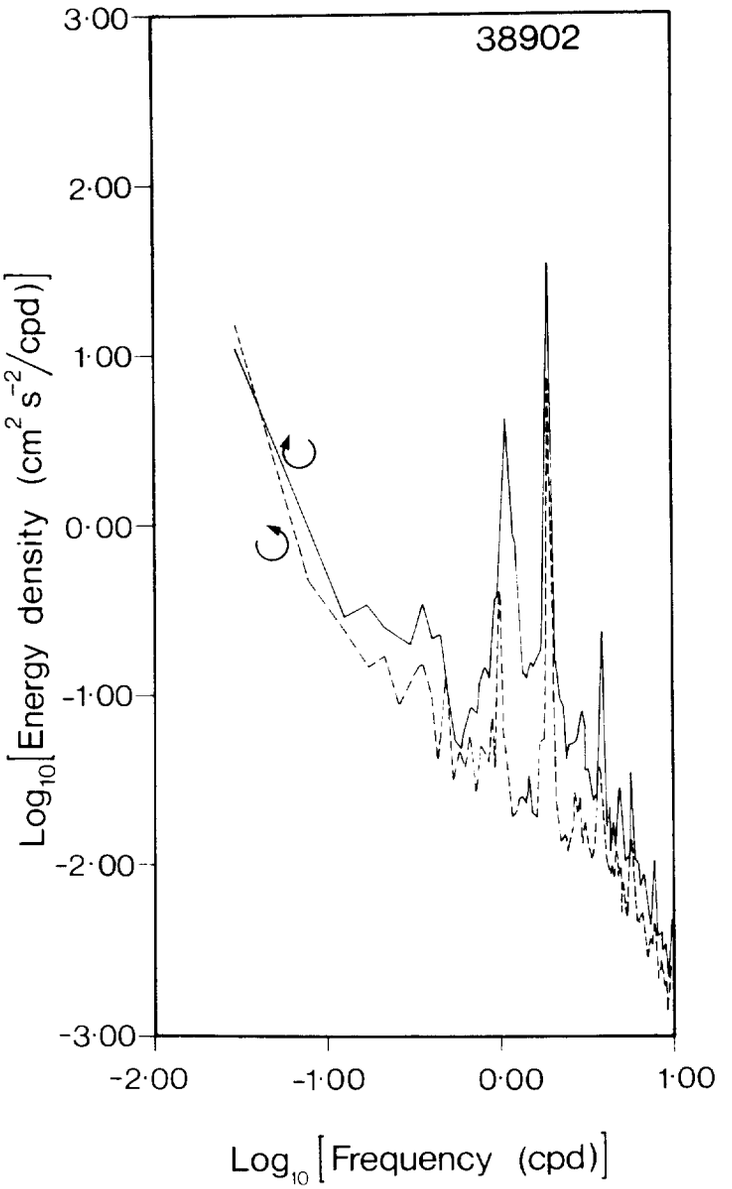
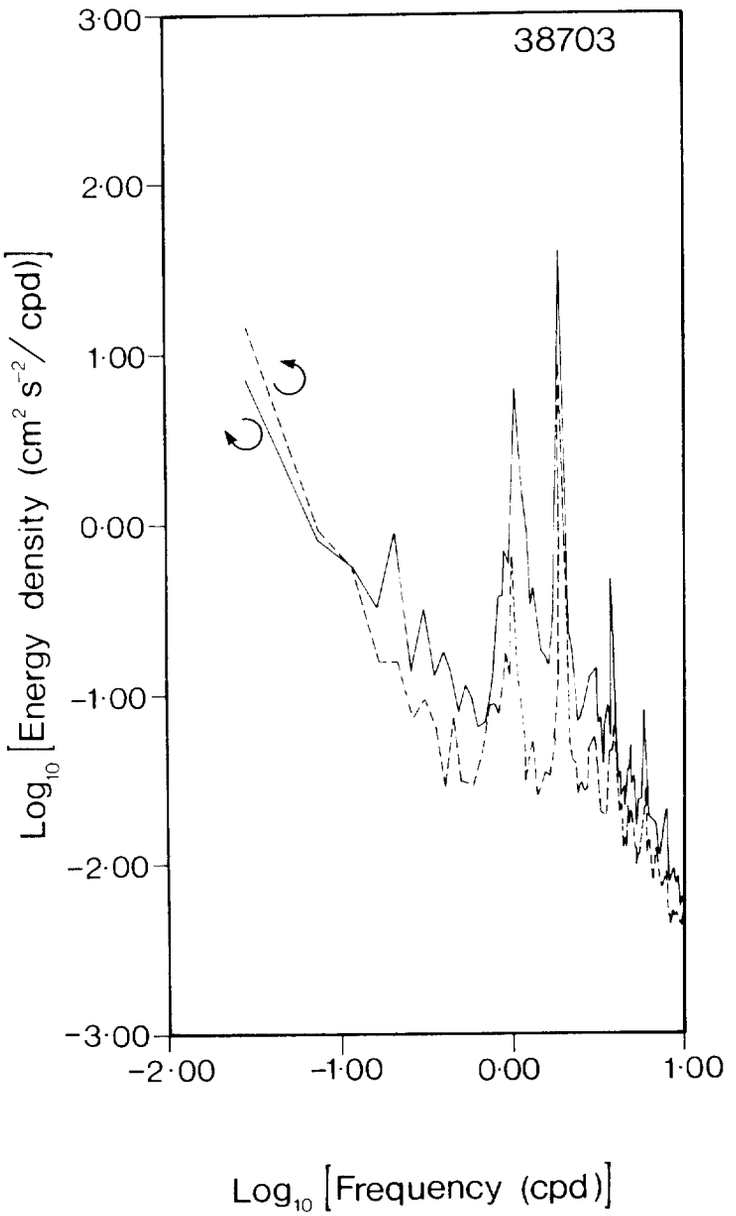


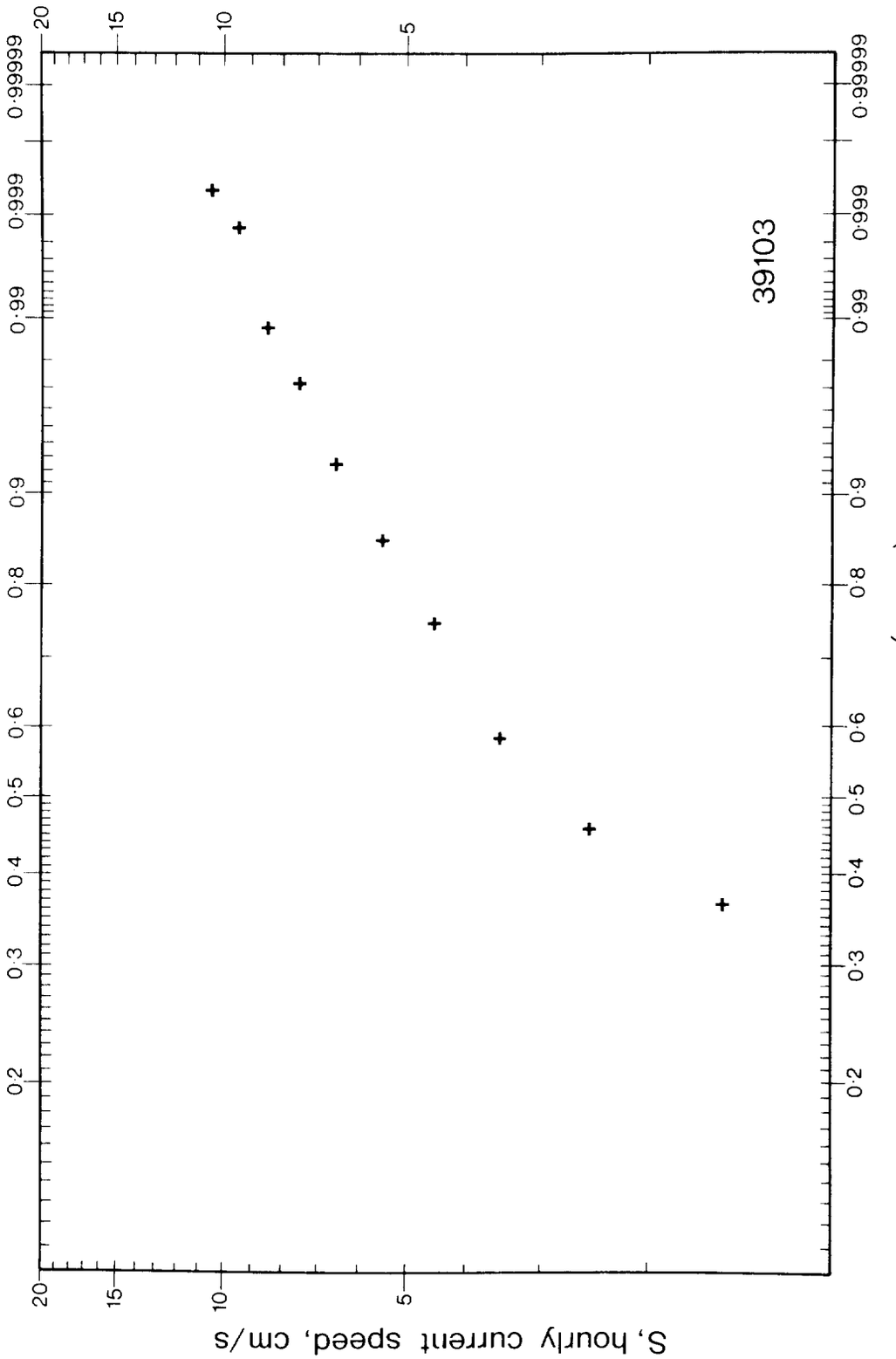
5. Rotary spectrum of 1 hour currents 10 m above sea-bed 391 PLAIN



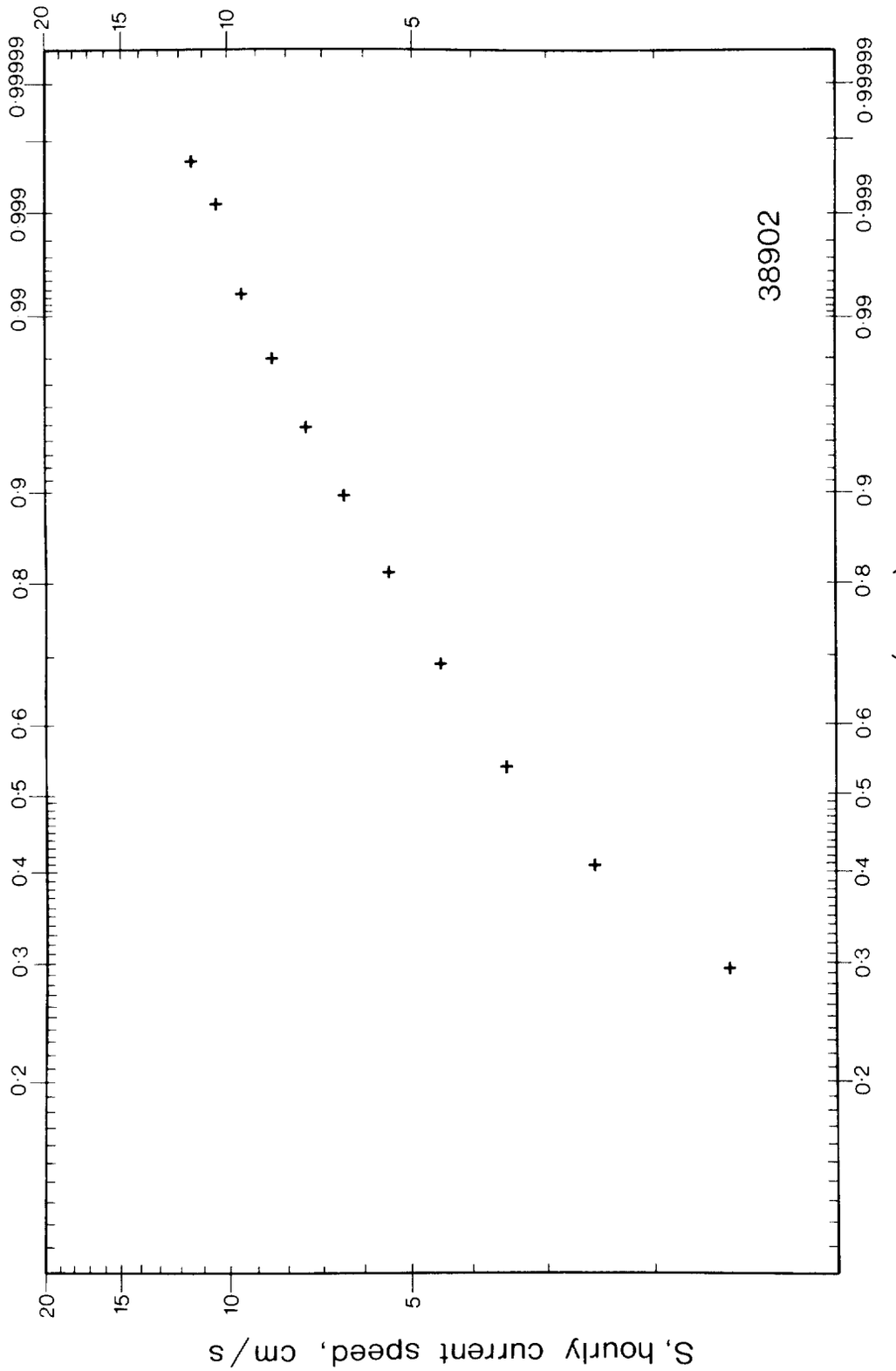
5. Rotary spectrum of 1 hour currents 100 m above sea-bed 389 HILL-FOOT



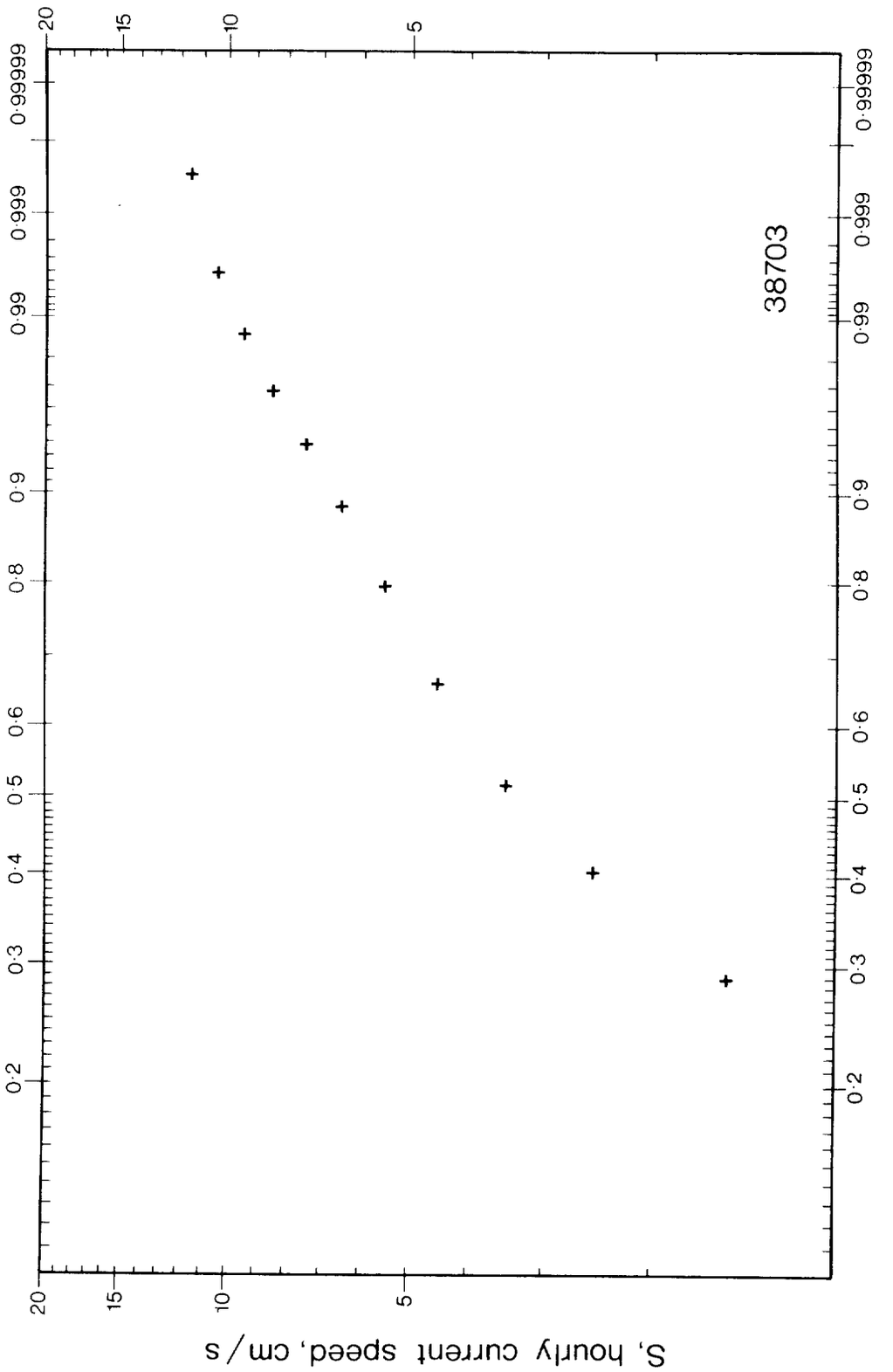
5. Rotary spectrum of 1 hour currents 10 m above sea-bed 387 HILL-TOP



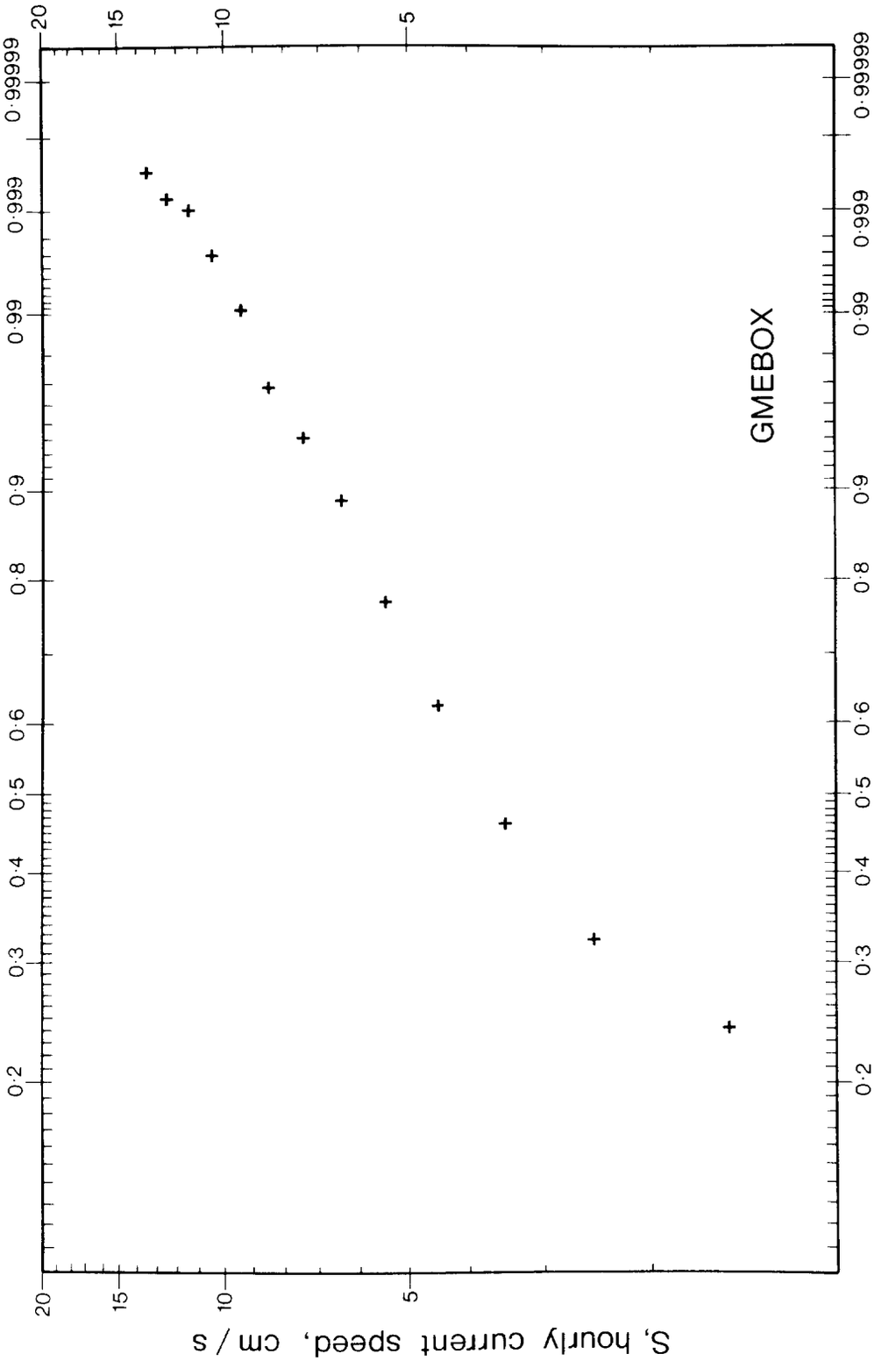
6. Probability of current speed 10 m above sea-bed less than a specified value. The plot linearises a Weibull distribution. 391 PLAIN



6. Probability of current speed 100 m above sea-bed less than a specified value. The plot linearises a Weibull distribution. 389 HILL-FOOT



6. Probability of current speed 10 m above sea-bed less than a specified value. The plot linearises a Weibull distribution. 387 HILL-TOP



6. Probability of current speed 3 m above sea-bed less than a specified value. The plot linearises a Weibull distribution. .GMEBOX

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 38701			NUMBER OF DATA CYCLES 6410	
INTERVAL 1 HR(S)	FROM 24-II-85		TO 18-XI-85	
INSTRUMENT RCM5 6708	DEPTH 3900 m		DEPTH OF WATER 4989 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-0.15	0.22	3.98	2.486
UNCERTAINTY	0.85	0.75	0.5	.0025
STD. DEVIATION	3.35	2.93	2.00	.0100
SKEWNESS	-0.01	-0.02	0.57	-
KURTOSIS	-0.57	-0.49	-0.68	-
MINIMUM	-9.21	-7.95	1.8	2.461
MAXIMUM	9.13	9.57	11.39	2.518
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	5.42	5.97	0.72	2.33
CORREL. COEFF.	0.55	0.18	0.02	0.12

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	326 °T	AND ITS MAGNITUDE	0.27 cm/s
	MAX. VARIABILITY	052	AND STD. DEVIATION	3.93
	MIN. VARIABILITY	142	AND STD. DEVIATION	2.08

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	3.83	1.28	0.51
MINOR AXIS	1.22	0.30	0.07
ELLIPTICITY	-0.32	-0.23	-0.14
DIRECTION, N FROM E	039	050	038
PHASE, DEG	-22	8	-53

COMMENTS 23 PER CENT ROTOR STALL

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 38701 NUMBER OF DATA CYCLES 1061

INTERVAL 6 HR(S) FROM 24-II-85 TO 18-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	324 °T	AND ITS MAGNITUDE	0.26 cm/s
	MAX. VARIABILITY	066	AND STD. DEVIATION	2.25
	MIN. VARIABILITY	156	AND STD. DEVIATION	1.31

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	3.98	2.80	3.39	64.9*

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	1.75	8.68	2.87	1.22
CORREL. COEFF.	0.53	0.54	0.21	0.15

MEAN POTENTIAL TEMPERATURE OF RECORD 2.142°C

*TEMP NOISE INCREASES AFTER MID AUGUST

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 38702			NUMBER OF DATA CYCLES 6410	
INTERVAL 1 HR(S)	FROM 24-II-85		TO 18-XI-85	
INSTRUMENT RCM5 6706	DEPTH 4882 m		DEPTH OF WATER 4989 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	1.30	-0.03	4.09	2.423
UNCERTAINTY	0.8	0.75	0.5	.001
STD. DEVIATION	3.24	2.99	2.12	.0041
SKEWNESS	0.07	-0.04	0.58	-
KURTOSIS	-0.44	-0.29	-0.53	-
MINIMUM	-8.64	-9.36	1.8	2.407
MAXIMUM	11.35	9.94	11.57	2.433
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	4.30	-4.44	-1.82	-0.95
CORREL. COEFF.	0.44	-0.34	-0.15	-0.11

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	092 °T	AND ITS MAGNITUDE	1.30 cm/s
	MAX. VARIABILITY	050	AND STD. DEVIATION	3.76
	MIN. VARIABILITY	140	AND STD. DEVIATION	2.32

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	3.80	1.24	0.59
MINOR AXIS	1.47	0.32	0.16
ELLIPTICITY	-0.39	-0.26	-0.28
DIRECTION, N FROM E	047	059	043
PHASE, DEG	-11	19	-46

COMMENTS 26 PER CENT ROTOR STALL
TEMPERATURES INCOMPATIBLE WITH 38703

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 38702 NUMBER OF DATA CYCLES 1061

INTERVAL 6 HR(S) FROM 24-II-85 TO 18-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	092 °T	AND ITS MAGNITUDE 1.29 cm/s
	MAX. VARIABILITY	080	AND STD. DEVIATION 1.91
	MIN. VARIABILITY	170	AND STD. DEVIATION 1.15

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	3.42	1.57	2.50	14.27

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	0.85	-4.96	-1.96	-3.80
CORREL. COEFF.	0.37	-0.71	-0.41	-0.65

MEAN POTENTIAL TEMPERATURE OF RECORD 1.959°C

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 38703			NUMBER OF DATA CYCLES 6410	
INTERVAL 1 HR(S)	FROM 24-II-84		TO 18-XI-85	
INSTRUMENT RCM5 3622	DEPTH 4978 m		DEPTH OF WATER 4989 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	1.32	0.22	4.13	2.431
UNCERTAINTY	0.8	0.7	0.5	.001
STD. DEVIATION	3.48	2.87	2.23	.0047
SKEWNESS	0.18	0.00	0.78	-
KURTOSIS	-0.43	-0.33	-0.06	-
MINIMUM	-9.18	-9.08	1.8	2.419
MAXIMUM	11.17	10.93	12.70	2.451
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	4.84	6.67	2.01	2.92
CORREL. COEFF.	0.49	0.41	0.15	0.28

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	080 °T	AND ITS MAGNITUDE	1.34 cm/s
	MAX. VARIABILITY	056	AND STD. DEVIATION	3.92
	MIN. VARIABILITY	146	AND STD. DEVIATION	2.22

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	3.85	1.26	0.63
MINOR AXIS	1.40	0.26	0.15
ELLIPTICITY	-0.36	-0.21	-0.24
DIRECTION, N FROM E	042	052	034
PHASE, DEG	-12	18	-52

COMMENTS 24 PER CENT ROTOR STALL
TEMPERATURES INCOMPATIBLE WITH 38702

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 38703 NUMBER OF DATA CYCLES 1061

INTERVAL 6 HR(S) FROM 24-II-85 TO 18-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	081 °T	AND ITS MAGNITUDE 1.32 cm/s
	MAX. VARIABILITY	083	AND STD. DEVIATION 2.20
	MIN. VARIABILITY	173	AND STD. DEVIATION 1.22

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	4.60	1.71	3.16	20.81

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	1.10	6.47	2.09	4.96
CORREL. COEFF.	0.39	0.66	0.35	0.63

MEAN POTENTIAL TEMPERATURE OF RECORD 1.954°C

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 38901			NUMBER OF DATA CYCLES 6400	
INTERVAL 1 HR(S)	FROM 24-II-85		TO 18-XI-85	
INSTRUMENT RCM5 7518	DEPTH 4341 m		DEPTH OF WATER 5433 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-0.04	-0.81	3.91	2.435
UNCERTAINTY	0.7	0.7	0.5	.002
STD. DEVIATION	3.02	3.05	1.94	.0074
SKEWNESS	-0.05	-0.01	0.43	-
KURTOSIS	-0.58	-0.58	-0.59	-
MINIMUM	-8.28	-10.88	1.5	2.412
MAXIMUM	8.75	7.23	11.65	2.470
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	4.43	4.15	0.17	1.10
CORREL. COEFF.	0.48	0.09	0.01	0.08

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	183 °T	AND ITS MAGNITUDE	0.82 cm/s
	MAX. VARIABILITY	045	AND STD. DEVIATION	3.69
	MIN. VARIABILITY	135	AND STD. DEVIATION	2.19

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	3.74	1.09	0.57
MINOR AXIS	1.61	0.28	0.14
ELLIPTICITY	-0.43	-0.25	-0.24
DIRECTION, N FROM E	050	060	047
PHASE, DEG	-16	13	-38

COMMENTS 18 PER CENT ROTOR STALL

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 38901 NUMBER OF DATA CYCLES 1059

INTERVAL 6 HR(S) FROM 24-II-85 TO 18-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	183 °T	AND ITS MAGNITUDE 0.82 cm/s
	MAX. VARIABILITY	069	AND STD. DEVIATION 2.10
	MIN. VARIABILITY	159	AND STD. DEVIATION 1.42

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	3.71	2.71	3.21	41.22

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	1.23	4.74	0.13	0.87
CORREL. COEFF.	0.39	0.38	0.01	0.15

MEAN POTENTIAL TEMPERATURE OF RECORD 2.039°C

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 38902			NUMBER OF DATA CYCLES 6400	
INTERVAL 1 HR(S)	FROM 24-II-85		TO 18-XI-85	
INSTRUMENT RCM5 6867	DEPTH 5327 m		DEPTH OF WATER 5433 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-0.19	-1.95	3.96	2.4735
UNCERTAINTY	0.6	0.7	0.5	.0005
STD. DEVIATION	2.70	3.06	2.20	.0022
SKEWNESS	0.00	-0.10	0.64	-
KURTOSIS	-0.41	-0.38	-0.37	-
MINIMUM	-8.11	-10.98	1.5	2.467
MAXIMUM	8.65	6.84	12.03	2.482
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	4.11	-1.01	-1.11	0.91
CORREL. COEFF.	0.50	-0.17	-0.16	0.19

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	185 °T	AND ITS MAGNITUDE	1.96 cm/s
	MAX. VARIABILITY	038	AND STD. DEVIATION	3.55
	MIN. VARIABILITY	128	AND STD. DEVIATION	2.02

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	3.59	1.03	0.45
MINOR AXIS	1.33	0.19	0.02
ELLIPTICITY	-0.37	-0.18	0.05
DIRECTION, N FROM E	050	059	045
PHASE, DEG	-18	11	-45

COMMENTS 21 PER CENT ROTOR STALL

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 38902 NUMBER OF DATA CYCLES 1059

INTERVAL 6 HR(S) FROM 24-II-85 TO 18-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	185 °T	AND ITS MAGNITUDE 1.96 cm/s
	MAX. VARIABILITY	024	AND STD. DEVIATION 1.97
	MIN. VARIABILITY	114	AND STD. DEVIATION 1.45

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	2.66	3.32	2.99	4.08

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	0.88	-0.97	-0.97	0.69
CORREL. COEFF.	0.30	-0.29	-0.26	0.24

MEAN POTENTIAL TEMPERATURE OF RECORD 1.949°C

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 38903			NUMBER OF DATA CYCLES 2788	
INTERVAL 1 HR(S)	FROM 24-II-85	TO 20-VI-85		
INSTRUMENT RCM5 6705	DEPTH 5422 m	DEPTH OF WATER 5433 m		
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-1.05	-2.05	3.52	none
UNCERTAINTY	0.8	0.9	0.8	-
STD. DEVIATION	2.32	2.68	2.35	-
SKEWNESS	0.18	-0.66	0.89	-
KURTOSIS	0.74	0.06	-0.37	-
MINIMUM	-8.52	-11.13	1.5	-
MAXIMUM	8.02	5.07	11.20	-
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	1.27			
CORREL. COEFF.	0.20			

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	204 °T	AND ITS MAGNITUDE	2.25 cm/s
	MAX. VARIABILITY	028	AND STD. DEVIATION	2.80
	MIN. VARIABILITY	118	AND STD. DEVIATION	2.18

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	3.03	0.92	0.67
MINOR AXIS	1.21	0.11	0.01
ELLIPTICITY	-0.40	-0.11	-0.02
DIRECTION, N FROM E	045	055	055
PHASE, DEG	-18	3	-37

COMMENTS 36 PER CENT ROTOR STALL
SHORT RECORD: TEMPERATURE DISCARDED

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 38903 NUMBER OF DATA CYCLES 457

INTERVAL 6 HR(S) FROM 24-II-85 TO 20-VI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	(MEAN	207 °T	AND ITS MAGNITUDE	2.30 cm/s
	(MAX. VARIABILITY	159	AND STD. DEVIATION	1.90
	(MIN. VARIABILITY	069	AND STD. DEVIATION	0.81

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	1.33	2.94	2.13	-

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	-1.32			
CORREL. COEFF.	-0.67			

MEAN POTENTIAL TEMPERATURE OF RECORD °C
TEMPERATURE DISCARDED

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 39101			NUMBER OF DATA CYCLES 5294	
INTERVAL 1 HR(S)	FROM 27-II-84		TO 05-X-85	
INSTRUMENT RCM5 420	DEPTH 4347 m		DEPTH OF WATER 5438 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-1.18	-0.11	3.24	2.452
UNCERTAINTY	0.6	0.6	0.5	.0025
STD. DEVIATION	2.55	2.57	2.00	.0094
SKEWNESS	-0.21	-0.03	1.22	-
KURTOSIS	0.69	0.96	0.83	-
MINIMUM	-11.90	-10.65	1.70	2.434
MAXIMUM	8.87	11.66	12.26	2.485
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	2.27	9.48	0.65	-2.07
CORREL. COEFF.	0.35	0.38	0.03	-0.11

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	265 °T	AND ITS MAGNITUDE	1.18 cm/s
	MAX. VARIABILITY	044	AND STD. DEVIATION	2.97
	MIN. VARIABILITY	134	AND STD. DEVIATION	2.07

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	2.87	1.17	0.73
MINOR AXIS	0.79	0.41	0.25
ELLIPTICITY	-0.28	-0.35	-0.34
DIRECTION, N FROM E	052	048	037
PHASE, DEG	-10	28	-25

COMMENTS 44 PER CENT ROTOR STALL
(SLTLY) SHORT RECORD

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 39101 NUMBER OF DATA CYCLES 875

INTERVAL 6 HR(S) FROM 27-II-84 TO 5-X-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	264 °T	AND ITS MAGNITUDE	1.19 cm/s
	MAX. VARIABILITY	096	AND STD. DEVIATION	1.59
	MIN. VARIABILITY	006	AND STD. DEVIATION	1.41

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	2.52	2.00	2.26	77.03

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	-0.10	9.40	0.60	-3.78
CORREL. COEFF.	-0.05	0.67	0.05	-0.46

MEAN POTENTIAL TEMPERATURE OF RECORD 2.056°C

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 39102 NUMBER OF DATA CYCLES 6343
INTERVAL 1 HR(S) FROM 27-II-85 TO 18-XI-85
INSTRUMENT RCM5 5207 DEPTH 5333 m DEPTH OF WATER 5438 m

UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-0.35	0.03	3.24	none
UNCERTAINTY	0.6	0.6	0.45	-
STD. DEVIATION	2.64	2.62	1.86	-
SKEWNESS	0.25	0.06	0.92	-
KURTOSIS	0.12	0.17	-0.30	-
MINIMUM	-8.26	-8.20	1.70	-
MAXIMUM	8.02	8.40	10.28	-

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	2.9			
CORREL. COEFF.	0.43			

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	275 °T	AND ITS MAGNITUDE	0.35 cm/s
	MAX. VARIABILITY	045	AND STD. DEVIATION	3.14
	MIN. VARIABILITY	135	AND STD. DEVIATION	1.99

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	2.78	1.12	0.67
MINOR AXIS	0.75	0.34	0.17
ELLIPTICITY	-0.27	-0.31	-0.26
DIRECTION, N FROM E	058	054	044
PHASE, DEG	-14	23	-35

COMMENTS 42 PER CENT ROTOR STALL TEMPERATURE DISCARDED
FREQUENCY OF HIGH SPEEDS ANOMALOUSLY LOW

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 39102 NUMBER OF DATA CYCLES 1050

INTERVAL 6 HR(S) FROM 27-II-85 TO 18-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	(MEAN	275 °T	AND ITS MAGNITUDE 0.36 cm/s
	(MAX. VARIABILITY	081	AND STD. DEVIATION 2.02
	(MIN. VARIABILITY	171	AND STD. DEVIATION 1.35

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	3.89	2.03	2.96	

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	0.84			
CORREL. COEFF.	0.30			

MEAN POTENTIAL TEMPERATURE OF RECORD - °C

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION 39103			NUMBER OF DATA CYCLES 6343	
INTERVAL 1 HR(S)	FROM 27-II-85		TO 18-XI-85	
INSTRUMENT RCM5 3624	DEPTH 5427 m		DEPTH OF WATER 5438 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-0.61	0.23	3.69	2.492
UNCERTAINTY	0.75	0.65	0.5	.0002
STD. DEVIATION	3.11	2.74	2.01	.0008
SKEWNESS	0.34	-0.11	1.75	-
KURTOSIS	-0.07	0.24	-0.29	-
MINIMUM	-9.74	-9.09	1.70	2.490
MAXIMUM	9.59	9.33	11.57	2.495
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	3.40	1.09	0.63	0.34
CORREL. COEFF.	0.40	0.37	0.25	0.18

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	290 °T	AND ITS MAGNITUDE	0.65 cm/s
	MAX. VARIABILITY	054	AND STD. DEVIATION	3.49
	MIN. VARIABILITY	144	AND STD. DEVIATION	2.24

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	3.03	1.19	0.77
MINOR AXIS	0.80	0.33	0.21
ELLIPTICITY	-0.26	-0.28	-0.27
DIRECTION, N FROM E	054	050	037
PHASE, DEG	-16	20	-36

COMMENTS 31 PER CENT ROTOR STALL

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION 39103 NUMBER OF DATA CYCLES 1050

INTERVAL 6 HR(S) FROM 27-II-85 TO 18-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	290 °T	AND ITS MAGNITUDE	0.66 cm/s
	MAX. VARIABILITY	087	AND STD. DEVIATION	2.44
	MIN. VARIABILITY	177	AND STD. DEVIATION	1.50

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	5.85	2.35	4.10	0.61

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	0.86	1.04	0.61	0.29
CORREL. COEFF.	0.23	0.55	0.51	0.37

MEAN POTENTIAL TEMPERATURE OF RECORD 1.953°C

TABLE 5(I)

RECORD-LONG STATISTICS

IDENTIFICATION GMEBOX			NUMBER OF DATA CYCLES 2941	
INTERVAL 1 HR(S)	FROM 19-VII-85		TO 19-XI-85	
INSTRUMENT RCM5 7643	DEPTH 5447 m		DEPTH OF WATER 5450 m	
UNITS	cm/s	cm/s	cm/s	deg C
VARIABLE	EAST	NORTH	SPEED	TEMPERATURE
MEAN	-1.20	1.46	4.30	2.494
UNCERTAINTY	1.0	1.1	0.7	.0015
STD. DEVIATION	3.01	3.29	2.24	.0046
SKEWNESS	0.22	0.30	0.51	-
KURTOSIS	-0.56	-0.30	-0.24	-
MINIMUM	-10.70	-6.75	1.50	2.480
MAXIMUM	12.78	12.35	14.40	2.512
UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	-2.59	-2.19	3.52	2.75
CORREL. COEFF.	-0.26	-0.16	0.23	0.27

DIRECTION and VARIABILITY

DIRECTION OF	MEAN	321 °T	AND ITS MAGNITUDE	1.89 cm/s
	MAX. VARIABILITY	144	AND STD. DEVIATION	3.56
	MIN. VARIABILITY	054	AND STD. DEVIATION	2.69

TIDES (SEMI-DIURNAL)

UNITS	cm/s M_2	cm/s S_2	cm/s N_2
MAJOR AXIS	2.49	0.68	0.44
MINOR AXIS	0.34	0.21	0.02
ELLIPTICITY	-0.14	-0.31	-0.05
DIRECTION, N FROM E	073	070	068
PHASE, DEG	-2	30	-13

COMMENTS 18 PER CENT ROTOR STALL
BATHYSNAP

TABLE 5(II)

RECORD LONG STATISTICS

FOR LOW PASS VERSION OF DATA

IDENTIFICATION GMEBOX NUMBER OF DATA CYCLES 483

INTERVAL 6 HR(S) FROM 19-VII-85 TO 19-XI-85

SEE COMPANION SHEET FOR FURTHER DETAILS

DIRECTION AND VARIABILITY

DIRECTION OF	MEAN	319 °T	AND ITS MAGNITUDE 1.88 cm/s
	MAX. VARIABILITY	106	AND STD. DEVIATION 3.05
	MIN. VARIABILITY	016	AND STD. DEVIATION 2.01

VARIANCE

UNITS	cm^2/s^2	cm^2/s^2	cm^2/s^2	$(m°C)^2$
VARIABLES	EAST	NORTH	K.E.	TEMPERATURE
VARIANCE	7.53	5.81	6.67	-

COVARIANCE

UNITS	cm^2/s^2	m°C cm/s	m°C cm/s	m°C cm/s
VARIABLES	EAST-NORTH	EAST-TEMP	NORTH-TEMP	SPEED-TEMP
COVARIANCE	-3.46	-2.41	2.86	0.89
CORREL. COEFF.	-0.52	-0.29	0.39	0.20

MEAN POTENTIAL TEMPERATURE OF RECORD 1.953°C
TEMPERATURE NOISY