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Hydrographic Data from the First Coastal Ocean Dynamics Experiment: R/V WECOMA, Leg 2, 10-14 April 1981

by

William E. Gilbert
Adriana Huyer
Richard Schramm

Data Report 89
Reference 81-12
November 1981

Code Technical Report No. 3

National Science Foundation
OCE—8014939

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Abstract

CTD observations were made along the CODE Central Line, extending offshore toward 225°T from the California coast at 38°40'N, during 12-14 April, 1981. The complete section with nine stations was occupied twice; the offshore portion was occupied three times. The maximum sampling depth was 1000 m. This report includes a summary of the observations, and vertical profile plots and listings at standard depths for each of the 23 stations.

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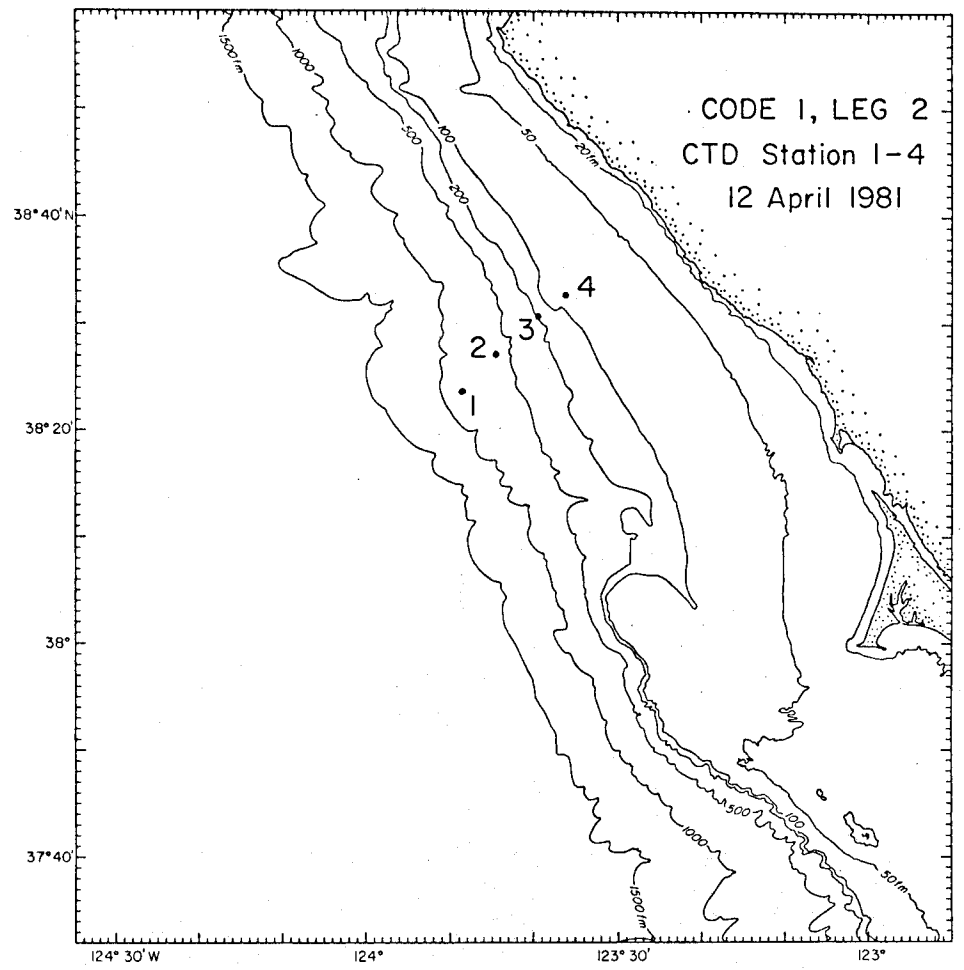
Introduction

The Coastal Ocean Dynamics Experiment seeks to describe the response of continental shelf waters to a time-varying wind stress. The main purpose of the R/V Wecoma cruise CODE-1, Leg 2, was to install the Woods Hole portion of the moored current meter array. Personnel from the CODE Shipboard Hydrography component joined the cruise to begin the time-series of repeated CTD sections along the CODE Central Line.

Our first opportunity to begin CTD work came early on 12 April. Our aim was to occupy nine stations along the Central Line (Table 1) sampling down to 1000 db at the offshore stations. The first night we completed only four stations (Fig. 1) before breaking off to resume mooring work. The next night (13 April) we began again at the offshore end and this time were able to complete the section. The entire section was repeated again the following night (14 April 1981). A final station was occupied at S4, the intended site for a moored "density chain" to be installed later by W. Brown and J. D. Irish of the University of New Hampshire.

Wind direction was nearly constant; wind speed appeared to be greater offshore and least very near shore (Table 2, Figure 2).

Personnel participating in the CTD data collection were Adriana Huyer, and Richard Schramm of Oregon State University, and Robert Beardsley and Carol Mills of Woods Hole Oceanographic Institution.



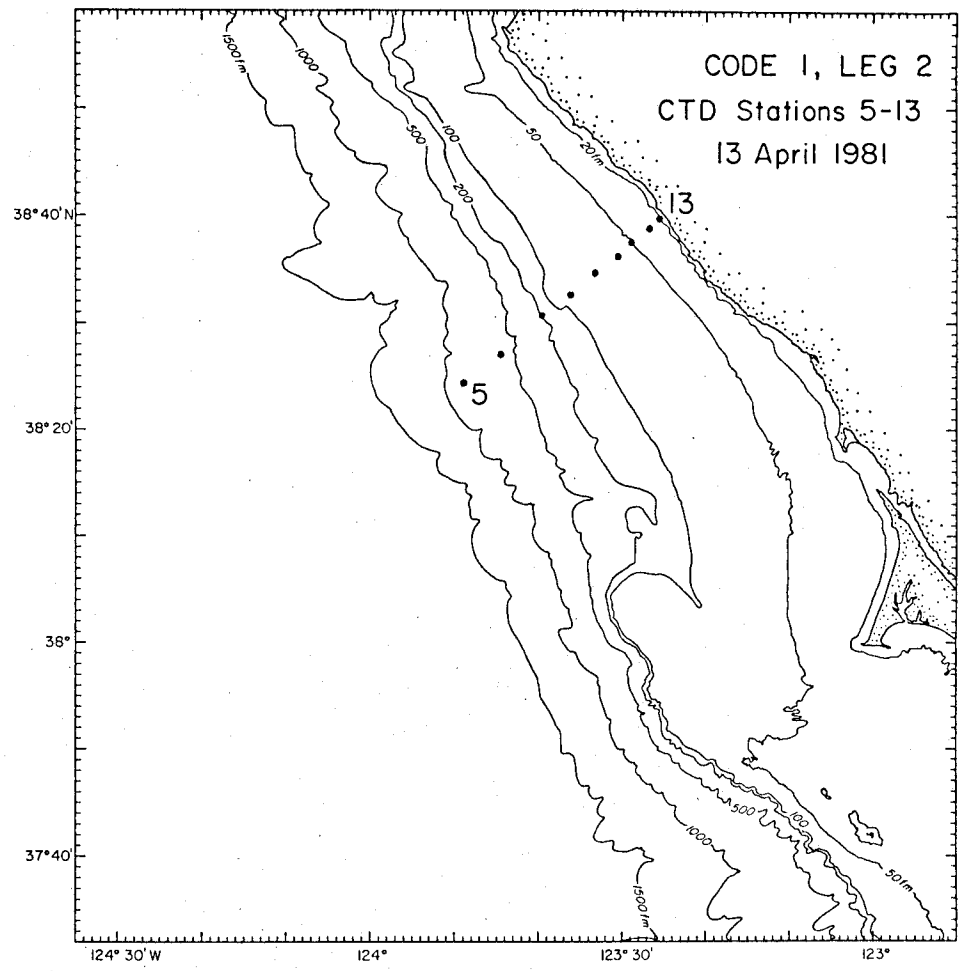


Figure 1. CTD stations during CODE-1, Leg 2, 12-14 April 1981

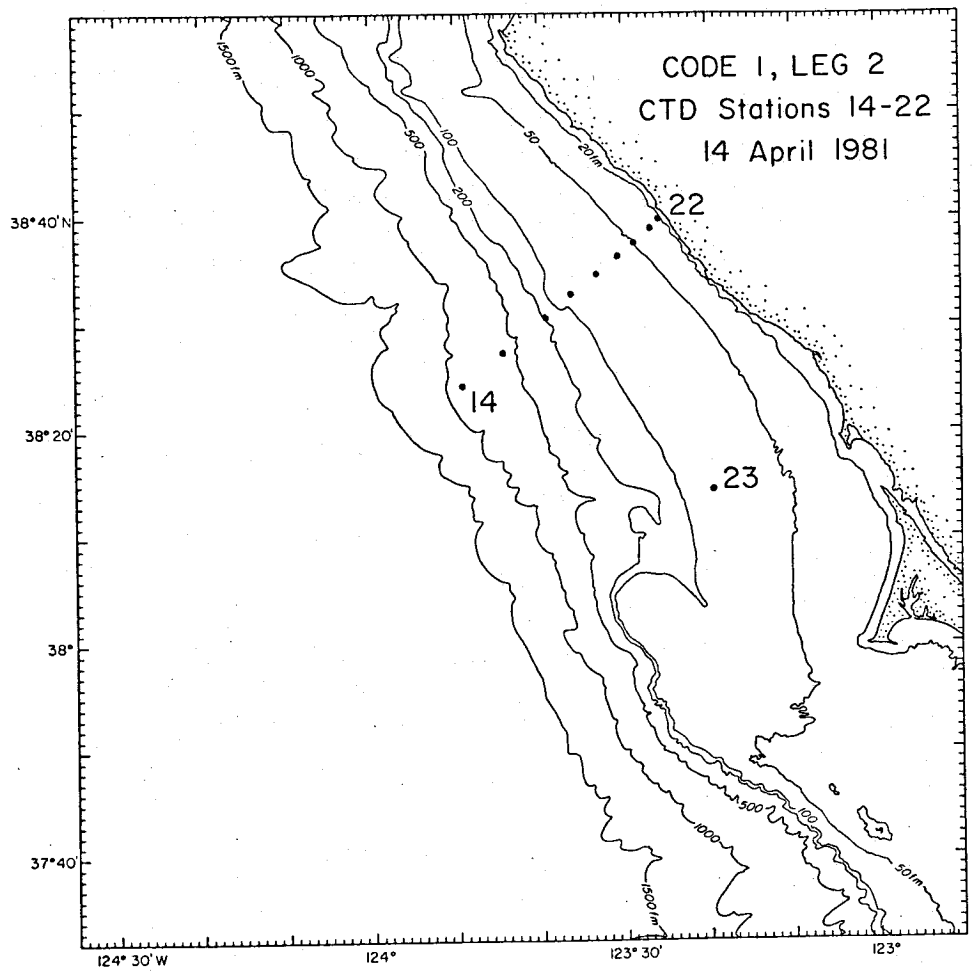


Figure 1 (cont.). CTD stations during CODE-1, Leg 2.

Table 1. Standard positions of hydrographic stations along the CODE-1 Central (COC) Line.

Name	Latitude	Longitude	Depth (m)
COC- 1	38°39.8'N	123°25.5'W	42
COC- 2	38 38.8	123 26.9	69
COC- 3	38 37.5	123 28.9	93
COC- 4	38 36.2	123 30.8	113
COC- 5	38 34.6	123 33.3	137
COC- 6	38 32.7	123 36.2	141
COC- 7	38 30.3	123 39.6	460
COC- 8	38 27.1	123 44.5	1190
COC- 9	38 24.0	123 49.2	1719

Table 2. List of CTD stations occupied during CODE-1, Leg 2, showing date and time, location, atmospheric pressure and wind speed and direction

	STATION NO.	NAME	LOCATION		PRESSURE	WIND	
April 12, 0724Z	1	COC-9	38°23.6'N	123°48.7'W	1022 mb	325°T	12kts
0910	2	COC-8	27.1'	44.5'	1022.1	320	13
1032	3	COC-7	30.4'	39.6'	1022.0	330	12
1126	4	COC-6	32.6'	36.1'	1021.9	330	14
April 13, 0052	5	COC-9	24.3'	49.0'	1020.9	320	20
0209	6	COC-8	27.0'	44.4'	1020.0	330	26
0334	7	COC-7	30.6'	39.7'	1020	330	26
0450	8	COC-6	32.5'	36.2'	1019.1	330	20
0530	9	COC-5	34.6'	33.3'	1019.2	330	23
0618	10	COC-4	36.2'	30.7'	1019.0	325	20
0650	11	COC-3	37.5'	28.9'	1019.0	330	16
0723	12	COC-2	38.8'	26.9'	1019.0	330	14
0807	13	COC-1	39.8'	25.6'	1019.0	330	6
April 14, 0509	14	COC-9	24.1'	49.2'	1019.4	340	20
0627	15	COC-8	27.1'	44.5'	1019.1	340	18
0748	16	COC-7	30.3'	39.6'	1018.7	330	18
0843	17	COC-6	32.7'	36.2'	1018.1	330	21
0923	18	COC-5	34.5'	33.3'	1018.0	330	20
1002	19	COC-4	36.2'	30.7'	1018	330	18
1036	20	COC-3	37.5'	28.8'	1018.0	330	16
1114	21	COC-2	38.7'	26.9'	1018.0	Variable	
1148	22	COC-1	39.7'	25.8'	1018.0	-	0
1846	23	S4	14.3'	19.7'	1019.6	000	6

Sampling Procedures

At each station, we lowered a Neil Brown Mark III-B CTD to within several meters of the bottom or to 1000 m. The CTD samples pressure, temperature and conductivity once every 0.032 seconds; all scans were recorded on both digital and audio tape. The CTD was lowered at about 45 m min^{-1}. The underwater unit had a pressure range of 1600 db, and the fast-response thermistor had been disabled and replaced in the circuitry with a precision 10 ohm resistor.

A Niskin bottle equipped with protected reversing thermometers was hung 1.5 m above the sensors to provide in situ calibration data. The sample depth was chosen on the basis of the data obtained during descent. We tried to choose a relatively homogeneous layer for each sample, but also tried to obtain a representative range of each variable. After reaching the maximum depth of the cast, the CTD was raised to the desired sampling depth, and the thermometers were allowed to equilibrate for five minutes. After the bottle tripped, the CTD was raised 2 m, so that the sensors were at the depth where the thermometers had just tripped. CTD output from this depth were compared to the sample values. Thermometers were read twice, and triplicate salinity samples were analyzed aboard ship using OSU's Autosal salinometer. The temperature differences (Fig. 3) between the sample and CTD values had a mean of -0.002°C and a standard deviation of 0.015°C. The salinity differences (Fig. 3) had a mean of -0.002°/$_{oo}$ and a standard deviation of 0.003°/$_{oo}$. Since these differences are within our sampling errors, no corrections were applied to the CTD data.

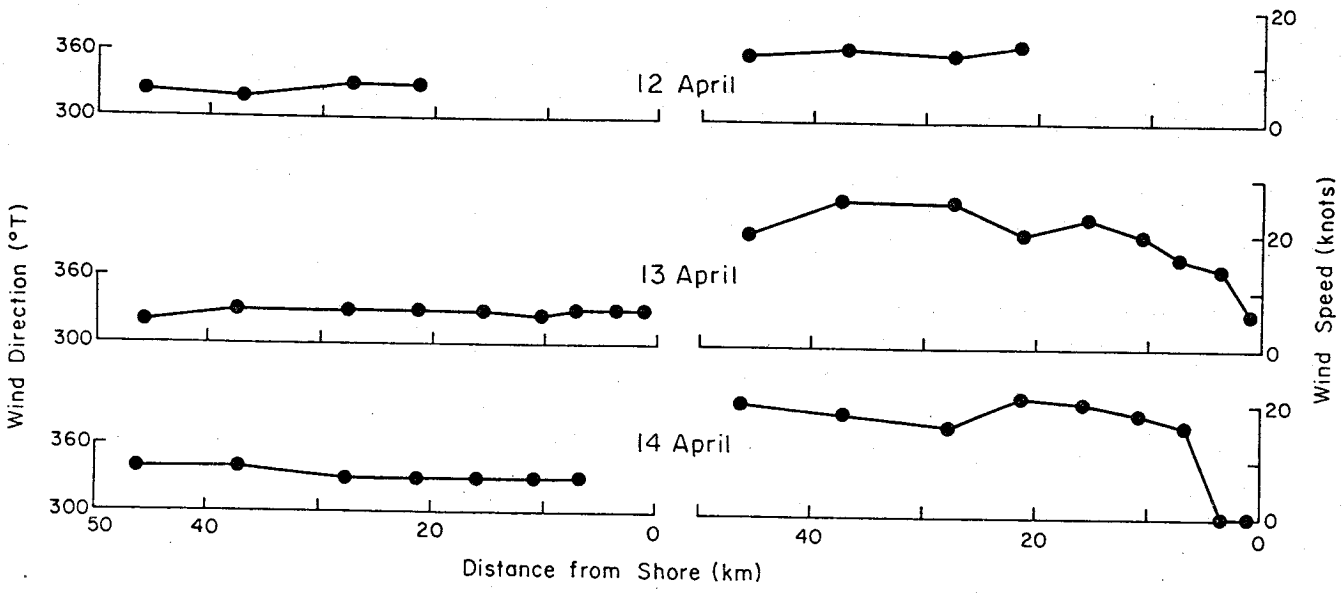


Figure 2. Wind speed and direction during each occupation of the CODE-1 Central Line.

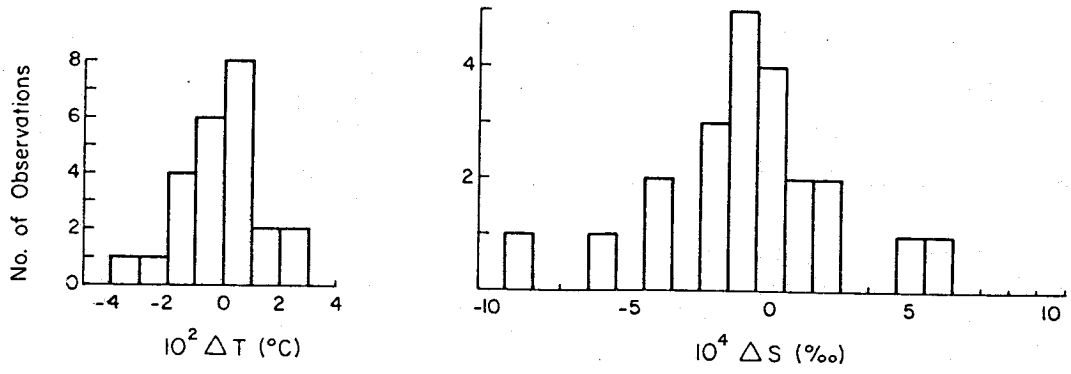


Figure 3. Histograms of the differences between sample temperature and CTD temperature, and between sample salinity and CTD salinity.

Data Processing Procedures

The time constant of the platinum resistance thermometer of the CTD was determined by computing the phase spectrum between the measured temperature and conductivity data (Millard, Toole and Swartz, 1980). For this particular CTD (#2567) we obtained a time constant (τ) of 0.200 seconds. We then applied a simple recursive filter to the conductivity and pressure data to remove the phase difference at low frequencies (< 1 cps). The recursive filter devised by Millard (Stan Hayes, pers. commun.) has the form

$$C(n) = \alpha\, C(n-1) + (1-\alpha)\, C_0(n)$$

where $C_0(n)$ is the observed value and $C(n)$ is the filtered value of the n^{th} scan, and α is a constant determined from τ and the time interval (Δt) between scans,

$$\alpha = \tau/(\tau + \Delta t).$$

The data are recorded at sea on a Kennedy 9-track data logger, with many stations on each tape. Data logging frequently begins as soon as the CTD is in the water, and continues until after the CTD has reached the maximum depth. The first step in data processing is to obtain a directory of the data tape using program NBCTD. For each station, this directory lists the header data, the block number in which the instrument descent begins, and the maximum pressure. This program also corrects the conductivity data for cell variations due to pressure and temperature. Using program CFILS (Fig. 4) we then adjust the conductivity calibration if necessary, check for extraneous values and extreme gradients, apply the recursive filter to pressure and conductivity and compute salinity from the algorithm given by Fofonoff, Hayes and Millard (1974).

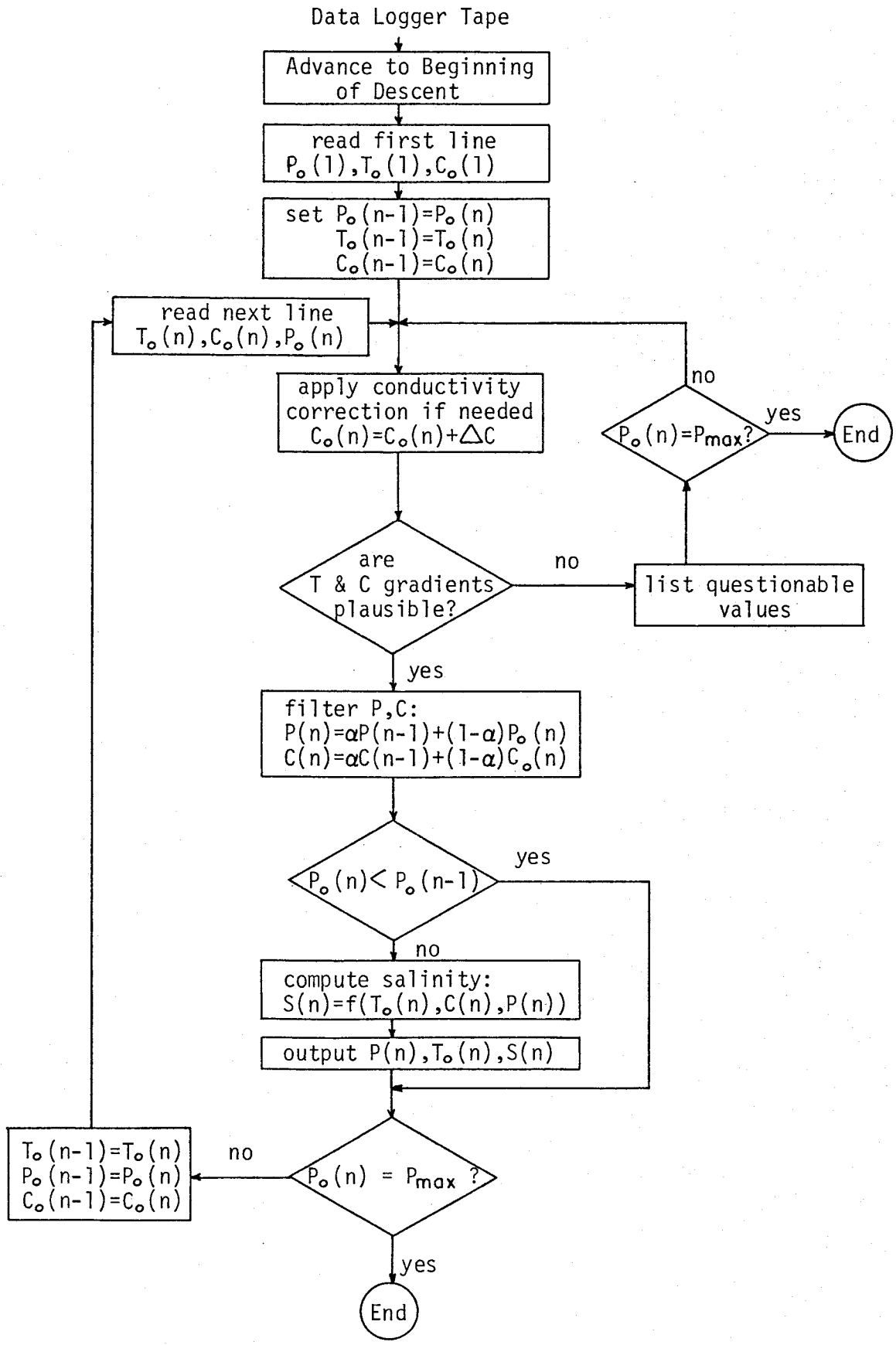


Figure 4. Schematic flow chart of program CFILS which reads the CTD data and calculates salinity.

The output from CFILS is further processed through the NBRED program (Figure 5). The filtered pressure data are used to eliminate ascending data caused by wave action. Data collected during descent are sorted into 1 db bins, and the extremes and averages computed for each bin. Profiles of the extremes of temperature and salinity are plotted to determine whether the input data files need further editing. Usually no editing is needed, and the 1 db mean temperatures and salinities constitute the processed data. When editing appears to be necessary, the original data files are examined, data points that are rejected are replaced by linearly interpolated values, and the files are reprocessed, using both CFILES and NBRED as necessary.

The processed data files containing integral pressure, average temperature, and average salinity are archived. These files are used to calculate other parameters of interest such as potential temperature (theta), potential density anomaly (sigma-theta), specific volume anomaly, dynamic height, Brunt-Vaisala Frequency, and sound velocity. These variables were computed using the subroutines in the appendix. Files including all of these variables are available on request. In this data report we show only profile plots of temperature, salinity and sigma-theta versus pressure, and listings at selected pressures of temperature, salinity, potential temperature, sigma-theta, specific volume anomaly and dynamic height.

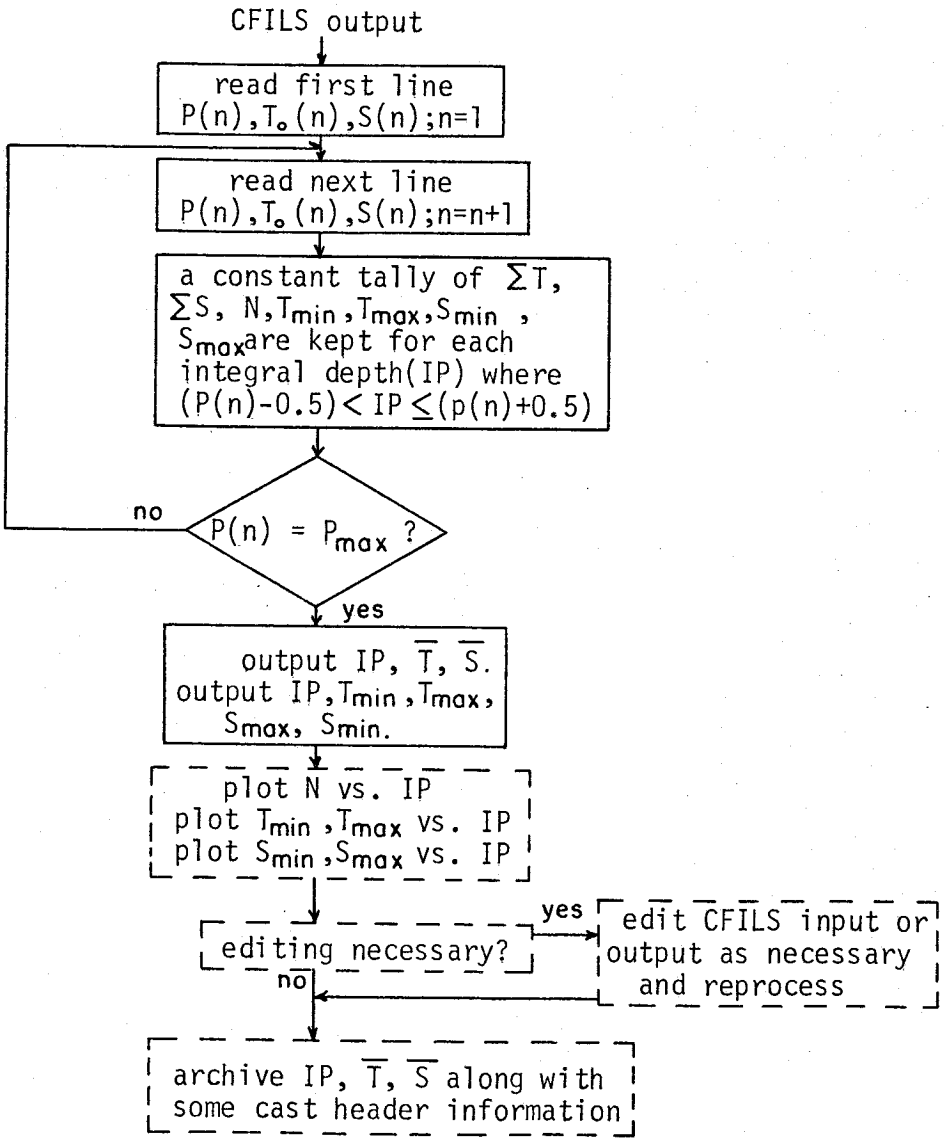


Figure 5. Schematic flow chart of program NBRED(solid lines) which sorts data into 1 db bins, and finds minimum, maximum and average values for each 1 db bin. Also shown (dotted lines) are the subsequent steps in the data processing.

Summary of Results

Vertical-offshore distributions of temperature, salinity and sigma-theta are shown in Figures 6-8. All three sections appear to be similar. Isotherms are approximately level over the continental slope but rise sharply upwards over the continental shelf. The coldest surface water occurs at the most inshore station: it has a temperature near 8°C, salinity near 34.0°/$_{oo}$ and sigma-theta near 26.6 (Fig. 9). The near-bottom water over the shelf appears to be isolated in this plane from water of the same properties over the slope-- the 7.5°C isotherm and the 26.6 isopycnal are discontinuous on both 13 and 14 April.

Dynamic height relative to 500 db and 1000 db was computed for each section in the manner described by Reid and Mantyla (1976). Offshore profiles are shown in Figure 9 and 10. At 45 km from shore, there was almost no change in the dynamic height at 0, 100 or 200 db, relative to either 500 db or 1000 db. Steric height near shore was lower on 13 April than 14 April. The geostrophic velocity was southeastward down to 200 db on 13 April. On 14 April, geostrophic velocity was still southeastward at the surface, but northwestward at 100 db and at 200 db.

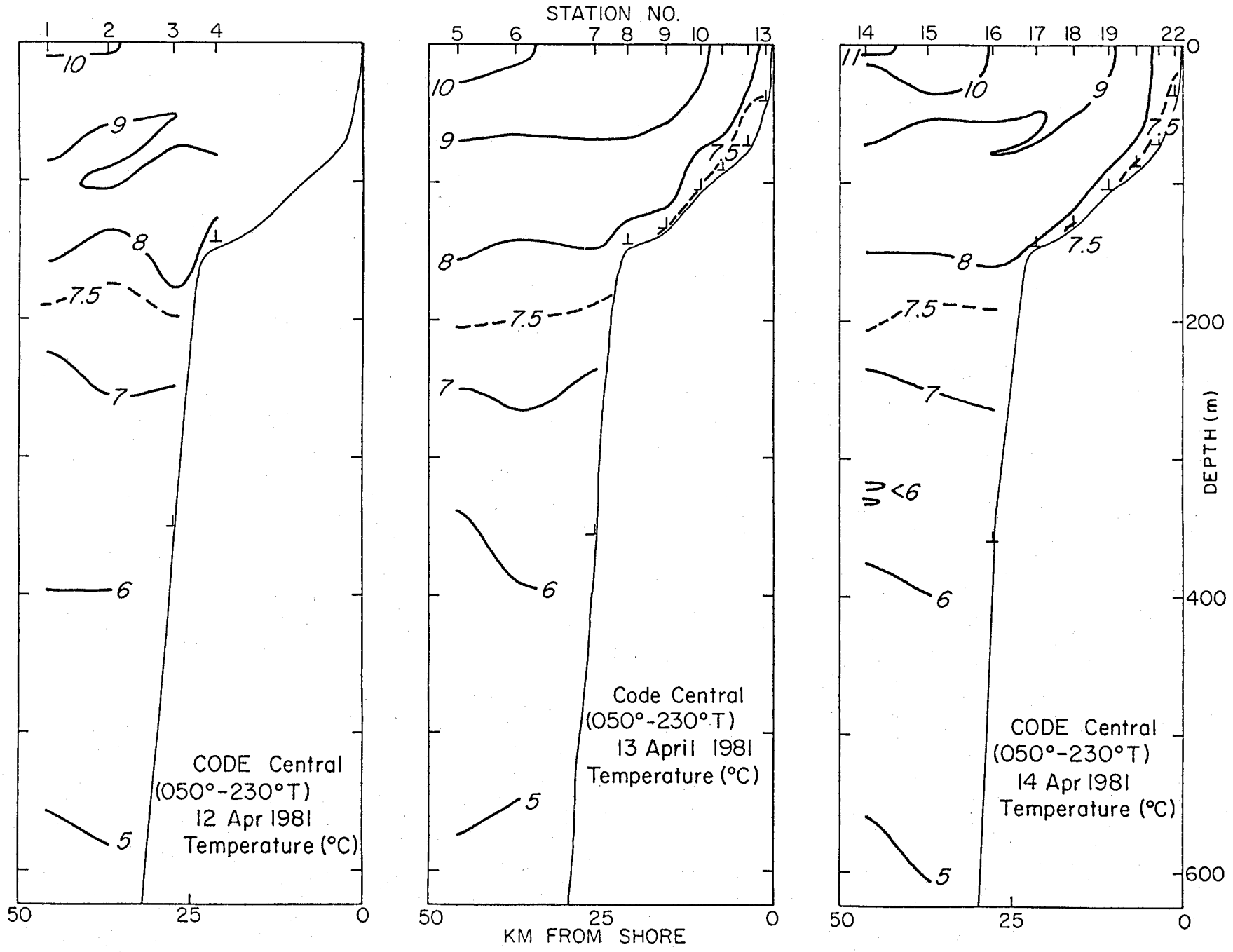


Figure 6. Vertical-offshore distributions of temperature along the

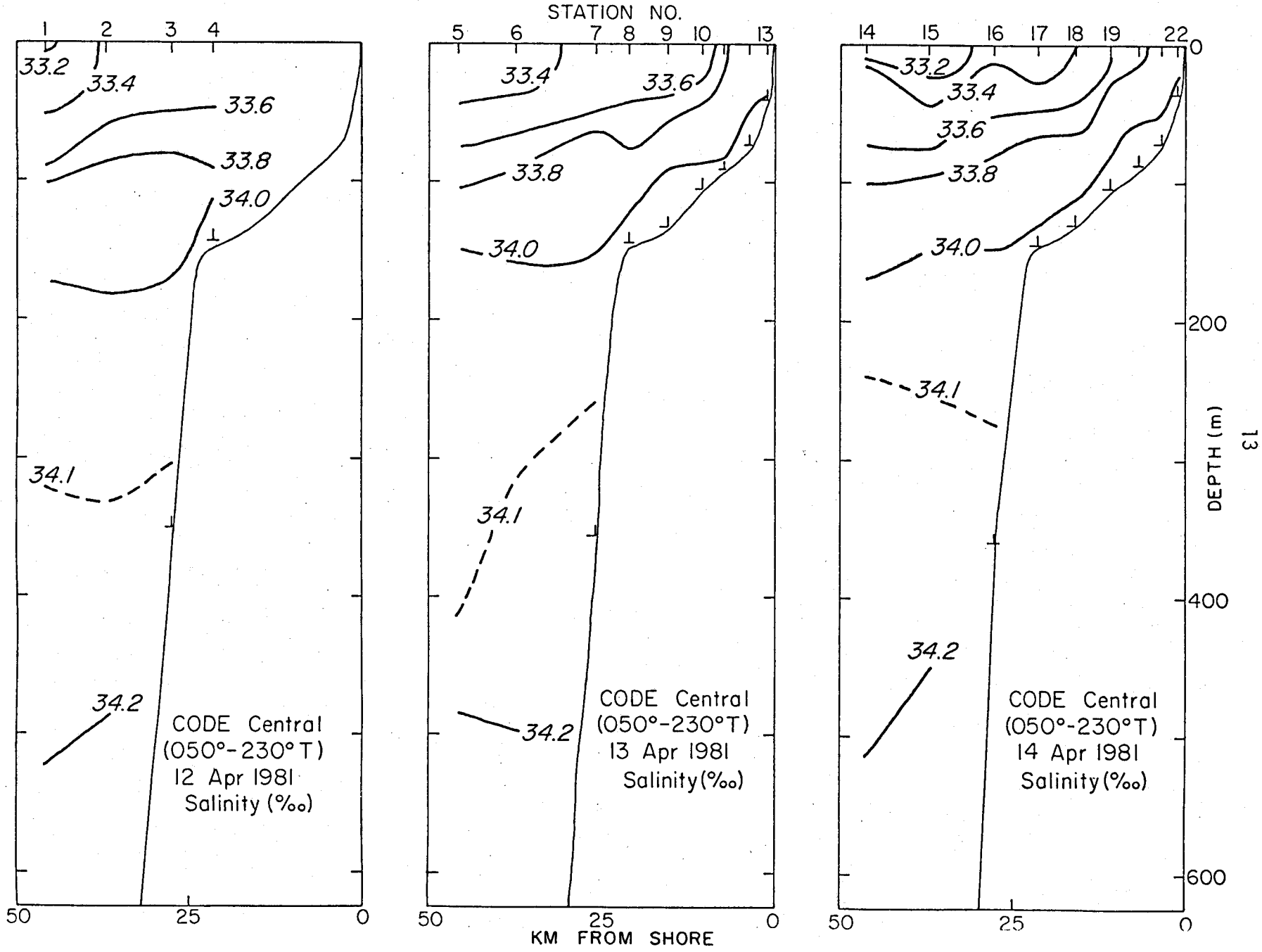


Figure 7. Vertical-offshore distributions of salinity along the CODE-1 Central Line.

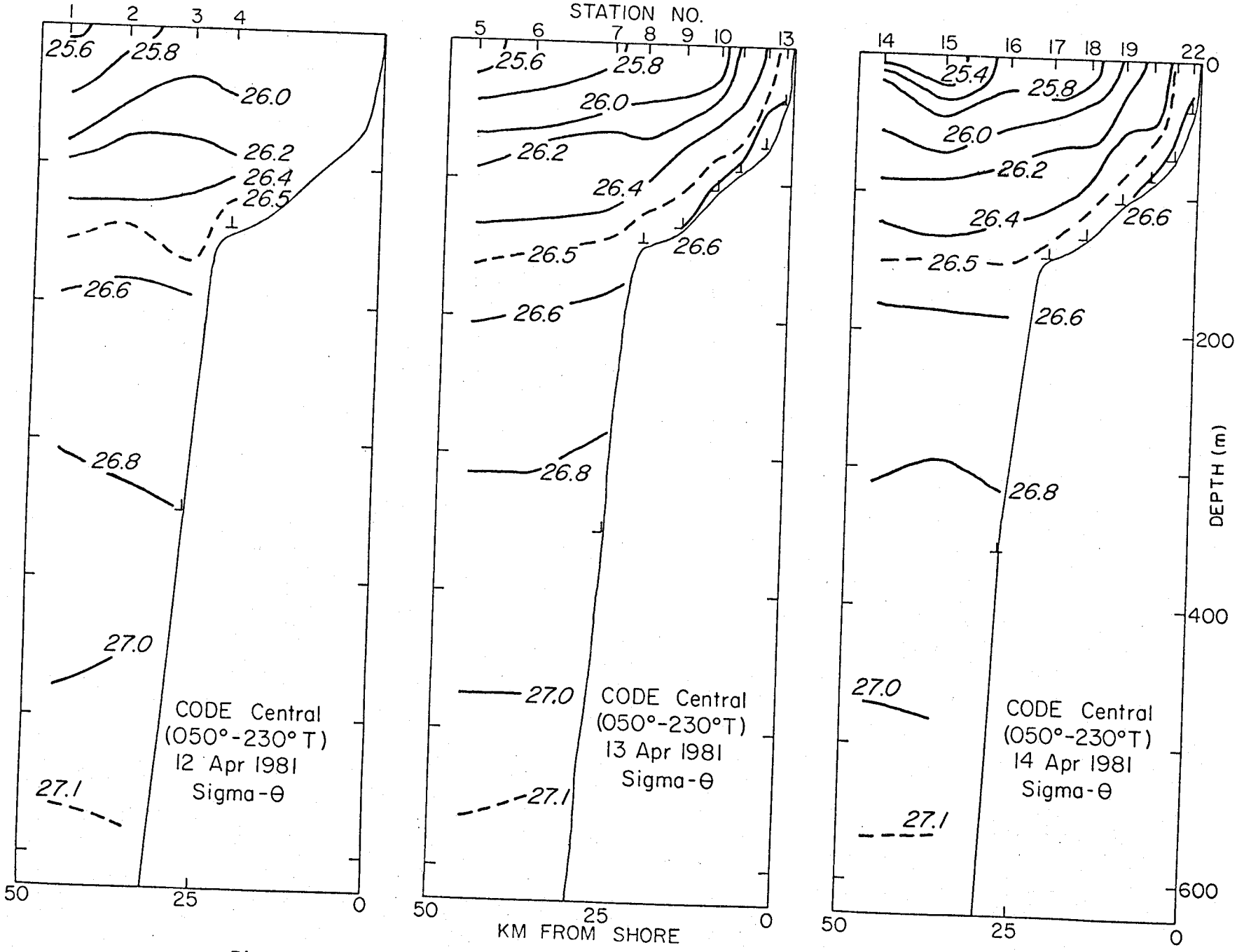


Figure 8. Vertical offshore

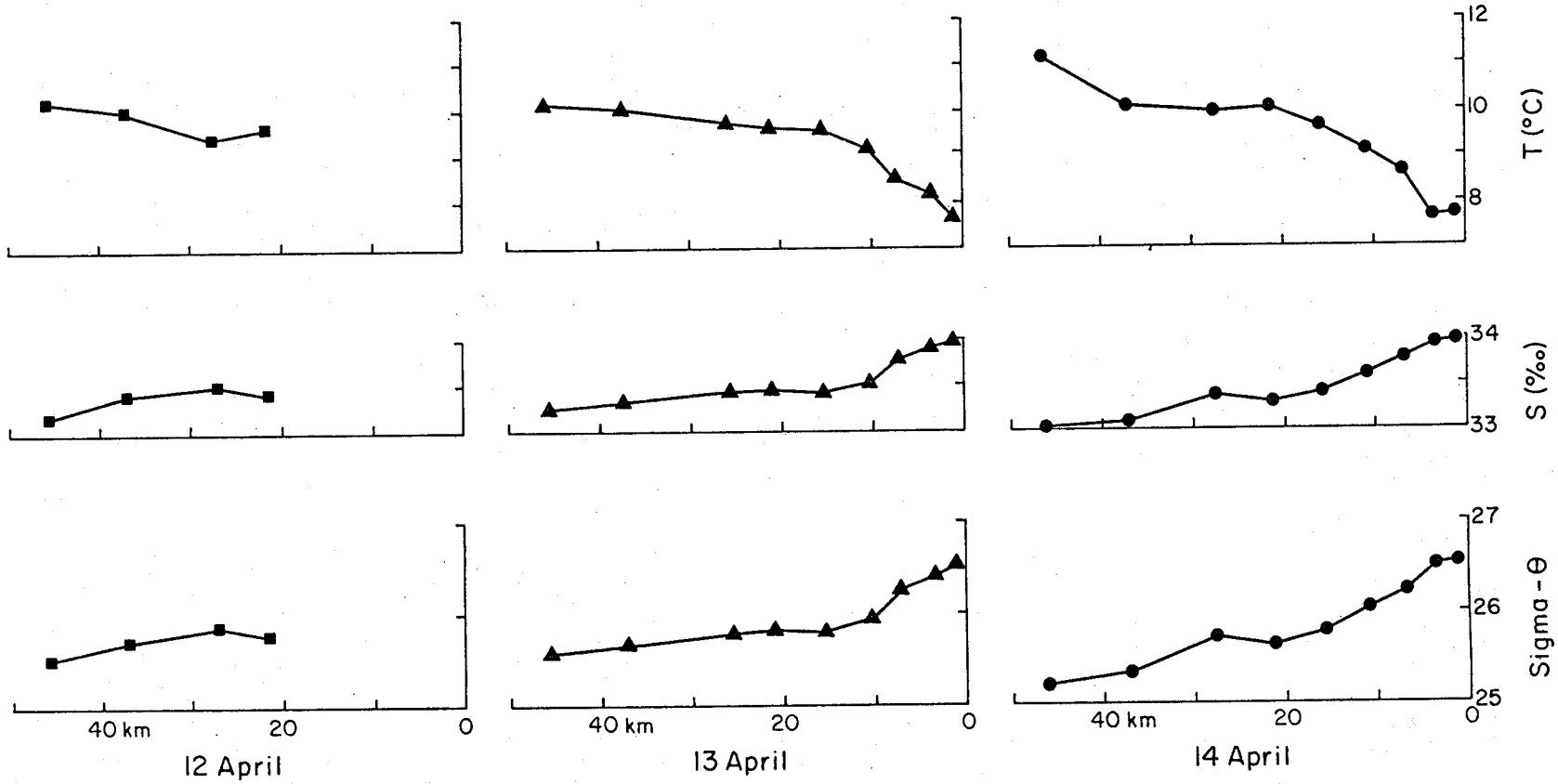


Figure 9. Offshore profiles of temperature, salinity and sigma-theta at the surface.

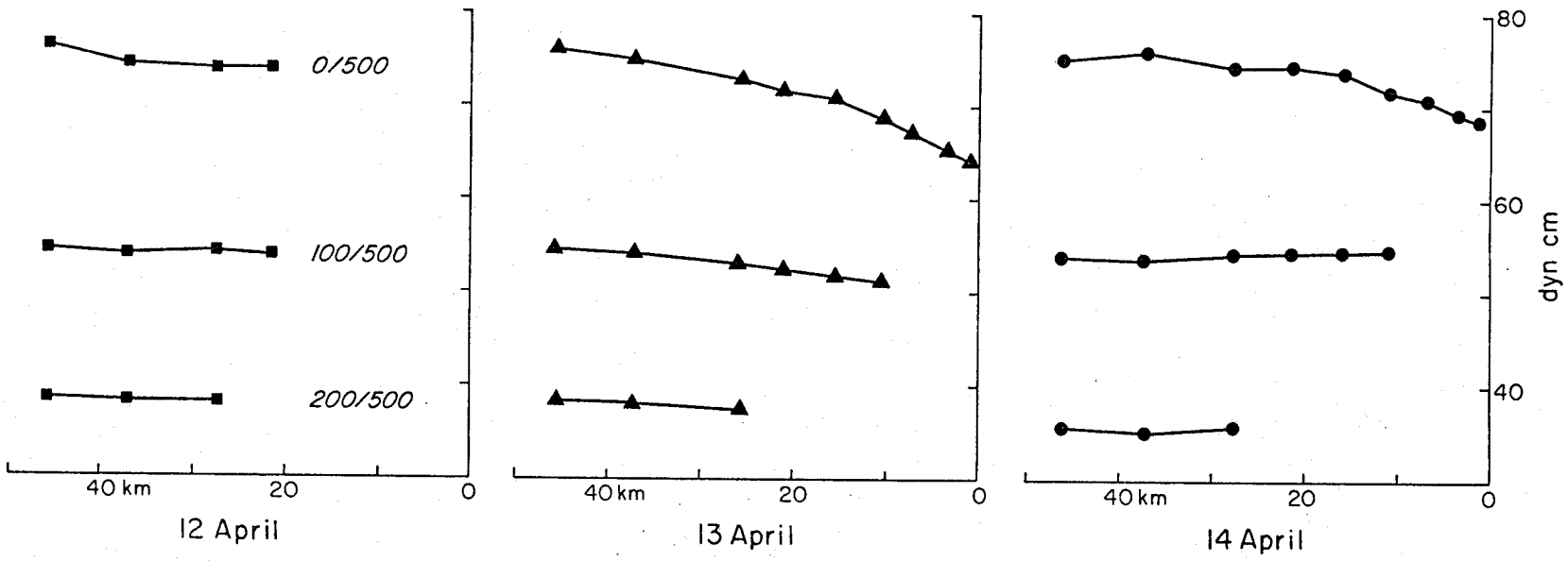


Figure 10. Dynamic height of the sea surface, the 100 db surface and the 200 db surface relative to 500 db. A slope of 1 cm/10 km corresponds to an alongshore geostrophic velocity of 11 cm/sec.

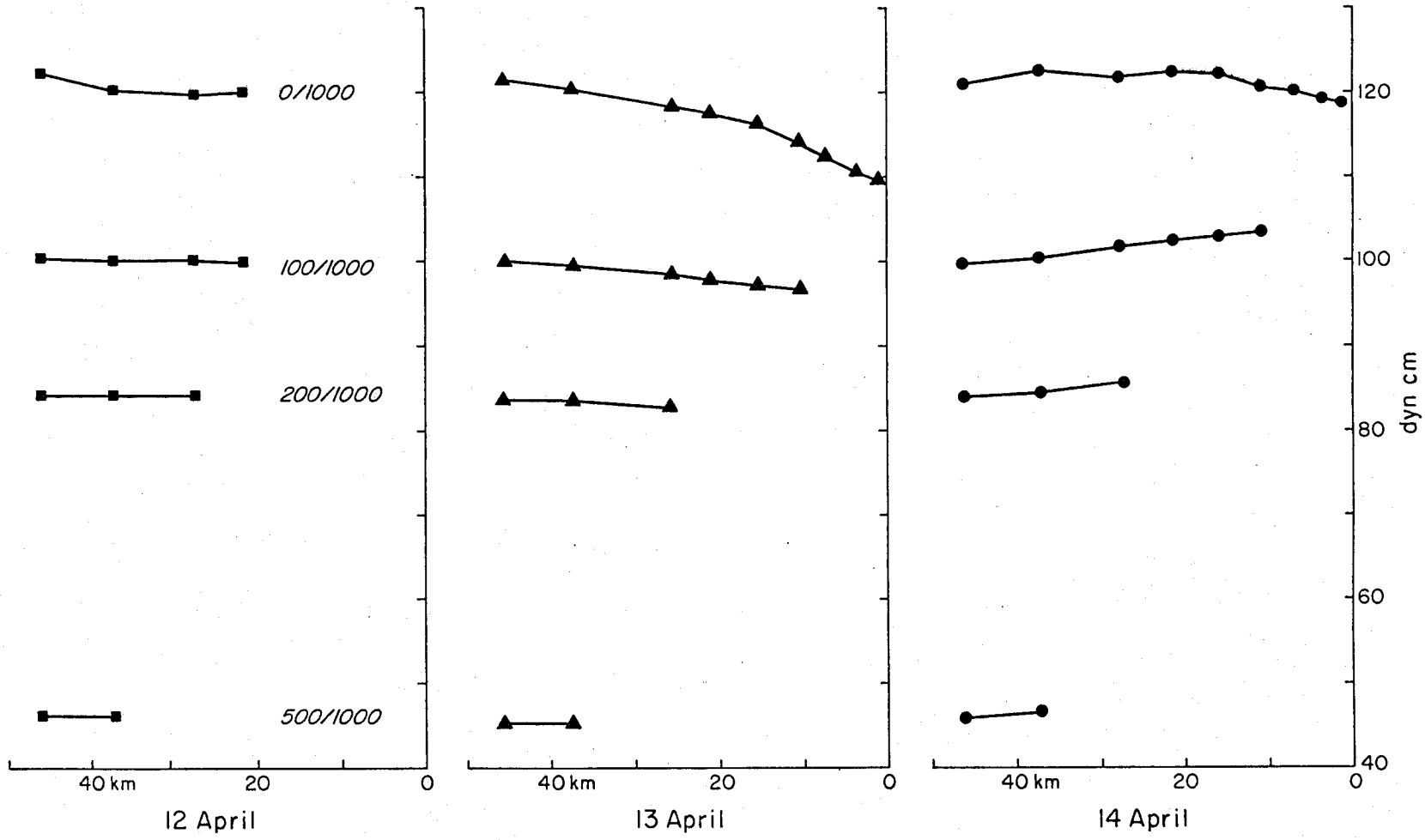


Figure 11. Dynamic height of the 0 db, 200 db and 5-0 db surfaces relative to 1000 db. A slope of 1 cm/10 km corresponds to an alongshore geostrophic velocity of 11 cm/sec.

Acknowledgments

We thank Stan Hayes and Bob Millard for sharing their knowledge of the Neil Brown CTD system, particularly in by-passing the fast-response thermistor data and applying the recursive filter to the conductivity data. We also thank Harry Bryden for providing the subroutines to calculate derived variables.

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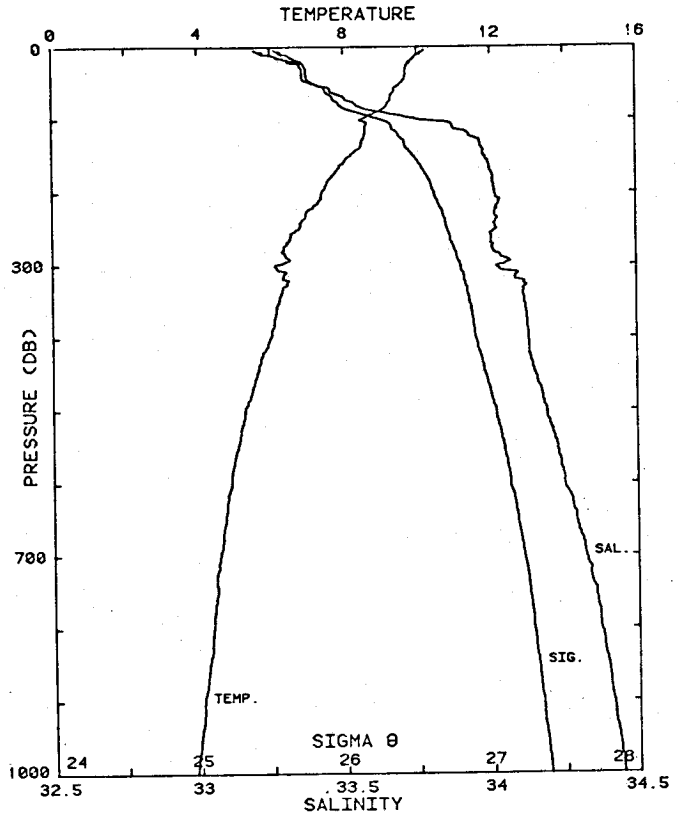
Fofonoff, N. P., S. P. Hayes and R. C. Millard, Jr. 1974. W.H.O.I./ Brown CTD microprofiler: methods of calibration and data handling Woods Hole Oceanographic Institution. WHOI-74-89, pp.66.

Millard, R., J. Toole and M. Swartz. 1980. A fast responding temperature measurement system for CTD applications. Ocean. Engng. 7:413-427.

Reid, J. L. and A. W. Mantyla. 1976. The effect of geostrophic flow upon coastal sea elevations in the northern North Pacific Ocean. J. Geophys. Res. 81(18):3100-3110.

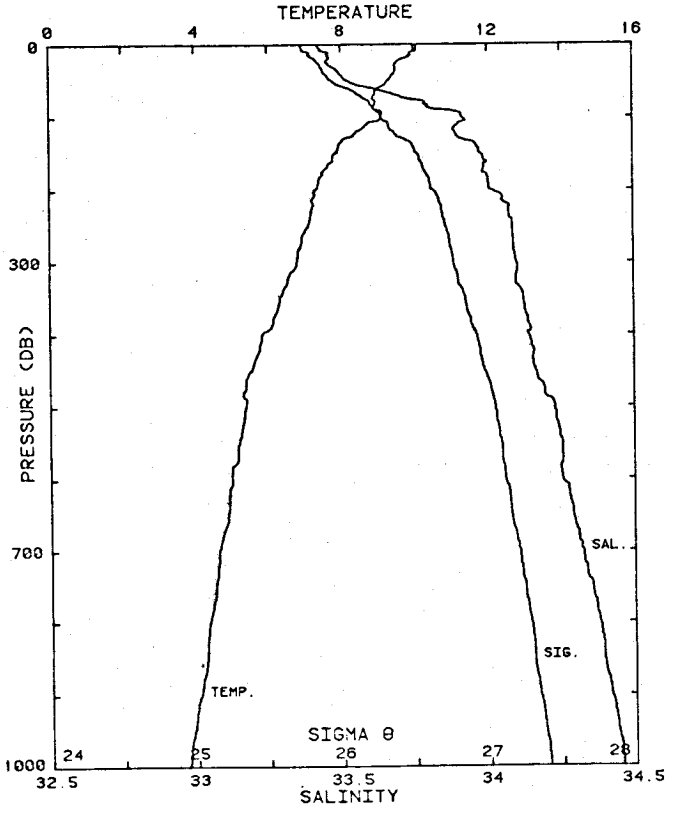
PROFILE PLOTS AND LISTINGS



STATION 1 COC 9

STA NO 1 COC 9 LAT: 38 23.6 N LONG: 123 48.7'W
12 APR 1981 0724 GMT PROBE 2567 DEPTH 1666M
45.7 KM FROM SHORE

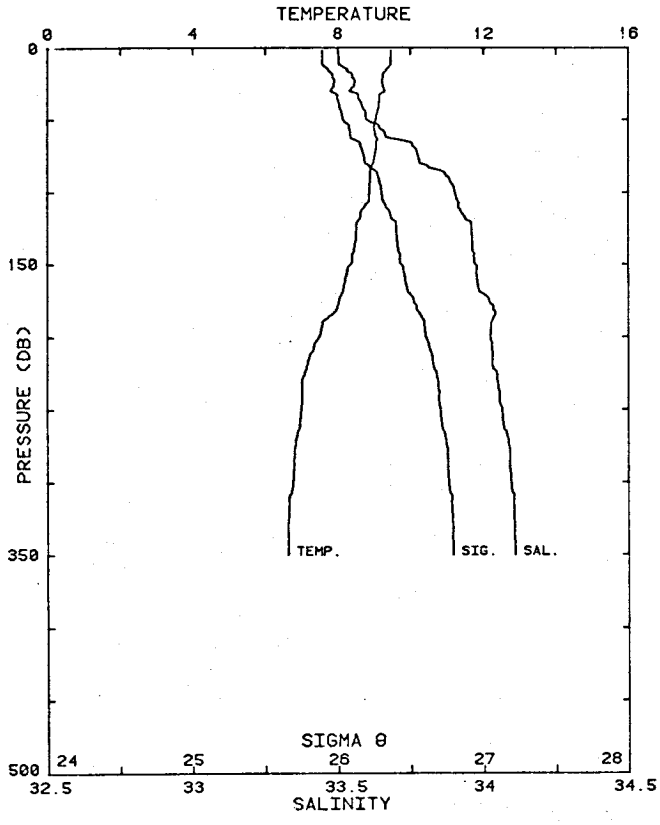
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
5	10.212	33.195	10.212	25.528	246.5	0.012
10	10.089	33.220	10.088	25.569	242.8	0.025
20	9.816	33.315	9.814	25.689	231.6	0.048
30	9.690	33.357	9.686	25.743	226.7	0.071
40	9.679	33.358	9.675	25.745	226.6	0.094
50	9.557	33.385	9.551	25.786	222.9	0.116
60	9.362	33.454	9.355	25.872	214.9	0.138
70	9.267	33.502	9.260	25.925	210.1	0.159
80	9.180	33.543	9.172	25.971	205.9	0.180
90	8.904	33.627	8.894	26.081	195.7	0.200
100	8.481	33.747	8.471	26.241	180.6	0.219
110	8.572	33.870	8.561	26.323	173.1	0.237
120	8.563	33.925	8.551	26.367	169.0	0.254
130	8.478	33.963	8.465	26.410	165.1	0.271
140	8.411	33.973	8.397	26.428	163.6	0.287
150	8.168	33.975	8.153	26.467	160.0	0.303
175	7.719	34.004	7.702	26.556	151.9	0.342
200	7.386	34.012	7.367	26.611	147.0	0.379
225	7.013	34.015	6.993	26.665	142.1	0.416
250	6.780	34.019	6.757	26.700	139.1	0.451
300	6.151	34.029	6.125	26.791	130.8	0.518
400	5.978	34.127	5.943	26.891	122.6	0.645
500	5.256	34.187	5.215	27.028	110.2	0.761
600	4.864	34.247	4.817	27.121	102.1	0.867
800	4.348	34.369	4.287	27.276	88.9	1.056
1000	3.860	34.446	3.786	27.389	79.2	1.223
1001	3.860	34.446	3.785	27.389	79.1	1.224



STATION 2 COC 8

STA NO 2 COC 8 LAT: 38 27.1 N LONG: 123 44.5'W
12 APR 1981 0910 GMT PROBE 2567 DEPTH 1160M
37.0 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
2	10.073	33.423	10.073	25.729	227.3	0.005
10	10.005	33.443	10.004	25.757	224.9	0.023
20	9.699	33.461	9.696	25.822	218.9	0.045
30	9.480	33.466	9.476	25.862	215.3	0.067
40	9.461	33.496	9.456	25.888	213.0	0.088
50	9.292	33.522	9.287	25.936	208.7	0.109
60	9.026	33.607	9.019	26.045	198.5	0.130
70	8.893	33.692	8.886	26.133	190.3	0.149
80	8.945	33.789	8.936	26.200	184.1	0.168
90	8.976	33.838	8.967	26.235	181.1	0.186
100	9.102	33.913	9.091	26.273	177.7	0.204
110	8.709	33.900	8.698	26.325	172.9	0.221
120	8.433	33.889	8.420	26.359	169.8	0.239
130	8.088	33.904	8.075	26.423	163.8	0.255
140	7.935	33.963	7.921	26.492	157.4	0.271
150	7.845	33.974	7.830	26.514	155.5	0.287
175	7.493	33.984	7.476	26.573	150.2	0.325
200	7.284	34.006	7.265	26.620	146.1	0.362
225	7.194	34.072	7.173	26.685	140.3	0.398
250	7.078	34.085	7.055	26.711	138.2	0.433
300	6.769	34.097	6.742	26.764	133.8	0.500
400	5.829	34.136	5.795	26.917	120.0	0.628
500	5.369	34.226	5.328	27.045	108.8	0.742
600	4.977	34.252	4.929	27.112	103.1	0.847
800	4.347	34.378	4.286	27.283	88.2	1.038
1000	3.738	34.456	3.664	27.409	76.9	1.204
1001	3.733	34.457	3.659	27.410	76.8	1.205



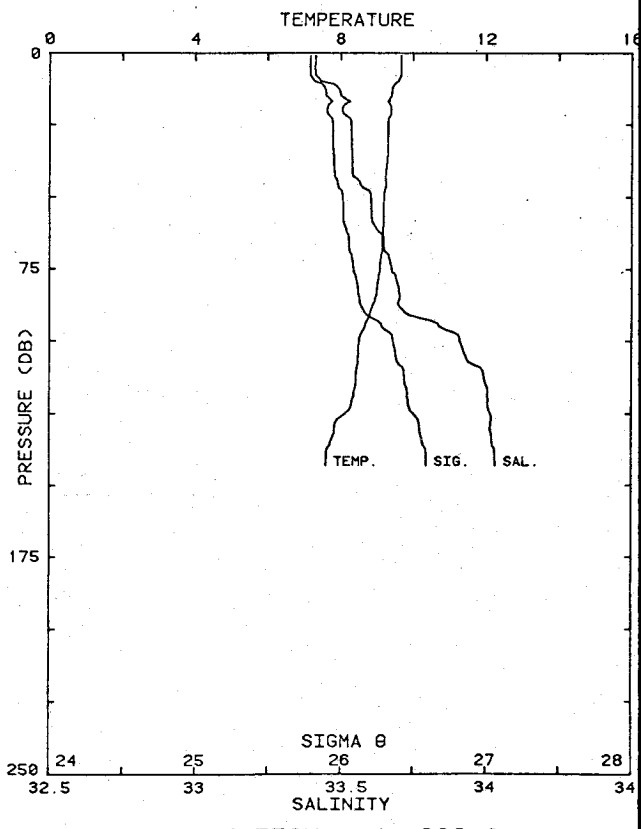
STATION 3 COC 7

STA NO 3 COC 7 LAT: 38 30.4 N LONG: 123 39.6'W
12 APR 1981 1032 GMT PROBE 2567 DEPTH 356M
27.4 KM FROM SHORE

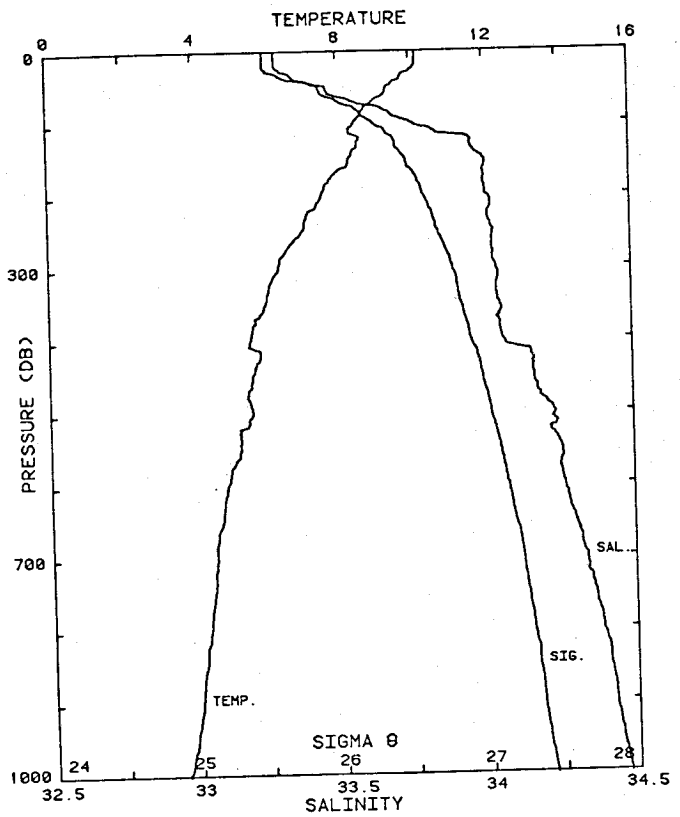
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
2	9.467	33.502	9.467	25.892	211.9	0.004
10	9.463	33.503	9.462	25.893	211.9	0.021
20	9.255	33.550	9.252	25.964	205.4	0.042
30	9.302	33.540	9.299	25.949	207.1	0.063
40	9.126	33.584	9.122	26.011	201.3	0.083
50	9.046	33.600	9.041	26.037	199.1	0.103
60	9.043	33.664	9.037	26.087	194.5	0.122
70	9.055	33.768	9.048	26.167	187.1	0.142
80	8.978	33.783	8.969	26.191	185.0	0.160
90	8.886	33.882	8.877	26.283	176.6	0.178
100	8.869	33.904	8.858	26.303	174.8	0.196
110	8.734	33.914	8.722	26.332	172.2	0.213
120	8.532	33.957	8.520	26.397	166.2	0.230
130	8.494	33.962	8.481	26.407	165.5	0.247
140	8.447	33.965	8.432	26.416	164.7	0.263
150	8.352	33.974	8.337	26.439	162.8	0.279
175	8.033	34.021	8.015	26.524	155.1	0.319
200	7.490	34.025	7.470	26.607	147.5	0.357
225	7.093	34.047	7.072	26.679	140.8	0.393
250	6.994	34.066	6.971	26.708	138.4	0.428
300	6.766	34.097	6.739	26.764	133.8	0.496
350	6.629	34.110	6.598	26.793	131.7	0.562

STA NO 4 COC 6 LAT: 38 32.6 N LONG: 123 36.1'W
12 APR 1981 1126 GMT PROBE 2567 DEPTH 148M
21.5 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	9.652	33.413	9.652	25.792	221.4	0.002
10	9.575	33.432	9.574	25.819	219.0	0.022
20	9.394	33.505	9.392	25.906	210.9	0.043
30	9.306	33.538	9.303	25.946	207.3	0.064
40	9.260	33.541	9.256	25.956	206.6	0.085
50	9.201	33.605	9.196	26.016	201.1	0.105
60	9.173	33.618	9.166	26.031	199.9	0.125
70	9.119	33.664	9.112	26.075	195.9	0.145
80	9.027	33.697	9.019	26.116	192.2	0.164
90	8.821	33.723	8.812	26.169	187.3	0.184
100	8.514	33.913	8.504	26.365	168.9	0.201
110	8.441	33.991	8.430	26.438	162.1	0.218
120	8.332	34.009	8.320	26.468	159.4	0.234
130	7.840	34.015	7.828	26.547	152.0	0.250
140	7.617	34.033	7.604	26.593	147.8	0.264
143	7.610	34.034	7.596	26.595	147.6	0.269



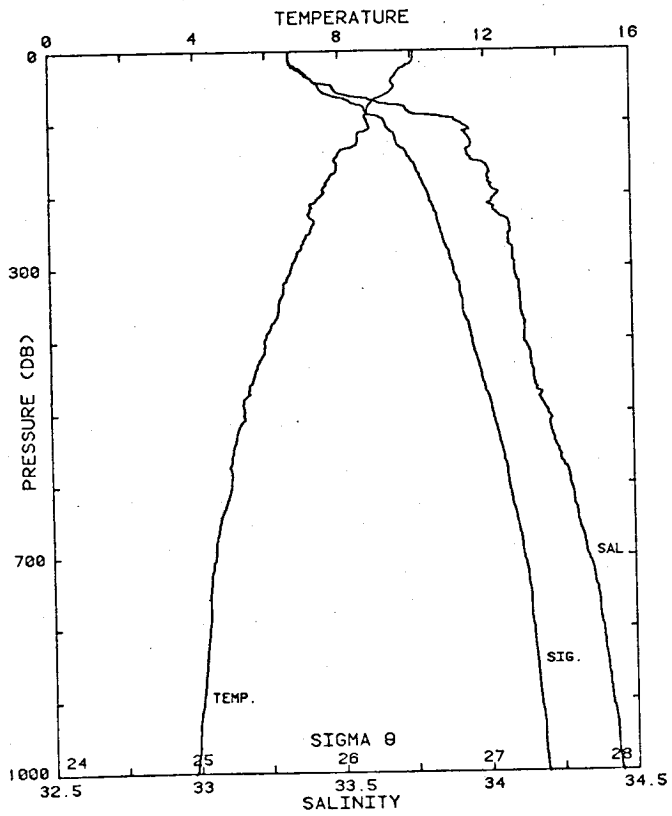
STATION 4 COC 6



STATION 5 COC 9

STA NO 5 COC 9 LAT: 38 24.3 N LONG: 123 49.0'W
13 APR 1981 0052 GMT PROBE 2567 DEPTH 1676M
45.7 KM FROM SHORE

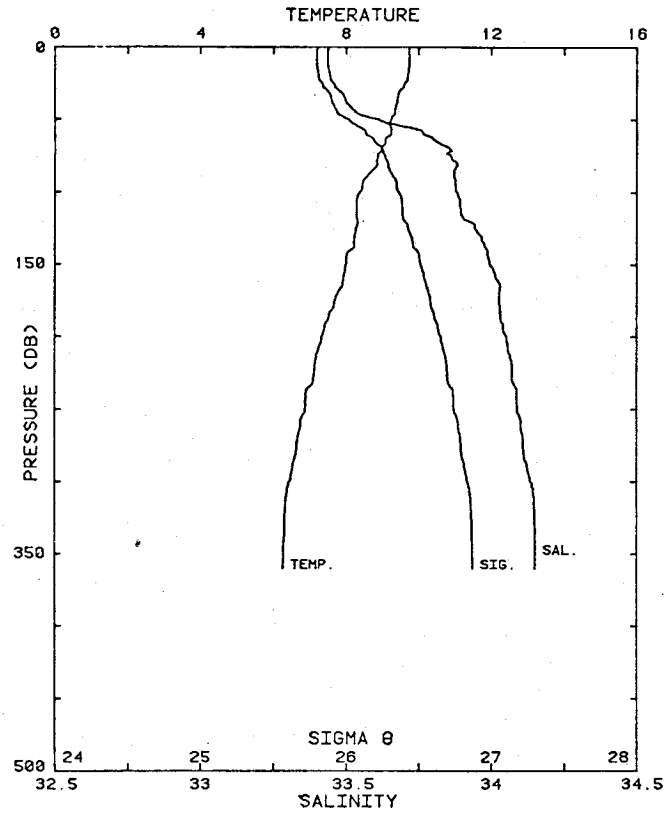
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	10.171	33.249	10.171	25.577	241.8	0.000
10	10.168	33.249	10.167	25.578	241.9	0.024
20	10.156	33.248	10.154	25.579	242.0	0.048
30	9.883	33.279	9.880	25.650	235.5	0.072
40	9.718	33.335	9.714	25.721	228.9	0.096
50	9.369	33.462	9.364	25.877	214.3	0.118
60	9.298	33.477	9.292	25.900	212.3	0.139
70	8.993	33.553	8.985	26.009	202.2	0.160
80	8.745	33.654	8.737	26.127	191.1	0.179
90	8.642	33.692	8.632	26.173	186.9	0.198
100	8.466	33.756	8.456	26.250	179.7	0.216
110	8.326	33.828	8.315	26.328	172.5	0.234
120	8.602	33.950	8.590	26.381	167.8	0.251
130	8.535	33.955	8.522	26.395	166.6	0.268
140	8.395	33.971	8.380	26.430	163.5	0.284
150	8.302	34.001	8.287	26.467	160.1	0.300
175	7.817	33.999	7.800	26.538	153.6	0.340
200	7.532	34.005	7.513	26.584	149.6	0.378
225	7.154	34.009	7.133	26.641	144.4	0.414
250	6.964	34.026	6.941	26.681	141.0	0.450
300	6.323	34.036	6.297	26.775	132.4	0.518
400	5.511	34.057	5.478	26.893	121.9	0.645
500	5.569	34.228	5.527	27.023	111.1	0.761
600	4.826	34.261	4.778	27.136	100.7	0.867
800	4.292	34.384	4.231	27.294	87.1	1.053
1000	3.626	34.469	3.553	27.431	74.7	1.215
1002	3.626	34.469	3.553	27.430	74.7	1.217



STATION 6 COC 8

STA NO 6 COC 8 LAT: 38 27.0 N LONG: 123 44.4'W
13 APR 1981 0209 GMT PROBE 2567 DEPTH 1218M
37.4 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	10.073	33.333	10.073	25.660	233.9	0.002
10	10.077	33.333	10.076	25.659	234.2	0.023
20	9.868	33.342	9.866	25.701	230.4	0.047
30	9.621	33.375	9.618	25.768	224.2	0.070
40	9.471	33.407	9.467	25.818	219.7	0.092
50	9.534	33.481	9.528	25.865	215.5	0.114
60	9.341	33.510	9.335	25.919	210.5	0.135
70	8.922	33.622	8.914	26.074	196.0	0.155
80	8.805	33.732	8.797	26.178	186.2	0.174
90	8.706	33.800	8.697	26.247	179.9	0.193
100	8.788	33.909	8.778	26.319	173.2	0.210
110	8.796	33.949	8.785	26.350	170.6	0.227
120	8.519	33.943	8.506	26.388	167.1	0.244
130	8.496	33.953	8.482	26.400	166.1	0.261
140	8.016	33.938	8.002	26.461	160.4	0.277
150	7.881	33.952	7.866	26.491	157.6	0.293
175	7.742	34.009	7.725	26.557	151.8	0.332
200	7.522	34.041	7.503	26.614	146.8	0.369
225	7.144	34.038	7.123	26.666	142.1	0.405
250	7.191	34.085	7.167	26.696	139.7	0.441
300	6.671	34.097	6.643	26.777	132.5	0.509
400	5.904	34.128	5.870	26.901	121.6	0.636
500	5.315	34.208	5.275	27.037	109.4	0.751
600	4.937	34.283	4.889	27.142	100.3	0.856
800	4.270	34.389	4.209	27.300	86.5	1.040
1000	3.845	34.447	3.770	27.392	78.9	1.205
1002	3.836	34.447	3.761	27.393	78.7	1.207



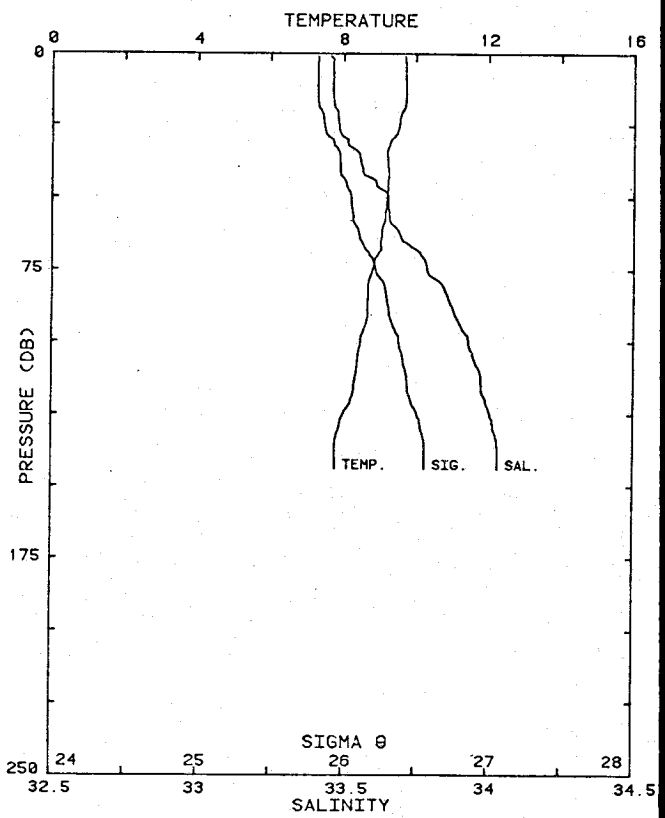
STATION 7 COC 7

STA NO 7 COC 7 LAT: 38 30.6 N LONG: 123 39.7'W
13 APR 1981 0334 GMT PROBE 2567 DEPTH 367M
25.7 KM FROM SHORE

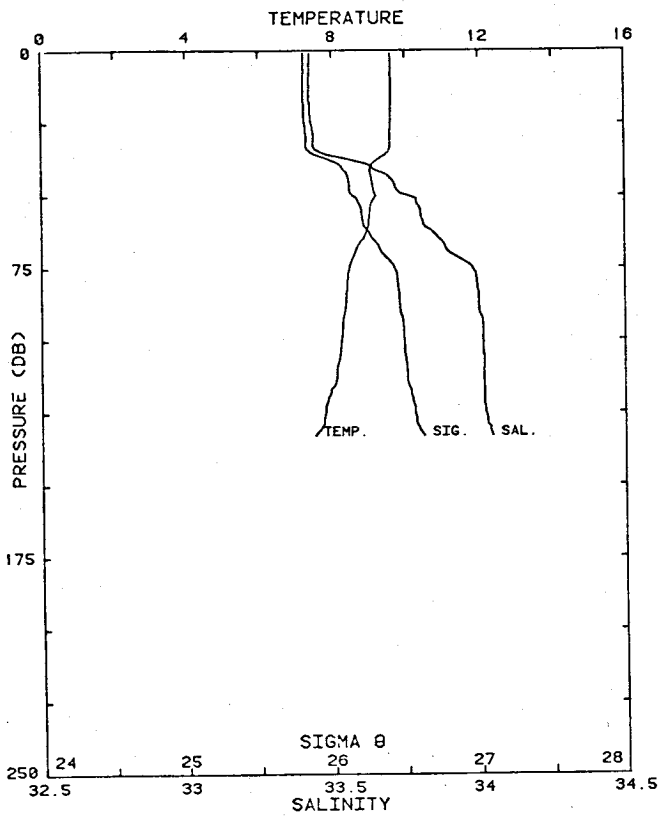
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	9.730	33.437	9.730	25.798	220.8	0.002
10	9.739	33.436	9.738	25.795	221.2	0.022
20	9.693	33.444	9.691	25.809	220.1	0.044
30	9.481	33.474	9.477	25.868	214.7	0.066
40	9.364	33.510	9.359	25.915	210.4	0.087
50	9.236	33.612	9.231	26.016	201.1	0.108
60	9.236	33.766	9.229	26.136	189.9	0.128
70	8.968	33.855	8.961	26.249	179.4	0.146
80	8.857	33.882	8.849	26.287	175.9	0.164
90	8.542	33.874	8.533	26.330	172.0	0.181
100	8.366	33.883	8.356	26.364	168.9	0.198
110	8.275	33.894	8.264	26.387	166.9	0.215
120	8.310	33.922	8.298	26.403	165.6	0.232
130	8.234	33.963	8.221	26.447	161.6	0.248
140	8.111	33.986	8.097	26.484	158.2	0.264
150	7.976	33.996	7.961	26.512	155.7	0.280
175	7.674	34.027	7.657	26.581	149.5	0.318
200	7.312	34.053	7.293	26.653	143.0	0.354
225	7.102	34.072	7.081	26.698	139.0	0.390
250	6.853	34.090	6.830	26.746	134.7	0.424
300	6.442	34.135	6.415	26.838	126.6	0.489
360	6.258	34.151	6.226	26.874	123.9	0.564

STA NO 8 COC 6 LAT: 38 32.5 N LONG: 123 36.2'W
13 APR 1981 0450 GMT PROBE 2567 DEPTH 147M
21.2 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	9.683	33.455	9.683	25.820	218.7	0.002
10	9.715	33.463	9.714	25.821	218.8	0.022
20	9.628	33.478	9.626	25.847	216.6	0.044
30	9.310	33.515	9.307	25.927	209.1	0.065
40	9.243	33.566	9.239	25.978	204.4	0.086
50	9.203	33.654	9.197	26.054	197.5	0.106
60	9.076	33.678	9.070	26.093	194.0	0.125
70	8.948	33.769	8.941	26.184	185.5	0.145
80	8.690	33.841	8.682	26.281	176.5	0.163
90	8.678	33.884	8.668	26.317	173.2	0.180
100	8.477	33.934	8.466	26.387	166.7	0.197
110	8.370	33.972	8.359	26.433	162.5	0.214
120	8.220	33.993	8.208	26.472	159.0	0.230
130	7.901	34.019	7.889	26.541	152.6	0.245
140	7.789	34.035	7.775	26.570	150.0	0.260
144	7.797	34.035	7.783	26.569	150.1	0.266



STATION 8 COC 6



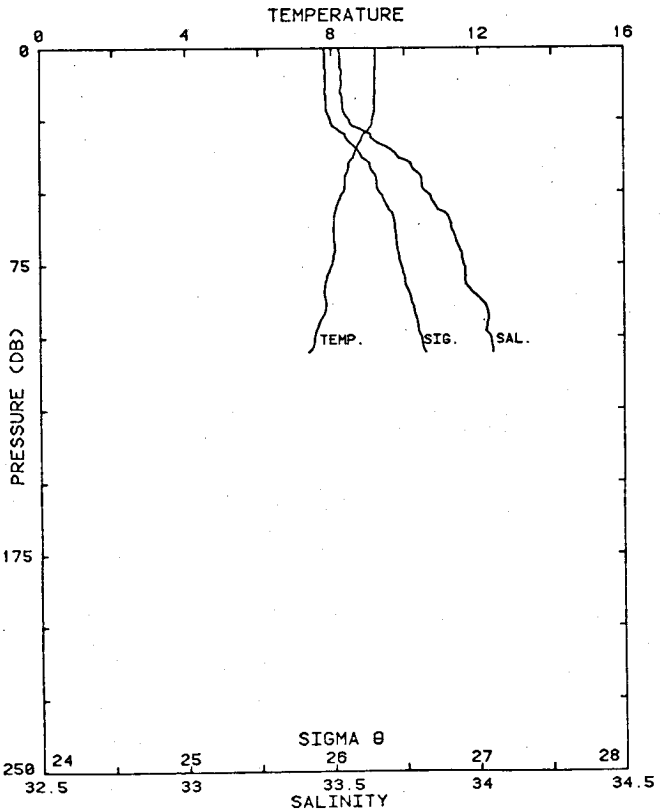
STATION 9 COC 5

STA NO 9 COC 5 LAT: 38 34.6 N LONG: 123 33.3'W
13 APR 1981 0530 GMT PROBE 2567 DEPTH 137M
15.5 KM FROM SHORE

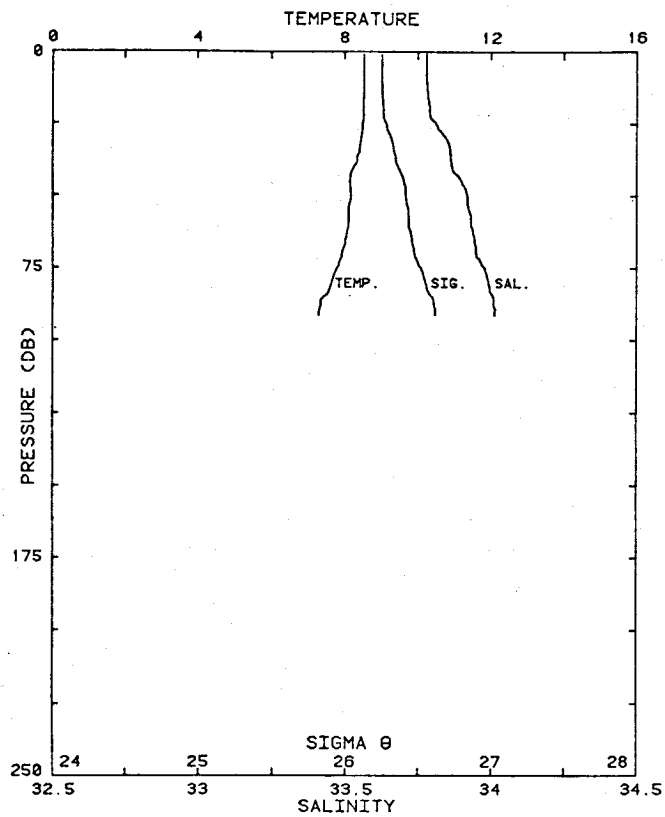
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	9.609	33.424	9.609	25.807	219.9	0.002
10	9.613	33.422	9.611	25.806	220.2	0.022
20	9.607	33.426	9.605	25.810	220.1	0.044
30	9.580	33.437	9.576	25.823	219.1	0.066
40	9.043	33.634	9.038	26.064	196.3	0.087
50	9.187	33.763	9.181	26.141	189.2	0.106
60	8.981	33.812	8.975	26.212	182.6	0.125
70	8.605	33.903	8.598	26.343	170.4	0.143
80	8.399	33.993	8.391	26.445	160.9	0.159
90	8.335	34.000	8.326	26.461	159.6	0.175
100	8.224	34.013	8.214	26.488	157.1	0.191
110	8.106	34.015	8.095	26.507	155.5	0.206
120	7.865	34.017	7.853	26.544	152.1	0.222
130	7.685	34.037	7.672	26.586	148.2	0.237
133	7.492	34.044	7.479	26.619	145.1	0.241

STA NO 10 COC 4 LAT: 38 36.2 N LONG: 123 30.7'W
13 APR 1981 0618 GMT PROBE 2567 DEPTH 108M
10.5 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	9.202	33.528	9.202	25.955	205.9	0.000
10	9.194	33.533	9.193	25.960	205.6	0.021
20	9.179	33.540	9.177	25.968	205.1	0.041
30	8.865	33.635	8.862	26.092	193.4	0.061
40	8.463	33.770	8.459	26.260	177.6	0.080
50	8.307	33.824	8.302	26.327	171.5	0.097
60	8.056	33.904	8.050	26.427	162.2	0.114
70	8.093	33.939	8.086	26.449	160.3	0.130
80	7.847	33.955	7.839	26.498	155.7	0.146
90	7.835	34.029	7.826	26.558	150.3	0.161
100	7.523	34.043	7.514	26.614	145.0	0.176
105	7.369	34.049	7.359	26.641	142.6	0.183



STATION 10 COC 4



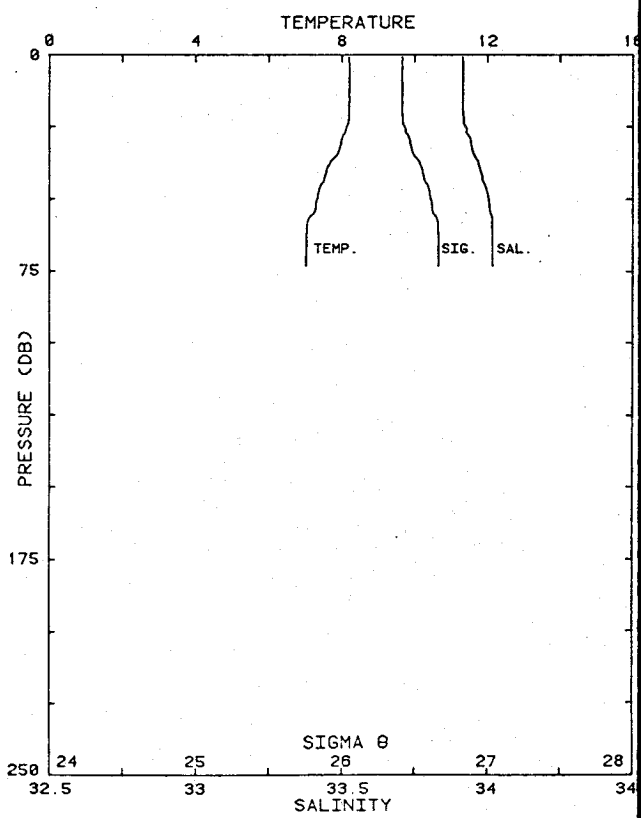
STATION 11 COC 3

STA NO 11 COC 3 LAT: 38 37.5 N LONG: 123 28.9'W
13 APR 1981 0650 GMT PROBE 2567 DEPTH 93M
7.4 KM FROM SHORE

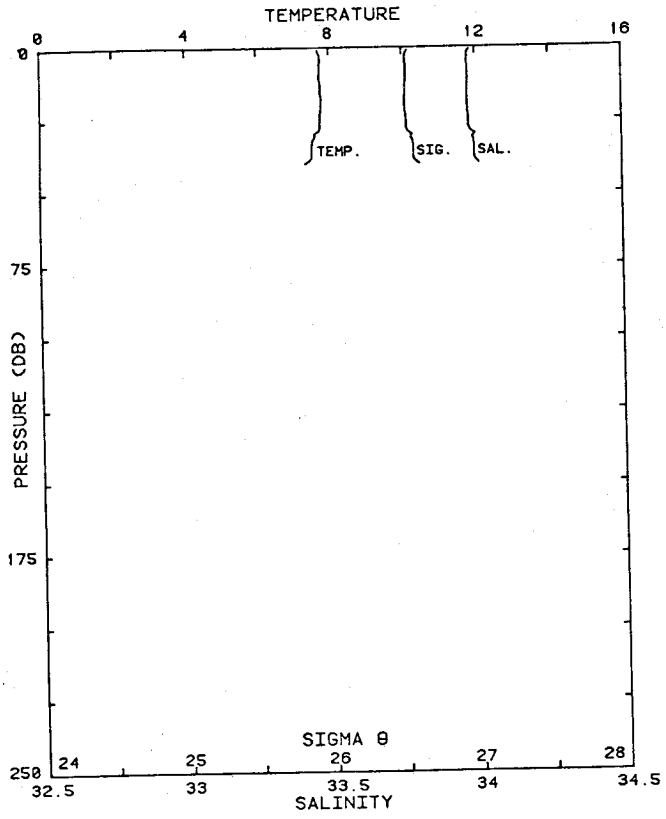
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	8.538	33.780	8.538	26.256	177.3	0.002
10	8.540	33.780	8.539	26.256	177.5	0.018
20	8.519	33.791	8.517	26.268	176.5	0.035
30	8.458	33.846	8.455	26.320	171.8	0.053
40	8.258	33.868	8.254	26.368	167.4	0.070
50	8.187	33.920	8.182	26.419	162.7	0.086
60	8.122	33.932	8.116	26.439	161.0	0.102
70	7.938	33.952	7.931	26.482	157.1	0.118
80	7.650	33.993	7.642	26.557	150.1	0.134
90	7.310	34.014	7.302	26.621	144.1	0.148
91	7.307	34.015	7.298	26.623	144.0	0.150

STA NO 12 COC 2 LAT: 38 38.8 N LONG: 123 26.9'W
13 APR 1981 0723 GMT PROBE 2567 DEPTH 76M
3.7 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	8.200	33.915	8.200	26.413	162.4	0.002
10	8.204	33.915	8.203	26.413	162.6	0.016
20	8.194	33.917	8.192	26.415	162.5	0.033
30	7.984	33.942	7.981	26.467	157.8	0.049
40	7.578	33.976	7.574	26.553	149.8	0.064
50	7.320	34.004	7.315	26.611	144.4	0.079
60	7.049	34.017	7.043	26.660	139.9	0.093
70	7.026	34.018	7.020	26.664	139.7	0.107
73	7.024	34.018	7.018	26.664	139.7	0.111



STATION 12 COC 2



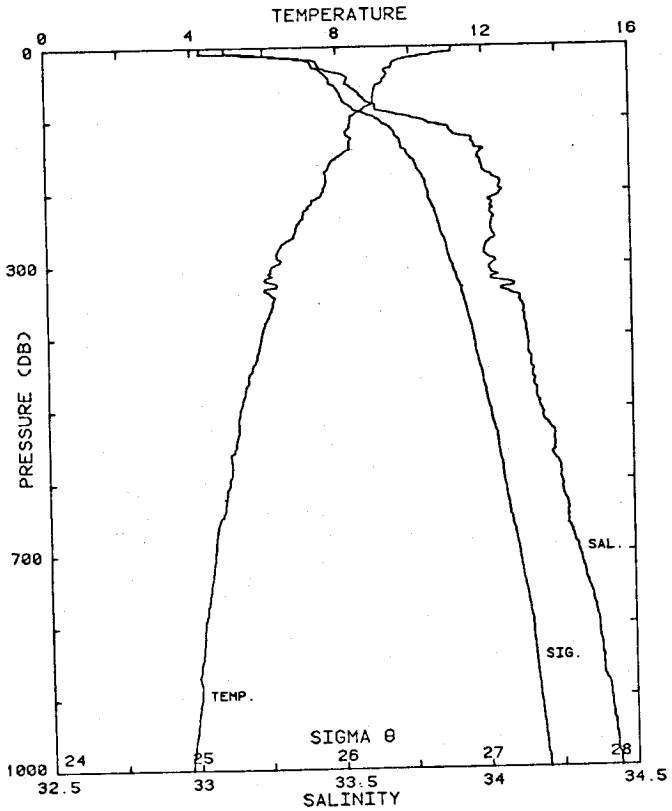
STATION 13 COC 1

STA NO 13 COC 1 LAT: 38 39.8 N LONG: 123 25.6'W
13 APR 1981 0807 GMT PROBE 2567 DEPTH 43M
1.1 KM FROM SHORE

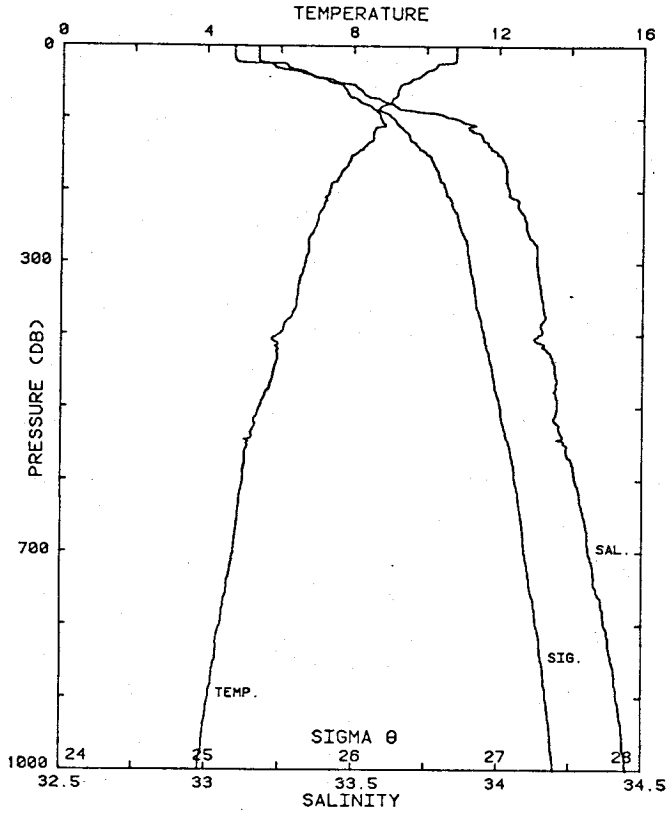
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	7.699	33.982	7.699	26.540	150.4	0.002
10	7.743	33.975	7.742	26.528	151.6	0.015
20	7.788	33.974	7.786	26.520	152.5	0.030
30	7.587	34.000	7.584	26.570	148.0	0.046
40	7.332	34.011	7.329	26.615	143.9	0.060

STA NO 14 COC 9 LAT: 38 24.1 N LONG: 123 49.2'W
14 APR 1081 0509 GMT PROBE 2567 DEPTH 1706M
46.2 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	11.188	33.033	11.188	25.232	274.6	0.000
10	10.626	33.181	10.624	25.446	254.4	0.027
20	9.640	33.429	9.637	25.806	220.4	0.051
30	9.390	33.450	9.386	25.864	215.1	0.073
40	9.363	33.530	9.359	25.931	209.0	0.094
50	9.213	33.530	9.208	25.955	206.9	0.115
60	9.034	33.565	9.028	26.011	201.7	0.135
70	9.003	33.592	8.996	26.037	199.5	0.155
80	8.935	33.635	8.927	26.082	195.4	0.175
90	8.573	33.673	8.564	26.168	187.4	0.194
100	8.368	33.782	8.358	26.285	176.4	0.212
110	8.350	33.868	8.339	26.355	169.9	0.230
120	8.241	33.896	8.229	26.394	166.4	0.246
130	8.336	33.959	8.323	26.429	163.3	0.263
140	8.316	33.974	8.302	26.444	162.1	0.279
150	8.047	33.981	8.032	26.489	157.9	0.295
175	7.677	34.015	7.660	26.571	150.4	0.333
200	7.577	34.057	7.557	26.619	146.3	0.370
225	7.066	34.021	7.045	26.663	142.3	0.407
250	6.830	34.022	6.807	26.696	139.5	0.442
300	6.245	34.024	6.218	26.776	132.3	0.510
400	5.855	34.142	5.821	26.919	119.9	0.635
500	5.240	34.185	5.199	27.028	110.2	0.751
600	4.928	34.253	4.880	27.119	102.4	0.857
800	4.173	34.374	4.113	27.299	86.4	1.045
1000	3.760	34.443	3.686	27.397	78.2	1.210
1001	3.760	34.443	3.686	27.397	78.2	1.211



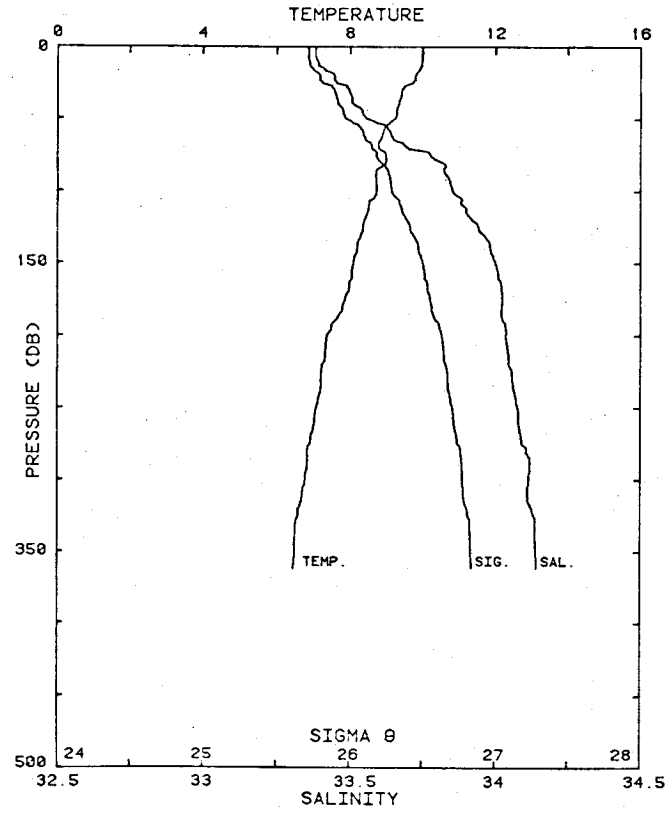
STATION 14 COC 9



STATION 15 COC 8

STA NO 15 COC 8 LAT: 38 27.1 N LONG: 123 44.5'W
14 APR 1981 0627 GMT PROBE 2567 DEPTH 1189M
37.2 KM FROM SHORE

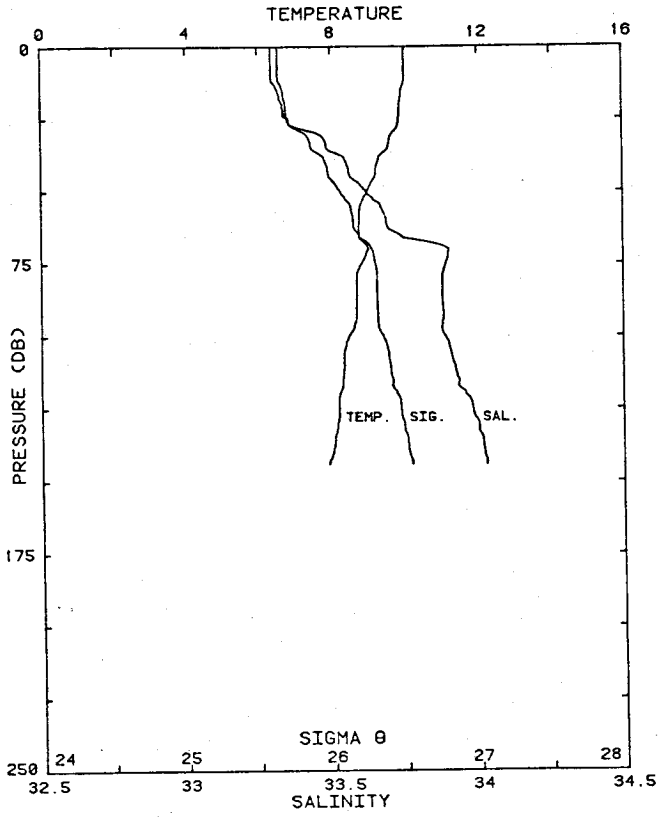
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	10.800	33.093	10.800	25.347	263.7	0.003
10	10.802	33.093	10.801	25.347	263.9	0.026
20	10.790	33.097	10.788	25.353	263.6	0.053
30	10.255	33.230	10.251	25.549	245.1	0.078
40	9.884	33.343	9.879	25.700	230.9	0.102
50	9.539	33.437	9.534	25.830	218.8	0.124
60	9.232	33.519	9.225	25.944	208.1	0.145
70	9.176	33.548	9.169	25.976	205.3	0.166
80	8.974	33.629	8.965	26.071	196.4	0.186
90	8.625	33.707	8.616	26.186	185.6	0.205
100	8.748	33.846	8.738	26.276	177.3	0.223
110	8.883	33.920	8.871	26.313	174.1	0.241
120	8.558	33.929	8.545	26.371	168.7	0.258
130	8.531	33.947	8.517	26.390	167.1	0.275
140	8.277	33.973	8.263	26.449	161.6	0.291
150	8.005	33.996	7.990	26.508	156.1	0.307
175	7.666	34.028	7.649	26.583	149.4	0.345
200	7.348	34.039	7.329	26.637	144.5	0.382
225	7.169	34.072	7.148	26.688	140.0	0.417
250	6.989	34.097	6.965	26.734	136.0	0.452
300	6.697	34.134	6.670	26.803	130.1	0.518
400	5.969	34.141	5.935	26.904	121.4	0.644
500	5.453	34.207	5.412	27.020	111.2	0.760
600	5.018	34.268	4.970	27.120	102.4	0.867
800	4.427	34.370	4.365	27.269	89.7	1.059
1000	3.830	34.447	3.755	27.393	78.7	1.226
1001	3.822	34.449	3.748	27.395	78.5	1.227



STATION 16 COC 7

STA NO 16 COC 7 LAT: 38 30.3 N LONG: 123 39.6'W
14 APR 1981 0748 GMT PROBE 2567 DEPTH 364M
27.6 KM FROM SHORE

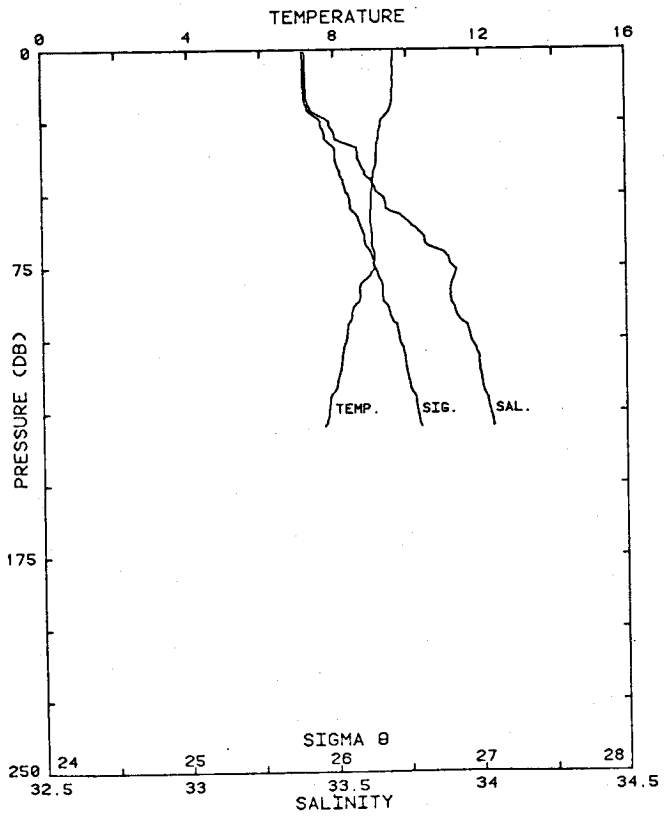
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	9.972	33.382	9.972	25.715	228.7	0.002
10	9.968	33.388	9.966	25.720	228.4	0.023
20	9.797	33.447	9.794	25.794	221.5	0.045
30	9.428	33.498	9.425	25.895	212.1	0.067
40	9.328	33.514	9.323	25.924	209.6	0.088
50	9.228	33.558	9.222	25.974	205.0	0.109
60	8.898	33.639	8.891	26.090	194.2	0.129
70	8.796	33.697	8.789	26.152	188.5	0.148
80	8.993	33.815	8.984	26.214	182.9	0.167
90	8.705	33.836	8.696	26.275	177.2	0.184
100	8.718	33.852	8.708	26.286	176.4	0.202
110	8.515	33.887	8.504	26.344	171.0	0.220
120	8.396	33.920	8.384	26.389	167.0	0.236
130	8.309	33.958	8.296	26.432	163.0	0.253
140	8.198	33.983	8.184	26.468	159.7	0.269
150	8.094	34.000	8.079	26.497	157.1	0.285
175	7.869	34.024	7.852	26.550	152.6	0.324
200	7.380	34.033	7.361	26.628	145.4	0.361
225	7.224	34.056	7.203	26.668	141.9	0.397
250	7.093	34.077	7.070	26.703	138.9	0.432
300	6.793	34.114	6.766	26.774	132.9	0.500
361	6.467	34.143	6.435	26.841	127.2	0.579



STATION 17 COC 6

STA NO 17 COC 6 LAT: 38 32.7 N LONG: 123 36.2'W
14 APR 1981 0843 GMT PROBE 2567 DEPTH 144M
21.3 KM FROM SHORE

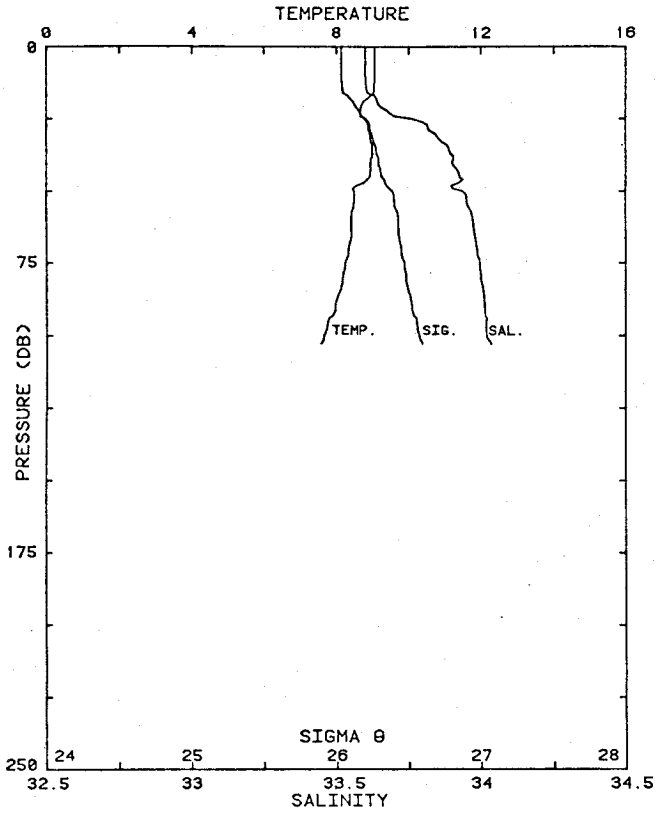
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	10.027	33.297	10.027	25.639	235.9	0.000
10	10.006	33.297	10.005	25.643	235.8	0.024
20	9.875	33.336	9.872	25.695	231.0	0.047
30	9.664	33.455	9.660	25.823	219.0	0.070
40	9.267	33.552	9.262	25.964	205.9	0.091
50	8.973	33.619	8.968	26.063	196.6	0.111
60	8.758	33.687	8.752	26.150	188.5	0.130
70	9.014	33.900	9.007	26.277	176.7	0.149
80	8.685	33.878	8.677	26.311	173.6	0.166
90	8.675	33.881	8.666	26.315	173.4	0.184
100	8.469	33.887	8.459	26.352	170.1	0.201
110	8.330	33.920	8.319	26.398	165.8	0.218
120	8.208	33.957	8.196	26.447	161.4	0.234
130	8.148	34.000	8.135	26.489	157.6	0.250
140	8.021	34.020	8.007	26.524	154.4	0.266
144	7.905	34.025	7.891	26.545	152.4	0.272



STATION 18 COC 5

STA NO 18 COC 5 LAT: 38 34.5 N LONG: 123 33.3'W
14 APR 1981 0923 GMT PROBE 2567 DEPTH 133M
15.9 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	9.632	33.400	9.632	25.785	222.1	0.002
10	9.615	33.403	9.614	25.790	221.7	0.022
20	9.542	33.418	9.540	25.814	219.7	0.044
30	9.204	33.501	9.201	25.934	208.5	0.066
40	9.129	33.590	9.125	26.016	200.9	0.086
50	8.990	33.655	8.985	26.089	194.2	0.106
60	8.979	33.757	8.973	26.170	186.7	0.125
70	9.081	33.875	9.073	26.246	179.7	0.143
80	8.776	33.902	8.768	26.316	173.2	0.161
90	8.467	33.913	8.457	26.372	167.9	0.178
100	8.293	33.967	8.283	26.441	161.6	0.194
110	8.140	33.996	8.129	26.487	157.4	0.210
120	7.854	34.022	7.842	26.550	151.6	0.226
130	7.693	34.042	7.680	26.589	148.0	0.241



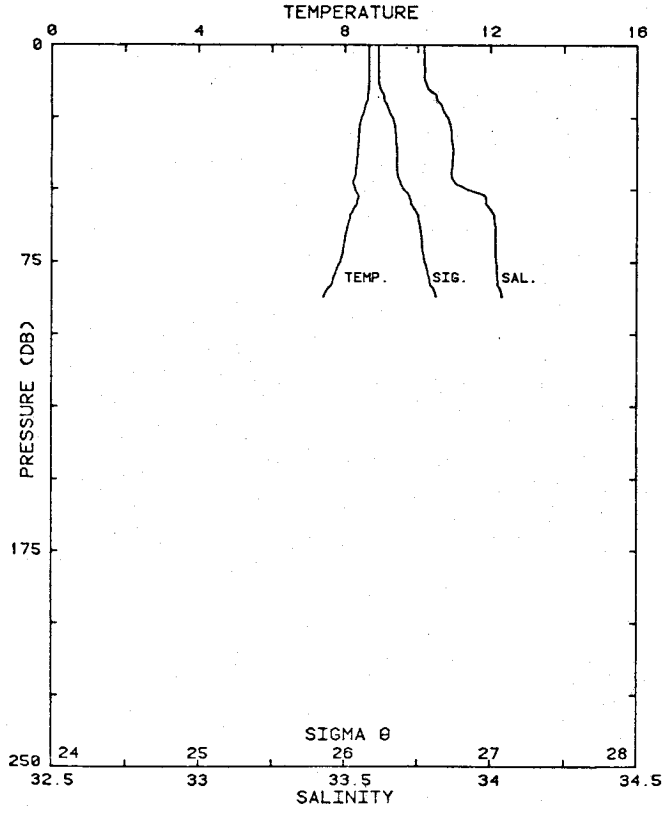
STATION 19 COC 4

STA NO 19 COC 4 LAT: 38 36.2 N LONG: 123 30.7'W
14 APR 1981 1002 GMT PROBE 2567 DEPTH 107M
10.9 KM FROM SHORE

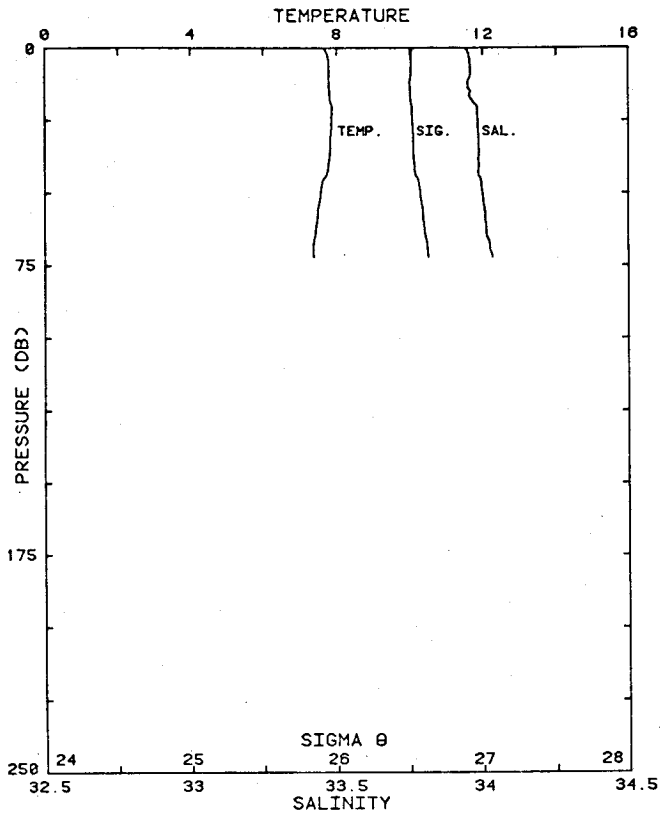
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	9.053	33.600	9.053	26.034	198.3	0.000
10	9.057	33.599	9.056	26.034	198.6	0.020
20	8.701	33.644	8.699	26.125	190.1	0.039
30	8.931	33.840	8.928	26.242	179.2	0.058
40	8.934	33.900	8.930	26.289	175.0	0.076
50	8.486	33.938	8.481	26.388	165.7	0.093
60	8.408	33.973	8.402	26.428	162.1	0.109
70	8.334	33.987	8.327	26.450	160.1	0.125
80	8.184	34.002	8.176	26.484	157.1	0.141
90	7.981	34.014	7.972	26.525	153.4	0.157
100	7.659	34.021	7.650	26.577	148.6	0.172
103	7.590	34.036	7.580	26.599	146.5	0.176

STA NO 20 COC 3 LAT: 38 37.5 N LONG: 123 28.8'W
14 APR 1981 1036 GMT PROBE 2567 DEPTH 91M
6.8 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	8.664	33.773	8.664	26.231	179.6	0.000
10	8.666	33.773	8.665	26.231	179.8	0.018
20	8.580	33.829	8.578	26.288	174.6	0.036
30	8.380	33.865	8.377	26.347	169.2	0.053
40	8.328	33.869	8.324	26.358	168.3	0.070
50	8.287	33.919	8.282	26.404	164.2	0.087
60	8.128	34.011	8.122	26.500	155.2	0.102
70	7.958	34.016	7.951	26.529	152.7	0.118
80	7.685	34.021	7.678	26.573	148.6	0.133
87	7.417	34.037	7.408	26.624	143.8	0.143



STATION 20 COC 3



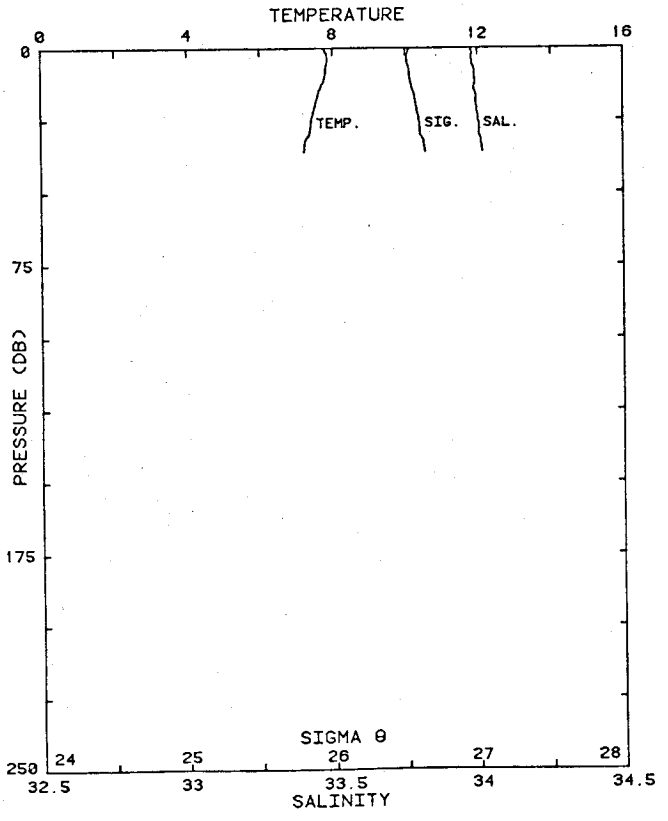
STATION 21 COC 2

STA NO 21 COC 2 LAT: 38 38.7 N LONG: 123 26.9'W
14 APR 1081 1114 GMT PROBE 2567 DEPTH 74M
3.5 KM FROM SHORE

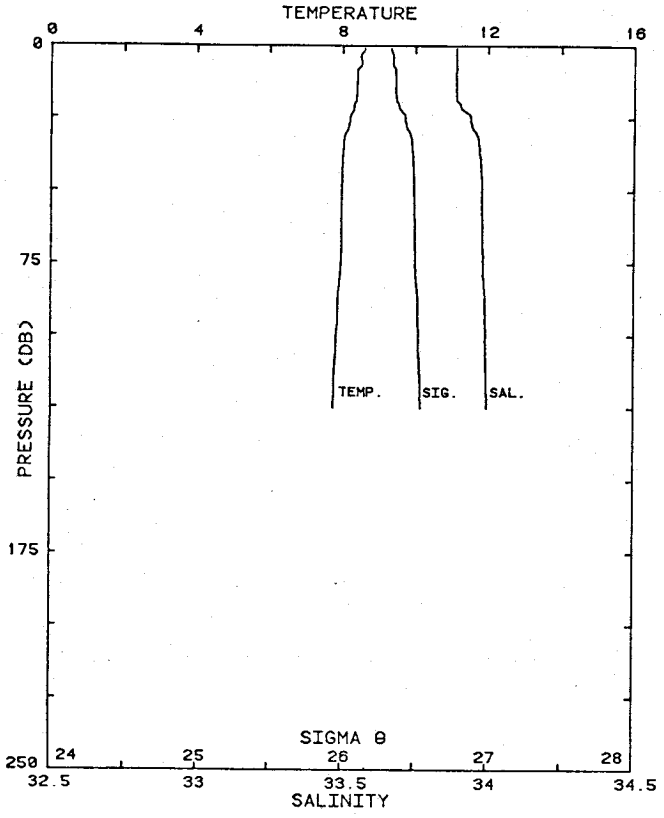
PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	7.677	33.943	7.677	26.512	153.0	0.000
10	7.795	33.956	7.794	26.505	153.8	0.015
20	7.869	33.979	7.867	26.512	153.3	0.031
30	7.838	33.984	7.835	26.522	152.6	0.046
40	7.778	33.985	7.774	26.531	151.9	0.061
50	7.568	33.998	7.563	26.572	148.2	0.076
60	7.470	34.009	7.464	26.594	146.2	0.091
70	7.362	34.025	7.356	26.622	143.7	0.105
72	7.369	34.032	7.362	26.627	143.3	0.108

STA NO 22 COC 1 LAT: 38 39.7 N LONG: 123 25.8'W
14 APR 1981 1148 GMT PROBE 2567 DEPTH 40M
1.1 KM FROM SHORE

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
0	7.743	33.978	7.743	26.530	151.2	0.000
10	7.788	33.989	7.787	26.532	151.2	0.015
20	7.520	33.995	7.518	26.576	147.3	0.030
30	7.361	34.004	7.358	26.605	144.6	0.045
36	7.208	34.017	7.204	26.638	141.6	0.053



STATION 22 COC 1



STATION 23 S 4

STA NO 23 S 4 LAT: 38 14.3 N LONG: 123 19.7'W
14 APR 1981 1846 GMT PROBE 2567 DEPTH 131M

PRESS	TEMP	SAL	POTEN TEMP	SIGMA THETA	SVA	DELD
1	8.599	33.890	8.599	26.332	170.1	0.002
10	8.398	33.889	8.397	26.363	167.3	0.017
20	8.324	33.903	8.322	26.385	165.4	0.034
30	8.101	33.959	8.098	26.463	158.2	0.050
40	8.014	33.976	8.010	26.489	155.9	0.065
50	7.995	33.980	7.990	26.495	155.5	0.081
60	7.984	33.982	7.978	26.499	155.3	0.097
70	7.976	33.984	7.970	26.501	155.3	0.112
80	7.939	33.987	7.931	26.509	154.7	0.128
90	7.877	33.992	7.868	26.523	153.6	0.143
100	7.846	33.995	7.836	26.529	153.1	0.158
110	7.811	33.997	7.801	26.536	152.7	0.174
120	7.790	33.998	7.778	26.541	152.4	0.189
125	7.774	33.999	7.762	26.544	152.2	0.196

APPENDIX

```
      FUNCTION BVF(PU,PL,TU,TL,SU,SL,PHID)
C     UNITS ARE (CYCLES/HOUR)**2
C     MOVE WATER ISENTROPICALLY TO MEAN PRESSURE
      SA=(SU+SL)/2.
      DP=(PL-PU)/2.
      PM=(PU+PL)/2.
      THU=THETA(PU,TU,SU,PM)
      THL=THETA(PL,TL,SL,PM)
      THA=(THU+THL)/2.
      G=GR(PHID)
      DEN=0.999975/ALPHA(PM,THA,SA)
      FS=(DEN*G*DEN*G)*(ALPHA(PM,THU,SU)-ALPHA(PM,THL,SL))
     1/(199995.*DP)
      BVF=FS*572.9578**2.
      RETURN
      END


      FUNCTION SONVEL(PO,TO,SO)
C     SOUND VELOCITY FROM FORMULA BY WILSON(1960),
C     JASA,32,1357. OUTPUT IS IN M/SEC
      P=PO*0.101976+1.03323
C     CHANGE PRESSURE TO TOTAL PRESSURE IN KM/CM**2
      S=SO-35.
C     CONVERT TEMPERATURE TO 1948 SCALE
      T=T48(TO)
      F1=1449.14+T*(4.5721+T*(-4.4532E-2+T*(-2.6045E-4
     1+T*7.9851E-6)))
      F2=1.39799+T*(-1.1244E-2+T*7.7711E-7)
      G1=F1+S*(F2+1.69202E-3*S)
      F3=1.60272E-1+T*(-1.8607E-4+T*(7.4812E-6+T*4.5283E-8))
      F4=7.7016E-5+T*(3.158E-8+T*1.5790E-9)
      G2=F3+S*F4
      F5=1.0268E-5+T*(-2.5294E-7+T*1.8563E-9)
      G3=F5-S*1.2943E-7
      G4=3.5216E-9-T*1.9646E-10
      SONVEL=G1+P*(G2+P*(G3+P*(G4-P*3.3603E-12)))
      RETURN
      END


      FUNCTION GR(PHID)
C     GRAVITY AS A FUNCTION OF LATITUDE. BULLETIN GEODESIQUE,
C     1967, SPECIAL PUBLICATION REFED. BY SAUNDERS AND FOFONOFF, DSR,23
C     DSR, 23, 109-111
C     G  IS IN CM/SEC**2
      PHI=PHID*1.745329E-2
      GR=978.0318*(1.+5.302E-3*(SIN(PHI))**2.-5.9E-6*
     1(SIN(PHI+PHI))**2.)
      END
```

```
      FUNCTION THETA(PO,TO,S,PF)
C     COMPUTES LOCAL POTENTIAL TEMPERATURE AT PF
C     FOURTH ORDER RUNGE-KUTTA INTEGRATION USING STEPS OF 1000DB
C     OR LESS. (RALSTON-WILF VOL 1 P115, EQ 26)
C     12 OCT 1975 N. FOFONOFF
      P=PO
      T=TO
      H=PF-P
      N=ABS(H)/1000.+1.
      H=H/FLOAT(N)
      DO 10 I=1,N
      XK=H*ATG(P,T,S)
      T=T+0.5*XK
      Q=XK
      P=P+0.5*H
      XK=H*ATG(P,T,S)
      T=T+0.29289322*(XK-Q)
      Q=0.58578644*XK+0.121320344*Q
      XK=H*ATG(P,T,S)
      T=T+1.707106781*(XK-Q)
      Q=3.414213562*XK-4.121320344*Q
      P=P+0.5*H
      XK=H*ATG(P,T,S)
      T=T+(XK-2.0*Q)/6.
   10 CONTINUE
      THETA=T
      RETURN
      END


      FUNCTION DELTA(PO,TO,SO)
C     CALCULATES SPECIFIC VOLUME ANOMALY TIMES 10**5
C     OUTPUT IS CL/TON
      P=PO
      F1=0.9726431+P*(1.326963403E-5+P*(-6.22760321E-12
     1-1.8851148E-16*P))
      AO=F1/(1.+1.83E-5*P)
      DELTA=1.E+5*(ALPHA(PO,TO,SO)-AO)
      END


      FUNCTION DEPTH(PO,DYNH,PHID)
C     SAUNDERS AND FOFONOFF, DSR,23,119-111
C     OUTPUT IS DEPTH IN METERS
      P=PO
      DEPTH=((0.712953+(1.113E-7-3.434E-12*P)*P)*P
     1+14190.7*ALOG(1.+1.83E-5*P))/((GR(PHID)+1.113E-4*P)*0.001)
     2+DYNH/0.98
      END
```

```
      FUNCTION SIGT(TO,SO)
C     CALCULATES SIGMA-T FROM FORMULA BY KNUDSEN REWRITTEN
C     BY FOFONOFF AND TABATA (1958).  OUTPUT IS SURFACE
C     ANOMALY OF DENSITY IN GM/ML.
C     CONVERT TO 1948 TEMPERATURES
      T=T48(TO)
      SI=SIGO(SO)
      F1=T*(4.531684262+T*(-0.5459391107+T*(-1.982483987E-3
     1-1.438030609E-7*T)))
      F2=(1.+T*(-4.7867E-3+T*(9.8185E-5-T*1.0843E-6)))
      F3=T*(1.8030E-5+T*(-8.164E-7+T*1.667E-8))
      SIGT=F1/(T+67.26)+SI*(F2+F3*SI)
      END


      FUNCTION SIGO(SO)
C     CALCULATES SIGMA-0 FROM FORMULA BY KNUDSEN.  REWRITTEN
C     BY FOFONOFF AND TABATA(1958) POG MANUSCRIPT REPORT 25.
C     OUTPUT IS IN GM/ML.
      SIGO=-0.0934458632+SO*(0.814876569+SO*(-4.824961403E-4
     1+SO*6.767861356E-6))
      END


      FUNCTION ALPHA(PO,TO,SO)
C     OUTPUT IS SPECIFIC VOLUME IN ML/GM
      P=PO
C     CONVERT TO 1948 TEMPERATURE
      T=T48(TO)
      AO=1./(1.+SIGT(TO,SO)*0.001)
      F1=4.886E-6*P/(1.+1.83E-5*P)
      SI=SIGO(SO)
      F2=-2.2072E-7+T*(3.6730E-8+T*(-6.63E-10+4.0E-12*T))
      F3=1.725E-8+T*(-3.28E-10+4.00E-12*T)
      F4=-4.5E-11+1.0E-12*T
      G1=F2+SI*(F3+SI*F4)
      F5=-6.68E-14+T*(-1.24064E-12+2.14E-14*T)
      F6=-4.248E-13+T*(1.206E-14-2.0E-16*T)
      F7=1.8E-15-6.0E-17*T
      G2=F5+SI*(F6+SI*F7)
      H1=P*(G1+P*(G2+P*1.5E-17*T))
      ALPHA=AO*(1.0-F1+H1)
      RETURN
      END
```

```
      FUNCTION POTEMP(PO,TO,SO)
      S=SO-35.
      P=PO
      T=T48(TO)
      F1=0.36504E-4+T*(0.83198E-5+T*(-0.54065E-7+T*0.40274E-9))
      F2=0.17439E-5-T*0.29778E-7
      F3=0.89309E-8-S*0.41057E-10+T*(-0.31628E-9+T*0.21987E-11)
      F4=-0.16056E-12+T*0.50484E-14
      TH=T-P*(F1+S*F2+P*(F3+P*F4))
      POTEMP=T68(TH)
      RETURN
      END


      FUNCTION T68(T)
C     CONVERTS TEMPERATURE TO 1968 SCALE
      T68=T-4.4E-6*T*(100.-T)
      END


      FUNCTIONT48(T)
C     CONVERTS 1968 SCALE TEMPS TO 1948 SCALE
      T48=T+4.4E-6*T*(100.-T)
      END


      FUNCTION ATG(PO,TO,S)
C     ADIABATIC TEMP GRADIENT. BRYDEN 1973
C     IN DEG. C/DBAR
      P=PO
      T=T48(TO)
      DS=S-35.
      ATG=(((-2.1687E-16*T+1.8676E-14)*T-4.6206E-13)*P
     1+((2.7759E-12*T-1.1351E-10)*DS+((-5.4481E-14*T
     2+8.733E-12)*T-6.7795E-10)*T+1.8741E-8))*P
     3+(-4.2393E-8*T+1.8932E-6)*DS
     4+((6.6228E-10*T-6.836E-8)*T+8.5258E-6)*T+3.5803E-5
      RETURN
      END
```