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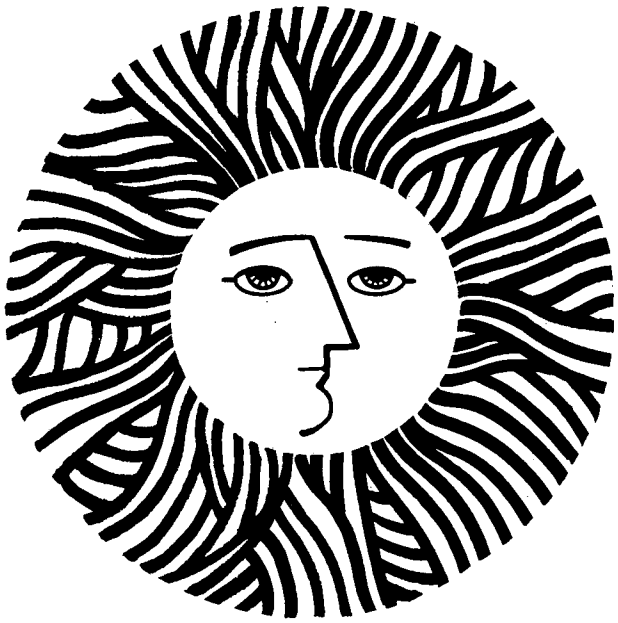

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PRELIMINARY DATA REPORT

CURRENT OBSERVATIONS OFFSHORE PUNTA TUNA, PUERTO RICO 21 JUNE TO 7 DECEMBER 1980

Prepared for

Lawrence Berkeley Laboratories
University of California
Berkeley, California 94720

Submitted by

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August 1981

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ACKNOWLEDGMENTS

This data report was prepared under contract with Lawrence Berkeley Laboratories by Daniel Frye, Karen Leavitt, and Ann Whitney, staff scientists, EG&G, Environmental Consultants. Data collection was performed by Mr. Frye and Mr. Alan Davison, field engineer.

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1. INTRODUCTION

EG&G, Environmental Consultants conducted an oceanographic measurement program in the vicinity of a proposed OTEC (Ocean Thermal Energy Conversion) site about 20 km offshore of Punta Tuna, Puerto Rico (Figure 1-1). As part of this program, a mooring consisting of five current meters was maintained between 21 June and 7 December 1980. This report presents a summary of the current data collected during this period. Included as attachments to the report are:

a) Listings of all current meter data,

b) Magnetic tapes of all current meter data,

c) Original current meter data tapes,

d) Magnetic tape of CTD (conductivity, temperature, and depth) casts conducted in August 1980 at this site,

e) Original XBT (Expendable Bathythermographic) traces from August and December 1980.

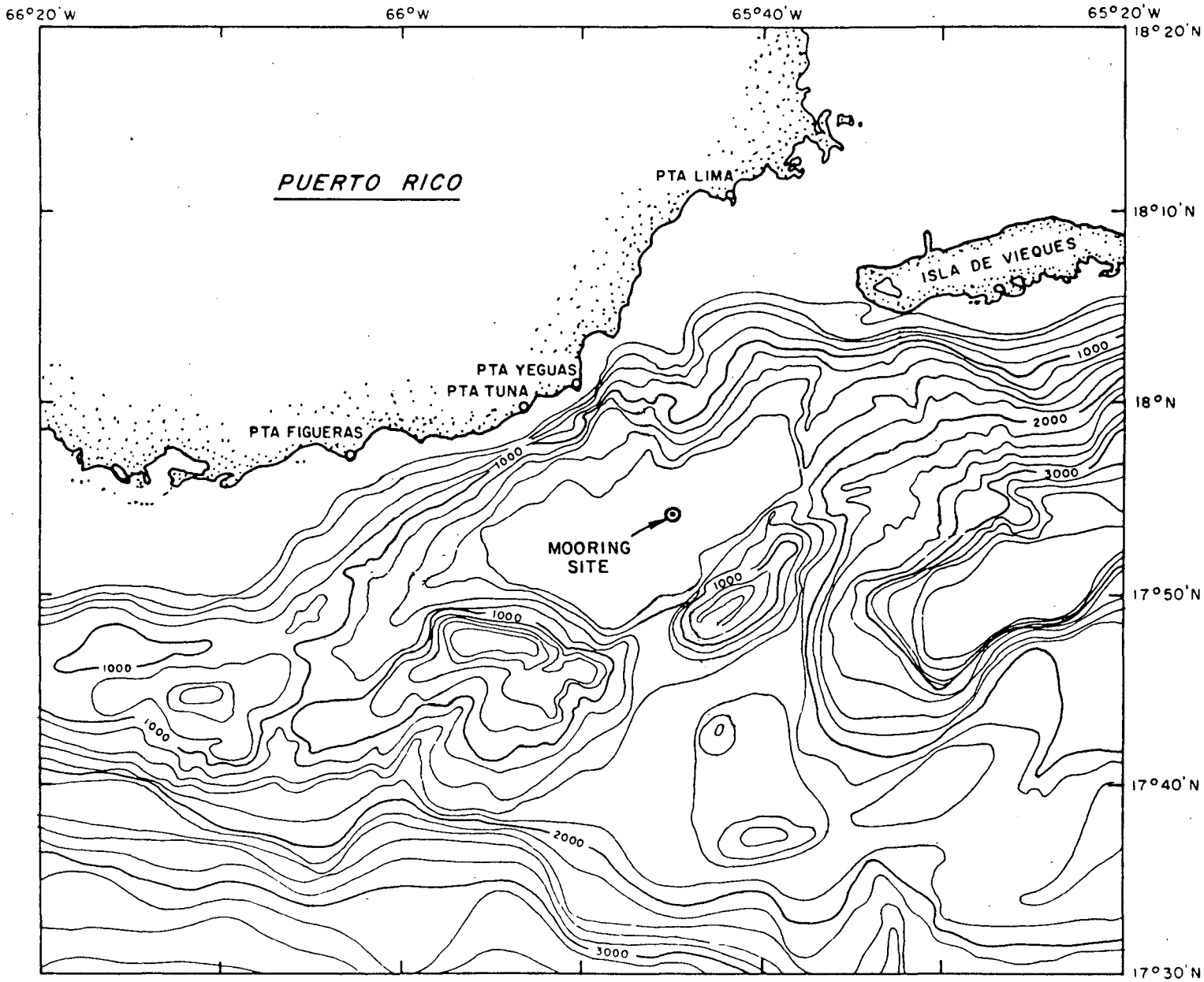

Figure 1-1. Location of the current meter mooring site.

2. MEASUREMENT PROGRAM

The current meter mooring (Figure 2-1) was deployed at 17°54'N and 65°45'W in 2020 meters of water on 21 June 1980. This mooring was retrieved on 16 August 1980 and reinstalled at approximately the same location on 18 August 1980 (Figure 2-2). The second deployment ended on 7 December 1980. An additional 5-month deployment began in December, but the resulting data are not included in this report.

During the June to August period, current meters were installed at depths of 120, 160, 242, 434, and 933 meters below the surface. Between August and December, current meters were located at depths of 40, 80, 160, 354, and 854-meters. Neil Brown Acoustic Current Meters (ACMs) were installed at the two upper levels, while Aanderaa RCM-5 current meters were installed at the lower three levels. The ACMs utilize the Doppler shift of an acoustic signal propagating through a moving fluid to measure two components of water velocity. They were programmed to record vector-averaged velocity at 3-minute intervals. Temperature was recorded at 30-minute intervals. The RCMs utilize a Savonius rotor and vane to measure average current speed and instantaneous direction, respectively. They were also equipped with temperature and pressure sensors. Data from each sensor were recorded every 15 minutes.

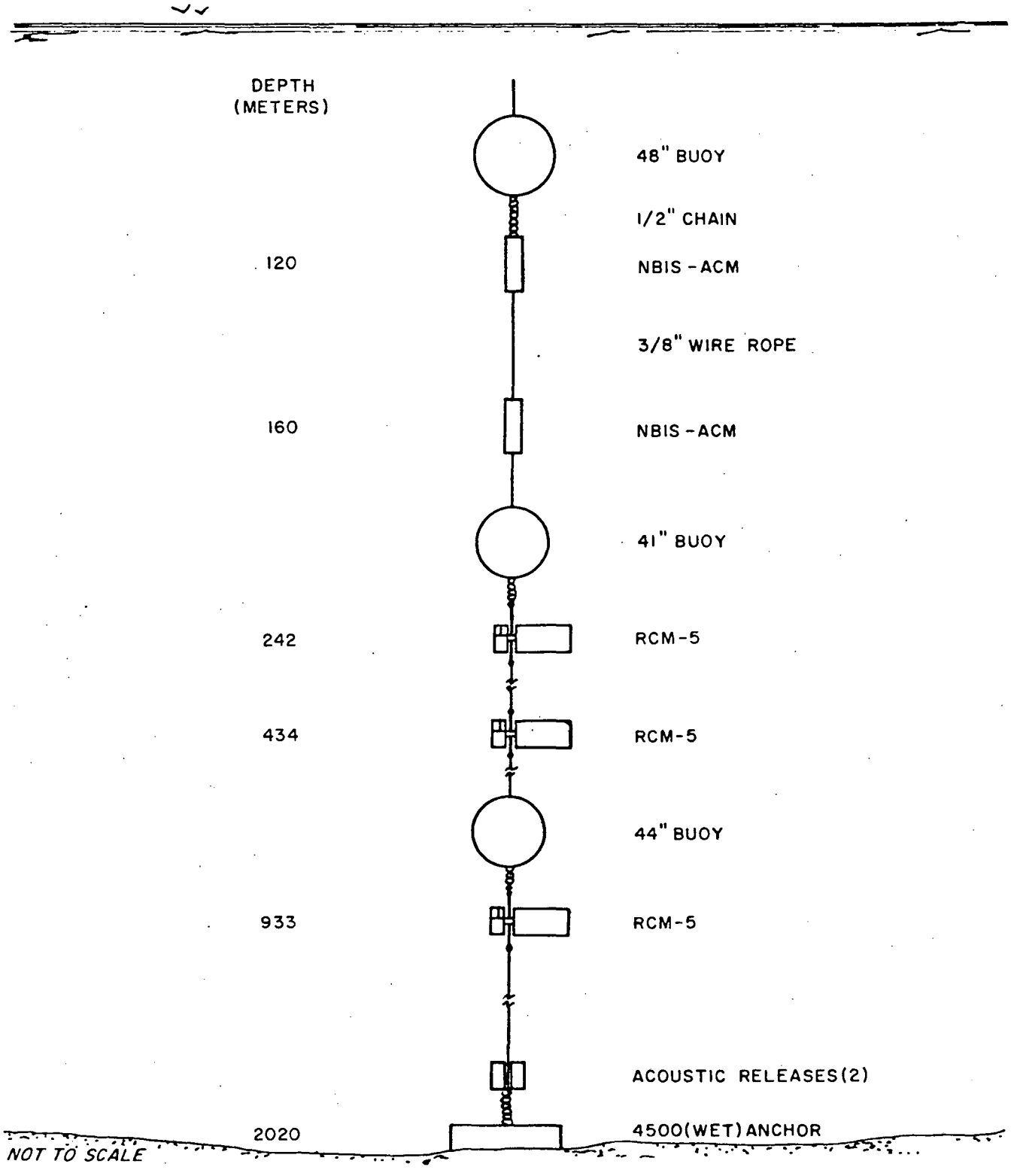

Figure 2-1. Mooring deployed at 17°54'N and 65°45'W between 21 June and 16 August 1980.

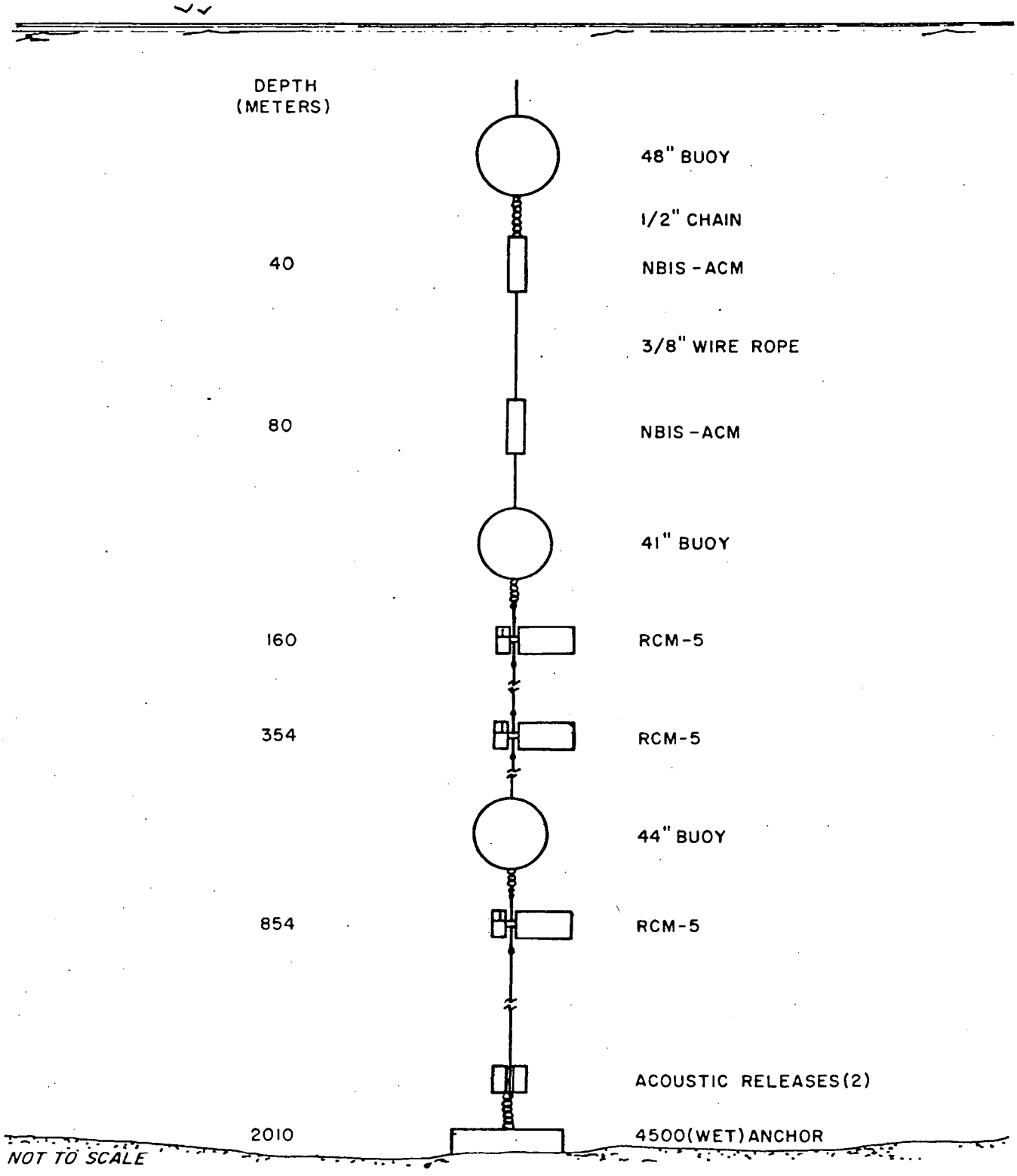

Figure 2-2. Mooring deployed at 17°54'N and 65°45'W between 18 August and 7 December 1980.

3. REVIEW OF DATA QUALITY

Data tapes from the current meters were transcribed onto 9-track tape, edited, and archived. Results of quality review of these tapes are shown in Table 3-1.

Good quality data were recorded on all instruments. Two records were short because of instrument malfunctions. During the June to August deployment, the ACM at the 160-meter depth recorded data for only 7 days (21 through 27 June). This same instrument failed again during the August to December deployment, when it was deployed at the 80 meter depth. Good quality data were recorded only between 18 August and 15 September.

Table 3-1. Results of quality review of current meter data collected at 17°54'N and 65°45'W between 21 June and 7 December 1980.

Instrument	Depth (m)	Data Period	Speed	Direction	Temperature	Pressure	Comment
ACM	120	6/21-8/16/80	Good	Good	Good	NA	
ACM	160	6/21-6/27/80	Good	Good	Good	NA	Short Record
RCM-5	242	6/21-8/16/80	Good	Good	Good	Good	
RCM-5	434	6/21-8/16/80	Good	Good	Good	Good	
RCM-5	933	6/21-8/16/80	Good	Good	Good	Good	
ACM	40	8/18-12/7-80	Good	Good	Good	NA	
ACM	80	8/18-9/15/80	Good	Good	Good	NA	Short Record
RCM-5	160	8/18-12/7-80	Good	Good	Good	Good	
RCM-5	354	8/18-12/7-80	Good	Good	Good	Good	
RCM-5	854	8/18-12/7/80	Good	Good	Good	Good	

4. DATA PRODUCTS

Current meter records from the ACMs and RCMs deployed between June and December 1981 were used to produce the following data products:

1) Data Listings (Attachment 1)

   a) Current speed (cm/sec) and direction (true) from half-hour averages of the data.

   b) Temperature (°C) based on half-hour averages.

   c) Pressure (mbars) based on half-hour averages.

2) Time Series Display

Hourly averages of current speed (cm/sec), direction (true), current vector (cm/sec), temperature (°C), and pressure (dbars) are plotted as a function of time in Figures 4-1 through 4-26. Current vector is shown on the third tier from the top. A vector pointing toward the top of the page represents current flowing to the north.

3) Current Statistics

Current data are summarized according to frequency of occurrence within 5 cm/sec speed and 15° direction intervals in Tables 4-1 through 4-10. Sums and percentages of total occurrence are given for each speed and direction class, along with mean speed, extreme speeds, mean component speeds, and standard deviations.

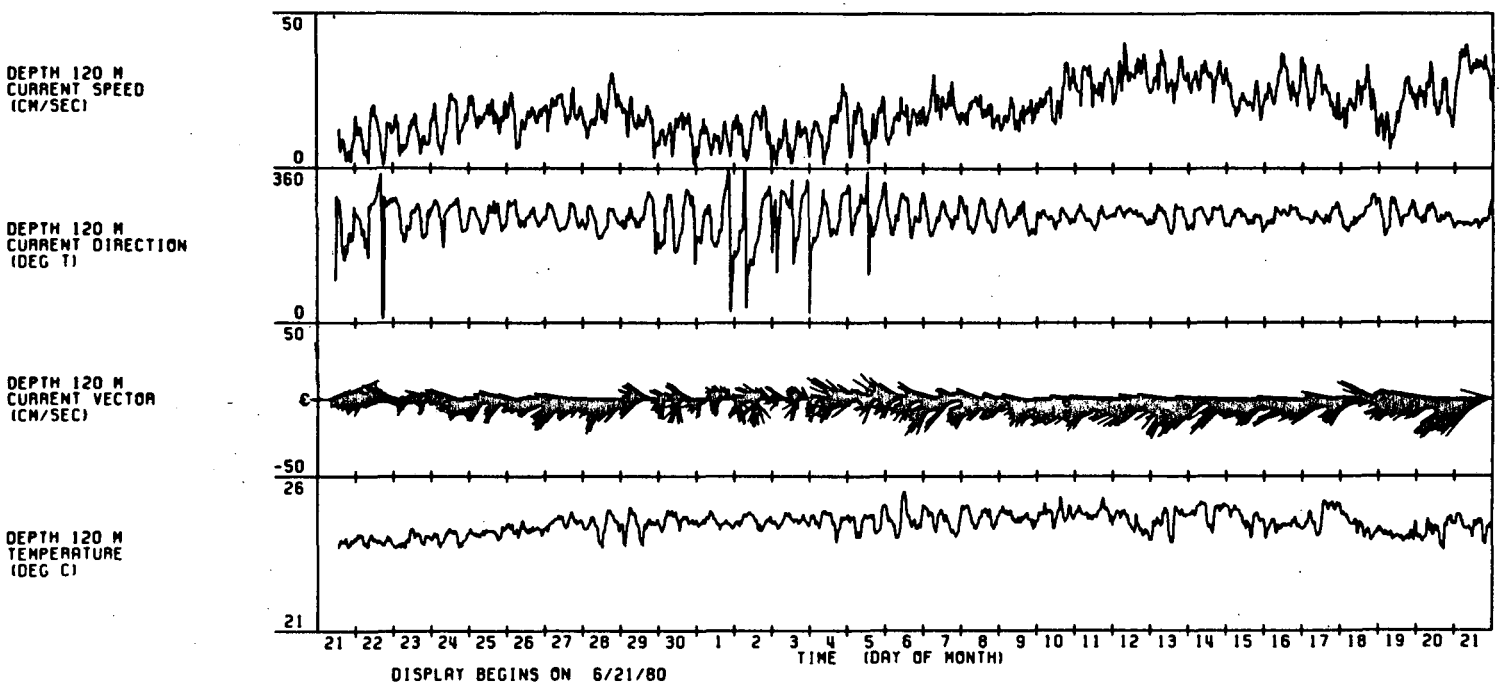

Figure 4-1. Time series plot of current and temperature from the 120-meter depth at 17°54'N and 65°45'W between 21 June and 20 July 1980.

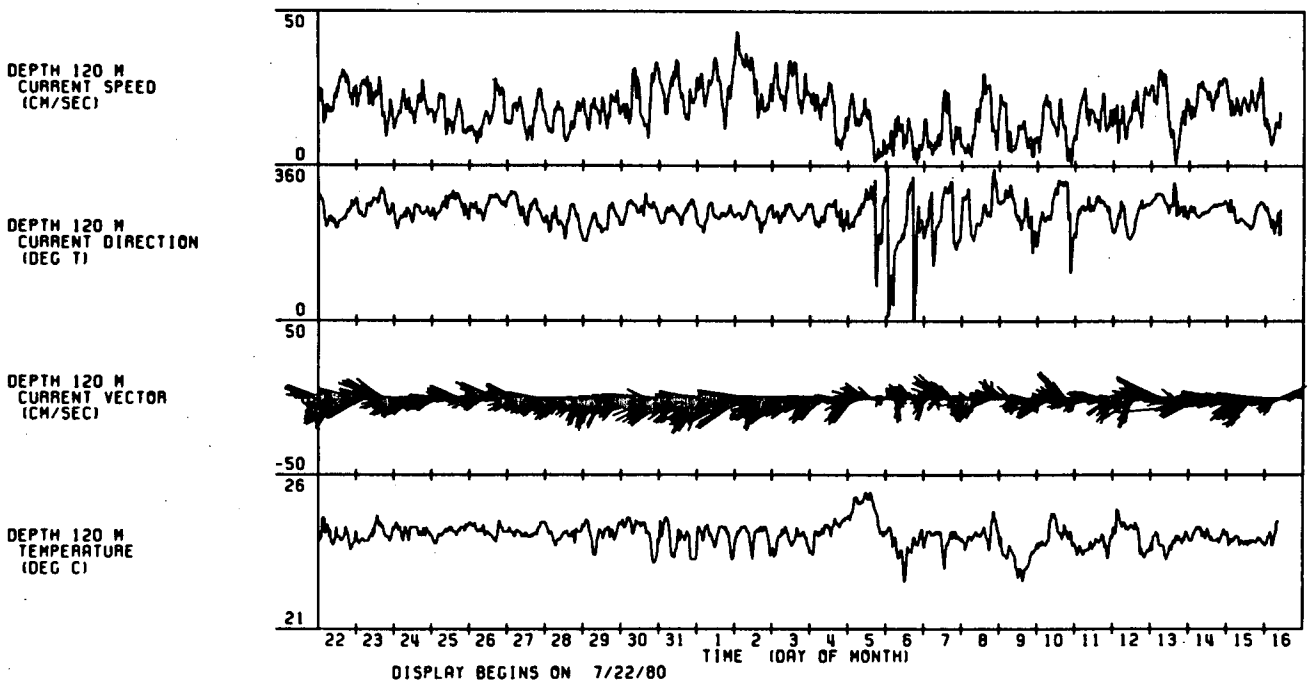

Figure 4-2. Time series plot of current and temperature from the 120-meter depth at 17°54'N and 65°45'W between 21 July and 16 August 1980.

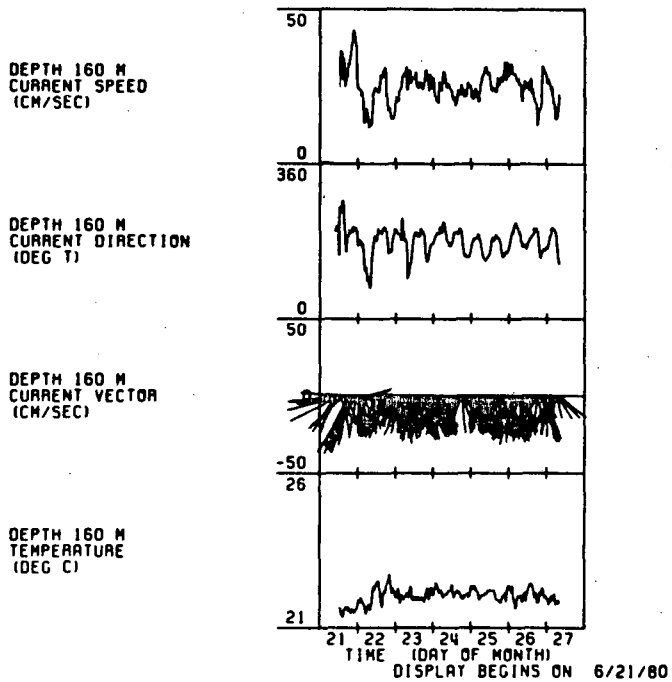

Figure 4-3. Time series plot of current and temperature from the 160-meter depth at 17°54'N and 65°45'W between 21 and 27 June 1980.

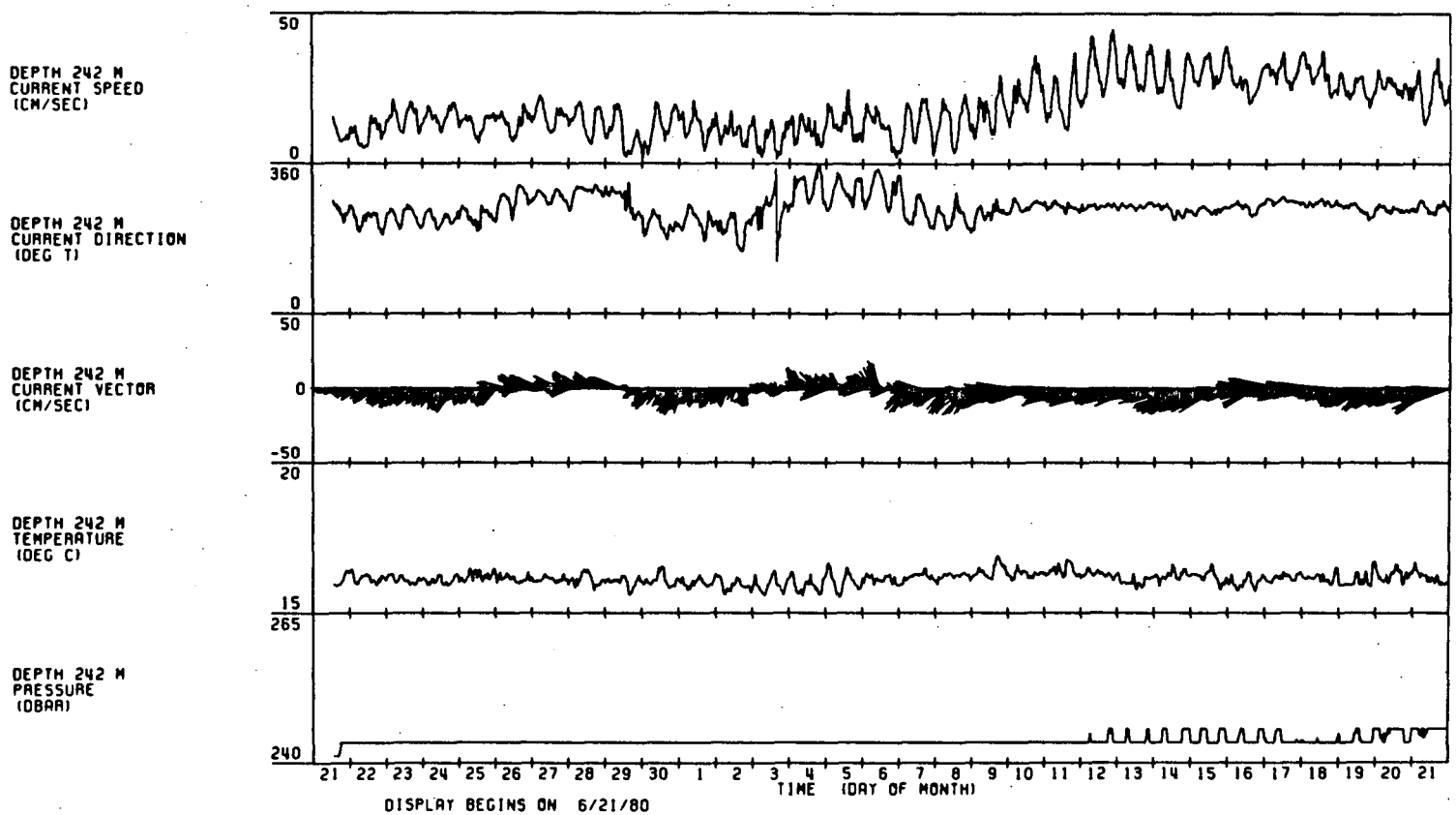

Figure 4-4. Time series plot of current, temperature, and pressure from the 242-meter depth at 17°54'N and 65°45'W between 21 June and 20 July 1980.

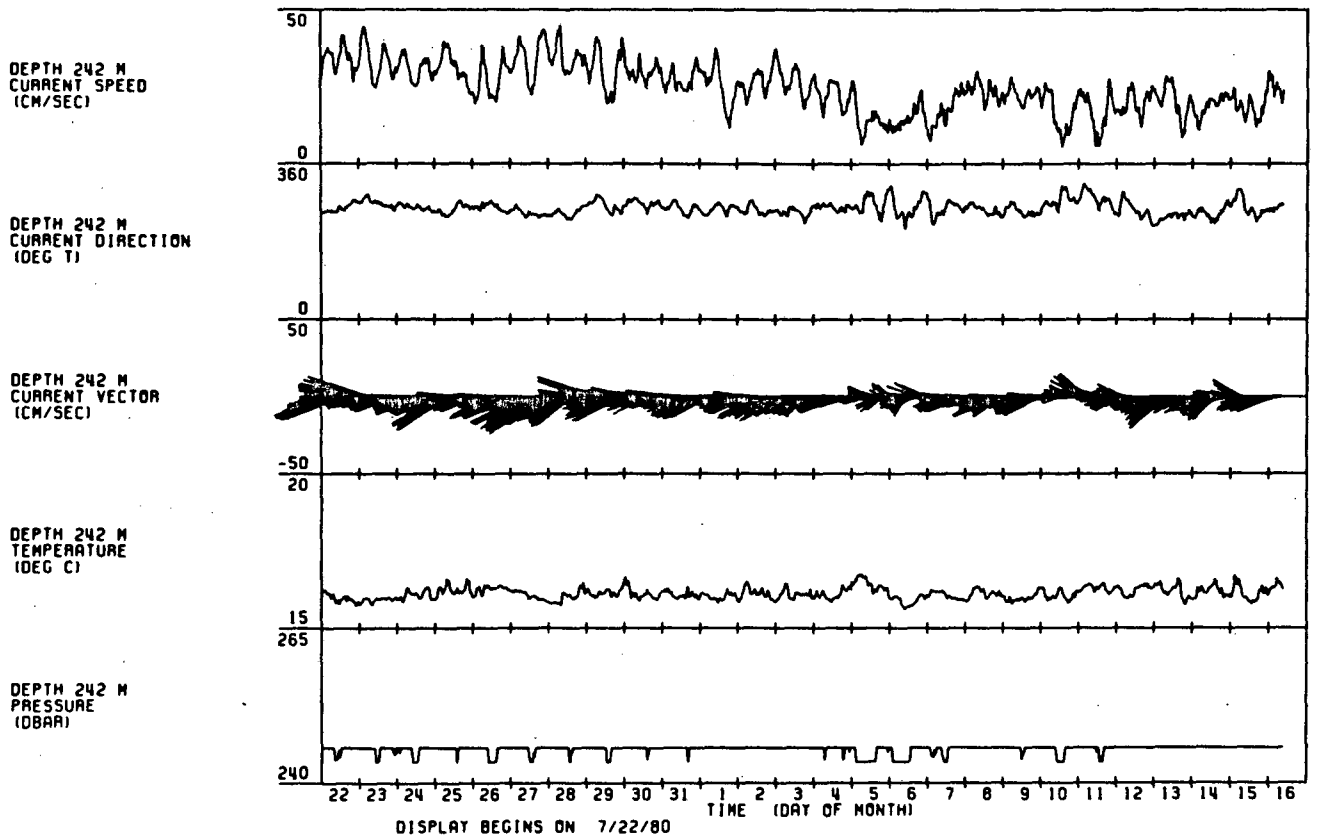

Figure 4-5. Time series plot of current, temperature, and pressure from the 242-meter depth at 17°54'N and 65°45'W between 21 July and 16 August 1980.

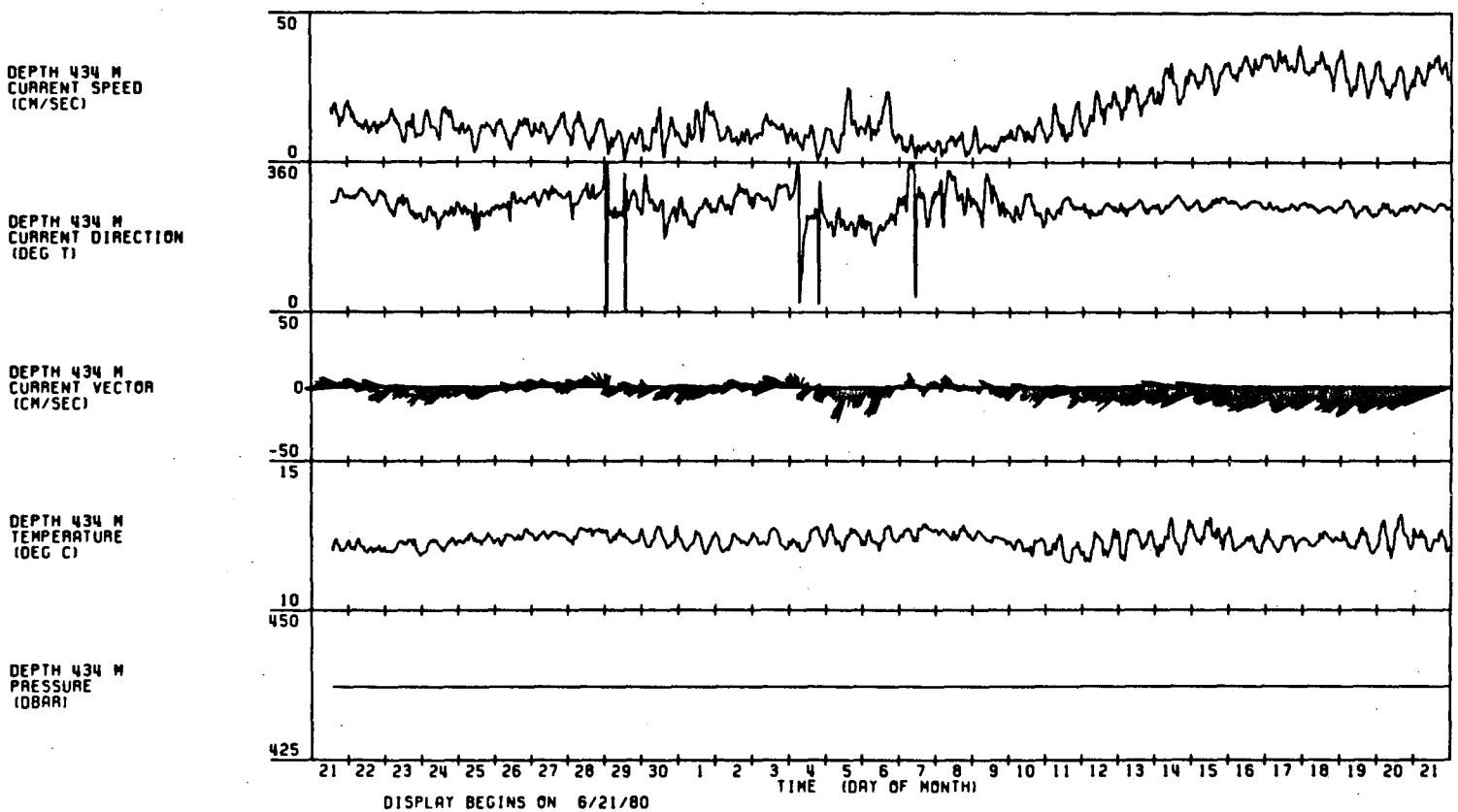

Figure 4-6. Time series plot of current, temperature, and pressure from the 434-meter depth at 17°54'N and 65°45'W between 21 June and 20 July 1980.

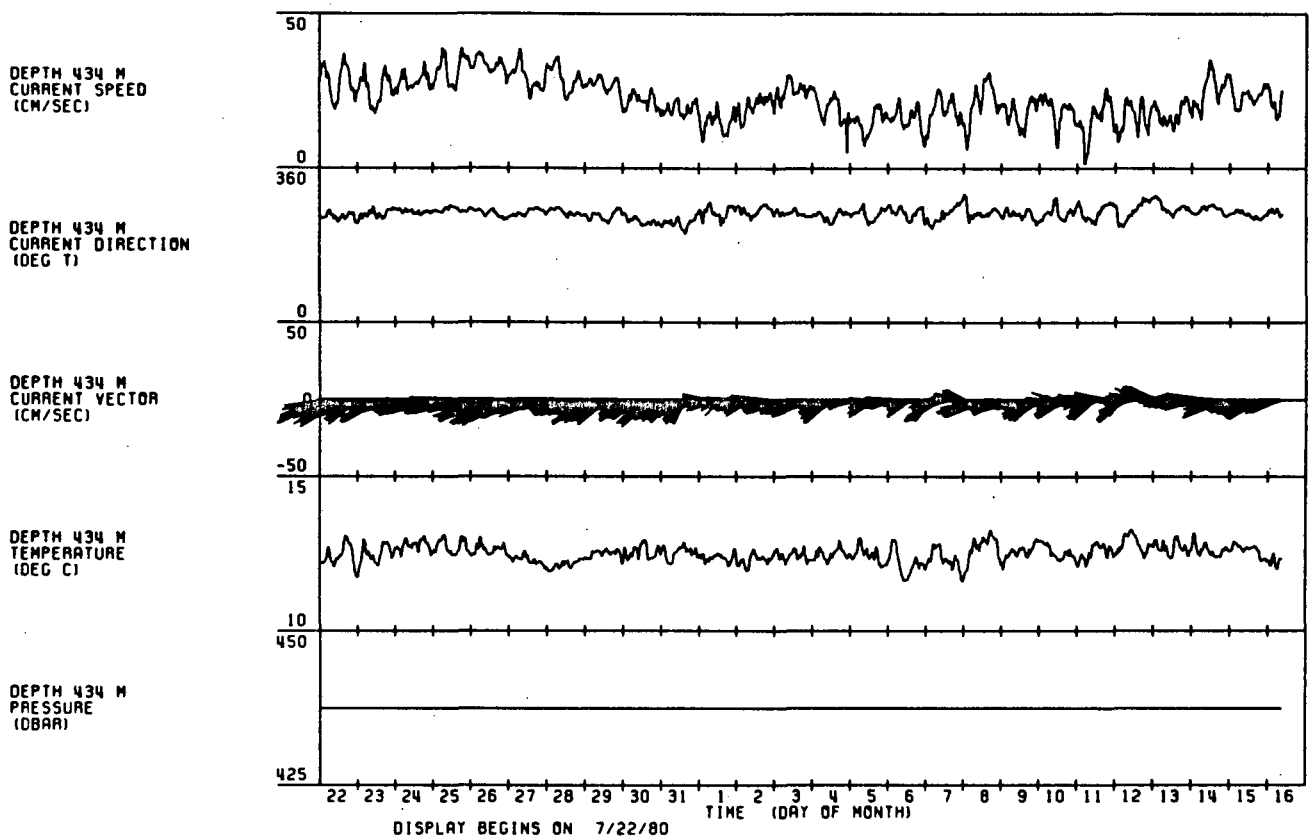

Figure 4-7. Time series plot of current, temperature, and pressure from the 434-meter depth at 17°54'N and 65°45'W between 21 July and 16 August 1980.

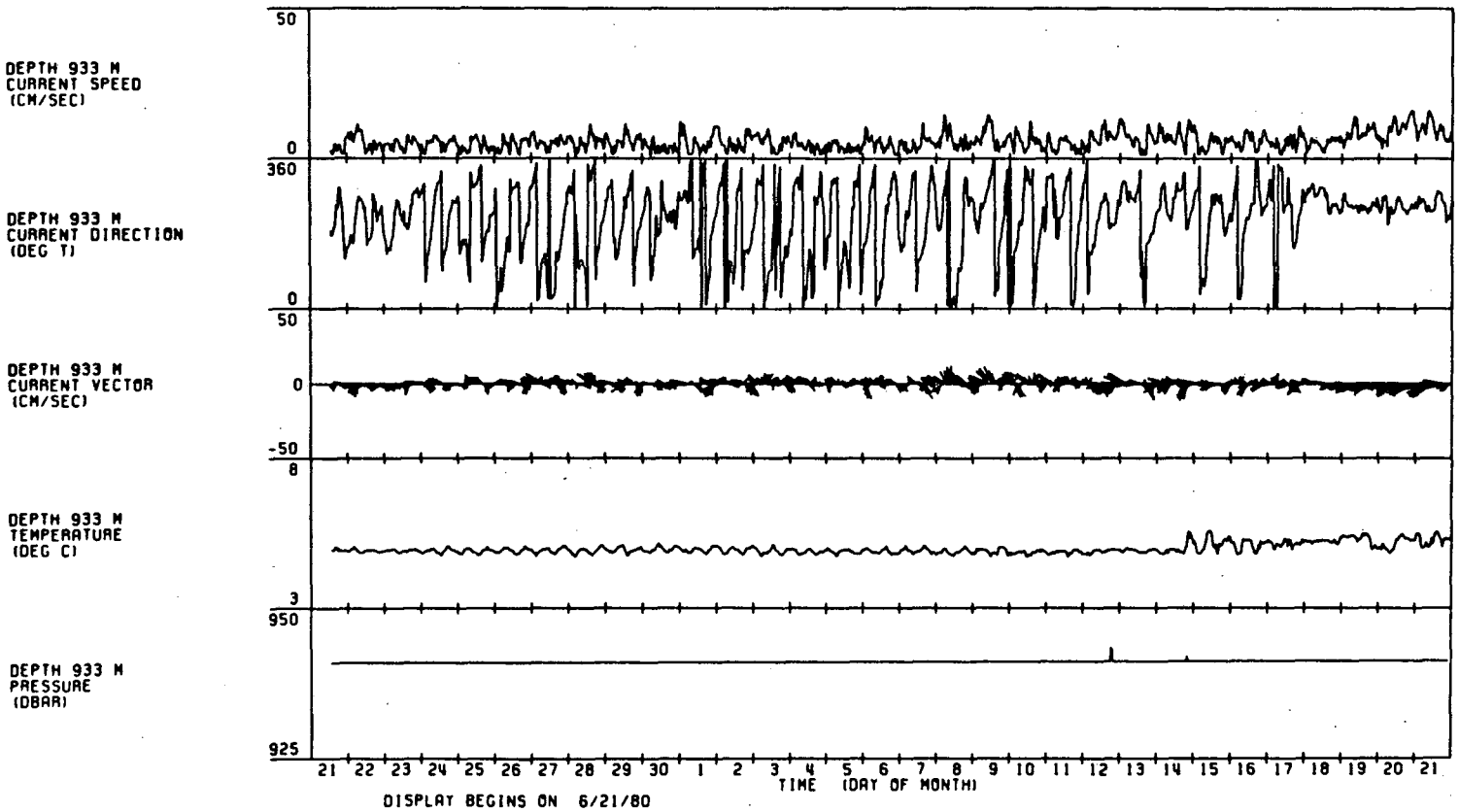

Figure 4-8. Time series plot of current, temperature, and pressure from the 933-meter depth at 17°54'N and 65°45'W between 21 June and 20 July 1980.

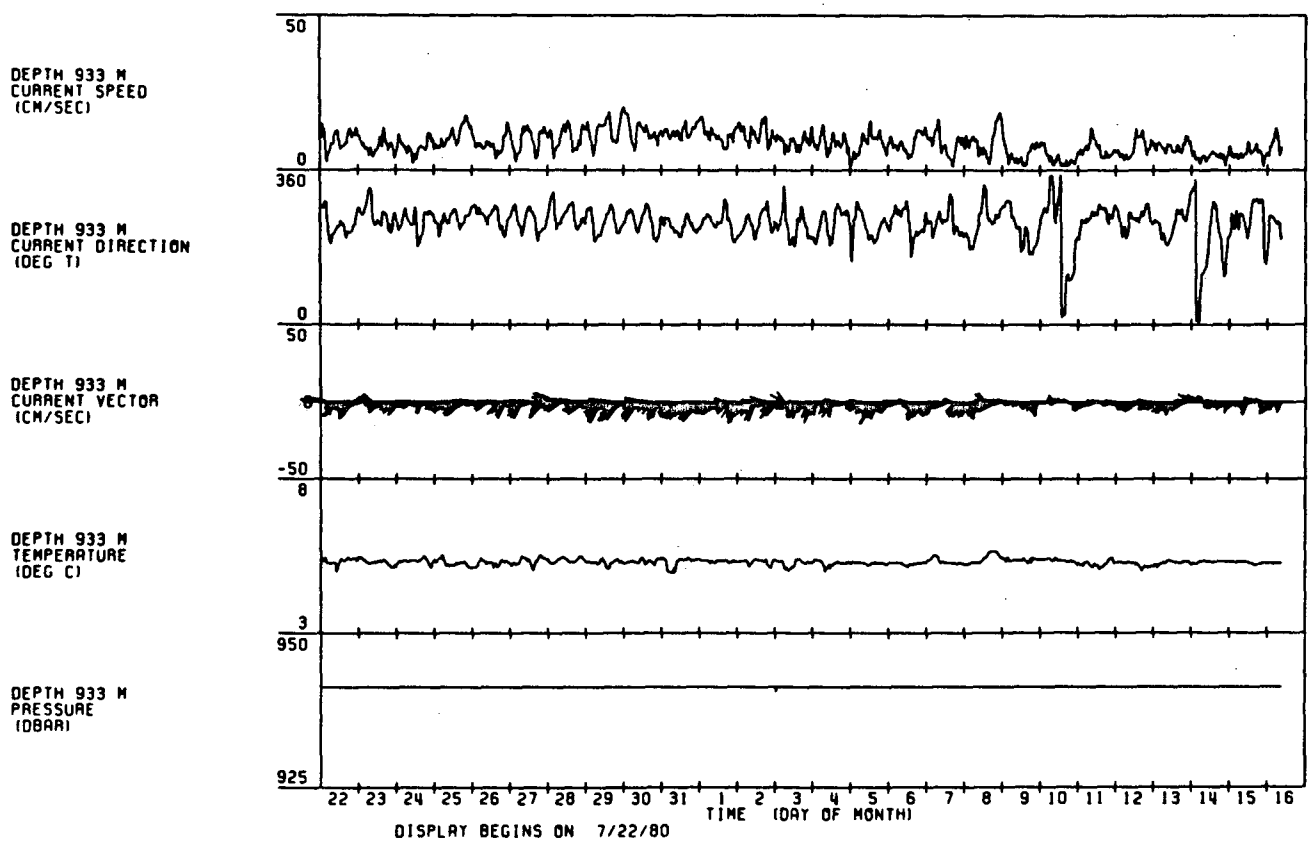

Figure 4-9. Time series plot of current, temperature, and pressure from the 933-meter depth at 17°54'N and 65°45'W between 21 July and 16 August 1980.

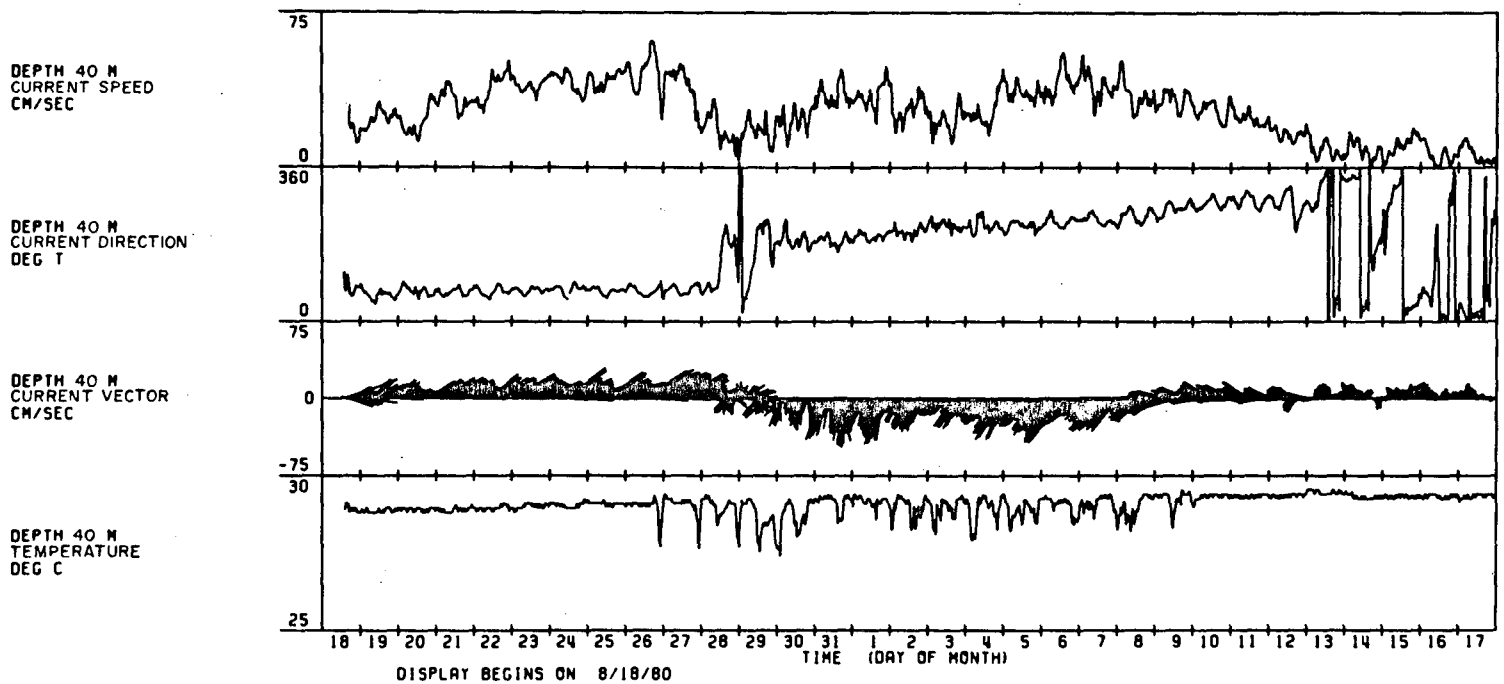

Figure 4-10. Time series plot of current and temperature from the 40-meter depth at 17°54'N and 65°45'W between 18 August and 17 September 1980.

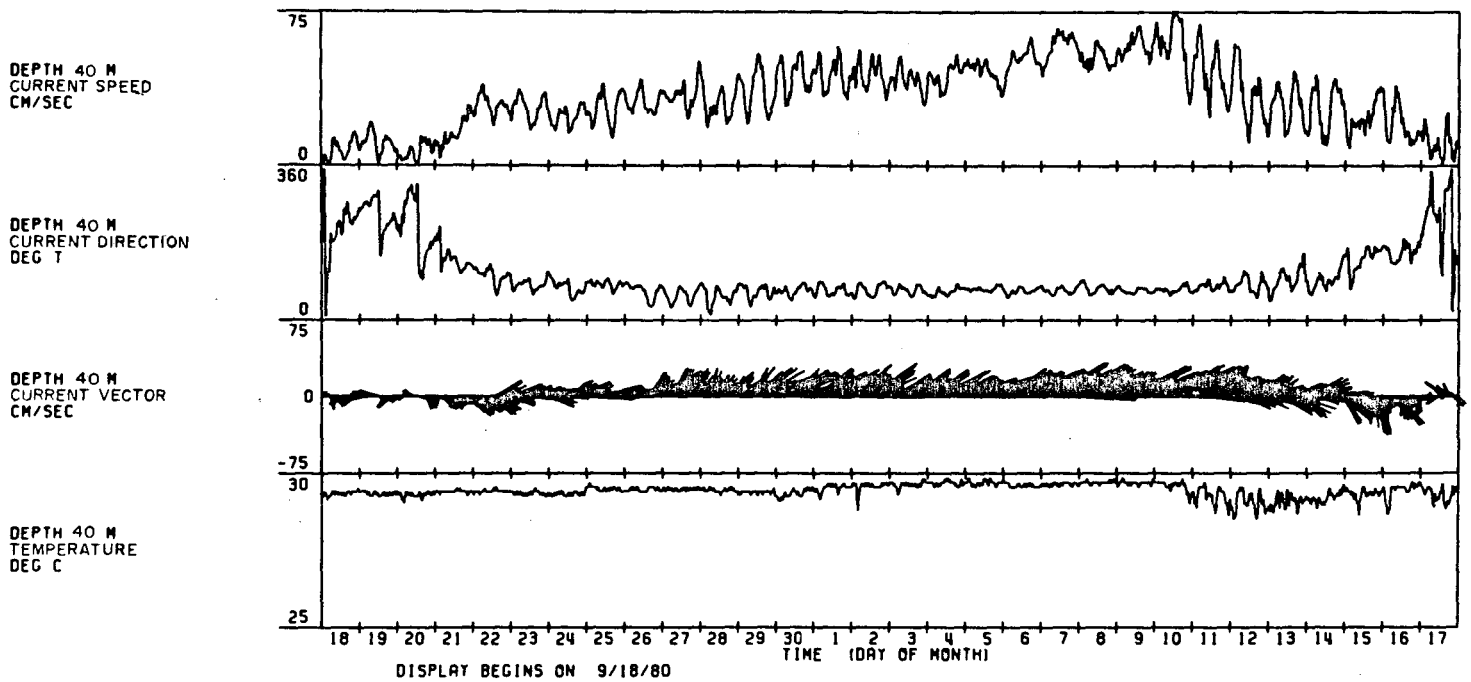

Figure 4-11. Time series plot of current and temperature from the 40-meter depth at 17°54'N and 65°45'W between 18 September and 17 October 1980.

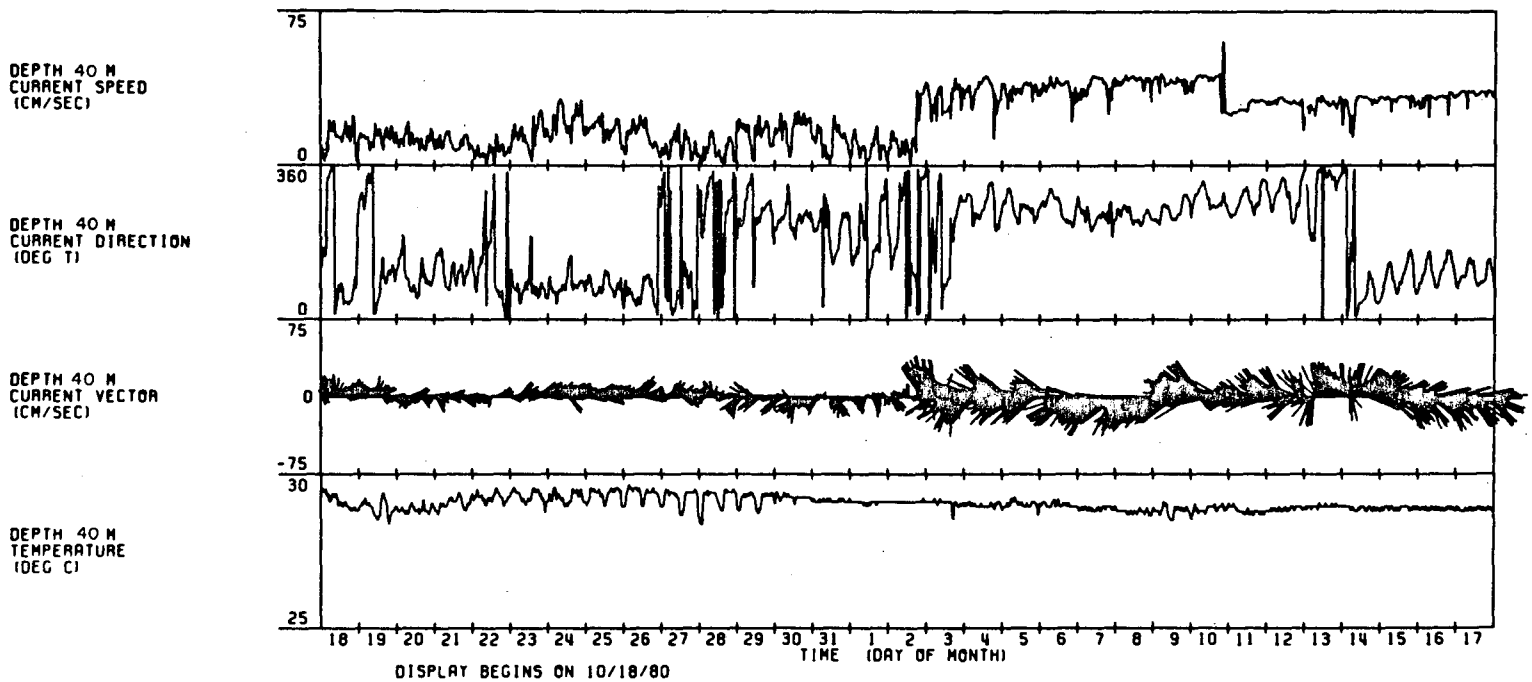

Figure 4-12. Time series plot of current and temperature from the 40-meter depth at 17°54'N and 65°45'W between 18 October and 17 November 1980.

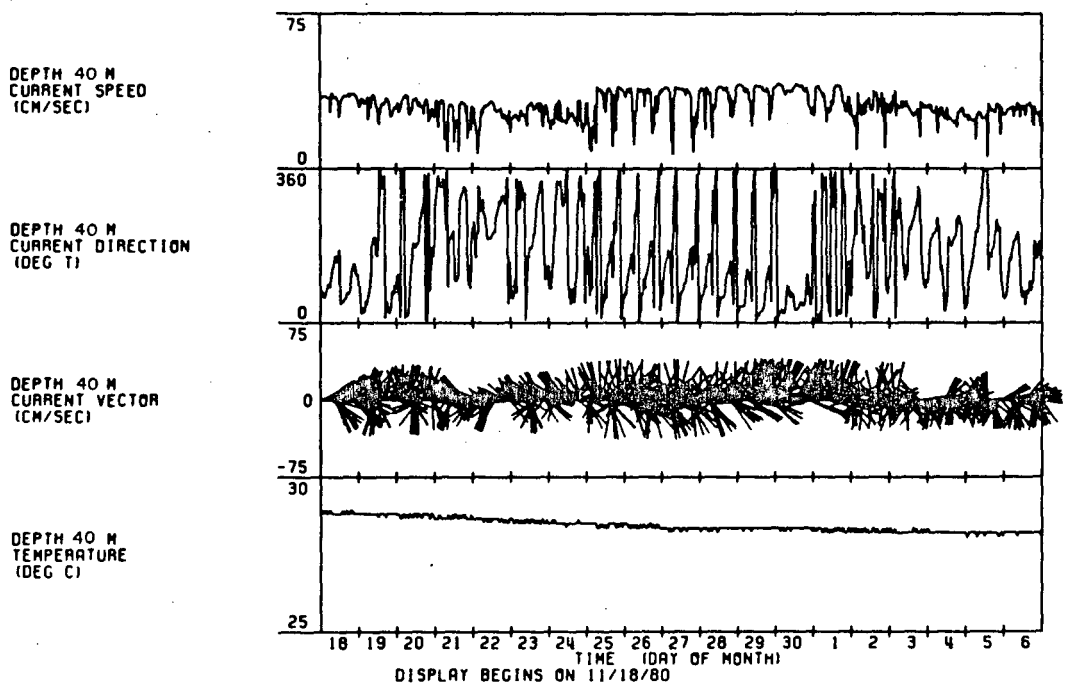

Figure 4-13. Time series plot of current and temperature from the 40-meter depth at 17°54'N and 65°45'W between 18 November and 7 December 1980.

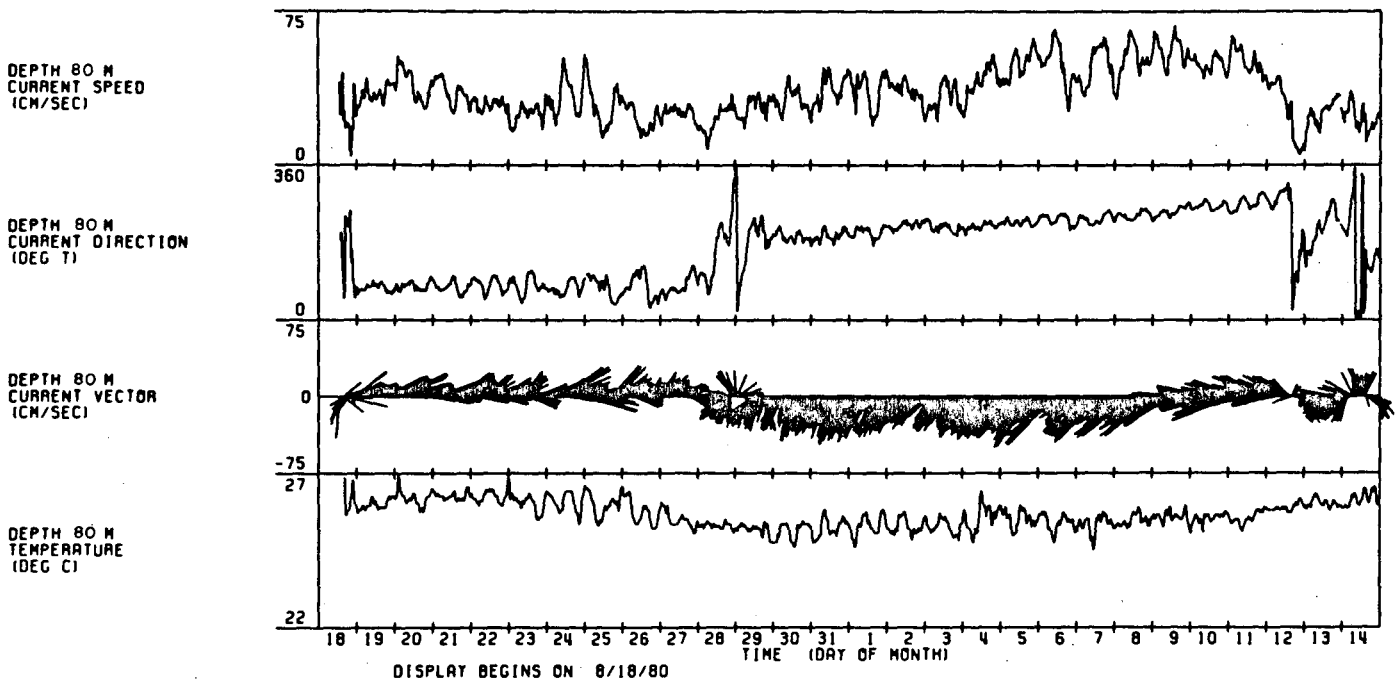

Figure 4-14. Time series plot of current and temperature from the 80-meter depth at 17°54'N and 65°45'W between 18 August and 14 September 1980.

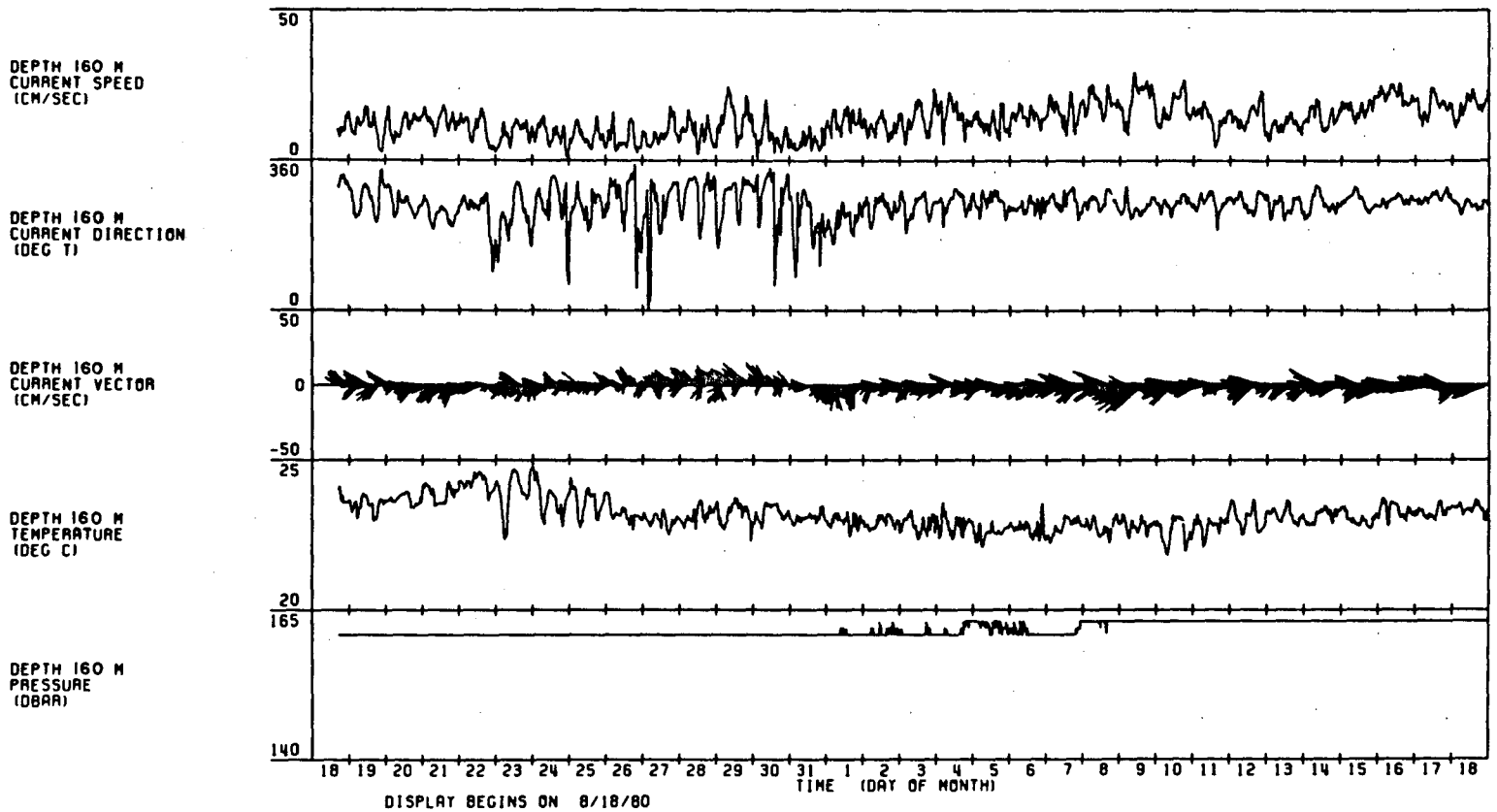

Figure 4-15. Time series plot of current, temperature, and pressure from the 160-meter depth at 17°54'N and 65°45'W between 18 August and 17 September 1980.

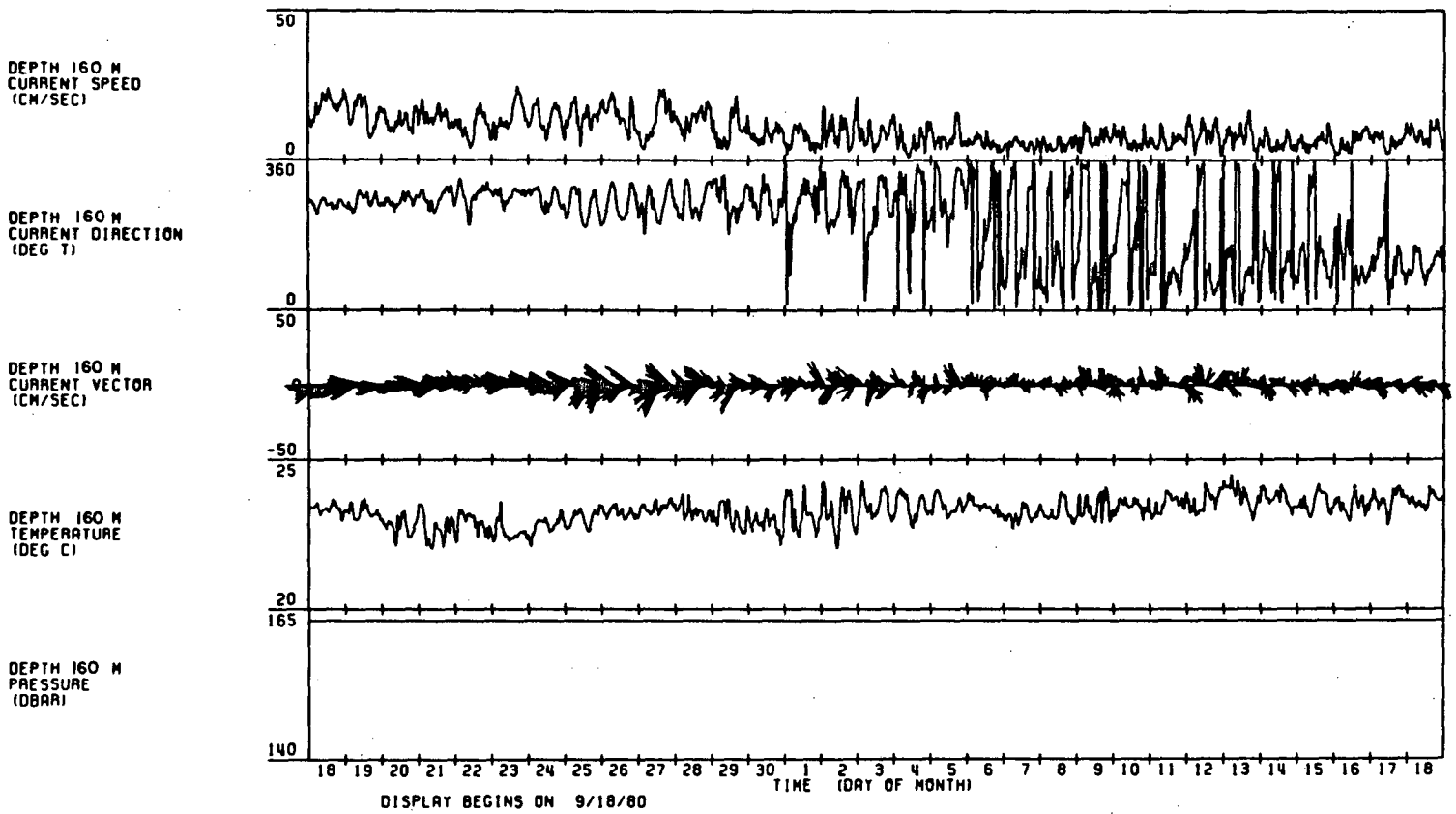

Figure 4-16. Time series plot of current, temperature, and pressure from the 160-meter depth at 17°54'N and 65°45'W between 18 September and 17 October 1980.

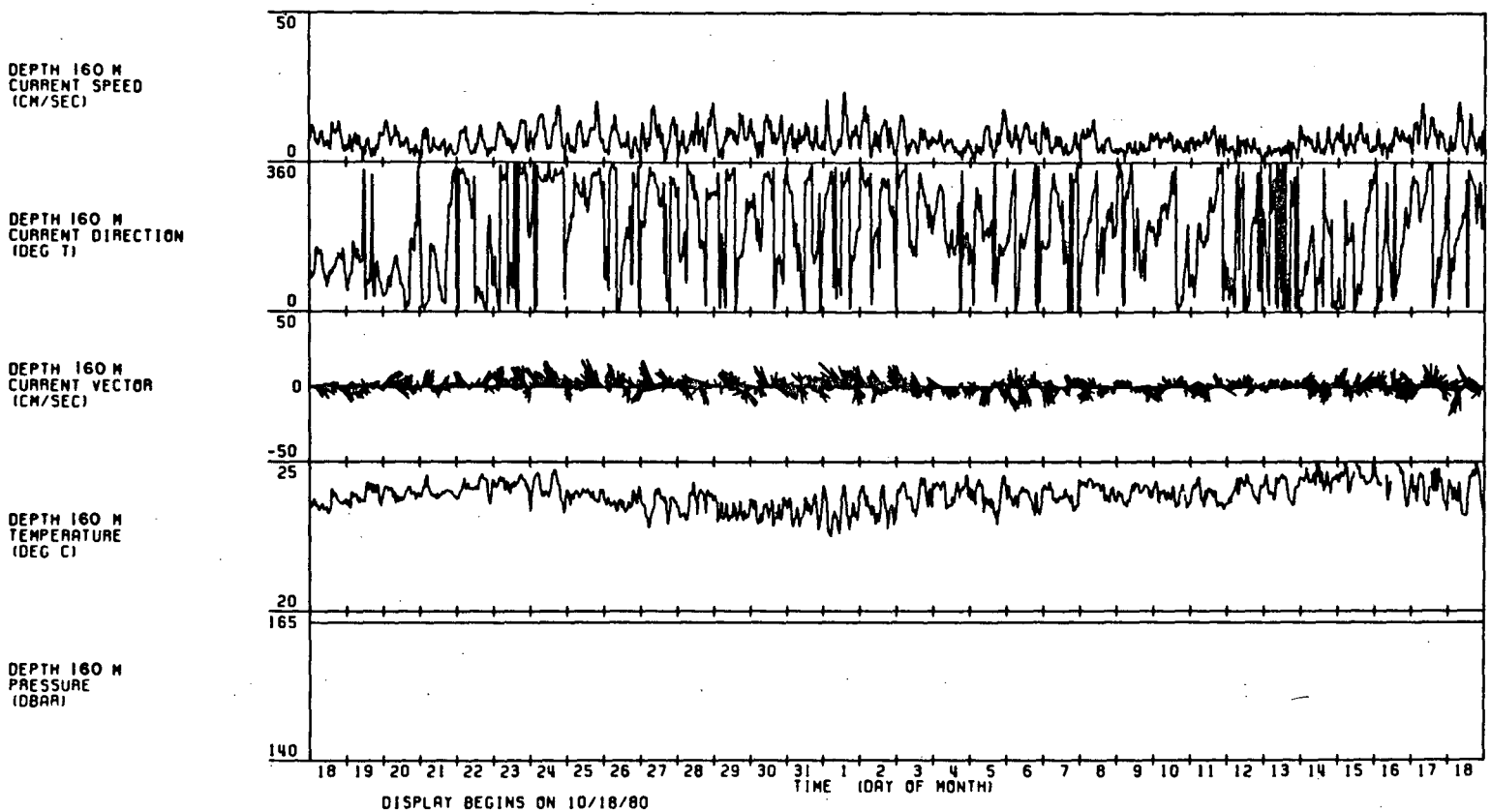

Figure 4-17. Time series plot of current, temperature, and pressure from the 160-meter depth at 17°54'N and 65°45'W between 18 October and 17 November 1980.

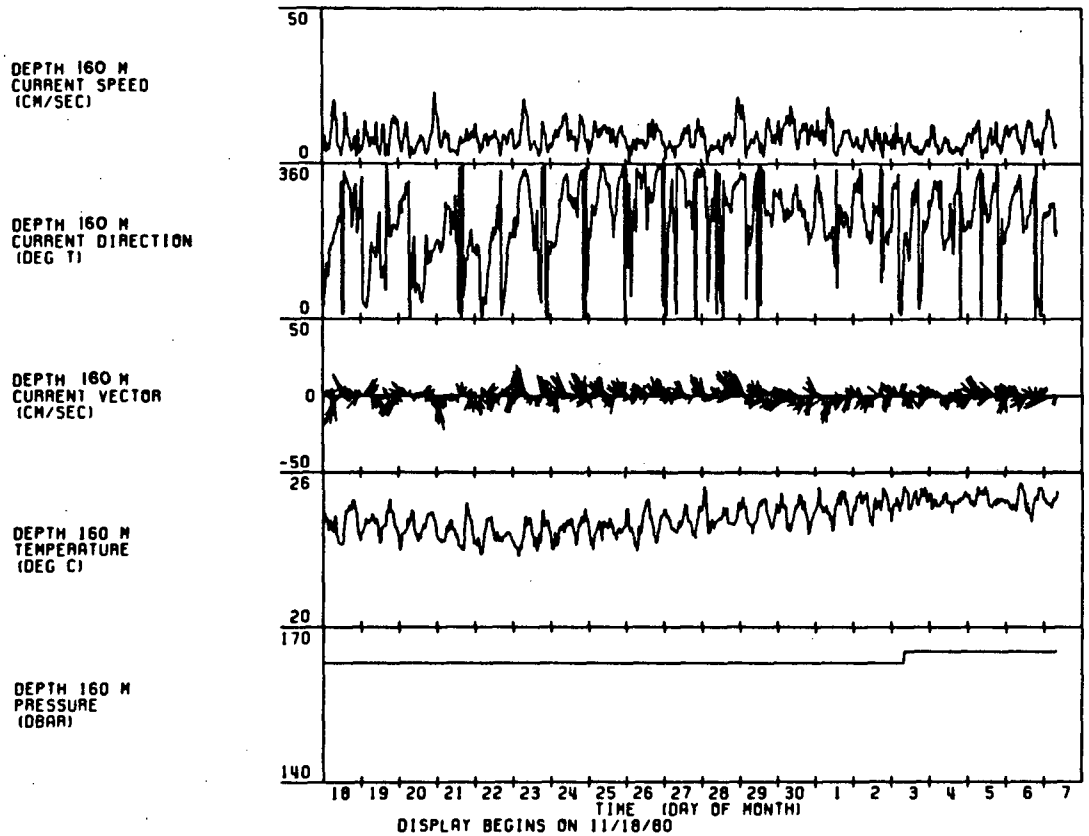

Figure 4-18. Time series plot of current, temperature, and pressure from the 160-meter depth at 17°54'N and 65°45'W between 18 November and 7 December 1980.

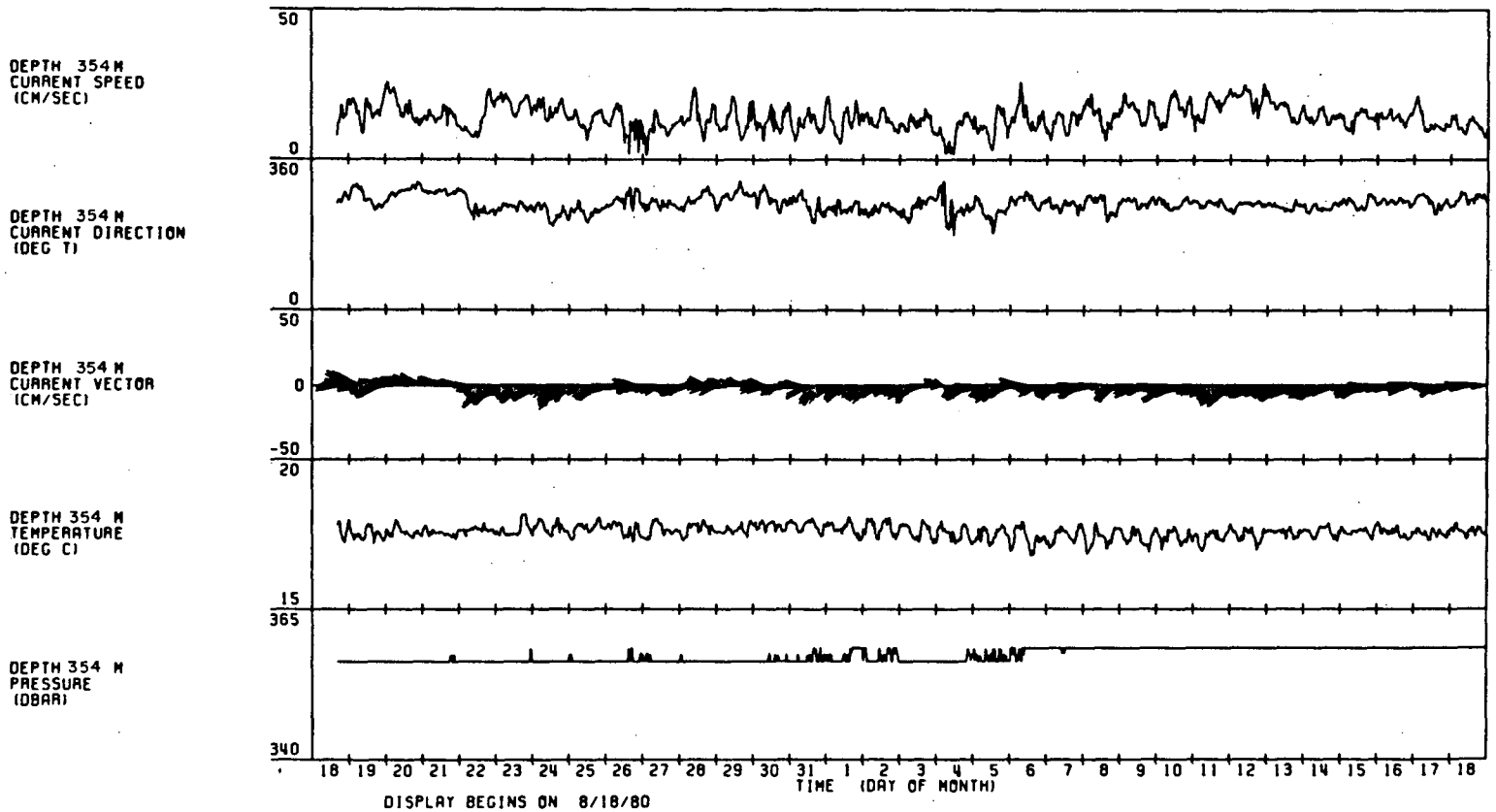

Figure 4-19. Time series plot of current, temperature, and pressure from the 354-meter depth at 17°54'N and 65°45'W between 18 August and 17 September 1980.

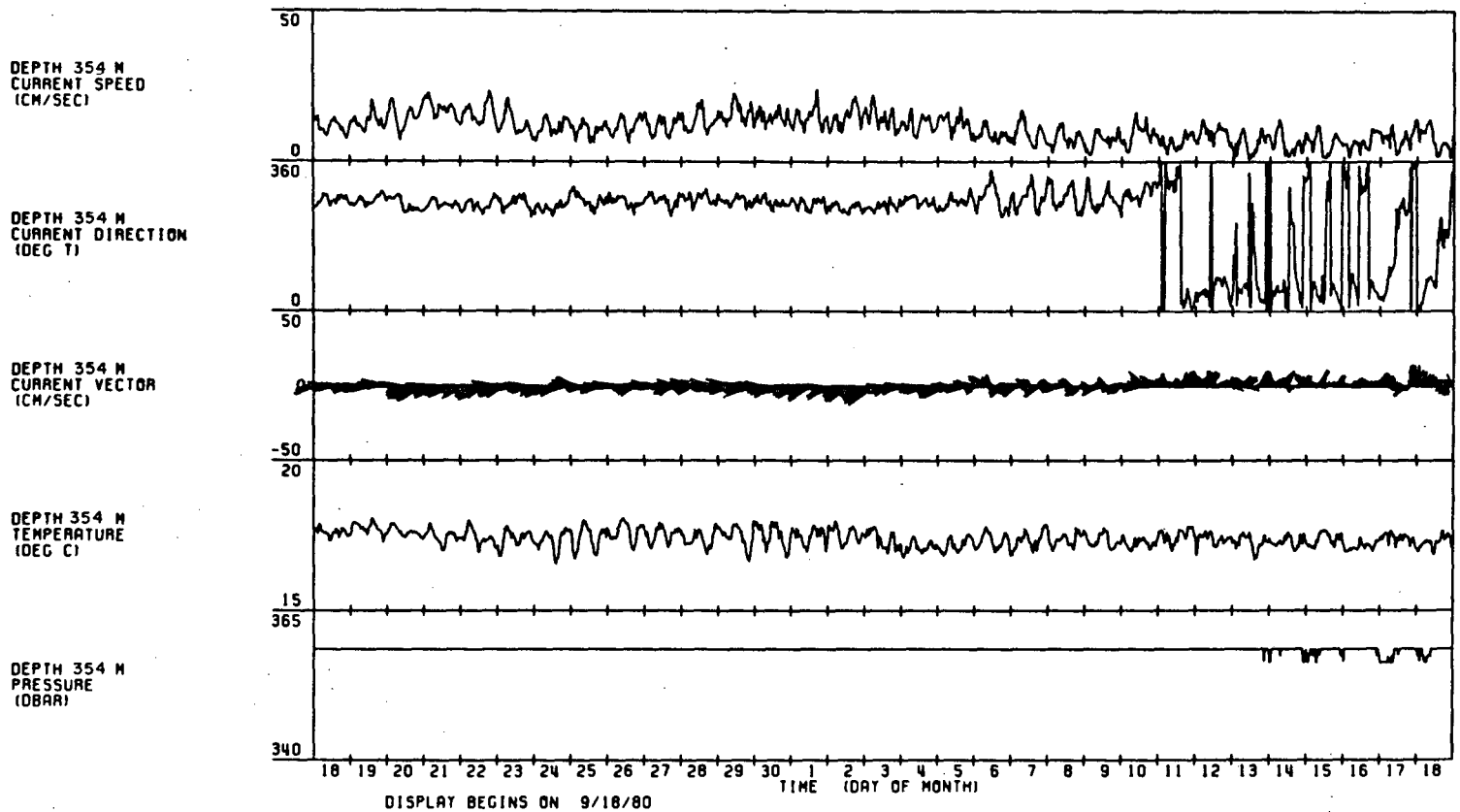

Figure 4-20. Time series plot of current, temperature, and pressure from the 354-meter depth at 17°54'N and 65°45'W between 18 September and 17 October 1980.

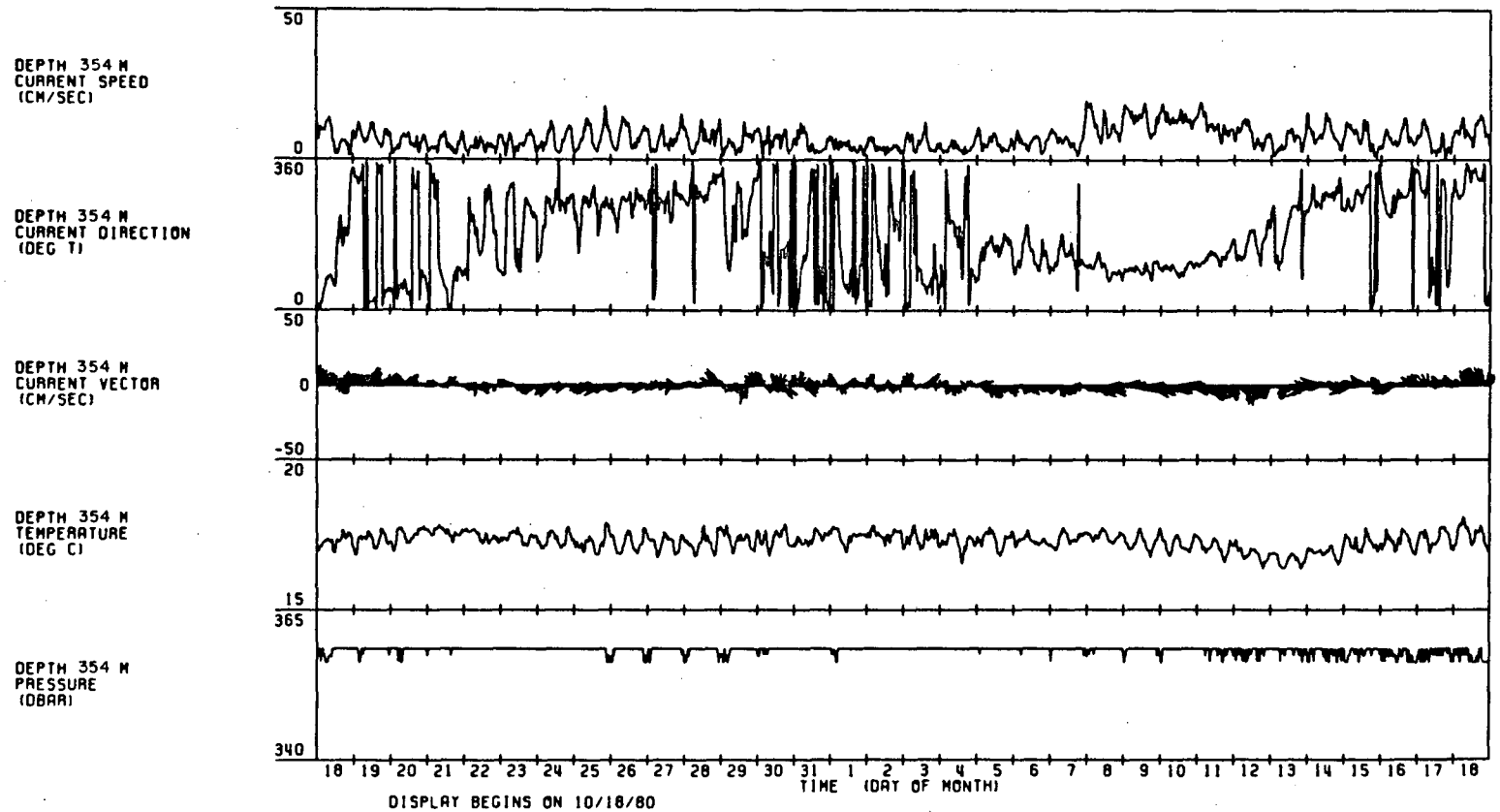

Figure 4-21. Time series plot of current, temperature, and pressure from the 354-meter depth at 17°54'N and 65°45'W between 18 October and 17 November 1980.

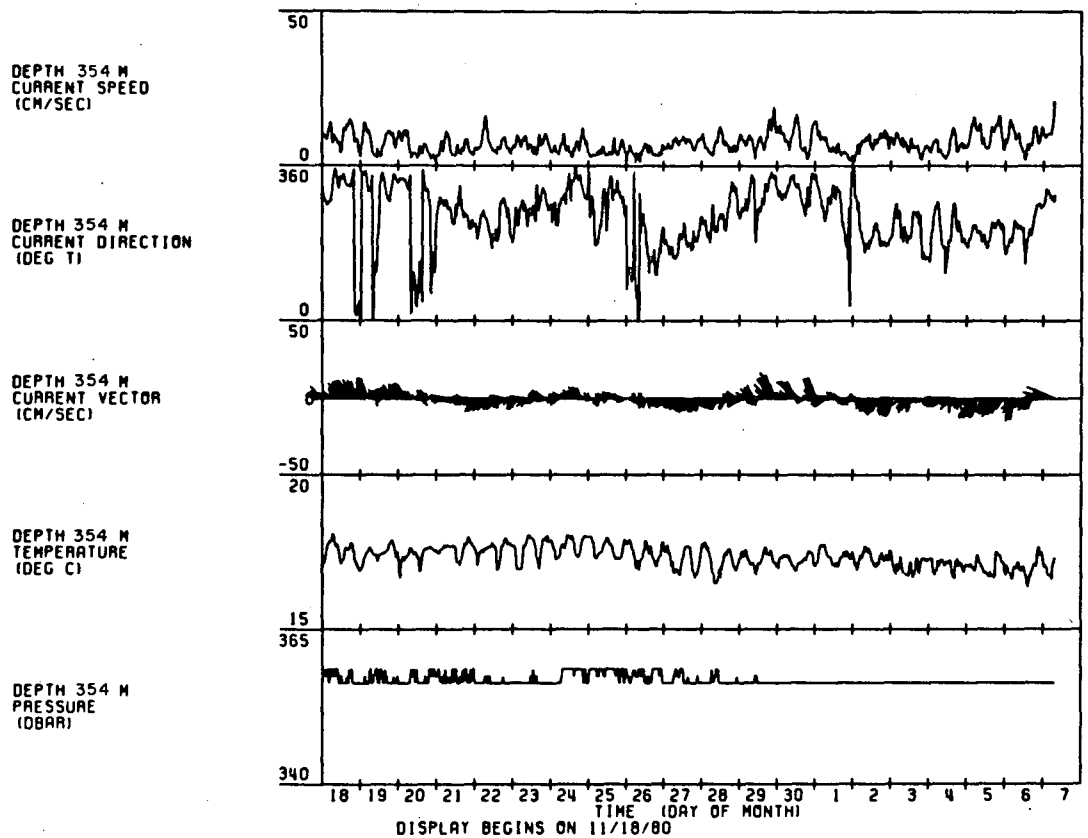

Figure 4-22. Time series plot of current, temperature, and pressure from the 354-meter depth at 17°54'N and 65°45'W between 18 November and 7 December 1980.

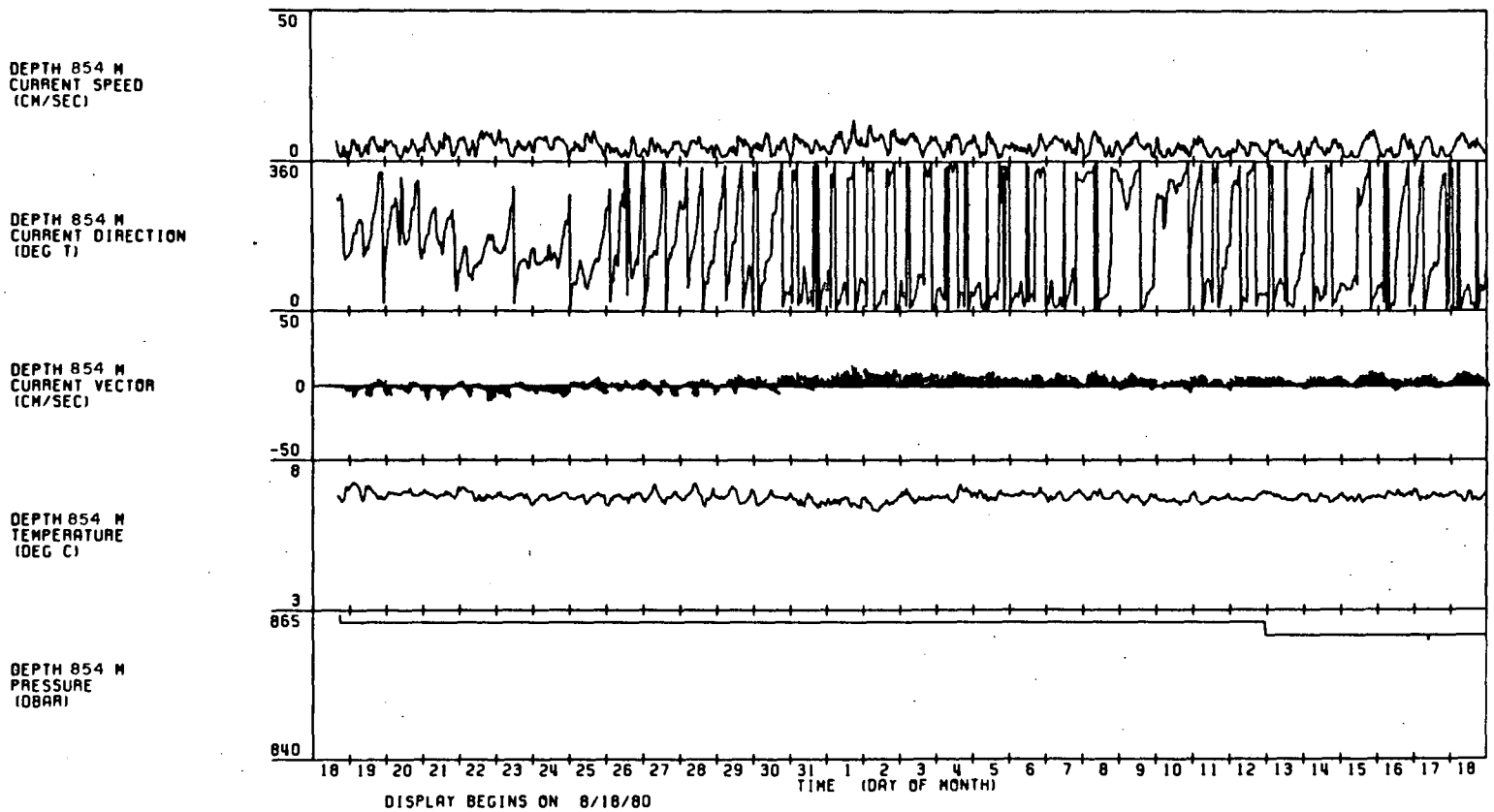

Figure 4-23. Time series plot of current, temperature, and pressure from the 854-meter depth at 17°54'N and 65°45'W between 18 August and 17 September 1980.

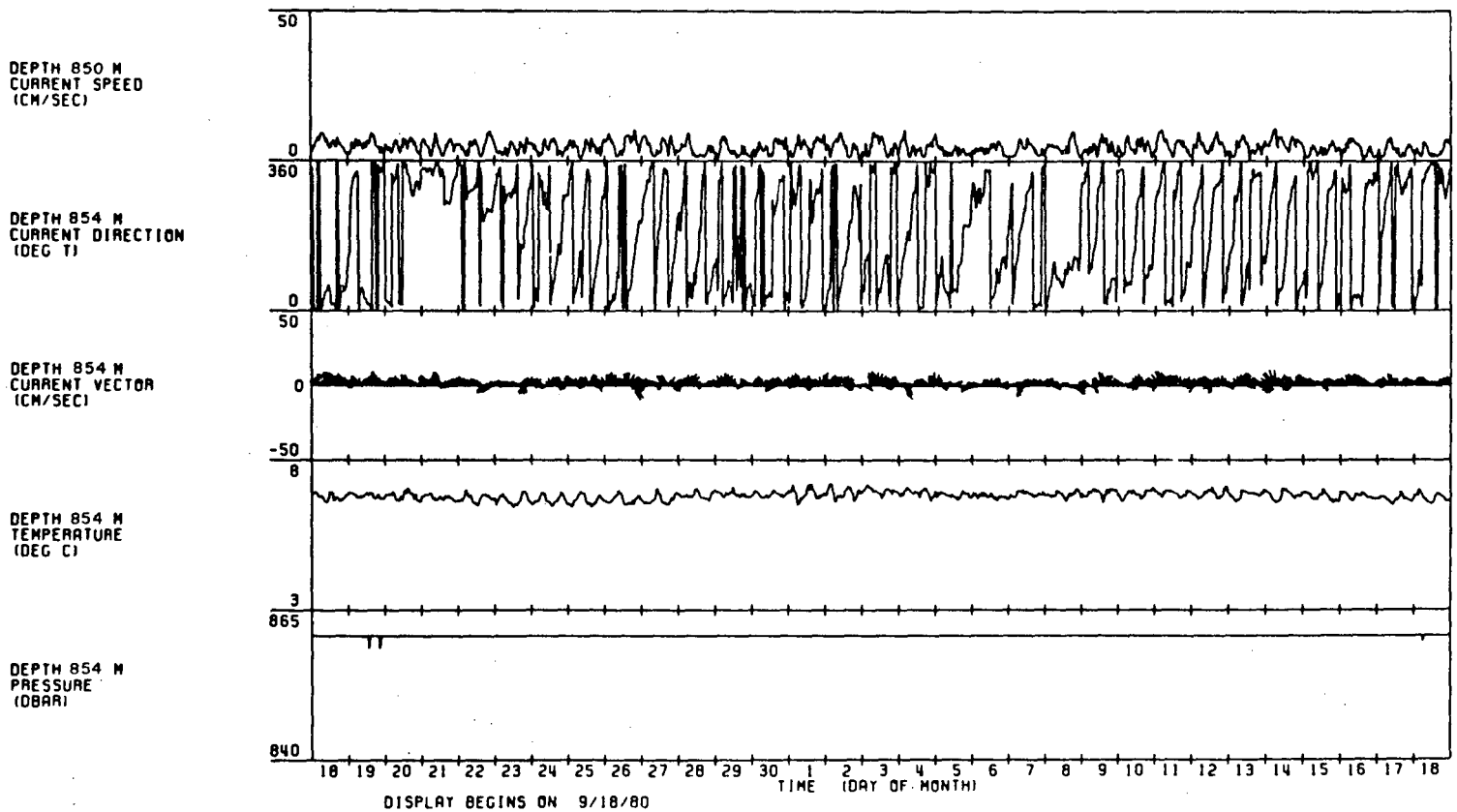

Figure 4-24. Time series plot of current, temperature, and pressure from the 854-meter depth at 17°54'N and 65°45'W between 18 September and 17 October 1980.

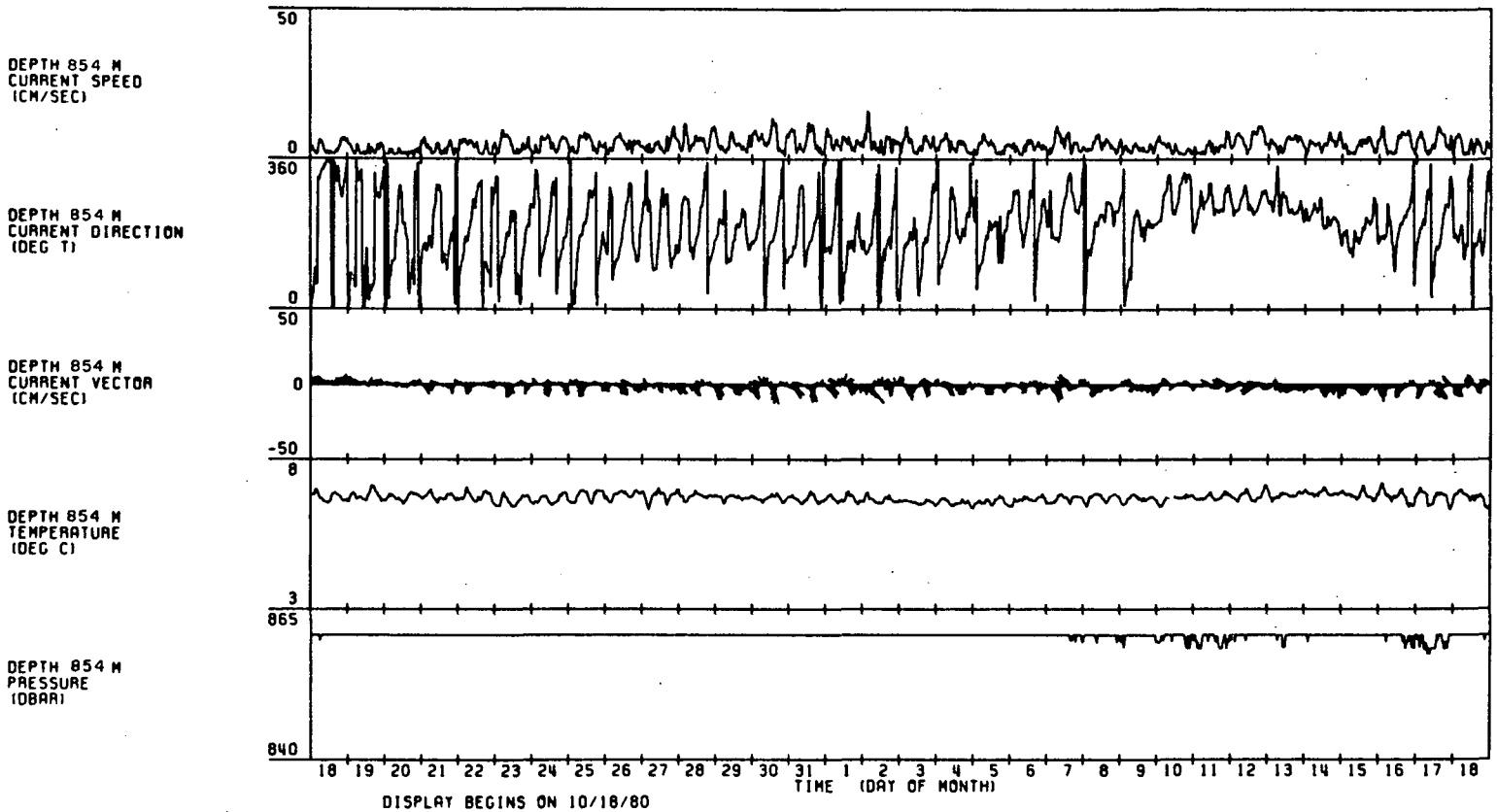

Figure 4-25. Time series plot of current, temperature, and pressure from the 854-meter depth at 17°54'N and 65°45'W between 18 October and 17 November 1980.

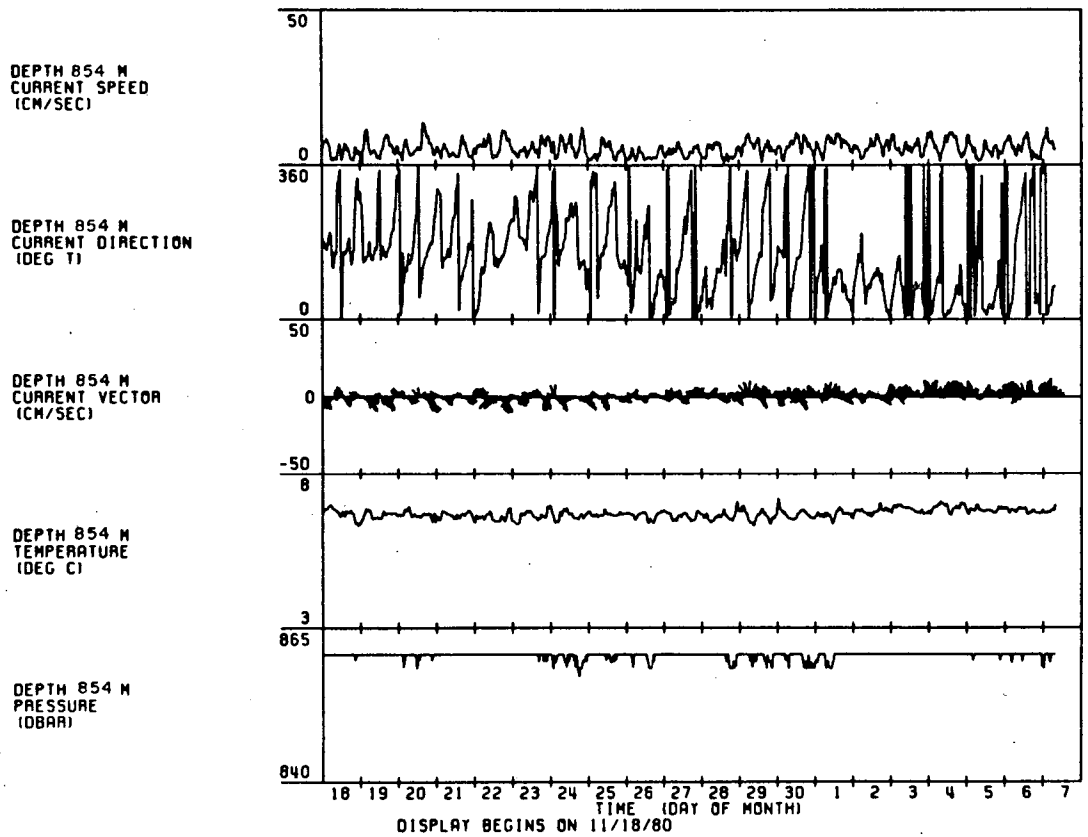

Figure 4-26. Time series plot of current, temperature, and pressure from the 854-meter depth at 17°54'N and 65°45'W between 18 November and 7 December 1980.

Table 4-1. Statistics of currents measured at the 120-meter depth at 17°54'N and 65°45'W between 21 June and 16 August 1980.

DISTRIBUTION FREQUENCY
0.5 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 120M

SPANNING 80/ 6/21 TO 80/ 8/16

DIRECTION DEGREES TRUE																SUM	PERCENT
0- 15	1	1	1													3	0.1
15- 30	1	2														3	0.1
30- 45	1	3	1													5	0.2
45- 60	1		1													2	0.1
60- 75	1															1	0.0
75- 90		1	1	1												3	0.1
90-105		1	1	1												3	0.1
105-120	3	1		1												5	0.2
120-135	2	2	1		2											7	0.3
135-150	1	3	2	2	1	1										10	0.4
150-165	2	4	7	1	1	4										19	0.7
165-180	1	5	5	8	8	4										31	1.2
180-195	1	10	10	13	16	9	3	1								63	2.4
195-210	2	16	28	22	13	23	11	10	1	2						128	4.8
210-225		12	13	23	40	47	39	32	15	7	3	1				232	8.7
225-240	2	5	17	25	38	72	93	61	40	29	23	10	6	3		424	15.8
240-255	2	5	31	22	50	89	94	77	75	50	45	31	9	4	1	585	21.8
255-270		8	11	30	45	87	71	78	52	43	38	22	6			491	18.3
270-285	1	15	22	33	51	47	57	61	40	24	10	8				369	13.8
285-300	4	10	8	24	37	31	30	19	10	5	3					181	6.8
300-315	2	5	5	9	12	14	6	4	5	1						63	2.4
315-330	2	3	6	11	6	5		3								35	1.3
330-345		2	4	1	2											9	0.3
345-360	1	3	2	1												7	0.3
																2680	

SPEED CM PER SEC	0.- 3.	3.- 6.	6.- 9.	9.- 12.	12.- 15.	15.- 18.	18.- 21.	21.- 24.	24.- 27.	27.- 30.	30.- 33.	33.- 36.	36.- 39.	39.- 42.	42.- 45.	45.- 48.	48.- 51.	51.- 54.	54.- 57.	57.- 60.	
SUM	31	117	177	228	322	433	404	346	238	161	122	72	21	7	1	0	0	0	0	0	2680
PERCENT	1.2	4.4	6.6	8.5	12.0	16.2	15.1	12.9	8.9	6.0	4.6	2.7	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 18.47 CM PER SEC STANDARD DEVIATION = 7.72 CM PER SEC

MAXIMUM = 43.61 CM PER SEC MINIMUM = 0.68 CM PER SEC RANGE = 42.94 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = -15.62 CM PER SEC STANDARD DEVIATION = 8.56 CM PER SEC

MEAN Y COMPONENT = -5.42 CM PER SEC STANDARD DEVIATION = 7.37 CM PER SEC

Table 4-2. Statistics of currents measured at the 160-meter depth at 17°54'N and 65°45'W between 21 and 27 June 1980.

DISTRIBUTION FREQUENCY
0.5 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 160M

SPANNING 80/ 6/21 TO 80/ 6/27

DIRECTION DEGREES TRUE																SUM	PERCENT
0- 15																0	0.0
15- 30																0	0.0
30- 45																0	0.0
45- 60																0	0.0
60- 75			1													1	0.4
75- 90			1	1												2	0.7
90-105	1		1				1									3	1.1
105-120			1	1				1	1							4	1.4
120-135			2	1	1	1		2								7	2.5
135-150				4	1	4	6	8	5							28	10.0
150-165			1	5	1	3	7	8	6	1						32	11.5
165-180				2	1	8	19	11	1							42	15.1
180-195			2	1	3	17	26	9	2	1						61	21.9
195-210			3	3	16	15	15	11	1	1	1	4				70	25.1
210-225					3	2	2	7	5		1	1	1			22	7.9
225-240								2								2	0.7
240-255											1					1	0.4
255-270										3						3	1.1
270-285								1								1	0.4
285-300																0	0.0
300-315																0	0.0
315-330																0	0.0
330-345																0	0.0
345-360																0	0.0
																279	

SPEED CM PER SEC	0.- 3.	3.- 6.	6.- 9.	9.- 12.	12.- 15.	15.- 18.	18.- 21.	21.- 24.	24.- 27.	27.- 30.	30.- 33.	33.- 36.	36.- 39.	39.- 42.	42.- 45.	45.- 48.	48.- 51.	51.- 54.	54.- 57.	57.- 60.	
SUM	0	0	0	1	12	18	26	50	76	60	21	6	3	5	1	0	0	0	0	0	279
PERCENT	0.0	0.0	0.0	0.4	4.3	6.5	9.3	17.9	27.2	21.5	7.5	2.2	1.1	1.8	0.4	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 25.03 CM PER SEC STANDARD DEVIATION = 5.32 CM PER SEC

MAXIMUM = 42.99 CM PER SEC MINIMUM = 11.74 CM PER SEC RANGE = 31.26 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = -0.70 CM PER SEC STANDARD DEVIATION = 11.31 CM PER SEC

MEAN Y COMPONENT = -22.02 CM PER SEC STANDARD DEVIATION = 6.47 CM PER SEC

Table 4-3. Statistics of currents measured at the 242-meter depth at 17°54'N and 65°45'W between 21 June and 16 August 1980.

DISTRIBUTION FREQUENCY
0.5 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 242M

SPANNING 80/ 6/21 TO 80/ 8/16

DIRECTION DEGREES TRUE	0.- 3.	3.- 6.	6.- 9.	9.- 12.	12.- 15.	15.- 18.	18.- 21.	21.- 24.	24.- 27.	27.- 30.	30.- 33.	33.- 36.	36.- 39.	39.- 42.	42.- 45.	45.- 48.	48.- 51.	51.- 54.	54.- 57.	57.- 60.	SUM	PERCENT
0- 15			1																		1	0.0
15- 30																					0	0.0
30- 45																					0	0.0
45- 60	1																				1	0.0
60- 75																					0	0.0
75- 90																					0	0.0
90-105																					0	0.0
105-120																					0	0.0
120-135																					0	0.0
135-150																					0	0.0
150-165		2	1	1	4																8	0.3
165-180		3	1	2																	6	0.2
180-195	2	5	9	4	1																21	0.8
195-210	2	6	13	22	22	12	5														82	3.1
210-225	3	6	14	24	35	12	17	8	3												122	4.6
225-240	2	9	21	29	47	54	54	37	10	19	10	5	7	4	1						309	11.5
240-255	1	14	14	36	57	90	88	103	117	81	66	44	33	12	9						765	28.5
255-270	1		15	37	53	44	47	114	135	118	88	67	47	11	7						784	29.2
270-285		7	8	26	28	41	19	29	41	42	37	17	8	2	4						309	11.5
285-300	2	3	16	24	23	32	27	7	1				1	8							144	5.4
300-315	1	7	9	10	18	6	17	5													73	2.7
315-330	1	5	4	8	10	5	1														34	1.3
330-345		5	1	4	4	1	1														16	0.6
345-360			2	1		2	1														6	0.2
																					2681	

SPEED CM PER SEC	0.- 3.	3.- 6.	6.- 9.	9.- 12.	12.- 15.	15.- 18.	18.- 21.	21.- 24.	24.- 27.	27.- 30.	30.- 33.	33.- 36.	36.- 39.	39.- 42.	42.- 45.	45.- 48.	48.- 51.	51.- 54.	54.- 57.	57.- 60.	
SUM	16	72	129	228	302	299	277	303	307	260	201	133	96	37	21	0	0	0	0	0	2681
PERCENT	0.6	2.7	4.8	8.5	11.3	11.2	10.3	11.3	11.5	9.7	7.5	5.0	3.6	1.4	0.8	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 21.33 CM PER SEC STANDARD DEVIATION = 8.96 CM PER SEC

MAXIMUM = 44.52 CM PER SEC MINIMUM = 1.64 CM PER SEC RANGE = 42.89 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = -19.49 CM PER SEC STANDARD DEVIATION = 9.56 CM PER SEC

MEAN Y COMPONENT = -4.84 CM PER SEC STANDARD DEVIATION = 6.36 CM PER SEC

Table 4-4. Statistics of currents measured at the 434-meter depth at 17°54'N and 65°45'W between 21 June and 16 August 1980.

DISTRIBUTION FREQUENCY
0.5 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 434M

SPANNING 80/ 6/21 TO 80/ 8/16

DIRECTION DEGREES TRUE																					SUM	PERCENT
0- 15			1																		1	0.0
15- 30	2		1																		3	0.1
30- 45			1																		1	0.0
45- 60																					0	0.0
60- 75	1		1																		2	0.1
75- 90																					0	0.0
90-105		2																			2	0.1
105-120																					0	0.0
120-135																					0	0.0
135-150		1																			1	0.0
150-165			1	1																	2	0.1
165-180	1	1		3																	5	0.2
180-195	2	2	6	4	3																17	0.6
195-210	1	4	12	11	5	4	5	2	1												45	1.7
210-225	1	9	16	29	16	14	5	5	1												96	3.6
225-240	3	17	39	60	42	37	53	50	31	15	4	6									357	13.3
240-255	2	21	39	62	64	66	89	98	94	86	103	75	15								814	30.4
255-270	3	20	37	52	82	76	90	91	104	96	100	42	29	1							823	30.7
270-285	2	23	43	54	54	47	29	27	12	6	10	4									311	11.6
285-300	3	18	29	32	31	5	11	1													130	4.9
300-315	1	8	9	7	5																30	1.1
315-330		8	7	1	1																17	0.6
330-345	1	1	5	2																	9	0.3
345-360	1	5	6	2																	14	0.5
																					2680	

SPEED CM PER SEC	0. - 3.	3. - 6.	6. - 9.	9. - 12.	12. - 15.	15. - 18.	18. - 21.	21. - 24.	24. - 27.	27. - 30.	30. - 33.	33. - 36.	36. - 39.	39. - 42.	42. - 45.	45. - 48.	48. - 51.	51. - 54.	54. - 57.	57. - 60.	
SUM	24	140	253	320	303	249	282	274	243	203	217	127	44	1	0	0	0	0	0	0	2680
PERCENT	0.9	5.2	9.4	11.9	11.3	9.3	10.5	10.2	9.1	7.6	8.1	4.7	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 18.95 CM PER SEC STANDARD DEVIATION = 8.94 CM PER SEC

MAXIMUM = 39.10 CM PER SEC MINIMUM = 0.58 CM PER SEC RANGE = 38.52 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = -17.41 CM PER SEC STANDARD DEVIATION = 9.10 CM PER SEC

MEAN Y COMPONENT = -4.98 CM PER SEC STANDARD DEVIATION = 5.30 CM PER SEC

Table 4-5. Statistics of currents measured at the 933-meter depth at 17°54'N and 65°45'W between 21 June and 16 August 1980.

DISTRIBUTION FREQUENCY
0.5 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 933M

SPANNING 80/ 6/21 TO 80/ 8/16

DIRECTION DEGREES TRUE								SUM	PERCENT
0- 15	10	18	8	2				38	1.4
15- 30	14	23	4					41	1.5
30- 45	8	15	2					25	0.9
45- 60	7	13						20	0.7
60- 75	12	10	2					24	0.9
75- 90	8	10	3	1				22	0.8
90-105	7	18	7					32	1.2
105-120	14	31	8					53	2.0
120-135	12	24	14	1				51	1.9
135-150	15	24	20	6	1			66	2.5
150-165	12	32	18	5				67	2.5
165-180	19	36	19	4				78	2.9
180-195	15	30	41	15	1			102	3.8
195-210	11	49	66	33	18	3		180	6.7
210-225	24	61	46	54	44	6		235	8.8
225-240	22	75	98	92	49	11	4	351	13.1
240-255	10	80	127	90	49	20	3	379	14.1
255-270	11	79	118	67	38	15	4	332	12.4
270-285	12	60	79	36	19	8		214	8.0
285-300	24	63	49	7	9			152	5.7
300-315	12	33	31	8	2			86	3.2
315-330	7	34	16	1	1			59	2.2
330-345	13	18	6	3				40	1.5
345-360	18	11	3	1				33	1.2
								2680	

SPEED CM PER SEC	0. - 3.	3. - 6.	6. - 9.	9. - 12.	12. - 15.	15. - 18.	18. - 21.	21. - 24.	24. - 27.	27. - 30.	30. - 33.	33. - 36.	36. - 39.	39. - 42.	42. - 45.	45. - 48.	48. - 51.	51. - 54.	54. - 57.	57. - 60.	
SUM	317	847	785	426	231	63	11	0	0	0	0	0	0	0	0	0	0	0	0	0	2680
PERCENT	11.8	31.6	29.3	15.9	8.6	2.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 7.13 CM PER SEC STANDARD DEVIATION = 3.62 CM PER SEC

MAXIMUM = 20.54 CM PER SEC MINIMUM = 0.85 CM PER SEC RANGE = 19.69 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH,

MEAN X COMPONENT = -4.41 CM PER SEC STANDARD DEVIATION = 4.78 CM PER SEC

MEAN Y COMPONENT = -2.38 CM PER SEC STANDARD DEVIATION = 3.99 CM PER SEC

Table 4-6. Statistics of currents measured at the 40-meter depth at 17°54'N and 65°45'W between 18 August and 7 December 1980.

DISTRIBUTION FREQUENCY
0.5 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 40M

SPANNING 80/ 8/18 TO 80/12/ 7

DIRECTION DEGREES TRUE																	SUM	PERCENT
0- 15	14	22	11	2	3	3	11	16	3								85	1.6
15- 30	11	15	15	3	4	10	7	18	16								99	1.9
30- 45	10	17	21	23	15	20	28	20	13								167	3.1
45- 60	5	12	20	22	52	31	46	44	27	29	9	2	3				302	5.7
60- 75	6	11	37	62	53	81	102	110	85	113	59	41	41	6	8	2	817	15.4
75- 90	5	13	40	50	49	80	116	108	87	59	56	34	15	13	4		729	13.7
90-105	5	13	22	40	37	34	43	41	12	3	2	1					253	4.8
105-120	8	13	31	15	24	23	49	27									190	3.6
120-135	9	19	21	10	13	28	37	24									161	3.0
135-150	7	14	22	13	16	15	19	25									131	2.5
150-165	9	12	28	11	10	20	17	20	2								129	2.4
165-180	6	9	23	11	17	19	13	10	1	1							110	2.1
180-195	11	14	21	10	22	37	34	10	5	1							165	3.1
195-210	9	14	17	13	21	30	39	17	14	3							177	3.3
210-225	10	10	23	27	27	37	31	23	20	3	5	1					217	4.1
225-240	8	10	18	28	33	39	42	57	65	5	4						309	5.8
240-255	12	14	14	13	20	35	31	41	37	4	3						224	4.2
255-270	16	17	11	19	33	35	35	38	42								246	4.6
270-285	12	13	21	18	25	29	38	35	14								205	3.9
285-300	10	16	9	14	20	30	42	18	16		1		1				177	3.3
300-315	9	13	7	10	8	25	22	4	9								107	2.0
315-330	7	16	12	2	4	7	38	9	7								102	1.9
330-345	13	8	30	6	6	11	27	18	1								120	2.3
345-360	8	13	4	8	10	11	17	18	1								90	1.7
																	5312	

SPEED CM PER SEC	0.-5.	5.-10.	10.-15.	15.-20.	20.-25.	25.-30.	30.-35.	35.-40.	40.-45.	45.-50.	50.-55.	55.-60.	60.-65.	65.-70.	70.-75.	75.-80.	80.-85.	85.-90.	90.-95.	95.-100.	
SUM	220	328	478	430	522	690	884	751	477	221	139	79	60	19	12	2	0	0	0	0	5312
PERCENT	4.1	6.2	9.0	8.1	9.8	13.0	16.6	14.1	9.0	4.2	2.6	1.5	1.1	0.4	0.2	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 28.71 CM PER SEC STANDARD DEVIATION = 13.73 CM PER SEC

MAXIMUM = 77.67 CM PER SEC MINIMUM = 0.11 CM PER SEC RANGE = 77.56 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = 7.91 CM PER SEC STANDARD DEVIATION = 25.96 CM PER SEC

MEAN Y COMPONENT = 0.90 CM PER SEC STANDARD DEVIATION = 16.61 CM PER SEC

Table 4-7. Statistics of currents measured at the 80-meter depth at 17°54'N and 65°45'W between 18 August and 15 September 1980.

DISTRIBUTION FREQUENCY
0.5 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 80M

SPANNING 80/ 8/18 TO 80/ 9/15

DIRECTION DEGREES TRUE	0.- 5.-	5.- 10.-	10.- 15.-	15.- 20.-	20.- 25.-	25.- 30.-	30.- 35.-	35.- 40.-	40.- 45.-	45.- 50.-	50.- 55.-	55.- 60.-	60.- 65.-	65.- 70.-	70.- 75.-	75.- 80.-	80.- 85.-	85.- 90.-	90.- 95.-	95.- 100.	SUM	PERCENT
0- 15				1	5																6	0.5
15- 30			1	4	2																7	0.5
30- 45			1	7	4	3	2	4													21	1.6
45- 60		1	1	2	8	15	10	9	2		2										50	3.8
60- 75		1	2	5	28	39	33	13	13	3	3										140	10.6
75- 90			4	11	11	36	29	17	12	8	1										129	9.7
90-105		2	4	21	6	15	25	9	4	2	2										90	6.8
105-120	1	1	1	16	11	11			2	1	1										45	3.4
120-135			6	6	1	3															16	1.2
135-150		3		3	3																9	0.7
150-165			1	1	9	4	1														16	1.2
165-180		3			7	6	4	2													22	1.7
180-195				1	16	22	18	9	7	3											76	5.7
195-210		1	1		9	18	28	22	12	3											94	7.1
210-225		1		5	9	24	16	44	48	11	11	10	3								182	13.7
225-240			1	2	5	14	16	16	17	13	19	18	10	7							138	10.4
240-255	1				5	6	7	4	11	26	20	17	16	2							115	8.7
255-270						2	3	5	7	25	28	9	3								82	6.2
270-285					1	3	3	6	7	13	4	6									43	3.2
285-300			1			3	3	3	9	5	2										26	2.0
300-315		1			2	3	3														9	0.7
315-330						3	1														4	0.3
330-345						1															1	0.1
345-360	1			1	2																4	0.3
																					1325	

SPEED CM PER SEC	0.- 5.	5.- 10.	10.- 15.	15.- 20.	20.- 25.	25.- 30.	30.- 35.	35.- 40.	40.- 45.	45.- 50.	50.- 55.	55.- 60.	60.- 65.	65.- 70.	70.- 75.	75.- 80.	80.- 85.	85.- 90.	90.- 95.	95.- 100.	
SUM	3	14	24	86	144	231	202	163	151	113	93	60	32	9	0	0	0	0	0	0	1325
PERCENT	0.2	1.1	1.8	6.5	10.9	17.4	15.2	12.3	11.4	8.5	7.0	4.5	2.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 35.49 CM PER SEC STANDARD DEVIATION = 12.41 CM PER SEC

MAXIMUM = 66.76 CM PER SEC MINIMUM = 2.46 CM PER SEC RANGE = 64.30 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = -6.89 CM PER SEC STANDARD DEVIATION = 30.04 CM PER SEC

MEAN Y COMPONENT = -11.00 CM PER SEC STANDARD DEVIATION = 18.53 CM PER SEC

Table 4-8. Statistics of currents measured at the 160-meter depth at 17°54'N and 65°45'W between 18 August and 7 December 1980.

DISTRIBUTION FREQUENCY
0.3 HOUR AVERAGES

STATION DIEC P.R. 1
DEPTH 160M

SPANNING 80/ 8/18 TO 80/12/ 7

DIRECTION DEGREES TRUE							SUM	PERCENT
0- 15	87	127	36	1			251	2.4
15- 30	76	124	31				231	2.2
30- 45	62	116	28				206	1.9
45- 60	60	113	22				195	1.8
60- 75	66	125	22				213	2.0
75- 90	60	130	30				220	2.1
90-105	68	132	24	4			228	2.1
105-120	77	94	16				187	1.8
120-135	59	135	29	2			225	2.1
135-150	66	133	42	7	1		249	2.3
150-165	73	163	58	8	1		303	2.9
165-180	62	159	46	11	1		279	2.6
180-195	67	191	77	13			348	3.3
195-210	66	210	119	23	9		427	4.0
210-225	72	231	180	52	8	2	545	5.1
225-240	71	249	273	113	23	4	733	6.9
240-255	83	272	360	218	65	15	1013	9.5
255-270	71	263	375	259	105	9	1082	10.2
270-285	77	252	300	211	92	14	946	8.9
285-300	74	256	224	166	65	3	788	7.4
300-315	74	257	176	71	22		600	5.6
315-330	75	206	178	52	9		520	4.9
330-345	74	171	119	58	4		426	4.0
345-360	89	205	100	12			406	3.8
							10621	

SPEED CM PER SEC	0.- 5.	5.- 10.	10.- 15.	15.- 20.	20.- 25.	25.- 30.	30.- 35.	35.- 40.	40.- 45.	45.- 50.	50.- 55.	55.- 60.	60.- 65.	65.- 70.	70.- 75.	75.- 80.	80.- 85.	85.- 90.	90.- 95.	95.- 100.	
SUM	1709	4314	2865	1281	405	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10621
PERCENT	16.1	40.6	27.0	12.1	3.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 9.93 CM PER SEC STANDARD DEVIATION = 4.99 CM PER SEC

MAXIMUM = 29.50 CM PER SEC MINIMUM = 1.87 CM PER SEC RANGE = 27.63 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = -5.27 CM PER SEC STANDARD DEVIATION = 7.58 CM PER SEC

MEAN Y COMPONENT = -0.41 CM PER SEC STANDARD DEVIATION = 6.19 CM PER SEC

Table 4-9. Statistics of currents measured at the 354-meter depth at 17°54'N and 65°45'W between 18 August and 7 December 1980.

DISTRIBUTION FREQUENCY
0.3 HOUR AVERAGES

STATION OTEC P.R. 1
DEPTH 354M

SPANNING 80/ 8/18 TO 80/12/ 7

DIRECTION DEGREES TRUE							SUM	PERCENT
0- 15	68	86	13				167	1.6
15- 30	59	89	21				169	1.6
30- 45	61	90	22				173	1.6
45- 60	62	107	38				207	1.9
60- 75	47	82	37				166	1.6
75- 90	48	83	50	9			190	1.8
90-105	67	93	78	49			287	2.7
105-120	71	76	71	44	1		263	2.5
120-135	72	89	44				205	1.9
135-150	54	104	23				181	1.7
150-165	64	70	12				146	1.4
165-180	78	126	10				214	2.0
180-195	74	138	28	1			241	2.3
195-210	76	129	34	7			246	2.3
210-225	91	160	87	28			366	3.4
225-240	82	225	347	164	52		870	8.2
240-255	81	351	750	453	128		1763	16.6
255-270	91	405	831	465	128	11	1931	18.2
270-285	97	384	527	224	62	2	1296	12.2
285-300	90	209	185	50	6		540	5.1
300-315	94	169	90	6			359	3.4
315-330	76	135	50	5			266	2.5
330-345	58	105	38	10			211	2.0
345-360	59	83	24				166	1.6
							10623	

SPEED CM PER SEC	0.- 5.	5.- 10.	10.- 15.	15.- 20.	20.- 25.	25.- 30.	30.- 35.	35.- 40.	40.- 45.	45.- 50.	50.- 55.	55.- 60.	60.- 65.	65.- 70.	70.- 75.	75.- 80.	80.- 85.	85.- 90.	90.- 95.	95.- 100.	
SUM	1720	3588	3410	1515	377	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10623
PERCENT	16.2	33.8	32.1	14.3	3.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 10.31 CM PER SEC STANDARD DEVIATION = 4.99 CM PER SEC

MAXIMUM = 26.33 CM PER SEC MINIMUM = 1.50 CM PER SEC RANGE = 24.83 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH,

MEAN X COMPONENT = -6.47 CM PER SEC STANDARD DEVIATION = 8.07 CM PER SEC

MEAN Y COMPONENT = -1.47 CM PER SEC STANDARD DEVIATION = 4.71 CM PER SEC

Table 4-10. Statistics of currents measured at the 854-meter depth at 17°54'N and 65°45'W between 18 August and 7 December 1980.

DISTRIBUTION FREQUENCY
0.3 HOUR AVERAGES

STATION UTEC P.R. 1
DEPTH 854M

SPANNING 80/ 8/18 TO 80/12/ 7

DIRECTION DEGREES TRUE					SUM	PERCENT
0- 15	325	300	12		637	6.0
15- 30	282	253	14		549	5.2
30- 45	284	268	5		557	5.2
45- 60	252	193	1		446	4.2
60- 75	247	184	1		432	4.1
75- 90	192	152			344	3.2
90-105	207	145	2		354	3.3
105-120	243	239	10		492	4.6
120-135	216	198	20		434	4.1
135-150	253	209	36	3	501	4.7
150-165	186	241	29		456	4.3
165-180	178	235	18		431	4.1
180-195	176	156	8		340	3.2
195-210	228	143	2		373	3.5
210-225	184	142	1		327	3.1
225-240	222	175			397	3.7
240-255	239	149	7		395	3.7
255-270	206	153	10		369	3.5
270-285	246	178	6		430	4.0
285-300	214	175	3		392	3.7
300-315	242	179			421	4.0
315-330	232	178	8		418	3.9
330-345	330	236	16		582	5.5
345-360	257	278	10		545	5.1
					10622	

SPEED CM PER SEC	0.- 5.	5.- 10.	10.- 15.	15.- 20.	20.- 25.	25.- 30.	30.- 35.	35.- 40.	40.- 45.	45.- 50.	50.- 55.	55.- 60.	60.- 65.	65.- 70.	70.- 75.	75.- 80.	80.- 85.	85.- 90.	90.- 95.	95.- 100.	
SUM	5641	4759	219	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10622
PERCENT	53.1	44.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

SUMMARY STATISTICS

MEAN SPEED = 4.94 CM PER SEC STANDARD DEVIATION = 2.34 CM PER SEC

MAXIMUM = 17.74 CM PER SEC MINIMUM = 1.50 CM PER SEC RANGE = 16.24 CM PER SEC

IN A COORDINATE SYSTEM WHOSE Y AXIS IS POSITIONED 0.0 DEGREES COUNTER-CLOCKWISE FROM TRUE NORTH.

MEAN X COMPONENT = 0.22 CM PER SEC STANDARD DEVIATION = 3.63 CM PER SEC

MEAN Y COMPONENT = 0.32 CM PER SEC STANDARD DEVIATION = 4.07 CM PER SEC

5. DISCUSSION

Preliminary analysis of current data collected offshore Punta Tuna between June and December 1980 indicates a multi-layered current structure with little coherence between layers. Mean currents in the surface well-mixed layer (50- to 60-meter depth) were isobath parallel, fluctuating between flow to the east-northeast and flow to the west-southwest. Mean vector speed (net speed) at the 40-meter depth between August and December was 8 cm/sec at 084°. Mean scalar speed was 29 cm/sec and maximum measured speed was 78 cm/sec.

Below the surface layer, 120 to at least 450 meters, currents were most often directed toward the west-southwest, particularly during summer. During the June to August period, net currents in this layer were about 20 cm/sec and mean scalar speeds were similar, indicating almost unidirectional flow. Maximum speeds were about 40 cm/sec. Between August and December, currents were lower in this region, with net currents of about 5 cm/sec and maximum currents of about 30 cm/sec. Currents were usually directed toward the west-southwest, but several current reversals were observed.

At intermediate depths (854 and 933 meters), currents were generally low and primarily of tidal origin with maximum values of about 20 cm/sec. In the June to August period, net currents were toward the west-southwest. After August, current directions were variable with little net flow.

Tidal currents with semidiurnal periods are present at all depths, but their magnitudes vary with depth — the largest occurring nearest the surface. Typical tidal currents in the well-mixed layer are ±10 cm/sec, decreasing to ±5 cm/sec or less at intermediate levels. Tidal currents at all levels are rotary, turning in a clockwise direction.

Weekly current maxima at each instrument level are plotted against time in Figure 5-1. This figure illustrates the variability of the low-frequency

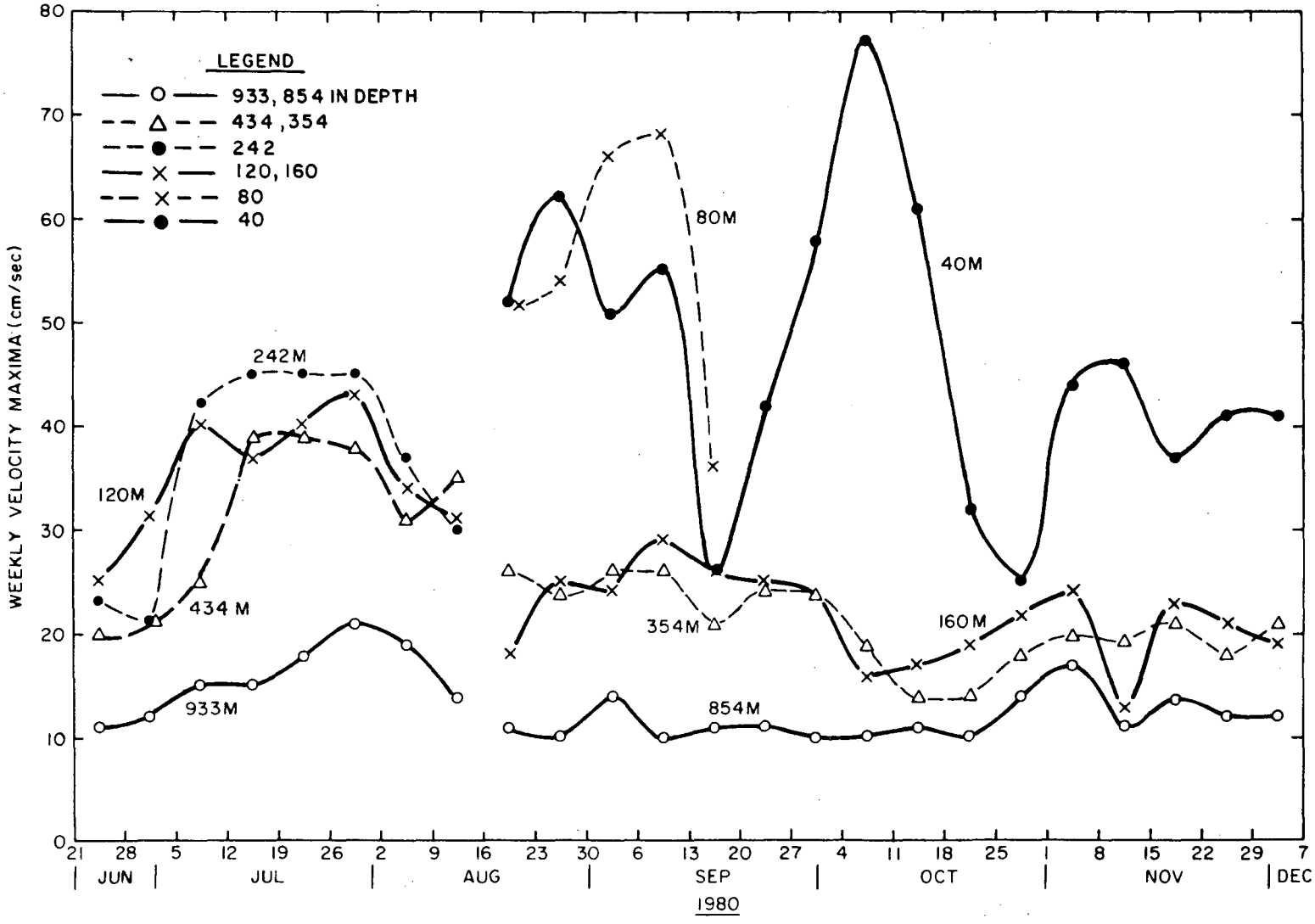

Figure 5-1. Weekly current speed maxima plotted against time from data collected at 17°54'N and 65°45'W between 21 June and 7 December 1980.

currents and suggests a seasonal variability in the level of current activity, especially below the well-mixed layer. A summary of current statistics is presented in Table 5-1. Additional data collected between September 1979 and February 1980[1] and between December 1980 and April 1981[2] may provide information on seasonality as well as inter-annual variability at this site.

Table 5-1. Summary of current statistics from 17°54'N and 65°45'W between 21 June and 7 December 1980.

Depth (m)	Time Interval	Current Maxima (cm/sec)	Mean Speed (Scalar) (cm/sec)	Mean Vector Speed (cm/sec)	Mean Vector Direction (°)
40	8/18 to 12/7/80	78	29	8	084
80	8/18 to 9/15/80	67	35	13	212
120	6/21 to 8/16/80	44	19	17	251
160	6/21 to 6/27/80	43	25	22	182
160	8/18 to 12/7/80	30	10	5	266
242	6/21 to 8/16/80	45	21	20	256
354	8/18 to 12/7/80	26	10	7	257
434	6/21 to 8/16/80	39	19	18	254
854	6/18 to 12/7/80	18	5	0.4	035
933	6/21 to 8/16/80	21	7	5	242

[1]Frye, D., A. Davison, and K. Leavitt, 1981. Physical Oceanographic Data from the OTEC Punta Tuna, Puerto Rico Site, LBL-12327, UC-64, Berkeley, California.

[2]Duncan, P. Private communication, Lawrence Berkeley Laboratories, Berkeley, California.

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