WHOI-97-01

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Woods Hole Oceanographic Institution

Trans-Equatorial Bottom Water Flow in the Western Atlantic, Volume XLVI in a series of reports presenting data from moored current meters.

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Susan A. Tarbell, John A. Whitehead, Melinda M. Hall
and Michael S. McCartney

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Technical Report

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Approved for Distribution:

Philip L. Richardson, Chair
Department of Physical Oceanography

Table of contents

Abstract

Current and temperature measurements from Vector Averaging Current Meters (VACMs) deployed from September 1992 to June 1994 as part of the Deep Basin Experiment (DBE) measuring the trans-equatorial water flow are presented. Salinity and temperature measurements from Conductivity/Temperature/Depth (CTD) casts taken during the mooring deployment and recovery cruises are also presented.

Six mooring sites were occupied with a total of 24 vector averaging current meters and 4 Aanderaa current meters. Three nominal depths (3900, 4100 and 4300 m.) were occupied on each mooring. Three of the 6 moorings had current meters at additional depths.

Basic data from the vector averaging current meters are presented both in statistical tables and graphically as histograms, scatter plots, progressive vector diagrams and spectral diagrams. One day Gaussian filtered plots are shown in composite displays of variables versus time.

Temperature and salinity profiles and θ/S plots for 22 CTD stations are presented.

Acknowledgments

The principal responsibility for the current meter preparations, deployment, and recovery was borne by Scott E. Worrilow. We thank him for outstanding performance of the sensors with over 99% data recovery. Richard Limeburner conducted the data acquisition and processing for both cruises. The quality of the data is superb and we thank him for an excellent job. We also must thank the officers and crew of the R/V Columbus Iselin, Michael Dick, Master, and the officers and crew of the R/V Knorr, Captain Carl F. Swanson, Master, for smooth operations and wonderful cooperation. Research supported by the Division of Ocean Sciences, National Science Foundation grant OCE-9105834.

Preface

This volume is the 46th in a series of technical reports presenting moored current meter and associated data collected by the WHOI Buoy Group.

Associated reports include a data directory and bibliography for the years 1963-1978 which has been published as WHOI technical report 79-88 and a technical memorandum, WHOI-3-88 which describes the WHOI Buoy Group current meter data processing system for VAX /VMS operating system.

Volume No.	WHOI ref. No.	Author	Years	Experiment Name
I	65-44	Webster, F., and N. P. Fofonoff	1963	miscellaneous
II	66-60	Webster, F., and N. P. Fofonoff	1962-4	near Bermuda
III	67-66	Webster, F., and N. P. Fofonoff	1964	miscellaneous
IV	70-40	Pollard, R.	1965	miscellaneous
V	71-50	Tarbell, S., and F. Webster	1966	miscellaneous
VI	74-4	Tarbell, S.	1967	miscellaneous
VII	74-52	Chausse, D., and S. Tarbell	1968	miscellaneous
VIII	75-7	Pollard, R., and S. Tarbell	1970	Site D array
IX	75-68	Tarbell, S., M. G. Briscoe and D. Chausse	1973	IWEX
X	76-40	Tarbell, S.	1969	misc. early 1969
XI	76-41	Tarbell, S.	1969	misc. late 1969
XII	76-101	Chausse, D., and S. Tarbell	1973	MODE
XIII	77-18	Tarbell, S., and A. Whitlatch	1970	miscellaneous
XIV	77-41	Tarbell, S., R. Payne, and R. Walden	1976	Mooring 952
XV	77-56	Tarbell, S., and A. Whitlatch	1971	miscellaneous
XVI	78-5	Tarbell S., and A. Spencer	1971-5	MODE-Site
XVII	78-49	Tarbell S., A. Spencer and R. Payne	1975-7	POLYMODE Array II
XVIII	79-65	Tarbell, S., M. G. Briscoe and R. A. Weller	1978	JASIN
XIX	79-34	Spencer, A., C. Mills and R. Payne	1974-5	POLYMODE Array I
XX	79-56	Spencer, A.	1974	Rise Array
XXI	79-85	Mills, C., and P. Rhines	1978	W.B.U.C
XXII	79-87	Tarbell, S. and R. Payne	1973	miscellaneous
XXIII	80-40	Tarbell, S.	1977-9	POLYMODE Array III
XXIV	80-41	Spencer, A., K. O'Neill and J. Luyten	1976	Indian Ocean Array
XXV	81-12	Spencer, A., E. D'Asaro and L. Armi	1966-7	benthic boundary
XXVI	81-45	Chausse, D., and R. Payne	1972	miscellaneous
XXVII	81-68	McKee, T., E. Francis, and N. Hogg	1975-7	miscellaneous
XXVIII	81-73	Mills, C., S. Tarbell, and R. Payne	1978	L.D.E
XXIX	82-16	Levy, E. et al.	1979	INDEX
XXX	82-43	Levy, E., S. Tarbell and N. P. Fofonoff	1979-80	GSE/NSOI
XXXI	83-30	Levy, E. and S. Tarbell	1980-2	WESPAC
XXXII	83-46	Levy, E.	1979	Vema Channel
XXXIII	84-6	Spencer, A., D. Chausse and W. B. Owens	1981	N.P.B.C.

XXXIV	84-16	Levy, E. and P. L. Richardson	1983	SEQUAL I
XXXV	84-36	Tarbell, S., N. J. Pennington and M. G. Briscoe	1982-4	LOTUS
XXXVI	84-37	Levy, E., and P. L. Richardson	1983-4	SEQUAL II
XXXVII	85-7	Levy, E., and P. L. Richardson	1984	SEQUAL III
XXXVIII	85-39	Tarbell, S., E. T. Montgomery & M. G. Briscoe	1983-4	LOTUS
XXXIX	86-14	Levy, E., and S. Tarbell	1983-4	HEBBLE
XL	87-19	Tarbell, S., P. L. Richardson and J. Price	1984-6	Canary Basin
XLI	87-20	Levy, E., and S. Tarbell	1983-5	Zonal Pacific
XLII	90-30	Luyten, J., et al.	1985-7	Agulhas
XLIII	90-18	Crescenti, G. H., S. Tarbell and R. A. Weller	1988-9	SESMOOR
XLIV	93-01	Tarbell, S., S. Worrilow and N. Hogg	1987-91	SYNOP
XLV	94-07	Tarbell, S., R. Meyer, N. Hogg, and W. Zenk	1991-2	Deep Basin

Presentation

The printed portion of this report contains introductory text, information about the instruments, data processing procedures, data quality assessments and composite plots of data. Tables and figures give information on moorings, instruments and CTDs.

All of the printed pages are included on the first page of the microfiche. Also included on the first fiche are the cruise reports for the deployment and recovery of the current meter moorings. Pagination of the fiche consists of a three part field, the fiche number, the row letter and the column number.

The second and third pages of fiche present data for the individual current meters. Each row of the fiche presents a different type of display, for instance, statistics are shown in row 'A'. Each column shows the variety of displays for the time series from a single instrument. Figure 1 shows the layout of the three fiche pages. Fiche 2 and 3, shown in the lower panel, have the same layout.

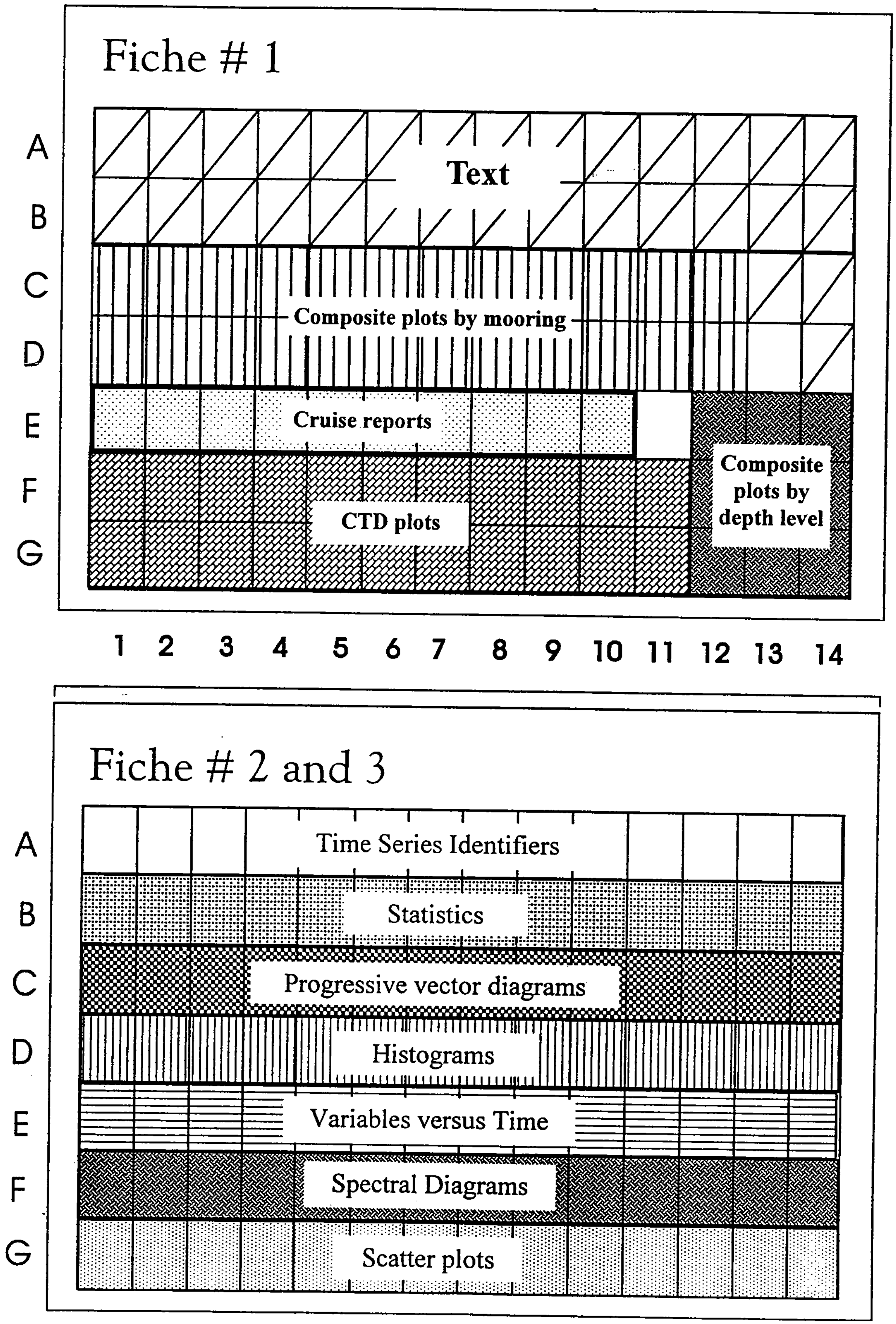

Figure 1 **Fiche diagrams**

Introduction

This program is a part of the Deep Basin Experiment of the World Ocean Circulation Experiment (WOCE). A description of the overall objectives of the experiment is given by Hogg et al., 1996. The objective of this part of the program was to measure the northward flow of Antarctic Bottom Water (AABW) out of the Brazil Basin in the South Atlantic and into the Guiana Basin in the North Atlantic. A current meter array of six moorings was set for about 600 days across the opening at the Equator between the Brazil Basin and the Guiana Basin west of the Mid-Atlantic Ridge. CTD profiles were taken near each mooring and between mooring locations to measure water properties during the current meter deployment cruise, approximately one month prior to mooring recovery (Smethie, 1996), and during the recovery cruise.

The mooring array was designed to extend in a north-south direction at 36° W with 6 moorings equally spaced between 1° N and 1°30' S (Figure 2). These locations evenly filled the passage between the Brazil and Guiana Basins from north to south, and put the array at approximately the east-west center of the almost perfectly zonal gap that steers the Antarctic Bottom Water. The depths of the Vector Averaging Current Meters (VACMs) were chosen to optimize measurement of the AABW. All six moorings had current meters placed at roughly 3900, 4100 and 4300 meter depths. The two moorings at roughly 1° N and S of the equator each had an additional VACM close to 3300 meters in depth to provide more information about the vertical shear and levels of no motion. One mooring, placed almost exactly on the equator, had VACMs at 2993, 3593 and 4485 meters in addition to the nominal depths mentioned above. Also on the equatorial mooring were four Aanderaa current meters, placed at shallower levels for use by scientists at the Institute für Meereskunde, Kiel, Germany (Fischer and Schott, 1997).

The deployment cruise on R/V Columbus Iselin, cruise CI 92-10, left Bridgetown, Barbados on September 18, 1992 and arrived in Recife, Brazil on October 9, 1992. Six moorings (#936 to #941) with a total of 24 VACMs were deployed. The mooring deployments went as planned for moorings 936, 937 and 939. Mooring 938 anchored about 5 miles west of the planned location due to a strong surface current. The designated location of mooring 940 at 01° 00' S was a little shallower than desired so the mooring was placed about 3 miles NW of the planned location. Mooring 941 was placed near 01° 20' S and 36° 05'W rather than 1° 30' S to place the mooring out of Brazilian waters as the government of Brazil did not grant clearance to deploy within their waters. Eleven CTD stations were taken near and between the mooring positions.

The recovery cruise, from Salvador, Brazil to Bridgetown, Barbados, took place from 27 May to 13 June, 1994 on RV Knorr, cruise 142-4. Every current meter was recovered, although mooring 941 had a failed release, due to a fractured end cap, and had to be recovered by dragging grappling hooks and depressor weights to snag the mooring. As before, a complete bathymetric profile was taken and eleven CTD casts were made at and between each mooring site. The CTD casts at mooring sites were made before mooring recovery so that VACM recorded temperatures and CTD temperature profiles could be compared.

The principal topic of this report will be the graphical displays of up to 610 days of current meter measurements per VACM. In addition, CTD station data plots will be presented.

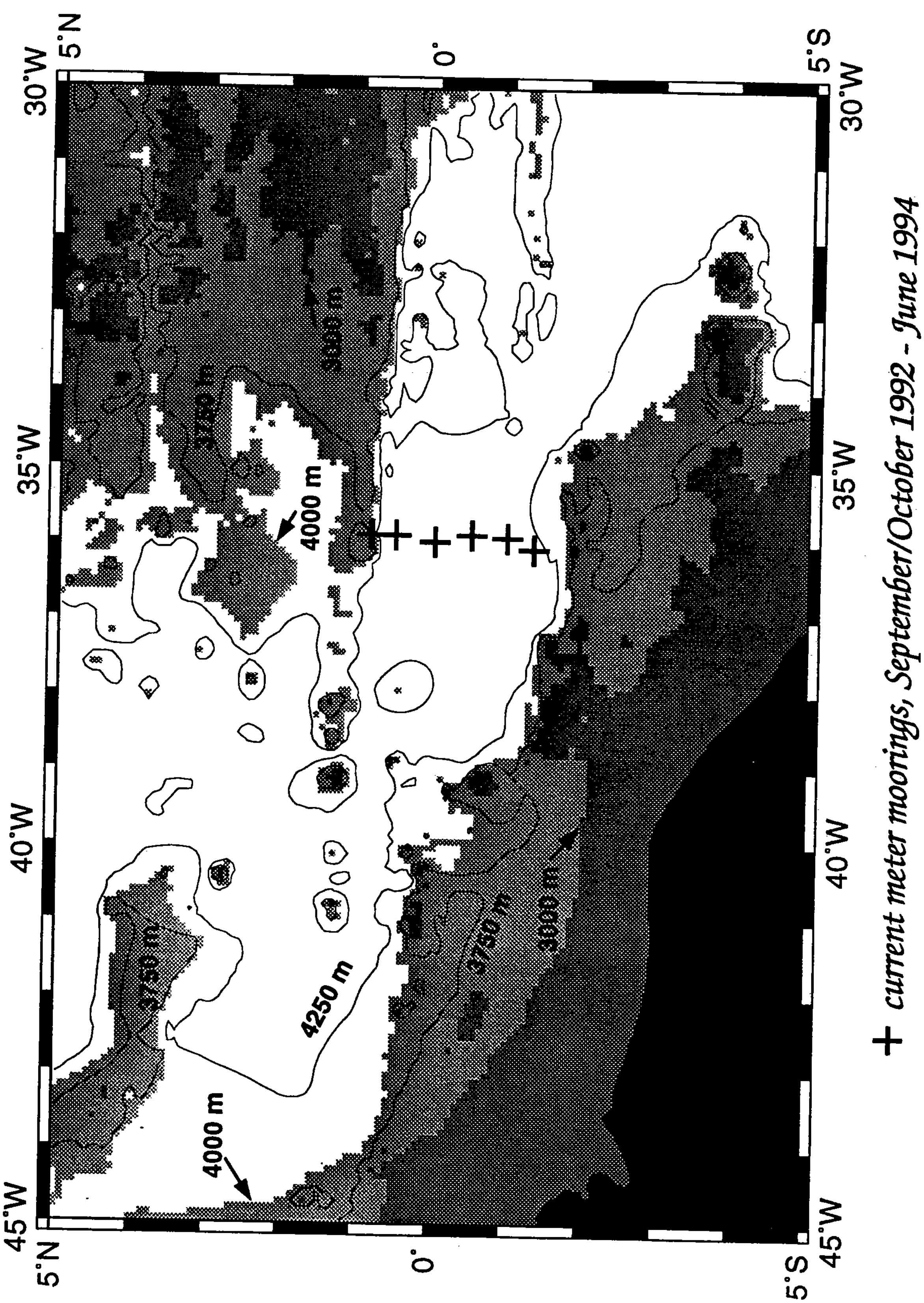

Figure 2 **Mooring positions for the Trans-Equatorial water flow**

The principal scientific results of the experiment are described by Hall, McCartney and Whitehead (1997) and can be summarized as follows:

1) Below θ=1.8° C. an average of $2.0 \times 10^{6} m^{3} sec^{-1}$ of AABW passes westward during the ~600 day array duration.

2) The westward AABW flow is persistent and strong at and south of the equator, but north of the equator the AABW flow is weak (neither persistent in direction, nor organized) and is negligible in transport.

3) Immediately above the AABW the Lower North Atlantic Deep Water flows strongly eastward in a boundary layer approximately 200 km wide, with eastward flow intensified to the south at the Parnaiba Ridge.

4) There is a quasi-annual signal in the AABW transports, with maxima occurring in September/October and minima occurring in February/March. The Lower North Atlantic Deep Water (LNADW) also displays quasi-annual variability, with strong flow episodes in April/May.

5) Both the hydrographic surveys and the temperature time series from the moored current meters show that the water below 3900m warms over the observation period (equivalently, isotherms lowered 50 to 80 meters).

Other scientific activities were undertaken on the cruises that set and recovered the moorings. For the cruise of the R/V Columbus Iselin these include the recovery of six SOFAR float listening stations that were part of the 1989-1992 Tropical Atlantic Experiment (Richardson et al., 1994). In addition sixteen RAFOS floats and three sound source moorings were launched as part of the WOCE Deep Basin Experiment (contact B. Owens, N. Hogg at W.H.O.I.). During the R/V Knorr cruise an unsuccessful attempt was made to recover a sediment trap during the steam to Barbados. In addition, the shipboard ADCP was calibrated in shallow waters off Barbados.

CTDs

Conductivity/Temperature/Depth (CTD) profiles were taken in the vicinity of and between each mooring during both the mooring launch and mooring recovery cruises. Table 1 lists the CTD station locations and the associated mooring number.

On the deployment cruise the hydrographic profiles were made using the R/V Iselin's NBIS Mark III CTD underwater unit, an NBIS Mark V deck unit in an 1150 configuration and a General Oceanics Rosette sampling system with 12 ten liter Niskin bottles. An acoustic pinger was used for bottom ranging with depths corrected for sound speed using Matthew's Tables and adding 3m for transducer depth.

The profiles taken on the recovery cruise used an NBIS Mark III underwater unit, an NBIS Mark III deck unit and a General Oceanics 1015 Rosette sampling system with 12 1.2 liter Niskin bottles. A Guildline salinometer was used to calibrate the salinities from the CTD. An acoustic pinger was used for bottom ranging with the depths corrected for sound speed; the corrections were calculated from the CTD data.

The CTD data represent full water column measurements of the temperature and salinity structure of the equatorial system near 36°W. Figures 3 a, b and c show the potential temperature distribution below 3000 meters for the three CTD sections with superimposed current meter locations. Discussions of older hydrographic data at and near this location may be found in articles by McCartney (1993), McCartney and Curry (1993), and Rhein, et al. (1995,1996).

Table 1 CTD Stations

R/V Columbus (cruise 92 10)

The temperature and salinity plots from these CTD stations are printed at the end of this report.

Station	Latitude	Longitude	Date 1992	Station Depth	Associated Mooring #
4	0 51.14 N	35 53.86 W	Sept. 28	4463	936
5	0 30.72 N	35 54.39 W	Sept. 28	4525	937
6	0 41.04 N	35 52.79 W	Sept. 29	4523	
7	0 00.34 N	35 54.24 W	Sept. 29	4525	938
8	0 15.84 N	35 54.58 W	Sept. 30	4527	
9	0 15.03 S	35 53.79 W	Sept. 30	4515	
10	0 30.08 S	35 55.13 W	Sept. 30	4490	939
11	0 44.74 S	35 54.59 W	Sept. 30	4413	
12	0 59.82 S	35 53.51 W	Oct. 1	4281	940
13	1 14.77 S	35 54.42 W	Oct. 1	4424	
14	1 19.14 S	36 04.32 W	Oct. 1	4441	941

Table 1 continued

R/V Knorr (cruise 142-3)

The temperature and salinity plots from these CTD stations are <u>not</u> shown in this report.

Station	Latitude	Longitude	Month 1994	Station Depth
10	1 31.95 S	35 56.90 W	Apr.	4058
11	1 39.51 S	35 57.10 W	Apr.	4243
12	1 20.04 S	35 56.79 W	Apr.	4381
13	0 59.04 S	35 57.12 W	Apr.	4460
16	0 14.95 S	35 57.21 W	Apr.	4582
17	0 00.01 N	35 56.97 W	Apr.	4597
18	0 14.97 N	35 57.00 W	Apr.	4596
19	0 30.00 N	35 56.99 W	Apr.	4606
20	0 39.97 N	35 56.94 W	Apr.	4600
21	0 51.91 N	35 56.87 W	Apr.	4527

R/V Knorr (cruise 142-4)

The temperature and salinity plots from these CTD stations are printed at the end of this report.

Station	Latitude	Longitude	Date 1994	Station Depth	Associated Mooring #
1	1 37.28 S	36 02.33 W	May 30	4205	
2	1 19.57 S	36 05.29 W	May 31	4439	941
3	0 58.81 S	35 55.96 W	May 31	4381	940
4	0 29.91 S	35 53.95 W	May 31	4470	939
5	0 14.86 S	35 59.70 W	June 1	4494	
6	0 00.02 S	35 55.17 W	June 1	4517	938
7	0 15.29 N	35 59.75 W	June 1	4519	
8	0 29.94 N	35 54.17 W	June 1	4525	937
9	0 45.17 N	35 59.54 W	June 2	4519	
10	0 50.26 N	35 50.62 W	June 2	4468	936
11	0 44.93 S	35 54.06 W	June 2	4451	

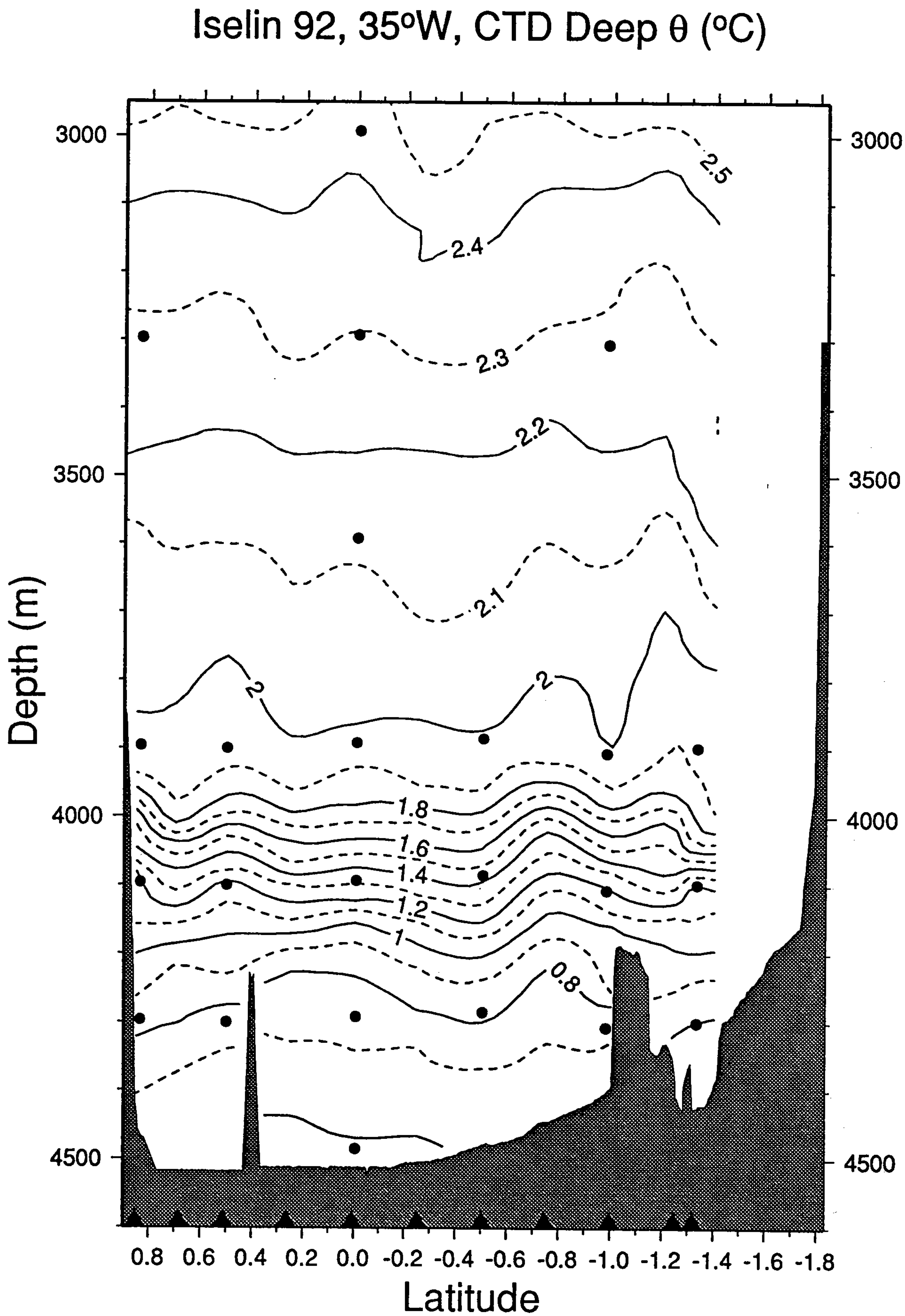

figure 3a - sections of deep θ taken during the mooring deployment cruise in September 1992. Filled circles indicate current meter locations; filled triangles indicate CTD casts

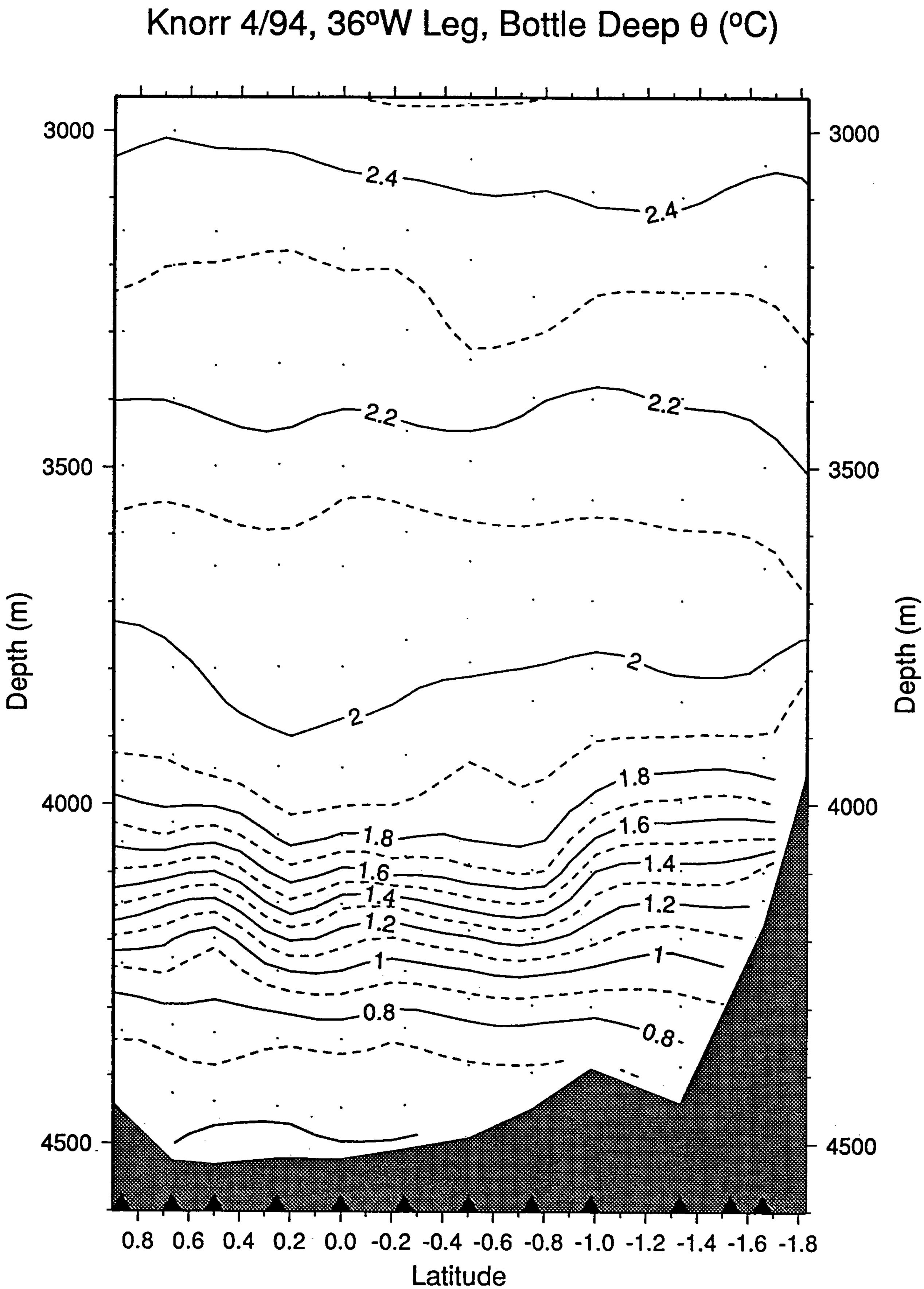

figure 3b - sections of deep θ taken in April 1994

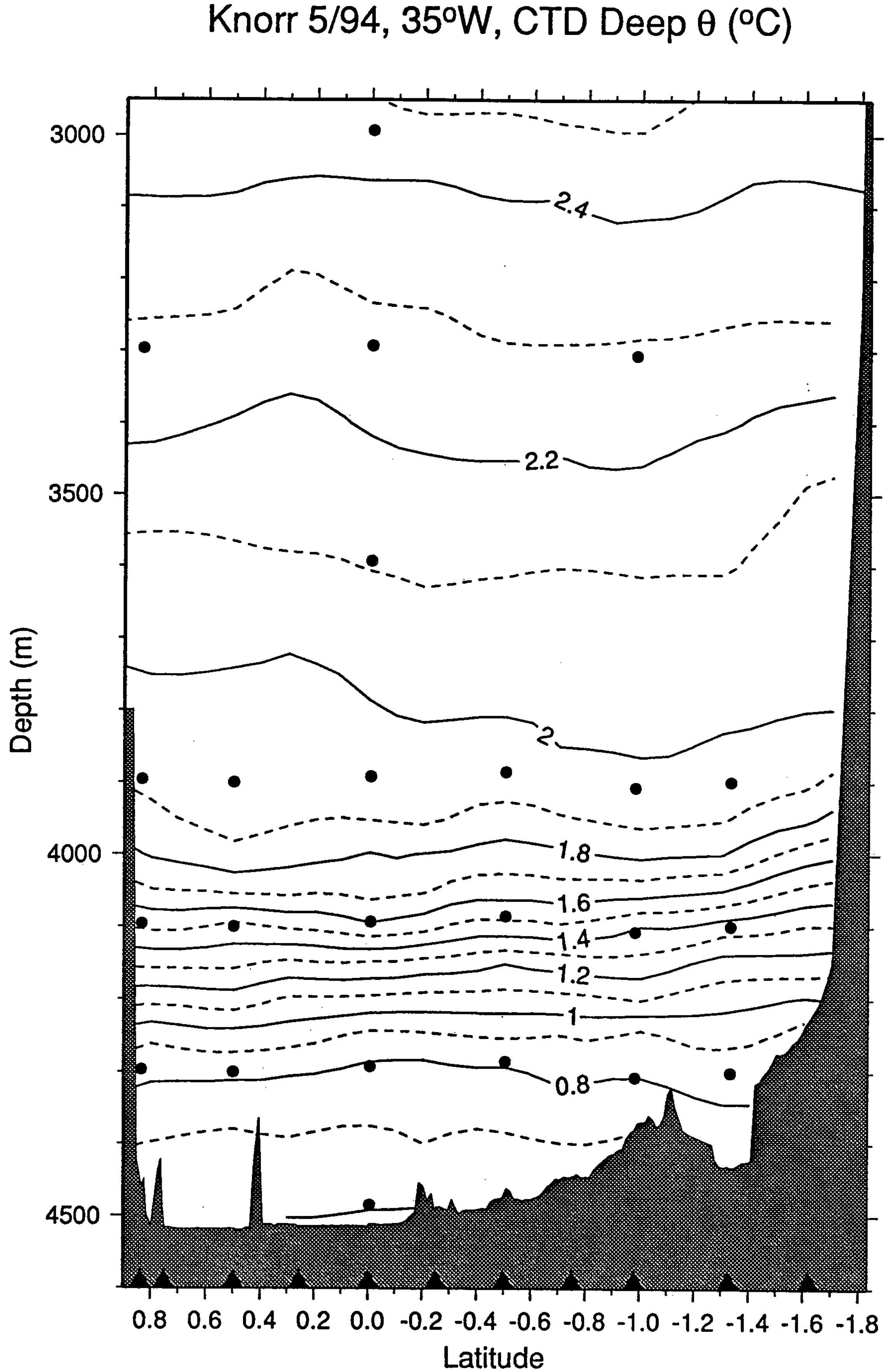

figure 3c - sections of deep θ taken during the mooring recovery cruise in May-June 1994

Moorings

Mooring locations are shown in Figure 2. Mooring latitude, longitude, deployment and recovery times are listed in Table 2. The moorings were set and recovered by Scott Worrilow using the R/V Iselin (cruise CI 92-10) from the University of Miami for the deployment cruise and the R/V Knorr (cruise 142-4) from the Woods Hole Oceanographic Institution for the recovery cruise. Mooring 938 was located about 5 miles west of the planned site due to a swift surface countercurrent affecting the deployment. The site for mooring 940 was deliberately shifted due to a bump in the sea floor, and the site for 941 was repositioned to be outside Brazilian waters.

Table 2 Mooring location and duration

Mooring #	Latitude	Longitude	Mag. Var.	Set 1992 mon,day,hr	Recovery 1994 mon,day,hr	Water Depth (m)
936	0 50.16 N	35 54.02 W	21w	Sep. 28, 14	Jun. 2, 09	4486
937	0 30.10 N	35 54.17 W	21w	Sep. 28, 22	Jun. 1, 19	4540
938	0 00.28 S	35 59.46 W	21w	Sep. 29, 21	Jun. 1, 10	4536
939	0 30.05 S	35 54.06 W	21w	Sep. 30, 16	May 31, 20	4485
940	0 58.80 S	35 55.95 W	21w	Oct. 1, 03	May 31, 12	4396
941	1 19.90 S	36 04.94 W	21w	Oct. 1, 19	Jun. 3, 21	4449

Times are in GMT.

The moorings in this experiment were standard WHOI Buoy Group subsurface moorings as described by Heinmiller (1976). Details of the mooring configurations are shown in Table 3.

Table 3 Itemized list of mooring components for each mooring

Item	936	937	936	939	940	941
--------------------	----	-----	-----	-----	-----	----
3 ball float depth	3251m	3854m	1256m	3839m	3261m	3854m
1/2" chain	3.	3.	3.	3.	3.	3.
transponder	.5	.5	.5	.5	.5	.5
17" glass balls	19.	19.	33.	19.	19.	19.
Aanderaa CM			1.			
3/16" wire			198.			
Aanderaa CM			1.			
3/16" wire			198.			
Aanderaa CM			1.			
3/16" wire			193.			
17" glass balls			5.			
Aanderaa CM			1.			
3/16" wire			1000.			
3/16" wire			85.			
17" glass balls			5.			
VACM @3000			1.8			
3/16" wire	20.	20.	296.	20.	20.	20.
VACM @3300	1.8		1.8		1.8	
3/16" wire			292.		590.	
17" glass balls			4.			
VACM @3600			1.8			
3/16" wire	590.		295.			
17" glass balls	5.				5.	
VACM @3900	1.8	1.8	1.8	1.8	1.8	1.8
3/16" wire	197.	197.	193.	197.	197.	197.
17" glass balls			4.			
VACM 4100	1.8	1.8	1.8	1.8	1.8	1.8
3/16" wire	179.	179.	176.	179.	179.	179.
17" glass balls	15.	15.		15.	15.	15.
3/8" chain	3.	3.		3.	3.	3.
VACM 4300	1.8	1.8	1.8	1.8	1.8	1.8
3/16" wire			100.			
3/16" wire			50.			
3/16" wire			20.			
17" glass balls			16.			
1/2" chain	3.	3.	3.			
VACM @4500			1.8			
1.2" chain			3.	3.	3.	3.
Release	1.8	1.8	1.8	1.8	1.8	1.8
1/2" chain	5.	5.	5.	5.	5.	5.
1/4" wire	100.	100.		100.	50.	100.
1/4" wire	50.	50.		50.		10.
1/4" wire		30.		10.		
1/4" wire		20.	11.			
3/4" nylon	20.	20.	20.	20.	20.	20.
1/2" chain	5.	5.	5.	5.	5.	5.
Anchor with Danforth						
Water depth	4486m	4540m	4536m	4485m	4396m	4449m

Instrument depths

Instruments depths are achieved by determining the water depth at the anticipated anchor launch site, then adding, or deleting, short components of mooring line at the bottom of the mooring string to adjust the overall mooring length (height). The mooring components are all input into program NOYFB (Moller, 1976) which calculates not only the instrument depths but also the buoyancy and mooring performance in different current conditions. Table 4 contains the instrument depths (in meters) for the VACM time series presented in this technical report.

Table 4 Instrument Placement

Mooring #	Instrument depth in meters						
936		3297		3896	4096	4297	
937				3900	4100	4300	
938 *	2993	3293	3593	3892	4093	4292	4485
939				3885	4085	4285	
940		3307		3907	4107	4307	
941				3899	4099	4300	

NOTE: * Four Aanderaa current meters, not described in this report, were included on this mooring at depths of 1293, 1493, 1693, and 1893 meters (Fischer and Schott, 1997)

Vector Averaging Current Meter (VACM)

Vector Averaging Current Meters were developed at WHOI in the early 1970's and were built by EG&G Ocean Products. They use a Savonius rotor to measure current flow, an external vane to measure the instrument's orientation to the current, and an internal compass to measure the instrument's orientation to magnetic north. Temperature is measured with a thermistor mounted in the end cap of the instrument. The VACM uses a crystal-controlled time reference with an accuracy to within one second per day. The 'clock' is synchronized with Universal Temps Coordonne (UTC) before deployment and the accrued error recorded after recovery. The VACM continuously sums vector increments of water flow sensed by the rotor and vane. At regular intervals, for this deployment every half hour, it records on a magnetic tape cassette the accumulated velocity information. The calibration of the VACM and its recording technique were discussed by McCullough (1975). Temperature values are averaged over the entire recording interval for those instruments that do not measure pressure. The instruments that have both a pressure and temperature sensor are multiplexed, that is they time-share the recording interval and average each sensor's input for one half the recording interval. Payne et al. (1976) discussed the accuracy of the temperature measurements. The WHOI temperature sensors were calibrated in the laboratory both before and after deployment. In this deployment several instruments had a pressure sensor which had been left in the instrument from a previous deployment. These shallow water sensors were not changed to deep water sensors as pressure measurements were not required for this experiment.

Current Meter Data Processing

Data from instrument cassettes (VACMs) were read onto a DOS formatted disc. A special interface card in the PC is needed for this transfer. The data were then transferred from the PC disc to a VAX disc in the BUOY format (Maltais, 1969).

Each time series went through a sequence of programs (Tarbell et al., 1988) that checked the time base and converted the data into scientific units. Then the quality of the data was determined (Table 5).

Next the individual variables were edited to remove miscellaneous bad points and the launch and retrieval transients were removed. Finally the Best Basic Version (BBV) was created by linearly interpolating through gaps in the data to make an evenly spaced time series. This series is the basis for all further processing.

Finally a Gaussian filtered series, with a half-width of 24 hours, was created from the BBV and subsampled to have one point a day. The BBV and the Gaussian filtered time series were used to create all the current meter data displays in this report.

Table 5 Current Meter Data quality

Data id.	Instru #	Depth(m)	Therm #	Comments
9361	V-5114	3297	T- 768	807 time interpolations (#1)
9362	V-5117	3896	T- 324	*** Good - no observed problems ***
9363	V-681	4096	T- 361	*** Good - no observed problems ***
9364	V-5102	4297	T- 309	*** Good - no observed problems ***
9371	V-436	3900	T- 237	*** Good - no observed problems ***
9372	V-645	4100	T- 376	*** Good - no observed problems ***
9373	V-5116	4300	T- 770	*** Good - no observed problems ***
9385	V-591P	2993	T-5574	*** Good - no observed problems ***
9386	V-141P	3293	T-5527	*** Good - no observed problems ***
9387	V-177P	3593	T-5529	*** Good - no observed problems ***
9388	V-5110	3892	T- 335	*** Good - no observed problems ***
9389	V-433	4093	T- 319	*** Good - no observed problems ***
93810	V-5115	4292	T- 418	Clock drift of 18m 27s (#2)
93811	V-5108	4485	T- 316	*** Good - no observed problems ***
9391	V-375	3885	T- 345	1203 time interpolations (#1)
9392	V-647	4085	T- 469	Clock drift of 14m 10s (#2)
9393	V-643	4285	T- 416	*** Good - no observed problems ***
9401	V-118P	3307	T-5503	Vane bad after June 22, 1993 Rotor dropout for several weeks Mar '94 Three time series versions were created: 9401C1800 - short, only good data included 9401TC1800 - full length, temperature only 9402XX1800 - includes 'bad' rotor and vane data.
9402	V-5105	3907	T- 155	*** Good - no observed problems ***
9403	V-685	4107	T- 428	*** Good - no observed problems ***
9404	V-5106	4307	T- 135	*** Good - no observed problems ***
9411	V-714	3899	T- 413	*** Good - no observed problems ***
9412	V-684	4099	T- 433	*** Good - no observed problems ***
9413	V-683	4300	T- 803	Two complete dropouts of all variables except time 1st 930922,161500 to 930922,214500 2nd 930628,211500 to 930705,234500 Three time series versions created - 9413X1800 - full length - includes gap interpolation 9413AC1800 - First 269 days 9413BC1800 - Last 332 days

#1 Most time series in this set have fewer than 10 time interpolations. Time interpolations (which include the interpolation of all variables) are required when data cycles are missing due to cassette tape reading problems. Interpolating 1000 scattered values in records with over 31,000 data cycles does not appreciably affect the data but is noteworthy as it is unusual.

#2 Most instruments had a clock drift of less than a minute over the 600 day deployment period.

Current Meter Temperatures

Thermistors are routinely calibrated in a series of seven temperature baths (0, 5, 10, 15, 20, 25 and 30 degrees) between each deployment. A fit of the temperature to thermistor resistance is derived from the seven bath measurements. The derived parameters (A, B, C's) are then applied to a set of standard resistances (corresponding to the 7 bath temperatures) and yield the numbers in Table 6, below, for thermistor #413. Intercomparison between these values allows the evaluation of the quality and stability of this thermistor.

Similar histories are kept for each thermistor. Payne et al. (1976) described in detail the procedures practiced by the WHOI Buoy Group to achieve the greatest accuracy possible in long term deep ocean thermistor deployments.

Table 6 Example of calibration history - thermistor # 413

Therm #	num days	bath #	rms	day month yr	Temperature differences (in millidegrees) 0	5	10	15	20	25	30
413	0.	59	0.13	15 JAN 76	91.4	93.4	93.7	91.7	87.7	81.8	73.8
413	238.	69	0.28	9 SEP 76	89.2	91.5	92.0	90.3	86.4	80.7	72.7
413	441.	79	0.19	31 MAR 77	90.8	92.7	92.9	90.9	86.8	80.9	72.8
413	691.	89	0.22	6 DEC 77	89.9	91.9	92.2	90.2	86.2	80.3	72.2
413	1419.	134	0.20	4 DEC 79	90.9	92.9	93.1	91.1	87.1	81.3	73.2
413	1776.	152	0.15	25 NOV 80	88.1	90.1	90.4	88.5	84.5	78.8	71.0
413	2300.	175	0.31	3 MAY 82	88.6	91.1	91.8	90.1	86.3	80.5	72.4
413	2660.	194	0.06	28 APR 83	88.3	90.3	90.6	88.8	85.0	79.5	71.7
413	3266.	215	0.12	24 DEC 84	87.1	89.6	90.2	88.6	84.9	79.3	71.4
413	3366.	219	0.22	3 APR 85	88.7	91.0	91.6	89.9	86.2	80.6	72.8
413	4635.	272	0.17	23 SEP 88	85.7	88.0	88.5	86.8	83.0	77.5	69.6
413	5381.	298	0.54	9 OCT 90	85.9	89.3	90.6	89.5	86.0	80.5	72.4
413	5986.	314	0.30	5 JUN 92	86.5	89.3	90.2	88.7	85.0	79.4	71.4

For thermistor # 413, the calibration history covered 5986 days and had an average drift of -0.19 millidegrees per year. Table 7 lists the drift rates for each thermistor used in this array.

Table 7 Thermistor drift rates

Data Name	therm #	num days	drift md/yr
9361	768	4523.	0.23
9362	324	6112.	0.01
9363	361	6032.	0.69
9364	309	6150.	0.45
9371	237	6539.	0.14
9372	376	5311.	0.14
9373	770	4485.	0.43
9385	5574	1534.	0.52
9386	5527	4699.	0.17
9387	5529	4699.	0.33
9388	335	6112.	1.44
9389	319	6112.	0.53
9391	345	6032.	0.09
9392	469	5710.	0.17
9393	416	5934.	0.09
9401	5503	4699.	0.07
9402	155	7024.	0.16
9403	428	5934.	0.45
9404	135	7050.	0.38
9411	413	5986.	-0.19
9412	433	5850.	0.09
9413	803	3486.	0.06
93810	418	5934.	0.00
93811	316	6250.	0.10

The electronics of each VACM is tuned prior to each deployment to known reference values to increase the accuracy of the temperature measurements.

Current Meter Data Identification

Each time series is identified by a mooring number, a sequential instrument position number, a letter to indicate the data version, and numbers to indicate the sampling rate. Therefore, 9362C1800 identifies data from the second (*2*) instrument on mooring *936*; the version is *C*, and the sampling rate is one record every 30 minutes (1800 seconds). 9362C1DG24 is a time series that has had a Gaussian filter (*G*) applied to the data; the filter has a half width of 24 hours (*24*) and is subsampled once a day (*1D*).

Descriptions of VACM data displays

There are two different types of plot pages; composite plot pages by depth or by mooring and individual plot pages. Each composite plot page contains data from several different time series. There are 4 composite pages for each of the 6 moorings and 3 composite pages for each of the 3 major instrumented depths (3900m, 4100m, 4300m). The composite plots are either ordered by depth, with the top of the page representing the shallowest time series, or ordered by latitude with the top of the page representing the northernmost time series.

Individual plot pages contain data from one time series. Each individual time series is displayed using histograms, progressive vector diagrams, statistics, variables versus time plots, UV scatter plots and spectral plots.

Histograms (individual)

The histograms were created using MATLAB. An attempt has been made to standardize the plots for the purpose of easier comparisons, instead of letting MATLAB assign parameters to maximize the individual variables presented. The peaks in the histograms at 2 cm/sec reflect a decoding program forced velocity threshold. Histograms are shown on the 2nd and 3rd fiche in row D.

Two histograms (for time series 9401 and 9413) were created from series where the East and North components were not continuous and data values had been interpolated through the gap.

Progressive Vector Diagrams (composite and individual)

Current vectors are placed head to tail to show the path a particle would have traveled in a perfectly homogeneous flow.

There are 3 composite progressive vector plots, one for each major depth level. The plot traces begin at the representative mooring location which is represented by a '*' (asterisk symbol), with '+' (plus) symbols along the trace marking each 100 days. Depth 3000 meters shows the data from the three instruments at that depth. Depths 3900 and 4100m each show the traces from the 6 instruments at those levels. Depth 4300m, shows not only the six traces from 4300m but also includes an additional trace from the instrument at 4485 meters which is shown with a thicker line and has circles each 100 days.

There are six 3-dimensional progressive vector plots, one for each mooring. The '*' marks the instrument depth/latitude/longitude position. For reference, a 'shadow' of each progressive vector trace is repeated on the bottom of the plot.

Plots for each individual time series are shown on the 2nd and 3rd fiche in row C. The individual progressive vector plots are annotated at the first of each month.

Statistics (composite and individual)

Statistics of U (eastward velocity) ,V (northward velocity), and T (temperature) from the filtered time series are included. The equations used to derive the statistical parameters were described by Tarbell et al., 1988. The printed text has a table of statistics from the Gaussian filtered version of the time series.

The statistics for each individual time series were created using the half hour sampled version of the data and the Gaussian filtered series. They are displayed on the 2nd and 3rd fiche in row B.

Variables versus Time (composite and individual)

Each of the individual Variable versus Time pages display the U (east) and V (north) components, a stick plot and a temperature plot. These plots are not shown on the printed pages but are shown on fiche 2 and 3 in row E.

The composite Variables versus Time plots show one type of plot for several different time series on one page. There are 33 plots in this category which are presented on both printed pages and on the first fiche.

Twenty-four of those plots are composite plots by mooring, that is, they display the same type of plot for the data from each instrument on that particular mooring. Fiche 1 row C contains *Vector Stick* and *U and V component* composite plots. Fiche 1 row D contains *Temperature* and *3D Progressive Vector* composite plots.

There are nine composite plots by depth level (3900, 4100 and 4300m.). Each of the depth level plots shows the same type of display for each of the 6 time series at that depth (one display for each mooring). Each of the three depths has three displays (*Vector Sticks*, *Temperature* and *Progressive Vectors* plots).

Vector stick plots versus Time

Because the mean flow of the current is predominately east/west the vector stick displays have been rotated so that 'east' is represented as 'up' and 'north' is left along the plotting axis. The velocity scales may differ for each mooring or for each level to best display the character of the measured currents, but all plots on each page have the same velocity scale.

Temperature versus Time

Temperature values are shown in degrees Celsius. The temperature composite plots may use different scales within the same plot to highlight the temperature activity.

U and V components versus Time

The U (East) and V (North) components are each plotted as individual variables versus time.

Spectral diagrams

Velocity and temperature data are displayed as auto-spectra using the program "Prospect" (Hunt, 1982). The horizontal kinetic energy (HKE) spectrum is half of the sum of the spectra of the east and north components. It has the advantage of not being tied to a particular coordinate system. The spectra are one-sided so that the integral of the spectrum with respect to frequency is equal to the variance of the original record.

The plots are log-log rather than 'variance preserving', that is, the contributions of various frequency bands to the total variance are not in proportion to the displayed areas. The unfiltered data for these calculations was prewhitened and recolored. These calculations were based on one piece with two degrees of freedom.

For plotting, 'Prospect' averages the spectra in increasingly larger groups at the higher frequencies to reduce superfluous points. In Table 8, below, each of the first 40 plotted points represents the average of 3 adjacent frequency bands, the next 15 points each represent the averages of 6 adjacent bands and so forth.

Table 8 Spectra frequency-averaging groups

Frequencies	plotted points
3	40
6	15
15	6
30	30
60	15
150	6
300	30
600	4
remainder	1

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Data presentation

The first page is a list of the statistics for each time series.

Following the page of statistics are groups of composite plots ordered by mooring. Data from each mooring is displayed using different presentations on 4 consecutive pages. The first page for each mooring contains the velocity vector stick diagrams; the second page contains the temperatures for that mooring. The third page displays the U and V components. The fourth page displays the progressive vector diagrams with the starting points lined up as if on a virtual mooring.

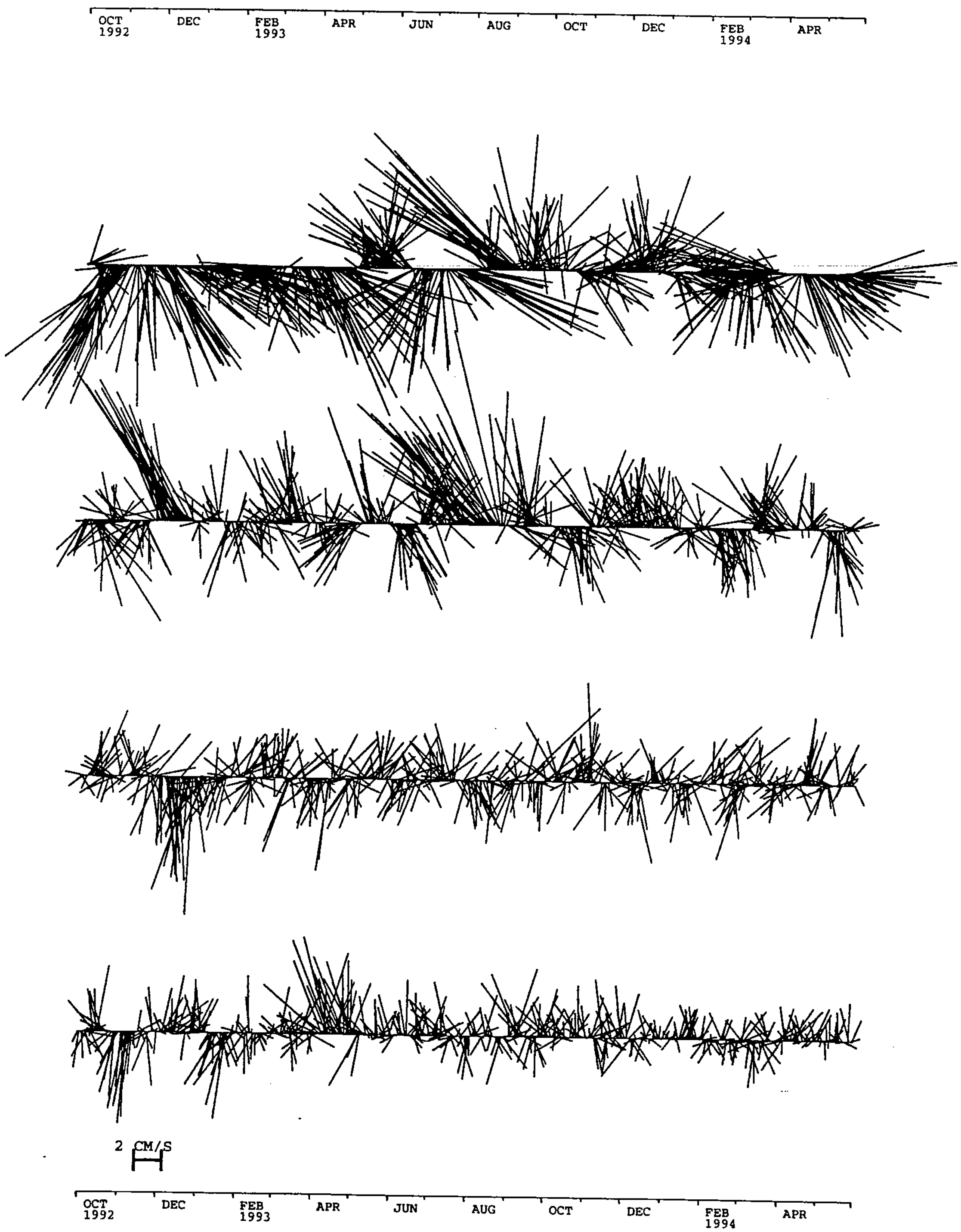
The next 9 pages are composite plots ordered by the 3 major instrument depths (3900m, 4100m, 4300m). For each depth there are composite stick plots, composite temperature plots and 3-dimensional progressive vector plots.

COMPOSITE PLOTS

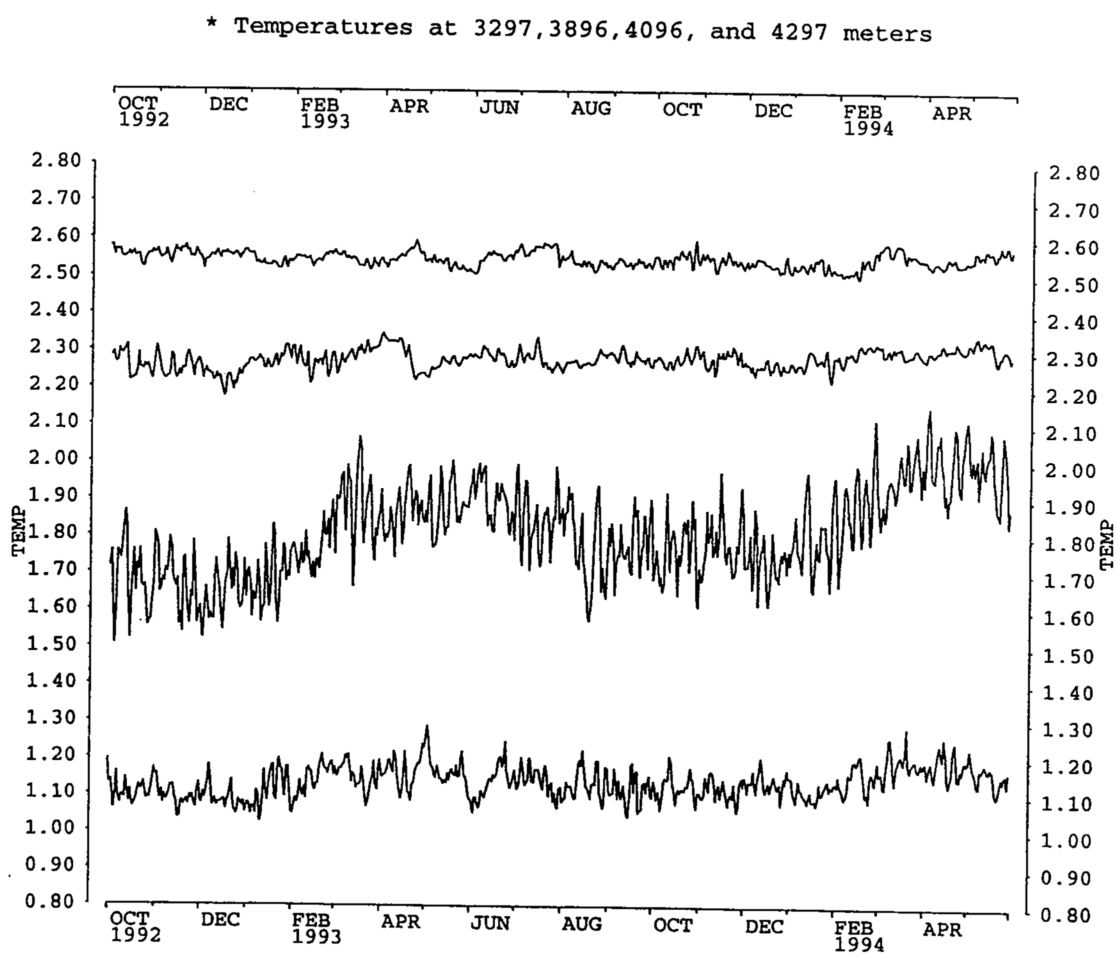
Statistics (U, V and T)

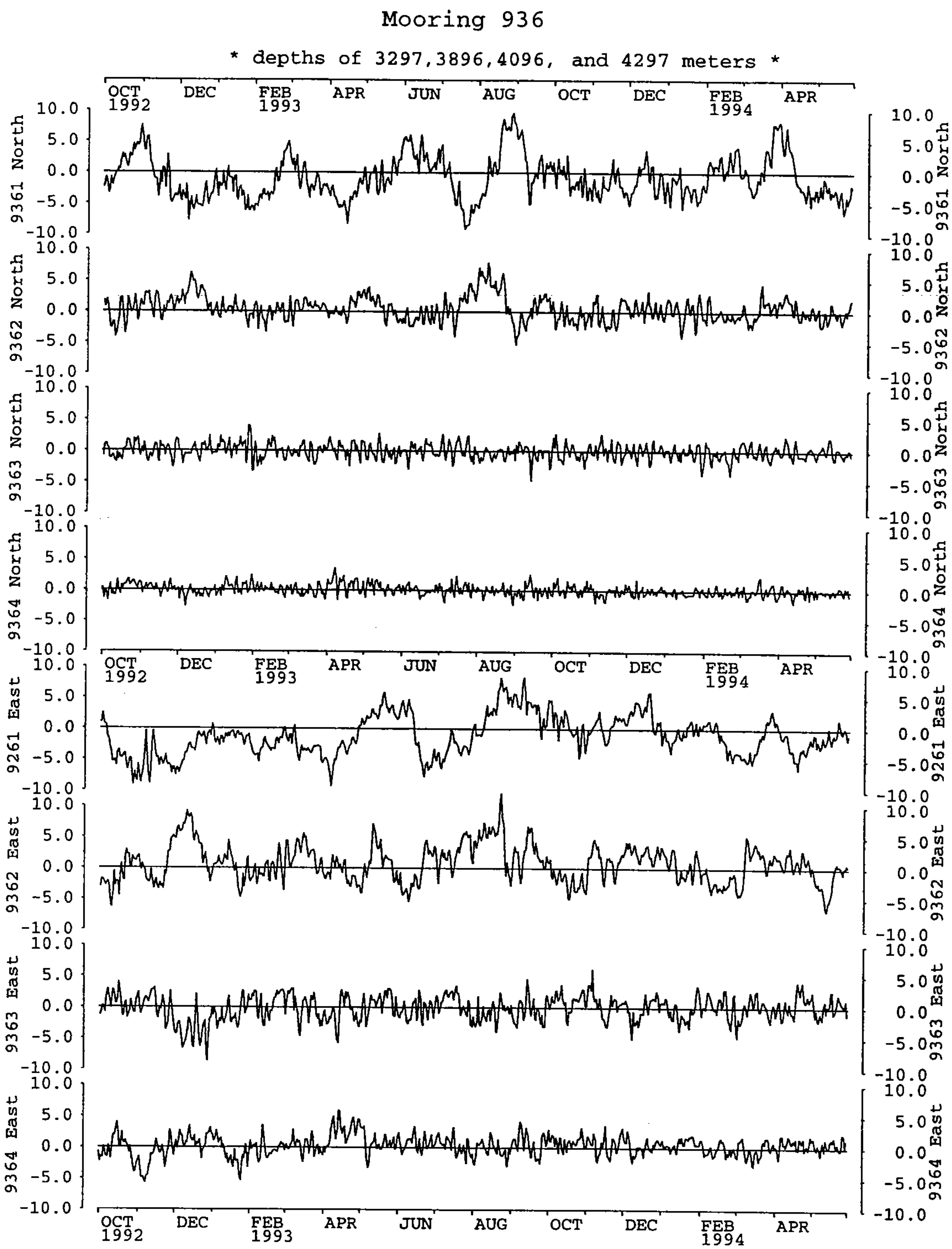
Data identifier	date yymmdd	#in av.	<U>	<V>	$<U>^2$	$<V>^2$	K.m	$<U'^2>$	$<V'^2>$	K.e	<U' V'>	<T>	$\sqrt{T'^2}$	<U' T'>	<V' T'>
9361B1DG24	920930	609	-1.1	-0.9	1.3	0.7	1.0	10.6	11.7	11.1	2.9	2.547	0.0186	-0.0195	-0.0110
9362C1DG24	920930	609	0.8	0.5	0.6	0.2	0.4	8.8	3.8	6.3	2.7	2.278	0.0282	-0.0256	-0.0238
9363C1DG24	920930	609	-0.1	0.0	0.0	0.0	0.0	4.1	1.4	2.8	-0.7	1.812	0.1266	0.0731	-0.0280
9364B1DG24	920930	609	0.3	0.1	0.1	0.0	0.1	2.7	0.7	1.7	0.0	1.135	0.0446	0.0063	-0.0016
9371B1DG24	920930	609	-0.4	0.9	0.2	0.8	0.5	12.6	8.0	10.3	6.0	2.280	0.0232	-0.0120	-0.0113
9372C1DG24	920930	609	-0.1	-0.1	0.0	0.0	0.0	8.9	4.0	6.5	2.2	1.769	0.1344	-0.0870	-0.0208
9373C1DG24	920930	609	0.0	0.1	0.0	0.0	0.0	6.6	3.2	4.9	2.7	1.116	0.0390	-0.0202	0.0080
9385B1DG24	921001	607	-0.9	-0.3	0.9	0.1	0.5	12.3	9.7	11.0	0.6	2.724	0.0275	0.0052	0.0072
9386C1DG24	921001	607	-2.0	0.1	4.1	0.0	2.1	9.4	6.4	7.9	-0.7	2.557	0.0223	-0.0065	0.0047
9387C1DG24	921001	607	-2.1	0.3	4.5	0.1	2.3	9.3	2.7	6.0	-0.1	2.432	0.0245	0.0044	0.0009
9388C1DG24	921001	607	-0.2	2.4	0.0	5.8	2.9	4.7	5.9	5.3	2.0	2.292	0.0257	0.0101	0.0154
9389C1DG24	921001	607	-1.8	0.5	3.2	0.2	1.7	6.1	3.4	4.7	-1.7	1.800	0.1356	0.0108	0.0215
93810C1DG24	921001	607	-0.6	0.0	0.4	0.0	0.2	5.5	2.5	4.0	-1.5	1.126	0.0363	-0.0497	0.0135
93811C1DG24	921001	607	-1.3	0.5	1.7	0.2	1.0	3.2	2.0	2.6	-0.3	0.929	0.0128	-0.0010	0.0013
9391C1DG24	921002	605	-1.5	1.6	2.4	2.4	2.4	9.3	7.3	8.3	1.4	2.303	0.0187	0.0108	0.0129
9392C1DG24	921002	606	-5.5	0.7	30.6	0.5	15.6	24.8	4.5	14.7	0.2	1.851	0.1268	0.4575	-0.0035
9393B1DG24	921002	606	-4.2	0.3	17.8	0.1	9.0	11.0	2.7	6.8	-1.2	1.147	0.0409	0.0124	-0.0068
9401XX1DG24	921003	604	0.6	0.3	0.4	0.1	0.2	3.5	2.4	2.9	0.0	2.537	0.0188	-0.0114	0.0026
9401C1DG24	921003	262	1.3	0.3	1.8	0.1	0.9	4.0	2.5	3.2	0.8	2.535	0.0186	-0.0157	-0.0105
9402C1DG24	921003	604	5.4	0.9	29.0	0.8	14.9	25.5	7.8	16.6	6.3	2.278	0.0235	0.0306	0.0089
9403C1DG24	921003	604	-1.9	1.0	3.6	1.0	2.3	13.7	12.1	12.9	4.8	1.669	0.1029	0.1144	-0.0517
9404C1DG24	921003	604	-1.3	0.0	1.8	0.0	0.9	6.9	8.5	7.7	4.4	1.123	0.0353	-0.0104	-0.0010
9411C1DG24	921003	608	9.9	-0.7	97.9	0.4	49.2	19.8	6.7	13.2	2.0	2.114	0.0456	0.0630	0.0196
9412C1DG24	921003	608	1.5	0.9	2.2	0.7	1.5	8.4	6.8	7.6	2.7	1.685	0.1115	-0.0356	-0.0309
9413AC1DG24	921003	268	-5.1	-0.4	26.0	0.2	13.1	14.8	2.8	8.8	2.5	1.185	0.0400	-0.0343	-0.0029
9413BC1DG24	930707	331	-4.7	-0.4	22.2	0.1	11.2	11.2	2.3	6.7	2.3	1.196	0.0319	-0.0171	-0.0015
9413X1DG24	921003	608	-4.8	-0.4	23.1	0.2	11.6	13.2	2.5	7.8	2.4	1.191	0.0360	-0.0241	-0.0022

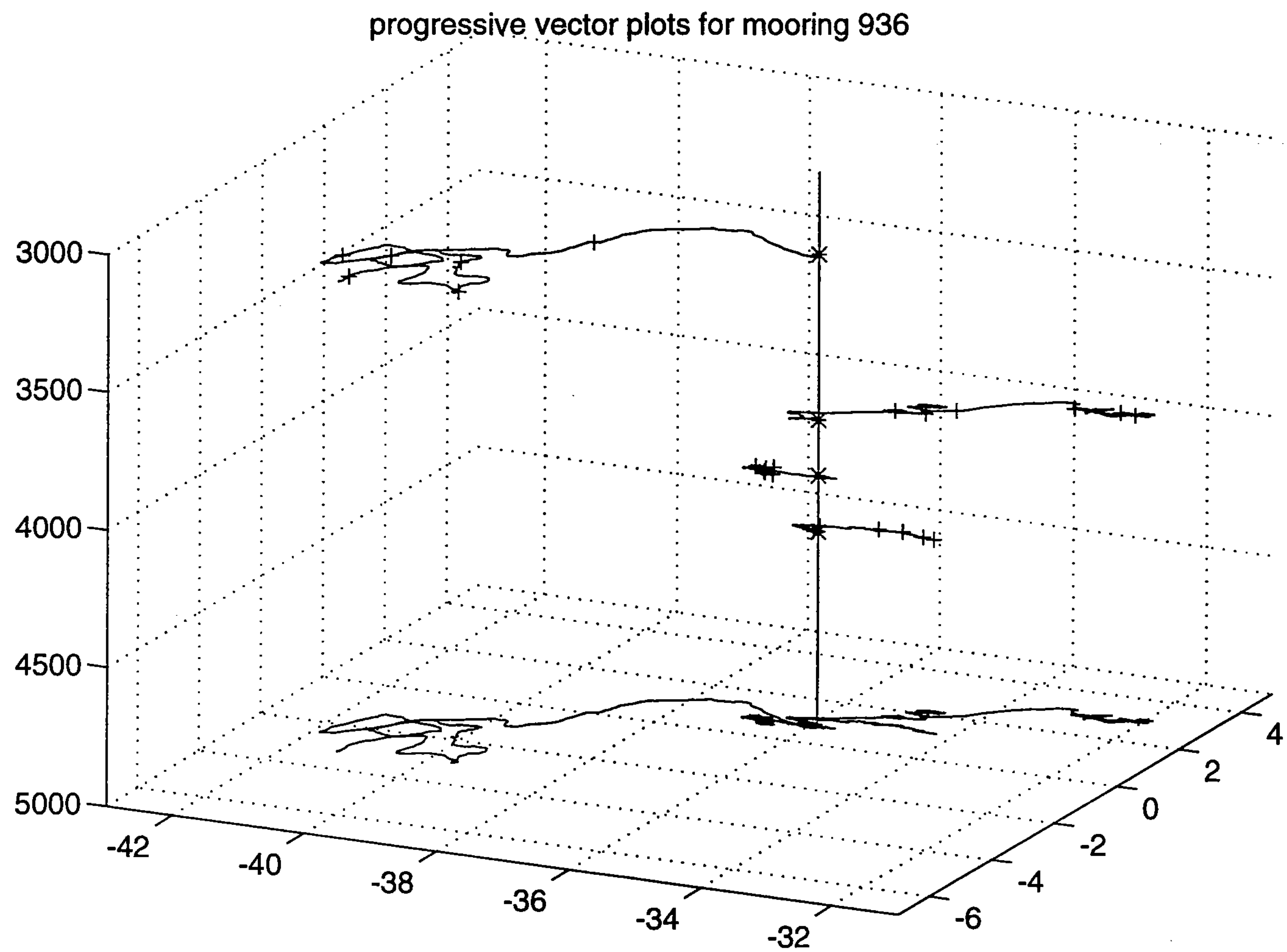
Mooring 936   * instrument depths are 3297, 3896, 4096 and 4297m.



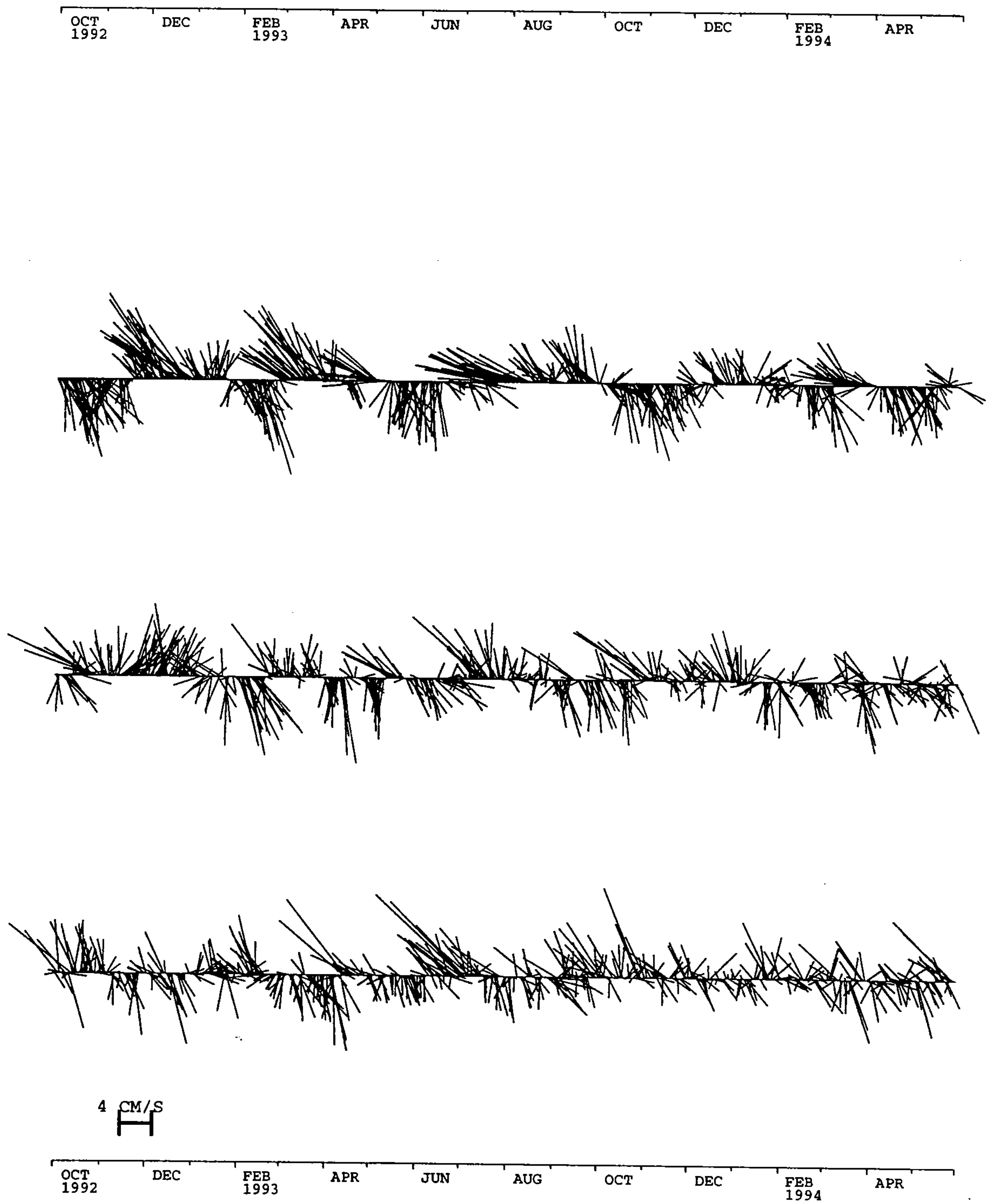
Mooring 936


* Temperatures at 3297,3896,4096, and 4297 meters
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
TEMP
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80


Mooring 936
* depths of 3297,3896,4096, and 4297 meters *
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
9361 North
9362 North
9363 North
9364 North
9261 East
9362 East
9363 East
9364 East
10.0
5.0
0.0
-5.0
-10.0

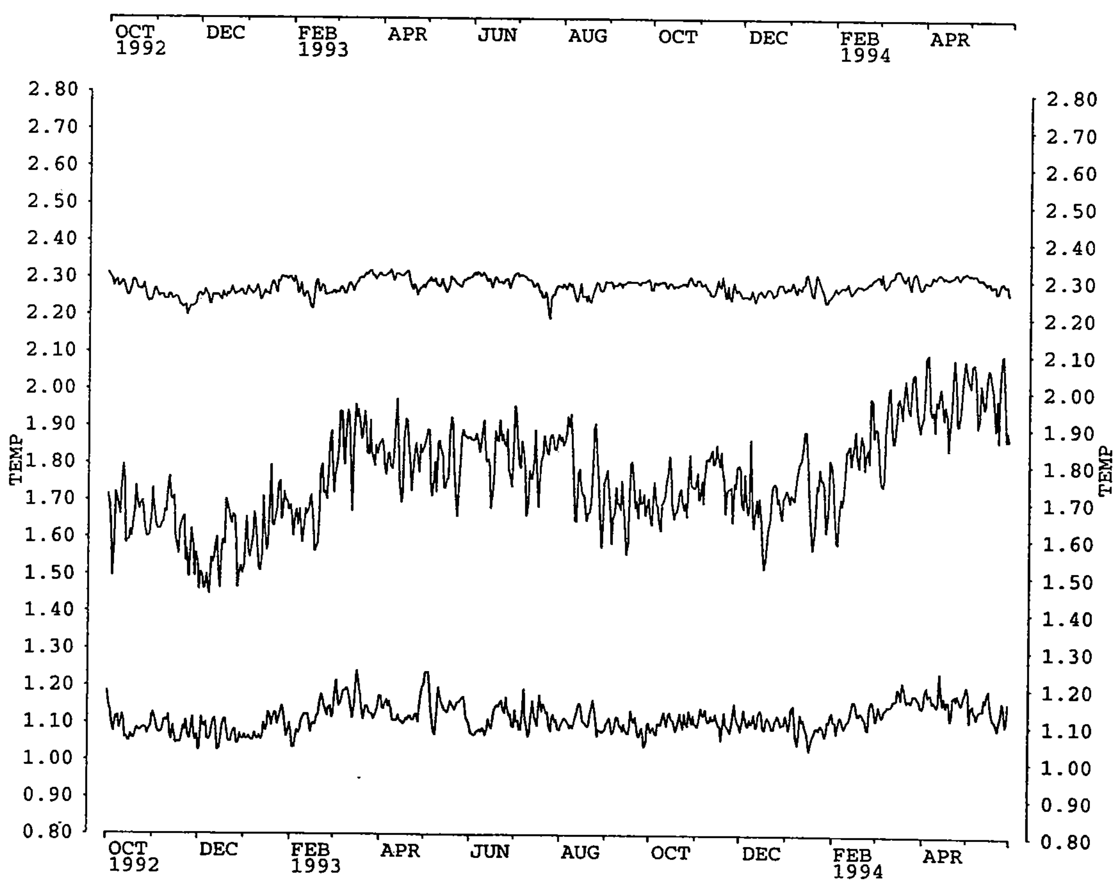

progressive vector plots for mooring 936
3000
3500
4000
4500
5000
-42
-40
-38
-36
-34
-32
4
2
0
-2
-4
-6

Mooring 937 * instrument depths are 3900, 4100 and 4300 meters



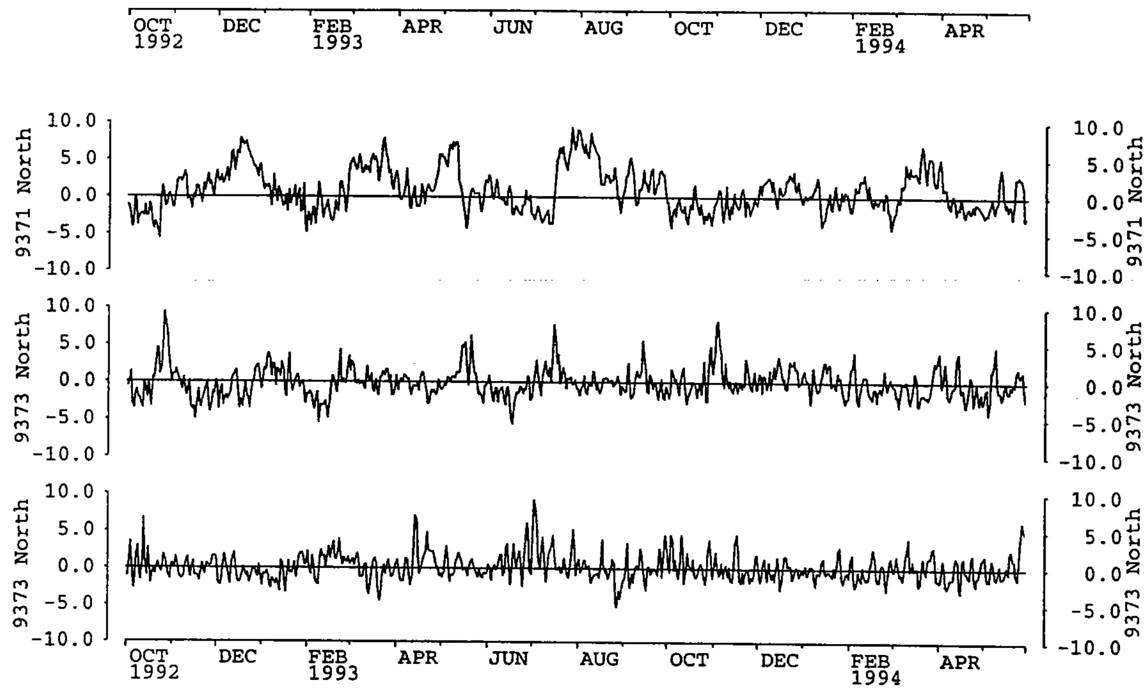
Mooring 937

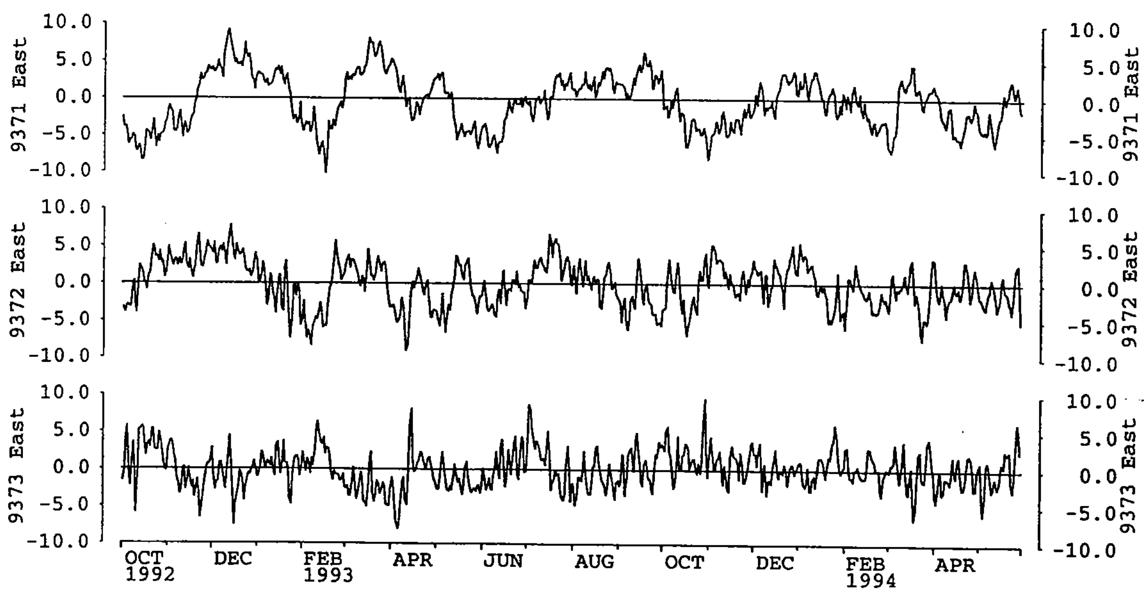
* Temperatures at 3900, 4100, and 4300 meters

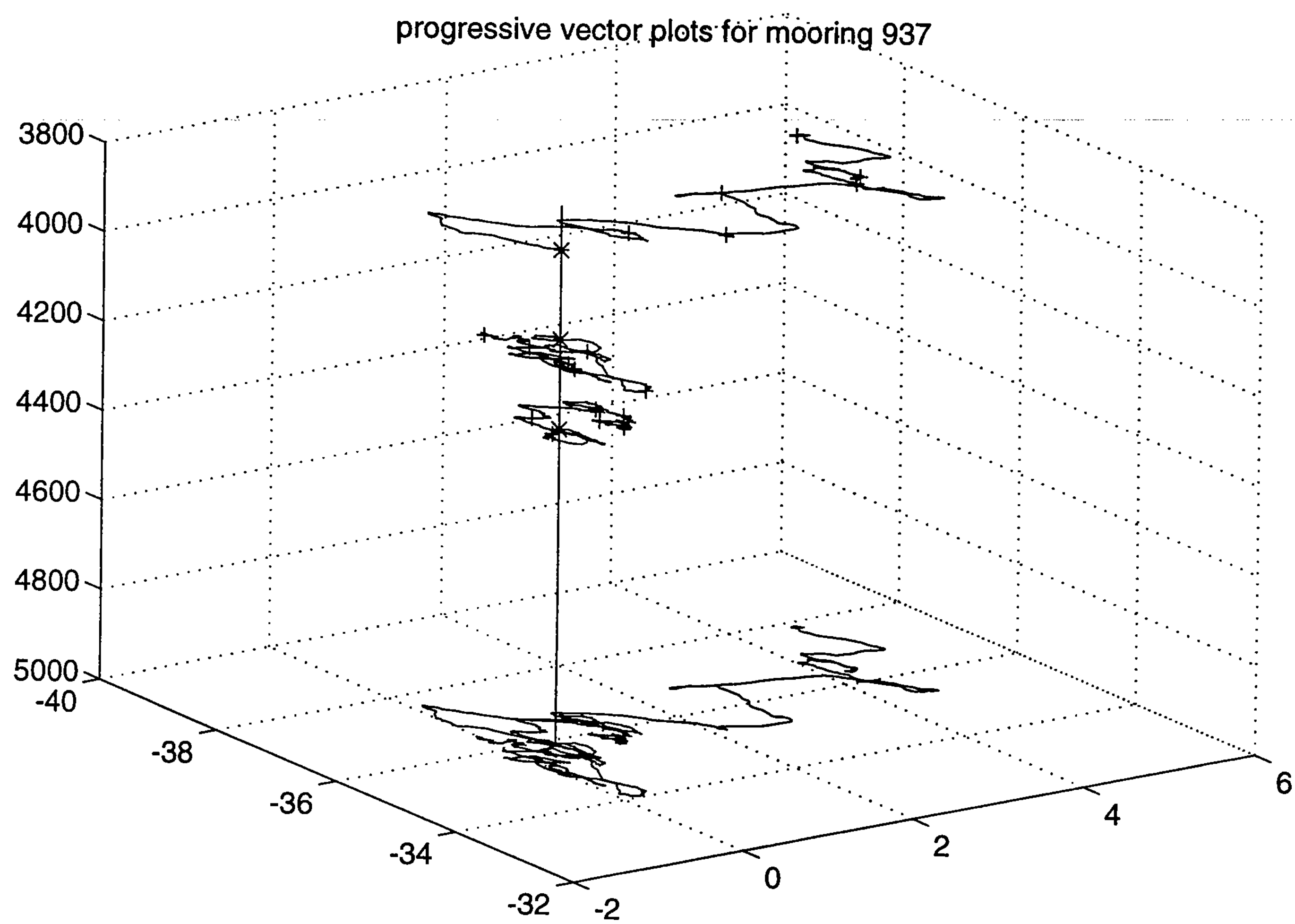


Mooring 937

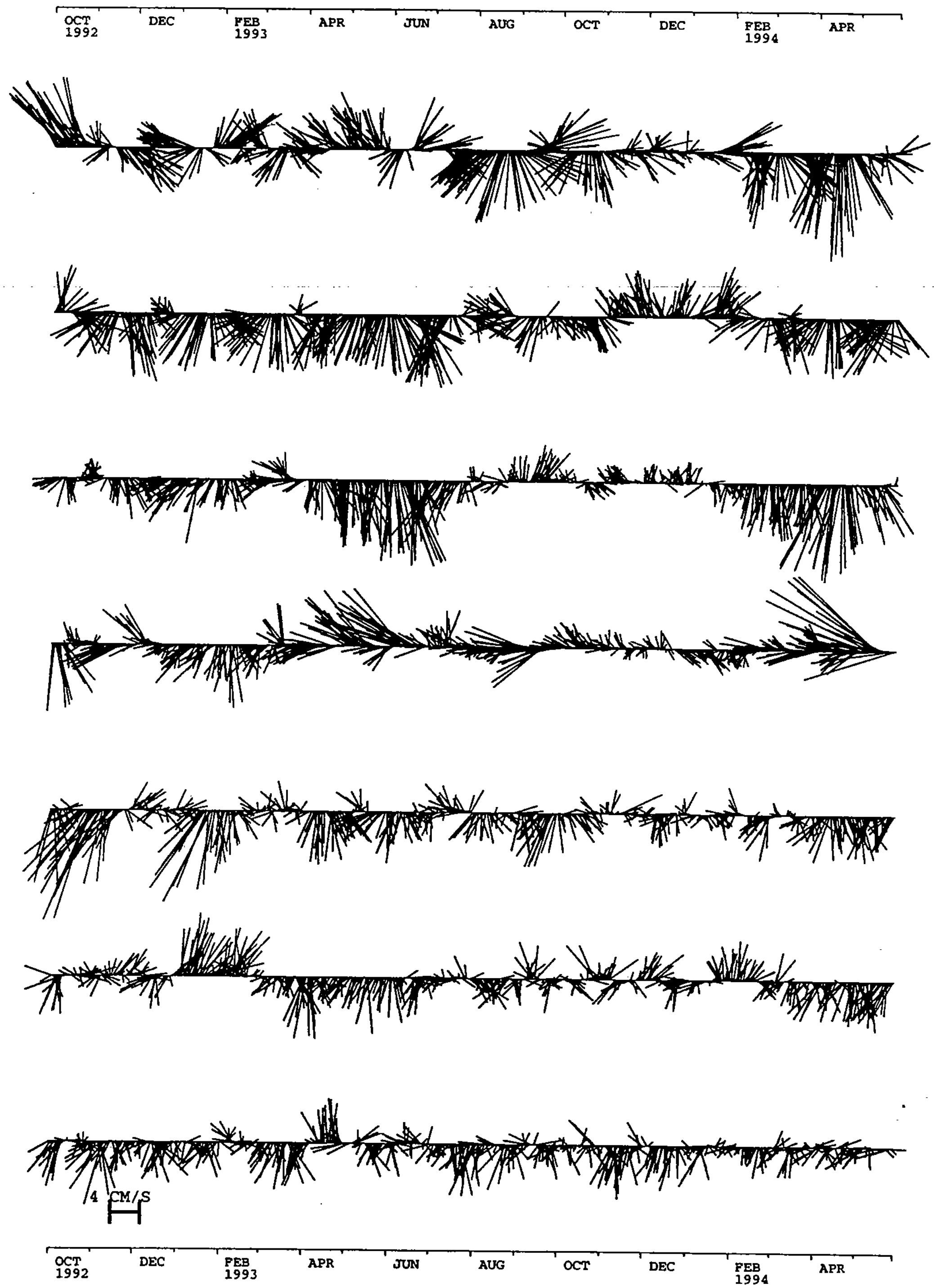
* depths of 3900, 4100, and 4300 meters *





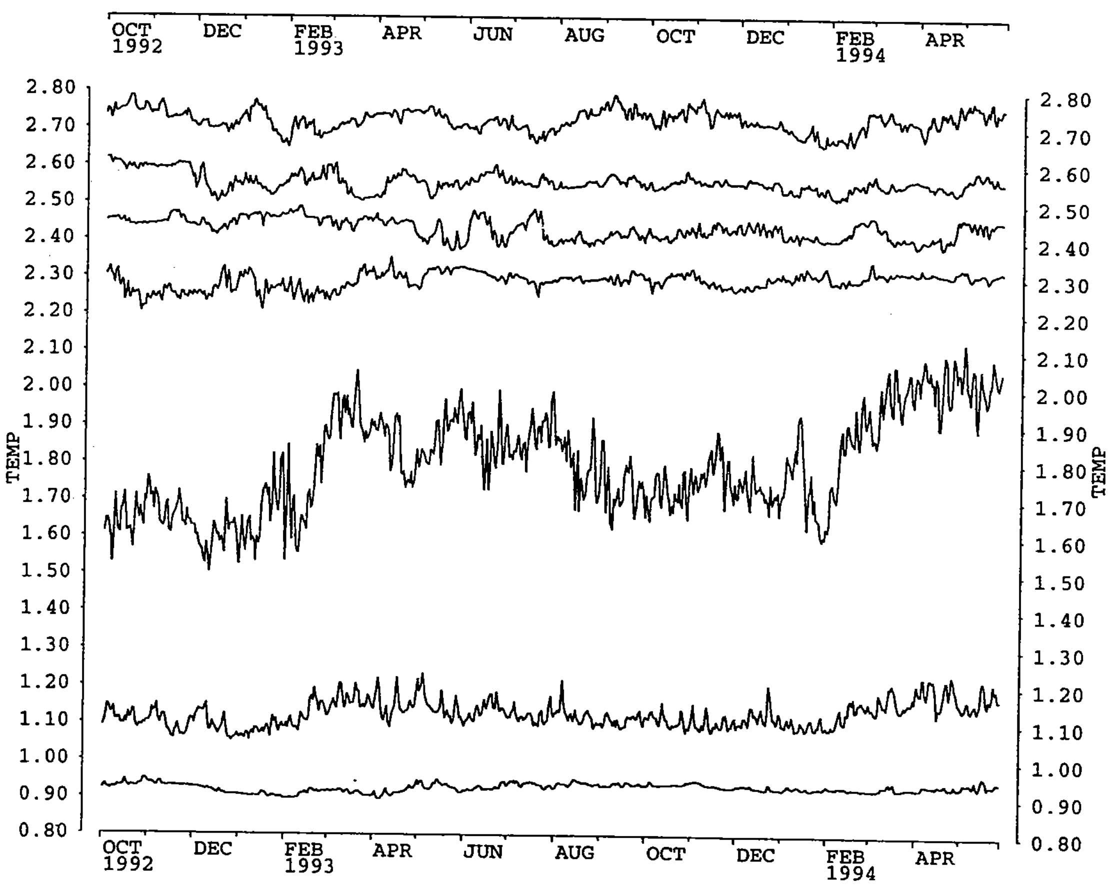

progressive vector plots for mooring 937
3800
4000
4200
4400
4600
4800
5000
-40
-38
-36
-34
-32
-2
0
2
4
6

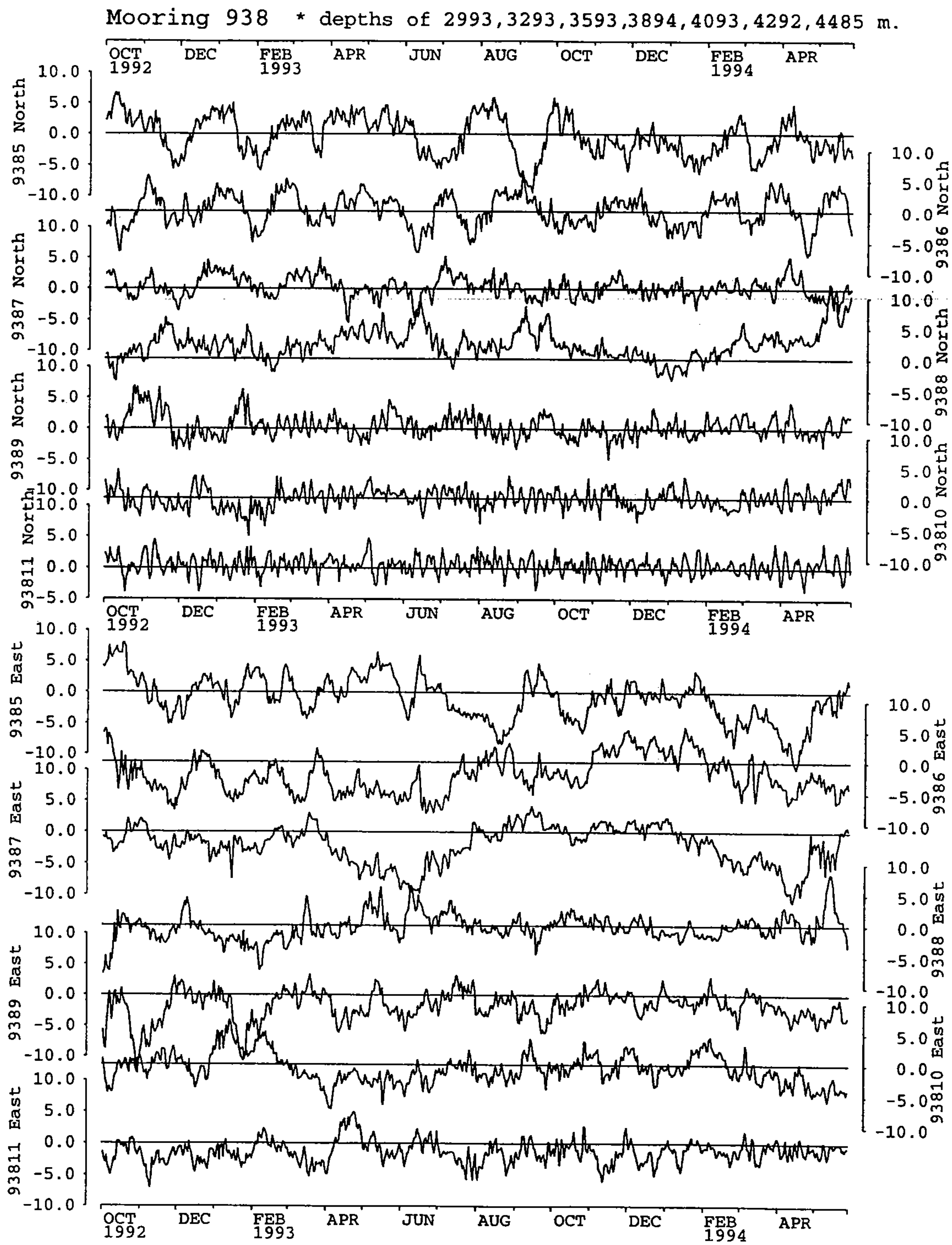
Mooring 938 * depths are 2993,3293,3593,3894, 4093,4292 and 4485m.



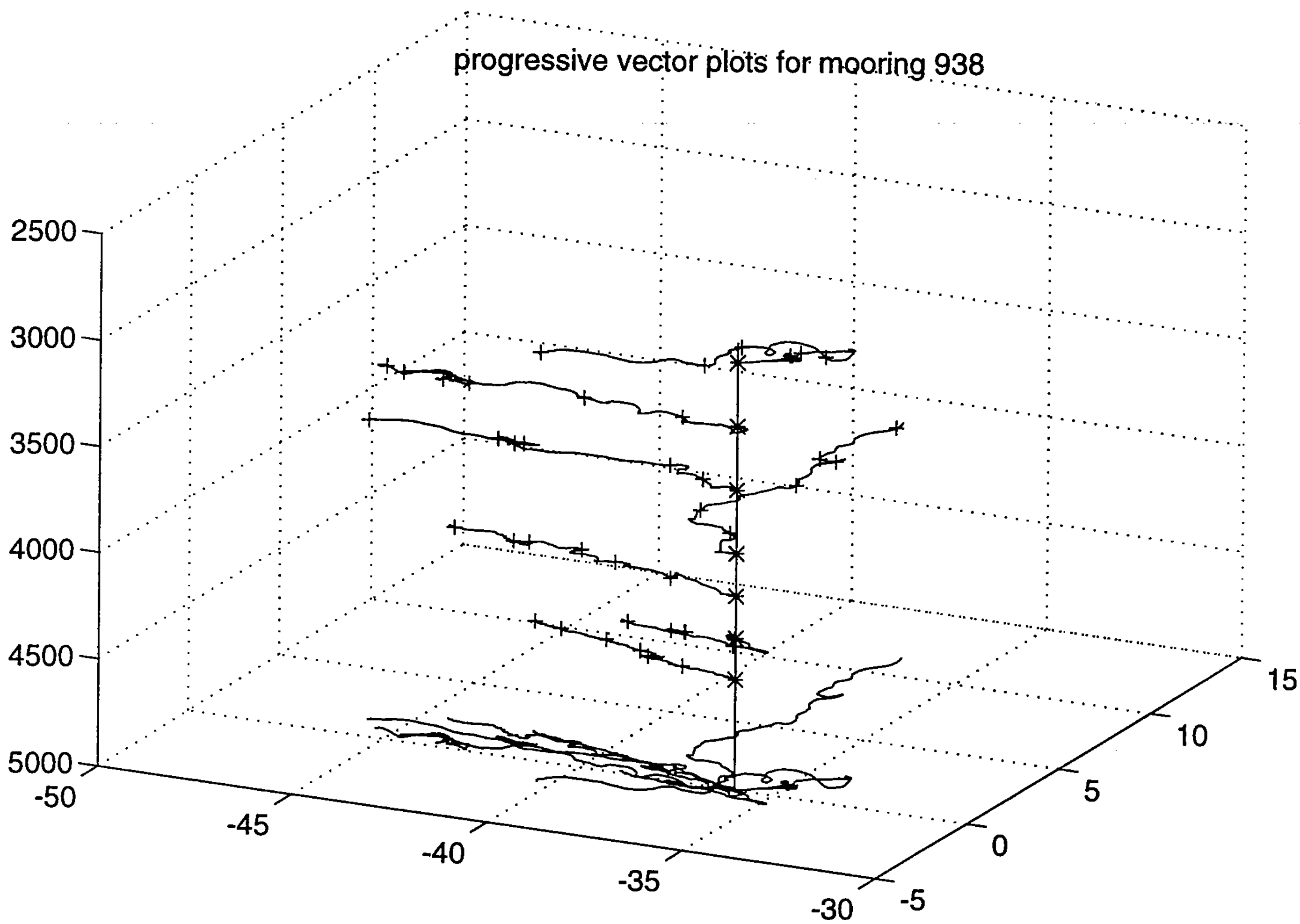
Mooring 938

* Temperatures at 2993,3293,3593,3894,4093,4292 and 4485 meters

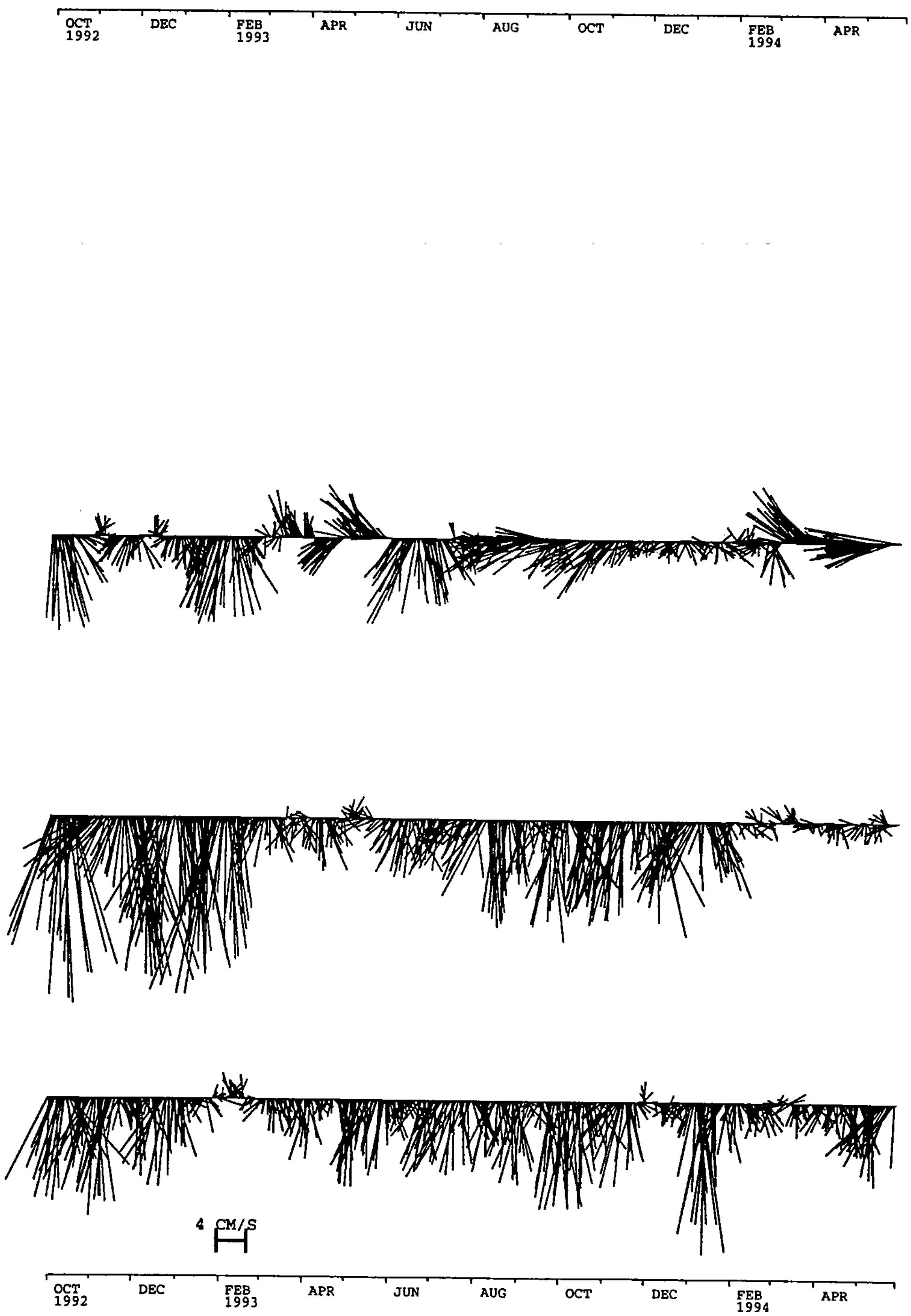




Mooring 938 * depths of 2993,3293,3593,3894,4093,4292,4485 m.
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
9385 North
9386 North
9387 North
9388 North
9389 North
93810 North
93811 North
9385 East
9386 East
9387 East
9388 East
9389 East
93810 East
93811 East
10.0
5.0
0.0
-5.0
-10.0

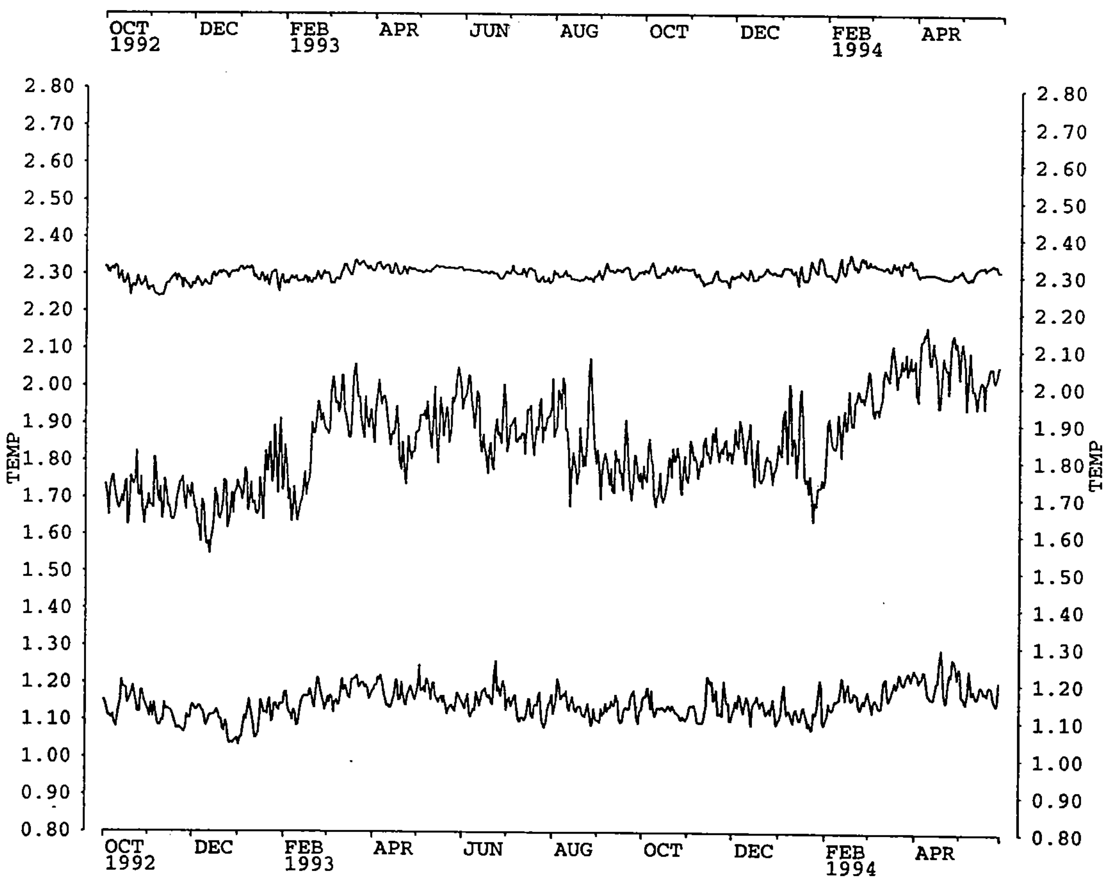

progressive vector plots for mooring 938
2500
3000
3500
4000
4500
5000
-50
-45
-40
-35
-30
-5
0
5
10
15

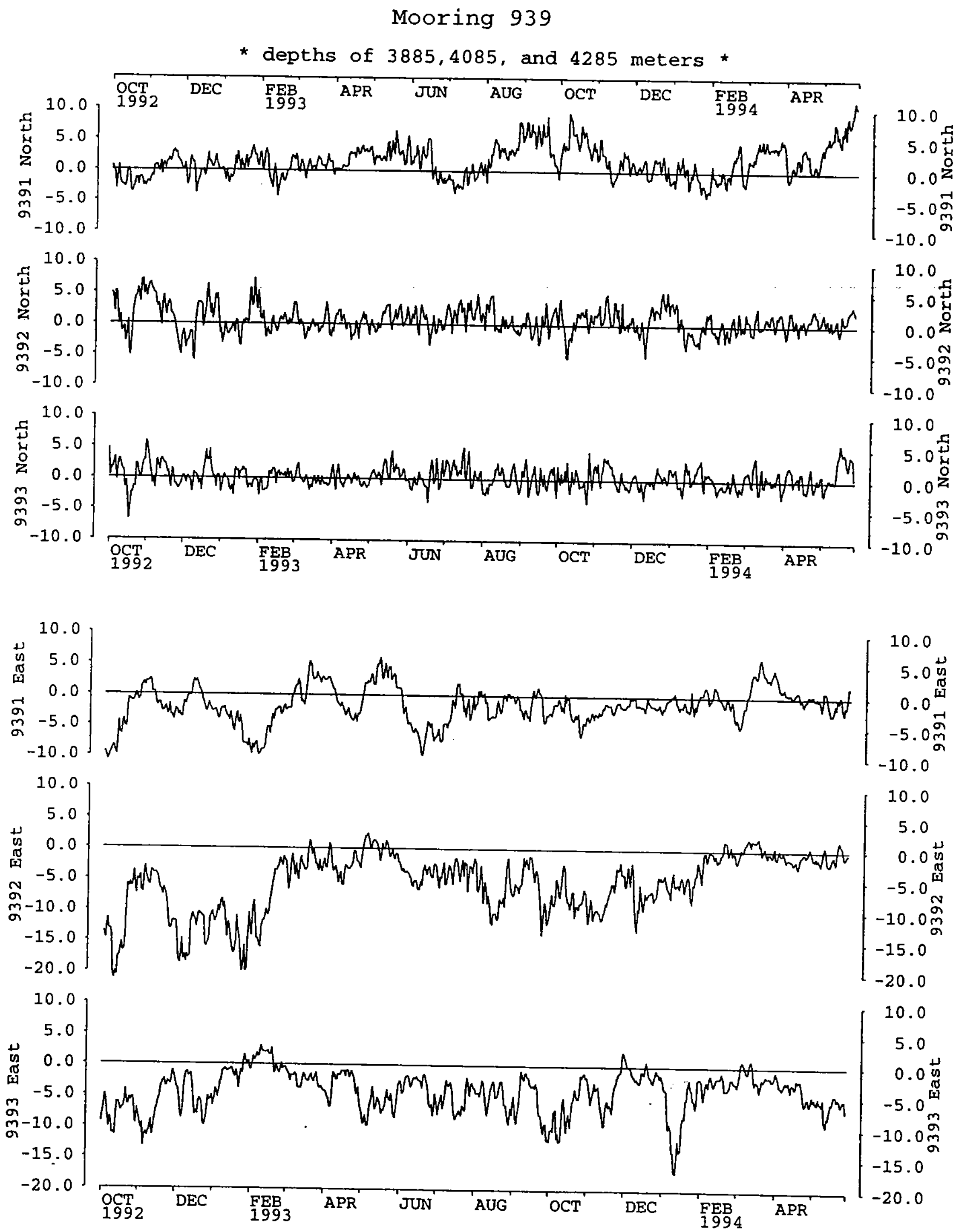
Mooring 939 * instrument depths are 3885, 4085 and 4285 meters.

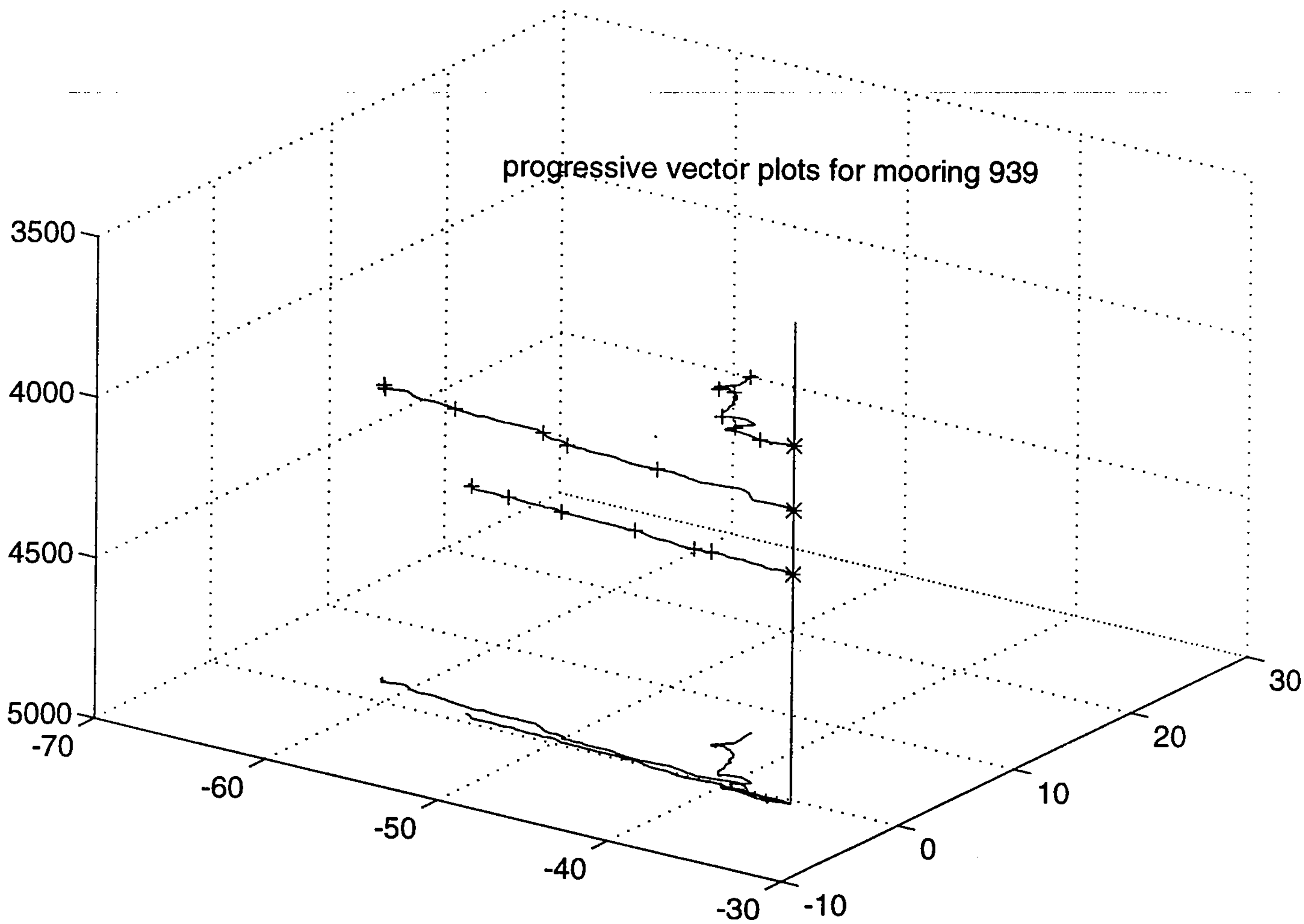


Mooring 939

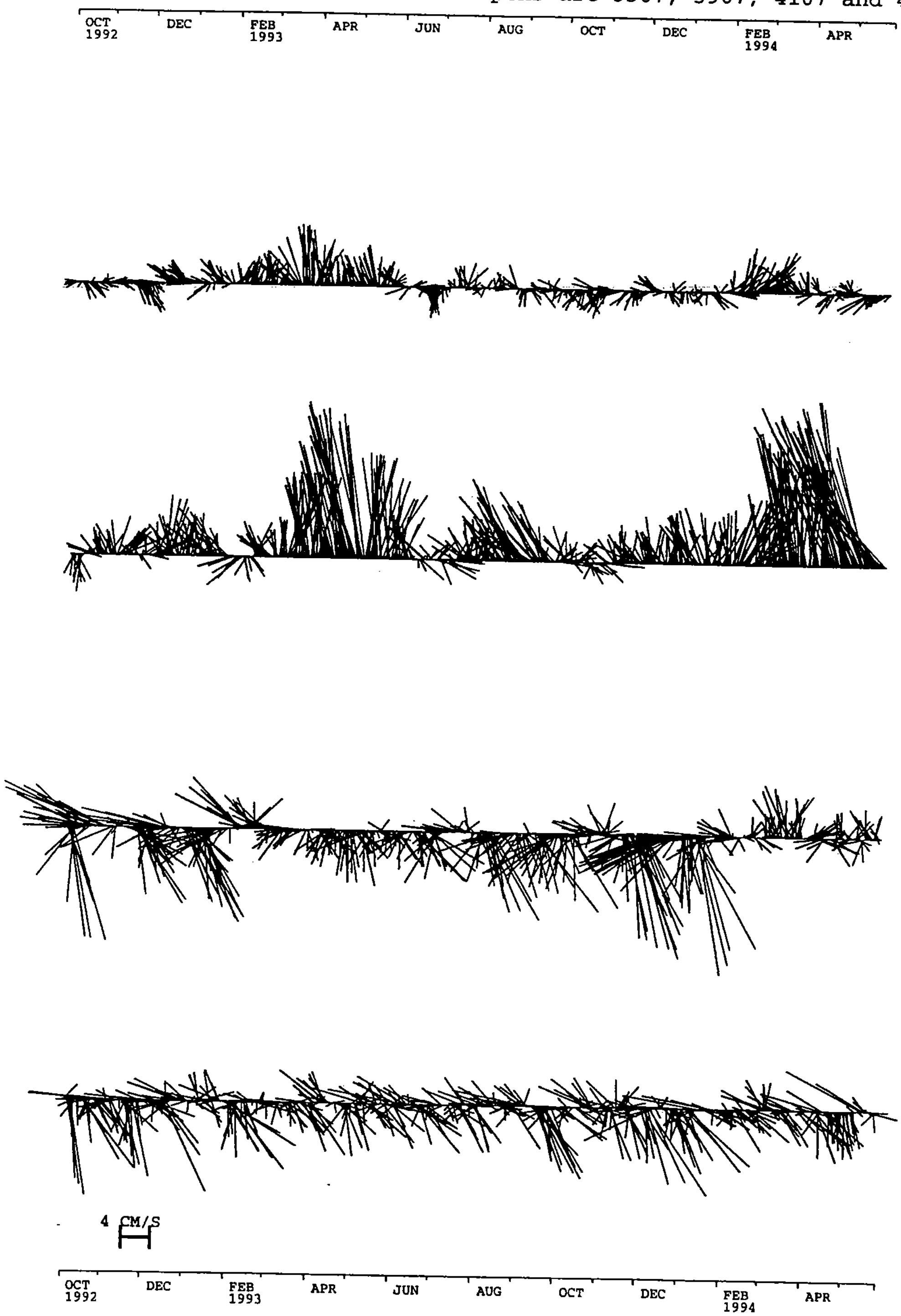
* Temperatures at 3885, 4085, and 4285 meters




Mooring 939
* depths of 3885,4085, and 4285 meters *
9391 North
9392 North
9393 North
9391 East
9392 East
9393 East
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR

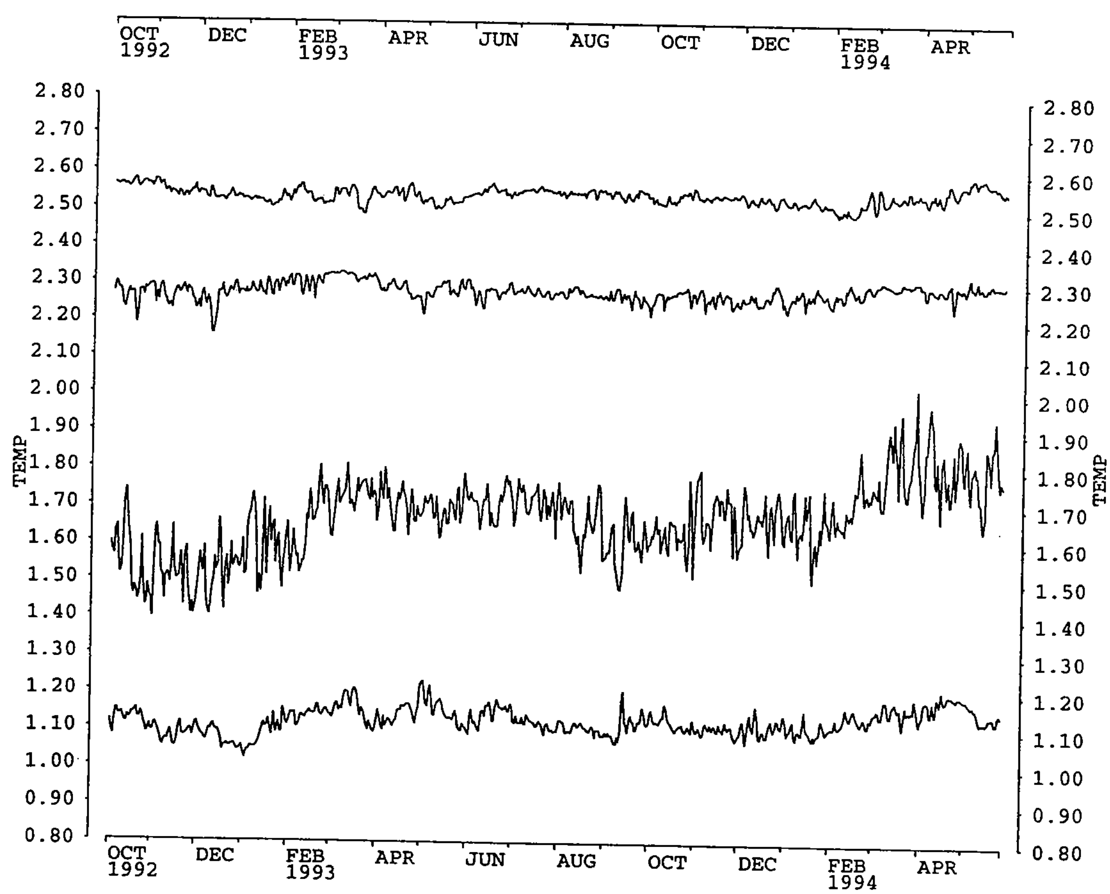

progressive vector plots for mooring 939
3500
4000
4500
5000
-70
-60
-50
-40
-30
-10
0
10
20
30

Mooring 940 * instrument depths are 3307, 3907, 4107 and 4307 meters



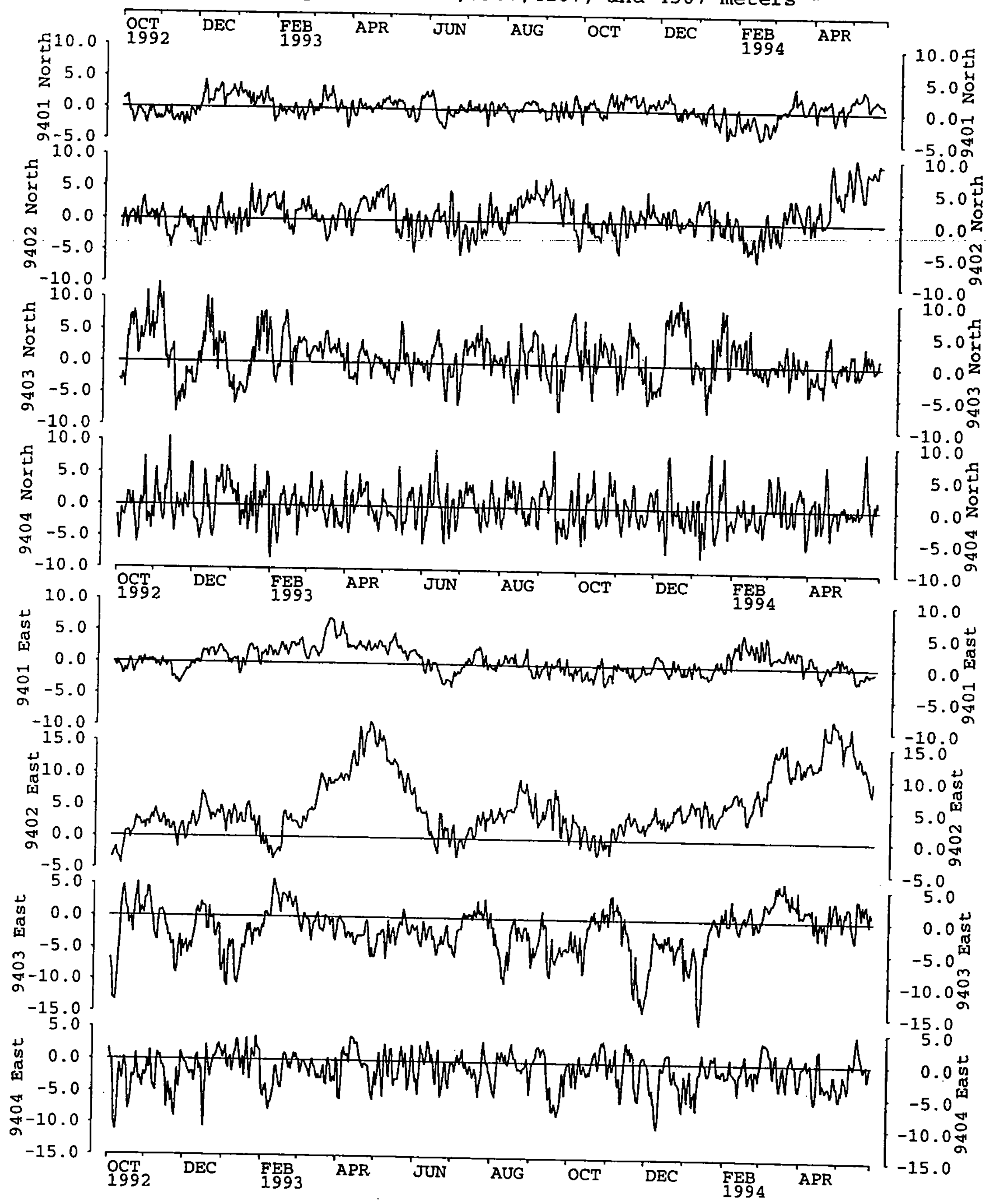
Mooring 940

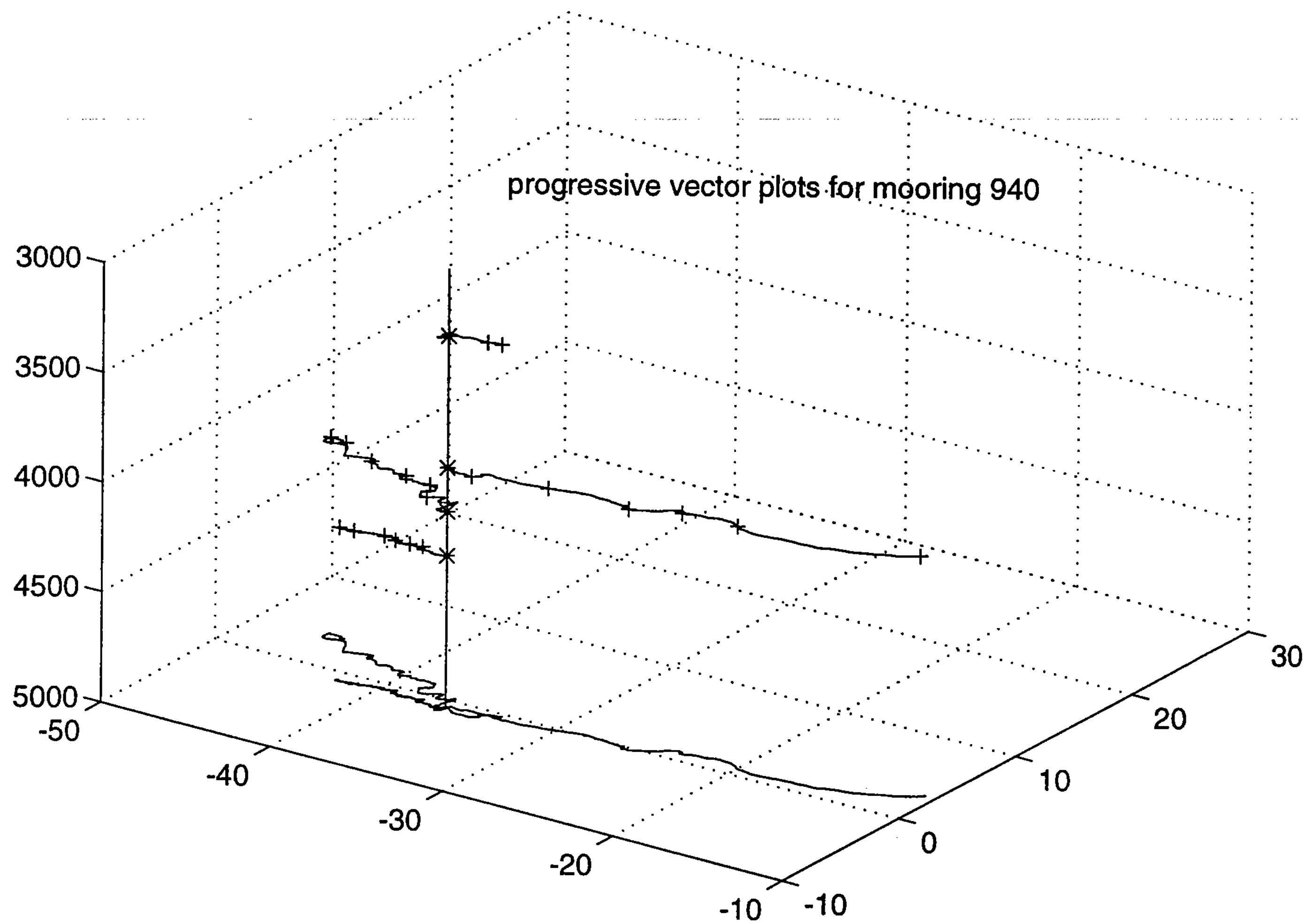
* Temperatures at 3307,3907,4107, and 4307 meters



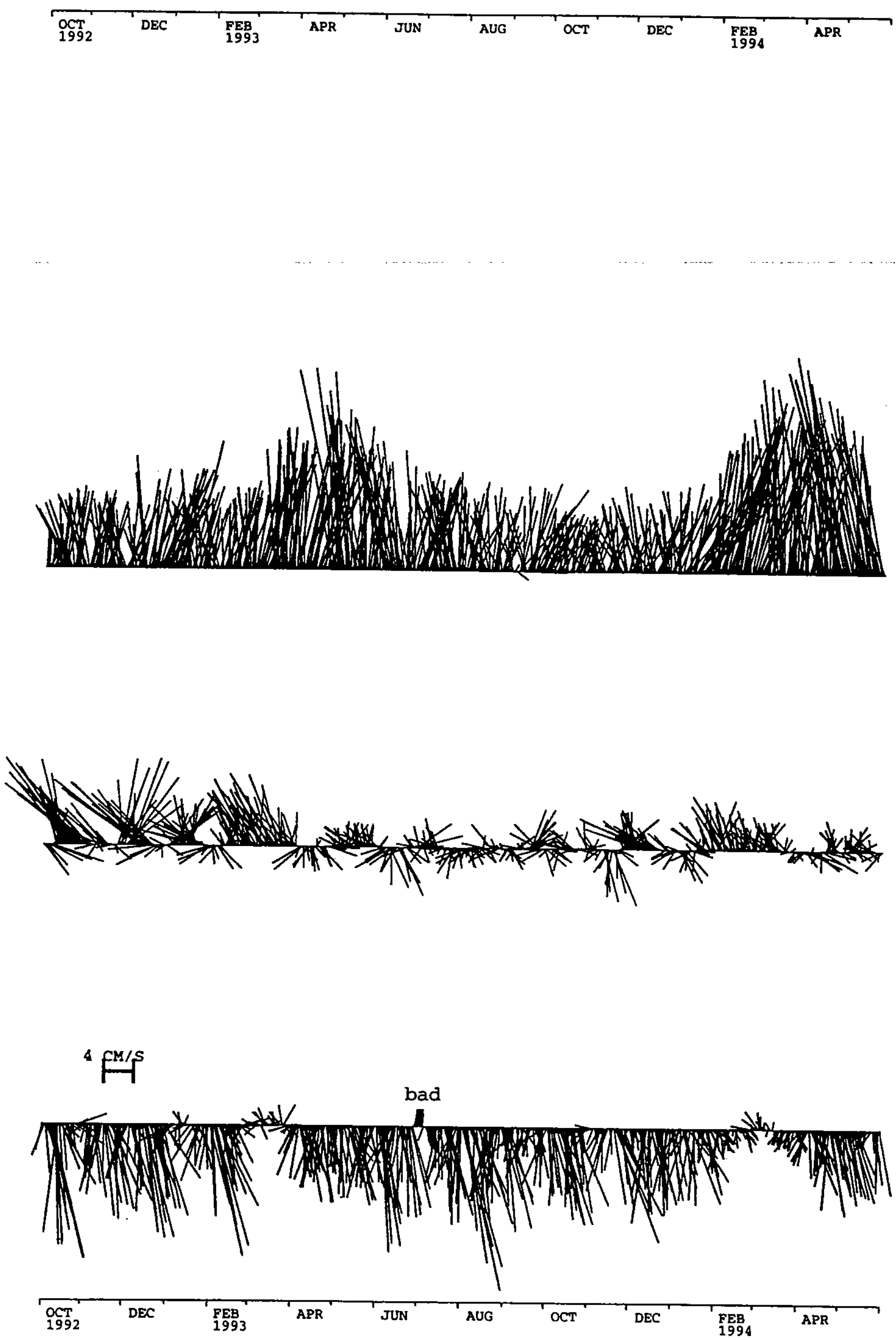
Mooring 940

* depths of 3307,3907,4107, and 4307 meters *

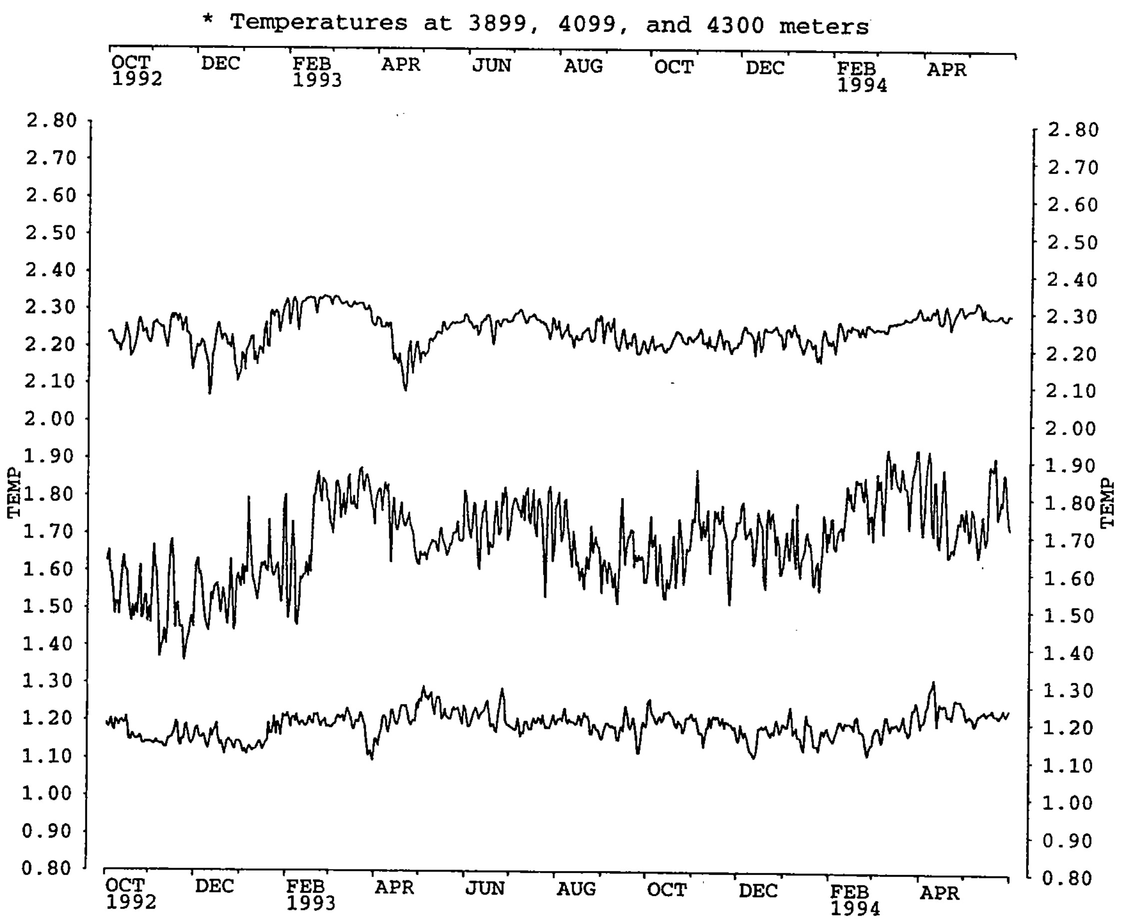


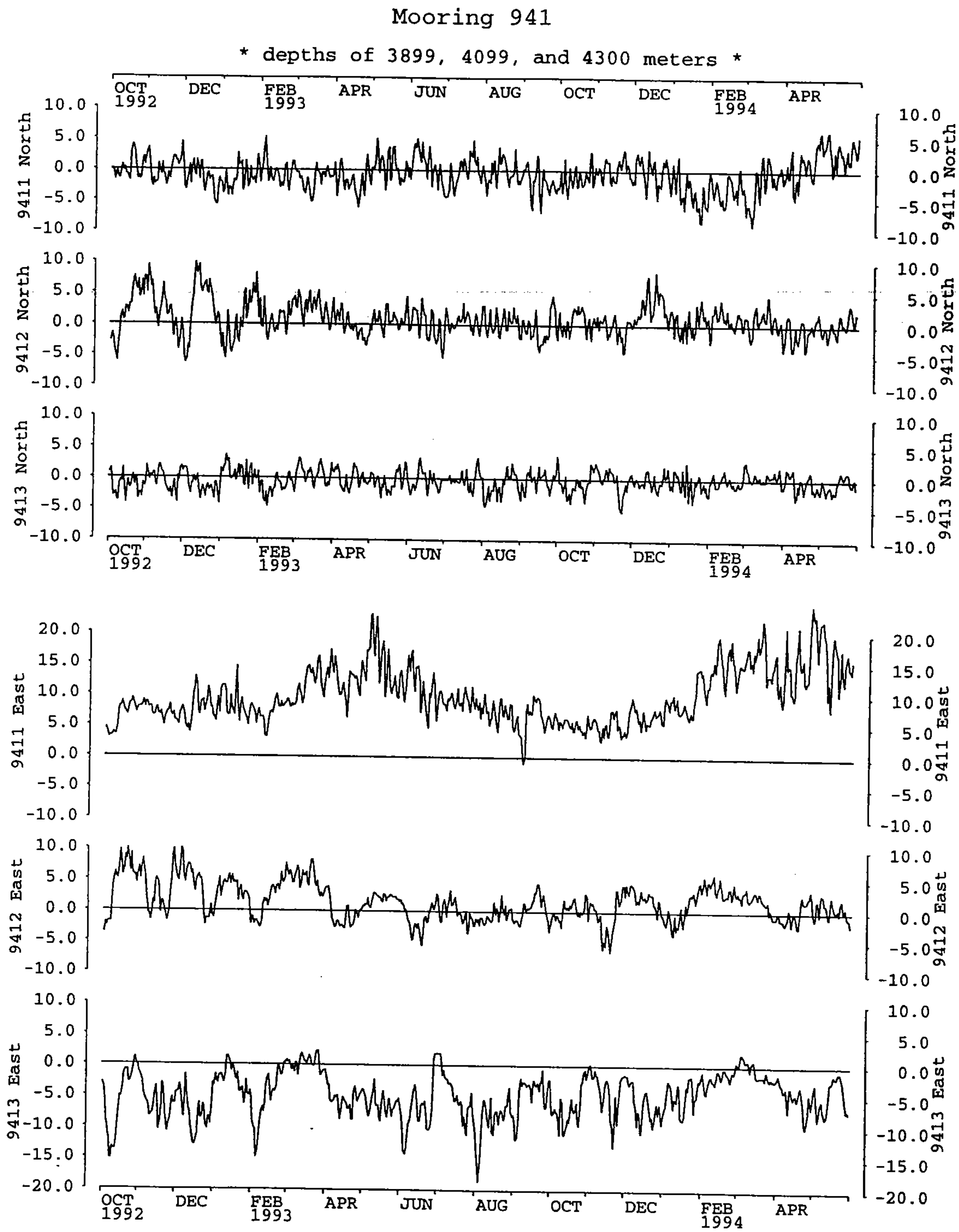

progressive vector plots for mooring 940
3000
3500
4000
4500
5000
-50
-40
-30
-20
-10
-10
0
10
20
30

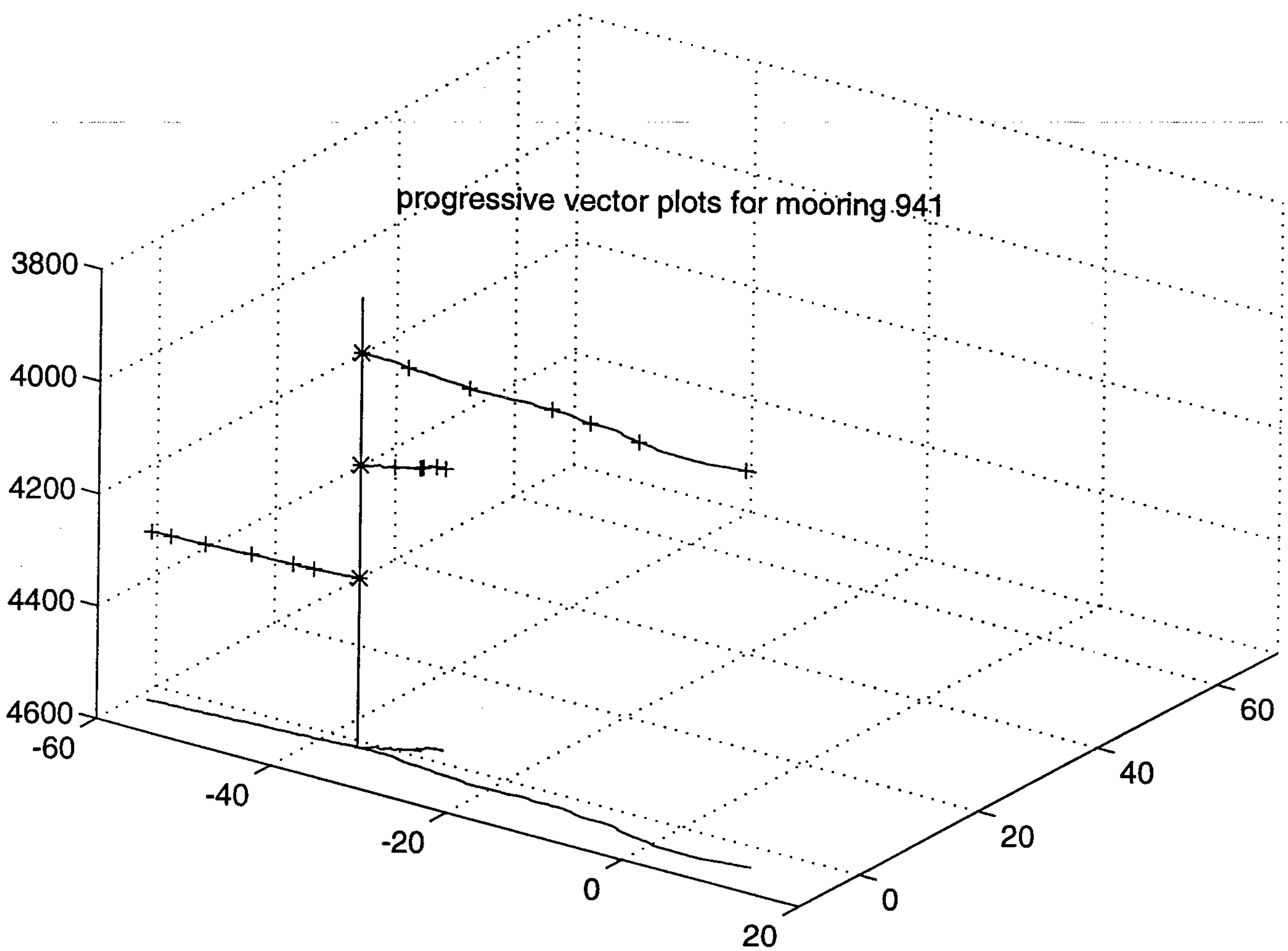
Mooring 941 * instrument depths are 3899, 4099 and 4300 meters



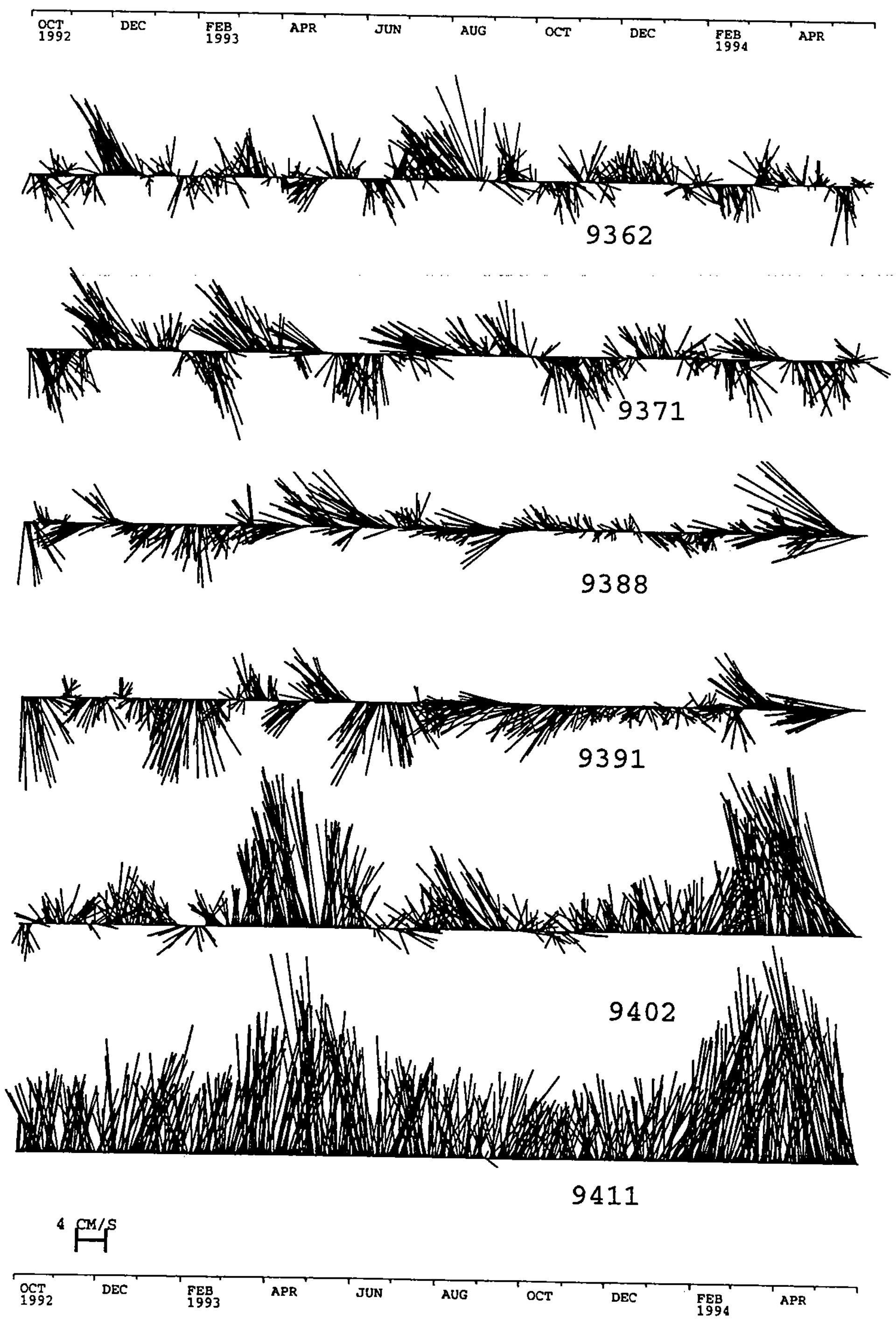
Mooring 941


* Temperatures at 3899, 4099, and 4300 meters
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
TEMP
2.80
2.70
2.60
2.50
2.40
2.30
2.20
2.10
2.00
1.90
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80

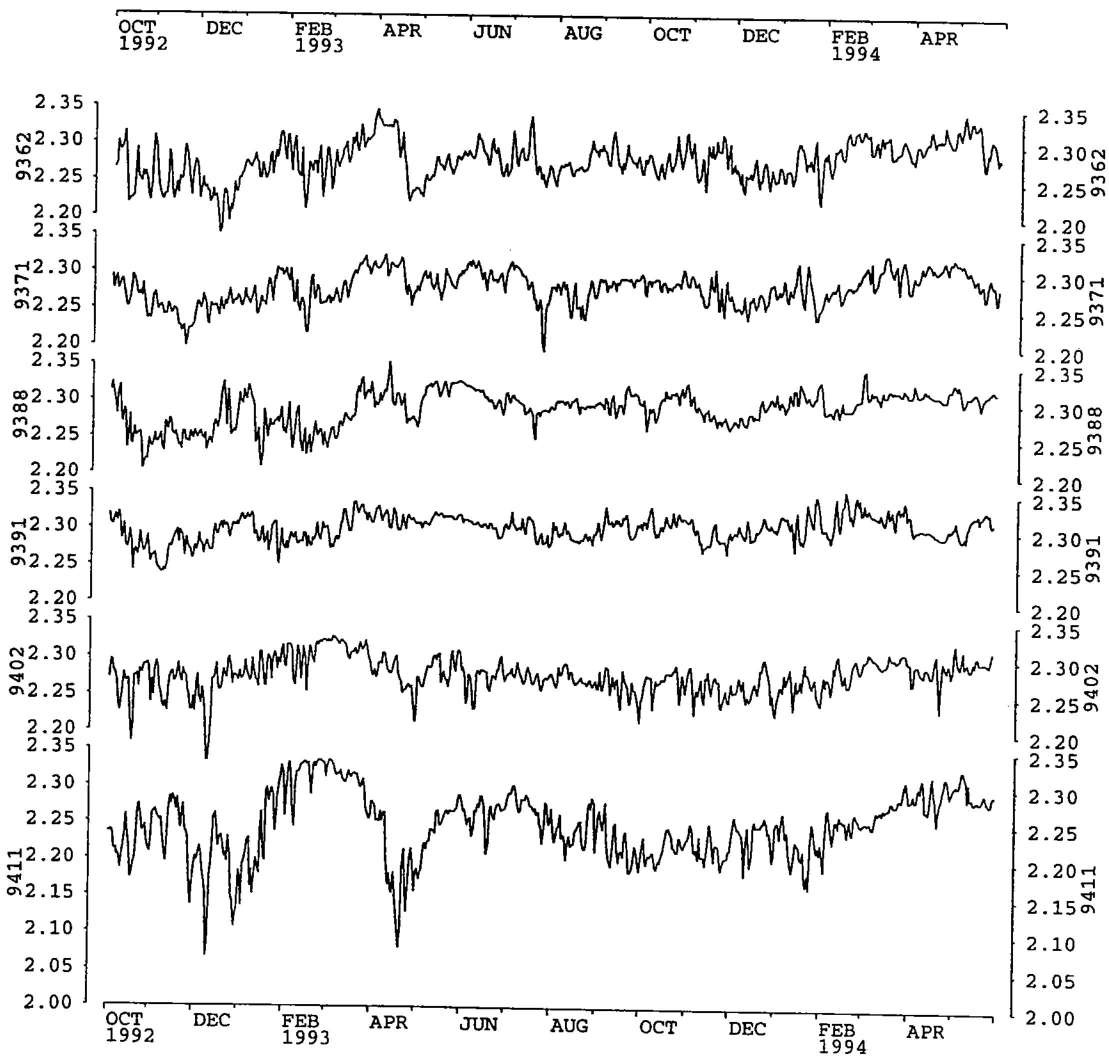

Mooring 941
* depths of 3899, 4099, and 4300 meters *
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
9411 North
9412 North
9413 North
9411 East
9412 East
9413 East
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0

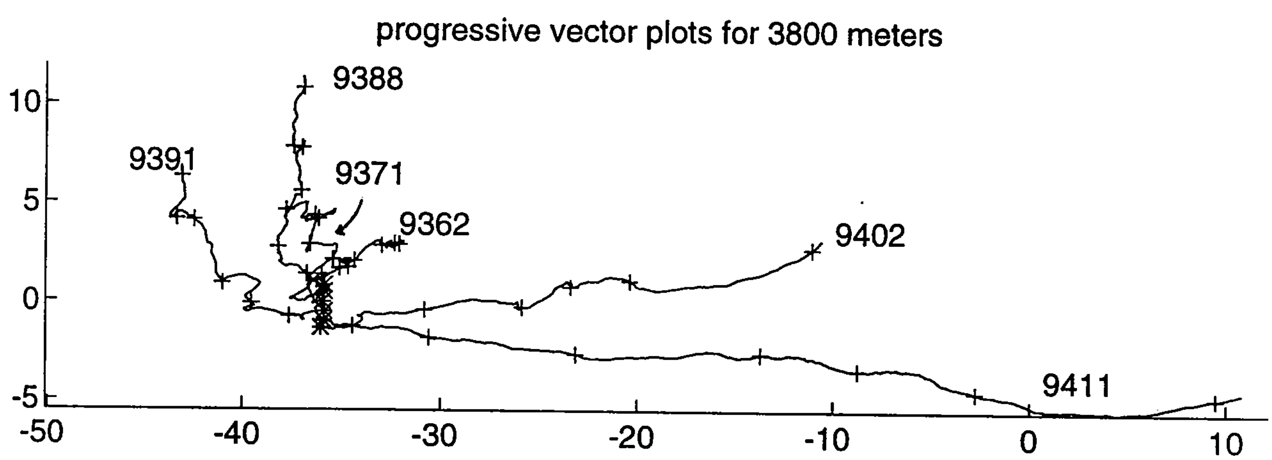

progressive vector plots for mooring 941
3800
4000
4200
4400
4600
-60
-40
-20
0
20
0
20
40
60

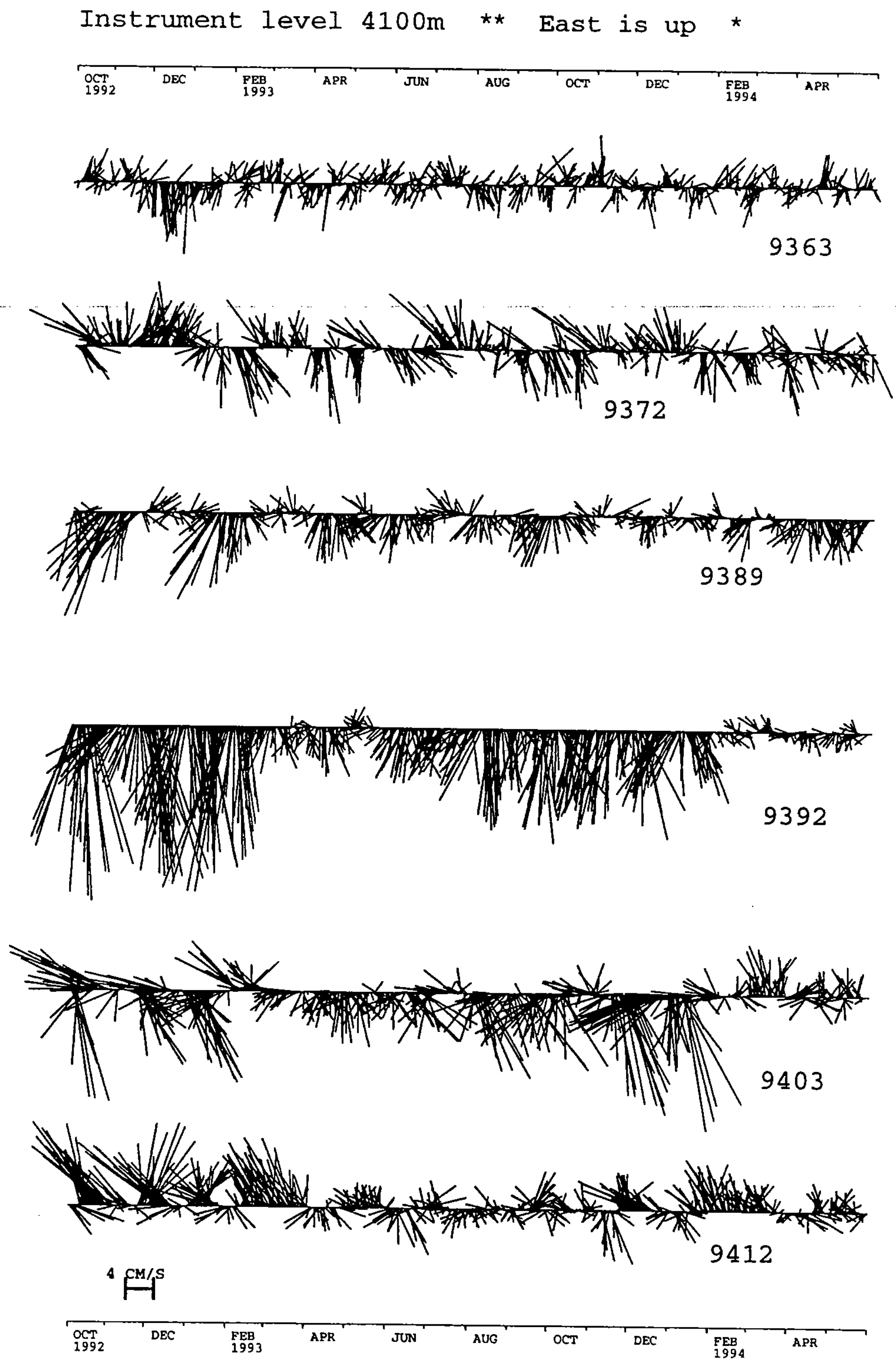
Instrument level 3900m ** East is up *



Temperatures at 3900 meters

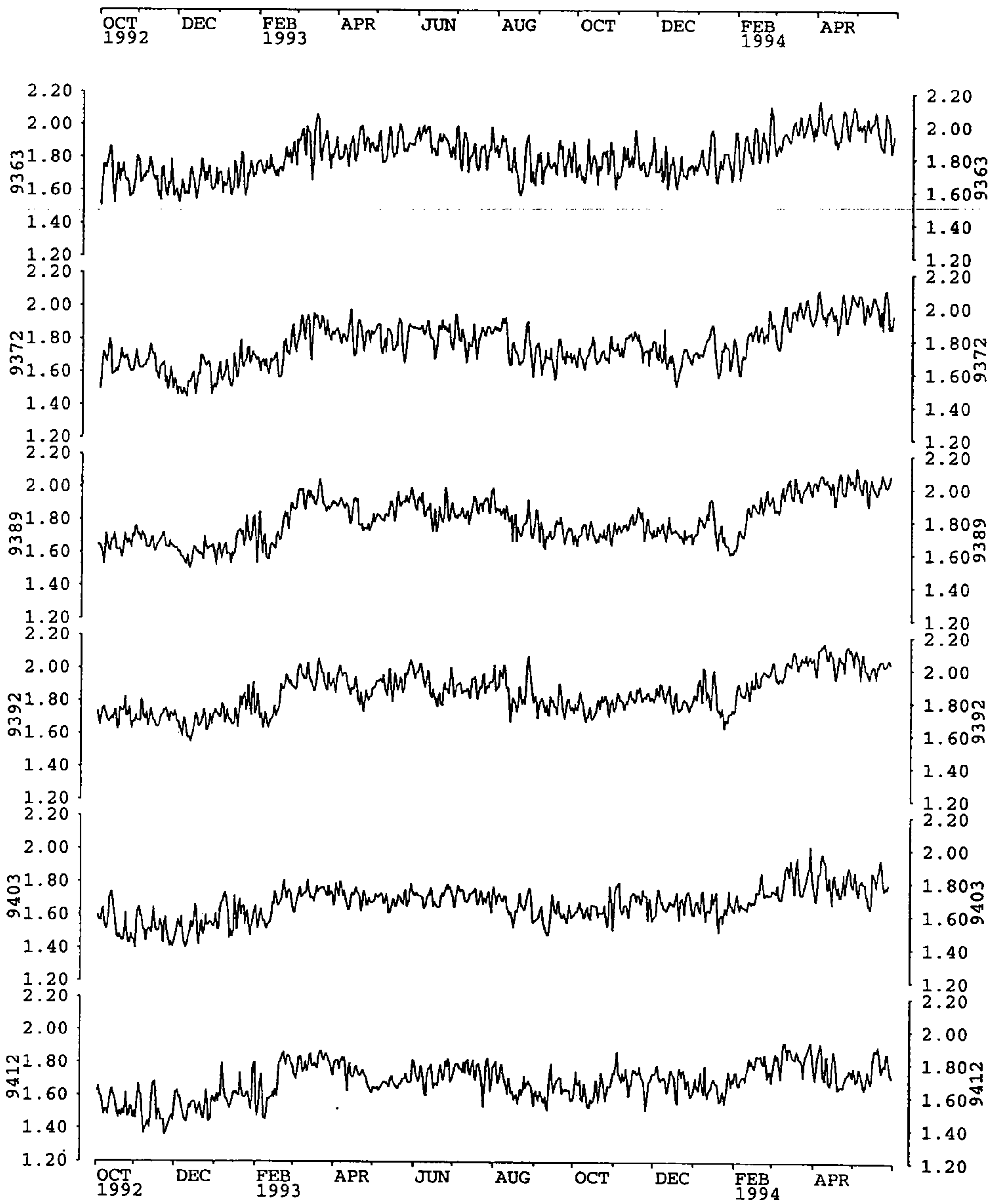



progressive vector plots for 3800 meters
9388
9391
9371
9362
9402
9411
10
5
0
-5
-50
-40
-30
-20
-10
0
10

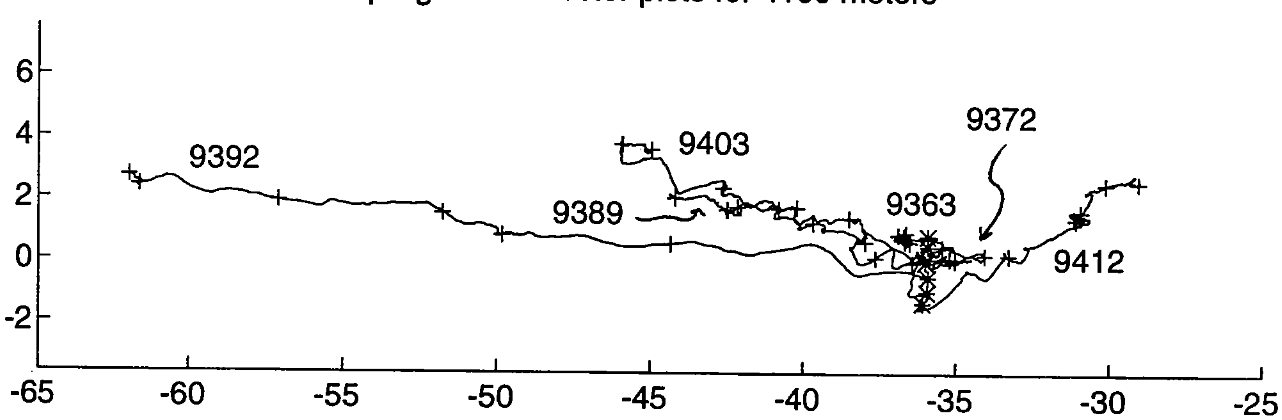


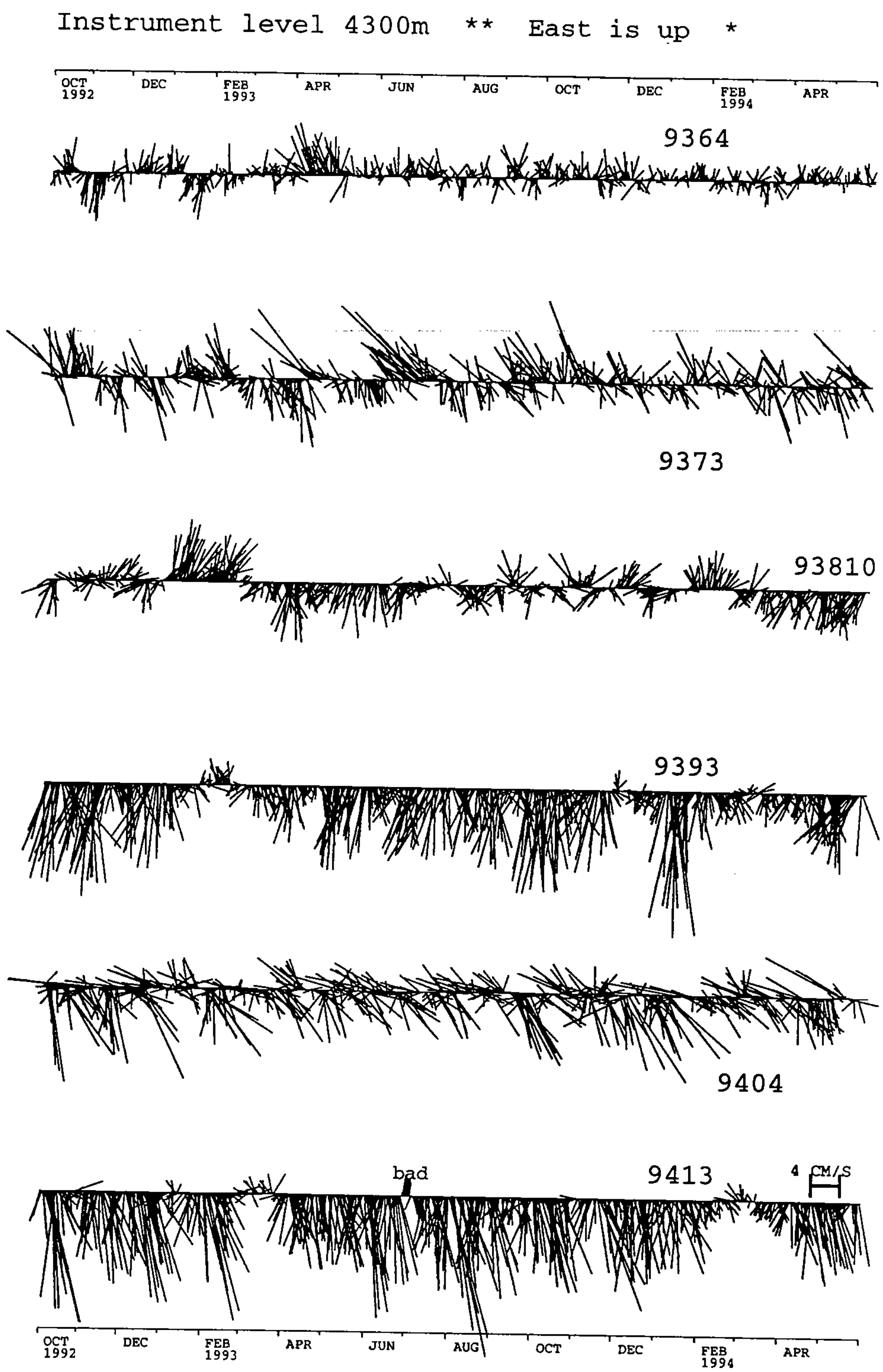
Instrument level 4100m ** East is up *
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
9363
9372
9389
9392
9403
9412
4 CM/S

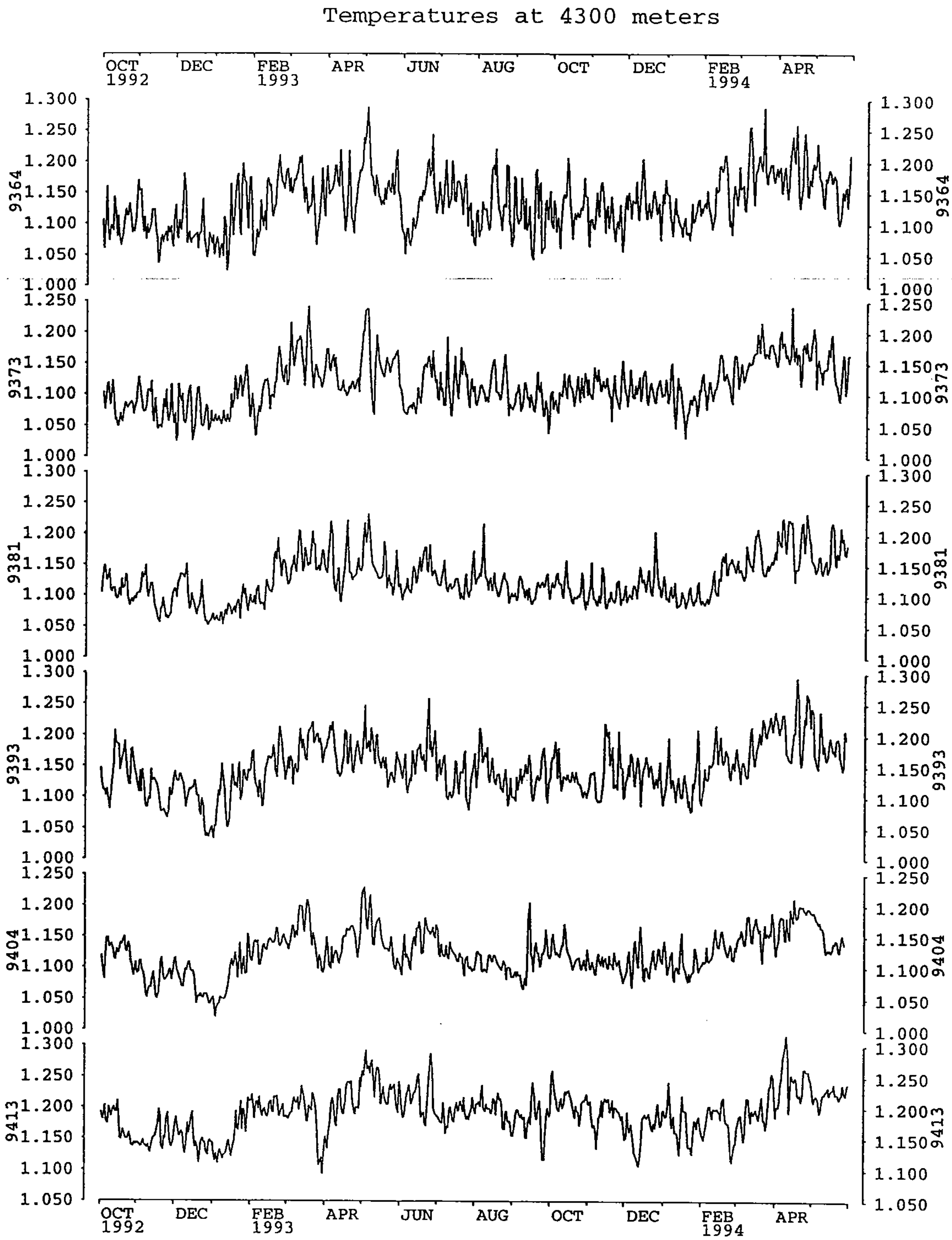
Temperatures at 4100 meters

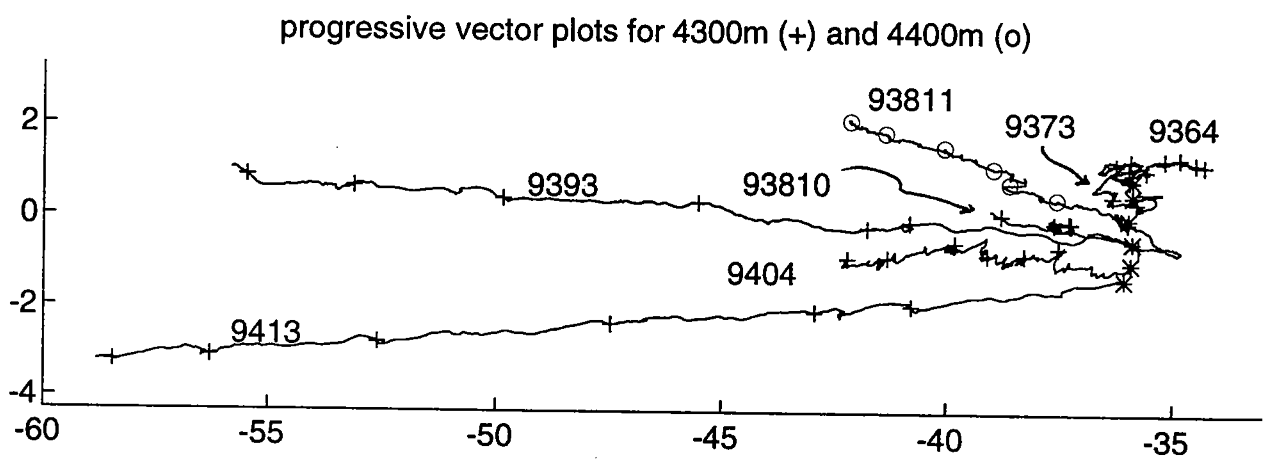


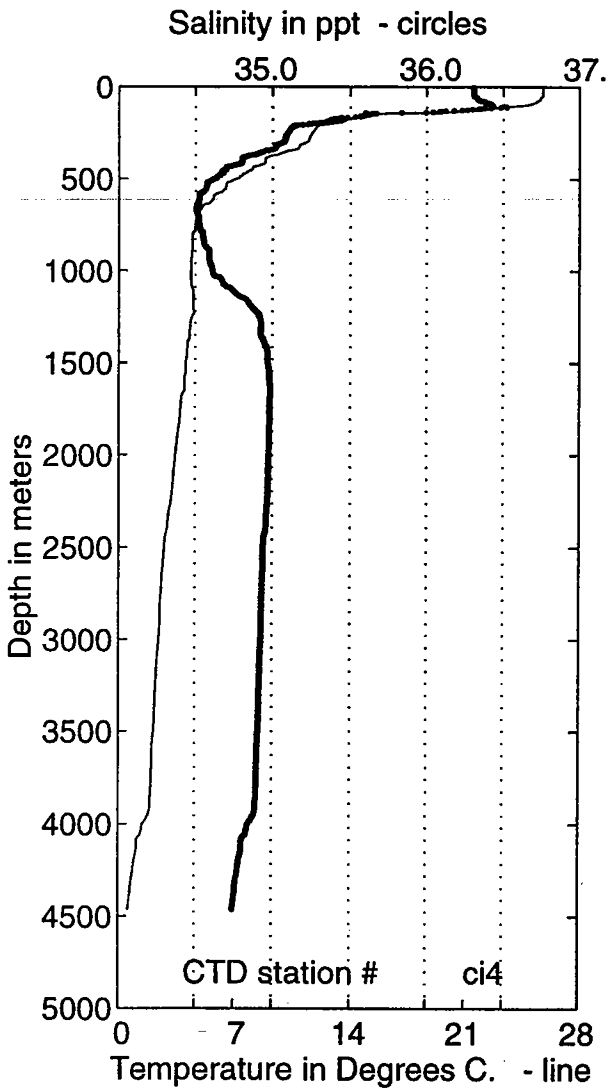
progressive vector plots for 4100 meters

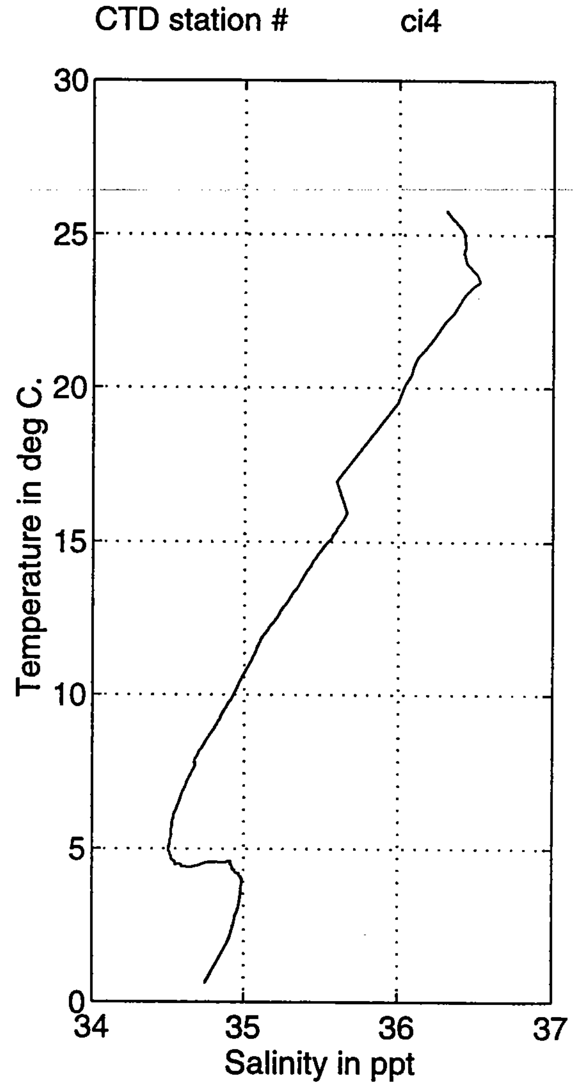


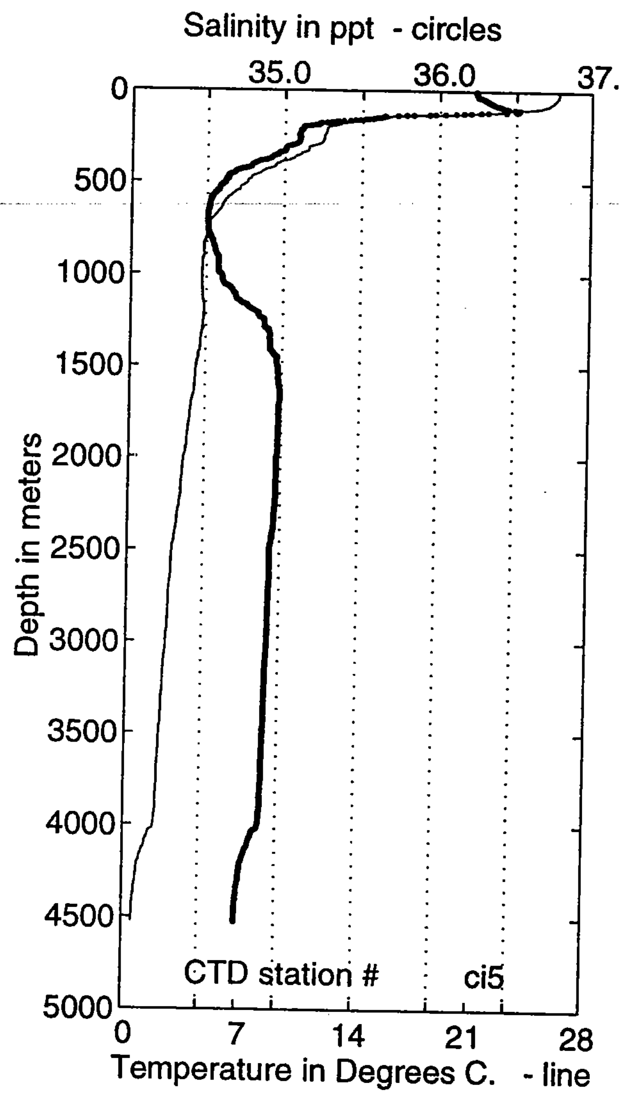

Instrument level 4300m ** East is up *
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
9364
9373
93810
9393
9404
bad
9413
4 CM/S

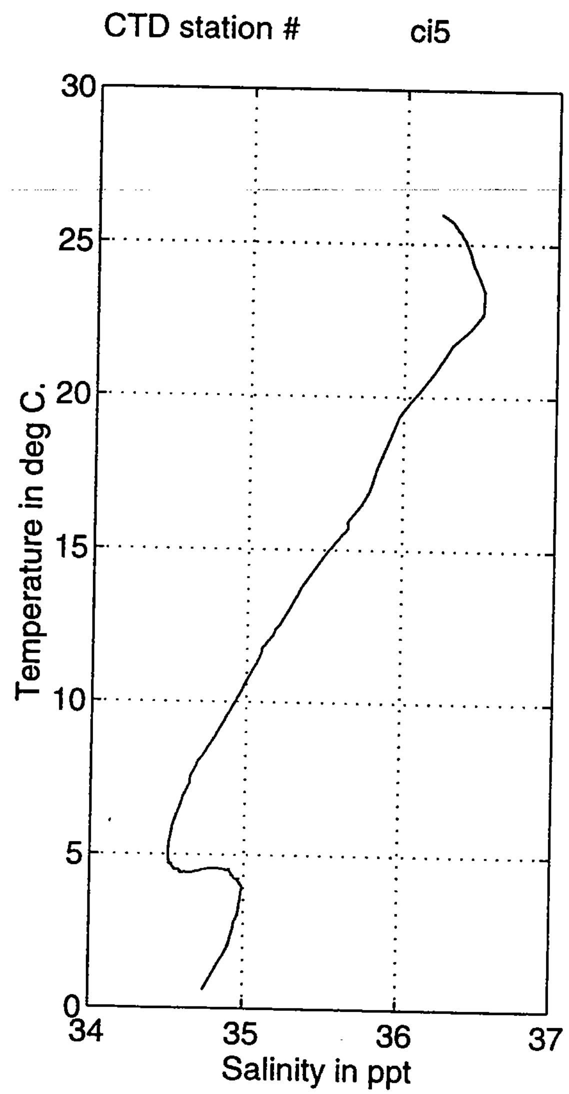

Temperatures at 4300 meters
OCT 1992
DEC
FEB 1993
APR
JUN
AUG
OCT
DEC
FEB 1994
APR
9364
9373
9381
9393
9404
9413
1.300
1.250
1.200
1.150
1.100
1.050
1.000

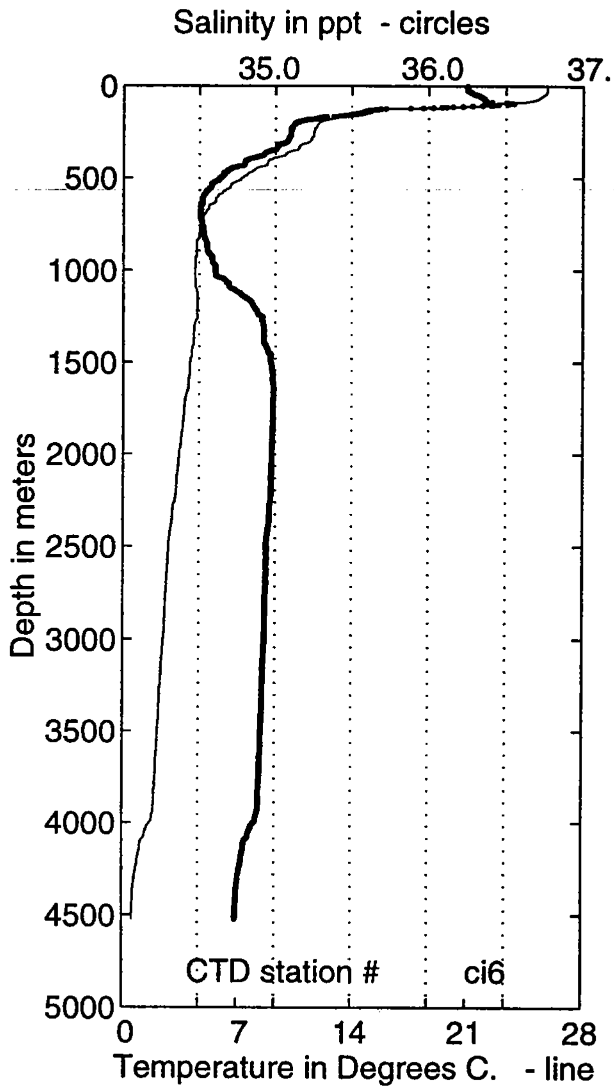

progressive vector plots for 4300m (+) and 4400m (o)
93811
9373
9364
9393
93810
9404
9413
2
0
-2
-4
-60
-55
-50
-45
-40
-35


Salinity in ppt - circles
35.0
36.0
37.
Depth in meters
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
CTD station # ci4
0
7
14
21
28
Temperature in Degrees C. - line

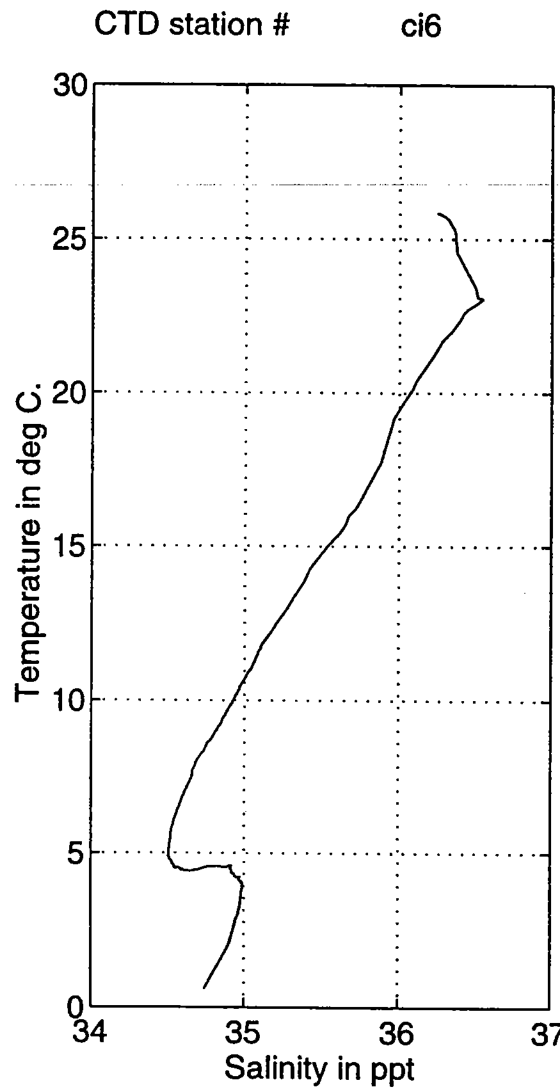

CTD station # ci4
Temperature in deg C.
30
25
20
15
10
5
0
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # ci5
0
7
14
21
28
Temperature in Degrees C. - line

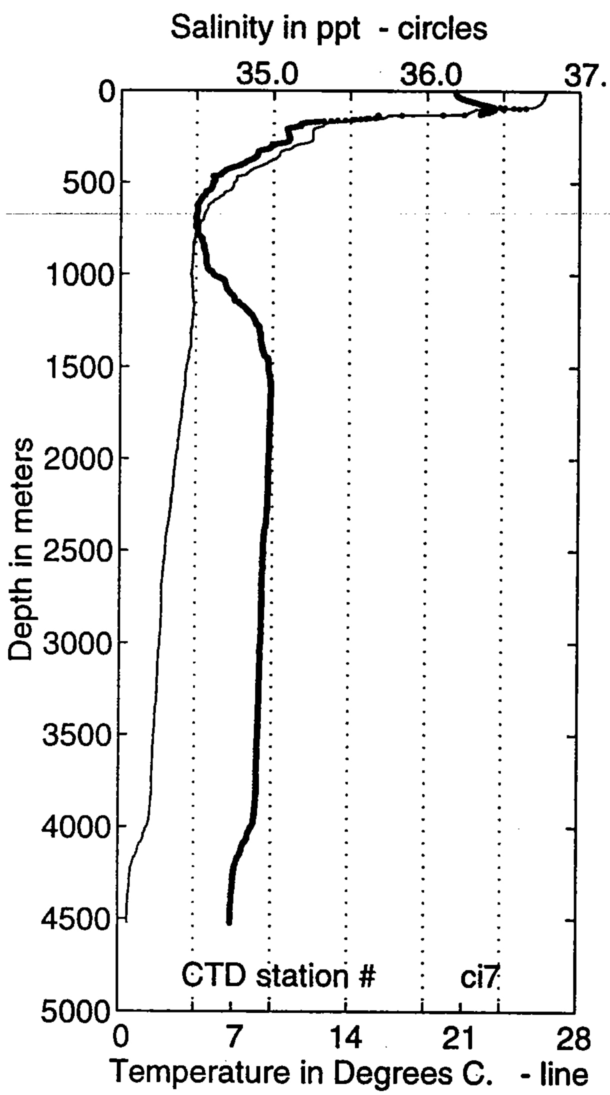

CTD station # ci5
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

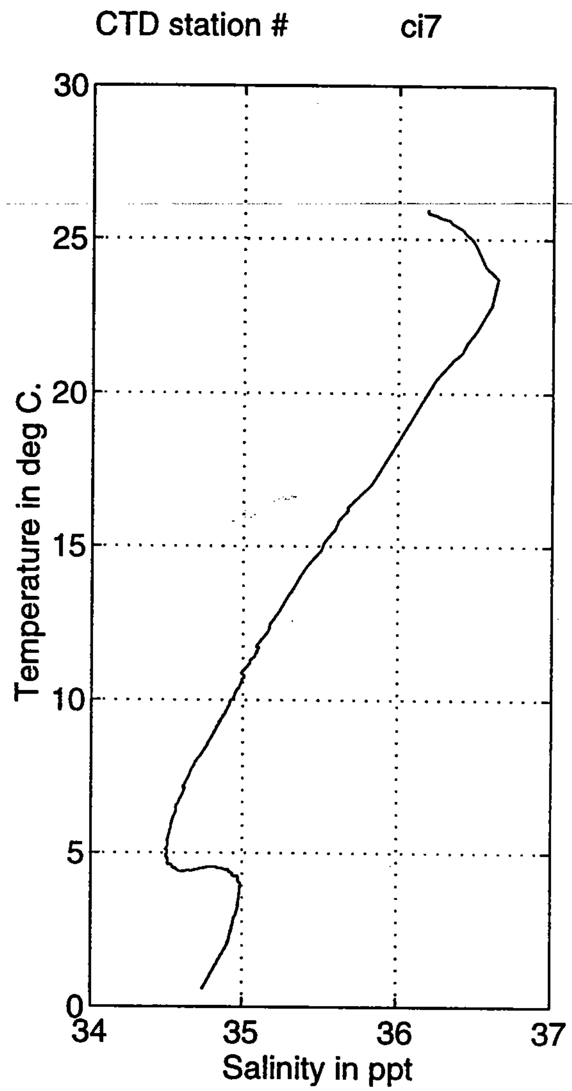


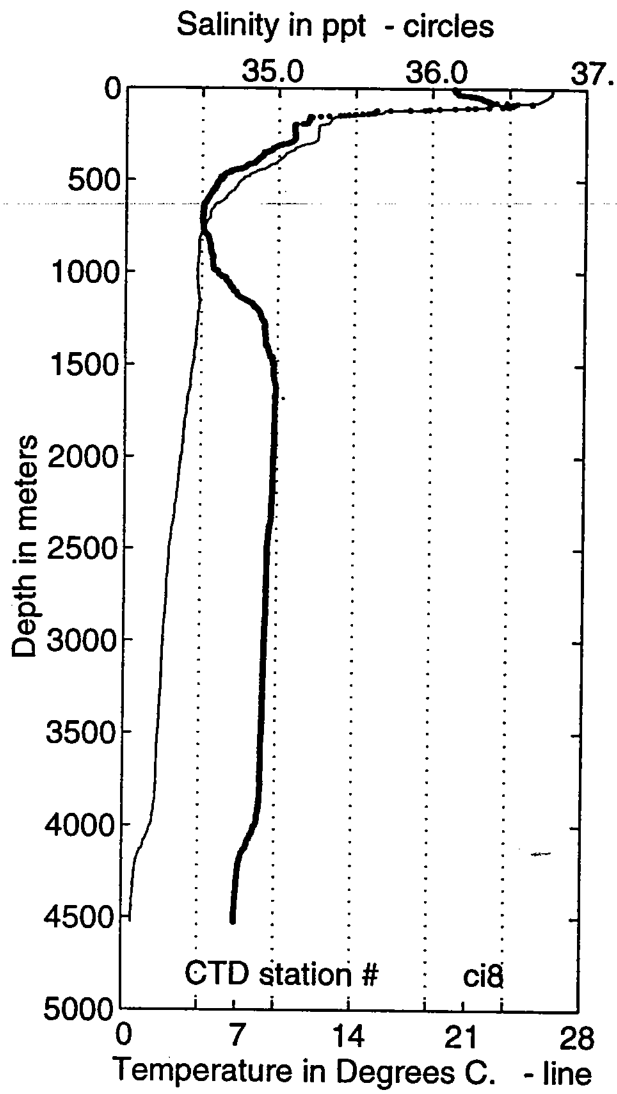
Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station #
ci6
0
7
14
21
28
Temperature in Degrees C. - line



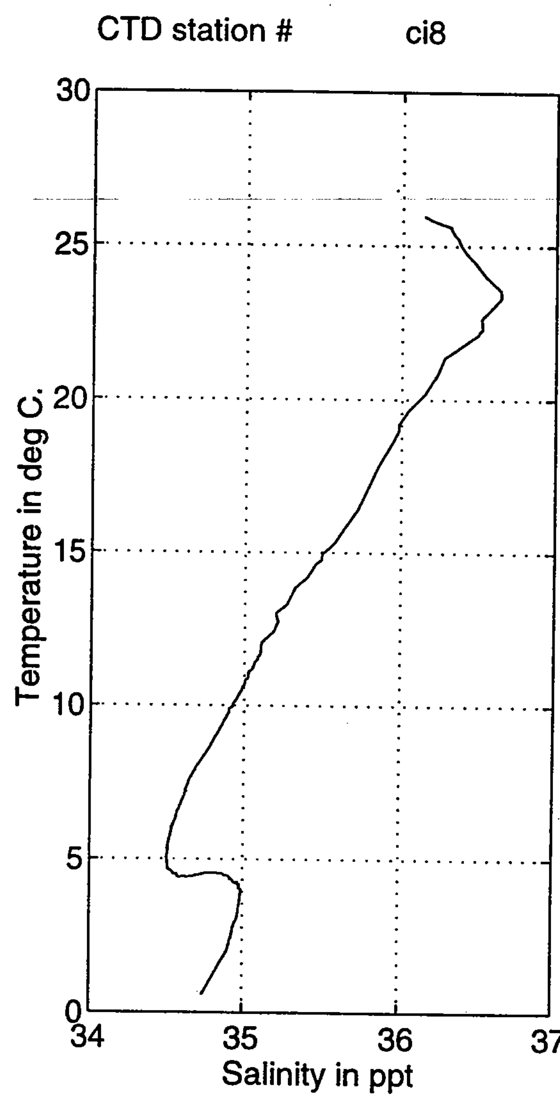
CTD station #
ci6
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # : ci7
0
7
14
21
28
Temperature in Degrees C. - line

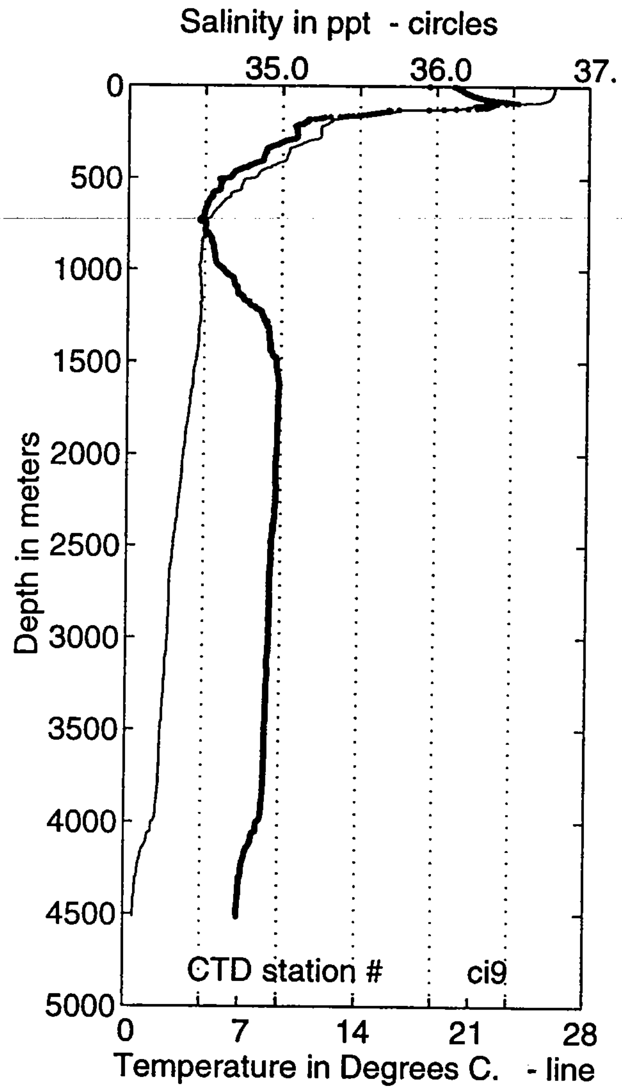

CTD station # ci7
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

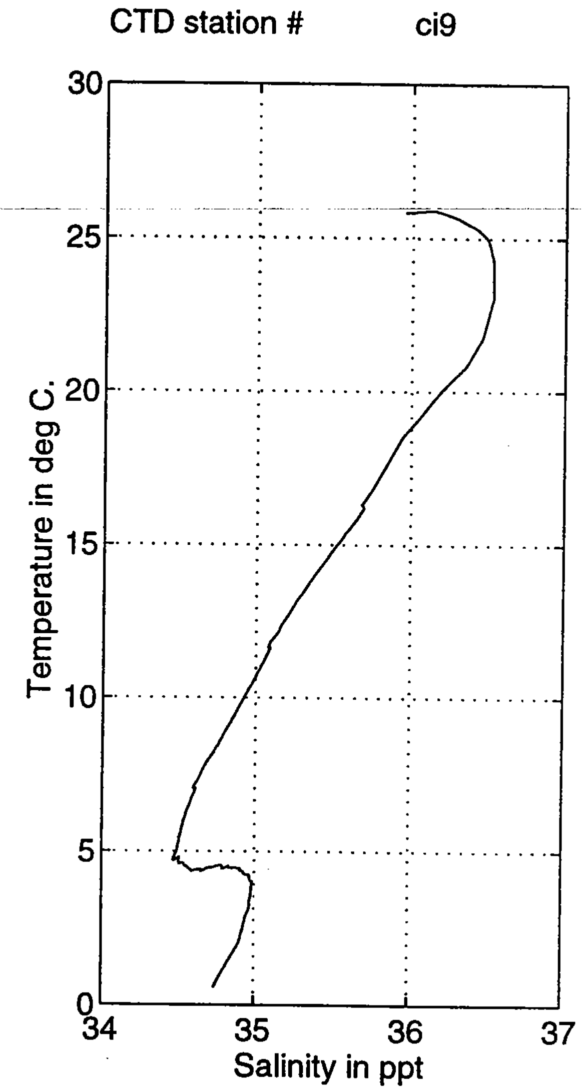


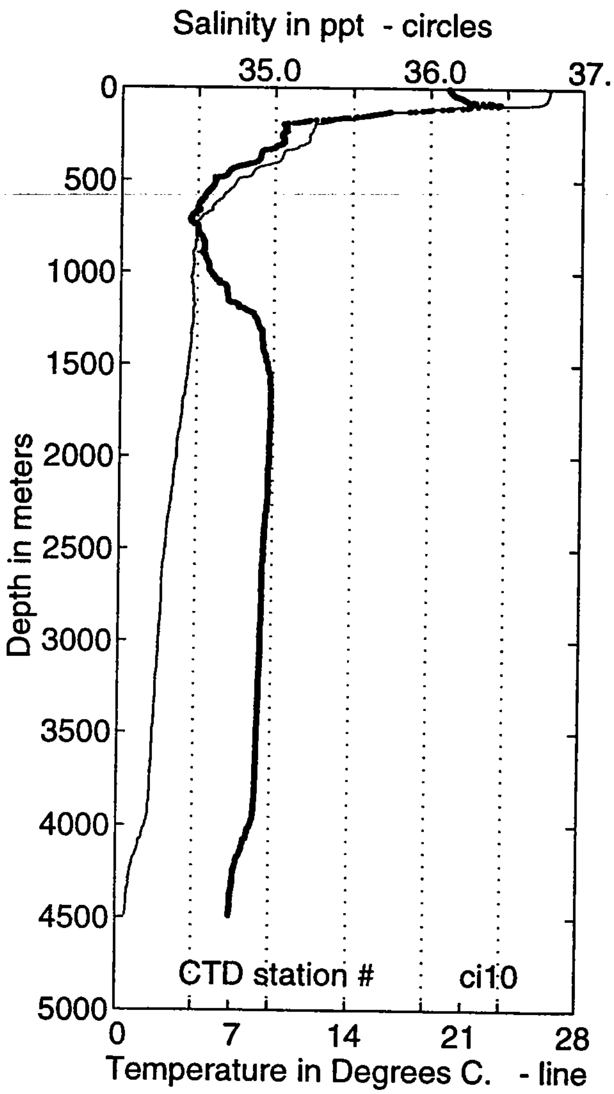
Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # ci8
0
7
14
21
28
Temperature in Degrees C. - line

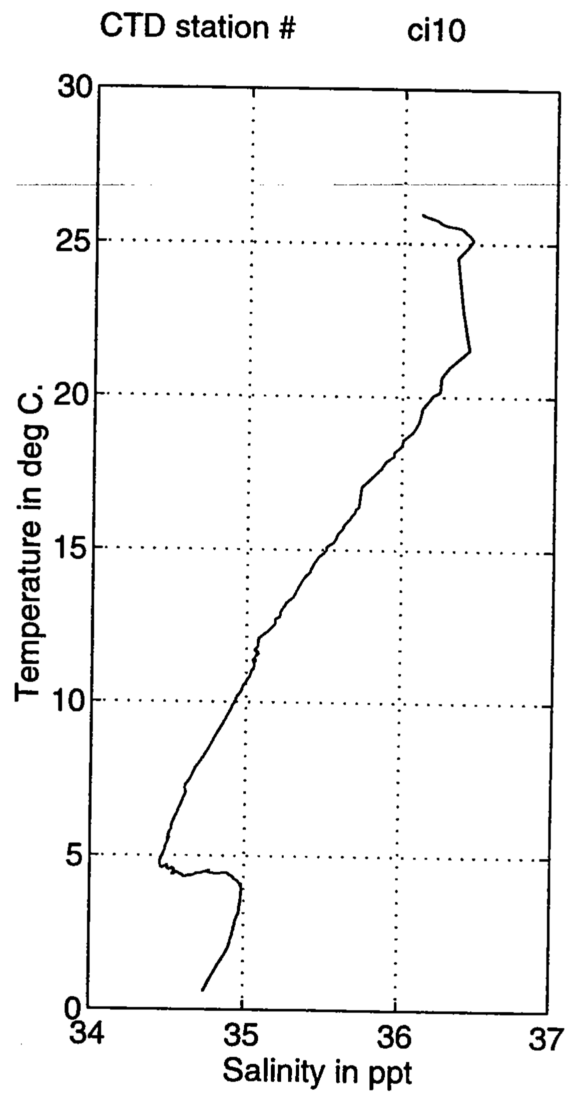


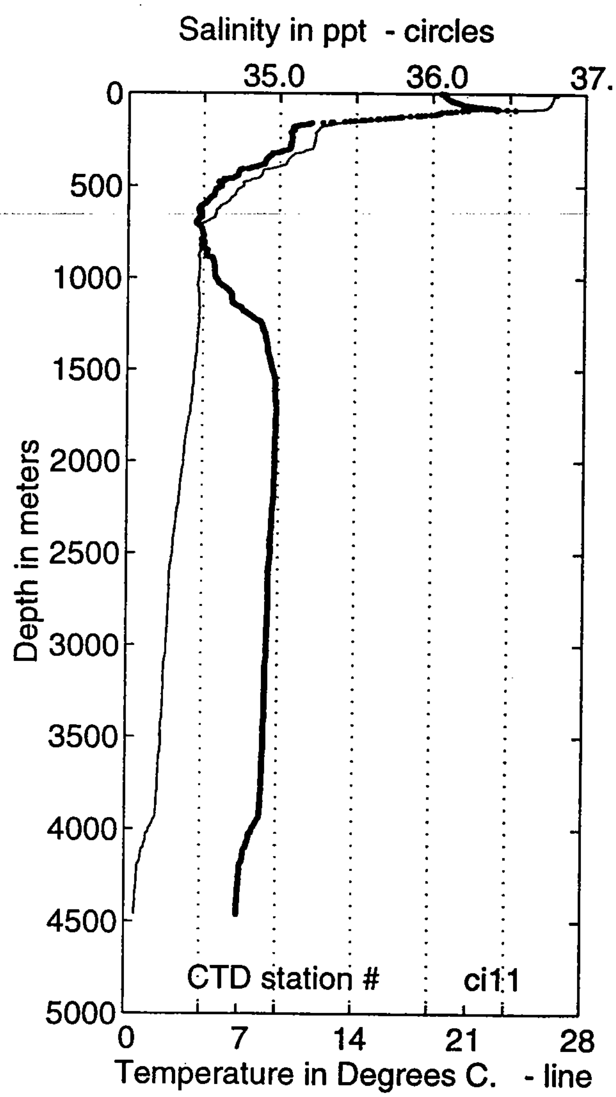
CTD station # ci8
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

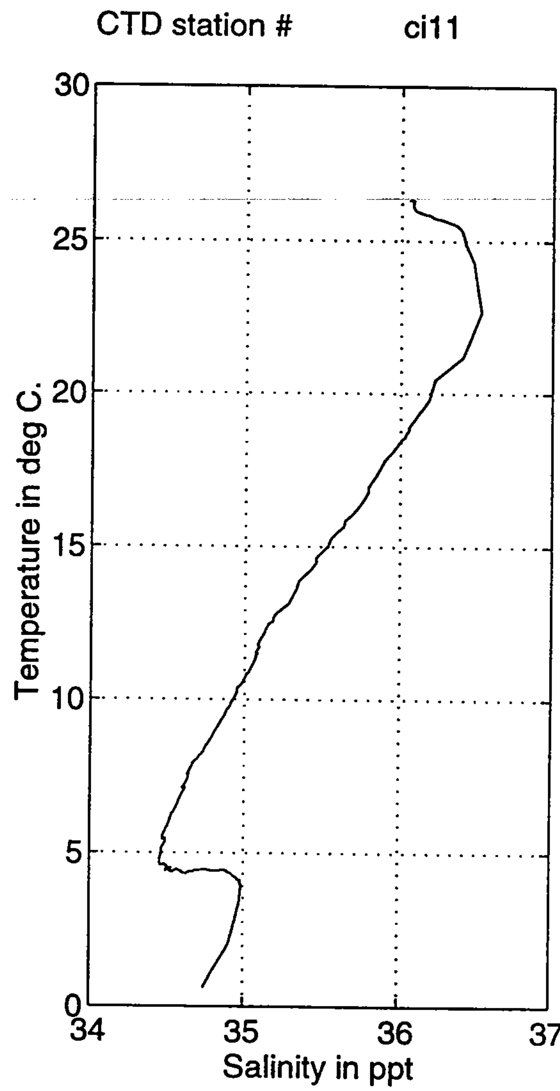

Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # ci9
0
7
14
21
28
Temperature in Degrees C. - line

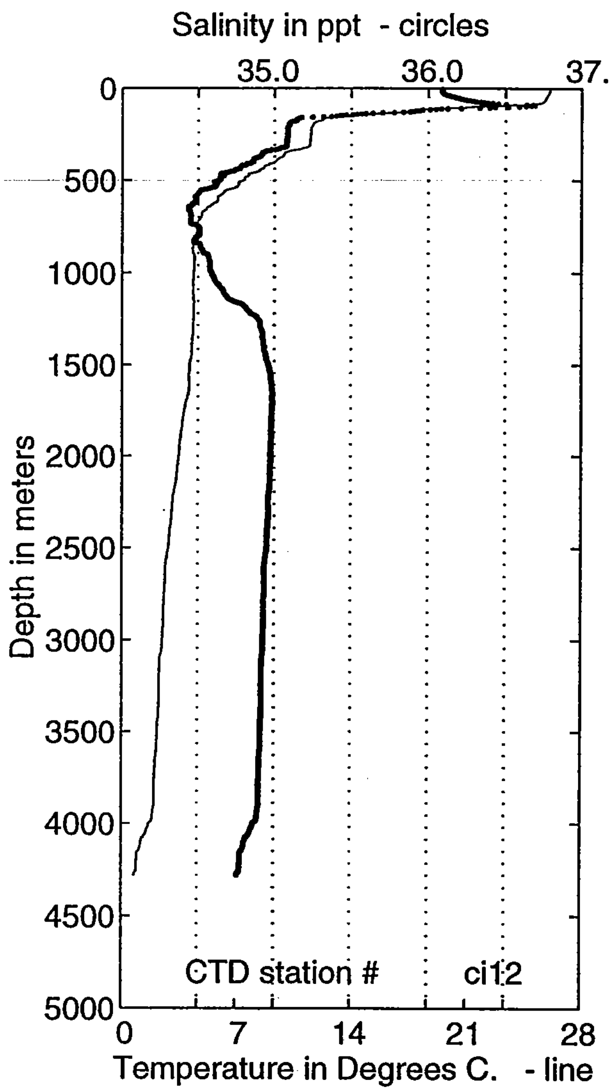

CTD station # ci9
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station #
ci10
0
7
14
21
28
Temperature in Degrees C. - line

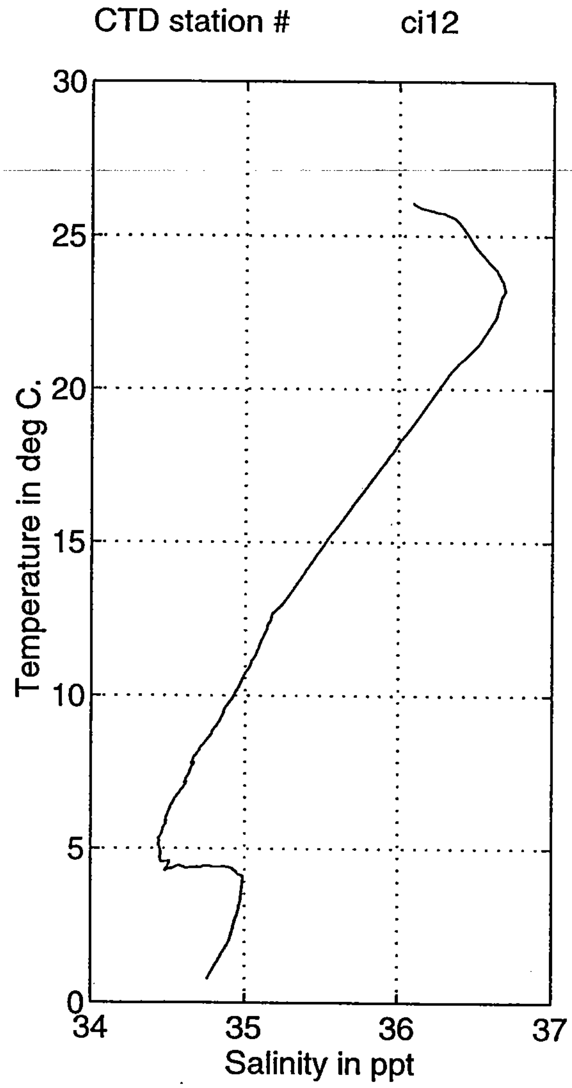

CTD station #
ci10
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # ci11
0
7
14
21
28
Temperature in Degrees C. - line

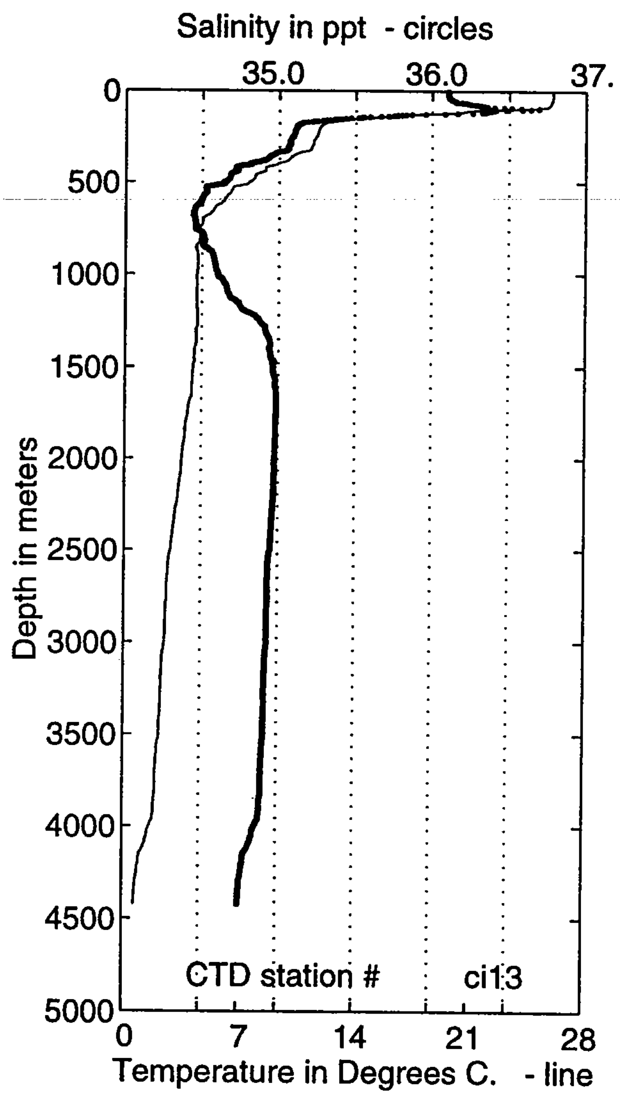

CTD station # ci11
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

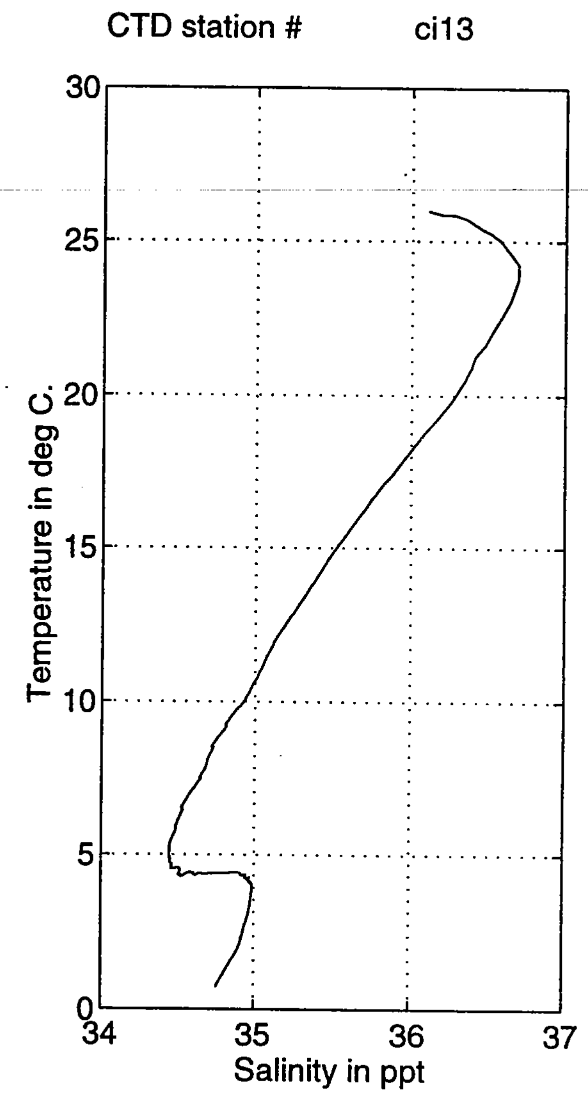


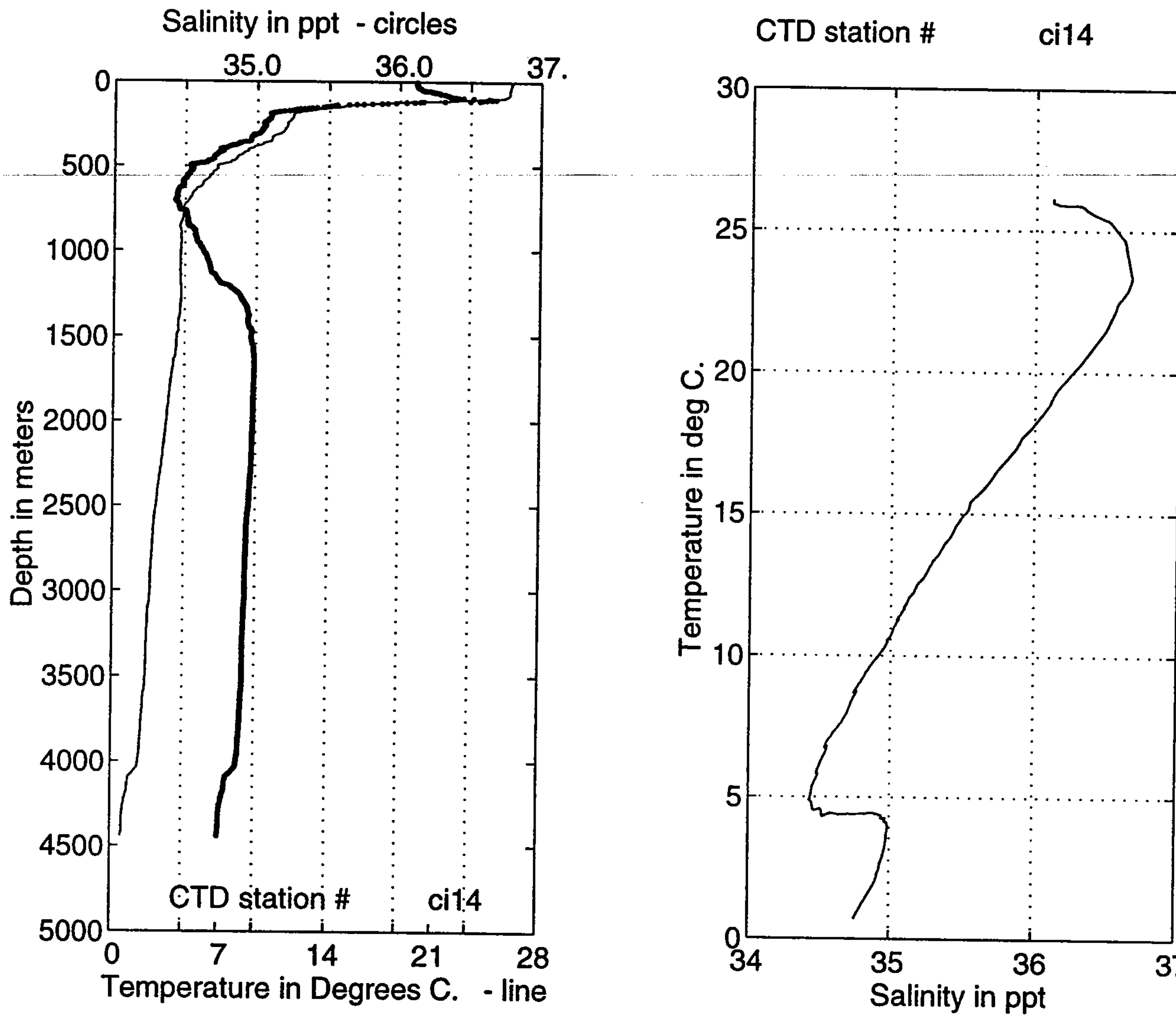
Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # ci12
0
7
14
21
28
Temperature in Degrees C. - line



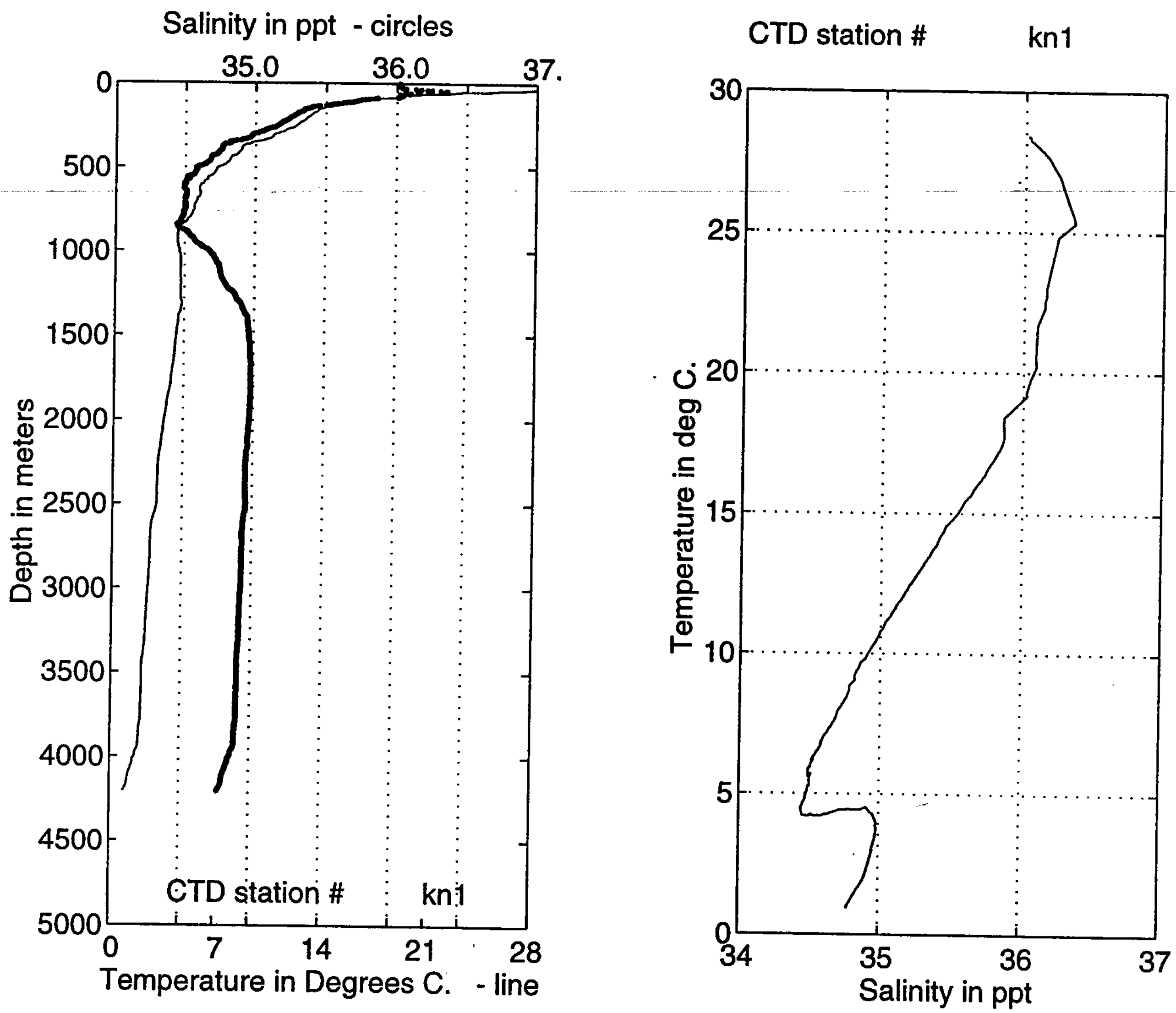
CTD station # ci12
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

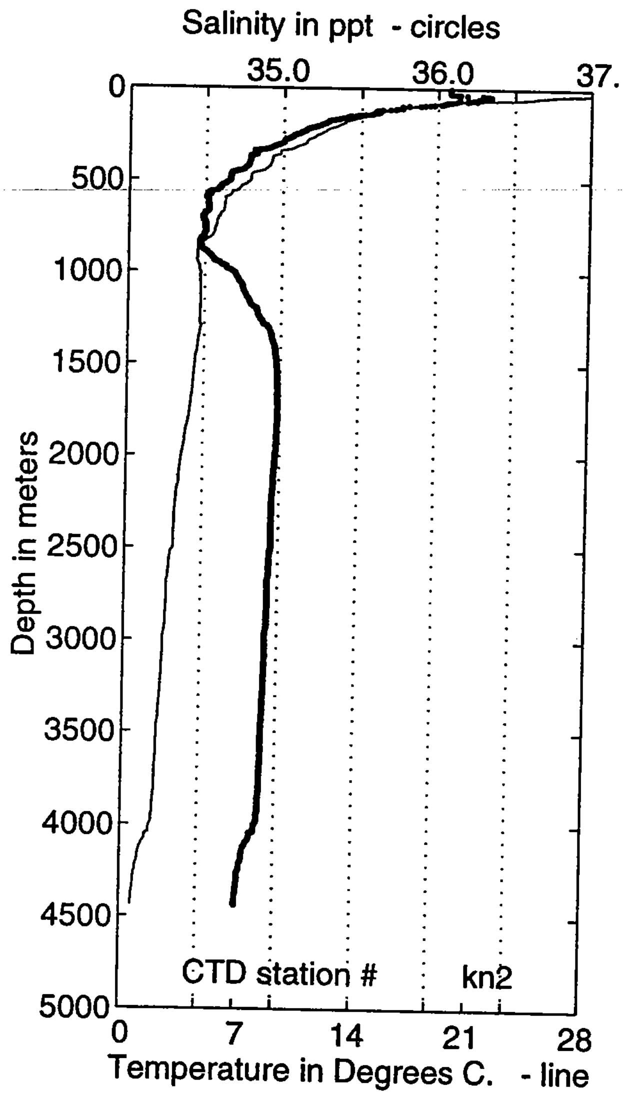

Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # ci13
0
7
14
21
28
Temperature in Degrees C. - line

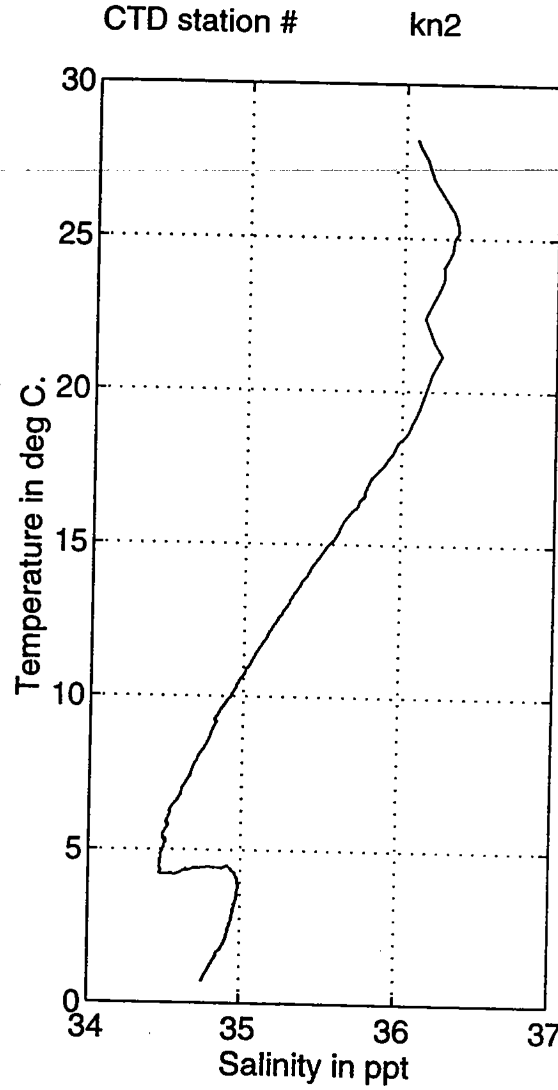

CTD station # ci13
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

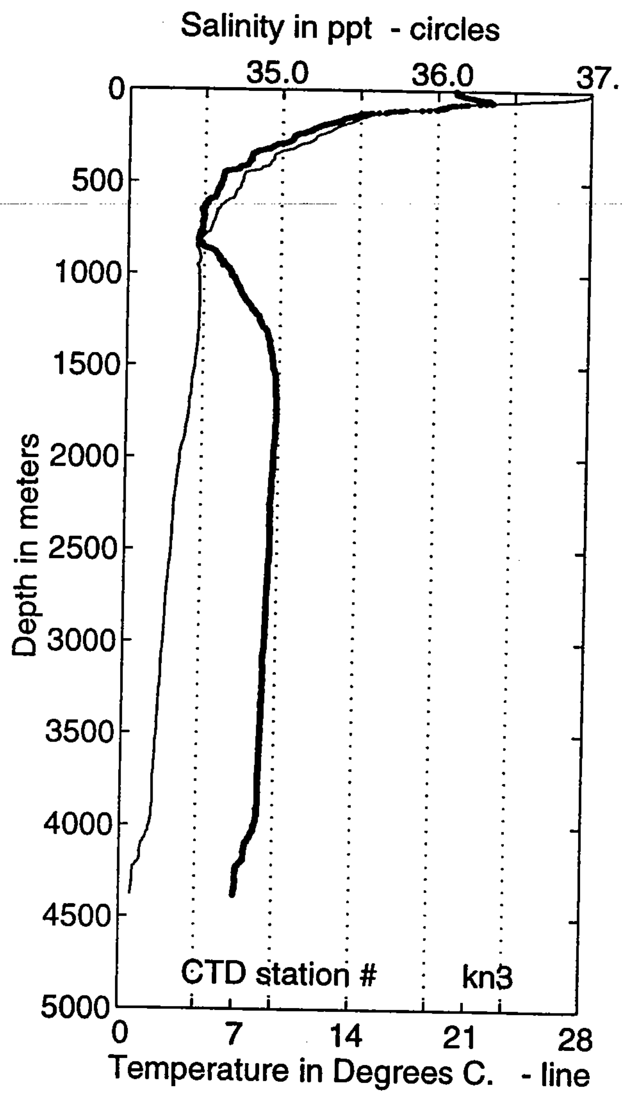


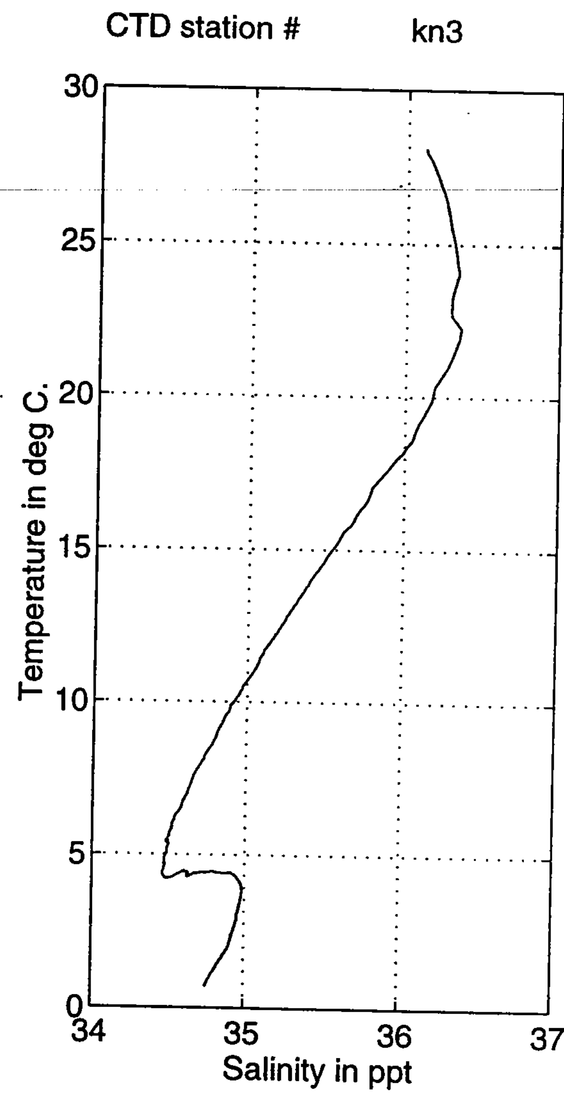
Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # ci14
0
7
14
21
28
Temperature in Degrees C. - line
CTD station # ci14
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

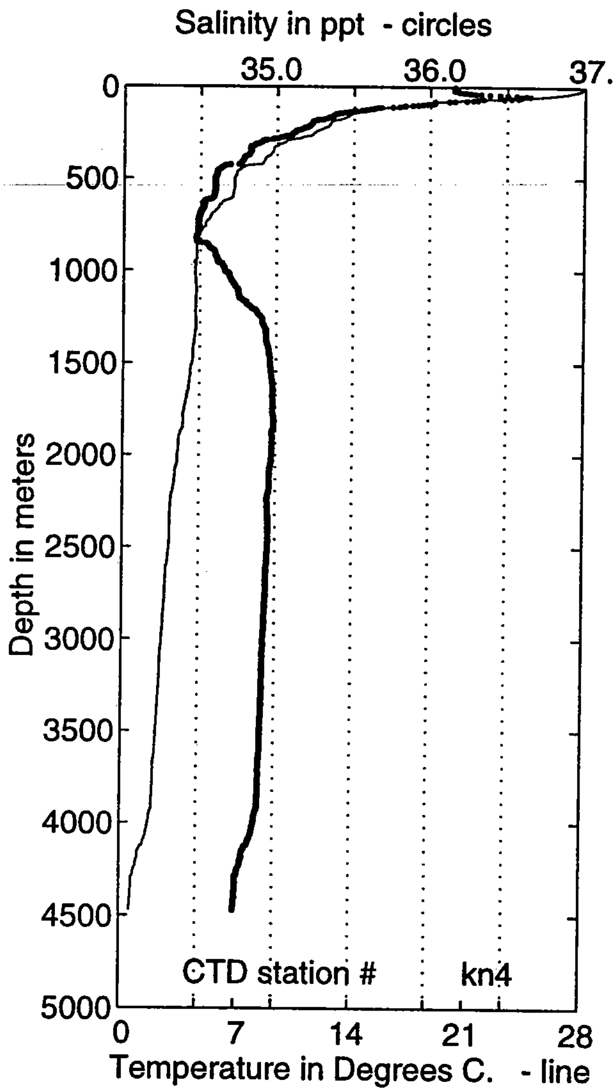

Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # kn1
0
7
14
21
28
Temperature in Degrees C. - line
CTD station # kn1
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

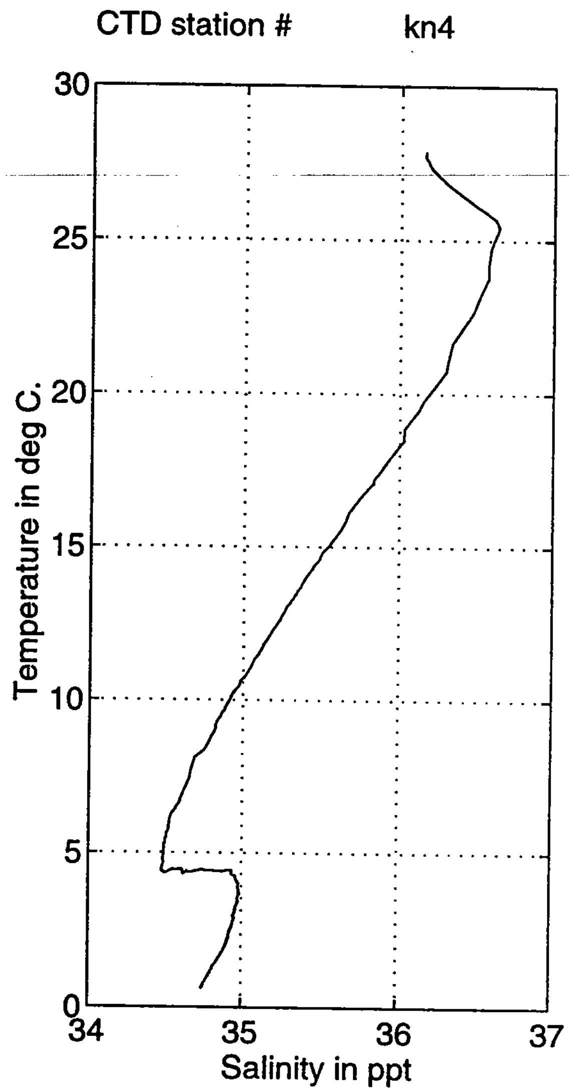

Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # kn2
0
7
14
21
28
Temperature in Degrees C. - line

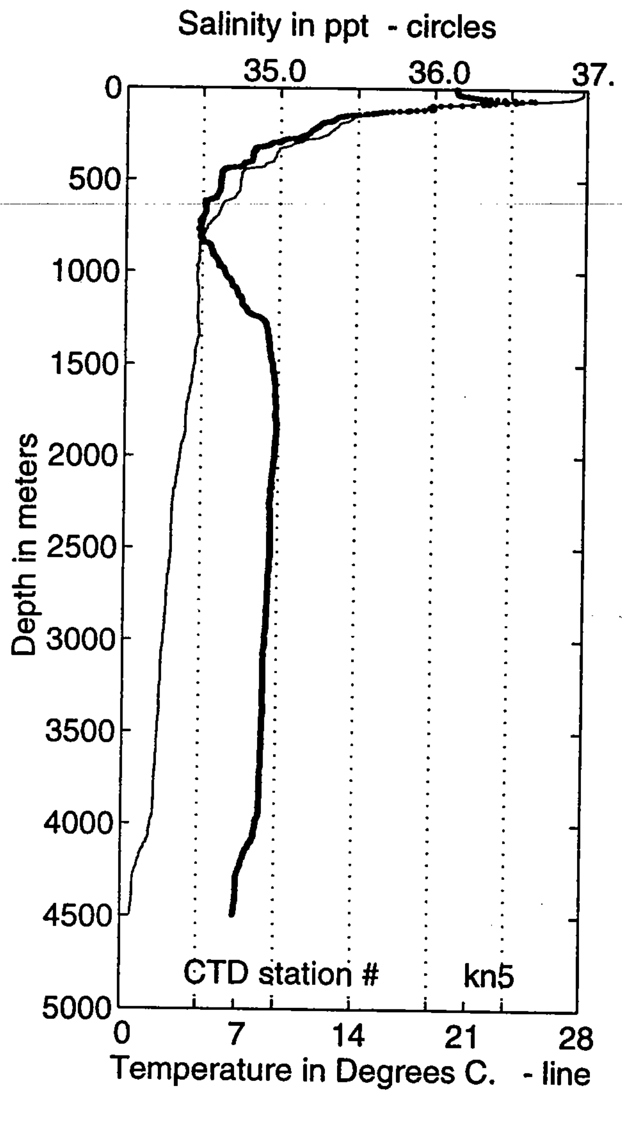

CTD station # kn2
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

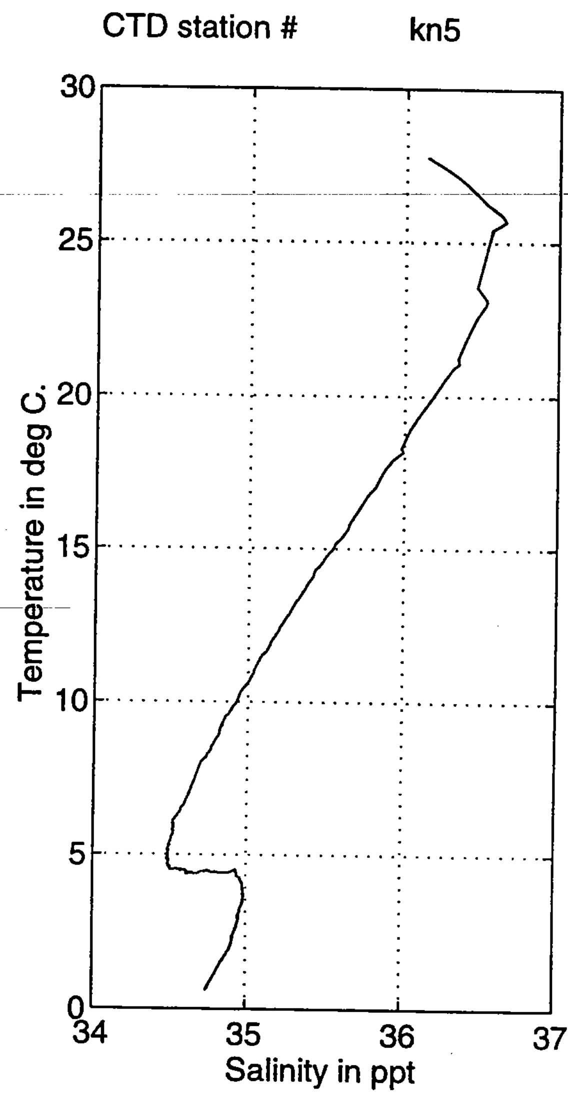

Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station #
kn3
0
7
14
21
28
Temperature in Degrees C. - line

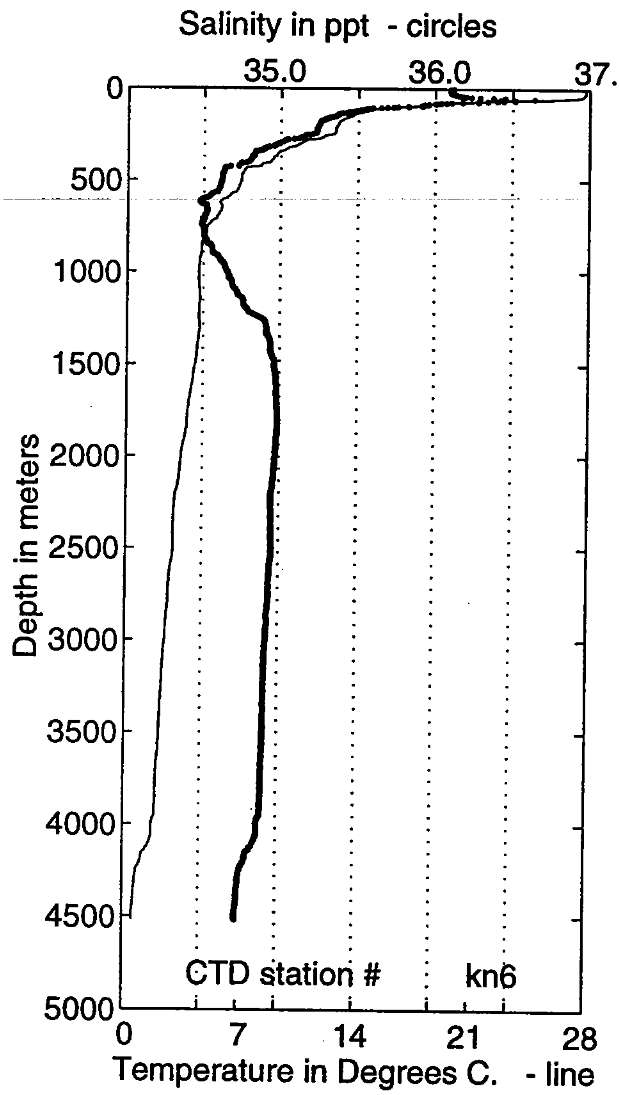

CTD station #
kn3
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

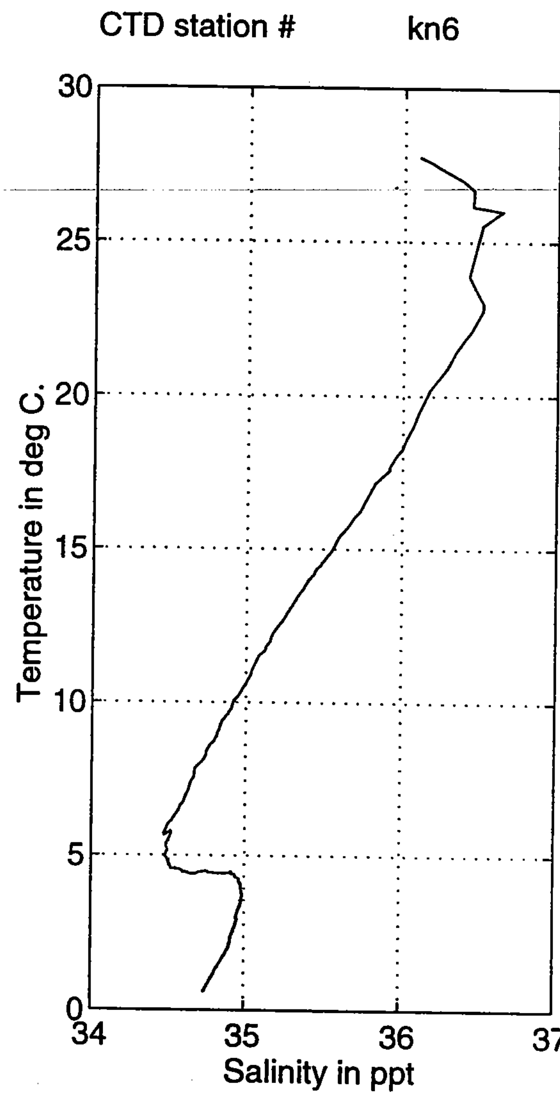

Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # kn4
0
7
14
21
28
Temperature in Degrees C. - line

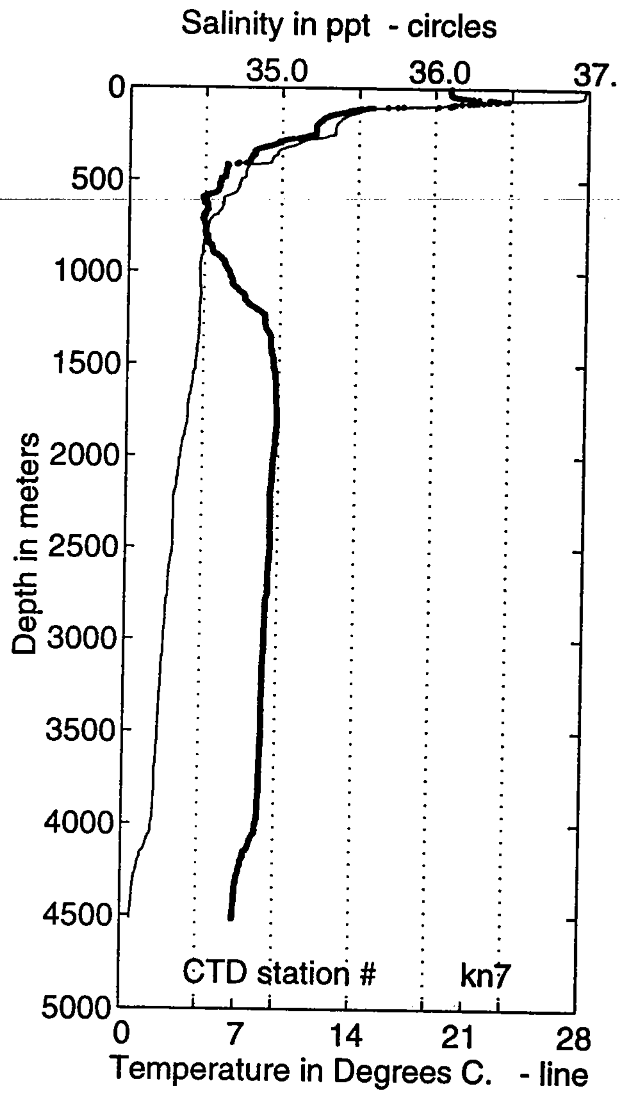

CTD station # kn4
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

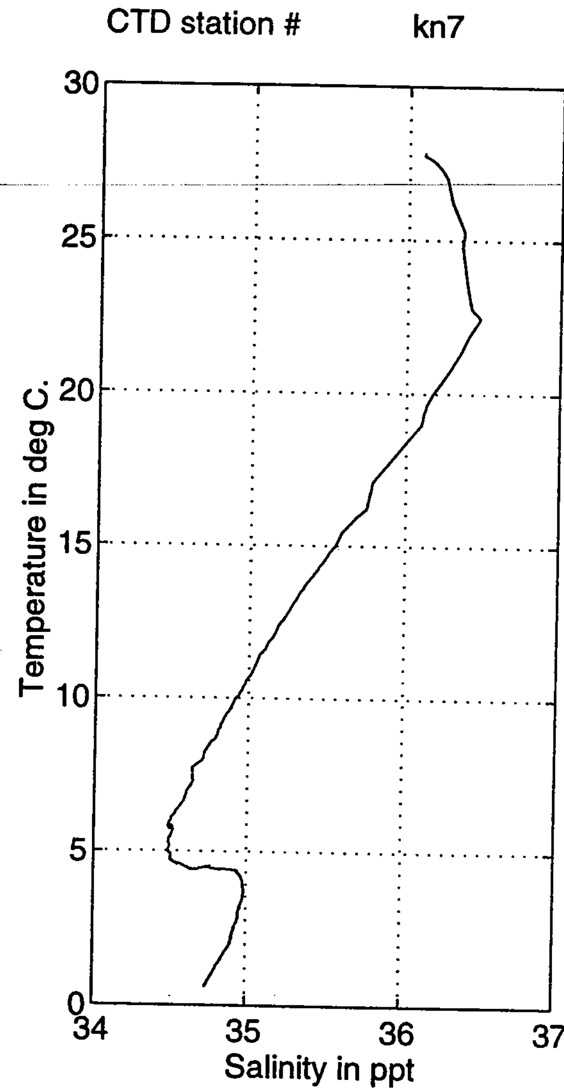

Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station #
kn5
0
7
14
21
28
Temperature in Degrees C. - line

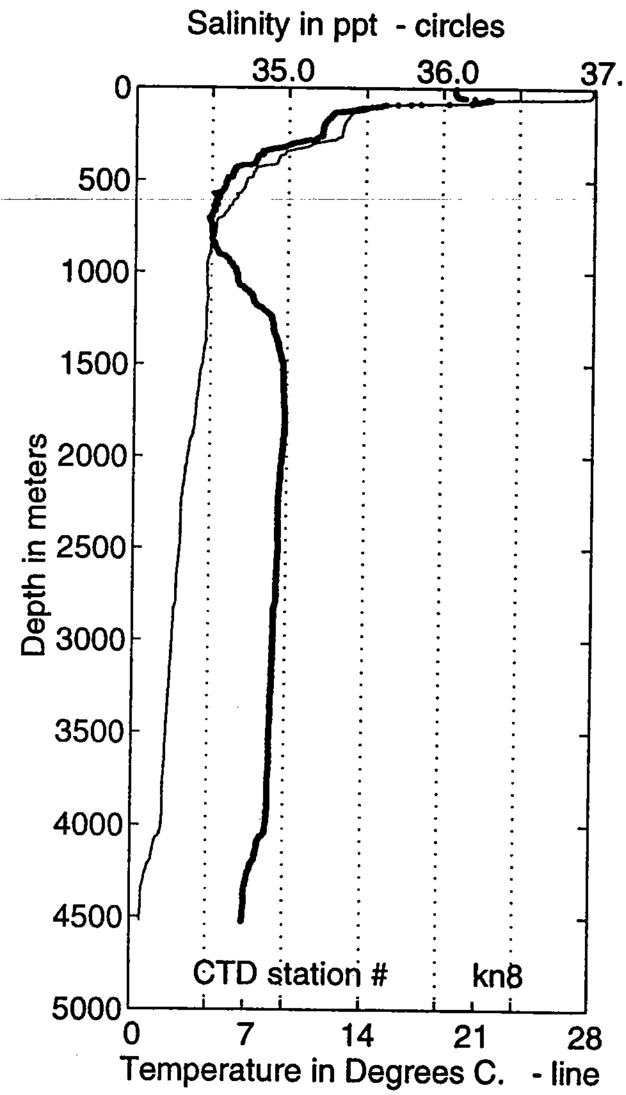

CTD station #
kn5
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # kn6
0
7
14
21
28
Temperature in Degrees C. - line

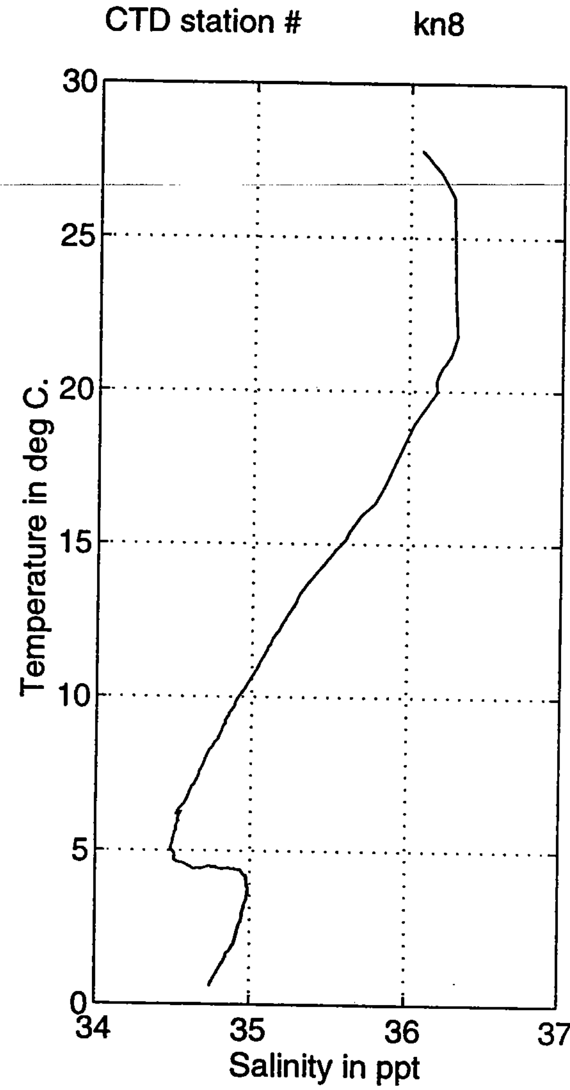

CTD station # kn6
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station #
kn7
0
7
14
21
28
Temperature in Degrees C. - line

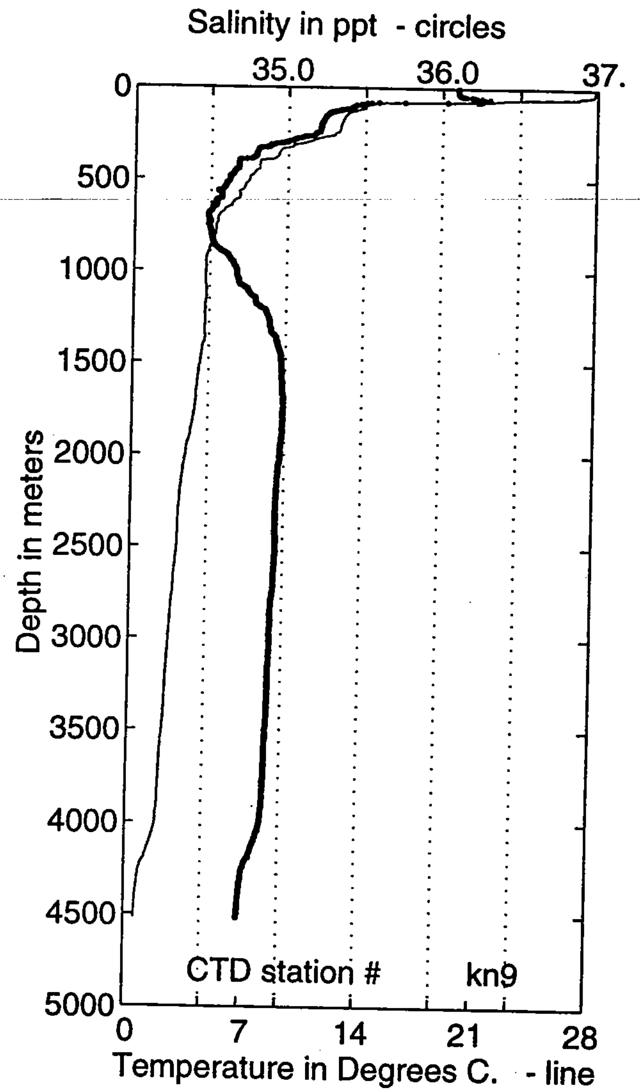

CTD station #
kn7
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

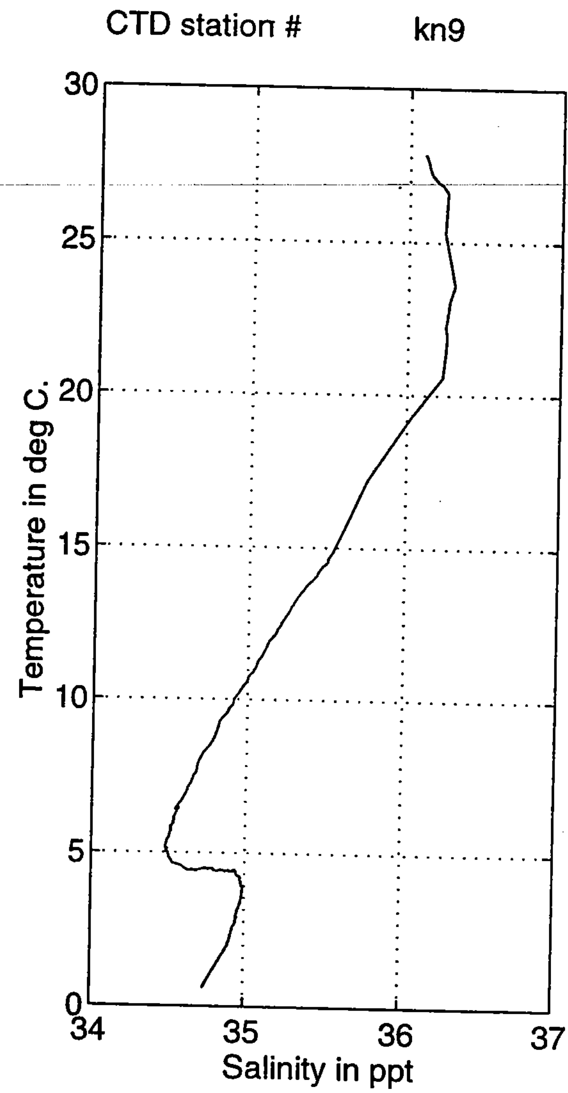


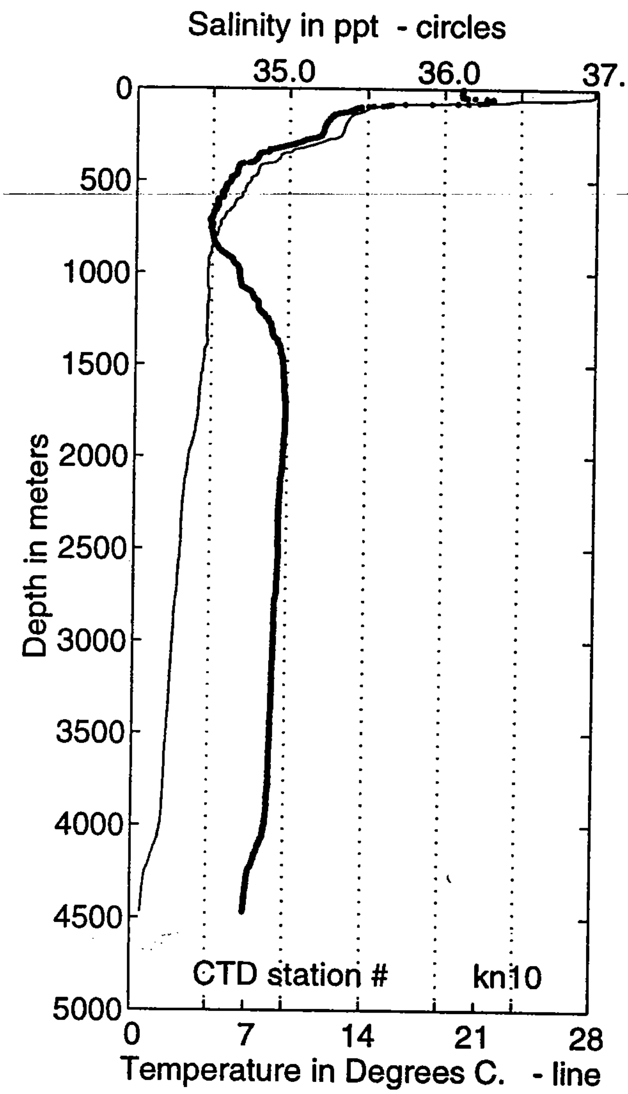
Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station #
kn8
0
7
14
21
28
Temperature in Degrees C. - line



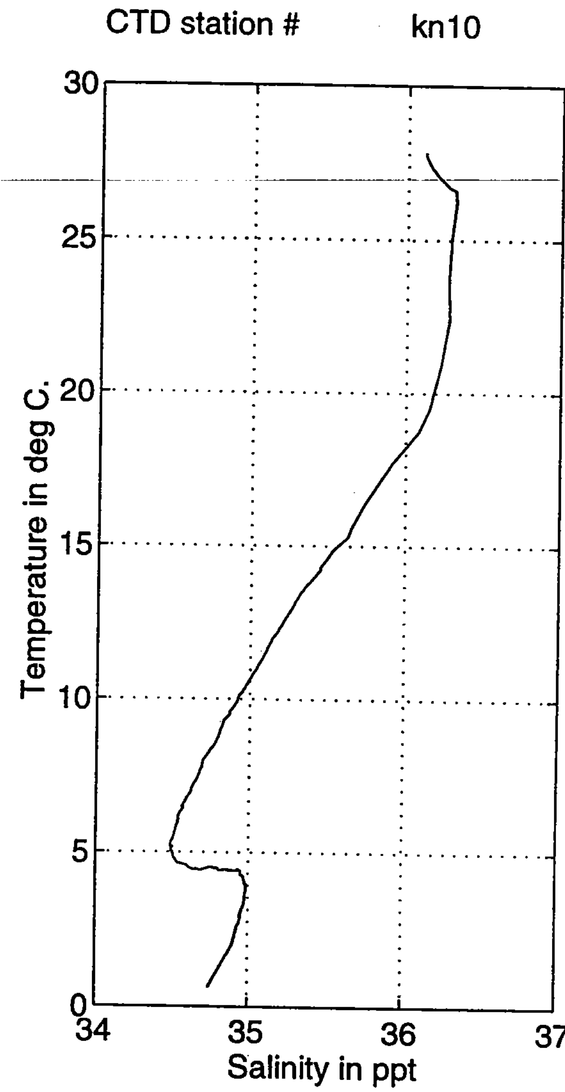
CTD station #
kn8
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station #
kn9
0
7
14
21
28
Temperature in Degrees C. - line

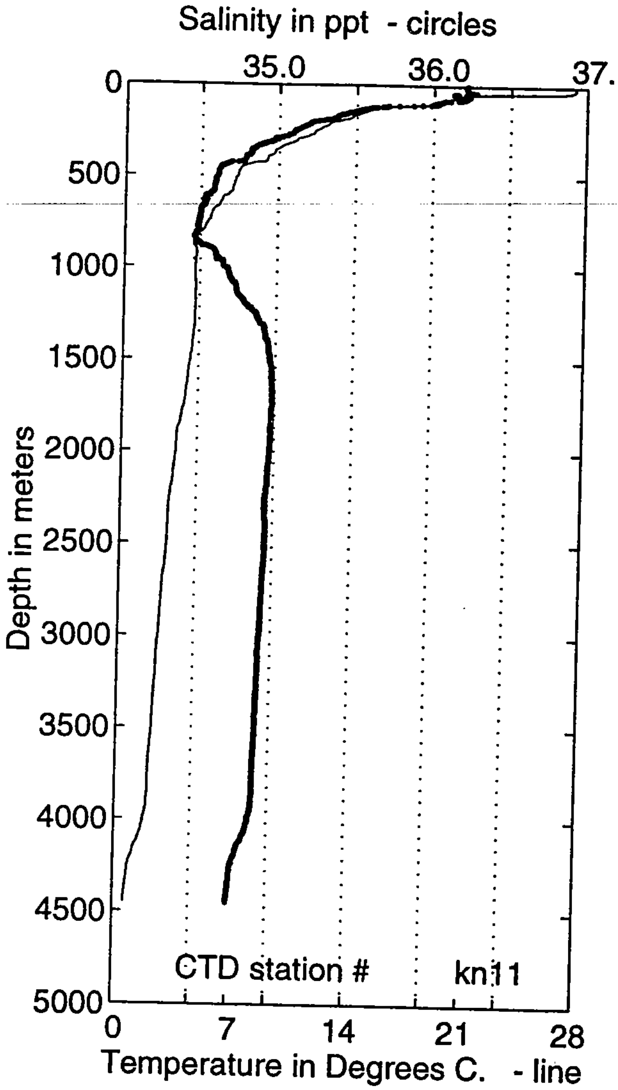

CTD station #
kn9
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

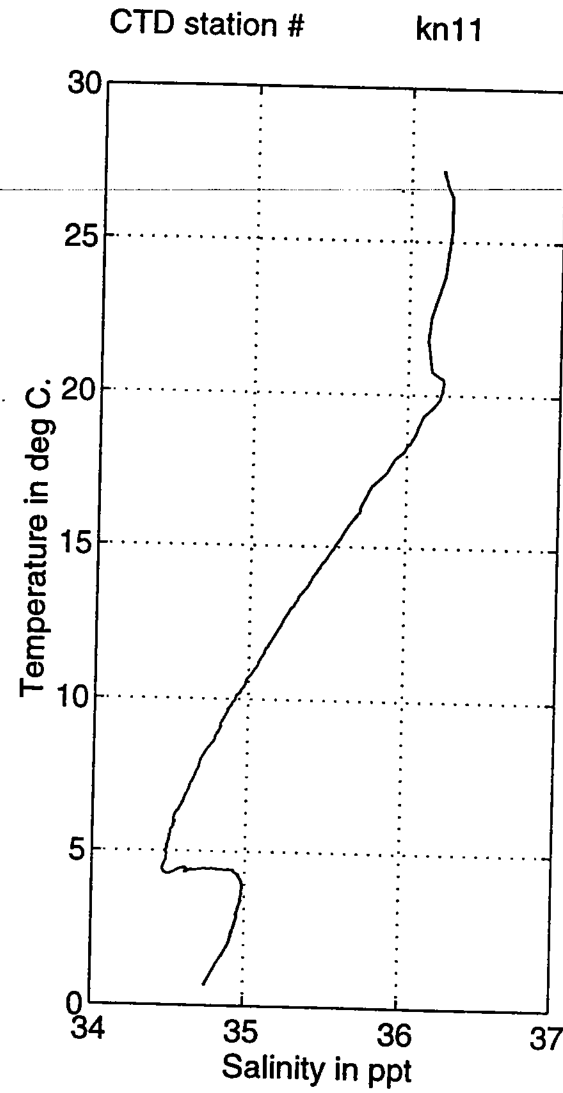


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # kn10
0
7
14
21
28
Temperature in Degrees C. - line



CTD station # kn10
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt


Salinity in ppt - circles
35.0
36.0
37.
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Depth in meters
CTD station # kn11
0
7
14
21
28
Temperature in Degrees C. - line


CTD station # kn11
30
25
20
15
10
5
0
Temperature in deg C.
34
35
36
37
Salinity in ppt

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50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-97-01	2.	3. Recipient's Accession No.

4. Title and Subtitle Trans-Equatorial Bottom Water Flow in the Western Atlantic, Volume XLVI in a series of reports presenting data from moored current meters.	5. Report Date February 1997 6.
7. Author(s) Susan A. Tarbell, John A. Whitehead, Melinda M. Hall and Michael S. McCartney	8. Performing Organization Rept. No. WHOI-97-01
9. Performing Organization Name and Address Woods Hole Oceanographic Institution Woods Hole, Massachusetts 02543	10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) OCE-9105834 (G)
12. Sponsoring Organization Name and Address National Science Foundation	13. Type of Report & Period Covered Technical Report 14.

15. Supplementary Notes

This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., WHOI-97-01.

16. Abstract (Limit: 200 words)

Current and temperature measurements from Vector Averaging Current Meters (VACMs) deployed from September 1992 to June 1994 as part of the Deep Basin Experiment (DBE) measuring the trans-equatorial water flow are presented. Salinity and temperature measurements from Conductivity/Temperature/Depth (CTD) casts taken during the mooring deployment and recovery cruises are also presented.

Six mooring sites were occupied with a total of 24 vector averaging current meters and 4 Aanderaa current meters. Three nominal depths (3900, 4100 and 4300 m.) were occupied on each mooring. Three of the 6 moorings had current meters at additional depths.

Basic data from the vector averaging current meters are presented both in statistical tables and graphically as histograms, scatter plots, progressive vector diagrams and spectral diagrams. One day Gaussian filtered plots are shown in composite displays of variables versus time.

Temperature and salinity profiles and θ/S plots for 22 CTD stations are presented.

17. Document Analysis a. Descriptors

moored current measurements

Antarctic bottom water

equatorial Atlantic Deep Water flow

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Approved for public release; distribution unlimited.	UNCLASSIFIED	90
	20. Security Class (This Page)	22. Price

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