OCS Study
MMS 87-0007

Gulf of Mexico
Physical Oceanography Program
Final Report: Year 4

Volume II: Technical Report

MMS
U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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Volume II: Technical Report

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I. INTRODUCTION

1.1 Program Objectives

The Gulf of Mexico Physical Oceanography Program (GMPOP), a Minerals Management Service (MMS) study funded under contract with Science Applications International Corp. (SAIC), has as its objective the development of an improved understanding of primary Gulf circulation patterns and the mechanisms producing these patterns. It is expected that insights from this program will provide an expanded basis for making informed management decisions related to Outer Continental Shelf (OCS) oil and gas exploration, production and transportation. This objective is in keeping with the OCS Lands Act requirements that the Department of the Interior conduct appropriate studies to evaluate the environmental impacts of offshore oil and gas development.

1.2 Program Background

In 1982, a multi-year investigation was initiated of physical oceanographic conditions related to or resulting from deep circulation patterns in the Gulf of Mexico. The program was designed with a phased regional emphasis. During Program Years 1, 2, and 4, measurements and associated interpretation focused on circulation in the eastern Gulf with special emphasis on the Loop Current and its interaction with the adjacent west Florida shelf and slope waters (Figure 1.2-1). As discussed in Chapter 2, three years of shelf and slope field measurements were completed and provide the basis for the present report. These measurements were designed to document the patterns and processes which occurred both along and across the slope and the outer half of the West Florida Shelf. A report describing Program Years 1 and 2 has been submitted and released (SAIC, 1986). The present report is a supplement to that initial submission.

1.3 Program Elements and Participants

To achieve the program objectives, five major measurement tasks were undertaken over the first two-year period. These included:

- Subsurface currents/temperature and pressure across and along the West Florida Shelf, and across the slope into the region often occupied by the Loop Current. Subsurface currents on the Louisiana and south Texas shelves.

- Several regional and process oriented hydrographic surveys on and adjacent to the West Florida Slope. These were designed to document conditions reflecting and affecting circulation and exchange along the eastern half of the Loop Current and shoreward to the outer half of the shelf, including studies of Loop Current boundary waves and perturbations.

- Use of satellite thermal imagery to define the spatial extent and time-dependent characteristics of the Loop Current boundary and related features.

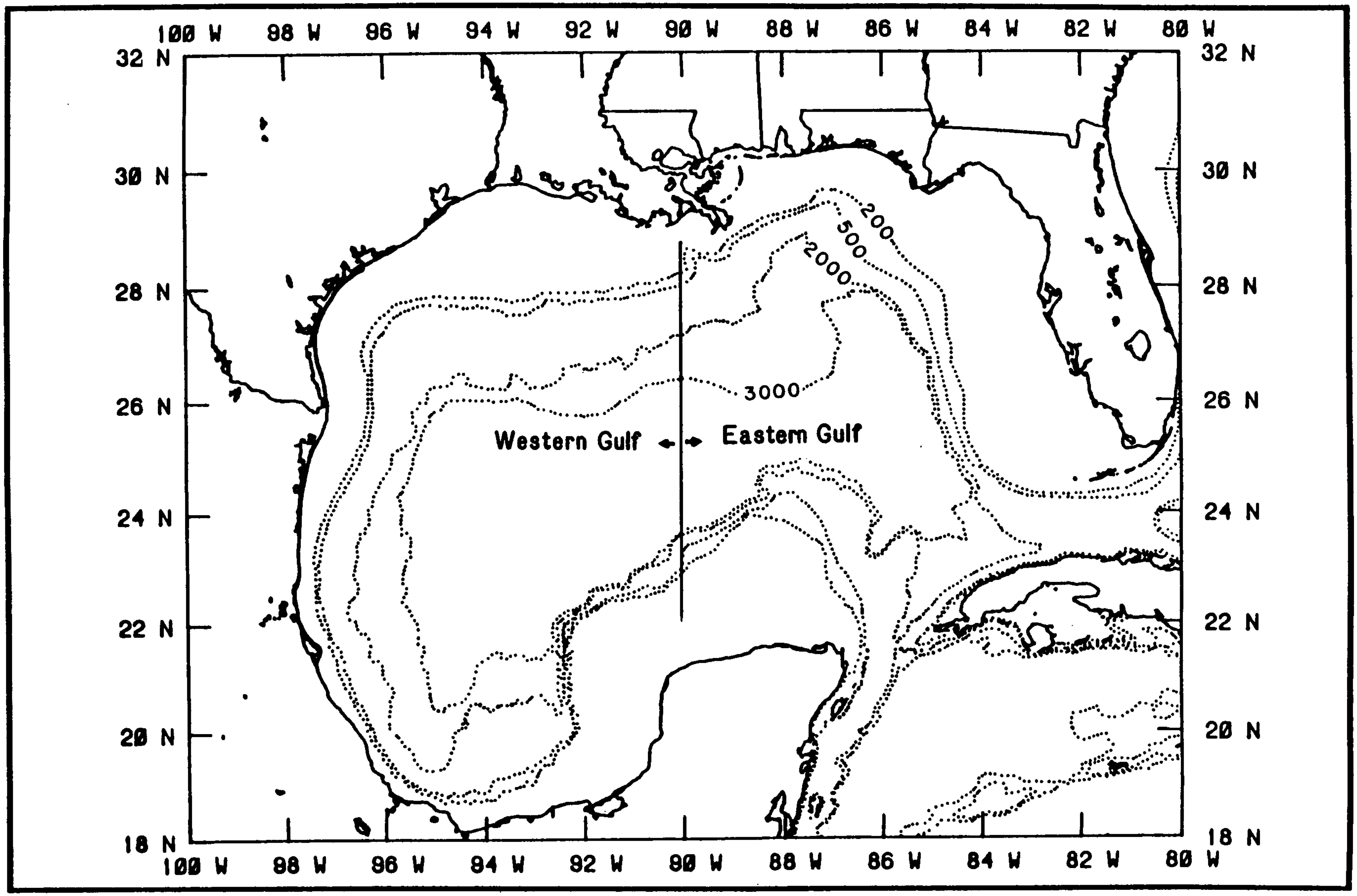

Figure 1.2-1. Gulf of Mexico bathymetric map showing the nominal partition of the eastern and western Gulf of Mexico study areas. This also partitions the emphasis on the Loop Current and Loop Current eddies.

- Tracking Lagrangian drifters deployed in major Loop Current eddies to document and partition the dynamic and kinematic characteristics of eddies shed by the Loop Current.

- Periodic and site-specific vertical temperature sections as estimated from expendable temperature probes dropped from Ships-of-Opportunity (SOOP) on regularly scheduled routes and on one-time opportunistic cruises.

These data are combined with routinely available observations such as coastal and at-sea (buoy) winds obtained from the National Weather Service, and coastal water level from the National Ocean Survey. Taken as a group, the above provided the data base necessary to develop the needed improved understanding of conditions in the eastern Gulf.

This data base also provides a standard against which the results of a concurrent numerical circulation modeling study can be compared. The modeling work is also MMS funded with time lines and deliverables coordinated with those on the present program.

To extract the important patterns and processes from the comprehensive multi-variate data set, a team of highly qualified scientists was established to work both independently and in collaboration. Presented alphabetically with their affiliation and primary areas of responsibility they were:

- Dr. L. Atkinson, Old Dominion University (ODU), hydrography

- Dr. J. Lewis, SAIC, Lagrangian drifters

- Dr. W. Sturges, FBN Oceanography Inc. (FBN), subsurface currents

- Dr. F. Vukovich, Research Triangle Institute (RTI), satellite thermal imagery

During Year 4, the following three program elements were continued:

- Subsurface currents

- Lagrangian drifters

- SOOP program

The latter two elements had the same scientific lead as during Years 1 and 2. In addition, support was provided to Dr. Atkinson for further analysis of the hydrographic and current profile data taken during Year 2. Subsurface currents analysis and interpretation by Dr. W. Sturges was supplemented by Drs. G. Lagerloef and P. Hamilton of SAIC.

Subsurface observations funded by this program were supplemented with additional current time series taken by:

- Environmental Science and Engineering (ESE) with MMS support.

- Dr. W. Sturges with National Science Foundation support.
- Observations provided by MMS and obtained as part of a permit request.

Details of these various data sets are discussed in Chapter 2.

1.4 Report Organization

The present report is an addendum to the Years 1 and 2 report (SAIC, 1986). In keeping with this perspective, most basic material described in that report will not be duplicated here. It will be identified by reference to the appropriate section of the previous document. For that material which is particularly relevant and is expanded on, some of the key information will be provided. As an example, aspects of the major cruise during Year 2 are given because it forms the basis for the expanded discussion of the combined current profiles and hydrography presented in the present report.

II. DATA ACQUISITION AND METHODOLOGY

2.1 Introduction

Chapter 2 provides an overview of appropriate data acquisition activities. These include two drifting buoys, one hydrographic cruise, and the extended and supplemental subsurface current measurements to be used in the Chapter 4 discussion. For many of these, additional information can be obtained in identified sections of the Years 1 and 2 Final Report (SAIC, 1986).

2.2 Lagrangian Drifters

In an effort to track a newly formed/forming Loop Current warm-core ring an ARGOS mini TOD drifter buoy (No. 3354) was deployed on 18 June 1985 at approximately 26°N 88°W. This buoy, equipped with a 100 meter tether and a window-shade drogue, immediately moved to the southeast, and was thought to be on its way out of the Gulf, through the Florida Straits and into the Atlantic Ocean. However, as the buoy approached the northern coast of Cuba near 23°N 84°W it turned to the south and west and began the first of six anticyclonic loops before leaving the Gulf around 25 September. Figure 2.2-1 documents this buoy's track. Similarly, on 18 July 1985 a second attempt was made to deploy an ARGOS buoy (No. 3378) into a newly detached Loop Current warm-core ring. This effort was successful with the deployment of a buoy equipped with a 200 meter thermistor string at approximately 26°24'N 89°24'W. The anticyclonic track of this buoy is shown through 30 September in Figure 2.2-2. The paths and dynamical characteristics of these two buoy tracks will be the subject of later discussion.

2.3 Hydrography/Current Profiles

2.3.1 Introduction

For the hydrographic cruises during Years 1 and 2, a preliminary cruise plan was developed for each prior to departure from port. These plans were based on the latest available data (typically satellite derived sea-surface temperatures) and were designed to be flexible so that modifications could be made during the cruises if weather conditions dictated or if first hand observations indicated that a change would significantly improve spatial or temporal resolution of the oceanic features of interest. Due to the inclusion of a large scale aircraft-based survey component during Year 2, the ship-based component was relieved of the responsibility of having to cover the entire Loop Current region, and was therefore afforded even greater flexibility to concentrate on mesoscale features in the vicinity of the west Florida shelf. It is this increased flexibility which allowed Cruise CF8405 to be uniquely successful in the effort to synoptically map a Loop Current frontal eddy.

2.3.2 Hydrography

2.3.2.1 Introduction

The ship-based hydrographic data were collected using a cable lowered package consisting of a Neil Brown CTD (Conductivity, Temperature, Depth) instrument

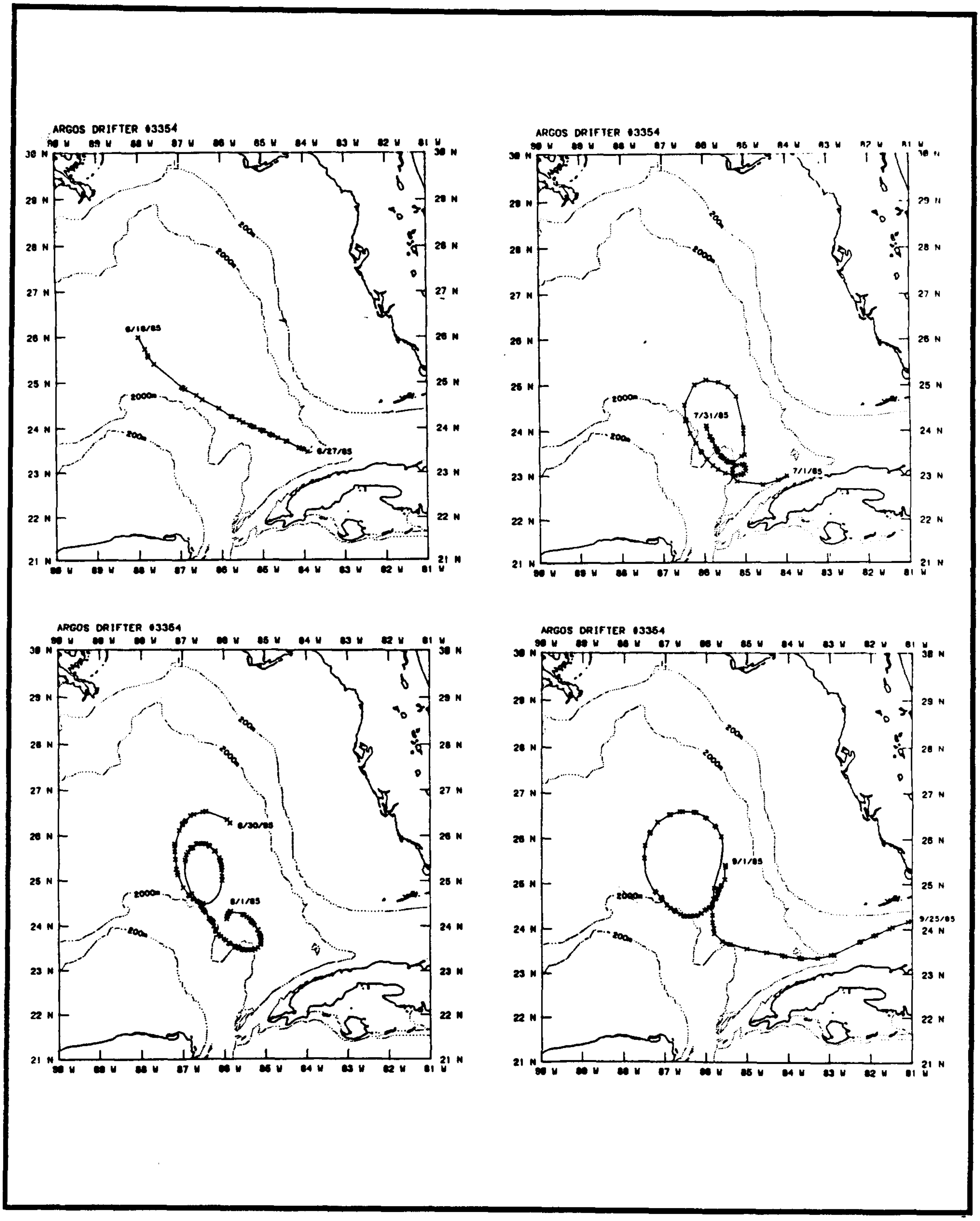

Figure 2.2-1. Track of ARGOS Drifter Bouy No. 3354 by month from the time of its deployment on 18 June 1985 until it left the Gulf around 25 September 1985.

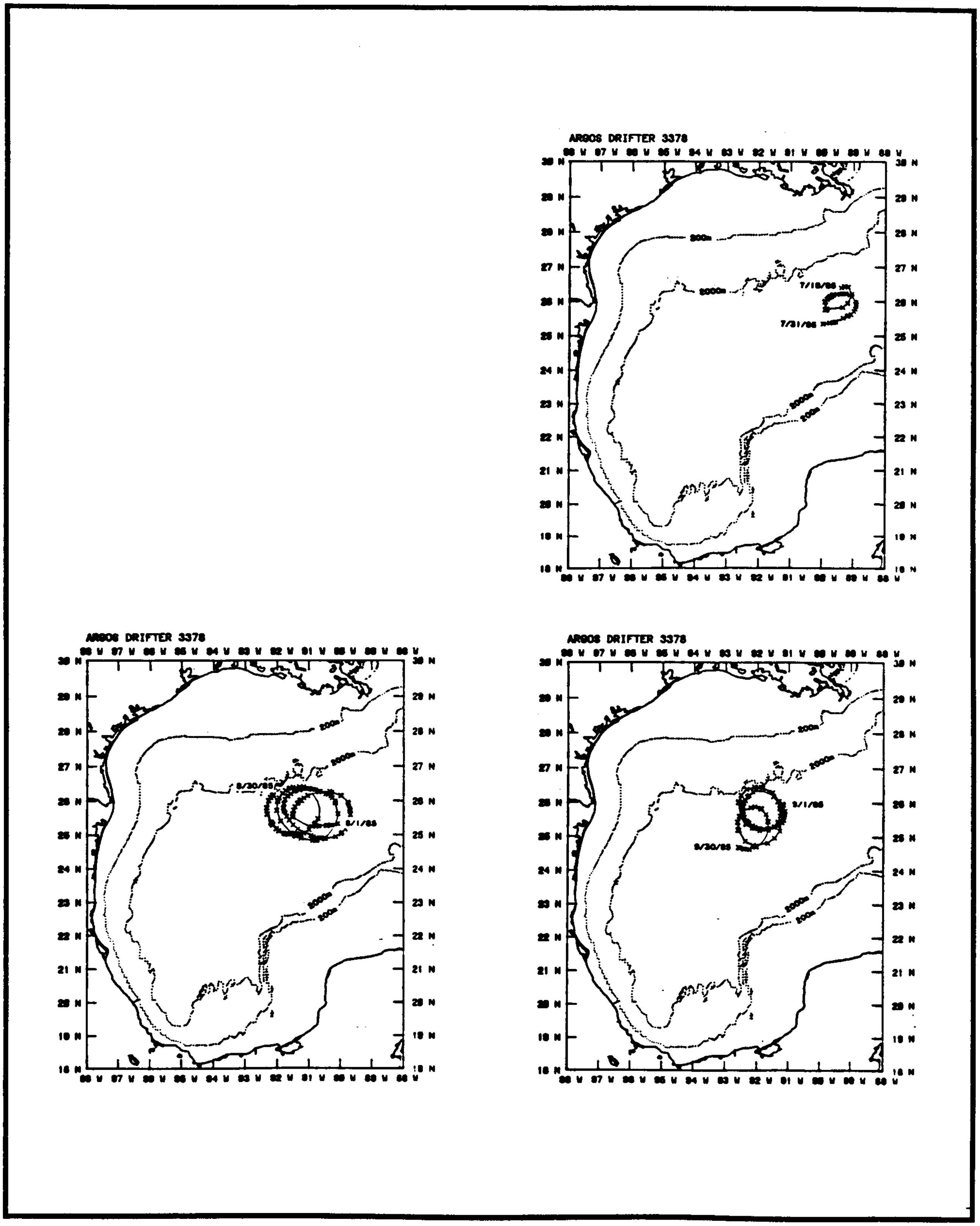

Figure 2.2-2. Track of ARGOS Drifter Bouy No. 3378 by month from the time of its deployment on 18 July through 30 September 1985.

and a General Oceanics Rosette water sampler. A Hewlett-Packard desktop computer controlled the operation of the underwater package and performed the data logging and graphical display functions during each CTD cast. Plots of temperature and salinity versus depth were available as soon as the CTD package was lowered to its maximum depth and were used to determine where to take water samples as the package was brought back to the surface. XBT (expendable bathythermograph) data were obtained using a BathySystems Inc. XBT controller and were logged by another Hewlett-Packard computer.

Standard calibration data were collected to verify all electronically measured parameters, but both the CTD and the XBT systems performed flawlessly and it was not necessary to apply corrections to the data. Water samples were processed for oxygen and chlorophyll content on board the ship, and aliquots were frozen and taken back to the laboratory for nutrient analysis. Standard analysis and calibration procedures were used. A detailed description of the CTD and XBT electronics systems as well as the water analyses and their respective calibration procedures may be found in Section 2.4 of the final report for Years 1 and 2 (SAIC, 1986) and will not be repeated here.

2.3.2.2 CF8405 Cruise Summary

Cruise CF8405 was conducted between 4 and 19 May 1984. During the two week period, 268 hydrographic stations were occupied. These data were obtained on 20 sections, 13 of which were in, or in the vicinity of a Loop Current frontal eddy, and three of which were through a cold perturbation of the Loop Current front southwest of the Dry Tortugas. The locations of the 20 sections are shown in Figures 2.3-1 through 2.3-4 and the hydrographic stations which make up each section are tabulated in Table 2.3-1.

Sections I, II and XX were through the cold perturbation; Sections III, IV, V, VIII, IX and X were in the vicinity of the frontal eddy; Sections XI, and XIV through XVIII comprise a time series of observations on two transects through which the frontal eddy passed. Since data were obtained at the beginning and at the end of the cruise in the cold perturbation, a fairly synoptic view of the decaying stage of this low frequency feature can be seen. Sections obtained prior to the arrival of the frontal eddy characterize an unperturbed Loop Current front while those obtained during the time series show the propagation of a frontal eddy feature southward along the shelf break.

Unlike the Year 1 cruises, Cruise CF8405 was relatively unhampered by adverse weather conditions. This, combined with the above mentioned added flexibility due to the aerial survey component, resulted in a highly productive cruise.

2.3.3 Acoustic Doppler Current Profiling

2.3.3.1 Introduction

Vertical profiles of horizontal currents were obtained using a hull mounted acoustic doppler current profiler (ADCP) manufactured by Ametek-Straza Inc. The technical details of this system were given in (SAIC, 1986) but will also be summarized here since this is a relatively new type of oceanographic instrument and is not yet considered standard equipment. Briefly, the model DCP-4400 ADCP is configured as a three beam 115 kilohertz system in which the three acoustic beams are separated from each other by 120 degrees in the

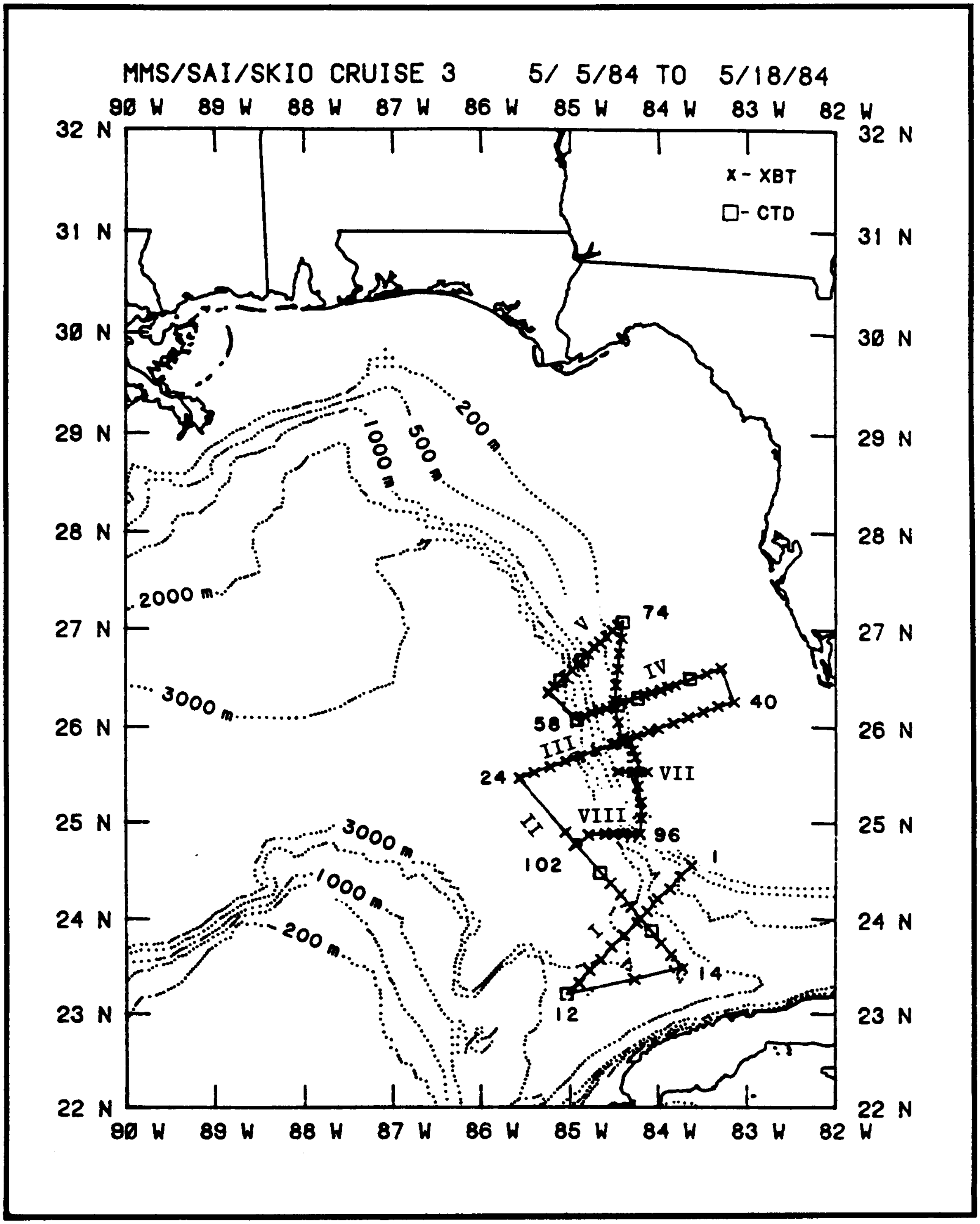

Figure 2.3-1. Cruise track showing XBT and CTD station locations for Stations 1-102 (Sections I-VIII) of Cruise CF8405.

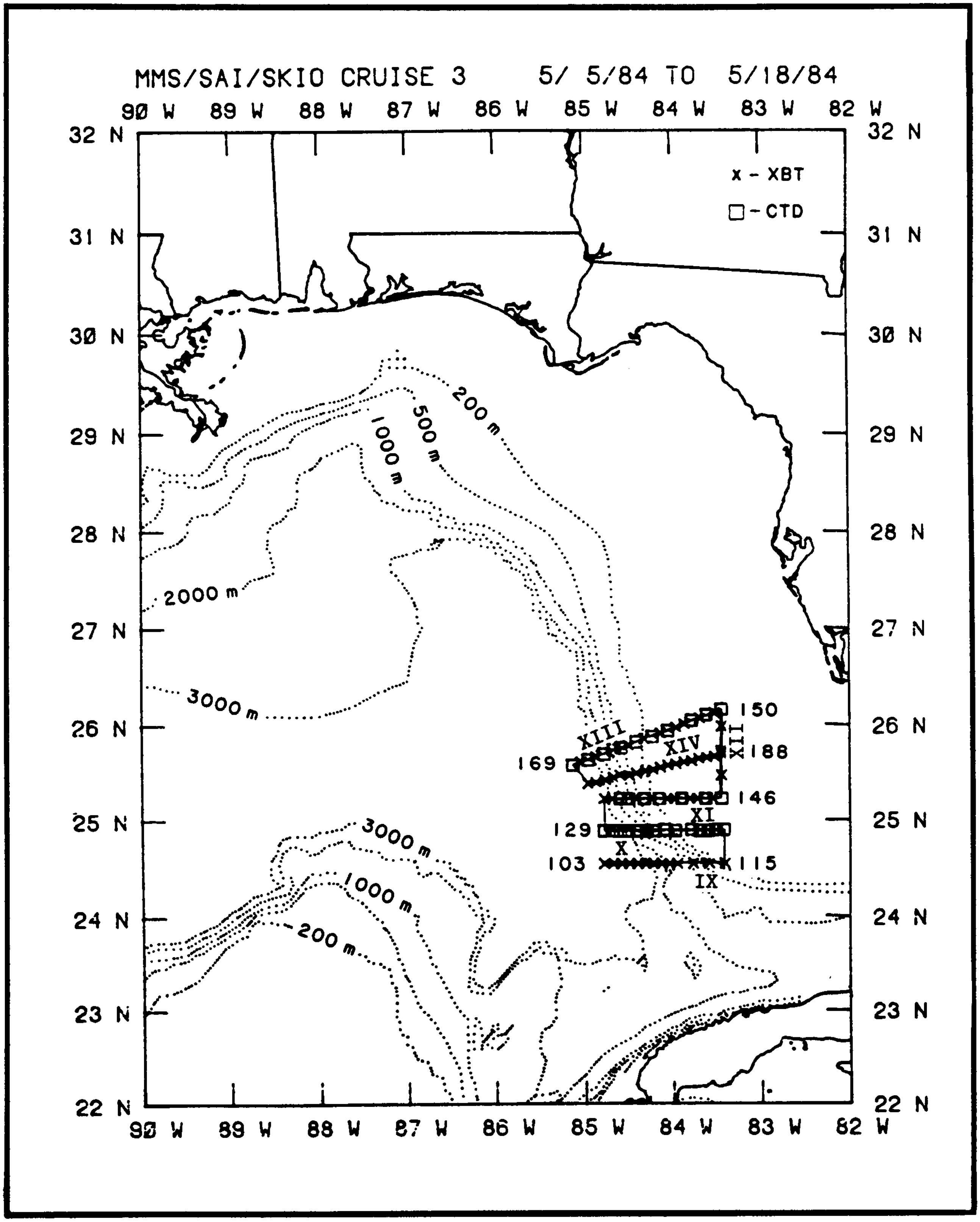

Figure 2.3-2. Cruise track showing XBT and CTD station locations for Stations 103-188 (Sections IX-XIV) of Cruise CF8405.

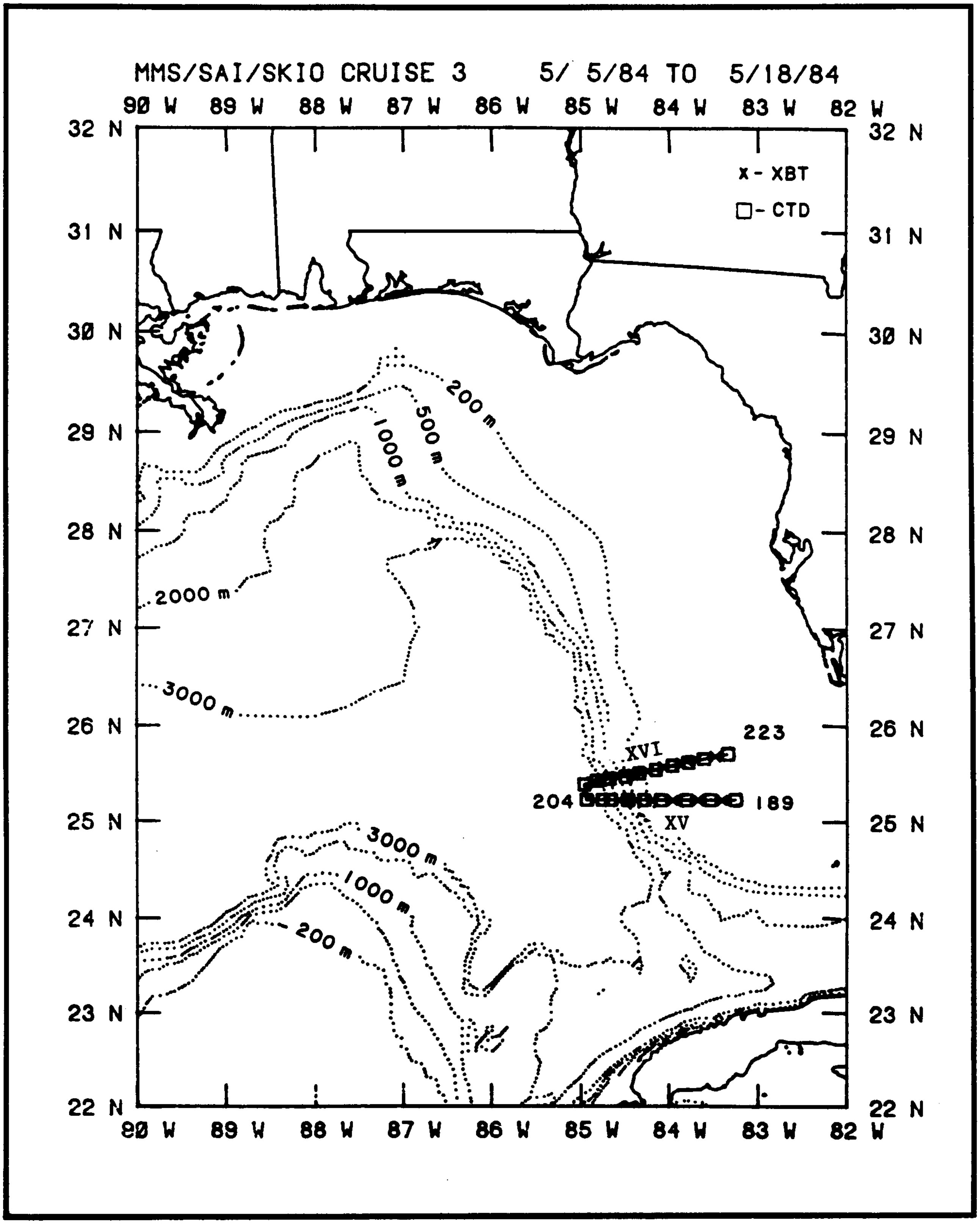

Figure 2.3-3. Cruise track showing XBT and CTD station locations for Stations 189-223 (Sections XV-XVI) of Cruise CF8405.

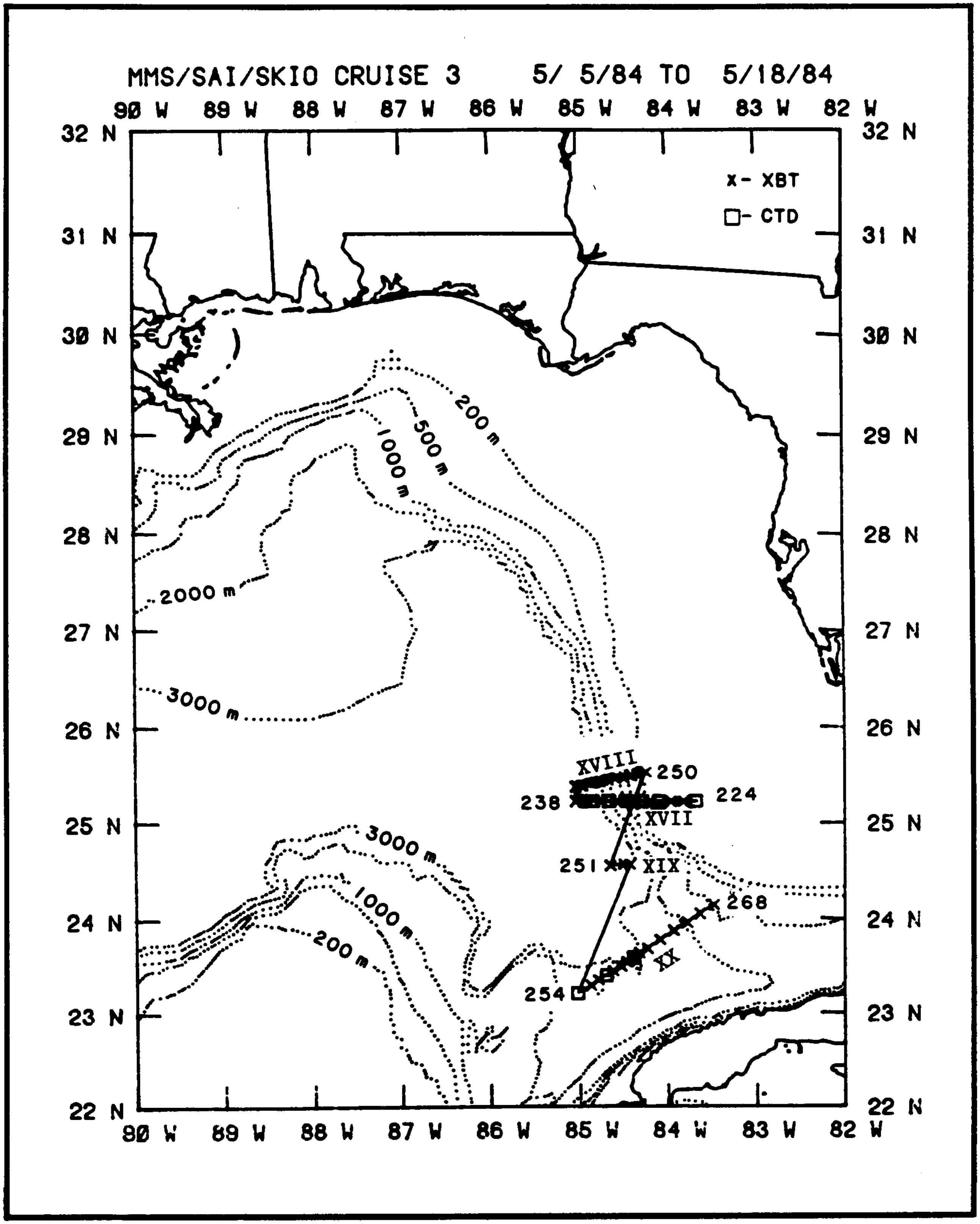

Figure 2.3-4. Cruise track showing XBT and CTD station locations for Stations 224-268 (Sections XVII-XX) of Cruise CF8405.

Table 2.3-1. Summary of stations according to sampling time and section number R/V CAPE FLORIDA cruise CF8405 for the period 4-19 May 1984.

Section	Date (GMT)	Station Numbers
I (A-B)	5-6 May	1X, 2X, 3X, 4X, 5X, 6X, 7X, 8X, 9X, 10X, 11X, 12C
II (C-E)	6-7 May	*13X, 14X, 15X, 16X, 17C, 18X, 19X, 20X, 21X, 22C, 23X, <u>24X</u>
III (E-F) (Mooring Line)	7-8 May	<u>24X</u>, 25X, 26X, 27X, 28X, 29X, 30X, 31X, 32X, 33X, 34C, 35X, 36X, 37X, 38X, 39X, 40X
IV (G-H)	8 May	41X, 42X, 43X, 44X, 45X, 46X, 47X, 48X, 49C, 50X, 51X, 52C, 53X, 54X, 55X, 56X, 57X, 58C
V (I-J)	9 May	59X, 60X, 61C, 65X, 63X, 66X, 67C, 68X, 69X, 70X, 71X, 72X, 73X, <u>74C</u>
VI-A (J-K)A	9 May	<u>74C</u>, 75X, 76X, 77X, 78X, 79X, <u>80X</u>
VI-B (J-K)B	9 May	<u>80X</u>, 81X, 83X, 84X
VI-C (J-K)C	9-10 May	85X, 86X, 87X, 88X
VII (L-M)	10 May	89X, 88X, <u>92X</u>, 91X
VI-D (J-K)D	10 May	<u>92X</u>, 93X, 94X, 95X, <u>96X</u>
VIII (K-N)	10 May	<u>96X</u>, 97X, 98X, 99X, 100X, 102X
IX (O-P)	10 May	103X, 104X, 105X, 106X, 107X, 108X, 109X, 110X, 111X, 112X, 113X, 114X, 115X
X (Q-R)	10-11 May	116C, 117c, 118C, 119C, 120C, 121C, 122C, 123C, 124C, 125C, 126C, 127C, 128C, 129C
XI (S-T)	11-12 May	130X, 131X, 132C, 133C, 134X, **135X, 136C, 137X, 138C, 139X, 140X, 141C, 142X, 143X, 144C, 145X, <u>146C</u>
XII (T-U)	12 May	<u>146C</u>, 147X, 148X, 149X, <u>150C</u>

Table 2.3-1. (Continued)

Section	Date (GMT)	Station Numbers
XIII (U-V) (Mooring Line)	12-13 May	150C, 151X, 152C, 153X, 154C, 155X, 156X, 157C, 158X, 159C, 160X, 161C, 162X, 163C, 164C, 165C, 166X, 167C, 168X, 169C
XIV (W-X)	13 May	170X, 171X, 172X, 173X, 174X, 175X, 176X, 177X, 178X, 179X, 180X, 181X, 182X, 183X, 184X, 185X, 186X, 187X, 188X
XV (Y-Z)	14 May	189C, 190X, 191C, 192X, 193C, 194X, 195C, 196X, 197C, 198X, 199C, 200X, 201C, 202C, 203X, 204C
XVI (AA-BB)	14-15 May	205C, 206X, 207C, 208X, 209C, 210X, 211C, 212X, 213C, 214X, 215C, 216X, 217C, 218X, 219C, 220X, 221C, 222X, 223C
XVII (CC-DD)	15-16 May	224C, 225X, 226X, 227C, 228X, 229C, 230X, 231C, 232X, 233C, 234X, 235C, 237X, 236C, 238X
XVIII (EE-FF)	16 May	239X, 240X, 241X, 242X, 243X, 244X, 245X, 246X, 247X, 249X, 250X
XIX (GG-HH)	17 May	251X, 252X, 253X
XX (II-JJ)	17-18 May	254C, 255X, 256X, 257C, 258X, 259X, 260X, 261C, 262X, 263X, 264X, 265X, 266X, 267X, 268X

* Actually between Sections I and II.

** Stations 135X and 136C are at the same location.

horizontal, and are inclined 30 degrees to the vertical. This transducer assembly was installed in the hull of the R/V CAPE FLORIDA such that one beam was aimed forward (and down into the water column) leaving the other two aimed slightly aft on the port and starboard sides. This configuration minimizes interference from acoustic noise generated in the wake of the ship.

A 115 kHz pulse of acoustic energy is emitted simultaneously from each of the three transducers and travels along narrow beam paths as described above. As it does so, a fraction of the acoustic energy is backscattered towards the transducer from which it was emitted. This backscattering occurs because of the presence of small density discontinuities in the water column. Sources of such density discontinuities include bubbles and phytoplankton as well as the density structure of the water itself. Due to the motion of the water containing the backscatterers, the frequency of the returning acoustic signal is Doppler shifted slightly from the original 115 kHz. This same principle is responsible for the apparent change in pitch of a train's whistle as the train passes the location of an observer. The Doppler shift is proportional to the speed of the backscattering water (or train). Combining the Doppler shifts from all three beams allows the horizontal velocity of the water relative to the ship to be calculated.

The DCP-4400 listens for the returning Doppler shifted acoustic energy for each beam in a time-gated fashion. Sixty-three such time bins are used, and when the speed of sound in sea water and the geometry of the system are accounted for, these correspond to 63 depth bins below the hull of the ship. In this fashion a vertical profile of horizontal velocity is obtained. The bin size is software controllable. Since past experience with this system indicated that the maximum effective depth penetration of the 115 kHz acoustic pulse was about 200 meters, 3.2 meters was selected as the bin size for Cruise CF8405. A special sixty-fourth bin is reserved for tracking the motion of the ocean bottom relative to the ship. Data from this bin may be used to subtract out the ship's motion relative to the earth from the other 63 bins to yield a vertical profile of water velocity relative to the earth (i.e., the geophysically interesting quantity). When the ship is operating in water too deep for the ADCP to detect the bottom motion, LORAN-C navigation data (which are necessary for defining the position of each profile) are used to calculate ship speed. In both cases, the ADCP records the ship's heading so that the resulting velocity data can be resolved into geographic (i.e., east and north) components.

The CF8405 ADCP data were averaged over (user selectable) 60-pulse cycles by the DCP-4400 during the acquisition stage. An indicator of data quality, the percentage of detectable returns during the 60-pulse cycle, as well as the Doppler shift data were written to magnetic media for later retrieval and analysis. The bin-to-bin error in velocity due to limitations in the acoustic/electronic system is estimated (Joyce et al., 1982) to be about 2 cm s-1 for each of the 64 bins. Thus, in shallow (~250 m) waters where the ADCP is bottom tracking successfully, total error in the absolute velocity is about 2 cm s-1. Ship speed calculations based on LORAN-C position data are accurate to within about 5 or 6 cm s-1 for the averaging periods used for Cruise CF8405.

2.3.3.2 CF8405 Cruise Summary

The ADCP operated successfully during more than 90% of the cruise. In the 60 cycle averaging mode, a data profile was generated and stored about every 160 seconds or about every 0.8 kilometers along the cruise track while the ship was steaming at a cruising speed of 10 knots. Both this horizontal resolution and the 3.2 meter vertical resolution are at least an order of magnitude better than that attainable with conventional moored current meter technology. Unfortunately, however, the most severe gap in the ADCP data was in the section corresponding to the location of the line of moored current meters. This data gap, however, was not due to a failure of the ADCP, but to the failure of the LORAN-C navigation data acquisition system which, as discussed above, is essential for removing ship speed from the data in deep water regions.

A total of 7035 vertical profiles of horizontal velocity were obtained with the ADCP during this cruise. As will be shown in the next chapter, it is very difficult to process ADCP data in a statistically reliable manner for times when the ship is manuvering rapidly such as in the vicinity of a hydrographic station. Therefore, the ADCP data set was edited accordingly and the resulting reduced data set consists of 3490 raw profiles.

2.4 Subsurface Currents: Deployment Periods and Data Return

In January 1985, six MMS moorings (A, C, DA, E, F and G) were re-deployed on the West Florida Shelf and slope in depths of 1700, 180, 75, 180, 50 and 3200 m, respectively (Figure 2.4-1 and Table 2.4-1). Re-deployment of these moorings served as a continuation of the field measurements first begun in this region in January 1983 with the possibility of obtaining a number of time series between two and three years in length. These moorings were finally recovered after two rotations in February 1986. In addition, over the course of the year, three other moorings (H, I, and J) were also deployed on the shelf for three to four month periods. Mooring H, an NSF mooring, was deployed by Dr. W. Sturges of FSU on the 180-m isobath approximately 75 nm NNW of Mooring E, and data from Moorings I and J along the 22 m isobath off Apalachee Bay were provided by MMS.

A time line of the deployment periods and relative data return for each current meter level for the three year study is presented in Figure 2.4-2. A summary of the type of instrument used and the percent data return for each current meter level by parameter (currents and temperature, and pressure when applicable) for the first two years of this study has been previously reported (SAIC, 1986). For this latest year, since January 1985, the same information is summarized in Tables 2.4-2 and 2.4-3. For completeness, a supplemental time line and table are also presented in Figure 2.4-3 and Table 2.4-1. They document eight additional moorings deployed in 1984 and 1985 on the West Florida Shelf for MMS by Environmental Science and Engineering, Inc. (ESE) in conjunction with a study of sediment transport.

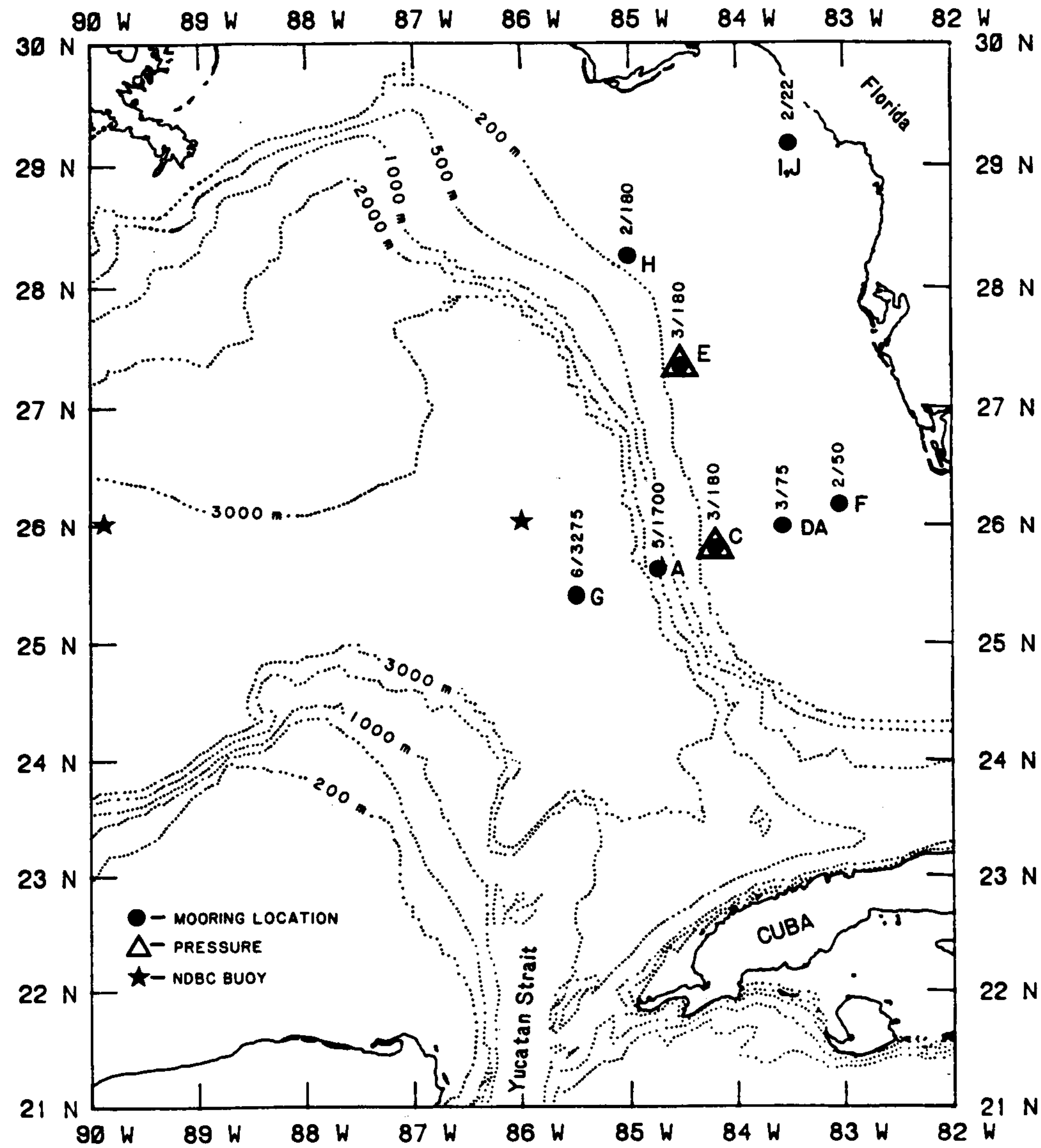

Figure 2.4-1. Bathymetry and mooring locations A through J in the eastern Gulf of Mexico.

Table 2.4-1. Mooring locations in the eastern Gulf for Year 4 of the MMS sponsored Gulf of Mexico Physical Oceanography Program.

Mooring	Location Latitude	Location Longitude	Depth (m)	Nominal Instrument Depths (m)
A	25°42.9'N	84°53.1'W	1700	172, 400, 738, 1100, 1600
C	25°53.2'N	84°19.2'W	180	50, 100, 179
DA	26°05.5'N	83°41.9'W	75	17, 50, 71
E	27°25.2'N	84°37.5'W	180	50, 100, 179
F	26°14.5'N	83°13.3'W	50	17, 40
G	25°36.2'N	85°29.8'W	3200	177, 397, 703, 1565, 2364, 3174
H	28°24.5'N	85°18.6'W	180	50, 100
I	29°15.0'N	83°57.5'W	22	9, 17
J	29°15.1'N	83°57.4'W	22	9, 17
ESE1	25°17.54 N	81°39.81 W	13	10
ESE2	20°16.90 N	83°57.30 W	125	122
ESE3	24°47.50 N	83°41.20 W	65	61
ESE4	25°16.90 N	83°37.80 W	74	71
ESE5	26°17.00 N	82°43.70 W	32	29
ESE6	24°36.20 N	82°42.00 W	27	24
ESE7	25°17.30 N	82°52.14 W	47	44
ESE8	26°17.71 N	82°12.66 W	13	10

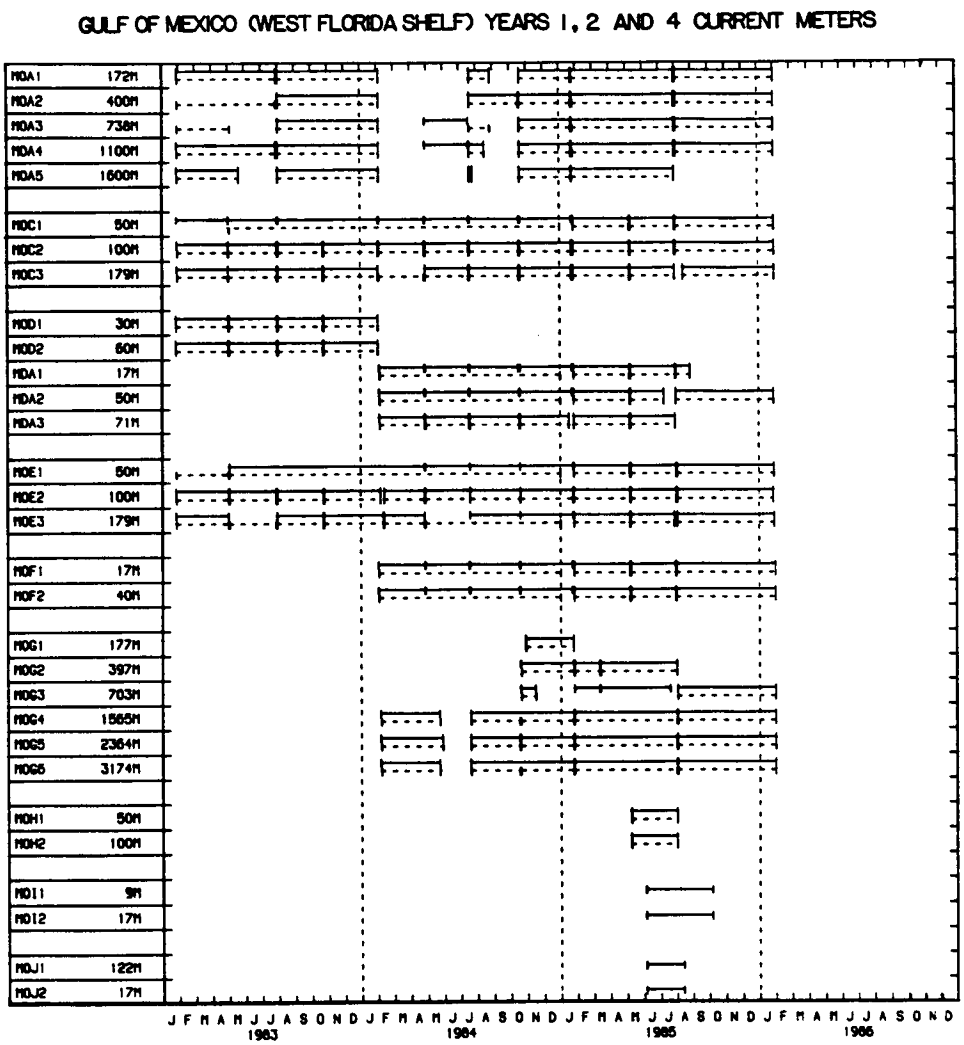

Figure 2.4-2. Time line of the deployment periods and data return for each current meter level for instruments deployed on Moorings A through J in the eastern Gulf for Years 1, 2, and 4 of the MMS sponsored Gulf of Mexico Physical Oceanography Program. The solid lines are for currents and the dashed lines are for temperature.

Table 2.4-2 Deployment periods and instrument types for each current meter level for Moorings A through J in the eastern Gulf for the period from 23 January 1985 through 1 February 1986.

METER ID (DEPTH)	PERIOD 9	PERIOD 10	PERIOD 11
A1 (172m)	MK	2	MK1
A2 (400m)	MK	1	MK1
A3 (738m)	MK	1	MK1
A4 (1100m)	MK	1	MK2
A5 (1600m)	MK	2	MK2
C1 (50m)	MK1	MK1	MK1
C2 (100m)	MK1	MK1	MK2
C3 (179m)	FSU	FSU	MK2
DA1 (17m)	MK1	MK1	MK1
DA2 (50m)	MK1	MK1	MK1
DA3 (71m)	FSU	FSU	MK2
E1 (50m)	MK1	MK1	MK1
E2 (100m)	MK1	MK1	MK1
E3 (179m)	FSU	FSU	MK1
F1 (17m)	MK1	MK1	MK1
F2 (40m)	MK1	MK1	MK1
G1 (177m)	MK	1	-----------------------
G2 (397m)	MK	1	-----------------------
G3 (704m)	MK	1	MK1
G4 (1565m)	MK	1	MK1
G5 (2364m)	MK	1	MK1
G6 (3174m)	MK	1	MK1
H1 (50m)	------------	FSU	-----------------------
H2 (100m)	------------	FSU	-----------------------
I1 (9m)	------------	---(TYP	105)-----------------
I2 (17m)	------------	---(TYP	105)-----------------
J1 (9m)	------------	---(TYP 105	)-----------------------
J2 (17m)	------------	---(TYP 105	)-----------------------

PERIOD 9: 01/23/85 - 05/06/85
PERIOD 10: 05/06/85 - 08/01/85
PERIOD 11: 08/01/85 - 02/01/86

TYPE 105 PERIODS:

I: 06/04/85 - 10/05/85
J: 06/04/85 - 08/12/85

Table 2.4-3 Data return for Moorings A through J in the eastern Gulf for the period from 23 January 1985 through 1 February 1986.

METER ID (DEPTH)	CURRENTS	TEMPERATURE	PRESSURE
A1 (172m)	100%	100%	100%
A2 (400m)	100%	100%	-----------
A3 (738m)	100%	100%	-----------
A4 (1100m)	100%	100%	100%
A5 (1600m)	50%	50%	50%
C1 (50m)	100%	100%	-----------
C2 (100m)	100%	100%	-----------
C3 (179m)	97%	97%	97%
DA1 (17m)	58%	58%	-----------
DA2 (50m)	94%	94%	-----------
DA3 (71m)	50%	50%	50%
E1 (50m)	100%	100%	-----------
E2 (100m)	99%	99%	-----------
E3 (179m)	99%	99%	99%
F1 (17m)	100%	100%	-----------
F2 (40m)	100%	100%	-----------
G1 (177m)	*0%	*0%	-----------
G2 (397m)	**100%	**100%	-----------
G3 (704m)	97%	49%	-----------
G4 (1565m)	100%	100%	-----------
G5 (2364m)	100%	100%	-----------
G6 (3174m)	100%	100%	-----------
H1 (50m)	100%	100%	-----------
H2 (100m)	100%	100%	-----------
I1 (9m)	100%	--------------	-----------
I2 (17m)	100%	--------------	-----------
J1 (9m)	100%	--------------	-----------
J2 (17m)	100%	--------------	-----------

*Instrument lost and not replaced on subsequent deployment.

**Excludes not-deployed period for 1 August 1985 to 1 February 1986.

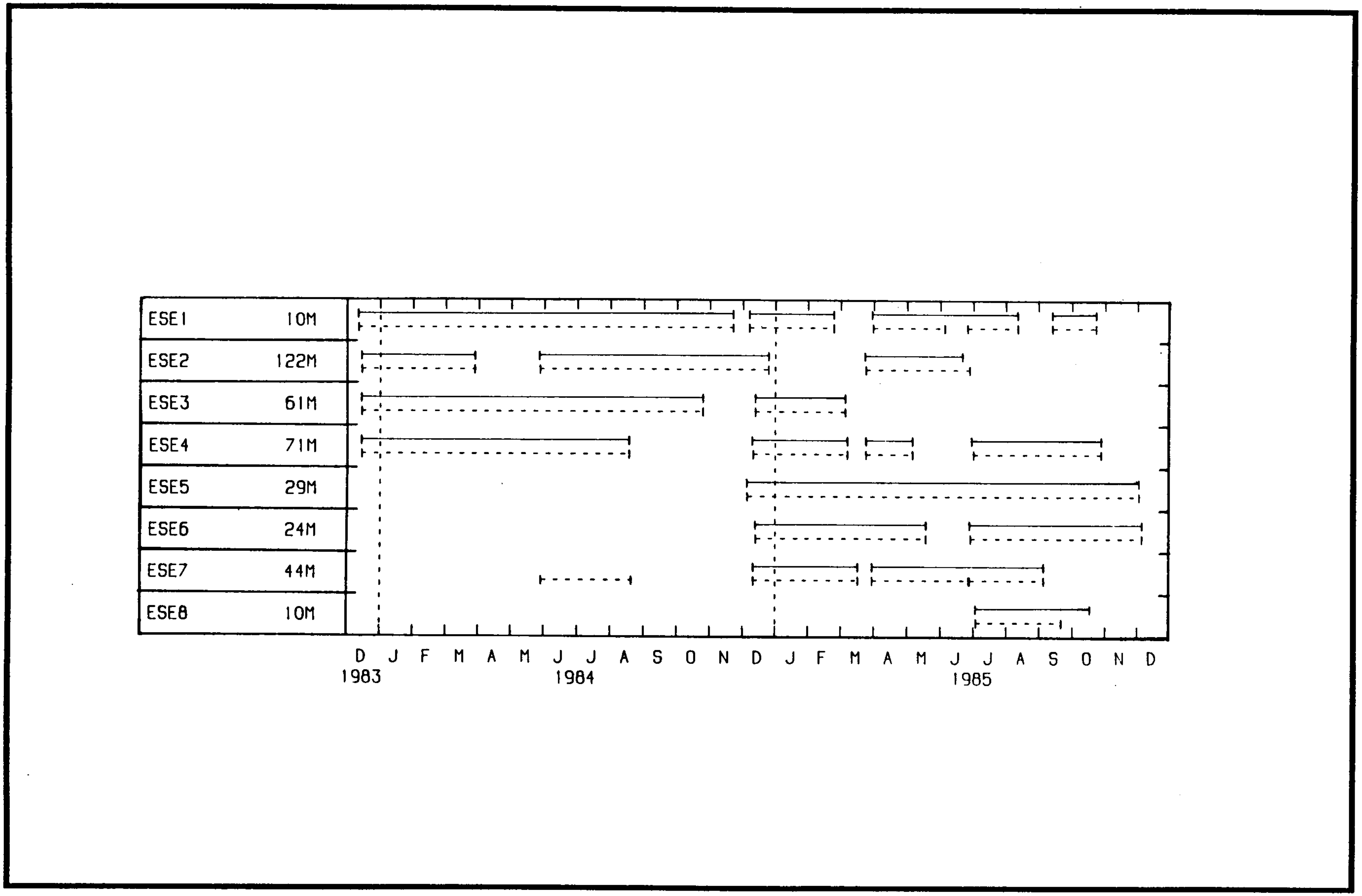

Figure 2.4-3. Time line for the ESE moorings on the West Florida Shelf (see Table 2.4-1 for locations). The solid lines are for currents, and the dashed lines are for temperature.

The total data return for the third year of MMS measurements at Moorings A through J was 85%. This percentage was primarily degraded by the loss of the upper instrument and flotation at Mooring G during the initial deployment, and subsequent re-deployment of the mooring without either the upper or next lower instrument. The total data return for the SAIC component of the three year study was 83%. Both percentages are based on the actual planned instrument levels and are degraded by non-deployments and instrument losses.

2.5 <u>Ships-of-Opportunity</u>

The MMS Ship-of-Opportunity (SOOP) program initiated in the eastern Gulf in 1983 was continued in support of the field effort for Years 3 and 4, and is continuing in Year 5. Tables 2.5-1 and 2.5-2 update these data sets in the eastern Gulf through 30 September 1986. Examples of the cruise tracks for the two main SOOP sections are presented in Figure 2.5-1, and examples of the standard data products produced are presented in Figure 2.5-2. Additional vertical temperature plots of the upper 200 m only were also generated for each section.

Table 2.5-1. MMS and NMFS/MMS Ship-of-Opportunity sections in the eastern Gulf of Mexico from 25 January 1985 through 30 September 1986.

Section	Ship	Dates	No. Trips
*I	NESTOR I	2/05/85 - 5/10/85	8
I	STENA HISPANIA	5/16/85 - 8/18/85	8
I	AMBASSADOR	9/05/85 - 9/27/86 (ongoing)	35
**II	E.M. QUEENY	2/07/85 - 9/22/86 (ongoing)	27

* MMS section from New Orleans to the Yucatan Straits.

** NMFS/MMS section from 27.0°N 90.0°W to 24.5°N 83.5°W.

Table 2.5-2. Additional MMS Ship-of-Opportunity data sets in the eastern Gulf of Mexico from 25 January 1985 through 30 September 1986.

Ship	Dates	Cruise ID
COLUMBUS LOUISIANA	05/26/85 - 05/27/85	CL8501
ERICA	03/05/86 - 03/08/86	ER8601
NAT CO 6	07/16/85 - 07/19/85	NC8501
SUNCOASTER	02/26/85 - 03/07/85	SC8503
SUNCOASTER	04/25/85 - 04/28/85	SC8512
SUNCOASTER	07/09/85 - 07/22/85	SC8513
SUNCOASTER	11/08/85 - 11/15/85	SC8519
SUNCOASTER	05/01/86 - 05/10/86	SC8608

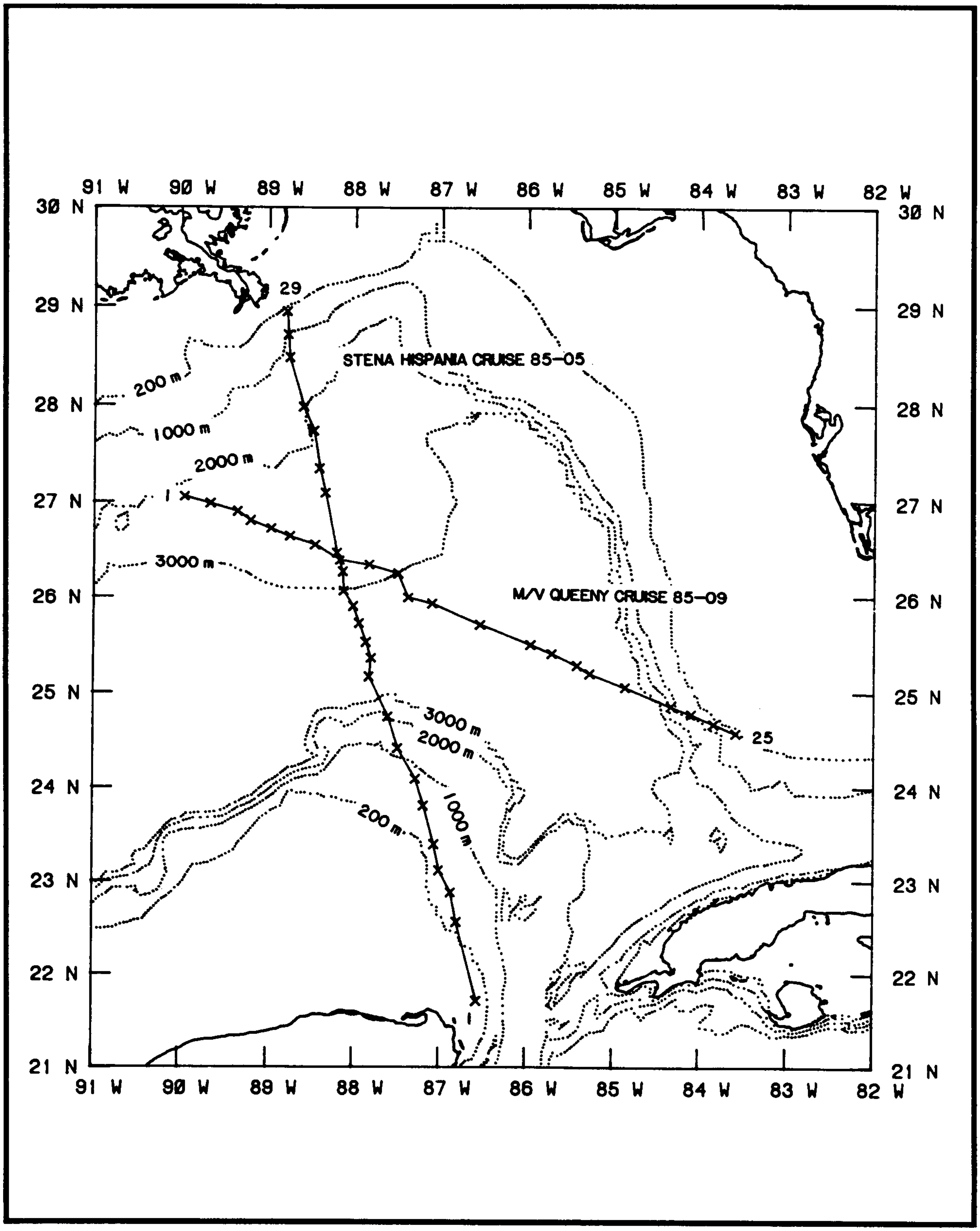

Figure 2.5-1. Examples of the cruise tracks for the repeated MMS and NMFS/MMS Ship-of-Opportunity sections in the eastern Gulf.

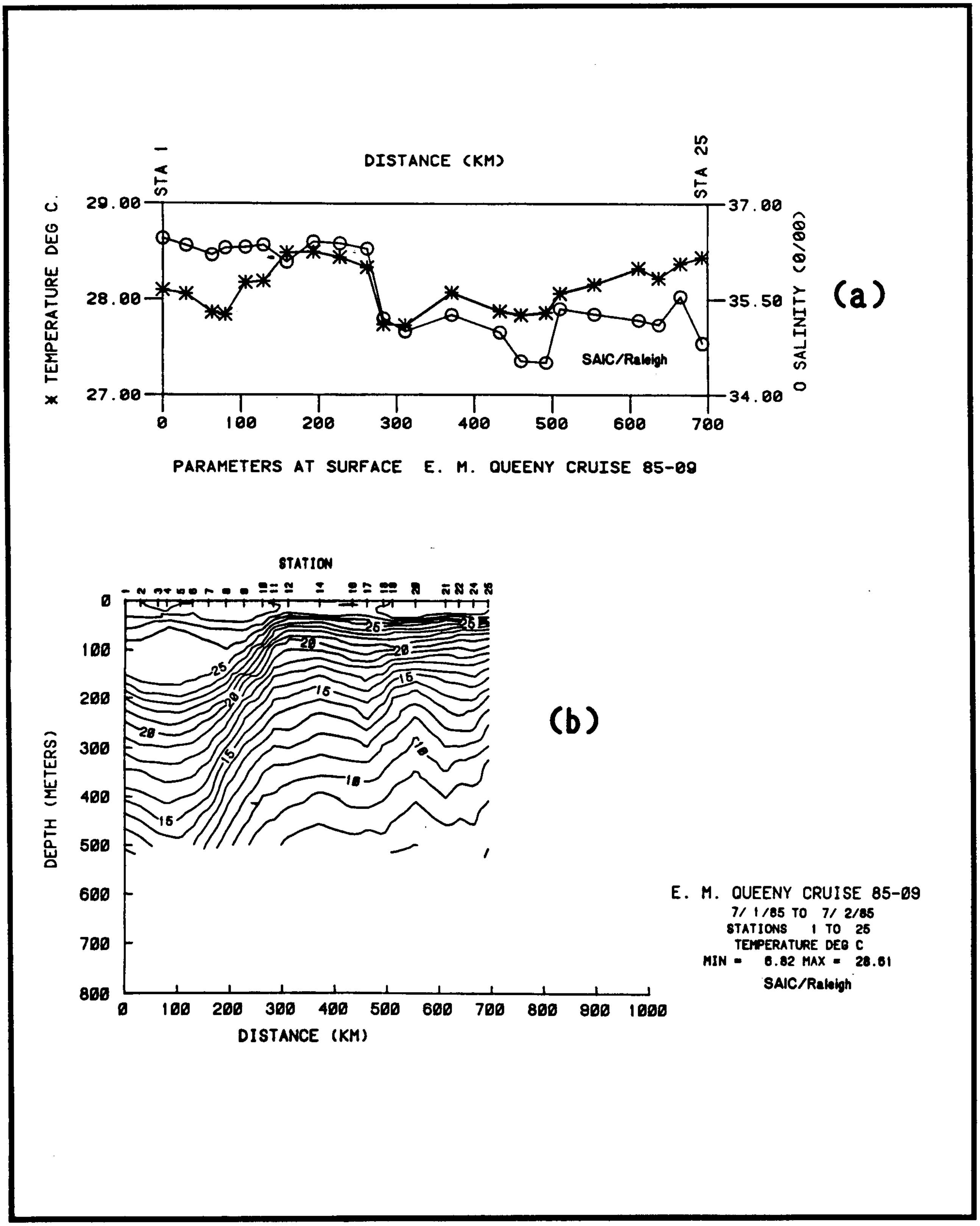

Figure 2.5-2. Examples of data products generated for each SOOP cruise: (a) surface parameters (b) vertical temperature.

III. DATA ANALYSIS

3.1 Introduction

Most of the analysis techniques and methodology used on data discussed in the present report were presented in the Years 1 and 2 Final Report, and for reference, the appropriate sections in that report are identified. In addition, because of the expanded analysis methodology applied to the Acoustic Doppler Current Profiler Data, a discussion of these techniques are presented, including some of the material previously provided.

3.2 Drifting Buoys

For a complete description of the analytical and numerical analysis procedures used on the buoy trajectory data the reader is referred to Section 3.2 in the GMPOP Final Report for Years 1 and 2.

3.3 Hydrography/Current Profiles

3.3.1 Introduction

The data reduction and presentation techniques employed during the post-cruise phase of analysis of the hydrographic and ADCP data are described in this chapter and examples of standard data products are given.

3.3.2 Hydrography

3.3.2.1 Introduction

Both during and after Cruise CF8405, the CTD data were checked for errors and edited accordingly. However, the state-of-the-art instrumentation ran essentially trouble free for the entire cruise. The water sample analyses for oxygen, chlorophyll and the various nutrients were conducted according to standard methods as detailed in SAIC (1986). Some spurious values were eliminated based on comparisons within the CF8405 data set and with historical data.

3.3.2.2 Procedures for Handling Ship-Based Hydrographic Data

During the cruise, the CTD data were read back from the raw data files created while on the hydrographic stations and edited for any spurious points. Occassional glitches did occur due to fluctuations in the ship's power supply or other electronic noise but these were obvious and easily eliminated. The data were then averaged over one-meter depth increments and combined with header information (including date, time, position, weather, etc.) and stored on disk for further post-cruise processing. Water samples for salinity calibration and reversing thermometer readings for temperature calibration were taken during the cruise; however, no modification to the original data was necessary. The data available at the end of the cruise, therefore, became the final CTD data set. The same is true of the XBT data set. After the cruise, temperature and salinity data were compared to historical data and to each other in the form of T-S (temperature versus salinity) plots as a further check on CTD data quality (Figure 3.3-1).

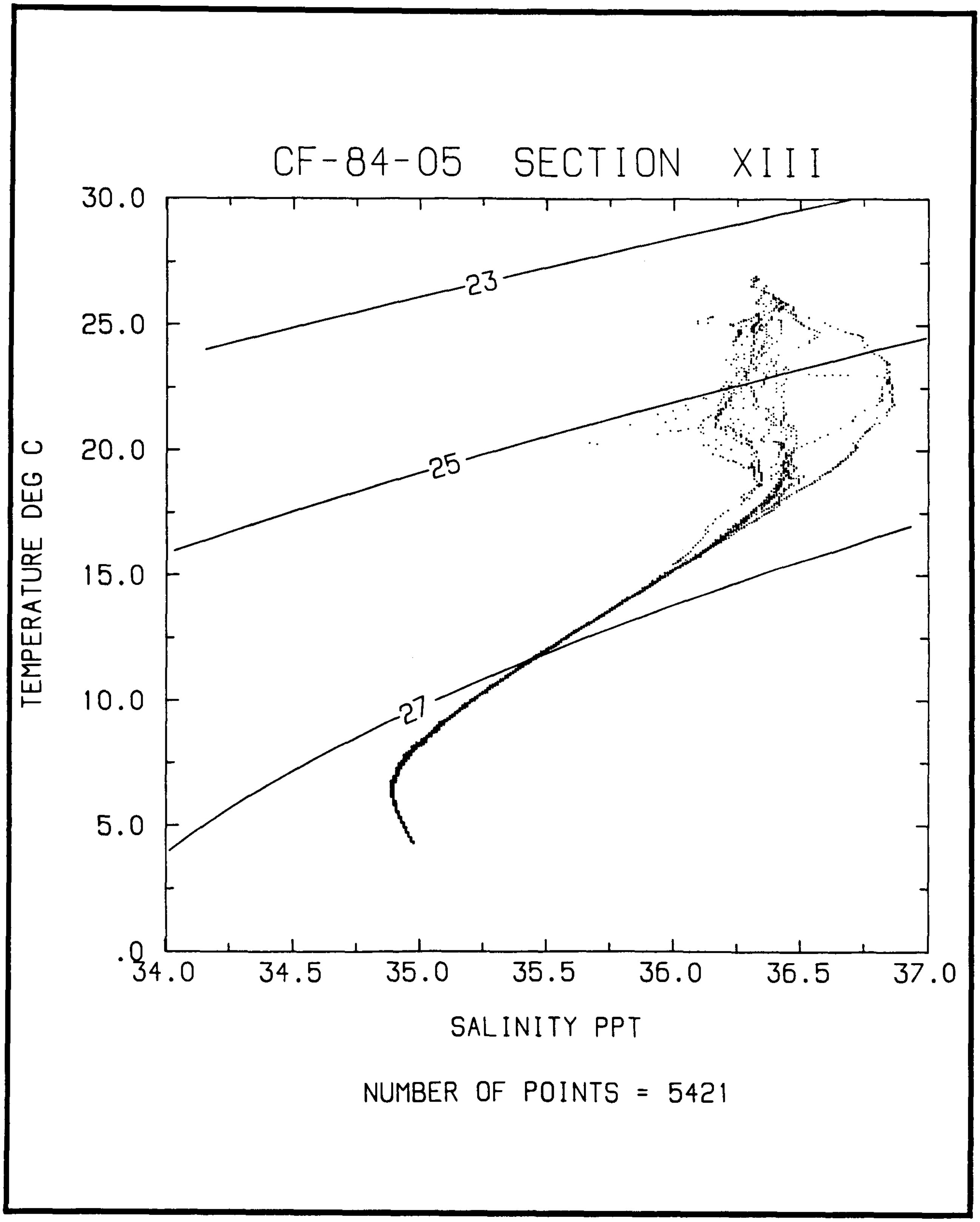

Figure 3.3-1. Temperature versus salinity plot for Section XIII of Cruise CF8405.

Upon completion of all laboratory analyses, the edited water sample data were merged with the one-meter averaged temperature and salinity data into a standard National Oceanographic Data Center (NODC) format and made available to other investigators involved in the GMPOP.

3.3.2.3 Hydrographic Data Products

In addition to the vertical profiles of temperature and salinity available from the cruise, and the T-S plots used in the error-checking process, a number of other data products have been generated. These include vertical cross-sections of the various measured parameters such as temperature and oxygen (Figures 3.3-2 and 3.3-3) and computed parameters such as sigma-t (Figure 3.3-4). Assuming a dynamical balance between the pressure gradient and the Coriolis forces (i.e., geostrophy), the cross-sections of temperature and density are useful in inferring the corresponding flow field, and the associated water sample data are useful for determining the origin of a particular water mass. For example, the upward doming isopycnals (Figure 3.3-4) and isotherms (Figure 3.3-2) of Section XV could be due to either an upwelling process or to a lateral advection of a shallow water mass having anomalous T-S characteristics. In view of the historical data, however, the oxygen cross-section confirms that in this case we have upwelling of a deeper water mass.

Additional hydrographic data products were generated and were described in SAIC (1986). Chapter 4 will rely primarily on the vertical cross-sections and will not elaborate further on the various data products which were routinely produced in the post-cruise analysis.

3.3.3 Acoustic Doppler Current Profiling

3.3.3.1 Introduction

Immediately following Cruise CF8405, the ADCP and LORAN-C data were transferred to a mainframe computer for the substantial post-cruise processing necessary to extract reliable information from the raw data set. An initial analysis had been completed at the time of the publication of SAIC (1986) and initial results as well as remaining analysis problems were described therein. The difficulties associated with computing the ship's velocity vector from LORAN-C data, the problem of misalignment of the transducer relative to the axis of the ship and the errors due to high frequency surface wave activity have all been addressed and the results are reviewed below.

3.3.3.2 Procedures for Handling ADCP Data

The ship speed related problems were resolved in two stages. First, the transducer misalignment angle was determined using a combination of LORAN-C and ADCP data and then, after the appropriate corrections for the misalignment had been made, ship speed was calculated from LORAN-C data and compared to ADCP bottom-tracked ship speed for various types of ship maneuvers associated with hydrographic survey work.

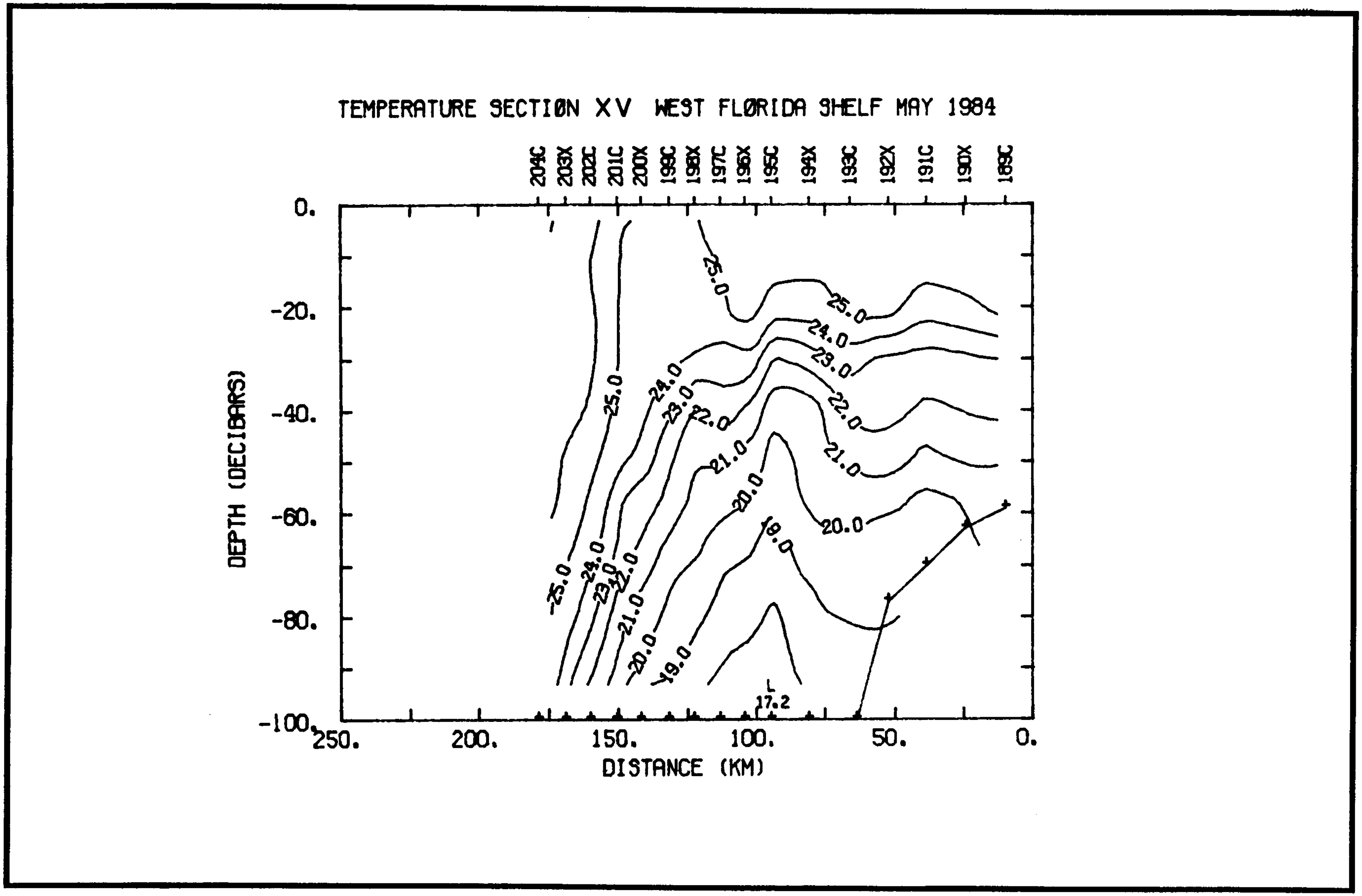

Figure 3.3-2. Vertical cross-section of temperature for Section XV of Cruise CF8405.

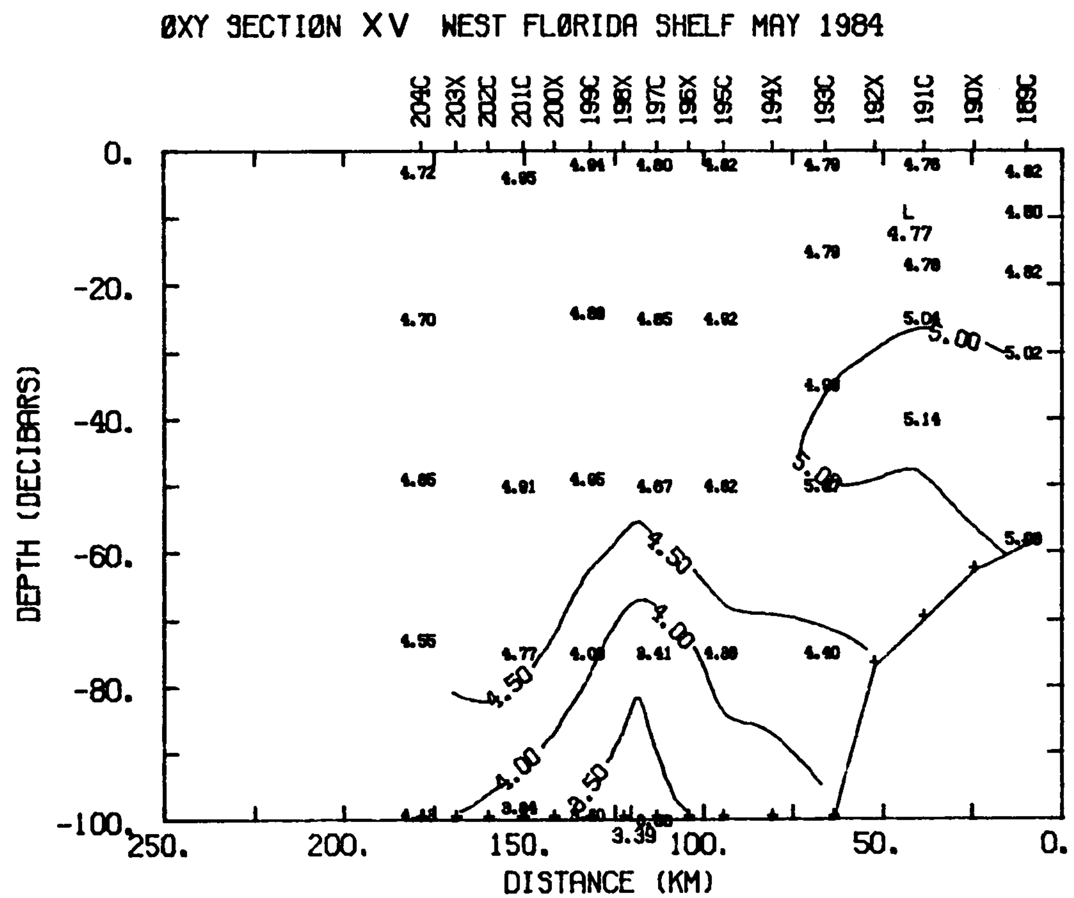

Figure 3.3-3. Vertical cross-section of dissolved oxygen for Section XV of Cruise CF8405.

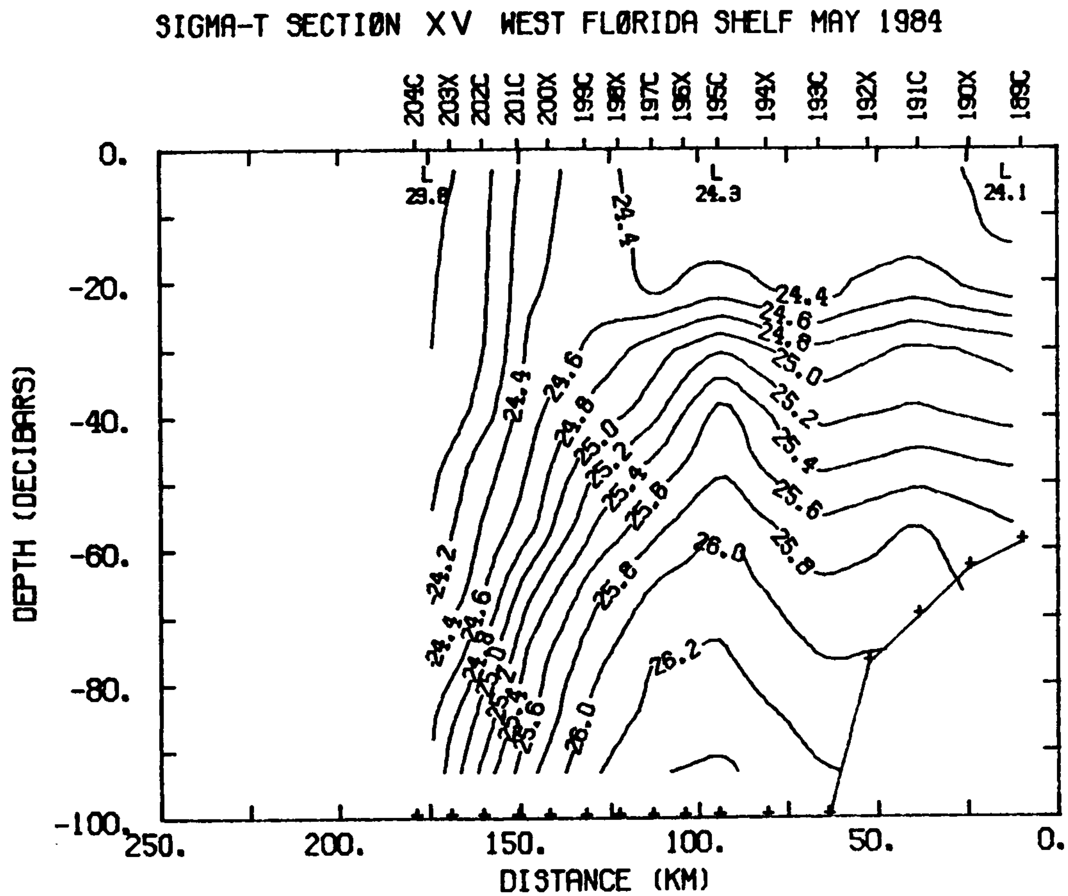

Figure 3.3-4. Vertical cross-section of sigma-t (density) for Section XV of Cruise CF8405.

The transducer misalignment can be approached as a simple coordinate transformation problem. If there is no misalignment, then in a quiescent ocean, water motion relative to the ship will be due only to the ship motion. In this case the fore-aft component of speed will be positive while the athwart ship component will be zero (assuming the ship is moving forward). However, for a nonzero value of the misalignment angle (i.e., if the forward beam is not directed precisely towards the bow of the ship), there will be a "false" athwart ship component measured by the ADCP. This can be represented mathematically by

$$u = u' \cos A - v' \sin A \qquad (1)$$

$$v = u' \sin A + v' \cos A \qquad (2)$$

where A is the misalignment angle, the primed quantities are velocity components in the misaligned coordinate system, and the unprimed quantities are the true components relative to the ship. The false athwart ship component will, of course, appear in the ADCP's bottom-tracked ship velocity as well as throughout the 63 water column bins.

The great similarity between the ADCP ship heading data and the LORAN-C ship heading data revealed that the misalignment angle was small, but as a simple example demonstrates, even a small angle can result in a non-negligible error in the athwart ship velocity component. Given a ship moving directly northward at a typical cruising speed of 10 knots (about 500 cm s-1) with a five degree misalignment angle, equations 1 and 2 can be solved simultaneously to yield u' = 44 cm s-1 and v' = 498 cm s-1. Thus, the error in the fore-aft component is quite negligible since it is on the order of the measurement noise level but the athwart ship error due to misalignment is substantial.

The misalignment angle for Cruise CF8405 was accurately determined by taking advantage of the fact that the error appears in the ADCP bottom tracked ship speed. By selecting a portion of the cruise track from a shallow water region (i.e., where the reliability of the ADCP bottom tracking capabilities is maximized) for which the ship's speed and heading were relatively constant for long periods of time (i.e., where ship speed based on LORAN-C data can be accurately calculated), we were able to compare two independent measures of the ship's velocity vector. Figure 3.3-5 shows the uncorrected east component of ship speed as measured by the ADCP and as calculated from the corresponding LORAN-C data for a five-hour time period. (Note that these data were obtained at the end of the preceeding cruise. However, the results about to be presented are equally valid for both cruises since the installation of the ADCP transducer assembly was not modified between cruises.) Between about 21:45 on the 22nd and 01:00 on the 23rd, the ship was steaming at approximately 10 knots on a heading of 180 degrees. The LORAN-C data correctly indicate an essentially zero eastward component while the ADCP data consistently indicate westward motion of the ship. This and several other cases where the stringent requirements mentioned above were met were analyzed. By mathematically rotating the measured ADCP ship velocity components through a range of angles and subtracting the LORAN-C based components, a misalignment angle

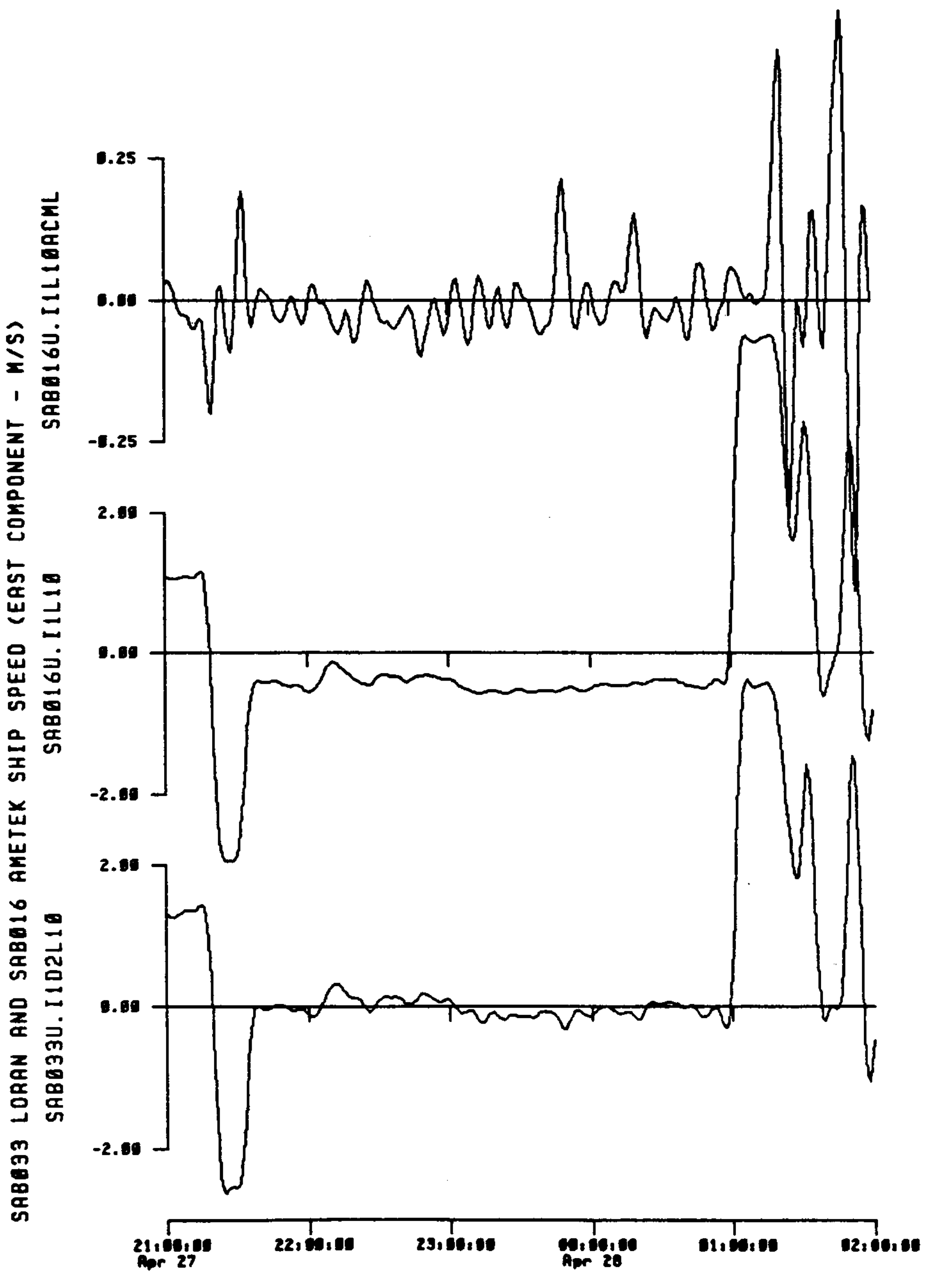

Figure 3.3-5. Time series of the east components of ship velocity based on LORAN data (lower panel) and ADCP bottom tracking data <u>prior to</u> transducer misalignment correction (middle panel). The difference between these two is shown in the upper panel. Note the differing velocity scales on the ordinates.

corresponding to the minimum in root mean square difference in speed between the two was found. This mean misalignment angle was 4.6 degrees and its standard deviation was 0.2 degrees. This standard deviation corresponds to about 1 cm s-1 error and is considered negligible.

Upon applying the coordinate rotation necessary to correct for the transducer misalignment, there still remained a small descrepancy (about 2%) between ADCP and LORAN-C ship speed values. Like the misalignment error, this difference was a function of ship speed; however, it affected both components equally. Without a means of verification, it is assumed that this is probably due to a small tilt of the transducer assembly from the vertical. Only a 1.3 degree tilt would be necessary to induce the observed difference and this is certainly within the limits of the installation uncertainty. Both components of all ADCP derived speeds were multiplied by a factor of 0.981 to correct this error. Figure 3.3-6 shows the misalignment and tilt corrected version of the uncorrected data shown in Figure 3.3-5. Recall that this comparison is valid only for the time period specified above.

Conventional wisdom among frequent users of ADCP instruments is that for only very short time scales (several seconds to half a minute) is contamination of the velocity signal by surface wave-induced ship motions significant. Since an individual ADCP pulse cycle is about one second and 60 such cycles were averaged into each recorded raw data record, the influence of a typical 7 to 15 second surface wave is minimal due to the fact that the ADCP sampling scheme both resolves the highest frequency waves and averages over several periods of the longest period waves. Thus, even without further averaging (to be discussed below) the effects of surface waves should be negligible.

Several differing concepts of the optimal method of removing ship speed from ADCP data using LORAN-C data exist within the scientific community. Each has undoubtedly been developed under the influence of the specific goals and type of data available to the particular investigator. The scheme used for the results given in SAIC (1986) involved fitting a third-order polynomial to the LORAN-C latitudes and longitudes for a particular time window for which the ship's speed and heading were thought to be relatively constant. This polynomial was then differentiated to yield east and north components of ship velocity at a time corresponding to an ADCP profile. While this scheme generally gives reasonable results, it does have some drawbacks. First, the fitting of a polynomial of fixed degree to data in a time window which varies in length depending on the amount of time between ship maneuvers results in a non-uniform smoothing of the LORAN-C data from one ADCP profile to the next. Thus, the statistical reliability of the results could vary within a particular cross-section and make interpretation of that section difficult. In implementing this scheme, an attempt was made to minimize this problem as much as possible without sacrificing spatial coverage. However, this was not always possible. Second, this scheme allowed for no averaging of adjacent ADCP profiles such that while any real deviations of the ship velocity from the fitted values were effectively averaged out, the corresponding deviations induced in the ADCP data were not. While these adverse effects are thought to have been generally small for the results presented in SAIC (1986), new methods of computing ship velocity from LORAN-C which are free of these difficulties were explored.

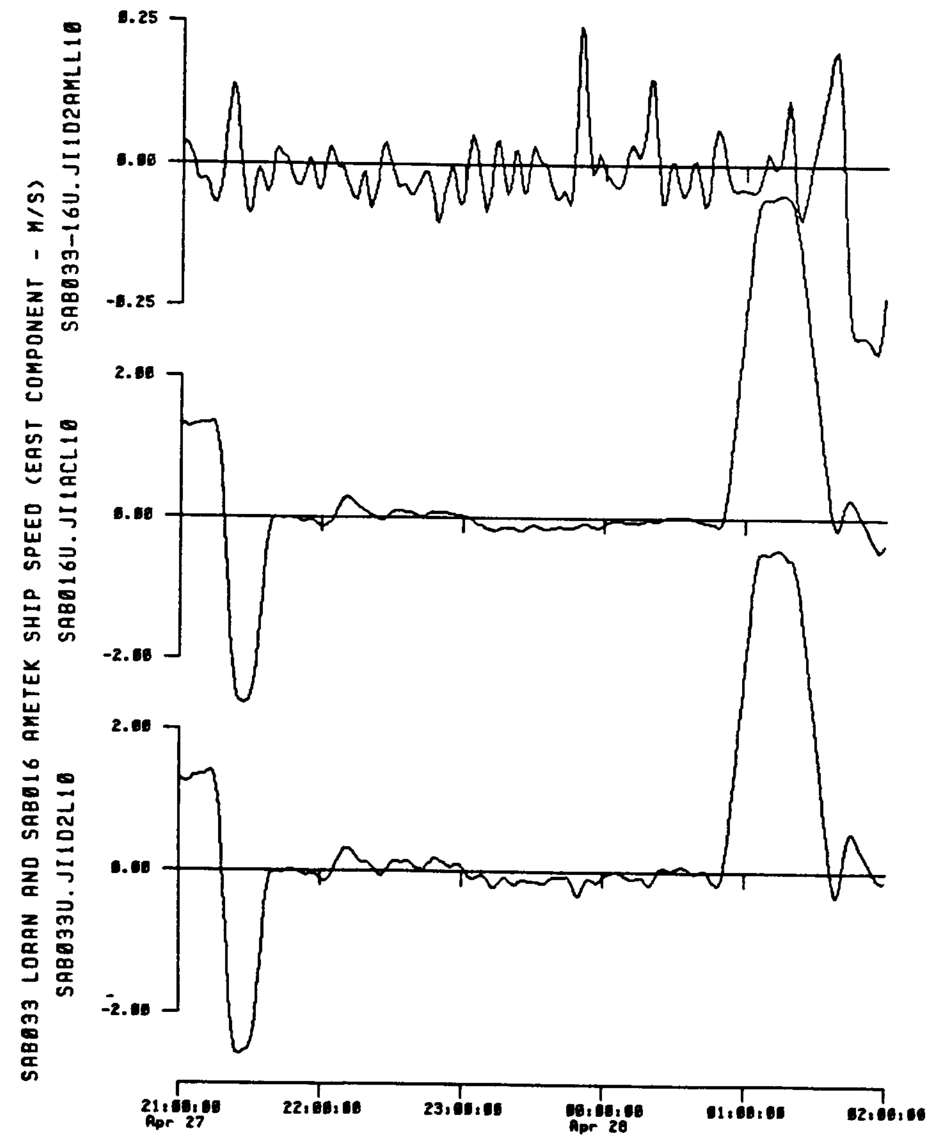

Figure 3.3-6. Time series of the east components of ship velocity based on LORAN data (lower panel) and ADCP bottom tracking data after transducer misalignment correction (middle panel). The difference between these two is shown in the upper panel. Note the differing velocity scales on the ordinates.

The most widely used LORAN-based ship velocity calculation method is probably the simplest. A noisy velocity is computed from adjacent pairs of LORAN-C data points (every 60 seconds in our case) and then averaged over a sufficiently long time period that the noise is reduced to an acceptable level. The acceptable level is usually taken to be the same order as the ADCP velocity error. Given a precision of 0.01 nautical miles for LORAN-C data, the resolution of a velocity calculation made over one minute is an unacceptably high 31 cm s-1. Theoretically this signal could be low pass filtered with a filter having a half power point in the neighborhood of 10 to 15 minutes and reduce the noise level to that of the ADCP system. In reality, such filtering is only practical for data sets having long time periods, while steaming at constant speed and heading. Sudden changes in speed and/or direction combined with the inevitable small time offsets between the LORAN-C and the ADCP data acquisitions result in large spikes in the difference between LORAN-C and ADCP ship speeds (and would therefore contaminate the water column velocities if LORAN-C data were used to remove ship speed). Such spikes are apparent at the beginning and end of the time series shown in Figures 3.3-5 and 3.3-6. Note that the time series shown in these figures have already been smoothed with a 10 minute low-pass filter. It is possible to average over much longer time periods and reduce even these large spikes but doing so would inevitably also remove much of the small scale frontal structure in which we are interested. Such long period averaging is often acceptable for large scale mid-ocean applications, but the spatial scales of interest in a study of Loop Current frontal features are sufficiently small that such a technique is not acceptable.

Although the statistics of such a filtering process are desirable and well known, it was abandoned for the majority of data analysis. Instead, a hybrid version of the two aforementioned schemes was used. The ADCP and LORAN-C data were interpolated to a common time base having a one minute time step, and the entire data set was subsampled for those portions of the cruise during which the (subjectively defined) criteria of steady speed and heading were met. Still, at this point in the analysis there existed the possibility of misalignment of the LORAN-C and ADCP time bases, since the two systems recorded their respective nominal times from independent clocks which themselves were subject to occasional fluctuations in the ship's power supply. It is strongly recommended that in future studies all computer systems log time data from a common clock to minimize the spiking described above. To reduce the possibility of contamination of the edited data set by time base misalignment problems, five additional minutes of data were eliminated from both ends of each retained data segment. For each data segment LORAN-C based ship speed was computed over a two minute time step with a value stored each minute.

The decision of whether to use the LORAN-C based ship speed or the ADCP bottom tracked ship speed was made based on the water depth and on the quality of the ADCP bottom tracking data as measured by the percent of detected acoustic returns in the bottom track bin. As discussed in SAIC (1986) and shown in Figure 3.3-7, for water depth (as measured independently with a precision depth recorder at each CTD station) greater than 300 meters the ADCP determined depth was often erroneous and in such cases the ADCP determined ship speed was considered unreliable. CTD station depth was interpolated in the same way as the LORAN-C and ADCP data. Where this interpolated depth was

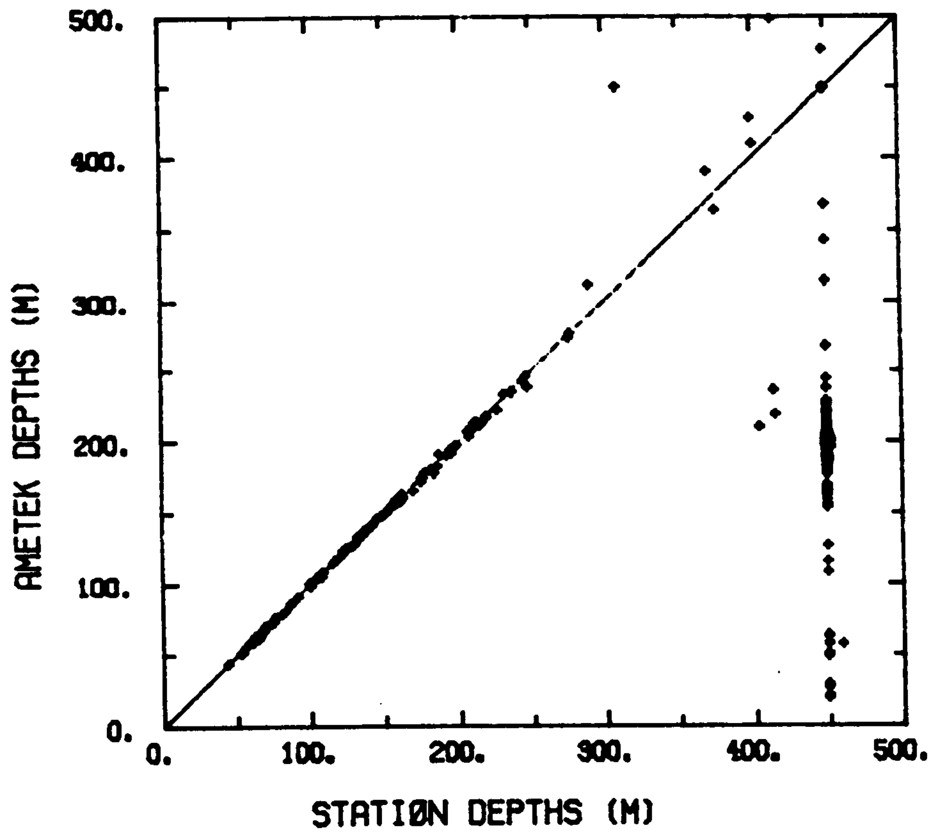

Figure 3.3-7. Comparison of PDR determined station depth and ADCP determined station depth. All depths greater than 500 meters were set equal to 450 meters. ADCP depth equals true depth for true (PDR) depth less than about 250 meters but the converse is not necessarily true.

less than 225 meters and the percentage of good ADCP bottom tracking returns was greater than 90, the ADCP ship velocity and bottom depth were used. Otherwise, the LORAN-C based ship velocity and the interpolated station depths were used. Once the best choice of ship velocity had been made, it was subtracted from the velocities in each of the 63 water column depth bins. The data quality of each bin was then examined and velocities in bins having less than 90% good acoustic detections were considered unreliable and set to a check value. In shallow water regions, bins deeper than a factor of 0.86 times the water depth were set equal to the check value. (This factor of 0.86 arises from the fact that occasionally a side lobe of the primary acoustic signal will travel directly to the acoustically strong reflecting bottom and return to the listening transducer at the same time as the desired signal reflecting along the primary acoustic beam. This contamination is not a problem for bins shallower than the cosine of the 30 degree inclination of the beam from vertical - thus the factor of 0.86.)

The profiles resulting from this analysis procedure were block averaged over 15-minute time intervals to reduce the signal to noise ratio as described above. While this analysis and averaging procedure yields results which are statistically uniform from profile to profile, the advantage of having a continuous time (and therefore distance along the cruise track) series has been eliminated. However, typically there is at least one final profile between each pair of CTD or XTB stations and comparisons with the hydrographic data are generally possible. In a few locations of particular interest fewer than the nominal 15 minutes were averaged to yield a final profile. Such cases are well documented internally.

3.3.3.3 ADCP Data Products

The fifteen minute averaged profiles have been displayed in a variety of ways including vertical cross-sections similar to those for the hydrographic data, plots of east and north components of velocity versus depth and horizontal maps of the velocity vectors along a cruise track. Examples of these are shown in Figures 3.3-8, 9 and 10, respectively. Note that the horizontal maps are based on the data resulting from the polynomial fitted LORAN-C data technique for removing ship speed. While statistical confidence may vary from point to point in these maps, the general conclusions which may be drawn from them remain unchanged. Analogous maps were not generated from the most recent analysis of the data since the vertical cross-section display technique has proven more useful.

3.4 Subsurface Currents

3.4.1 Introduction

The basic methodology used to analyze the Year 4 data and the complementary data (NSF, MMS, ESE) is identical to that described in Sections 3 and 4 of the Years 1 and 2 Final Report with the exception of the introduction of the method of complex demodulation which is discussed below. Recurrence and duration calculations were also made of the three year data records in this report and are discussed and presented in Appendix A.

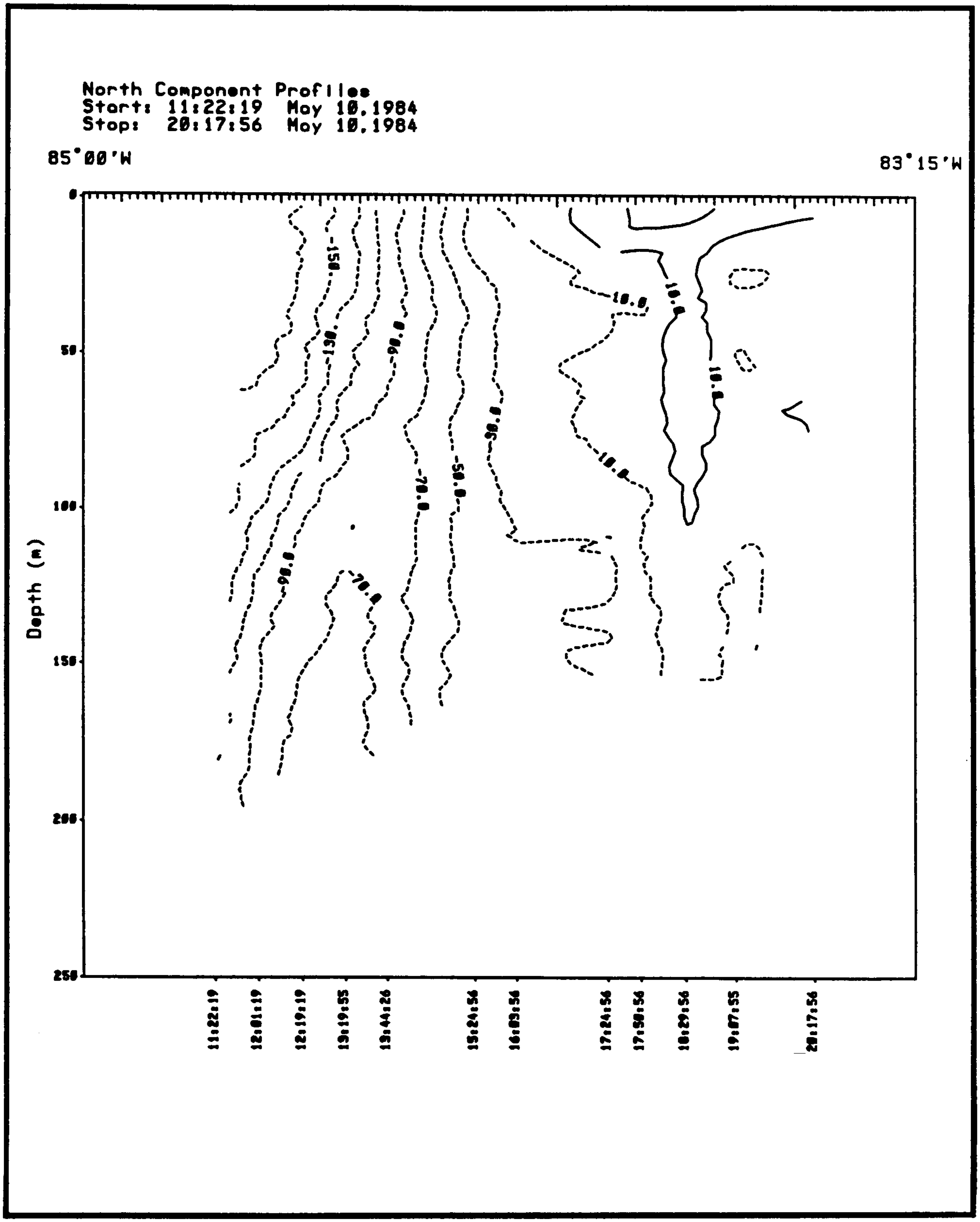

Figure 3.3-8. Vertical cross-section of the north component of horizontal ADCP velocity for Section IX of Cruise CF8405. Note that dashed (solid) lines indicate southward (northward) flow. The times and positions of the 15 minute averaged profiles which make up the section are shown at the bottom.

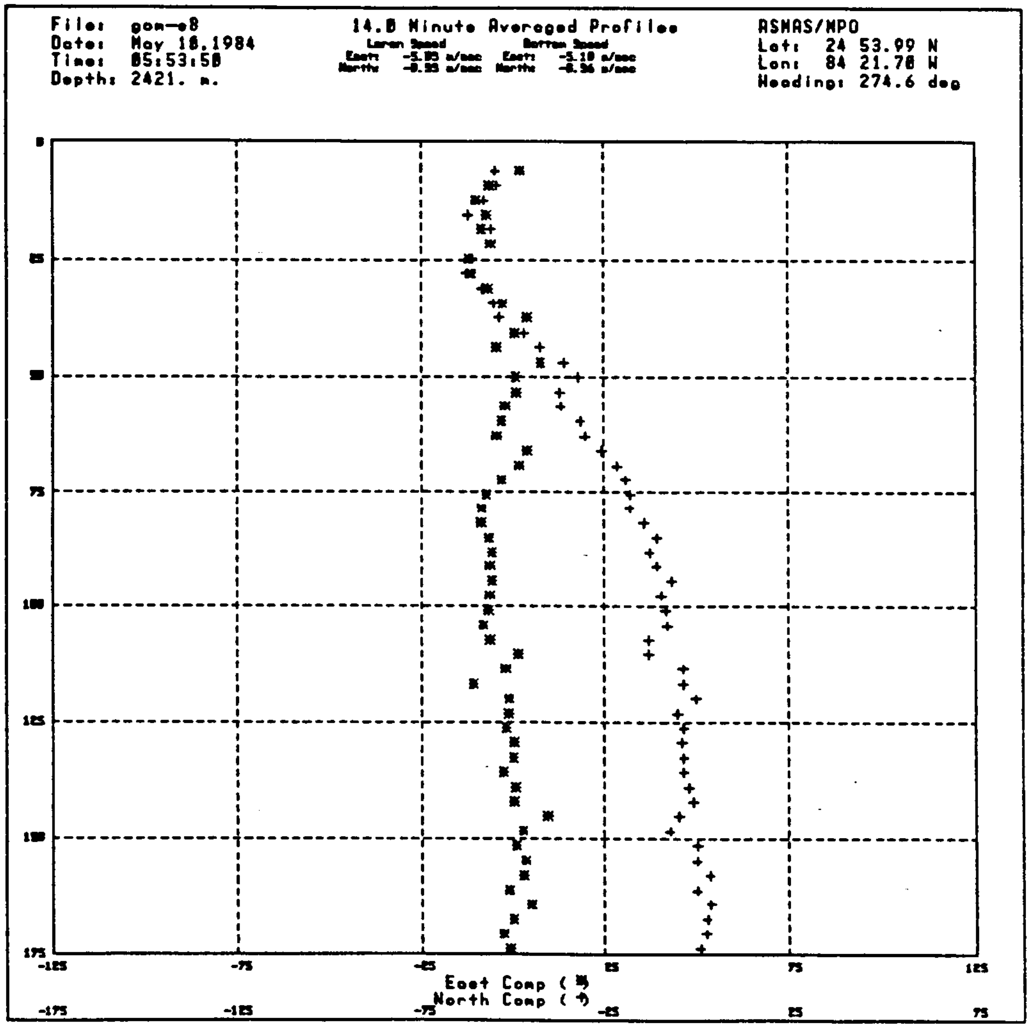

Figure 3.3-9. Vertical profile of the east and north components of velocity for a particular averaged ADCP profile from Cruise CF8405. Note the differing velocity scales for the respective components shown at the bottom of the figure.

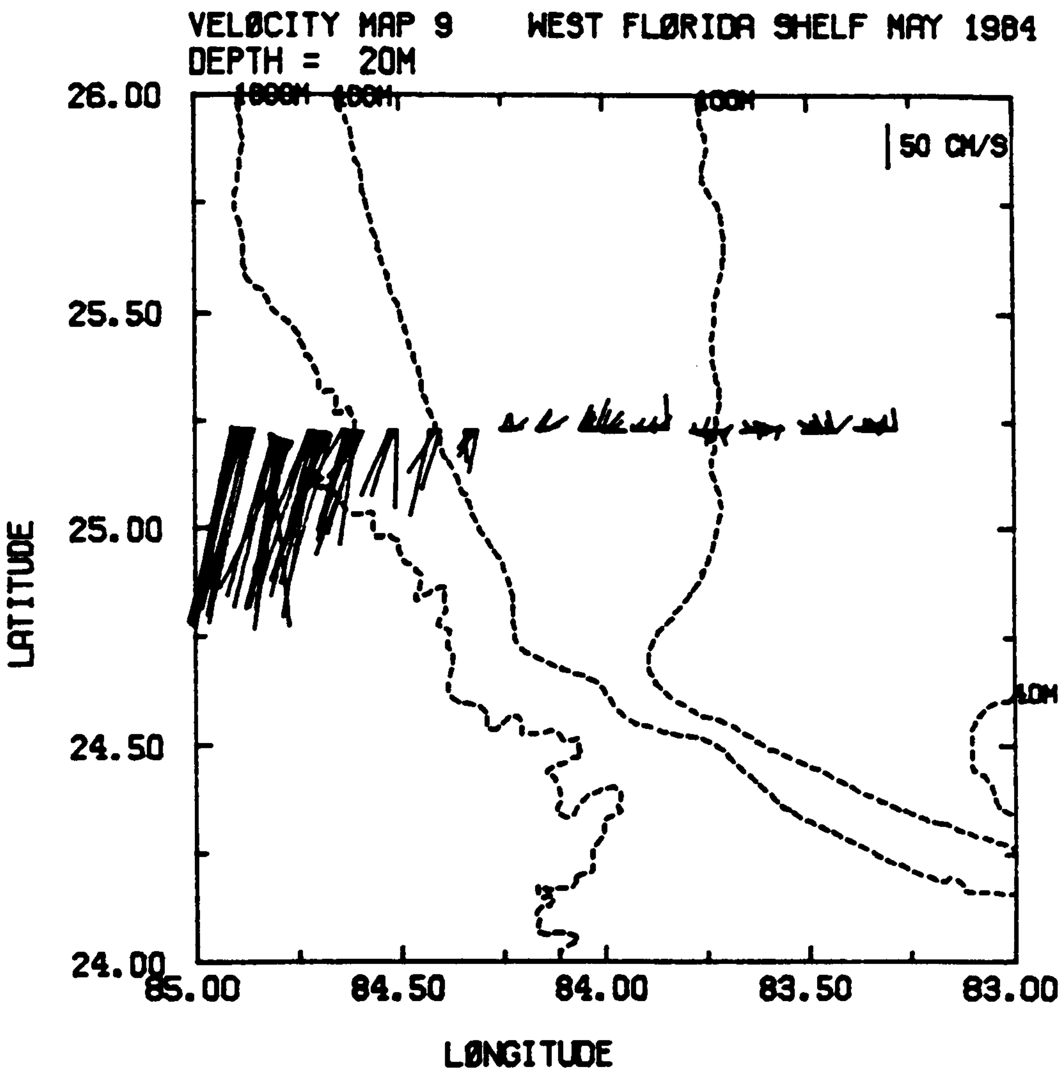

Figure 3.3-10. Stick plots of ADCP velocity at 20 m depth for Section XV obtained just after the arrival of a frontal eddy.

3.4.2 Complex Demodulation

Near inertial internal waves are characterized in current meter records as a clockwise rotating velocity vector. Thus, for a single inertial oscillation, the tip of the velocity vector prescribes a roughly circular path over an inertial period, which is about twenty seven hours at 26°N. Inertial currents are also intermittent since they are forced by time and space variable winds acting on the sea surface. Therefore, they are stochastic in nature and not phase locked as are tidal currents. Because of the highly variable nature of inertial currents, conventional spectral analysis is not very useful in characterizing the changes in the amplitude of the current oscillations over time. An analysis method which provides useful information on the time variability of the strength of the inertial currents is complex demodulation. This method, in effect, least square fits the current velocity records to a unit vector rotating clockwise at the inertial frequency, f. If a velocity vector is decomposed into components using complex notation (i.e., $\underline{V}(t) = u + iv$) then the amplitude and phase of currents rotating at frequency $\overline{f}$ can be calculated as a function of time from the real and imaginary parts of:

$$\int_{-T/2}^{T/2} (u + iv)\, e^{-ift}\, dt$$

where the integration period, T, is the inertial period. In our study, this simple formula is modified by using a low pass filter to isolate the inertial currents and provides some smoothing for the amplitudes and phases. This technique is discussed more thoroughly in Kundu (1976). Thus, given a velocity record consisting of a constant speed rotating clockwise at exactly frequency f, complex demodulation will result in a constant amplitude equal to the speed and constant phase angle over the time span of the record.

IV. SYNTHESIS AND INTERPRETATION

4.1 Introduction

Chapter 4 contains a discussion of the various data sets identified in Chapters 1 and 2. The objective in this chapter is to identify and describe key processes. In keeping with the approach identified in this report, this discussion can "stand alone" but is supplemental to the material presented in the previous year's final report. The reader is strongly urged to read that material to have a more comprehensive description and understanding of conditions on the West Florida Shelf and in the Loop Current.

4.2 Loop Current Dynamics and Kinematics from a Lagrangian Perspective

4.2.1 Introduction

During June 1985, an attempt was made to deploy an ARGOS drifter into a ring that was pinching off from the Loop Current in the Gulf of Mexico (GOM). However, the ring had not totally disconnected from the Loop Current, and the drifter became entrained in the Loop Current proper for approximately three months before exiting the GOM through the Florida Straits in September 1985 (Figure 4.2-1, Drifter 3354). A second drifter (Drifter 3378, Figure 4.2-1) was deployed in the desired ring in July 1985. Together, these two Lagrangian data sets provide a unique look at the motion of the deeper waters of the central and eastern GOM. This is especially true in terms of Loop Current kinematics as the Current extends northward, as well as the kinematics of the final product of such extensions, a Loop Current ring.

Here we present an overview of the movement of the two drifters using insights provided by available sea-surface temperature (SST) data and XBT data. These have allowed identification of a possible new process by which anticyclonic vortices are formed that can eventually become Loop Current rings. The generating mechanism appears to be the lateral shearing stresses caused by the Loop Current off the northwest coast of Cuba.

A detailed description of the rotational characteristics of the Loop Current and a ring is provided by a kinematic analysis of the drifter paths. This analysis gives the time histories of the rotation rate, eccentricity and orientation of the ellipses of the trajectories, swirl velocities, and movement of the centers of rotation. A comparison is made of the kinematics of the Loop Current (designated by Drifter 3354) during the time it coexisted with a ring (designated by Drifter 3378). In addition, the kinematics during the later part of Drifter 3354 were compared with those of the first month of Ring 3378 to contrast the motion characteristics of a GOM ring before and after it breaks off from the Loop Current.

4.2.2 Position Data

The data used in this study are the position data of the drifters with ARGOS identification numbers 3354 and 3378. The GOM ring that was seeded by Drifter 3378 will be referred to as Ring 3378. References to Drifter 3354 will

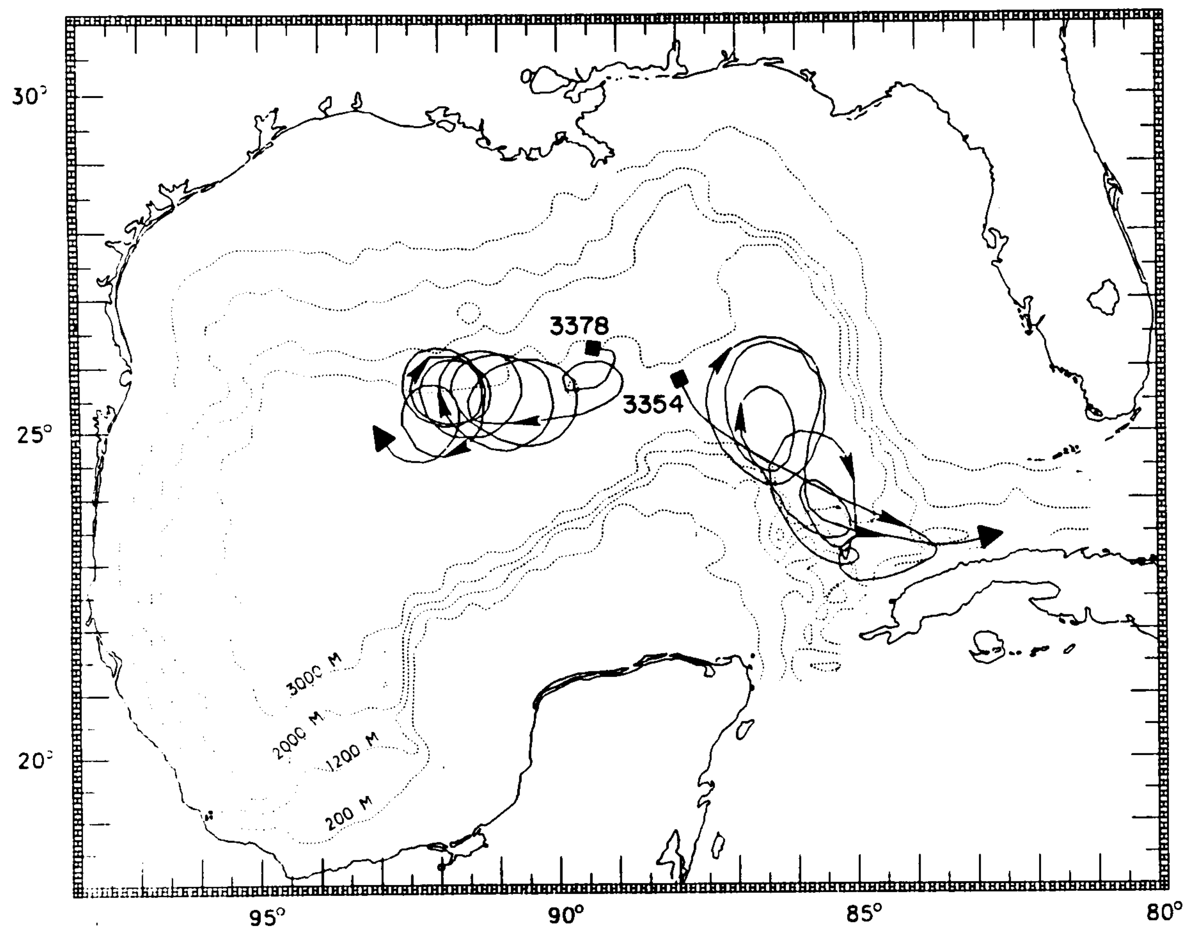

Figure 4.2-1. Trajectories of Drifter 3354 from mid-June through mid-September 1985 and of Drifter 3378 from mid-July through September 1985. Squares denote the beginning positions and triangles denote the end positions.

indicate a reference to the Loop Current proper. Drifter 3378 was drogued by a weighted 200-m line, while Drifter 3354 was drogued by a window shade drogue at 100 m. These drogues should both provide a mean drogue depth of approximately 100 m.

Drifter 3354 was seeded at 25.9°N, 87.9°W on 18 June 1985. The drifter immediately moved southeastward approximately 525 kilometers and reached 23.2°N, 83.7°W by 29 June 1985. At this point, the drifter became entrained in a westward, anticyclonic flow field with a center of rotation at about 24°N, 85.5°W. After two major rotations (into mid-August), this field of flow moved northwestward and made three additional rotations centered at about 25.5°N, 86.5°W. The drifter left this flow pattern in mid-September 1985 and eventually left the GOM through the Florida Straits.

Drifter 3378 was seeded in Ring 3378 at 26.4°N, 89.3°W on 18 July 1985. By that time, the ring had totally separated from the Loop Current. As shown in Figure 4.2-1, Ring 3378 slowly moved westward, reaching approximately the 91°W meridian by mid-August. Recall that after mid-August the Loop Current (as determined by Drifter 3354) moved northwestward and remained there until at least mid-September. During that same 30-day period, Ring 3378 continued moving westward, reaching to the 92.5°W meridian.

4.2.3 Temperature Data

XBT transects were collected in the eastern GOM during May-September 1985 (Table 4.2-1). These data provide indications of the location and structure of the Loop Current and Ring 3378. In addition, weekly SST contour charts are available for the entire Gulf. Some of these SST data are presented here, but unfortunately little in the way of structure can be discerned since the SST gradients are small in the GOM during the study period (summer and early fall).

Cruise tracks for the period 26-31 May 1985 are shown in Figure 4.2-2. The resulting XBT data are shown in Figures 4.2-3 through 4.2-5. These data were collected while Ring 3378 was still connected to the Loop Current. The edges of the Current and direction of flow as indicated by the XBT data are shown on the cruise tracks in Figure 4.2-2. (Gentler isotherm slopes were taken as an indication that the transects were crossing the Loop Current edge at an angle less than 90 degrees. Such crossings are drawn at a 45 degree angle to the track.) In general, it appears that the Loop Current was flowing northward on the east side of the Yucatan Straits, swirled westward and around what would be Ring 3378, turned eastward but then looped northward somewhat before exiting the GOM.

As previously mentioned, Drifter 3354 was deployed in the northward extension of the Loop Current during mid-June 1985. The trajectory of 3354 during 18-24 June 1985 is plotted on the corresponding GOM SST chart in Figure 4.2-6. As indicated by the trajectory (and to some degree by the SST data), Ring 3378 had obviously not quite separated from the Loop Current at this time. The return flow from the area of the northward extension appears to be mostly southeastward, toward the northern coast of Cuba.

Three XBT data sets were collected during 26 June through 2 July 1985 (Figure 4.2-7). The temperature profiles are shown in Figures 4.2-8 through 4.2-10. The outline of Ring 3378 is quite distinct in Figures 4.2-8 and 4.2-9, while

Table 4.2-1. A listing of cruises during which XBT data were collected in the central and eastern Gulf of Mexico.

Available XBT Data	
Vessel	Date (1985)
E. M. QUEENY	5/07 - 5/08
M/V NESTOR I	5/10 - 5/11
M/V STENA HISPANIA	5/17 - 5/18
E. M. QUEENY	5/26 - 5/27
M/V STENA HISPANIA	5/27 - 5/28
M/V STENA HISPANIA	5/30 - 5/31
E. M. QUEENY	6/07 - 6/08
E. M. QUEENY	6/13 - 6/14
M/V STENA HISPANIA	6/26 - 6/28
M/V STENA HISPANIA	6/29 - 6/30
E. M. QUEENY	7/01 - 7/02
R/V SUNCOASTER	7/09 - 7/22
M/V NAT CO 6	7/16 - 7/19
M/V STENA HISPANIA	7/16 - 7/17
E. M. QUEENY	7/31 - 8/01
M/V STENA HISPANIA	8/16 - 8/18
M/V AMBASSADOR	9/04 - 9/05
M/V AMBASSADOR	9/13 - 9/14
M/V AMBASSADOR	9/24 - 9/25

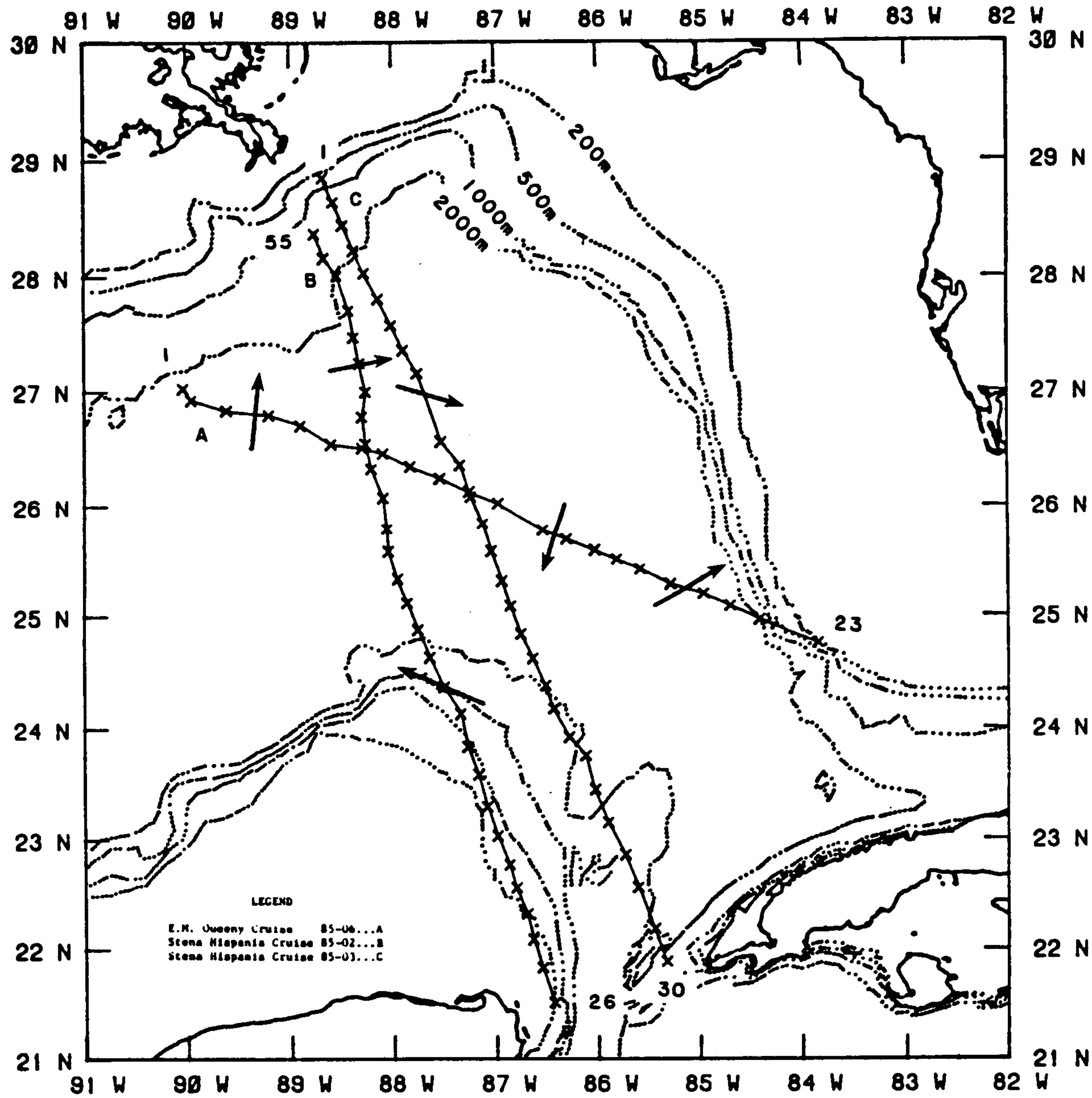

Figure 4.2-2. Cruise tracks for XBT data collected during 26-31 May 1985. The arrows denote the flow at the edges of the Loop Current based on the vertical temperature structure.

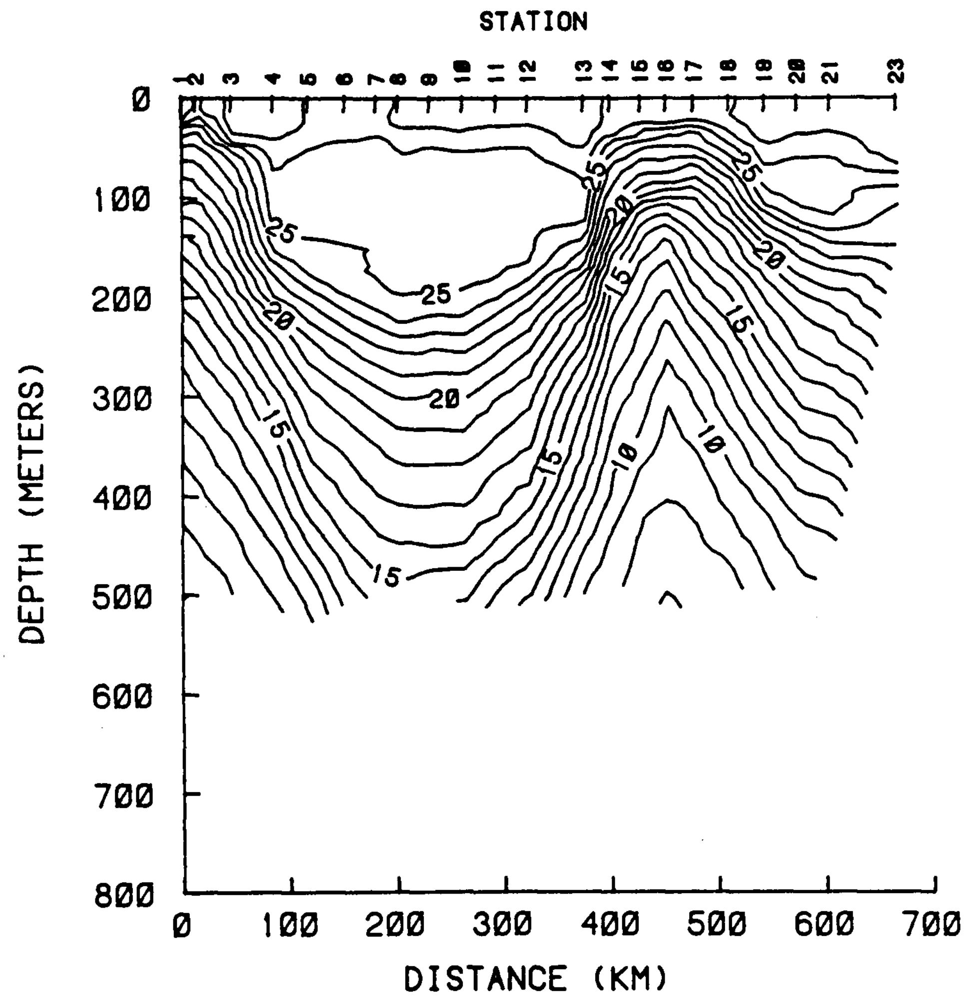

Figure 4.2-3. Vertical cross-section of temperature from the E. M. QUEENY cruise, 26-27 May 1985.

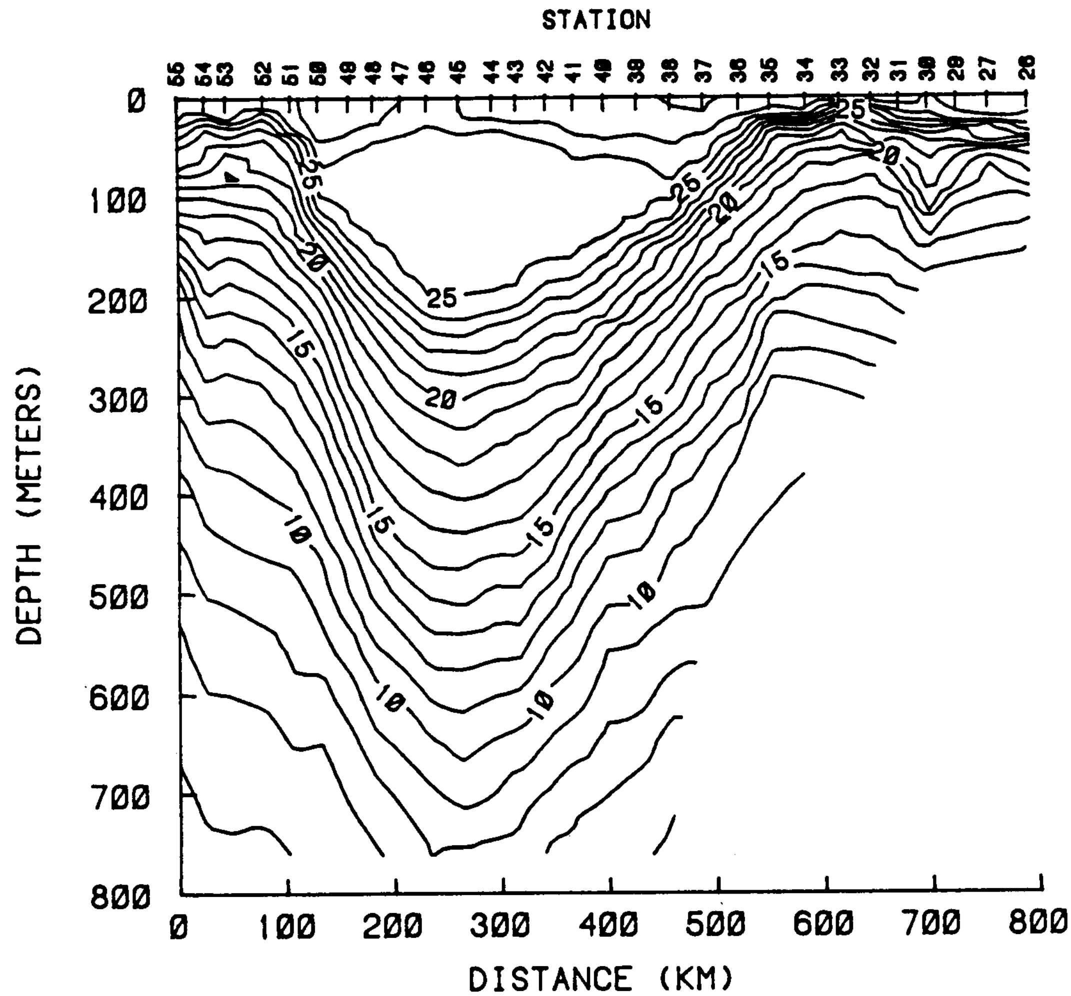

Figure 4.2-4. Vertical cross-section of temperature from the STENA HISPANIA cruise, 27-28 May 1985.

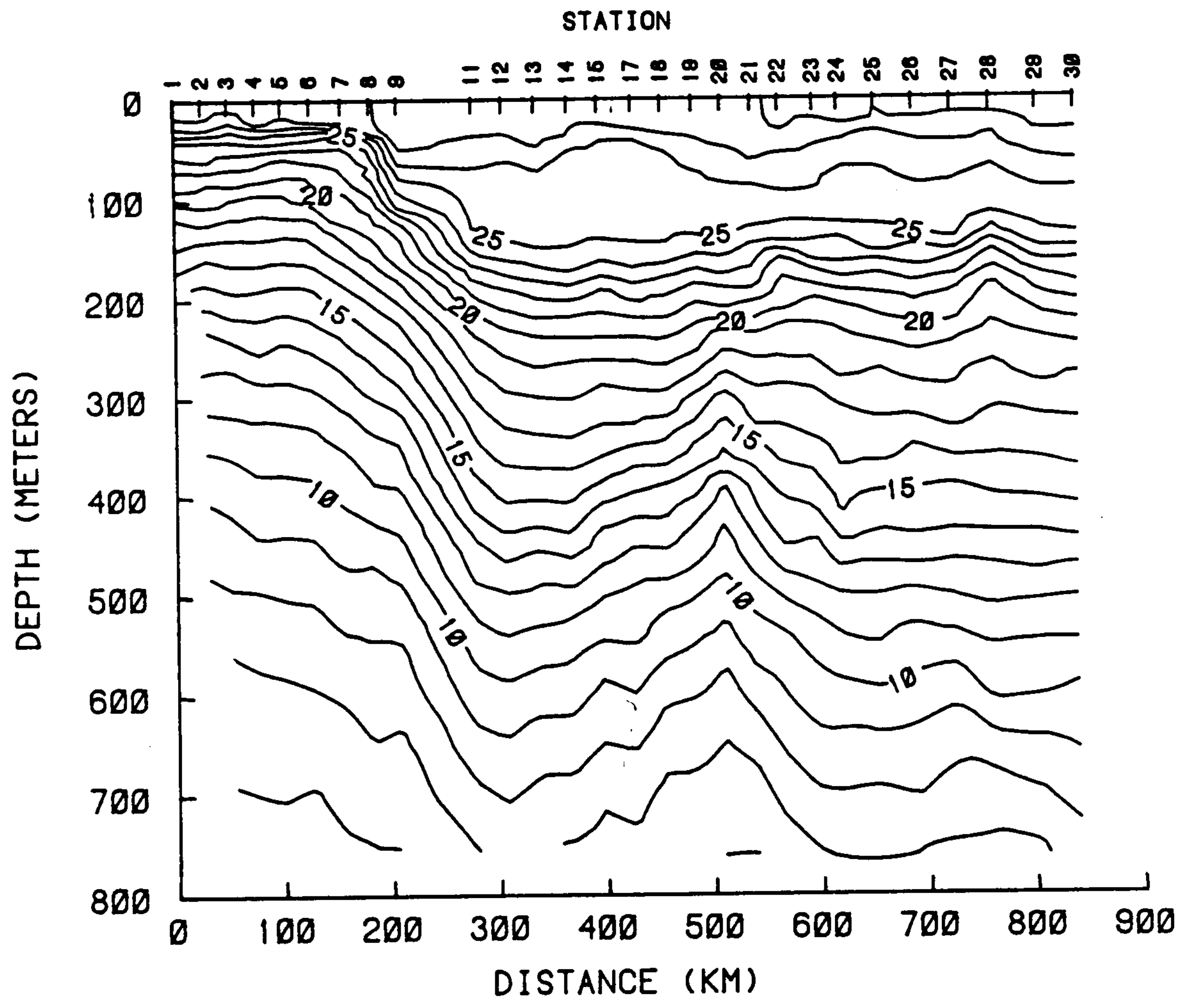

Figure 4.2-5. Vertical cross-section of temperature from the STENA HISPANIA cruise, 30-31 May 1985.

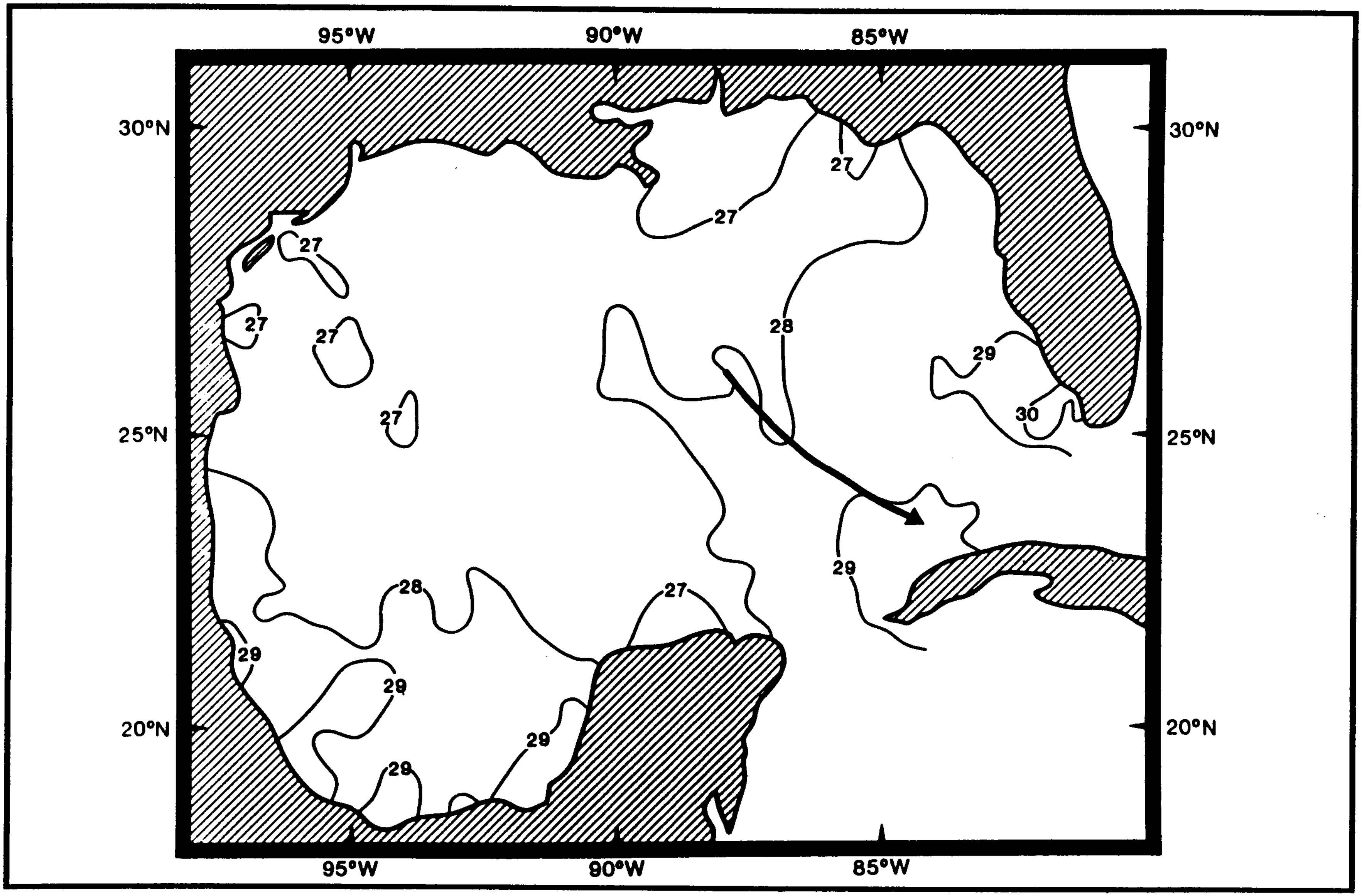

Figure 4.2-6. Trajectory of Drifter 3354 and SST data for 18-24 June 1985.

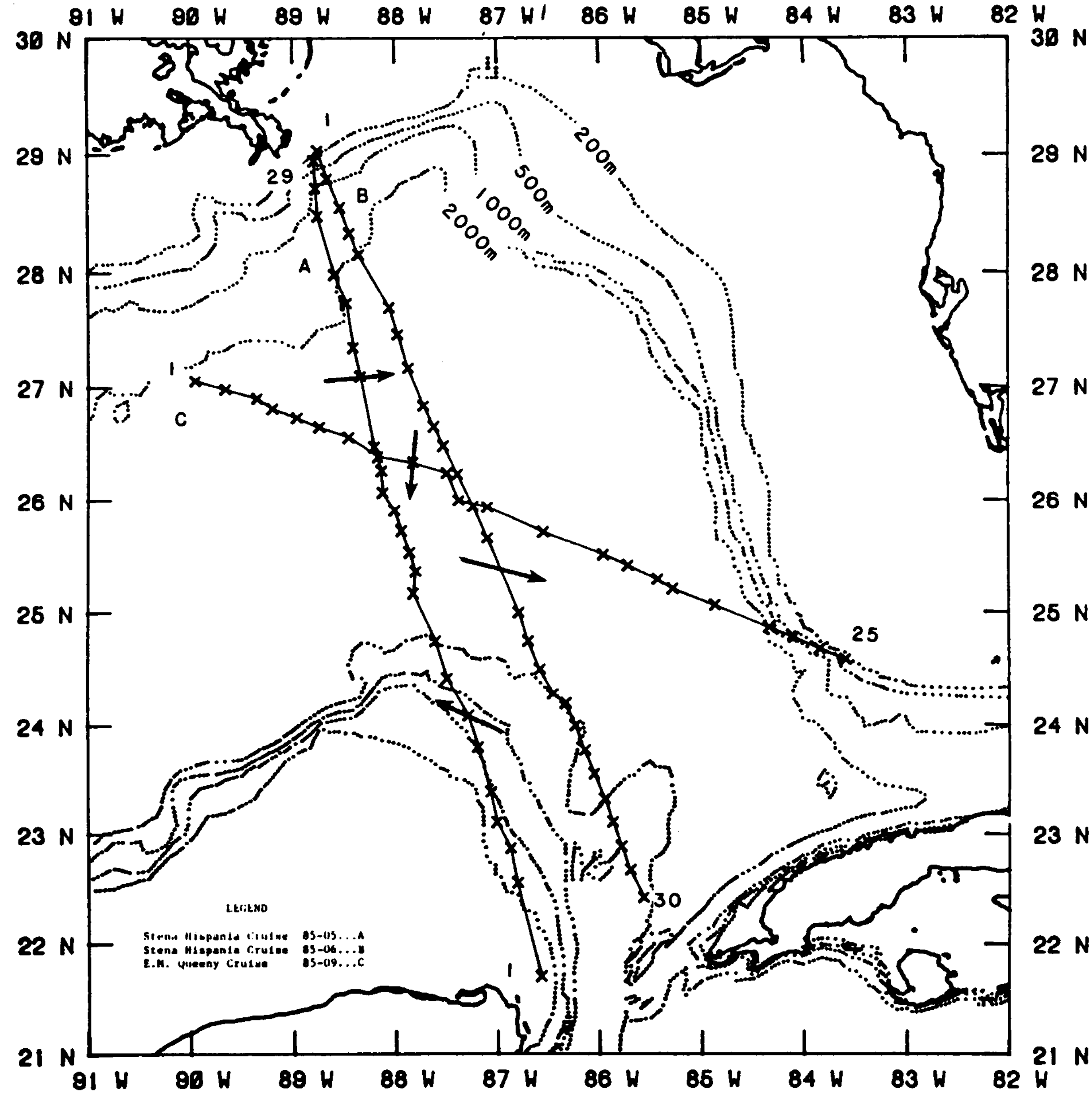

Figure 4.2-7. Cruise tracks for XBT data collected during 26 June - 2 July 1985. The arrows denote the flow at the edges of the Loop Current based on the vertical temperature structure.

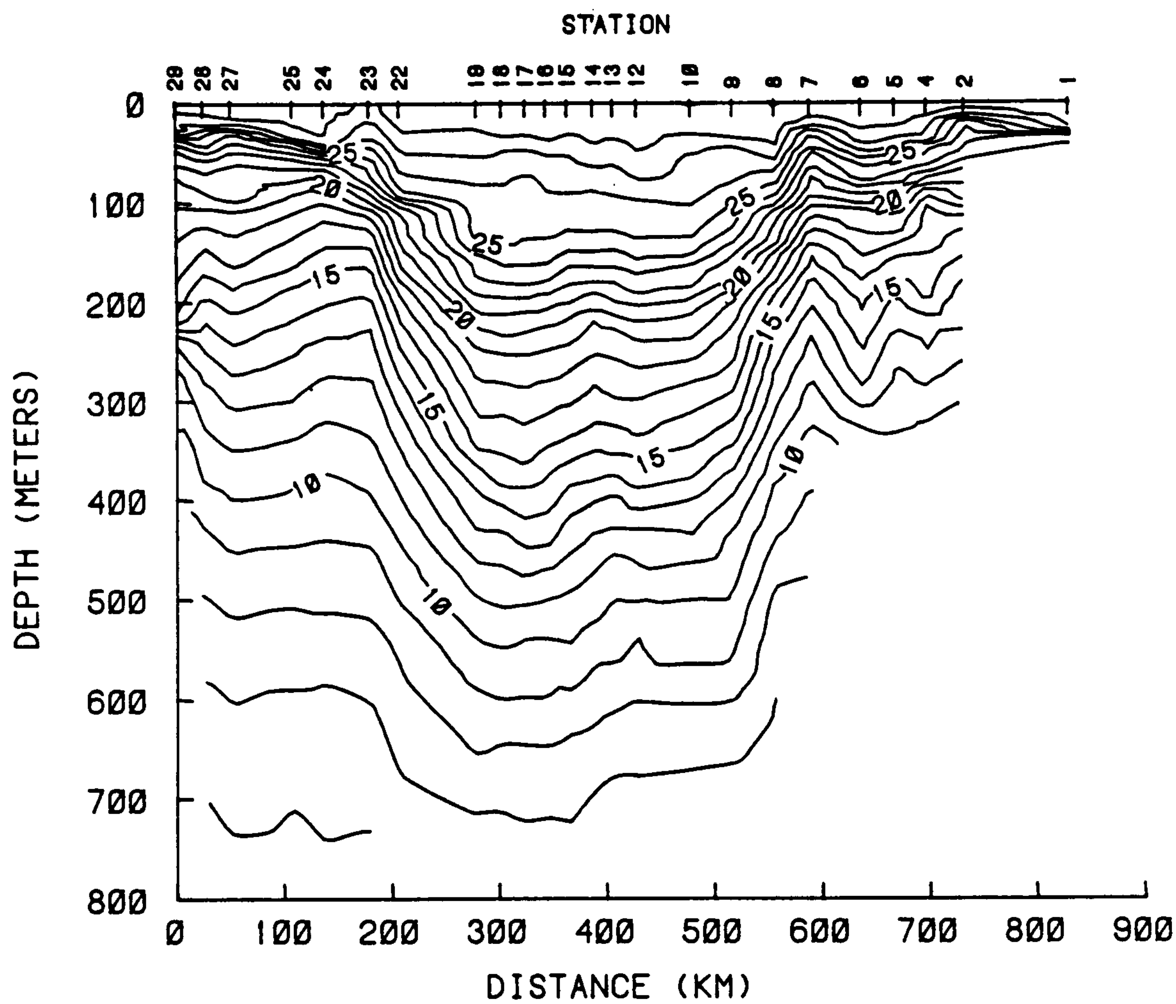

Figure 4.2-8. Vertical cross-section of temperature from the STENA HISPANIA cruise, 26-28 June 1985.

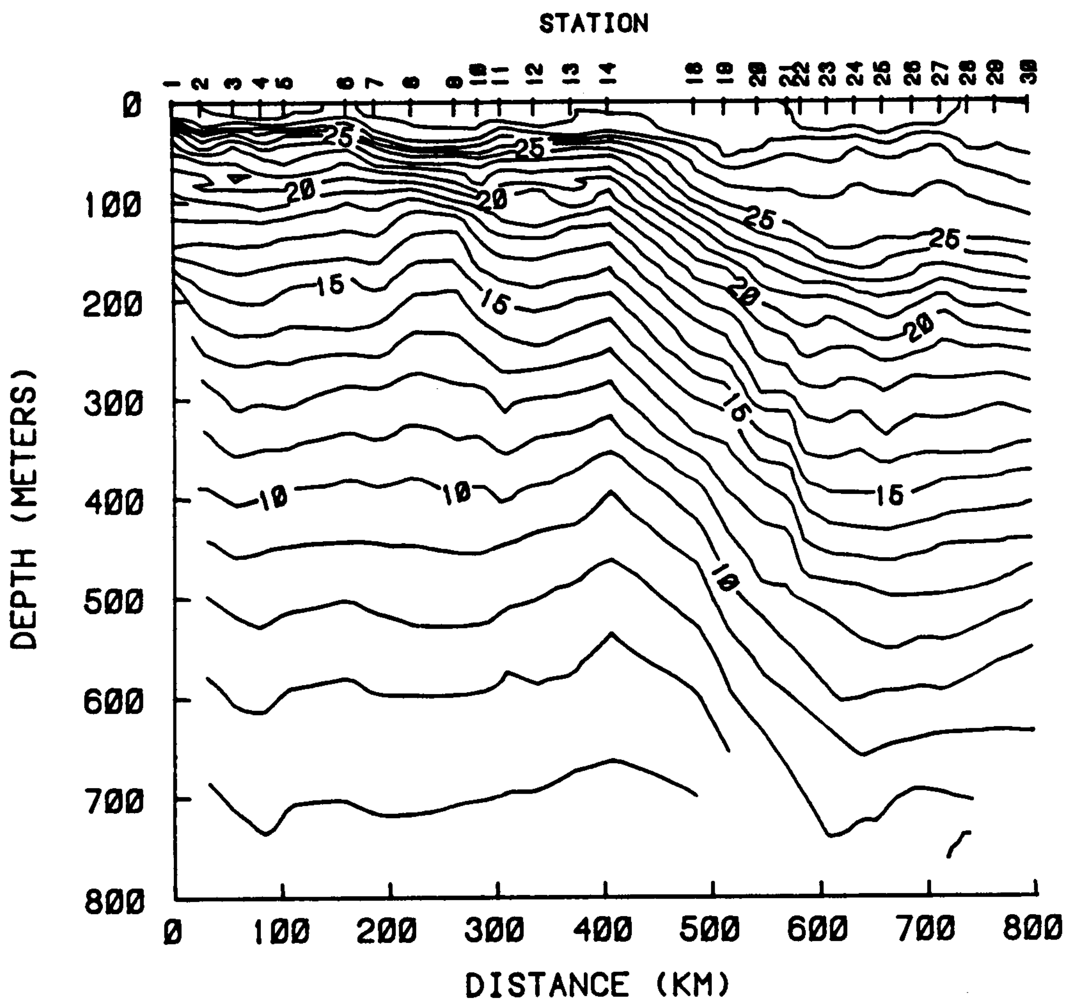

Figure 4.2-9. Vertical cross-section of temperature from the STENA HISPANIA cruise, 29-30 June 1985.

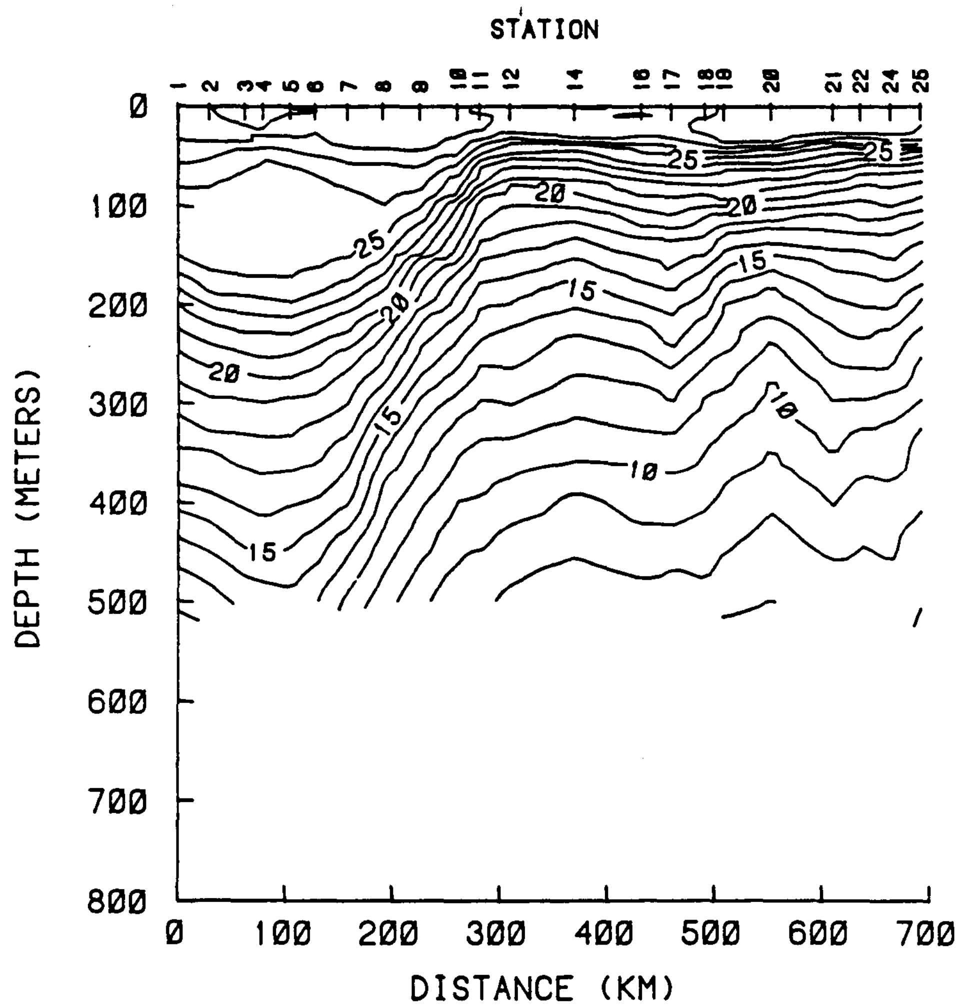

Figure 4.2-10. Vertical cross-section of temperature from the E. M. QUEENY cruise, 1-2 July 1985.

the Loop Current can be seen to extend to 25°N in Figure 4.2-10. These data seem to imply that Ring 3378 is still connected to the Loop Current. The SST data for 29 June through 5 July 1985 along with the associated trajectory of Drifter 3354 are shown in Figure 4.2-11. The outlines of the ring and the Loop Current from the XBT data in Figure 4.2-7 are also shown, and we see the beginning of the rotational characteristics within the Loop Current from Drifter 3354. These rotational characteristics near the Cuban coast continue into mid-July.

During 16-19 July 1985, two XBT data sets were collected (Figure 4.2-12) which distinctly show that Ring 3378 had separated from the Loop Current (Figures 4.2-13 through 4.2-15). The SST contours for the same period are shown in Figure 4.2-16. There is no surface signature of Ring 3378, although its rotation is well outlined by the trajectory of Drifter 3378 (see Figure 4.2-16). As for the Loop Current, Figure 4.2-16 shows that the rotational feature within the Current had reached the northern edge of the Loop Current, about 25°N.

Both the Loop Current and Ring 3378 continued to rotate through August 1985. An XBT data set collected on 16-18 August 1985 (Figure 4.2-17) indicates that the Loop Current had extended northward to 26.6°N (Figure 4.2-18). The SST map for 12-19 August 1985 (Figure 4.2-19) shows that Ring 3378 and the Loop Current were rotating at about the same latitude, 25.5°N. By mid-September, the sea surface had cooled sufficiently in the eastern GOM so that the Loop Current northern extension is readily defined (Figure 4.2-20). The trajectories for this period show Ring 3378 strongly rotating but Drifter 3354 leaving the rotational feature of the Loop Current along the eastern side of a 28°C tongue of water. The following week's SST chart (Figure 4.2-21) shows the 28°C tongue reaching up to 27.5°N while Drifter 3354 moved toward the Florida Straits along the northern coast of Cuba. Ring 3378 was still rotating with a center at about 25.5°N, 92°W.

4.2.4 Kinematic Analysis

4.2.4.1 Introduction

The trajectory data were used to calculate various kinematic parameters of the flow field. The methodology outlined by Kirwan et al. (1984) for geophysical fluids was used in these calculations. Although Kirwan et al. used a 100-hour low-pass filter in making their calculations for a ring in the western GOM, it was found in this study that such a filter was not sufficient to remove higher frequency, non-ring fluctuations. As a result, a 164-hour (half power point) low-pass filter was used on the velocity data of the drifters to remove non-ring influences. Following the work of Kirwan et al., the rotation rate, ellipticity and orientation, swirl velocity, and the motion of the center of rotation as seen by Drifter 3354 and then by Drifter 3378 were calculated.

4.2.4.2 Loop Current Kinematics

The observed Loop Current velocities (filtered) as seen by Drifter 3354 are shown in Figure 4.2-22. The maximum speed fluctuates in magnitude from 15 to 80 cm s-1 with minimums at the beginning of the record and during Julian days 210-225. During Julian days 220-230 Drifter 3354 moved northwestward, an

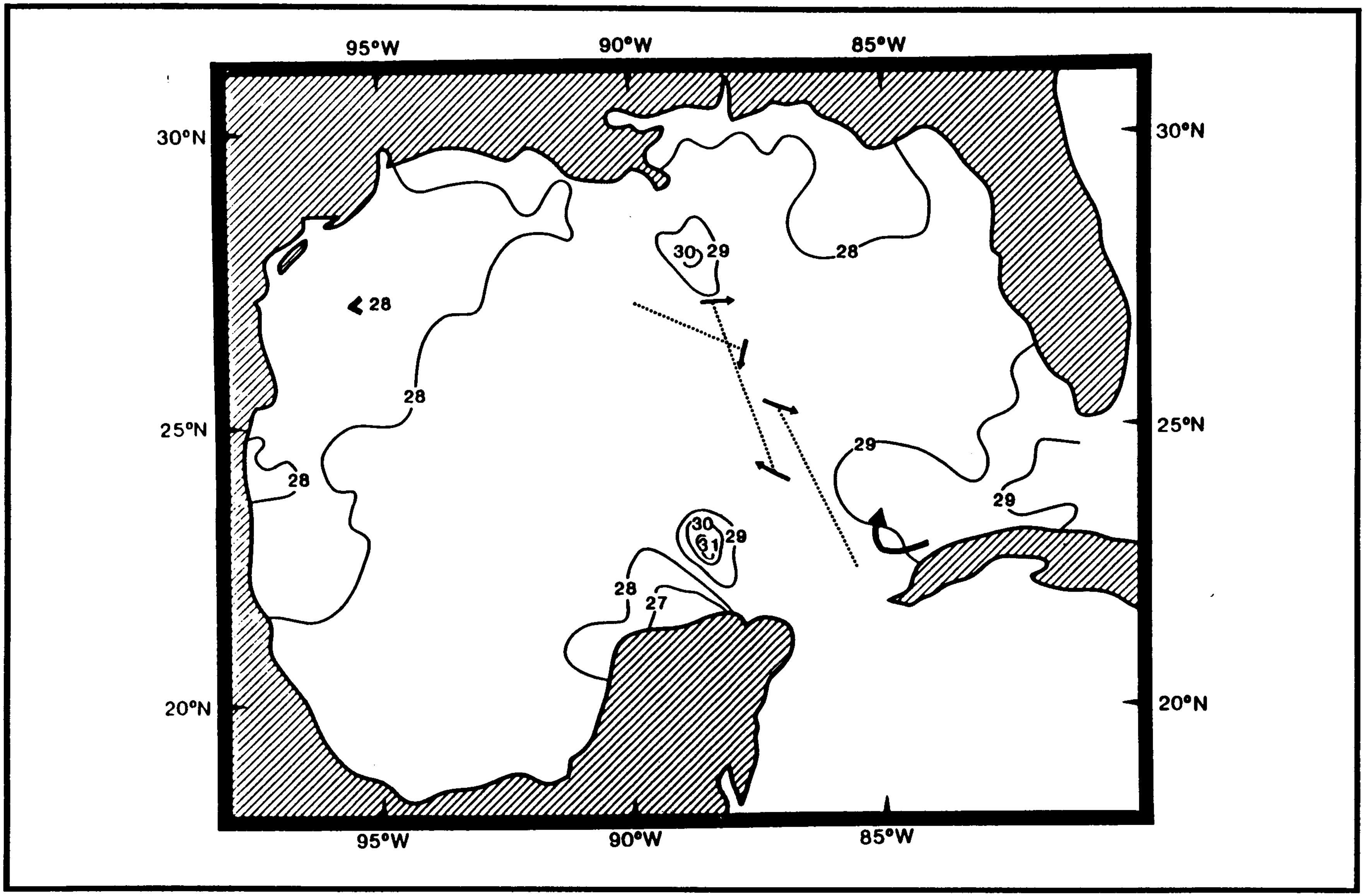

Figure 4.2-11. Trajectory of Drifter 3354 (large arrow) and SST data (in degrees C) for 29 June - 5 July 1985. Shorter arrows denote the flow at the edges of the Loop Current while dotted lines indicate the locations of Loop Current waters (based on XBT data).

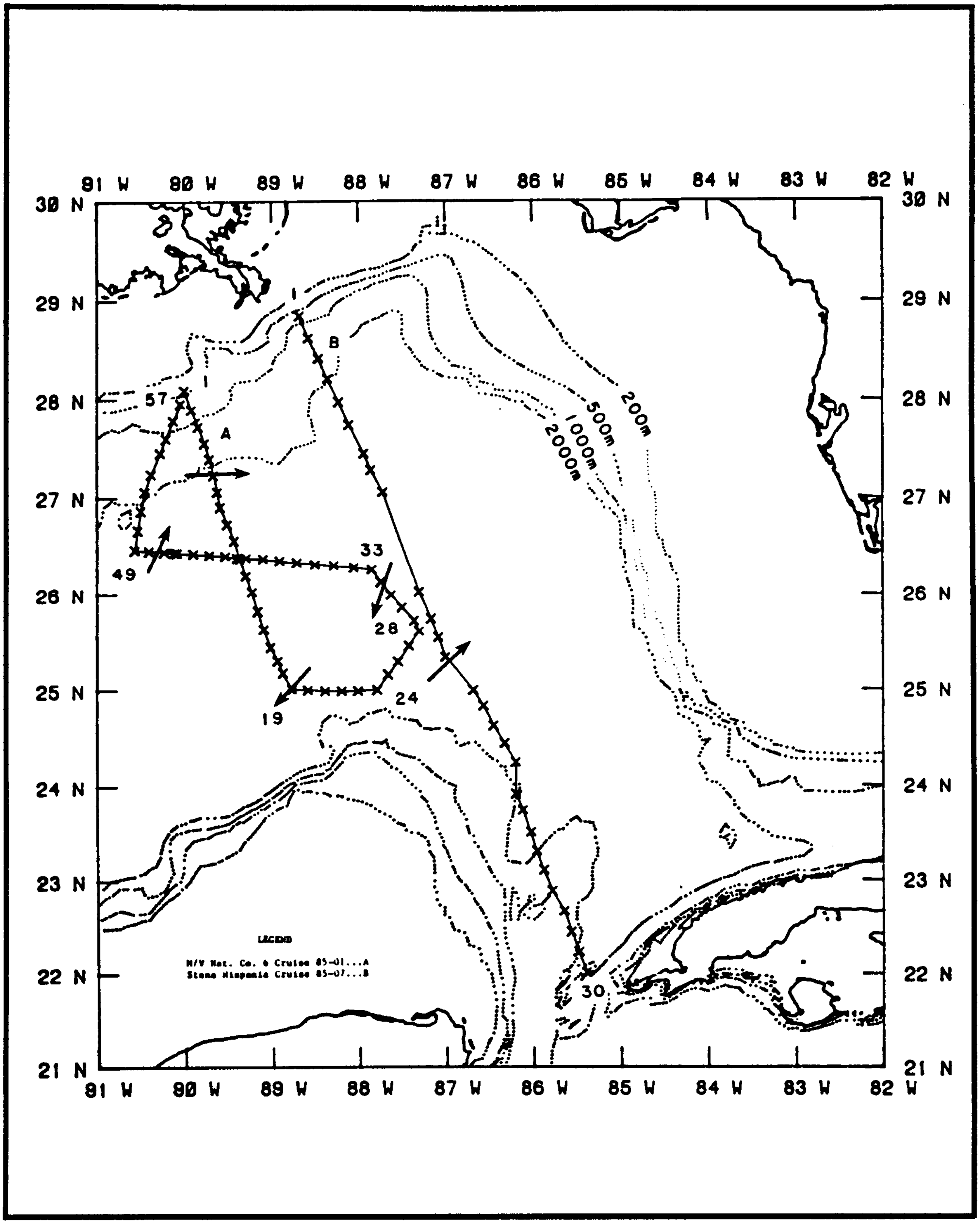

Figure 4.2-12. Cruise tracks for XBT data collected during 16-19 July 1985. The arrows denote the flow at the edges of the Loop Current and ring based on the vertical temperature structure.

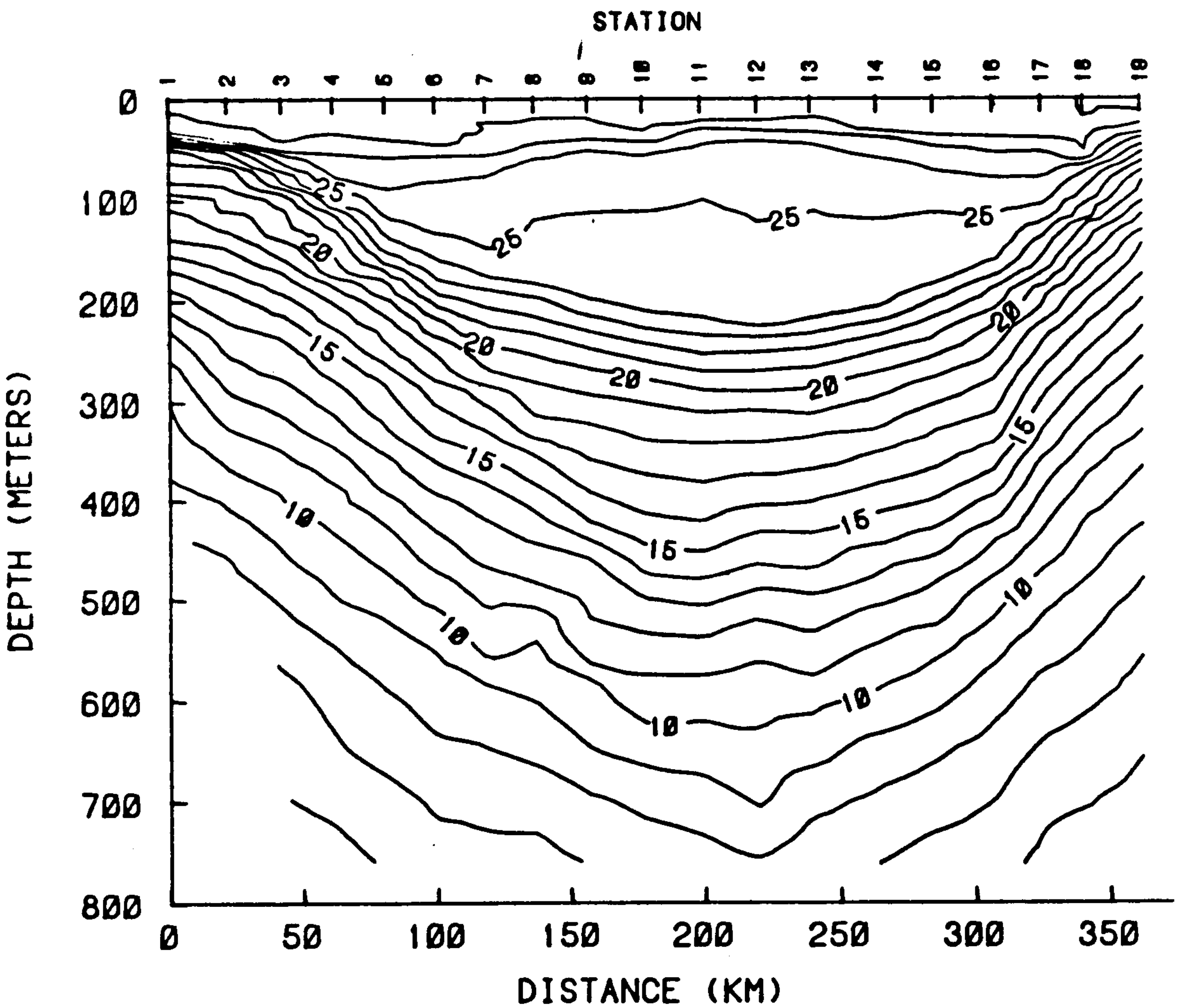

Figure 4.2-13. Vertical cross-section of temperature from the M/V NAT CO 6 cruise, 16-19 July 1985.

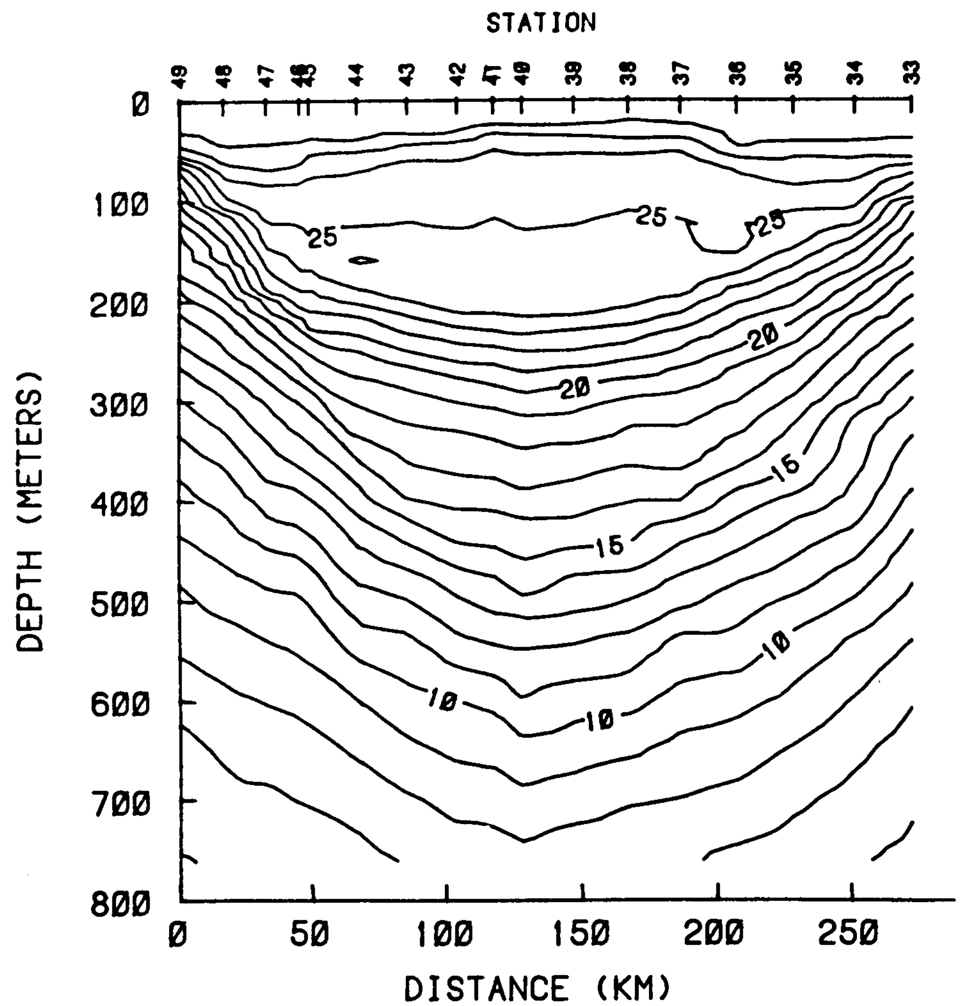

Figure 4.2-14. Vertical cross-section of temperature from the M/V NAT CO 6 cruise, 16-19 July 1985.

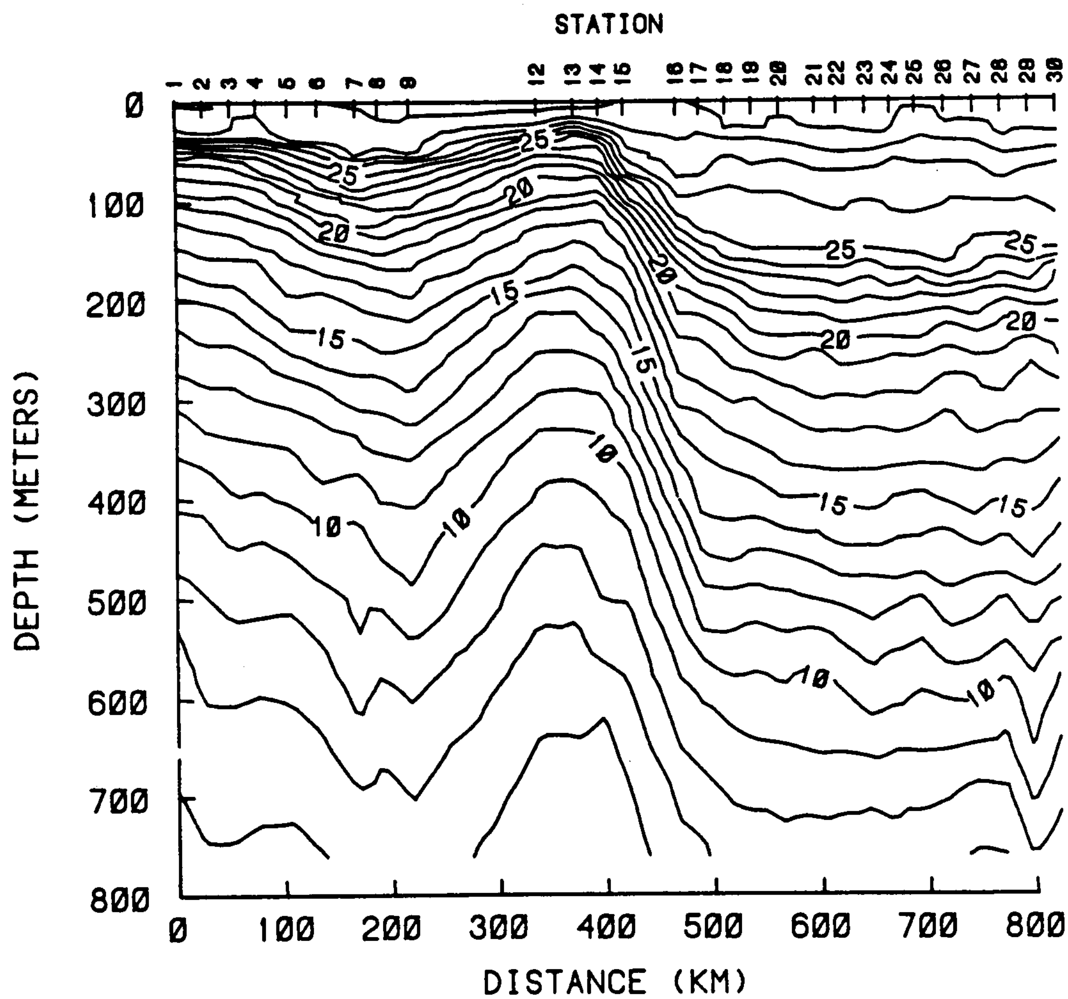

Figure 4.2-15. Vertical cross-section of temperature from the STENA HISPANIA cruise, 16-17 July 1985.

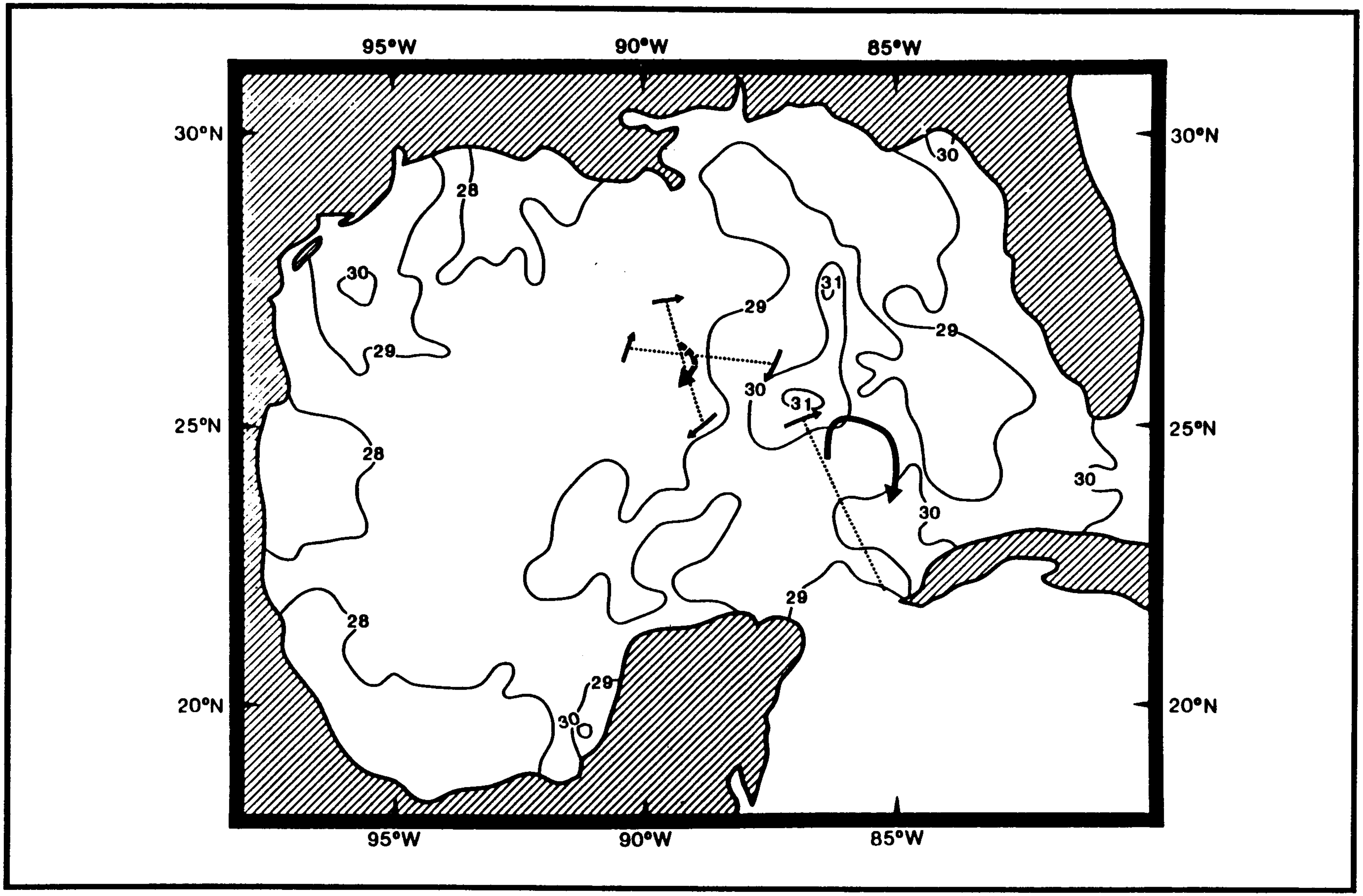

Figure 4.2-16. Trajectories of Drifter 3354 (solid large arrow) and 3378 (dashed large arrow) and SST data (in degrees C) for 16-23 July 1985. Shorter arrows denote the flow at the edges of the Loop Current while dotted lines indicate the locations of Loop Current waters (based on XBT data).

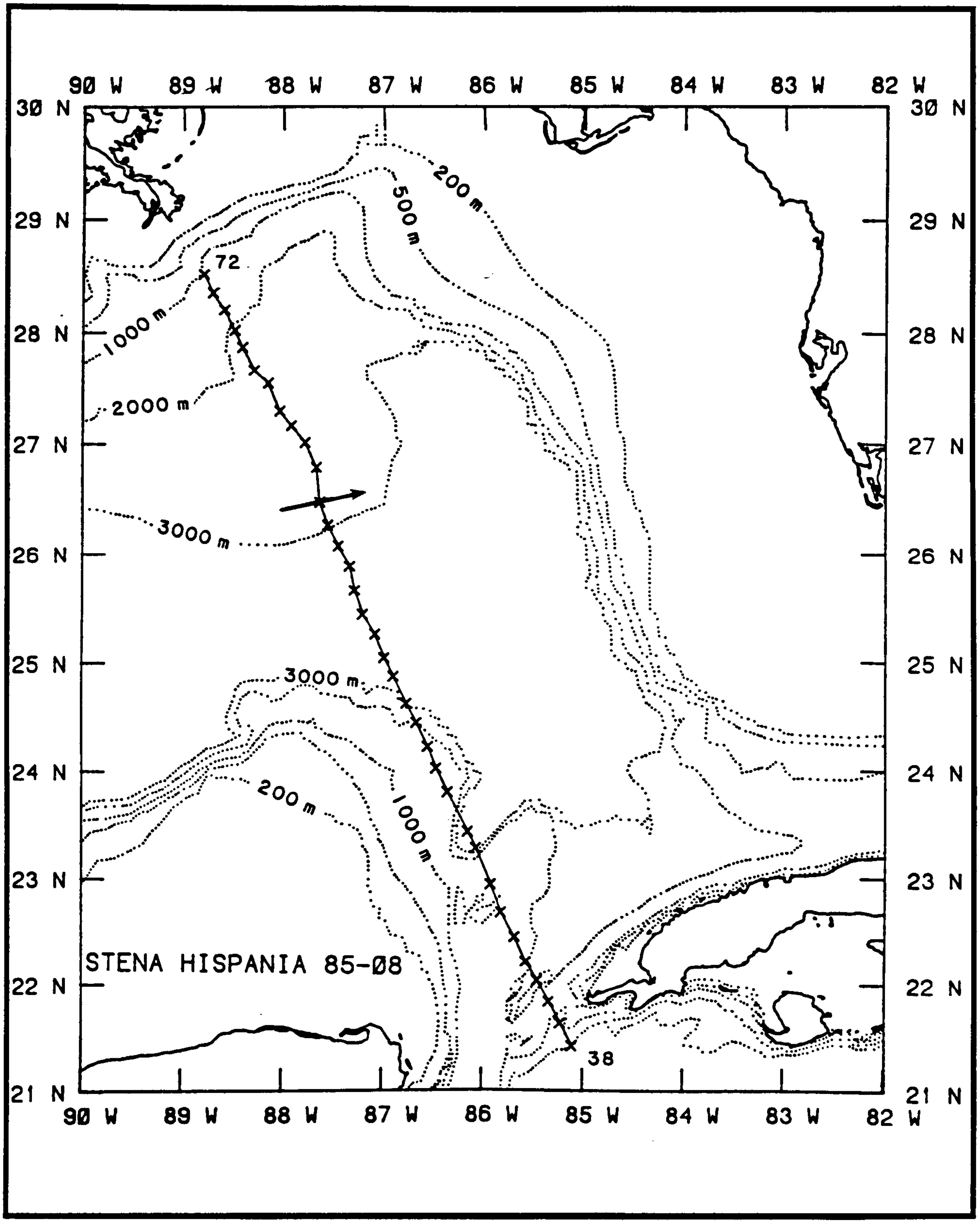

Figure 4.2-17. Cruise track for XBT data collected during 16-18 August 1985. The arrow denotes the flow at the edge of the Loop Current based on the vertical temperature structure.

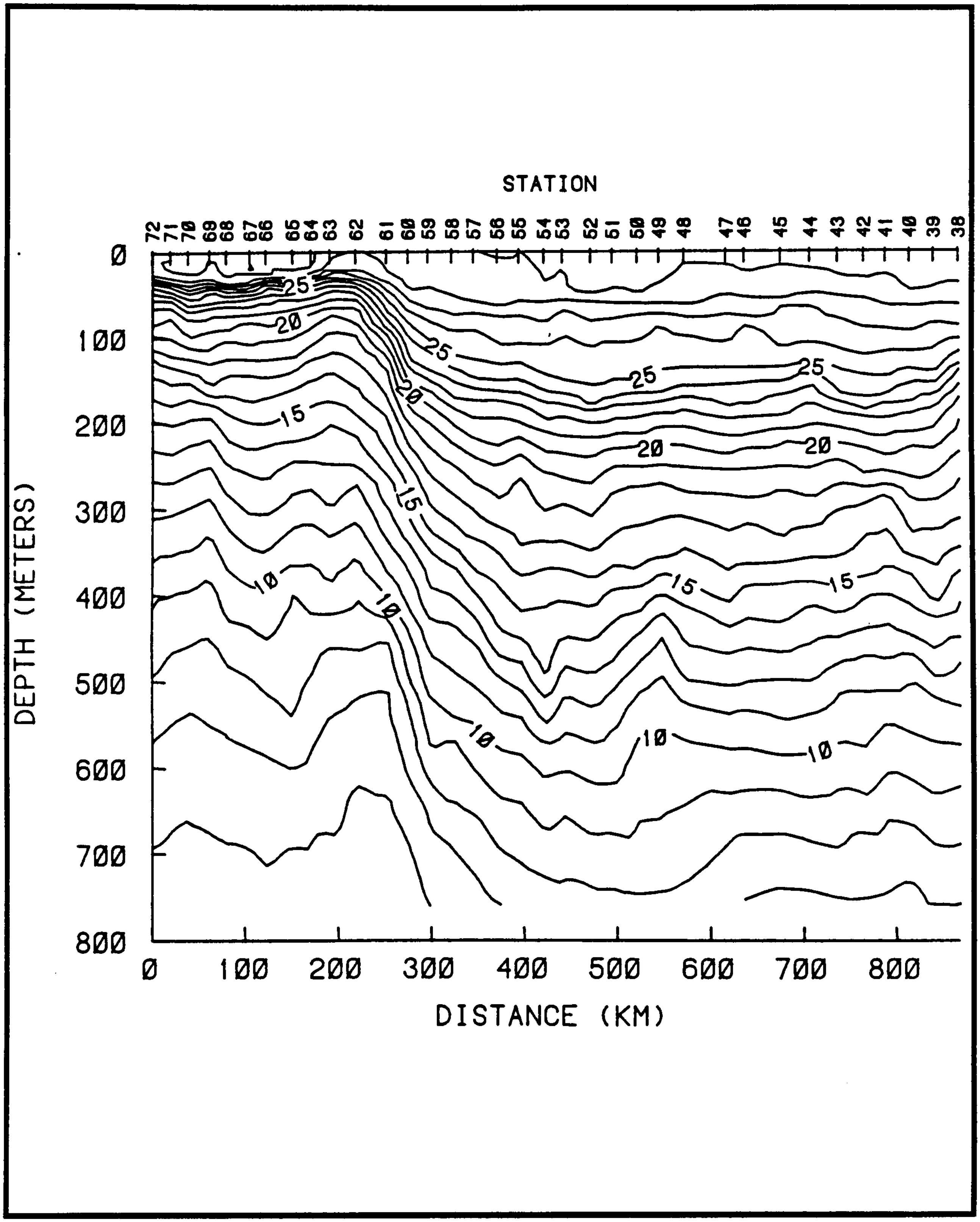

Figure 4.2-18. Vertical cross-section of temperature from the STENA HISPANIA cruise, 16-18 August 1985.

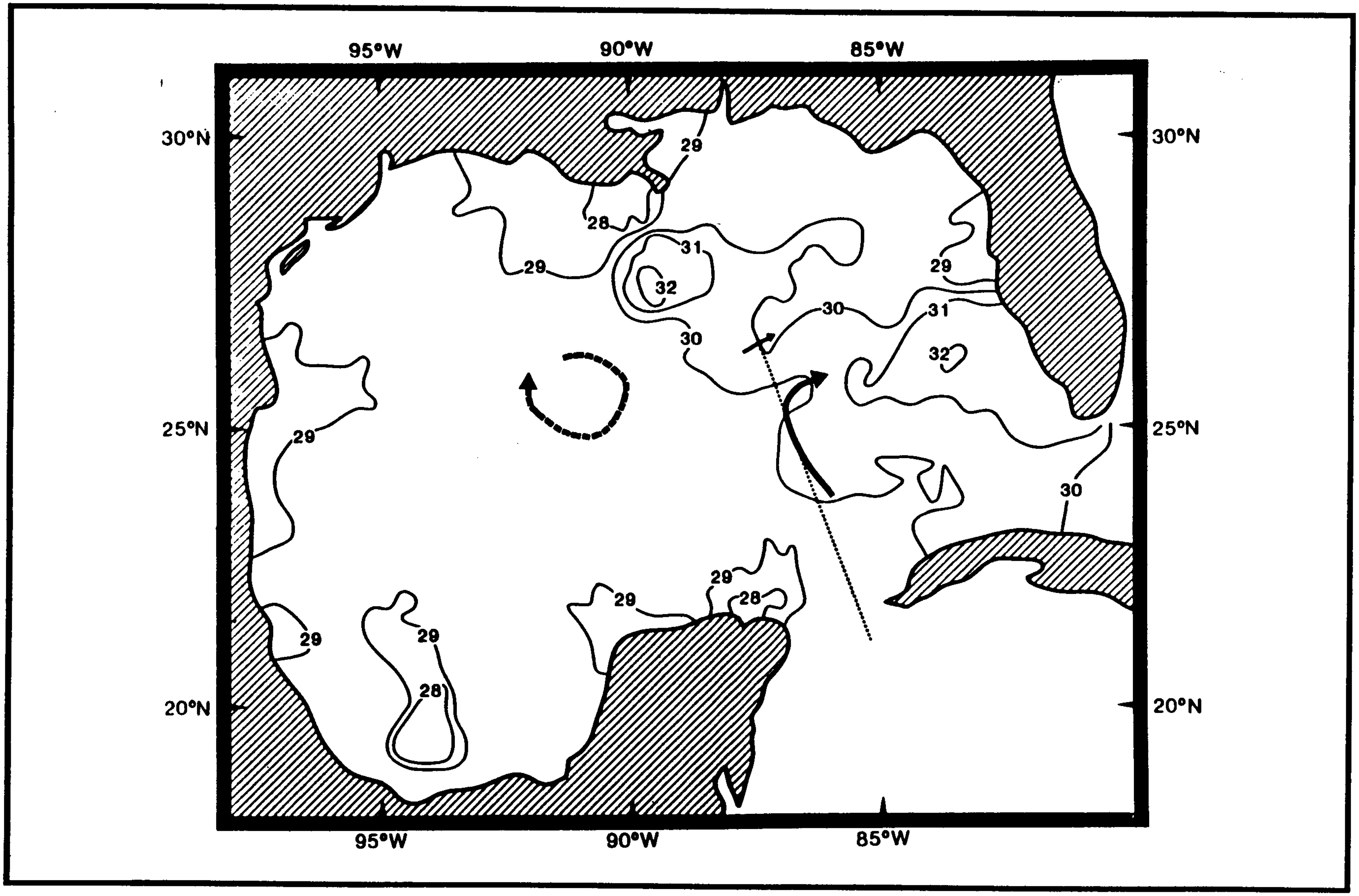

Figure 4.2-19. Trajectories of Drifters 3354 (solid large arrow) and 3378 (dashed large arrow) and SST data (in degrees C) for 12-19 August 1985. Shorter arrow denotes the flow at the edge of the Loop Current while dotted lines indicate the location of Loop Current waters (based on XBT data).

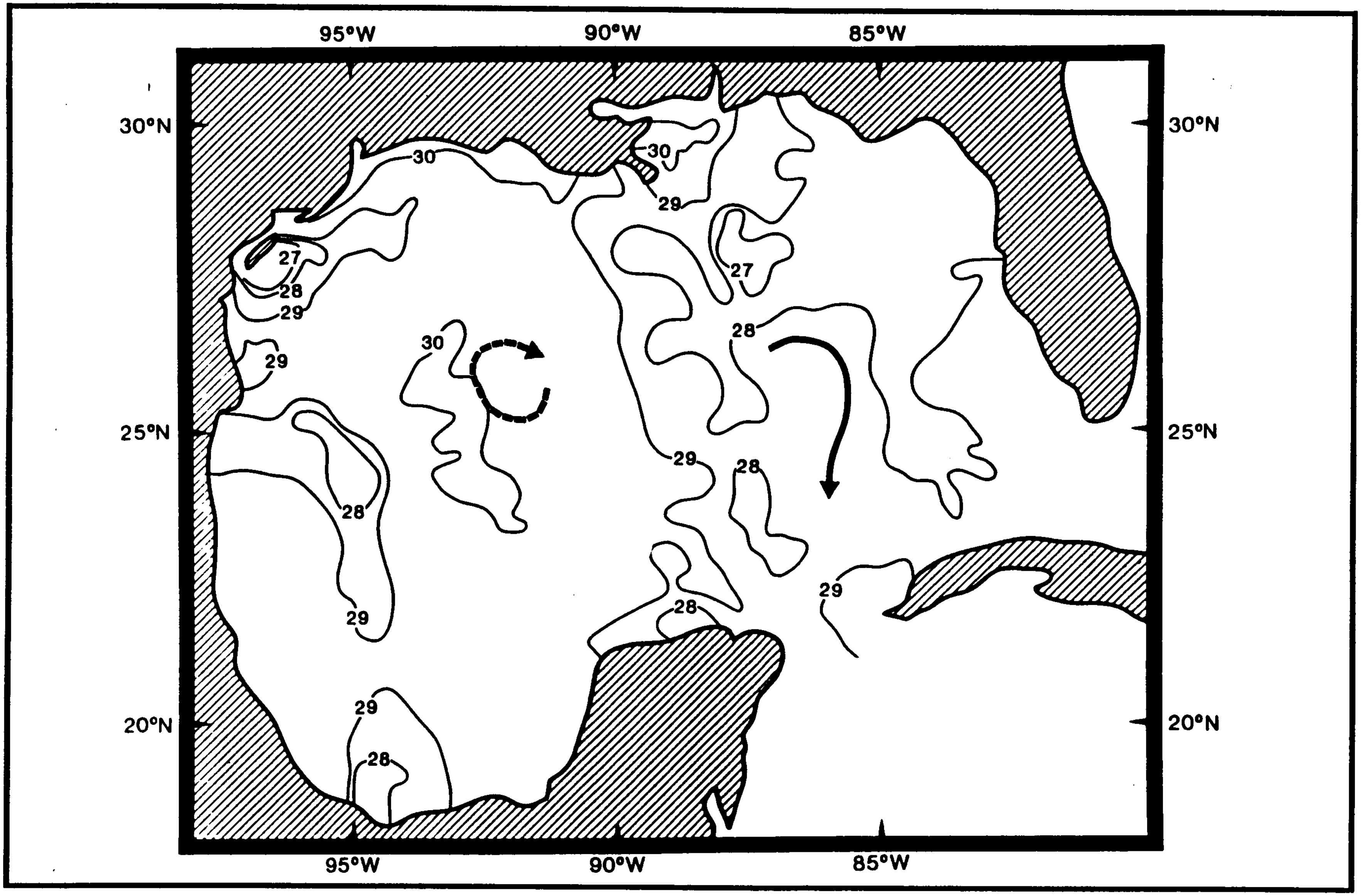

Figure 4.2-20. Trajectories of Drifters 3354 (solid large arrow) and 3378 (dashed large arrow) and SST data (in degrees C) for 10-17 September 1985.

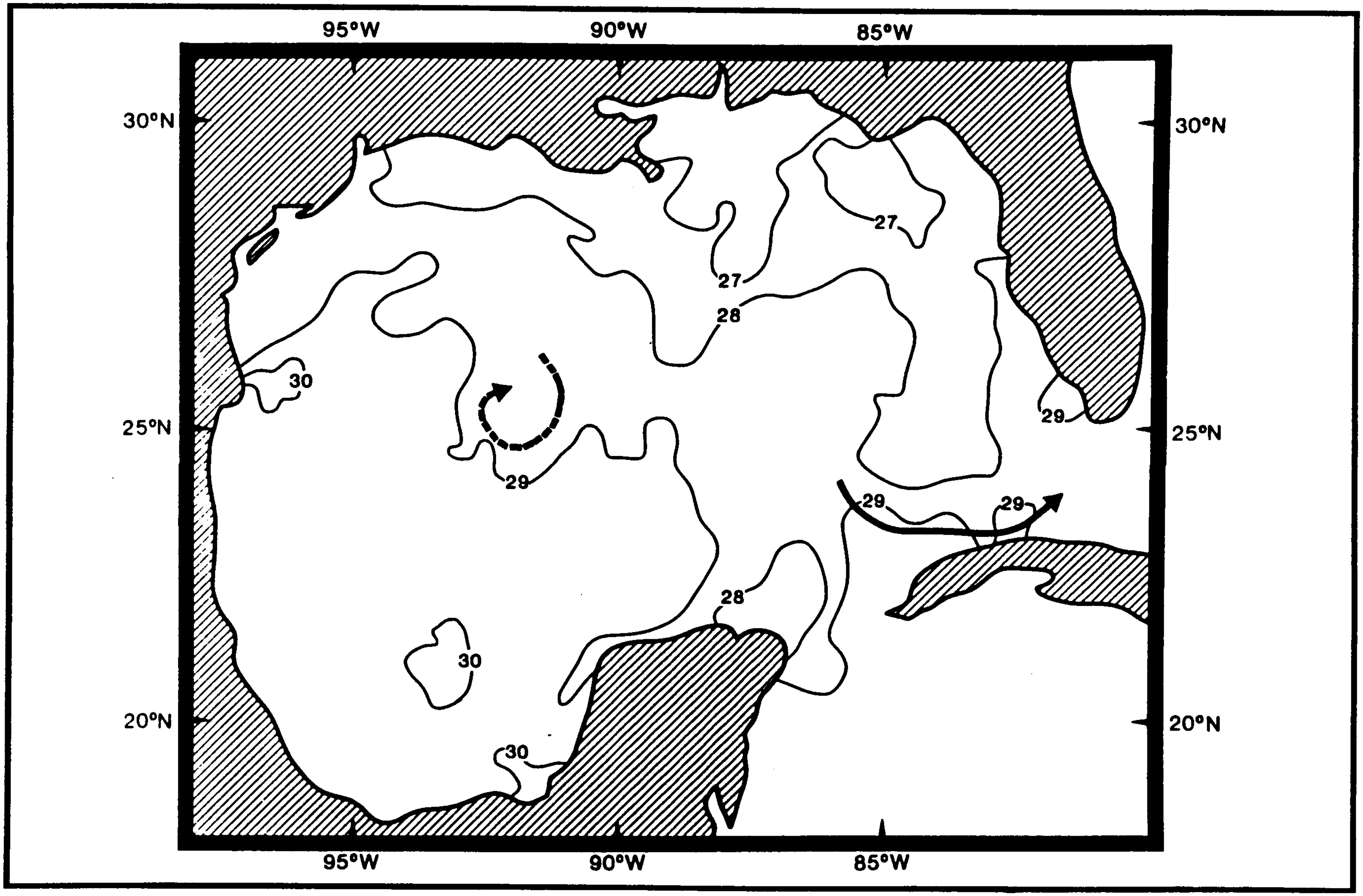

Figure 4.2-21. Trajectories of Drifters 3354 (solid large arrow) and 3378 (dashed large arrow) and SST data (in degrees C) for 17-24 September 1985.

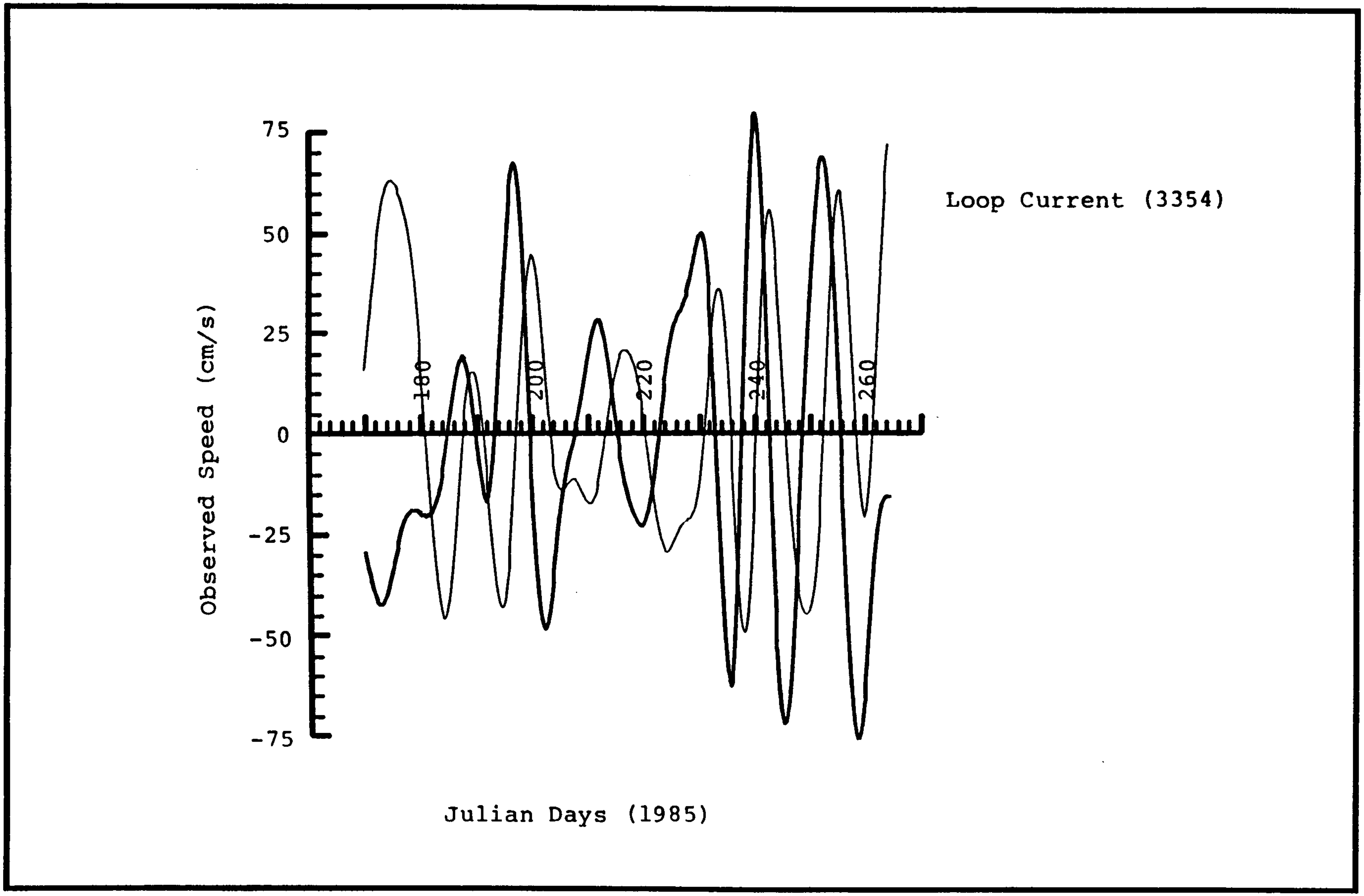

Figure 4.2-22. Time histories of the filtered observed speed components for Drifter 3354. The light line is the east/west speed and the darker line is the north/south speed.

apparent rapid northward extension of the Loop Current. The swirl velocity associated with Loop Current rotation is shown in Figure 4.2-23. These magnitudes also vary from 15 to 80 cm s-1.

The time histories of the translation speed components for the center of rotation in the Loop Current are shown in Figure 4.2-24, and the rapid northwest extension of the system during days 220-230 can easily be seen. The maximum speed of this extension was close to 40 cm s-1 (34 km day-1), a most rapid movement for such a large amount of water. The extent of water involved with this movement is indicated by Figure 4.2-25 which shows the time history of the distances from the drifter to the center of rotation. Prior to the northwest movement, the maximum radius of the rotation as seen by the drifter was 85 km. After the northwest movement, the radius increased up to 100 km.

The rotational frequency of the Loop Current is shown in Figure 4.2-26. This figure shows a general decrease and then increase in frequency, with a minimum occurring right before the northwestward extension of the water mass. As the water moved, the mean period of rotation decreased from about 13 days to approximately 10.5 days. A comparison of Figures 4.2-25 and 4.2-26 shows that longer periods tend to be associated with larger radii, a factor that indicates lateral shear in the angular velocity of this anticyclone.

Eccentricity (e), defined as the major axis length/minor axis length, was used to define the shape of the field of rotation. Also, the north/east orientation of the major axis was calculated. Both of these variables are shown in Figure 4.2-27. The flow field starts out rather elliptical (e = 1.75), but becomes more circular by day 250 (e = 1.4). The elliptical orientation was mostly east/west at first, but eventually became more northwest/southeast.

4.2.4.3 Kinematics of Ring 3378

The filtered velocities of Ring 3378 are shown in Figure 4.2-28. The magnitudes of these oscillations are relatively large, up to 85 cm s-1 with a minimum of about 50 cm s-1. The swirl speeds are shown in Figure 4.2-29, and here there is an initial increase from 20 cm s-1 to 75 cm s-1 followed by a decrease to about 50 to 60 cm s-1. These variations in swirl magnitude coincide with variations in the size of the circle of rotation (Figure 4.2-1). Figure 4.2-30 quantifies the distances from the center of rotation, with a maximum radius of 90 km.

The rotation frequency of Ring 3378 is shown in Figure 4.2-31. The initial minimum in frequency (0.09/day) is followed by an increase to about 0.12/day. From about day 225 and on, Ring 3378 had an almost constant rotation period of eight to nine days, slightly increasing with time.

Considering the shape, the data indicate that the ring was initially quite elliptical (Figure 4.2-32). Within two rotation periods, this extreme eccentricity disappears, with the ring becoming essentially circular. The results shown in Figure 4.2-32 imply that the initial ellipse orientation was mostly east/west. As the ring became more circular, this orientation became more northwest/southeast.

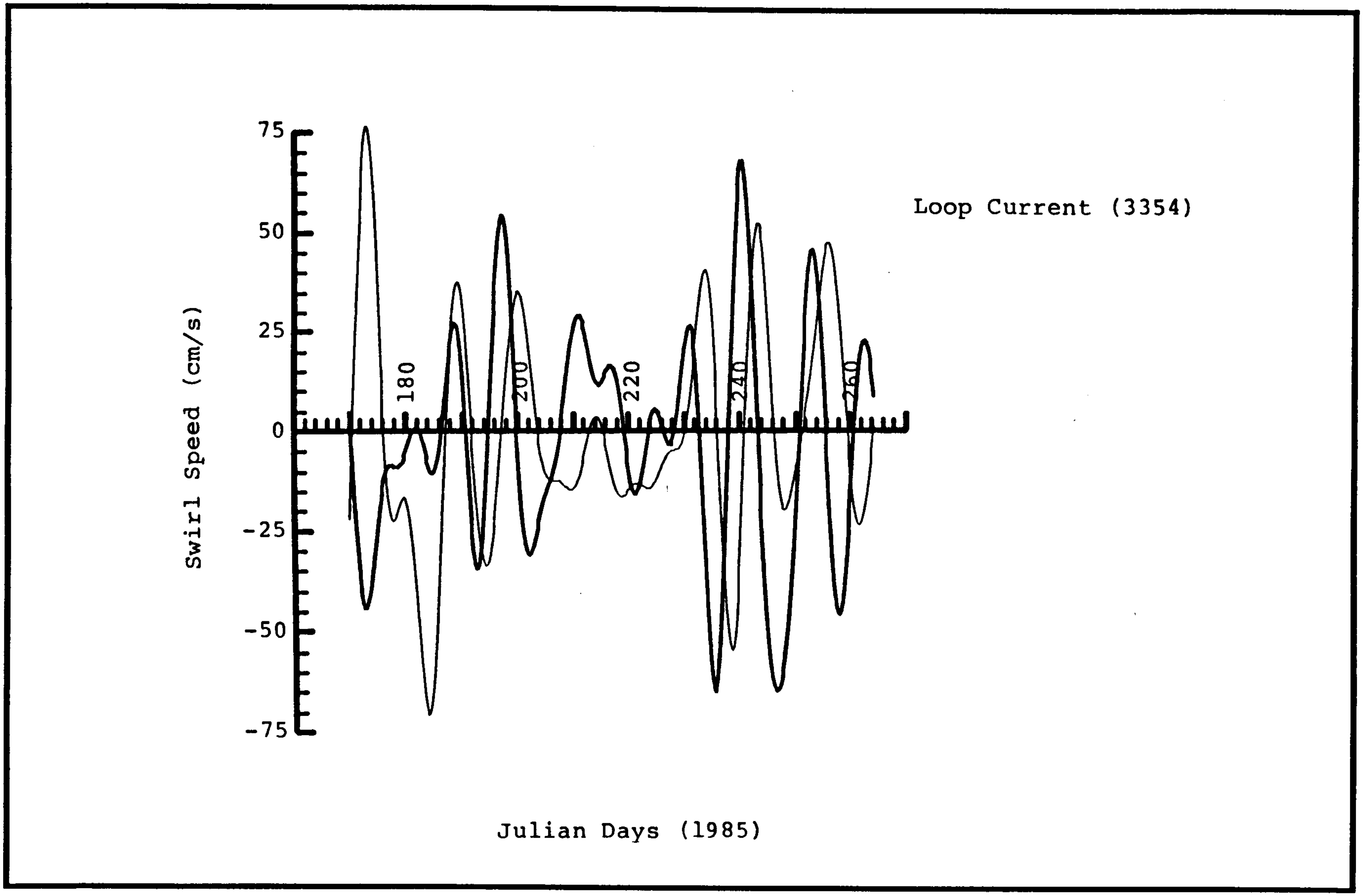

Figure 4.2-23. Time histories of the swirl speed components about the center of rotation for the Loop Current. The light line is the east/west speed and the darker line is the north/south speed.

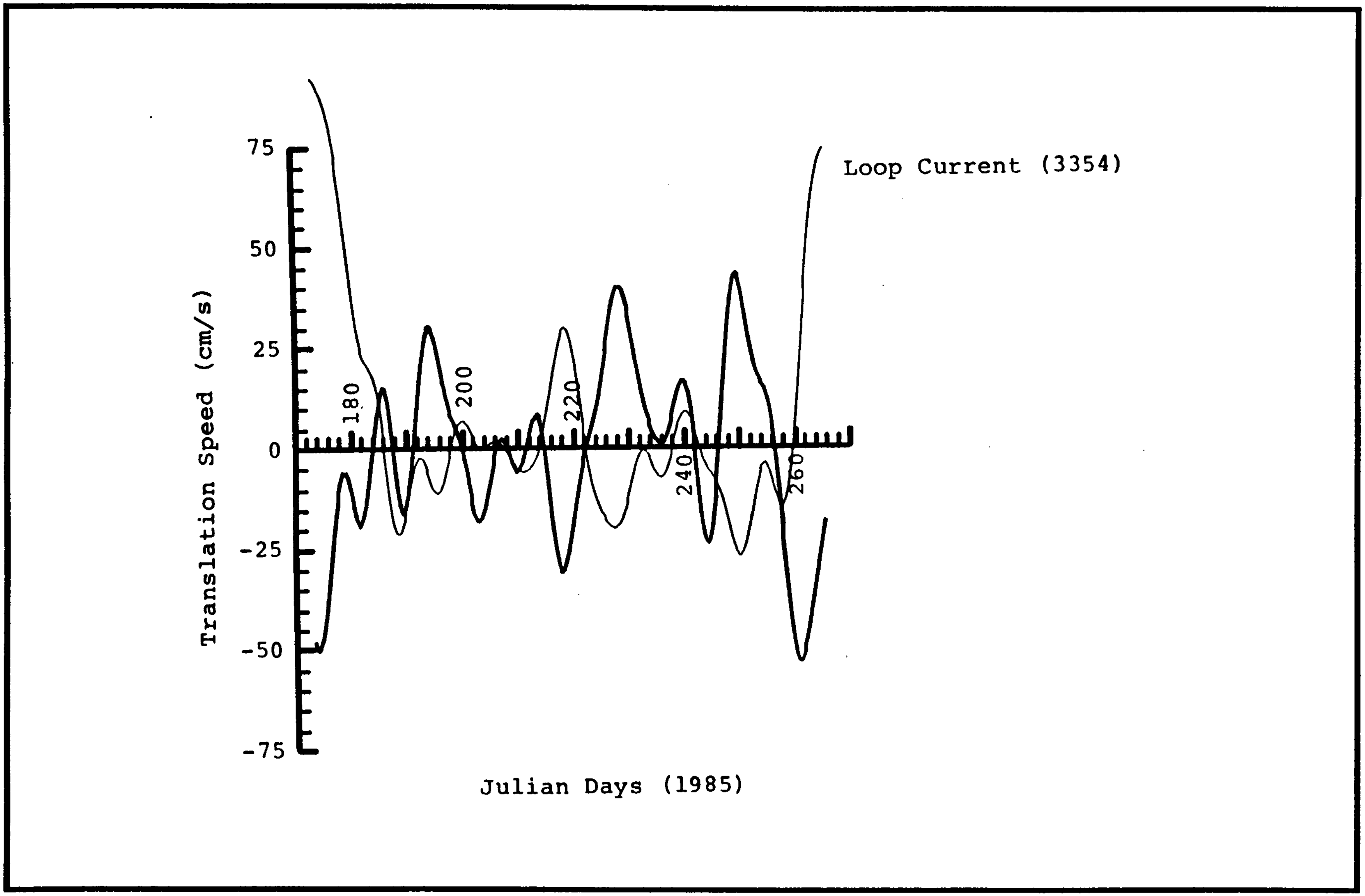

Figure 4.2-24. Time histories of the translation speed components for the center of rotation in the Loop Current. The light line is the east/west speed and the darker line is the north/south speed.

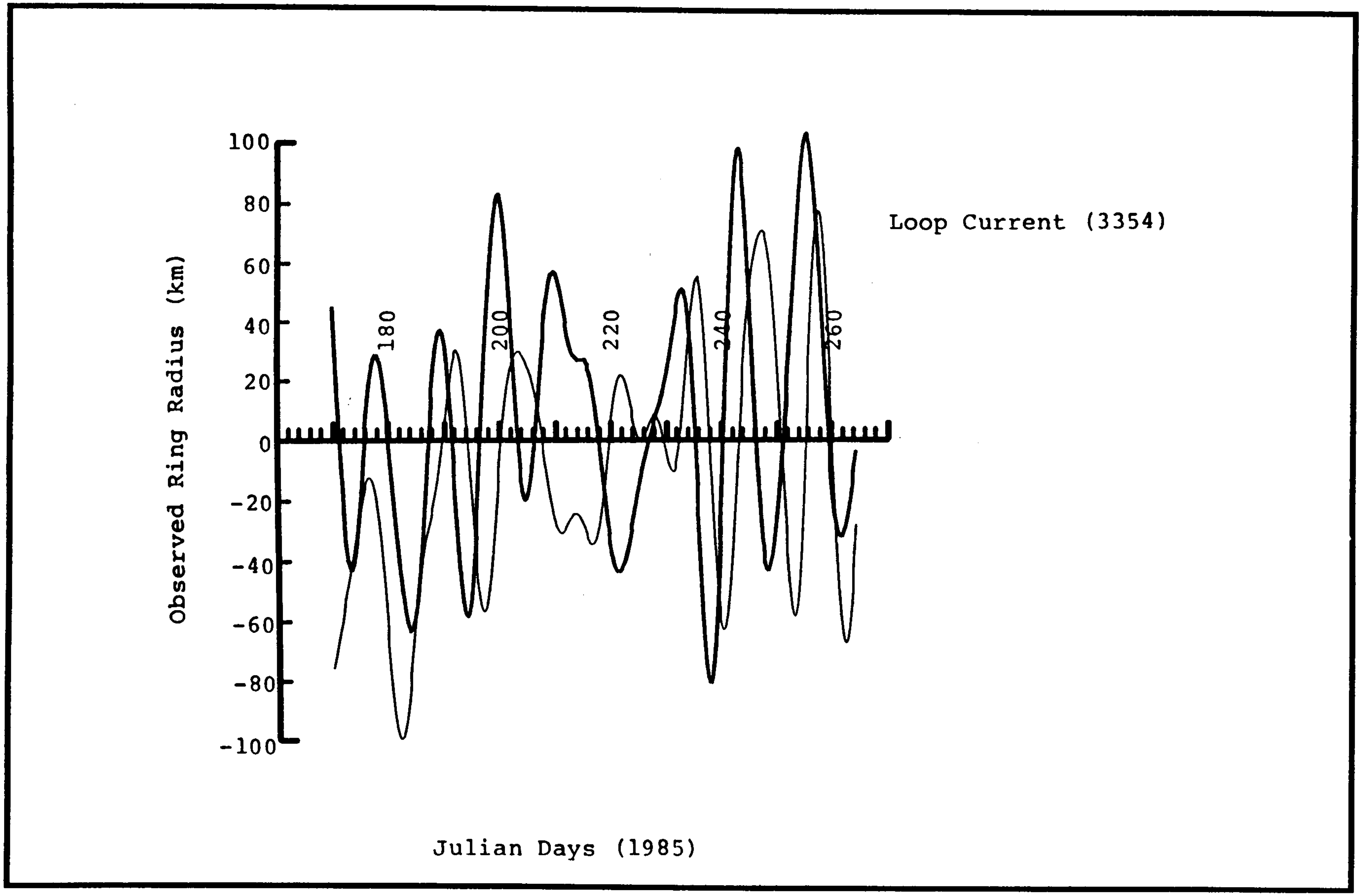

Figure 4.2-25. Time histories of the east/west (light line) and north/south (darker line) distances of Drifter 3354 from the center of rotation in the Loop Current.

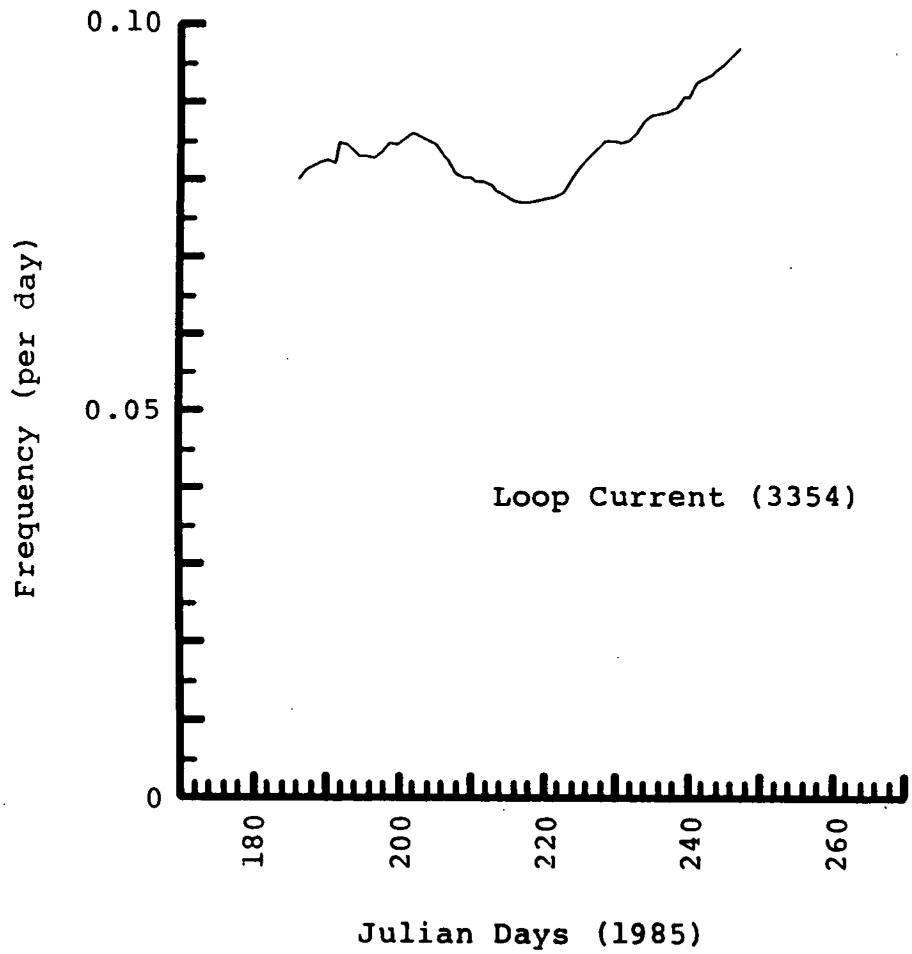

Figure 4.2-26. Time history of the rotational frequency within the Loop Current.

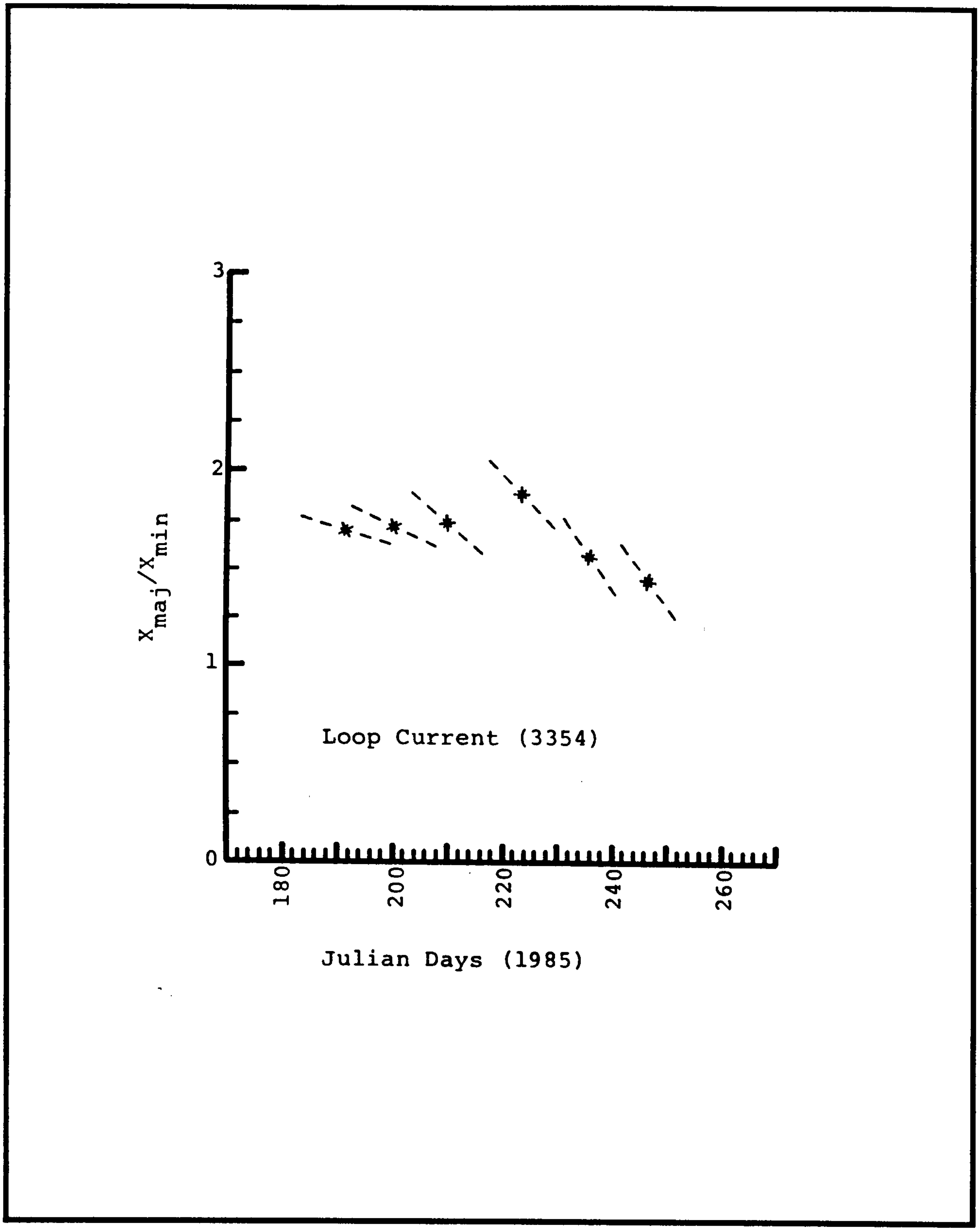

Figure 4.2-27. Time histories of the Loop Current eccentricity (asterisk) and orientation of major axis (dashed line). For the flow field orientation, north is in the positive e direction and east is in the positive time direction.

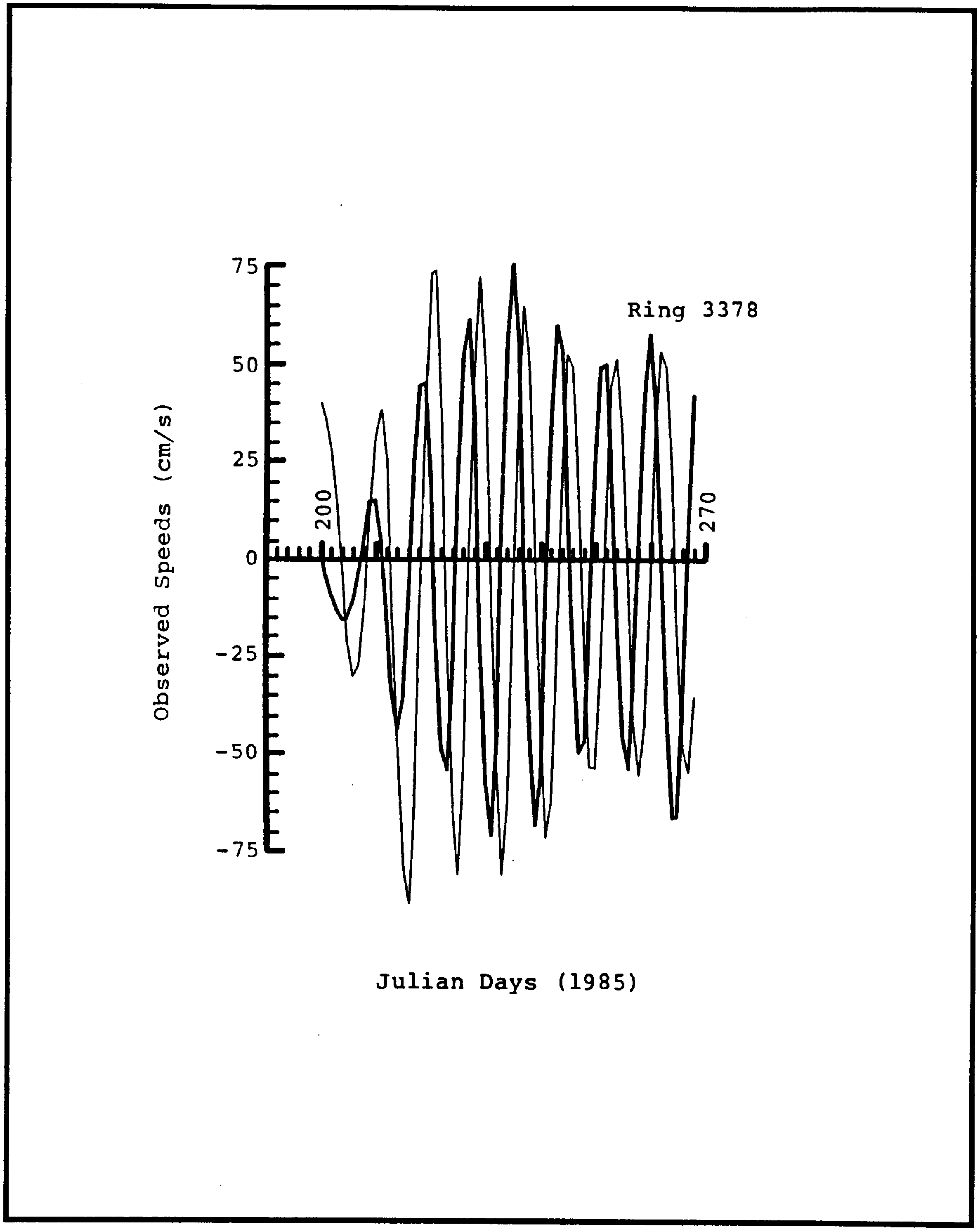

Figure 4.2-28. Time histories of the filtered observed speed components for Ring 3378. The light line is the east/west speed and the darker line is the north/south speed.

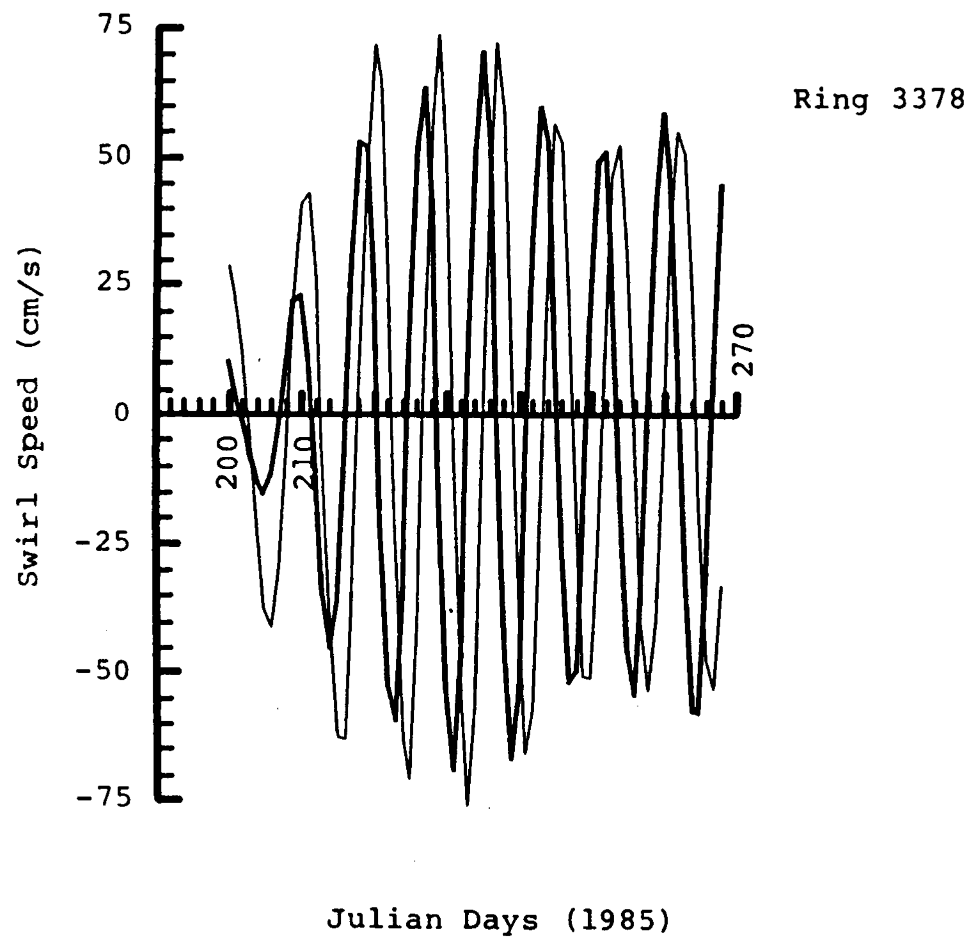

Figure 4.2-29. Time histories of the swirl speed components about the center of rotation for Ring 3378. The light line is the east/west speed and the darker line is the north/south speed.

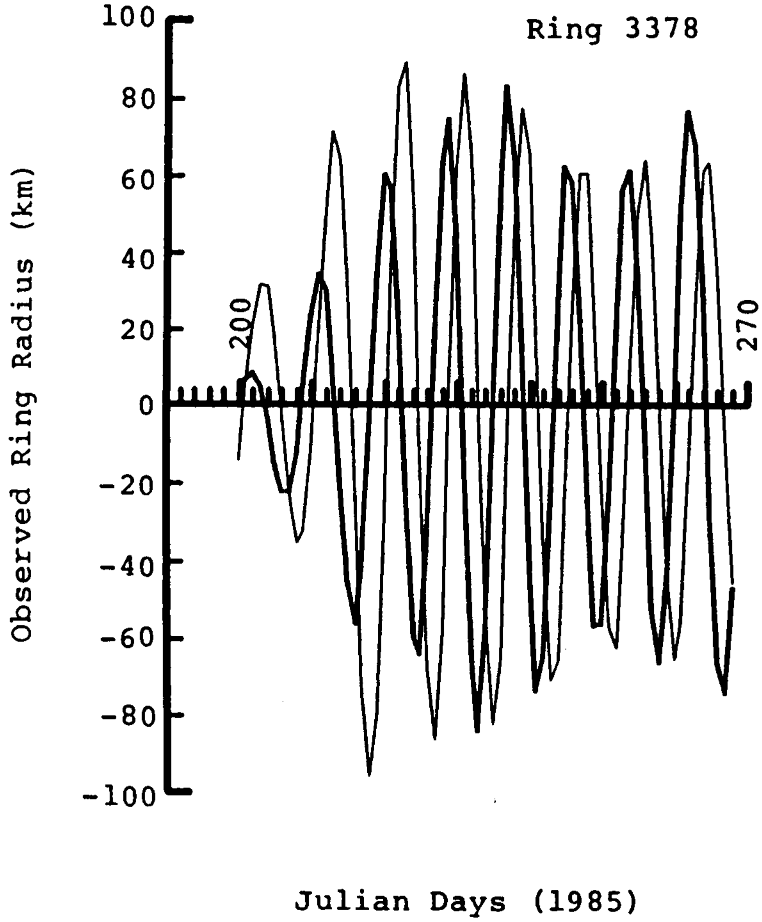

Figure 4.2-30. Time histories of the east/west (light line) and north/south (darker line) distances of Drifter 3378 from the center of rotation of Ring 3378.

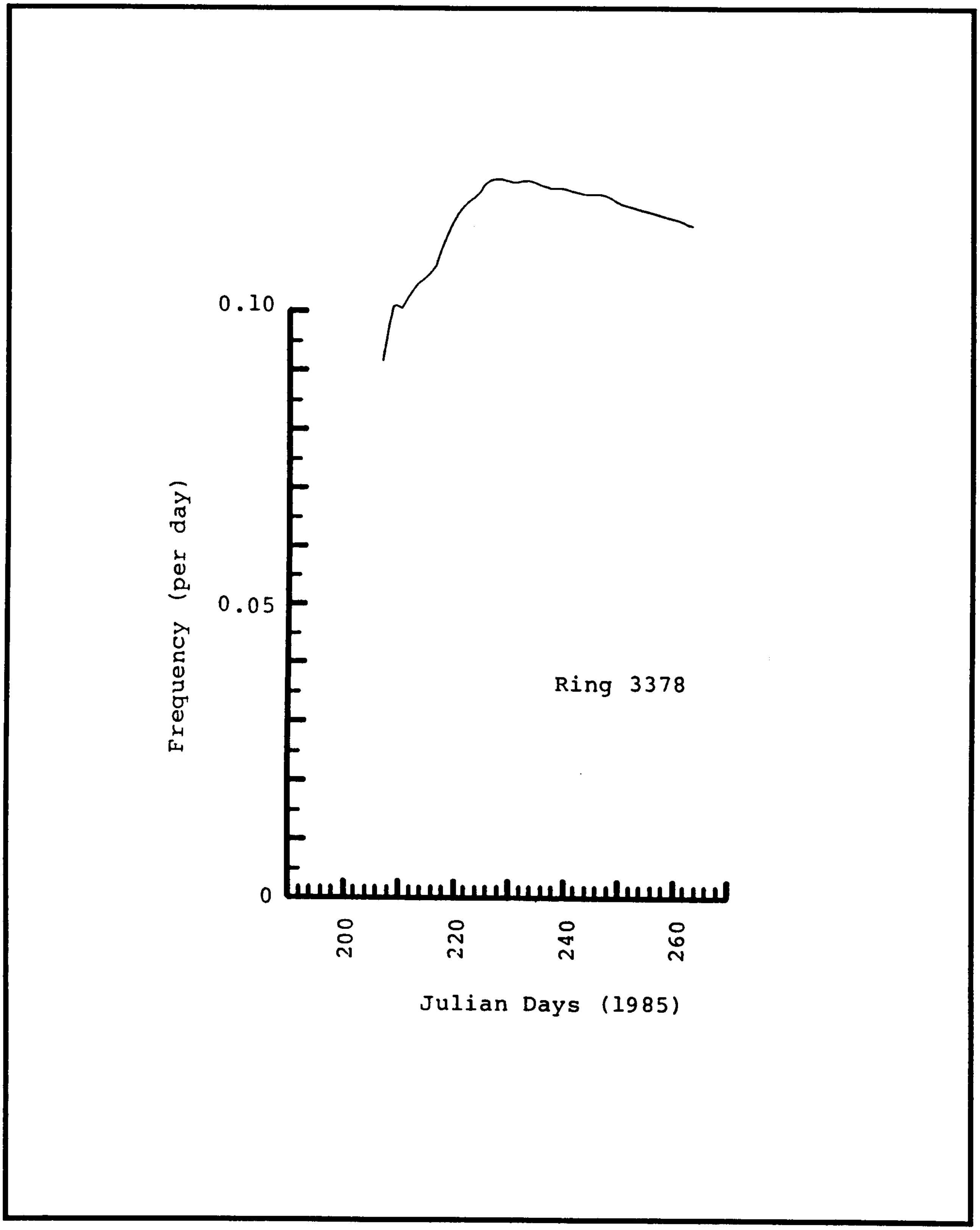

Figure 4.2-31. Time history of the rotational frequency of Ring 3378.

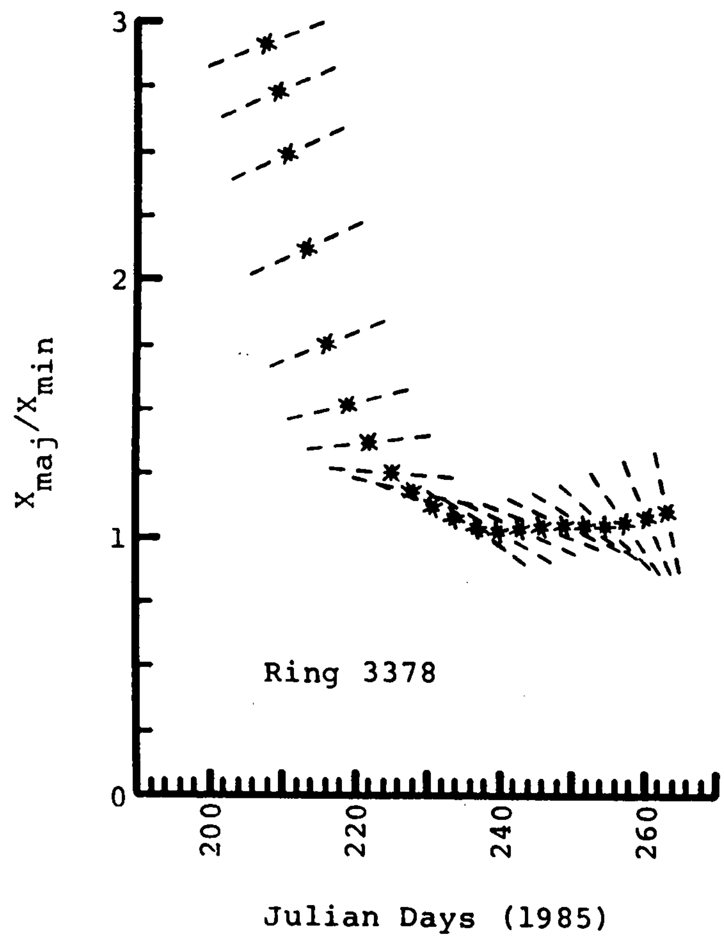

Figure 4.2-32. Time histories of the eccentricity (asterisk) and major axis orientation (dashed line) for Ring 3378. For the flow field orientation, north is in the positive e direction and east is in the positive time direction.

4.2.5 Discussion

4.2.5.1 Loop Current vs. Ring Kinematics

Drifters 3354 and 3378 were both in the GOM during Julian days 199-264, 1985. However, the initial variations of the kinematic parameters of Ring 3378 (Figures 4.2-28 through 4.2-32) all indicate an adjustment period during which time the drifter (with its 200-m weighted line) found an appropriate location within the ring. This location reflects a balance of forces acting on the entire drifter structure, and it would appear that a balance was achieved at about day 225. Thus, the ring and Loop Current kinematics from day 225 to day 264, are appropriate for comparison. At the beginning of this time period, the Loop Current was rotating with a period of about 10.5 days while Ring 3378 had a period of ~8.2 days. The orientations of the ellipses of rotation (Figures 4.2-27 and 4.2-32) were quite similar (northwest to southeast) but the Loop Current was more elliptical (e = 1.5) than Ring 3378 (e = 1.1).

The swirl speeds and the radii of revolution for both anticyclones were quite similar for days 225-264: 80 cm s-1 for the swirl speeds and 90 km for the radii. Interestingly, both anticyclones experienced longer periods of rotation for smaller distances from the center of rotation. This form of current shear implies a flux of momentum toward the interior of the anticyclones.

4.2.5.2 Kinematics Before and After a Ring Breaks Off

This brings us to the point of discussing the kinematics of the Loop Current at its most northerly extension (Julian days 230-264) and the kinematics of Ring 3378 soon after it broke free from the Loop Current (Julian days 225-235). Although these data represent two different anticyclonic events, it is assumed that these conditions are typical of GOM rings before and after they break off from the Loop Current.

The similarities between these two sets of kinematics are considerable. Firstly, the magnitudes of the swirl speeds and of the radii are practically identical. Moreover, their elliptical orientations are the same. The Loop Current was slightly more elliptical than Ring 3378, but one might expect such a difference in ellipticity seeing that an anticyclone still attached to the Loop Current is a forced phenomena while a detached ring represents a free mode. The similarities of the anticyclones plus their close periods of rotation imply that the basic kinematic characteristics of GOM rings can be established as the Loop Current pushes northwestward off the shore of Cuba.

4.2.5.3 Generation of a Loop Current Eddy

The classical concept of Loop Current processes is one in which part of the Gulf Stream at first flows directly from the Yucatan Straits to the Florida Straits. Within this flow field, barotropic and baroclinic instabilities exist which result in meandering of the Loop Current. As the size of the meander increases and reaches northward, it is generally believed that the flow field wraps back onto itself and "shorts" the stream of flow: part of the flow would still go northward around the Loop Current extension while the remainder of the flow would take the more direct, southerly route to the Florida Straits. This is analogous to other geophysical phenomena, such as the creation of ox-bow lakes by meandering rivers. Finally, as the curvature of the flow reaches its maximum, more of the Loop Current flow takes the southerly route, and a GOM ring is eventually pinched off.

One of the most interesting points indicated by the data is the anticyclonic characteristic within the Loop Current. Even though Ring 3378 was just pinching off, Drifter 3354 shows that another rotational feature existed in the southern portion of the Loop Current at the same time. The existence of this second anticyclone leads to the hypothesis of a new process for the eventual creation of Loop Current rings.

It has been shown in numerical studies that the flow of the Loop Current can itself create an anticyclonic flow field off the northwestern coast of Cuba (Thompson, 1986). It is proposed that such a flow field could eventually pinch off as a GOM ring. The northward flow west of the tip of Cuba along with the southeasterly flow along the north-central coast of Cuba will obviously produce negative vorticity off Cuba's northwestern shore. This appears to be the flow field in which Drifter 3354 became entrained. This flow field moved slightly northwest while Ring 3378 was still connected to the Loop Current. But, it was only shortly after Ring 3378 pinched off that this Loop Current anticyclone pushed more northwesterly, to about 26.5°N. Figures 4.2-20 and 4.2-21 indicate that after this final push (late August 1985), this rotational field was an integral component of the Loop Current. Thus, the data imply that the kernels of Loop Current rings may come from waters off the northwest coast of Cuba, vortices which are spun up by the lateral shear of the Loop Current boundaries. Thus, the scenario implied here is one in which the essence of the ring is established off the northwest coast of Cuba, develops in deeper waters off the coastline, and then takes on its final characteristics shortly after the previous ring completely detaches from the Loop Current.

The implication of such a mechanism is that of time scales. One is not required to wait until instabilities in the flow field grow large enough to produce a closed rotational feature. These data show that, indeed, a new Loop Current rotational feature can be well established even before the previous ring has totally pinched off. We know that Ring 3378 was free of the Loop Current by mid-July 1985, but we also see that the new rotational feature had moved to latitude 26.5°N by the beginning of September 1985. Thus, the Loop Current was completely reconfigured to begin another ring separation only 1.5 months after the previous ring separation. One could conjecture that if it were to take another 1.5 to 2.5 months for a ring to pinch off, then it would be possible to have three or four GOM rings produced each year. This concurs, in part, with Elliot's (1982) documentation of three ring separations in a 12 month period based on hydrographic data. Model studies (e.g. Hurlburt and Thompson, 1980; Thompson, 1986; Wallcraft, 1986), however, report lower - numbers, with separation rates of one ring every 6 to 18 months.

An example of a modeled ring pinch-off in the GOM is shown in Figures 4.2-33 and 4.2-34 (from Wallcraft, 1986). On day 63 (Figure 4.2-33), the model shows the configuration similar to that when Drifter 3354 was seeded. The ring is well defined as the northern extension of the Loop Current, but it has not

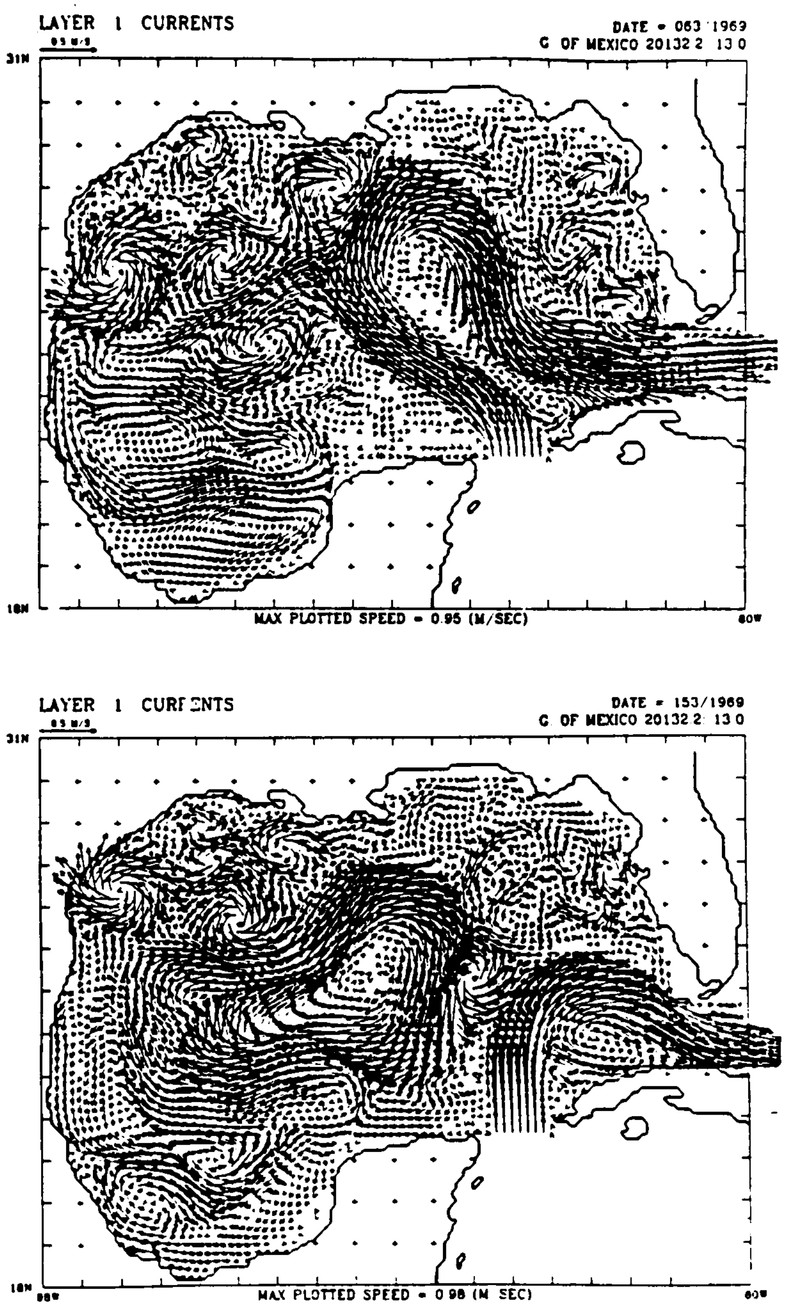

Figure 4.2-33. Upper layer water velocities from a model of the Gulf of Mexico for days 63 (top) and 153 (bottom) (from Wallcraft, 1986). The top layer is 200 m deep.

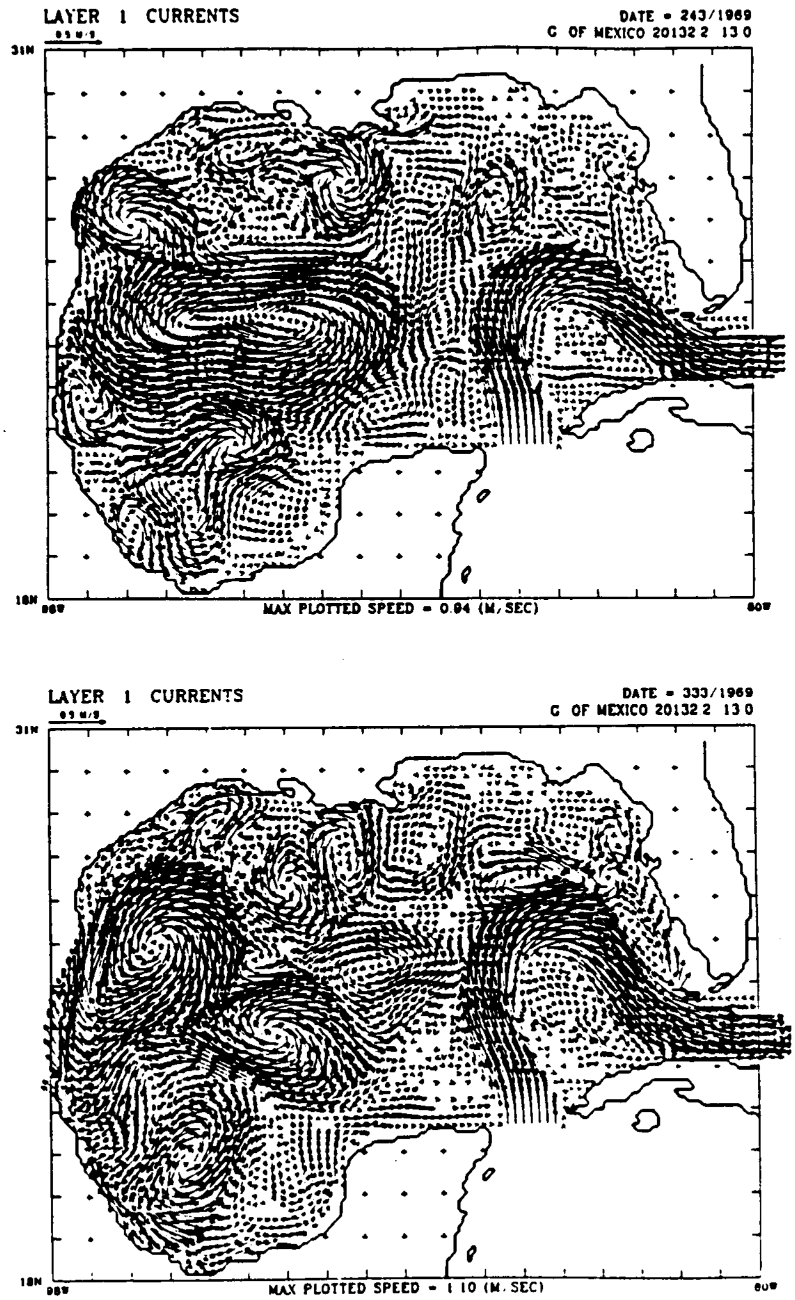

Figure 4.2-34. Upper layer water velocities from a model of the Gulf of Mexico for days 243 (top) and 333 (bottom) (from Wallcraft, 1986). The top layer is 200 m deep.

completely pinched off. Note that there does exist a hint of anticyclonic motion off the northwestern coast of Cuba. By day 153 (three months later), the model shows that the ring is free of the Loop Current. Moreover, the anticyclone off Cuba is larger and better defined. However, it is not until another four months before the modeled Loop Current pushes northward again to begin the process of pinching off another ring (Figure 4.2-34). By this time, the anticyclone that had been spun up by the Loop Current had lost its identity (day 333, Figure 4.2-34). Therefore, the process described using the trajectory of Drifter 3354, in one sense, varies from the model in the shorter time period required to obtain the results predicted by the model.

4.3 Loop Current Boundary Features

4.3.1 Introduction

This section presents the current state of understanding of mesoscale processes affecting flow along the margin of the West Florida Shelf (WFS) as determined from the Acoustic Dopper Current Profile (ADCP) and associated data. The Loop Current can influence the hydrographic and flow fields of the outer WFS in three ways:

- An onshore or offshore translation of the primary Loop Current front.
- A propagation of waves along the front which results in meandering of the front.
- The growth of eddies on the front due to unstable versions of these waves.

The mesoscale eddies provide an efficient mechanism for exchange of WFS and Loop Current water masses. These features were the primary focus of Cruise CF8405. In Section 4.3.2, observations of the cold perturbation southwest of the Dry Tortugas are summarized while in Section 4.3.3, the same is done for the frontal eddy observed along the southwestern portion of the WFS. These two features appear in a plot of temperature at 200-m depth derived from aerially deployed probe data (Figure 4.3-1) as cold pools along the eastern boundary of the Loop Current having temperatures less than 12°C. A discussion of results in the context of the existing literature on similar features is given in Section 4.3.4. A brief summary is presented in the final section.

4.3.2 Cold Perturbation Southwest of the Dry Tortugas

4.3.2.1 Introduction

The Loop Current typically flows southward along the outer margin of the WFS roughly following the bottom topography and turns eastward at about 24°N latitude to exit the Gulf of Mexico between the Florida Keys and Cuba as the Florida Current. In the few weeks preceeding the beginning of CF8405, development of an anomalous southwestward perturbation of the Loop Current was apparent from satellite derived sea-surface temperature (SST) patterns (Figure 4.3-2). This perturbation continued to exist throughout the duration of the cruise and was sampled twice in transit to and from the primary work area along the WFS.

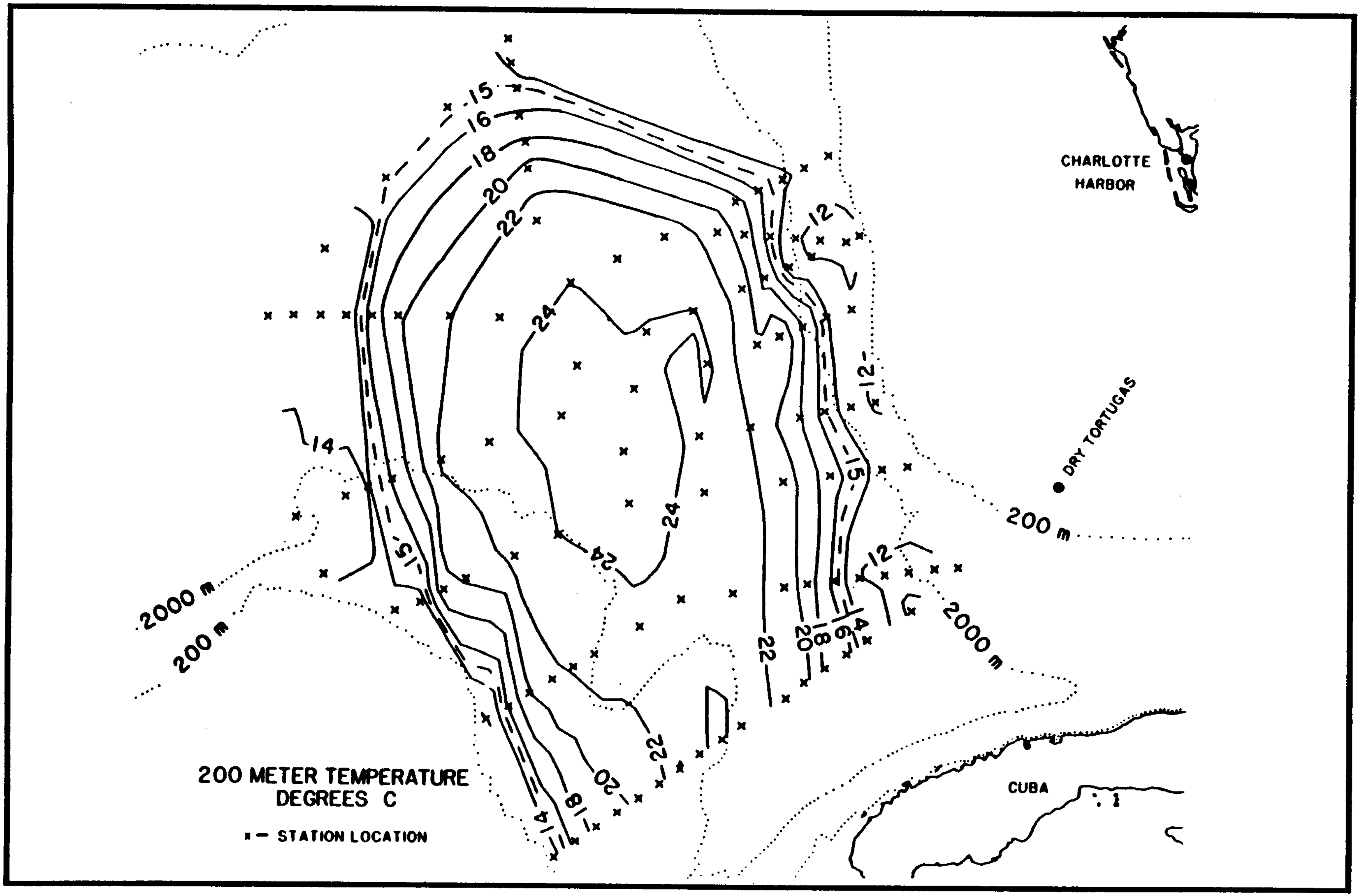

Figure 4.3-1. Horizontal contours of temperature of the Loop Current at 200 m depth from an aerial XBT survey. The 15 degree C isotherm is the dashed line. Note the isolated cold pools along the eastern boundary.

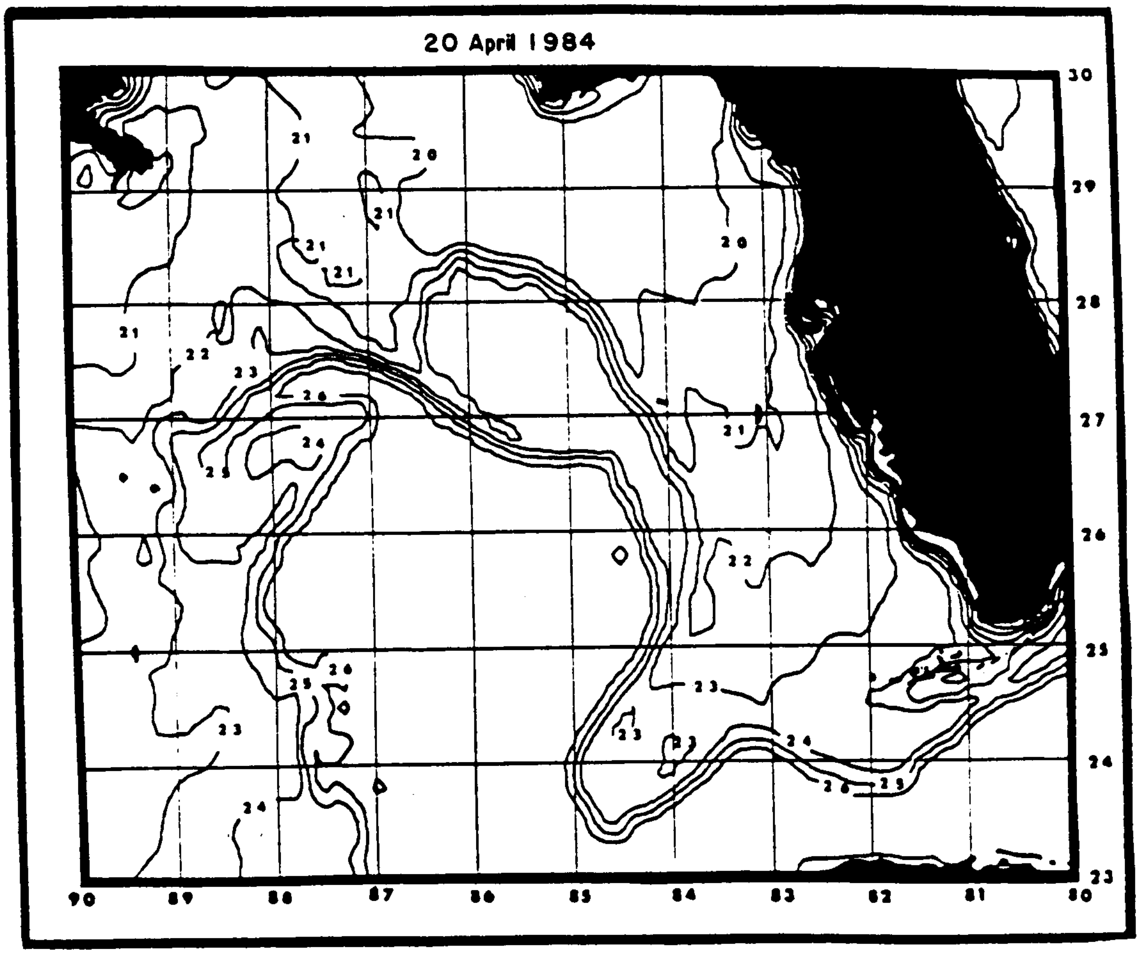

Figure 4.3-2. Sea-surface temperature (SST in degrees C) for 20 April 1984.

4.3.2.2 Visit I

Transect I (Line A-B) of Cruise CF8405 (Figure 4.3-3) was designed to traverse the northeast - southwest axis of the cold perturbation. While the location of this transect was determined based on sea-surface temperature data from more than a week prior to arrival on the section, Figure 4.3-4 confirms that the feature remained in the same location until Transect I and II (Line C-E) were completed, although the intensity of the surface temperature expression of the feature had decreased somewhat. The vertical cross-section of temperature from Transect I (Figure 4.3-5) reveals a weak doming of all isotherms less than 20°C, which is consistent with a cyclonic circulation inferred from the surface temperature field. The near surface (less than 50 meters) isotherms are quite convoluted and probably do not directly reflect larger scale motion. The corresponding ADCP vertical cross-section of the north component of velocity (Figure 4.3-6) shows the sharp cyclonic shear zone associated with the steeply sloping isotherms near the southwestern end of the section. North of 23.5°N both the horizontal and the vertical shears are weak. The north component tends to zero at the northeastern end of the section. The east component (Figure 4.3-7) exhibits a weak flow symmetric about the mid-point of the section. This confirms the cyclonic circulation inferred from the SST patterns and expected from geostrophic dynamics.

A second section was oriented across the axis of the perturbation (Figure 4.3-3) in the southeast - northwest direction. The temperature cross-section from Transect II (Line C-E) (Figure 4.3-8) reveals, more clearly than that of Transect I, the upward doming of isotherms typical of northern hemisphere cyclones. At the southern end of this section (Figures 4.3-9 and 4.3-10) an east-northeast flow was observed of about 1.5 knots associated with the southern edge of the cyclone and the exit of the Loop Current from the Gulf. (Note that to facilitate comparison of the ADCP data from Section II with that of Section I, the Section II ADCP data are presented in a format such that south is on the left in Figures 4.3-9 and 4.3-10.) On the northwestern side of the cold perturbation the Loop Current front was very sharp (Figure 4.3-9) and speeds of four knots to the south-southwest were observed. A shear of more than 100 cm s-1 over a distance of less than 20 kilometers was observed in the ADCP data. Compare this with the much weaker shear at the Loop Current front near the southwestern end of Section I. (It should be noted that typical hydrographic station spacing of about 10 kilometers is barely capable of resolving such features even if the stations are optimally located.)

4.3.2.3 Visit II

The cold perturbation was sampled again two weeks after the initial visit. Time was available for only the southwest - northeast axial Transect XX (Line II-JJ) shown in Figure 4.3-11 as we returned to port at the end of the cruise. As shown in Figure 4.3-12, the domed iostherms were still present and a narrow cold band had upwelled to the surface just shoreward of the primary Loop Current front. During the two weeks since the first visit, the cold perturbation had moved about one degree of longitude eastward but still retained the basic characteristics observed at the beginning of the cruise. The ADCP data (Figures 4.3-13 and 4.3-14) again show the expected south-southeasterly flow at the offshore end of the section and a weak north westward flow nearshore. The maximum speed in the core of the Loop Current was about 3.3 knots, slightly more than that observed on the axial section during the first visit. This increase in speed may be associated with the

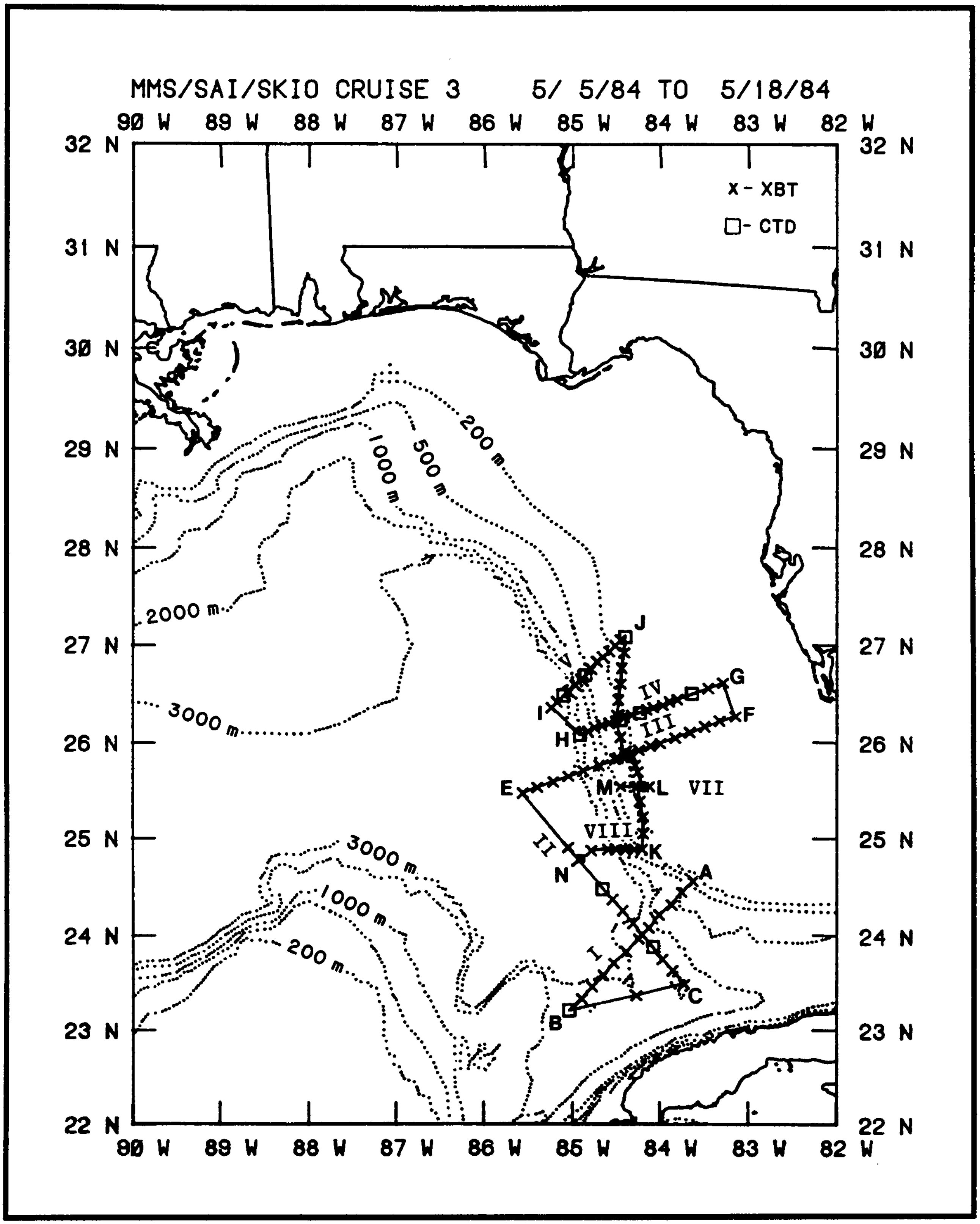

Figure 4.3-3. Cruise track showing XBT and CTD station locations for Transects I through VIII of Cruise CF8405.

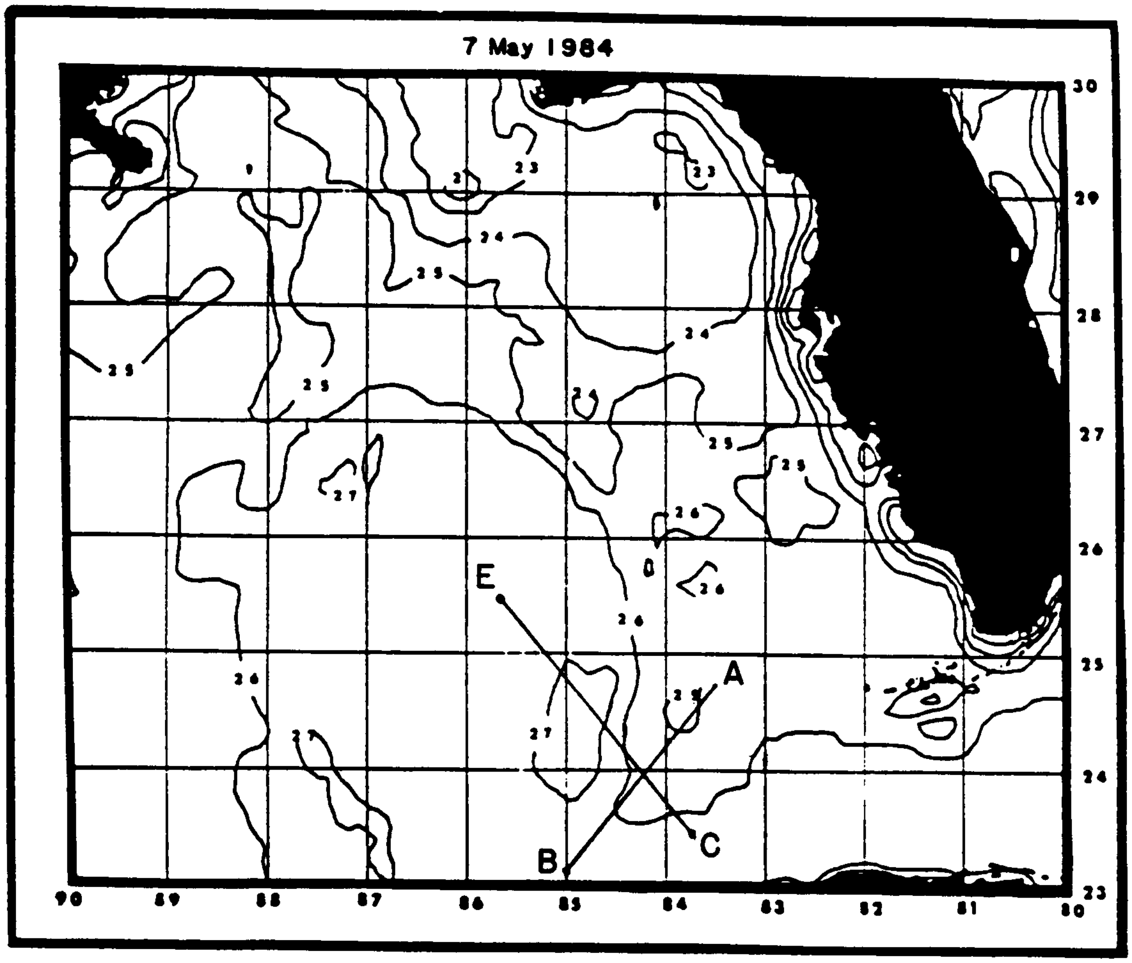

Figure 4.3-4. Sea-surface temperature (SST in degrees C) for 7 May 1984. Sections labled AB and CE are Transects I and II, respectively, as discussed in the text.

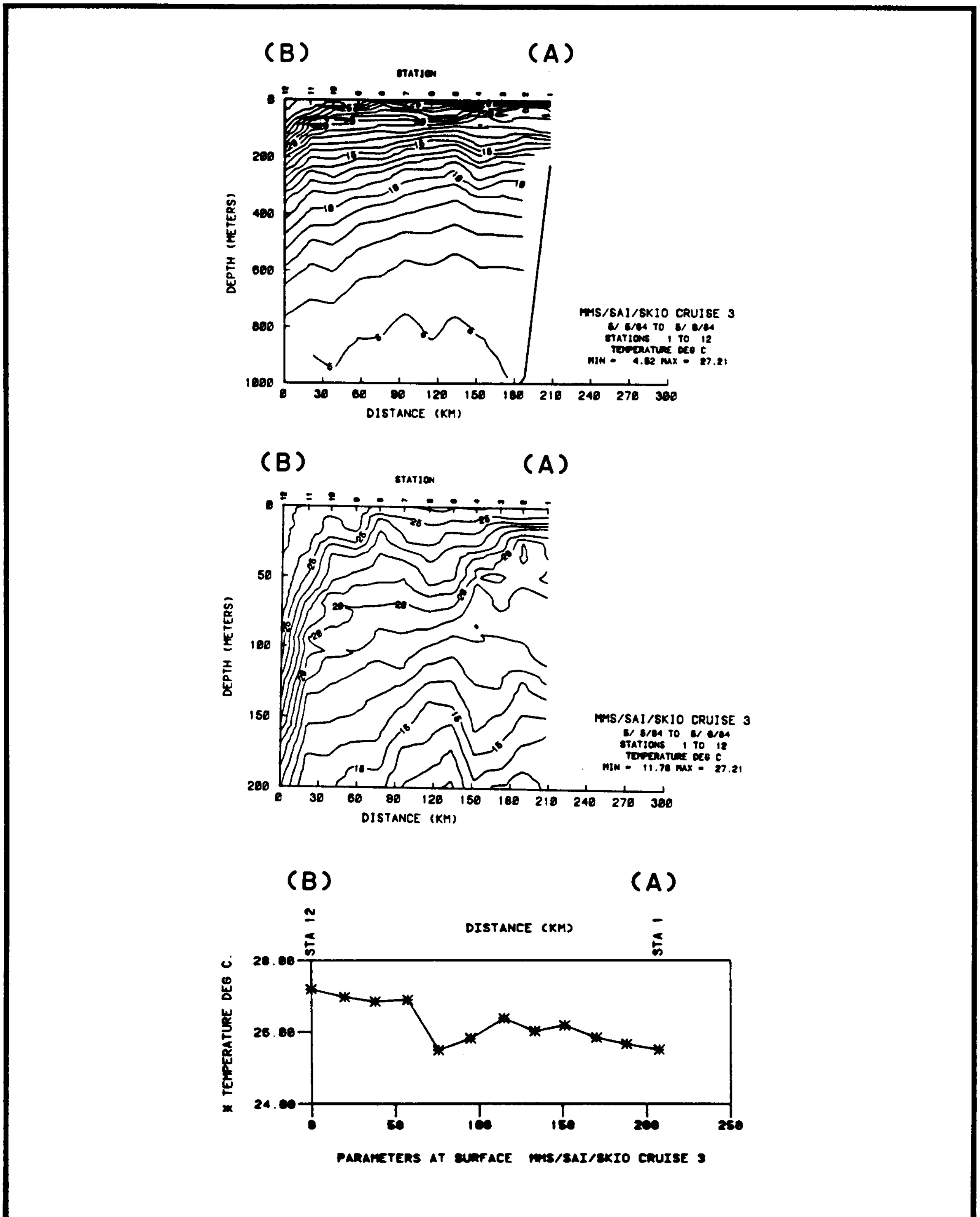

Figure 4.3-5. Vertical temperature section down the northeast - southwest axis of the cold perturbation (Transect I). Both 1000 and 200 meter scales are shown. SST is shown in the lower panel.

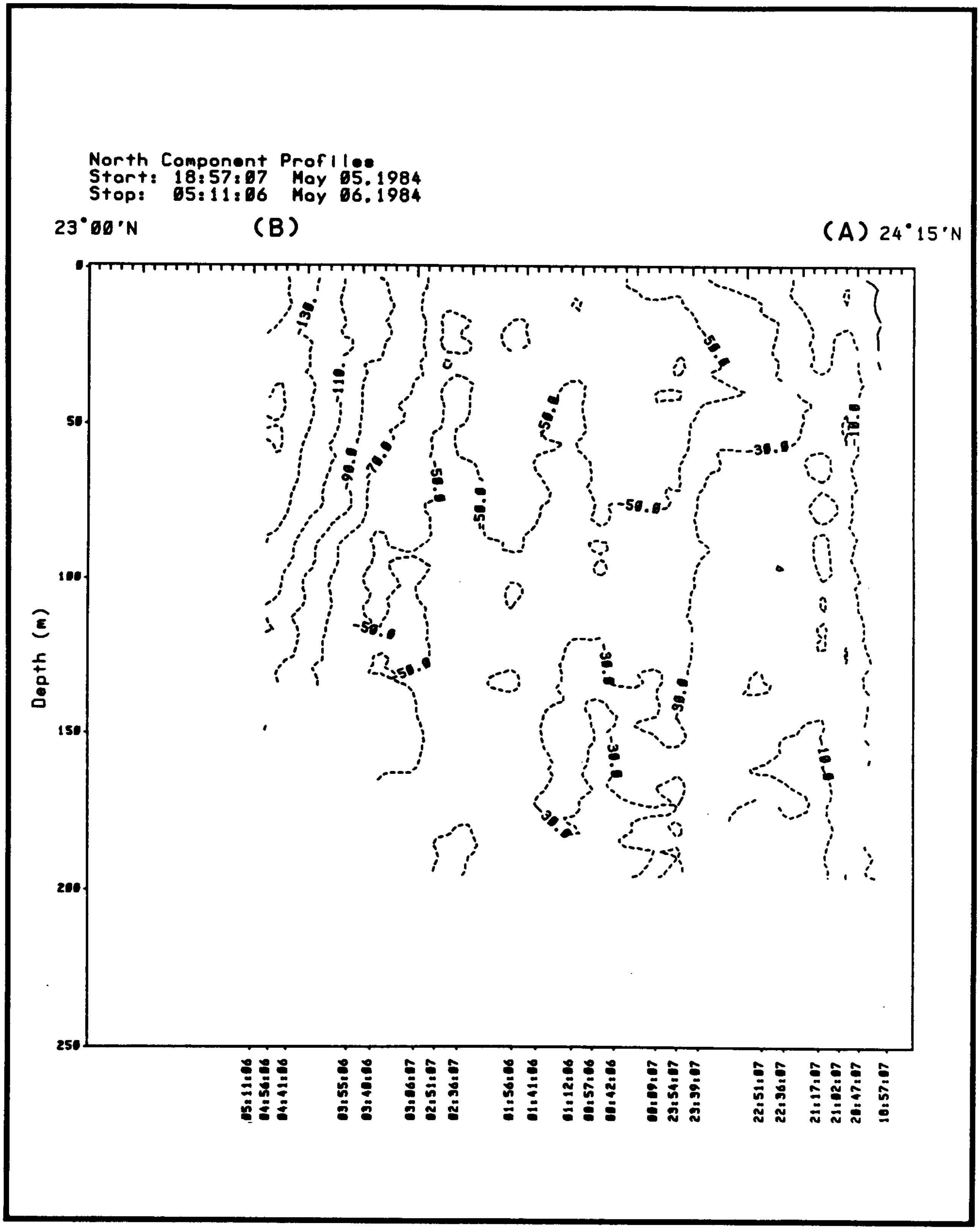

Figure 4.3-6. Vertical cross-section of the north component of horizontal velocity for Transect I of Cruise CF8405.

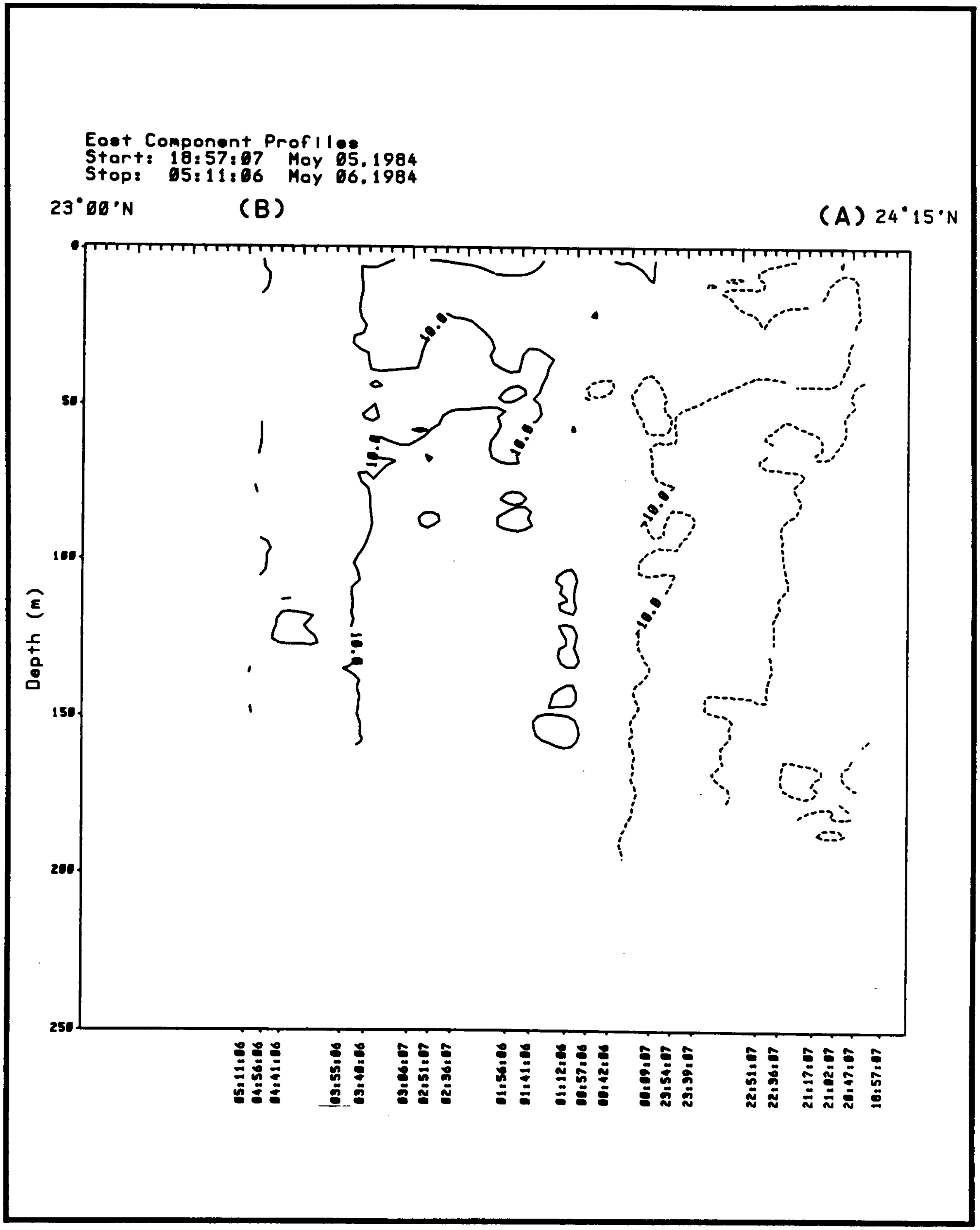

Figure 4.3-7. Vertical cross-section of the east component of horizontal velocity for Transect I of Cruise CF8405.

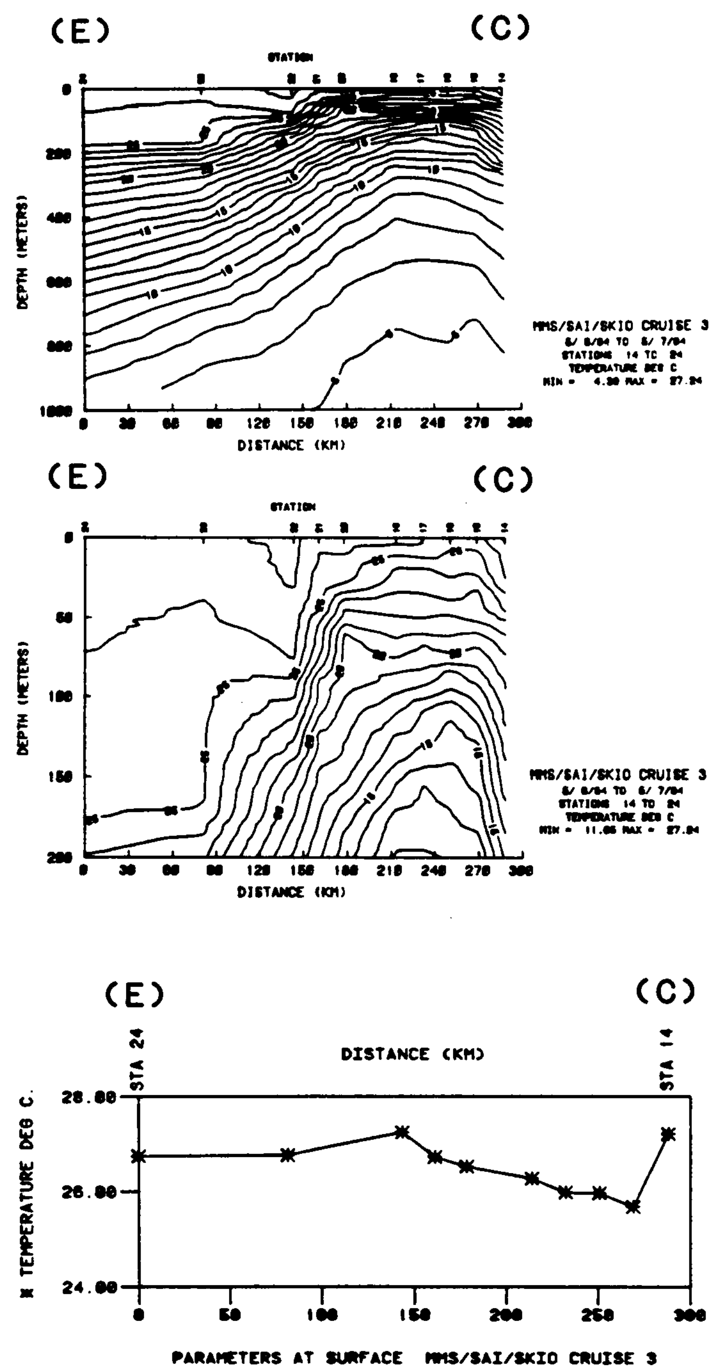

Figure 4.3-8. Temperature section across the cold perturbation (Transect II). Both 1000 and 200 meter scales are shown. SST is shown in the lower panel.

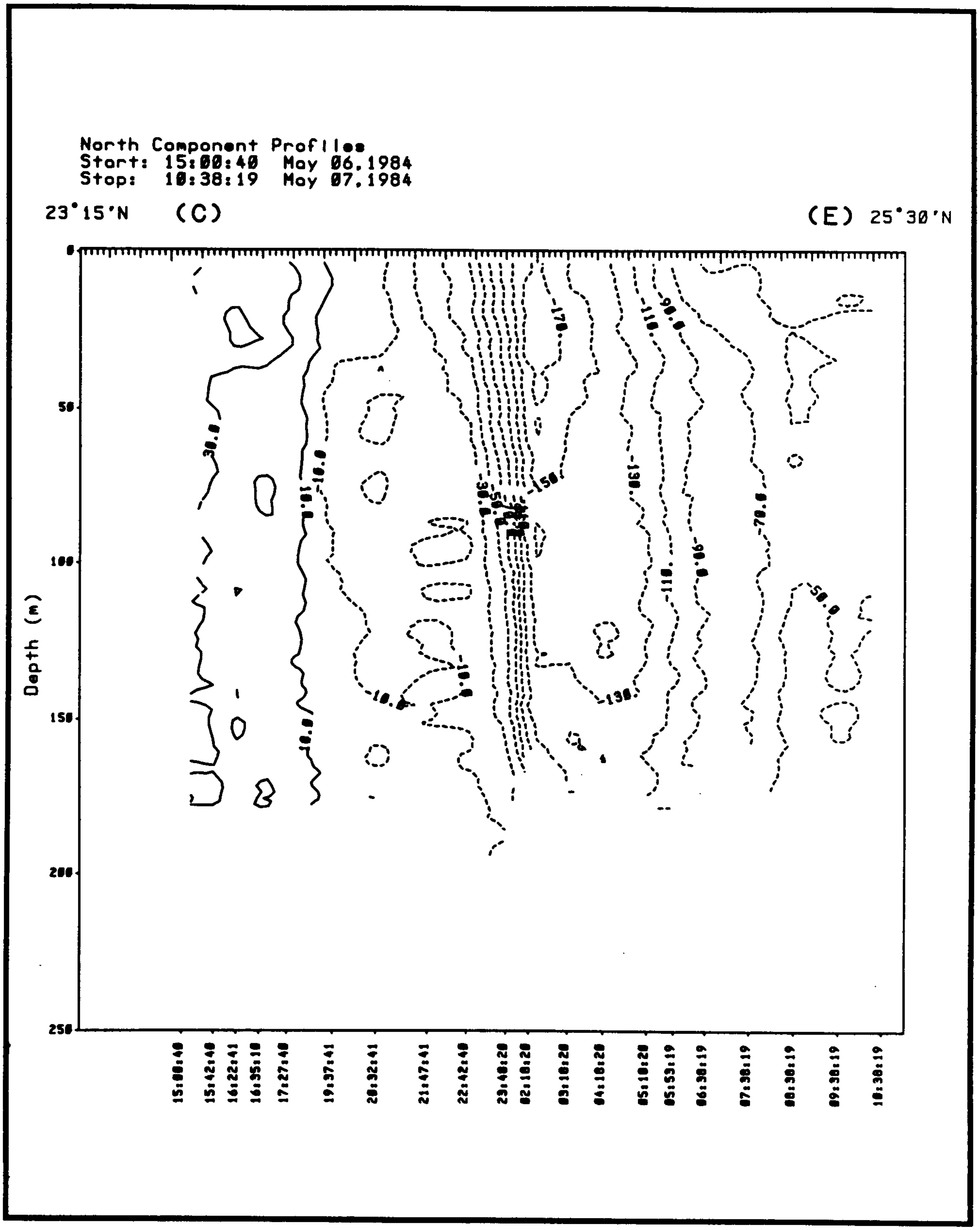

Figure 4.3-9. Vertical cross-section of the north component of horizontal velocity for Transect II of Cruise CF8405.

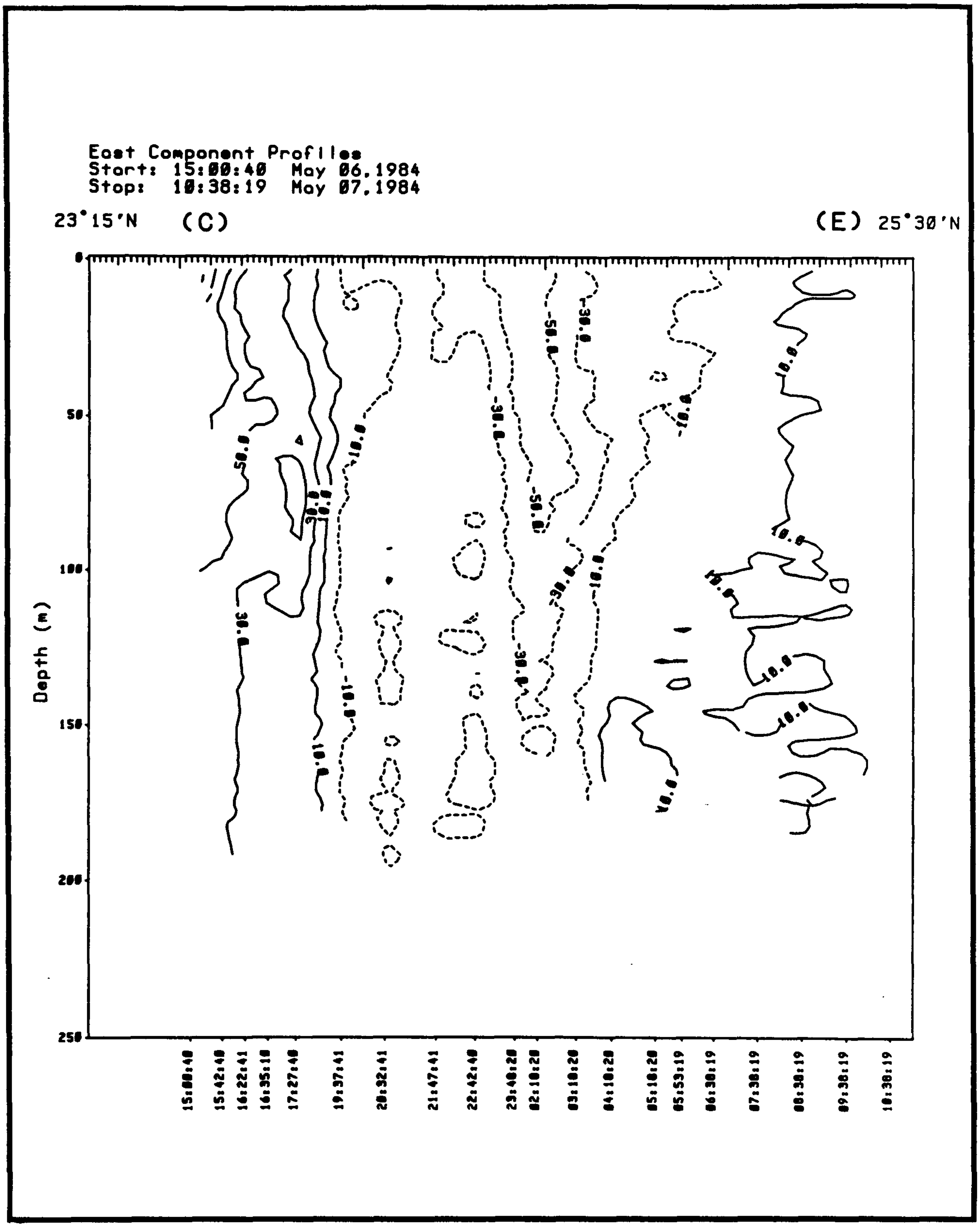

Figure 4.3-10. Vertical cross-section of the east component of horizontal velocity for Transect II of Cruise CF8405.

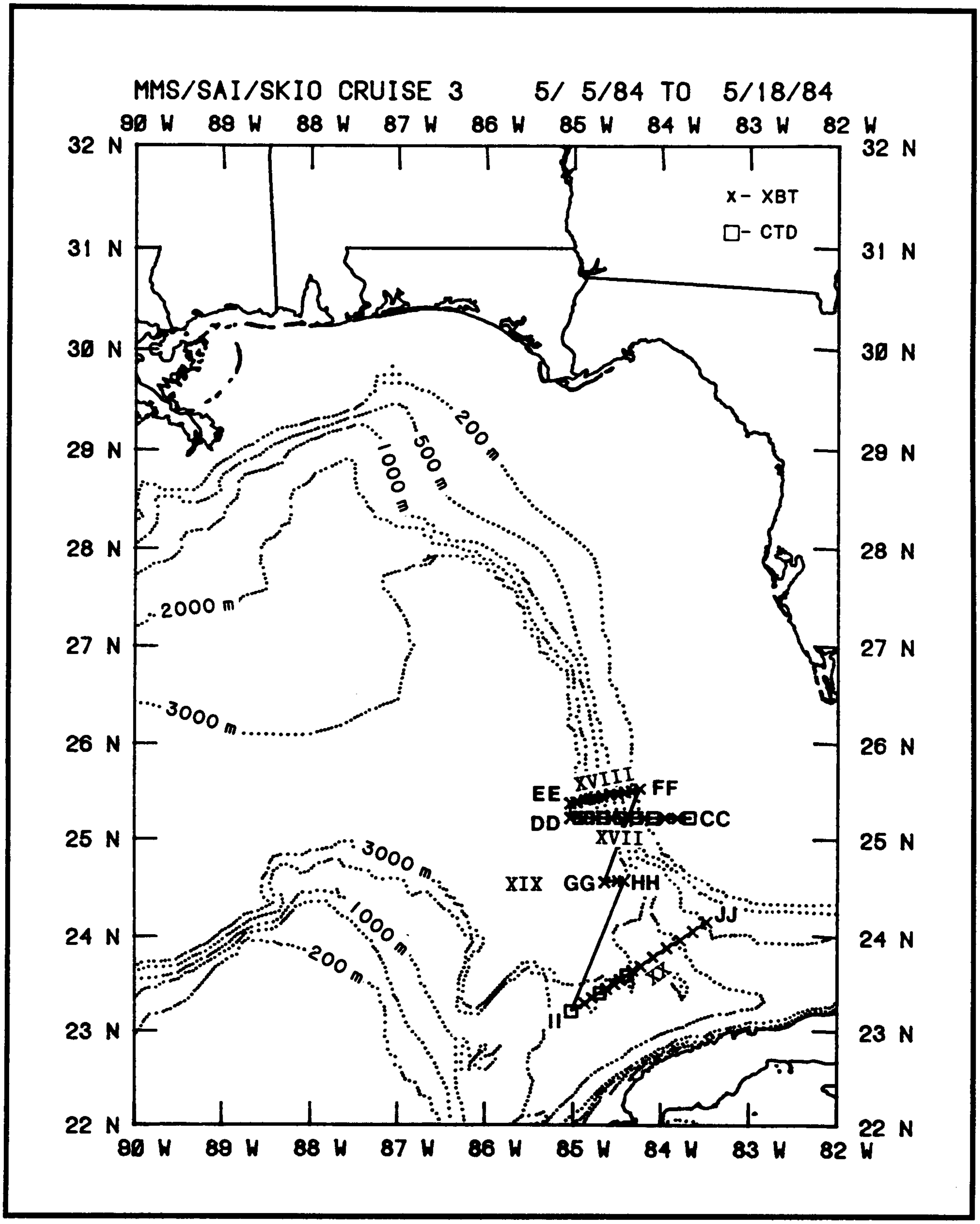

Figure 4.3-11. Cruise track showing XBT and CTD station locations for Transects XVII through XX of Cruise CF8405.

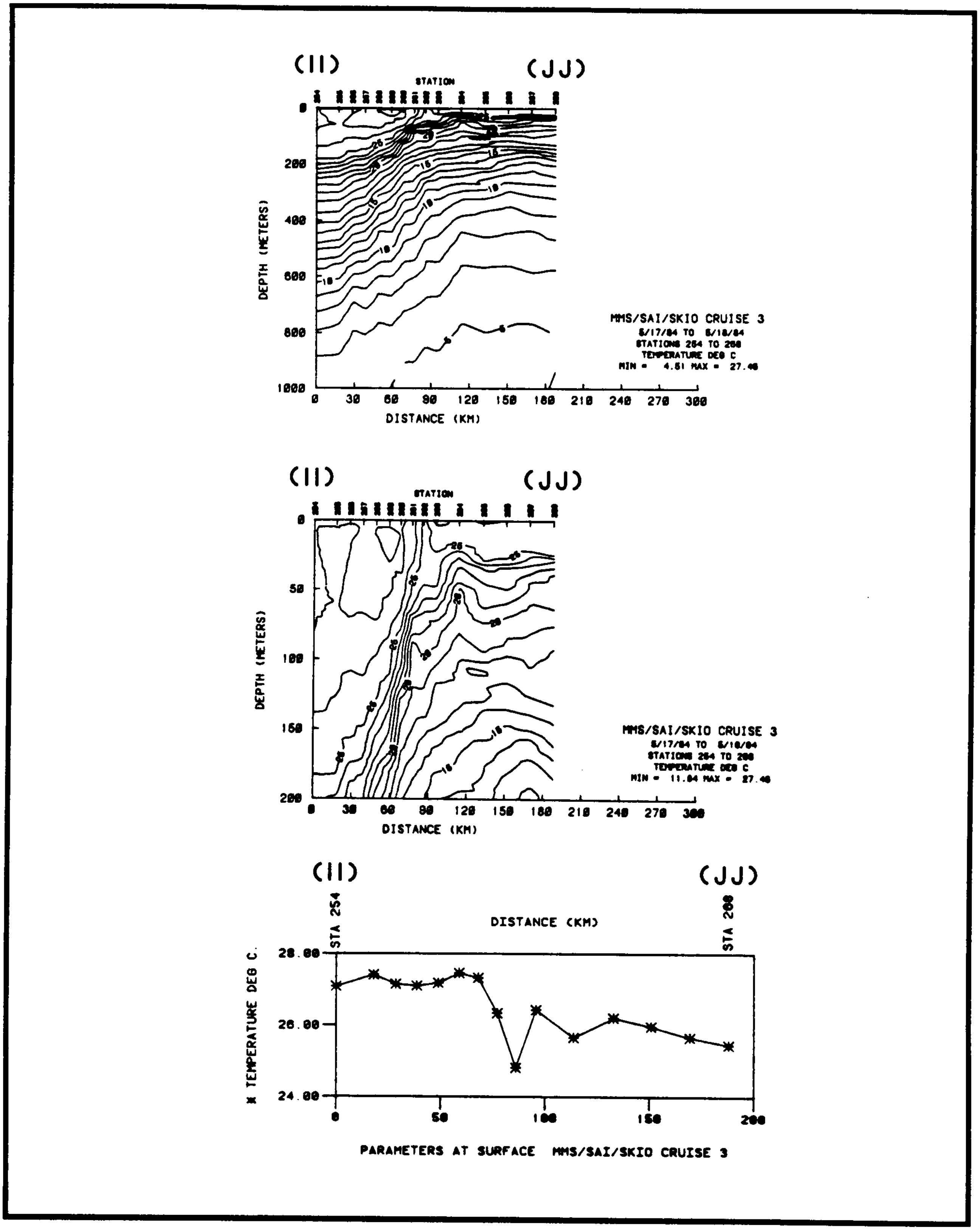

Figure 4.3-12. Vertical temperature section along the axis of the cold perturbation (Transect XX). Both 1000 and 200 meter scales are shown. SST is shown in the lower panel.

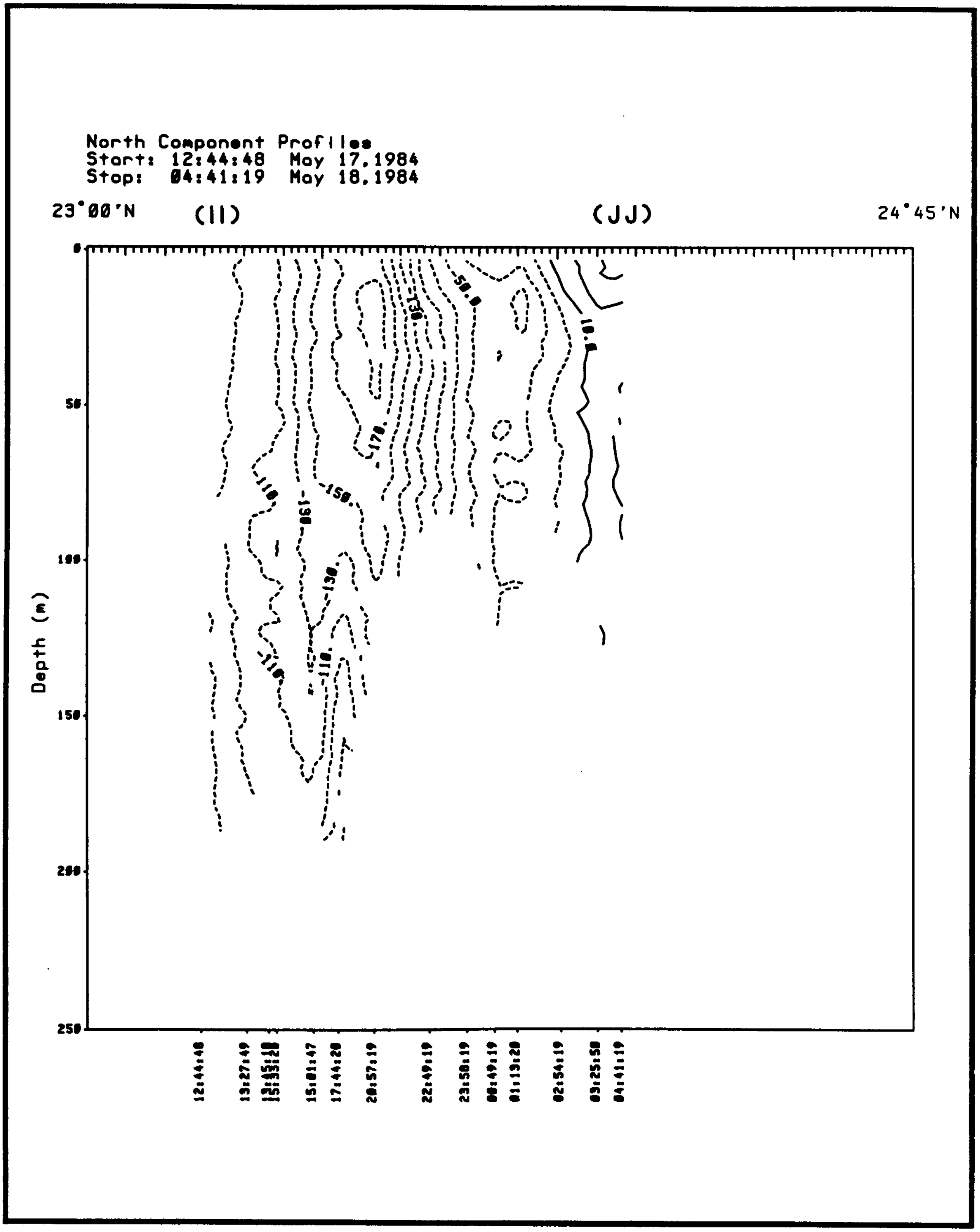

Figure 4.3-13. Vertical cross-section of the north component of horizontal velocity for Transect XX of Cruise CF8405.

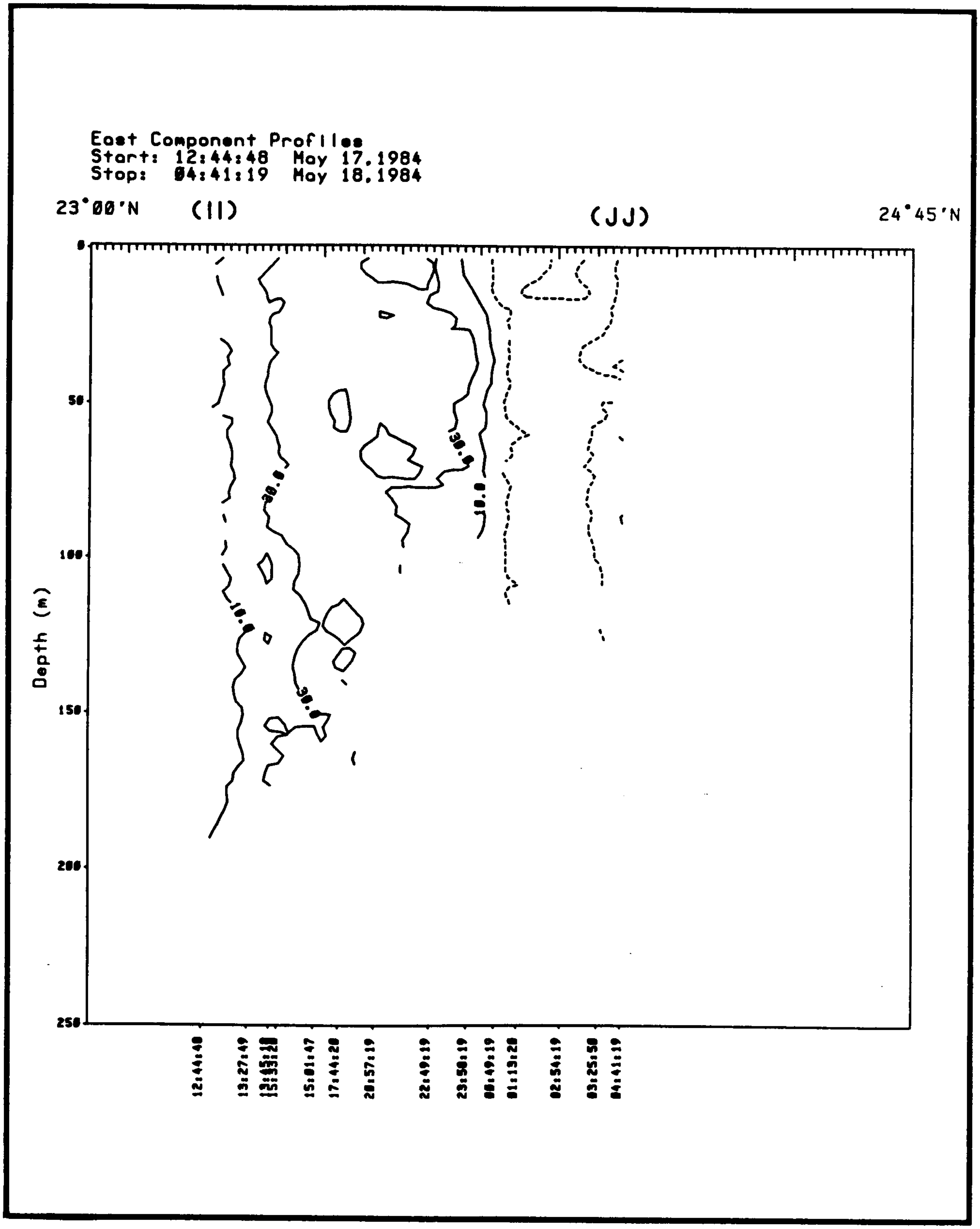

Figure 4.3-14. Vertical cross-section of the east component of horizontal velocity for Transect XX of Cruise CF8405.

return of the Loop Current to its normal geometry but lack of sufficient observations and/or theoretical framework preclude such a conclusion.

4.3.3 Loop Current Frontal Eddy

4.3.3.1 Introduction

This section describes observations of an example of the third mechanism mentioned above by which the Loop Current can affect flow patterns on the outer WFS. These data consist of a regional mapping of the southwestern WFS immediately after the first visit to the cold perturbation discussed above followed by a time series of data collected on two closely spaced transects through which a frontal eddy passed.

4.3.3.2 Initial Mapping

The first mapping of the Loop Current frontal region adjacent to the WFS was begun with the occupation of Transect III (Line E-F) shown in Figure 4.3-3. It corresponded geographically to a line of moored current meters deployed as part of the GMPOP (Figure 4.3-15). Unfortunately, as stated in Section 2.3.2, lack of navigation data along this section renders a direct comparison of the moored and ADCP data impossible. Figure 4.3-16 shows current vectors for three depths at Mooring C which was located on the 180-m isobath near the shelf break. The beginning of this time series corresponds to the occupation of Transect III (7-8 May). Between the 8th and 10th of May (day 131) a weak cyclonic feature propagated past Mooring C, reversing the flow at all depths. This flow reversal persisted for several days. Note that it was not until 10 days later that the primary Loop Current front returned to the shelf break along this transect and a strong southward flow was re-established. No strong evidence was observed in the hydrographic data of the presence of the frontal eddy responsible for the flow reversal, and it is concluded that in this space and time frame, the feature must have been either relatively young (and therefore weak) or, if mature, just approaching this area as it moved south.

On Transect IV (Line G-H shown in Figure 4.3-3) which was located about 20 nautical miles to the north, the high velocity core of the Loop Current was more than a half degree of longitude west of the shelf break and the surface flow (Figure 4.3-17) was directed southwestward across the local isobaths. The corresponding vertical cross-section of the north component of ADCP velocity (Figure 4.3-18) shows a weak cyclonic return flow to the north extending from the surface down to about 75-m depth and having about the same magnitude (10 cm s-1) as the northward return flow measured on Transect III by the moored current meters. It is possible that this is the same frontal feature visible in the SST data for 20 April (Figure 4.3-2) but not apparent in the 7 May SST image (Figure 4.3-4).

The decision was made to steam southward to the southern limit of the work area and map the local frontal region prior to the arrival of the Loop Current frontal eddy. Near-surface velocity vectors are shown for Transect IX through

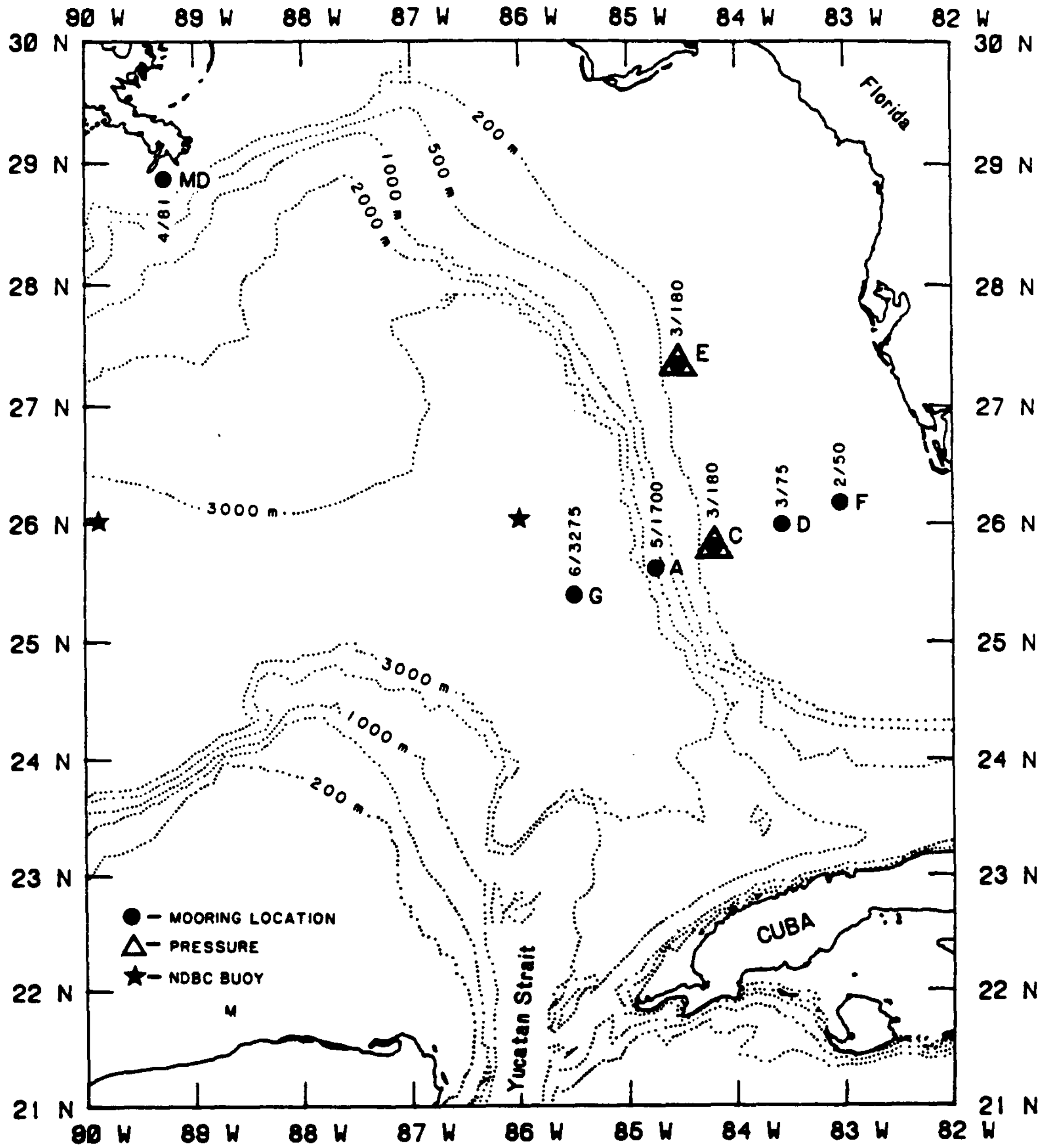

Figure 4.3-15. Location of Moorings A through G and MD deployed in the eastern Gulf of Mexico as part of the GMPOP. The numbers represent the number of current meters and the bottom depth.

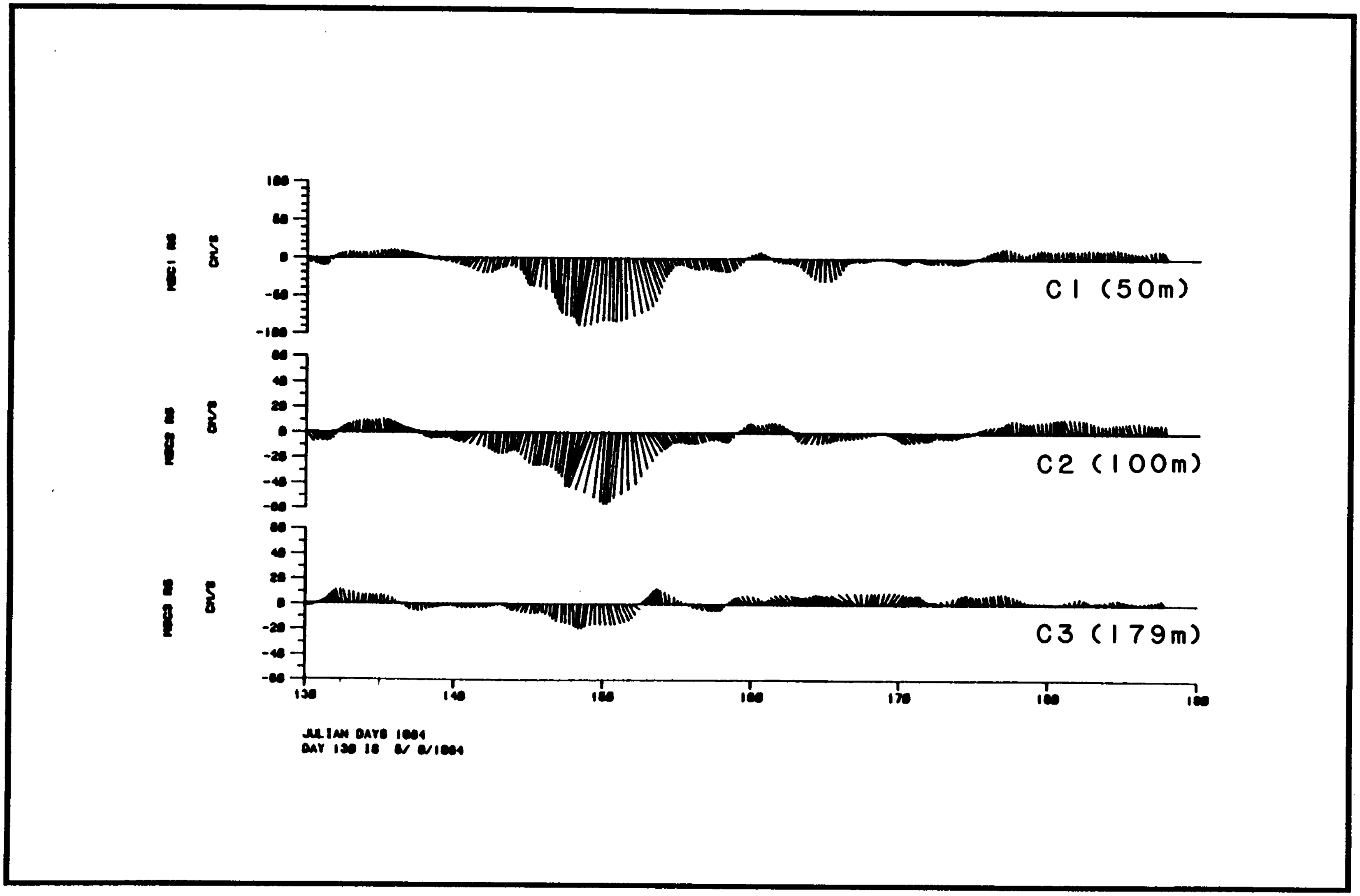

Figure 4.3-16. Stick plots of velocity from the three depths sampled by Mooring C.

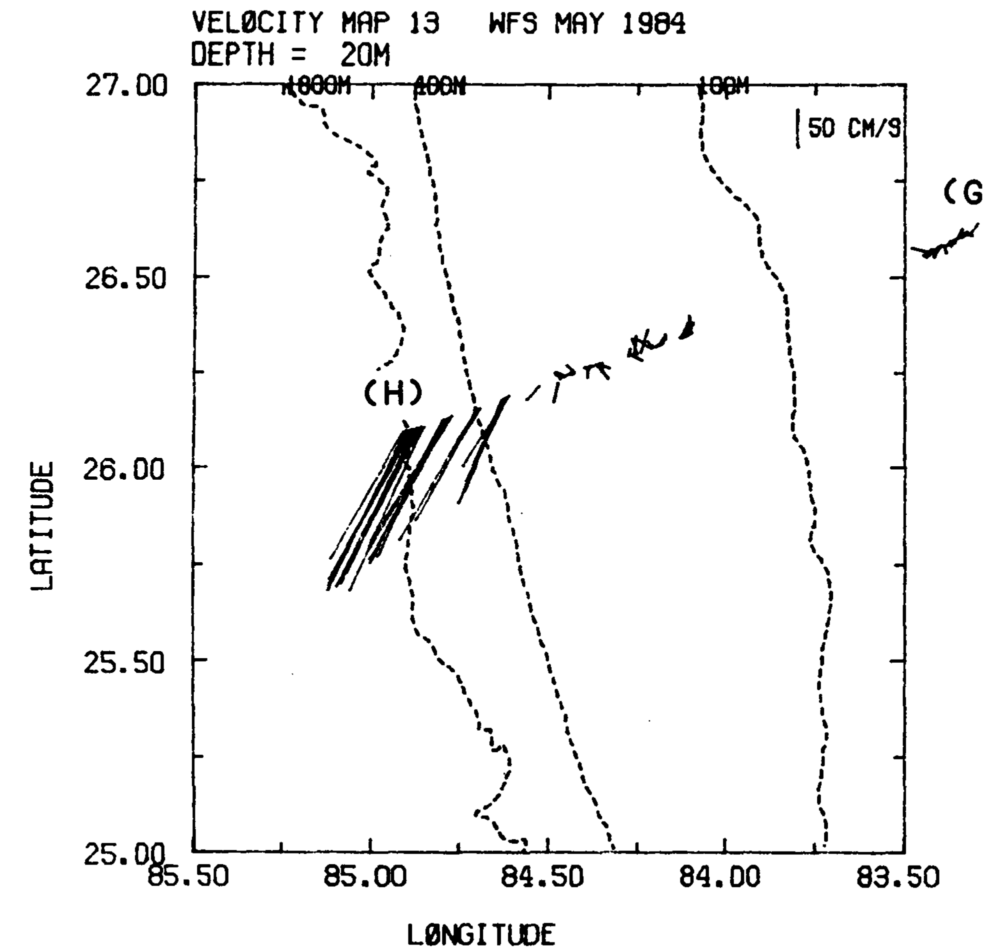

Figure 4.3-17. Stick plots of ADCP velocity from Transect IV of Cruise CF8405.

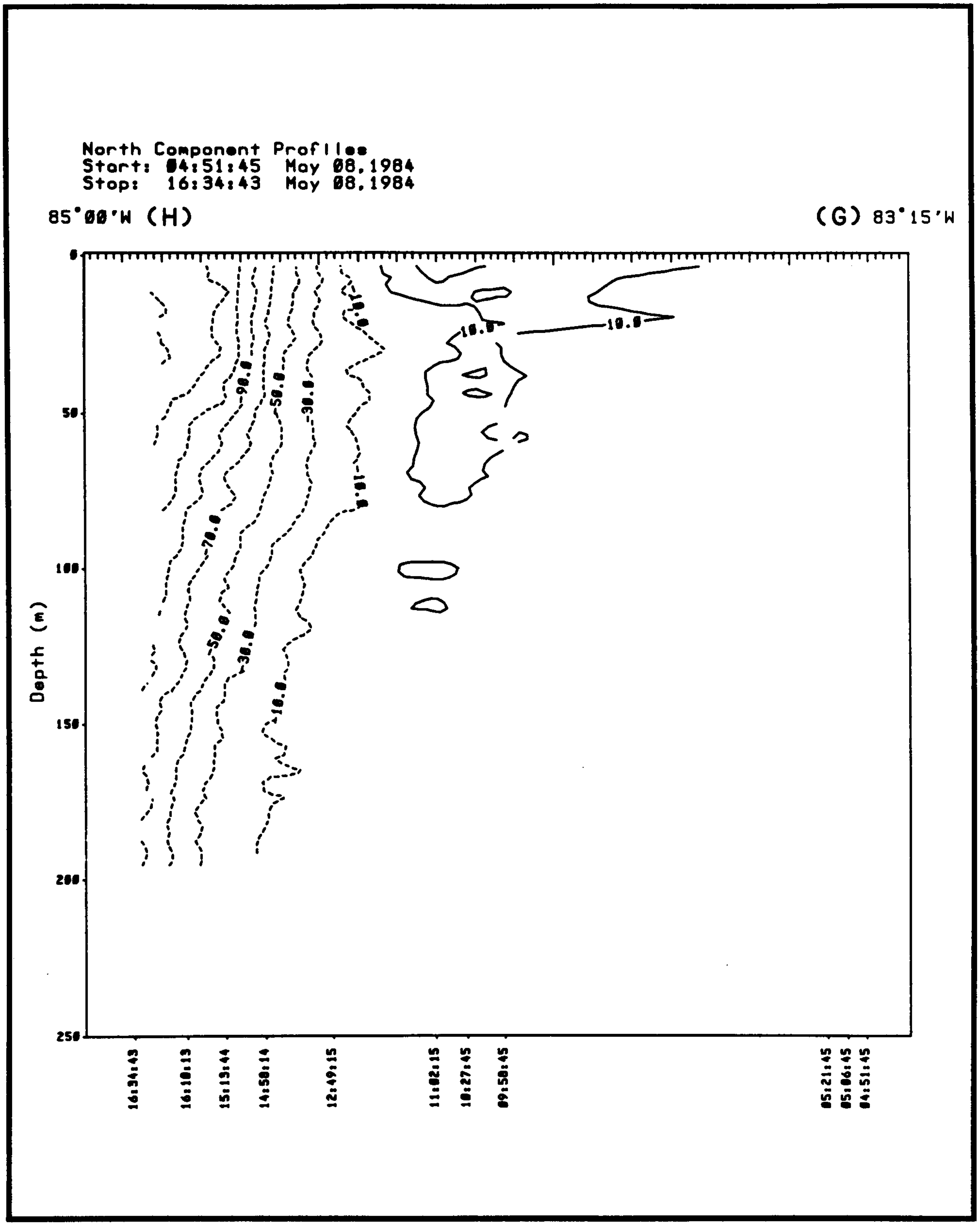

Figure 4.3-18. Vertical cross-section of the north component of horizontal velocity for Transect IV of Cruise CF8405.

XIII (Figure 4.3-19) in Figure 4.3-20. The northward flow in the eastern portion of Transect IX is thought to be a remnant of the cold perturbation discussed in Section 4.3.2. Transects X and XI show no deviations from the classic concept of an unperturbed Loop Current front. Transect XIII, however, exhibits not only the offshore cross-isobath flow seen on Transect IV, but also a distinct region between the 400- and 100-m isobaths where the flow is northward. The corresponding cross-section of the north component of velocity as measured by the ADCP (Figure 4.3-21) shows northward flow at all depths east of 84.5°W longitude. A small area within this region has northward flow exceeding 20 cm s-1. Transect XIII was located on the above mentioned mooring line. The time series data from Mooring C, corresponding to the time of Transect XIII (12-13 May), agree quite well, with both systems giving northward flow at all depths of about 10 cm s-1.

This, in contrast to the situation at Transects X and XI, is the circulation pattern expected for a typical cold core/warm filament cyclonic frontal eddy. This represents the first time the circulation in such a feature has been directly measured on length scales small enough to resolve the details of such features.

4.3.3.3 Time Series Observations

Once the Loop Current frontal eddy had been positively identified and located on Transect XIII, two cross-isobath sections were chosen south of Transect XIII for repeated occupation as the eddy propagated through the work area. The locations of these are shown in Figure 4.3-22. The series at the southern transect consists of Transects XI, XV and XVII while the northern series consists of Transects XIV, XVI and XVIII as given in Table 4.3-1.

On the first circuit of these two cross-sections, the Loop Current was characterized by a sharp cyclonic shear zone centered over the 400-m isobath. At Transect XI (Line S-T of Figure 4.3-19), the ADCP and temperature fields (Figures 4.3-23 and 4.3-24, respectively) indicate no evidence of frontal eddy activity. However, to the north at Transect XIV (Line W-X) more doming of the isotherms was evident (Figure 4.3-25), indicative of the southern leading edge of the upwelling cold core; and a warm pool of water was found flowing to the north (Figure 4.3-26) in the eastern portion of the transect. Two days later, the doming of the isotherms had continued to intensify (Figure 4.3-27) and the velocity field was fully developed on both the northern and southern transects (Transects XVI and XV in Figures 4.3-28 and 4.3-29, respectively) with the northward return flow extending throughout the entire water column at the shelf break. It is interesting to note that the high speed core of the Loop Current is now directed east of south (Figures 4.3-30 and 4.3-31) at both Transects XV and XVI indicating that the eddy is in the lee (i.e., to the north of), an onshore meander of the primary front. During the third and final circuit of the time series transects, the Loop Current continued to move offshore and the cold core/warm filament circulation persisted as evidenced by the temperature field (Figure 4.3-32) and the northward component of the velocity field for Transects XVII and XVIII (Figures 4.3-33 and 4.3-34). While the east component of velocity in the Loop Current front is still directed east of south for Transect XVII (the final southern cross-section, Figure 4.3-35), it is slightly west of south on Transect XVIII on 16 May (the

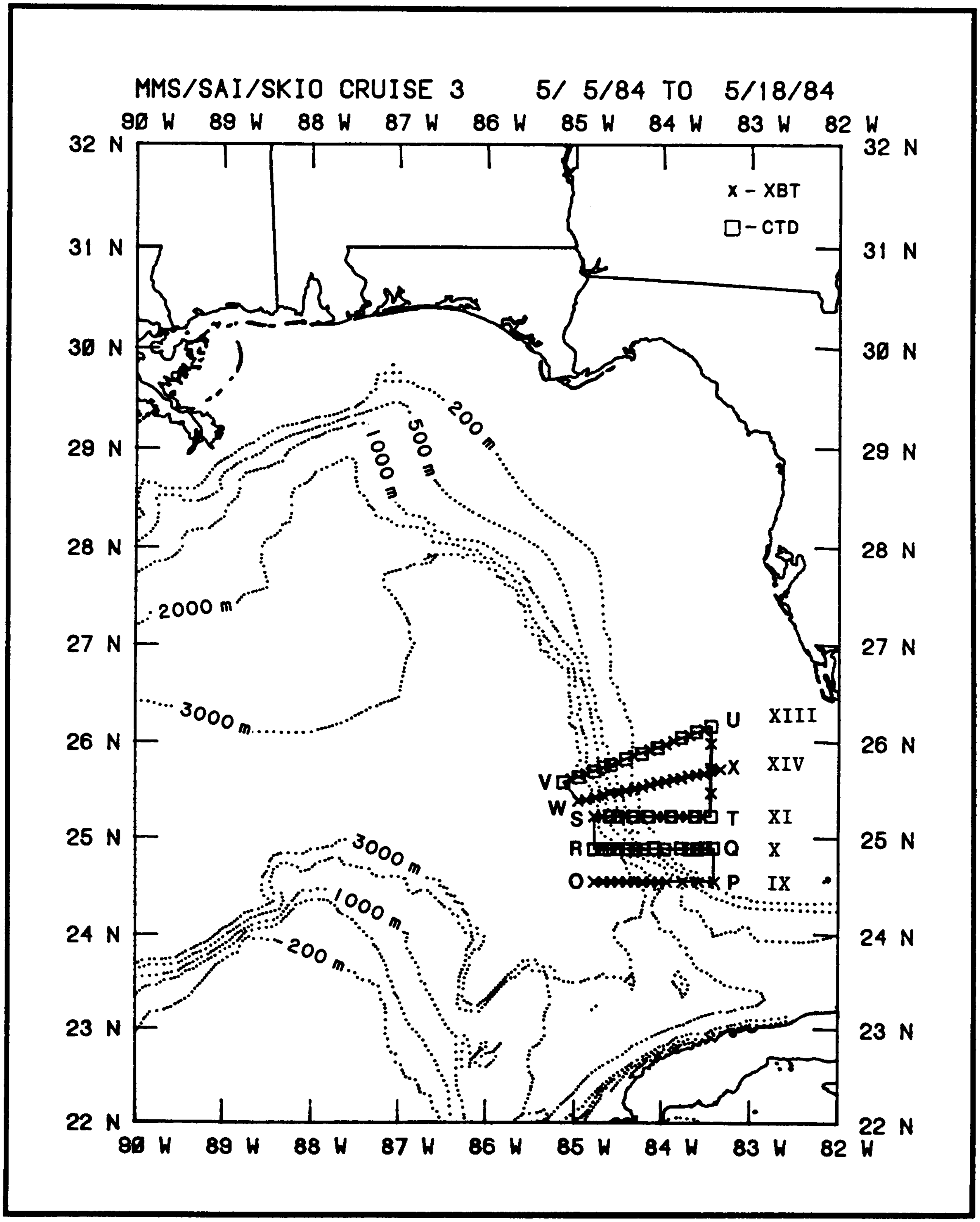

Figure 4.3-19. Cruise track showing XBT and CTD station locations for Transects IX through XIV of Cruise CF8405.

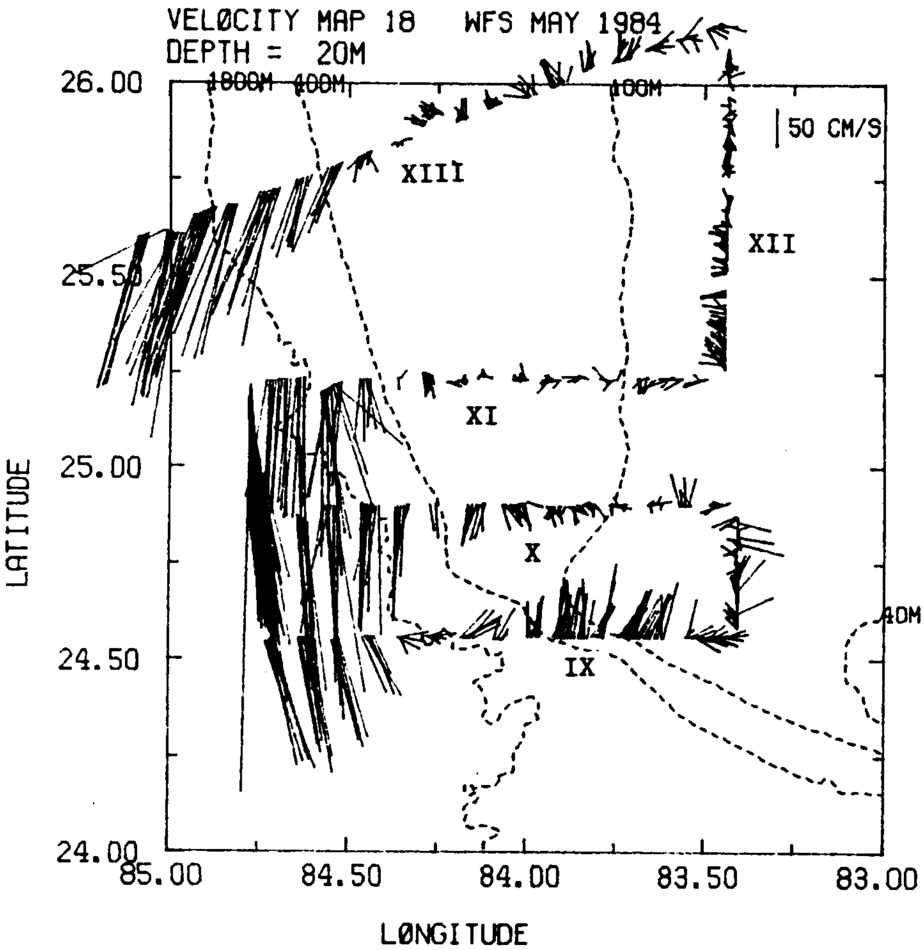

Figure 4.3-20. Stick plots of ADCP velocity from Transects IX through XIII (moving south to north).

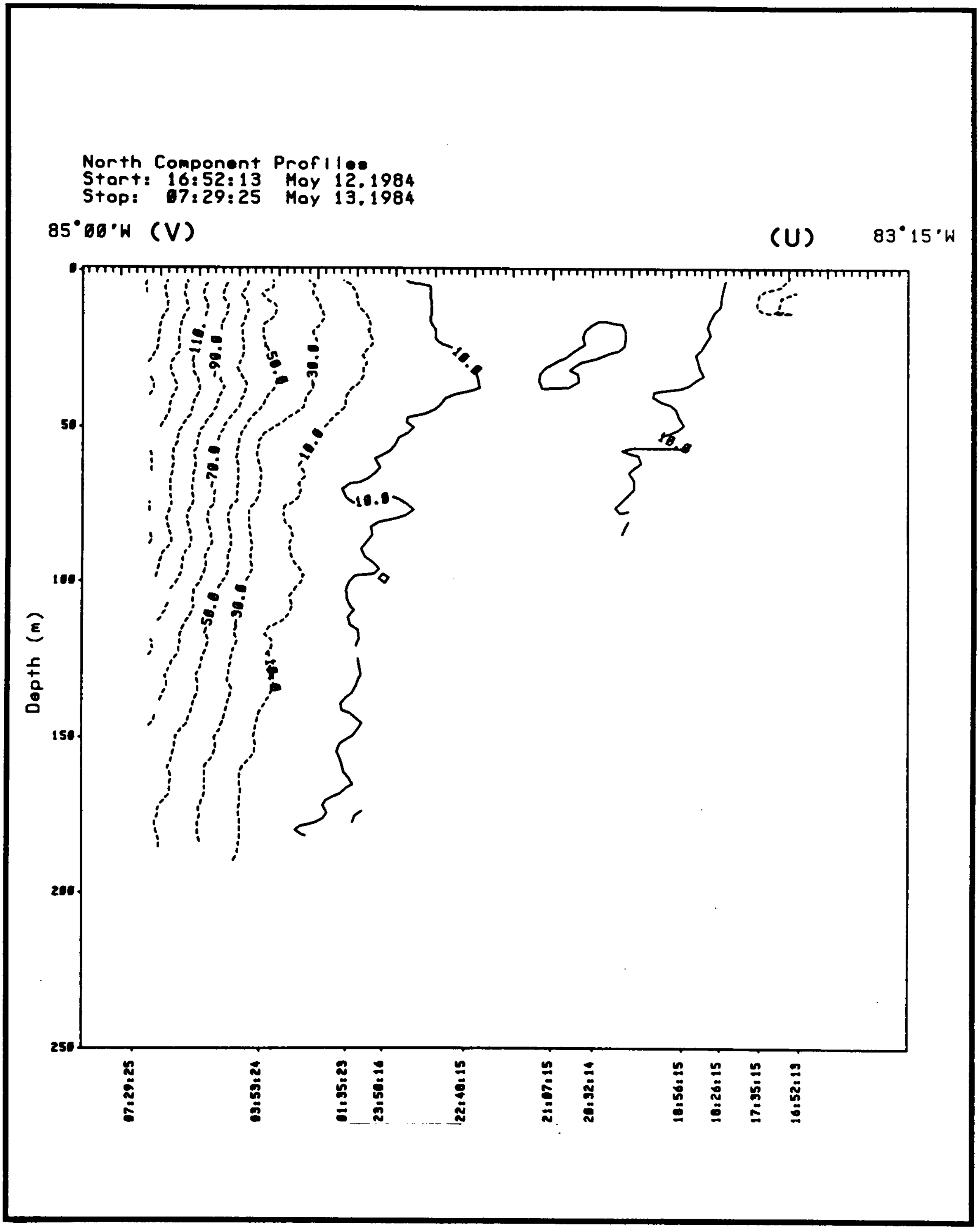

Figure 4.3-21. Vertical cross-section of the north component of horizontal velocity for Transect XIII of Cruise CF8405.

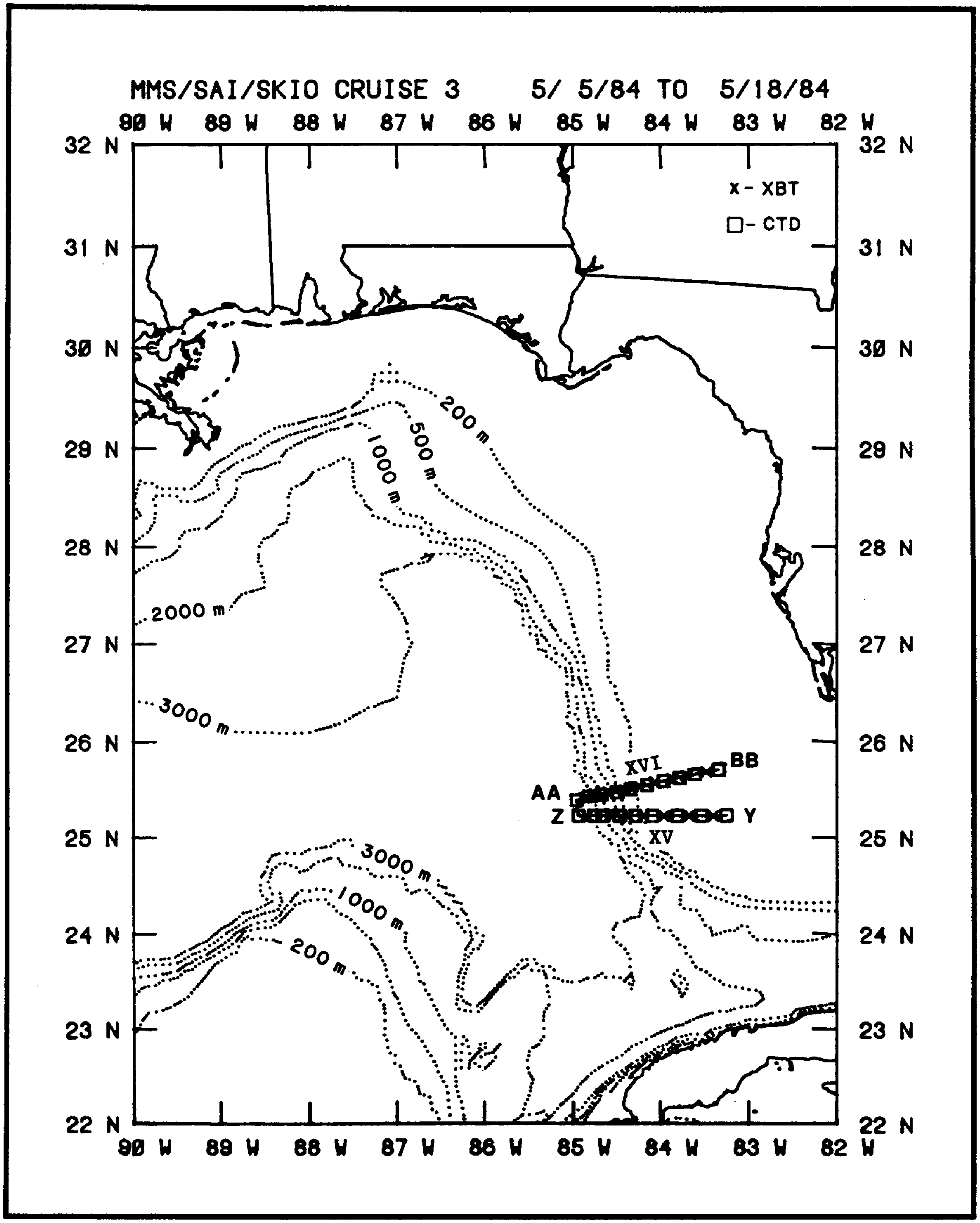

Figure 4.3-22. Cruise track showing XBT and CTD station locations for Transects XV and XVI, two of the time series transects for Cruise CF8405 (see Table 4.3-1).

Table 4.3-1. Time series sections for cruise CF8405, 4-19 May 1984.

Northern Section		Southern Section	
Section	Hydrographic Stations	Section	Hydrographic Stations
XIV (W-X)	170X - 188X (13 May)	XI (S-T)	130X - 146C (11-12 May)
XVI (AA-BB)	205C - 223C (14-15 May)	XV (Y-Z)	189C - 204C (14 May)
XVIII (EE-FF)	239X - 250X (16 May)	XVII (CC-DD)	224C - 238X (15-16 May)

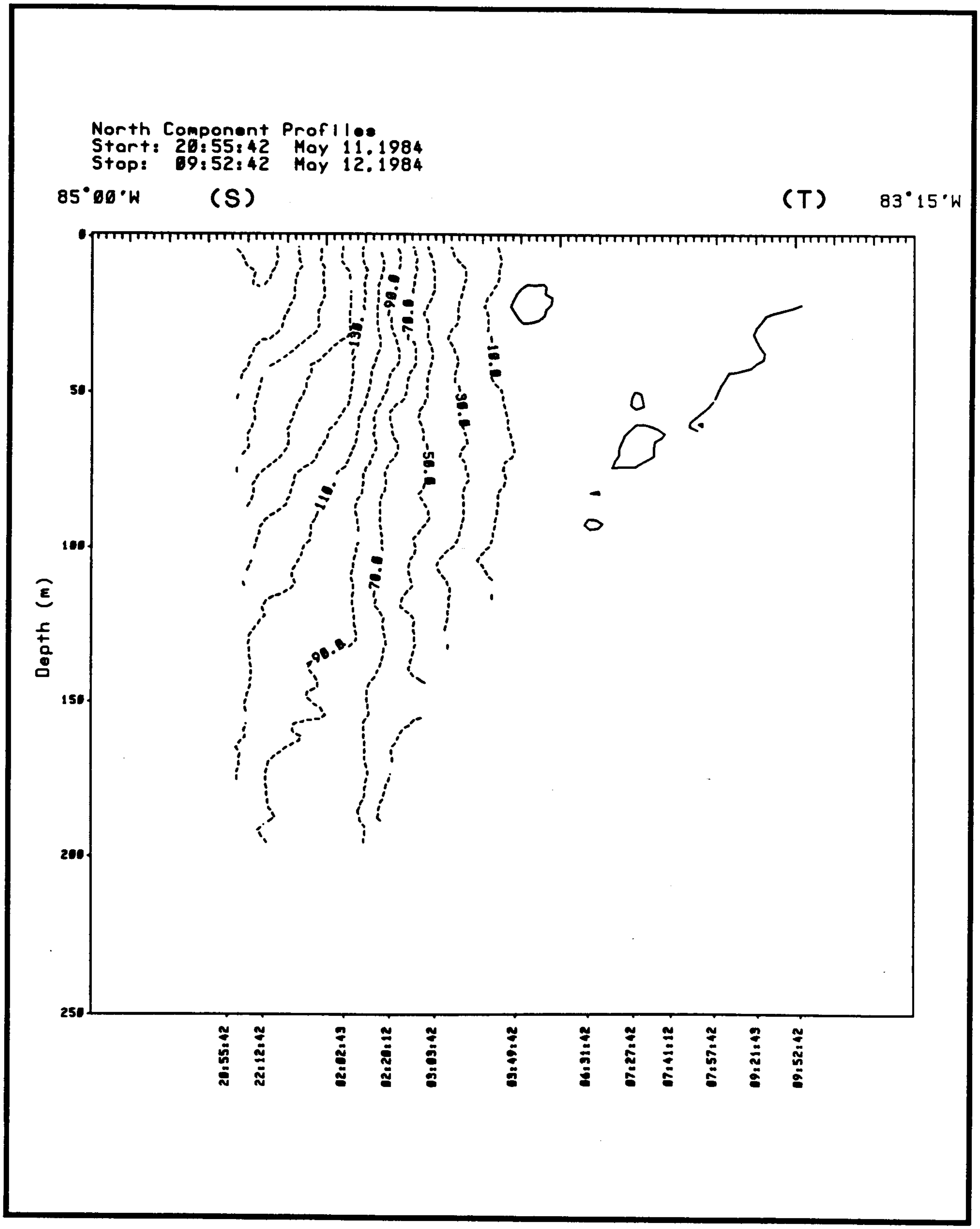

Figure 4.3-23. Vertical cross-section of the north component of horizontal velocity for Transect XI of Cruise CF8405.

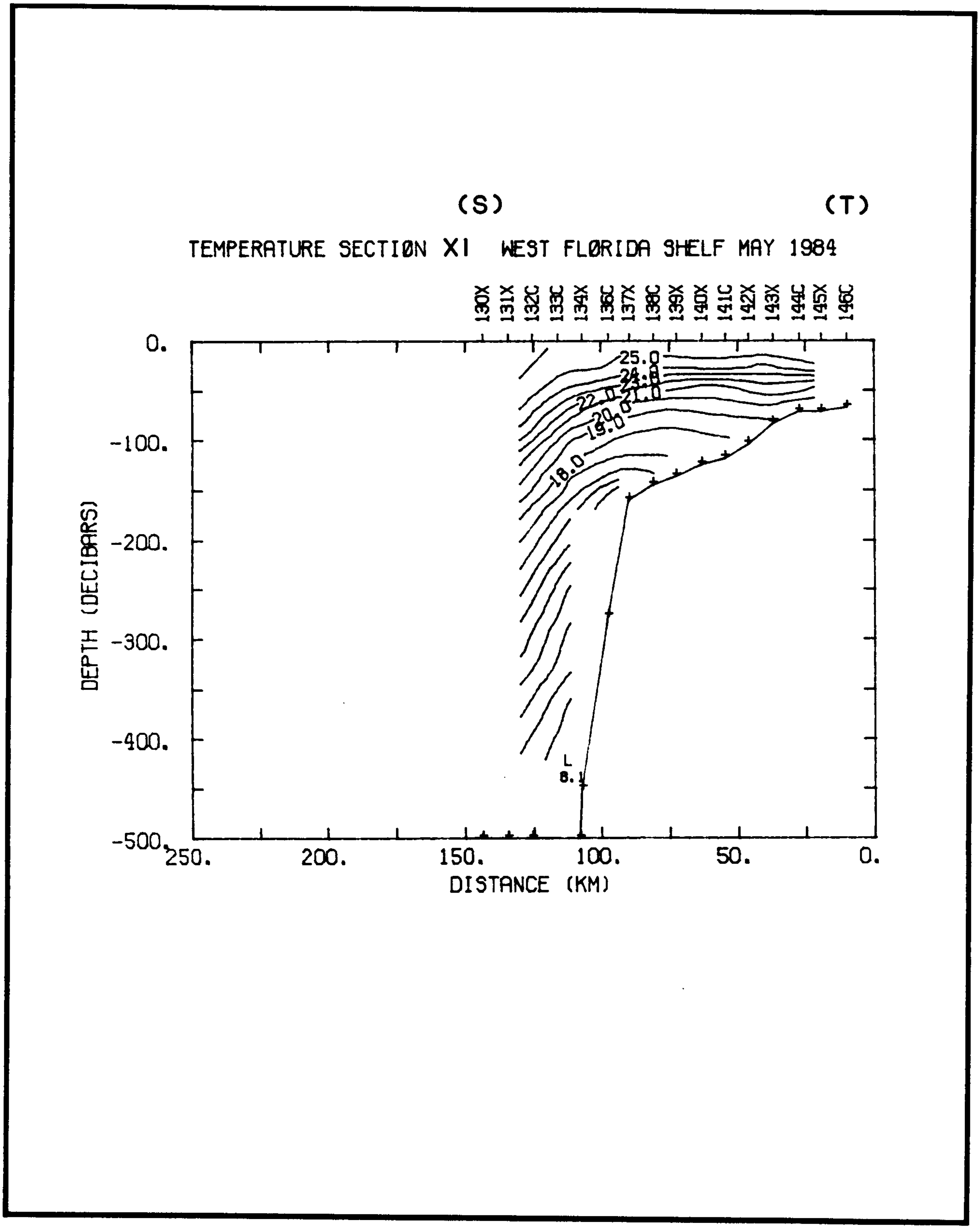

Figure 4.3-24. Vertical cross-section of temperature for Transect XI of Cruise CF8405.

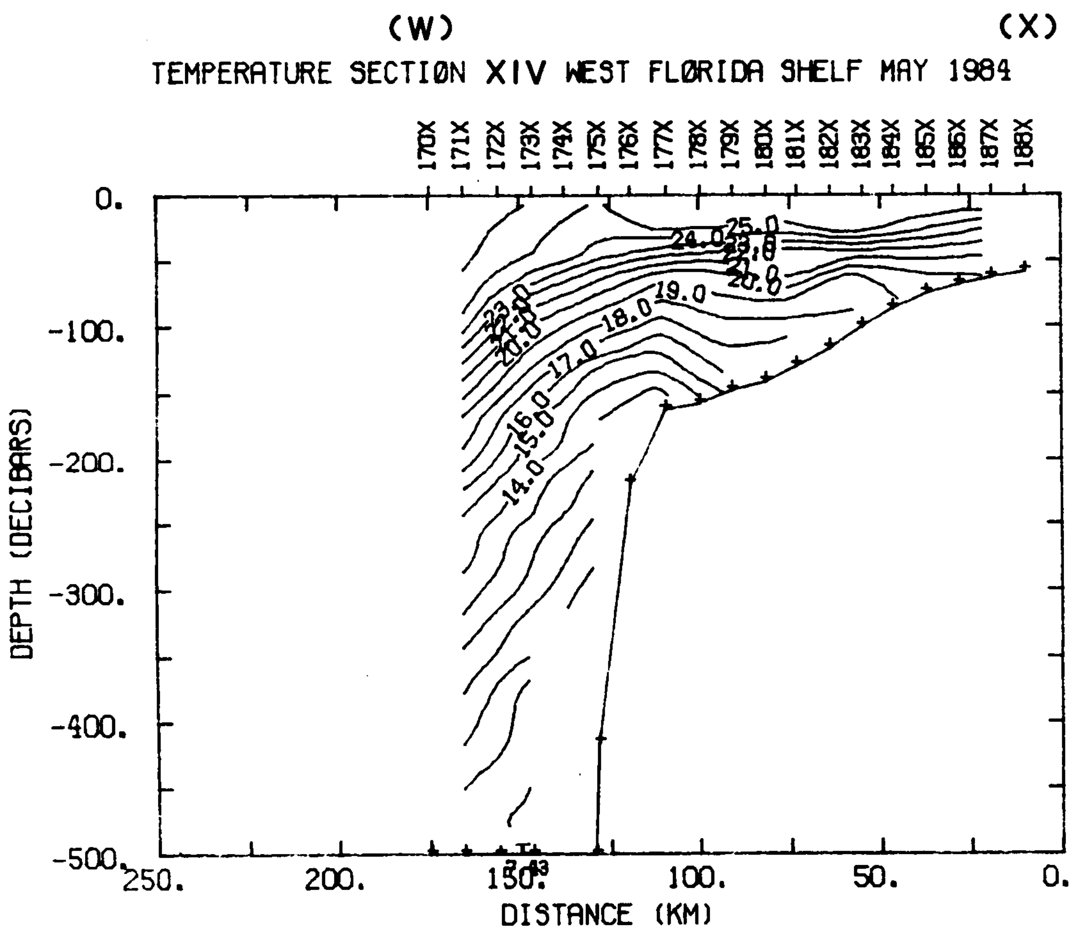

Figure 4.3-25. Vertical cross-section of temperature for Transect XIV of Cruise CF8405.

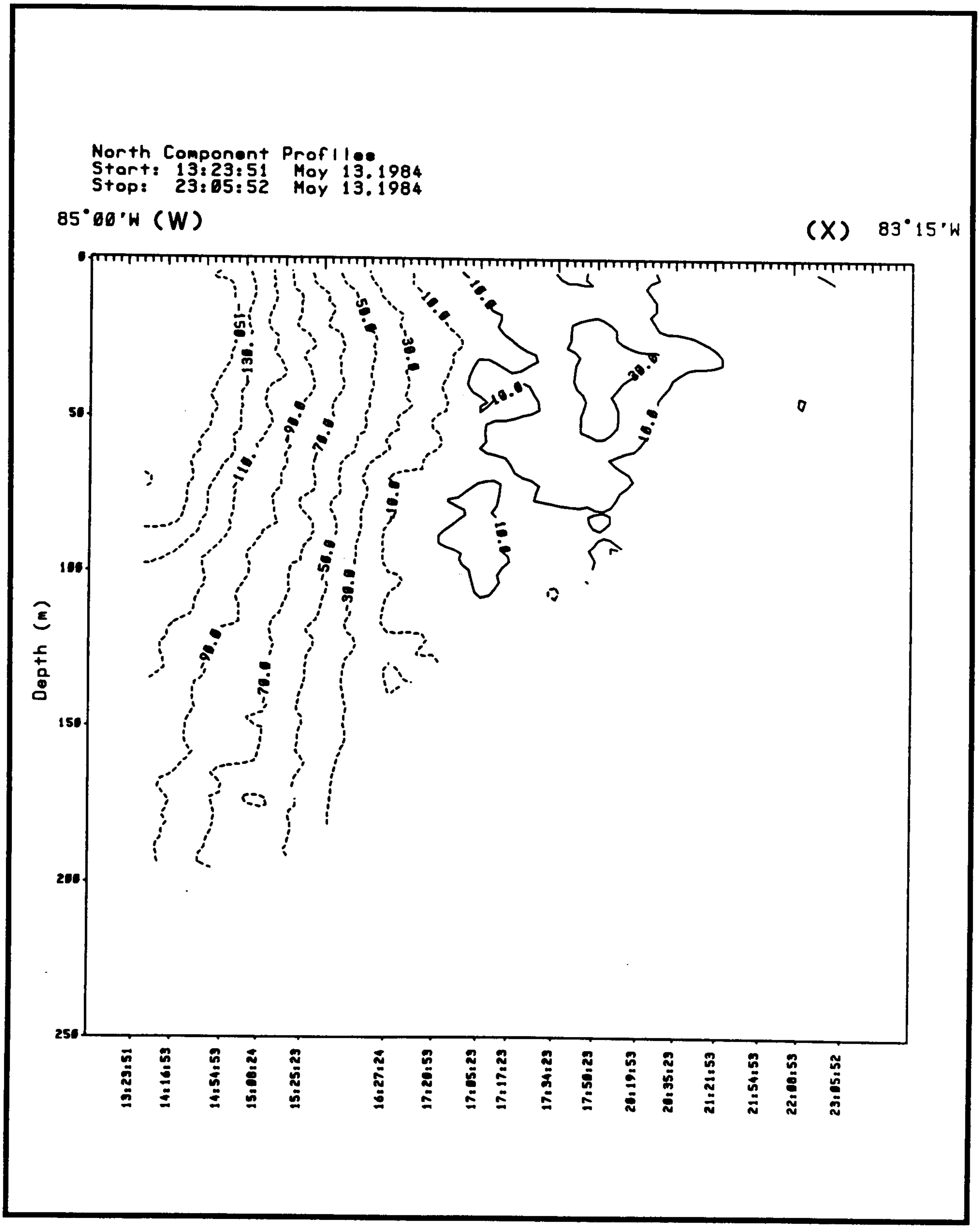

Figure 4.3-26. Vertical cross-section of the north component of horizontal velocity for Transect XIV of Cruise CF8405.

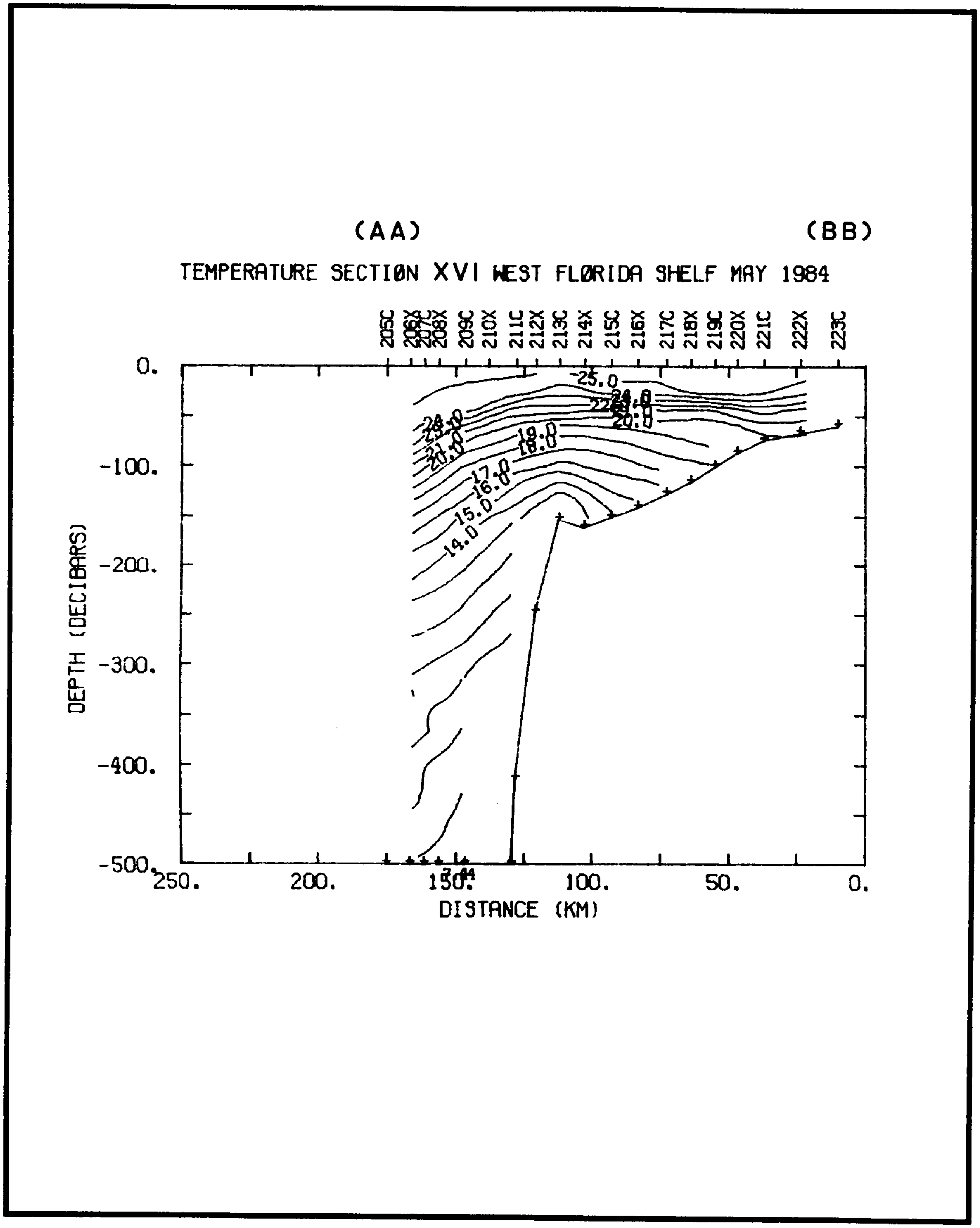

Figure 4.3-27. Vertical cross-section of temperature for Transect XVI of Cruise CF8405.

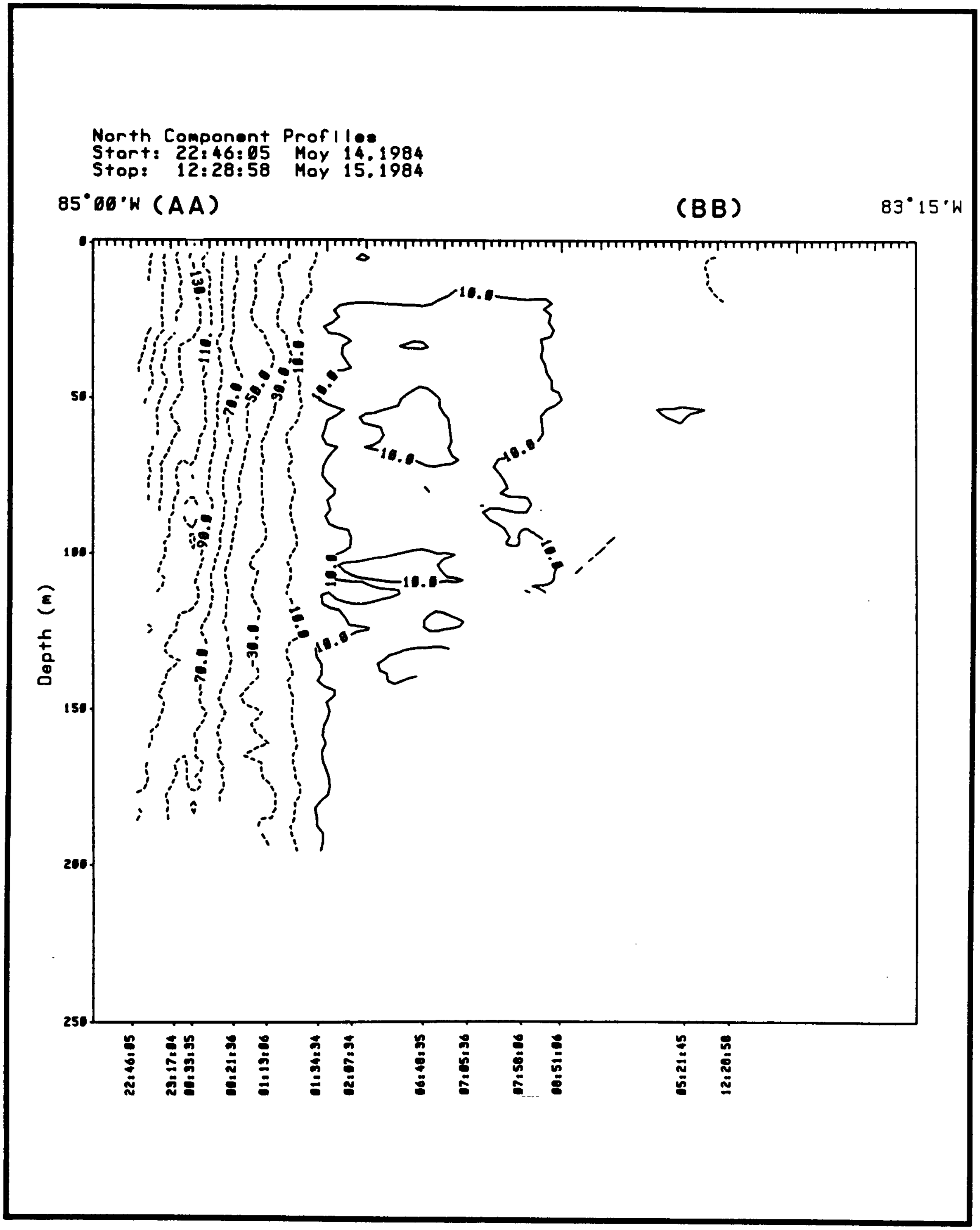

Figure 4.3-28. Vertical cross-section of the north component of horizontal velocity for Transect XVI of Cruise CF8405.

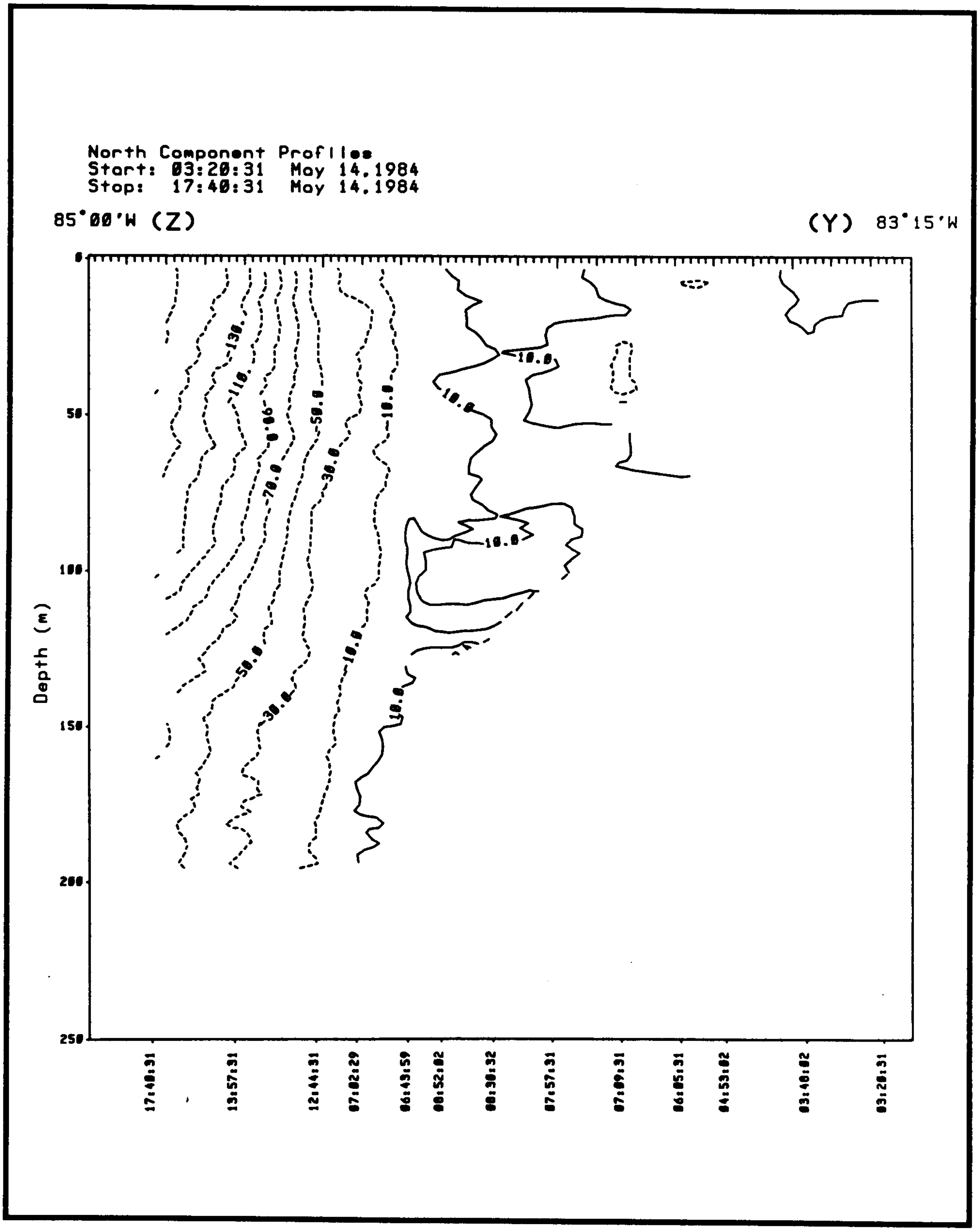

Figure 4.3-29. Vertical cross-section of the north component of horizontal velocity for Transect XV of Cruise CF8405.

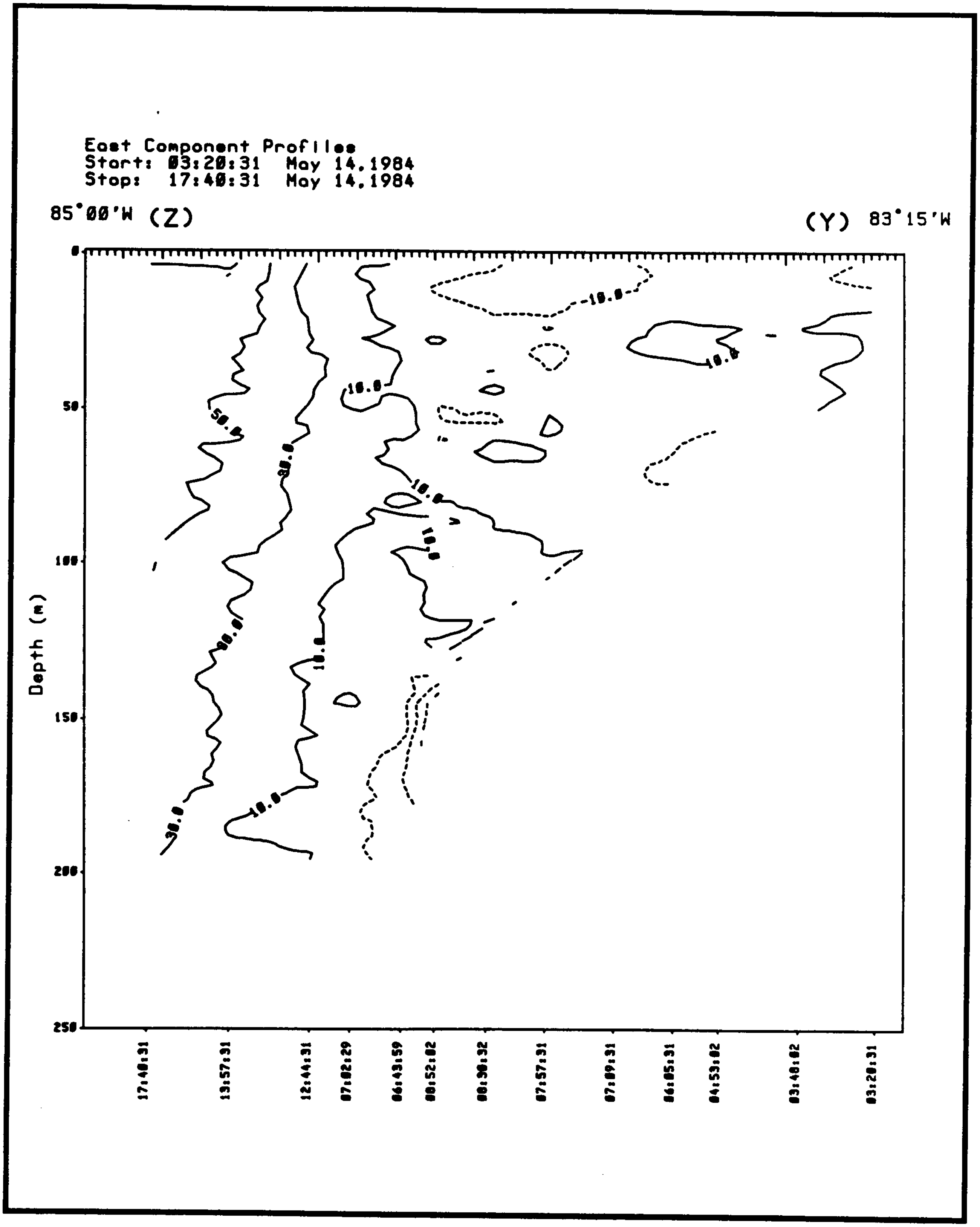

Figure 4.3-30. Vertical cross-section of the east component of horizontal velocity for Transect XV of Cruise CF8405.

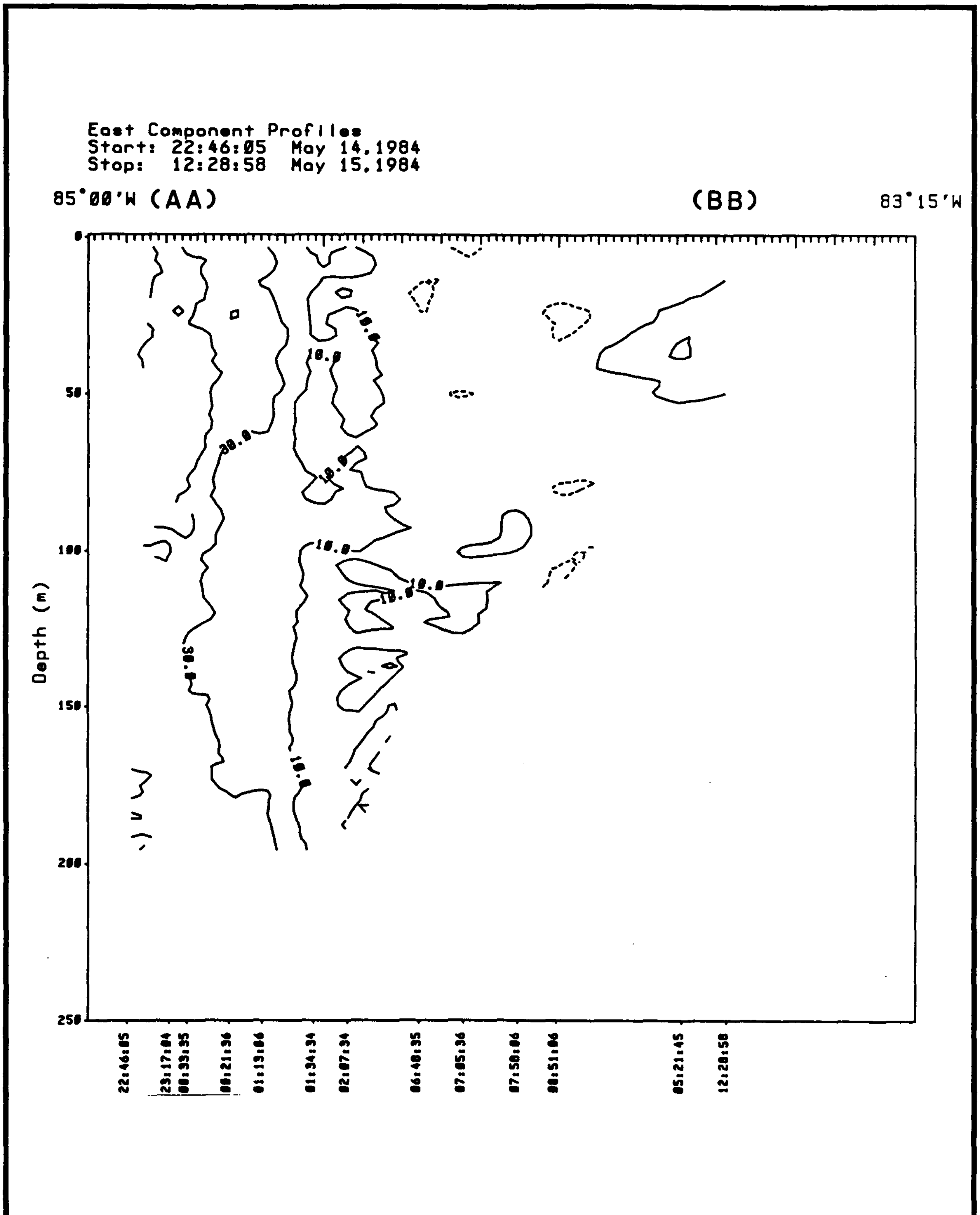

Figure 4.3-31. Vertical cross-section of the east component of horizontal velocity for Transect XVI of Cruise CF8405.

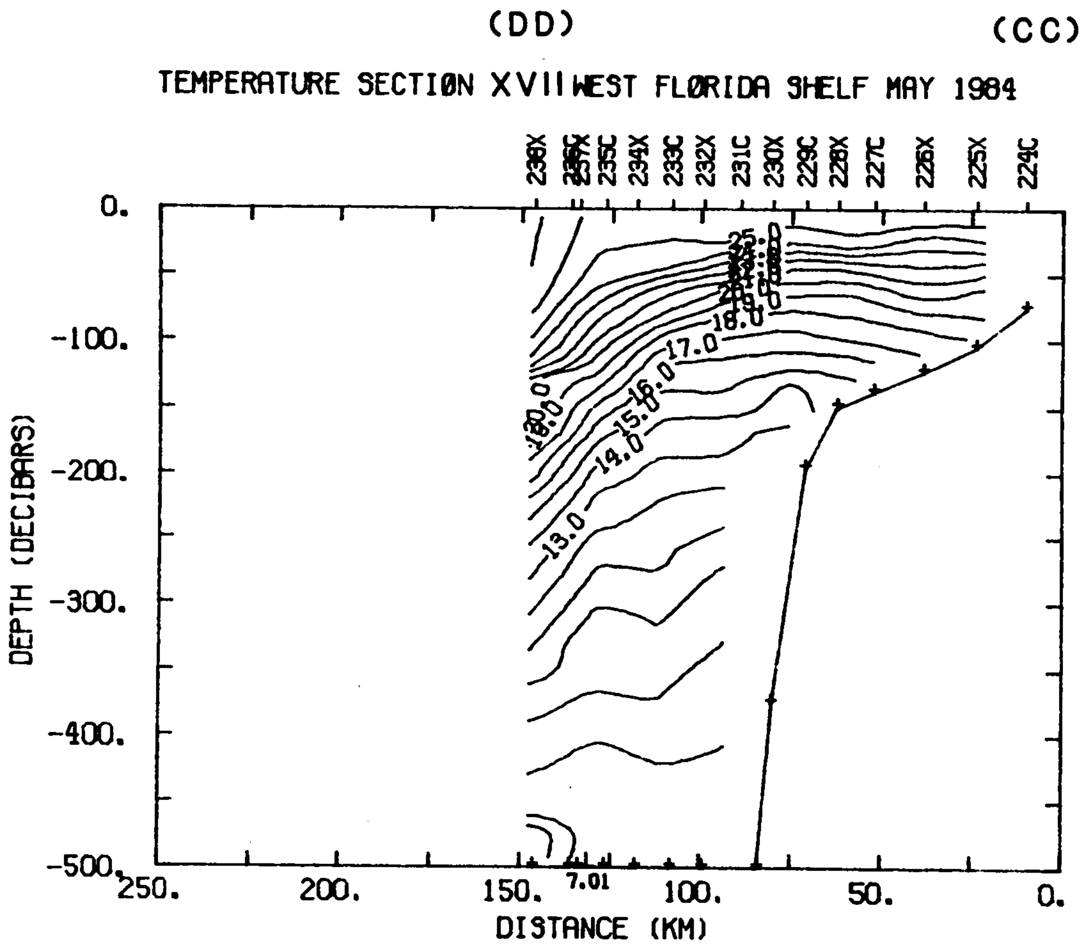

Figure 4.3-32. Vertical cross-section of temperature for Transect XVII of Cruise CF8405 (see Figure 4.3-11).

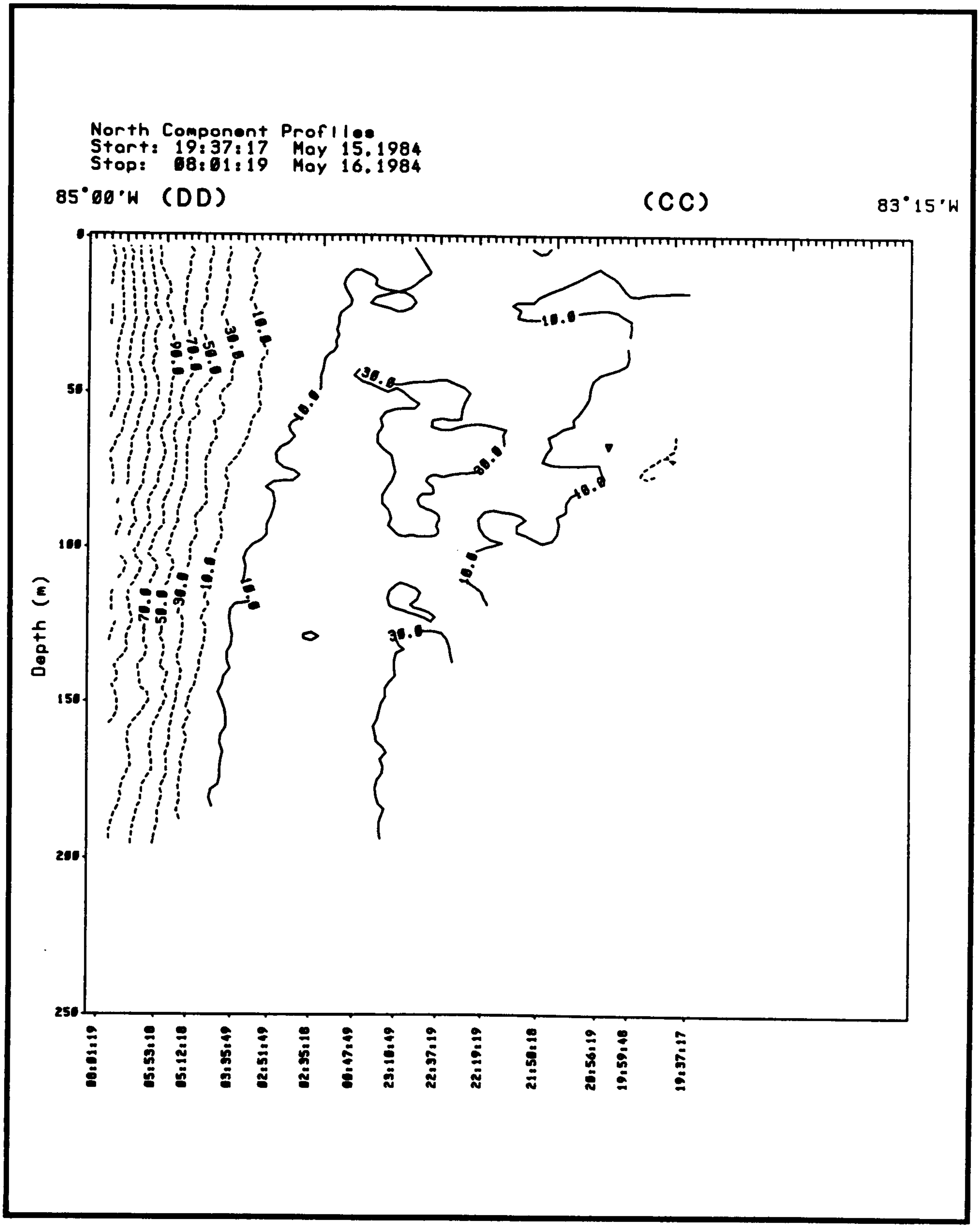

Figure 4.3-33. Vertical cross-section of the north component of horizontal velocity for Transect XVII of Cruise CF8405.

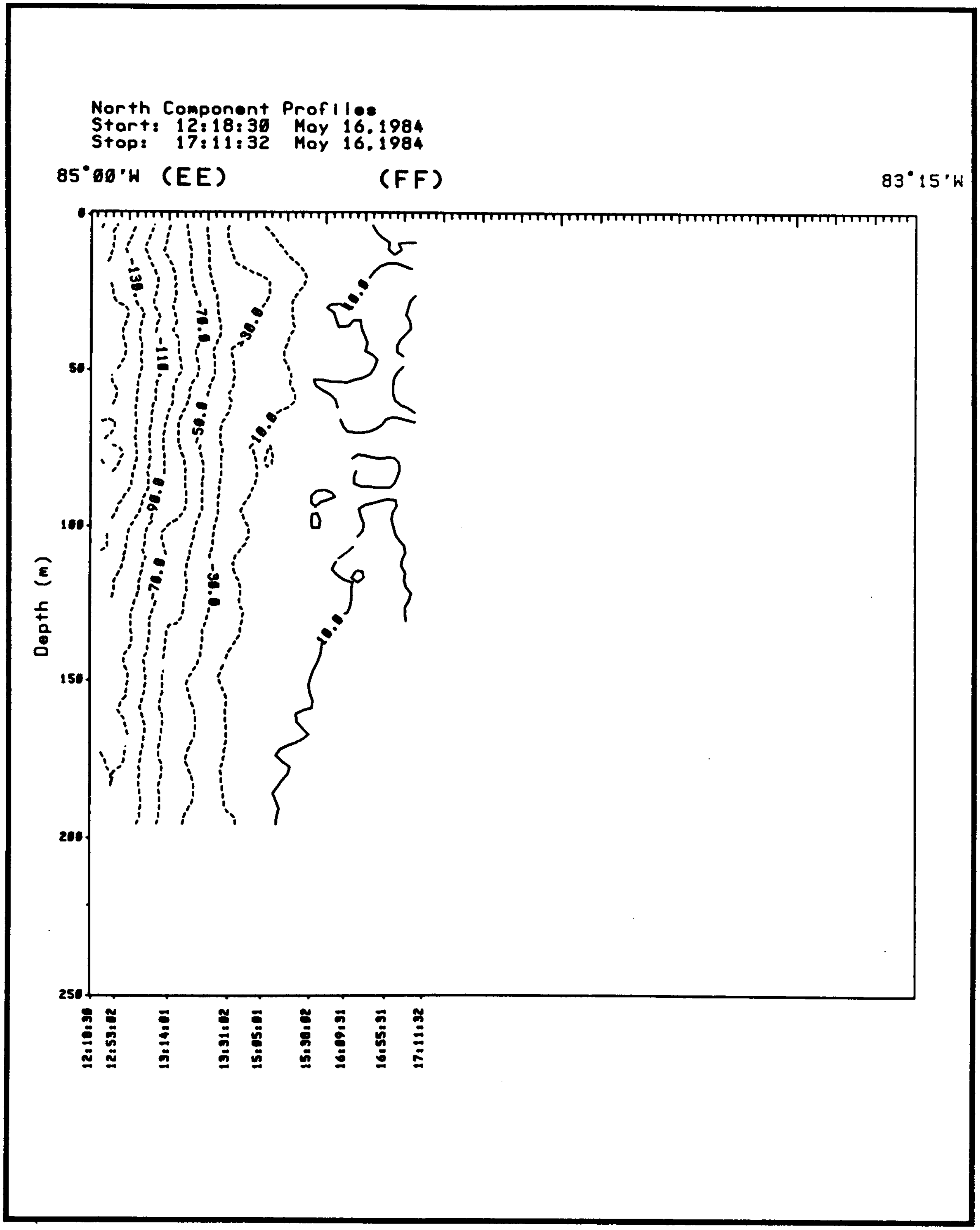

Figure 4.3-34. Vertical cross-section of the north component of horizontal velocity for Transect XVIII of Cruise CF8405 (see Figure 4.3-11).

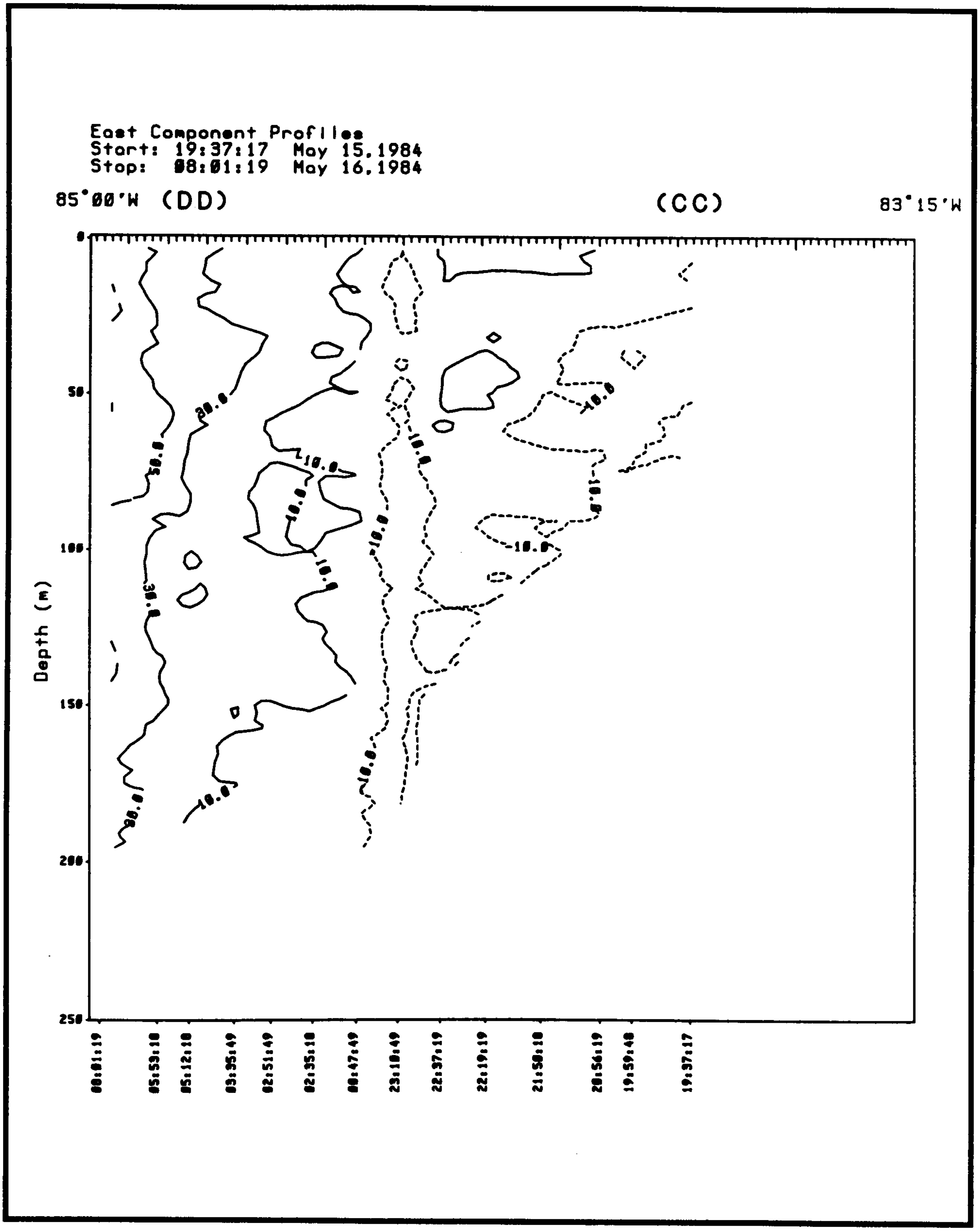

Figure 4.3-35. Vertical cross-section of the east component of horizontal velocity for Transect XVII of Cruise CF8405.

final northern cross-section, Figure 4.3-36), indicating that the trough of the meander responsible for the eddy has passed the latitude of the northern transect and that the next onshore crest should arrive within a few days. This is indeed consistent with the moored current meter data obtained 20 miles to the north since the end of the cyclonic event observed in the moored time series occurs at about this time.

A conceptual model which describes frontal eddies as upwelling vortices generated in the lee of southward (northward) propagating onshore meanders of the Loop Current (Gulf Stream) front has been proposed in the recent literature (Lee, Atkinson and Legeckis, 1981 and Pietrafesa, 1983). Such a model is supported by these observations.

4.3.4 Summary and Discussion

The dynamics of the outer continental shelf waters of Florida's west coast is dominated by the Loop Current and its frontal perturbations. Similar meanders and perturbations exist along the outer continental shelf of the southeastern United States due to the presence of the Gulf Stream and these have been studied extensively both observationally and theoretically during the last 15 years. Li et al. (1985) have utilized inverted echo sounders and current meters on a cross-shelf transect to monitor the position and flow field of the Gulf Stream in this region (commonly referred to as the South Atlantic Bight or SAB). They have shown quantitatively that while direct Gulf Stream forcing is negligible compared to wind forcing at mid-shelf, it dominates the near-surface flow and is at least as important as wind forcing at depth (i.e., below the Gulf Stream front) in the vicinity of the shelf-break. Similar results were presented by Lee and Atkinson (1983) based on data from a more extensive along- and cross-shelf current meter array which covered the central portion of the SAB between Cape Canaveral, FL and Cape Romain, SC.

The primary mode of Loop Current forcing of outer shelf circulation is, like that of the Gulf Stream, due to downstream-propagating lateral wave-like meanders of the axis of the Loop Current flow field and its associated density structure. In the Gulf Stream it is in the wake of an onshore meander crest that investigators have often observed the spawning of a cyclonic eddy consisting of an upwelled cold core surrounded on the downstream (northward) and shoreward (westward) sides by a thin surface filament of warm Loop Current water which grows roughly along isobath in the upstream (southerly) direction. The surface manifestation of these frontal eddies as well as that of the meanders has been observed repeatedly in satellite thermal infrared imagery [Stumpf and Rao (1975), Legeckis (1975), Legeckis (1979), Lee, Atkinson and Legeckis (1981), Vukovich and Maul (1985)] in both the Gulf Stream and the Loop Current. Quasi-synoptic mappings of the three dimensional hydrographic structure of several frontal eddies observed in various locations have been reported in the literature [Bane, Brooks and Lorenson (1981) off Onslow Bay, NC.; Lee and Atkinson (1983) east of Jacksonville, FL.; Paluszkiewicz et al. (1983) on the West Florida Shelf]. These hydrographic data are indicative of a cyclonic geostrophic circulation around a cold core of water upwelled from beneath the Gulf Stream (or Gulf of Mexico Loop Current in the case of the West Florida Shelf eddy) which is in accord with inferences based on the IR imagery. This circulation has been directly observed for the event discussed in Section 4.3.3.

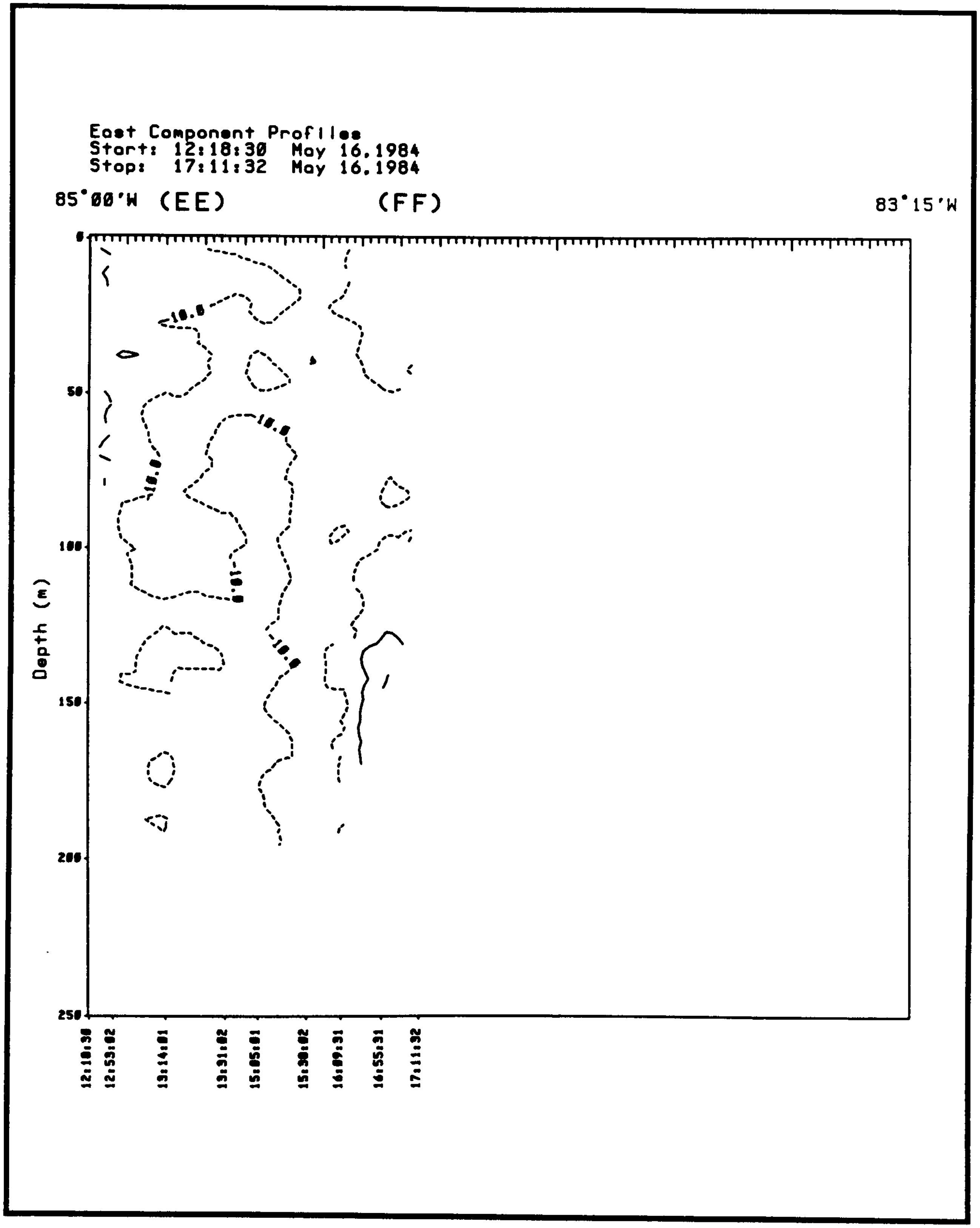

Figure 4.3-36. Vertical cross-section of the east component of horizontal velocity for Transect XVIII of Cruise CF8405.

The time series of moored current meter data reported by various investigators [including Brooks and Bane (1981), Lee, Atkinson and Legeckis (1981), Pietrafesa (1983), and Lee and Atkinson (1983)] confirm this cyclonic circulation around a Gulf Stream cold core, to the extent that their horizontal spatial resolution allows. However, there remains a controversy regarding the circulation within the warm filament. The southern end of the warm filament is observed in satellite thermal infrared imagery not to reconnect to the primary Gulf Stream front as would be necessary to form a true ring-like feature but rather remains to the west of the primary front by a distance comparable to the width of the surface expression of the upwelled cold core. Lee, Atkinson and Legeckis (1981) have characterized the flow within the warm filament as being uniformly southward and presumably balanced by frictional dissipation while Chew (1981) has presented a case for anticyclonic circulation within the warm filament which would return warm water to the north along the western side of the filament. Lee and Atkinson (1983) report the absence of propagating warm anticyclonic perturbations shoreward of the cold domes observed in their current meter time series and reject Chew's (1981) hypothesis; however, Pietrafesa (1983) has analyzed a subset of the same data used by Lee and Atkinson (1983) in conjunction with sea-surface temperature data from one particular frontal eddy and concludes that Chew's (1981) description is realistic. The observations reported here are not sufficient to resolve this controversy since efforts were concentrated mainly in the region of the cold core and primary Loop Current front. Thus, except for the details of circulation within their warm filaments, the general form and descriptive characteristics of Gulf Stream and Loop Current frontal eddies are relatively well known.

Our understanding of the dynamics of Loop Current and Gulf Stream frontal meanders and particularly that of the frontal eddies with which they often coexist is not yet complete. Both barotropically and baroclinically unstable waves have been proposed as explanations for the existence of frontal meanders in the South Atlantic Bight (by Niiler and Mysak, 1971 and Orlanski and Cox, 1973, respectively). These theories apply equally well in the eastern Gulf of Mexico. Theory predicts that both types of waves could exist on the length and time scales typical of Gulf Stream or Loop Current frontal events (i.e., about 150 kilometers and a week to 10 days). In a series of papers, Chew (1974, 1975, 1979) has developed a set of equations relating many quantities (shear vorticity, divergence, banking terms, curvature vorticity, etc.) which are potentially dynamically important in determining the form and behavior of such meanders. Chew, Bane and Brooks (1985) have generated a composite picture of the density and velocity fields of a propagating meander and its associated cold dome by combining data obtained from a drogue experiment in the Florida Straits and a hydrographic survey off Onslow Bay, NC. Until the dynamical constraints on the propagating meanders are more completely understood, the dynamics of the associated frontal eddies are not likely to be revealed. While the theoretical and conventional observational treatments mentioned are a step in the right direction, more detailed observations of the type presented herein are needed from various geographic locations and from under widely varying climatic conditions. While this study's contribution to the existing body of knowledge regarding frontal eddies is significant, to draw general conclusions from the one frontal eddy event presented would be inappropriate.

Little is known about the reasons for the formation and decay of the cold perturbation features such as the one described in section 4.3.2. They appear similar to other mesoscale features such as cold core Gulf Stream rings although they are typically of smaller radius. It has been speculated (although not published) that these perturbations are triggered by the propagation of a Loop Current frontal eddy into the formation region, but although eddies have been observed in SST data to propagate into a pre-existing cold perturbation, the formation process has not been observed in detail.

In conclusion, presented here is an unprecedented detailed view in both space and time of the hydrographic structure and velocity field associated with a Loop Current frontal eddy. Existing theories do not predict distinct characteristics which could be easily tested by observations. More detailed data are needed to direct and stimulate further theoretical advancements regarding the dynamics of both frontal eddies and the cold core perturbations.

4.4 West Florida Shelf Circulation--Patterns and Processes

4.4.1 Introduction

The Minerals Management Service (MMS) has supported observations of currents on the West Florida Continental Shelf since January 1983. This report discusses the major results of the third year of this program, focusing on the data from 1985, although the results of the first two years will be summarized briefly. Figure 4.4-1 shows the locations of the moorings. The primary line of moorings, near 26°N, has been in place for the full three years. Moorings G and F, however, were installed in early 1984. Mooring H was installed in 1985 and is supported by a grant from the National Science Foundation to Florida State University. The moorings just offshore from Cedar Key (Moorings I and J) were installed by Continental Shelf Associates, as part of an environmental monitoring effort in the summer of 1985. The moorings near the Florida Keys (Moorings 1 through 8) were by Environmental Science and Engineering, Inc., sponsored by MMS, and were in place for 1984 and parts of 1985. With these few exceptions, however, the mooring program was part of GMPOP.

It is appropriate to summarize here briefly the primary results from the first two program years. Most of the results normally presented, such as stick plots, have been filtered to suppress the high frequency information, such as tides and inertial period motions. It is appropriate therefore to point out that a substantial part of the energy in these records is near the inertial period, which is approximately 27 hr at this latitude. Figure 4.4-2 shows the spectra from less than three months of data from Moorings A, C, D, and F, in the usual way (left) and also in the "variance preserving form" (right), in which the area under the curves shows (to the eye, and linearly) the amount of energy present in individual frequency bands. It is obvious in these figures that when the inertial period motions have been filtered out in order to use daily values for the stick plots, a significant fraction of the energy in the flow field has been removed. Because there is so much energy at mooring A at period near two weeks or longer (400 hr), the relative amount of energy near the inertial period seems small, although the near-inertial energy at Mooring A is roughly half that at C. On the shelf, however, where the

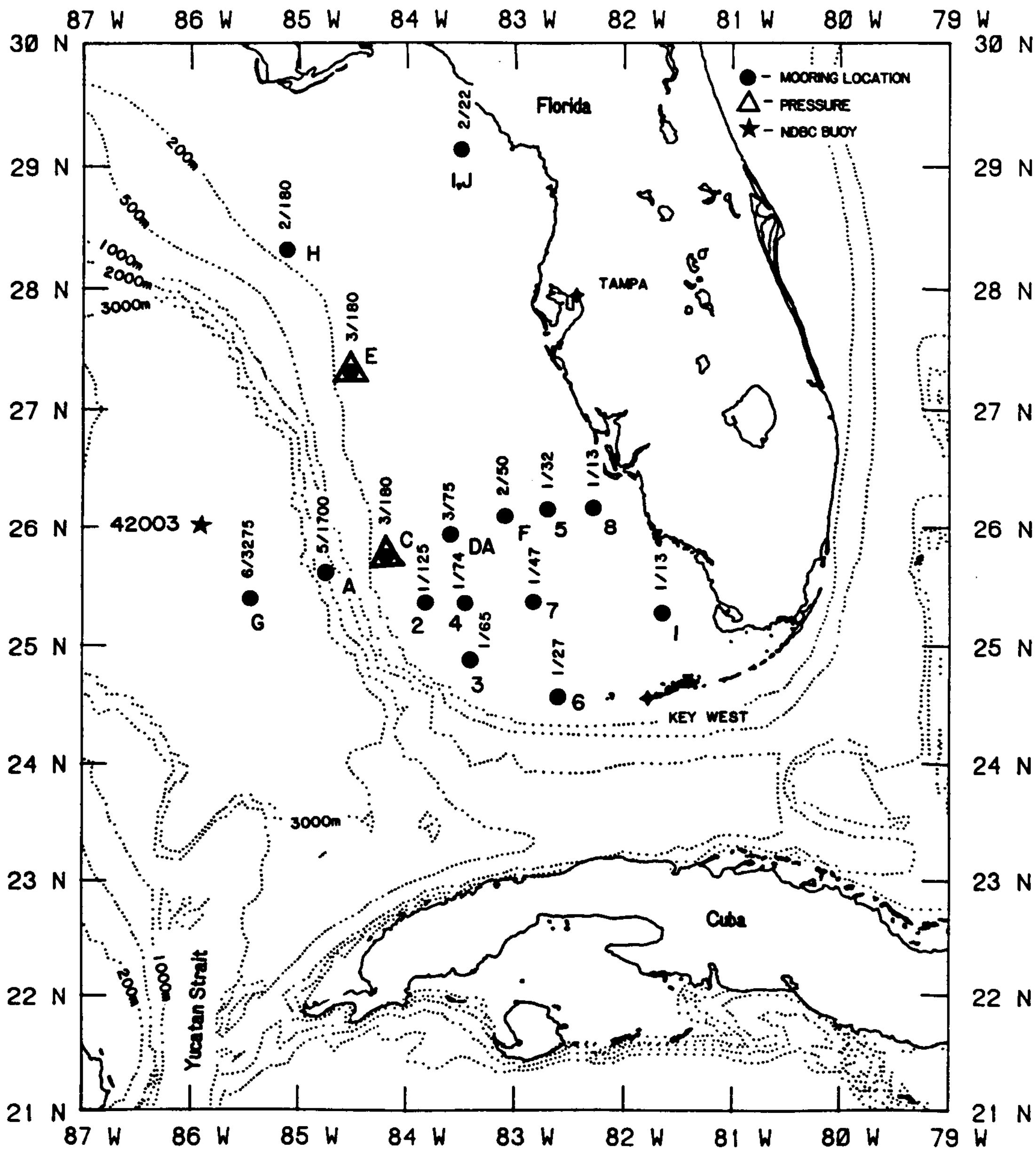

Figure 4.4-1. Bathymetry and mooring locations in the eastern Gulf of Mexico. The letters A through J and numbers 1 through 8 refer to mooring locations, as described in the text. Also shown are the locations of wind observations. (Note that an additional set of numbers (x/yy) represent the number of current meters and the bottom depth at each mooring).

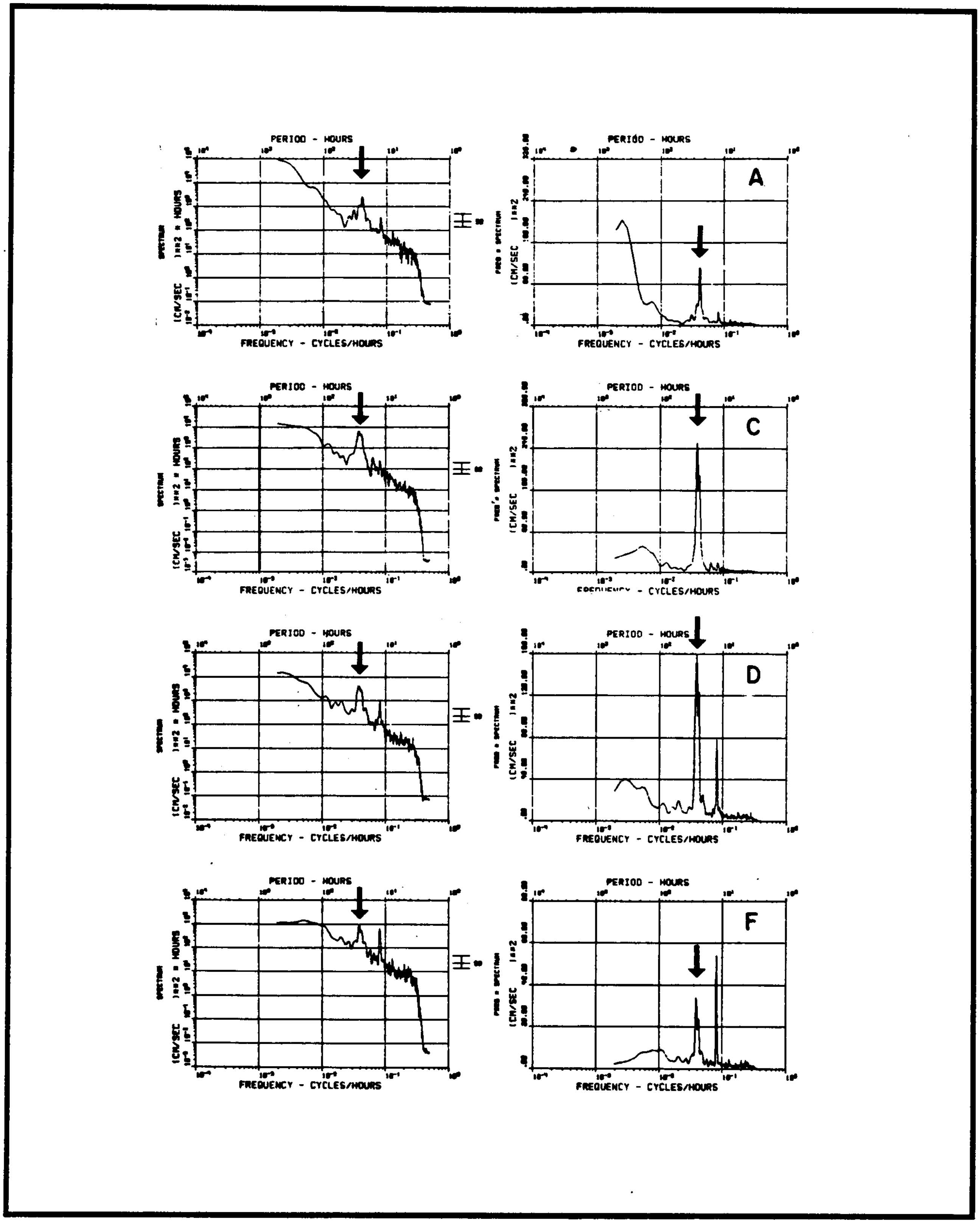

Figure 4.4-2. Spectra from four mooring locations (the upper instrument at Mooring A, C, D and F) showing the relative proportion of energy in the inertial frequency band (indicated by an arrow). The longshore component of observed velocity is used. Hourly data are used from 1/26-4/21, 1985; the spectra are smoothed with nine Hanning passes giving 15 degrees of freedom.

wind-driven flow at periods of less than three to ten days is the dominant signal, there is roughly the same amount of energy in the inertial band as in the wind-driven band (Figure 4.4-2, Moorings C-D). At Mooring F, the proportion of inertial-period motion is smaller than at C or D. Note that the scales on the Y axis double from F to D and from D to C. The propagation of inertial-period motions in the ocean has been studied extensively. Kunze and Sanford (1986) discuss the effects of sloping bottom topography on inertial currents, and Lai and Sanford (1986) show observations of inertial currents after the passage of a hurricane. At Mooring H, when Hurricane Elena passed nearby in late August, 1985, the inertial-period currents at 50 m reached 50 cm s-1.

It is also clear in Figure 4.4-2 that inertial-period motions are substantially more energetic than the tides. These figures show the V, or north-south along-shore component of the flow. At Moorings D and F, the semi-diurnal tide is noticeable in these figures. At Mooring C, at the edge of the shelf, the predominant tidal motion is in the onshore, or east-west component, and so does not show up in the figure. Although there is a significant amount of energy at the inertial periods, it may be appropriate to point out here that for a given value of current speed, a low-frequency fluctuation will provide a larger net particle movement than will a higher-frequency fluctuation. (This effect is a simple linear function of the period.)

4.4.2 Inertial Currents on the West Florida Shelf

4.4.2.1 General Description Of Inertial Motions

Oceanic inertial currents are circular motions of water particles at or near the local Coriolis frequency, f. These motions are most easily visualized from current meter data with the use of a progressive vector diagram (PVD), as shown in Figure 4.4-3. The current vector rotates clockwise (in the northern hemisphere), causing the particle trajectories to trace circular motions superimposed on the mean drift. The Coriolis frequency varies geographically with latitude, from 2 cycles per day (cpd) at the poles to zero at the equator. At 26°N, the approximate latitude of the West Florida Shelf mooring line, f=0.88 cpd, corresponds to an oscillation period of 27.4 hours.

These currents are associated with a class of internal gravity waves modified by the earth's rotation, often referred to as near-inertial internal waves or inertio-gravity waves. These waves exist only with frequencies within a band between f and the buoyancy frequency, N, which is generally one or two orders of magnitude larger than f. Theoretical treatment of these waves is quite cumbersome and need not be presented here, but it has revealed several properties of inertio-gravity waves worth mentioning. At frequencies close to f, the particle trajectories are horizontal and circular. However, as frequencies increase close to N, the waves become more like pure internal gravity waves with particle motions in a vertical plane aligned along the direction of phase propagation. Only the part of the spectrum close to f is of interest here, however, and the dispersion relation for these waves indicates that the closer the frequency is to f, the more circular the trajectory and the longer the horizontal wavelength. At exactly f, the wavelength is theoretically infinite, so in principle, oscillations with frequencies at or below f do not exist (although there are exceptions, as will

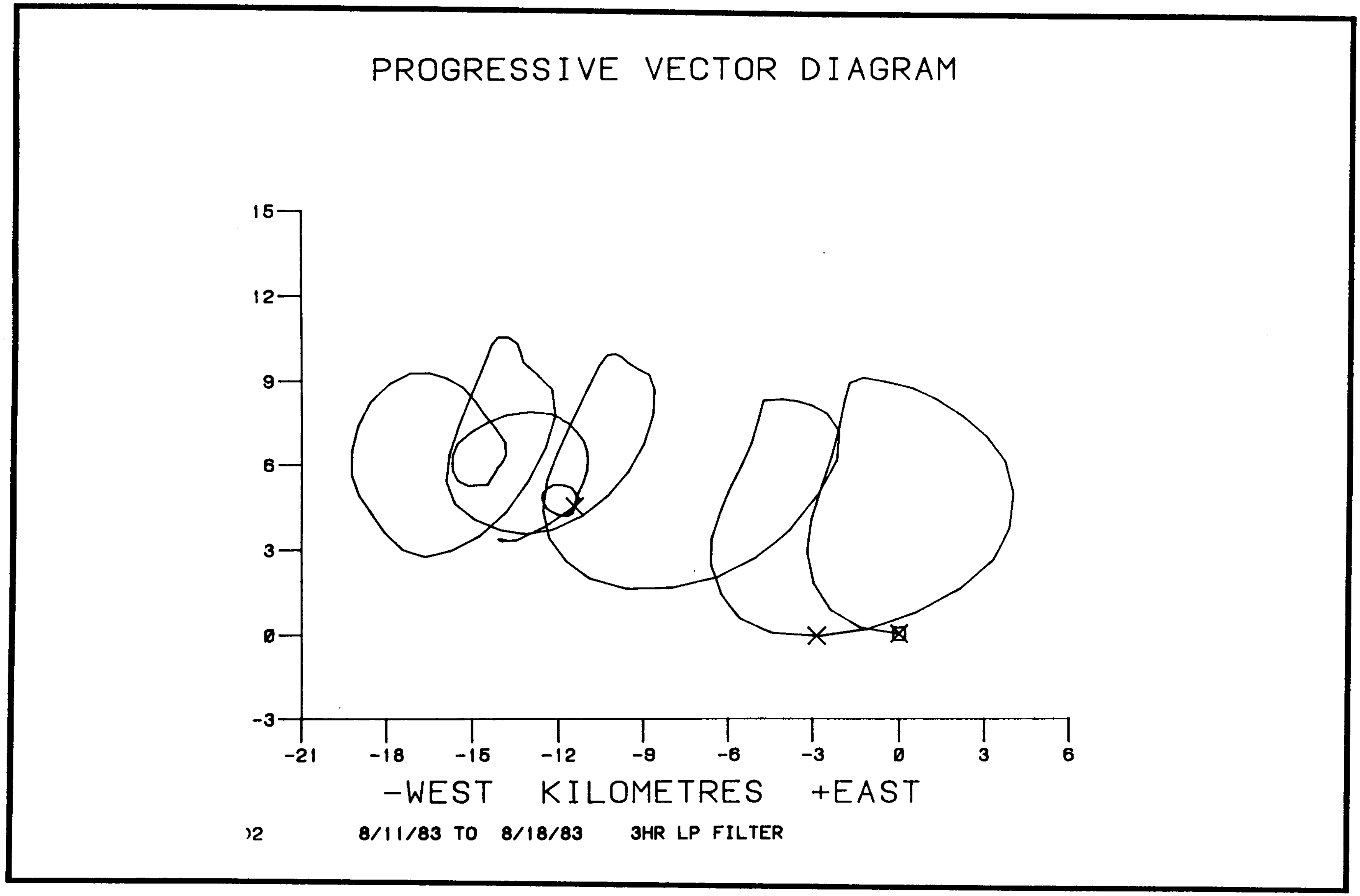

Figure 4.4-3. Progressive Vector Diagram of inertial currents at Mooring D (60 m).

be discussed below). Even at frequencies very near f, the wavelengths would be longer than the length scales of the oceanic media supporting the waves. Consequently, the vast majority of observations of near-inertial motions are at frequencies measurably offset above f, generally within a range of 1.03f to 1.2f. Even within this fairly broad band, the wave properties are much more inertial-like, with horizontal circular motions, than like internal gravity waves.

Frequencies slightly below f have been observed. One mechanism to explain this is that the effective lower bound frequency for inertial waves is reduced below f for waves propagating in anticyclonic shear (Kunze, 1985). Modeling studies by Kundu and Thomson (1985) show that intermittent apparent sub-inertial fluctuations may appear for two or three cycles when there are intervals of decreasing phase.

It is important to recognize that these waves are a sub-class of internal waves and, as such, require a stratified medium to exist. Barotropic modes are theoretically possible, but they are weak and propagate away rapidly (Gill, 1984). This leaves the system dominated by vertical modes. The degree of stratification and its vertical distribution (uniform versus sharp pycnocline, for example) affect both the amplitude and the modal structure of the inertial currents. Measured currents are the result of the summation over all the modes. Currents should be coherent vertically, but with a clockwise phase shift with depth, as shown in Figure 4.4-4 (from Kundu, 1984).

Inertial currents are ubiquitous in measurements throughout the ocean and are commonly measured in the mid and outer shelf regions where there is sufficient stratification. The primary forcing mechanism is rapidly varying wind stress. A sharp increase in inertial current amplitude in the surface mixed layer is commonly associated with the passage of a weather front. Wind stress which rotates clockwise on a time scale near 1/f is most efficient in generating inertial waves (D'Asaro, 1985b). Nevertheless, it has been shown that impulse forcing and randomly time-varying wind generate inertial currents and the response to a real time series of varying wind stress is considerably larger than the response to a single impulse forcing of like magnitude (Kundu, 1984). Furthermore, Kundu (1985) has shown, through a linear model, that only very weak inertial oscillations are generated from a wind input time series if the near-inertial wind components are first removed by band-pass filtering, even when only a small amount of the rms wind variance has been removed. This implies that the coastal ocean can derive a quasi-continuous input of energy for inertial currents from relatively weak but constantly time-varying winds, with variability in the near-inertial band, such as are common over the West Florida Shelf during summer. Nevertheless, when intermittent, intense frontal passages occur, a few dozen such events can account for more than half of the annual inertial forcing in some regions (D'Asaro, 1985b).

One of the more unique and prevalent features of inertial current observations is their intermittency in amplitude with time. This is exemplified in the plot of the demodulated amplitude for the inertial currents at Mooring C in Figure 4.4-5. (An explanation of the demodulation process is given in Section 3.4.2). It is clear that the inertial amplitudes increase and decrease sharply on time scales of 5 - 20 inertial periods. This is typical for

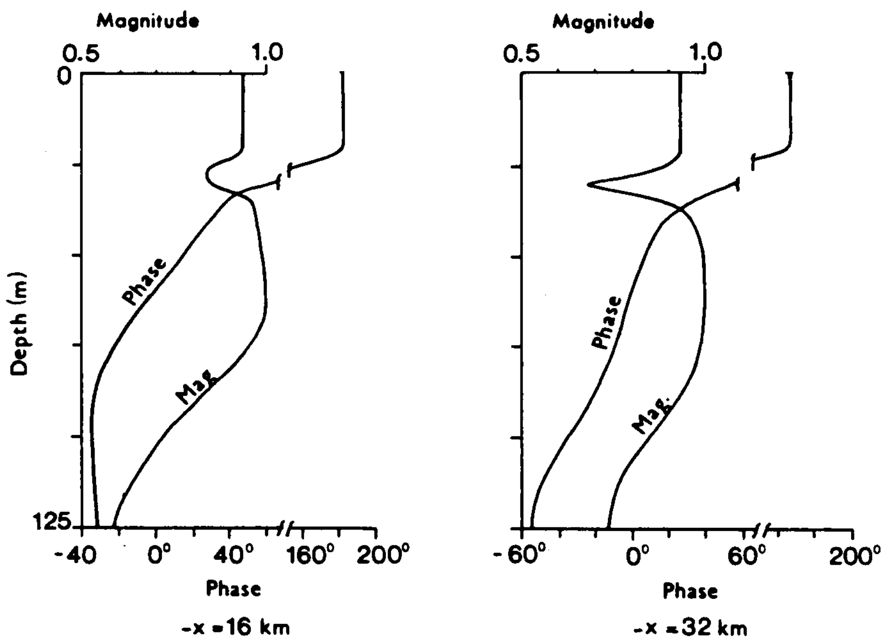

Figure 4.4-4. Magnitude and phase of correlated inertial currents with depth at two stations at offshore distances of 16 and 32 km, respectively. Results are from a constant-depth, shelf model forced by a step-input alongshore wind (from Kundu, 1984).

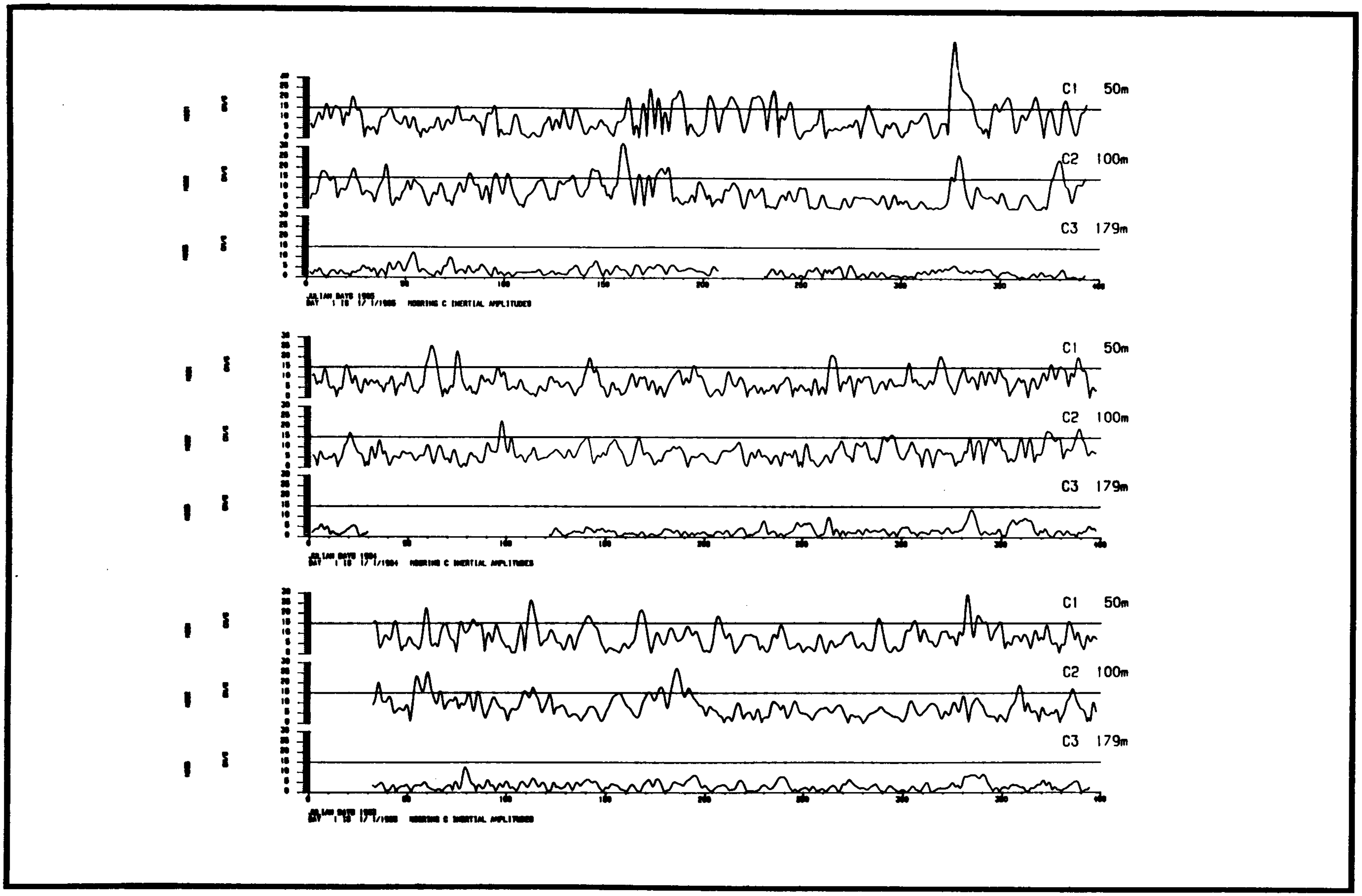

Figure 4.4-5. Demodulated amplitudes of inertial currents at Mooring C (1983-1985).

inertial currents observed elsewhere (e.g. Kundu, 1976). Several explanations for such intermittency have been proposed. D'Asaro (1985b) suggests that: (1) the major forcing events themselves are intermittent, and (2) that the energy transfer function from the wind to inertial currents is proportional to the fourth or sixth power of wind speed, making small fluctuations in wind speed appear as very large fluctuations in energy transfer. Kundu (1984) showed that the response to rapidly time-varying wind was more intermittent than the response to step input forcing. Solutions to the equations for inertial waves have indicated a dependency of amplitude on the strength of stratification, varying approximately with the square-root of the buoyancy frequency, N (Kundu, 1976; D'Asaro and Perkins, 1984). Consequently, energetic inertial currents are more likely during periods when the water column stratification is strong than when stratification is weak. Once inertial waves are set in motion, interference among the first few modes, which all have slightly different frequencies, can cause the amplitude to modulate, or beat, on time scales consistent with observations (Gill, 1984; Kundu and Thompson, 1985). The presence of oceanic fronts and geostrophic anti-cyclonic shear can cause trapping of inertial waves (Kunze, 1985; Kunze and Sanford, 1984). By this mechanism, a zone of anti-cyclonic shear becomes a wave guide which traps and amplifies inertial waves propagating into the shear zone. This implies that intermittency may be associated with shifting or meandering geostrophic jets such as the Loop Current. With several such competing mechanisms governing the amplitudes of the observed inertial currents, it may prove difficult to show a significant correlation between inertial current amplitude and other measured parameters such as wind stress, stratification and shear. Nevertheless, these will be examined in the following section.

As noted above, oscillations of frequency near f must be associated with long wavelengths, typically on the order of 100 km for observed frequencies. Consequently, one would expect spatial coherence in inertial currents over similar length scales. In certain instances of waves following in the wakes of a weather front, this has been observed (Kundu and Thomson, 1985). Enigmatically, however, this is typically not the case. More often, inertial currents are found to be spatially uncorrelated over distances on the order of 10 km. Kunze (1985) shows that oceanic frontal shear zones focus and trap inertial waves which could result in more incoherence due to the superposition of many waves. Kundu (1986) discusses other factors, such as beta plane effects, bottom reflection, and superposition of waves propagating from remote wind-forced generation, which could contribute to the observed spatial incoherence.

The study of inertial motions is an important problem in physical oceanography for a number of reasons:

1. They represent an important mechanism for wind forcing to extend into the deeper layers of the ocean. Inertial currents are directly forced only in the ocean surface mixed layer, yet energetic inertial currents are observed below the thermocline (D'Asaro, 1985a). Models such as Gill (1984) and Rubenstein (1983) suggest that mixed layer inertial currents propagate energy downwards through the thermocline, as a result of the vertical component of the group velocity of inertio-gravity waves, to excite inertial motions below. Gill (1984) describes how mixed layer

inertial waves cause vertical displacements in the thermocline at the inertial frequency, which then "pump" inertial energy into the deeper layers. White (1986) describes how this pumping mechanism may contribute to the Eularian mean motion (as sensed by current meters), but that the net Lagrangian drift due to this mechanism is cancelled by the Stokes drift of the inertial waves. Kundu (1984 and 1986) has observed that measured subsurface oscillations are considerably more energetic than can be accounted for with models that rely on inertial wave propagation alone and forcing by single atmospheric events. He has generated more realistic subsurface amplitudes by including time varying wind forcing and a coastal boundary. This latter condition causes "coastal inhibition" of inertial waves which leads to intensified downward energy propagation in the coastal boundary region. Kundu (1986) also notes that inertial waves are shifted to higher frequencies (blue shifted) with increasing depth.

2. Inertial waves are an important mixing mechanism for the surface mixed layer. D'Asaro (1985a), for example, gives observations of mixed layer deepening as a result of a storm. The wind induced inertial currents lead to increased shear, and consequent increased mixing and deepening at the base of the mixed layer.

3. Inertial currents may be important to the dynamics of oceanic fronts. Rubenstein and Roberts (1986) find that strong inertial oscillations in the mixed layer can result in strong cross frontal variability in the mixed-layer depth. Mixed layer deepening can occur more rapidly on the negative vorticity side of the front, where waves tend to be trapped.

4.4.2.2 West Florida Shelf Observations

The three years of current meter observations on the West Florida Shelf extended from 1983 through 1985. The measurements from waters shallower than 200 m are applied here to describe the nature of the inertial currents. Specifics of the mooring design, instrumentation, or tidal and low frequency variability are covered elsewhere in this report and the Years 1 and 2 Final Report (SAIC, 1986). Figure 4.4-6 gives the mooring locations and designations and includes the tracks of the significant hurricanes. These are discussed in the context of the generation of inertial currents by the wind, often directly related to the passage of a storm or front. The dynamics of inertial currents are also related to the density structure of the water column, particularly the strength of the pycnocline and the depth of the mixed layer. Figure 4.4-7 shows the location and depth of the current meters relative to a typical cross-shelf temperature field. Note that the depth of the mixed layer increases from about 50 m on the shelf to about 100 m seaward of the shelf break. The mooring array, therefore, sampled different domains as far as the stratification and bottom depth were concerned. The dynamical significance of this for inertial currents is treated later in this section.

The oscillating frequency of inertial currents varies with latitude and is generally close to tidal frequencies. Data processing must be handled carefully in order to properly separate the inertial currents from the tides. In this case, the inertial frequency, f, is close to the major diurnal tidal constituents which are dominant in the Gulf of Mexico. For this study, the

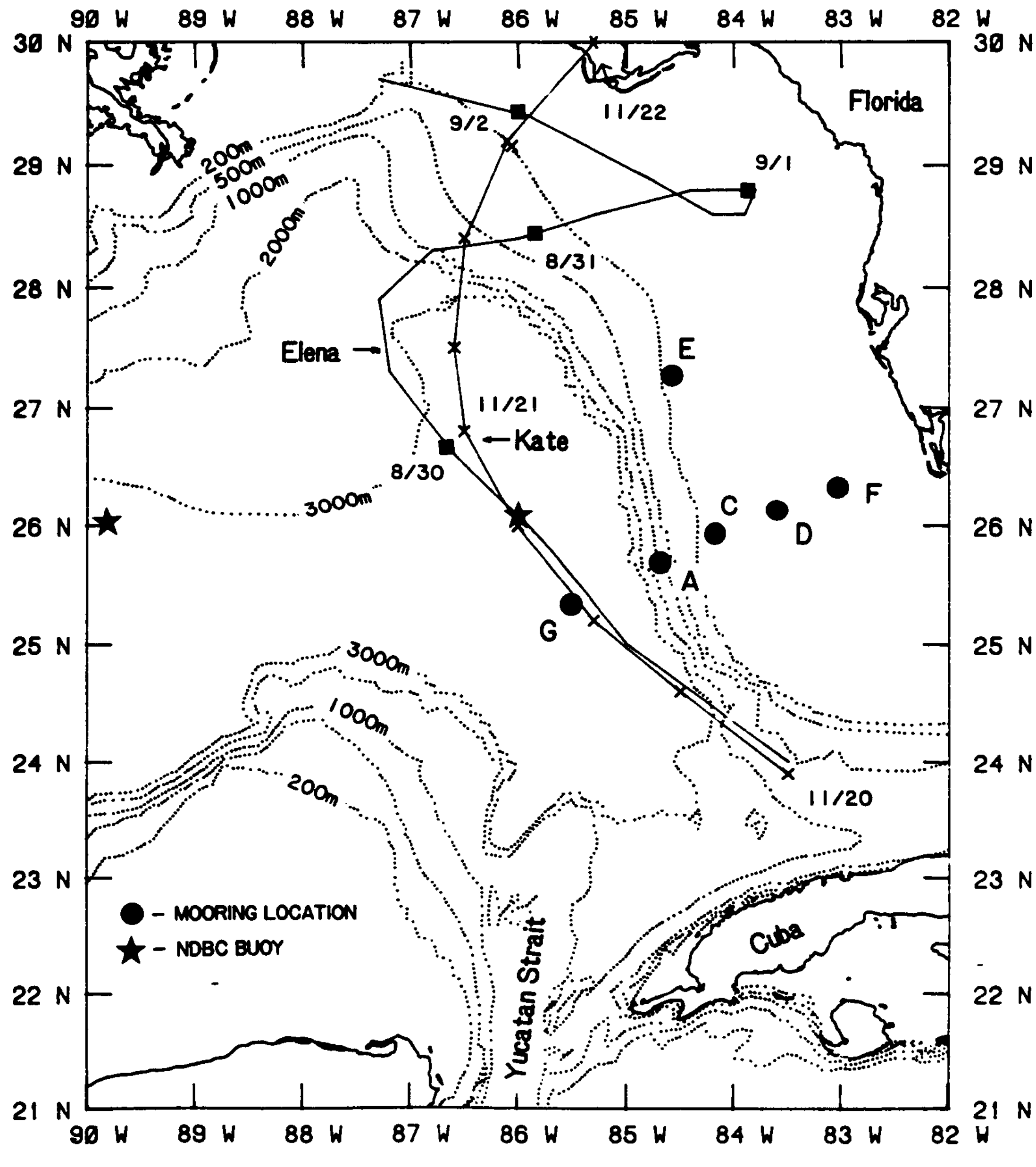

Figure 4.4-6. Map of the locations of the West Florida Shelf moorings (A through G) and the storm tracks of hurricanes Elena and Kate (both in 1985).

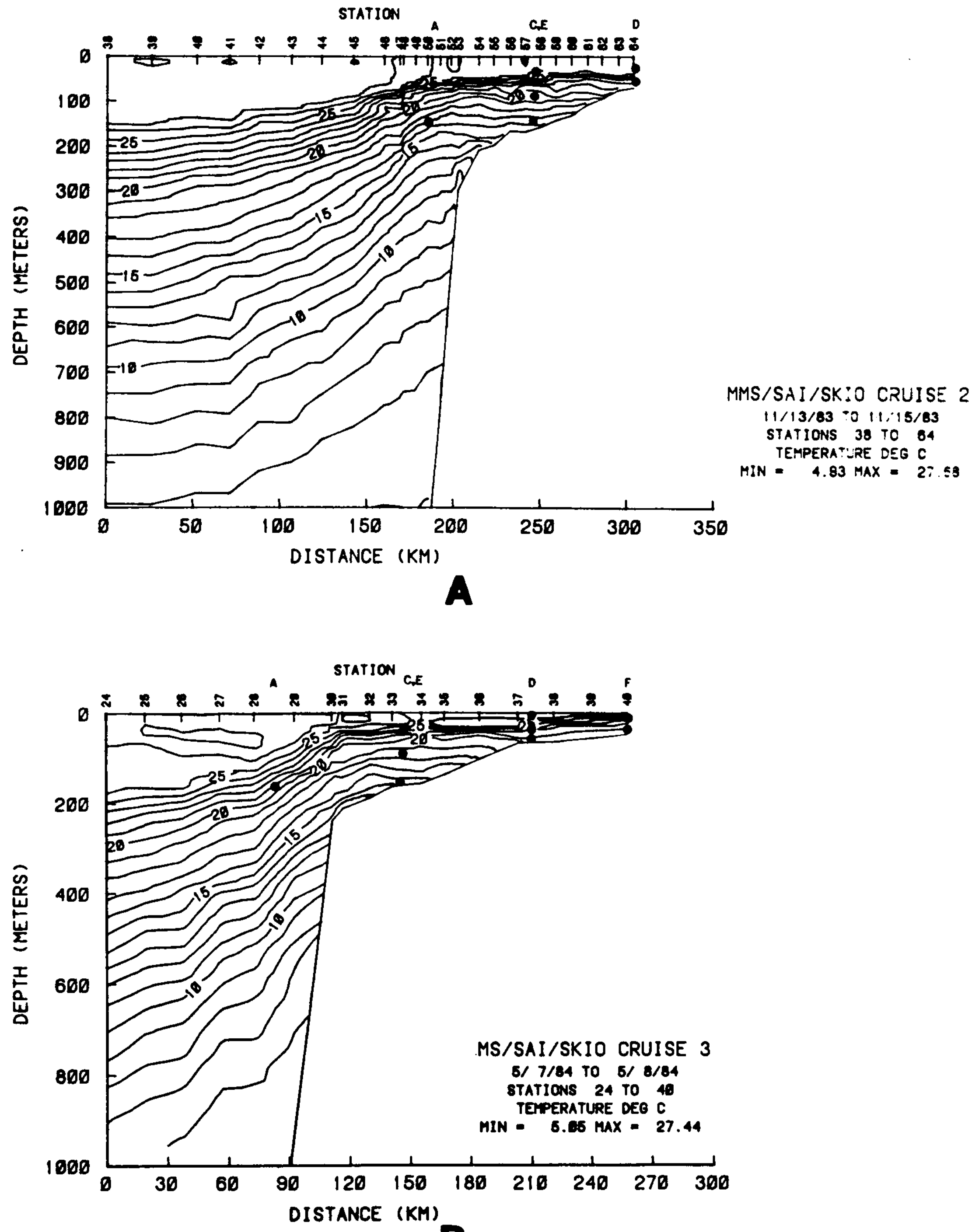

Figure 4.4-7a. Cross-sectional temperature field from a CTD transect through the moored current meter array, November 1983 (Cruise 2).

b. Cross-sectional temperature field from a CTD transect through the moored current meter array, May 1984 (Cruise 3).

data were first analyzed for principal tidal components. These were used to generate a tidal signal which was then subtracted from the original data to form a de-tided time series with the inertial oscillations preserved. An example of the results of this process can be seen in the energy spectra of a pre- and post-detided data set in Figure 4.4-8, where the reduced peak at one cycle per day (cpd) reflects the removal of diurnal tides. In order to simplify the analysis further, the de-tided current data were demodulated, with Kundu's method (1976), to extract the amplitude and phase of the inertial currents. The inertial amplitudes varied over time as inertial currents came and went, and the time series of these amplitude data form the basis for this discussion. A complete set of the demodulated data from all moorings and all years is provided in Appendix B. Several records are reproduced in this section as appropriate for discussion.

As a general rule, inertial currents were clearly evident at all locations. The amplitudes were quite intermittent in time, modulating between maximum and minimum amplitudes over 10 to 20 day periods. Peak amplitudes often exceeded 20 cm s-1 (which also exceeds dominant diurnal tidal amplitudes at about 4-6 cm s-1), and at times exceeded 30 cm s-1. Consequently, inertial currents accounted for a significant fraction of the tidal band variance.

In addition to being intermittent in time, the inertial amplitudes were often poorly correlated vertically among observations on the same mooring. As shown, for example, in Figure 4.4-9 amplitudes at different depths often peaked at different times, particularly during the summer months. However, more vertical uniformity was evident in fall and winter. This observed vertical decoupling of amplitude modulations is consistent with the modeling studies by Kundu (1986), which show that the amplitudes tend to modulate more or less out-of-phase above and below the pycnocline (Figure 4.4-10). The amplitudes were also poorly correlated horizontally between mooring locations at the same depth level. As in the vertical, however, there was more evident horizontal correspondence of amplitude peaks in fall and winter than in summer (Figure 4.4-11). This suggests that inertial currents in the later seasons were more often forced by large synoptic wind patterns which affected each location similarly, rather than by localized random wind forcing which may have been more characteristic in summer.

A common feature noticeable in the records at Mooring D was that inertial amplitudes tended to be greater at mid-depths than in the near surface or near bottom samples (Figure 4.4-12). The weaker amplitudes near bottom are readily explained by bottom friction. The relatively weaker near surface amplitudes are more puzzling, given that inertial currents are excited by wind stress acting on the mixed layer. However, from Figure 4.4-7, it can be seen that the mid-depth samples at this mooring site approximately coincided with the bottom of the mixed layer, at a depth where vertical density gradients tend to peak. This observation is consistent with the model of Gill (1984) in which the highest amplitudes were found just below the mixed layer. This trend is not evident, however, in the models by Kundu (1986, 1984), which show the greatest amplitudes more consistently in the mixed layer. This apparent amplification or trapping of inertial wave energy at the base of the mixed layer was a consistent feature at Mooring D where measurement depths happened to allow the trend to be detected. If it is real, it must be fundamental to the dynamics of inertial currents and deserves further study.

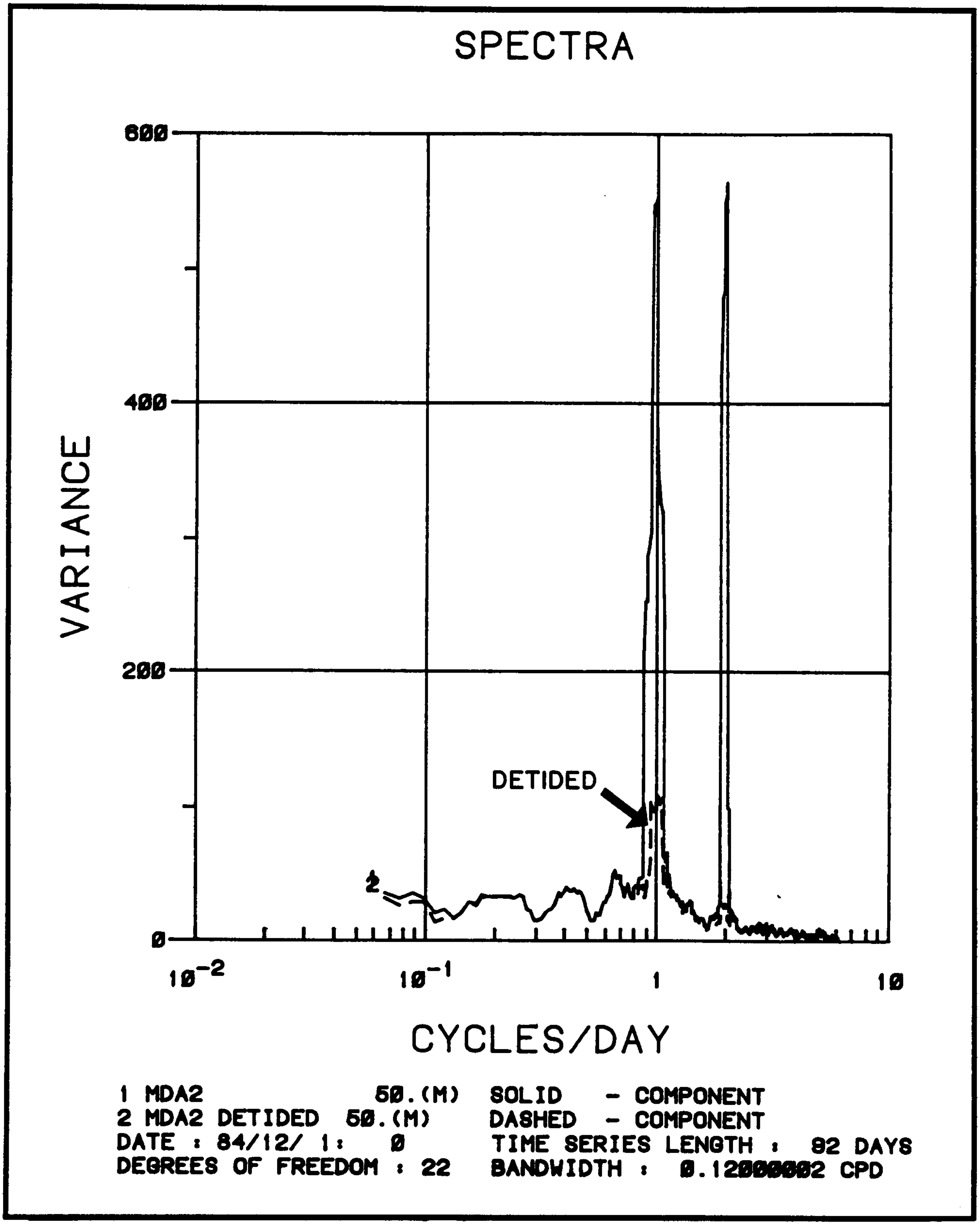

Figure 4.4-8. Variance preserving spectra of the clockwise-rotary component of the 3-HLP and the detided 3-HLP record at D2 for the winter of 1984-1985.

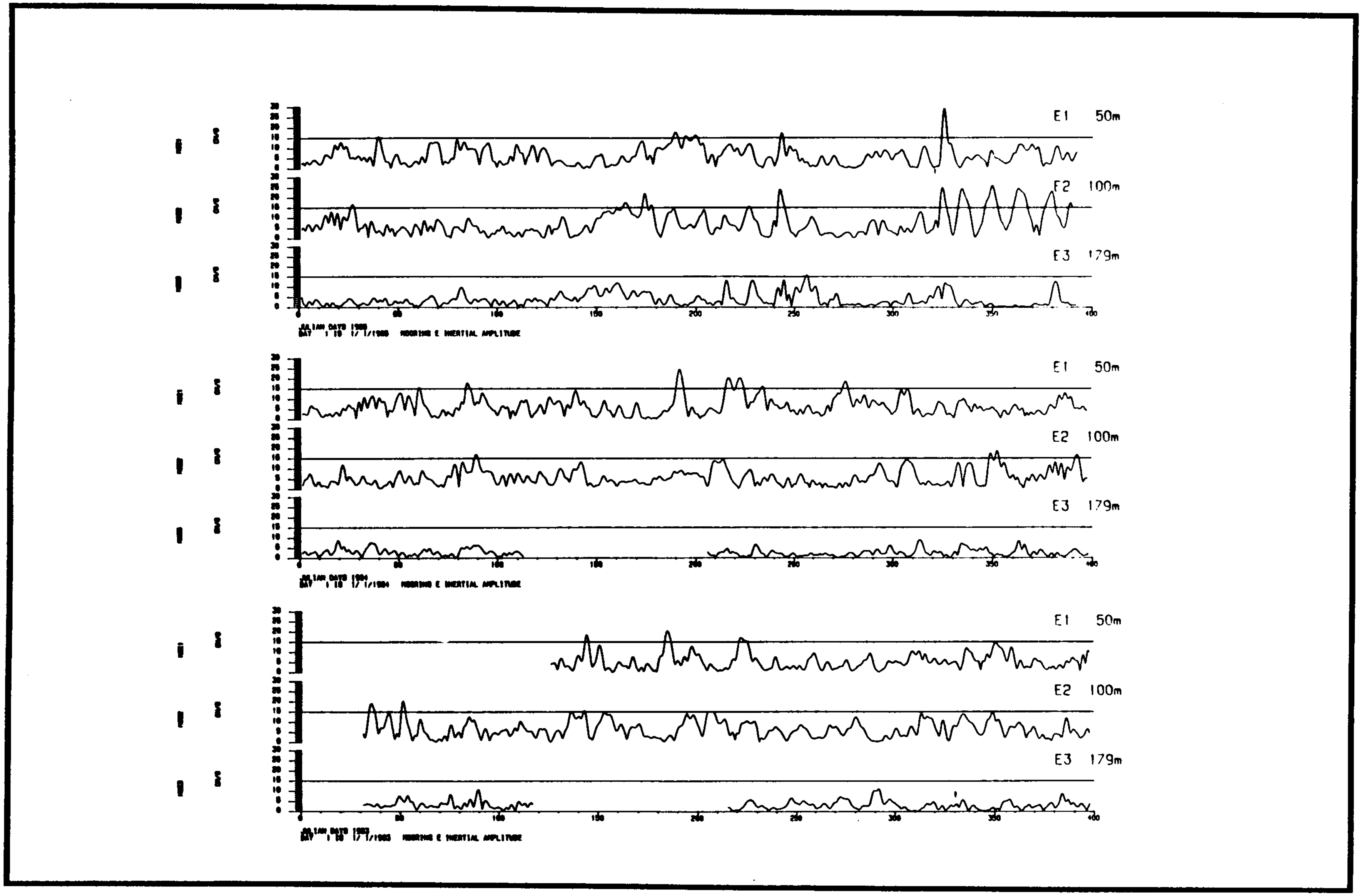

Figure 4.4-9. Demodulated amplitudes of inertial currents at Mooring E (1983-1985).

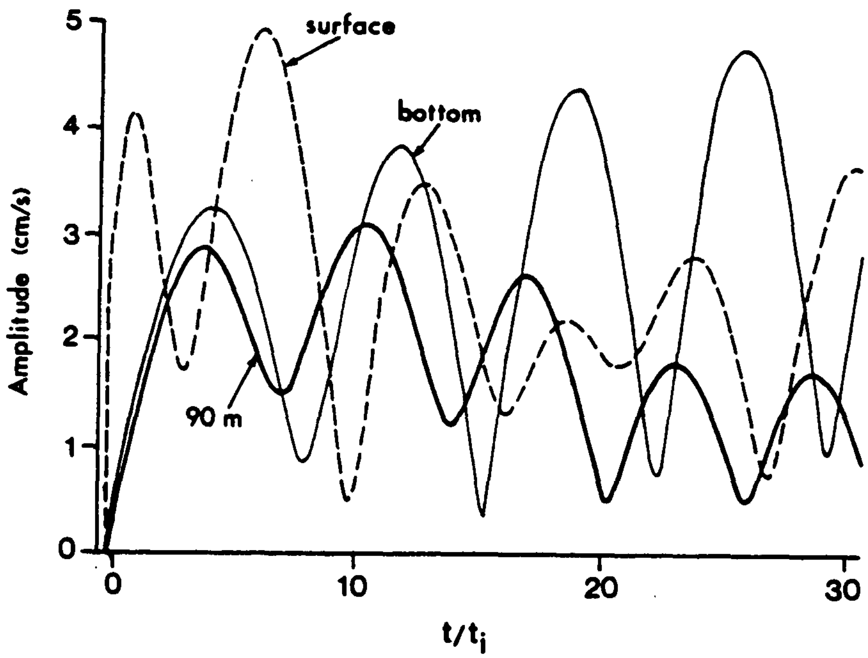

Figure 4.4-10. Amplitudes of inertial oscillations at surface, mid-depth and bottom from a model of the continental shelf. Note that modulations at different depths are not in unison (from Kundu, 1986).

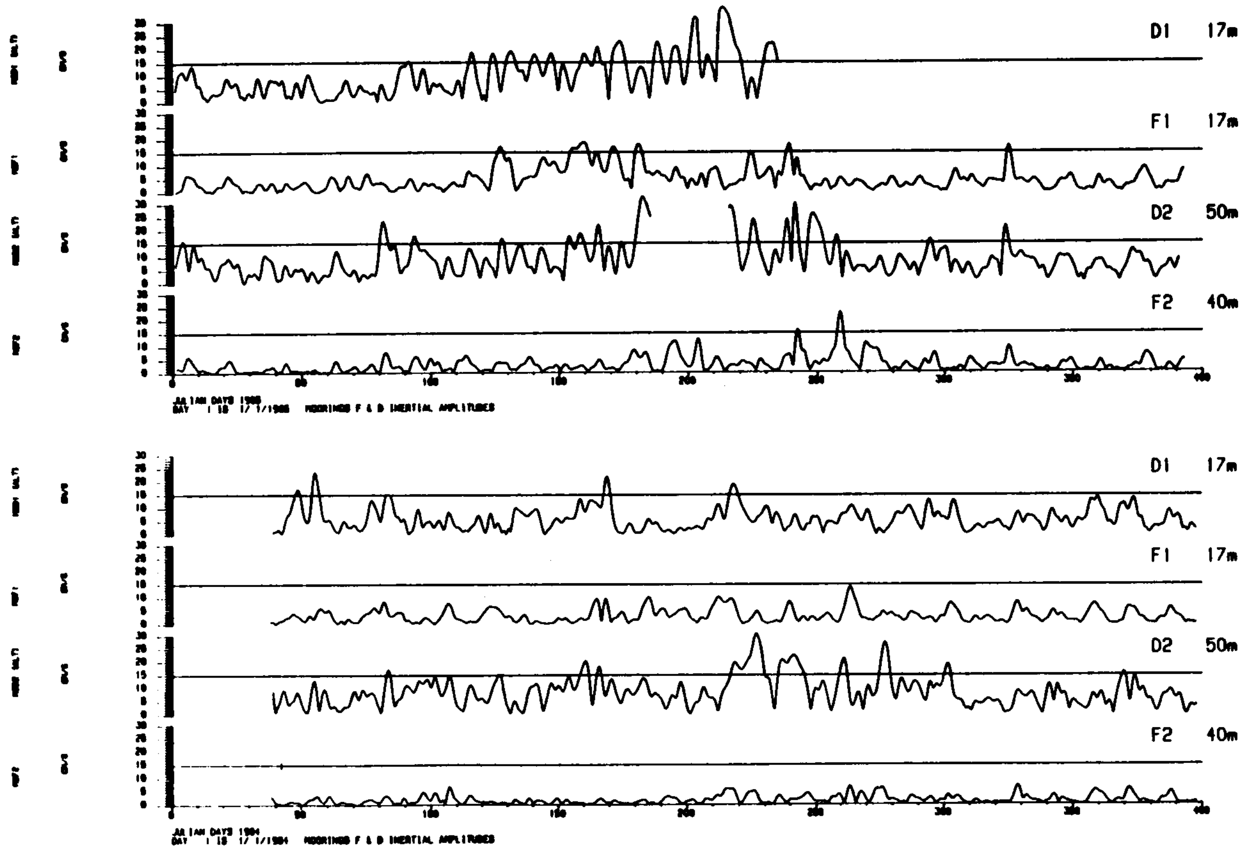

Figure 4.4-11. Demodulated amplitudes of inertial currents at Moorings F and D (1984 and 1985).

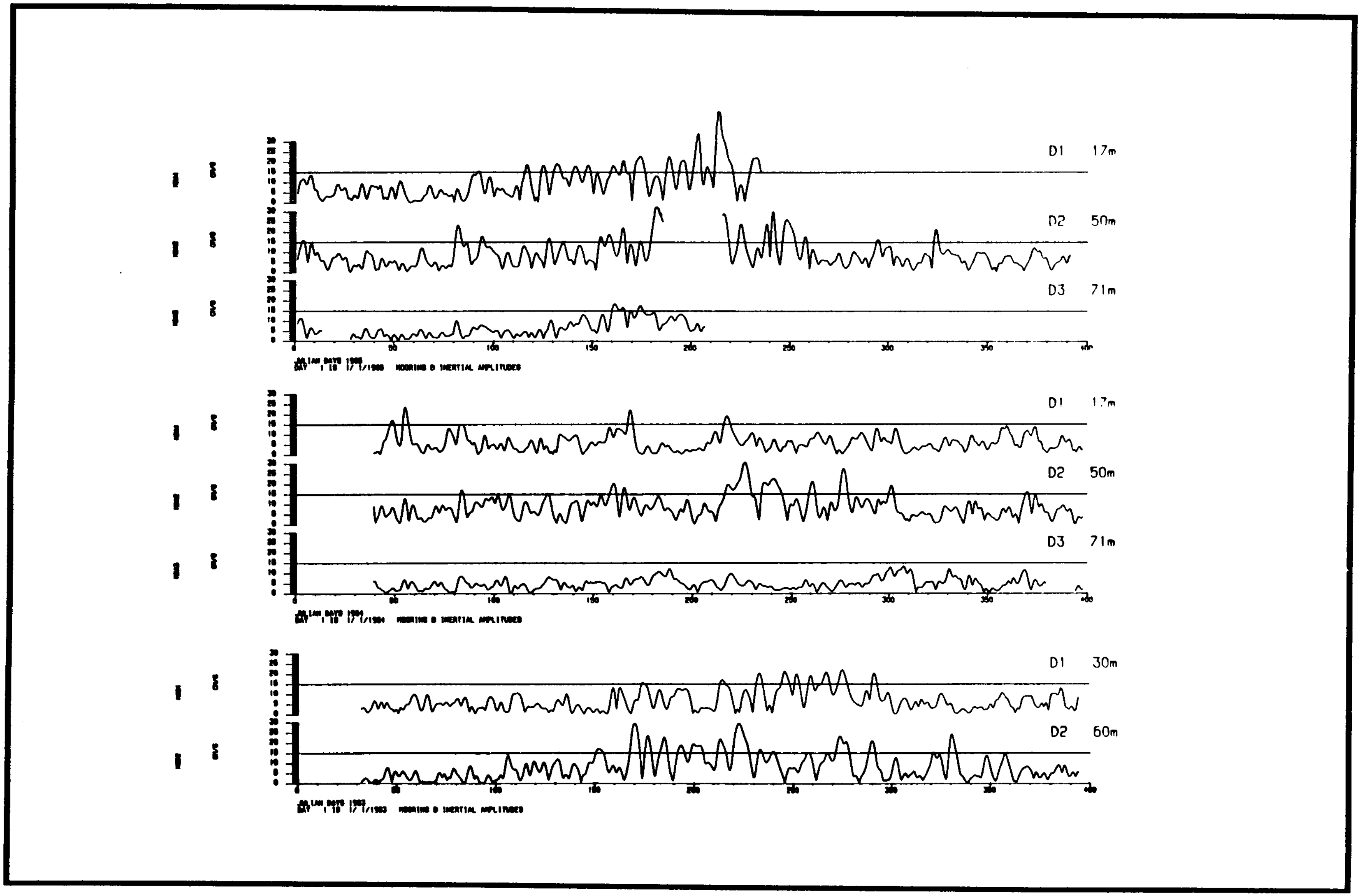

Figure 4.4-12. Demodulated amplitudes of inertial currents at Mooring D (1983-1985).

In several records at shelf sites D and F, peak amplitudes were measurably higher during the summer months than during the winter. In some instances, the higher amplitude periods included the late spring or early fall. This trend, however, was not as clear seaward of the shelf break at Moorings A, C and E. Examples from the shelf moorings are shown in Figure 4.4-13, in which the amplitude variations are shown along with the time series of vertical temperature differences between meter depths. There is a definite correspondence on seasonal time scales between the inertial current amplitudes and the vertical temperature gradients. The correlation between the two, however, is not high on time scales of the inertial amplitude modulations (approximately 20 days) because the modulations are created by the summation of many modes of slightly different near-inertial frequencies associated with both locally and remotely driven propagating inertial waves. Nevertheless, the apparent seasonal correlation between inertial amplitudes and vertical stratification is a noteworthy feature in these data. For comparison, Lagerloef and Muench (1986) have found that inertial currents on the Bering Sea shelf were very energetic when the shelf stratification was two-layered in spring and fall, but nonexistent during the winter when the water column was well mixed to the bottom.

The amplitude of inertial waves is dependent on several factors, the most important being the wind forcing and subsequent amplitude modulation. All else being equal, however, amplitude is dependent on the strength of vertical stratification, which is generally parameterized by the buoyancy frequency, N. Analytical studies (Kundu and Thomson, 1985) have shown that the amplitude is proportional to the square root of N, which in turn, is proportional to the square root of the vertical density gradient. Thus, ignoring all other factors, amplitudes are proportional to the fourth root of the density gradient. Vertical temperature gradients in Figure 4.4-13 underwent a nearly eight-to-ten-fold seasonal summer increase in some instances, while peak inertial amplitudes increased about two-fold. This is not exactly a fourth-power relationship, but is consistent considering other factors which may be important.

One of the other key factors is the intensity of wind forcing. Shown in Figure 4.4-14 is the 40-hour low-pass wind vector time series for Tampa, Florida. The mid-summer winds were noticeably diminished relative to the other seasons. This reflects the seasonal climatological variations whereby brisk winds and frontal passages are more common in non-summer months. This is noteworthy because this season of reduced wind intensity was also the season for peak episodes of inertial current amplitudes at the shelf moorings. Therefore, there does not appear to have been a direct relation between the winds and the greater inertial amplitudes during the summer.

This interpretation of the wind data deserves further scrutiny. Wind forcing for inertial currents is most effective when the wind stress has clockwise rotation on time scales near the inertial period. A rotary spectrum of the Tampa wind data shows a prominent clockwise peak at the diurnal period (one cpd) associated with the land/sea breeze effect (Figure 4.4-15). A secondary peak at two cpd is a harmonic. (The heights of the peaks in this spectrum are somewhat misleading because, in the variance preserving form, the portion of energy in the band is related to the area under the peak, not simply the

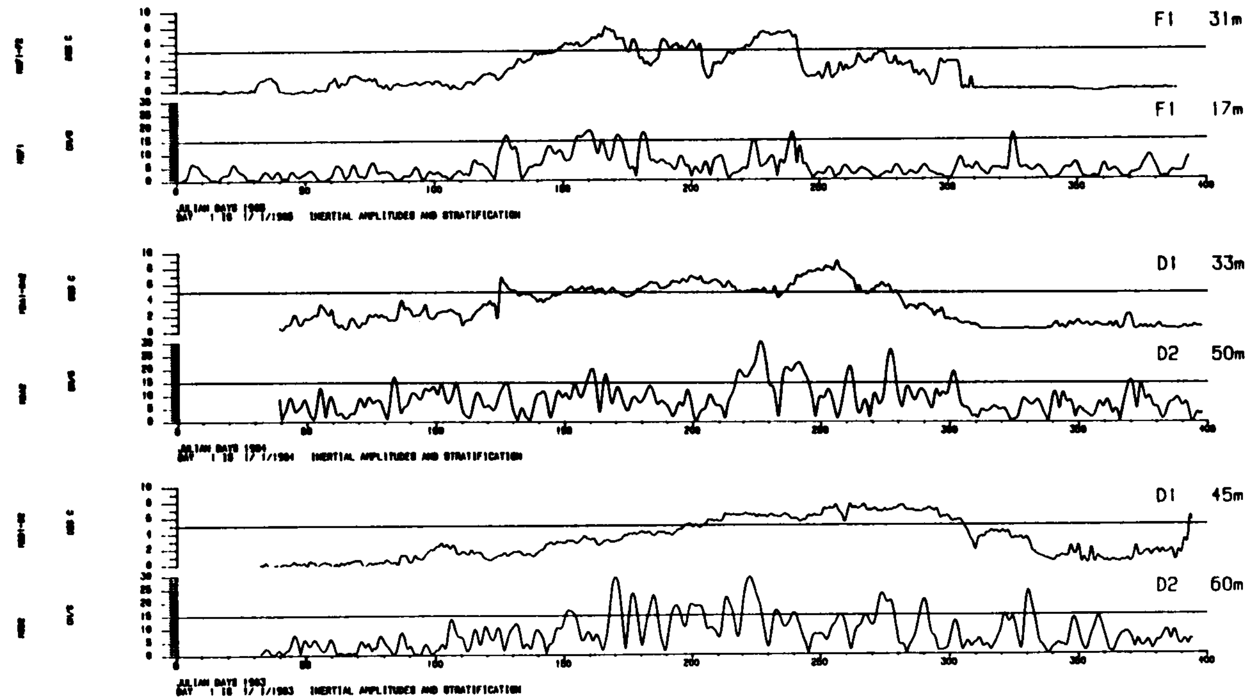

Figure 4.4-13. Demodulated amplitudes of inertial currents and vertical temperature differences for D1 and D2 (1983 and 1984) and F1 and F2 (1985).

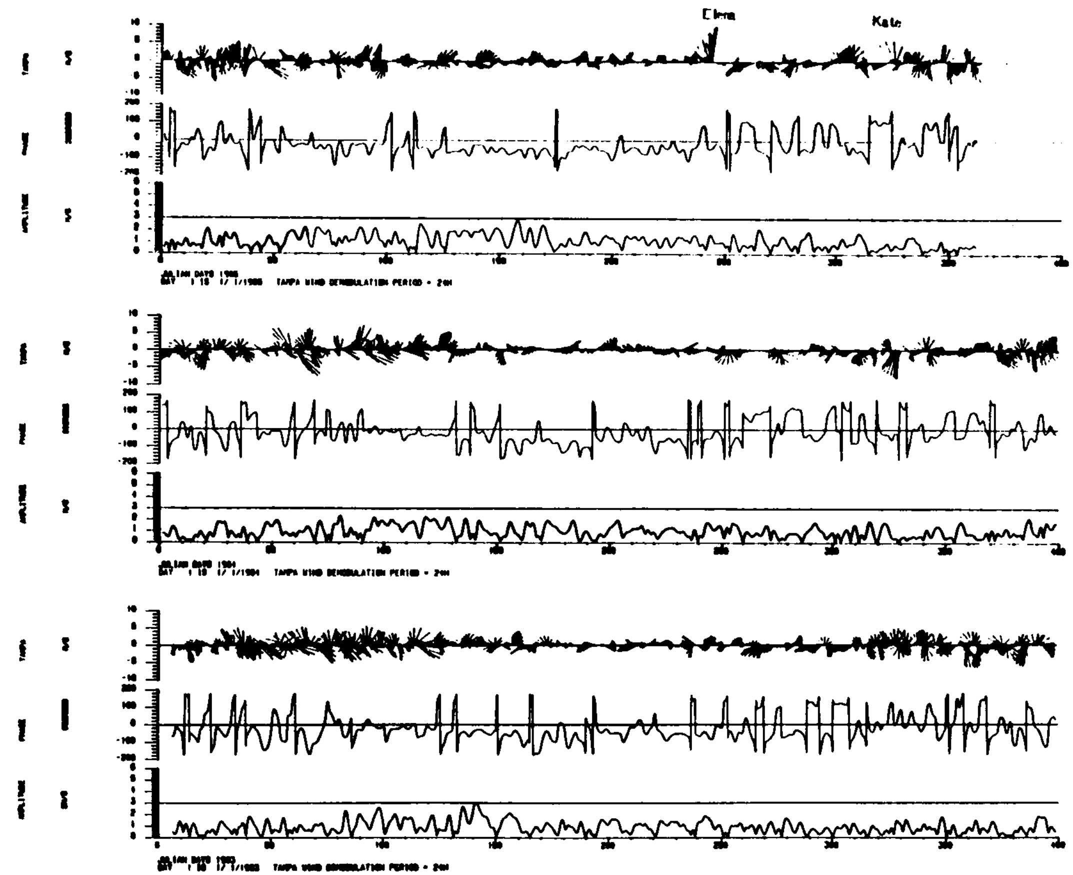

Figure 4.4-14. 40-HLP wind record and demodulated amplitudes and phases of the diurnal (24 hour) winds from Tampa, Florida.

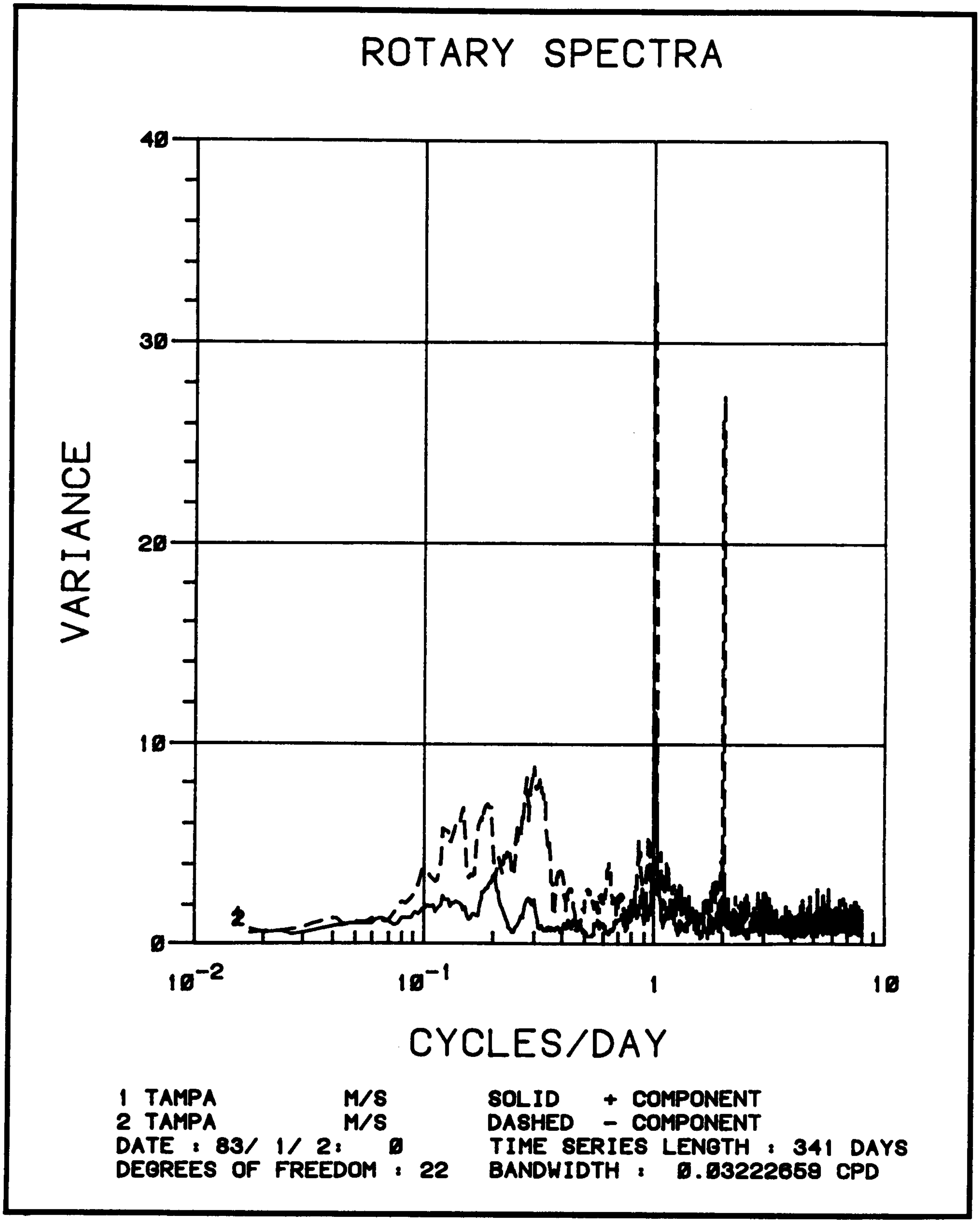

Figure 4.4-15. Variance preserving rotary spectra for Tampa winds.

height of the peak.) The nature of the diurnal variability in the winds was investigated further by performing the demodulation of the wind data to generate time series of amplitude at the diurnal frequency, analogus to the demodulation at the inertial frequency done on the current data. Because the diurnal and inertial frequencies are so close in the study area, the demodulated wind amplitudes parameterize an important energy source for the inertial currents. These are also plotted on Figure 4.4-14, along with the vector time series. It can be seen that the diurnal amplitudes did not show the summer decrease evident in the low-pass vector wind data. Indeed, they tended to be somewhat higher in late spring and early summer, even as the low-pass data were diminishing. This, in fact, may partially account for the spring-summer increases in inertial current amplitudes. It may also account for the fact that such seasonal patterns were most prominent on the shelf (Moorings D and F) because the deeper moorings may have been beyond the influence of the coastal sea-breezes.

The passage of storms or weather fronts is the most conspicuous source for the generation of inertial currents in many ocean areas (D'Asaro, 1985b), and the vicinity of the West Florida Shelf is no exception. Such events can be distinguished from other peaks in the inertial amplitude records by the near simultaneous appearance of a peak, at all locations, coincident with the known passage of a storm. The 1985 record has two such events (Figure 4.4-16), associated with Hurricane Elena (Aug 28 - Sep 4) and Hurricane Kate (Nov 15 - Nov 23). These storms had nearly identical tracks, entering the Gulf of Mexico along the north coast of Cuba, then curving northward, and making landfall in the Florida panhandle (Figure 4.4-6). These tracks resulted in a sharp clockwise veering of the wind stress over a 24-hour time period as the storms moved northward with the eye remaining to the west of the moorings. The wind events were high intensity and with the correct rotation and time scale to be perfect for exciting inertial currents. Hurricane Kate, in fact, was associated with the strongest amplitude peak for the entire three-year record at Moorings A, C and E, which were closest to the storm center.

At Mooring E, the response to Hurricane Kate was unusual in one other respect. The amplitudes at 100-m depth modulated dramatically for 70 days after the passage of the storm, with successive peaks of the same amplitude as the first. In contrast, the subsequent modulations at the other stations, including the 50-m depth at Mooring C, were characteristically damped (Figure 4.4-16). Furthermore, the response at 100 m on Mooring E was much different for Hurricane Elena, two months earlier, than for Hurricane Kate, with the Elena response more resembling the damping evident elsewhere. Consequently, the conditions in the vicinity of Mooring E in November must have been unique in some way to allow such an unusual response. There were no coincident hydrographic or XBT data for comparison, but it may be that the current meter was positioned at a critical depth of the pycnocline where such modulations were possible. Explanations for this observation are highly speculative at this time, but present and future models could be examined to see if they can account for this.

4.4.2.3 Summary

1. Inertial currents were prominent at all locations studied in the West Florida Shelf mooring array, and were quite energetic, with peak amplitudes from 15 to 30 cm s-1, and occasionally greater.

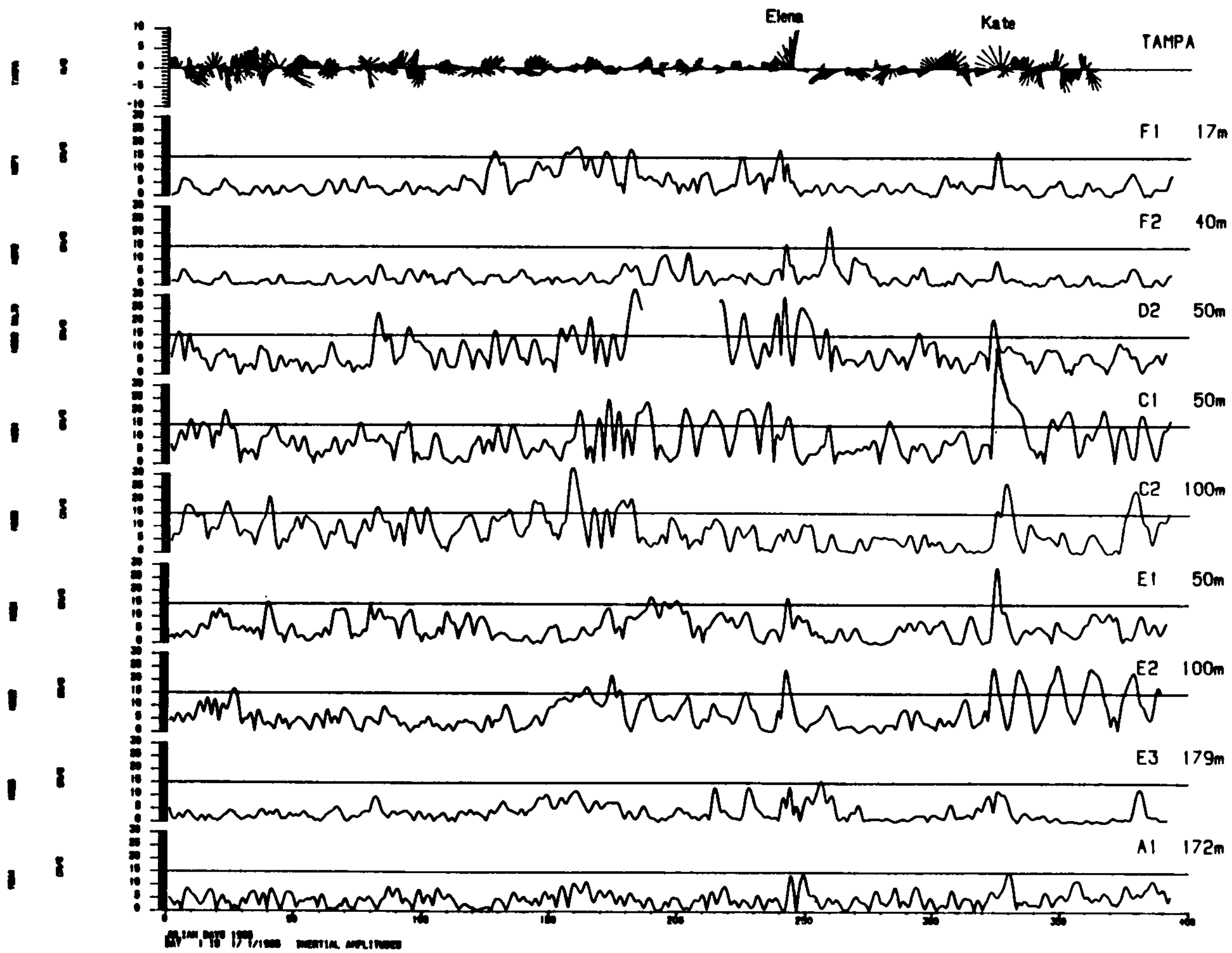

Figure 4.4-16. Demodulated amplitudes of inertial currents at the indicated instruments, along with 40-HLP wind velocity record from Tampa.

2. The amplitudes were intermittent in time and space, as is commonly observed for inertial currents in general. Amplitudes commonly peaked at different times at different depths of the same mooring string, as is consistent with models (Kundu, 1986). Amplitudes were also not well correlated between mooring locations separated by 70 kilometers except during isolated events forced by major storms.

3. Mid-depth maxima of inertial amplitudes were common at moorings which sampled near the base of the mixed layer, suggesting that peak amplitudes were associated with the pycnocline. This was consistent with the model of Gill (1984), but not with those of Kundu (1984, 1986).

4. Moorings on the shelf (D and F) showed noticeable increases in inertial amplitudes during summer. This occurred even as 40 hour low-pass winds diminished in summer. However, vertical stratification and diurnal wind amplitudes were both generally greater in spring or summer, possibly accounting for the increased inertial amplitudes.

5. Two hurricanes in 1985 (Elena and Kate) had similar tracks and produced sharp peaks of inertial amplitudes at all sites. Hurricane Kate produced the largest inertial amplitude peak measured for the three-year data set at the deeper moorings (A, C and E).

6. The 100-m depth amplitude at Mooring E modulated strongly for two months after the passage of Kate. This was uncharacteristic of the response to the earlier storm, Elena, and of the responses at the other moorings to Kate. Similar modulations were noted at other moorings, but not in response to an intense storm.

In general, inertial currents are important to the dynamics of the West Florida Shelf oceanography. They are energetic, with amplitudes often exceeding magnitudes of mean currents, low frequency fluctuations and tides. They are ubiquitous in location and common throughout the year. They are undoubtedly important to the dynamics of the mixed layer and to transport and mixing processes in general.

4.4.3 Lower Frequency Motions

4.4.3.1 Overview

Some results from the first two years of data perhaps could have been anticipated, but they required data before they could be made specific. The stick plots, such as for Mooring C (shown later in this report) are a good example. It is well known that the typical wind energy is to be found in periods of 3-10 days, and that there will be eddy signals at somewhat longer periods (see, e.g., Mitchum and Sturges, 1982; Cragg, Mitchum and Sturges, 1983). Therefore it might be anticipated that a record two years long would be "long" in some statistical sense -- thereby providing a good measure of the mean flow field. The data, however, show the contrary. The typical speeds (at the upper instruments at C) approach 20 cm s-1, and more energetic events are likely to have occasional peak speeds of 40 to 60 cm s-1. A remarkable event in mid-August, 1984, shows speeds exceeding 100 cm s-1 at the upper current meter (50-m deep) and 80 cm s-1 at the 100-m instrument. This burst of flow lasted nearly 40 days. If this very energetic event were not in the record, the mean values of the observed currents could be computed with more confidence. One value of seeing the stick plots, however, is partly from the "cautionary effect" they have. A mean value can be computed, of course, and then its standard deviation, but any such mean value should be interpreted with a healthy measure of prudence. Statistical measures, such as the standard error of the mean, must be interpreted cautiously (i.e., they may be meaningless when irregular bursts are present in the data), because the process is not stationary in a statistical sense.

Note that this large flow at Mooring C was in late August 1984. The extraordinary behavior of Hurricane Elena, which could have caused large flows by staying so long over the shelf, took place in August-September, 1985.

While it is natural to assume that isolated events at Mooring C are caused by meanders of the Loop Current, similar effects are seen at the other instruments. At Mooring D, at the 50-m instrument, although typical speeds are rarely as large as 20 cm s-1, the occasional "event" goes by, with speeds approaching one knot to the south (December, 1983), or 30 cm s-1 to the north. Similarly, at Mooring F, although typical speeds are roughly 5-10 cm s-1 (peak to peak) at the upper instrument and less at the lower instrument (40-m deep), there are numerous instances where the speeds are much larger -- over 20 cm s-1 at the upper meter and 15 cm s-1 at the lower.

The near-shore currents in this area are primarily wind driven (Mitchum and Clarke, 1986a, 1986b). High coherence was found between wind and the currents at mid-shelf, at depths of 50 to 80 m. Figure 4.4-17 shows a cross spectrum between the alongshore currents at the upper current meters at Moorings D and F. The important feature to note is that the coherence is high throughout the wind driven band of 3-10 days, and the phase shift is small between the two instruments. Because the currents are so closely in phase, it can be concluded that the flow is primarily of a simple "shape" in the offshore direction. Figure 4.4-18 shows a similar result, but for longer periods, from Mooring D to the tide gauge at Clearwater (near Tampa). Therefore, the phase shift is small from Mooring D to the coast.

The phase shifts are small at all periods of three days and longer. Figure 4.4-19, however, makes a rather different point. It shows the frequency distribution of the energy, as it varies in the offshore direction, at periods longer than one day. At Mooring F (50-m depth; top figure), the energy is roughly half in the wind driven band and roughly half in the band at periods longer than ten days. At Mooring D (80-m depth), the amplitude of the currents is larger than at F. Even more noticeable is the fact that the energy at periods longer than ten days is substantially larger than the wind-driven energy. In other words, the eddy-like motions are larger than the wind-driven motions. At Mooring C the eddy-like motions are seen to be at even longer periods and have a greater proportion of the energy. Note that although at periods of less than two weeks the eddy-motions are beginning to be found, there is still wind forcing at these periods.

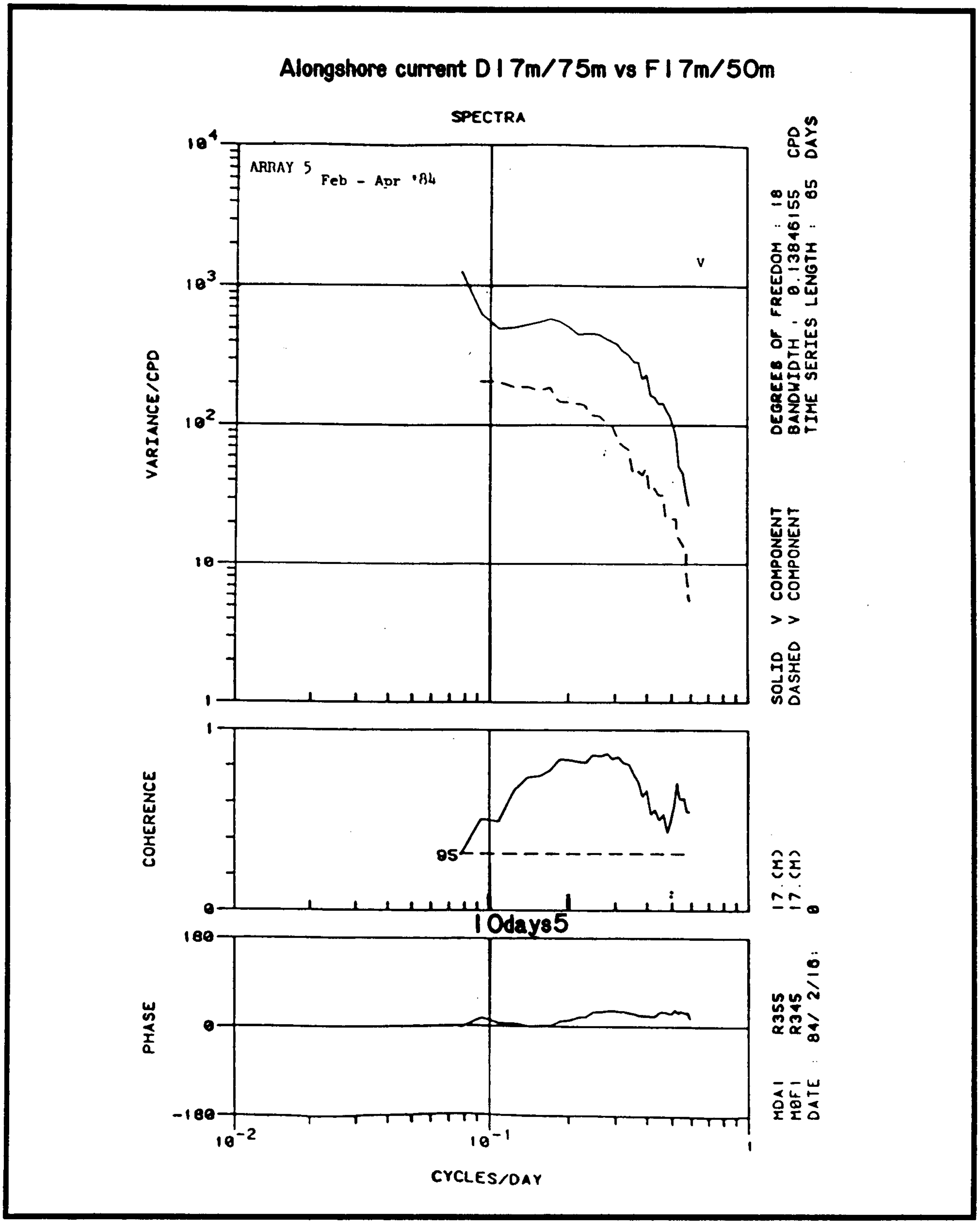

Figure 4.4-17. Cross spectra between the upper instrument at Moorings D and F for 3 months (February through April 1984) in the longshore component. The upper panel shows the spectral amplitudes, and the lower panels show coherence and phase.

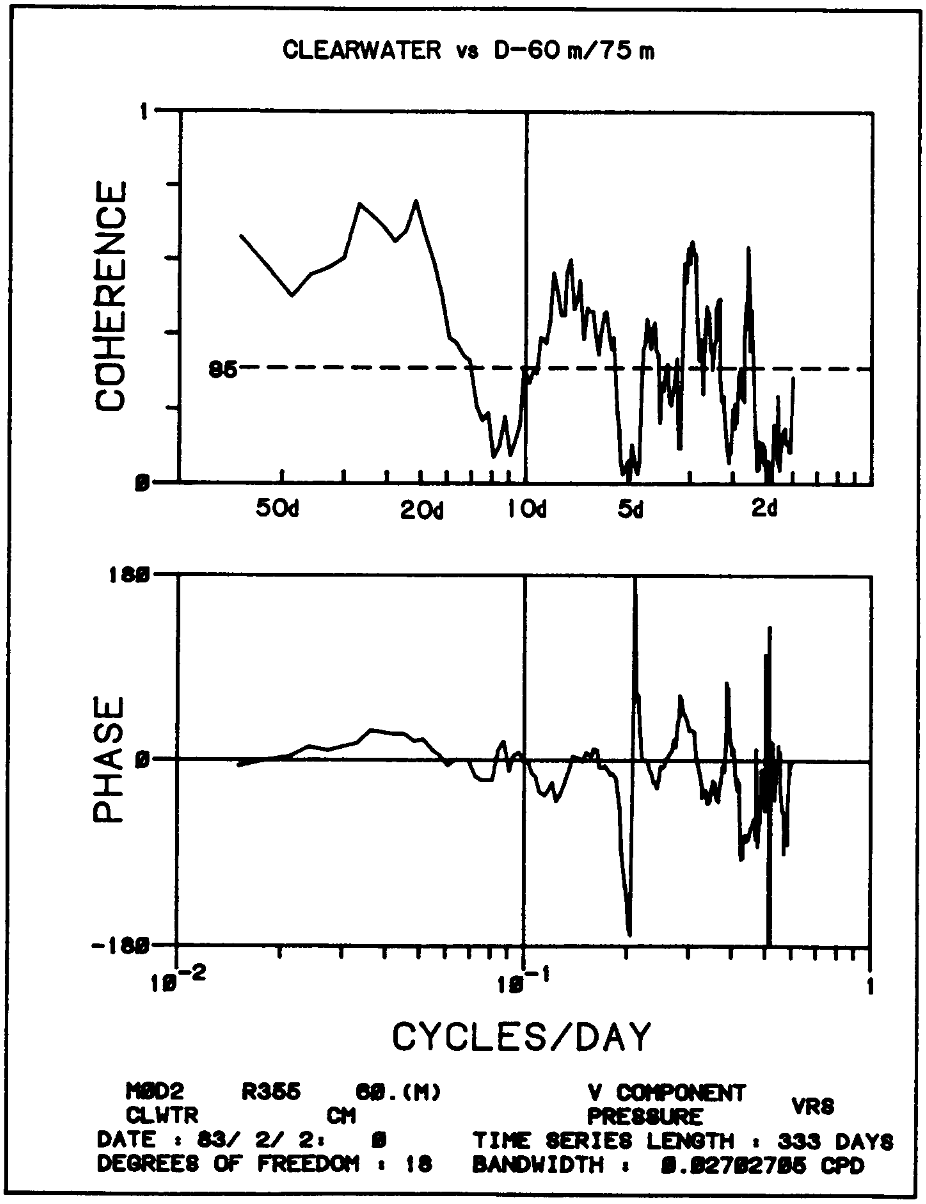

Figure 4.4-18. Cross spectra between the 60 m instrument on Mooring D and the Clearwater tide gauge (adjusted to constant atmospheric pressure) for approximately one year of data.

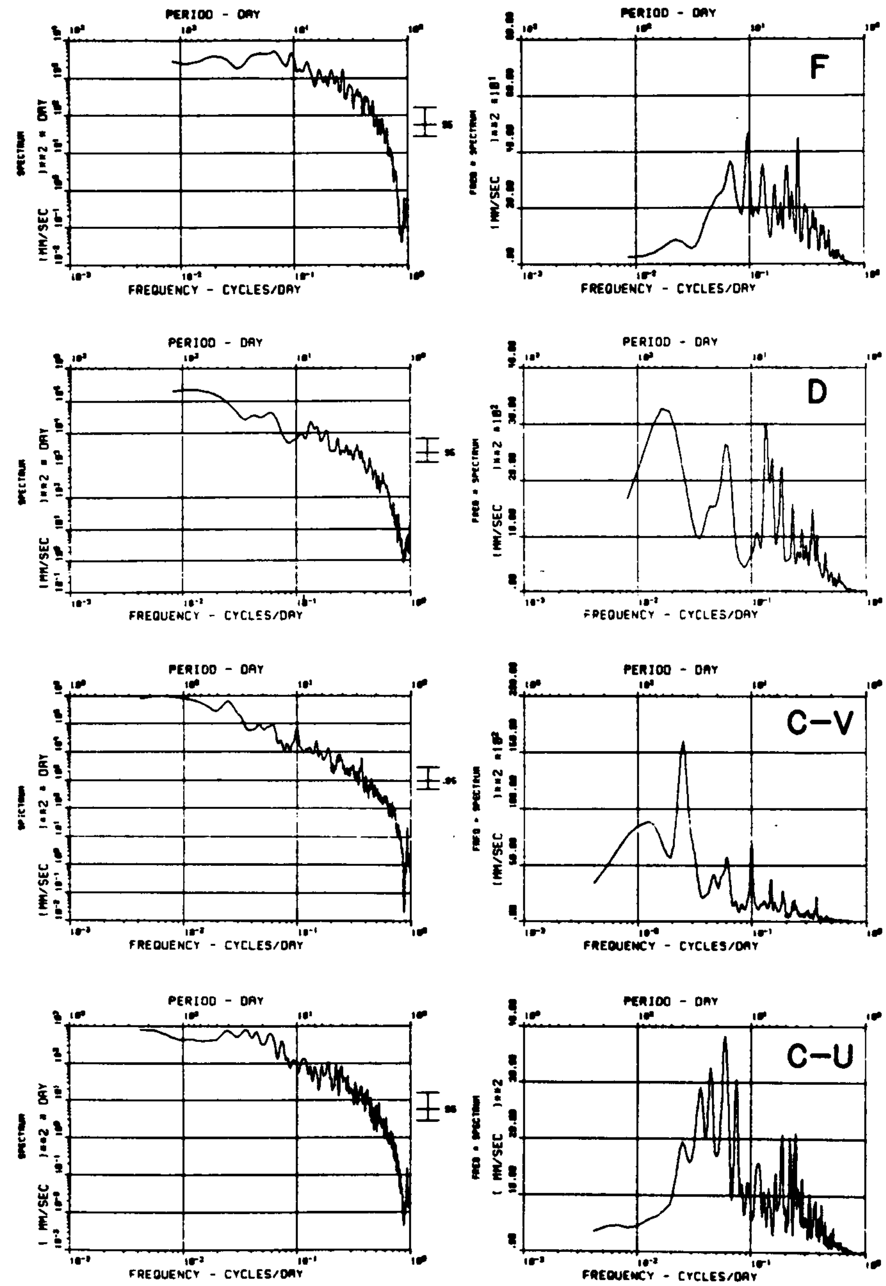

Figure 4.4-19. Spectra of currents observed at Moorings F, D and C beginning in February 1984, with the original hourly data filtered to two points per day. The alongshore component is shown at F (40 m) and D (60 m), and both components at C (100 m) where V = alongshore and U = across shelf. The spectra have been smoothed by five Hanning passes to give 11 degrees of freedom. Ninety-five percent confidence limits are shown.

Although we are confident that in the near-shore waters and at the wind driven frequencies the currents are highly coherent with local wind forcing, the statement can be verified only in the fall and winter, when wind forcing is strong. In the spring and summer, when the wind forcing is light, the computed coherence between wind and currents falls off substantially, presumably as a result of the decrease in the signal-to-noise ratio, as will be discussed in Section 4.4.3.3.

Based on theoretical predictions (Clarke and Van Gorder, 1986) it is expected that the amplitude of the wind-driven signal will increase from south to north. This is confirmed by comparing coherence between tidal heights and wind at various positions along the coast. The current amplitude in the wind-driven band also increases, but more data are available from tide-gauges than current-meters.

At Moorings A and G, a very strong flow is seen as the Loop Current moves over the moorings, as evidenced by the satellite IR pictures. The instruments on the upper part of the moorings obviously see a coherent Loop Current, and the instruments in deeper water see eddy-like signals. These eddy-like signals tend to be coherent between Mooring A and G at the deepest instrument at A (1600 m) and the deeper instruments at G.

The strongest currents at Mooring A that appear to be related to the close, direct influence of the Loop Current show southerly flow that is coherent only at the upper instruments. By contrast, when the flow is to the north, it is often coherent all the way to the deepest instrument. Additional information about the flow observed during 1983-1984 is also given in Section 4.4.3.3.

In order to summarize the data from the full experiment, Figures 4.4-20 through 4.4-22 show the stick plots of the daily values for the three years of the experiment. Figures 4.4-20A, 4.4-21A and 4.4-22A show the values at Mooring A, Figures 4.4-21C and 4.4-22C show Mooring G, and Figures 4.4-20B, 4.4-21B, and 4.4-22B show the plots for Moorings C, D, and F along the main mooring line, as well as Moorings E and H along the shelf break to the north.

For these plots, the higher-frequency motions have been filtered, so as to allow the three years of data to be shown in a small space. The 7-day low pass filter used suppresses the energy at periods shorter than 7 to 10 days. In this more compressed view, it is easy to see that the fluctuations at Mooring C tend to be quite coherent at the upper two instruments but that the flow near the bottom (the instrument that is only 1 m above the bottom) is usually counter to that seen higher in the water column. Similarly at Mooring D and F, the flow is usually coherent from the upper to the lower instruments. This kind of nearly-barotropic response is to be expected on a shelf that has a small slope (i.e., it is wide) even for conditions of moderate stratification (Clarke and Brink, 1985). At Mooring E, in a fashion rather like at C, the upper two instruments were usually very similar but not so at the bottom. At Moorings A and G, the instruments in the upper 1000 m are quite coherent vertically, on a single mooring, but the deeper waters tend to behave independently. In the following sections, the effects of the wind and the Loop Current in forcing the currents as shown in these stick plots will be addressed.

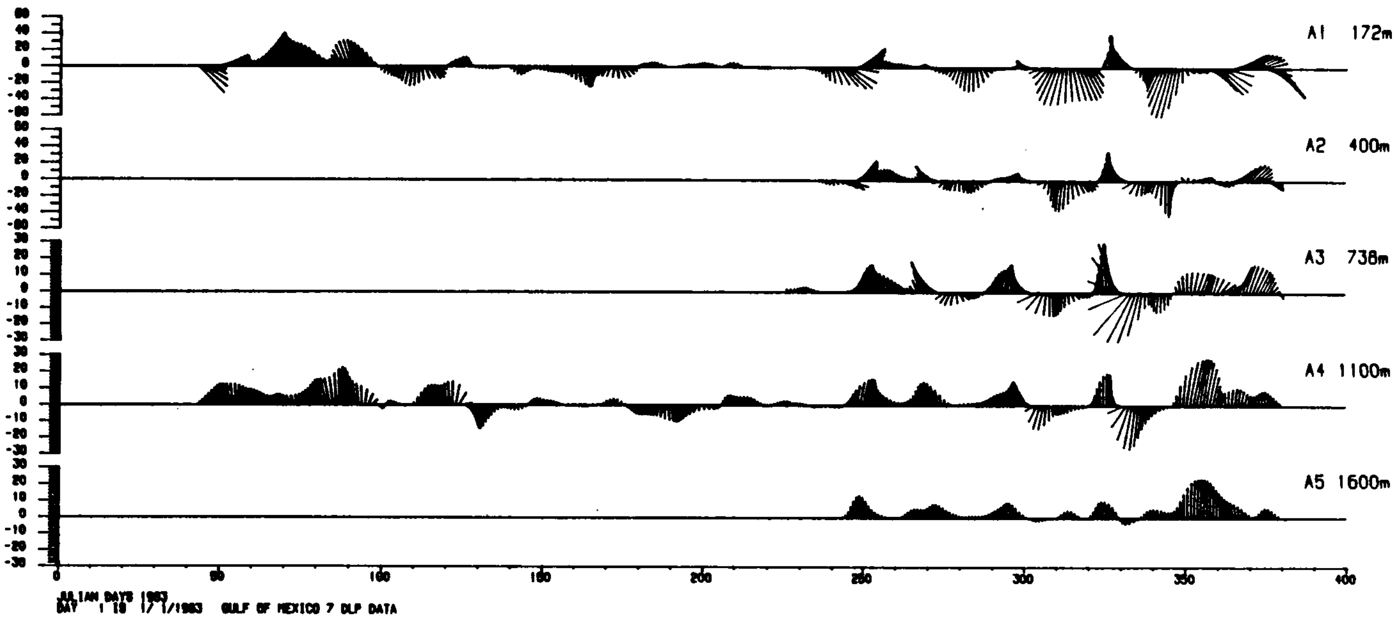

Figure 4.4-20a. Stick plots of the Mooring A current-meter data for 1983, using a 7-day low-pass filter (see text); one value is plotted per day. At each mooring, the depths are given. Note that at the end of the first year, the depths of some instruments were changed. For position locations, see Figure 4.4-1.

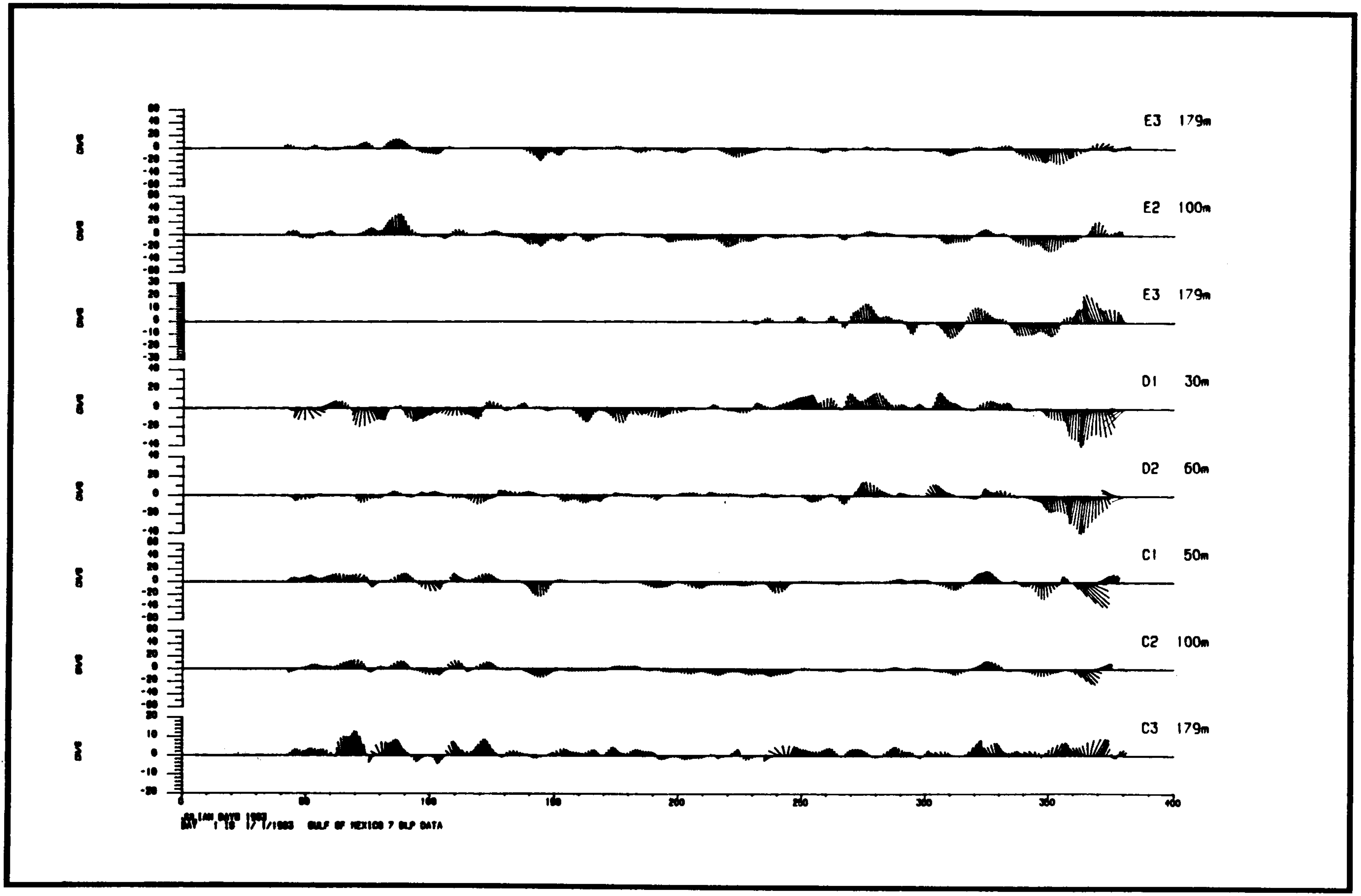

Figure 4.4-20b. Same as Figure 4.4-20a, but for Moorings E, D, and C for 1983.

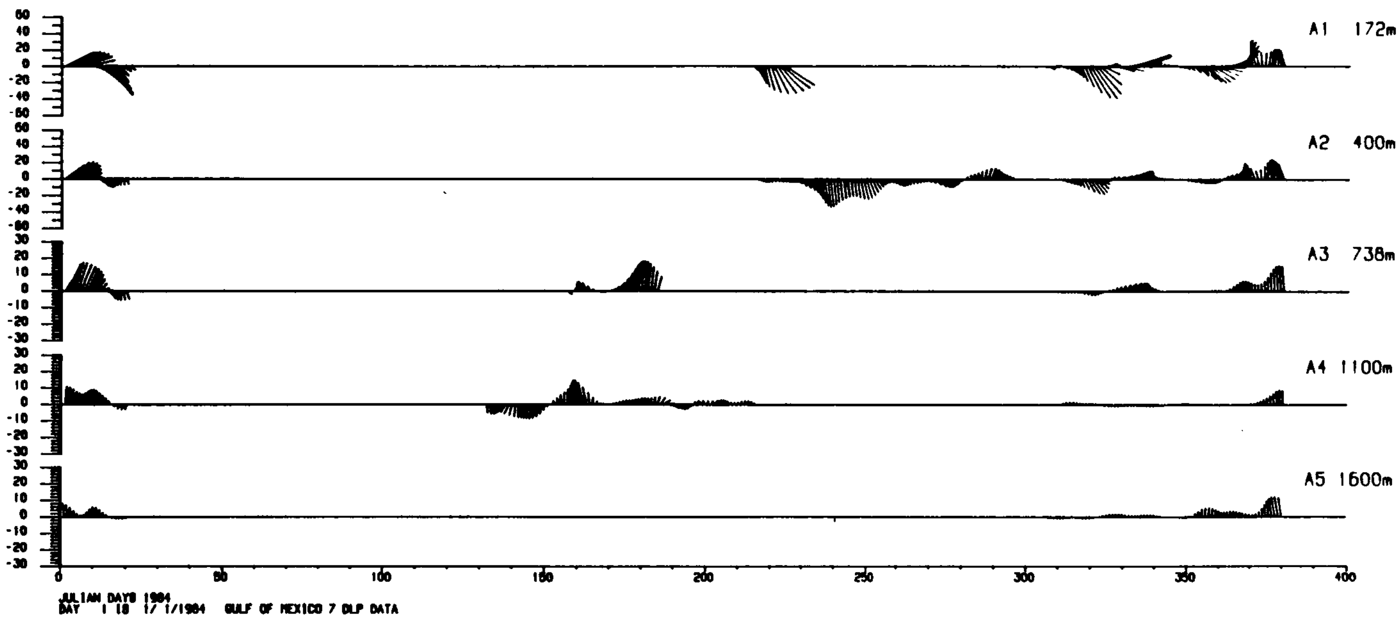

Figure 4.4-21a. Stick plots of the Mooring A current-meter data for 1984, using a 7-day low-pass filter (see text); one value is plotted per day. At each mooring, the depths are given. Note that at the end of the first year, the depths of some instruments were changed. For position locations, see Figure 4.4-1.

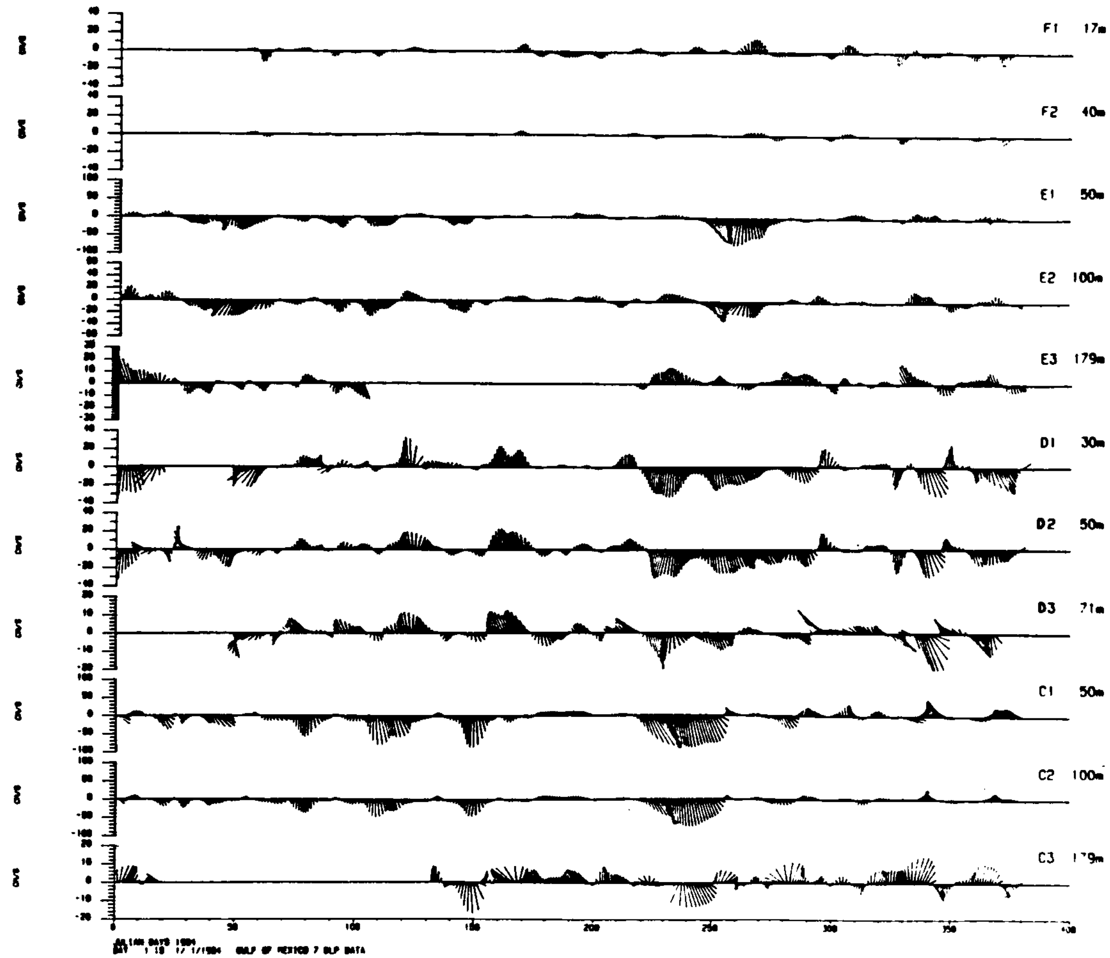

Figure 4.4-21b. Same as Figure 4.4-21a, but for Moorings F, E, D, and C for 1984.

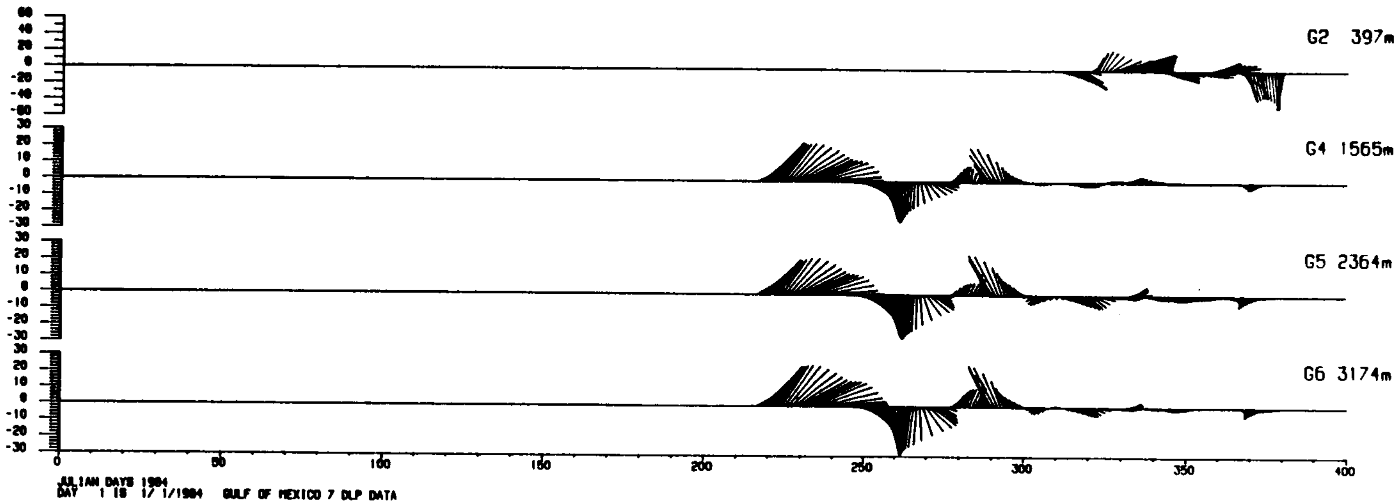

Figure 4.4-21c. Same as Figure 4.4-21a, but for Mooring G for 1984.

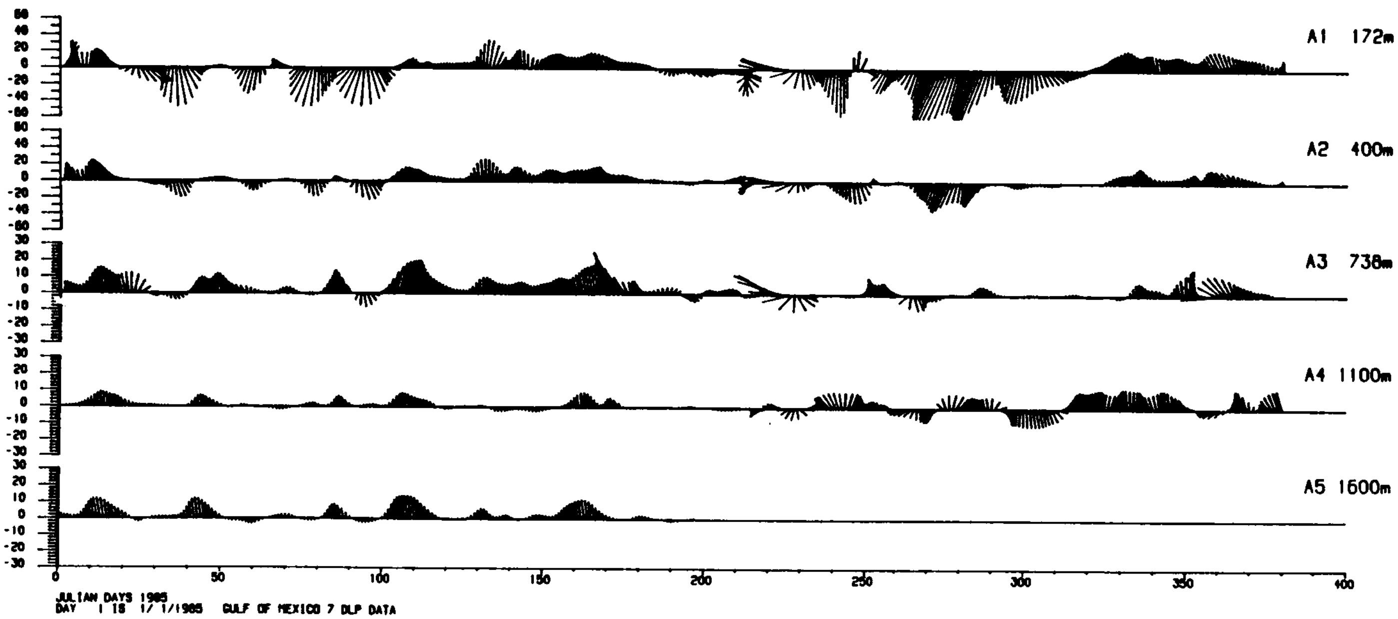

Figure 4.4-22a. Stick plots of the Mooring A current-meter data for 1985, using a 7-day low-pass filter (see text); one value is plotted per day. At each mooring, the depths are given. Note that at the end of the first year, the depths of some instruments were changed. For position locations, see Figure 4.4-1.

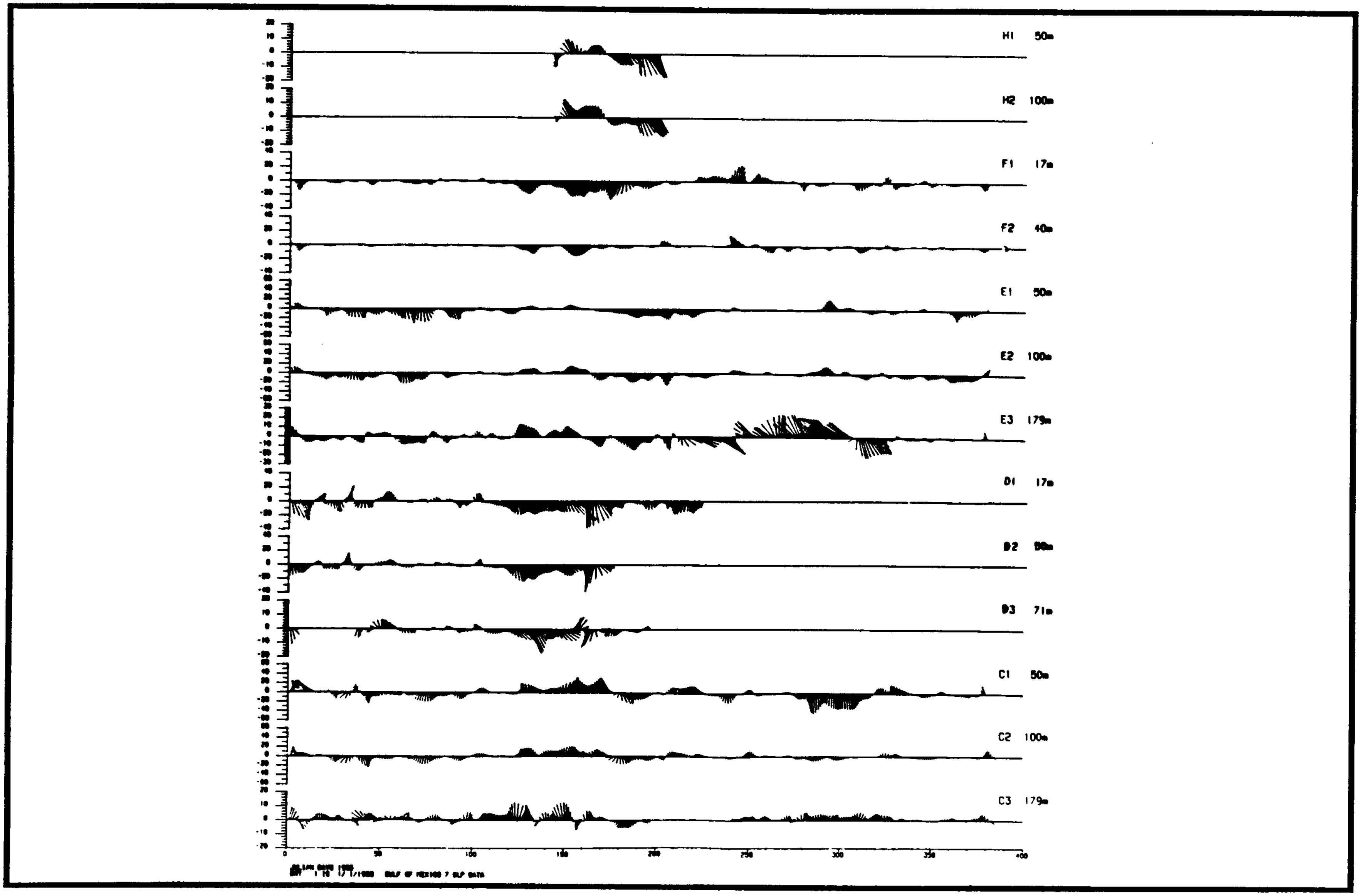

Figure 4.4-22b. Same as Figure 4.4-22a, but for Moorings H, F, E, D, and C for 1985.

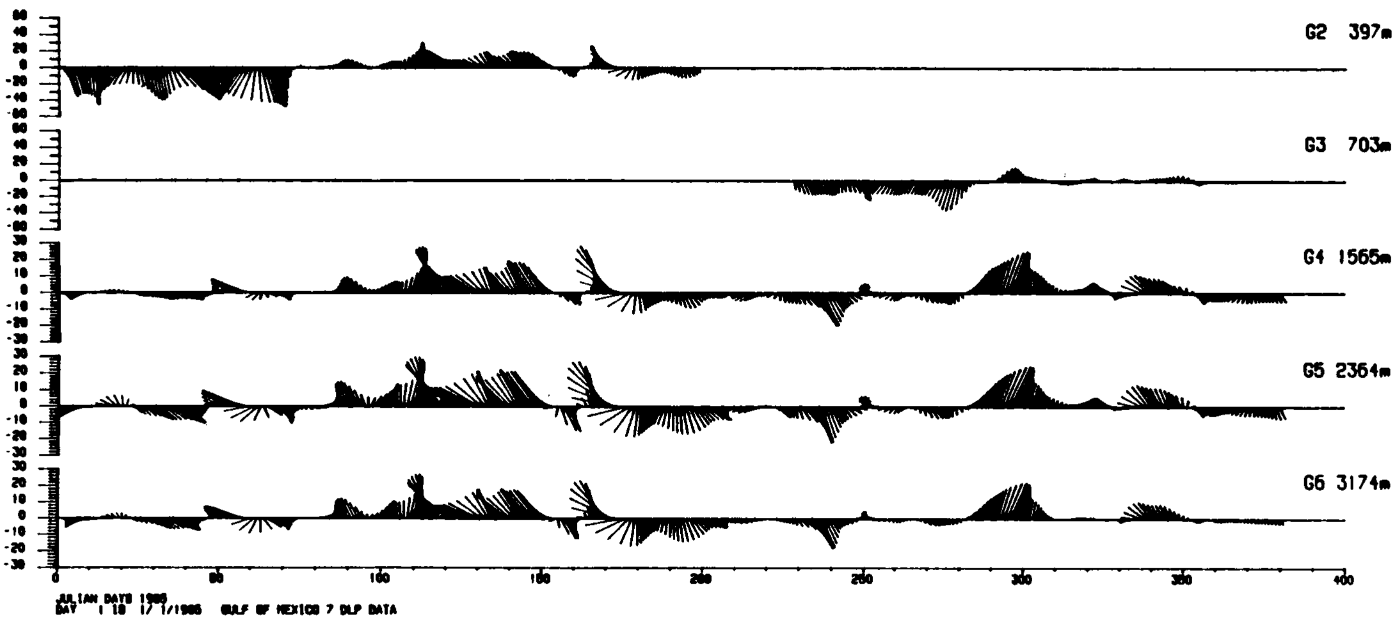

Figure 4.4-22c. Same as Figure 4.4-22a, but for Mooring G for 1985.

4.4.3.2 Coherence With Wind Forcing

Three main sources of wind data are appropriate: from Key West, from Tampa, and from the meteorological data buoy at 26°N 86°W. The wind records from these three locations were compared. If a relatively long record, such as one full year, is used, the results are clear; there is high coherence between all three stations at all frequencies. On the other hand, individual frontal systems come through the area from different directions. Some frontal systems that go past the mooring array and Tampa Airport may just barely reach Key West (if at all). From a dynamical point of view, however, it is known that shelf waves propagate only to the north on this coast, so it would seem that the forcing at Key West would be the most important. If a wind event propagates across the moorings, yet does not quite reach the Key West meteorological station, however, the wind data from Key West may not be appropriate.

With this in mind, coherences with the moorings on the shelf are computed with winds from the data buoy, from Key West, and from Tampa, independently, to see whether it made much difference. The results show [illegible]

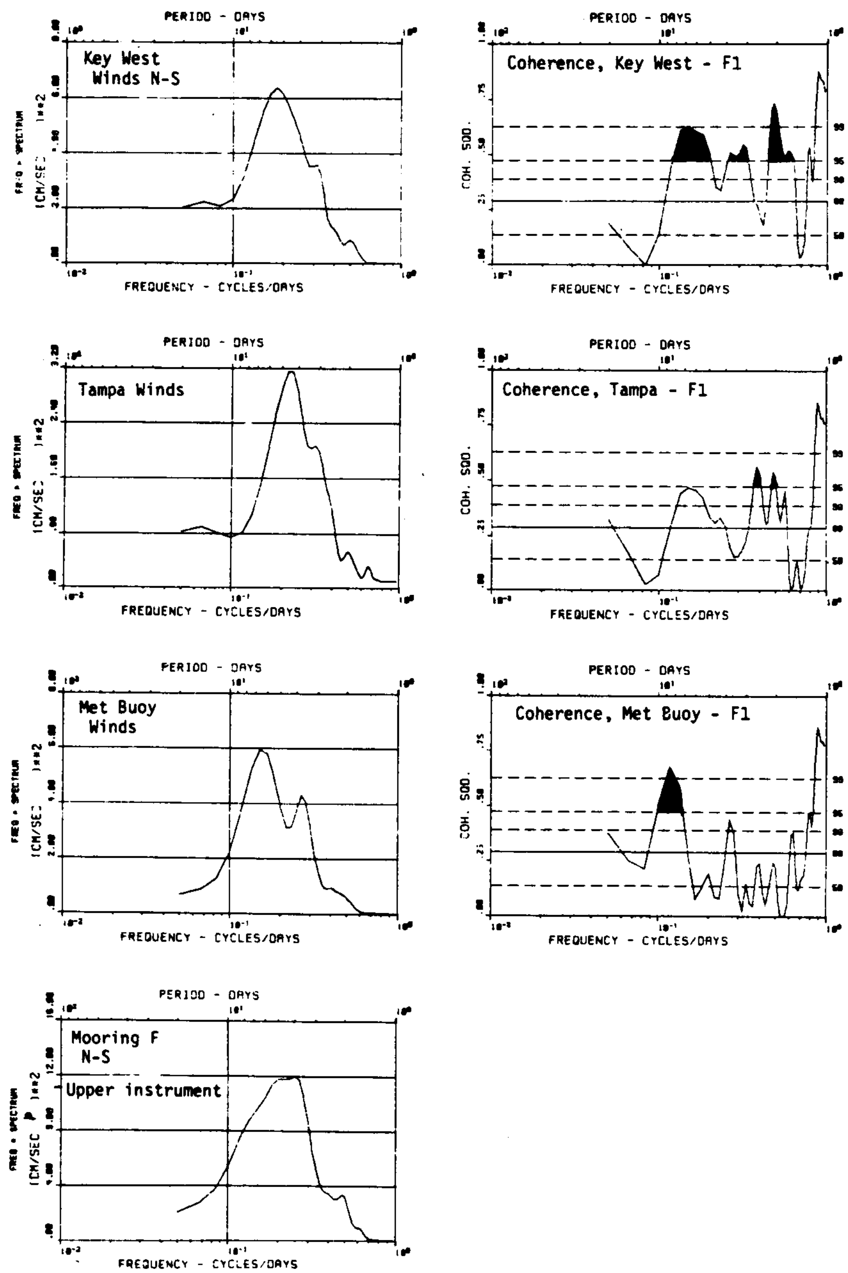

Figure 4.4-23. Coherence between observed wind fields -- at Key West, Tampa, and the meteorological buoy -- and currents observed at the upper instrument on Mooring F, for a two-month period beginning in February 1985. The spectra of the various observations are shown in the left-hand panel. The right-hand panel shows coherence between the observed currents and the three observed wind sets. The data used are two points per day, filtered from hourly data. The spectra are smoothed with five Hanning passes. The various confidence limits are shown on the coherence plots.

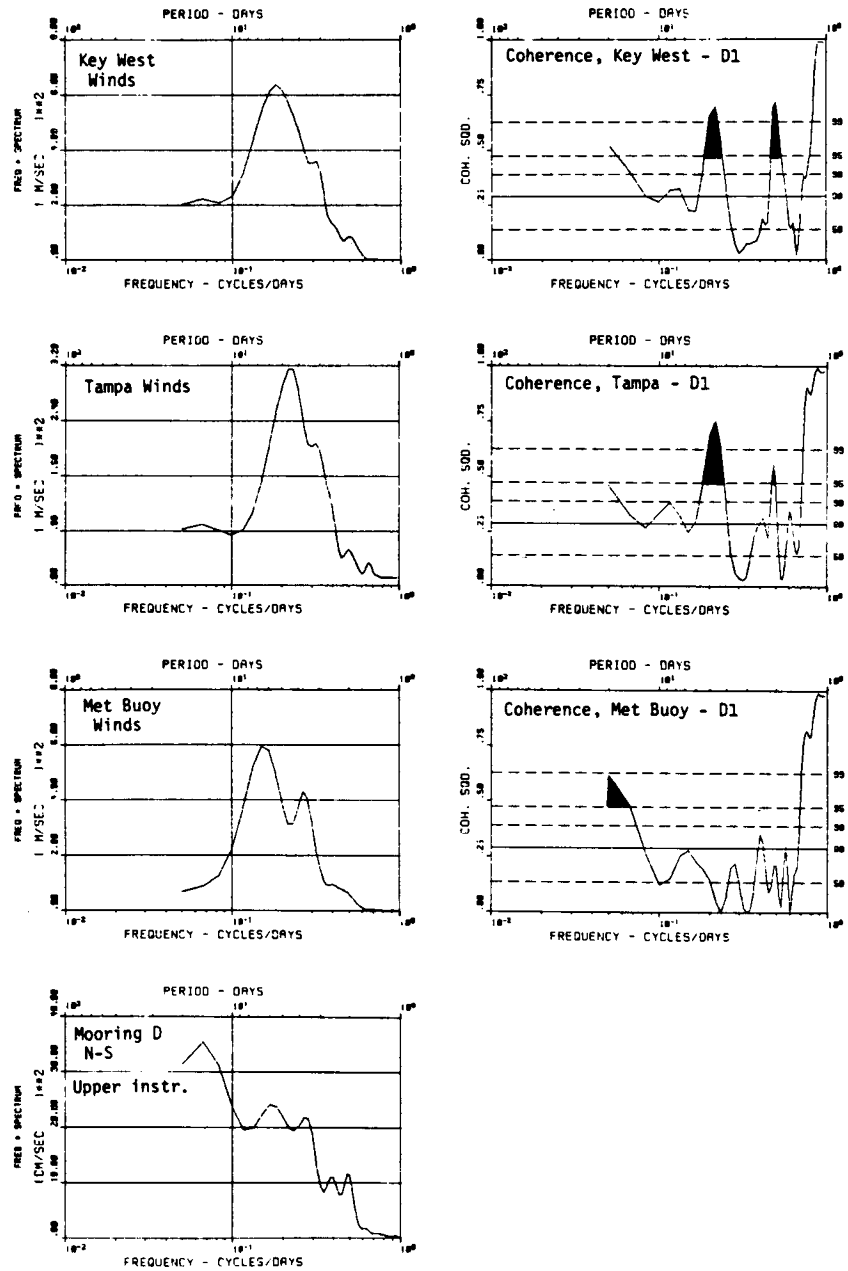

Figure 4.4-24. **Coherence between the three wind fields -- at Key West, Tampa, and the meteorological buoy -- and currents observed at the upper instrument on Mooring D, for a two-month period beginning in February 1985. The spectra of the various observations are shown in the left-hand panel. The right-hand panel shows coherence between the observed currents and the three observed wind sets. The data used are two points per day, filtered from hourly data. The spectra are smoothed with five Hanning passes. The various confidence limits are shown on the coherence plots.**

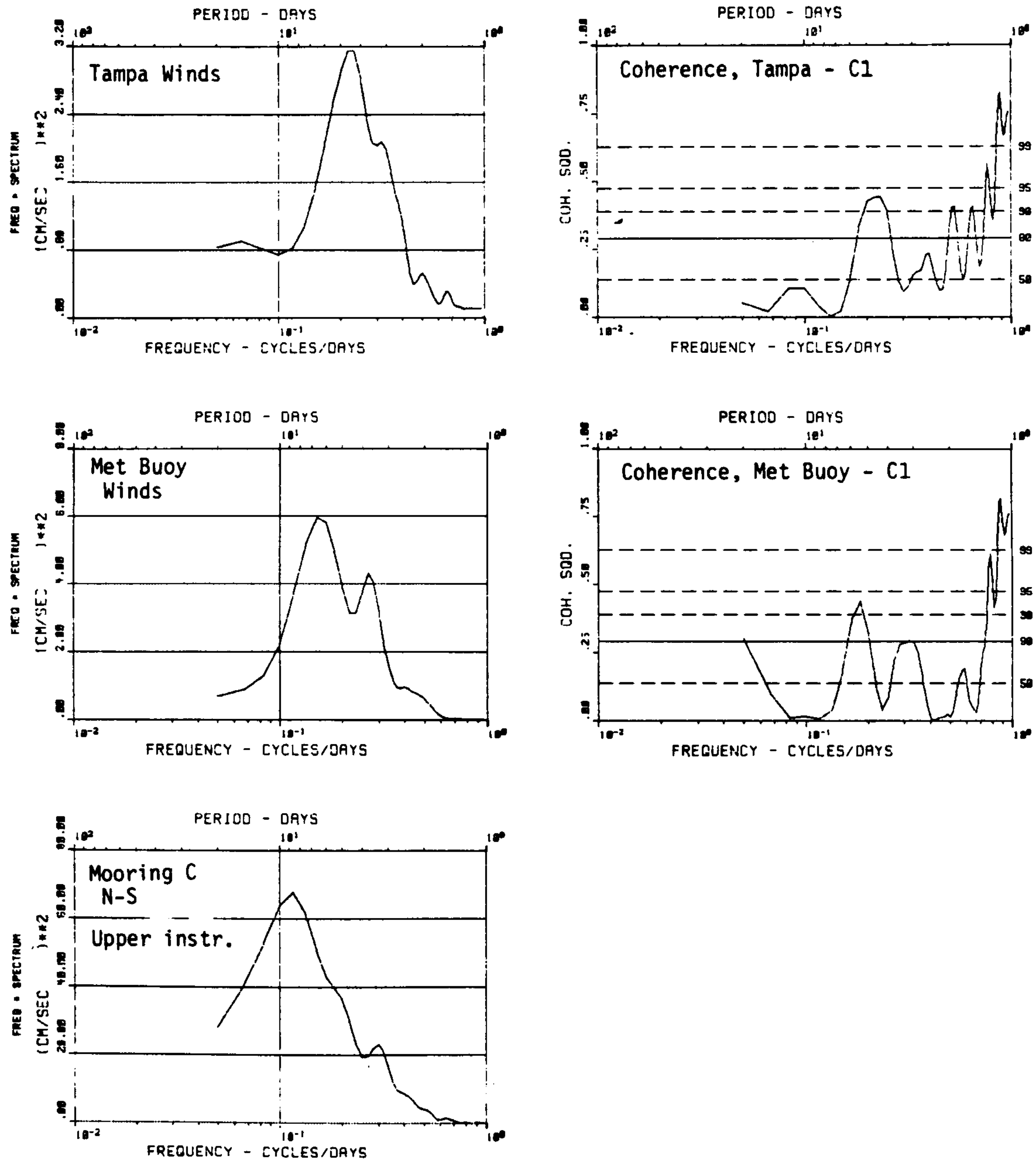

Figure 4.4-25. **Coherence between the three wind fields — at Key West, Tampa, and the meteorological buoy — and currents observed at the upper (50 m) instrument on Mooring C, for a two-month period beginning in February 1985. The spectra of the various observations are shown in the left-hand panel. Because there is negligible coherence with the Key West winds the coherence with that data is not shown. The data used are two points per day, filtered from hourly data. The spectra are smoothed with five Hanning passes. The various confidence limits are shown on the coherence plots.**

But the best coherence is found using winds observed at Tampa. However, this coherence is found at periods of less than four to six days, whereas most of the energy observed by the current meter is at periods slightly longer than this. This result should not be interpreted to mean that the wind driven currents cannot be predicted by a reasonable model at Mooring C, (recalling the results of Figure 4.4-24) but that the wind-driven flow at the edge of the shelf is, at times, a small fraction of the observed current field. Note for the time interval selected for these calculations (early 1985) the mean flow is very small at Moorings D and F.

The principal result of this section is that the wind-driven flow can be modeled well on the West Florida Shelf, but that the forcing by the wind must be included carefully in two dimensions if the details of the time-dependent flow field are to be modeled accurately.

4.4.3.3 Time Variation of Wind Results

As shown in the previous section, the wind-forced currents on the shelf are coherent with winds observed at the three locations near the moorings, but to different degrees. From the point of view of the propagation of free shelf waves, the Key West winds would seem to be a better predictor of currents than would be the Tampa winds. The winds observed at the meteorological data buoy, however, are closer to the moorings than either Key West or Tampa, so these winds should be used in a model, if possible. But the actual computed coherence, and which wind forcing has highest coherence with the currents, is found to be a function of frequency.

One question that arises when looking at the results of comparisons such as were done in the previous section is to what extent might these results change, from season to season, or from year to year.

Figures 4.4-26 through 4.4-28 show one way to examine that question. The coherence and phase between the winds and currents at the upper instruments on Moorings D and F have been compared with the winds in a rather different way. The calculations of cross spectra have been done using two-month data segments. The results are shown for specific frequency bands, although this choice is not critical.

For periods of four to twelve days, Figures 4.4-26 and 4.4-27 show that the wind power at Tampa and coherence with the upper instrument at Mooring D vary as a function of season. The general result is that very low wind strength leads to low currents and to low coherence, as a result of the poor signal-to-noise ratio. The phase is not plotted if the coherence is below 80% confidence.

A similar set of results (Key West winds, currents at Mooring F) at a slightly longer period (12 days) is shown in Figure 4.4-28. This is a longer period than is usually considered to be in the directly wind-driven band, but the coherence seems reliable for many of the calculations. Again, the phase is plotted only for coherence (squared) greater than the 80% confidence limit. As the uncertainty of a single phase calculation is about 40° (at 90% confidence limits), the scatter is surprisingly small.

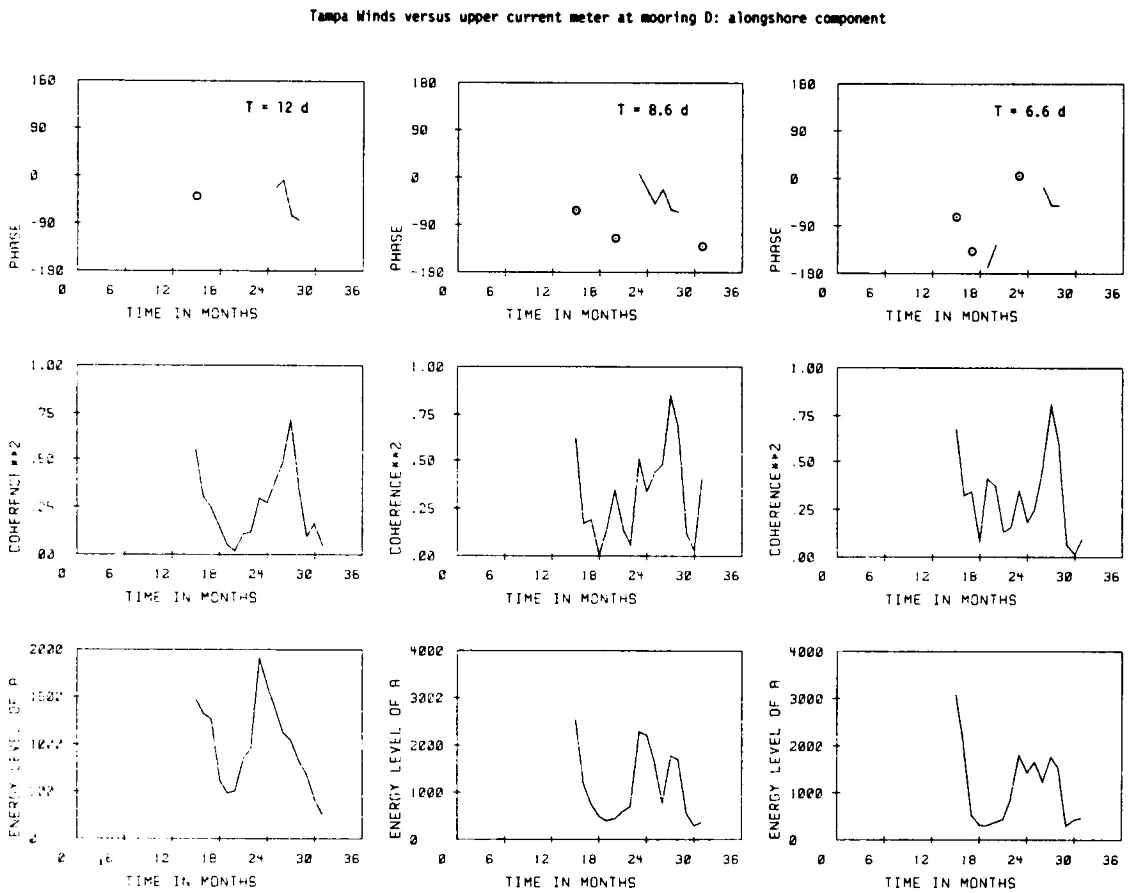

Figure 4.4-26. **Results of a series of calculations of cross spectra, beginning January 1983 for the Tampa winds versus the upper current meter at Mooring D (alongshore component). The bottom panel shows the magnitude of the wind stress, for several periods, using the Tampa meteorological data. The middle panel shows the coherence between winds and the observed currents at the upper current meter, Mooring D. The upper panel shows phase between the wind and observed currents, and is plotted only for coherence squared greater than the 80% confidence limits. The dots with circles around them represent single data points.**

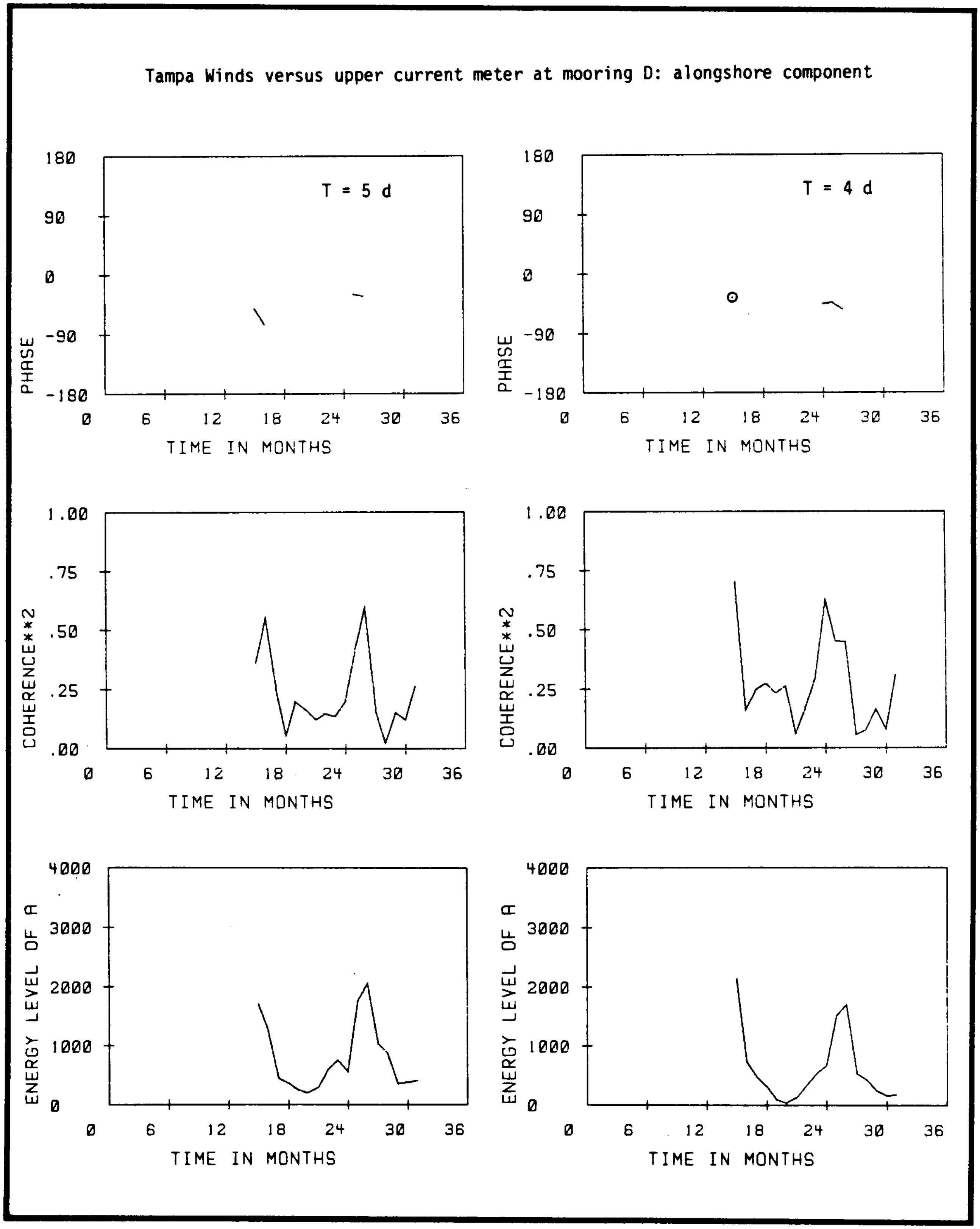

Figure 4.4-27. Same as Figure 4.4-26, but showing phase between Tampa winds and the currents observed at the upper instrument at Mooring D at periods of five and four days. The phase is not plotted if the coherence is lower than the 80% confidence limit.

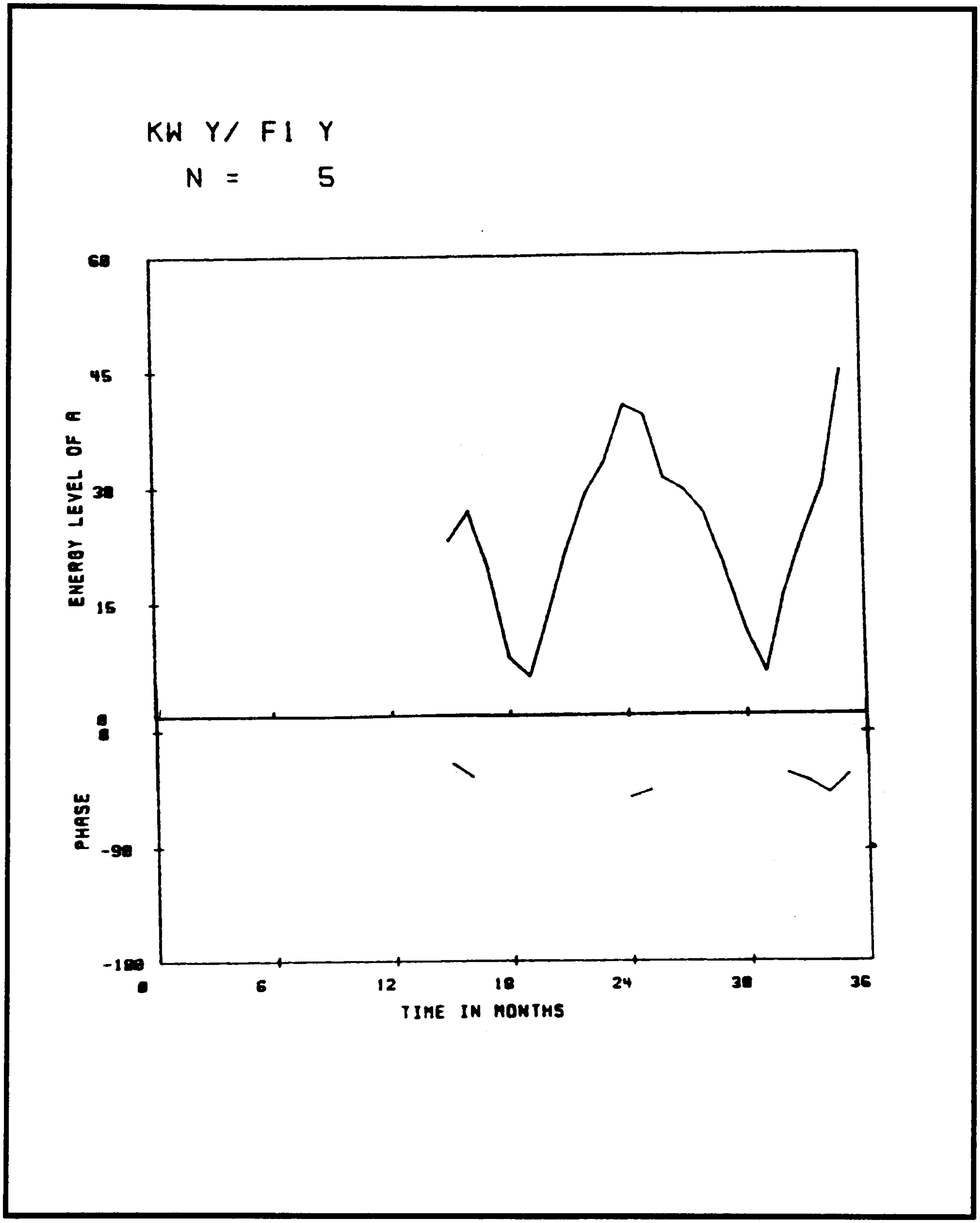

Figure 4.4-28. Similar to Figure 4.4-26 except for winds observed at Key West compared with the upper instrument at Mooring F, at a period of 12 days. Sixty days of data and five Hanning passes are used for each calculation.

The general results to be found in these figures are four-fold. First, there is a natural variability in the response to wind forcing. The variation in the results is occasionally larger than might be expected, on the basis of the 90% phase confidence limits, but is usually small. Second, when determining model parameters, it may be appropriate to use only those segments of the data set where the coherence is high, rather than obtaining an apparently higher coherence level by using a longer data set, in which there is little signal. Third, it is clear from these results that the Key West winds are the most coherent with currents, but at five-day periods the data buoy winds seem equally useful. And fourth, it seems likely that some of the variability in the results arises from eddy noise. The results of a large number of comparisons of this type, when compared with information about the eddy field (from hydrographic and IR data), allow determination of which calculations are more (or less) influenced by the eddy signals. This information can be used in two ways: 1) to determine the best parameters (for wind forcing) to use for model work, 2) to use the anomalous phase information as a diagnostic tool when searching the records for strong eddy signals.

4.4.3.4 Loop Current Forcing

Figure 4.4-29 shows a representative satellite infra-red (IR) image for the Gulf. In this figure, the Loop Current is slightly north of 25° but has been deleted to allow the moorings to be shown. The main purpose of the figure is to show the locations of the moorings in the main mooring array on the same scale as the following new figures. This map forms a base map for a collection of IR snapshots show in Figures 4.4-30 through 4.4-32. These figures contain a great deal of information in a small space, yet this level of detail is necessary in order to compare the time variability seen in the mooring data with the horizontal spatial variability found in the eddy field. The satellite data are rich in spatial information, and complement the moored current-meter data, which are sampled well in time, but are sparse in spatial information.

In each of the small snapshots in those figures, the 85°W meridian can be seen in the center (of each) and the 25°N latitude line near the bottom. Each small picture covers approximately 600 km east-west, and nearly 800 km north-south. The most important feature for locating the shelf topography is the dashed line showing the 200-m isobath. Tampa Bay can be seen in the center right and the date of each snapshot (beginning in 1985) is written in the top right corner. These figures are based for the most part on high-resolution satellite (AVHRR) images. During cloudy weather, an occasional image will be introduced from the geostationary GOES satellite of lower resolution. The surface temperatures, given in whole degrees C, are thought to be accurate to about 1°C. The arrows that are marked "LC" are intended to represent where the analyst's believed the highest Loop Current speeds would be found -- and not necessarily the edge of the Loop Current. A certain amount of artistic license is necessary to draw these pictures.

There are several purposes for introducing these figures. It is desirable, of course, to be able to compare the position of the Loop Current with the velocities observed at the moorings. When the Loop Current is near the moorings and when it is far away can, for the most part, be determined from

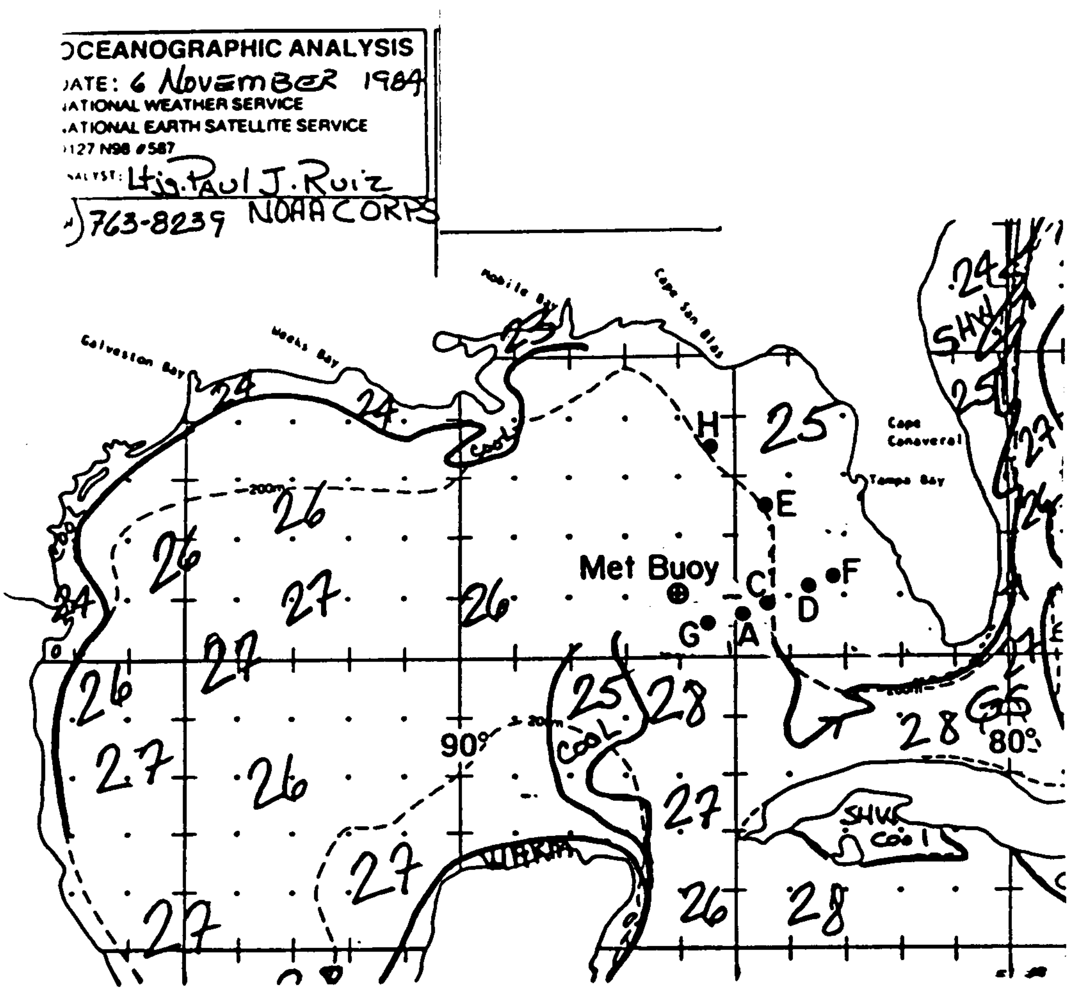

Figure 4.4-29. Satellite infra-red data for 6 November 1984, for the Gulf of Mexico. The position of the Loop Current has been partially deleted in order to show the position of the moorings and of the meteorological buoy. Surface temperatures (e.g., 26,27) are given in degrees C.

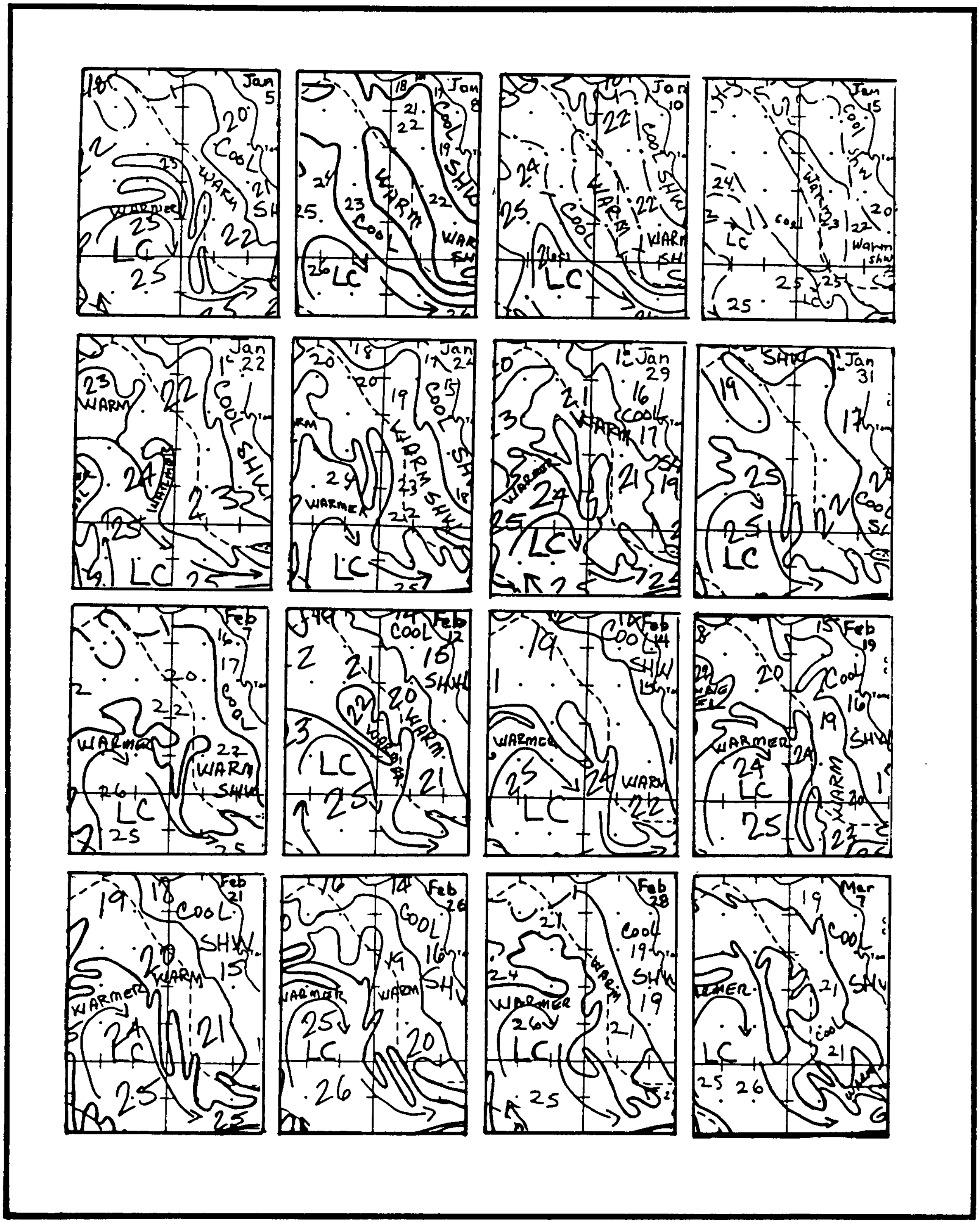

Figure 4.4-30. A collection of satellite infra-red maps beginning 5 January 1985 for the region near the west Florida Shelf, as in Figure 4.4-29, but for a more limited area (the 85°W meridian and the 25°N parallel are shown). The date (in 1985) is shown in the upper right corner of each picture.

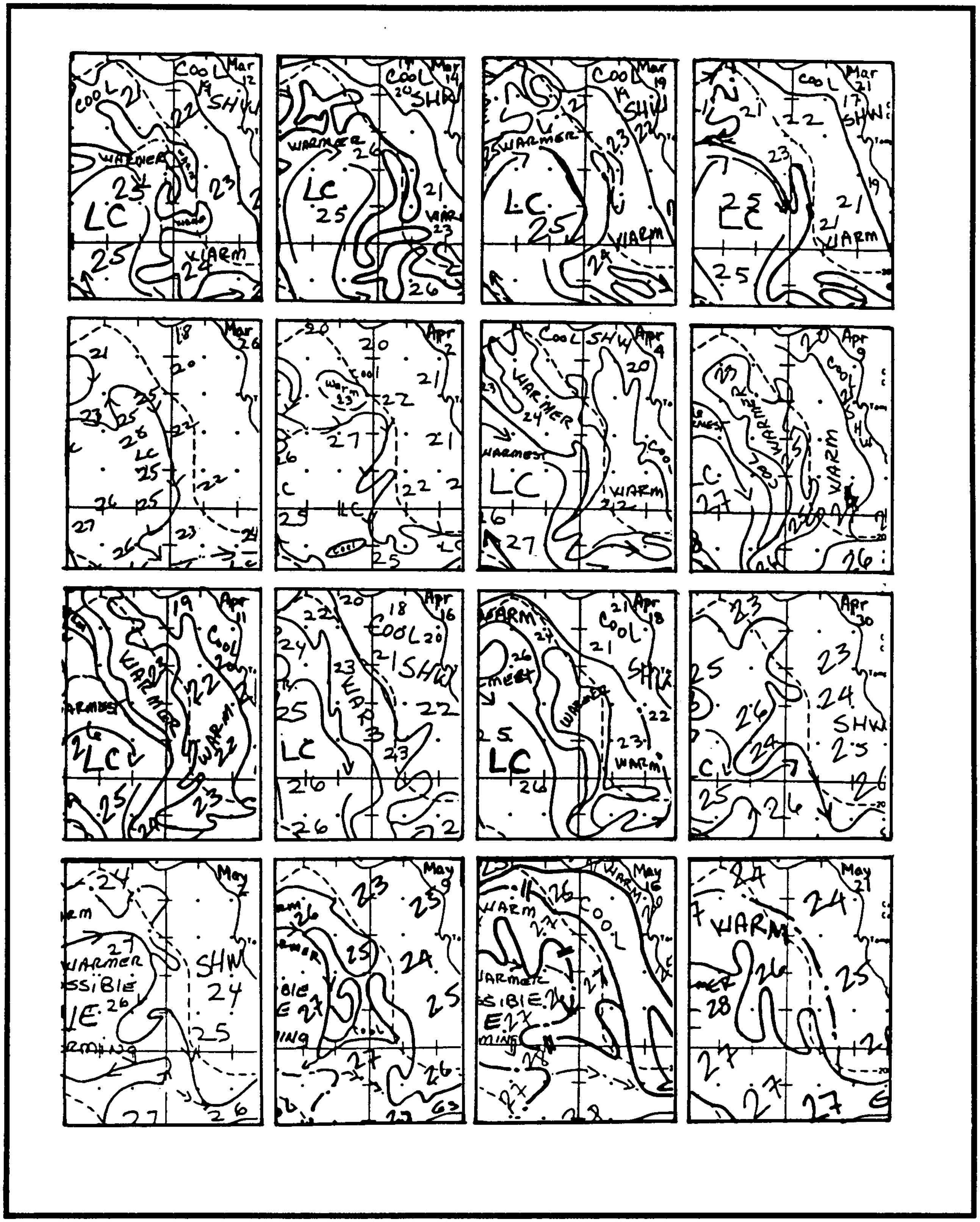

Figure 4.4-31. Similar to Figure 4.4-30 except beginning 12 March 1985.

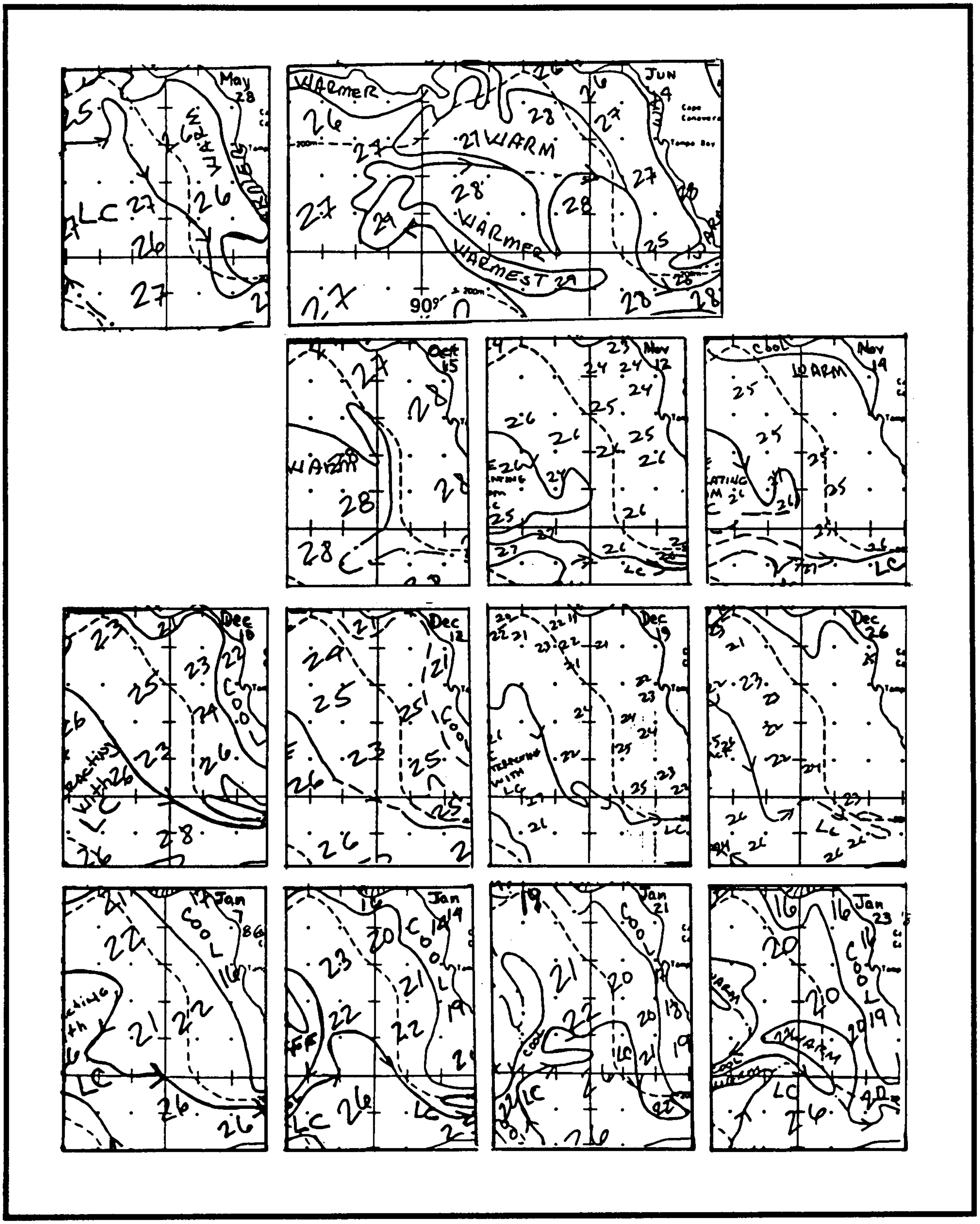

Figure 4.4-32. Similar to Figure 4.4-30 except beginning 28 May 1985. Note that the 4 June picture is the last one for the spring, and after a summer gap, the data set picks up again on 15 October. The bottom row contains pictures from January 1986.

the pictures. Moreover, it is possible to see eddy-like features that become detached from the inshore edge of the Loop Current, and long streamers of cool or warmer water along the shelf edge.

There are two major variations of the Loop Current in these pictures, as well as the small-scale features. First there is the north-south progression of the Loop Current itself, and second there is the east-west variation. The smaller-scale fluctuations seem to take place at periods of approximately ten days to three to four weeks, as will be described below. The primary fluctuations of the Loop Current body itself, however, take place somewhat more slowly.

In Figure 4.4-29 (6 November 1984), the Loop Current is just barely north of 25°N. By early March the Loop Current is up to about 27°N, and appears to be near 28°N by the middle of March (e.g. see, March 14). In early May, one finds the notation "possible warm eddy forming", but this eddy appears to be still "becoming detached" in the 4 June picture. The position of the Loop Current is now extremely far to the west. Note in Figure 4.4-32 the abrupt change (in time) from the June picture to the 15 October picture; the inclusion of the larger-than-normal snapshot in June is intended to help emphasize the break in the timing. There are a few "furtive" glimpses of the Loop Current from satellite data in September and October, but the availability of useful images increases again in November. The 12 November picture shows again "warm eddy possibly separating from the Loop Current". By 14 January the notation "warm eddy breaking off" still occurs.

The east-west variations of the Loop Current can also be seen in these figures. Early in January 1985, the Loop Current is west of 85°W, although there are numerous warm filamentous structures along the edge of the shelf. Throughout January, the warm filaments that seem to "leak" water away from the edge of the current can be seen just offshore, and in early February a warm filament comes inside the 200-m isobath. In the February pictures, the Loop Current appears to be consistently far offshore. The 19 March picture would suggest that the Loop Current has meandered rather far to the east, but most of the March pictures show the Loop Current no farther east than 85°W. The April data suggest that the Loop Current is moving farther to the west. The 28 May picture and the 4 June picture would suggest a substantial amount of flow of the Loop Current itself at the edge of the shelf.

In the Fall 1985 images, the Loop Current, although it appears close to the edge of the shelf in the 15 October picture, is rather far away for the remainder of these images, being for the most part west of 86°W at 26°N. In mid-January, however, a meandering feature again comes as far north and as far inshore as the mooring line.

To study the Loop Current fluctuations more carefully, the positions of the Loop Current as seen in the satellite IR images have been digitized. The larger features are resolved well, but smaller features having a radius of curvature of approximately 10 km or less are ignored. For some calculations, the digitized positions have been determined along a series of approximately radial coordinate lines, which are perpendicular to the mean position of the Loop Current.

Figure 4.4-33 shows cross spectra between positions of the Loop Current along two east-west lines. One line (No. 25) is approximately parallel to the mooring array between 25N and 26N, and the second (No. 24) is roughly one degree to the north at the edge of the shelf. These positions were obtained from the satellite maps using every available picture. They are available on a schedule of a two-day separation, then a five-day separation; thus, although two pictures are produced per week, they are on a staggered basis. These positions were read, and then interpolated using a cubic spline to produce daily values. It is obvious that there should be no useful information at periods shorter than four days; the information content should be high at periods longer than seven to ten days. It is known that the most information per data point is obtained by distributing the measuring intervals randomly, rather than uniformly spaced. The present scheme appears to be suitable for these Loop Current fluctuations (see Sturges, 1983; Sturges and Evans 1983). The spectra rise steeply from periods of approximately ten days to three weeks. Although fluctuations at periods of four days would not be measured well, such information, if it were in a database, would show up in the spectra. Fortunately, however, the spectra show very little power at periods of four to seven days. Thus, it can be concluded that these figures and data are a fairly accurate representation of the variations along the edge of the Loop Current.

The most interesting feature of Figure 4.4-33 is the phase information. In a region at periods of less that two weeks a substantial phase shift occurs between the two data lines. This phase shift is consistent with the simple advection, from north to south, of small eddy-like features along the edge of the Loop Current (in these figures, if the phase is positive the first signal leads). At periods longer that two weeks, however, the phase shift is essentially zero, suggesting that at these periods the fluctuations are moving onshore and offshore at both locations simultaneously. Such fluctuations would be expected to drive the eddy-like currents at the edge of the shelf by forcing water across the sloping bottom. The results are presented only for cross spectra between two lines, but similar calculations were done with an additional line to the north, with similar results.

The gain (or transfer or filter function) presented in Figure 4.4-33 is a measure of the relative strength of the coherent portions of two signals. A value greater than one indicates an increased amplitude and a value less than one indicates an amplitude reduction. In this case, the gain shows the relative strength of the LC edge position along Line 25 relative to Line 24.

The coherence between the east-west position of the Loop Current and the currents observed at Moorings A and C is shown in Figures 4.4-34 and 4.4-35. The comparisons are made for the full "viewing season" of November 1984-June 1985 (232 days). At Mooring A, there is a small energetic region at periods near eight to ten days in the V-component. These fluctuations (perhaps surprisingly) show coherence at the 90% confidence level with a similar "bump" in the spectra of the Loop Current fluctuations, and they are 180° out of phase. For periods longer than a month, the coherence again rises, and the fluctuations have decreasing phase shift at lower frequencies.

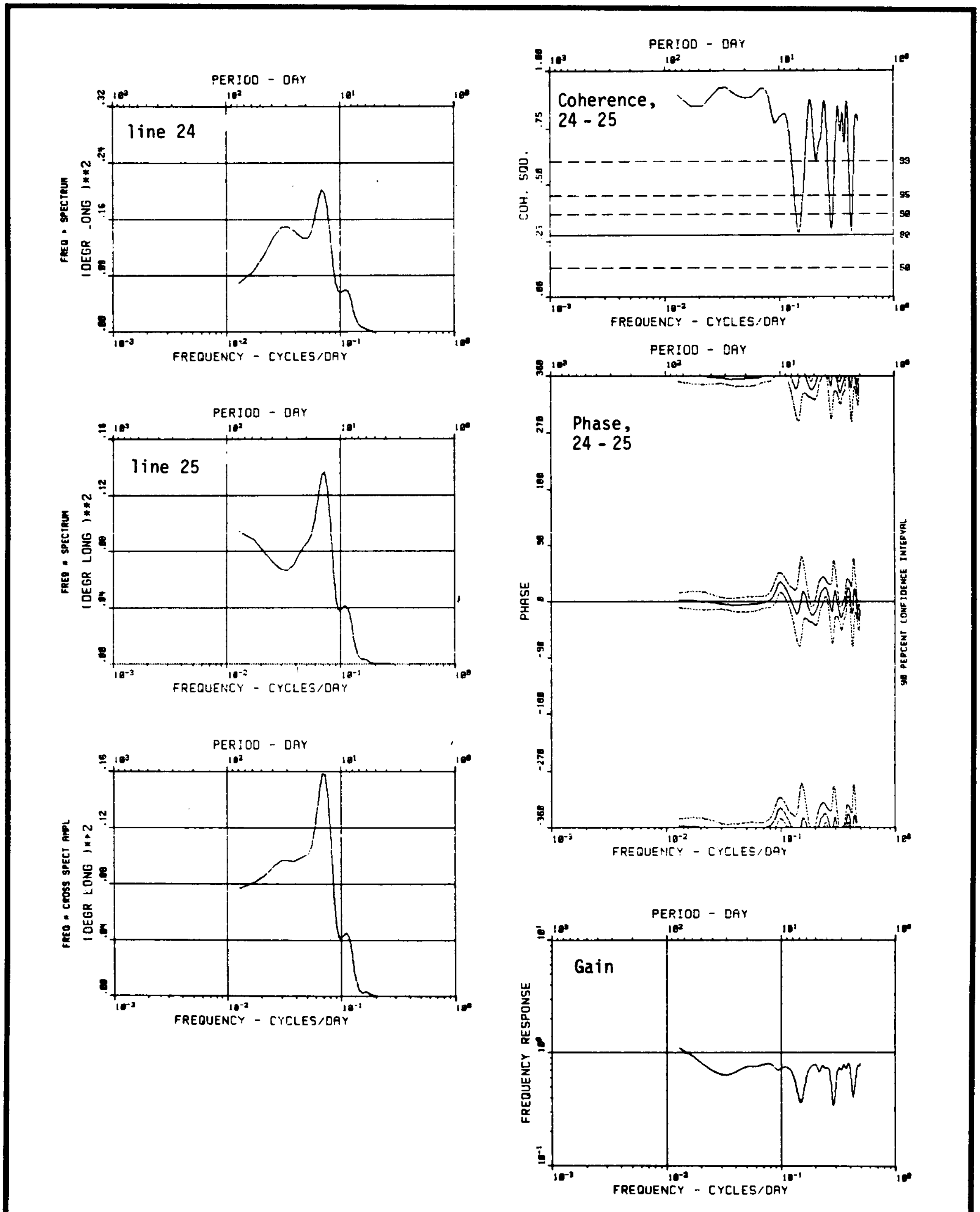

Figure 4.4-33. Cross spectra between positions of the inshore edge of the Loop Current near 26°N (see text). The left hand panel shows spectra of Loop Current positions approximately 1° apart (north-south), and the right-hand panel shows coherence and phase. The lower left figure shows the amplitude of the cross spectra.

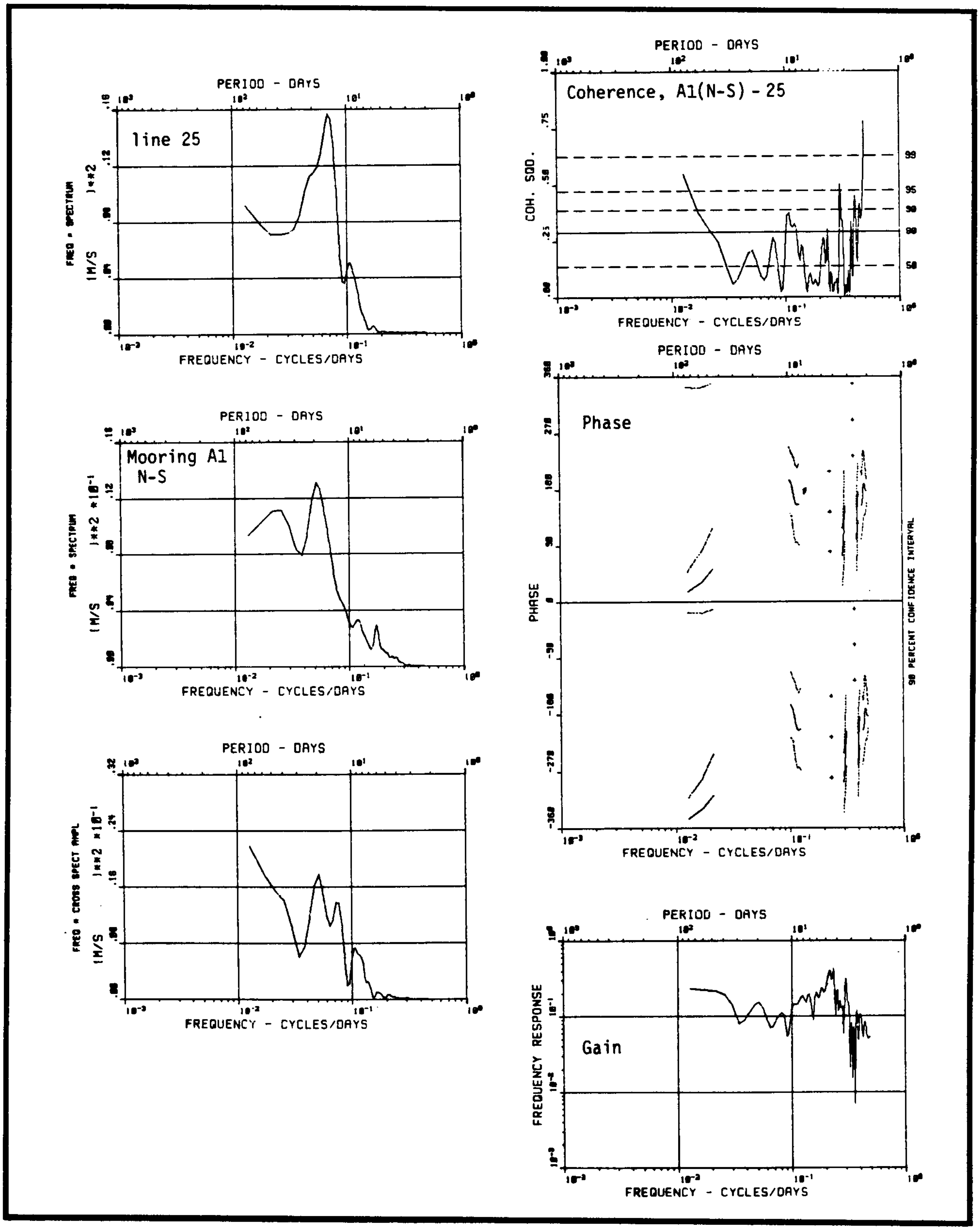

Figure 4.4-34a. Cross spectra between the positions of the inshore edge of the Loop Current (east-west fluctuations near the mooring line) versus currents observed at the upper current meter on Mooring A (at 172 m) for the north-south components. The data points are daily values, filtered from hourly data at the current meter, and interpolated from twice-weekly observations of satellite positions (see text). Data begin on 6 November 1984, for 232 days.

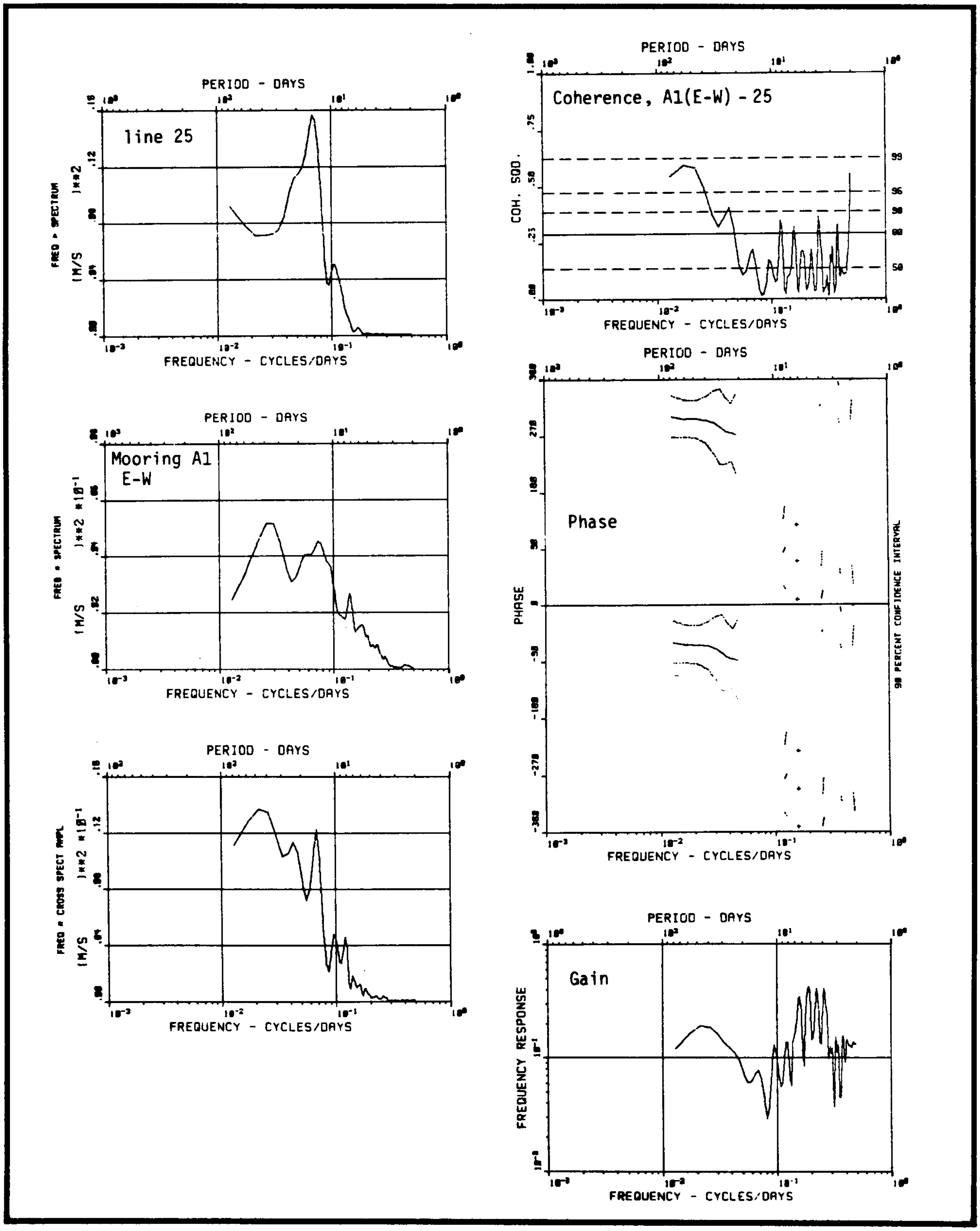

Figure 4.4-34b. Same as 4.4-34a using the east-west component of currents observed at Mooring A.

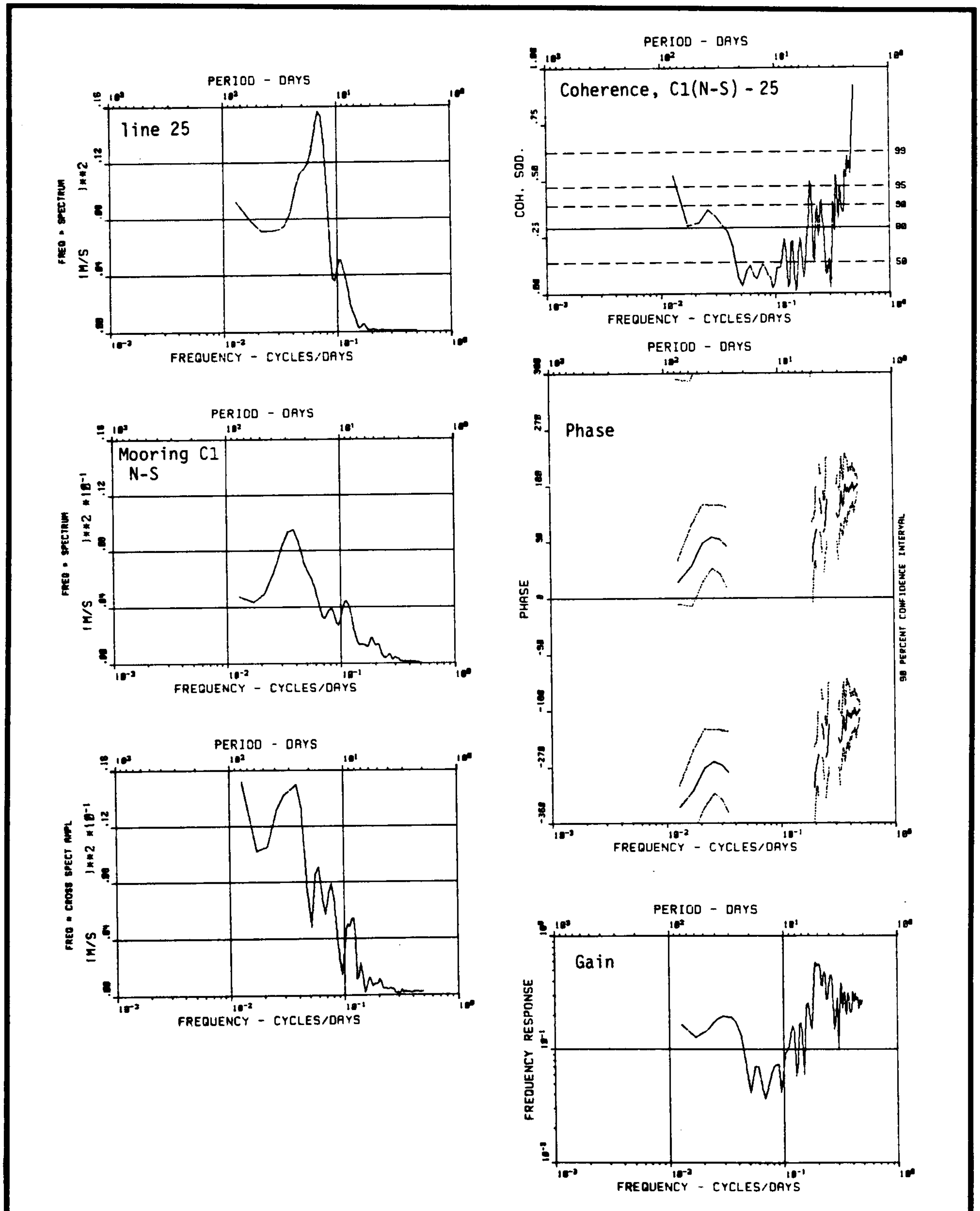

Figure 4.4-35a. Same as 4.4-34a for the cross spectra between the fluctuations of the inshore edge of the Loop Current and the currents observed at the upper instrument on Mooring C (at 50 m) for the alongshore component.

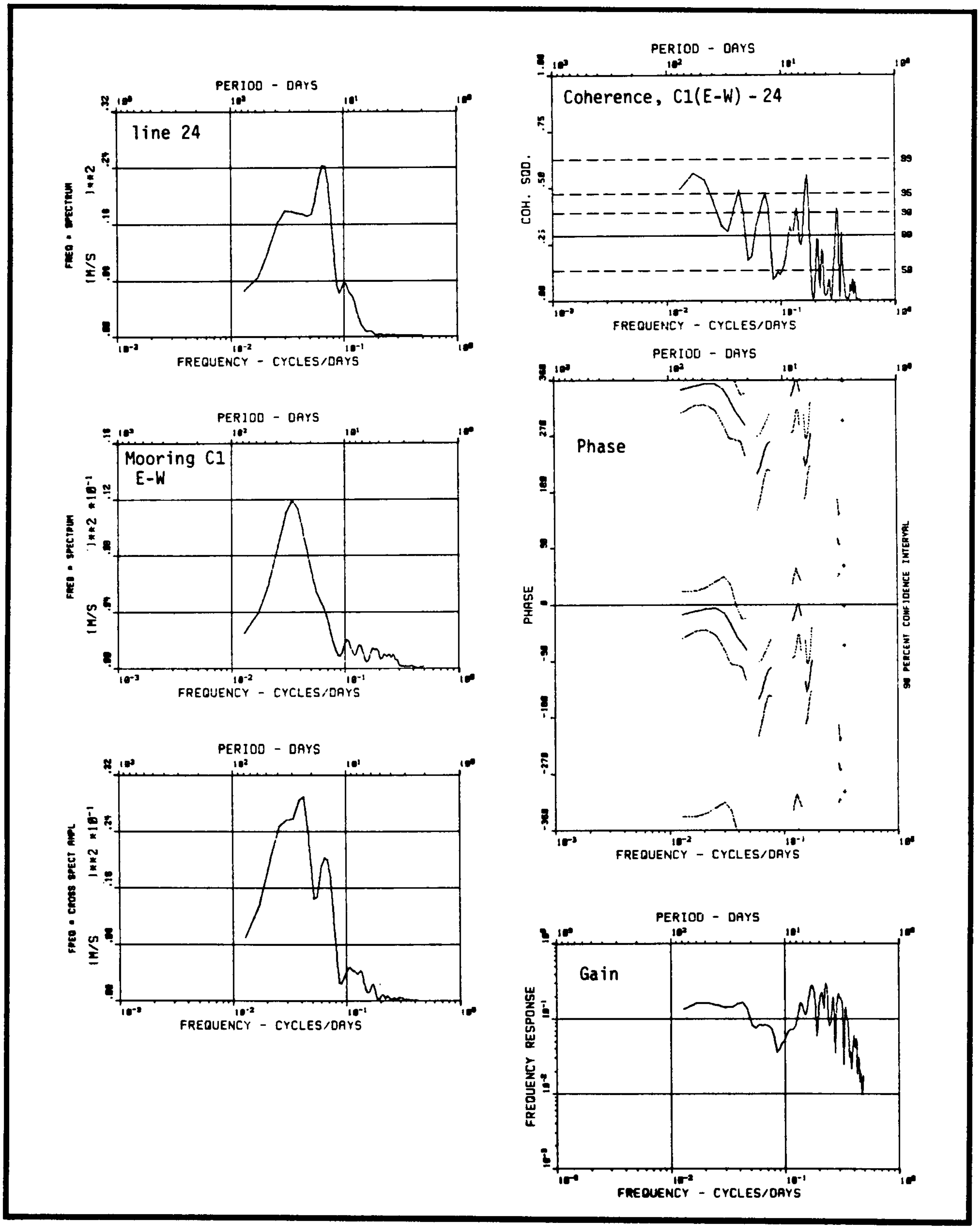

Figure 4.4-35b. Same as 4.4-35a for the onshore components of currents observed at Mooring C.

At Mooring C, the coherence is high for periods of 30 days, and the phase shift seems to decrease at longer periods. The "bump" in the spectra of currents near eight or nine days is also seen in these data, but the coherence is lower (not up to the 80% confidence level) for the V-component of current than at Mooring A.

Figures 4.4-36 and 4.4-37 show the coherence and phase at the upper current meter (172 m) at Mooring A (in 1700-m depth) for U vs V and V vs T. Wave-like fluctuations go by with U and V approximately 90° out of phase, but with V and T 180° out of phase. This same result is also seen at the next two instruments, at 400 m and 738 m. This is true not only at periods of two weeks and longer, which would be associated with Loop Current meanders, but it is also true -- perhaps surprisingly -- at the wind-driven periods near five days, as well.

This result can be interpreted from the fact that Mooring A is near, or just outside, the edge of the usual Loop Current position. Meanders which bring the Loop Current position in toward the shelf/slope region bringing warmer water past a point in the thermocline are therefore associated with stronger outflow (but a larger negative value of the component). Recall that the isotherms are deep offshore and slope upward toward the coast across the flow.

In deep water contrasting results occur (Figure 4.4-38). At Mooring G, at 2364 m, the eddy-like motions show that V and T are nearly in phase, which is the opposite of the results at the upper instruments at A. At the 3174-m instrument at Mooring G, the coherence is negligible between V and T, perhaps because the temperature gradients are so small.

Figure 4.4-39 shows that at the deepest instrument at Mooring A (1600 m), the U and V components are now almost out of phase, showing that the meandering motion of the Loop Current is not dominant at that depth.

Figures 4.4-40 and 4.4-41 show that the U and V eddy-like components at these depths are coherent between Moorings A and G, at depths of 1600 m. This is just above sill depth (approximately 1800 m) in the Yucatan Channel, but substantially deeper than the Straits of Florida. At periods of two weeks (~.07 cycles day^{-1}) and longer, for the first mooring of 1985, both the U and the V components are approximately 90° out of phase. From the phase information in the V-component it can be concluded that the east-west "diameter" is less than two times the separation between Moorings A and G, or approximately 80 km.

4.4.3.5 Results From the Moorings Near Cedar Key

Figures 4.4-42 and 4.4-43 show a calculation using data from a mooring installed by Continental Shelf Associates in 20-m depth off Cedar Key. The cross-spectra are computed between the upper and lower instruments, at 9 and 17 m. The V (along-shelf) components are essentially in phase, as expected, except at high frequencies where inertial motions dominate. Thus, even in June and July, the water column responds almost barotropically, as discussed by Clarke and Brink (1985). The U (cross-shelf) components, however, are clearly 180° out of phase. This shows that the two instruments are, most of the time, in the surface and bottom boundary layers, which influence the

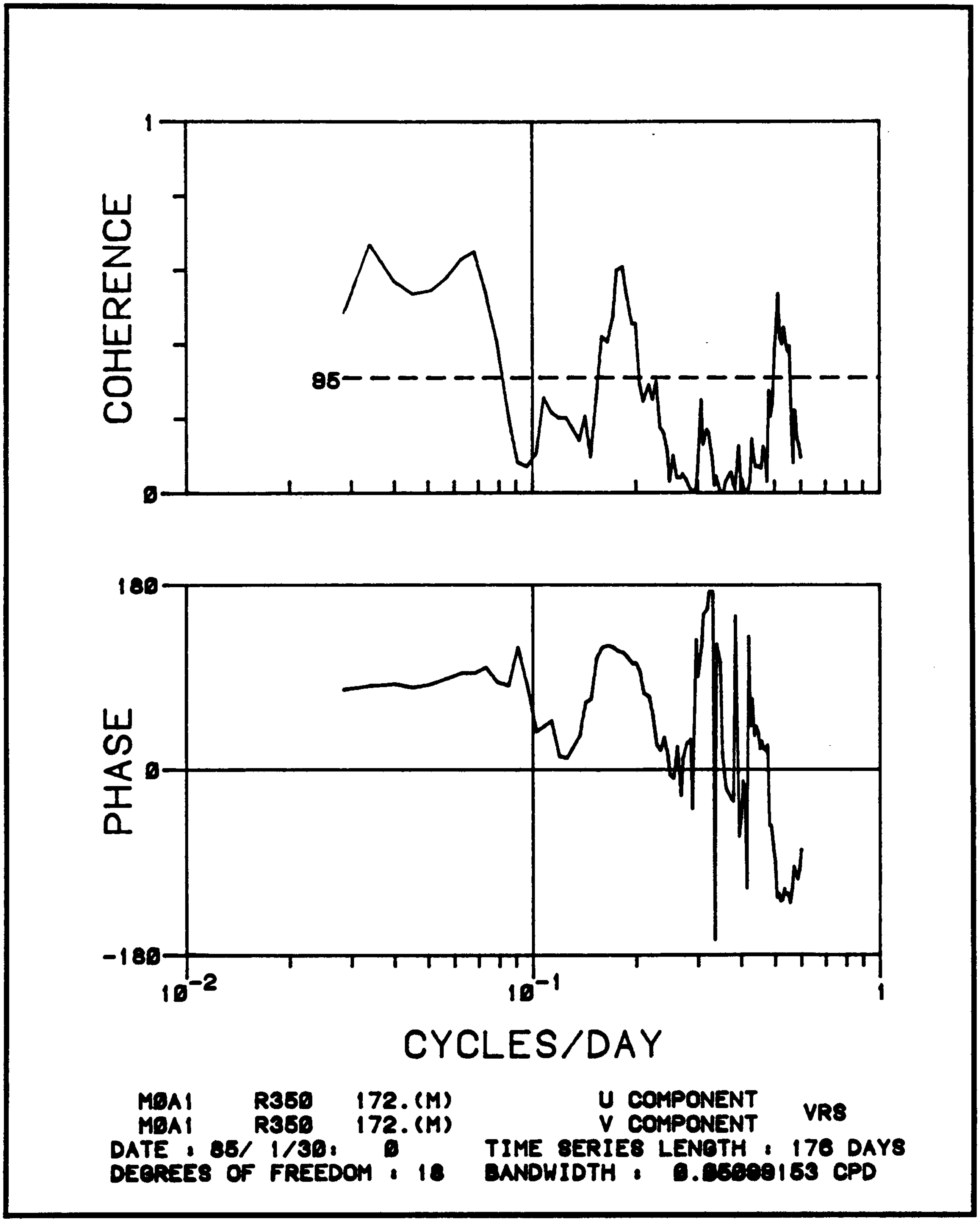

Figure 4.4-36. Phase and coherence between the U and V components at the upper instrument (172-m deep) at Mooring A for the first implacement of 1985.

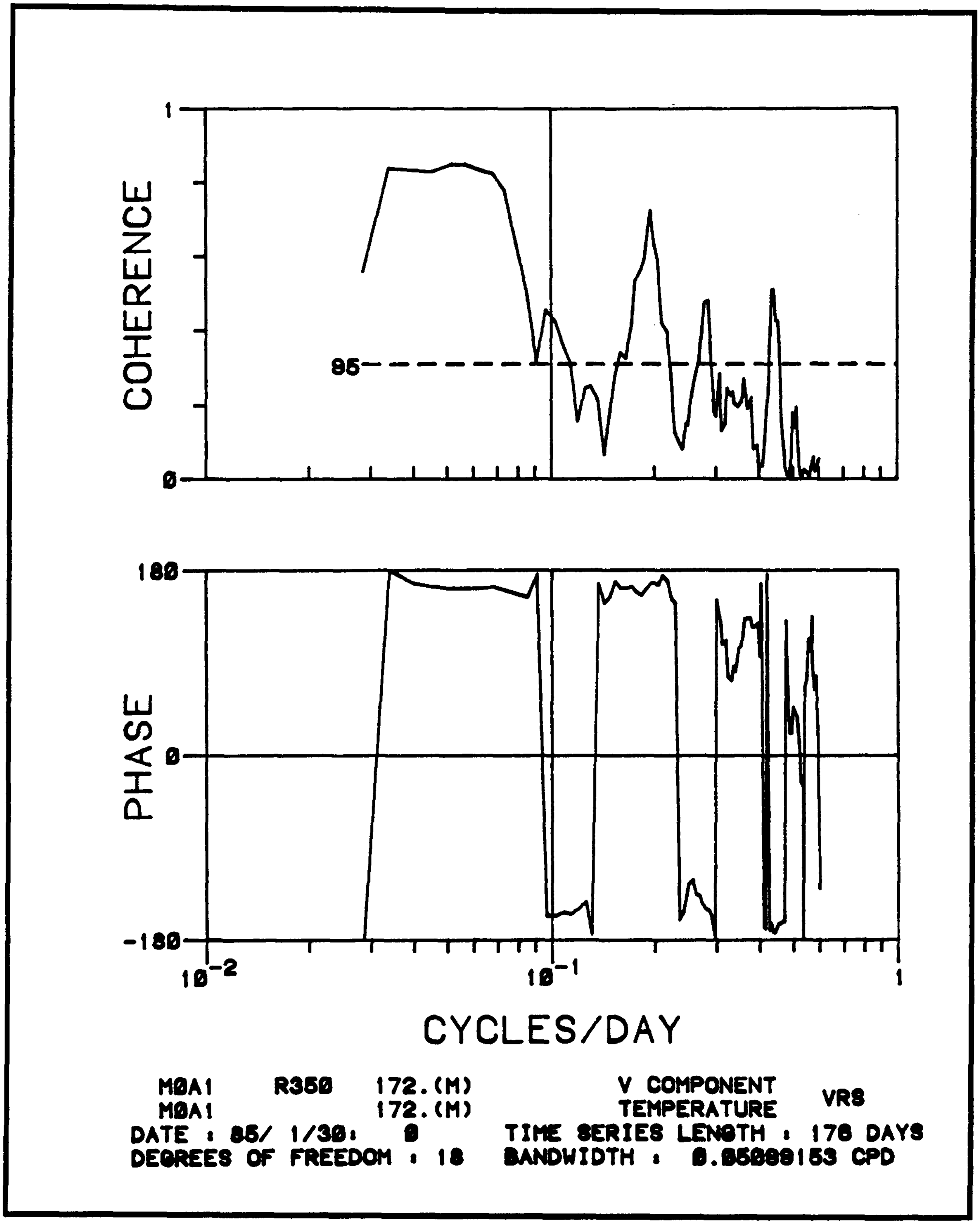

Figure 4.4-37. Same as Figure 4.4-36 showing the phase and coherence between temperature and the alongshore component of current.

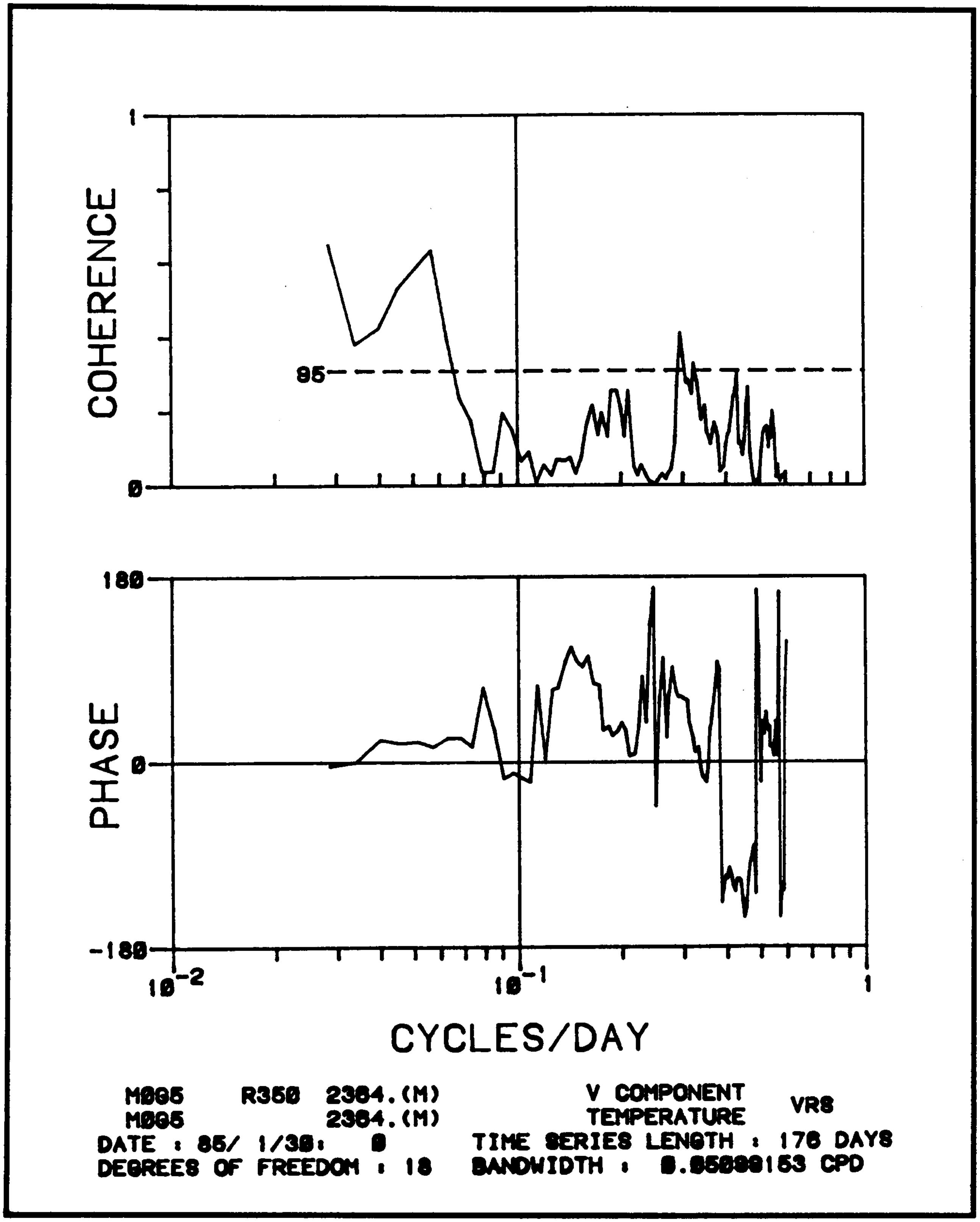

Figure 4.4-38. Same as Figure 4.4-37 showing the V and T phase and coherence at the 2,364 m instrument on Mooring G.

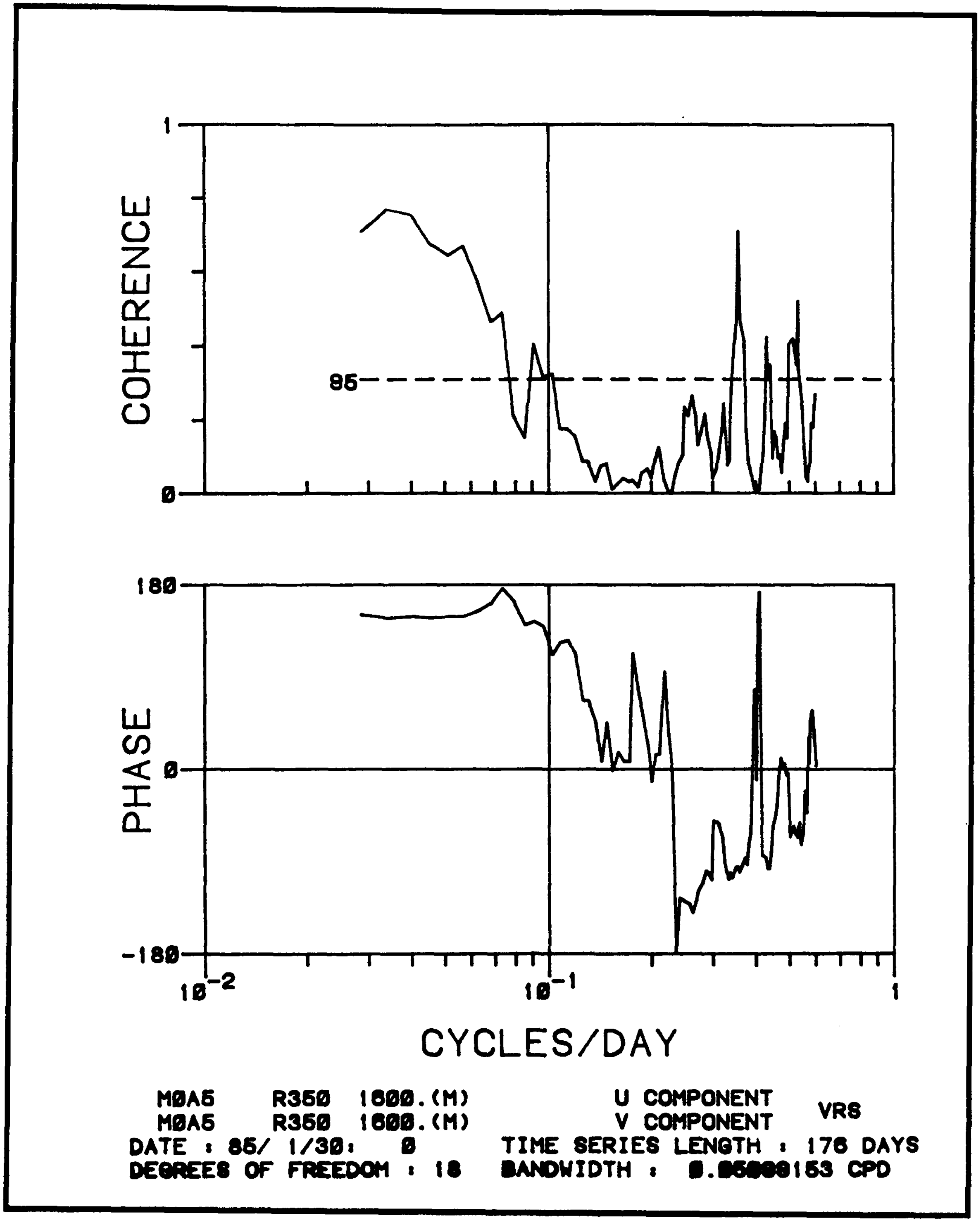

Figure 4.4-39. Same as Figure 4.4-36 for Mooring A, at the deepest instrument (1600 m) for the U, V correlation.

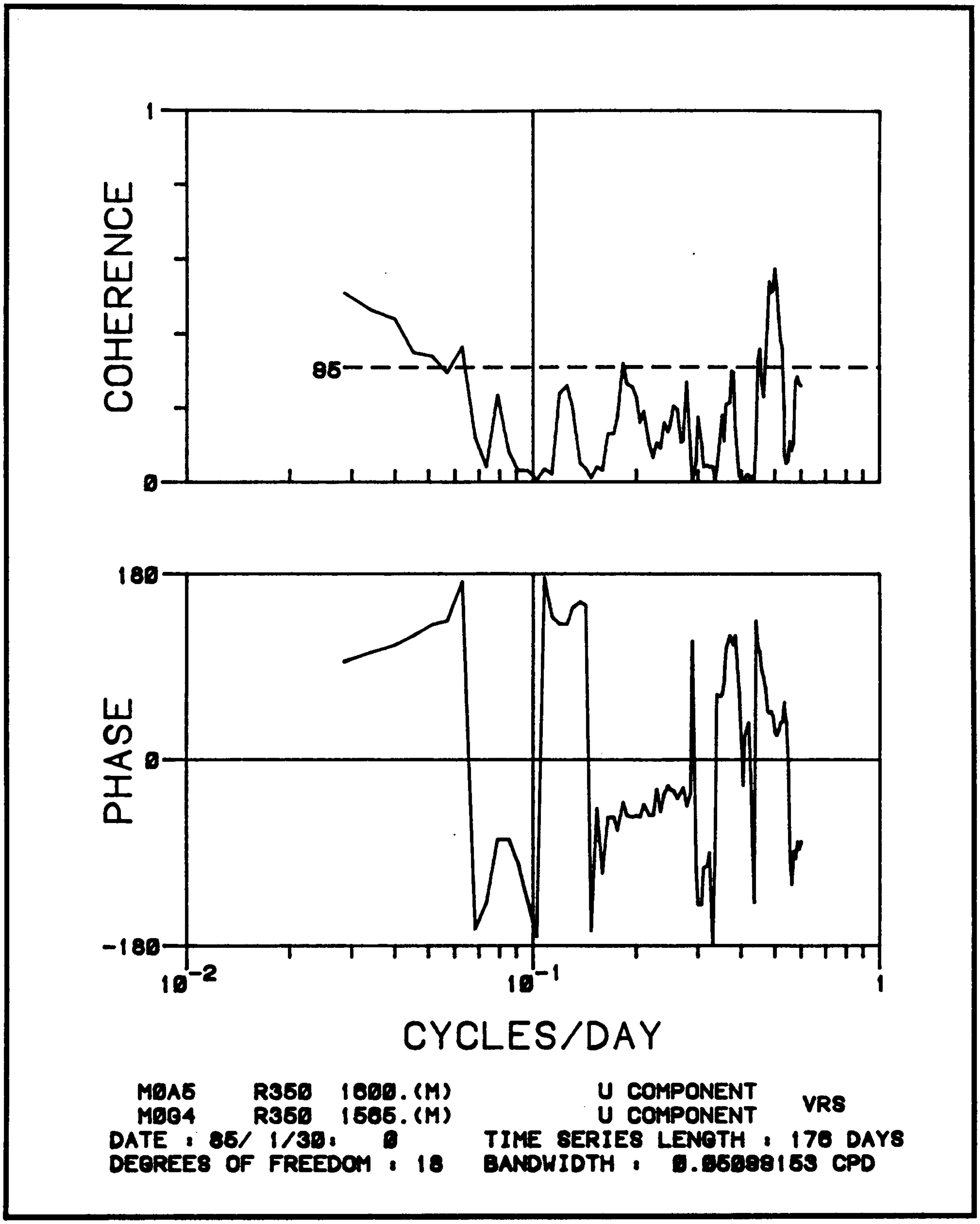

Figure 4.4-40. Phase and coherence for observations near 1600 m at Moorings A and G, the onshore components.

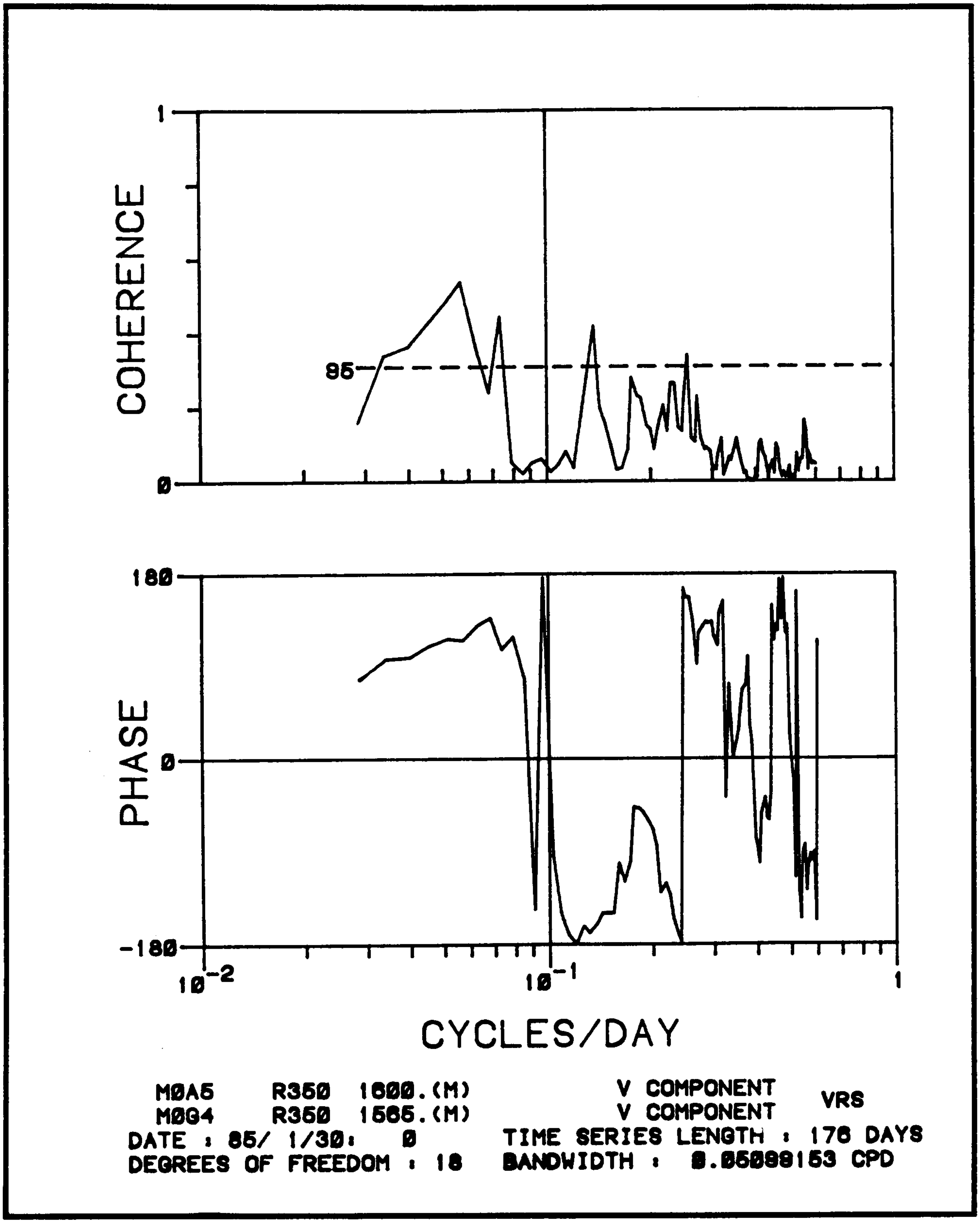

Figure 4.4-41. Phase and coherence for 1600 m observations at Moorings A and G, the alongshore component.

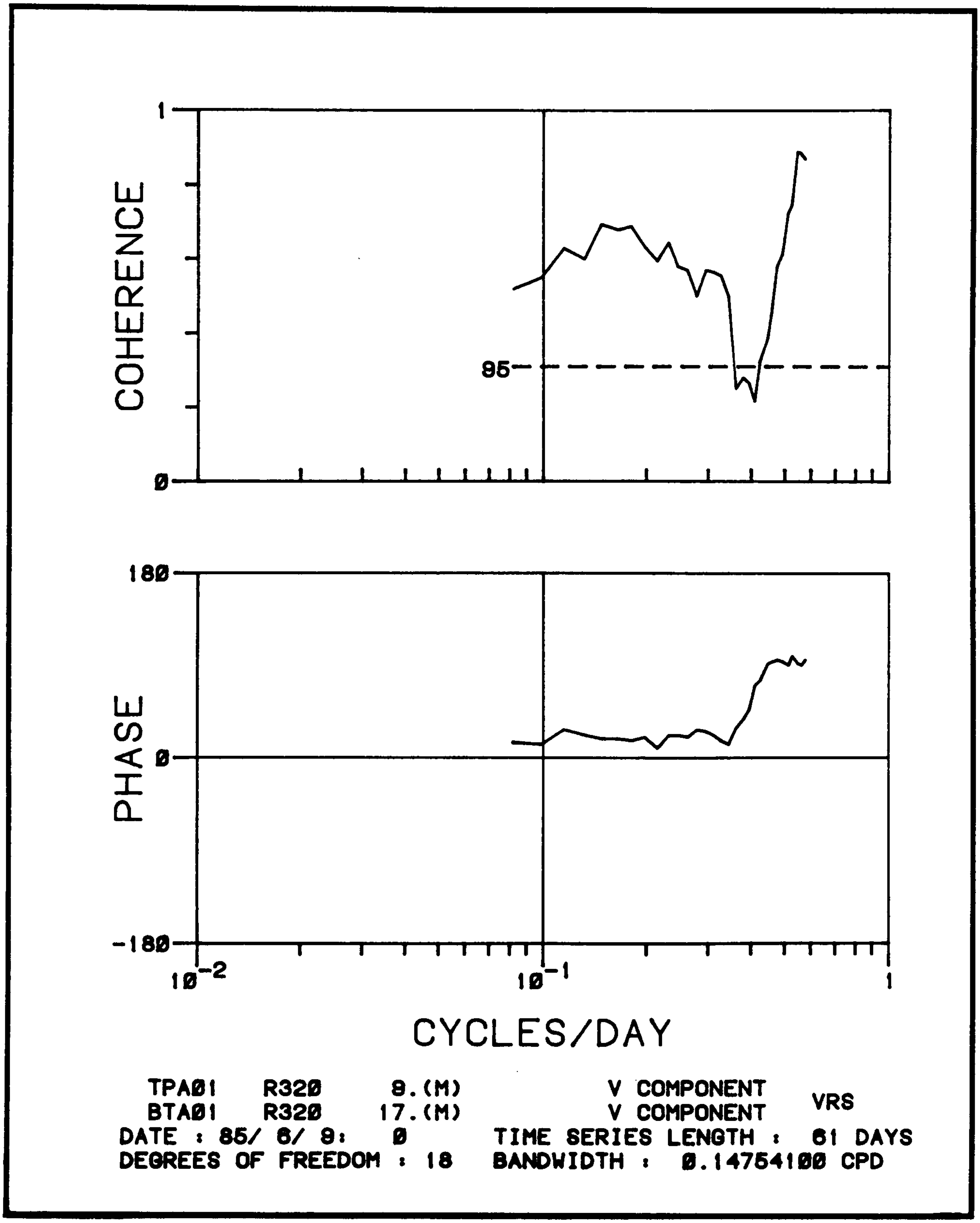

Figure 4.4-42. Cross spectra between upper and lower instruments at a CSA/SOHIO mooring (Mooring I, Figure 4.4-1) in 20-m depth offshore from Cedar Key, beginning 9 June 1985 for 61 days (alongshore component).

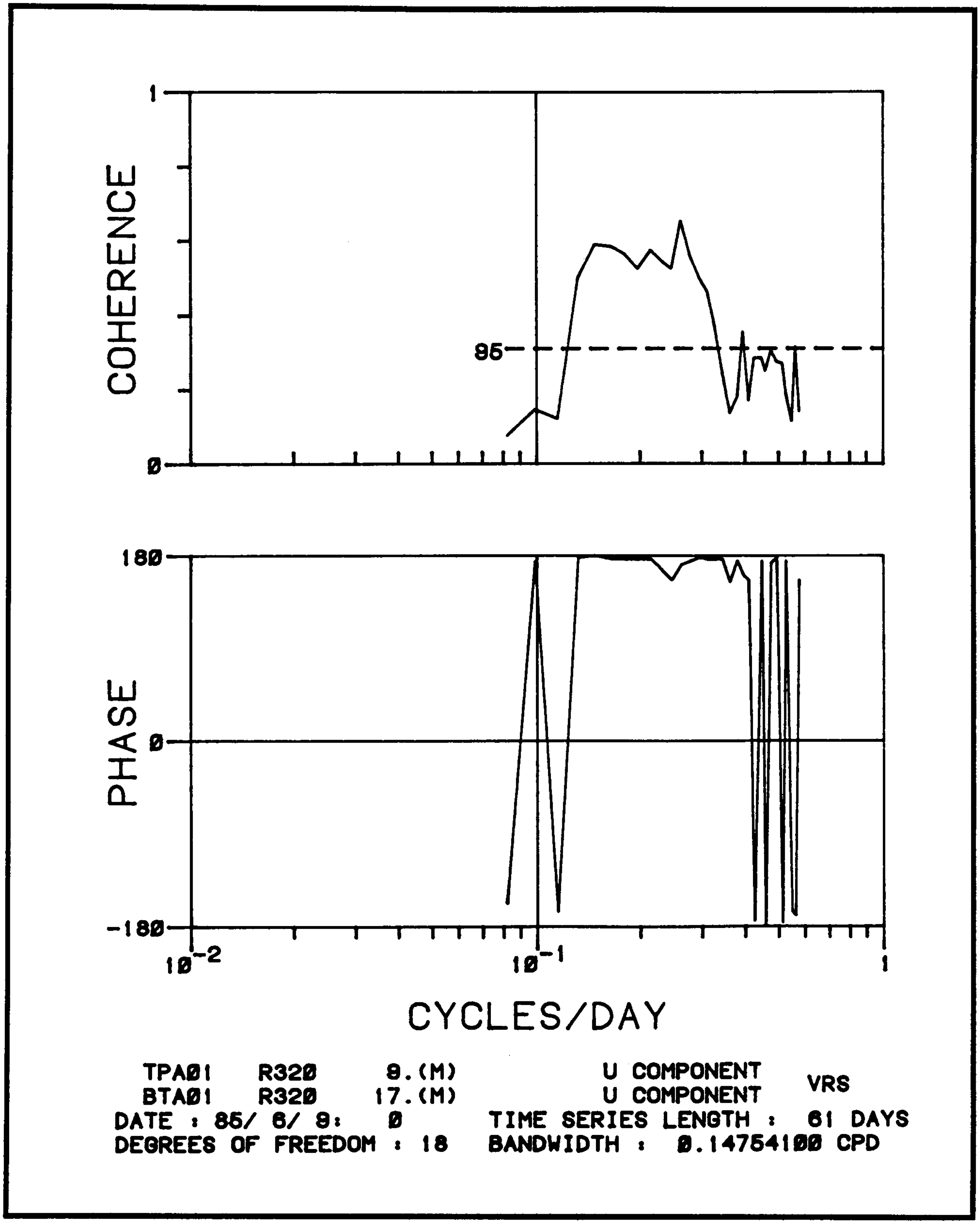

Figure 4.4-43. Same as Figure 4.4-42 for the onshore component.

onshore-offshore flow. This record appears to be of good quality for the first 61 days before the passage of Hurricane Elena, at which point the current meter rotors probably became fouled with sea grass.

4.4.3.6 A Baroclinic, Internal Overtide

One result of these data may be of interest because of the implications for mixing. Figure 4.4-44 shows the spectra from Mooring E, for the May-July 1985 period. The U-component is shown, which is the stronger component at the shelf edge. The tidal peaks near 24 and 12 hrs are expected. The pronounced peak near eight hrs, however, and preferentially at 100 m (mid-depth), suggests that this is a baroclinic, non-linear overtide (designated OT) resulting from the sum of the frequencies of the 24 and 12 hr constituents. Figures 4.4-45 and 4.4-46 show that a similar signal is found at Mooring F (more so at the lower instrument) in both U and T.

4.4.4 Southwest Florida Shelf - Near Bottom Currents

4.4.4.1 Shallow, Wind-Driven Flows

The main GMPOP mooring array is near 26°N. Another line of moorings is shown in Figure 4.4-1 near 25°N, which was also sponsored by MMS, in support of a separate program. The data were collected by Environmental Science and Engineering, of Gainesville, Florida. A single (Endeco) tethered current meter was used at each mooring, hung from a tripod approximately 3 m above the bottom. The data from the program, beginning in December 1983, were made available to SAIC.

The two-year data record at the mooring closest inshore, in 13 m depth (referred to here as ESE1) was compared with the wind observations at Key West, and found to be highly coherent in all seasons. Figures 4.4-47 through 4.4-52 show the spectra from these comparisons. At the moorings farther offshore and near 27°N, this coherence is low in the summer as a result of low signal strength in the wind forcing, and a low signal-to-noise ratio. At those moorings close to shore, however, the eddy signals and "noise" from other kinds of motions appear to be damped more by bottom friction which leads to high coherence between the winds and currents, in all seasons except when wind speed is very low. In the winter season (Figure 4.4-47), the coherence at 95% confidence level and at periods longer than about 4 days (~ .25 cycles day^{-1}) can be resolved in a 3-month record. This coherence extends out to periods as long as 30 days, as will be seen later, even though the "wind-driven" forcing is usually thought of as having 3 - 10 day periodicities.

Figures 4.4-47 through 4.4-51 show the cross-spectra, coherence and phase between the alongshore (N-S) components of winds and currents at ESE1. As expected in the approximately 2.5 month records this coherence is generally high in the wind driven bands. Figure 4.4-52 shows N-S winds and currents for approximately one-year concatinated records. During spring, 1984 the alongshelf forcing was weaker but the cross-shelf component of wind was stronger and that coherence was found to be high. It is important to note that at ESE1 the concept of alongshore can be distorted because of the generally flat, shallow bottom and the bounding coastline and islands on several sides.

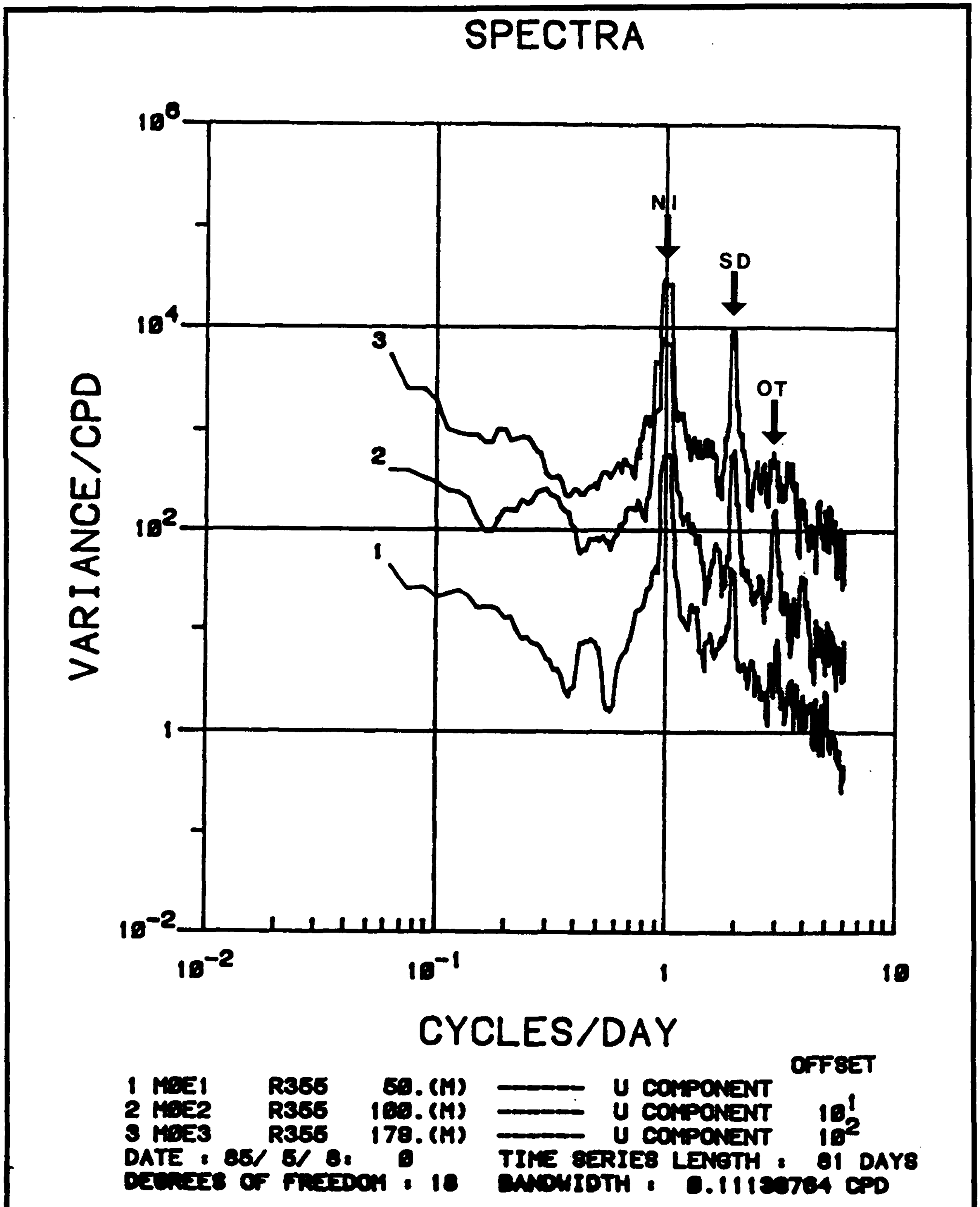

Figure 4.4-44. Spectra of the onshore component observed at Mooring E at all three instruments using hourly data. The near-inertial (NI) period motion is seen at periods of approximately one day. The semi-diurnal (SD) tide is apparent at periods of approximately 1/2 day, and a pronounced overtide (OT) at a period of approximately eight hours (frequency of three cycles per day).

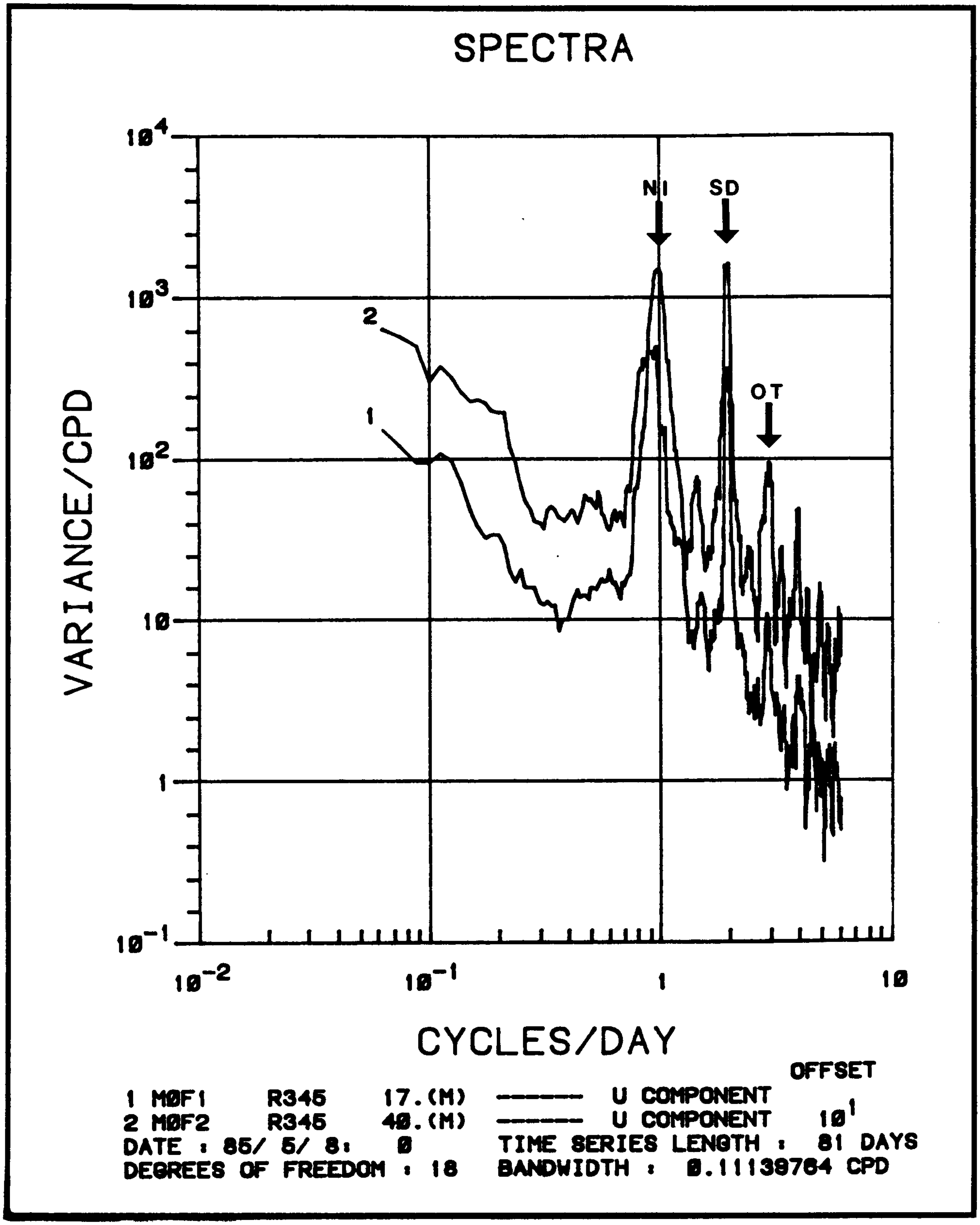

Figure 4.4-45. Similar to Figure 4.4-44 using observed currents at both instruments on Mooring F for data beginning 8 May 1985 (onshore component).

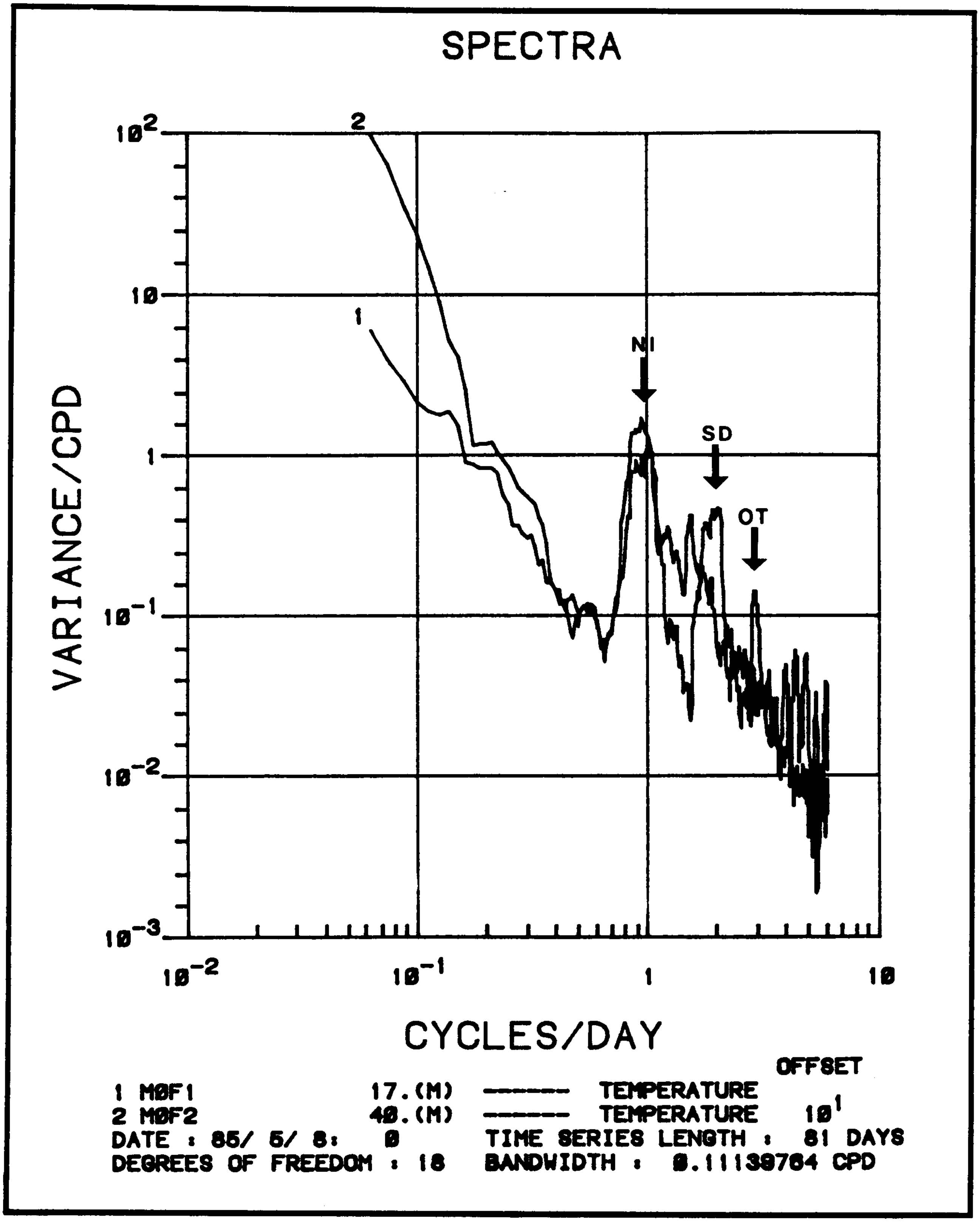

Figure 4.4-46. Same as Figure 4.4-45 except for the observed temperature.

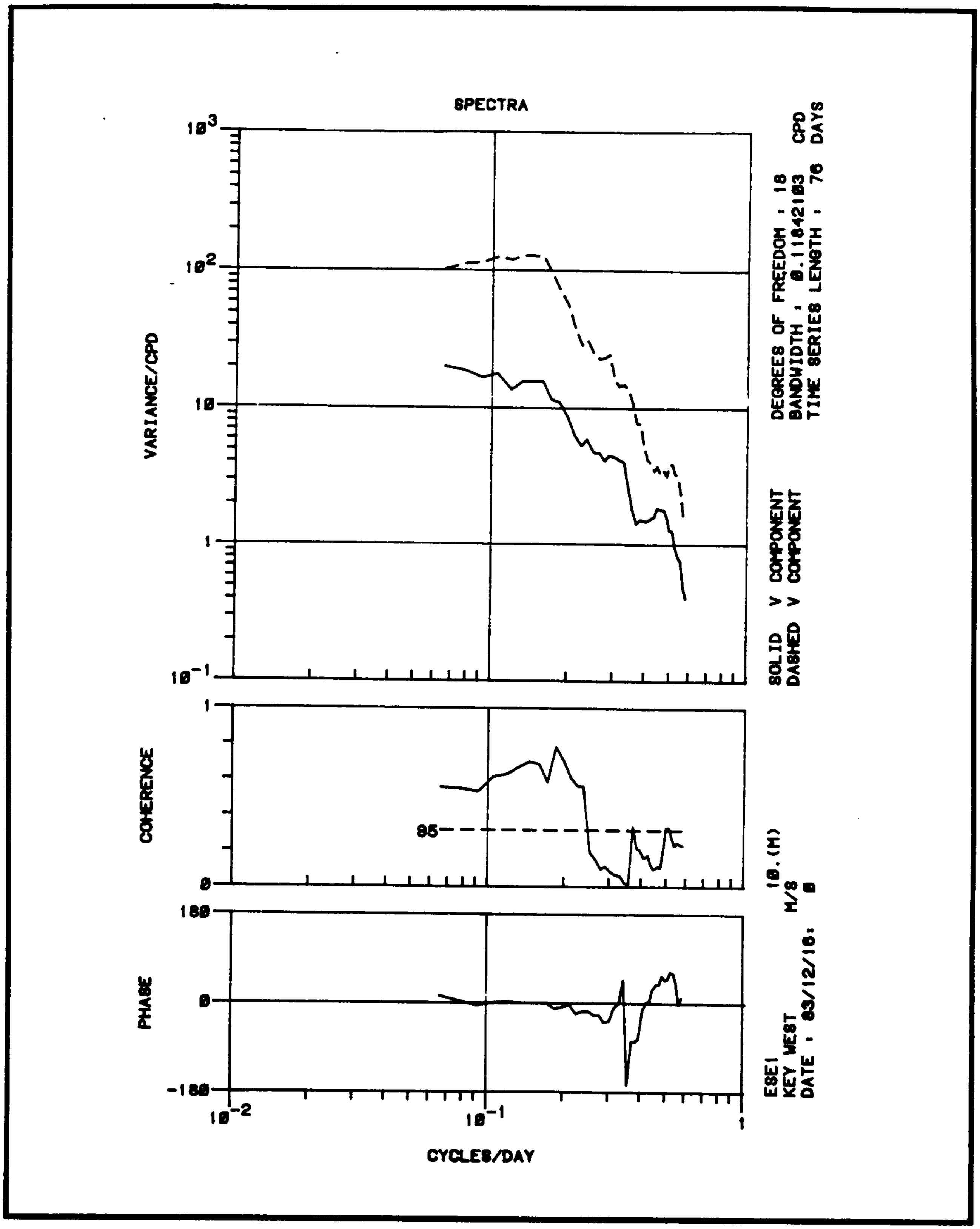

Figure 4.4-47. Comparison between currents at Mooring ESE1 and winds at Key West, Florida, for the longshore component for the winter "season". The original (5-min.) data have been low-pass filtered, and hourly data are used for these calculations. This data setment uses 76 days of data beginning 16 December 1983. Current meters are three meters above the bottom.

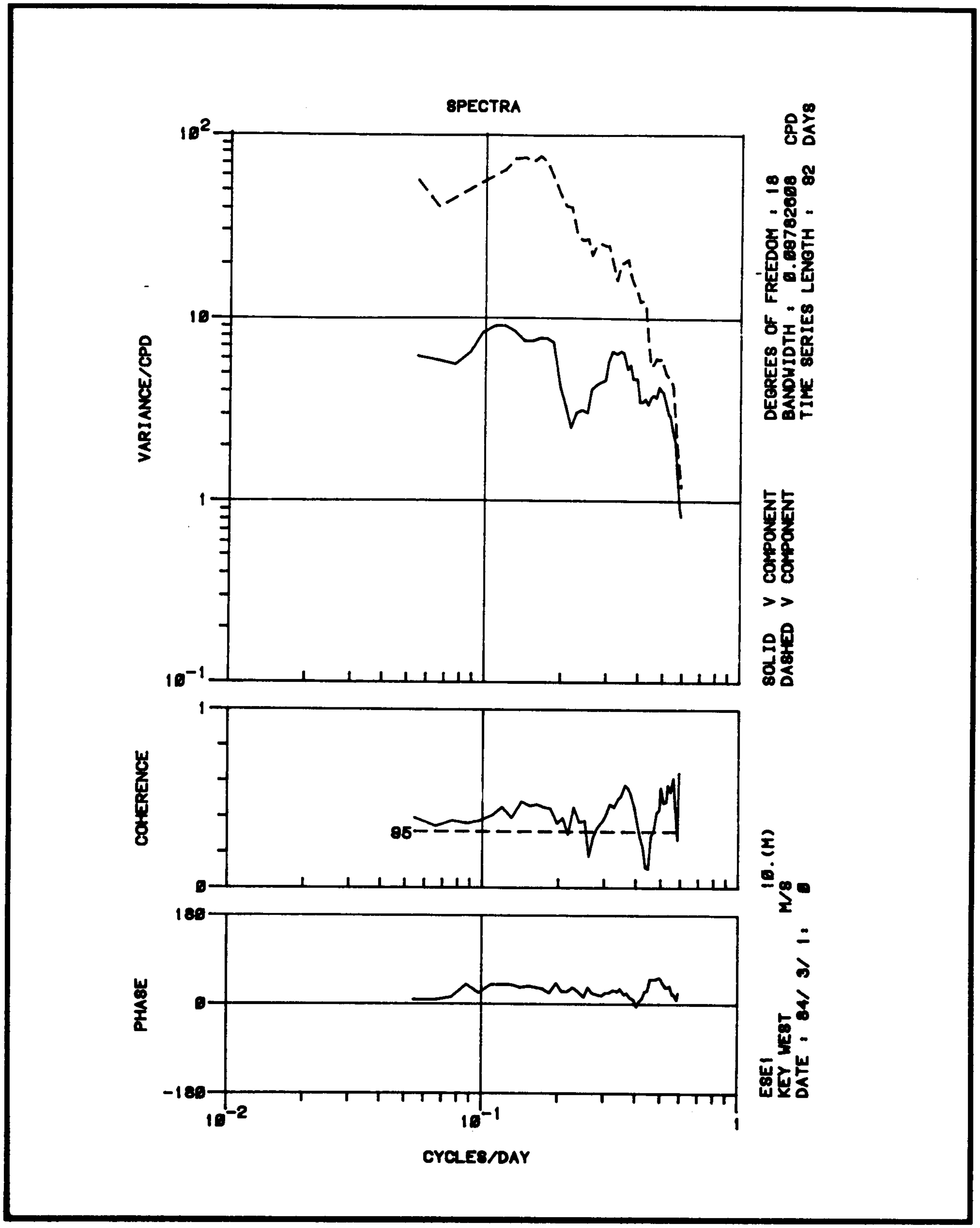

Figure 4.4-48. Comparison between currents at Mooring ESE1 and winds at Key West, Florida, for the longshore component for the spring "season". The original (5-min.) data have been low-pass filtered, and hourly data are used for these calculations. This data segment uses 92 days of data beginning 1 March 1984.

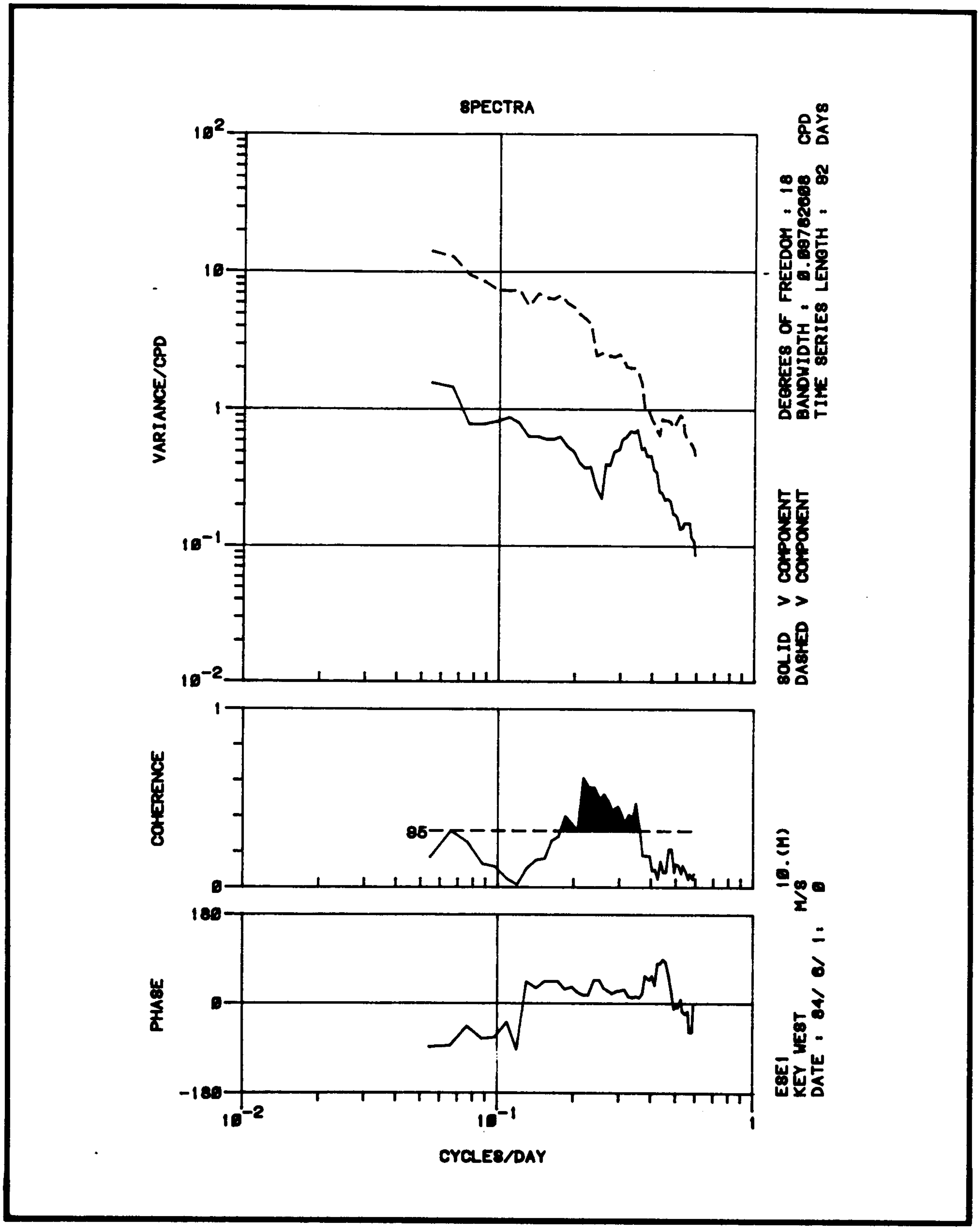

Figure 4.4-49. Comparison between currents at Mooring ESE1 and winds at Key West, Florida, for the longshore component for the summer "season". This data segment uses 92 days of data beginning 1 June 1984.

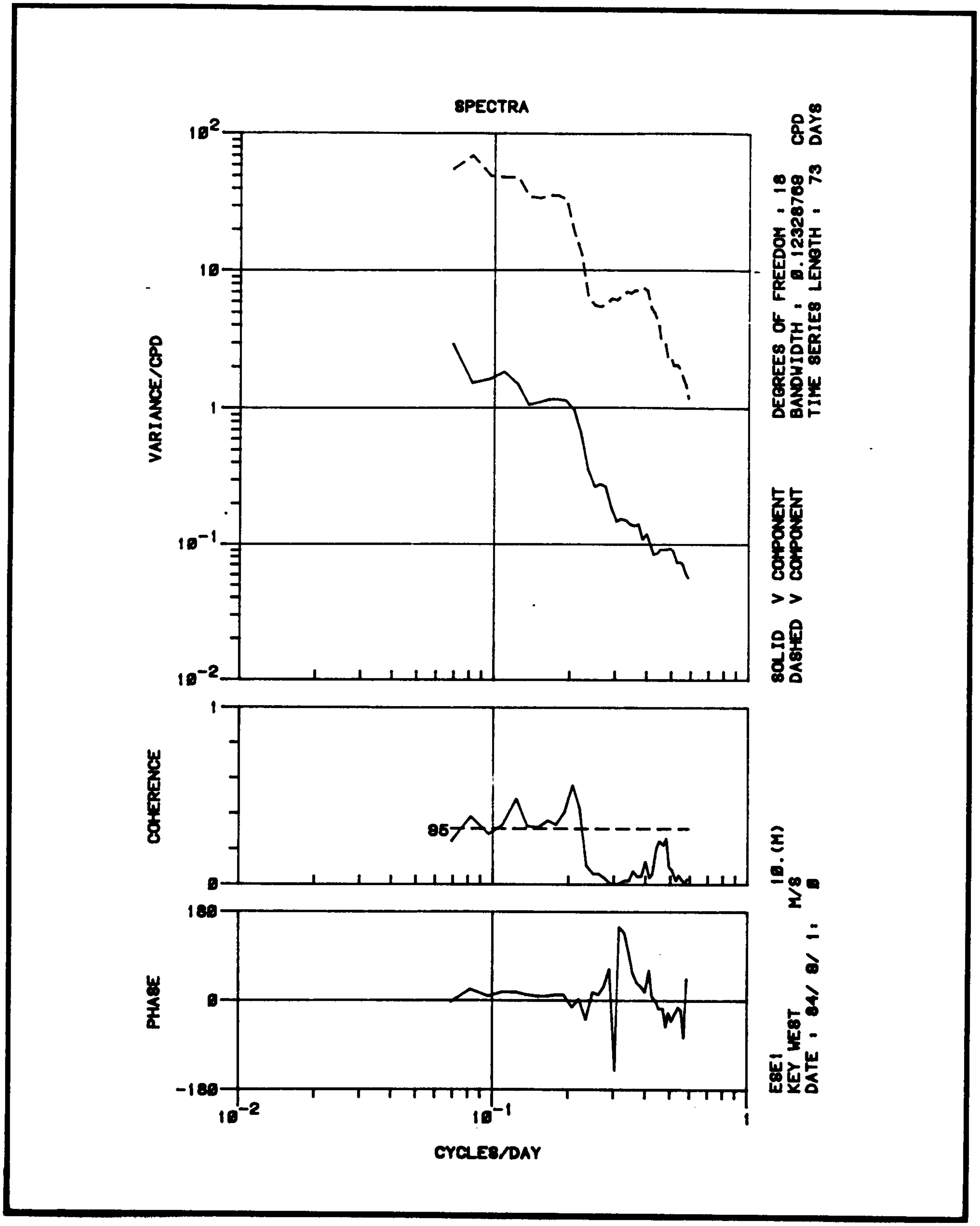

Figure 4.4-50. Comparison between currents at Mooring ESE1 and winds at Key West, Florida, for the longshore component for the fall "season". This data segment uses 73 days of data beginning 1 September 1984.

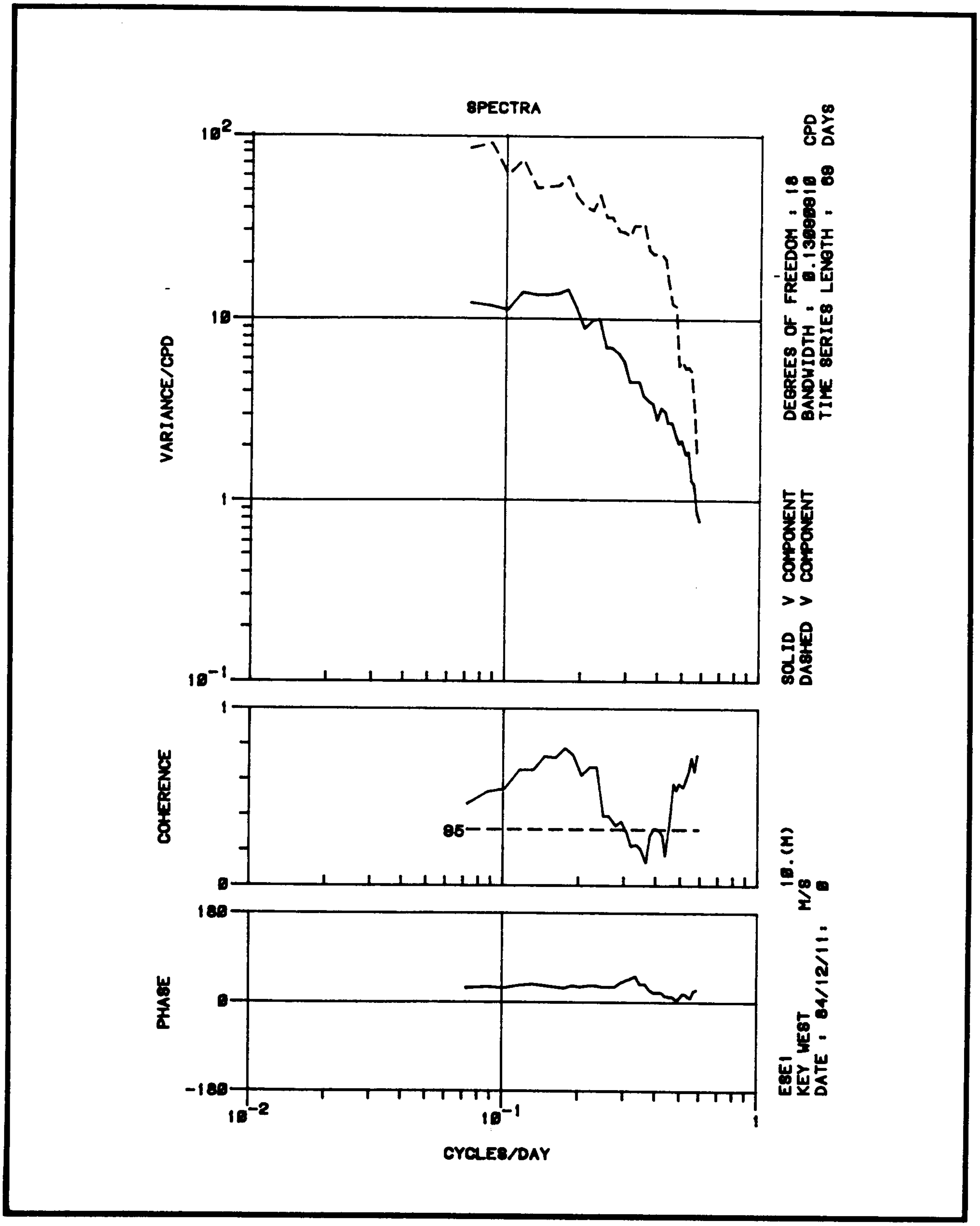

Figure 4.4-51. Comparison between currents at Mooring ESE1 and winds at Key West, Florida, for the longshore component for the winter "season". The original (5-min.) data have been low-pass filtered, and hourly data are used for these calculations. This data segment uses 76 days of data beginning 11 December 1984. Current meters are three meters above the bottom.

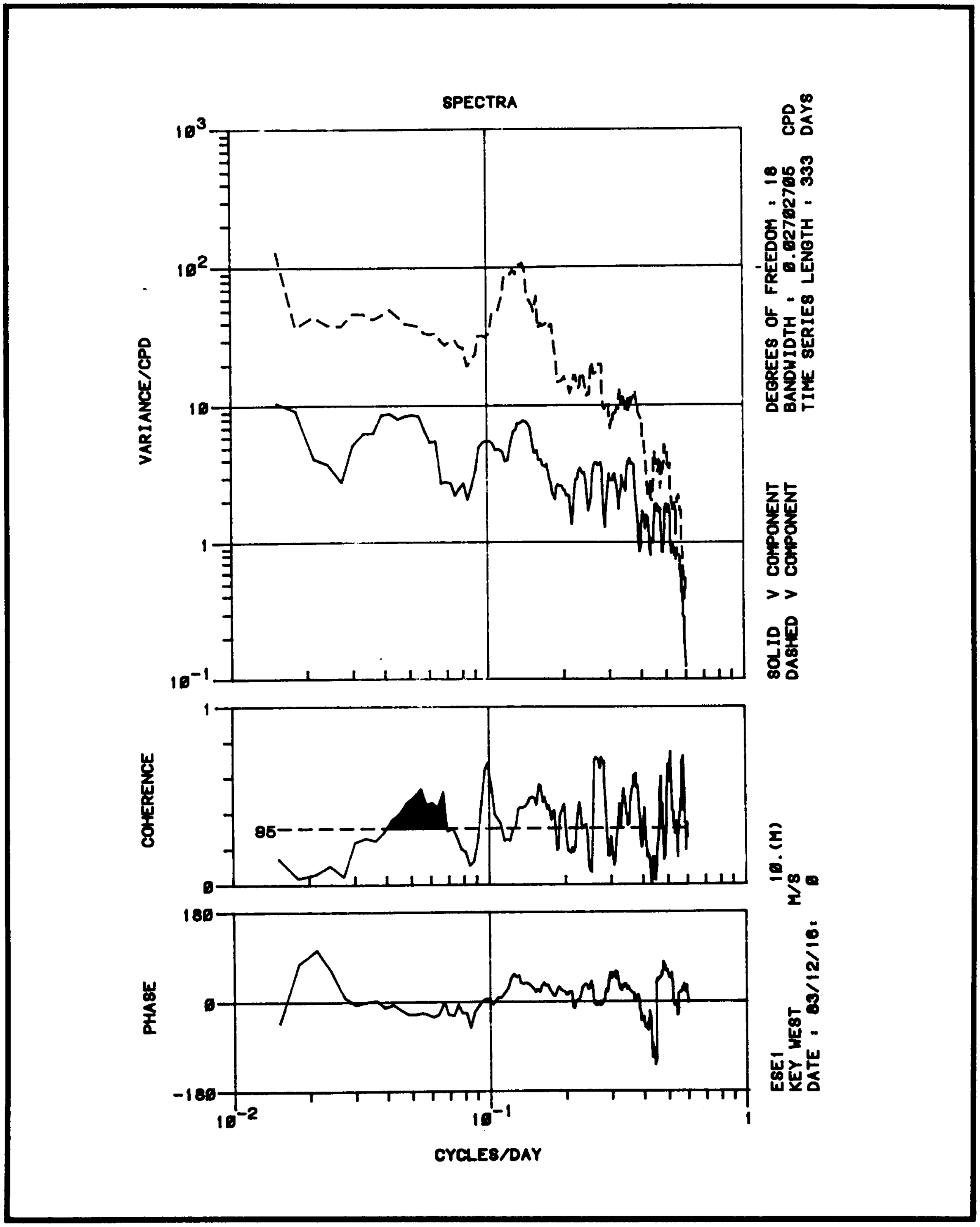

Figure 4.4-52. Comparison between currents at Mooring ESE1 and winds at Key West, Florida, for the longshore component. This data segment is for 11 months of data beginning 16 December 1983.

In the summer (Figure 4.4-49), the wind-current coherence is up to the 95% confidence limits in the normal 3 to 6 day period (.33 to .17 cycles day^{-1}) band. At periods of 10 days (.1 cycle day^{-1}), the currents appear to be relatively incoherent with the wind. Because the wind stress is less by a factor of roughly an order of magnitude in summer, lower coherences are not unexpected. In all the figures (Figure 4.4-47 through 4.4-51), the phase delay is nearly constant as a function of frequency where coherence is high. Figure 4.4-52 shows the comparison for a nearly year-long record. Again we find that for periods of 15 to 30 days (.067 to .033 cycles day^{-1}) there is significant coherence between the winds and the currents. This is, at least in part, a surprising result, as we do not usually expect to see the wind-forced response to extend to these longer periods. Nevertheless, the result is clearly significant. The peak of the energy is near periods of 20 days (.05 cycles day^{-1}); with a record length of 333 days. This gives about 17 realizations of the energy, or 33 degrees of freedom, which is by even conservative standards a very reliable result.

4.4.4.2 Spatial Coherence of Current Field

Most of the moorings put out by ESE are at depths similar to those of the main 3-year GMPOP array to the north, so it is appropriate to compare these records. The alongshore separation is approximately 100 km, which is a small part of the wavelength of most of the (expected) shelf waves. If long coastal trapped waves are the primary response to the wind forcing, we would expect that the currents at the ESE or SW Florida moorings would be highly coherent with those observed farther to the north. This is what is observed. On the other hand, if the main energetic motions consist of eddy signals whose horizontal scales were much shorter than 100 km, we could expect to find low coherence between the two sets of observations. This is not observed.

In comparing moorings ESE3 and ESE4, we find that the coherence is very high, although the U components show lower coherence than the V components. Figure 4.4-53 shows that the V or alongshelf component is smaller by a factor of about .8 at Mooring 3 than at Mooring 4. This tendency is in keeping with the Clarke and Van Gorder theory of wave reflection at the abrupt drop-off in bottom depths just south of Mooring 3. In this figure, for the winter data, the coherence is high and the phase shift is small (but appears to be decreasing with increasing period, as would be expected for fast non-dispersive waves).

Figure 4.4-54 shows that, even in the summer, when the wind strength is low, the currents at ESE3 and ESE4 are coherent at well above the 95 confidence limit, but the phase difference is surprising; not near zero, as expected, but greater than 90 degrees, which suggests that some other processes may have been involved. Figures 4.4-55 and 4.4-56 show the comparisons between these two instruments for a 239-day long record for both the U and V components. At the longest periods, coherence is near 1 for the V, or alongshore component, and near 90% or greater for U. At periods near 6 to 10 days (.167 to .1 cycles day^{-1}), the "V" power at ESE4 (Figure 4.4-55, solid line) looks very similar to that of the Key West winds (Figure 4.4-52), more so than does the record at ESE3 (Figure 4.4-55, dashed line).

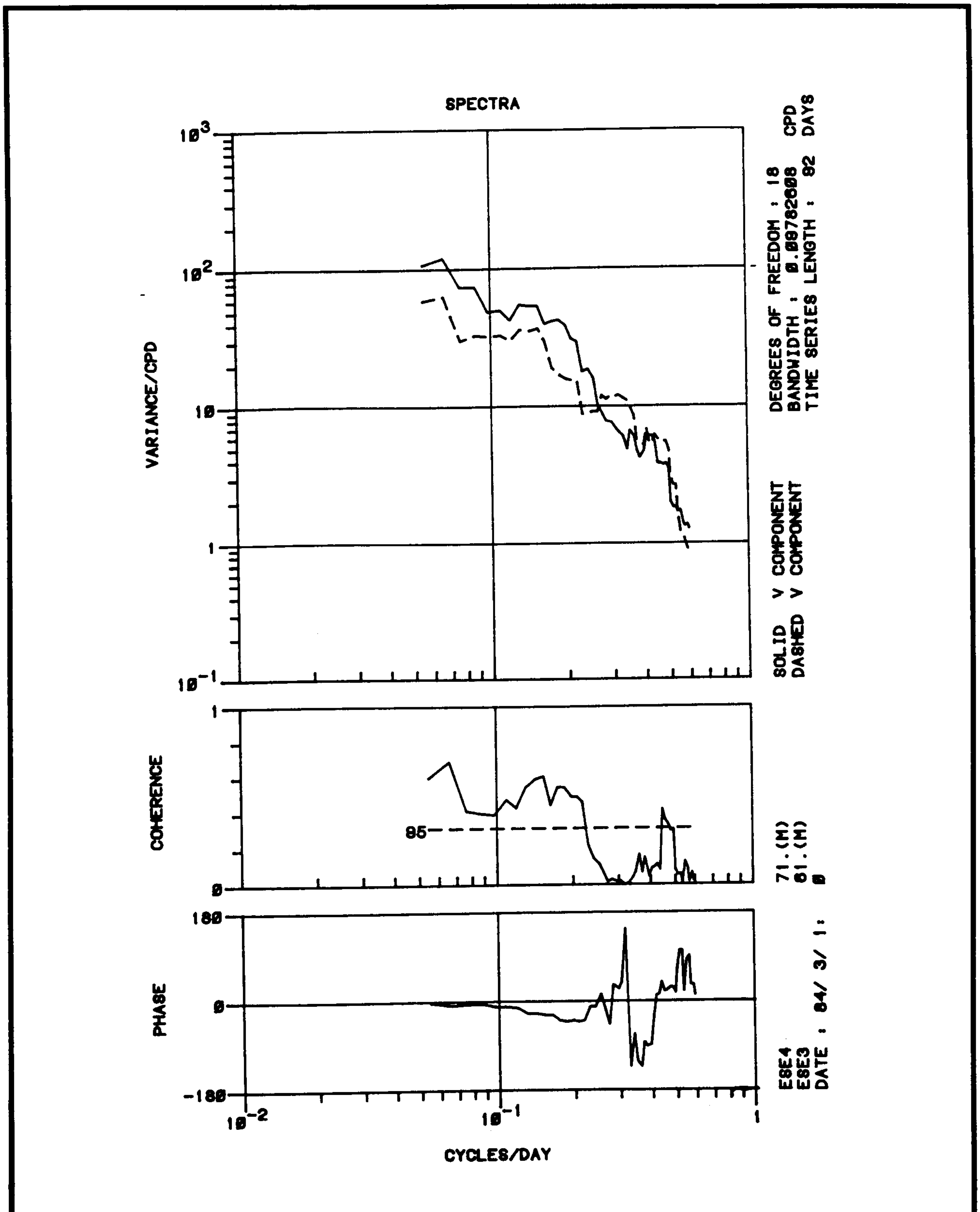

Figure 4.4-53. Comparison between the longshore component of current at Moorings ESE3 and ESE4 for the spring "season". This data segment uses 92 days of data beginning 1 March 1984.

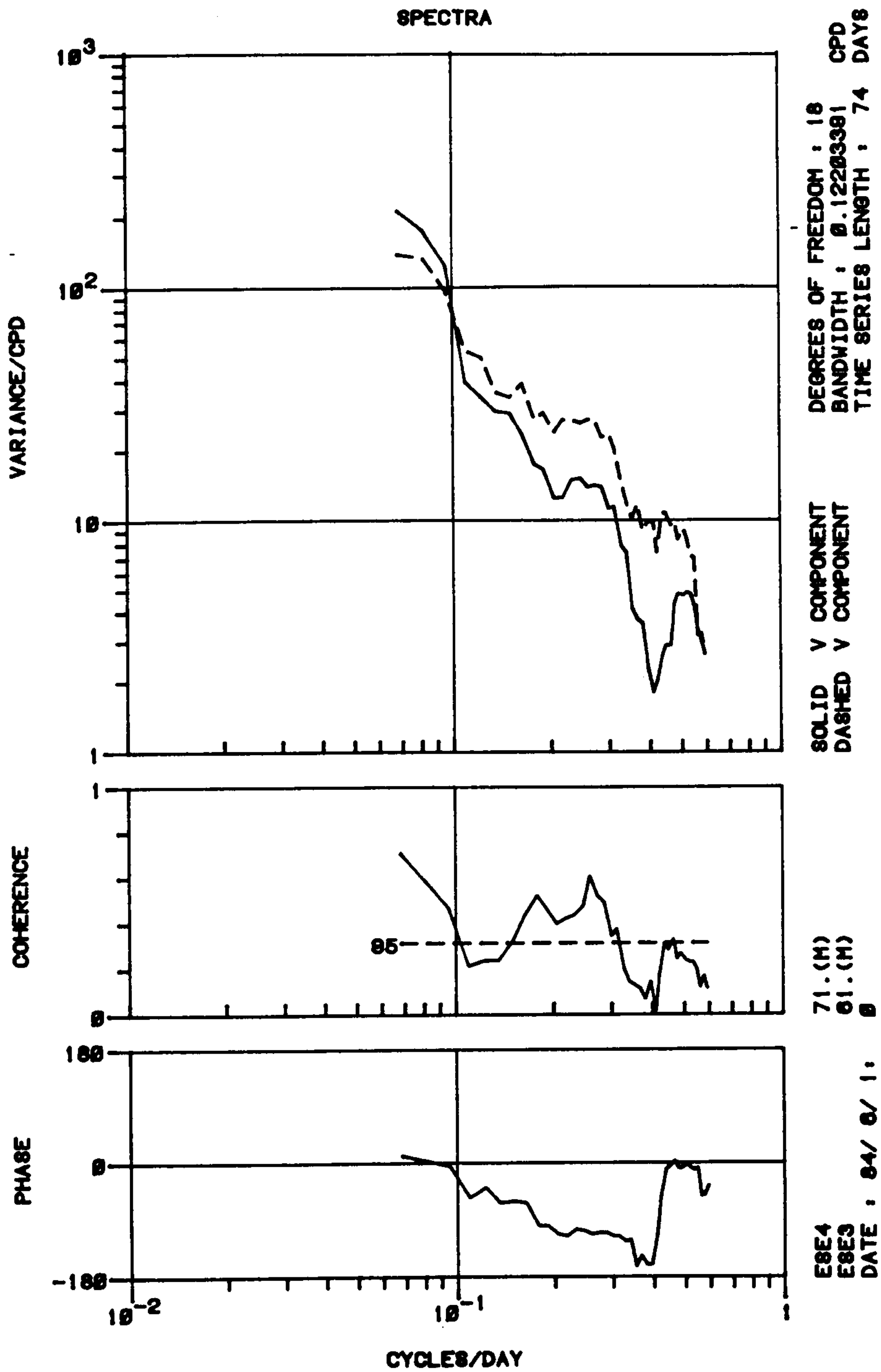

Figure 4.4-54. Comparison between the longshore component of current at Moorings ESE3 and ESE4 for the summer "season". This data segment uses 74 days of data beginning 1 June 1984.

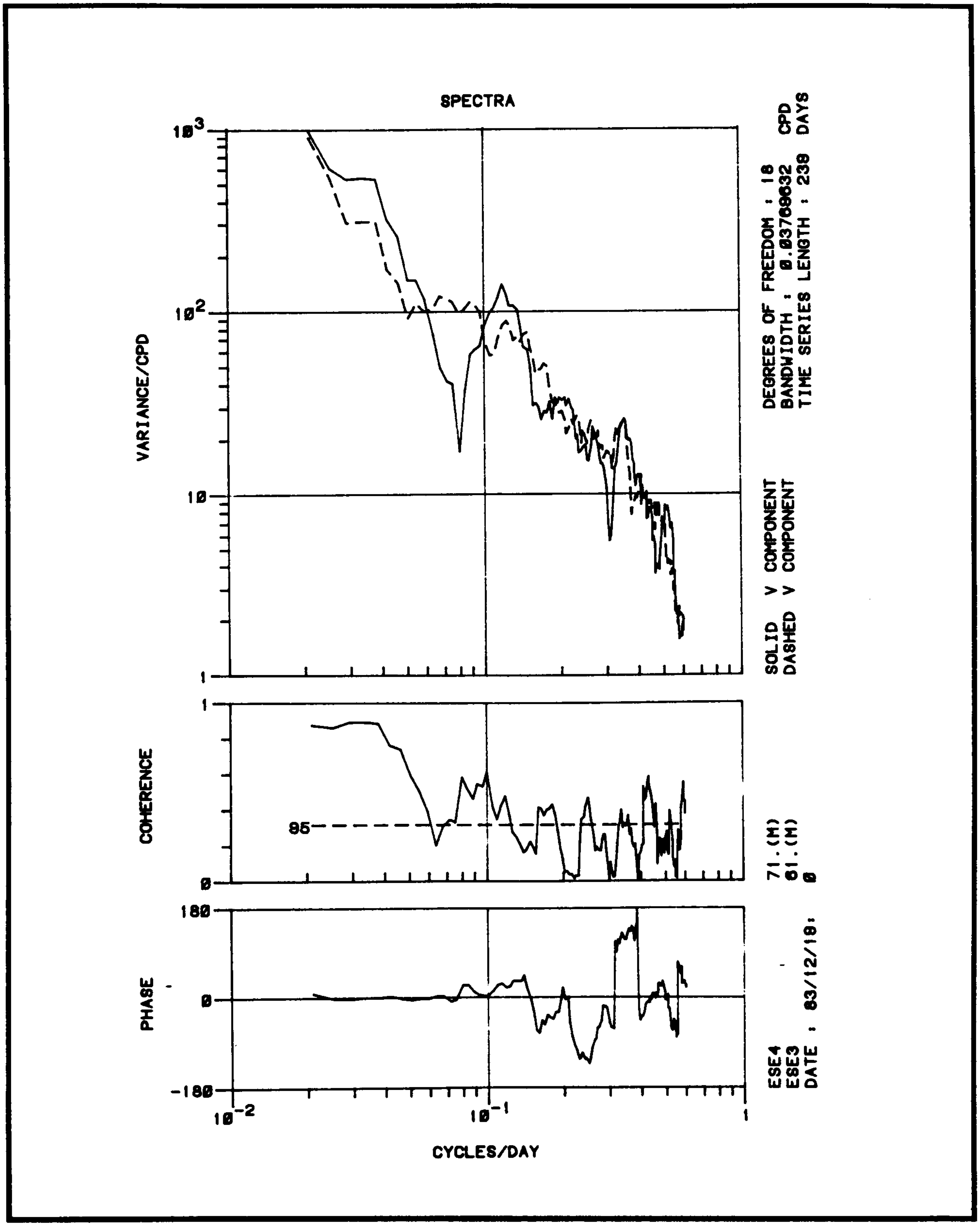

Figure 4.4-55. Comparison between the longshore component of current at Moorings ESE3 and ESE4 for 10 months of data beginning 19 December 1983.

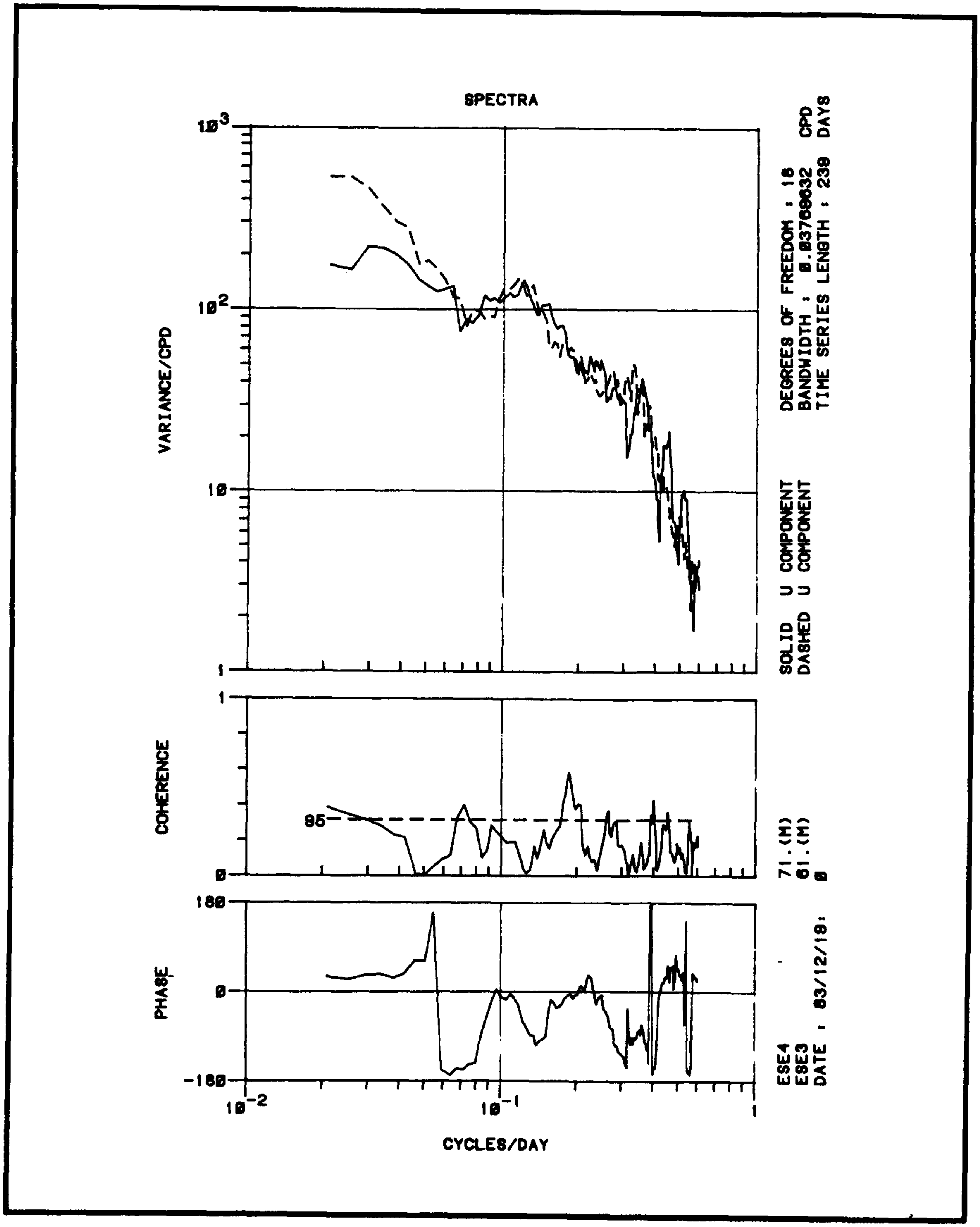

Figure 4.4-56. Comparison between the onshore component of current at Moorings ESE3 and ESE4 for 10 months of data beginning 19 December 1983.

Figures 4.4-57 through 4.4-60 show the coherence between Moorings D (50-m instrument) and ESE 4, for both components, for a winter array and a spring array, and in Figures 4.4-61 and 4.4-62 for the full 239 days. The coherence is at some places high both in the normal wind-driven periods and at the longer, eddy-like periods. The speeds at Mooring D are larger by nearly an order of magnitude. Part of this difference is attributable to the position of Mooring D farther to the north, and part to the fact that the ESE moorings had instruments 3 m above the bottom, which will be influenced by bottom friction.

The comparisons between Moorings C and ESE2 close to the outer edge of the shelf show lower coherence (see Figures 4.4-63 through 4.4-66). Mooring ESE2 is at about 125 m, and Mooring C is at 180 m. Out near the edge of the wide continental shelf, rather weak wind-driven currents are expected. This is shown in the two sets of observations which are not generally coherent in the wind-driven band, in either the U or V component. However, there is some small coherence in the U component near 3- and 7-day periods. The currents at Mooring C have higher velocities by a factor of 10 to 20, during the winter. During the summer, however, Figures 4.4-65 and 4.4-66 show that the two moorings record very similar current speeds. The level at Mooring ESE2 is about the same, but at Mooring C the level has dropped. For the U and V components, Figures 4.4-67 and 4.4-68 show that at the longer periods, the two sets of observations are reliably coherent. The coherence and signal strengths are lower in the U component.

The currents observed at Mooring F at 17 m depth are highly coherent with wind forcing at Key West (see Figure 4.4-23). In addition, it is known that currents closer inshore on the shelf such as at Mooring ESE1 at 10 m depth are even more highly coherent with wind forcing. Thus, the currents at Moorings F and ESE1 will be highly coherent.

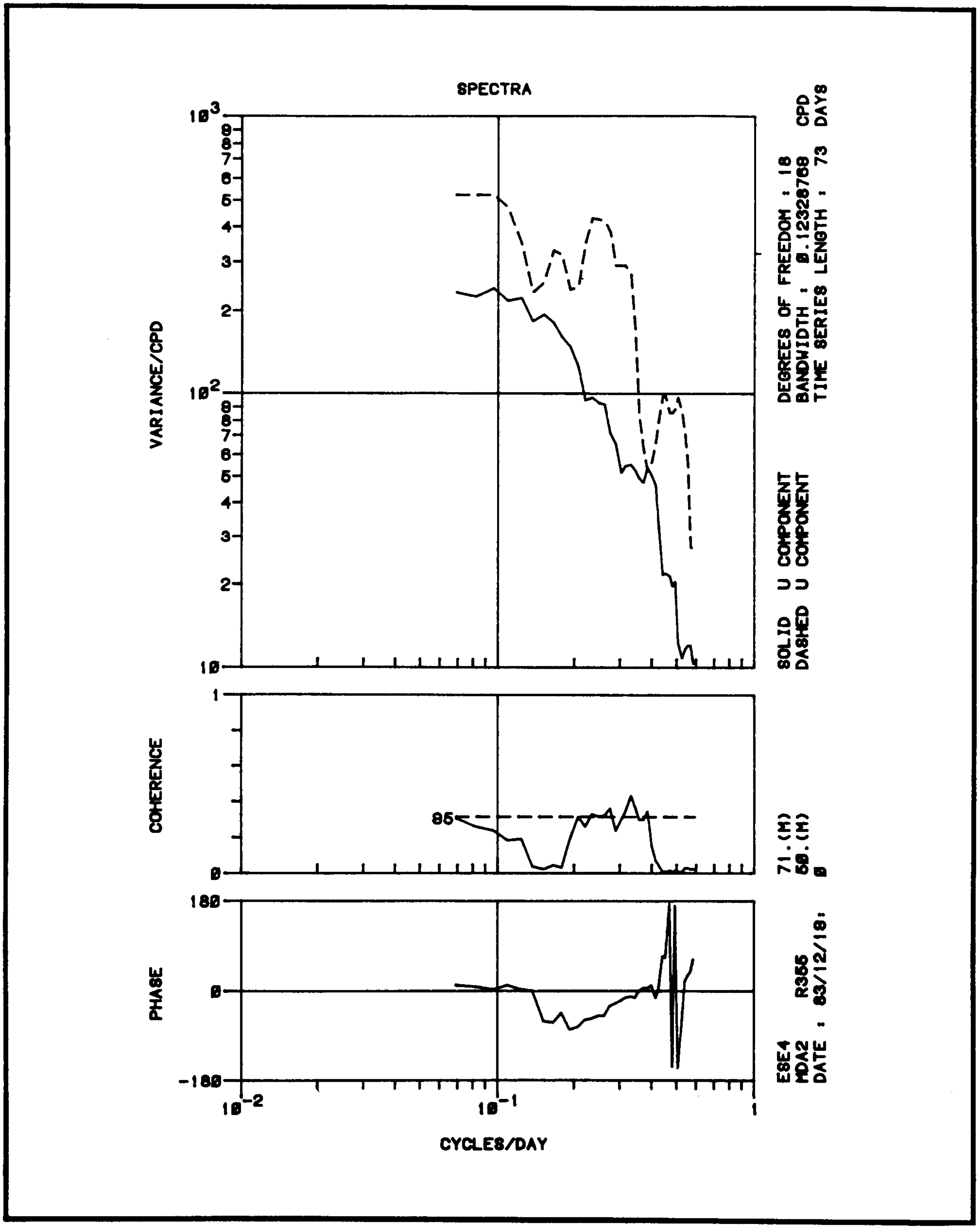

Figure 4.4-57. Comparison between onshore currents at Moorings ESE4 and D (50-m instrument) for 73 days of data beginning 19 December 1983.

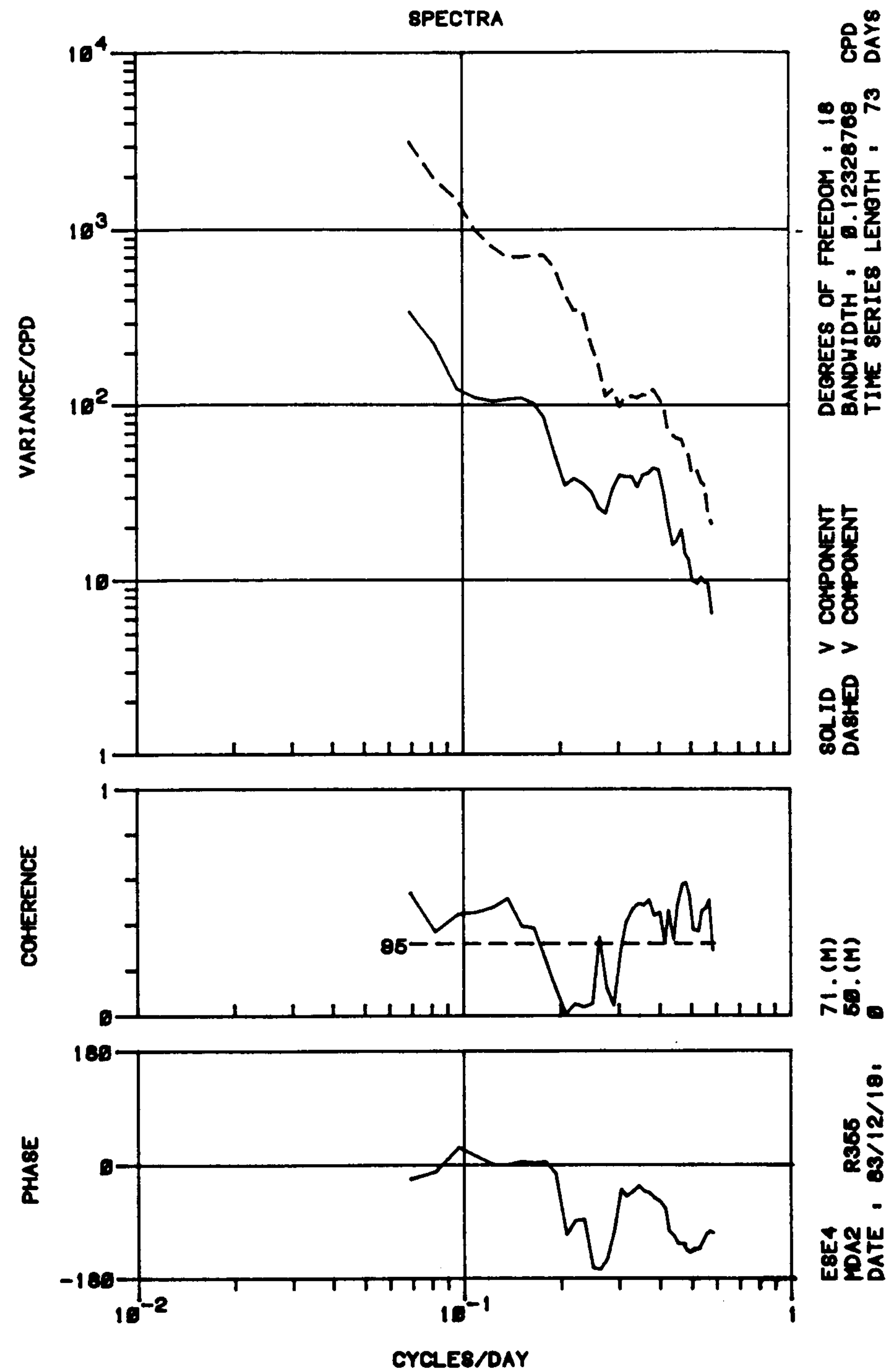

Figure 4.4-58. Comparison between longshore currents at Moorings ESE4 and D (50-m instrument) for 73 days of data beginning 19 December 1983.

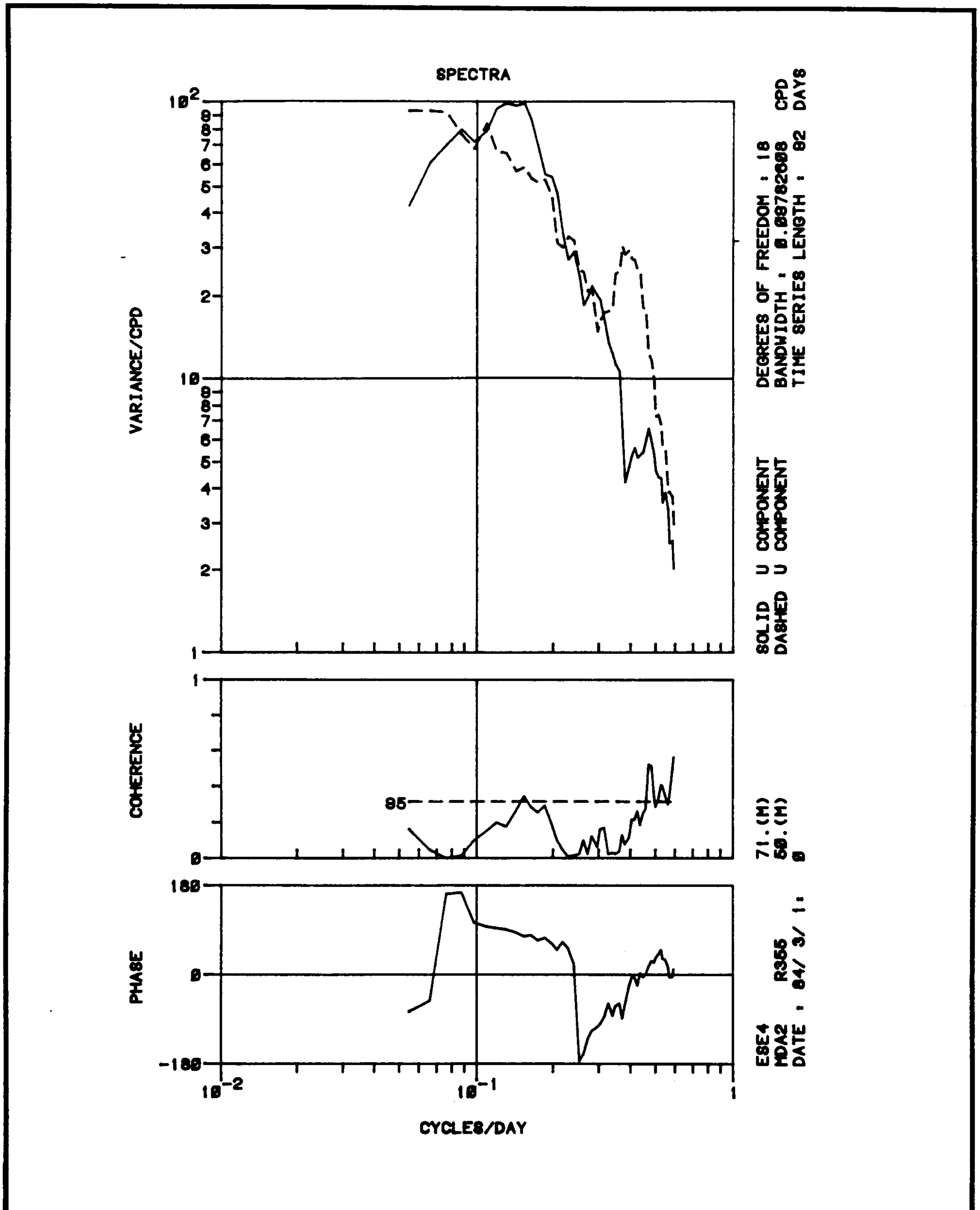

Figure 4.4-59. Comparison between onshore currents at Moorings ESE4 and D (50-m instrument) for 82 days of data beginning 1 March 1984.

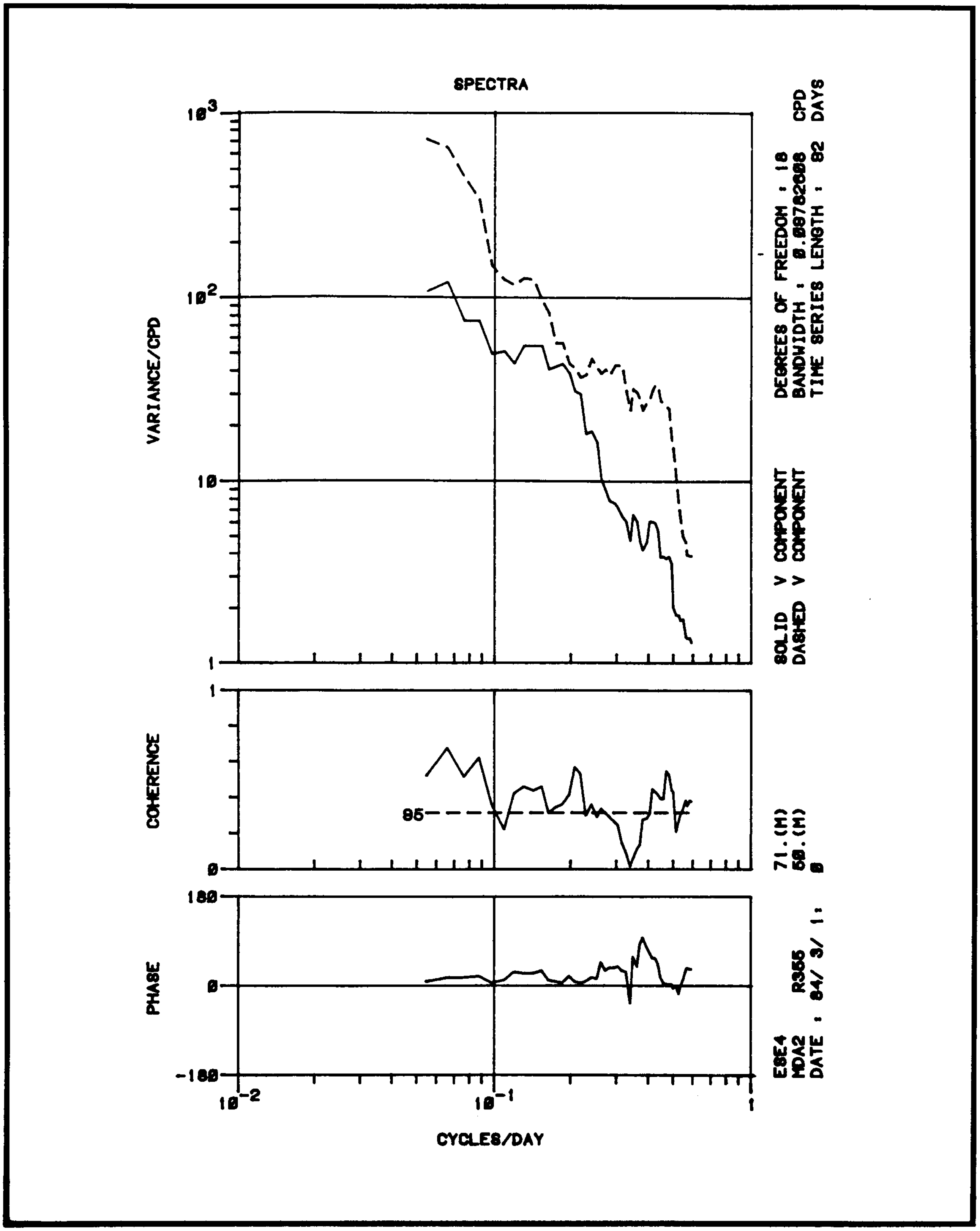

Figure 4.4-60. Comparison between longshore currents at Moorings ESE4 and D (50-m instrument) for 82 days of data beginning 1 March 1984.

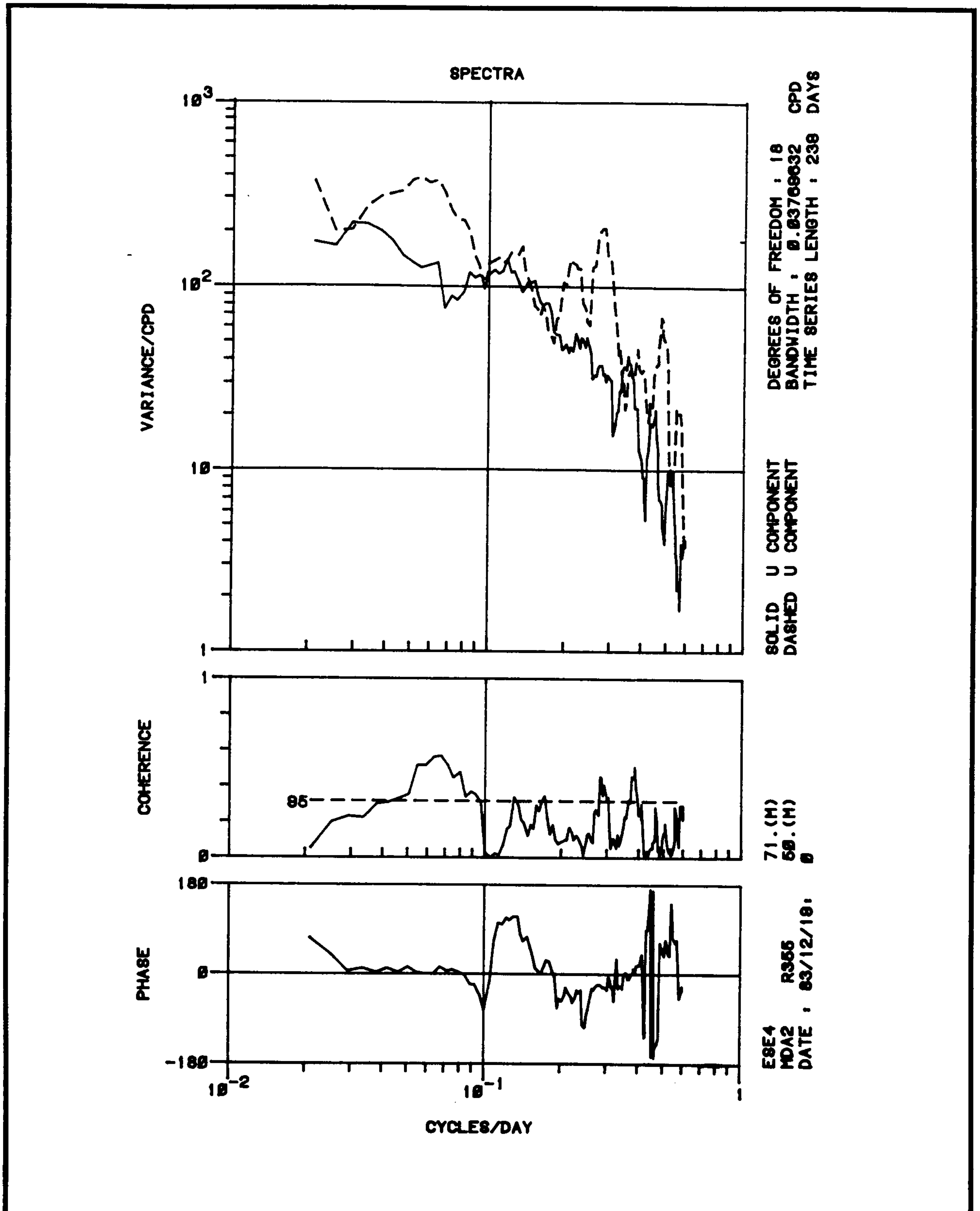

Figure 4.4-61. Comparison between onshore currents at Moorings ESE4 and D (50-m instrument) for 10 months of data beginning 19 December 1983.

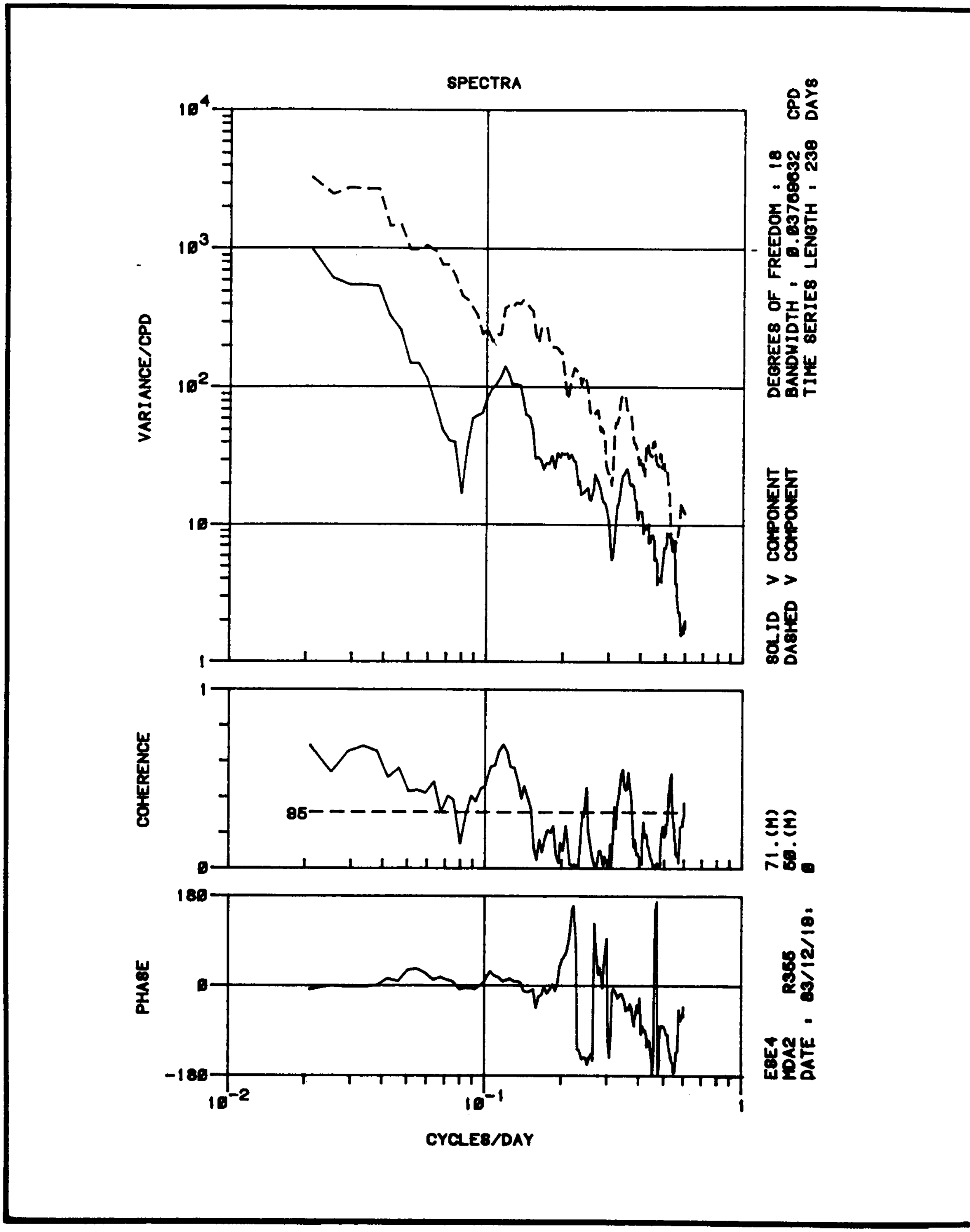

Figure 4.4-62. Comparison between longshore currents at Moorings ESE4 and D (50-m instrument) for 10 months of data beginning 19 December 1983.

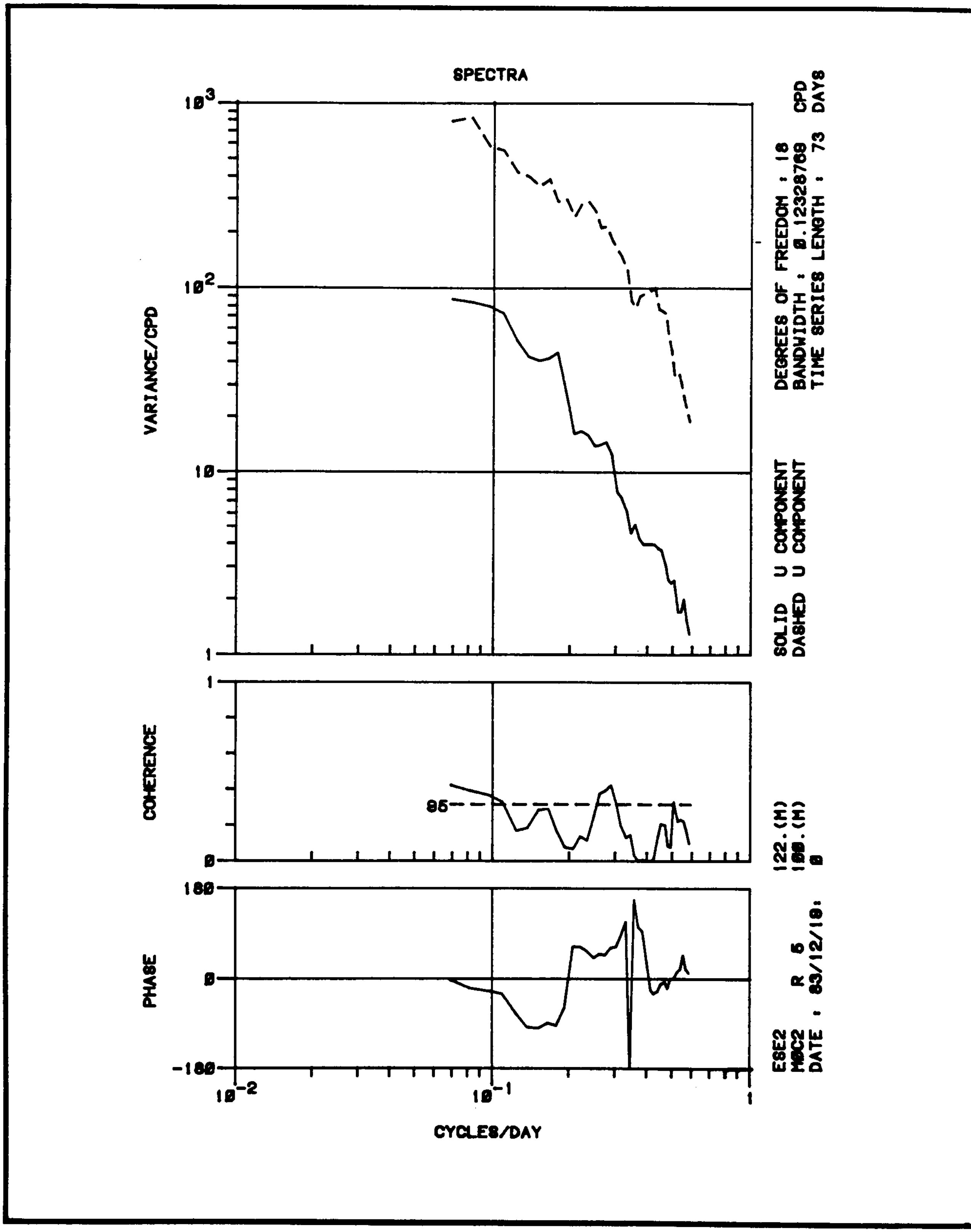

Figure 4.4-63. Comparison between onshore currents at Moorings ESE2 (at 122 m) and C (100-m instrument) for 73 days of data beginning 19 December 1983.

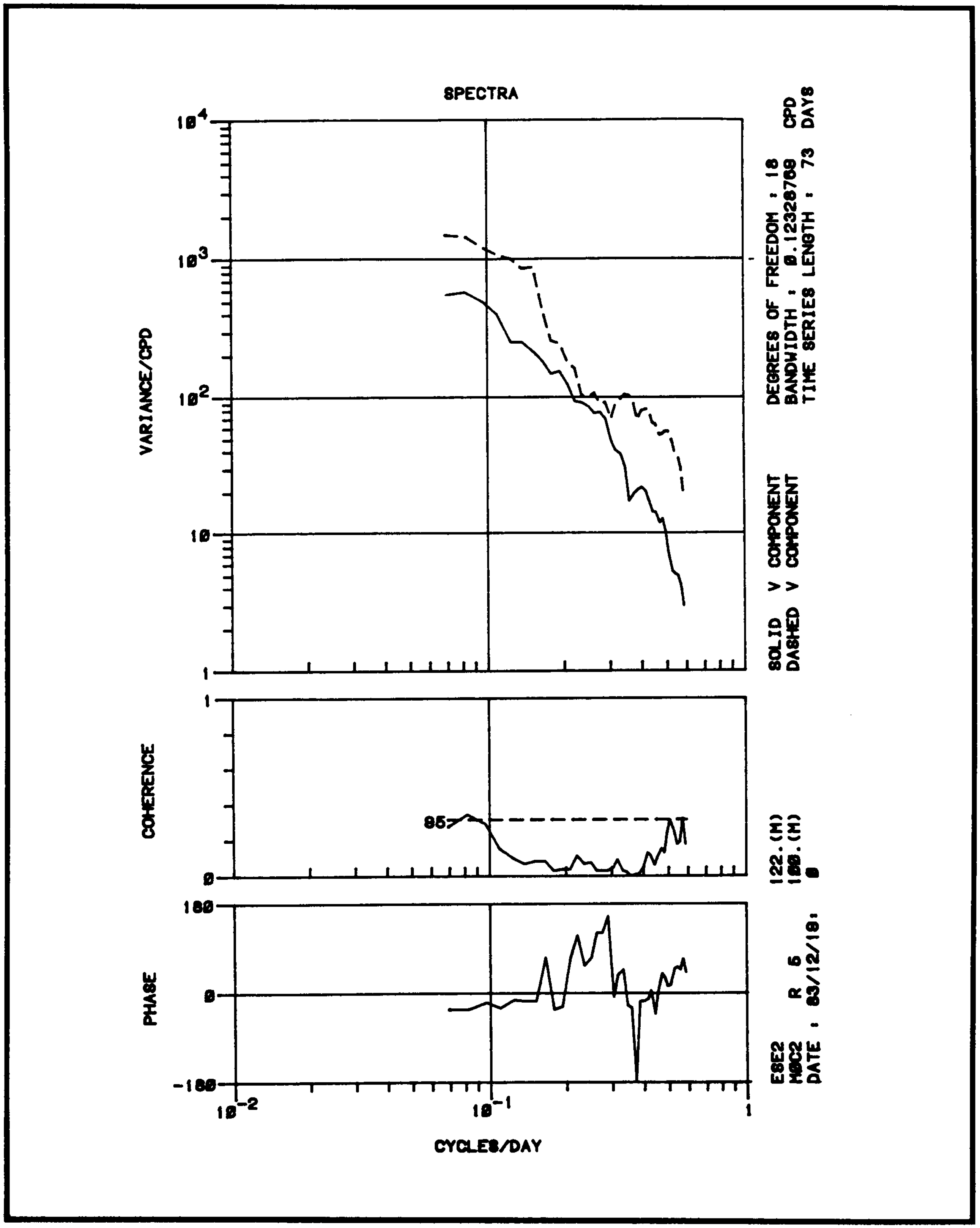

Figure 4.4-64. Comparison between longshore currents at Moorings ESE2 (at 122 m) and C (100-m instrument) for 73 days of data beginning 19 December 1983.

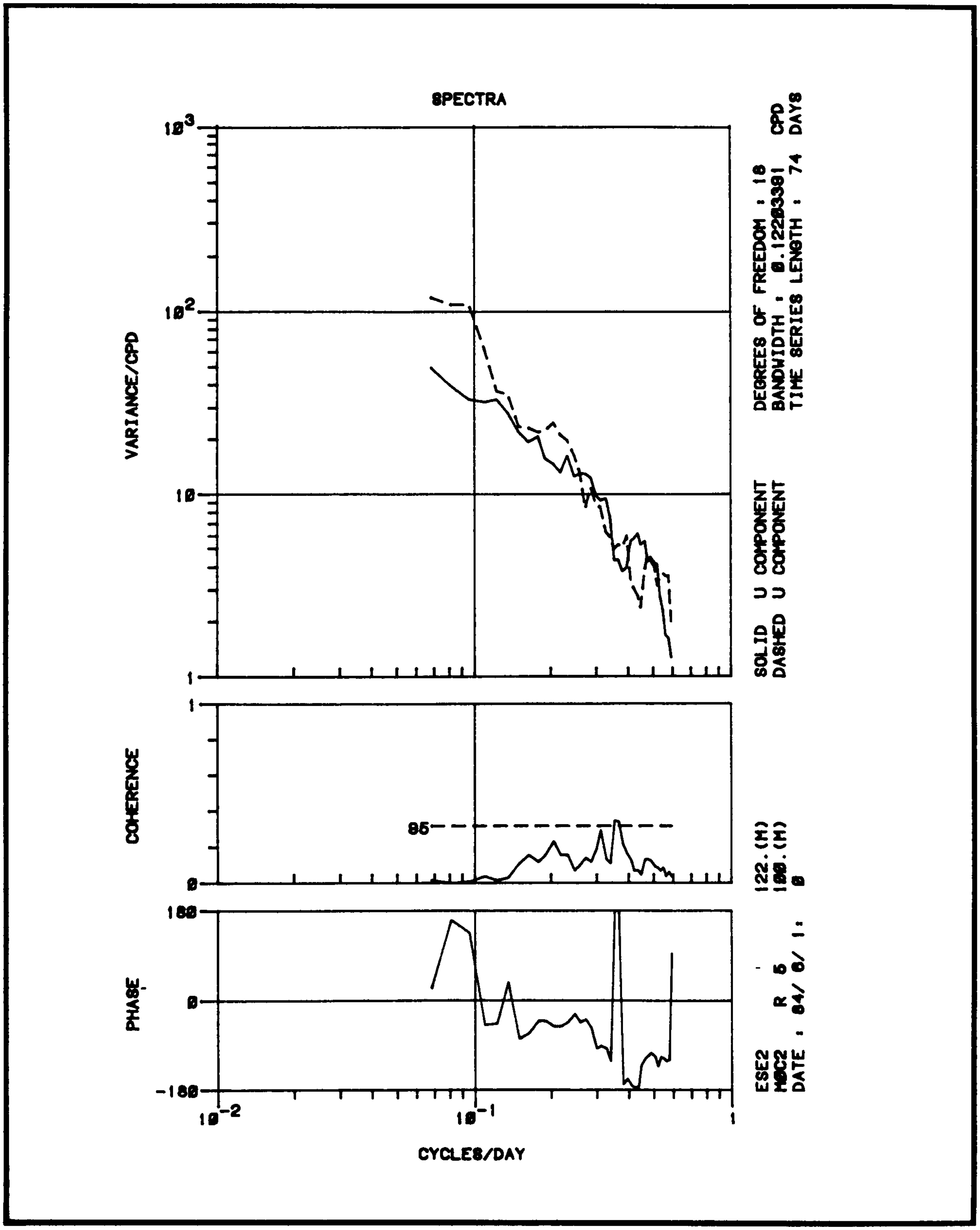

Figure 4.4-65. Comparison between onshore currents at Moorings ESE2 (at 122 m) and C (100-m instrument) for 74 days of summer data beginning 1 June 1984.

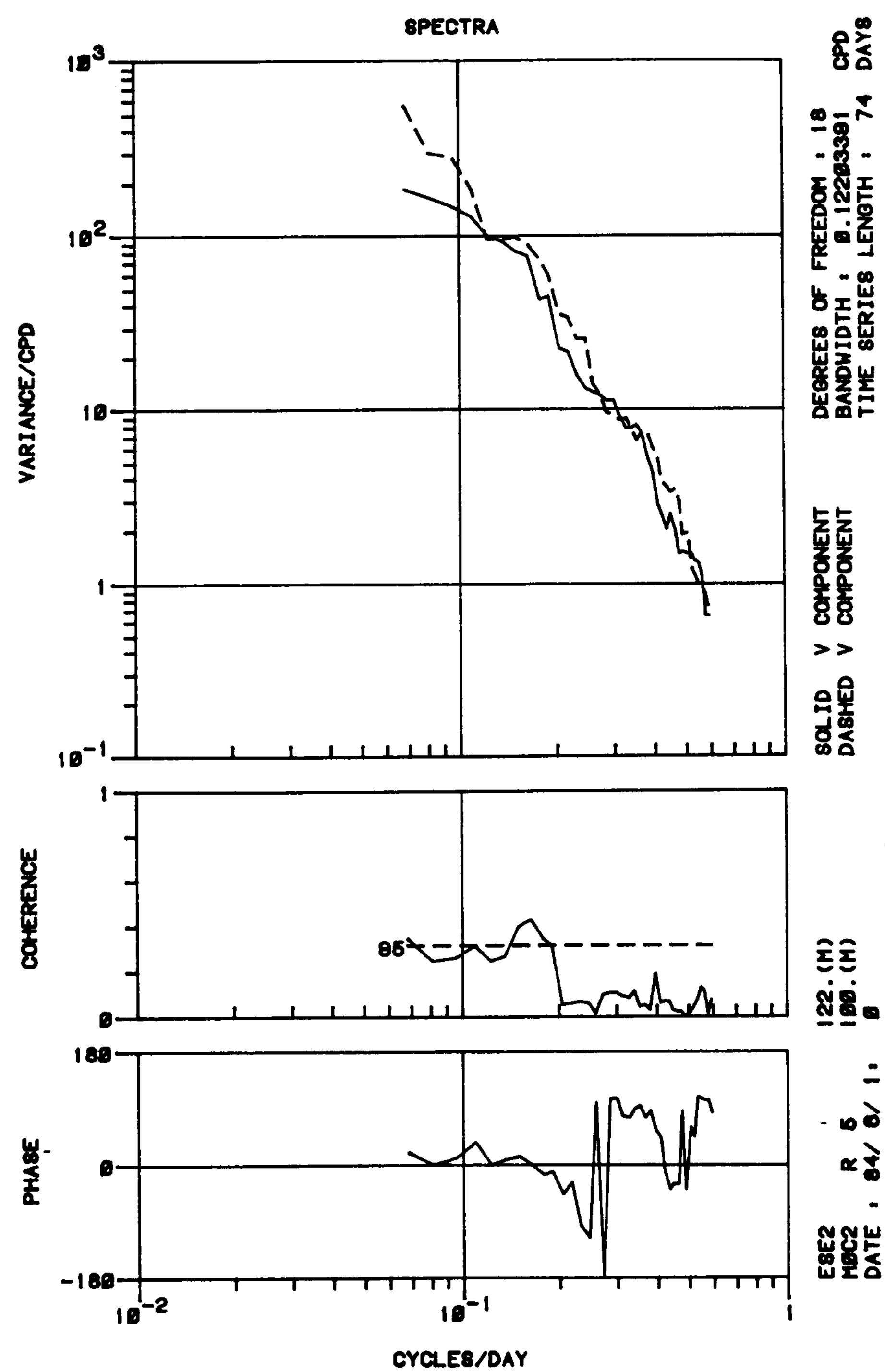

Figure 4.4-66. Comparison between longshore currents at Moorings ESE2 (at 122 m) and C (100-m instrument) for 74 days of summer data beginning 1 June 1984.

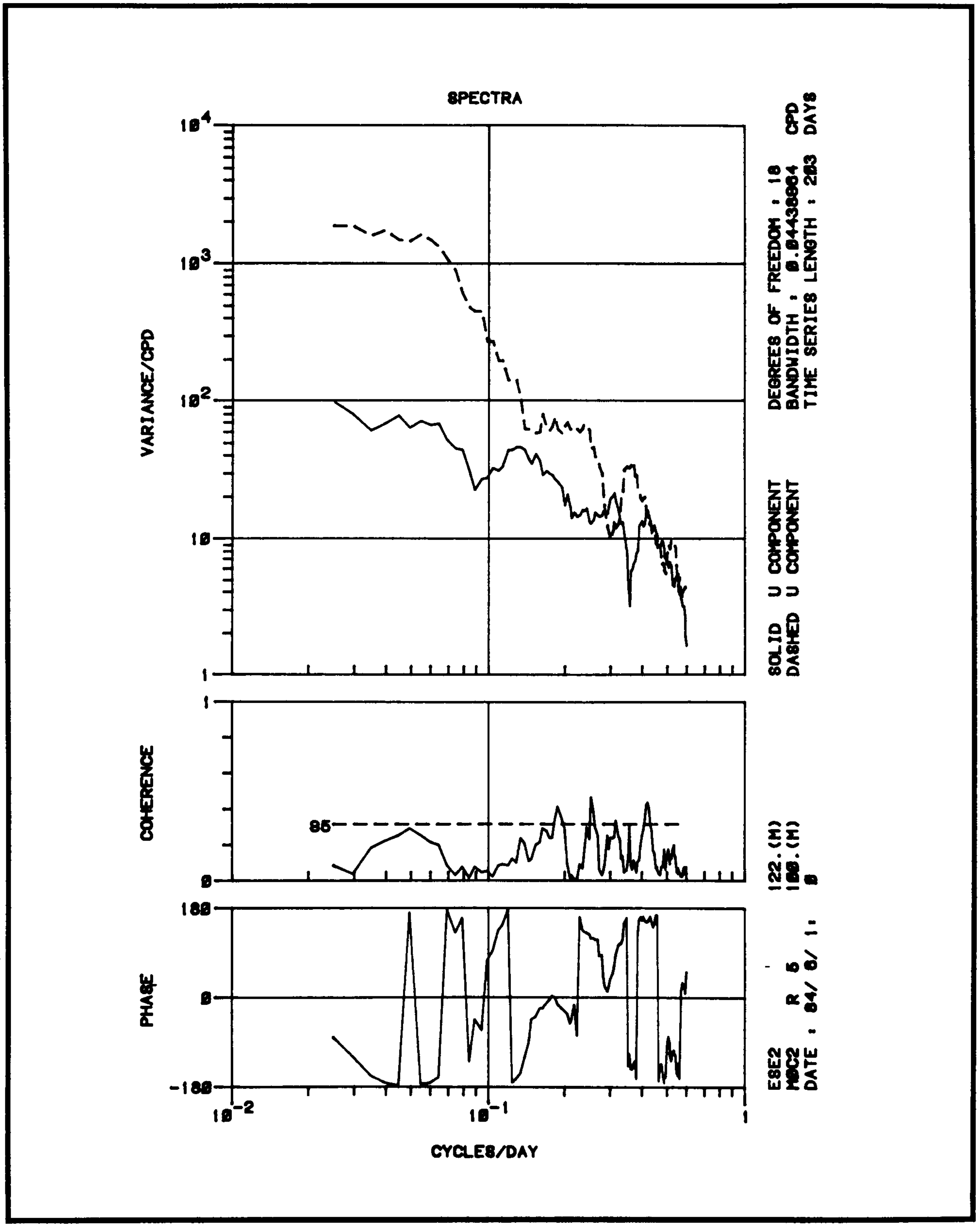

Figure 4.4-67. Comparison between currents at Moorings ESE2 (at 122 m) and C (100-m instrument) for the onshore component for 203 days of data beginning 1 June 1984.

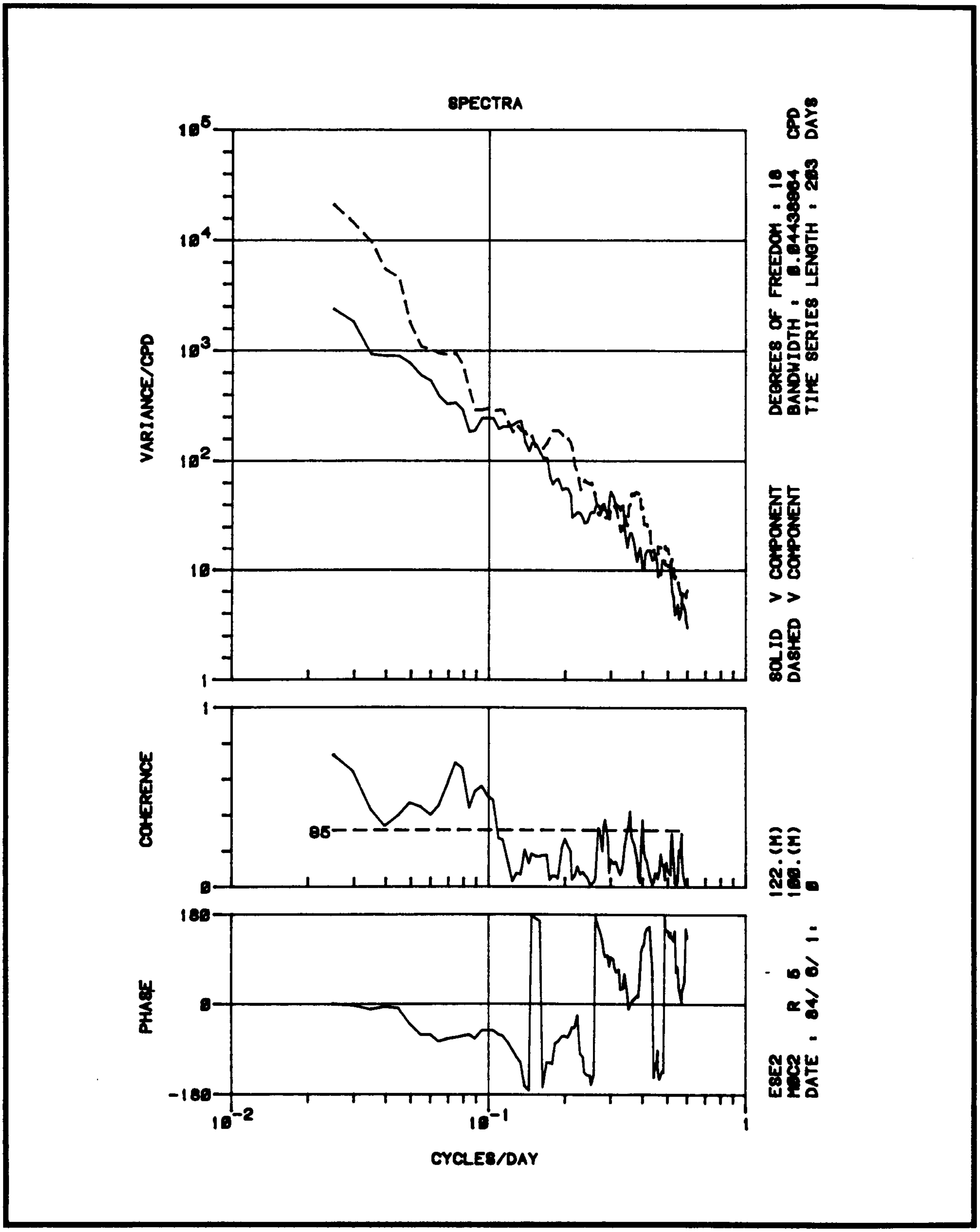

Figure 4.4-68. Comparison between currents at Moorings ESE2 (at 122 m) and C (100-m instrument) for the longshore component for 203 days of data beginning 1 June 1984.

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APPENDIX A

RECURRENCE AND DURATION ANALYSIS
FOR
MOORINGS F, D, DA, C, A, AND G

A.1 Duration and Recurrence Interval Analysis

A time series of current speed can be analyzed to identify intervals during which the speed is:

- greater than a selected or threshold value.
- less than or equal to a selected value.

The interval during which a current speed is greater than a set value is the duration of that current event above that value. Likewise, the period during which the speed remains less than or equal to a threshold value defines the recurrence interval of a current event of that speed. Depending on the threshold speed, duration and recurrence intervals have different lengths. The present effort analyzed duration and recurrence intervals as a function of speed and length of the interval. The results are shown as a percent of the total time series.

As an example, Table A.1-1 (Duration) shows that for speeds greater than 35 cm/s, 15.8% of the record was involved with episodes lasting 6 hours or longer. This percent dropped to 10% for durations of greater than 24 hours. Further examination for 35 cm/s shows a gradual decrease in the percent of record involved when the episode duration increases. For durations greater than 114 hours, 2.9% of the record is still involved. The recurrence analysis in Table A-1b shows that for speeds of greater than 35 cm/s, 30.9% of the record was involved in recurrence intervals of 6 hours or greater and 72.4% with intervals of 114 hours or greater.

Along the right side of both the duration and recurrence intervals is a listing of the total number of hours during with speeds above (for duration) or below (for recurrence) the indicated values. Clearly for any selected speed the number of hours above, below and equal to a given speed equals the total record length. This is a built in check on the analysis.

These kinds of analyses are useful in evaluating the general speed environment at a location and provide quidance as to how frequent and how long particular energetic (duration) or quiescent (recurrence) conditions are.

For proper understanding, it is essential that the reader remain aware that the number given represent the percent of the total record which satisfies the given limits of speed and duration.

These analyses are seperated by mooring and are presented in the following order:

F
D,DA
C
A
G
E

which is from shallow to deeper along the main line of moorings. Within a mooring they are presented from the top to the bottom of the mooring.

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA1 3 HRLP SPANNING 1/29/83 TO 2/ 3/84 (8895 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8895
OVER 7.0:	67.8	65.4	61.1	55.3	52.5	52.0	50.8	50.0	50.0	48.2	48.2	47.5	45.9	45.0	45.0	45.0	44.0	44.0	42.8	42.8	6032
OVER 14.0:	50.5	47.1	43.3	39.6	36.2	35.9	34.7	33.4	33.4	32.9	32.9	32.2	30.7	29.8	28.9	28.9	28.9	28.9	28.9	2.9	4496
OVER 21.0:	38.3	36.0	33.2	30.2	28.7	27.7	27.7	26.8	26.3	25.8	25.1	25.1	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	3408
OVER 28.0:	27.2	25.6	23.1	21.2	18.5	17.9	17.5	16.6	16.6	16.6	16.0	16.0	16.0	14.3	14.3	12.3	11.3	11.3	10.1	10.1	2419
OVER 35.0:	17.6	15.8	13.9	11.4	10.0	9.6	8.1	7.7	7.7	6.5	5.9	5.2	5.2	5.2	5.2	5.2	4.1	4.1	4.1	2.9	1565
OVER 42.0:	8.6	7.4	6.0	4.4	4.1	4.1	4.1	3.2	2.7	2.7	2.7	2.0	2.0	1.1	1.1	1.1	1.1	.0	.0	.0	768
OVER 49.0:	3.3	2.7	2.0	1.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	297
OVER 56.0:	1.5	1.3	1.0	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.0	.0	.0	.0	.0	.0	.0	133
OVER 63.0:	.7	.6	.6	.6	.6	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	61
OVER 70.0:	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	22
OVER 77.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

(A)

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGE STATION: MOA1 3 HRLP SPANNING 1/29/83 TO 2/ 3/84 (8895 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	32.2	29.3	25.3	20.4	18.9	18.2	17.5	17.0	16.5	15.9	15.3	14.6	13.8	13.8	13.8	13.8	13.8	12.7	12.7	11.4	2863
OVER 14.0:	49.5	46.6	42.7	37.5	33.4	33.1	31.2	30.7	30.2	29.6	29.6	27.5	25.9	24.2	23.3	23.3	23.3	23.3	22.1	22.1	4399
OVER 21.0:	61.7	59.9	56.7	52.8	52.1	50.8	50.5	49.6	49.1	47.3	46.6	45.2	44.4	44.4	42.6	39.7	39.7	39.7	39.7	38.4	5497
OVER 28.0:	72.8	70.9	68.4	66.1	65.4	65.4	65.0	65.0	64.5	64.5	63.9	63.9	63.1	62.2	62.2	59.3	59.3	58.2	57.0	55.7	6476
OVER 35.0:	82.4	80.9	78.9	76.8	74.4	74.1	73.7	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	7330
OVER 42.0:	91.4	90.4	89.6	87.3	85.3	84.7	84.7	84.7	84.7	84.7	84.0	83.3	82.5	82.5	82.5	82.5	80.4	80.4	80.4	80.4	8127
OVER 49.0:	96.7	96.3	95.8	95.5	94.7	94.7	94.4	94.4	94.4	94.4	93.7	93.0	93.0	92.2	92.2	92.2	92.2	92.2	92.2	92.2	8598
OVER 56.0:	98.5	98.5	98.3	98.2	98.2	98.2	98.2	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	8762
OVER 63.0:	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	8834
OVER 70.0:	99.8	99.7	99.7	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	8873
OVER 77.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8892
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

(B)

Table A.1-1. **(A) Duration analysis indicating the percent of the total record length which satisfies the given speed and duration interval; (B) Recurrence analysis indicating the percent of the total record which satisfies the given speed and recurrence interval. The sum of the hours which occur in all duration (or recurrence) intervals for a given speed are listed on the right. For a given speed, the numbers of hours for all durations plus the hours for all recurrence equals the total record length. The calendar interval and the included number of hours is shown at the top of each table.**

Each table presents the duration (upper) and recurrence for the same interval. Due to breaks in the time series at a given instrument depth, there may be several sets of duration and recurrance at a given instrument. Each set then is calculated over the indicated measurement period.

DURATION AND RECURRANCE FOR MOORING F

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MOF1   3 HRLP   SPANNING 2/ 3/84 TO 2/ 1/86 (17500 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	17500
OVER 7.0:	37.3	26.3	15.0	8.9	5.0	3.8	2.1	2.1	1.5	1.5	.9	.5	.5	.5	.5	.0	.0	.0	.0	.0	6526
OVER 14.0:	17.4	10.9	5.7	3.0	1.2	1.2	.6	.4	.4	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	3053
OVER 21.0:	8.3	5.6	2.7	1.1	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1461
OVER 28.0:	4.0	2.6	.9	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	695
OVER 35.0:	1.7	.9	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	289
OVER 42.0:	.5	.3	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	91
OVER 49.0:	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	42
OVER 56.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	24
OVER 63.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	14
OVER 70.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MOF1   3 HRLP   SPANNING 2/ 3/84 TO 2/ 1/86 (17500 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	62.7	53.8	42.3	29.9	21.0	19.1	17.3	16.0	13.9	13.6	11.9	10.8	9.6	8.8	8.3	6.8	6.3	5.1	5.1	3.2	10974
OVER 14.0:	82.6	79.4	73.6	65.1	57.5	55.7	54.3	52.5	50.7	48.3	47.7	47.0	44.6	42.5	41.1	41.1	40.5	39.4	39.4	38.1	14447
OVER 21.0:	91.7	90.2	88.3	84.4	80.6	80.0	79.6	79.2	76.8	75.9	73.9	73.5	73.1	72.2	71.8	71.8	70.2	69.6	69.6	69.6	16039
OVER 28.0:	96.0	95.5	94.5	91.8	89.6	89.1	89.0	89.0	88.7	88.4	88.4	87.7	86.1	86.1	86.1	85.6	85.6	85.6	85.0	85.0	16805
OVER 35.0:	98.3	98.2	98.0	96.4	94.8	94.8	94.6	94.6	94.1	94.1	93.8	93.8	93.8	93.8	93.3	92.8	92.8	92.8	92.8	92.8	17211
OVER 42.0:	99.5	99.4	99.4	99.3	98.8	98.8	98.8	98.6	98.3	98.0	98.0	98.0	98.0	98.0	98.0	97.5	97.5	97.5	96.9	96.2	17409
OVER 49.0:	99.8	99.7	99.7	99.7	99.6	99.5	99.5	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	98.7	98.7	98.7	98.7	17458
OVER 56.0:	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.3	99.3	99.3	99.3	17476
OVER 63.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	17486
OVER 70.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	17497
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOF2 3 MRLP SPANNING 2/ 3/84 TO 2/ 1/86 (17499 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	17499
OVER 6.0:	24.1	14.6	6.0	3.5	2.3	1.8	1.2	1.2	1.0	.4	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	4225
OVER 12.0:	9.6	4.8	1.8	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1679
OVER 18.0:	3.9	1.8	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	681
OVER 24.0:	1.5	.7	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	258
OVER 30.0:	.5	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	96
OVER 36.0:	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	46
OVER 42.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	20
OVER 48.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	13
OVER 54.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	8
OVER 60.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5
OVER 66.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	12	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOF2 3 MRLP SPANNING 2/ 3/84 TO 2/ 1/86 (17499 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 6.0:	75.9	70.3	62.6	49.4	37.0	34.1	30.5	27.7	23.8	22.6	20.9	19.9	19.4	19.0	18.1	15.6	13.5	12.4	11.2	9.3	13274
OVER 12.0:	90.4	88.5	85.4	81.2	72.5	71.3	70.9	69.0	66.2	64.4	663.4	61.5	59.9	56.6	55.2	53.7	52.1	50.9	48.6	48.6	15820
OVER 18.0:	96.1	95.4	94.3	92.3	88.2	87.7	87.7	87.0	86.3	85.7	85.4	83.9	82.7	82.3	82.3	81.8	81.8	80.6	79.4	78.1	16818
OVER 24.0:	98.5	98.5	97.8	97.2	95.6	95.4	95.4	95.2	94.9	94.9	94.6	93.9	93.9	93.4	93.0	92.5	92.5	92.5	91.9	91.9	17241
OVER 30.0:	99.5	99.4	99.3	99.0	98.9	98.7	98.5	98.5	98.3	98.3	98.3	98.3	98.3	98.3	98.3	97.8	97.8	97.8	97.8	97.8	17403
OVER 36.0:	99.7	99.7	99.7	99.5	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	98.8	98.8	98.8	98.8	17453
OVER 42.0:	99.9	99.9	99.9	99.8	99.7	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.0	99.0	99.0	99.0	17479
OVER 48.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	17486
OVER 54.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	17491
OVER 60.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	17494
OVER 66.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	17497
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

DURATION AND RECURRANCE FOR MOORING D, DA

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOD1 3 HRLP SPANNING 1/28/83 TO 2/ 2/84 (8891 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8891
OVER 6.0:	69.8	63.9	54.3	46.1	35.9	32.6	30.7	28.4	27.4	26.3	24.4	23.7	22.9	22.0	21.1	20.1	18.0	14.6	14.6	12.1	6206
OVER 12.0:	48.0	39.6	29.7	21.7	14.0	12.5	10.5	10.1	9.1	7.9	7.3	5.2	4.4	3.6	3.6	3.6	2.6	2.6	2.6	2.6	4272
OVER 18.0:	30.4	23.2	15.1	10.0	5.9	5.4	4.9	3.6	3.1	3.1	3.1	3.1	2.3	2.3	1.4	1.4	1.4	1.4	1.4	1.4	2706
OVER 24.0:	17.3	11.3	5.6	3.6	3.1	3.1	2.7	2.3	2.3	1.7	1.0	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	1536
OVER 30.0:	7.7	4.5	2.9	2.7	2.5	2.5	2.1	1.6	1.6	1.6	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	685
OVER 36.0:	3.4	2.4	1.6	1.0	.8	.8	.8	.8	.8	.8	.8	.8	.0	.0	.0	.0	.0	.0	.0	.0	305
OVER 42.0:	1.7	1.3	.8	.7	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	150
OVER 48.0:	.8	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	74
OVER 54.0:	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	16
OVER 60.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
OVER 66.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	12	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOD1 3 HRLP SPANNING 1/28/83 TO 2/ 2/84 (8891 HOURS)

SPEED CM/S																					NUMBER OF HOUPS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 6.0:	30.2	21.3	14.0	9.7	7.9	6.7	6.3	5.4	3.9	3.3	3.3	2.6	1.8	1.0	1.0	.0	.0	.0	.0	.0	2685
OVER 12.0:	52.0	43.6	34.1	25.0	19.4	16.9	14.7	14.3	12.2	11.0	11.0	11.0	9.5	8.6	7.7	6.7	6.7	6.7	6.7	6.7	4619
OVER 18.0:	69.6	64.9	57.6	47.0	40.0	37.2	33.0	30.4	29.3	28.1	26.8	25.4	24.6	24.6	22.8	21.8	18.7	18.7	18.7	16.2	6185
OVER 24.0:	82.7	79.8	74.7	67.8	60.5	57.8	55.9	51.8	48.7	48.7	46.7	45.3	43.7	43.7	42.8	39.8	38.7	36.5	35.4	31.6	7355
OVER 30.0:	92.3	91.4	90.2	86.7	82.0	80.2	79.8	78.9	77.9	76.1	74.8	73.4	71.0	71.0	70.1	70.1	70.1	69.0	67.9	65.4	8206
OVER 36.0:	96.6	96.2	95.6	94.7	93.6	93.3	93.3	92.4	92.4	92.4	91.2	91.2	90.4	90.4	90.4	90.4	89.3	89.3	89.3	89.3	8586
OVER 42.0:	98.3	98.2	98.2	97.3	96.8	96.8	96.5	95.6	95.6	94.9	94.9	94.9	94.9	94.9	94.9	94.9	93.9	93.9	93.9	93.9	8741
OVER 48.0:	99.2	99.1	98.9	98.9	98.7	98.4	98.4	97.9	97.9	97.9	97.9	97.9	97.9	97.1	97.1	97.1	96.0	94.9	94.9	94.9	8817
OVER 54.0:	99.8	99.8	99.7	99.7	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	8875
OVER 60.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8889
OVER 66.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8890
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	22	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOD2 3 HRLP SPANNING 1/28/83 TO 2/ 2/84 (8890 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8890
OVER 6.0:	64.1	56.5	46.9	36.4	28.8	26.0	23.7	22.8	19.8	18.6	17.3	15.2	14.4	12.7	10.0	9.0	7.9	6.8	6.8	5.6	5697
OVER 12.0:	43.9	35.8	27.7	18.3	11.4	9.6	8.8	7.5	6.0	4.9	4.9	3.5	3.5	3.5	2.6	2.6	2.6	2.6	1.4	1.4	3905
OVER 18.0:	28.8	21.6	14.2	8.0	5.1	4.8	4.4	4.4	3.4	3.4	2.2	2.2	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2556
OVER 24.0:	17.1	11.6	6.5	3.1	2.2	2.2	2.2	2.2	2.2	1.0	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	1518
OVER 30.0:	8.5	4.9	2.2	1.4	1.4	1.4	1.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	753
OVER 36.0:	3.9	2.0	.9	.8	.5	.5	.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	351
OVER 42.0:	1.7	.8	.6	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	149
OVER 48.0:	.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	40
OVER 54.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	11
OVER 60.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOD2 3 HRLP SPANNING 1/28/83 TO 2/ 2/84 (8890 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 6.0:	35.9	24.5	14.2	6.7	4.0	3.1	2.0	1.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3193
OVER 12.0:	56.1	49.1	39.1	29.1	22.4	20.8	16.3	15.4	13.4	12.8	12.1	10.7	9.9	9.9	9.0	9.0	9.0	9.0	6.6	6.6	4985
OVER 18.0:	71.2	67.1	60.2	48.3	40.1	38.2	37.4	35.6	31.6	29.3	27.3	27.3	24.2	24.2	24.2	23.3	22.2	22.2	19.9	19.9	6334
OVER 24.0:	82.9	80.7	76.4	67.2	58.7	57.0	55.8	55.4	50.2	48.4	47.2	45.0	44.2	43.4	40.6	39.6	39.6	39.6	38.4	38.4	7372
OVER 30.0:	91.5	90.7	89.3	84.1	78.0	75.8	75.8	74.5	72.9	72.4	71.1	68.9	68.2	66.5	64.7	62.8	60.7	58.5	57.3	54.8	8137
OVER 36.0:	96.1	95.8	95.3	93.7	89.2	87.8	87.4	85.5	85.0	83.8	83.2	83.2	83.2	82.3	80.5	80.5	77.4	76.3	76.3	73.8	8539
OVER 42.0:	98.3	98.2	98.2	97.7	95.3	95.3	95.3	95.3	95.3	95.3	95.3	94.6	93.8	93.8	92.8	92.8	92.8	92.8	92.8	91.6	8741
OVER 48.0:	99.6	99.6	99.3	99.1	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	97.7	97.7	8850
OVER 54.0:	99.9	99.9	99.9	99.9	99.6	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	8879
OVER 60.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8889
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MDA1 3 HRLP SPANNING 2/ 4/84 TO 8/27/85 (13696 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13696
OVER 7.0:	62.6	56.5	49.0	39.1	26.4	23.5	21.5	21.0	18.6	18.3	17.0	15.6	14.0	12.9	11.2	11.2	10.5	9.7	8.2	8.2	8570
OVER 14.0:	45.4	39.8	32.4	23.3	15.6	14.3	12.2	11.4	10.1	9.7	8.5	8.0	8.0	6.4	5.8	5.8	5.8	5.8	5.0	5.0	6219
OVER 21.0:	31.2	25.3	18.1	11.4	8.3	7.3	7.1	5.6	4.6	4.3	3.4	2.5	2.5	1.4	1.4	.8	.8	.8	.0	.0	4273
OVER 28.0:	17.8	13.6	8.3	5.8	2.6	2.0	1.2	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2442
OVER 35.0:	9.5	7.0	3.9	1.9	.5	.5	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1298
OVER 42.0:	4.2	2.6	1.2	.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	569
OVER 49.0:	2.0	1.2	.6	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	273
OVER 56.0:	.8	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	108
OVER 63.0:	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	50
OVER 70.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	11
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MDA1 3 HRLP SPANNING 2/ 4/84 TO 8/27/85 (13696 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	37.4	29.4	18.7	12.2	8.9	7.7	6.0	5.4	4.8	4.1	3.7	3.7	3.2	2.6	2.6	2.6	2.6	2.6	1.8	1.0	5126
OVER 14.0:	54.6	48.4	40.9	31.0	24.6	23.6	21.8	20.6	19.3	16.7	55.0	14.5	13.5	12.4	10.6	10.6	10.6	9.9	9.1	9.1	7477
OVER 21.0:	68.8	64.0	57.4	47.7	41.9	40.7	40.0	38.3	36.6	35.5	35.5	35.0	33.5	31.8	29.5	28.2	27.5	25.3	25.3	22.9	9423
OVER 28.0:	82.2	79.8	75.7	68.7	62.9	61.7	60.5	58.5	55.2	53.7	53.2	52.3	50.8	49.1	47.9	44.8	43.4	42.0	41.2	40.4	11254
OVER 35.0:	90.5	89.4	87.5	83.3	79.1	77.8	77.5	76.3	75.7	74.5	73.3	72.8	72.3	71.8	71.8	71.8	69.7	69.0	67.4	65.8	12398
OVER 42.0:	95.8	95.5	94.9	93.0	89.8	89.2	88.9	88.6	87.6	86.5	86.1	86.1	86.1	85.6	85.6	84.9	84.2	84.2	84.2	84.2	13127
OVER 49.0:	98.0	97.8	97.6	96.9	95.8	95.6	95.6	95.3	95.0	94.2	93.4	93.4	93.4	92.9	92.9	92.9	92.9	92.9	92.9	92.9	13423
OVER 56.0:	99.2	99.1	99.1	98.6	98.6	98.6	98.6	98.6	98.6	98.6	98.2	98.2	98.2	98.2	98.2	98.2	98.2	97.5	97.5	97.5	13588
OVER 63.0:	99.6	99.5	99.5	99.4	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	98.5	98.5	98.5	13646
OVER 70.0:	99.9	99.9	99.9	99.9	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	13685
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MDA2   3 HRLP   SPANNING 7/31/85 TO 1/30/86 (4403 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4403
OVER 7.0:	78.8	67.5	54.6	43.4	34.5	30.2	27.2	23.6	18.6	16.3	16.3	14.9	13.3	11.7	9.8	9.8	9.8	9.8	9.8	9.8	3470
OVER 14.0:	48.6	36.3	26.4	18.6	9.9	8.2	7.4	5.6	5.6	3.2	3.2	3.2	.0	.0	.0	.0	.0	.0	.0	.0	2141
OVER 21.0:	28.2	20.3	11.8	4.9	3.0	1.8	1.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1240
OVER 28.0:	12.6	7.4	2.9	.7	.7	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	553
OVER 35.0:	5.3	3.1	1.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	234
OVER 42.0:	1.8	.9	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	78
OVER 49.0:	.8	.8	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	36
OVER 56.0:	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	19
OVER 63.0:	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	9
OVER 70.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
OVER 77.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MDA2   3 HRLP   SPANNING 7/31/85 TO 1/30/86 (4403 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	21.2	6.8	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	937
OVER 14.0:	51.4	37.6	23.2	13.5	7.9	5.2	2.9	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2262
OVER 21.0:	71.8	65.8	57.1	47.0	36.4	33.3	33.3	30.6	26.6	26.6	25.3	25.3	25.3	25.3	25.3	23.3	21.1	18.9	16.5	16.5	3163
OVER 28.0:	87.4	84.7	81.6	73.9	66.8	65.0	64.3	63.4	61.4	57.9	57.9	54.9	53.3	53.3	53.3	53.3	51.2	51.2	48.8	46.2	3850
OVER 35.0:	94.7	93.6	93.0	90.0	84.9	82.6	82.6	81.7	80.6	78.4	78.4	76.9	73.8	73.8	73.8	73.8	73.8	73.8	73.8	71.3	4169
OVER 42.0:	98.2	97.9	97.9	96.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	93.8	91.9	91.9	89.8	89.8	89.8	89.8	4325
OVER 49.0:	99.2	99.2	99.2	99.2	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	96.7	96.7	96.7	96.7	96.7	4367
OVER 56.0:	99.6	99.4	99.4	99.4	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	4384
OVER 63.0:	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	4394
OVER 70.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	4399
OVER 77.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4402
RECURRENCE (GREATER THAN	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MDA2 3 HRLP SPANNING 1/28/83 TO 7/ 8/85 (21425 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	21425
OVER 7.0:	65.9	59.6	50.2	38.7	25.1	22.9	21.1	19.8	17.3	15.8	15.0	14.5	13.5	11.0	9.5	8.7	7.9	7.9	7.4	6.9	14124
OVER 14.0:	43.2	35.6	26.3	17.2	9.3	8.5	8.2	7.7	6.2	5.5	4.7	4.1	4.1	3.4	3.0	3.0	2.6	2.6	2.6	2.6	9262
OVER 21.0:	26.7	20.7	13.5	7.3	4.3	4.2	3.6	2.5	2.5	2.2	2.2	1.6	1.0	1.0	1.0	1.0	1.0	.5	.5	.5	5712
OVER 28.0:	12.9	8.5	4.6	1.8	1.1	1.1	1.1	1.1	.9	.9	.9	.9	.9	.9	.9	.5	.5	.0	.0	.0	2766
OVER 35.0:	5.2	3.3	1.3	.8	.3	.3	.3	.3	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1112
OVER 42.0:	1.9	1.1	.3	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	417
OVER 49.0:	.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	121
OVER 56.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	29
OVER 63.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12
OVER 70.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MDA2 3 HRLP SPANNING 1/28/83 TO 7/ 8/85 (21425 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	34.1	24.0	14.3	8.5	4.5	3.7	2.7	2.2	1.5	1.3	1.3	1.3	.9	.9	.5	.5	.5	.5	.5	.5	7301
OVER 14.0:	56.8	49.8	39.7	28.9	22.8	20.5	18.8	16.4	14.9	13.0	11.1	8.7	7.8	7.8	7.0	6.2	5.7	5.3	4.3	4.3	12163
OVER 21.0:	73.3	69.6	62.2	50.9	42.8	41.0	39.5	37.4	33.6	30.8	29.7	29.4	28.4	27.0	26.3	23.8	22.9	22.5	22.0	20.4	15713
OVER 28.0:	87.1	85.6	82.3	75.7	68.4	67.2	66.4	64.0	62.7	61.8	59.9	56.9	54.9	53.9	52.3	51.5	50.7	49.7	47.7	47.7	18659
OVER 35.0:	94.8	94.5	93.7	90.8	86.5	85.6	85.3	83.7	82.5	81.5	81.3	81.0	80.0	79.6	78.1	77.7	76.8	76.8	76.3	74.2	20313
OVER 42.0:	98.1	97.9	97.9	96.5	94.2	94.0	93.7	93.7	93.5	93.5	93.2	92.9	92.2	92.2	91.5	91.5	91.5	91.0	90.5	90.0	21008
OVER 49.0:	99.4	99.4	99.3	98.7	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	97.9	97.9	97.9	97.4	96.9	21304
OVER 56.0:	99.9	99.9	99.9	99.7	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	21396
OVER 63.0:	99.9	99.9	99.9	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	21413
OVER 70.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	21422
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MDA2   3 HRLP   SPANNING 2/ 4/84 TO 7/ 8/85 (12497 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	12497
OVER 7.0:	70.4	64.6	55.2	42.9	26.3	23.8	21.6	20.3	18.2	17.3	16.4	15.9	15.4	13.0	11.7	10.3	9.5	9.5	8.7	7.8	8799
OVER 14.0:	46.9	39.4	29.2	19.9	10.7	10.3	10.1	9.7	7.9	6.7	5.3	4.8	4.8	4.2	4.2	4.2	3.4	3.4	3.4	3.4	5861
OVER 21.0:	29.3	23.5	15.8	8.2	5.0	5.0	3.9	2.4	2.4	2.4	2.4	1.4	.8	.8	.8	.8	.8	.0	.0	.0	3666
OVER 28.0:	14.1	9.7	5.1	2.0	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.0	.0	.0	1767
OVER 35.0:	5.7	4.1	1.5	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	711
OVER 42.0:	2.1	1.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	268
OVER 49.0:	.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	86
OVER 56.0:	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	26
OVER 63.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12
OVER 70.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MDA2   3 HRLP   SPANNING 2/ 4/84 TO 7/ 8/85 (12497 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	29.6	19.3	10.6	5.8	2.8	1.7	1.2	.6	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	3698
OVER 14.0:	53.1	45.4	34.5	22.6	17.3	15.0	13.9	13.0	11.5	9.4	7.2	5.1	4.0	4.0	3.4	2.7	1.9	1.1	1.1	1.1	6636
OVER 21.0:	70.7	66.4	58.8	46.5	39.6	37.6	35.7	33.5	30.3	28.3	26.9	26.4	25.8	24.0	23.3	19.8	18.3	17.6	17.6	16.7	8831
OVER 28.0:	85.9	84.2	80.0	72.8	66.1	65.5	64.4	61.3	60.5	60.1	58.3	55.7	53.5	52.3	52.3	51.5	51.5	50.0	47.4	47.4	10730
OVER 35.0:	94.3	93.9	92.8	89.4	85.2	85.0	84.5	83.5	82.0	81.2	80.8	80.3	79.1	79.1	77.8	77.8	77.8	77.8	77.0	76.1	11786
OVER 42.0:	97.9	97.8	97.5	95.7	93.5	93.0	92.5	92.5	92.2	92.2	91.2	91.2	90.7	90.7	90.0	90.0	90.0	89.2	88.4	88.4	12229
OVER 49.0:	99.3	99.3	99.3	98.3	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.0	97.0	97.0	97.0	96.1	12411
OVER 56.0:	99.8	99.8	99.8	99.5	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	12471
OVER 63.0:	99.9	99.9	99.9	99.9	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	12485
OVER 70.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	12494
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MDA3 3 HRLP SPANNINE 2/ 4/84 TO 1/17/85 (8370 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8370
OVER 4.0:	92.5	89.5	84.3	77.2	64.8	60.6	57.7	54.4	49.5	46.6	44.5	43.8	42.1	39.4	37.4	35.3	35.3	31.7	30.4	30.4	7741
OVER 8.0:	67.3	56.3	41.5	33.5	21.0	17.5	16.7	15.8	14.1	12.9	12.3	12.3	9.8	9.8	9.8	9.8	9.8	8.6	8.6	7.3	5634
OVER 12.0:	37.2	24.2	14.8	8.7	5.9	4.6	3.4	3.4	2.3	2.3	2.3	2.3	2.3	2.3	1.3	1.3	1.3	1.3	1.3	.0	3111
OVER 16.0:	16.8	9.7	5.7	3.0	2.3	2.0	2.0	2.0	2.0	2.0	1.3	1.3	11.3	1.3	1.3	1.3	1.3	1.3	1.3	.0	1403
OVER 20.0:	7.8	4.5	2.3	1.8	1.8	1.8	1.8	1.8	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	.0	.0	654
OVER 24.0:	3.4	1.9	.9	.6	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	287
OVER 28.0:	1.6	.5	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	137
OVER 32.0:	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	53
OVER 36.0:	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	14
OVER 40.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5
OVER 44.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
OVER 48.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MDA3 3 HRLP SPANNING 2/ 4/84 TO 1/17/85 (8370 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	7.5	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	629
OVER 8.0:	32.7	18.4	8.5	4.8	2.3	2.0	1.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2736
OVER 12.0:	62.8	52.4	40.9	31.6	22.2	19.6	16.4	15.9	12.6	11.9	11.9	10.4	8.8	6.9	6.0	5.0	5.0	5.0	5.0	5.0	5259
OVER 16.0:	83.2	79.7	73.0	66.7	59.1	56.2	52.8	48.1	43.7	43.1	41.7	41.0	37.5	36.7	33.7	33.7	32.6	29.1	29.1	26.5	6967
OVER 20.0:	92.2	90.8	88.1	83.9	78.4	78.4	78.0	77.5	75.8	75.2	73.8	73.1	73.1	72.2	71.2	69.1	68.0	68.0	68.0	68.0	7716
OVER 24.0:	96.6	96.1	95.2	93.7	91.1	89.8	89.4	88.5	87.3	87.3	86.0	85.2	83.6	82.7	82.7	82.7	81.5	81.5	81.5	81.5	8083
OVER 28.0:	98.4	98.1	97.7	97.3	95.8	95.1	94.8	94.8	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	94.2	8233
OVER 32.0:	99.4	99.3	99.3	99.3	97.8	97.5	97.5	97.5	97.5	97.5	96.1	96.1	96.1	95.2	95.2	95.2	95.2	95.2	95.2	95.2	8317
OVER 36.0:	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.2	98.6	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	8356
OVER 40.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	8365
OVER 44.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8368
OVER 48.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8369
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MDA3 3 HRLP SPANNING 1/24/85 TO 7/30/85 (4494 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4494
OVER 3.0:	96.8	95.4	93.1	87.9	82.1	77.7	77.0	72.5	70.5	68.3	68.3	68.3	63.8	60.4	58.6	54.7	52.6	48.1	48.1	45.7	4348
OVER 6.0:	80.8	71.9	61.6	54.0	42.3	38.8	36.5	34.7	33.7	29.1	29.1	26.3	23.2	19.9	16.4	12.5	12.5	12.5	10.1	10.1	3630
OVER 9.0:	58.7	50.1	40.9	32.8	20.9	18.6	16.4	12.0	10.9	7.5	6.2	6.2	4.6	4.6	2.9	2.9	2.9	2.9	2.9	2.9	2639
OVER 12.0:	41.3	31.4	22.0	12.0	5.8	5.2	5.2	1.7	1.7	1.7	1.7	1.7	1.7	.0	.0	.0	.0	.0	.0	.0	1857
OVER 15.0:	26.8	17.1	9.9	4.3	1.2	1.2	1.2	1.2	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1203
OVER 18.0:	15.0	6.5	4.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	673
OVER 21.0:	7.9	3.3	.9	.0	.0	.0	00	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	354
OVER 24.0:	3.6	1.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	163
OVER 27.0:	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	64
OVER 30.0:	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	23
OVER 33.0:	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	7
OVER 36.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MDA3 3 HRLP SPANNING 1/24/85 TO 7/30/85 (4494 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 3.0:	3.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	146
OVER 6.0:	19.2	8.5	3.5	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	864
OVER 9.0:	41.3	31.2	22.4	15.2	12.3	11.7	9.5	6.9	5.0	3.8	3.8	3.8	3.8	2.2	2.2	2.2	2.2	.0	.0	.0	1855
OVER 12.0:	58.7	48.8	39.7	34.3	28.0	27.4	26.7	24.9	23.9	23.9	22.5	22.5	22.5	20.9	20.9	18.9	16.8	16.8	14.4	14.4	2637
OVER 15.0:	73.2	65.5	56.8	47.2	43.8	43.2	40.2	39.3	36.3	35.1	33.8	30.9	30.9	30.9	29.1	27.1	27.1	27.1	27.1	27.1	3291
OVER 18.0:	85.0	80.1	73.4	66.0	57.8	57.2	56.4	54.7	52.6	50.3	49.0	47.6	46.0	46.0	46.0	46.0	43.9	43.9	43.9	43.9	3821
OVER 21.0:	92.1	90.5	86.9	78.8	71.4	69.6	66.6	64.0	64.0	64.0	61.5	61.5	59.9	58.2	58.2	58.2	58.2	58.2	55.9	55.9	4140
OVER 24.0:	96.4	95.7	94.0	90.2	85.8	84.7	84.7	84.7	83.7	83.7	83.7	82.3	80.8	80.8	78.9	78.9	76.9	74.7	74.7	72.3	4331
OVER 27.0:	98.6	98.4	98.3	98.0	94.7	94.7	94.7	93.0	92.0	92.0	92.0	90.6	90.6	90.6	90.6	88.7	88.7	88.7	88.7	88.7	4430
OVER 30.0:	99.5	99.4	99.2	99.2	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	95.7	95.7	95.7	95.7	95.7	95.7	95.7	4471
OVER 33.0:	99.8	99.8	99.8	99.8	99.4	99.4	99.4	99.4	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	4487
OVER 36.0:	99.9	99.9	99.9	99.9	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	4490
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

DURATION AND RECURRANCE FOR MOORING C

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MOC1   3 HRLP   SPANNING 1/28/83 TO 1/31/86 (26395 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	26395
OVER 11.0:	61.0	56.9	49.9	38.3	29.5	27.5	26.5	25.4	23.2	22.5	22.0	20.8	20.3	19.7	19.1	19.1	19.1	18.7	18.7	17.9	16108
OVER 22.0:	36.7	31.9	25.5	18.0	15.1	14.4	13.8	13.0	12.2	12.2	11.7	11.5	11.0	10.4	10.4	10.4	9.7	9.7	9.7	9.7	9678
OVER 33.0:	17.1	15.0	11.3	9.2	8.6	8.5	8.3	7.7	7.5	7.5	7.3	7.3	6.6	6.6	6.3	5.6	5.6	5.6	5.6	5.6	4505
OVER 44.0:	8.9	7.9	6.7	5.9	5.4	5.3	5.3	5.1	4.8	4.8	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	2341
OVER 55.0:	5.2	4.7	4.3	4.2	4.0	3.9	3.9	3.7	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.1	3.1	1367
OVER 66.0:	3.8	3.6	3.4	3.3	3.3	3.3	3.3	3.1	3.1	2.9	2.9	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	991
OVER 77.0:	2.7	2.6	2.4	2.2	2.2	1.8	1.8	1.5	1.5	1.5	1.3	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	705
OVER 88.0:	1.6	1.5	1.3	1.0	1.0	1.0	1.0	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	422
OVER 99.0:	.6	.5	.4	.3	.3	.2	.2	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	162
OVER 110.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MOC1   3 HRLP   SPANNING 1/28/83 TO 1/31/86 (26395 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 11.0:	39.0	33.1	23.9	16.5	13.5	11.5	10.6	9.9	8.9	7.7	7.3	6.8	6.2	5.7	4.7	4.4	4.4	4.0	3.6	2.3	10287
OVER 22.0:	63.3	59.9	53.0	44.5	39.0	37.6	35.9	34.9	33.0	31.6	30.1	27.7	26.3	25.5	24.9	23.5	22.8	22.1	21.6	21.6	16717
OVER 33.0:	82.9	81.9	79.8	75.3	72.1	71.0	70.5	70.0	68.5	67.9	67.7	66.0	64.4	63.5	62.9	61.3	59.9	59.5	58.7	58.7	21890
OVER 44.0:	91.1	90.7	90.0	88.3	86.9	86.9	86.8	86.4	86.2	85.6	85.4	85.2	84.1	83.8	82.9	82.6	82.6	82.2	81.8	81.8	24054
OVER 55.0:	94.8	94.7	94.2	93.7	93.5	93.4	93.3	92.8	92.3	92.1	92.1	92.1	92.1	92.1	92.1	92.1	91.8	91.8	91.8	91.8	25028
OVER 66.0:	96.2	96.1	96.1	96.0	96.0	95.9	95.9	95.8	95.4	95.0	94.8	94.8	94.8	94.6	94.6	94.6	94.6	94.6	94.6	94.6	25404
OVER 77.0:	97.3	97.1	97.0	97.0	97.0	97.0	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	25690
OVER 88.0:	98.4	98.3	98.2	98.0	97.9	97.7	97.6	97.6	97.6	97.4	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	25973
OVER 99.0:	99.4	99.4	99.3	99.1	99.0	99.0	99.0	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.8	98.5	98.5	98.5	98.5	98.5	26233
OVER 110.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	26378
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)

1.00 HOURLY DATA STATION: MOC2 3 HRLP SPANNING 1/28/83 TO 1/31/86 (26396 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	26396
OVER 9.0:	66.5	61.4	54.7	41.3	28.6	25.8	24.6	23.4	22.0	20.3	19.2	18.5	16.4	16.1	15.5	15.2	15.2	14.1	13.2	13.2	17558
OVER 18.0:	34.9	29.6	23.1	14.5	11.7	11.5	11.0	10.4	9.7	8.7	8.5	8.5	8.0	7.1	6.8	6.8	6.8	6.5	6.5	6.5	9222
OVER 27.0:	15.8	12.7	9.3	6.6	5.9	5.7	5.6	5.4	5.1	5.1	4.8	4.6	4.6	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4161
OVER 36.0:	7.1	6.0	4.6	4.0	3.8	3.5	3.3	3.3	3.2	3.0	3.0	3.0	3.0	3.0	3.0	2.6	2.6	2.3	2.3	2.3	1885
OVER 45.0:	3.9	3.4	2.9	2.6	2.5	2.4	2.2	2.1	2.1	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1020
OVER 54.0:	2.4	2.1	2.0	1.8	1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	627
OVER 63.0:	1.3	1.1	1.0	.9	.9	.8	.8	.8	.8	.8	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	343
OVER 72.0:	.6	.5	.5	.4	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	168
OVER 81.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	37
OVER 90.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)

1.00 HOUR AVERAGES STATION: MOC2 3 HRLP SPANNING 1/28/83 TO 1/31/86 (26396 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 9.0:	33.5	25.7	15.3	9.1	6.5	5.2	4.4	3.6	3.3	2.5	2.1	2.1	2.1	2.1	2.1	1.7	1.4	1.4	1.4	1.0	8838
OVER 18.0:	65.1	61.4	53.8	45.3	39.5	37.6	35.4	34.3	32.3	30.7	29.0	27.5	27.0	25.6	25.3	23.9	22.1	22.1	21.0	20.1	17174
OVER 27.0:	84.2	83.0	80.1	74.7	70.2	69.5	69.1	68.7	66.2	65.1	64.0	61.8	61.1	60.5	59.9	58.2	56.8	56.0	55.6	54.8	22235
OVER 36.0:	92.9	92.5	91.6	89.9	88.1	87.8	87.7	87.1	86.6	86.4	86.2	85.9	85.2	85.2	84.8	84.5	83.5	83.1	83.1	82.7	24511
OVER 45.0:	96.1	96.0	95.7	94.9	94.4	94.3	94.1	94.0	93.7	93.5	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	93.2	92.8	25376
OVER 54.0:	97.6	97.5	97.3	96.9	96.7	96.7	96.7	96.6	96.6	96.6	96.6	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	25769
OVER 63.0:	98.7	98.6	98.4	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	26053
OVER 72.0:	99.4	99.3	99.3	99.2	98.9	98.9	98.9	98.9	98.9	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	26228
OVER 81.0:	99.9	99.8	99.8	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.3	99.3	99.3	26359
OVER 90.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	26393
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOC3 3 HRLP SPANNING 1/28/83 TO 2/ 2/84 (8896 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8896
OVER 3.0:	86.8	79.6	71.2	61.1	48.1	39.6	34.4	29.5	24.9	20.3	19.0	16.8	15.3	14.4	12.6	11.6	10.6	9.5	9.5	8.3	7723
OVER 6.0:	55.3	42.2	28.7	20.7	11.8	9.2	6.6	5.7	5.7	4.6	2.7	2.7	1.1	1.1	1.1	1.1	1.1	.0	.0	.0	4919
OVER 9.0:	26.5	16.0	8.8	3.6	1.8	1.2	1.2	1.2	.7	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2358
OVER 12.0:	10.2	4.3	2.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	911
OVER 15.0:	3.6	1.1	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	320
OVER 18.0:	1.2	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	..0	.0	.0	.0	.0	.0	105
OVER 21.0:	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	39
OVER 24.0:	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	15
OVER 27.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
OVER 30.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
OVER 33.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOC3 3 HRLP SPANNING 1/28/83 TO 2/ 2/84 (8896 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	..0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 3.0:	13.2	2.3	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1173
OVER 6.0:	44.7	29.4	16.5	10.6	5.6	4.0	2.5	1.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3977
OVER 9.0:	73.5	65.5	55.7	45.3	36.5	31.6	30.0	27.3	25.8	24.1	22.8	20.6	20.6	20.6	20.6	19.6	18.6	17.4	17.4	17.4	6538
OVER 12.0:	89.8	87.9	84.5	78.8	70.9	67.1	64.2	60.6	59.0	57.9	55.9	54.5	53.7	52.0	51.1	48.1	46.1	43.8	42.6	40.1	7985
OVER 15.0:	96.4	95.7	94.3	93.0	89.8	88.9	87.4	86.0	84.0	83.4	82.8	82.8	81.2	80.4	78.6	76.6	74.5	73.4	72.2	72.2	8576
OVER 18.0:	98.8	98.7	98.5	97.9	96.9	96.9	96.9	96.9	96.4	95.2	94.5	94.5	94.5	94.5	94.5	94.5	94.5	93.4	93.4	92.1	8791
OVER 21.0:	99.6	99.5	99.5	99.3	98.8	98.8	98.8	98.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	8857
OVER 24.0:	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	8881
OVER 27.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8892
OVER 30.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8895
OVER 33.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8895
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MOC3   3 HRLP   SPANNING 4/27/84 TO 7/30/85 (11029 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11029
OVER 3.0:	92.4	88.9	84.2	76.8	66.8	62.0	58.1	54.1	48.2	44.0	40.3	39.8	37.9	34.5	33.0	31.4	28.0	26.2	23.3	21.3	10190
OVER 6.0:	69.5	58.7	47.0	36.4	27.1	22.7	20.7	18.5	16.8	14.5	13.5	11.7	9.9	9.2	9.2	8.4	7.5	5.7	4.8	4.8	7667
OVER 9.0:	40.9	28.9	20.3	13.6	9.4	8.4	7.8	7.1	5.9	5.0	5.0	5.0	5.0	4.3	4.3	3.5	1.9	1.9	1.9	1.9	4515
OVER 12.0:	19.9	12.5	7.7	3.6	2.2	1.5	.6	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	2197
OVER 15.0:	8.6	4.5	2.1	.9	.6	.6	.6	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	950
OVER 18.0:	3.2	1.7	.8	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	355
OVER 21.0:	1.5	.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	167
OVER 24.0:	.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	77
OVER 27.0:	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	39
OVER 30.0:	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17
OVER 33.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MOC3   3 HRLP   SPANNING 4/27/84 TO 7/30/85 (11029 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 3.0:	7.6	.9	.3	.3	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	839
OVER 6.0:	30.5	16.3	6.3	1.6	.9	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3362
OVER 9.0:	59.1	49.9	37.8	27.2	19.3	16.3	13.6	7.8	6.6	5.2	3.7	3.1	2.5	1.8	1.8	1.8	1.8	.0	.0	.0	6514
OVER 12.0:	80.1	76.1	69.9	63.3	54.5	51.3	48.6	45.9	43.4	38.7	37.6	35.9	31.5	29.4	28.7	28.7	24.4	22.6	21.7	20.7	8832
OVER 15.0:	91.4	89.6	86.9	83.5	78.9	77.0	75.7	74.0	71.5	69.7	69.1	66.9	65.6	64.9	64.2	62.6	61.8	60.9	59.0	57.0	10079
OVER 18.0:	96.8	96.5	95.4	94.4	92.2	90.9	90.9	90.5	90.1	89.2	88.6	88.6	88.0	86.6	86.6	85.0	85.0	85.0	85.0	82.0	10674
OVER 21.0:	98.5	98.2	97.7	96.7	95.5	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.3	94.5	93.8	93.8	93.8	93.8	93.8	10862
OVER 24.0:	99.3	99.3	99.1	98.6	98.0	97.8	97.8	97.8	97.3	97.3	97.3	97.3	97.3	97.3	96.6	95.8	95.8	95.8	95.8	95.8	10952
OVER 27.0:	99.6	99.6	99.6	99.3	99.1	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.9	98.0	98.0	98.0	98.0	10990
OVER 30.0:	99.8	99.8	99.8	99.8	99.4	99.4	99.4	99.4	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	11012
OVER 33.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11025
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOC3 3 HRLP SPANNING 8/15/85 TO 1/31/86 (4076 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 1.0:	6.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	279
OVER 2.0:	14.4	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	588
OVER 3.0:	21.4	4.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	874
OVER 4.0:	27.1	9.4	2.6	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1105
OVER 5.0:	33.0	14.7	4.5	2.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1346
OVER 6.0:	38.8	19.8	7.0	3.1	.9	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1581
OVER 7.0:	49.1	30.0	15.7	8.0	5.4	3.5	3.5	1.5	1.5	1.5	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	2003
OVER 8.0:	63.4	44.6	27.4	18.3	11.6	9.5	7.1	7.1	4.9	4.9	4.9	1.8	.0	.0	.0	.0	.0	.0	.0	.0	2583
OVER 9.0:	78.5	66.7	52.2	37.3	28.4	23.2	19.2	18.3	16.0	14.8	12.0	10.4	10.4	10.4	6.4	6.4	6.4	6.4	6.4	6.4	3200
OVER 10.0:	90.8	84.9	79.1	69.6	60.6	56.0	52.7	48.0	44.6	39.5	32.2	32.2	30.5	28.6	24.6	20.3	15.7	15.7	13.1	10.4	3701
OVER 11.0:	96.8	96.0	93.5	90.3	85.5	84.9	81.5	80.5	80.5	75.4	68.4	66.9	66.9	61.3	59.3	52.9	48.3	45.9	45.9	43.1	3946
OVER 12.0:	98.6	98.5	97.5	97.5	97.0	96.4	95.5	94.5	93.3	93.3	93.3	93.3	91.6	91.6	85.6	83.4	81.1	78.7	76.2	73.4	4019
OVER 13.0:	99.3	99.2	98.7	98.7	98.7	98.7	97.8	97.8	97.8	97.8	97.8	97.8	96.1	96.1	94.1	91.9	91.9	91.9	91.9	91.9	4049
OVER 14.0:	99.7	99.6	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	97.1	97.1	97.1	97.1	97.1	4064
OVER 15.0:	99.9	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	97.5	97.5	97.5	97.5	97.5	4071
OVER 16.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	97.8	97.8	97.8	97.8	97.8	4075
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)

1.00 HOURLY DATA STATION: MOC3 3 HRLP SPANNING 8/15/85 TO 1/31/86 (4076 HOURS)

SPEED CM/S \ DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4076
OVER 1.0:	93.2	87.6	78.6	68.7	58.6	54.0	46.9	41.0	38.7	33.7	29.6	24.9	23.1	21.2	21.2	21.2	21.2	21.2	21.2	15.8	3797
OVER 2.0:	85.6	74.5	62.0	51.4	39.5	34.4	31.2	27.4	24.0	20.3	18.9	15.9	14.1	12.3	12.3	12.3	12.3	12.3	12.3	9.7	3488
OVER 3.0:	78.6	67.8	54.6	41.7	28.9	24.3	21.7	20.8	17.5	14.9	13.5	13.5	13.5	9.9	9.9	9.9	9.9	9.9	9.9	7.2	3202
OVER 4.0:	72.9	61.5	46.0	33.9	23.0	19.7	15.5	14.5	12.2	12.2	10.8	10.8	10.8	9.0	6.9	2.6	2.6	2.6	.0	.0	2971
OVER 5.0:	67.0	53.1	36.0	26.0	17.7	14.4	8.6	3.8	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	.0	.0	2730
OVER 6.0:	61.2	43.9	30.3	19.3	11.8	10.4	7.2	3.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	.0	.0	.0	.0	.0	2495
OVER 7.0:	50.9	30.1	16.5	7.9	6.4	3.7	2.1	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2073
OVER 8.0:	36.6	16.7	7.7	2.2	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1493
OVER 9.0:	21.5	6.7	3.1	1.1	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	876
OVER 10.0:	9.2	2.3	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	375
OVER 11.0:	3.2	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	130
OVER 12.0:	1.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	57
OVER 13.0:	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27
OVER 14.0:	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12
OVER 15.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	5
OVER 16.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1

DURATION AND RECURRANCE FOR MOORING A

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: NOA1 3 HRLP SPANNING 1/29/83 TO 2/ 3/84 (8895 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8895
OVER 7.0:	67.8	65.4	61.1	55.3	52.5	52.0	50.8	50.0	50.0	48.2	48.2	47.5	45.9	45.0	45.0	45.0	44.0	44.0	42.8	42.8	6032
OVER 14.0:	50.5	47.1	43.3	39.6	36.2	35.9	34.7	33.4	33.4	32.9	32.9	32.2	30.7	29.8	28.9	28.9	28.9	28.9	28.9	2.9	4496
OVER 21.0:	38.3	36.0	33.2	30.2	28.7	27.7	27.7	26.8	26.3	25.8	25.1	25.1	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	3408
OVER 28.0:	27.2	25.6	23.1	21.2	18.5	17.9	17.5	16.6	16.6	16.6	16.0	16.0	16.0	14.3	14.3	12.3	11.3	11.3	10.1	10.1	2419
OVER 35.0:	17.6	15.8	13.9	11.4	10.0	9.6	8.1	7.7	7.7	6.5	5.9	5.2	5.2	5.2	5.2	5.2	4.1	4.1	4.1	2.9	1565
OVER 42.0:	8.6	7.4	6.0	4.4	4.1	4.1	4.1	3.2	2.7	2.7	2.7	2.0	2.0	1.1	1.1	1.1	1.1	.0	.0	.0	768
OVER 49.0:	3.3	2.7	2.0	1.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.0	.0	.0	.0	.0	297
OVER 56.0:	1.5	1.3	1.0	.8	.8	.8	.8	.8	.8	.8	.8	.8	.8	.0	.0	.0	.0	.0	.0	.0	133
OVER 63.0:	.7	.6	.6	.6	.6	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	61
OVER 70.0:	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	22
OVER 77.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGE STATION: NOA1 3 HRLP SPANNING 1/29/83 TO 2/ 3/84 (8895 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	32.2	29.3	25.3	20.4	18.9	18.2	17.5	17.0	16.5	15.9	15.3	14.6	13.8	13.8	13.8	13.8	13.8	12.7	12.7	11.4	2863
OVER 14.0:	49.5	46.6	42.7	37.5	33.4	33.1	31.2	30.7	30.2	29.6	29.6	27.5	25.9	24.2	23.3	23.3	23.3	23.3	22.1	22.1	4399
OVER 21.0:	61.7	59.9	56.7	52.8	52.1	50.8	50.5	49.6	49.1	47.3	46.6	45.2	44.4	44.4	42.6	39.7	39.7	39.7	39.7	38.4	5487
OVER 28.0:	72.8	70.9	68.4	66.1	65.4	65.4	65.0	65.0	64.5	64.5	63.9	63.9	63.1	62.2	62.2	59.3	59.3	58.2	57.0	55.7	6476
OVER 35.0:	82.4	80.9	78.9	76.8	74.4	74.1	73.7	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	72.4	7330
OVER 42.0:	91.4	90.4	89.6	87.3	85.3	84.7	84.7	84.7	84.7	84.7	84.0	83.3	82.5	82.5	82.5	82.5	80.4	80.4	80.4	80.4	8127
OVER 49.0:	96.7	96.3	95.8	95.5	94.7	94.7	94.4	94.4	94.4	94.4	93.7	93.0	93.0	92.2	92.2	92.2	92.2	92.2	92.2	92.2	8598
OVER 56.0:	98.5	98.5	98.3	98.2	98.2	98.2	98.2	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	8762
OVER 63.0:	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	8834
OVER 70.0:	99.8	99.7	99.7	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	8873
OVER 77.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8892
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA1 3 MRLP SPANNING 7/19/84 TO 8/26/84 (928 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	928
OVER 5.0:	94.2	93.1	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	88.8	874
OVER 10.0:	88.1	86.0	86.0	86.0	81.6	81.6	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	77.8	818
OVER 15.0:	81.5	79.4	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	756
OVER 20.0:	65.8	62.1	60.9	59.3	50.5	50.5	50.5	50.5	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	45.9	611
OVER 25.0:	53.0	51.1	47.2	42.5	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	492
OVER 30.0:	41.8	39.7	38.1	36.3	36.3	36.3	33.0	24.6	24.6	18.9	18.9	18.9	18.9	18.9	10.1	10.1	.0	.0	.0	.0	388
OVER 35.0:	34.3	32.8	31.8	27.0	24.9	22.0	14.7	14.7	9.5	9.5	9.5	9.5	9.5	9.5	9.5	.0	.0	.0	.0	.0	318
OVER 40.0:	20.8	17.6	10.9	4.8	4.8	4.8	4.8	4.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	193
OVER 45.0:	6.6	4.2	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	61
OVER 50.0:	1.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12
OVER 55.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOA1 3 MRLP SPANNING 7/19/84 TO 8/26/84 (928 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 5.0:	5.8	4.2	2.9	2.9	2.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	54
OVER 10.0:	11.9	9.3	7.1	5.6	5.6	5.6	5.6	5.6	5.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	110
OVER 15.0:	18.5	15.2	12.4	8.9	8.9	5.9	5.9	5.9	5.9	5.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	172
OVER 20.0:	34.2	30.0	28.2	26.8	22.3	19.2	19.2	14.7	14.7	9.4	9.4	9.4	9.4	9.4	9.4	.0	.0	.0	.0	.0	317
OVER 25.0:	47.0	45.9	39.5	38.0	38.0	34.9	34.9	34.9	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2	436
OVER 30.0:	58.2	56.0	53.8	53.8	51.6	48.5	44.7	44.7	44.7	44.7	44.7	44.7	44.7	36.3	36.3	36.3	36.3	36.3	36.3	36.3	540
OVER 35.0:	65.7	63.9	60.5	58.6	56.1	52.9	52.9	52.9	52.9	47.6	47.6	47.6	47.6	47.6	47.6	47.6	47.6	37.1	37.1	37.1	610
OVER 40.0:	79.2	75.9	71.9	67.3	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	65.2	735
OVER 45.0:	93.4	91.8	88.3	84.8	80.4	80.4	80.4	80.4	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	70.9	867
OVER 50.0:	98.7	98.7	98.7	98.7	96.3	96.3	96.3	96.3	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	916
OVER 55.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	927
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: NOA1 3 HRLP SPANNING 10/19/84 TO 2/ 1/86 (11284 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11284
OVER 8.0:	82.8	79.6	73.7	64.4	57.6	56.2	54.1	53.7	51.3	49.0	49.0	47.9	47.3	46.0	45.2	45.2	44.4	44.4	43.5	43.5	9346
OVER 16.0:	61.3	58.3	52.0	42.2	37.2	36.2	35.6	34.9	33.3	32.9	32.9	32.3	32.3	32.3	32.3	31.5	31.5	31.5	31.5	29.6	6920
OVER 24.0:	41.0	37.4	33.1	28.7	26.7	26.5	25.6	24.2	23.8	23.8	23.8	23.8	22.0	21.3	20.6	20.6	19.8	19.8	19.8	19.8	4629
OVER 32.0:	24.2	21.8	19.5	17.1	16.2	15.9	15.9	15.6	15.2	14.8	14.8	14.8	13.6	13.6	12.1	10.6	9.8	9.8	9.8	9.8	2729
OVER 40.0:	14.1	12.7	10.7	9.8	8.9	8.7	8.7	7.7	7.7	7.2	7.2	6.1	6.1	5.4	4.7	4.7	3.9	3.9	3.9	3.9	1591
OVER 48.0:	7.4	6.9	6.2	6.2	5.4	5.1	5.1	4.4	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	836
OVER 56.0:	4.6	4.1	3.7	3.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	1.2	1.2	1.2	517
OVER 64.0:	2.2	1.9	1.7	1.4	1.4	1.4	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	250
OVER 72.0:	1.0	.7	.5	.4	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	109
OVER 80.0:	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	20
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: NOA1 3 HRLP SPANNING 10/19/84 TO 2/ 1/86 (11284 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 8.0:	17.2	10.0	3.2	1.4	.9	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1938
OVER 16.0:	38.7	34.6	27.0	20.8	17.8	17.6	17.0	16.3	15.5	15.5	15.0	14.4	13.7	13.7	13.0	13.0	13.0	13.0	13.0	13.0	4364
OVER 24.0:	59.0	56.9	52.6	44.9	40.2	37.8	36.3	33.1	31.5	29.7	29.7	28.0	26.8	26.1	26.1	24.6	22.9	22.9	22.9	21.9	6655
OVER 32.0:	75.8	74.3	72.0	69.8	67.8	67.1	66.2	65.8	65.0	63.6	63.1	61.4	60.8	60.1	60.1	58.6	57.7	56.9	56.9	56.9	8555
OVER 40.0:	85.9	84.7	83.8	82.4	81.5	81.2	81.0	80.6	80.6	79.7	79.2	78.1	77.5	76.9	76.1	76.1	76.1	75.2	75.2	75.2	9693
OVER 48.0:	92.6	92.1	91.7	91.6	91.6	91.6	91.6	91.6	91.2	91.2	91.2	90.6	90.6	90.6	89.9	89.9	89.9	89.9	88.1	87.1	10448
OVER 56.0:	95.4	95.0	94.6	94.3	93.9	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.0	93.0	93.0	93.0	93.0	93.0	10767
OVER 64.0:	97.8	97.7	97.6	97.3	96.9	96.9	96.9	96.9	96.9	96.9	96.9	96.9	96.9	96.9	96.2	96.2	96.2	96.2	96.2	96.2	11034
OVER 72.0:	99.0	98.8	98.7	98.6	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	11175
OVER 80.0:	99.8	99.7	99.7	99.7	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	11264
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA2 3 HRLF SPANNING 7/31/83 TO 2/ 3/84 (4503 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4503
OVER 6.0:	70.2	66.2	60.4	51.5	46.4	44.7	44.7	43.9	40.8	40.8	40.8	40.8	37.8	34.4	34.4	34.4	34.4	34.4	32.0	29.5	3161
OVER 12.0:	46.4	41.7	36.1	28.5	25.2	25.2	24.5	24.5	23.5	23.5	23.5	23.5	23.5	23.5	21.8	21.8	19.7	19.7	19.7	19.7	2089
OVER 18.0:	29.9	26.4	23.6	20.1	18.8	18.1	18.1	18.1	18.1	17.0	17.0	15.6	14.1	14.1	12.3	12.3	12.3	12.3	12.3	9.7	1348
OVER 24.0:	19.6	18.0	15.9	14.3	12.8	12.8	12.8	11.1	11.1	11.1	9.8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	6.1	6.1	883
OVER 30.0:	11.5	10.2	8.2	6.4	5.5	4.9	4.9	4.9	4.9	4.9	4.9	4.9	3.3	.0	.0	.0	.0	.0	.0	.0	517
OVER 36.0:	5.3	3.3	2.6	2.6	2.2	2.2	2.2	1.4	1.4	1.4	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	238
OVER 42.0:	1.5	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	67
OVER 48.0:	.8	.7	.7	.7	.7	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	37
OVER 54.0:	.6	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27
OVER 60.0:	.3	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	13
OVER 66.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOA2 3 HRLP SPANNING 7/31/83 TO 2/ 3/84 (4503 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 6.0:	29.8	23.9	17.2	13.9	12.5	11.9	11.9	11.0	11.0	11.0	11.0	11.0	11.0	9.4	9.4	9.4	9.4	9.4	9.4	9.4	1342
OVER 12.0:	53.6	49.1	41.6	35.8	32.2	30.9	30.9	29.2	26.1	26.1	23.5	23.5	23.5	23.5	23.5	21.6	21.6	21.6	21.6	19.1	2414
OVER 18.0:	70.1	68.0	63.7	59.2	55.1	53.8	53.8	51.9	50.9	49.8	49.8	46.9	43.9	43.9	40.3	40.3	38.2	38.2	38.2	38.2	3155
OVER 24.0:	80.4	79.3	77.5	75.8	74.8	74.3	74.3	72.5	69.4	68.3	68.3	68.3	66.7	65.0	63.2	61.2	61.2	61.2	58.9	58.9	3620
OVER 30.0:	88.5	87.3	86.5	85.1	83.4	83.4	82.7	82.7	82.7	82.7	81.4	81.4	81.4	81.4	81.4	81.4	81.4	81.4	81.4	81.4	3986
OVER 36.0:	94.7	93.8	92.3	90.8	90.4	90.4	90.4	90.4	89.4	89.4	89.4	89.4	89.4	89.4	87.6	87.6	85.5	85.5	85.5	85.5	4265
OVER 42.0:	98.5	98.5	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	4436
OVER 48.0:	99.2	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	4466
OVER 54.0:	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	4476
OVER 60.0:	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	4490
OVER 66.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4501
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MOA2   3 HRLP   SPANNING 7/19/84 TO 2/ 1/86 (13491 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13491
OVER 5.0:	63.0	56.6	50.3	41.3	35.5	33.2	32.0	31.4	30.0	28.1	27.3	27.3	26.8	25.1	24.5	24.5	23.8	23.1	20.8	19.1	8503
OVER 10.0:	43.6	37.9	31.9	26.1	21.8	20.8	19.8	19.5	19.2	17.6	17.2	15.4	14.3	13.2	13.2	12.5	12.5	11.1	11.1	10.2	5882
OVER 15.0:	30.9	27.3	23.0	17.3	14.8	13.8	12.7	12.7	11.1	10.7	9.0	8.5	8.0	7.5	6.9	6.9	6.2	5.5	5.5	5.5	4171
OVER 20.0:	20.8	17.8	13.8	10.3	8.0	7.6	6.8	5.4	4.3	4.3	3.9	3.9	3.9	3.9	3.3	3.3	3.3	2.6	2.6	2.6	2801
OVER 25.0:	12.1	9.3	6.3	4.2	3.7	3.1	2.4	2.4	2.4	2.4	2.4	2.4	2.4	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1631
OVER 30.0:	5.2	3.4	2.4	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	.7	.7	.7	.7	.7	.7	.0	.0	.0	708
OVER 35.0:	2.0	1.3	1.3	1.1	1.1	1.1	.7	.7	.7	.7	.7	.7	.7	.7	.7	.0	.0	.0	.0	.0	268
OVER 40.0:	1.0	.6	.6	.6	.5	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	129
OVER 45.0:	.4	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	54
OVER 50.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	16
OVER 55.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	6
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MOA2   3 HRLP   SPANNING 7/19/84 TO 2/ 1/86 (13491 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 5.0	37.0	28.7	20.9	14.6	12.3	11.1	10.3	10.0	9.0	9.0	9.0	8.5	8.0	8.0	7.4	6.7	6.7	6.7	6.7	6.7	4988
OVER 10.0:	56.4	51.8	45.2	36.6	31.9	30.5	28.9	28.1	26.4	26.1	24.3	23.9	22.8	21.7	21.7	21.7	21.7	21.7	21.7	21.7	7609
OVER 15.0:	69.1	65.9	61.5	55.4	50.8	48.9	48.6	46.9	46.6	46.6	45.3	44.4	44.4	43.8	40.2	39.6	39.6	38.8	38.8	38.8	9320
OVER 20.0:	79.2	77.0	73.6	68.9	66.0	65.0	64.1	63.5	62.5	61.3	60.9	60.0	59.5	58.9	58.9	58.9	57.6	56.8	56.1	56.1	10690
OVER 25.0:	87.9	86.3	83.8	80.4	76.6	75.4	74.8	74.0	72.7	71.5	70.7	70.7	70.1	69.6	69.6	68.9	68.9	68.9	67.4	67.4	11860
OVER 30.0:	94.8	94.0	93.1	91.4	89.4	89.1	87.9	87.0	87.0	87.0	87.0	87.0	86.5	86.5	85.9	85.9	84.5	84.5	84.5	83.7	12783
OVER 35.0:	98.0	97.8	97.8	97.5	96.5	96.5	96.5	96.2	96.2	96.2	96.2	96.2	95.6	95.6	95.0	95.0	95.0	95.0	95.0	95.0	13223
OVER 40.0:	99.0	98.8	98.7	98.7	98.7	98.7	98.7	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	13362
OVER 45.0:	99.6	99.6	99.6	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	13437
OVER 50.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	13475
OVER 55.0:	100.0	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	13485
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA3 3 HRLP SPANNING 7/31/83 TO 2/ 3/84 (4503 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4503
OVER 5.0:	70.8	64.4	56.8	51.0	46.1	44.8	44.1	44.1	42.2	40.0	40.0	38.5	37.0	35.3	33.5	31.6	31.6	31.6	31.6	31.6	3186
OVER 10.0:	42.7	38.3	33.8	28.1	24.5	23.3	20.3	17.5	17.5	16.4	15.0	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	1923
OVER 15.0:	23.9	19.1	13.8	9.9	8.2	7.5	7.5	7.5	7.5	7.5	6.3	6.3	6.3	6.3	6.3	6.3	4.2	4.2	4.2	4.2	1074
OVER 20.0:	13.1	10.5	7.8	5.9	5.4	5.4	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	2.9	2.9	2.9	2.9	2.9	2.9	592
OVER 25.0:	6.6	5.6	4.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	1.8	.0	.0	.0	.0	.0	.0	295
OVER 30.0:	3.7	3.2	3.2	2.9	2.9	2.9	2.9	2.9	2.9	2.9	1.6	1.6	1.6	.0	.0	.0	.0	.0	.0	.0	166
OVER 35.0:	2.1	1.9	1.9	1.9	1.9	1.4	1.4	1.4	1.4	1.4	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	96
OVER 40.0:	1.3	1.2	1.2	.9	.9	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	57
OVER 45.0:	.7	.6	.6	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	30
OVER 50.0:	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	19
OVER 55.0:	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12
OVER 60.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOA3 3 HRLP SPANNING 7/31/83 TO 2/ 3/84 (4503 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 5.0:	29.2	21.5	15.8	10.5	10.1	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	7.2	7.2	1317
OVER 10.0:	57.3	52.6	48.9	42.2	38.3	36.4	35.7	34.9	34.9	30.3	30.3	28.9	27.4	25.6	23.8	23.8	23.8	23.8	23.8	21.3	2580
OVER 15.0:	76.1	72.0	66.2	62.9	55.5	54.9	54.1	54.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	51.1	51.1	51.1	51.1	3429
OVER 20.0:	86.9	85.5	84.7	79.7	76.9	75.1	72.3	72.3	70.3	69.1	69.1	69.1	67.6	67.6	67.6	67.6	65.5	65.5	65.5	63.1	3911
OVER 25.0:	93.4	93.0	91.8	90.7	89.3	89.3	89.3	88.4	88.4	88.4	85.9	84.6	84.6	84.6	84.6	84.6	84.6	82.4	82.4	82.4	4208
OVER 30.0:	96.3	96.2	96.0	96.0	95.6	95.6	94.8	94.8	92.8	92.8	92.8	92.8	92.8	92.8	92.8	92.8	92.8	92.8	92.8	92.8	4337
OVER 35.0:	97.9	97.7	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	95.5	95.5	95.5	95.5	95.5	95.5	4407
OVER 40.0:	98.7	98.5	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	96.3	96.3	96.3	96.3	4446
OVER 45.0:	99.3	99.3	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	96.8	96.8	4473
OVER 50.0:	99.6	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	4484
OVER 55.0:	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	4491
OVER 60.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4502
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: NOA3 3 HRLP SPANNING 5/22/84 TO 7/17/84 (1360 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1360
OVER 2.0:	77.9	71.8	66.7	59.8	53.7	51.9	51.9	48.9	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	45.7	1060
OVER 4.0:	66.7	62.8	57.2	44.6	39.9	39.9	39.9	36.8	33.5	33.5	33.5	33.5	28.5	22.9	22.9	22.9	22.9	22.9	22.9	22.9	907
OVER 6.0:	58.7	55.7	45.8	33.0	29.6	29.6	29.6	29.6	26.1	22.5	22.5	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	799
OVER 8.0:	50.1	45.9	39.7	30.4	24.3	22.4	22.4	22.4	12.6	12.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	682
OVER 10.0:	43.1	39.3	31.0	25.7	19.9	18.0	18.0	18.0	8.1	4.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	586
OVER 12.0:	38.1	34.0	26.6	21.8	12.9	12.9	10.2	7.1	3.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	518
OVER 14.0:	32.5	27.9	20.7	13.7	9.2	9.2	9.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	442
OVER 16.0:	25.0	19.3	16.7	7.1	5.6	5.6	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	340
OVER 18.0:	17.9	13.9	10.4	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	244
OVER 20.0:	12.4	10.6	6.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	168
OVER 22.0:	8.4	6.3	1.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	114
OVER 24.0:	5.4	3.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	73
OVER 26.0:	2.6	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	00	.0	.0	.0	.0	.0	.0	36
OVER 28.0:	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: NOA3 3 HRLP SPANNING 5/22/84 TO 7/17/84 (1360 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 2.0:	22.1	11.3	5.7	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	300
OVER 4.0:	33.3	28.3	21.2	15.8	10.7	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	.0	.0	.0	.0	.0	453
OVER 6.0:	41.2	35.2	26.8	22.1	22.1	18.4	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	8.2	.0	561
OVER 8.0:	49.9	43.1	32.4	28.0	26.5	26.5	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	24.2	15.9	678
OVER 10.0:	56.9	52.1	43.2	34.2	29.6	27.6	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	17.0	774
OVER 12.0:	61.9	58.2	50.5	43.8	37.3	37.3	34.6	34.6	31.3	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	27.5	842
OVER 14.0:	67.5	63.2	57.4	47.9	41.9	41.9	41.9	39.1	35.6	31.8	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	918
OVER 16.0:	75.0	70.1	61.1	58.5	57.0	55.1	52.8	46.8	43.5	43.5	39.4	39.4	39.4	34.0	28.2	28.2	28.2	28.2	28.2	28.2	1020
OVER 18.0:	82.1	79.0	71.5	67.0	64.0	64.0	59.2	56.3	56.3	56.3	56.3	56.3	51.0	45.4	45.4	45.4	45.4	45.4	45.4	45.4	1116
OVER 20.0:	87.6	86.2	82.1	80.1	78.7	78.7	78.7	73.2	73.2	73.2	69.1	69.1	69.1	69.1	69.1	69.1	62.4	62.4	62.4	62.4	1192
OVER 22.0:	91.6	90.8	84.7	82.5	82.5	82.5	82.5	82.5	82.5	82.5	78.2	78.2	78.2	78.2	78.2	78.2	71.2	71.2	71.2	71.2	1246
OVER 24.0:	94.6	94.1	92.4	89.2	87.8	87.8	87.8	87.8	87.8	87.8	83.5	83.5	83.5	83.5	83.5	83.5	83.5	83.5	83.5	83.5	1287
OVER 26.0:	97.4	96.8	96.8	93.5	90.2	90.2	90.2	90.2	90.2	90.2	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	1324
OVER 28.0:	99.1	99.1	99.1	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	90.0	90.0	1348
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)

1.00 HOURLY DATA STATION: MOA3 3 WRLP SPANNING 10/19/84 TO 1/31/86 (11270 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11270
OVER 4.0:	46.9	41.3	35.5	24.3	19.5	17.0	17.0	17.0	14.1	14.1	12.6	12.0	11.3	10.7	9.2	9.2	9.2	9.2	9.2	8.2	5287
OVER 8.0:	27.1	22.5	17.8	11.4	8.8	7.6	6.4	6.0	3.6	3.2	2.2	2.2	.9	.9	.9	.9	.9	.9	.0	.0	3056
OVER 12.0:	17.0	13.7	9.9	6.5	4.9	3.7	2.8	2.8	2.0	1.5	1.5	1.5	.9	.9	.9	.9	.9	.0	.0	.0	1918
OVER 16.0:	10.9	9.0	6.1	2.7	2.1	1.6	1.6	1.3	.9	.9	.9	.9	.9	.9	.9	.9	.9	.0	.0	.0	1231
OVER 20.0:	6.8	4.9	3.2	1.5	1.0	.7	.7	.7	.7	.7	.7	.7	.7	.7	.0	.0	.0	.0	.0	.0	768
OVER 24.0:	3.8	2.7	1.5	.9	.7	.7	.7	.7	.7	.7	.7	.7	.7	.0	.0	.0	.0	.0	.0	.0	427
OVER 28.0:	1.8	1.2	.8	.4	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	208
OVER 32.0:	.9	.6	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	103
OVER 36.0:	.4	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	40
OVER 40.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
OVER 44.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)

1.00 HOUR AVERAGES STATION: MOA3 3 WRLP SPANNING 10/19/84 TO 1/31/86 (11270 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	53.1	46.5	39.0	33.7	29.0	28.5	26.5	25.1	25.1	25.1	24.1	24.1	22.8	22.2	22.2	20.6	19.8	18.0	16.1	15.1	5983
OVER 8.0:	72.9	69.4	63.8	57.4	52.4	51.5	50.0	48.2	46.6	46.1	45.6	43.9	43.3	42.0	42.0	41.2	41.2	40.3	37.4	37.4	8214
OVER 12.0:	83.0	80.8	77.0	72.5	68.2	67.0	66.1	65.0	63.8	63.8	63.8	62.6	62.0	60.7	59.9	59.1	59.1	59.1	56.3	55.4	9352
OVER 16.0:	89.1	87.8	86.1	81.7	78.3	77.6	77.6	77.3	77.3	75.9	75.4	74.2	74.2	73.6	73.6	72.8	72.8	72.8	70.0	70.0	10039
OVER 20.0:	93.2	92.6	91.0	88.2	84.9	84.0	83.7	83.3	82.5	82.0	82.0	81.5	81.5	80.8	80.1	80.1	80.1	80.1	80.1	79.1	10502
OVER 24.0:	96.2	95.9	95.3	94.2	91.6	91.2	90.6	89.9	89.1	88.2	87.7	87.7	87.7	87.7	86.9	86.9	86.9	86.9	85.1	85.1	10843
OVER 28.0:	98.2	98.0	97.6	96.8	96.6	96.6	96.3	96.0	96.0	96.0	96.0	95.4	94.2	94.2	94.2	93.4	93.4	93.4	93.4	93.4	11062
OVER 32.0:	99.1	98.9	98.8	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	97.6	97.6	97.6	97.6	97.6	11167
OVER 36.0:	99.6	99.6	99.6	99.5	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	11230
OVER 40.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11266
OVER 44.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11269
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA4 3 HRLP SPANNING 1/29/83 TO 2/ 3/84 (8895 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8895
OVER 4.0:	80.2	74.1	67.4	59.9	51.9	48.9	47.1	45.3	43.8	41.5	40.2	38.1	38.1	37.2	35.4	35.4	35.4	33.1	32.0	32.0	7131
OVER 8.0:	38.3	32.9	26.8	20.6	16.8	16.2	15.1	14.2	12.2	11.6	11.0	10.3	10.3	9.4	9.4	9.4	9.4	9.4	9.4	9.4	3405
OVER 12.0:	21.0	17.1	13.4	10.1	8.2	7.6	6.5	5.1	5.1	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	3.4	2.2	1869
OVER 16.0:	12.0	9.4	6.2	4.7	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.3	3.3	3.3	2.4	1.4	1.4	1.4	1.4	1.4	1069
OVER 20.0:	7.1	5.2	4.2	3.3	3.1	3.1	3.1	2.6	2.1	2.1	2.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	628
OVER 24.0:	3.9	2.7	2.4	2.1	1.9	1.9	1.9	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	349
OVER 28.0:	1.8	1.4	.9	.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	161
OVER 32.0:	.9	.6	.5	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	78
OVER 36.0:	.3	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27
OVER 40.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOA4 3 HRLP SPANNING 1/29/83 TO 2/ 3/84 (8895 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	19.8	11.2	7.3	4.9	3.6	3.2	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1764
OVER 8.0:	61.7	56.7	50.8	45.0	40.9	39.0	38.2	37.4	37.4	36.8	35.5	34.8	34.1	34.1	32.3	32.3	31.2	30.1	28.9	27.7	5490
OVER 12.0:	79.0	76.1	71.6	66.7	63.7	63.1	62.0	61.6	60.6	60.0	60.0	59.3	58.5	58.5	58.5	57.6	56.5	56.5	55.3	54.1	7026
OVER 16.0:	88.0	86.3	84.4	81.2	76.3	75.2	75.2	74.3	73.8	73.2	72.5	71.8	71.8	71.8	71.8	70.9	70.9	69.7	69.7	69.7	7826
OVER 20.0:	92.9	92.4	91.2	88.9	85.8	85.4	84.7	84.7	83.1	83.1	81.8	81.8	81.8	81.0	81.0	81.0	81.0	81.0	81.0	79.7	8267
OVER 24.0:	96.1	95.3	95.1	94.3	92.1	92.1	92.1	91.6	91.6	91.6	90.9	90.9	90.9	90.1	90.1	90.1	90.1	90.1	90.1	90.1	8546
OVER 28.0:	98.2	97.9	97.5	97.0	96.5	96.5	96.5	96.5	96.5	96.5	95.9	95.9	95.9	95.1	95.1	95.1	95.1	95.1	95.1	95.1	8734
OVER 32.0:	99.1	99.1	99.0	98.6	98.4	98.4	98.4	98.4	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	97.9	8817
OVER 36.0:	99.7	99.6	99.6	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	8868
OVER 40.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	8891
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: NOA4 3 HRLP SPANNING 4/27/84 TO 8/16/84 (2671 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	2671
OVER 2.0:	74.1	61.8	54.6	49.0	46.6	44.4	44.4	43.0	43.0	41.1	41.1	38.7	38.7	38.7	38.7	38.7	31.7	28.1	28.1	28.1	1979
OVER 4.0:	54.1	46.0	40.2	34.4	28.8	27.8	27.8	23.2	20.0	18.0	18.0	13.3	10.6	10.6	10.6	7.3	3.8	.0	.0	.0	1445
OVER 6.0:	37.8	29.2	22.8	12.5	8.6	8.6	6.6	2.7	2.7	2.7	2.7	2.7	.0	.0	.0	.0	.0	.0	.0	.0	1009
OVER 8.0:	22.8	15.9	9.8	4.5	3.0	3.0	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	608
OVER 10.0:	12.5	9.3	3.9	3.3	2.5	1.5	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	334
OVER 12.0:	8.4	6.2	3.1	2.5	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	224
OVER 14.0:	5.8	3.3	1.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	154
OVER 16.0:	3.8	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	101
OVER 18.0:	1.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	47
OVER 20.0:	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	13
OVER 22.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: NOA4 3 HRLP SPANNING 4/27/84 TO 8/16/84 (2671 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 2.0:	25.9	11.8	4.4	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	692
OVER 4.0:	45.9	37.3	29.5	25.5	20.8	13.9	12.5	11.1	9.5	9.5	9.5	9.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	1226
OVER 6.0:	62.2	52.6	47.0	36.8	35.3	33.4	32.0	32.0	32.0	30.0	30.0	27.6	25.0	22.3	19.2	19.2	19.2	19.2	19.2	19.2	1662
OVER 8.0:	77.2	71.5	65.3	56.1	49.0	48.0	46.6	45.1	43.4	41.4	41.4	39.0	39.0	33.2	30.1	26.8	26.8	26.8	26.8	26.8	2063
OVER 10.0:	87.5	84.9	82.3	76.0	69.2	67.1	67.1	67.1	65.3	61.5	61.5	61.5	61.5	61.5	58.4	58.4	58.4	51.1	51.1	51.1	2337
OVER 12.0:	91.6	90.3	89.7	84.7	77.6	75.7	75.7	75.7	75.7	75.7	73.6	73.6	73.6	70.8	70.8	70.8	70.8	70.8	70.8	70.8	2447
OVER 14.0:	94.2	93.3	92.4	87.4	85.1	83.2	83.2	83.2	81.5	81.5	81.5	81.5	78.8	78.8	78.8	78.8	78.8	78.8	78.8	78.8	2517
OVER 16.0:	96.2	95.5	94.9	93.2	89.4	89.4	89.4	89.4	89.4	85.8	85.8	85.8	85.8	83.0	83.0	83.0	83.0	83.0	83.0	83.0	2570
OVER 18.0:	98.2	97.8	96.6	96.0	92.9	92.9	92.9	92.9	91.1	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2	89.2	2624
OVER 20.0:	99.5	99.5	99.5	99.0	96.7	95.7	95.7	95.7	95.7	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	93.9	2658
OVER 22.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	2670
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA4 3 HRLP SPANNING 10/19/84 TO 1/31/86 (11271 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11271
OVER 2.0:	70.3	58.9	51.1	43.7	37.4	35.7	35.1	33.0	31.8	30.4	29.9	29.9	29.9	29.9	29.1	29.1	28.3	28.3	27.4	27.4	7927
OVER 4.0:	46.7	43.0	40.0	34.9	31.2	30.2	30.2	28.8	28.0	27.5	27.5	27.0	27.0	26.3	26.3	26.3	25.5	24.6	23.7	23.7	5269
OVER 6.0:	41.3	38.0	33.5	30.5	28.3	28.0	27.1	26.4	25.2	25.2	25.2	24.1	23.4	22.8	21.3	21.3	21.3	20.5	20.5	20.5	4658
OVER 8.0:	36.5	33.3	28.3	26.1	22.9	21.3	20.0	19.0	17.8	16.9	15.4	15.4	14.1	12.1	12.1	12.1	11.3	10.4	8.6	6.6	4119
OVER 10.0:	30.0	25.0	19.2	14.2	10.8	8.9	8.0	7.3	6.5	5.1	4.1	4.1	4.1	2.8	2.8	2.0	2.0	2.0	2.0	2.0	3382
OVER 12.0:	18.1	10.3	5.4	3.0	2.4	2.0	1.1	1.1	1.1	1.1	.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	2036
OVER 14.0:	3.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	382
OVER 16.0:	.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	99
OVER 18.0:	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	54
OVER 20.0:	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	20
OVER 22.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	7
OVER 24.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
OVER 26.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOA4 3 HRLP SPANNING 10/19/84 TO 1/31/86 (11271 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 2.0:	29.7	17.6	10.3	5.8	3.3	2.5	1.6	1.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3344
OVER 4.0:	53.3	48.7	45.2	42.7	38.1	37.4	37.4	36.7	36.7	36.3	35.3	35.3	34.6	31.9	31.2	29.7	29.7	27.9	27.9	26.9	6002
OVER 6.0:	58.7	54.6	51.6	48.5	46.2	46.2	45.9	45.9	45.1	45.1	45.1	44.5	44.5	43.9	43.9	43.9	43.0	43.0	41.2	41.2	6613
OVER 8.0:	63.5	59.2	56.3	52.3	50.8	50.8	49.6	49.6	49.6	49.2	49.2	49.2	47.9	47.9	47.2	47.2	46.4	46.4	46.4	46.4	7152
OVER 10.0:	70.0	64.8	61.4	56.9	53.9	52.8	52.5	52.5	52.5	52.5	52.0	51.4	51.4	51.4	51.4	51.4	51.4	50.5	49.6	49.6	7889
OVER 12.0:	81.9	76.3	71.5	64.9	59.3	57.6	56.8	56.4	55.6	55.6	55.1	55.1	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8	9235
OVER 14.0:	96.6	95.0	93.6	90.5	84.5	81.2	80.0	77.6	76.7	75.4	73.9	72.7	70.8	68.2	68.2	67.4	64.1	64.1	61.3	61.3	10889
OVER 16.0:	99.1	99.1	99.0	98.1	97.5	96.8	96.8	96.1	94.5	94.0	94.0	93.4	93.4	93.4	93.4	93.4	93.4	93.4	93.4	92.4	11172
OVER 18.0:	99.5	99.5	99.5	99.2	99.0	99.0	98.7	98.3	97.6	97.6	97.6	97.0	97.0	97.0	97.0	97.0	97.0	96.1	96.1	96.1	11217
OVER 20.0:	99.8	99.8	99.8	99.8	99.6	99.4	99.4	99.4	99.4	99.4	98.9	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	11251
OVER 22.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	11264
OVER 24.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11267
OVER 26.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	11270
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA5 3 HRLP SPANNING 1/29/83 TO 5/20/83 (2678 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	2678
OVER 2.0:	56.6	41.7	34.4	30.6	27.4	26.5	26.5	25.0	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	23.3	1516
OVER 4.0:	34.4	24.8	20.8	14.5	10.7	8.6	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	921
OVER 6.0:	20.9	15.2	9.5	5.9	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	559
OVER 8.0:	12.5	8.8	4.3	3.3	3.3	2.2	2.2	2.2	2.2	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	336
OVER 10.0:	7.3	4.6	2.5	2.0	1.2	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	196
OVER 12.0:	4.8	3.0	1.2	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	129
OVER 14.0:	3.0	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	80
OVER 16.0:	1.8	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	48
OVER 18.0:	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	25
OVER 20.0:	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17
OVER 22.0:	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10
OVER 24.0:	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	7
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOA5 3 HRLP SPANNING 1/29/83 TO 5/20/83 (2678 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 2.0:	43.4	26.5	16.4	12.7	9.7	7.6	7.6	4.5	2.7	2.7	2.7	2.7	2.7	.0	.0	.0	.0	.0	.0	.0	1162
OVER 4.0:	65.6	58.5	50.5	42.1	40.5	38.5	36.0	33.0	26.3	26.3	24.0	21.6	21.6	21.6	21.6	18.3	18.3	18.3	18.3	5.7	1757
OVER 6.0:	79.1	74.6	67.7	64.3	61.2	57.1	57.1	55.6	55.6	53.8	53.8	53.8	51.1	51.1	51.1	51.1	51.1	51.1	51.1	46.9	2119
OVER 8.0:	87.5	85.4	81.8	74.6	73.2	71.2	68.7	68.7	67.1	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	63.3	59.3	55.2	2342
OVER 10.0:	92.7	91.2	89.4	86.4	83.9	81.8	81.8	78.9	75.4	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	73.5	2482
OVER 12.0:	95.2	93.9	92.3	91.7	90.2	89.1	87.9	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	86.4	83.0	83.0	83.0	83.0	2549
OVER 14.0:	97.0	95.9	93.7	92.6	92.6	91.4	90.3	88.7	88.7	88.7	88.7	88.7	88.7	88.7	88.7	88.7	88.7	88.7	88.7	88.7	2596
OVER 16.0:	98.2	97.5	96.7	95.7	94.8	94.8	94.8	94.8	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	91.4	2630
OVER 18.0:	99.1	98.8	98.1	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	2653
OVER 20.0:	99.4	99.2	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	2661
OVER 22.0:	99.6	99.6	99.6	99.6	99.6	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	2668
OVER 24.0:	99.7	99.6	99.6	99.6	99.6	99.6	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.5	2671
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MOA5   3 HRLP   SPANNING 7/31/83 TO 2/ 3/84 (4503 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4503
OVER 3.0:	45.7	40.2	36.3	28.9	26.2	25.6	23.4	22.5	20.6	20.6	19.3	19.3	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	2059
OVER 6.0:	29.6	26.1	21.9	16.4	13.5	12.9	12.9	12.0	11.0	11.0	11.0	9.5	9.5	9.5	9.5	9.5	9.5	9.5	7.2	7.2	1334
OVER 9.0:	17.5	14.0	10.4	7.7	7.7	7.1	7.1	7.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	787
OVER 12.0:	11.3	9.2	7.2	6.2	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	511
OVER 15.0:	7.5	5.6	4.2	3.8	3.8	3.8	3.8	3.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	337
OVER 18.0:	4.9	3.9	3.9	3.6	3.2	1.9	1.9	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	222
OVER 21.0:	3.4	2.8	1.4	1.4	.9	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	153
OVER 24.0:	2.0	.8	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	90
OVER 27.0:	.8	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	34
OVER 30.0:	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	9
OVER 33.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MOA5   3 HRLP   SPANNING 7/31/83 TO 2/ 3/84 (4503 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 3.0:	54.3	48.9	42.5	38.4	33.6	29.9	29.2	28.3	27.3	25.0	21.2	21.2	21.2	19.5	19.5	17.5	17.5	17.5	17.5	17.5	2444
OVER 6.0:	70.4	68.3	64.0	59.4	52.4	51.8	50.3	48.5	48.5	47.3	46.1	46.1	42.9	42.9	42.9	42.9	42.9	38.5	36.1	33.7	3169
OVER 9.0:	82.5	81.2	78.6	71.9	69.3	69.3	69.3	69.3	69.3	68.2	68.2	62.6	61.1	61.1	61.1	61.1	59.0	59.0	59.0	59.0	3716
OVER 12.0:	88.7	87.4	86.3	83.0	79.7	79.1	79.1	79.1	78.2	78.2	78.2	78.2	78.2	78.2	78.2	74.3	74.3	74.3	74.3	74.3	3992
OVER 15.0:	92.5	91.0	90.0	89.2	88.3	88.3	88.3	88.3	85.3	85.3	85.3	83.9	83.9	83.9	83.9	81.9	81.9	81.9	81.9	81.9	4166
OVER 18.0:	95.1	94.1	93.7	93.4	92.9	91.7	91.0	91.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	87.9	87.9	87.9	87.9	4281
OVER 21.0:	96.6	95.9	95.7	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	4350
OVER 24.0:	98.0	97.4	96.7	96.0	96.0	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	4413
OVER 27.0:	99.2	99.0	98.0	98.0	97.6	97.0	97.0	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	4469
OVER 30.0:	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	4494
OVER 33.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4501
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOA5 3 HRLP SPANNING 10/19/84 TO 7/30/85 (6833 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6833
OVER 3.0:	41.6	29.9	21.1	15.5	13.7	12.0	11.5	9.8	9.8	8.3	8.3	8.3	8.3	7.2	7.2	7.2	7.2	5.7	4.2	2.6	2840
OVER 6.0:	19.2	16.3	13.2	9.0	7.2	6.8	6.8	6.2	5.5	5.5	4.7	4.7	4.7	3.6	3.6	3.6	3.6	2.2	2.2	2.2	1315
OVER 9.0:	14.0	11.9	9.2	6.1	4.0	3.7	2.7	2.7	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	.0	.0	.0	.0	955
OVER 12.0:	9.2	7.8	5.1	2.0	.7	.7	.7	.7	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	630
OVER 15.0:	3.6	1.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	247
OVER 18.0:	.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	47
OVER 21.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	8
OVER 24.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
OVER 27.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2
OVER 30.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
OVER 33.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOA5 3 HRLP SPANNING 10/19/84 TO 7/30/85 (6833 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 3.0:	58.4	47.1	35.0	26.3	19.1	16.3	13.9	12.1	10.8	10.1	8.5	6.6	6.6	5.5	5.5	4.2	4.2	4.2	4.2	4.2	3993
OVER 6.0:	80.8	79.1	75.7	71.8	68.7	67.9	65.5	63.7	62.4	61.6	60.8	57.0	56.0	54.9	52.5	52.5	49.8	46.9	45.3	45.3	5518
OVER 9.0:	86.0	85.2	82.2	78.8	75.4	75.4	75.0	74.4	74.4	73.6	73.6	72.7	71.7	70.6	70.6	69.3	69.3	69.3	69.3	67.7	5878
OVER 12.0:	90.8	90.0	88.2	84.8	82.4	81.2	80.7	80.7	80.7	80.7	79.9	79.9	79.9	78.8	78.8	78.8	78.8	78.8	78.8	78.8	6203
OVER 15.0:	96.4	95.9	95.3	91.6	89.0	88.6	88.6	88.6	88.6	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	6586
OVER 18.0:	99.3	99.3	99.3	98.8	97.9	97.2	97.2	97.2	97.2	96.4	96.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	6786
OVER 21.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	6825
OVER 24.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6831
OVER 27.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6831
OVER 30.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6832
OVER 33.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6832
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

DURATION AND RECURRANCE FOR MOORING G

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: M062 3 HRLP SPANNING 10/20/84 TO 3/11/85 (3421 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	3421
OVER 7.0:	89.2	88.2	87.2	87.2	86.6	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	3053
OVER 14.0:	85.1	84.8	44.6	84.2	83.6	82.8	80.8	80.8	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	79.4	2912
OVER 21.0:	80.7	79.6	79.1	77.8	75.4	74.7	73.8	73.8	72.5	70.9	70.9	70.9	70.9	70.9	70.9	68.3	68.3	68.3	68.3	65.0	2761
OVER 28.0:	67.2	64.4	61.0	56.6	51.6	50.2	49.3	48.1	46.7	46.7	46.7	46.7	46.7	44.5	44.5	44.5	44.5	44.5	41.4	41.4	2298
OVER 35.0:	46.4	42.4	36.8	32.9	28.7	27.1	27.1	25.9	24.6	24.6	22.9	22.9	22.9	22.9	22.9	22.9	20.2	20.2	20.2	20.2	1589
OVER 42.0:	24.9	21.4	18.4	15.3	12.9	11.2	11.2	11.2	9.8	9.8	9.8	9.8	9.8	7.6	7.6	5.0	5.0	5.0	5.0	5.0	852
OVER 49.0:	9.2	7.2	5.3	4.5	3.2	3.2	3.2	3.2	33.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	.0	314
OVER 56.0:	2.7	2.5	1.9	1.5	1.5	1.5	1.5	1.5	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	92
OVER 63.0:	1.1	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	36
OVER 70.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: M062 3 HRLP SPANNING 10/20/84 TO 3/11/85 (3421 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 7.0:	10.8	10.1	8.8	8.0	8.0	6.4	5.5	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	.0	368
OVER 14.0:	14.9	14.0	13.1	12.7	11.4	11.4	11.4	11.4	11.4	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	9.9	509
OVER 21.0:	19.3	17.8	17.0	15.2	14.6	14.6	13.7	13.7	13.7	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	660
OVER 28.0:	32.8	28.6	23.9	21.1	20.0	20.0	19.0	19.0	16.3	14.9	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	1123
OVER 35.0:	53.6	49.9	46.3	41.7	38.1	38.1	38.1	38.1	34.2	34.2	34.2	30.5	30.5	30.5	30.5	30.5	30.5	24.7	24.7	18.2	1832
OVER 42.0:	75.1	71.9	67.0	64.3	61.2	61.2	61.2	61.2	58.6	58.6	58.6	56.6	56.5	56.5	56.5	54.0	54.0	54.0	44.7	44.7	2569
OVER 49.0:	90.8	89.2	88.3	86.2	82.3	81.6	81.6	81.6	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	80.3	3107
OVER 56.0:	97.3	97.2	96.8	96.4	96.4	96.4	96.4	96.4	96.4	94.9	94.9	94.9	94.9	94.9	94.9	94.9	94.9	94.9	91.9	91.9	3329
OVER 63.0:	98.9	98.8	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	3385
OVER 70.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	3418
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: M063   3 MRLP   SPANNING 1/26/85 TO 3/11/85 (1069 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	1069
OVER 3.0:	99.6	99.6	99.6	99.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	1065
OVER 6.0:	97.2	96.9	94.3	94.3	89.0	86.6	86.6	86.6	78.3	78.3	78.3	78.3	78.3	78.3	78.3	78.3	69.4	69.4	69.4	69.4	1039
OVER 9.0:	91.4	87.7	84.2	77.6	70.0	64.7	64.7	64.7	60.4	60.4	60.4	60.4	54.2	54.2	54.2	54.2	45.7	45.7	45.7	45.7	977
OVER 12.0:	82.1	77.7	76.1	64.5	54.5	46.9	46.9	46.9	42.6	42.6	42.6	42.6	42.6	42.6	34.9	34.9	34.9	34.9	34.9	34.9	878
OVER 15.0:	71.3	66.0	60.2	43.1	28.6	23.9	20.8	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	762
OVER 18.0:	58.9	52.0	38.4	24.4	6.0	3.6	3.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	630
OVER 21.0:	44.5	36.3	23.0	12.3	3.1	3.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	476
OVER 24.0:	21.5	20.6	8.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	315
OVER 27.0:	14.0	6.7	2.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	150
OVER 30.0:	5.7	2.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	61
OVER 33.0:	1.7	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	18
OVER 36.0:	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: M063   3 MRLP   SPANNING 1/26/85 TO 3/11/85 (1069 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 3.0:	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4
OVER 6.0:	2.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	30
OVER 9.0:	8.6	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	92
OVER 12.0:	17.9	10.7	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	191
OVER 15.0:	28.7	20.8	14.2	5.1	3.0	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	307
OVER 18.0:	41.1	32.5	23.4	13.8	12.1	12.1	12.1	8.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	439
OVER 21.0:	55.5	45.4	34.2	23.6	15.5	12.7	12.7	8.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	593
OVER 24.0:	70.5	63.8	52.5	39.5	27.6	25.3	22.0	22.0	18.0	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	754
OVER 27.0:	86.0	83.6	78.9	68.5	51.0	40.9	40.9	33.3	33.3	33.3	33.3	33.3	33.3	19.1	19.1	19.1	19.1	19.1	19.1	19.1	919
OVER 30.0:	94.3	93.9	93.9	90.7	81.1	78.8	75.8	72.2	68.2	68.2	68.2	62.3	62.3	62.3	54.9	54.9	54.9	54.9	54.9	54.9	1008
OVER 33.0:	98.3	98.1	98.1	98.1	96.4	96.4	96.4	96.4	96.4	96.4	90.8	84.8	84.8	84.8	84.8	76.3	76.3	76.3	76.3	76.3	1051
OVER 36.0:	99.6	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.4	1065
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: M063 3 HRLP SPANNING 8/ 2/85 TO 1/31/86 (4375 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	10.0	4375
OVER 4.0:	64.6	62.4	56.3	47.7	39.8	38.1	36.6	36.6	35.6	35.6	35.6	34.1	32.5	30.9	30.9	28.9	24.6	24.6	24.6	24.6	2828
OVER 8.0:	50.9	48.5	42.5	37.0	31.8	29.9	29.9	28.1	28.1	26.9	25.6	25.6	24.0	20.5	20.5	20.5	18.4	18.4	16.0	16.0	2229
OVER 12.0:	38.7	35.2	30.5	24.7	19.0	16.5	14.9	14.9	14.9	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	10.4	10.4	10.4	1693
OVER 16.0:	27.2	24.9	22.1	12.3	10.9	9.7	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	6.2	6.2	6.2	6.2	6.2	1188
OVER 20.0:	19.3	16.8	14.2	8.2	7.2	6.7	6.7	6.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	845
OVER 24.0:	12.9	10.8	7.1	5.1	3.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	.0	.0	.0	.0	.0	566
OVER 28.0:	5.9	4.0	2.5	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	.0	.0	.0	.0	.0	.0	260
OVER 32.0:	3.2	2.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	.0	.0	.0	.0	.0	.0	.0	138
OVER 36.0:	2.1	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	.0	.0	.0	.0	.0	.0	.0	93
OVER 40.0:	.9	.7	.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	39
OVER 44.0:	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	9
OVER 48.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: M063 3 HRLP SPANNING 8/ 2/85 TO 1/31/86 (4375 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	35.4	32.5	24.7	18.7	16.3	16.3	14.8	13.9	11.7	11.7	11.7	11.7	10.2	8.5	8.5	4.6	2.4	2.4	.0	.0	1547
OVER 8.0:	49.1	46.6	41.1	33.0	28.5	27.9	27.1	27.1	26.0	24.9	24.9	23.4	21.8	21.8	20.0	20.0	20.0	17.6	17.6	17.6	2146
OVER 12.0:	61.3	58.2	53.9	48.4	42.1	39.6	39.6	36.8	35.8	35.8	35.8	34.4	32.8	31.1	31.1	31.1	26.9	24.6	24.6	24.6	2682
OVER 16.0:	72.8	69.6	64.6	61.5	59.0	58.5	58.5	57.6	54.5	54.5	53.1	53.1	53.1	51.5	49.6	47.5	47.5	47.5	47.5	47.5	3187
OVER 20.0:	80.7	79.3	75.0	69.2	65.9	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	65.3	63.1	63.1	63.1	3530
OVER 24.0:	87.1	85.5	84.2	78.3	75.3	74.7	74.7	74.7	73.6	73.6	73.6	72.2	72.2	72.2	72.2	70.2	70.2	67.9	67.9	67.9	3809
OVER 28.0:	94.1	93.7	92.8	90.0	86.6	86.6	84.4	83.4	83.4	82.3	82.3	82.3	82.3	82.3	82.3	82.3	80.2	77.9	77.9	75.4	4115
OVER 32.0:	96.8	96.8	96.6	95.5	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	91.2	91.2	91.2	4237
OVER 36.0:	97.9	97.9	97.6	97.6	97.1	96.5	96.5	96.5	96.5	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.3	95.3	4282
OVER 40.0:	99.1	99.0	98.8	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4	4336
OVER 44.0:	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	4366
OVER 48.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	4374
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: M064   3 HRLP   SPANNING 7/20/84 TO 1/31/86 (13447 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13447
OVER 4.0:	80.1	77.9	75.0	69.4	62.4	61.4	60.9	60.6	58.9	58.2	58.2	57.2	55.7	54.6	54.0	52.0	50.6	50.6	49.8	48.1	10777
OVER 8.0:	45.0	41.8	37.9	33.6	32.4	31.7	31.7	31.1	31.1	30.7	30.7	30.7	30.7	30.7	30.1	30.1	30.1	28.6	28.6	28.6	6053
OVER 12.0:	33.3	31.5	28.8	26.8	25.6	25.2	24.5	24.2	23.5	22.4	22.4	22.4	21.8	21.3	21.3	20.6	20.6	19.9	19.9	18.3	4478
OVER 16.0:	23.3	21.6	19.7	18.4	17.0	16.8	16.	16.5	15.8	14.7	14.7	14.2	13.7	13.7	13.1	12.4	12.4	11.7	11.7	11.7	3134
OVER 20.0:	15.7	14.8	13.7	12.6	11.6	10.8	10.6	10.3	9.9	9.5	9.5	9.1	9.1	9.1	9.1	9.1	8.4	8.4	7.6	7.6	2110
OVER 24.0:	11.4	10.0	9.0	8.2	7.9	7.7	7.7	7.7	7.7	7.3	6.9	6.9	6.4	5.3	5.3	4.6	4.6	4.6	4.6	4.6	1537
OVER 28.0:	6.2	5.5	5.0	4.1	4.1	4.1	3.8	2.9	2.9	2.5	2.0	2.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	839
OVER 32.0:	3.2	2.9	2.4	2.2	1.7	1.7	1.2	.7	.7	.7	.7	.7	.7	.7	.7	.0	.0	.0	.0	.0	427
OVER 36.0:	.9	.7	.7	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	122
OVER 40.0:	.3	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	34
OVER 44.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: M064   3 HRLP   SPANNING 7/20/84 TO 1/31/86 (13447 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	19.9	15.7	12.4	9.8	8.4	7.6	7.0	7.0	7.0	7.0	6.2	5.2	5.2	4.7	4.1	4.1	4.1	4.1	4.1	4.1	2670
OVER 8.0:	55.0	52.8	48.4	42.5	38.6	38.2	37.0	36.7	35.0	34.2	32.9	31.5	30.5	28.8	28.8	28.8	28.8	28.1	28.1	27.3	7394
OVER 12.0:	66.7	65.4	63.3	60.0	58.1	57.9	57.9	57.6	57.2	56.5	56.5	55.5	55.0	55.0	55.0	55.0	55.0	53.6	53.6	53.6	8969
OVER 16.0:	76.7	75.4	73.7	71.8	69.6	69.6	69.1	69.1	68.8	68.8	68.8	68.3	68.3	68.3	68.3	68.3	68.3	68.3	68.3	67.4	10313
OVER 20.0:	84.3	83.4	82.4	81.0	80.2	79.6	79.1	79.1	78.8	78.4	78.4	78.4	77.9	77.9	77.3	76.6	75.9	75.9	75.9	75.1	11337
OVER 24.0:	88.6	87.6	86.6	85.9	84.5	84.5	84.3	84.0	84.0	83.6	83.6	83.6	83.6	83.6	83.6	83.6	82.9	82.2	82.2	82.2	11910
OVER 28.0:	93.8	92.9	92.5	92.1	91.5	91.5	91.5	91.5	91.2	91.2	90.7	90.7	90.7	90.7	90.7	90.7	90.7	90.0	89.2	89.2	12608
OVER 32.0:	96.8	96.5	96.2	95.7	95.5	95.5	95.5	95.2	95.2	95.2	95.2	95.2	95.2	95.2	95.2	94.6	94.6	94.6	94.6	94.6	13020
OVER 36.0:	99.1	99.0	98.9	98.6	98.5	98.5	98.2	98.2	98.2	98.2	98.2	98.2	98.2	97.7	97.7	97.7	97.7	97.7	97.7	97.7	13325
OVER 40.0:	99.7	99.7	99.6	99.6	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	99.5	13413
OVER 44.0:	100.0	100.0	100.0	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	13444
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: M065 3 HRLP SPANNING 7/20/84 TO 1/31/86 (13449 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13449
OVER 4.0:	91.8	90.5	89.3	85.5	78.9	78.9	78.9	78.9	78.5	78.5	78.5	77.6	77.6	77.0	77.0	77.0	77.0	77.0	77.0	76.2	12345
OVER 8.0:	66.9	64.8	61.0	56.6	54.6	54.4	53.7	53.4	52.7	52.3	52.3	51.8	51.8	51.3	51.3	50.6	48.5	48.5	46.9	46.9	8992
OVER 12.0:	47.8	46.3	44.1	40.5	38.7	38.3	38.3	38.0	37.3	37.3	36.9	36.0	35.5	33.2	32.6	32.0	32.0	31.2	30.5	30.5	6425
OVER 16.0:	31.4	30.5	28.7	26.9	26.6	26.4	26.2	25.6	24.2	24.2	24.2	24.2	24.2	23.6	23.6	23.0	22.3	22.3	21.5	21.5	4225
OVER 20.0:	23.0	22.3	21.5	20.0	19.3	19.3	19.3	18.9	18.6	18.2	16.4	15.9	14.9	14.3	14.3	14.3	13.6	13.6	13.6	13.6	3093
OVER 24.0:	15.0	14.2	13.4	11.6	10.8	10.3	10.0	9.4	9.0	8.3	8.3	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	2018
OVER 28.0:	8.0	7.4	6.7	5.7	5.7	5.1	5.1	4.5	3.8	3.8	3.4	3.4	3.4	2.8	2.3	2.3	1.6	1.6	1.6	1.6	1075
OVER 32.0:	3.1	2.8	2.3	1.7	1.5	1.5	1.3	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	421
OVER 36.0:	1.1	.8	.6	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	142
OVER 40.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	18
OVER 44.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: M065 3 HRLP SPANNING 7/20/84 TO 1/31/86 (13449 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	8.2	5.2	2.6	2.0	1.5	1.5	1.5	1.5	1.1	.7	.7	.7	.7	.7	.7	.7	.7	.0	.0	.0	1104
OVER 8.0:	33.1	31.3	27.5	21.2	17.8	17.4	17.1	16.8	16.2	15.1	14.6	13.7	13.2	13.2	12.0	12.0	11.3	9.9	8.3	8.3	4457
OVER 12.0:	52.2	51.0	48.2	46.0	43.9	43.5	43.3	42.7	42.4	42.0	41.2	41.2	40.1	39.6	39.6	39.6	38.8	38.8	38.0	37.2	7024
OVER 16.0:	68.6	68.1	66.5	64.1	63.7	63.3	63.3	62.4	62.0	61.6	61.2	61.2	61.2	61.2	60.6	59.9	58.5	58.5	58.5	57.7	9224
OVER 20.0:	77.0	76.4	75.3	74.0	72.8	72.6	72.6	72.3	71.9	71.9	71.9	71.9	71.9	71.9	71.3	71.3	71.3	71.3	71.3	71.3	10356
OVER 24.0:	85.0	84.4	83.3	81.5	80.5	80.3	80.3	80.3	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	79.6	11431
OVER 28.0:	92.0	91.6	90.9	89.9	89.4	89.4	89.2	88.9	88.9	88.5	88.5	88.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	12374
OVER 32.0:	96.9	96.6	96.2	95.5	95.3	95.1	94.9	94.9	94.9	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	13028
OVER 36.0:	98.9	98.8	98.7	98.6	98.4	98.4	98.4	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	98.2	97.4	97.4	97.4	97.4	13307
OVER 40.0:	99.9	99.9	99.9	99.8	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6	13431
OVER 44.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13448
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: M066   3 HRLP   SPANNING 7/20/84 TO 1/31/86 (13447 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13447
OVER 4.0:	73.1	71.6	67.7	60.6	58.0	57.8	57.8	57.5	57.2	56.8	56.4	55.4	54.4	54.4	54.4	54.4	53.0	53.0	53.0	53.0	9827
OVER 8.0:	54.0	52.2	48.9	45.5	43.0	42.6	42.6	41.8	40.8	40.8	40.8	40.3	39.8	39.8	39.2	38.5	38.5	37.0	37.0	37.0	7261
OVER 12.0:	39.4	38.1	35.6	32.2	30.9	30.9	30.4	30.4	30.1	30.1	30.1	29.6	29.6	29.0	29.0	28.4	27.6	27.6	27.6	27.6	5300
OVER 16.0:	27.0	26.1	24.9	23.6	2..2	23.0	23.0	23.0	22.4	22.0	21.6	21.6	20.5	20.5	19.9	19.9	19.9	18.5	18.5	18.5	3624
OVER 20.0:	20.1	19.4	18.8	17.7	16.9	16.7	16.0	15.3	15.3	14.9	14.9	14.5	13.9	13.9	13.9	13.3	12.6	12.6	12.6	12.6	2697
OVER 24.0:	13.4	12.7	11.7	10.9	10.0	10.0	9.8	9.4	9.4	9.4	9.4	9.0	9.0	9.0	8.4	8.4	8.4	7.6	6.8	6.8	1803
OVER 28.0:	8.1	7.7	7.2	6.6	6.1	6.1	5.9	5.5	5.5	5.5	5.1	4.6	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	1094
OVER 32.0:	3.5	3.2	2.6	2.3	2.3	2.3	2.3	2.0	1.7	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	475
OVER 36.0:	1.5	1.2	1.1	1.0	1.0	.8	.8	.8	.5	.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	197
OVER 40.0:	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	31
OVER 44.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	8
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: M066   3 HRLP   SPANNING 7/20/84 TO 1/31/86 (13447 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	26.9	25.2	20.2	15.3	13.0	12.6	12.6	11.5	10.1	9.7	9.2	9.2	8.7	8.7	7.5	7.5	6.8	6.8	6.0	5.2	3620
OVER 8.0:	46.0	44.6	41.9	37.5	34.1	33.5	33.0	32.1	31.4	30.6	29.7	28.8	28.8	26.5	26.5	25.9	25.9	24.4	22.8	22.8	6186
OVER 12.0:	60.6	59.7	57.3	54.5	52.4	51.8	51.3	51.0	50.7	50.3	50.3	49.8	49.3	48.7	47.5	47.5	46.8	46.8	46.0	46.0	8147
OVER 16.0:	73.0	72.6	71.8	70.0	68.7	68.7	68.5	68.5	67.5	67.5	66.6	66.1	66.1	66.1	66.1	66.1	66.1	66.1	65.3	65.3	9823
OVER 20.0:	79.9	79.3	78.2	77.6	77.3	77.3	76.7	76.4	76.1	75.7	75.7	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	75.2	10750
OVER 24.0:	86.6	85.9	84.9	84.3	84.0	83.8	83.8	83.5	83.2	83.2	83.2	82.7	82.7	82.1	81.5	81.5	81.5	80.8	80.8	80.8	11644
OVER 28.0:	91.9	91.4	90.8	90.8	90.6	90.6	90.1	90.1	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8	89.8	12353
OVER 32.0:	96.5	96.2	95.9	95.4	94.9	94.9	94.7	94.7	94.3	94.3	94.3	94.3	94.3	94.3	94.3	94.3	93.6	93.6	93.6	93.6	12972
OVER 36.0:	98.5	98.3	98.2	98.2	98.0	97.8	97.8	97.8	9722	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	13250
OVER 40.0:	99.8	99.7	99.7	99.6	99.6	99.6	99.6	99.6	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	13416
OVER 44.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	13439
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

DURATION AND RECURRANCE FOR MOORING E

FREQUENCY DISTRIBUTION   DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA   STATION: MOE1   3 HRLP   SPANNING 5/ 2/83 TO 1/30/86 (24115 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	24115
OVER 8.0:	51.9	46.0	37.6	28.1	21.0	19.1	18.2	17.2	14.9	14.5	13.7	12.7	11.5	10.0	9.6	9.6	9.6	9.2	9.2	7.8	12525
OVER 16.0:	30.6	26.0	20.4	13.1	10.3	9.7	8.6	7.6	6.9	6.9	6.4	6.1	5.3	5.3	5.3	4.2	3.8	3.8	3.8	3.3	7374
OVER 24.0:	17.6	14.3	10.1	6.9	5.3	5.1	4.8	4.3	3.9	3.9	3.9	3.4	3.4	3.1	3.1	3.1	3.1	3.1	3.1	3.1	4241
OVER 32.0:	8.2	6.6	4.6	3.7	3.0	2.8	2.6	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	1987
OVER 40.0:	4.1	3.4	2.9	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	977
OVER 48.0:	2.7	2.5	2.2	2.1	2.0	2.0	2.0	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	661
OVER 56.0:	1.9	1.7	1.5	1.4	1.3	1.2	1.2	1.2	1.2	1.2	1.2	.9	.9	.9	.9	.9	.5	.5	.5	.5	451
OVER 64.0:	1.0	.9	.8	.8	.6	.6	.6	.6	.6	.6	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0	251
OVER 72.0:	.6	.6	.5	.5	.5	.5	.5	.3	.3	.3	.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	151
OVER 80.0:	.3	.3	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	76
OVER 88.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	14
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION   RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES   STATION: MOE1   3 HRLP   SPANNING 5/ 2/83 TO 1/30/86 (24115 HOURS)

SPEED CM/S																					NUMBER OF HORS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 8.0:	48.1	42.0	32.5	23.3	18.3	16.9	15.5	13.7	12.5	11.9	10.7	10.2	9.1	7.8	7.5	7.5	7.5	6.7	6.2	5.8	11590
OVER 16.0:	69.4	66.4	59.9	52.5	46.7	45.1	43.7	41.4	38.7	36.6	35.2	34.9	32.6	32.0	30.3	29.6	28.4	27.2	26.3	25.4	16741
OVER 24.0:	82.4	80.9	76.8	70.8	66.8	65.8	64.9	63.7	61.6	60.3	59.6	58.8	57.6	55.8	53.4	52.7	52.3	51.5	51.1	50.6	19874
OVER 32.0:	91.8	91.1	90.1	87.4	84.5	84.0	83.7	82.4	82.0	81.5	81.1	80.8	79.7	79.7	78.6	77.6	77.6	76.7	76.7	74.9	22128
OVER 40.0:	95.9	95.8	95.6	94.8	94.0	93.7	93.3	93.0	92.6	92.4	92.1	91.9	91.9	91.2	90.9	90.9	90.5	90.1	89.7	89.7	23138
OVER 48.0:	97.3	97.1	97.1	96.7	96.5	96.5	96.5	96.5	96.5	96.5	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	23454
OVER 56.0:	98.1	97.9	97.8	97.8	97.8	97.8	97.7	97.7	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	23664
OVER 64.0:	99.0	98.8	98.7	98.5	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	97.9	97.9	97.9	23864
OVER 72.0:	99.4	99.3	99.3	99.2	99.1	99.1	99.1	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	98.6	98.6	98.6	98.6	23964
OVER 80.0:	99.7	99.6	99.6	99.6	99.6	99.6	99.5	99.5	99.5	99.5	99.5	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2	24039
OVER 88.0:	99.9	99.9	99.9	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	24101
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOE2 3 HRLP SPANNING 1/27/83 TO 1/28/86 (26348 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	26348
OVER 6.0:	60.6	55.4	47.5	34.6	23.1	20.4	19.2	17.8	15.5	14.2	14.0	12.6	11.5	10.7	9.4	9.1	8.7	8.3	6.7	6.7	15963
OVER 12.0:	38.2	33.0	26.4	15.5	10.3	9.5	8.8	7.7	7.0	6.6	5.5	5.3	5.0	4.7	4.7	4.1	3.7	3.7	3.7	3.7	10073
OVER 18.0:	25.3	20.9	13.8	8.2	6.2	5.7	5.2	4.9	4.1	3.7	3.4	3.2	3.2	3.2	3.2	2.9	2.9	2.9	2.5	2.5	6655
OVER 24.0:	14.3	10.6	5.8	3.7	2.5	2.2	1.9	1.9	1.2	1.2	1.2	1.2	1.2	.9	.9	.9	.9	.9	.9	.5	3763
OVER 30.0:	5.2	3.2	1.8	.8	.7	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	139
OVER 36.0:	1.5	.8	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	406
OVER 42.0:	.4	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	117
OVER 48.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	39
OVER 54.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10
OVER 60.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOE2 3 HRLP SPANNING 1/27/83 TO 1/28/86 (26348 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 6.0:	39.4	31.8	21.0	12.9	9.1	7.8	6.4	5.4	4.7	4.5	3.6	2.9	2.6	2.6	2.3	2.3	1.9	1.9	1.5	1.5	10384
OVER 12.0:	61.8	57.9	47.9	39.3	32.7	31.0	30.5	29.0	27.3	24.9	23.1	21.9	21.7	20.5	18.7	17.7	17.3	16.9	14.6	13.7	16275
OVER 18.0:	74.7	72.4	66.0	57.4	51.0	49.8	48.9	48.0	45.8	44.8	44.6	43.2	40.8	39.4	38.1	36.2	35.4	34.3	32.7	31.9	19693
OVER 24.0:	85.7	84.1	80.7	74.8	70.1	69.1	67.5	66.0	64.7	63.1	62.2	61.3	60.0	58.8	57.3	56.9	55.1	54.8	52.8	51.1	22585
OVER 30.0:	94.8	94.2	93.0	90.4	88.9	88.4	87.9	87.3	86.1	85.1	84.4	83.2	82.4	82.1	80.9	80.2	79.5	78.8	78.8	77.9	24989
OVER 36.0:	98.5	98.3	97.9	97.4	96.4	96.1	96.1	95.8	95.6	95.6	95.4	94.9	94.1	94.1	94.1	94.1	94.1	94.1	94.1	93.3	25942
OVER 42.0:	99.6	99.5	99.5	99.3	99.0	99.0	98.8	98.7	98.5	98.5	98.5	98.5	98.5	98.5	98.5	98.2	98.2	98.2	98.2	98.2	26231
OVER 48.0:	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	26309
OVER 54.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	26338
OVER 60.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	26347
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOE3 3 HRLP SPANNING 7/30/83 TO 4/26/84 (6510 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6510
OVER 4.0:	87.9	82.1	73.2	63.9	57.1	49.6	48.0	46.7	41.9	38.7	37.0	36.0	33.9	33.9	30.1	30.1	30.1	30.1	28.5	26.8	5722
OVER 8.0:	52.2	40.9	30.3	24.5	20.2	18.6	18.6	17.4	16.6	15.1	14.2	13.1	9.9	8.7	8.7	6.1	6.1	6.1	6.1	6.1	3395
OVER 12.0:	21.6	14.5	4.7	4.3	3.7	2.4	2.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1408
OVER 16.0:	6.3	3.8	1.9	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	.0	.0	.0	412
OVER 20.0:	2.6	1.8	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	.0	.0	.0	.0	169
OVER 24.0:	1.3	.8	.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	82
OVER 28.0:	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	18
OVER 32.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
OVER 36.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
OVER 40.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOE3 3 HRLP SPANNING 7/30/83 TO 4/26/84 (6510 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 4.0:	12.1	2.1	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	788
OVER 8.0:	47.8	36.3	25.8	17.5	13.3	11.2	10.3	8.4	7.0	7.0	7.0	7.0	7.0	4.6	4.6	4.6	3.2	1.7	1.7	.0	3115
OVER 12.0:	78.4	73.5	66.8	61.0	53.6	49.4	45.3	44.1	39.8	38.2	33.8	31.8	29.7	27.4	23.6	21.0	21.0	19.5	19.5	19.5	5102
OVER 16.0:	93.7	92.7	91.2	87.4	84.8	83.6	83.6	80.0	79.3	77.7	76.8	75.8	75.8	74.7	73.5	73.5	73.5	73.5	71.8	71.8	6098
OVER 20.0:	97.4	97.3	97.3	96.7	95.0	94.5	94.5	93.2	93.2	92.4	92.4	92.4	92.4	92.4	92.4	92.4	92.4	90.8	90.8	90.8	6341
OVER 24.0:	98.7	98.6	98.3	98.3	97.7	97.7	97.7	97.7	97.0	97.0	97.0	96.0	96.0	96.0	96.0	96.0	96.0	94.5	94.5	94.5	6428
OVER 28.0:	99.7	99.6	99.6	99.4	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	99.1	97.6	97.6	97.6	6492
OVER 32.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.4	98.4	6507
OVER 36.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6509
OVER 40.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	6509
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATIONINTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOE3 3 MRLP SPANNING 7/20/84 TO 1/30/86 (13436 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13436
OVER 5.0:	67.5	61.0	51.0	40.3	36.4	34.5	33.8	31.8	29.1	28.3	27.0	26.5	23.9	23.9	23.3	23.3	23.3	23.3	22.5	22.5	9064
OVER 10.0:	42.2	35.9	28.5	25.3	23.0	22.8	22.5	22.5	22.2	21.4	21.0	21.0	20.0	19.4	19.4	19.4	19.4	19.4	19.4	19.4	5674
OVER 15.0:	27.0	24.0	21.2	20.6	20.0	19.6	19.1	19.1	18.7	18.7	18.7	18.3	17.2	17.2	17.2	17.2	17.2	17.2	16.4	16.4	3634
OVER 20.0:	20.9	20.0	18.9	18.8	18.1	17.1	16.3	15.4	15.0	14.3	14.3	13.8	12.7	12.7	12.7	12.7	12.0	12.0	12.0	11.2	2802
OVER 25.0:	9.8	7.8	6.5	4.2	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	1311
OVER 30.0:	.6	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	76
OVER 35.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	13
OVER 40.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	10
OVER 45.0:	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	8
OVER 50.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
OVER 55.0:	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOE3 3 HRLP SPANNING 7/20/84 TO 1/30/86 (13436 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 5.0:	32.5	25.0	15.3	8.7	6.3	6.3	5.5	5.5	5.2	4.4	4.0	4.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4372
OVER 10.0:	57.8	53.2	46.4	38.2	31.5	30.7	28.5	25.1	23.2	21.3	20.4	18.9	16.4	15.3	14.1	12.7	12.0	10.5	10.5	8.9	7762
OVER 15.0:	73.0	71.8	69.7	64.1	61.7	60.9	60.1	59.6	57.2	56.4	55.1	53.7	53.1	50.9	50.3	50.3	49.7	48.9	48.1	46.5	9802
OVER 20.0:	79.1	78.3	77.8	76.6	74.9	74.7	74.7	74.4	73.3	73.3	72.9	72.4	72.4	72.4	72.4	72.4	71.7	71.7	71.7	71.7	10634
OVER 25.0:	90.2	88.8	87.3	84.8	82.5	81.8	81.3	80.7	80.0	79.2	79.2	78.8	78.8	78.8	78.8	76.8	78.8	78.8	78.8	78.8	12125
OVER 30.0:	99.4	99.3	99.1	98.8	98.2	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.0	96.4	96.4	96.4	96.4	96.4	13360
OVER 35.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	13423
OVER 40.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	13426
OVER 45.0:	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	13428
OVER 50.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13433
OVER 55.0:	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	13435
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION DURATION INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOURLY DATA STATION: MOE3 3 HRLP SPANNING 1/27/83 TO 5/ 1/83 (2260 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	2260
OVER 2.0:	97.8	96.4	94.8	93.5	91.7	87.0	85.6	81.9	78.0	75.7	75.7	75.7	69.6	66.4	66.4	66.4	66.4	66.4	66.4	66.4	2211
OVER 4.0:	89.6	84.3	74.2	69.6	55.6	47.4	43.1	43.1	41.2	36.6	34.0	34.0	34.0	30.6	30.6	26.8	26.8	26.8	26.8	21.9	2026
OVER 6.0:	74.6	62.4	48.7	42.7	29.8	25.2	25.2	20.0	15.8	13.6	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	1686
OVER 8.0:	55.0	41.1	33.1	24.8	16.9	13.3	11.8	8.5	8.5	8.5	5.9	3.2	.0	.0	.0	.0	.0	.0	.0	.0	1243
OVER 10.0:	36.2	25.6	16.3	9.4	2.8	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	817
OVER 12.0:	22.9	14.6	8.1	4.2	1.5	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	518
OVER 14.0:	13.4	8.4	3.1	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	302
OVER 16.0:	7.8	3.8	2.2	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	176
OVER 18.0:	4.4	1.8	.9	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	100
OVER 20.0:	2.6	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	59
OVER 22.0:	1.2	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	27
OVER 24.0:	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	15
OVER 26.0:	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	3
DURATION (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

FREQUENCY DISTRIBUTION RECURRENCE INTERVAL (PERCENT OF TOTAL RECORD)
1.00 HOUR AVERAGES STATION: MOE3 3 HRLP SPANNING 1/27/83 TO 5/ 1/83 (2260 HOURS)

SPEED CM/S																					NUMBER OF HOURS
0 & ABOVE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	0
OVER 2.0:	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	49
OVER 4.0:	10.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	234
OVER 6.0:	25.4	9.3	4.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	574
OVER 8.0:	45.0	30.4	15.3	6.9	4.1	1.6	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1017
OVER 10.0:	63.8	54.2	43.1	29.3	22.5	16.4	13.6	4.8	2.9	2.9	2.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	1443
OVER 12.0:	77.1	71.4	64.0	55.0	48.1	45.6	39.8	36.3	36.3	31.7	29.0	29.0	20.0	16.7	16.7	12.9	12.9	12.9	12.9	12.9	1742
OVER 14.0:	86.6	83.6	75.6	73.4	71.3	67.6	64.6	62.8	58.6	54.1	54.1	51.4	51.4	51.4	51.4	51.4	51.4	51.4	46.6	46.6	1958
OVER 16.0:	92.2	90.6	87.7	83.8	80.0	76.4	76.4	76.4	76.4	74.1	69.2	69.2	69.2	69.2	65.5	65.5	65.5	65.5	65.5	65.5	2084
OVER 18.0:	95.6	95.2	92.3	91.5	89.5	88.4	88.4	88.4	86.4	86.4	83.9	83.9	83.9	83.9	83.9	83.9	83.9	83.9	83.9	79.1	2160
OVER 20.0:	97.4	96.6	95.3	94.7	93.8	90.3	90.3	90.3	88.3	88.3	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	80.9	2201
OVER 22.0:	98.8	98.6	97.8	97.2	97.2	97.2	97.2	97.2	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	95.1	90.3	2233
OVER 24.0:	99.3	99.1	99.1	99.1	99.1	97.9	97.9	97.9	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	95.8	2245
OVER 26.0:	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	2257
RECURRENCE (GREATER THAN HOURS)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	

APPENDIX B

STICK PLOTS OF 2-YEARS OF SW FLORIDA SHELF (ESE) NEAR-BOTTOM CURRENT MEASUREMENTS

B. Southwest Florida Shelf - Near-Bottom Currents

B.1 Introduction

Presented in the following figures are 40-hour low pass stick plots and temperature time series plots for the near-bottom observations taken on the SW Florida Shelf by Environmental Science and Engineering as part of an MMS-funded benthic ecology study. The positions of the ESE moorings are shown as location 1-8 on Figure B.1-1.

The accompanying figures are presented in two groups:

(1) The original 4 moorings and where available Mooring 7.

(2) Moorings 5, 6 and 8.

The second set was deployed only during the second year. Although Mooring 7 was also only out for the second year it is part of a cross-shelf transect composed of Moorings 1, 7, 4 and 2. Within each group the plots are presented in chronological order.

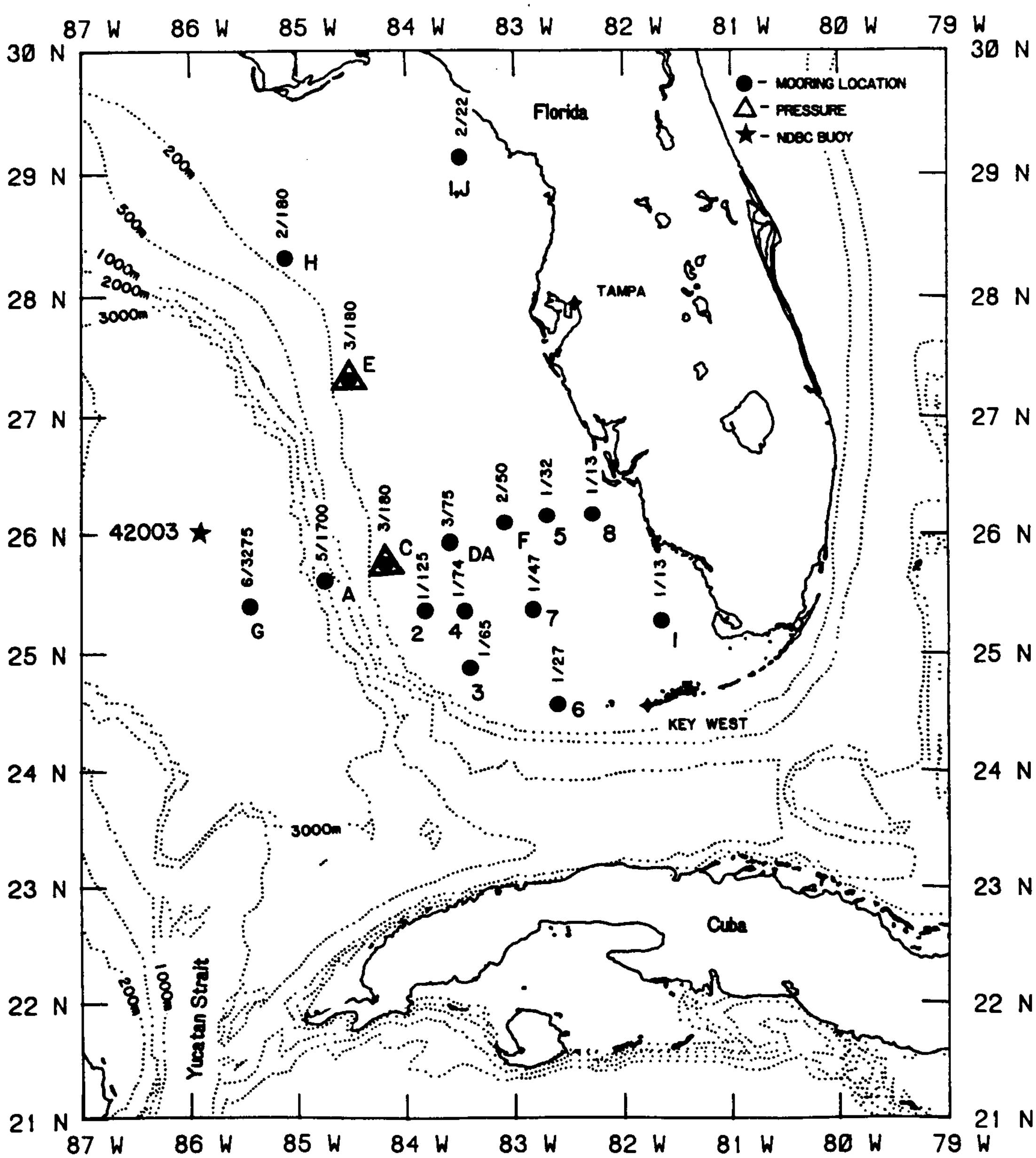

Figure B.1-1. Bathymetry in the eastern Gulf of Mexico. The letters A....J refer to mooring locations, as described in the text. Also shown are the locations of wind observations. Mooring locations 1-8 represent MMS/ESE near-bottom current measurement sites.

MOORINGS 1, 2, 3, 4 AND 7

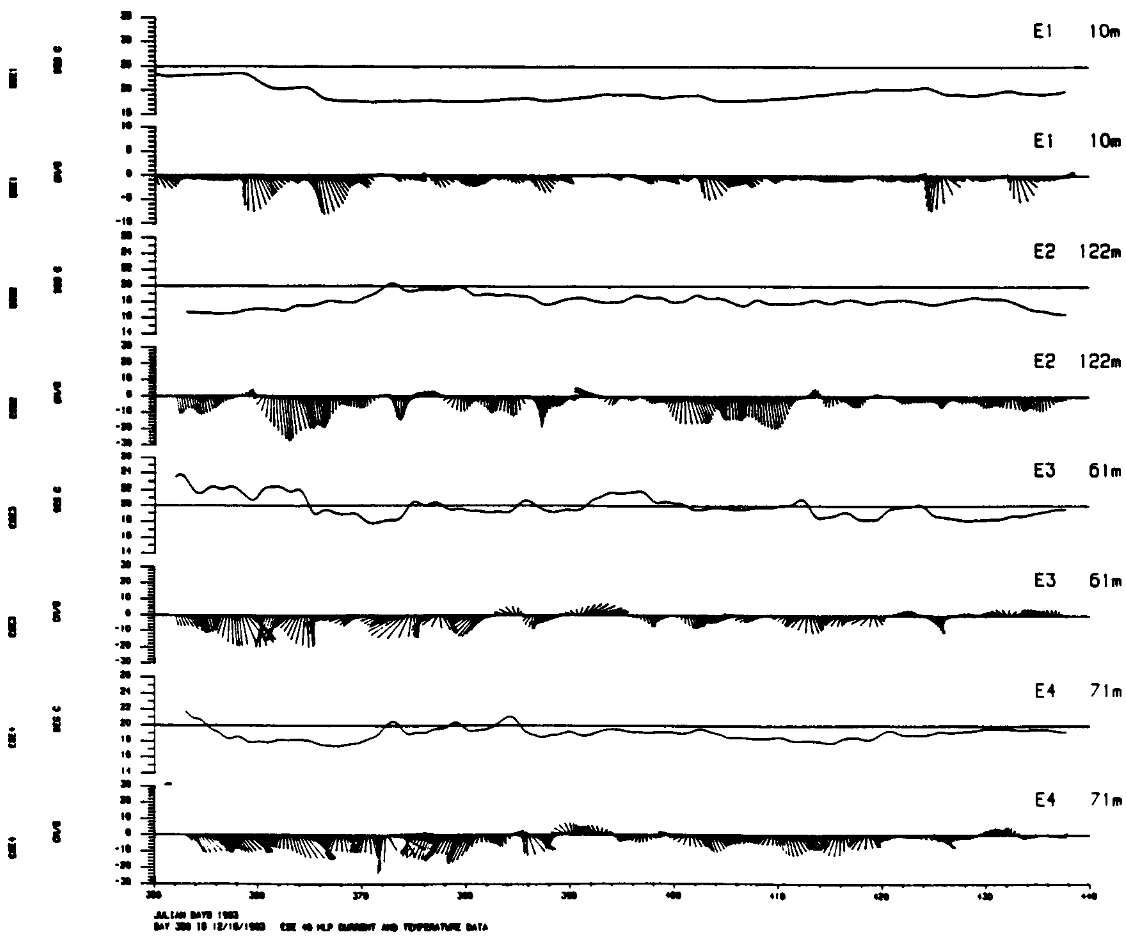

Figure B.1-2. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 12/16/83.

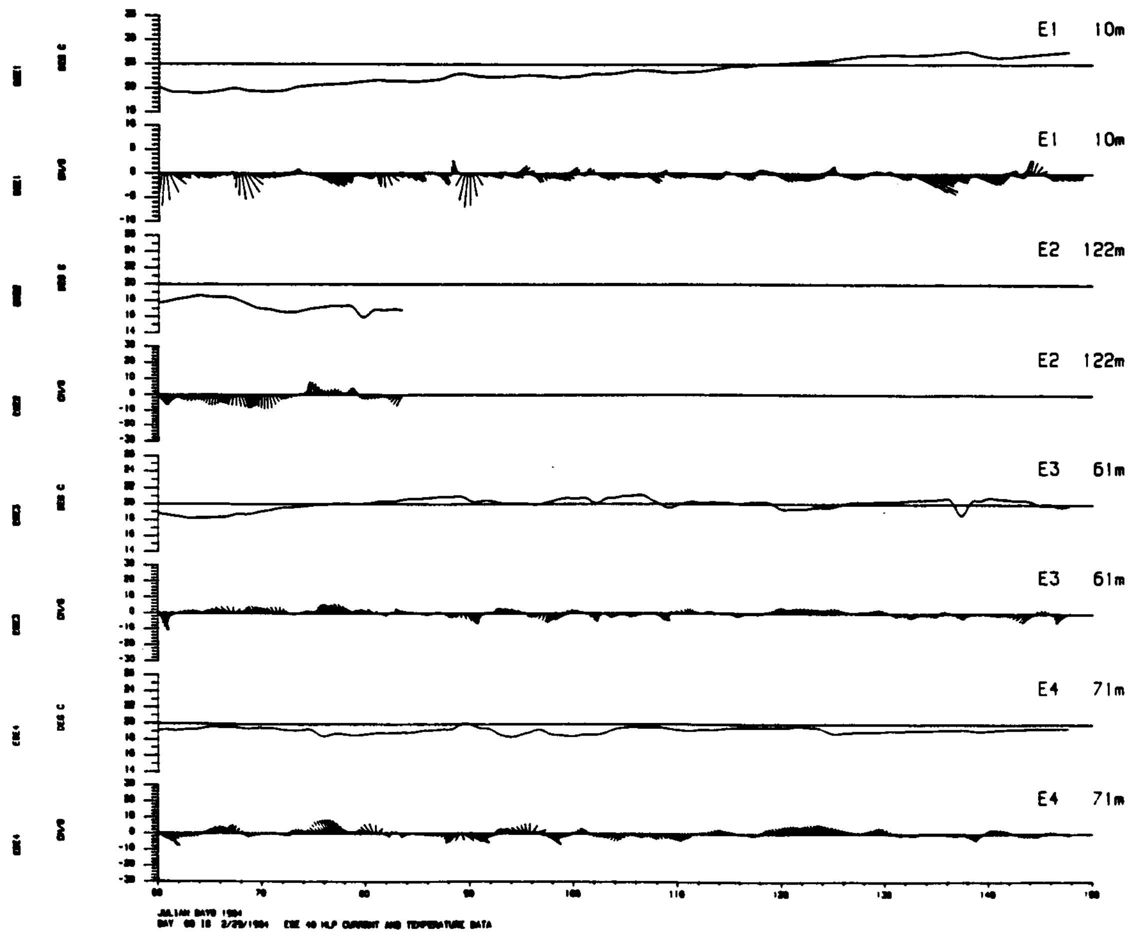

Figure B.1-3. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 2/29/84.

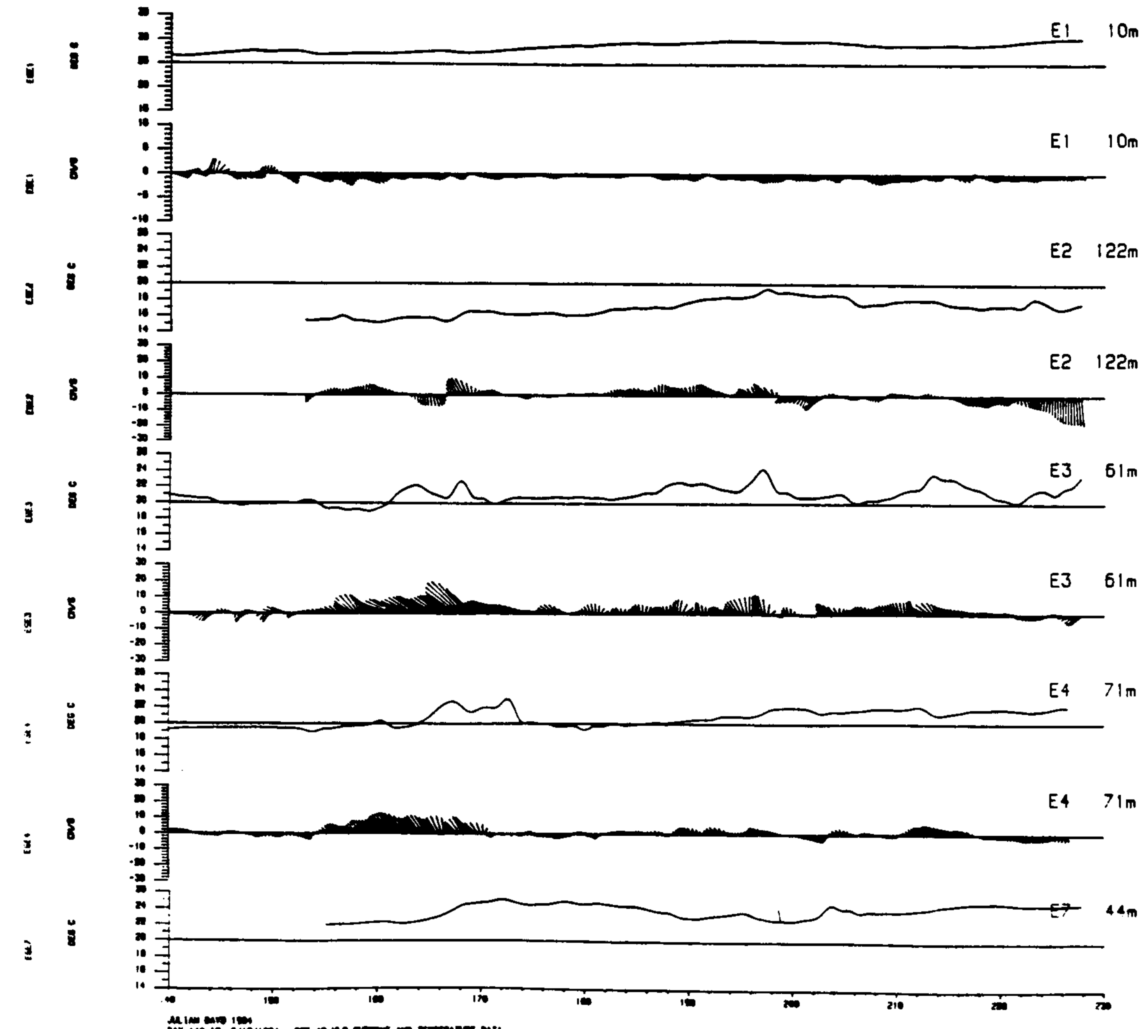

Figure B.1-4. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 5/19/84.

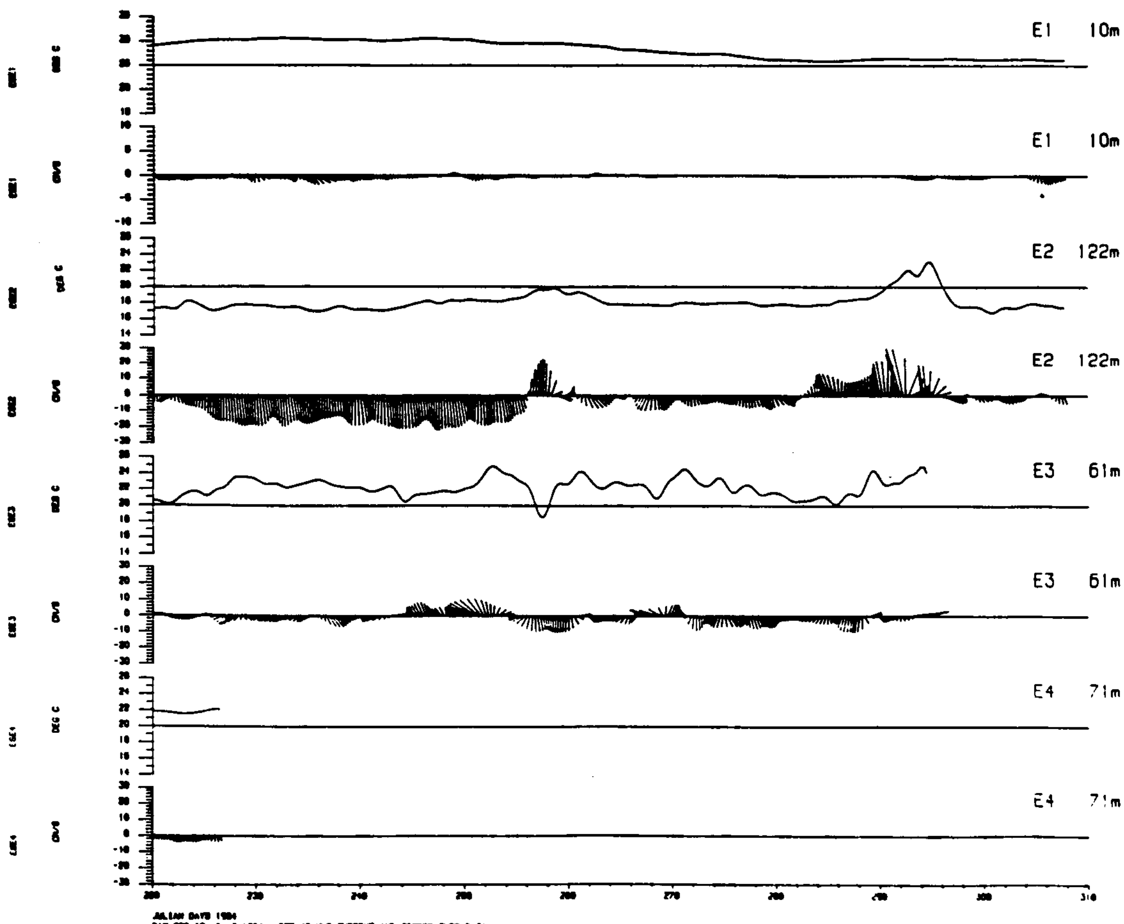

Figure B.1-5. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 8/7/84.

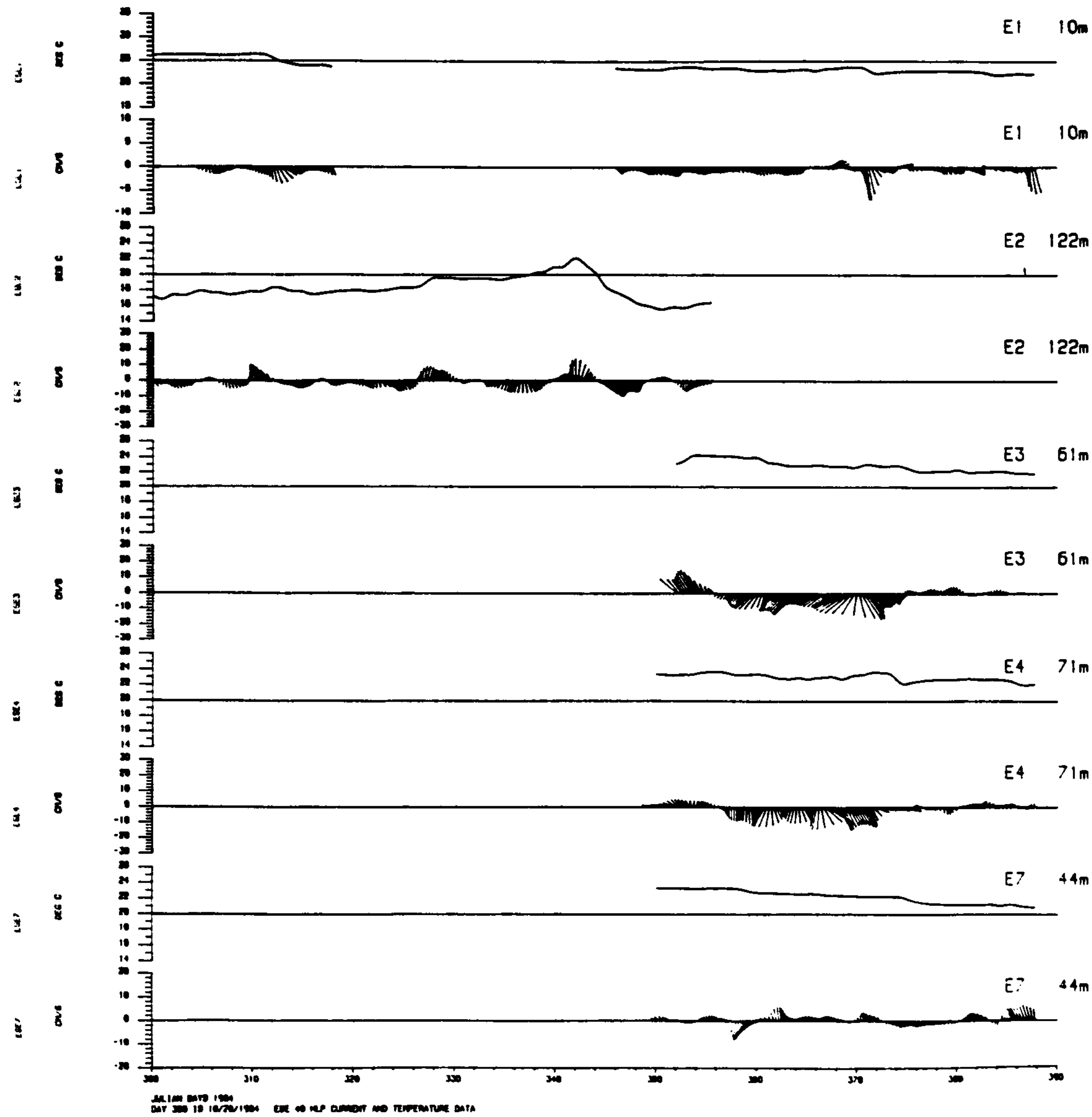

Figure B.1-6. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 10/26/84.

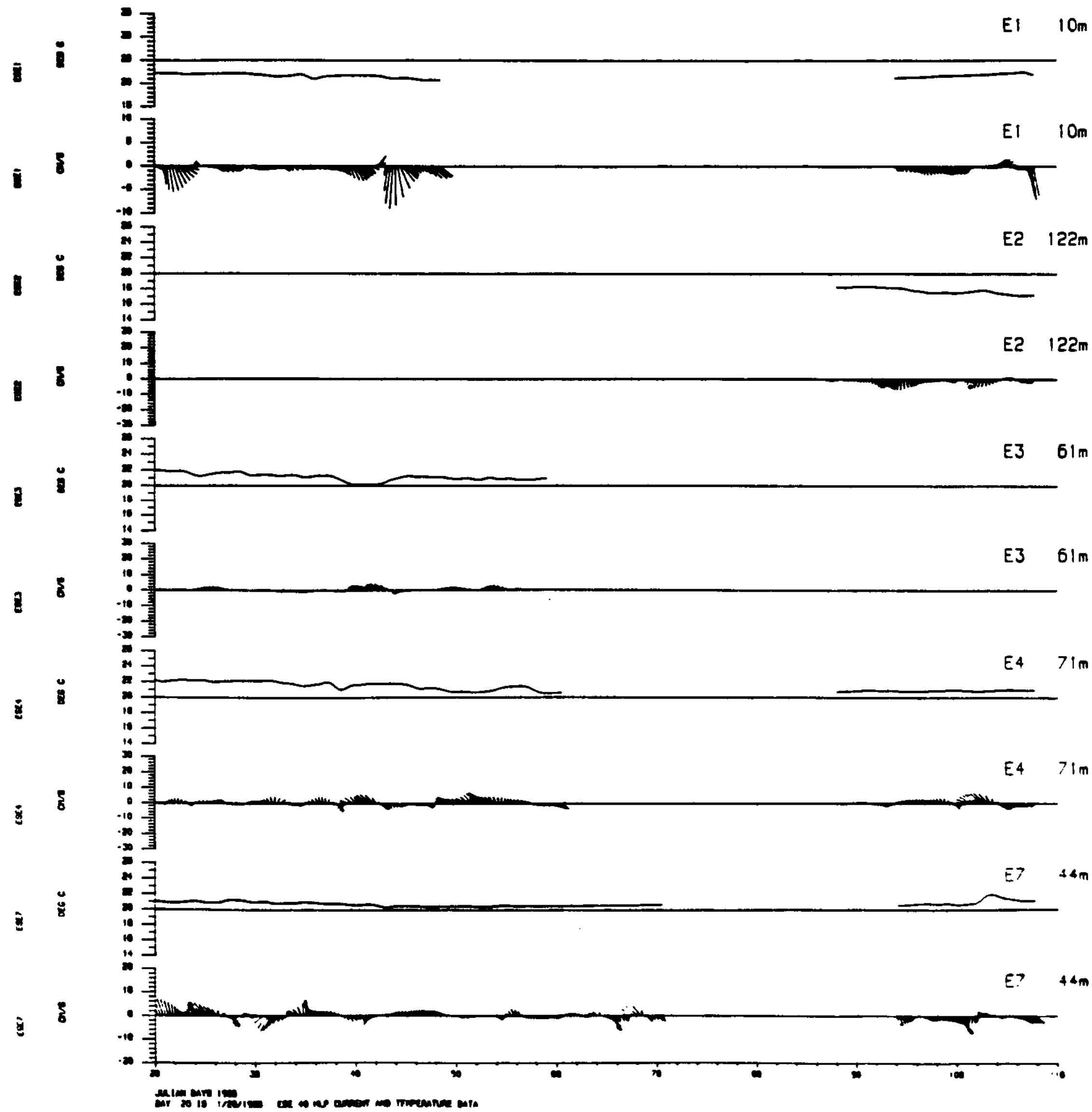

Figure B.1-7. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 1/20/85.

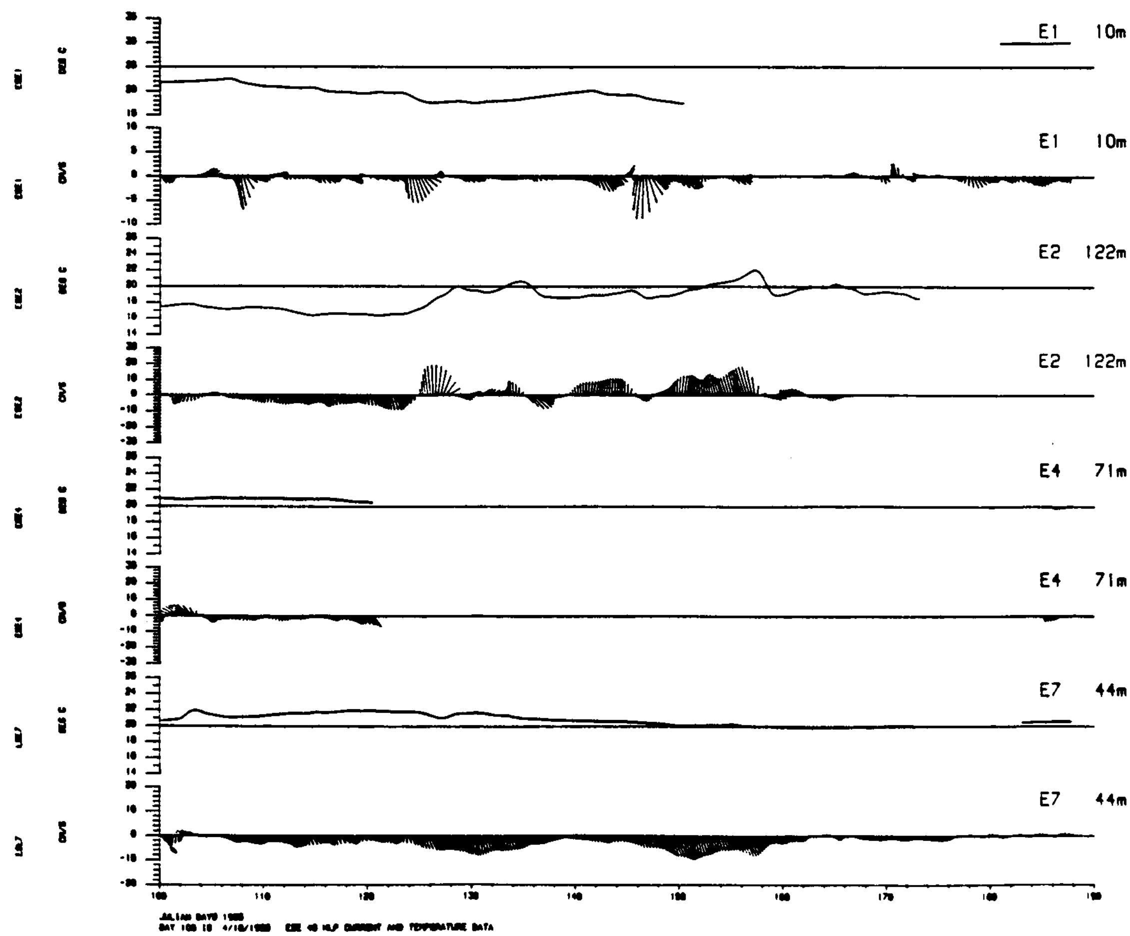

Figure B.1-8. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 4/10/85.

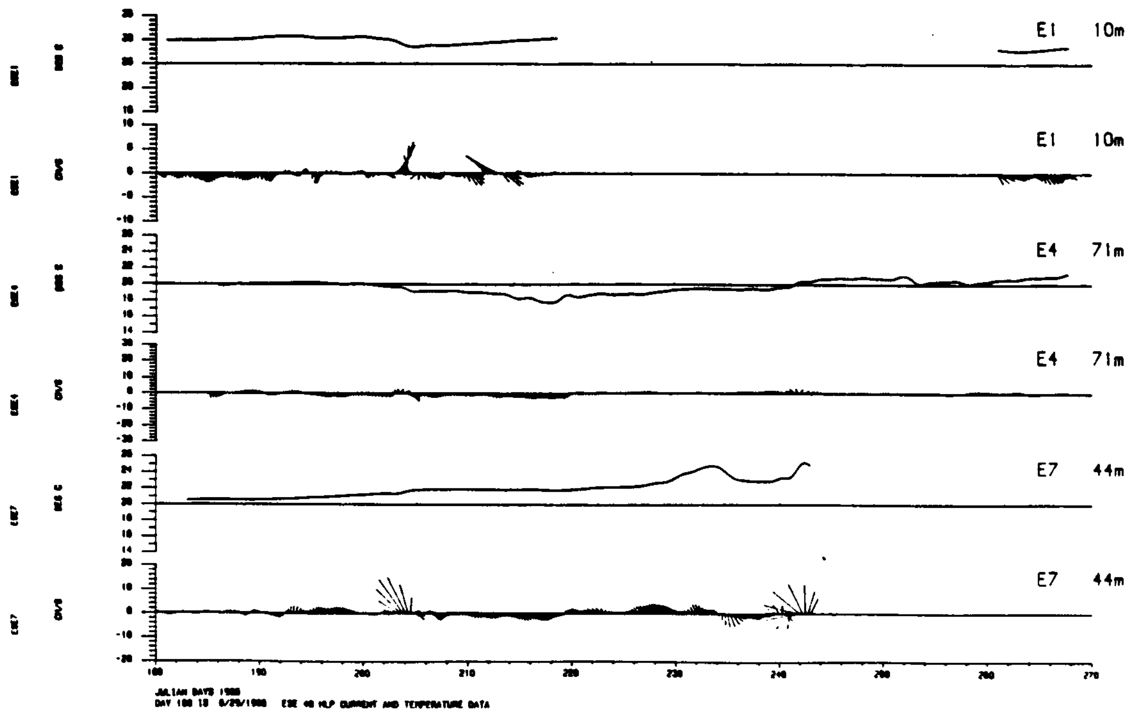

Figure B.1-9. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 6/29/85.

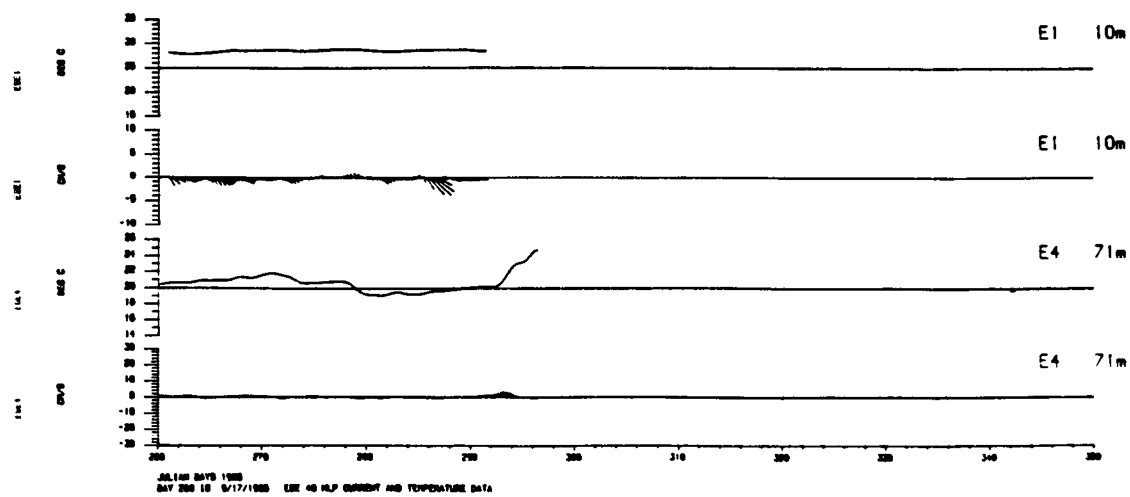

Figure B.1-10. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 9/17/85.

MOORINGS 5, 6 and 8

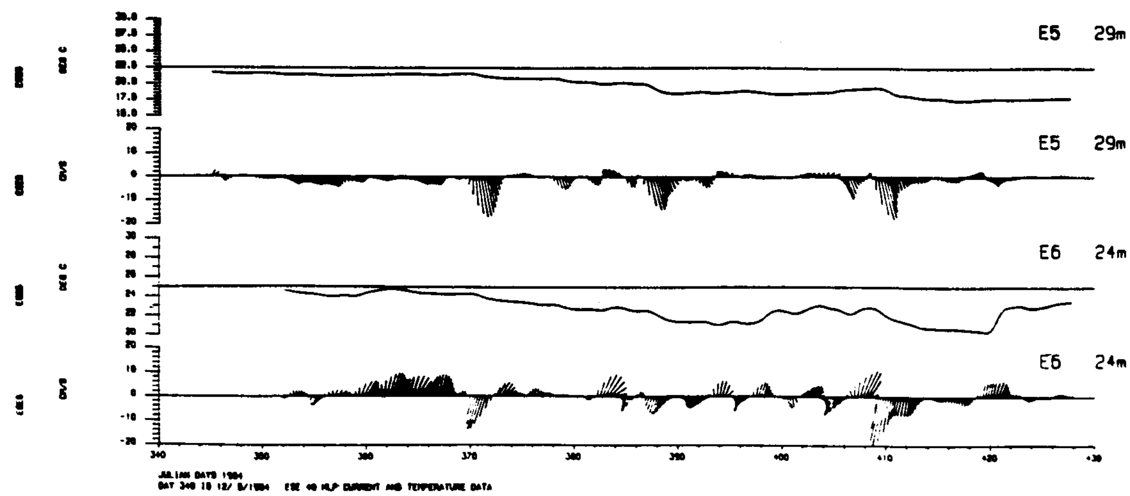

Figure B.1-11. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 12/5/84.

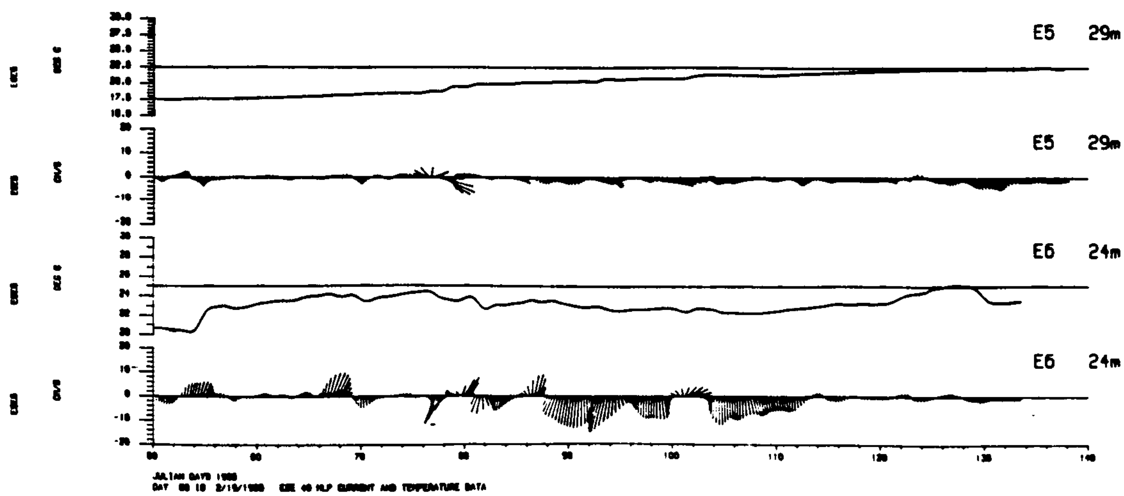

Figure B.1-12. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 2/19/85.

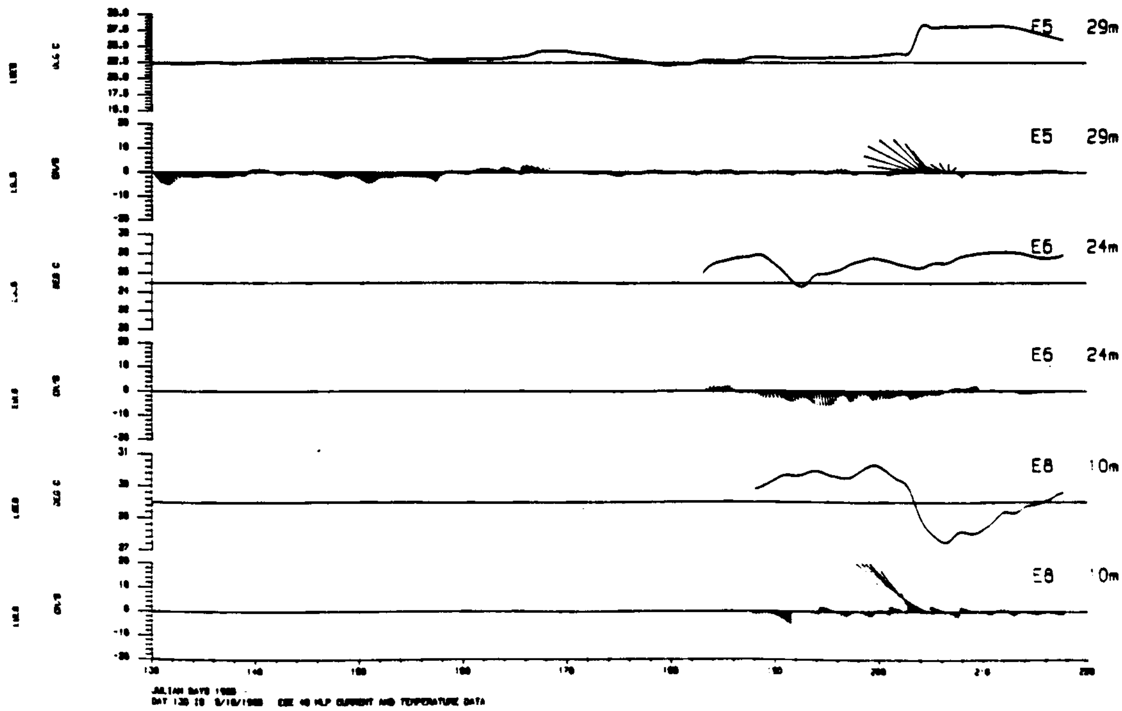

Figure B.1-13. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 5/10/85.

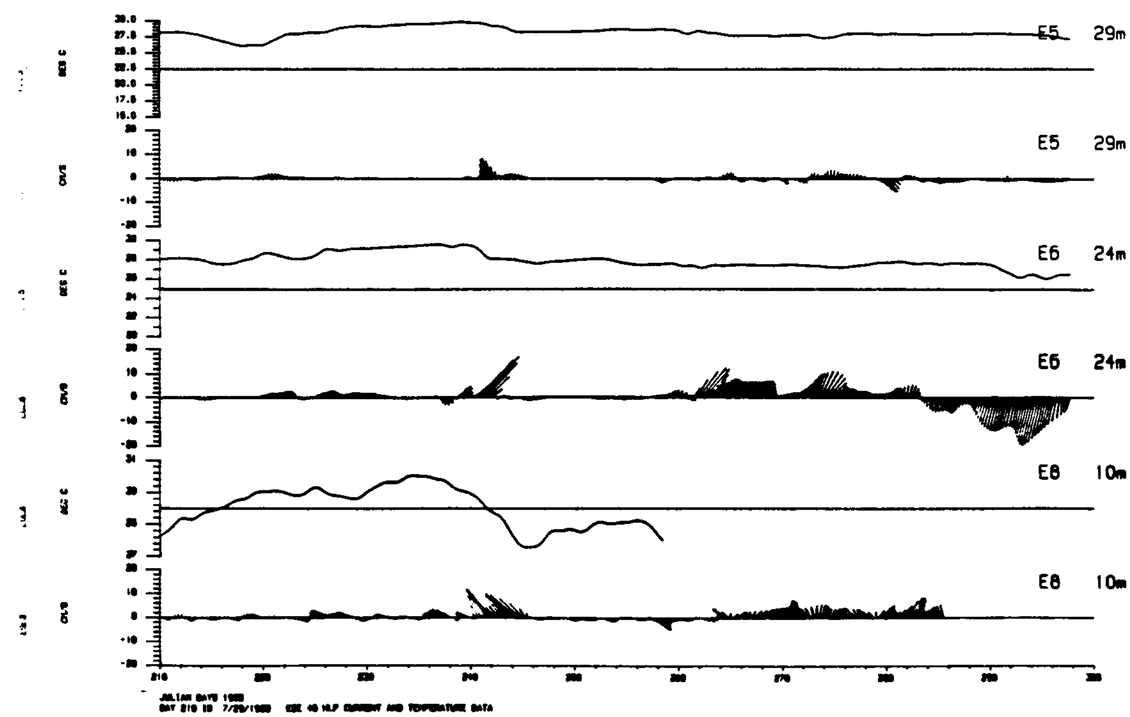

Figure B.1-14. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 7/29/85.

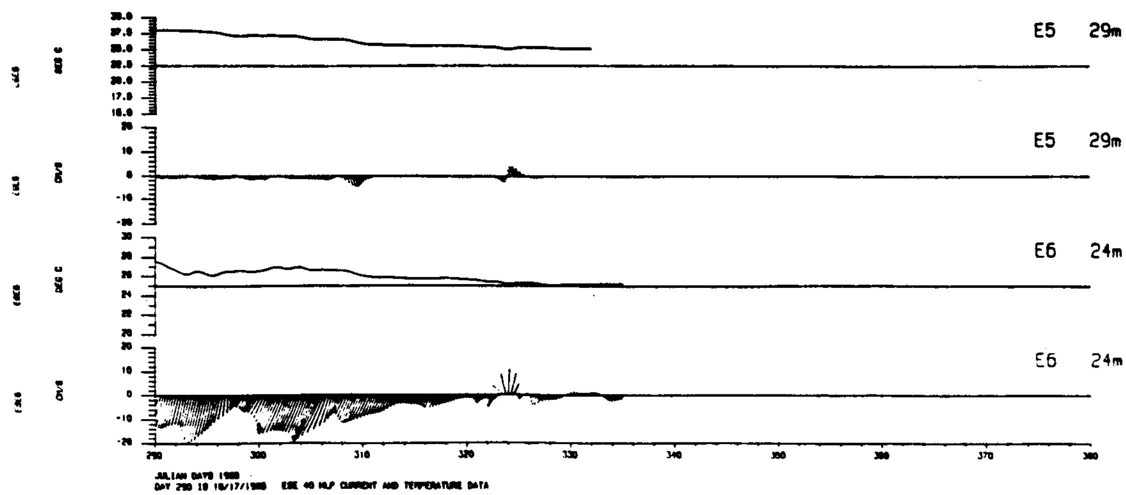

Figure B.1-15. 40 HLP stick plots of ESE velocity and temperature data for the period beginning 10/17/85.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.