SOUTHWEST FISHERIES CENTER

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SOUTHWEST FISHERIES CENTER
NATIONAL MARINE FISHERIES SERVICE

THE CONSISTENCY OF EXPENDABLE BATHYTHERMOGRAPHY (XBT) PROBES AS INFERRED FROM SIMULTANEOUS CASTS

BY

L. E. EBER

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1. Introduction

The accuracy and reliability of data obtained with the Expendable Bathythermograph (XBT) have concerned oceanographers for many years. Saur and Stewart (1967) reported on one of the earliest attempts to use the XBT to monitor subsurface thermal structure from ships of opportunity. More recent efforts to determine the accuracy of XBT data, based on comparisons with data from STD (Salinity-temperature-Depth) and CTD (Conductivity-Temperature-Depth) instrumentation, have been described by Heinmiller, et.al (1983), Seaver and Kuleshov (1982) and Flierl and Robinson (1977).

In September, 1979 the Southwest Fisheries Center conducted a cruise aboard David Starr Jordan, in cooperation with Sippican Corp., to carry out quality control tests of T-7 and T-5 probes, and to test a newly developed computerized XBT digitization system.

The experiment took place in the Los Angeles Bight, off

Southern California, over a period of several days. The XBT probes were launched in pairs, from launchers mounted on either side of the ship. Digitized data were sucessfully recorded from 169 pairs of T-7 (750 meter) and 16 pairs of T-5 (1830 meter) probes.

2. Experimental Procedure

Each of the two XBT launchers was connected to its own analog chart recorder which, in turn, was connected to an analog to digital (A-D) converter. The (A-D) converters were on-line components of an HP9825A (Hewlett Packard) desktop computer. The analog signals from the XBT probes were transmitted as electric voltages through the chart recorders to the A-D converters, which were interrogated at predetermined intervals by the computer. In the course of the tests, the probes, launchers and chart recorders were handled by Sippican technicians; the XBT digitization system was operated by Southwest Fisheries Center personnel.

The HP9825A was programmed to wait in a standby mode until the probes entered the water and then start to interrogate the A-D converters, in turn, at intervals of 0.475 sec. for the first 23.75 seconds and at intervals of 4.750 sec. thereafter. This corresponded approximately to depth intervals of three meters in the upper 150 meters and thirty meters below that. Although the probes in each pair were released together as nearly as possible, simultaneity was rarely achieved. The HP9825A was programed to start recording as soon as either probe hit the water; consequently, the two temperature values recorded at each time interval were not measured at the same depth in most cases.

The tests were carried out in a series of transects, during which XBT casts were made at approximately 5 minute intervals for T-7 probes, and at 10 minute intervals for T-5 probes. The transects were laid out along the relatively deep basins in the Bight in order to avoid banks and shoal areas.

3. Data Analysis and Results

Printed tabulations of the digitized output from each pair of sucessfully recorded casts constituted the primary data for the comparison tests. The digitization system provided for data storage on magnetic tape casettes, however, it proved difficult to transfer the data from the casettes to the VAX-11/780 computer, on which the comparison analysis was performed, and they were not used. The analog data from the recorder charts were used for verification of the digitization system, which will be covered in the next section.

Two examples from the data set are shown in Table 1. The tabulations were examined subjectively for evidence of probe malfunction or excessive offset of paired temperature profiles. After rejecting problem casts, data from 119 pairs (70%) of digitized T-7 casts and from 11 pairs (69%) of digitized T-5 casts were selected for comparison.

Figures 1 and 2 show typical thermal structure for the upper 150 meters in the region and period of the experiment, constructed with data from Table 1. A shallow mixed layer overlies a sharp thermocline between 15 and 45 meters, below which the vertical temperature gradient decreases in magnitude with increasing depth. The profiles from cast D79 (Figure 1) are nearly identical, while those from D80 (Figure 2) have a significant offset, exceeding 0.3 deg C below the thermocline.

Before computing temperature differences from paired probes, it was necessary to determine the depth lag between them during their descent through the water. Depths recorded in the data set are based on a constant descent rate of 0.475 seconds per three meters. They differ from those computed with the nonlinear Sippican formula for depth, as a function of time, by less than 3 meters between the surface and 540 meters.

A starting depth, for comparing temperatures, was selected by looking for the shallowest depth at which temperatures from port and starboard launchers differed by less than 1 deg C. This procedure depended on the mixed layer depth being greater than the lag, and was successful in all but one case, when the mixed layer was so thin that the first probe was already into the thermocline before the second probe hit the water.

The depth lag was determined from data between the starting depth and 75 meters by, in essence, statistically adjusting one of the two temperature profiles up or down to find the best fit. In practice, this consisted of interpolating the temperatures recorded at 3 meter intervals to 0.5 meter intervals. Then the standard deviations of the differences between port and starboard temperatures was computed for lags varying by half meter increments from -18 to 18 meters. The lag yielding the smallest standard deviation for each pair of probes was used to compute mean temperature differences for that pair. In order to ascertain whether a depth-related bias existed the differences were computed separately for each of four depth ranges:

0-75 meters, 75-150 meters, 150-540 meters and 540-1800 meters. Only data from the T-5 probes were used for comparisons in the deepest layer.

The results are presented in Tables 2 and 4. Data for the 75-150 meter layer were also interpolated to half meter intervals, for the initial purpose of making an independent determination of the depth lag between paired probes. The differences between lags computed for 0-75 meters and 75-150 meters were not significant and the former were used for making temperature comparisons in all four layers. As a consequence, however, the values listed for N, in Table 2, for the two upper layers, indicate the number of comparisons at half meter intervals, and do not represent statistical degrees of freedom.

The mean differences for the upper three layers are summarized graphically in Figures 3a-3c. Differences with magnitudes of less than 0.2 deg C range from 84% of the total in the upper layer to 71% in the lower layer. The standard deviations of the differences are less than 0.10 in all but 13% of the cases.

The histograms in Figures 3a-3c are slightly skewed, indicating a positive bias of temperatures from the port launcher relative to those from the starboard launcher. The reason for this is not known, however, it might be the result of systematic differences in the two recorders and/or analog to digital devices. If this were true, the bias could be avoided by comparing temperatures from consecutive casts with the same launcher, recorder and A-D units. Since the ship traveled at 9 knots during transects, probes dropped at 5 minute intervals were separated by about 1.4 km along the track. While this is a considerably greater distance than that between the port and starboard launchers, the temperature profiles at locations of consecutive casts should still be comparable.

In order to make such comparisons, the data from the port and starboard launchers were separated and re-ordered so that each cast from each side was paired with the succeeding cast from that side. All such pairs for which the time difference did not exceed 8 minutes were accepted for testing.

A depth lag was computed for the two probes in each pair by the same method that was used for data from the simultaneous casts and, similiarly, the recorded temperatures at 3 meter intervals were interpolated to half meter intervals for computing mean differences and standard deviations.

The results are presented in Table 3 and in Figures 3d-3f. The percentages mean differences with magnitudes less than 0.2 deg C range from 74% to 81%. These values are very similiar to those obtained in the comparisons of simultaneous casts, however, the histograms in this case do not show any systematic skewness.

The standard deviations of the differences for consecutive casts were only slightly higher than for simultaneous casts, with all but 18% of the values being less than 0.10 deg C in the layers below 75 meters. Standard deviations for consecutive casts were significantly higher in the upper 75 meters, reflecting small scale spacial and temporal variations in thermocline structure.

In order to illustrate small scale features in the vertical temperature field, and the extent to which they are depicted by both port and starboard data sets, the latter were independently processed with an objective analysis and contouring procedure (Eber, 1982) to make vertical sections along three transects, for the upper 150 meters. The locations of these transects, identified as legs I, II and III, are shown in Figure 4. The distances covered range from approximately 33 km for leg II to 117 km for leg I. Local times are entered near the starting point of each transect.

The three pairs of contoured temperature plots are presented in Figures 5a-5f. The units along the horizontal coordinate are labeled in hours, corresponding to the times shown in Figure 4. The sections reveal considerable small scale fluctuation in the thermocline and a progressive change of thermocline depth.

4. Verification of the Digitization System

The principal reasons for developing an XBT digitization system are to attain the capability for recording both temperature and depth with sufficient precision to capture all the resolution which the instrument can provide and for storing the data in a computer compatible format. As an experimental system, however, it is pertinent to examine the accuracy of the digitized data relative to the analog data recorded on the strip charts.

For this purpose, it is necessary to take into account the non-linear relationship between probe depth and time from launching. Moreover, for the digitized data, the time from launching is known only for the first probe (of each pair) to enter the water. Taking these facts into account, a comparison of data from analog traces and digitized output was made with 20 casts from each launcher. The results are tabulated in Table 5. The digitized temperatures were extracted for ten time intervals (from launch time) and the corresponding depths were computed with the Sippican formula, given below:

D = 6.4648 x S - 0.00196 x SxS

where D is depth in meters and S is time in seconds.

Temperatures were read from the analog charts at the computed depths and mean differences between corresponding digitized and chart values, and their standard deviations, were computed for the 20 casts from each launcher, for each selected depth. Data from the port launcher reveal excessively large values of mean difference and standard deviation at 30.7 meters, which probable resulted from imperfect positioning of the XBT recorder stylus at the top of the chart, along with the large vertical temperature gradient at that depth. Below the thermocline, the mean differences ranged from -0.111 to 0.141 deg C. The magnitude of the differences were less than 0.08 deg C in 78% of the cases. Positive differences indicate that digitized temperatures were higher than those read from the analog charts. The standard deviations of the differences ranged from 0.054 to 0.113 deg C, below the thermocline. Considering that the resolution of temperature read from the chart is only 0.05 deg C, the differences do not appear to be significant.

There was, however, a systematic shift from negative to positive differences with increasing depth, evident in the comparisons from both port and starboard launchers. The reason for this shift is not known, although it seems plausible that it may have resulted from timing discrepencies between the chart paper drive and the HP9825A timer.

5. Conclusions

The XBT was designed to meet an accuracy requirement of ±0.2 deg C. Attempts to determine XBT accuracy by comparisons with STD and CTD data have revealed systematic differences of 0.1 to 0.2 deg C. (Heinmiller, et.al, 1983). The analysis of data from XBT probes launched simultaneously, in pairs, suggests that an additional, random error of 0.2 deg C can be expected in one out of five cases.

The standard deviations of differences for paired casts with temperature offsets exceeding 0.2 deg C were very small below 75 meters (averaging less than 0.04 deg C), indicating a high consistency in the detail structure of the profiles. Also, the paired profiles showed no systematic increases of mean difference or standard deviation with depth. Therefore, the XBT may accurately depict fine gradient structure in temperature profiles even when the actual temperatures may be in question by a several tenths of a degree.

Acknowledgments. The HP9825A computer program for recording digitized data was adapted for this experiment by Ken Bliss. Nelson Ross and Donna Mallicoate assisted in the operation of the HP9825A system and collection of data. Celeste Santos performed the editing and data entry tasks prequisite to the computer analyses.

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Heinmiller, Robert H., Curtis C. Ebbesmeyer, Bruce A. Taft. Donald B. Olson and Oleg P. Nikitin, 1983. Systematic Errors in Expendable Bathythermograph (XBT) Profiles. Deep-Sea Research, Part A, Oceanographic Research Papers, 30, 1185-1196.

Saur, J.F.T., and Dorothy D. Stewart, 1967. Expendable Bathythermograph Data on Subsurface Thermal Structure in the Eastern North Pacific Ocean. U.S. Fish and Wildlife Ser., Special Scientific Rept.-Fisheries No. 548, 70pp.

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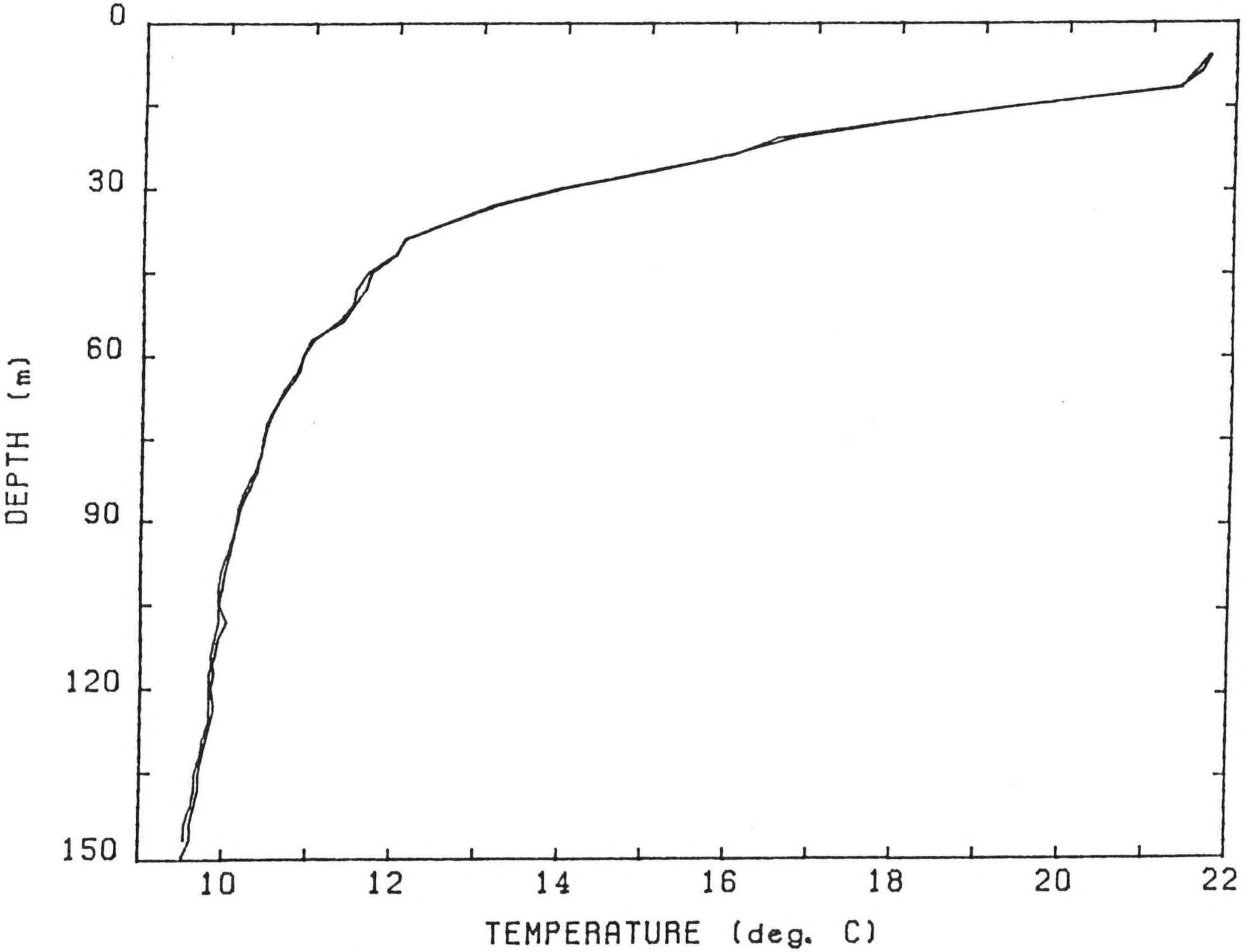


Figure 2. XBT CAST D80

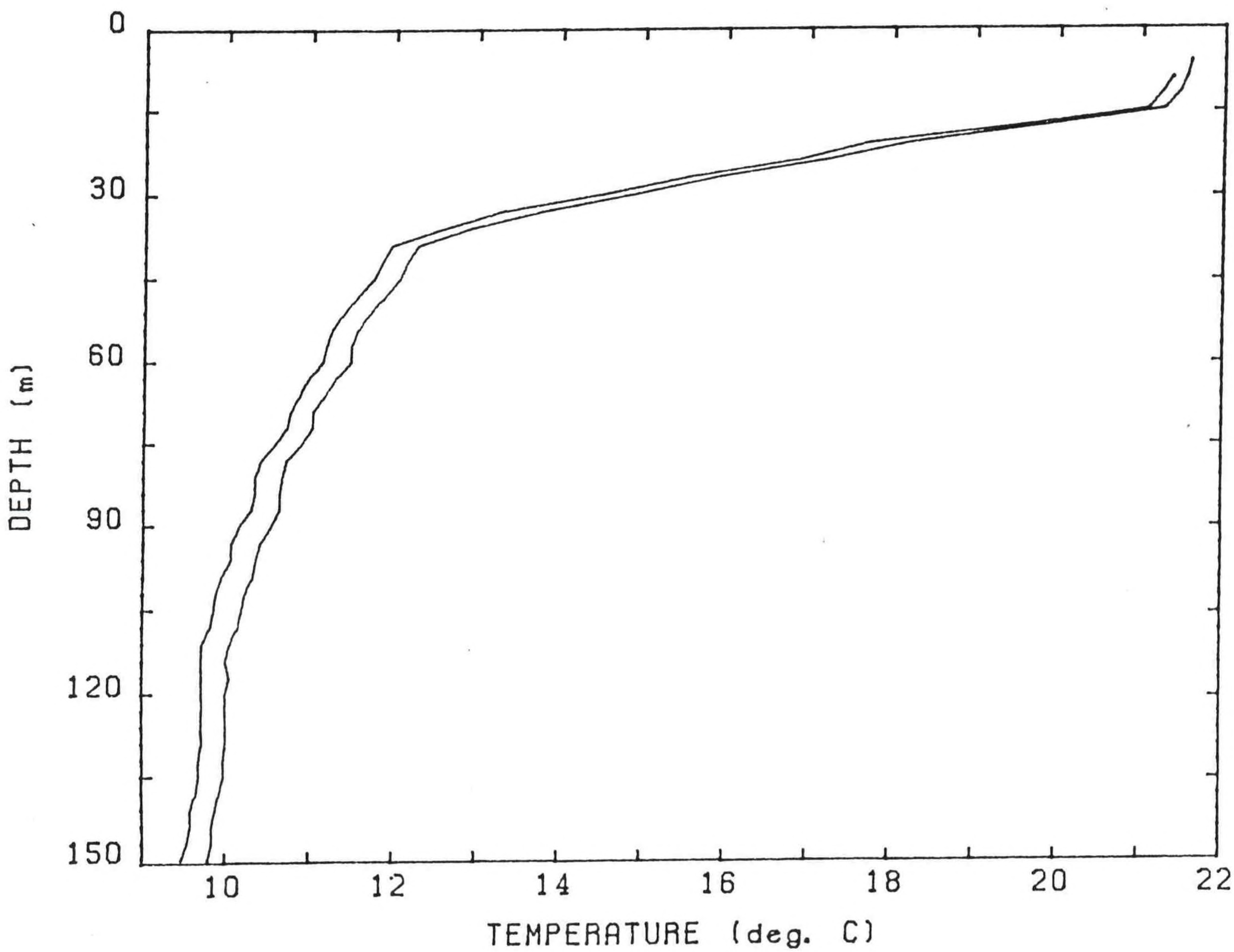


Figure 3a

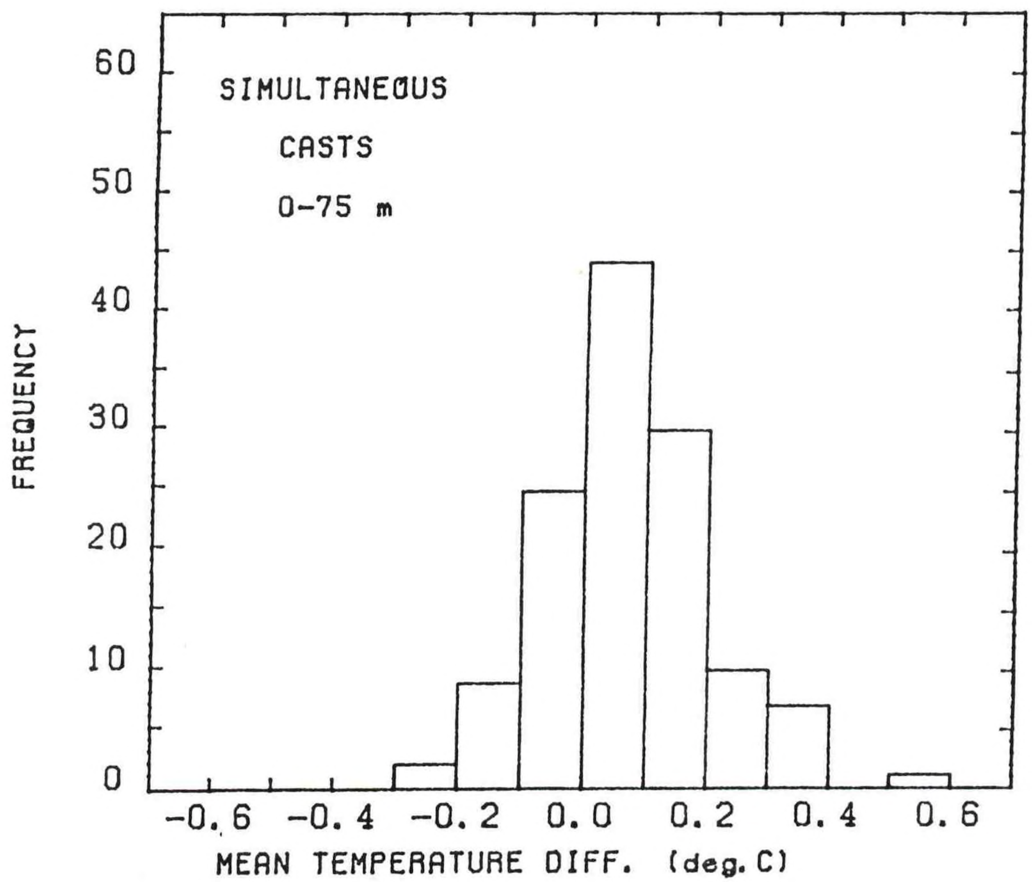

SIMULTANEOUS
CASTS
0-75 m
FREQUENCY
0
10
20
30
40
50
60
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEAN TEMPERATURE DIFF. (deg. C)

Figure 3b.

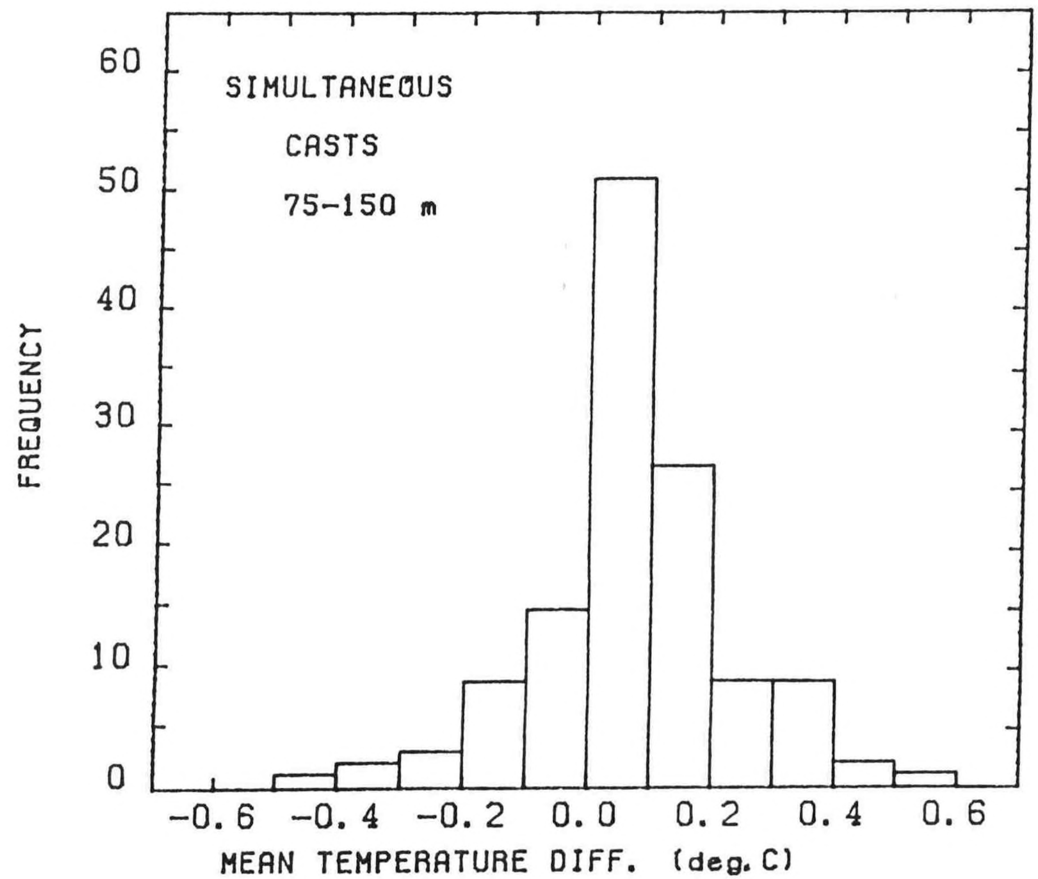

SIMULTANEOUS
CASTS
75-150 m
FREQUENCY
0
10
20
30
40
50
60
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEAN TEMPERATURE DIFF. (deg.C)

Figure 3a.

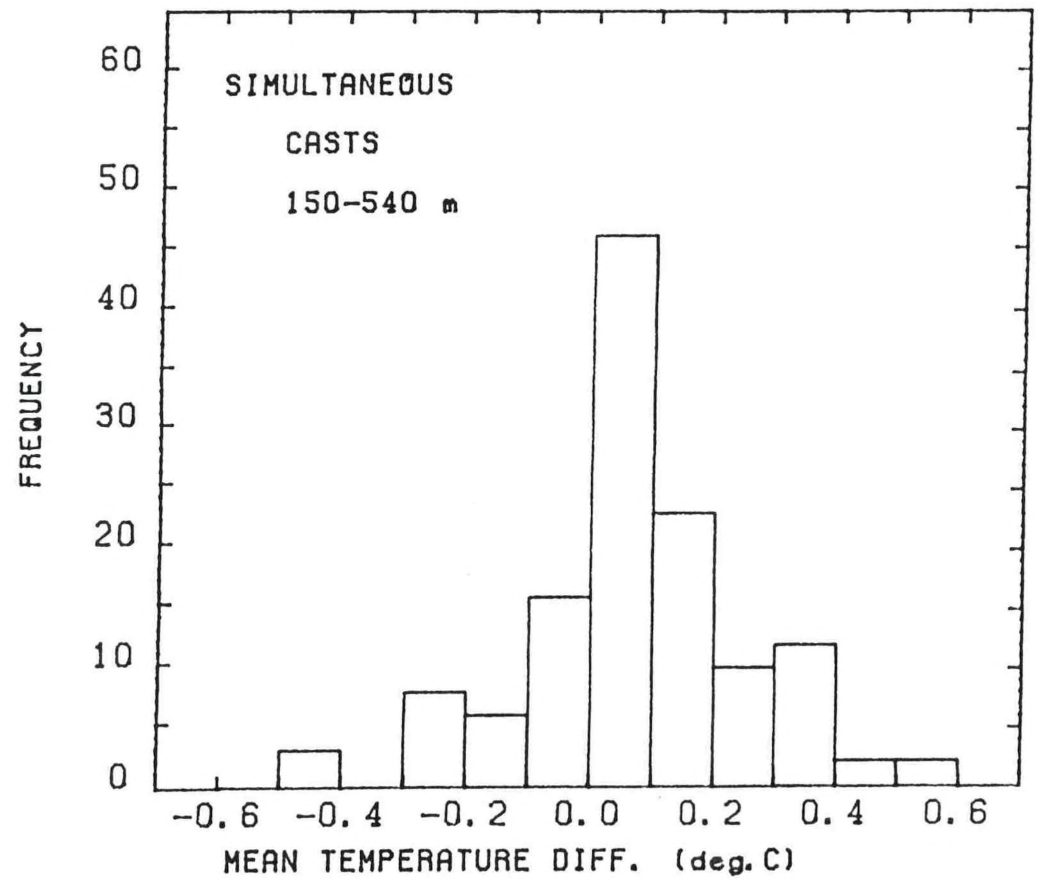

SIMULTANEOUS
CASTS
150-540 m
FREQUENCY
0
10
20
30
40
50
60
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEAN TEMPERATURE DIFF. (deg. C)

Figure 3d.

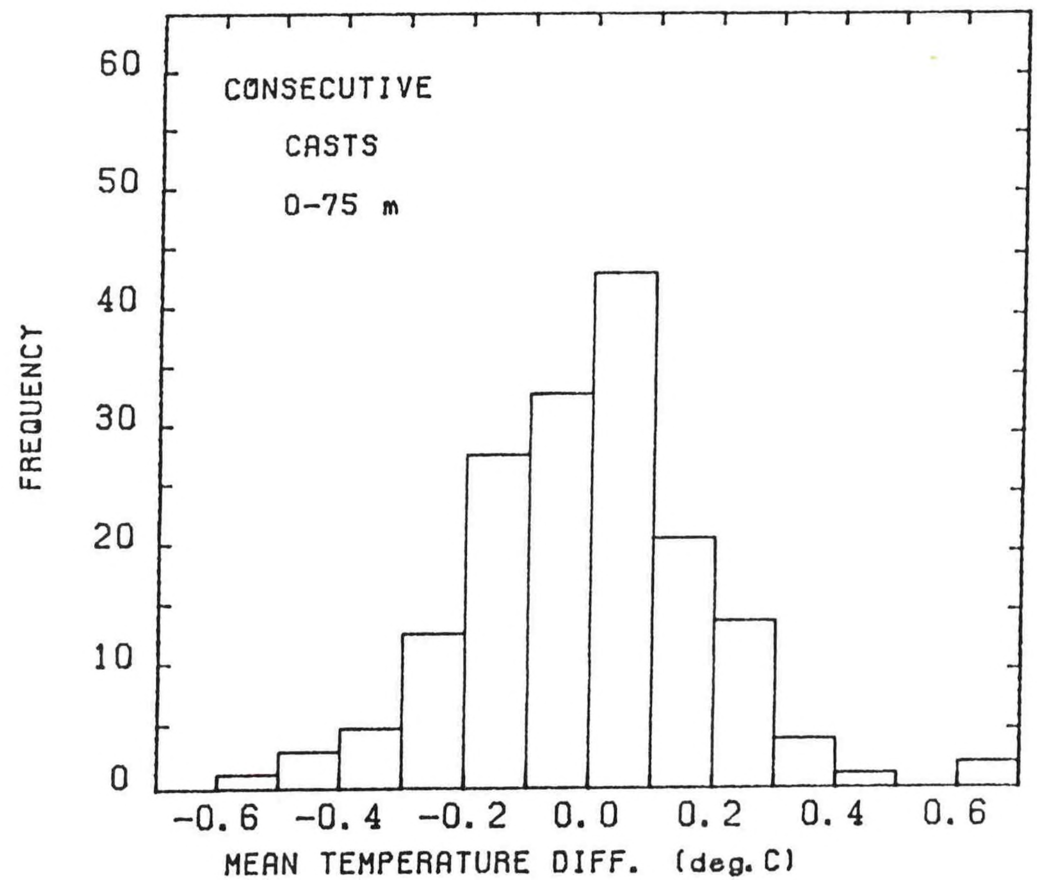
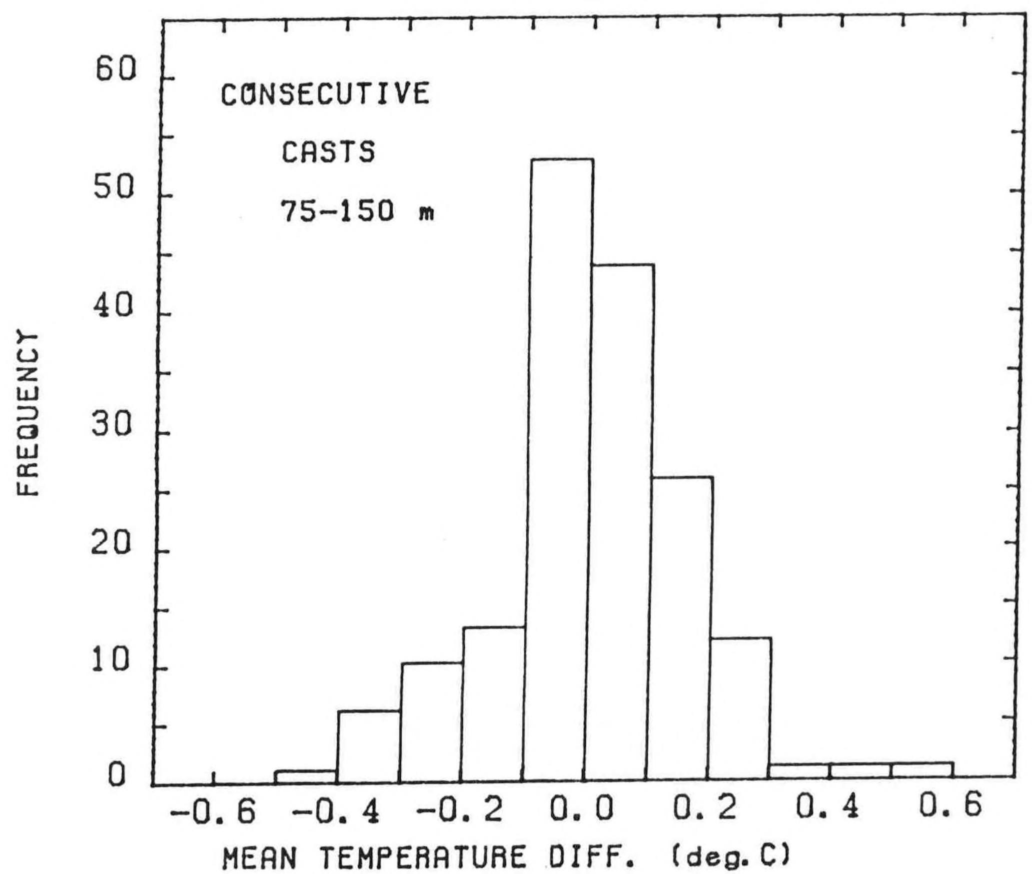
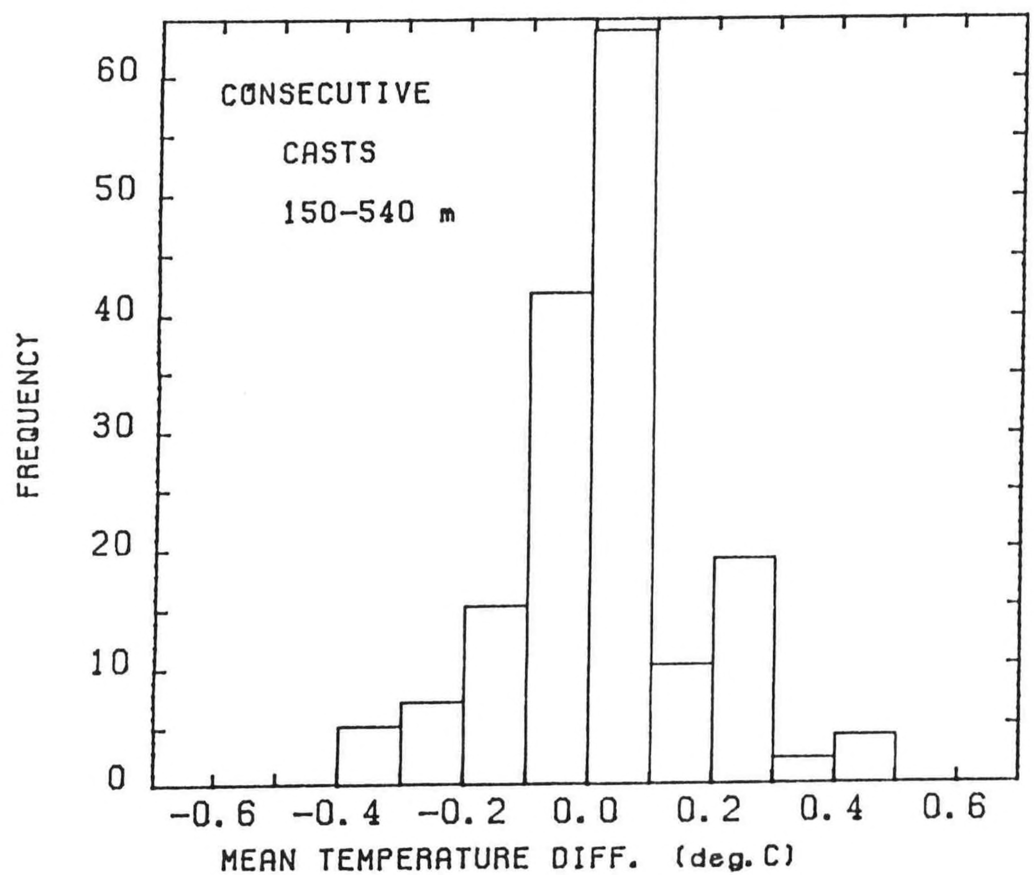

CONSECUTIVE
CASTS
0-75 m
FREQUENCY
0
10
20
30
40
50
60
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEAN TEMPERATURE DIFF. (deg. C)

Figure 3e.



CONSECUTIVE
CASTS
75–150 m
FREQUENCY
60
50
40
30
20
10
0
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEAN TEMPERATURE DIFF. (deg. C)

Figure 3f.



CONSECUTIVE
CASTS
150-540 m
FREQUENCY
0
10
20
30
40
50
60
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
MEAN TEMPERATURE DIFF. (deg. C)

Figure 4. LOCATION OF XBT SECTIONS

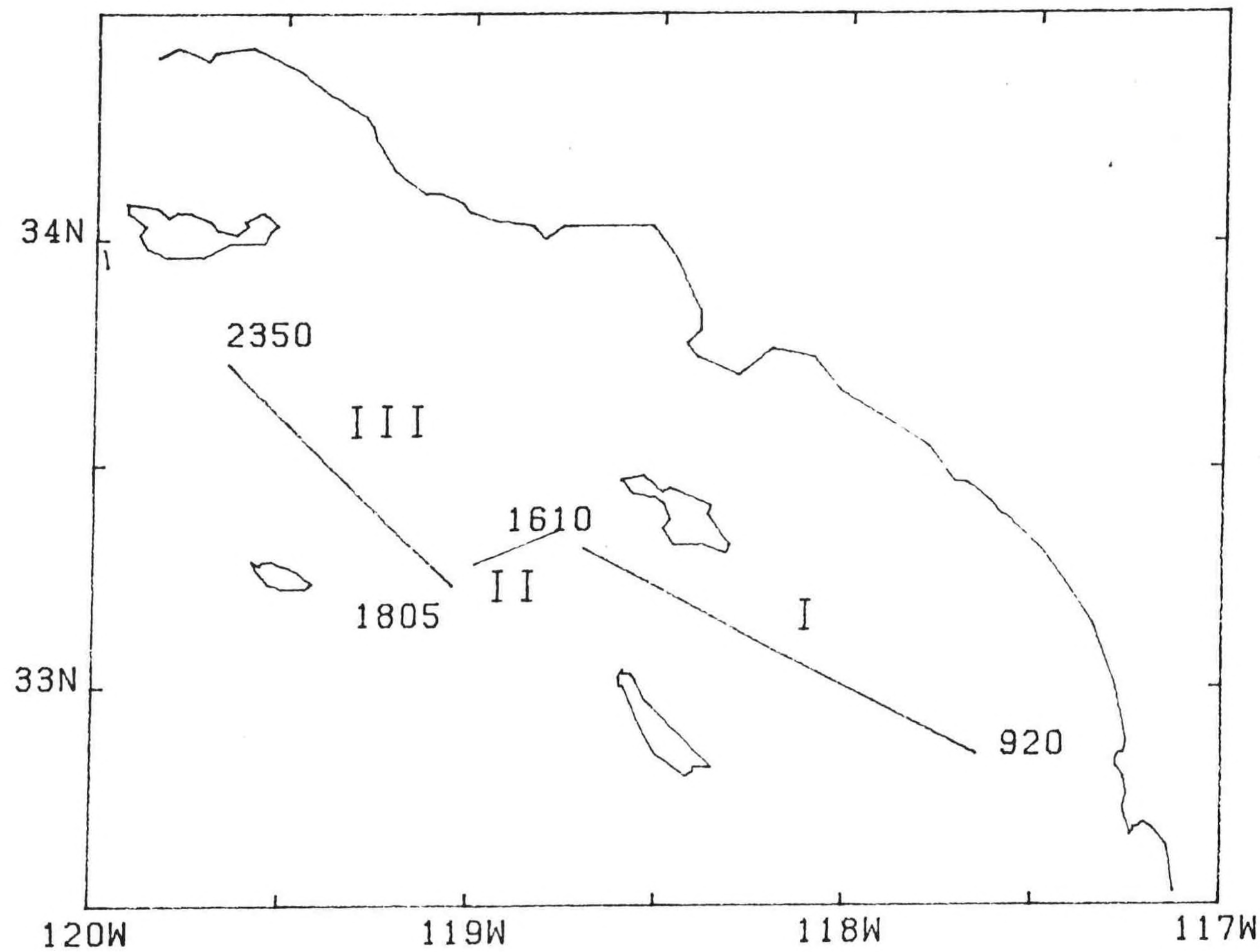


Figure 5a. XBT LEG I (STBD)

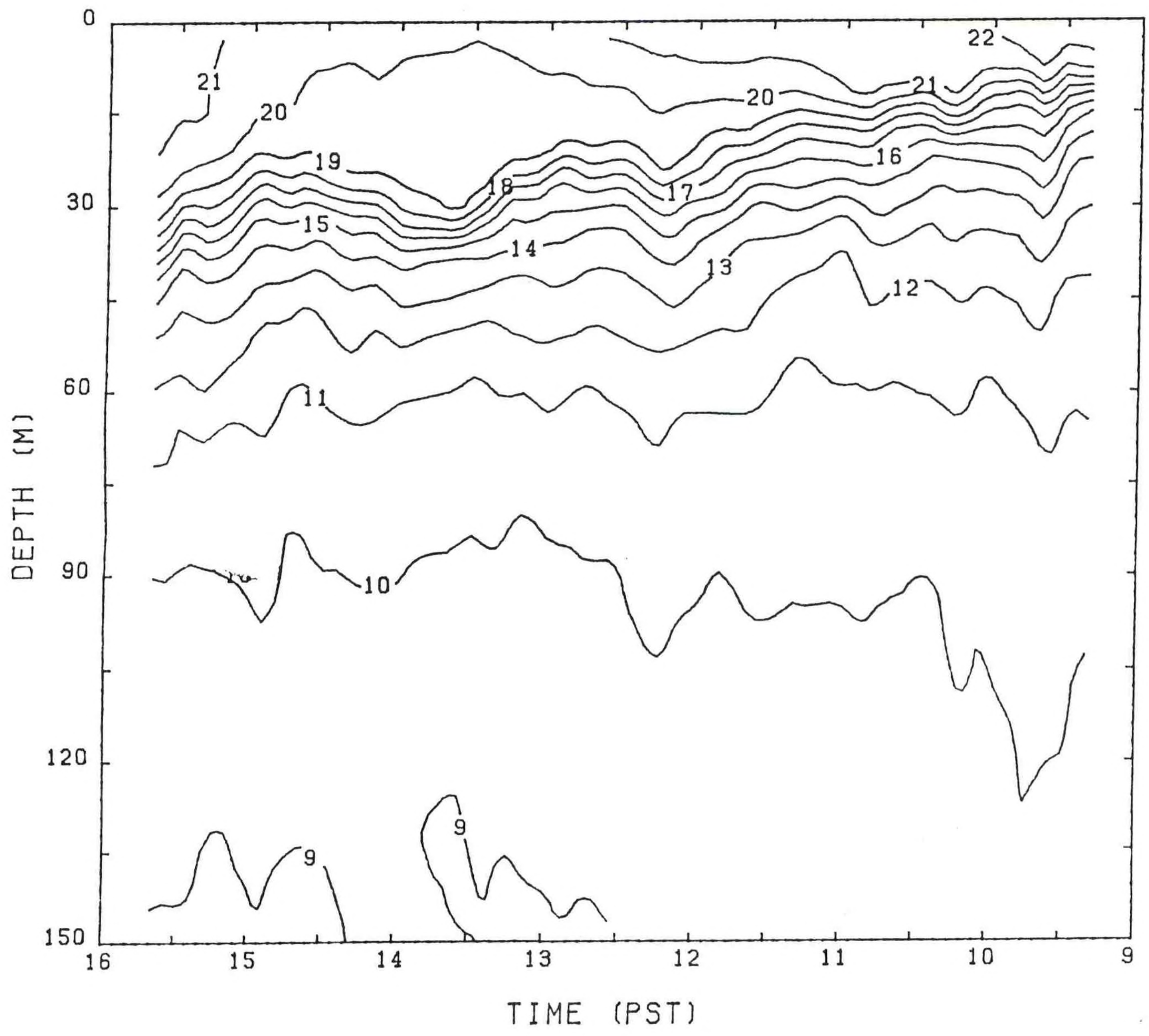


Figure 5b. XBT LEG I (PØRT)

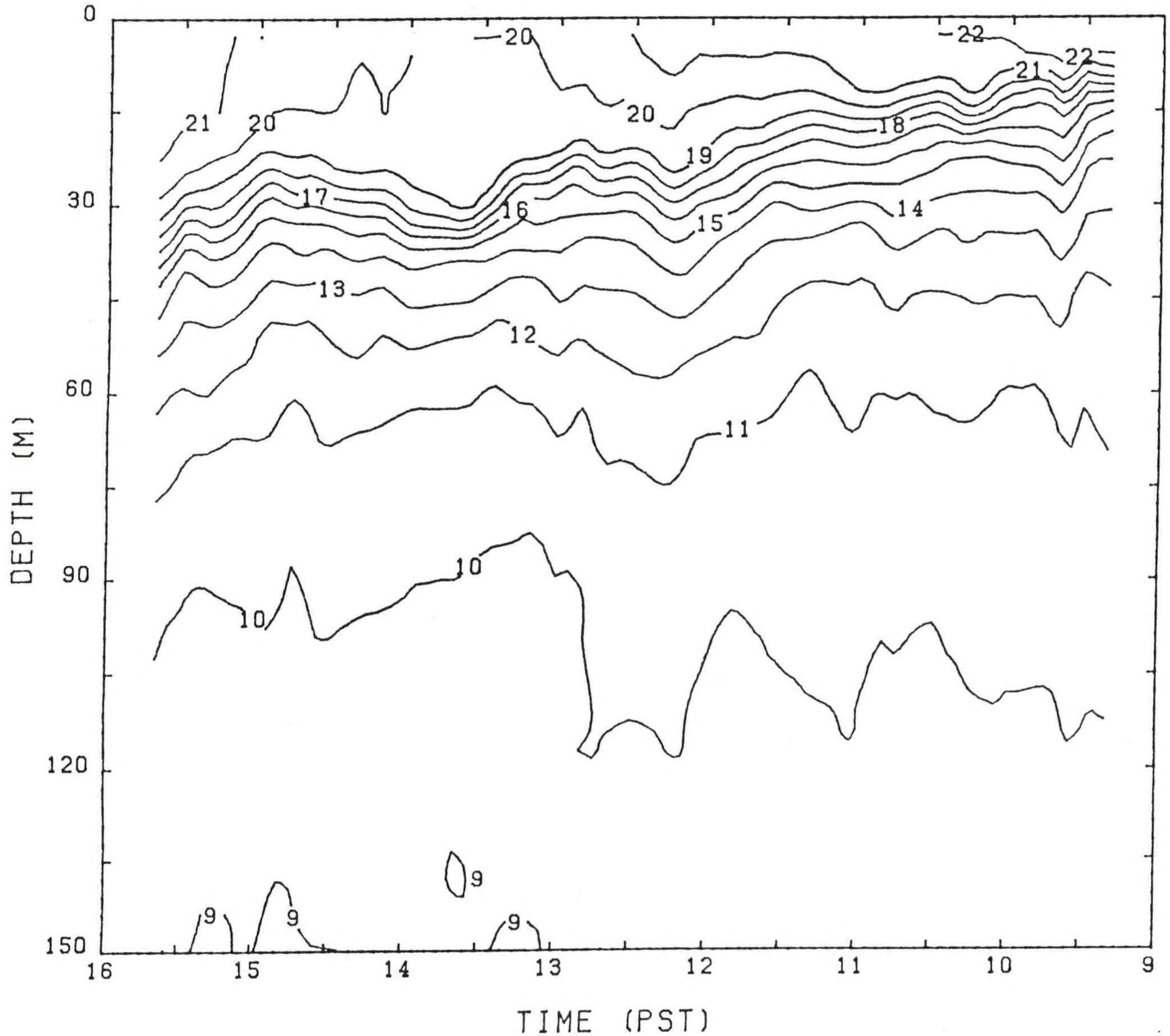


Figure 5c. XBT LEG II (STBD)

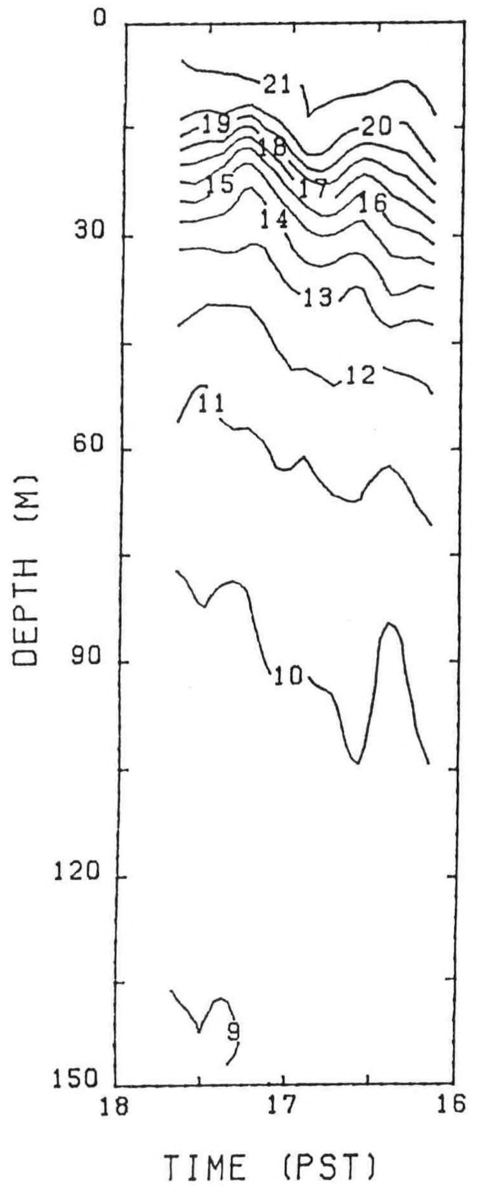


Figure 5d. XBT LEG II (PØRT)

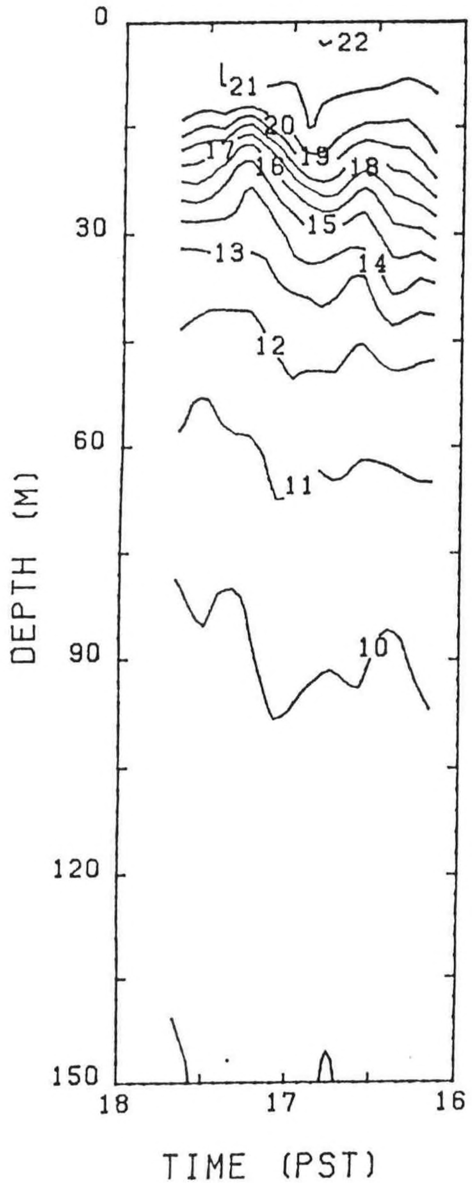


Figure 5e. XBT LEG III (STBD)

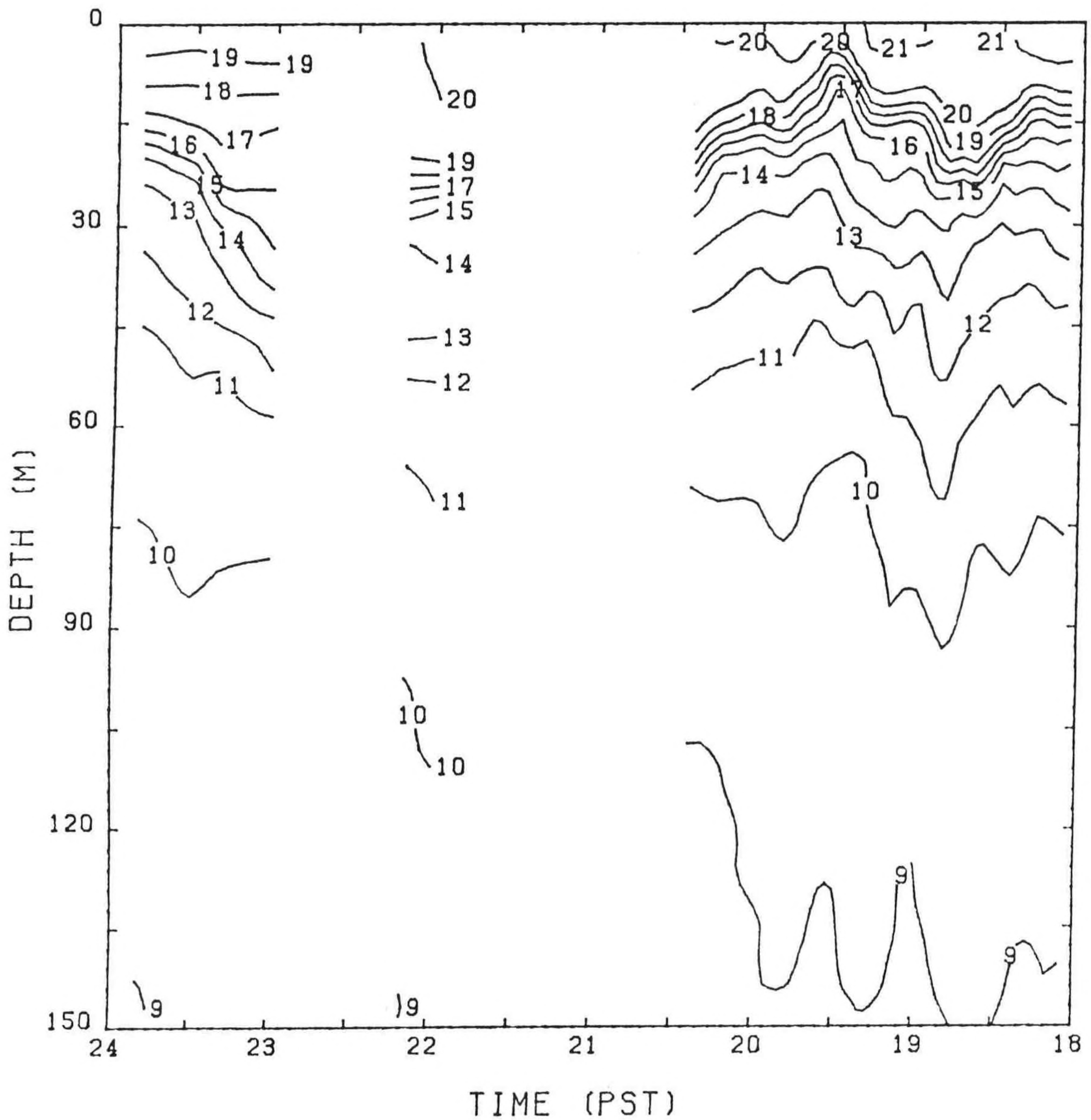


Figure 5f. XBT LEG III (PØRT)

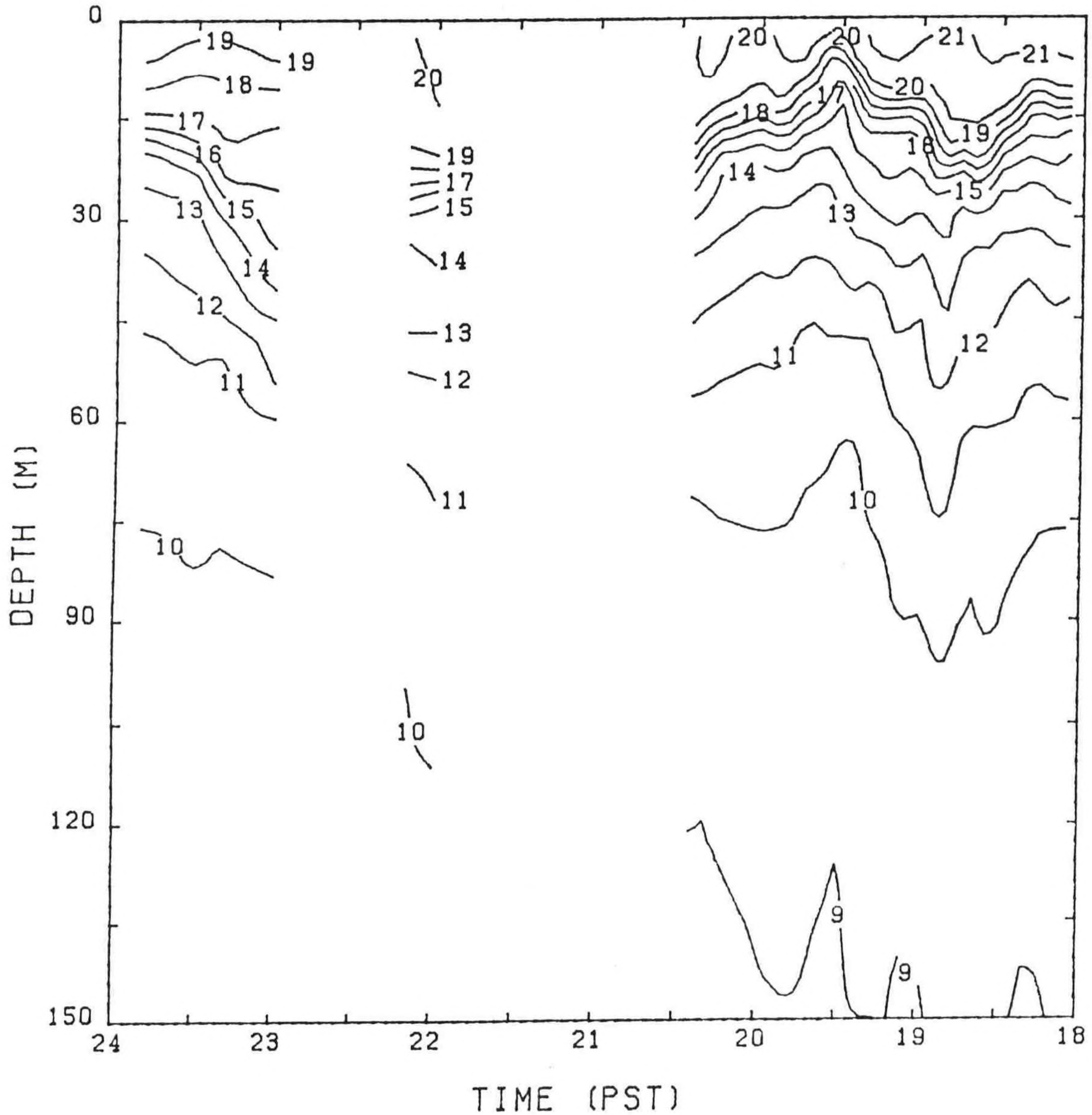


TABLE 1. EXAMPLE OF DIGITIZED TEMPERATURES
RECORDED FROM PAIRED XBT CASTS

CAST D79 1055PST 6 SEP

D(m)	PORT	STBD	D(m)	PORT	STBD	D(m)	PORT	STBD	D(m)	PORT	STBD
0	25.62	16.61	3	21.89	16.61	6	21.71	21.83	9	21.59	21.69
12	21.32	21.51	15	19.56	21.34	18	17.94	19.52	21	16.54	18.01
24	16.01	16.72	27	15.06	15.98	30	14.00	15.00	33	13.21	13.95
36	12.64	13.15	39	12.11	12.62	42	11.98	12.10	45	11.67	11.99
48	11.53	11.71	51	11.49	11.64	54	11.31	11.50	57	11.04	11.36
60	10.91	11.01	63	10.87	10.91	66	10.73	10.84	69	10.60	10.70
72	10.51	10.59	75	10.46	10.49	78	10.42	10.45	81	10.37	10.42
84	10.29	10.35	87	10.20	10.24	90	10.15	10.17	93	10.10	10.14
96	10.06	10.10	99	10.01	10.03	102	9.98	9.96	105	9.93	9.93
108	9.93	9.93	111	9.88	10.03	114	9.84	9.93	117	9.88	9.89
120	9.84	9.82	123	9.88	9.82	126	9.84	9.82	129	9.79	9.82
132	9.74	9.75	135	9.70	9.72	138	9.70	9.65	141	9.65	9.65
144	9.61	9.61	147	9.61	9.54	150	9.52	9.54	180	9.29	9.26
210	9.16	8.98	240	8.80	8.74	270	8.58	8.53	300	8.35	8.32
330	8.16	8.21	360	7.84	7.79	390	7.61	7.51	420	7.39	7.34
450	7.16	7.13	480	6.93	6.88	510	6.59	6.60	540	6.36	6.32

CAST D80 1100PST 6 SEP

D(m)	PORT	STBD	D(m)	PORT	STBD	D(m)	PORT	STBD	D(m)	PORT	STBD
0	16.85	17.63	3	25.26	21.48	6	21.59	21.37	9	21.54	21.23
12	21.45	21.06	15	21.27	19.48	18	19.78	17.70	21	18.20	16.86
24	17.20	15.53	27	15.88	14.51	30	14.88	13.29	33	13.78	12.59
36	12.91	11.96	39	12.28	11.85	42	12.15	11.75	45	12.06	11.57
48	11.89	11.40	51	11.71	11.26	54	11.57	11.19	57	11.49	11.15
60	11.49	10.98	63	11.31	10.87	66	11.18	10.77	69	11.04	10.73
72	11.04	10.59	75	10.91	10.42	78	10.73	10.35	81	10.68	10.35
84	10.65	10.31	87	10.65	10.17	90	10.55	10.07	93	10.42	10.07
96	10.37	9.96	99	10.33	9.89	102	10.24	9.86	105	10.20	9.82
108	10.15	9.72	111	10.06	9.72	114	10.01	9.72	117	10.06	9.72
120	10.01	9.72	123	10.01	9.72	126	10.01	9.72	129	10.01	9.68
132	9.98	9.68	135	9.98	9.65	138	9.93	9.58	141	9.88	9.58
144	9.84	9.54	147	9.84	9.47	150	9.79	9.47	180	9.48	9.12
210	9.34	9.02	240	9.03	8.67	270	8.80	8.49	300	8.58	8.18
330	8.48	8.00	360	8.07	7.65	390	7.79	7.48	420	7.65	7.30
450	7.43	7.02	480	7.11	6.78	510	6.93	6.53	540	6.59	6.25

TABLE 2. COMPARISON OF SIMULTANEOUS XBT CASTS

DEPTH	CAST	LAG	N	MDF	SDEV	CAST	LAG	N	MDF	SDEV
0-75	AI0	0.0	145	-0.013	0.079	AI1	0.0	145	0.114	0.048
75-150		0.0	151	-0.052	0.016		0.0	151	0.092	0.029
150-540		0.0	13	-0.098	0.034		0.0	13	0.092	0.023
0-75	AI2	-2.5	140	0.282	0.066	AI3	2.5	140	0.016	0.080
75-150		-2.5	146	0.285	0.029		2.5	146	0.008	0.031
150-540		-2.5	13	0.317	0.042		2.5	13	0.023	0.042
0-75	AI4	1.0	143	0.079	0.069	AI5	0.0	145	0.019	0.034
75-150		1.0	149	0.060	0.031		0.0	151	0.035	0.038
150-540		1.0	13	0.047	0.023		0.0	13	0.024	0.026
0-75	AI6	0.5	144	0.138	0.078	AI7	-1.0	143	0.080	0.099
75-150		0.5	150	0.145	0.043		-1.0	149	0.123	0.043
150-540		0.5	13	0.096	0.033		-1.0	13	0.085	0.049
0-75	AI9	-0.5	144	0.010	0.085	AI10	-2.5	140	-0.024	0.126
75-150		-0.5	150	-0.100	0.055		-2.5	146	0.042	0.028
150-540		-0.5	13	-0.201	0.031		-2.5	13	0.009	0.054
0-75	AI19	2.0	141	0.038	0.071	AI20	-3.0	139	-0.024	0.047
75-150		2.0	147	0.031	0.036		-3.0	145	0.012	0.028
150-540		2.0	13	-0.052	0.121		-3.0	13	0.042	0.059
0-75	AI21	-5.0	135	0.006	0.107	AI22	-0.5	144	0.105	0.051
75-150		-5.0	141	0.136	0.044		-0.5	150	0.091	0.014
150-540		-5.0	13	0.224	0.043		-0.5	13	0.310	0.581
0-75	AI23	-5.0	135	0.003	0.085	AI24	2.5	140	0.176	0.054
75-150		-5.0	141	0.064	0.075		2.5	146	0.181	0.022
150-540		-5.0	13	0.356	0.193		2.5	13	0.152	0.035
0-75	AI25	-1.0	143	0.103	0.102	AI26	-1.0	143	0.229	0.101
75-150		-1.0	149	0.061	0.028		-1.0	149	0.291	0.035
150-540		-1.0	13	0.044	0.024		-1.0	13	0.330	0.043
0-75	AI27	-2.5	140	0.075	0.048	AI28	-4.5	136	0.013	0.115
75-150		-2.5	146	0.049	0.027		-4.5	142	0.022	0.027
150-540		-2.5	13	0.056	0.036		-4.5	13	0.041	0.038
0-75	AII29	0.5	144	-0.031	0.091	AII30	0.0	145	0.013	0.035
75-150		0.5	150	0.033	0.022		0.0	151	-0.001	0.022
150-540		0.5	13	0.031	0.020		0.0	13	-0.021	0.027
0-75	AII31	1.5	142	0.365	0.117	AII33	0.5	144	0.028	0.076
75-150		1.5	148	0.357	0.029		0.5	150	0.045	0.027
150-540		1.5	13	0.315	0.027		0.5	13	0.041	0.048
0-75	AII35	1.5	142	-0.172	0.155	AII36	-1.0	143	0.223	0.146
75-150		1.5	148	-0.016	0.134		-1.0	149	0.167	0.029
150-540		1.5	13	-0.012	0.077		-1.0	13	0.151	0.027
0-75	AII48	2.5	140	0.120	0.079	AII49	2.0	141	-0.150	0.197
75-150		2.5	146	0.083	0.025		2.0	147	-0.347	0.024
150-540		2.5	13	0.055	0.055		2.0	13	-0.439	0.038
0-75	AII50	4.0	137	-0.232	0.139	AII51	2.0	141	-0.089	0.138
75-150		4.0	143	-0.411	0.034		2.0	147	-0.203	0.026
150-540		4.0	13	-0.492	0.040		2.0	13	-0.273	0.034
0-75	AII53	7.5	124	0.272	0.097	AII54	-0.5	144	-0.117	0.115
75-150		7.5	136	0.200	0.028		-0.5	150	-0.245	0.044
150-540		7.5	13	0.212	0.069		-0.5	13	-0.279	0.026
0-75	AII55	3.0	139	0.196	0.050	D60	0.5	144	0.077	0.083
75-150		3.0	145	0.201	0.026		0.5	150	0.097	0.022
150-540		3.0	13	0.143	0.022		0.5	13	0.092	0.035

TABLE 2. COMPARISON OF SIMULTANEOUS XBT CASTS

DEPTH	CAST	LAG	N	MDF	SDEV	CAST	LAG	N	MDF	SDEV
0-75	D61	3.0	133	0.093	0.038	D62	1.5	142	-0.177	0.127
75-150		3.0	145	0.078	0.026		1.5	148	-0.162	0.025
150-540		3.0	13	0.069	0.056		1.5	13	-0.189	0.023
0-75	D63	7.0	119	-0.024	0.116	D64	2.0	141	-0.060	0.119
75-150		7.0	137	-0.014	0.025		2.0	147	-0.146	0.026
150-540		7.0	13	-0.028	0.019		2.0	13	-0.246	0.048
0-75	D65	2.0	141	-0.088	0.129	D69	1.5	142	0.140	0.099
75-150		2.0	147	-0.195	0.028		1.5	148	0.138	0.027
150-540		2.0	13	-0.258	0.031		1.5	13	0.138	0.031
0-75	D70	1.5	142	-0.018	0.074	D72	3.0	139	0.097	0.028
75-150		1.5	148	-0.030	0.024		3.0	145	0.085	0.024
150-540		1.5	13	-0.087	0.048		3.0	13	0.056	0.025
0-75	D73	3.5	132	0.212	0.095	D74	4.0	131	0.077	0.086
75-150		3.5	144	0.150	0.030		4.0	143	0.073	0.036
150-540		3.5	13	0.126	0.022		4.0	13	0.043	0.041
0-75	D76	-3.5	132	0.087	0.083	D77	2.5	134	0.131	0.058
75-150		-3.5	144	0.095	0.026		2.5	146	0.131	0.050
150-540		-3.5	13	0.131	0.025		2.5	13	0.125	0.029
0-75	D78	0.0	145	0.017	0.081	D79	3.0	133	-0.001	0.051
75-150		0.0	151	-0.003	0.019		3.0	145	0.021	0.037
150-540		0.0	13	-0.137	0.081		3.0	13	0.067	0.053
0-75	D80	-3.0	133	0.321	0.062	D84	-1.0	143	0.073	0.063
75-150		-3.0	145	0.316	0.027		-1.0	149	0.077	0.022
150-540		-3.0	13	0.393	0.054		-1.0	13	0.059	0.032
0-75	D87	-1.5	142	-0.019	0.067	D88	-0.5	144	0.084	0.067
75-150		-1.5	148	0.037	0.022		-0.5	150	0.097	0.029
150-540		-1.5	13	0.170	0.079		-0.5	13	0.063	0.030
0-75	D90	-10.5	112	0.095	0.092	D93	-1.0	143	0.159	0.093
75-150		-10.5	130	0.087	0.026		-1.0	149	0.227	0.031
150-540		-10.5	13	0.260	0.059		-1.0	13	0.230	0.054
0-75	D94	3.0	139	0.192	0.084	D95	1.5	142	0.354	0.119
75-150		3.0	145	0.316	0.025		1.5	148	0.222	0.033
150-540		3.0	13	0.330	0.033		1.5	13	0.093	0.055
0-75	D96	1.0	143	0.361	0.128	D98	1.0	143	0.386	0.153
75-150		1.0	149	0.434	0.026		1.0	149	0.533	0.027
150-540		1.0	13	0.460	0.028		1.0	13	0.557	0.048
0-75	D99	-3.5	132	0.026	0.079	D100	4.0	137	0.133	0.112
75-150		-3.5	144	0.136	0.244		4.0	143	0.157	0.045
150-540		-3.5	13	0.071	0.068		4.0	13	0.108	0.085
0-75	D101	0.0	145	0.274	0.141	D102	0.5	144	0.048	0.060
75-150		0.0	151	0.261	0.015		0.5	150	0.061	0.017
150-540		0.0	13	0.255	0.033		0.5	13	0.039	0.027
0-75	D103	0.0	145	0.073	0.113	D104	1.0	143	0.011	0.065
75-150		0.0	151	0.097	0.024		1.0	149	0.037	0.026
150-540		0.0	13	0.078	0.048		1.0	13	0.030	0.023
0-75	D106	-2.0	141	-0.096	0.122	D107	1.0	143	0.144	0.066
75-150		-2.0	147	0.021	0.040		1.0	149	0.169	0.024
150-540		-2.0	13	0.046	0.024		1.0	13	0.154	0.025
0-75	D108	-3.0	139	0.127	0.073	D113	3.0	133	0.040	0.036
75-150		-3.0	145	0.127	0.051		3.0	145	0.019	0.020
150-540		-3.0	13	0.121	0.071		3.0	13	-0.005	0.061

TABLE 2. COMPARISON OF SIMULTANEOUS XBT CASTS

DEPTH	CAST	LAG	N	MDF	SDEV	CAST	LAG	N	MDF	SDEV
0-75	D115	-2.0	141	0.056	0.074	D117	0.5	144	0.074	0.062
75-150		-2.0	147	0.107	0.028		0.5	150	0.087	0.025
150-540		-2.0	13	0.108	0.038		0.5	13	0.083	0.029
0-75	D120	-1.5	142	0.328	0.069	D121	-1.0	143	0.267	0.099
75-150		-1.5	148	0.346	0.025		-1.0	149	0.314	0.022
150-540		-1.5	13	0.296	0.030		-1.0	13	0.324	0.033
0-75	D122	0.5	144	0.046	0.076	D124	6.0	133	-0.016	0.119
75-150		0.5	150	0.043	0.018		6.0	139	-0.040	0.026
150-540		0.5	13	0.047	0.020		6.0	13	-0.042	0.031
0-75	D125	3.0	139	0.121	0.070	D127	-2.0	141	0.110	0.083
75-150		3.0	145	0.090	0.014		-2.0	147	0.176	0.024
150-540		3.0	13	0.071	0.036		-2.0	13	0.190	0.049
0-75	D129	-1.0	143	0.111	0.057	D130	3.0	133	0.064	0.046
75-150		-1.0	149	0.098	0.081		3.0	145	0.078	0.020
150-540		-1.0	13	0.101	0.022		3.0	13	0.064	0.030
0-75	D131	0.0	145	0.276	0.075	D132	0.0	145	0.068	0.055
75-150		0.0	151	0.356	0.024		0.0	151	0.041	0.026
150-540		0.0	13	0.324	0.031		0.0	13	0.009	0.041
0-75	D133	-4.0	131	0.311	0.165	E139	-0.5	138	-0.187	0.068
75-150		-4.0	143	0.431	0.028		-0.5	150	-0.182	0.031
150-540		-4.0	13	0.498	0.059		-0.5	13	-0.201	0.046
0-75	E140	-1.0	143	-0.233	0.083	E141	-1.5	142	-0.009	0.086
75-150		-1.0	149	-0.246	0.020		-1.5	148	0.001	0.024
150-540		-1.0	13	-0.234	0.036		-1.5	13	-0.005	0.054
0-75	E142	4.5	130	0.037	0.064	E144	1.5	142	-0.152	0.075
75-150		4.5	142	0.028	0.030		1.5	148	-0.300	0.045
150-540		4.5	13	0.039	0.032		1.5	13	-0.495	0.097
0-75	E146	1.5	142	-0.073	0.118	E147	0.5	144	-0.091	0.195
75-150		1.5	148	-0.095	0.031		0.5	150	-0.131	0.020
150-540		1.5	13	-0.108	0.032		0.5	13	-0.141	0.035
0-75	E148	2.5	140	0.175	0.086	E149	0.0	145	-0.010	0.140
75-150		2.5	146	0.266	0.026		0.0	151	0.023	0.029
150-540		2.5	13	0.264	0.043		0.0	13	0.018	0.037
0-75	E150	0.0	145	0.262	0.103	E151	0.5	144	0.023	0.101
75-150		0.0	151	0.330	0.033		0.5	150	0.070	0.021
150-540		0.0	13	0.352	0.038		0.5	13	0.038	0.031
0-75	E152	8.0	123	0.095	0.124	E153	5.5	128	0.087	0.074
75-150		8.0	135	0.118	0.027		5.5	140	0.070	0.014
150-540		8.0	13	0.118	0.040		5.5	13	0.046	0.052
0-75	E154	7.0	119	0.039	0.104	E155	3.0	133	0.160	0.048
75-150		7.0	137	0.037	0.023		3.0	145	0.179	0.026
150-540		7.0	13	0.006	0.093		3.0	13	0.208	0.040
0-75	E156	3.5	132	0.069	0.056	E157	5.5	128	0.078	0.073
75-150		3.5	144	0.060	0.022		5.5	140	0.066	0.019
150-540		3.5	13	0.022	0.034		5.5	13	0.083	0.023
0-75	E158	0.5	144	-0.043	0.100	E159	0.5	144	0.048	0.103
75-150		0.5	150	0.042	0.023		0.5	150	0.061	0.020
150-540		0.5	13	0.081	0.068		0.5	13	0.061	0.037
0-75	E160	0.0	145	0.089	0.052	E161	1.0	143	0.122	0.105
75-150		0.0	151	0.070	0.020		1.0	149	0.124	0.024
150-540		0.0	13	0.036	0.039		1.0	13	0.090	0.026

TABLE 2. COMPARISON OF SIMULTANEOUS XBT CASTS

DEPTH	CAST	LAG	N	MDF	SDEV	CAST	LAG	N	MDF	SDEV
0-75	E162	0.5	144	-0.028	0.062	E163	14.5	98	0.503	0.365
75-150		0.5	150	-0.005	0.026		14.5	122	0.344	0.029
150-540		0.5	13	-0.004	0.025		14.5	13	0.342	0.028
0-75	E165	-5.0	135	0.161	0.067	E166	0.0	145	-0.017	0.055
75-150		-5.0	141	0.163	0.025		0.0	151	0.009	0.030
150-540		-5.0	13	0.213	0.044		0.0	13	-0.009	0.030
0-75	E167	3.5	126	0.158	0.077	E169	-3.5	138	0.221	0.124
75-150		3.5	144	0.154	0.030		-3.5	144	0.211	0.029
150-540		3.5	13	0.123	0.045		-3.5	13	0.246	0.083
0-75	E170	0.0	145	0.134	0.053	E171	3.0	139	0.159	0.069
75-150		0.0	151	0.100	0.020		3.0	145	0.109	0.019
150-540		0.0	13	0.095	0.030		3.0	13	0.151	0.039
0-75	E172	6.0	127	-0.109	0.087	E173	-2.0	141	0.186	0.121
75-150		6.0	139	-0.151	0.025		-2.0	147	0.312	0.025
150-540		6.0	13	-0.188	0.045		-2.0	13	0.316	0.063
0-75	E174	6.0	127	-0.181	0.125	E175	-1.5	142	-0.035	0.120
75-150		6.0	139	-0.173	0.023		-1.5	148	-0.001	0.030
150-540		6.0	13	-0.224	0.052		-1.5	13	-0.018	0.045
0-75	E176	0.5	144	0.014	0.161	E177	-3.0	139	0.047	0.075
75-150		0.5	150	0.098	0.023		-3.0	145	0.077	0.021
150-540		0.5	13	0.069	0.030		-3.0	13	0.105	0.029
0-75	E178	8.0	123	-0.062	0.133	E179	5.0	135	0.019	0.115
75-150		8.0	135	-0.015	0.028		5.0	141	-0.079	0.023
150-540		8.0	13	-0.007	0.032		5.0	13	-0.060	0.025
0-75	E181	-2.0	141	0.079	0.124	F196	2.0	141	0.162	0.102
75-150		-2.0	147	0.116	0.026		2.0	147	0.166	0.055
150-540		-2.0	13	0.185	0.045		2.0	13	0.170	0.017
0-75	F198	-2.5	140	-0.117	0.071	F199	-0.5	144	-0.096	0.050
75-150		-2.5	146	-0.072	0.020		-0.5	150	-0.130	0.021
150-540		-2.5	13	-0.042	0.031		-0.5	13	-0.150	0.038
0-75	F201	2.0	141	0.143	0.094	F226	0.5	144	0.020	0.124
75-150		2.0	147	0.092	0.021		0.5	150	0.124	0.070
150-540		2.0	13	0.082	0.027		0.5	13	0.104	0.092
0-75	F227	0.0	145	-0.055	0.076	F229	-1.5	142	0.140	0.123
75-150		0.0	151	-0.032	0.052		-1.5	148	0.153	0.051
150-540		0.0	13	-0.051	0.037		-1.5	13	0.157	0.030
0-75	F231	-5.0	135	0.169	0.078	F232	-4.0	137	0.145	0.094
75-150		-5.0	141	0.167	0.037		-4.0	143	0.143	0.048
150-540		-5.0	13	0.511	0.185		-4.0	13	0.181	0.047

TABLE 3. COMPARISON OF CONSECUTIVE XBT CASTS

DEPTH	CAST1	CAST2	PORT LAG	PORT N	PORT MDF	PORT SDEV	STBD LAG	STBD N	STBD MDF	STBD SDEV
0-75	AI1	AI2	-1.0	143	0.022	0.260	1.5	142	-0.146	0.266
75-150			-1.0	149	0.265	0.060	1.5	148	0.073	0.061
150-540			-1.0	13	0.152	0.057	1.5	13	-0.052	0.049
0-75	AI2	AI3	6.5	132	0.082	0.321	1.5	142	0.341	0.337
75-150			6.5	138	-0.006	0.229	1.5	148	0.262	0.230
150-540			6.5	13	-0.059	0.125	1.5	13	0.202	0.110
0-75	AI3	AI4	1.0	143	0.062	0.329	2.5	140	-0.005	0.316
75-150			1.0	149	0.050	0.061	2.5	146	-0.001	0.083
150-540			1.0	13	-0.028	0.070	2.5	13	-0.051	0.077
0-75	AI4	AI5	3.0	139	0.076	0.186	4.0	137	0.136	0.181
75-150			3.0	145	0.188	0.113	4.0	143	0.217	0.129
150-540			3.0	13	0.070	0.088	4.0	13	0.093	0.099
0-75	AI5	AI6	0.0	145	0.049	0.201	0.0	145	-0.013	0.165
75-150			0.0	151	-0.188	0.147	0.0	151	-0.284	0.154
150-540			0.0	13	0.164	0.222	0.0	13	0.093	0.241
0-75	AI6	AI7	-1.0	143	-0.169	0.325	0.0	145	-0.167	0.287
75-150			-1.0	149	0.179	0.126	0.0	151	0.188	0.111
150-540			-1.0	13	0.047	0.149	0.0	13	0.062	0.170
0-75	AI9	AI10	0.0	145	0.208	0.195	2.0	141	0.244	0.294
75-150			0.0	151	-0.072	0.194	2.0	147	-0.214	0.176
150-540			0.0	13	0.420	0.265	2.0	13	0.215	0.272
0-75	AI19	AI20	-3.0	139	-0.018	0.399	1.5	142	-0.025	0.366
75-150			-3.0	145	-0.078	0.132	1.5	148	-0.069	0.119
150-540			-3.0	13	-0.113	0.272	1.5	13	-0.177	0.163
0-75	AI20	AI21	2.0	141	0.046	0.247	4.0	137	0.016	0.211
75-150			2.0	147	0.181	0.065	4.0	143	0.059	0.070
150-540			2.0	13	0.065	0.128	4.0	13	-0.095	0.139
0-75	AI21	AI22	1.0	143	-0.027	0.137	-3.5	138	-0.123	0.103
75-150			1.0	149	-0.114	0.078	-3.5	144	-0.074	0.066
150-540			1.0	13	-0.005	0.589	-3.5	13	-0.128	0.117
0-75	AI22	AI23	-2.5	140	0.162	0.127	1.5	142	0.205	0.167
75-150			-2.5	146	0.175	0.092	1.5	148	0.189	0.072
150-540			-2.5	13	0.273	0.650	1.5	13	0.214	0.135
0-75	AI23	AI24	5.0	135	0.140	0.184	-2.5	140	-0.021	0.206
75-150			5.0	141	0.205	0.099	-2.5	146	0.089	0.076
150-540			5.0	13	-0.159	0.141	-2.5	13	0.002	0.210
0-75	AI24	AI25	1.0	143	-0.137	0.142	5.0	135	-0.006	0.210
75-150			1.0	149	-0.131	0.088	5.0	141	0.000	0.093
150-540			1.0	13	-0.166	0.053	5.0	13	-0.049	0.051
0-75	AI25	AI26	5.0	135	0.144	0.197	5.0	135	0.034	0.176
75-150			5.0	141	0.219	0.082	5.0	141	-0.017	0.103
150-540			5.0	13	0.298	0.054	5.0	13	0.019	0.045
0-75	AI26	AI27	-1.5	142	-0.296	0.247	0.0	145	-0.140	0.191
75-150			-1.5	148	-0.244	0.040	0.0	151	-0.004	0.028
150-540			-1.5	13	-0.252	0.087	0.0	13	0.017	0.090
0-75	AI27	AI28	2.5	140	-0.032	0.138	4.0	137	-0.037	0.138
75-150			2.5	146	-0.066	0.073	4.0	143	-0.050	0.052
150-540			2.5	13	0.013	0.031	4.0	13	0.052	0.052
0-75	AII29	AII30	2.0	141	0.206	0.124	3.0	139	0.224	0.115
75-150			2.0	147	0.132	0.135	3.0	145	0.179	0.139
150-540			2.0	13	0.013	0.043	3.0	13	0.069	0.041

TABLE 3. COMPARISON OF CONSECUTIVE XBT CASTS

DEPTH	CAST1	CAST2	PORT LAG	PORT N	PORT MDF	PORT SDEV	STBD LAG	STBD N	STBD MDF	STBD SDEV
0-75	AI130	AI131	-1.0	143	0.258	0.331	-2.0	141	-0.031	0.269
75-150			-1.0	149	0.193	0.066	-2.0	147	-0.155	0.074
150-540			-1.0	13	0.277	0.057	-2.0	13	-0.040	0.062
0-75	AI135	AI136	-3.5	138	0.026	0.218	-1.0	143	-0.368	0.206
75-150			-3.5	144	-0.303	0.114	-1.0	149	-0.489	0.084
150-540			-3.5	13	-0.176	0.155	-1.0	13	-0.380	0.140
0-75	AI148	AI149	0.0	145	0.020	0.276	0.5	144	0.274	0.379
75-150			0.0	151	0.026	0.102	0.5	150	0.461	0.078
150-540			0.0	13	-0.120	0.298	0.5	13	0.377	0.239
0-75	AI149	AI150	2.0	141	0.082	0.195	-0.5	144	0.089	0.342
75-150			2.0	147	-0.049	0.044	-0.5	150	0.012	0.056
150-540			2.0	13	-0.010	0.068	-0.5	13	0.040	0.066
0-75	AI150	AI151	3.0	139	-0.062	0.201	5.0	135	-0.229	0.293
75-150			3.0	145	0.100	0.083	5.0	141	-0.109	0.083
150-540			3.0	13	0.016	0.062	5.0	13	-0.203	0.091
0-75	AI153	AI154	2.0	141	-0.127	0.156	10.0	119	0.256	0.195
75-150			2.0	147	0.054	0.151	10.0	131	0.505	0.142
150-540			2.0	13	-0.097	0.055	10.0	13	0.401	0.041
0-75	AI154	AI155	-0.5	144	0.164	0.111	-4.0	137	-0.143	0.139
75-150			-0.5	150	0.163	0.060	-4.0	143	-0.279	0.069
150-540			-0.5	13	0.173	0.054	-4.0	13	-0.220	0.059
0-75	D60	D61	-1.5	142	-0.056	0.193	-4.5	130	-0.160	0.184
75-150			-1.5	148	-0.039	0.028	-4.5	142	-0.029	0.026
150-540			-1.5	13	0.008	0.091	-4.5	13	0.078	0.099
0-75	D61	D62	2.5	140	0.087	0.187	4.0	131	0.361	0.259
75-150			2.5	146	0.043	0.060	4.0	143	0.284	0.045
150-540			2.5	13	-0.015	0.107	4.0	13	0.244	0.105
0-75	D62	D63	-4.0	137	0.134	0.232	-9.5	48	-0.157	0.038
75-150			-4.0	143	-0.053	0.073	-9.5	132	-0.210	0.055
150-540			-4.0	13	0.082	0.094	-9.5	13	0.004	0.137
0-75	D63	D64	-1.0	143	0.221	0.292	4.5	124	0.401	0.224
75-150			-1.0	149	-0.022	0.073	4.5	142	0.103	0.082
150-540			-1.0	13	0.029	0.059	4.5	13	0.244	0.047
0-75	D64	D65	2.5	140	-0.191	0.190	2.0	141	-0.247	0.162
75-150			2.5	146	-0.068	0.078	2.0	147	-0.032	0.079
150-540			2.5	13	0.024	0.060	2.0	13	0.031	0.099
0-75	D69	D70	-1.5	142	-0.073	0.368	-1.5	142	0.086	0.351
75-150			-1.5	148	-0.058	0.068	-1.5	148	0.110	0.058
150-540			-1.5	13	0.008	0.076	-1.5	13	0.238	0.063
0-75	D72	D73	2.0	141	0.082	0.208	1.5	136	-0.028	0.183
75-150			2.0	147	0.036	0.044	1.5	148	-0.032	0.041
150-540			2.0	13	0.038	0.069	1.5	13	-0.032	0.080
0-75	D73	D74	0.0	145	0.033	0.184	0.0	145	0.234	0.263
75-150			0.0	151	-0.027	0.046	0.0	151	0.057	0.044
150-540			0.0	13	-0.055	0.047	0.0	13	0.033	0.064
0-75	D76	D77	3.0	133	0.105	0.194	-3.0	133	0.063	0.217
75-150			3.0	145	0.059	0.077	-3.0	145	0.021	0.040
150-540			3.0	13	0.092	0.047	-3.0	13	0.094	0.054
0-75	D77	D78	-1.5	142	-0.159	0.232	1.0	137	-0.047	0.272
75-150			-1.5	148	0.002	0.069	1.0	149	0.135	0.060
150-540			-1.5	13	-0.005	0.037	1.0	13	0.233	0.069

TABLE 3. COMPARISON OF CONSECUTIVE XBT CASTS

			PORT				STBD			
DEPTH	CAST1	CAST2	LAG	N	MDF	SDEV	LAG	N	MDF	SDEV
0-75	D78	D79	0.0	145	-0.213	0.208	-3.0	133	-0.203	0.192
75-150			0.0	151	-0.029	0.041	-3.0	145	-0.053	0.060
150-540			0.0	13	0.005	0.067	-3.0	13	-0.169	0.062
0-75	D79	D80	-2.5	134	0.198	0.250	3.5	132	-0.123	0.222
75-150			-2.5	146	0.227	0.062	3.5	144	-0.067	0.073
150-540			-2.5	13	0.256	0.053	3.5	13	-0.057	0.060
0-75	D87	D88	0.0	145	0.105	0.149	-0.5	144	0.075	0.162
75-150			0.0	151	0.040	0.071	-0.5	150	-0.013	0.060
150-540			0.0	13	-0.077	0.081	-0.5	13	0.015	0.043
0-75	D93	D94	-0.5	144	0.001	0.124	-4.0	137	0.037	0.174
75-150			-0.5	150	0.082	0.061	-4.0	143	0.001	0.053
150-540			-0.5	13	0.081	0.061	-4.0	13	0.026	0.060
0-75	D94	D95	-0.5	138	0.184	0.199	0.5	144	-0.024	0.246
75-150			-0.5	150	-0.036	0.096	0.5	150	0.053	0.076
150-540			-0.5	13	-0.155	0.057	0.5	13	0.076	0.078
0-75	D98	D99	-2.5	134	-0.164	0.258	2.0	141	0.204	0.233
75-150			-2.5	146	-0.391	0.228	2.0	147	0.009	0.045
150-540			-2.5	13	-0.394	0.134	2.0	13	0.099	0.120
0-75	D99	D100	4.0	131	0.128	0.141	-3.5	138	0.012	0.185
75-150			4.0	143	-0.035	0.255	-3.5	144	-0.055	0.054
150-540			4.0	13	-0.042	0.105	-3.5	13	-0.078	0.086
0-75	D100	D101	-1.5	142	0.126	0.205	2.5	140	-0.017	0.171
75-150			-1.5	148	0.073	0.078	2.5	146	-0.029	0.058
150-540			-1.5	13	0.278	0.098	2.5	13	0.096	0.072
0-75	D101	D102	-1.5	142	-0.470	0.224	-2.5	140	-0.316	0.181
75-150			-1.5	148	-0.311	0.066	-2.5	146	-0.120	0.079
150-540			-1.5	13	-0.284	0.077	-2.5	13	-0.055	0.061
0-75	D102	D103	-1.5	142	-0.127	0.132	-0.5	144	-0.089	0.158
75-150			-1.5	148	0.024	0.050	-0.5	150	-0.002	0.050
150-540			-1.5	13	0.021	0.040	-0.5	13	-0.023	0.074
0-75	D103	D104	1.0	143	-0.003	0.157	0.0	145	0.064	0.169
75-150			1.0	149	-0.064	0.053	0.0	151	-0.002	0.076
150-540			1.0	13	-0.089	0.075	0.0	13	-0.041	0.064
0-75	D106	D107	1.0	143	0.084	0.111	-2.0	141	-0.155	0.186
75-150			1.0	149	0.018	0.069	-2.0	147	-0.134	0.075
150-540			1.0	13	0.067	0.102	-2.0	13	-0.037	0.105
0-75	D107	D108	-5.0	135	-0.080	0.203	-1.0	143	-0.068	0.185
75-150			-5.0	141	-0.026	0.122	-1.0	149	0.023	0.124
150-540			-5.0	13	0.007	0.084	-1.0	13	0.023	0.067
0-75	D120	D121	1.5	142	-0.018	0.276	0.5	144	-0.025	0.251
75-150			1.5	148	-0.089	0.075	0.5	150	-0.069	0.081
150-540			1.5	13	-0.008	0.084	0.5	13	-0.035	0.068
0-75	D121	D122	-0.5	144	-0.130	0.209	-2.0	141	0.081	0.190
75-150			-0.5	150	-0.236	0.083	-2.0	147	0.036	0.092
150-540			-0.5	13	-0.300	0.068	-2.0	13	-0.020	0.070
0-75	D124	D125	-1.0	143	0.099	0.206	2.5	140	0.060	0.215
75-150			-1.0	149	-0.043	0.085	2.5	146	-0.175	0.080
150-540			-1.0	13	-0.048	0.062	2.5	13	-0.158	0.069
0-75	D129	D130	2.0	141	0.100	0.190	-1.5	136	0.222	0.180
75-150			2.0	147	0.056	0.047	-1.5	148	0.089	0.102
150-540			2.0	13	0.064	0.061	-1.5	13	0.105	0.068

TABLE 3. COMPARISON OF CONSECUTIVE XBT CASTS

DEPTH	CAST1	CAST2	PORT LAG	PORT N	PORT MDF	PORT SDEV	STBD LAG	STBD N	STBD MDF	STBD SDEV
0-75	D130	D131	1.0	143	0.107	0.182	3.5	132	-0.194	0.221
75-150			1.0	149	0.290	0.052	3.5	144	0.001	0.066
150-540			1.0	13	0.299	0.051	3.5	13	0.035	0.051
0-75	D131	D132	-4.5	136	-0.261	0.166	-4.0	137	0.026	0.193
75-150			-4.5	142	-0.302	0.086	-4.0	143	0.024	0.082
150-540			-4.5	13	-0.306	0.079	-4.0	13	0.039	0.129
0-75	D132	D133	-5.5	128	0.235	0.314	-1.5	142	-0.033	0.215
75-150			-5.5	140	0.271	0.112	-1.5	148	-0.113	0.102
150-540			-5.5	13	0.433	0.072	-1.5	13	-0.093	0.096
0-75	E139	E140	3.5	138	0.195	0.182	3.5	132	0.142	0.178
75-150			3.5	144	-0.035	0.055	3.5	144	0.019	0.052
150-540			3.5	13	0.046	0.089	3.5	13	0.084	0.091
0-75	E140	E141	-1.5	142	-0.104	0.363	-1.0	143	-0.324	0.334
75-150			-1.5	148	-0.097	0.071	-1.0	149	-0.343	0.078
150-540			-1.5	13	0.033	0.067	-1.0	13	-0.197	0.087
0-75	E141	E142	1.5	142	0.025	0.157	-4.5	130	-0.028	0.160
75-150			1.5	148	0.001	0.037	-4.5	142	-0.027	0.047
150-540			1.5	13	-0.038	0.084	-4.5	13	-0.035	0.091
0-75	E146	E147	-1.5	142	-0.148	0.244	-0.5	144	-0.115	0.236
75-150			-1.5	148	0.032	0.054	-0.5	150	0.067	0.042
150-540			-1.5	13	-0.045	0.091	-0.5	13	-0.017	0.081
0-75	E147	E148	0.5	138	0.025	0.165	-1.5	142	-0.267	0.223
75-150			0.5	150	0.186	0.088	-1.5	148	-0.215	0.068
150-540			0.5	13	0.206	0.112	-1.5	13	-0.181	0.115
0-75	E148	E149	1.5	142	0.056	0.192	4.5	136	0.333	0.201
75-150			1.5	148	-0.072	0.104	4.5	142	0.187	0.098
150-540			1.5	13	-0.219	0.054	4.5	13	0.030	0.054
0-75	E149	E150	4.0	137	0.268	0.214	4.0	137	0.025	0.201
75-150			4.0	143	0.337	0.050	4.0	143	0.034	0.060
150-540			4.0	13	0.428	0.052	4.0	13	0.095	0.051
0-75	E150	E151	-1.0	143	-0.493	0.313	-1.5	142	-0.259	0.313
75-150			-1.0	149	-0.336	0.091	-1.5	148	-0.079	0.106
150-540			-1.0	13	-0.367	0.058	-1.5	13	-0.055	0.068
0-75	E151	E152	3.5	138	0.118	0.187	-4.0	131	0.049	0.143
75-150			3.5	144	-0.031	0.033	-4.0	143	-0.078	0.038
150-540			3.5	13	0.023	0.051	-4.0	13	-0.003	0.054
0-75	E152	E153	-1.0	143	0.069	0.250	0.5	144	-0.111	0.351
75-150			-1.0	149	-0.079	0.057	0.5	150	-0.046	0.062
150-540			-1.0	13	0.027	0.108	0.5	13	0.070	0.100
0-75	E153	E154	-3.0	139	-0.357	0.198	-3.0	139	-0.045	0.303
75-150			-3.0	145	-0.114	0.062	-3.0	145	-0.074	0.041
150-540			-3.0	13	-0.049	0.133	-3.0	13	0.009	0.032
0-75	E154	E155	0.5	144	0.015	0.358	5.0	123	-0.030	0.411
75-150			0.5	150	0.238	0.041	5.0	141	0.109	0.052
150-540			0.5	13	0.173	0.077	5.0	13	-0.024	0.068
0-75	E155	E156	-1.5	142	-0.118	0.150	-2.0	135	-0.035	0.150
75-150			-1.5	148	-0.244	0.030	-2.0	147	-0.121	0.035
150-540			-1.5	13	-0.181	0.071	-2.0	13	0.012	0.063
0-75	E156	E157	0.0	145	0.076	0.294	-0.5	144	0.330	0.351
75-150			0.0	151	-0.057	0.058	-0.5	150	-0.041	0.051
150-540			0.0	13	0.017	0.086	-0.5	13	-0.028	0.100

TABLE 3. COMPARISON OF CONSECUTIVE XBT CASTS

DEPTH	CAST1	CAST2	PORT LAG	PORT N	PORT MDF	PORT SDEV	STBD LAG	STBD N	STBD MDF	STBD SDEV
0-75	E158	E159	-0.5	144	0.102	0.243	-0.5	144	0.011	0.199
75-150			-0.5	150	0.022	0.027	-0.5	150	0.002	0.034
150-540			-0.5	13	-0.070	0.085	-0.5	13	-0.043	0.062
0-75	E159	E160	1.0	143	-0.106	0.184	1.5	142	-0.143	0.154
75-150			1.0	149	-0.085	0.060	1.5	148	-0.094	0.062
150-540			1.0	13	0.009	0.073	1.5	13	0.034	0.054
0-75	E160	E161	1.0	143	0.058	0.194	0.0	145	0.025	0.197
75-150			1.0	149	0.107	0.072	0.0	151	0.055	0.090
150-540			1.0	13	0.005	0.055	0.0	13	-0.048	0.059
0-75	E161	E162	-4.0	137	-0.082	0.148	-3.5	138	0.066	0.154
75-150			-4.0	143	0.028	0.052	-3.5	144	0.154	0.050
150-540			-4.0	13	0.133	0.067	-3.5	13	0.223	0.057
0-75	E162	E163	0.0	145	-0.016	0.287	-12.0	103	-0.149	0.744
75-150			0.0	151	0.189	0.064	-12.0	127	-0.144	0.045
150-540			0.0	13	0.234	0.044	-12.0	13	0.060	0.068
0-75	E165	E166	9.5	126	-0.001	0.130	4.5	136	0.198	0.152
75-150			9.5	132	0.043	0.074	4.5	142	0.189	0.087
150-540			9.5	13	-0.118	0.041	4.5	13	0.027	0.056
0-75	E166	E167	-3.0	139	0.679	0.372	-6.0	121	0.630	0.294
75-150			-3.0	145	0.169	0.162	-6.0	139	0.049	0.137
150-540			-3.0	13	0.282	0.073	-6.0	13	0.183	0.094
0-75	E169	E170	5.0	135	0.085	0.344	0.5	144	0.013	0.342
75-150			5.0	141	-0.057	0.071	0.5	150	0.033	0.077
150-540			5.0	13	-0.077	0.089	0.5	13	0.015	0.065
0-75	E170	E171	-1.5	142	0.125	0.246	-4.0	137	0.190	0.230
75-150			-1.5	148	0.154	0.092	-4.0	143	0.153	0.081
150-540			-1.5	13	0.285	0.065	-4.0	13	0.260	0.076
0-75	E171	E172	1.5	142	-0.472	0.345	-2.0	135	-0.300	0.326
75-150			1.5	148	-0.276	0.152	-2.0	147	-0.037	0.137
150-540			1.5	13	-0.248	0.100	-2.0	13	0.095	0.115
0-75	E172	E173	-4.5	136	-0.281	0.255	3.5	132	-0.575	0.273
75-150			-4.5	142	0.241	0.140	3.5	144	-0.234	0.153
150-540			-4.5	13	0.390	0.061	3.5	13	-0.147	0.060
0-75	E175	E176	3.0	139	-0.142	0.399	1.0	143	-0.178	0.440
75-150			3.0	145	0.142	0.047	1.0	149	0.043	0.040
150-540			3.0	13	0.091	0.073	1.0	13	-0.005	0.062
0-75	E176	E177	-8.0	129	-0.328	0.234	-4.0	137	-0.295	0.254
75-150			-8.0	135	0.003	0.032	-4.0	143	0.029	0.048
150-540			-8.0	13	0.070	0.088	-4.0	13	0.019	0.071
0-75	E177	E178	3.0	139	-0.019	0.228	-7.5	124	0.160	0.243
75-150			3.0	145	0.110	0.067	-7.5	136	0.207	0.074
150-540			3.0	13	-0.034	0.077	-7.5	13	0.134	0.084
0-75	E178	E179	-3.5	138	-0.014	0.146	0.0	133	0.007	0.137
75-150			-3.5	144	0.035	0.095	0.0	151	0.095	0.117
150-540			-3.5	13	0.181	0.061	0.0	13	0.190	0.070
0-75	F231	F232	-4.0	137	-0.256	0.198	-5.0	135	-0.257	0.170
75-150			-4.0	143	-0.119	0.097	-5.0	141	-0.083	0.078
150-540			-4.0	13	-0.336	0.249	-5.0	13	-0.004	0.071

TABLE 4. COMPARISON OF SIMULTANEOUS XBT CASTS

DEPTH	CAST	LAG	N	MDF	SDEV	CAST	LAG	N	MDF	SDEV
540-1800	F190	0.5	22	0.014	0.024	F191	-0.5	20	0.060	0.029
540-1800	F196	2.0	22	0.109	0.042	F198	-2.5	21	-0.093	0.034
540-1800	F199	-0.5	21	-0.161	0.030	F201	2.0	22	0.043	0.042
540-1800	F226	0.5	21	-0.020	0.026	F227	0.0	13	-0.061	0.036
540-1800	F229	-1.5	21	0.124	0.027	F230	-1.5	21	0.036	0.028
540-1800	F232	-4.0	21	0.098	0.086					

TABLE 5. COMPARISON OF DIGITIZED XBT DATA WITH RECORDER CHART TRACES

TIME FROM LAUNCH (sec)	DEPTH (meters)	PORT LAUNCHER MDF (deg C)	PORT LAUNCHER SDEV (deg C)	STBD LAUNCHER MDF (deg C)	STBD LAUNCHER SDEV (deg C)
4.75	30.7	0.249	0.836	0.055	0.206
9.50	61.2	-0.060	0.082	-0.041	0.097
23.75	152.4	-0.075	0.056	-0.111	0.064
38.00	242.8	-0.003	0.091	-0.064	0.067
52.25	332.4	0.056	0.097	-0.003	0.113
66.50	421.2	0.021	0.065	0.022	0.096
80.75	509.3	0.035	0.054	0.031	0.086
95.00	596.5	0.079	0.074	0.023	0.063
109.25	682.9	0.104	0.083	0.078	0.091
118.75	740.1	0.141	0.072	0.119	0.108