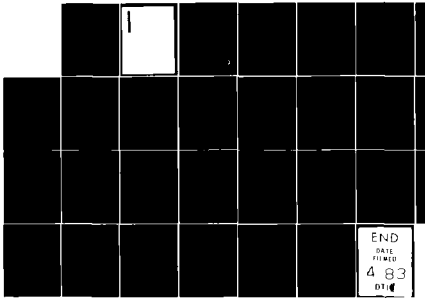
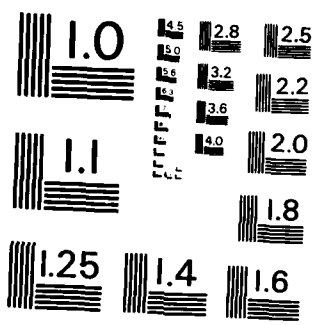
AD-A125 737 THE LONG TERM UPPER OCEAN STUDY (LOTUS) CRUISE SUMMARY AND HYDROGRAPHIC D..(U) WOODS HOLE OCEANOGRAPHIC INSTITUTION MA R P TRASK ET AL. FEB 83 WHOI-83-7 1/1

UNCLASSIFIED N00014-76-C-0197 F/G 8/10 NL





UNCLASSIFIED 2/83

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER WHOI-83-7	2. GOVT ACCESSION NO. AD-A125737	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE LONG TERM UPPER OCEAN STUDY (LOTUS) CRUISE SUMMARY AND HYDROGRAPHIC DATA REPORT OCEANUS 119 - MAY 1982		5. TYPE OF REPORT & PERIOD COVERED Technical 6. PERFORMING ORG. REPORT NUMBER WHOI-83-7
7. AUTHOR(s) Richard P. Trask and Melbourne G. Briscoe		8. CONTRACT OR GRANT NUMBER(s) N00014-76-C-0197; NR 083-400
9. PERFORMING ORGANIZATION NAME AND ADDRESS Woods Hole Oceanographic Institution Woods Hole, Massachusetts 02543		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 083-400
11. CONTROLLING OFFICE NAME AND ADDRESS NORDA, National Space Technology Laboratory Bay St. Louis, MS 39529		12. REPORT DATE February 1983 13. NUMBER OF PAGES 43
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept. WHOI-83-7.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

1. LOTUS
2. Hydrographic data
3. Sargasso Sea

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Please see reverse side.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 68 IS OBSOLETE
S/N 0102-014-6601 |

20.

OCEANUS cruise number 119 (6-14 May, 1982) was the seventh in a series of cruises to the Long Term Upper Ocean Study (LOTUS) area centered at 34°N, 70°W. During this cruise five moorings were set at the LOTUS site; four for the LOTUS experiment and one, a profiling current meter mooring, for C.S. Draper Labs - MIT. In addition an engineering mooring was set at 39°30'N, 70°W. Two XBT sections were made along 70°W between 40°N and 33°N during the trip to and from the LOTUS site. Five CTD stations were also completed in the LOTUS area.

Part I of this report is a summary of the major cruise activities and part II presents the hydrographic data (CTD and XBT) collected during the cruise.

WHOI-83-7

THE LONG TERM UPPER OCEAN STUDY (LOTUS) CRUISE SUMMARY AND HYDROGRAPHIC DATA REPORT OCEANUS 119 - MAY 1982

By

Richard P. Trask
and
Melbourne G. Briscoe

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

February 1983

TECHNICAL REPORT

Prepared for the Office of Naval Research under Contract N00014-76-C-0197; NR 083-400.

Approved for Distribution: N. P. Fofonoff

N. P. Fofonoff, Chairman
Department of Physical Oceanography

Abstract

OCEANUS cruise number 119 (6-14 May, 1982) was the seventh in a series of cruises to the Long Term Upper Ocean Study (LOTUS) area centered at 34°N, 70°W. During this cruise five moorings were set at the LOTUS site; four for the LOTUS experiment and one, a profiling current meter mooring, for C.S. Draper Labs - MIT. In addition, an engineering mooring was set at 39°30'N, 70°W. Two XBT sections were made along 70°W between 40°N and 33°N during the trip to and from the LOTUS site. Five CTD stations were also completed in the LOTUS area.

Part I of this report is a summary of the major cruise activities and part II presents the hydrographic data (CTD and XBT) collected during the cruise.

Table of Contents

List of Figures

List of Tables

Acknowledgements

The moorings set during OCEANUS cruise number 119 were jointly designed, prepared and deployed by the WHOI Buoy Group and the Ocean Structures and Moorings Section of the Ocean Engineering Department.

We are grateful for the skill of Captain Paul Howland and the personnel of the R/V OCEANUS. We also wish to thank Nancy Pennington for her assistance in organizing the graphics displayed in this report.

This work was supported by the Office of Naval Research under Contract No. N00014-76-C-01907, NR 083-400.

INTRODUCTION

The main purpose of OCEANUS cruise number 119 was to deploy four moorings for the Long Term Upper Ocean Study (LOTUS) (Briscoe and Trask, 1983) in the vicinity of 34°N, 70°W. Figure 1 shows the LOTUS area (33-35°N, 69-71°W) relative to the Gulf Stream, the East coast of the United States, and Bermuda. The site is in the mid-ocean away from the direct influences of topography and the Gulf Stream, in the path of hurricanes and Gulf Stream rings, and at the edge of the region of eighteen-degree water formation and of high eddy kinetic energy.

The deployment of the mooring array was the first of a series of four science deployments planned for the LOTUS experiment. The array deployed during OCEANUS 119 has been designated as LOTUS-3. The LOTUS-1 and LOTUS-2 mooring deployments were made during the LOTUS engineering test period (Trask et al., 1982). A C.S. Draper Labs - MIT profiling current meter (PCM) mooring and a WHOI engineering test mooring were also deployed during the cruise. As time and weather permitted CTD stations and XBT sections were made. Part I of this report summarizes the major cruise events. Part II presents the CTD stations and XBT sections made during the cruise.

Following each LOTUS cruise a report of similar content to this will be issued. Upon recovery of the entire moored array, annual data reports presenting the moored current meter and thermistor chain data, and meteorological data will be available. Table 1 gives the nominal contents and publication dates of the LOTUS report series.

Navigation

All navigation on OC119 and all positions shown in this report are based on LORAN-C and the geographical calculation performed by the Northstar 7000 LORAN-C unit. The Northstar algorithm provides a geographical position that is southeast of the true (satellite-based) position. From numerous simultaneous position fixes in the LOTUS area we have determined an average offset of the LORAN-based calculation. Some of our earlier engineering cruises used a Northstar 6000, which had an offset of similar magnitude to the 7000, but in the opposite direction.

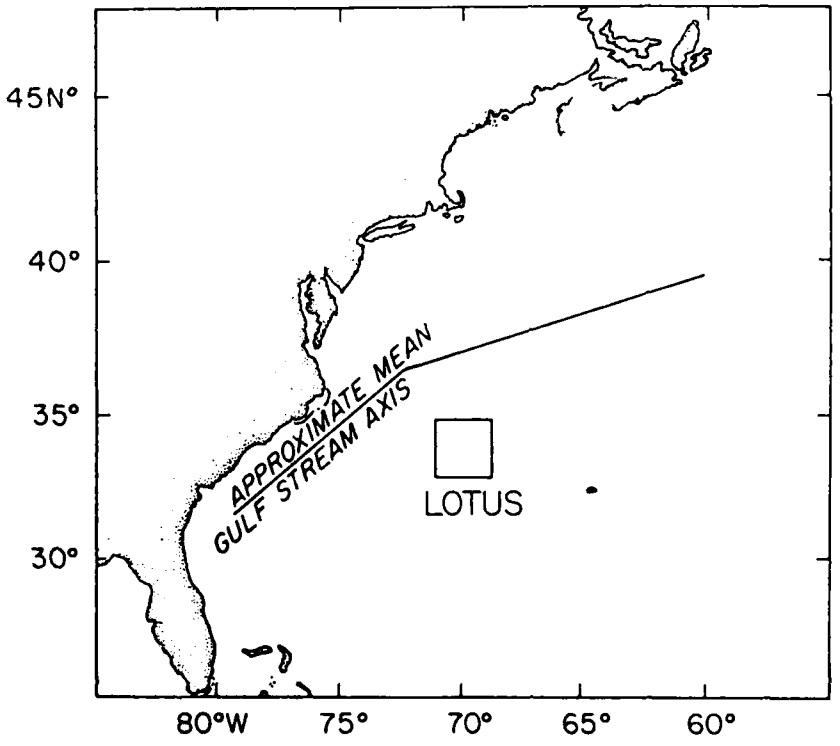


Figure 1. The location of the Long Term Upper-Ocean Study area.

Table 1. LOTUS-related WHOI Technical Reports.

PRESENTLY AVAILABLE REPORTS

Subject	WHOI No.	Date
A Summary of the Historical Data and Engineering Test Data.	82-53	Dec 82
*Cruise Summary and Hydrographic Data Report, OCEANUS 119, May 1982.		Feb 83

PLANNED FUTURE REPORTS

Subject	Expected Availability
An introduction to the experiment and its instrumentation.	May 83
Cruise summary and hydrographic data report, October-November 1982.	Apr 83
Meteorological Sensors and derived quantities LOTUS-3.	Apr 83
Cruise summary and hydrographic data report, April 83.	Oct 83
Meteorological data report, LOTUS-4.	Oct 83
Current meter data report, LOTUS 3 and 4.	Oct 83
Cruise summary and hydrographic data report, October 83.	Apr 84
Meteorological data report, LOTUS-5.	Apr 84
Cruise summary and hydrographic data report, April 84.	Oct 84
Meteorological data report, LOTUS-6.	Oct 84
Current meter data report, LOTUS 5 and 6.	Oct 84
A summary of the LOTUS experiment.	Jan 85

* This report.

Table 2 shows the offsets and standard deviations for the Northstar 6000 and 7000, based on seven cruises over three years to the two-degree square around the LOTUS area.

Positions listed in Tables and Figures in this report are all the LORAN-7000 positions; to convert to absolute geographical positions the offsets shown for the Northstar 7000 in Table 2 should be added.

Table 2. Offsets (and standard deviations) from LORAN position to geographical position, based on simultaneous LORAN and satellite position fixes (GEOG = LORAN + OFFSET).

UNIT	OFFSET (S.D.)		OFFSET (S.D.)	
	NORTH	WEST	RANGE [km]*	BEARING
Northstar 6000	-0.75'(.20)	-.90'(.20)	1.97 (.39)	135° (8)
Northstar 7000	1.07'(.15)	1.24'(.16)	2.76 (.32)	316° (4)

* 1 km = .54 nautical miles

Part I

Cruise Summary

OCEANUS 119

May 1982

Cruise number 119 of the R/V OCEANUS left Woods Hole on 6 May 1982 bound for the LOTUS area, i.e. the vicinity of 34°N, 70°W. The trip was the seventh in a series of cruises planned for the LOTUS experiment. The cruise was nine days long with the R/V OCEANUS returning to Woods Hole on 14 May.

A total of six moorings were set during OCEANUS 119. Five moorings were deployed in the LOTUS area and one, an engineering test mooring, was set to the north in the vicinity of WHOI Site D (39°30'N, 70°W). The LOTUS mooring array consisted of a surface mooring, a near-surface mooring and two subsurface moorings. The surface mooring has a 10' diameter discus buoy from which meteorological measurements are made. This mooring will be deployed for 6 months at which time it will be replaced by a nearly identical mooring. The other three moorings will remain in the water for 1 year. Additional details of the LOTUS moored array can be found in Briscoe and Trask (1983). A C.S. Draper Labs - MIT profiling current meter (PCM) mooring was also set in the LOTUS area in cooperation with C. Eriksen (MIT). Five CTD stations were completed in the LOTUS area and two XBT sections along 70°W between 40°N and 33°N and a short XBT section along 34°N between 70°W and 69°W were made.

The engineering test mooring (number 763) was deployed at Site D during the trip south. Upon arrival at the LOTUS area a bathymetry survey was conducted in the region where the four LOTUS moorings were to be deployed. The two subsurface moorings (numbers 764 and 765) were then set followed by the PCM mooring. The near-surface mooring (number 766) was set just prior to a period of inclement weather which delayed the deployment of the surface mooring (number 767) for two days. Figure 2 is a chart of a section of the LOTUS area showing the location of the four LOTUS moorings and the Draper Labs PCM mooring. Mooring diagrams of the LOTUS moorings appear in Figure 3. Table 3 summarizes the mooring deployment times and positions. Details of the CTD and XBT work are presented in Part II of this report. A chronological log of OCEANUS cruise 119 along with a plot of the cruise track appears in the Appendix.

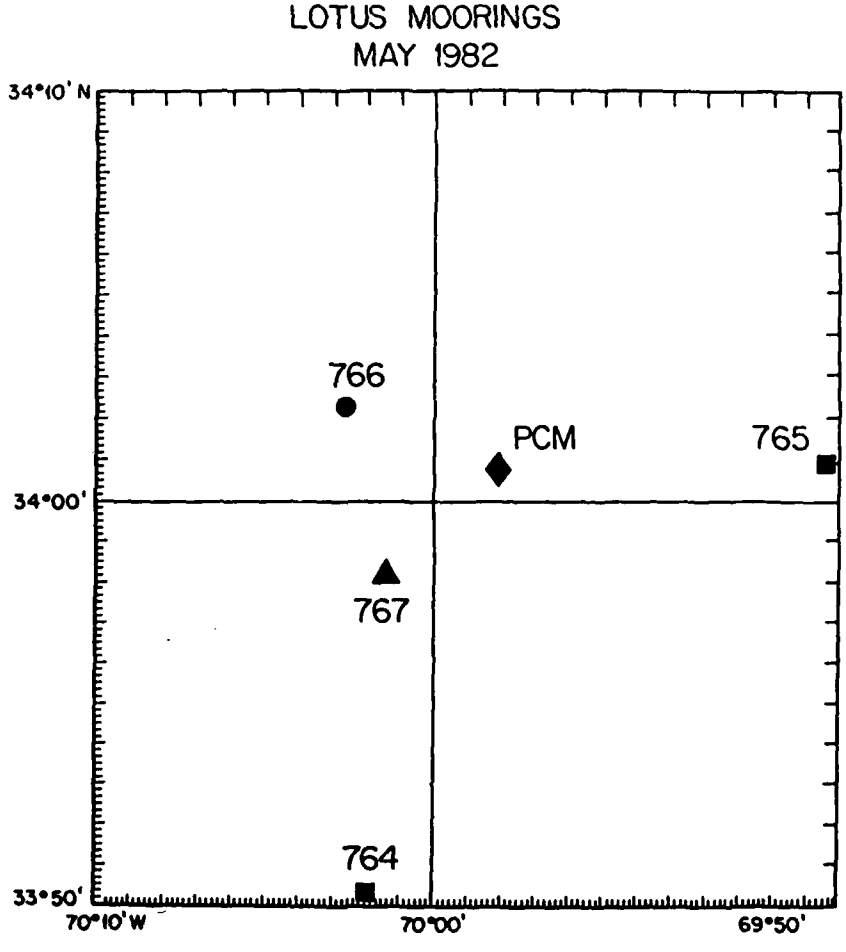


Figure 2. A chart of a section of the LOTUS area showing the location of the LOTUS surface mooring (▲), near-surface mooring (●), and subsurface moorings (■) as well as the C.S. Draper Lab - MIT PCM mooring (◆).

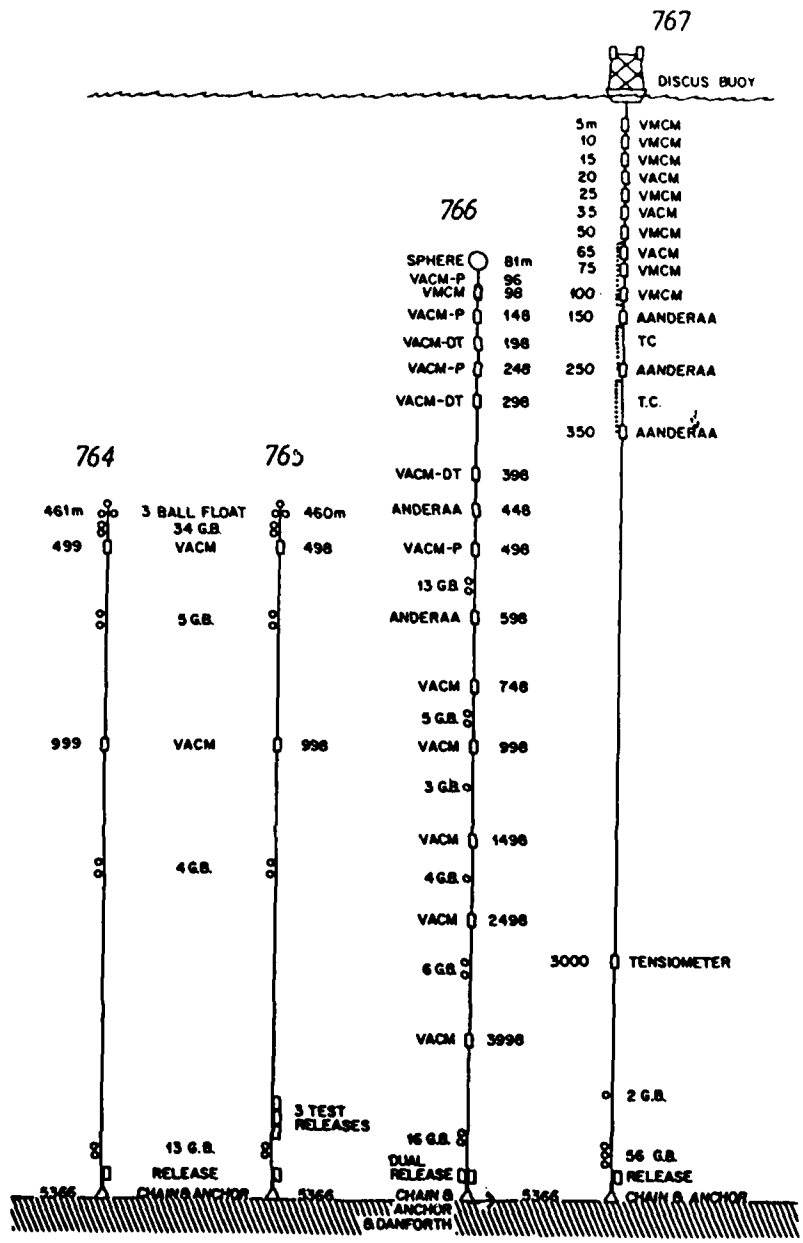


Figure 3. Mooring diagrams of the four LOTUS moorings set during OCEANUS cruise number 119 in May 1982.

Table 3. A summary of the mooring work conducted during OCEANUS cruise 119 in the LOTUS area.

Mooring ID	Date/Time Set	LORAN-C Anchor Position
764 LOTUS-3 South subsurface	8 May 82 1935 Z	33°49.23'N 70°00.73'W
765 LOTUS-3 East subsurface	9 May 82 0507 Z	33°59.80'N 69°47.16'W
PCM MIT - Draper Labs Profiling Current Meter	9 May 82 1751 Z	33°59.6' N 69°56.8' W
766 LOTUS-3 near-surface	10 May 82 1608 Z	34°01.16'N 70°01.37'W
767 LOTUS-3 surface mooring	12 May 82 1924 Z	33°57.17'N 70°00.13'W

Part II

Hydrographic Data

a. CTD Data

Five CTD stations were made during OCEANUS cruise 119 in the vicinity of the LOTUS area (Figure 4). The CTD measurements were made by a Neil Brown Instrument Systems internal recording conductivity-temperature-depth profiler (CTD/IR). Mechanical and operational details of the LOTUS CTD/IR are found in Trask (1981).

CTD/IR stations 1, 2 and 3 are all nearly full depth profiles. Station 1 is in close proximity to the surface and near-surface moorings deployed during the cruise. Stations 2 and 3 are situated one degree to the south and east of station 1 respectively. Station 4 consists of a series of shallow yo-yo's (several down and up profiles) between the surface and 200 m in the vicinity of the PCM mooring. These short profiles were made at approximately the same time and over the same depth range that the PCM instrument was designed to operate. Station 5, one degree to the north of station 1, was intended to be a full depth profile, however a large roll of the ship caused the sampling bottles to trip and the CTD/IR to shut-off prematurely at 2590 dbars. A summary of the CTD/IR stations taken during OCEANUS cruise 119 appears in Table 4.

Calibration and preliminary data processing procedures are found in Briscoe and Trask (1983); a brief summary is below.

Data Presentation

The CTD/IR data are presented in two forms, tabular listings and graphical profiles. The profiles are reproductions of the original computer plots. Included here are profiles of potential temperature, salinity, Brunt Väisälä frequency, and potential density referenced to the surface. Full depth profiles as well as profiles of the upper 750 meters are presented. In addition a potential temperature-salinity diagram is presented for each station. The listings of data include the above parameters plus sigma-t, potential temperature gradient, dynamic height, and sound speed, all at standard pressures as well as at the design depths of the instrumentation on the moorings.

The heading of the tabular listing includes the ship name (OC = OCEANUS) and cruise number, CTD number, year, year day, time, the latitude and longitude (LORAN-7000 position) of the CTD station when it started and the water depth at that station. Abbreviations used in the listings include PRESS for pressure, TEMP for temperature, SALIN for salinity, POTEMP for potential temperature, POTGRD for potential temperature gradient, POTDEN for potential density, BR-V for Brunt Väisälä frequency, SSPEED for sound speed and DYNHGT for dynamic height.

Summary of Calibration and Data Processing Procedures

The CTD/IR routinely undergoes pre-cruise laboratory calibrations at WHOI. The laboratory calibration of the temperature and pressure sensors is relied on totally for adjusting the calibration coefficients of those sensors. The conductivity sensor is calibrated using water samples collected at the bottom of each cast. Based on a comparison of the water sample salinities and the CTD/IR conductivity readings a conductivity cell factor is computed for each station. The cell factor is the scaling factor the measured conductivity must be multiplied by to obtain the "true" conductivity. The conductivity values of the entire cast are then multiplied by the appropriate cell factor to obtain the "true" conductivities.

The preliminary CTD/IR data processing is accomplished with a SEA DATA 12A cassette reader and Asynchronous Reader Interface in conjunction with a Hewlett Packard (HP) 85 desk top computer and HP 5.25 inch flexible disc drive, printer and 7225B plotter. The preliminary processing presently takes the raw down cast data from cassette and applies the appropriate calibration coefficients, edits wild points, applies a pressure and conductivity sensor time lag correction, pressure averages the data (2 dbar pressure range) and stores the data on flexible disc.

All salinity computations are based on the 1978 Practical Salinity Scale (Lewis and Perkin, 1981) as recommended by the Joint Panel on Oceanographic Tables and Standards. Further processing incorporates the new equation of state for sea water (Millero, et al., 1980) for computing density and its related parameters such as specific volume and specific

volume anomaly. Potential temperature at a reference pressure is computed using a fourth order Runge Kutta integration algorithm (Fofonoff, 1977) which uses the Bryden (1973) polynomial for adiabatic lapse rate. Sound speed calculations are based on the algorithms of Chen and Millero (1977). These algorithms are the basis of further computations which yield quantities of sigma-t, sigma-theta, dynamic height, potential temperature gradients and Brunt-Väisälä frequency. The Brunt Väisälä frequency calculation incorporates a sliding least squares fit to the potential density data over user specified smoothing windows. Four windows were chosen for this calculation. A smoothing interval of 10 dbars was used between 0 and 150 dbars, a 50 dbar interval between 150 and 1500 dbars, 62 dbar interval between 1500 and 3500 dbars and a 90 dbar smocthing interval between 3500 dbars and the bottom.

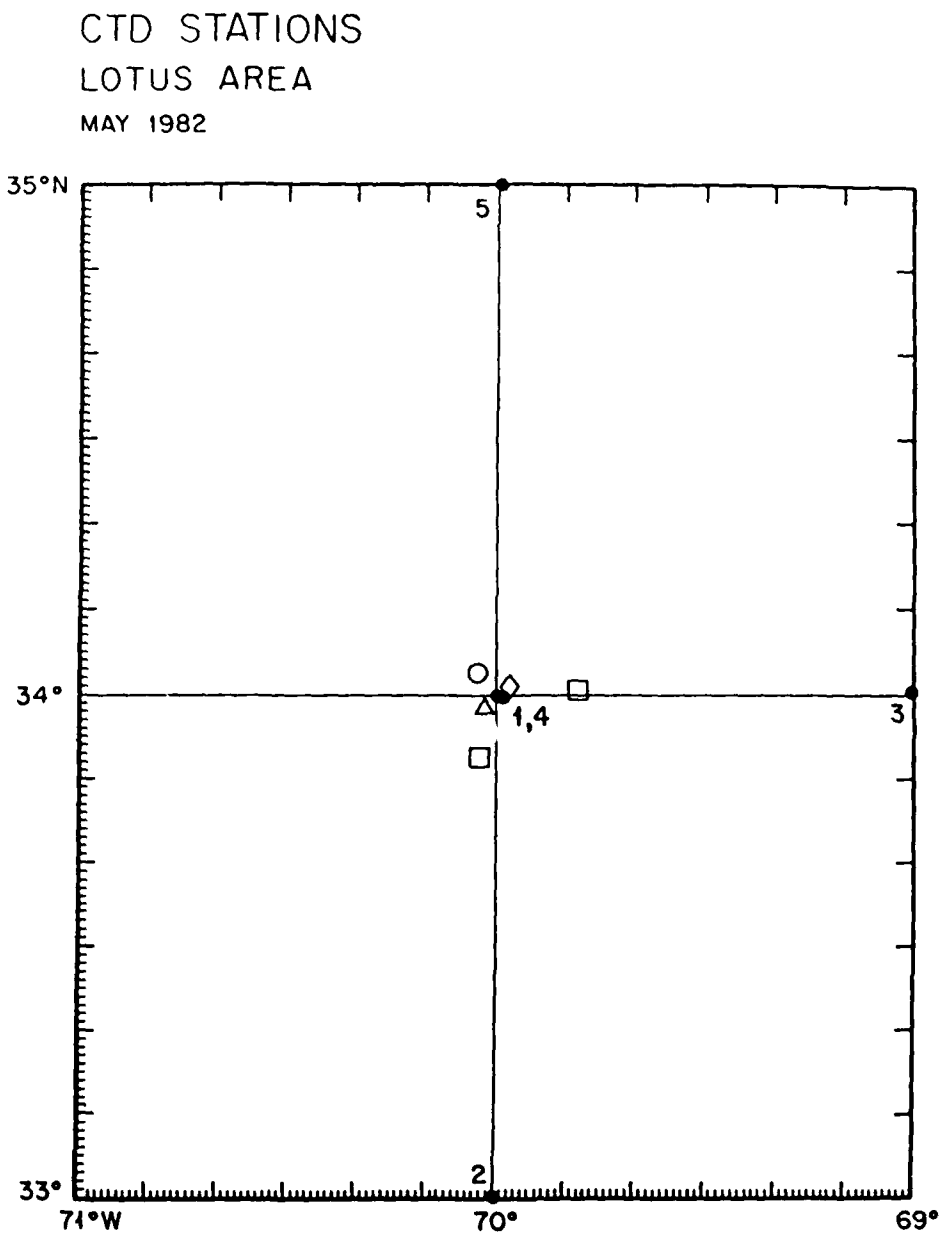


Figure 4. Chart of the LOTUS area showing the locations of the CTD/IR stations (●) made during OC 119 and their proximity to the LOTUS surface mooring (△), near-surface mooring (○), and subsurface moorings (□) as well as to the PCM mooring (◇).

Table 4: A summary of the CTD/IR work conducted on OCEANUS cruise 119.

CTD Station	Date (year day)	Start Time (UTC)	Deployed Position Lat. (N)	Long (W)	Pressure Range (dbar)
1	9 May 82 (129)	0732	33°59.94	69°59.94	0-5239
2	10 May 82 (130)	0243	33°00.01'	69°59.61	0-5196
3	10 May 82 (130)	2318	34°00.31'	69°00.68	0-5316
4	13 May 82 (131)	0022	33°59.70'	69°59.29	0-200
5	13 May 82 (131)	0820	34°59.97'	69°59.88'	0-2590

Table 5: Listing of CTD data and derived quantities for station 1.

OC119	CTD 001	1982 129 0730Z		34 00.00N	70 00.00W		corrD: Sigma	
PRESS	TEMP	SALIN	POTEMP	POTGRD	SIGMA-t	POTDEN	BR-V	SSPEED	DYNHGT
dbar	°C	psu	°C	m°C/db	kg/m**3	kg/m**3	cph	m/s	dyn m
2.	19.654	36.531	19.653	0.00	26.039	26.023	0.00	1522.3	0.0000
6.	19.652	36.554	19.651	2.28	26.056	26.041	2.78	1522.3	.0074
10.	19.617	36.547	19.615	12.50	26.060	26.046	3.98	1522.3	.0158
16.	19.503	36.554	19.500	3.28	26.096	26.081	2.20	1522.1	.0271
20.	19.490	36.553	19.487	4.51	26.098	26.083	1.56	1522.1	.0345
26.	19.469	36.554	19.464	5.29	26.104	26.090	1.79	1522.2	.0459
30.	19.457	36.553	19.451	3.54	26.107	26.093	1.06	1522.2	.0540
36.	19.436	36.546	19.429	.12	26.107	26.093	.59	1522.2	.0656
50.	19.435	36.546	19.426	.38	26.107	26.094	-.23	1522.5	.0925
66.	19.362	36.547	19.350	5.74	26.127	26.114	3.40	1522.5	.1235
76.	19.155	36.547	19.142	28.18	26.181	26.169	4.47	1522.1	.1423
100.	18.873	36.552	18.855	2.47	26.257	26.246	2.00	1521.7	.1861
126.	18.687	36.548	18.665	11.69	26.301	26.292	2.76	1521.6	.2322
150.	18.581	36.549	18.554	4.90	26.329	26.321	1.79	1521.7	.2748
200.	18.445	36.551	18.410	2.91	26.365	26.359	1.67	1522.2	.3615
250.	18.256	36.531	18.212	8.07	26.398	26.394	1.38	1522.4	.4479
300.	18.129	36.530	18.086	2.65	26.426	26.424	1.19	1522.9	.5336
350.	18.042	36.525	17.981	3.54	26.446	26.446	1.31	1523.4	.6189
400.	17.872	36.500	17.803	3.72	26.469	26.472	1.39	1523.8	.7046
450.	17.704	36.475	17.626	11.72	26.492	26.496	1.63	1524.1	.7887
500.	17.451	36.429	17.365	.81	26.519	26.525	.67	1524.1	.8735
550.	17.177	36.379	17.084	13.43	26.546	26.554	1.83	1524.1	.9577
600.	16.615	36.277	16.515	8.78	26.602	26.611	2.15	1523.1	1.0405
650.	15.736	36.120	15.632	22.28	26.687	26.695	2.51	1521.0	1.1206
700.	14.978	35.994	14.870	5.24	26.760	26.768	2.42	1519.4	1.1972
750.	14.066	35.843	13.955	25.94	26.842	26.849	2.69	1517.1	1.2702
800.	13.050	35.687	12.937	21.04	26.933	26.939	2.49	1514.4	1.3390
900.	10.549	35.344	10.437	3.86	27.143	27.145	2.73	1507.1	1.4634
1000.	8.822	35.191	8.709	34.49	27.316	27.315	3.00	1502.3	1.5689
1100.	7.048	35.100	6.938	15.28	27.511	27.506	2.63	1497.1	1.6553
1200.	6.131	35.079	6.018	.41	27.619	27.613	1.76	1495.2	1.7257
1300.	5.519	35.065	5.402	7.91	27.685	27.679	1.68	1494.4	1.7872
1400.	5.049	35.048	4.926	2.16	27.729	27.722	1.11	1494.1	1.8430
1500.	4.715	35.028	4.586	5.03	27.752	27.745	.97	1494.4	1.8959
1600.	4.523	35.017	4.387	2.00	27.765	27.758	.79	1495.2	1.9476
1800.	4.225	35.001	4.074	1.64	27.784	27.779	.72	1497.3	2.0489
2000.	3.995	34.989	3.828	-.30	27.799	27.795	.59	1499.7	2.1485
2200.	3.810	34.987	3.626	7.81	27.817	27.814	.70	1502.3	2.2475
2400.	3.590	34.980	3.389	.15	27.834	27.832	.67	1504.8	2.3441
2500.	3.465	34.970	3.256	.45	27.838	27.837	.58	1505.9	2.3915
2600.	3.365	34.966	3.149	1.15	27.845	27.844	.65	1507.2	2.4388
2800.	3.215	34.956	2.980	1.10	27.851	27.852	.56	1509.9	2.5326
3000.	3.031	34.944	2.779	1.06	27.859	27.860	.68	1512.5	2.6254
3200.	2.986	34.935	2.616	.95	27.865	27.868	.65	1515.3	2.7174
3400.	2.719	34.926	2.432	1.00	27.873	27.876	.64	1518.0	2.8082
3600.	2.587	34.918	2.281	.04	27.879	27.883	.55	1520.8	2.8976
3800.	2.477	34.910	2.152	.06	27.882	27.887	.49	1523.8	2.9862
4000.	2.396	34.904	2.051	.57	27.884	27.891	.41	1526.9	3.0747
4200.	2.356	34.899	1.988	.22	27.883	27.892	.36	1530.2	3.1639
4400.	2.333	34.895	1.942	.31	27.882	27.892	.28	1533.5	3.2542
4600.	2.318	34.891	1.904	.12	27.880	27.892	.25	1536.9	3.3462
4800.	2.309	34.888	1.871	.21	27.878	27.892	.23	1540.3	3.4402
5000.	2.310	34.885	1.847	.33	27.876	27.892	.24	1543.8	3.5361
5200.	2.302	34.880	1.814	-.02	27.872	27.890	0.00	1547.3	3.6340

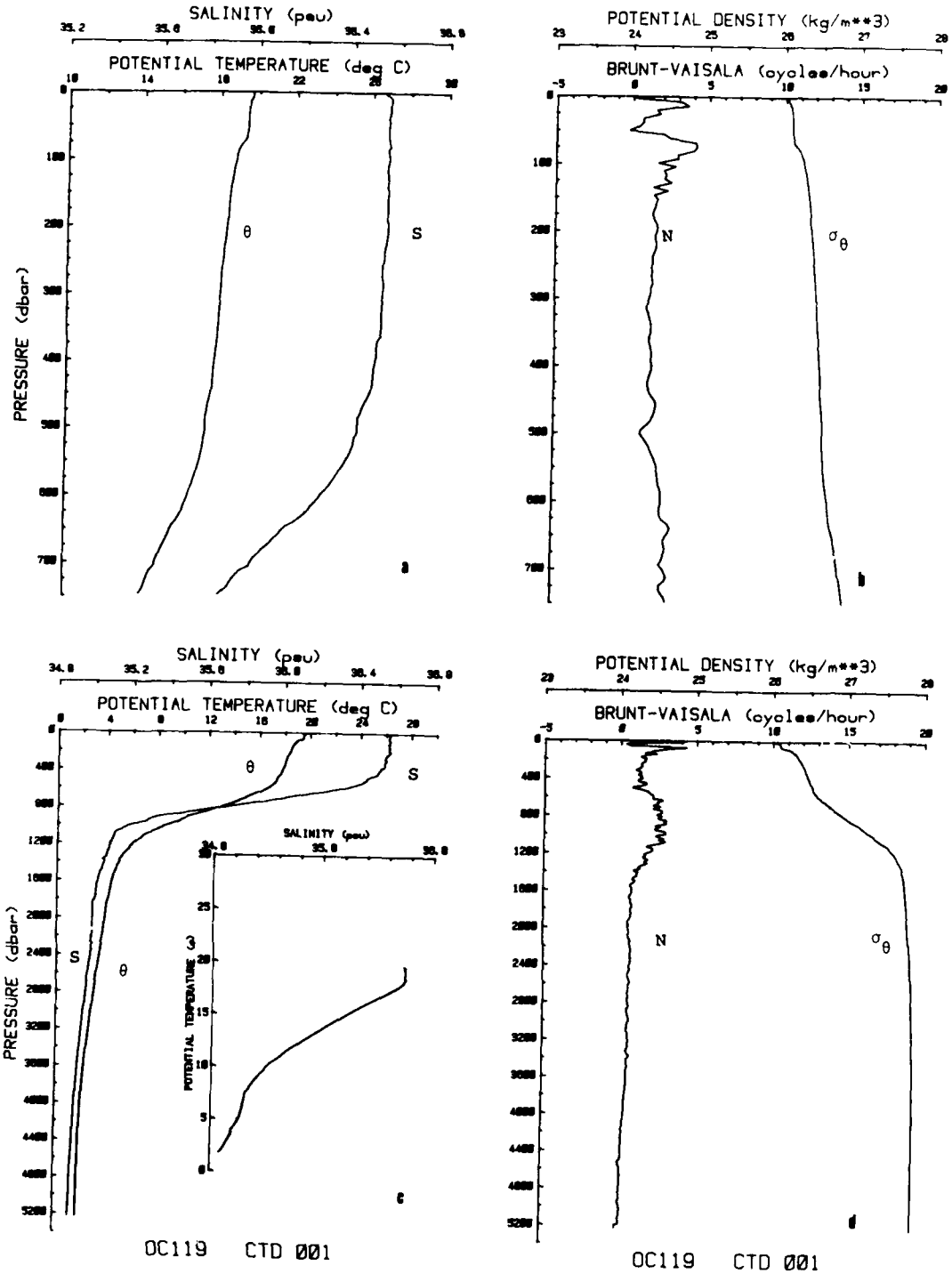


Figure 5. CTD station 1. Profiles of potential temperature (θ) and salinity (S), and Brunt Väisälä frequency (N) and potential density (σ_θ) for the upper 750 meters (a and b respectively) and for the entire cast (c and d respectively). θ-S diagram included in c.

Table 6: Listing of CTD data and derived quantities for station 2.

QC119	CTD 002		1982 130 0243Z		33 00.01N	69 59.61W		corrD: 5408m
PRESS	TEMP	SALIN	POTEMP	POTGRD	SIGMA-t	POTDEN	BR-V	SSPEED	DYNHGT
dbar	°C	psu	°C	m°C/db	kg/m**3	kg/m**3	cph	m/s	dyn m
2.	19.512	36.592	19.512	0.00	26.122	26.107	0.00	1521.9	0.0000
6.	19.514	36.595	19.513	.22	26.124	26.109	1.00	1522.0	.0071
10.	19.509	36.595	19.507	2.01	26.125	26.110	1.23	1522.1	.0152
16.	19.470	36.595	19.468	18.12	26.135	26.121	4.21	1522.0	.0266
20.	19.304	36.588	19.300	61.05	26.173	26.159	6.88	1521.6	.0340
26.	18.964	36.579	18.959	13.28	26.254	26.240	3.81	1520.9	.0447
30.	18.935	36.578	18.929	8.35	26.261	26.247	2.04	1520.8	.0518
36.	18.923	36.577	18.916	1.77	26.263	26.250	1.15	1520.8	.0622
50.	18.907	36.577	18.898	.06	26.267	26.254	.51	1521.0	.0874
66.	18.897	36.575	18.885	1.71	26.268	26.256	1.29	1521.2	.1157
76.	18.865	36.572	18.852	3.99	26.274	26.262	1.76	1521.3	.1340
100.	18.762	36.559	18.745	2.01	26.290	26.280	1.01	1521.4	.1767
126.	18.596	36.551	18.574	8.09	26.327	26.317	2.69	1521.4	.2229
150.	18.401	36.548	18.375	5.01	26.374	26.365	1.85	1521.2	.2675
200.	18.355	36.551	18.320	1.00	26.388	26.382	.99	1521.9	.3485
250.	18.199	36.536	18.155	2.04	26.415	26.411	1.44	1522.3	.4347
300.	18.100	36.531	18.048	2.37	26.436	26.435	1.33	1522.3	.5199
350.	17.993	36.519	17.932	1.34	26.454	26.454	1.24	1522.3	.6041
400.	17.800	36.497	17.731	3.91	26.482	26.484	1.14	1521.5	.6888
450.	17.604	36.464	17.527	3.81	26.508	26.512	1.42	1521.4	.7737
500.	17.279	36.407	17.194	2.59	26.544	26.549	1.59	1521.6	.8568
550.	16.836	36.324	16.745	7.61	26.586	26.593	1.62	1521.9	.9390
600.	16.101	36.191	16.004	14.80	26.657	26.665	2.88	1521.4	1.0194
650.	15.282	36.051	15.180	10.30	26.737	26.744	2.13	1519.5	1.0980
700.	14.301	35.892	14.196	9.14	26.829	26.836	2.63	1517.1	1.1792
750.	13.379	35.752	13.271	-.05	26.916	26.921	1.80	1514.7	1.2597
800.	12.729	35.656	12.617	15.44	26.974	26.979	2.53	1513.3	1.3057
900.	10.460	35.352	10.349	24.16	27.165	27.166	2.82	1506.8	1.4264
1000.	8.378	35.166	8.269	19.71	27.366	27.364	2.98	1500.6	1.5267
1100.	6.687	35.087	6.580	11.03	27.551	27.545	2.33	1495.7	1.6061
1200.	5.732	35.063	5.622	5.86	27.658	27.651	1.62	1493.5	1.6712
1300.	5.216	35.049	5.102	5.55	27.709	27.702	1.06	1493.1	1.7285
1400.	4.862	35.035	4.742	1.82	27.740	27.733	.93	1493.3	1.7824
1500.	4.593	35.020	4.466	6.86	27.759	27.752	.81	1193.9	1.8341
1600.	4.397	35.008	4.263	1.48	27.771	27.765	.77	1494.7	1.8848
1800.	4.222	35.010	4.071	.97	27.792	27.787	.69	1497.3	1.9845
2000.	4.042	35.009	3.874	.81	27.810	27.807	.69	1499.9	2.0827
2200.	3.796	34.994	3.612	1.12	27.824	27.821	.77	1502.3	2.1796
2400.	3.587	34.982	3.387	.22	27.836	27.834	.72	1504.7	2.2757
2500.	3.475	34.976	3.266	1.20	27.842	27.841	.67	1505.9	2.3225
2600.	3.369	34.968	3.153	3.48	27.846	27.845	.61	1507.2	2.3695
2800.	3.203	34.959	2.968	.85	27.855	27.856	.60	1509.9	2.4628
3000.	3.031	34.950	2.780	.66	27.863	27.865	.62	1512.5	2.5559
3200.	2.877	34.938	2.607	1.36	27.869	27.871	.56	1515.3	2.6464
3400.	2.715	34.930	2.428	1.20	27.877	27.881	.64	1518.0	2.7363
3600.	2.574	34.922	2.269	1.58	27.883	27.888	.61	1520.8	2.8248
3800.	2.471	34.914	2.146	.23	27.885	27.891	.46	1522.8	2.9125
4000.	2.412	34.909	2.067	.14	27.886	27.893	.34	1523.9	3.0005
4200.	2.371	34.906	2.003	.04	27.887	27.896	.30	1525.2	3.0892
4400.	2.346	34.902	1.956	.15	27.886	27.896	.28	1525.6	3.1794
4600.	2.322	34.897	1.918	-.15	27.883	27.896	.22	1527.0	3.2717
4800.	2.322	34.893	1.884	.60	27.881	27.895	.22	1528.4	3.3649
5000.	2.315	34.889	1.852	-.24	27.878	27.894	.25	1529.8	3.4605

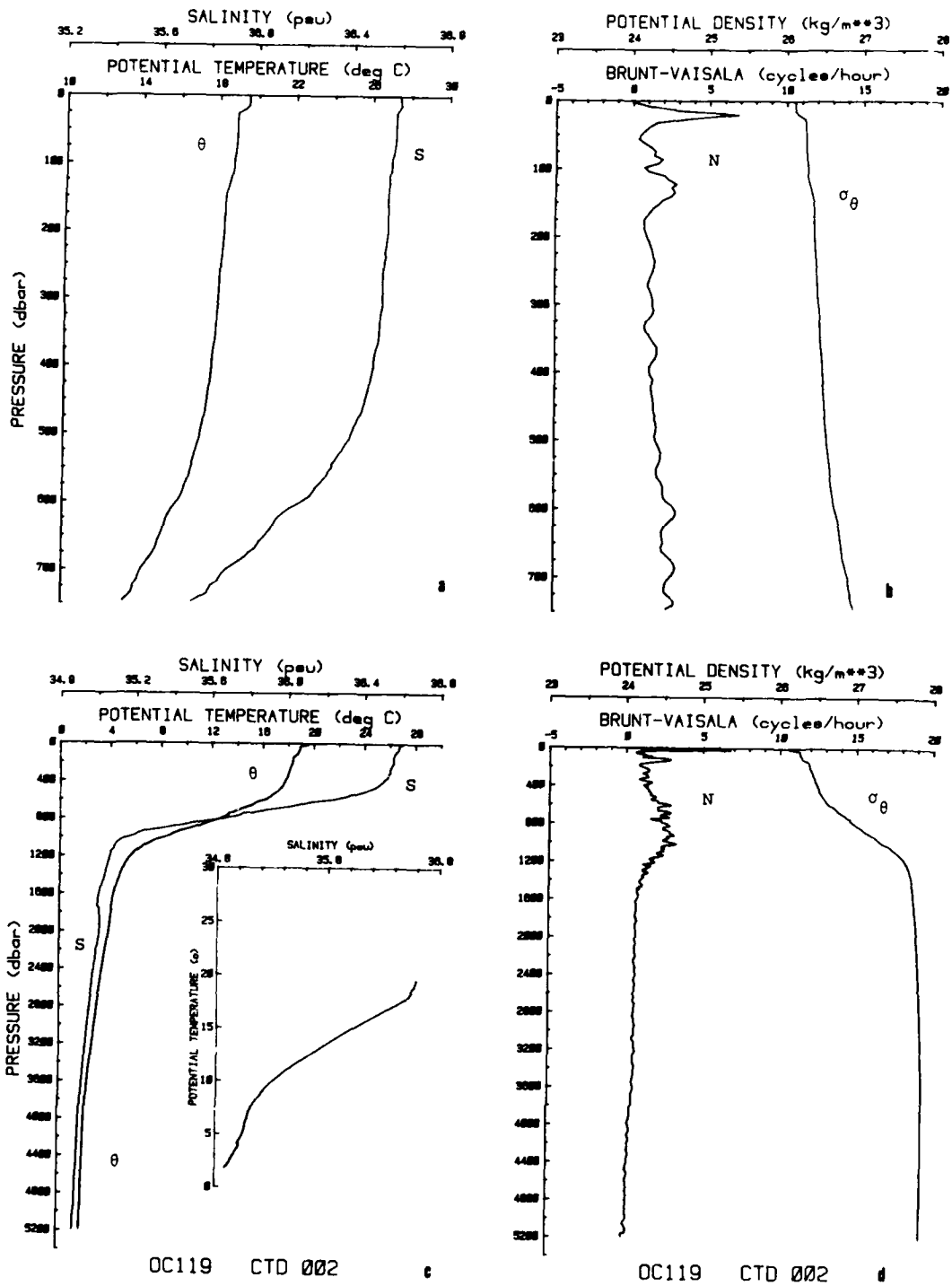


Figure 6. CTD station 2. Profiles of potential temperature (θ) and salinity (S), and Brunt Väisälä frequency (N) and potential density (σ_θ) for the upper 750 meters (a and b respectively) and for the entire cast (c and d respectively). θ-S diagram included in c.

Table 7: Listings of CTD data and derived quantities for station 3.

OC119 CTD 007 1982 130 2319Z 34 00.3N 59 00.6W corrD: 5363m

PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BRV cph	SSPEED m/s	DYNHGT dyn m
0.	21.758	36.428	21.757	0.00	25.389	25.373	0.00	1527.8	0.0000
5.	21.795	36.441	21.794	-3.32	25.389	25.373	-1.60	1528.0	.0099
10.	21.795	36.436	21.793	2.05	25.385	25.369	-2.26	1528.1	.0203
15.	21.810	36.429	21.807	-2.18	25.375	25.360	-1.08	1528.2	.0360
20.	21.807	36.427	21.803	2.34	25.375	25.360	.44	1528.2	.0458
25.	21.813	36.429	21.808	-2.51	25.375	25.360	-.34	1528.4	.0612
30.	21.817	36.430	21.811	-2.42	25.374	25.360	-.50	1528.4	.0716
35.	21.771	36.430	21.764	21.22	25.387	25.372	6.10	1528.4	.0877
50.	20.697	36.490	20.688	62.99	25.728	25.715	7.66	1525.9	.1226
65.	20.271	36.521	20.259	-.64	25.867	25.854	3.21	1525.0	.1573
75.	20.226	36.531	20.212	5.79	25.887	25.875	2.37	1525.1	.1799
100.	19.711	36.501	19.693	5.78	26.000	25.990	3.24	1524.0	.2296
125.	19.428	36.542	19.405	52.11	26.106	26.097	3.33	1523.7	.2823
150.	19.296	36.582	19.269	-14.42	26.171	26.163	2.94	1523.8	.3279
200.	18.660	36.545	18.624	15.56	26.306	26.300	2.78	1522.8	.4204
250.	18.469	36.546	18.425	3.73	26.355	26.351	1.70	1523.0	.5089
300.	18.263	36.530	18.211	6.31	26.394	26.393	1.49	1523.3	.5956
350.	18.128	36.527	18.067	6.56	26.426	26.426	1.74	1523.7	.6828
400.	18.023	36.516	17.953	3.00	26.444	26.446	.86	1524.2	.7688
450.	17.894	36.496	17.815	4.42	26.461	26.465	1.31	1524.7	.8558
500.	17.633	36.460	17.547	7.89	26.498	26.504	1.63	1524.7	.9414
550.	17.282	36.399	17.189	12.27	26.537	26.544	1.69	1524.4	1.0261
600.	16.935	36.340	16.834	.54	26.575	26.584	1.61	1524.1	1.1092
650.	16.391	36.240	16.284	20.14	26.627	26.637	2.05	1523.2	1.1924
700.	15.610	36.104	15.499	40.44	26.703	26.712	2.47	1521.5	1.2718
750.	14.702	35.950	14.587	8.41	26.787	26.797	1.92	1519.3	1.3480
800.	13.828	35.806	13.710	19.82	26.863	26.872	2.51	1517.1	1.4206
900.	12.003	35.544	11.881	16.13	27.029	27.035	2.07	1512.4	1.5533
1000.	9.193	35.182	9.078	12.32	27.248	27.248	2.72	1503.6	1.6673
1100.	7.211	35.076	7.100	.67	27.469	27.465	2.49	1497.7	1.7583
1200.	5.821	35.020	5.711	13.92	27.612	27.605	2.14	1493.3	1.8294
1300.	5.379	35.054	5.263	3.65	27.694	27.687	1.41	1493.8	1.8896
1400.	4.985	35.034	4.863	4.89	27.725	27.719	1.20	1493.8	1.9456
1500.	4.658	35.008	4.531	2.30	27.742	27.735	.94	1494.1	1.9992
1600.	4.461	34.994	4.326	1.96	27.753	27.746	.71	1495.0	2.0513
1800.	4.249	34.993	4.097	1.08	27.776	27.771	.70	1497.4	2.1544
2000.	4.017	34.987	3.845	.66	27.796	27.792	.71	1499.8	2.2557
2200.	3.843	34.983	3.658	2.01	27.811	27.809	.64	1502.4	2.3552
2400.	3.676	34.980	3.473	.71	27.825	27.824	.82	1505.1	2.4541
2500.	3.555	34.975	3.345	1.08	27.833	27.833	.68	1506.3	2.5029
2600.	3.471	34.974	3.252	2.85	27.841	27.841	.68	1507.6	2.5510
2800.	3.285	34.959	3.049	.64	27.847	27.848	.59	1510.2	2.6465
3000.	3.116	34.949	2.862	1.70	27.854	27.856	.60	1512.9	2.7413
3200.	2.951	34.937	2.680	.41	27.861	27.864	.69	1515.6	2.8351
3400.	2.793	34.927	2.504	.19	27.867	27.871	.58	1518.3	2.9276
3600.	2.628	34.918	2.321	.34	27.875	27.879	.57	1521.0	3.0139
3800.	2.514	34.911	2.188	.34	27.879	27.885	.54	1524.0	3.1088
4000.	2.417	34.903	2.071	1.06	27.881	27.888	.47	1527.0	3.1984
4200.	2.355	34.897	1.988	.17	27.881	27.890	.32	1530.2	3.2879
4400.	2.325	34.893	1.935	.12	27.881	27.892	.27	1533.5	3.3786
4600.	2.314	34.889	1.901	-.05	27.879	27.891	.23	1536.9	3.4706
4800.	2.311	34.886	1.873	.04	27.876	27.891	.21	1540.3	3.5648
5000.	2.311	34.883	1.348	.18	27.874	27.890	.17	1543.8	3.6611
5200.	2.310	34.879	1.822	-.01	27.871	27.889	.21	1547.3	3.7592

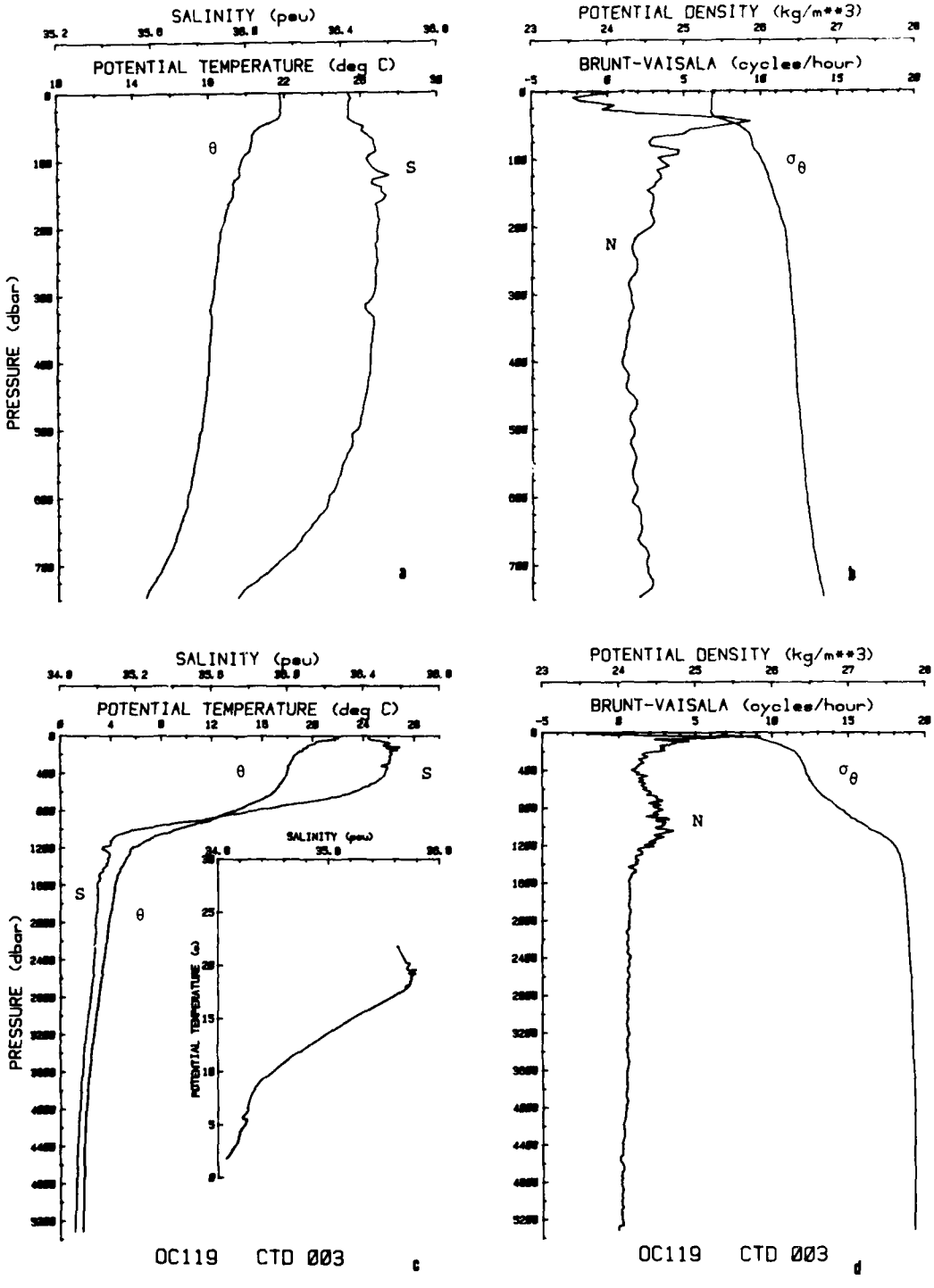


Figure 7. CTD station 3. Profiles of potential temperature (θ) and salinity (S), and Brunt Väisälä frequency (N) and potential density (σ_θ) for the upper 750 meters (a and b respectively) and for the entire cast (c and d respectively). θ-S diagram included in c.

Table 8: Listing of CTD data and derived quantities for station 4.

OC119 CTD 004 1982 133 0022Z 33 59.70N 69 59.29W corrD: 5366m

PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	20.192	36.532	20.191	0.00	25.897	25.882	0.00	1523.7	0.0000
6.	20.225	36.512	20.224	-3.23	25.872	25.857	-3.02	1523.9	.0079
10.	20.227	36.511	20.225	-.57	25.871	25.856	.38	1523.9	.0159
16.	20.220	36.513	20.217	1.37	25.874	25.859	.91	1524.0	.0238
20.	20.221	36.512	20.218	.37	25.873	25.859	-.44	1524.1	.0318
26.	20.229	36.511	20.224	-3.69	25.870	25.856	-1.30	1524.2	.0397
30.	20.233	36.510	20.228	.22	25.869	25.855	.45	1524.3	.0477
36.	20.231	36.511	20.224	-.35	25.870	25.856	1.14	1524.4	.0557
50.	20.176	36.513	20.167	21.14	25.886	25.873	4.86	1524.5	.0715
66.	19.665	36.526	19.653	3.02	26.032	26.019	2.63	1523.3	.1044
76.	19.571	36.525	19.557	16.06	26.056	26.044	3.75	1523.2	.1245
100.	19.278	36.534	19.260	15.36	26.139	26.128	3.41	1522.8	.1709
126.	19.130	36.537	19.107	8.71	26.179	26.170	2.46	1522.9	.2004
150.	18.997	36.541	18.970	3.14	26.217	26.208	1.59	1522.9	.2294
200.	18.768	36.549	18.733	14.52	26.282	26.276	0.00	1523.1	.2882

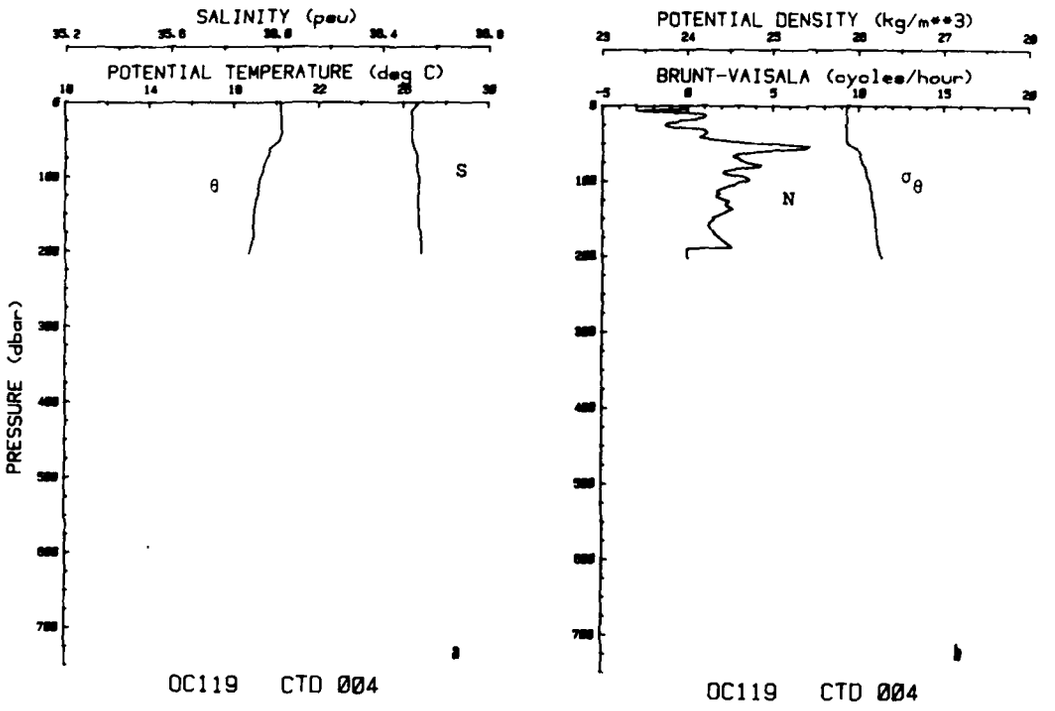


Figure 8. CTD station 4. Profiles of potential temperature (θ) and salinity (S), and Brunt Väisälä frequency (N) and potential density (σ_θ) for the upper 200 meters (a and b respectively).

Table 9: Listing of CTD data and derived quantities for station 5.

OC119	CTD 005	1982 133 0820Z	34 59.97N	69 59.98W	corrD: 5094m				
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	20.788	36.519	20.787	0.00	25.726	25.710	0.00	1525.3	0.0000
6.	20.779	36.513	20.778	3.08	25.724	25.709	-1.64	1525.4	.0088
10.	20.798	36.510	20.796	-8.74	25.717	25.701	-1.97	1525.5	.0186
16.	20.801	36.509	20.798	-.01	25.715	25.700	-.51	1525.6	.0316
20.	20.799	36.509	20.795	.83	25.716	25.701	.63	1525.7	.0411
26.	20.800	36.509	20.795	.04	25.715	25.701	.39	1525.8	.0556
30.	20.798	36.509	20.792	.93	25.716	25.701	.65	1525.8	.0647
36.	20.797	36.509	20.790	.79	25.715	25.702	.93	1525.9	.0782
50.	20.769	36.511	20.759	2.91	25.725	25.712	1.43	1526.1	.1099
66.	20.335	36.533	20.323	21.71	25.859	25.847	6.83	1525.2	.1461
76.	19.775	36.530	19.761	19.87	26.006	25.994	3.79	1523.8	.1669
100.	19.492	36.527	19.474	6.75	26.077	26.067	2.41	1523.4	.2154
126.	19.196	36.558	19.173	10.74	26.179	26.169	3.05	1523.1	.2655
150.	18.962	36.566	18.935	15.44	26.245	26.237	2.54	1522.8	.3099
200.	18.613	36.544	18.578	1.38	26.317	26.311	2.12	1522.6	.3994
250.	18.428	36.544	18.384	3.62	26.364	26.360	1.50	1522.9	.4882
300.	18.313	36.536	18.260	5.91	26.387	26.385	1.14	1523.4	.5755
350.	18.214	36.530	18.152	1.24	26.407	26.407	1.13	1524.0	.6624
400.	18.090	36.522	18.020	3.62	26.432	26.434	1.17	1524.4	.7496
450.	17.971	36.510	17.893	3.23	26.452	26.457	1.54	1524.9	.8367
500.	17.763	36.480	17.676	2.24	26.481	26.488	1.18	1525.1	.9271
550.	17.575	36.452	17.481	2.74	26.505	26.514	1.61	1525.3	1.0091
600.	17.193	36.380	17.091	14.29	26.544	26.553	1.68	1524.9	1.0942
650.	16.810	36.314	16.701	4.03	26.585	26.595	2.06	1524.5	1.1777
700.	15.969	36.163	15.856	14.26	26.666	26.676	2.60	1522.6	1.2592
750.	15.002	35.997	14.886	6.01	26.757	26.767	2.07	1520.3	1.3374
800.	14.084	35.848	13.965	7.21	26.842	26.851	2.27	1518.0	1.4109
900.	12.200	35.572	12.077	27.34	27.013	27.019	3.00	1513.1	1.5471
1000.	9.626	35.259	9.508	41.13	27.237	27.238	2.80	1505.3	1.6829
1100.	7.925	35.133	7.808	6.52	27.410	27.408	2.66	1500.5	1.7594
1200.	6.562	35.078	6.445	19.00	27.561	27.556	2.08	1496.8	1.8384
1300.	5.767	35.062	5.648	5.87	27.652	27.647	1.32	1495.3	1.9048
1400.	5.243	35.049	5.118	8.58	27.707	27.701	1.42	1494.9	1.9642
1500.	4.963	35.043	4.832	7.97	27.735	27.729	1.00	1495.4	2.0197
1600.	4.721	35.034	4.583	5.91	27.756	27.750	.97	1496.1	2.0734
1800.	4.307	35.002	4.155	-1.72	27.776	27.771	.76	1497.7	2.1774
2000.	4.073	34.990	3.904	2.55	27.792	27.788	.63	1500.0	2.2793
2200.	3.907	34.986	3.721	1.61	27.806	27.804	.66	1502.7	2.3803
2400.	3.759	34.985	3.555	.51	27.821	27.820	.60	1505.5	2.4803
2500.	3.658	34.983	3.446	.86	27.830	27.829	.70	1506.7	2.5299
2600.	3.542	34.972	3.322	.29	27.832	27.833	.64	1507.9	2.5789

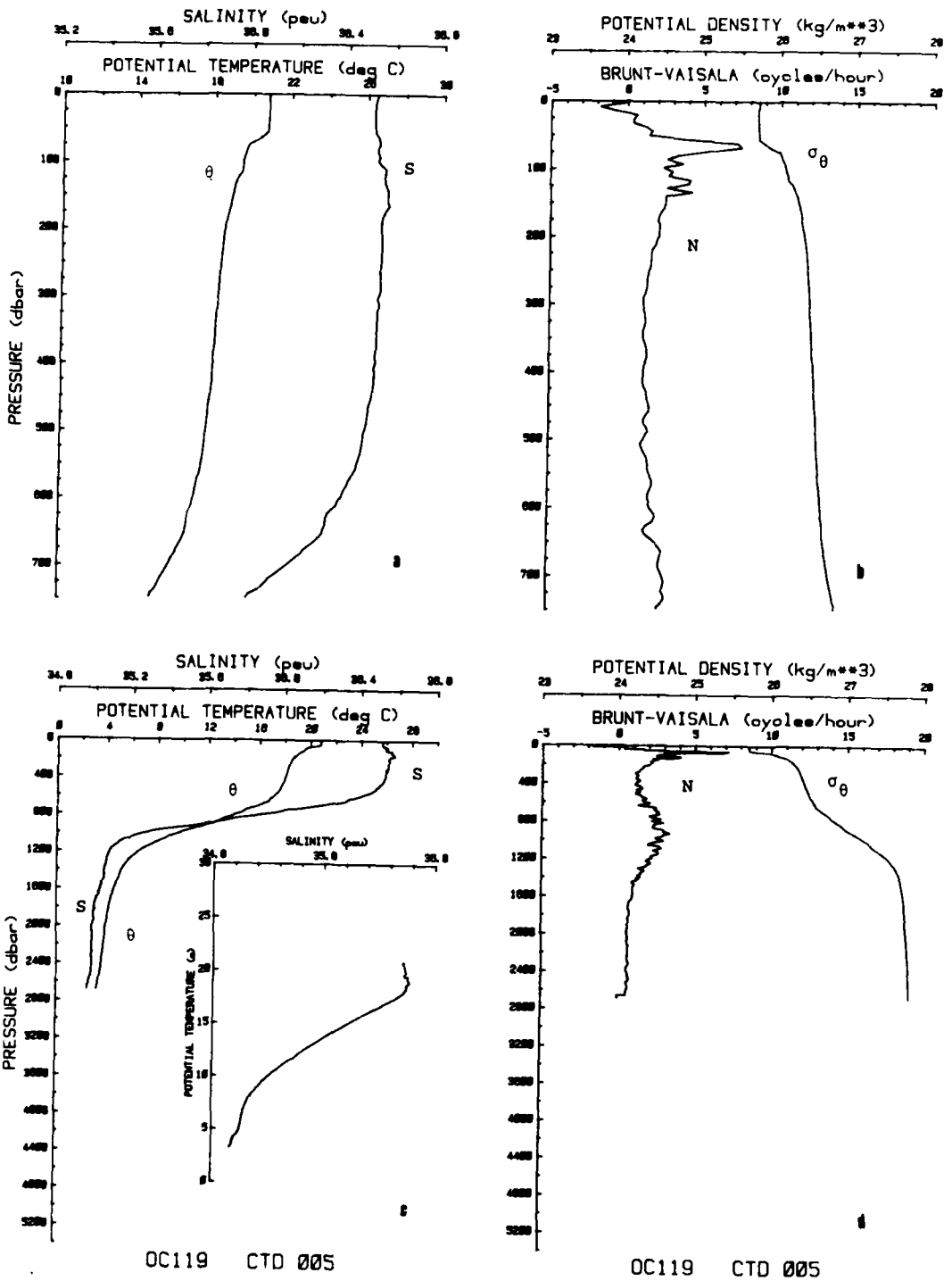


Figure 9. CTD station 5. Profiles of potential temperature (θ) and salinity (S), and Brunt Väisälä frequency (N) and potential density (σ_θ) for the upper 750 meters (a and b respectively) and for the entire cast (c and d respectively). θ-S diagram included in c.

b. XBT Data

Expendable bathythermograph data were collected approximately every 20 km (i.e., hourly) during the trip to and from the LOTUS area along 70°W longitude. The section made while traveling south begins at 40°N and ends at 33°N. The homebound section begins at 34°N and ends at 40°N. A short section to the east along 34°N between 70°W and 69°W was also completed.

A description of the instrumentation and preliminary data processing procedures associated with the XBT's appears in Briscoe and Trask (1983).

A malfunction of the Bathy Systems digital XBT recorder during the southbound trip prevented data from being recorded on cassette tape. For this reason the section was repeated during the homebound trip during which time the Bathy Systems recorder functioned properly. Strip chart records however were made during both sections.

The depths of the whole degree isotherms were transcribed from the strip chart records and plotted. Figure 10 is a chart showing the location of individual XBTs taken during the trip south and to the east. Figure 11 shows the XBT section from the southbound trip and figure 12 shows the section made to the east while in the LOTUS area. Figure 13 is an overplot of all the XBTs made in the LOTUS area during OC 119 (numbers 56-63). This presentation shows the range of temperatures observed due to the combined effects of the temporal and spatial variations. Figure 14 is a chart showing the locations of the XBTs taken during the homebound trip. The corresponding XBT section appears in figure 15. Vertical exaggeration of the XBT sections is 1:463.

All LOTUS XBT traces are supplied to the National Oceanographic Data Center for inclusion in the National files for general access and usage.

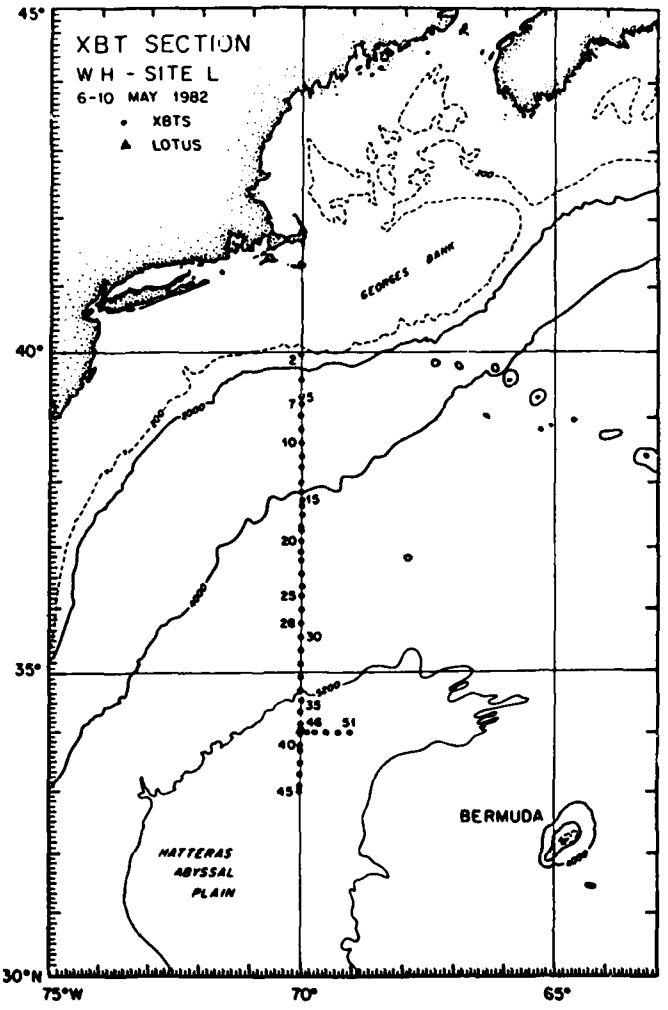


Figure 10. Chart showing the location of individual XBTs taken during the trip south and to the east.

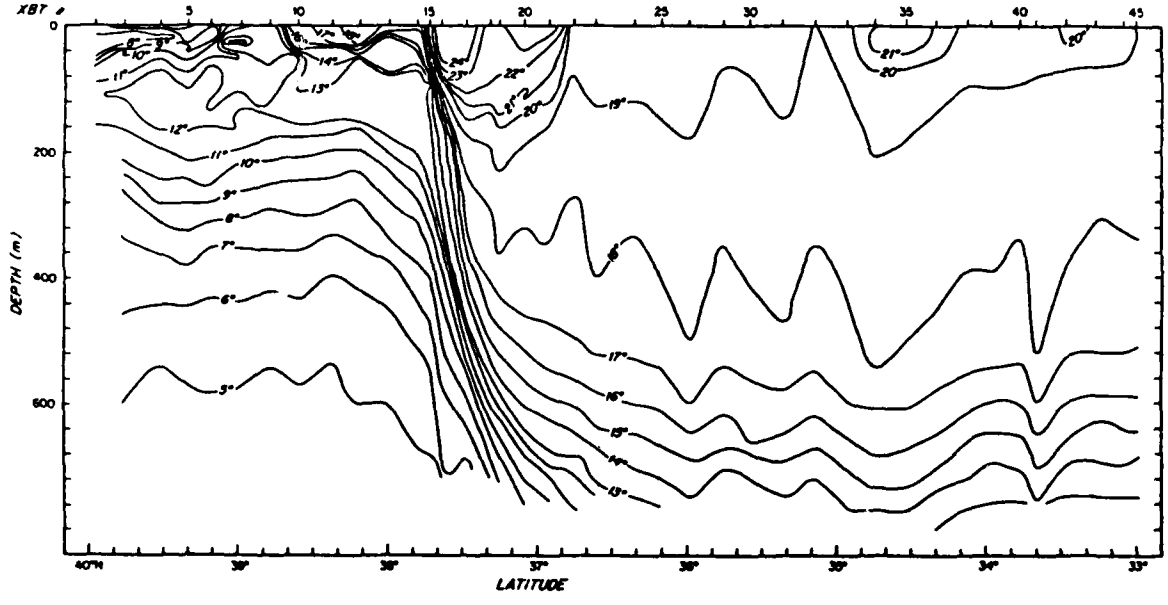


Figure 11. XBT section from southbound trip along 70°W between 40°N and 33°N.

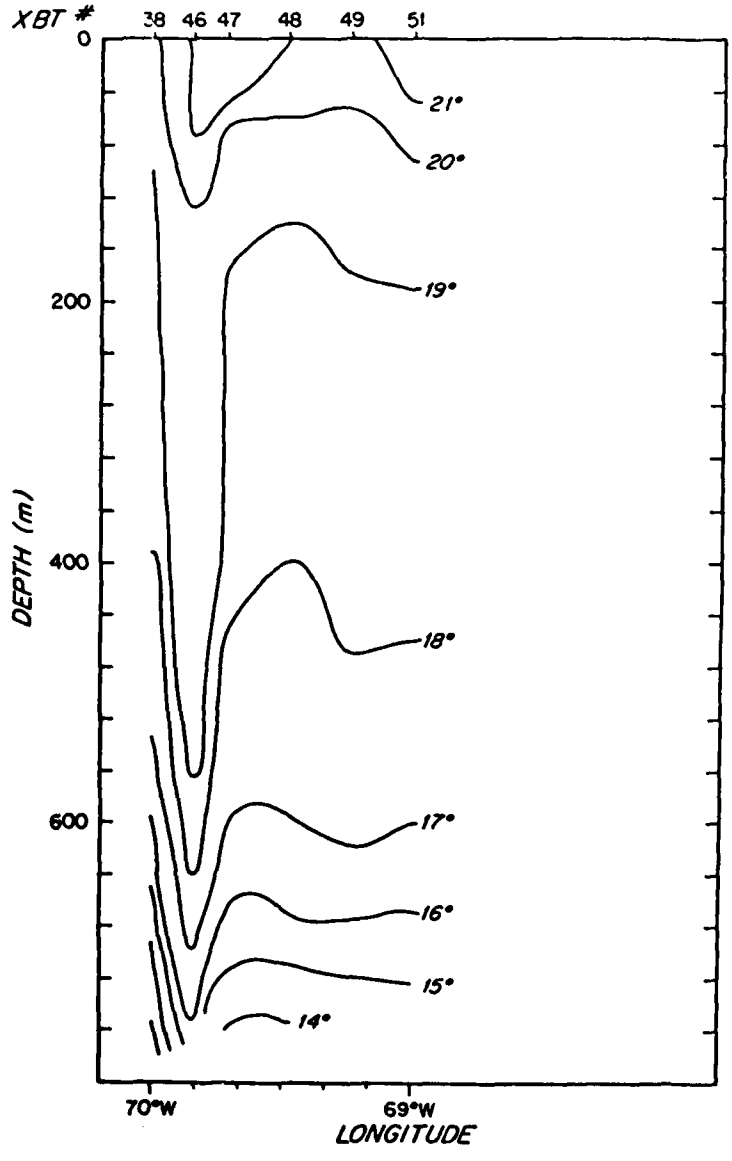


Figure 12. Short XBT section along 34°N between 70°W and 69°W.

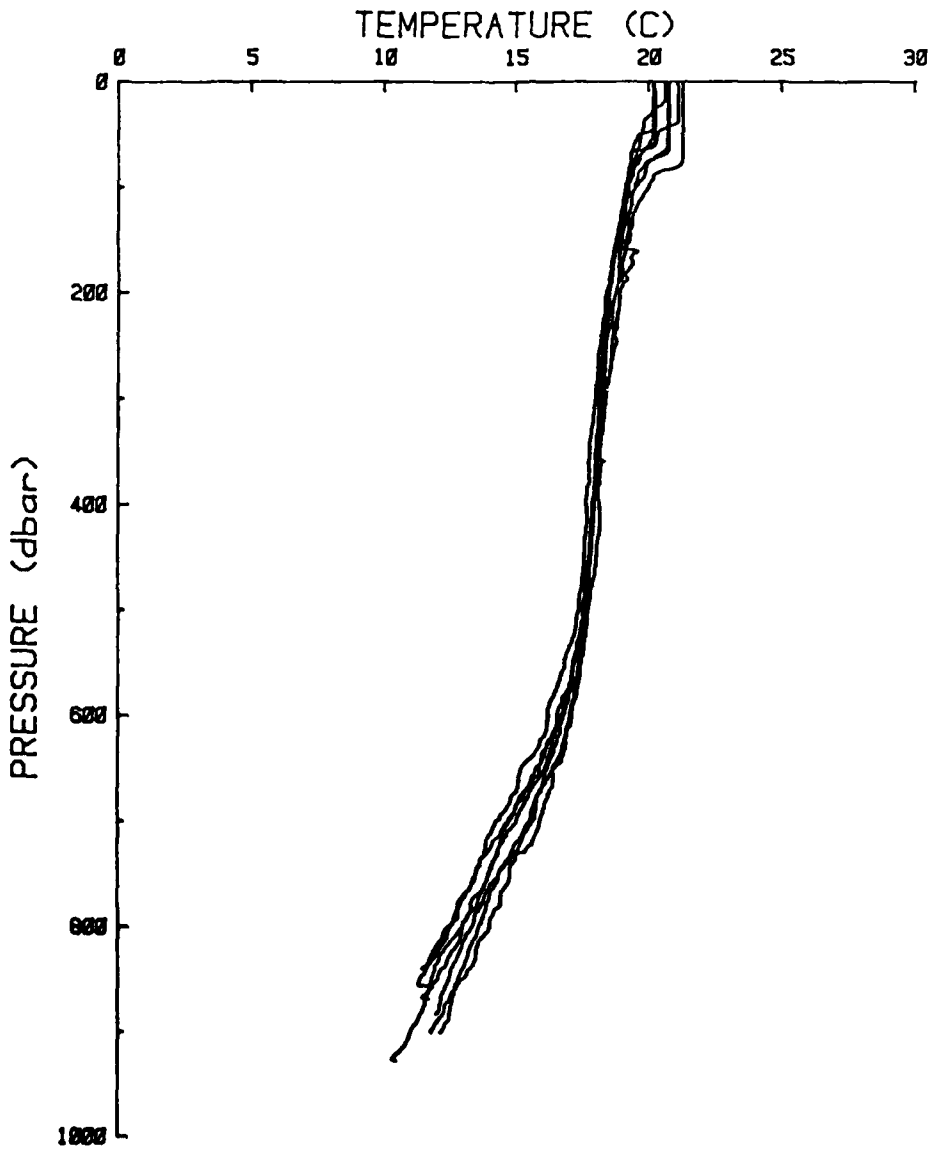


Figure 13. An overplot of all the XBTs taken in the LOTUS area during OCEANUS 119.

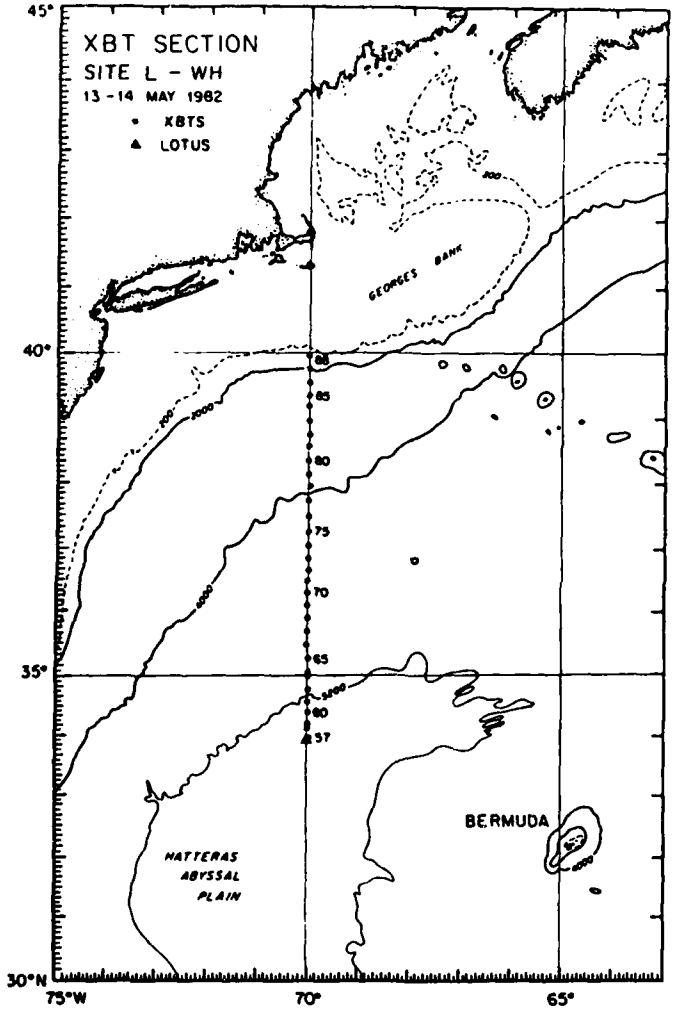


Figure 14. Chart showing the location of individual XBTs taken during the homebound trip.

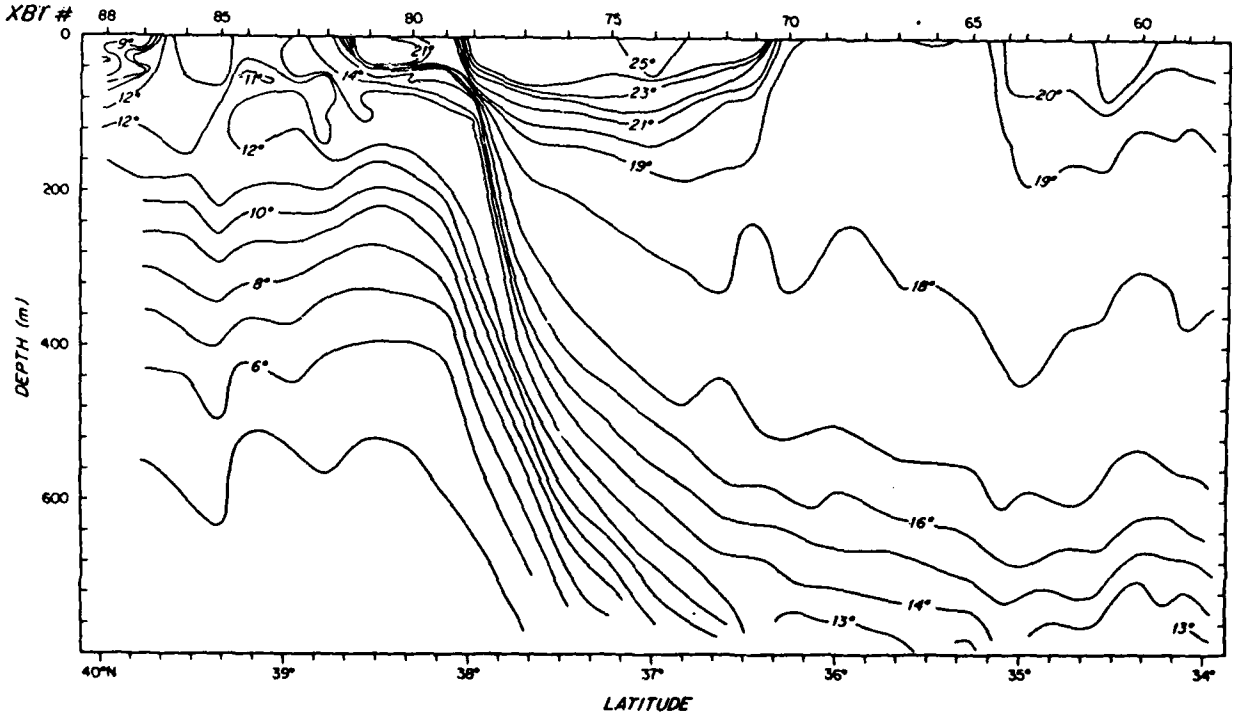


Figure 15. XBT section from homebound trip along 70°W between 34°N and 40°N.

References

Briscoe, M. G., and R. P. Trask, 1983. The Long Term Upper Ocean Study (LOTUS), An introduction to the experiment and its instrumentation. Woods Hole Oceanographic Institution Technical Report, in preparation.

Bryden, H. L., 1973. New polynomials for thermal expansion, adiabatic temperature gradient and potential temperature of sea water. Deep-Sea Res., 20, 401-408.

Chen, C-T., and F. J. Millero, 1977. Speed of sound in sea water at high pressures. J. Acoust. Soc. Amer., 62, No. 5, 1129-1135.

Fofonoff, N. P., 1977. Computation of potential temperature of sea water for an arbitrary reference pressure. Deep-Sea Res., 24, 489-491.

Lewis, E. L., and R. G. Perkin, 1981. The practical salinity scale 1978: conversion of existing data. Deep-Sea Res., 28, 307-328.

Millero, F. J., C-T. Chen, A. Bradshaw, and K. Schleicher, 1980. A new high pressure equation of state for sea water. Deep-Sea Res., 27A, 255-264.

Trask, R. P., 1981. Mechanical and operational details of a Neil Brown Instrument Systems internally recording conductivity, temperature, depth (CTD) profiler. Woods Hole Oceanographic Institution Technical Report 81-74.

Trask, R. P., M. G. Briscoe, and N. J. Pennington, 1982. Long Term Upper Ocean Study (LOTUS), A summary of the historical data and engineering test data. Woods Hole Oceanographic Institution Technical Report 82-53.

Appendix

OCEANUS 119

Chronological Log

Days are Year Days, Times are UTC

126/82

1415	Depart from Woods Hole.
1800	Science meeting in library.
2000	Fire and boat drill.
2114	Familiarizing watch with XBT and PDR operation procedures.
2300	Hourly XBTs started.
	PDR started for trip south.

127/82

0224	Ship stopped for release tests on the hydro-wire.
0351	Bearing problems with Markey winch. Release test terminated at approximately 800 m. Slow rehaul.
0437	Commenced launch of engineering test mooring number 763.
0630	Engineering mooring anchor away.
0700	Hourly XBTs resumed.
1700	Hydro-wire streamed aft.
1900	XBTs temporarily discontinued due to course change.
2200	XBTs resumed.

128/82

1337	Starting bathymetry survey along 70°W between 34°00.00'N and 33°49.2'N.
1450	On station (33°45'N, 79°W) for release tests.
1643	Release tests complete. Steaming to start position for mooring launch.
1714	Commenced launch of subsurface mooring number 764.
1935	Subsurface mooring anchor away.
2120	Ranging on the release.
2357	Starting bathymetry survey along 34°N between 70°05'W and 69°45'W.

129/82

0144	Steaming to start position of subsurface mooring launch.
0210	Commenced launch of subsurface mooring number 765.
0507	Subsurface mooring anchor away.
0732	Starting CTD station number 1 at 33°59.94'N, 69°59.94'W.
1025	CTD station completed.
1125	Start release tests for PCM mooring.
1221	Release tests completed.
1346	Moving to PCM launch start position.
1430	Commenced launch of PCM mooring.
1751	PCM mooring anchor away.
1850	Recovered three glass balls seen on surface immediately after anchor drop.
1916	Started near-surface mooring release tests.
2104	Release tests completed.

130/82

0243	Starting CTD station number 2 at 33°00.01'N, 69°59.61'W.
0557	CTD station completed.
0630	Steaming to launch position for near-surface mooring.
1305	Commenced launch of near-surface mooring number 766.
1608	Near surface mooring anchor away.
1647	Ranging on the release.
1814	Steaming to 34°N, 69°W.
1830	Hourly XBTs resumed on the hour along 34°N to 69°W.
2318	Starting CTD station number 3 at 34°00.31'N, 69°00.68'W

131/82

0225	CTD station completed.
	Underway to mooring 765.
0615	Disabled release on mooring 765.
0620	Attempted a CTD station down wind of mooring 765, but sea conditions were too rough to deploy CTD.
1020	Hove to, 30-40 knot winds, large swell.

132/82

0000 Hove to, large seas running.

0802 Weather improving.

1030 Testing releases for surface mooring.

1245 Moving to surface mooring launch start position.

1444 Commenced launch of surface mooring number 767.
Buoy in water.

1925 Surface mooring anchor away.

2100 Zodiac leaves ship with five scientific personnel and one crew. Three persons to dive on mooring to inspect VMCM propellor blades. Two persons to attach meteorological sensor.

2153 Zodiac returns to ship. Divers report VMCM propellors look good.

2212 Ranging on the surface mooring release.

2251 Starting to collect C. Olson's water samples.

2323 Collection of water samples completed.

133/82

0022 Starting CTD station number 4 near the PCM mooring (33°59.7'N, 69°59.29'W). Shallow station (0-200 m) in conjunction with scheduled PCM excursion.

0130 CTD station completed.

0820 Starting CTD station number 5 at 34°59.97'N, 69°59.88'W.

1039 CTD station number 5 completed.
Underway northward along 70°W.
Hourly XBTs resumed for trip home.

134/82

1100 Last XBT on homebound section.

1950 Docked at Woods Hole.

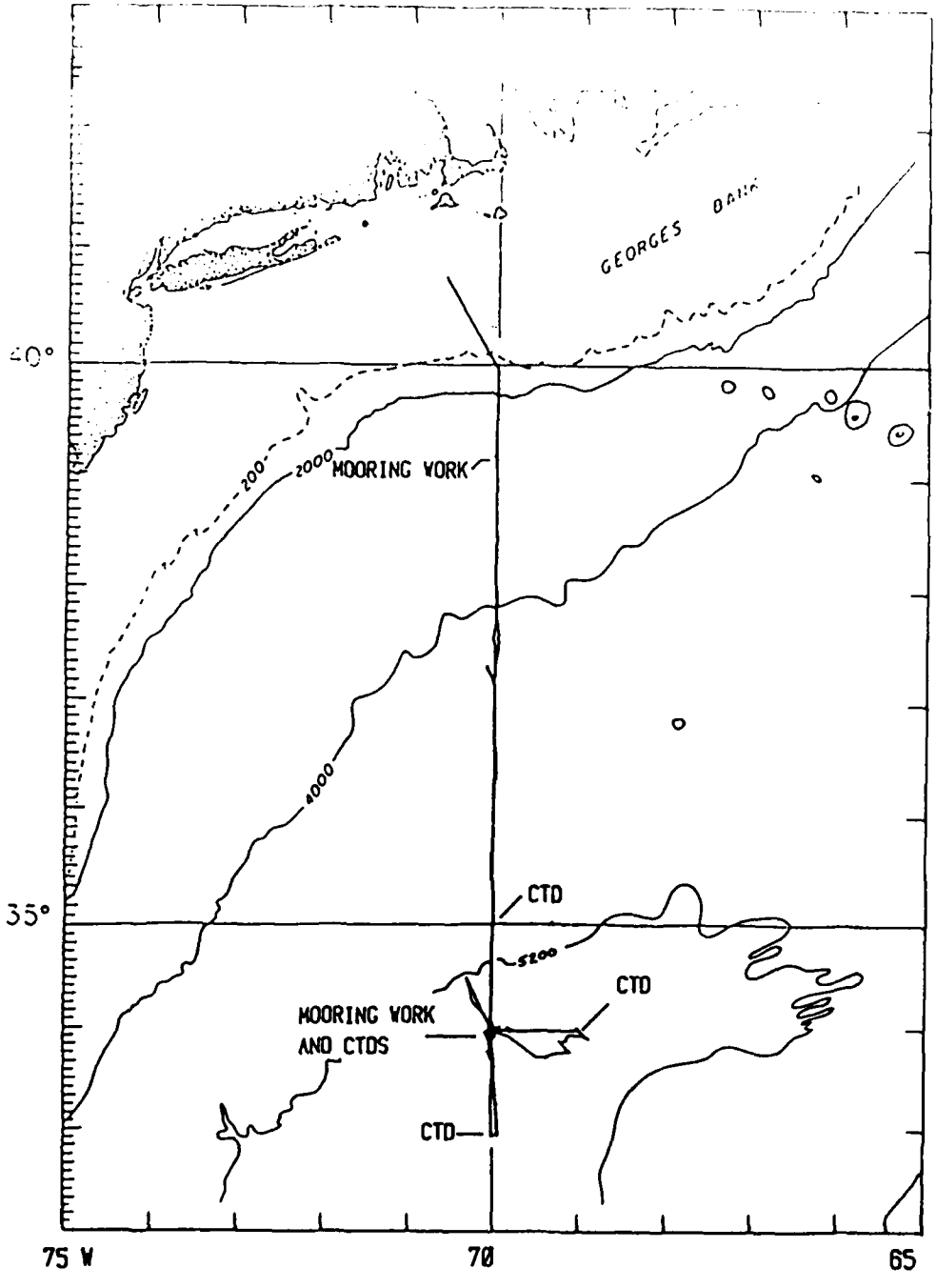


Figure A-1. Cruise track of OCEANUS cruise number 119.

MANDATORY DISTRIBUTION LIST

FOR UNCLASSIFIED TECHNICAL REPORTS, REPRINTS, AND FINAL REPORTS
PUBLISHED BY OCEANOGRAPHIC CONTRACTORS
OF THE OCEAN SCIENCE AND TECHNOLOGY DIVISION
OF THE OFFICE OF NAVAL RESEARCH

(REVISED NOVEMBER 1978)

1 Deputy Under Secretary of Defense
(Research and Advanced Technology)
Military Assistant for Environmental Science
Room 3D129
Washington, D.C. 20301

Office of Naval Research
800 North Quincy Street
Arlington, VA 22217
3 ATTN: Code 483
1 ATTN: Code 420C
2 ATTN: 102B

1 CDR Joe Spigai, (USN)
ONR Representative
Woods Hole Oceanographic Inst.
Woods Hole, MA 02543

Commanding Officer
Naval Research Laboratory
Washington, D.C. 20375
6 ATTN: Library, Code 2627

12 Defense Technical Information Center
Cameron Station
Alexandria, VA 22314
ATTN: DCA

Commander
Naval Oceanographic Office
NSTL Station
Bay St. Louis, MS 39522
1 ATTN: Code 8100
1 ATTN: Code 6000
1 ATTN: Code 3300

1 NODC/NOAA
Code D781
Wisconsin Avenue, N.W.
Washington, D.C. 20235

1 Mr. Michael H. Kelly
Administrative Contracting Officer
Department of the Navy
Office of Naval Research
Eastern/Central Regional Office
Building 114, Section D
666 Summer Street
Boston, MA 02210

END

DATE
FILMED

4-83

DTIC