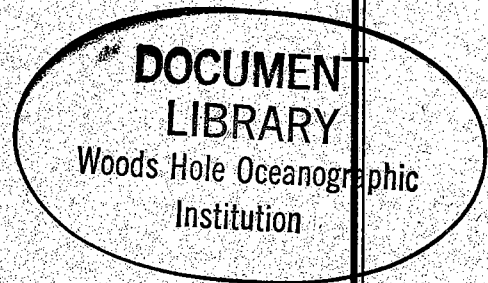


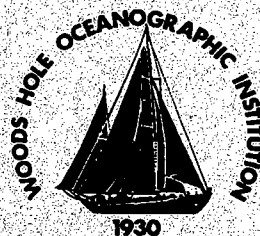
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Woods Hole Oceanographic Institution



Coastal Ocean Processes Inner-Shelf Study: Coastal and Moored Physical Oceanographic Measurements

by

Carol A. Alessi, Steven J. Lentz, and Jay Austin

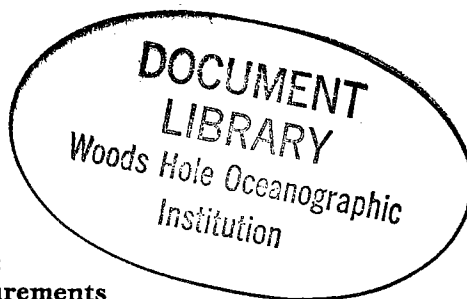
May 1996

Technical Report

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Carol A. Alessi, Steven J. Lentz, and Jay Austin

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

May 1996

Technical Report

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A handwritten signature in cursive script, appearing to read "Philip L. Richardson".

Philip L. Richardson, Chair
Department of Physical Oceanography



Table of Contents

List of Tables	iii
List of Figures	iv
Abstract	vii
1. Introduction	1
2. Description of the Inner-Shelf Arrays	7
2.1 Cross-Shelf Array Design	10
2.1.1 13-m Site	12
2.1.2 20-m Site	15
2.1.3 25-m Site	18
2.2 Along-Shelf Array Design	23
2.3 Data Return	28
2.3.1 13-m Site	28
2.3.2 20-m Site	28
2.3.3 25-m Site	30
2.3.4 Sites DP, N2, S2, and Jetted Pipes	30
2.4 Data Return Timeline	31
Meteorology, Wind and Current	31
Pressure, Conductivity and Salinity	32
Water Temperature	33
3. Instrumentation	34
3.1 VMCM	34
3.1.1 Specifications	35
3.1.2 VMCM Record Format	36
3.2 SeaCat	36
3.2.1 Specifications	37
3.3 VAWR	37
3.3.1 Specifications	40
3.4 SeaGauge	42
3.4.1 Specifications	44
4. Data Processing	45
4.1 VMCM	45
4.1.1 Calibration and Measurement Process	46

4.1.2	Summary of Results	46
4.1.3	13-m Site	47
4.1.4	20-m Site	47
4.1.5	25-m Site	48
4.2	SeaCats	48
4.2.1	Comparison Data Sources and Types	49
4.2.2	Comparison Method	50
4.2.3	Summary of Results	50
4.2.4	FRF Pier	51
4.2.5	13-m Site	51
4.2.6	20-m Site	51
4.2.7	25-m Site	51
4.2.8	North and South 20-m Sites	52
4.3	VAWR	52
4.3.1	Data Sources and Types	53
4.3.2	Summary of Results	54
4.3.3	Wind	55
4.3.4	Air Temperature (AT)	56
4.3.5	Barometric Pressure (BP)	56
4.3.6	Relative Humidity (RH)	57
4.3.7	Water Temperature (WT)	57
4.4	SeaGauges	57
4.4.1	Summary of Results	58
4.4.2	Conductivity	58
4.5	NOS Sea Level Data	59
4.6	NDBC Coastal Wind Stations	60
5.	Description of Data Presentation	61
6.	Statistics	62
7.	Acknowledgments	67
8.	References	67
9.	Data Presentation	69
Appendix 1:	Cruise Chronology	117
	Deployment Cruise Log EN-249	117
	Recovery Cruise Log EN-258	124
Appendix 2:	Data from Service Argos	129
Appendix 3:	Wind Direction Comparison Tests	133
Appendix 4:	CoOP Inner-Shelf Study Mooring Deployment Procedures	136

List of Tables

Table 1.	Principal Investigators	2
Table 2.	Station Information	9
Table 3.	Cross-Shelf Array Instrumentation Summary	20
Table 4.	Along-Shelf Array Instrumentation Summary	27
Table 5.	Intermittent Time Periods for Velocity: D2 at 11.5 m	29
Table 6.	VMCM Specifications	35
Table 7.	SeaCat Specifications	37
Table 8.	VAWR Specifications	40
Table 9.	SeaGauge Specifications	44
Table 10.	Meteorological Comparison Results	55
Table 11.	Bottom Pressure Anchor Shifts	58
Table 12.	NOS Tide Gauge Stations	59
Table 13.	NDBC Coastal Wind and C-MAN Stations	60
Table 14.	NDBC Operational Specifications	60
Table 15.	Hourly Averaged Statistics for:	
	Cross-Shelf and Along-Shelf Wind	62
	Atmospheric Pressure	62
	Air and Surface Water Temperature	62
	Relative Humidity and Long-Wave Insolation	62
	Short-Wave Insolation	63
	Bottom Pressure and Sea Level	63
	Conductivity	63
	Salinity, and Sigma-Theta	64
	Cross-Shelf and Along-Shelf Velocity	65
	Water Temperature	66
Table A1.1	CTD Transects	122
Table A1.2	Mooring Deployment and Recovery Information	128

List of Figures

Figure 1.	Cartoon showing various regions of the shelf	3
Figure 2a.	Temperature/Salinity transects near Duck, NC	4
Figure 2b.	Temperature/Salinity transects during CoOP, August 1994	5
Figure 2c.	Temperature/Salinity transects during CoOP, October 1994	6
Figure 3.	Location Map of the Moored Array Site	8
Figure 4.	Schematic showing planned layout of moorings and tripods	10
Figure 5.	Schematic of Cross-Shelf Array	11
Figure 6.	13 m Surface Mooring Diagram (Site D1)	12
Figure 7.	13 m Subsurface Mooring Diagram (Site D1)	13
Figure 8.	20 m Surface Mooring Diagram (Site D2)	16
Figure 9.	20 m Subsurface Mooring Diagram (Site D2)	17
Figure 10.	25 m Surface Mooring Diagram (Site D3)	18
Figure 11.	25 m Subsurface Mooring Diagram (Site D3)	19
Figure 12.	SeaCat Mooring Diagram (Sites N2, S2)	24
Figure 13.	SeaGauge Mooring Diagram (Sites N2, D2, S2)	25
Figure 14.	Schematic of Along-Shelf Array	26
Figure 15.	Data Return Timeline: Meteorology, Wind and Current ...	31
Figure 16.	Data Return Timeline: Pressure, Conductivity, and Salinity	32
Figure 17.	Data Return Timeline: Water Temperature	33
Figure 18.	Photograph of VMCMs after recovery	35
Figure 19a.	Schematic of Discus Buoy and Meteorology Sensors	39
Figure 19b.	VAWR sensor averaging periods	41
Figure 20.	Drawing of a SeaGauge mounted on jetted pipes	43
Figure 21.	Photograph of SeaGauges mounted on anchors	43

List of Figures (continued)

Figure 22.	Composite vector plots of the hourly averaged winds	69
Figures 23–24.	Composite stacked line plots of the hourly averaged wind components	70
Figure 25.	Time series of the 20-m VAWR hourly averaged atmospheric pressure, air temperature, relative humidity, long-wave and short-wave radiation	72
Figure 26.	Time series of air temperature at the meteorological sites ..	73
Figure 27.	Time series of atmospheric pressure at the meteorological sites	74
Figure 28.	Time series of surface water temperature at the meteorological sites	75
Figures 29–31.	Time series of the hourly averaged atmospheric pressure, bottom pressure, and sea level pressure	76
Figure 32.	Composite vector plots of the hourly averaged currents	80
Figures 33–34.	Composite stacked line plots of the hourly averaged current components	82
Figures 35–39.	Composite stacked plots of the hourly averaged individual salinity time series records	86
Figures 40–44.	Composite stacked plots of the hourly averaged individual conductivity time series records	91
Figures 45–49.	Composite stacked plots of the hourly averaged individual water temperature time series records	96
Figures 50–53.	Individual time series of the hourly averaged current components and water temperature, in the form of vector and line plots for each VMCM depth at site D1	101
Figures 54–59.	Individual time series of the hourly averaged current components and water temperature, in the form of vector and line plots for each VMCM depth at site D2	105

List of Figures (continued)

Figures 60–65.	Individual time series of the hourly averaged current components and water temperature, in the form of vector and line plots for each VMCM depth at site D3	111
Figure A2.1	Argos data obtained from 20 m VAWR	130
Figure A2.2	Recorded data from 20 m VAWR	131
Figure A2.3	Argos data obtained from 25 m VAWR	132
Figure A3.1	Spin-test results for the 20 m VAWR direction sensor	134
Figure A3.2	Spin-test results for the 25 m VAWR direction sensor	135
Figure A4.1	25 m Discus Deployment Example	138
Figure A4.2	25 m Discus Anchor Deployment	139
Figure A4.3	CoOP inner-shelf <i>R/V Endeavor</i> Fantail Layout	140
Figure A4.4	Stern View 25 m Instrument Lowering	141
Figure A4.5	Starboard View 25 m Instrument Lowering	142

Abstract

To improve our understanding of the physical and biological processes influencing planktonic larval distributions over the inner shelf, an interdisciplinary field program funded by the National Science Foundation's Coastal Ocean Processes program (CoOP) was conducted near Duck, North Carolina in the southern portion of the Middle Atlantic Bight. The field program took place from August to December, 1994 and included both moored and shipboard measurements of physical, biological and sedimentological variables.

This report summarizes the observations from one component of this field program, a moored array of physical oceanographic and meteorological instruments. This component of the field program consisted of a cross-shelf array of three surface/subsurface mooring pairs in 13 m, 20 m and 25 m of water supporting instruments to measure currents, temperature and conductivity, a suite of meteorological instruments on surface buoys at the 20 -m and 25 -m site, and an along-shelf array of temperature, conductivity and bottom pressure sensors mounted on jetted pipes along the 5-m isobath and on moorings along the 20-m isobath. The report includes descriptions of the cross-shelf and along-shelf arrays, the four types of instruments used (VAWRs, VMCMs, SeaCats, and SeaGauges), and the data return from the field program. Statistical and graphical summaries of the atmospheric (wind, air temperature, barometric pressure, relative humidity, short- and long-wave radiation), and oceanic (current, water temperature, conductivity and bottom pressure) measurements are presented.

1. Introduction

To improve our understanding of the physical and biological processes influencing planktonic larval distributions over the inner-shelf, an interdisciplinary field program funded by the National Science Foundation's Coastal Ocean Processes program (CoOP) was conducted in the southern portion of the Middle Atlantic Bight. Past studies of the relationships between physical processes and larval settlement have been hindered by limitations in measuring changes in planktonic larval distributions on the same time and space scales as the physics (Butman, 1987; Levin, 1990; GLOBEC, 1988, 1991a,b,c). Therefore this field program included two complementary observational approaches: deployment of a fixed array of biological and physical instruments, and detailed shipboard surveys of the region acquiring both biological and physical measurements. This study (referred to as the CoOP inner-shelf study in the remainder of this report) was planned and conducted by a group of seven principal investigators from five institutions representing the disciplines of biology, geology, and physical oceanography. The principal investigators and their technical responsibilities are listed in Table 1.

The CoOP inner-shelf field program was conducted on the North Carolina shelf between Chesapeake Bay and Oregon Inlet, focusing on the inner-shelf near Duck, from August to December 1994. The inner-shelf is defined as the portion of the continental shelf shoreward of where the surface and bottom boundary layers interact (about three surface Ekman layer depths, Mitchum and Clarke, 1986) and seaward of the surf zone, spanning water depths of roughly 5–30 m (Figure 1). The inner-shelf is most studied at its shoreward (surf zone) and seaward (traditional shelf studies) boundaries, with far fewer measurements in the depth range of 4 to 15 m.

In the CoOP inner-shelf field program the observations were concentrated between the 4-m and 25-m isobaths. The site near Duck was chosen for its relatively simple, straight shoreline and parallel isobaths which may minimize biological, hydrodynamical and sedimentological variation in the along-shelf direction. There were two intensive study periods representative of strong (August) and weak (October) stratification (Figure 2a, from Boicourt, 1973), when most of the shipboard surveys and the fixed array biological and bottom boundary layer measurements were made. Figure 2b shows two sections collected during the CoOP inner-shelf field program from the *R/V Cape Hatteras* during August 1994, representative of strong stratification, and Figure 2c shows data collected during October 1994, a period of weak stratification. The fixed array physical oceanography measurements spanned the intervening month of September to provide continuity between the two intensive study periods.

This report focuses on one component of the interdisciplinary CoOP inner-shelf field program, a moored array of physical oceanographic and meteorological instruments. This

component of the field program consisted of a cross-shelf array of three surface/subsurface mooring pairs in 13, 20, and 25 m of water supporting instruments to measure currents, temperature and conductivity, a suite of meteorological instruments on surface buoys at the 20-m and 25-m site, and an along-shelf array of temperature, conductivity and bottom pressure sensors mounted on jetted pipes roughly along the 6-m isobath and on moorings along the 20-m isobath. The other major physical oceanographic components of the CoOP inner-shelf field program were an array of nearshore moorings and extensive shipboard hydrographic surveys (Table 1).

Table 1: Principal Investigators and Technical Responsibilities

<u>Physical Oceanography</u>		
S. J. Lentz	WHOI	Acquisition and analysis of the current, temperature, and conductivity measurements on the 13, 20, and 25 m moorings, and for the alongshelf array of bottom pressure/temperature/conductivity measurements.
J. Largier	SIO	Large-scale CTD surveys, anchor stations, and small boat CTD surveys.
R. T. Guza	SIO	All aspects of the current meters, pressure sensors, and thermistors in 8 m and shallower locations.
<u>Biological Oceanography</u>		
C. A. Butman	WHOI	Moored larval pumps and colonization tray.
A. L. Shanks	UO	Shipboard and pier larval pump sampling and beach surveys.
<u>Geological Oceanography and Ocean Engineering</u>		
L. D. Wright	VIMS	Bottom-boundary-layer instrumentation systems (tetrapods), and conducting surveys of bottom and substrate characteristics (e.g., side-scan sonar, coring, bottom photography, etc.)
O. S. Madsen	MIT	Modeling of wave current boundary layers.

Notes:

WHOI: Woods Hole Oceanographic Institution SIO: Scripps Institution of Oceanography
 MIT: Massachusetts Institute of Technology VIMS: Virginia Institute of Marine Science
 UO: University of Oregon

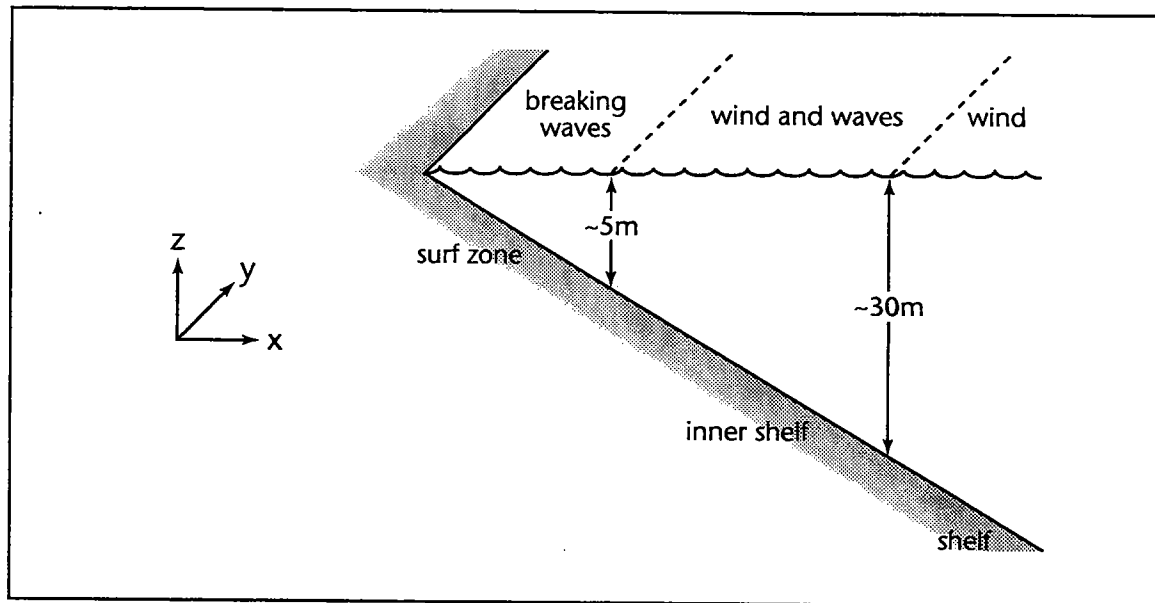


Figure 1: Cartoon showing various regions of the shelf and the principal driving forces of the flows in those regions. The coordinate system used is also shown.

The scientific objectives of the physical oceanographic component include determining:

- the role of the wind stress, waves, and pressure gradients in the along-shelf momentum balance as a function of cross-shelf position;
- the processes influencing the vertical and cross-shelf structure of the cross-shelf velocity field; and
- the processes influencing the temporal evolution and vertical and cross-shelf structure of the density field.

The objective of this report is to present statistical and graphical summaries of data from the physical oceanography component of the CoOP inner-shelf study. This includes the 13-m, 20-m, and 25-m mooring sites and the along-shelf array of temperature, conductivity and bottom pressure instruments. This report is organized in the following way:

- Section 2 gives a description of the cross-shelf and along-shelf array design, the placement of instruments at the various measurement sites, associated data return, and problems affecting the data return.

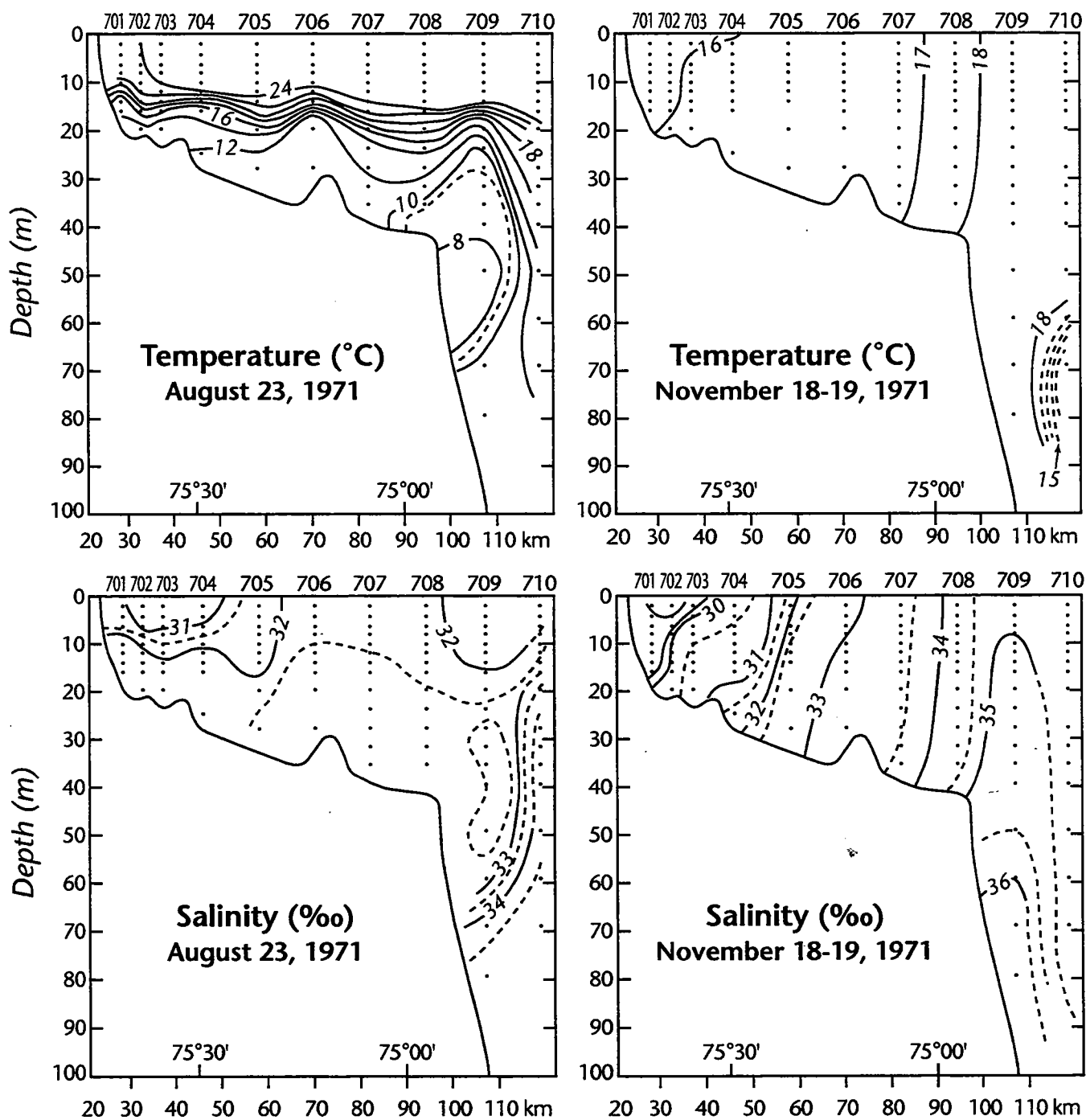


Figure 2a: Temperature/Salinity transects near Duck, NC (Boicourt, 1973) showing the temperature and salinity structure out to 120 km offshore.

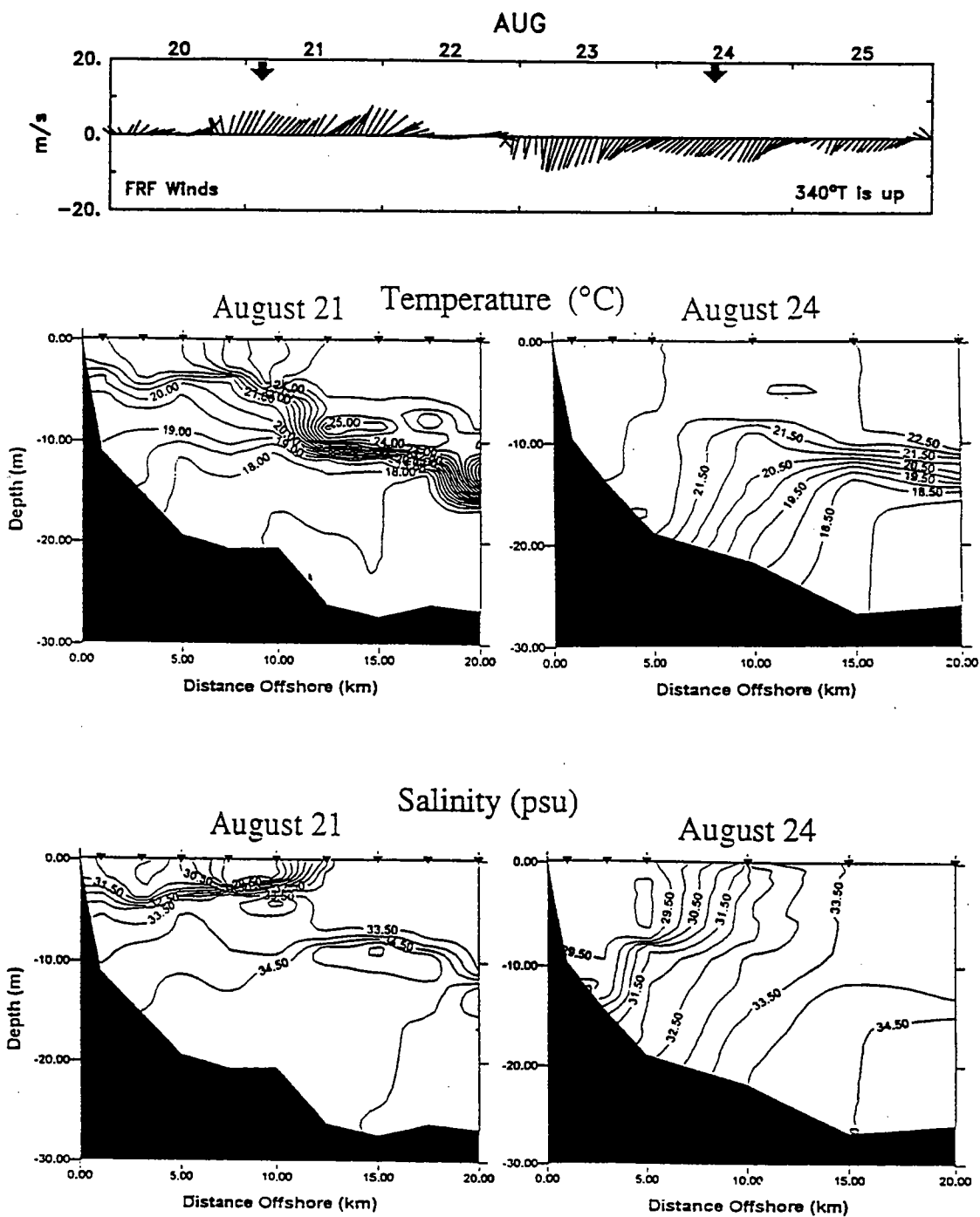


Figure 2b: Temperature/Salinity sections out to 20 km along the central line from shipboard surveys taken on August 21 (lefthand figures) and August 24 (righthand figures). For reference, a time series of wind vectors from the FRF pier is shown at the top. A vector toward the top of the page indicates alongshore winds toward 340°T. Bold arrows indicate when sections were taken.

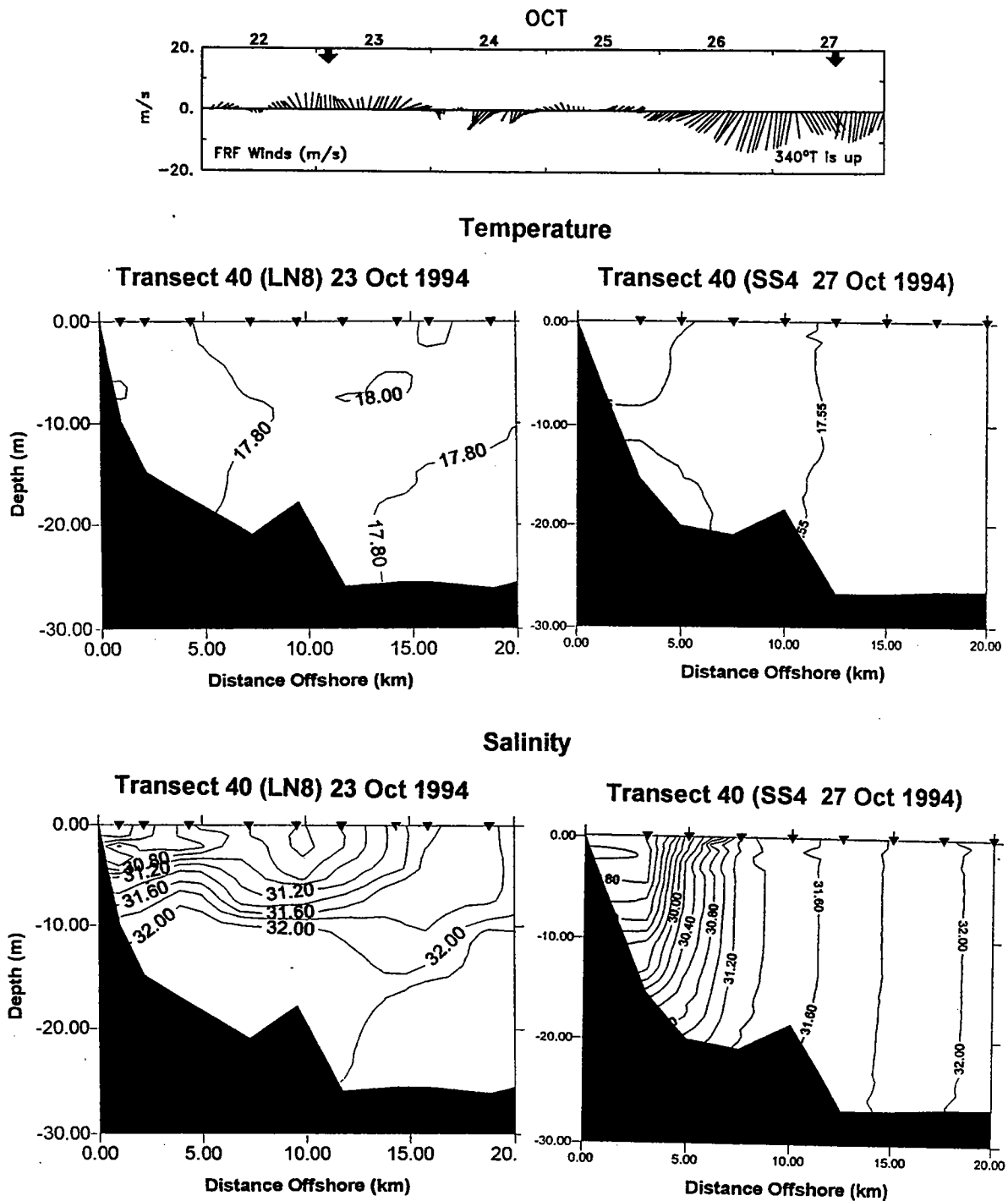


Figure 2c: Temperature/Salinity sections out to 20 km along the central line from shipboard surveys taken on October 23 and October 27. For reference, a time series of wind vectors from the FRF pier is shown at the top. Bold arrows indicate when sections were taken.

- Section 3 gives a description of the four types of instruments used in the WHOI physical oceanography cross-shelf and along-shelf arrays including accuracy specifications.
- Section 4 describes general processing of the data including the coordinate system used, and a description of the meteorological and oceanic data analysis procedures. This includes comparisons made with other instruments collecting the same type of data to detect any systematic errors.
- Section 5 contains a description of the time series data presentation.
- The basic statistics of the hourly-averaged data covering the entire time period for each record are presented in Section 6.
- Time series plots for each instrument are presented in Section 9. This includes the coastal and moored meteorological measurements, moored velocity measurements, and the temperature, conductivity, and salinity measurements.

2. Description of the Inner-Shelf Arrays

The focal point of the physical oceanographic component of the CoOP inner-shelf study was a cross-shelf three-element array of surface/subsurface mooring pairs measuring winds, currents, temperature, and conductivity (discussed in Section 2.1), and an along-shelf array of temperature, conductivity, and bottom pressure sensors mounted on jetted pipes along the shore and deeper sensors mounted on surface moorings (Section 2.2). A location map of the cross-shelf moored array sites is shown in Figure 3 along with the sea level and coastal wind stations and the along-shelf array. The U.S. Army Corps of Engineers CERC Field Research Facility (FRF) is located at Duck. Collaboration with FRF allowed access to supplementary data on winds, waves, inshore currents, and accurate bathymetric surveys. Listed in Table 2 are the locations of various sites, abbreviated station names, water depths, and positions.

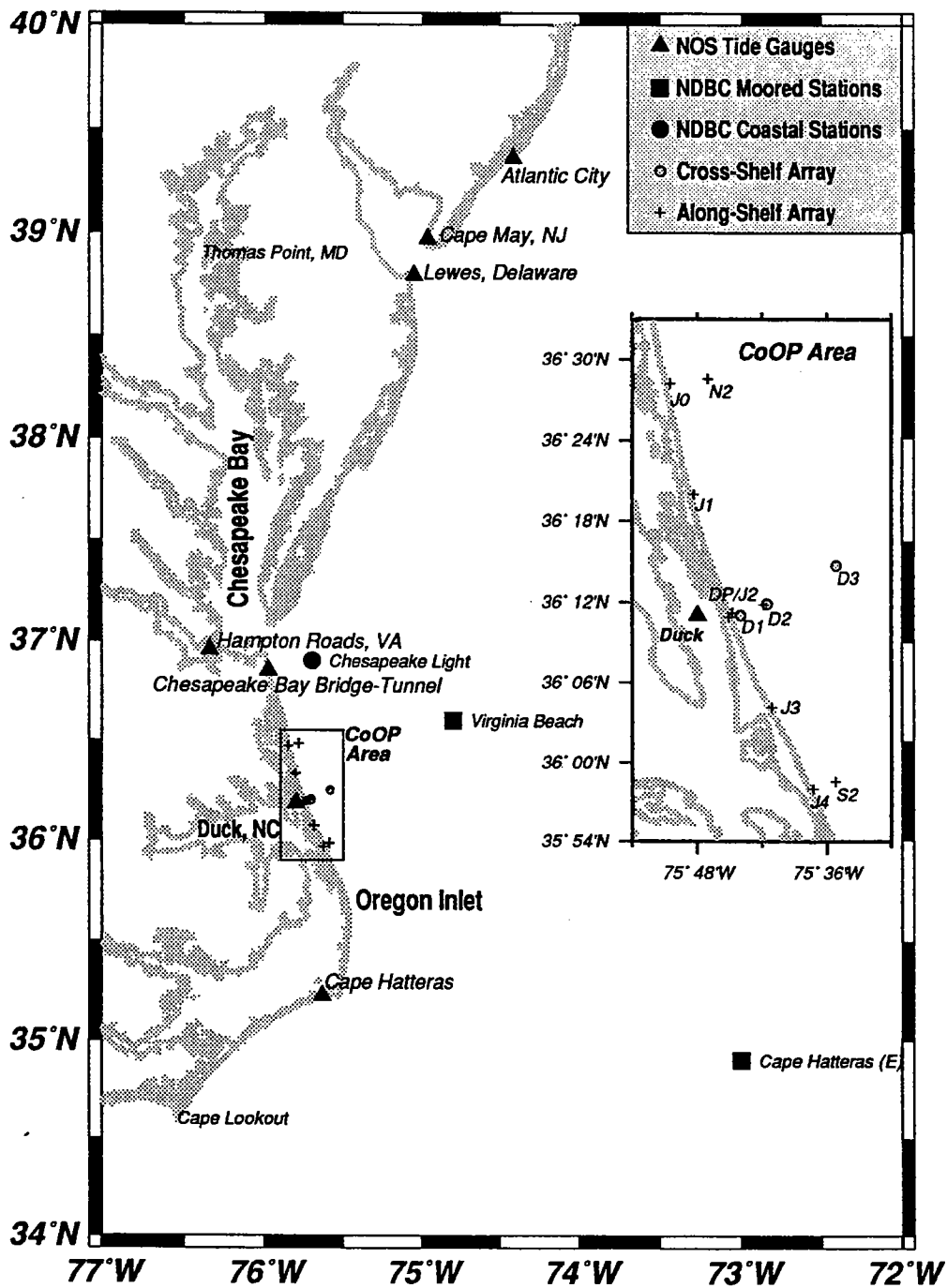


Figure 3: Location Map of the cross- and along-shelf array sites, sea level and coastal wind stations. The inset shows the cross-shelf mooring pairs deployed along the central-line, perpendicular to the coast near Duck (labelled D1, D2 and D3), and the bottom pressure sites (labelled J0, J1, J2, J3, and J4). The FRF pier (located at Duck) extends 500m offshore.

