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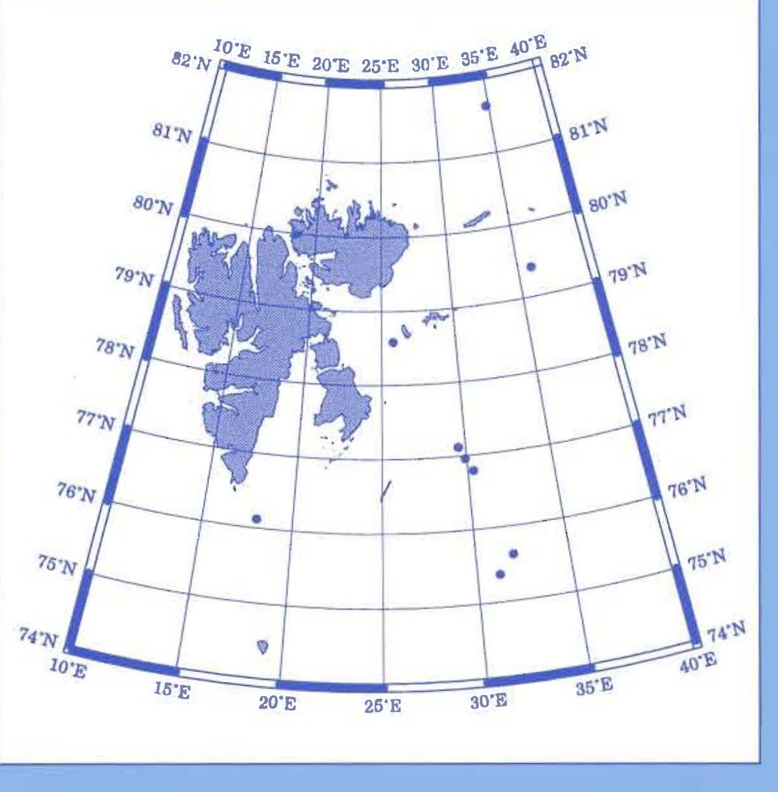
TERJE B. LØYNING AND W. PAUL BUDGELL:

PHYSICAL OCEANOGRAPHY DATA REPORT FROM THE ICEBAR CRUISE 1996



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Physical Oceanography Data Report

The physical oceanographic component of ICEBAR'96 was designed to:

1. provide a general description of the water mass and circulation characteristics of the study area,
2. characterize the influence of topography and ice cover on water mass distribution and circulation, and
3. supply information on some of the abiotic factors, such as oceanic mixing and vertical structure, which influence biomass distribution and primary productivity.

The northern Barents Sea is a region which is usually ice-covered, even in summer. The ICEBAR'96 cruise aboard R/V Lance, a vessel with "ice-breaking" capabilities, afforded a unique opportunity to map the ocean hydrography (TS) in a part of the world ocean where there previously have been few observations. The ICEBAR'96 cruise was particularly noteworthy in that, due to favorable ice conditions, stations were occupied as far north as 81.6°N. It should thus be possible to trace water mass development and evolution all the way from the Arctic Ocean to the Hopen Trough.

The area of interest in the programme, from 76°N to 81.6°N and from 25°E to 35°E, is a shelf sea with depths less than 350 m. The topography in the area is highly variable, with order (1) depth variation, that is, the variation in the bottom topography is equal to the mean depth in the region. This means that a strong barotropic (constant with depth) circulation can be expected, a part of the circulation which can not be estimated from CTD surveys. Instead, we have to measure the actual velocities in the water column. Because the R/V Lance is an ice-class vessel equipped with an ADCP (acoustic doppler current profiler), it was possible for the first time to obtain direct measurements of the currents throughout this region.

The measurement programme which was conducted from 20 July to 15 August 1996, consisted of CTD profiles, continuous ship-board ADCP sampling, ADCP moorings and DOC (dissolved organic carbon) samples. The CTD sampling was conducted along transects and during time series stations. The station spacing was generally 10 nautical miles (18 km) in order to provide regional coverage of water mass variations. When mesoscale (5 km) structures, such as the Polar Front or ice edge regimes, were anticipated, station spacing was reduced to 2 nm (3.6 km) in an attempt to resolve these small scale features.

The ship-board ADCP was run continuously throughout the cruise. In addition to the velocity profiles mentioned previously, the ADCP system logged the intensity of backscatter through the water column. These backscatter intensities seem correlated with both biomass and zooplankton densities, as well as with video observations from an ROV. It is possible that the backscatter intensities, which were collected as a byproduct, may complement some of the other measures of biological activity in the water column.

Two self-contained ADCP instruments were moored around Kvitøya in an attempt to obtain indications of the strength of tidal currents suspected to provide the mixing necessary to produce the Kvitøya polynya observed during the programme. The ice concentration and strong drift speed made recovery difficult, and only one mooring was retrieved.

Water samples were collected at various locations for subsequent DOC analysis by colleagues at SINTEF in Trondheim and the Geophysical Institute, Universiy of Bergen. It is anticipated that the DOC measurements will help characterize water mass origin and history.

Description, list and map of the CTD stations

The CTD work onboard on this cruise was organised in two six-hour shifts, with Gen Hashida (NIPR) on the 6-12 shift and Terje Brinck Løyning (NP) on the 12-6 shift. Paul Budgell filtered and analysed the data on daytime. Altogether 217 CTD stations were fulfilled, and nearly 200 water samples were taken for conductivity cell calibration and DOC measurements.

The equipment used was a Neill Brown Mark IIIB (S/N 01-2826-01) CTD with a General Oceanics Rosette sampler with 2.5 l Niskin bottles. The CTD was calibrated before the cruise at the laboratory of Ocean Scientific International in England. The analysis of the salinity was done onboard with a portable salinometer (Guildline Portasal). The results of the analysis and the comparison with the CTD measurements are presented in the next section.

The equipment worked fairly well, although the rosette sampler occasionally had some failures, especially at the largest depths (700-800 m). The failures could probably be explained by salt water in the electrical cable connections. However, the equipment is quite old (~15 years) and could therefore be a threat to the quality of the fieldwork and the measurements. The equipment is recommended renewed. On this cruise additional water samples for chemical and biological analysis had to be taken together with the salinity and DOC sampling. The 2.5 l Niskin bottles were in this case of marginal size. The use of 5 l or even 10 l sampling bottles should be considered for the next cruises. It would also be wise to have equipment which could allow manual sampling (i.e. manual winch and messengers) as a backup in case the electronics should fail.

The CTD profiles are averaged over 2 m and written in ASCII files. The ASCII files are available on either laser disks (CD) or Digital Audio Tapes (DAT).

Table 1: List of CTD stations

St.	Act	Date+CET	Depth	Ice	Latitude	Longitude	Gear	Sample	Sign.	St.
ABC	ABCDE	YYMMDDHHMM	000	0	0000.00N	0000.00E	ABC	ABCD	AB	ABC
-	HS0001	9607211235	253	0	7607.30N	1800.00E	CTD	TCSP	PB	
-	HS0002	9607211530	41	0	7546.25N	1959.50E	CTD	TCSP	PB	Bird 1
-	HS0003	9607212345	152	0	7524.37N	2459.46E	CTD	TCSP	PB	Bird 1
-	HS0004	9607220800	378	0	7459.79N	2958.60E	CTD	TCSP	PB	Bird 1
-	HS0005	9607221030	370	0	7507.73N	3023.48E	CTD	TCSP	PB	Bird 2
-	HS0006	9607221150	372	0	7515.16N	3046.57E	CTD	TCSP	PB	Bird 2
-	HS0007	9607221315	348	0	7522.25N	3111.08E	CTD	TCSP	PB	Bird 2
-	HS0008	9607221430	350	0	7529.96N	3134.95E	CTD	TCSP	PB	Bird 2
-	HS0009	9607221550	331	0	7537.34N	3200.40E	CTD	TCSP	PB	Bird 2
-	HS0010	9607221617	322	0	7545.08N	3226.33E	CTD	TCSP	PB	Bird 2
-	HS0011	9607221830	286	0	7552.65N	3251.66E	CTD	TCSP	PB	Bird 2
-	HS0012	9607222003	304	0	7600.16N	3316.49E	CTD	TCSP	PB	Bird 2
-	HS0013	9607222130	291	0	7607.78N	3342.80E	CTD	TCSP	PB	Bird 2
-	HS0014	9607222255	316	0	7615.99N	3410.91E	CTD	TCSP	PB	Bird 2
-	HS0015	9607230005	275	0	7621.92N	3430.06E	CTD	TCSP	PB	Bird 2
-	HS0016	9607230111	241	0	7626.92N	3449.96E	CTD	TCSP	PB	Bird 2
-	HS0017	9607230150	243	0	7627.56N	3448.39E	CTD	TCSP	PB	Sect A
-	HS0018	9607230305	194	0	7638.34N	3449.81E	CTD	TCSP	PB	Sect A
-	HS0019	9607230415	135	0	7648.67N	3449.37E	CTD	TCSP	PB	Sect A
-	HS0020	9607230607	119	0	7659.36N	3449.18E	CTD	TCSP	PB	Sect A
-	HS0021	9607230730	148	0	7709.17N	3449.36E	CTD	TCSP	PB	Sect A
-	HS0022	9607230912	170		7719.07N	3448.95E	CTD	TCSP	PB	Sect A
-	HS0023	9607230912	203	3	7729.07N	3446.70E	CTD	TCSP	PB	Sect A
-	HS0024	9607231337	203	1	7726.67N	3450.02E	CTD	TCSP	PB	Sect A
-	HS0025	9607231438	196		7724.38N	3450.37E	CTD	TCSP	PB	Sect A
-	HS0026	9607231515	179		7722.40N	3449.25E	CTD	TCSP	PB	Sect A
-	HS0027	9607231548	162		7720.23N	3450.35E	CTD	TCSP	PB	Sect A
-	HS0028	9607231622	160		7715.12N	3450.03E	CTD	TCSP	PB	Sect A
-	HS0029	9607231820	194		7724.07N	3449.40E	CTD	TCSP	PB	Sect A
-	HS0030	9607231925	200		7726.07N	3449.80E	CTD	TCSP	PB	Sect A
-	HS0031	9607232000	199	1	7728.05N	3450.20E	CTD	TCSP	PB	Sect A
-	HS0032	9607232110	216	3	7730.06N	3447.55E	CTD	TCSP	PB	Sect A
-	HS0033	9607232156	200	3	7732.10N	3450.63E	CTD	TCSP	PB	Sect A
-	HS0034	9607232235	203	3	7734.15N	3450.30E	CTD	TCSP	PB	Sect A
-	HS0035	9607232316	194	1	7736.08N	3450.73E	CTD	TCSP	PB	Sect A
-	HS0036	9607232353	188	1	7738.07N	3445.70E	CTD	TCSP	PB	Sect A
-	HS0037	9607240041	162	1	7739.99N	3449.92E	CTD	TCSP	PB	Sect A
-	HS0038	9607240130	177	1	7742.66N	3449.52E	CTD	TCSP	PB	Sect A
-	HS0039	9607240223	182	1	7744.20N	3450.07E	CTD	TCSP	PB	Sect A
-	HS0040	9607240344	188	1	7746.58N	3450.61E	CTD	TCSP	PB	Sect A/Q
-	HS0041	9607240420	173	1	7748.84N	3450.39E	CTD	TCSP	PB	Sect A/Q
-	HS0042	9607240454	164	1	7751.09N	3450.23E	CTD	TCSP	PB	Sect A/Q
-	HS0043	9607240530	186	1	7752.92N	3449.79E	CTD	TCSP	PB	Sect A/Q
-	HS0044	9607240615	192	3	7755.04N	3449.41E	CTD	TCSP	PB	Sect A
-	HS0045	9607240640	173	3	7756.06N	3450.19E	CTD	TCSP	PB	Sect A/Q
-	HS0046	9607240715	148	3	7758.15N	3450.09E	CTD	TCSP	PB	Sect A/Q
-	HS0047	9607240750	147	3	7800.06N	3451.15E	CTD	TCSP	PB	Sect A/Q
-	HS0048	9607240820	135	5	7802.04N	3451.06E	CTD	TCSP	PB	Sect A/Q
-	HS0049	9607240915	161	5	7804.01N	3444.13E	CTD	TCSP	PB	Sect A

-	HS0050	9607241207	242	7812.57N	3424.21E	CTD	TCSP	PB	Sect A
-	HS0051	9607241433	114	7823.08N	3431.95E	CTD	TCSP	PB	Sect A
-	HS0052	9607241635	202	7832.53N	3428.65E	CTD	TCSP	PB	Sect A
-	HS0053	9607241800	306	7843.04N	3413.22E	CTD	TCSP	PB	Sect A
-	HS0054	9607241955	285	7853.09N	3420.57E	CTD	TCSP	PB	Sect A
-	HS0055	9607242125	245	7903.41N	3421.25E	CTD	TCSP	PB	Sect A
-	HS0056	9607242330	213	7913.23N	3420.50E	CTD	TCSP	PB	Sect A
-	HS0057	9607250115	253	7920.14N	3350.96E	CTD	TCSP	PB	Sect A
-	HS0058	9607250247	291	7930.39N	3340.21E	CTD	TCSP	PB	Sect A
-	HS0059	9607250420	352	7940.19N	3344.73E	CTD	TCSP	PB	Sect A
-	HS0060	9607250551	253	7950.24N	3348.17E	CTD	TCSP	PB	Sect A
-	HS0061	9607250725	215	8000.11N	3347.45E	CTD	TCSP	PB	Sect A
-	HS0062	9607251232	70	8000.37N	3221.37E	ADM	UVTW	PB	ADCP 1
-	HS0063	9607251554	212	7959.97N	3400.54E	CTD	TCSP	PB	Sect A
-	HS0064	9607251731	222	8010.11N	3359.98E	CTD	TCSP	PB	Sect A
-	HS0065	9607251850	242	8020.13N	3359.85E	CTD	TCSP	PB	Sect A
-	HS0066	9607252000	170	8029.88N	3400.20E	CTD	TCSP	PB	Sect A
-	HS0067	9607252155	50	8030.16N	3315.14E	ADM	UVTW	PB	ADCP 2
-	HS0068	9607260059	167	8040.11N	3340.02E	CTD	TCSP	PB	Sect A
-	HS0069	9607260327	177	8050.13N	3418.54E	CTD	TCSP	PB	Sect A
-	HS0070	9607260543	223	8100.12N	3412.71E	CTD	TCSP	PB	Sect A
-	HS0071	9607260750	188	8110.45N	3405.74E	CTD	TCSP	PB	Sect A
-	HS0072	9607261000	200	8120.17N	3328.88E	CTD	TCSP	PB	Sect A
-	HS0073	9607261150	194	8129.98N	3325.26E	CTD	TCSP	PB	Sect A
-	HS0074	9607261425	226	8130.72N	3413.01E	CTD	TCSP	PB	Sect A
-	HS0075	9607262030	261	8133.22N	3432.18E	CTD	TCSP	PB	Sect A
-	HS0076	9607262330	263	8131.81N	3418.67E	CTD	TCSP	PB	Sect A
I1A-	HS0077	9607271406	270	8133.02N	3445.67E	CTD	TCSP	PB	
I1A-	HS0078	9607272005	271	8134.06N	3452.22E	CTD	TCSP	PB	
I1A-	HS0079	9607272300	278	8133.88N	3454.08E	CTD	TCSP	PB	
I1A-	HS0080	9607280204	271	8133.72N	3451.68E	CTD	TCSP	PB	
I1A-	HS0081	9607280504	275	8134.10N	3451.05E	CTD	TCSP	PB	
I1A-	HS0082	9607280800	281	8134.23N	3452.68E	CTD	TCSP	PB	
I1A-	HS0083	9607281100	283	8134.26N	3453.14E	CTD	TCSP	PB	
I1A-	HS0084	9607281400	273	8133.81N	3457.78E	CTD	TCSP	PB	
I1A-	HS0085	9607281720	266	8133.54N	3450.27E	CTD	TCSP	PB	
I1A-	HS0086	9607282000	213	8133.25N	3450.70E	CTD	TCSP	PB	
I1A-	HS0087	9607282300	267	8132.68N	3449.54E	CTD	TCSP	PB	
I1A-	HS0088	9607290237	259	8137.95N	3445.28E	CTD	TCSP	PB	
I1A-	HS0089	9607290610	260	8131.51N	3442.50E	CTD	TCSP	PB	
I1A-	HS0090	9607290810	258	8131.41N	3440.67E	CTD	TCSP	PB	
I1A-	HS0091	9607290940	256	8131.47N	3440.53E	CTD	TCSP	PB	
I1A-	HS0092	9607291100	257	8131.20N	3438.92E	CTD	TCSP	PB	
I1A-	HS0093	9607291305	254	8130.92N	3437.88E	CTD	TCSP	PB	
I1A-	HS0094	9607291437	263	8130.81N	3437.11E	CTD	TCSP	PB	
I1A-	HS0095	9607291600	250	8130.53N	3437.43E	CTD	TCSP	PB	
I1A-	HS0096	9607291705	250	8130.30N	3437.27E	CTD	TCSP	PB	
I1A-	HS0097	9607291800	240	8130.13N	3436.63E	CTD	TCSP	PB	
I1A-	HS0098	9607292045	238	8130.00N	3433.51E	CTD	TCSP	PB	
I1A-	HS0099	9607292305	233	8130.00N	3431.84E	CTD	TCSP	PB	
I1A-	HS0100	9607300204	234	8129.66N	3432.39E	CTD	TCSP	PB	
I1A-	HS0101	9607300500	226	8129.14N	3433.63E	CTD	TCSP	PB	

I1A-	HS0102	9607300600	226	8128.90N	3433.65E	CTD	TCSP	PB	
I1A-	HS0103	9607300800	223	8128.58N	3433.63E	CTD	TCSP	PB	
I1A-	HS0104	9607301000	219	8128.24N	3432.97E	CTD	TCSP	PB	
I1A-	HS0105	9607301130	213	8128.06N	3431.25E	CTD	TCSP	PB	
I1A-	HS0106	9607301410	213	8127.98N	3429.65E	CTD	TCSP	PB	
I1A-	HS0107	9607301450	215	8127.86N	3429.91E	CTD	TCSP	PB	
I1A-	HS0108	9607301540	208	8127.74N	3430.36E	CTD	TCSP	PB	
I1A-	HS0109	9607301630	215	8127.70N	3430.54E	CTD	TCSP	PB	
I1A-	HS0110	9607301656	214	8127.50N	3430.90E	CTD	TCSP	PB	
I1A-	HS0111	9607302000	200	8126.20N	3431.80E	CTD	TCSP	PB	
I1A-	HS0112	9607302300	190	8125.43N	3427.19E	CTD	TCSP	PB	
I1A-	HS0113	9607310200	197	8125.36N	3424.19E	CTD	TCSP	PB	
I1A-	HS0114	9607310500	185	8124.63N	3425.75E	CTD	TCSP	PB	
I1A-	HS0115	9607310800	178	8124.64N	3425.70E	CTD	TCSP	PB	
I0A-	HS0116	9608010740	818	8136.77N	3254.90E	CTD	TCSP	PB	
I0A-	HS0117	9608010500	706	8135.57N	3300.63E	CTD	TCSP	PB	
I0A-	HS0118	9608011128	790	8134.23N	3249.88E	CTD	TCSP	PB	
I0A-	HS0119	9608011550	678	8134.47N	3259.29E	CTD	TCSP	PB	
I0A-	HS0120	9608012250	434	8132.40N	3306.23E	CTD	TCSP	PB	
I0A-	HS0121	9608012300	488	8132.32N	3303.16E	CTD	TCSP	PB	
I0A-	HS0122	9608020550	229	8131.08N	3314.80E	CTD	TCSP	PB	
I0A-	HS0123	9608020800	188	8130.89N	3315.33E	CTD	TCSP	PB	
I0A-	HS0124	9608021644	186	8129.98N	3225.30E	CTD	TCSP	PB	
-	HS0125	9608031635	215	8022.56N	3408.87E	CTD	TCSP	PB	Tucker T
-	HS0126	9608040845	126	8008.43N	3459.71E	CTD	TCSP	PB	Kvit Sec
-	HS0127	9608040915	140	8008.38N	3447.44E	CTD	TCSP	PB	Kvit Sec
-	HS0128	9608040942	234	8008.04N	3435.03E	CTD	TCSP	PB	Kvit Sec
-	HS0129	9608040942	232	8008.04N	3435.03E	CTD	TCSP	PB	Kvit Sec
-	HS0130	9608041013	215	8008.52N	3422.59E	CTD	TCSP	PB	Kvit Sec
-	HS0131	9608041046	221	8008.48N	3410.57E	CTD	TCSP	PB	Kvit Sec
-	HS0132	9608041118	239	8008.63N	3358.96E	CTD	TCSP	PB	Kvit Sec
-	HS0133	9608041154	217	8009.25N	3347.15E	CTD	TCSP	PB	Kvit Sec
-	HS0134	9608041225	167	8009.49N	3338.65E	CTD	TCSP	PB	Kvit Sec
I2A-	HS0135	9608050812	320	7928.76N	3215.41E	CTD	TCSP	PB	
I2A-	HS0136	9608051055	306	7930.05N	3236.09E	CTD	TCSP	PB	
I2A-	HS0137	9608051405	312	7928.66N	3237.91E	CTD	TCSP	PB	
I2A-	HS0138	9608051720	298	7928.37N	3236.81E	CTD	TCSP	PB	
I2A-	HS0139	9608052011	303	7930.14N	3244.83E	CTD	TCSP	PB	
I2A-	HS0140	9608052308	297	7929.28N	3255.53E	CTD	TCSP	PB	
I2A-	HS0141	9608060200	295	7927.72N	3258.29E	CTD	TCSP	PB	
I2A-	HS0142	9608061000	298	7930.05N	3220.10E	CTD	TCSP	PB	
I2A-	HS0143	9608061554	307	7930.00N	3321.29E	CTD	TCSP	PB	
-	HS0144	9608070300	76	7911.08N	3200.64E	CTD	TCSP	PB	Sect B
-	HS0145	9608070353	82	7905.17N	3217.05E	CTD	TCSP	PB	Sect B
-	HS0146	9608070452	221	7859.59N	3236.62E	CTD	TCSP	PB	Sect B
-	HS0147	9608070550	294	7853.52N	3253.27E	CTD	TCSP	PB	Sect B
-	HS0148	9608070653	256	7847.35N	3310.91E	CTD	TCSP	PB	Sect B
-	HS0149	9608070750	294	7841.54N	3329.08E	CTD	TCSP	PB	Sect B
-	HS0150	9608070850	265	7835.80N	3347.24E	CTD	TCSP	PB	Sect B
-	HS0151	9608070955	179	7829.53N	3403.99E	CTD	TCSP	PB	Sect B
-	HS0152	9608071103	89	7822.25N	3425.64E	CTD	TCSP	PB	Sect B
I3A-	HS0153	9608081208	161	7832.42N	2550.04E	CTD	TCSP	PB	

I3A-	HS0154	9608081419	171	7832.00N	2550.39E	CTD	TCSP	PB	
I3A-	HS0155	9608081808	160	7832.60N	2546.41E	CTD	TCSP	PB	
I3A-	HS0156	9608082023	151	7833.72N	2545.93E	CTD	TCSP	PB	
I3A-	HS0157	9608082300	151	7833.75N	2546.10E	CTD	TCSP	PB	
I3A-	HS0158	9608090200	129	7834.93N	2546.85E	CTD	TCSP	PB	
I3A-	HS0159	9608090508	126	7835.55N	2545.90E	CTD	TCSP	PB	
I3A-	HS0160	9608091000	91	7839.90N	2548.28E	CTD	TCSP	PB	
I3A-	HS0161	9608091410	86	7839.90N	2553.58E	CTD	TCSP	PB	
-	HS0162	9608092040	92	7841.61N	2549.50E	CTD	TCSP	PB	Sect C
-	HS0163	9608092115	96	7839.76N	2545.34E	CTD	TCSP	PB	Sect C
-	HS0164	9608092151	122	7838.18N	2540.12E	CTD	TCSP	PB	Sect C
-	HS0165	9608092223	139	7836.42N	2536.59E	CTD	TCSP	PB	Sect C
-	HS0166	9608092302	149	7834.65N	2532.20E	CTD	TCSP	PB	Sect C
-	HS0167	9608092328	178	7832.65N	2528.18E	CTD	TCSP	PB	Sect C
-	HS0168	9608092355	181	7830.60N	2524.03E	CTD	TCSP	PB	Sect C
-	HS0169	9608100028	186	7828.72N	2519.80E	CTD	TCSP	PB	Sect C
-	HS0170	9608100050	186	7826.90N	2515.69E	CTD	TCSP	PB	Sect C
-	HS0171	9608100118	202	7824.88N	2511.77E	CTD	TCSP	PB	Sect C
-	HS0172	9608100147	196	7825.03N	2511.89E	CTD	TCSP	PB	Sect C
-	HS0173	9608100210	143	7820.58N	2501.84E	CTD	TCSP	PB	Sect C
-	HS0174	9999999999	-999	9999.99N	9999.99E	CTD	TCSP	PB	Missing
-	HS0175	9608100240	141	7818.62N	2457.40E	CTD	TCSP	PB	Sect C
-	HS0176	9608100318	116	7816.75N	2453.31E	CTD	TCSP	PB	Sect C
-	HS0177	9608100329	97	7814.77N	2449.23E	CTD	TCSP	PB	Sect C
-	HS0178	9608100350	82	7812.83N	2445.39E	CTD	TCSP	PB	Sect C
-	HS0179	9608100410	76	7810.98N	2441.33E	CTD	TCSP	PB	Sect C
O1A-	HS0180	9608100927	160	7745.52N	2525.35E	CTD	TCSP	PB	
O1A-	HS0181	9608101324	159	7743.77N	2525.69E	CTD	TCSP	PB	
O1A-	HS0182	9608101910	167	7743.51N	2536.17E	CTD	TCSP	PB	
O1A-	HS0183	9608102220	168	7743.99N	2535.68E	CTD	TCSP	PB	
-	HS0184	9608120007	132	7804.35N	2527.76E	CTD	TCSP	PB	Leg 1
-	HS0185	9608120111	192	7800.92N	2605.43E	CTD	TCSP	PB	Leg 1
-	HS0186	9608120220	160	7801.77N	2653.79E	CTD	TCSP	PB	Leg 1
-	HS0187	9608120330	245	7803.26N	2740.72E	CTD	TCSP	PB	Leg 1
-	HS0188	9608120442	291	7804.34N	2829.04E	CTD	TCSP	PB	Leg 1
-	HS0189	9608120317	323	7805.52N	2913.53E	CTD	TCSP	PB	Leg 2
-	HS0190	9608120705	292	7756.77N	2934.61E	CTD	TCSP	PB	Leg 2
-	HS0191	9608120829	239	7747.91N	2957.35E	CTD	TCSP	PB	Leg 2
-	HS0192	9608120950	217	7734.82N	3028.18E	CTD	TCSP	PB	Leg 2
-	HS0193	9608121052	202	7726.83N	3029.08E	CTD	TCSP	PB	Leg 3
-	HS0194	9608121135	192	7721.44N	3028.70E	CTD	TCSP	PB	Leg 3
-	HS0195	9608121203	188	7719.58N	3028.54E	CTD	TCSP	PB	Leg 3
-	HS0196	9608121228	188	7717.63N	3027.78E	CTD	TCSP	PB	Leg 3
-	HS0197	9608121253	188	7715.79N	3026.79E	CTD	TCSP	PB	Leg 3
-	HS0198	9608121319	195	7713.60N	3026.20E	CTD	TCSP	PB	Leg 3
-	HS0199	9608121347	202	7711.44N	3026.18E	CTD	TCSP	PB	Leg 3
-	HS0200	9608121429	206	7706.77N	3024.94E	CTD	TCSP	PB	Leg 3
-	HS0201	9608121537	238	7657.18N	3021.80E	CTD	TCSP	PB	Leg 3
-	HS0202	9608121654	252	7647.19N	3018.76E	CTD	TCSP	PB	Leg 3
-	HS0203	9608121811	242	7656.16N	3038.18E	CTD	TCSP	PB	Leg 4
~	HS0204	9608121935	216	7706.34N	3101.98E	CTD	TCSP	PB	Leg 4
-	HS0205	9608122150	150	7716.40N	3124.26E	CTD	TCSP	PB	Leg 5

-	HS0206	9608122250	179	7716.51N	3043.07E	CTD	TCSP	PB	Leg 5
-	HS0207	9608122352	184	7716.53N	3002.64E	CTD	TCSP	PB	Leg 5
-	HS0208	9608130105	178	7716.51N	2914.60E	CTD	TCSP	PB	Leg 5
-	HS0209	9608130247	198	7707.20N	2934.36E	CTD	TCSP	PB	Leg 6
-	HS0210	9608130350	240	7657.69N	2954.84E	CTD	TCSP	PB	Leg 6
-	HS0211	9608130511	254	7647.22N	3019.69E	CTD	TCSP	PB	Leg 6
-	HS0212	9608130644	258	7645.80N	2936.52E	CTD	TCSP	PB	Leg 7
-	HS0213	9608130751	222	7644.61N	2853.84E	CTD	TCSP	PB	Leg 7
-	HS0214	9608130858	152	7643.44N	2811.00E	CTD	TCSP	PB	Leg 7
-	HS0215	9608131000	113	7642.09N	2718.63E	CTD	TCSP	PB	Leg 7
-	HS0216	9608131102	88	7640.16N	2644.53E	CTD	TCSP	PB	Leg 7
-	HS0217	9608131230	26	7639.90N	2537.79E	CTD	TCSP	PB	Leg 7

ICE-BAR '96 CTD stations

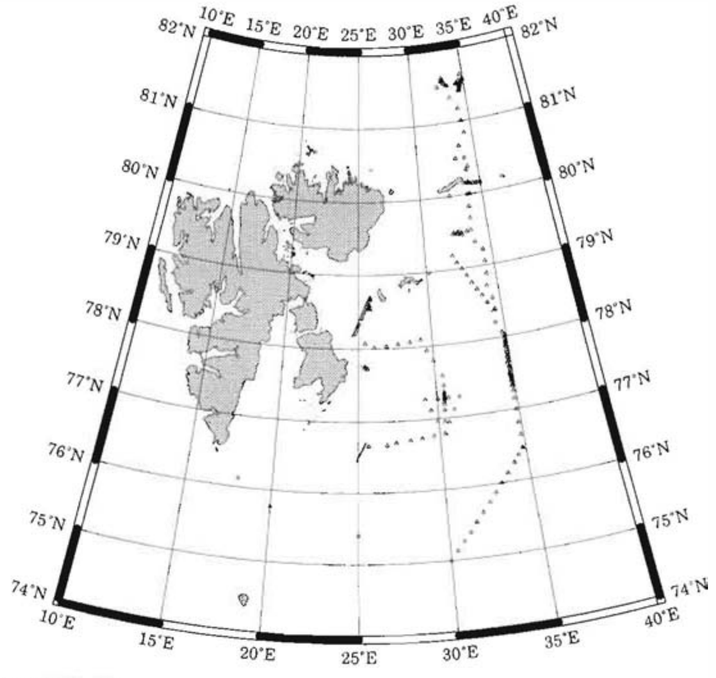


Figure 1: Map of CTD stations.

Comparison of the CTD-measured salinity and the salinity measured in the water samples

Close to 200 water samples were collected during the cruise, and 150 of them were analysed onboard and included in this comparison. Figure 2 is a scatter plot of the difference between the CTD-measured salinity and the salinity measured in the water samples. We can see that there is a larger spread in the upper parts of the water layers, although there are some outliers around 150 m and close to 250 m. A larger spread in the upper layers can be explained by a larger variability over depths so small that the water sample actually had different properties when measured by the CTD.

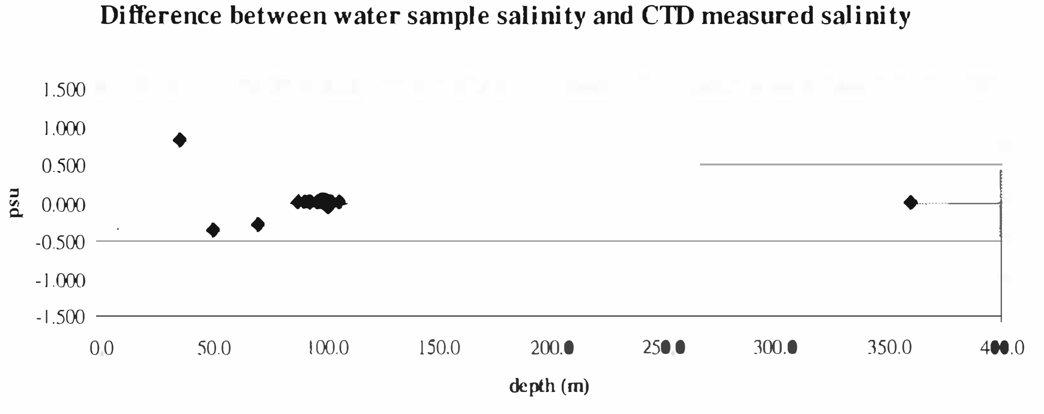


Figure 2: The difference between water sample salinity and CTD measured salinity vs. depth.

Table 2 gives a summary of the descriptive statistics of the differences represented in fig. 2.

Table 2: Statistics of the differences between the CTD-measured salinity and the salinity measured in the water samples.

Statistics of the differences	
Mean	0.02113972
Standard error	0.019628591
Median	0.013166667
Mode	0.009
Standard deviation	0.241997526
Sample variance	0.058562802
Range	2.546
Minimum	-1.487
Maximum	1.059
Count	152
Largest(1)	1.059
Smallest(1)	-1.487
Confidence level(99.0%)	0.051206606

If we arrange the observed differences in percentiles and plot them as in fig. 3, we clearly see that the most extreme differences are contained in the lower (10^{th}) and upper (90^{th}) percentiles.

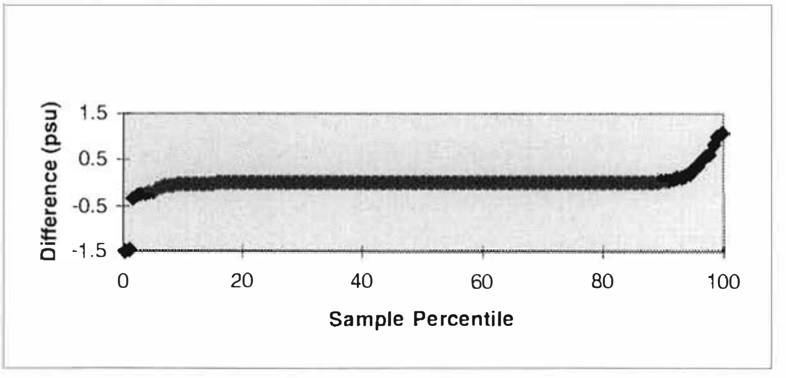


Figure 3: Observed differences arranged in percentiles.

We think that the values between the 10^{th} and 90^{th} percentile are more representative as a correction value to the CTD measurements than the more extreme values at both ends in fig. 3. The median value in table 3 will therefore be a more "proper" value as a correction to the CTD measurements. To verify this, we removed the lower (10^{th}) and the upper (90^{th}) percentiles from the original observations, to get a trimmed mean from the remaining observations. The statistics from the reduced data set are presented in table 3. We can see from table 3 that the median is unchanged from table 2, but that the mean is closer to the median in the reduced data set (table 3) than in the original data set (table 2).

Table 3: Trimmed statistics of the differences between the CTD-measured salinity and the salinity measured in the water samples.

Trimmed statistics of the differences	
Mean	0.014134734
Standard error	0.000758386
Median	0.013
Mode	0.009
Standard deviation	0.008273018
Sample variance	6.84428E-05
Range	0.048
Minimum	-0.005
Maximum	0.043
Count	119
Largest(1)	0.043
Smallest(1)	-0.005
Confidence level(99.0%)	0.001985565

A regression analysis on this reduced data set was also performed, with the CTD-measured salinity as the independent variable and the water sample salinity as the dependent value. The R Square in the first part of the table 4 represents the proportion of the variability of the water sample salinity explained by the linear relation with the CTD salinity. R itself will be the correlation coefficient of the water sample salinity and the CTD salinity. As expected R is close to one.

The last part of table 4 gives us the coefficients of the linear relation $y = \alpha x x + \beta$, where α= 0.9981 and β=0.05134. The variable x represents the measured salinity by the CTD and the variable y will then represent the corrected value of salinity. The linear relation is graphically presented in fig. 4.

The second part of table 4, consists of coefficients from an analysis of variation (ANOVA). The first column is degree of freedom (df), the second sum of squares (SS), the third mean square (MS) and the two last columns are used for test of the hypothesis that there is no linear relation. The table tells us that most of the variation is explained by a linear relation, and a small portion of the variation is unexplained (due to errors). The latter conclusion can also be seen in fig. 5, where the residuals are spread randomly around zero.

Table 4: Regression analysis.

Regression statistics	
Multiple R	0.99993
R Square	0.99987
Adjusted R square	0.99987
Standard error	0.00820
Observations	119

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	59.0864	59.0864	879397.6	1.311E-228
Residual	117	0.0079	0.0001		
Total	118	59.0942			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	0.05134008	0.036603946	1.402583	0.163389	-0.02115211	0.1238323
CTD salinity	0.99809578	0.001064338	937.762	1.3E-228	0.995987913	1.0002036

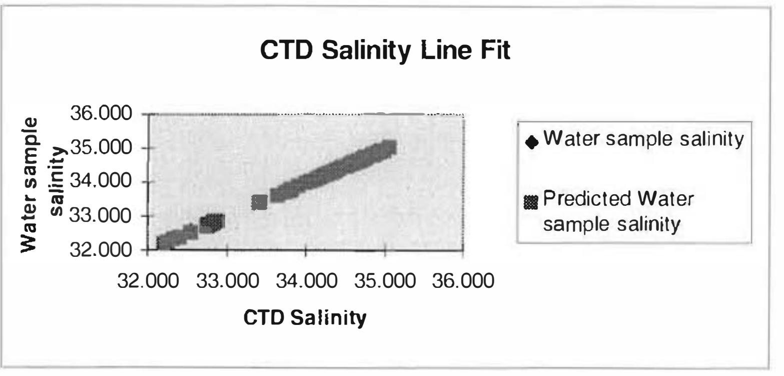


Figure 4: Regression line.

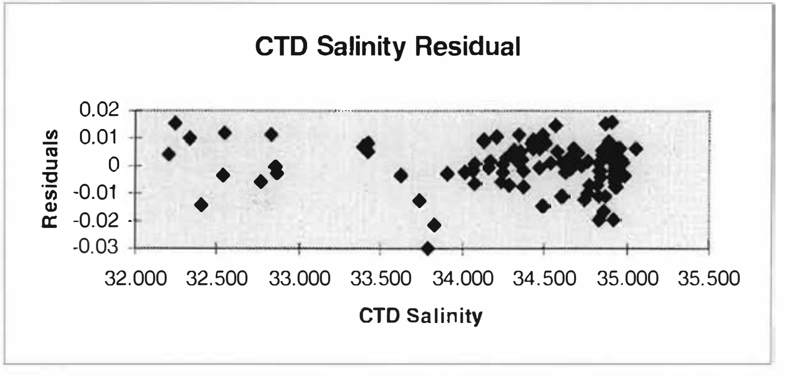


Figure 5 Plot of the residuals, i.e. differences between CTD measured salinity and salinity in the water samples.

List and map of DOC sampling

60 samples of Dissolved Organic Carbon (DOC) were taken. The map shows the locations of the sampling, where more than half of the samples where collected at the ice floe stations. The rest were sampled in open water.

At the three ice floe stations, four samples from three depths were taken: at the bottom, in the mid depth and at the surface. Two of the samples at each depth were filtered.

All samples were frozen immediately to be transported to the Norwegian University of Science and Technology, Department of Biotechnology, in Trondheim for analysis after the cruise.

DCM 12 Deployments and recovery

Deployments

Originally the DCM 12 moorings were planned to be set out at 70 m depths in Russian sector. However, denial from Russian authorities to allow the Lance cruise operate in the

Russian sector led to a change of cruise plans, and we had to look for deployment positions west of the 35E longitude.

The pressure sensor in the instrument is constructed with a pressure range of 0-100 psia which equals 0-70 m. There are few locations where such depths can be found, but proper positions were found on the shallow banks around Kvitøya. The first mooring was deployed south of Kvitøya at 12:30 (local time) on 25 July at position N80° 00.268 E32°21.3, at 69 m. The second mooring was deployed north of Kvitøya at 21:55 (local time) on the same day at position N80° 30.136 E33° 15.206 at 50 m. The weather and ice conditions were good, sunshine and ice free (open) waters. Because of the good weather conditions, we decided to put a line from the end of the ground line and up to the surface with surface floats.

ICE-BAR '96 DOC stations

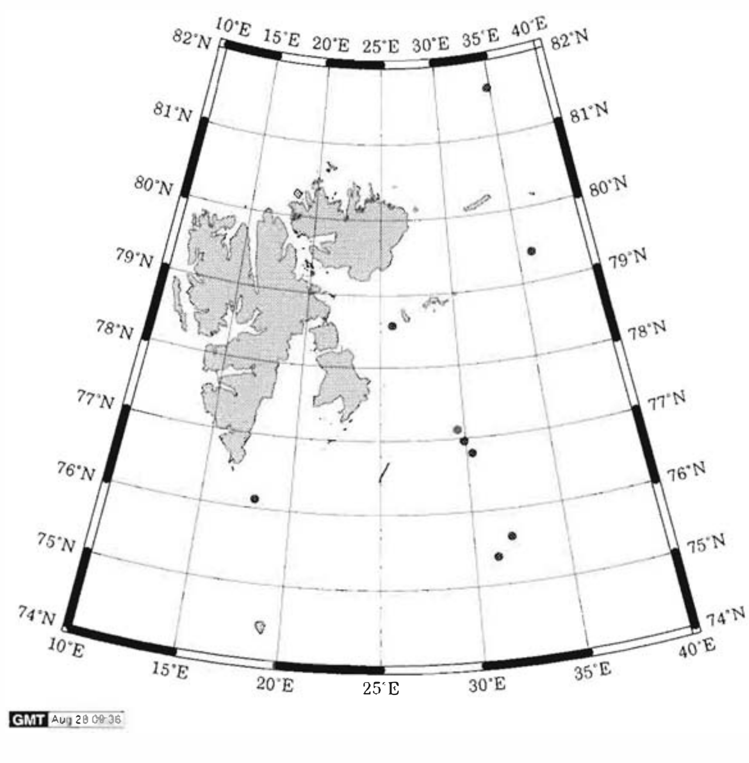


Figure 6: Map of DOC sampling stations.

Recovery

We arrived at the northern DCM 12 mooring in the morning on 4 August, 11 days after deployment. After several days with northerly winds, the shallow banks were covered with multiyear ice floes and the sea ice concentration was 2-3. The surface floats were not found. The ice concentration, in addition to strong drift, made dragging difficult and two dragging attempts were made, unsuccessfully. We left the area to continue the research program, but came back to the northern position the same afternoon. The weather and ice conditions were now more favourable for dragging. However, this dragging was not successful either.

We then steamed south of Kvitøya, to retrieve the southern mooring. This bank was also covered with ice, although the waters around the bank were ice free. The surface floats were not to be found. We dragged twice, and the second attempt was successful, with the mooring on deck at 01:10 the 5. July. The DCM 12 tent was broken and filled with stones and gravel. The mooring had apparently been dragged along the bottom. A handle on the top of the instrument was broken off, but the external battery package and the instrument itself had not been damaged. The mooring line was cut off close to the end, i.e. most of the line was recovered. The instrument recordings could probably reveal when dragging occurred, and thereby tell if the mooring was dragged by ice or by Lance.

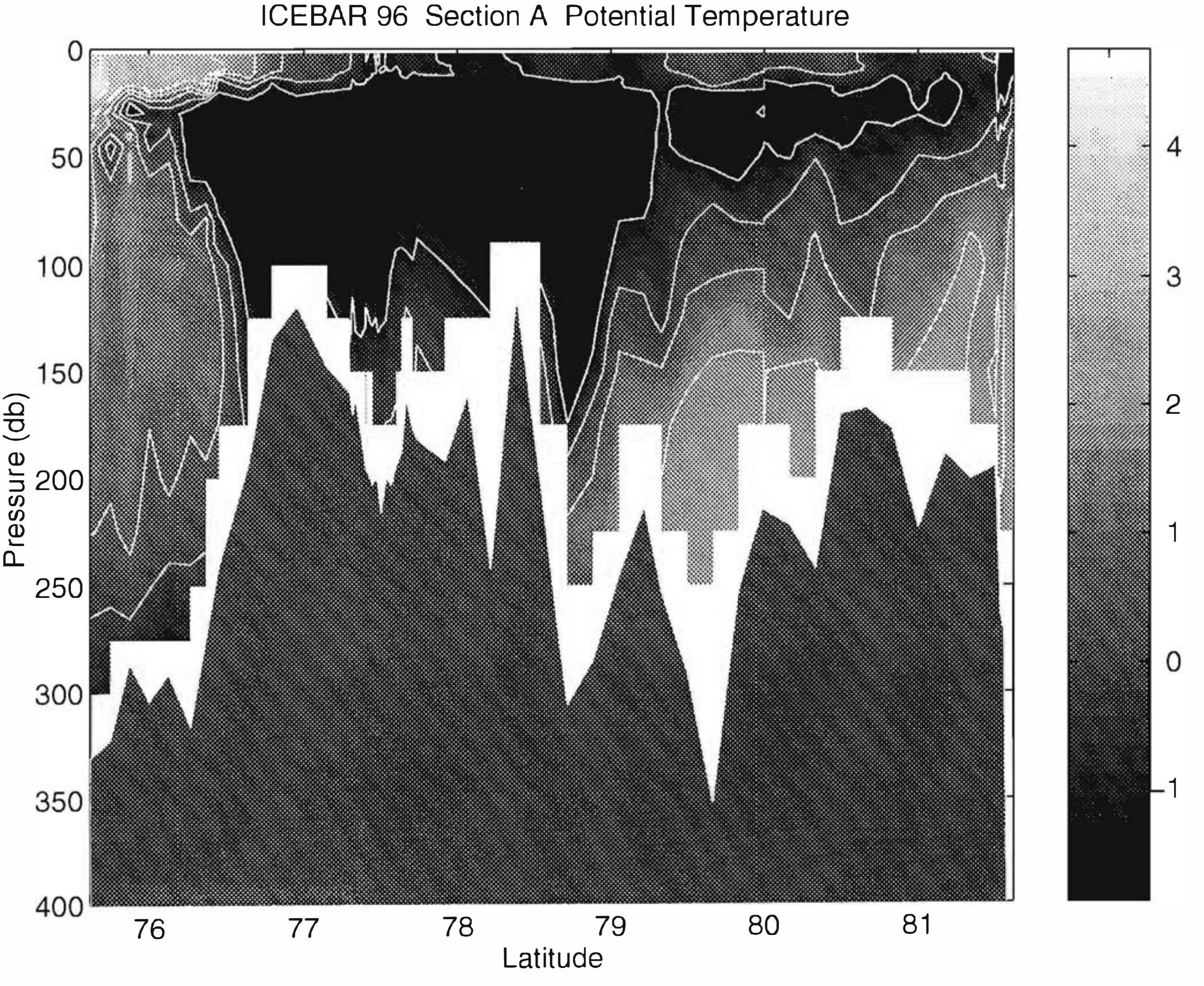
Possible explanations of the unsuccessful recovery of one DCM 12:

- The surface floats had probably been taken by the drifting ice.
- There are strong tidal currents around these shallow banks. The drift of the vessel were measured to be around 3 knots. (The ADCP onboard Lance will give a more accurate current velocity.) Due to the properties of the pressure sensor in the DCM 12's as mentioned above, the instruments had to be deployed on these shallow banks, if they were to be deployed at all.
- It is possible that a wrong type of dragging anchor was used. We used another dragging anchor for the DCM 12 that was successfully recovered.

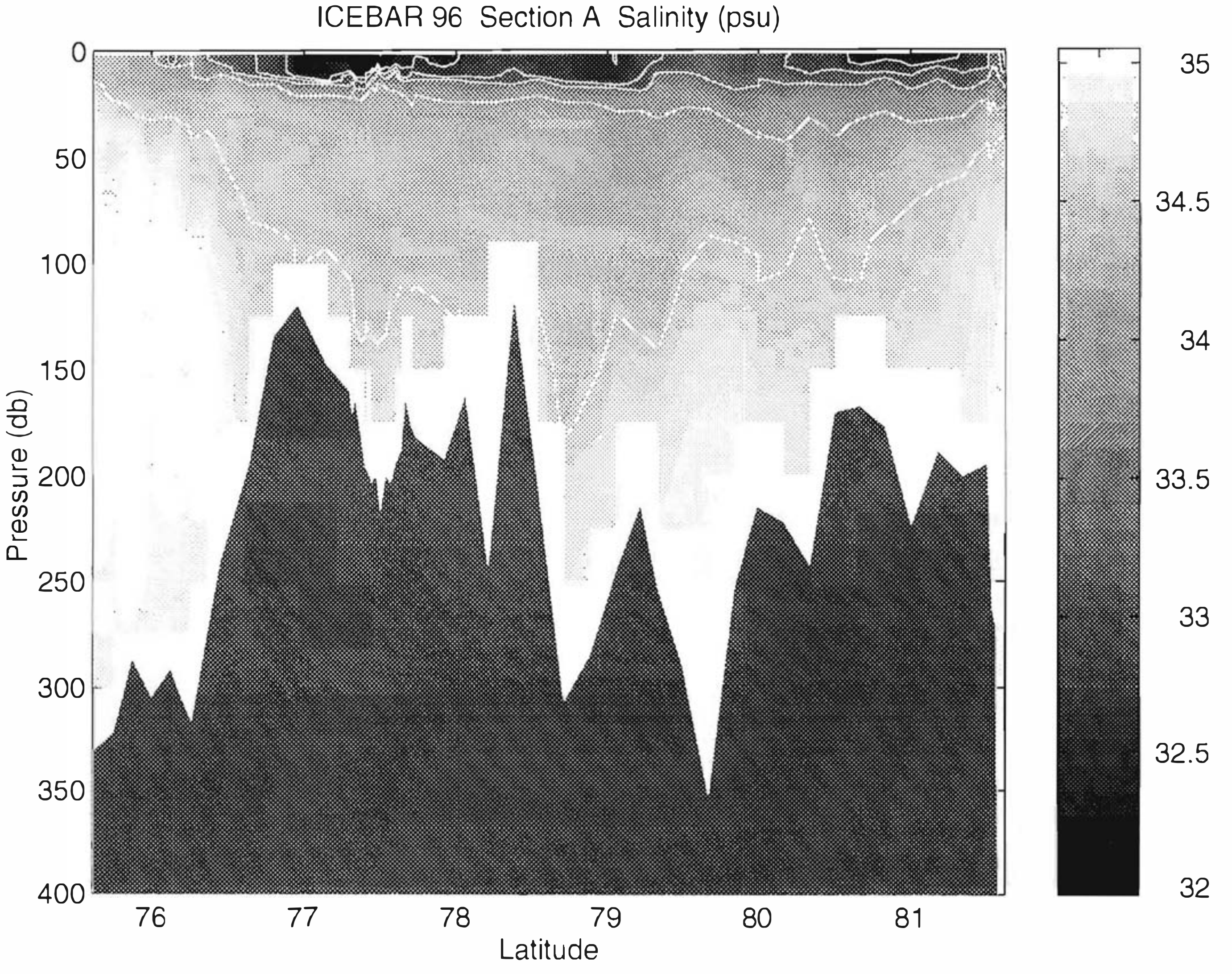
Description and map of ULS recovery

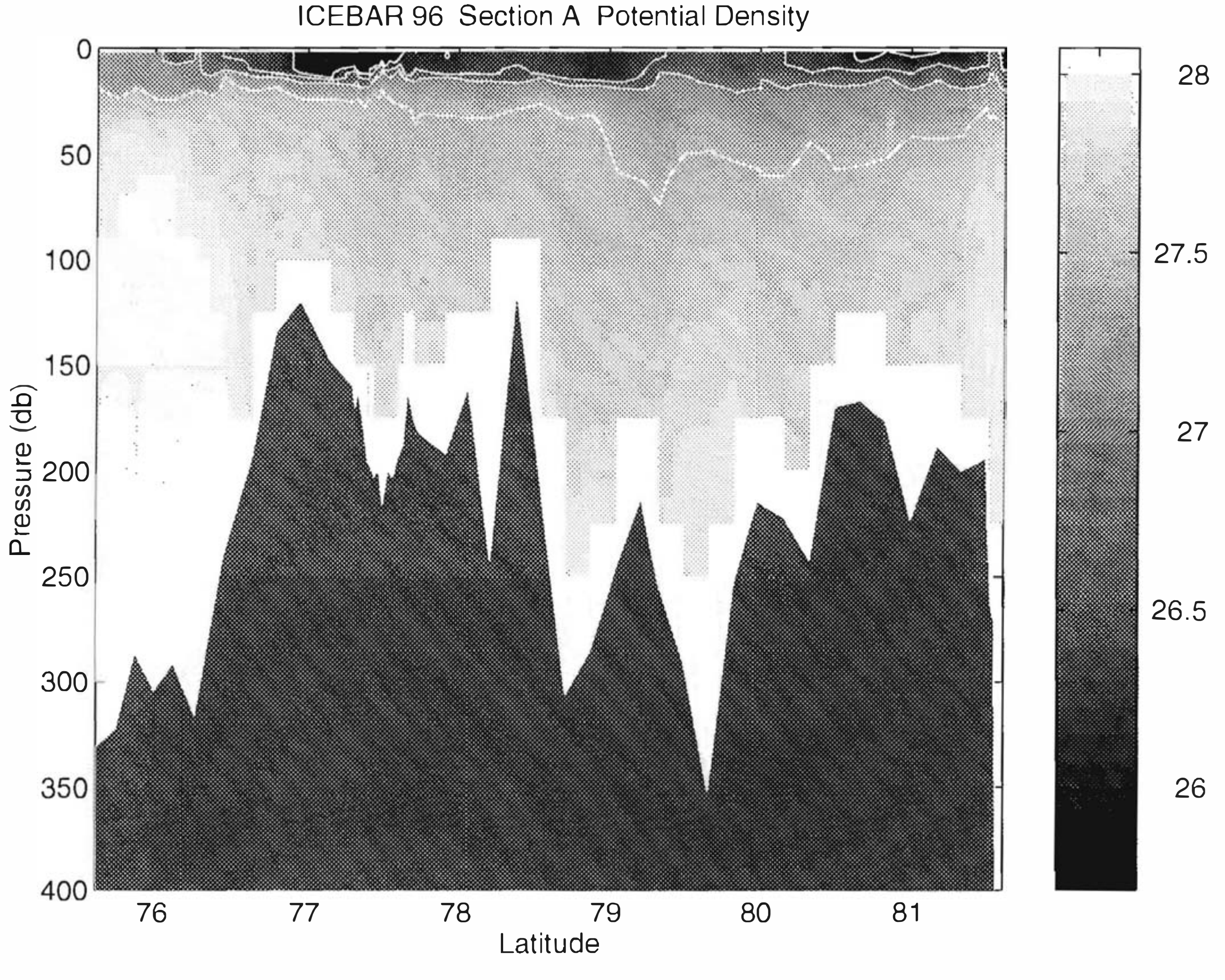
The ULS in position N77° 54.56 E28° 21.45 with a ground line, RCM7 and an APL ULS, was recovered on the first dragging attempt. No new ULS mooring was deployed, because the instrument and buoyancy floats were missing when we left Longyearbyen the 20 July. The ULS in position N77° 40.34 E26° 27.048, with an acoustic release, ULS and ARGOS transmitter, was not recovered. Two attempts were made, and the technique used was to circle around the position with the dragging anchor at the bottom, in order to hook up the mooring. The diameters of the circles made were 500-800 metres, and the length of the wire with the dragging anchor 1500-1800 meters.

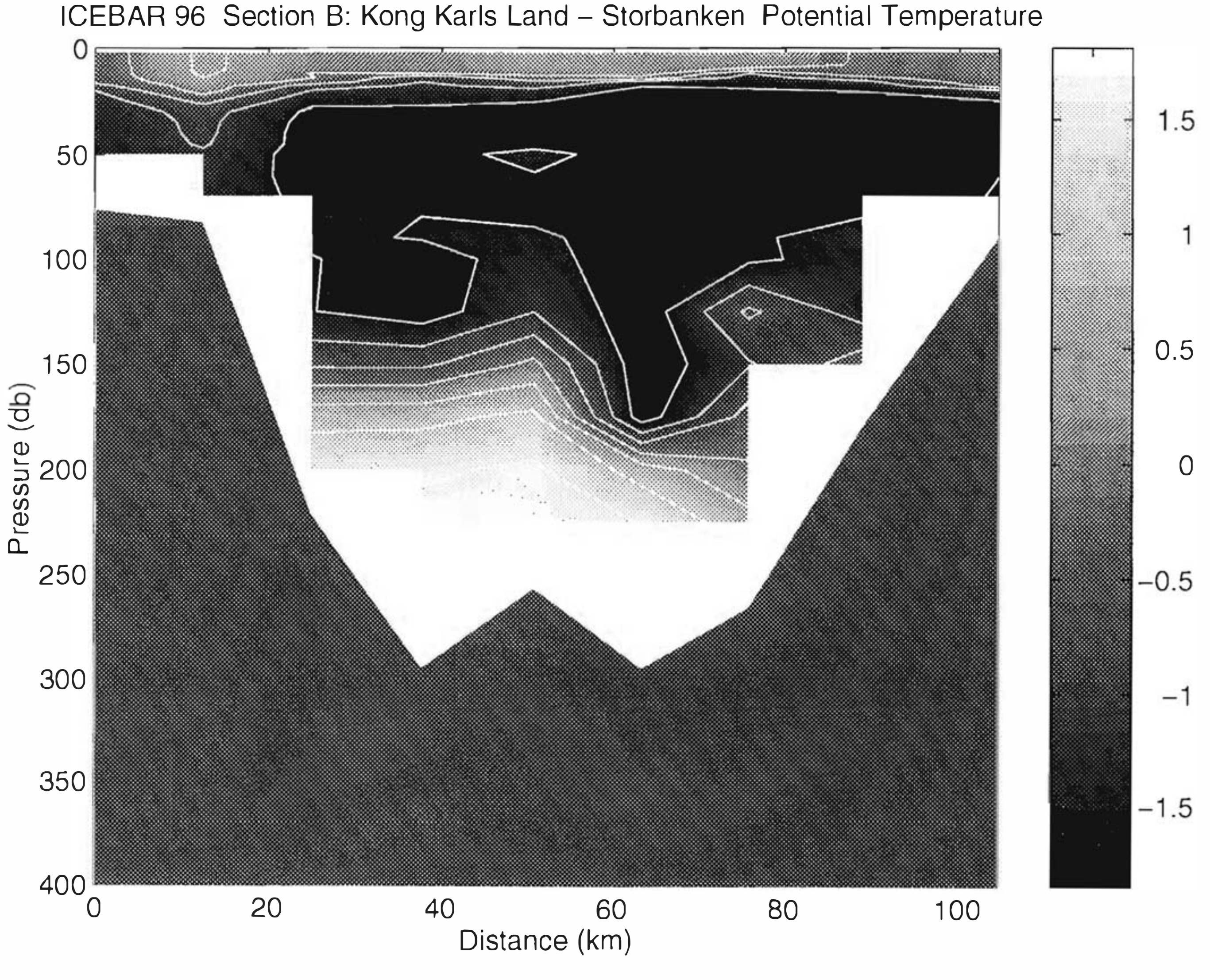
The following pages show different parameters in sections and profiles of temperature, salinity and density for every 10th station.

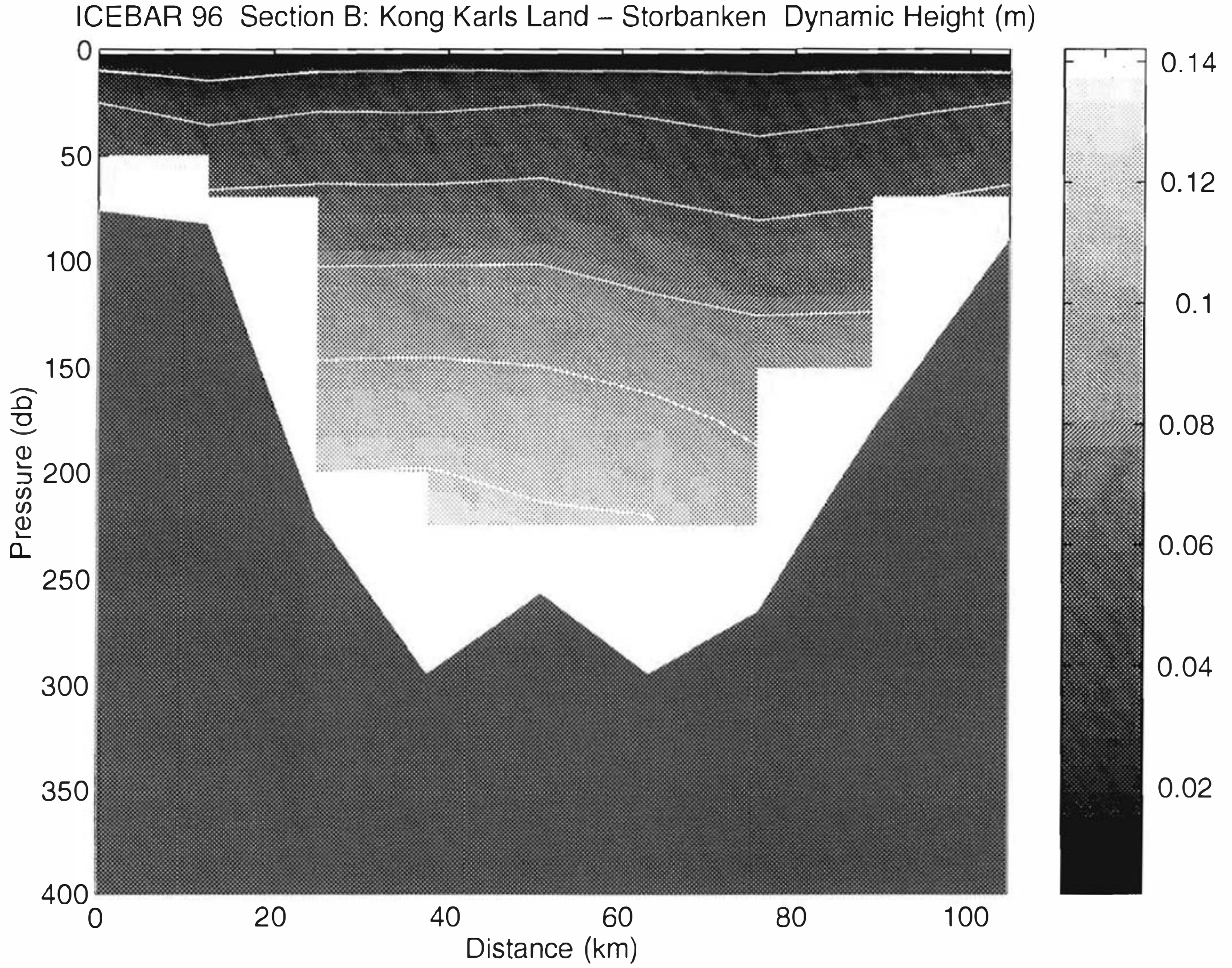


ICEBAR 96 Section A Potential Temperature
Pressure (db)
0
50
100
150
200
250
300
350
400
76
77
78
79
80
81
Latitude
4
3
2
1
0
-1

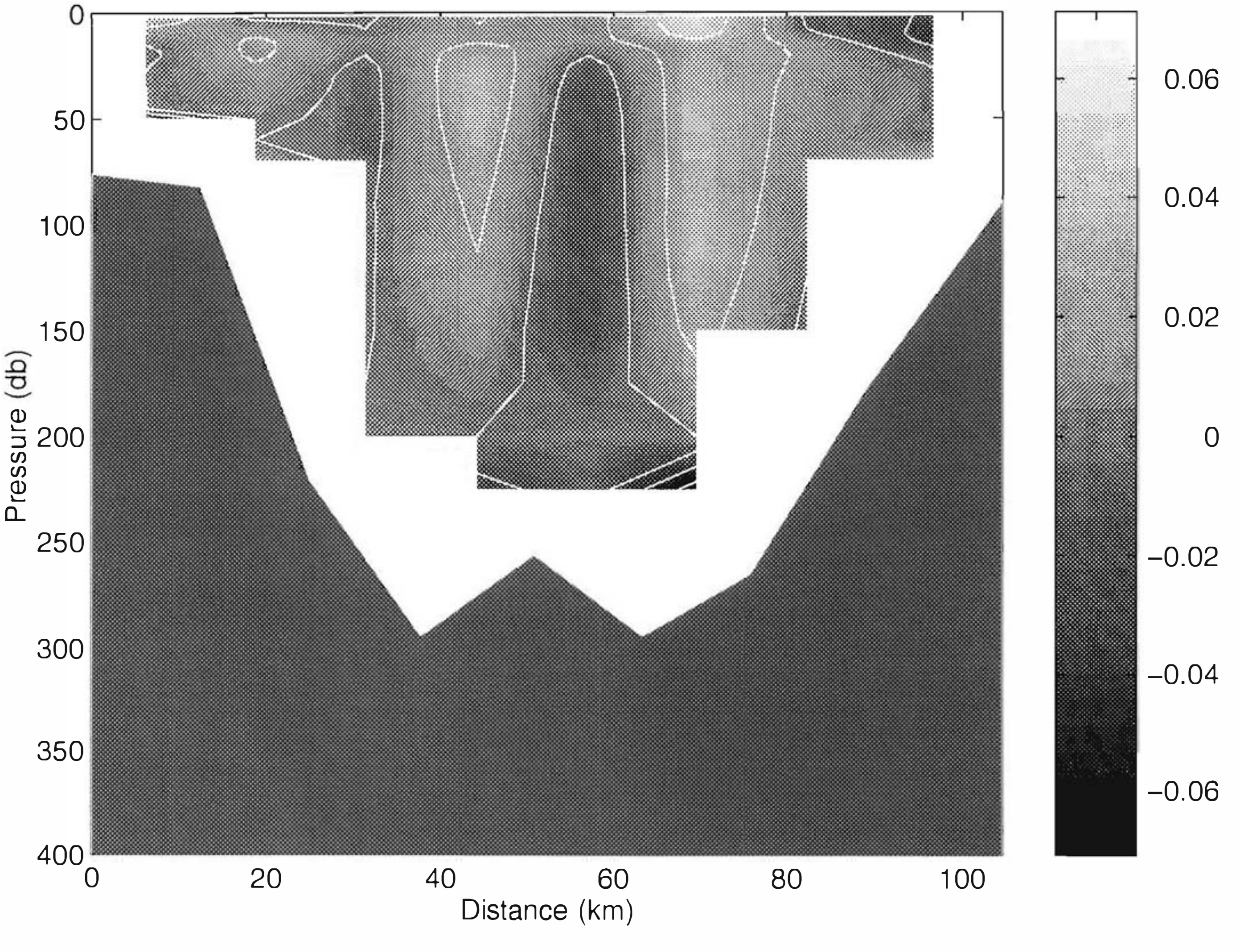

ICEBAR 96 Section A Salinity (psu)
Pressure (db)
0
50
100
150
200
250
300
350
400
76
77
78
79
80
81
Latitude
35
34.5
34
33.5
33
32.5
32

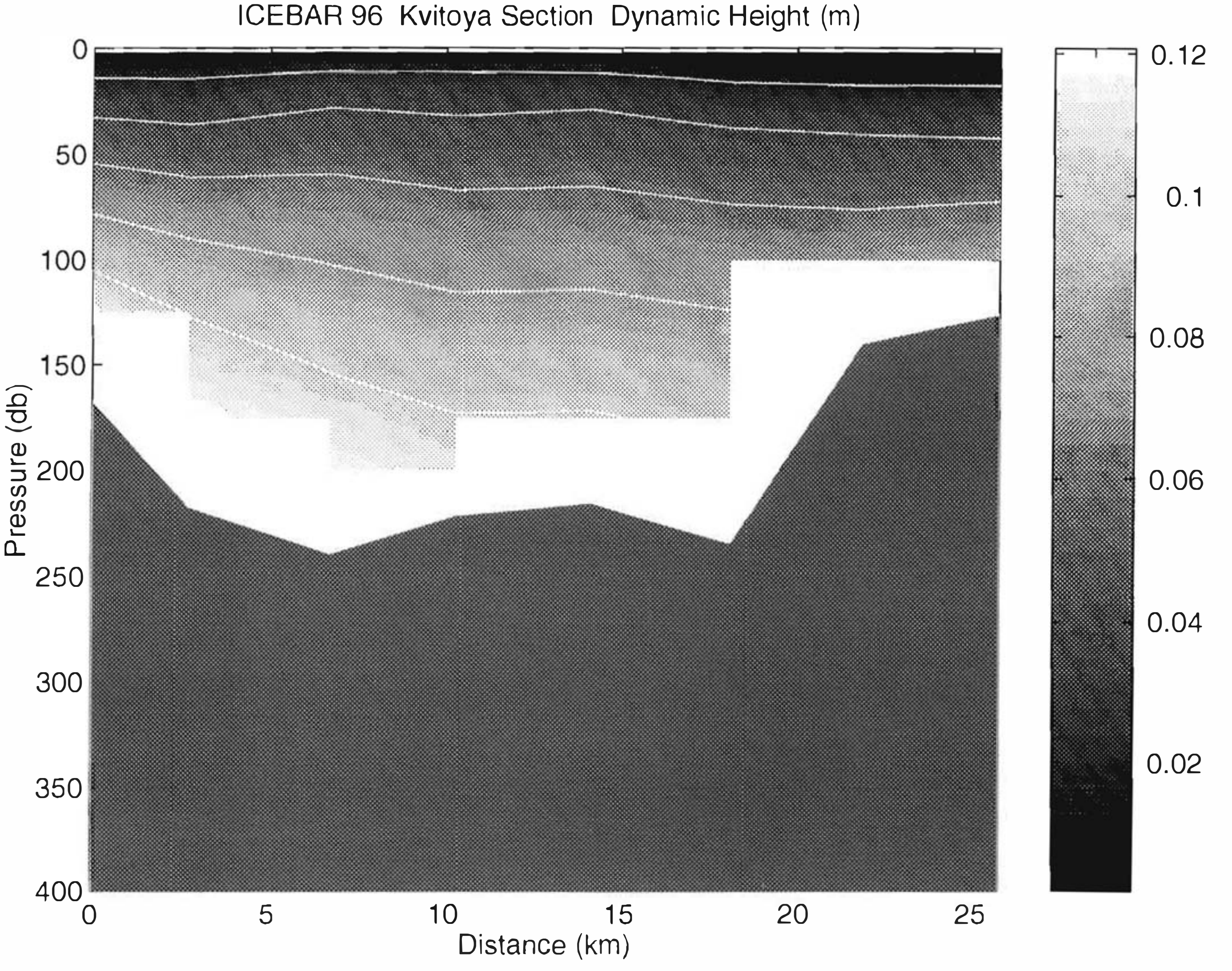

ICEBAR 96 Section A Potential Density
Pressure (db)
0
50
100
150
200
250
300
350
400
76
77
78
79
80
81
Latitude
28
27.5
27
26.5
26

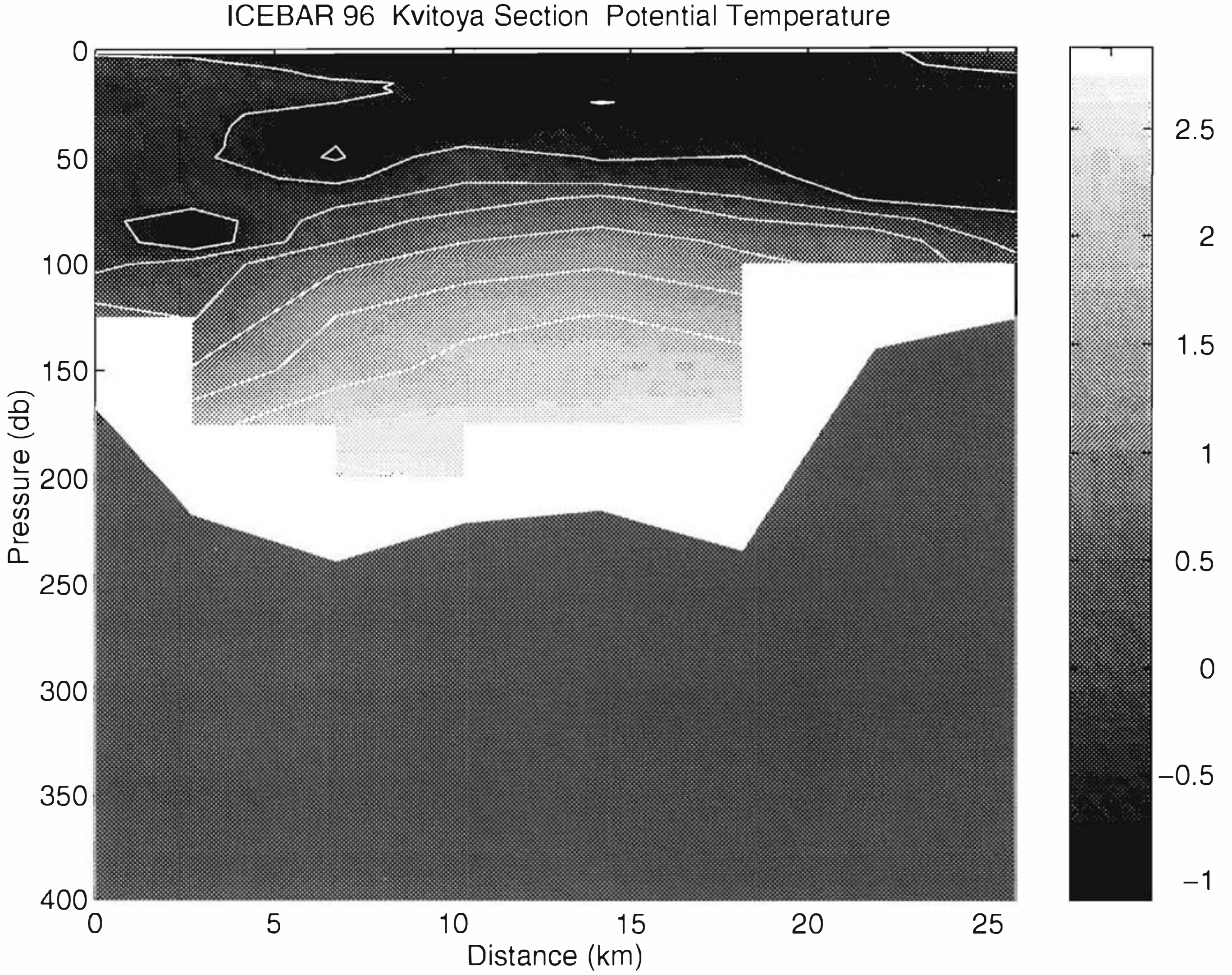

ICEBAR 96 Section B: Kong Karls Land – Storbanken Potential Temperature
Pressure (db)
Distance (km)
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100
1.5
1
0.5
0
−0.5
−1
−1.5

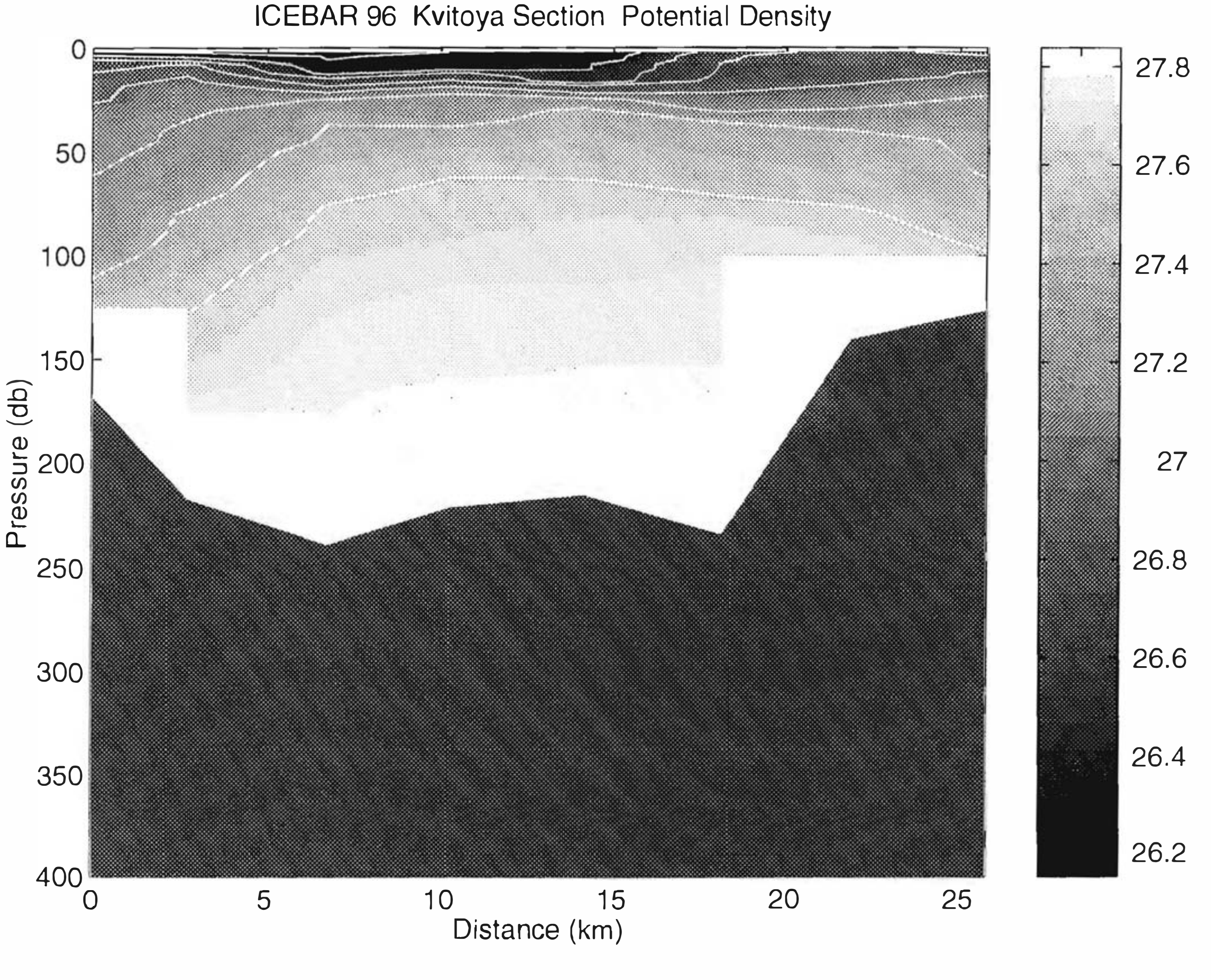

ICEBAR 96 Section B: Kong Karls Land – Storbanken Dynamic Height (m)
Pressure (db)
Distance (km)
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100
0.14
0.12
0.1
0.08
0.06
0.04
0.02

ICEBAR 96 Section B: Kong Karls Land – Storbanken Geostrophic Velocity

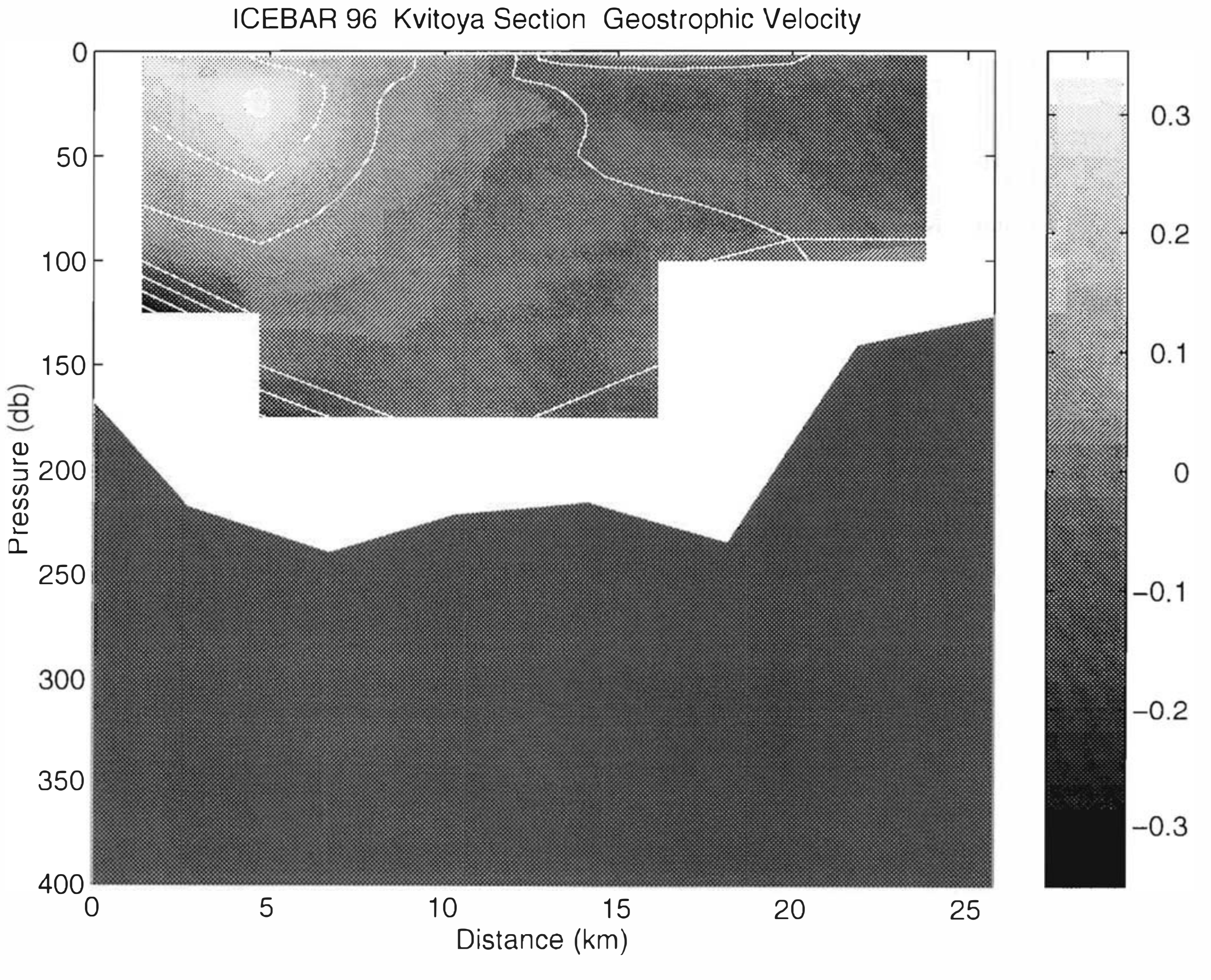



ICEBAR 96 Kvitoya Section Dynamic Height (m)
Pressure (db)
0
50
100
150
200
250
300
350
400
Distance (km)
0
5
10
15
20
25
0.12
0.1
0.08
0.06
0.04
0.02

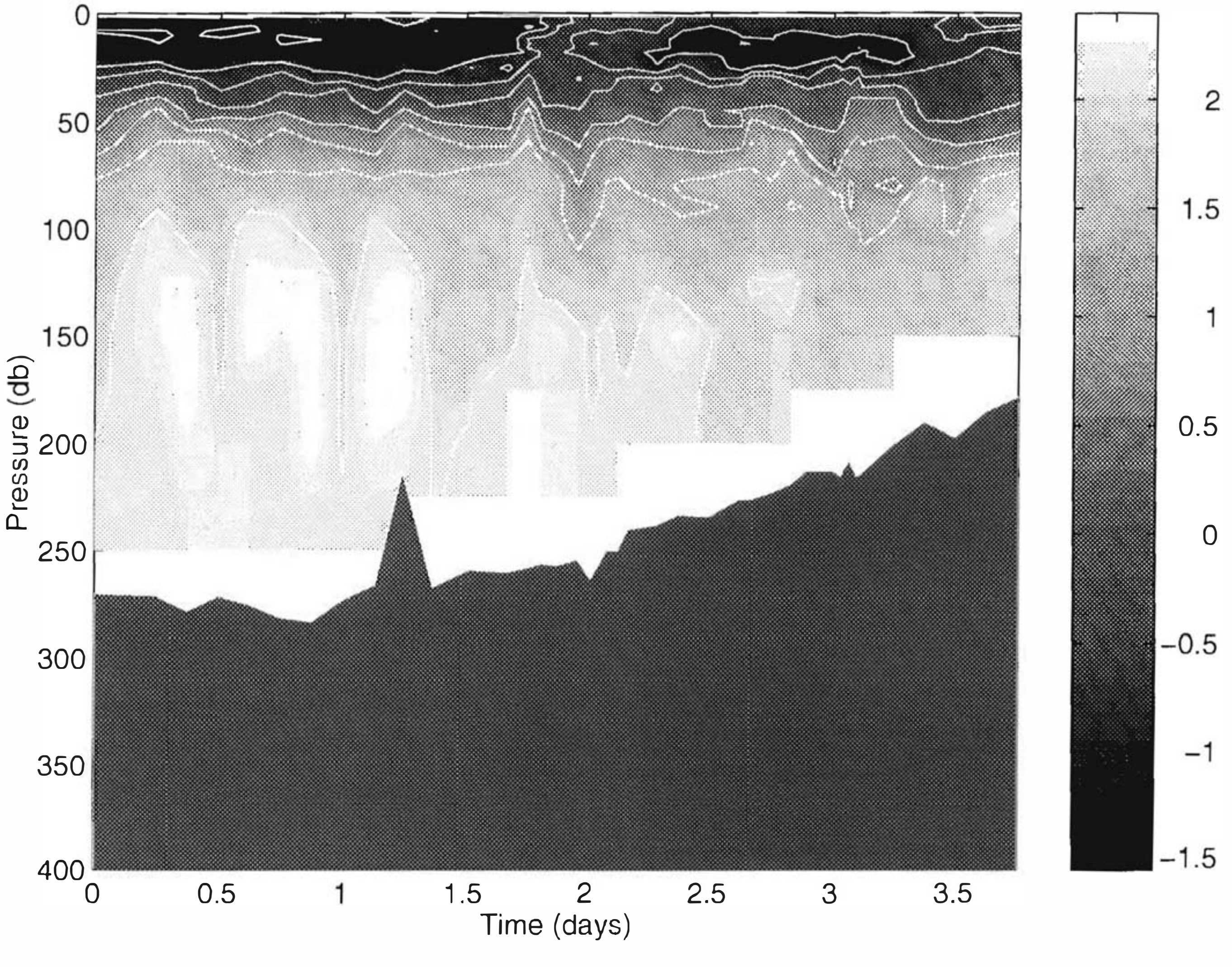

ICEBAR 96 Kvitoya Section Potential Temperature
Pressure (db)
0
50
100
150
200
250
300
350
400
Distance (km)
0
5
10
15
20
25
2.5
2
1.5
1
0.5
0
−0.5
−1



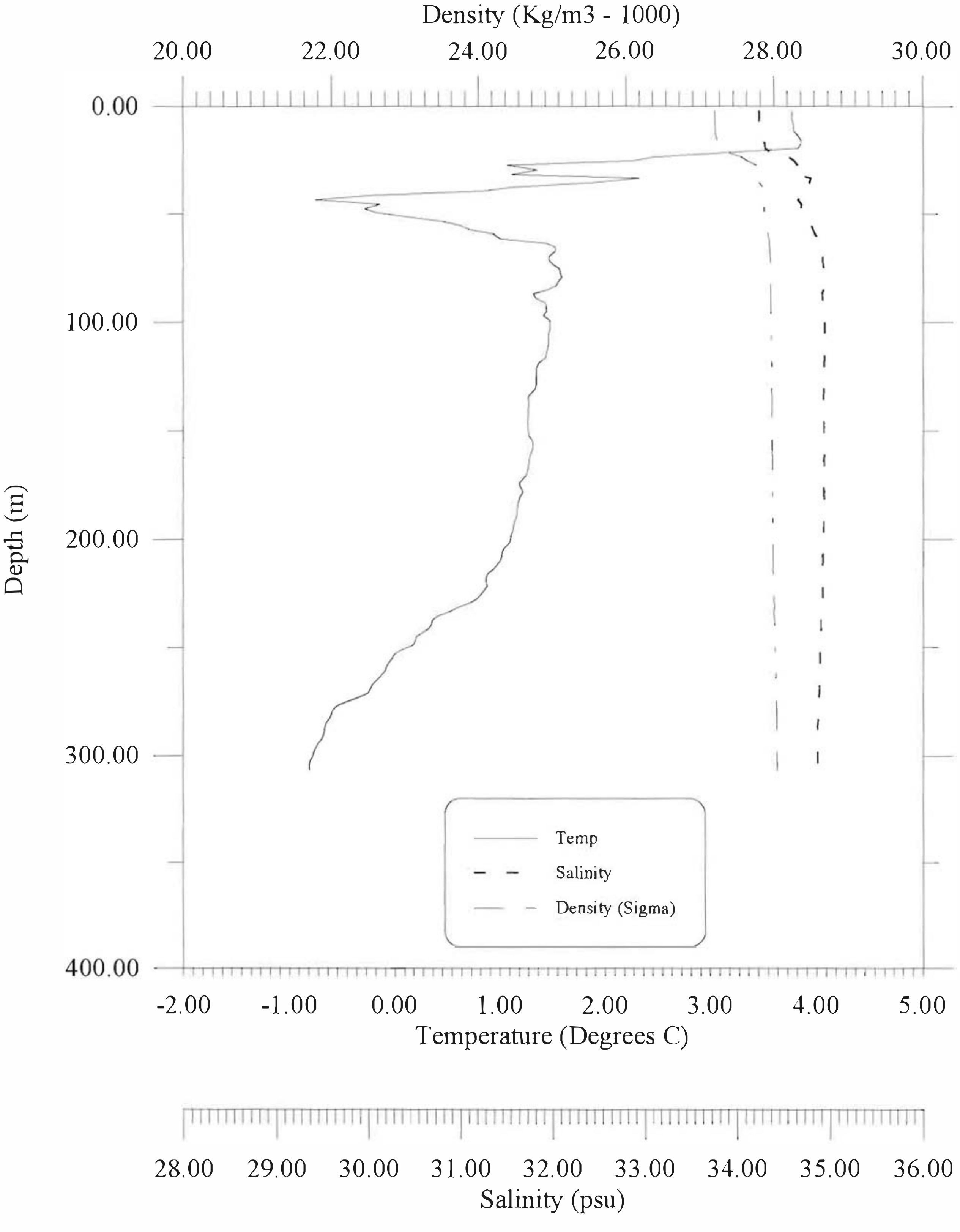
ICEBAR 96 Kvitoya Section Potential Density
Pressure (db)
0
50
100
150
200
250
300
350
400
Distance (km)
0
5
10
15
20
25
27.8
27.6
27.4
27.2
27
26.8
26.6
26.4
26.2


ICEBAR 96 Kvitoya Section Geostrophic Velocity
Pressure (db)
Distance (km)
0
50
100
150
200
250
300
350
400
0
5
10
15
20
25
0.3
0.2
0.1
0
−0.1
−0.2
−0.3

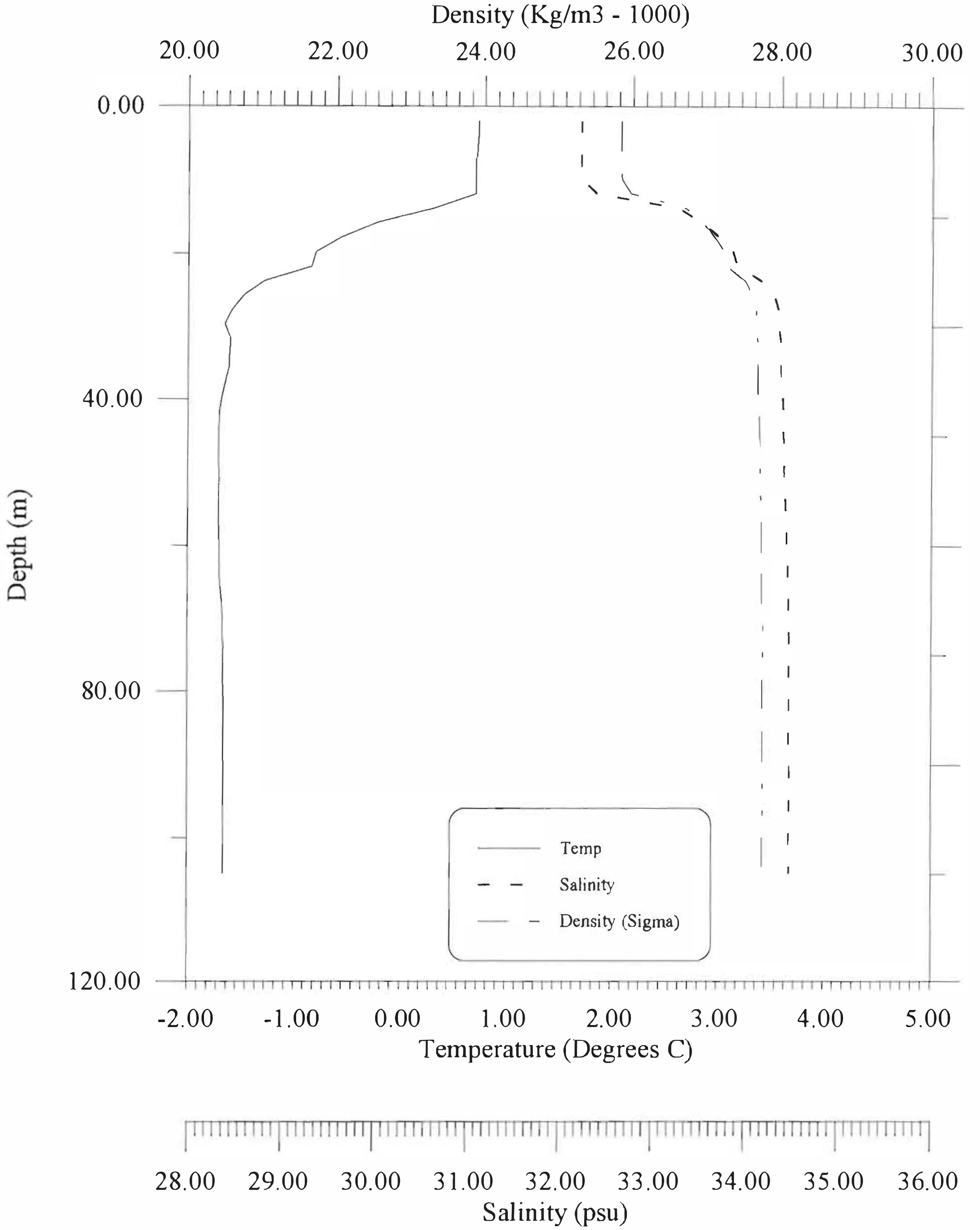
ICEBAR 96 Ice Station I1 Potential Temperature



ICEBAR 96
CTD Station # 10



ICEBAR 96
CTD Station # 20



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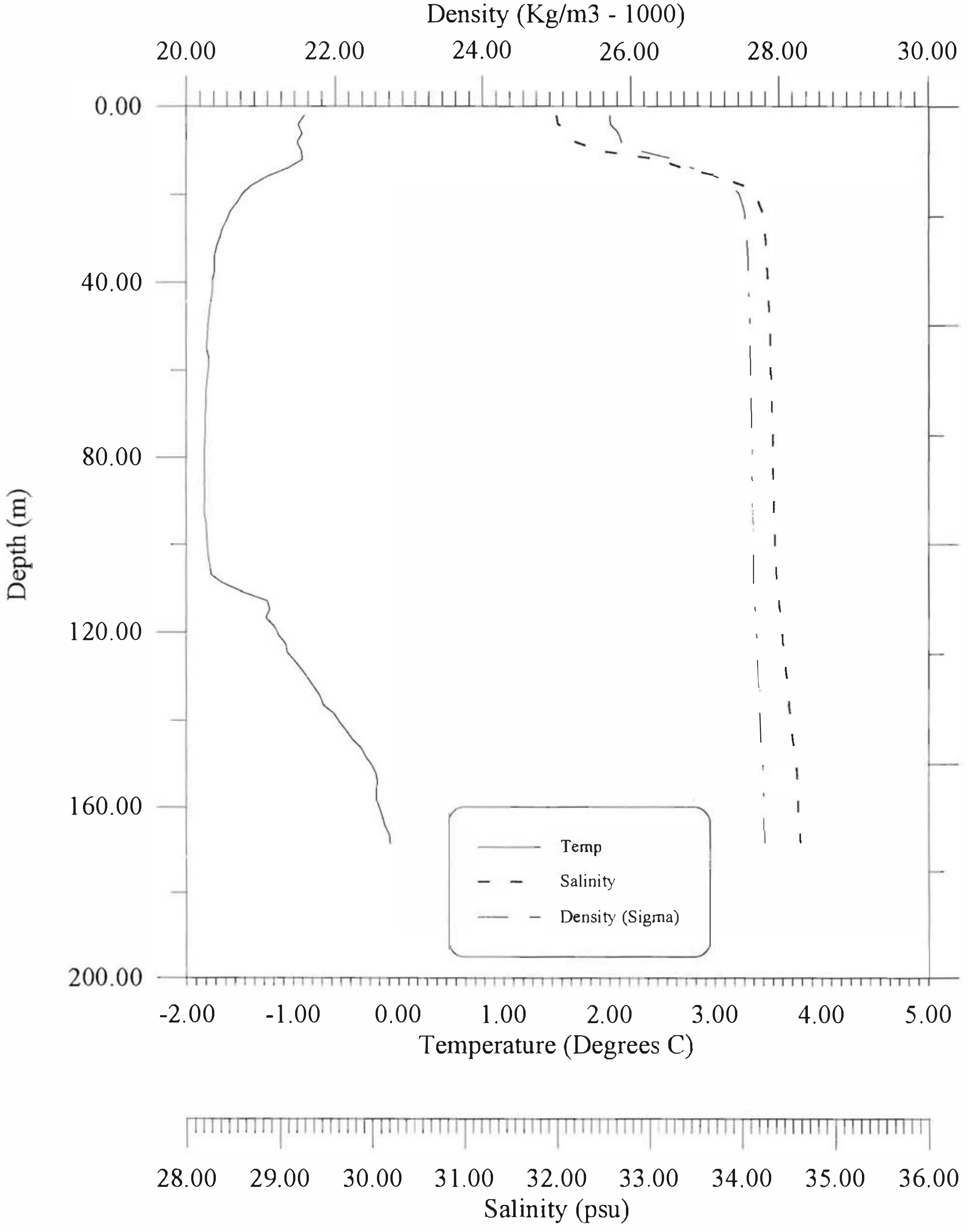
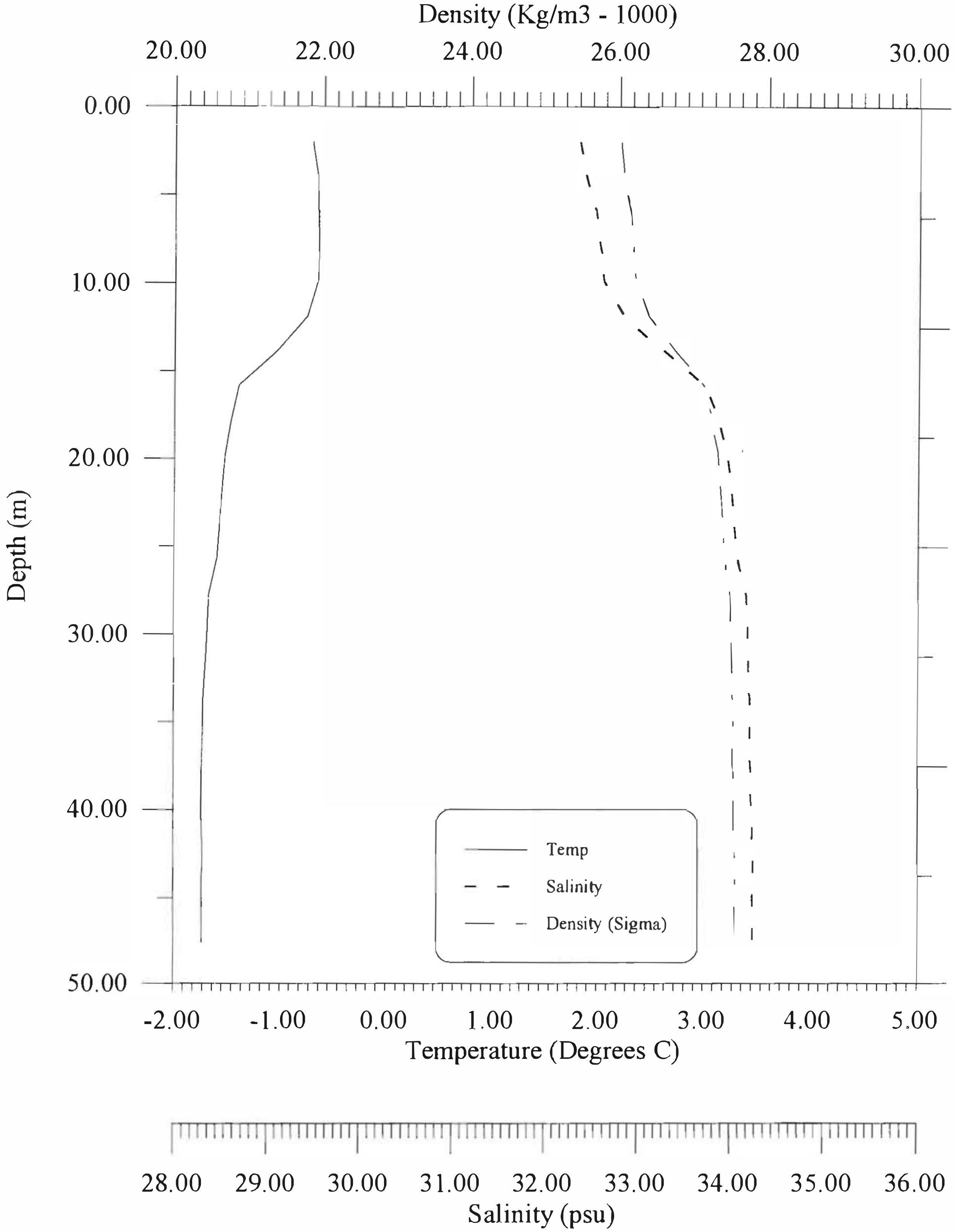
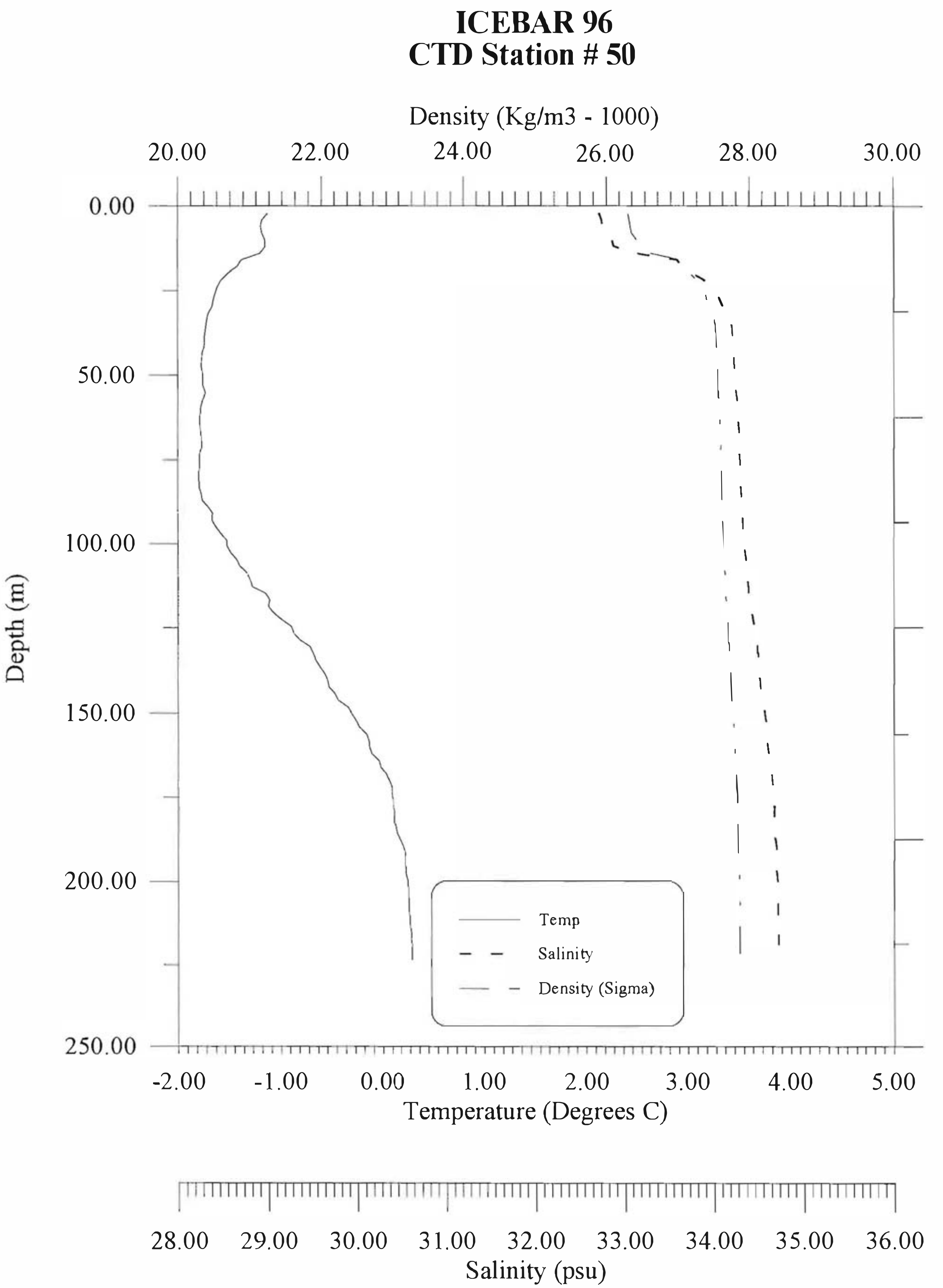
CTD Station # 30

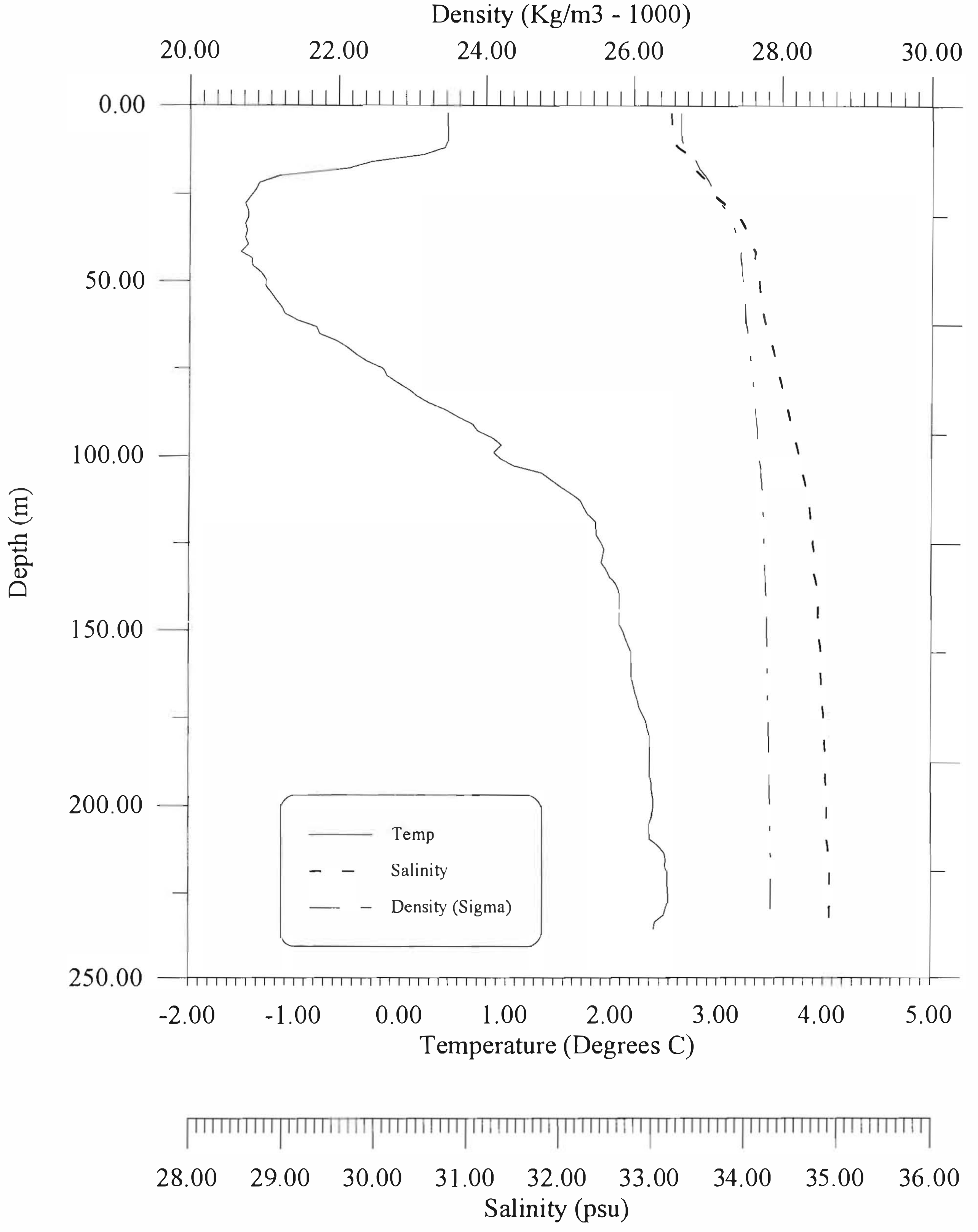


ICEBAR 96
CTD Station # 40




ICEBAR 96
CTD Station # 50
Density (Kg/m3 - 1000)
20.00
22.00
24.00
26.00
28.00
30.00
0.00
50.00
100.00
150.00
200.00
250.00
Depth (m)
Temp
Salinity
Density (Sigma)
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
Temperature (Degrees C)
28.00
29.00
30.00
31.00
32.00
33.00
34.00
35.00
36.00
Salinity (psu)

ICEBAR 96
CTD Station # 60



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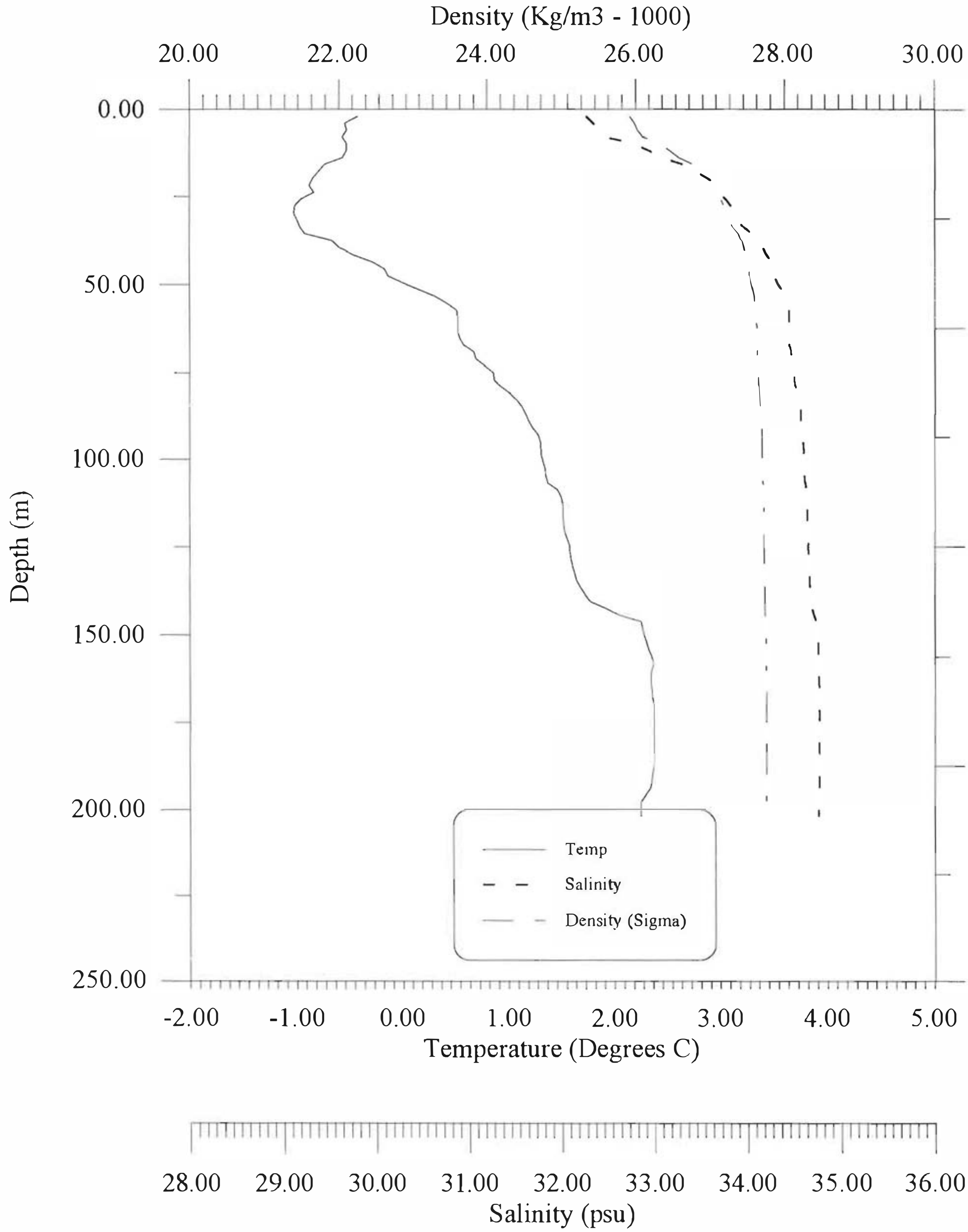
CTD Station # 70



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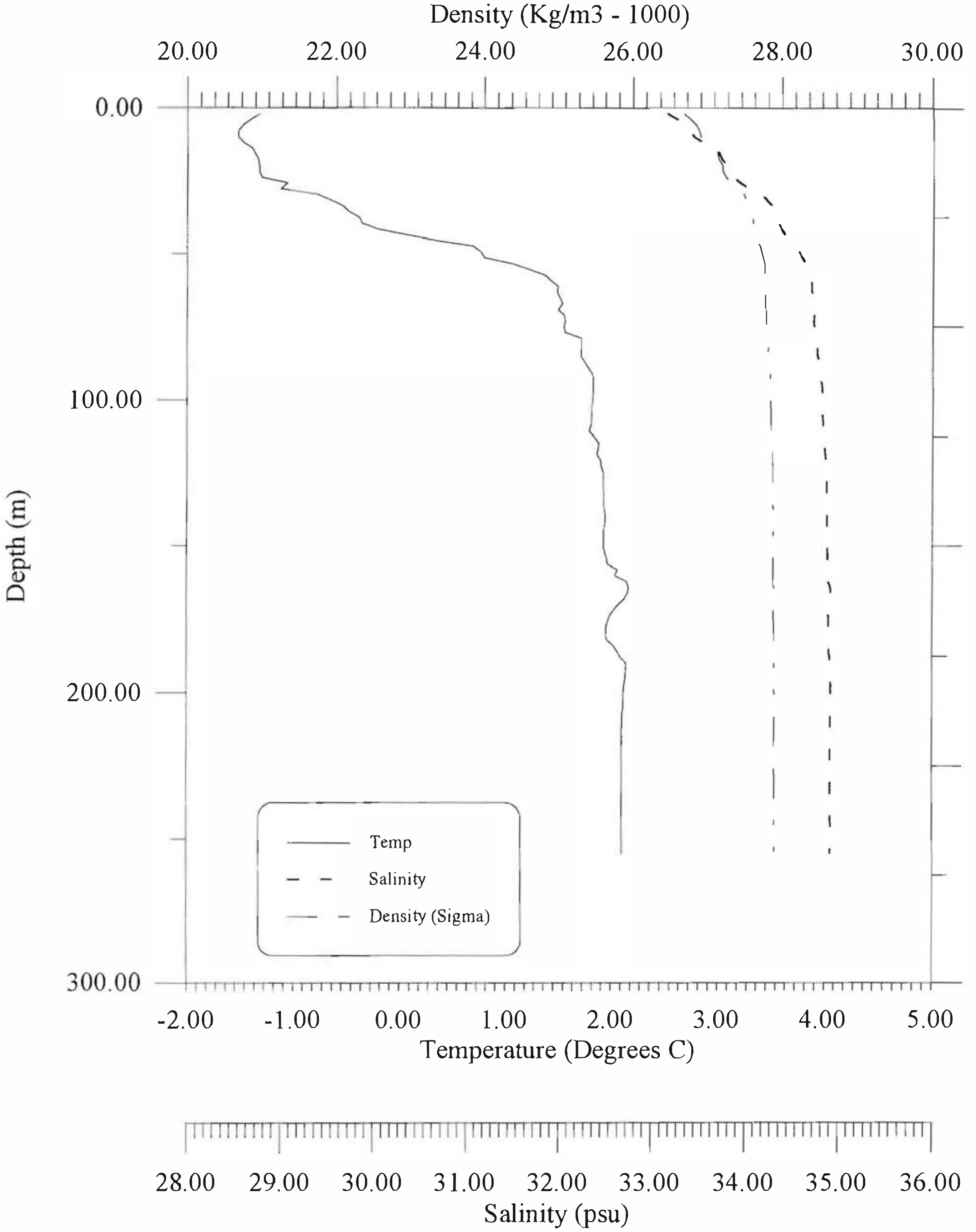
CTD Station # 80



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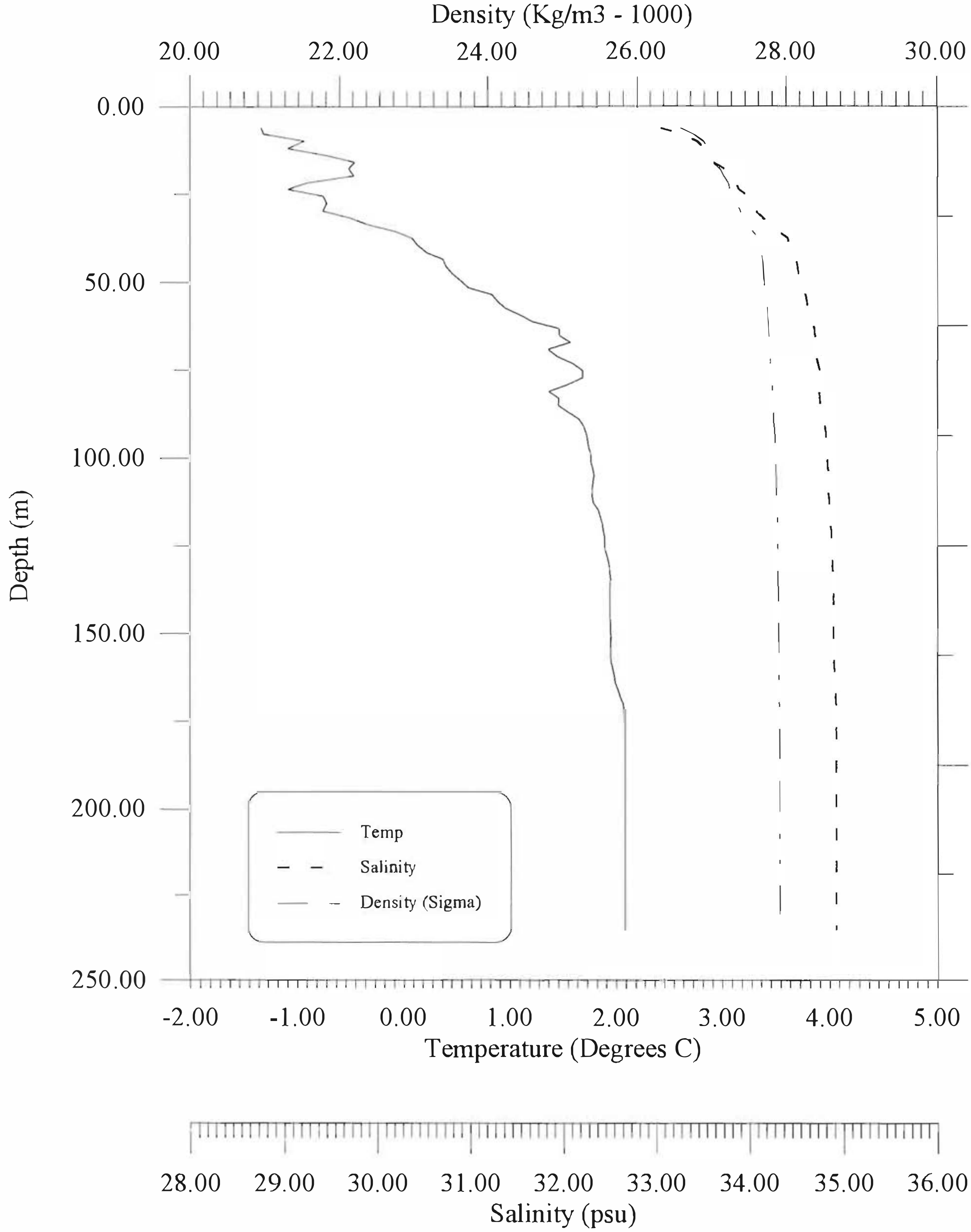
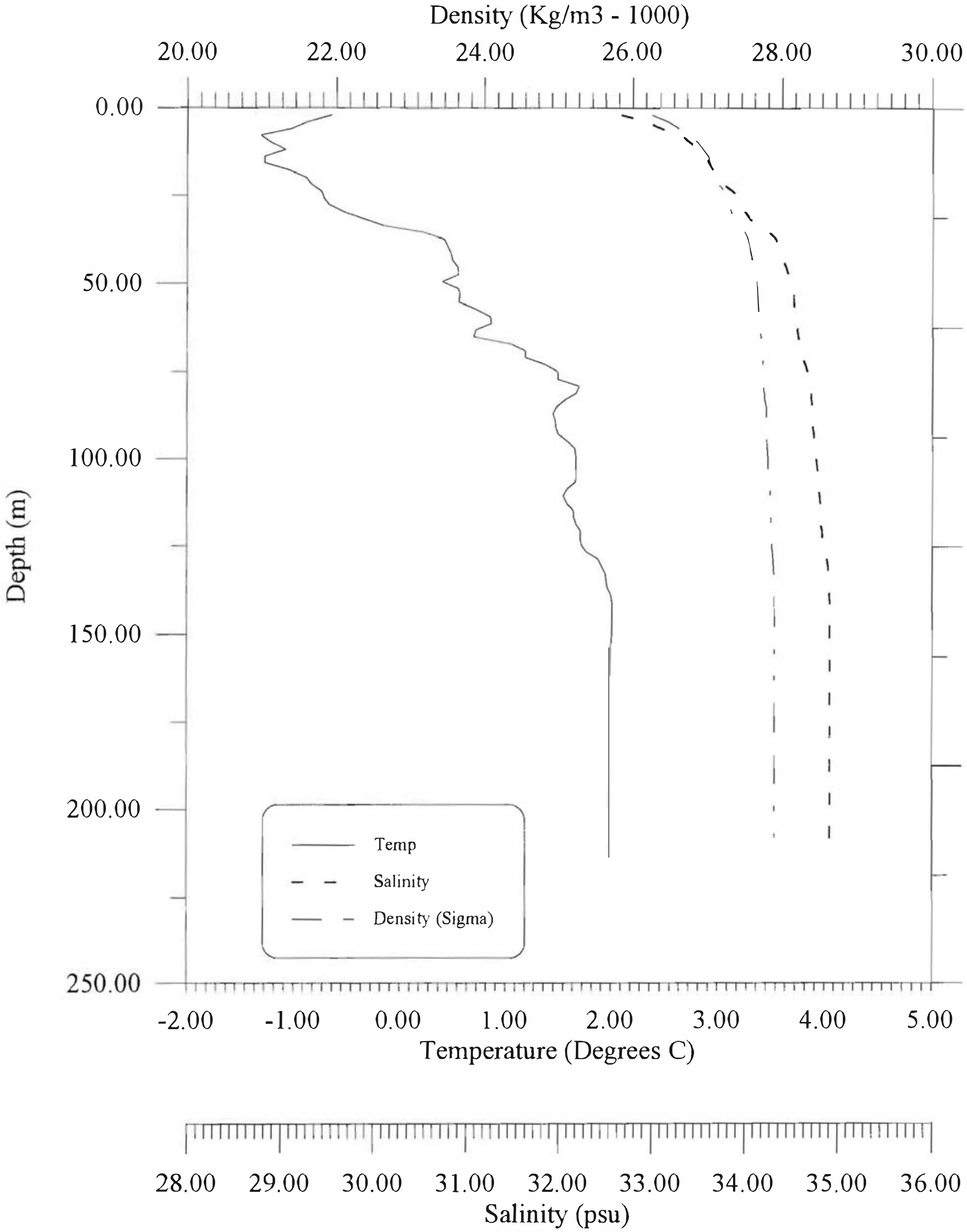
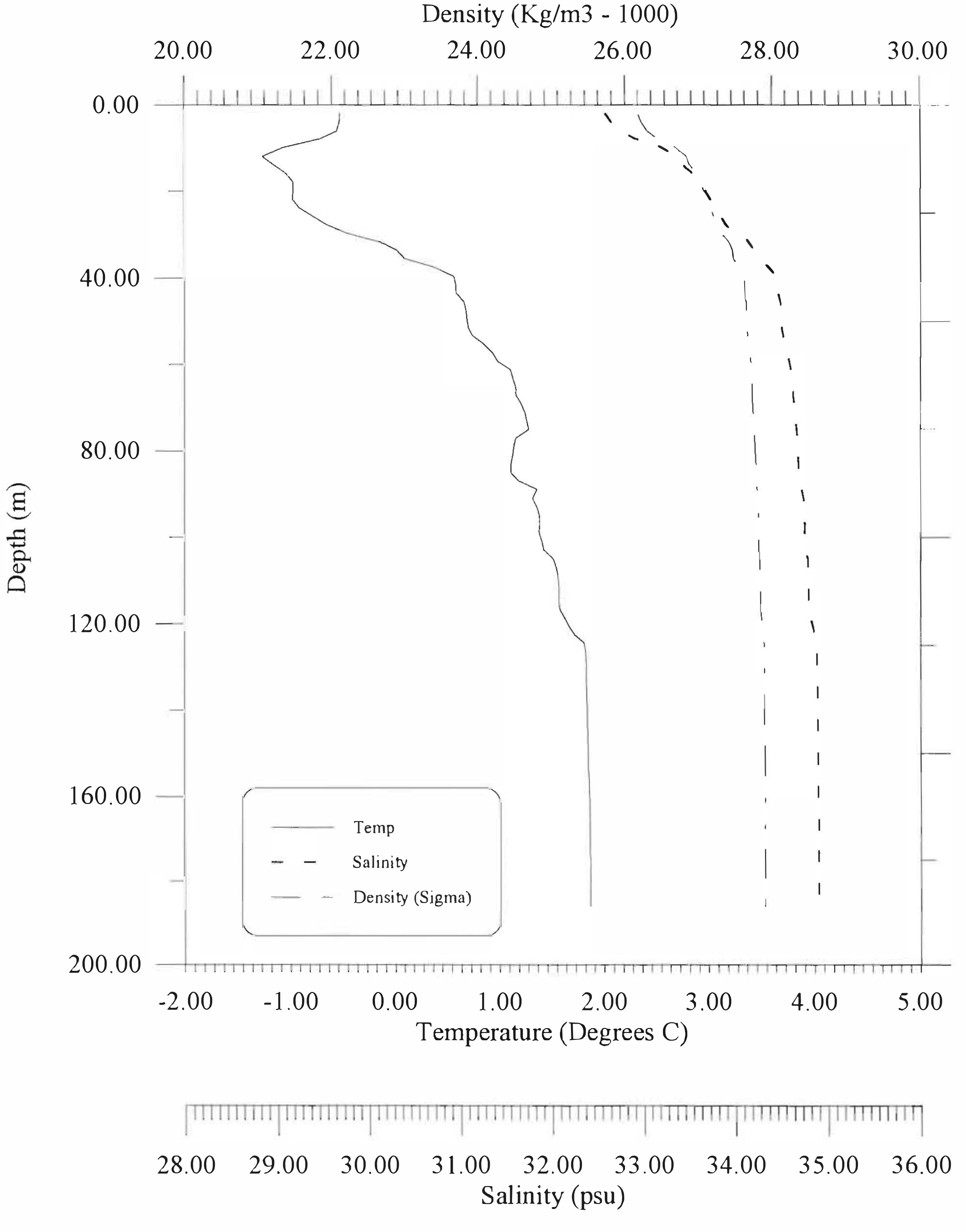
CTD Station # 90



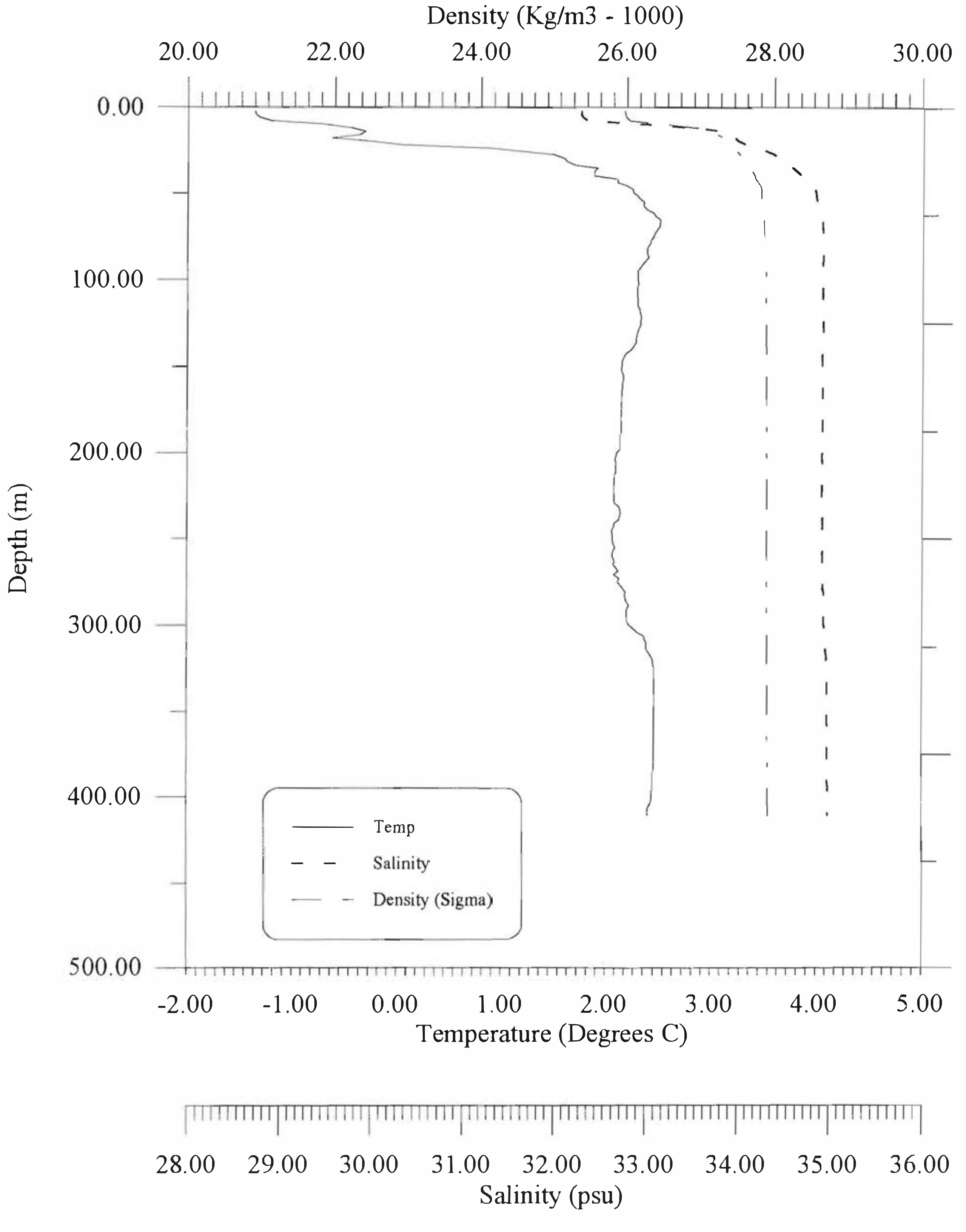
ICEBAR 96
CTD Station # 100



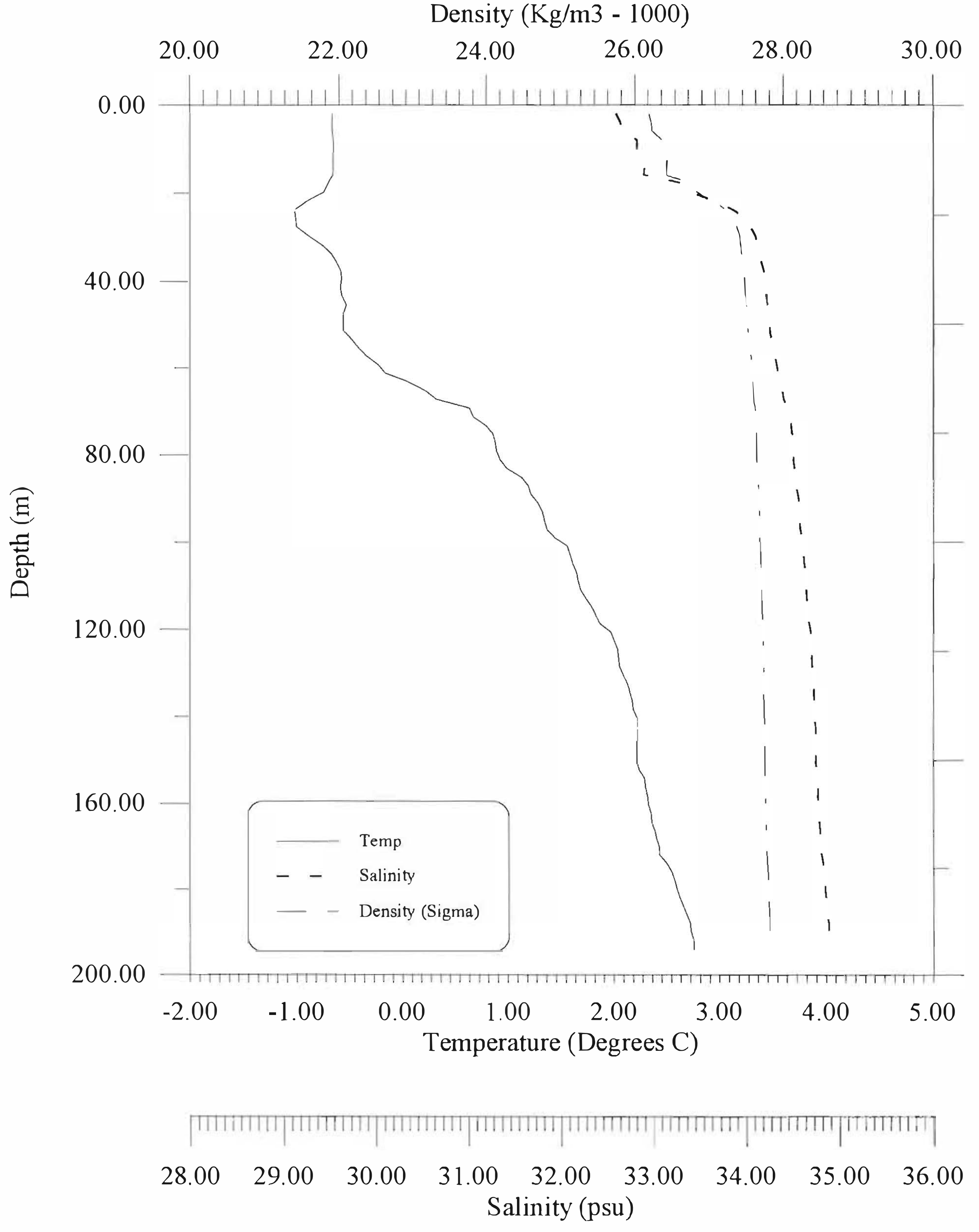
ICEBAR 96
CTD Station # 110



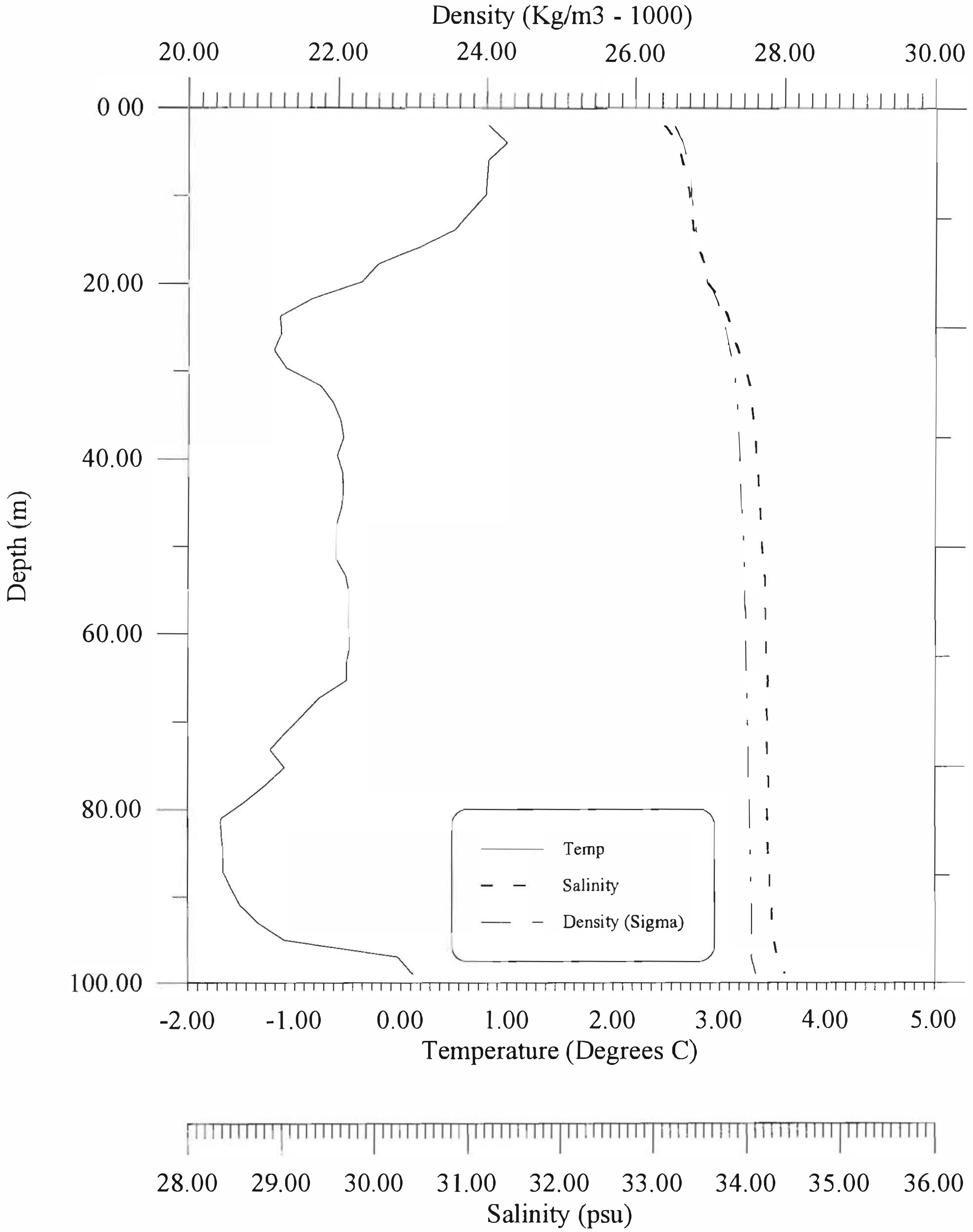
ICEBAR 96
CTD Station # 120



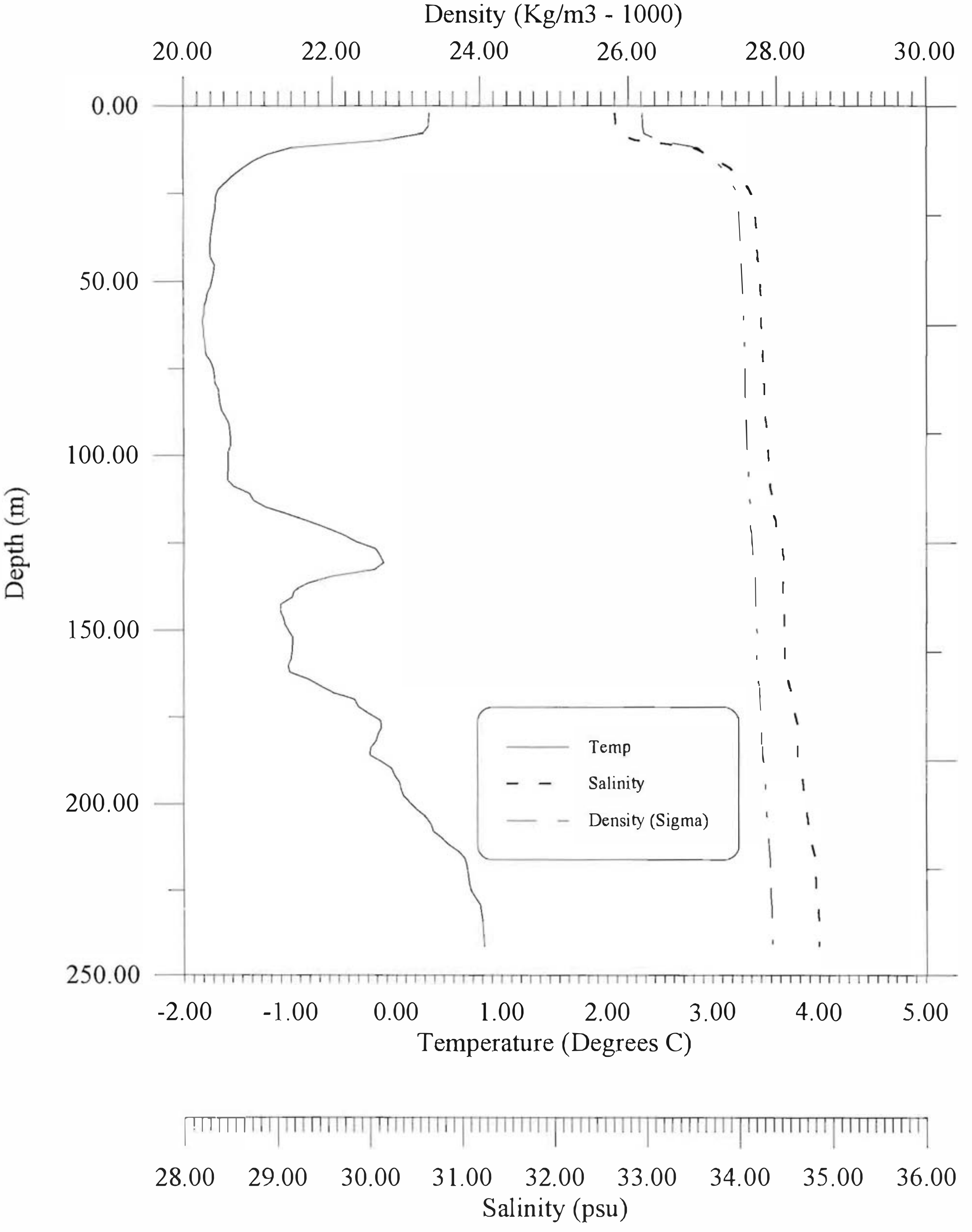
ICEBAR 96
CTD Station # 130



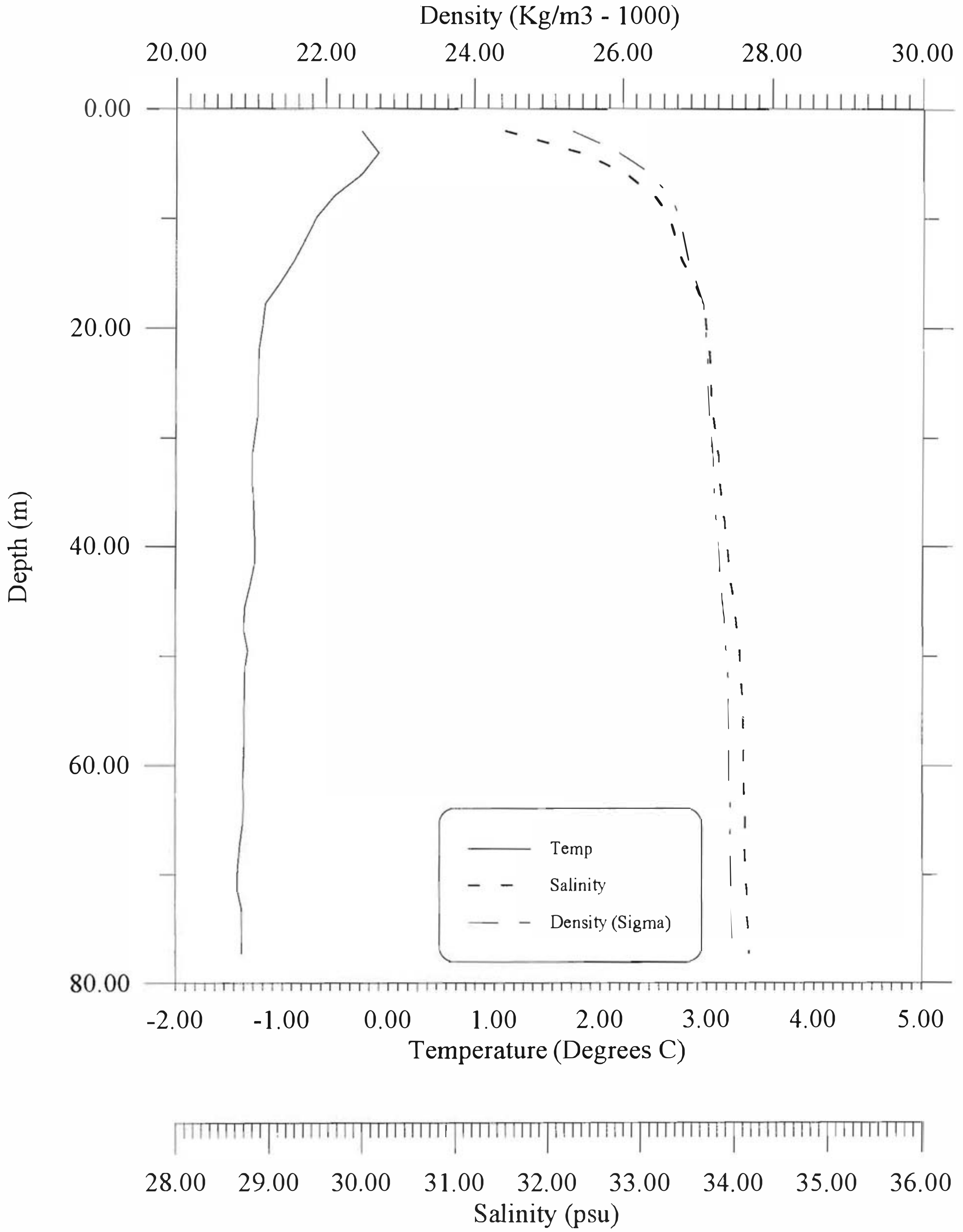
ICEBAR 96
CTD Station # 140



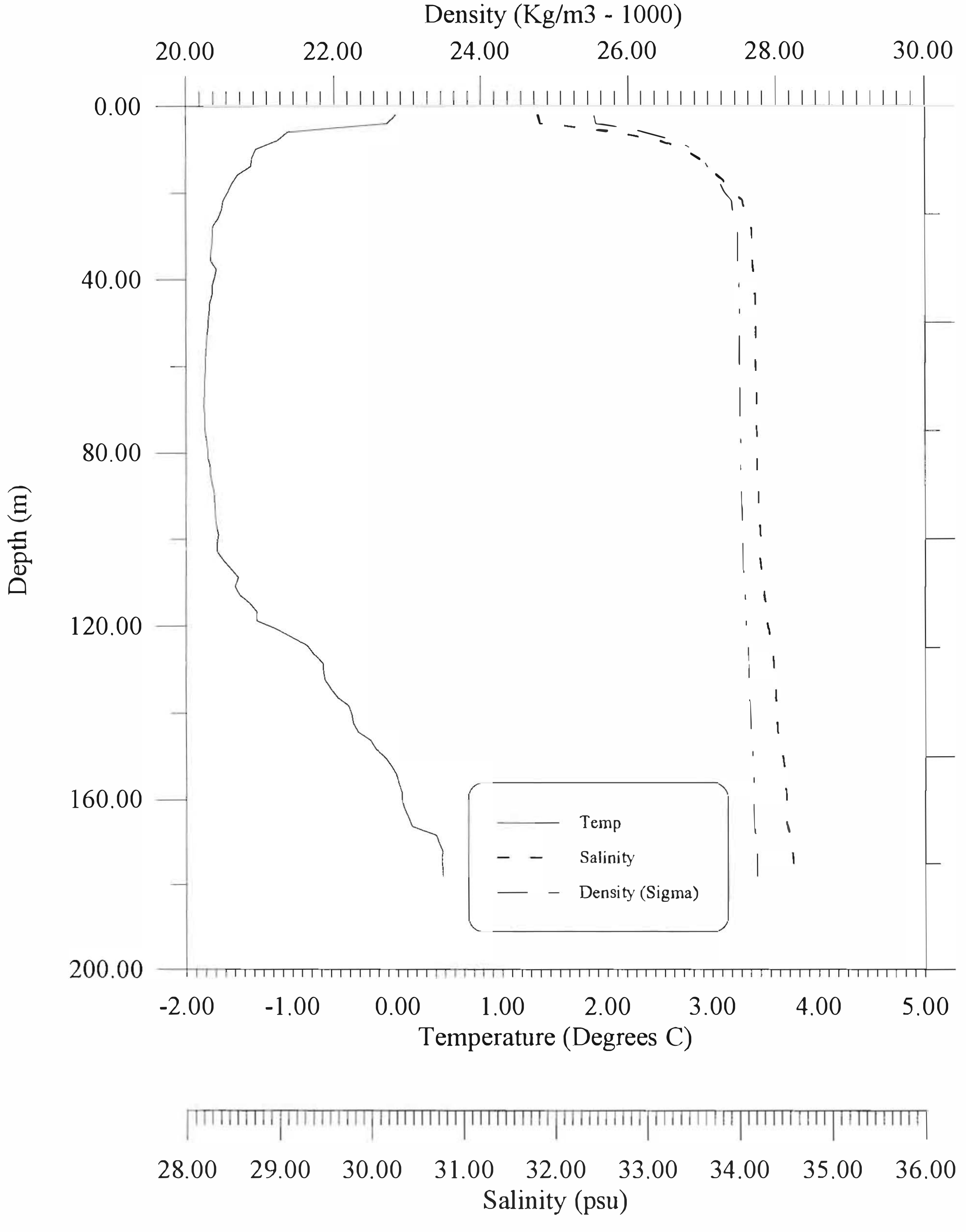
ICEBAR 96
CTD Station # 150



ICEBAR 96
CTD Station # 160



ICEBAR 96
CTD Station # 170



ICEBAR 96
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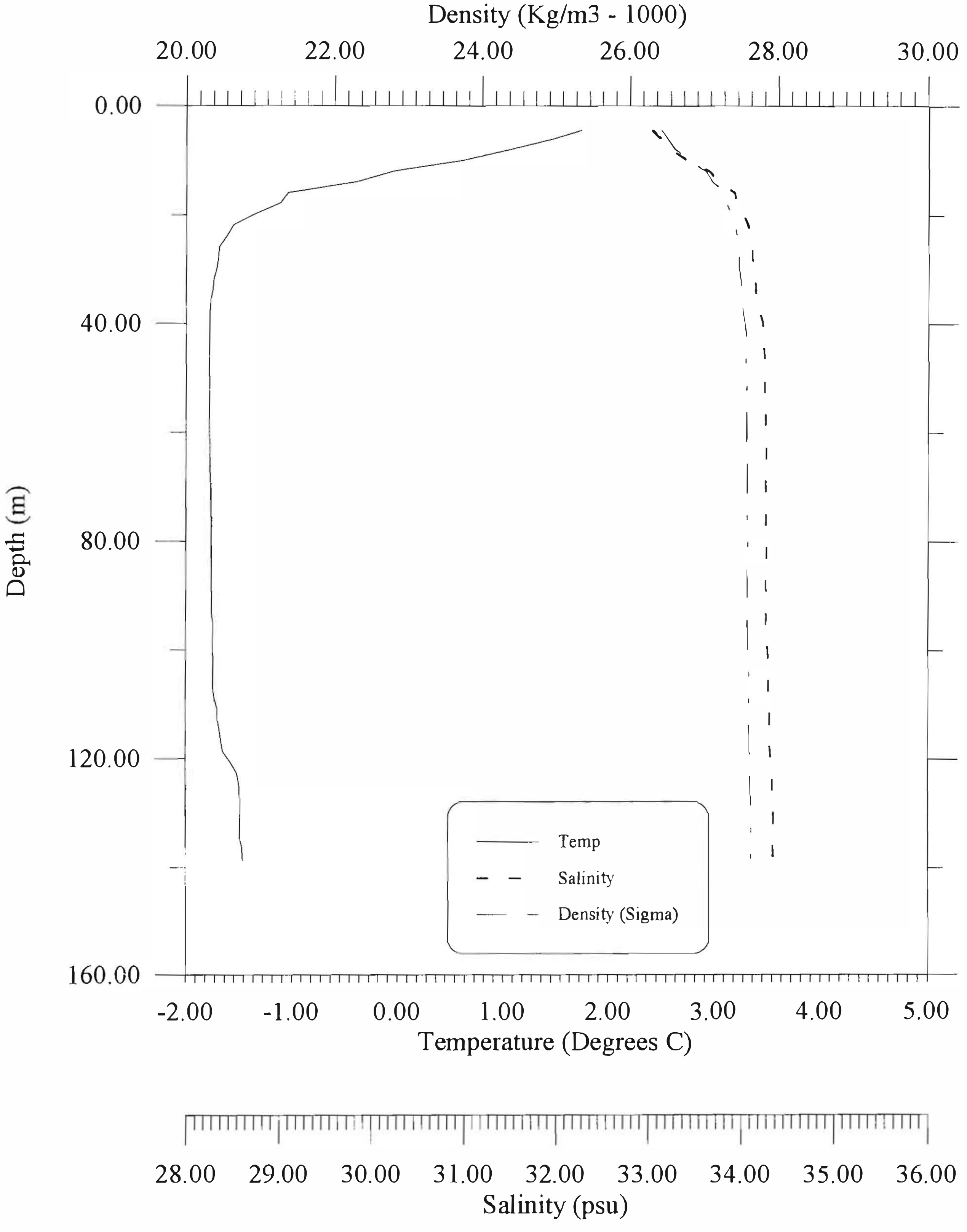
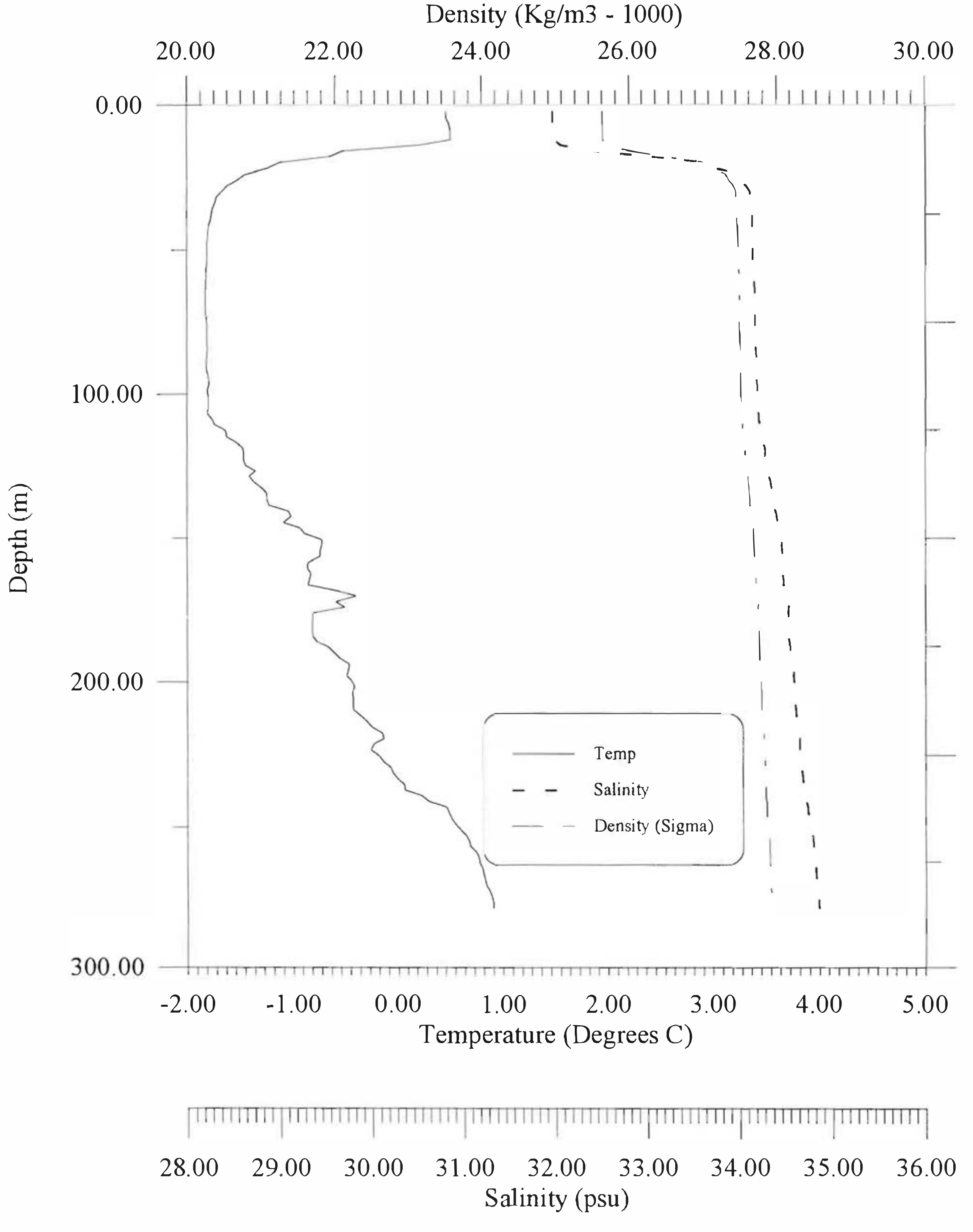
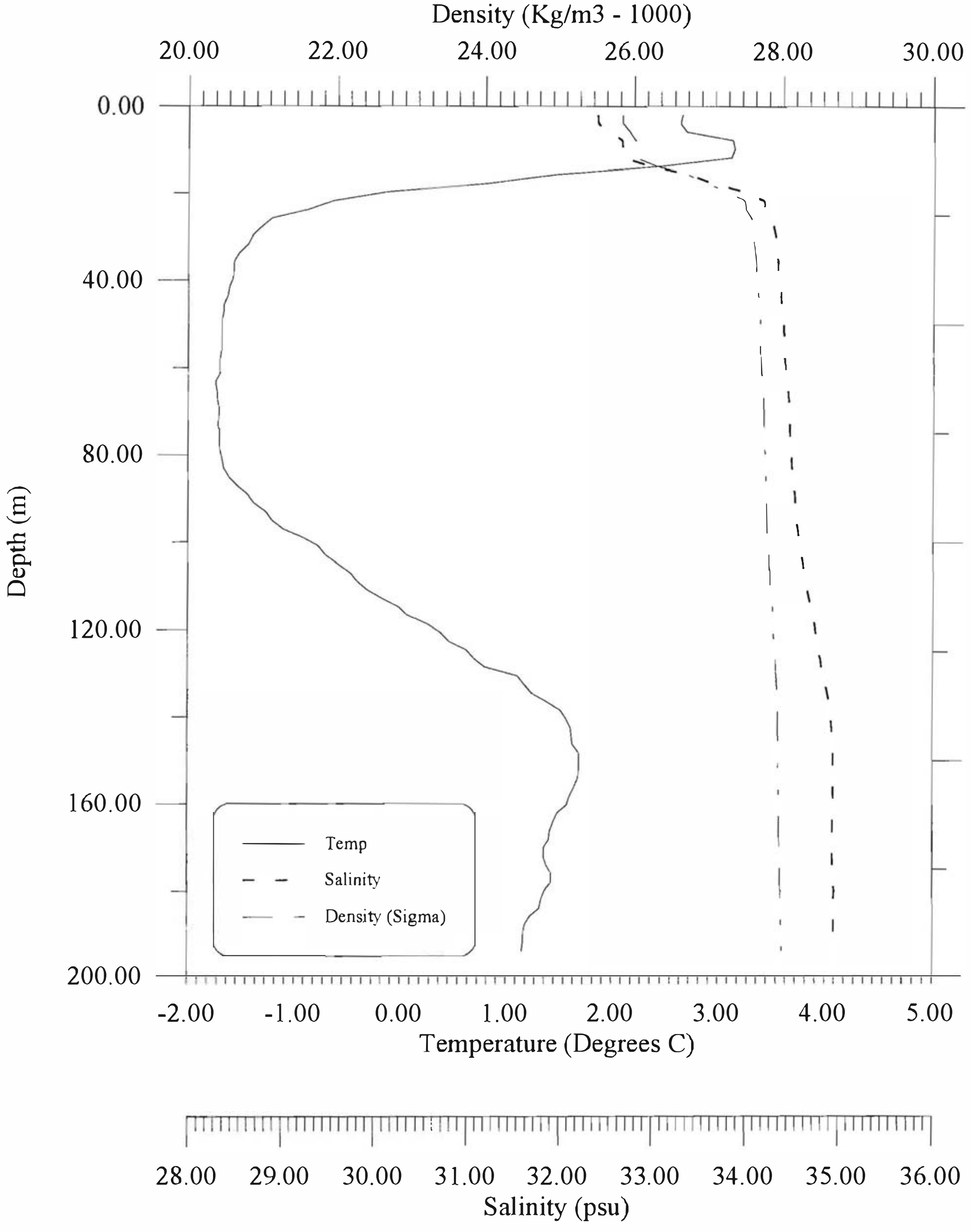


ICEBAR 96
CTD Station # 190



ICEBAR 96
CTD Station # 200



ICEBAR 96
CTD Station # 210