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HYDROGRAPHIC STATION DATA OBTAINED IN THE VICINITY OF
NANTUCKET SHOALS, MAY, JULY, SEPTEMBER 1978

by

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TECHNICAL REPORT

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Abstract

Three cruises were made during May, July, and September 1978, to measure the regional hydrographic structure in the vicinity of Nantucket Shoals on the New England Continental Shelf. A summary of the hydrographic observations made during Cruise NS1, NS2, and NS3 on the R/V EDGERTON is presented in graphic form.

1. Introduction

This report presents preliminary results of three hydrographic cruises made in the Nantucket Shoals region of the New England continental shelf. These cruises are part of a Sea Grant-supported research program designed to: a) measure and document the spatial and temporal structure and variability of the water properties in the Nantucket Shoals/Great South Channel region over one annual cycle, b) conduct a pilot moored current meter array experiment to obtain direct measurements of wind-driven and other subtidal transient currents, and c) synthesize the new hydrographic and current data into an improved circulation scheme for Nantucket Shoals. A total of six hydrographic cruises are planned and three have been completed at approximate intervals of one cruise every two months. The first hydrographic survey, cruise NS1, was conducted May 28-June 2, 1978; the second survey, cruise NS2, on July 15-20, 1978; and the third survey, cruise NS3, on September 14-19, 1978. All three cruises were completed on the MIT 65' converted T-boat, the R/V EDGERTON. CTD stations were taken approximately every five nautical miles along a cruise track which covered the coastal zone between one and fifty nautical miles offshore, and in the general area to the east and south of Cape Cod, Nantucket, and Marthas Vineyard. The cruise tracks for the three cruises are shown in figures 1, 2, and 3, together with station locations, the station numbering scheme, and the regional topography. At station locations where strong tidal currents produced a vertically mixed water column, only a surface water sample was taken. A total of

108 CTD stations were taken on cruise NS1, 120 CTD stations on cruise NS2, and 100 CTD stations on cruise NS3. The CTD data has been edited and analyzed at WHOI and 2 decibar averaged profile data will soon be submitted in GATE format to the National Oceanographic Data Center, Washington, D.C. 20235.

2. Instrumentation

A. CTD

A Plessey model 9040 CTD fish with a Plessey model 8400 digital data logger was used as the profiling instrument on all three cruises.

B. Calibration samples

Salinity samples were obtained during each CTD profile at the surface using a water sample bucket. Deep calibration samples were obtained using standard Nansen bottles at stations where the vertical salinity and temperature gradients were minimal. Surface temperature was measured with a Hewlett-Packard model 2850c quartz crystal temperature sensor. Normally, the CTD profile was begun at a depth of 2 meters, but frequently heavy seas required lowering the CTD fish to a depth of 4 meters before the profile was begun. The procedure was to attach the Nansen bottle 4 m above the CTD fish and lower the instrument to within 5 m of the bottom for a continuous down profile. The CTD fish was then raised until the Nansen bottle was located in a zone of minimal temperature and salinity gradients as estimated from the analog temperature and conductivity downtraces. The winch was stopped and 5 minutes were allowed for the reversing thermometers to equilibrate before the bottle was tripped. The fish was then raised 4 m, the three instrument output frequencies logged, and then the fish was brought back to the surface. The Nansen bottle temperature represents the average of two protected thermometer measurements and has an estimated accuracy of $\pm 0.005^{\circ}\text{C}$.

The salinity of the surface and deep water samples were measured at Woods Hole within a week after each cruise.

C. Navigation

A Northstar 6000 Loran-C instrument was used on each cruise for an estimated position error of ± 1 nautical miles at each station.

3. Data analysis

The raw data tapes were first edited for proper header information and file structure using the WHOI computer program "TIDE". A second test of the structural integrity of the data files was made with program "PLSSY" (written by W. Sass) which transcribes the raw data into CTD format and detects any bad scans which are located in the data files. The data was then processed with program "AAA", a multi-level general CTD processing program written by J. Vermersch. This program can be used to: (1) apply user-specified calibration constants; (2) correct for sensor time lag; (3) compute salinity, sigma-t and other derived variables; (4) edit up to four variables via first-difference or acceptable range methods; and (5) sort the data by pressure to provide a uniform pressure series. The linear corrections determined from the calibration temperature and salinity measurements were not applied to the instrument temperature and conductivity data since the corrections were not significant in relation to the mode of presentation of the data. (The calibration results are discussed in the next section and the mean offsets of the CTD data listed in Table 1.) A time lag of 2.5 scans (.625 sec) was used on all station data from the three cruises. Previous hydrographic data analysis with the Plessy system experienced "spiking" of the salinity data in areas of strong temperature gradients due to the different time constants associated with the conductivity and temperature sensors of the fish. The spiking effects were minimized by the choice of time-lag given above, first difference editing of the data, and by

pressure sorting at two decibar intervals with a least-square technique which gives the "best" value of each measured or computed variable at the center of each two-decibar interval. The two-decibar pressure-sorted data will be submitted in GATE format to NODC and has been used on all subsequent analysis and graphical presentations.

4. Error analysis

Instrumental error in the hydrographic data is related to three possible sources: (a) an offset associated with the instrument calibration and obtained by comparison with the Nansen bottle data, (b) the differential response time associated with the temperature and conductivity sensors in regions of strong vertical gradients, and (c) spurious conductivity spiking not associated with a temperature gradient. Table 1 summarizes the mean offset and standard deviations computed between the Nansen bottle and CTD calibration data. The offsets were calculated at CTD stations where no vertical temperature or salinity gradient was observed when the Nansen bottle was tripped. Plots of offset versus station number showed no recognizable calibration drift. The offsets given in Table 1 are small relative to the mode of presentation of the data, and thus the corrections were not applied to the data.

Vertical profiles and T/S diagrams indicated "spiking" of the salinity data in areas of strong, mid-level temperature gradients due to the different time constants associated with the conductivity and temperature sensors. The spiking effects were minimized by first difference editing of the data and by pressure sorting at two-decibar intervals, but unstable density stratification associated with a salinity spike is still apparent in approximately 1% of the edited data. When these apparent salinity and density errors were observed in the edited data a new salinity was calculated such as to give minimum stability to the density structure. These calculations were applied

Table 1. Calibration Results

	<u>Average Offset</u>	<u>Standard Deviation</u>
NS1		
Temp	+.006°C	.016°C
Salinity	-.001 ‰	.015 ‰
NS2		
Temp	.010°C	.021°C
Salinity	-.015 ‰	.014 ‰
NS3		
Temp	.001°C	.011°C
Salinity	-.004 ‰	.014 ‰

to the graphical data included in this report and were not applied to the edited data.

The third source of error was associated with station 24 on the third cruise in which a salinity spike of .567 ‰ was observed at 90 m with no associated temperature gradient. The spike was evident on a T/S figure and on the raw analogue trace for this station and the cause is not known. This spurious spiking in conductivity was not observed at any other station.

Each cruise lasted approximately five days so the data should be fairly synoptic in time. However, strong tidal currents essentially advect the hydrographic structure about the shoals in an elliptical pattern so there is an inherent noise level in the horizontal structure on the order of the M_2 tidal excursion or 15 km.

5. Data presentation

The hydrographic data taken on the three cruises are presented here in two formats, horizontal sections and T/S diagrams. Horizontal plan view sections of temperature, salinity, and density are presented for each cruise at standard depths 0, 10 m, 20 m, 30 m, 40 m, and the bottom. In general, the profiling instrument was lowered to within 5 m of the bottom and the hydrographic parameters were considered to be equivalent to those at the bottom. Bottom boundary layers in excess of 5 m were frequently observed. The horizontal cross-sections are drawn with contour intervals of 1°C, 2 ‰, and .1 in sigma-t. Vertical sigma-t differences are plotted with solid contour intervals of .5 and dashed contours of .1 and .3. T/S diagrams are shown next for groups of stations along the cruise track. The data begins at 2 m and the symbols are plotted along each line with a frequency of 10 m in depth. At stations over Nantucket Shoals, symbols may be overprinted on each other indicating a vertically well-mixed structure and minimal instrumental noise.

6. Acknowledgments

All three hydrographic cruises were supported by The Department of Commerce, NOAA Office of Sea Grant under Grant #04-7-158-44104 and #04-8-M01-149. R. Beardsley and R. Limeburner from WHOI served as co-chief scientists. Other scientific personnel included J. Vermersch, J. Lillibridge, and D. Ou from WHOI, M. Turner from MIT, P. Kaneta from Stony Brook (SUNY), and Tom Owens from Brookhaven National Laboratory. Brad Butman of the USGS supplied the CTD fish, hydrowinch, and deck unit.

The skill and competence of Howard Ossinger, Captain of the R/V EDGERTON, contributed significantly to the success of the three cruises.

Figure 23. EDGERTON May T/S for Gulf of Maine

Figure 24. EDGERTON May T/S for Nantucket Shoals

Figure 25. EDGERTON May T/S for Nantucket Shoals

NS1021T2.5	□	2.0	12.0
NS1027T2.5	○	0.0	10.0
NS1029T2.5	△	0.0	14.0
NS1043T2.5	△	0.0	80.0
NS1052T2.5	+	2.0	44.0
NS1055T2.5	+	2.0	32.0
NS1077T2.5	X	2.0	34.0
NS1082T2.5	X	0.0	22.0
NS1083T2.5	◇	2.0	22.0
NS1085T2.5	◇	0.0	28.0
NS1086T2.5	+	0.0	28.0
NS1087T2.5	+	0.0	26.0
NS1088T2.5	X	2.0	24.0
NS1090T2.5	X	0.0	12.0
NS1098T2.5	Y	0.0	10.0
NS1099T2.5	Y	2.0	6.0

Figure 26. EDGERTON May T/S for Upwelling Zone

Figure 27. EDGERTON May T/S for Shelf South of Shoals

Figure 28. EDGERTON May T/S for Shelf South of Marthas Vineyard

Figure 48. EDGERTON July T/S for Stations 18-29

Figure 49. EDGERTON July T/S for Stations 30-49

Figure 50. EDGERTON July T/S for Stations 50-70

NS2050T2.5	□	2.0	50.0
NS2051T2.5	○	4.0	54.0
NS2052T2.5	△	2.0	66.0
NS2053T2.5	+	4.0	46.0
NS2054T2.5	X	2.0	42.0
NS2055T2.5	◇	2.0	48.0
NS2056T2.5	♠	2.0	38.0
NS2057T2.5	X	2.0	48.0
NS2058T2.5	Z	4.0	50.0
NS2059T2.5	Y	2.0	48.0
NS2060T2.5	⋈	2.0	34.0
NS2061T2.5	⋈	2.0	32.0
NS2062T2.5	✱	4.0	32.0
NS2063T2.5	✱	4.0	30.0
NS2065T2.5	⋈	2.0	16.0
NS2066T2.5	⋈	0.0	16.0
NS2067T2.5	I	4.0	20.0
NS2068T2.5	I	4.0	20.0
NS2069T2.5	★	2.0	22.0
NS2070T2.5	★	2.0	18.0

Figure 51. EDGERTON July T/S for Stations 71-90

Figure 52. EDGERTON July T/S for Stations 91-110

Figure 53. EDGERTON July T/S for Stations 112-132.

Figure 73. EDGERTON September T/S for Stations 10-30

NS3010T2.5	□	0.0	54.0
NS3011T2.5	○	2.0	12.0
NS3012T2.5	△	0.0	46.0
NS3014T2.5	+	2.0	98.0
NS3016T2.5	◇	2.0	144.0
NS3017T2.5	4	4.0	140.0
NS3018T2.5	X	0.0	140.0
NS3019T2.5	Z	2.0	106.0
NS3020T2.5	Y	2.0	38.0
NS3021T2.5	⋈	0.0	14.0
NS3023T2.5	*	0.0	62.0
NS3025T2.5	Σ	2.0	62.0
NS3026T2.5	Σ	0.0	40.0
NS3028T2.5	I	2.0	8.0
NS3030T2.5	*	2.0	24.0

Figure 74. EDGERTON September T/S for Stations 31-50

Figure 75. EDGERTON September T/s for Stations 51-72

Figure 76. EDGERTON September T/s for Stations 73-107.

NS3073	T2.5	□	2.0	18.0
NS3074	T2.5	○	2.0	24.0
NS3075	T2.5	△	2.0	18.0
NS3076	T2.5	+	2.0	22.0
NS3078	T2.5	×	2.0	34.0
NS3080	T2.5	◇	2.0	32.0
NS3082	T2.5	♠	2.0	42.0
NS3083	T2.5	×	2.0	44.0
NS3084	T2.5	Z	0.0	28.0
NS3085	T2.5	Y	2.0	20.0
NS3086	T2.5	⋈	2.0	20.0
NS3087	T2.5	⋈	2.0	28.0
NS3089	T2.5	✱	2.0	20.0
NS3100	T2.5	✱	2.0	32.0
NS3102	T2.5	⋈	2.0	14.0
NS3103	T2.5	⋈	2.0	18.0
NS3104	T2.5	I	2.0	22.0
NS3105	T2.5	I	2.0	32.0
NS3106	T2.5	✱	2.0	38.0
NS3107	T2.5	✱	2.0	42.0

Figure 77. EDGERTON September T/S for Stations 109-132

March 1979

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