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Mean Temperatures and Salinities from an Ocean Climate Station by Newfoundland

by

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ABSTRACT

Tables of temperature and salinity from the Northwest Atlantic Fisheries Centre ocean climate station 27 (47°33'N, 52°35'W) are presented for 1931-81. The original data are from approximately twice monthly occupations of this station, situated 2 nautical miles east of Cape Spear in 174 m of water. The station is indicative of the inshore branch of the Labrador Current, also called the Avalon Channel Current. The data is presented as linearly time and depth averaged means for each month and the depth intervals 0-20, 0-100, 0-170, and 100-170 meters. These tables are expected to be useful for correlations in fisheries research and other ocean climate analyses.

INTRODUCTION

Station 27 (47°33'N, 52°35'W) is an ocean climate station located 2 nautical miles due east of Cape Spear, Newfoundland, in 174 m of water. The inshore branch of the Labrador Current, sometimes referred to as the Avalon Channel Current, flows past this station, and it is assumed that climate variations in the Labrador Current are indicated by the variations in measurements at Station 27. This large current is undoubtedly of profound influence on the fisheries of Atlantic Canada, and this makes Station 27 important.

The Northwest Atlantic Fisheries Centre (NAFC) and its predecessor biological stations have monitored temperature and salinity at Station 27 by Knudsen bottles with reversing thermometers, and by mechanical and electronic bathythermographs. Recently there are increasing numbers of electronic (eg. CTD) profiles at this site. Observations are forwarded to the federal oceanographic data base maintained by the Marine Environmental Data Service (MEDS). The earliest archived observation is from 1910, and there are some summer observations from 1931 to 1935, and from 1945 to 1950, but good seasonal coverage was not achieved until 1951. The station 27 time series was started in 1931 under Dr. Harold Thompson.

MATERIALS AND METHODS

The archived raw data for the region surrounding Station 27 was supplied by MEDS in 1981. This included all the data from before 1978. Data from 1978 to 1981 was from the files of the NAFC. The 1980 and 1981 data included expendable bathythermograph observations (XBT, Sippican Corp. Marion, MA) read at standard depths for dates when Knudsen bottle or CTD casts were not done. This was the only bathythermograph data used. The data from before 1931 was not used in what follows.

A fraction of the raw data was identified as erroneous and was removed before summarization. This excluded some unusually high salinity values from the early years of silver nitrate titrations, duplicated records, and also excluded the data points flagged as probable errors by the analysis of Keeley (1981). The remaining data consisted of 7942 observations of temperature and somewhat fewer for salinity.

A computer program for determining the linearly weighted mean temperature of a portion of the water column was written (included as Appendix 1) and applied for each occupation of Station 27 for the depth range 0-20 m, 0-100 m, 0-170 m, and 100-170 m, for both temperature and salinity. A station had to have observations in each of the ranges 0-20, 20-100 and 100-

170 that were part of the mean being calculated before acceptance. For instance, just surface and bottom observations were not felt to be sufficient to allow computing a mean for the whole water column. There were 879 acceptable data collections made at Station 27.

From the eight data sets of depth weighted means, time-weighted monthly means were calculated using another new computer program (Appendix 2). For months when there were no observations, the monthly mean was calculated by interpolation and flagged. If there was a data gap of over 2 weeks before or after a month with no data (i.e. data gap of over 6 weeks), then no mean was calculated.

Annual means were computed from these monthly tables. The process of computing annual means when there is missing data can be approached by either dealing with monthly anomalies to get a annual anomailes, or by attempting to estimate the missing value. For this report, the means are regressed against dummy variables for years and months, giving an equation that estimates the missing value as the monthly mean plus an adjustment for the yearly value. The two techniques should produce the same result.

RESULTS

Tables of monthly mean temperature and salinity were calculated for each of the four depth ranges, these are the Tables numbered 1-8. From these were calculated the 1951-81 annual means for temperature and salinity for the surface and the entire water column, these are the Tables numbered 9-12. The summer (June-September inclusive) surface temperature and salinity were also extracted and are the Tables 13 and 14. Tables 9-14 were graphed as Figures 1-6 to demonstrate the presence and general characteristics of trends in the data.

DISCUSSION

Huyer and Verney (1975) summarized the decade 1950-1959 for Station 27 in graphical form. This analysis was repeated with more sophisticated techniques by Keeley (1981). While both analyses prompt insight into the processes and events that characterize Station 27, neither report presents the data in a form suitable for correlations to fisheries or other time-series. The object of these tables is to correct this gap in data accessibility and thereby promote the application of environmental data to fisheries research.

The data files used in this report are available upon request.

ACKNOWLEDGMENTS

F. O'Rouke did the computer programming for this exercise, C. Fitzpatrick and A. G. Kelland did much of the original collecting and compilation of the data, R. Keeley of MEDS forwarded data from before 1978. The participation of dozens of anonymous investigators for over 30 years was required to make the Station 27 project possible, the credit for this data series goes to them.

REFERENCES

Huyer, A., and Verney, A. 1975. Temperature, salinity and sigma-t at Station 27 (47°33'N, 52°35'W), 1950-1959. Mar. Environ. Data Serv. Tech. Rep. No. 3, 35 p. Dept. Fish. and Oceans, Ottawa.

Keeley, J. R. 1981. Temperature, salinity and sigma-t at Station 27 (47°33'N, 52°35'W). An analysis of historical data. Mar. Environ Data. Serv. Tech. Rep. No. 8, 56 p. Plus microfiche. Dept. of Fish. and Oceans, Ottawa.

Table 1. Monthly mean salinity, 0 to 20 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						31.99	32.08		31.33	31.42		
1932					32.30				31.32			
1933						31.74	31.83	31.29	30.89			
1934					32.75	32.35	31.47	31.32	31.67	31.61		
1935			32.77		32.71	32.38	32.19	30.89	30.90	30.81		
1946						32.32	31.79	31.20	31.04	31.07	31.55	31.77
1947			32.54		32.27	32.06	31.85	31.58*	31.34	31.19		
1948			33.00	32.54	32.28	32.22	31.88	33.05				
1949						32.09	31.95*	31.50	31.30	31.48		32.04
1950			32.71	32.84	32.54*	32.25	32.12	31.61	31.31		31.61	31.63
1951	32.07	32.10	32.14	31.97	31.72	31.74	31.75	31.87	31.43	31.19		
1952	32.01			32.29	32.19	32.13	31.54	30.92	30.67	30.81		31.68
1953		32.02		31.94	31.88	31.88	31.67	31.81	31.44	31.45	31.51	31.87
1954	32.20	32.13	32.34	32.53	32.43	32.30	31.94	31.99	31.77	31.47	31.71	31.98
1955	32.20	32.41	32.40*	32.10	31.94	31.89	31.88	31.43	31.21	31.56	31.41	31.80
1956	31.88	32.08	32.28	32.24	32.24	32.01	32.05	32.07	31.55	31.38	31.59	31.70
1957	32.08	32.44	32.49	32.55	31.97	31.51	31.36	31.74	31.02	30.83	31.02	31.66
1958	31.88	31.99	32.14	32.12	32.10	31.99	31.65	31.58	31.15	31.26	31.38	31.79
1959	32.15	32.58	32.82	32.73	32.42	32.16	31.83	31.54	31.09	31.06	31.38	31.57
1960	31.84		32.20	32.23	31.97	31.82	31.89	31.26	30.86	31.22	31.41	31.73
1961	32.03	32.30	32.38			31.78	31.85	31.55	31.27	31.28	31.40	
1962	32.00	32.37	32.28		32.23	32.08	31.69	31.71	31.33	31.16	31.22	31.93
1963	31.91	32.28	32.53	32.54	32.35	32.16	31.96	31.97	31.25	31.12	31.34	31.76
1964	31.75	32.41	32.61	32.64	32.47	32.15	32.28	31.78	31.13	31.31	31.67	31.82
1965	32.08	32.46	32.31	32.32	32.25	31.68	31.76	31.89	31.80	31.54	31.79	32.05
1966	32.23	32.41	32.36	32.22	32.22	32.07	32.03	31.94	31.37	31.52	31.58	31.58
1967	31.62	32.01	32.39	32.25	31.98	31.95	31.92	31.84	31.41	31.37	31.66	32.01
1968	32.26	32.23	32.38	32.29	32.27	32.12	31.87	31.52	30.97	31.01	31.37	31.67
1969	32.21	32.32	32.21	32.22	32.15	31.94	31.84	31.56	31.20	31.22	31.46	31.62
1970	31.87	31.82	31.88	32.03	31.89	31.47	31.47	30.78	30.66*	30.66	30.67	31.15
1971	32.01	31.78	32.06	32.20	32.10	31.92	31.56	31.19	30.69	30.97	31.33	31.68
1972	31.99	32.34	32.56	32.55	32.43	32.19	31.96	31.41	30.94	30.84	31.37	
1973	32.10	32.24	32.42	32.29	31.38	31.51	31.40	31.27	30.93	31.06	31.57	31.78
1974	32.05	32.29	32.50	32.66	32.56	32.07	31.38	30.82	30.12	30.17	30.76	
1975	31.96	32.35			32.30	32.28	32.13	31.38	30.84	30.99	31.43	31.76
1976	32.06	32.15	32.43	32.49	32.42	32.35	32.12	31.76	31.15	31.22	31.76	31.84
1977	32.24	32.50	32.43	32.46	32.49	31.98	31.90	31.19	30.64	30.72	31.17	31.68
1978	32.06	32.24	32.26	32.28	32.23	32.30	31.91		30.88	31.43	31.81	
1979	32.18	32.34	32.39	32.63	32.20	32.16	32.09	31.43	31.15	31.33	31.38	31.55
1980	32.10	32.21	32.32	32.37	32.31	32.06	31.91	31.55	31.14	31.02	31.24	31.63
1981	32.03	32.13*	32.38	32.24	32.20	32.10	31.78	31.45*	31.00	31.01	31.27	31.58

Table 2. Monthly mean salinity, 0 to 100 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						32.54	32.66		32.20	32.06		
1932					32.67				32.07			
1933						32.32	32.23	32.22	32.07			
1934					33.01	32.78	32.54	32.36	32.62	32.15		
1935			32.83		32.76	32.69	32.74	32.62*	32.18	31.67		
1946						32.62	32.35	31.94	31.87	31.72	31.86	31.98
1947			32.60		32.52	32.43	32.22	32.10*	31.84	31.57		
1948			33.28	32.72	32.62	32.68		33.18				
1949						32.51	32.49*	32.40	32.11	32.09		32.22
1950		32.19	32.77	32.93	32.82*	32.64	32.78	32.55	32.14		31.99	32.02
1951	32.30	32.19	32.37	32.31	32.17	32.40	32.27	32.48	32.06	31.93		
1952	32.34			32.58	32.64	32.61	32.55	32.28	31.84	31.78		31.97
1953		32.22		32.46	32.51	32.46	32.44	32.37	31.87	31.86	31.76	32.06
1954	32.36	32.28	32.50	32.55	32.58	32.60	32.62	32.74	32.54	32.10	31.94	32.27
1955	32.29	32.53	32.54*	32.25	32.37	32.50	32.59	32.37	32.06	32.25	31.91	32.06
1956	32.22	32.30	32.36	32.40	32.49	32.56	32.59	32.62	32.20	31.90	31.87	32.00
1957	32.21	32.48	32.54	32.61	32.44	32.23	32.23	32.64	31.98	31.85	31.73	31.97
1958	32.02	32.25	32.30	32.34	32.44	32.41	32.27	32.27	31.87	31.75	31.86	31.98
1959	32.48	32.68	32.85	32.82	32.62	32.49	32.44	32.42	31.79	31.74	31.68	31.75
1960	31.98		32.31	32.35	32.31	32.29	32.42	32.21	31.86	31.86	31.76	32.03
1961	32.17	32.35	32.44			32.49	32.50	32.29	31.89	31.85	31.81	
1962	32.19	32.45	32.42		32.46	32.54	32.47	32.53	32.04	31.90	31.88	32.48
1963	32.19	32.37	32.57	32.61	32.59	32.59	32.58	32.61	32.07	31.76	31.89	32.04
1964	31.79	32.54	32.64	32.74	32.67	32.70	32.83	32.56	32.16	32.07	31.93	32.22
1965	32.30	32.51	32.37	32.51	32.47	32.26	32.51	32.57	32.35	32.02	32.15	32.23
1966		32.55	32.51	32.38	32.52	32.35	32.56	32.48	32.03	32.11	31.93	31.91
1967	31.86	32.23	32.46	32.44	32.48	32.46	32.54	32.51	32.09	31.92	32.11	32.20
1968	32.26	32.32	32.52	32.41	32.42	32.42	32.31	32.00	31.83	31.55	31.78	31.90
1969	32.32	32.43	32.33	32.31	32.37	32.34	32.38	32.37	32.03	31.75	31.96	32.16
1970	32.13	32.03	32.17	32.18	32.25	32.13	32.24	32.05	31.71*	31.32	31.29	31.45
1971	32.21	32.10	32.35	32.38	32.37	32.34	32.22	32.09	31.63	31.37	31.76	31.84
1972	32.04	32.38	32.64	32.62	32.57	32.56	32.59	32.40	31.98	31.72	31.80	
1973	32.32	32.39	32.52	32.57	32.35	32.41	32.36	32.25	31.69	31.81	32.14	31.96
1974	32.07	32.39	32.59	32.75	32.75	32.60	32.32	32.38	31.73	31.47	31.54	
1975	32.15	32.42			32.49	32.49	32.55	32.31	32.19	31.77	31.87	32.01
1976	32.28	32.28	32.49	32.61	32.60	32.56	32.45	32.38	31.91	31.80	31.91	31.90
1977	32.36	32.57	32.52	32.59	32.74	32.55	32.58	32.16	31.75	31.51	31.75	31.86
1978	32.19	32.39	32.64	32.45	32.57	32.75	32.50		31.58	32.36	32.10	
1979	32.41	32.64	32.56	32.69	32.47	32.63	32.54	32.28	31.90	32.00	31.91	31.79
1980	32.29	32.30	32.43	32.40	32.52	32.52	32.55	32.32	31.94	31.97	31.86	31.90
1981	32.21	32.36*	32.48	32.44	32.53	32.49	32.46	32.26	31.99	31.66	31.70	31.84

Table 3. Monthly mean salinity, 0 to 170 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						32.73	32.88					
1932					32.82							
1933						32.67		32.46	32.43			
1934						32.92	32.81	32.74*	32.91	32.61		
1935							33.16	33.06*	32.76			
1946						32.75	32.58	32.37	32.30	32.23	32.21	32.26
1947			32.67		32.65	32.60	32.40	32.32*	32.23	32.13	32.49	
1948			33.31	32.84	32.79	32.89	32.73	33.14				
1949						32.73	32.73*	32.69	32.48	32.53		32.51
1950			32.84	33.00	32.97*	32.87	32.97	32.86	32.58		32.42	32.37
1951	32.50	32.40	32.59	32.56	32.48	32.68	32.60	32.75	32.52	32.34		
1952	32.62			32.81	32.90	33.00	32.84	32.89	32.27	32.20		32.29
1953		32.44		32.76	32.77	32.75	32.75	32.66	32.26	32.33	32.24	32.35
1954	32.62	32.51	32.50	32.78	32.69	32.81	32.89	32.97	32.79	32.49	32.37	32.60
1955	32.51	32.70	32.72*	32.53	32.79	32.72	32.84	32.69	32.45	32.67	32.37	32.37
1956	32.46	32.57	32.54	32.52	32.60	32.76	32.80	32.80	32.52	32.32	32.27	32.32
1957	32.46	32.65	32.66	32.75	32.72	32.59	32.57	32.92	32.39	32.37	32.25	32.36
1958	32.35	32.55	32.54	32.59	32.65	32.63	32.54	32.59	32.28	32.18	32.19	32.25
1959	32.67	32.75	32.92	32.88	32.76	32.76	32.66	32.67	32.26	32.26	32.15	32.12
1960	32.24	32.29	32.44	32.54	32.51	32.49	32.63	32.47	32.34	32.27	32.21	32.29
1961	32.39	32.45	32.52		32.53	32.72	32.73	32.55	32.25	32.29	32.25	
1962	32.53	32.63	32.52		32.70	32.77	32.75	32.81	32.39	32.42	32.36	32.86
1963	32.46	32.58	32.68	32.70	32.77	32.79	32.79	32.84	32.43	32.24	32.33	32.35
1964		32.78	32.79	32.88	32.81	32.88	32.99	32.85	32.56	32.52	32.41	32.62
1965	32.56	32.53	32.59	32.69	32.65	32.56	32.75	32.78	32.62	32.45	32.51	32.58
1966	32.46	32.69	32.69	32.62	32.70	32.63	32.80	32.73	32.48	32.51	32.41	32.30
1967	32.22	32.46	32.67	32.57	32.68	32.68	32.73	32.70	32.42	32.36	32.48	32.44
1968	32.40	32.51	32.69	32.60	32.67	32.63	32.63	32.53	32.32	32.18	32.33	32.33
1969	32.60	32.70	32.57	32.49	32.57	32.57	32.60	32.67	32.44	32.25	32.33	32.49
1970	32.36	32.48	32.40	32.40	32.50	32.42	32.57	32.41	32.20*	31.92	31.87	31.83
1971	32.39	32.40	32.59	32.57	32.53	32.54	32.49	32.42	32.11	31.86	32.22	32.17
1972	32.30	32.58	32.74	32.72	32.72	32.73	32.79	32.61	32.40	32.25	32.21	
1973	32.47	32.56	32.68	32.73	32.60	32.66	32.66	32.61	32.23	32.33	32.54	32.29
1974	32.22	32.52	32.68	32.84	32.89	32.89	32.68	32.71	32.32	32.12	32.16	
1975	32.36	32.62			32.60	32.64	32.75	32.63	32.62	32.21	32.30	32.30
1976	32.54	32.49	32.60	32.72	32.73	32.76	32.68	32.67	32.36	32.32	32.40	32.32
1977	32.62	32.73	32.66	32.73	32.89	32.77	32.80	32.50	32.24	32.20	32.26	32.24
1978	32.48	32.60	32.83	32.63	32.78	32.90	32.68		32.15	32.73	32.45	
1979	32.67	32.81	32.74	32.87	32.71	32.87	32.74	32.62	32.41	32.52	32.45	32.25
1980	32.57	32.48	32.65	32.71	32.75	32.75	32.76	32.63	32.43	32.45	32.31	32.35
1981	32.56	32.66*	32.63	32.63	32.73	32.71	32.64	32.54*	32.39	32.14	32.17	32.32

Table 4. Monthly mean salinity, 100 to 170 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						33.00	33.16					
1932					33.04							
1933						33.00		32.82	32.94			
1934						33.12	33.21	33.20*	33.31	33.21		
1935							33.42	33.47*	33.27			
1946						32.94	32.91	32.99	32.91	32.95	32.71	32.66
1947			32.72		32.86	32.86	32.67	32.63*	32.78	32.92	32.93	
1948			33.33	33.00	33.01	33.17	33.08	33.35				
1949						33.03	33.06*	33.11	32.99	33.14		32.94
1950			32.96	33.14	33.18*	33.19	33.31	33.29	33.21		33.04	32.88
1951	32.78	32.71	32.91	32.92	32.91	33.08	33.07	33.14	33.16	32.91		
1952	33.03			33.14	33.26	33.36	33.22	33.25	32.89	32.83		32.75
1953		32.76		33.19	33.14	33.15	33.19	33.08	32.86	33.01	32.91	32.76
1954	33.02	32.85	32.87	33.10	32.87	33.14	33.26	33.30	33.16	33.05	33.16	33.06
1955	32.82	32.94	32.98*	32.94	33.11	33.03	33.21	33.17	33.14	33.26	33.12	32.81
1956	32.81	32.95	32.82	32.70	32.82	33.05	33.09	33.05	32.98	32.99	32.93	32.77
1957	32.83	32.95	32.85	33.00	33.14	33.15	33.05	33.31	33.03	33.23	32.99	32.92
1958	32.82	32.96	32.86	32.94	33.03	32.95	32.94	33.05	32.92	32.98	32.87	32.64
1959	32.93	32.84	33.02	32.98	32.96	33.00	32.99	33.04	32.94	32.99	32.82	32.64
1960	32.59	32.54	32.67	32.79	32.79	32.76	32.93	32.82	33.01	32.86	32.84	32.68
1961	32.69	32.59	32.63		32.96	33.04	33.04	32.97	32.79	32.91	32.86	
1962	33.01	32.88	32.66		33.04	33.10	33.15	33.19	32.91	33.15	33.04	33.39
1963	32.85	32.90	32.82	32.84	33.02	33.09	33.08	33.17	32.95	32.94	32.94	32.78
1964		32.95	33.00	33.06	33.01	33.15	33.22	33.27	33.14	33.18	33.20	33.19
1965	32.93	32.73	32.89	32.95	32.90	32.98	33.09	33.09	33.01	33.06	33.03	33.08
1966	32.61	32.91	32.95	32.96	32.98	33.02	33.14	33.06	33.13	33.08	33.11	32.85
1967	32.74	32.81	32.97	32.75	32.97	32.98	33.01	32.97	32.88	32.98	33.01	32.80
1968	32.59	32.78	32.94	32.86	33.02	32.95	33.07	33.01	33.06	33.08	33.11	32.94
1969	33.00	33.06	32.89	32.75	32.86	32.88	32.92	33.10	33.03	33.00	32.87	32.96
1970	32.70	32.87	32.73	32.72	32.85	32.83	33.03	32.94	32.90*	32.77	32.69	32.37
1971	32.64	32.84	32.93	32.83	32.77	32.81	32.88	32.89	32.79	32.57	32.89	32.64
1972	32.67	32.88	32.88	32.86	32.94	32.98	33.09	33.08	33.00	32.88	32.79	
1973	32.70	32.80	32.90	32.94	32.96	33.01	33.09	33.12	33.00	33.09	33.10	32.75
1974	32.44	32.70	32.82	32.96	33.08	33.17	33.16	33.18	33.15	33.06	33.06	
1975	32.66	32.89			32.75	32.85	33.03	33.07	33.23	32.83	32.92	32.73
1976	32.92	32.84	32.77	32.88	32.92	33.05	33.02	33.08	33.00	33.07	33.11	32.92
1977	33.00	32.96	32.88	32.93	33.10	33.08	33.12	32.98	32.94	33.07	32.98	32.78
1978	32.88	32.91	33.11	32.89	33.08	33.10	32.92		32.97	33.28	32.95	
1979	33.04	33.06	32.99	33.14	33.05	33.21	33.04	33.11	33.14	33.26	33.23	32.91
1980	32.96	32.76	32.97	32.96	33.05	33.08	33.06	33.09	33.13	33.14	32.95	33.00
1981	33.05	33.07*	32.84	32.90	33.03	33.04	32.94	32.91*	32.97	32.85	32.86	33.02

Table 5. Monthly mean temperature 0 to 20 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						5.78	7.13		11.07	8.90		
1932					2.76				10.27			
1933						3.82	3.70	10.55	11.37			
1934					2.77	4.43	7.49	11.44	12.32	9.91		
1935		-1.77	-1.66		0.10	4.89	8.89	12.07	10.45	8.39		
1946						5.54	6.85	13.63	12.14	9.21	5.36	2.03
1947			-1.22		0.59	4.23	9.09	11.83*	11.39	8.13	3.92	
1948			-1.39	-0.69	1.06	5.07	7.49	8.99				
1949						6.68	8.11	9.96	10.31	7.28		2.45
1950			-1.47	-0.39	1.40*	4.28	8.00	9.49	10.04		4.52	3.83
1951	-0.09	-0.46	-0.18	1.20	2.90	6.19	10.09	10.33	11.69	9.25		
1952	-0.06			0.34	2.32	5.65	9.08	13.93	11.79	9.08		2.51
1953		0.01		1.43	1.84	4.26	8.68	10.61	10.92	9.31	5.33	2.77
1954	-0.47	-1.08	-0.96	-0.80	0.73	3.59	8.55	8.44	7.90	7.57	4.28	2.27
1955	0.56	-0.11	-0.57*	-1.20	-0.17	3.16	8.47	10.09	10.20	6.78	4.82	2.27
1956	1.08	-0.07	-0.61	-0.51	1.06	4.01	7.04	8.16	9.99	7.98	5.69	3.61
1957	-0.60	-1.67	-1.64	-1.06	-0.14	2.69	7.13	6.89	7.91	7.60	5.20	1.77
1958	0.49	0.12	-0.02	0.90	2.20	5.14	9.60	11.71	11.27	7.73	4.68	1.67
1959	-0.47	-1.48	-1.64	-0.68	0.98	3.01	7.51	12.30	11.63	8.30	4.50	2.70
1960	0.05	-0.40	-0.61	-0.26	1.20	5.63	9.49	12.29	12.84	8.89	4.13	2.28
1961	-0.18	-1.23	-1.63		0.21	5.24	9.66	12.89	11.31	10.98	7.08	
1962	1.13	-0.72	-1.33	-0.63	1.76	3.87	7.62	9.98	10.72	8.81	6.06	4.34
1963	0.80	-0.32	-1.13	-0.66	1.10	4.76	9.45	11.75	10.71	8.30	5.71	2.48
1964	0.10	-1.19	-1.49	-0.77	0.24	4.37	7.71	10.89	10.70	8.40	4.26	2.45
1965	0.24	-1.28	-1.23	-0.40	1.09	4.62	8.11	10.68	6.09	8.43	4.84	2.82
1966	0.62	-0.25	-0.61	0.01	1.25	4.90	9.81	9.53	10.64	8.20	5.16	3.43
1967	1.05	-0.82	-1.31	-1.51	-0.24	3.78	10.00	13.89	13.07	10.81	7.24	3.61
1968	0.91	0.01	-0.63	0.26	1.51	3.56	7.88	10.48	10.50	8.54	5.50	3.01
1969	0.31	-0.20	0.10	0.41	2.09	5.07	7.53	11.33	11.17	7.91	5.08	4.07
1970	0.74	-0.11	-0.03	0.16	2.49	5.63	9.93	12.70	10.39*	8.67	6.42	3.07
1971	-0.83	-1.17	-0.88	0.49	2.97	6.75	9.51	13.10	11.72	8.31	4.87	2.51
1972	-0.56	-1.61	-1.42	-0.34	0.81	4.71	8.98	11.69	10.42	8.48	4.63	
1973	-1.71	-1.64	-1.59	-1.22	0.02	3.32	9.00	12.02	11.87	9.31	5.15	2.81
1974	-1.04	-1.53	-1.43	-0.57	1.24	2.76	6.52	9.15	11.22	8.68	4.74	
1975	-0.56	-1.29	-1.33*	-0.58	0.71	2.90	7.22	11.58	10.78	7.97	4.47	2.22
1976	0.09	-1.19	-1.15	-0.19	2.01	4.75	7.03	11.55	12.19	8.30	3.23	2.24
1977	-0.57	-1.56	-1.26	-0.18	2.24	5.19	8.41	10.41	10.44	8.36	5.32	2.16
1978	-0.28	-0.56	-0.96	-0.43	2.33	3.42	8.91	14.00	10.21	7.64	4.07	
1979	0.47	-0.98	-1.30	0.04	1.09	4.75	9.33	13.54	12.24	9.00	5.40	3.08
1980	-0.46	-1.30	-1.45	-0.87	2.01	5.09	7.35	8.72	9.72	8.63	5.50	2.84
1981	-0.01	-0.47*	-0.49	0.12	3.14	6.76	10.73	13.00	11.72	8.61	5.56	3.76

Table 6. Monthly mean temperature 0 to 100 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						1.19	1.34		3.27	2.42		
1932					-0.02				3.88			
1933						0.11	0.69	2.37	3.13			
1934					0.06	1.26	2.07	3.22	4.18	4.31		
1935		-1.79	-1.77		-0.66	1.37	1.98	3.85	2.81	3.86		
1946						0.87	2.43	4.46	5.11	6.35	4.07	1.79
1947			-1.34		-0.13	1.77	3.79	3.87*	4.11	4.96	3.21	
1948			-0.91	-1.06	-0.43	1.26	2.27	1.86				
1949						2.44	2.21	2.96	3.70	4.03		1.82
1950			-1.59	-1.11	-0.39*	0.85	1.86	2.09	3.36		3.35	2.74
1951	0.23	-0.47	-0.46	0.09	0.55	1.07	2.11	2.41	6.15	4.96		
1952	-0.30			-0.40	0.13	1.09	2.21	3.14	4.92	4.65		1.83
1953		-0.08		0.20	0.04	1.27	2.13	3.64	6.21	5.64	4.32	2.37
1954	-0.31	-1.09	-1.23	-0.95	-0.21	0.81	1.62	1.25	1.74	3.60	3.65	1.51
1955	0.56	-0.24	-0.75*	-1.39	-0.60	0.42	1.66	3.14	4.44	3.53	3.50	1.80
1956	0.60	-0.24	-0.68	-0.67	-0.21	0.58	1.45	1.25	3.61	4.70	4.40	2.69
1957	-0.59	-1.67	-1.66	-1.24	-0.89	0.03	0.88	0.68	2.88	3.33	3.21	1.32
1958	0.43	-0.01	-0.16	0.01	0.23	1.28	2.75	3.70	4.93	4.63	3.42	1.30
1959	-0.50	-1.50	-1.57	-0.88	-0.16	1.01	1.76	2.41	4.63	4.19	3.12	2.01
1960	0.03	-0.67	-0.69	-0.57	-0.20	0.86	1.28	2.51	4.31	3.93	2.85	1.54
1961	-0.25	-1.57	-1.71		-0.67	0.46	2.03	3.45	4.72	5.57	4.61	
1962	0.95	-0.69	-1.41	-0.98	0.07	0.66	1.59	2.04	4.22	4.87	3.47	1.85
1963	0.56	-0.33	-1.28	-1.03	-0.09	1.14	2.21	3.58	4.31	4.69	3.10	1.84
1964	0.10	-1.18	-1.54	-1.10	-0.60	0.23	1.34	2.94	4.28	4.19	3.46	1.89
1965	0.07	-1.03	-1.14	-1.04	-0.02	1.35	1.59	2.44	2.70	4.82	3.26	2.21
1966	0.63	-0.25	-0.87	-0.36	0.08	1.62	2.10	1.99	4.70	3.62	3.66	2.44
1967	0.70	-0.94	-1.48	-1.52	-1.25	0.15	1.52	3.03	5.27	6.31	4.63	2.95
1968	0.92	-0.18	-0.70	-0.48	0.44	1.64	2.81	3.99	4.61	6.08	3.93	2.39
1969	0.19	-0.14	-0.19	0.00	0.77	1.36	1.70	3.05	4.01	5.34	3.27	2.25
1970	0.26	-0.37	-0.62	-0.36	0.06	1.28	2.57	3.33	3.99*	4.90	3.75	2.14
1971	-0.89	-1.17	-1.19	-0.49	0.54	1.35	2.25	3.67	4.17	5.33	3.36	2.09
1972	-0.61	-1.59	-1.65	-1.03	-0.57	0.28	1.72	2.53	3.43	3.26	2.99	
1973	-1.72	-1.67	-1.67	-1.57	-1.25	-0.27	1.59	3.42	5.61	4.89	2.87	2.33
1974	-1.14	-1.63	-1.63	-1.19	-0.36	0.35	1.72	1.47	2.72	3.51	2.69	
1975	-0.62	-1.34	-1.45*	-0.80	0.03	1.18	1.98	2.68	2.16	3.82	3.34	1.79
1976	-0.31	-1.22	-1.40	-0.80	0.00	1.61	2.28	3.00	4.87	4.54	2.62	2.06
1977	-0.68	-1.55	-1.53	-1.04	-0.05	0.73	1.86	3.23	4.55	3.75	3.26	1.97
1978	-0.02	-0.64	-1.03	-1.08	-0.01	-0.07	1.86	3.24	5.54	2.60	3.08	
1979	0.06	-1.02	-1.46	-0.11	-0.16	0.35	1.92	3.81	5.47	4.49	3.56	2.32
1980	-0.50	-1.27	-1.47	-0.53	0.21	1.42	1.11	2.08	4.15	4.17	4.13	2.86
1981	-0.05	-0.42*	-0.80	-0.42	0.57	1.81	2.09	2.81	3.55	4.64	4.29	3.15

Table 7. Monthly mean temperature 0 to 170 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						0.21	0.30					
1932					-0.57							
1933						-0.46		0.78	1.28			
1934						0.13	0.64	1.29*	1.27	2.23		
1935							0.61	0.85*	0.99			
1946						-0.09	0.99	2.46	2.60	3.37	1.87	1.15
1947			-1.30		-0.61	0.58	2.16	2.24*	2.22	2.14	2.15	
1948			-0.80	-1.24	-0.83	0.21	0.82	0.64				
1949						0.91	0.82	1.30	1.82	2.06		1.03
1950			-1.56	-1.32	-0.87*	-0.14	0.44	0.61	1.42		1.76	1.51
1951	0.22	-0.44	-0.59	-0.30	-0.08	0.15	0.90	1.13	3.45	2.67		
1952	-0.42			-0.56	-0.18	0.42	1.09	1.45	2.45	2.34		1.07
1953		-0.11		0.03	-0.19	0.27	0.72	1.73	3.46	3.01	2.42	1.42
1954	-0.27	-0.91	-1.11	-0.86	-0.66	0.06	0.40	0.18	0.49	1.72	2.11	0.82
1955	0.48	-0.23	-0.66*	-1.19	-0.73	-0.21	0.52	1.36	2.17	1.95	2.04	1.06
1956	0.34	-0.19	-0.56	-0.68	-0.59	-0.21	0.35	0.22	1.64	2.38	2.46	1.68
1957	-0.53	-1.42	-1.62	-1.33	-1.08	-0.59	-0.09	-0.28	1.18	1.55	1.72	0.49
1958	0.13	-0.23	-0.33	-0.26	-0.21	0.34	1.18	1.79	2.42	1.98	1.90	0.91
1959	-0.37	-1.39	-1.38	-1.04	-0.66	-0.29	0.48	0.88	2.26	1.95	1.74	1.05
1960	-0.07	-0.69	-0.69	-0.68	-0.59	0.03	0.31	0.96	2.07	1.88	1.33	0.75
1961	-0.33	-1.38	-1.61		-0.97	-0.27	0.67	1.82	2.55	3.07	2.49	
1962	0.75	-0.39	-1.35	-1.09	-0.41	-0.04	0.55	0.75	2.03	2.53	1.75	0.80
1963	0.30	-0.32	-1.15	-1.18	-0.56	0.21	0.89	1.80	2.06	2.35	1.52	0.99
1964	0.10	-1.12	-1.45	-1.29	-0.91	-0.43	0.15	1.29	1.90	2.03	2.05	1.00
1965	-0.06	-0.98	-1.07	-1.15	-0.62	0.27	0.47	1.02	1.20	2.52	1.67	1.21
1966	1.23	-0.09	-0.63	-0.43	-0.23	0.75	1.15	0.92	2.65	2.01	2.03	1.46
1967	0.47	-0.81	-1.34	-1.45	-1.29	-0.50	0.33	1.17	2.67	3.40	2.51	1.95
1968	0.82	-0.12	-0.51	-0.57	0.07	0.58	1.29	3.06	2.40	3.21	1.98	1.36
1969	0.03	-0.28	-0.24	-0.19	0.19	0.49	0.65	1.53	1.94	2.79	1.63	0.99
1970	0.01	-0.42	-0.60	-0.59	-0.32	0.35	1.17	1.50	1.81*	2.37	1.68	1.08
1971	-0.85	-1.02	-1.07	-0.80	-0.22	0.25	0.78	1.68	1.99	2.94	1.69	1.29
1972	-0.49	-1.24	-1.55	-1.22	-0.91	-0.41	0.35	0.82	1.40	1.37	1.57	
1973	-1.66	-1.64	-1.65	-1.59	-1.39	-0.82	0.28	1.34	2.67	2.28	1.14	1.27
1974	-1.09	-1.58	-1.63	-1.39	-0.87	-0.46	0.32	0.19	0.96	1.46	1.06	
1975	-0.61	-1.26	-1.35*	-0.93	-0.49	0.17	0.63	1.05	0.88	2.14	1.93	1.24
1976	-0.27	-0.91	-1.32	-1.00	-0.47	0.51	0.90	1.26	2.37	2.14	1.16	0.93
1977	-0.71	-1.42	-1.49	-1.16	-0.60	-0.10	0.51	1.35	2.08	1.68	1.41	1.01
1978	-0.98	-0.52	-0.93	-1.14	-0.48	-0.53	0.56	1.34	2.83	1.20	1.74	
1979	-0.06	-0.86	-1.43	-0.23	-0.55	-0.34	0.63	1.71	2.72	2.27	1.74	1.27
1980	-0.51	-1.17	-1.36	-0.87	-0.32	0.38	0.07	0.68	1.94	2.01	2.33	2.15
1981	-0.28	-0.52*	-0.78	-0.62	-0.10	0.68	0.90	1.84	1.89	2.40	2.35	1.83

Table 8. Monthly mean temperature 100 to 170 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1931						-1.10	-1.07					
1932					-1.35							
1933						-1.43		-1.50	-1.35			
1934						-1.50	-1.40	-1.56*	-1.54	-1.47		
1935							-0.97	-0.90*	-0.94			
1946						-1.46	-1.07	-0.41	-0.99	-0.88	-0.18	0.23
1947			-1.22		-1.29	-1.15	-0.18	-0.11*	-0.51	-0.58	0.58	
1948			-0.64	-1.50	-1.40	-1.30	-1.25	-1.10				
1949						-1.28	-1.16	-1.07	-0.88	-0.76		-0.09
1950			-1.53	-1.61	-1.55*	-1.54	-1.58	-1.51	-1.35		-0.52	-0.22
1951	0.20	-0.41	-0.78	-0.86	-0.97	-1.17	-0.83	-0.72	-0.42	-0.60		
1952	-0.57			-0.78	-0.64	-0.60	-0.60	-0.96	-1.08	-1.05		-0.02
1953		-0.15		-0.21	-0.62	-1.17	-1.29	-1.05	-0.66	-0.72	-0.29	0.06
1954	-0.20	-0.64	-0.94	-0.72	-1.32	-1.03	-1.35	-1.38	-1.30	-0.97	-0.86	-0.18
1955	0.35	-0.21	-0.54*	-0.91	-0.91	-1.11	-1.09	-1.20	-1.04	-1.00	-0.59	0.00
1956	-0.05	-0.11	-0.41	-0.69	-1.13	-1.34	-1.22	-1.26	-1.17	-1.11	-0.50	0.22
1957	-0.37	-0.92	-1.57	-1.45	-1.32	-1.42	-1.48	-1.19	-1.17	-0.94	-0.41	-0.69
1958	-0.30	-0.55	-0.58	-0.64	-0.74	-1.00	-1.06	-0.91	-1.18	-0.81	-0.36	0.37
1959	-0.18	-1.21	-1.12	-1.26	-1.38	-1.38	-1.34	-1.30	-1.11	-1.24	-0.24	-0.34
1960	-0.20	-0.72	-0.69	-0.83	-1.14	-1.16	-1.08	-1.26	-1.13	-1.05	-0.85	-0.37
1961	-0.44	-1.26	-1.47		-1.40	-1.32	-1.27	-1.29	-1.08	-0.49	-0.54	
1962	0.48	0.04	-1.25	-1.23	-1.11	-1.04	-0.93	-1.10	-1.09	-0.79	-0.69	-0.70
1963	-0.09	-0.29	-0.96	-1.40	-1.24	-1.12	-1.11	-0.90	-1.15	-1.01	-0.72	-0.21
1964	0.09	-1.06	-1.32	-1.55	-1.35	-1.39	-1.34	-1.26	-1.33	-1.20	0.04	-0.27
1965	-0.26	-0.87	-0.97	-1.31	-1.46	-1.27	-1.13	-1.01	-0.94	-0.77	-0.60	-0.22
1966	1.19	0.04	-0.28	-0.54	-0.69	-0.51	-0.22	-0.60	-0.28	-0.32	-0.30	0.07
1967	0.16	-0.63	-1.14	-1.35	-1.37	-1.43	-1.36	-1.50	-1.07	-0.75	-0.52	0.53
1968	0.68	-0.05	-0.24	-0.70	-0.46	-0.94	-0.88	-0.82	-1.02	-0.90	-0.81	-0.12
1969	-0.20	-0.45	-0.41	-0.43	-0.62	-0.76	-0.85	-0.64	-1.01	-0.92	-0.72	-0.82
1970	-0.36	-0.50	-0.76	-0.90	-0.87	-0.99	-0.83	-1.10	-1.30*	-1.24	-1.29	-0.45
1971	-0.79	-0.81	-0.89	-1.23	-1.30	-1.31	-1.32	-1.15	-1.11	-0.49	-0.68	0.15
1972	-0.31	-0.77	-1.41	-1.48	-1.41	-1.40	-1.59	-1.62	-1.51	-1.33	-0.46	
1973	-1.57	-1.59	-1.62	-1.63	-1.60	-1.61	-1.58	-1.63	-1.51	-1.47	-1.33	-0.22
1974	-1.02	-1.52	-1.64	-1.67	-1.60	-1.61	-1.69	-1.66	-1.57	-1.48	-1.26	
1975	-0.60	-1.15	-1.21*	-1.10	-1.24	-1.29	-1.31	-1.28	-1.04	-0.41	-0.09	0.44
1976	-0.22	-0.47	-1.22	-1.28	-1.16	-1.05	-1.09	-1.24	-1.21	-1.28	-0.92	-0.69
1977	-0.76	-1.23	-1.42	-1.33	-1.38	-1.31	-1.41	-1.35	-1.44	-1.28	-1.24	-0.35
1978	-1.91	-0.36	-0.80	-1.24	-1.14	-1.19	-1.27	-1.41	-1.05	-0.78	-0.18	
1979	-0.25	-0.64	-1.40	-0.42	-1.13	-1.34	-1.20	-1.30	-1.19	-0.84	-0.85	-0.23
1980	-0.54	-1.02	-1.22	-1.19	-1.09	-1.11	-1.42	-1.32	-1.21	-1.08	-0.22	1.13
1981	-0.61	-0.68*	-0.76	-0.92	-1.07	-1.03	-1.16	-1.04	-0.99	-1.00	-0.48	-0.05

Table 9. Mean annual salinity, 0-20 meters

YR	MEAN
51	31.7455
52	31.6545
53	31.8215
54	32.0658
55	31.8525
56	31.9225
57	31.7225
58	31.7525
59	31.9442
60	31.7127
61	31.8465
62	31.8654
63	31.9308
64	32.0017
65	31.9942
66	31.9608
67	31.8675
68	31.8300
69	31.8292
70	31.3625
71	31.6242
72	31.8619
73	31.6625
74	31.5709
75	31.8469
76	31.9792
77	31.7833
78	31.9024
79	31.9025
80	31.8217
81	31.7642

Table 10. Mean annual salinity, 0-170 meters

YR	MEAN
51	32.542
52	32.647
53	32.531
54	32.668
55	32.613
56	32.540
57	32.557
58	32.445
59	32.572
60	32.393
61	32.468
62	32.613
63	32.580
64	32.735
65	32.606
66	32.585
67	32.534
68	32.485
69	32.523
70	32.280
71	32.359
72	32.550
73	32.530
74	32.548
75	32.503
76	32.549
77	32.553
78	32.623
79	32.638
80	32.570
81	32.510

Table 11. Mean annual temperature, 0-20 meters

YR	MEAN
51	5.04103
52	5.03499
53	4.57295
54	3.33500
55	3.69167
56	3.95250
57	2.84000
58	4.62417
59	3.88833
60	4.62750
61	4.84007
62	4.30083
63	4.41250
64	3.80583
65	3.66750
66	4.39083
67	4.96417
68	4.29417
69	4.57250
70	5.00500
71	4.77917
72	4.03154
73	3.94500
74	3.48154
75	3.67417
76	4.07167
77	4.08000
78	4.26427
79	4.72167
80	3.81500
81	5.20250

Table 12. Mean annual temperature, 0-170 meters

YR	MEAN
51	0.91571
52	0.69054
53	1.05910
54	0.16417
55	0.54667
56	0.57000
57	-0.16667
58	0.80167
59	0.26917
60	0.38417
61	0.53755
62	0.49000
63	0.57583
64	0.27667
65	0.37333
66	0.90167
67	0.59250
68	1.13083
69	0.79417
70	0.66333
71	0.55500
72	0.03348
73	0.01917
74	-0.21380
75	0.28333
76	0.44167
77	0.21333
78	0.34257
79	0.57250
80	0.44417
81	0.79917

Table 13. Mean summer - salinity, 0-20 meters

YR	MEAN
51	31.6975
52	31.3150
53	31.7000
54	32.0000
55	31.6025
56	31.9200
57	31.4075
58	31.5925
59	31.6550
60	31.4575
61	31.6125
62	31.7025
63	31.8350
64	31.8350
65	31.7825
66	31.8525
67	31.7800
68	31.6200
69	31.6350
70	31.0950
71	31.3400
72	31.6250
73	31.2775
74	31.0975
75	31.6575
76	31.8450
77	31.4275
78	31.6791
79	31.7075
80	31.6650
81	31.5825

Table 14. Mean summer - temperature, 0-20 meters

YR	MEAN
51	9.5750
52	10.1125
53	8.6175
54	7.1200
55	7.9800
56	7.3000
57	6.1550
58	9.4300
59	8.6125
60	10.0625
61	9.7750
62	8.0475
63	9.1675
64	8.4175
65	7.3750
66	8.7200
67	10.1850
68	8.1050
69	8.7750
70	9.6625
71	10.2700
72	8.9500
73	9.0525
74	7.4125
75	8.1200
76	8.8800
77	8.6125
78	9.1350
79	9.9650
80	7.7200
81	10.5525

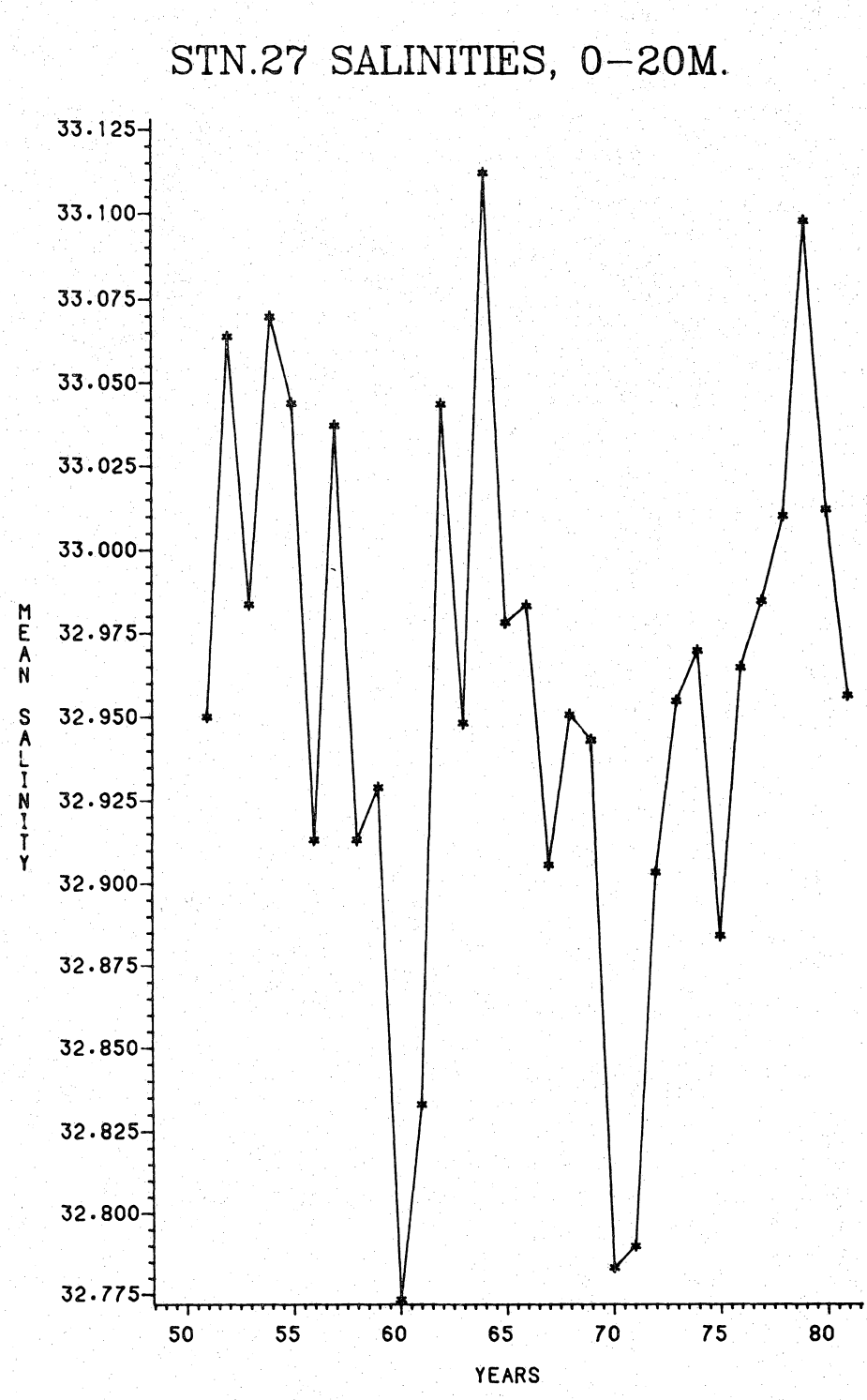

Fig. 1. Annual mean salinity 0-20 meters

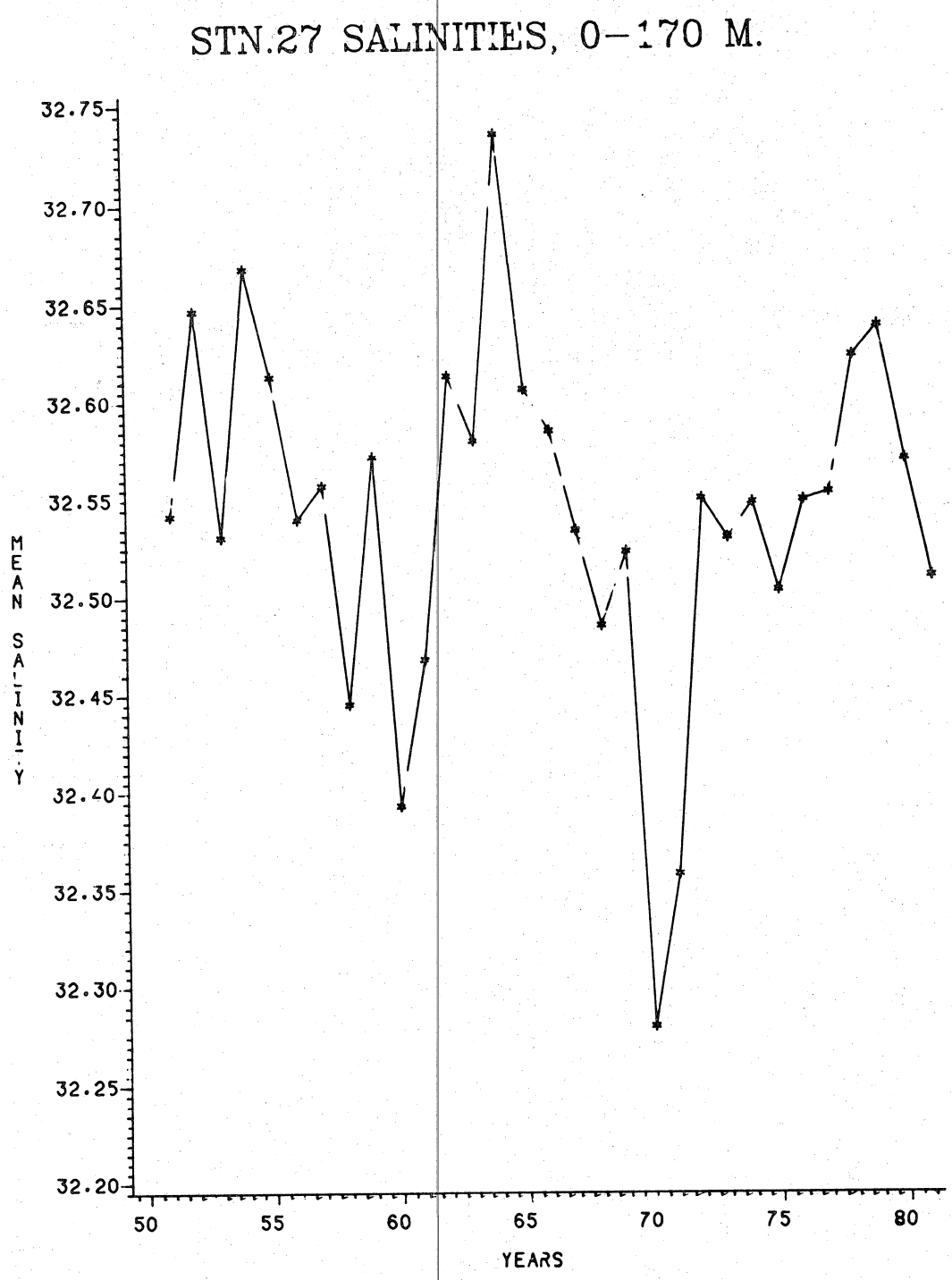

Fig. 2. Annual mean salinity 0-170 meters

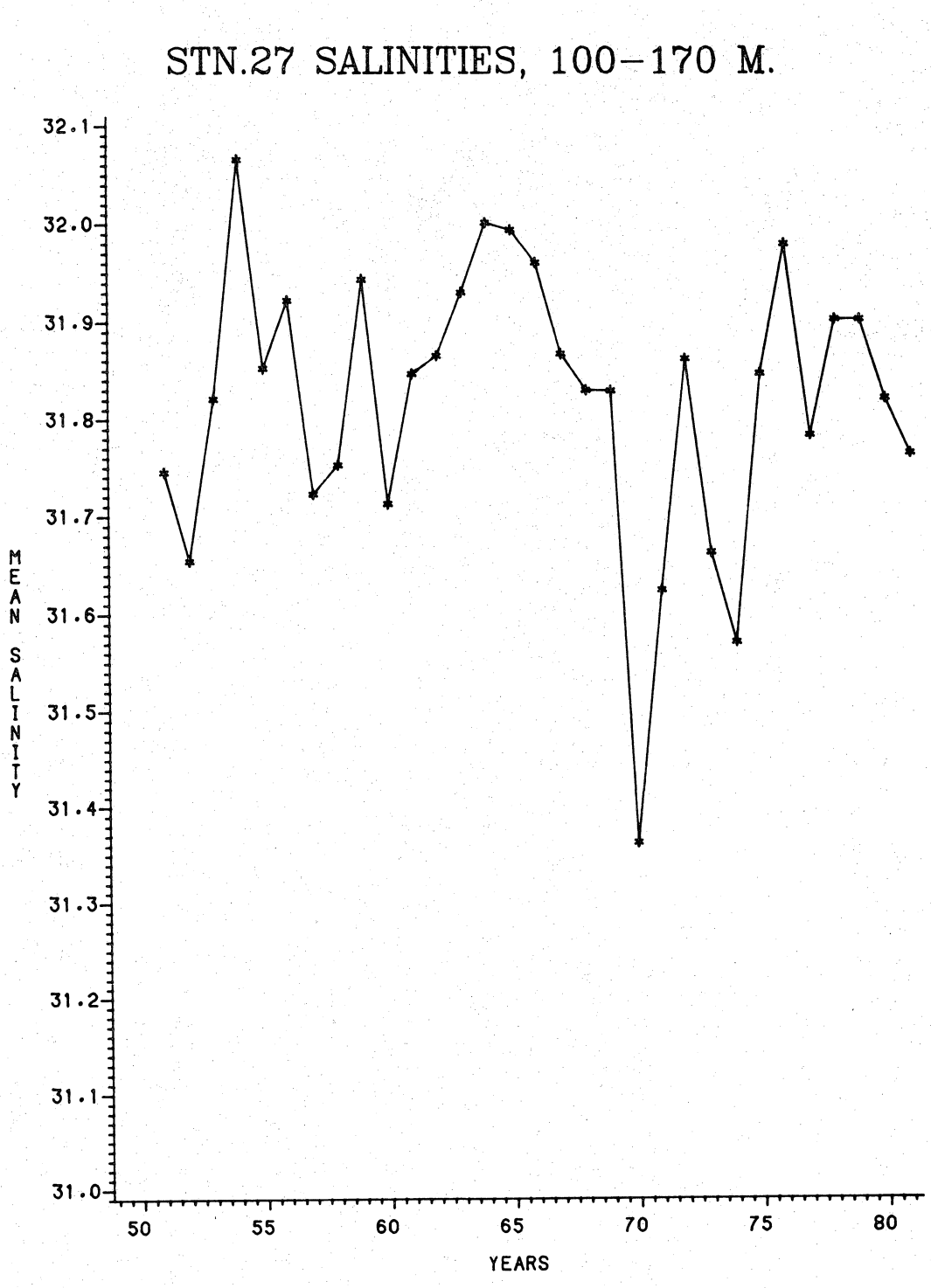

Fig. 3. Annual mean salinity 100-170 meters

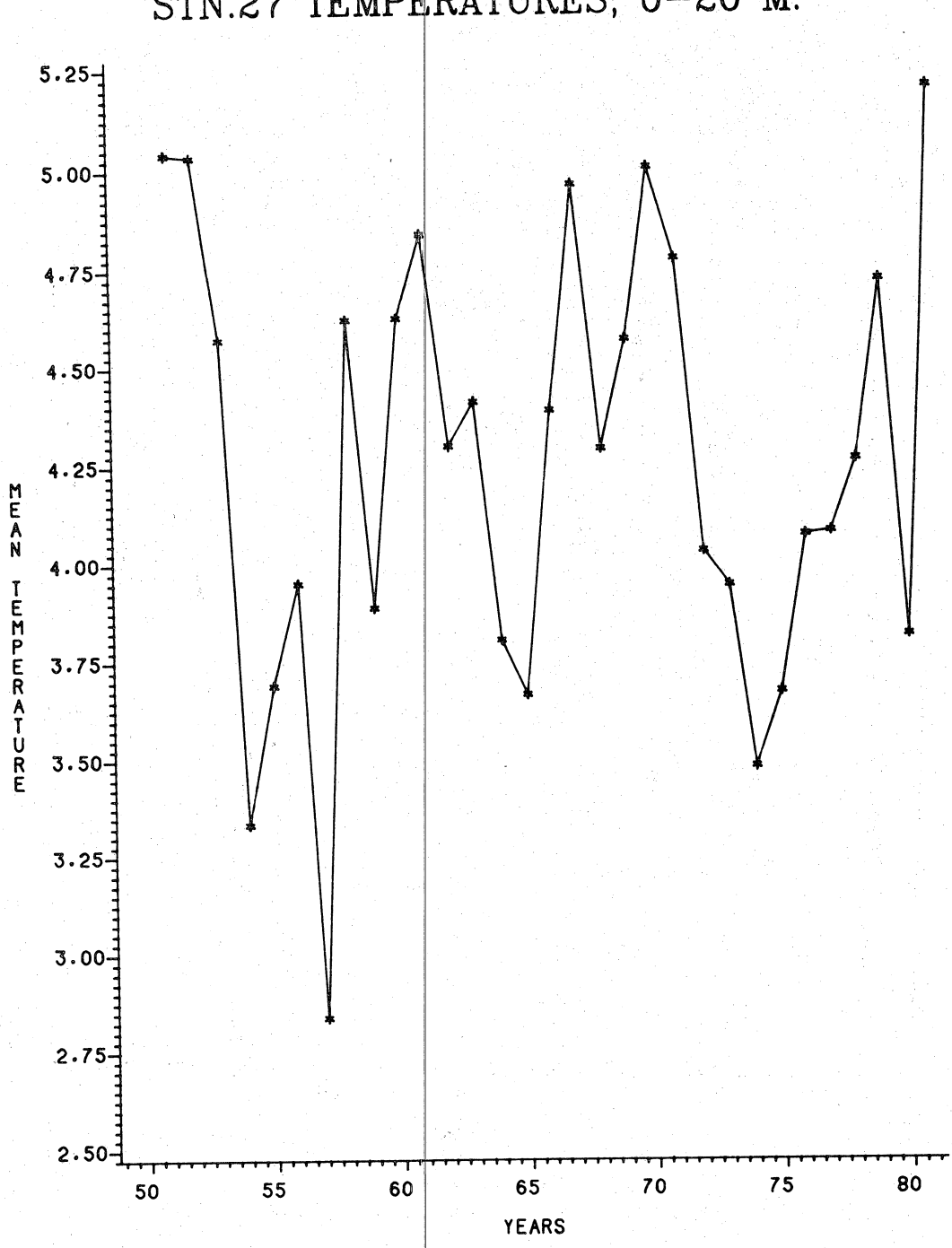

Fig. 4. Annual mean temperature 0-20 meters

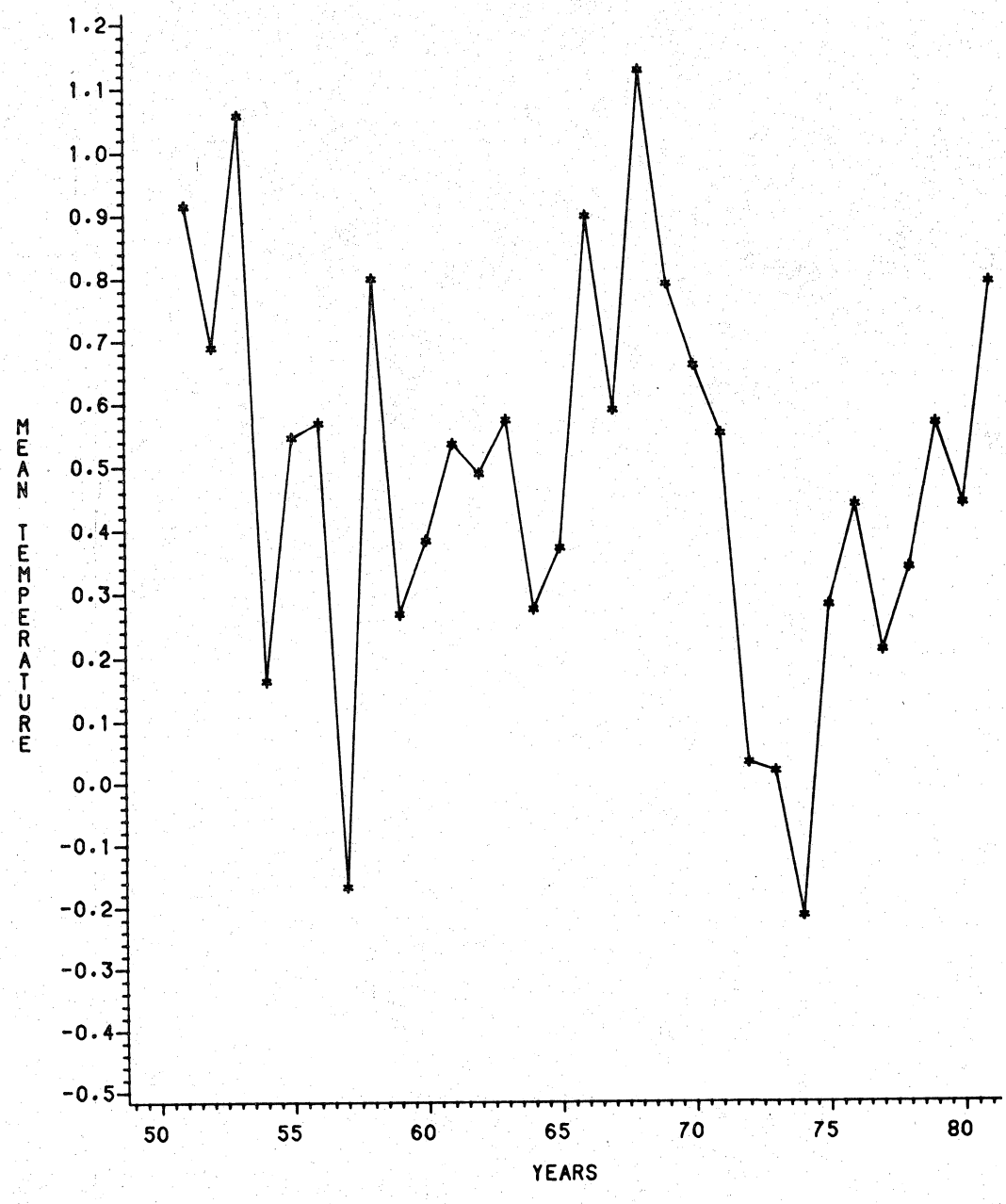

Fig. 5. Annual mean temperature 0-170 meters

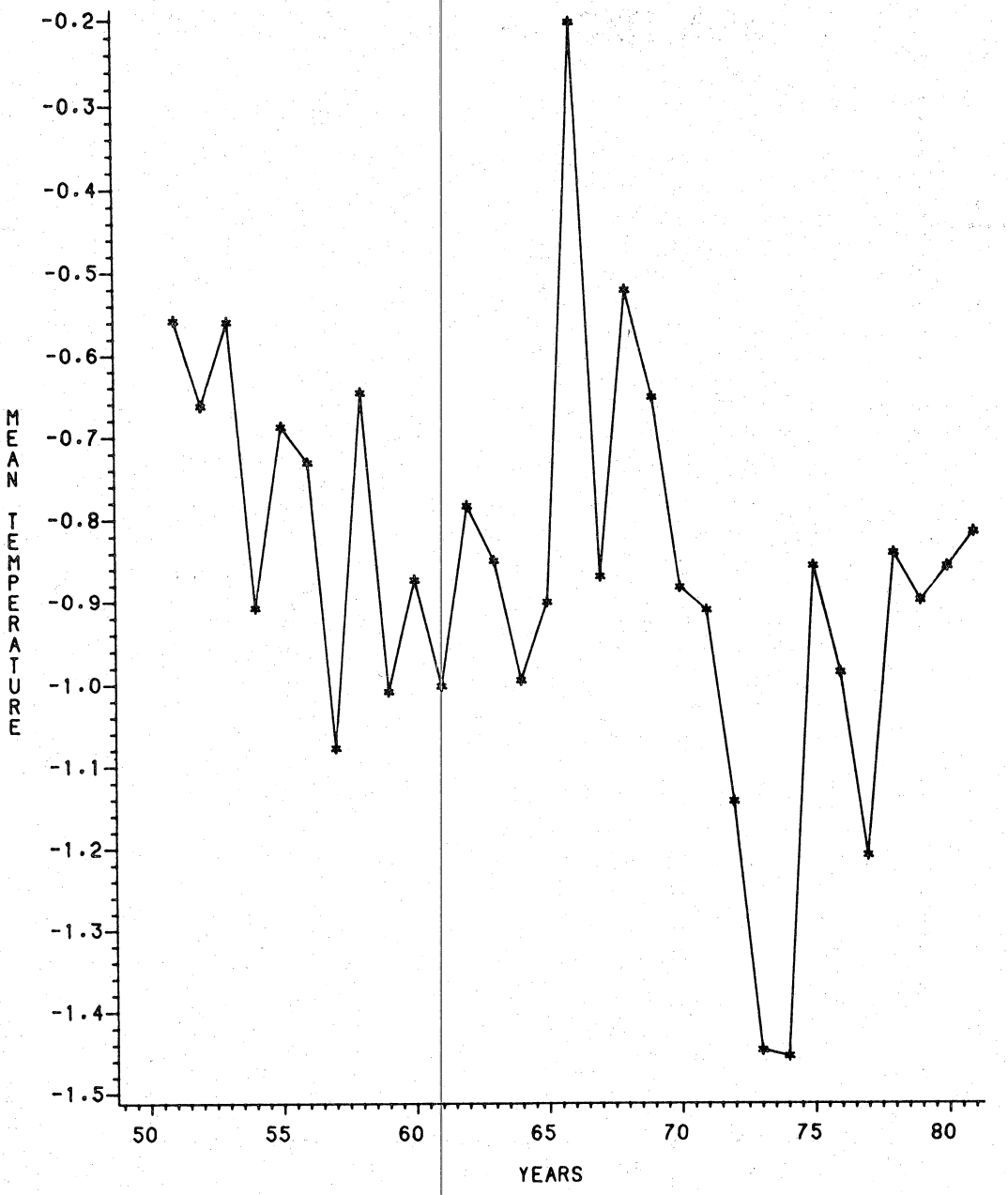

Fig. 6. Annual mean temperature 100-170 meters

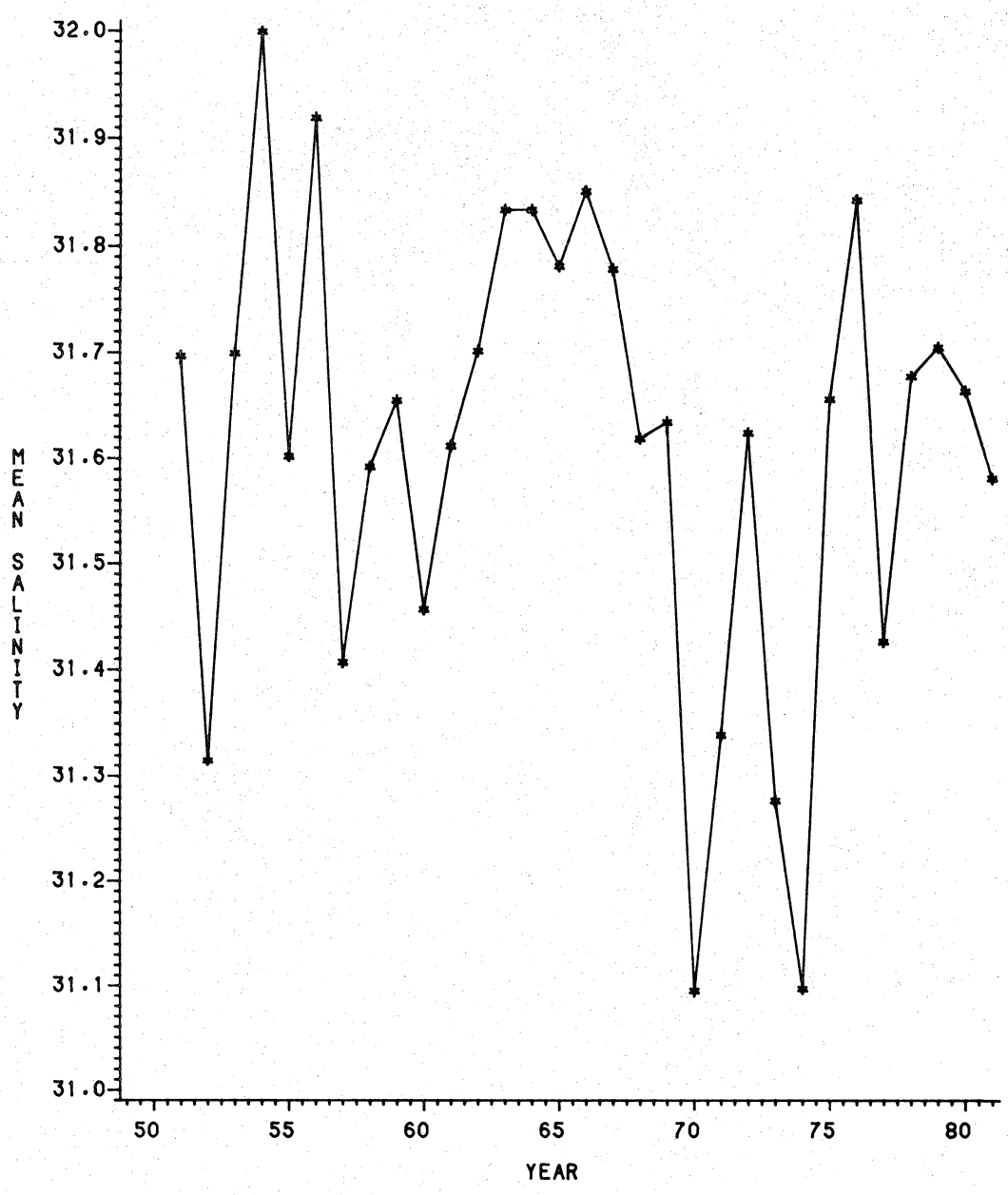

Fig. 7. Summer mean salinity 0-20 meters

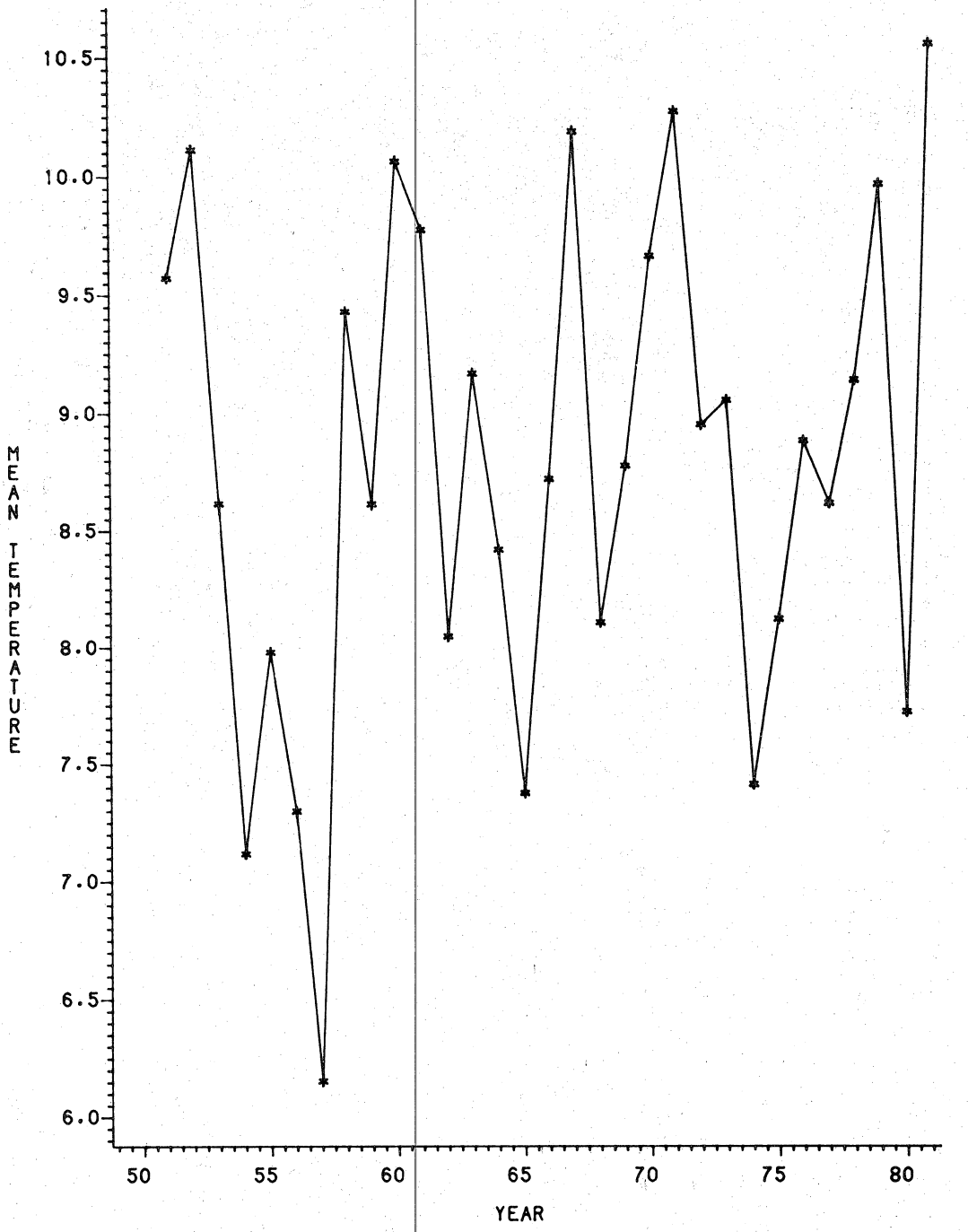

Fig. 8. Summer mean temperature 0-20 meters

APPENDIX 1: A computer program to calcualte linearly time-averaged monthly means from irregular observations.

```
C       TIME WEIGHTING PROGRAM
C
C         PROGRAM CALCULATES A TIME WEIGHTED VALUE FOR SALINITY'S
C         OR TEMPERATURE'S FOR EACH REPRESENTED MONTH. WEIGHTS
C         ARE ASSIGNED ACCORDING TO MIDPOINT DISTANCES BETWEEN
C         OBSERVATIONS. IF THE MIDPOINT OF TWO OBSERVATIONS,
C         ONE OF WHICH IS FROM THE PRECEEDING OR FOLLOWING MONTH,
C         FALLS WITHIN THE MONTHLY PARAMETERS THEN THE OUTSIDE
C         VALUE WILL RECIEVE A WEIGHT ACCORDING TO WHERE THE MIDPOINT
C         FALLS.
C
C
          INTEGER OLDMNT,OLDYER,ADDYER,ADDONE,YEAR,MONTH,DAY,I,A,STATUS
          INTEGER DAYS(20),LYIR,HOLDAY,CHECK,FSTDAY,LSTDAY,MNTVAL(12,2)
          INTEGER LASTD
          REAL    LASTS,VAL,S(20),LYR,LYRI,HOLDS
          REAL    TIMAVG,ADDUP,WTADD
          DATA MNTVAL /0,31,59,90,120,150,181,212,243,273,304,334,
     1                 31,59,90,120,150,181,212,243,273,304,334,356/
          STATUS = 0
          OLDMNT = 6
          OLDYER = 31
C
C     VARIABLE LASTD WILL HOLD THE DAY UPON WHICH THE LAST
C     OBSERVATION FROM THE PRECEDING MONTH WAS TAKEN. THE VALUE
C     WILL BE SET TO -5000 WHEN THE PRECEEDING OBSERVATION IS
C     PROVEN TO BE FROM A DIFFERENT YEAR AND MORE THAN ONE MONTH
C     AWAY. LASTS WILL HOLD THE VALUE FOR THE OBSERVATION FROM
C     THAT DAY.
C
          LASTD = -5000
          LASTS = 0.0
          I = 0
    1     ADDYER= 0
          ADDONE = 0
   10     READ(8,123,END=987)YEAR,MONTH,DAY,VAL
  123     FORMAT(I2,2X,I2,2X,I3,2X,F6.2)
          I = I + 1
C
C     ARRAYS 'S' AND 'DAYS' WILL HOLD THE OBSERVATIONS FOR THE MONTH
C     PLUS THE FIRST OBSERVATION FROM THE FOLLOWING MONTH.
C
          S(I) = VAL
          DAYS(I) = DAY
          IF(MONTH .EQ. OLDMNT) GOTO 10
    2     A = I - 1
          LYR = FLOAT(OLDYER)/4.0
          LYRI = LYR
          LYIR = LYRI * 1.0
          IF((LYIR .EQ. LYR) .AND. (OLDMNT .NE. 1)) ADDONE = 1
          IF(YEAR .NE. OLDYER) ADDYER = 365 + ADDONE
          FSTDAY = MNTVAL(OLDMNT,1) + ADDONE
          LSTDAY = MNTVAL(OLDMNT,2) + ADDONE
          IF(OLDMNT .EQ. 2) FSTDAY = FSTDAY - ADDONE
          HOLDAY = DAYS(A)
          HOLDS = S(A)
C
C     IF THE VALUE FOR THE OBSERVATION FROM THE FOLLOWING MONTH
C     IS FROM THE FOLLOWING YEAR CHECK TO SEE IF IT IS FROM MONTH 1.
C
```

```
      IF(YEAR .EQ. OLDYER) GOTO 20
      IF(YEAR .NE. 1) GOTO 11
      HOLDAY = ADDYER - DAYS(A)
      GOTO 20
C
CC    IF NOT SET DAY VALUES SO THE OBSERVATION IS NOT USED
C
 11   HOLDAY = -5000
      DAYS(I) = 5000
      TIMAVG = 0.0
 20   CALL CALC(LSTDAY,DAYS,S,FSTDAY,ADDYER,TIMAVG,A,I,LASTS,LASTD)
      WRITE(9,456)OLDYER,OLDMNT,TIMAVG
456   FORMAT(I2,2X,I2,2X,F7.2)
C
CC    RESET VARIABLES FOR NEXT MONTH
C
      OLDYER = YEAR
      OLDMNT = MONTH
      LASTD = HOLDAY
      LASTS = HOLDS
      S(1) = VAL
      DAYS(1) = DAY
      I = 1
      IF(STATUS .EQ. 9) GOTO 654
      GOTO 1
C
CC    END OF FILE PROCESSING
C
987   STATUS = 9
      I = I + 1
      S(I) = 0.0
      DAYS(I) = 5000
      GOTO 2
654   STOP
      END
C
CC    CALCULATION ROUTINE:
C
      SUBROUTINE CALC(LSTDAY,DAYS,S,FSTDAY,ADDYER,TIMAVG,A,I,LASTS,
     1                LASTD)
      INTEGER FSTDAY,LSTDAY,ADDYER,A,I,DAYS(20),Z,LASTD
      REAL    WTA,WTB,WTC,ADDUP,TIMAVG,LASTS,DIVI,S(20)
C
CC    FSTDAY AND LSTDAY OR THE BEGINNING AND ENDING JULIAN DAY VALUES
CC    FOR THE MONTH IN QUESTION. DIVI WILL BE THE LENGTH OF THE MONTH.
CC    WTB WILL BE THE WEIGHT IF ANY ASSIGNED TO THE PRECEEDING MONTH
CC    VALUE WHILE WTA WILL HOLD SAME FOR THE FOLLOWING MONTH VALUE.
C
      DIVI = LSTDAY - FSTDAY
      WTB = (LASTD + DAYS(1))/2
      IF(WTB .LT. FSTDAY) WTB = FSTDAY
      WTB = WTB - FSTDAY
      WTA = (DAYS(A) + (DAYS(I) + ADDYER))/2
      IF(WTA .GT. LSTDAY) WTA = LSTDAY
      WTA = LSTDAY - WTA
      IF(I .NE. 2) GOTO 30
C
CC    HERE THERE IS ONLY ONE OBSERVATION FOR THE MONTH
C
      WTC = (LSTDAY - FSTDAY) - (WTA + WTB)
      TIMAVG = (((WTB * LASTS) + (WTC * S(A)) + (WTA * S(I)))/DIVI)

      GOTO 999
 30   ADDUP = 0.0
      WTADD = FSTDAY + WTB
      Z = 1
 40   WTC = ((DAYS(Z) + DAYS(Z+1))/2)-WTADD
      WTADD = WTADD + WTC
      ADDUP = ADDUP + (WTC * S(Z))
      Z = Z + 1
      IF(Z .LT. A) GOTO 40
      WTC = LSTDAY - (WTADD + WTA)
      TIMAVG = (((WTB*LASTS) + (WTA*S(I)) + (WTC*S(A))+ADDUP)/DIVI)
999   CONTINUE
      RETURN
      END
```

APPENDIX 2: A computer program to calcualte linearly depth-weighted means of oceanographic observations, station by station.

```
C      DEPTH AVERAGING PROGRAM
CC
CC
CC        PROGRAM TO OBTAIN AVERAGE VALUES FOR A "CAST", WHERE A
CC        CAST IS DEFINED AS A SET OF SALINITY AND TEMPERATURE
CC        VALUES OBTAINED AT DIFFERENT DEPTHS AT THE SAME LOCATION.
CC        AT LEAST TWO DEPTHS ARE NEEDED FOR A VALID EVALUATION.
CC        THIS PROGRAM IS SET TO AVERAGE FOR RANGES OF '0 - 20',
CC        '100 - 170' AND '0 - 170'. HOWEVER THESE RANGES CAN BE
CC        EASILY ADJUSTED FOR EVALUATION FOR DIFFERENT RANGES.
CC        WEIGHTS ARE ASSIGNED TO EACH OBSERVATION ACCORDING TO
CC        THE DISTANCES BETWEEN THE MIDPOINTS OF THE INDIVIDUAL
CC        DEPTHS FOR EACH READING.
C
          INTEGER DEPTH,STATUS,I,J,STATE,MONTH,YEAR,S,T
          INTEGER MONTHY,YEARY,JDAY,JADEY,A,B,C,X,SI1,TI1
          INTEGER STHLD1,STHLD2,STHLD4,STHLD5
          REAL    WGSUBS,WGSUBT,DS(20),DT(20),SALR(20),TEMPR(20)
          REAL    SPCWGT,WGT100,WGTS(20),WGTT(20),ADDS,ADDT,LSTDEP
          REAL    HOLD1,HOLD2,HOLD3,HOLD4,HOLD5,HOLD6,SI1,TI1,CK1,CK2
          REAL    ADDEMS,ADDEMT,SPCADD
C
C    HOLD1 WILL OBTAIN THE CALCULATED VALUE FOR SALINITY '0 - 20' ,
C    HOLD2 -> '0 - 170' , HOLD3 -> '100 - 170'.
C    HOLD4-6 ARE SIMILIAR FOR TEMPERATURE.
C
          HOLD1 = 0.0
          HOLD2 = 0.0
          HOLD3 = 0.0
          HOLD4 = 0.0
          HOLD5 = 0.0
          HOLD6 = 0.0
          STATE1 = 0
          STATE2 = 0
          STHLD1 = 0
          STHLD2 = 0
          STHLD4 = 0
          STHLD5 = 0
C PRELIMINARY READ
          READ(8,123)DEPTH,YEAR,MONTH,JDAY,CK1,CK2,SI1,TI1
  123     FORMAT(10X,I4,2X,I2,I2,4X,I3,2X,I6,2X,I6,2X,I6,2X,I6)
          IF(YEAR .LT. 30) GOTO 1
          STATUS = 0
          GOTO 20
C
C    END OF CAST PROCESSING STHLD1,2,4 AND 5 ARE STATUS CHECKS
C    THAT ARE TRIPPED IF A VALUE FOR A RANGE CANNOT BE DETERMINED
C    BECAUSE DATA IS NOT AVAILABLE.
C
    10    IF(STHLD2 .NE. 1) GOTO 11
          HOLD2 = 99.9
          HOLD3 = 99.9
    11    IF(STHLD1 .NE. 1) GOTO 12
          HOLD1 = 99.9
    12    IF(STHLD5 .NE. 1) GOTO 13
          HOLD5 = 99.9
          HOLD6 = 99.9
    13    IF(STHLD4 .NE. 1) GOTO 14
          STHLD4 = 99.9
    14    WRITE(10,124)YEARY,MONTHY,JDAYEY,HOLD1,HOLD2,HOLD3,
      1                                      HOLD4,HOLD5,HOLD6
```

```
  124   FORMAT(I2,2X,I2,2X,I3,6(2X,F7.3))
        IF(STATUS .EQ. 9) GOTO 9876
        HOLD1 = 0.0
        HOLD2 = 0.0
        HOLD3 = 0.0
        HOLD4 = 0.0
        HOLD5 = 0.0
        HOLD6 = 0.0
        STHLD1 = 0
        STHLD2 = 0
        STHLD4 = 0
        STHLD5 = 0
   20   I = 1
        J = 1
        MONTHY = MONTH
        YEARY = YEAR
        JDAYEY = JDAY
        WGSUBS = 0.0
        WGSURT = 0.0
        STATE1 = 0
        STATE2 = 0
C
CC   THE REASON COMPUTATIONS FOR SALINTY AND TEMPERATURE ARE
CC   TOTALLY SEPERATED IS THAT DATA FOR ONE OR THE OTHER AT
CC   DIFFERENT DEPTHS MAY BE MISSING OR MAY HAVE BEEN DELETED
CC   AS BAD DATA.
C
        DS(I) = DEPTH
        DT(J) = DEPTH
        LSTDEP = DEPTH
        SALR(I) = SI1 * .001
        TEMPR(J) = TI1 * .001
C
CC   CK1 AND CK2 ARE FIELDS IN THE INPUT DATA THAT FLAG BAD
CC   FOR MISSING VALUES.
C
        IF(CK1 .LT. -25.0) I = 0
        IF(CK2 .GT. 50.0) J = 0
        I = I + 1
        J = J + 1
   21   READ(8,121,END=9)DEPTH,YEAR,MONTH,JDAY,CK1,CK2,SI1,TI1
        IF(DEPTH .LT. LSTDEP) GOTO 30
        IF(DEPTH .GT. 176) GOTO 21
        DS(I) = DEPTH
        DT(J) = DEPTH
        LSTDEP = DEPTH
        SALR(I) = SI1 * .001
        TEMPR(J) = TI1 * .001
        IF(CK1 .LT. -25.0) GOTO 25
        IF(I .NE. 1) GOTO 23
        I = I + 1
        GOTO 25
   23   A = I - 1
        WGTS(A) = ((DS(A) + DS(I))/2) - WGSUBS
        WGSUBS = WGSUBS + WGTS(A)
C
CC   CHECK FOR FIRST VALUE AT A DEPTH > 20 M. CHECK IF ANY VALUES
CC   <= 20. IF SO CALCULATE .
C
        IF((DS(I) .LT. 20.0) .OR.(STATE1 .GT. 1)) GOTO 24
        STATE1 = 2
```

```
          IF(DS(1) .LE. 20.0) GOTO 2301
          STHLD1 = 1
          GOTO 24
C
C    IF THE FIRST VALUE < 20 HAS A PRECEEDING MIDPOINT THAT FALLS
C    WITHIN 20 THEN IT ALSO IS ASSIGNED A WEIGHT AND USED IN THE
C    EVALUATION.
C
 2301     SPCWGT = 20.0 - WGSUBS
          IF(WGSUBS .GT. 20.0) SPCWGT = 0.0
          SPCADD = 0.0
          ADDEMS = 0.0
          WGTADD = 0.0
          WGTERR = 0.0
          DO 111 X=1,A
          WGTADD = WGTADD + WGTS(X)
          IF(WGTADD .GT. 20.0) WGTERR = WGTADD - 20.0
          ADDEMS = ADDEMS + (SALR(X) * (WGTS(X) - WGTERR))
  111     CONTINUE
          SPCADD = (SALR(I) * SPCWGT) + ADDEMS
          HOLD1 = SPCADD/20.0
   24     I = I + 1
C
C    NEXT SECTION OF CODE IS FOR TEMPERATURE AND IS IDENTICAL TO
C    THE PRECEEDING CODE FOR SALINITY.
C
   25     IF(TEMPC .GT. 50.0) GOTO 21
          IF(J .NE. 1) GOTO 26
          J = J + 1
          GOTO 21
   26     B = J - 1
          WGTT(B) = ((DT(B) + DT(J))/2) - WGSUBT
          WGSUBT = WGSUBT + WGTT(B)
          IF((DT(J) .LT. 20.1) .OR.(STATE2 .GT. 1)) GOTO 27
          STATE2 = 2
          IF(DT(1) .LE. 20.1) GOTO 2601
          STHLD4 = 1
          J = J + 1
          GOTO 21
 2601     SPCWGT = 20.0 - WGSUBT
          IF(WGSUBT .GT. 20.0) SPCWGT = 0.0
          SPCADD = 0.0
          ADDEMT = 0.0
          WGTADD = 0.0
          WGTERR = 0.0
          DO 222 X=1,B
          WGTADD = WGTADD + WGTT(X)
          IF(WGTADD .GT. 20.0) WGTERR = WGTADD - 20.0
          ADDEMT = ADDEMT + (TEMPR(X) * (WGTT(X) - WGTERR))
   222    CONTINUE
          SPCADD = (TEMPR(J) * SPCWGT) + ADDEMT
          HOLD4 = SPCADD/20.0
   27     J = J + 1
          GOTO 21
    9     STATUS = 9
C
C    ALL VALUES FOR THE CAST HAVE BEEN OBTAINED. NOW CHECK FOR
C    VALUES >= 100 TO DETERMINE IF AN EVALUATION FOR THE RANGE
C    '100 - 170' OR '0 - 170' IS NEEDED. AGAIN IF THE MIDPOINT
C    FOR THE FIRST VALUE BEFORE AND AFTER 100 FALLS AFTER 100
C    A WEIGHT WILL BE ASSIGNED TO THE PRECEEDING VALUE AND IT
```

```
C    WILL BE USED IN THE COMPUTATION FOR THE RANGE '100 - 170'.
C
  30     IF(I .NE. 1) GOTO 31
         GOTO 40
  31     A = I - 1
         IF(DS(A) .GE. 99.9) GOTO 32
         STHLD2 = 1
         GOTO 40
C
CC   WGTS(A) IS THE WEIGHT FOR THE FINAL VALUE
C
  32     WGTS(A) = 170.0 - WGSUBS
         ADDS = 0.0
         DO 333 K=1,A
         IF((DS(K) .LT. 99.9) .OR. (STATE1 .GT. 3)) GOTO 33
C
CC   X WILL MARK THE PLACE OF THE FIRST VALUE AT A DEPTH >= 100
C
         X = K
         STATE1 = 4
  33     ADDS = ADDS + (SALR(K) * WGTS(K))
 333     CONTINUE
         HOLD2 = ADDS/170.0
C
CC   X WILL EQUAL A IF THER IS ONLY ONE DEPTH >= 100
C
         IF(X .EQ. A) GOTO 34
C
CC   WGT100 IS THE READJUSTED WEIGHT FOR THE FIRST DEPTH >= 100
C
         C = X + 1
         WGT100 = ((DS(X) + DS(C))/2) - 100.0
         GOTO 35
C
CC   IF ONLY ONE VALUE FOR DEPTH >= 100 THEN A WEIGHT IS CALCULATED
CC   FOR THE PRECEDING OBSERVATION IF IT'S MIDPOINT FALLS WITHIN
CC   THE PROPER RANGE.
C
  34     G = X - 1
         WGTS(G) = WGSUBS - 100.0
         SPCADD = 0.0
         GOTO 36
  35     SPCADD = SALR(X) * WGT100
  36     ADDEMS = 0.0
         IF(X .EQ. A) C = A - 1
         IF(WGTS(A) .LE. 70.0) GOTO 37
         WGTS(C) = 0.0
         WGTS(A) = 70.0
  37     DO 444 X=C,A
         ADDEMS = ADDEMS + (SALR(X) * WGTS(X))
 444     CONTINUE
         ADDEMS = ADDEMS + SPCADD
         HOLD3 = ADDEMS/70.0
C
CC   NEXT SECTION OF CODE IS IDENTICAL AS THAT FOR SALINITY
CC   COMPUTATIONS FOR RANGES '0 - 170' AND '100 - 170', ONLY
CC   FOR TEMPERATURE.
C
  40     IF(J .EQ. 1) GOTO 10
         B = J - 1
         IF(DT(B) .GE. 99.9) GOTO 41
```

```
      STHLD5 = 1
      GOTO 10
   41 WGTT(B) = 170.0 - WGSUBT
      ADDT = 0.0
      DO 555 K =1,B
      IF((DT(K) .LT. 99.9) .OR. (STATE2 .GT. 3)) GOTO 42
      X = K
      STATE2 = 4
   42 ADDT = ADDT + (TEMPR(K) * WGTT(K))
  555 CONTINUE
      HOLD5 = ADDT/170.0
      IF(X .EQ. B) GOTO 43
      C = X + 1
      WGT100 = ((DT(X) + DT(C))/2) - 100.0
      GOTO 44
   43 G = X - 1
      WGTT(G) = WGSUBT - 100.0
      SPCADD = 0.0
      GOTO 45
   44 SPCADD = TEMPR(X) * WGT100
   45 ADDEMT = 0.0
      IF(X .EQ. B) C = B - 1
      IF(WGTT(B) .LE. 70.0) GOTO 46
      WGTT(C) = 0.0
      WGTT(B) = 70.0
   46 DO 666 X=C,B
      ADDEMT = ADDEMT + (TEMPR(X) * WGTT(X))
  666 CONTINUE
      ADDEMT = ADDEMT + SPCADD
      HOLD6 = ADDEMT/70.0
      GOTO 11
 9876 CONTINUE
      STOP
      END
```